

X20 system

User's Manual

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1 General information

1.1 Manual history

| Version | Date | Comment ¹⁾ |
|---------|--------------|---|
| 3.60 | April 2020 | <p>Updated book.</p> <ul style="list-style-type: none"> • Updated data sheets. • Section "Mechanical and electrical configuration" <ul style="list-style-type: none"> ◦ Changed accessories under "Installation with increased vibration requirements". ◦ Changed section "Safe cutoff of a potential group". • Section "Mechanical handling" <ul style="list-style-type: none"> ◦ Added "Labeling options for the X20 system" • Section "International standards and certifications" <ul style="list-style-type: none"> ◦ Added certification "KR" and removed "GOST-R". • Section "Accessories" <ul style="list-style-type: none"> ◦ Added accessory "Cover for interface modules". • Section "Additional information" <ul style="list-style-type: none"> ◦ Added "NetTime". <p>Updated existing module groups.</p> <ul style="list-style-type: none"> • CPUs • Analog input modules • Digital output modules • Motor controllers • Other functions |
| 3.50 | October 2018 | <p>Updated book.</p> <ul style="list-style-type: none"> • Updated data sheets. <ul style="list-style-type: none"> ◦ Added missing freewheeling diodes in connection examples for DO modules. • Section "Mechanical and electrical configuration" <ul style="list-style-type: none"> ◦ Added oblique and horizontal installation under "Installation". ◦ Revised "Safe cutoff". ◦ Revised "Calculating the power balance". ◦ Added "Dimensioning the external 24 VDC power supply". • Section "Additional information" <ul style="list-style-type: none"> ◦ Added "Using I/O modules on the bus controller". ◦ Updated "General CPU data points". ◦ Added "Blackout mode". <p>Updated existing module groups.</p> <ul style="list-style-type: none"> • Other functions • reACTION Technology |
| 3.40 | October 2017 | <p>Updated book.</p> <ul style="list-style-type: none"> • Updated data sheets. • Section "System characteristics" <ul style="list-style-type: none"> ◦ Updated X20 CPUs. • Section "Mechanical and electrical configuration" <ul style="list-style-type: none"> ◦ Revised "Safe cutoff". ◦ Revised "Calculating the power balance". • Section "Accessories" <ul style="list-style-type: none"> ◦ New accessories: "End clamp set" and "shield connection clamp" ◦ Update cable descriptions. • Section "Additional information" <ul style="list-style-type: none"> ◦ Added "General CPU data points". <p>New module groups</p> <ul style="list-style-type: none"> • Compact-S CPUs • Compact-S CPUs - System modules <p>Updated existing module groups.</p> |

General information

| Version | Date | Comment ¹⁾ |
|---------|---------------|---|
| | | <ul style="list-style-type: none"> • Bus controller • Bus receivers and bus transmitters • Other functions • Added new coated modules. |
| 3.35 | October 2016 | <p>Updated book.</p> <ul style="list-style-type: none"> • Revised and updated section "Standards and certifications". <ul style="list-style-type: none"> ◦ Added detailed overview of standards and testing requirements. ◦ Added links to certificates on B&R website. ◦ Added "Applicable standards" for individual certifications. • Updated names of standards throughout book. <p>Updated existing module groups.</p> <ul style="list-style-type: none"> • Added new coated modules. |
| 3.30 | August 2016 | <p>Updated book.</p> <ul style="list-style-type: none"> • Updated data sheets. • Modified section structure. <ul style="list-style-type: none"> ◦ Added separate section "Safety guidelines" after "General information". ◦ Moved all data sheets after section "Standards and certifications". ◦ Combined module overviews into one section and removed section "Coated modules". ◦ Added new section "Additional information" after section "Data sheets". ◦ Removed order number index, index and appendices. • Added, updated and moved content. <ul style="list-style-type: none"> ◦ Moved section "General information - Abbreviations" from appendix. ◦ Added new section "System characteristics - Unique terminal numbering". ◦ Added new section "Mechanical and electrical configuration - Installation with increased vibration requirements". ◦ Updated section "Mechanical and electrical configuration - Shielding". ◦ Moved section "Module overview - Overview of B&R ID codes" from appendix. ◦ Renamed "re LEDs" and moved along with "General data points" to section "Additional information". <p>Updated existing module groups.</p> <ul style="list-style-type: none"> • Bus controller • reACTION Technology • Temperature modules |
| 3.20 | February 2016 | <p>Updated book.</p> <ul style="list-style-type: none"> • Harmonized formatting. • Added and updated content. <ul style="list-style-type: none"> ◦ Section "General information - Connecting/Disconnecting IF modules" ◦ Section "System characteristics - re LEDs" ◦ Section "Mechanical and electrical configuration - Safe cutoff" ◦ Section "X20 system modules - Data point information" ◦ Section "Standards and certifications - Certifications" • Combined coated and non-coated modules into one document. • Modified section "Coated modules". • Revised section overviews "X20 system modules" and "Coated modules". <p>Updated existing module groups.</p> <ul style="list-style-type: none"> • Analog input modules • Digital input modules • Digital signal processor modules • Other modules • Temperature modules <p>New module group "reACTION Technology"</p> |
| 3.10 | May 2015 | <p>Updated book.</p> <p>Updated existing module groups.</p> <ul style="list-style-type: none"> • Counter modules • Motor modules • Communication in the X20 electronics module • Digital signal processor modules <p>Updated section "Coated modules".</p> |

| Version | Date | Comment ¹⁾ |
|---------|--------------|---|
| 3.00 | October 2014 | <p>New edition</p> <ul style="list-style-type: none"> Revised all sections. Added register description for each module. <p>The following module groups are still being revised and have not yet been added to the manual, or they contain some modules that are not yet fully completed:</p> <ul style="list-style-type: none"> Analog input modules Digital signal processor modules Communication in the X20 electronics module Motor modules Other modules Temperature modules Counter modules <p>Current data sheets of affected modules can be downloaded from the website.</p> |
| 2.10 | March 2009 | <p>Updated book.</p> <p>Added new module groups.</p> <ul style="list-style-type: none"> Expandable bus controller Expandable bus controller system modules X20 hub system System modules of the X20 hub system X20 redundancy system System modules of the X20 redundancy system <p>Updated existing module groups.</p> <ul style="list-style-type: none"> Compact CPU system modules Fieldbus CPU system modules Bus controller system modules Communication in the X20 electronics module Bus transmitter Bus controller Digital input modules Digital output modules Analog input modules Temperature modules Other modules Counter modules <p>Updated accessories. New: Appendix B "B&R ID codes"</p> |
| 2.00 | July 2007 | <p>Updated book.</p> <p>Added new module groups.</p> <ul style="list-style-type: none"> CPUs Compact CPUs Compact CPU system modules Fieldbus CPUs Fieldbus CPU system modules Communication in the X20 IF module Communication in the X20 electronics module Digital mixed modules Other modules <p>Updated existing module groups.</p> <ul style="list-style-type: none"> Bus modules Terminal blocks Bus controller Power supply modules Digital input modules Digital output modules Analog input modules Counter modules <p>Updated accessories.</p> |
| 1.20 | June 2006 | First edition |

1) Column "Comment" contains only the most important changes in this user's manual. Several updates, corrections and format variations are not included.

1.2 Introduction

Programmable logic controllers, operating/monitoring devices (e.g. industrial PCs, Power Panels, Mobile Panels, etc.) as well as uninterruptible power supplies have all been designed, developed and manufactured by B&R for conventional use or for use with increased safety requirements (safety technology) in industry. They were not designed, developed and manufactured for any use involving serious risks or hazards that could lead to death, injury, serious physical damage or loss of any kind without the implementation of exceptionally stringent safety precautions. In particular, such risks and hazards include the use of these devices to monitor nuclear reactions in nuclear power plants, their use in flight control or flight safety systems as well as in the control of mass transportation systems, medical life support systems or weapons systems.

When using programmable logic controllers or operating/monitoring devices as control systems together with a Soft PLC (e.g. B&R Automation Runtime or comparable product) or Slot PLC (e.g. B&R LS251 comparable product), safety precautions relevant to industrial control systems (e.g. the provision of safety devices such as emergency stop circuits, etc.) must be observed in accordance with applicable national and international regulations. The same applies for all other devices connected to the system, e.g. drives.

All tasks such as the installation, commissioning and servicing of devices are only permitted to be carried out by qualified personnel. Qualified personnel are those familiar with the transport, mounting, installation, commissioning and operation of devices who also have the appropriate qualifications (e.g. IEC 60364-1). National accident prevention regulations must be observed.

The safety notices, connection descriptions (type plate and documentation) and limit values listed in the technical data are to be read carefully before installation and commissioning and must be observed.

1.3 Intended use

Electronic devices are never completely failsafe. If the programmable logic controller, operating/monitoring device or uninterruptible power supply fails, the user is responsible for ensuring that other connected devices such as motors are brought to a safe state.

Modules from B&R are designed as "open equipment" (EN 61131-2) and "open type equipment" (UL). They are therefore designated for installation in an enclosed control cabinet. In all cases, it is necessary to observe and comply with all applicable national and international standards and guidelines, such as machinery directive 2006/42/EC.

1.4 Transport and storage

During transport and storage, devices must be protected against undue stress (mechanical loads, temperature, moisture, corrosive atmospheres, etc.).

Devices contain components sensitive to electrostatic charges that can be damaged by improper handling. It is therefore necessary to provide the required protective measures against electrostatic discharge when installing or removing these devices (see "[Protection against electrostatic discharges](#)" on page 20).

1.5 Mounting orientation

- Installation must be performed according to this documentation using suitable equipment and tools.
- Devices are only permitted to be installed by qualified personnel without voltage applied.
- General safety guidelines and national accident prevention regulations must be observed.
- Electrical installation must be carried out in accordance with applicable guidelines (e.g. line cross sections, fuses, protective ground connections).
- Take the necessary steps to protect against electrostatic discharges (see "[Protection against electrostatic discharges](#)" on page 20).

1.5.1 Inserting and removing I/O modules while the controller is running

I/O modules may be connected and disconnected while the controller is running under the following conditions:

- Connectors are not allowed to carry voltages and must be removed.
- Replacing a module during operation must be supported by the software; otherwise, disconnecting a module will cause an emergency stop of the controller.

1.5.2 Connecting/Disconnecting IF modules while the controller is running

Unlike I/O modules, IF module CANNOT be connected or disconnected while the controller is running.

Warning!

IF modules that are connected or disconnected while the controller is running are not recognized by the CPU or bus controller and will cause the application to behave incorrectly.

1.6 Operation

1.6.1 Protection against touching electrical parts

Danger!

In order to operate programmable logic controllers, operating and monitoring devices and the uninterruptible power supply, it is necessary for certain components to carry dangerous voltages. Touching one of these components can result in a life-threatening electric shock. There is a risk of death, serious injury or damage to property.

Before switching on the programmable logic controllers, operating and monitoring devices and uninterruptible power supply, it must be ensured that the housing is properly connected to ground potential (PE rail). The ground connection must also be made if the operating and monitoring device and uninterruptible power supply are only connected for testing purposes or only operated for a short time!

Before switching on the device, all voltage-carrying components must be securely covered. During operation, all covers must remain closed.

1.7 Environmentally friendly disposal

All B&R control components are designed to inflict as little harm on the environment as possible.

1.7.1 Separation of materials

It is necessary to separate different materials so the device can undergo an environmentally friendly recycling process.

| Component | Disposal |
|---------------------------|---------------------------|
| X20 modules Cables | Electronic recycling |
| Cardboard/paper packaging | Paper/Cardboard recycling |

Table 1: Environmentally friendly separation of materials

Disposal must comply with applicable legal regulations.

1.8 Terminology

| Term | Description |
|------|--|
| SG3 | <p>System Generation 3 (SG3) - CPUs with Motorola processors</p> <p>The following CPUs belong to this series:</p> <ul style="list-style-type: none"> • IF161, IP161 • XP152 • CP100, CP104, CP152, CP153, CP200, CP210, CP260, CP430, CP470, CP474, CP476, CP770, CP774 • PP15, PP21, PP35, PP41 |
| SG4 | <p>System Generation 4 (SG4) - CPUs with Intel processors</p> <p>The following CPUs belong to this series:</p> <ul style="list-style-type: none"> • CP1583, CP1584, CP1585, CP1586, CP3583, CP3584, CP3585, CP3586 • CP1483, CP1483-1 • CP340, CP360, CP380, CP382, CP570 • PP45, PP65 • PP100/200, PP300/400 • MP100/200 • EC20, EC21 • AC140, AC141 • ARsim, ARwin, ARemb • APC620, APC700, APC810 |
| SGC | <p>System Generation Compact CPUs (SGC) - CPUs with Motorola processors (embedded μP)</p> <p>The following CPUs belong to this series:</p> <ul style="list-style-type: none"> • CP0201, CP0291, CP0292 • XC0201, XC0202, XC0292 |

1.9 Abbreviations

The following abbreviations appear throughout the user's manual, for example in data tables or descriptions of pinouts.

| Abbreviation | Stands for | Description |
|--------------|-----------------|---|
| NC | Normally closed | Normally closed relay contact. |
| | Not connected | Used in pinout descriptions if a terminal or pin is not connected to a module. |
| ND | Not defined | In data tables, this stands for a value that has not been defined. This may be because a cable manufacturer does not provide certain technical data, for example. |
| NO | Normally open | Normally open relay contact. |
| TBD | To be defined | Used in technical data tables when certain information is not yet available. The value will be provided later. |

2 Safety guidelines

2.1 Organization of notices

Safety notices

Contain **only** information that warns of dangerous functions or situations.

| Signal word | Description |
|-----------------|---|
| Danger! | Failure to observe these safety guidelines and notices will result in death, severe injury or substantial damage to property. |
| Warning! | Failure to observe these safety guidelines and notices can result in death, severe injury or substantial damage to property. |
| Caution! | Failure to observe these safety guidelines and notices can result in minor injury or damage to property. |
| Notice! | Failure to observe these safety guidelines and notices can result in damage to property. |

General notices

Contain **useful** information for users and instructions for avoiding malfunctions.

| Signal word | Description |
|---------------------|--|
| Information: | Useful information, application tips and instructions for avoiding malfunctions. |

2.2 Protection against electrostatic discharges

Electrical components that can be damaged by ESD (**E**lectro**S**tatic **D**ischarges) must be handled properly.

2.2.1 Packaging

- Electrical components with a housing
...do not require special ESD packaging but must be handled properly (see "[Electrical components with a housing](#)" on page 21).
- Electrical components without a housing
...are protected by ESD-suitable packaging.

2.2.2 Guidelines for proper ESD handling

Electrical components with a housing

- Do not touch the male connector contacts on the device (bus data contacts).
- Do not touch the male connector contacts on connected cables
- Do not touch the contact tips on circuit boards

Electrical components without a housing

The following points apply in addition to the points listed under "Electrical components with a housing":

- Any persons handling electrical components or devices with installed electrical components must be grounded.
- Components are only permitted to be touched on their narrow sides or front plate.
- Components must always be placed on or stored in a suitable medium (ESD packaging, conductive foam, etc.).

Information:

Metallic surfaces are not suitable storage surfaces.

- Components must not be subjected to electrostatic discharge (e.g. caused by charged plastics).
- Observe a minimum distance of 10 cm from monitors and television sets.
- Measuring instruments and equipment must be grounded.
- Probe tips of galvanically isolated measuring instruments must be temporarily discharged on suitably grounded surfaces before taking measurements.

Individual components

- ESD protective measures for individual components are thoroughly implemented at B&R (conductive floors, footwear, arm bands, etc.).
- Increased ESD protective measures for individual components are not required for handling B&R products at customer locations.

3 System features

3.1 Setting the standards in automation

There are many different I/O slice systems. With the X20 system, B&R continues to set standards according to its motto "Perfection in Automation". Born from experience gained from applications all over the world, numerous conversations with customers and with the aim for easier, more economical and secure usage, the X20 system is a universal solution for any automated task in machine and system manufacturing.

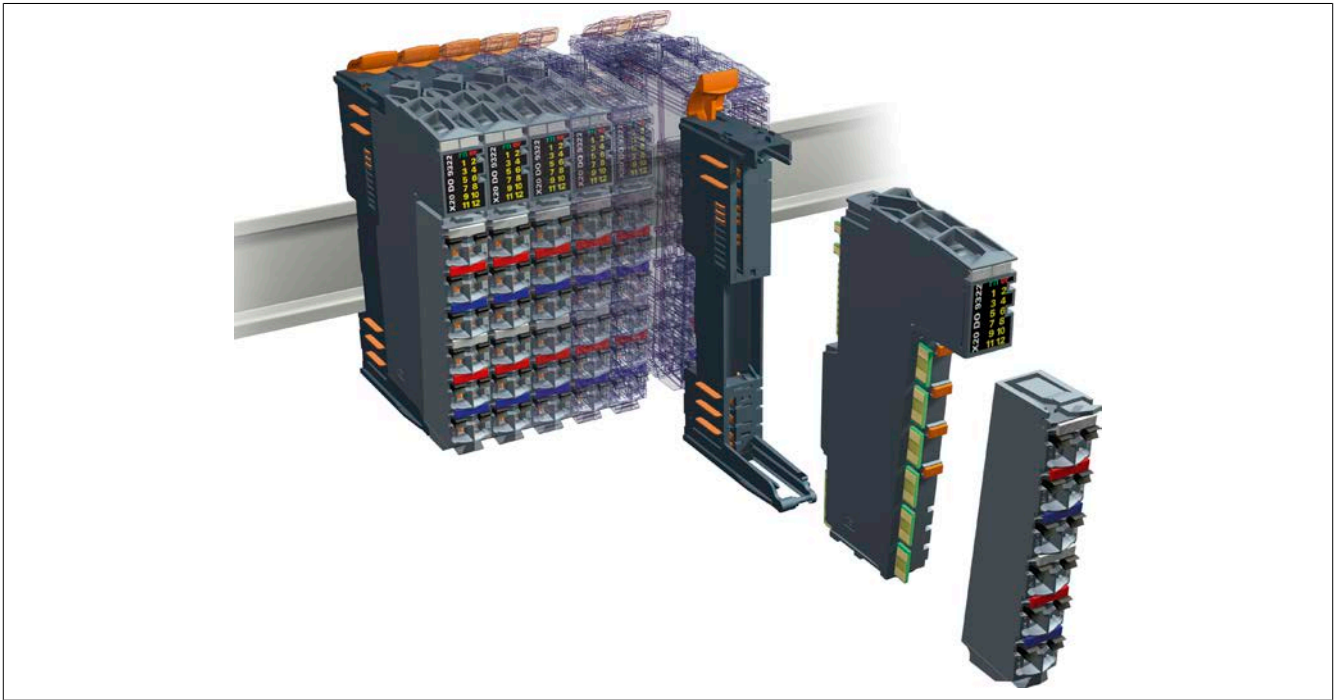


Figure 1: Each module consists of 3 subcomponents – terminal block, electronics module and bus module.

3.1.1 More than just I/O

With its well thought-out details and a sophisticated ergonomic design, the X20 system is more than a remote I/O system – it's a complete control solution. The X20 system family makes it possible to combine the exact components needed to meet any application requirements.

- The X20 system is the ideal addition to a standard fieldbus and expands the possibilities of conventional control systems. Simply connect it, configure it and you're done.
- Teamed up with other B&R components, the X20 system achieves its full potential and allows the implementation of applications with unimagined performance and flexibility. This type of seamless integration is a major advantage.

3.1.2 3 x 1 = 1

Three basic elements make up one module: Terminal block – Electronic module – Bus module

This modularity results in a system that combines the advantages of both rack and I/O slice systems:

- Prewiring without the module
- Hot pluggable electronics
- Extra bus slots for added options

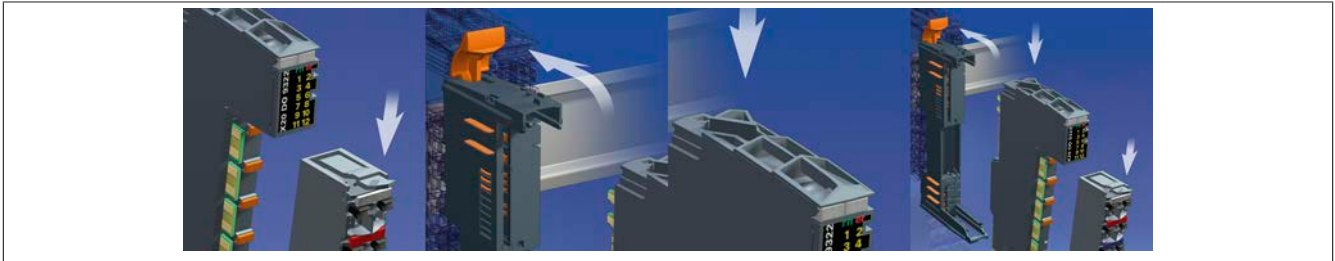


Figure 2: X20 modules are divided into three parts to guarantee the simplest usability

The X20 system delivers 50% more component density, perfected connection technology and optimal granularity.

- **Added value**
12 channels with a width of 12.5 mm allow a component density never before achieved with optimal terminal ergonomics. As a result, the X20 system offers 50% more channels than conventional slice systems. And this without sacrificing terminal connections.
- **Uniformity**
Consistent implementation of 1-, 2- or 3-wire connections – no additional jumper terminals needed.
- **Granularity**
1-channel and 2-channel modules: Maximum flexibility so you only have to pay for what you really need.

3.2 Optimized design

X20 modules consist of three submodules to provide maximum ease of use throughout their entire life cycle. This division into bus module, electronics module and terminal block has several advantages.

- **Preconfigured for different machine types**

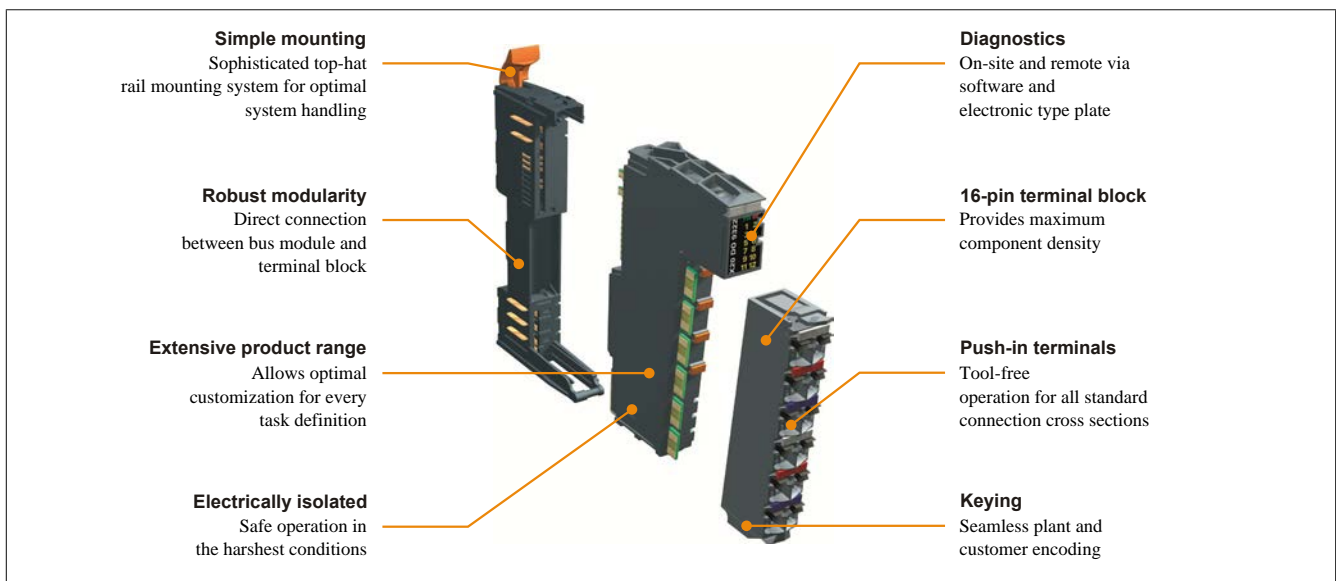
The X20 system bus modules are the basic platform for many machine variations. The design of the machine determines which electronics modules are used. The software recognizes this design automatically and makes sure that the right functions are provided where they are needed. Handling a range of different machine variants couldn't be easier.

- **Industrial control cabinet construction**

X20 system terminal blocks are separate from the electronics module and make it possible to pre-wire the entire control cabinet. This is especially ideal for series-produced machines.

- **Easy maintenance**

X20 modules can be easily exchanged to simplify troubleshooting. The electronic modules can be exchanged without interrupting operation. The wiring remains exactly the same thanks to the separate terminal blocks. Being able to exchange the automation components quickly reduces downtime.



3.3 Remote backplane

The main idea: Remote backplane for a rack system – in other words, the cable is the backplane. All modules are connected to the uniform backplane (X2X Link). Directly connected X20, X67 or XV modules can each be placed at a distance of up to 100 m outside the confines of the control cabinet. X2X Link guarantees the highest possible level of resistance to disturbances based on twisted copper cables.

This not only provides a universal remote backplane which handles the communication between bus modules and via the X2X Link cable, but makes it possible without converters or any loss in performance. A unique feature of the X20 system is the possibility to later integrate machine options on bus modules that are not yet being used without having to change the software addressing.

Remark:

A 100 m X2X Link cable is available from B&R for custom assembly (model number: X67CA0X99.1000).

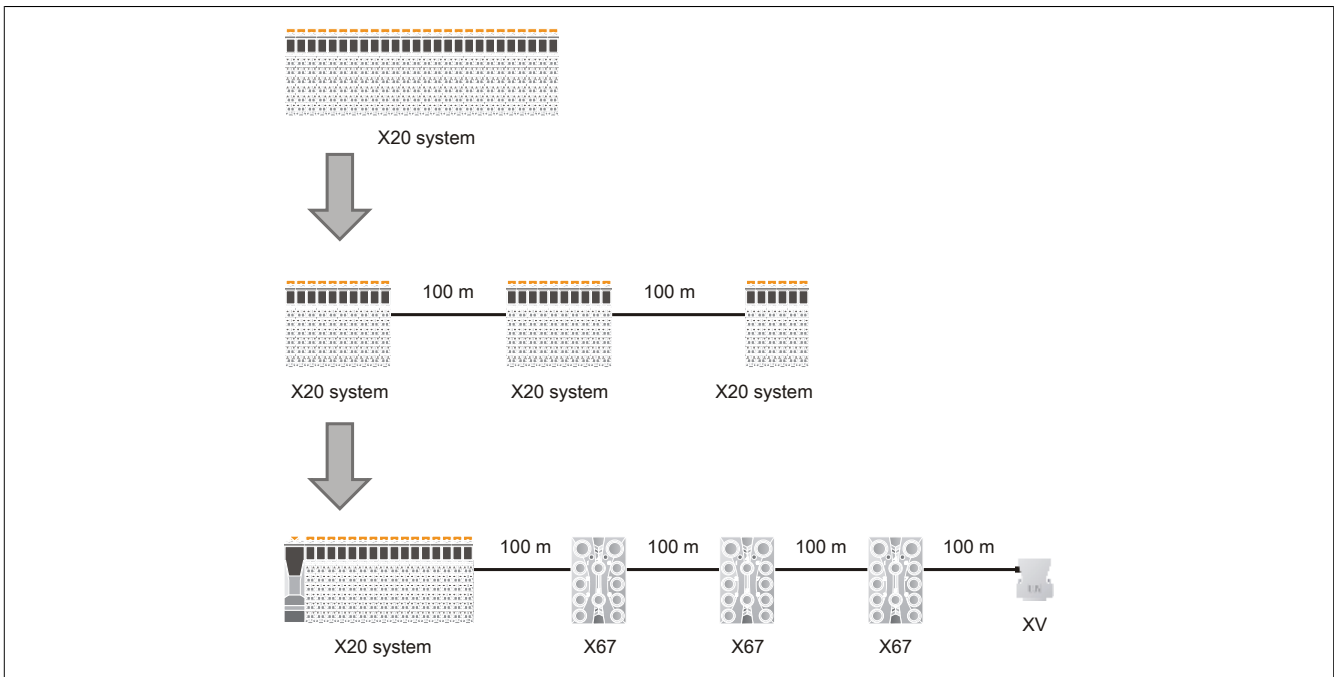
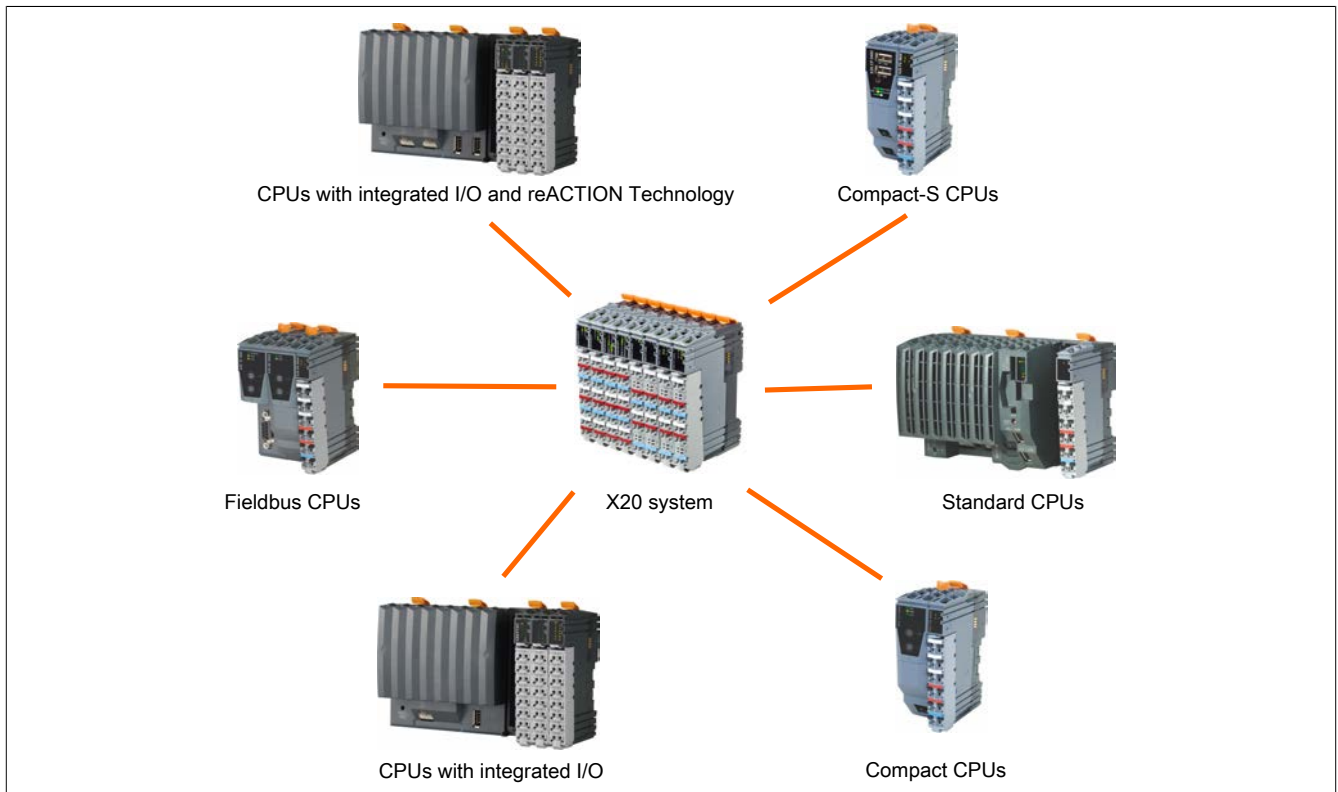


Figure 3: X2X Link - universal backplane based on twisted copper cables

3.4 X20 CPUs

The series of CPUs in the X20 system landscape cover a wide range of requirements. Areas of use include simple applications where cycle times in the millisecond range are sufficient to applications that place the highest demands on performance. In these, even cycle times of 100 μ s can be used effectively.

The design of the CPUs is in line with the X20 system landscape. X20 I/O modules are connected directly to the CPU. Attached seamlessly to the CPU, they allow the entire space-saving system to fit inside the control cabinet. The supply for the CPU, X2X Link network and I/O modules is part of the CPU. No additional power supply modules are required.



CPUs are divided into the following 6 categories:

- Standard CPUs
- Standard CPUs with integrated I/O
- Standard CPUs with integrated I/O and reACTION Technology
- Compact CPUs
- Compact-S CPUs
- Fieldbus CPUs

3.4.1 Features

Remote backplane

A power supply integrated in the CPU with I/O power supply terminals powers the backplane, I/O sensors and actuators, eliminating the need for additional system components. A direct I/O connection to an X20 CPU opens up all of the advantages of a remote backplane, in particular the ability to place as many I/O sections as needed within 100 m using a cable or to add modules with IP67 protection.

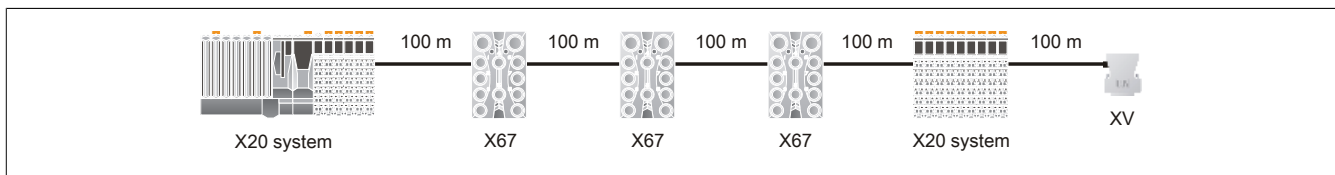


Figure 4: X20 CPUs - Direct I/O connection to X20 CPUs and the advantages of the remote backplane

Programming

B&R Automation Studio is the only programming tool needed for all platforms. All relevant IEC 61131-3 languages and C can be used to create the application software.

Depending on the CPU series, integrated HMI, NC / soft CNC functions and web server technologies complete the range of powerful features.

Industrial strength

Covering a broad performance spectrum and equipped with standard interfaces that can be expanded as needed with interface modules, system dimensions still remain extremely compact. The size and shape of the CPU matches that of the X20 modules to prevent unnecessary wasted space in the control cabinet.

None of the processors require a fan, making them virtually maintenance-free.

3.4.2 Many CPU series

To cover a wide range of requirements, X20 CPUs are divided into 6 different series.

Standard CPUs

Based on Intel ATOM processor technology, this CPU series covers a wide spectrum of requirements. Areas of use include standard applications to applications that place the highest demands on performance.

The basic model includes USB, Ethernet, POWERLINK V1/V2 and removable CompactFlash card. The standard Ethernet interface is capable of handling gigabit communication. For even more real-time network performance, the onboard POWERLINK interface supports poll response chaining mode (PRC).

Up to 3 more slots are available for additional interface modules to increase flexibility.

- CPU clock frequency from 100 to 1600 MHz
- Onboard Ethernet, POWERLINK V1/V2 with poll response chaining and USB
- 1 or 3 slots for modular interface expansion
- CompactFlash as removable application memory
- Up to 512 MB DDR2 SRAM according to performance requirements
- CPU redundancy possible
- Fanless

Standard CPUs with integrated I/O

This CPU series is available with processor speeds of 200 MHz and 400 MHz. Depending on the variant, up to 256 MB RAM and up to 32 kB nonvolatile onboard RAM is available. A built-in flash drive is available to store up to 2 GB of application and other data.

All CPUs come equipped with Ethernet, USB and one RS232 interface. In both performance classes, integrated POWERLINK and CAN bus interfaces are also available. If additional fieldbus connections are needed, the CPU can be upgraded with an interface module from the standard X20 product range. These CPUs do not require fans or batteries and are therefore maintenance-free. 30 digital inputs and outputs and 2 analog inputs are integrated in the devices. 1 analog input can be used for PT1000 resistance temperature measurement.

- CPU clock frequency from 200 to 400 MHz
- Onboard Ethernet, POWERLINK with poll response chaining and USB
- 1 slot for modular interface expansion
- 30 digital inputs/outputs and 2 analog inputs integrated in the device
- 1/2 GB onboard flash drive
- 128/256 MB DDR3 SDRAM
- Fanless with no batteries
- Battery-backed real-time clock

Standard CPUs with integrated I/O and reACTION Technology

This CPU series is available with processor speeds of 200 MHz and 400 MHz. Depending on the variant, up to 256 MB RAM and up to 32 kB nonvolatile onboard RAM is available. A built-in flash drive is available to store up to 2 GB of application and other data.

These CPUs come equipped with POWERLINK, Ethernet, CAN bus, 2x USB and one RS232 interface. If additional fieldbus connections are needed, the CPU can be upgraded with an interface module from the standard X20 product range. These CPUs do not require fans or batteries and are therefore maintenance-free. 30 digital inputs and outputs and 2 analog inputs are integrated in the devices. 1 analog input can be used for PT1000 resistance temperature measurement.

The CPUs are equipped with the ultrafast reACTION Technology. All integrated I/O channels are reACTION-capable and can be operated by the reACTION program. These I/O channels are controlled with a response time up to 1 μ s. All of the commands that can be used for reACTION programs are provided as function blocks in special libraries (e.g. AsIORTI). Programming in compliance with IEC 61131-3 requirements takes place in the Function Block Diagram editor in Automation Studio.

- CPU clock frequency from 200 to 400 MHz
- Onboard Ethernet, POWERLINK with poll response chaining and USB
- 1 slot for modular interface expansion
- Onboard reACTION Technology
- 30 digital inputs/outputs and 2 analog inputs integrated in the device
- 1/2 GB onboard flash drive
- 128/256 MB DDR3 SDRAM
- Fanless with no batteries
- Battery-backed real-time clock



Compact CPUs

Compact CPUs are ideal for situations where cycle times in the millisecond range are sufficient and a cost-benefit analysis plays a decisive role. A range of models with CAN and Ethernet can be adapted optimally to meet all requirements.

- Embedded μ P 16 / μ P 25 with additional I/O processor
- 100/750 kB User SRAM
- 1/3 MB User FlashPROM
- X20CP0291 and X20CP0292: Onboard Ethernet
- No battery
- Only 37.5 mm wide

Compact-S CPUs

The CPUs in the X20 Compact-S family are available in 5 different variants. This way, customers get the product that best meets the requirements of the machine – technically and economically.

The processor performance of the compact CPUs ranges from 166 MHz (compatible) to 667 MHz. The most economical variant comes equipped with 128 MB RAM, 8 kB nonvolatile RAM and 256 MB flash drive. The most powerful version of the Compact-S CPUs achieves cycle times down to 400 μ s and has 64 kB nonvolatile RAM as well as 2 GB internal flash drive.

With POWERLINK, Ethernet, USB and RS232, the CPUs offer a wide range of communication options. An optional CAN interface is also available. If the application requires additional interfaces, the CPU can be modularly expanded by one or two X20 interface slots. This allows the entire product range of X20 fieldbus interfaces to be used.

The fanless, battery-free design of Compact-S CPUs means they are completely maintenance-free.

- CPU clock frequency from 166 to 667 MHz
- Depending on the variant: POWERLINK with poll-response chaining
- 2x onboard USB
- Up to 2 slots for modular interface expansions
- 128 to 256 MB DDR3 SDRAM
- 256 MB to 2 GB onboard flash drive
- Fanless with no batteries
- Width
 - Without fieldbus slot: 37.5
 - 1 fieldbus slot: 62.5 mm
 - 2 fieldbus slots: 87.5 mm

Fieldbus CPUs

Fieldbus CPUs are variants of Compact CPUs. In addition to these features, fieldbus modules can be connected to the left side. These CPUs make applications possible in which data preprocessing must take place remotely on the I/O bus interface.

- Embedded μ P 16 / μ P 25 with additional I/O processor
- 100/750 kB User SRAM
- 1/3 MB User FlashPROM
- X20XC0292: Onboard Ethernet
- Up to 2 slots for fieldbus modules
- No battery
- Width
 - 1 fieldbus slot: 62.5 mm
 - 2 fieldbus slots: 87.5 mm

3.5 For all fieldbuses, integration through standardization

The X20 system is ideally suited for expanding existing control systems using standard fieldbus technology.

For example, a bus controller allows the X20 system to be used as a powerful I/O expansion unit. Standardized EDS or GSD description files allow X20 system components to be integrated, configured, and programmed in the programming environment of a non-B&R system.

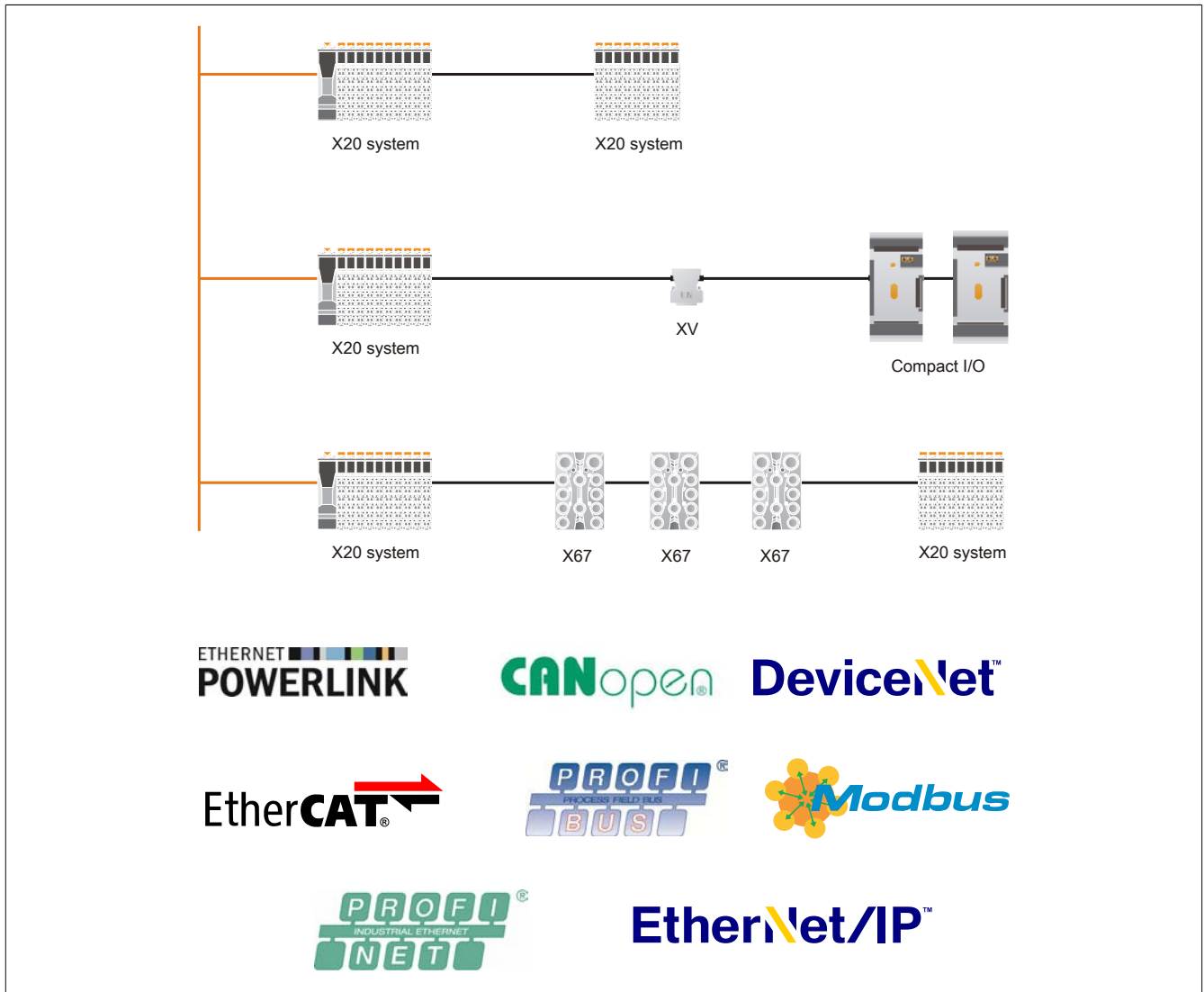


Figure 5: Expansion of existing control systems using standard fieldbuses and the X20 system

3.6 Complete system

3.6.1 IP67 - then X67

The X67 is the robust version of the X20 for use outside the control cabinet. The same basic technology, with an extremely robust housing and 4 to 32 channel modules, guarantees economical solutions in the roughest conditions.

3.6.2 Integrated valve terminal control

The development of the XV system allows for the first time direct and manufacturer-independent control of valve terminals. A complete digital output module in a size and form comparable with a normal DSUB connector. XV allows any valve terminal manufacturer to be selected because it is connected directly to the standardized multiple pin connector on the valve terminal.

Fully integrated in the remote backplane, it rounds off the X20 and X67 for complete automation solutions. One system, several variations - advantages that pay off. You select your automation components and distribute them as needed inside and outside the control cabinet.

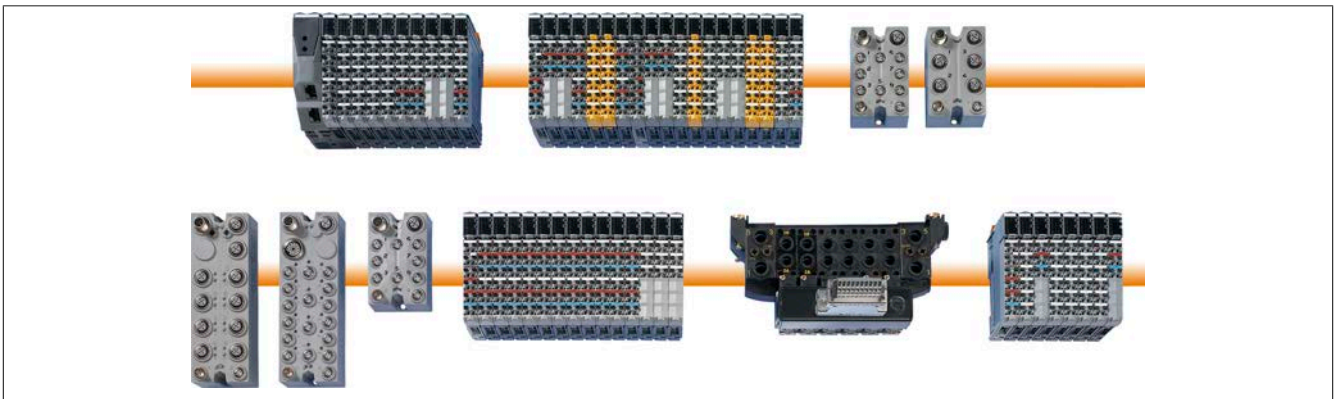


Figure 6: X20, X67, XV - variations of a single system

3.7 Easy wiring

Industrial control cabinet construction streamlines production cycles. Prefabricated cable trees enable faster and easier assembly directly on the machine or system. The X20 system supports efficient prewiring of the entire control cabinet using separate terminal blocks. The complete X20 system configuration is mounted in the control cabinet and connected to the prewired cable trees.

The supply of the X20 modules and the supply of the sensors and actuators do not add any requirements for energy distribution. The X20 system reduces manual wiring to a minimum.


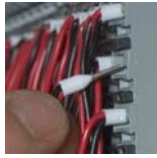


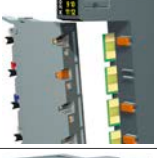



3.7.1 Install the wires, plug it in, and it's ready to go

Simple, tool-free wiring for fast installation. The X20 system terminal blocks use a fully integrated and proven push-in connector system. Each terminal can also handle double wire sleeves up to a diameter of 2x 0.75 mm². The user saves time wiring the system multiple times and distributing the signals.

The wire connections can be removed with a screwdriver. Each terminal also has an access point for a measurement probe.

Notice!

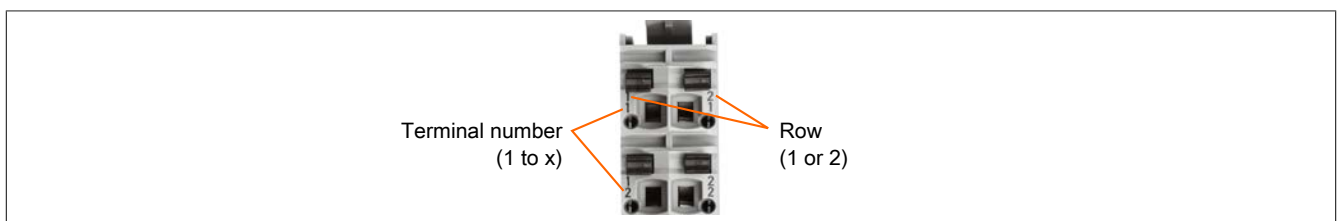
To avoid damaging the terminals, the X20AC0SD1 B&R screwdriver should be used.

| | | | |
|---|--|---|--|
|  | <p>Detached The terminals can be prewired apart from the actual I/O module. This provides many advantages for control cabinet construction. Separate manufacturing, just-in-time logistics and the installation of preassembled systems during start-up become reality.</p> |  | <p>Tool-free Simple, tool-free wiring for fast installation. The X20 system terminals use a fully integrated and proven push-in connector system. Available with 6-pin and extremely compact 12-pin terminals.</p> |
|  | <p>Coded in the system Factory coding prevents dangerous mix-ups. Coding guarantees that only parts which are permitted to be combined can be combined. Intuitively and without additional work.</p> |  | <p>Ergonomic Component density does not have to negatively affect ergonomics. With terminal spacing of more than 5 mm, this was handled optimally on the X20 system. Experience gained in the field - used in the field.</p> |
|  | <p>Coded in the application Incorrectly inserting terminals does not necessarily damage the electronics, but always causes faulty functioning of the system. Application coding prevents this problem.</p> |  | <p>Unmistakable Distinct forms intuitively define various functions, such as clearly assigned latching and unlatching functions for terminals. This prevents errors from the very beginning.</p> |
|  | <p>Labeling Each terminal is clearly labeled, directly in the plastic. Additional label tags are available as system accessories including a printer with ECAD connection.</p> |  | <p>Easy servicing A system's strengths can be seen in its details: In addition to the terminal connector and unlocking mechanism, each terminal has an access point for a test probe. You can easily measure the terminal potential without disconnecting the wire.</p> |

3.7.2 Unique terminal numbering

Each terminal connection is unique and can be identified by the numbers in the plastic. In this way, terminal assignments can be clearly assigned in the planning stage without any danger of mix-up.

- Upper number: Row number 1 or 2
- Lower number: Terminal numbers 1 to 3 (6-pin terminal block), 1 to 6 (12-pin terminal block), 1 to 8 (16-pin terminal block)



3.8 Sophisticated mechanics

The name B&R stands for many years of experience in developing and manufacturing industrial electronics. But it's also the mechanics of the X20 system that have been thought through to the last detail. Its robust design, long guides and strengthened housing guarantee the stability it needs in industrial environments. These features allow the X20 system to be mounted on a top-hat rail with the same ease as a rack system. They also make it just as simple to remove it from the rail.

The sophisticated mechanics of the X20 are needed not just to provide this type of handling, but also to be able to quickly and easily remove I/O slices from the entire system.

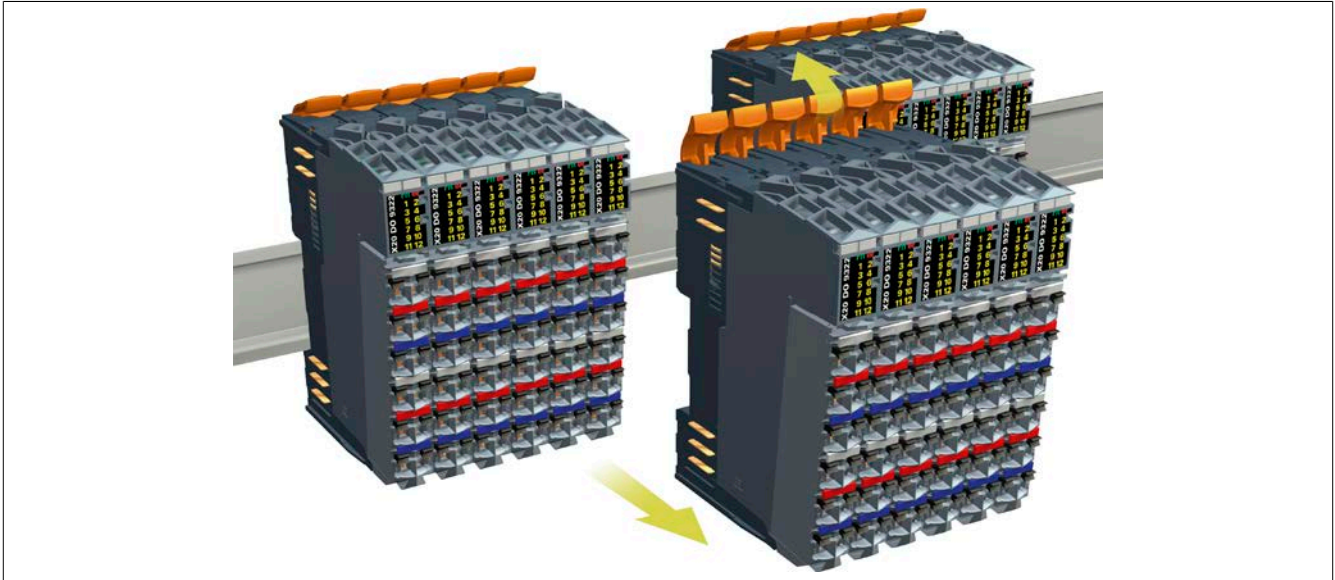


Figure 7: Easy mounting on and removal from the top-hat rail

| | | | |
|--|---|--|--|
| | <p>Unlocking mechanism with two positions Closed for secure fit on the top-hat rail.</p> | | <p>Defined open position makes the difference Open to remove a module or the entire system.</p> |
| | <p>Removing a single module from the system Remove or reconnect vertically.</p> | | <p>Mount the entire system as a whole Or just as easily removing the entire system.</p> |

3.9 Diagnostics

Outstanding diagnostic options are needed for errors to be found quickly. The X20 system offers several levels of diagnostics:

- Direct on the module using visual LED displays. Bus status, I/O status and channel states are displayed in direct relationship to the channels or the function. The different states are displayed in different ways, e.g. green for OK, red for error.
For details, see "[Diagnostic LEDs](#)" on page 3787.
- Via software in the cyclic data image. With the X20 system, status data does not result in an additional communication load, which would result in considerable differences between theoretically possible bus speeds and real requirements during operation. All necessary status data is always transferred cyclically, with no exceptions.
- Expanded diagnostic data in acyclic data traffic without loss in performance. If a problem occurs, detailed diagnostic data can be requested from the application by the respective module using an asynchronous channel. This does not result in additional communication load and cycle times remain unchanged.



Figure 8: Visual diagnostics directly on the module using LED indicators

3.10 Embedded parameter chip

Information such as module type, serial number, functionality and version number is contained in the embedded parameter chip of the X20 module. This information is automatically evaluated by the programming environment (Automation Studio) and by the application program. This prevents errors during both commissioning and service. In addition, the system configuration is automated and flexible variations are made possible.

For validated systems, it is becoming increasingly important to have module serial numbers that are unique world-wide – as required by the FDA, for example.

Information:

All modules that require 0.01 W of power on the X2X Link network must be supplied via the internal I/O power supply. If the I/O power supply fails, the module shuts down and communication is lost. In this case, ModuleOk returns the value "False" and data can no longer be read from the "[embedded parameter chip](#)".

3.11 Space for options

The X20 system makes it possible to combine the exact components necessary depending on the user's demands and individual application requirements. This allows machine options to be implemented easily and flexibly. Bus modules provide the base, and are more or less a rack replacement. Depending on the option, the necessary electronics modules are then inserted in the predefined slots.

Addresses are assigned implicitly via the slot. Software that has been developed once is valid for all versions and does not need to be changed. This is even possible for later machine expansion. The I/O modules are simply inserted in the defined bus modules, and assigned to the corresponding potential groups and E-stop groups.

To prevent unwanted expansion, each module can be identified and then enabled using the application software.




3.12 Flexibility for options

The implementation of different machine variations using free bus modules is only one of the many features that the X20 system offers. With the support of Automation Studio, there is an optimized solution using I/O mapping.

In the process, each I/O configuration is created optimally according to the actual requirements. However, the application software is designed to handle all potential options. Only the I/O channels that are actually available are mapped to the application program. If an expansion is required, then the additional hardware needed can be easily connected and the I/O mapping changed. This is possible without having to compile the application software.

It doesn't matter where the I/O mapping list is created:

- Manually in B&R Automation Studio
- With tools, e.g. with a database or a table calculation program
- Directly from an ERP system, just like the parts list for the machine
- Automatically in the application software, depending on the hardware used

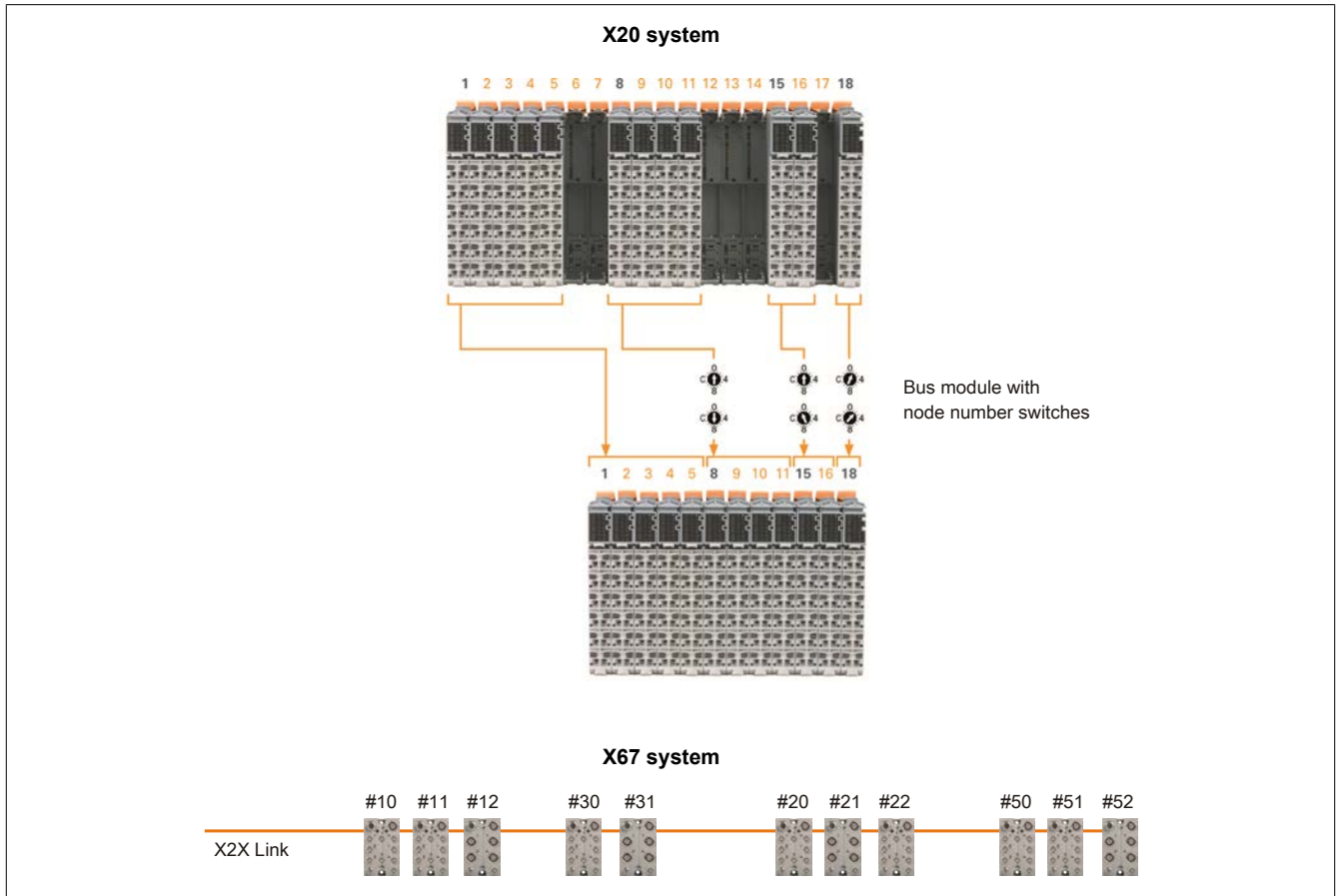
| | |
|---|--|
|  | <p>Machine variation A</p> <p>The possibilities of the X20 system can be best explained using examples. This is a machine constellation with two variations, A and B. All of the necessary electronics modules for machine variation A are shown in the picture to the left. The bus modules needed for variation B are also present, but without electronic modules.</p> |
|  | <p>Machine variation B</p> <p>Variation B shows the necessary electronic modules but the modules necessary for variation A are missing. The distribution of the free bus modules for the variations is also clear: The variable I/O modules can be very easily connected to the required electrically isolated groups and don't need to be attached in the back. The extensive process of taking apart the configuration to expand existing electrically isolated groups is also eliminated. Simply insert the electronic module and attach the terminal block.</p> |
|  | <p>Machine variation A - optimized</p> <p>The features included in Automation Studio can also be used to achieve completely optimized hardware configurations without losing the advantage of comprehensive application software for all variations. As described earlier, simply mapping physical I/O points to the application program makes it extremely easy to optimize the hardware variations without even requiring compilation.</p> |

3.13 Configurable X2X Link address

The remote X2X Link backplane, which connects the individual I/O modules with each other, is set up to be self-addressing. Because of this, it is not necessary to set the node numbers. The module address is assigned according to its position in the X2X Link line.

In certain cases, e.g. when configurations of modular machines change, it is necessary to define specific module groups at a fixed address, regardless of the preceding modules in the line.

For this purpose, there are modules in both the X20 system and the X67 system with node number switches that allow you to set the X2X Link address. All subsequent modules refer to this offset and use it automatically for addressing purposes.



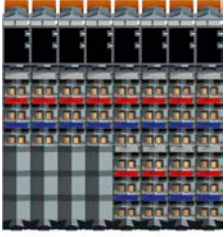
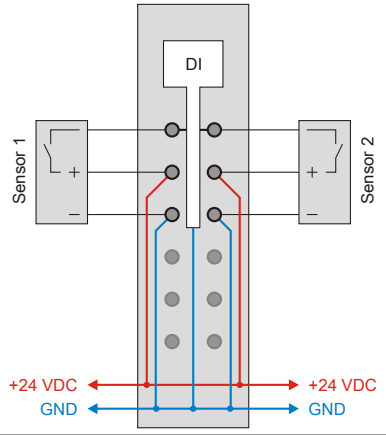
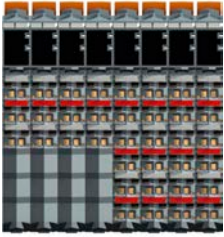
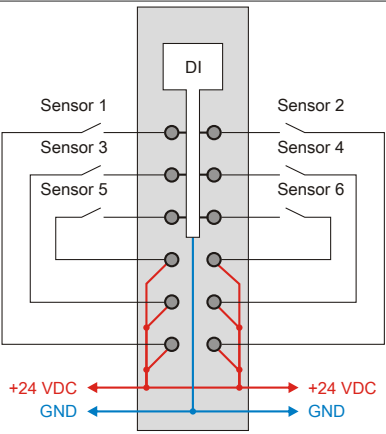
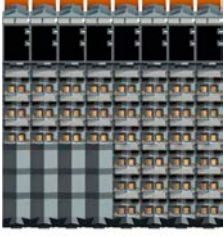
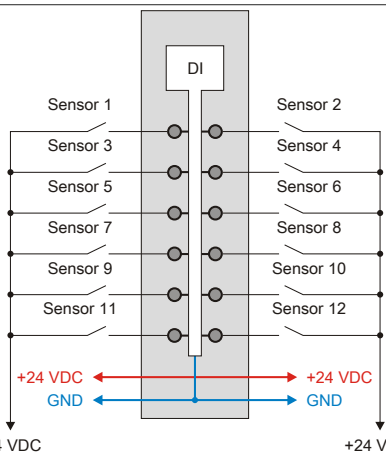
3.13.1 Bus modules with node number switches

Symbols are printed on the locking lever of bus modules with node number switches. This provides a way to see from outside that the X20 system mounted in this slot is using node number switches.



3.14 Universal 1, 2, 3-wire connections

Consistent connection types for all requirements – no additional jumper terminals are needed. All connection types can also be mixed and matched.

| | | |
|--|---|---|
| <p>System-wide 3-wire connections Integrated supply and ground for sensors and actuators.</p> |  |  |
| <p>System-wide 2-wire connections No extra terminals needed.</p> |  |  |
| <p>System-wide 1-wire connections 12 channels - unequaled component density</p> |  |  |

3.15 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, Method 4, Exposure 21 days

Differences between coated and uncoated modules

- Suitable for operation in adverse atmospheric environments
- Suitable for operation in 100% humidity, condensing
- Coated modules have a different Module ID than the corresponding uncoated variants



3.16 Redundancy

The X20 system provides the following forms of redundancy:

- Controller
- Network
- Power supply modules for X20 standalone devices and expandable POWERLINK bus controllers
- X2X Link supply

The first 3 areas are covered in user's manual "Redundancy for control systems". This user's manual is available in the Downloads section under www.br-automation.com.

For a description of the redundant X2X Link power supply, see section "X2X Link supply" on page 62.

3.17 reACTION technology

The X20 Compact CPUs and a number of I/O modules are available featuring ultrafast reACTION technology. This allows the I/O channels integrated in the reACTION module to be controlled with response times down to 1 μ s. This new approach allows extremely time-critical subprocesses to be managed using standard hardware – which lowers hardware costs by reducing the load on the controller and allowing it to be scaled down.

All of the commands that can be used for reACTION programs are provided as function blocks in special libraries (e.g. ASIORTI). Programming using the standard Function Block Diagram (FBD) editor in Automation Studio is compliant with IEC 61131-3.

Documentation for reACTION technology is included in the Automation Studio help system.



3.18 X20 system configuration

The X20 system is designed so that can be connected to standard fieldbuses (with a bus controller) or the remote X2X Link backplane (with a bus receiver). The connection to the next station is made with a bus transmitter. Supply modules and I/O modules are placed between the bus receiver or bus controller and the bus transmitter as needed.

The power supply system used in the X20 systems is described in the section "The supply concept" on page 59.

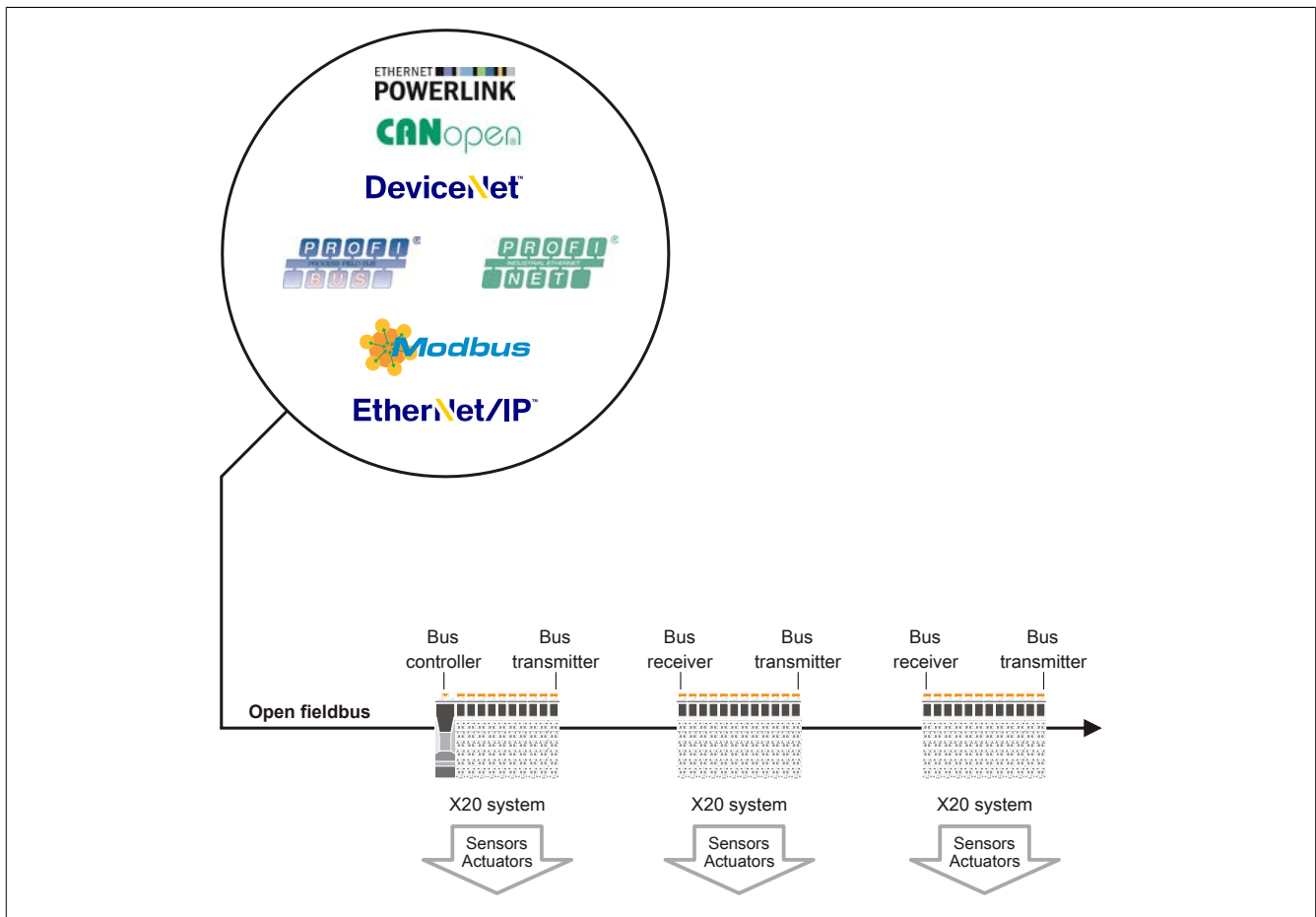


Figure 9: X20 system configuration

3.18.1 Fieldbus connection

Several bus controllers for standard fieldbus technologies like POWERLINK, DeviceNet, PROFIBUS, CANopen, ModbusTCP or EtherNet/IP are available to connect X20 modules to existing control systems. Fieldbus configurators transparently integrate the X20 system into the 3rd-party development environment.

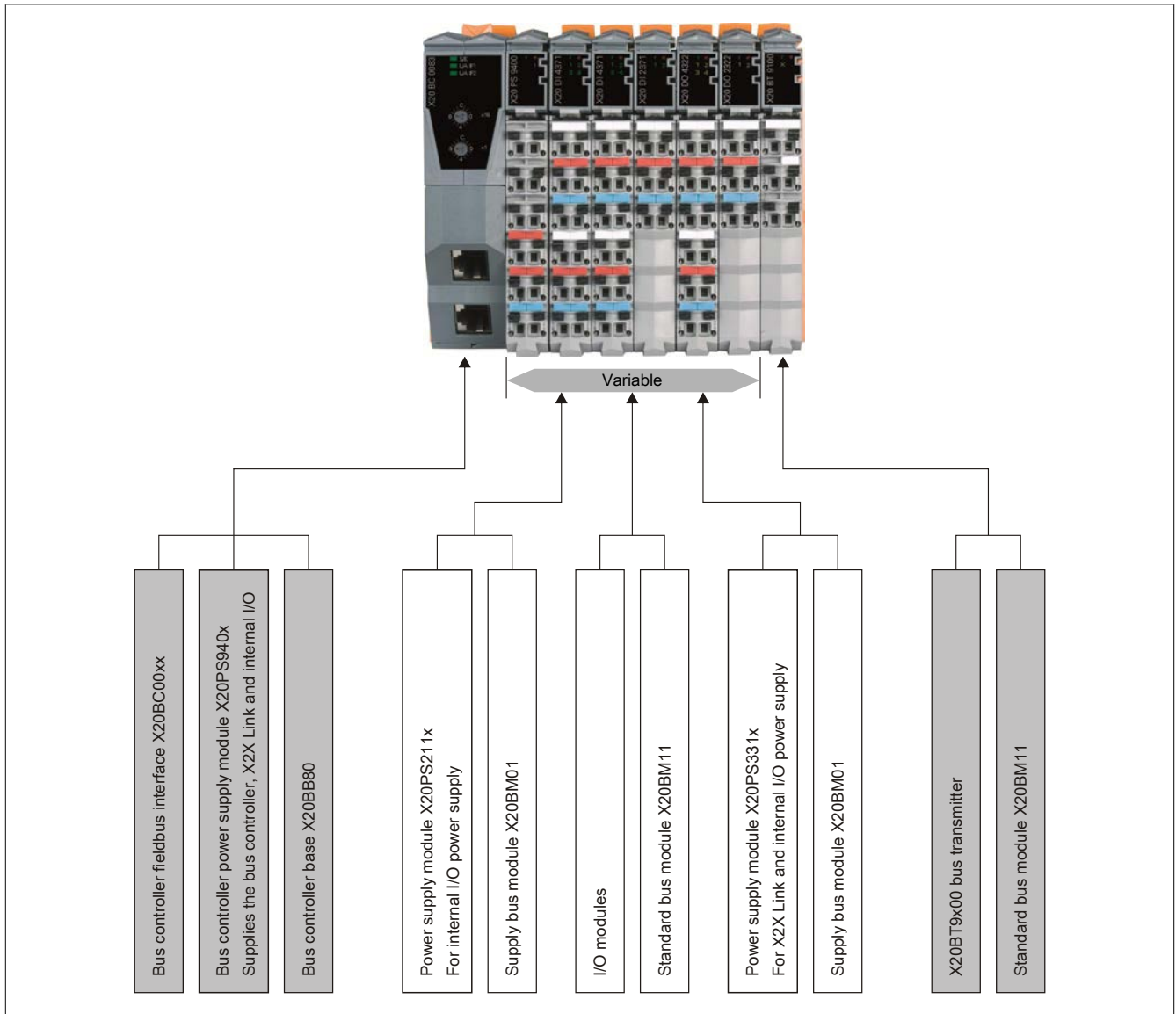


Figure 10: X20 system configurator for fieldbus connection

3.18.2 Connection to X2X Link backplane

The bus receiver X20BR9300 is used to connect the X20 system directly to the remote X2X Link backplane.

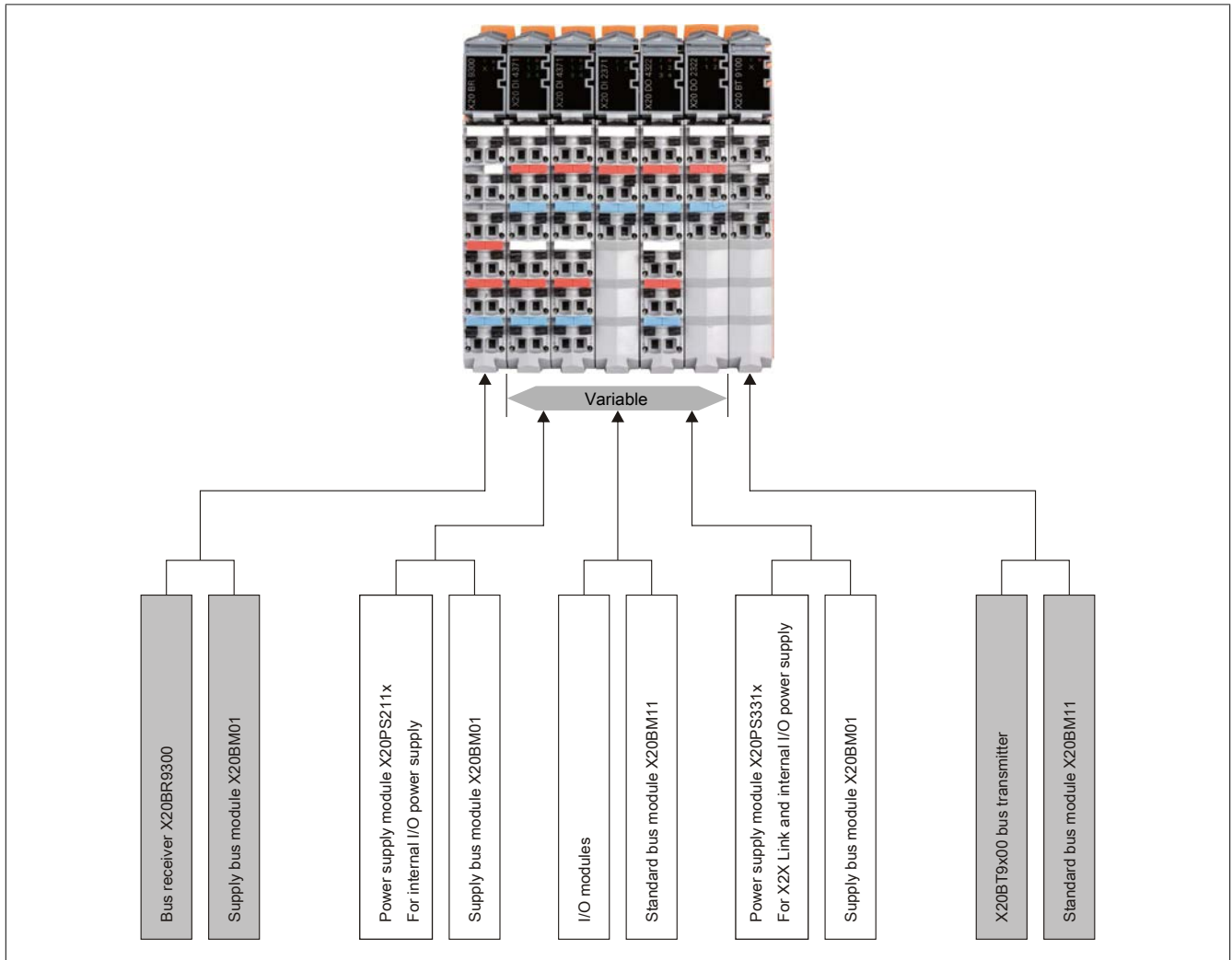


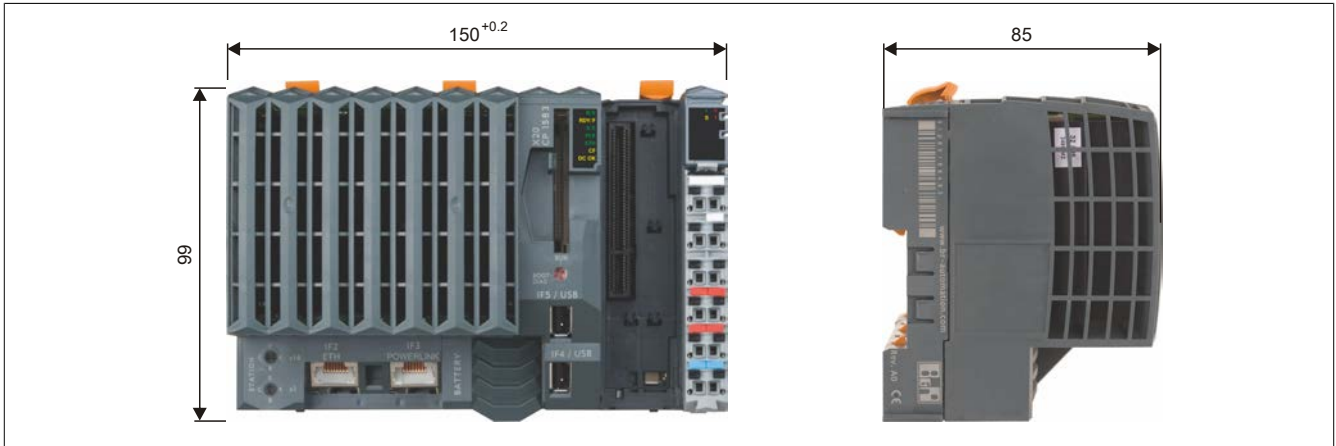
Figure 11: X20 system configurator for connection to X2X Link backplane

4 Mechanical and electrical configuration

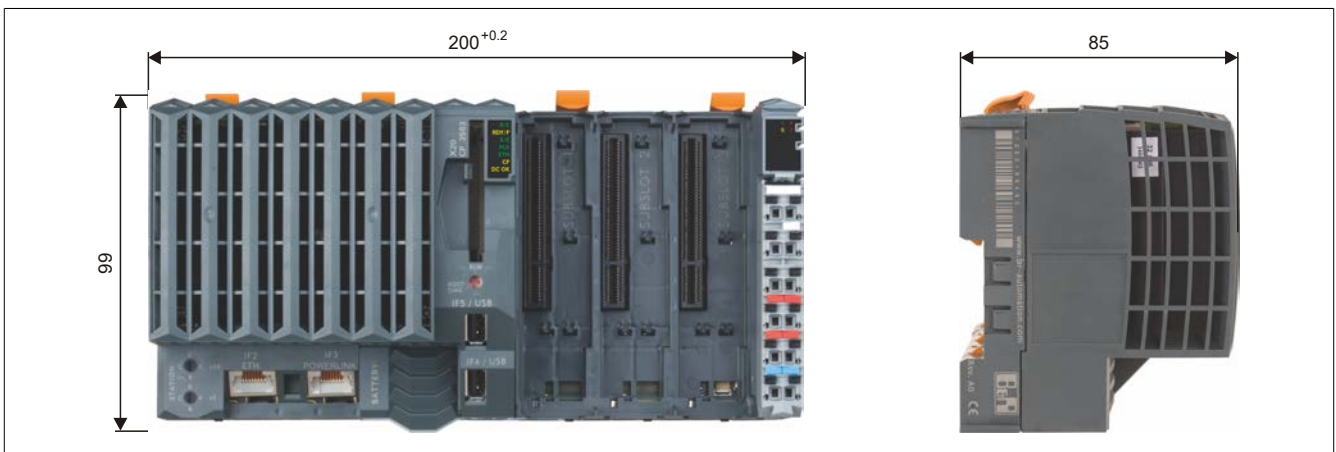
4.1 Dimensions

4.1.1 X20 CPUs

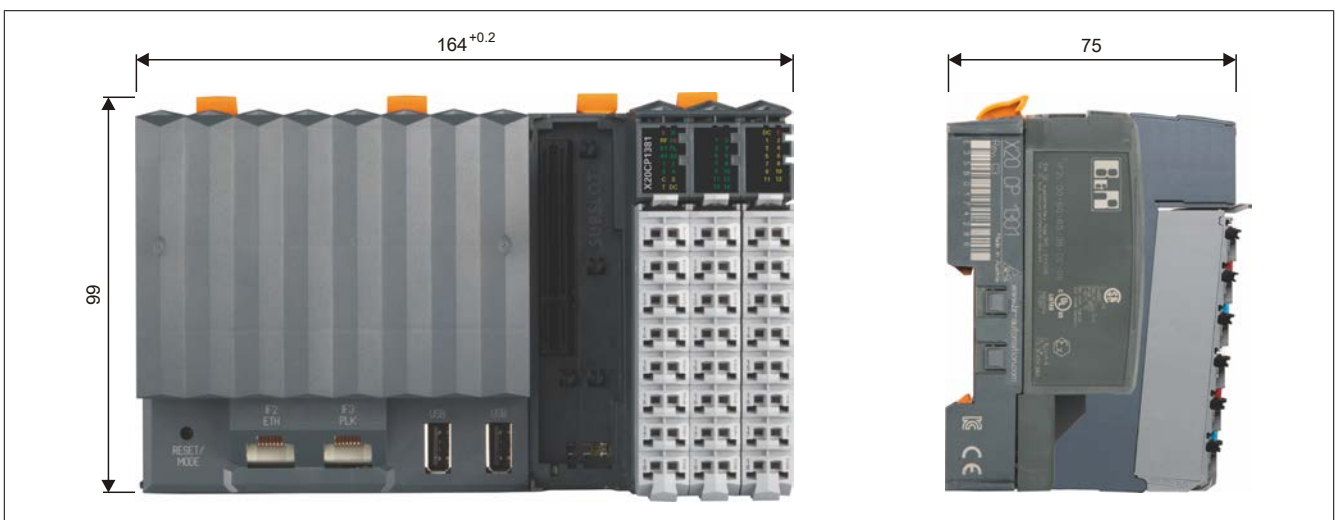
CPUs with 1 slot for interface modules



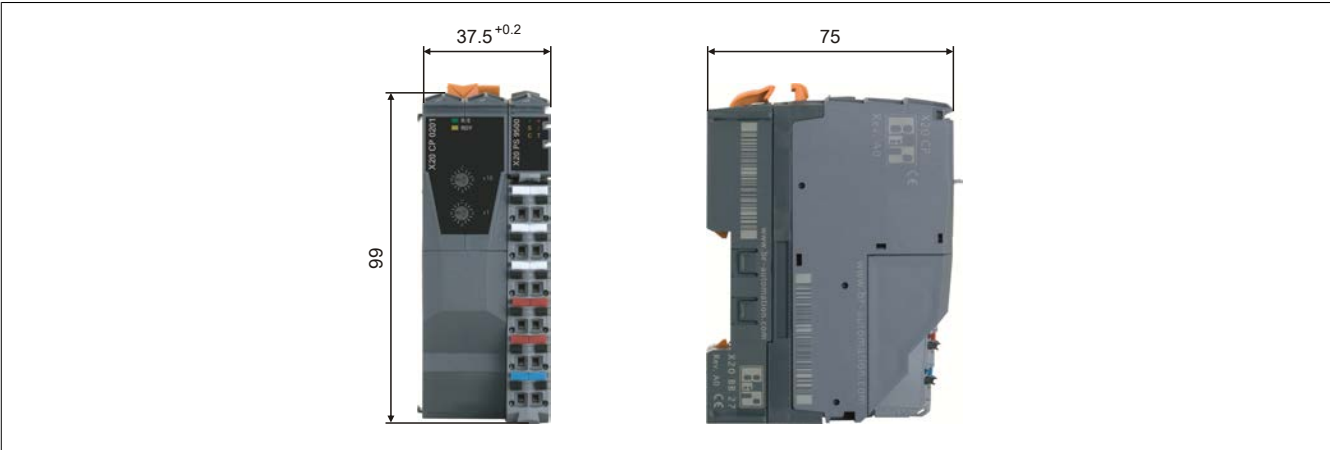
CPUs with 3 slots for interface modules



4.1.2 X20 CPUs with integrated I/O

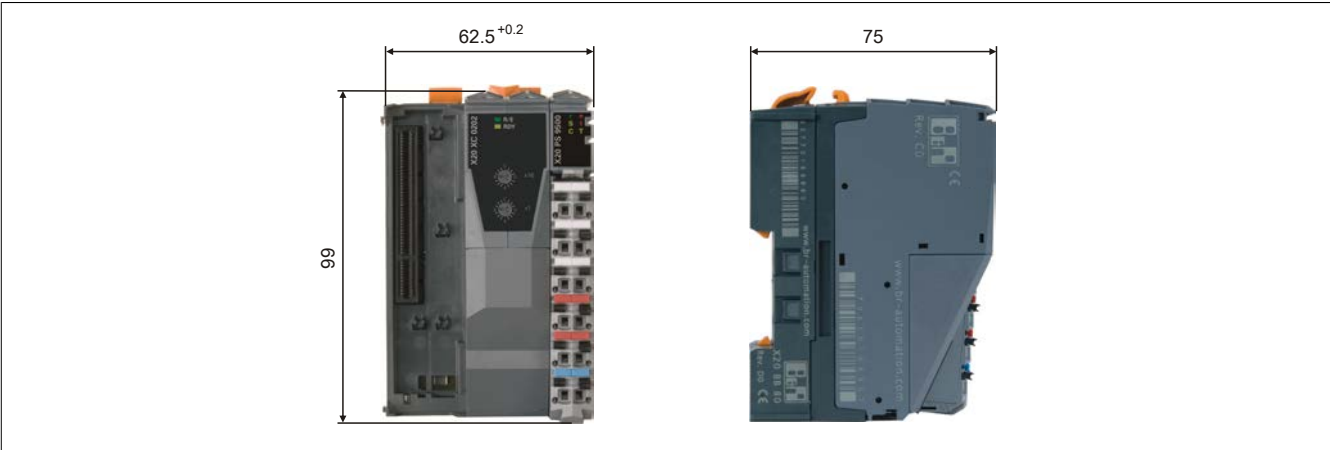


4.1.3 Compact/Compact-S CPUs and bus controllers

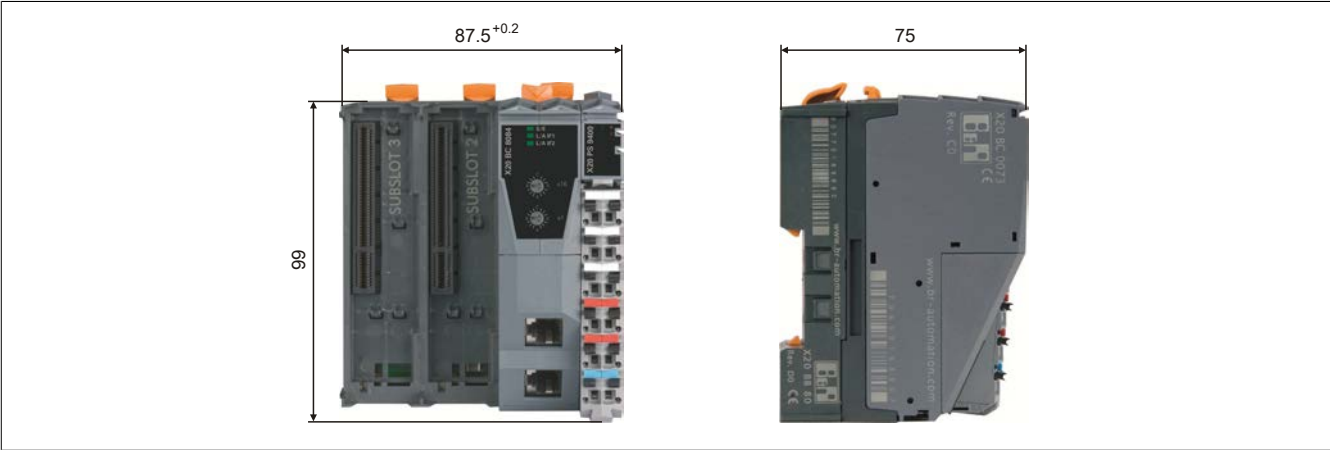


4.1.4 Fieldbus CPUs and expandable bus controller

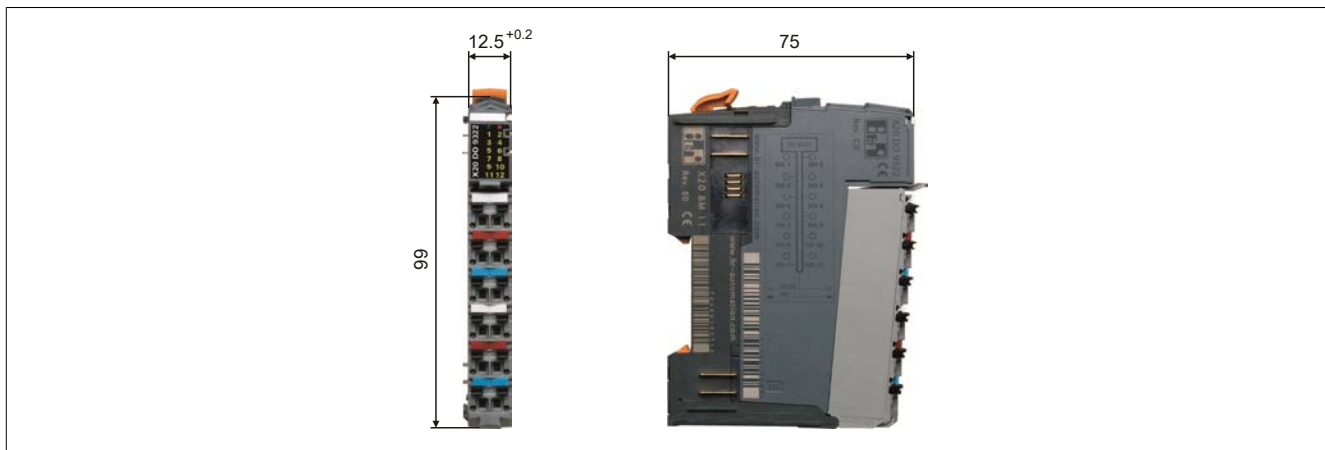
With 1 additional slot



With 2 additional slots



4.1.5 I/O modules



4.1.6 End cover plates

In addition to the dimensions for CPUs and modules specified in this section, it is possible to add end cover plates on the left and right sides of each module block. The following space must be provided for this:

- **Right side:** 5 mm
- **Left side:** 3.5 mm

4.2 Design support

4.2.1 CAD support

To ensure CAD support, the dimensions are included in the ECAD macros in 2D. STEP data is available to allow 3D viewing.

The STEP data can be downloaded from the B&R website (www.br-automation.com) in the Downloads section for the respective module.

4.2.2 Macros for ECAD systems

The electronics in a machine must be designed in a way that optimizes use of available space and materials. Graphic ECAD systems have proven themselves as the right tool for this job.

Every module in the X20 system is delivered with pre-designed electronic descriptions of the mechanical dimensions, electrical signals and module functions. These macros can be loaded directly to proven ECAD systems. The wiring plans are automatically applied by the configuration and programming system, Automation Studio. Design and changes are immediately reflected at all levels of development. This saves time for the more important tasks and prevents errors right from the start. The accelerated development, programming, maintenance and documentation involved with the X20 system mean lower costs, enhanced quality and increased sales by earlier entry into the market.

4.2.3 Printing support

System printers and standard identification labels are supported by the appropriate printer software. Printing can be done manually from table calculations or directly from ECAD software (all methods are supported). The software and printer systems correspond with the Weidmüller standard.

4.3 Installation

A top-hat rail conforming to the EN 60715 standard (TH35-7.5) is required to mount the PLC. The conductive top-hat rail is fastened to the back wall of the control cabinet.

The complete system including all individual modules is hung in the desired location on the top-hat rail with the unlocking mechanisms open and locked in place by closing the unlocking mechanisms. Finally, the modules are equipped with the prewired terminal blocks.

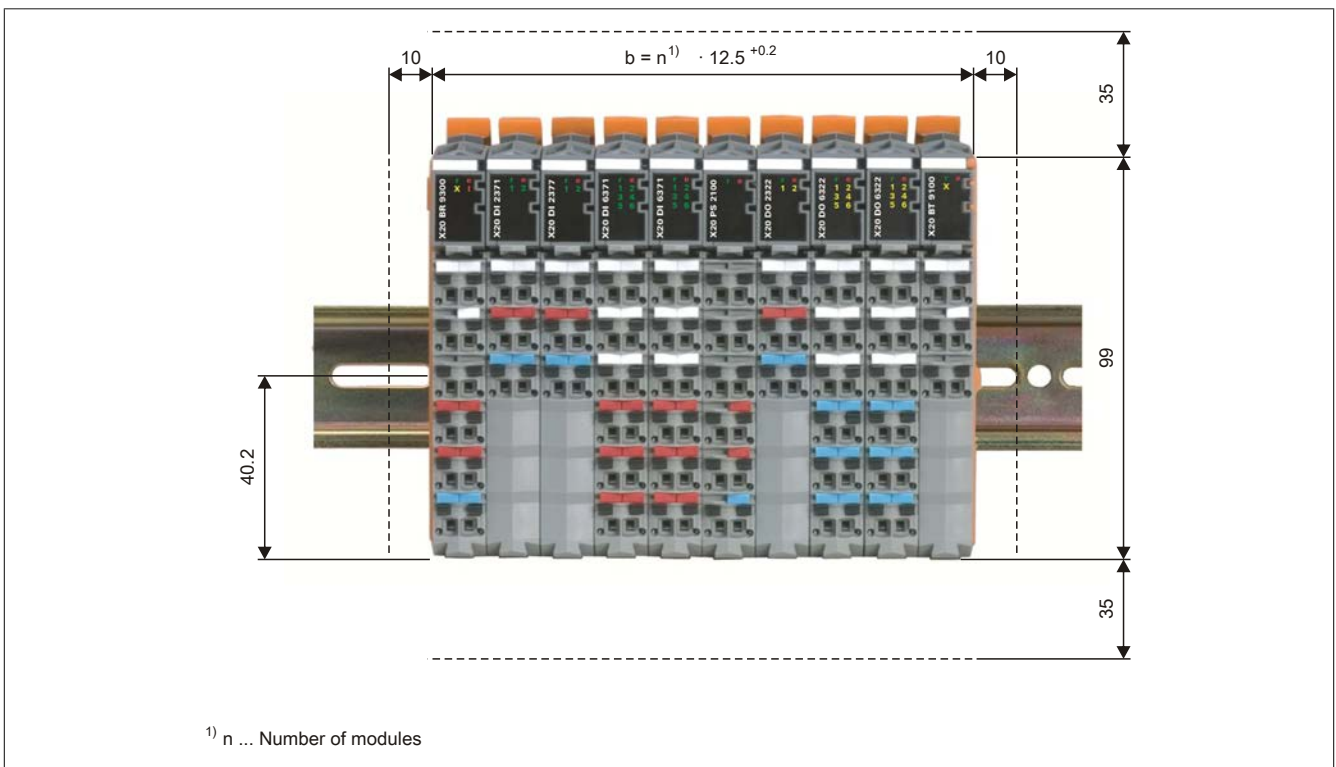
Installation methods

- Vertical installation
- Horizontal installation
- Oblique installation
- Lying installation

Information:

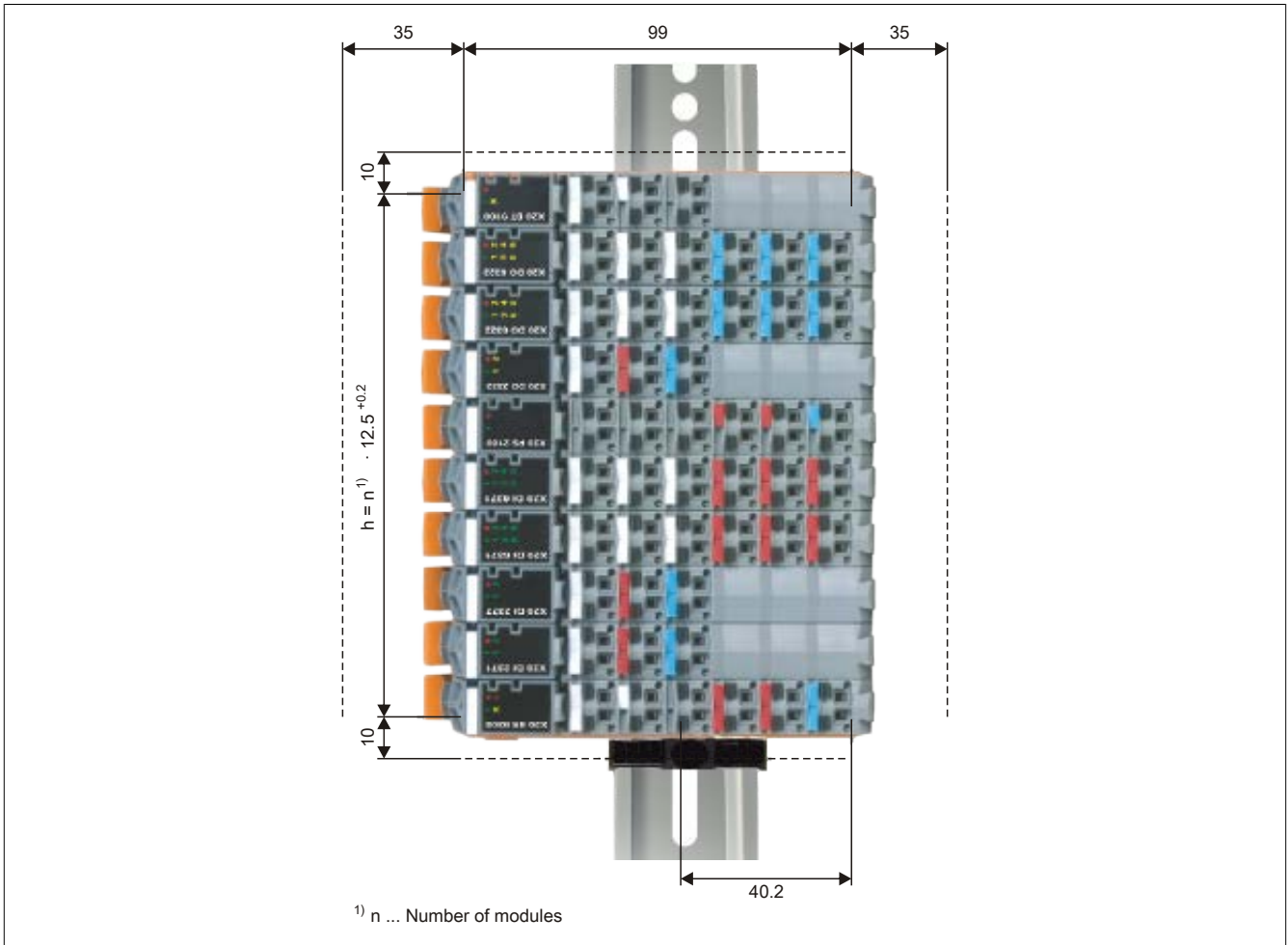
Other installation methods are not permitted.

4.3.1 Horizontal installation



For optimal cooling and air circulation, there must be at least 35 mm free space above the modules. To the left and right of the X20 system, there must be at least 10 mm of free space. Underneath the modules, 35 mm space must be left free for I/O and power supply cabling.

4.3.2 Vertical installation



For optimal cooling and air circulation, there must be at least 35 mm free space to the left of the modules. Above and below the X20 system, there must be at least 10 mm of free space. To the right of the modules, 35 mm space must be left free for I/O and power supply cabling.

The modules must be arranged so that the controller is on the lower end of the system. The temperature range is limited to -25 to 50°C when modules are mounted vertically.

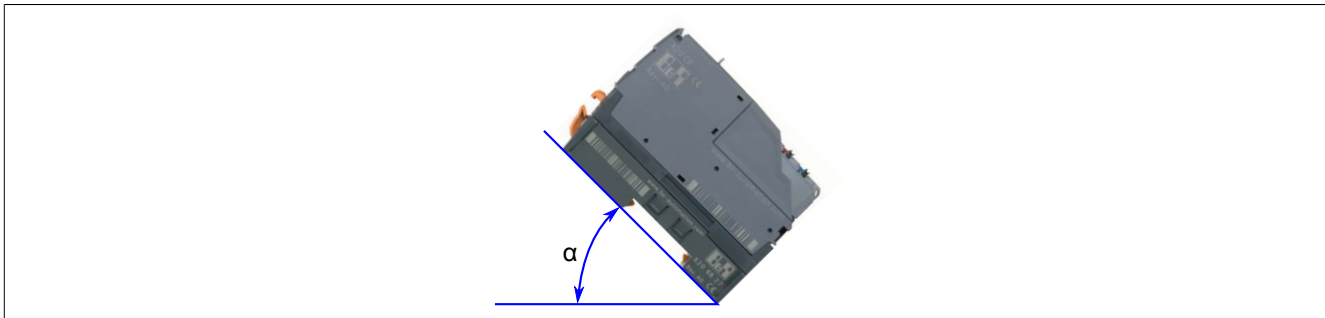
Information:

The controller must be secured against slipping with an [end clamp](#).



When using an overhead bus controller or a CPU, an additional derating of 5°C based on the vertical installation must be observed. The additional derating applies only to the bus controller, CPU and corresponding power supply unit.

4.3.3 Oblique installation



For oblique installation, the derating depends on angle α .

- $\alpha < 70^\circ$: An additional derating of 15°C based on the horizontal installation must be observed (corresponds to [lying installation](#)).
- $\alpha > 70^\circ$: No additional derating (corresponds to [horizontal installation](#))

4.3.4 Lying installation



An additional derating of 15°C based on the horizontal installation must be observed when installing with the top-hat rail at the bottom.

4.3.5 Installation with increased vibration requirements (4 g)

The following additional measures are necessary to fulfill increased vibration requirements regardless of whether X20 modules are installed horizontally or vertically:

1. Apply foam tape along the entire length of the module configuration under the top edge.
2. Use special end clamps to the left and right to provide additional fixation (supplement foam tape as shown in the image).
3. For CPUs with exchangeable battery, foam tape must be applied to the inner side of the battery cover to help hold the battery in place.
4. If slots are free, use dummy housings to ensure that the controller is held effectively in place.
5. Proper strain relief on all wires

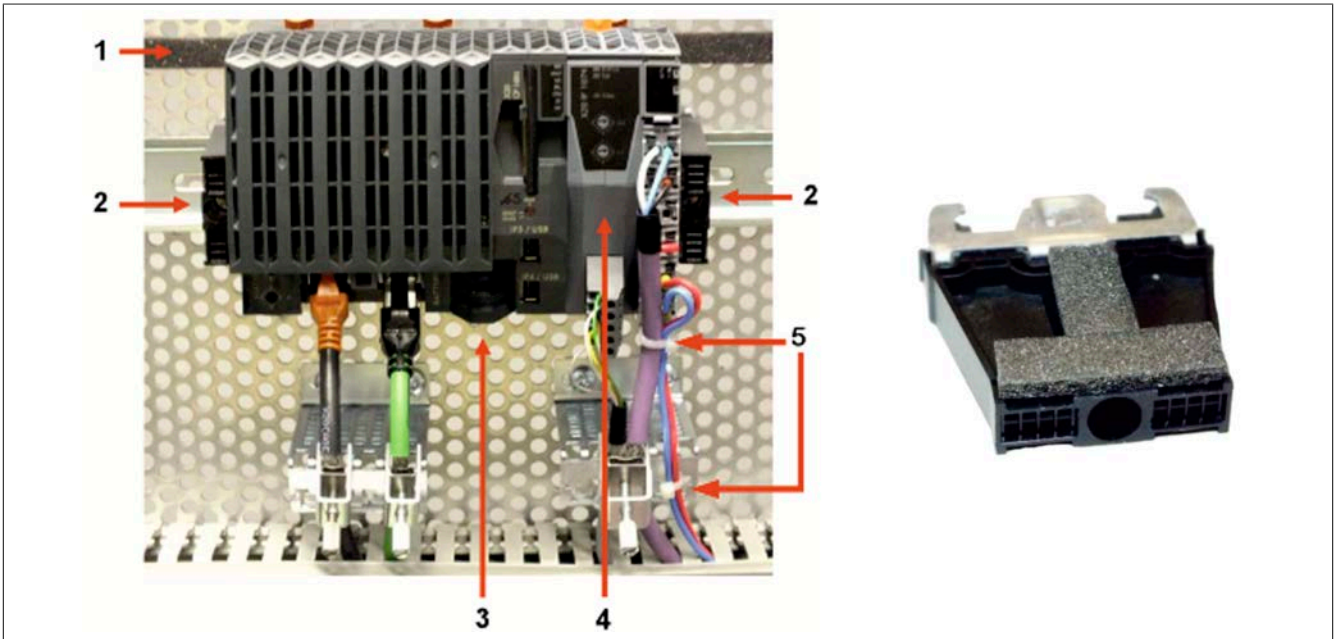


Figure 12: X20 system - Installation with increased vibration requirements (4 g) and end clamp




Notice!

The attachable end cover plates for some X20 modules should be removed for "installation with increased vibration requirements (4 g)"!



Figure 13: X20 system - Removing the end cover plates

Required accessories

| Beschreibung | Abbildung |
|---|---|
| <p>1x Set X20AC0RF1 bestehend aus 2x Endklammern für Hutschiene TH35 (Schaumstoffband ergänzen) und 1x Schaumstoffband 12 x 3 x 1000 mm (Höhe x Breite x Länge)</p> |  |
| <p>Batterieabdeckung bei CPU's mit Schaumstoffband L=15 mm bekleben.</p> |  |
| <p>Leergehäuse X20IF0000 im Fall freier Steckplätze</p> |  |

4.4 Wiring

In order to achieve a secure connection in the terminal blocks, wires must be stripped accordingly.

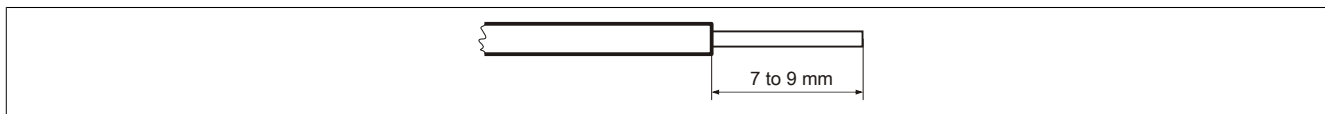


Figure 14: Wire stripping length for a secure connection

Information:

The wire stripping length is not permitted to be more or less than 7 to 9 mm.

4.5 Stress relief using cable ties



Figure 15: Stress relief using cable ties

The X20 system terminal blocks have slots for the cable ties. If needed, a cable tie can be fed through these slots to reduce the stress on the cable.

Cable tie dimensions: Width \leq 4.0 mm
 Thickness \leq 1.2 mm



Figure 16: Slots through which the cable ties are fed

4.6 Shielding

In principle, the shield must be grounded in all shielded cables:

- Analog signals (inputs and outputs)
- Interface modules
- Counter modules
- X2X Link cables
- Fieldbus connections (PROFIBUS DP, CAN bus, etc.)

In general, the following guidelines apply for shielding:

- The X20 top-hat rail must always be mounted to a conductive backplane.
- Shielded cables must be grounded on both sides.

4.6.1 Direct shielding connection

The shield is twisted and connected to the bus module's ground connection using a cable lug (2.8 x 0.5 mm). The cable is additionally secured to the terminal block using a cable tie (stress relief).

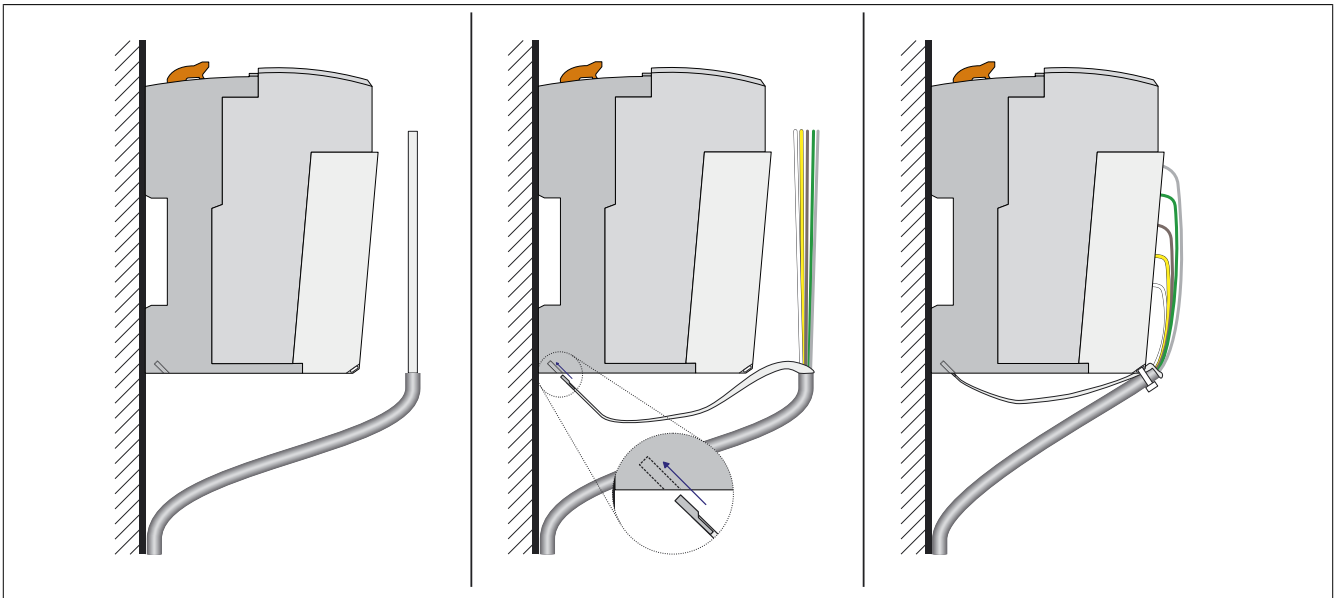


Figure 17: Direct shielding connection

Information:

The ground connection should be made as short and with as little resistance as possible.

4.6.2 X20 cable shield clamp

The X20 cable shield clamp (model number X20AC0SG1) is latched to the terminal block and connected to the bus module's ground connection using a cable lug. Cable ties are used to press the shield against the grounding plate.

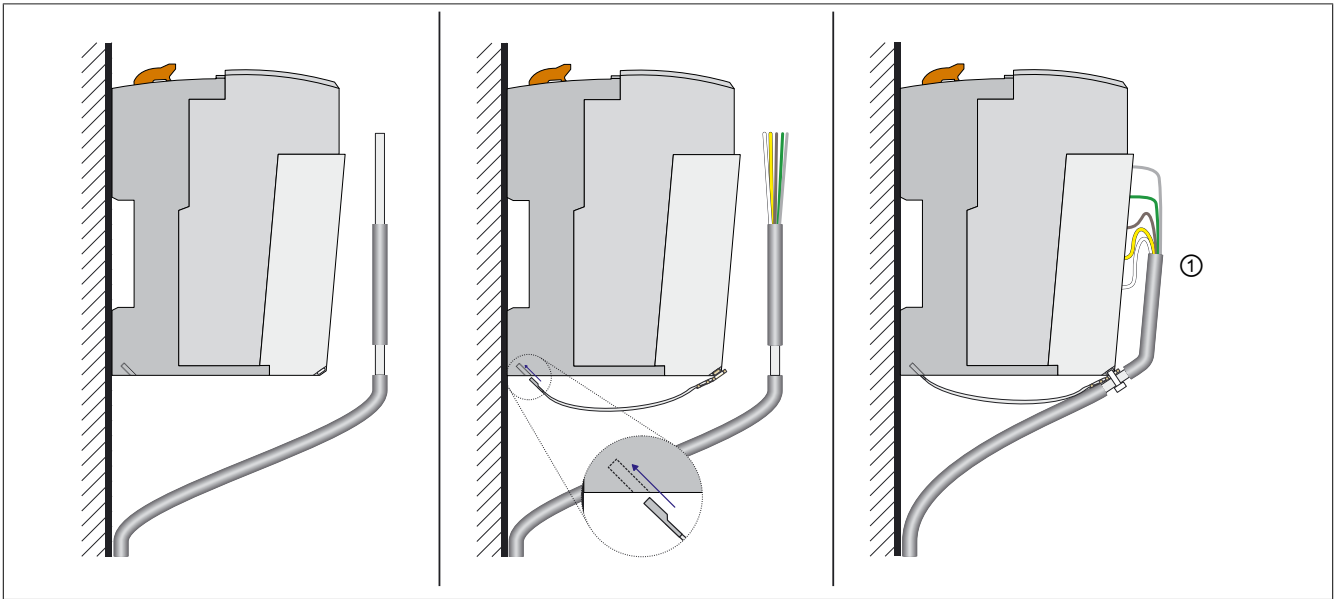


Figure 18: Shielding via X20 cable shield clamp

To reduce the EMC emissions most effectively, the cable shield must be as long as possible after the cable tie (see ① in the diagram above).

4.6.3 X20 shielding bracket

Order data

| Model number | Short description |
|----------------|-------------------------------------|
| | Shielding bracket |
| X20AC0SF7.0010 | X20 shielding bracket 66 mm 10 pcs. |
| X20AC0SF9.0010 | X20 shielding bracket 88 mm 10 pcs. |

Table 2: X20AC0SF7.0010, X20AC0SF9.0010 - Order data

The X20 shielding bracket is installed underneath the X20 system. The shield is pressed against the shielding bracket using ground terminals from another manufacturer (e.g. PHOENIX or WAGO) or a cable tie.

2 lengths are available depending on the application:

| Model number | Length | Application |
|----------------|--------|--|
| X20AC0SF7.0010 | 66 mm | <ul style="list-style-type: none"> I/O modules Power supply modules Integrated I/O on X20CP13xx systems Onboard interfaces on CPUs |
| X20AC0SF9.0010 | 88 mm | <ul style="list-style-type: none"> Interface modules Bus controller modules CPUs constructed in the form of an interface module |

Dimensions

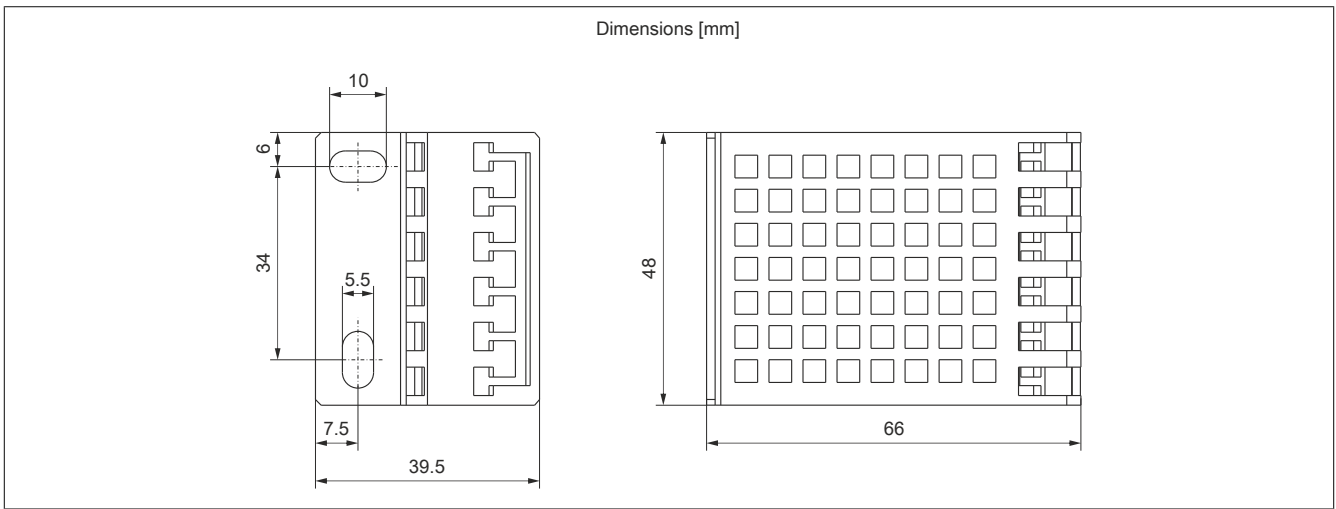


Figure 19: X20AC0SF7.0010 - Dimensions

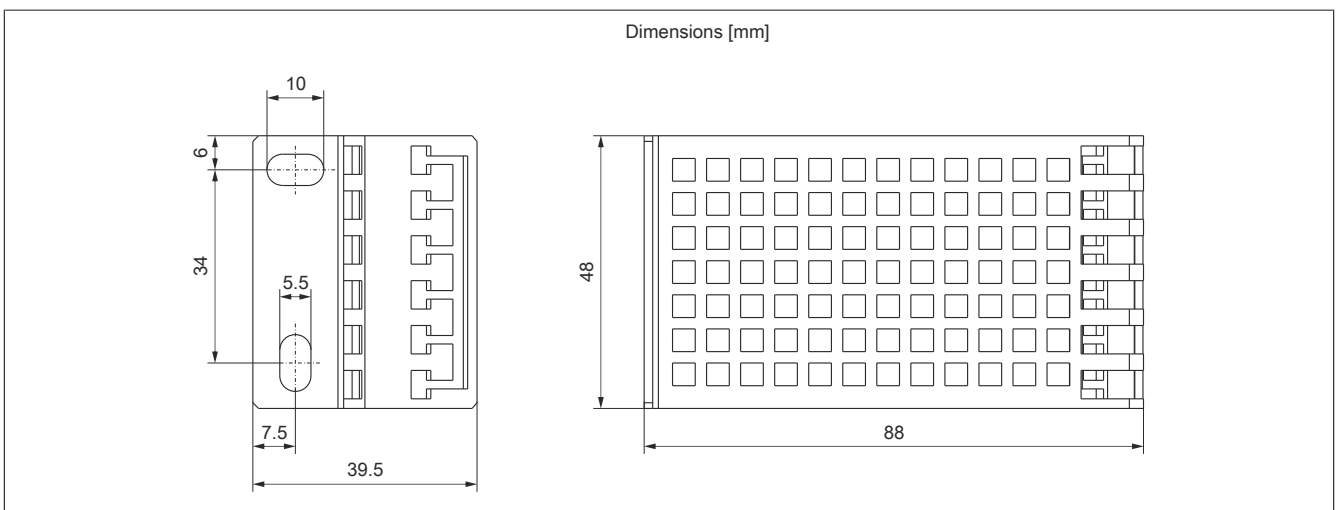


Figure 20: X20AC0SF9.0010 - Dimensions

Package contents

- 10 pcs. X20 shielding bracket
- Installation template

4.6.3.1 X20AC0SF7.0010 - 66 mm shielding bracket

Application example

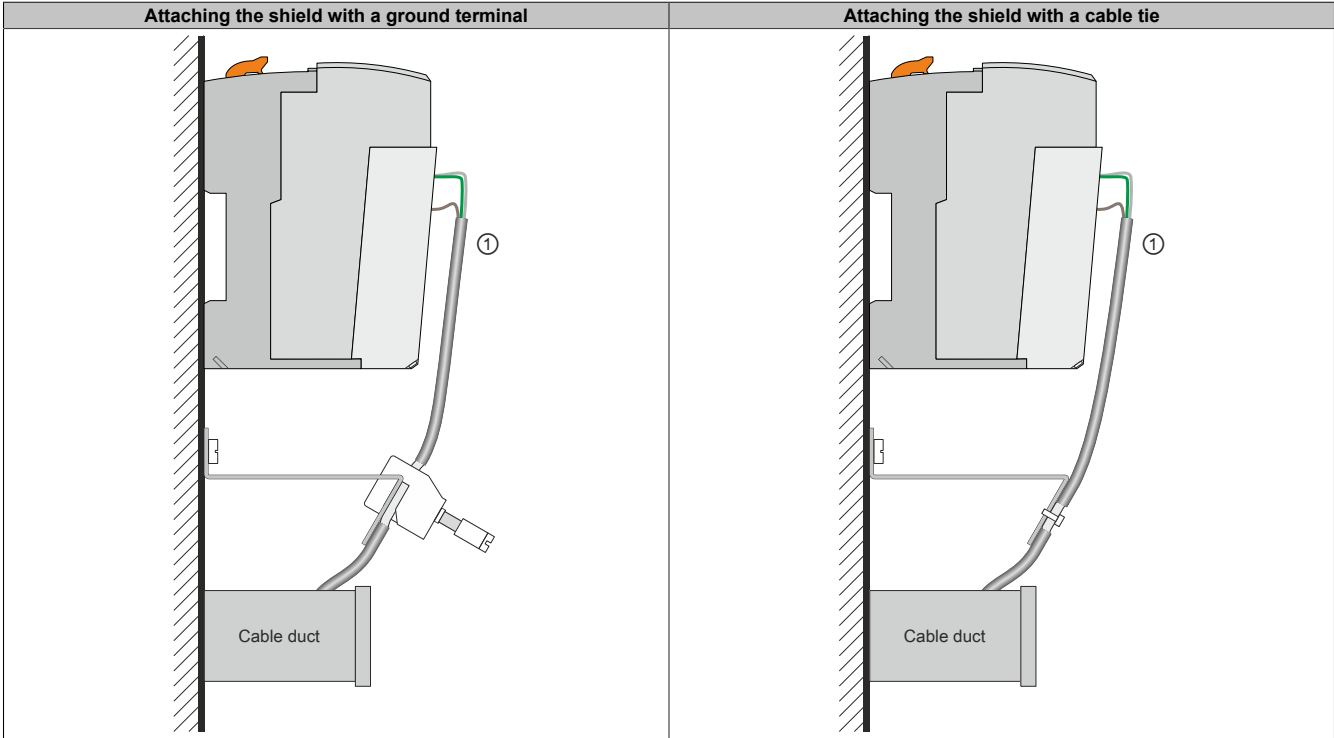
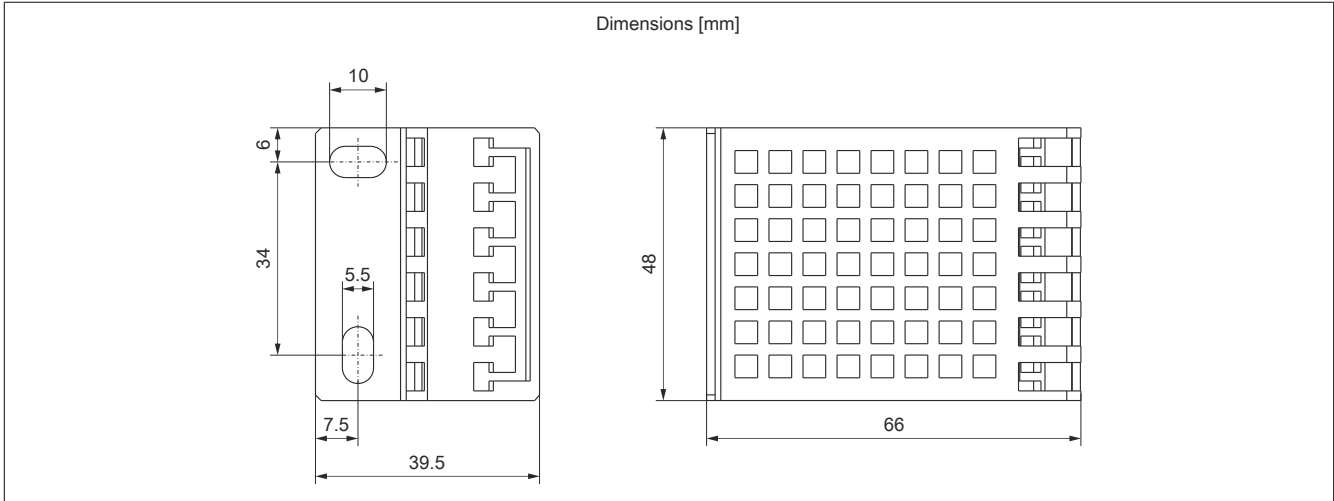


Table 3: Cable shielding via X20 shielding bracket

To reduce EMC emissions as much as possible, the cable shield must reach as high as possible after attaching the cable to the shielding bracket (see ① in the figure above).

Dimensions



Content of delivery

- 10 X20 shielding brackets
- Installation template

4.6.3.2 X20AC0SF9.0010 - 88 mm shielding bracket

Application example

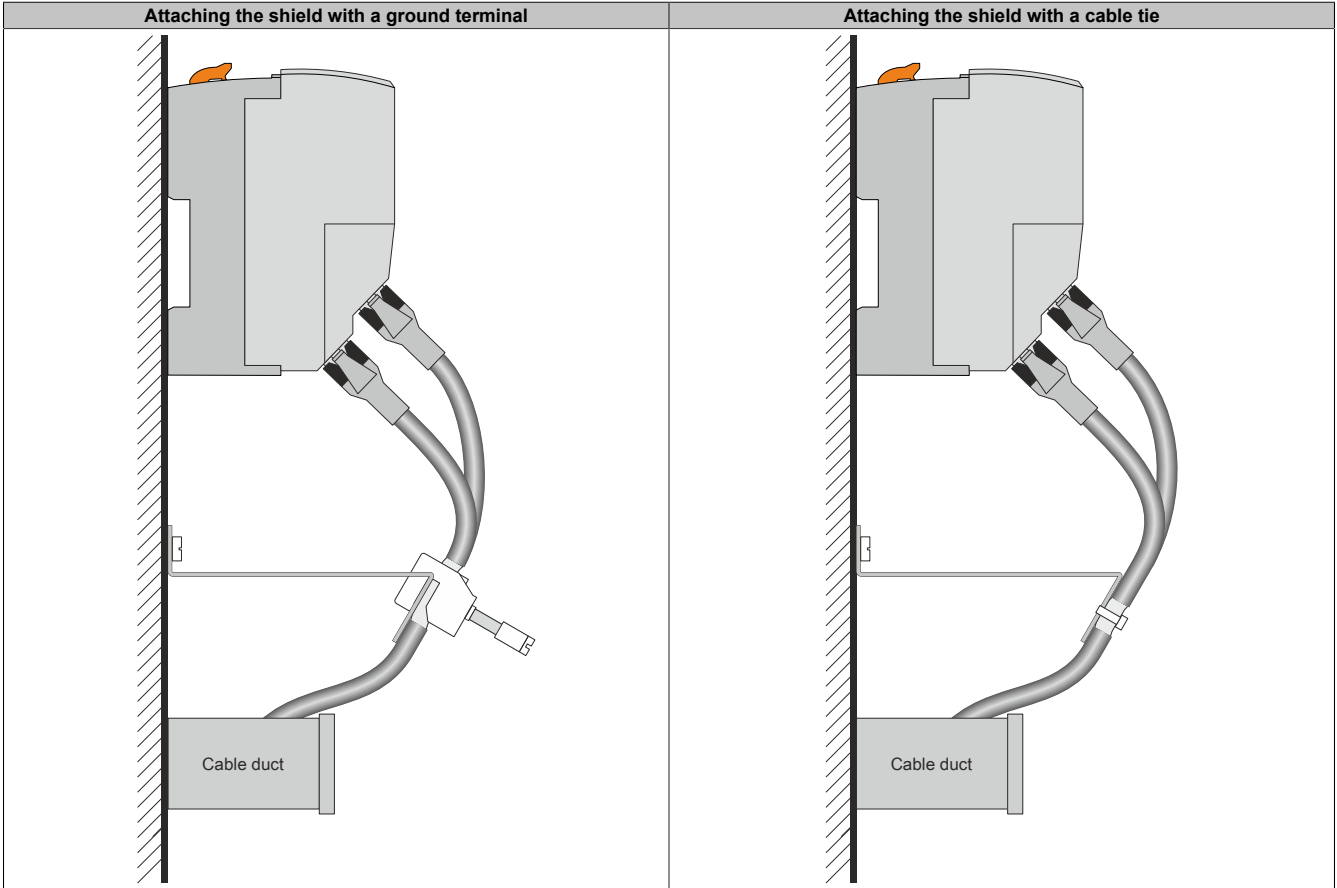
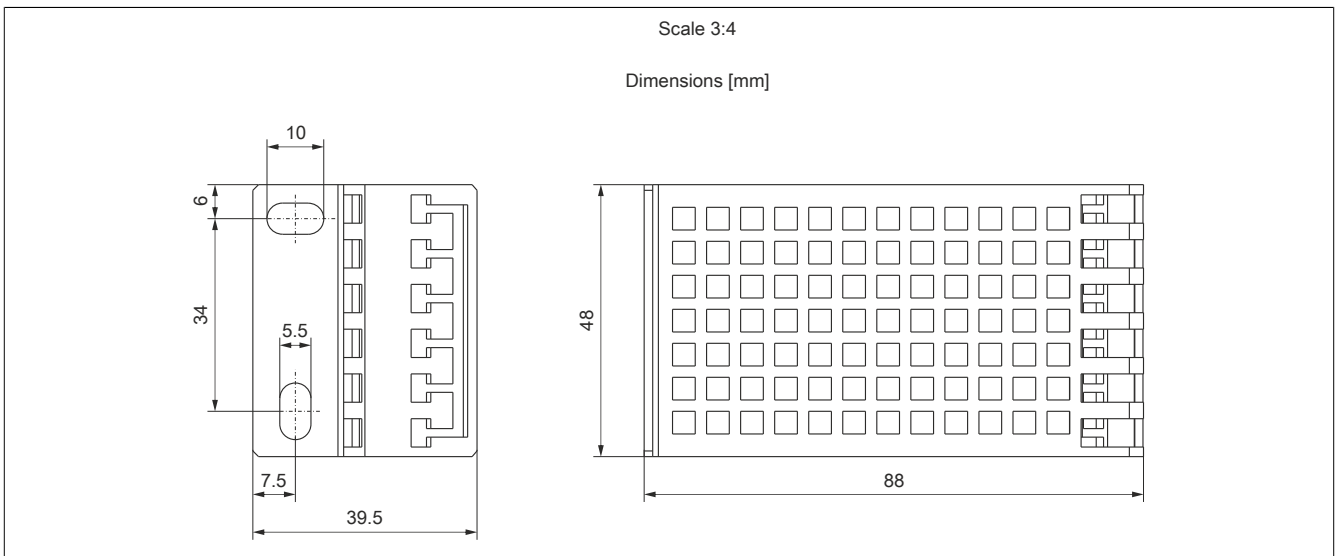


Table 4: Cable shielding via X20 shielding bracket

Dimensions



Content of delivery

- 10 X20 shielding brackets
- Installation template

4.6.4 Shielding via top-hat rail or bus bar

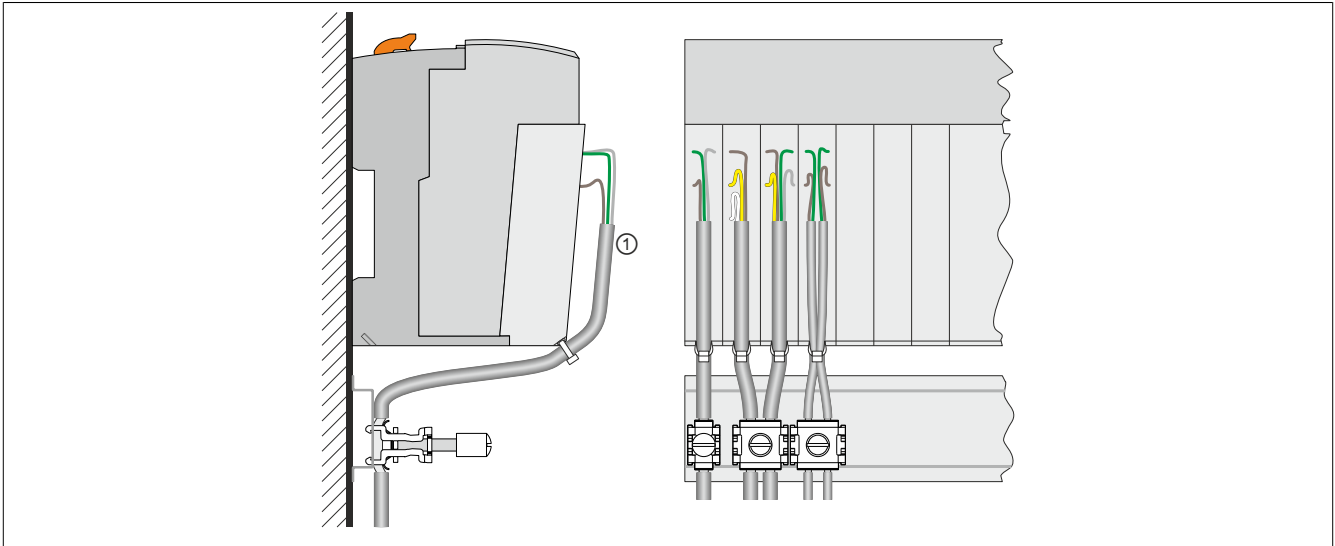


Figure 21: Shielding via top-hat rail or bus bar

Grounding terminals from other manufacturers (such as GOGATEC) can be used to achieve shielding right on the top-hat rail or on special bus bars directly below the controller.

- B&R recommends always using a grounding terminal via the top-hat rail to connect the X2X Link cable shield directly with the conductive and grounded backplane. This will generally exceed the specified EMC minimal requirements.
- The shielded cables from other modules can be grouped and clamped together. This may also be necessary due to space limitations. A different number of cables can be grounded together with a single terminal depending on the grounding terminals being used.

To reduce the EMC emissions most effectively, the cable shield must be as long as possible after the cable tie (see ① in the diagram above).

4.7 Cabling guidelines for X20 modules with an Ethernet cable

A number of X20 modules are based on Ethernet technology. POWERLINK cables offered by B&R can be used for the necessary wiring.

| Model number | Connection type |
|----------------|--|
| X20CA0E61.xxxx | Connection cable - RJ45 to RJ45 |
| X20CA3E61.xxxx | RJ45 to RJ45 connection cable, can be used in drag chains |
| X67CA0E41.xxxx | Attachment cable - RJ45 to M12 |
| X67CA3E41.xxxx | RJ45 to M12 attachment cable, can be used in cable drag chains |

The following cabling guidelines must be observed:

- Use CAT5 SFTP cables.
- Observe minimum cable bend radius (see data sheet for the cable).
- Secure the cable underneath the bus controller. The cable must be secured vertically under the RJ45 connector on the bus controller.

Information:

Using POWERLINK cables offered by B&R satisfies the EN 61131-2 product standard.

For any further requirements, the customer must take additional measures.

Wiring diagram

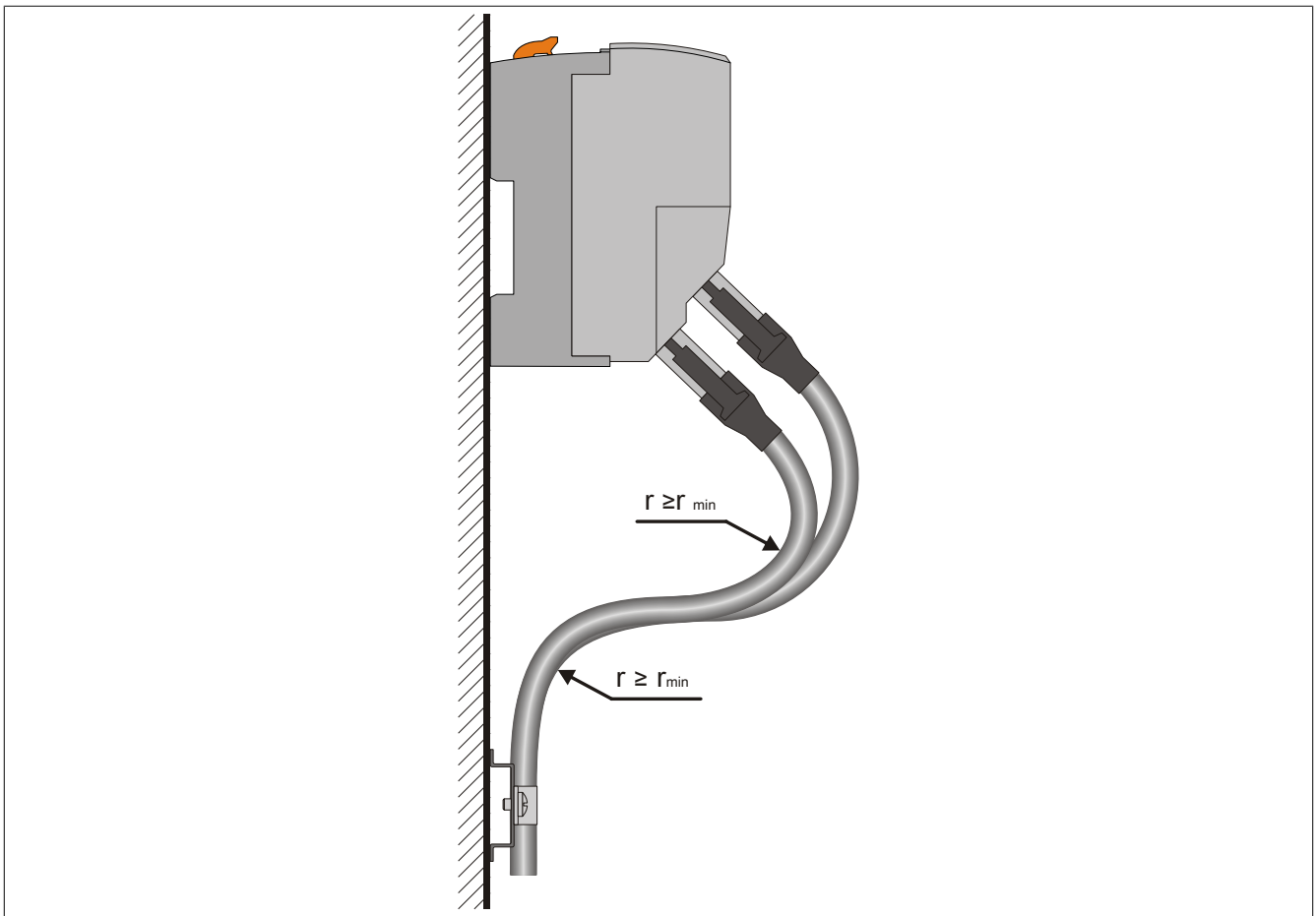


Figure 22: Wiring diagram for X20 modules with an Ethernet cable

4.8 The supply concept

Danger!

In order to guarantee a specific supply voltage, a SELV power supply that conforms to EN 60204-1 must be used to supply the bus and I/O.

4.8.1 Bus module rack replacement

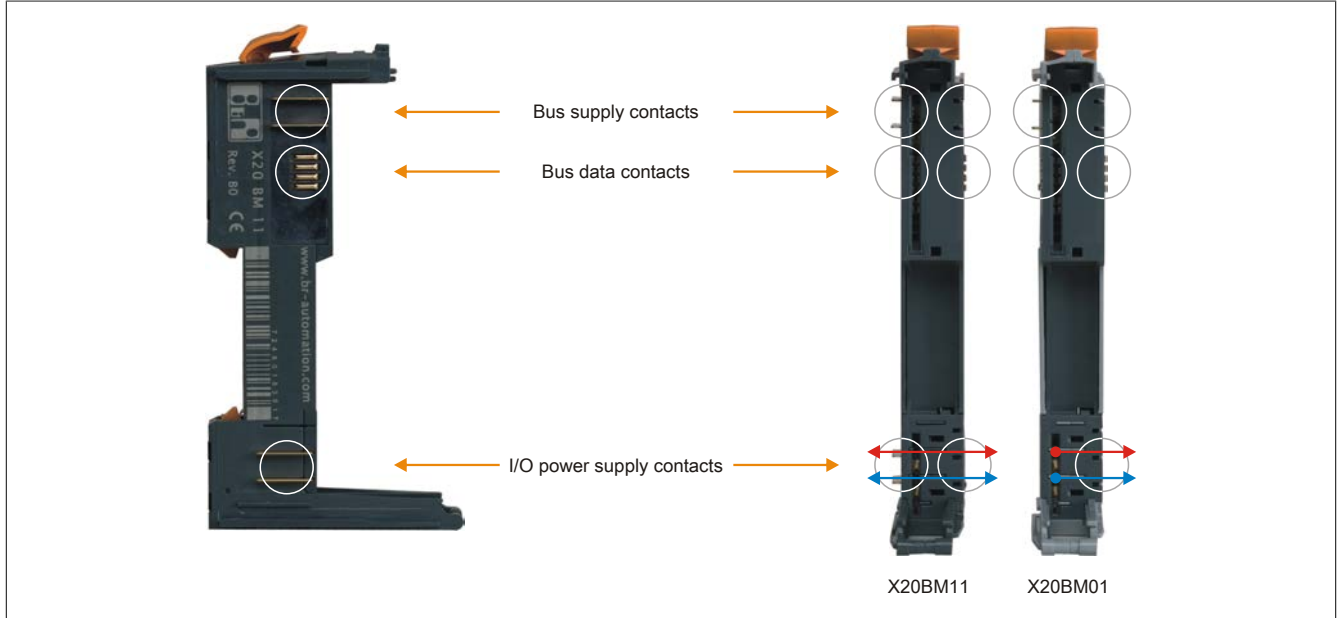


Figure 23: The bus module replaces the rack in the X20 system

The bus module is the backbone of the X20 system regarding the bus supply and bus data as well as the I/O supply for the electronics modules. Each bus module is an active bus station, even without an electronics module. There are two variations of the bus module:

- Interconnected I/O supply
- I/O supply isolated to the left (for power supply modules)

4.8.2 X20 system infrastructure

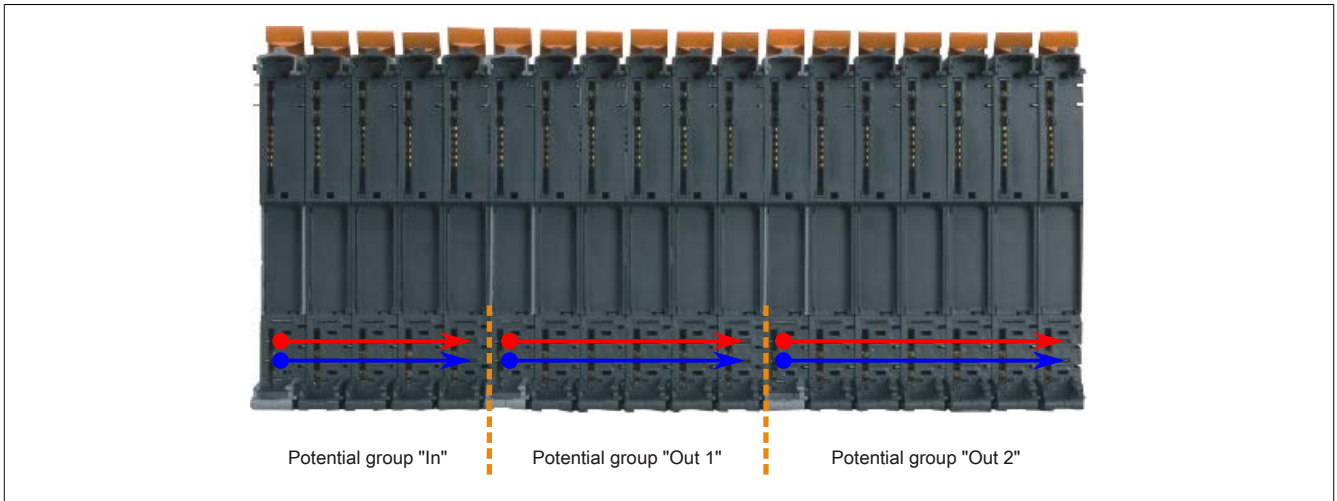


Figure 24: Simple implementation of different potential groups

Different potential groups can be implemented with the appropriate arrangement of supply bus modules, (e.g. for input groups or different emergency stop circuits on the outputs). The I/O power supply is fed by power supply modules.

4.8.3 Bus supply

Because the remote X2X Link backplane and I/O electronics are completely electrically isolated, the X2X Link power supply needs to be fed in at certain intervals. This is initially handled by the bus receiver. A supply module for X2X Link must be added to refresh the supply after approximately 30 modules (for an example calculation, see ["Calculating the power requirements" on page 81](#)). On the same module, a separate feed for the I/O power supply can also be connected.

4.8.4 Potential groups

The I/O supply is connected via the bus modules, and the supply is fed in using corresponding power supply modules. This makes it possible to implement simple potential groups (e.g. for input groups or different output groups). For isolation, the corresponding bus module is also necessary, which provides isolation of the internal I/O supply.

4.8.5 Output modules with supply

Generally, a power supply module is also necessary for current output modules with many channels, such as the 8 channel output module with 2 amp outputs. This is not the case with the X20 system. With this module, the supply is provided directly on the module, thereby saving power supply modules and construction width.

4.8.6 Bus receiver with supply

The X20BR9300 bus receiver for the X20 system is equipped with a supply for X2X Link as well as for the internal I/O supply. This eliminates the need for an additional power supply module.

4.8.7 Supply module for internal I/O supply

The first I/O modules in an X20 system are supplied by the bus receiver. The internal I/O supply is refreshed via the X20PS2100 power supply module.

4.8.8 Power supply module for internal I/O supply and bus supply

The X2X Link is fed by the X20BR9300 bus receiver. After approx. 30 modules (see section "[Calculating the power requirements](#)" on page 81 for a calculation example), the supply must be "refreshed". The X20PS3300 power supply module is used for this. This module is equipped with a feed for X2X Link as well as for the internal I/O power supply.

4.8.9 Bus transmitter with supply

The X20BT9100 bus transmitter has an integrated I/O supply feed. This saves a power supply module for the last potential group.

4.8.10 Internal I/O power supply failure (ModuleOk)

The ModuleOk status for monitoring the X20 modules is made up of different module parameters.

Information:

All modules that require 0.01 W of power on the X2X Link network must be supplied via the internal I/O power supply. If the I/O power supply fails, the module shuts down and communication is lost. In this case, ModuleOk returns the value "False" and data can no longer be read from the "embedded parameter chip".

4.8.11 X20 system power supply

The power supply for the X20 system is provided by B&R 24 VDC power supplies. B&R power supplies ensure that control systems are reliably supplied even when operated at the minimum mains input voltage or when maximum power is output even in the event of temporary power failures (≤ 10 ms).

The power to be provided by the B&R power supply must be calculated (see "[Dimensioning the external 24 VDC power supply](#)" on page 94).

4.8.12 X2X Link supply

The X2X Link remote backplane is supplied separately from the I/O points. This ensures that the remote backplane does not fail if there is a power failure on the I/O side, for example during an emergency stop. After approx. 30 modules, it is necessary to "refresh" with a power supply module for X2X Link.

To achieve increased supply security, it is possible to set up a redundant X2X Link power supply. To do so, the necessary X2X Link power must be determined and then covered by the corresponding quantity plus at least one additional X2X Link power supply module. This guarantees the functionality of the remote backplane even if the X2X Link power supply fails.

Please note the following for the correct calculation:

- To determine the necessary X2X Link power, calculate using 75% of the power supply module's rated power during parallel operation.

Information:

This must be done for all power supply modules at the same time for a non-redundant X2X Link power supply or when completely turning the X2X supply of an X20 module block on/off.

4.8.12.1 Example for extended X2X Link supply

It is possible to set up potential groups through the use of different supplies for the power supply modules.

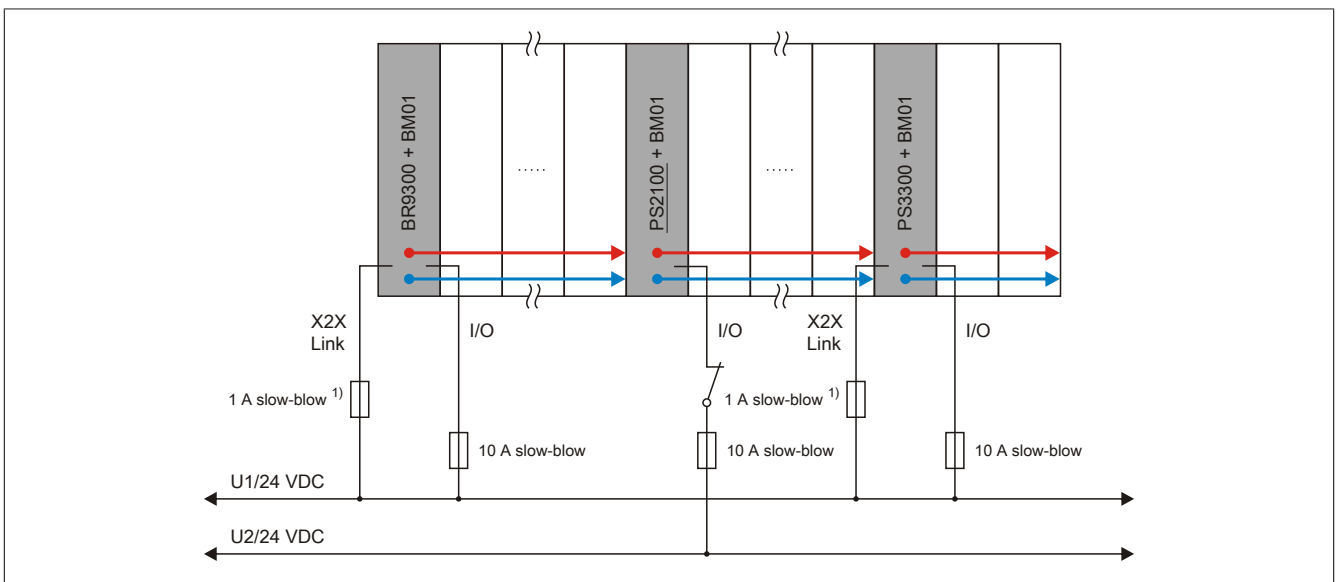


Figure 25: Example for extended X2X Link supply

1) Recommended for line protection.

The X20PS3300 power supply module supplies both the X2X Link and I/O; the X20PS2100 power supply module only supplies the I/O.

4.8.12.2 Example for redundant X2X Link supply

Multiple X20PS3300 power supply modules can be set up in parallel. It is possible to set up potential groups through the use of different supplies.

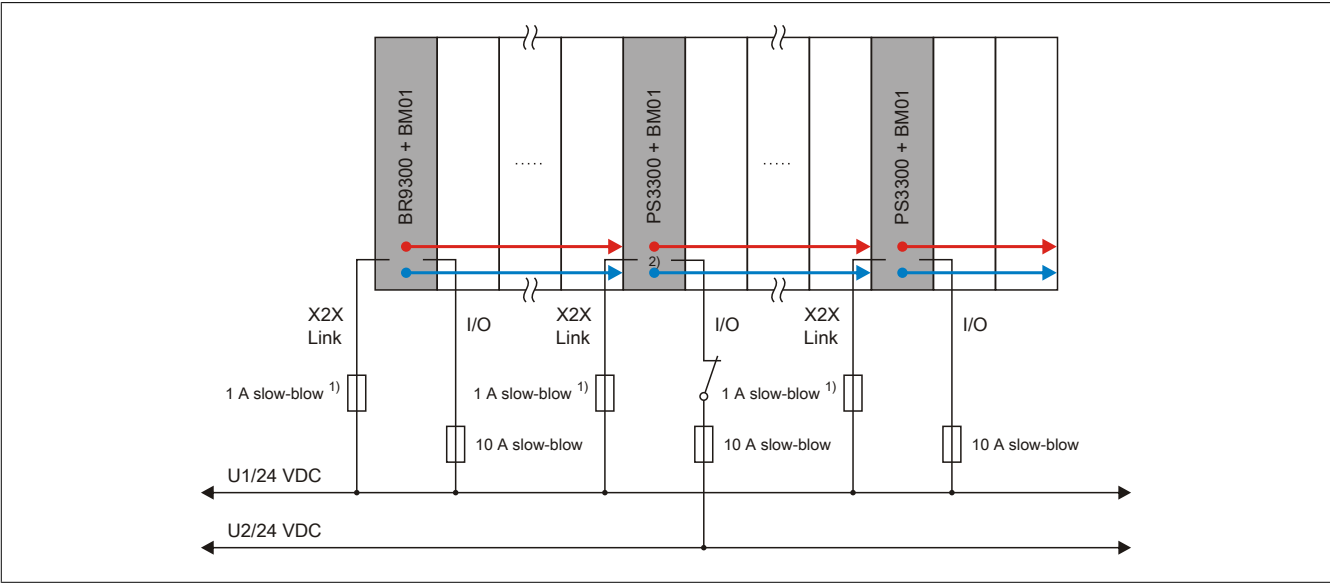


Figure 26: Example for redundant X2X Link supply

- 1) Recommended for line protection.
- 2) With separate supplies, the two reference potentials (GND_1 and GND_2) are combined via the terminal block on the PS3300.

The X20PS3300 power supply module supplies both X2X Link and the I/O.

4.9 X20 system protection

The protection for the X20 system depends on the supply concept.

4.9.1 Potential groups

Using the X20BM01 bus module and organizing the power supply bus modules accordingly allows various potential groups to be implemented (e.g. for input groups or various power circuits for the outputs).

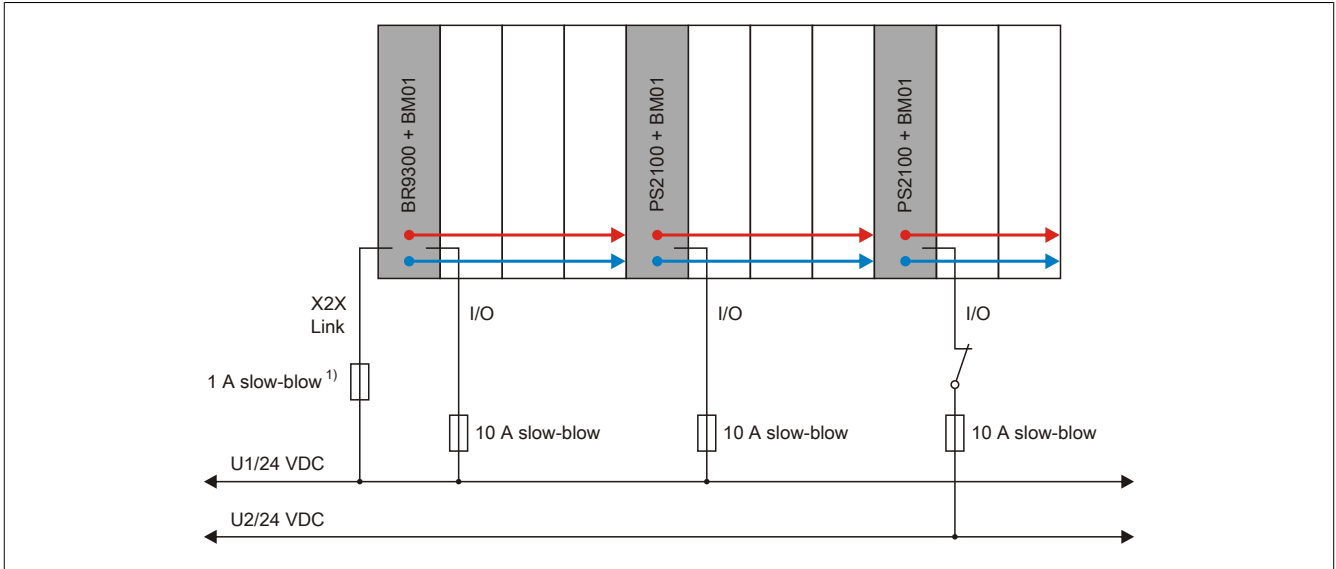


Figure 27: Protecting various potential groups

1) Recommended for line protection.

4.9.2 Supply via bus transmitter

The bus transmitter has an integrated internal I/O supply feed. This saves a power supply module for the last potential group.

Keep in mind: this potential group is separated from the rest of the potential groups by an I/O module with the x20(c)BM01 bus module.

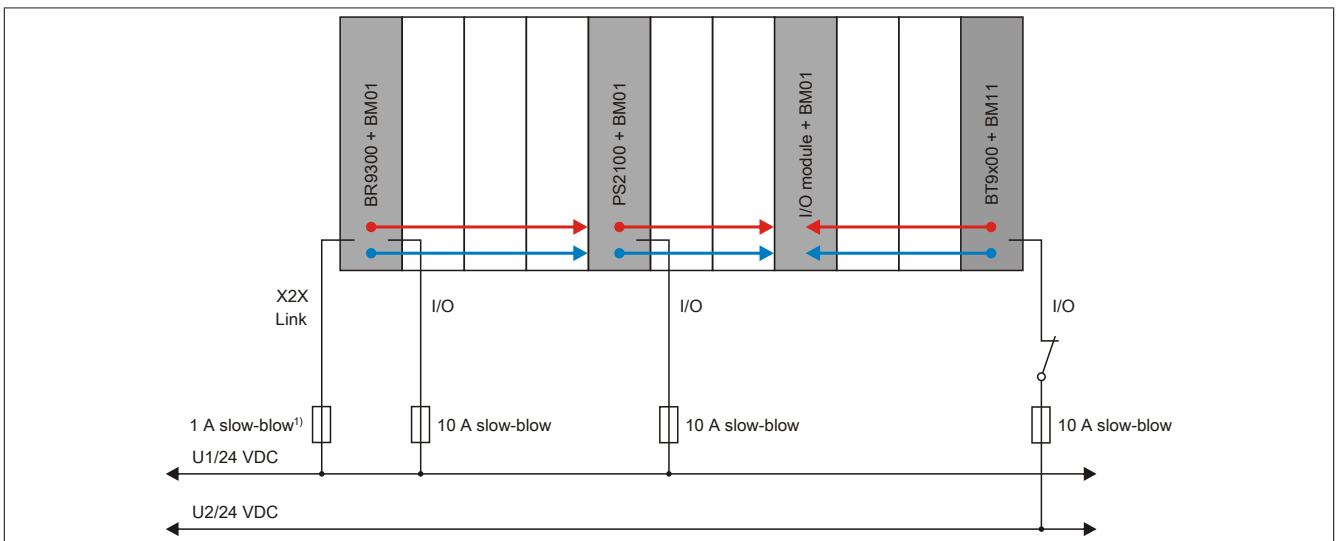


Figure 28: Protection when supplied via bus transmitter

1) Recommended for line protection.

4.10 Safe cutoff of a potential group

Information:

B&R keeps user's manuals as current as possible. From a safety standpoint however, the current certified version of the document must be used.

The current certified document is available for download under [Website > Downloads > Certificates > Safety technology > X20, X67 > Safe cutoff of potential groups](#).

4.10.1 Description of function

The operating principle "Safe cutoff of a potential group" enables the user to execute safety-related functions within a B&R system in combination with an external safety relay.

The safety function is limited to cutting off or interrupting the power to connected actuators.

Functionality

An external safety relay is connected to the I/O power supply for the potential group or an X20SP1130 power supply module is used. When the functional safe state is requested or state "Failsafe" occurs, then this feed cuts off the I/O power supply of the potential group. The power is then also cut off for all actuators connected to this potential group. However, module-internal energy storage devices (e.g. capacitors) remain charged and must be taken into account in the assessment of the safety function.

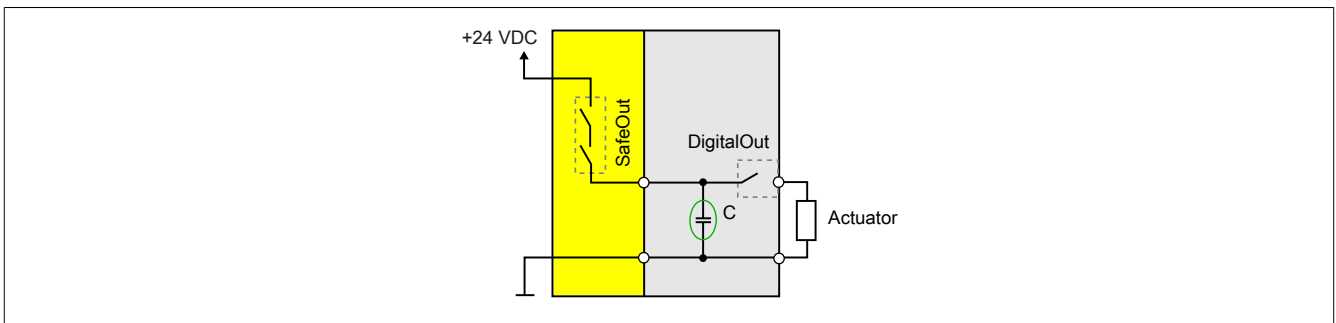


Figure 29: Functionality with internal energy storage

4.10.2 Scope of application / Standards referenced

The operating principle is confined to machine manufacturing applications and therefore implicitly to the following standards:

- EN ISO 13849-1:2015 / EN ISO 13849-2:2012

Requirements of other standards are not taken into consideration.

4.10.3 Intended use

Danger!

Danger from incorrect use of safety-related products/functions

Proper functionality is only ensured if the products/functions are used in accordance with their intended use by qualified personnel and the provided safety information is taken into account. The aforementioned conditions must be observed or covered by supplementary measures on your own responsibility in order to ensure the specified protective functions.

4.10.3.1 Qualified personnel

Use of safety-related products is restricted to the following persons:

- Qualified personnel who are familiar with relevant safety concepts for automation technology as well as applicable standards and regulations
- Qualified personnel who plan, develop, install and commission safety equipment in machines and systems

Qualified personnel in the context of this manual's safety guidelines are those who, because of their training, experience and instruction combined with their knowledge of relevant standards, regulations, accident prevention guidelines and operating conditions, are qualified to carry out essential tasks and recognize and avoid potentially dangerous situations.

In this regard, sufficient language skills are also required in order to be able to properly understand this manual.

4.10.3.2 Area of application

The safety-related B&R control components described in this manual were designed, developed and manufactured for special applications for machine and personnel protection. They are not suitable for any use involving serious risks or hazards that could lead to the injury or death of several people or serious environmental impact without the implementation of exceptionally stringent safety precautions. In particular, this includes the use of these devices to monitor nuclear reactions in nuclear power plants, flight control systems, air traffic control, the control of mass transport vehicles, medical life support systems and the control of weapon systems.

When using safety-oriented control components, the safety precautions applying to industrial control systems (e.g. the provision of safety devices such as emergency stop circuits, etc.) must be observed in accordance with applicable national and international regulations. The same applies for all other devices connected to the system, e.g. drives or light curtains.

The safety guidelines, information about connection conditions (nameplate and documentation) and limit values specified in the technical data must be read carefully before installation and commissioning and must be strictly observed.

4.10.3.3 Security concept

B&R products communicate via a network interface and were developed for integration into a secure network. The network and B&R products are affected by the following hazards (not a complete list):

- Unauthorized access
- Digital intrusion
- Data leakage
- Data theft
- A variety of other types of IT security breaches

It is the responsibility of the operator to provide and maintain a secure connection between B&R products and the internal network as well as other networks, such as the Internet, if necessary. The following measures and security solutions are suitable for this purpose:

- Segmentation of the network (e.g. separation of the IT and OT networks)
- Firewalls for the secure connection of network segments
- Implementation of a security-optimized user account and password concept
- Intrusion prevention and authentication systems
- Endpoint security solutions with modules for anti-malware, data leakage prevention, etc.
- Data encryption

It is the responsibility of the operator to take appropriate measures and to implement effective security solutions.

B&R Industrial Automation GmbH and its subsidiaries are not liable for damages and/or losses resulting from, for example, IT security breaches, unauthorized access, digital intrusion, data leakage and/or data theft.

Before B&R releases products or updates, they are subjected to appropriate functional testing. Independently of this, the development of customized test processes is recommended in order to be able to check the effects of changes in advance. Such changes include, for example:

- Installation of product updates
- Notable system modifications such as configuration changes
- Import of updates or patches for third-party software (non-B&R software)
- Hardware replacement

These tests should ensure that implemented security measures remain effective and that systems behave as expected.

4.10.3.4 Safety technology disclaimer

The proper use of all B&R products must be guaranteed by the customer through the implementation of suitable training, instruction and documentation measures. The guidelines set forth in system user's manuals must be taken into consideration here as well. B&R has no obligation to provide verification or warnings with regard to the customer's purpose of using the delivered product.

Changes to the devices are not permitted when using safety-related components. Only certified products are permitted to be used. Currently valid product versions in each case are listed in the corresponding certificates. Current certificates are available on the B&R website (www.br-automation.com) in the Downloads section for the respective product. The use of non-certified products or product versions is not permitted.

All relevant information regarding these safety products must be read in the latest version of the related data sheet and the corresponding safety notices observed before the safety products are permitted to be operated. Certified data sheets are available on the B&R website (www.br-automation.com) in the Downloads section for the respective product.

B&R and its employees are not liable for any damages or loss resulting from the incorrect use of these products. The same applies to misuse that may result from specifications or statements made by B&R in connection with sales, support or application activities. It is the sole responsibility of the user to check all specifications and statements made by B&R for proper application as it pertains to safety-related applications. In addition, the user assumes sole responsibility for the proper design of the safety function as it pertains to safety-related applications.

4.10.3.5 Installation notes for X20 safety modules

Products must be protected against impermissible dirt and contaminants. Products are protected from dirt and contaminants up to pollution degree II as specified in the IEC 60664 standard.

Pollution degree II can usually be achieved in an enclosure with IP54 protection, but uncoated modules are NOT permitted to be operated in condensing relative humidity and temperatures under 0°C.

The operation of coated modules is allowed in condensing relative humidity.

Danger!

Pollution levels higher than specified by pollution degree II in standard IEC 60664 can result in dangerous failures. It is extremely important that you ensure a proper operating environment.

Danger!

In order to guarantee a specific voltage supply, a SELV power supply that conforms to IEC 60204 must be used to supply the bus, SafeIO and SafeLOGIC controller. This also applies to all digital signal sources that are connected to the modules.

If the power supply is grounded (PELV system), then only a GND connection is permitted for grounding. Grounding types that have ground connected to +24 VDC are not permitted.

The supply of X20 potential groups must generally be protected using a fuse with a maximum of 10 A. For more information, see chapter "Mechanical and electrical configuration" of the X20 or X67 user's manual.

4.10.3.6 Installation notes for X67 safety modules

Danger!

The following points must be taken into account to ensure IP67 protection:

- The union nuts on female/male connectors must be tightly secured with the specified tightening torque. For the tightening torque, see the X67 system user's manual.
- Female/Male connectors that are not being used must be closed with threaded caps!
 - Threaded caps M8, 50 pcs.: X67AC0M08
 - Threaded caps M12, 50 pcs.: X67AC0M12

Danger!

The shock and vibration resistance values (see chapter "International and national certifications" of the X67 system user's manual) apply if cables are laid solidly.

Danger!

In order to guarantee a specific voltage supply, a SELV power supply that conforms to IEC 60204 must be used to supply the bus, SafeIO and SafeLOGIC controller. This also applies to all digital signal sources that are connected to the modules.

If the power supply is grounded (PELV system), then only a GND connection is permitted for grounding. Grounding types that have ground connected to +24 VDC are not permitted.

Danger!

Unused female connectors must be covered with threaded caps (X67AC0M08 or X67AC0M12 accessory). Otherwise, hazardous conditions may arise if the module fails to function properly.

4.10.3.7 Safe state

If an error is detected by the module (internal or wiring error), the modules enable the safe state. The safe state is structurally designed as a low state or cutoff and cannot be modified.

Applications in which the safe state must actively switch on an actuator cannot be implemented with this module. In these cases, other measures must be taken to meet this safety-related requirement (e.g. mechanical brakes for hanging load that engage on power failure).

4.10.4 System-specific information

The operating principle applies to a potential group.

All potential groups are generally only permitted to be supplied by 1 power supply module. The possible further processing of the power supply on the module is not permitted to result in multiple supply instances.

In the X20 system, only modules of type X20BM01, X20BM23 and X20BM26 that ensure the interruption of the internal I/O power supply to the left are permitted to be used as bus modules for power supply modules.

On modules X20PS9400 and X20PS3300, only the I/O power supply (+24 V I/O) is permitted to be switched with the safety relay. The bus power supply (+24 V BC/X2X L.) must be isolated.

When using module X67PS1300 to supply power to the X67 potential group, only the I/O power supply (+24 V I/O) is permitted to be switched with the safety relay. The bus power supply (+24 V BC/X2X L.) must be isolated.

The operating principle is limited to the modules listed in the following certificate.



Certificate

[Website > Downloads > Certificates > Safety technology > X20, X67 > Safe cutoff of potential groups](#)

4.10.5 Safety guidelines

This section provides a summary of safety notices for the user.

Danger!

Failure of the safety function due to misuse

Observe the following safety guidelines. Failure to observe any of the following notices can lead to the failure of the safety function and may result in serious injury.

- When using the operating principle, it is the user's responsibility to adhere to the relevant standards and safety directives. In addition, the guidelines for proper use must be observed.
- For all potentials supplying the modules, SELV/PELV power supplies must be used.
- The potential groups for which the operating principle is applied are only permitted to contain modules listed from certificate "Safe cutoff of potential groups".
- Uncoated X20 modules in which the operating principle is used are not permitted to be operated in condensing air humidity or at temperatures below 0°C.
- It is not permitted to mix modules from different systems (X20, X67, 7XV) within a potential group.
- It is not permitted to install multiple power supplies in a potential group (particularly with regard to power supply modules that also supply the bus supply).
- Ensure that the upstream safety relay is wired properly.
- Ensure that ALL sensors and actuators connected to the potential group are wired properly.
- Note possible impairments of the safety function due to the internal energy storage devices. If this is sufficient to enable a connected actuator and subsequently leads to a dangerous state, the protection objective is not given and alternatives or supplementary measures must be installed.
- The switch-off time must be verified by a control measurement!
- For modules with isolated I/O potential for sensors and actuators, the upstream safety relay must shut off the supply for both the sensors and actuators.
- The ground connections should be used as functional ground and not as protective ground and must not be connected to the 24 V supply voltage (GND is permitted). In addition, no protective components are permitted to be used between the ground and the 24 V supply voltage.

4.10.5.1 Capacitances within the potential group

The internal capacitances of the module remain charged at the time of shutdown. The total capacitance of the potential group results from the sum of the capacitances of the individual modules, upstream external safety relay and actuator.

$$C_{total} = \sum_{i=1}^n C_i$$

The capacitances of the corresponding B&R modules are listed in the certificate.



Certificate

[Website > Downloads > Certificates > Safety technology > X20, X67 > Safe cutoff of potential groups](#)

At the time a safety function is requested, it is not ensured that the standard outputs are enabled. If an output is disabled at the time of the request, the affected module-internal capacitances remain permanently charged. If the output is enabled by the standard application, an unexpected voltage peak occurs on the output.

In connection with the supply voltage, the total capacitance present in the system results in a charge that must be taken into account during cutoff. In the worst case scenario, it can be assumed that the total capacitance present in the system buffers each output present in the potential group. This behavior is not permitted to lead to a safety-critical state due to actuators in the potential group; alternatives or supplementary corrective measures must be installed.

4.10.5.2 Potential group structure

The potential group is only permitted to be made up of modules listed in the following certificate. Modules not listed in this certificate endanger the "absence of feedback" of the external cutoff and therefore the safety function.

**Certificate**

[Website > Downloads > Certificates > Safety technology > X20, X67 > Safe cutoff of potential groups](#)

To ensure clarity and that the external cutoff is triggered when a fault occurs, installing multiple power supply sources in a potential group is not permitted.

SELV/PELV power supplies must be used for both the bus supply (X2X) and the I/O power supply; otherwise, safety-related malfunctions can occur due to overvoltages.

For modules with isolated I/O potential for sensors and actuators, the upstream safety relay must shut off the supply for both the sensors and actuators; otherwise, feedback cannot be excluded.

4.10.5.3 Circuit examples

Single-channel without feedback

The following example shows a load being cutoff using the emergency stop safety function. Only safe actuators such as motors or input "Enable" of an ACOPOS/ACOPOSmulti drive are permitted to be used as the load in this case.

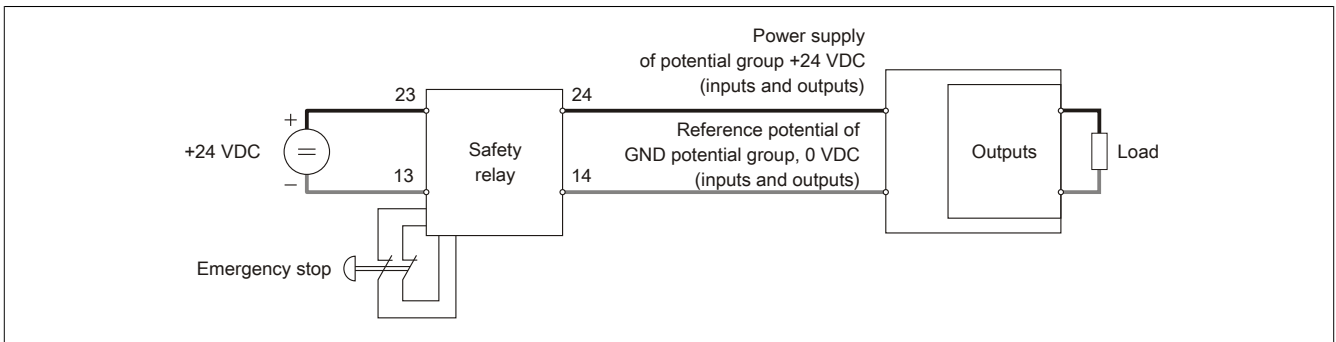


Figure 30: Circuit example: 1-channel without feedback

Provided that the external components being used (emergency stop switch, safety relay, load) satisfy the respective requirements, this example can achieve PL e (performance level as specified in EN ISO 13849-1:2015).

Dual-channel with feedback

The following example shows a load being cutoff using the emergency stop safety function. Feedback allows errors in the actuator to also be detected, and a cutoff is also possible if a fault event occurs due to the full dual-channel design. Whether or not 2 fully isolated potential groups – as shown in the example – are necessary depends on the application and how the safety solution is designed.

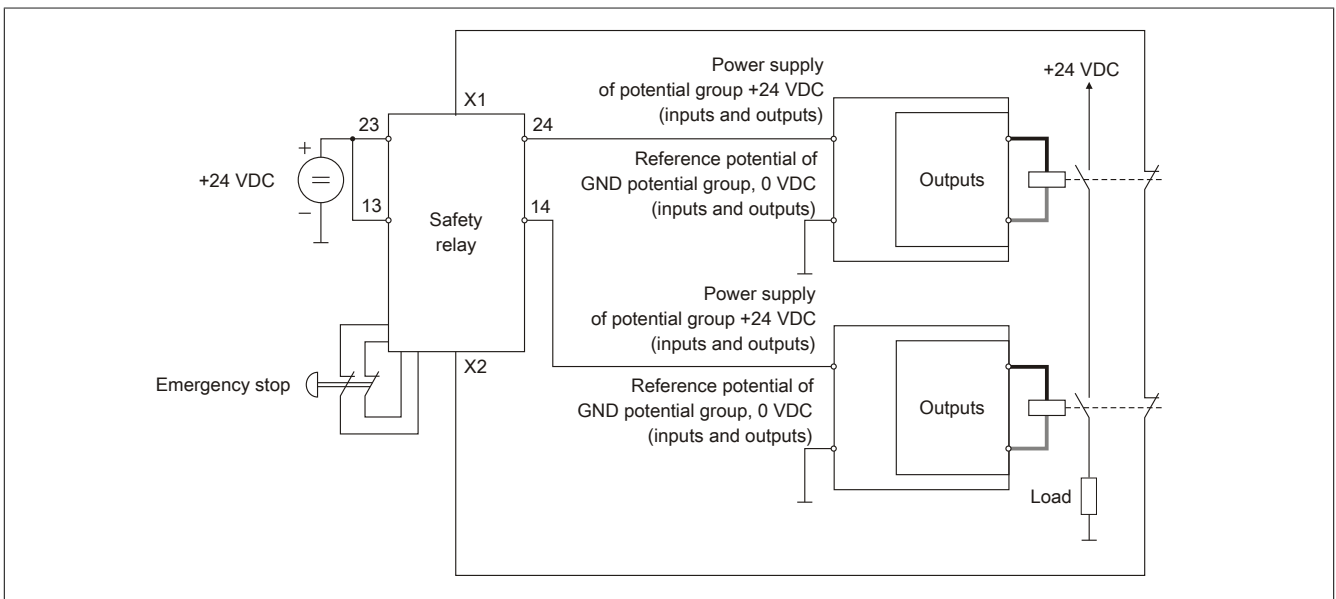


Figure 31: Circuit example: 2-channel with feedback

Provided that the external components being used (emergency stop switch, safety relay, load) satisfy the respective requirements, this example can achieve PL e.

Example with power supply module X20SP1130

The following examples show a load being cut off using safe power supply module X20SP1130 along with safe input module X20SI4100 and the "emergency stop" safety function.

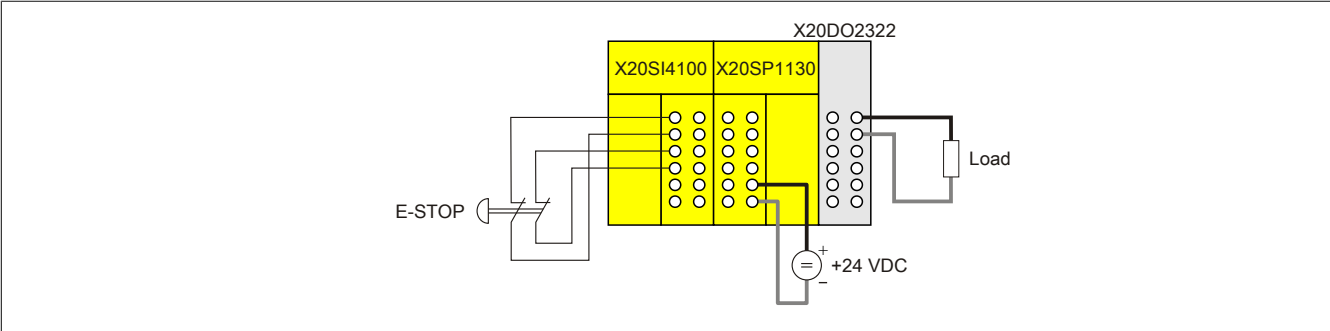


Figure 32: Circuit example with power supply module X20SP1130

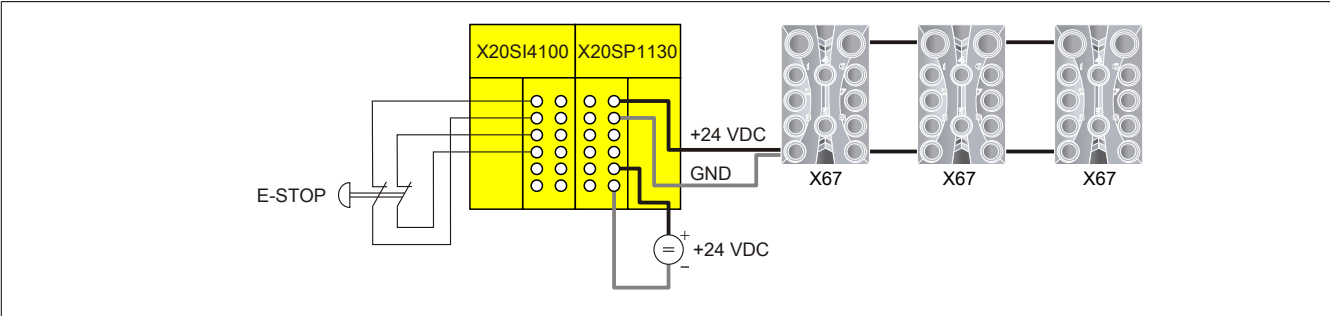


Figure 33: Circuit example with power supply module X20SP1130 and X67

Provided that the external components being used (emergency stop switch, load) satisfy the respective requirements, these examples can achieve PL e.

4.10.5.4 Wiring information

The operating principle "Safe cutoff of a potential group" only applies to the B&R modules being used. All other parts of the safety chain such as the application, upstream sensors or downstream actuators are NOT included in this principle.

For this reason, it is important to take the following points into consideration:

- Ensure proper wiring of the safety relay with the I/O supply. A short circuit between the output of the safety relay and an external 24 V voltage source can cause an unintended supply of 24 V to the internal supply voltage of the potential group. As a result, the safety function can no longer be guaranteed, which means that **ALL** of the channels in the potential group can no longer be cut off by the upstream safety relay.
- Make sure that **ALL** of the potential group's input and output channels and the connected sensors and actuators are wired properly. A short circuit between an input or output of the potential group and an external 24 V voltage source can cause the unintended feedback of 24 V to the internal supply voltage of the potential group. As a result, the safety function can no longer be guaranteed, which means that **ALL** of the output channels in the potential group can no longer be cut off by the upstream safety relay.
- In accordance with EN ISO 13849-2:2012, appendix D.2, table D.4, a short circuit between any 2 conductors can be excluded, provided that:
 - They are permanently installed and protected against external damage (e.g. using a cable duct or armored conduit)
 - OR they are in separate plastic-sheathed cables
 - OR they are installed within an electrical enclosure. This requires that the wiring as well as the area for electrical equipment meet the respective requirements [see EN 60204-1]
 - OR they are individually shielded with a ground connection

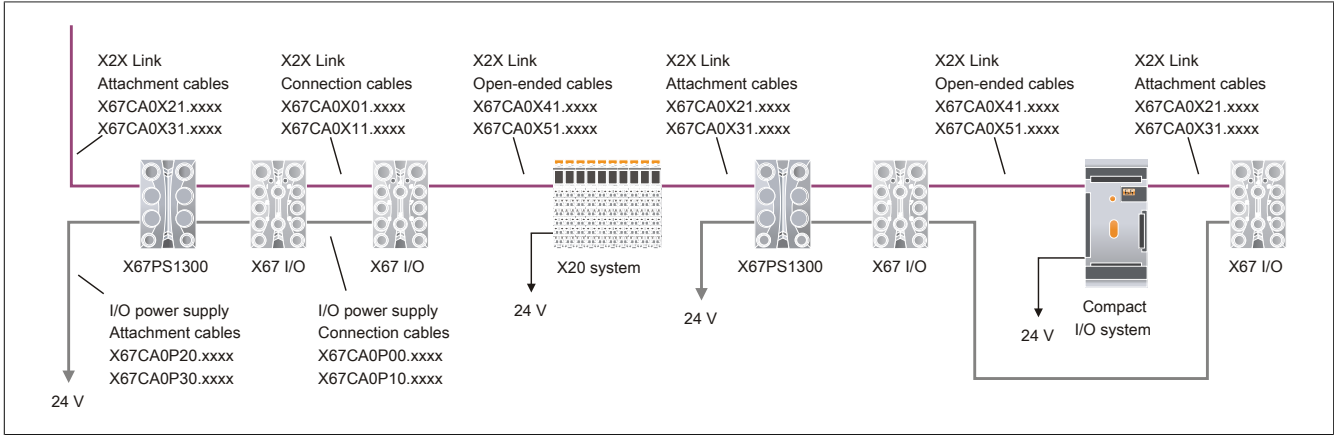
4.11 Combining X2X Link systems

The X2X Link provides a complete remote backplane, which is used for communicating between bus modules and over the X2X Link cable. Systems based on X2X Link can be combined with one another as needed.

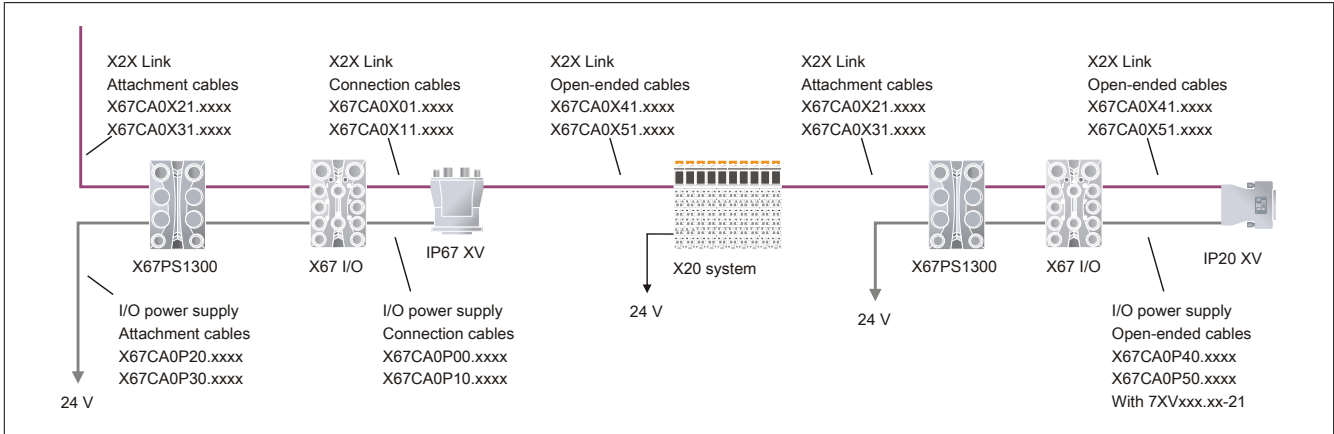
4.11.1 Connection overviews

The following connection overviews illustrate combinations of different systems that are based on X2X Link. The model numbers indicate which standard cables available from B&R can be used to connect with one another.

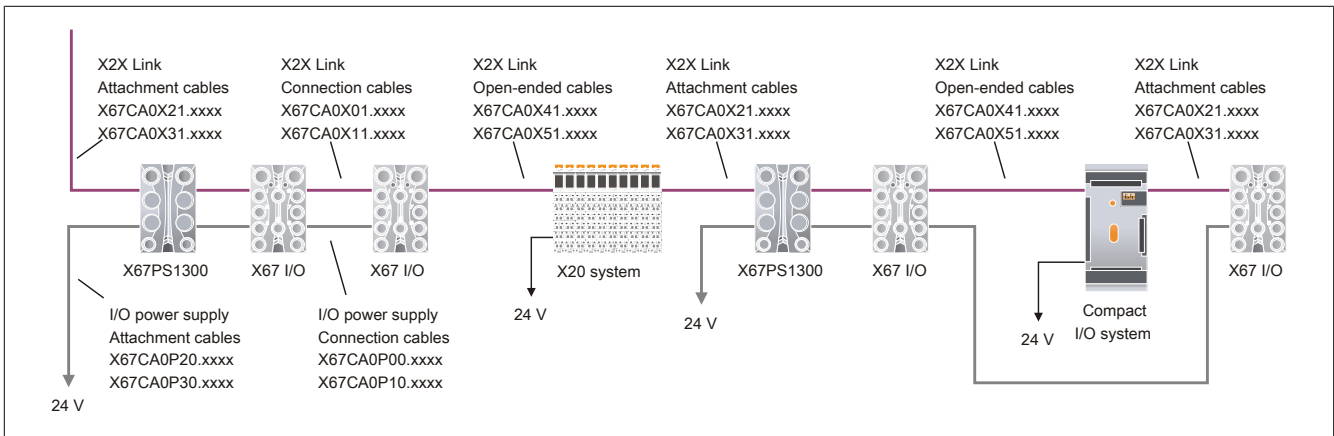
Combining X20, X67 and compact I/O system



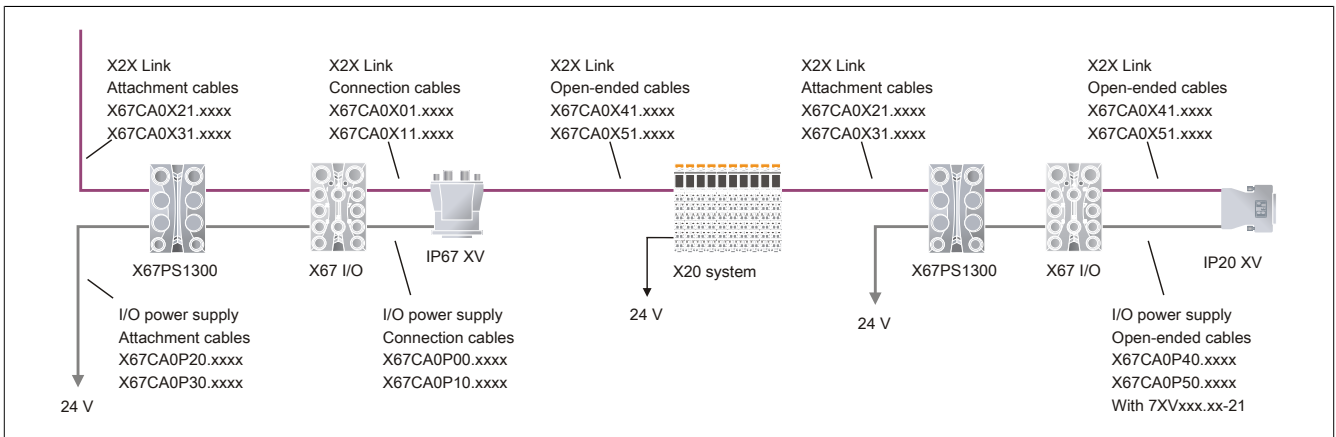
Combining X20, X67 and valve terminal connections



4.11.1.1 Combining X20, X67 and compact I/O system



4.11.1.2 Combining X20, X67 and valve terminal connections



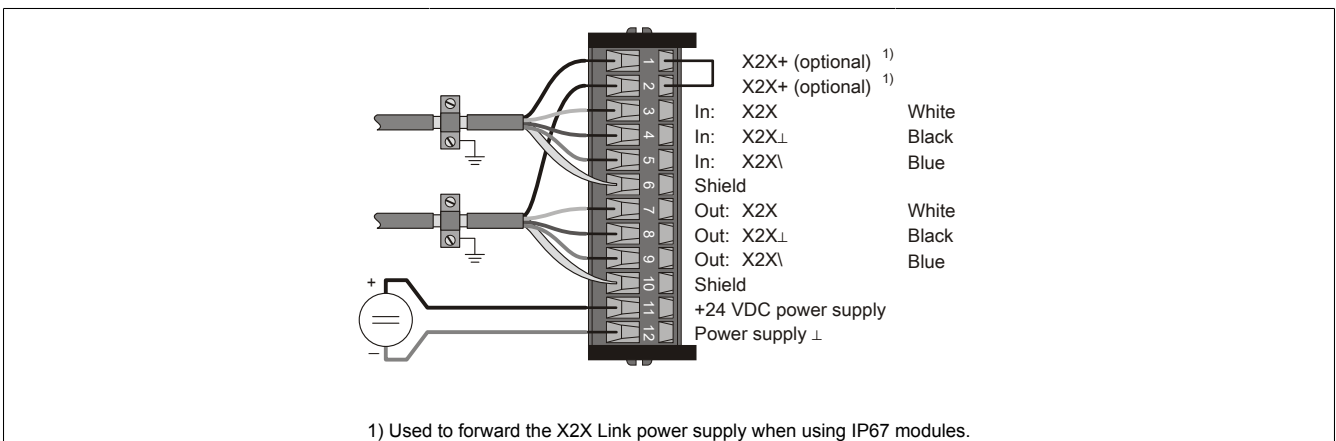
4.11.2 Connection examples

4.11.2.1 X20 system

Connection examples are listed in the module description:

- X20BR9300 bus receiver: "Connection examples" on page 975
- X20BT9100 bus transmitter: "Connection examples" on page 982

4.11.2.2 Compact I/O system

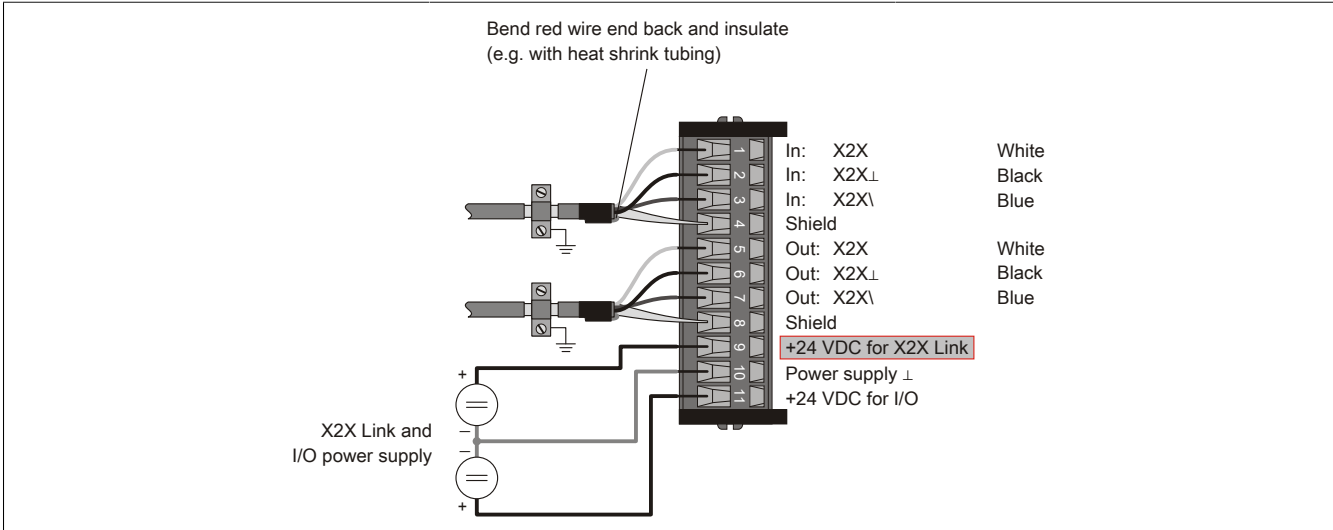


| Signal | Cable type | Model number |
|-----------------|---------------------------------|----------------|
| X2X Link In | Open-ended cables ¹⁾ | X67CA0X41.xxxx |
| | | X67CA0X51.xxxx |
| X2X Link Out | Attachment cables ¹⁾ | X67CA0X21.xxxx |
| | | X67CA0X31.xxxx |
| X2X Link in/out | Cable for custom assembly | X67CA0X99.1000 |

1) Bridge for X2X+ in connection with X67 modules.

4.11.2.3 Valve connection

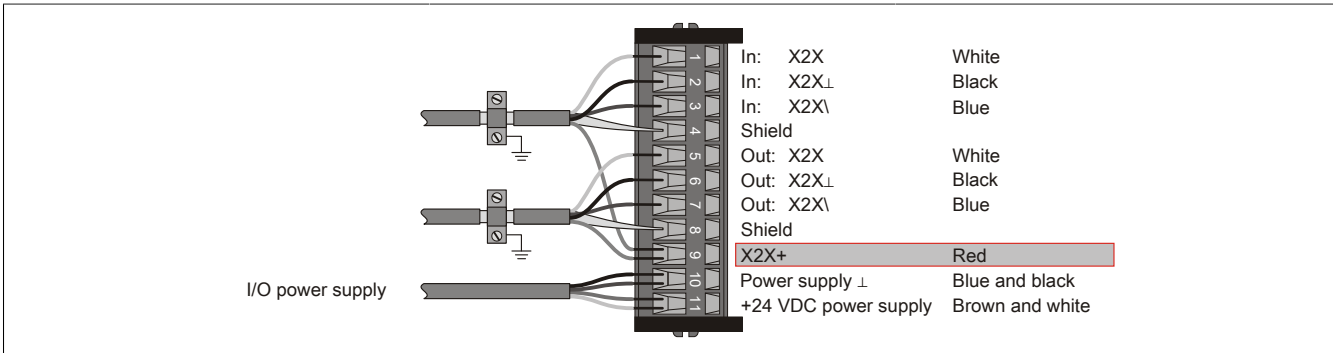
Connection example with 7XVxxx.xx-11/-12



| Signal | Cable type | Model number |
|-----------------|---------------------------------|----------------|
| X2X Link In | Open-ended cables ¹⁾ | X67CA0X41.xxxx |
| | | X67CA0X51.xxxx |
| X2X Link Out | Attachment cables ¹⁾ | X67CA0X21.xxxx |
| | | X67CA0X31.xxxx |
| X2X Link in/out | Cable for custom assembly | X67CA0X99.xxxx |

1) In connection with X67 modules.

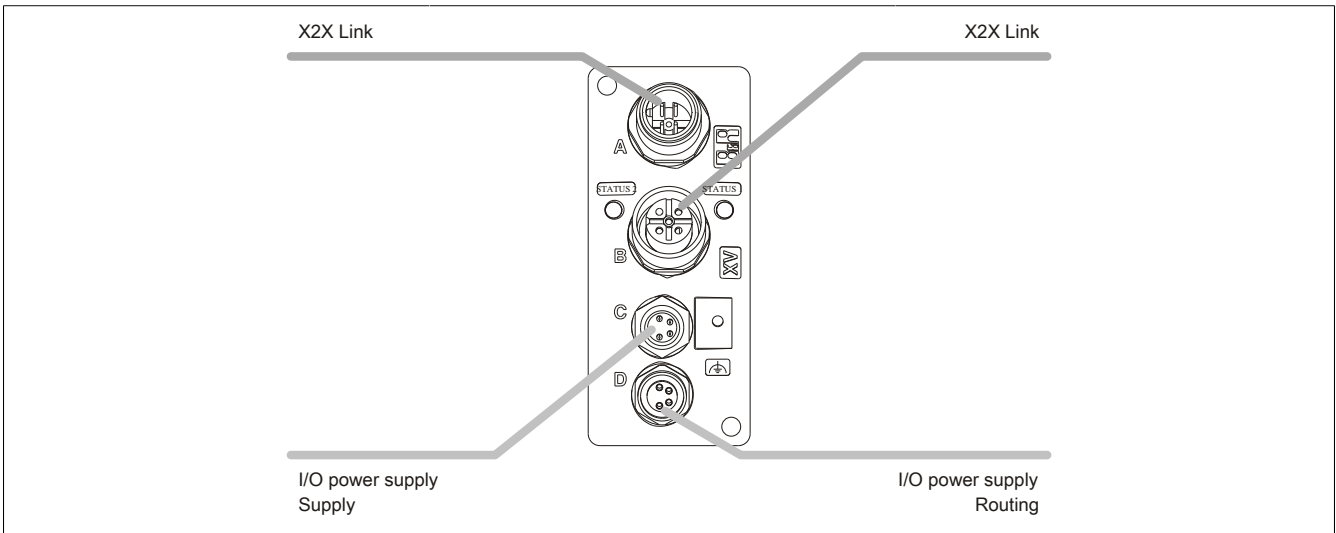
Connection example with 7XVxxx.xx-21



| Signal | Cable type | Model number |
|------------------|---------------------------------|----------------|
| X2X Link In | Open-ended cables ¹⁾ | X67CA0X41.xxxx |
| | | X67CA0X51.xxxx |
| X2X Link Out | Attachment cables ¹⁾ | X67CA0X21.xxxx |
| | | X67CA0X31.xxxx |
| X2X Link in/out | Cable for custom assembly | X67CA0X99.xxxx |
| I/O power supply | Open-ended cables ¹⁾ | X67CA0P40.xxxx |
| | | X67CA0P50.xxxx |

1) In connection with X67 modules.

Connection example with 7XVxxx.xx-51/-62



| Signal | Cable type | Model number |
|------------------|---------------------------------|----------------|
| X2X Link | Connection cables ¹⁾ | X67CA0X01.xxxx |
| | | X67CA0X11.xxxx |
| I/O power supply | Connection cables ¹⁾ | X67CA0P00.xxxx |
| | | X67CA0P10.xxxx |

1) In connection with X67 modules.

4.12 Calculating the power requirements

The power requirements are calculated based on the power consumption of the individual modules listed in the respective data sheets. Due to the separate power supplies, the power requirements of the **X2X Link power supply** and **I/O power supply** must be calculated independently of one another.

For the power consumption of both areas, see the technical data. This makes it possible to quickly yet clearly establish the power requirements for a certain hardware configuration. The power consumption values of individual modules should then be subtracted from the power provided by the power supply module. The sum is not permitted to be less than zero.

The following entries in the technical data are used for the calculation:

X2X Link power supply

- **General information - Power consumption - Bus**
This entry refers to the power consumption needed to operate the X2X Link network. The power consumption of the I/O modules and bus base modules are taken into account in the calculation.

I/O power supply

- **General information - Power consumption - Internal I/O**
This entry refers to the power consumption needed to operate the actual I/O module as well as the inputs and outputs.
- **Sensor power supply - Power consumption**
This entry contains the power consumption needed by the I/O module to provide power to connected sensors, for example.
- **Actuator power supply - Power consumption**
This entry contains the power consumption needed by the I/O module to provide power to connected actuators, for example.

The power consumption of I/O modules whose power is supplied externally does not need to be taken into account.

Information:

All modules that require 0.01 W of power on the X2X Link network must be supplied via the internal I/O power supply. If the I/O power supply fails, the module shuts down and communication is lost. In this case, ModuleOk returns the value "False" and data can no longer be read from the "embedded parameter chip".

Information:

The I/O power actually needed can vary depending on the application. In order to properly calculate the power requirements for the respective application, additional specifications such as simultaneity of the outputs, actual required output current, etc. must be taken into account.

4.12.1 Overview of the bus and I/O power supply

The power necessary to operate the X20 system is provided by the power supplied modules, X20 CPUs, bus receivers and bus transmitters.

| Module | Power supplied to internal I/O | Power supplied to bus |
|-------------------------|--------------------------------|------------------------|
| X20CP1483, X20CPx58x | +240 W | +7 W |
| X20CP13xx, X20CP13xx-RT | +240 W | +2 W |
| X20BR7300 | +240 W | +2 W |
| X20BR9300 | +240 W | +7 W |
| X20PS2100 | +240 W | (-0.2 W) ¹⁾ |
| X20PS2110 | +144 W | (-0.2 W) ¹⁾ |
| X20PS3300 | +240 W | +7 W |
| X20PS3310 | +144 W | +7 W |
| X20PS9xxx | +240 W | +7 W |
| X20SP1130 | +240 W | (-0.2 W) ¹⁾ |

1) This module does not provide extra power to the bus (X2X Link) but requires power itself for operation.

Bus transmitter

When calculating the power balance for bus transmitters, it is important to know whether they are only being used as such or are also being used as an I/O power supply module.

| Material number | Power supplied to internal I/O | | Bus power |
|-----------------|------------------------------------|--|------------------------|
| | When operated as a bus transmitter | When operated as a bus transmitter and I/O power supply module | |
| X20BT9100 | (-0.1 W) | +240 W | (-0.5 W) ¹⁾ |
| X20BT9400 | (-0.1 W) | +240 W | (-0.5 W) ¹⁾ |

1) This module does not provide extra power to the bus (X2X Link) but requires power itself for operation.

Information:

If the bus or I/O power consumption of the connected modules exceeds the available power, additional power supply modules must be added (see "[X20 system infrastructure](#)" on page 60).

4.12.2 Example: CPU and modules

Calculating the power balance for the bus and I/O power supply of a module block with X20 CPU.

Power supplied by the CPU

| Module | Power supplied to bus | Power supplied to the I/O power supply |
|-----------|-----------------------|--|
| X20CP3585 | +7 W | +240 W |

Power requirements of the modules

| Module | Bus power supply requirements | | I/O power supply requirements | |
|---------------------------------|-------------------------------|-------------|-------------------------------|--|
| | Bus modules | I/O modules | Internal I/O | Sensor/Actuator power supply |
| X20CP3585 ¹⁾ | - | - | -0.60 W | - |
| X20BM11 + X20DI9371 | -0.13 W | -0.18 W | 0.00 W | 0.00 W |
| X20BM33 + X20SI9100 | -0.13 W | -0.40 W | -1.60 W | 0.00 W |
| X20BM11 + X20AI4622 | -0.13 W | -0.01 W | -1.10 W | 0.00 W |
| X20BM11 + X20AO2622 | -0.13 W | -0.01 W | -1.10 W | 0.00 W |
| X20BM33 + X20SI4100 | -0.13 W | -0.32 W | -1.25 W | 0.00 W |
| X20BM11 + X20DO4322 | -0.13 W | -0.16 W | -0.49 W | Max. -12 W (actuator power supply) Max. -48 W (digital outputs) ²⁾ |
| X20BM11 + X20DI4371 | -0.13 W | -0.14 W | -0.59 W | Max. -12 W (sensor power supply) |
| Subtotal | -0.91 W | -1.22 W | -6.73 W | Max. -72 W |
| Total power requirements | -2.13 W | | -78.73 W | |

1) The power requirements of the power supply module (CPU) do not have to be taken into account in this calculation.

2) Nominal power at 24 VDC and 2 A.

Calculating the power balance

| | Bus power supply | I/O power supply |
|---------------------------|------------------|------------------|
| Power supplied by the CPU | +7 W | +240 W |
| Total power requirements | -2.13 W | -78.73 W |
| Remaining power | +4.87 W | +161.27 W |

The power comparison indicates that the power provided by the CPU power supply module is sufficient. Additional power supply modules are not necessary.

4.12.3 Example: Bus controller and modules

Calculating the power balance for the bus and I/O power supply of a module block with bus controller.

Power supplied by the power supply module

| Module | Power supplied to bus | Power supplied to the I/O power supply |
|-----------|-----------------------|--|
| X20PS9400 | +7 W | +240 W |

Power requirements of the modules

| Module | Bus power supply requirements | | I/O power supply requirements | |
|------------------------------------|-------------------------------|--------------------|-------------------------------|---|
| | Bus modules | I/O modules | Internal I/O | Sensor/Actuator power supply |
| X20PS9400 ¹⁾ | - | - | -0.60 W | - |
| X20BB81 + X20BC8083 + X20HB2880 | -0.50 W | -2.00 W -1.17 W | - | 0.00 W |
| X20BM33 + X20SI9100 | -0.13 W | -0.40 W | -1.60 W | 0.00 W |
| X20BM11 + X20AI4622 | -0.13 W | -0.01 W | -1.10 W | 0.00 W |
| X20BM11 + X20AO2622 | -0.13 W | -0.01 W | -1.10 W | 0.00 W |
| X20BM33 + X20SO2530 | -0.13 W | -0.26 W | -1.15 W | 0.00 W |
| X20BM33 + X20SO4120 | -0.13 W | -0.25 W | -1.30 W | Max. -120 W (digital outputs) ²⁾ |
| X20BM33 + X20DO8322 | -0.13 W | -0.26 W | -0.80 W | Max. -96 W (digital outputs) ³⁾ |
| X20BM11 + X20DI2371 | -0.13 W | -0.12 W | -0.29 W | Max. -12 W (sensor power supply) |
| Subtotal | -1.41 W | -4.48 W | -7.94 W | Max. -228 W |
| Total power requirements | -5.89 W | | -235.94 W | |

- 1) The power requirements of the power supply module do not have to be taken into account in this calculation.
- 2) Nominal power at 24 VDC and 5 A.
- 3) Nominal power at 24 VDC and 4 A.

Calculating the power balance

| | Bus power supply | I/O power supply |
|---|------------------|------------------|
| Power supplied by the power supply module | +7 W | +240 W |
| Total power requirements | -5.89 W | -235.94 |
| Remaining power | +1.11 W | +4.06 |

The power comparison indicates that the power provided by the power supply module is sufficient. Additional power modules are not necessary.

4.12.4 Example: Potential groups

With a large number of I/O modules, the power provided by a power supply module is insufficient to operate all of the modules. In this case, the modules must be divided into potential groups.

Example of module group on bus receiver X20BR9300.

Power supplied by the bus receiver

A power supply module is already integrated in the bus receiver.

| Module | Power supplied to bus | Power supplied to the I/O power supply |
|-----------|-----------------------|--|
| X20BR9300 | +7 W | +240 W |

Power requirements of the entire module group

| Module | Bus power supply requirements | | I/O power supply requirements | |
|-----------------------------------|-------------------------------|-------------|-------------------------------|--|
| | Bus modules | I/O modules | Internal I/O | Sensor/Actuator power supply |
| X20BM01 + X20BR9300 ¹⁾ | -0.13 W | - | -0.60 W | - |
| X20BM11 + X20DI9371 | -0.13 W | -0.18 W | 0.00 W | 0.00 W |
| X20BM33 + X20SI9100 | -0.13 W | -0.40 W | -1.60 W | 0.00 W |
| X20BM11 + X20AI4622 | -0.13 W | -0.01 W | -1.10 W | 0.00 W |
| X20BM11 + X20AO2622 | -0.13 W | -0.01 W | -1.10 W | 0.00 W |
| X20BM33 + X20SI4100 | -0.13 W | -0.32 W | -1.25 W | 0.00 W |
| X20BM11 + X20DO4322 | -0.13 W | -0.16 W | -0.49 W | Max. -12 W (actuator power supply) Max. -48 W (digital outputs) ²⁾ |
| X20BM11 + X20DI4371 | -0.13 W | -0.14 W | -0.59 W | Max. -12 W (sensor power supply) |
| X20BM33 + X20SI9400 | -0.13 W | 0.40 W | -1.60 W | 0.00 W |
| X20BM11 + X20AI4622 | -0.13 W | -0.01 W | -1.10 W | 0.00 W |
| X20BM11 + X20AO2622 | -0.13 W | -0.01 W | -1.10 W | 0.00 W |
| X20BM33 + X20SO2530 | -0.13 W | -0.26 W | -1.15 W | 0.00 W |
| X20BM33 + X20SO4120 | -0.13 W | -0.25 W | -1.30 W | Max. -120 W (digital outputs) ³⁾ |
| X20BM11 + X20DO8322 | -0.13 W | -0.26 W | -0.80 W | Max. -96 W (digital outputs) ⁴⁾ |
| X20BM11 + X20DI2371 | -0.13 W | -0.12 W | -0.29 W | Max. -12 W (sensor power supply) |
| Subtotal | -1.95 W | -2.53 W | -14.06 W | Max. -300 W |
| Total power requirements | -4.48 W | | -314.06 W | |

1) The power requirements of the bus receiver do not have to be taken into account in this calculation.

2) Nominal power at 24 VDC and 2 A.

3) Nominal power at 24 VDC and 5 A.

4) Nominal power at 24 VDC and 4 A.

Calculating the power balance

| | Bus power supply | I/O power supply |
|------------------------------------|------------------|------------------|
| Power supplied by the bus receiver | +7 W | +240 W |
| Total power requirements | -4.48 W | -314.06 W |
| Remaining power | +2.52 W | -74.06 W |

The power comparison indicates that the power provided by the bus receiver is insufficient. As additional power supply module is necessary to ensure the missing 74.06 W for the I/O power supply.

For this reason, the module group is divided into 2 potential groups.

Potential group 1

Power supplied by the bus receiver

A power supply module is already integrated in the bus receiver.

| Module | Power supplied to bus | Power supplied to the I/O power supply |
|-----------|-----------------------|--|
| X20BR9300 | +7 W | +240 W |

Power requirements of the modules

| Module | Bus power supply requirements | | I/O power supply requirements | |
|-----------------------------------|-------------------------------|-------------|-------------------------------|--|
| | Bus modules | I/O modules | Internal I/O | Sensor/Actuator power supply |
| X20BM01 + X20BR9300 ¹⁾ | -0.13 W | - | -0.60 W | - |
| X20BM11 + X20DI9371 | -0.13 W | -0.18 W | 0.00 W | 0.00 W |
| X20BM33 + X20SI9100 | -0.13 W | -0.40 W | -1.60 W | 0.00 W |
| X20BM11 + X20AI4622 | -0.13 W | -0.01 W | -1.10 W | 0.00 W |
| X20BM11 + X20AO2622 | -0.13 W | -0.01 W | -1.10 W | 0.00 W |
| X20BM11 + X20DO4322 | -0.13 W | -0.16 W | -0.49 W | Max. -12 W (actuator power supply) Max. -48 W (digital outputs) ²⁾ |
| X20BM11 + X20DI4371 | -0.13 W | -0.14 W | -0.59 W | Max. -12 W (sensor power supply) |
| X20BM11 + X20AI4622 | -0.13 W | -0.01 W | -1.10 W | 0.00 W |
| X20BM11 + X20AO2622 | -0.13 W | -0.01 W | -1.10 W | 0.00 W |
| X20BM11 + X20DO8322 | -0.13 W | -0.26 W | -0.80 W | Max. -96 W (digital outputs) ³⁾ |
| X20BM11 + X20DI2371 | -0.13 W | -0.12 W | -0.29 W | Max. -12 W (sensor power supply) |
| Subtotal | -1.43 W | -1.30 W | -8.77 W | Max. -180 W |
| Total power requirements | -2.73 W | | -188.77 W | |

- 1) The power requirements of the bus receiver do not have to be taken into account in this calculation.
- 2) Nominal power at 24 VDC and 2 A.
- 3) Nominal power at 24 VDC and 4 A.

Potential group 2

Power supplied by the power supply module

| Module | Power supplied to bus | Power supplied to the I/O power supply |
|-----------|-----------------------|--|
| X20SP1130 | - | +240 W |

Power requirements of the modules

| Module | Bus power supply requirements | | I/O power supply requirements | |
|-----------------------------------|-------------------------------|-------------|-------------------------------|---|
| | Bus modules | I/O modules | Internal I/O | Sensor/Actuator power supply |
| X20BM23 + X20SP1130 ¹⁾ | -0.13 W | -0.2 W | -1.50 W | - |
| X20BM33 + X20SI4100 | -0.13 W | -0.32 W | -1.25 W | 0.00 W |
| X20BM33 + X20SI9100 | -0.13 W | -0.40 W | -1.60 W | 0.00 W |
| X20BM33 + X20SO2530 | -0.13 W | -0.26 W | -1.15 W | 0.00 W |
| X20BM33 + X20SO4120 | -0.13 W | -0.25 W | -1.30 W | Max. -120 W (digital outputs) ²⁾ |
| Subtotal | -0.65 W | -1.43 W | -6.80 W | Max. -120 W |
| Total power requirements | -2.08 W | | -126.80 W | |

- 1) The power requirements of the power supply module do not have to be taken into account in this calculation.
- 2) Nominal power at 24 VDC and 5 A.

Power balance for the bus power supply

| | Bus power supply |
|------------------------------------|-------------------------|
| Power supplied by the bus receiver | +7 W |
| Power balance of potential group 1 | -2.73 W |
| Power balance of potential group 2 | -2.08 W |
| Remaining power | +2.19 W |

The power comparison indicates that the power provided by the bus receiver is sufficient. Additional power supply modules for the bus power supply are not necessary.

Power balance for the I/O power supply

Potential group 1

| | I/O power supply |
|------------------------------------|-------------------------|
| Power supplied by the bus receiver | +240 W |
| Total power requirements | -188.77 W |
| Remaining power | +51.23 W |

Potential group 2

| | I/O power supply |
|---|-------------------------|
| Power supplied by the power supply module | +240 W |
| Total power requirements | -126.80 W |
| Remaining power | +113.20 W |

The power comparison indicates that the power provided by the power supply modules is now sufficient for both potential groups.

4.13 Power dissipation of power supply modules

Power supply modules are used to supply power to an X20 system. The power supply modules are either a separate module or part of a CPU or bus controller.

The power consumed by the power supply modules is passed on to the X20 system, taking into consideration its own power requirements and the effectiveness of the power supplies. The data sheets for the power supply modules list their own power requirements and power dissipation (as maximum power consumption). With the formulas in the following sections, the exact power consumption can also be calculated. This calculation is explained using an example.

The following image shows where the power supply module uses power for its own requirements. It also shows where the power supply module uses power to supply the system and where power dissipation occurs.

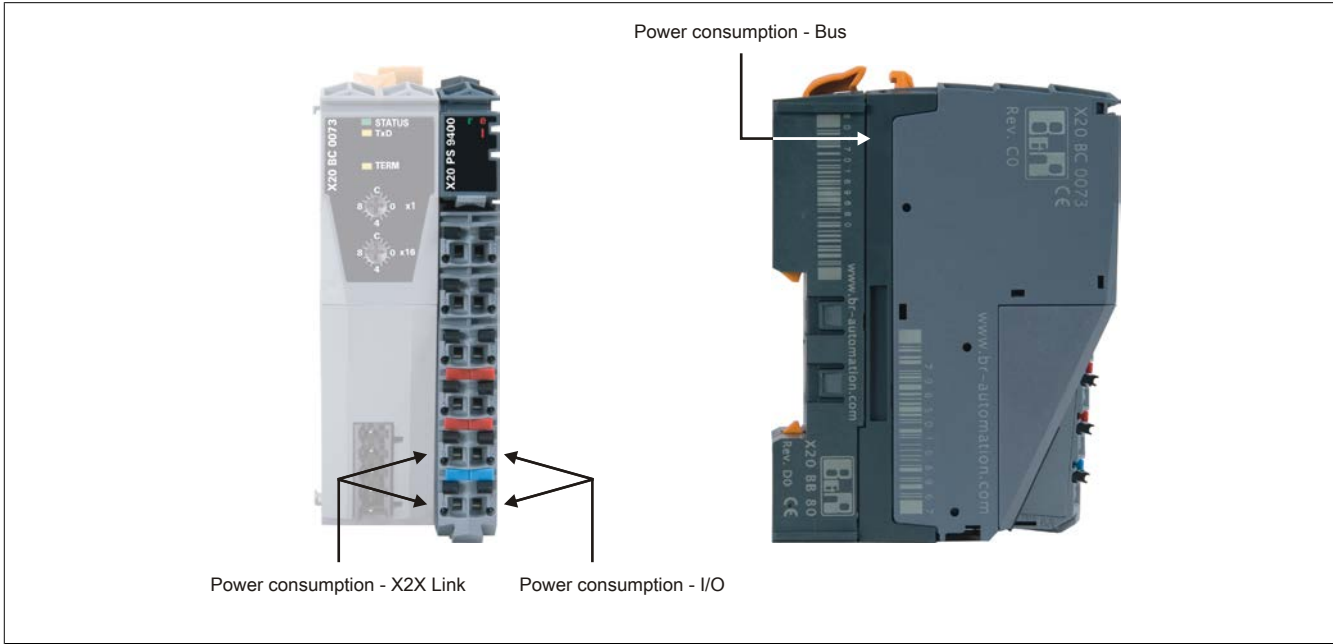


Figure 34: Power supply modules draw power at up to 3 supply points

4.13.1 Power consumption of power supply modules

The following table provides an overview of the power consumed by the power supply modules. The exact power requirement can be calculated using the specified formulas.

| Module | Bus | | | Power consumption - I/O-internal [W] |
|--|-----------------------|--|--|---|
| | Power consumption [W] | Power consumption - X2X Link (internal) [W] | Power consumption - Total [W] | |
| X20PS3300, X20PS9400, X20PS9500, X20PS9600, X20CP1483, X20CP1483-1, X20CP158x, X20CP358x | 0.2 | $0.8 + \frac{0.06 \cdot \sum P_{X2X_{X20}}}{n}$ | $1.42 \geq 0.2 + 0.8 + \frac{0.06 \cdot \sum P_{X2X_{X20}}}{n}$ | $0.6 \geq 0.1 + I_{IO}^2 \times 0.005$ |
| X20PS3310 | 0.2 | $0.8 + \frac{0.06 \cdot \sum P_{X2X_{X20}}}{n}$ | $1.42 \geq 0.2 + 0.8 + \frac{0.06 \cdot \sum P_{X2X_{X20}}}{n}$ | $0.82 \geq 0.1 + I_{IO}^2 \times 0.02$ |
| X20BR9300 | 0.4 | $0.8 + \frac{0.06 \cdot \sum P_{X2X_{X20}}}{n}$ | $1.62 \geq 0.4 + 0.8 + \frac{0.06 \cdot \sum P_{X2X_{X20}}}{n}$ | $0.6 \geq 0.1 + I_{IO}^2 \times 0.005$ |
| X20PS9402, X20PS9502, X20PS9602 | 0.2 | $0.6 + \frac{0.12 \cdot \sum P_{X2X_{X20}}}{n=1}$ | $1.64 \geq 0.2 + 0.6 + \frac{0.12 \cdot \sum P_{X2X_{X20}}}{n=1}$ | $0.6 \geq 0.1 + I_{IO}^2 \times 0.005$ |
| X20PS2100 | 0.2 | - | 0.2 | $0.6 \geq 0.1 + I_{IO}^2 \times 0.005$ |
| X20PS2110 | 0.2 | - | 0.2 | $0.82 \geq 0.1 + I_{IO}^2 \times 0.02$ |
| X20BT9100 | 0.5 | - | 0.5 | $0.6 \geq 0.1 + I_{IO}^2 \times 0.005$ |
| X20BT9400 | 0.5 | $0.5 + \frac{0.147 \cdot \sum P_{X2X_{X67}}}{n=1}$ | $1.88 \geq 0.5 + 0.5 + \frac{0.147 \cdot \sum P_{X2X_{X67}}}{n=1}$ | $0.6 \geq 0.1 + I_{IO}^2 \times 0.005$ |
| X20PS8002 | - | $0.5 + \frac{0.12 \cdot P_{Out}}{n=1}$ | $1.34 \geq 0.5 + \frac{0.12 \cdot P_{Out}}{n=1}$ | - |
| X20PD2113 | 0.12 | - | 0.12 | $1.15 \geq 0.28 + I_{IO}^2 \times 0.02$ |

$\sum P_{X2X_{X20}}$... Sum of the bus power consumption of all modules in the X20 system (Compact-S CPU, Compact CPU, Fieldbus CPU, BC, BR, I/O, BM, BT)

$\sum P_{X2X_{X67}}$... Sum of the bus power consumption of all I/O modules in the X67 system

P_{Out} ... Sum of the power consumption of all modules (HB) supplied by the power supply module

n ... Number of all power supply modules in the X20 system with X2X Link power supply, including X20BR9300

I_{IO} ... I/O summation current of all I/O modules supplied by this power supply module (max. 10 A)

X20PS2110 and X20PS3110:

The summation current of these modules is not permitted to exceed 6 A.

X20PD2113:

If the module is used as a power supply module for the I/O power supply, I_{IO} corresponds to the summation current of all I/O modules supplied by the X20PD2113 (max. 10 A).

4.13.2 Example

Calculation of the total internal power consumption of bus receiver X20BR9300 using the following hardware configuration:

| Module | Bus module - Power | Bus power [W] | I/O-internal power [W] |
|------------|--------------------|---------------|------------------------|
| X20BR9300 | | 0 | 0 |
| X20DI4371 | 0.13 | 0.14 | 0.59 |
| X20DI2371 | 0.13 | 0.12 | 0.29 |
| X20DO4322 | 0.13 | 0.16 | 0.49 |
| X20DO4322 | 0.13 | 0.16 | 0.49 |
| X20BT9100 | 0.13 | 0.50 | 0.10 |
| Sum | 0.65 | 1.08 | 1.96 |

2 power values have to be calculated in order to determine the entire internal power consumption of the bus receiver.

- Internal X2X Link power consumption of the X20BR9300
- Internal I/O power consumption of the X20BR9300

4.13.2.1 Calculating the internal X2X Link power consumption of the X20BR9300

Bus power consumption of all modules in the X20 system

In order to calculate the internal X2X Link power consumption of the X20BR9300, the sum of the bus power consumption of all modules in the X20 system is required.

The sum for the example configuration is calculated using the following formula: The bus module of the X20BR9300 does not have to be taken into account in the calculation. The power consumption of the bus module is already included with a factor of 0.8 (see formula below).

A power consumption of 0.13 W for each bus module must be included in the calculation for the 4 I/O modules and the bus transmitter.

$$\sum P_{X2X_{X20}} = P_{X2X_{Bus_{BR9300}}} + \sum P_{X2X_{Bus_{IOMod}}} + \sum P_{X2X_{Bus_{Busmod}}} = 0.4 + 1.08 + 5 \cdot 0.13 = 2.13 \text{ W}$$

Internal X2X Link power consumption of the X20BR9300

The internal X2X Link power consumption of the X20BR9300 is calculated using the following formula. Since X2X Link is only supplied by the X20BR9300 bus receiver, the factor is $n = 1$:

$$P_{X2X_{int.BR9300}} = 0.8 + \frac{0.06 \cdot \sum P_{X2X_{X20}}}{n} = 0.8 + \frac{0.06 \cdot 2.13}{1} = 0.8 + 0.13 = 0.93 \text{ W}$$

4.13.2.2 Calculating the internal I/O power consumption of the X20BR9300

The I/O summation current of all I/O modules supplied by the X20BR9300 is needed to calculate the internal I/O power consumption. The I/O summation current is composed of 3 parts:

- Internal power consumption of the I/O modules
- Sum of the output currents
- Sum of the actuator currents

Internal power consumption of the I/O modules

The current that results from the internal consumption of the I/O modules is calculated according to the following formula:

$$I_{IO_{int.}} = \frac{P_{IO_{int.}}}{U} = \frac{1.96}{24} = 0.082 A$$

Sum of output and actuator currents

Two X20DO4322 modules are included in the example configuration. The following images show which outputs are wired and how high the output current and actuator current are per channel.

Connections and currents of the first X20DO4322:

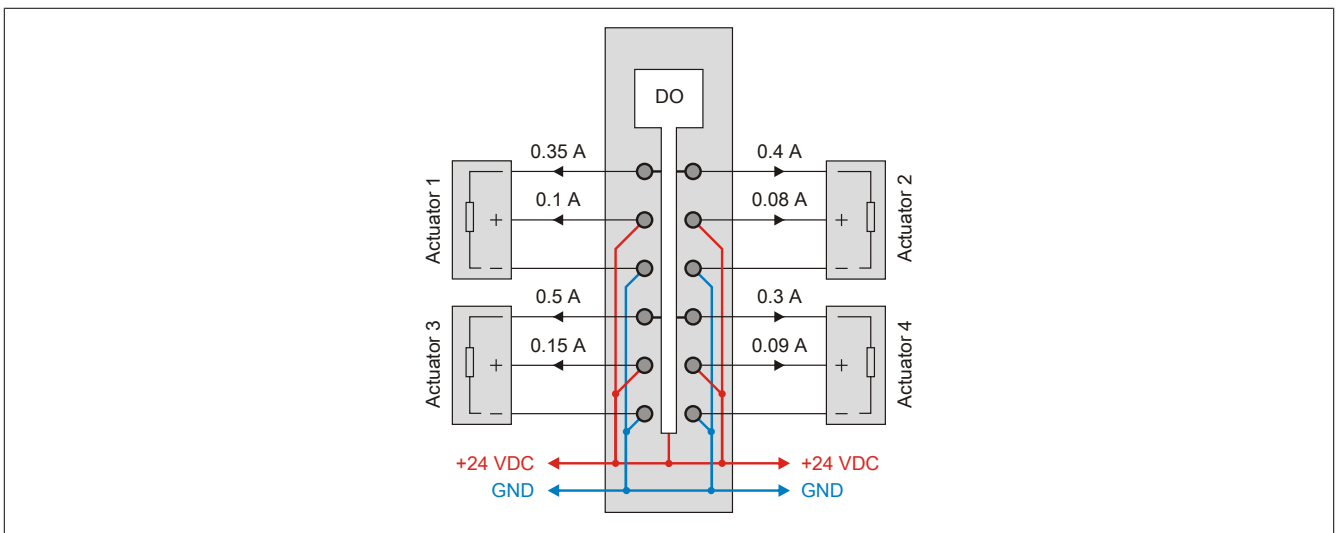


Figure 35: Connections and currents of the first X20DO4322

Connections and currents of the second X20DO4322:

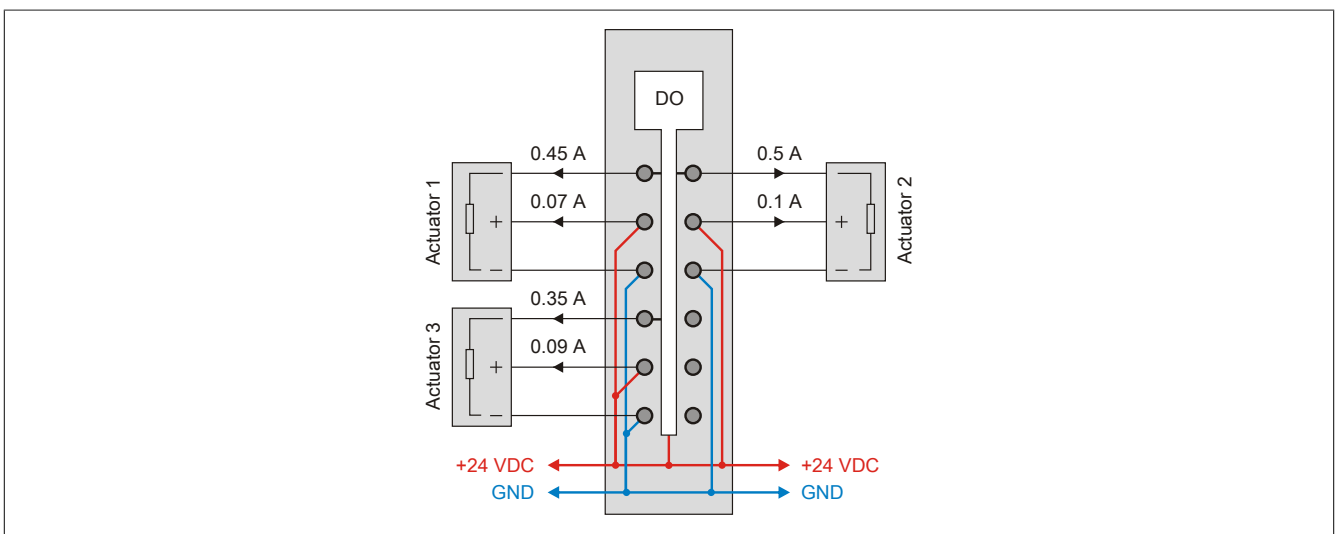


Figure 36: Connections and currents of the second X20DO4322

Calculating the sum of the output currents:

$$I_{DO} = I_{DO_1} + I_{DO_2} = 0.35 + 0.4 + 0.5 + 0.3 + 0.45 + 0.5 + 0.35 = 2.85 \text{ A}$$

Calculating the sum of the actuator currents:

$$I_{Actuator} = I_{Actuator_1} + I_{Actuator_2} = 0.1 + 0.08 + 0.15 + 0.09 + 0.07 + 0.1 + 0.09 = 0.68 \text{ A}$$

Calculating the I/O summation current

The I/O summation current is calculated from the sum of all 3 partial currents.

$$I_{IO} = I_{IO_{int.}} + I_{DO} + I_{Actuator} = 0.082 + 2.85 + 0.68 = 3.612 \text{ A}$$

Calculating the internal I/O power consumption of the X20BR9300

The internal I/O power consumption is calculated using the following formula:

$$P_{IO_{int.}BR9300} = 0.1 + I_{IO}^2 \cdot 0.005 = 0.1 + 3.612^2 \cdot 0.005 = 0.17 \text{ W}$$

4.13.2.3 Total internal power consumption of the X20BR9300

The following 3 power values must be added together to calculate the total internal power consumption of the X20BR9300:

- Power consumption - Bus
- Power consumption - X2X Link (internal)
- Power consumption - I/O-internal

$$P_{BR9300_{int.}Tot} = P_{X2X_{Bus}BR9300} + P_{X2X_{int.}BR9300} + P_{IO_{int.}BR9300} = 0.4 + 0.93 + 0.17 = 1.5 \text{ W}$$

4.14 Calculation of the additional power dissipation resulting from actuators

Calculation of power dissipation when specifying $R_{DS(on)}$

Explaining output load with an X20DO4332 example

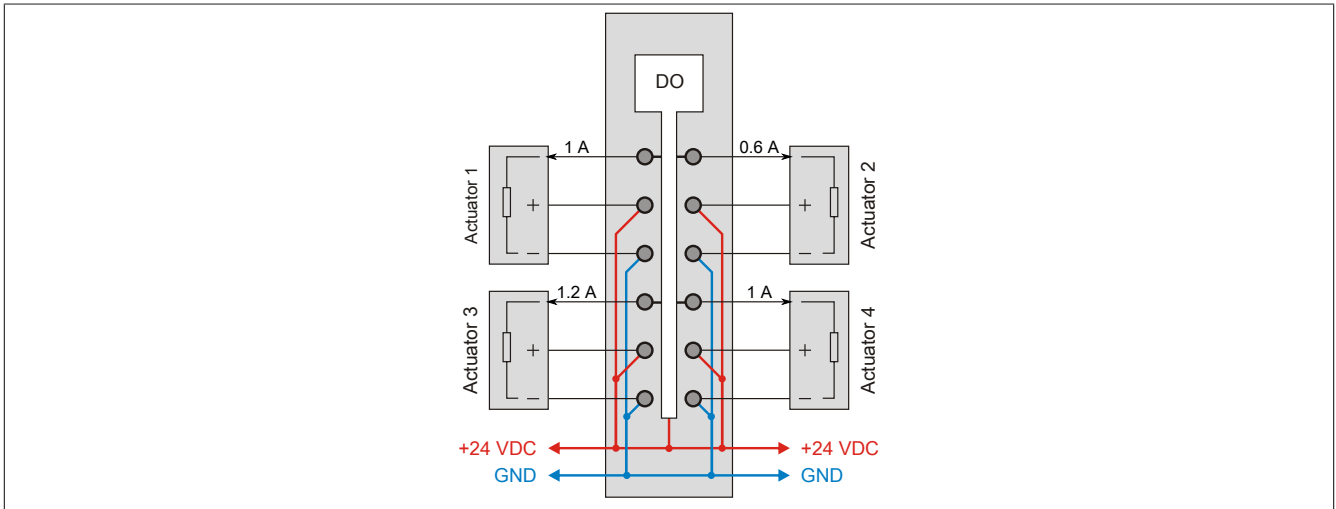


Figure 37: Calculation of power dissipation when specifying $R_{DS(on)}$

Theoretically highest power dissipation resulting from actuators:

Number of outputs * $R_{DS(on)}$ * nominal output current² = power dissipation

$$4 * 140 \text{ m}\Omega * 2 \text{ A}^2 = 2.24 \text{ W}$$

Power dissipation resulting from actuators in this example:

$$140 \text{ m}\Omega * (1 \text{ A}^2 + 0.6 \text{ A}^2 + 1.2 \text{ A}^2 + 1 \text{ A}^2) = 0.532 \text{ W}$$

Power dissipation calculation when specifying the residual voltage

Explaining output load with an X20DO4623 example

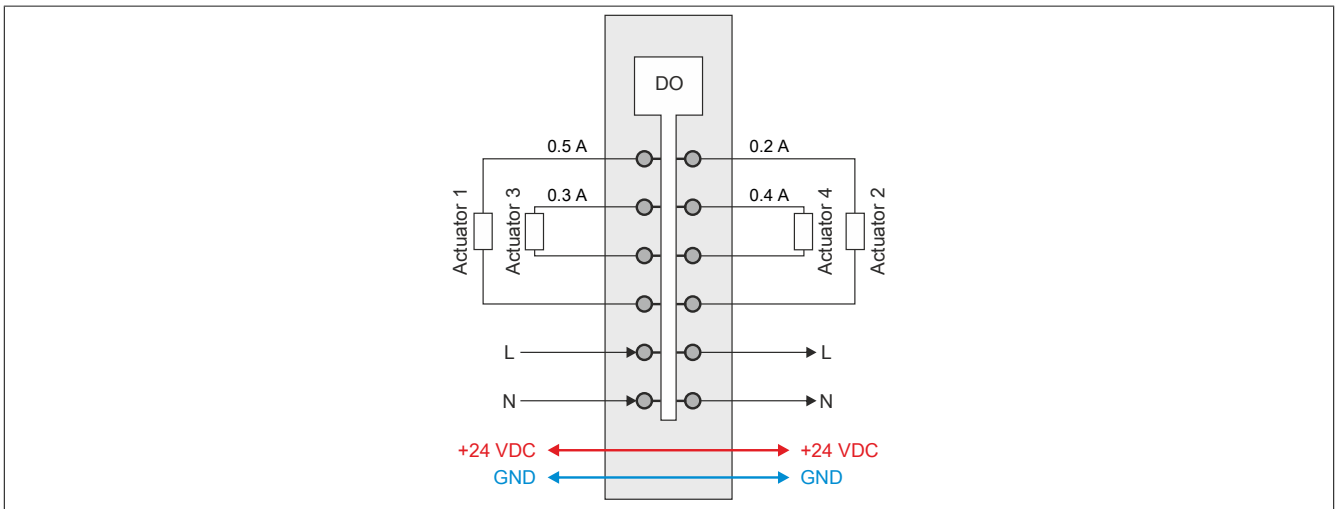


Figure 38: Power dissipation calculation when specifying the residual voltage

Theoretically highest power dissipation resulting from actuators:

Number of outputs * residual voltage * nominal output current = power dissipation

$$4 * 1.6 \text{ V} * 0.5 \text{ A} = 3.2 \text{ W}$$

Power dissipation resulting from actuators in this example:

$$1.6 \text{ V} * (0.5 \text{ A} + 0.2 \text{ A} + 0.3 \text{ A} + 0.4 \text{ A}) = 2.24 \text{ W}$$

Power dissipation calculation when specifying the contact resistance

Explaining output load with an X20DO4649 example

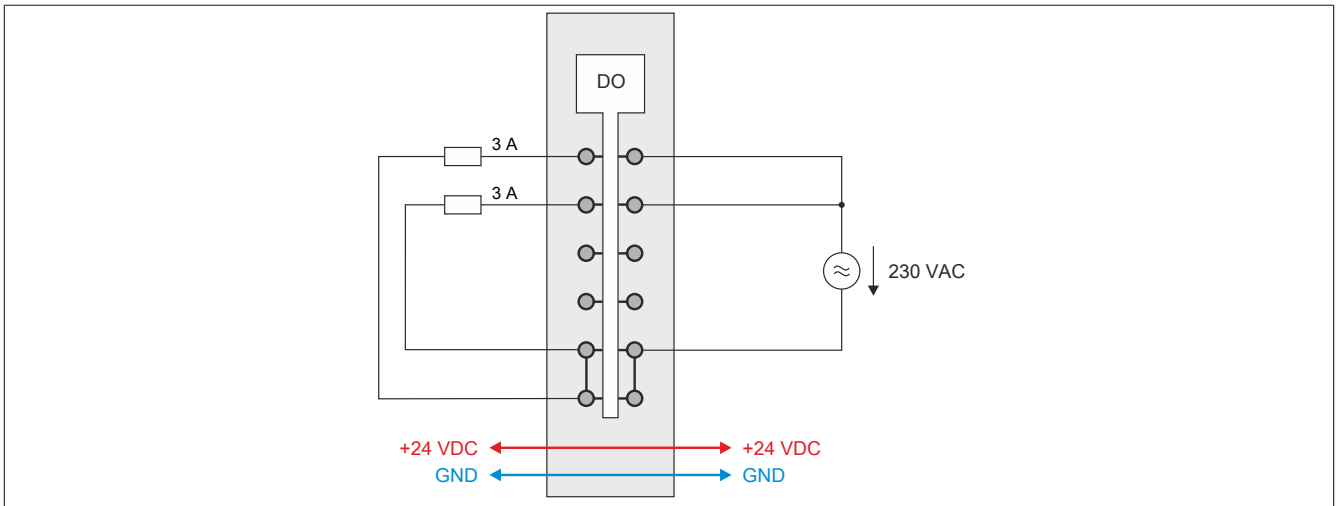


Figure 39: Power dissipation calculation when specifying the contact resistance

Theoretically highest power dissipation resulting from actuators:

Number of outputs * contact resistance * nominal output current² = power dissipation

$$4 * 100 \text{ m}\Omega * 5 \text{ A}^2 = 10 \text{ W}$$

Power dissipation resulting from actuators in this example:

$$100 \text{ m}\Omega * (3 \text{ A}^2 + 3 \text{ A}^2) = 1.8 \text{ W}$$

4.15 Dimensioning the external 24 VDC power supply

X20 systems are provided with external 24 VDC power supplies. The following examples illustrate how to determine the power to be provided.

4.15.1 X20BRx300 bus receivers and X20PS33xx power supply modules

Calculation example with bus receiver X20BR9300

For dimensioning the external 24 VDC power supply, the following power values are included in the calculation:

| Power | Description | Bus power supply | I/O power supply |
|--|--|------------------|------------------|
| Power consumption of the bus and I/O modules | Example for calculating the power requirements: See "Example: Potential groups" on page 84. | 2.73 W | 188.77 W |
| Power consumption of the X20BR9300 | For the value, see the technical data in the data sheet: General information - Power consumption of the X2X Link power supply | 1.62 W | - |
| Subtotal | | 4.35 W | 188.77 W |
| Total power requirements | | 193.12 W | |

The external 24 VDC power supply must provide 193.12 W.

4.15.2 Power supply modules X20PS9400 and X20PS9402

Calculation example with X20PS9400, X20BC0083 and X20BB80

For dimensioning the external 24 VDC power supply, the following power values are included in the calculation:

| Power | Description | Bus power supply | I/O power supply |
|--|--|------------------|------------------|
| Power consumption of the bus and I/O modules | Example for calculating the power requirements: See "Example: Bus controller and modules" on page 83. In the example for calculating the power requirements, expandable bus controller X20BC8083 is used with 1-hub expansion module X20HB2880. If X20BC0083 is used, there is no need for a 1-hub expansion module and the following values are included in the calculation: <ul style="list-style-type: none"> X20BB80: -0.25 W X20BC0083: -2 W | 4.47 W | 235.94 W |
| Power consumption of the X20PS9400 | For the value, see the technical data in the data sheet: General information - Power consumption of the X2X Link power supply | 1.42 W | - |
| Subtotal | | 5.89 W | 235.94 W |
| Total power requirements | | 241.83 W | |

The external 24 VDC power supply must provide 241.83 W.

Calculation example with X20PS9400, X20BC8083, X20HB2880 and X20BB81

For dimensioning the external 24 VDC power supply, the following power values are included in the calculation:

| Power | Description | Bus power supply | I/O power supply |
|--|--|------------------|------------------|
| Power consumption of the bus and I/O modules | Example for calculating the power requirements: See "Example: Bus controller and modules" on page 83. | 5.89 W | 235.94 W |
| Power consumption of the X20PS9400 | For the value, see the technical data in the data sheet: General information - Power consumption of the X2X Link power supply | 1.42 W | - |
| Subtotal | | 7.31 W | 235.94 W |
| Total power requirements | | 243.25 W | |

The external 24 VDC power supply must provide 243.25 W.

4.15.3 CPUs X20CP1483 and X20CPx58x

Calculation example with X20CP3585 and 3 interface modules

For dimensioning the external 24 VDC power supply, the following power values are included in the calculation:

| Power | Description | Bus power supply | I/O power supply |
|---|---|------------------|------------------|
| Power consumption of the bus and I/O modules | Example for calculating the power requirements: See " Example: CPU and modules " on page 82. | 2.13 W | 78.73 W |
| Power consumption of X20CP3585 without interface module and USB | For the value, see the technical data in the data sheet: General information - Power consumption without interface module and USB | 8.8 W | - |
| Power consumption for generating the X2X Link power supply | For the value, see the technical data in the data sheet: General information - Power consumption of the X2X Link power supply | 1.42 W | - |
| 2x USB interface | 3 W must be taken into account for each USB interface used | 6 W | - |
| Power consumption of the X20IF1091 | For the value, see the technical data in the data sheet: General information - Power consumption | 0.97 W | - |
| Power consumption of the X20IF10E1-1 | | 2 W | - |
| Power consumption of the X20IF10E3-1 | | 2 W | - |
| Power consumption of X20CP3585 per interface module | The CPU consumes 0.6 W per interface module. The power consumption of 3 interface modules is: $3 \times 0.6 \text{ W} = 1.8 \text{ W}$ | 1.8 W | - |
| Subtotal | | 25.12 W | 78.73 W |
| Total power requirements | | 103.85 W | |

The external 24 VDC power supply must provide 103.85 W.

4.15.4 Compact-S CPUs X20CP04xx

4.15.4.1 Compact-S CPU without an interface module

The first part of this example shows the calculation of the power requirements for the bus and I/O power supply of a Compact-S CPU without an interface module. Dimensioning the external 24 VDC power supply is explained in the second part.

Power supplied by the power supply module

| Module | Power supplied to the bus | Power supplied to the I/O power supply |
|-----------|---------------------------|--|
| X20PS9600 | +7 W | +240 W |

Power requirements of the Compact-S CPU

| Module | Bus power supply requirements | I/O power supply requirements |
|---------------------------------|-------------------------------|-------------------------------|
| X20PS9600 | - | -0.6 W |
| X20BB52 | -0.55 W | - |
| X20CP0410 | -2.2 W | - |
| 2x USB interface | -2 W ¹⁾ | - |
| Total power requirements | -4.75 W | -0.6 W |

1) $2 \times 5 \text{ V} \times 0.2 \text{ A} = 2 \text{ W}$

Power balance for the bus supply

The power requirements of the Compact-S CPU are completely covered by the bus power supply. In a power balance, it must be checked whether the power supply module covers the power requirements of the Compact-S CPU.

| | Bus power supply |
|---|------------------|
| Power supplied by the power supply module | +7 W |
| Total power requirements | -4.75 W |
| Remaining power | +2.25 W |

The power comparison indicates that the power provided by the power supply module is sufficient. Additional power supply modules are not necessary.

External 24 VDC power supply

For dimensioning the external 24 VDC power supply, the following power values are included in the calculation:

| Power | Description | Bus power supply | I/O power supply |
|--|---|------------------|------------------|
| Power consumption of the bus and I/O modules | Examples for calculating the power requirements: See "Calculating the power requirements" on page 81. The following values are assumed for this example: <ul style="list-style-type: none"> Bus power supply: 3.67 W I/O power supply: 192.51 W | 3.67 W | 192.51 W |
| Power consumption of the X20PS9600 | For the values, see the technical data in the data sheet: General information - Power consumption of the X2X Link power supply | 1.42 W | 0.6 W |
| Power requirements of the Compact-S CPU | The values calculated in section "Power requirements of the Compact-S CPU" on page 96 are used for the bus and I/O power supply. | 4.75 W | - |
| Subtotal | | 9.84 W | 193.11 W |
| Total power requirements | | 202.95 W | |

The external 24 VDC power supply must provide 202.95 W.

4.15.4.2 Compact-S CPU with 1 interface module

The first part of this example shows the calculation of the power requirements for the bus and I/O power supply of a Compact-S CPU with an interface module. Dimensioning the external 24 VDC power supply is explained in the second part.

Power supplied by the power supply module

| Module | Power supplied to the bus | Power supplied to the I/O power supply |
|-----------|---------------------------|--|
| X20PS9600 | +7 W | +240 W |

Power requirements of the Compact-S CPU

| Module | Bus power supply requirements | I/O power supply requirements |
|---------------------------------|-------------------------------|-------------------------------|
| X20PS9600 | - | -0.6 W |
| X20BB62 | -0.94 W | - |
| X20CP0410 | -2.2 W | - |
| 2x USB interface | -2 W ¹⁾ | - |
| X20IF1063-1 | -1.8 W | - |
| Total power requirements | -6.94 W | -0.6 W |

1) $2 \times 5 \text{ V} \times 0.2 \text{ A} = 2 \text{ W}$

Power balance for the bus supply

The power requirements of the Compact-S CPU are completely covered by the bus power supply. In a power balance, it must be checked whether the power supply module covers the power requirements of the Compact-S CPU.

| | Bus power supply |
|---|------------------|
| Power supplied by the power supply module | +7 W |
| Total power requirements | -6.94 W |
| Remaining power | +0.06 W |

The power comparison indicates that the power provided by the power supply module is sufficient. Additional power supply modules are not necessary.

External 24 VDC power supply

For dimensioning the external 24 VDC power supply, the following power values are included in the calculation:

| Power | Description | Bus power supply | I/O power supply |
|--|---|------------------|------------------|
| Power consumption of the bus and I/O modules | Examples for calculating the power requirements: See "Calculating the power requirements" on page 81. The following values are assumed for this example: <ul style="list-style-type: none"> • Bus power supply: 3.67 W • I/O power supply: 192.51 W | 3.67 W | 192.51 W |
| Power consumption of the X20PS9600 | For the values, see the technical data in the data sheet: General information - Power consumption of the X2X Link power supply | 1.42 W | 0.6 W |
| Power requirements of the Compact-S CPU | The values calculated in section "Power requirements of the Compact-S CPU" on page 97 are used for the bus and I/O power supply. | 6.94 W | - |
| Subtotal | | 12.03 W | 193.11 W |
| Total power requirements | | 205.14 W | |

The external 24 VDC power supply must provide 205.14 W.

4.15.4.3 Compact-S CPU with 2 interface modules

Calculating the power requirements for the bus and I/O power supply of a Compact-S CPU with 2 interface modules is shown in the first part of this example. Dimensioning the external 24 VDC power supply is explained in the second part.

Power supplied by the power supply module

| Module | Power supplied to the bus | Power supplied to the I/O power supply |
|-----------|---------------------------|--|
| X20PS9600 | +7 W | +240 W |

Power requirements of the Compact-S CPU

| Module | Bus power supply requirements | I/O power supply requirements |
|---------------------------------|-------------------------------|-------------------------------|
| X20PS9600 | - | -0.6 W |
| X20BB72 | -1.17 W | - |
| X20CP0410 | -2.2 W | - |
| 2x USB interface | -2 W ¹⁾ | - |
| X20IF1043-1 | -1.1 W | - |
| X20IF1063-1 | -1.8 W | - |
| Total power requirements | -8.27 W | -0.6 W |

1) $2 \times 5 \text{ V} \times 0.2 \text{ A} = 2 \text{ W}$

Power balance for the bus supply

The power requirements of the Compact-S CPU are completely covered by the bus power supply. In a power balance, it must be checked whether the power supply module covers the power requirements of the Compact-S CPU.

| | Bus power supply |
|---|------------------|
| Power supplied by the power supply module | +7 W |
| Total power requirements | -8.27 W |
| Remaining power | -1.27 W |

The power comparison indicates that the power provided by the power supply module is insufficient. An additional X20PS3300 power supply module is required (see "[Hardware configuration](#)" on page 99).

External 24 VDC power supply

For dimensioning the external 24 VDC power supply, the following power values are included in the calculation:

| Power | Description | Bus power supply | I/O power supply |
|--|---|------------------|------------------|
| Power consumption of the bus and I/O modules | Examples for calculating the power requirements: See " Calculating the power requirements " on page 81. The following values are assumed for this example: <ul style="list-style-type: none"> Bus power supply: 3.67 W I/O power supply: 192.51 W | 3.67 W | 192.51 W |
| Power consumption of the X20PS9600 | For the values, see the technical data in the data sheet: General information - Power consumption of the X2X Link power supply | 1.42 W | 0.6 W |
| Power requirements of the Compact-S CPU | The values calculated in section " Power requirements of the Compact-S CPU " on page 98 are used for the bus and I/O power supply. | 8.27 W | - |
| Subtotal | | 13.36 W | 193.11 W |
| Total power requirements | | 206.47 W | |

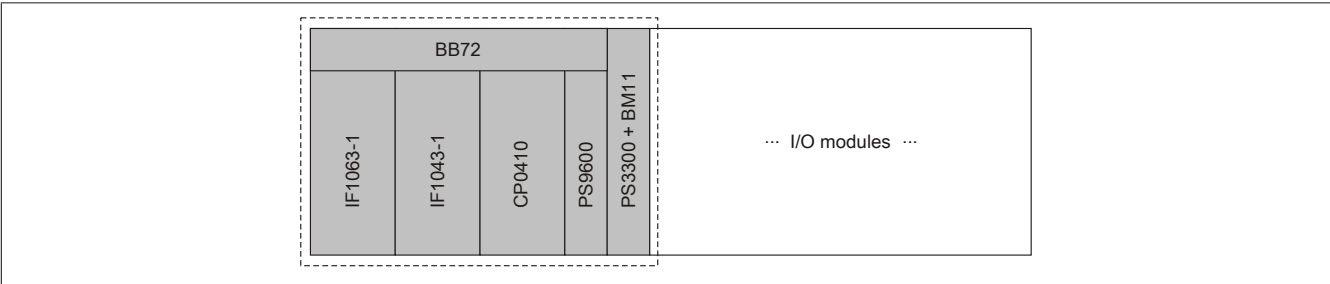
The external 24 VDC power supply must provide 206.47 W.

Hardware configuration

To provide sufficient power for the bus power supply, X20PS3300 power supply modules can be connected in parallel via bus module X20BM11. It is important to note that in order to determine the necessary bus power supply in parallel operation, 75% of the nominal power of the power supply modules must be calculated.

Example for calculating the bus power for 1 X20PS9600 and 1 X20PS3300:

$$\text{Bus power} = 2 \times 7 \text{ W} \times 0.75 = 10.5 \text{ W}$$



Connection example for power supply modules

X20PS9600

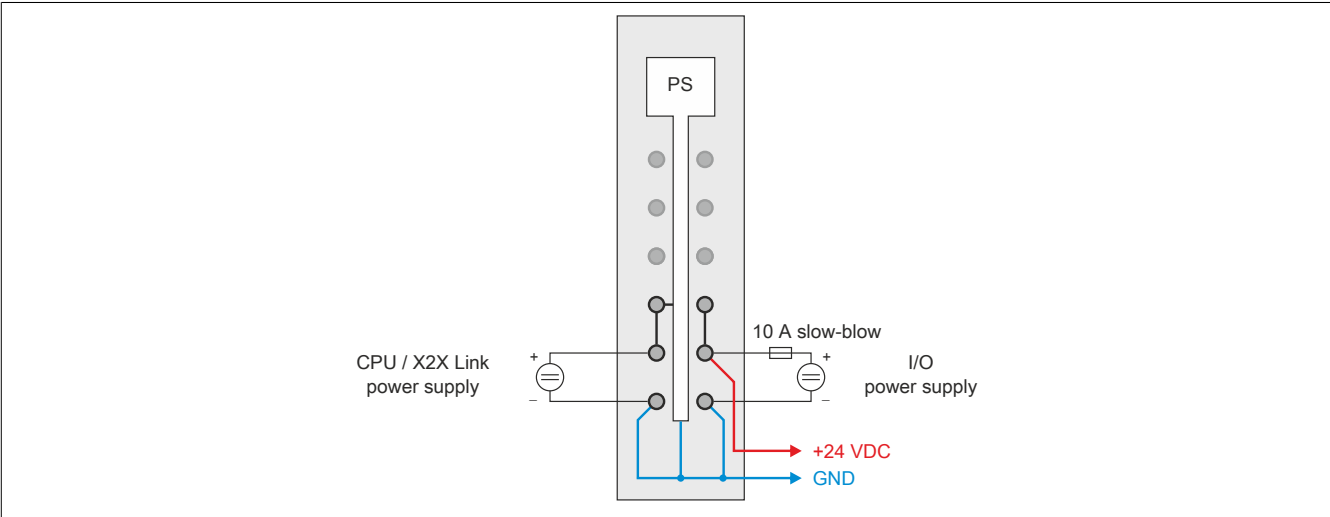


Figure 40: The X20PS9600 is connected as usual.

X20PS3300

Power supply module X20PS3300 is operated with bus module X20BM11. Only the CPU / X2X Link power supply is connected. By using bus module X20BM11, the I/O power supply of power supply module X20PS9600 is connected through to the I/O modules.

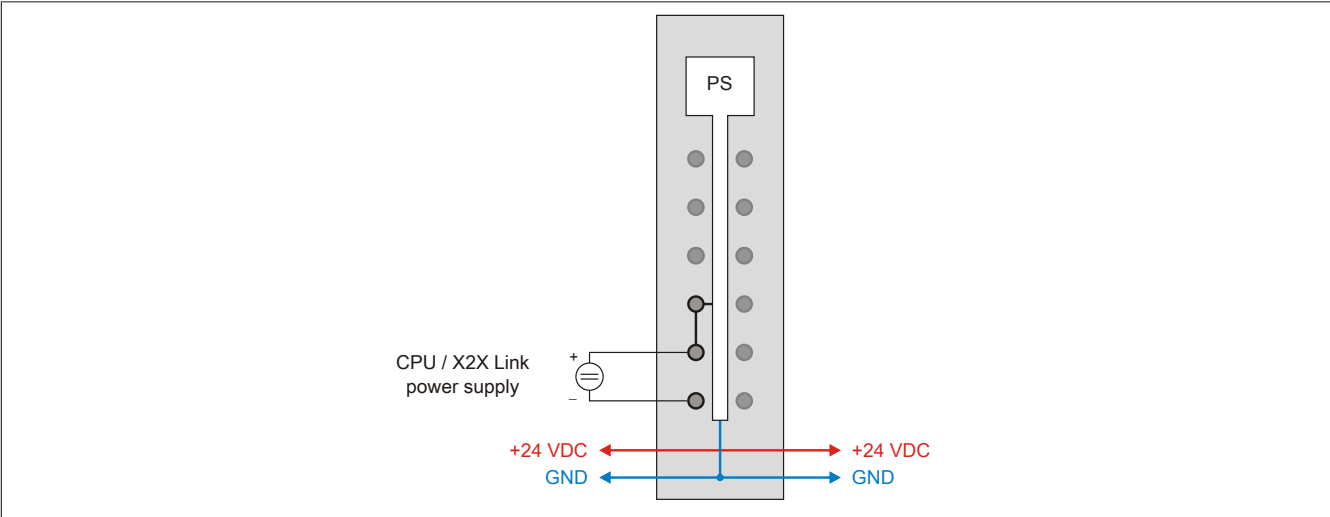


Figure 41: Only the CPU / X2X Link power supply is connected for the X20PS3300.

4.15.5 SafeLOGIC controller X20SL81xx

4.15.5.1 SafeLOGIC controller X20SL8100

For dimensioning the external 24 VDC power supply, only the power consumption of the SafeLOGIC controller must be taken into account.

| Power | Description | Requirements |
|--------------------------------|---|--------------|
| Power consumption of X20SL8100 | For the value, see the technical data in the data sheet: General information - Power consumption | 4.3 W |

The external 24 VDC power supply must provide 4.3 W.

4.15.5.2 SafeLOGIC controller X20SL8110

Calculation example with interface module X20IF10E3-1

For dimensioning the external 24 VDC power supply, the following power values are included in the calculation:

| Power | Description | Requirements |
|---|---|--------------|
| Power consumption of X20SL8110 | For the value, see the technical data in the data sheet: General information - Power consumption | 3.9 W |
| Power consumption of the X20IF10E3-1 | For the value, see the technical data in the data sheet: General information - Power consumption | 2 W |
| Power consumption of the X20SL8110 for the interface module | The CPU consumes 0.6 W for the operation of the interface module. | 0.6 W |
| Total power requirements | | 6.5 W |

The external 24 VDC power supply must provide 6.5 W.

4.15.5.3 SafeLOGIC controller X20SL8101

For dimensioning the external 24 VDC power supply, the following power values are included in the calculation:

| Power | Description | Bus power supply | I/O power supply |
|--|--|------------------|------------------|
| Power consumption of the bus and I/O modules | Example for calculating the power requirements: See " Example: CPU and modules " on page 82 | 2.13 W | 78.73 W |
| Power consumption of X20SL8101 | For the value, see the technical data in the data sheet: General information - Power consumption | 5.3 W | - |
| Power consumption for generating the X2X Link power supply | For the value, see the technical data in the data sheet: General information - Power consumption of the X2X Link power supply | 1.42 W | - |
| Subtotal | | 8.85 W | 78.73 W |
| Total power requirements | | 87.58 W | |

The external 24 VDC power supply must provide 87.58 W.

4.16 Power dissipation calculation of I/O modules

Some modules require that neighboring modules are not permitted to exceed a certain power dissipation during operation.

4.16.1 Example: Operation of module X20SM1436

The power dissipation of the immediate neighboring modules of the SM module is not permitted to exceed 1 W. A maximum power dissipation of 1.8 W is permitted for the next modules.

| | | | | | | |
|--|--|--|---|--|--|--|
| | X20 module Power dissipation ≤ 1.8 W | Neighboring module Power dissipation ≤ 1 W | SM1436 Operation with current derating (3.0 A) | Neighboring module Power dissipation ≤ 1 W | X20 module Power dissipation ≤ 1.8 W | |
|--|--|--|---|--|--|--|

4.16.2 Calculation of the power dissipation of I/O modules adjacent to the X20SM1436

The power dissipation of I/O modules consists of the following power values:

- Power consumption - Bus module
- Power consumption - Bus
- Power consumption - I/O-internal
- Power consumption - I/O-external
- Additional power dissipation caused by actuators (resistive)

Immediate neighboring modules

The table describes the calculation of the power dissipation of I/O modules that can be operated directly next to the SM module. The power dissipation of these modules is not permitted to exceed 1 W.

| Power value | X20AI2622 | X20AT2402 | X20DI2653 | X20DO4322 |
|--|-----------|-----------|-----------|-----------|
| Power consumption - Bus module [W] | 0.13 | 0.13 | 0.13 | 0.13 |
| Power consumption - Bus [W] | 0.01 | 0.01 | 0.14 | 0.16 |
| Power consumption - I/O-internal [W] | 0.8 | 0.72 | - | 0.49 |
| Power consumption - I/O-external [W] | - | - | 0.55 | - |
| Additional power dissipation caused by actuators (resistive) [W] | - | - | - | 0.21 |
| Power dissipation of the I/O module [W] | 0.94 | 0.86 | 0.82 | 0.99 |

All modules have a power dissipation ≤ 1 W and can therefore be operated directly next to module X20SM1436.

Modules in the 2nd row

The table describes the calculation of the power dissipation of I/O modules that can be operated in the 2nd row next to the SM module. The power dissipation of these modules is not permitted to exceed 1.8 W.

| Power value | X20AI4632 | X20AT4222 | X20DI8371 | X20DO6322 |
|--|-----------|-----------|-----------|-----------|
| Power consumption - Bus module [W] | 0.13 | 0.13 | 0.13 | 0.13 |
| Power consumption - Bus [W] | 0.01 | 0.01 | 0.18 | 0.18 |
| Power consumption - I/O-internal [W] | 1.5 | 1.1 | - | 0.71 |
| Power consumption - I/O-external [W] | - | - | 1.2 | - |
| Additional power dissipation caused by actuators (resistive) [W] | - | - | - | 0.31 |
| Power dissipation of the I/O module [W] | 1.64 | 1.24 | 1.51 | 1.33 |

All modules have a power dissipation ≤ 1.8 W and can therefore be operated in the 2nd row next to module X20SM1436.

5 Mechanical handling

5.1 Solid mechanics

With all the advantages that the three-part modularity of the X20 system offers, one emphasis has always been solid mechanical design.

Its robust design, long guides and strengthened housing guarantee the stability it needs in industrial environments. These features allow the X20 system to be mounted on a top-hat rail with the same ease as a rack system. They also make it just as simple to remove it from the rail.

The following sections describe the mechanical handling of the X20 system step-by-step with the aid of pictures.

5.2 Number of connection cycles

The modules of the X20 system are divided into three parts. A module is made up of three basic elements:

- Bus module
- Electronic module
- Terminal block

The number of connection cycles between the respective basic elements is specified at 50.

| Basic element | Number of connection cycles |
|------------------------------------|-----------------------------|
| Bus module ↔ Bus module | 50 |
| Bus module ↔ Electronic module | |
| Electronic module ↔ Terminal block | |

Table 5: Number of connection cycles between the respective basic elements

5.3 Assembling an X20 system

There are several ways to assemble an X20 system. Two methods are described below:

| Assembling an X20 system | Description |
|--------------------------|--|
| Variant 1 | The X20 system is completely assembled and then installed on the top-hat rail. |
| Variant 2 | The X20 system is installed and assembled directly on the top-hat rail. |

Table 6: Two of the several methods for assembling an X20 system

Information:

- Store X20 modules in the protective packaging until immediately before assembly.
- Only touch X20 modules on the housing.
- Take necessary protective measures against electrostatic discharge (see also [Protection against electrostatic discharges](#)).

5.3.1 Variant 1

The X20 system is completely assembled and then installed on the top-hat rail.

1. Remove X20 modules from protective packaging. Check modules for obvious mechanical damages.
2. Insert electronic module in the guides on the bus module.



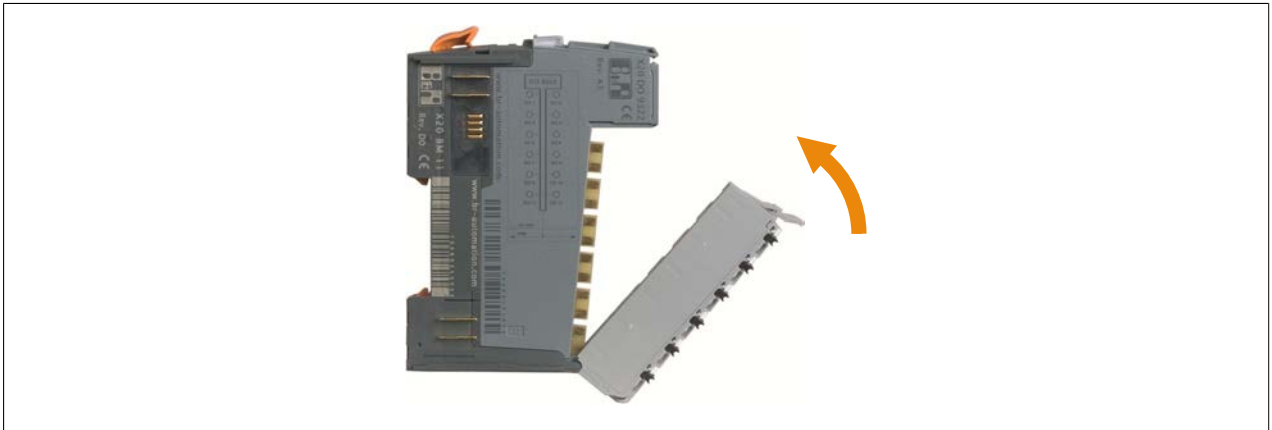
3. Push the electronic module and the bus module flush together.



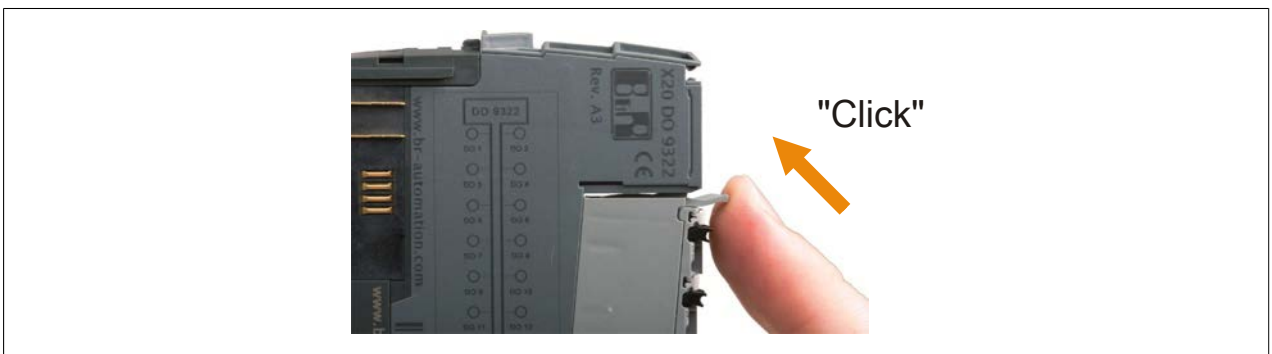
4. Hang the bottom edge of the terminal block in its place on the bus module.



5. Rotate the terminal block up into place.



6. The terminal block latch must close with an audible click. If the latch does not catch, the lever must be pushed up.



7. Individual X20 modules should be assembled from left to right (viewed from front) to form the complete X20 system. To do this, connect the right module from behind to the guides for the left bus module.



8. Slide the right module forward until the two modules fit flush together.
 9. Proceed like this until the second to last module.
 10. For the last module, only insert the bus module in the guides of the left bus module.
 11. Slide the right bus module forward until the two bus modules fit flush together.

12. Insert the right locking plate into the guides on the bus module from the front and push it all the way in.



13. Insert the electronic module into the bus module and push firmly so that the two modules fit flush together.

14. Hang the bottom of the terminal block in its place on the bus module and push it up into place. The terminal block latch must close with an audible click.

15. Lay the left locking plate on the left module and insert it in the guides. Finally, slide the locking plate forward.



16. The procedure for hanging the X20 system on the top-hat rail is described in section ["Installing the X20 system on the top-hat rail"](#) on page 110.

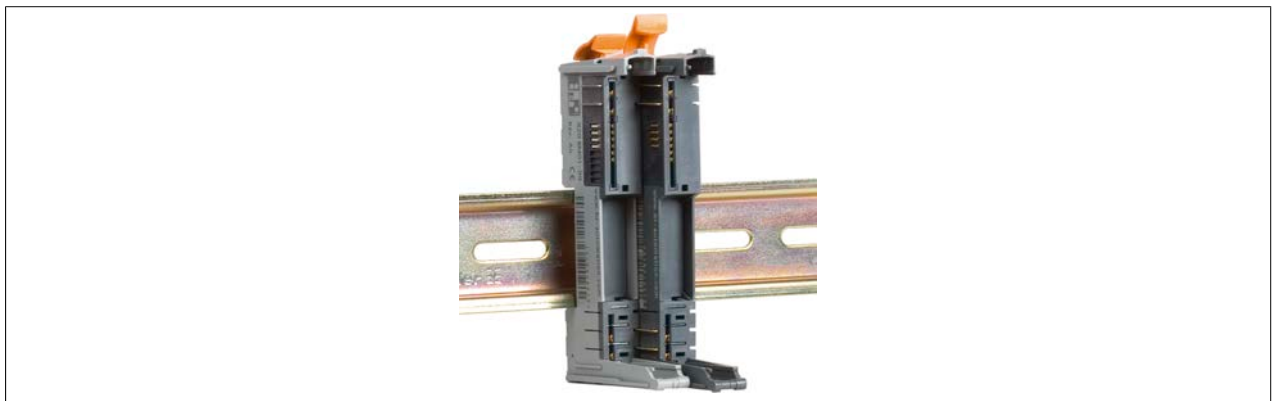
5.3.2 Variant 2

The X20 system is installed and assembled directly on the top-hat rail.

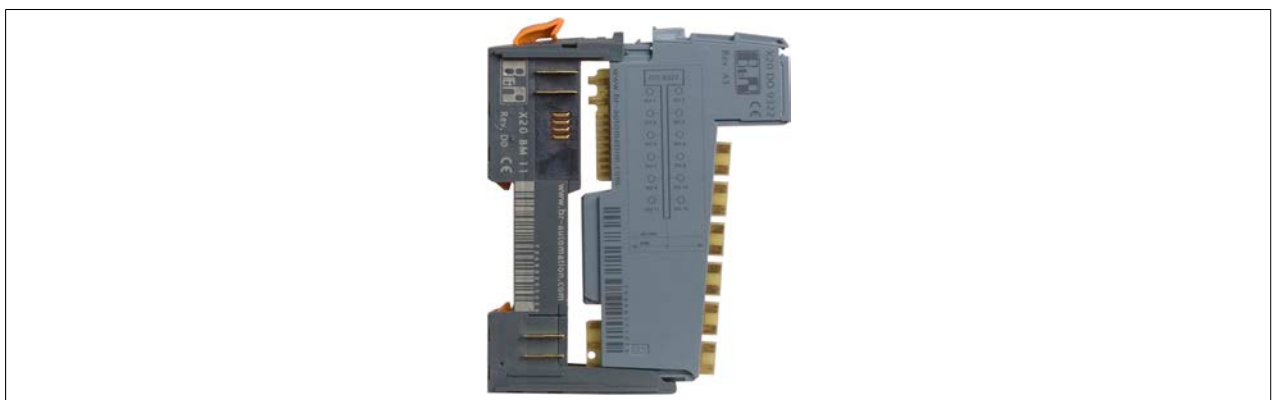
1. Remove X20 modules from protective packaging. Check modules for obvious mechanical damages.
2. Push the locking lever all the way up on all of the bus modules. This opens the locking mechanism for top-hat rail installation.



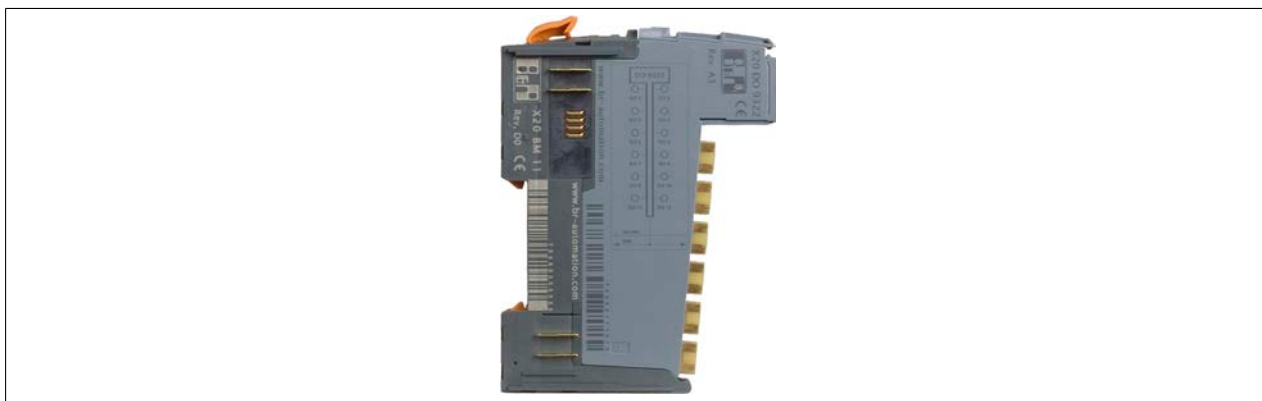
3. Hang the first bus module in the desired position on the top-hat rail and close the locking mechanism by pushing the lever down.
4. Insert the next bus module in the guides of the previously mounted bus module.



5. Slide the bus module in against the top-hat rail and secure it by pushing down the locking lever.
6. Proceed like this with the rest of the bus modules.
7. Insert the corresponding electronic module in the guides on the leftmost bus module.



8. Push the electronic module and the bus module flush together.



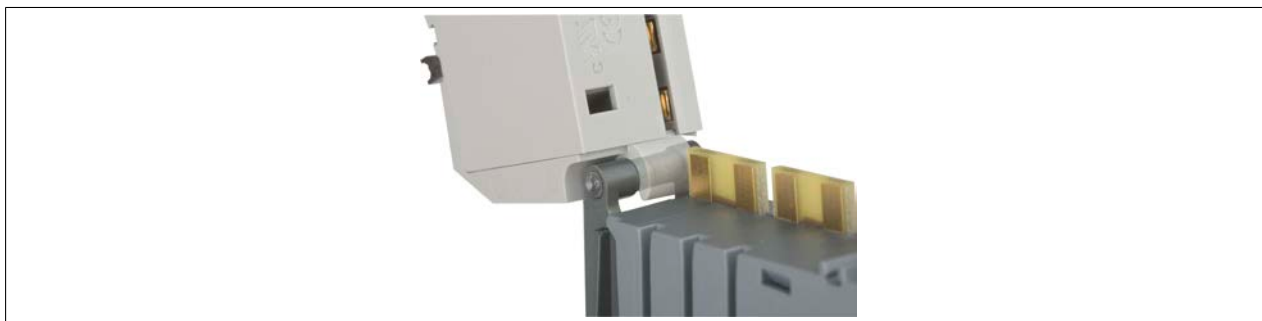
9. Proceed like this until the second to last electronic module.

10. Insert the right locking plate into the guides from the front and push it in all the way.

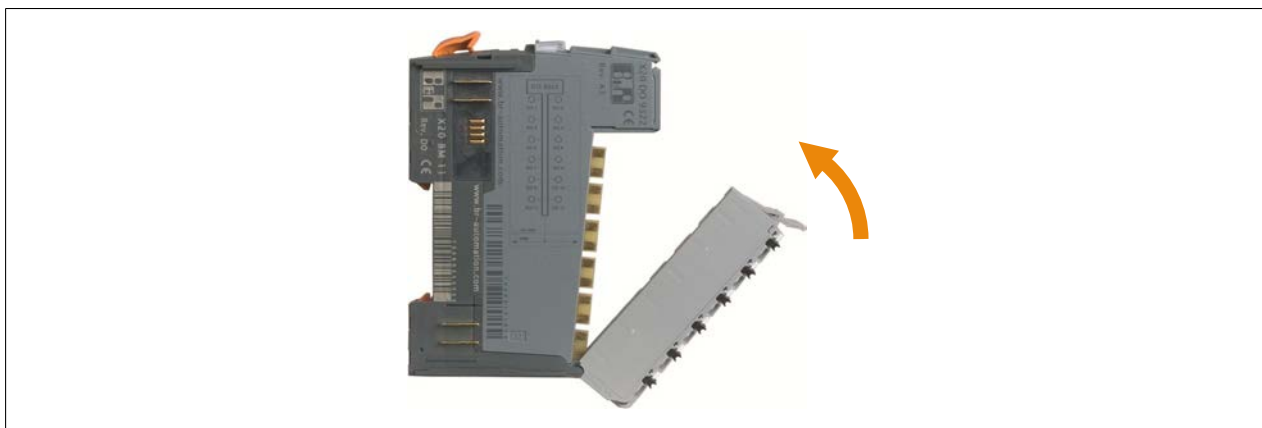


11. Insert the electronic module into the bus module and push firmly so that the two modules fit flush together.

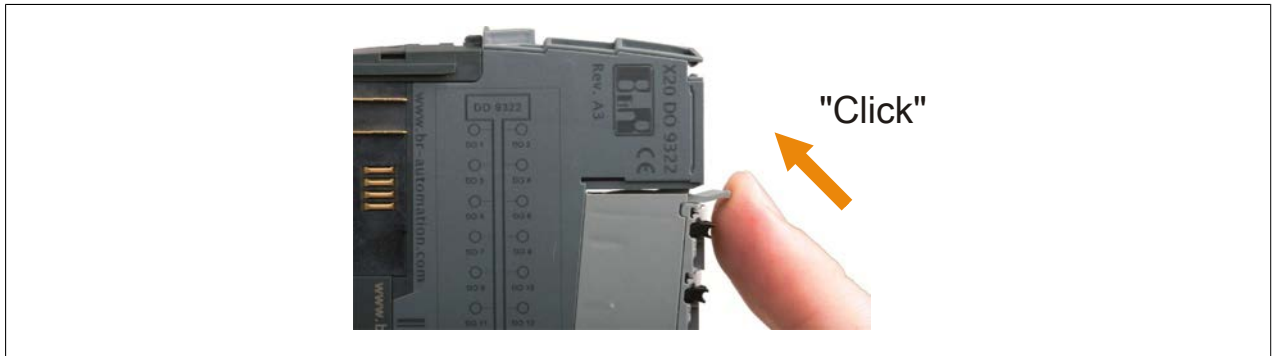
12. Hang the terminal block in its place on the leftmost bus module.



13. Rotate the terminal block up into place.



14. The terminal block latch must close with an audible click. If the latch does not catch, the lever must be pushed up.



15. Proceed like this with the rest of the terminal blocks.

16. Lay the left locking plate on the left module and insert it in the guides. Finally, slide the locking plate forward.



5.4 Installing the X20 system on the top-hat rail

Complete the following steps to install an assembled X20 system on the top-hat rail.

1. Push the locking lever all the way up on all of the bus modules. This opens the locking mechanism for top-hat rail installation.



2. Hang the X20 system in the desired position on the top-hat rail and close the locking mechanism by pushing the lever down.

5.5 Removing the X20 system from the top-hat rail

5.5.1 Remove the entire system from the top-hat rail

1. Push the locking lever all the way up on all of the bus modules. This opens the locking mechanism for top-hat rail installation.



2. Remove the X20 system from the top-hat rail.

5.5.2 Removing a block of modules from the top-hat rail

1. Push the locking lever all the way up on all of the modules that you wish to remove from the top-hat rail. This opens the locking mechanism for top-hat rail installation.



2. The terminal block must be removed from the module to the left of the module block that is to be removed. To do this, push down on the locking lever on the terminal block ① and rotate the terminal block out and down ②.



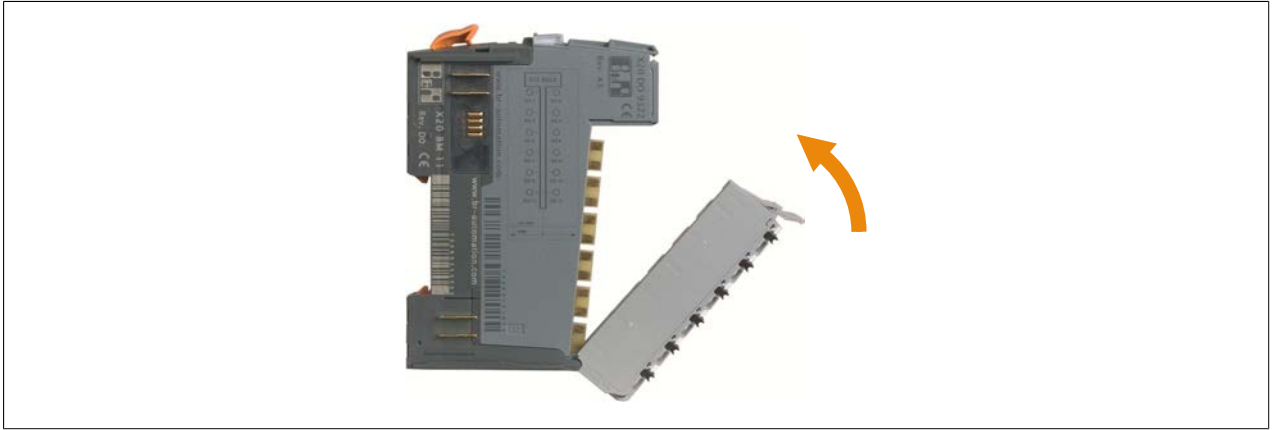
3. Remove the module block from the top-hat rail.



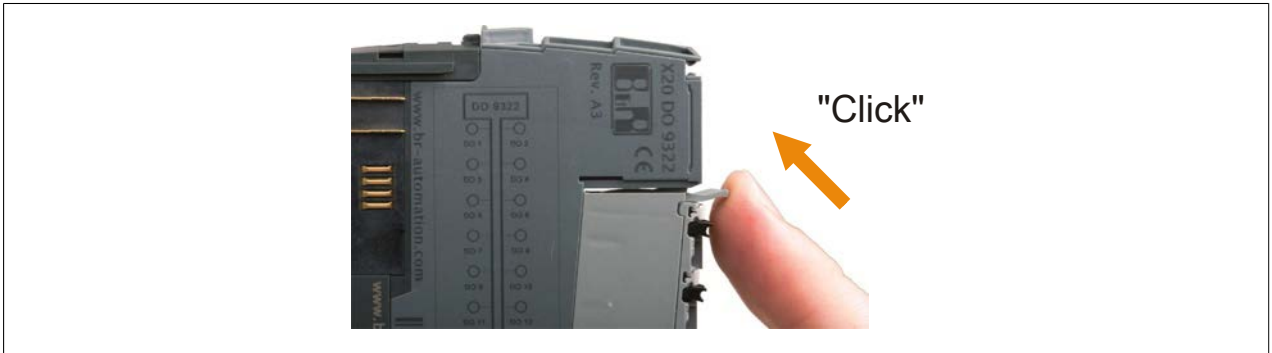
4. Put the removed terminal block back on the module. To do this, hang the bottom in place in the bus module.



5. Rotate the terminal block up into place.



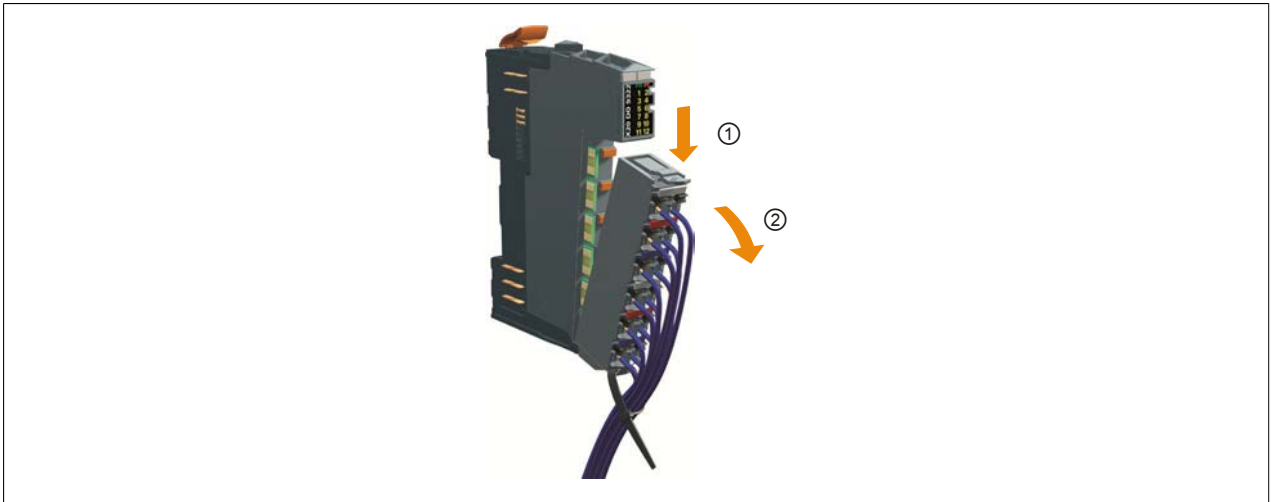
6. The terminal block latch must close with an audible click. If the latch does not catch, the lever must be pushed up.



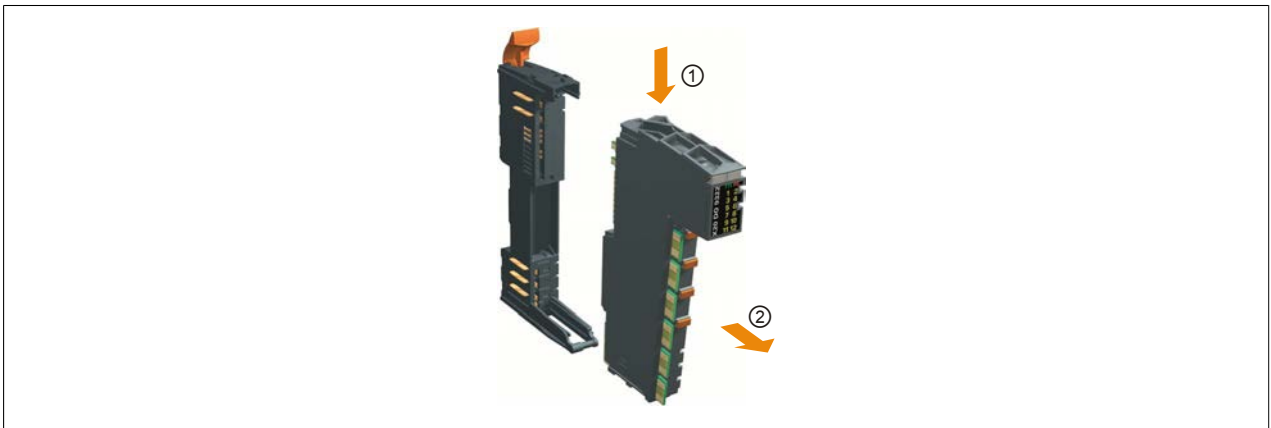
5.6 Expanding an X20 system

If you want to expand an existing X20 system to the right, the right locking plate must be removed.

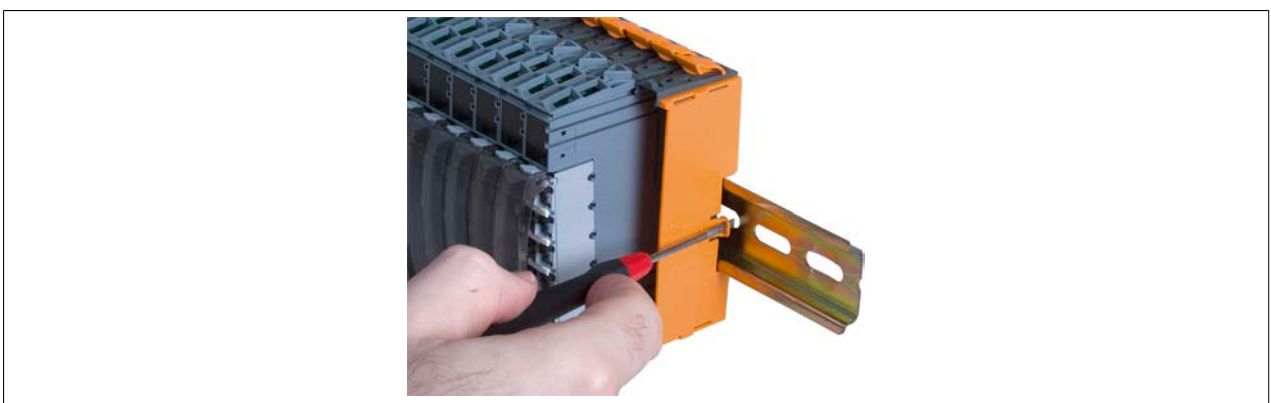
1. Remove the terminal block from the rightmost module. To do this, push down on the locking lever on the terminal block ① and rotate the terminal block out and down ②.



2. Push down on the electronic module's locking lever ① and remove the electronic module ②.



3. Use a screwdriver to lift the locking lever of the right locking plate and pull the locking plate off of the bus module.



4. Additional modules can now also be installed as described in assembly method 2 (see ["Variant 2" on page 107](#)).

5.7 Installing accessories

5.7.1 Additional locking mechanisms

Some specific areas require additional locking mechanisms to prevent accidental release of the mechanical components.

5.7.1.1 Accessory locking clips

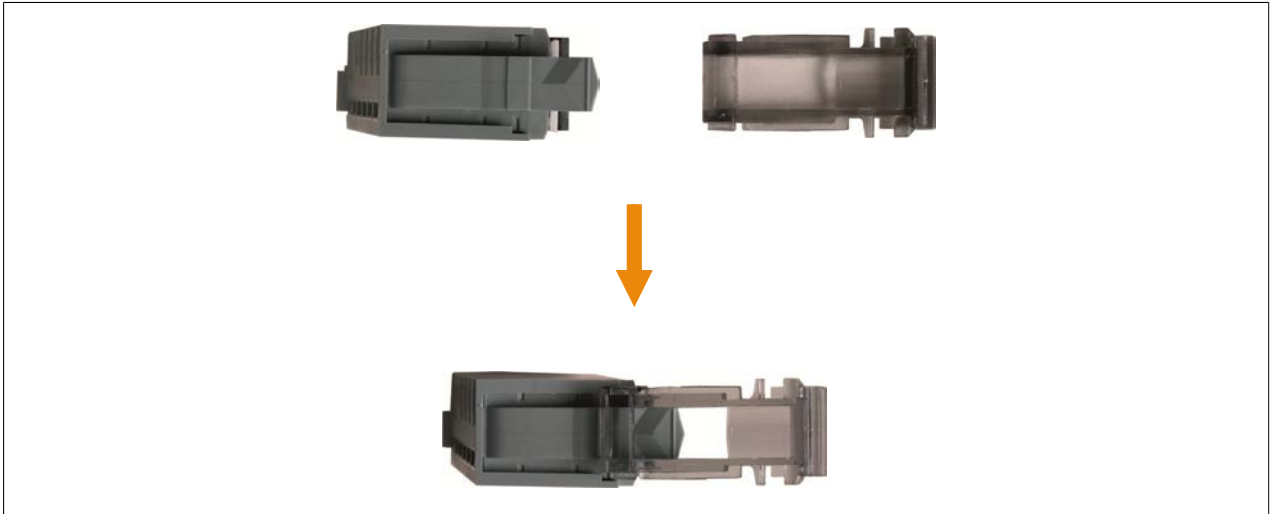
The accessory locking clip attaches the electronic module to the bus module. The locking clip is inserted in the appropriate opening on the module and pushed down.



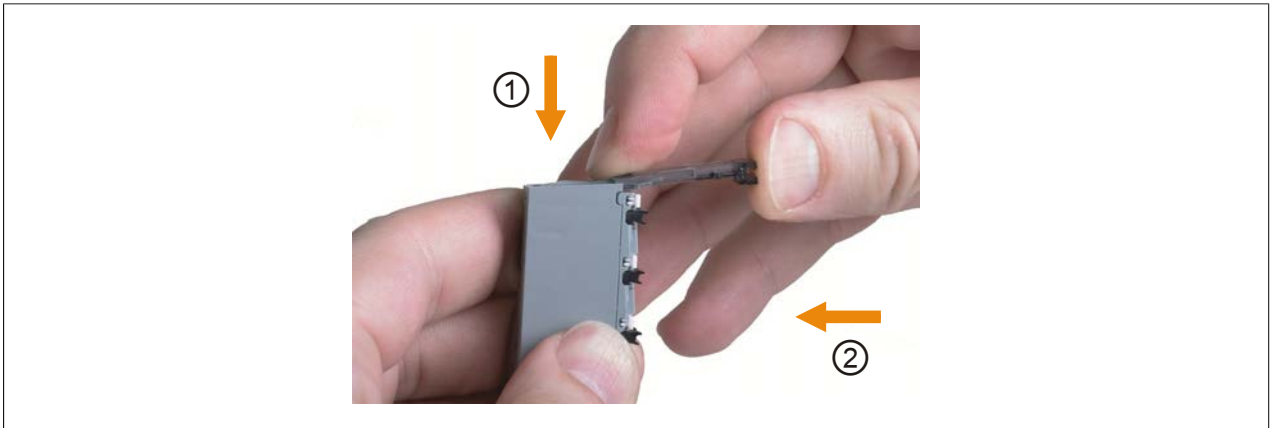
5.7.1.2 Terminal locking clip

The terminal locking clip attaches the terminal block securely to the electronic module.

1. Set the terminal locking clip on the terminal block locking lever as shown.



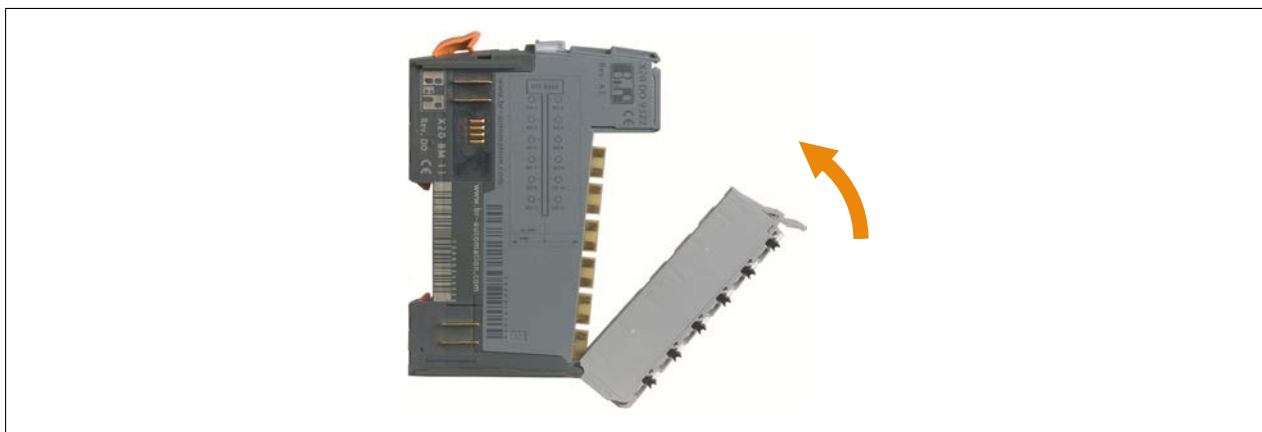
2. Push down and hold the terminal locking clip and the locking lever with your index finger ①. Finally, slide the terminal locking clip forward with your thumb ②.



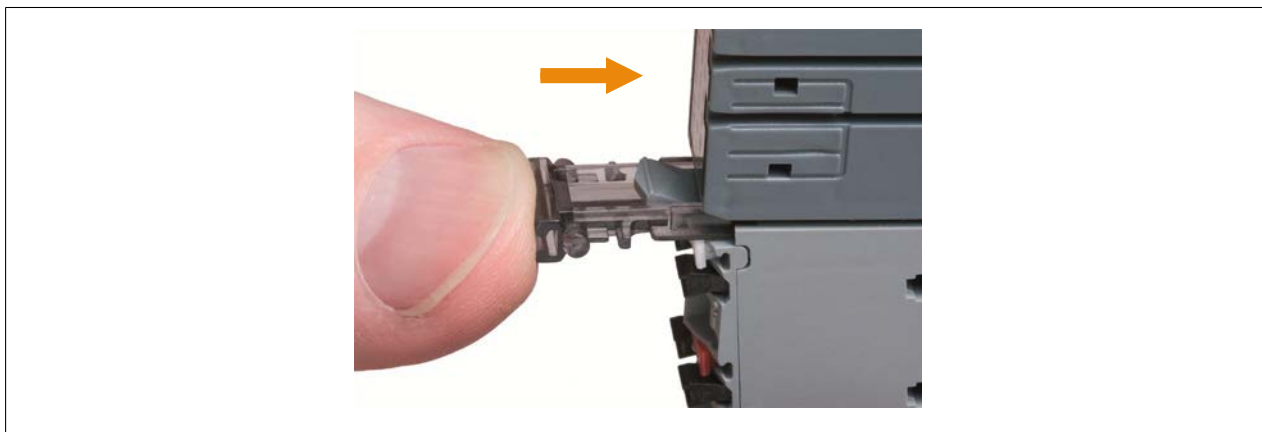
3. Hang the bottom edge of the terminal block in its place on the bus module.



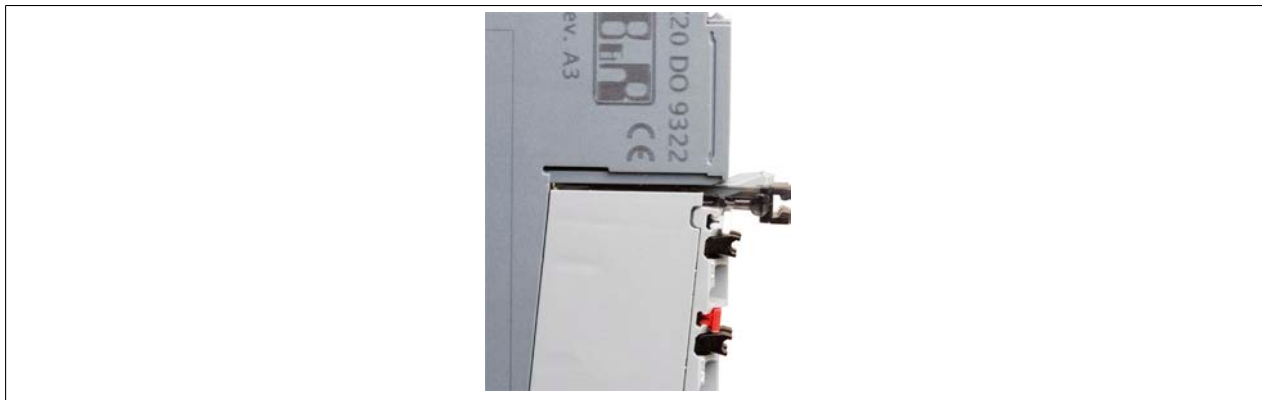
4. Rotate the terminal block up into place.



5. Secure the terminal block in the electronic module by pushing in the terminal locking clip.



6. Installed terminal locking clip.

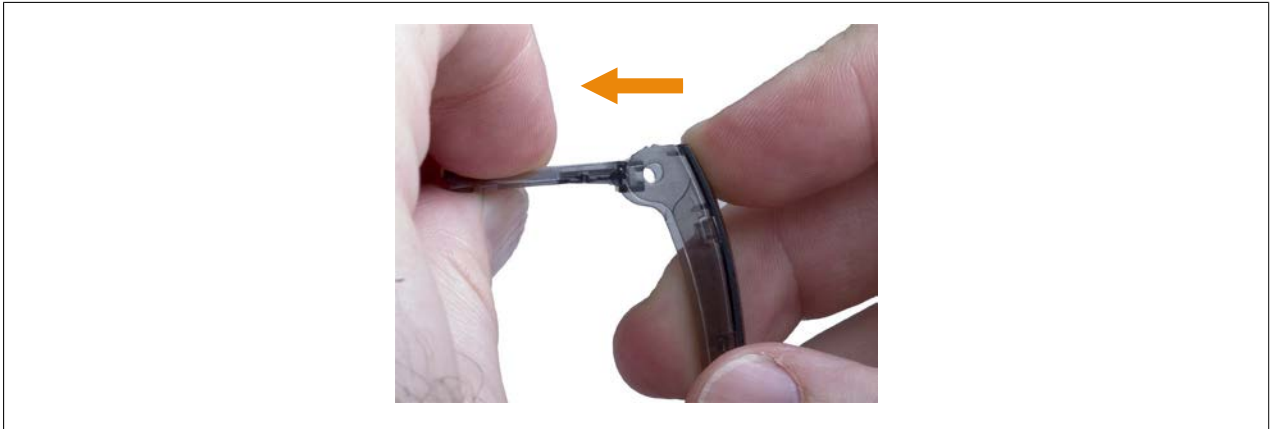


7. To remove the terminal block, pull the terminal locking clip out again.

5.7.2 Plain text tag for X20 modules

Tags are available for X20 modules into which plain text slide-in labels can be inserted. The tags are attached to the terminal locking clips.

1. Hold the plain text tag at a 90° angle to the terminal locking clip.
2. Push the plain text tag into the terminal locking clip's slot until it clicks into place.

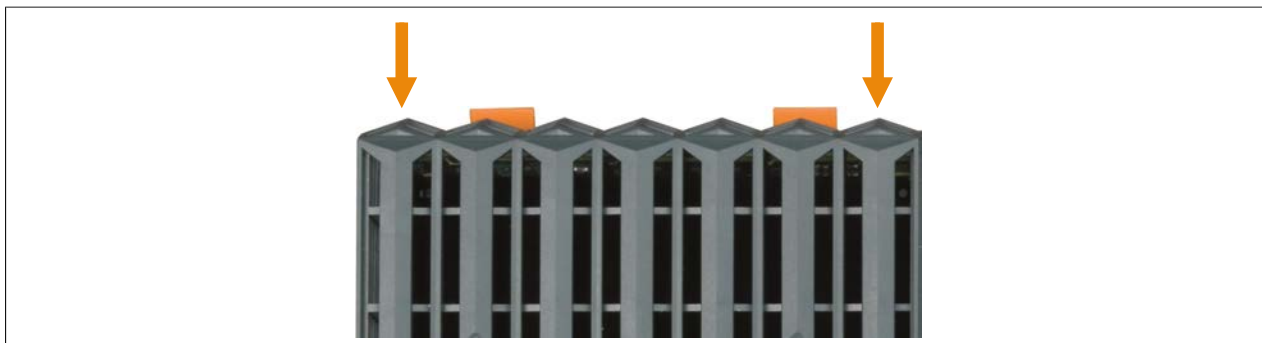


5.7.3 Plain text tag for X20 CPUs

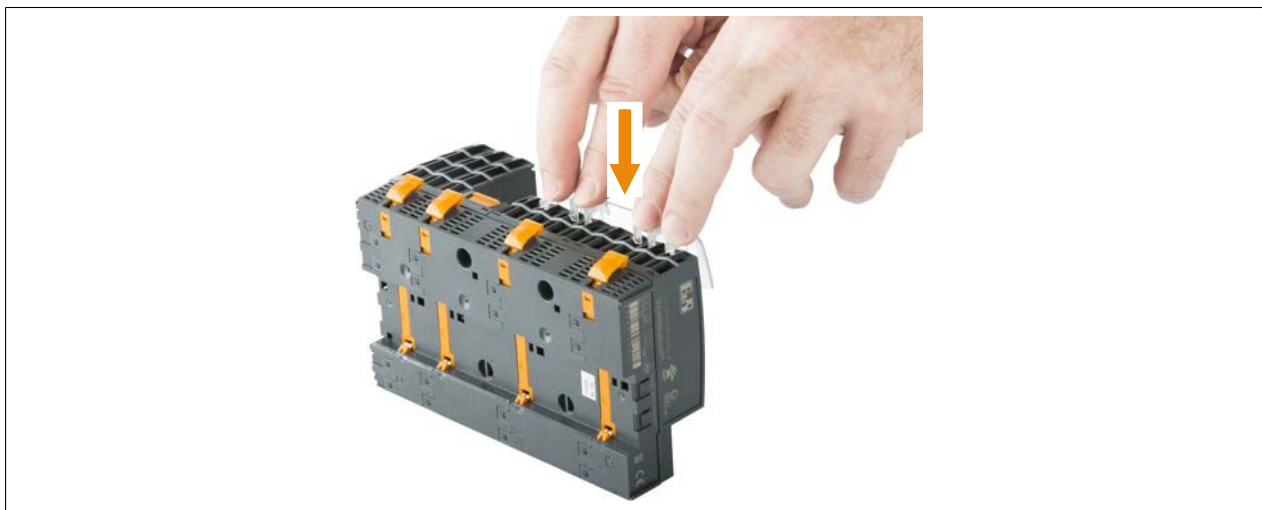
Tags are available for X20 CPUs into which plain text slide-in labels can be inserted. The tags are placed on the housing of the CPU.

Installation

1. Place the plain text tag on the housing so that the outer clips rest on raised edges.

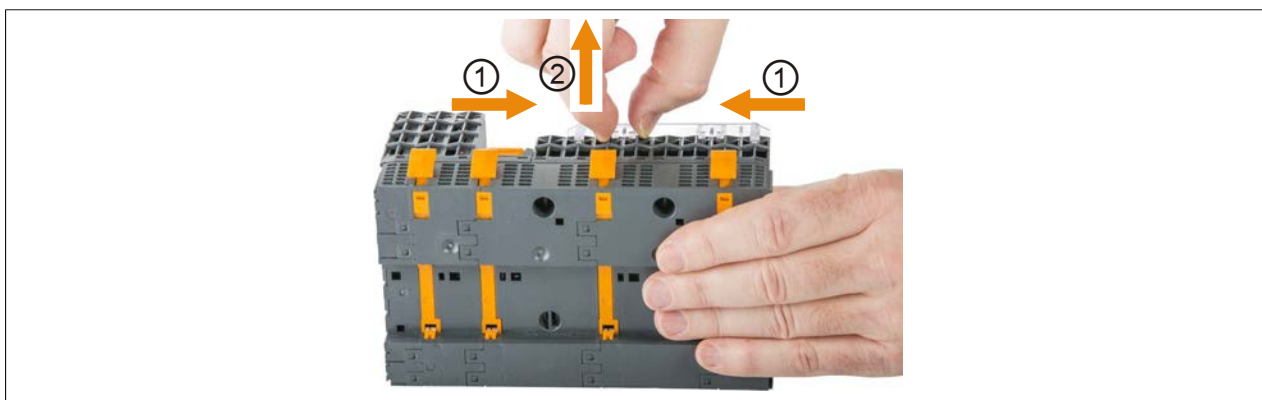


2. Press the plain text tag down until the clips latch into place.





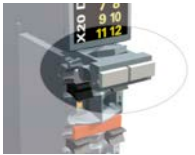
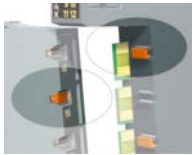
Removal

1. Pinch the clips together ① to release them while lifting the tag off of the housing ②.



5.8 Label tags

Label tags can serve the following purposes:

| | | | |
|---|----------------------------------|---|------------------------|
|  | Labeling the terminal connection |  | Labeling the module |
|  | Labeling the terminal blocks |  | Labeling the terminals |

The labeling tool is needed to attach the label tags.

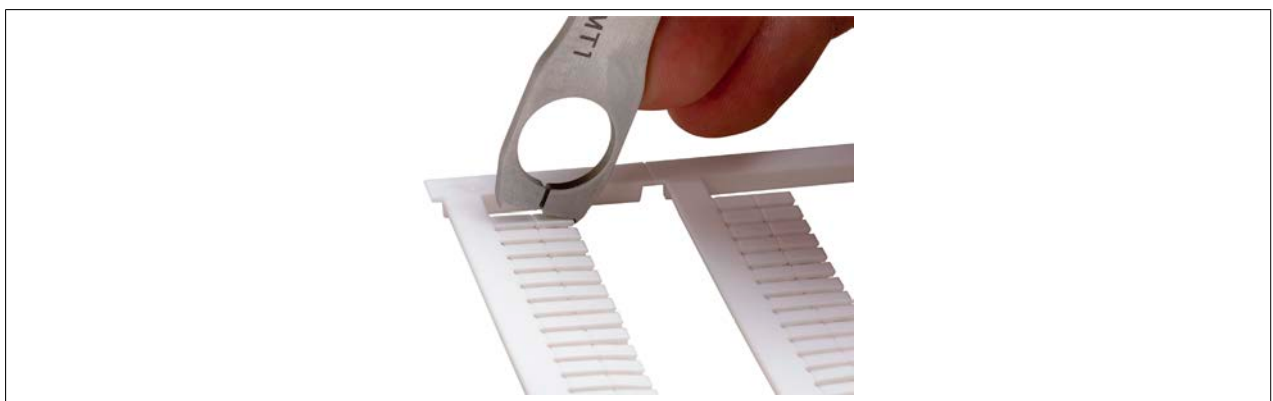


5.8.1 Labeling the terminal connection

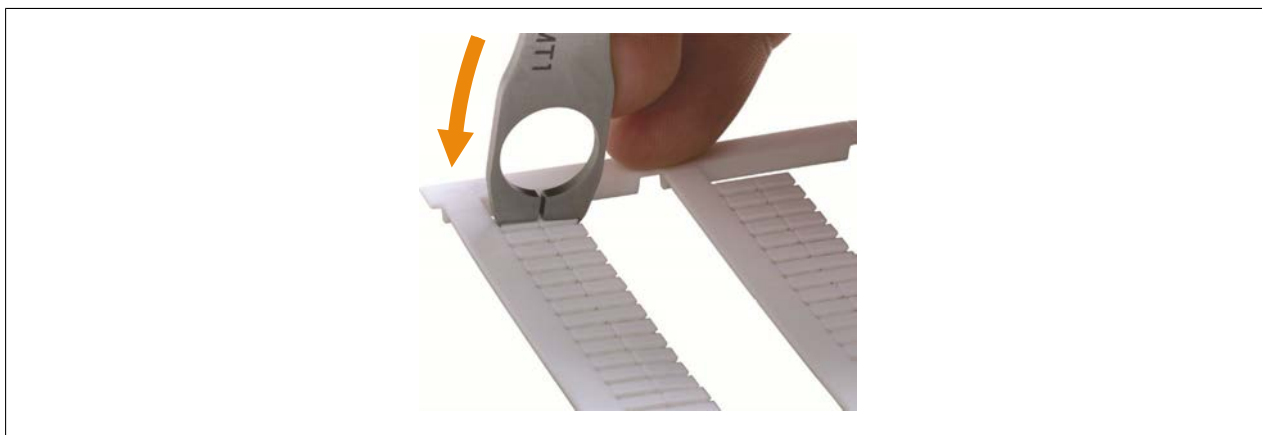
This section explains how to label the terminal connection. The terminal connection, terminal blocks and modules are labeled in a similar manner.



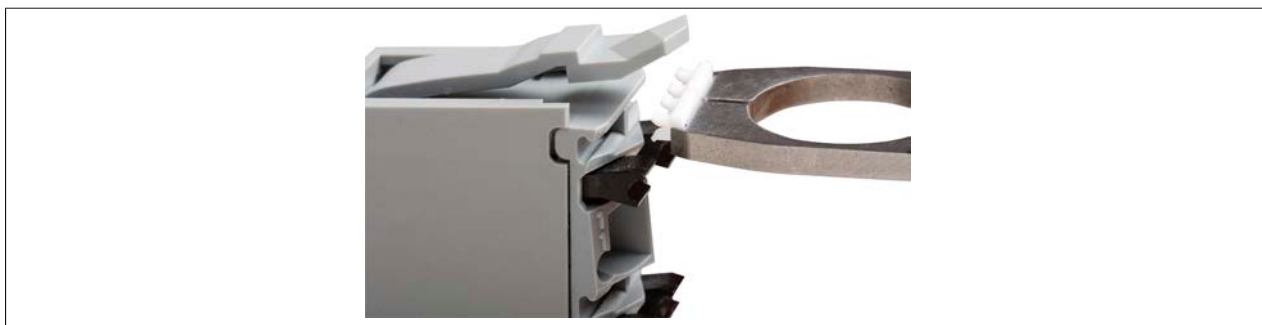
1. Grip the desired label tags with the double-width cutters of the labeling tool.



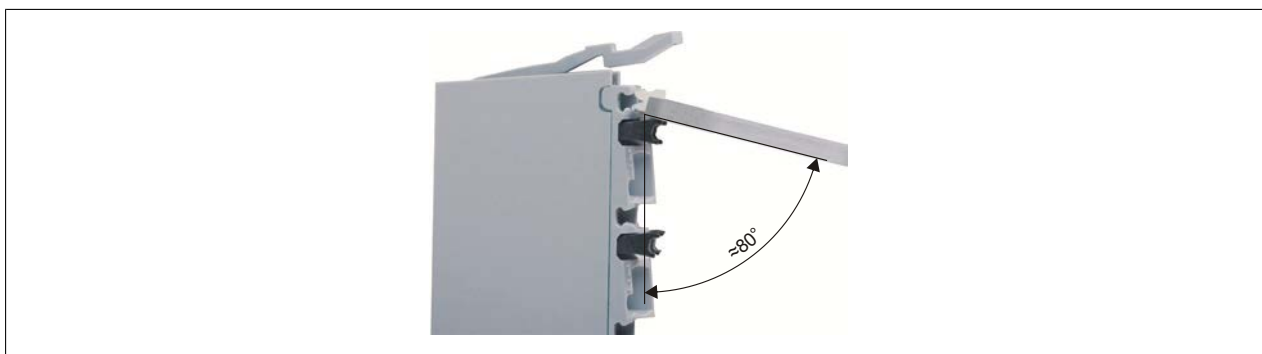
2. Press with the labeling tool to separate the label tags.



3. Center the label tags over the slot on the terminal block.

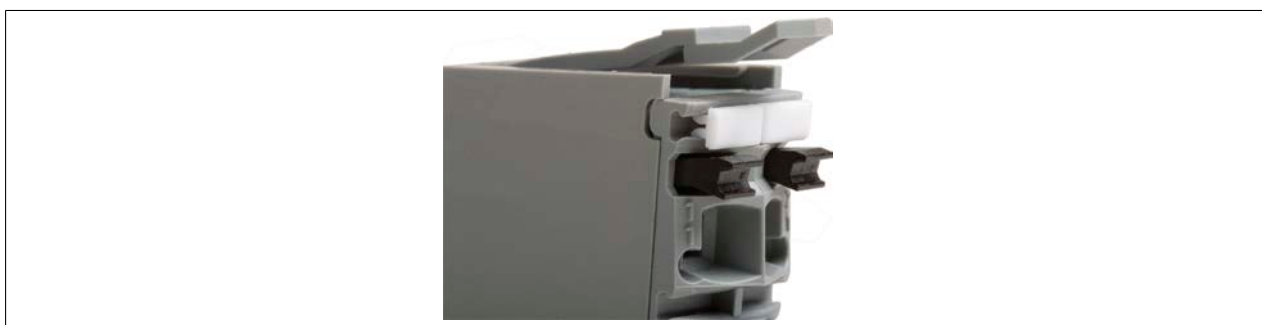


4. Hold the labeling tool at approximately an 80° angle to the terminal block.



5. Press with the labeling tool to insert the feet of the label tags into the slot.

6. Inserted label tag.

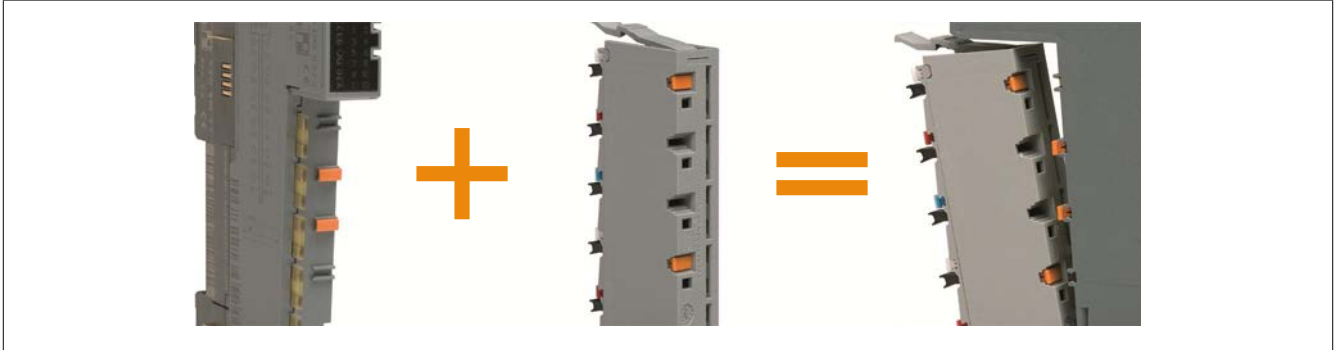


5.8.2 Terminal keying

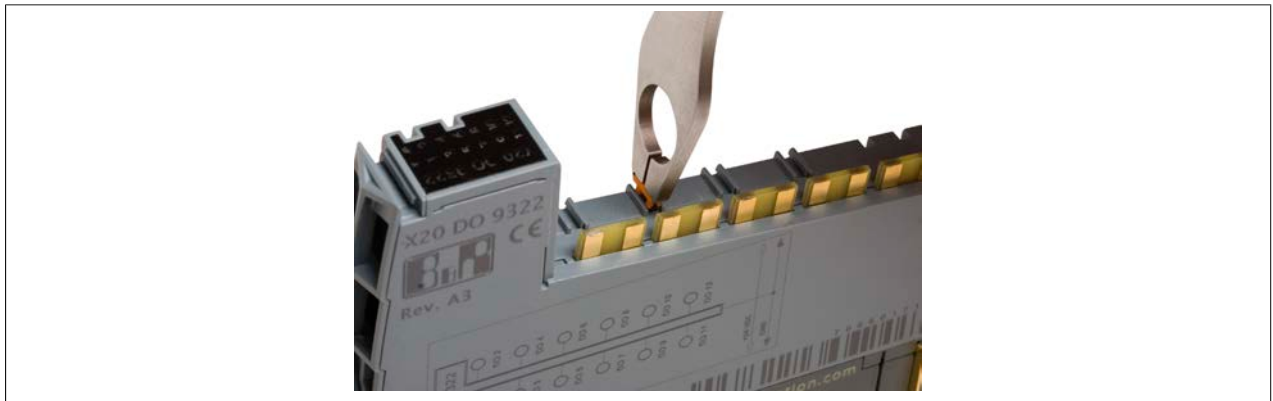
To prevent errors, X20 terminal blocks can be keyed. This prevents terminal blocks from being connected to an unrelated electronics module.

Information:

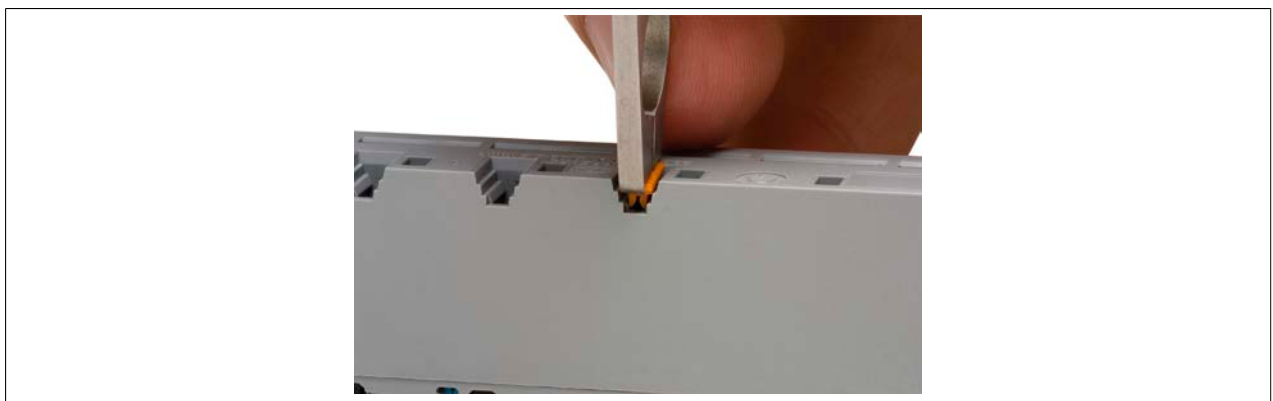
Terminal keying is not possible for double-width modules (e.g. X20CM4810)!



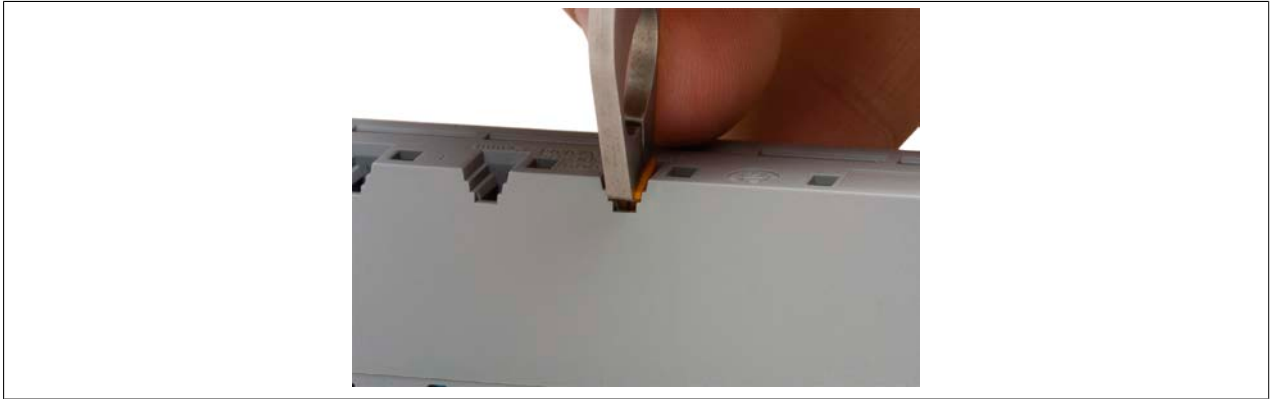
1. Remove a label tag with the single blade of the labeling tool (see "[Labeling the terminal connection](#)" on page 119).
2. Center the label tag over the slot on the electronic module.



3. Hold the labeling tool at a 90° angle to the electronic module and press to insert the label's feet into the slot.
4. Remove a label tag with the single-width cutter of the labeling tool.
5. Set the label tag in the slot on the back of the terminal block as shown.



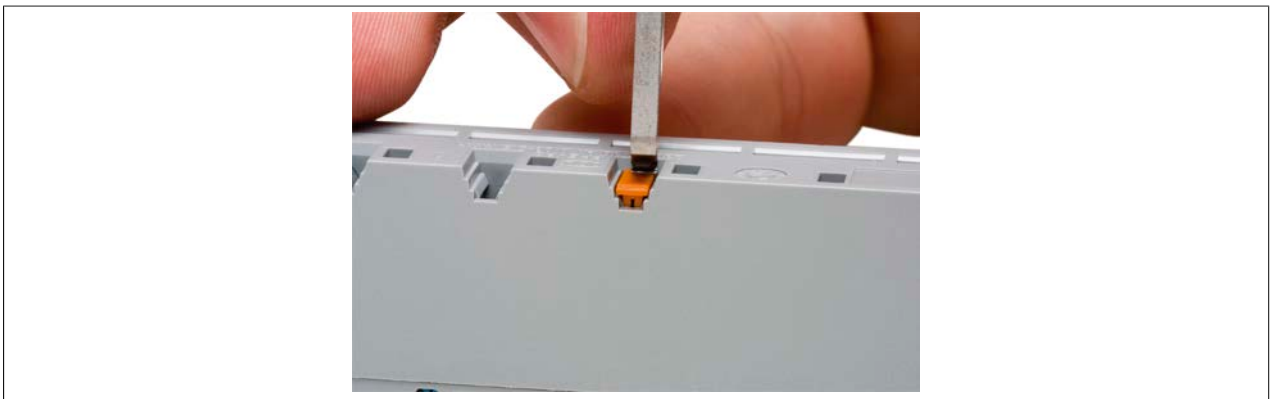
6. Use the labeling tool to push the left feet of the label into the slot.



7. With the labeling tool, press the right feet of the label into the slot.



8. Inserted label for terminal coding.



5.9 Labeling options for the X20 system

The following components can be individually labeled for the X20 system:

- X20 modules
- X20 CPUs
- Terminal connections


5.9.1 Labeling X20 modules

The following components are required for labeling X20 modules:

- Tag holder
- Plain text tag for X20 modules
- Slide-in labels


Tag holder

The plain text tags are put on the tag holders. The tag holders are also used for terminal locking.

| Order number | Short description | Figure |
|----------------|---|---|
| | Tag holder, terminal locking clip |  |
| X20AC0SC1 | X20 terminal locking clip and tag holder for plain text tag | |
| X20AC0SC1.0100 | X20 terminal locking clip and tag holder for plain text tag, 100 pcs. per package | |

Plain text tags and slide-in labels

Slide-in labels are available for the plain text tags. A template file is available on the B&R website in the "Downloads" tab under the model number for the X20 slide-in labels, X20AC0LB2.0100. This template is in Excel format and allows you to enter the desired texts for the slide-in labels.

| Model number | Short description | Figure |
|----------------|---|---|
| | Plain text cover |  |
| X20AC0SH1 | X20 plain text tag | |
| X20AC0SH1.0100 | X20 plain text tag, 100 pcs. per package | |
| | X20 legend strips | |
| X20AC0LB2.0100 | X20 slide-in labels for X20 plain text tags, paper, white, perforated, 88 strips on A4 sheets, 100 sheets per package | |

Example photo



5.9.2 Labeling X20 CPUs

Plain text tag

The plain text tag is labeled with commercially available adhesive labels. The adhesive labels are not available as accessories.

| Model number | Short description | Figure |
|----------------|-------------------------|--------|
| | X20 CPU Label | |
| X20AC0SH2.0010 | X20 CPU labels, 10 pcs. | |

Example photo



5.9.3 Labeling terminal connections

The following components are required for labeling terminal connections:

- Terminal label
- Labeling tool

Terminal label


Each terminal connection is identified clearly directly on the terminal. Label tags can also be installed to label terminals individually.

The labeling tool is needed for the installation.

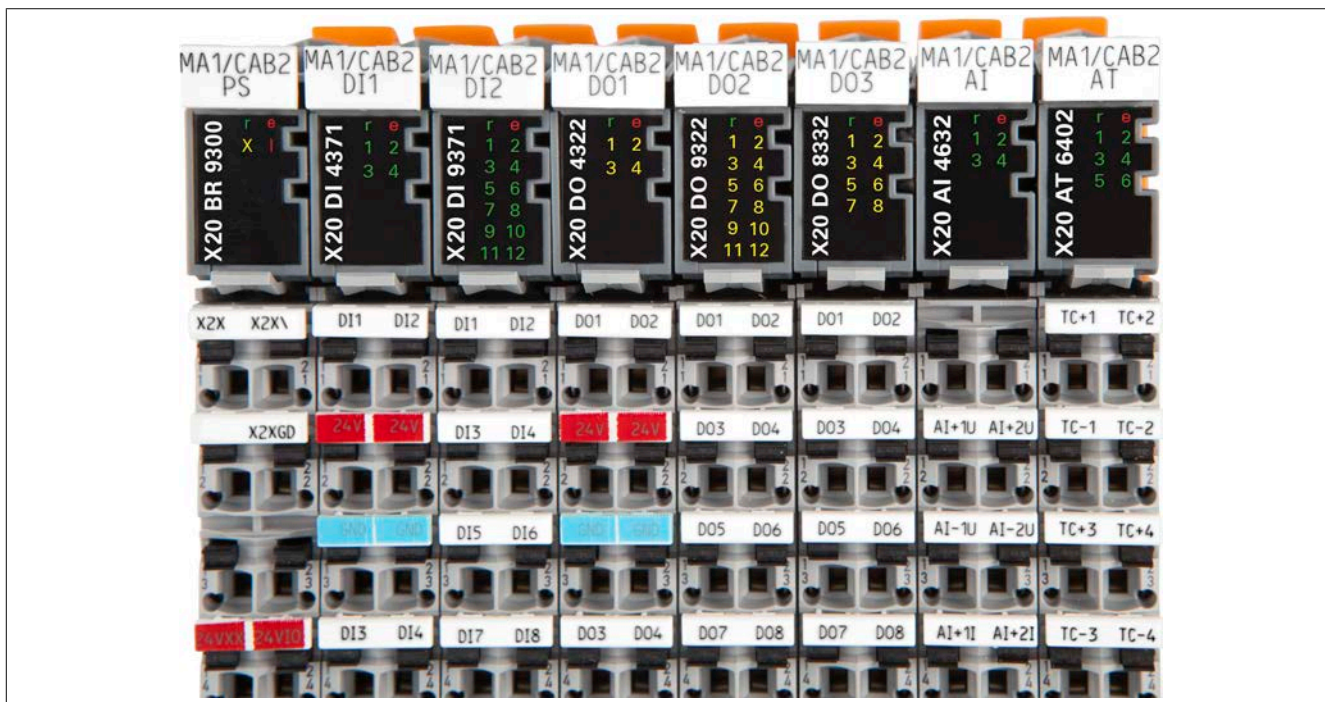
| | | | |
|---|--|--|--|
|  | |  | |
| X20AC0M0x / X20AC0M1x | | X20AC0M21 | |
| Blank X20 labels (10.4 x 2.4 mm) | | | |
| X20AC0M01 | Blank X20 labels, white, set for 16 modules | | |
| X20AC0M02 | Blank X20 labels, red, set for 16 modules | | |
| X20AC0M03 | Blank X20 labels, blue, set for 16 modules | | |
| X20AC0M04 | Blank X20 labels, orange, set for 16 modules | | |
| Printed X20 labels (10.4 x 2.4 mm) | | | |
| X20AC0M11 | Printed X20 labels, white, set for 16 modules, label: Module (1 to 16), terminal (1 to 192) | | |
| X20AC0M12 | Printed X20 labels, red, set for 16 modules, label: +24 V | | |
| X20AC0M13 | Printed X20 labels, blue, set for 16 modules, label: GND | | |
| X20AC0M14 | Printed X20 labels, orange, set for 16 modules, label: Module (module 1 to 16), terminal (1 to 192) | | |
| Blank X20 labels, 10 pcs. per package (10.4 x 2.4 mm) | | | |
| X20AC0M01.0010 | Blank X20 labels, white, set for 16 modules, 10 pcs. per package | | |
| X20AC0M02.0010 | Blank X20 labels, red, set for 16 modules, 10 pcs. per package | | |
| X20AC0M03.0010 | Blank X20 labels, blue, set for 16 modules, 10 pcs. per package | | |
| X20AC0M04.0010 | Blank X20 labels, orange, set for 16 modules, 10 pcs. per package | | |
| Printed X20 labels, 10 pcs. per package (10.4 x 2.4 mm) | | | |
| X20AC0M11.0010 | Printed X20 labels, white, set for 16 modules, 10 pcs. per package, label: Module (module 1 to 16), terminal (1 to 192) | | |
| X20AC0M12.0010 | Printed X20 labels, red, set for 16 modules, 10 pcs. per package, label: +24 V | | |
| X20AC0M13.0010 | Printed X20 labels, blue, set for 16 modules, 10 pcs. per package, label: GND | | |
| X20AC0M14.0010 | Printed X20 labels, orange, set for 16 modules, 10 pcs. per package, label: Module (module 1 to 16), terminal (1 to 192) | | |
| Blank X20 labels, large (10.4 x 7.0 mm) | | | |
| X20AC0M21 | Blank X20 labels, large, white, set for 48 modules | | |
| X20AC0M21.0010 | Blank X20 labels, large, white, set for 48 modules, 10 pcs. per package | | |

Labeling tool

The labeling tool is needed to attach the tag labels.

| Order number | Short description | Figure |
|--------------|---|---|
| X20AC0MT1 | X20 labeling tool for X20 labeling system |  |

Example photo



Printing terminal labels

Assembly order

B&R offers the assembly of the X20 system as a service. Based on an assembly order, the X20 system is completely assembled at B&R and shipped to the customer. If requested by the customer, the labels are printed and the terminal connections are marked accordingly.

Print by yourself

You can also print the labels by yourself. The "PrintJet PRO" printer from Weidmüller can be used for this purpose.

6 Module overviews

6.1 Standard modules

6.1.1 Module overview: Alphabetically

| Order number | Short description | Page |
|--------------|--|------|
| X20AI1744 | X20 analog input module, 1 full-bridge strain gauge input, 24-bit converter resolution, 5 kHz input filter | 196 |
| X20AI1744-3 | X20 analog input module, 1 full-bridge strain gauge input, 24-bit converter resolution, 5 Hz input filter | 243 |
| X20AI1744-10 | X20 analog input module, 1 full-bridge strain input 10 V, 24-bit converter resolution, 5 kHz input filter | 289 |
| X20AI2222 | X20 analog input module, 2 inputs, ± 10 V, 13-bit converter resolution, configurable input filter | 318 |
| X20AI2237 | X20 analog input module, 2 inputs, ± 10 V, 16-bit converter resolution, single-channel isolation with separate sensor power supply, NetTime function | 328 |
| X20AI2322 | X20 analog input module, 2 inputs, 0-20 mA / 4-20 mA, 12-bit converter resolution, configurable input filter | 346 |
| X20AI2437 | X20 analog input module, 2 inputs, 4 to 20 mA, 16-bit converter resolution, single-channel isolation with separate sensor power supply, NetTime function | 357 |
| X20AI2438 | X20 analog input module, 2 inputs, 4 to 20 mA, 16-bit converter resolution, single-channel isolation with separate sensor power supply, supports the HART protocol, NetTime function | 373 |
| X20AI2622 | X20 analog input module, 2 inputs, ± 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution, configurable input filter | 397 |
| X20AI2632 | X20 analog input module, 2 inputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, configurable input filter, oscilloscope functions | 408 |
| X20AI2632-1 | X20 analog input module, 2 inputs, ± 11 V or 0 to 22 mA, 16-bit converter resolution, configurable input filter | 433 |
| X20AI2636 | X20 analog input module, 2 inputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, configurable input filter, oversampling functions | 458 |
| X20AI4222 | X20 analog input module, 4 inputs, ± 10 V, 13-bit converter resolution, configurable input filter | 489 |
| X20AI4322 | X20 analog input module, 4 inputs, 0-20 mA / 4-20 mA, 12-bit converter resolution, configurable input filter | 499 |
| X20AI4622 | X20 analog input module, 4 inputs, ± 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution, configurable input filter | 509 |
| X20AI4632 | X20 analog input module, 4 inputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, configurable input filter, oscilloscope functions | 520 |
| X20AI4632-1 | X20 analog input module, 4 inputs, ± 11 V or 0 to 22 mA, 16-bit converter resolution, configurable input filter, oscilloscope functions | 545 |
| X20AI4636 | X20 analog input module, 4 inputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, configurable input filter, oversampling functions | 570 |
| X20AI8221 | X20 analog input module, 8 inputs, ± 10 V, 13-bit converter resolution | 602 |
| X20AI8321 | X20 analog input module, 8 inputs, 0 to 20 mA, 12-bit converter resolution | 612 |
| X20AIA744 | X20 analog input module, 2 full-bridge strain inputs, 24-bit converter resolution, 2.5 kHz input filter | 622 |
| X20AIB744 | X20 analog input module, 4 full-bridge strain inputs, 24-bit converter resolution, 2.5 kHz input filter | 641 |
| X20AO2437 | X20 analog output module, 2 outputs, 4 to 20 mA / 0 to 20 mA or 0 to 24 mA, 16-bit converter resolution, single channel electrically isolated | 735 |
| X20AO2438 | X20 analog output module, 2 outputs, 4 to 20 mA / 0 to 20 mA or 0 to 24 mA, 16-bit converter resolution, single-channel isolation, supports the HART protocol, NetTime function | 748 |
| X20AO2622 | X20 analog output module, 2 outputs, 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution | 773 |
| X20AO2632 | X20 analog output module, 2 outputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, NetTime function | 780 |
| X20AO2632-1 | X20 analog output module, 2 outputs, ± 11 V or 0 to 22 mA, 16-bit converter resolution, NetTime function | 788 |
| X20AO4622 | X20 analog output module, 4 outputs, ± 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution | 796 |
| X20AO4632 | X20 analog output module, 4 outputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution | 805 |
| X20AO4632-1 | X20 analog output module, 4 outputs, ± 11 V or 0 to 22 mA, 16-bit converter resolution, NetTime function | 815 |
| X20AO4635 | X20 analog output module, 4 outputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, low temperature drift | 824 |
| X20AP3111 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 20 mA AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20AP3121 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 1 A AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20AP3122 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 1 A AC, groundable, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20AP3131 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 5 A AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20AP3132 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 5 A AC, groundable, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20AP3161 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 333 mV AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20AP3171 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, Rogowski adjustable ($\mu\text{V/A}$), max. 52 mV, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20AT2222 | X20 temperature input module, 2 inputs for resistance measurement, PT100, PT1000, resolution 0.1°C, 3-wire connections | 3649 |
| X20AT2311 | X20 temperature input module, 2 resistance measurement inputs, PT100, resolution 0.001°C, 4-wire connections | 3659 |
| X20AT2402 | X20 temperature input module, 2 thermocouple inputs, Type J, K, N, S, B, R, resolution 0.1°C | 3667 |
| X20AT4222 | X20 temperature input module, 4 inputs for resistance measurement, PT100, PT1000, resolution 0.1°C, 3-wire connections | 3679 |
| X20AT4232 | X20 temperature input module, 4 inputs for resistance measurement, NTC 10 k Ω , resolution 0.1°C, 2-wire connections | 3689 |
| X20AT6402 | X20 temperature input module, 6 thermocouple inputs, Type J, K, N, S, B, R, resolution 0.1°C | 3698 |
| X20ATA312 | X20 temperature input module, 2 resistance measurement inputs, PT100, resolution 0.01°C, 4-wire connections, NetTime function | 3710 |

Module overviews

| Order number | Short description | Page |
|--------------|---|------|
| X20ATA492 | X20 temperature input module, 2 thermocouple inputs, type J, K, N, S, B, R, E, C, T, single-channel isolation, NetTime function, 2x PT1000 integrated in terminal block X20TB1E for temperature compensation, order terminal block separately. | 3723 |
| X20ATB312 | X20 temperature input module, 4 resistance measurement inputs, PT100, resolution 0.01°C, 4-wire connections, NetTime function | 3742 |
| X20ATC402 | X20 temperature input module, 6 thermocouple inputs, type J, K, N, S, B, R, E, C, T, NetTime function, 2x PT1000 integrated in terminal block X20TB1E for temperature compensation, order terminal block separately. | 3755 |
| X20BB22 | X20 compact CPU base, for compact CPU and compact CPU power supply module, base for integrated RS232 interface, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 1001 |
| X20BB27 | X20 compact CPU base, for compact CPU and compact CPU power supply module, base for integrated RS232 and CAN bus interface, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 1003 |
| X20BB32 | X20 Fieldbus CPU base, for Fieldbus CPU and Compact CPU power supply module, base for integrated RS232 interface, slot for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 2253 |
| X20BB37 | X20 Fieldbus CPU base, for Fieldbus CPU and Compact CPU power supply module, base for integrated RS232 and CAN bus interface, slot for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 2255 |
| X20BB42 | X20 fieldbus CPU base, for fieldbus CPU and compact CPU power supply module, base for integrated RS232 interface, 2 slots for X20 interface modules, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 2258 |
| X20BB47 | X20 fieldbus CPU base, for fieldbus CPU and compact CPU power supply module, base for integrated RS232 and CAN bus interface, 2 slots for X20 interface modules, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 2260 |
| X20BB52 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 interface, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 1035 |
| X20BB57 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 and CAN bus interface, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 1037 |
| X20BB62 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 interface, slots for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 1039 |
| X20BB67 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 and CAN bus interface, slot for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 1041 |
| X20BB72 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 interface, 2 slots for X20 interface modules, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 1043 |
| X20BB77 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 and CAN bus interface, 2 slots for X20 interface modules, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 1045 |
| X20BB80 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | 922 |
| X20BB81 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with one expansion slot for an X20 add-on module (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 2234 |
| X20BB82 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with 2 expansion slots for 2 X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 2237 |
| X20BC0043-10 | X20 bus controller, 1 CANopen interface, order 1x terminal block TB2105 separately! Order bus base, power supply module and terminal block separately! | 834 |
| X20BC0053 | X20 bus controller, 1 DeviceNet interface, order 1x TB2105 terminal block separately Order bus base, power supply module and terminal block separately | 841 |
| X20BC0063 | X20 bus controller, 1 PROFIBUS DP interface, 9-pin DSUB connection, order bus base, power supply module and terminal block separately | 847 |
| X20BC0073 | X20 bus controller, 1 CAN I/O interface, order 1x TB2105 terminal block separately Order bus base, power supply module and terminal block separately | 851 |
| X20BC0083 | X20 bus controller, 1 POWERLINK interface, integrated 2-port hub, 2x RJ45, order bus base, power supply module and terminal block separately! | 859 |
| X20BC0087 | X20 bus controller, 1 Modbus TCP or Modbus UDP interface, integrated 2-port switch, 2x RJ45, order bus base, power supply module and terminal block separately. | 864 |
| X20BC0087-10 | X20 bus controller, 1 Modbus TCP or Modbus UDP interface, producer mode feature (via UDP), integrated switch, 2x RJ45, order bus base, power supply module and terminal block separately. | 870 |
| X20BC0088 | X20 bus controller, 1 EtherNet/IP interface, integrated switch, web interface, 2x RJ45, order bus base, power supply module and terminal block separately! | 877 |
| X20BC008U | X20 bus controller, 1 OPC UA Ethernet interface, integrated 2-port switch, 2x RJ45, order bus base, power supply module and terminal block separately. | 882 |
| X20BC00E3 | X20 bus controller, 1 PROFINET IO interface, integrated 2-port switch, 2x RJ45, order bus base, power supply module and terminal block separately! | 904 |
| X20BC00G3 | X20 bus controller, 1 EtherCAT interface, 2x RJ45, order bus base, power supply module and terminal block separately. | 910 |
| X20BC0143-10 | X20 bus controller, 1 CANopen interface, 9-pin DSUB, Order 1x connector 7AC911.9 separately! Order bus base, power supply module and terminal block separately! | 914 |
| X20BC1083 | X20 bus controller, 1 POWERLINK interface, integrated 2-port hub, supports X20 interface module expansions, 2 RJ45, order bus base, power supply module and terminal block separately | 2213 |
| X20BC8083 | X20 bus controller, 1 POWERLINK interface, integrated 2-port hub, supports expansion with X20 hub modules, 2 RJ45, order bus base, power supply module and terminal block separately. | 2220 |
| X20BC8084 | X20 bus controller, 1 POWERLINK interface, 1x link selector for POWERLINK cable redundancy, supports expansion with enabled X20 hub modules, 2x RJ45, order bus base, power supply module and terminal block separately! | 2227 |
| X20BM01 | X20 power supply bus module, 24 VDC keyed, internal I/O supply interrupted to the left | 939 |
| X20BM05 | X20 power supply bus module, with node number switch, 24 VDC keyed, internal I/O supply interrupted to the left | 942 |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | 945 |
| X20BM12 | X20 bus module, 240 VAC keyed, internal I/O power supply connected through | 948 |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | 951 |
| X20BM21 | X20 power supply bus module, for double-width modules, 24 VDC keyed, internal I/O supply interrupted to the left | 954 |
| X20BM31 | X20 bus module for double-width modules, 24 VDC keyed, internal I/O supply continuous | 956 |
| X20BM32 | X20 bus module for double-width modules, 240 VAC keyed, internal I/O supply continuous | 959 |
| X20BR7300 | X20 bus receiver, CAN I/O, supply for X2X Link and internal I/O power supply, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 964 |

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| X20BR9300 | X20 bus receiver, X2X Link, supply for X2X Link and internal I/O power supply, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 973 |
| X20BT9100 | X20 bus transmitter, X2X Link, supply for internal I/O supply | 980 |
| X20BT9400 | X20 bus transmitter X2X Link, feed for internal I/O supply, X2X Link supply for X67 modules, reverse polarity protection, short circuit protection, overload protection, parallel connection possible, redundancy operation possible | 986 |
| X20CM0985 | X20 digital and analog mixed module, multi-measurement transducer/ synchronization module, 5 digital outputs, 24 VDC, 0.5 A source, 1 relay, 1 A, changeover contact, 8 analog inputs, ± 480 V / 120 V, 16-bit converter resolution, 3 analog inputs 5 A / 1 A AC, 16-bit converter resolution, order terminal blocks 0TB3102-7011, 0TB3104-7011, 0TB3102-7012, 0TB3104-7012 and 2x TB12 separately. | 2803 |
| X20CM0985-02 | X20 digital and analog mixed module, multi-measurement transducer / synchronization module, 5 digital outputs, 24 VDC, 0.5 A, source, 1 relay, 1 A, 8 analog inputs, ± 480 V / 120 V, 16-bit converter resolution, 3 analog inputs, 5 A / 1 A AC, 16-bit converter resolution, additional software functionalities, adapted to VDE guidelines (2018), order terminal blocks 0TB3102-7011, 0TB3104-7011, 0TB3102-7012, 0TB3104-7012 and 2x X20TB12 separately! | 2846 |
| X20CM0985-1 | X20 digital and analog mixed module, multi-measurement transducer / synchronization module, 5 digital outputs, 24 VDC, 0.5 A, source, 1 relay, 1 A, 8 analog inputs, ± 480 V / 120 V, 16-bit converter resolution, 3 analog inputs, 5 A / 1 A AC, 16-bit converter resolution, additional software functionalities, order terminal blocks 0TB3102-7011, 0TB3104-7011, 0TB3102-7012, 0TB3104-7012 and 2x X20TB12 separately! | 2921 |
| X20CM1201 | X20 combination module, 1 AB incremental encoder, 24 V, 4 digital inputs 24 V, 4 channels 24 V configurable as inputs or outputs, flexible digital controller logic | 1875 |
| X20CM1941 | X20 resolver module, 14-bit resolver input, converter up to 12-bit ABR output | 1063 |
| X20CM4323 | X20 PWM module, 4 digital outputs for switching electromechanical loads, 24 VDC, oversampling output functions, time-triggered output functions, NefTime function | 2992 |
| X20CM4800X | X20 analog input module, vibration measurement, 4 IEPE analog inputs, 50 kHz sampling frequency, 24-bit converter resolution | 3021 |
| X20CM4810 | X20 analog input module, for vibration measurement and analysis of condition monitoring tasks, 4 IEPE analog inputs, 51.5625 kHz sampling frequency, 24-bit converter resolution | 3039 |
| X20CM6209 | X20 diode array module, 1 A, 40 V reverse voltage, no module status data | 3174 |
| X20CM8281 | X20 universal mixed module, 4 digital inputs, 24 VDC, sink, 1-wire connections, 2 digital outputs, 0.5 A, source, 1-wire connections, 1 analog input, ± 10 V or 0 to 20 mA / 4 to 20 mA, 12-bit converter resolution, 1 analog output, ± 10 V / 0 to 20 mA, 12-bit converter resolution, 2 counters as event counters or gate measurement | 3178 |
| X20CM8323 | X20 PWM module, 8 digital outputs for switching electromechanical loads, 0.6 A continuous current, 2 A peak current, current monitoring, switching time detection | 3197 |
| X20CMR010 | X20 cabinet monitoring module, integrated temperature and humidity sensor, production data acquisition, 512 kB flash memory for user data | 3216 |
| X20CMR100 | X20 cabinet monitoring module, integrated temperature and humidity sensor, production data acquisition, integrated Technology Guard | 3230 |
| X20CMR111 | X20 cabinet monitoring module, integrated temperature sensor, moisture sensor and accelerometer, production data acquisition, 2 inputs for external PT1000, 2 digital inputs 24 V, 1 digital output 24 V, 0.5 A, 512 kB flash memory for user data, integrated Technology Guard | 3242 |
| X20CP0201 | X20 compact CPU, μ P 16, 100 kB SRAM, 1 MB FlashPROM, support of RS232, CAN bus according to compact CPU base, order bus base, power supply module and terminal block separately | 994 |
| X20CP0291 | X20 compact CPU, μ P 16, 100 kB SRAM, 1 MB FlashPROM, support of RS232, CAN bus according to compact CPU base, 1 Ethernet interface 100 Base-T, order bus base, power supply module and terminal block separately | 994 |
| X20CP0292 | X20 compact CPU, μ P 25, 100 kB SRAM, 1 MB FlashPROM, support of RS232, CAN bus according to compact CPU base, 3 Ethernet interface 750 Base-T, order bus base, power supply module and terminal block separately | 994 |
| X20CP0410 | X20 Compact-S CPU, ARM Cortex-A9-166 (compatible), 128 MB DDR3 RAM, 8 kB FRAM, 256 MB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T. Order bus base, power supply module and terminal block separately! | 1019 |
| X20CP0411 | X20 Compact-S CPU, ARM Cortex-A9-240, 128 MB DDR3 RAM, 16 kB FRAM, 512 MB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T. Order bus base, power supply module and terminal block separately! | 1019 |
| X20CP0420 | X20 Compact-S CPU, ARM Cortex-A9-166 (compatible), 128 MB DDR3 RAM, 8 kB FRAM, 256 MB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 2 Ethernet interfaces 10/100BASE-T (switch). Order bus base, power supply module and terminal block separately! | 1019 |
| X20CP0482 | X20 Compact-S CPU, ARM Cortex-A9-300, 128 MB DDR3 RAM, 16 kB FRAM, 1 GB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, can be expanded with X20 interface slot. Order bus base, power supply module and terminal block separately! | 1019 |
| X20CP0483 | X20 Compact-S CPU, ARM Cortex-A9-500, 256 MB DDR3 RAM, 32 kB FRAM, 1 GB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, can be expanded with X20 interface slot. Order bus base, power supply module and terminal block separately! | 1019 |
| X20CP0484 | X20 Compact-S CPU, ARM Cortex-A9-667, 256 MB DDR3 RAM, 64 kB FRAM, 2 GB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, can be expanded with X20 interface slot. Order bus base, power supply module and terminal block separately! | 1019 |
| X20CP0484-1 | X20 Compact-S CPU, ARM Cortex-A9-667, 512 MB DDR3 RAM, 64 kB FRAM, 2 GB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, can be expanded with X20 interface slot. Order bus base, power supply module and terminal block separately! | 1019 |
| X20CP1301 | X20 CPU, with integrated I/O, x86-200, 128 MB DDR3 RAM, 16 kB FRAM, 1 GB onboard flash drive, 1 insert slot for X20 interface modules, 1 USB interface, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 μ s, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μ s, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs ± 10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included | 1324 |
| X20CP1381 | X20 CPU, with integrated I/O, x86-200, 128 MB DDR3 RAM, 16 kB FRAM, 1 GB onboard flash drive, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 CAN bus interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 μ s, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μ s, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs ± 10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included | 1324 |
| X20CP1381-RT | X20 CPU, with integrated I/O, x86-200, 128 MB DDR3 RAM, 16 kB FRAM, 1 GB onboard flash drive, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 CAN bus interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, reACTION Technology, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 μ s, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μ s, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs ± 10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included | 3382 |

Module overviews

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| X20CP1382 | X20 CPU, with integrated I/O, x86-400, 256 MB DDR3 RAM, 32 kB FRAM, 2 GB onboard flash drive, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 CAN bus interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, 14 digital inputs, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μ s, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs \pm 10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included | 1324 |
| X20CP1382-RT | X20 CPU, with integrated I/O, x86-400, 256 MB DDR3 RAM, 32 kB FRAM, 2 GB onboard flash drive, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 CAN bus interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, reACTION Technology, 14 digital inputs, 24 VDC, sink, 4 digital outputs, 2 μ s, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μ s, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs \pm 10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included | 3382 |
| X20CP1483 | X20 CPU, x86 100 MHz Intel compatible, 32 MB DRAM, 128 kB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1380 |
| X20CP1483-1 | X20 CPU, x86 100 MHz Intel compatible, 64 MB DRAM, 128 kB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1380 |
| X20CP1583 | X20 CPU, Atom 333 MHz Intel compatible, 128 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1397 |
| X20CP1584 | X20 CPU, Atom 0.6 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1397 |
| X20CP1585 | X20 CPU, Atom 1.0 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1397 |
| X20CP1586 | X20 CPU, Atom 1.6 GHz, 512 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1397 |
| X20CP1684 | X20 CPU, Atom 0.4 GHz (compatible), 512 MB DDR4 RAM, 1 MB SRAM, 1 GB onboard flash drive, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! | 1418 |
| X20CP1685 | X20 CPU, Atom 0.8 GHz, 512 MB DDR4 RAM, 1 MB SRAM, 1 GB onboard flash drive, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! | 1418 |
| X20CP1686X | X20 CPU, Atom 1.3 GHz, 1 GB DDR4 RAM, 1 MB SRAM, 2 GB onboard flash drive, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! | 1418 |
| X20CP3583 | X20 CPU, Atom 333 MHz Intel compatible, 128 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1401 |
| X20CP3584 | X20 CPU, Atom 0.6 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1401 |
| X20CP3585 | X20 CPU, Atom 1.0 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1401 |
| X20CP3586 | X20 CPU, Atom 1.6 GHz, 512 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1401 |
| X20CP3684 | X20 CPU, Atom 0.4 GHz (compatible), 512 MB DDR4 RAM, 1 MB SRAM, 1 GB onboard flash drive, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! | 1422 |
| X20CP3685 | X20 CPU, Atom 0.8 GHz, 512 MB DDR4 RAM, 1 MB SRAM, 1 GB onboard flash drive, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! | 1422 |
| X20CP3686X | X20 CPU, Atom 1.3 GHz, 1 GB DDR4 RAM, 1 MB SRAM, 2 GB onboard flash drive, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! | 1422 |
| X20CP3687X | X20 CPU, Atom 1.6 GHz, 2 GB DDR4 RAM, 1 MB SRAM, 2 GB onboard flash drive, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! | 1422 |
| X20CS1011 | X20 interface module, 1 Moeller SmartWire interface | 2101 |
| X20CS1012 | X20 interface module, 1 M-Bus master interface, integrated slave supply | 2116 |
| X20CS1013 | X20 interface module, 1 DALI master interface | 2136 |
| X20CS1020 | X20 interface module, 1 RS232 interface, max. 115.2 kbit/s | 2147 |

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| X20CS1030 | X20 interface module, 1 RS422/485 interface, max. 115.2 kbit/s | 2162 |
| X20CS1070 | X20 interface module, 1 CAN bus interface, max. 1 Mbit/s, object buffers in both send and receive directions | 2177 |
| X20CS2770 | X20 interface module, 2 CAN bus interfaces, max. 1 Mbit/s, object buffers in both send and receive directions | 2194 |
| X20DC1073 | X20 digital counter module, 1x SinCos, 1 Vss, 400 kHz input frequency, encoder monitoring, NetTime function | 1899 |
| X20DC1176 | X20 digital counter module, 1 ABR incremental encoder, 5 V, 600 kHz input frequency, 4x evaluation, encoder monitoring, Net-Time function | 1071 |
| X20DC1178 | X20 digital counter module, 1 SSI absolute encoder, 5 V, 1 Mbit/s, 32-bit, encoder monitoring, NetTime function | 1087 |
| X20DC1196 | X20 digital counter module, 1 ABR incremental encoders, 5 V, 600 kHz input frequency, 4x resolution | 1105 |
| X20DC1198 | X20 digital counter module, 1 SSI absolute encoder, 5 V, 1 Mbit/s, 32-bit | 1115 |
| X20DC11A6 | X20 digital counter module, 1 ABR incremental encoder, 5 V, 5 MHz input frequency, 4x evaluation, encoder monitoring, Net-Time function | 1122 |
| X20DC1376 | X20 digital counter module, 1 ABR incremental encoder, 24 V, 100 kHz input frequency, 4x evaluation, encoder monitoring, NetTime function | 1137 |
| X20DC137A | X20 digital counter module, 1 ABR incremental encoder, 24 V (differential), 300 kHz input frequency, 4x evaluation, encoder monitoring, NetTime function | 1153 |
| X20DC1396 | X20 digital counter module, 1 ABR incremental encoders, 24 V, 100 kHz input frequency, 4x evaluation | 1169 |
| X20DC1398 | X20 digital counter module, 1 SSI absolute encoder, 24 V, 125 kbit/s, 32-bit | 1179 |
| X20DC1976 | X20 digital counter module, 1 ABR incremental encoder, 5 V (single-ended), 250 kHz input frequency, 4x evaluation, encoder monitoring, NetTime function | 1186 |
| X20DC2190 | X20 digital counter module, ultrasonic transducer module, interfaces: EP start/stop, DPI/IP, 2 transducer rods, 4-position detection | 1202 |
| X20DC2395 | X20 digital counter module, 1 SSI absolute encoder, 24 V, 1 ABR incremental encoder, 24 V, 2 AB incremental encoders, 24 V, 4 event counters or 2 PWM, local time measurement function | 1216 |
| X20DC2396 | X20 digital counter module, 2 ABR incremental encoders, 24 V, 100 kHz input frequency, 4x evaluation | 1256 |
| X20DC2398 | X20 digital counter module, 2 SSI absolute encoder, 24 V, 125 kbit/s, 32-bit | 1267 |
| X20DC4395 | X20 digital counter module, 2 SSI absolute encoders, 24 V, 2 ABR incremental encoders, 24 V, 4 AB incremental encoders, 24 V, 8 event counters or 4 PWM, local time measurement functions | 1275 |
| X20DI0471 | X20 digital input module, 10 inputs, 5-48 VDC, sink, configurable input filter, 1-wire connections | 1439 |
| X20DI2371 | X20 digital input module, 2 inputs, 24 VDC, sink, configurable input filter, 3-wire connections | 1446 |
| X20DI2372 | X20 digital input module, 2 inputs, 24 VDC, source, configurable input filter, 3-wire connections | 1452 |
| X20DI2377 | X20 digital input module, 2 inputs, 24 VDC, sink, configurable input filter, 2 event counters 50 kHz, 3-wire connections | 1458 |
| X20DI2653 | X20 digital input module, 2 inputs, 100 to 240 VAC, 240 V keyed, 3-wire connections | 1467 |
| X20DI4371 | X20 digital input module, 4 inputs, 24 VDC, sink, configurable input filter, 3-wire connections | 1473 |
| X20DI4372 | X20 digital input module, 4 inputs, 24 VDC, source, configurable input filter, 3-wire connections | 1480 |
| X20DI4375 | X20 digital input module, 4 inputs, 24 VDC, sink, configurable input filter, open-circuit and short-circuit detection, 3-wire connections | 1486 |
| X20DI4653 | X20 digital input module, 4 inputs, 100 to 240 VAC, 240 V keyed, 2-wire connections | 1499 |
| X20DI4760 | X20 digital input module, 4 NAMUR inputs, 8.05 V | 1505 |
| X20DI6371 | X20 digital input module, 6 inputs, 24 VDC, sink, configurable input filter, 2-wire connections | 1514 |
| X20DI6372 | X20 digital input module, 6 inputs, 24 VDC, source, configurable input filter, 2-wire connections | 1520 |
| X20DI6373 | X20 digital input module, 6 inputs, 24 VDC, sink/source, all inputs floating, configurable input filter, 2-wire connections | 1526 |
| X20DI6553 | X20 digital input module, 6 inputs, 100 to 120 VAC, 240 V keyed, 1-wire connections | 1532 |
| X20DI8371 | X20 digital input module, 8 inputs, 24 VDC, sink, configurable input filter, 1-wire connections | 1538 |
| X20DI9371 | X20 digital input module, 12 inputs, 24 VDC, sink, configurable input filter, 1-wire connections | 1544 |
| X20DI9372 | X20 digital input module, 12 inputs, 24 VDC, source, configurable input filter, 1-wire connections | 1551 |
| X20DID371 | X20 digital input module, 8 inputs, 24 VDC, sink, configurable input filter, 2-wire connections | 1558 |
| X20DIF371 | X20 digital input module, 16 inputs, 24 VDC, sink, configurable input filter, 1-wire connections | 1564 |
| X20DM9324 | X20 digital mixed module, 8 inputs, 24 VDC, sink, configurable input filter, 4 outputs, 24 VDC, 0.5 A, source 1-wire connections | 1572 |
| X20DO2321 | X20 digital output module, 2 outputs, 24 VDC, 0.5 A, sink, 3-wire connections | 1581 |
| X20DO2322 | X20 digital output module, 2 outputs, 24 VDC, 0.5 A, source, 3-wire connections | 1590 |
| X20DO2623 | X20 digital output module, 2 outputs, 100 to 240 VAC, 1 A, source, 240 V keyed, 3-wire connections | 1599 |
| X20DO2633 | X20 digital output module, 2 triac outputs, 48 to 240 VAC, 2 A, L-switching, phase angle control, 240 V keyed | 1610 |
| X20DO2649 | X20 digital output module, 2 relays, changeover contacts, 240 VAC / 5 A, 24 VDC / 5 A | 1626 |
| X20DO4321 | X20 digital output module, 4 outputs, 24 VDC, 0.5 A, sink, 3-wire connections | 1632 |
| X20DO4322 | X20 digital output module, 4 outputs, 24 VDC, 0.5 A, source, 3-wire connections | 1641 |
| X20DO4331 | X20 digital output module, 4 outputs, 24 VDC, 2 A, sink, 3-wire connections | 1649 |
| X20DO4332 | X20 digital output module, 4 outputs, 24 VDC, 2 A, source, 3-wire connections | 1659 |
| X20DO4332-1 | X20 digital output module, 4 outputs, 24 VDC, 2 A, source, 3-wire connections, PWM output | 1669 |
| X20DO4529 | X20 digital output module, 4 relays, changeover contacts, 115 VAC / 0.5 A, 24 VDC / 1 A | 1679 |
| X20DO4613 | X20 digital output module, 4 triac coupler outputs, 48 to 240 VAC, 50 mA, zero-crossing detection, 240 V keyed | 1686 |
| X20DO4623 | X20 digital output module, 4 outputs, 100 to 240 VAC, 0.5 A, source, 240 V keyed, 2-wire connections | 1699 |
| X20DO4633 | X20 digital output module, 4 triac outputs, 48 to 240 VAC, 1 A, L-switching, phase angle control, 240 V keyed | 1709 |
| X20DO4649 | X20 digital output module, 4 relays, N.O. contacts, 240 VAC / 5 A | 1726 |
| X20DO4F49 | X20 digital output module, 4 relays, 2x normally open contacts, 2x changeover contacts, 240 VAC / 2 A, 250 VDC / 0.28 A | 1732 |
| X20DO6321 | X20 digital output module, 6 outputs, 24 VDC, 0.5 A, sink, 2-wire connections | 1739 |
| X20DO6322 | X20 digital output module, 6 outputs, 24 VDC, 0.5 A, source, 2-wire connections | 1746 |
| X20DO6325 | X20 digital output module, 6 outputs, 24 VDC, 0.5 A, source, open line and overload detection, 2-wire connections | 1755 |
| X20DO6529 | X20 digital output module, 6 relays, normally open contacts, 115 VAC / 0.5 A, 30 VDC / 1 A | 1766 |
| X20DO6639 | X20 digital output module, 6 relays, normally open contacts, 240 VAC / 2 A, 30 VDC / 2 A | 1773 |
| X20DO8232 | X20 digital output module, 8 outputs, 12 VDC, 2 A, source, supply directly on module, 1-wire connections | 1779 |
| X20DO8322 | X20 digital output module, 8 outputs, 24 VDC, 0.5 A, source, 1-wire connections | 1791 |
| X20DO8323 | X20 digital output module, 8 outputs, 12 to 24 V, 0.5 A, sink/source, 1-wire connections, full bridge, half bridge, thermal overload protection | 1799 |
| X20DO8331 | X20 digital output module, 8 outputs, 24 VDC, 2 A, sink, supply directly on module, 1-wire connections | 1808 |
| X20DO8332 | X20 digital output module, 8 outputs, 24 VDC, 2 A, source, supply directly on module, 1-wire connections | 1820 |

Module overviews

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| X20DO8332-1 | X20 digital output module, 8 outputs, 24 VDC, 2 A, source, optimized for inductive loads, power supply directly on module, 1-wire connections | 1832 |
| X20DO9321 | X20 digital output module, 12 outputs, 24 VDC, 0.5 A, sink, 1-wire connections | 1843 |
| X20DO9322 | X20 digital output module, 12 outputs, 24 VDC, 0.5 A, source, 1-wire connections | 1851 |
| X20DOD322 | X20 digital output module, 8 outputs, 24 VDC, 0.5 A, source, 2-wire connections | 1859 |
| X20DOF322 | X20 digital output module, 16 output, 24 VDC, 0.5 A, source, 1-wire connections | 1866 |
| X20DS1119 | X20 multifunction digital signal processor, 3 digital channels 5 V (symmetrical) configurable as inputs or outputs, 2 digital input channels 24 V (asymmetrical), max. 2 event counters, 1 universal counter pair as AB counter or up/down counter, linear movement generator (A/B, direction/frequency) with 1 reference pulse, 1 SSI absolute encoder, NetTime function | 1914 |
| X20DS1319 | X20 multifunction digital signal processor, 4 digital input channels, 4 digital channels configurable as inputs or outputs, 2 event counters 1 universal counter pair as AB counter or up/down counter, linear movement generator (A/B, direction/frequency) with max. 2 reference pulses, SSI absolute encoder, NetTime function | 1957 |
| X20DS1828 | X20 digital signal module, 1 HIPERFACE interface, NetTime function | 1999 |
| X20DS1928 | X20 digital signal module, 1 EnDat 2.1/2.2 interface, NetTime function | 2031 |
| X20DS4387 | X20 digital signal module, 4x IO-Link master, 4 digital channels configurable as inputs or outputs, 3-wire connections | 3269 |
| X20DS4389 | X20 digital signal module, 4 digital inputs, 24 VDC, 4 digital outputs, 24 VDC, 0.1 A, oversampling I/O functions, time-triggered I/O functions, NetTime function | 2056 |
| X20DS438A | X20 digital signal module, 4x IO-Link master V1.1, 4 digital channels configurable as inputs or outputs, 3-wire connections, Net-Time function | 3287 |
| X20ET8819 | X20 Ethernet analysis tool, can be expanded with active hub modules, 2x RJ45 | 2468 |
| X20HB1881 | X20 hub expansion module, integrated 1-port hub, for multimode fiber optic cable | 3619 |
| X20HB1882 | X20 hub expansion module, integrated 1-port hub, for monomode fiber optic cables | 3623 |
| X20HB2880 | X20 hub expansion module, integrated 2-port hub, 2x RJ45 | 3627 |
| X20HB2881 | X20 hub expansion module, integrated 2-port hub, for fiber optic cable | 3632 |
| X20HB2885 | X20 hub expansion module, integrated active 2-port hub, 2x RJ45 | 3641 |
| X20HB2886 | X20 hub expansion module, integrated active 2-port hub, 2 fiber optic interfaces | 3644 |
| X20HB8815 | X20 POWERLINK - TCP/IP gateway, can be expanded with active hub modules, 2x RJ45 | 2480 |
| X20HB8880 | X20 base hub module, integrated 2-port hub, 2x RJ45 | 2490 |
| X20HB8884 | X20 compact link selector, 2x RJ45, order bus base, power supply module and terminal block separately. | 3614 |
| X20IF0000 | X20 dummy interface module (non-functional) | 2092 |
| X20IF1020 | X20 interface module, 1 RS232 interface, max. 115.2 kbit/s, electrically isolated | 2268 |
| X20IF1030 | X20 interface module, 1 RS422/485 interface, max. 115.2 kbit/s, electrically isolated | 2271 |
| X20IF1041-1 | X20 interface module, for DTM configuration, 1 CANopen master interface, electrically isolated, order 1x TB2105 terminal block separately | 2274 |
| X20IF1043-1 | X20 interface module, for DTM configuration, 1 CANopen slave interface, electrically isolated, order 1x TB2105 terminal block separately | 2288 |
| X20IF1051-1 | X20 interface module, for DTM configuration, 1 DeviceNet scanner (master) interface, electrically isolated, order 1x terminal block TB2105 separately! | 2302 |
| X20IF1053-1 | X20 interface module, for DTM configuration, 1 DeviceNet adapter (slave) interface, electrically isolated, order 1x terminal block TB2105 separately! | 2315 |
| X20IF1061-1 | X20 interface module for DTM configuration, 1 PROFIBUS DP V0/V1 master interface, electrically isolated | 2328 |
| X20IF1063 | X20 interface module, 1 PROFIBUS DP V0 slave interface, max. 12 Mbit/s, electrically isolated | 2339 |
| X20IF1063-1 | X20 interface module, for DTM configuration, 1 PROFIBUS DP V1 slave interface, electrically isolated | 2342 |
| X20IF1072 | X20 interface module, 1 CAN bus interface, max. 1 Mbit/s, electrically isolated, order 1x TB2105 terminal block separately | 2353 |
| X20IF1074 | X20 interface module, for SGC, 1 CAN bus interface, max. 1 Mbit/s, electrically isolated, order 1x TB2105 terminal block separately | 2263 |
| X20IF1082 | X20 interface module, 1 POWERLINK interface, managing or controlled node, integrated 2-port hub, ring redundancy function | 2357 |
| X20IF1082-2 | X20 interface module, 1 POWERLINK interface, managing or controlled node, integrated 2-port hub, ring redundancy function PRC function | 2363 |
| X20IF1086-2 | X20 interface module, 1 POWERLINK interface, managing or controlled node, PRC function, 1 fiber optic connection | 2369 |
| X20IF1091 | X20 interface module, 1 X2X Link master interface, electrically isolated, order 1x TB704 terminal block separately | 2375 |
| X20IF1091-1 | X20 interface module, for expandable bus controller, 1 X2X Link master interface, electrically isolated, order 1x TB704 terminal block separately | 2240 |
| X20IF10A1-1 | X20 interface module, for DTM configuration, 1 ASi master interface, electrically isolated, order 1x terminal block TB704 separately! | 2378 |
| X20IF10D1-1 | X20 interface module, for DTM configuration, 1 EtherNet/IP scanner (master) interface, electrically isolated | 2392 |
| X20IF10D3-1 | X20 interface module, for DTM configuration, 1 EtherNet/IP adapter (slave) interface, electrically isolated | 2402 |
| X20IF10E1-1 | X20 interface module, for DTM configuration, 1 PROFINET IO controller (master) interface, electrically isolated | 2413 |
| X20IF10E3-1 | X20 interface module, for DTM configuration, 1 PROFINET IO device (slave) interface module, electrically isolated | 2424 |
| X20IF10G3-1 | X20 interface module for DTM configuration, 1 EtherCAT slave interface, electrically isolated | 2434 |
| X20IF10X0 | X20 interface module, 1 redundancy link interface 1000BASE-SX, CPU-CPU data synchronization module for controller redundancy | 2447 |
| X20IF2181-2 | X20 interface module, 1x link selector for POWERLINK cable redundancy, POWERLINK functions: - Managing node - Controlled node for iCN operation - Redundant managing node for controller redundancy - Ring redundancy - 2x hub - Multi ASend - PRC function 2x RJ45 | 2452 |
| X20IF2772 | X20 interface module, 2 CAN bus interfaces, max. 1 Mbit/s, electrically isolated, order 2x TB2105 terminal block separately | 2458 |
| X20IF2792 | X20 interface module, 1 CAN bus interface, max. 1 Mbit/s, electrically isolated, 1 X2X Link master interface, electrically isolated, order 1x terminal block TB2105 and 1x terminal block TB704 separately! | 2462 |
| X20MM2436 | X20 PWM motor module, 24 to 39 VDC $\pm 25\%$, 2 PWM motor bridges, 3 A continuous current, 3.5 A peak current, 4 digital inputs 24 VDC, sink, configurable as incremental encoder | 2496 |
| X20MM3332 | X20 digital motor module, 24 VDC, 3 digital outputs, full bridge (H bridge), 3 A continuous current, 5 A peak current | 2523 |
| X20MM4331 | X20 digital motor module, 24 VDC, 4 digital outputs, half bridge, 3 A continuous current, 5 A peak current | 2538 |
| X20MM4455 | X20 PWM motor module, 24 to 48 VDC $\pm 25\%$, 4 PWM motor bridges, 6 A continuous current, 10 A peak current, 4x 3 digital inputs 5 VDC single-ended, source, configurable as incremental encoder | 2551 |
| X20MM4456 | X20 PWM motor module, 24 to 48 VDC $\pm 25\%$, 4 PWM motor bridges, 6 A continuous current, 10 A peak current, 4x 4 digital inputs 24 VDC, sink, configurable as incremental encoder | 2577 |
| X20PD0011 | X20 potential distributor module, 12x GND, integrated microfuse | 3327 |
| X20PD0012 | X20 potential distributor module, 12x 24 VDC, integrated microfuse | 3332 |

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| X20PD0016 | X20 potential distributor module, 5x GND, 5x 24 VDC, each with 1x floating feed, integrated microfuse | 3337 |
| X20PD2113 | X20 potential distributor module, 6x GND, 6x 24 VDC, with feed option, integrated microfuse | 3343 |
| X20PS2100 | X20 power supply module, for internal I/O supply | 3356 |
| X20PS2110 | X20 power supply module, for internal I/O power supply, integrated microfuse | 3361 |
| X20PS3300 | X20 power supply module, for X2X Link and internal I/O power supply | 3367 |
| X20PS3310 | X20 power supply module, for X2X Link and internal I/O power supply, integrated microfuse | 3373 |
| X20PS4951 | X20 power supply module, for potentiometers, 4x ± 10 V for potentiometer supply | 3349 |
| X20PS8002 | X20 power supply module for standalone hub and compact link selector | 3636 |
| X20PS9400 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply | 926 |
| X20PS9402 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply, supply not electrically isolated | 932 |
| X20PS9500 | X20 power supply module for Compact and Fieldbus CPUs and internal I/O power supply, X2X Link power supply | 1006 |
| X20PS9502 | X20 power supply module, for Compact and Fieldbus CPUs and internal I/O power supply, X2X Link power supply, supply not electrically isolated | 1012 |
| X20PS9600 | X20 power supply module, for Compact-S CPU and internal I/O power supply, X2X Link power supply | 1047 |
| X20PS9602 | X20 power supply module, for Compact-S CPU and internal I/O power supply, X2X Link power supply, power supply not electrically isolated | 1055 |
| X20RT8001 | X20 reACTION module, 4 digital inputs, 24 VDC, $< 1 \mu\text{s}$, 4 digital channels, 24 VDC, 0.1 A, $< 1 \mu\text{s}$, configurable as inputs or outputs, reACTION Technology module | 3448 |
| X20RT8201 | X20 reACTION module, 4 digital inputs, 24 VDC, $< 1 \mu\text{s}$, 4 digital channels, 24 VDC, 0.1 A, $< 1 \mu\text{s}$, configurable as inputs or outputs, 2 analog inputs ± 10 V, 500 kHz sampling frequency, 13-bit converter resolution including sign, configurable input filter, reACTION Technology module | 3477 |
| X20RT8202 | X20 reACTION module, 4 digital inputs, 24 VDC, $< 1 \mu\text{s}$, 4 digital channels, 24 VDC, 0.1 A, $< 1 \mu\text{s}$, configurable as inputs or outputs, 2 analog outputs ± 10 V, 2 μs , 13-bit converter resolution including sign, reACTION Technology module | 3511 |
| X20RT8381 | X20 reACTION module, real computing function, 4 digital inputs, 24 VDC, $< 1 \mu\text{s}$, 4 digital channels, 24 VDC, 0.1 A, $< 1 \mu\text{s}$, configurable as inputs or outputs, 2 analog inputs ± 10 V, 500 kHz sampling frequency, 13-bit converter resolution including sign, configurable input filter, 1 analog output ± 10 V, 2 μs , 13-bit converter resolution including sign, reACTION Technology module | 3543 |
| X20RT8401 | X20 reACTION module, 4 digital inputs, 24 VDC, $< 1 \mu\text{s}$, 4 digital channels, 24 VDC, 0.1 A, $< 1 \mu\text{s}$, configurable as inputs or outputs, 1 analog input ± 10 V, 500 kHz sampling frequency, 13-bit converter resolution including sign, configurable input filter, 1 analog output ± 10 V, 2 μs , 13-bit converter resolution including sign, reACTION Technology module | 3577 |
| X20SM1426 | X20 stepper motor module, 1 motor connection, 1 A continuous current, 1.2 A peak current, 4 digital inputs 24 VDC, sink, configurable as incremental encoder, NetTime function | 2603 |
| X20SM1436 | X20 stepper motor module, module power supply 24 to 39 VDC $\pm 25\%$, 1 motor connection, 3 A continuous current, 3.5 A peak current, 4 digital inputs 24 VDC, sink, configurable as incremental encoder, NetTime function | 2652 |
| X20SM1436-1 | X20 stepper motor module, with current reduction function, module power supply 24 to 48 VDC $\pm 25\%$, 1 motor connection, 2.5 A continuous current, 3.5 A peak current, 4 digital inputs 24 VDC, sink, configurable as incremental encoder, NetTime function | 2700 |
| X20SM1446-1 | X20 stepper motor module, module power supply 24 to 48 VDC $\pm 25\%$, with current reduction function, 1 motor connection, 5 A continuous current, 10 A peak current, 4 digital inputs 24 VDC, sink, configurable as incremental encoder, NetTime function, double-width module | 2751 |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | 3775 |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | 3775 |
| X20TB1E | X20 terminal block, 12-pin, 24 VDC keyed, 2x PT1000 integrated for terminal temperature compensation | 3778 |
| X20TB1F | X20 terminal block, 16-pin, 24 VDC keyed | 3781 |
| X20TB32 | X20 terminal block, 12-pin, 240 VAC keyed | 3784 |
| X20XC0201 | X20 fieldbus CPU, μP 16, 100 kB SRAM, 1 MB FlashPROM, support of RS232, CAN bus and interface module according to fieldbus CPU base, order power supply module, bus base and terminal block separately | 2245 |
| X20XC0202 | X20 fieldbus CPU, μP 25, 750 kB SRAM, 3 MB FlashPROM, support of RS232, CAN bus and interface module according to fieldbus CPU base, order power supply module, bus base and terminal block separately | 2245 |
| X20XC0292 | X20 fieldbus CPU, μP 25 750 kB SRAM, 3 MB FlashPROM, support of RS232, CAN bus and interface module, according to fieldbus CPU base, 1 Ethernet interface 100 Base-T, order bus base, power supply module and terminal block separately | 2245 |
| X20ZF0000 | Dummy X20 module (non-functional) | 2094 |
| X20ZF0002 | X20 dummy module (no function), 240 VAC coded | 2096 |
| X20ZF000F | Dummy X20 module (non-functional) | 2098 |

6.1.2 Module overview: Grouped

6.1.2.1 CPUs

Standard CPU

| Order number | Short description | Page |
|--------------|---|------|
| X20CP1301 | X20 CPU, with integrated I/O, x86-200, 128 MB DDR3 RAM, 16 kB FRAM, 1 GB onboard flash drive, 1 insert slot for X20 interface modules, 1 USB interface, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 μ s, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μ s, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs \pm 10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included | 1324 |
| X20CP1381 | X20 CPU, with integrated I/O, x86-200, 128 MB DDR3 RAM, 16 kB FRAM, 1 GB onboard flash drive, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 CAN bus interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 μ s, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μ s, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs \pm 10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included | 1324 |
| X20CP1382 | X20 CPU, with integrated I/O, x86-400, 256 MB DDR3 RAM, 32 kB FRAM, 2 GB onboard flash drive, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 CAN bus interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 μ s, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μ s, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs \pm 10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included | 1324 |
| X20CP1483 | X20 CPU, x86 100 MHz Intel compatible, 32 MB DRAM, 128 kB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1380 |
| X20CP1483-1 | X20 CPU, x86 100 MHz Intel compatible, 64 MB DRAM, 128 kB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1380 |
| X20CP1583 | X20 CPU, Atom 333 MHz Intel compatible, 128 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1397 |
| X20CP1584 | X20 CPU, Atom 0.6 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1397 |
| X20CP1585 | X20 CPU, Atom 1.0 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1397 |
| X20CP1586 | X20 CPU, Atom 1.6 GHz, 512 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1397 |
| X20CP1684 | X20 CPU, Atom 0.4 GHz (compatible), 512 MB DDR4 RAM, 1 MB SRAM, 1 GB onboard flash drive, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! | 1418 |
| X20CP1685 | X20 CPU, Atom 0.8 GHz, 512 MB DDR4 RAM, 1 MB SRAM, 1 GB onboard flash drive, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! | 1418 |
| X20CP1686X | X20 CPU, Atom 1.3 GHz, 1 GB DDR4 RAM, 1 MB SRAM, 2 GB onboard flash drive, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! | 1418 |
| X20CP3583 | X20 CPU, Atom 333 MHz Intel compatible, 128 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1401 |
| X20CP3584 | X20 CPU, Atom 0.6 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1401 |
| X20CP3585 | X20 CPU, Atom 1.0 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1401 |
| X20CP3586 | X20 CPU, Atom 1.6 GHz, 512 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1401 |

| Order number | Short description | Page |
|--------------|---|------|
| X20CP3684 | X20 CPU, Atom 0.4 GHz (compatible), 512 MB DDR4 RAM, 1 MB SRAM, 1 GB onboard flash drive, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! | 1422 |
| X20CP3685 | X20 CPU, Atom 0.8 GHz, 512 MB DDR4 RAM, 1 MB SRAM, 1 GB onboard flash drive, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! | 1422 |
| X20CP3686X | X20 CPU, Atom 1.3 GHz, 1 GB DDR4 RAM, 1 MB SRAM, 2 GB onboard flash drive, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! | 1422 |
| X20CP3687X | X20 CPU, Atom 1.6 GHz, 2 GB DDR4 RAM, 1 MB SRAM, 2 GB onboard flash drive, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! | 1422 |

Compact CPU

| Order number | Short description | Page |
|--------------|---|------|
| X20CP0201 | X20 compact CPU, μ P 16, 100 kB SRAM, 1 MB FlashPROM, support of RS232, CAN bus according to compact CPU base, order bus base, power supply module and terminal block separately | 994 |
| X20CP0291 | X20 compact CPU, μ P 16, 100 kB SRAM, 1 MB FlashPROM, support of RS232, CAN bus according to compact CPU base, 1 Ethernet interface 100 Base-T, order bus base, power supply module and terminal block separately | 994 |
| X20CP0292 | X20 compact CPU, μ P 25, 100 kB SRAM, 1 MB FlashPROM, support of RS232, CAN bus according to compact CPU base, 3 Ethernet interface 750 Base-T, order bus base, power supply module and terminal block separately | 994 |

Compact-S CPU

| Order number | Short description | Page |
|--------------|---|------|
| X20CP0410 | X20 Compact-S CPU, ARM Cortex-A9-166 (compatible), 128 MB DDR3 RAM, 8 kB FRAM, 256 MB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T. Order bus base, power supply module and terminal block separately! | 1019 |
| X20CP0411 | X20 Compact-S CPU, ARM Cortex-A9-240, 128 MB DDR3 RAM, 16 kB FRAM, 512 MB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T. Order bus base, power supply module and terminal block separately! | 1019 |
| X20CP0420 | X20 Compact-S CPU, ARM Cortex-A9-166 (compatible), 128 MB DDR3 RAM, 8 kB FRAM, 256 MB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 2 Ethernet interfaces 10/100BASE-T (switch). Order bus base, power supply module and terminal block separately! | 1019 |
| X20CP0482 | X20 Compact-S CPU, ARM Cortex-A9-300, 128 MB DDR3 RAM, 16 kB FRAM, 1 GB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, can be expanded with X20 interface slot. Order bus base, power supply module and terminal block separately! | 1019 |
| X20CP0483 | X20 Compact-S CPU, ARM Cortex-A9-500, 256 MB DDR3 RAM, 32 kB FRAM, 1 GB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, can be expanded with X20 interface slot. Order bus base, power supply module and terminal block separately! | 1019 |
| X20CP0484 | X20 Compact-S CPU, ARM Cortex-A9-667, 256 MB DDR3 RAM, 64 kB FRAM, 2 GB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, can be expanded with X20 interface slot. Order bus base, power supply module and terminal block separately! | 1019 |
| X20CP0484-1 | X20 Compact-S CPU, ARM Cortex-A9-667, 512 MB DDR3 RAM, 64 kB FRAM, 2 GB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, can be expanded with X20 interface slot. Order bus base, power supply module and terminal block separately! | 1019 |

Fieldbus CPU

| Order number | Short description | Page |
|--------------|--|------|
| X20XC0201 | X20 fieldbus CPU, μ P 16, 100 kB SRAM, 1 MB FlashPROM, support of RS232, CAN bus and interface module according to fieldbus CPU base, order power supply module, bus base and terminal block separately | 2245 |
| X20XC0202 | X20 fieldbus CPU, μ P 25, 750 kB SRAM, 3 MB FlashPROM, support of RS232, CAN bus and interface module according to fieldbus CPU base, order power supply module, bus base and terminal block separately | 2245 |
| X20XC0292 | X20 fieldbus CPU, μ P 25 750 kB SRAM, 3 MB FlashPROM, support of RS232, CAN bus and interface module, according to fieldbus CPU base, 1 Ethernet interface 100 Base-T, order bus base, power supply module and terminal block separately | 2245 |

reACTION Technology CPU

| Order number | Short description | Page |
|------------------------------|---|------|
| X20CP1381-RT | X20 CPU, with integrated I/O, x86-200, 128 MB DDR3 RAM, 16 kB FRAM, 1 GB onboard flash drive, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 CAN bus interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, reACTION Technology, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 µs, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 µs, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs ±10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included | 3382 |
| X20CP1382-RT | X20 CPU, with integrated I/O, x86-400, 256 MB DDR3 RAM, 32 kB FRAM, 2 GB onboard flash drive, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 CAN bus interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, reACTION Technology, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 µs, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 µs, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs ±10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included | 3382 |

6.1.2.2 Module overview: Grouped

Analog outputs

| Order number | Short description | Page |
|--------------|--|------|
| X20AO2437 | X20 analog output module, 2 outputs, 4 to 20 mA / 0 to 20 mA or 0 to 24 mA, 16-bit converter resolution, single channel electrically isolated | 735 |
| X20AO2438 | X20 analog output module, 2 outputs, 4 to 20 mA / 0 to 20 mA or 0 to 24 mA, 16-bit converter resolution, single-channel isolation, supports the HART protocol, NetTime function | 748 |
| X20AO2622 | X20 analog output module, 2 outputs, 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution | 773 |
| X20AO2632 | X20 analog output module, 2 outputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, NetTime function | 780 |
| X20AO2632-1 | X20 analog output module, 2 outputs, ± 11 V or 0 to 22 mA, 16-bit converter resolution, NetTime function | 788 |
| X20AO4622 | X20 analog output module, 4 outputs, ± 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution | 796 |
| X20AO4632 | X20 analog output module, 4 outputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution | 805 |
| X20AO4632-1 | X20 analog output module, 4 outputs, ± 11 V or 0 to 22 mA, 16-bit converter resolution, NetTime function | 815 |
| X20AO4635 | X20 analog output module, 4 outputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, low temperature drift | 824 |
| X20CM8281 | X20 universal mixed module, 4 digital inputs, 24 VDC, sink, 1-wire connections, 2 digital outputs, 0.5 A, source, 1-wire connections, 1 analog input, ± 10 V or 0 to 20 mA / 4 to 20 mA, 12-bit converter resolution, 1 analog output, ± 10 V / 0 to 20 mA, 12-bit converter resolution, 2 counters as event counters or gate measurement | 3178 |
| X20RT8202 | X20 reACTION module, 4 digital inputs, 24 VDC, <1 μ s, 4 digital channels, 24 VDC, 0.1 A, <1 μ s, configurable as inputs or outputs, 2 analog outputs ± 10 V, 2 μ s, 13-bit converter resolution including sign, reACTION Technology module | 3511 |
| X20RT8401 | X20 reACTION module, 4 digital inputs, 24 VDC, <1 μ s, 4 digital channels, 24 VDC, 0.1 A, <1 μ s, configurable as inputs or outputs, 1 analog input ± 10 V, 500 kHz sampling frequency, 13-bit converter resolution including sign, configurable input filter, 1 analog output ± 10 V, 2 μ s, 13-bit converter resolution including sign, reACTION Technology module | 3577 |

Analog inputs

| Order number | Short description | Page |
|--------------|---|------|
| X20AI1744 | X20 analog input module, 1 full-bridge strain gauge input, 24-bit converter resolution, 5 kHz input filter | 196 |
| X20AI1744-3 | X20 analog input module, 1 full-bridge strain gauge input, 24-bit converter resolution, 5 Hz input filter | 243 |
| X20AI1744-10 | X20 analog input module, 1 full-bridge strain input 10 V, 24-bit converter resolution, 5 kHz input filter | 289 |
| X20AI2222 | X20 analog input module, 2 inputs, ± 10 V, 13-bit converter resolution, configurable input filter | 318 |
| X20AI2237 | X20 analog input module, 2 inputs, ± 10 V, 16-bit converter resolution, single-channel isolation with separate sensor power supply, NetTime function | 328 |
| X20AI2322 | X20 analog input module, 2 inputs, 0-20 mA / 4-20 mA, 12-bit converter resolution, configurable input filter | 346 |
| X20AI2437 | X20 analog input module, 2 inputs, 4 to 20 mA, 16-bit converter resolution, single-channel isolation with separate sensor power supply, NetTime function | 357 |
| X20AI2438 | X20 analog input module, 2 inputs, 4 to 20 mA, 16-bit converter resolution, single-channel isolation with separate sensor power supply, supports the HART protocol, NetTime function | 373 |
| X20AI2622 | X20 analog input module, 2 inputs, ± 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution, configurable input filter | 397 |
| X20AI2632 | X20 analog input module, 2 inputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, configurable input filter, oscilloscope functions | 408 |
| X20AI2632-1 | X20 analog input module, 2 inputs, ± 11 V or 0 to 22 mA, 16-bit converter resolution, configurable input filter | 433 |
| X20AI2636 | X20 analog input module, 2 inputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, configurable input filter, oversampling functions | 458 |
| X20AI4222 | X20 analog input module, 4 inputs, ± 10 V, 13-bit converter resolution, configurable input filter | 489 |
| X20AI4322 | X20 analog input module, 4 inputs, 0-20 mA / 4-20 mA, 12-bit converter resolution, configurable input filter | 499 |
| X20AI4622 | X20 analog input module, 4 inputs, ± 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution, configurable input filter | 509 |
| X20AI4632 | X20 analog input module, 4 inputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, configurable input filter, oscilloscope functions | 520 |
| X20AI4632-1 | X20 analog input module, 4 inputs, ± 11 V or 0 to 22 mA, 16-bit converter resolution, configurable input filter, oscilloscope functions | 545 |
| X20AI4636 | X20 analog input module, 4 inputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, configurable input filter, oversampling functions | 570 |
| X20AI8221 | X20 analog input module, 8 inputs, ± 10 V, 13-bit converter resolution | 602 |
| X20AI8321 | X20 analog input module, 8 inputs, 0 to 20 mA, 12-bit converter resolution | 612 |
| X20AIA744 | X20 analog input module, 2 full-bridge strain inputs, 24-bit converter resolution, 2.5 kHz input filter | 622 |
| X20AIB744 | X20 analog input module, 4 full-bridge strain inputs, 24-bit converter resolution, 2.5 kHz input filter | 641 |
| X20AP3111 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 20 mA AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20AP3121 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 1 A AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20AP3122 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 1 A AC, groundable, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20AP3131 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 5 A AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20AP3132 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 5 A AC, groundable, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20AP3161 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 333 mV AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20AP3171 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, Rogowski adjustable (μ V/A), max. 52 mV, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20CM0985 | X20 digital and analog mixed module, multi-measurement transducer/ synchronization module, 5 digital outputs, 24 VDC, 0.5 A source, 1 relay, 1 A, changeover contact, 8 analog inputs, ± 480 V / 120 V, 16-bit converter resolution, 3 analog inputs 5 A / 1 A AC, 16-bit converter resolution, order terminal blocks 0TB3102-7011, 0TB3104-7011, 0TB3102-7012, 0TB3104-7012 and 2x TB12 separately. | 2803 |
| X20CM0985-1 | X20 digital and analog mixed module, multi-measurement transducer / synchronization module, 5 digital outputs, 24 VDC, 0.5 A, source, 1 relay, 1 A, 8 analog inputs, ± 480 V / 120 V, 16-bit converter resolution, 3 analog inputs, 5 A / 1 A AC, 16-bit converter resolution, additional software functionalities, order terminal blocks 0TB3102-7011, 0TB3104-7011, 0TB3102-7012, 0TB3104-7012 and 2x X20TB12 separately! | 2921 |
| X20CM8281 | X20 universal mixed module, 4 digital inputs, 24 VDC, sink, 1-wire connections, 2 digital outputs, 0.5 A, source, 1-wire connections, 1 analog input, ± 10 V or 0 to 20 mA / 4 to 20 mA, 12-bit converter resolution, 1 analog output, ± 10 V / 0 to 20 mA, 12-bit converter resolution, 2 counters as event counters or gate measurement | 3178 |
| X20RT8201 | X20 reACTION module, 4 digital inputs, 24 VDC, < 1 μ s, 4 digital channels, 24 VDC, 0.1 A, < 1 μ s, configurable as inputs or outputs, 2 analog inputs ± 10 V, 500 kHz sampling frequency, 13-bit converter resolution including sign, configurable input filter, reACTION Technology module | 3477 |
| X20RT8401 | X20 reACTION module, 4 digital inputs, 24 VDC, < 1 μ s, 4 digital channels, 24 VDC, 0.1 A, < 1 μ s, configurable as inputs or outputs, 1 analog input ± 10 V, 500 kHz sampling frequency, 13-bit converter resolution including sign, configurable input filter, 1 analog output ± 10 V, 2 μ s, 13-bit converter resolution including sign, reACTION Technology module | 3577 |

Dummy modules

| Order number | Short description | Page |
|--------------|---|------|
| X20IF0000 | X20 dummy interface module (non-functional) | 2092 |
| X20ZF0000 | Dummy X20 module (non-functional) | 2094 |
| X20ZF0002 | X20 dummy module (no function), 240 VAC coded | 2096 |
| X20ZF000F | Dummy X20 module (non-functional) | 2098 |

Bus controller

| Order number | Short description | Page |
|--------------|---|------|
| X20BC0043-10 | X20 bus controller, 1 CANopen interface, order 1x terminal block TB2105 separately! Order bus base, power supply module and terminal block separately! | 834 |
| X20BC0053 | X20 bus controller, 1 DeviceNet interface, order 1x TB2105 terminal block separately Order bus base, power supply module and terminal separately | 841 |
| X20BC0063 | X20 bus controller, 1 PROFIBUS DP interface, 9-pin DSUB connection, order bus base, power supply module and terminal block separately | 847 |
| X20BC0073 | X20 bus controller, 1 CAN I/O interface, order 1x TB2105 terminal block separately Order bus base, power supply module and terminal separately | 851 |
| X20BC0083 | X20 bus controller, 1 POWERLINK interface, integrated 2-port hub, 2x RJ45, order bus base, power supply module and terminal block separately! | 859 |
| X20BC0087 | X20 bus controller, 1 Modbus TCP or Modbus UDP interface, integrated 2-port switch, 2x RJ45, order bus base, power supply module and terminal block separately. | 864 |
| X20BC0087-10 | X20 bus controller, 1 Modbus TCP or Modbus UDP interface, producer mode feature (via UDP), integrated switch, 2x RJ45, order bus base, power supply module and terminal block separately. | 870 |
| X20BC0088 | X20 bus controller, 1 EtherNet/IP interface, integrated switch, web interface, 2x RJ45, order bus base, power supply module and terminal block separately! | 877 |
| X20BC008U | X20 bus controller, 1 OPC UA Ethernet interface, integrated 2-port switch, 2x RJ45, order bus base, power supply module and terminal block separately. | 882 |
| X20BC00E3 | X20 bus controller, 1 PROFINET IO interface, integrated 2-port switch, 2x RJ45, order bus base, power supply module and terminal block separately! | 904 |
| X20BC00G3 | X20 bus controller, 1 EtherCAT interface, 2x RJ45, order bus base, power supply module and terminal block separately. | 910 |
| X20BC0143-10 | X20 bus controller, 1 CANopen interface, 9-pin DSUB, Order 1x connector 7AC911.9 separately! Order bus base, power supply module and terminal block separately! | 914 |

Bus receivers and bus transmitters

| Order number | Short description | Page |
|--------------|--|------|
| X20BR7300 | X20 bus receiver, CAN I/O, supply for X2X Link and internal I/O power supply, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 964 |
| X20BR9300 | X20 bus receiver, X2X Link, supply for X2X Link and internal I/O power supply, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 973 |
| X20BT9100 | X20 bus transmitter, X2X Link, supply for internal I/O supply | 980 |
| X20BT9400 | X20 bus transmitter X2X Link, feed for internal I/O supply, X2X Link supply for X67 modules, reverse polarity protection, short circuit protection, overload protection, parallel connection possible, redundancy operation possible | 986 |

Bus modules

| Order number | Short description | Page |
|--------------|--|------|
| X20BM01 | X20 power supply bus module, 24 VDC keyed, internal I/O supply interrupted to the left | 939 |
| X20BM05 | X20 power supply bus module, with node number switch, 24 VDC keyed, internal I/O supply interrupted to the left | 942 |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | 945 |
| X20BM12 | X20 bus module, 240 VAC keyed, internal I/O power supply connected through | 948 |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | 951 |
| X20BM21 | X20 power supply bus module, for double-width modules, 24 VDC keyed, internal I/O supply interrupted to the left | 954 |
| X20BM31 | X20 bus module for double-width modules, 24 VDC keyed, internal I/O supply continuous | 956 |
| X20BM32 | X20 bus module for double-width modules, 240 VAC keyed, internal I/O supply continuous | 959 |

Digital outputs

| Order number | Short description | Page |
|--------------|---|------|
| X20CM0985 | X20 digital and analog mixed module, multi-measurement transducer/ synchronization module, 5 digital outputs, 24 VDC, 0.5 A source, 1 relay, 1 A, changeover contact, 8 analog inputs, ± 480 V / 120 V, 16-bit converter resolution, 3 analog inputs 5 A / 1 A AC, 16-bit converter resolution, order terminal blocks 0TB3102-7011, 0TB3104-7011, 0TB3102-7012, 0TB3104-7012 and 2x TB12 separately. | 2803 |
| X20CM0985-1 | X20 digital and analog mixed module, multi-measurement transducer / synchronization module, 5 digital outputs, 24 VDC, 0.5 A, source, 1 relay, 1 A, 8 analog inputs, ± 480 V / 120 V, 16-bit converter resolution, 3 analog inputs, 5 A / 1 A AC, 16-bit converter resolution, additional software functionalities, order terminal blocks 0TB3102-7011, 0TB3104-7011, 0TB3102-7012, 0TB3104-7012 and 2x X20TB12 separately! | 2921 |
| X20CM0985-02 | X20 digital and analog mixed module, multi-measurement transducer / synchronization module, 5 digital outputs, 24 VDC, 0.5 A, source, 1 relay, 1 A, 8 analog inputs, ± 480 V / 120 V, 16-bit converter resolution, 3 analog inputs, 5 A / 1 A AC, 16-bit converter resolution, additional software functionalities, adapted to VDE guidelines (2018), order terminal blocks 0TB3102-7011, 0TB3104-7011, 0TB3102-7012, 0TB3104-7012 and 2x X20TB12 separately! | 2846 |
| X20CM1201 | X20 combination module, 1 AB incremental encoder, 24 V, 4 digital inputs 24 V, 4 channels 24 V configurable as inputs or outputs, flexible digital controller logic | 1875 |
| X20CM4323 | X20 PWM module, 4 digital outputs for switching electromechanical loads, 24 VDC, oversampling output functions, time-triggered output functions, NetTime function | 2992 |
| X20CM8281 | X20 universal mixed module, 4 digital inputs, 24 VDC, sink, 1-wire connections, 2 digital outputs, 0.5 A, source, 1-wire connections, 1 analog input, ± 10 V or 0 to 20 mA / 4 to 20 mA, 12-bit converter resolution, 1 analog output, ± 10 V / 0 to 20 mA, 12-bit converter resolution, 2 counters as event counters or gate measurement | 3178 |
| X20CM8323 | X20 PWM module, 8 digital outputs for switching electromechanical loads, 0.6 A continuous current, 2 A peak current, current monitoring, switching time detection | 3197 |
| X20DM9324 | X20 digital mixed module, 8 inputs, 24 VDC, sink, configurable input filter, 4 outputs, 24 VDC, 0.5 A, source 1-wire connections | 1572 |
| X20DO2321 | X20 digital output module, 2 outputs, 24 VDC, 0.5 A, sink, 3-wire connections | 1581 |
| X20DO2322 | X20 digital output module, 2 outputs, 24 VDC, 0.5 A, source, 3-wire connections | 1590 |
| X20DO2623 | X20 digital output module, 2 outputs, 100 to 240 VAC, 1 A, source, 240 V keyed, 3-wire connections | 1599 |
| X20DO2633 | X20 digital output module, 2 triac outputs, 48 to 240 VAC, 2 A, L-switching, phase angle control, 240 V keyed | 1610 |
| X20DO2649 | X20 digital output module, 2 relays, changeover contacts, 240 VAC / 5 A, 24 VDC / 5 A | 1626 |
| X20DO4321 | X20 digital output module, 4 outputs, 24 VDC, 0.5 A, sink, 3-wire connections | 1632 |
| X20DO4322 | X20 digital output module, 4 outputs, 24 VDC, 0.5 A, source, 3-wire connections | 1641 |
| X20DO4331 | X20 digital output module, 4 outputs, 24 VDC, 2 A, sink, 3-wire connections | 1649 |
| X20DO4332 | X20 digital output module, 4 outputs, 24 VDC, 2 A, source, 3-wire connections | 1659 |
| X20DO4332-1 | X20 digital output module, 4 outputs, 24 VDC, 2 A, source, 3-wire connections, PWM output | 1669 |
| X20DO4529 | X20 digital output module, 4 relays, changeover contacts, 115 VAC / 0.5 A, 24 VDC / 1 A | 1679 |
| X20DO4613 | X20 digital output module, 4 triac coupler outputs, 48 to 240 VAC, 50 mA, zero-crossing detection, 240 V keyed | 1686 |
| X20DO4623 | X20 digital output module, 4 outputs, 100 to 240 VAC, 0.5 A, source, 240 V keyed, 2-wire connections | 1699 |
| X20DO4633 | X20 digital output module, 4 triac outputs, 48 to 240 VAC, 1 A, L-switching, phase angle control, 240 V keyed | 1709 |
| X20DO4649 | X20 digital output module, 4 relays, N.O. contacts, 240 VAC / 5 A | 1726 |
| X20DO4F49 | X20 digital output module, 4 relays, 2x normally open contacts, 2x changeover contacts, 240 VAC / 2 A, 250 VDC / 0.28 A | 1732 |
| X20DO6321 | X20 digital output module, 6 outputs, 24 VDC, 0.5 A, sink, 2-wire connections | 1739 |
| X20DO6322 | X20 digital output module, 6 outputs, 24 VDC, 0.5 A, source, 2-wire connections | 1746 |
| X20DO6325 | X20 digital output module, 6 outputs, 24 VDC, 0.5 A, source, open line and overload detection, 2-wire connections | 1755 |
| X20DO6529 | X20 digital output module, 6 relays, normally open contacts, 115 VAC / 0.5 A, 30 VDC / 1 A | 1766 |
| X20DO6639 | X20 digital output module, 6 relays, normally open contacts, 240 VAC / 2 A, 30 VDC / 2 A | 1773 |
| X20DO8232 | X20 digital output module, 8 outputs, 12 VDC, 2 A, source, supply directly on module, 1-wire connections | 1779 |
| X20DO8322 | X20 digital output module, 8 outputs, 24 VDC, 0.5 A, source, 1-wire connections | 1791 |
| X20DO8323 | X20 digital output module, 8 outputs, 12 to 24 V, 0.5 A, sink/source, 1-wire connections, full bridge, half bridge, thermal overload protection | 1799 |
| X20DO8331 | X20 digital output module, 8 outputs, 24 VDC, 2 A, sink, supply directly on module, 1-wire connections | 1808 |
| X20DO8332 | X20 digital output module, 8 outputs, 24 VDC, 2 A, source, supply directly on module, 1-wire connections | 1820 |
| X20DO8332-1 | X20 digital output module, 8 outputs, 24 VDC, 2 A, source, optimized for inductive loads, power supply directly on module, 1-wire connections | 1832 |
| X20DO9321 | X20 digital output module, 12 outputs, 24 VDC, 0.5 A, sink, 1-wire connections | 1843 |
| X20DO9322 | X20 digital output module, 12 outputs, 24 VDC, 0.5 A, source, 1-wire connections | 1851 |
| X20DOD322 | X20 digital output module, 8 outputs, 24 VDC, 0.5 A, source, 2-wire connections | 1859 |
| X20DOF322 | X20 digital output module, 16 output, 24 VDC, 0.5 A, source, 1-wire connections | 1866 |
| X20DS1119 | X20 multifunction digital signal processor, 3 digital channels 5 V (symmetrical) configurable as inputs or outputs, 2 digital input channels 24 V (asymmetrical), max. 2 event counters, 1 universal counter pair as AB counter or up/down counter, linear movement generator (A/B, direction/frequency) with 1 reference pulse, 1 SSI absolute encoder, NetTime function | 1914 |
| X20DS1319 | X20 multifunction digital signal processor, 4 digital input channels, 4 digital channels configurable as inputs or outputs, 2 event counters 1 universal counter pair as AB counter or up/down counter, linear movement generator (A/B, direction/frequency) with max. 2 reference pulses, SSI absolute encoder, NetTime function | 1957 |
| X20RT8001 | X20 reACTION module, 4 digital inputs, 24 VDC, <1 μ s, 4 digital channels, 24 VDC, 0.1 A, <1 μ s, configurable as inputs or outputs, reACTION Technology module | 3448 |
| X20RT8201 | X20 reACTION module, 4 digital inputs, 24 VDC, <1 μ s, 4 digital channels, 24 VDC, 0.1 A, <1 μ s, configurable as inputs or outputs, 2 analog inputs ± 10 V, 500 kHz sampling frequency, 13-bit converter resolution including sign, configurable input filter, reACTION Technology module | 3477 |
| X20RT8202 | X20 reACTION module, 4 digital inputs, 24 VDC, <1 μ s, 4 digital channels, 24 VDC, 0.1 A, <1 μ s, configurable as inputs or outputs, 2 analog outputs ± 10 V, 2 μ s, 13-bit converter resolution including sign, reACTION Technology module | 3511 |
| X20RT8401 | X20 reACTION module, 4 digital inputs, 24 VDC, <1 μ s, 4 digital channels, 24 VDC, 0.1 A, <1 μ s, configurable as inputs or outputs, 1 analog input ± 10 V, 500 kHz sampling frequency, 13-bit converter resolution including sign, configurable input filter, 1 analog output ± 10 V, 2 μ s, 13-bit converter resolution including sign, reACTION Technology module | 3577 |

Digital inputs

| Order number | Short description | Page |
|--------------|--|------|
| X20CM1201 | X20 combination module, 1 AB incremental encoder, 24 V, 4 digital inputs 24 V, 4 channels 24 V configurable as inputs or outputs, flexible digital controller logic | 1875 |
| X20CM8281 | X20 universal mixed module, 4 digital inputs, 24 VDC, sink, 1-wire connections, 2 digital outputs, 0.5 A, source, 1-wire connections, 1 analog input, ± 10 V or 0 to 20 mA / 4 to 20 mA, 12-bit converter resolution, 1 analog output, ± 10 V / 0 to 20 mA, 12-bit converter resolution, 2 counters as event counters or gate measurement | 3178 |
| X20DI0471 | X20 digital input module, 10 inputs, 5-48 VDC, sink, configurable input filter, 1-wire connections | 1439 |
| X20DI2371 | X20 digital input module, 2 inputs, 24 VDC, sink, configurable input filter, 3-wire connections | 1446 |
| X20DI2372 | X20 digital input module, 2 inputs, 24 VDC, source, configurable input filter, 3-wire connections | 1452 |
| X20DI2377 | X20 digital input module, 2 inputs, 24 VDC, sink, configurable input filter, 2 event counters 50 kHz, 3-wire connections | 1458 |
| X20DI2653 | X20 digital input module, 2 inputs, 100 to 240 VAC, 240 V keyed, 3-wire connections | 1467 |
| X20DI4371 | X20 digital input module, 4 inputs, 24 VDC, sink, configurable input filter, 3-wire connections | 1473 |
| X20DI4372 | X20 digital input module, 4 inputs, 24 VDC, source, configurable input filter, 3-wire connections | 1480 |
| X20DI4375 | X20 digital input module, 4 inputs, 24 VDC, sink, configurable input filter, open-circuit and short-circuit detection, 3-wire connections | 1486 |
| X20DI4653 | X20 digital input module, 4 inputs, 100 to 240 VAC, 240 V keyed, 2-wire connections | 1499 |
| X20DI4760 | X20 digital input module, 4 NAMUR inputs, 8.05 V | 1505 |
| X20DI6371 | X20 digital input module, 6 inputs, 24 VDC, sink, configurable input filter, 2-wire connections | 1514 |
| X20DI6372 | X20 digital input module, 6 inputs, 24 VDC, source, configurable input filter, 2-wire connections | 1520 |
| X20DI6373 | X20 digital input module, 6 inputs, 24 VDC, sink/source, all inputs floating, configurable input filter, 2-wire connections | 1526 |
| X20DI6553 | X20 digital input module, 6 inputs, 100 to 120 VAC, 240 V keyed, 1-wire connections | 1532 |
| X20DI8371 | X20 digital input module, 8 inputs, 24 VDC, sink, configurable input filter, 1-wire connections | 1538 |
| X20DI9371 | X20 digital input module, 12 inputs, 24 VDC, sink, configurable input filter, 1-wire connections | 1544 |
| X20DI9372 | X20 digital input module, 12 inputs, 24 VDC, source, configurable input filter, 1-wire connections | 1551 |
| X20DID371 | X20 digital input module, 8 inputs, 24 VDC, sink, configurable input filter, 2-wire connections | 1558 |
| X20DIF371 | X20 digital input module, 16 inputs, 24 VDC, sink, configurable input filter, 1-wire connections | 1564 |
| X20DM9324 | X20 digital mixed module, 8 inputs, 24 VDC, sink, configurable input filter, 4 outputs, 24 VDC, 0.5 A, source 1-wire connections | 1572 |
| X20DS1119 | X20 multifunction digital signal processor, 3 digital channels 5 V (symmetrical) configurable as inputs or outputs, 2 digital input channels 24 V (asymmetrical), max. 2 event counters, 1 universal counter pair as AB counter or up/down counter, linear movement generator (A/B, direction/frequency) with 1 reference pulse, 1 SSI absolute encoder, NetTime function | 1914 |
| X20DS1319 | X20 multifunction digital signal processor, 4 digital input channels, 4 digital channels configurable as inputs or outputs, 2 event counters 1 universal counter pair as AB counter or up/down counter, linear movement generator (A/B, direction/frequency) with max. 2 reference pulses, SSI absolute encoder, NetTime function | 1957 |
| X20RT8001 | X20 reACTION module, 4 digital inputs, 24 VDC, < 1 μ s, 4 digital channels, 24 VDC, 0.1 A, < 1 μ s, configurable as inputs or outputs, reACTION Technology module | 3448 |
| X20RT8201 | X20 reACTION module, 4 digital inputs, 24 VDC, < 1 μ s, 4 digital channels, 24 VDC, 0.1 A, < 1 μ s, configurable as inputs or outputs, 2 analog inputs ± 10 V, 500 kHz sampling frequency, 13-bit converter resolution including sign, configurable input filter, reACTION Technology module | 3477 |
| X20RT8202 | X20 reACTION module, 4 digital inputs, 24 VDC, < 1 μ s, 4 digital channels, 24 VDC, 0.1 A, < 1 μ s, configurable as inputs or outputs, 2 analog outputs ± 10 V, 2 μ s, 13-bit converter resolution including sign, reACTION Technology module | 3511 |
| X20RT8401 | X20 reACTION module, 4 digital inputs, 24 VDC, < 1 μ s, 4 digital channels, 24 VDC, 0.1 A, < 1 μ s, configurable as inputs or outputs, 1 analog input ± 10 V, 500 kHz sampling frequency, 13-bit converter resolution including sign, configurable input filter, 1 analog output ± 10 V, 2 μ s, 13-bit converter resolution including sign, reACTION Technology module | 3577 |

Digital inputs and outputs

| Order number | Short description | Page |
|--------------|--|------|
| X20CM1201 | X20 combination module, 1 AB incremental encoder, 24 V, 4 digital inputs 24 V, 4 channels 24 V configurable as inputs or outputs, flexible digital controller logic | 1875 |
| X20CM8281 | X20 universal mixed module, 4 digital inputs, 24 VDC, sink, 1-wire connections, 2 digital outputs, 0.5 A, source, 1-wire connections, 1 analog input, ± 10 V or 0 to 20 mA / 4 to 20 mA, 12-bit converter resolution, 1 analog output, ± 10 V / 0 to 20 mA, 12-bit converter resolution, 2 counters as event counters or gate measurement | 3178 |
| X20DM9324 | X20 digital mixed module, 8 inputs, 24 VDC, sink, configurable input filter, 4 outputs, 24 VDC, 0.5 A, source 1-wire connections | 1572 |
| X20RT8001 | X20 reACTION module, 4 digital inputs, 24 VDC, < 1 μ s, 4 digital channels, 24 VDC, 0.1 A, < 1 μ s, configurable as inputs or outputs, reACTION Technology module | 3448 |
| X20RT8201 | X20 reACTION module, 4 digital inputs, 24 VDC, < 1 μ s, 4 digital channels, 24 VDC, 0.1 A, < 1 μ s, configurable as inputs or outputs, 2 analog inputs ± 10 V, 500 kHz sampling frequency, 13-bit converter resolution including sign, configurable input filter, reACTION Technology module | 3477 |
| X20RT8202 | X20 reACTION module, 4 digital inputs, 24 VDC, < 1 μ s, 4 digital channels, 24 VDC, 0.1 A, < 1 μ s, configurable as inputs or outputs, 2 analog outputs ± 10 V, 2 μ s, 13-bit converter resolution including sign, reACTION Technology module | 3511 |
| X20RT8401 | X20 reACTION module, 4 digital inputs, 24 VDC, < 1 μ s, 4 digital channels, 24 VDC, 0.1 A, < 1 μ s, configurable as inputs or outputs, 1 analog input ± 10 V, 500 kHz sampling frequency, 13-bit converter resolution including sign, configurable input filter, 1 analog output ± 10 V, 2 μ s, 13-bit converter resolution including sign, reACTION Technology module | 3577 |

Digital signal processing and preparation

| Order number | Short description | Page |
|--------------|---|------|
| X20CM1201 | X20 combination module, 1 AB incremental encoder, 24 V, 4 digital inputs 24 V, 4 channels 24 V configurable as inputs or outputs, flexible digital controller logic | 1875 |
| X20DC1073 | X20 digital counter module, 1x SinCos, 1 Vss, 400 kHz input frequency, encoder monitoring, NetTime function | 1899 |
| X20DS1119 | X20 multifunction digital signal processor, 3 digital channels 5 V (symmetrical) configurable as inputs or outputs, 2 digital input channels 24 V (asymmetrical), max. 2 event counters, 1 universal counter pair as AB counter or up/down counter, linear movement generator (A/B, direction/frequency) with 1 reference pulse, 1 SSI absolute encoder, NetTime function | 1914 |
| X20DS1319 | X20 multifunction digital signal processor, 4 digital input channels, 4 digital channels configurable as inputs or outputs, 2 event counters 1 universal counter pair as AB counter or up/down counter, linear movement generator (A/B, direction/frequency) with max. 2 reference pulses, SSI absolute encoder, NetTime function | 1957 |
| X20DS1828 | X20 digital signal module, 1 HIPERFACE interface, NetTime function | 1999 |
| X20DS1928 | X20 digital signal module, 1 EnDat 2.1/2.2 interface, NetTime function | 2031 |
| X20DS4389 | X20 digital signal module, 4 digital inputs, 24 VDC, 4 digital outputs, 24 VDC, 0.1 A, oversampling I/O functions, time-triggered I/O functions, NetTime function | 2056 |

Power supply modules

| Order number | Short description | Page |
|--------------|---|------|
| X20PS2100 | X20 power supply module, for internal I/O supply | 3356 |
| X20PS2110 | X20 power supply module, for internal I/O power supply, integrated microfuse | 3361 |
| X20PS3300 | X20 power supply module, for X2X Link and internal I/O power supply | 3367 |
| X20PS3310 | X20 power supply module, for X2X Link and internal I/O power supply, integrated microfuse | 3373 |

Expandable bus controllers

| Order number | Short description | Page |
|--------------|--|------|
| X20BC1083 | X20 bus controller, 1 POWERLINK interface, integrated 2-port hub, supports X20 interface module expansions, 2 RJ45, order bus base, power supply module and terminal block separately | 2213 |
| X20BC8083 | X20 bus controller, 1 POWERLINK interface, integrated 2-port hub, supports expansion with X20 hub modules, 2 RJ45, order bus base, power supply module and terminal block separately. | 2220 |
| X20BC8084 | X20 bus controller, 1 POWERLINK interface, 1x link selector for POWERLINK cable redundancy, supports expansion with enabled X20 hub modules, 2x RJ45, order bus base, power supply module and terminal block separately! | 2227 |

Terminal blocks

| Order number | Short description | Page |
|--------------|--|------|
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | 3775 |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | 3775 |
| X20TB1E | X20 terminal block, 12-pin, 24 VDC keyed, 2x PT1000 integrated for terminal temperature compensation | 3778 |
| X20TB1F | X20 terminal block, 16-pin, 24 VDC keyed | 3781 |
| X20TB32 | X20 terminal block, 12-pin, 240 VAC keyed | 3784 |

Hub system

| Order number | Short description | Page |
|--------------|--|------|
| X20ET8819 | X20 Ethernet analysis tool, can be expanded with active hub modules, 2x RJ45 | 2468 |
| X20HB8815 | X20 POWERLINK - TCP/IP gateway, can be expanded with active hub modules, 2x RJ45 | 2480 |
| X20HB8880 | X20 base hub module, integrated 2-port hub, 2x RJ45 | 2490 |

Communication in the X20 electronics module

| Order number | Short description | Page |
|--------------|---|------|
| X20CS1011 | X20 interface module, 1 Moeller SmartWire interface | 2101 |
| X20CS1012 | X20 interface module, 1 M-Bus master interface, integrated slave supply | 2116 |
| X20CS1013 | X20 interface module, 1 DALI master interface | 2136 |
| X20CS1020 | X20 interface module, 1 RS232 interface, max. 115.2 kbit/s | 2147 |
| X20CS1030 | X20 interface module, 1 RS422/485 interface, max. 115.2 kbit/s | 2162 |
| X20CS1070 | X20 interface module, 1 CAN bus interface, max. 1 Mbit/s, object buffers in both send and receive directions | 2177 |
| X20CS2770 | X20 interface module, 2 CAN bus interfaces, max. 1 Mbit/s, object buffers in both send and receive directions | 2194 |

Communication in the X20 interface module

| Order number | Short description | Page |
|--------------|---|------|
| X20IF1020 | X20 interface module, 1 RS232 interface, max. 115.2 kbit/s, electrically isolated | 2268 |
| X20IF1030 | X20 interface module, 1 RS422/485 interface, max. 115.2 kbit/s, electrically isolated | 2271 |
| X20IF1041-1 | X20 interface module, for DTM configuration, 1 CANOpen master interface, electrically isolated, order 1x TB2105 terminal block separately | 2274 |
| X20IF1043-1 | X20 interface module, for DTM configuration, 1 CANOpen slave interface, electrically isolated, order 1x TB2105 terminal block separately | 2288 |
| X20IF1051-1 | X20 interface module, for DTM configuration, 1 DeviceNet scanner (master) interface, electrically isolated, order 1x terminal block TB2105 separately! | 2302 |
| X20IF1053-1 | X20 interface module, for DTM configuration, 1 DeviceNet adapter (slave) interface, electrically isolated, order 1x terminal block TB2105 separately! | 2315 |
| X20IF1061-1 | X20 interface module for DTM configuration, 1 PROFIBUS DP V0/V1 master interface, electrically isolated | 2328 |
| X20IF1063 | X20 interface module, 1 PROFIBUS DP V0 slave interface, max. 12 Mbit/s, electrically isolated | 2339 |
| X20IF1063-1 | X20 interface module, for DTM configuration, 1 PROFIBUS DP V1 slave interface, electrically isolated | 2342 |
| X20IF1072 | X20 interface module, 1 CAN bus interface, max. 1 Mbit/s, electrically isolated, order 1x TB2105 terminal block separately | 2353 |
| X20IF1082 | X20 interface module, 1 POWERLINK interface, managing or controlled node, integrated 2-port hub, ring redundancy function | 2357 |
| X20IF1082-2 | X20 interface module, 1 POWERLINK interface, managing or controlled node, integrated 2-port hub, ring redundancy function PRC function | 2363 |
| X20IF1086-2 | X20 interface module, 1 POWERLINK interface, managing or controlled node, PRC function, 1 fiber optic connection | 2369 |
| X20IF1091 | X20 interface module, 1 X2X Link master interface, electrically isolated, order 1x TB704 terminal block separately | 2375 |
| X20IF10A1-1 | X20 interface module, for DTM configuration, 1 ASi master interface, electrically isolated, order 1x terminal block TB704 separately! | 2378 |
| X20IF10D1-1 | X20 interface module, for DTM configuration, 1 EtherNet/IP scanner (master) interface, electrically isolated | 2392 |
| X20IF10D3-1 | X20 interface module, for DTM configuration, 1 EtherNet/IP adapter (slave) interface, electrically isolated | 2402 |
| X20IF10E1-1 | X20 interface module, for DTM configuration, 1 PROFINET IO controller (master) interface, electrically isolated | 2413 |
| X20IF10E3-1 | X20 interface module, for DTM configuration, 1 PROFINET IO device (slave) interface module, electrically isolated | 2424 |
| X20IF10G3-1 | X20 interface module for DTM configuration, 1 EtherCAT slave interface, electrically isolated | 2434 |
| X20IF10X0 | X20 interface module, 1 redundancy link interface 1000BASE-SX, CPU-CPU data synchronization module for controller redundancy | 2447 |
| X20IF2181-2 | X20 interface module, 1x link selector for POWERLINK cable redundancy, POWERLINK functions: - Managing node - Controlled node for iCN operation - Redundant managing node for controller redundancy - Ring redundancy - 2x hub - Multi ASend - PRC function 2x RJ45 | 2452 |
| X20IF2772 | X20 interface module, 2 CAN bus interfaces, max. 1 Mbit/s, electrically isolated, order 2x TB2105 terminal block separately | 2458 |
| X20IF2792 | X20 interface module, 1 CAN bus interface, max. 1 Mbit/s, electrically isolated, 1 X2X Link master interface, electrically isolated, order 1x terminal block TB2105 and 1x terminal block TB704 separately! | 2462 |

Motor controllers

| Order number | Short description | Page |
|--------------|---|------|
| X20MM2436 | X20 PWM motor module, 24 to 39 VDC $\pm 25\%$, 2 PWM motor bridges, 3 A continuous current, 3.5 A peak current, 4 digital inputs 24 VDC, sink, configurable as incremental encoder | 2496 |
| X20MM3332 | X20 digital motor module, 24 VDC, 3 digital outputs, full bridge (H bridge), 3 A continuous current, 5 A peak current | 2523 |
| X20MM4331 | X20 digital motor module, 24 VDC, 4 digital outputs, half bridge, 3 A continuous current, 5 A peak current | 2538 |
| X20MM4455 | X20 PWM motor module, 24 to 48 VDC $\pm 25\%$, 4 PWM motor bridges, 6 A continuous current, 10 A peak current, 4x 3 digital inputs 5 VDC single-ended, source, configurable as incremental encoder | 2551 |
| X20MM4456 | X20 PWM motor module, 24 to 48 VDC $\pm 25\%$, 4 PWM motor bridges, 6 A continuous current, 10 A peak current, 4x 4 digital inputs 24 VDC, sink, configurable as incremental encoder | 2577 |
| X20SM1426 | X20 stepper motor module, 1 motor connection, 1 A continuous current, 1.2 A peak current, 4 digital inputs 24 VDC, sink, configurable as incremental encoder, NetTime function | 2603 |
| X20SM1436 | X20 stepper motor module, module power supply 24 to 39 VDC $\pm 25\%$, 1 motor connection, 3 A continuous current, 3.5 A peak current, 4 digital inputs 24 VDC, sink, configurable as incremental encoder, NetTime function | 2652 |
| X20SM1436-1 | X20 stepper motor module, with current reduction function, module power supply 24 to 48 VDC $\pm 25\%$, 1 motor connection, 2.5 A continuous current, 3.5 A peak current, 4 digital inputs 24 VDC, sink, configurable as incremental encoder, NetTime function | 2700 |
| X20SM1446-1 | X20 stepper motor module, module power supply 24 to 48 VDC $\pm 25\%$, with current reduction function, 1 motor connection, 5 A continuous current, 10 A peak current, 4 digital inputs 24 VDC, sink, configurable as incremental encoder, NetTime function, double-width module | 2751 |

reACTION I/O modules

| Order number | Short description | Page |
|--------------|---|------|
| X20RT8001 | X20 reACTION module, 4 digital inputs, 24 VDC, $<1 \mu\text{s}$, 4 digital channels, 24 VDC, 0.1 A, $<1 \mu\text{s}$, configurable as inputs or outputs, reACTION Technology module | 3448 |
| X20RT8201 | X20 reACTION module, 4 digital inputs, 24 VDC, $<1 \mu\text{s}$, 4 digital channels, 24 VDC, 0.1 A, $<1 \mu\text{s}$, configurable as inputs or outputs, 2 analog inputs $\pm 10 \text{ V}$, 500 kHz sampling frequency, 13-bit converter resolution including sign, configurable input filter, reACTION Technology module | 3477 |
| X20RT8202 | X20 reACTION module, 4 digital inputs, 24 VDC, $<1 \mu\text{s}$, 4 digital channels, 24 VDC, 0.1 A, $<1 \mu\text{s}$, configurable as inputs or outputs, 2 analog outputs $\pm 10 \text{ V}$, 2 μs , 13-bit converter resolution including sign, reACTION Technology module | 3511 |
| X20RT8381 | X20 reACTION module, real computing function, 4 digital inputs, 24 VDC, $<1 \mu\text{s}$, 4 digital channels, 24 VDC, 0.1 A, $<1 \mu\text{s}$, configurable as inputs or outputs, 2 analog inputs $\pm 10 \text{ V}$, 500 kHz sampling frequency, 13-bit converter resolution including sign, configurable input filter, 1 analog output $\pm 10 \text{ V}$, 2 μs , 13-bit converter resolution including sign, reACTION Technology module | 3543 |
| X20RT8401 | X20 reACTION module, 4 digital inputs, 24 VDC, $<1 \mu\text{s}$, 4 digital channels, 24 VDC, 0.1 A, $<1 \mu\text{s}$, configurable as inputs or outputs, 1 analog input $\pm 10 \text{ V}$, 500 kHz sampling frequency, 13-bit converter resolution including sign, configurable input filter, 1 analog output $\pm 10 \text{ V}$, 2 μs , 13-bit converter resolution including sign, reACTION Technology module | 3577 |

Redundancy system

| Order number | Short description | Page |
|--------------|--|------|
| X20HB8884 | X20 compact link selector, 2x RJ45, order bus base, power supply module and terminal block separately. | 3614 |

Other functions

| Order number | Short description | Page |
|--------------|--|------|
| X20CM0985 | X20 digital and analog mixed module, multi-measurement transducer/ synchronization module, 5 digital outputs, 24 VDC, 0.5 A source, 1 relay, 1 A, changeover contact, 8 analog inputs, $\pm 480\text{ V} / 120\text{ V}$, 16-bit converter resolution, 3 analog inputs 5 A / 1 A AC, 16-bit converter resolution, order terminal blocks 0TB3102-7011, 0TB3104-7011, 0TB3102-7012, 0TB3104-7012 and 2x TB12 separately. | 2803 |
| X20CM0985-02 | X20 digital and analog mixed module, multi-measurement transducer / synchronization module, 5 digital outputs, 24 VDC, 0.5 A, source, 1 relay, 1 A, 8 analog inputs, $\pm 480\text{ V} / 120\text{ V}$, 16-bit converter resolution, 3 analog inputs, 5 A / 1 A AC, 16-bit converter resolution, additional software functionalities, adapted to VDE guidelines (2018), order terminal blocks 0TB3102-7011, 0TB3104-7011, 0TB3102-7012, 0TB3104-7012 and 2x X20TB12 separately! | 2846 |
| X20CM0985-1 | X20 digital and analog mixed module, multi-measurement transducer / synchronization module, 5 digital outputs, 24 VDC, 0.5 A, source, 1 relay, 1 A, 8 analog inputs, $\pm 480\text{ V} / 120\text{ V}$, 16-bit converter resolution, 3 analog inputs, 5 A / 1 A AC, 16-bit converter resolution, additional software functionalities, order terminal blocks 0TB3102-7011, 0TB3104-7011, 0TB3102-7012, 0TB3104-7012 and 2x X20TB12 separately! | 2921 |
| X20CM4323 | X20 PWM module, 4 digital outputs for switching electromechanical loads, 24 VDC, oversampling output functions, time-triggered output functions, NetTime function | 2992 |
| X20CM4800X | X20 analog input module, vibration measurement, 4 IEPE analog inputs, 50 kHz sampling frequency, 24-bit converter resolution | 3021 |
| X20CM4810 | X20 analog input module, for vibration measurement and analysis of condition monitoring tasks, 4 IEPE analog inputs, 51.5625 kHz sampling frequency, 24-bit converter resolution | 3039 |
| X20CM6209 | X20 diode array module, 1 A, 40 V reverse voltage, no module status data | 3174 |
| X20CM8281 | X20 universal mixed module, 4 digital inputs, 24 VDC, sink, 1-wire connections, 2 digital outputs, 0.5 A, source, 1-wire connections, 1 analog input, $\pm 10\text{ V}$ or 0 to 20 mA / 4 to 20 mA, 12-bit converter resolution, 1 analog output, $\pm 10\text{ V} / 0$ to 20 mA, 12-bit converter resolution, 2 counters as event counters or gate measurement | 3178 |
| X20CM8323 | X20 PWM module, 8 digital outputs for switching electromechanical loads, 0.6 A continuous current, 2 A peak current, current monitoring, switching time detection | 3197 |
| X20CMR010 | X20 cabinet monitoring module, integrated temperature and humidity sensor, production data acquisition, 512 kB flash memory for user data | 3216 |
| X20CMR100 | X20 cabinet monitoring module, integrated temperature and humidity sensor, production data acquisition, integrated Technology Guard | 3230 |
| X20CMR111 | X20 cabinet monitoring module, integrated temperature sensor, moisture sensor and accelerometer, production data acquisition, 2 inputs for external PT1000, 2 digital inputs 24 V, 1 digital output 24 V, 0.5 A, 512 kB flash memory for user data, integrated Technology Guard | 3242 |
| X20DS4387 | X20 digital signal module, 4x IO-Link master, 4 digital channels configurable as inputs or outputs, 3-wire connections | 3269 |
| X20DS438A | X20 digital signal module, 4x IO-Link master V1.1, 4 digital channels configurable as inputs or outputs, 3-wire connections, Net-Time function | 3287 |
| X20PD0011 | X20 potential distributor module, 12x GND, integrated microfuse | 3327 |
| X20PD0012 | X20 potential distributor module, 12x 24 VDC, integrated microfuse | 3332 |
| X20PD0016 | X20 potential distributor module, 5x GND, 5x 24 VDC, each with 1x floating feed, integrated microfuse | 3337 |
| X20PD2113 | X20 potential distributor module, 6x GND, 6x 24 VDC, with feed option, integrated microfuse | 3343 |
| X20PS4951 | X20 power supply module, for potentiometers, 4x $\pm 10\text{ V}$ for potentiometer supply | 3349 |

System modules for bus controllers

| Order number | Short description | Page |
|--------------|--|------|
| X20BB80 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | 922 |
| X20PS9400 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply | 926 |
| X20PS9402 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply, supply not electrically isolated | 932 |

System modules for Compact CPUs

| Order number | Short description | Page |
|--------------|--|------|
| X20BB22 | X20 compact CPU base, for compact CPU and compact CPU power supply module, base for integrated RS232 interface, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 1001 |
| X20BB27 | X20 compact CPU base, for compact CPU and compact CPU power supply module, base for integrated RS232 and CAN bus interface, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 1003 |
| X20PS9500 | X20 power supply module for Compact and Fieldbus CPUs and internal I/O power supply, X2X Link power supply | 1006 |
| X20PS9502 | X20 power supply module, for Compact and Fieldbus CPUs and internal I/O power supply, X2X Link power supply, supply not electrically isolated | 1012 |

System modules for Compact-S CPUs

| Order number | Short description | Page |
|--------------|---|------|
| X20BB52 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 interface, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 1035 |
| X20BB57 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 and CAN bus interface, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 1037 |
| X20BB62 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 interface, slots for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 1039 |
| X20BB67 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 and CAN bus interface, slot for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 1041 |
| X20BB72 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 interface, 2 slots for X20 interface modules, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 1043 |
| X20BB77 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 and CAN bus interface, 2 slots for X20 interface modules, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 1045 |
| X20PS9600 | X20 power supply module, for Compact-S CPU and internal I/O power supply, X2X Link power supply | 1047 |
| X20PS9602 | X20 power supply module, for Compact-S CPU and internal I/O power supply, X2X Link power supply, power supply not electrically isolated | 1055 |

System modules for expandable bus controllers

| Order number | Short description | Page |
|--------------|---|------|
| X20BB81 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with one expansion slot for an X20 add-on module (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 2234 |
| X20BB82 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with 2 expansion slots for 2 X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 2237 |
| X20HB1881 | X20 hub expansion module, integrated 1-port hub, for multimode fiber optic cable | 3619 |
| X20HB1882 | X20 hub expansion module, integrated 1-port hub, for monomode fiber optic cables | 3623 |
| X20HB2880 | X20 hub expansion module, integrated 2-port hub, 2x RJ45 | 3627 |
| X20HB2881 | X20 hub expansion module, integrated 2-port hub, for fiber optic cable | 3632 |
| X20HB2885 | X20 hub expansion module, integrated active 2-port hub, 2x RJ45 | 3641 |
| X20HB2886 | X20 hub expansion module, integrated active 2-port hub, 2 fiber optic interfaces | 3644 |
| X20IF1041-1 | X20 interface module, for DTM configuration, 1 CANopen master interface, electrically isolated, order 1x TB2105 terminal block separately | 2274 |
| X20IF1043-1 | X20 interface module, for DTM configuration, 1 CANopen slave interface, electrically isolated, order 1x TB2105 terminal block separately | 2288 |
| X20IF1051-1 | X20 interface module, for DTM configuration, 1 DeviceNet scanner (master) interface, electrically isolated, order 1x terminal block TB2105 separately! | 2302 |
| X20IF1053-1 | X20 interface module, for DTM configuration, 1 DeviceNet adapter (slave) interface, electrically isolated, order 1x terminal block TB2105 separately! | 2315 |
| X20IF1061-1 | X20 interface module for DTM configuration, 1 PROFIBUS DP V0/V1 master interface, electrically isolated | 2328 |
| X20IF1063-1 | X20 interface module, for DTM configuration, 1 PROFIBUS DP V1 slave interface, electrically isolated | 2342 |
| X20IF1091-1 | X20 interface module, for expandable bus controller, 1 X2X Link master interface, electrically isolated, order 1x TB704 terminal block separately | 2240 |
| X20IF10A1-1 | X20 interface module, for DTM configuration, 1 ASi master interface, electrically isolated, order 1x terminal block TB704 separately! | 2378 |
| X20IF10D1-1 | X20 interface module, for DTM configuration, 1 EtherNet/IP scanner (master) interface, electrically isolated | 2392 |
| X20IF10D3-1 | X20 interface module, for DTM configuration, 1 EtherNet/IP adapter (slave) interface, electrically isolated | 2402 |
| X20IF10E1-1 | X20 interface module, for DTM configuration, 1 PROFINET IO controller (master) interface, electrically isolated | 2413 |
| X20IF10E3-1 | X20 interface module, for DTM configuration, 1 PROFINET IO device (slave) interface module, electrically isolated | 2424 |
| X20IF10G3-1 | X20 interface module for DTM configuration, 1 EtherCAT slave interface, electrically isolated | 2434 |
| X20PS9400 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply | 926 |
| X20PS9402 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply, supply not electrically isolated | 932 |

System modules for Fieldbus CPUs

| Order number | Short description | Page |
|--------------|---|------|
| X20BB32 | X20 Fieldbus CPU base, for Fieldbus CPU and Compact CPU power supply module, base for integrated RS232 interface, slot for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 2253 |
| X20BB37 | X20 Fieldbus CPU base, for Fieldbus CPU and Compact CPU power supply module, base for integrated RS232 and CAN bus interface, slot for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 2255 |
| X20BB42 | X20 fieldbus CPU base, for fieldbus CPU and compact CPU power supply module, base for integrated RS232 interface, 2 slots for X20 interface modules, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 2258 |
| X20BB47 | X20 fieldbus CPU base, for fieldbus CPU and compact CPU power supply module, base for integrated RS232 and CAN bus interface, 2 slots for X20 interface modules, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 2260 |
| X20IF1074 | X20 interface module, for SGC, 1 CAN bus interface, max. 1 Mbit/s, electrically isolated, order 1x TB2105 terminal block separately | 2263 |
| X20PS9500 | X20 power supply module for Compact and Fieldbus CPUs and internal I/O power supply, X2X Link power supply | 1006 |
| X20PS9502 | X20 power supply module, for Compact and Fieldbus CPUs and internal I/O power supply, X2X Link power supply, supply not electrically isolated | 1012 |

System modules for hub system

| Order number | Short description | Page |
|--------------|---|------|
| X20BB80 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | 922 |
| X20BB81 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with one expansion slot for an X20 add-on module (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 2234 |
| X20BB82 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with 2 expansion slots for 2 X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 2237 |
| X20HB1881 | X20 hub expansion module, integrated 1-port hub, for multimode fiber optic cable | 3619 |
| X20HB1882 | X20 hub expansion module, integrated 1-port hub, for monomode fiber optic cables | 3623 |
| X20HB2880 | X20 hub expansion module, integrated 2-port hub, 2x RJ45 | 3627 |
| X20HB2881 | X20 hub expansion module, integrated 2-port hub, for fiber optic cable | 3632 |
| X20PS8002 | X20 power supply module for standalone hub and compact link selector | 3636 |
| X20PS9400 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply | 926 |
| X20PS9402 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply, supply not electrically isolated | 932 |

System modules for redundancy system

| Order number | Short description | Page |
|--------------|--|------|
| X20HB2885 | X20 hub expansion module, integrated active 2-port hub, 2x RJ45 | 3641 |
| X20HB2886 | X20 hub expansion module, integrated active 2-port hub, 2 fiber optic interfaces | 3644 |

Temperature measurement

| Order number | Short description | Page |
|--------------|--|------|
| X20AT2222 | X20 temperature input module, 2 inputs for resistance measurement, PT100, PT1000, resolution 0.1°C, 3-wire connections | 3649 |
| X20AT2311 | X20 temperature input module, 2 resistance measurement inputs, PT100, resolution 0.001°C, 4-wire connections | 3659 |
| X20AT2402 | X20 temperature input module, 2 thermocouple inputs, Type J, K, N, S, B, R, resolution 0.1°C | 3667 |
| X20AT4222 | X20 temperature input module, 4 inputs for resistance measurement, PT100, PT1000, resolution 0.1°C, 3-wire connections | 3679 |
| X20AT4232 | X20 temperature input module, 4 inputs for resistance measurement, NTC 10 kΩ, resolution 0.1°C, 2-wire connections | 3689 |
| X20AT6402 | X20 temperature input module, 6 thermocouple inputs, Type J, K, N, S, B, R, resolution 0.1°C | 3698 |
| X20ATA312 | X20 temperature input module, 2 resistance measurement inputs, PT100, resolution 0.01°C, 4-wire connections, NetTime function | 3710 |
| X20ATA492 | X20 temperature input module, 2 thermocouple inputs, type J, K, N, S, B, R, E, C, T, single-channel isolation, NetTime function, 2x PT1000 integrated in terminal block X20TB1E for temperature compensation, order terminal block separately. | 3723 |
| X20ATB312 | X20 temperature input module, 4 resistance measurement inputs, PT100, resolution 0.01°C, 4-wire connections, NetTime function | 3742 |
| X20ATC402 | X20 temperature input module, 6 thermocouple inputs, type J, K, N, S, B, R, E, C, T, NetTime function, 2x PT1000 integrated in terminal block X20TB1E for temperature compensation, order terminal block separately. | 3755 |

Counter functions

| Order number | Short description | Page |
|--------------|---|------|
| X20CM1201 | X20 combination module, 1 AB incremental encoder, 24 V, 4 digital inputs 24 V, 4 channels 24 V configurable as inputs or outputs, flexible digital controller logic | 1875 |
| X20CM1941 | X20 resolver module, 14-bit resolver input, converter up to 12-bit ABR output | 1063 |
| X20CM8281 | X20 universal mixed module, 4 digital inputs, 24 VDC, sink, 1-wire connections, 2 digital outputs, 0.5 A, source, 1-wire connections, 1 analog input, ± 10 V or 0 to 20 mA / 4 to 20 mA, 12-bit converter resolution, 1 analog output, ± 10 V / 0 to 20 mA, 12-bit converter resolution, 2 counters as event counters or gate measurement | 3178 |
| X20DC1073 | X20 digital counter module, 1x SinCos, 1 Vss, 400 kHz input frequency, encoder monitoring, NetTime function | 1899 |
| X20DC1176 | X20 digital counter module, 1 ABR incremental encoder, 5 V, 600 kHz input frequency, 4x evaluation, encoder monitoring, NetTime function | 1071 |
| X20DC1178 | X20 digital counter module, 1 SSI absolute encoder, 5 V, 1 Mbit/s, 32-bit, encoder monitoring, NetTime function | 1087 |
| X20DC1196 | X20 digital counter module, 1 ABR incremental encoders, 5 V, 600 kHz input frequency, 4x resolution | 1105 |
| X20DC1198 | X20 digital counter module, 1 SSI absolute encoder, 5 V, 1 Mbit/s, 32-bit | 1115 |
| X20DC11A6 | X20 digital counter module, 1 ABR incremental encoder, 5 V, 5 MHz input frequency, 4x evaluation, encoder monitoring, NetTime function | 1122 |
| X20DC1376 | X20 digital counter module, 1 ABR incremental encoder, 24 V, 100 kHz input frequency, 4x evaluation, encoder monitoring, NetTime function | 1137 |
| X20DC1396 | X20 digital counter module, 1 ABR incremental encoders, 24 V, 100 kHz input frequency, 4x evaluation | 1169 |
| X20DC137A | X20 digital counter module, 1 ABR incremental encoder, 24 V (differential), 300 kHz input frequency, 4x evaluation, encoder monitoring, NetTime function | 1153 |
| X20DC1398 | X20 digital counter module, 1 SSI absolute encoder, 24 V, 125 kbit/s, 32-bit | 1179 |
| X20DC1976 | X20 digital counter module, 1 ABR incremental encoder, 5 V (single-ended), 250 kHz input frequency, 4x evaluation, encoder monitoring, NetTime function | 1186 |
| X20DC2190 | X20 digital counter module, ultrasonic transducer module, interfaces: EP start/stop, DPI/IP, 2 transducer rods, 4-position detection | 1202 |
| X20DC2395 | X20 digital counter module, 1 SSI absolute encoder, 24 V, 1 ABR incremental encoder, 24 V, 2 AB incremental encoders, 24 V, 4 event counters or 2 PWM, local time measurement function | 1216 |
| X20DC2396 | X20 digital counter module, 2 ABR incremental encoders, 24 V, 100 kHz input frequency, 4x evaluation | 1256 |
| X20DC2398 | X20 digital counter module, 2 SSI absolute encoder, 24 V, 125 kbit/s, 32-bit | 1267 |
| X20DC4395 | X20 digital counter module, 2 SSI absolute encoders, 24 V, 2 ABR incremental encoders, 24 V, 4 AB incremental encoders, 24 V, 8 event counters or 4 PWM, local time measurement functions | 1275 |
| X20DS1119 | X20 multifunction digital signal processor, 3 digital channels 5 V (symmetrical) configurable as inputs or outputs, 2 digital input channels 24 V (asymmetrical), max. 2 event counters, 1 universal counter pair as AB counter or up/down counter, linear movement generator (A/B, direction/frequency) with 1 reference pulse, 1 SSI absolute encoder, NetTime function | 1914 |

6.2 Coated modules

6.2.1 Module overview: Alphabetically

| Order number | Short description | Page |
|---------------|---|------|
| X20cAI1744 | X20 analog input module, coated, 1 full-bridge strain gauge input, 24-bit converter resolution, 5 kHz input filter | 196 |
| X20cAI1744-3 | X20 analog input module, coated, 1 full-bridge strain gauge input, 24-bit converter resolution, 5 Hz input filter | 243 |
| X20cAI2438 | X20 analog input module, coated, 2 inputs, 4 to 20 mA, 16-bit converter resolution, single-channel isolation with separate sensor power supply, supports the HART protocol, NetTime function | 373 |
| X20cAI4622 | X20 analog input module, coated, 4 inputs, ± 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution, configurable input filter | 509 |
| X20cAI4632 | X20 analog input module, coated, 4 inputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, configurable input filter, oscilloscope functions | 520 |
| X20cAI4632-1 | X20 analog input module, coated, 4 inputs, ± 11 V or 0 to 22 mA, 16-bit converter resolution, configurable input filter, oscilloscope functions | 545 |
| X20cAO2437 | X20 analog output module, coated, 2 outputs, 4 to 20 mA / 0 to 20 mA or 0 to 24 mA, 16-bit converter resolution, single channel electrically isolated | 735 |
| X20cAO2438 | X20 analog output module, coated, 2 outputs, 4 to 20 mA / 0 to 20 mA or 0 to 24 mA, 16-bit converter resolution, single-channel isolation, supports the HART protocol, NetTime function | 748 |
| X20cAO4622 | X20 analog output module, coated, 4 outputs, ± 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution | 796 |
| X20cAO4632 | X20 analog output module, coated, 4 outputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, NetTime function | 805 |
| X20cAO4632-1 | X20 analog output module, coated, 4 outputs, ± 11 V or 0 to 22 mA, 16-bit converter resolution, NetTime function | 815 |
| X20cAP3121 | X20 energy metering module, coated, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 1 A AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20cAP3131 | X20 energy metering module, coated, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 5 A AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20cAT2311 | X20 temperature input module, coated, 2 resistance measurement inputs, PT100, resolution 0.001°C, 4-wire connections | 3659 |
| X20cAT4222 | X20 temperature input module, coated, 4 inputs for resistance measurement, PT100, PT1000, resolution 0.1°C, 3-wire connections | 3679 |
| X20cAT6402 | X20 temperature input module, coated, 6 thermocouple inputs, Type J, K, N, S, B, R, resolution 0.1°C | 3698 |
| X20cBB80 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | 922 |
| X20cBB81 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with one expansion slot for an X20 add-on module (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 2234 |
| X20cBB82 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with two expansion slots for two X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 2237 |
| X20cBC0083 | X20 bus controller, coated, 1 POWERLINK interface, integrated 2-port hub, 2x RJ45, order bus base, power supply module and terminal block separately! | 859 |
| X20cBC0087 | X20 bus controller, coated, Modbus/TCP or Modbus/UDP interface, integrated 2-port switch, 2x RJ45, order bus base, power supply module and terminal block separately | 864 |
| X20cBC0088 | X20 bus controller, coated, 1 EtherNet/IP interface, integrated switch, web interface, 2x RJ45, order bus base, power supply module and terminal block separately! | 877 |
| X20cBC00E3 | X20 bus controller, coated, 1 PROFINET IO interface, integrated 2-port switch, 2x RJ45, order bus base, power supply module and terminal block separately! | 904 |
| X20cBC1083 | X20 bus controller, coated, 1 POWERLINK interface, integrated 2-port hub, supports X20 interface module expansions, 2 RJ45, order bus base, power supply module and terminal block separately | 2213 |
| X20cBC8083 | X20 bus controller, coated, 1 POWERLINK interface, integrated 2-port hub, supports X20 hub module expansions, 2 RJ45, order bus base, power supply module and terminal block separately | 2220 |
| X20cBC8084 | X20 bus controller, coated, 1 POWERLINK interface, 1x link selector for POWERLINK cable redundancy, supports expansion with active X20 hub modules, 2x RJ45, order bus base, power supply module and terminal block separately! | 2227 |
| X20cBM01 | X20 power supply bus module, coated, 24 VDC keyed, internal I/O supply interrupted to the left | 939 |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | 945 |
| X20cBM12 | X20 bus module, coated, 240 VAC keyed, internal I/O supply continuous | 948 |
| X20cBM31 | X20 bus module, coated, for double-width modules, 24 VDC keyed, internal I/O supply continuous | 956 |
| X20cBM32 | X20 bus module, coated, for double-width modules, 240 VAC keyed, internal I/O supply continuous | 959 |
| X20cBR9300 | X20 bus receiver, coated, X2X Link, supply for X2X Link and internal I/O power supply, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 973 |
| X20cBT9100 | X20 bus transmitter, coated, X2X Link, supply for internal I/O supply | 980 |
| X20cCM0985-1 | X20 digital and analog mixed module, coated, multi-measurement transducer / synchronization module, 5 digital outputs, 24 VDC, 0.5 A, source, 1 relay, 1 A, 8 analog inputs, ± 480 V / 120 V, 16-bit converter resolution, 3 analog inputs, 5 A / 1 A AC, 16-bit converter resolution, additional software functionalities, order terminal blocks 0TB3102-7011, 0TB3104-7011, 0TB3102-7012, 0TB3104-7012 and 2x X20TB12 separately! | 2921 |
| X20cCM4810 | X20 analog input module, coated, for vibration measurement and analysis of condition monitoring tasks, 4 IEPe analog inputs, 51.5625 kHz sampling frequency, 24-bit converter resolution | 3039 |
| X20cCP1301 | X20 CPU coated, with integrated I/O, x86-200, 128 MB DDR3 RAM, 16 kB FRAM, 1 GB onboard flash drive, 1 insert slot for X20 interface modules, 1 USB interface, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 μ s, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μ s, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs ± 10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included | 1324 |
| X20cCP1382-RT | X20 CPU, coated with integrated I/O, x86-400, 256 MB DDR3 RAM, 32 kB FRAM, 2 GB flash drive on board, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 CAN bus interface, 1 POWERLINK interface, 1 Ethernet interface 10/100 Base-T, reACTION Technology, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 μ s, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μ s, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs ± 10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, including supply module, 3x X20TB1F terminal blocks, slot cover and X20AC0SR1 end cover plate (right) included | 3382 |
| X20cCP1584 | X20 CPU, coated, Atom 0.6 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1397 |

| Order number | Short description | Page |
|--------------|---|------|
| X20cCP1586 | X20 CPU, coated, Atom 1.6 GHz, 512 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1397 |
| X20cCP3584 | X20 CPU, coated, ATOM 0.6 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000 Base-T, 1 POWERLINK interface, incl. supply module, 1 X20TB12 terminal block, slot covers and X20 end cover plate (right) X20AC0SR1 included, order application memory separately. | 1401 |
| X20cCP3586 | X20 CPU, coated, ATOM 1.6 GHz, 512 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000 Base-T, 1 POWERLINK interface, incl. supply module, 1 X20TB12 terminal block, slot covers and X20 end cover plate (right) X20AC0SR1 included, order application memory separately. | 1401 |
| X20cCS1020 | X20 interface module, coated, 1 RS232 interface, max. 115.2 kbit/s | 2147 |
| X20cCS1030 | X20 interface module, coated, 1 RS422/485 interface, max. 115.2 kbit/s | 2162 |
| X20cDC1196 | X20 digital counter module, coated, 1 ABR incremental encoder, 5 V, 600 kHz input frequency, 4x resolution | 1105 |
| X20cDC1198 | X20 digital counter module, coated, 1 SSI absolute encoders, 5 V, 1 Mbit/s, 32-bit | 1115 |
| X20cDC1396 | X20 digital counter module, coated, 1 ABR incremental encoders, 24 V, 100 kHz input frequency, 4x evaluation | 1169 |
| X20cDC2190 | X20 digital counter module, coated, ultrasonic transducer module, interfaces: EP start/stop, DPI/IP, 2 transducer rods, 4-position detection | 1202 |
| X20cDC2395 | X20 digital counter module, coated, 1 SSI absolute encoder, 24 V, 1 ABR incremental encoder, 24 V, 2 AB incremental encoders, 24 V, 4 event counters or 2 PWM, local time measurement function | 1216 |
| X20cDI4371 | X20 digital input module, coated, 4 inputs, 24 VDC, sink, configurable input filter, 3-wire connections | 1473 |
| X20cDI4375 | X20 digital input module, coated, 4 inputs, 24 VDC, sink, configurable input filter, open-circuit and short-circuit detection, 3-wire connections | 1486 |
| X20cDI4760 | X20 digital input module, coated, 4 NAMUR inputs, 8.05 V | 1505 |
| X20cDI6371 | X20 digital input module, coated, 6 inputs, 24 VDC, sink, configurable input filter, 2-wire connections | 1514 |
| X20cDI6372 | X20 digital input module, coated, 6 inputs, 24 VDC, source, configurable input filter, 2-wire connections | 1520 |
| X20cDI9371 | X20 digital input module, coated, 12 inputs, 24 VDC, sink, configurable input filter, 1-wire connections | 1544 |
| X20cDI9372 | X20 digital input module, coated, 12 inputs, 24 VDC, source, configurable input filter, 1-wire connections | 1551 |
| X20cDIF371 | X20 digital input module, coated, 16 inputs, 24 VDC, sink, configurable input filter, 1-wire connections | 1564 |
| X20cDM9324 | X20 digital mixed module, coated, 8 inputs, 24 VDC, sink, configurable input filter, 4 outputs, 24 VDC, 0.5 A, source, 1-wire connections | 1572 |
| X20cDO2633 | X20 digital output module, coated, 2 triac outputs, 48 to 240 VAC, 2 A, L switching, phase angle control, 240 V keyed | 1610 |
| X20cDO4322 | X20 digital output module, coated, 4 outputs, 24 VDC, 0.5 A, source, 3-wire connections | 1641 |
| X20cDO4332 | X20 digital output module, coated, 4 outputs, 24 VDC, 2 A, source, 3-wire connections | 1659 |
| X20cDO4633 | X20 digital output module, coated, 4 triac outputs, 48 to 240 VAC, 1 A, L switching, phase angle control, 240 V keyed | 1709 |
| X20cDO4649 | X20 digital output module, coated, 4 relays, N.O. contacts, 240 VAC / 5 A | 1726 |
| X20cDO6321 | X20 digital output module, coated, 6 outputs, 24 VDC, 0.5 A, sink, 2-wire connections | 1739 |
| X20cDO6322 | X20 digital output module, coated, 6 outputs, 24 VDC, 0.5 A, source, 2-wire connections | 1746 |
| X20cDO6529 | X20 digital output module, coated, 6 relays, normally open contacts, 115 VAC / 0.5 A, 30 VDC / 1 A | 1766 |
| X20cDO6639 | X20 digital output module, coated, 6 relays, normally open contacts, 240 VAC / 2 A, 30 VDC / 2 A | 1773 |
| X20cDO8331 | X20 digital output module, coated, 8 outputs, 24 VDC, 2 A, sink, supply directly on module, 1-wire connections | 1808 |
| X20cDO8332 | X20 digital output module, coated, 8 outputs, 24 VDC, 2 A, source, supply directly on module, 1-wire connections | 1820 |
| X20cDO9321 | X20 digital output module, coated, 12 outputs, 24 VDC, 0.5 A, sink, 1-wire connections | 1843 |
| X20cDO9322 | X20 digital output module, coated, 12 outputs, 24 VDC, 0.5 A, source, 1-wire connections | 1851 |
| X20cDOF322 | X20 digital output module, coated, 16 output, 24 VDC, 0.5 A, source, 1-wire connections | 1866 |
| X20cDS1119 | X20 multifunction digital signal processor, coated, 3 digital channels 5 V (symmetrical) configurable as inputs or outputs, 2 digital input channels 24 V (asymmetrical), max. 2 event counters, 1 universal counter pair as AB counter or up/down counter, linear movement generator (A/B, direction/frequency) with 1 reference pulse, 1 SSI absolute encoder, NetTime function | 1914 |
| X20cDS438A | X20 digital signal module, coated, 4x IO-Link master V1.1, 4 digital channels configurable as inputs or outputs, 3-wire connections, NetTime function | 3287 |
| X20cHB1881 | X20 hub expansion module, coated, integrated 1-port hub, for fiber optic cable | 3619 |
| X20cHB2880 | X20 hub expansion module, coated, integrated 2-port hub, 2x RJ45 | 3627 |
| X20cHB2881 | X20 hub expansion module, coated, integrated 2-port hub, for fiber optic cable | 3632 |
| X20cHB2885 | X20 hub expansion module, coated, integrated active 2-port hub, 2x RJ45 | 3641 |
| X20cHB2886 | X20 hub expansion module, coated, integrated active 2-port hub, 2 fiber optic interfaces | 3644 |
| X20cHB8815 | X20 POWERLINK - TCP/IP gateway, coated, can be expanded with active hub modules, 2x RJ45 | 2480 |
| X20cHB8880 | X20 base hub module, coated, integrated 2-port hub, 2x RJ45 | 2490 |
| X20cHB8884 | X20 compact link selector, coated, 2x RJ45, order bus base, power supply module and terminal block separately. | 3614 |
| X20clF1030 | X20 interface module, coated, 1 RS422/485 interface, max. 115.2 kbit/s, electrically isolated | 2271 |
| X20clF1041-1 | X20 interface module, coated, for DTM configuration, 1 CANopen master interface, electrically isolated, order 1x TB2105 terminal block separately | 2274 |
| X20clF1061-1 | X20 interface module coated, for DTM configuration, 1 PROFIBUS DP V0/V1 master interface, electrically isolated | 2328 |
| X20clF1063-1 | X20 interface module, coated, for DTM configuration, 1 PROFIBUS DP V1 slave interface, electrically isolated | 2342 |
| X20clF1072 | X20 interface module, coated, 1 CAN bus interface, max. 1 Mbit/s, electrically isolated, order 1x TB2105 terminal block separately | 2353 |
| X20clF1082-2 | X20 interface module, coated, 1 POWERLINK interface, managing or controlled node, integrated 2-port hub, ring redundancy function PRC function | 2363 |
| X20clF10D1-1 | X20 interface module, coated, for DTM configuration, 1 EtherNet/IP scanner (master) interface, electrically isolated | 2392 |
| X20clF10D3-1 | X20 interface module, coated, for DTM configuration, 1 EtherNet/IP adapter (slave) interface, electrically isolated | 2402 |
| X20clF10E3-1 | X20 interface module, coated, for DTM configuration, 1 PROFINET IO device (slave) interface module, electrically isolated | 2424 |
| X20clF10X0 | X20 interface module, coated, 1 redundancy link interface 1000 Base-FX, CPU-CPU data synchronization for controller redundancy | 2447 |
| X20clF2181-2 | X20 interface module, coated, 1x link selector for POWERLINK cable redundancy, POWERLINK functions: - Managing node - Controlled node for iCN operation - Redundant managing node for controller redundancy - Ring redundancy - 2x hub - Multi ASend - PRC function 2x RJ45 | 2452 |
| X20cMM2436 | Coated X20 PWM motor module, 24 to 39 VDC \pm 25%, 2 PWM motor bridges, 3 A continuous current, 3.5 A peak current, 4 digital inputs 24 VDC, sink, configurable as incremental encoder | 2496 |

Module overviews

| Order number | Short description | Page |
|----------------------------|--|----------------------|
| X20cPD2113 | X20 potential distributor, coated, 6x GND, 6x 24 VDC, with supply option, integrated microfuse | 3343 |
| X20cPS2100 | X20 power supply module, coated, for internal I/O supply | 3356 |
| X20cPS2110 | X20 power supply module, coated, for internal I/O power supply, integrated microfuse | 3361 |
| X20cPS3300 | X20 power supply module, coated, for X2X Link and internal I/O power supply | 3367 |
| X20cPS3310 | X20 power supply module, coated, for X2X Link and internal I/O power supply integrated microfuse | 3373 |
| X20cPS8002 | X20 power supply module, coated, for standalone hub and compact link selector | 3636 |
| X20cPS9400 | X20 power supply module, coated, for bus controller and internal I/O power supply, X2X Link power supply | 926 |

6.2.2 Module overview: Grouped

6.2.2.1 CPUs

Standard CPU

| Order number | Short description | Page |
|----------------------------|--|----------------------|
| X20cCP1301 | X20 CPU coated, with integrated I/O, x86-200, 128 MB DDR3 RAM, 16 kB FRAM, 1 GB onboard flash drive, 1 insert slot for X20 interface modules, 1 USB interface, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T, 14 digital inputs, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μ s, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs \pm 10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included | 1324 |
| X20cCP1584 | X20 CPU, coated, Atom 0.6 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1397 |
| X20cCP1586 | X20 CPU, coated, Atom 1.6 GHz, 512 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1397 |
| X20cCP3584 | X20 CPU, coated, ATOM 0.6 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000 Base-T, 1 POWERLINK interface, incl. supply module, 1 X20TB12 terminal block, slot covers and X20 end cover plate (right) X20AC0SR1 included, order application memory separately. | 1401 |
| X20cCP3586 | X20 CPU, coated, ATOM 1.6 GHz, 512 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000 Base-T, 1 POWERLINK interface, incl. supply module, 1 X20TB12 terminal block, slot covers and X20 end cover plate (right) X20AC0SR1 included, order application memory separately. | 1401 |

reACTION Technology CPU

| Order number | Short description | Page |
|-------------------------------|---|----------------------|
| X20cCP1382-RT | X20 CPU, coated with integrated I/O, x86-400, 256 MB DDR3 RAM, 32 kB FRAM, 2 GB flash drive on board, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 CAN bus interface, 1 POWERLINK interface, 1 Ethernet interface 10/100 Base-T, reACTION Technology, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 μ s, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μ s, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs \pm 10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, including supply module, 3x X20TB1F terminal blocks, slot cover and X20AC0SR1 end cover plate (right) included | 3382 |

6.2.2.2 Other modules

Analog outputs

| Order number | Short description | Page |
|--------------|---|------|
| X20cAO2437 | X20 analog output module, coated, 2 outputs, 4 to 20 mA / 0 to 20 mA or 0 to 24 mA, 16-bit converter resolution, single channel electrically isolated | 735 |
| X20cAO2438 | X20 analog output module, coated, 2 outputs, 4 to 20 mA / 0 to 20 mA or 0 to 24 mA, 16-bit converter resolution, single-channel isolation, supports the HART protocol, NetTime function | 748 |
| X20cAO4622 | X20 analog output module, coated, 4 outputs, ± 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution | 796 |
| X20cAO4632 | X20 analog output module, coated, 4 outputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, NetTime function | 805 |
| X20cAO4632-1 | X20 analog output module, coated, 4 outputs, ± 11 V or 0 to 22 mA, 16-bit converter resolution, NetTime function | 815 |

Analog inputs

| Order number | Short description | Page |
|--------------|---|------|
| X20cAI1744 | X20 analog input module, coated, 1 full-bridge strain gauge input, 24-bit converter resolution, 5 kHz input filter | 196 |
| X20cAI1744-3 | X20 analog input module, coated, 1 full-bridge strain gauge input, 24-bit converter resolution, 5 Hz input filter | 243 |
| X20cAI2438 | X20 analog input module, coated, 2 inputs, 4 to 20 mA, 16-bit converter resolution, single-channel isolation with separate sensor power supply, supports the HART protocol, NetTime function | 373 |
| X20cAI4622 | X20 analog input module, coated, 4 inputs, ± 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution, configurable input filter | 509 |
| X20cAI4632 | X20 analog input module, coated, 4 inputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, configurable input filter, oscilloscope functions | 520 |
| X20cAI4632-1 | X20 analog input module, coated, 4 inputs, ± 11 V or 0 to 22 mA, 16-bit converter resolution, configurable input filter, oscilloscope functions | 545 |
| X20cAP3121 | X20 energy metering module, coated, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 1 A AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20cAP3131 | X20 energy metering module, coated, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 5 A AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20cCM0985-1 | X20 digital and analog mixed module, coated, multi-measurement transducer / synchronization module, 5 digital outputs, 24 VDC, 0.5 A, source, 1 relay, 1 A, 8 analog inputs, ± 480 V / 120 V, 16-bit converter resolution, 3 analog inputs, 5 A / 1 A AC, 16-bit converter resolution, additional software functionalities, order terminal blocks 0TB3102-7011, 0TB3104-7011, 0TB3102-7012, 0TB3104-7012 and 2x X20TB12 separately! | 2921 |

Bus Controllers

| Order number | Short description | Page |
|--------------|--|------|
| X20cBC0083 | X20 bus controller, coated, 1 POWERLINK interface, integrated 2-port hub, 2x RJ45, order bus base, power supply module and terminal block separately! | 859 |
| X20cBC0087 | X20 bus controller, coated, Modbus/TCP or Modbus/UDP interface, integrated 2-port switch, 2x RJ45, order bus base, power supply module and terminal block separately | 864 |
| X20cBC0088 | X20 bus controller, coated, 1 EtherNet/IP interface, integrated switch, web interface, 2x RJ45, order bus base, power supply module and terminal block separately! | 877 |
| X20cBC00E3 | X20 bus controller, coated, 1 PROFINET IO interface, integrated 2-port switch, 2x RJ45, order bus base, power supply module and terminal block separately! | 904 |

Bus receivers and bus transmitters

| Order number | Short description | Page |
|--------------|---|------|
| X20cBR9300 | X20 bus receiver, coated, X2X Link, supply for X2X Link and internal I/O power supply, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 973 |
| X20cBT9100 | X20 bus transmitter, coated, X2X Link, supply for internal I/O supply | 980 |

Bus modules

| Order number | Short description | Page |
|--------------|---|------|
| X20cBM01 | X20 power supply bus module, coated, 24 VDC keyed, internal I/O supply interrupted to the left | 939 |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | 945 |
| X20cBM12 | X20 bus module, coated, 240 VAC keyed, internal I/O supply continuous | 948 |
| X20cBM31 | X20 bus module, coated, for double-width modules, 24 VDC keyed, internal I/O supply continuous | 956 |
| X20cBM32 | X20 bus module, coated, for double-width modules, 240 VAC keyed, internal I/O supply continuous | 959 |

Digital outputs

| Order number | Short description | Page |
|--------------|---|------|
| X20cCM0985-1 | X20 digital and analog mixed module, coated, multi-measurement transducer / synchronization module, 5 digital outputs, 24 VDC, 0.5 A, source, 1 relay, 1 A, 8 analog inputs, ± 480 V / 120 V, 16-bit converter resolution, 3 analog inputs, 5 A / 1 A AC, 16-bit converter resolution, additional software functionalities, order terminal blocks OTB3102-7011, OTB3104-7011, OTB3102-7012, OTB3104-7012 and 2x X20TB12 separately! | 2921 |
| X20cDM9324 | X20 digital mixed module, coated, 8 inputs, 24 VDC, sink, configurable input filter, 4 outputs, 24 VDC, 0.5 A, source, 1-wire connections | 1572 |
| X20cDO2633 | X20 digital output module, coated, 2 triac outputs, 48 to 240 VAC, 2 A, L switching, phase angle control, 240 V keyed | 1610 |
| X20cDO4322 | X20 digital output module, coated, 4 outputs, 24 VDC, 0.5 A, source, 3-wire connections | 1641 |
| X20cDO4332 | X20 digital output module, coated, 4 outputs, 24 VDC, 2 A, source, 3-wire connections | 1659 |
| X20cDO4633 | X20 digital output module, coated, 4 triac outputs, 48 to 240 VAC, 1 A, L switching, phase angle control, 240 V keyed | 1709 |
| X20cDO4649 | X20 digital output module, coated, 4 relays, N.O. contacts, 240 VAC / 5 A | 1726 |
| X20cDO6321 | X20 digital output module, coated, 6 outputs, 24 VDC, 0.5 A, sink, 2-wire connections | 1739 |
| X20cDO6322 | X20 digital output module, coated, 6 outputs, 24 VDC, 0.5 A, source, 2-wire connections | 1746 |
| X20cDO6529 | X20 digital output module, coated, 6 relays, normally open contacts, 115 VAC / 0.5 A, 30 VDC / 1 A | 1766 |
| X20cDO6639 | X20 digital output module, coated, 6 relays, normally open contacts, 240 VAC / 2 A, 30 VDC / 2 A | 1773 |
| X20cDO8331 | X20 digital output module, coated, 8 outputs, 24 VDC, 2 A, sink, supply directly on module, 1-wire connections | 1808 |
| X20cDO8332 | X20 digital output module, coated, 8 outputs, 24 VDC, 2 A, source, supply directly on module, 1-wire connections | 1820 |
| X20cDO9321 | X20 digital output module, coated, 12 outputs, 24 VDC, 0.5 A, sink, 1-wire connections | 1843 |
| X20cDO9322 | X20 digital output module, coated, 12 outputs, 24 VDC, 0.5 A, source, 1-wire connections | 1851 |
| X20cDOF322 | X20 digital output module, coated, 16 output, 24 VDC, 0.5 A, source, 1-wire connections | 1866 |
| X20cDS1119 | X20 multifunction digital signal processor, coated, 3 digital channels 5 V (symmetrical) configurable as inputs or outputs, 2 digital input channels 24 V (asymmetrical), max. 2 event counters, 1 universal counter pair as AB counter or up/down counter, linear movement generator (A/B, direction/frequency) with 1 reference pulse, 1 SSI absolute encoder, NetTime function | 1914 |

Digital inputs

| Order number | Short description | Page |
|--------------|---|------|
| X20cDI4371 | X20 digital input module, coated, 4 inputs, 24 VDC, sink, configurable input filter, 3-wire connections | 1473 |
| X20cDI4375 | X20 digital input module, coated, 4 inputs, 24 VDC, sink, configurable input filter, open-circuit and short-circuit detection, 3-wire connections | 1486 |
| X20cDI4760 | X20 digital input module, coated, 4 NAMUR inputs, 8.05 V | 1505 |
| X20cDI6371 | X20 digital input module, coated, 6 inputs, 24 VDC, sink, configurable input filter, 2-wire connections | 1514 |
| X20cDI6372 | X20 digital input module, coated, 6 inputs, 24 VDC, source, configurable input filter, 2-wire connections | 1520 |
| X20cDI9371 | X20 digital input module, coated, 12 inputs, 24 VDC, sink, configurable input filter, 1-wire connections | 1544 |
| X20cDI9372 | X20 digital input module, coated, 12 inputs, 24 VDC, source, configurable input filter, 1-wire connections | 1551 |
| X20cDIF371 | X20 digital input module, coated, 16 inputs, 24 VDC, sink, configurable input filter, 1-wire connections | 1564 |
| X20cDM9324 | X20 digital mixed module, coated, 8 inputs, 24 VDC, sink, configurable input filter, 4 outputs, 24 VDC, 0.5 A, source, 1-wire connections | 1572 |
| X20cDS1119 | X20 multifunction digital signal processor, coated, 3 digital channels 5 V (symmetrical) configurable as inputs or outputs, 2 digital input channels 24 V (asymmetrical), max. 2 event counters, 1 universal counter pair as AB counter or up/down counter, linear movement generator (A/B, direction/frequency) with 1 reference pulse, 1 SSI absolute encoder, NetTime function | 1914 |

Digital inputs and outputs

| Order number | Short description | Page |
|--------------|---|------|
| X20cDM9324 | X20 digital mixed module, coated, 8 inputs, 24 VDC, sink, configurable input filter, 4 outputs, 24 VDC, 0.5 A, source, 1-wire connections | 1572 |

Digital signal processing and preparation

| Order number | Short description | Page |
|--------------|---|------|
| X20cDS1119 | X20 multifunction digital signal processor, coated, 3 digital channels 5 V (symmetrical) configurable as inputs or outputs, 2 digital input channels 24 V (asymmetrical), max. 2 event counters, 1 universal counter pair as AB counter or up/down counter, linear movement generator (A/B, direction/frequency) with 1 reference pulse, 1 SSI absolute encoder, NetTime function | 1914 |

Power supply modules

| Order number | Short description | Page |
|--------------|--|------|
| X20cPS2100 | X20 power supply module, coated, for internal I/O supply | 3356 |
| X20cPS2110 | X20 power supply module, coated, for internal I/O power supply, integrated microfuse | 3361 |
| X20cPS3300 | X20 power supply module, coated, for X2X Link and internal I/O power supply | 3367 |
| X20cPS3310 | X20 power supply module, coated, for X2X Link and internal I/O power supply integrated microfuse | 3373 |

Electronics module communication

| Order number | Short description | Page |
|--------------|---|------|
| X20cBC1083 | X20 bus controller, coated, 1 POWERLINK interface, integrated 2-port hub, supports X20 interface module expansions, 2 RJ45, order bus base, power supply module and terminal block separately | 2213 |
| X20cBC8083 | X20 bus controller, coated, 1 POWERLINK interface, integrated 2-port hub, supports X20 hub module expansions, 2 RJ45, order bus base, power supply module and terminal block separately | 2220 |
| X20cBC8084 | X20 bus controller, coated, 1 POWERLINK interface, 1x link selector for POWERLINK cable redundancy, supports expansion with active X20 hub modules, 2x RJ45, order bus base, power supply module and terminal block separately! | 2227 |

Expandable bus controllers

| Order number | Short description | Page |
|--------------|--|------|
| X20cHB8815 | X20 POWERLINK - TCP/IP gateway, coated, can be expanded with active hub modules, 2x RJ45 | 2480 |
| X20cHB8880 | X20 base hub module, coated, integrated 2-port hub, 2x RJ45 | 2490 |

Expandable bus controllers System modules

| Order number | Short description | Page |
|--------------|--|------|
| X20cCS1020 | X20 interface module, coated, 1 RS232 interface, max. 115.2 kbit/s | 2147 |
| X20cCS1030 | X20 interface module, coated, 1 RS422/485 interface, max. 115.2 kbit/s | 2162 |

Interface module communication

| Order number | Short description | Page |
|--------------|---|------|
| X20clF1030 | X20 interface module, coated, 1 RS422/485 interface, max. 115.2 kbit/s, electrically isolated | 2271 |
| X20clF1041-1 | X20 interface module, coated, for DTM configuration, 1 CANopen master interface, electrically isolated, order 1x TB2105 terminal block separately | 2274 |
| X20clF1061-1 | X20 interface module coated, for DTM configuration, 1 PROFIBUS DP V0/V1 master interface, electrically isolated | 2328 |
| X20clF1063-1 | X20 interface module, coated, for DTM configuration, 1 PROFIBUS DP V1 slave interface, electrically isolated | 2342 |
| X20clF1072 | X20 interface module, coated, 1 CAN bus interface, max. 1 Mbit/s, electrically isolated, order 1x TB2105 terminal block separately | 2353 |
| X20clF1082-2 | X20 interface module, coated, 1 POWERLINK interface, managing or controlled node, integrated 2-port hub, ring redundancy function PRC function | 2363 |
| X20clF10D1-1 | X20 interface module, coated, for DTM configuration, 1 EtherNet/IP scanner (master) interface, electrically isolated | 2392 |
| X20clF10D3-1 | X20 interface module, coated, for DTM configuration, 1 EtherNet/IP adapter (slave) interface, electrically isolated | 2402 |
| X20clF10E3-1 | X20 interface module, coated, for DTM configuration, 1 PROFINET IO device (slave) interface module, electrically isolated | 2424 |
| X20clF10X0 | X20 interface module, coated, 1 redundancy link interface 1000 Base-FX, CPU-CPU data synchronization for controller redundancy | 2447 |
| X20clF2181-2 | X20 interface module, coated, 1x link selector for POWERLINK cable redundancy, POWERLINK functions: - Managing node - Controlled node for iCN operation - Redundant managing node for controller redundancy - Ring redundancy - 2x hub - Multi ASend - PRC function 2x RJ45 | 2452 |

Motor controllers

| Order number | Short description | Page |
|--------------|--|------|
| X20cMM2436 | Coated X20 PWM motor module, 24 to 39 VDC \pm 25%, 2 PWM motor bridges, 3 A continuous current, 3.5 A peak current, 4 digital inputs 24 VDC, sink, configurable as incremental encoder | 2496 |

Hub system

| Order number | Short description | Page |
|--------------|--|------|
| X20cHB8884 | X20 compact link selector, coated, 2x RJ45, order bus base, power supply module and terminal block separately. | 3614 |

Other functions

| Order number | Short description | Page |
|--------------|---|------|
| X20cCM0985-1 | X20 digital and analog mixed module, coated, multi-measurement transducer / synchronization module, 5 digital outputs, 24 VDC, 0.5 A, source, 1 relay, 1 A, 8 analog inputs, \pm 480 V / 120 V, 16-bit converter resolution, 3 analog inputs, 5 A / 1 A AC, 16-bit converter resolution, additional software functionalities, order terminal blocks 0TB3102-7011, 0TB3104-7011, 0TB3102-7012, 0TB3104-7012 and 2x X20TB12 separately! | 2921 |
| X20cCM4810 | X20 analog input module, coated, for vibration measurement and analysis of condition monitoring tasks, 4 IEPE analog inputs, 51.5625 kHz sampling frequency, 24-bit converter resolution | 3039 |
| X20cDS438A | X20 digital signal module, coated, 4x IO-Link master V1.1, 4 digital channels configurable as inputs or outputs, 3-wire connections, NetTime function | 3287 |
| X20cPD2113 | X20 potential distributor, coated, 6x GND, 6x 24 VDC, with supply option, integrated microfuse | 3343 |

Redundancy system

| Order number | Short description | Page |
|--------------|--|------|
| X20cBB80 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | 922 |
| X20cPS9400 | X20 power supply module, coated, for bus controller and internal I/O power supply, X2X Link power supply | 926 |

System modules for expandable bus controllers

| Order number | Short description | Page |
|--------------|--|------|
| X20cBB81 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with one expansion slot for an X20 add-on module (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 2234 |
| X20cBB82 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with two expansion slots for two X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 2237 |
| X20cHB1881 | X20 hub expansion module, coated, integrated 1-port hub, for fiber optic cable | 3619 |
| X20cHB2880 | X20 hub expansion module, coated, integrated 2-port hub, 2x RJ45 | 3627 |
| X20cHB2881 | X20 hub expansion module, coated, integrated 2-port hub, for fiber optic cable | 3632 |
| X20cHB2885 | X20 hub expansion module, coated, integrated active 2-port hub, 2x RJ45 | 3641 |
| X20cHB2886 | X20 hub expansion module, coated, integrated active 2-port hub, 2 fiber optic interfaces | 3644 |
| X20cIF1041-1 | X20 interface module, coated, for DTM configuration, 1 CANopen master interface, electrically isolated, order 1x TB2105 terminal block separately | 2274 |
| X20cIF1061-1 | X20 interface module coated, for DTM configuration, 1 PROFIBUS DP V0/V1 master interface, electrically isolated | 2328 |
| X20cIF1063-1 | X20 interface module, coated, for DTM configuration, 1 PROFIBUS DP V1 slave interface, electrically isolated | 2342 |
| X20cIF10D3-1 | X20 interface module, coated, for DTM configuration, 1 EtherNet/IP adapter (slave) interface, electrically isolated | 2402 |
| X20cIF10E3-1 | X20 interface module, coated, for DTM configuration, 1 PROFINET IO device (slave) interface module, electrically isolated | 2424 |
| X20cPS9400 | X20 power supply module, coated, for bus controller and internal I/O power supply, X2X Link power supply | 926 |

System modules for the X20 hub system

| Order number | Short description | Page |
|--------------|--|------|
| X20cBB80 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | 922 |
| X20cBB81 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with one expansion slot for an X20 add-on module (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 2234 |
| X20cBB82 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with two expansion slots for two X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 2237 |
| X20cHB1881 | X20 hub expansion module, coated, integrated 1-port hub, for fiber optic cable | 3619 |
| X20cHB2880 | X20 hub expansion module, coated, integrated 2-port hub, 2x RJ45 | 3627 |
| X20cHB2881 | X20 hub expansion module, coated, integrated 2-port hub, for fiber optic cable | 3632 |
| X20cPS8002 | X20 power supply module, coated, for standalone hub and compact link selector | 3636 |
| X20cPS9400 | X20 power supply module, coated, for bus controller and internal I/O power supply, X2X Link power supply | 926 |

System modules for the X20 redundancy system

| Order number | Short description | Page |
|--------------|--|------|
| X20cHB2885 | X20 hub expansion module, coated, integrated active 2-port hub, 2x RJ45 | 3641 |
| X20cHB2886 | X20 hub expansion module, coated, integrated active 2-port hub, 2 fiber optic interfaces | 3644 |

Temperature measurement

| Order number | Short description | Page |
|--------------|--|------|
| X20cAT2311 | X20 temperature input module, coated, 2 resistance measurement inputs, PT100, resolution 0.001°C, 4-wire connections | 3659 |
| X20cAT4222 | X20 temperature input module, coated, 4 inputs for resistance measurement, PT100, PT1000, resolution 0.1°C, 3-wire connections | 3679 |
| X20cAT6402 | X20 temperature input module, coated, 6 thermocouple inputs, Type J, K, N, S, B, R, resolution 0.1°C | 3698 |

Counter functions

| Order number | Short description | Page |
|--------------|---|------|
| X20cDC1196 | X20 digital counter module, coated, 1 ABR incremental encoder, 5 V, 600 kHz input frequency, 4x resolution | 1105 |
| X20cDC1198 | X20 digital counter module, coated, 1 SSI absolute encoders, 5 V, 1 Mbit/s, 32-bit | 1115 |
| X20cDC1396 | X20 digital counter module, coated, 1 ABR incremental encoders, 24 V, 100 kHz input frequency, 4x evaluation | 1169 |
| X20cDC2190 | X20 digital counter module, coated, ultrasonic transducer module, interfaces: EP start/stop, DPI/IP, 2 transducer rods, 4-position detection | 1202 |
| X20cDC2395 | X20 digital counter module, coated, 1 SSI absolute encoder, 24 V, 1 ABR incremental encoder, 24 V, 2 AB incremental encoders, 24 V, 4 event counters or 2 PWM, local time measurement function | 1216 |
| X20cDS1119 | X20 multifunction digital signal processor, coated, 3 digital channels 5 V (symmetrical) configurable as inputs or outputs, 2 digital input channels 24 V (asymmetrical), max. 2 event counters, 1 universal counter pair as AB counter or up/down counter, linear movement generator (A/B, direction/frequency) with 1 reference pulse, 1 SSI absolute encoder, NetTime function | 1914 |

6.3 B&R ID codes

Module ID codes are displayed in Automation Studio error messages, for example. The ID code and following tables can be used to determine the affected module and associated data sheet.

6.3.1 B&R ID codes sorted by model number

| Model number | B&R ID code (hex.) | B&R ID code (dec.) | on page |
|--------------|--------------------|--------------------|---------|
| X20AI1744 | 0x1CDE | 7390 | 196 |
| X20AI1744-10 | 0xF1A7 | 61863 | 289 |
| X20AI1744-3 | 0xA4EF | 42223 | 243 |
| X20AI2222 | 0xCAB0 | 51888 | 318 |
| X20AI2237 | 0xC9C4 | 51652 | 328 |
| X20AI2322 | 0xCAB2 | 51890 | 346 |
| X20AI2437 | 0xB784 | 46980 | 357 |
| X20AI2438 | 0xB3A9 | 45993 | 373 |
| X20AI2622 | 0x1B9E | 7070 | 397 |
| X20AI2632 | 0x1BA0 | 7072 | 408 |
| X20AI2632-1 | 0xA29E | 41630 | 433 |
| X20AI2636 | 0xB3A7 | 45991 | 458 |
| X20AI4222 | 0xCAB1 | 51889 | 489 |
| X20AI4322 | 0xCAB3 | 51891 | 499 |
| X20AI4622 | 0x1BAA | 7082 | 509 |
| X20AI4632 | 0x1BA1 | 7073 | 520 |
| X20AI4632-1 | 0xA29D | 41629 | 545 |
| X20AI4636 | 0xB3A8 | 45992 | 570 |
| X20AI8221 | 0xD82F | 55343 | 602 |
| X20AI8321 | 0xD831 | 55345 | 612 |
| X20AIA744 | 0xE50C | 58636 | 622 |
| X20AIB744 | 0xE286 | 57990 | 641 |
| X20AO2437 | 0xB785 | 46981 | 735 |
| X20AO2438 | 0xB3AA | 45994 | 748 |
| X20AO2622 | 0x1BA2 | 7074 | 773 |
| X20AO2632 | 0x1BA4 | 7076 | 780 |
| X20AO2632-1 | 0xC36E | 50030 | 788 |
| X20AO4622 | 0x1BA3 | 7075 | 796 |
| X20AO4632 | 0x1BA5 | 7077 | 805 |
| X20AO4632-1 | 0xC36F | 50031 | 815 |
| X20AO4635 | 0xA7FE | 43006 | 824 |
| X20AP3111 | 0xC9DA | 51674 | 661 |
| X20AP3121 | 0xC9DB | 51675 | 661 |
| X20AP3122 | 0xE7BF | 59327 | 661 |
| X20AP3131 | 0xC9DC | 51676 | 661 |
| X20AP3132 | 0xE7C0 | 59328 | 661 |
| X20AP3161 | 0xE17B | 57723 | 661 |
| X20AP3171 | 0xE7C1 | 59329 | 661 |
| X20AT2222 | 0x1BA6 | 7078 | 3649 |
| X20AT2311 | 0xA4AA | 42154 | 3659 |
| X20AT2402 | 0x1BA8 | 7080 | 3667 |
| X20AT4222 | 0x1BA7 | 7079 | 3679 |
| X20AT4232 | 0xEA85 | 60037 | 3689 |
| X20AT6402 | 0x1BA9 | 7081 | 3698 |
| X20ATA312 | 0xE0E4 | 57572 | 3710 |
| X20ATA492 | 0xBB98 | 48024 | 3723 |
| X20ATB312 | 0xE0EF | 57583 | 3742 |
| X20ATC402 | 0xBB99 | 48025 | 3755 |
| X20BB52 | 0xEB0A | 60170 | 1035 |
| X20BB57 | 0xEB09 | 60169 | 1037 |
| X20BB62 | 0xEB08 | 60168 | 1039 |
| X20BB67 | 0xEB07 | 60167 | 1041 |
| X20BB72 | 0xEB06 | 60166 | 1043 |
| X20BB77 | 0xEB05 | 60165 | 1045 |
| X20BC0043-10 | 0xA8B8 | 43192 | 834 |
| X20BC0053 | 0x1F1B | 7963 | 841 |
| X20BC0063 | 0x1F1C | 7964 | 847 |
| X20BC0073 | 0x1F1D | 7965 | 851 |
| X20BC0083 | 0x1F1E | 7966 | 859 |
| X20BC0087 | 0x227C | 8828 | 864 |
| X20BC0087-10 | 0xEA9F | 60063 | 870 |
| X20BC0088 | 0x26D8 | 9944 | 877 |
| X20BC008U | 0xEAFB | 60155 | 882 |
| X20BC00E3 | 0xBB7D | 47997 | 904 |
| X20BC00G3 | 0xAC23 | 44067 | 910 |
| X20BC0143-10 | 0xAD3E | 44350 | 914 |

| Model number | B&R ID code (hex.) | B&R ID code (dec.) | on page |
|--------------|--------------------|--------------------|---------|
| X20BC1083 | 0x2268 | 8808 | 2213 |
| X20BC8083 | 0x2673 | 9843 | 2220 |
| X20BC8084 | 0x2674 | 9844 | 2227 |
| X20BR7300 | 0xEBED | 60397 | 964 |
| X20BR9300 | 0x1BC1 | 7105 | 973 |
| X20BT9100 | 0x1BC2 | 7106 | 980 |
| X20BT9400 | 0xA238 | 41528 | 986 |
| X20CM0985 | 0x2433 | 9267 | 2803 |
| X20CM0985-02 | 0xF425 | 62501 | 2846 |
| X20CM0985-1 | 0xB768 | 46952 | 2921 |
| X20CM1201 | 0x21EF | 8687 | 1875 |
| X20CM1941 | 0x1E85 | 7813 | 1063 |
| X20CM4323 | 0xEC21 | 60449 | 2992 |
| X20CM4800X | 0xF1C5 | 61893 | 3021 |
| X20CM4810 | 0xC8F9 | 51449 | 3039 |
| X20CM6209 | 0xA7A1 | 42913 | 3174 |
| X20CM8281 | 0x24C3 | 9411 | 3178 |
| X20CM8323 | 0x1D43 | 7491 | 3197 |
| X20CMR010 | 0xF1AC | 61868 | 3216 |
| X20CMR100 | 0xF1AD | 61869 | 3230 |
| X20CMR111 | 0xF1AE | 61870 | 3242 |
| X20CP0201 | 0x22A2 | 8866 | 994 |
| X20CP0291 | 0x22A4 | 8868 | 994 |
| X20CP0292 | 0x22A6 | 8870 | 994 |
| X20CP0410 | 0xE94F | 59727 | 1019 |
| X20CP0411 | 0xE950 | 59728 | 1019 |
| X20CP0420 | 0xF4D3 | 62675 | 1019 |
| X20CP0482 | 0xE951 | 59729 | 1019 |
| X20CP0483 | 0xE952 | 59730 | 1019 |
| X20CP0484 | 0xE953 | 59731 | 1019 |
| X20CP0484-1 | 0xFA24 | 64036 | 1019 |
| X20CP1301 | 0xE35B | 58203 | 1324 |
| X20CP1381 | 0xE35C | 58204 | 1324 |
| X20CP1381-RT | 0xE35D | 58205 | 3382 |
| X20CP1382 | 0xDABB | 55995 | 1324 |
| X20CP1382-RT | 0xE35E | 58206 | 3382 |
| X20CP1483 | 0xA239 | 41529 | 1380 |
| X20CP1483-1 | 0xAEC5 | 44741 | 1380 |
| X20CP1583 | 0xD45B | 54363 | 1397 |
| X20CP1584 | 0xC370 | 50032 | 1397 |
| X20CP1585 | 0xC3AE | 50094 | 1397 |
| X20CP1586 | 0xC3B0 | 50096 | 1397 |
| X20CP1684 | 0xF9EA | 63978 | 1418 |
| X20CP1685 | 0xF9EB | 63979 | 1418 |
| X20CP1686X | 0xF9EC | 63980 | 1418 |
| X20CP3583 | 0xD45C | 54364 | 1401 |
| X20CP3584 | 0xC3AD | 50093 | 1401 |
| X20CP3585 | 0xC3AF | 50095 | 1401 |
| X20CP3586 | 0xBF2B | 48939 | 1401 |
| X20CP3684 | 0xF9ED | 63981 | 1422 |
| X20CP3685 | 0xF9EE | 63982 | 1422 |
| X20CP3686X | 0xF9F9 | 63993 | 1422 |
| X20CP3687X | 0xF9FA | 63994 | 1422 |
| X20CS1011 | 0xA38D | 41869 | 2101 |
| X20CS1012 | 0xCABF | 51903 | 2116 |
| X20CS1013 | 0xDE85 | 56965 | 2136 |
| X20CS1020 | 0x1FCF | 8143 | 2147 |
| X20CS1030 | 0x1FD0 | 8144 | 2162 |
| X20CS1070 | 0x1FD1 | 8145 | 2177 |
| X20CS2770 | 0xA009 | 40969 | 2194 |
| X20DC1073 | 0xAEC6 | 44742 | 1899 |
| X20DC1176 | 0xA706 | 42758 | 1071 |
| X20DC1178 | 0xA708 | 42760 | 1087 |
| X20DC1196 | 0x1BAF | 7087 | 1105 |
| X20DC1198 | 0x1BB0 | 7088 | 1115 |
| X20DC11A6 | 0xB76B | 46955 | 1122 |
| X20DC1376 | 0xA705 | 42757 | 1137 |
| X20DC137A | 0xDD28 | 56616 | 1153 |
| X20DC1396 | 0x1BAC | 7084 | 1169 |
| X20DC1398 | 0x1BAE | 7086 | 1179 |
| X20DC1976 | 0xA707 | 42759 | 1186 |
| X20DC2190 | 0x2188 | 8584 | 1202 |
| X20DC2395 | 0x1CD4 | 7380 | 1216 |
| X20DC2396 | 0x1BAB | 7083 | 1256 |

Module overviews

| Model number | B&R ID code (hex.) | B&R ID code (dec.) | on page |
|--------------|--------------------|--------------------|---------|
| X20DC2398 | 0x1BAD | 7085 | 1267 |
| X20DC4395 | 0x1CC5 | 7365 | 1275 |
| X20DI0471 | 0xE7CE | 59342 | 1439 |
| X20DI2371 | 0x1B8D | 7053 | 1446 |
| X20DI2372 | 0x22A7 | 8871 | 1452 |
| X20DI2377 | 0x1B8E | 7054 | 1458 |
| X20DI2653 | 0x2544 | 9540 | 1467 |
| X20DI4371 | 0x1B92 | 7058 | 1473 |
| X20DI4372 | 0x22A8 | 8872 | 1480 |
| X20DI4375 | 0xA911 | 43281 | 1486 |
| X20DI4653 | 0x2545 | 9541 | 1499 |
| X20DI4760 | 0x2105 | 8453 | 1505 |
| X20DI6371 | 0x1B93 | 7059 | 1514 |
| X20DI6372 | 0x1B94 | 7060 | 1520 |
| X20DI6373 | 0xA7A2 | 42914 | 1526 |
| X20DI6553 | 0x256F | 9583 | 1532 |
| X20DI8371 | 0xA4AB | 42155 | 1538 |
| X20DI9371 | 0x1B95 | 7061 | 1544 |
| X20DI9372 | 0x1D28 | 7464 | 1551 |
| X20DID371 | 0xC0E7 | 49383 | 1558 |
| X20DIF371 | 0xC0E8 | 49384 | 1564 |
| X20DM9324 | 0x20B9 | 8377 | 1572 |
| X20DO2321 | 0x22B3 | 8883 | 1581 |
| X20DO2322 | 0x1B96 | 7062 | 1590 |
| X20DO2623 | 0x267B | 9851 | 1599 |
| X20DO2633 | 0xAC39 | 44089 | 1610 |
| X20DO2649 | 0x20DA | 8410 | 1626 |
| X20DO4321 | 0x22B4 | 8884 | 1632 |
| X20DO4322 | 0x1B97 | 7063 | 1641 |
| X20DO4331 | 0x22B5 | 8885 | 1649 |
| X20DO4332 | 0x1B9C | 7068 | 1659 |
| X20DO4332-1 | 0xF5F9 | 62969 | 1669 |
| X20DO4529 | 0x20D9 | 8409 | 1679 |
| X20DO4613 | 0xAD05 | 44293 | 1686 |
| X20DO4623 | 0x267C | 9852 | 1699 |
| X20DO4633 | 0xAC3A | 44090 | 1709 |
| X20DO4649 | 0xA704 | 42756 | 1726 |
| X20DO4F49 | 0xF76A | 63338 | 1732 |
| X20DO6321 | 0x1B99 | 7065 | 1739 |
| X20DO6322 | 0x1B98 | 7064 | 1746 |
| X20DO6325 | 0xE284 | 57988 | 1755 |
| X20DO6529 | 0x2019 | 8217 | 1766 |
| X20DO6639 | 0xDF50 | 57168 | 1773 |
| X20DO8232 | 0xA4AD | 42157 | 1779 |
| X20DO8322 | 0xA4AC | 42156 | 1791 |
| X20DO8323 | 0xDF4E | 57166 | 1799 |
| X20DO8331 | 0x22EB | 8939 | 1808 |
| X20DO8332 | 0x1B9D | 7069 | 1820 |
| X20DO8332-1 | 0xF321 | 62241 | 1832 |
| X20DO9321 | 0x1B9B | 7067 | 1843 |
| X20DO9322 | 0x1B9A | 7066 | 1851 |
| X20DOD322 | 0xC0E9 | 49385 | 1859 |
| X20DOF322 | 0xC0EA | 49386 | 1866 |
| X20DS1119 | 0xA067 | 41063 | 1914 |
| X20DS1319 | 0x2547 | 9543 | 1957 |
| X20DS1828 | 0xAEC7 | 44743 | 1999 |
| X20DS1928 | 0xA912 | 43282 | 2031 |
| X20DS4387 | 0xA38E | 41870 | 3269 |
| X20DS4389 | 0xA93B | 43323 | 2056 |
| X20DS438A | 0xCAC0 | 51904 | 3287 |
| X20IF1020 | 0x1F27 | 7975 | 2268 |
| X20IF1030 | 0x1F28 | 7976 | 2271 |
| X20IF1041-1 | 0xA709 | 42761 | 2274 |
| X20IF1043-1 | 0xA70B | 42763 | 2288 |
| X20IF1051-1 | 0xA70C | 42764 | 2302 |
| X20IF1053-1 | 0xA715 | 42773 | 2315 |
| X20IF1061-1 | 0xA716 | 42774 | 2328 |
| X20IF1063 | 0x1F23 | 7971 | 2339 |
| X20IF1063-1 | 0xA717 | 42775 | 2342 |
| X20IF1072 | 0x1F20 | 7968 | 2353 |
| X20IF1074 | 0xA399 | 41881 | 2263 |
| X20IF1082 | 0x1F1F | 7967 | 2357 |
| X20IF1082-2 | 0xA7A3 | 42915 | 2363 |
| X20IF1086-2 | 0xB455 | 46165 | 2369 |

| Model number | B&R ID code (hex.) | B&R ID code (dec.) | on page |
|---------------|--------------------|--------------------|---------|
| X20IF1091 | 0x1F24 | 7972 | 2375 |
| X20IF1091-1 | 0x2525 | 9509 | 2240 |
| X20IF10A1-1 | 0xA718 | 42776 | 2378 |
| X20IF10D1-1 | 0xA71B | 42779 | 2392 |
| X20IF10D3-1 | 0xA71C | 42780 | 2402 |
| X20IF10E1-1 | 0xA71D | 42781 | 2413 |
| X20IF10E3-1 | 0xA71E | 42782 | 2424 |
| X20IF10G3-1 | 0xA72C | 42796 | 2434 |
| X20IF10X0 | 0xC3B4 | 50100 | 2447 |
| X20IF2181-2 | 0xC3B3 | 50099 | 2452 |
| X20IF2772 | 0x1F25 | 7973 | 2458 |
| X20IF2792 | 0x1F26 | 7974 | 2462 |
| X20MM2436 | 0x26B5 | 9909 | 2496 |
| X20MM3332 | 0xA982 | 43394 | 2523 |
| X20MM4331 | 0xA976 | 43382 | 2538 |
| X20MM4455 | 0xE8A4 | 59556 | 2551 |
| X20MM4456 | 0xA177 | 41335 | 2577 |
| X20PD0011 | 0x267D | 9853 | 3327 |
| X20PD0012 | 0x267E | 9854 | 3332 |
| X20PD0016 | 0x2680 | 9856 | 3337 |
| X20PD2113 | 0x267F | 9855 | 3343 |
| X20PS2100 | 0x1BBF | 7103 | 3356 |
| X20PS2110 | 0x2016 | 8214 | 3361 |
| X20PS3300 | 0x1BC0 | 7104 | 3367 |
| X20PS3310 | 0x2017 | 8215 | 3373 |
| X20PS4951 | 0x1F43 | 8003 | 3349 |
| X20PS9400 | 0x1F8C | 8076 | 926 |
| X20PS9402 | 0xA389 | 41865 | 932 |
| X20PS9500 | 0x2018 | 8216 | 1006 |
| X20PS9502 | 0xA38A | 41866 | 1012 |
| X20PS9600 | 0xEB03 | 60163 | 1047 |
| X20PS9602 | 0xEB04 | 60164 | 1055 |
| X20RT8001 | 0xE559 | 58713 | 3448 |
| X20RT8201 | 0xE55A | 58714 | 3477 |
| X20RT8202 | 0xE55B | 58715 | 3511 |
| X20RT8381 | 0xF24E | 62030 | 3543 |
| X20RT8401 | 0xE55C | 58716 | 3577 |
| X20SM1426 | 0x2681 | 9857 | 2603 |
| X20SM1436 | 0x2682 | 9858 | 2652 |
| X20SM1436-1 | 0xF1B0 | 61872 | 2700 |
| X20SM1446-1 | 0xF3B0 | 62384 | 2751 |
| X20XC0201 | 0x2563 | 9571 | 2245 |
| X20XC0202 | 0x2564 | 9572 | 2245 |
| X20XC0292 | 0xA252 | 41554 | 2245 |
| X20cAI1744 | 0xE754 | 59220 | 196 |
| X20cAI1744-3 | 0xEB00 | 60160 | 243 |
| X20cAI2438 | 0xE1EE | 57838 | 373 |
| X20cAI4622 | 0xE1EF | 57839 | 509 |
| X20cAI4632 | 0xE1F0 | 57840 | 520 |
| X20cAI4632-1 | 0xD57A | 54650 | 545 |
| X20cAO2437 | 0xE1F2 | 57842 | 735 |
| X20cAO2438 | 0xE211 | 57873 | 748 |
| X20cAO4622 | 0xE212 | 57874 | 796 |
| X20cAO4632 | 0xD575 | 54645 | 805 |
| X20cAO4632-1 | 0xE213 | 57875 | 815 |
| X20cAP3121 | 0xE214 | 57876 | 661 |
| X20cAP3131 | 0xEB55 | 60245 | 661 |
| X20cAT2311 | 0xF3B6 | 62390 | 3659 |
| X20cAT4222 | 0xE215 | 57877 | 3679 |
| X20cAT6402 | 0xDD57 | 56663 | 3698 |
| X20cBC0083 | 0xE216 | 57878 | 859 |
| X20cBC0087 | 0xD577 | 54647 | 864 |
| X20cBC0088 | 0xE67F | 59007 | 877 |
| X20cBC00E3 | 0xE4E0 | 58592 | 904 |
| X20cBC1083 | 0xE217 | 57879 | 2213 |
| X20cBC8083 | 0xE218 | 57880 | 2220 |
| X20cBC8084 | 0xDF10 | 57104 | 2227 |
| X20cBR9300 | 0xDD48 | 56648 | 973 |
| X20cBT9100 | 0xE219 | 57881 | 980 |
| X20cCM0985-1 | 0xE4FF | 58623 | 2921 |
| X20cCM4810 | 0xE7F0 | 59376 | 3039 |
| X20cCP1301 | 0xEB58 | 60248 | 1324 |
| X20cCP1382-RT | 0xE707 | 59143 | 3382 |
| X20cCP1584 | 0xE21B | 57883 | 1397 |

| Model number | B&R ID code (hex.) | B&R ID code (dec.) | on page |
|--------------|--------------------|--------------------|---------|
| X20cCP1586 | 0xE21C | 57884 | 1397 |
| X20cCP3584 | 0xE21D | 57885 | 1401 |
| X20cCP3586 | 0xE21E | 57886 | 1401 |
| X20cCS1020 | 0xE7F2 | 59378 | 2147 |
| X20cCS1030 | 0xE500 | 58624 | 2162 |
| X20cDC1196 | 0xEB54 | 60244 | 1105 |
| X20cDC1198 | 0xE501 | 58625 | 1115 |
| X20cDC1396 | 0xE502 | 58626 | 1169 |
| X20cDC2190 | 0xEE9D | 61085 | 1202 |
| X20cDC2395 | 0xE503 | 58627 | 1216 |
| X20cDI4371 | 0xE21F | 57887 | 1473 |
| X20cDI4375 | 0xE220 | 57888 | 1486 |
| X20cDI4760 | 0xE221 | 57889 | 1505 |
| X20cDI6371 | 0xE222 | 57890 | 1514 |
| X20cDI6372 | 0xE223 | 57891 | 1520 |
| X20cDI9371 | 0xD574 | 54644 | 1544 |
| X20cDI9372 | 0xE224 | 57892 | 1551 |
| X20cDIF371 | 0xDD44 | 56644 | 1564 |
| X20cDM9324 | 0xE225 | 57893 | 1572 |
| X20cDO2633 | 0xE680 | 59008 | 1610 |
| X20cDO4322 | 0xE226 | 57894 | 1641 |
| X20cDO4332 | 0xE227 | 57895 | 1659 |
| X20cDO4633 | 0xE67D | 59005 | 1709 |
| X20cDO4649 | 0xE67E | 59006 | 1726 |
| X20cDO6321 | 0xE228 | 57896 | 1739 |
| X20cDO6322 | 0xE229 | 57897 | 1746 |
| X20cDO6529 | 0xE751 | 59217 | 1766 |
| X20cDO6639 | 0xE22A | 57898 | 1773 |
| X20cDO8331 | 0xE22B | 57899 | 1808 |
| X20cDO8332 | 0xE22C | 57900 | 1820 |
| X20cDO9321 | 0xE22D | 57901 | 1843 |
| X20cDO9322 | 0xD578 | 54648 | 1851 |
| X20cDOF322 | 0xDD4C | 56652 | 1866 |
| X20cDS1119 | 0xE20D | 57869 | 1914 |
| X20cDS438A | 0xEB57 | 60247 | 3287 |
| X20clF1030 | 0xE233 | 57907 | 2271 |
| X20clF1041-1 | 0xE505 | 58629 | 2274 |
| X20clF1061-1 | 0xE234 | 57908 | 2328 |
| X20clF1063-1 | 0xE235 | 57909 | 2342 |
| X20clF1072 | 0xE506 | 58630 | 2353 |
| X20clF1082-2 | 0xE236 | 57910 | 2363 |
| X20clF10D1-1 | 0xE753 | 59219 | 2392 |
| X20clF10D3-1 | 0xE237 | 57911 | 2402 |
| X20clF10E3-1 | 0xE238 | 57912 | 2424 |
| X20clF10X0 | 0xE239 | 57913 | 2447 |
| X20clF2181-2 | 0xE23A | 57914 | 2452 |
| X20cMM2436 | 0xE752 | 59218 | 2496 |
| X20cPD2113 | 0xE23B | 57915 | 3343 |
| X20cPS2100 | 0xE23C | 57916 | 3356 |
| X20cPS2110 | 0xE23D | 57917 | 3361 |
| X20cPS3300 | 0xDF13 | 57107 | 3367 |
| X20cPS3310 | 0xDD46 | 56646 | 3373 |
| X20cPS9400 | 0xD579 | 54649 | 926 |

6.3.2 B&R ID codes sorted by ID code

| Model number | B&R ID code (hex.) | B&R ID code (dec.) | on page |
|--------------|--------------------|--------------------|---------|
| X20DI2371 | 0x1B8D | 7053 | 1446 |
| X20DI2377 | 0x1B8E | 7054 | 1458 |
| X20DI4371 | 0x1B92 | 7058 | 1473 |
| X20DI6371 | 0x1B93 | 7059 | 1514 |
| X20DI6372 | 0x1B94 | 7060 | 1520 |
| X20DI9371 | 0x1B95 | 7061 | 1544 |
| X20DO2322 | 0x1B96 | 7062 | 1590 |
| X20DO4322 | 0x1B97 | 7063 | 1641 |
| X20DO6322 | 0x1B98 | 7064 | 1746 |
| X20DO6321 | 0x1B99 | 7065 | 1739 |
| X20DO9322 | 0x1B9A | 7066 | 1851 |
| X20DO9321 | 0x1B9B | 7067 | 1843 |
| X20DO4332 | 0x1B9C | 7068 | 1659 |
| X20DO8332 | 0x1B9D | 7069 | 1820 |
| X20AI2622 | 0x1B9E | 7070 | 397 |
| X20AI2632 | 0x1BA0 | 7072 | 408 |
| X20AI4632 | 0x1BA1 | 7073 | 520 |
| X20AO2622 | 0x1BA2 | 7074 | 773 |
| X20AO4622 | 0x1BA3 | 7075 | 796 |
| X20AO2632 | 0x1BA4 | 7076 | 780 |
| X20AO4632 | 0x1BA5 | 7077 | 805 |
| X20AT2222 | 0x1BA6 | 7078 | 3649 |
| X20AT4222 | 0x1BA7 | 7079 | 3679 |
| X20AT2402 | 0x1BA8 | 7080 | 3667 |
| X20AT6402 | 0x1BA9 | 7081 | 3698 |
| X20AI4622 | 0x1BAA | 7082 | 509 |
| X20DC2396 | 0x1BAB | 7083 | 1256 |
| X20DC1396 | 0x1BAC | 7084 | 1169 |
| X20DC2398 | 0x1BAD | 7085 | 1267 |
| X20DC1398 | 0x1BAE | 7086 | 1179 |
| X20DC1196 | 0x1BAF | 7087 | 1105 |
| X20DC1198 | 0x1BB0 | 7088 | 1115 |
| X20PS2100 | 0x1BBF | 7103 | 3356 |
| X20PS3300 | 0x1BC0 | 7104 | 3367 |
| X20BR9300 | 0x1BC1 | 7105 | 973 |
| X20BT9100 | 0x1BC2 | 7106 | 980 |
| X20DC4395 | 0x1CC5 | 7365 | 1275 |
| X20DC2395 | 0x1CD4 | 7380 | 1216 |
| X20AI1744 | 0x1CDE | 7390 | 196 |
| X20DI9372 | 0x1D28 | 7464 | 1551 |
| X20CM8323 | 0x1D43 | 7491 | 3197 |
| X20CM1941 | 0x1E85 | 7813 | 1063 |
| X20BC0053 | 0x1F1B | 7963 | 841 |
| X20BC0063 | 0x1F1C | 7964 | 847 |
| X20BC0073 | 0x1F1D | 7965 | 851 |
| X20BC0083 | 0x1F1E | 7966 | 859 |
| X20IF1082 | 0x1F1F | 7967 | 2357 |
| X20IF1072 | 0x1F20 | 7968 | 2353 |
| X20IF1063 | 0x1F23 | 7971 | 2339 |
| X20IF1091 | 0x1F24 | 7972 | 2375 |
| X20IF2772 | 0x1F25 | 7973 | 2458 |
| X20IF2792 | 0x1F26 | 7974 | 2462 |
| X20IF1020 | 0x1F27 | 7975 | 2268 |
| X20IF1030 | 0x1F28 | 7976 | 2271 |
| X20PS4951 | 0x1F43 | 8003 | 3349 |
| X20PS9400 | 0x1F8C | 8076 | 926 |
| X20CS1020 | 0x1FCF | 8143 | 2147 |
| X20CS1030 | 0x1FD0 | 8144 | 2162 |
| X20CS1070 | 0x1FD1 | 8145 | 2177 |
| X20PS2110 | 0x2016 | 8214 | 3361 |
| X20PS3310 | 0x2017 | 8215 | 3373 |
| X20PS9500 | 0x2018 | 8216 | 1006 |
| X20DO6529 | 0x2019 | 8217 | 1766 |
| X20DM9324 | 0x20B9 | 8377 | 1572 |
| X20DO4529 | 0x20D9 | 8409 | 1679 |
| X20DO2649 | 0x20DA | 8410 | 1626 |
| X20DI4760 | 0x2105 | 8453 | 1505 |
| X20DC2190 | 0x2188 | 8584 | 1202 |
| X20CM1201 | 0x21EF | 8687 | 1875 |
| X20BC1083 | 0x2268 | 8808 | 2213 |
| X20BC0087 | 0x227C | 8828 | 864 |
| X20CP0201 | 0x22A2 | 8866 | 994 |

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| Model number | B&R ID code (hex.) | B&R ID code (dec.) | on page |
|--------------|--------------------|--------------------|---------|
| X20CP0291 | 0x22A4 | 8868 | 994 |
| X20CP0292 | 0x22A6 | 8870 | 994 |
| X20DI2372 | 0x22A7 | 8871 | 1452 |
| X20DI4372 | 0x22A8 | 8872 | 1480 |
| X20DO2321 | 0x22B3 | 8883 | 1581 |
| X20DO4321 | 0x22B4 | 8884 | 1632 |
| X20DO4331 | 0x22B5 | 8885 | 1649 |
| X20DO8331 | 0x22EB | 8939 | 1808 |
| X20CM0985 | 0x2433 | 9267 | 2803 |
| X20CM8281 | 0x24C3 | 9411 | 3178 |
| X20IF1091-1 | 0x2525 | 9509 | 2240 |
| X20DI2653 | 0x2544 | 9540 | 1467 |
| X20DI4653 | 0x2545 | 9541 | 1499 |
| X20DS1319 | 0x2547 | 9543 | 1957 |
| X20XC0201 | 0x2563 | 9571 | 2245 |
| X20XC0202 | 0x2564 | 9572 | 2245 |
| X20DI6553 | 0x256F | 9583 | 1532 |
| X20BC8083 | 0x2673 | 9843 | 2220 |
| X20BC8084 | 0x2674 | 9844 | 2227 |
| X20DO2623 | 0x267B | 9851 | 1599 |
| X20DO4623 | 0x267C | 9852 | 1699 |
| X20PD0011 | 0x267D | 9853 | 3327 |
| X20PD0012 | 0x267E | 9854 | 3332 |
| X20PD2113 | 0x267F | 9855 | 3343 |
| X20PD0016 | 0x2680 | 9856 | 3337 |
| X20SM1426 | 0x2681 | 9857 | 2603 |
| X20SM1436 | 0x2682 | 9858 | 2652 |
| X20MM2436 | 0x26B5 | 9909 | 2496 |
| X20BC0088 | 0x26D8 | 9944 | 877 |
| X20CS2770 | 0xA009 | 40969 | 2194 |
| X20DS1119 | 0xA067 | 41063 | 1914 |
| X20MM4456 | 0xA177 | 41335 | 2577 |
| X20BT9400 | 0xA238 | 41528 | 986 |
| X20CP1483 | 0xA239 | 41529 | 1380 |
| X20XC0292 | 0xA252 | 41554 | 2245 |
| X20AI4632-1 | 0xA29D | 41629 | 545 |
| X20AI2632-1 | 0xA29E | 41630 | 433 |
| X20PS9402 | 0xA389 | 41865 | 932 |
| X20PS9502 | 0xA38A | 41866 | 1012 |
| X20CS1011 | 0xA38D | 41869 | 2101 |
| X20DS4387 | 0xA38E | 41870 | 3269 |
| X20IF1074 | 0xA399 | 41881 | 2263 |
| X20AT2311 | 0xA4AA | 42154 | 3659 |
| X20DI8371 | 0xA4AB | 42155 | 1538 |
| X20DO8322 | 0xA4AC | 42156 | 1791 |
| X20DO8232 | 0xA4AD | 42157 | 1779 |
| X20AI1744-3 | 0xA4EF | 42223 | 243 |
| X20DO4649 | 0xA704 | 42756 | 1726 |
| X20DC1376 | 0xA705 | 42757 | 1137 |
| X20DC1176 | 0xA706 | 42758 | 1071 |
| X20DC1976 | 0xA707 | 42759 | 1186 |
| X20DC1178 | 0xA708 | 42760 | 1087 |
| X20IF1041-1 | 0xA709 | 42761 | 2274 |
| X20IF1043-1 | 0xA70B | 42763 | 2288 |
| X20IF1051-1 | 0xA70C | 42764 | 2302 |
| X20IF1053-1 | 0xA715 | 42773 | 2315 |
| X20IF1061-1 | 0xA716 | 42774 | 2328 |
| X20IF1063-1 | 0xA717 | 42775 | 2342 |
| X20IF10A1-1 | 0xA718 | 42776 | 2378 |
| X20IF10D1-1 | 0xA71B | 42779 | 2392 |
| X20IF10D3-1 | 0xA71C | 42780 | 2402 |
| X20IF10E1-1 | 0xA71D | 42781 | 2413 |
| X20IF10E3-1 | 0xA71E | 42782 | 2424 |
| X20IF10G3-1 | 0xA72C | 42796 | 2434 |
| X20CM6209 | 0xA7A1 | 42913 | 3174 |
| X20DI6373 | 0xA7A2 | 42914 | 1526 |
| X20IF1082-2 | 0xA7A3 | 42915 | 2363 |
| X20AO4635 | 0xA7FE | 43006 | 824 |
| X20BC0043-10 | 0xA8B8 | 43192 | 834 |
| X20DI4375 | 0xA911 | 43281 | 1486 |
| X20DS1928 | 0xA912 | 43282 | 2031 |
| X20DS4389 | 0xA93B | 43323 | 2056 |
| X20MM4331 | 0xA976 | 43382 | 2538 |
| X20MM3332 | 0xA982 | 43394 | 2523 |

| Model number | B&R ID code (hex.) | B&R ID code (dec.) | on page |
|--------------|--------------------|--------------------|---------|
| X20BC00G3 | 0xAC23 | 44067 | 910 |
| X20DO2633 | 0xAC39 | 44089 | 1610 |
| X20DO4633 | 0xAC3A | 44090 | 1709 |
| X20DO4613 | 0xAD05 | 44293 | 1686 |
| X20BC0143-10 | 0xAD3E | 44350 | 914 |
| X20CP1483-1 | 0xAEC5 | 44741 | 1380 |
| X20DC1073 | 0xAEC6 | 44742 | 1899 |
| X20DS1828 | 0xAEC7 | 44743 | 1999 |
| X20AI2636 | 0xB3A7 | 45991 | 458 |
| X20AI4636 | 0xB3A8 | 45992 | 570 |
| X20AI2438 | 0xB3A9 | 45993 | 373 |
| X20AO2438 | 0xB3AA | 45994 | 748 |
| X20IF1086-2 | 0xB455 | 46165 | 2369 |
| X20CM0985-1 | 0xB768 | 46952 | 2921 |
| X20DC11A6 | 0xB76B | 46955 | 1122 |
| X20AI2437 | 0xB784 | 46980 | 357 |
| X20AO2437 | 0xB785 | 46981 | 735 |
| X20BC00E3 | 0xBB7D | 47997 | 904 |
| X20ATA492 | 0xBB98 | 48024 | 3723 |
| X20ATC402 | 0xBB99 | 48025 | 3755 |
| X20CP3586 | 0xBF2B | 48939 | 1401 |
| X20DID371 | 0xC0E7 | 49383 | 1558 |
| X20DIF371 | 0xC0E8 | 49384 | 1564 |
| X20DOD322 | 0xC0E9 | 49385 | 1859 |
| X20DOF322 | 0xC0EA | 49386 | 1866 |
| X20AO2632-1 | 0xC36E | 50030 | 788 |
| X20AO4632-1 | 0xC36F | 50031 | 815 |
| X20CP1584 | 0xC370 | 50032 | 1397 |
| X20CP3584 | 0xC3AD | 50093 | 1401 |
| X20CP1585 | 0xC3AE | 50094 | 1397 |
| X20CP3585 | 0xC3AF | 50095 | 1401 |
| X20CP1586 | 0xC3B0 | 50096 | 1397 |
| X20IF2181-2 | 0xC3B3 | 50099 | 2452 |
| X20IF10X0 | 0xC3B4 | 50100 | 2447 |
| X20CM4810 | 0xC8F9 | 51449 | 3039 |
| X20AI2237 | 0xC9C4 | 51652 | 328 |
| X20AP3111 | 0xC9DA | 51674 | 661 |
| X20AP3121 | 0xC9DB | 51675 | 661 |
| X20AP3131 | 0xC9DC | 51676 | 661 |
| X20AI2222 | 0xCAB0 | 51888 | 318 |
| X20AI4222 | 0xCAB1 | 51889 | 489 |
| X20AI2322 | 0xCAB2 | 51890 | 346 |
| X20AI4322 | 0xCAB3 | 51891 | 499 |
| X20CS1012 | 0xCABF | 51903 | 2116 |
| X20DS438A | 0xCAC0 | 51904 | 3287 |
| X20CP1583 | 0xD45B | 54363 | 1397 |
| X20CP3583 | 0xD45C | 54364 | 1401 |
| X20cDI9371 | 0xD574 | 54644 | 1544 |
| X20cAO4632 | 0xD575 | 54645 | 805 |
| X20cBC0087 | 0xD577 | 54647 | 864 |
| X20cDO9322 | 0xD578 | 54648 | 1851 |
| X20cPS9400 | 0xD579 | 54649 | 926 |
| X20cAI4632-1 | 0xD57A | 54650 | 545 |
| X20AI8221 | 0xD82F | 55343 | 602 |
| X20AI8321 | 0xD831 | 55345 | 612 |
| X20CP1382 | 0xDABB | 55995 | 1324 |
| X20DC137A | 0xDD28 | 56616 | 1153 |
| X20cDIF371 | 0xDD44 | 56644 | 1564 |
| X20cPS3310 | 0xDD46 | 56646 | 3373 |
| X20cBR9300 | 0xDD48 | 56648 | 973 |
| X20cDOF322 | 0xDD4C | 56652 | 1866 |
| X20cAT6402 | 0xDD57 | 56663 | 3698 |
| X20CS1013 | 0xDE85 | 56965 | 2136 |
| X20cBC8084 | 0xDF10 | 57104 | 2227 |
| X20cPS3300 | 0xDF13 | 57107 | 3367 |
| X20DO8323 | 0xDF4E | 57166 | 1799 |
| X20DO6639 | 0xDF50 | 57168 | 1773 |
| X20ATA312 | 0xE0E4 | 57572 | 3710 |
| X20ATB312 | 0xE0EF | 57583 | 3742 |
| X20AP3161 | 0xE17B | 57723 | 661 |
| X20cAI2438 | 0xE1EE | 57838 | 373 |
| X20cAI4622 | 0xE1EF | 57839 | 509 |
| X20cAI4632 | 0xE1F0 | 57840 | 520 |
| X20cAO2437 | 0xE1F2 | 57842 | 735 |

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| Model number | B&R ID code (hex.) | B&R ID code (dec.) | on page |
|---------------|--------------------|--------------------|---------|
| X20cDS1119 | 0xE20D | 57869 | 1914 |
| X20cAO2438 | 0xE211 | 57873 | 748 |
| X20cAO4622 | 0xE212 | 57874 | 796 |
| X20cAO4632-1 | 0xE213 | 57875 | 815 |
| X20cAP3121 | 0xE214 | 57876 | 661 |
| X20cAT4222 | 0xE215 | 57877 | 3679 |
| X20cBC0083 | 0xE216 | 57878 | 859 |
| X20cBC1083 | 0xE217 | 57879 | 2213 |
| X20cBC8083 | 0xE218 | 57880 | 2220 |
| X20cBT9100 | 0xE219 | 57881 | 980 |
| X20cCP1584 | 0xE21B | 57883 | 1397 |
| X20cCP1586 | 0xE21C | 57884 | 1397 |
| X20cCP3584 | 0xE21D | 57885 | 1401 |
| X20cCP3586 | 0xE21E | 57886 | 1401 |
| X20cDI4371 | 0xE21F | 57887 | 1473 |
| X20cDI4375 | 0xE220 | 57888 | 1486 |
| X20cDI4760 | 0xE221 | 57889 | 1505 |
| X20cDI6371 | 0xE222 | 57890 | 1514 |
| X20cDI6372 | 0xE223 | 57891 | 1520 |
| X20cDI9372 | 0xE224 | 57892 | 1551 |
| X20cDM9324 | 0xE225 | 57893 | 1572 |
| X20cDO4322 | 0xE226 | 57894 | 1641 |
| X20cDO4332 | 0xE227 | 57895 | 1659 |
| X20cDO6321 | 0xE228 | 57896 | 1739 |
| X20cDO6322 | 0xE229 | 57897 | 1746 |
| X20cDO6639 | 0xE22A | 57898 | 1773 |
| X20cDO8331 | 0xE22B | 57899 | 1808 |
| X20cDO8332 | 0xE22C | 57900 | 1820 |
| X20cDO9321 | 0xE22D | 57901 | 1843 |
| X20clF1030 | 0xE233 | 57907 | 2271 |
| X20clF1061-1 | 0xE234 | 57908 | 2328 |
| X20clF1063-1 | 0xE235 | 57909 | 2342 |
| X20clF1082-2 | 0xE236 | 57910 | 2363 |
| X20clF10D3-1 | 0xE237 | 57911 | 2402 |
| X20clF10E3-1 | 0xE238 | 57912 | 2424 |
| X20clF10X0 | 0xE239 | 57913 | 2447 |
| X20clF2181-2 | 0xE23A | 57914 | 2452 |
| X20cPD2113 | 0xE23B | 57915 | 3343 |
| X20cPS2100 | 0xE23C | 57916 | 3356 |
| X20cPS2110 | 0xE23D | 57917 | 3361 |
| X20DO6325 | 0xE284 | 57988 | 1755 |
| X20AIB744 | 0xE286 | 57990 | 641 |
| X20CP1301 | 0xE35B | 58203 | 1324 |
| X20CP1381 | 0xE35C | 58204 | 1324 |
| X20CP1381-RT | 0xE35D | 58205 | 3382 |
| X20CP1382-RT | 0xE35E | 58206 | 3382 |
| X20cBC00E3 | 0xE4E0 | 58592 | 904 |
| X20cCM0985-1 | 0xE4FF | 58623 | 2921 |
| X20cCS1030 | 0xE500 | 58624 | 2162 |
| X20cDC1198 | 0xE501 | 58625 | 1115 |
| X20cDC1396 | 0xE502 | 58626 | 1169 |
| X20cDC2395 | 0xE503 | 58627 | 1216 |
| X20clF1041-1 | 0xE505 | 58629 | 2274 |
| X20clF1072 | 0xE506 | 58630 | 2353 |
| X20AIA744 | 0xE50C | 58636 | 622 |
| X20RT8001 | 0xE559 | 58713 | 3448 |
| X20RT8201 | 0xE55A | 58714 | 3477 |
| X20RT8202 | 0xE55B | 58715 | 3511 |
| X20RT8401 | 0xE55C | 58716 | 3577 |
| X20cDO4633 | 0xE67D | 59005 | 1709 |
| X20cDO4649 | 0xE67E | 59006 | 1726 |
| X20cBC0088 | 0xE67F | 59007 | 877 |
| X20cDO2633 | 0xE680 | 59008 | 1610 |
| X20cCP1382-RT | 0xE707 | 59143 | 3382 |
| X20cDO6529 | 0xE751 | 59217 | 1766 |
| X20cMM2436 | 0xE752 | 59218 | 2496 |
| X20clF10D1-1 | 0xE753 | 59219 | 2392 |
| X20cAI1744 | 0xE754 | 59220 | 196 |
| X20AP3122 | 0xE7BF | 59327 | 661 |
| X20AP3132 | 0xE7C0 | 59328 | 661 |
| X20AP3171 | 0xE7C1 | 59329 | 661 |
| X20DI0471 | 0xE7CE | 59342 | 1439 |
| X20cCM4810 | 0xE7F0 | 59376 | 3039 |
| X20cCS1020 | 0xE7F2 | 59378 | 2147 |

| Model number | B&R ID code (hex.) | B&R ID code (dec.) | on page |
|--------------|--------------------|--------------------|---------|
| X20MM4455 | 0xE8A4 | 59556 | 2551 |
| X20CP0410 | 0xE94F | 59727 | 1019 |
| X20CP0411 | 0xE950 | 59728 | 1019 |
| X20CP0482 | 0xE951 | 59729 | 1019 |
| X20CP0483 | 0xE952 | 59730 | 1019 |
| X20CP0484 | 0xE953 | 59731 | 1019 |
| X20AT4232 | 0xEA85 | 60037 | 3689 |
| X20BC0087-10 | 0xEA9F | 60063 | 870 |
| X20BC008U | 0xEAFB | 60155 | 882 |
| X20cAI1744-3 | 0xEB00 | 60160 | 243 |
| X20PS9600 | 0xEB03 | 60163 | 1047 |
| X20PS9602 | 0xEB04 | 60164 | 1055 |
| X20BB77 | 0xEB05 | 60165 | 1045 |
| X20BB72 | 0xEB06 | 60166 | 1043 |
| X20BB67 | 0xEB07 | 60167 | 1041 |
| X20BB62 | 0xEB08 | 60168 | 1039 |
| X20BB57 | 0xEB09 | 60169 | 1037 |
| X20BB52 | 0xEB0A | 60170 | 1035 |
| X20cDC1196 | 0xEB54 | 60244 | 1105 |
| X20cAP3131 | 0xEB55 | 60245 | 661 |
| X20cDS438A | 0xEB57 | 60247 | 3287 |
| X20cCP1301 | 0xEB58 | 60248 | 1324 |
| X20BR7300 | 0xEBED | 60397 | 964 |
| X20CM4323 | 0xEC21 | 60449 | 2992 |
| X20cDC2190 | 0xEE9D | 61085 | 1202 |
| X20AI1744-10 | 0xF1A7 | 61863 | 289 |
| X20CMR010 | 0xF1AC | 61868 | 3216 |
| X20CMR100 | 0xF1AD | 61869 | 3230 |
| X20CMR111 | 0xF1AE | 61870 | 3242 |
| X20SM1436-1 | 0xF1B0 | 61872 | 2700 |
| X20CM4800X | 0xF1C5 | 61893 | 3021 |
| X20RT8381 | 0xF24E | 62030 | 3543 |
| X20DO8332-1 | 0xF321 | 62241 | 1832 |
| X20SM1446-1 | 0xF3B0 | 62384 | 2751 |
| X20cAT2311 | 0xF3B6 | 62390 | 3659 |
| X20CM0985-02 | 0xF425 | 62501 | 2846 |
| X20CP0420 | 0xF4D3 | 62675 | 1019 |
| X20DO4332-1 | 0xF5F9 | 62969 | 1669 |
| X20DO4F49 | 0xF76A | 63338 | 1732 |
| X20CP1684 | 0xF9EA | 63978 | 1418 |
| X20CP1685 | 0xF9EB | 63979 | 1418 |
| X20CP1686X | 0xF9EC | 63980 | 1418 |
| X20CP3684 | 0xF9ED | 63981 | 1422 |
| X20CP3685 | 0xF9EE | 63982 | 1422 |
| X20CP3686X | 0xF9F9 | 63993 | 1422 |
| X20CP3687X | 0xF9FA | 63994 | 1422 |
| X20CP0484-1 | 0xFA24 | 64036 | 1019 |

7 Accessories

7.1 Additional equipment for X20 modules and CPUs

The following additional equipment is available for X20 modules and CPUs:

- X20 modules** Plain text tag, accessory locking clip and tag holder that also serves as a terminal locking clip
- X20 CPU** Plain text tag

Installation of these accessories is described in section ["Installing accessories"](#) on page 114.

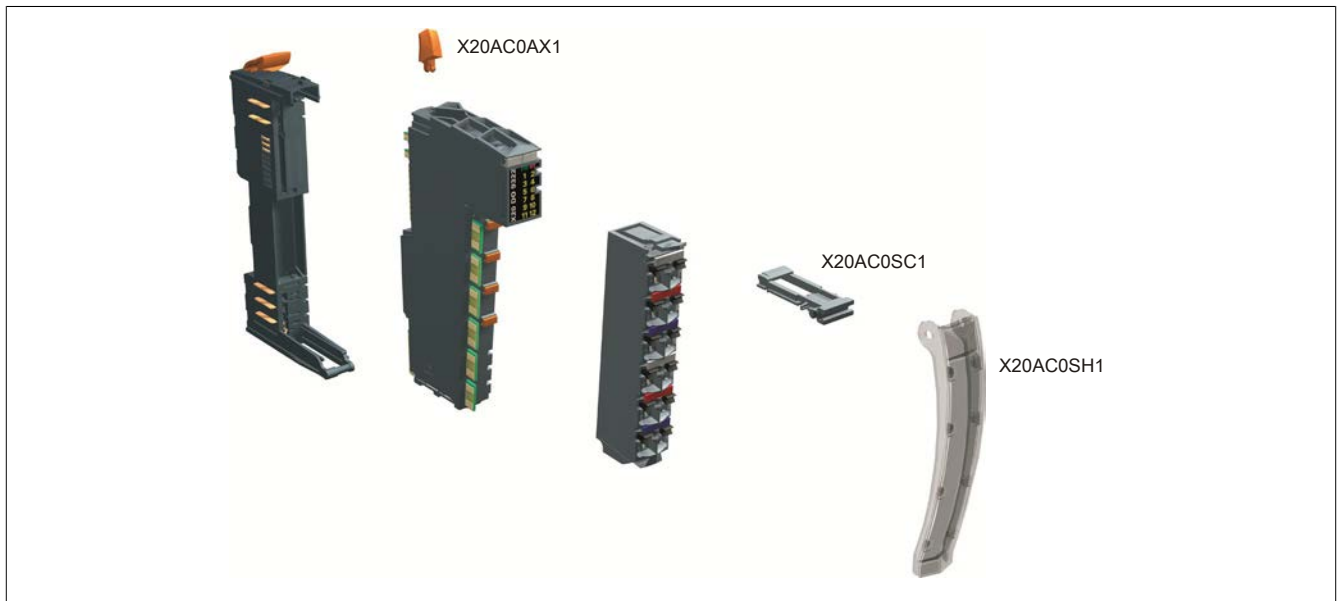



Figure 42: Additional equipment for X20 modules





Figure 43: Additional equipment for X20 CPUs

7.1.1 Tag holder, terminal locking clip

| Order number | Short description | Figure |
|----------------|---|---|
| | Tag holder, terminal locking clip |  |
| X20AC0SC1 | X20 terminal locking clip and tag holder for plain text tag | |
| X20AC0SC1.0100 | X20 terminal locking clip and tag holder for plain text tag, 100 pcs. per package | |


7.1.2 Plain text tag for X20 modules

A template file is available for X20 slide-in labels on the B&R website in the "Downloads" section under order number X20AC0LB2.0100. This template is in Excel format and makes it possible to enter the desired texts for the slide-in labels.


| Model number | Short description | Figure |
|----------------|---|--|
| | Plain text cover |  |
| X20AC0SH1 | X20 plain text tag | |
| X20AC0SH1.0100 | X20 plain text tag, 100 pcs. per package | |
| | X20 legend strips |  |
| X20AC0LB2.0100 | X20 slide-in labels for X20 plain text tags, paper, white, perforated, 88 strips on A4 sheets, 100 sheets per package | |

7.1.3 Plain text tag for X20 CPUs

The plain text tag is labeled with commercially available adhesive labels. The adhesive labels are not available as accessories.


| Model number | Short description | Figure |
|----------------|-------------------------|---|
| | X20 CPU Label |  |
| X20AC0SH2.0010 | X20 CPU labels, 10 pcs. | |

7.1.4 Accessory locking clips

| Order number | Short description | Figure |
|----------------|--|---|
| | Accessory locking clip |  |
| X20AC0AX1 | X20 accessory locking clip | |
| X20AC0AX1.0100 | X20 accessory locking clip, 100 pcs. per package | |

7.2 Locking plates

The locking plate protects the modules on the outside against dirt and damage.

| Order number | Short description | Figure |
|----------------|--|---|
| | End cover plate |  |
| X20AC0SL1 | X20 end cover plate (left) | |
| X20AC0SR1 | X20 end cover plate (right) | |
| X20AC0SL1.0010 | X20 end cover plate (left), 10 pcs. per package | |
| X20AC0SR1.0010 | X20 end cover plate (right), 10 pcs. per package | |

7.3 Cover for interface modules

The cover protects the slots for interface modules from dirt and damage.



| Model number | Short description | Figure |
|----------------|---|--|
| | Interface module slot cover |  |
| X20AC0IC1.0010 | X20 cover for interface module slot, 10-pc. package | |

Table 11: X20AC0IC1.0010 - Order data

7.4 Cable shield clamp

For information on use, see section "X20 cable shield clamp" on page 53.

| Model number | Short description | Figure |
|----------------|--|---|
| | Cable shield clamp |  |
| X20AC0SG1.0010 | X20 cable shield grounding clamp, 10 pcs. per package | |
| X20AC0SG1.0100 | X20 cable shield grounding clamp, 100 pcs. per package | |

7.5 Shielding bracket

The X20 shielding bracket provides an easy and space-saving way to ground the cable shielding (see "X20 shielding bracket" on page 53).


| Model number | Short description | Figure |
|----------------|-------------------------------------|---|
| | Shielding bracket |  |
| X20AC0SF7.0010 | X20 shielding bracket 66 mm 10 pcs. | |
| X20AC0SF9.0010 | X20 shielding bracket 88 mm 10 pcs. | |

Table 12: X20AC0SF7.0010, X20AC0SF9.0010 - Order data

7.6 End clamp set


| Model number | Short description | Figure |
|--------------|---------------------------------------|--|
| | End clamp set |  |
| X20AC0RF1 | X20 end clamp set for high vibrations | |

Table 13: X20AC0RF1 - Order data

7.7 Shield connection clamp


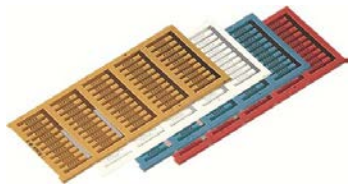

|  | |
|---|--|
| Model number | Short description |
| | Shield connection clamp |
| X20AC0SA08.0010 | X20 shield connection clamp 3 to 8 mm, 10 pieces |
| X20AC0SA14.0010 | X20 shield connection clamp 3 to 14 mm, 10 pieces |
| X20AC0SA20.0010 | X20 shield connection clamp 5 to 20 mm, 10 pieces |
| X20AC0SA35.0010 | X20 shield connection clamp 20 to 35 mm, 10 pieces |

Table 14: X20AC0SA08.0010, X20AC0SA14.0010, X20AC0SA20.0010, X20AC0SA35.0010 - Order data

7.8 Terminal labeling


Each terminal connection is identified clearly directly on the terminal. It is also possible to attach tags to label the terminals individually.

The labeling tool is needed for attachment (see "Label tags" on page 119). For information about printing terminal labels, see "Printing support" on page 45.

| | | | |
|---|--|--|--|
|  | |  | |
| X20AC0M0x / X20AC0M1x | | X20AC0M21 | |
| Blank X20 tag labels (10.4 x 2.4 mm) | | | |
| X20AC0M01 | Blank X20 tag labels, white, set for 16 modules | | |
| X20AC0M02 | Blank X20 tag labels, red, set for 16 modules | | |
| X20AC0M03 | Blank X20 tag labels, blue, set for 16 modules | | |
| X20AC0M04 | Blank X20 tag labels, orange, set for 16 modules | | |
| Printed X20 tag labels (10.4 x 2.4 mm) | | | |
| X20AC0M11 | Printed X20 tag labels, white, set for 16 modules, label text: Module (modules 1 to 16), terminal (1 to 192) | | |
| X20AC0M12 | Printed X20 tag labels, red, set for 16 modules, label text: +24 V | | |
| X20AC0M13 | Printed X20 tag labels, blue, set for 16 modules, label text: GND | | |
| X20AC0M14 | Printed X20 tag labels, orange, set for 16 modules, label text: Module (modules 1 to 16), terminal (1 to 192) | | |
| Blank X20 tag labels, 10 pcs. per package (10.4 x 2.4 mm) | | | |
| X20AC0M01.0010 | Blank X20 tag labels, white, set for 16 modules, 10 pcs. per package | | |
| X20AC0M02.0010 | Blank X20 tag labels, red, set for 16 modules, 10 pcs. per package | | |
| X20AC0M03.0010 | Blank X20 tag labels, blue, set for 16 modules, 10 pcs. per package | | |
| X20AC0M04.0010 | Blank X20 tag labels, orange, set for 16 modules, 10 pcs. per package | | |
| Printed X20 tag labels, 10 pcs. per package (10.4 x 2.4 mm) | | | |
| X20AC0M11.0010 | Printed X20 tag labels, white, set for 16 modules, 10 pcs. per package, label text: Module (modules 1 to 16), terminal (1 to 192) | | |
| X20AC0M12.0010 | Printed X20 tag labels, red, set for 16 modules, 10 pcs. per package, label text: +24 V | | |
| X20AC0M13.0010 | Printed X20 tag labels, blue, set for 16 modules, 10 pcs. per package, label text: GND | | |
| X20AC0M14.0010 | Printed X20 tag labels, orange, set for 16 modules, 10 pcs. per package, label text: Module (modules 1 to 16), terminal (1 to 192) | | |
| Blank X20 tag labels, large (10.4 x 7.0 mm) | | | |
| X20AC0M21 | Blank X20 tag labels, large white, set for 48 modules | | |
| X20AC0M21.0010 | Blank X20 tag labels, large white, set for 48 modules, 10 pcs. per package | | |

7.9 Labeling tool

The labeling tool is needed to attach the tag labels.

| Order number | Short description | Figure |
|--------------|---|---|
| | Labeling tool | |
| X20AC0MT1 | X20 labeling tool for X20 labeling system |  |

7.10 Screwdriver

The screwdriver was developed specially for use with terminal blocks X20TB1E and X20TB1F to prevent damage to the terminals.





| Model number | Short description | Figure |
|--------------|--------------------|---|
| | Screwdriver | |
| X20AC0SD1 | B&R screwdriver |  |

Table 15: X20AC0SD1 - Order data

7.11 Pre-assembled cables

7.11.1 POWERLINK/Ethernet cables

| Short description, order number | | | |
|---------------------------------|--|--|--|
| Length | Connection cables - RJ45 to RJ45 | | Attachment cables - RJ45 to M12 |
| 0.2 m | | X20CA0E61.00020 | |
| 0.25 m | | X20CA0E61.00025 | |
| 0.3 m | | X20CA0E61.00030 | |
| 0.35 m | | X20CA0E61.00035 | |
| 0.4 m | | X20CA0E61.00040 | |
| 0.5 m | | X20CA0E61.00050 | |
| 1 m | | X20CA0E61.00100 | X67CA0E41.0010 |
| 1.5 m | | X20CA0E61.00150 | |
| 2 m | | X20CA0E61.00200 | X67CA0E41.0020 |
| 3 m | | | X67CA0E41.0030 |
| 5 m | | X20CA0E61.00500 | X67CA0E41.0050 |
| 10 m | X20CA3E61.0100 | X20CA0E61.01000 | |
| 15 m | X20CA3E61.0150 | X20CA0E61.01500 | X67CA3E41.0150 X67CA0E41.0150 |
| 20 m | X20CA3E61.0200 | X20CA0E61.02000 | |
| 30 m | X20CA0E61.0300 | | |
| 40 m | X20CA0E61.0400 | | |
| 50 m | X20CA0E61.0500 | | X67CA0E41.0500 |
| 100 m | X20CA0E61.1000 | | |
| |  |  |  |

| Length | Tolerances for cable lengths |
|------------------------|------------------------------|
| X20CA0E61.xxxx | |
| 10 to 100 m | +2% of the length |
| X20CA0E61.xxxxx | |
| 0.2 to 0.5 m | +0.01 m |
| 1 to 5 m | +0.04 m |
| 6 to 20 m | +1% of the length |
| X67CAxE41.xxxx | |
| 0 to <10 m | +10 cm |
| 10 m to <50 m | +2% of the length |

7.11.1.1 Technical data

| Product ID | X20CA0E61.xxxxx | X20CA0E61.xxxx | X67CA0E41 | X20CA3E61 | X67CA3E41 |
|-----------------------------------|--|---|-------------------------|--|----------------------------|
| General information | | | | | |
| Note | Lead-free | Halogen-free | | | |
| Durability | Flame-retardant in accordance with IEC 60332-3-24 | Flame-retardant in accordance with IEC 60332-1-2 | | Oil resistant in accordance with EN 60811-2-1 Flame-retardant in accordance with IEC 60332-1-2 UV resistant in accordance with UL 2556 | |
| Connection | RJ45 to RJ45 | | RJ45 to M12; 4-pin | RJ45 to RJ45 | RJ45 to M12; 4-pin |
| Type | Connection cables | | Attachment cables | Connection cables | Attachment cables |
| Cable cross section | | | | | |
| AWG | 4x 2x 26 AWG | | 4x 22 AWG | | |
| mm ² | 4x 2x 0.14 mm ² | | 4x 0.34 mm ² | | |
| RoHS-compliant ¹⁾ | Yes | | | | |
| Cable construction | | | | | |
| Complete shielding | Aluminum-clad foil (overlapping), tinned copper braiding, 85% covering | | | | |
| Outer sheathing | | | | | |
| Material | Polyvinyl chloride(PVC) | Polyurethane (PUR) | | | |
| Color | Black | Green | | | |
| Labeling | "B&R" + Model number + Revision number | | | | |
| Lines | | | | | |
| Wire insulation | Polyethylene (PE) | | | | |
| Wire colors | Blue-white, blue, orange-white, orange, green-white, green, brown-white, brown | White, yellow, blue, orange | | | |
| Type | Tinned copper stranded wire Stranded wire (4x 2x 26 AWG) | Tinned copper stranded wire Fine stranded wire (7x 0.25 mm / 7x 22 AWG) | | | |
| Stranding | Twisted pair wires | | 4-wire twisted pair | | |
| Electrical characteristics | | | | | |
| Operating voltage | Max. 125 V | | - | | |
| Conductor resistance | ≤145 Ω/km at 20°C | | ≤120 Ω/km at 20°C | | |
| Transfer properties | Category 5 according to EN 50288-2-2 (2004) / IEC 61156-6 (2002) | Category 5 / Class D up to 100 MHz in accordance with ISO/IEC 11801 (EN50173-1), ISO/IEC 24702 (EN 50173-3) | | | |
| Transfer rate | 10/100 Mbit/s | | | | |
| Insulation resistance | ≥5 GΩ/km at 20°C | | ≥500 MΩ/km at 20°C | | |
| Operating conditions | | | | | |
| EN 60529 protection | | | | | |
| Cables | IP67 | | | | |
| Male M12 connector | - | IP67, only when screwed in | | - | IP67, only when screwed in |
| RJ45 connector | IP20, only when connected properly | | | | |
| Environmental conditions | | | | | |
| Temperature | | | | | |
| Transport | -40 to 80°C | | -40 to 70°C | | |
| Fixed installation | -40 to 80°C | | -40 to 70°C | | |
| Flexible installation | -10 to 60°C | | -20 to 60°C | | |
| Mechanical characteristics | | | | | |
| Dimensions | | | | | |
| Length | Various | | | | 15 m |
| Diameter | 6.7 mm ±0.2 mm | | 6.5 mm ±0.2 mm | | |
| Bend radius | ≥8x outer diameter | | ≥7x outer diameter | | |
| Drag chain data | | | | | |
| Acceleration | - | | 4 m/s ² | | |
| Flex cycles | - | | Min. 3 million | | |
| Speed | - | | 4 m/s | | |
| Weight | 0.058 kg/m | 0.064 kg/m | 0.061 kg/m | | |

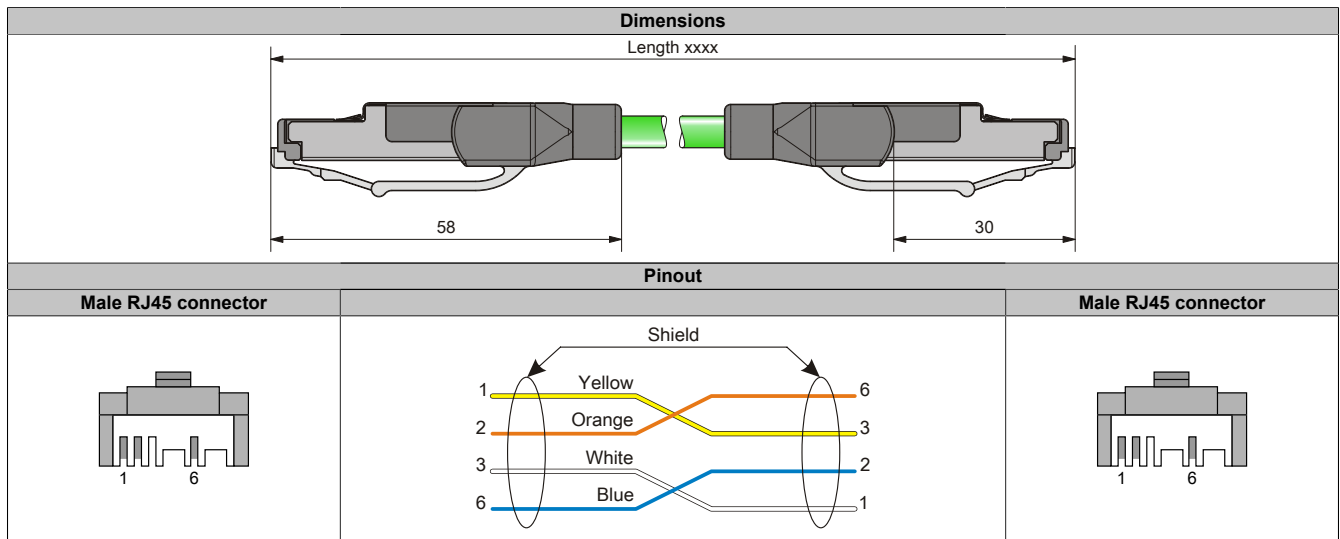
Table 16: X20CAxE61 / X67CAxE41 - Technical data

- 1) RoHS (Restriction of the use of certain Hazardous Substances) limits the use of the following substances in electrical and electronic devices: lead, mercury, cadmium, chrome VI as well as flame-retardant polybrominated biphenyl (PBB) and polybrominated diphenyl ether (PBDE).

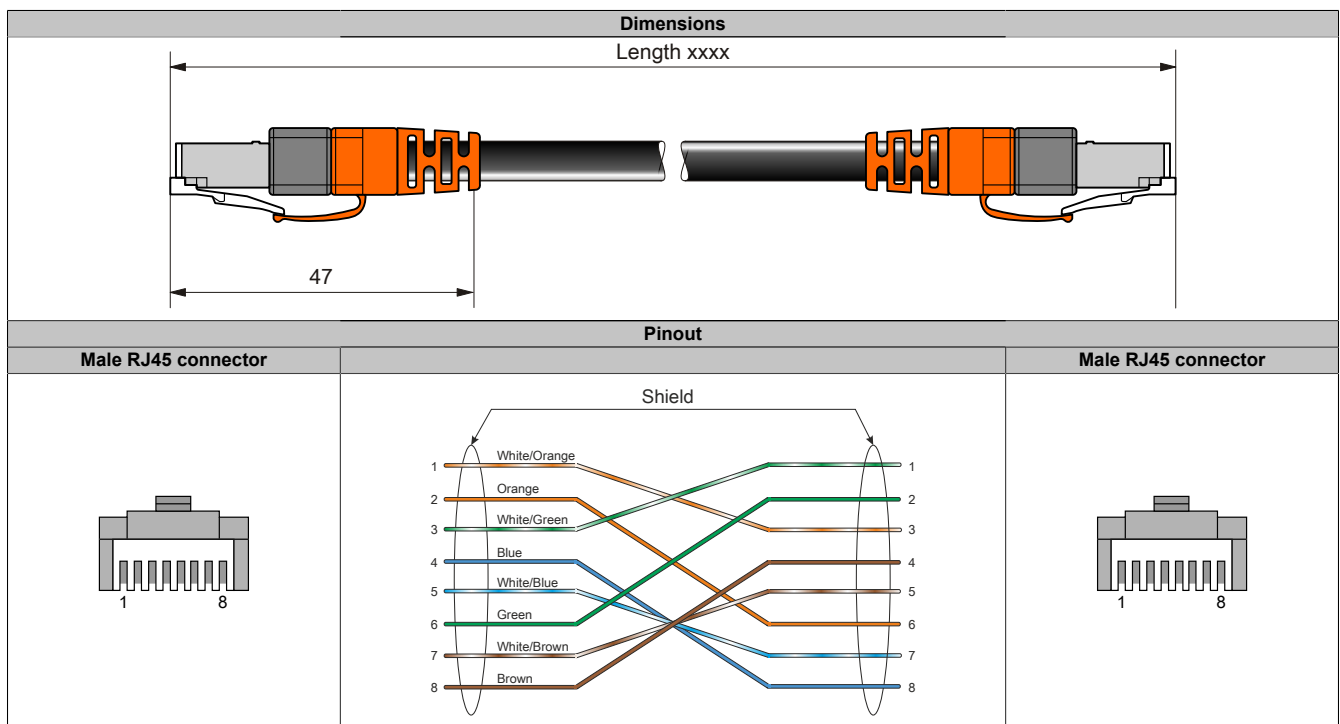
7.11.1.2 X20CA0E61.xxxx and X20CA3E61.xxxx

This cable is offered in 2 variants:

- X20CA0E61: Standard design
- X20CA3E61: Can be used in cable drag chains



7.11.1.3 X20CA0E61.xxxxx





7.11.1.4 X67CA0E41.xxxx and X67CA3E41.xxxx

This cable is offered in 2 variants:


- X67CA0Exx: Standard variant
- X67CA3Exx: Can be used in cable drag chains

| Dimensions | | | | |
|---------------------|-------|-------------|---------|----------------|
| | | | | |
| Pinout | | | | |
| Male RJ45 connector | Pin | Description | Diagram | M12 connector |
| | 1 - 1 | TXD | | <p>D-coded</p> |
| | 2 - 3 | RXD | | |
| | 3 - 2 | TXD\ | | |
| | 6 - 4 | RXD\ | | |

7.11.2 X2X Link cables

| Length | Short description, model number | |
|--------|---|---|
| | Attachment cables | Connection cables |
| 0.3 m | | X20CA0X68.0003 |
| 1 m | X20CA0X48.0010 | X20CA0X68.0010 |
| 2 m | X20CA0X48.0020 | X20CA0X68.0020 |
| 5 m | X20CA0X48.0050 | X20CA0X68.0050 |
| 10 m | X20CA0X48.0100 | X20CA0X68.0100 |
| 20 m | X20CA0X48.0200 | |
| |  |  |

| Length | Tolerances for cable lengths |
|---------------|------------------------------|
| 0 to <10 m | +10 cm |
| 10 m to <50 m | +2% of the length |

| Length | Short description, model number |
|--------|---|
| | X2X Link cables for custom assembly |
| 100 m | X67CA0X99.1000 |
| 500 m | X67CA0X99.5000 |
| |  |

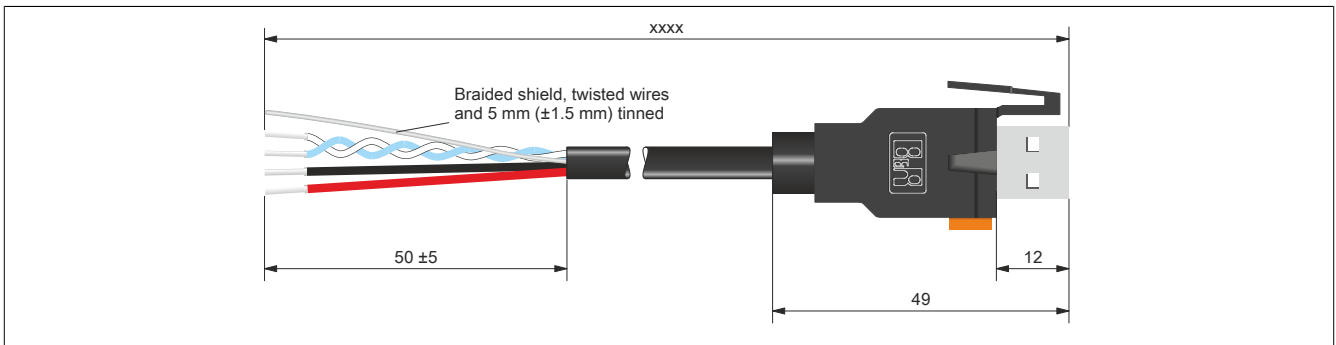
7.11.2.1 Technical data

| Product ID | X20CA0X48 | X20CA0X68 | X67CA0X99 |
|-----------------------------------|--|-------------------|--|
| General information | | | |
| Note | | | Halogen-free |
| Durability | Flame-retardant according to VW-1 and FT1 | | Flame-retardant |
| Connection | USB A, male | | - |
| Type | Attachment cables | Connection cables | - |
| Cable cross section | | | |
| Data cables | | | |
| AWG | 2x 24 AWG | | |
| mm ² | 2x 0.25 mm ² | | |
| Supply lines | | | |
| AWG | 2x 22 AWG | | |
| mm ² | 2x 0.34 mm ² | | |
| RoHS-compliant ¹⁾ | Yes | | |
| Cable construction | | | |
| Signal lines | | | |
| Shield | Paired shield with aluminum foil | | |
| Stranding | Twisted pair wires | | |
| Cable stranding | 7/36 (28 AWG) with filler | | 0.35 mm ² (22 AWG) with filler |
| Complete shielding | Tinned copper braiding, coverage >85% | | |
| Outer sheathing | | | |
| Material | Polyvinyl chloride(PVC) | | Thermoplastic polyurethane (TPU) |
| Color | Black | | Violet |
| Labeling | "B&R" + Model number + Revision number | | B&R X67CA0X99.xxxx |
| Lines | | | |
| Type | Tinned copper stranded wire | | Tinned copper ETB1 Data line: Fine stranded wire (19x 0.13 mm) Supply line: Fine stranded wire (19x 0.15 mm) |
| Wire colors | | | |
| Data cables | Blue, white | | |
| Supply lines | Red, black | | |
| Wire insulation | | | |
| Data cables | Polyethylene foam | | Cell polyethylene (PE) |
| Supply lines | SR PVC | | Polyethylene (PE) |
| Electrical characteristics | | | |
| Operating voltage | 30 V | | Max. 2500 VAC |
| Degree of insulation | - | | Category II in accordance with IEC 61076-2 |
| Conductor resistance | Data line: <93.2 Ω/km at 20°C Supply line: <55 Ω/km at 20°C | | Data line: ≤78 Ω/km Supply line: ≤55 Ω/km |
| Operating conditions | | | |
| EN 60529 protection | | | |
| Connector/Coupling | IP20, only when connected properly | | - |
| Environmental conditions | | | |
| Temperature | -25 to 80°C | | -40 to 80°C |
| Fixed installation | -25 to 80°C | | -40 to 80°C |
| Flexible installation | -20 to 80°C | | -25 to 60°C |
| Mechanical characteristics | | | |
| Dimensions | | | |
| Length | Various | | |
| Diameter | 7 mm ± 0.19 mm | | 6.9 mm ±0.2 mm |
| Bend radius | ≥8x outer diameter | | ≥15x outer diameter |
| Drag chain data | | | |
| Acceleration | - | | Max. 4 m/s ² |
| Flex cycles | - | | Min. 2 million |
| Speed | - | | Max. 3 m/s |
| Weight | - | | 0.063 kg/m |

Table 17: X20CA0Xx8 / x67CA0X99 - Technical data

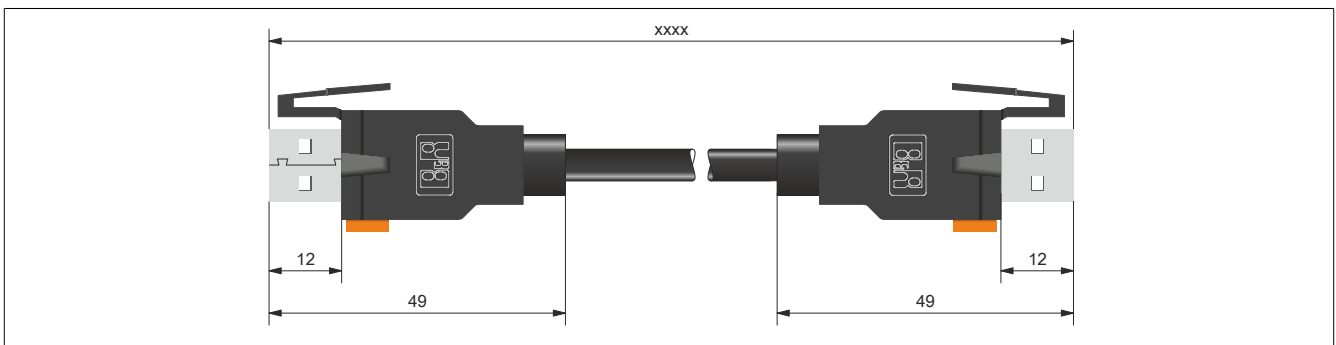
- 1) RoHS (Restriction of the use of certain Hazardous Substances) limits the use of the following substances in electrical and electronic devices: lead, mercury, cadmium, chrome VI as well as flame-retardant polybrominated biphenyl (PBB) and polybrominated diphenyl ether (PBDE).

7.11.2.2 X20CA0X48.xxxx



| Pinout | | | | |
|-------------------|----------------|------------------|------------|---|
| Open | Pin | Name | Wire color | Male connector |
| For custom Wiring | 1 | X2X+ | Red | <p>Shield</p> <p>1</p> <p>4</p> <p>Keying for X3A</p> |
| | 2 | X2X\ | Blue | |
| | 3 | X2X | White | |
| | 4 | X2X _L | Black | |
| | Male connector | SHLD | Shield | |

7.11.2.3 X20CA0X68.xxxx



| Pinout | | | | |
|---------------------------------|----------------|------------------|------------|---------------------------------|
| Male connector | Pin | Name | Wire color | Male connector |
| <p>Shield</p> <p>1</p> <p>4</p> | 1 | X2X+ | Red | <p>Shield</p> <p>1</p> <p>4</p> |
| | 2 | X2X\ | Blue | |
| | 3 | X2X | White | |
| | 4 | X2X _L | Black | |
| | Male connector | SHLD | Shield | |

7.11.2.4 X67CA0X99.xxxx

| Dimensions | | | |
|-------------------|------------------|-------------|-------------------|
| | | | |
| Pinout | | | |
| For custom Wiring | Description | Wire colors | For custom Wiring |
| | X2X+ | Red | |
| | X2X | White | |
| | X2X _L | Black | |
| | X2X\ | Blue | |
| SHLD | - | | |

8 International and national certifications












Products and services from B&R comply with applicable standards. This includes international standards from organizations such as ISO, IEC and CENELEC, as well as national standards from organizations such as UL, CSA, DNV GL, etc. We are committed to ensuring the reliability of our products in an industrial environment.

Information:

Certifications that apply to a particular module are available at the following places:

- The data sheet's technical data under "Certifications".
- At www.br-automation.com under "Products" in the "General information → Certifications" area of the technical data
- On the side of the module housing

8.1 Overview of certifications

| Mark | Explanation | Certificate authority | Region |
|---|---|--|----------------------------|
|  | CE marking | Notified bodies | Europe (EU) |
|  | Functional safety (CE) | Notified bodies | Europe (EU) |
|  | Explosion protection (CE) | Notified bodies | Europe (EU) |
|  | Underwriters Laboratories Inc. (UL) (certification for US and Canada) | UL | Canada USA |
|  | Canadian Standards Association (CSA) (certification for US and Canada) | CSA | Canada USA |
|  | Det Norske Veritas - Germanischer Lloyd (DNV GL) | DNV GL | Germany Norway |
|  | Korean Register of Shipping (KR) | KR | Korea |
|  | Lloyd's Register (LR) | LR | Great Britain |
|  | Eurasian Conformity (EAC) | Federal agency on technical regulat- ing and metrology | Eurasian Economic Union |
|  | Korean Conformity (KC) | Radio Research Agency (RRA) | Korea |
|  | Regulatory Compliance Mark (RCM) | ACMA | Australia Oceania |

8.2 EU directives and standards (CE)

CE marking



Europe (EU)

The respective product complies with all applicable EU directives and relevant harmonized standards.

Certification of these products is performed in cooperation with accredited testing laboratories.

EMC Directive 2014/30/EU

All devices satisfy the protection requirements of the "EMC Directive" and are designed for industrial use.

Applicable standards from this directive:

| | |
|--------------|--|
| EN 61131-2 | Programmable logic controllers - Part 2: Equipment requirements and tests |
| EN 61000-6-2 | Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments |
| EN 61000-6-4 | Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments |

Low Voltage Directive 2014/35/EU

The low voltage directive applies to electrical equipment with a nominal voltage from 50 to 1000 VAC and from 75 to 1500 VDC.

All devices within the area of application of this directive satisfy the its protection requirements.

Applicable standard from this directive:

| | |
|------------|--|
| EN 61131-2 | Programmable logic controllers - Part 2: Equipment requirements and tests |
|------------|--|

The corresponding declaration of conformity is available for download from the B&R website. For information about the versions of applicable standards, see the declaration of conformity.



Declaration of conformity

[Website > Downloads > Certificates > Declarations of conformity > Declaration of conformity - PLC](#)

Machinery directive 2006/42/EC**Functional safety****Europe (EU)**

In accordance with the machinery directive, safety technology products are designed, developed, tested and labeled for special applications providing protection to machinery and personnel.

Certification of these products is performed exclusively in cooperation with EU-authorized bodies (Notified Bodies).

Applicable standards from this directive:

SIL 3:

| | |
|-------------|--|
| IEC 61508-1 | Functional safety of electrical / electronic / programmable electronic safety-related systems - Part 1: General requirements |
| IEC 61508-2 | Functional safety of electrical / electronic / programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems |
| IEC 61508-3 | Functional safety of electrical / electronic / programmable electronic safety-related systems - Part 3: Software requirements |
| IEC 61508-4 | Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 4: Definitions and abbreviations |
| EN 62061 | Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems |
| IEC 61511-1 | Functional safety - Safety instrumented systems for the process industry sector - Part 1: Framework, definitions, system, hardware and software requirements |

PL e, Cat. 4:

| | |
|----------------|--|
| EN ISO 13849-1 | Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design |
| EN 61131-2 | Programmable logic controllers - Part 2: Equipment requirements and tests |

Declarations of conformity, certificates and any other safety-related documentation can be downloaded from the B&R website. For information about the versions of applicable standards, see the declaration of conformity.

**Declaration of conformity**

[Website > Downloads > Certificates > Declarations of conformity > Declaration of conformity - FS PLC](#)

**Certificates**

[FS EN 50156 certificate - SafeLOGIC, SafeIO](#)
[FS certificate - SafeDESIGNER, SafeLOGIC, SafeIO](#)
[Safe cutoff of potential groups](#)

**User's manual**

[Website > Downloads > Safety technology > Integrated safety technology user's manual](#)

ATEX directive 2014/34/EU

ATEX / Zone 2



II 3G Ex nA nC IIA T5 Gc

Europe (EU)

Products with this mark are suitable for use in potentially explosive atmospheres. The X20 system is certified for use in environments with explosive gases with a normal level of safety (Zone 2).

Certification of these products is performed exclusively in cooperation with EU-authorized bodies (Notified Bodies).

Each module is also accompanied by an information sheet providing detailed installation and safety guidelines.

Applicable standards from this directive:

| | |
|-------------|--|
| EN 60079-0 | Explosive atmospheres Part 0: Equipment - General requirements |
| EN 60079-15 | Explosive atmospheres - Part 15: Equipment protection by type of protection "n" |

The declaration of conformity and certificate can be downloaded from the B&R website. For information about the versions of applicable standards, see the declaration of conformity.



Declaration of conformity

[Website > Downloads > Certificates > Declaration of conformity > Declaration of conformity - ATEX X20](#)



Certificate

[Website > Downloads > Certificates > ATEX > X20 > FTZÙ 09 ATEX 0083X](#)

8.2.1 Overview of standards

| Standard | Description |
|--------------------------------|--|
| EN ISO 13849-1 | Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design |
| EN 50581 | Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances |
| EN 55011 (CISPR 11) | Industrial, scientific and medical equipment - Radio frequency disturbance characteristics - Limits and methods of measurement |
| EN 55016-2-1 (CISPR 16-2-1) | Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-1: Methods of measurement of disturbances and immunity - Conducted disturbance measurements |
| EN 55016-2-3 (CISPR 16-2-3) | Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-3: Methods of measurement of disturbances and immunity - Radiated disturbance measurements |
| EN 55022 (CISPR 22) | Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement |
| EN 60068-2-6 | Environmental testing - Part 2-6: Procedures - Test Fc: Vibration (sinusoidal) |
| EN 60068-2-27 | Environmental testing - Part 2-27: Test procedure - Test Ea and guidance: Shock |
| EN 60068-2-31 ¹⁾ | Environmental testing - Part 2-31: Test procedure - Test Ec: Rough handling shocks, mainly for devices |
| EN 60079-0 | Explosive atmospheres Part 0: Equipment - General requirements |
| EN 60079-15 | Explosive atmospheres - Part 15: Equipment protection by type of protection "n" |
| EN 60529 | Degrees of protection provided by enclosures (IP code) |
| EN 60664-1 | Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests |
| EN 60721-3-2 | Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 2: Transport and handling |
| EN 60721-3-3 | Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 3: Stationary use at weather-protected locations |
| EN 61000-4-2 | Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test |
| EN 61000-4-3 | Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test |
| EN 61000-4-4 | Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test |
| EN 61000-4-5 | Electromagnetic compatibility (EMC) - Part 4-5: Testing and measuring techniques - Surge immunity test |
| EN 61000-4-6 | Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields |
| EN 61000-4-8 | Electromagnetic compatibility (EMC) - Part 4-8: Testing and measuring techniques - Power frequency magnetic field immunity test |
| EN 61000-4-11 | Electromagnetic compatibility (EMC) - Part 4-11: Testing and measuring techniques - Voltage dips, short interruptions and voltage variations |
| EN 61000-4-29 | Electromagnetic compatibility (EMC) - Part 4-29: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests |
| EN 61000-6-2 | Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments |
| EN 61000-6-4 | Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments |
| EN 61131-2 | Programmable logic controllers - Part 2: Guidance for inspection and routine testing |
| IEC 61508-1 | Functional safety of electrical / electronic / programmable electronic safety-related systems - Part 1: General requirements |
| IEC 61508-2 | Functional safety of electrical / electronic / programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems |
| IEC 61508-3 | Functional safety of electrical / electronic / programmable electronic safety-related systems - Part 3: Software requirements |
| IEC 61508-4 | Functional safety of electrical / electronic / programmable electronic safety-related systems - Part 4: Definitions and abbreviations |
| IEC 61511-1 | Functional safety - Safety instrumented systems for the process industry sector - Part 1: Framework, definitions, system, hardware and software requirements |
| EN 62061 | Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems |

1) Replacement for EN 60068-2-32

8.2.2 Requirements for immunity to disturbances

| Immunity | Test carried out in accordance with | Requirements in accordance with |
|---|-------------------------------------|--|
| Electrostatic discharge (ESD) | EN 61000-4-2 | EN 61131-2: Product standard - Programmable logic controllers EN 61000-6-2: Generic standard - Immunity to disturbances in industrial sectors |
| High-frequency electromagnetic fields (HF field) | EN 61000-4-3 | EN 61131-2: Product standard - Programmable logic controllers EN 61000-6-2: Generic standard - Immunity to disturbances in industrial sectors |
| High-speed transient electrical disturbances (Burst) | EN 61000-4-4 | EN 61131-2: Product standard - Programmable logic controllers EN 61000-6-2: Generic standard - Immunity to disturbances in industrial sectors |
| Surge voltages (Surge) | EN 61000-4-5 | EN 61131-2: Product standard - Programmable logic controllers EN 61000-6-2: Generic standard - Immunity to disturbances in industrial sectors |
| Conducted disturbances | EN 61000-4-6 | EN 61131-2: Product standard - Programmable logic controllers EN 61000-6-2: Generic standard - Immunity to disturbances in industrial sectors |
| Magnetic fields with electrical frequencies | EN 61000-4-8 | EN 61131-2: Product standard - Programmable logic controllers EN 61000-6-2: Generic standard - Immunity to disturbances in industrial sectors |
| Voltage dips (AC) Short-term interruptions (AC) Voltage fluctuations (AC) | EN 61000-4-11 | EN 61131-2: Product standard - Programmable logic controllers EN 61000-6-2: Generic standard - Immunity to disturbances in industrial sectors |
| Short-term interruptions (DC) Voltage fluctuations (DC) | EN 61000-4-29 | EN 61131-2: Product standard - Programmable logic controllers |

Evaluation criteria for performance

| Criteria | During testing | After testing |
|----------|--|---|
| A | The PLC system shall continue to operate as intended. No loss of function or performance. | The PLC system shall continue to operate as intended. |
| B | Degradation of performance accepted. No change of operating mode. No irreversible loss of stored data. | The PLC system shall continue to operate as intended. Temporary degradation of performance must be self-recoverable. |
| C | Loss of functions accepted, but no destruction of hardware or software (programme or data). | The PLC system shall continue to operate as intended automatically, after manual restart or power off/power on. |
| D | Degradation or failure of functionality that can no longer be restored. | PLC system permanently damaged or destroyed. |

Electrostatic discharge (ESD)

| Test carried out in accordance with EN 61000-4-2 | Requirements in accordance with EN 61131-2 / Zone B | Requirements in accordance with EN 61000-6-2 |
|---|---|--|
| Contact discharge (CD) to conductive external parts | | ±4 kV Criteria B |
| Air discharge (AD) to insulating external parts | | ±8 kV Criteria B |

High-frequency electromagnetic fields (HF field)

| Test carried out in accordance with EN 61000-4-3 | Requirements in accordance with EN 61131-2 / Zone B | Requirements in accordance with EN 61000-6-2 |
|--|---|---|
| Housing, completely wired | | 80 MHz to 1 GHz, 10 V/m 1.4 GHz to 2 GHz, 3 V/m 2 GHz to 2.7 GHz, 1 V/m Criteria A |

High-speed transient electrical disturbances (Burst)

| Test carried out in accordance with EN 61000-4-4 | Requirements in accordance with EN 61131-2 / Zone B | Requirements in accordance with EN 61000-6-2 |
|--|---|--|
| AC power inputs | | ±2 kV / 5 kHz Criteria B |
| AC power outputs | ±2 kV / 5 kHz ¹⁾ Criteria B | ±2 kV / 5 kHz Criteria B |
| AC other I/Os | ±2 kV / 5 kHz ¹⁾ Criteria B | - |
| DC mains inputs/outputs | | ±2 kV / 5 kHz ¹⁾ Criteria B |
| Other I/Os and interfaces | | ±1 kV / 5 kHz ¹⁾ Criteria B |

1) Only for connections with a permitted line length >3 m.

Surge voltages (Surge)

| Test carried out in accordance with EN 61000-4-5 | Requirements in accordance with EN 61131-2 / Zone B | Requirements in accordance with EN 61000-6-2 |
|--|---|--|
| AC mains inputs/outputs Line / line | | ±1 kV Criteria B |
| AC mains inputs/outputs Line / ground | | ±2 kV Criteria B |
| DC mains inputs/outputs Line / line | ±0.5 kV ¹⁾ Criteria B | ±0.5 kV Criteria B |
| DC power inputs Line / ground | ±0.5 kV ¹⁾ Criteria B | ±0.5 kV Criteria B |
| DC power outputs Line / ground | ±0.5 kV ¹⁾ Criteria B | ±0.5 kV Criteria B |
| Signal connections, unshielded Line / ground | | ±1 kV ¹⁾ Criteria B |
| All shielded lines Line / ground | ±1 kV ¹⁾ Criteria B | - |

1) Only for connections with a permitted line length >30 m.

Conducted disturbances

| Test carried out in accordance with EN 61000-4-6 | Requirements in accordance with EN 61131-2 / Zone B | Requirements in accordance with EN 61000-6-2 |
|--|---|---|
| AC mains inputs/outputs | | 10 V 150 kHz to 80 MHz 80% AM (1 kHz) Criteria A |
| DC mains inputs/outputs | | 10 V 150 kHz to 80 MHz 80% AM (1 kHz) Criteria A |
| Other I/Os and interfaces | | 10 V ¹⁾ 150 kHz to 80 MHz 80% AM (1 kHz) Criteria A |

1) Only for connections with a permitted line length >3 m.

Magnetic fields with electrical frequencies

| Test carried out in accordance with EN 61000-4-8 | Requirements in accordance with EN 61131-2 / Zone B | Requirements in accordance with EN 61000-6-2 |
|--|---|--|
| Housing, completely wired | | 30 A/m 3 axes (x, y, z) 50/60 Hz ¹⁾ Criteria A |

1) Mains frequency per manufacturer data

Voltage dips

| Test carried out in accordance with EN 61000-4-11 | Requirements in accordance with EN 61131-2 / Zone B | Requirements in accordance with EN 61000-6-2 |
|--|--|---|
| AC power inputs | 0% residual voltage 250/300 periods (50/60 Hz) ¹⁾ 20 attempts Criteria C | |
| | 40% residual voltage 10/12 periods (50/60 Hz) ¹⁾ 20 attempts Criteria C | |
| | 70% residual voltage 25/30 periods (50/60 Hz) ¹⁾ 20 attempts Criteria C | |

1) Mains frequency per manufacturer data

Short-term interruptions

| Test carried out in accordance with EN 61000-4-11 / EN 61000-4-29 | Requirements in accordance with EN 61131-2 / Zone B | Requirements in accordance with EN 61000-6-2 |
|--|---|---|
| AC power inputs | 0% residual voltage 0.5 periods (50/60 Hz) ¹⁾ 20 interruptions Criteria A | 0% residual voltage 1 period (50/60 Hz) ¹⁾ 3 interruptions Criteria B |
| DC power inputs | 0% residual voltage ≥10 ms (PS2) 20 interruptions Criteria A | - |

1) Mains frequency per manufacturer data

Voltage fluctuations

| Test carried out in accordance with EN 61000-4-11 / EN 61000-4-29 | Requirements in accordance with EN 61131-2 / Zone B | Requirements in accordance with EN 61000-6-2 |
|--|---|---|
| AC power inputs | -15% / +10% Test duration per 30 minutes Criteria A | - |
| DC power inputs | -15% / +20% Test duration per 30 minutes Criteria A | - |

8.2.3 Emission requirements

| Phenomenon | Test carried out in accordance with | Limits in accordance with |
|----------------------------|-------------------------------------|---|
| Emissions related to lines | EN 55011 / EN 55022 EN 55016-2-1 | EN 61131-2: Product standard - Programmable logic controllers |
| | | EN 61000-6-4: Generic standard - Emissions in industrial sectors |
| Radiated emissions | EN 55011 / EN 55022 EN 55016-2-3 | EN 61131-2: Product standard - Programmable logic controllers |
| | | EN 61000-6-4: Generic standard - Emissions in industrial sectors |

Emissions related to lines

| Test carried out in accordance with EN 55011 / EN 55022 / EN 55016-2-1 | Limits in accordance with EN 61131-2 / Zone B | Limits in accordance with EN 61000-6-4 |
|---|---|--|
| AC mains connection 150 kHz to 30 MHz | 150 kHz to 500 kHz 79 dB (µV) quasi-peak value 66 dB (µV) average value | |
| | 500 kHz to 30 MHz 73 dB (µV) quasi-peak value 60 dB (µV) average value | |
| Telecommunications / network connection 150 kHz to 30 MHz | - | 150 kHz to 500 kHz 97 to 87 dB (µV) quasi-peak value 53 to 40 dB (µA) quasi-peak value 84 to 74 dB (µV) average value 40 to 30 dB (µA) average value |
| | - | 500 kHz to 30 MHz 87 dB (µV) quasi-peak value 43 dB (µA) quasi-peak value 74 dB (µV) average value 30 dB (µA) average value |

Radiated emissions

| Test carried out in accordance with EN 55011 / EN 55022 / EN 55016-2-3 | Limits in accordance with EN 61131-2 / Zone B | Limits in accordance with EN 61000-6-4 |
|---|--|---|
| Electric field / Measured from 10 m 30 MHz to 1 GHz | 30 MHz to 230 MHz 40 dB (µV/m) quasi-peak value | |
| | 230 MHz to 1 GHz 47 dB (µV/m) quasi-peak value | |
| Electric field / Measured from 3 m 1 GHz to 6 GHz ¹⁾ | - | 1 GHz to 3 GHz ¹⁾ 76 dB (µV/m) peak value 56 dB (µV/m) average value |
| | - | 3 GHz to 6 GHz ¹⁾ 80 dB (µV/m) peak value 60 dB (µV/m) average value |

1) Depending on highest internal frequency

8.2.4 Mechanical conditions

| Testing | Test carried out in accordance with | Requirements in accordance with |
|---|-------------------------------------|---|
| Vibration (sinusoidal) / Operation | EN 60068-2-6 | EN 61131-2: Product standard - Programmable logic controllers EN 60721-3-3 / Class 3M4 |
| Shock / Operation | EN 60068-2-27 | EN 61131-2: Product standard - Programmable logic controllers EN 60721-3-3 / Class 3M4 |
| Vibration (sinusoidal) / Transport (packaged) | EN 60068-2-6 | EN 60721-3-2 / Class 2M1 EN 60721-3-2 / Class 2M2 EN 60721-3-2 / Class 2M3 |
| Shock / Transport (packaged) | EN 60068-2-27 | EN 60721-3-2 / Class 2M1 EN 60721-3-2 / Class 2M2 |
| Free fall / Transport (packaged) | EN 60068-2-31 ¹⁾ | EN 61131-2: Product standard - Programmable logic controllers EN 60721-3-2 / Class 2M1 |
| Toppling / Transport (packaged) | EN 60068-2-31 | EN 60721-3-2 / Class 2M1 EN 60721-3-2 / Class 2M2 EN 60721-3-2 / Class 2M3 |

1) Replacement for EN 60068-2-32

Vibration (sinusoidal) / Operation

| Test carried out in accordance with EN 60068-2-6 | Requirements in accordance with EN 61131-2 | | Requirements in accordance with EN 60721-3-3 / Class 3M4 | |
|---|---|--------------------------------|---|--------------------------------|
| | Frequency | Amplitude | Frequency | Amplitude |
| Vibration (sinusoidal) / Operation ¹⁾ | 5 to 8.4 Hz | Deflection 3.5 mm | 2 to 9 Hz | Deflection 3 mm |
| | 8.4 to 150 Hz | Acceleration 1 g ²⁾ | 9 to 200 Hz | Acceleration 1 g ²⁾ |
| | 20 sweeps for each axis ³⁾ | | | |

1) Uninterrupted duty with movable frequency in all 3 axes (x, y, z); 1 octave per minute

2) 1 g = 10 m/s²

3) 2 sweeps = 1 frequency cycle (fmin → fmax → fmin)

Shock / Operation

| Test carried out in accordance with EN 60068-2-27 | Requirements in accordance with EN 61131-2 | Requirements in accordance with EN 60721-3-3 / Class 3M4 |
|--|--|---|
| Shock / Operation ¹⁾ | Acceleration 15 g Duration 11 ms 18 shocks | Acceleration 10 g Duration 11 ms 18 shocks |

1) Pulse (half-sine) stress in all 3 axes (x, y, z)

Vibration (sinusoidal) / Transport (packaged)

| Test carried out in accordance with EN 60068-2-6 | Requirements in accordance with EN 60721-3-2 / Class 2M1 | | Requirements in accordance with EN 60721-3-2 / Class 2M2 | | Requirements in accordance with EN 60721-3-2 / Class 2M3 | |
|---|---|-------------------------------------|---|-------------------------------------|---|-----------------------------------|
| | Frequency | Amplitude | Frequency | Amplitude | Frequency | Amplitude |
| Vibration (sinusoidal) / Transport (packaged) ¹⁾ | 2 to 9 Hz | Deflection 3.5 mm | 2 to 9 Hz | Deflection 3.5 mm | 2 to 8 Hz | Deflection 7.5 mm |
| | 9 to 200 Hz | Acceleration 1 g ²⁾ | 9 to 200 Hz | Acceleration 1 g ²⁾ | 8 to 200 Hz | Acceleration 2 g ²⁾ |
| | 200 to 500 Hz | Acceleration 1.5 g ²⁾ | 200 to 500 Hz | Acceleration 1.5 g ²⁾ | 200 to 500 Hz | Acceleration 4 g ²⁾ |
| 20 sweeps for each axis ³⁾ | | | | | | |

1) Uninterrupted duty with movable frequency in all 3 axes (x, y, z); 1 octave per minute

2) 1 g = 10 m/s²

3) 2 sweeps = 1 frequency cycle (fmin → fmax → fmin)

Shock / Transport (packaged)

| Test carried out in accordance with EN 60068-2-27 | Requirements in accordance with EN 60721-3-2 / Class 2M1 | Requirements in accordance with EN 60721-3-2 / Class 2M2 |
|--|---|---|
| Shock / Transport (packaged) ¹⁾ | Type I Acceleration 10 g Duration 11 ms 18 shocks | |
| | Type II - | Type II Acceleration 30 g Duration 6 ms 18 shocks |

1) Pulse (half-sine) stress in all 3 axes (x, y, z)

Free fall / Transport (packaged)

| Tests in accordance with EN 60068-2-31 | Requirements in accordance with EN 61131-2 with shipping packaging | | Requirements in accordance with EN 61131-2 with shipping packaging | | Requirements in accordance with EN 60721-3-2 / Class 2M1 | |
|--|--|--------|--|--------|--|--------|
| | Weight | Height | Weight | Height | Weight | Height |
| Free fall / Transport (packaged) | <10 kg | 1.0 m | <10 kg | 0.3 m | <20 kg | 0.25 m |
| | 10 to 40 kg | 0.5 m | 10 to 40 kg | 0.3 m | 20 to 100 kg | 0.25 m |
| | >40 kg | 0.25 m | >40 kg | 0.25 m | >100 kg | 0.1 m |
| 5 attempts | | | | | | |

1) Replacement for EN 60068-2-32

Toppling / Transport (packaged)

| Test carried out in accordance with EN 60068-2-31 | Requirements in accordance with EN 60721-3-2 / Class 2M1 | | Requirements in accordance with EN 60721-3-2 / Class 2M2 | | Requirements in accordance with EN 60721-3-2 / Class 2M3 | |
|---|--|----------|--|----------|--|----------|
| | Weight | Required | Weight | Required | Weight | Required |
| Toppling / Transport (packaged) | <20 kg | Yes | <20 kg | Yes | <20 kg | Yes |
| | 20 to 100 kg | - | 20 to 100 kg | Yes | 20 to 100 kg | Yes |
| | >100 kg | - | >100 kg | - | >100 kg | Yes |
| Topple on all edges | | | | | | |

8.2.5 Electrical safety**Overvoltage category**

| Requirement per EN 61131-2 | Definition per EN 60664-1 |
|----------------------------|--|
| Overvoltage category II | Equipment of "Overvoltage category II" is energy-consuming equipment to be supplied by the fixed installation. |

Pollution degree

| Requirement per EN 61131-2 | Definition per EN 60664-1 |
|----------------------------|---|
| Pollution degree 2 | Only non-conductive pollution occurs. Occasionally, however, temporary conductivity caused by condensation is to be expected. |

Protection rating provided by enclosure (IP code)

| Requirement per EN 61131-2 | Meaning of codes per EN 60529 | Meaning for the protection of equipment | Meaning for the protection of personnel |
|----------------------------|-------------------------------|--|--|
| ≥IP20 | First number IP2x | Protected against solid foreign bodies with a diameter ≥ 12.5 mm. | Protected against touching dangerous parts with fingers. |
| | Second number IPx0 | Not protected. | - |

8.3 UL / CSA



Underwriters Laboratories (UL)

Products with this mark are tested by Underwriters Laboratories and listed as "industrial control equipment" in category NRAQ (programmable controllers) with file number E115267.

The mark is valid for the USA and Canada and facilitates the certification of your machines and systems in this economic area.

Standards applied:

UL 508
UL 61010-1
UL 61010-2-201

CSA C22.2 No. 142-M1987
CSA C22.2 No. 61010-1
CSA C22.2 No. 61010-2-201

Standard for industrial control equipment
Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements
Standard for safety requirements for electrical equipment for measurement, control and laboratory use - Part 2-201: Particular requirements for control equipment
Process control equipment
Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements
Safety requirements for electrical equipment for measurement, control and laboratory use - Part 2-201: Particular requirements for control equipment



Certificate

[Website > Downloads > Certificates > UL > X20 > E115267 UL Certificate of Compliance - X20](#)

CSA HazLoc



Canada / USA

Canadian Standards Association (CSA)

Products with this mark are certified by the Canadian Standard Association and suitable for use in potentially explosive atmospheres.

The products are listed in CLASS 2258 (Process control equipment - For hazardous locations) with file number 244665.

The X20 system has a hazardous locations certification for class I, division 2.

Each certified module is accompanied by an information sheet providing detailed installation and safety guidelines.

The mark is valid for the USA and Canada and facilitates the certification of your machines and systems in this economic area.

Standards applied:

CSA C22.2 No. 0-M1991
CSA C22.2 No. 142-M1987
CSA C22.2 No. 213-M1987
UL Std No. 916:2007
ANSI/ISA 12.12.01:2007

General requirements - Canadian electrical code part II
Process control equipment
Nonincendive electrical equipment for use in class I, division 2 hazardous locations
Energy management equipment
Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Division 1 and 2 Hazardous (Classified) Locations



Certificate

[Website > Downloads > Certificate > HazLoc > CSA > X20, X67 > 244665 CSA HazLoc Certificate of Compliance - X20, X67](#)

8.4 Offshore/Maritime

With regard to maritime certification, B&R will limit itself to DNV GL for the time being. DNV GL testing is performed in accordance with the applicable standards: DNV GL, IACS E10 and IEC 60945 Section 1c. As a result, the tests comply with the requirements of other maritime classification societies.

DNV GL



**Germany
Norway**

Det Norske Veritas - Germanischer Lloyd

Many B&R products are certified by DNV GL and suitable for use in maritime environments.

DNV GL Maritime certificates (type approval) are generally accepted by other classification societies during ship acceptance procedures.

For corresponding environmental categories, see the technical data for the respective product.

Standards applied:

DNVGL-CG-0339

Environmental test specification for electrical, electronic and programmable equipment and systems



Certificate

[Website > Downloads > Certificates > Maritime > DNV GL > X20 / Power Panel T/C > DNV GL Type Approval Certificate](#)

KR



Korean Register of Shipping

Products are suitable for use in maritime environments in accordance with the guidelines set forth by the Korean Register of Shipping.

Standards applied:

List of Approved Manufacturers and Type Approved Equipment (Pt. 6, Ch. 2, Art. 301 of the Rules for Classification, Steel Ships).



Certificate

[Website > Downloads > Certificates > Maritime > KR > X20 > KR type approval certificate MIL39390-AC003 \(X20 system\)](#)

LR



15/20082

Great Britain

Lloyd's Register

Products are suitable for use in maritime environments in accordance with the guidelines set forth by the Lloyd's Register classification society.

Certification has taken place for marine, offshore and industrial applications for environmental categories ENV1, ENV2 and ENV3.

Safety technology assemblies are certified for ENV1 and ENV2

These environmental categories are defined in Lloyd's Register's type approval system, test specification number 1-2015.

Covered standard:

Test Specification Number 1-2015

Lloyd's Register's type approval system



Certificate

[Website](#) > [Downloads](#) > [Certificates](#) > [Maritime](#) > [LR](#) > [X20](#) > [Lloyds Register](#)

8.5 Other certifications

EAC

**Eurasian Conformity (EAC)**

Products with this marking have been tested by an accredited testing laboratory and approved for import (based on EU compliance) to the newly founded Eurasian Economic Union (Russia, Belarus, Kazakhstan, etc.).

KC

**Korean Conformity (KC)**

Products with this marking have been tested by an accredited testing laboratory and approved for import to the Korean market (based on EU compliance).

RCM

**Regulatory Compliance Mark (RCM)**

Products with this marking have been tested by an accredited testing laboratory and certified by the ACMA. This marking is valid in Australia/Oceania and simplifies the certification of your machines and systems in these areas (based on EU compliance).

9 Data sheets

9.1 Analog input modules

Analog input modules convert measured values (voltages, currents) into numerical values, which can be processed by the PLC.

In the PLC, analog data is always in 16-bit 2s complement regardless of the resolution. Therefore, the resolution of the module used does not have to be taken into consideration when creating an application program.

Every channel on an analog input module has a status LED.

9.1.1 Summary

| Model number | Short description | Page |
|--------------|---|------|
| X20AI1744 | X20 analog input module, 1 full-bridge strain gauge input, 24-bit converter resolution, 5 kHz input filter | 196 |
| X20AI1744-10 | X20 analog input module, 1 full-bridge strain input 10 V, 24-bit converter resolution, 5 kHz input filter | 289 |
| X20AI1744-3 | X20 analog input module, 1 full-bridge strain gauge input, 24-bit converter resolution, 5 Hz input filter | 243 |
| X20AI2222 | X20 analog input module, 2 inputs, ± 10 V, 13-bit converter resolution, configurable input filter | 318 |
| X20AI2237 | X20 analog input module, 2 inputs, ± 10 V, 16-bit converter resolution, single-channel isolation with separate sensor power supply, NetTime function | 328 |
| X20AI2322 | X20 analog input module, 2 inputs, 0-20 mA / 4-20 mA, 12-bit converter resolution, configurable input filter | 346 |
| X20AI2437 | X20 analog input module, 2 inputs, 4 to 20 mA, 16-bit converter resolution, single-channel isolation with separate sensor power supply, NetTime function | 357 |
| X20AI2438 | X20 analog input module, 2 inputs, 4 to 20 mA, 16-bit converter resolution, single-channel isolation with separate sensor power supply, supports the HART protocol, NetTime function | 373 |
| X20AI2622 | X20 analog input module, 2 inputs, ± 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution, configurable input filter | 397 |
| X20AI2632 | X20 analog input module, 2 inputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, configurable input filter, oscilloscope functions | 408 |
| X20AI2632-1 | X20 analog input module, 2 inputs, ± 11 V or 0 to 22 mA, 16-bit converter resolution, configurable input filter | 433 |
| X20AI2636 | X20 analog input module, 2 inputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, configurable input filter, oversampling functions | 458 |
| X20AI4222 | X20 analog input module, 4 inputs, ± 10 V, 13-bit converter resolution, configurable input filter | 489 |
| X20AI4322 | X20 analog input module, 4 inputs, 0-20 mA / 4-20 mA, 12-bit converter resolution, configurable input filter | 499 |
| X20AI4622 | X20 analog input module, 4 inputs, ± 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution, configurable input filter | 509 |
| X20AI4632 | X20 analog input module, 4 inputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, configurable input filter, oscilloscope functions | 520 |
| X20AI4632-1 | X20 analog input module, 4 inputs, ± 11 V or 0 to 22 mA, 16-bit converter resolution, configurable input filter, oscilloscope functions | 545 |
| X20AI4636 | X20 analog input module, 4 inputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, configurable input filter, oversampling functions | 570 |
| X20AI8221 | X20 analog input module, 8 inputs, ± 10 V, 13-bit converter resolution | 602 |
| X20AI8321 | X20 analog input module, 8 inputs, 0 to 20 mA, 12-bit converter resolution | 612 |
| X20AIA744 | X20 analog input module, 2 full-bridge strain inputs, 24-bit converter resolution, 2.5 kHz input filter | 622 |
| X20AIB744 | X20 analog input module, 4 full-bridge strain inputs, 24-bit converter resolution, 2.5 kHz input filter | 641 |
| X20AP3111 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 20 mA AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20AP3121 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 1 A AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20AP3122 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 1 A AC, groundable, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20AP3131 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 5 A AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20AP3132 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 5 A AC, groundable, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20AP3161 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 333 mV AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20AP3171 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, Rogowski adjustable (μ V/A), max. 52 mV, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20cAI1744 | X20 analog input module, coated, 1 full-bridge strain gauge input, 24-bit converter resolution, 5 kHz input filter | 196 |
| X20cAI1744-3 | X20 analog input module, coated, 1 full-bridge strain gauge input, 24-bit converter resolution, 5 Hz input filter | 243 |
| X20cAI2438 | X20 analog input module, coated, 2 inputs, 4 to 20 mA, 16-bit converter resolution, single-channel isolation with separate sensor power supply, supports the HART protocol, NetTime function | 373 |
| X20cAI4622 | X20 analog input module, coated, 4 inputs, ± 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution, configurable input filter | 509 |
| X20cAI4632 | X20 analog input module, coated, 4 inputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, configurable input filter, oscilloscope functions | 520 |
| X20cAI4632-1 | X20 analog input module, coated, 4 inputs, ± 11 V or 0 to 22 mA, 16-bit converter resolution, configurable input filter, oscilloscope functions | 545 |

| Model number | Short description | Page |
|--------------|---|------|
| X20cAP3121 | X20 energy metering module, coated, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 1 A AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |
| X20cAP3131 | X20 energy metering module, coated, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 5 A AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | 661 |

9.1.2 X20(c)AI1744

Data sheet version: 4.25

This data sheet describes 2 module revisions. The module revision is laser-marked on the side of the module. Select the desired module revision from the following table to view its description.

| Module | Revision | Page |
|------------|----------|------|
| X20AI1744 | ≥H0 | 195 |
| X20cAI1744 | All | |
| X20AI1744 | <H0 | 225 |

9.1.2.1 X20(c)AI1744 with Rev. ≥H0

9.1.2.1.1 General information

This module works with both 4-wire and 6-wire strain gauge load cells. The concept applied by the module requires compensation in the measurement system. This compensation eliminates the absolute uncertainty in the measurement circuit, such as component tolerances, effective bridge voltage or zero point offset. The measurement precision refers to the absolute (compensated) value, which will only change as a result of changes in the operating temperature.

- 1 full-bridge strain gauge input
- Data output rate configurable from 0.1 Hz to 7.5 kHz
- Special operating modes (synchronous mode and multiple sampling)
- Configurable filter level

9.1.2.1.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.1.2.1.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.1.2.1.3 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Analog inputs |  |
| X20AI1744 | X20 analog input module, 1 full-bridge strain gauge input, 24-bit converter resolution, 5 kHz input filter | |
| X20cAI1744 | X20 analog input module, coated, 1 full-bridge strain gauge input, 24-bit converter resolution, 5 kHz input filter | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 18: X20AI1744, X20cAI1744 - Order data

9.1.2.1.4 Technical data

| Model number | X20AI1744 | X20cAI1744 |
|--|---|------------|
| Short description | 1 full-bridge strain gauge input | |
| I/O module | | |
| General information | | |
| B&R ID code | 0x1CDE | 0xE754 |
| Status indicators | Channel status, operating status, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Open circuit | Yes, using status LED and software | |
| Input | Yes, using status LED and software | |
| Power consumption | | |
| Bus | 0.01 W | |
| Internal I/O | 0.5 W | |
| Additional power dissipation caused by actuators (resistive) [W] | Max. +0.36 ¹⁾ | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| EAC | Yes | |
| KC | Yes | - |
| Full-bridge strain gauge | | |
| Strain gauge factor | 2 to 256 mV/V, configurable using software | |
| Connection | 4- or 6-wire connections ²⁾ | |
| Input type | Differential, used to evaluate a full-bridge strain gauge | |
| Digital converter resolution | 24-bit | |
| Conversion time | Depends on the configured data output rate | |
| Data output rate | 0.1 - 7500 samples per second, configurable using software (f_{DATA}) | |
| Input filter | | |
| Cutoff frequency | 5 kHz | |
| Order | 3 | |
| Slope | 60 dB | |
| ADC filter characteristics | Sigma-delta, see section "Filter characteristics of the sigma-delta A/D converter" | |
| Operating range / Measurement sensor | 85 to 5000 Ω | |
| Influence of cable length ³⁾ | See section "Calculation example". | |
| Input protection | RC protection | |
| Common-mode range | 0 to 3 VDC Permissible input voltage range (with regard to the potential strain gauge GND) on inputs "Input +" and "Input -" | |
| Isolation voltage between input and bus | 500 V _{eff} | |
| Conversion procedure | Sigma-delta | |

Table 19: X20AI1744, X20cAI1744 - Technical data


| Model number | X20AI1744 | X20cAI1744 |
|---|--|---|
| Output of digital value | | |
| Broken bridge supply line | Value approaches 0 | |
| Broken sensor line | Value approaching \pm end value (status bit "Line status monitoring" is set in register "Module status") | |
| Valid range of values | 0xFF800001 to 0x007FFFFFFF (-8,388,607 to 8,388,607) | |
| Strain gauge supply | | |
| Voltage | 5.5 VDC / max. 65 mA | |
| Short-circuit and overload resistant | Yes | |
| Voltage drop for short-circuit protection | Max. 0.2 VDC at 65 mA and 25°C | |
| Quantization ⁴⁾ | | |
| LSB value (16-bit) | | |
| 2 mV/V | 336 nV | |
| 4 mV/V | 671 nV | |
| 8 mV/V | 1.343 μ V | |
| 16 mV/V | 2.686 μ V | |
| 32 mV/V | 5.371 μ V | |
| 64 mV/V | 10.74 μ V | |
| 128 mV/V | 21.48 μ V | |
| 256 mV/V | 42.97 μ V | |
| LSB value (24-bit) | | |
| 2 mV/V | 1.31 nV | |
| 4 mV/V | 2.62 nV | |
| 8 mV/V | 5.25 nV | |
| 16 mV/V | 10.49 nV | |
| 32 mV/V | 20.98 nV | |
| 64 mV/V | 41.96 nV | |
| 128 mV/V | 83.92 nV | |
| 256 mV/V | 167.85 nV | |
| Max. gain drift | 12 ppm/°C ⁵⁾ | |
| Max. offset drift | 2 ppm/°C ⁶⁾ | |
| Nonlinearity | <10 ppm ⁶⁾ | |
| Electrical properties | | |
| Electrical isolation | Bus isolated from analog input and strain gauge supply voltage Channel not isolated from I/O power supply | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Hardware configuration" | |
| Starting temperature | - | Yes, -40°C |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x terminal block X20TB12 separately Order 1x bus module X20BM11 separately | Order 1x terminal block X20TB12 separately Order 1x bus module X20cBM11 separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 19: X20AI1744, X20cAI1744 - Technical data

- 1) Depends on the full-bridge strain gauge being used.
- 2) With 6-wire connections, line compensation does not function (see section "Connection examples").
- 3) Sensor cable with twisted and shielded conductors, cable length as short as possible, cable routing separate from load circuits, without intermediate terminal to the sensor.
- 4) Quantization depends on the strain gauge factor.
- 5) Based on the current measured value.
- 6) Based on the entire measurement range.

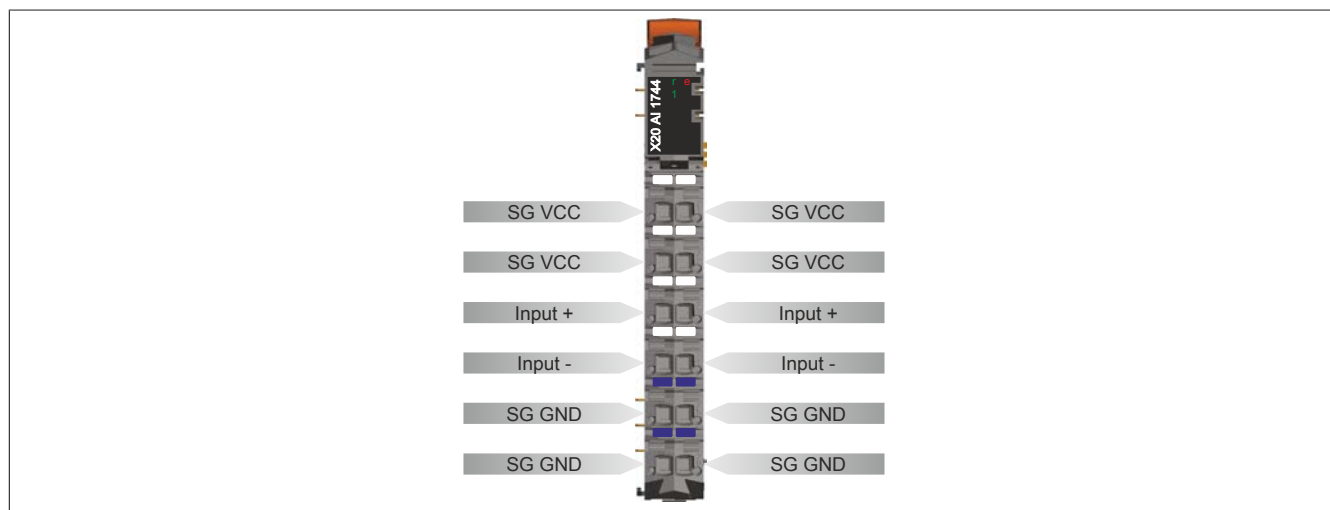
9.1.2.1.5 LED status indicators

For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-----|-------|--------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | 1 | Green | Off | Possible causes: <ul style="list-style-type: none"> • Open circuit • Sensor is disconnected • Converter is busy |
| | | | On | Analog/digital converter running, value OK |

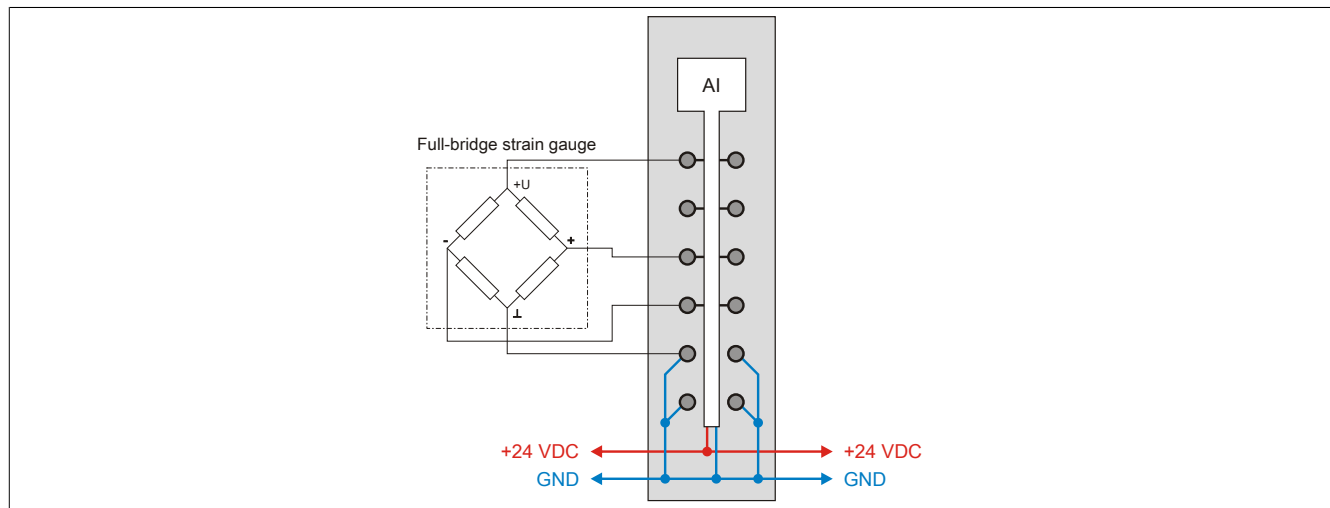
1) Depending on the configuration, a firmware update can take up to several minutes.

9.1.2.1.6 Pinout



9.1.2.1.7 Connection examples

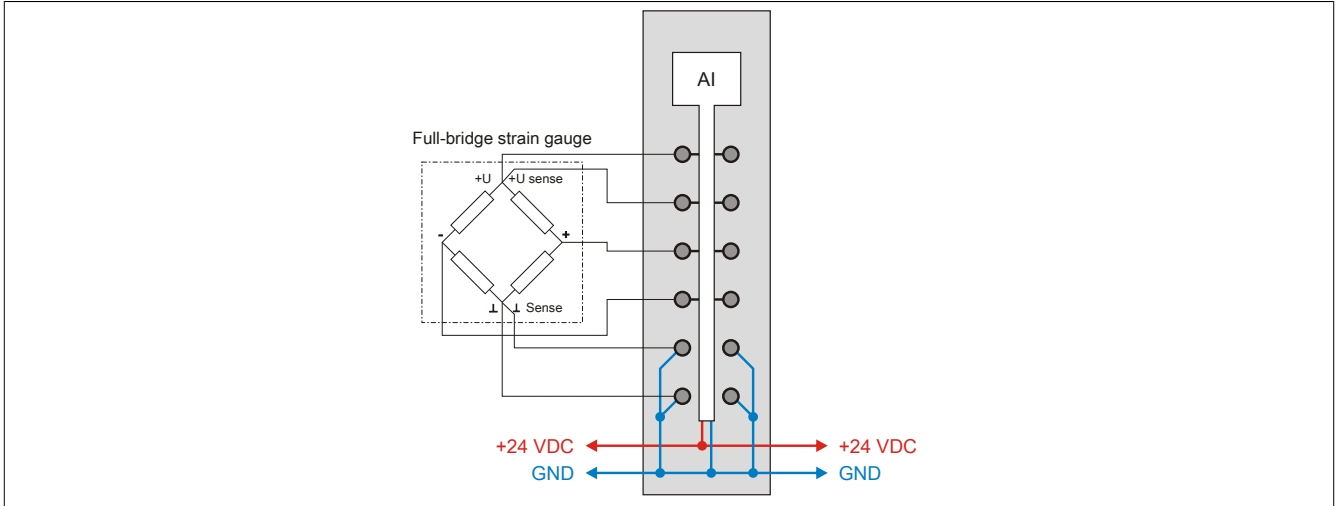
Full-bridge strain gauge with 4-wire connections



Full-bridge strain gauge with 6-wire connections

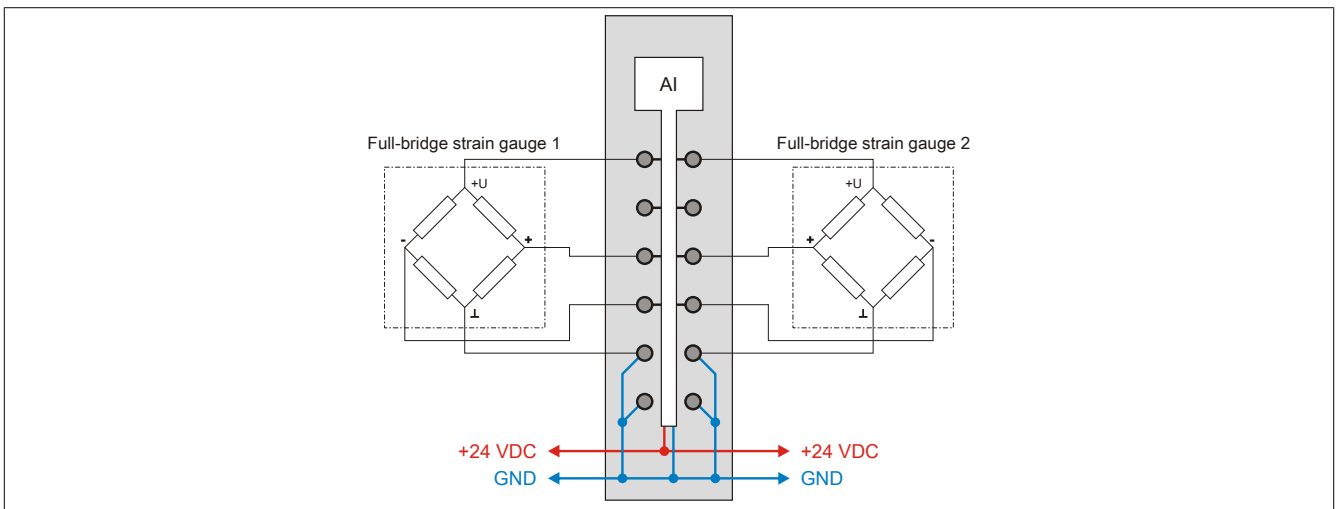
Full-bridge strain gauges can be connected to this module with 6-wire connections. Line compensation is not supported by the module, however. The sense lines are short circuited by the internally connected strain gauge VCC and GND connections (see "Input circuit diagram" on page 200). The measurement precision is therefore affected by changes in operating temperature. Longer cable lengths and smaller cable cross sections also increase the potential for errors in the measurement system.

In order to reduce cable resistance, the sense lines should be connected in parallel with the strain gauge supply lines. Optimal signal quality can be obtained by using a shielded twisted pair cable. The connections for the strain gauge supply lines, the sensor lines and the bridge differential voltage lines should each use one twisted pair cable.



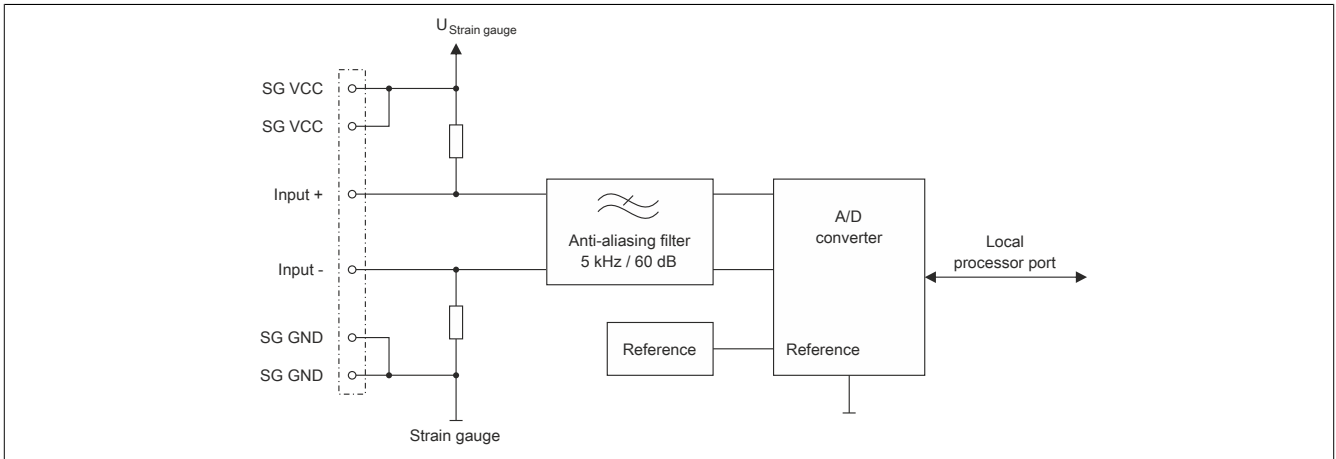
Parallel connection of 2 full-bridge strain gauges (4-wire connections)

If connecting the full-bridge strain gauges in parallel, the manufacturer's guidelines must be observed.



When connecting 3 or more full-bridge strain gauges in parallel, 2 lines must be connected together in an X20 terminal block.

9.1.2.1.8 Input circuit diagram

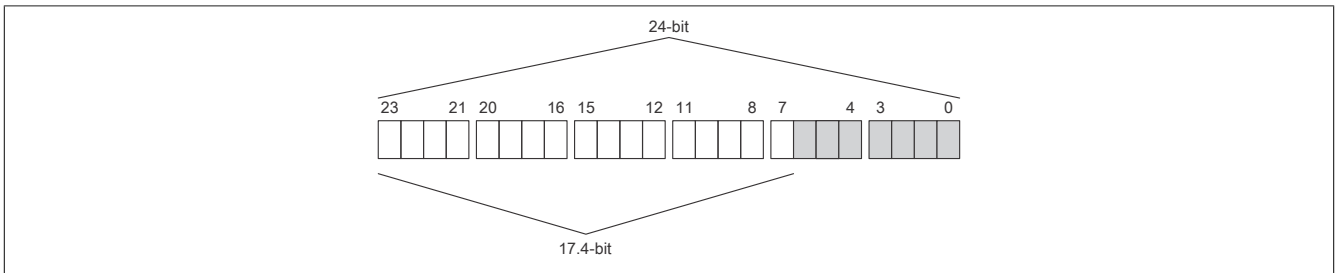


9.1.2.1.9 Effective resolution of the A/D converter

The A/D converter on the module provides a 24-bit measured value. The actual attainable noise-free resolution is always less than 24-bit, however. This "effective resolution" depends on the data rate and measurement range.

Example:

Based on the conversion method, a data rate of 2.5 Hz and a specified measurement range of 2 mV/V result in an effective resolution of 17.4 bits:



The low-order bits (grayed out) contain only noise instead of valid values and are therefore not permitted to be evaluated.

With "Function model 1 - Multisampling", only the highest 16 bits are made available.

9.1.2.1.10 Calculation example

The following example shows the influence of the length of the measuring cable on the bridge voltage of the module and the quantization calculated with it.

9.1.2.1.10.1 Bridge voltage

Although the measuring bridge must be adjusted with the module, the cable length has an influence on the accuracy of the measurement. The reason for this is the voltage drop on the power supply lines of the measuring bridge. As a result, the strain gauge supply voltage at the measuring bridge no longer amounts to the full 5.5 V. The reduced bridge voltage also has an effect on the quantization.

Example

Characteristics of the measuring device used:

- Full-bridge strain gauge with 4-wire connections
- Material-dependent conductivity of the cable (copper: $12 \frac{\text{m}}{\Omega \cdot \text{mm}^2}$)
- Cross section of the cable: 22 AWG = 0.34 mm²
- Length of the cable: 5 m
- Nominal current of the measuring bridge: 15 mA
- Bridge voltage of the module: 5.5 V

Actual bridge voltage taking the voltage drop on the measuring line into account:

$$5.5\text{V} - \frac{2 \cdot 5\text{m}}{12 \frac{\text{m}}{\Omega \cdot \text{mm}^2} \cdot 0.34\text{mm}^2} \cdot 0.015\text{A} = 5.463\text{V}$$

The quantization must be calculated using the actual calculated bridge voltage (see ["Quantization" on page 202](#)).

9.1.2.1.10.2 Quantization

In a weighing application, the corresponding weight located on the connected load cell should be determined from the value derived from the module.

Example

The characteristics of the strain gauge load cell are as follows:

- Rated load: 1000 kg
- Strain gauge factor: 4 mV/V
- Actual bridge voltage: 5.463 V

Maximum quantization:

Multiplying the bridge factor of the strain gauge load cell with the bridge supply voltage from the module results in the value for the positive full-scale deflection at a specified rated load of 1000 kg:

$$4 \text{ mV/V} \cdot 5.5 \text{ V} = 22 \text{ mV}$$

Actual quantization:

Taking the voltage drop on the measuring line into account, the actual bridge voltage is 5.463 V (for the calculation, see section "Bridge voltage" on page 201). If this voltage is multiplied by the strain gauge factor of 4 mV/V, the following actual quantization results:

$$4 \text{ mV/V} \cdot 5.463 \text{ V} = 21.85 \text{ mV}$$

These 21.85 mV correspond to 99.3% of the maximum possible measurement range.

Information:

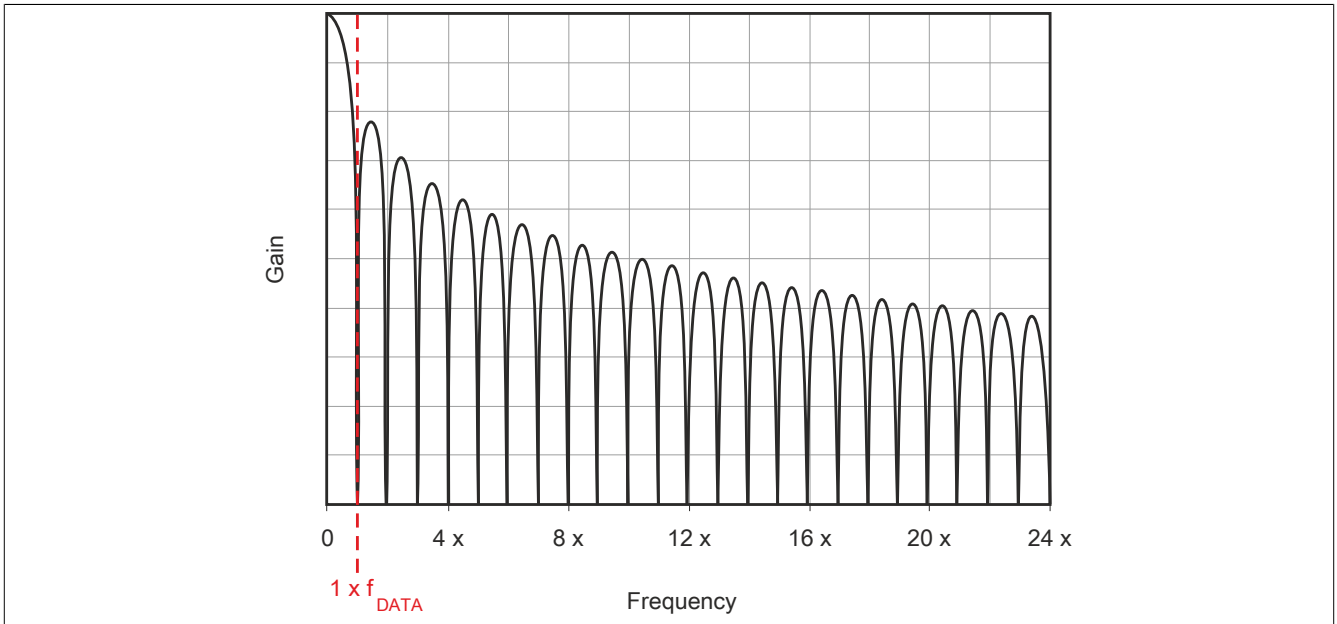
If the quantization decreases, the maximum possible effective resolution also decreases (see "Effective resolution of the A/D converter" on page 200).

With a simple Rule of Three calculation, the corresponding value can be calculated (as seen in the table) from weight to the converter value and vice versa. This simplified theoretical approach is only valid for an ideal measurement system. Calibration of the entire measurement system is recommended because not only the module, but particularly the strain gauge bridges exhibit tolerances (offset, gain). When taring, the gradient offset is recalculated and the gain of the linear equation is determined when normalized. In addition to the calculation displayed in the table, these calculations must also be carried out in the application.

| 24-bit value of the module | | Quantization | Corresponding weight |
|----------------------------|-----------|---------------|----------------------|
| 0x007F FFFF | 8,388,607 | 21.85 mV | 1000 kg |
| 0x0000 0001 | 1 | 2.61 nV | 0.119 g |
| 0x0000 20C3 | 8387 | 21.85 μ V | 1 kg |
| 0x0001 0000 | 65536 | 170.7 μ V | 7.81 kg |

The values for 1 LSB are also included in the module's technical data under item "Quantization" (1 LSB each for 16 bits and 24 bits).

9.1.2.1.11 Filter characteristics of the sigma-delta A/D converter

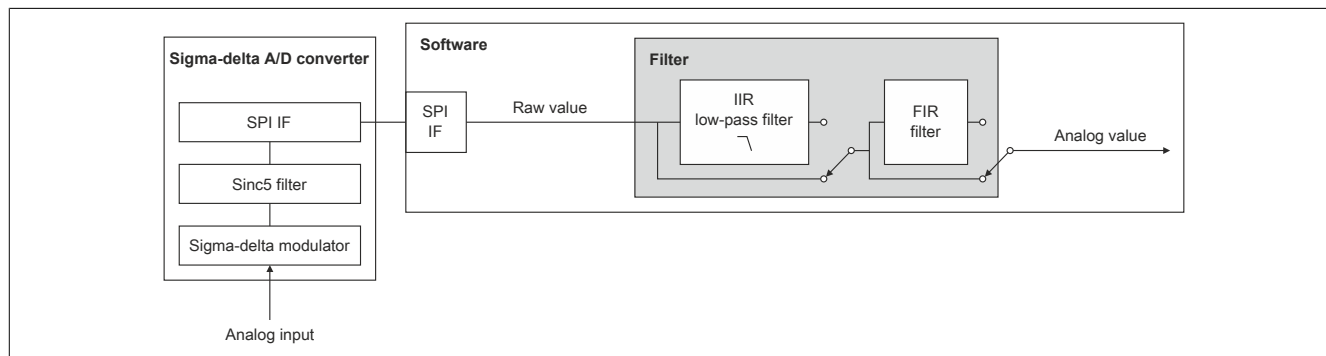


9.1.2.1.12 Software filters

2 filters are available for the analog input. They can be individually enabled and configured at runtime. By default, both filters are disabled when the device is switched on. The filters are controlled and configured using "Function model 2 - Extended filter".

In order to allow the filter behavior to be adapted to the measuring situation or machine cycle (high dynamics and low precision or low dynamics and high precision), the filter characteristics of both the IIR low-pass filter as well as the FIR filter can be changed synchronously at any time.

Filter diagram



9.1.2.1.12.1 IIR low-pass filter

General information

The IIR low-pass filter is used to generally smooth and increase the resolution of the analog value. The filter works according to the following formula:

$$y = y_{\text{Old}} + \frac{x - y_{\text{Old}}}{2^{\text{Filter level}}}$$

- x ... Current filter input value
- y_{Old} ... Old filter output value
- y ... New filter output value

Parameter "Filter level" in the formula above is configured using register "ConfigCommonOutput01" on page 222. "Filter level" = 0 if the IIR low-pass filter is disabled.

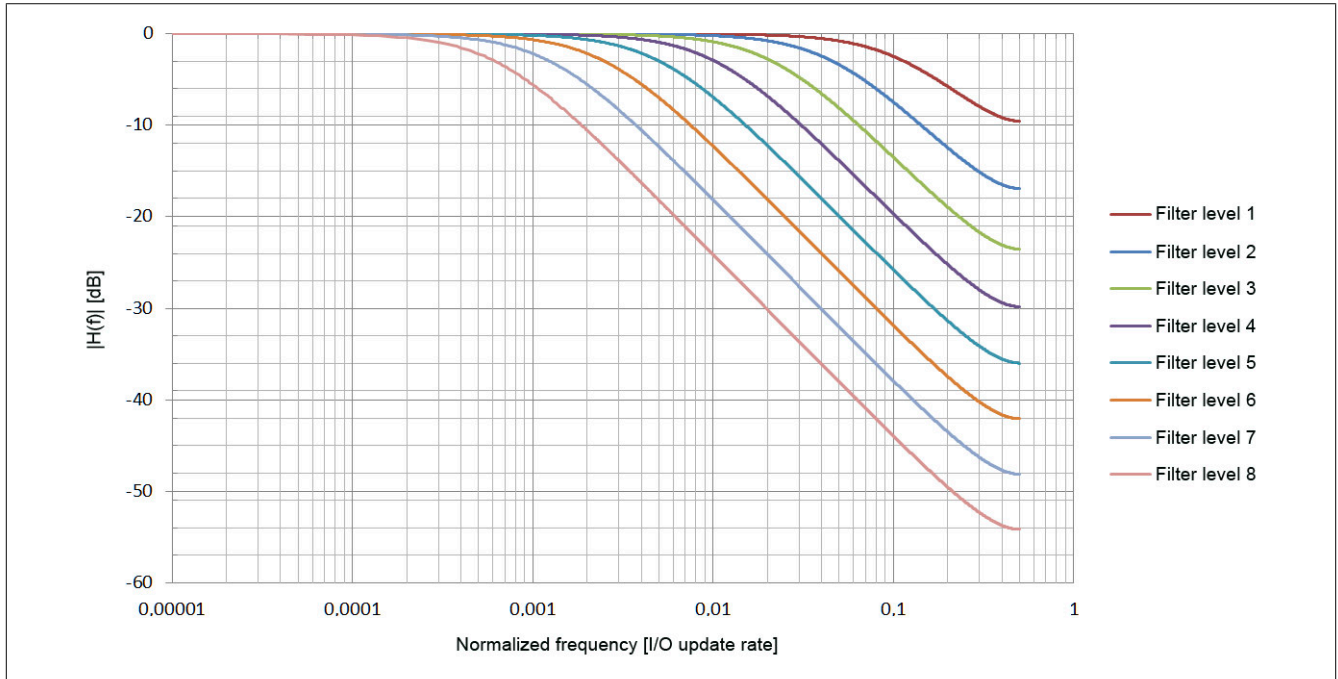
Filter characteristics of the first-order IIR low-pass filter

Limit frequency f_c

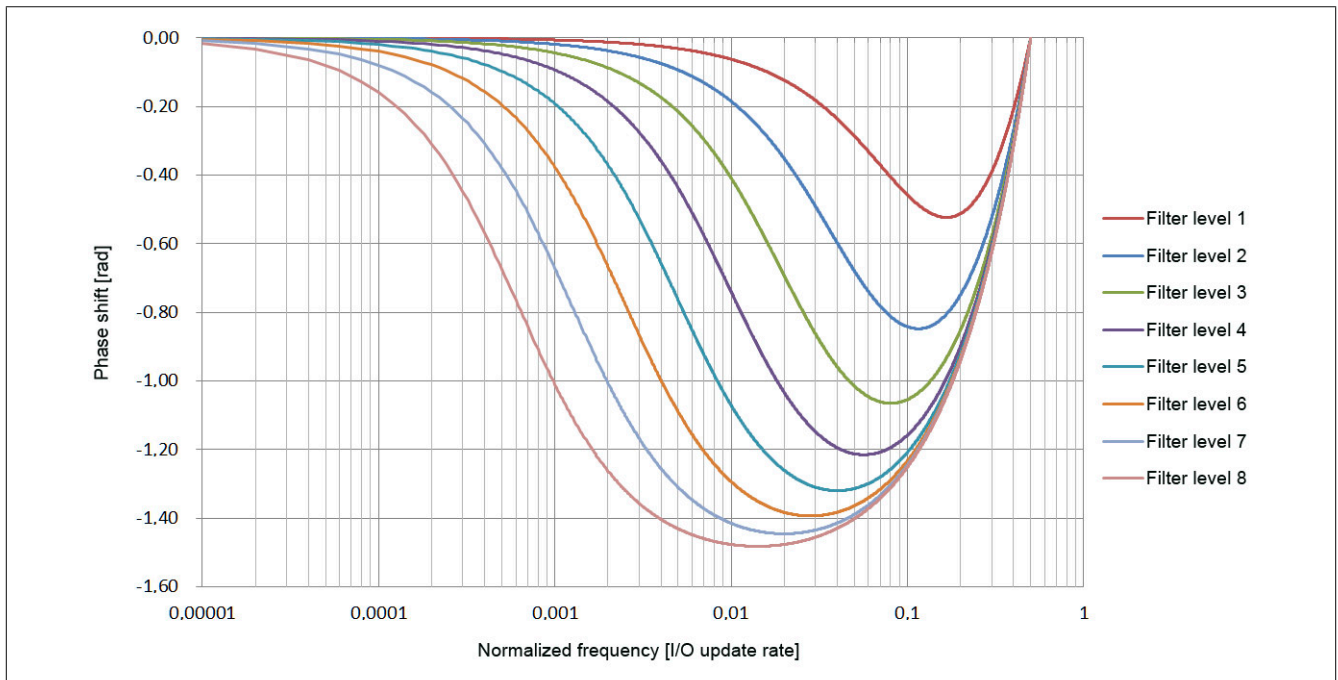
The following table provides an overview of the -3 dB limit frequency f_c depending on the configured filter level.

| Filter level | Normalized f_c [I/O update rate] | f_c [Hz] I/O update rate = 15000/s | f_c [Hz] I/O update rate = 20000/s |
|--------------|---------------------------------------|---|---|
| 1 | 0.11476 | 1721.4 | 2295.2 |
| 2 | 0.046 | 690 | 920 |
| 3 | 0.02124 | 318.6 | 424.8 |
| 4 | 0.01026 | 153.9 | 205.2 |
| 5 | 0.00504 | 75.6 | 100.8 |
| 6 | 0.0025 | 37.5 | 50 |
| 7 | 0.00124 | 18.6 | 24.8 |
| 8 | 0.00062 | 9.3 | 12.4 |

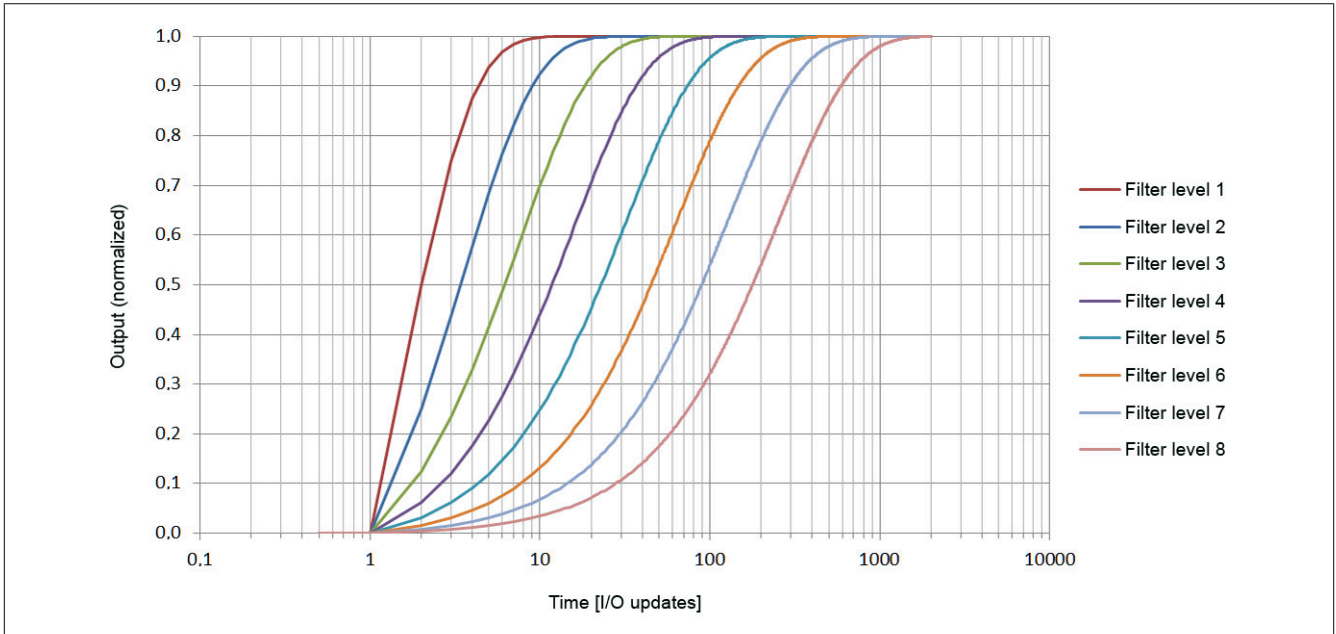
Gain of the IIR low-pass filter



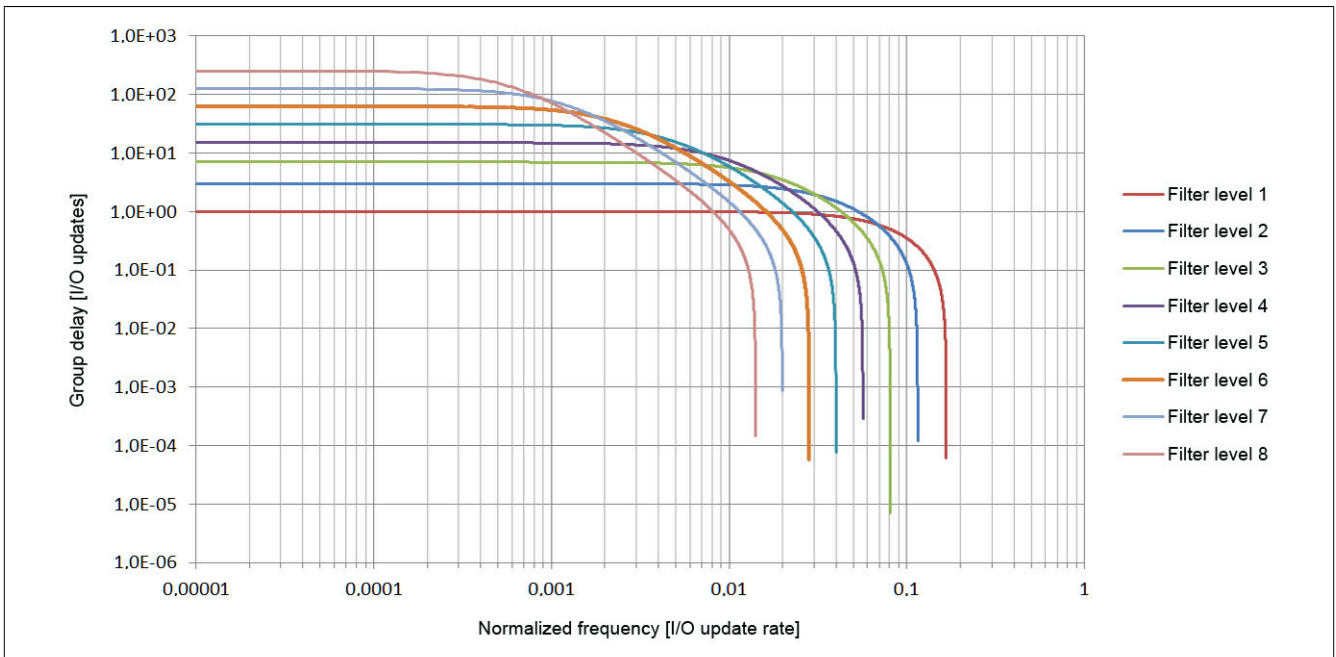
Phase shift of the IIR low-pass filter



Step response of the IIR low-pass filter



Group delay of the IIR low-pass filter



9.1.2.1.12.2 FIR filter

Like the IIR low-pass filter, the FIR filter can also be used to smooth out the signal and increase its resolution. In addition, configuring the filter length accordingly makes it possible to target and efficiently filter out individual interference frequencies. The source of these interference frequencies may be mechanical or electromagnetic. Multiples of these are also filtered out (as long as they are a whole-number factor of the data output rate).

Example:

Data output rate = 15000 samples/s, averaging over 15 values → "Notch" at 1 kHz (2 kHz, etc.)

When reconfiguring the filter, it takes 1/data rate (FIR filter in mode "Selectable data rate") or 1/filter frequency (FIR filter in mode "High-resolution data rate") until the filter is tuned. During tuning, bit 5 is set in register "StatusInput01" on page 224.

Characteristics of the FIR filter in mode "Selectable data rate"

The following table applies to "Function model 0 - Standard" and "Function model 254 - Bus controller" as well as for "Function model 2 - Extended filter" in mode "Selectable data rate".

| Set value 1) 2) | Data rate (f_{Data}) [Hz] 3) 4) | f_{Notch} [Hz] | I/O update rate [Hz] | | I/O update time [ms] | |
|--------------------|---|-------------------------|------------------------------|---|------------------------------|---|
| | | | Function models 0 and 254 | Function model 2 (mode "Selectable data rate") | Function models 0 and 254 | Function model 2 (mode "Selectable data rate") |
| 0000 | 2.5 | 2.5 | 2.5 | 15000 | 400 | 0.0667 |
| 0001 | 5 | 5 | 5 | 15000 | 200 | 0.0667 |
| 0010 | 10 | 10 | 10 | 15000 | 100 | 0.0667 |
| 0011 | 15 | 15 | 15 | 15000 | 66.6667 | 0.0667 |
| 0100 | 25 | 25 | 25 | 15000 | 40 | 0.0667 |
| 0101 | 30 | 30 | 30 | 15000 | 33.3333 | 0.0667 |
| 0110 | 50 | 50 | 50 | 15000 | 20 | 0.0667 |
| 0111 | 60 | 60 | 60 | 15000 | 16.6667 | 0.0667 |
| 1000 | 100 | 100 | 100 | 15000 | 10 | 0.0667 |
| 1001 | 500 | 500 | 500 | 15000 | 2 | 0.0667 |
| 1010 | 1000 | 1000 | 1000 | 15000 | 1 | 0.0667 |
| 1011 | 2000 | 2000 | 2000 | 20000 | 0.5 | 0.05 |
| 1100 | 3750 | 3750 | 3750 | 15000 | 0.2667 | 0.0667 |
| 1101 | 7500 | 7500 | 7500 | 15000 | 0.1333 | 0.0667 |
| 1110 | | | Reserved | | | |
| 1111 | | | Reserved | | | |

- 1) Function model 0 and 254: Bits 0 to 3 of register "ConfigOutput01" on page 215
- 2) Function model 2: Bits 0 to 3 of register "ConfigDataRateOutput01" on page 223
- 3) Function models 0 and 254: Data rate = 1/Filter length [s] (f_{Notch}) = I/O update rate
- 4) Function model 2: Data rate = 1/Filter length [s] (f_{Notch})

Characteristics of the FIR filter in mode "High-resolution data rate"

The following table applies to "Function model 2 - Extended filter".

| Setpoint [0.1 Hz] ¹⁾ | Data rate (f _{Data}) [Hz] | f _{Notch} [Hz] | I/O update time [μs] |
|---------------------------------|-------------------------------------|-------------------------|----------------------|
| 1 to 65535 | Setpoint / 10 | = Data rate | ≈50 μs ²⁾ |

- 1) Setpoint from register "ConfigHighResolutionOutput01" on page 223
- 2) The value varies between 42 and 56 μs (see also the next section "I/O update time")

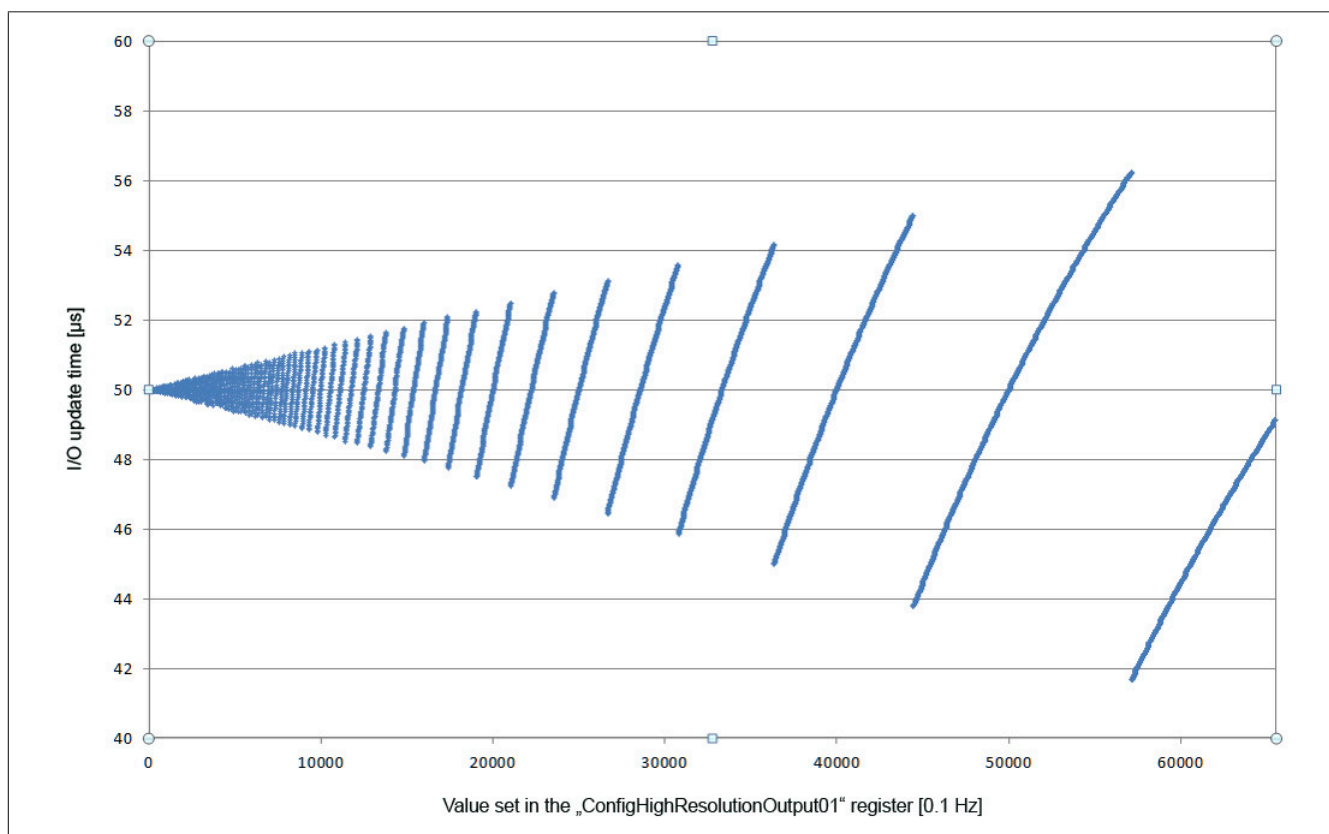
I/O update time

The value of the I/O update time depends on the setpoint and varies between 42 and 56 μs. The following formula can be used to precisely calculate the I/O update time:

$$\text{I/O update time} = 1e6 \cdot (1e-4 - 10 / (\text{Setpoint} \cdot [10 / (5e-5 \cdot \text{Setpoint})]))$$

Legend: The square brackets in the formula above mean that the calculated value must be rounded to a whole number.

The following image shows the I/O update time depending on the setpoint:

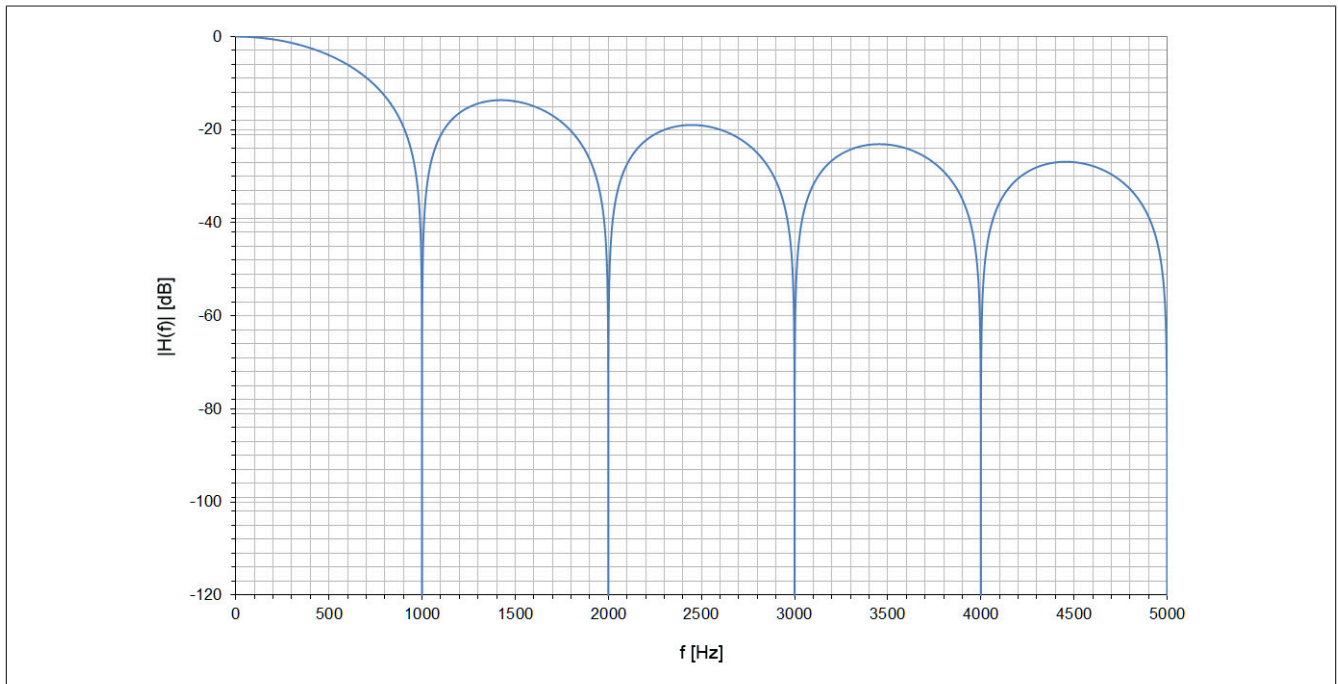


Examples for the gain of the FIR filter

Example 1

Filter setting = 10:

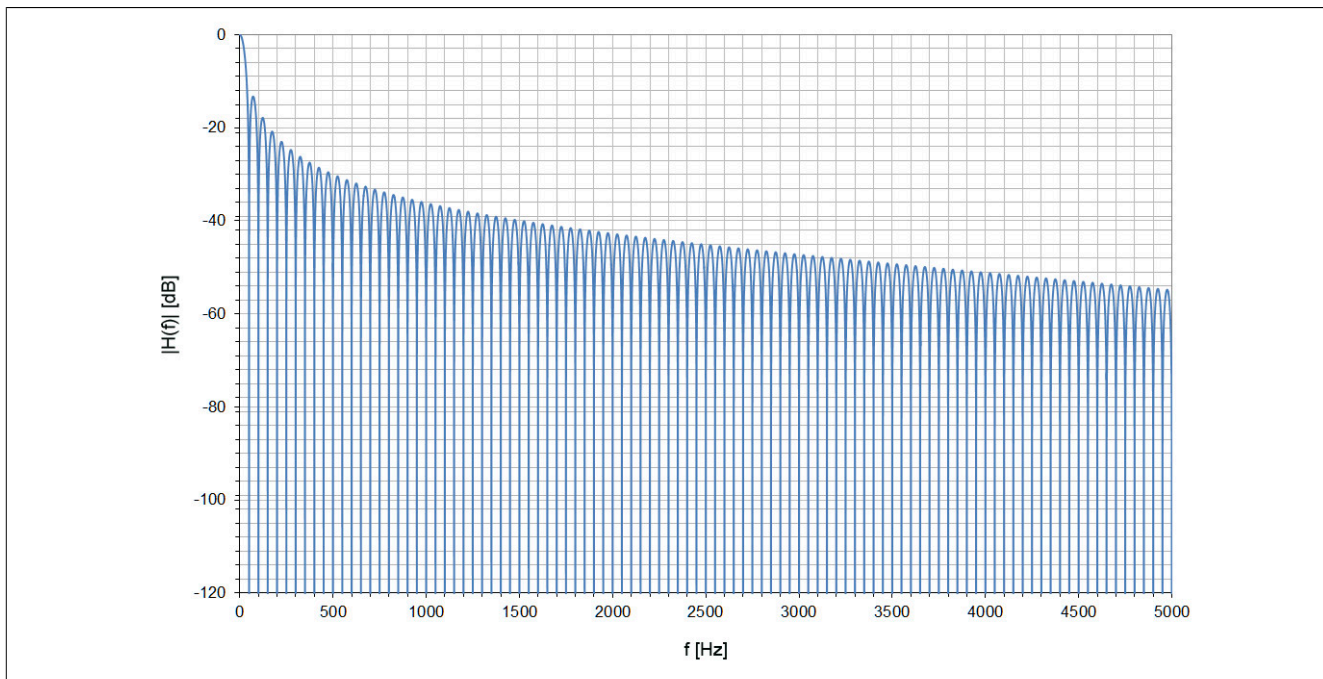
- $f_{\text{Notch}} = 1000 \text{ Hz}$
- $f_c = 439.3 \text{ Hz}$



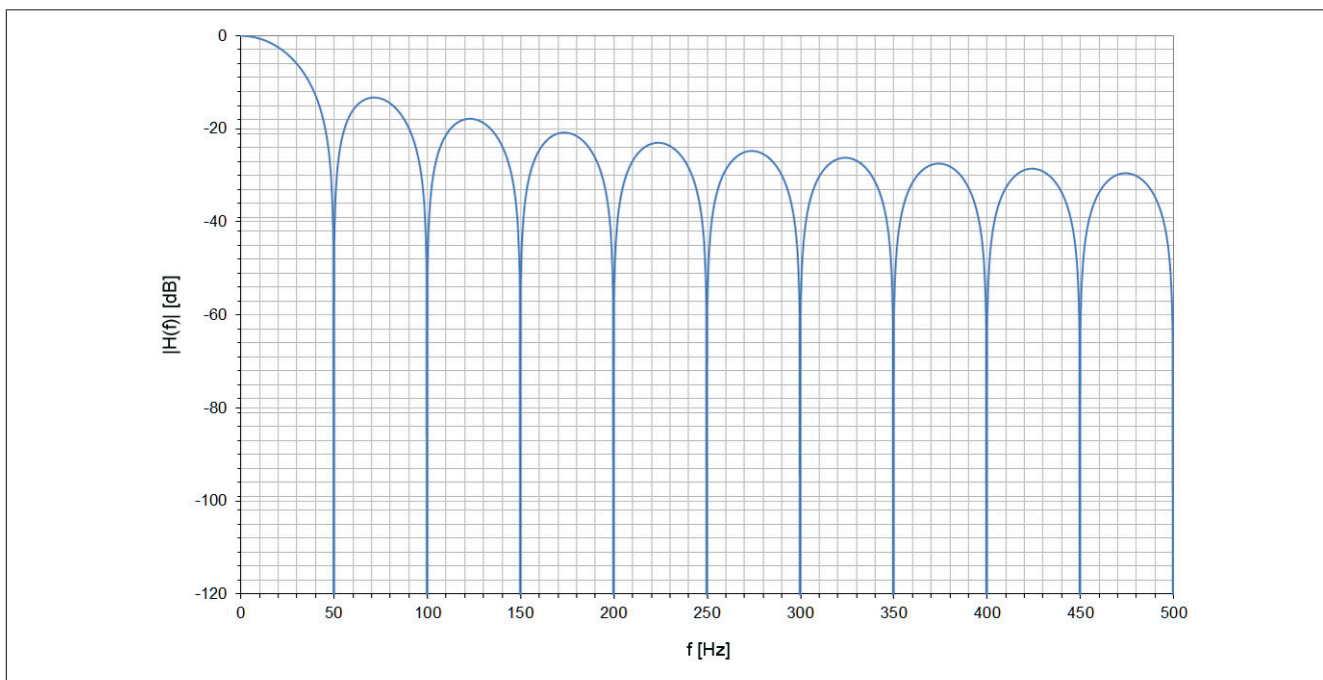
Example 2

Filter setting = 6:

- $f_{\text{Notch}} = 50 \text{ Hz}$
- $f_c = 21.8 \text{ Hz}$



Detailed excerpt from the filter curve shown above:

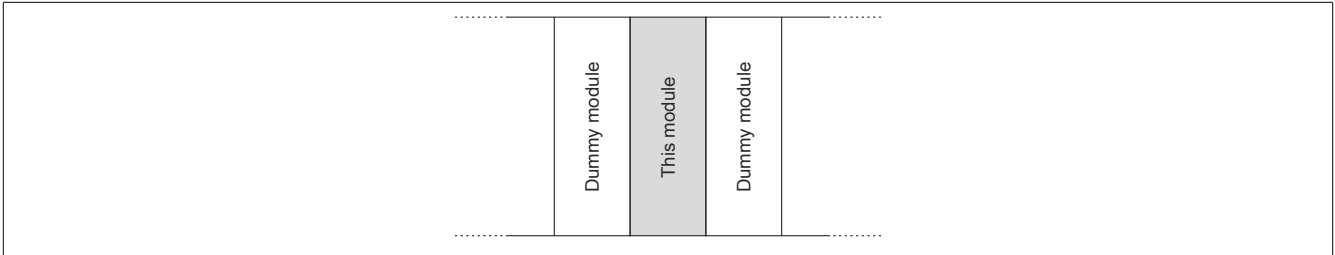


9.1.2.1.13 Hardware configuration

9.1.2.1.13.1 Hardware configuration for horizontal installation starting at 55°C ambient temperature

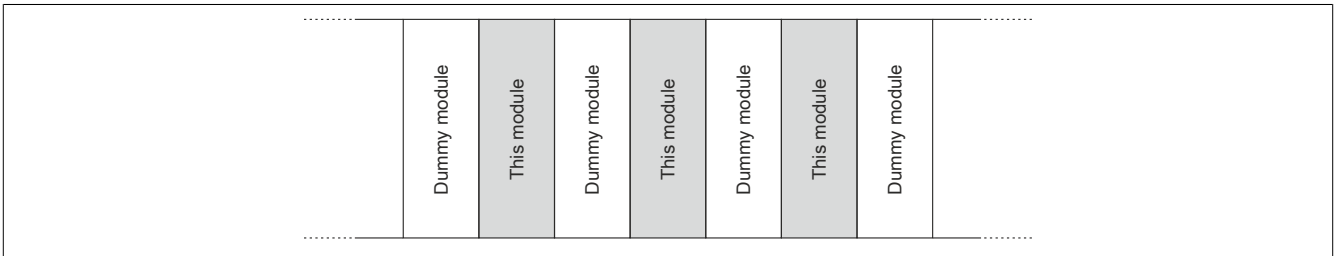
Operating a strain gauge module

Starting at an ambient temperature of 55°C, a dummy module must be connected to the left and right of the strain gauge module in a horizontal mounting orientation.



Operating multiple strain gauge modules side by side

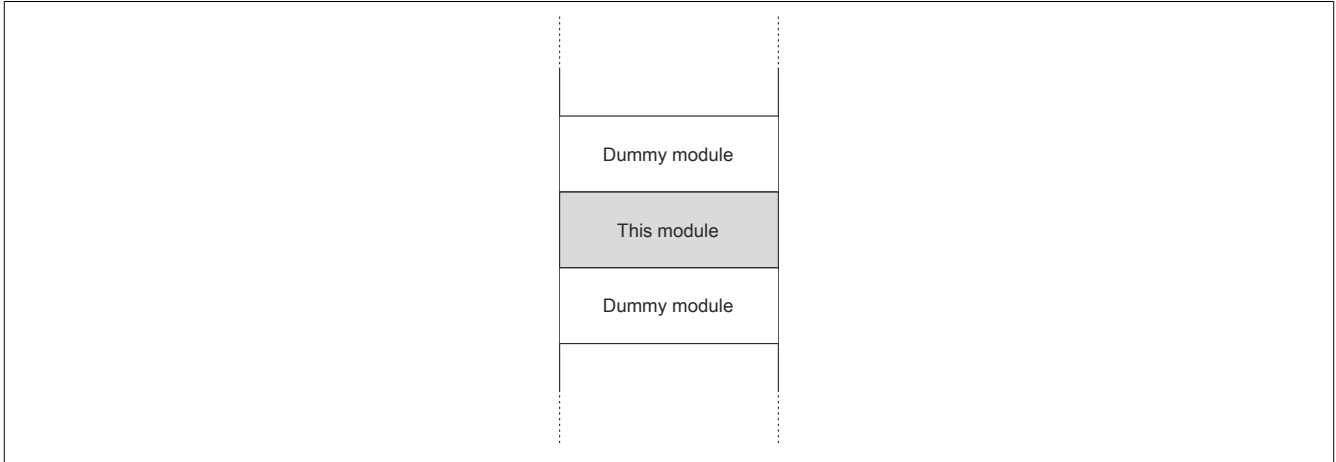
If 2 or more horizontal strain gauge modules are being operated in a cluster, the following arrangement of modules must be observed.



9.1.2.1.13.2 Hardware configuration for vertical installation starting at 45°C ambient temperature

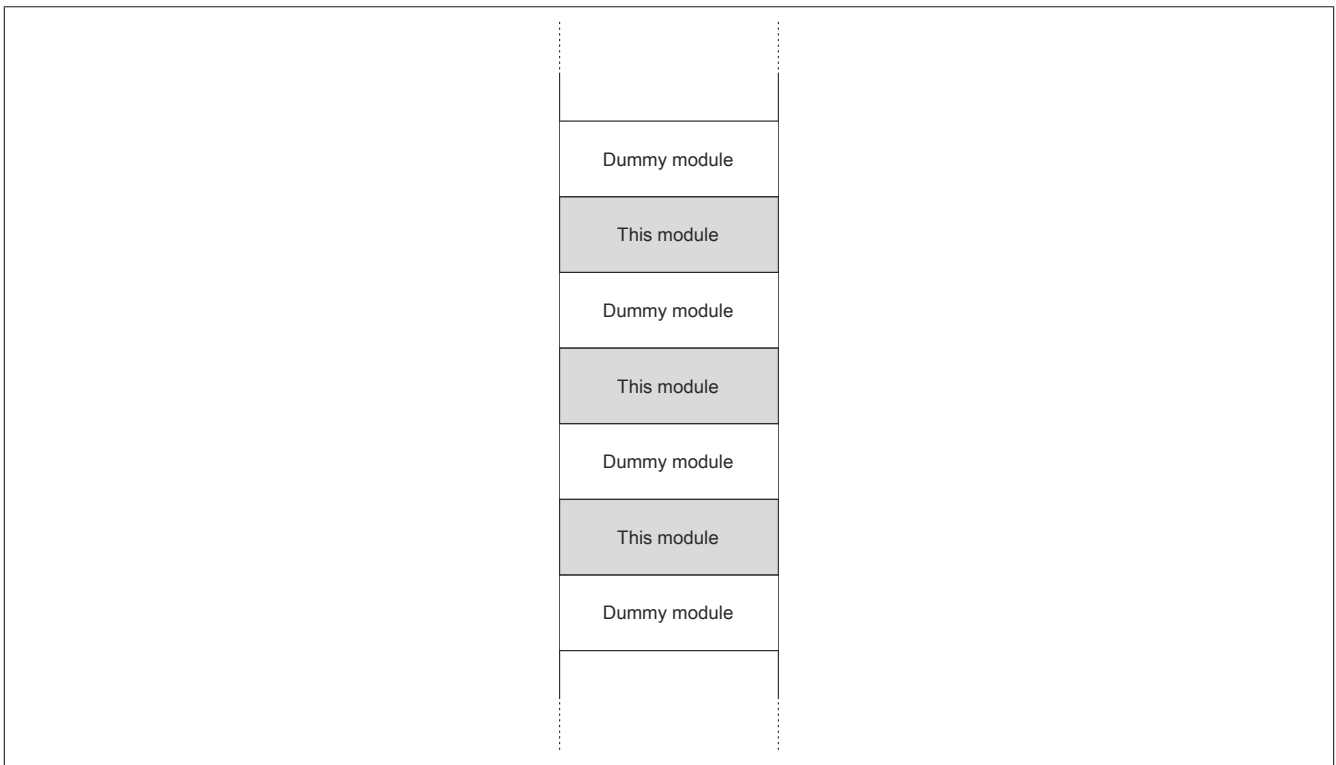
Operating a strain gauge module

Starting at an ambient temperature of 45°C, a dummy module must be connected to the left and right of the strain gauge module in a vertical mounting orientation.



Operating multiple strain gauge modules side by side

If 2 or more vertical strain gauge modules are being operated in a cluster, the following arrangement of modules must be observed.



9.1.2.1.14 Register description

9.1.2.1.14.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.1.2.1.14.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog signal - Configuration | | | | | | |
| 16 | ConfigOutput01 (A/D converter configuration) | USINT | | | • | |
| 18 | ConfigCycletime01 | UINT | | | | • |
| 32 | AdcClkFreqShift01 | USINT | | | | • |
| Analog signal - Communication | | | | | | |
| 2 | StatusInput01 | USINT | • | | | |
| 4 | AnalogInput01 | DINT | • | | | |

9.1.2.1.14.3 Function model 1 - Multisampling

In this function model, the A/D converter is operated synchronously to X2X Link with a predefined A/D converter cycle time. The value is configurable as 50 or 100 μ s.

The module returns between 3 and 10 measured values per X2X cycle depending on the configuration. With an X2X cycle time of 400 μ s and A/D converter cycle time of 50 μ s, exactly 8 measurements are performed and the module can return 8 values (strain gauge value 01 to strain gauge value 08).

If a longer cycle time is used, the values returned correspond to the last measurements. If using an X2X cycle time that is not a whole number multiple of the A/D converter cycle time, then the conversion cannot be synchronized with X2X Link. In this case, the module outputs the invalid value 0x8000.

Example 1

If using an X2X cycle time of 800 μ s, it is possible to perform 16 measurements per X2X cycle if the A/D converter cycle time equals 50 μ s. The first 6 measured values are discarded; the last 10 measured values are provided by the module.

With a shorter X2X cycle time, the number of measured values should not exceed the number of measurements that can actually be made. All other measured values are invalid (0x8000). To minimize the load on the X2X Link network, it is possible to disable these unneeded registers (see ["Number of measured values" on page 220](#)).

Example 2

If using an X2X cycle time of 300 μ s, it is possible to perform 6 measurements per X2X cycle if the A/D converter cycle time equals 50 μ s. For this reason, only the first 6 registers are valid. The registers for the 7th through 10th measured value ([AnalogInput07](#) to [AnalogInput10](#)) should be disabled by setting [Number of measured values](#) to "6 measured values" in the I/O configuration.

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog signal - Configuration | | | | | | |
| 1601 | ConfigGain01_MultiSample | USINT | | | • | |
| 1603 | ConfigCycletime01_MultiSample | USINT | | | | • |
| Analog signal - Communication | | | | | | |
| 2 | StatusInput01 | USINT | • | | | |
| 1534 + N * 4 | AnalogInput0N (N = 1 to 10) | INT | • | | | |

9.1.2.1.14.4 Function model 2 - Extended filter

This function model allows the IIR low-pass filter and the FIR filter to be enabled.

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog signal - Configuration | | | | | | |
| 272 | ConfigCommonOutput01 (A/D converter and IIR filter configuration) | USINT | | | • | |
| 288 | ConfigFilterOutput01 | UINT | | | | • |
| 273 | ConfigDatarateOutput01 | USINT | | | • | |
| 274 | ConfigHighResolutionOutput01 | UINT | | | • | |
| Analog signal - Communication | | | | | | |
| 2 | StatusInput01 | USINT | • | | | |
| 4 | AnalogInput01 | DINT | • | | | |
| 256 | AdcConvTimeStampInput01 | DINT | • | | | |

9.1.2.1.14.5 Function model 254 - Bus controller

In function model "254 - Bus controller", the module behaves as it does in "Function model 0 - Standard" with the exception that it is not synchronized to the X2X Link network even if synchronous mode is enabled in register "ConfigOutput01" on page 215. Instead, the module behaves as if the set A/D converter cycle time is not a factor or multiple of the X2X cycle time and attempts to maintain the set A/D converter cycle time as precisely as possible.

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog signal - Configuration | | | | | | | |
| 16 | 0 | ConfigOutput01 (A/D converter configuration) | USINT | | | • | |
| 18 | 18 | ConfigCycletime01 | UINT | | | | • |
| 32 | 32 | AdcClkFreqShift01 | USINT | | | | • |
| Analog signal - Communication | | | | | | | |
| 2 | 4 | StatusInput01 | USINT | • | | | |
| 4 | 0 | AnalogInput01 | DINT | • | | | |

1) The offset specifies the position of the register within the CAN object.

Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "Using I/O modules on the bus controller" on page 3789.

CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.1.2.1.14.6 Registers for function models "0 - Standard" and "254 - Bus controller"

A/D converter configuration

Name:

ConfigOutput01

The data rate and measurement range of the A/D converter can be configured in this register.

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| USINT | See bit structure. | 13 |

Bit structure:

| Bit | Description | Value | Information | |
|-------|--|--|--|----------|
| 0 - 3 | Data rate f_{DATA} (samples per second): | 0000 | 2.5 | |
| | | 0001 | 5 | |
| | | 0010 | 10 | |
| | | 0011 | 15 | |
| | | 0100 | 25 | |
| | | 0101 | 30 | |
| | | 0110 | 50 | |
| | | 0111 | 60 | |
| | | 1000 | 100 | |
| | | 1001 | 500 | |
| | | 1010 | 1000 | |
| | | 1011 | 2000 | |
| | | 1100 | 3750 | |
| | | 1101 | 7500 (bus controller default setting) | |
| 4 - 6 | Standard measurement range (bit 6 = 0) | 000 | 16 mV/V (bus controller default setting) | |
| | | 001 | 8 mV/V | |
| | | 010 | 4 mV/V | |
| | | 011 | 2 mV/V | |
| | | Extended measurement range (bit 6 = 1) | 100 | 256 mV/V |
| | | | 101 | 128 mV/V |
| 110 | 64 mV/V | | | |
| 7 | Reserved | 111 | 32 mV/V | |
| | | 0 | (must be 0) | |

Synchronous mode

The module's analog/digital converter (A/D converter) can optionally be operated and read synchronously to the X2X Link network. Synchronous mode is enabled by selecting the respective operating mode in register "ConfigOutput01" on page 215. A time between 200 and 2000 μ s must be set in register "ConfigCycletime01" on page 216 for this. If this time is a whole number factor or multiple of the configured cycle time of X2X Link, then the A/D converter is read synchronously to X2X Link.

Information:

The A/D converter cycle time must be $\geq 1/4$ of the X2X cycle time!

Bit 2 in *Module status* is set (i.e. A/D converter not running synchronously)...

- ... If the configured A/D converter cycle time cannot be synchronized with X2X Link.
- ... If the module is still in the settling phase.

Jitter, dead time and settling time:

| | | |
|---|--|---|
| Jitter | | |
| A/D converter cycle times <1500 μ s | | Max. $\pm 1 \mu$ s |
| A/D converter cycle times >1500 μ s | | Max. $\pm 4 \mu$ s |
| X2X link dead time | | 50μ s + $\frac{X2X \text{ cycle time}}{128}$ |
| Settling time | | 150 x X2X cycle time |

The settling time corresponds to the time needed until the A/D converter can be operated after enabling synchronous mode or following conversion of the A/D converter cycle time.

A/D converter cycle time

Name:

ConfigCycletime01

This register is only used in [Synchronous mode](#). If synchronous mode is enabled in the A/D converter configuration, then the module attempts to operate the A/D converter as synchronously as possible to the X2X Link network (based on the A/D converter cycle time set in this register). It is of course necessary for the X2X Link cycle time and the A/D converter cycle time to have a certain ratio. The following conditions must be observed:

- 1) A/D converter cycle time $\geq 1/4$ X2X cycle time
- 2) A/D converter cycle time corresponds to a whole number factor or multiple of the X2X cycle time
- 3) A/D converter cycle time must be in the range 50 to 2000 μ s

| Data type | Values | Information |
|-----------|------------|-------------------------------------|
| UINT | 50 to 2000 | Bus controller default setting: 400 |

A/D converter clock frequency shift

Name:

AdcClkFreqShift01

In rare cases, strain gauge modules connected to neighboring slots can influence one another. This can result in temporary, minimal deviations in measured values. This can only occur if the sigma-delta A/D converters on the neighboring strain gauge modules are operated at exactly the same clock frequency.

In most cases, these clock frequencies vary slightly due to part variances. When they are the same however, this register on the strain gauge module provides a safe way for an application to prevent this type of mutual influence.

| Data type | Values | Information |
|-----------|-------------|-------------------------------------|
| SINT | -128 to 127 | Bus controller default setting: 127 |

This register can be used to vary the clock frequency in increments of 200 ppm. Setting values from -50 to 50 cover a range of -10000 ppm to 10000 ppm. This corresponds with -1% to 1%.

Values beyond this range will cause activation of a default mode. The frequency shift is derived from the last 2 digits of the serial number by the module firmware. This saves time that would otherwise be needed for programming, provided that the last two digits of the serial numbers on the neighboring modules are not the same

| Register value | Frequency shift in ppm | Example of a sampling rate ¹⁾ |
|----------------|--|--|
| 127 | $((\text{SerialNo. modulo } 100) - 50) * (-200)$ ppm | Based on the serial number |
| ... | ... | ... |
| 51 | $((\text{SerialNo. modulo } 100) - 50) * (-200)$ ppm | Based on the serial number |
| 50 | 10000 | 505 |
| 49 | 9800 | 504.9 |
| ... | ... | ... |
| 2 | 400 | 500.2 |
| 1 | 200 | 500.1 |
| 0 | 0 | 500 |
| -1 | -200 | 499.9 |
| -2 | -400 | 499.8 |
| ... | ... | ... |
| -50 | -10000 | 495 |
| -51 | $((\text{SerialNo. modulo } 100) - 50) * (-200)$ ppm | Based on the serial number |
| ... | ... | ... |
| -128 | $((\text{SerialNo. modulo } 100) - 50) * (-200)$ ppm | Based on the serial number |

1) Nominal sampling rate of 500 samples per second

Important:

As shown in the table above, shifting the A/D converter clock frequency will equally shift the A/D converter sampling rate. Shifting the A/D converter clock frequency too much can cause problems with disturbance suppression particularly when a very specific sampling rate has been defined to suppress existing disturbances (e.g. 50 Hz to suppress the 50 Hz hum). See also "[Filter characteristics of the sigma-delta A/D converter](#)" on page 203.

It is situations like this where the option to manually shift the frequency in the I/O configuration or ASIOACC library should be utilized rather than relying on the default frequency shift that is based on the serial number.

A frequency shift like the one shown below would be sufficient to prevent modules from influencing one another and would not cause any noticeable difference to the filter characteristics.

| Slot | 1 | 2 | 3 | 4 | 5 | 6 | ... |
|-------------------------------------|---|---|----|---|----|---|-----|
| A/D converter clock frequency shift | 0 | 2 | -1 | 1 | -2 | 0 | ... |

Information:

- This register has no effect in synchronous mode because the firmware regulates the A/D converter clock frequency in such a way that the A/D converter cycle is synchronous with the X2X cycle.
- When writing to this register using the ASIOACC library, only the lowest value byte of the written value is accepted. For example, the value 256 (=0x100) is identical to the value 0 (=0x00).

Module status

Name:

StatusInput01

The current state of the module is indicated in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------------|-------|---|
| 0 | A/D converter value | 0 | Valid A/D converter value |
| | | 1 | Invalid A/D converter value (analog value = 0xFF800000). Possible causes: <ul style="list-style-type: none"> • Strain gauge supply error • I/O power supply error • A/D converter not (yet) configured |
| 1 | Line monitoring | 0 | Ok |
| | | 1 | Open circuit |
| 2 | Only valid in synchronous mode | 0 | A/D converter runs synchronous to X2X Link |
| | | 1 | A/D converter does not run synchronous to X2X Link |
| 3 - 7 | Reserved | - | |

Strain gauge value

Name:

AnalogInput01

This register contains the raw value determined by the A/D converter for the full-bridge strain gauge with 24-bit resolution.

| Data type | Values | Information |
|-----------|-----------------------|--|
| DINT | -8,388,608 | Negative invalid value |
| | -8,388,607 | Negative full-scale deflection / Underflow |
| | -8,388,606 to 8388606 | Valid range |
| | 8,388,607 | Positive full-scale deflection / Overflow / Open circuit |

Effective resolution

In principle, the effective resolution of the A/D converter is dependent on the data rate and the measurement range (see "Effective resolution of the A/D converter" on page 200).

The following table shows how the effective resolution (in bits) or effective range of values of the strain gauge value depend on the module configuration (data rate, measurement range).

| Data rate f_{DATA} [Hz] | Measurement range | | | | | | | |
|-------------------------------------|-------------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|
| | ± 16 mV/V | | ± 8 mV/V | | ± 4 mV/V | | ± 2 mV/V | |
| | Bits | Range of values | Bits | Range of values | Bits | Range of values | Bits | Range of values |
| 2.5 | 19.9 | $\pm 489,000$ | 19.1 | $\pm 281,000$ | 18.0 | $\pm 131,000$ | 17.4 | $\pm 86,500$ |
| 5 | 19.4 | $\pm 346,000$ | 18.2 | $\pm 151,000$ | 17.5 | $\pm 92,700$ | 16.4 | $\pm 43,200$ |
| 10 | 18.5 | $\pm 185,000$ | 17.8 | $\pm 114,000$ | 16.8 | $\pm 57,100$ | 15.9 | $\pm 30,600$ |
| 15 | 18.2 | $\pm 151,000$ | 17.3 | $\pm 80,700$ | 16.4 | $\pm 43,200$ | 15.4 | $\pm 21,600$ |
| 25 | 17.8 | $\pm 114,000$ | 16.9 | $\pm 61,100$ | 16.0 | $\pm 32,800$ | 14.9 | $\pm 15,300$ |
| 30 | 17.8 | $\pm 114,000$ | 16.8 | $\pm 57,100$ | 15.9 | $\pm 30,600$ | 14.8 | $\pm 14,300$ |
| 50 | 17.4 | $\pm 86,500$ | 16.3 | $\pm 40,300$ | 15.4 | $\pm 21,600$ | 14.4 | $\pm 10,800$ |
| 60 | 17.4 | $\pm 86,500$ | 16.2 | $\pm 37,600$ | 15.3 | $\pm 20,200$ | 14.1 | $\pm 8,780$ |
| 100 | 16.9 | $\pm 61,100$ | 15.9 | $\pm 30,600$ | 14.8 | $\pm 14,300$ | 13.8 | $\pm 7,130$ |
| 500 | 15.5 | $\pm 23,200$ | 14.5 | $\pm 11,600$ | 13.5 | $\pm 5,790$ | 12.5 | $\pm 2,900$ |
| 1000 | 15.0 | $\pm 16,400$ | 14.1 | $\pm 8,780$ | 13.1 | $\pm 4,390$ | 11.9 | $\pm 1,910$ |
| 2000 | 14.5 | $\pm 11,600$ | 13.4 | $\pm 5,400$ | 12.6 | $\pm 3,100$ | 11.4 | $\pm 1,350$ |
| 3750 | 14.1 | $\pm 8,780$ | 13.1 | $\pm 4,390$ | 12.1 | $\pm 2,190$ | 11.1 | $\pm 1,100$ |
| 7500 | 13.8 | $\pm 7,130$ | 12.7 | $\pm 3,330$ | 11.8 | $\pm 1,780$ | 10.6 | ± 776 |

Table 20: Effective resolution of the strain gauge value in bits for the measurement range 2 to 16 mV/V

| Data rate f_{DATA} [Hz] | Measurement range | | | | | | | |
|-------------------------------------|-------------------|-----------------|----------------|-----------------|---------------|-----------------|---------------|-----------------|
| | ± 256 mV/V | | ± 128 mV/V | | ± 64 mV/V | | ± 32 mV/V | |
| | Bits | Range of values | Bits | Range of values | Bits | Range of values | Bits | Range of values |
| 2.5 | 22.0 | $\pm 2,100,000$ | 22.0 | $\pm 2,100,000$ | 21.2 | $\pm 1,200,000$ | 20.5 | $\pm 741,000$ |
| 5 | 21.7 | $\pm 1,700,000$ | 21.4 | $\pm 1,380,000$ | 20.8 | $\pm 913,000$ | 20.3 | $\pm 645,000$ |
| 10 | 20.8 | $\pm 913,000$ | 20.8 | $\pm 913,000$ | 20.2 | $\pm 602,000$ | 19.4 | $\pm 346,000$ |
| 15 | 20.7 | $\pm 852,000$ | 20.5 | $\pm 741,000$ | 19.9 | $\pm 489,000$ | 19.3 | $\pm 323,000$ |
| 25 | 20.1 | $\pm 562,000$ | 19.9 | $\pm 489,000$ | 19.7 | $\pm 426,000$ | 18.9 | $\pm 245,000$ |
| 30 | 19.9 | $\pm 489,000$ | 19.9 | $\pm 489,000$ | 19.4 | $\pm 346,000$ | 18.8 | $\pm 228,000$ |
| 50 | 19.8 | $\pm 456,000$ | 19.2 | $\pm 301,000$ | 19.2 | $\pm 301,000$ | 18.2 | $\pm 151,000$ |
| 60 | 19.5 | $\pm 371,000$ | 19.2 | $\pm 301,000$ | 19.0 | $\pm 262,000$ | 18.2 | $\pm 151,000$ |
| 100 | 19.0 | $\pm 262,000$ | 18.8 | $\pm 228,000$ | 18.5 | $\pm 185,000$ | 17.6 | $\pm 99,300$ |
| 500 | 17.8 | $\pm 114,000$ | 17.5 | $\pm 92,700$ | 17.1 | $\pm 70,200$ | 16.4 | $\pm 43,200$ |
| 1000 | 17.2 | $\pm 75,300$ | 17.1 | $\pm 70,200$ | 16.7 | $\pm 53,200$ | 15.8 | $\pm 28,500$ |
| 2000 | 16.7 | $\pm 53,200$ | 16.5 | $\pm 46,300$ | 16.1 | $\pm 35,100$ | 15.2 | $\pm 18,800$ |
| 3750 | 16.2 | $\pm 37,600$ | 16.1 | $\pm 35,100$ | 15.8 | $\pm 28,500$ | 14.9 | $\pm 15,300$ |
| 7500 | 15.9 | $\pm 30,600$ | 15.8 | $\pm 28,500$ | 15.3 | $\pm 20,200$ | 14.6 | $\pm 12,400$ |

Table 21: Effective resolution of the strain gauge value in bits for the measurement range 32 to 256 mV/V

9.1.2.1.14.7 Register for "Function model 1 - Multisampling"**A/D converter configuration**

Name:

ConfigGain01_MultiSample

The measurement range for the A/D converter can be configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|-------------|
| 0 - 2 | Standard measurement range (bit 2 = 0) | 000 | 16 mV/V |
| | | 001 | 8 mV/V |
| | | 010 | 4 mV/V |
| | | 011 | 2 mV/V |
| | Extended measurement range (bit 2 = 1) | 100 | 256 mV/V |
| | | 101 | 128 mV/V |
| | | 110 | 64 mV/V |
| 3 - 7 | Reserved | 111 | 32 mV/V |
| | | 0 | (must be 0) |

A/D converter cycle time

Name:

ConfigCycletime01_MultiSample

The A/D converter cycle time can be configured in this register.

In order for multisampling to work, the X2X cycle time must be divisible by the A/D converter cycle time to produce a whole number.

| Data type | Value | Information |
|-----------|----------|----------------------|
| USINT | 0 | 50 μ s (default) |
| | 1 | 100 μ s |
| | 2 to 255 | Reserved |

Number of measured values

If the X2X cycle time is too short, then not all 10 measurements can be performed. To reduce the load on X2X Link, it makes sense to only transfer as many values as measurements that can be made. This is why it is possible to configure the number of measured values to be transferred (see "Function model 1 - Multisampling" on page 213).

Example: A/D converter cycle time = 50 μ s

| X2X cycle time | Number of measured values to be transferred |
|--------------------|---|
| 250 μ s | 5 |
| 300 μ s | 6 |
| 350 μ s | 7 |
| 400 μ s | 8 |
| 450 μ s | 9 |
| \geq 500 μ s | 10 |

Example: A/D converter cycle time = 100 μ s

| X2X cycle time | Number of measured values to be transferred |
|----------------|---|
| 300 μ s | 3 |
| 400 μ s | 4 |
| 500 μ s | 5 |
| 600 μ s | 6 |
| 700 μ s | 7 |
| 800 μ s | 8 |
| 900 μ s | 9 |
| \geq 1 ms | 10 |

Module status

Name:
StatusInput01

This register contains the current state of the module.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------------|-------|--|
| 0 | A/D converter values | 0 | Valid A/D converter value |
| | | 1 | Invalid A/D converter value |
| 1 | Line monitoring | 0 | OK |
| | | 1 | Open circuit An open circuit was found during at least one measurement in this X2X cycle. This bit is reset if all measurements are OK after correcting this error, i.e. it does not have to be acknowledged. |
| 2 | Synchronous mode | 0 | A/D converter runs synchronous to X2X Link |
| | | 1 | A/D converter does not run synchronous to X2X Link |
| 3 - 7 | Reserved | - | |

Strain gauge value - Multiple

Name:
AnalogInput01 to AnalogInput10

This register contains the raw value determined by the A/D converter for the full-bridge strain gauge with 16-bit resolution. The module returns between 3 and 10 measured values per X2X cycle depending on the configuration.

Effective resolution

In principle, the effective resolution of the A/D converter is dependent on the data rate and measurement range (see "[Effective resolution of the A/D converter](#)" on page 200).

The following table shows how the effective resolution (in bits) or effective range of values of the strain gauge value depend on the module configuration (data rate, measurement range).

| Measurement range | | | | | | | |
|-------------------|-----------------|---------|-----------------|---------|-----------------|---------|-----------------|
| ±16 mV/V | | ±8 mV/V | | ±4 mV/V | | ±2 mV/V | |
| Bits | Range of values | Bits | Range of values | Bits | Range of values | Bits | Range of values |
| 13.4 | ±5,240 | 12.3 | ±2,510 | 11.3 | ±1,300 | 10.3 | ±630 |

Table 22: Effective resolution of the strain gauge value in bits for the measurement range 2 to 16 mV/V

| Measurement range | | | | | | | |
|-------------------|-----------------|-----------|-----------------|----------|-----------------|----------|-----------------|
| ±256 mV/V | | ±128 mV/V | | ±64 mV/V | | ±32 mV/V | |
| Bits | Range of values | Bits | Range of values | Bits | Range of values | Bits | Range of values |
| 15.5 | ±23,200 | 15.0 | ±16,400 | 15.0 | ±16,400 | 14.1 | ±8,490 |

Table 23: Effective resolution of the strain gauge value in bits for the measurement range 32 to 256 mV/V

9.1.2.1.14.8 Register for "Function model 2 - Extended filter"**A/D converter and IIR filter configuration**

Name:

ConfigCommonOutput01

The IIR low-pass filter and measurement range of the A/D converter can be configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------------------|-------------|--|
| | | | Filter level |
| 0 - 3 | IIR low-pass filter | 0000 | 0: IIR low-pass filter switched off |
| | | 0001 | 1 |
| | | 0010 | 2 |
| | | 0011 | 3 |
| | | 0100 | 4 |
| | | 0101 | 5 |
| | | 0110 | 6 |
| | | 0111 | 7 |
| | | 1000 | 8 |
| | | 1001 - 1111 | The analog input value indicates an invalid range. |
| 4 - 6 | Default measurement range | 000 | 16 mV/V |
| | | 001 | 8 mV/V |
| | | 010 | 4 mV/V |
| | | 011 | 2 mV/V |
| | Extended measurement range | 100 | 256 mV/V |
| | | 101 | 128 mV/V |
| | | 110 | 64 mV/V |
| | | 111 | 32 mV/V |
| 7 | Reserved | 0 | (must be 0) |

Data rate configuration

Name:

ConfigFilterOutput01

Whether a selectable data rate or a high-resolution data rate is being used for the FIR filter is configured in this register.

| Data type | Values | Information |
|-----------|--------|--|
| UINT | 0 | Mode "Selectable data rate": A selectable data rate is used for the FIR filter (default). Configuration takes place in register "ConfigDatarateOutput01" on page 223. |
| | 1 | Mode "High-resolution data rate": A high-resolution data rate is used for the FIR filter. Configuration takes place in register "ConfigHighResolutionOutput01" on page 223. |

Name:

ConfigDatarateOutput01

The data rate of the FIR filter in mode "Selectable data rate" is configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------------|--|
| 0 - 3 | Data rate f_{DATA} (samples per second): | 0000 | 2.5 |
| | | 0001 | 5 |
| | | 0010 | 10 |
| | | 0011 | 15 |
| | | 0100 | 25 |
| | | 0101 | 30 |
| | | 0110 | 50 |
| | | 0111 | 60 |
| | | 1000 | 100 |
| | | 1001 | 500 |
| | | 1010 | 1000 |
| | | 1011 | 2000 |
| | | 1100 | 3750 |
| | | 1101 | 7500 |
| | | 1110 - 1111 | The analog input value indicates an invalid range. |
| 4 - 7 | Reserved | 0 | (must be 0) |

Name:

ConfigHighResolutionOutput01

The data rate of the FIR filter in 0.1 Hz steps is configured in this register (0.1 to 6553.5 Hz).

| Data type | Values | Information |
|-----------|-------------|-------------------------|
| UINT | 0 | Disables the FIR filter |
| | 1 to 65,535 | 0.1 to 6553.5 Hz |

Module status

Name:

StatusInput01

This register contains the current state of the module. If there is a fault in the module power supply or strain gauge supply, the analog input value indicates an invalid range and the buffer of the enabled filter is reset.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------------|-------|------------------------------|
| 0 | A/D converter values | 0 | Valid A/D converter value |
| | | 1 | Invalid A/D converter value |
| 1 | Line monitoring | 0 | OK |
| | | 1 | Open circuit |
| 2 | Reserved | - | |
| 3 | Module power supply | 0 | OK |
| | | 1 | Error in module power supply |
| 4 | Strain gauge supply | 0 | OK |
| | | 1 | Error in strain gauge supply |
| 5 | FIR filter ready | 0 | OK |
| | | 1 | FIR filter not yet ready |
| 6 - 7 | Reserved | - | |

A/D converter conversion timestamp

Name:

AdcConvTimeStampInput01

This register holds the timestamp of the last analog conversion. This is always the point in time in [μ s] at which the conversion of the latest A/D converter raw value is completed.

| Data type | Values | Explanation |
|-----------|---------------------------------|--|
| DINT | -2,147,483,648 to 2,147,483,647 | Timestamp [μ s] of the last analog conversion |

9.1.2.1.14.9 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 250 μ s |

9.1.2.1.14.10 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

For the I/O update times for function models "0 - Standard", "2 - Extended filter" and "254 - Bus controller", see section ["Characteristics of the FIR filter in mode "Selectable data rate" on page 207.](#)

Depending on the setting in register ["ConfigCycletime01_MultiSample" on page 220](#), the I/O update time in "Function model 1 - Multisampling" is 50 or 100 μ s.

9.1.2.2 X20AI1744 - With Rev. <H0

9.1.2.2.1 General information

This module works with both 4-wire and 6-wire strain gauge load cells. The concept applied by the module requires compensation in the measurement system. This compensation eliminates the absolute uncertainty in the measurement circuit, such as component tolerances, effective bridge voltage or zero point offset. The measurement precision refers to the absolute (compensated) value, which will only change as a result of changes in the operating temperature.

- 1 full-bridge strain gauge input
- Data output rate configurable from 2.5 Hz to 7.5 kHz
- Special operating modes (synchronous mode and multiple sampling)

9.1.2.2.2 Order data


| Model number | Short description | Figure |
|--------------|--|--|
| | Analog inputs |  |
| X20AI1744 | X20 analog input module, 1 full-bridge strain gauge input, 24-bit converter resolution, 5 kHz input filter | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O power supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O power supply connected through | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 24: X20AI1744 - Order data

9.1.2.2.3 Technical data

| Product ID | X20AI1744 |
|--|---|
| Short description | |
| I/O module | 1 full-bridge strain gauge input |
| General information | |
| B&R ID code | 0x1CDE |
| Status indicators | Channel status, operating status, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Open circuit | Yes, using status LED and software |
| Input | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.25 W |
| Additional power dissipation caused by actuators (resistive) [W] | Max. +0.36 ¹⁾ |
| Electrical isolation | |
| Bus - Analog input | Yes |
| Bus - Bridge supply voltage | Yes |
| Channel - I/O power supply | No |
| Certifications | |
| CE | Yes |
| KC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta = 0 - Max. 60°C FTZÚ 09 ATEX 0083X |
| Full-bridge strain gauge | |
| Strain gauge factor | 2 to 256 mV/V, configurable using software |
| Connection | 4- or 6-wire connections ²⁾ |

Table 25: X20AI1744 - Technical data

| Product ID | X20AI1744 |
|---|---|
| Input type | Differential, used to evaluate a full-bridge strain gauge |
| Digital converter resolution | 24-bit |
| Conversion time | Depends on the configured data output rate |
| Data output rate | 2.5 - 7500 samples per second, configurable using software (f_{DATA}) |
| Input filter | |
| Cutoff frequency | 5 kHz |
| Order | 3 |
| Slope | 60 dB |
| ADC filter characteristics | Sigma-delta, see section "Filter characteristics of the sigma-delta A/D converter" |
| Operating range / Measurement sensor | 85 to 5000 Ω |
| Influence of cable length | The shielded twisted pair cable should be as short as possible and run separately to the sensor (isolated from load circuit) without intermediate terminals |
| Input protection | RC protection |
| Common-mode range | 0 to 3 VDC Permissible input voltage range (with regard to the potential strain gauge GND) on inputs "Input +" and "Input -" |
| Isolation voltage between input and bus | 500 V _{eff} |
| Conversion procedure | Sigma-delta |
| Output of digital value | |
| Broken bridge supply line | Value approaches 0 |
| Broken sensor line | Value approaches \pm end value ("open circuit" status bit is set in the <i>Module status</i> register) |
| Valid range of values | 0xFF800001 to 0x007FFFFF (-8,388,607 to 8,388,607) |
| Strain gauge supply | |
| Voltage | 5.5 VDC / max. 65 mA ³⁾ |
| Short-circuit and overload resistant | Yes |
| Voltage drop for short-circuit protection | Max. 0.2 VDC at 65 mA |
| Quantization ⁴⁾ | |
| LSB value (16-bit) | |
| 2 mV/V | 336 nV |
| 4 mV/V | 671 nV |
| 8 mV/V | 1.343 μ V |
| 16 mV/V | 2.686 μ V |
| 32 mV/V | 5.371 μ V |
| 64 mV/V | 10.74 μ V |
| 128 mV/V | 21.48 μ V |
| 256 mV/V | 42.97 μ V |
| LSB value (24-bit) | |
| 2 mV/V | 1.31 nV |
| 4 mV/V | 2.62 nV |
| 8 mV/V | 5.25 nV |
| 16 mV/V | 10.49 nV |
| 32 mV/V | 20.98 nV |
| 64 mV/V | 41.96 nV |
| 128 mV/V | 83.92 nV |
| 256 mV/V | 167.85 nV |
| Temperature coefficient | |
| Rev. \geq E0 | 10 ppm/ $^{\circ}$ C |
| Rev. $<$ E0 | 30 ppm/ $^{\circ}$ C |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5 $^{\circ}$ C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | 0 to 55 $^{\circ}$ C |
| Vertical mounting orientation | 0 to 50 $^{\circ}$ C |
| Derating | See section "Hardware configuration" |
| Storage | -25 to 70 $^{\circ}$ C |
| Transport | -25 to 70 $^{\circ}$ C |

Table 25: X20AI1744 - Technical data


| Product ID | X20AI1744 |
|------------------------------|--|
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately Order 1x bus module X20BM11 separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 25: X20AI1744 - Technical data

- 1) Depends on the full-bridge strain gauge being used.
- 2) With 6-wire connections, line compensation does not function (see section "Connection examples").
- 3) The maximum current of 90 mA is permitted up to an operating temperature of 45°C.
- 4) Quantization depends on the strain gauge factor.

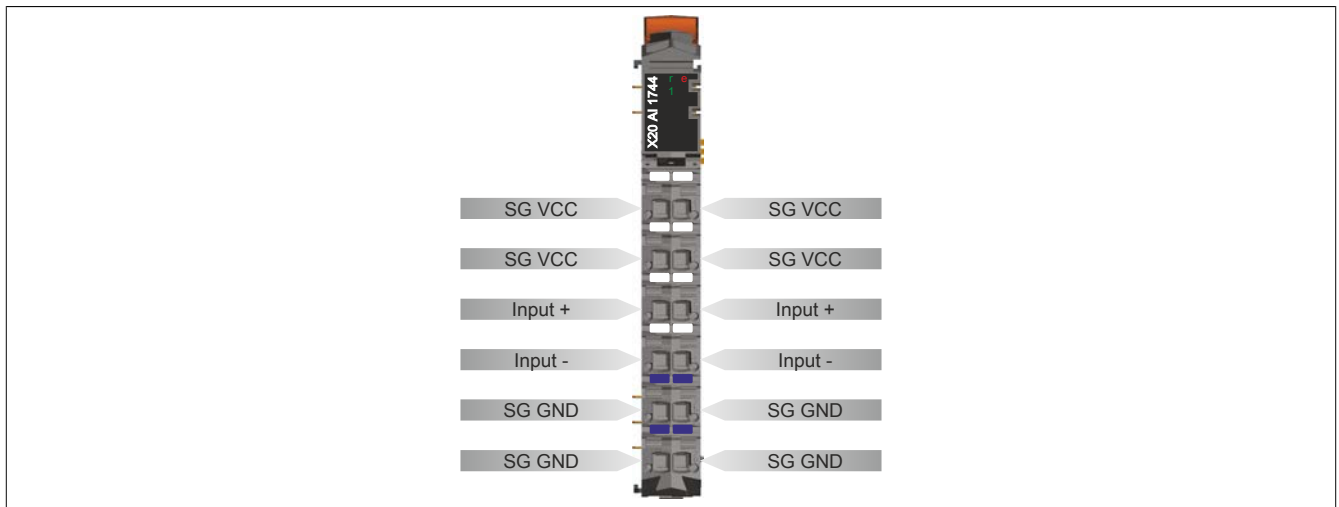
9.1.2.2.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-----|-------|--------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | 1 | Green | Off | Possible causes: <ul style="list-style-type: none"> • Open circuit • Sensor is disconnected • Converter is busy |
| | | | On | Analog/digital converter running, value OK |
| | | | On | Analog/digital converter running, value OK |

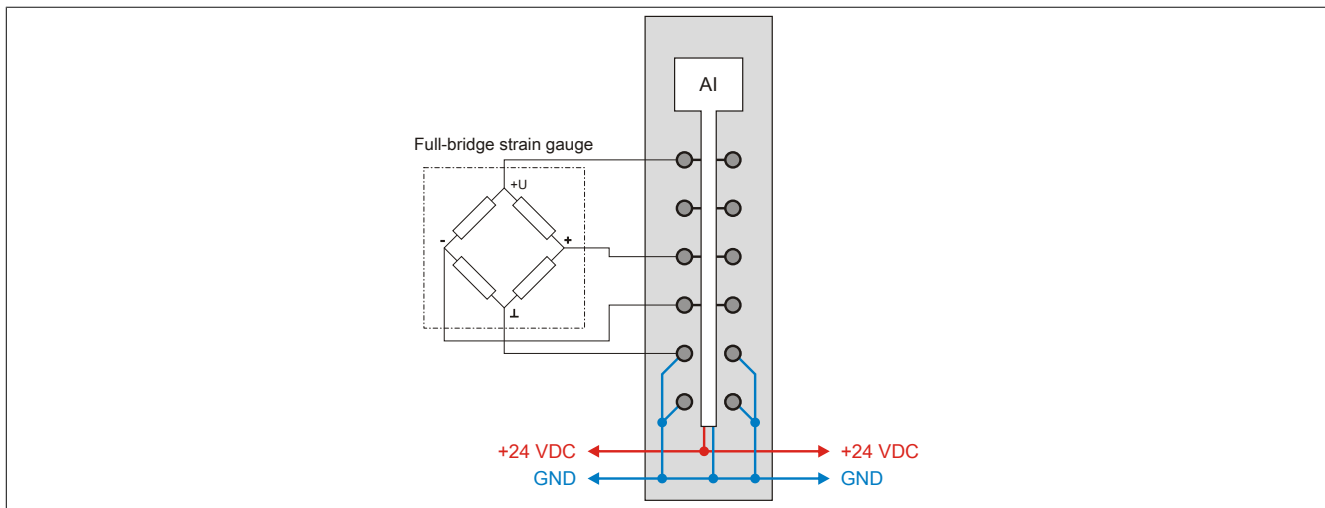
- 1) Depending on the configuration, a firmware update can take up to several minutes.

9.1.2.2.5 Pinout



9.1.2.2.6 Connection examples

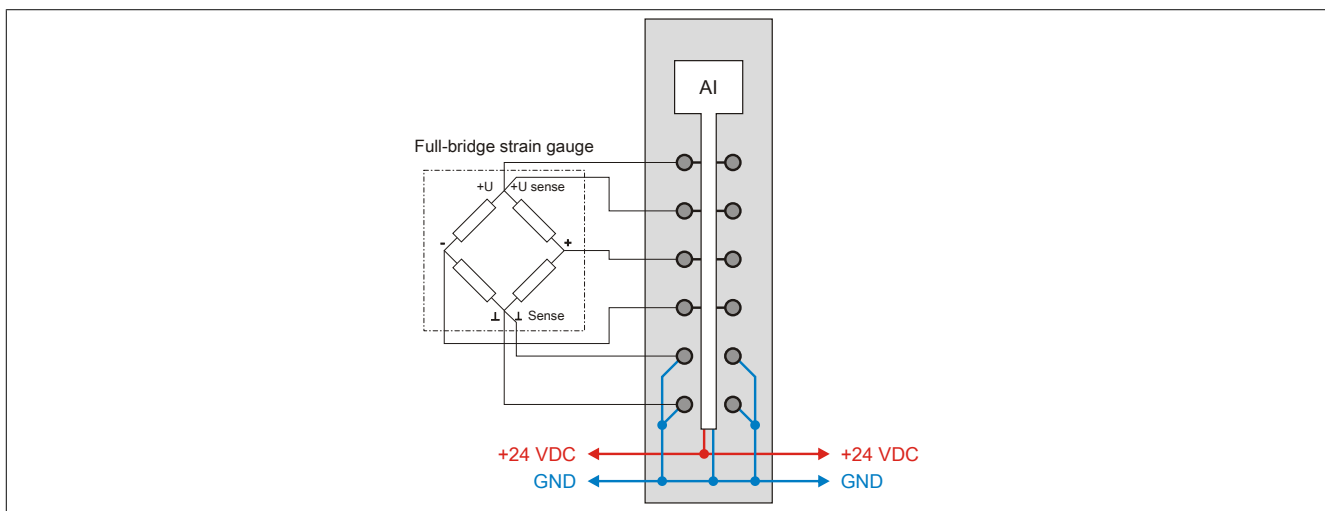
Full-bridge strain gauge with 4-wire connections



Full-bridge strain gauge with 6-wire connections

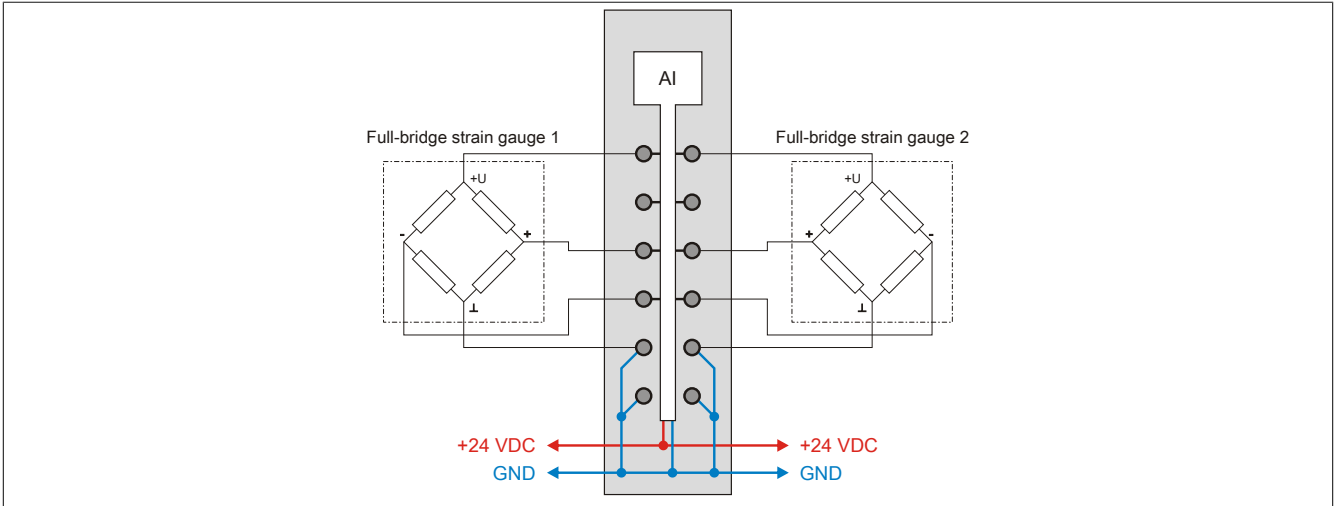
Full-bridge strain gauges can be connected to this module with 6-wire connections. Line compensation is not supported by the module, however. The sense lines are short circuited by the internally connected strain gauge VCC and GND connections (see "Input circuit diagram" on page 229). The measurement precision is therefore affected by changes in operating temperature. Longer cable lengths and smaller cable cross sections also increase the potential for errors in the measurement system.

In order to reduce cable resistance, the sense lines should be connected in parallel with the strain gauge supply lines. Optimal signal quality can be obtained by using a shielded twisted pair cable. The connections for the strain gauge supply lines, the sensor lines, and the bridge differential voltage lines should each use one twisted pair cable.



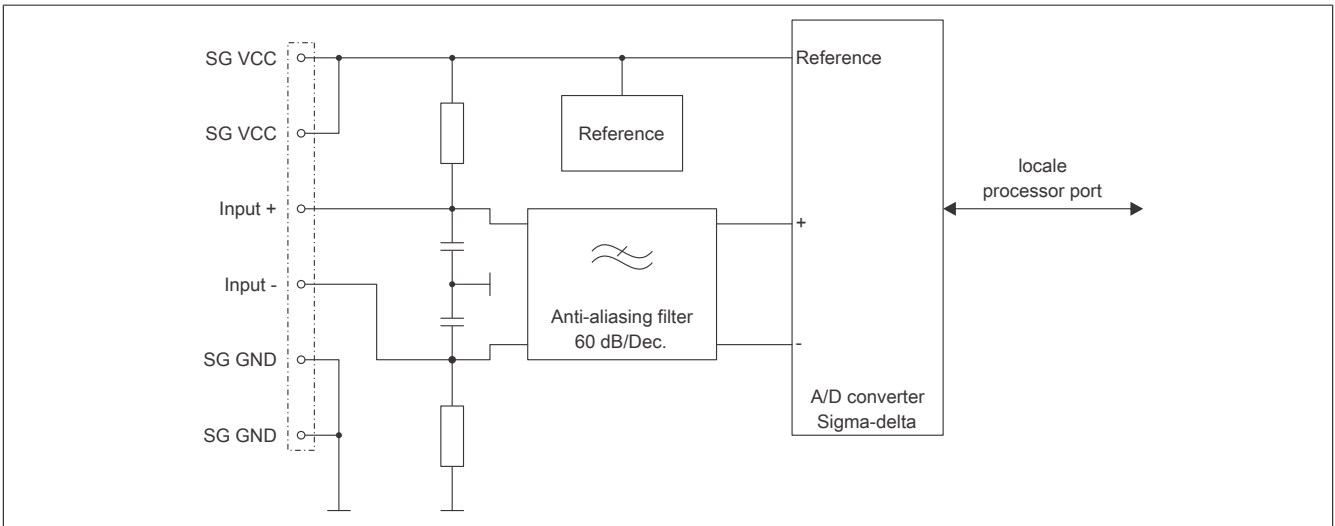
Parallel connection of 2 full-bridge strain gauges (4-wire connections)

If connecting the full-bridge strain gauges in parallel, the manufacturer's guidelines must be observed.

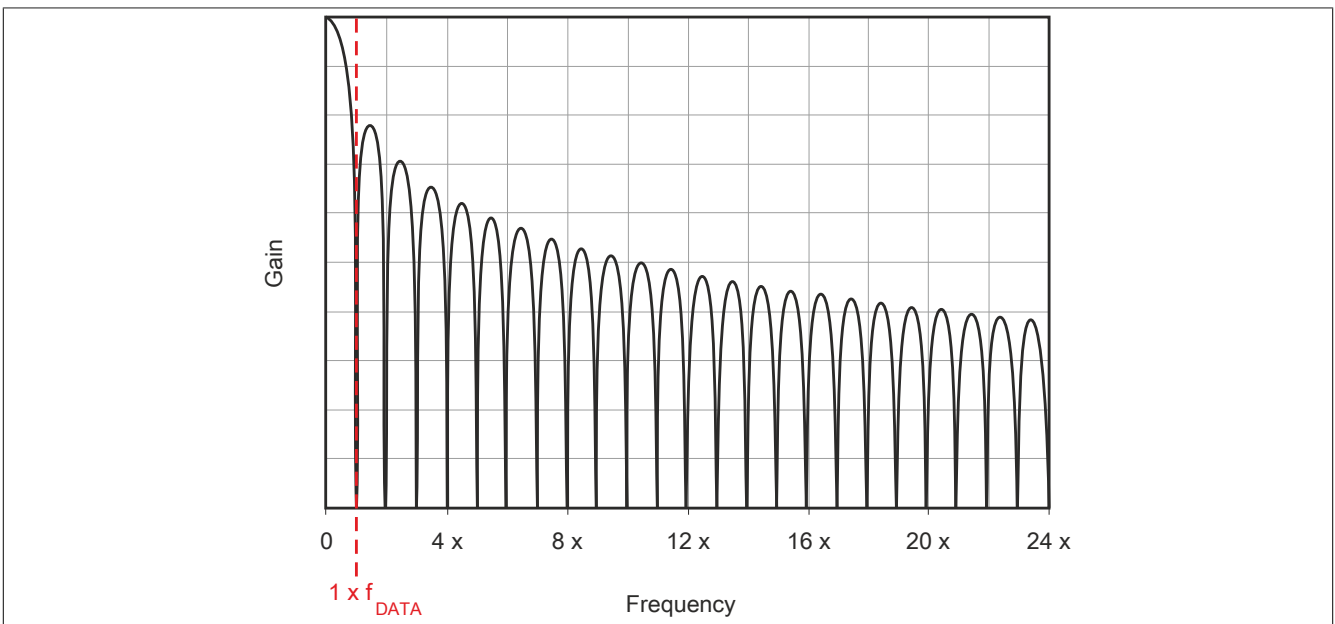


When connecting 3 or more full-bridge strain gauges in parallel, 2 lines must be connected together in an X20 terminal block.

9.1.2.2.7 Input circuit diagram



9.1.2.2.8 Filter characteristics of the sigma-delta A/D converter

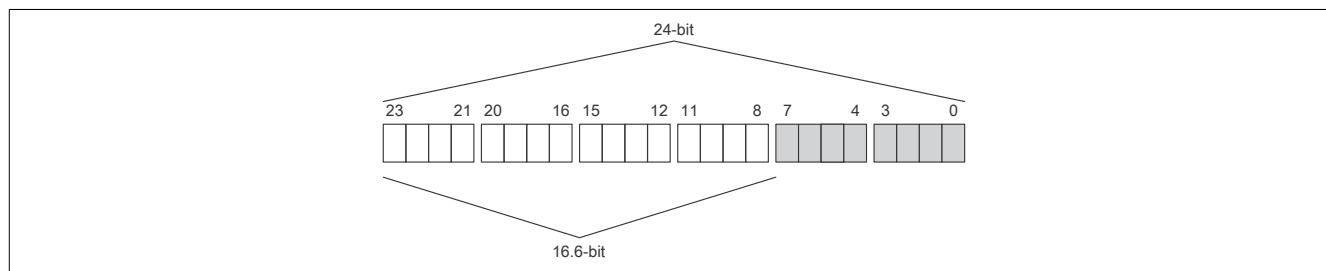


9.1.2.2.9 Effective resolution of the A/D converter

The A/D converter on the module provides a 24-bit measured value. The actual attainable noise-free resolution is always less than 24-bit, however. This "effective resolution" depends on the data rate and measurement range.

Example:

Based on the conversion method, a data rate of 2.5 Hz and a specified measurement range of 2 mV/V result in an effective resolution of 16.6 bits:



The low-order bits (grayed out) contain only noise instead of valid values and must therefore not be evaluated.

With "Function model 1 - Multisampling", only the highest 16 bits are made available.

9.1.2.2.10 Calculation example / Quantization

In a weighing application, the corresponding weight located on the connected load cell should be determined from the value derived from the module.

The characteristics of the strain gauge load cell are as follows:

- Rated load: 1000 kg
- Strain gauge factor: 4 mV/V

The value for the positive full-scale deflection at a specified rated load of 1000 kg is derived from the bridge factor of the strain gauge load cell (multiplication with the bridge supply voltage from the module):

$$4 \text{ mV/V} \times 5.5 \text{ V} = 22 \text{ mV}$$

With a simple Rule of Three calculation, the corresponding value can be calculated (as seen in the table) from weight to the converter value and vice versa. This simplified theoretical approach is only valid for an ideal measurement system. Calibration of the entire measurement system is recommended because not only the module, but particularly the strain gauge bridges exhibit tolerances (offset, gain). When taring, the gradient offset is recalculated and the gain of the linear equation is determined when normalized. In addition to the calculation displayed in the table, these calculations must also be carried out in the application.

| 24-bit value of the module | | Quantization | Corresponding weight |
|----------------------------|-----------|---------------|----------------------|
| 0x007F FFFF | 8,388,607 | 22.0 mV | 1000 kg |
| 0x0000 0001 | 1 | 2.62 nV | 0.119 g |
| 0x0000 20C3 | 8387 | 22.0 μ V | 1 kg |
| 0x0001 0000 | 65536 | 171.9 μ V | 7.81 kg |

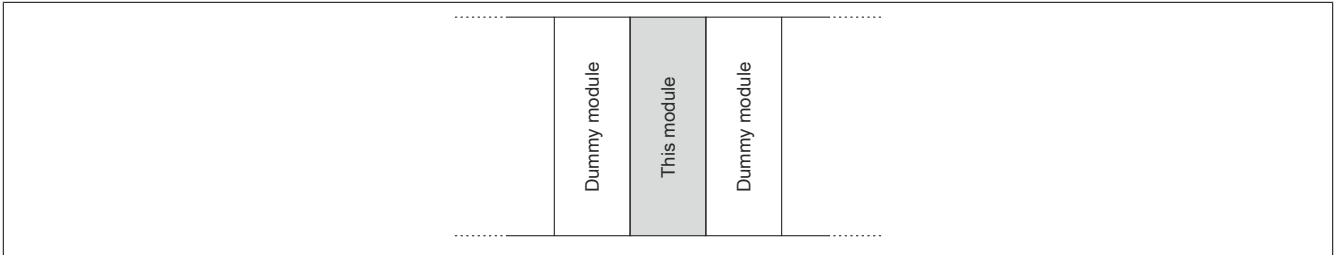
The values for each LSB can be found in the technical data of the module under "Quantization" (1 LSB in reference to 16-bit and 1 LSB in reference to 24-bit).

9.1.2.2.11 Hardware configuration

9.1.2.2.11.1 Hardware configuration for horizontal installation at 50°C ambient temperature

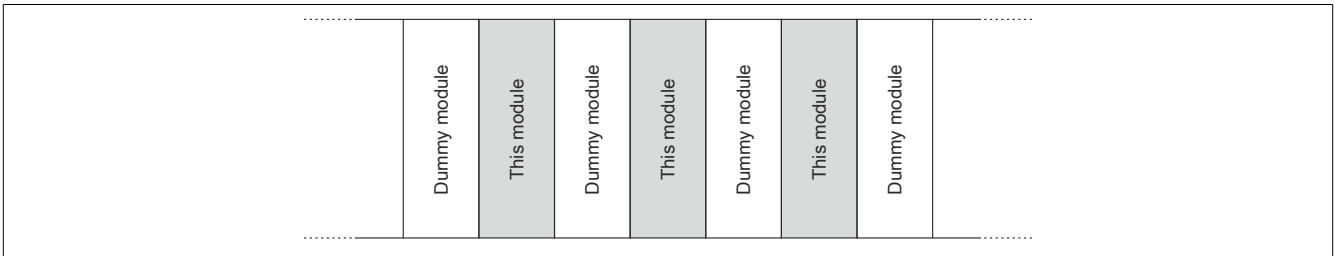
Operating a strain gauge module

Starting at an ambient temperature of 50°C, a dummy module must be connected to the left and right of the strain gauge module in a horizontal mounting orientation.



Operating multiple strain gauge modules side by side

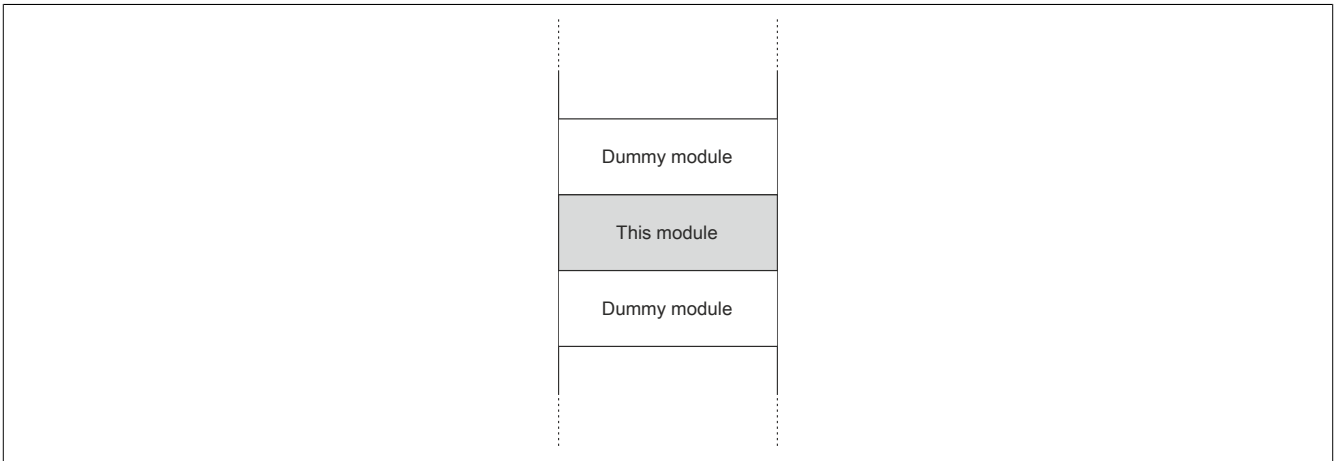
If 2 or more horizontal strain gauge modules are being operated in a cluster, the following arrangement of modules must be observed.



9.1.2.2.11.2 Hardware configuration for vertical installation at 40°C ambient temperature

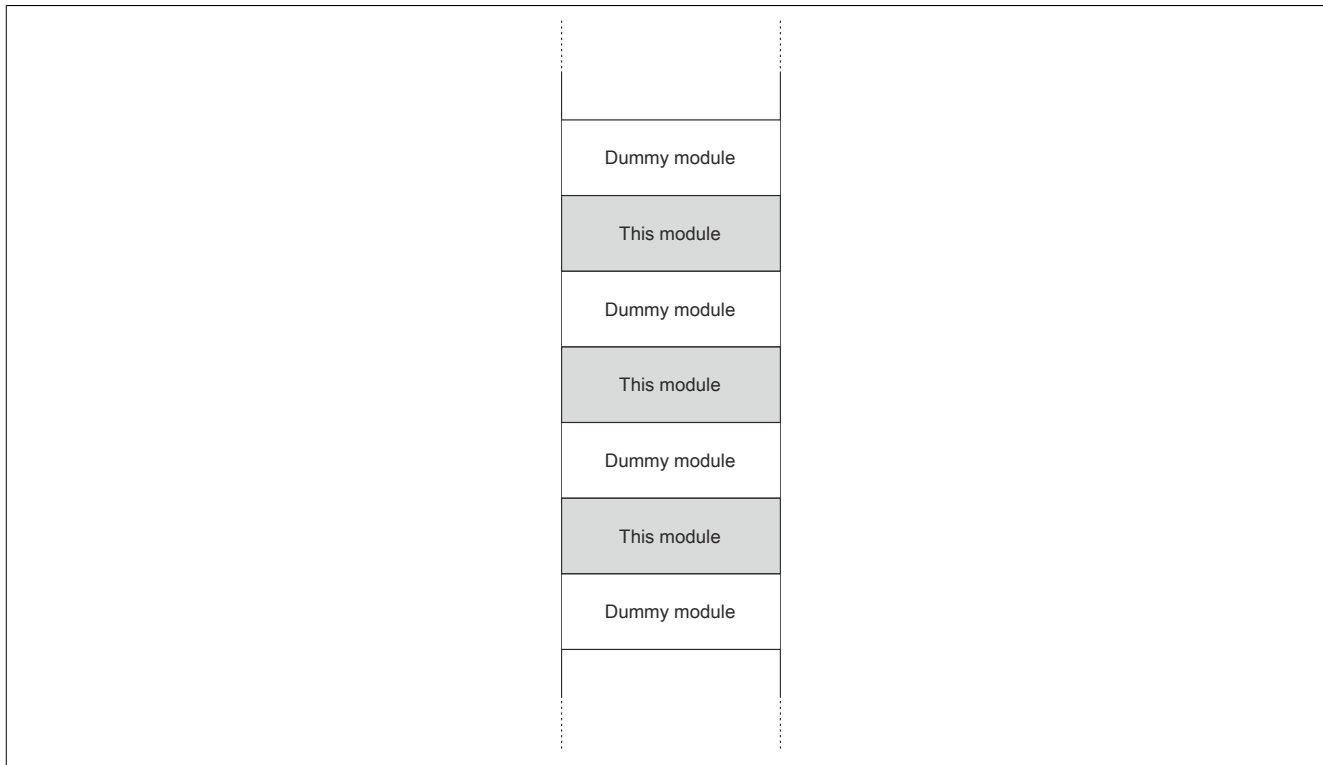
Operating a strain gauge module

Starting at an ambient temperature of 40°C, a dummy module must be connected to the left and right of the strain gauge module in a vertical mounting orientation.



Operating multiple strain gauge modules side by side

If 2 or more vertical strain gauge modules are being operated in a cluster, the following arrangement of modules must be observed.



9.1.2.2.12 Register description

9.1.2.2.12.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.1.2.2.12.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------|---------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | StatusInput01 | USINT | • | | | |
| 4 | AnalogInput01 | DINT | • | | | |
| 16 | ConfigOutput01 | USINT | | | • | |
| 18 | ConfigCycletime01 | UINT | | | | • |
| 32 | AdcClkFreqShift01 ¹⁾ | USINT | | | | • |

1) Firmware version 8 / Upgrade 1.3.0.0 or higher

9.1.2.2.12.3 Function model 1 - Multisampling

In this function model, the A/D converter is operated synchronously to X2X Link with a predefined A/D converter cycle time. The value is configurable as 50 or 100 μ s.

The module returns between 3 and 10 measured values per X2X cycle depending on the configuration. With an X2X cycle time of 400 μ s and A/D converter cycle time of 50 μ s, exactly 8 measurements are performed and the module can return 8 values (strain gauge value 01 to strain gauge value 08).

If a longer cycle time is used, the values returned correspond to the last measurements. If using an X2X cycle time that is not a whole number multiple of the A/D converter cycle time, then the conversion cannot be synchronized with X2X Link. In this case, the module outputs the invalid value 0x8000.

Example 1

If using an X2X cycle time of 800 μ s, it is possible to perform 16 measurements per X2X cycle if the A/D converter cycle time equals 50 μ s. The first 6 measured values are discarded; the last 10 measured values are provided by the module.

With a shorter X2X cycle time, the number of measured values should not exceed the number of measurements that can actually be made. All other measured values are invalid (0x8000). To minimize the load on the X2X Link network, it is possible to disable these unneeded registers (see ["Number of measured values" on page 240](#)).

Example 2

If using an X2X cycle time of 300 μ s, it is possible to perform 6 measurements per X2X cycle if the A/D converter cycle time equals 50 μ s. For this reason, only the first 6 registers are valid. The registers for the 7th through 10th measured value (AnalogInput07 to AnalogInput10) should be disabled by setting [Number of measured values](#) to "6 measured values" in the I/O configuration.

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|-------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog signal - Configuration | | | | | | |
| 1601 | ConfigGain01_MultiSample | USINT | | | • | |
| 1603 | ConfigCycletime01_MultiSample | USINT | | | | • |
| Analog signal - Communication | | | | | | |
| 2 | StatusInput01 | USINT | • | | | |
| 1534 + N * 4 | AnalogInput0N (N = 1 to 10) | INT | • | | | |

9.1.2.2.12.4 Function model 254 - Bus controller

In function model "254 - Bus controller", the module behaves as it does in "Function model 0 - Standard" with the exception that it is not synchronized to the X2X Link network even if synchronous mode is enabled in register "ConfigOutput01" on page 236. Instead, the module behaves as if the set A/D converter cycle time is not a factor or multiple of the X2X cycle time and attempts to maintain the set A/D converter cycle time as precisely as possible.

| Register | Name | Data type | Read | | Write | |
|----------|---------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | StatusInput01 | USINT | • | | | |
| 4 | AnalogInput01 | DINT | • | | | |
| 16 | ConfigOutput01 | USINT | | | • | |
| 18 | ConfigCycleTime01 | UINT | | | | • |
| 32 | AdcClkFreqShift01 ¹⁾ | USINT | | | | • |

1) Firmware version 8 / Upgrade 1.3.0.0 or later

9.1.2.2.12.5 Registers for function models "0 - Standard" and "254 - Bus controller"

Module status

Name:

StatusInput01

The current state of the module is indicated in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------------|-------|---|
| 0 | A/D converter value | 0 | Valid A/D converter value |
| | | 1 | Invalid A/D converter value (analog value = 0xFF800000). Possible causes: <ul style="list-style-type: none"> Strain gauge supply error I/O power supply error A/D converter not (yet) configured |
| 1 | Line monitoring | 0 | Ok |
| | | 1 | Open circuit |
| 2 | Only valid in synchronous mode | 0 | A/D converter runs synchronous to X2X Link |
| | | 1 | A/D converter does not run synchronous to X2X Link |
| 3 - 7 | Reserved | - | |

Strain gauge value

Name:

AnalogInput01

This register contains the raw value determined by the A/D converter for the full-bridge strain gauge with 24-bit resolution.

| Data type | Values | Information |
|-----------|-------------------------|--|
| DINT | -8,388,608 | Negative invalid value |
| | -8,388,607 | Negative full-scale deflection / Underflow |
| | -8,388,606 to 8,388,606 | Valid range |
| | 8,388,607 | Positive full-scale deflection / Overflow / Open circuit |

Effective resolution

In principle, the effective resolution of the A/D converter is dependent on the data rate and measurement range (see "Effective resolution of the A/D converter" on page 230).

The following table shows how the effective resolution (in bits), or the RMS value range of the strain gauge value depend on the module configuration (data rate, measurement area).

| Data rate f_{DATA} [Hz] | Measurement range | | | | | | | |
|-------------------------------------|-------------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|
| | ± 16 mV/V | | ± 8 mV/V | | ± 4 mV/V | | ± 2 mV/V | |
| | Bits | Range of values | Bits | Range of values | Bits | Range of values | Bits | Range of values |
| 2.5 | 21.3 | $\pm 1,290,000$ | 20.8 | $\pm 912,000$ | 19.7 | $\pm 425,000$ | 18.7 | $\pm 212,000$ |
| 5 | 20.7 | $\pm 851,000$ | 20.3 | $\pm 645,000$ | 19.3 | $\pm 322,000$ | 18.3 | $\pm 161,000$ |
| 10 | 20.4 | $\pm 691,000$ | 19.9 | $\pm 490,000$ | 18.9 | $\pm 244,000$ | 17.9 | $\pm 122,000$ |
| 15 | 20.1 | $\pm 562,000$ | 19.3 | $\pm 320,000$ | 18.7 | $\pm 212,000$ | 17.7 | $\pm 106,000$ |
| 25 | 19.7 | $\pm 425,000$ | 19.2 | $\pm 301,000$ | 18.5 | $\pm 185,000$ | 17.5 | $\pm 92,000$ |
| 30 | 19.6 | $\pm 397,000$ | 19.0 | $\pm 262,000$ | 18.1 | $\pm 140,000$ | 17.1 | $\pm 72,000$ |
| 50 | 19.4 | $\pm 346,000$ | 18.8 | $\pm 230,000$ | 17.9 | $\pm 122,000$ | 16.9 | $\pm 61,000$ |
| 60 | 19.3 | $\pm 320,000$ | 18.8 | $\pm 230,000$ | 17.8 | $\pm 114,000$ | 16.8 | $\pm 57,000$ |
| 100 | 19.1 | $\pm 280,000$ | 18.5 | $\pm 185,000$ | 17.4 | $\pm 86,000$ | 16.4 | $\pm 43,000$ |
| 500 | 18.0 | $\pm 130,000$ | 17.3 | $\pm 80,000$ | 16.3 | $\pm 40,000$ | 15.3 | $\pm 20,000$ |
| 1000 | 17.2 | $\pm 75,000$ | 16.5 | $\pm 46,000$ | 15.6 | $\pm 25,000$ | 14.6 | $\pm 12,000$ |
| 2000 | 16.6 | $\pm 49,600$ | 16.1 | $\pm 35,000$ | 15.3 | $\pm 20,000$ | 14.3 | $\pm 10,000$ |
| 3750 | 16.2 | $\pm 37,600$ | 15.7 | $\pm 26,600$ | 14.7 | $\pm 13,000$ | 13.7 | $\pm 6,600$ |
| 7500 | 15.8 | $\pm 28,500$ | 15.3 | $\pm 20,200$ | 14.4 | $\pm 10,800$ | 13.4 | $\pm 5,400$ |

Table 26: Effective resolution of the strain gauge value in bits for the measurement range 2 to 16 mV/V

| Data rate f_{DATA} [Hz] | Measurement range | | | | | | | |
|-------------------------------------|-------------------|-----------------|----------------|-----------------|---------------|-----------------|---------------|-----------------|
| | ± 256 mV/V | | ± 128 mV/V | | ± 64 mV/V | | ± 32 mV/V | |
| | Bits | Range of values | Bits | Range of values | Bits | Range of values | Bits | Range of values |
| 2.5 | 23 | $\pm 4,194,000$ | 22.6 | $\pm 3,179,000$ | 22.1 | $\pm 2,248,000$ | 21.7 | $\pm 1,703,000$ |
| 5 | 22.3 | $\pm 2,582,000$ | 22.4 | $\pm 2,767,000$ | 21.9 | $\pm 1,957,000$ | 21.3 | $\pm 1,291,000$ |
| 10 | 22.3 | $\pm 2,582,000$ | 22 | $\pm 2,097,000$ | 21.6 | $\pm 1,589,000$ | 21 | $\pm 1,049,000$ |
| 15 | 22 | $\pm 2,097,000$ | 21.7 | $\pm 1,703,000$ | 21.3 | $\pm 1,291,000$ | 20.7 | $\pm 852,000$ |
| 25 | 21.7 | $\pm 1,703,000$ | 21.4 | $\pm 1,384,000$ | 21.1 | $\pm 1,124,000$ | 20.5 | $\pm 741,000$ |
| 30 | 21.8 | $\pm 1,826,000$ | 21.3 | $\pm 1,291,000$ | 20.8 | $\pm 913,000$ | 20.4 | $\pm 692,000$ |
| 50 | 21.3 | $\pm 1,291,000$ | 21.1 | $\pm 1,124,000$ | 20.4 | $\pm 692,000$ | 19.9 | $\pm 489,000$ |
| 60 | 21.3 | $\pm 1,291,000$ | 20.9 | $\pm 978,000$ | 20.5 | $\pm 741,000$ | 19.8 | $\pm 456,000$ |
| 100 | 20.9 | $\pm 978,000$ | 20.7 | $\pm 852,000$ | 20.2 | $\pm 602,000$ | 19.6 | $\pm 397,000$ |
| 500 | 20.1 | $\pm 562,000$ | 19.6 | $\pm 397,000$ | 19.1 | $\pm 281,000$ | 18.6 | $\pm 199,000$ |
| 1000 | 19 | $\pm 262,000$ | 18.6 | $\pm 199,000$ | 18.1 | $\pm 140,000$ | 17.5 | $\pm 93,000$ |
| 2000 | 18.5 | $\pm 185,000$ | 18.1 | $\pm 140,000$ | 17.8 | $\pm 114,000$ | 17 | $\pm 66,000$ |
| 3750 | 18.1 | $\pm 140,000$ | 17.8 | $\pm 114,000$ | 17.3 | $\pm 81,000$ | 16.6 | $\pm 50,000$ |
| 7500 | 17.7 | $\pm 106,000$ | 17.3 | $\pm 81,000$ | 16.9 | $\pm 61,000$ | 16.2 | $\pm 38,000$ |

Table 27: Effective resolution of the strain gauge value in bits for the measurement range 32 to 256 mV/V

A/D converter configuration

Name:

ConfigOutput01

The data rate and measurement range of the A/D converter can be configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|-------------|
| 0 - 3 | Data rate f_{DATA} (samples per second): | 0000 | 2.5 |
| | | 0001 | 5 |
| | | 0010 | 10 |
| | | 0011 | 15 |
| | | 0100 | 25 |
| | | 0101 | 30 |
| | | 0110 | 50 |
| | | 0111 | 60 |
| | | 1000 | 100 |
| | | 1001 | 500 |
| | | 1010 | 1000 |
| | | 1011 | 2000 |
| | | 1100 | 3750 |
| | | 1101 | 7500 |
| 1110 | Synchronous mode ¹⁾ | | |
| 1111 | Reserved | | |
| 4 - 6 | Standard measurement range (bit 6 = 0) | 000 | 16 mV/V |
| | | 001 | 8 mV/V |
| | | 010 | 4 mV/V |
| | | 011 | 2 mV/V |
| | Extended measurement range (bit 6 = 1) ²⁾ | 100 | 256 mV/V |
| | | 101 | 128 mV/V |
| | | 110 | 64 mV/V |
| | | 111 | 32 mV/V |
| 7 | Reserved | 0 | (must be 0) |

1) A/D converter is operated synchronously with X2X Link if possible - firmware version 2 or higher.

2) Firmware version 4 or higher

Synchronous mode

Beginning with firmware version 2, the analog/digital converter (A/D converter) of the module can be operated and read synchronously to X2X Link. Synchronous mode is enabled by selecting the respective operating mode in register "ConfigOutput01" on page 236. A time between 200 and 2000 μ s must also be set in register "ConfigCycletime01" on page 237. If this time is a whole number factor or multiple of the configured cycle time of X2X Link, then the A/D converter is read synchronously to X2X Link.

Information:

The A/D converter cycle time must be $\geq 1/4$ of the X2X cycle time!

Bit 2 in *Module status* is set (i.e. A/D converter not running synchronously)...

- ... If the configured A/D converter cycle time cannot be synchronized with X2X Link.
- ... If the module is still in the settling phase.

Jitter, dead time and settling time:

| | | |
|---|--|---|
| Jitter | | |
| A/D converter cycle times <1500 μ s | | Max. $\pm 1 \mu$ s |
| A/D converter cycle times >1500 μ s | | Max. $\pm 4 \mu$ s |
| X2X link dead time | | 50μ s + $\frac{X2X \text{ cycle time}}{128}$ |
| Settling time | | |
| Firmware version ≤ 4 | | Max. 150 x A/D converter cycle time |
| Firmware version ≥ 5 | | 150 x X2X cycle time |

The settling time corresponds to the time needed until the A/D converter can be operated after enabling synchronous mode or following conversion of the A/D converter cycle time.

A/D converter cycle time

Name:

ConfigCycletime01

This register is only used in [Synchronous mode](#). If synchronous mode is enabled in the A/D converter configuration, then the module attempts to operate the A/D converter as synchronously as possible to X2X Link (based on the A/D converter cycle time set in this register). It is of course necessary for the X2X Link cycle time and the A/D converter cycle time to have a certain ratio. The following conditions must be observed:

- 1) A/D converter cycle time $\geq 1/4$ X2X cycle time
- 2) A/D converter cycle time corresponds to a whole number factor or multiple of the X2X cycle time
- 3) A/D converter cycle time must be in the range 50 to 2000 μ s

| Data type | Value |
|-----------|------------|
| UINT | 50 to 2000 |

A/D converter clock frequency shift

Name:

AdcClkFreqShift01

In rare cases, strain gauge modules connected to neighboring slots can influence one another. This can result in temporary, minimal deviations in measured values. This can only occur if the sigma-delta A/D converters on the neighboring strain gauge modules are operated at exactly the same clock frequency.

In most cases, these clock frequencies vary slightly due to part variances. When they are the same however, this register on the strain gauge module provides a safe way for an application to prevent this type of mutual influence.

| Data type | Value |
|-----------|-------------|
| SINT | -128 to 127 |

This register can be used to vary the clock frequency in increments of 200 ppm. Setting values from -50 to 50 cover a range of -10000 ppm to 10000 ppm. This corresponds with -1% to 1%.

Values beyond this range will cause activation of a default mode. The frequency shift is derived from the last 2 digits of the serial number by the module firmware. This saves time that would otherwise be needed for programming, provided that the last two digits of the serial numbers on the neighboring modules are not the same

| Register value | Frequency shift in ppm | Example of a sampling rate ¹⁾ |
|----------------|--|--|
| 127 | $((\text{SerialNo. modulo } 100) - 50) * (-200)$ ppm | Based on the serial number |
| ... | ... | ... |
| 51 | $((\text{SerialNo. modulo } 100) - 50) * (-200)$ ppm | Based on the serial number |
| 50 | 10000 | 505 |
| 49 | 9800 | 504.9 |
| ... | ... | ... |
| 2 | 400 | 500.2 |
| 1 | 200 | 500.1 |
| 0 | 0 | 500 |
| -1 | -200 | 499.9 |
| -2 | -400 | 499.8 |
| ... | ... | ... |
| -50 | -10000 | 495 |
| -51 | $((\text{SerialNo. modulo } 100) - 50) * (-200)$ ppm | Based on the serial number |
| ... | ... | ... |
| -128 | $((\text{SerialNo. modulo } 100) - 50) * (-200)$ ppm | Based on the serial number |

1) Nominal sampling rate of 500 samples per second

Important:

As shown in the table above, shifting the A/D converter clock frequency will equally shift the A/D converter sampling rate. Shifting the A/D converter clock frequency too much can cause problems with disturbance suppression particularly when a very specific sampling rate has been defined to suppress existing disturbances (e.g. 50 Hz to suppress the 50 Hz hum). See also "[Filter characteristics of the sigma-delta A/D converter](#)" on page 229.

It's situations like this where the option to manually shift the frequency in the I/O configuration or ASIOACC library should be utilized rather than relying on the default frequency shift that is based on the serial number.

A frequency shift like the one shown below would be sufficient to prevent modules from influencing one another and would not cause any noticeable difference to the filter characteristics.

| Slot | 1 | 2 | 3 | 4 | 5 | 6 | ... |
|-------------------------------------|---|---|----|---|----|---|-----|
| A/D converter clock frequency shift | 0 | 2 | -1 | 1 | -2 | 0 | ... |

Information:

- This register has no effect in synchronous mode because the firmware regulates the A/D converter clock frequency in such a way that the A/D converter cycle is synchronous with the X2X cycle.
- When writing to this register using the ASIOACC library, only the lowest value byte of the written value is accepted. For example, the value 256 (=0x100) is identical to the value 0 (=0x00).

9.1.2.2.12.6 Register for "Function model 1 - Multisampling"

Module status

Name:

StatusInput01

This register contains the current state of the module.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------------|-------|--|
| 0 | A/D converter values | 0 | Valid A/D converter value |
| | | 1 | Invalid A/D converter value |
| 1 | Line monitoring | 0 | OK |
| | | 1 | Open circuit An open circuit was found during at least one measurement in this X2X cycle. This bit is reset if all measurements are OK after correcting this error, i.e. it does not have to be acknowledged. |
| 2 | Synchronous mode | 0 | A/D converter runs synchronous to X2X Link |
| | | 1 | A/D converter does not run synchronous to X2X Link |
| 3 - 7 | Reserved | - | |

Strain gauge value - Multiple

Name:

AnalogInput01 to AnalogInput10

This register contains the raw value determined by the A/D converter for the full-bridge strain gauge with 16-bit resolution. The module returns between 3 and 10 measured values per X2X cycle depending on the configuration.

Effective resolution

In principle, the effective resolution of the A/D converter is dependent on the data rate and measurement range (see).

The following table shows how the effective resolution (in bits), or the RMS value range of the strain gauge value depend on the module configuration (data rate, measurement area).

| Measurement range | | | | | | | |
|-------------------|-----------------|---------|-----------------|---------|-----------------|---------|-----------------|
| ±16 mV/V | | ±8 mV/V | | ±4 mV/V | | ±2 mV/V | |
| Bits | Range of values | Bits | Range of values | Bits | Range of values | Bits | Range of values |
| 15.4 | 22,000 | 14.6 | 12,000 | 13.8 | 7,000 | 12.8 | 4,000 |

Table 28: Effective resolution of the strain gauge value in bits for the measurement range 2 to 16 mV/V

| Measurement range | | | | | | | |
|-------------------|-----------------|-----------|-----------------|----------|-----------------|----------|-----------------|
| ±256 mV/V | | ±128 mV/V | | ±64 mV/V | | ±32 mV/V | |
| Bits | Range of values | Bits | Range of values | Bits | Range of values | Bits | Range of values |
| 17.1 | 70,000 | 16.7 | 53,000 | 16.4 | 43,000 | 15.9 | 31,000 |

Table 29: Effective resolution of the strain gauge value in bits for the measurement range 32 to 256 mV/V

A/D converter configuration

Name:

ConfigGain01_MultiSample

The measurement range for the A/D converter can be configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|-------------|
| 0 - 2 | Standard measurement range (bit 2 = 0) | 000 | 16 mV/V |
| | | 001 | 8 mV/V |
| | | 010 | 4 mV/V |
| | | 011 | 2 mV/V |
| | Extended measurement range (bit 2 = 1) ¹⁾ | 100 | 256 mV/V |
| | | 101 | 128 mV/V |
| | | 110 | 64 mV/V |
| 3 - 7 | Reserved | 111 | 32 mV/V |
| | | 0 | (must be 0) |

1) Firmware V4 and later. In the standard measurement range (2 to 16 mV/V), open-circuit detection works reliably at all adjustable data rates. In the extended measurement range (32 to 256 mV/V), open circuit detection does not work reliably (because of the variable input impedance of the amplifier in relation to the set data rate).

A/D converter cycle time

Name:

ConfigCycletime01_MultiSample

The A/D converter cycle time can be configured in this register.

In order for multiple sampling to work, the X2X cycle time must be divisible by the A/D converter cycle time (i.e. result in a whole number).

| Data type | Value | Information |
|-----------|----------|-----------------|
| USINT | 0 | 50 µs (default) |
| | 1 | 100 µs |
| | 2 to 255 | Reserved |

Number of measured values

If the X2X cycle time is too short, then not all 10 measurements can be performed. To reduce the load on X2X Link, it makes sense to only transfer as many values as measurements that can be made. This is why it is possible to configure the number of measured values to be transferred (see "[Function model 1 - Multisampling](#)" on page 233).

Example: A/D converter cycle time = 50 µs

| X2X cycle time | Number of measured values to be transferred |
|----------------|---|
| 250 µs | 5 |
| 300 µs | 6 |
| 350 µs | 7 |
| 400 µs | 8 |
| 450 µs | 9 |
| ≥500 µs | 10 |

Example: A/D converter cycle time = 100 µs

| X2X cycle time | Number of measured values to be transferred |
|----------------|---|
| 300 µs | 3 |
| 400 µs | 4 |
| 500 µs | 5 |
| 600 µs | 6 |
| 700 µs | 7 |
| 800 µs | 8 |
| 900 µs | 9 |
| ≥1 ms | 10 |

9.1.2.2.12.7 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 250 μ s |

9.1.2.2.12.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

There is no limitation or basic dependency on the bus cycle time. In function model "0 - Standard", the I/O update time is defined using registers "[ConfigOutput01](#)" on page 236 and "[ConfigCycletime01](#)" on page 237.

Depending on the setting in register "[ConfigCycletime01_MultiSample](#)" on page 240, the I/O update time in function model "1 - Multiple sampling" is 50 or 100 μ s.

9.1.3 X20(c)AI1744-3

Data sheet version: 4.15

This data sheet describes 2 module revisions. The module revision is laser-marked on the side of the module. Select the desired module revision from the following table to view its description.

| Module | Revision | Page |
|--------------|----------|------|
| X20AI1744-3 | ≥G0 | 242 |
| X20cAI1744-3 | All | |
| X20AI1744-3 | <G0 | 272 |

9.1.3.1 X20(c)AI1744-3 with Rev. ≥G0

9.1.3.1.1 General information

This module works with both 4-wire and 6-wire strain gauge load cells. The concept applied by the module requires compensation in the measurement system. This compensation eliminates the absolute uncertainty in the measurement circuit, such as component tolerances, effective bridge voltage or zero point offset. The measurement precision refers to the absolute (compensated) value, which will only change as a result of changes in the operating temperature.

- 1 full-bridge strain gauge input
- Data output rate configurable from 0.1 Hz to 7.5 kHz
- Special operating modes (synchronous mode and multiple sampling)
- Configurable filter level

9.1.3.1.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.1.3.1.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.1.3.1.3 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Analog inputs |  |
| X20AI1744-3 | X20 analog input module, 1 full-bridge strain gauge input, 24-bit converter resolution, 5 Hz input filter | |
| X20cAI1744-3 | X20 analog input module, coated, 1 full-bridge strain gauge input, 24-bit converter resolution, 5 Hz input filter | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 30: X20AI1744-3, X20cAI1744-3 - Order data

9.1.3.1.4 Technical data

| Model number | X20AI1744-3 | X20cAI1744-3 |
|--|---|--------------|
| Short description | 1 full-bridge strain gauge input | |
| I/O module | | |
| General information | | |
| B&R ID code | 0xA4EF | 0xEB00 |
| Status indicators | Channel status, operating status, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Open circuit | Yes, using status LED and software | |
| Input | Yes, using status LED and software | |
| Power consumption | | |
| Bus | 0.01 W | |
| Internal I/O | 0.5 W | |
| Additional power dissipation caused by actuators (resistive) [W] | Max. +0.36 ¹⁾ | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| EAC | Yes | |
| KC | Yes | - |
| Full-bridge strain gauge | | |
| Strain gauge factor | 2 to 256 mV/V, configurable using software | |
| Connection | 4- or 6-wire connections ²⁾ | |
| Input type | Differential, used to evaluate a full-bridge strain gauge | |
| Digital converter resolution | 24-bit | |
| Conversion time | Depends on the configured data output rate | |
| Data output rate | 0.1 - 7500 samples per second, configurable using software (f_{DATA}) | |
| Input filter | | |
| Cutoff frequency | 5 Hz | |
| Order | 3 | |
| Slope | 60 dB | |
| ADC filter characteristics | Sigma-delta, see section "Filter characteristics of the sigma-delta A/D converter" | |
| Operating range / Measurement sensor | 85 to 5000 Ω | |
| Influence of cable length ³⁾ | See section "Calculation example". | |
| Input protection | RC protection | |
| Common-mode range | 0 to 3 VDC Permissible input voltage range (with regard to the potential strain gauge GND) on the inputs "Input +" and "Input -" | |
| Isolation voltage between input and bus | 500 V _{Eff} | |
| Conversion procedure | Sigma-delta | |

Table 31: X20AI1744-3, X20cAI1744-3 - Technical data


| Model number | X20AI1744-3 | X20cAI1744-3 |
|---|--|---|
| Output of digital value | Value approaches 0 | |
| Broken bridge supply line | Value approaching \pm end value (status bit "Line status monitoring" is set in register "Module status") | |
| Broken sensor line | Value approaching \pm end value (status bit "Line status monitoring" is set in register "Module status") | |
| Valid range of values | 0xFF800001 to 0x007FFFFFFF (-8,388,607 to 8,388,607) | |
| Strain gauge supply | | |
| Voltage | 5.5 VDC / max. 65 mA | |
| Short-circuit and overload resistant | Yes | |
| Voltage drop for short-circuit protection | Max. 0.2 VDC at 65 mA and 25°C | |
| Quantization ⁴⁾ | | |
| LSB value (16-bit) | | |
| 2 mV/V | 336 nV | |
| 4 mV/V | 671 nV | |
| 8 mV/V | 1.343 μ V | |
| 16 mV/V | 2.686 μ V | |
| 32 mV/V | 5.371 μ V | |
| 64 mV/V | 10.74 μ V | |
| 128 mV/V | 21.48 μ V | |
| 256 mV/V | 42.97 μ V | |
| LSB value (24-bit) | | |
| 2 mV/V | 1.31 nV | |
| 4 mV/V | 2.62 nV | |
| 8 mV/V | 5.25 nV | |
| 16 mV/V | 10.49 nV | |
| 32 mV/V | 20.98 nV | |
| 64 mV/V | 41.96 nV | |
| 128 mV/V | 83.92 nV | |
| 256 mV/V | 167.85 nV | |
| Max. gain drift | 12 ppm/°C ⁵⁾ | |
| Max. offset drift | 2 ppm/°C ⁶⁾ | |
| Nonlinearity | <10 ppm ⁶⁾ | |
| Electrical properties | | |
| Electrical isolation | Bus isolated from analog input and strain gauge supply voltage Channel not isolated from I/O power supply | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Hardware configuration" | |
| Starting temperature | - | Yes, -40°C |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x terminal block X20TB12 separately Order 1x bus module X20BM11 separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 31: X20AI1744-3, X20cAI1744-3 - Technical data

- 1) Depends on the full-bridge strain gauge being used.
- 2) With 6-wire connections, line compensation does not function (see section "Connection examples").
- 3) Sensor cable with twisted and shielded conductors, cable length as short as possible, cable routing separate from load circuits, without intermediate terminal to the sensor.
- 4) Quantization depends on the strain gauge factor.
- 5) Based on the current measured value.
- 6) Based on the entire measurement range.

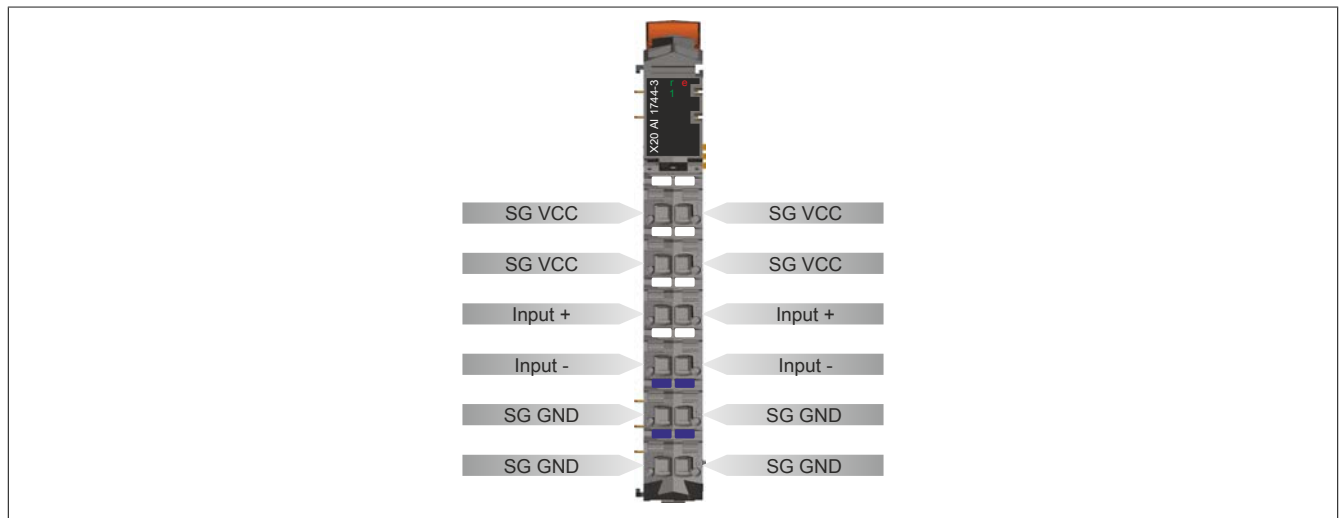
9.1.3.1.5 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-----|-------|--------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | 1 | Green | Off | Possible causes: <ul style="list-style-type: none"> • Open circuit • Sensor is disconnected • Converter is busy |
| | | | On | Analog/digital converter running, value OK |
| | | | On | Analog/digital converter running, value OK |

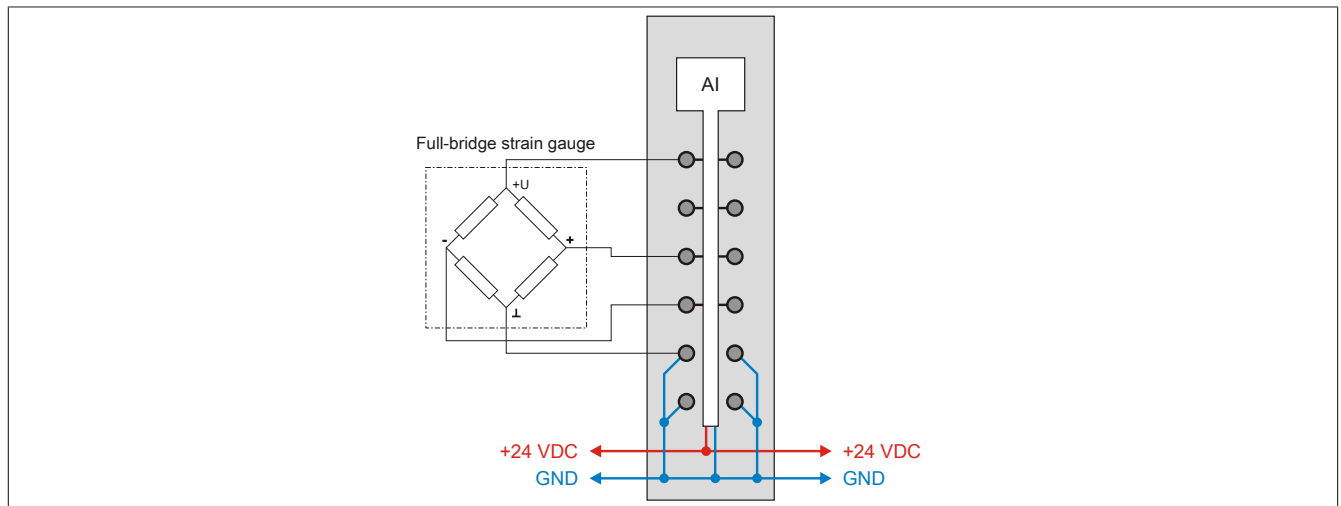
1) Depending on the configuration, a firmware update can take up to several minutes.

9.1.3.1.6 Pinout



9.1.3.1.7 Connection examples

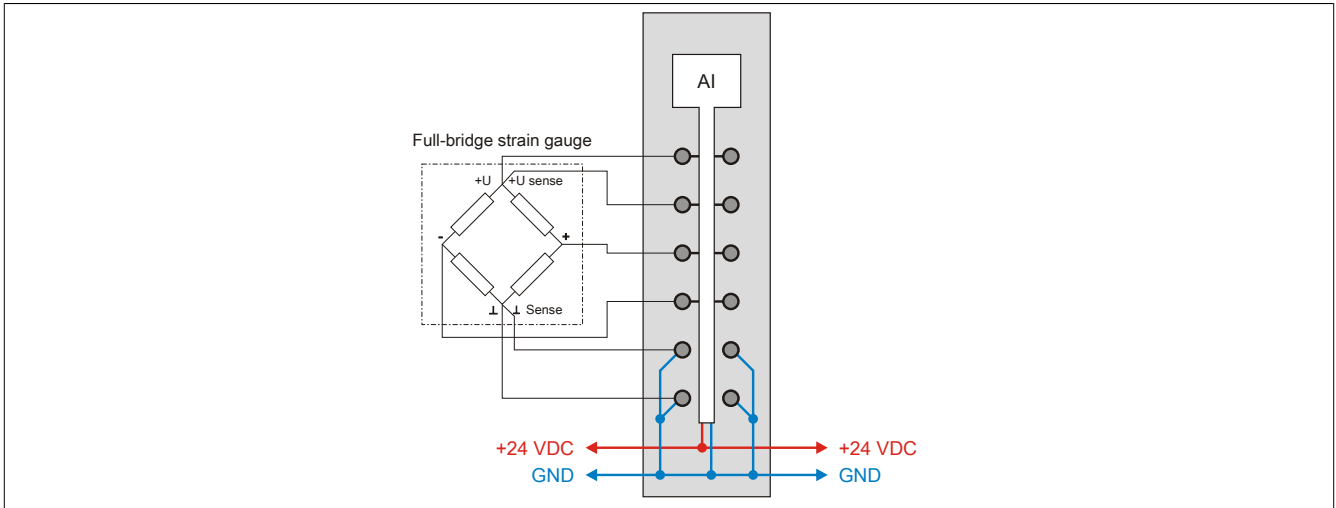
Full-bridge strain gauge with 4-wire connections



Full-bridge strain gauge with 6-wire connections

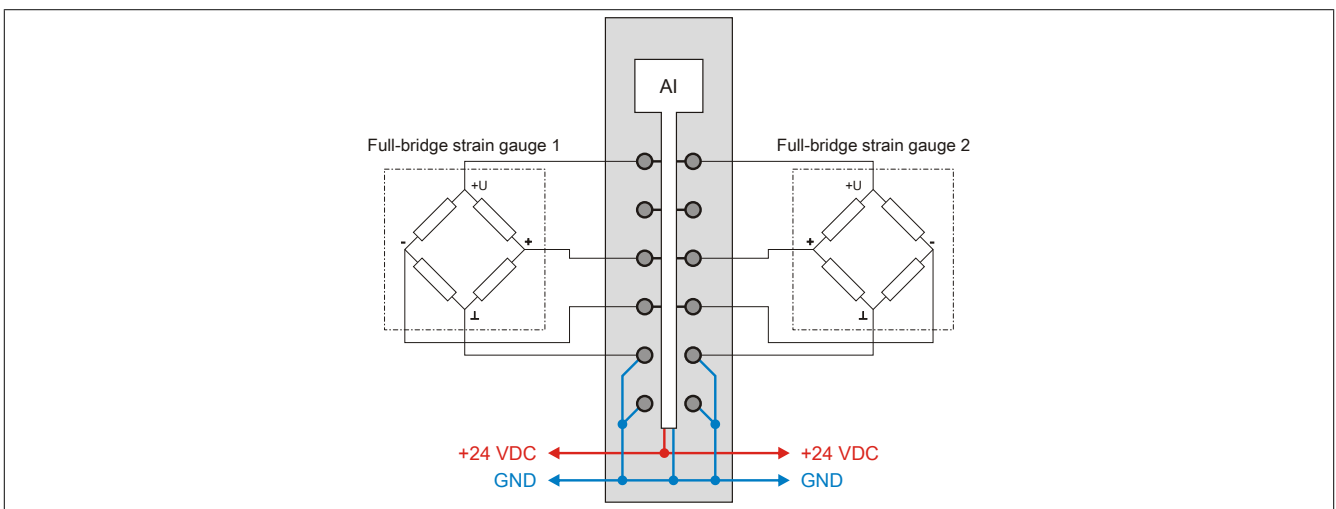
Full-bridge strain gauges can be connected to this module with 6-wire connections. Line compensation is not supported by the module, however. The sense lines are short circuited by the internally connected strain gauge VCC and GND connections (see "Input circuit diagram" on page 247). The measurement precision is therefore affected by changes in operating temperature. Longer cable lengths and smaller cable cross sections also increase the potential for errors in the measurement system.

In order to reduce cable resistance, the sense lines should be connected in parallel with the strain gauge supply lines. Optimal signal quality can be obtained by using a shielded twisted pair cable. The connections for the strain gauge supply lines, the sensor lines and the bridge differential voltage lines should each use one twisted pair cable.



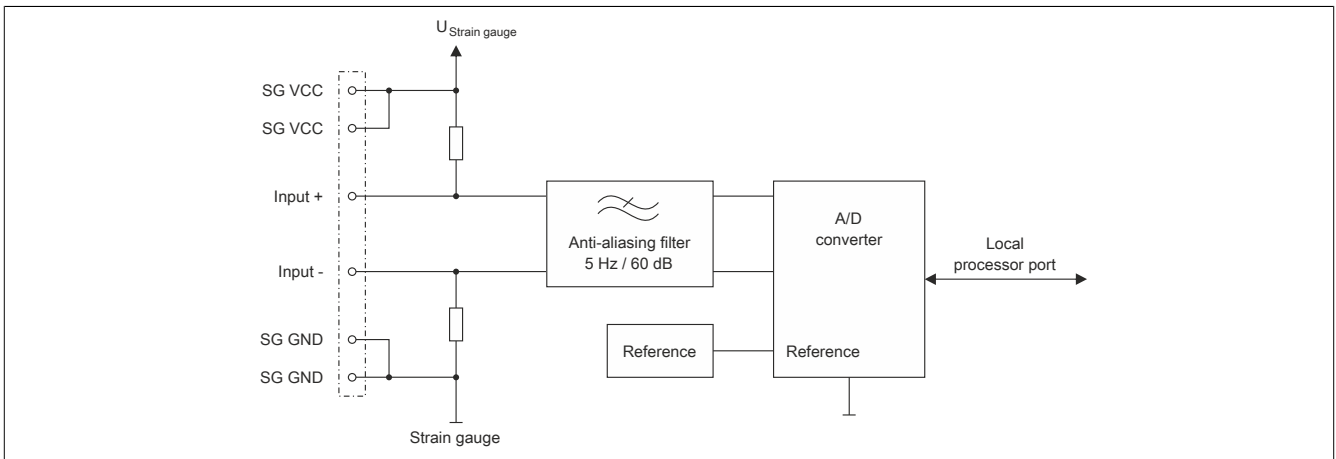
Parallel connection of 2 full-bridge strain gauges (4-wire connections)

If connecting the full-bridge strain gauges in parallel, the manufacturer's guidelines must be observed.



When connecting 3 or more full-bridge strain gauges in parallel, 2 lines must be connected together in an X20 terminal block.

9.1.3.1.8 Input circuit diagram

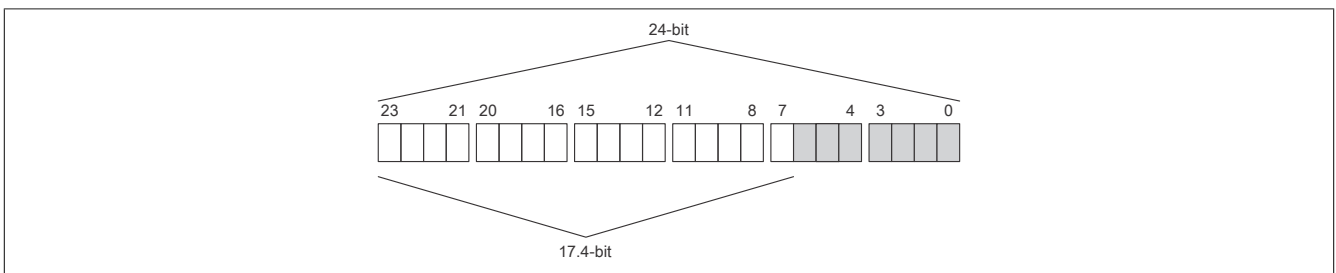


9.1.3.1.9 Effective resolution of the A/D converter

The A/D converter on the module provides a 24-bit measured value. The actual attainable noise-free resolution is always less than 24-bit, however. This "effective resolution" depends on the data rate and measurement range.

Example:

Based on the conversion method, a data rate of 2.5 Hz and a specified measurement range of 2 mV/V result in an effective resolution of 17.4 bits:



The low-order bits (grayed out) contain only noise instead of valid values and are therefore not permitted to be evaluated.

With "Function model 1 - Multisampling", only the highest 16 bits are made available.

9.1.3.1.10 Calculation example

The following example shows the influence of the length of the measuring cable on the bridge voltage of the module and the quantization calculated with it.

9.1.3.1.10.1 Bridge voltage

Although the measuring bridge must be adjusted with the module, the cable length has an influence on the accuracy of the measurement. The reason for this is the voltage drop on the power supply lines of the measuring bridge. As a result, the strain gauge supply voltage at the measuring bridge no longer amounts to the full 5.5 V. The reduced bridge voltage also has an effect on the quantization.

Example

Characteristics of the measuring device used:

- Full-bridge strain gauge with 4-wire connections
- Material-dependent conductivity of the cable (copper: $12 \frac{\text{m}}{\Omega \cdot \text{mm}^2}$)
- Cross section of the cable: 22 AWG = 0.34 mm²
- Length of the cable: 5 m
- Nominal current of the measuring bridge: 15 mA
- Bridge voltage of the module: 5.5 V

Actual bridge voltage taking the voltage drop on the measuring line into account:

$$5.5\text{V} - \frac{2 \cdot 5\text{m}}{12 \frac{\text{m}}{\Omega \cdot \text{mm}^2} \cdot 0.34\text{mm}^2} \cdot 0.015\text{A} = 5.463\text{V}$$

The quantization must be calculated using the actual calculated bridge voltage (see "Quantization" on page 249).

9.1.3.1.10.2 Quantization

In a weighing application, the corresponding weight located on the connected load cell should be determined from the value derived from the module.

Example

The characteristics of the strain gauge load cell are as follows:

- Rated load: 1000 kg
- Strain gauge factor: 4 mV/V
- Actual bridge voltage: 5.463 V

Maximum quantization:

Multiplying the bridge factor of the strain gauge load cell with the bridge supply voltage from the module results in the value for the positive full-scale deflection at a specified rated load of 1000 kg:

$$4 \text{ mV/V} \cdot 5.5 \text{ V} = 22 \text{ mV}$$

Actual quantization:

Taking the voltage drop on the measuring line into account, the actual bridge voltage is 5.463 V (for the calculation, see section "Bridge voltage" on page 248). If this voltage is multiplied by the strain gauge factor of 4 mV/V, the following actual quantization results:

$$4 \text{ mV/V} \cdot 5.463 \text{ V} = 21.85 \text{ mV}$$

These 21.85 mV correspond to 99.3% of the maximum possible measurement range.

Information:

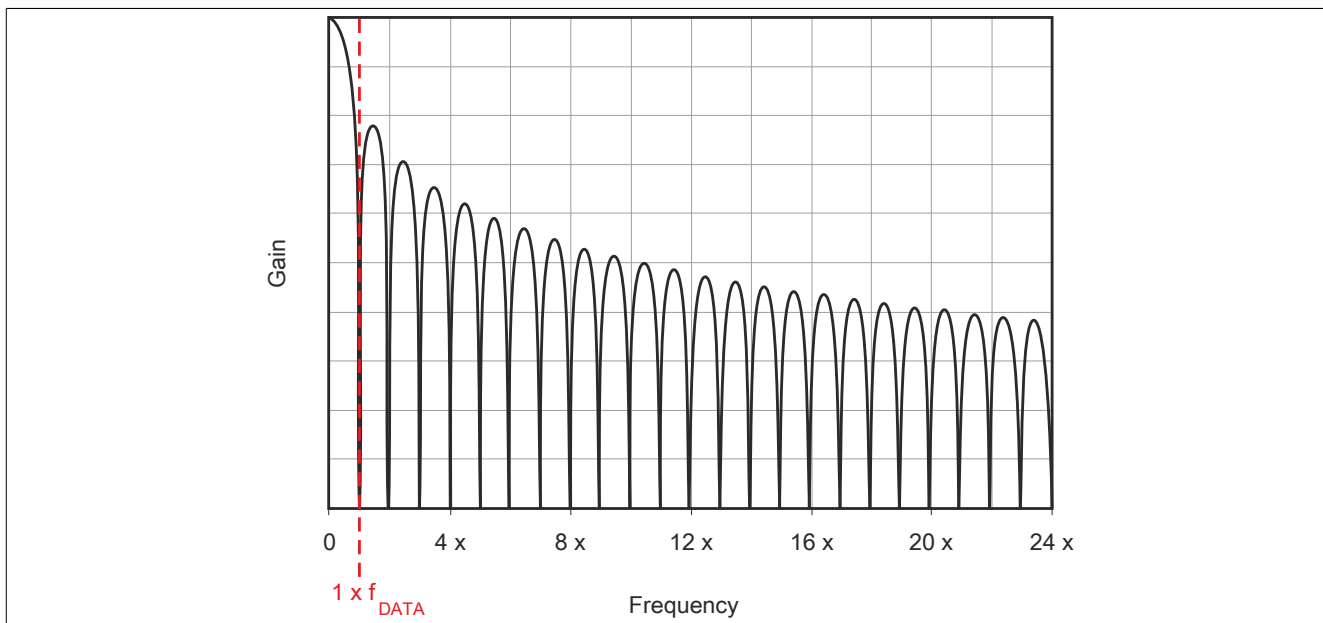
If the quantization decreases, the maximum possible effective resolution also decreases (see "Effective resolution of the A/D converter" on page 247).

With a simple Rule of Three calculation, the corresponding value can be calculated (as seen in the table) from weight to the converter value and vice versa. This simplified theoretical approach is only valid for an ideal measurement system. Calibration of the entire measurement system is recommended because not only the module, but particularly the strain gauge bridges exhibit tolerances (offset, gain). When taring, the gradient offset is recalculated and the gain of the linear equation is determined when normalized. In addition to the calculation displayed in the table, these calculations must also be carried out in the application.

| 24-bit value of the module | | Quantization | Corresponding weight |
|----------------------------|-----------|---------------|----------------------|
| 0x007F FFFF | 8,388,607 | 21.85 mV | 1000 kg |
| 0x0000 0001 | 1 | 2.61 nV | 0.119 g |
| 0x0000 20C3 | 8387 | 21.85 μ V | 1 kg |
| 0x0001 0000 | 65536 | 170.7 μ V | 7.81 kg |

The values for 1 LSB are also included in the module's technical data under item "Quantization" (1 LSB each for 16 bits and 24 bits).

9.1.3.1.11 Filter characteristics of the sigma-delta A/D converter

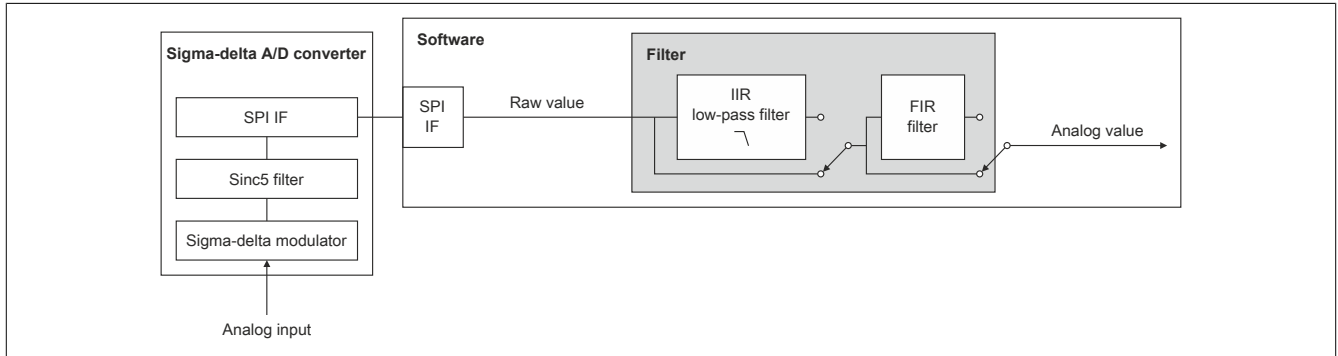


9.1.3.1.12 Software filters

2 filters are available for the analog input. They can be individually enabled and configured at runtime. By default, both filters are disabled when the device is switched on. The filters are controlled and configured using "Function model 2 - Extended filter".

In order to allow the filter behavior to be adapted to the measuring situation or machine cycle (high dynamics and low precision or low dynamics and high precision), the filter characteristics of both the IIR low-pass filter as well as the FIR filter can be changed synchronously at any time.

Filter diagram



9.1.3.1.12.1 IIR low-pass filter

General information

The IIR low-pass filter is used to generally smooth and increase the resolution of the analog value. The filter works according to the following formula:

$$y = y_{\text{Old}} + \frac{x - y_{\text{Old}}}{2^{\text{Filter level}}}$$

- x ... Current filter input value
- y_{Old} ... Old filter output value
- y ... New filter output value

Parameter "Filter level" in the formula above is configured using register "ConfigCommonOutput01" on page 269. "Filter level" = 0 if the IIR low-pass filter is disabled.

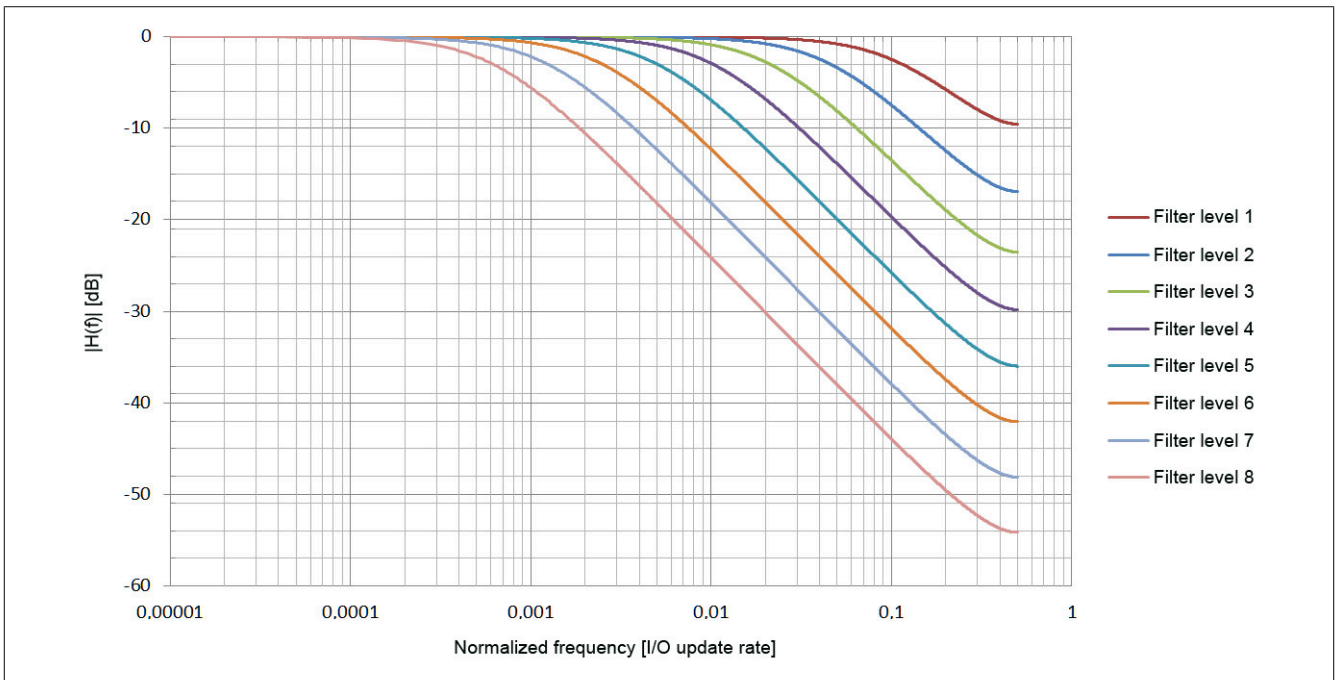
Filter characteristics of the first-order IIR low-pass filter

Limit frequency f_c

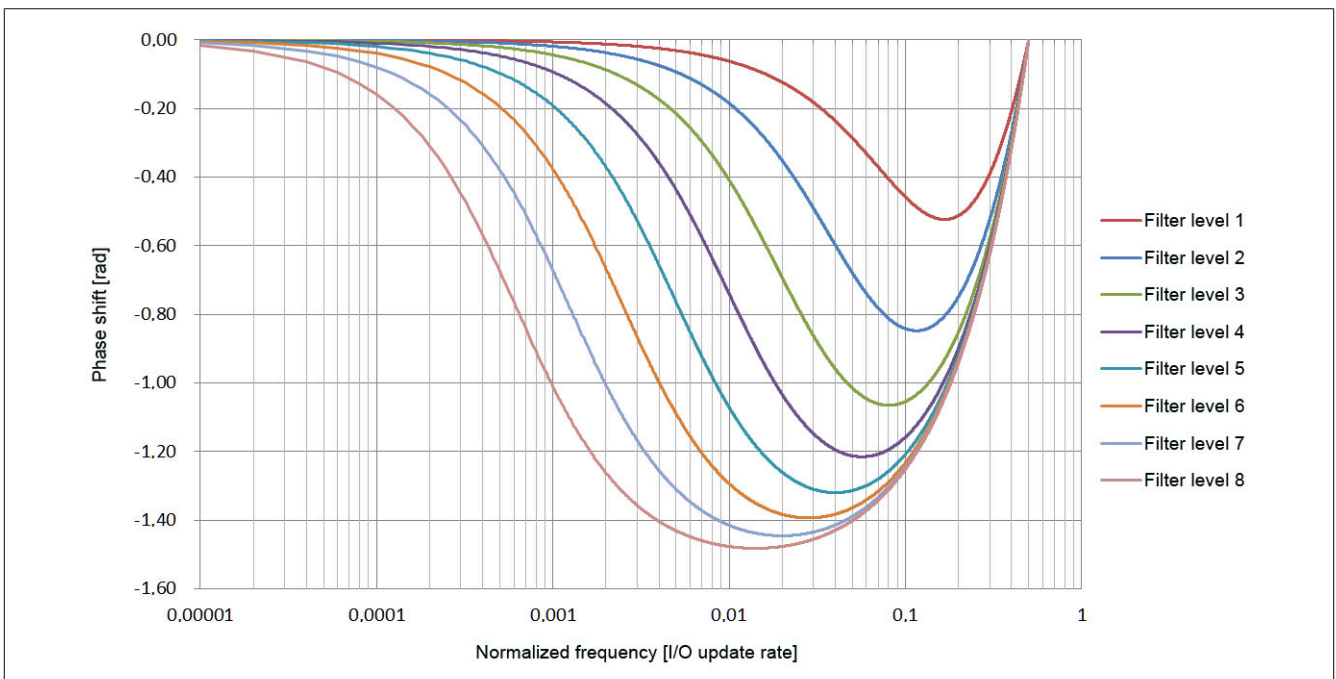
The following table provides an overview of the -3 dB limit frequency f_c depending on the configured filter level.

| Filter level | Normalized f_c [I/O update rate] | f_c [Hz] | |
|--------------|---------------------------------------|---------------------------|---------------------------|
| | | I/O update rate = 15000/s | I/O update rate = 20000/s |
| 1 | 0.11476 | 1721.4 | 2295.2 |
| 2 | 0.046 | 690 | 920 |
| 3 | 0.02124 | 318.6 | 424.8 |
| 4 | 0.01026 | 153.9 | 205.2 |
| 5 | 0.00504 | 75.6 | 100.8 |
| 6 | 0.0025 | 37.5 | 50 |
| 7 | 0.00124 | 18.6 | 24.8 |
| 8 | 0.00062 | 9.3 | 12.4 |

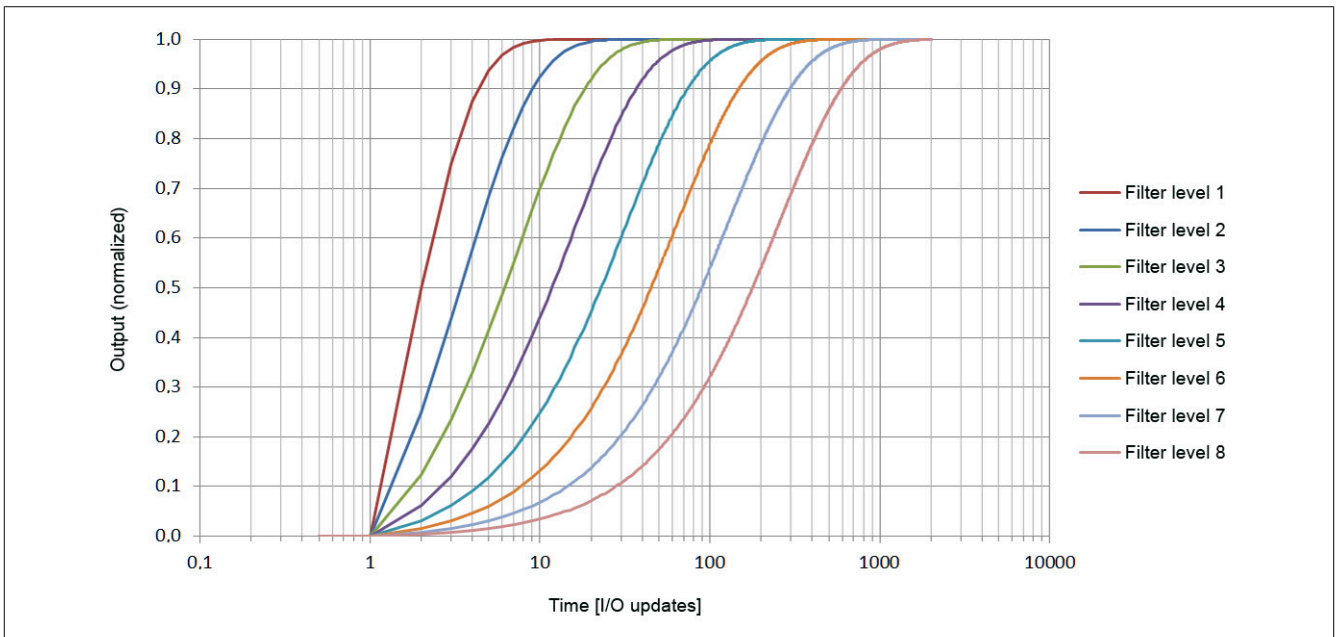
Gain of the IIR low-pass filter



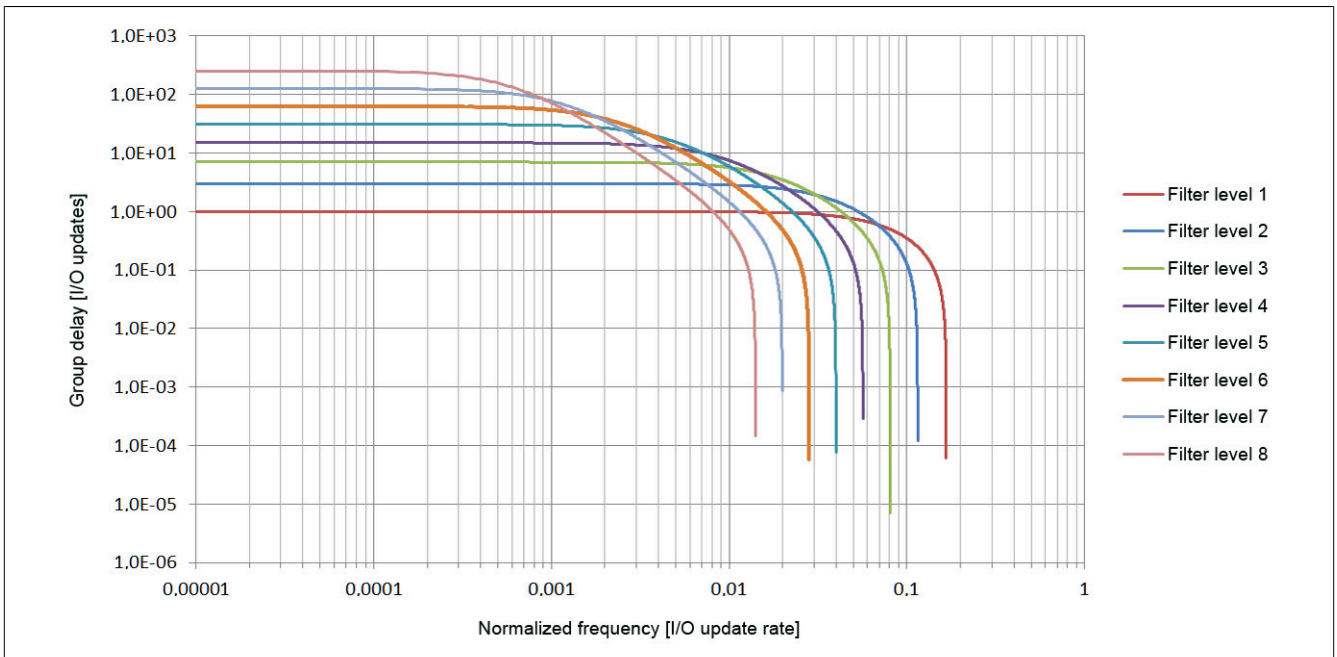
Phase shift of the IIR low-pass filter



Step response of the IIR low-pass filter



Group delay of the IIR low-pass filter



9.1.3.1.12.2 FIR filter

Like the IIR low-pass filter, the FIR filter can also be used to smooth out the signal and increase its resolution. In addition, configuring the filter length accordingly makes it possible to target and efficiently filter out individual interference frequencies. The source of these interference frequencies may be mechanical or electromagnetic. Multiples of these are also filtered out (as long as they are a whole-number factor of the data output rate).

Example:

Data output rate = 15000 samples/s, averaging over 15 values → "Notch" at 1 kHz (2 kHz, etc.)

When reconfiguring the filter, it takes 1/data rate (FIR filter in mode "Selectable data rate") or 1/filter frequency (FIR filter in mode "High-resolution data rate") until the filter is tuned. During tuning, bit 5 is set in register "StatusInput01" on page 271.

Characteristics of the FIR filter in mode "Selectable data rate"

The following table applies to "Function model 0 - Standard" and "Function model 254 - Bus controller" as well as for "Function model 2 - Extended filter" in mode "Selectable data rate".

| Set value 1) 2) | Data rate (f_{Data}) [Hz] 3) 4) | f_{Notch} [Hz] | I/O update rate [Hz] | | I/O update time [ms] | |
|--------------------|---|-------------------------|------------------------------|---|------------------------------|---|
| | | | Function models 0 and 254 | Function model 2 (mode "Selectable data rate") | Function models 0 and 254 | Function model 2 (mode "Selectable data rate") |
| 0000 | 2.5 | 2.5 | 2.5 | 15000 | 400 | 0.0667 |
| 0001 | 5 | 5 | 5 | 15000 | 200 | 0.0667 |
| 0010 | 10 | 10 | 10 | 15000 | 100 | 0.0667 |
| 0011 | 15 | 15 | 15 | 15000 | 66.6667 | 0.0667 |
| 0100 | 25 | 25 | 25 | 15000 | 40 | 0.0667 |
| 0101 | 30 | 30 | 30 | 15000 | 33.3333 | 0.0667 |
| 0110 | 50 | 50 | 50 | 15000 | 20 | 0.0667 |
| 0111 | 60 | 60 | 60 | 15000 | 16.6667 | 0.0667 |
| 1000 | 100 | 100 | 100 | 15000 | 10 | 0.0667 |
| 1001 | 500 | 500 | 500 | 15000 | 2 | 0.0667 |
| 1010 | 1000 | 1000 | 1000 | 15000 | 1 | 0.0667 |
| 1011 | 2000 | 2000 | 2000 | 20000 | 0.5 | 0.05 |
| 1100 | 3750 | 3750 | 3750 | 15000 | 0.2667 | 0.0667 |
| 1101 | 7500 | 7500 | 7500 | 15000 | 0.1333 | 0.0667 |
| 1110 | | | Reserved | | | |
| 1111 | | | Reserved | | | |

- 1) Function model 0 and 254: Bits 0 to 3 of register "ConfigOutput01" on page 262
- 2) Function model 2: Bits 0 to 3 of register "ConfigDatarateOutput01" on page 223
- 3) Function models 0 and 254: Data rate = 1/Filter length [s] (f_{Notch}) = I/O update rate
- 4) Function model 2: Data rate = 1/Filter length [s] (f_{Notch})

Characteristics of the FIR filter in mode "High-resolution data rate"

The following table applies to "Function model 2 - Extended filter".

| Setpoint [0.1 Hz] ¹⁾ | Data rate (f_{Data}) [Hz] | f_{Notch} [Hz] | I/O update time [μ s] |
|---------------------------------|-------------------------------|------------------|----------------------------------|
| 1 to 65535 | Setpoint / 10 | = Data rate | $\approx 50 \mu$ s ²⁾ |

1) Setpoint from register "ConfigHighResolutionOutput01" on page 223

2) The value varies between 42 and 56 μ s (see also the next section "I/O update time")

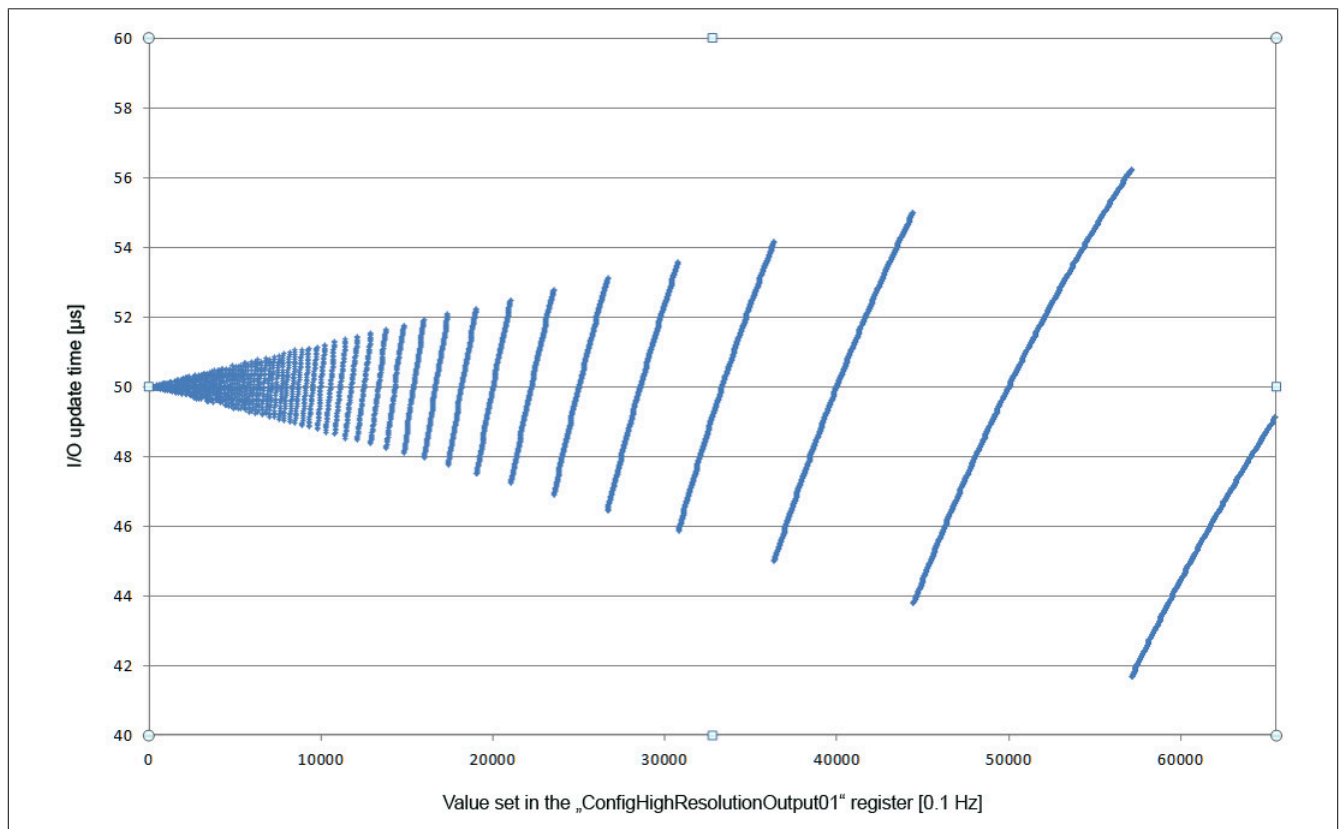
I/O update time

The value of the I/O update time depends on the setpoint and varies between 42 and 56 μ s. The following formula can be used to precisely calculate the I/O update time:

$$\text{I/O update time} = 1e6 \cdot (1e-4 - 10 / (\text{Setpoint} \cdot [10 / (5e-5 \cdot \text{Setpoint})]))$$

Legend: The square brackets in the formula above mean that the calculated value must be rounded to a whole number.

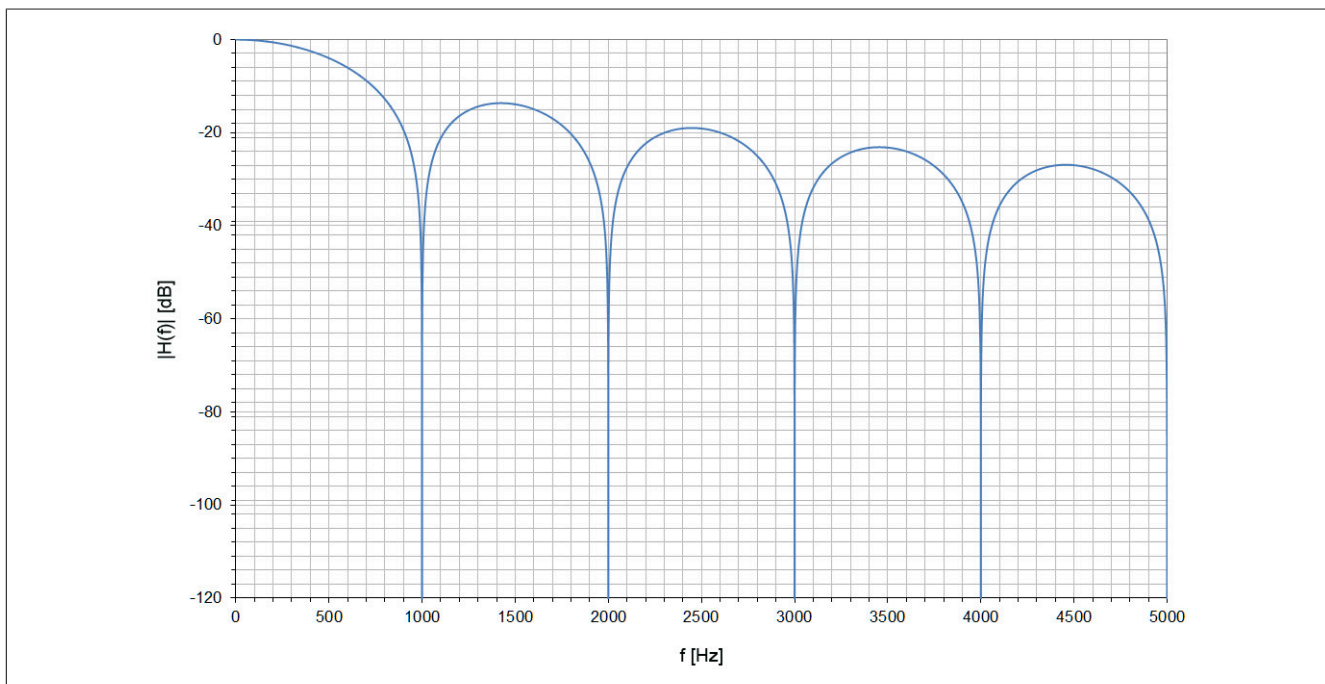
The following image shows the I/O update time depending on the setpoint:



Examples for the gain of the FIR filter**Example 1**

Filter setting = 10:

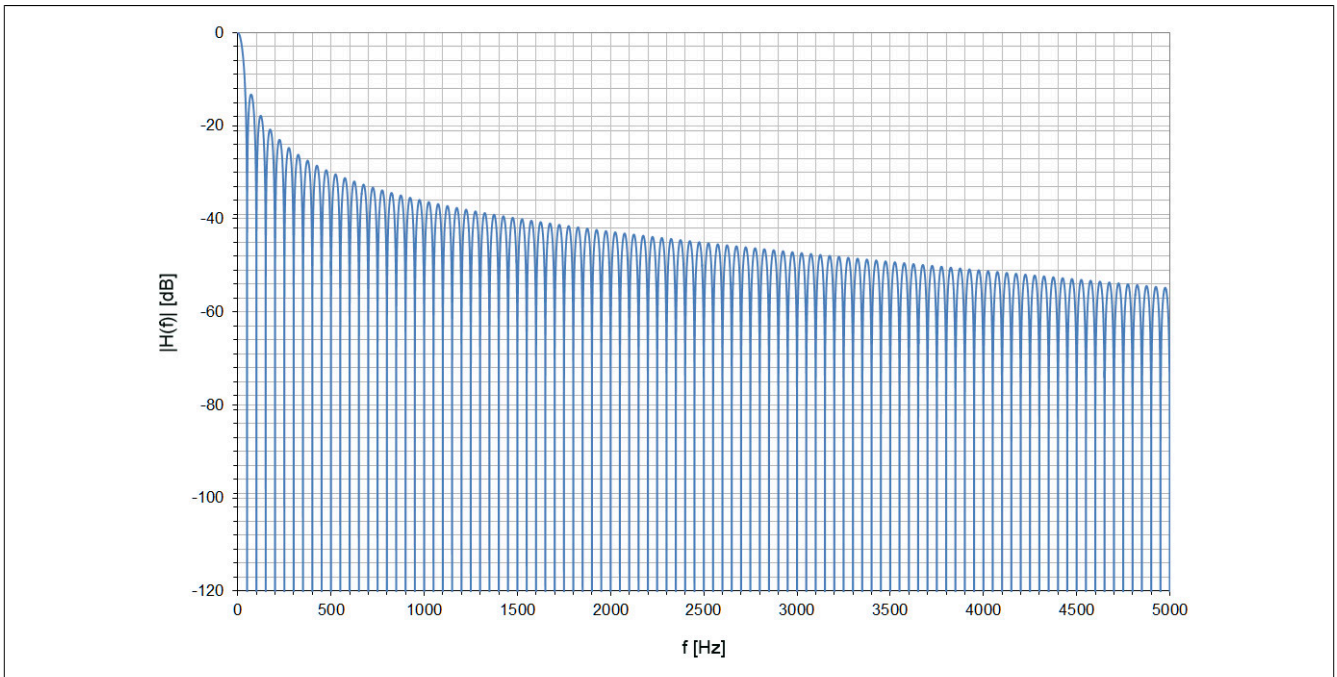
- $f_{\text{Notch}} = 1000 \text{ Hz}$
- $f_c = 439.3 \text{ Hz}$



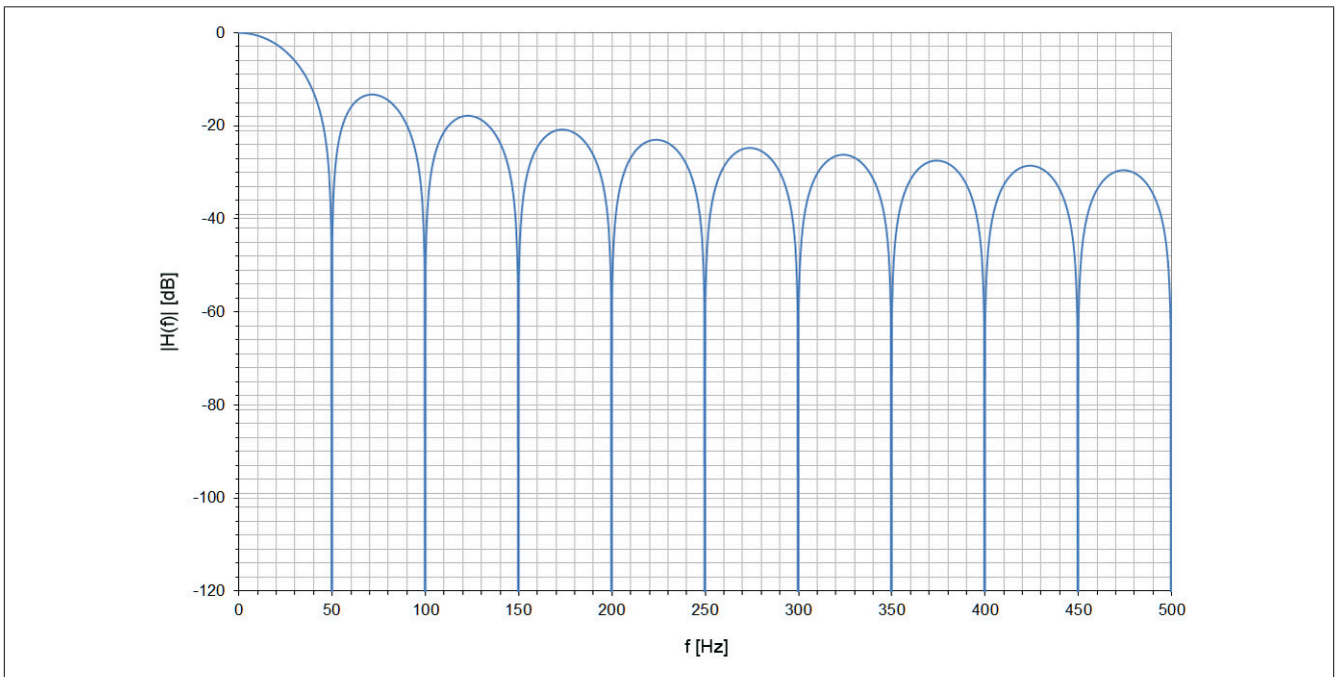
Example 2

Filter setting = 6:

- $f_{\text{Notch}} = 50 \text{ Hz}$
- $f_c = 21.8 \text{ Hz}$



Detailed excerpt from the filter curve shown above:

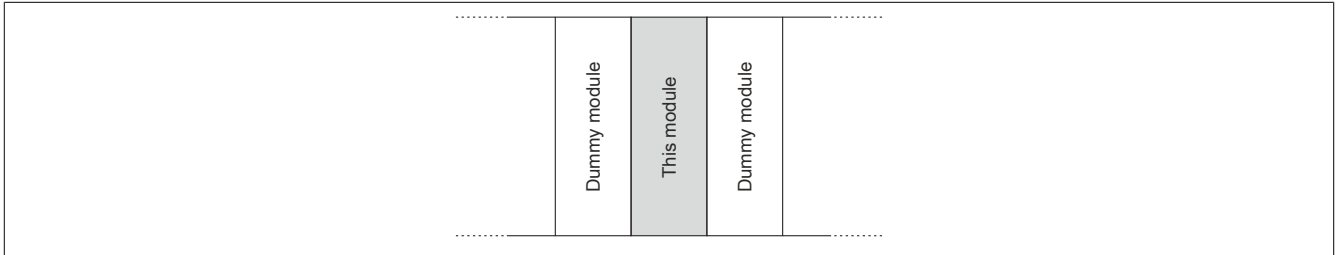


9.1.3.1.13 Hardware configuration

9.1.3.1.13.1 Hardware configuration for horizontal installation starting at 55°C ambient temperature

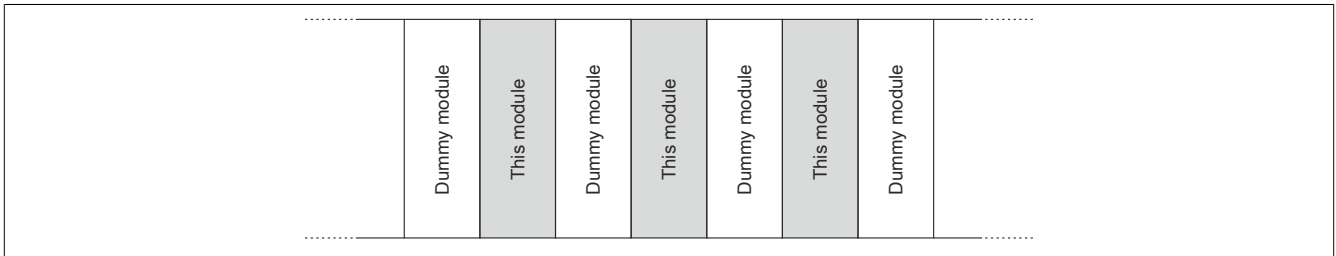
Operating a strain gauge module

Starting at an ambient temperature of 55°C, a dummy module must be connected to the left and right of the strain gauge module in a horizontal mounting orientation.



Operating multiple strain gauge modules side by side

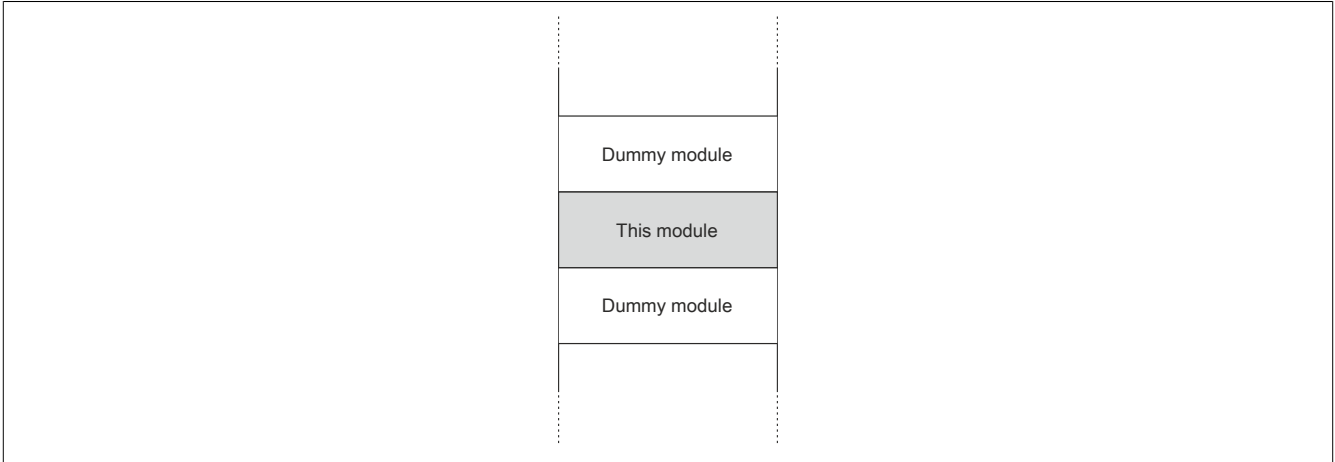
If 2 or more horizontal strain gauge modules are being operated in a cluster, the following arrangement of modules must be observed.



9.1.3.1.13.2 Hardware configuration for vertical installation starting at 45°C ambient temperature

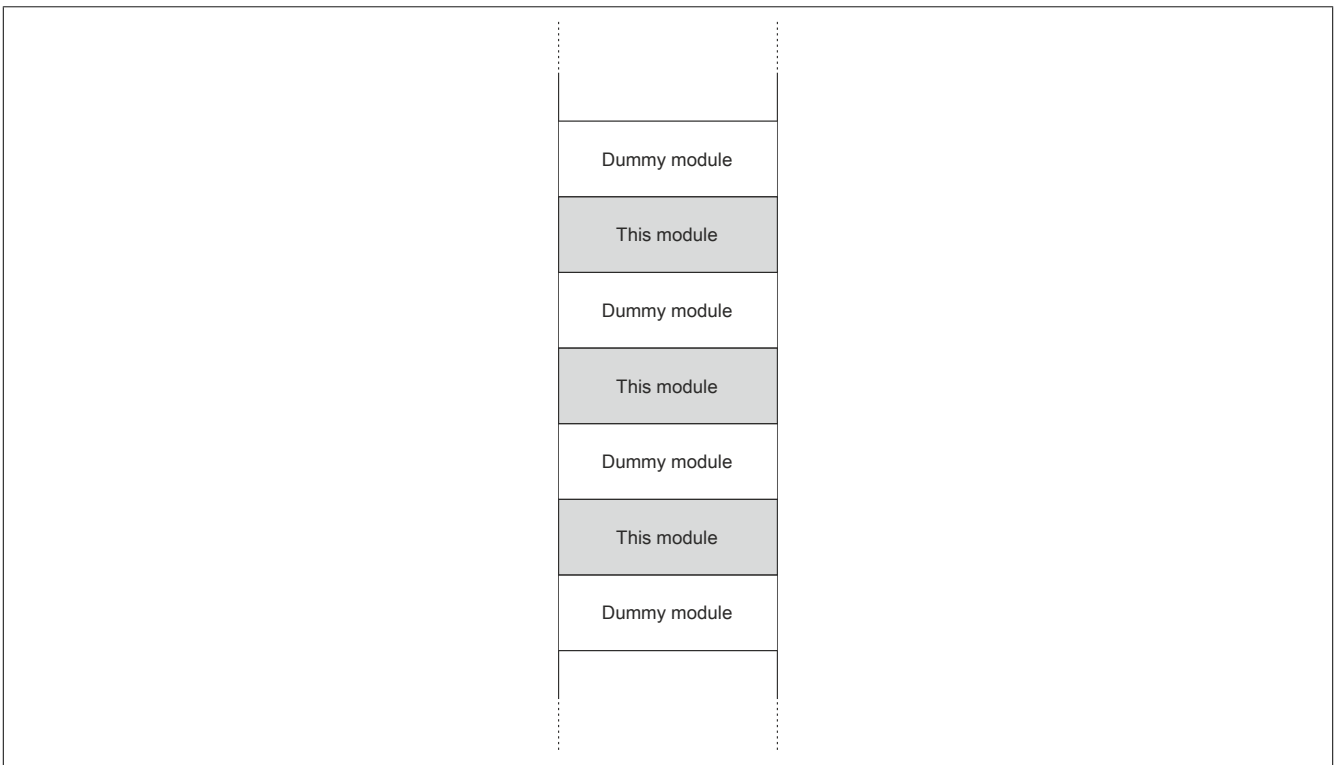
Operating a strain gauge module

Starting at an ambient temperature of 45°C, a dummy module must be connected to the left and right of the strain gauge module in a vertical mounting orientation.



Operating multiple strain gauge modules side by side

If 2 or more vertical strain gauge modules are being operated in a cluster, the following arrangement of modules must be observed.



9.1.3.1.14 Register description

9.1.3.1.14.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.1.3.1.14.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog signal - Configuration | | | | | | |
| 16 | ConfigOutput01 (A/D converter configuration) | USINT | | | • | |
| 18 | ConfigCycletime01 | UINT | | | | • |
| 32 | AdcClkFreqShift01 | USINT | | | | • |
| Analog signal - Communication | | | | | | |
| 2 | StatusInput01 | USINT | • | | | |
| 4 | AnalogInput01 | DINT | • | | | |

9.1.3.1.14.3 Function model 1 - Multisampling

In this function model, the A/D converter is operated synchronously to X2X Link with a predefined A/D converter cycle time. The value is configurable as 50 or 100 μ s.

The module returns between 3 and 10 measured values per X2X cycle depending on the configuration. With an X2X cycle time of 400 μ s and A/D converter cycle time of 50 μ s, exactly 8 measurements are performed and the module can return 8 values (strain gauge value 01 to strain gauge value 08).

If a longer cycle time is used, the values returned correspond to the last measurements. If using an X2X cycle time that is not a whole number multiple of the A/D converter cycle time, then the conversion cannot be synchronized with X2X Link. In this case, the module outputs the invalid value 0x8000.

Example 1

If using an X2X cycle time of 800 μ s, it is possible to perform 16 measurements per X2X cycle if the A/D converter cycle time equals 50 μ s. The first 6 measured values are discarded; the last 10 measured values are provided by the module.

With a shorter X2X cycle time, the number of measured values should not exceed the number of measurements that can actually be made. All other measured values are invalid (0x8000). To minimize the load on the X2X Link network, it is possible to disable these unneeded registers (see "[Number of measured values](#)" on page 267).

Example 2

If using an X2X cycle time of 300 μ s, it is possible to perform 6 measurements per X2X cycle if the A/D converter cycle time equals 50 μ s. For this reason, only the first 6 registers are valid. The registers for the 7th through 10th measured value ([AnalogInput07](#) to [AnalogInput10](#)) should be disabled by setting [Number of measured values](#) to "6 measured values" in the I/O configuration.

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog signal - Configuration | | | | | | |
| 1601 | ConfigGain01_MultiSample | USINT | | | • | |
| 1603 | ConfigCycletime01_MultiSample | USINT | | | | • |
| Analog signal - Communication | | | | | | |
| 2 | StatusInput01 | USINT | • | | | |
| 1534 + N * 4 | AnalogInput0N (N = 1 to 10) | INT | • | | | |

9.1.3.1.14.4 Function model 2 - Extended filter

This function model allows the IIR low-pass filter and the FIR filter to be enabled.

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog signal - Configuration | | | | | | |
| 272 | ConfigCommonOutput01 (A/D converter and IIR filter configuration) | USINT | | | • | |
| 288 | ConfigFilterOutput01 | UINT | | | | • |
| 273 | ConfigDatarateOutput01 | USINT | | | • | |
| 274 | ConfigHighResolutionOutput01 | UINT | | | • | |
| Analog signal - Communication | | | | | | |
| 2 | StatusInput01 | USINT | • | | | |
| 4 | AnalogInput01 | DINT | • | | | |
| 256 | AdcConvTimeStampInput01 | DINT | • | | | |

9.1.3.1.14.5 Function model 254 - Bus controller

In function model "254 - Bus controller", the module behaves as it does in "Function model 0 - Standard" with the exception that it is not synchronized to the X2X Link network even if synchronous mode is enabled in register "ConfigOutput01" on page 262. Instead, the module behaves as if the set A/D converter cycle time is not a factor or multiple of the X2X cycle time and attempts to maintain the set A/D converter cycle time as precisely as possible.

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog signal - Configuration | | | | | | | |
| 16 | 0 | ConfigOutput01 (A/D converter configuration) | USINT | | | • | |
| 18 | 18 | ConfigCycletime01 | UINT | | | | • |
| 32 | 32 | AdcClkFreqShift01 | USINT | | | | • |
| Analog signal - Communication | | | | | | | |
| 2 | 4 | StatusInput01 | USINT | • | | | |
| 4 | 0 | AnalogInput01 | DINT | • | | | |

1) The offset specifies the position of the register within the CAN object.

Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "Using I/O modules on the bus controller" on page 3789.

CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.1.3.1.14.6 Registers for function models "0 - Standard" and "254 - Bus controller"

A/D converter configuration

Name:

ConfigOutput01

The data rate and measurement range of the A/D converter can be configured in this register.

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| USINT | See bit structure. | 13 |

Bit structure:

| Bit | Description | Value | Information | |
|-------|--|--|--|----------|
| 0 - 3 | Data rate f_{DATA} (samples per second): | 0000 | 2.5 | |
| | | 0001 | 5 | |
| | | 0010 | 10 | |
| | | 0011 | 15 | |
| | | 0100 | 25 | |
| | | 0101 | 30 | |
| | | 0110 | 50 | |
| | | 0111 | 60 | |
| | | 1000 | 100 | |
| | | 1001 | 500 | |
| | | 1010 | 1000 | |
| | | 1011 | 2000 | |
| | | 1100 | 3750 | |
| | | 1101 | 7500 (bus controller default setting) | |
| 4 - 6 | Standard measurement range (bit 6 = 0) | 000 | 16 mV/V (bus controller default setting) | |
| | | 001 | 8 mV/V | |
| | | 010 | 4 mV/V | |
| | | 011 | 2 mV/V | |
| | | Extended measurement range (bit 6 = 1) | 100 | 256 mV/V |
| | | | 101 | 128 mV/V |
| 110 | 64 mV/V | | | |
| 7 | Reserved | 111 | 32 mV/V | |
| | | 0 | (must be 0) | |

Synchronous mode

The module's analog/digital converter (A/D converter) can optionally be operated and read synchronously to the X2X Link network. Synchronous mode is enabled by selecting the respective operating mode in register "ConfigOutput01" on page 262. A time between 200 and 2000 μ s must be set in register "ConfigCycletime01" on page 263 for this. If this time is a whole number factor or multiple of the configured cycle time of X2X Link, then the A/D converter is read synchronously to X2X Link.

Information:

The A/D converter cycle time must be $\geq 1/4$ of the X2X cycle time!

Bit 2 in *Module status* is set (i.e. A/D converter not running synchronously)...

- ... If the configured A/D converter cycle time cannot be synchronized with X2X Link.
- ... If the module is still in the settling phase.

Jitter, dead time and settling time:

| | | |
|---|--|---|
| Jitter | | |
| A/D converter cycle times <1500 μ s | | Max. $\pm 1 \mu$ s |
| A/D converter cycle times >1500 μ s | | Max. $\pm 4 \mu$ s |
| X2X link dead time | | 50μ s + $\frac{X2X \text{ cycle time}}{128}$ |
| Settling time | | 150 x X2X cycle time |

The settling time corresponds to the time needed until the A/D converter can be operated after enabling synchronous mode or following conversion of the A/D converter cycle time.

A/D converter cycle time

Name:

ConfigCycletime01

This register is only used in [Synchronous mode](#). If synchronous mode is enabled in the A/D converter configuration, then the module attempts to operate the A/D converter as synchronously as possible to the X2X Link network (based on the A/D converter cycle time set in this register). It is of course necessary for the X2X Link cycle time and the A/D converter cycle time to have a certain ratio. The following conditions must be observed:

- 1) A/D converter cycle time $\geq 1/4$ X2X cycle time
- 2) A/D converter cycle time corresponds to a whole number factor or multiple of the X2X cycle time
- 3) A/D converter cycle time must be in the range 50 to 2000 μ s

| Data type | Values | Information |
|-----------|------------|-------------------------------------|
| UINT | 50 to 2000 | Bus controller default setting: 400 |

A/D converter clock frequency shift

Name:

AdcClkFreqShift01

In rare cases, strain gauge modules connected to neighboring slots can influence one another. This can result in temporary, minimal deviations in measured values. This can only occur if the sigma-delta A/D converters on the neighboring strain gauge modules are operated at exactly the same clock frequency.

In most cases, these clock frequencies vary slightly due to part variances. When they are the same however, this register on the strain gauge module provides a safe way for an application to prevent this type of mutual influence.

| Data type | Values | Information |
|-----------|-------------|-------------------------------------|
| SINT | -128 to 127 | Bus controller default setting: 127 |

This register can be used to vary the clock frequency in increments of 200 ppm. Setting values from -50 to 50 cover a range of -10000 ppm to 10000 ppm. This corresponds with -1% to 1%.

Values beyond this range will cause activation of a default mode. The frequency shift is derived from the last 2 digits of the serial number by the module firmware. This saves time that would otherwise be needed for programming, provided that the last two digits of the serial numbers on the neighboring modules are not the same

| Register value | Frequency shift in ppm | Example of a sampling rate ¹⁾ |
|----------------|--|--|
| 127 | $((\text{SerialNo. modulo } 100) - 50) * (-200) \text{ ppm}$ | Based on the serial number |
| ... | ... | ... |
| 51 | $((\text{SerialNo. modulo } 100) - 50) * (-200) \text{ ppm}$ | Based on the serial number |
| 50 | 10000 | 505 |
| 49 | 9800 | 504.9 |
| ... | ... | ... |
| 2 | 400 | 500.2 |
| 1 | 200 | 500.1 |
| 0 | 0 | 500 |
| -1 | -200 | 499.9 |
| -2 | -400 | 499.8 |
| ... | ... | ... |
| -50 | -10000 | 495 |
| -51 | $((\text{SerialNo. modulo } 100) - 50) * (-200) \text{ ppm}$ | Based on the serial number |
| ... | ... | ... |
| -128 | $((\text{SerialNo. modulo } 100) - 50) * (-200) \text{ ppm}$ | Based on the serial number |

1) Nominal sampling rate of 500 samples per second

Important:

As shown in the table above, shifting the A/D converter clock frequency will equally shift the A/D converter sampling rate. Shifting the A/D converter clock frequency too much can cause problems with disturbance suppression particularly when a very specific sampling rate has been defined to suppress existing disturbances (e.g. 50 Hz to suppress the 50 Hz hum). See also "[Filter characteristics of the sigma-delta A/D converter](#)" on page 250.

It is situations like this where the option to manually shift the frequency in the I/O configuration or ASIOACC library should be utilized rather than relying on the default frequency shift that is based on the serial number.

A frequency shift like the one shown below would be sufficient to prevent modules from influencing one another and would not cause any noticeable difference to the filter characteristics.

| Slot | 1 | 2 | 3 | 4 | 5 | 6 | ... |
|-------------------------------------|---|---|----|---|----|---|-----|
| A/D converter clock frequency shift | 0 | 2 | -1 | 1 | -2 | 0 | ... |

Information:

- This register has no effect in synchronous mode because the firmware regulates the A/D converter clock frequency in such a way that the A/D converter cycle is synchronous with the X2X cycle.
- When writing to this register using the ASIOACC library, only the lowest value byte of the written value is accepted. For example, the value 256 (=0x100) is identical to the value 0 (=0x00).

Module status

Name:

StatusInput01

The current state of the module is indicated in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------------|-------|---|
| 0 | A/D converter value | 0 | Valid A/D converter value |
| | | 1 | Invalid A/D converter value (analog value = 0xFF800000). Possible causes: <ul style="list-style-type: none"> • Strain gauge supply error • I/O power supply error • A/D converter not (yet) configured |
| 1 | Line monitoring | 0 | Ok |
| | | 1 | Open circuit |
| 2 | Only valid in synchronous mode | 0 | A/D converter runs synchronous to X2X Link |
| | | 1 | A/D converter does not run synchronous to X2X Link |
| 3 - 7 | Reserved | - | |

Strain gauge value

Name:

AnalogInput01

This register contains the raw value determined by the A/D converter for the full-bridge strain gauge with 24-bit resolution.

| Data type | Values | Information |
|-----------|-----------------------|--|
| DINT | -8,388,608 | Negative invalid value |
| | -8,388,607 | Negative full-scale deflection / Underflow |
| | -8,388,606 to 8388606 | Valid range |
| | 8,388,607 | Positive full-scale deflection / Overflow / Open circuit |

Effective resolution

In principle, the effective resolution of the A/D converter is dependent on the data rate and the measurement range (see "Effective resolution of the A/D converter" on page 247).

The following table shows how the effective resolution (in bits) or effective range of values of the strain gauge value depend on the module configuration (data rate, measurement range).

| Data rate f_{DATA} [Hz] | Measurement range | | | | | | | |
|-------------------------------------|-------------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|
| | ± 16 mV/V | | ± 8 mV/V | | ± 4 mV/V | | ± 2 mV/V | |
| | Bits | Range of values | Bits | Range of values | Bits | Range of values | Bits | Range of values |
| 2.5 | 19.9 | $\pm 489,000$ | 19.1 | $\pm 281,000$ | 18.0 | $\pm 131,000$ | 17.4 | $\pm 86,500$ |
| 5 | 19.4 | $\pm 346,000$ | 18.2 | $\pm 151,000$ | 17.5 | $\pm 92,700$ | 16.4 | $\pm 43,200$ |
| 10 | 18.5 | $\pm 185,000$ | 17.8 | $\pm 114,000$ | 16.8 | $\pm 57,100$ | 15.9 | $\pm 30,600$ |
| 15 | 18.2 | $\pm 151,000$ | 17.3 | $\pm 80,700$ | 16.4 | $\pm 43,200$ | 15.4 | $\pm 21,600$ |
| 25 | 17.8 | $\pm 114,000$ | 16.9 | $\pm 61,100$ | 16.0 | $\pm 32,800$ | 14.9 | $\pm 15,300$ |
| 30 | 17.8 | $\pm 114,000$ | 16.8 | $\pm 57,100$ | 15.9 | $\pm 30,600$ | 14.8 | $\pm 14,300$ |
| 50 | 17.4 | $\pm 86,500$ | 16.3 | $\pm 40,300$ | 15.4 | $\pm 21,600$ | 14.4 | $\pm 10,800$ |
| 60 | 17.4 | $\pm 86,500$ | 16.2 | $\pm 37,600$ | 15.3 | $\pm 20,200$ | 14.1 | $\pm 8,780$ |
| 100 | 16.9 | $\pm 61,100$ | 15.9 | $\pm 30,600$ | 14.8 | $\pm 14,300$ | 13.8 | $\pm 7,130$ |
| 500 | 15.5 | $\pm 23,200$ | 14.5 | $\pm 11,600$ | 13.5 | $\pm 5,790$ | 12.5 | $\pm 2,900$ |
| 1000 | 15.0 | $\pm 16,400$ | 14.1 | $\pm 8,780$ | 13.1 | $\pm 4,390$ | 11.9 | $\pm 1,910$ |
| 2000 | 14.5 | $\pm 11,600$ | 13.4 | $\pm 5,400$ | 12.6 | $\pm 3,100$ | 11.4 | $\pm 1,350$ |
| 3750 | 14.1 | $\pm 8,780$ | 13.1 | $\pm 4,390$ | 12.1 | $\pm 2,190$ | 11.1 | $\pm 1,100$ |
| 7500 | 13.8 | $\pm 7,130$ | 12.7 | $\pm 3,330$ | 11.8 | $\pm 1,780$ | 10.6 | ± 776 |

Table 32: Effective resolution of the strain gauge value in bits for the measurement range 2 to 16 mV/V

| Data rate f_{DATA} [Hz] | Measurement range | | | | | | | |
|-------------------------------------|-------------------|-----------------|----------------|-----------------|---------------|-----------------|---------------|-----------------|
| | ± 256 mV/V | | ± 128 mV/V | | ± 64 mV/V | | ± 32 mV/V | |
| | Bits | Range of values | Bits | Range of values | Bits | Range of values | Bits | Range of values |
| 2.5 | 22.0 | $\pm 2,100,000$ | 22.0 | $\pm 2,100,000$ | 21.2 | $\pm 1,200,000$ | 20.5 | $\pm 741,000$ |
| 5 | 21.7 | $\pm 1,700,000$ | 21.4 | $\pm 1,380,000$ | 20.8 | $\pm 913,000$ | 20.3 | $\pm 645,000$ |
| 10 | 20.8 | $\pm 913,000$ | 20.8 | $\pm 913,000$ | 20.2 | $\pm 602,000$ | 19.4 | $\pm 346,000$ |
| 15 | 20.7 | $\pm 852,000$ | 20.5 | $\pm 741,000$ | 19.9 | $\pm 489,000$ | 19.3 | $\pm 323,000$ |
| 25 | 20.1 | $\pm 562,000$ | 19.9 | $\pm 489,000$ | 19.7 | $\pm 426,000$ | 18.9 | $\pm 245,000$ |
| 30 | 19.9 | $\pm 489,000$ | 19.9 | $\pm 489,000$ | 19.4 | $\pm 346,000$ | 18.8 | $\pm 228,000$ |
| 50 | 19.8 | $\pm 456,000$ | 19.2 | $\pm 301,000$ | 19.2 | $\pm 301,000$ | 18.2 | $\pm 151,000$ |
| 60 | 19.5 | $\pm 371,000$ | 19.2 | $\pm 301,000$ | 19.0 | $\pm 262,000$ | 18.2 | $\pm 151,000$ |
| 100 | 19.0 | $\pm 262,000$ | 18.8 | $\pm 228,000$ | 18.5 | $\pm 185,000$ | 17.6 | $\pm 99,300$ |
| 500 | 17.8 | $\pm 114,000$ | 17.5 | $\pm 92,700$ | 17.1 | $\pm 70,200$ | 16.4 | $\pm 43,200$ |
| 1000 | 17.2 | $\pm 75,300$ | 17.1 | $\pm 70,200$ | 16.7 | $\pm 53,200$ | 15.8 | $\pm 28,500$ |
| 2000 | 16.7 | $\pm 53,200$ | 16.5 | $\pm 46,300$ | 16.1 | $\pm 35,100$ | 15.2 | $\pm 18,800$ |
| 3750 | 16.2 | $\pm 37,600$ | 16.1 | $\pm 35,100$ | 15.8 | $\pm 28,500$ | 14.9 | $\pm 15,300$ |
| 7500 | 15.9 | $\pm 30,600$ | 15.8 | $\pm 28,500$ | 15.3 | $\pm 20,200$ | 14.6 | $\pm 12,400$ |

Table 33: Effective resolution of the strain gauge value in bits for the measurement range 32 to 256 mV/V

9.1.3.1.14.7 Register for "Function model 1 - Multisampling"

A/D converter configuration

Name:

ConfigGain01_MultiSample

The measurement range for the A/D converter can be configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|-------------|
| 0 - 2 | Standard measurement range (bit 2 = 0) | 000 | 16 mV/V |
| | | 001 | 8 mV/V |
| | | 010 | 4 mV/V |
| | | 011 | 2 mV/V |
| | Extended measurement range (bit 2 = 1) | 100 | 256 mV/V |
| | | 101 | 128 mV/V |
| | | 110 | 64 mV/V |
| | | 111 | 32 mV/V |
| 3 - 7 | Reserved | 0 | (must be 0) |

A/D converter cycle time

Name:

ConfigCycletime01_MultiSample

The A/D converter cycle time can be configured in this register.

In order for multisampling to work, the X2X cycle time must be divisible by the A/D converter cycle time to produce a whole number.

| Data type | Value | Information |
|-----------|----------|----------------------|
| USINT | 0 | 50 μ s (default) |
| | 1 | 100 μ s |
| | 2 to 255 | Reserved |

Number of measured values

If the X2X cycle time is too short, then not all 10 measurements can be performed. To reduce the load on X2X Link, it makes sense to only transfer as many values as measurements that can be made. This is why it is possible to configure the number of measured values to be transferred (see "Function model 1 - Multisampling" on page 260).

Example: A/D converter cycle time = 50 μ s

| X2X cycle time | Number of measured values to be transferred |
|--------------------|---|
| 250 μ s | 5 |
| 300 μ s | 6 |
| 350 μ s | 7 |
| 400 μ s | 8 |
| 450 μ s | 9 |
| \geq 500 μ s | 10 |

Example: A/D converter cycle time = 100 μ s

| X2X cycle time | Number of measured values to be transferred |
|----------------|---|
| 300 μ s | 3 |
| 400 μ s | 4 |
| 500 μ s | 5 |
| 600 μ s | 6 |
| 700 μ s | 7 |
| 800 μ s | 8 |
| 900 μ s | 9 |
| \geq 1 ms | 10 |

Module status

Name:
StatusInput01

This register contains the current state of the module.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------------|-------|--|
| 0 | A/D converter values | 0 | Valid A/D converter value |
| | | 1 | Invalid A/D converter value |
| 1 | Line monitoring | 0 | OK |
| | | 1 | Open circuit An open circuit was found during at least one measurement in this X2X cycle. This bit is reset if all measurements are OK after correcting this error, i.e. it does not have to be acknowledged. |
| 2 | Synchronous mode | 0 | A/D converter runs synchronous to X2X Link |
| | | 1 | A/D converter does not run synchronous to X2X Link |
| 3 - 7 | Reserved | - | |

Strain gauge value - Multiple

Name:
AnalogInput01 to AnalogInput10

This register contains the raw value determined by the A/D converter for the full-bridge strain gauge with 16-bit resolution. The module returns between 3 and 10 measured values per X2X cycle depending on the configuration.

Effective resolution

In principle, the effective resolution of the A/D converter is dependent on the data rate and measurement range (see "[Effective resolution of the A/D converter](#)" on page 247).

The following table shows how the effective resolution (in bits) or effective range of values of the strain gauge value depend on the module configuration (data rate, measurement range).

| Measurement range | | | | | | | |
|-------------------|-----------------|---------|-----------------|---------|-----------------|---------|-----------------|
| ±16 mV/V | | ±8 mV/V | | ±4 mV/V | | ±2 mV/V | |
| Bits | Range of values | Bits | Range of values | Bits | Range of values | Bits | Range of values |
| 13.4 | ±5,240 | 12.3 | ±2,510 | 11.3 | ±1,300 | 10.3 | ±630 |

Table 34: Effective resolution of the strain gauge value in bits for the measurement range 2 to 16 mV/V

| Measurement range | | | | | | | |
|-------------------|-----------------|-----------|-----------------|----------|-----------------|----------|-----------------|
| ±256 mV/V | | ±128 mV/V | | ±64 mV/V | | ±32 mV/V | |
| Bits | Range of values | Bits | Range of values | Bits | Range of values | Bits | Range of values |
| 15.5 | ±23,200 | 15.0 | ±16,400 | 15.0 | ±16,400 | 14.1 | ±8,490 |

Table 35: Effective resolution of the strain gauge value in bits for the measurement range 32 to 256 mV/V

9.1.3.1.14.8 Register for "Function model 2 - Extended filter"**A/D converter and IIR filter configuration**

Name:

ConfigCommonOutput01

The IIR low-pass filter and measurement range of the A/D converter can be configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------------------|-------------|--|
| | | | Filter level |
| 0 - 3 | IIR low-pass filter | 0000 | 0: IIR low-pass filter switched off |
| | | 0001 | 1 |
| | | 0010 | 2 |
| | | 0011 | 3 |
| | | 0100 | 4 |
| | | 0101 | 5 |
| | | 0110 | 6 |
| | | 0111 | 7 |
| | | 1000 | 8 |
| | | 1001 - 1111 | The analog input value indicates an invalid range. |
| 4 - 6 | Default measurement range | 000 | 16 mV/V |
| | | 001 | 8 mV/V |
| | | 010 | 4 mV/V |
| | | 011 | 2 mV/V |
| | Extended measurement range | 100 | 256 mV/V |
| | | 101 | 128 mV/V |
| | | 110 | 64 mV/V |
| | | 111 | 32 mV/V |
| 7 | Reserved | 0 | (must be 0) |

Data rate configuration

Name:

ConfigFilterOutput01

Whether a selectable data rate or a high-resolution data rate is being used for the FIR filter is configured in this register.

| Data type | Values | Information |
|-----------|--------|--|
| UINT | 0 | Mode "Selectable data rate": A selectable data rate is used for the FIR filter (default). Configuration takes place in register "ConfigDatarateOutput01" on page 223. |
| | 1 | Mode "High-resolution data rate": A high-resolution data rate is used for the FIR filter. Configuration takes place in register "ConfigHighResolutionOutput01" on page 223. |

Name:

ConfigDatarateOutput01

The data rate of the FIR filter in mode "Selectable data rate" is configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------------|--|-------|--|
| 0 - 3 | Data rate f_{DATA} (samples per second): | 0000 | 2.5 |
| | | 0001 | 5 |
| | | 0010 | 10 |
| | | 0011 | 15 |
| | | 0100 | 25 |
| | | 0101 | 30 |
| | | 0110 | 50 |
| | | 0111 | 60 |
| | | 1000 | 100 |
| | | 1001 | 500 |
| | | 1010 | 1000 |
| | | 1011 | 2000 |
| | | 1100 | 3750 |
| 1101 | 7500 | | |
| 1110 - 1111 | | | The analog input value indicates an invalid range. |
| 4 - 7 | Reserved | 0 | (must be 0) |

Name:

ConfigHighResolutionOutput01

The data rate of the FIR filter in 0.1 Hz steps is configured in this register (0.1 to 6553.5 Hz).

| Data type | Values | Information |
|-----------|-------------|-------------------------|
| UINT | 0 | Disables the FIR filter |
| | 1 to 65,535 | 0.1 to 6553.5 Hz |

Module status

Name:

StatusInput01

This register contains the current state of the module. If there is a fault in the module power supply or strain gauge supply, the analog input value indicates an invalid range and the buffer of the enabled filter is reset.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------------|-------|------------------------------|
| 0 | A/D converter values | 0 | Valid A/D converter value |
| | | 1 | Invalid A/D converter value |
| 1 | Line monitoring | 0 | OK |
| | | 1 | Open circuit |
| 2 | Reserved | - | |
| 3 | Module power supply | 0 | OK |
| | | 1 | Error in module power supply |
| 4 | Strain gauge supply | 0 | OK |
| | | 1 | Error in strain gauge supply |
| 5 | FIR filter ready | 0 | OK |
| | | 1 | FIR filter not yet ready |
| 6 - 7 | Reserved | - | |

A/D converter conversion timestamp

Name:

AdcConvTimeStampInput01

This register holds the timestamp of the last analog conversion. This is always the point in time in [μ s] at which the conversion of the latest A/D converter raw value is completed.

| Data type | Values | Explanation |
|-----------|---------------------------------|--|
| DINT | -2,147,483,648 to 2,147,483,647 | Timestamp [μ s] of the last analog conversion |

9.1.3.1.14.9 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 250 μ s |

9.1.3.1.14.10 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

For the I/O update times for function models "0 - Standard", "2 - Extended filter" and "254 - Bus controller", see section ["Characteristics of the FIR filter in mode "Selectable data rate" on page 254.](#)

Depending on the setting in register ["ConfigCycletime01_MultiSample" on page 267](#), the I/O update time in "Function model 1 - Multisampling" is 50 or 100 μ s.

9.1.3.2 X20AI1744-3 with Rev. <G0

9.1.3.2.1 General information

This module works with both 4-wire and 6-wire strain gauge load cells. The concept applied by the module requires compensation in the measurement system. This compensation eliminates the absolute uncertainty in the measurement circuit, such as component tolerances, effective bridge voltage or zero point offset. The measurement precision refers to the absolute (compensated) value, which will only change as a result of changes in the operating temperature.

- 1 full-bridge strain gauge input
- Data output rate configurable from 2.5 Hz to 7.5 kHz
- Special operating modes (synchronous mode and multiple sampling)

9.1.3.2.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Analog inputs |  |
| X20AI1744-3 | X20 analog input module, 1 full-bridge strain gauge input, 24-bit converter resolution, 5 Hz input filter | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O power supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O power supply connected through | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 36: X20AI1744-3 - Order data

9.1.3.2.3 Technical data

| Product ID | X20AI1744-3 |
|--|---|
| Short description | |
| I/O module | 1 full-bridge strain gauge input |
| General information | |
| B&R ID code | 0xA4EF |
| Status indicators | Channel status, operating status, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Open circuit | Yes, using status LED and software |
| Input | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.25 W |
| Additional power dissipation caused by actuators (resistive) [W] | Max. +0.36 ¹⁾ |
| Electrical isolation | |
| Bus - Analog input | Yes |
| Bus - Bridge supply voltage | Yes |
| Channel - I/O power supply | No |
| Certifications | |
| CE | Yes |
| KC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta = 0 - Max. 60°C FTZÚ 09 ATEX 0083X |
| Full-bridge strain gauge | |
| Strain gauge factor | 2 to 256 mV/V, configurable using software |
| Connection | 4- or 6-wire connections ²⁾ |

Table 37: X20AI1744-3 - Technical data

| Product ID | X20AI1744-3 |
|---|---|
| Input type | Differential, used to evaluate a full-bridge strain gauge |
| Digital converter resolution | 24-bit |
| Conversion time | Depends on the configured data output rate |
| Data output rate | 2.5 - 7500 samples per second, configurable using software (f_{DATA}) |
| Input filter | |
| Cutoff frequency | 5 Hz |
| Order | 3 |
| Slope | 60 dB |
| ADC filter characteristics | Sigma-delta, see section "Filter characteristics of the sigma-delta A/D converter" |
| Operating range / Measurement sensor | 85 to 5000 Ω |
| Influence of cable length | The shielded twisted pair cable should be as short as possible and run separately to the sensor (isolated from load circuit) without intermediate terminals |
| Input protection | RC protection |
| Common-mode range | 0 to 3 VDC Permissible input voltage range (with regard to the potential strain gauge GND) on the inputs "Input +" and "Input -" |
| Isolation voltage between input and bus | 500 V _{Eff} |
| Conversion procedure | Sigma-delta |
| Output of digital value | |
| Broken bridge supply line | Value approaches 0 |
| Broken sensor line | Value approaches \pm end value ("open circuit" status bit is set in the <i>Module status</i> register) |
| Valid range of values | 0xFF800001 to 0x007FFFFF (-8,388,607 to 8,388,607) |
| Strain gauge supply | |
| Voltage | 5.5 VDC / max. 65 mA ³⁾ |
| Short-circuit and overload resistant | Yes |
| Voltage drop for short-circuit protection | Max. 0.2 VDC at 65 mA |
| Quantization ⁴⁾ | |
| LSB value (16-bit) | |
| 2 mV/V | 336 nV |
| 4 mV/V | 671 nV |
| 8 mV/V | 1.343 μ V |
| 16 mV/V | 2.686 μ V |
| 32 mV/V | 5.371 μ V |
| 64 mV/V | 10.74 μ V |
| 128 mV/V | 21.48 μ V |
| 256 mV/V | 42.97 μ V |
| LSB value (24-bit) | |
| 2 mV/V | 1.31 nV |
| 4 mV/V | 2.62 nV |
| 8 mV/V | 5.25 nV |
| 16 mV/V | 10.49 nV |
| 32 mV/V | 20.98 nV |
| 64 mV/V | 41.96 nV |
| 128 mV/V | 83.92 nV |
| 256 mV/V | 167.85 nV |
| Temperature coefficient | |
| Rev. \geq E0 | 10 ppm/ $^{\circ}$ C |
| Rev. $<$ E0 | 30 ppm/ $^{\circ}$ C |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5 $^{\circ}$ C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | 0 to 55 $^{\circ}$ C |
| Vertical mounting orientation | 0 to 50 $^{\circ}$ C |
| Derating | See section "Hardware configuration" |
| Storage | -25 to 70 $^{\circ}$ C |
| Transport | -25 to 70 $^{\circ}$ C |

Table 37: X20AI1744-3 - Technical data


| Product ID | X20AI1744-3 |
|------------------------------|--|
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately Order 1x bus module X20BM11 separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 37: X20AI1744-3 - Technical data

- 1) Depends on the full-bridge strain gauge being used.
- 2) With 6-wire connections, line compensation does not function (see section "Connection examples").
- 3) The maximum current of 90 mA is permitted up to an operating temperature of 45°C.
- 4) Quantization depends on the strain gauge factor.

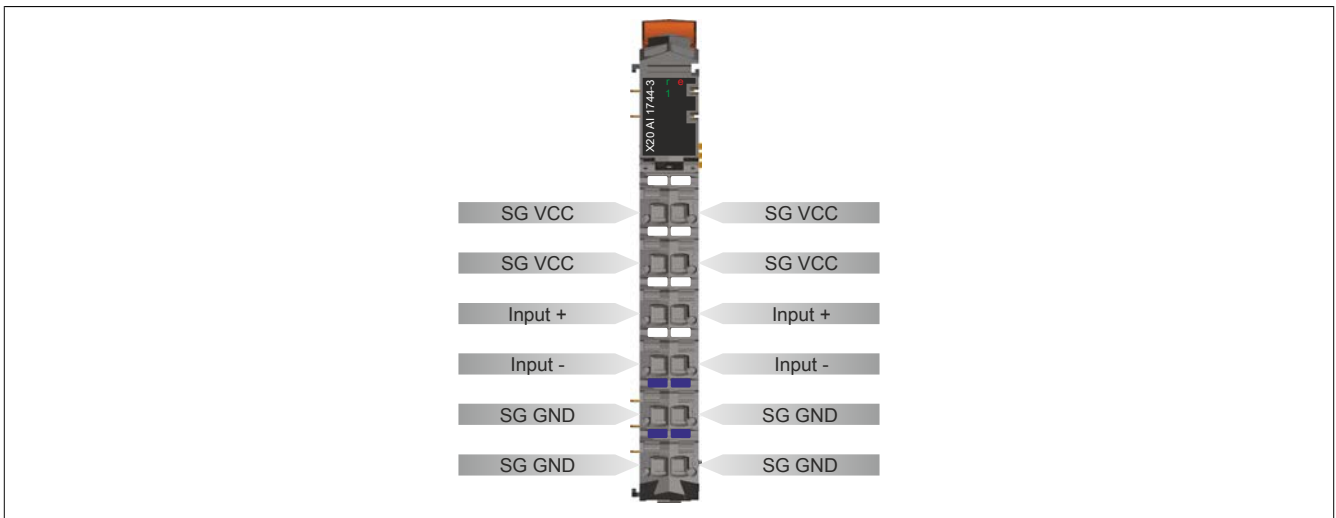
9.1.3.2.4 LED status indicators

For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-----|-------|--------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | 1 | Green | Off | Possible causes: <ul style="list-style-type: none"> • Open circuit • Sensor is disconnected • Converter is busy |
| | | | On | Analog/digital converter running, value OK |

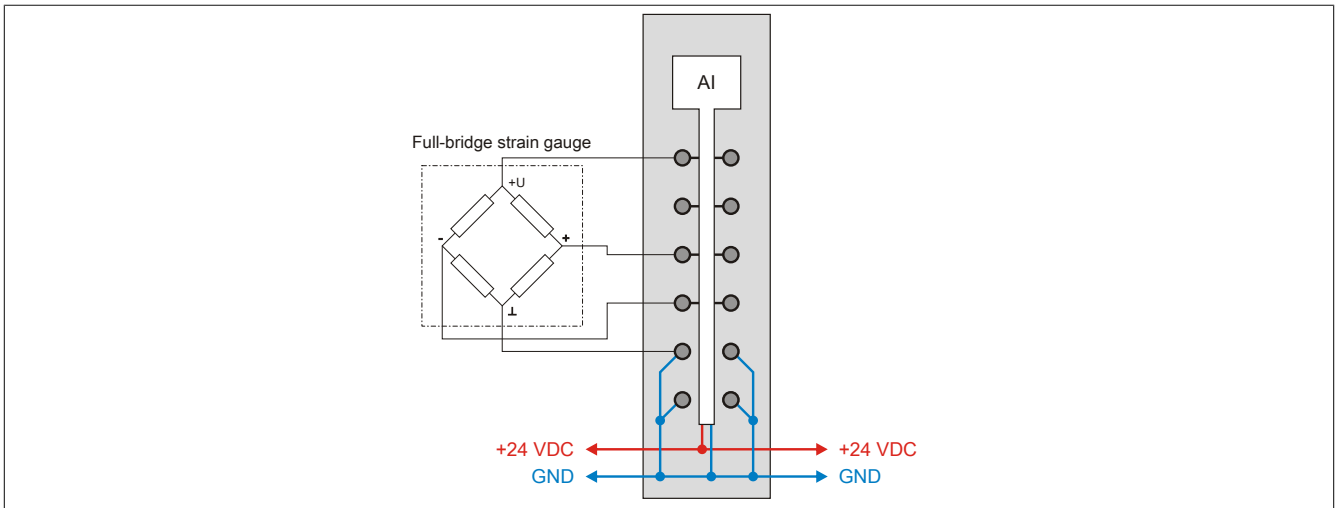
1) Depending on the configuration, a firmware update can take up to several minutes.

9.1.3.2.5 Pinout



9.1.3.2.6 Connection examples

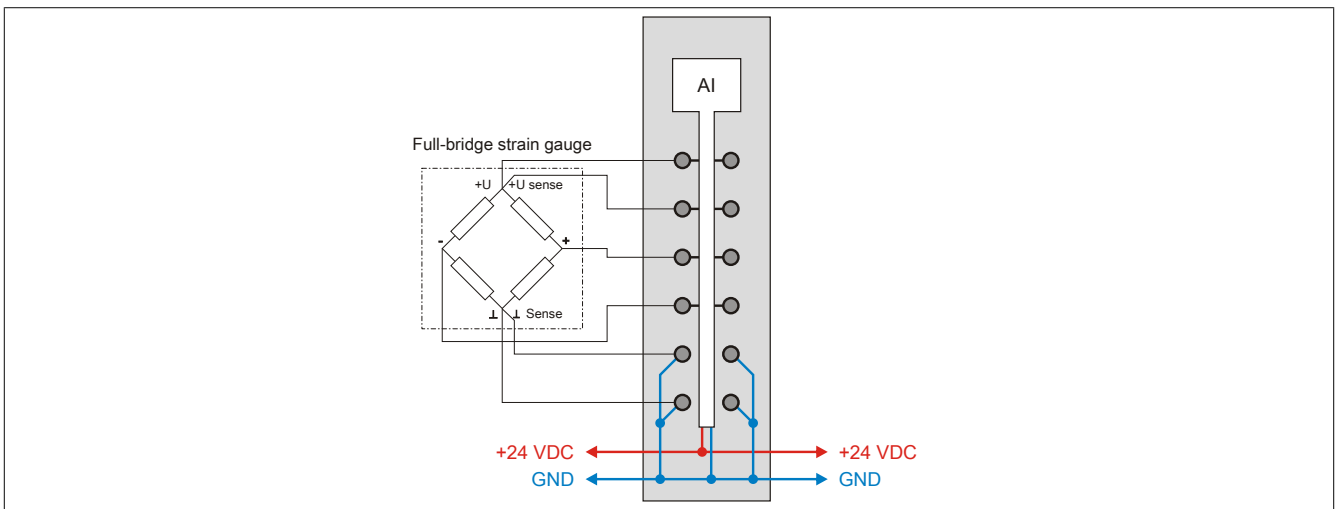
Full-bridge strain gauge with 4-wire connections



Full-bridge strain gauge with 6-wire connections

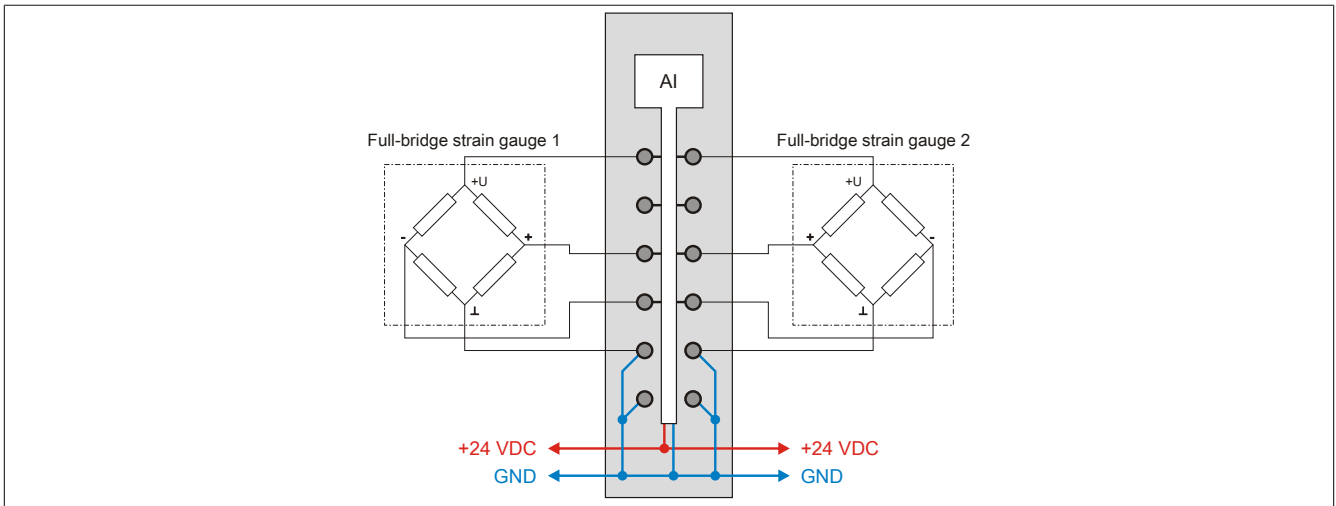
Full-bridge strain gauges can be connected to this module with 6-wire connections. Line compensation is not supported by the module, however. The sense lines are short circuited by the internally connected strain gauge VCC and GND connections (see "Input circuit diagram" on page 276). The measurement precision is therefore affected by changes in operating temperature. Longer cable lengths and smaller cable cross sections also increase the potential for errors in the measurement system.

In order to reduce cable resistance, the sense lines should be connected in parallel with the strain gauge supply lines. Optimal signal quality can be obtained by using a shielded twisted pair cable. The connections for the strain gauge supply lines, the sensor lines, and the bridge differential voltage lines should each use one twisted pair cable.



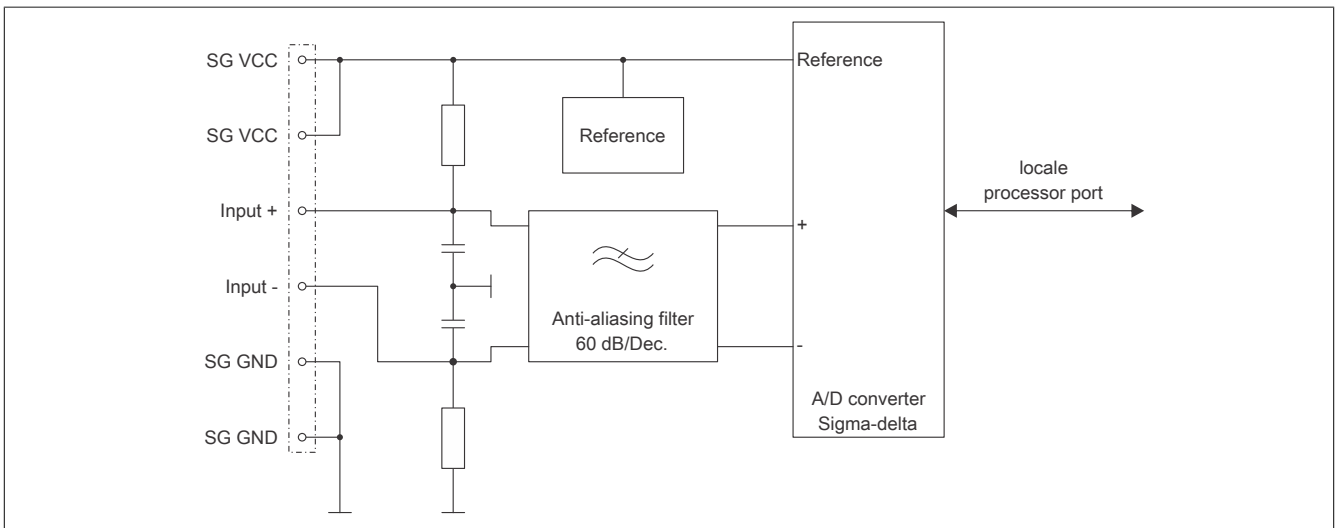
Parallel connection of 2 full-bridge strain gauges (4-wire connections)

If connecting the full-bridge strain gauges in parallel, the manufacturer's guidelines must be observed.

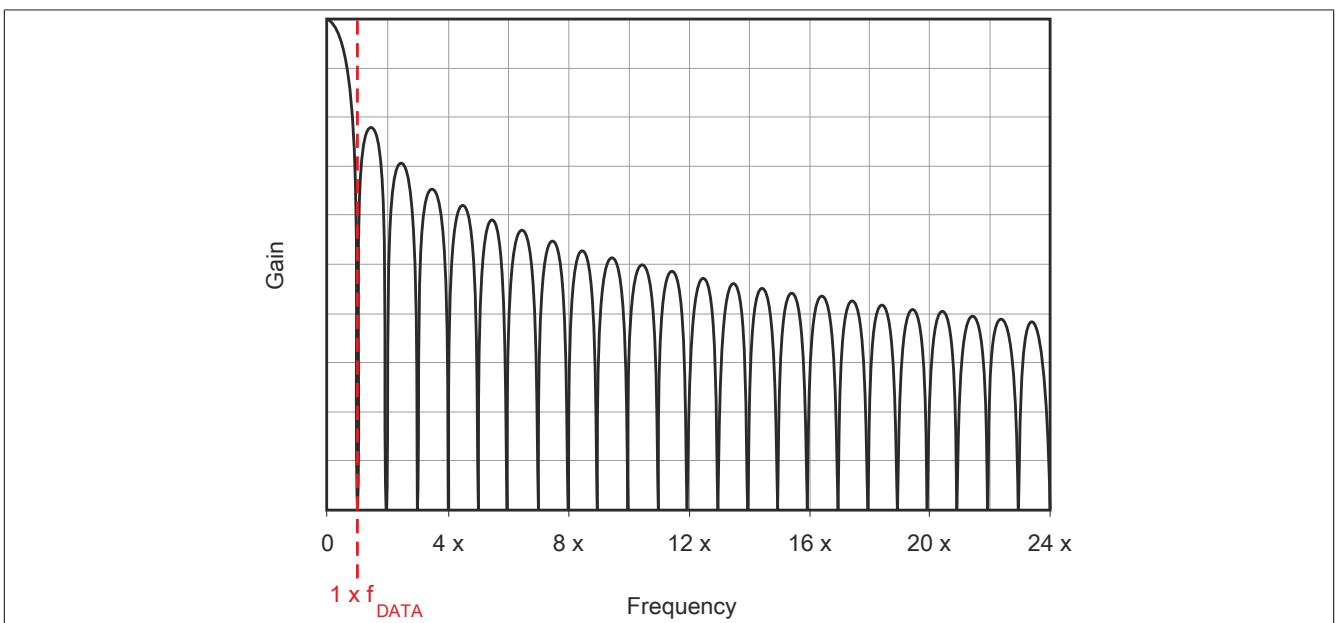


When connecting 3 or more full-bridge strain gauges in parallel, 2 lines must be connected together in an X20 terminal block.

9.1.3.2.7 Input circuit diagram



9.1.3.2.8 Filter characteristics of the sigma-delta A/D converter

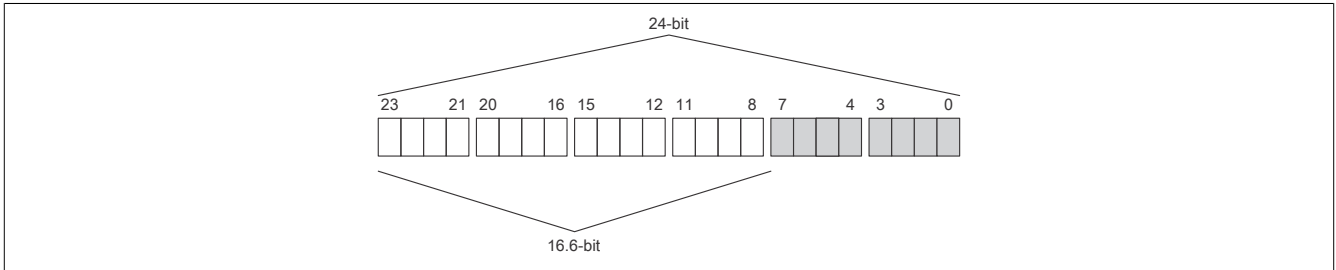


9.1.3.2.9 Effective resolution of the A/D converter

The A/D converter on the module provides a 24-bit measured value. The actual attainable noise-free resolution is always less than 24-bit, however. This "effective resolution" depends on the data rate and measurement range.

Example:

Based on the conversion method, a data rate of 2.5 Hz and a specified measurement range of 2 mV/V result in an effective resolution of 16.6 bits:



The low-order bits (grayed out) contain only noise instead of valid values and must therefore not be evaluated.

With "Function model 1 - Multisampling", only the highest 16 bits are made available.

9.1.3.2.10 Calculation example / Quantization

In a weighing application, the corresponding weight located on the connected load cell should be determined from the value derived from the module.

The characteristics of the strain gauge load cell are as follows:

- Rated load: 1000 kg
- Strain gauge factor: 4 mV/V

The value for the positive full-scale deflection at a specified rated load of 1000 kg is derived from the bridge factor of the strain gauge load cell (multiplication with the bridge supply voltage from the module):

$$4 \text{ mV/V} \times 5.5 \text{ V} = 22 \text{ mV}$$

With a simple Rule of Three calculation, the corresponding value can be calculated (as seen in the table) from weight to the converter value and vice versa. This simplified theoretical approach is only valid for an ideal measurement system. Calibration of the entire measurement system is recommended because not only the module, but particularly the strain gauge bridges exhibit tolerances (offset, gain). When taring, the gradient offset is recalculated and the gain of the linear equation is determined when normalized. In addition to the calculation displayed in the table, these calculations must also be carried out in the application.

| 24-bit value of the module | | Quantization | Corresponding weight |
|----------------------------|-----------|---------------|----------------------|
| 0x007F FFFF | 8,388,607 | 22.0 mV | 1000 kg |
| 0x0000 0001 | 1 | 2.62 nV | 0.119 g |
| 0x0000 20C3 | 8387 | 22.0 μ V | 1 kg |
| 0x0001 0000 | 65536 | 171.9 μ V | 7.81 kg |

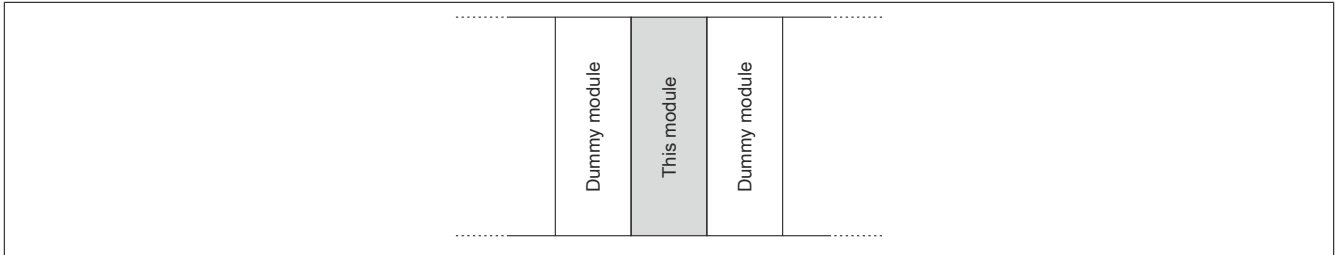
The values for each LSB can be found in the technical data of the module under "Quantization" (1 LSB in reference to 16-bit and 1 LSB in reference to 24-bit).

9.1.3.2.11 Hardware configuration

9.1.3.2.11.1 Hardware configuration for horizontal installation at 50°C ambient temperature

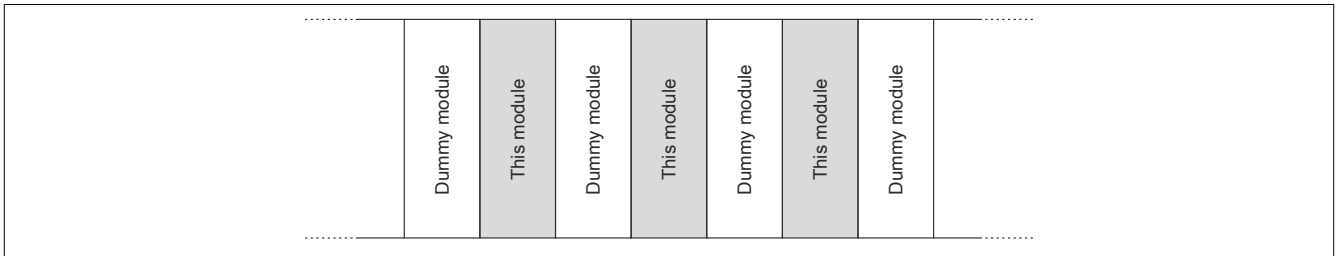
Operating a strain gauge module

Starting at an ambient temperature of 50°C, a dummy module must be connected to the left and right of the strain gauge module in a horizontal mounting orientation.



Operating multiple strain gauge modules side by side

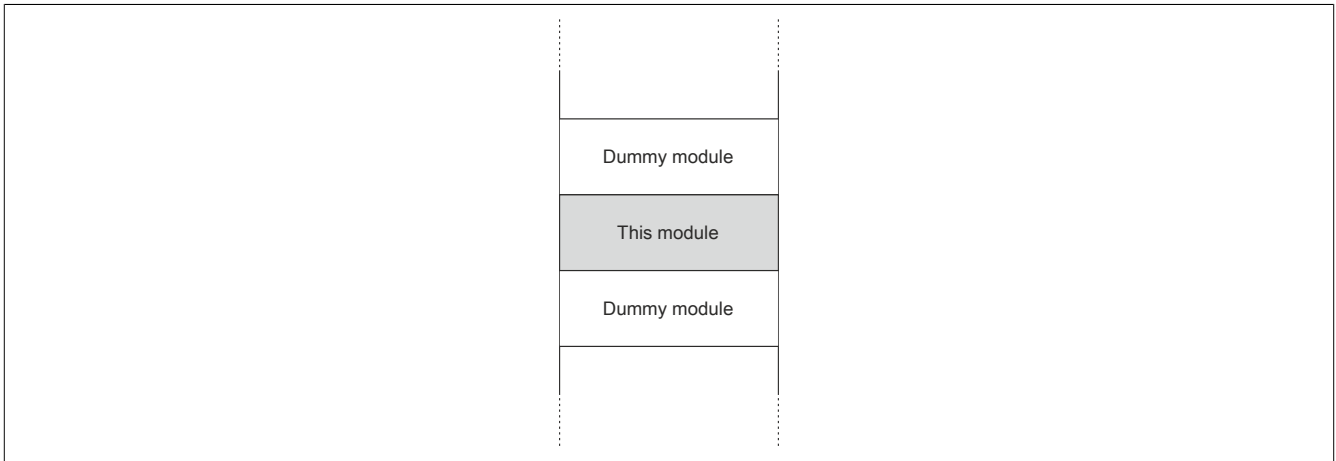
If 2 or more horizontal strain gauge modules are being operated in a cluster, the following arrangement of modules must be observed.



9.1.3.2.11.2 Hardware configuration for vertical installation at 40°C ambient temperature

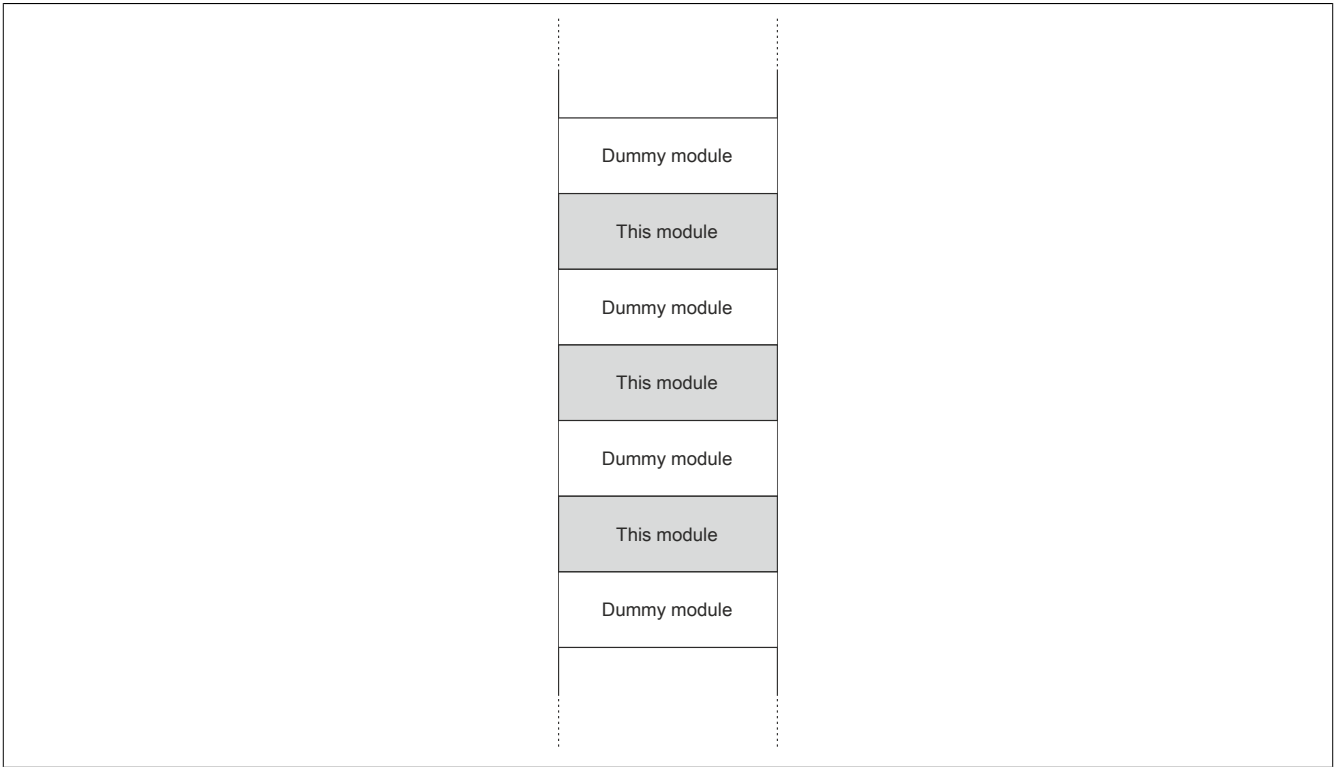
Operating a strain gauge module

Starting at an ambient temperature of 40°C, a dummy module must be connected to the left and right of the strain gauge module in a vertical mounting orientation.



Operating multiple strain gauge modules side by side

If 2 or more vertical strain gauge modules are being operated in a cluster, the following arrangement of modules must be observed.



9.1.3.2.12 Register description

9.1.3.2.12.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.1.3.2.12.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | StatusInput01 | USINT | • | | | |
| 4 | AnalogInput01 | DINT | • | | | |
| 16 | ConfigOutput01 | USINT | | | • | |
| 18 | ConfigCycletime01 | UINT | | | | • |
| 32 | AdcClkFreqShift01¹⁾ | USINT | | | | • |

1) Firmware version 8 / Upgrade 1.2.0.0 or higher

9.1.3.2.12.3 Function model 1 - Multisampling

In this function model, the A/D converter is operated synchronously to X2X Link with a predefined A/D converter cycle time. The value is configurable as 50 or 100 μ s.

The module returns between 3 and 10 measured values per X2X cycle depending on the configuration. With an X2X cycle time of 400 μ s and A/D converter cycle time of 50 μ s, exactly 8 measurements are performed and the module can return 8 values (strain gauge value 01 to strain gauge value 08).

If a longer cycle time is used, the values returned correspond to the last measurements. If using an X2X cycle time that is not a whole number multiple of the A/D converter cycle time, then the conversion cannot be synchronized with X2X Link. In this case, the module outputs the invalid value 0x8000.

Example 1

If using an X2X cycle time of 800 μ s, it is possible to perform 16 measurements per X2X cycle if the A/D converter cycle time equals 50 μ s. The first 6 measured values are discarded; the last 10 measured values are provided by the module.

With a shorter X2X cycle time, the number of measured values should not exceed the number of measurements that can actually be made. All other measured values are invalid (0x8000). To minimize the load on the X2X Link network, it is possible to disable these unneeded registers (see "[Number of measured values](#)" on page 287).

Example 2

If using an X2X cycle time of 300 μ s, it is possible to perform 6 measurements per X2X cycle if the A/D converter cycle time equals 50 μ s. For this reason, only the first 6 registers are valid. The registers for the 7th through 10th measured value (AnalogInput07 to AnalogInput10) should be disabled by setting [Number of measured values](#) to "6 measured values" in the I/O configuration.

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog signal - Configuration | | | | | | |
| 1601 | ConfigGain01_MultiSample | USINT | | | • | |
| 1603 | ConfigCycletime01_MultiSample | USINT | | | | • |
| Analog signal - Communication | | | | | | |
| 2 | StatusInput01 | USINT | • | | | |
| 1534 + N * 4 | AnalogInput0N (N = 1 to 10) | INT | • | | | |

9.1.3.2.12.4 Function model 254 - Bus controller

In function model "254 - Bus controller", the module behaves as it does in "Function model 0 - Standard" with the exception that it is not synchronized to the X2X Link network even if synchronous mode is enabled in register "ConfigOutput01" on page 283. Instead, the module behaves as if the set A/D converter cycle time is not a factor or multiple of the X2X cycle time and attempts to maintain the set A/D converter cycle time as precisely as possible.

| Register | Name | Data type | Read | | Write | |
|----------|---------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | StatusInput01 | USINT | • | | | |
| 4 | AnalogInput01 | DINT | • | | | |
| 16 | ConfigOutput01 | USINT | | | • | |
| 18 | ConfigCycleTime01 | UINT | | | | • |
| 32 | AdcClkFreqShift01 ¹⁾ | USINT | | | | • |

1) Firmware version 8 / Upgrade 1.2.0.0 or later

9.1.3.2.12.5 Registers for function models "0 - Standard" and "254 - Bus controller"

Module status

Name:

StatusInput01

The current state of the module is indicated in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------------|-------|---|
| 0 | A/D converter value | 0 | Valid A/D converter value |
| | | 1 | Invalid A/D converter value (analog value = 0xFF800000). Possible causes: <ul style="list-style-type: none"> Strain gauge supply error I/O power supply error A/D converter not (yet) configured |
| 1 | Line monitoring | 0 | Ok |
| | | 1 | Open circuit |
| 2 | Only valid in synchronous mode | 0 | A/D converter runs synchronous to X2X Link |
| | | 1 | A/D converter does not run synchronous to X2X Link |
| 3 - 7 | Reserved | - | |

Strain gauge value

Name:

AnalogInput01

This register contains the raw value determined by the A/D converter for the full-bridge strain gauge with 24-bit resolution.

| Data type | Values | Information |
|-----------|-------------------------|--|
| DINT | -8,388,608 | Negative invalid value |
| | -8,388,607 | Negative full-scale deflection / Underflow |
| | -8,388,606 to 8,388,606 | Valid range |
| | 8,388,607 | Positive full-scale deflection / Overflow / Open circuit |

Effective resolution

In principle, the effective resolution of the A/D converter is dependent on the data rate and measurement range (see "Effective resolution of the A/D converter" on page 277).

The following table shows how the effective resolution (in bits), or the RMS value range of the strain gauge value depend on the module configuration (data rate, measurement area).

| Data rate f_{DATA} [Hz] | Measurement range | | | | | | | |
|------------------------------|-------------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|
| | ± 16 mV/V | | ± 8 mV/V | | ± 4 mV/V | | ± 2 mV/V | |
| | Bits | Range of values | Bits | Range of values | Bits | Range of values | Bits | Range of values |
| 2.5 | 21.3 | $\pm 1,290,000$ | 20.8 | $\pm 912,000$ | 19.7 | $\pm 425,000$ | 18.7 | $\pm 212,000$ |
| 5 | 20.7 | $\pm 851,000$ | 20.3 | $\pm 645,000$ | 19.3 | $\pm 322,000$ | 18.3 | $\pm 161,000$ |
| 10 | 20.4 | $\pm 691,000$ | 19.9 | $\pm 490,000$ | 18.9 | $\pm 244,000$ | 17.9 | $\pm 122,000$ |
| 15 | 20.1 | $\pm 562,000$ | 19.3 | $\pm 320,000$ | 18.7 | $\pm 212,000$ | 17.7 | $\pm 106,000$ |
| 25 | 19.7 | $\pm 425,000$ | 19.2 | $\pm 301,000$ | 18.5 | $\pm 185,000$ | 17.5 | $\pm 92,000$ |
| 30 | 19.6 | $\pm 397,000$ | 19.0 | $\pm 262,000$ | 18.1 | $\pm 140,000$ | 17.1 | $\pm 72,000$ |
| 50 | 19.4 | $\pm 346,000$ | 18.8 | $\pm 230,000$ | 17.9 | $\pm 122,000$ | 16.9 | $\pm 61,000$ |
| 60 | 19.3 | $\pm 320,000$ | 18.8 | $\pm 230,000$ | 17.8 | $\pm 114,000$ | 16.8 | $\pm 57,000$ |
| 100 | 19.1 | $\pm 280,000$ | 18.5 | $\pm 185,000$ | 17.4 | $\pm 86,000$ | 16.4 | $\pm 43,000$ |
| 500 | 18.0 | $\pm 130,000$ | 17.3 | $\pm 80,000$ | 16.3 | $\pm 40,000$ | 15.3 | $\pm 20,000$ |
| 1000 | 17.2 | $\pm 75,000$ | 16.5 | $\pm 46,000$ | 15.6 | $\pm 25,000$ | 14.6 | $\pm 12,000$ |
| 2000 | 16.6 | $\pm 49,600$ | 16.1 | $\pm 35,000$ | 15.3 | $\pm 20,000$ | 14.3 | $\pm 10,000$ |
| 3750 | 16.2 | $\pm 37,600$ | 15.7 | $\pm 26,600$ | 14.7 | $\pm 13,000$ | 13.7 | $\pm 6,600$ |
| 7500 | 15.8 | $\pm 28,500$ | 15.3 | $\pm 20,200$ | 14.4 | $\pm 10,800$ | 13.4 | $\pm 5,400$ |

Table 38: Effective resolution of the strain gauge value in bits for the measurement range 2 to 16 mV/V

| Data rate f_{DATA} [Hz] | Measurement range | | | | | | | |
|------------------------------|-------------------|-----------------|----------------|-----------------|---------------|-----------------|---------------|-----------------|
| | ± 256 mV/V | | ± 128 mV/V | | ± 64 mV/V | | ± 32 mV/V | |
| | Bits | Range of values | Bits | Range of values | Bits | Range of values | Bits | Range of values |
| 2.5 | 23 | $\pm 4,194,000$ | 22.6 | $\pm 3,179,000$ | 22.1 | $\pm 2,248,000$ | 21.7 | $\pm 1,703,000$ |
| 5 | 22.3 | $\pm 2,582,000$ | 22.4 | $\pm 2,767,000$ | 21.9 | $\pm 1,957,000$ | 21.3 | $\pm 1,291,000$ |
| 10 | 22.3 | $\pm 2,582,000$ | 22 | $\pm 2,097,000$ | 21.6 | $\pm 1,589,000$ | 21 | $\pm 1,049,000$ |
| 15 | 22 | $\pm 2,097,000$ | 21.7 | $\pm 1,703,000$ | 21.3 | $\pm 1,291,000$ | 20.7 | $\pm 852,000$ |
| 25 | 21.7 | $\pm 1,703,000$ | 21.4 | $\pm 1,384,000$ | 21.1 | $\pm 1,124,000$ | 20.5 | $\pm 741,000$ |
| 30 | 21.8 | $\pm 1,826,000$ | 21.3 | $\pm 1,291,000$ | 20.8 | $\pm 913,000$ | 20.4 | $\pm 692,000$ |
| 50 | 21.3 | $\pm 1,291,000$ | 21.1 | $\pm 1,124,000$ | 20.4 | $\pm 692,000$ | 19.9 | $\pm 489,000$ |
| 60 | 21.3 | $\pm 1,291,000$ | 20.9 | $\pm 978,000$ | 20.5 | $\pm 741,000$ | 19.8 | $\pm 456,000$ |
| 100 | 20.9 | $\pm 978,000$ | 20.7 | $\pm 852,000$ | 20.2 | $\pm 602,000$ | 19.6 | $\pm 397,000$ |
| 500 | 20.1 | $\pm 562,000$ | 19.6 | $\pm 397,000$ | 19.1 | $\pm 281,000$ | 18.6 | $\pm 199,000$ |
| 1000 | 19 | $\pm 262,000$ | 18.6 | $\pm 199,000$ | 18.1 | $\pm 140,000$ | 17.5 | $\pm 93,000$ |
| 2000 | 18.5 | $\pm 185,000$ | 18.1 | $\pm 140,000$ | 17.8 | $\pm 114,000$ | 17 | $\pm 66,000$ |
| 3750 | 18.1 | $\pm 140,000$ | 17.8 | $\pm 114,000$ | 17.3 | $\pm 81,000$ | 16.6 | $\pm 50,000$ |
| 7500 | 17.7 | $\pm 106,000$ | 17.3 | $\pm 81,000$ | 16.9 | $\pm 61,000$ | 16.2 | $\pm 38,000$ |

Table 39: Effective resolution of the strain gauge value in bits for the measurement range 32 to 256 mV/V

A/D converter configuration

Name:

ConfigOutput01

The data rate and measurement range of the A/D converter can be configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|--------------------------------|
| 0 - 3 | Data rate f_{DATA} (samples per second): | 0000 | 2.5 |
| | | 0001 | 5 |
| | | 0010 | 10 |
| | | 0011 | 15 |
| | | 0100 | 25 |
| | | 0101 | 30 |
| | | 0110 | 50 |
| | | 0111 | 60 |
| | | 1000 | 100 |
| | | 1001 | 500 |
| | | 1010 | 1000 |
| | | 1011 | 2000 |
| | | 1100 | 3750 |
| | | 1101 | 7500 |
| | | 1110 | Synchronous mode ¹⁾ |
| | | 1111 | Reserved |
| 4 - 6 | Standard measurement range (bit 6 = 0) | 000 | 16 mV/V |
| | | 001 | 8 mV/V |
| | | 010 | 4 mV/V |
| | | 011 | 2 mV/V |
| | Extended measurement range (bit 6 = 1) ²⁾ | 100 | 256 mV/V |
| | | 101 | 128 mV/V |
| | | 110 | 64 mV/V |
| | | 111 | 32 mV/V |
| 7 | Reserved | 0 | (must be 0) |

1) A/D converter is operated synchronously with X2X Link if possible - firmware version 2 or higher.

2) Firmware version 4 or higher

Synchronous mode

Beginning with firmware version 2, the analog/digital converter (A/D converter) of the module can be operated and read synchronously to X2X Link. Synchronous mode is enabled by selecting the respective operating mode in register "ConfigOutput01" on page 283. A time between 200 and 2000 μ s must also be set in register "ConfigCycletime01" on page 284. If this time is a whole number factor or multiple of the configured cycle time of X2X Link, then the A/D converter is read synchronously to X2X Link.

Information:

The A/D converter cycle time must be $\geq 1/4$ of the X2X cycle time!

Bit 2 in *Module status* is set (i.e. A/D converter not running synchronously)...

- ... If the configured A/D converter cycle time cannot be synchronized with X2X Link.
- ... If the module is still in the settling phase.

Jitter, dead time and settling time:

| | | |
|---|--|---|
| Jitter | | |
| A/D converter cycle times <1500 μ s | | Max. $\pm 1 \mu$ s |
| A/D converter cycle times >1500 μ s | | Max. $\pm 4 \mu$ s |
| X2X link dead time | | 50μ s + $\frac{X2X \text{ cycle time}}{128}$ |
| Settling time | | |
| Firmware version ≤ 4 | | Max. 150 x A/D converter cycle time |
| Firmware version ≥ 5 | | 150 x X2X cycle time |

The settling time corresponds to the time needed until the A/D converter can be operated after enabling synchronous mode or following conversion of the A/D converter cycle time.

A/D converter cycle time

Name:

ConfigCycletime01

This register is only used in [Synchronous mode](#). If synchronous mode is enabled in the A/D converter configuration, then the module attempts to operate the A/D converter as synchronously as possible to X2X Link (based on the A/D converter cycle time set in this register). It is of course necessary for the X2X Link cycle time and the A/D converter cycle time to have a certain ratio. The following conditions must be observed:

- 1) A/D converter cycle time $\geq 1/4$ X2X cycle time
- 2) A/D converter cycle time corresponds to a whole number factor or multiple of the X2X cycle time
- 3) A/D converter cycle time must be in the range 50 to 2000 μs

| Data type | Value |
|-----------|------------|
| UINT | 50 to 2000 |

A/D converter clock frequency shift

Name:

AdcClkFreqShift01

In rare cases, strain gauge modules connected to neighboring slots can influence one another. This can result in temporary, minimal deviations in measured values. This can only occur if the sigma-delta A/D converters on the neighboring strain gauge modules are operated at exactly the same clock frequency.

In most cases, these clock frequencies vary slightly due to part variances. When they are the same however, this register on the strain gauge module provides a safe way for an application to prevent this type of mutual influence.

| Data type | Value |
|-----------|-------------|
| SINT | -128 to 127 |

This register can be used to vary the clock frequency in increments of 200 ppm. Setting values from -50 to 50 cover a range of -10000 ppm to 10000 ppm. This corresponds with -1% to 1%.

Values beyond this range will cause activation of a default mode. The frequency shift is derived from the last 2 digits of the serial number by the module firmware. This saves time that would otherwise be needed for programming, provided that the last two digits of the serial numbers on the neighboring modules are not the same

| Register value | Frequency shift in ppm | Example of a sampling rate ¹⁾ |
|----------------|--|--|
| 127 | $((\text{SerialNo. modulo } 100) - 50) * (-200) \text{ ppm}$ | Based on the serial number |
| ... | ... | ... |
| 51 | $((\text{SerialNo. modulo } 100) - 50) * (-200) \text{ ppm}$ | Based on the serial number |
| 50 | 10000 | 505 |
| 49 | 9800 | 504.9 |
| ... | ... | ... |
| 2 | 400 | 500.2 |
| 1 | 200 | 500.1 |
| 0 | 0 | 500 |
| -1 | -200 | 499.9 |
| -2 | -400 | 499.8 |
| ... | ... | ... |
| -50 | -10000 | 495 |
| -51 | $((\text{SerialNo. modulo } 100) - 50) * (-200) \text{ ppm}$ | Based on the serial number |
| ... | ... | ... |
| -128 | $((\text{SerialNo. modulo } 100) - 50) * (-200) \text{ ppm}$ | Based on the serial number |

1) Nominal sampling rate of 500 samples per second

Important:

As shown in the table above, shifting the A/D converter clock frequency will equally shift the A/D converter sampling rate. Shifting the A/D converter clock frequency too much can cause problems with disturbance suppression particularly when a very specific sampling rate has been defined to suppress existing disturbances (e.g. 50 Hz to suppress the 50 Hz hum). See also "[Filter characteristics of the sigma-delta A/D converter](#)" on page 276.

It's situations like this where the option to manually shift the frequency in the I/O configuration or ASIOACC library should be utilized rather than relying on the default frequency shift that is based on the serial number.

A frequency shift like the one shown below would be sufficient to prevent modules from influencing one another and would not cause any noticeable difference to the filter characteristics.

| Slot | 1 | 2 | 3 | 4 | 5 | 6 | ... |
|-------------------------------------|---|---|----|---|----|---|-----|
| A/D converter clock frequency shift | 0 | 2 | -1 | 1 | -2 | 0 | ... |

Information:

- This register has no effect in synchronous mode because the firmware regulates the A/D converter clock frequency in such a way that the A/D converter cycle is synchronous with the X2X cycle.
- When writing to this register using the ASIOACC library, only the lowest value byte of the written value is accepted. For example, the value 256 (=0x100) is identical to the value 0 (=0x00).

9.1.3.2.12.6 Register for "Function model 1 - Multisampling"**Module status**

Name:
StatusInput01

This register contains the current state of the module.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------------|-------|--|
| 0 | A/D converter values | 0 | Valid A/D converter value |
| | | 1 | Invalid A/D converter value |
| 1 | Line monitoring | 0 | OK |
| | | 1 | Open circuit An open circuit was found during at least one measurement in this X2X cycle. This bit is reset if all measurements are OK after correcting this error, i.e. it does not have to be acknowledged. |
| 2 | Synchronous mode | 0 | A/D converter runs synchronous to X2X Link |
| | | 1 | A/D converter does not run synchronous to X2X Link |
| 3 - 7 | Reserved | - | |

Strain gauge value - Multiple

Name:
AnalogInput01 to AnalogInput10

This register contains the raw value determined by the A/D converter for the full-bridge strain gauge with 16-bit resolution. The module returns between 3 and 10 measured values per X2X cycle depending on the configuration.

Effective resolution

In principle, the effective resolution of the A/D converter is dependent on the data rate and measurement range (see).

The following table shows how the effective resolution (in bits), or the RMS value range of the strain gauge value depend on the module configuration (data rate, measurement area).

| Measurement range | | | | | | | |
|-------------------|-----------------|---------|-----------------|---------|-----------------|---------|-----------------|
| ±16 mV/V | | ±8 mV/V | | ±4 mV/V | | ±2 mV/V | |
| Bits | Range of values | Bits | Range of values | Bits | Range of values | Bits | Range of values |
| 15.4 | 22,000 | 14.6 | 12,000 | 13.8 | 7,000 | 12.8 | 4,000 |

Table 40: Effective resolution of the strain gauge value in bits for the measurement range 2 to 16 mV/V

| Measurement range | | | | | | | |
|-------------------|-----------------|-----------|-----------------|----------|-----------------|----------|-----------------|
| ±256 mV/V | | ±128 mV/V | | ±64 mV/V | | ±32 mV/V | |
| Bits | Range of values | Bits | Range of values | Bits | Range of values | Bits | Range of values |
| 17.1 | 70,000 | 16.7 | 53,000 | 16.4 | 43,000 | 15.9 | 31,000 |

Table 41: Effective resolution of the strain gauge value in bits for the measurement range 32 to 256 mV/V

A/D converter configuration

Name:

ConfigGain01_MultiSample

The measurement range for the A/D converter can be configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|-------------|
| 0 - 2 | Standard measurement range (bit 2 = 0) | 000 | 16 mV/V |
| | | 001 | 8 mV/V |
| | | 010 | 4 mV/V |
| | | 011 | 2 mV/V |
| | Extended measurement range (bit 2 = 1) ¹⁾ | 100 | 256 mV/V |
| | | 101 | 128 mV/V |
| | | 110 | 64 mV/V |
| 3 - 7 | Reserved | 111 | 32 mV/V |
| | | 0 | (must be 0) |

1) Firmware V4 and later. In the standard measurement range (2 to 16 mV/V), open-circuit detection works reliably at all adjustable data rates. In the extended measurement range (32 to 256 mV/V), open circuit detection does not work reliably (because of the variable input impedance of the amplifier in relation to the set data rate).

A/D converter cycle time

Name:

ConfigCycletime01_MultiSample

The A/D converter cycle time can be configured in this register.

In order for multiple sampling to work, the X2X cycle time must be divisible by the A/D converter cycle time (i.e. result in a whole number).

| Data type | Value | Information |
|-----------|----------|-----------------|
| USINT | 0 | 50 µs (default) |
| | 1 | 100 µs |
| | 2 to 255 | Reserved |

Number of measured values

If the X2X cycle time is too short, then not all 10 measurements can be performed. To reduce the load on X2X Link, it makes sense to only transfer as many values as measurements that can be made. This is why it is possible to configure the number of measured values to be transferred (see "Function model 1 - Multisampling" on page 280).

Example: A/D converter cycle time = 50 µs

| X2X cycle time | Number of measured values to be transferred |
|----------------|---|
| 250 µs | 5 |
| 300 µs | 6 |
| 350 µs | 7 |
| 400 µs | 8 |
| 450 µs | 9 |
| ≥500 µs | 10 |

Example: A/D converter cycle time = 100 µs

| X2X cycle time | Number of measured values to be transferred |
|----------------|---|
| 300 µs | 3 |
| 400 µs | 4 |
| 500 µs | 5 |
| 600 µs | 6 |
| 700 µs | 7 |
| 800 µs | 8 |
| 900 µs | 9 |
| ≥1 ms | 10 |

9.1.3.2.12.7 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 250 μ s |

9.1.3.2.12.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

There is no limitation or basic dependency on the bus cycle time. In function model "0 - Standard", the I/O update time is defined using registers "[ConfigOutput01](#)" on page 283 and "[ConfigCycletime01](#)" on page 284.

Depending on the setting in register "[ConfigCycletime01_MultiSample](#)" on page 287, the I/O update time in function model "1 - Multiple sampling" is 50 or 100 μ s.

9.1.4 X20AI1744-10

Data sheet version: 1.01

9.1.4.1 General information

This module works with both 4-wire and 6-wire strain gauge load cells. The concept applied by the module requires compensation in the measurement system. This compensation eliminates the absolute uncertainty in the measurement circuit, such as component tolerances, effective bridge voltage or zero point offset. The measurement precision refers to the absolute (compensated) value, which will only change as a result of changes in the operating temperature.

- 1 full-bridge strain gauge input
- Bridge voltage 10 VDC
- Data output rate configurable from 0.1 Hz to 7.5 kHz
- Special operating modes (synchronous mode and multisampling)
- Configurable filter level

9.1.4.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Analog inputs |  |
| X20AI1744-10 | X20 analog input module, 1 full-bridge strain input 10 V, 24-bit converter resolution, 5 kHz input filter | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 42: X20AI1744-10 - Order data

9.1.4.3 Technical data

| Model number | X20AI1744-10 |
|--|--|
| Short description | |
| I/O module | 1 full-bridge strain gauge input |
| General information | |
| B&R ID code | 0xF1A7 |
| Status indicators | Channel status, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| Open circuit | Yes, using LED status indicator and software |
| Input | Yes, using LED status indicator and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 0.65 W |
| Additional power dissipation caused by actuators (resistive) [W] | Max. +0.68 ¹⁾ |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| Full-bridge strain gauge | |
| Strain gauge factor | 2 to 256 mV/V, configurable using software |
| Connection | 4- or 6-wire connections ²⁾ |
| Input type | Differential, used to evaluate a full-bridge strain gauge |
| Digital converter resolution | 24-bit |

Table 43: X20AI1744-10 - Technical data

| Model number | X20AI1744-10 |
|---|---|
| Conversion time | Depends on the configured data output rate |
| Data output rate | 0.1 - 7500 samples per second, configurable using software (f_{DATA}) |
| Input filter | |
| Cutoff frequency | 5 kHz |
| Order | 3 |
| Slope | 60 dB |
| ADC filter characteristics | Sigma-delta, see section "Filter characteristics of the sigma-delta A/D converter" |
| Operating range / Measurement sensor | 162 to 5000 Ω |
| Influence of cable length ³⁾ | See section "Calculation example". |
| Input protection | RC protection |
| Common-mode range | 0 to 3 VDC Permissible input voltage range (with regard to the potential strain gauge GND) on inputs "Input +" and "Input -" |
| Isolation voltage between input and bus | 500 V _{eff} |
| Conversion procedure | Sigma-delta |
| Output of digital value | |
| Broken bridge supply line | Value approaching 0 |
| Broken sensor line | Value approaching \pm end value (status bit "Line status monitoring" is set in register "Module status") |
| Valid range of values | 0xFF800001 to 0x007FFFFF (-8,388,607 to 8,388,607) |
| Strain gauge supply | |
| Voltage | 10.5 VDC / Max. 65 mA ⁴⁾ |
| Short-circuit and overload resistant | Yes |
| Voltage drop for short-circuit protection | Max. 0.2 VDC at 65 mA and 25°C |
| Quantization ⁵⁾ | |
| LSB value (16-bit) | |
| 2 mV/V | 641 nV |
| 4 mV/V | 1.28 μ V |
| 8 mV/V | 2.56 μ V |
| 16 mV/V | 5.13 μ V |
| 32 mV/V | 10.25 μ V |
| 64 mV/V | 20.51 μ V |
| 128 mV/V | 41.02 μ V |
| 256 mV/V | 82.03 μ V |
| LSB value (24-bit) | |
| 2 mV/V | 2.50 nV |
| 4 mV/V | 5.01 nV |
| 8 mV/V | 10.01 nV |
| 16 mV/V | 20.03 nV |
| 32 mV/V | 40.05 nV |
| 64 mV/V | 80.11 nV |
| 128 mV/V | 160.22 nV |
| 256 mV/V | 320.43 nV |
| Temperature coefficient | |
| Rev. \geq E0 | 10 ppm/°C |
| Rev. <E0 | 30 ppm/°C |
| Electrical properties | |
| Electrical isolation | Bus isolated from analog input and strain gauge supply voltage Channel not isolated from I/O power supply |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Hardware configuration" |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |

Table 43: X20AI1744-10 - Technical data


| Model number | X20AI1744-10 |
|-----------------------|--|
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x bus module X20BM11 separately. |
| Pitch | 12.5 ^{+0.2} mm |

Table 43: X20AI1744-10 - Technical data

- 1) Depends on the full-bridge strain gauge being used.
- 2) With 6-wire connections, line compensation does not function (see section "Connection examples").
- 3) Sensor cable with twisted and shielded conductors, cable length as short as possible, cable routing separate from load circuits, without intermediate terminal to the sensor.
- 4) The maximum current of 90 mA is permitted up to an operating temperature of 45°C.
- 5) Quantization depends on the strain gauge factor.

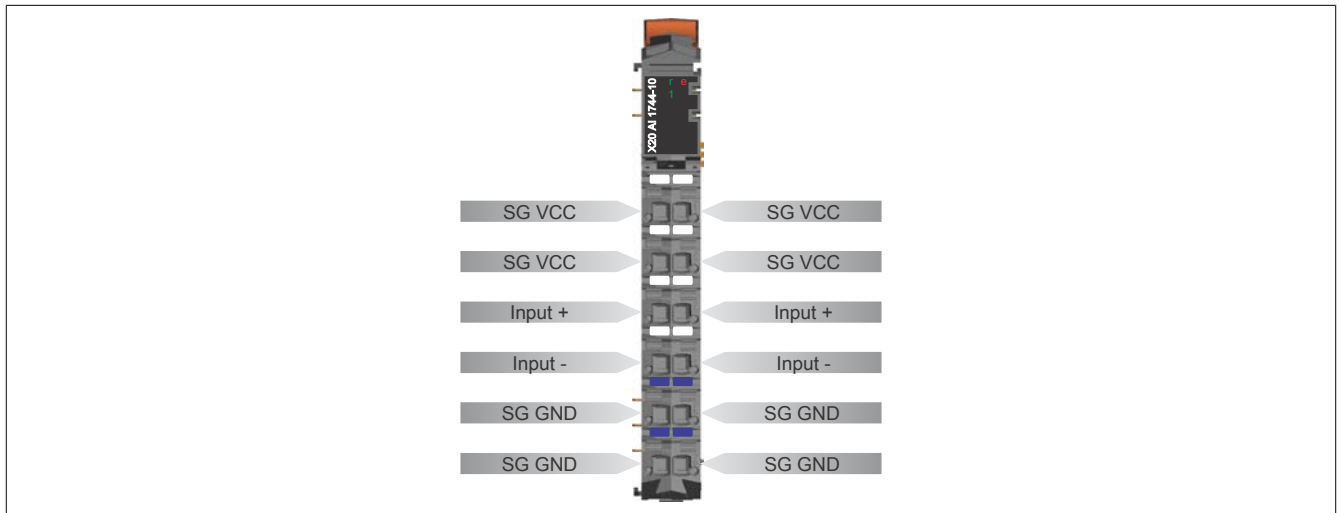
9.1.4.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|--|-----|-------|--------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | Mode RESET |
| | | | Double flash | Mode BOOT (during firmware update) ¹⁾ |
| | | | Blinking | Mode PREOPERATIONAL |
| | e | Red | On | Mode RUN |
| | | | Off | No power to module or everything OK |
| | 1 | Green | On | Error or reset state |
| | | | Off | Possible causes: <ul style="list-style-type: none"> • Open circuit • Sensor is disconnected • Converter is busy |
| | | | On | Analog/digital converter running, value OK |

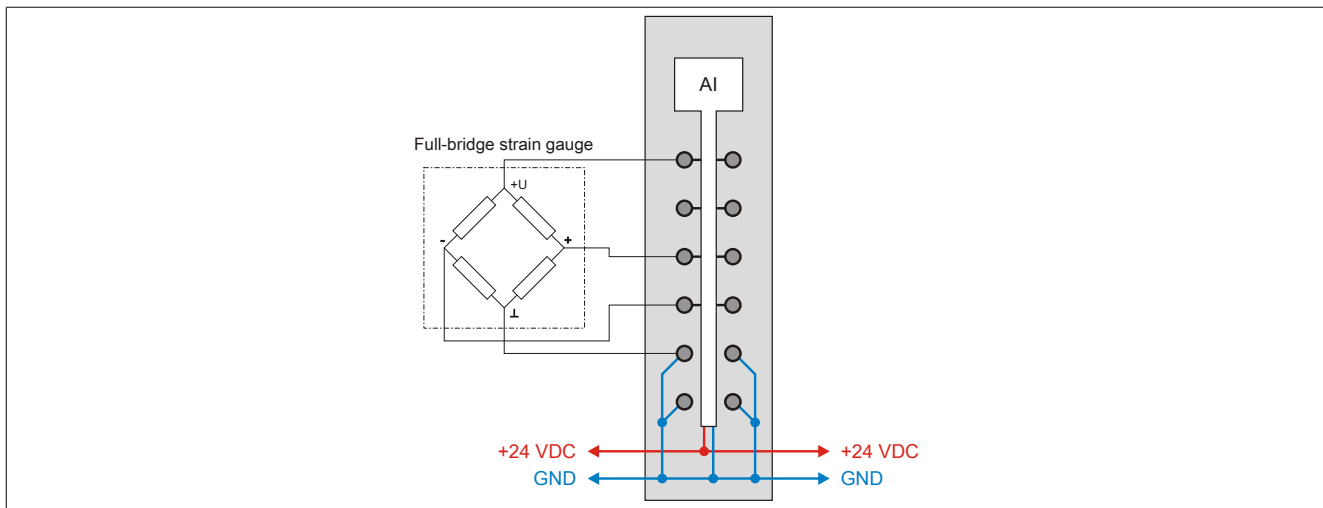
- 1) Depending on the configuration, a firmware update can take up to several minutes.

9.1.4.5 Pinout



9.1.4.6 Connection examples

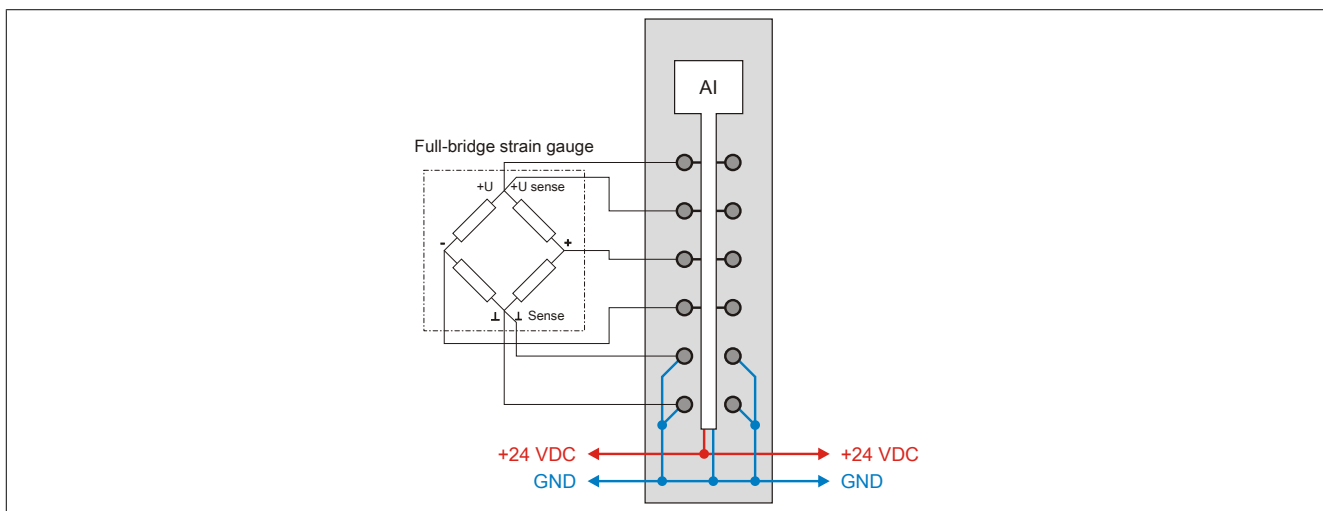
Full-bridge strain gauge with 4-wire connections



Full-bridge strain gauge with 6-wire connections

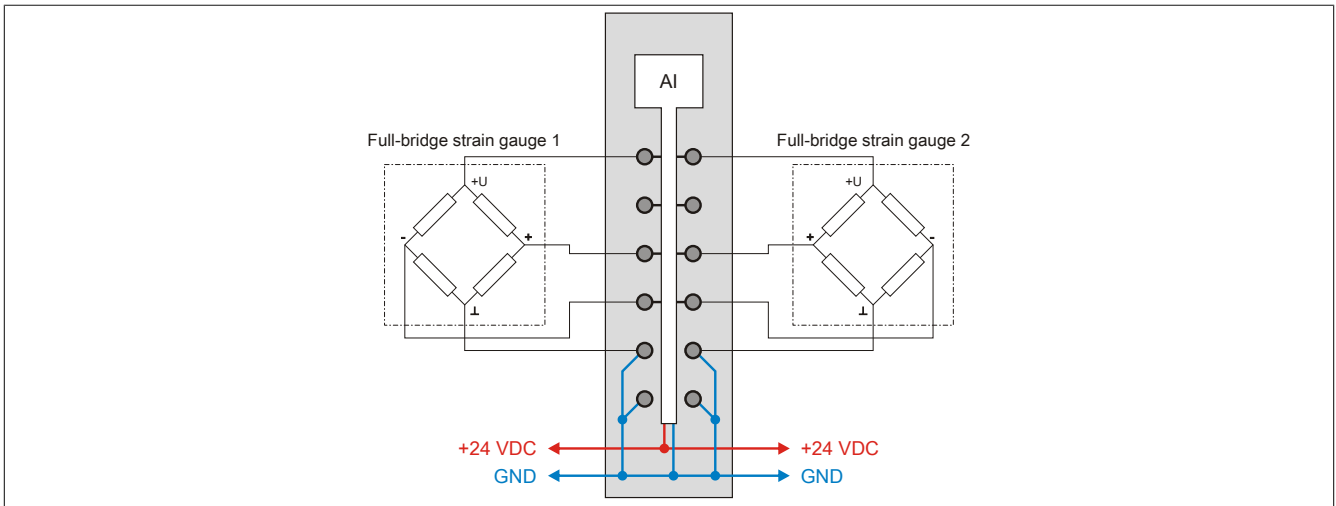
Full-bridge strain gauges can be connected to this module with 6-wire connections. Line compensation is not supported by the module, however. The sense lines are short circuited by the internally connected strain gauge VCC and GND connections (see "Input circuit diagram" on page 293). The measurement precision is therefore affected by changes in operating temperature. Longer cable lengths and smaller cable cross sections also increase the potential for errors in the measurement system.

In order to reduce cable resistance, the sense lines should be connected in parallel with the strain gauge supply lines. Optimal signal quality can be obtained by using a shielded twisted pair cable. The connections for the strain gauge supply lines, the sensor lines and the bridge differential voltage lines should each use one twisted pair cable.



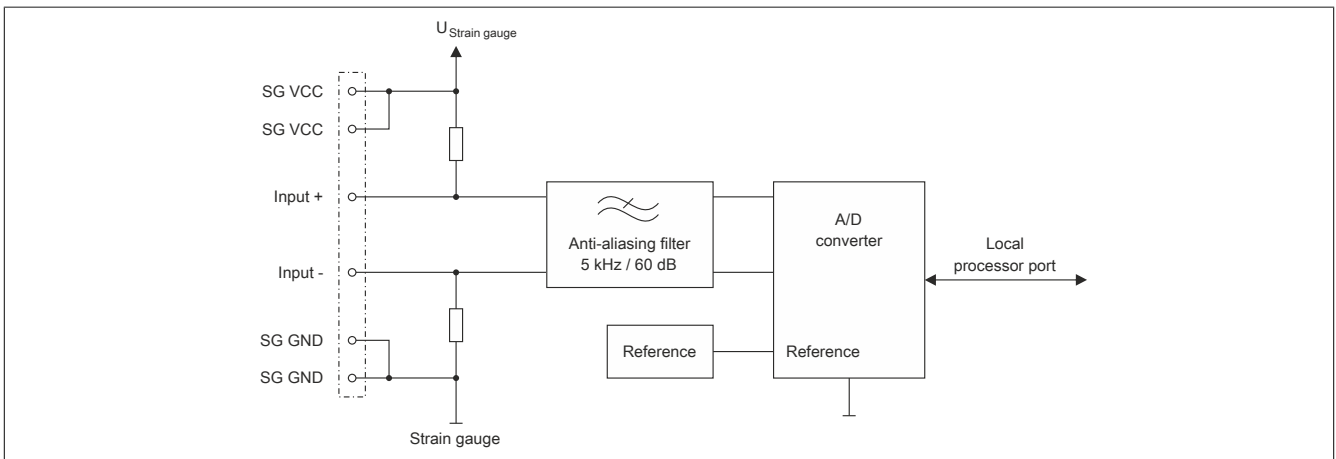
Parallel connection of 2 full-bridge strain gauges (4-wire connections)

If connecting the full-bridge strain gauges in parallel, the manufacturer's guidelines must be observed.



When connecting 3 or more full-bridge strain gauges in parallel, 2 lines must be connected together in an X20 terminal block.

9.1.4.7 Input circuit diagram

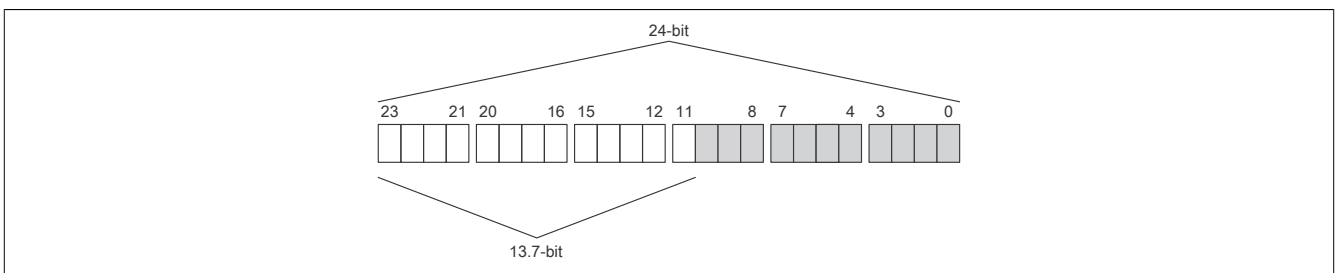


9.1.4.8 Effective resolution of the A/D converter

The A/D converter on the module provides a 24-bit measured value. The actual attainable noise-free resolution is always less than 24-bit, however. This "effective resolution" depends on the data rate and measurement range.

Example:

Based on the conversion method, a data rate of 2.5 Hz and a specified measurement range of 2 mV/V result in an effective resolution of 13.7 bits:



The low-order bits (grayed out) contain only noise instead of valid values and are therefore not permitted to be evaluated.

With "Function model 1 - Multisampling", only the highest 16 bits are made available.

9.1.4.9 Calculation example

The following example shows the influence of the length of the measuring cable on the bridge voltage of the module and the quantization calculated with it.

9.1.4.9.1 Bridge voltage

Although the measuring bridge must be adjusted with the module, the cable length has an influence on the accuracy of the measurement. The reason for this is the voltage drop on the power supply lines of the measuring bridge. As a result, the strain gauge supply voltage at the measuring bridge no longer amounts to the full 10.5 V. The reduced bridge voltage also has an effect on the quantization.

Example

Characteristics of the measuring device used:

- Full-bridge strain gauge with 4-wire connections
- Material-dependent conductivity of the cable (copper: $12 \frac{\text{m}}{\Omega \cdot \text{mm}^2}$)
- Cross section of the cable: 22 AWG = 0.34 mm²
- Length of the cable: 5 m
- Nominal current of the measuring bridge: 15 mA
- Bridge voltage of the module: 10.5 V

Actual bridge voltage taking the voltage drop on the measuring line into account:

$$10.5 \text{ V} - \frac{2 \cdot 5 \text{ m}}{12 \frac{\text{m}}{\Omega \cdot \text{mm}^2} \cdot 0.34 \text{ mm}^2} \cdot 0.015 \text{ A} = 10.463 \text{ V}$$

The quantization must be calculated using the actual calculated bridge voltage (see ["Quantization" on page 295](#)).

9.1.4.9.2 Quantization

In a weighing application, the corresponding weight located on the connected load cell should be determined from the value derived from the module.

Example

The characteristics of the strain gauge load cell are as follows:

- Rated load: 1000 kg
- Strain gauge factor: 4 mV/V
- Actual bridge voltage: 10.463 V

Maximum quantization:

Multiplying the bridge factor of the strain gauge load cell with the bridge supply voltage from the module results in the value for the positive full-scale deflection at a specified rated load of 1000 kg:

$$4 \text{ mV/V} \cdot 10.5 \text{ V} = 42 \text{ mV}$$

Actual quantization:

Taking the voltage drop on the measuring line into account, the actual bridge voltage is 10.463 V (for the calculation, see section "Bridge voltage" on page 294). If this voltage is multiplied by the strain gauge factor of 4 mV/V, the following actual quantization results:

$$4 \text{ mV/V} \cdot 10.463 \text{ V} = 41.85 \text{ mV}$$

These 41.85 mV correspond to 99.6% of the maximum possible measurement range.

Information:

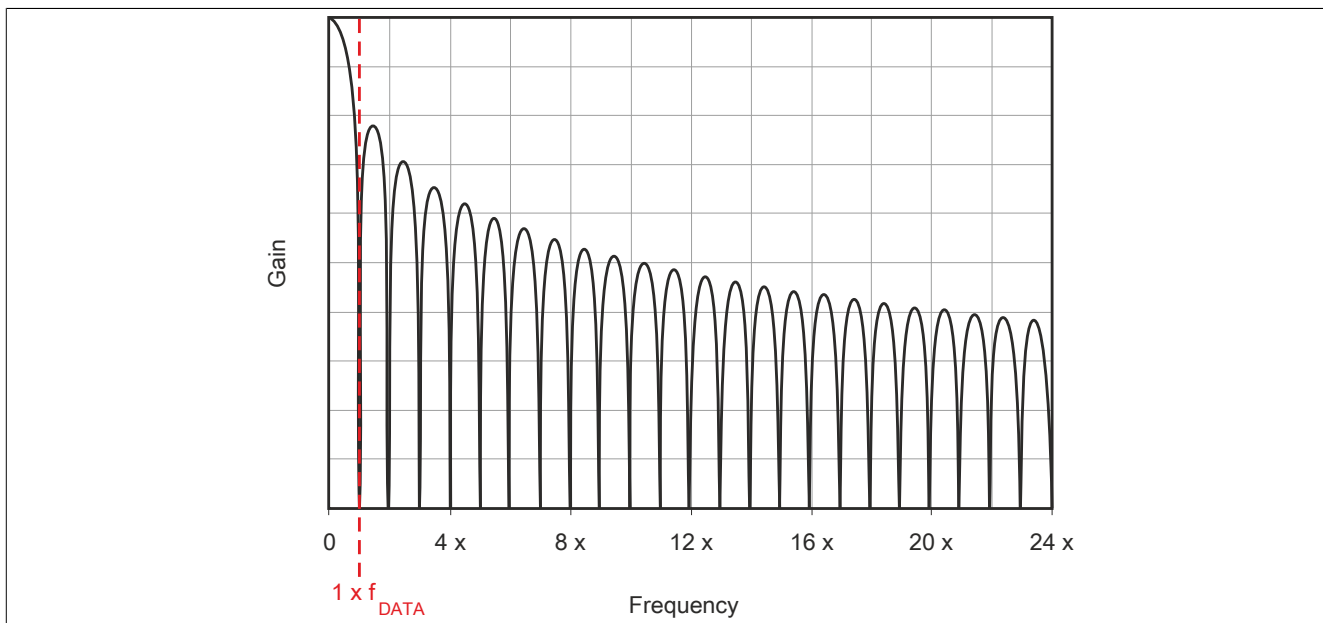
If the quantization decreases, the maximum possible effective resolution also decreases (see "Effective resolution of the A/D converter" on page 293).

With a simple Rule of Three calculation, the corresponding value can be calculated (as seen in the table) from weight to the converter value and vice versa. This simplified theoretical approach is only valid for an ideal measurement system. Calibration of the entire measurement system is recommended because not only the module, but particularly the strain gauge bridges exhibit tolerances (offset, gain). When taring, the gradient offset is recalculated and the gain of the linear equation is determined when normalized. In addition to the calculation displayed in the table, these calculations must also be carried out in the application.

| 24-bit value of the module | | Quantization | Corresponding weight |
|----------------------------|-----------|--------------|----------------------|
| 0x007F FFFF | 8,388,607 | 41.85 mV | 1000 kg |
| 0x0000 0001 | 1 | 4.99 nV | 0.119 g |
| 0x0000 20C3 | 8387 | 41.84 µV | 1 kg |
| 0x0001 0000 | 65536 | 327.0 µV | 7.81 kg |

The values for 1 LSB are also included in the module's technical data under item "Quantization" (1 LSB each for 16 bits and 24 bits).

9.1.4.10 Filter characteristics of the sigma-delta A/D converter

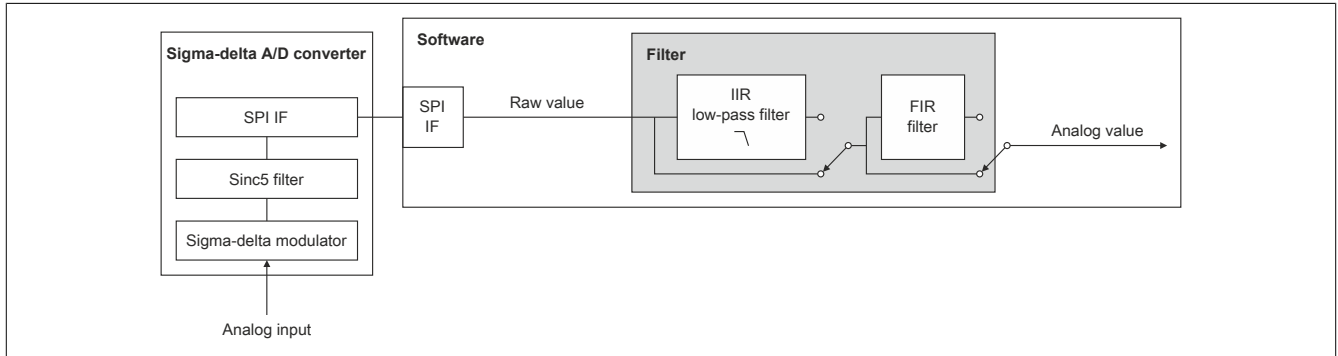


9.1.4.11 Software filters

2 filters are available for the analog input. They can be individually enabled and configured at runtime. By default, both filters are disabled when the device is switched on. The filters are controlled and configured using "Function model 2 - Extended filter".

In order to allow the filter behavior to be adapted to the measuring situation or machine cycle (high dynamics and low precision or low dynamics and high precision), the filter characteristics of both the IIR low-pass filter as well as the FIR filter can be changed synchronously at any time.

Filter diagram



9.1.4.11.1 IIR low-pass filter

9.1.4.11.1.1 General information

The IIR low-pass filter is used to generally smooth and increase the resolution of the analog value. The filter works according to the following formula:

$$y = y_{\text{Old}} + \frac{x - y_{\text{Old}}}{2^{\text{Filter level}}}$$

- x ... Current filter input value
- y_{Old} ... Old filter output value
- y ... New filter output value

Parameter "Filter level" in the formula above is configured using register "ConfigCommonOutput01" on page 315. "Filter level" = 0 if the IIR low-pass filter is disabled.

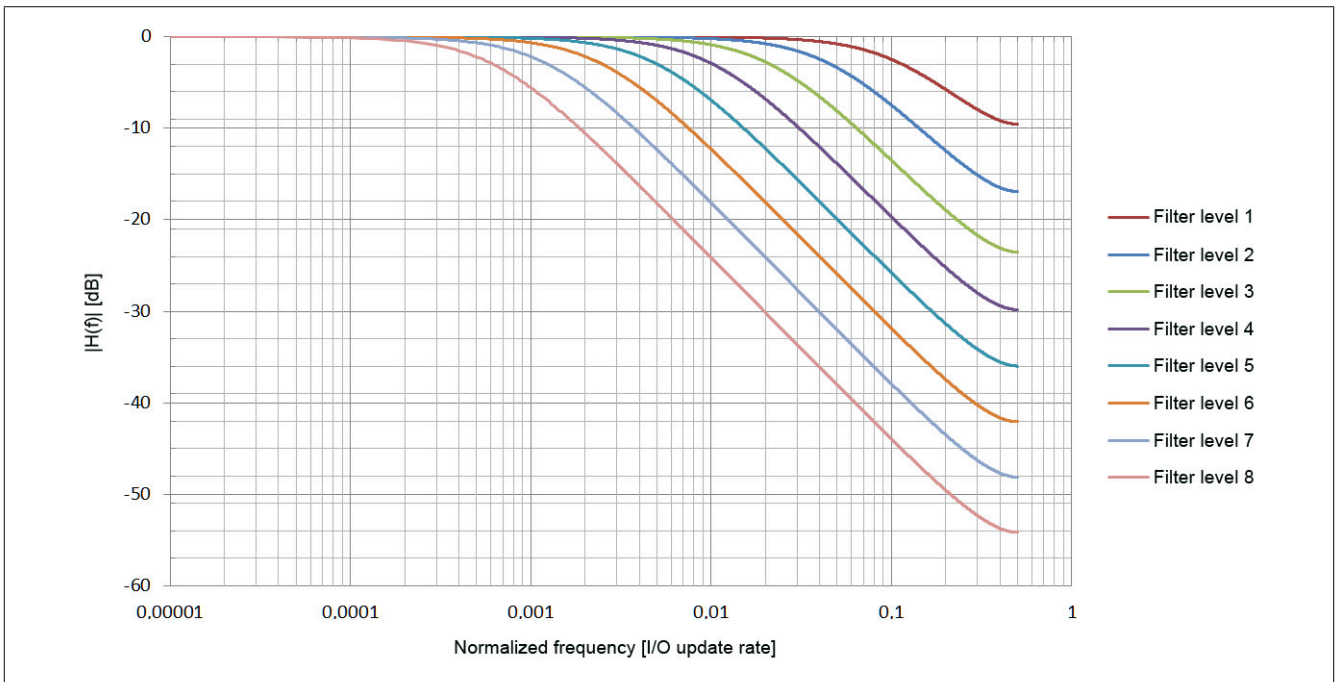
9.1.4.11.1.2 Filter characteristics of the first-order IIR low-pass filter

Limit frequency f_c

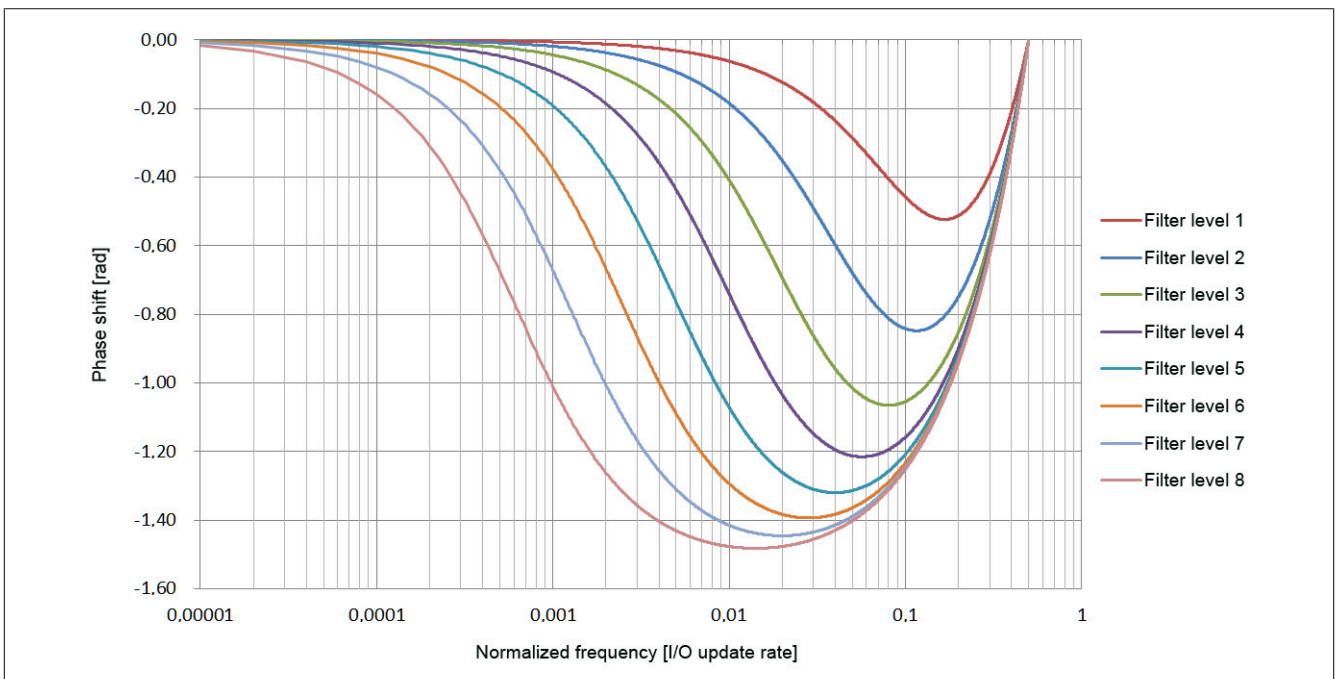
The following table provides an overview of the -3 dB limit frequency f_c depending on the configured filter level.

| Filter level | Normalized f_c [I/O update rate] | f_c [Hz] | |
|--------------|---------------------------------------|---------------------------|---------------------------|
| | | I/O update rate = 15000/s | I/O update rate = 20000/s |
| 1 | 0.11476 | 1721.4 | 2295.2 |
| 2 | 0.046 | 690 | 920 |
| 3 | 0.02124 | 318.6 | 424.8 |
| 4 | 0.01026 | 153.9 | 205.2 |
| 5 | 0.00504 | 75.6 | 100.8 |
| 6 | 0.0025 | 37.5 | 50 |
| 7 | 0.00124 | 18.6 | 24.8 |
| 8 | 0.00062 | 9.3 | 12.4 |

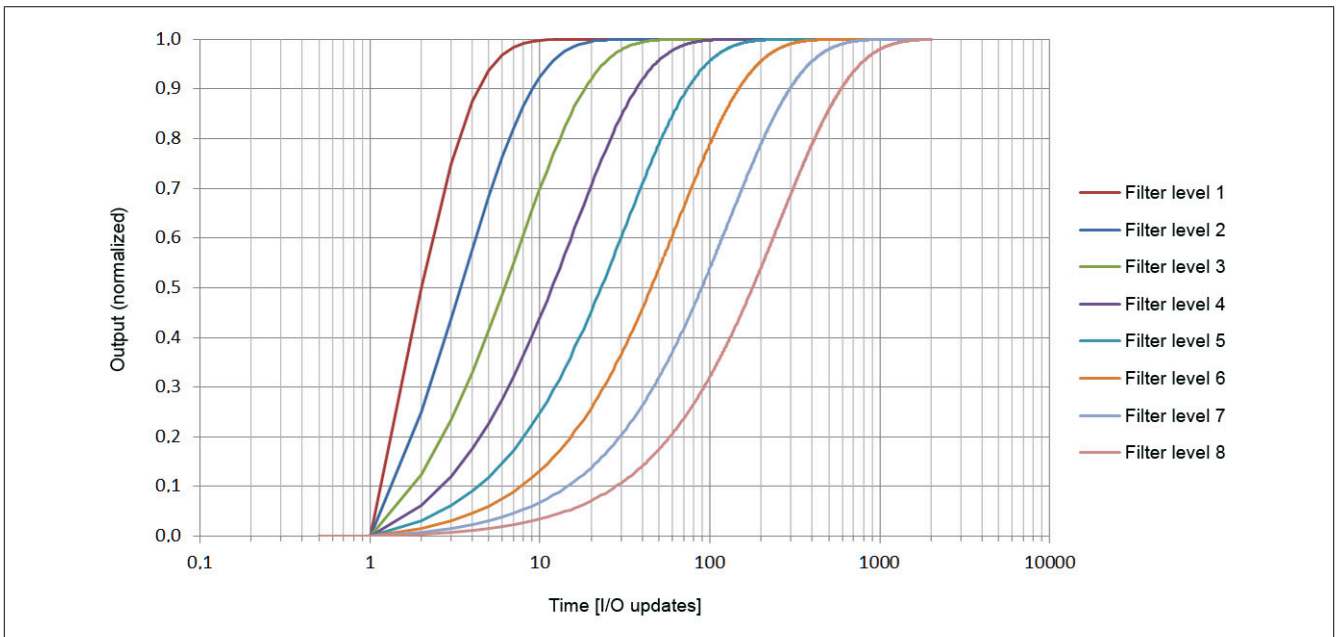
Gain of the IIR low-pass filter



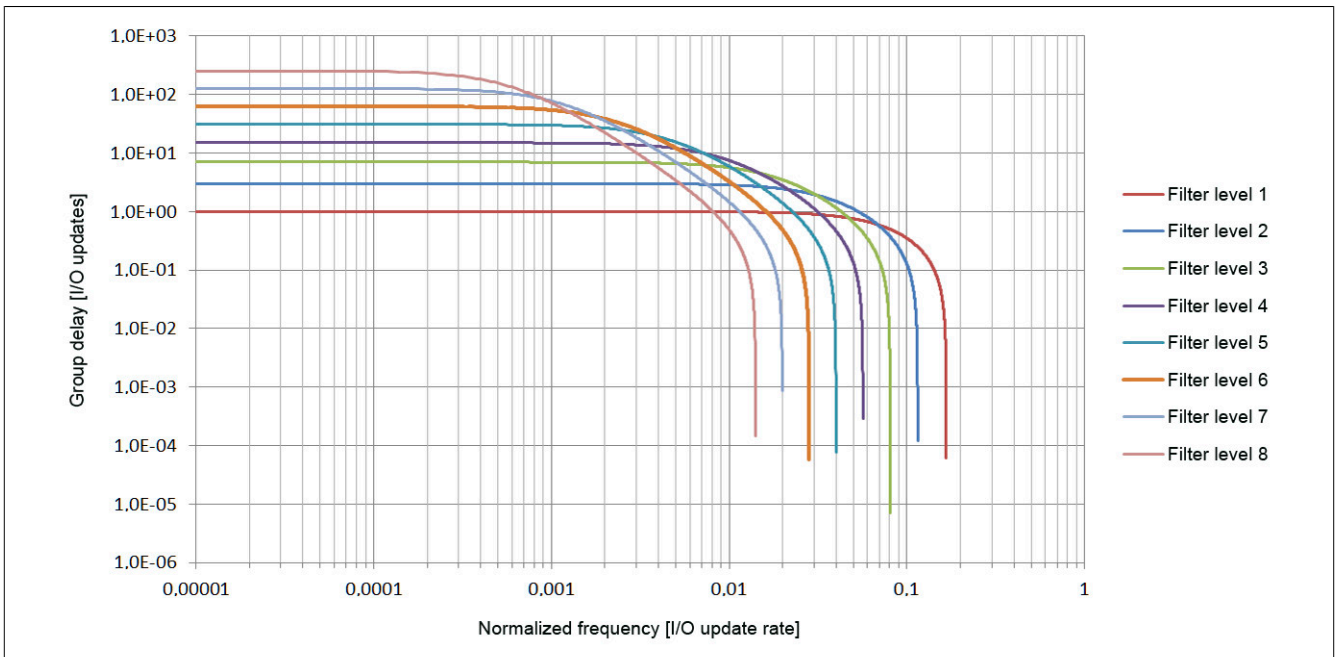
Phase shift of the IIR low-pass filter



Step response of the IIR low-pass filter



Group delay of the IIR low-pass filter



9.1.4.11.2 FIR filter

Like the IIR low-pass filter, the FIR filter can also be used to smooth out the signal and increase its resolution. In addition, configuring the filter length accordingly makes it possible to target and efficiently filter out individual interference frequencies. The source of these interference frequencies may be mechanical or electromagnetic. Multiples of these are also filtered out (as long as they are a whole-number factor of the data output rate).

Example:

Data output rate = 15000 samples/s, averaging over 15 values → "Notch" at 1 kHz (2 kHz, etc.)

When reconfiguring the filter, it takes 1/data rate (FIR filter in mode "Selectable data rate") or 1/filter frequency (FIR filter in mode "High-resolution data rate") until the filter is tuned. During tuning, bit 5 is set in register "StatusInput01" on page 317.

9.1.4.11.2.1 Characteristics of the FIR filter in mode "Selectable data rate"

The following table applies to "Function model 0 - Standard" and "Function model 254 - Bus controller" as well as for "Function model 2 - Extended filter" in mode "Selectable data rate".

| Set value 1) 2) | Data rate (f_{Data}) [Hz] 3) 4) | f_{Notch} [Hz] | I/O update rate [Hz] | | I/O update time [ms] | |
|--------------------|---|-------------------------|------------------------------|---|------------------------------|---|
| | | | Function models 0 and 254 | Function model 2 (mode "Selectable data rate") | Function models 0 and 254 | Function model 2 (mode "Selectable data rate") |
| 0000 | 2.5 | 2.5 | 2.5 | 15000 | 400 | 0.0667 |
| 0001 | 5 | 5 | 5 | 15000 | 200 | 0.0667 |
| 0010 | 10 | 10 | 10 | 15000 | 100 | 0.0667 |
| 0011 | 15 | 15 | 15 | 15000 | 66.6667 | 0.0667 |
| 0100 | 25 | 25 | 25 | 15000 | 40 | 0.0667 |
| 0101 | 30 | 30 | 30 | 15000 | 33.3333 | 0.0667 |
| 0110 | 50 | 50 | 50 | 15000 | 20 | 0.0667 |
| 0111 | 60 | 60 | 60 | 15000 | 16.6667 | 0.0667 |
| 1000 | 100 | 100 | 100 | 15000 | 10 | 0.0667 |
| 1001 | 500 | 500 | 500 | 15000 | 2 | 0.0667 |
| 1010 | 1000 | 1000 | 1000 | 15000 | 1 | 0.0667 |
| 1011 | 2000 | 2000 | 2000 | 20000 | 0.5 | 0.05 |
| 1100 | 3750 | 3750 | 3750 | 15000 | 0.2667 | 0.0667 |
| 1101 | 7500 | 7500 | 7500 | 15000 | 0.1333 | 0.0667 |
| 1110 | Reserved | | | | | |
| 1111 | Reserved | | | | | |

- 1) Function model 0 and 254: Bits 0 to 3 of register "ConfigOutput01" on page 308
- 2) Function model 2: Bits 0 to 3 of register "ConfigDatarateOutput01" on page 223
- 3) Function models 0 and 254: Data rate = 1/Filter length [s] (f_{Notch}) = I/O update rate
- 4) Function model 2: Data rate = 1/Filter length [s] (f_{Notch})

9.1.4.11.2.2 Characteristics of the FIR filter in mode "High-resolution data rate"

The following table applies to "Function model 2 - Extended filter".

| Setpoint [0.1 Hz] ¹⁾ | Data rate (f_{Data}) [Hz] | f_{Notch} [Hz] | I/O update time [μ s] |
|---------------------------------|-------------------------------|------------------|----------------------------------|
| 1 to 65535 | Setpoint / 10 | = Data rate | $\approx 50 \mu$ s ²⁾ |

1) Setpoint from register "ConfigHighResolutionOutput01" on page 223

2) The value varies between 42 and 56 μ s (see also the next section "I/O update time")

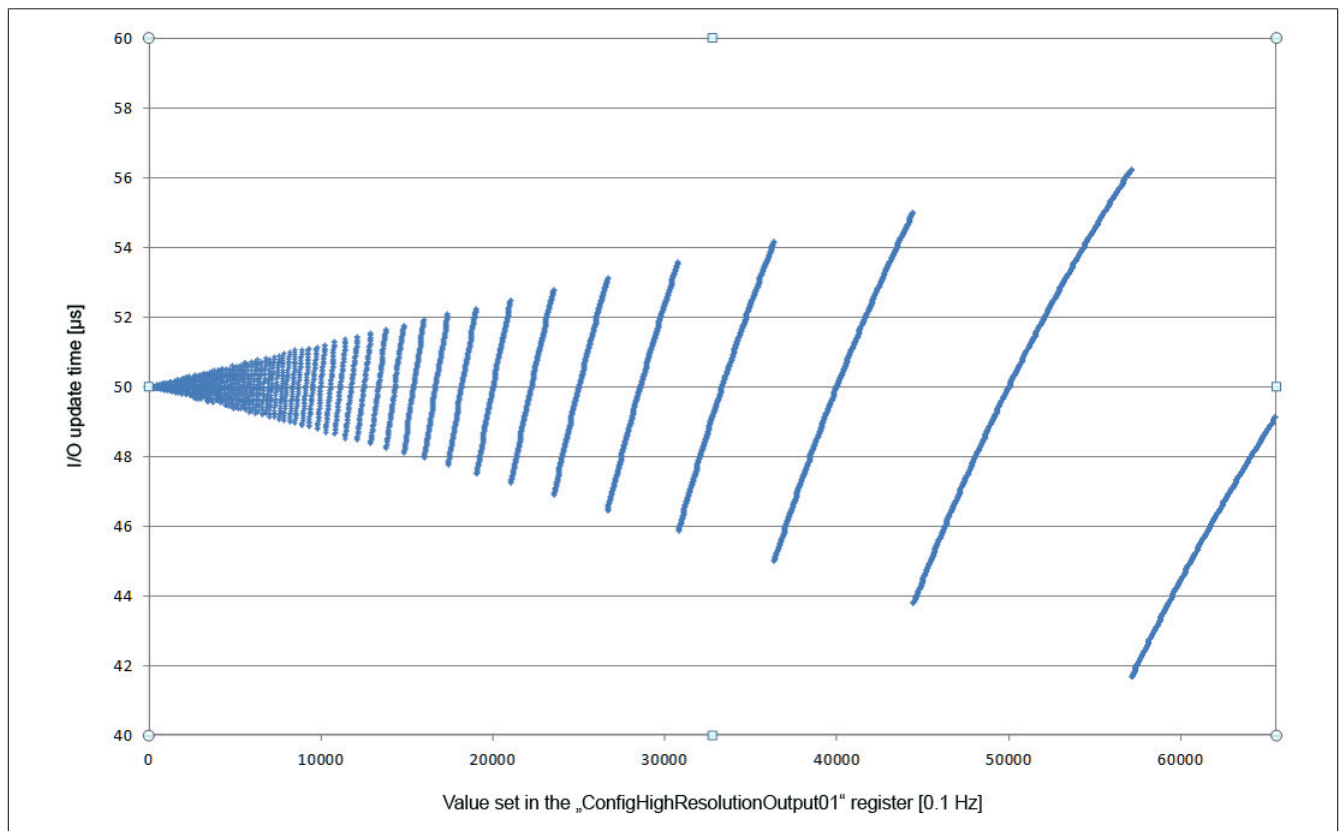
I/O update time

The value of the I/O update time depends on the setpoint and varies between 42 and 56 μ s. The following formula can be used to precisely calculate the I/O update time:

$$\text{I/O update time} = 1e6 \cdot (1e-4 - 10 / (\text{Setpoint} \cdot [10 / (5e-5 \cdot \text{Setpoint})]))$$

Legend: The square brackets in the formula above mean that the calculated value must be rounded to a whole number.

The following image shows the I/O update time depending on the setpoint:

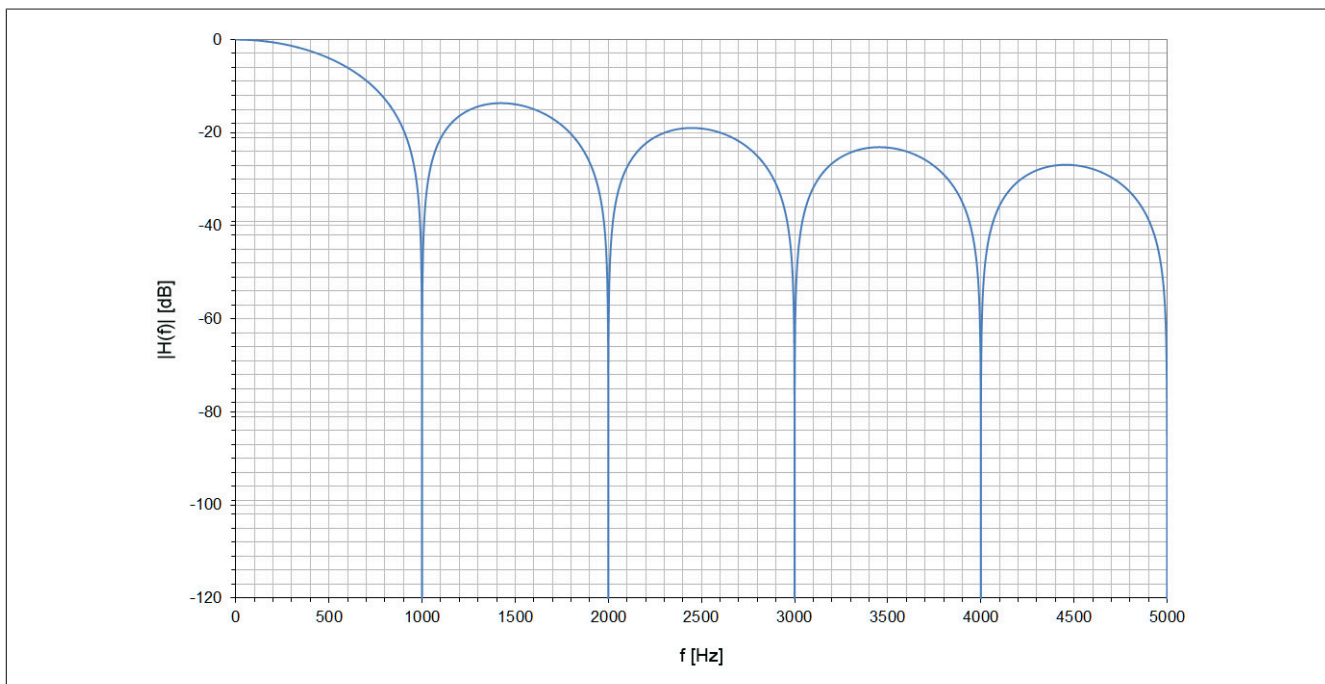


9.1.4.11.2.3 Examples for the gain of the FIR filter

Example 1

Filter setting = 10:

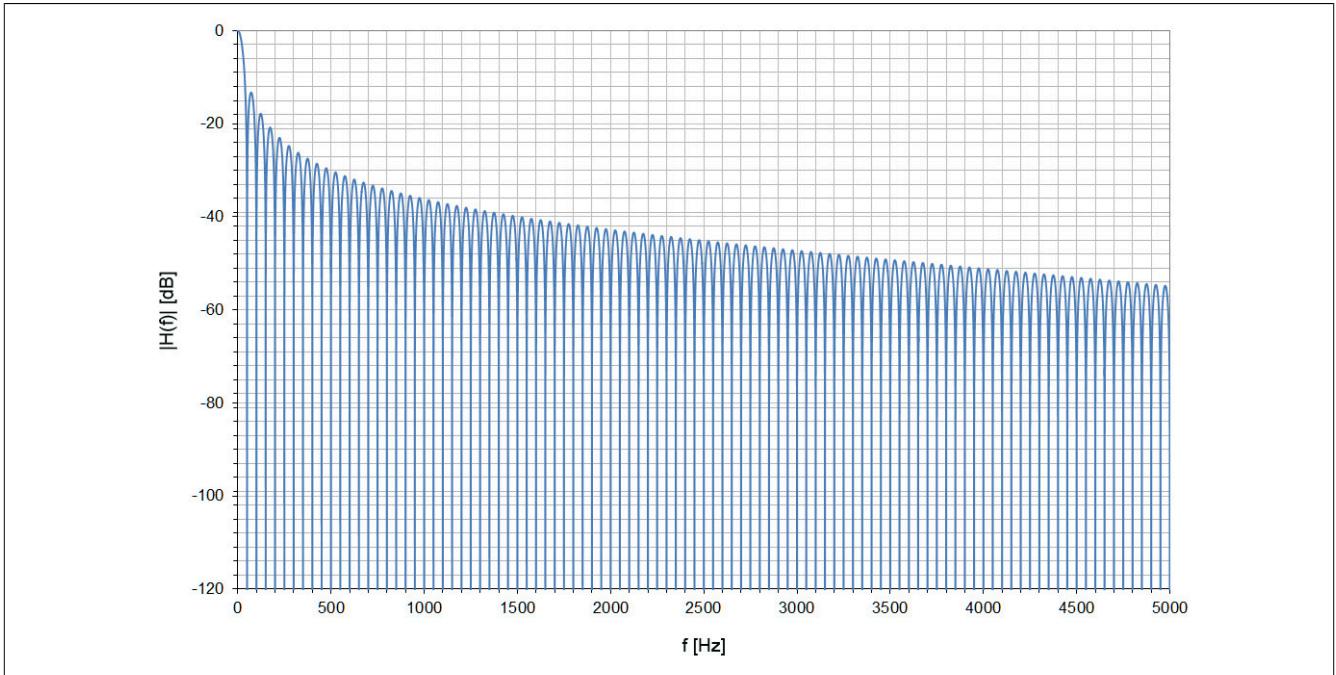
- $f_{\text{Notch}} = 1000 \text{ Hz}$
- $f_c = 439.3 \text{ Hz}$



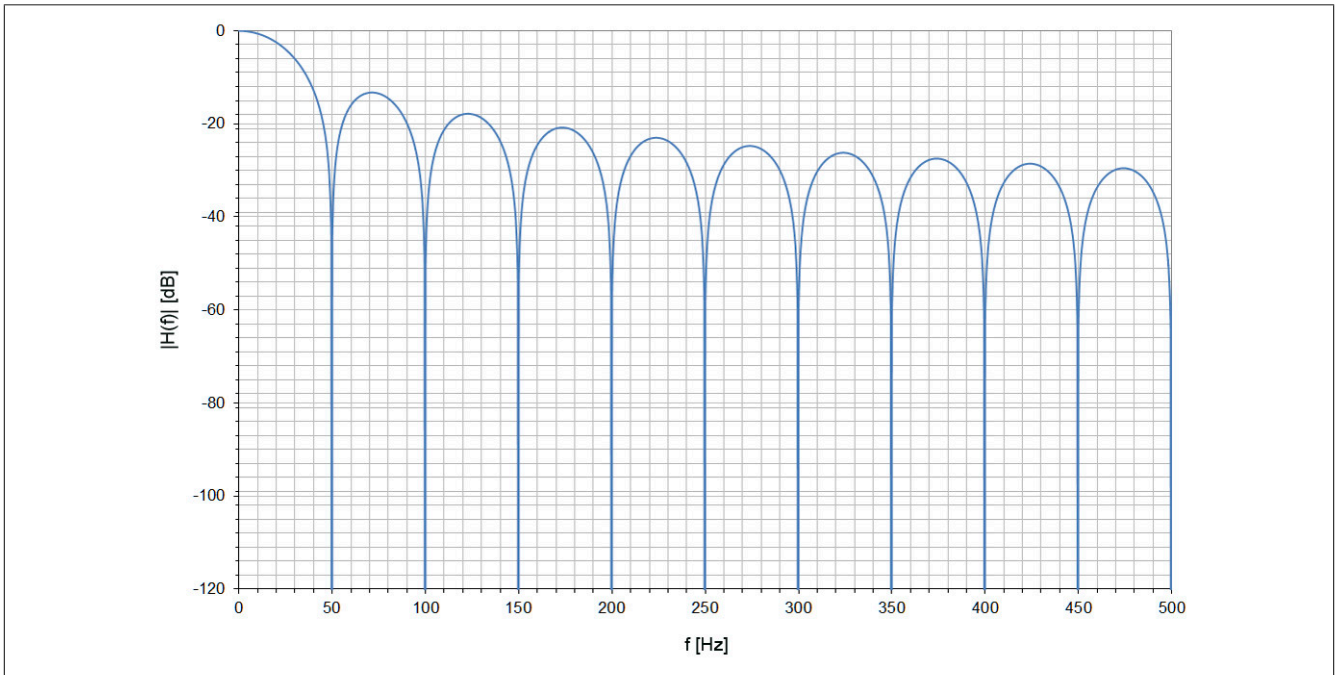
Example 2

Filter setting = 6:

- $f_{\text{Notch}} = 50 \text{ Hz}$
- $f_c = 21.8 \text{ Hz}$



Detailed excerpt from the filter curve shown above:

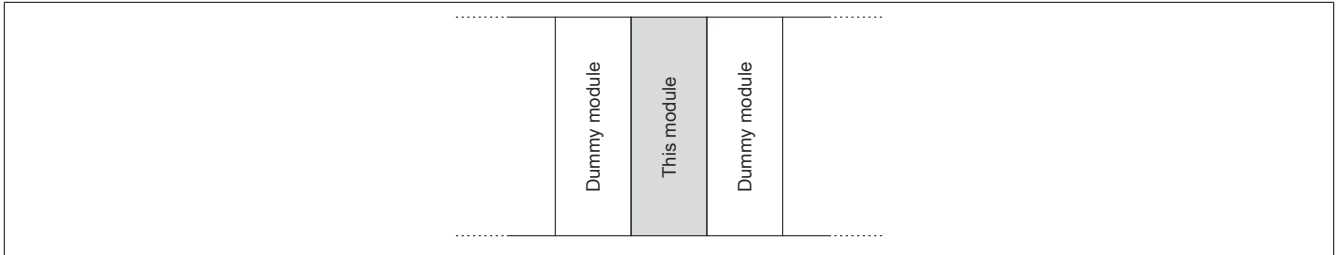


9.1.4.12 Hardware configuration

9.1.4.12.1 Hardware configuration for horizontal installation starting at 55°C ambient temperature

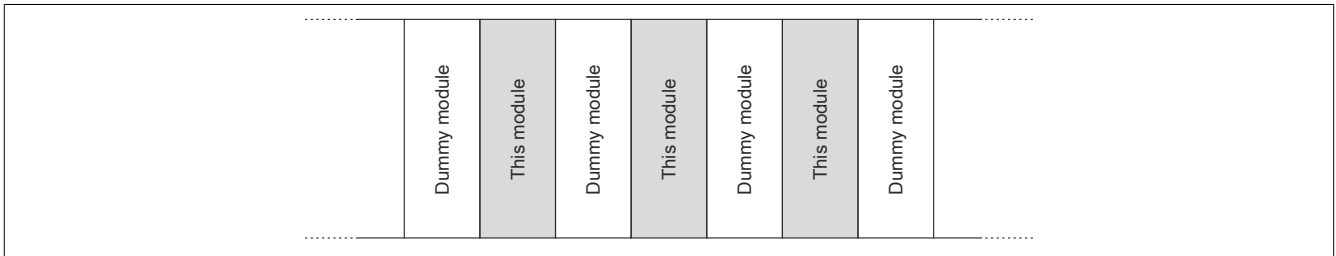
Operating a strain gauge module

Starting at an ambient temperature of 55°C, a dummy module must be connected to the left and right of the strain gauge module in a horizontal mounting orientation.



Operating multiple strain gauge modules side by side

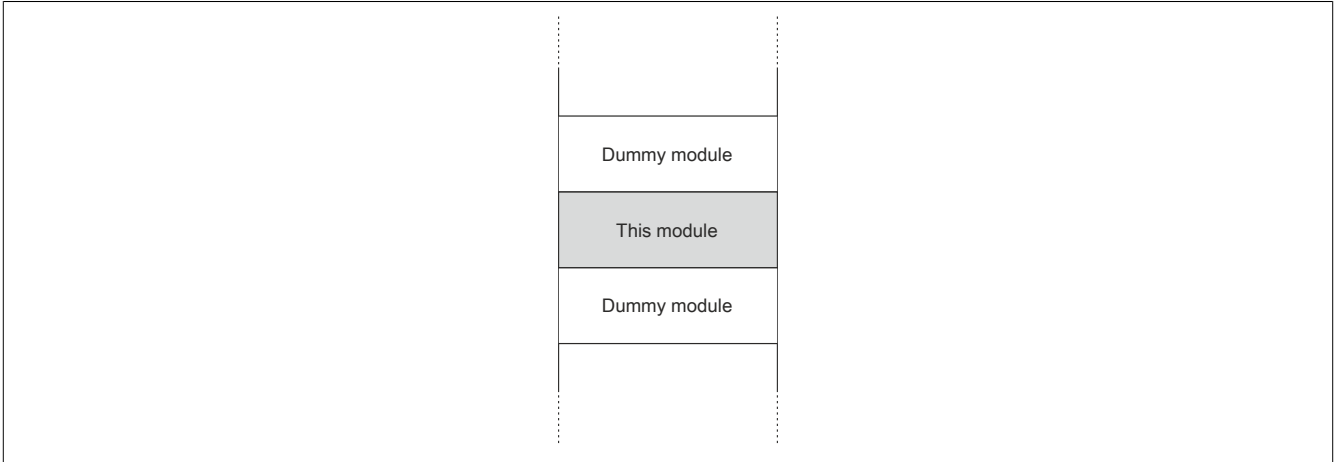
If 2 or more horizontal strain gauge modules are being operated in a cluster, the following arrangement of modules must be observed.



9.1.4.12.2 Hardware configuration for vertical installation starting at 45°C ambient temperature

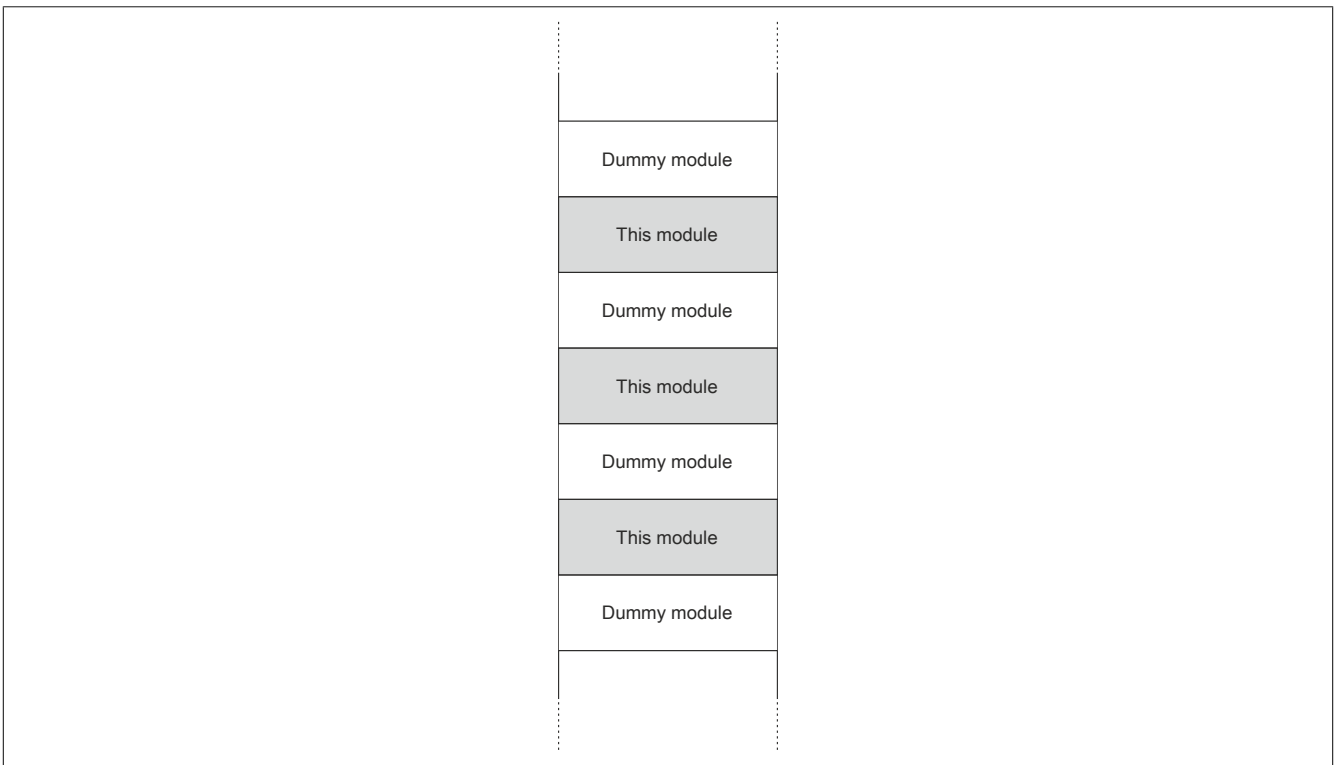
Operating a strain gauge module

Starting at an ambient temperature of 45°C, a dummy module must be connected to the left and right of the strain gauge module in a vertical mounting orientation.



Operating multiple strain gauge modules side by side

If 2 or more vertical strain gauge modules are being operated in a cluster, the following arrangement of modules must be observed.



9.1.4.13 Register description

9.1.4.13.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.1.4.13.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog signal - Configuration | | | | | | |
| 16 | ConfigOutput01 (A/D converter configuration) | USINT | | | • | |
| 18 | ConfigCycletime01 | UINT | | | | • |
| 32 | AdcClkFreqShift01 | USINT | | | | • |
| Analog signal - Communication | | | | | | |
| 2 | StatusInput01 | USINT | • | | | |
| 4 | AnalogInput01 | DINT | • | | | |

9.1.4.13.3 Function model 1 - Multisampling

In this function model, the A/D converter is operated synchronously to X2X Link with a predefined A/D converter cycle time. The value is configurable as 50 or 100 μ s.

The module returns between 3 and 10 measured values per X2X cycle depending on the configuration. With an X2X cycle time of 400 μ s and A/D converter cycle time of 50 μ s, exactly 8 measurements are performed and the module can return 8 values (strain gauge value 01 to strain gauge value 08).

If a longer cycle time is used, the values returned correspond to the last measurements. If using an X2X cycle time that is not a whole number multiple of the A/D converter cycle time, then the conversion cannot be synchronized with X2X Link. In this case, the module outputs the invalid value 0x8000.

Example 1

If using an X2X cycle time of 800 μ s, it is possible to perform 16 measurements per X2X cycle if the A/D converter cycle time equals 50 μ s. The first 6 measured values are discarded; the last 10 measured values are provided by the module.

With a shorter X2X cycle time, the number of measured values should not exceed the number of measurements that can actually be made. All other measured values are invalid (0x8000). To minimize the load on the X2X Link network, it is possible to disable these unneeded registers (see "[Number of measured values](#)" on page 313).

Example 2

If using an X2X cycle time of 300 μ s, it is possible to perform 6 measurements per X2X cycle if the A/D converter cycle time equals 50 μ s. For this reason, only the first 6 registers are valid. The registers for the 7th through 10th measured value (AnalogInput07 to AnalogInput10) should be disabled by setting [Number of measured values](#) to "6 measured values" in the I/O configuration.

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog signal - Configuration | | | | | | |
| 1601 | ConfigGain01_MultiSample | USINT | | | • | |
| 1603 | ConfigCycletime01_MultiSample | USINT | | | | • |
| Analog signal - Communication | | | | | | |
| 2 | StatusInput01 | USINT | • | | | |
| 1534 + N * 4 | AnalogInput0N (N = 1 to 10) | INT | • | | | |

9.1.4.13.4 Function model 2 - Extended filter

This function model allows the IIR low-pass filter and the FIR filter to be enabled.

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog signal - Configuration | | | | | | |
| 272 | ConfigCommonOutput01 (A/D converter and IIR filter configuration) | USINT | | | • | |
| 288 | ConfigFilterOutput01 | UINT | | | | • |
| 273 | ConfigDatarateOutput01 | USINT | | | • | |
| 274 | ConfigHighResolutionOutput01 | UINT | | | • | |
| Analog signal - Communication | | | | | | |
| 2 | StatusInput01 | USINT | • | | | |
| 4 | AnalogInput01 | DINT | • | | | |
| 256 | AdcConvTimeStampInput01 | DINT | • | | | |

9.1.4.13.5 Function model 254 - Bus controller

In function model "254 - Bus controller", the module behaves as it does in "Function model 0 - Standard" with the exception that it is not synchronized to the X2X Link network even if synchronous mode is enabled in register "ConfigOutput01" on page 308. Instead, the module behaves as if the set A/D converter cycle time is not a factor or multiple of the X2X cycle time and attempts to maintain the set A/D converter cycle time as precisely as possible.

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog signal - Configuration | | | | | | | |
| 16 | 0 | ConfigOutput01 (A/D converter configuration) | USINT | | | • | |
| 18 | 18 | ConfigCycletime01 | UINT | | | | • |
| 32 | 32 | AdcClkFreqShift01 | USINT | | | | • |
| Analog signal - Communication | | | | | | | |
| 2 | 4 | StatusInput01 | USINT | • | | | |
| 4 | 0 | AnalogInput01 | DINT | • | | | |

1) The offset specifies the position of the register within the CAN object.

9.1.4.13.5.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "Using I/O modules on the bus controller" on page 3789.

9.1.4.13.5.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.1.4.13.6 Registers for function models "0 - Standard" and "254 - Bus controller"

9.1.4.13.6.1 A/D converter configuration

Name:

ConfigOutput01

The data rate and measurement range of the A/D converter can be configured in this register.

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| USINT | See bit structure. | 13 |

Bit structure:

| Bit | Description | Value | Information | |
|-------|--|--|--|----------|
| 0 - 3 | Data rate f_{DATA} (samples per second): | 0000 | 2.5 | |
| | | 0001 | 5 | |
| | | 0010 | 10 | |
| | | 0011 | 15 | |
| | | 0100 | 25 | |
| | | 0101 | 30 | |
| | | 0110 | 50 | |
| | | 0111 | 60 | |
| | | 1000 | 100 | |
| | | 1001 | 500 | |
| | | 1010 | 1000 | |
| | | 1011 | 2000 | |
| | | 1100 | 3750 | |
| | | 1101 | 7500 (bus controller default setting) | |
| 4 - 6 | Standard measurement range (bit 6 = 0) | 000 | 16 mV/V (bus controller default setting) | |
| | | 001 | 8 mV/V | |
| | | 010 | 4 mV/V | |
| | | 011 | 2 mV/V | |
| | | Extended measurement range (bit 6 = 1) | 100 | 256 mV/V |
| | | | 101 | 128 mV/V |
| 110 | 64 mV/V | | | |
| 7 | Reserved | 111 | 32 mV/V | |
| | | 0 | (must be 0) | |

Synchronous mode

The module's analog/digital converter (A/D converter) can optionally be operated and read synchronously to the X2X Link network. Synchronous mode is enabled by selecting the respective operating mode in register "ConfigOutput01" on page 308. A time between 200 and 2000 μ s must be set in register "ConfigCycletime01" on page 309 for this. If this time is a whole number factor or multiple of the configured cycle time of X2X Link, then the A/D converter is read synchronously to X2X Link.

Information:

The A/D converter cycle time must be $\geq 1/4$ of the X2X cycle time!

Bit 2 in *Module status* is set (i.e. A/D converter not running synchronously)...

- ... If the configured A/D converter cycle time cannot be synchronized with X2X Link.
- ... If the module is still in the settling phase.

Jitter, dead time and settling time:

| | | |
|---|--|---|
| Jitter | | |
| A/D converter cycle times <1500 μ s | | Max. $\pm 1 \mu$ s |
| A/D converter cycle times >1500 μ s | | Max. $\pm 4 \mu$ s |
| X2X link dead time | | 50μ s + $\frac{X2X \text{ cycle time}}{128}$ |
| Settling time | | 150 x X2X cycle time |

The settling time corresponds to the time needed until the A/D converter can be operated after enabling synchronous mode or following conversion of the A/D converter cycle time.

9.1.4.13.6.2 A/D converter cycle time

Name:

ConfigCycletime01

This register is only used in [Synchronous mode](#). If synchronous mode is enabled in the A/D converter configuration, then the module attempts to operate the A/D converter as synchronously as possible to the X2X Link network (based on the A/D converter cycle time set in this register). It is of course necessary for the X2X Link cycle time and the A/D converter cycle time to have a certain ratio. The following conditions must be observed:

- 1) A/D converter cycle time $\geq 1/4$ X2X cycle time
- 2) A/D converter cycle time corresponds to a whole number factor or multiple of the X2X cycle time
- 3) A/D converter cycle time must be in the range 50 to 2000 μ s

| Data type | Values | Information |
|-----------|------------|-------------------------------------|
| UINT | 50 to 2000 | Bus controller default setting: 400 |

9.1.4.13.6.3 A/D converter clock frequency shift

Name:

AdcClkFreqShift01

In rare cases, strain gauge modules connected to neighboring slots can influence one another. This can result in temporary, minimal deviations in measured values. This can only occur if the sigma-delta A/D converters on the neighboring strain gauge modules are operated at exactly the same clock frequency.

In most cases, these clock frequencies vary slightly due to part variances. When they are the same however, this register on the strain gauge module provides a safe way for an application to prevent this type of mutual influence.

| Data type | Values | Information |
|-----------|-------------|-------------------------------------|
| SINT | -128 to 127 | Bus controller default setting: 127 |

This register can be used to vary the clock frequency in increments of 200 ppm. Setting values from -50 to 50 cover a range of -10000 ppm to 10000 ppm. This corresponds with -1% to 1%.

Values beyond this range will cause activation of a default mode. The frequency shift is derived from the last 2 digits of the serial number by the module firmware. This saves time that would otherwise be needed for programming, provided that the last two digits of the serial numbers on the neighboring modules are not the same

| Register value | Frequency shift in ppm | Example of a sampling rate ¹⁾ |
|----------------|--|--|
| 127 | $((\text{SerialNo. modulo } 100) - 50) * (-200)$ ppm | Based on the serial number |
| ... | ... | ... |
| 51 | $((\text{SerialNo. modulo } 100) - 50) * (-200)$ ppm | Based on the serial number |
| 50 | 10000 | 505 |
| 49 | 9800 | 504.9 |
| ... | ... | ... |
| 2 | 400 | 500.2 |
| 1 | 200 | 500.1 |
| 0 | 0 | 500 |
| -1 | -200 | 499.9 |
| -2 | -400 | 499.8 |
| ... | ... | ... |
| -50 | -10000 | 495 |
| -51 | $((\text{SerialNo. modulo } 100) - 50) * (-200)$ ppm | Based on the serial number |
| ... | ... | ... |
| -128 | $((\text{SerialNo. modulo } 100) - 50) * (-200)$ ppm | Based on the serial number |

1) Nominal sampling rate of 500 samples per second

Important:

As shown in the table above, shifting the A/D converter clock frequency will equally shift the A/D converter sampling rate. Shifting the A/D converter clock frequency too much can cause problems with disturbance suppression particularly when a very specific sampling rate has been defined to suppress existing disturbances (e.g. 50 Hz to suppress the 50 Hz hum). See also "[Filter characteristics of the sigma-delta A/D converter](#)" on page 296.

It is situations like this where the option to manually shift the frequency in the I/O configuration or ASIOACC library should be utilized rather than relying on the default frequency shift that is based on the serial number.

A frequency shift like the one shown below would be sufficient to prevent modules from influencing one another and would not cause any noticeable difference to the filter characteristics.

| Slot | 1 | 2 | 3 | 4 | 5 | 6 | ... |
|-------------------------------------|---|---|----|---|----|---|-----|
| A/D converter clock frequency shift | 0 | 2 | -1 | 1 | -2 | 0 | ... |

Information:

- This register has no effect in synchronous mode because the firmware regulates the A/D converter clock frequency in such a way that the A/D converter cycle is synchronous with the X2X cycle.
- When writing to this register using the ASIOACC library, only the lowest value byte of the written value is accepted. For example, the value 256 (=0x100) is identical to the value 0 (=0x00).

9.1.4.13.6.4 Module status

Name:

StatusInput01

The current state of the module is indicated in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------------|-------|---|
| 0 | A/D converter value | 0 | Valid A/D converter value |
| | | 1 | Invalid A/D converter value (analog value = 0xFF800000). Possible causes: <ul style="list-style-type: none"> • Strain gauge supply error • I/O power supply error • A/D converter not (yet) configured |
| 1 | Line monitoring | 0 | Ok |
| | | 1 | Open circuit |
| 2 | Only valid in synchronous mode | 0 | A/D converter runs synchronous to X2X Link |
| | | 1 | A/D converter does not run synchronous to X2X Link |
| 3 - 7 | Reserved | - | |

9.1.4.13.6.5 Strain gauge value

Name:

AnalogInput01

This register contains the raw value determined by the A/D converter for the full-bridge strain gauge with 24-bit resolution.

| Data type | Values | Information |
|-----------|-----------------------|--|
| DINT | -8,388,608 | Negative invalid value |
| | -8,388,607 | Negative full-scale deflection / Underflow |
| | -8,388,606 to 8388606 | Valid range |
| | 8,388,607 | Positive full-scale deflection / Overflow / Open circuit |

Effective resolution

In principle, the effective resolution of the A/D converter is dependent on the data rate and the measurement range (see "Effective resolution of the A/D converter" on page 293).

The following table shows how the effective resolution (in bits) or effective range of values of the strain gauge value depend on the module configuration (data rate, measurement range).

| Data rate f_{DATA} [Hz] | Measurement range | | | | | | | |
|-------------------------------------|-------------------|-----------------|--------------|-----------------|--------------|-----------------|--------------|-----------------|
| | ± 16 mV/V | | ± 8 mV/V | | ± 4 mV/V | | ± 2 mV/V | |
| | Bits | Range of values | Bits | Range of values | Bits | Range of values | Bits | Range of values |
| 2.5 | 16.9 | $\pm 61,100$ | 15.4 | $\pm 21,600$ | 14.5 | $\pm 11,600$ | 13.7 | $\pm 6,650$ |
| 5 | 16.6 | $\pm 49,700$ | 15.2 | $\pm 18,800$ | 14.2 | $\pm 9,410$ | 13.6 | $\pm 6,210$ |
| 10 | 16.0 | $\pm 32,800$ | 15.2 | $\pm 18,800$ | 14.2 | $\pm 9,410$ | 13.1 | $\pm 4,390$ |
| 15 | 16.0 | $\pm 32,800$ | 15.2 | $\pm 18,800$ | 14.1 | $\pm 8,780$ | 13.1 | $\pm 4,390$ |
| 25 | 15.9 | $\pm 30,600$ | 14.7 | $\pm 13,300$ | 13.9 | $\pm 7,640$ | 12.7 | $\pm 3,330$ |
| 30 | 15.7 | $\pm 26,600$ | 14.6 | $\pm 12,400$ | 13.6 | $\pm 6,210$ | 12.7 | $\pm 3,330$ |
| 50 | 15.4 | $\pm 21,600$ | 14.5 | $\pm 11,600$ | 13.3 | $\pm 5,040$ | 12.2 | $\pm 2,350$ |
| 60 | 15.2 | $\pm 18,800$ | 14.3 | $\pm 10,100$ | 13.1 | $\pm 4,390$ | 12.2 | $\pm 2,350$ |
| 100 | 14.9 | $\pm 15,300$ | 13.8 | $\pm 7,130$ | 13.0 | $\pm 4,100$ | 12.0 | $\pm 2,050$ |
| 500 | 13.8 | $\pm 7,130$ | 12.8 | $\pm 3,570$ | 11.7 | $\pm 1,660$ | 10.7 | ± 832 |
| 1000 | 13.3 | $\pm 5,040$ | 12.3 | $\pm 2,520$ | 11.3 | $\pm 1,260$ | 10.3 | ± 630 |
| 2000 | 12.7 | $\pm 3,330$ | 11.9 | $\pm 1,910$ | 10.8 | ± 891 | 9.7 | ± 416 |
| 3750 | 12.4 | $\pm 2,700$ | 11.4 | $\pm 1,350$ | 10.4 | ± 676 | 9.2 | ± 294 |
| 7500 | 12.0 | $\pm 2,050$ | 11.0 | $\pm 1,020$ | 10.1 | ± 549 | 8.9 | ± 239 |

Table 44: Effective resolution of the strain gauge value in bits for the measurement range 2 to 16 mV/V

| Data rate f_{DATA} [Hz] | Measurement range | | | | | | | |
|-------------------------------------|-------------------|-----------------|----------------|-----------------|---------------|-----------------|---------------|-----------------|
| | ± 256 mV/V | | ± 128 mV/V | | ± 64 mV/V | | ± 32 mV/V | |
| | Bits | Range of values | Bits | Range of values | Bits | Range of values | Bits | Range of values |
| 2.5 | 20.8 | $\pm 913,000$ | 20.0 | $\pm 524,000$ | 18.8 | $\pm 228,000$ | 17.6 | $\pm 99,300$ |
| 5 | 20.2 | $\pm 602,000$ | 19.5 | $\pm 371,000$ | 18.3 | $\pm 161,000$ | 17.4 | $\pm 86,500$ |
| 10 | 20.1 | $\pm 562,000$ | 19.4 | $\pm 346,000$ | 18.3 | $\pm 161,000$ | 17.0 | $\pm 65,500$ |
| 15 | 19.8 | $\pm 456,000$ | 19.0 | $\pm 262,000$ | 17.9 | $\pm 122,000$ | 17.0 | $\pm 65,500$ |
| 25 | 19.7 | $\pm 426,000$ | 18.8 | $\pm 228,000$ | 17.9 | $\pm 122,000$ | 16.7 | $\pm 53,200$ |
| 30 | 19.7 | $\pm 426,000$ | 18.5 | $\pm 185,000$ | 17.5 | $\pm 92,700$ | 16.7 | $\pm 53,200$ |
| 50 | 19.2 | $\pm 301,000$ | 18.3 | $\pm 161,000$ | 17.5 | $\pm 92,700$ | 16.3 | $\pm 40,300$ |
| 60 | 19.2 | $\pm 301,000$ | 18.2 | $\pm 151,000$ | 17.2 | $\pm 75,300$ | 16.2 | $\pm 37,600$ |
| 100 | 18.9 | $\pm 245,000$ | 17.9 | $\pm 122,000$ | 16.8 | $\pm 57,100$ | 15.9 | $\pm 30,600$ |
| 500 | 17.6 | $\pm 99,300$ | 16.8 | $\pm 57,100$ | 15.8 | $\pm 28,500$ | 14.8 | $\pm 14,300$ |
| 1000 | 17.2 | $\pm 75,300$ | 16.2 | $\pm 37,600$ | 15.2 | $\pm 18,800$ | 14.3 | $\pm 10,100$ |
| 2000 | 16.5 | $\pm 46,300$ | 15.8 | $\pm 28,500$ | 14.7 | $\pm 13,300$ | 13.8 | $\pm 7,130$ |
| 3750 | 16.1 | $\pm 35,100$ | 15.4 | $\pm 21,600$ | 14.3 | $\pm 10,100$ | 13.3 | $\pm 5,040$ |
| 7500 | 15.9 | $\pm 30,600$ | 15.0 | $\pm 16,400$ | 14.0 | $\pm 8,190$ | 13.0 | $\pm 4,100$ |

Table 45: Effective resolution of the strain gauge value in bits for the measurement range 32 to 256 mV/V

9.1.4.13.7 Register for "Function model 1 - Multisampling"

9.1.4.13.7.1 A/D converter configuration

Name:

ConfigGain01_MultiSample

The measurement range for the A/D converter can be configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|-------------|
| 0 - 2 | Standard measurement range (bit 2 = 0) | 000 | 16 mV/V |
| | | 001 | 8 mV/V |
| | | 010 | 4 mV/V |
| | | 011 | 2 mV/V |
| | Extended measurement range (bit 2 = 1) | 100 | 256 mV/V |
| | | 101 | 128 mV/V |
| | | 110 | 64 mV/V |
| 3 - 7 | Reserved | 0 | (must be 0) |

9.1.4.13.7.2 A/D converter cycle time

Name:

ConfigCycletime01_MultiSample

The A/D converter cycle time can be configured in this register.

In order for multisampling to work, the X2X cycle time must be divisible by the A/D converter cycle time to produce a whole number.

| Data type | Value | Information |
|-----------|----------|----------------------|
| USINT | 0 | 50 μ s (default) |
| | 1 | 100 μ s |
| | 2 to 255 | Reserved |

9.1.4.13.7.3 Number of measured values

If the X2X cycle time is too short, then not all 10 measurements can be performed. To reduce the load on X2X Link, it makes sense to only transfer as many values as measurements that can be made. This is why it is possible to configure the number of measured values to be transferred (see "Function model 1 - Multisampling" on page 306).

Example: A/D converter cycle time = 50 μ s

| X2X cycle time | Number of measured values to be transferred |
|--------------------|---|
| 250 μ s | 5 |
| 300 μ s | 6 |
| 350 μ s | 7 |
| 400 μ s | 8 |
| 450 μ s | 9 |
| \geq 500 μ s | 10 |

Example: A/D converter cycle time = 100 μ s

| X2X cycle time | Number of measured values to be transferred |
|----------------|---|
| 300 μ s | 3 |
| 400 μ s | 4 |
| 500 μ s | 5 |
| 600 μ s | 6 |
| 700 μ s | 7 |
| 800 μ s | 8 |
| 900 μ s | 9 |
| \geq 1 ms | 10 |

9.1.4.13.7.4 Module status

Name:
StatusInput01

This register contains the current state of the module.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------------|-------|--|
| 0 | A/D converter values | 0 | Valid A/D converter value |
| | | 1 | Invalid A/D converter value |
| 1 | Line monitoring | 0 | OK |
| | | 1 | Open circuit An open circuit was found during at least one measurement in this X2X cycle. This bit is reset if all measurements are OK after correcting this error, i.e. it does not have to be acknowledged. |
| 2 | Synchronous mode | 0 | A/D converter runs synchronous to X2X Link |
| | | 1 | A/D converter does not run synchronous to X2X Link |
| 3 - 7 | Reserved | - | |

9.1.4.13.7.5 Strain gauge value - Multiple

Name:
AnalogInput01 to AnalogInput10

This register contains the raw value determined by the A/D converter for the full-bridge strain gauge with 16-bit resolution. The module returns between 3 and 10 measured values per X2X cycle depending on the configuration.

Effective resolution

In principle, the effective resolution of the A/D converter is dependent on the data rate and measurement range (see "[Effective resolution of the A/D converter](#)" on page 293).

The following table shows how the effective resolution (in bits) or effective range of values of the strain gauge value depend on the module configuration (data rate, measurement range).

| Measurement range | | | | | | | |
|-------------------|-----------------|---------|-----------------|---------|-----------------|---------|-----------------|
| ±16 mV/V | | ±8 mV/V | | ±4 mV/V | | ±2 mV/V | |
| Bits | Range of values | Bits | Range of values | Bits | Range of values | Bits | Range of values |
| 11.7 | ±1,700 | 10.7 | ±840 | 9.8 | ±430 | 8.8 | ±220 |

Table 46: Effective resolution of the strain gauge value in bits for the measurement range 2 to 16 mV/V

| Measurement range | | | | | | | |
|-------------------|-----------------|-----------|-----------------|----------|-----------------|----------|-----------------|
| ±256 mV/V | | ±128 mV/V | | ±64 mV/V | | ±32 mV/V | |
| Bits | Range of values | Bits | Range of values | Bits | Range of values | Bits | Range of values |
| 15.8 | ±27,600 | 15.0 | ±16,400 | 13.7 | ±6,520 | 12.8 | ±3,570 |

Table 47: Effective resolution of the strain gauge value in bits for the measurement range 32 to 256 mV/V

9.1.4.13.8 Register for "Function model 2 - Extended filter"**9.1.4.13.8.1 A/D converter and IIR filter configuration**

Name:

ConfigCommonOutput01

The IIR low-pass filter and measurement range of the A/D converter can be configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------------------|-------------|--|
| | | | Filter level |
| 0 - 3 | IIR low-pass filter | 0000 | 0: IIR low-pass filter switched off |
| | | 0001 | 1 |
| | | 0010 | 2 |
| | | 0011 | 3 |
| | | 0100 | 4 |
| | | 0101 | 5 |
| | | 0110 | 6 |
| | | 0111 | 7 |
| | | 1000 | 8 |
| | | 1001 - 1111 | The analog input value indicates an invalid range. |
| 4 - 6 | Default measurement range | 000 | 16 mV/V |
| | | 001 | 8 mV/V |
| | | 010 | 4 mV/V |
| | | 011 | 2 mV/V |
| | Extended measurement range | 100 | 256 mV/V |
| | | 101 | 128 mV/V |
| | | 110 | 64 mV/V |
| | | 111 | 32 mV/V |
| 7 | Reserved | 0 | (must be 0) |

9.1.4.13.8.2 Data rate configuration

Name:

ConfigFilterOutput01

Whether a selectable data rate or a high-resolution data rate is being used for the FIR filter is configured in this register.

| Data type | Values | Information |
|-----------|--------|--|
| UINT | 0 | Mode "Selectable data rate": A selectable data rate is used for the FIR filter (default). Configuration takes place in register "ConfigDatarateOutput01" on page 223. |
| | 1 | Mode "High-resolution data rate": A high-resolution data rate is used for the FIR filter. Configuration takes place in register "ConfigHighResolutionOutput01" on page 223. |

Name:

ConfigDatarateOutput01

The data rate of the FIR filter in mode "Selectable data rate" is configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------------|--|-------|--|
| 0 - 3 | Data rate f_{DATA} (samples per second): | 0000 | 2.5 |
| | | 0001 | 5 |
| | | 0010 | 10 |
| | | 0011 | 15 |
| | | 0100 | 25 |
| | | 0101 | 30 |
| | | 0110 | 50 |
| | | 0111 | 60 |
| | | 1000 | 100 |
| | | 1001 | 500 |
| | | 1010 | 1000 |
| | | 1011 | 2000 |
| | | 1100 | 3750 |
| 1101 | 7500 | | |
| 1110 - 1111 | | | The analog input value indicates an invalid range. |
| 4 - 7 | Reserved | 0 | (must be 0) |

Name:

ConfigHighResolutionOutput01

The data rate of the FIR filter in 0.1 Hz steps is configured in this register (0.1 to 6553.5 Hz).

| Data type | Values | Information |
|-----------|-------------|-------------------------|
| UINT | 0 | Disables the FIR filter |
| | 1 to 65,535 | 0.1 to 6553.5 Hz |

9.1.4.13.8.3 Module status

Name:

StatusInput01

This register contains the current state of the module. If there is a fault in the module power supply or strain gauge supply, the analog input value indicates an invalid range and the buffer of the enabled filter is reset.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------------|-------|------------------------------|
| 0 | A/D converter values | 0 | Valid A/D converter value |
| | | 1 | Invalid A/D converter value |
| 1 | Line monitoring | 0 | OK |
| | | 1 | Open circuit |
| 2 | Reserved | - | |
| 3 | Module power supply | 0 | OK |
| | | 1 | Error in module power supply |
| 4 | Strain gauge supply | 0 | OK |
| | | 1 | Error in strain gauge supply |
| 5 | FIR filter ready | 0 | OK |
| | | 1 | FIR filter not yet ready |
| 6 - 7 | Reserved | - | |

9.1.4.13.8.4 A/D converter conversion timestamp

Name:

AdcConvTimeStampInput01

This register holds the timestamp of the last analog conversion. This is always the point in time in [μ s] at which the conversion of the latest A/D converter raw value is completed.

| Data type | Values | Explanation |
|-----------|---------------------------------|--|
| DINT | -2,147,483,648 to 2,147,483,647 | Timestamp [μ s] of the last analog conversion |

9.1.4.13.9 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 250 μ s |

9.1.4.13.10 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

For the I/O update times for function models "0 - Standard", "2 - Extended filter" and "254 - Bus controller", see section "[Characteristics of the FIR filter in mode "Selectable data rate"](#)" on page 300.

Depending on the setting in register "[ConfigCycletime01_MultiSample](#)" on page 313, the I/O update time in "Function model 1 - Multisampling" is 50 or 100 μ s.

9.1.5 X20AI2222

Data sheet version: 1.21

9.1.5.1 General information

The module is equipped with 2 inputs with 13-bit (including sign) digital converter resolution. It can be used to capture voltage signals in the range from ± 10 V.

This module is designed for X20 6-pin terminal blocks. If needed (e.g. for logistical reasons), the 12-pin terminal block can also be used.

- 2 analog inputs ± 10 V
- 13-bit digital converter resolution

9.1.5.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Analog inputs |  |
| X20AI2222 | X20 analog input module, 2 inputs, ± 10 V, 13-bit converter resolution, configurable input filter | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |

Table 48: X20AI2222 - Order data

9.1.5.3 Technical data

| | |
|--|--|
| Model number | X20AI2222 |
| Short description | |
| I/O module | 2 analog inputs ± 10 V |
| General information | |
| B&R ID code | 0xCAB0 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Inputs | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 0.8 W ¹⁾ |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Analog inputs | |
| Input | ± 10 V |
| Input type | Differential input |
| Digital converter resolution | ± 12 -bit |
| Conversion time | 300 μ s for all inputs |
| Output format | |
| Data type | INT |
| Voltage | 0x8001 - 0x7FFF / 1 LSB = 0x0008 = 2.441 mV |
| Input impedance in signal range | 20 M Ω |
| Input protection | Protection against wiring with supply voltage |
| Permissible input signal | Max. ± 30 V |
| Output of digital value during overload | Configurable |
| Conversion procedure | SAR |
| Input filter | 3rd-order low pass / cut-off frequency 1 kHz |
| Max. error at 25°C | |
| Gain | 0.08% ²⁾ |
| Offset | 0.015% ³⁾ |
| Max. gain drift | 0.006 %/°C ²⁾ |
| Max. offset drift | 0.002 %/°C ³⁾ |
| Common-mode rejection | |
| DC | 70 dB |
| 50 Hz | 70 dB |
| Common-mode range | ± 12 V |
| Crosstalk between channels | -70 dB |
| Nonlinearity | <0.025% ³⁾ |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |

Table 49: X20AI2222 - Technical data


| Model number | X20AI2222 |
|---------------------------------|---|
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB06 or X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 49: X20AI2222 - Technical data

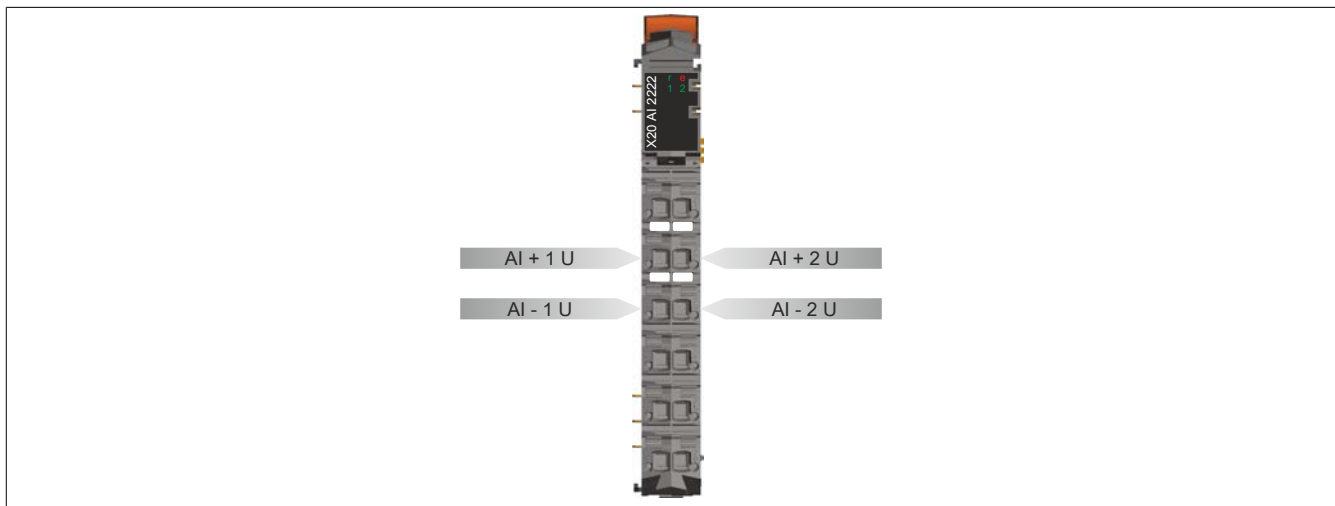
- 1) To reduce power dissipation, B&R recommends bridging unused inputs on the terminals.
- 2) Based on the current measured value.
- 3) Based on the 20 V measurement range.

9.1.5.4 LED status indicators

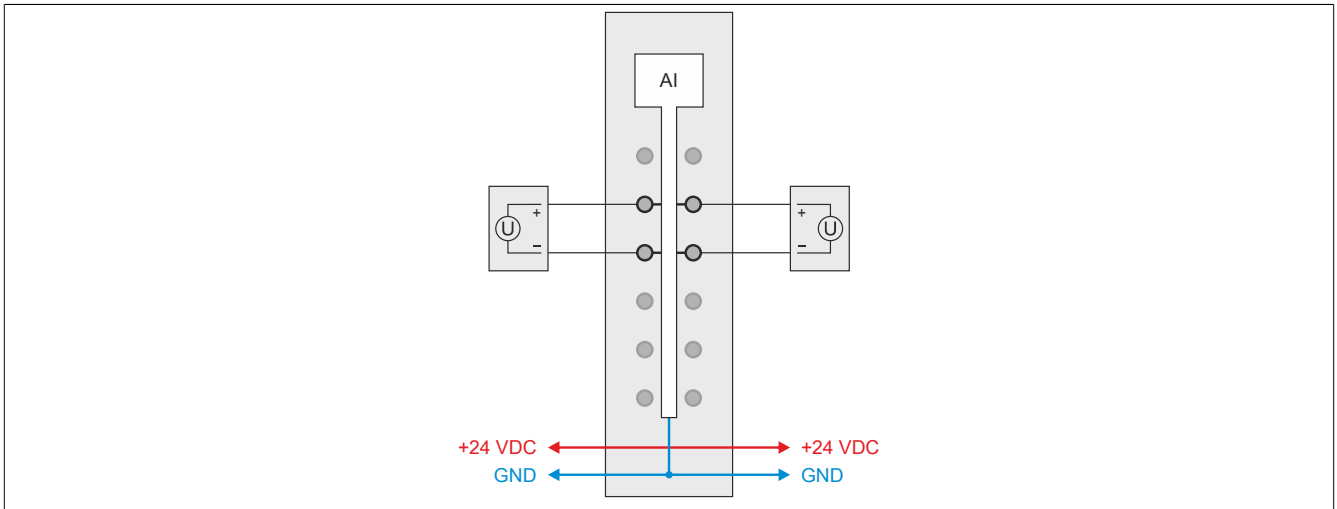
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|--|-------|-----------------------------|------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1 - 2 | Green | Off | Open line or sensor is disconnected |
| | | | Blinking | Input signal overflow or underflow |
| | | | On | Analog/digital converter running, value OK |

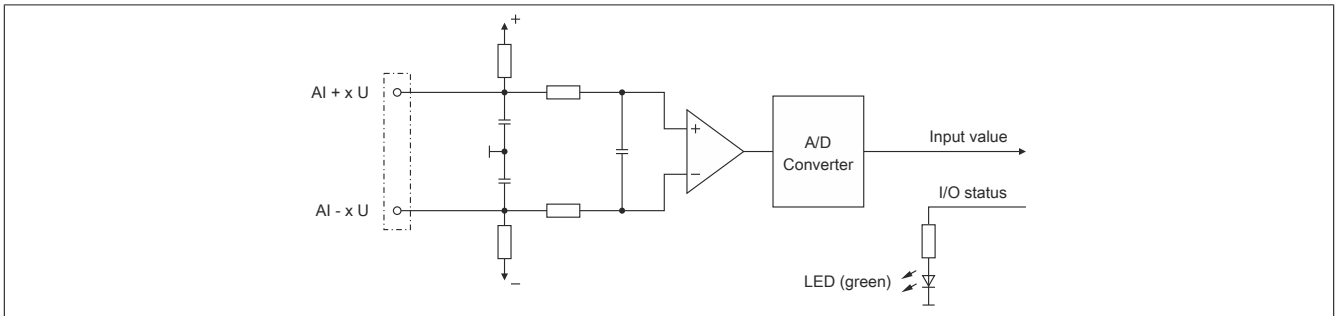
9.1.5.5 Pinout



9.1.5.6 Connection example



9.1.5.7 Input circuit diagram



9.1.5.8 Register description

9.1.5.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.1.5.8.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|------------------------------------|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog signal - Configuration | | | | | | |
| 16 | ConfigOutput01 (Input filter) | USINT | | | | • |
| 20 | ConfigOutput03 (Lower limit value) | INT | | | | • |
| 22 | ConfigOutput04 (Upper limit value) | INT | | | | • |
| Analog signal - Communication | | | | | | |
| 0 | AnalogInput01 | INT | • | | | |
| 2 | AnalogInput02 | INT | • | | | |
| 30 | StatusInput01 | USINT | • | | | |

9.1.5.8.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------------|----------------------|------------------------------------|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog signal - Configuration | | | | | | | |
| 16 | - | ConfigOutput01 (Input filter) | USINT | | | | • |
| 20 | - | ConfigOutput03 (Lower limit value) | INT | | | | • |
| 22 | - | ConfigOutput04 (Upper limit value) | INT | | | | • |
| Analog signal - Communication | | | | | | | |
| 0 | 0 | AnalogInput01 | INT | • | | | |
| 2 | 2 | AnalogInput02 | INT | • | | | |
| 30 | - | StatusInput01 | USINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.1.5.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.1.5.8.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.1.5.8.4 Analog inputs

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

9.1.5.8.5 Input values of analog inputs

Name:

AnalogInput01 to AnalogInput02

The analog input value is mapped in this register.

| Data type | Value | Input signal: |
|-----------|-----------------|------------------------------|
| INT | -32768 to 32767 | Voltage signal -10 to 10 VDC |

9.1.5.8.6 Input filter

This module is equipped with a configurable input filter. The minimum cycle time must be $>500\ \mu\text{s}$. Filtering is disabled for shorter cycle times.

If the input filter is active, then the scan rate for the channels is measured in ms. The time offset between the channels is $200\ \mu\text{s}$. The conversion takes place asynchronously to the network cycle.

9.1.5.8.6.1 Input ramp limiting

Input ramp limiting can only be performed in conjunction with filtering. Input ramp limiting is performed before filtering.

The difference of the input value change is checked for exceeding the specified limit. In the event of overshoot, the tracked input value is equal to the old value \pm the limit value.

Configurable limit values:

| Value | Limit value |
|-------|---|
| 0 | The input value is used without limitation. |
| 1 | $0x3FFF = 16383$ |
| 2 | $0x1FFF = 8191$ |
| 3 | $0x0FFF = 4095$ |
| 4 | $0x07FF = 2047$ |
| 5 | $0x03FF = 1023$ |
| 6 | $0x01FF = 511$ |
| 7 | $0x00FF = 255$ |

Input ramp limiting is well suited for suppressing disturbances (spikes). The following examples show the functionality of input ramp limiting based on an input step and a disturbance.

Example 1

The input value jumps from 8000 to 17000. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = $0x07FF = 2047$

Filter level = 2

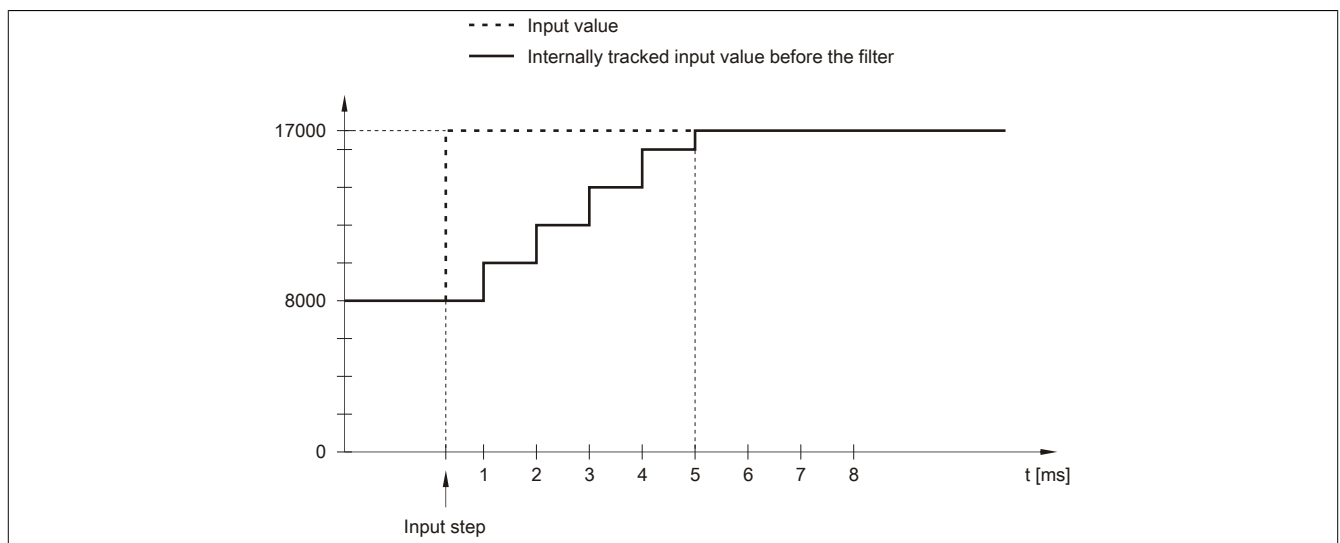


Figure 44: Tracked input value for input step

Example 2

A disturbance interferes with the input value. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = 0x07FF = 2047

Filter level = 2

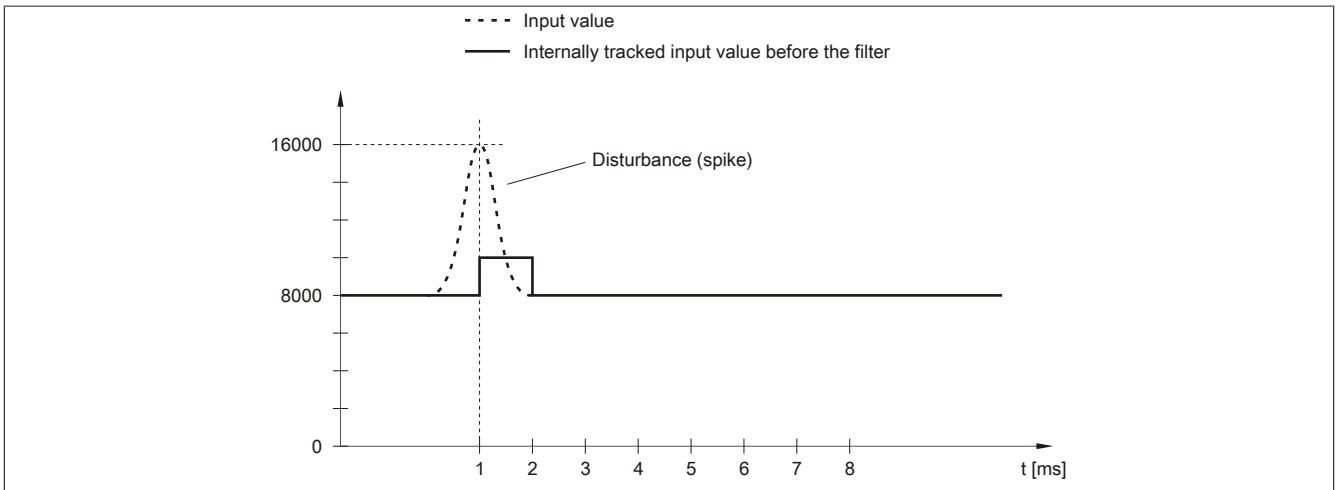


Figure 45: Tracked input value for disturbance

9.1.5.8.6.2 Filter level

A filter can be defined to prevent large input jumps. This filter is used to bring the input value closer to the actual analog value over a period of several bus cycles.

Filtering takes place after input ramp limitation.

Formula for calculating the input value:

$$\text{Value}_{\text{New}} = \text{Value}_{\text{Old}} - \frac{\text{Value}_{\text{Old}}}{\text{Filter level}} + \frac{\text{Input value}}{\text{Filter level}}$$

Adjustable filter levels:

| Value | Filter level |
|-------|---------------------|
| 0 | Filter switched off |
| 1 | Filter level 2 |
| 2 | Filter level 4 |
| 3 | Filter level 8 |
| 4 | Filter level 16 |
| 5 | Filter level 32 |
| 6 | Filter level 64 |
| 7 | Filter level 128 |

The following examples show how filtering works in the event of an input jump or disturbance.

Example 1

The input value jumps from 8000 to 16000. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

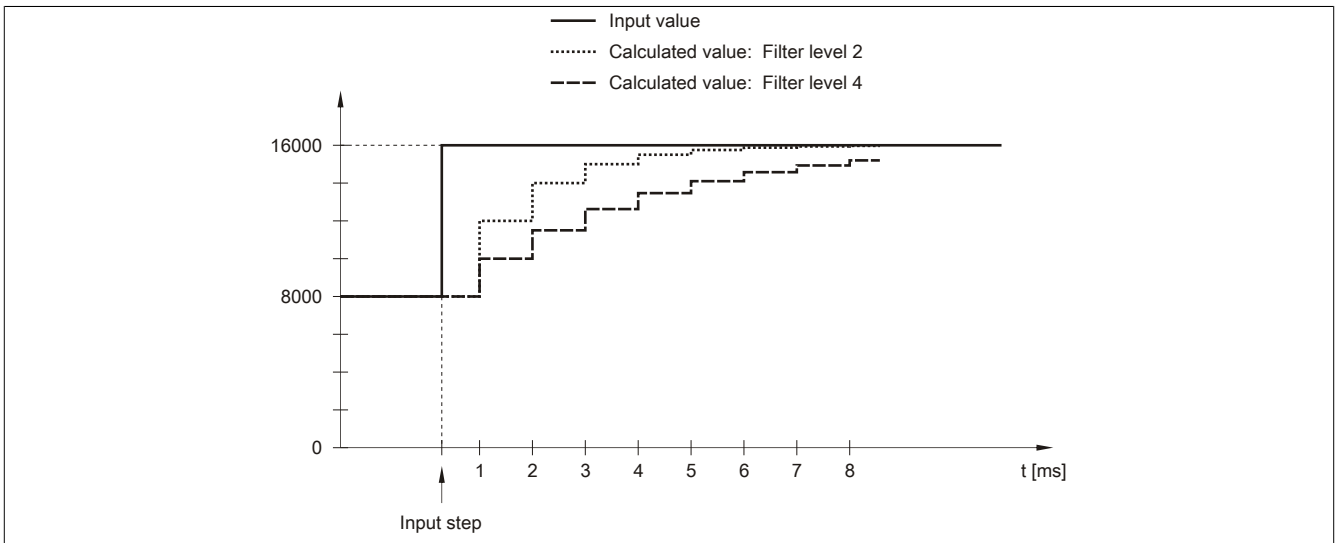


Figure 46: Calculated value during input step

Example 2

A disturbance interferes with the input value. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

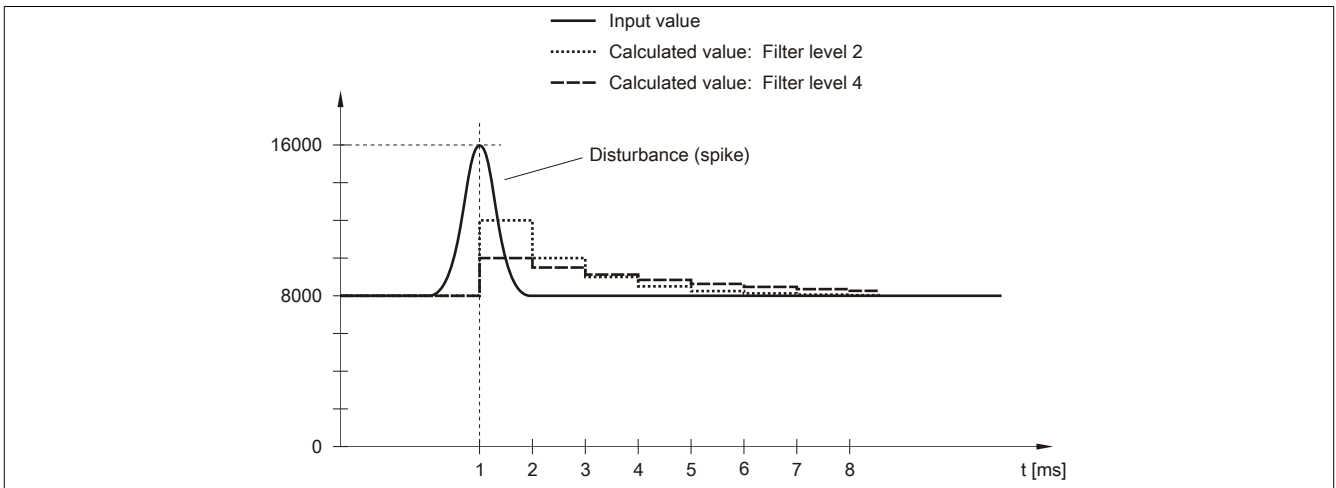


Figure 47: Calculated value during disturbance

9.1.5.8.7 Configuring the input filter

Name:

ConfigOutput01

The filter level and input ramp limiting of the input filter are set in this register.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------------|-------|--|
| 0 - 2 | Defines the filter level | 000 | Filter disabled (bus controller default setting) |
| | | 001 | Filter level 2 |
| | | 010 | Filter level 4 |
| | | 011 | Filter level 8 |
| | | 100 | Filter level 16 |
| | | 101 | Filter level 32 |
| | | 110 | Filter level 64 |
| | | 111 | Filter level 128 |
| 3 | Reserved | 0 | |
| 4 - 6 | Defines input ramp limiting | 000 | The input value is applied without limitation (bus controller default setting) |
| | | 001 | Limit value = 0x3FFF (16383) |
| | | 010 | Limit value = 0x1FFF (8191) |
| | | 011 | Limit value = 0x0FFF (4095) |
| | | 100 | Limit value = 0x07FF (2047) |
| | | 101 | Limit value = 0x03FF (1023) |
| | | 110 | Limit value = 0x01FF (511) |
| | | 111 | Limit value = 0x00FF (255) |
| 7 | Reserved | 0 | |

9.1.5.8.8 Lower limit value

Name:

ConfigOutput03

This register can be used to configure the lower limit for analog values. If the analog value goes below the limit value, it is frozen at this value and the corresponding error status bit is set.

| Data type | Values | Information |
|-----------|-----------------|--|
| INT | -32767 to 32767 | Bus controller default setting: -32767 |

Information:

The default value of -32767 corresponds to the minimum default value of -10 VDC.

Keep in mind that this setting applies to all channels!

9.1.5.8.9 Upper limit value

Name:

ConfigOutput04

This register can be used to configure the upper limit for analog values. If the analog value goes above the limit value, it is frozen at this value and the corresponding error status bit is set.

| Data type | Values | Information |
|-----------|-----------------|---------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 32767 |

Information:

The default value of 32767 corresponds to the maximum default value at +10 VDC.

Keep in mind that this setting applies to all channels!

9.1.5.8.10 Input status

Name:
StatusInput01

This register is used to monitor the module inputs. A change in the monitoring status generates an error message.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|----------------------------|
| 0 - 1 | Channel 1 | 00 | No error |
| | | 01 | Lower limit value exceeded |
| | | 10 | Upper limit value exceeded |
| | | 11 | Open line |
| 2 - 3 | Channel 2 | 00 | No error |
| | | 01 | Lower limit value exceeded |
| | | 10 | Upper limit value exceeded |
| | | 11 | Open line |
| 4 - 7 | Reserved | 0 | |

Limiting the analog value

In addition to the status information, the analog value is fixed to the values listed below by default in an error state. The analog value is limited to the new values if the limit values were changed.

| Error state | Digital value on error (default values) |
|-----------------------------|---|
| Open circuit | +32767 (0x7FFF) |
| Upper limit value overshoot | +32767 (0x7FFF) |
| Lower limit value undershot | -32767 (0x8001) |
| Invalid value | -32768 (0x8000) |

9.1.5.8.11 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------------|--------|
| Inputs without filtering | 100 µs |
| Inputs with filtering | 500 µs |

9.1.5.8.12 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|--------------------------|-----------------------|
| Inputs without filtering | 300 µs for all inputs |
| Inputs with filtering | 1 ms |

9.1.6 X20AI2237

Data sheet version: 1.30

9.1.6.1 General information

The module is equipped with 2 voltage measurement inputs with 16-bit digital converter resolution.

Each voltage input has its own sensor supply. The two channels with their respective sensor supplies are electrically isolated from each other.

- 2 analog voltage inputs
- Electrically isolated analog channels
- Electrically isolated sensor supplies
- 16-bit digital converter resolution
- Very high sampling rate
- NetTime timestamp: Moment of measurement

NetTime timestamp of the measurement

For many applications, not only the measured value is important, but also the exact time of the measurement. The module is equipped with a NetTime timestamp function for this that supplies a timestamp for the recorded position and trigger time with microsecond accuracy.

The timestamp function is based on synchronized timers. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

9.1.6.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Analog inputs |  |
| X20AI2237 | X20 analog input module, 2 inputs, ± 10 V, 16-bit converter resolution, single-channel isolation with separate sensor power supply, NetTime function | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 50: X20AI2237 - Order data

9.1.6.3 Technical data

| Model number | X20AI2237 |
|--|---|
| Short description | |
| I/O module | 2 analog inputs ± 10 V |
| General information | |
| B&R ID code | 0xC9C4 |
| Status indicators | I/O function per channel, operating state, module status, sensor supply per channel |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Inputs | Yes, using status LED and software |
| Sensor power supply | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.05 W |
| Internal I/O | 1.05 W (Rev. \geq D0), 1.15 W (Rev. $<$ D0) ¹⁾ |
| External I/O | 1.5 W ²⁾ |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| Analog inputs | |
| Input | ± 10 V |
| Input type | Differential input |
| Digital converter resolution | ± 15 -bit |
| Data output rate | 10,000 samples per second |
| Output format | |
| Data type | INT |
| Voltage | INT 0x8001 - 0x7FFF / 1 LSB = 0x0001 = 305.176 μ V |
| Input impedance in signal range | 20 M Ω |
| Input protection | Up to 30 VDC, reverse polarity protection |
| Open-circuit detection | Yes, using software |
| Permissible input signal | Max. ± 30 V |
| Output of digital value during overload | Configurable |
| Conversion procedure | SAR |
| Input filter | 4th-order low pass / cutoff frequency 10 kHz |
| Max. error at 25°C | |
| Gain | 0.013% ³⁾ |
| Offset | 0.0035% ⁴⁾ |
| Max. gain drift | <0.0008 %/°C ³⁾ |
| Max. offset drift | <0.0025 %/°C ⁴⁾ |
| Common-mode rejection | |
| DC | 84 dB |
| Up to 60 Hz | 84 dB |
| Up to 10 kHz | 82 dB |
| Common-mode range | ± 14 V |
| Nonlinearity | $<0.003\%$ ⁴⁾ |
| Test voltage between | |
| Channel and channel | 1000 VAC |
| Channel and bus | 1000 VAC |
| Channel and ground | 1000 VAC |
| Bus and ground | 800 VAC |
| Sensor power supply | |
| Nominal voltage | 25 V $\pm 2\%$ |
| Nominal output current | Max. 30 mA |
| Short-circuit proof | Yes, continuous |
| Electrical isolation | |
| Sensor power supply - Channel | No |
| Sensor power supply - Sensor power supply | Yes |
| Max. voltage ripple | |
| Up to 100 kHz | ≤ 2.2 mV |
| Up to 1 MHz | ≤ 22 mV |
| Higher | ≤ 100 mV |

Table 51: X20AI2237 - Technical data


| Model number | X20AI2237 |
|--|--|
| Short-circuit current | |
| Typical | <50 mA |
| Maximum | 60 mA |
| Behavior on short circuit | Current limitation |
| Electrical properties | |
| Electrical isolation | Channel isolated from channel and bus |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm |

Table 51: X20AI2237 - Technical data

- 1) To reduce power dissipation, B&R recommends bridging unused inputs.
- 2) Sensor supply
- 3) Based on the current measured value.
- 4) Based on the 20 V measurement range.

9.1.6.4 LED status indicators

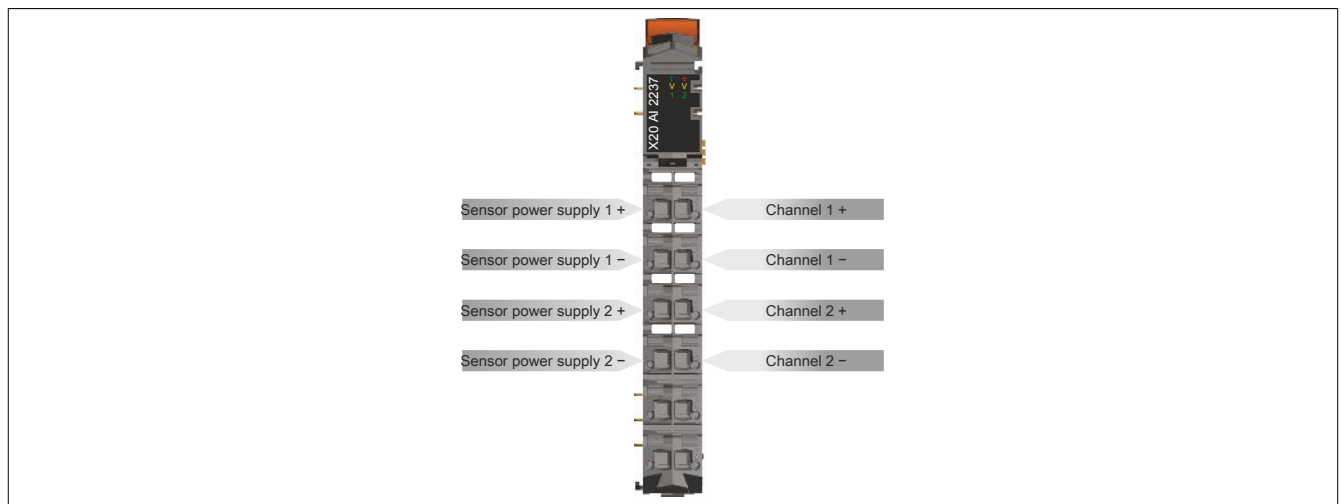
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|------------------------|--------|------------------|---|
|  | Operating state | | | |
| | r | Green | Off | No power to module |
| | | | Single flash | UNLINK mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking quickly | SYNC mode |
| | | | Blinking slowly | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | Module status | | | |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | Sensor supply | | | |
| | V | Yellow | Off | Module supply not connected or overload |
| | | | On | Sensor supply in its normal operating range |
| | Analog input | | | |
| | 1 - 2 | Green | Off | Indicates one of the following cases: <ul style="list-style-type: none"> • No power to module • Channel disabled • Open line |
| | | | Single flash | Input signal overflow or underflow |
| | | | On | Analog/digital converter running, value OK |

1) Depending on the configuration, a firmware update can take up to several minutes.

9.1.6.5 Pinout

Shielded twisted pair cables should be used to minimize coupling disturbances. Use either one cable for each channel or a multiple twisted pair cable for both channels.

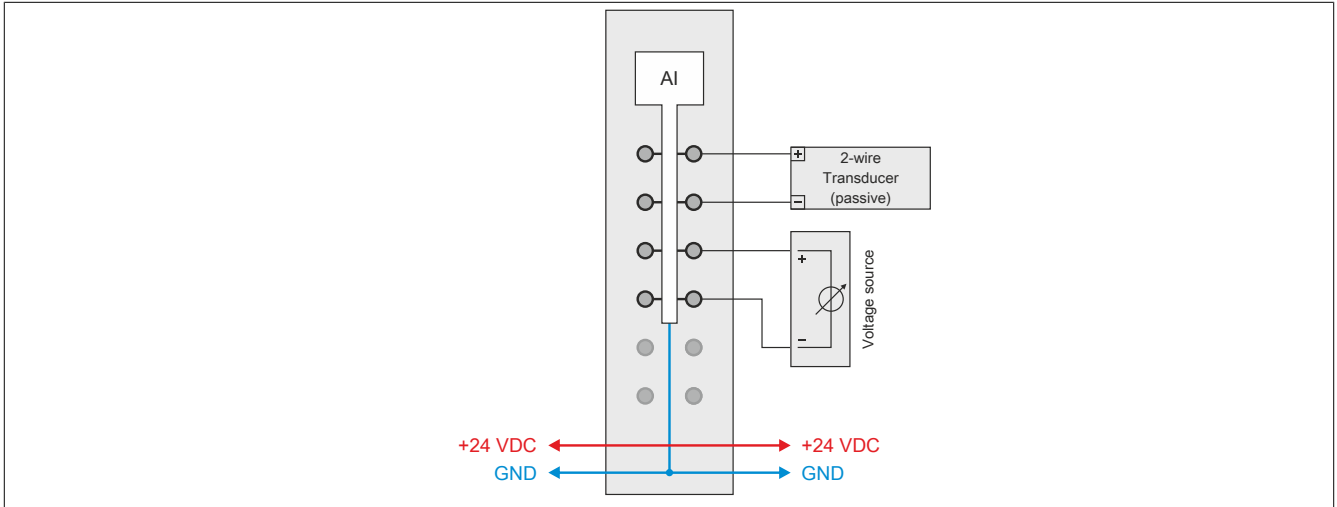


9.1.6.6 Connection examples

2-wire connections

A 2-wire connection can be implemented as follows:

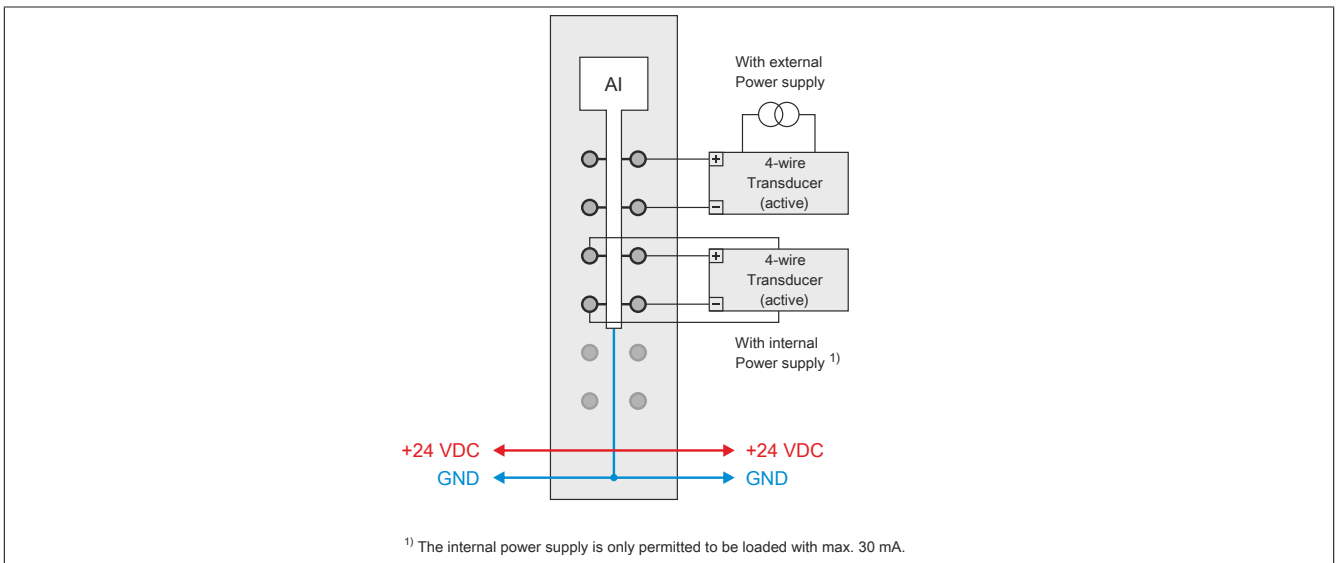
- 2-wire transducer
- Active voltage source



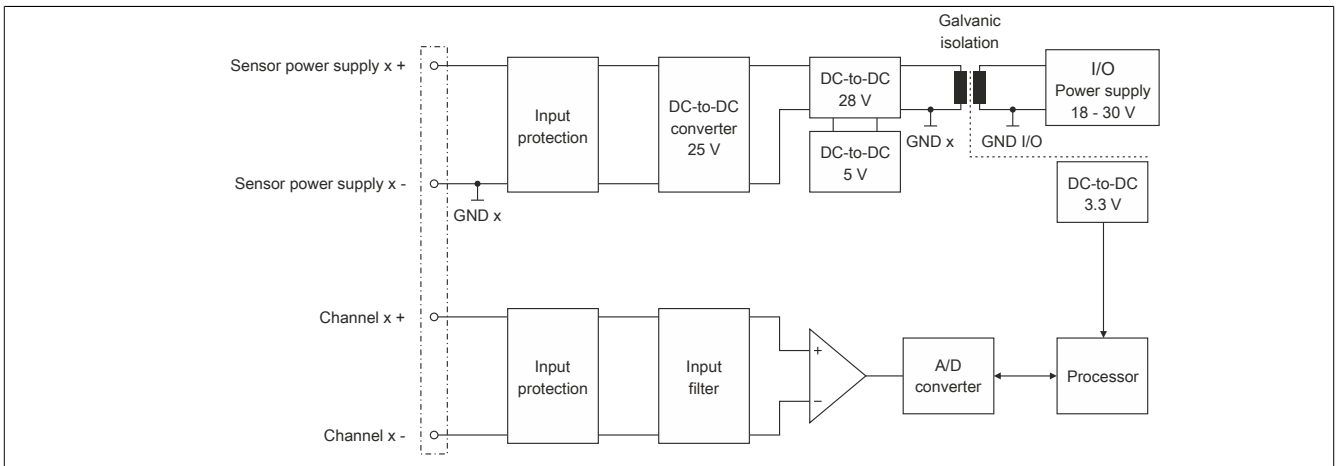
4-wire connections

A 4-wire connection can be implemented as follows:

- 4-wire transducer with external supply
- 4-wire transducer supplied by the module

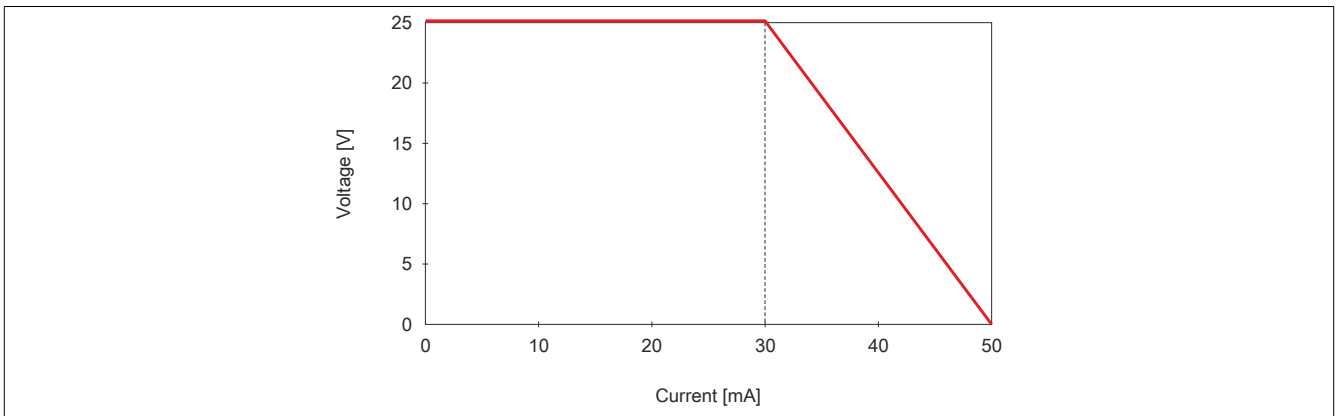


9.1.6.7 Input circuit diagram



9.1.6.8 Behavior in the event of short circuit

In the event of a short circuit, the output current for the sensor supply is limited according to the following diagram.



9.1.6.9 Register description

9.1.6.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.1.6.9.2 Function model 0 - default

| Register | Name | Data type | Read | | Write | |
|-------------------------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog input - Configuration | | | | | | |
| 390 434 | AnalogFilter01 AnalogFilter02 | UINT | | | | • |
| 386 430 | AnalogMode01 AnalogMode02 | UINT | | | | • |
| 402 446 | UpperLimit01 UpperLimit02 | INT | | | | • |
| 398 442 | LowerLimit01 LowerLimit02 | INT | | | | • |
| 406 450 | Hysteres01 Hysteres02 | INT | | | | • |
| 414 458 | ReplacementUpper01 ReplacementUpper02 | INT | | | | • |
| 410 454 | ReplacementLower01 ReplacementLower02 | INT | | | | • |
| 426 470 | PreparationInterval01 PreparationInterval02 | UINT | | | | • |
| 418 462 | ErrorDelay01 ErrorDelay02 | UINT | | | | • |
| 422 466 | SumErrorDelay01 SumErrorDelay02 | UINT | | | | • |
| Analog input - Communication | | | | | | |
| 0 2 | AnalogInput01 (limited) AnalogInput02 (limited) | INT | • | | | |
| 258 262 | AnalogInput01 (original value) AnalogInput02 (original value) | INT | • | | | |
| 284 292 | AnalogSampletime01 (32-bit) AnalogSampletime02 (32-bit) | DINT | • | | | |
| 282 290 | AnalogSampletime01 (16-bit) AnalogSampletime02 (16-bit) | INT | • | | | |
| 273 275 | AnalogStatus01 AnalogStatus02 | USINT | • | | | |
| | UnderflowAnalogInput01 or 02 | Bit 0 | | | | |
| | OverflowAnalogInput01 or 02 | Bit 1 | | | | |
| | OpenLineAnalogInput01 or 02 | Bit 2 | | | | |
| | SumErrorAnalogInput01 or 02 | Bit 4 | | | | |
| | SensorErrorAnalogInput01 or 02 | Bit 6 | | | | |
| | IoSuppErrorAnalogInput01 or 02 | Bit 7 | | | | |

9.1.6.9.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|-------------------------------------|----------------------|--------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog input - Configuration | | | | | | | |
| 390 | - | AnalogFilter01 | UINT | | | | • |
| 434 | - | AnalogFilter02 | | | | | |
| 386 | - | AnalogMode01 | UINT | | | | • |
| 430 | - | AnalogMode02 | | | | | |
| 402 | - | UpperLimit01 | INT | | | | • |
| 446 | - | UpperLimit02 | | | | | |
| 398 | - | LowerLimit01 | INT | | | | • |
| 442 | - | LowerLimit02 | | | | | |
| 406 | - | Hysteres01 | INT | | | | • |
| 450 | - | Hysteres02 | | | | | |
| 414 | - | ReplacementUpper01 | INT | | | | • |
| 458 | - | ReplacementUpper02 | | | | | |
| 410 | - | ReplacementLower01 | INT | | | | • |
| 454 | - | ReplacementLower02 | | | | | |
| 426 | - | PreparationInterval01 | UINT | | | | • |
| 470 | - | PreparationInterval02 | | | | | |
| 418 | - | ErrorDelay01 | UINT | | | | • |
| 462 | - | ErrorDelay02 | | | | | |
| 422 | - | SumErrorDelay01 | UINT | | | | • |
| 466 | - | SumErrorDelay02 | | | | | |
| Analog input - Communication | | | | | | | |
| 0 | 0 | AnalogInput01 | INT | • | | | |
| 2 | 2 | AnalogInput02 | | | | | |
| 273 | - | AnalogStatus01 | USINT | | • | | |
| 275 | - | AnalogStatus02 | | | | | |
| | | UnderflowAnalogInput01 or 02 | Bit 0 | | | | |
| | | OverflowAnalogInput01 or 02 | Bit 1 | | | | |
| | | OpenLineAnalogInput01 or 02 | Bit 2 | | | | |
| | | SumErrorAnalogInput01 or 02 | Bit 4 | | | | |
| | | SensorErrorAnalogInput01 or 02 | Bit 6 | | | | |
| | | IoSuppErrorAnalogInput01 or 02 | Bit 7 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.1.6.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.1.6.9.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.1.6.9.4 General information

The module provides 2 electrically isolated channels. Each channel can read an electrical voltage signal in the ± 10 V range and supply the signal encoder with 24 VDC.

9.1.6.9.5 Analog input - Configuration

Each channel is configured and enabled separately. First, the user must set the scaling of the input value and select a replacement value strategy. Depending on the requirements of the application, the user can also set user-defined limit values and define an input filter.

Scaling

The module's A/D converter works with a resolution of 16 bits (± 15 bits). This allows the input value of ± 10 V to be mapped using ± 32767 steps. To simplify implementation, the user can configure scaling to ± 10000 steps. The conversion value corresponds to the voltage in mV, and with a resolution of more than 14 bits (± 13 bits) is still precise enough for the many different application that use this technology.

Replacement value strategy

The detected voltage is evaluated in order to ensure the quality of the read value. For example, if a logically impermissible voltage value or an open line is detected, the limit monitor triggers an appropriate response.

The response is determined by the replacement value strategy selected by the user. With the option "Replace with static value", the user defines two values that replace the converted value when the upper and lower limits are exceeded. The alternative "Retain last valid value" keeps the last validated value. However, the evaluation for this option takes more time. Depending on the "[preparation interval](#)", the value currently being read may be delayed.

Limit Value Monitoring

In addition to the qualitative evaluation of the input, the module also provides the option of adapting the range of permitted values to the requirements of the application. The registers "[UpperLimit](#)" on page 341 and "[LowerLimit](#)" on page 341 can be used to place additional restrictions on the permitted upper and lower limit. When this feature is used, the selected replacement value strategy is implemented according to the new limits.

9.1.6.9.5.1 Input filter

Analog input signals can experience brief disturbances caused by external factors (EMC). The A/D converters high sampling rate allows you to filter out these types of signal peaks without hindering the application processes.

2 configuration points are available for interpolating the input signal:

- "Input ramp limiting" on page 337
- "Filter level" on page 338

Input ramp limiting

Input ramp limiting can only be performed in conjunction with filtering. Input ramp limiting is performed before filtering.

The difference of the input value change is checked for exceeding the specified limit. In the event of overshoot, the tracked input value is equal to the old value \pm the limit value.

Configurable limit values:

| Value | Limit value |
|-------|---|
| 0 | The input value is used without limitation. |
| 1 | 0x3FFF = 16383 |
| 2 | 0x1FFF = 8191 |
| 3 | 0x0FFF = 4095 |
| 4 | 0x07FF = 2047 |
| 5 | 0x03FF = 1023 |
| 6 | 0x01FF = 511 |
| 7 | 0x00FF = 255 |

Input ramp limiting is well suited for suppressing disturbances (spikes). The following examples show the functionality of input ramp limiting based on an input step and a disturbance.

Example 1

The input value jumps from 8000 to 17000. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = 0x07FF = 2047

Filter level = 2

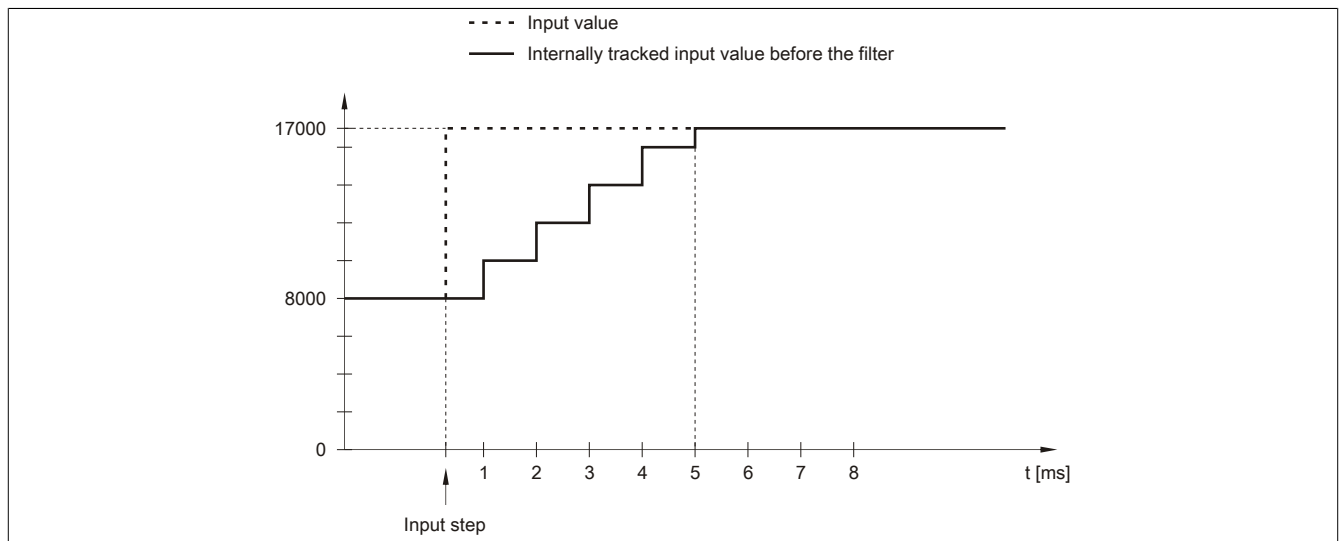


Figure 48: Tracked input value for input step

Example 2

A disturbance interferes with the input value. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = 0x07FF = 2047

Filter level = 2

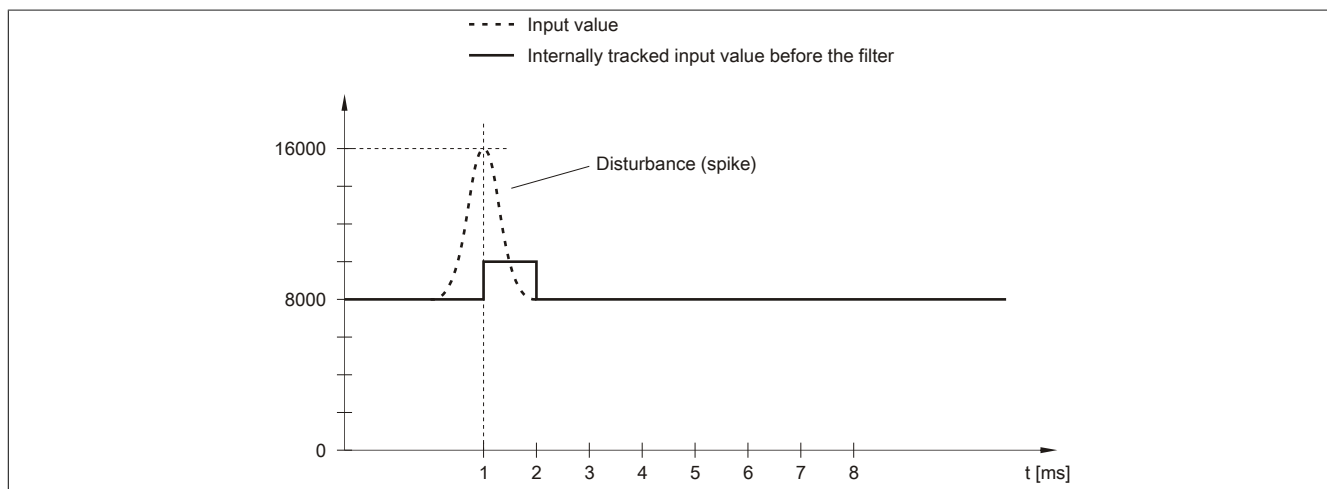


Figure 49: Tracked input value for disturbance

Filter level

A filter can be defined to prevent large input jumps. This filter is used to bring the input value closer to the actual analog value over a period of several bus cycles.

Filtering takes place after input ramp limitation.

Formula for calculating the input value:

$$Value_{New} = Value_{Old} - \frac{Value_{Old}}{Filter\ level} + \frac{Input\ value}{Filter\ level}$$

Adjustable filter levels:

| Value | Filter level |
|-------|---------------------|
| 0 | Filter switched off |
| 1 | Filter level 2 |
| 2 | Filter level 4 |
| 3 | Filter level 8 |
| 4 | Filter level 16 |
| 5 | Filter level 32 |
| 6 | Filter level 64 |
| 7 | Filter level 128 |

The following examples show how filtering works in the event of an input jump or disturbance.

Example 1

The input value jumps from 8000 to 16000. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

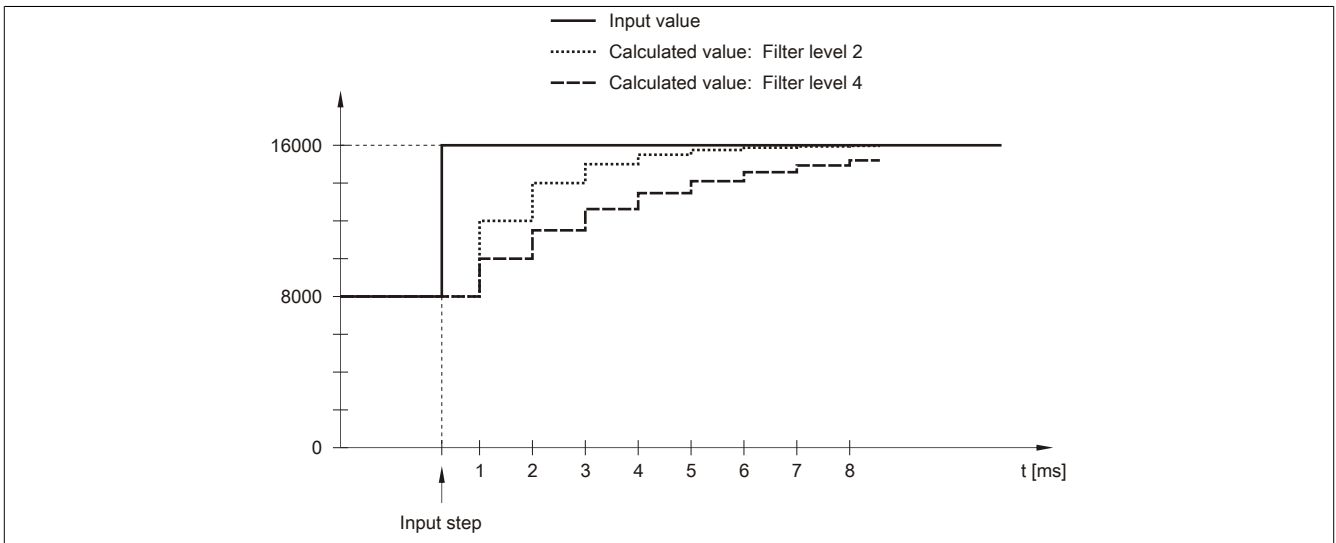


Figure 50: Calculated value during input step

Example 2

A disturbance interferes with the input value. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

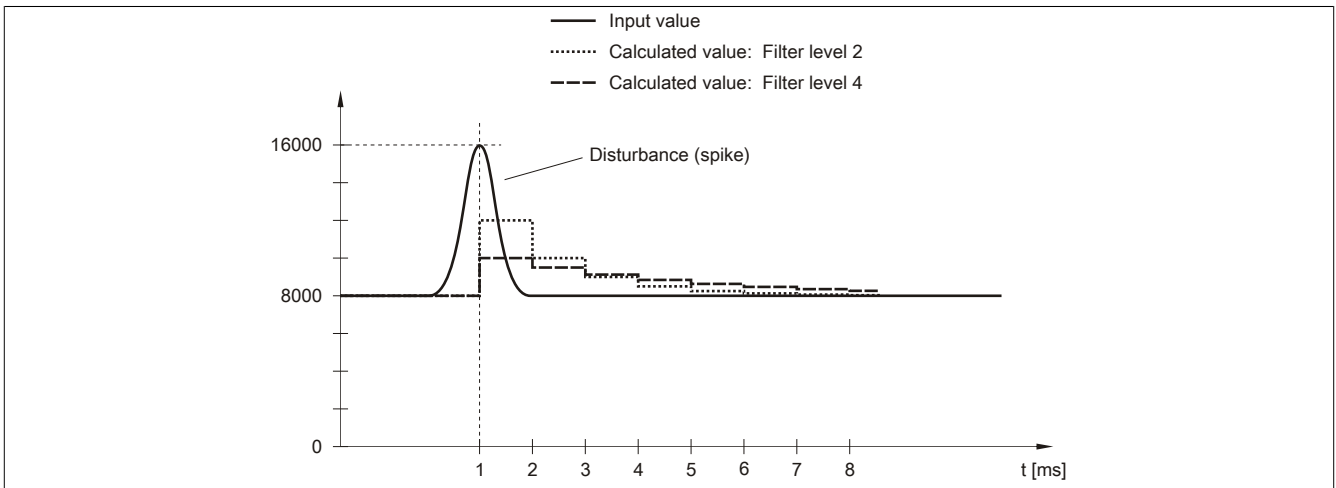


Figure 51: Calculated value during disturbance

Configuring filters

Name:

AnalogFilter01 to AnalogFilter02

This register is used to define the filter level and input ramp limitation of the input filter.

| Data type | Value | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| UINT | See bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------------|-------|--|
| 0 - 2 | Defines the filter level | 000 | Filter disabled (bus controller default setting) |
| | | 001 | Filter level 2 |
| | | 010 | Filter level 4 |
| | | 011 | Filter level 8 |
| | | 100 | Filter level 16 |
| | | 101 | Filter level 32 |
| | | 110 | Filter level 64 |
| | | 111 | Filter level 128 |
| 3 | Reserved | 0 | |
| 4 - 6 | Defines input ramp limiting | 000 | The input value is applied without limitation (bus controller default setting) |
| | | 001 | Limit value = 0x3FFF (16383) |
| | | 010 | Limit value = 0x1FFF (8191) |
| | | 011 | Limit value = 0x0FFF (4095) |
| | | 100 | Limit value = 0x07FF (2047) |
| | | 101 | Limit value = 0x03FF (1023) |
| | | 110 | Limit value = 0x01FF (511) |
| | | 111 | Limit value = 0x00FF (255) |
| 7 | Reserved | 0 | |

9.1.6.9.5.2 Channel parameters

Name:

AnalogMode01 to AnalogMode02

These registers are used to predefine the operating parameters that the module will be using for the respective channel. Each channel must be enabled individually and can be configured and operated independently.

Information:

Different limit values must be configured for any display normalizing that needs to take place.

| Data type | Value | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| UINT | See bit structure. | 15 |

Bit structure:

| Bit | Name | Value | Information |
|--------|----------------------------|-------|--|
| 0 | Channel (on/off) | 0 | Disabled |
| | | 1 | Enabled (bus controller default setting) |
| 1 | Limit exceeded | 0 | Disabled |
| | | 1 | Enabled (bus controller default setting) |
| 2 | Lower limit violation | 0 | Disabled |
| | | 1 | Enabled (bus controller default setting) |
| 3 | Reserved | 0 | |
| 4 | Replacement value strategy | 0 | Replace with static value |
| | | 1 | Retain last valid value |
| 5 | Measured value scaling | 0 | ±32767 (resolution: 16-bit) |
| | | 1 | ±10000 (resolution: >14-bit) |
| 6 - 15 | Reserved | 0 | |

9.1.6.9.5.3 Upper limit value

Name:

UpperLimit01 to UpperLimit02

If the value range needs to be restricted further, this register can be used to enter new user-specific upper limit values.

| Data type | Value | Information |
|-----------|------------------|---------------------------------------|
| INT | -32767 to 32767. | Bus controller default setting: 32767 |
| | -10000 to 10000 | |

Information:

The defined limit values must take the configured scaling into consideration.

9.1.6.9.5.4 Lower limit value

Name:

LowerLimit01 to LowerLimit02

If the value range needs to be restricted further, this register can be used to enter new user-specific lower limit values.

| Data type | Value | Information |
|-----------|------------------|--|
| INT | -32767 to 32767. | Bus controller default setting: -32767 |
| | -10000 to 10000 | |

Information:

The defined limit values must take the configured scaling into consideration.

9.1.6.9.5.5 Hysteresis

Name:

Hysteres01 to Hysteres02

If the user-specific limit values are being used, then a hysteresis range should also be defined. These registers configure how far a limit value can be exceeded before a response is triggered.

The error status is cleared when the scaled input value once again passes the limit by at least the hysteresis value in the permitted direction.

| Data type | Value | Information |
|-----------|------------------|-------------------------------------|
| INT | -32767 to 32767. | Bus controller default setting: 100 |
| | -10000 to 10000 | |

Information:

The hysteresis value must take the scaling into consideration.

9.1.6.9.5.6 Upper replacement value

Name:

ReplacementUpper01 to ReplacementUpper02

This register is used to define the static values to be displayed instead of the current measured value when the limit is violated.

| Data type | Value | Information |
|-----------|------------------|---------------------------------------|
| INT | -32767 to 32767. | Bus controller default setting: 32767 |

9.1.6.9.5.7 Lower replacement value

Name:

ReplacementLower01 to ReplacementLower02

This register is used to define the lower static values to be displayed instead of the current measured value when the limit is violated.

| Data type | Value | Information |
|-----------|-----------------|--|
| INT | -32767 to 32767 | Bus controller default setting: -32767 |

9.1.6.9.5.8 Preparation time for the measured values

Name:

PreparationInterval01 to PreparationInterval02

If the last valid measured value should be kept when violating the limit value, then PreparationInterval must be defined. The measured values continue to be acquired and converted according to the configured I/O update time. They are then checked and discarded if they do not meet the specifications. When an error does not occur, therefore, the measured value acquired 2 preparation intervals ago is constantly output.

| Data type | Value | Information |
|-----------|------------|---|
| UINT | 0 to 65535 | In 0.1 ms. Bus controller default setting: 0 |

| | | |
|--|---|---|
| <p>Functionality: Measured values are continuously converted and stored to measured value memory depending on the configured input filter. The current contents of the measured value memory are checked within the configured interval. If a permissible value is present, then the contents of the buffer memory are passed to output memory and the contents of the measured value memory are passed to the buffer. If the check turns up an impermissible value, then the contents of the measured value memory are discarded. The copy direction between output and buffer memory reverses and the last valid value continues to be output.</p> <p>Information: If configured to keep the last valid value, the delay time from measuring to outputting the value will be at least twice the preparation interval. In the worst case scenario, this can also take twice the interval time plus the configured conversion rate of the A/D converter.</p> | | "Application" Value being measured (analog) |
| | ↓ | Condition: - Conversion interval (A/D converter) elapsed |
| | | "Measured value memory" Measured value (digital) |
| | ↓ | Condition: - PreparationInterval elapsed - Measured value permissible |
| | | "Buffer" Last valid value |
| | ↓ | Condition: - PreparationInterval elapsed - Measured value permissible |
| | | "Output memory" Next-to-last valid/ displayed value |

9.1.6.9.5.9 Delaying error messages

Name:

ErrorDelay01 to ErrorDelay02

This register specifies the number of consecutive conversion procedures where an error is pending until the corresponding individual error status bit is set. The delay applies to underflow, overflow and open circuit errors. This delay can be used to hide temporary measured value deviations, for example.

| Data type | Value | Information |
|-----------|------------|-----------------------------------|
| UINT | 0 to 65535 | Bus controller default setting: 2 |

9.1.6.9.5.10 Time for composite error bit

Name:

SumErrorDelay01 to SumErrorDelay02

This register can be used to set the time that an error must remain pending before the composite error bit is set.

| Data type | Value | Information |
|-----------|------------|--------------------------------------|
| UINT | 0 to 65535 | Bus controller default setting: 4000 |

9.1.6.9.6 Analog input - Communication

The measured voltage data can be obtained via 2 different registers: The [unevaluated measured value](#) contains the scaled converter value. The [evaluated measured value](#) also takes the limit values and the configured replacement value strategy into consideration.

9.1.6.9.6.1 Analog input values - Original values

Name:

AnalogInput01 to AnalogInput02

These registers are used to indicate the actual input values after standardization.

| Data type | Value |
|-----------|-----------------|
| INT | -32767 to 32767 |
| | -10000 to 10000 |

9.1.6.9.6.2 Analog input values - Limited

Name:

AnalogInput01 to AnalogInput02

These registers are used to indicate the actual input values after standardization. In addition, the settings for limit value monitoring and replacement value strategy are applied to this register.

| Data type | Value |
|-----------|-----------------|
| INT | -32767 to 32767 |
| | -10000 to 10000 |

9.1.6.9.6.3 Sample time

Name:

Sampletime01 to Sampletime02

These registers return the timestamp for when the module reads the current channel mapping. The values are provided as signed 2-byte or 4-byte values.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Values [μ s] | Information |
|-----------|---------------------------------|--|
| INT | -32,768 to 32767 | NetTime timestamp of the current input value |
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime timestamp of the current input value |

9.1.6.9.6.4 Status of the inputs

Name:

AnalogStatus01 to AnalogStatus02

UnderflowAnalogInput01 to UnderflowAnalogInput02

OverflowAnalogInput01 to OverflowAnalogInput02

OpenLineAnalogInput01 to OpenLineAnalogInput02

SumErrorAnalogInput01 to SumErrorAnalogInput02

SensorErrorAnalogInput01 to SensorErrorAnalogInput02

IoSuppErrorAnalogInput01 to IoSuppErrorAnalogInput02

The current error status of the module channels is displayed in this register, regardless of the configured replacement value strategy. Some error information may be delayed according to the previously configured condition.

Setting "Format of status information" in Automation Studio allows you to specify whether the status information is transferred as USINT or bitwise.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|--------------------------------|-------|---------------------------------|
| 0 | UnderflowAnalogInput01 or 02 | 0 | No error |
| | | 1 | Below lower limit value |
| 1 | OverflowAnalogInput01 or 02 | 0 | No error |
| | | 1 | Above upper limit value |
| 2 | OpenLineAnalogInput01 or 02 | 0 | No error |
| | | 1 | Open line detected |
| 3 | Reserved | 0 | |
| 4 | SumErrorAnalogInput01 or 02 | 0 | No error |
| | | 1 | Composite error detected |
| 5 | Reserved | 0 | |
| 6 | SensorErrorAnalogInput01 or 02 | 0 | Sensor voltage OK |
| | | 1 | Sensor load too high |
| 7 | IoSuppErrorAnalogInput01 or 02 | 0 | I/O power supply OK |
| | | 1 | I/O power supply error detected |

UnderflowAnalogInput

The signal underflow error status is indicated here according to the configuration. This error information is enabled as a multiple of the conversion cycle only after the configurable delay time has passed (see "[ErrorDelay](#)" on page 342 register).

OverflowAnalogInput

The signal overflow error status is indicated here according to the configuration. This error information is enabled as a multiple of the conversion cycle only after the configurable delay time has passed (see "[ErrorDelay](#)" on page 342 register).

SumErrorAnalogInput

This error information derives from the status of individual errors and is only activated after the configurable delay time has passed [ms] (see "[SumErrorDelay](#)" on page 342 register). Linking this error information to an application makes it possible to hide temporary temperature value overflows and underflows, for example.

SensorErrorAnalogInput

In addition to the analog input, the module also provides the option of supplying the connected encoder with 24 VDC. If the input impedance for the sensor is too high, however, the integrated voltage supply will fail.

IoSuppErrorAnalogInput

This error is activated immediately as soon as the module detects that the necessary supply voltage is no longer being provided (<20 VDC).

9.1.6.9.7 NetTime Technology

For a description of NetTime Technology, see "[NetTime Technology](#)" on page 3035.

9.1.6.9.8 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μ s |

9.1.6.9.9 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 1 ms |

9.1.7 X20AI2322

Data sheet version: 1.21

9.1.7.1 General information

The module is equipped with 2 inputs with 12-bit digital converter resolution. It is possible to select between the two current ranges 0 to 20 mA and 4 to 20 mA.

This module is designed for X20 6-pin terminal blocks. If needed (e.g. for logistical reasons), the 12-pin terminal block can also be used.

- 2 analog inputs, 0 to 20 mA or 4 to 20 mA
- 12-bit digital converter resolution

9.1.7.2 Order data


| Model number | Short description | Figure |
|--------------|--|--|
| | Analog inputs |  |
| X20AI2322 | X20 analog input module, 2 inputs, 0-20 mA / 4-20 mA, 12-bit converter resolution, configurable input filter | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |

Table 52: X20AI2322 - Order data

9.1.7.3 Technical data

| Model number | X20AI2322 |
|--|--|
| Short description | |
| I/O module | 2 analog inputs 0 to 20 mA / 4 to 20 mA |
| General information | |
| B&R ID code | 0xCAB2 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Inputs | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 0.8 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| Analog inputs | |
| Input | 0 to 20 mA/4 to 20 mA |
| Input type | Differential input |
| Digital converter resolution | 12-bit |
| Conversion time | 300 µs for all inputs |
| Output format | |
| Data type | INT |
| Current | 0x0000 - 0x7FFF / 1 LSB = 0x0008 = 4.883 µA |
| Load | <400 Ω |
| Input protection | Protection against wiring with supply voltage |
| Permissible input signal | Max. ±50 mA |
| Output of digital value during overload | Configurable |
| Conversion procedure | SAR |
| Input filter | 3rd-order low pass / cutoff frequency 1 kHz |
| Max. error at 25°C | |
| Gain | |
| 0 to 20 mA | 0.08% ¹⁾ |
| 4 to 20 mA | 0.1% ¹⁾ |
| Offset | |
| 0 to 20 mA | 0.03% ²⁾ |
| 4 to 20 mA | 0.16% ²⁾ |
| Max. gain drift | |
| 0 to 20 mA | 0.009 %/°C ¹⁾ |
| 4 to 20 mA | 0.0113 %/°C ¹⁾ |
| Max. offset drift | |
| 0 to 20 mA | 0.004 %/°C ²⁾ |
| 4 to 20 mA | 0.005 %/°C ²⁾ |
| Common-mode rejection | |
| DC | 70 dB |
| 50 Hz | 70 dB |
| Common-mode range | ±12 V |
| Crosstalk between channels | -70 dB |
| Nonlinearity | <0.05% ²⁾ |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |

Table 53: X20AI2322 - Technical data


| Model number | X20AI2322 |
|--|---|
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB06 or X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm |

Table 53: X20AI2322 - Technical data

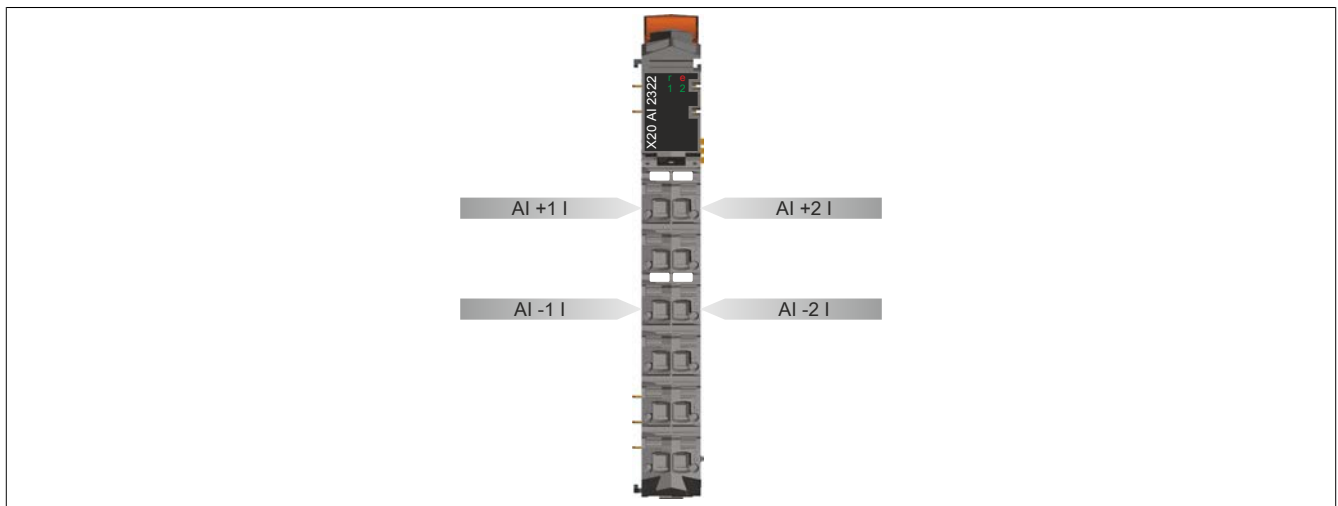
- 1) Based on the current measured value.
- 2) Based on the 20 mA measurement range.

9.1.7.4 LED status indicators

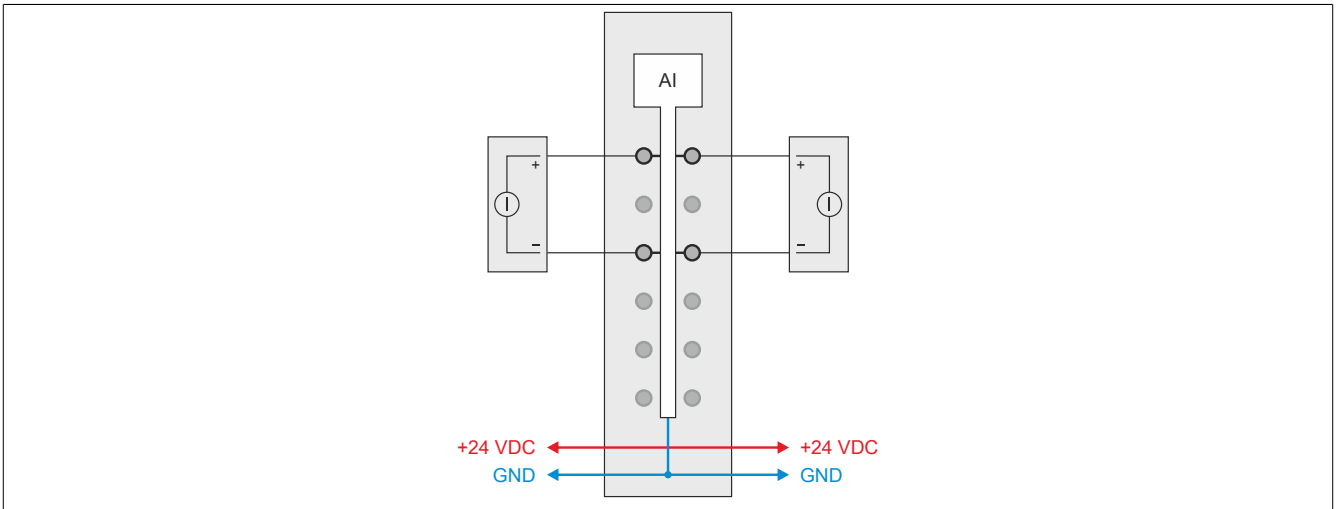
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|--|-------|-----------------------------|--|-------------------------------------|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1 - 2 | Green | Blinking | Input signal overflow or underflow |
| On | | | Analog/digital converter running, value OK | |

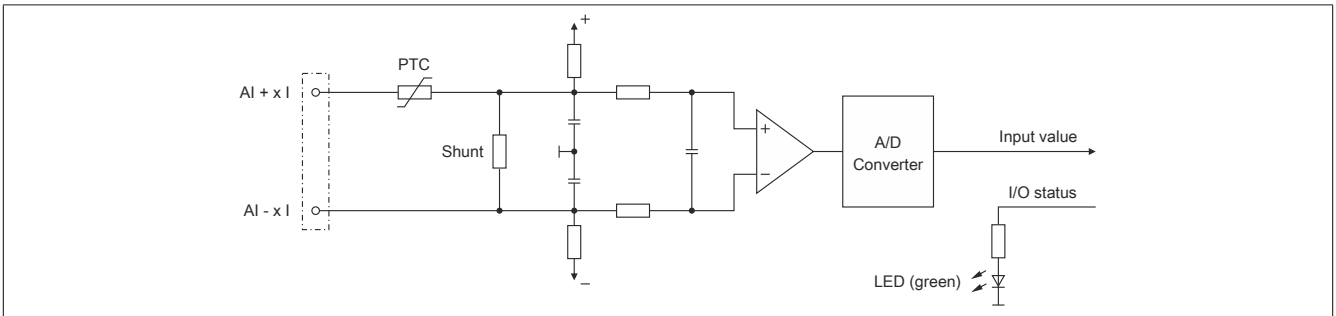
9.1.7.5 Pinout



9.1.7.6 Connection example



9.1.7.7 Input circuit diagram



9.1.7.8 Register description

9.1.7.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.1.7.8.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|--|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog signal - Configuration | | | | | | |
| 16 | ConfigOutput01 (Input filter) | USINT | | | | • |
| 18 | ConfigOutput02 (Channel type) | USINT | | | | • |
| 20 | ConfigOutput03 (Lower limit value) | INT | | | | • |
| 22 | ConfigOutput04 (Upper limit value) | INT | | | | • |
| Analog signal - Communication | | | | | | |
| 0 | AnalogInput01 | INT | • | | | |
| 2 | AnalogInput02 | INT | • | | | |
| 30 | StatusInput01 | USINT | • | | | |

9.1.7.8.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------------|----------------------|--|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog signal - Configuration | | | | | | | |
| 16 | - | ConfigOutput01 (Input filter) | USINT | | | | • |
| 18 | - | ConfigOutput02 (Channel type) | USINT | | | | • |
| 20 | - | ConfigOutput03 (Lower limit value) | INT | | | | • |
| 22 | - | ConfigOutput04 (Upper limit value) | INT | | | | • |
| Analog signal - Communication | | | | | | | |
| 0 | 0 | AnalogInput01 | INT | • | | | |
| 2 | 2 | AnalogInput02 | INT | • | | | |
| 30 | - | StatusInput01 | USINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.1.7.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.1.7.8.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.1.7.8.4 Analog inputs

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

9.1.7.8.5 Analog input values

Name:

AnalogInput01 to AnalogInput02

The analog input values are mapped to this register.

| Data type | Value | Input signal: |
|-----------|----------------|---|
| INT | 0 to 32767 | Current signal 0 to 20 mA |
| | -8192 to 32767 | Current signal 4 to 20 mA (value 0 corresponds to 4 mA) |

9.1.7.8.6 Input filter

This module is equipped with a configurable input filter. The minimum cycle time must be $>500 \mu\text{s}$. Filtering is disabled for shorter cycle times.

If the input filter is active, then the scan rate for the channels is measured in ms. The time offset between the channels is $200 \mu\text{s}$. The conversion takes place asynchronously to the network cycle.

9.1.7.8.6.1 Input ramp limiting

Input ramp limiting can only be performed in conjunction with filtering. Input ramp limiting is performed before filtering.

The difference of the input value change is checked for exceeding the specified limit. In the event of overshoot, the tracked input value is equal to the old value \pm the limit value.

Configurable limit values:

| Value | Limit value |
|-------|---|
| 0 | The input value is used without limitation. |
| 1 | $0x3FFF = 16383$ |
| 2 | $0x1FFF = 8191$ |
| 3 | $0x0FFF = 4095$ |
| 4 | $0x07FF = 2047$ |
| 5 | $0x03FF = 1023$ |
| 6 | $0x01FF = 511$ |
| 7 | $0x00FF = 255$ |

Input ramp limiting is well suited for suppressing disturbances (spikes). The following examples show the functionality of input ramp limiting based on an input step and a disturbance.

Example 1

The input value jumps from 8000 to 17000. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = $0x07FF = 2047$

Filter level = 2

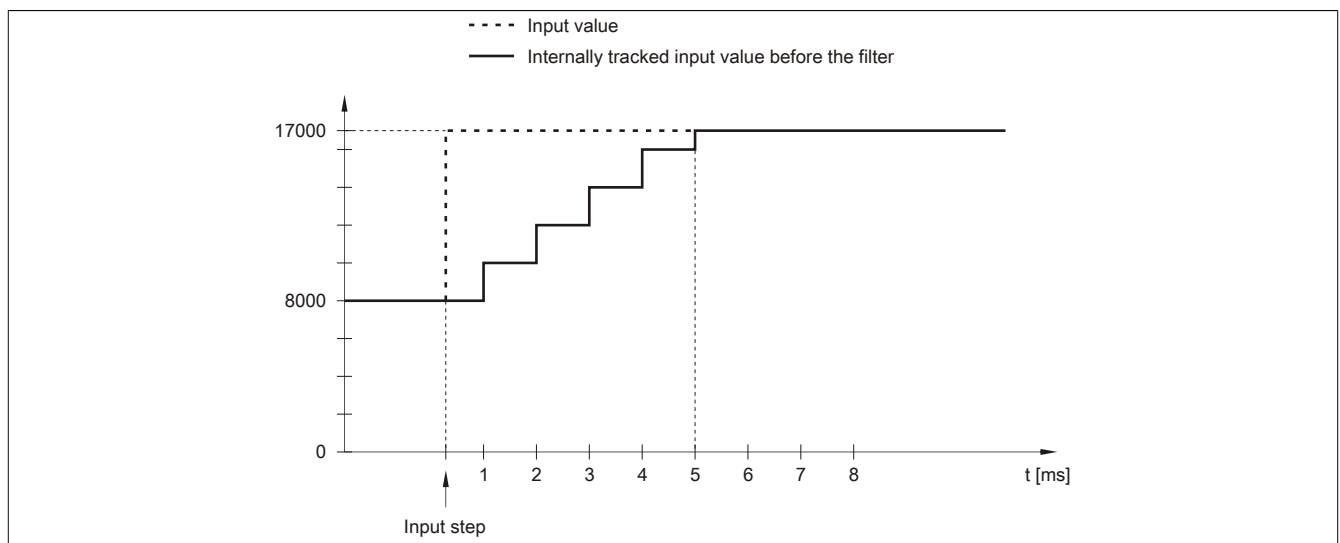


Figure 52: Tracked input value for input step

Example 2

A disturbance interferes with the input value. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = 0x07FF = 2047

Filter level = 2

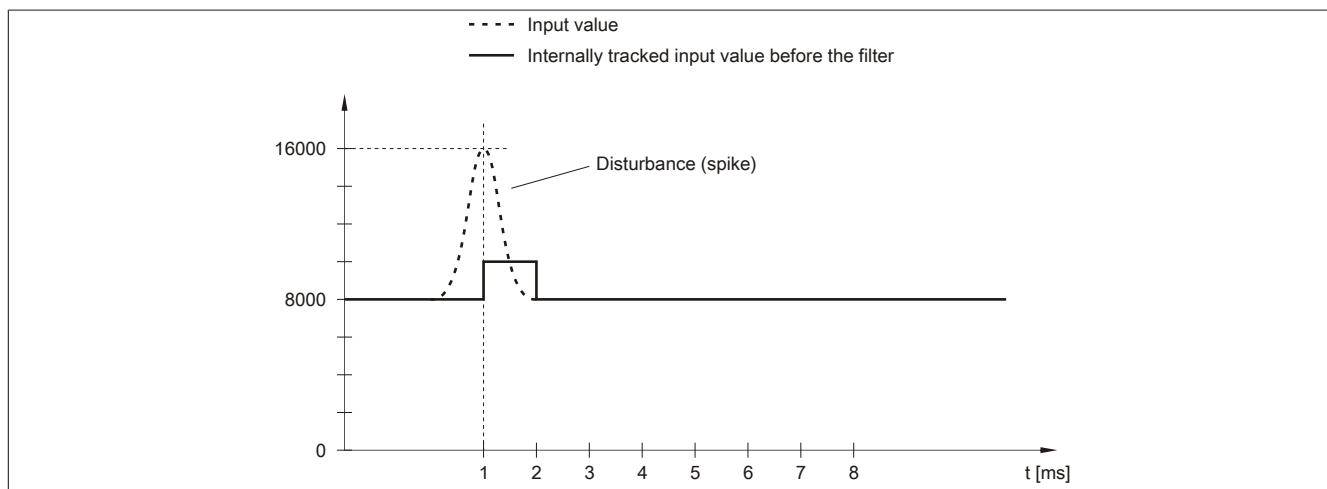


Figure 53: Tracked input value for disturbance

9.1.7.8.6.2 Filter level

A filter can be defined to prevent large input jumps. This filter is used to bring the input value closer to the actual analog value over a period of several bus cycles.

Filtering takes place after input ramp limitation.

Formula for calculating the input value:

$$\text{Value}_{\text{New}} = \text{Value}_{\text{Old}} - \frac{\text{Value}_{\text{Old}}}{\text{Filter level}} + \frac{\text{Input value}}{\text{Filter level}}$$

Adjustable filter levels:

| Value | Filter level |
|-------|---------------------|
| 0 | Filter switched off |
| 1 | Filter level 2 |
| 2 | Filter level 4 |
| 3 | Filter level 8 |
| 4 | Filter level 16 |
| 5 | Filter level 32 |
| 6 | Filter level 64 |
| 7 | Filter level 128 |

The following examples show how filtering works in the event of an input jump or disturbance.

Example 1

The input value jumps from 8000 to 16000. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

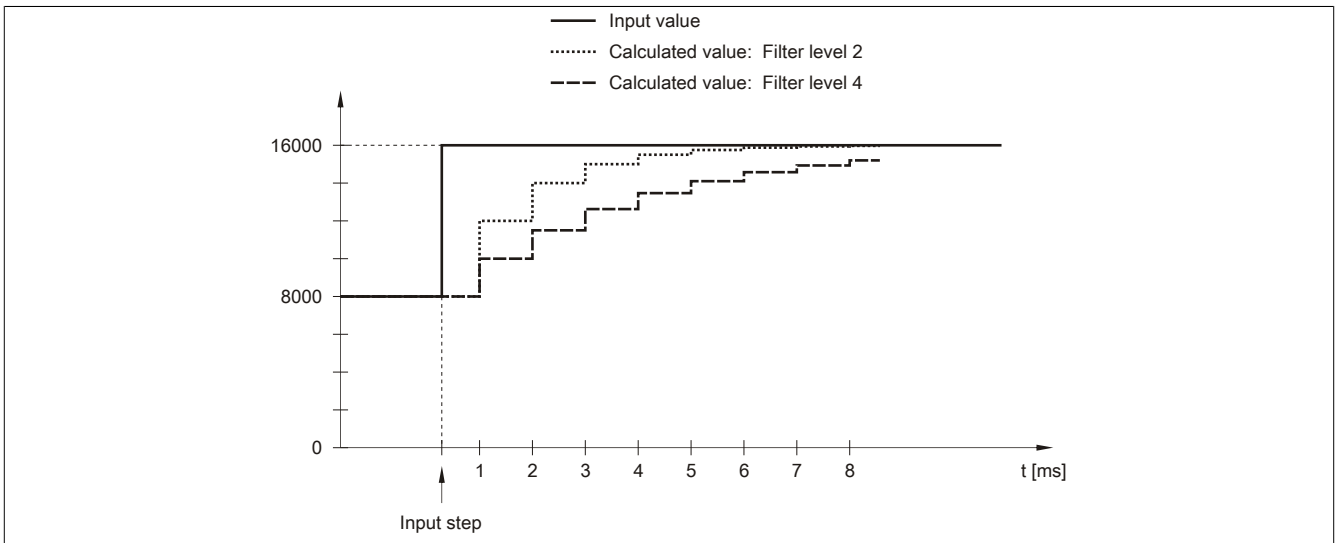


Figure 54: Calculated value during input step

Example 2

A disturbance interferes with the input value. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

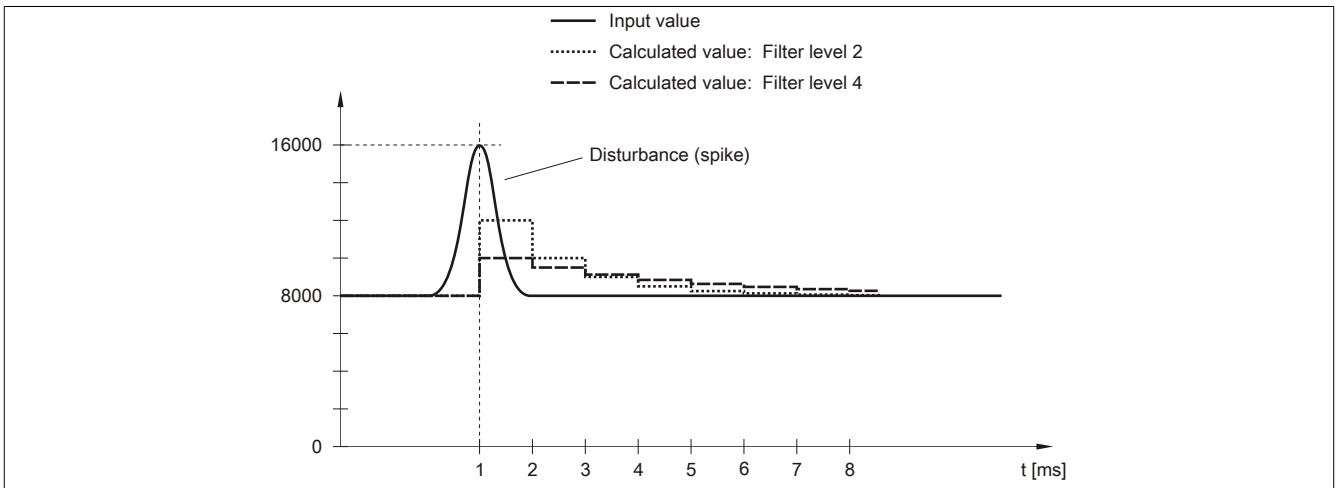


Figure 55: Calculated value during disturbance

9.1.7.8.7 Configuring the input filter

Name:

ConfigOutput01

The filter level and input ramp limiting of the input filter are set in this register.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------------|-------|--|
| 0 - 2 | Defines the filter level | 000 | Filter disabled (bus controller default setting) |
| | | 001 | Filter level 2 |
| | | 010 | Filter level 4 |
| | | 011 | Filter level 8 |
| | | 100 | Filter level 16 |
| | | 101 | Filter level 32 |
| | | 110 | Filter level 64 |
| | | 111 | Filter level 128 |
| 3 | Reserved | 0 | |
| 4 - 6 | Defines input ramp limiting | 000 | The input value is applied without limitation (bus controller default setting) |
| | | 001 | Limit value = 0x3FFF (16383) |
| | | 010 | Limit value = 0x1FFF (8191) |
| | | 011 | Limit value = 0x0FFF (4095) |
| | | 100 | Limit value = 0x07FF (2047) |
| | | 101 | Limit value = 0x03FF (1023) |
| | | 110 | Limit value = 0x01FF (511) |
| | | 111 | Limit value = 0x00FF (255) |
| 7 | Reserved | 0 | |

9.1.7.8.8 Channel type

Name:

ConfigOutput02

This register can be used to set the range of the current signal. This is determined by how they are configured. The following input signals can be set:

- 0 to 20 mA current signal
- 4 to 20 mA current signal

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 3 |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------------------|-------|--|
| 0 - 1 | Reserved | 1 | |
| 2 - 3 | Reserved | 0 | |
| 4 | Channel 1: Current measurement range | 0 | 0 to 20 mA current signal (bus controller default setting) |
| | | 1 | 4 to 20 mA current signal |
| 5 | Channel 2: Current measurement range | 0 | 0 to 20 mA current signal (bus controller default setting) |
| | | 1 | 4 to 20 mA current signal |
| 6 - 7 | Reserved | 0 | |

9.1.7.8.9 Lower limit value

Name:

ConfigOutput03

This register can be used to configure the lower limit for analog values. If the analog value goes below the limit value, it is frozen at this value and the corresponding error status bit is set.

| Data type | Values | Information |
|-----------|-----------------|--|
| INT | -32768 to 32767 | Bus controller default setting: -32767 |

Information:

- When configured as 0 to 20 mA, this value should be set to 0.
- When configured as 4 to 20 mA, this value can be set to -8192 (corresponds to 0 mA) in order to display values <4 mA.

Keep in mind that this setting applies to all channels!

9.1.7.8.10 Upper limit value

Name:

ConfigOutput04

This register can be used to configure the upper limit for analog values. If the analog value goes above the limit value, it is frozen at this value and the corresponding error status bit is set.

| Data type | Values | Information |
|-----------|-----------------|---------------------------------------|
| INT | -32768 to 32767 | Bus controller default setting: 32767 |

Information:

The default value of 32767 corresponds to the maximum default value at 20 mA.

Keep in mind that this setting applies to all channels!

9.1.7.8.11 Input status

Name:

StatusInput01

This register is used to monitor the module inputs. A change in the monitoring status generates an error message.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|----------------------------|
| 0 - 1 | Channel 1 | 00 | No error |
| | | 01 | Lower limit value exceeded |
| | | 10 | Upper limit value exceeded |
| 2 - 3 | Channel 2 | 00 | No error |
| | | 01 | Lower limit value exceeded |
| | | 10 | Upper limit value exceeded |
| 4 - 7 | Reserved | 0 | |

Limiting the analog value

In addition to the status information, the analog value is set to the values listed below by default when an error occurs. The analog value is limited to the new values if the limit values were changed.

| Error status | Digital value for error (default values) | |
|----------------------------|--|----------------|
| | 0 to 20 mA | 4 to 20 mA |
| Upper limit value exceeded | +32767 (0x7FFF) | |
| Lower limit value exceeded | 0 | -8191 (0xE001) |

9.1.7.8.12 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------------|--------|
| Inputs without filtering | 100 µs |
| Inputs with filtering | 500 µs |

9.1.7.8.13 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|--------------------------|----------------------------|
| Inputs without filtering | 300 μ s for all inputs |
| Inputs with filtering | 1 ms |

9.1.8 X20AI2437

Data sheet version: 1.31

9.1.8.1 General information

The module is equipped with 2 current measurement inputs with 16-bit digital converter resolution.

Each current measurement input has its own sensor supply. The two channels with their respective sensor supplies are electrically isolated from each other. The user can select between the two measurement ranges 4 to 20 mA and 0 to 25 mA.

- 2 analog current measurement inputs
- Electrically isolated analog channels
- Electrically isolated sensor supplies
- 16-bit digital converter resolution
- NetTime timestamp: Moment of measurement

NetTime timestamp of the measurement

For many applications, not only the measured value is important, but also the exact time of the measurement. The module is equipped with a NetTime timestamp function for this that supplies a timestamp for the recorded position and trigger time with microsecond accuracy.

The timestamp function is based on synchronized timers. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

9.1.8.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Analog inputs |  |
| X20AI2437 | X20 analog input module, 2 inputs, 4 to 20 mA, 16-bit converter resolution, single-channel isolation with separate sensor power supply, NetTime function | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 54: X20AI2437 - Order data

9.1.8.3 Technical data

| Model number | X20AI2437 |
|--|--|
| Short description | |
| I/O module | 2 analog inputs 4 to 20 mA or 0 to 25 mA |
| General information | |
| B&R ID code | 0xB784 |
| Status indicators | I/O function per channel, operating state, module status, sensor supply per channel |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Inputs | Yes, using status LED and software |
| Sensor power supply | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.05 W |
| Internal I/O | 1.15 W ¹⁾ |
| External I/O | 1.5 W ²⁾ |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| Analog inputs | |
| Input | 4 to 20 mA or 0 to 25 mA, configurable using software |
| Input type | Differential input |
| Digital converter resolution | 15-bit |
| Data output rate | 4.7 to 960 samples per second, configurable using software |
| Output format | INT |
| Output format | |
| 4 to 20 mA | INT 0x0000 - 0x7FFF / 1 LSB = 0x0001 = 488.281 nA |
| 0 to 25 mA | INT 0x0000 - 0x7FFF / 1 LSB = 0x0001 = 762.939 nA |
| 0 to 25,000 µA | INT 0x0000 - 0x61A8 / 1 LSB = 0x0001 = 1000 nA |
| Load | I _{IN} ≥ 0.1 mA: R < 8000 Ω I _{IN} ≥ 1 mA: R < 1100 Ω I _{IN} ≥ 4 mA: R < 510 Ω |
| Input protection | Up to 30 VDC, reverse polarity protection (max. 0.1 A) |
| Open-circuit detection | Yes, using software |
| Permissible input signal | 0 to 25 mA |
| Output of digital value during overload | Configurable |
| Conversion procedure | Sigma-delta |
| Max. error at 25°C | |
| Gain | |
| 0 to 25 mA | <0.046% ³⁾ |
| 4 to 20 mA | <0.046% ³⁾ |
| Offset | |
| 0 to 25 mA | <0.004% ⁴⁾ |
| 4 to 20 mA | <0.013% ⁴⁾ |
| Common-mode rejection | |
| DC | 80 dB |
| 50 Hz | Depends on the sampling rate: e.g. >130 dB for 50 scans per second |
| Common-mode range | 0 to 7 V |
| Nonlinearity | <0.003% ⁴⁾ |
| Input filter | |
| Hardware | 1st-order low pass / cutoff frequency 2.5 kHz |
| Software | Sinc ⁴ filter |
| Max. gain drift | |
| 0 to 25 mA | 0.003 %/°C ³⁾ |
| 4 to 20 mA | 0.003 %/°C ³⁾ |
| Max. offset drift | |
| 0 to 25 mA | 0.0002 %/°C ⁴⁾ |
| 4 to 20 mA | 0.0007 %/°C ⁴⁾ |

Table 55: X20AI2437 - Technical data


| Model number | X20AI2437 |
|---|--|
| Test voltage between | |
| Channel and channel | 1000 VAC |
| Channel and bus | 1000 VAC |
| To ground | 1000 VAC |
| Sensor power supply | |
| Nominal voltage | 25 V ±2% |
| Nominal output current | Max. 30 mA |
| Short-circuit proof | Yes, continuous |
| Electrical isolation | |
| Sensor power supply - Channel | No |
| Sensor power supply - Sensor power supply | Yes |
| Max. voltage ripple | |
| Up to 100 kHz | ≤2.2 mV |
| Up to 1 MHz | ≤22 mV |
| Higher | ≤100 mV |
| Short-circuit current | |
| Typical | <50 mA |
| Maximum | 60 mA |
| Behavior on short circuit | Current limitation |
| Electrical properties | |
| Electrical isolation | Channel isolated from channel and bus |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm |

Table 55: X20AI2437 - Technical data

- 1) To reduce power dissipation, B&R recommends leaving unused inputs open.
- 2) Sensor supply
- 3) Based on the current measured value.
- 4) Based on the 25 mA measurement range.

9.1.8.4 LED status indicators

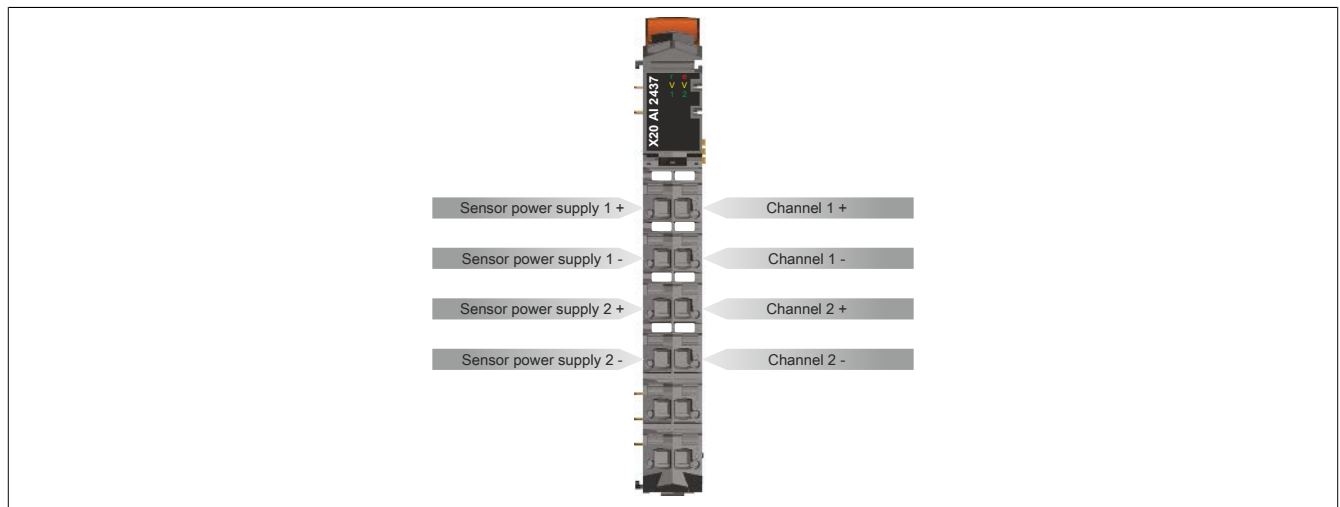
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|------------------------|--------|------------------|---|
|  | Operating state | | | |
| | r | Green | Off | No power to module |
| | | | Single flash | UNLINK mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking quickly | SYNC mode |
| | | | Blinking slowly | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | Module status | | | |
| | e | Red | Off | No power to module or everything OK |
| | | | Single flash | A conversion error has occurred. This status is output along with a double flash on the channel LED of the analog input where the error occurs. |
| | | | On | Error or reset status |
| | Sensor supply | | | |
| | V | Yellow | Off | Overload |
| | | | On | Sensor supply in its normal operating range |
| | Analog input | | | |
| | 1 - 2 | Green | Off | Indicates one of the following cases: <ul style="list-style-type: none"> • No power to module • Channel disabled • Open line |
| | | | Single flash | Input signal overflow or underflow |
| | | | Double flash | A conversion error has occurred. A single flash is output on the red "e" module status LED. |
| | | | On | Analog/digital converter running, value OK |

1) Depending on the configuration, a firmware update can take up to several minutes.

9.1.8.5 Pinout

Shielded twisted pair cables should be used to minimize coupling disturbances. Use either one cable for each channel or a multiple twisted pair cable for both channels.

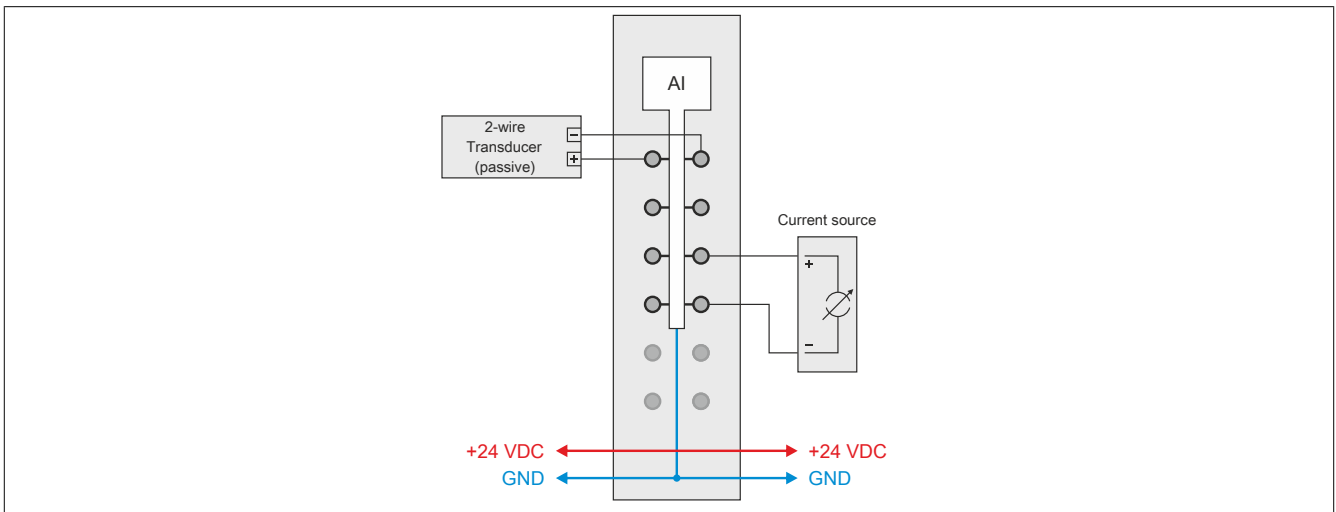


9.1.8.6 Connection examples

2-wire connections

A 2-wire connection can be implemented as follows:

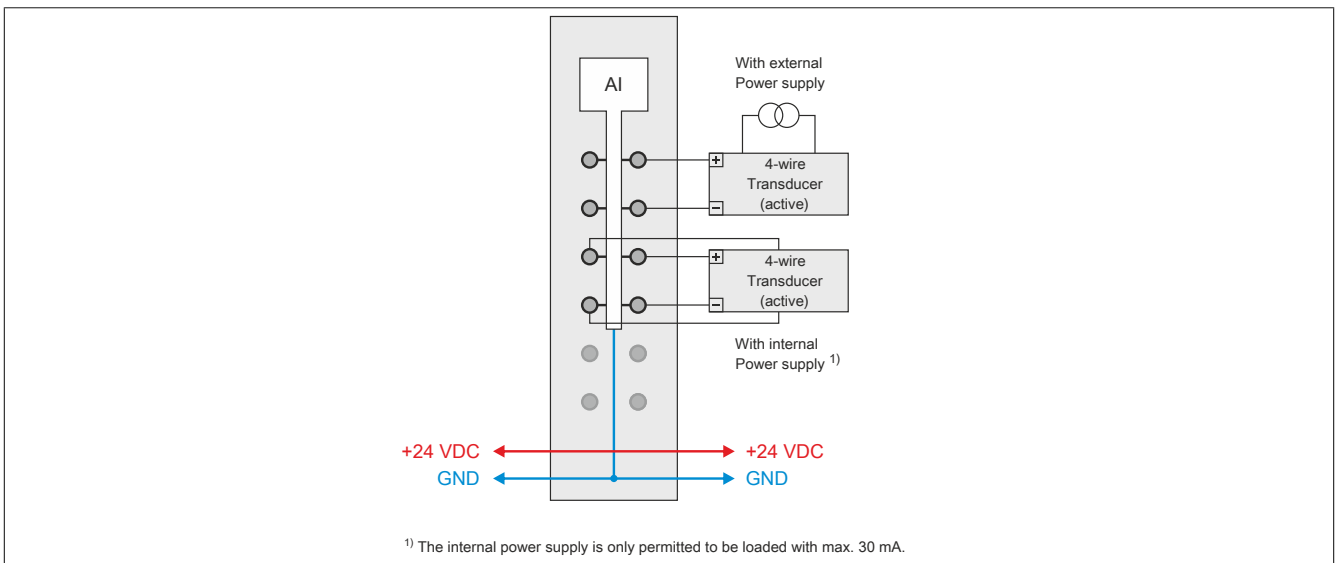
- 2-wire transducer
- Active current source



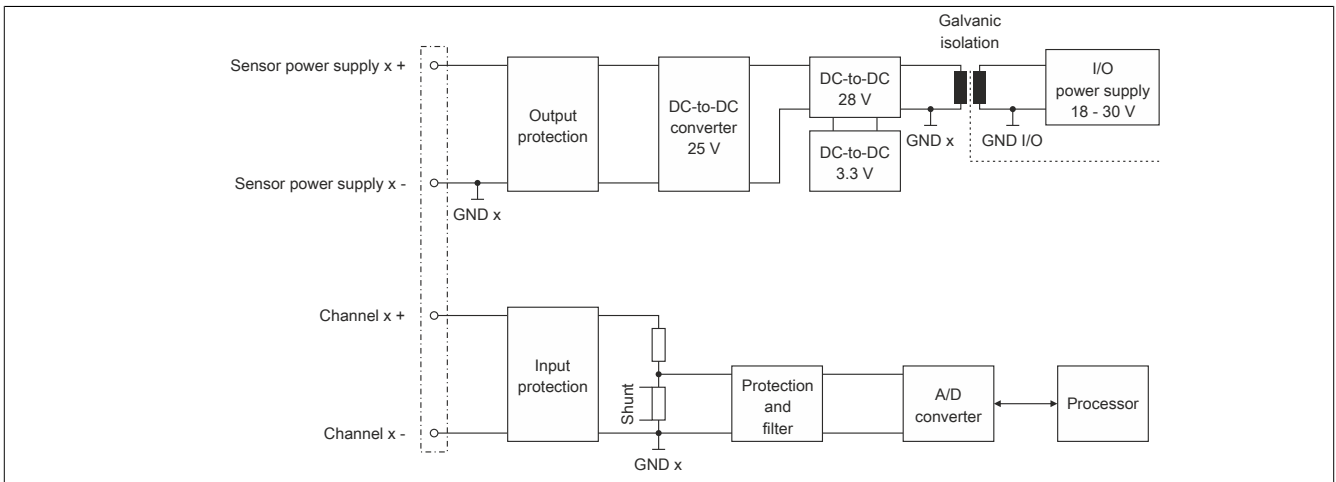
4-wire connections

A 4-wire connection can be implemented as follows:

- 4-wire transducer with external supply
- 4-wire transducer supplied by the module

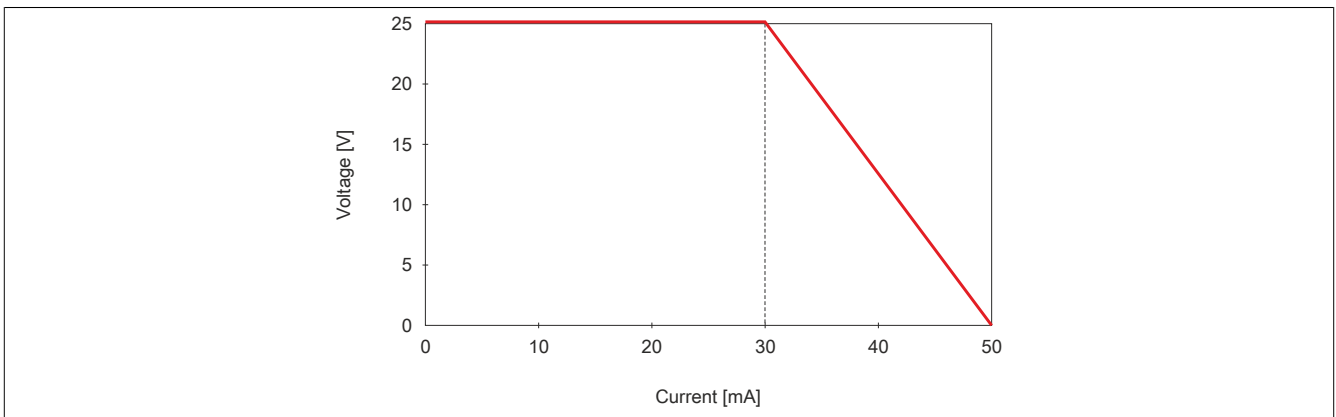


9.1.8.7 Input circuit diagram



9.1.8.8 Behavior in the event of short circuit

In the event of a short circuit, the output current for the sensor supply is limited according to the following diagram.



9.1.8.9 Register description

9.1.8.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.1.8.9.2 Function model 0 - default

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog signal - Configuration | | | | | | |
| 386 426 | AnMode_1 AnMode_2 | UINT | | | | • |
| 390 430 | Samplerate_1 Samplerate_2 | UINT | | | | • |
| 394 434 | OpenLoopLimit_1 OpenLoopLimit_2 | (U)INT | | | | • |
| 398 438 | LowerLimit_1 LowerLimit_2 | (U)INT | | | | • |
| 402 442 | UpperLimit_1 UpperLimit_2 | (U)INT | | | | • |
| 406 446 | Hysteres_1 Hysteres_2 | (U)INT | | | | • |
| 410 450 | ReplacementLower_1 ReplacementLower_2 | (U)INT | | | | • |
| 414 454 | ReplacementUpper_1 ReplacementUpper_2 | INT | | | | • |
| 418 458 | ErrorDelay_1 ErrorDelay_2 | UINT | | | | • |
| 422 462 | SumErrorDelay_1 SumErrorDelay_2 | UINT | | | | • |
| 466 482 | PreparationInterval_1 PreparationInterval_2 | UINT | | | | • |
| Analog signal - Communication | | | | | | |
| 266 270 | AnalogInput01 (if replacement value strategy on) AnalogInput02 (if replacement value strategy on) | (U)INT | • | | | |
| 258 262 | AnalogInput01 (if replacement value strategy off) AnalogInput02 (if replacement value strategy off) AnalogInput02 (if replacement value strategy off) | (U)INT | • | | | |
| 282 290 | AnalogSampletime01 (16-bit) AnalogSampletime02 (16-bit) | INT | • | | | |
| 284 292 | AnalogSampletime01 (32-bit) AnalogSampletime02 (32-bit) | DINT | • | | | |
| 30 31 | AnalogStatus01 AnalogStatus02 | USINT | • | | | |
| | UnderflowAnalogInput01 or 02 | Bit 0 | | | | |
| | OverflowAnalogInput01 or 02 | Bit 1 | | | | |
| | OpenLineAnalogInput01 or 02 | Bit 2 | | | | |
| | ConversionErrorAnalogInput01 or 02 | Bit 3 | | | | |
| | SumErrorAnalogInput01 or 02 | Bit 4 | | | | |
| | SensorErrorAnalogInput01 or 02 | Bit 6 | | | | |
| | IoSuppErrorAnalogInput01 or 02 | Bit 7 | | | | |

9.1.8.9.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog signal - Configuration | | | | | | | |
| 386 | - | AnMode_1 | UINT | | | | • |
| 426 | - | AnMode_2 | | | | | |
| 390 | - | Samplerate_1 | UINT | | | | • |
| 430 | - | Samplerate_2 | | | | | |
| 394 | - | OpenLoopLimit_1 | INT | | | | • |
| 434 | - | OpenLoopLimit_2 | | | | | |
| 398 | - | LowerLimit_1 | (U)INT | | | | • |
| 438 | - | LowerLimit_2 | | | | | |
| 402 | - | UpperLimit_1 | (U)INT | | | | • |
| 442 | - | UpperLimit_2 | | | | | |
| 406 | - | Hysteres_1 | (U)INT | | | | • |
| 446 | - | Hysteres_2 | | | | | |
| 410 | - | ReplacementLower_1 | (U)INT | | | | • |
| 450 | - | ReplacementLower_2 | | | | | |
| 414 | - | ReplacementUpper_1 | (U)INT | | | | • |
| 454 | - | ReplacementUpper_2 | | | | | |
| 418 | - | ErrorDelay_1 | UINT | | | | • |
| 458 | - | ErrorDelay_2 | | | | | |
| 422 | - | SumErrorDelay_1 | UINT | | | | • |
| 462 | - | SumErrorDelay_2 | | | | | |
| 466 | - | PreparationInterval_1 | UINT | | | | • |
| 482 | - | PreparationInterval_2 | | | | | |
| Analog signal - Communication | | | | | | | |
| 266 | 0 | AnalogInput01 (if replacement value strategy on) | (U)INT | • | | | |
| 270 | 2 | AnalogInput02 (if replacement value strategy on) | | | | | |
| 258 | - | AnalogInput01 (if replacement value strategy off) | (U)INT | | • | | |
| 262 | - | AnalogInput02 (if replacement value strategy off) | | | | | |
| 30 | - | AnalogStatus01 | USINT | | • | | |
| 31 | - | AnalogStatus02 | | | | | |
| | | UnderflowAnalogInput01 or 02 | Bit 0 | | | | |
| | | OverflowAnalogInput01 or 02 | Bit 1 | | | | |
| | | OpenLineAnalogInput01 or 02 | Bit 2 | | | | |
| | | ConversionErrorAnalogInput01 or 02 | Bit 3 | | | | |
| | | SumErrorAnalogInput01 or 02 | Bit 4 | | | | |
| | | SensorErrorAnalogInput01 or 02 | Bit 6 | | | | |
| | | loSuppErrorAnalogInput01 or 02 | Bit 7 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.1.8.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.1.8.9.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.1.8.9.4 General information

The module is equipped with 2 independent electrically isolated channels. Both channels can be used to read in an analog signal. All registers necessary for this have a dual design so that the channels can be configured and operated independently of one another.

The current input signals (0 to 25 mA) can be displayed in different formats.

Specific features:

- Channels electrically isolated
- Internal supply with short circuit protection <30 mA per channel
- Configurable filter (default 50 Hz)
- Selective line monitoring can be enabled for: open line (<2 mA), underflow (<3.6 mA) or overflow (>21 mA) of a configurable threshold
- Selectable error strategy: Replacement value for the respective threshold (default) or use the last valid value

9.1.8.9.5 Analog signal - Configuration

How the analog signal is displayed can be adapted to the requirements of the application. Separate configuration registers per channel are available to aid in this.

9.1.8.9.5.1 Channel parameters

Name:

AnMode_1 to AnMode_2

These registers are used to predefine the operating parameters that the module will be using for the respective channel. Each channel must be enabled individually and can be configured and operated independently.

Information:

Different limit values must be configured for any display normalizing that needs to take place.

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| UINT | See bit structure. | 29 |

Bit structure:

| Bit | Name | Value | Information |
|--------|----------------------------|-------|---|
| 0 | Channel | 0 | Channel 0x turned off |
| | | 1 | Channel 0x enabled (bus controller default setting) |
| 1 | Open line detection | 0 | Open line monitoring turned off |
| | | 1 | Open circuit monitoring enabled (bus controller default setting) |
| 2 | Underflow detection | 0 | Underflow detection turned off |
| | | 1 | Underflow detection enabled (bus controller default setting) |
| 3 | Replacement value strategy | 0 | Use replacement values in the event of error (bus controller default setting) |
| | | 1 | Keep the last valid converted value |
| 4 - 5 | Normalization | 00 | Displays 0 to 25 mA as 0 to 32767 |
| | | 01 | Display 0 to 25 mA as 0 to 25000 [µA] (bus controller default setting) |
| | | 10 | Displays 4 to 20 mA as 0 to 32767 |
| | | 11 | Displays 0 to 25 mA as 0 to 65535 |
| 6 - 15 | Reserved | - | |

9.1.8.9.5.2 Sample rate

Name:

Samplerate_1 to Samplerate_2

A sample rate can be configured for both analog inputs independently of one another. The following formula for this parameter is derived using the desired sampling frequency:

$$\text{Sampling rate for A/D converter} = (4920000 / 1024) / \text{Sampling frequency}$$

| Data type | Value | Information | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------|-------------|--|-------|------|-----------|-----|------------|----------|-----|------------|-----------|-----|-------------|-----------|-----|-----------|-----------|-----|-------------|-----------|----|-----------|--|----|-------------|-----------|----|-----------|------------|---|----------|------------|---|----------|-------------|
| UINT | 4 to 1023 | Sample rate Examples of configurable values <table border="1"> <thead> <tr> <th>Value</th> <th>Time</th> <th>Frequency</th> </tr> </thead> <tbody> <tr> <td>960</td> <td>... 200 ms</td> <td>... 5 Hz</td> </tr> <tr> <td>480</td> <td>... 100 ms</td> <td>... 10 Hz</td> </tr> <tr> <td>320</td> <td>... 66.7 ms</td> <td>... 15 Hz</td> </tr> <tr> <td>192</td> <td>... 40 ms</td> <td>... 25 Hz</td> </tr> <tr> <td>160</td> <td>... 33.3 ms</td> <td>... 30 Hz</td> </tr> <tr> <td>96</td> <td>... 20 ms</td> <td>... 50 Hz (bus controller default setting)</td> </tr> <tr> <td>80</td> <td>... 16.7 ms</td> <td>... 60 Hz</td> </tr> <tr> <td>48</td> <td>... 10 ms</td> <td>... 100 Hz</td> </tr> <tr> <td>9</td> <td>... 2 ms</td> <td>... 500 Hz</td> </tr> <tr> <td>4</td> <td>... 1 ms</td> <td>... 1000 Hz</td> </tr> </tbody> </table> | Value | Time | Frequency | 960 | ... 200 ms | ... 5 Hz | 480 | ... 100 ms | ... 10 Hz | 320 | ... 66.7 ms | ... 15 Hz | 192 | ... 40 ms | ... 25 Hz | 160 | ... 33.3 ms | ... 30 Hz | 96 | ... 20 ms | ... 50 Hz (bus controller default setting) | 80 | ... 16.7 ms | ... 60 Hz | 48 | ... 10 ms | ... 100 Hz | 9 | ... 2 ms | ... 500 Hz | 4 | ... 1 ms | ... 1000 Hz |
| Value | Time | Frequency | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 960 | ... 200 ms | ... 5 Hz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 480 | ... 100 ms | ... 10 Hz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 320 | ... 66.7 ms | ... 15 Hz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 192 | ... 40 ms | ... 25 Hz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 160 | ... 33.3 ms | ... 30 Hz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 96 | ... 20 ms | ... 50 Hz (bus controller default setting) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 80 | ... 16.7 ms | ... 60 Hz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 48 | ... 10 ms | ... 100 Hz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | ... 2 ms | ... 500 Hz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | ... 1 ms | ... 1000 Hz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Setting to 1000 Hz will result in jitter when acquiring measured values. Jitter-free operation is possible up to 960 Hz (sample rate setting = 5).

9.1.8.9.5.3 Limit value for open line detection

Name:

OpenLoopLimit_1 to OpenLoopLimit_2

The limit value for the respective analog input must be set when open circuit monitoring is enabled and if required by the configured normalization.

| Data type | Value | Information |
|-----------|-----------------|---|
| INT | -32767 to 32767 | Open circuit limit value. Bus controller default setting: 2621 |
| UINT | 0 to 65535 | Open circuit limit value |

If limit value monitoring is active, the corresponding error status is output after a configured delay when falling below this value. Using a default value of 2000 μA , the following values and formulas result for this parameter:

- Displays 0 to 25 mA as 0 to 25000: 2000
- Displays 0 to 25 mA as 0 to 32767: 2621, limit value = $([\mu\text{A}] * 32767) / 25000$
- Displays 4 to 20 mA as 0 to 32767: -4096, limit value = $(([\mu\text{A}] * 1.31068) - 5242.72) * 1.5625$
- Displays 0 to 25 mA as 0 to 65535: 5243, limit value = $([\mu\text{A}] * 65535) / 25000$

9.1.8.9.5.4 Lower limit value

Name:

LowerLimit_1 to LowerLimit_2

If the value range needs to be restricted further, this register can be used to enter new user-specific lower limit values.

| Data type | Value | Information |
|-----------|-----------------|--------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 4718 |
| UINT | 0 to 65535 | |

The limit value must be set for the respective analog input depending on the configured normalization. After the configured delay time has passed, the corresponding error status is given if the respective value is overrun or underrun. When this error state occurs, the "AnalogInput0x" on page 369 channel is evaluated according to the replacement value strategy. Using a default value of 3600 μA , the following values and formulas result for this parameter:

- Displays 0 to 25 mA as 0 to 25000: 3600
- Displays 0 to 25 mA as 0 to 32767: 4718, limit value = $([\mu\text{A}] * 32767) / 25000$
- Displays 4 to 20 mA as 0 to 32767: -819, limit value = $(([\mu\text{A}] * 1.31068) - 5242.72) * 1.5625$
- Displays 0 to 25 mA as 0 to 65535: 9437, limit value = $([\mu\text{A}] * 65535) / 25000$

9.1.8.9.5.5 Upper limit value

Name:

UpperLimit_1 to UpperLimit_2

If the value range needs to be restricted further, this register can be used to enter new user-specific upper limit values.

| Data type | Value | Information |
|-----------|-----------------|---------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 27524 |
| UINT | 0 to 65535 | |

The limit value must be set for the respective analog input depending on the configured normalization. After the configured delay time has passed, the corresponding error status is given if the respective value is overrun or underrun. When this error state occurs, the "AnalogInput0x" on page 369 channel is evaluated according to the replacement value strategy. Using a default value of 21000 μ A, the following values and formulas result for this parameter:

- Displays 0 to 25 mA as 0 to 25000: 21000
- Displays 0 to 25 mA as 0 to 32767: 27524, limit value = $([\mu\text{A}] * 32767) / 25000$
- Displays 4 to 20 mA as 0 to 32767: 32767, limit value = $(([\mu\text{A}] * 1.31068) - 5242.72) * 1.5625$
- Displays 0 to 25 mA as 0 to 65535: 55049, limit value = $([\mu\text{A}] * 65535) / 25000$

9.1.8.9.5.6 Hysteresis

Name:

Hysteres_1 to Hysteres_2

If the user-specific limit values are being used, then a hysteresis range should also be defined. These registers configure how far a limit value can be exceeded before a response is triggered.

| Data type | Value | Information |
|-----------|-----------------|-------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 131 |
| UINT | 0 to 65535 | |

The hysteresis value must be set for the respective analog input depending on the configured normalization. The error status is cleared if the actual analog value changes by at least this hysteresis value from the limit value in the allowed direction. Using a default value of 100 μ A, the following values and formulas result for this parameter:

- Displays 0 to 25 mA as 0 to 25000: 100
- Displays 0 to 25 mA as 0 to 32767: 131, limit value = $([\mu\text{A}] * 32767) / 25000$
- Displays 4 to 20 mA as 0 to 32767: 156, limit value = $[\mu\text{A}] * 1.5625$
- Displays 0 to 25 mA as 0 to 65535: 262, limit value = $([\mu\text{A}] * 65535) / 25000$

9.1.8.9.5.7 Lower replacement value

Name:

ReplacementLower_1 to ReplacementLower_2

This register is used to define the lower static values to be displayed instead of the current measured value when the lower limit is violated.

| Data type | Value | Information |
|-----------|-----------------|--------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 4718 |
| UINT | 0 to 65535 | |

If the replacement strategy "Use replacement values when an error occurs" is enabled, the replacement value must be set for the respective analog input taking the configured normalization into account as well. When an overflow or underflow error status occurs, the "AnalogInput0x" on page 369 channel is replaced with the corresponding value. Using a default value of 3600 μ A, the following values and formulas result for this parameter:

- Displays 0 to 25 mA as 0 to 25000: 3600
- Displays 0 to 25 mA as 0 to 32767: 4718, limit value = $([\mu\text{A}] * 32767) / 25000$
- Displays 4 to 20 mA as 0 to 32767: -819, limit value = $(([\mu\text{A}] * 1.31068) - 5242.72) * 1.5625$
- Displays 0 to 25 mA as 0 to 65535: 9437, limit value = $([\mu\text{A}] * 65535) / 25000$

9.1.8.9.5.8 Upper replacement value

Name:

ReplacementUpper_1 to ReplacementUpper_2

This register is used to define the static values to be displayed instead of the current measured value when the upper limit is violated.

| Data type | Value | Information |
|-----------|-----------------|---------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 27524 |
| UINT | 0 to 65535 | |

If the replacement strategy "Use replacement values when an error occurs" is activated, the replacement value must be set for the respective analog input taking the configured normalization into account as well. When an overflow or underflow error status occurs, the "[AnalogInput0x](#)" on page 369 channel is replaced with the corresponding value. Using a default value of 21000 μ A, the following values and formulas result for this parameter:

- Displays 0 to 25 mA as 0 to 25000: 21000
- Displays 0 to 25 mA as 0 to 32767: 27524, limit value = $([\mu\text{A}] * 32767) / 25000$
- Displays 4 to 20 mA as 0 to 32767: 32767, limit value = $(([\mu\text{A}] * 1.31068) - 5242.72) * 1.5625$
- Displays 0 to 25 mA as 0 to 65535: 55049, limit value = $([\mu\text{A}] * 65535) / 25000$

9.1.8.9.5.9 Delaying error messages

Name:

ErrorDelay_1 to ErrorDelay_2

This register specifies the number of consecutive conversion procedures where an error is pending until the corresponding individual error status bit is set. The delay applies to underflow, overflow and open circuit errors. This delay can be used to hide temporary measured value deviations, for example.

| Data type | Value | Information |
|-----------|---------|--|
| UINT | 0 to 10 | Error formation delay in conversion cycles. Bus controller default setting: 2 |

9.1.8.9.5.10 Time for composite error bit

Name:

SumErrorDelay_1 to SumErrorDelay_2

This register specifies the time in milliseconds that one of the individual error bits must be pending until the composite error status bit is set.

| Data type | Value | Information |
|-----------|------------|--|
| UINT | 0 to 65535 | Composite error bit delay in ms. Bus controller default setting: 4000 |

9.1.8.9.5.11 Preparation time for the measured values

Name:

PreparationInterval01 to PreparationInterval02

If the last valid measured value should be kept when violating the limit value, then PreparationInterval must be defined. The measured values continue to be acquired and converted according to the configured I/O update time. They are then checked and discarded if they do not meet the specifications. When an error does not occur, therefore, the measured value acquired 2 preparation intervals ago is constantly output.

| Data type | Value | Information |
|-----------|------------|---|
| UINT | 0 to 65535 | In 0.1 ms. Bus controller default setting: 0 |

| | | |
|---|---|---|
| <p>Functionality: Measured values are continuously converted and stored to measured value memory. The current contents of the measured value memory are checked within the configured interval. If a permissible value is present, then the contents of the buffer memory are passed to output memory and the contents of the measured value memory are passed to the buffer. If the check turns up an impermissible value, then the contents of the measured value memory are discarded. The copy direction between output and buffer memory reverses and the last valid value continues to be output.</p> <p>Information: If configured to keep the last valid value, the delay time from measuring to outputting the value will be at least twice the preparation interval. In the worst case scenario, this can also take twice the interval time plus the configured conversion rate of the A/D converter.</p> | | "Application" Value being measured (analog) |
| | ↓ | Condition: - Conversion interval (A/D converter) elapsed |
| | | "Measured value memory" Measured value (digital) |
| | ↓ | Condition: - PreparationInterval elapsed - Measured value permissible |
| | | "Buffer" Last valid value |
| | ↓ | Condition: - PreparationInterval elapsed - Measured value permissible |
| | "Output memory" Next-to-last valid/ displayed value | |

9.1.8.9.6 Analog signal - Communication

9.1.8.9.6.1 Analog input values

Name:

AnalogInput01 to AnalogInput02

The analog input value is mapped in this register.

| Data type | Value | Information |
|-----------|----------------|---|
| INT | 0 to 25000 | Normalizing option 0 to 25 mA |
| | 0 to 32,767 | Normalizing option 0 to 25 mA |
| | -8192 to 32767 | Normalizing option 4 to 20 mA (value 0 corresponds to 4 mA) |
| UINT | 0 to 65535 | Normalizing option 0 to 25 mA |

Predefining values and timing

If a replacement value strategy was configured, value "0" (zero) is output from the beginning until a valid measured value has been calculated.

The timing for acquiring measured values is determined by the converter hardware and the set sampling rate. The two channels are converted independently of each other and are not synchronized with the X2X Link.

| Conversion time |
|--------------------------|
| Channel 0x sampling rate |

9.1.8.9.6.2 Sample time

Name:

AnalogSampletime01 to AnalogSampletime02

These registers return the timestamp for when the module reads the current channel mapping. The values are provided as signed 2-byte or 4-byte values.

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

| Data type | Values | Information |
|-----------|---------------------------|---|
| INT | -32,768 to 32767 | NetTime timestamp of the current input value in μ s |
| DINT | -2147483648 to 2147483647 | NetTime timestamp of the current input value in μ s |

9.1.8.9.6.3 Status of the inputs

Name:

AnalogStatus01 to AnalogStatus02

UnderflowAnalogInput01 to UnderflowAnalogInput02

OverflowAnalogInput01 to OverflowAnalogInput02

OpenLineAnalogInput01 to OpenLineAnalogInput02

ConversionErrorAnalogInput01 to ConversionErrorAnalogInput02

SumErrorAnalogInput01 to SumErrorAnalogInput02

SensorErrorAnalogInput01 to SensorErrorAnalogInput02

IoSuppErrorAnalogInput01 to IoSuppErrorAnalogInput02

The current error state of the module channels is indicated in this register regardless of the configured replacement value strategy. Some error information is delayed according to the previously configured condition.

Setting "Format of status information" in Automation Studio makes it possible to define whether the status information is transferred as USINT or bit values.

| Data type | Values |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Values | Information |
|-----|------------------------------------|--------|--------------------------------------|
| 0 | UnderflowAnalogInput01 or 02 | 0 | No error |
| | | 1 | Lower limit value undershot |
| 1 | OverflowAnalogInput01 or 02 | 0 | No error |
| | | 1 | Upper limit value overshoot |
| 2 | OpenLineAnalogInput01 or 02 | 0 | No error |
| | | 1 | Open circuit determined |
| 3 | ConversionErrorAnalogInput01 or 02 | 0 | No error |
| | | 1 | Conversion error determined |
| 4 | SumErrorAnalogInput01 or 02 | 0 | No error |
| | | 1 | Composite error determined |
| 5 | Reserved | - | |
| 6 | SensorErrorAnalogInput01 or 02 | 0 | Sensor voltage OK |
| | | 1 | Sensor load too high |
| 7 | IoSuppErrorAnalogInput01 or 02 | 0 | I/O power supply OK |
| | | 1 | Error in I/O power supply determined |

UnderflowAnalogInput

The signal underflow error state is represented here based on the configuration. This error information is enabled as a multiple of the conversion cycles only after the configurable delay time has passed (see register "[ErrorDelay](#)" on page 368).

OverflowAnalogInput

The signal overflow error status state is represented here based on the configuration. This error information is enabled as a multiple of the conversion cycles only after the configurable delay time has passed (see register "[ErrorDelay](#)" on page 368).

OpenLineAnalogInput

Based on the configuration, the measurement information is checked for values <2 mA (register "[OpenLoopLimit](#)" on page 366) to detect a failure signal. Open circuit detection is performed using a configurable hysteresis value (default: 100 µA, register "[Hysteresis](#)" on page 367). It is possible to disable open circuit detection (register "[AnalogMode](#)" on page 365) to suppress the generation of alarms when hardware is missing. This error information is enabled as a multiple of the conversion cycles only after the configurable delay time has passed (register "[ErrorDelay](#)" on page 368).

ConversionErrorAnalogInput

This error state is triggered when the hardware overshoots the conversion time.

SumErrorAnalogInput

This error information is derived from the state of individual errors and enabled only after the configurable delay time has passed [ms] (see register "[SumErrorDelay](#)" on page 368). Linking this error information in an application makes it possible to hide temporary overshoots or undershoots of the temperature value, for example.

SensorErrorAnalogInput

This error is enabled immediately after a fault is detected in the internal sensor power supply.

IoSuppErrorAnalogInput

This error is enabled immediately after a supply voltage undershoot is detected (<20 VDC).

9.1.8.9.7 NetTime Technology

For a description of NetTime Technology, see "[NetTime Technology](#)" on page 3035.

9.1.8.9.8 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 µs |

9.1.8.9.9 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 1 ms |

9.1.9 X20(c)AI2438

Data sheet version: 1.32

9.1.9.1 General information

The module is equipped with 2 current measurement inputs with 16-bit digital converter resolution. It supports the HART communication standard for data transfer, parameter configuration and diagnostics.

Each current measurement input has its own sensor supply. The two channels with their respective sensor supplies are electrically isolated from each other. The user can select between the two measurement ranges 4 to 20 mA and 0 to 25 mA.

- 2 analog current measurement inputs
- Integrated HART protocol
- Supports HART variables
- Electrically isolated analog channels
- Electrically isolated sensor supplies
- 16-bit digital converter resolution
- NetTime timestamp: Moment of measurement, HART image

NetTime timestamp of the measurement

For many applications, not only the measured value is important, but also the exact time of the measurement. The module is equipped with a NetTime timestamp function for this that supplies a timestamp for the recorded position and trigger time with microsecond accuracy.

The timestamp function is based on synchronized timers. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

9.1.9.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.1.9.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.1.9.3 Order data

| Model number | Short description | Figure |
|--------------|--|--------|
| | Analog inputs | |
| X20AI2438 | X20 analog input module, 2 inputs, 4 to 20 mA, 16-bit converter resolution, single-channel isolation with separate sensor power supply, supports the HART protocol, NetTime function | |
| X20cAI2438 | X20 analog input module, coated, 2 inputs, 4 to 20 mA, 16-bit converter resolution, single-channel isolation with separate sensor power supply, supports the HART protocol, NetTime function | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 56: X20AI2438, X20cAI2438 - Order data

9.1.9.4 Technical data

| Model number | X20AI2438 | X20cAI2438 |
|--|--|------------|
| Short description | | |
| I/O module | 2 analog inputs 4 to 20 mA or 0 to 25 mA | |
| General information | | |
| B&R ID code | 0xB3A9 | 0xE1EE |
| Status indicators | I/O function per channel, operating state, module status, sensor supply per channel, HART | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Inputs | Yes, using status LED and software | |
| Sensor power supply | Yes, using status LED and software | |
| HART link | Yes, using status LED and software | |
| HART error | Yes, using status LED and software | |
| Power consumption | | |
| Bus | 0.05 W | |
| Internal I/O | 1.15 W ¹⁾ | |
| External I/O | 1.5 W ²⁾ | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Analog inputs | | |
| Input | 4 to 20 mA or 0 to 25 mA, configurable using software | |
| Input type | Differential input | |
| Digital converter resolution | 15-bit | |
| Data output rate | | |
| With HART | 4.7 to 10 samples per second, configurable using software | |
| Analog | 4.7 to 100 samples per second, configurable using software | |
| Output format | INT | |
| Output format | | |
| 4 to 20 mA | INT 0x0000 - 0x7FFF / 1 LSB = 0x0001 = 488.281 nA | |
| 0 to 25 mA | INT 0x0000 - 0x7FFF / 1 LSB = 0x0001 = 762.939 nA | |
| 0 to 25,000 µA | INT 0x0000 - 0x61A8 / 1 LSB = 0x0001 = 1000 nA | |
| Load | I _{IN} ≥ 0.1 mA: R < 8000 Ω I _{IN} ≥ 1 mA: R < 1100 Ω I _{IN} ≥ 4 mA: R < 510 Ω | |
| Input protection | Up to 30 VDC, reverse polarity protection (max. 0.1 A) | |
| Open-circuit detection | Yes, using software | |
| Permissible input signal | 0 to 25 mA | |
| Output of digital value during overload | Configurable | |
| Conversion procedure | Sigma-delta | |
| Max. error | | |
| Gain | | |
| 0 to 25 mA | <0.046% ³⁾ | |
| 4 to 20 mA | <0.046% ³⁾ | |
| Offset | | |
| 0 to 25 mA | <0.004% ⁴⁾ | |
| 4 to 20 mA | <0.013% ⁴⁾ | |
| Common-mode rejection | | |
| DC | 80 dB | |
| 50 Hz | Depends on the sampling rate: e.g. >130 dB for 50 scans per second | |
| Common-mode range | 0 to 7 V | |
| Nonlinearity | <0.003% ⁴⁾ | |
| Input filter | | |
| Hardware | 1st-order low pass / cutoff frequency 100 Hz | |
| Software | Sinc ⁴ filter | |

Table 57: X20AI2438, X20cAI2438 - Technical data


| Model number | X20AI2438 | X20cAI2438 |
|---|--|---|
| Max. gain drift | | |
| 0 to 25 mA | | 0.003 %/°C ³⁾ |
| 4 to 20 mA | | 0.003 %/°C ³⁾ |
| Max. offset drift | | |
| 0 to 25 mA | | 0.0002 %/°C ⁴⁾ |
| 4 to 20 mA | | 0.0007 %/°C ⁴⁾ |
| Test voltage | | |
| Channel - Channel | | 1000 VAC |
| Channel - Bus | | 1000 VAC |
| Channel - Ground | | 1000 VAC |
| Sensor power supply | | |
| Nominal voltage | | 25 V ±2% |
| Nominal output current | | Max. 30 mA |
| Short-circuit proof | | Yes, continuous |
| Electrical isolation | | |
| Sensor power supply - Channel | | No |
| Sensor power supply - Sensor power supply | | Yes |
| Max. voltage ripple | | |
| Up to 100 kHz | | ≤2.2 mV |
| Up to 1 MHz | | ≤22 mV |
| Higher | | ≤100 mV |
| Short-circuit current | | |
| Typical | | <50 mA |
| Maximum | | 60 mA |
| Behavior on short circuit | | Current limitation |
| HART | | |
| Transfer rate | | 1200 bit/s |
| Operating frequencies | | 1200 Hz / 2200 Hz |
| Multi-drop operation | | |
| Possible | | Yes |
| Stations | | 5 nodes (when using HART slaves with a nominal current of 4 mA) Up to 15 (taking into account the maximum permissible input signal of 25 mA) |
| Burst operation possible | | Yes |
| Transmission amplitude | | |
| Minimum | | 400 mV _{pp} |
| Typical | | 500 mV _{pp} |
| Maximum | | 600 mV _{pp} |
| Receiving amplitude | | |
| Minimum | | 120 mV _{pp} |
| Maximum | | 800 mV _{pp} |
| Electrical properties | | |
| Electrical isolation | | Channel isolated from channel and bus |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | | Yes |
| Vertical | | Yes |
| Installation elevation above sea level | | |
| 0 to 2000 m | | No limitations |
| >2000 m | | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | | IP20 |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | | -25 to 60°C |
| Vertical mounting orientation | | -25 to 50°C |
| Derating | | - |
| Storage | | -40 to 85°C |
| Transport | | -40 to 85°C |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 57: X20AI2438, X20cAI2438 - Technical data

- 1) To reduce power dissipation, B&R recommends leaving unused inputs open.
- 2) Sensor supply
- 3) Based on the current measured value.
- 4) Based on the 25 mA measurement range.

9.1.9.5 LED status indicators

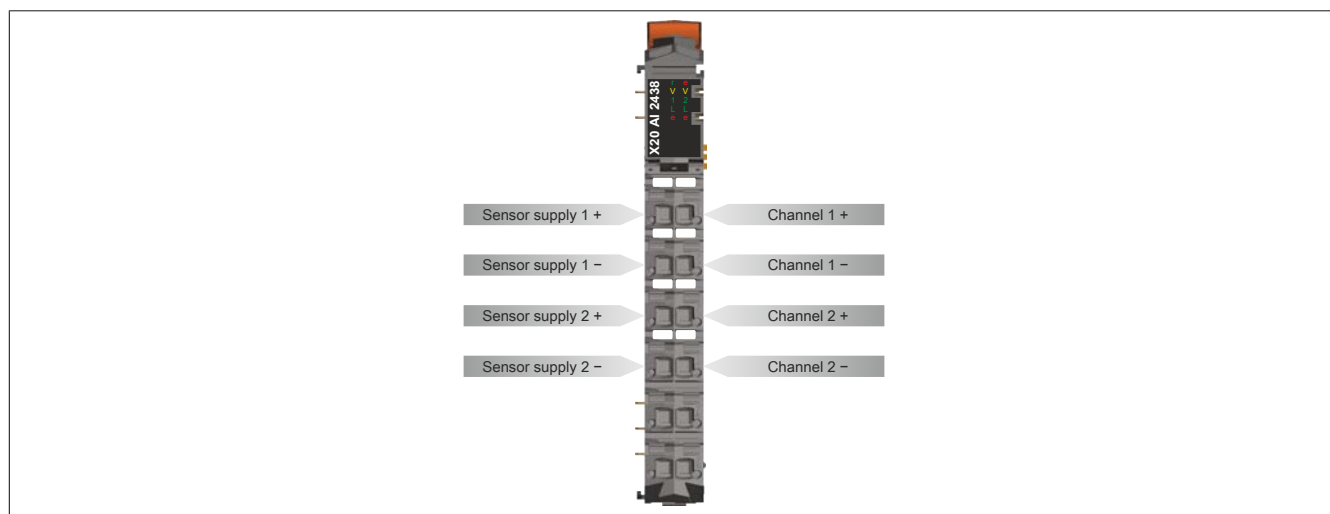
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|------------------------|--------|------------------|---|
|  | Operating state | | | |
| | r | Green | Off | No power to module |
| | | | Single flash | UNLINK mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking quickly | SYNC mode |
| | | | Blinking slowly | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | Module status | | | |
| | e | Red | Off | No power to module or everything OK |
| | | | Single flash | A conversion error has occurred. This status is output along with a double flash on the channel LED of the analog input where the error occurs. |
| | | | On | Error or reset status |
| | Sensor supply | | | |
| | V | Yellow | Off | Module supply not connected or overload |
| | | | On | Sensor supply in its normal operating range |
| | Analog input | | | |
| | 1 - 2 | Green | Off | Indicates one of the following cases: <ul style="list-style-type: none"> No power to module Channel disabled Open line |
| | | | Single flash | Input signal overflow or underflow |
| | | | Double flash | A conversion error has occurred. A single flash is output on the red "e" module status LED. |
| | | | On | Analog/digital converter running, value OK |
| | HART link | | | |
| | L | Green | Off | Indicates one of the following cases: <ul style="list-style-type: none"> No power to module HART disabled for the respective channel |
| | | | Flickering | Carrier signal active (DCD or RTS) |
| | HART error | | | |
| | e | Red | Off | Indicates one of the following cases: <ul style="list-style-type: none"> Communication taking place without errors No power to module HART disabled for the respective channel |
| | | | On | Communication error |

1) Depending on the configuration, a firmware update can take up to several minutes.

9.1.9.6 Pinout

Shielded twisted pair cables should be used to minimize coupling disturbances. Use either one cable for each channel or a multiple twisted pair cable for both channels.

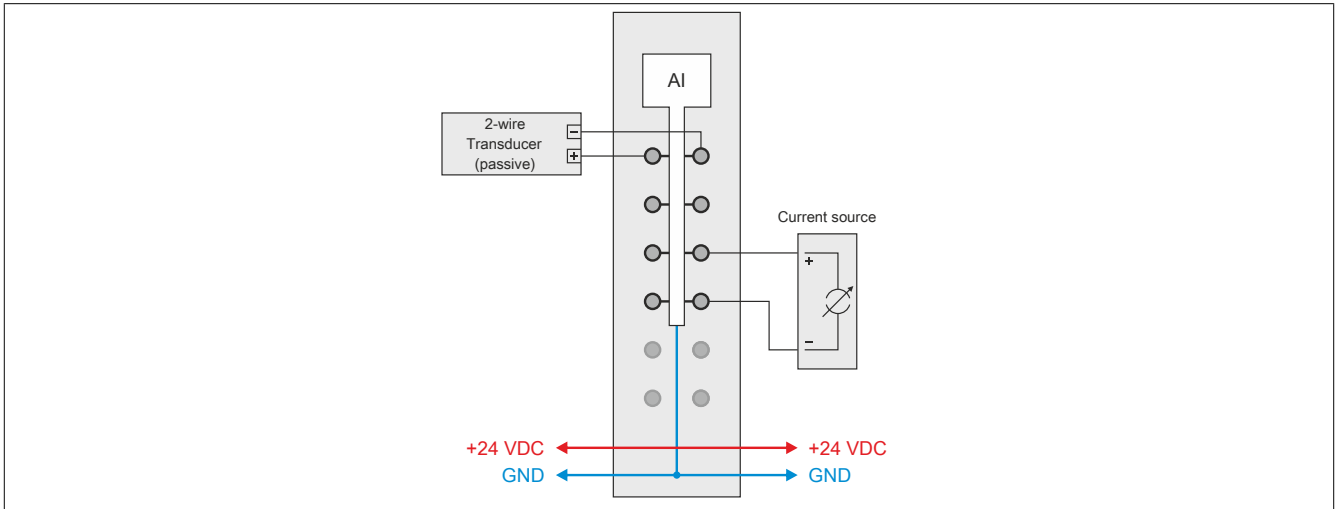


9.1.9.7 Connection examples

2-wire connections

A 2-wire connection can be implemented as follows:

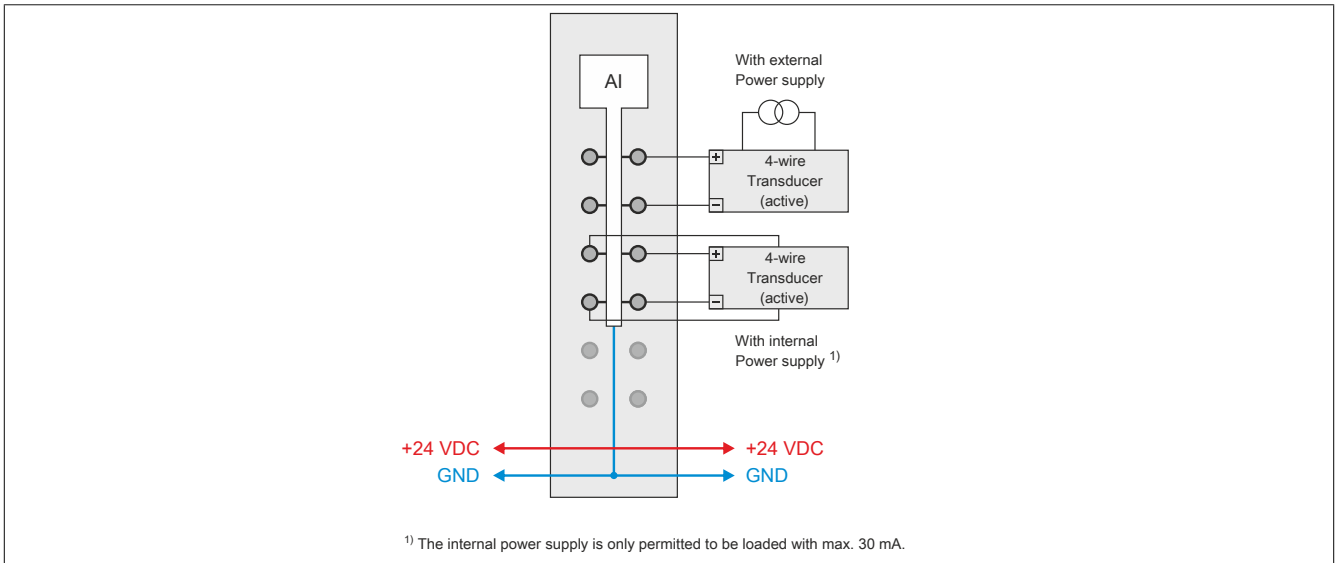
- 2-wire transducer
- Active current source



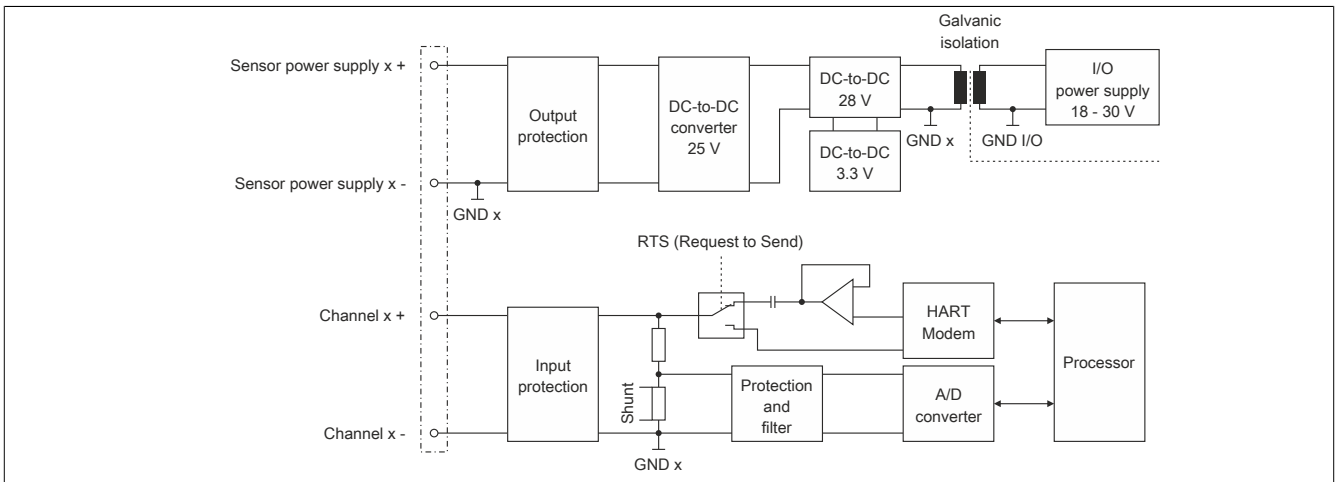
4-wire connections

A 4-wire connection can be implemented as follows:

- 4-wire transducer with external supply
- 4-wire transducer supplied by the module

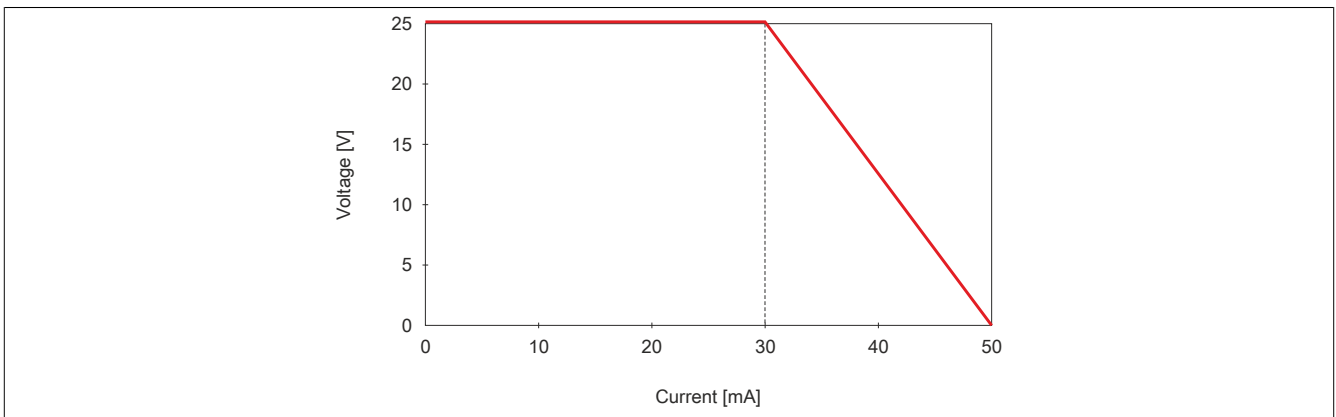


9.1.9.8 Input circuit diagram



9.1.9.9 Behavior in the event of short circuit

In the event of a short circuit, the output current for the sensor supply is limited according to the following diagram.



9.1.9.10 Register description

9.1.9.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.1.9.10.2 Register overview - Function model 0 (standard)

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog signal - Configuration | | | | | | |
| 386 426 | AnMode_1 AnMode_2 | UINT | | | | • |
| 390 430 | Samplerate_1 Samplerate_2 | UINT | | | | • |
| 394 434 | OpenLoopLimit_1 OpenLoopLimit_2 | (U)INT | | | | • |
| 398 438 | LowerLimit_1 LowerLimit_2 | (U)INT | | | | • |
| 402 442 | UpperLimit_1 UpperLimit_2 | (U)INT | | | | • |
| 406 446 | Hysteres_1 Hysteres_2 | (U)INT | | | | • |
| 410 450 | ReplacementLower_1 ReplacementLower_2 | (U)INT | | | | • |
| 414 454 | ReplacementUpper_1 ReplacementUpper_2 | (U)INT | | | | • |
| 418 458 | ErrorDelay_1 ErrorDelay_2 | UINT | | | | • |
| 422 462 | SumErrorDelay_1 SumErrorDelay_2 | UINT | | | | • |
| 466 482 | PreparationInterval_1 PreparationInterval_2 | UINT | | | | • |
| Analog signal - Communication | | | | | | |
| 266 270 | AnalogInput01 (if replacement value strategy on) AnalogInput02 (if replacement value strategy on) | (U)INT | • | | | |
| 258 262 | AnalogInput01 (if replacement value strategy off) AnalogInput02 (if replacement value strategy off) | (U)INT | • | | | |
| 282 290 | AnalogSampletime01 (16-bit) AnalogSampletime02 (16-bit) | INT | • | | | |
| 284 292 | AnalogSampletime01 (32-bit) AnalogSampletime02 (32-bit) | DINT | • | | | |
| 30 31 | AnalogStatus01 AnalogStatus02 | USINT | • | | | |
| | UnderflowAnalogInput01 or 02 | Bit 0 | | | | |
| | OverflowAnalogInput01 or 02 | Bit 1 | | | | |
| | OpenLineAnalogInput01 or 02 | Bit 2 | | | | |
| | ConversionErrorAnalogInput01 or 02 | Bit 3 | | | | |
| | SumErrorAnalogInput01 or 02 | Bit 4 | | | | |
| | SensorErrorAnalogInput01 or 02 | Bit 6 | | | | |
| | IoSuppErrorAnalogInput01 or 02 | Bit 7 | | | | |
| HART - Configuration | | | | | | |
| 1537 1665 | HartNodeCnt_1 HartNodeCnt_2 | USINT | | | | • |
| 1539 1667 | HartMode_1 HartMode_2 | USINT | | | | • |
| 1541 1669 | HartBurstNode_1 HartBurstNode_2 | USINT | | | | • |
| HART - Extended configuration | | | | | | |
| 1558 1686 | HartNodeDisable_1 HartNodeDisable_2 | UINT | | | | • |
| 1546 1674 | HartProtTimeOut_1 HartProtTimeOut_2 | UINT | | | | • |
| 1550 1678 | HartProtRetry_1 HartProtRetry_2 | UINT | | | | • |
| 1554 1682 | HartPreamble_1 HartPreamble_2 | UINT | | | | • |
| HART - Communication (P2P) | | | | | | |
| 612 + N*24 1124 + N*24 | PvInput01_ON (index N = 1 to 4) PvInput02_ON (index N = 1 to 4) | REAL | • | • | | |
| 617 + N*24 1129 + N*24 | PvUnit01_ON (index N = 1 to 4) PvUnit02_ON (index N = 1 to 4) | USINT | • | • | | |
| 628 1140 | PvSampleTime01 PvSampleTime02 | DINT | • | • | | |
| 626 1138 | PvSampleTime01 PvSampleTime02 | INT | • | | | |

| Register | Name | Data type | Read | | Write | |
|---|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 566 1078 | PvNodeComStatus01 PvNodeComStatus02 | DINT | | • | | |
| HART - Communication (multidrop) | | | | | | |
| 612 + N*24 1124 + N*24 | PvInput01_N (index N = 01 to 15) PvInput02_N (index N = 01 to 15) | REAL | • | • | | |
| 617 + N*24 1129 + N*24 | PvUnit01_N (index N = 01 to 15) PvUnit02_N (index N = 01 to 15) | USINT | • | • | | |
| 604 + N*24 1116 + N*24 | PvSampleTime01_N (index N = 01 to 15) PvSampleTime02_N (index N = 01 to 15) | DINT | • | • | | |
| 602 + N*24 1114 + N*24 | PvSampleTime01_N (index N = 01 to 15) PvSampleTime02_N (index N = 01 to 15) | INT | • | | | |
| 562 + N*4 1074 + N*4 | PvNodeComStatus01_N (index N = 01 to 15) PvNodeComStatus02_N (index N = 01 to 15) | DINT | | • | | |
| HART - Extended communication | | | | | | |
| 522 1034 | PvCountHartRequest01 PvCountHartRequest02 | UINT | • | | | |
| 530 1042 | PvCountHartTimeout01 PvCountHartTimeout02 | UINT | • | | | |
| 538 1050 | PvCountHartRxError01 PvCountHartRxError02 | UINT | • | | | |
| 546 1058 | PvCountHartFrameError01 PvCountHartFrameError02 | UINT | • | | | |
| 554 1066 | PvNodeFound01 PvNodeFound02 | UINT | • | | | |
| 558 1070 | PvNodeError01 PvNodeError02 | UINT | • | | | |
| Flatstream - Configuration | | | | | | |
| 1793 | OutputMTU | USINT | | | | • |
| 1795 | InputMTU | USINT | | | | • |
| 1797 | FlatstreamMode | USINT | | | | • |
| 1799 | Forward | USINT | | | | • |
| 1801 | ForwardDelay | UINT | | | | • |
| Flatstream - Communication | | | | | | |
| 1857 | InputSequence | USINT | • | | | |
| 1857 + N*2 | RxByteN (index N = 1 to 15) | USINT | • | | | |
| 1889 | OutputSequence | USINT | | | • | |
| 1889 + N*2 | TxByteN (index N = 1 to 15) | USINT | | | • | |

9.1.9.10.3 Register overview - Function model 254 (bus controller)

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog signal - Configuration | | | | | | | |
| 386 426 | - - | AnMode_1 AnMode_2 | UINT | | | | • |
| 390 430 | - - | Samplerate_1 Samplerate_2 | UINT | | | | • |
| 394 434 | - - | OpenLoopLimit_1 OpenLoopLimit_2 | (U)INT | | | | • |
| 398 438 | - - | LowerLimit_1 LowerLimit_2 | (U)INT | | | | • |
| 402 442 | - - | UpperLimit_1 UpperLimit_2 | (U)INT | | | | • |
| 406 446 | - - | Hysteres_1 Hysteres_2 | (U)INT | | | | • |
| 410 450 | - - | ReplacementLower_1 ReplacementLower_2 | (U)INT | | | | • |
| 414 454 | - - | ReplacementUpper_1 ReplacementUpper_2 | (U)INT | | | | • |
| 418 458 | - - | ErrorDelay_1 ErrorDelay_2 | UINT | | | | • |
| 422 462 | - - | SumErrorDelay_1 SumErrorDelay_2 | UINT | | | | • |
| 466 482 | - - | PreparationInterval_1 PreparationInterval_2 | UINT | | | | • |
| Analog signal - Communication | | | | | | | |
| 266 270 | 0 8 | AnalogInput01 (if replacement value strategy on) AnalogInput02 (if replacement value strategy on) | (U)INT | • | | | |
| 258 262 | - - | AnalogInput01 (if replacement value strategy off) AnalogInput02 (if replacement value strategy off) | (U)INT | | • | | |
| 30 31 | - - | AnalogStatus01 AnalogStatus02 | USINT | | • | | |
| | | UnderflowAnalogInput01 or 02 | Bit 0 | | | | |
| | | OverflowAnalogInput01 or 02 | Bit 1 | | | | |

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|---|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| | | OpenLineAnalogInput01 or 02 | Bit 2 | | | | |
| | | ConversionErrorAnalogInput01 or 02 | Bit 3 | | | | |
| | | SumErrorAnalogInput01 or 02 | Bit 4 | | | | |
| | | SensorErrorAnalogInput01 or 02 | Bit 6 | | | | |
| | | IoSuppErrorAnalogInput01 or 02 | Bit 7 | | | | |
| HART - Configuration | | | | | | | |
| 1537 | - | HartNodeCnt_1 | USINT | | | | • |
| 1665 | - | HartNodeCnt_2 | USINT | | | | • |
| 1539 | - | HartMode_1 | USINT | | | | • |
| 1667 | - | HartMode_2 | USINT | | | | • |
| 1541 | - | HartBurstNode_1 | USINT | | | | • |
| 1669 | - | HartBurstNode_2 | USINT | | | | • |
| HART - Extended configuration | | | | | | | |
| 1558 | - | HartNodeDisable_1 | UINT | | | | • |
| 1686 | - | HartNodeDisable_2 | UINT | | | | • |
| 1546 | - | HartProtTimeOut_1 | UINT | | | | • |
| 1674 | - | HartProtTimeOut_2 | UINT | | | | • |
| 1550 | - | HartProtRetry_1 | UINT | | | | • |
| 1678 | - | HartProtRetry_2 | UINT | | | | • |
| 1554 | - | HartPreamble_1 | UINT | | | | • |
| 1682 | - | HartPreamble_2 | UINT | | | | • |
| HART - Communication (P2P) | | | | | | | |
| 636 | 4 | PvInput01_01 | REAL | • | | | |
| 1148 | 12 | PvInput02_01 | REAL | | | | |
| 612 + N*24 | - | PvInput01_0N (index N = 2 to 4) | REAL | | • | | |
| 1124 + N*24 | - | PvInput02_0N (index N = 2 to 4) | REAL | | | | |
| 641 | 2 | PvUnit01_01 | USINT | • | | | |
| 1153 | 10 | PvUnit02_01 | USINT | | | | |
| 617 + N*24 | - | PvUnit01_0N (index N = 2 to 4) | USINT | | • | | |
| 1129 + N*24 | - | PvUnit02_0N (index N = 2 to 4) | USINT | | | | |
| 566 | - | PvNodeComStatus01 | DINT | | • | | |
| 1078 | - | PvNodeComStatus02 | DINT | | | | |
| HART - Communication (multidrop) | | | | | | | |
| 636 | 4 | PvInput01_01 | REAL | • | | | |
| 1148 | 12 | PvInput02_01 | REAL | | | | |
| 612 + N*24 | - | PvInput01_N (index N = 02 to 15) | REAL | | • | | |
| 1124 + N*24 | - | PvInput02_N (index N = 02 to 15) | REAL | | | | |
| 641 | 2 | PvUnit01_01 | USINT | • | | | |
| 1153 | 10 | PvUnit02_01 | USINT | | | | |
| 617 + N*24 | - | PvUnit01_N (index N = 02 to 15) | USINT | | • | | |
| 1129 + N*24 | - | PvUnit02_N (index N = 02 to 15) | USINT | | | | |
| 562 + N*4 | - | PvNodeComStatus01_N (index N = 01 to 15) | DINT | | • | | |
| 1074 + N*4 | - | PvNodeComStatus02_N (index N = 01 to 15) | DINT | | | | |
| HART - Extended communication | | | | | | | |
| 522 | - | PvCountHartRequest01 | UINT | | • | | |
| 1034 | - | PvCountHartRequest02 | UINT | | | | |
| 530 | - | PvCountHartTimeout01 | UINT | | • | | |
| 1042 | - | PvCountHartTimeout02 | UINT | | | | |
| 538 | - | PvCountHartRxError01 | UINT | | • | | |
| 1050 | - | PvCountHartRxError02 | UINT | | | | |
| 546 | - | PvCountHartFrameError01 | UINT | | • | | |
| 1058 | - | PvCountHartFrameError02 | UINT | | | | |
| 554 | - | PvNodeFound01 | UINT | | • | | |
| 1066 | - | PvNodeFound02 | UINT | | | | |
| 558 | - | PvNodeError01 | UINT | | • | | |
| 1070 | - | PvNodeError02 | UINT | | | | |

1) The offset specifies the position of the register within the CAN object.

9.1.9.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "Using I/O modules on the bus controller" on page 3789.

9.1.9.10.3.2 CAN I/O bus controller

The module occupies 2 analog logical slots on CAN I/O.

9.1.9.10.4 General information

This module is equipped with two independent electrically isolated channels with integrated HART modems. Both channels can be used to read in an analog signal and handle HART communication. All registers necessary for this have a dual design so that the channels can be configured and operated independently of one another. The current input signals (0 to 25 mA) can be displayed in various formats and used as conventional analog inputs. The integrated HART modems retrieve digital information from the memory on the HART slave using the same physical lines that modulate the HART signals.

When using the 0 to 25 mA current input variant, the module is conceived as a HART master for 2 channels (loops), with FSK modulation of the HART protocol and sensor supply for up to 15 slaves per channel.

Each channel can use one of the following connection variants:

- Connection of one HART node (point-to-point) with evaluation of the analog signal and output of 4 HART process variables OR
- Connection of up to 15 HART nodes in multidrop mode with output of the primary HART variable from activated nodes

Specific features:

- Channels electrically isolated
- Up to 15 HART input variables per channel
- Configurable sampling rate (input filter) to transfer HART and analog signal without interference (default: 50 Hz or 20 ms)
- Internal supply with short circuit protection <30 mA per channel
- Selective line monitoring can be enabled for: open line (<2 mA), underflow (<3.6 mA) or overflow (>21 mA) of a configurable threshold
- Selectable error strategy (static replacement value or retention of the last permitted value)
- Cyclic "HART status" polling (HART command 0), the status information received is made available for channel diagnostics
- Compatible with an additional secondary master in the HART network (module acts as the primary master)
- "HART communication error bit" (shows loss of HART connection if a connection had already been established successfully)
- Optional: Burst mode for one node per channel
- Optional: Cyclic polling of "HART variables" (HART command 3 or 9)
- Optional: Sensor power supply for max. 15 nodes per channel in the multidrop variant
- Optional: Flatstream functionality (module acts as bridge for HART packets)

Information:

Maximum number of HART nodes per channel:

- **5 nodes (when using HART nodes with a nominal current of 4 mA)**
- **Up to 15 HART nodes (taking into account the maximum permissible input signal or nominal output current of the sensor power supply of 25 mA)**

9.1.9.10.5 Analog signal - Configuration

How the analog signal is displayed can be adapted to the requirements of the application. Separate configuration registers per channel are available to aid in this.

9.1.9.10.5.1 Channel parameters

Name:

AnMode_1 to AnMode_2

These registers are used to predefine the operating parameters that the module will be using for the respective channel. Each channel must be enabled individually and can be configured and operated independently.

Information:

Different limit values must be configured for any display normalizing that needs to take place.

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| UINT | See bit structure. | 29 |

Bit structure:

| Bit | Name | Value | Information |
|--------|----------------------------|-------|---|
| 0 | Channel | 0 | Channel 0x turned off |
| | | 1 | Channel 0x enabled (bus controller default setting) |
| 1 | Open line detection | 0 | Open line monitoring turned off |
| | | 1 | Open circuit monitoring enabled (bus controller default setting) |
| 2 | Underflow detection | 0 | Underflow detection turned off |
| | | 1 | Underflow detection enabled (bus controller default setting) |
| 3 | Replacement value strategy | 0 | Use replacement values in the event of error (bus controller default setting) |
| | | 1 | Keep the last valid converted value |
| 4 - 5 | Normalization | 00 | Displays 0 to 25 mA as 0 to 32767 |
| | | 01 | Display 0 to 25 mA as 0 to 25000 [μ A] (bus controller default setting) |
| | | 10 | Displays 4 to 20 mA as 0 to 32767 |
| | | 11 | Displays 0 to 25 mA as 0 to 65535 |
| 6 - 15 | Reserved | - | |

9.1.9.10.5.2 Sample rate

Name:

Samplerate_1 to Samplerate_2

A sample rate can be configured for both analog inputs independently of one another. The following formula for this parameter is derived using the desired sampling frequency:

$$\text{Sampling rate for A/D converter} = (4920000 / 1024) / \text{Sampling frequency}$$

| Data type | Value | Information | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------|-------------|---|--------|------|-----------|-----|------------|----------|-----|------------|-----------|-----|-------------|-----------|-----|-----------|-----------|-----|-------------|-----------|----|-----------|--|----|-------------|-----------|----|-----------|------------|---|----------|------------|---|----------|-------------|
| UINT | 4 to 1023 | Sample rate Examples of configurable values <table border="1"> <thead> <tr> <th>Val-ue</th> <th>Time</th> <th>Frequency</th> </tr> </thead> <tbody> <tr> <td>960</td> <td>... 200 ms</td> <td>... 5 Hz</td> </tr> <tr> <td>480</td> <td>... 100 ms</td> <td>... 10 Hz</td> </tr> <tr> <td>320</td> <td>... 66.7 ms</td> <td>... 15 Hz</td> </tr> <tr> <td>192</td> <td>... 40 ms</td> <td>... 25 Hz</td> </tr> <tr> <td>160</td> <td>... 33.3 ms</td> <td>... 30 Hz</td> </tr> <tr> <td>96</td> <td>... 20 ms</td> <td>... 50 Hz (bus controller default setting)</td> </tr> <tr> <td>80</td> <td>... 16.7 ms</td> <td>... 60 Hz</td> </tr> <tr> <td>48</td> <td>... 10 ms</td> <td>... 100 Hz</td> </tr> <tr> <td>9</td> <td>... 2 ms</td> <td>... 500 Hz</td> </tr> <tr> <td>4</td> <td>... 1 ms</td> <td>... 1000 Hz</td> </tr> </tbody> </table> | Val-ue | Time | Frequency | 960 | ... 200 ms | ... 5 Hz | 480 | ... 100 ms | ... 10 Hz | 320 | ... 66.7 ms | ... 15 Hz | 192 | ... 40 ms | ... 25 Hz | 160 | ... 33.3 ms | ... 30 Hz | 96 | ... 20 ms | ... 50 Hz (bus controller default setting) | 80 | ... 16.7 ms | ... 60 Hz | 48 | ... 10 ms | ... 100 Hz | 9 | ... 2 ms | ... 500 Hz | 4 | ... 1 ms | ... 1000 Hz |
| Val-ue | Time | Frequency | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 960 | ... 200 ms | ... 5 Hz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 480 | ... 100 ms | ... 10 Hz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 320 | ... 66.7 ms | ... 15 Hz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 192 | ... 40 ms | ... 25 Hz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 160 | ... 33.3 ms | ... 30 Hz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 96 | ... 20 ms | ... 50 Hz (bus controller default setting) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 80 | ... 16.7 ms | ... 60 Hz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 48 | ... 10 ms | ... 100 Hz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | ... 2 ms | ... 500 Hz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | ... 1 ms | ... 1000 Hz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

The fastest sample rate of 10 ms for the analog inputs is predefined by the cutoff frequency of the hardware filter. When using HART communication, however, a sample rate not faster than 100 ms is recommended.

9.1.9.10.5.3 Limit value for open line detection

Name:

OpenLoopLimit_1 to OpenLoopLimit_2

The limit value for the respective analog input must be set when open circuit monitoring is enabled and if required by the configured normalization.

| Data type | Value | Information |
|-----------|-----------------|---|
| INT | -32767 to 32767 | Open circuit limit value. Bus controller default setting: 2621 |
| UINT | 0 to 65535 | Open circuit limit value |

If limit value monitoring is active, the corresponding error status is output after a configured delay when falling below this value. Using a default value of 2000 μ A, the following values and formulas result for this parameter:

- Displays 0 to 25 mA as 0 to 25000: 2000
- Displays 0 to 25 mA as 0 to 32767: 2621, limit value = $([\mu\text{A}] * 32767) / 25000$
- Displays 4 to 20 mA as 0 to 32767: -4096, limit value = $(([\mu\text{A}] * 1.31068) - 5242.72) * 1.5625$
- Displays 0 to 25 mA as 0 to 65535: 5243, limit value = $([\mu\text{A}] * 65535) / 25000$

9.1.9.10.5.4 Preparation time for the measured values

Name:

PreparationInterval01 to PreparationInterval02

If the last valid measured value should be kept when violating the limit value, then PreparationInterval must be defined. The measured values continue to be acquired and converted according to the configured I/O update time. They are then checked and discarded if they do not meet the specifications. When an error does not occur, therefore, the measured value acquired 2 preparation intervals ago is constantly output.

| Data type | Value | Information |
|-----------|------------|---|
| UINT | 0 to 65535 | In 0.1 ms. Bus controller default setting: 0 |

| | |
|---|--|
| <p>Functionality: Measured values are continuously converted and stored to measured value memory. The current contents of the measured value memory are checked within the configured interval. If a permissible value is present, then the contents of the buffer memory are passed to output memory and the contents of the measured value memory are passed to the buffer. If the check turns up an impermissible value, then the contents of the measured value memory are discarded. The copy direction between output and buffer memory reverses and the last valid value continues to be output.</p> <p>Information: If configured to keep the last valid value, the delay time from measuring to outputting the value will be at least twice the preparation interval. In the worst case scenario, this can also take twice the interval time plus the configured conversion rate of the A/D converter.</p> | <p>"Application" Value being measured (analog)</p> |
| | <p>↓ Condition: - Conversion interval (A/D converter) elapsed</p> |
| | <p>"Measured value memory" Measured value (digital)</p> |
| | <p>↓ Condition: - PreparationInterval elapsed - Measured value permissible</p> |
| | <p>"Buffer" Last valid value</p> |
| <p>↓ Condition: - PreparationInterval elapsed - Measured value permissible</p> | |
| <p>"Output memory" Next-to-last valid/ displayed value</p> | |

9.1.9.10.5.5 Lower replacement value

Name:

ReplacementLower_1 to ReplacementLower_2

This register is used to define the lower static values to be displayed instead of the current measured value when the lower limit is violated.

| Data type | Value | Information |
|-----------|-----------------|--------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 4718 |
| UINT | 0 to 65535 | |

If the replacement strategy "Use replacement values when an error occurs" is enabled, the replacement value must be set for the respective analog input taking the configured normalization into account as well. When an overflow or underflow error status occurs, the "AnalogInput0x" on page 387 channel is replaced with the corresponding value. Using a default value of 3600 μ A, the following values and formulas result for this parameter:

- Displays 0 to 25 mA as 0 to 25000: 3600
- Displays 0 to 25 mA as 0 to 32767: 4718, limit value = $([\mu\text{A}] * 32767) / 25000$
- Displays 4 to 20 mA as 0 to 32767: -819, limit value = $(([\mu\text{A}] * 1.31068) - 5242.72) * 1.5625$
- Displays 0 to 25 mA as 0 to 65535: 9437, limit value = $([\mu\text{A}] * 65535) / 25000$

9.1.9.10.5.6 Upper replacement value

Name:

ReplacementUpper_1 to ReplacementUpper_2

This register is used to define the static values to be displayed instead of the current measured value when the upper limit is violated.

| Data type | Value | Information |
|-----------|-----------------|---------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 27524 |
| UINT | 0 to 65535 | |

If the replacement strategy "Use replacement values when an error occurs" is activated, the replacement value must be set for the respective analog input taking the configured normalization into account as well. When an overflow or underflow error status occurs, the "[AnalogInput0x](#)" on page 387 channel is replaced with the corresponding value. Using a default value of 21000 μ A, the following values and formulas result for this parameter:

- Displays 0 to 25 mA as 0 to 25000: 21000
- Displays 0 to 25 mA as 0 to 32767: 27524, limit value = $([\mu\text{A}] * 32767) / 25000$
- Displays 4 to 20 mA as 0 to 32767: 32767, limit value = $(([\mu\text{A}] * 1.31068) - 5242.72) * 1.5625$
- Displays 0 to 25 mA as 0 to 65535: 55049, limit value = $([\mu\text{A}] * 65535) / 25000$

9.1.9.10.5.7 Lower limit value

Name:

LowerLimit_1 to LowerLimit_2

If the value range needs to be restricted further, this register can be used to enter new user-specific lower limit values.

| Data type | Value | Information |
|-----------|-----------------|--------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 4718 |
| UINT | 0 to 65535 | |

The limit value must be set for the respective analog input depending on the configured normalization. After the configured delay time has passed, the corresponding error status is given if the respective value is overrun or underrun. When this error state occurs, the "[AnalogInput0x](#)" on page 387 channel is evaluated according to the replacement value strategy. Using a default value of 3600 μ A, the following values and formulas result for this parameter:

- Displays 0 to 25 mA as 0 to 25000: 3600
- Displays 0 to 25 mA as 0 to 32767: 4718, limit value = $([\mu\text{A}] * 32767) / 25000$
- Displays 4 to 20 mA as 0 to 32767: -819, limit value = $(([\mu\text{A}] * 1.31068) - 5242.72) * 1.5625$
- Displays 0 to 25 mA as 0 to 65535: 9437, limit value = $([\mu\text{A}] * 65535) / 25000$

9.1.9.10.5.8 Upper limit value

Name:

UpperLimit_1 to UpperLimit_2

If the value range needs to be restricted further, this register can be used to enter new user-specific upper limit values.

| Data type | Value | Information |
|-----------|-----------------|---------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 27524 |
| UINT | 0 to 65535 | |

The limit value must be set for the respective analog input depending on the configured normalization. After the configured delay time has passed, the corresponding error status is given if the respective value is overrun or underrun. When this error state occurs, the "[AnalogInput0x](#)" on page 387 channel is evaluated according to the replacement value strategy. Using a default value of 21000 μ A, the following values and formulas result for this parameter:

- Displays 0 to 25 mA as 0 to 25000: 21000
- Displays 0 to 25 mA as 0 to 32767: 27524, limit value = $([\mu\text{A}] * 32767) / 25000$
- Displays 4 to 20 mA as 0 to 32767: 32767, limit value = $(([\mu\text{A}] * 1.31068) - 5242.72) * 1.5625$
- Displays 0 to 25 mA as 0 to 65535: 55049, limit value = $([\mu\text{A}] * 65535) / 25000$

9.1.9.10.5.9 Hysteresis

Name:

Hysteres_1 to Hysteres_2

If the user-specific limit values are being used, then a hysteresis range should also be defined. These registers configure how far a limit value can be exceeded before a response is triggered.

| Data type | Value | Information |
|-----------|-----------------|-------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 131 |
| UINT | 0 to 65535 | |

The hysteresis value must be set for the respective analog input depending on the configured normalization. The error status is cleared if the actual analog value changes by at least this hysteresis value from the limit value in the allowed direction. Using a default value of 100 μ A, the following values and formulas result for this parameter:

- Displays 0 to 25 mA as 0 to 25000: 100
- Displays 0 to 25 mA as 0 to 32767: 131, limit value = $([\mu\text{A}] * 32767) / 25000$
- Displays 4 to 20 mA as 0 to 32767: 156, limit value = $[\mu\text{A}] * 1.5625$
- Displays 0 to 25 mA as 0 to 65535: 262, limit value = $([\mu\text{A}] * 65535) / 25000$

9.1.9.10.5.10 Delaying error messages

Name:

ErrorDelay_1 to ErrorDelay_2

This register specifies the number of consecutive conversion procedures where an error is pending until the corresponding individual error status bit is set. The delay applies to underflow, overflow and open circuit errors. This delay can be used to hide temporary measured value deviations, for example.

| Data type | Value | Information |
|-----------|---------|--|
| UINT | 0 to 10 | Error formation delay in conversion cycles. Bus controller default setting: 2 |

9.1.9.10.5.11 Time for composite error bit

Name:

SumErrorDelay_1 to SumErrorDelay_2

This register specifies the time in milliseconds that one of the individual error bits must be pending until the composite error status bit is set.

| Data type | Value | Information |
|-----------|------------|--|
| UINT | 0 to 65535 | Composite error bit delay in ms. Bus controller default setting: 4000 |

9.1.9.10.6 Analog signal - Communication

9.1.9.10.6.1 Analog input values

Name:

AnalogInput01 to AnalogInput02

The analog input value is mapped in this register.

| Data type | Value | Information |
|-----------|----------------|---|
| INT | 0 to 25000 | Normalizing option 0 to 25 mA |
| | 0 to 32,767 | Normalizing option 0 to 25 mA |
| | -8192 to 32767 | Normalizing option 4 to 20 mA (value 0 corresponds to 4 mA) |
| UINT | 0 to 65535 | Normalizing option 0 to 25 mA |

Predefining values and timing

If a replacement value strategy was configured, value "0" (zero) is output from the beginning until a valid measured value has been calculated.

The timing for acquiring measured values is determined by the converter hardware and the set sampling rate. The two channels are converted independently of each other and are not synchronized with the X2X Link.

| Conversion time |
|--------------------------|
| Channel 0x sampling rate |

9.1.9.10.6.2 Sample time

Name:

AnalogSampletime01 to AnalogSampletime02

These registers return the timestamp for when the module reads the current channel mapping. The values are provided as signed 2-byte or 4-byte values.

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

| Data type | Values | Information |
|-----------|---------------------------|---|
| INT | -32,768 to 32767 | NetTime timestamp of the current input value in μ s |
| DINT | -2147483648 to 2147483647 | NetTime timestamp of the current input value in μ s |

9.1.9.10.6.3 Status of the inputs

Name:

AnalogStatus01 to AnalogStatus02
 UnderflowAnalogInput01 to UnderflowAnalogInput02
 OverflowAnalogInput01 to OverflowAnalogInput02
 OpenLineAnalogInput01 to OpenLineAnalogInput02
 ConversionErrorAnalogInput01 to ConversionErrorAnalogInput02
 SumErrorAnalogInput01 to SumErrorAnalogInput02
 SensorErrorAnalogInput01 to SensorErrorAnalogInput02
 IoSuppErrorAnalogInput01 to IoSuppErrorAnalogInput02

The current error state of the module channels is indicated in this register regardless of the configured replacement value strategy. Some error information is delayed according to the previously configured condition.

Setting "Format of status information" in Automation Studio makes it possible to define whether the status information is transferred as USINT or bit values.

| Data type | Values |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Values | Information |
|-----|------------------------------------|--------|--------------------------------------|
| 0 | UnderflowAnalogInput01 or 02 | 0 | No error |
| | | 1 | Lower limit value undershot |
| 1 | OverflowAnalogInput01 or 02 | 0 | No error |
| | | 1 | Upper limit value overshoot |
| 2 | OpenLineAnalogInput01 or 02 | 0 | No error |
| | | 1 | Open circuit determined |
| 3 | ConversionErrorAnalogInput01 or 02 | 0 | No error |
| | | 1 | Conversion error determined |
| 4 | SumErrorAnalogInput01 or 02 | 0 | No error |
| | | 1 | Composite error determined |
| 5 | Reserved | - | |
| 6 | SensorErrorAnalogInput01 or 02 | 0 | Sensor voltage OK |
| | | 1 | Sensor load too high |
| 7 | IoSuppErrorAnalogInput01 or 02 | 0 | I/O power supply OK |
| | | 1 | Error in I/O power supply determined |

UnderflowAnalogInput

The signal underflow error state is represented here based on the configuration. This error information is enabled as a multiple of the conversion cycles only after the configurable delay time has passed (see register "ErrorDelay" on page 386).

OverflowAnalogInput

The signal overflow error status state is represented here based on the configuration. This error information is enabled as a multiple of the conversion cycles only after the configurable delay time has passed (see register "ErrorDelay" on page 386).

OpenLineAnalogInput

Based on the configuration, the measurement information is checked for values <2 mA (register "OpenLoopLimit" on page 384) to detect a failure signal. Open circuit detection is performed using a configurable hysteresis value (default: 100 µA, register "Hysteresis" on page 386). It is possible to disable open circuit detection (register "AnalogMode" on page 383) to suppress the generation of alarms when hardware is missing. This error information is enabled as a multiple of the conversion cycles only after the configurable delay time has passed (register "ErrorDelay" on page 386).

ConversionErrorAnalogInput

This error state is triggered when the hardware overshoots the conversion time.

SumErrorAnalogInput

This error information is derived from the state of individual errors and enabled only after the configurable delay time has passed [ms] (see register "SumErrorDelay" on page 386). Linking this error information in an application makes it possible to hide temporary overshoots or undershoots of the temperature value, for example.

SensorErrorAnalogInput

This error is enabled immediately after a fault is detected in the internal sensor power supply.

IoSuppErrorAnalogInput

This error is enabled immediately after a supply voltage undershoot is detected (<20 VDC).

9.1.9.10.7 HART

HART (Highway Addressable Remote Transducer) is a protocol for communicating with intelligent field devices. It was developed in order to more efficiently use the infrastructure for transferring analog signals. The digital HART notifications are modulated to the analog signal using Frequency Shift Keying (FSK). HART can thus use the same physical line as the analog signal without influencing the original function.

HART slaves are able to determine different process data independently and prepare HART concordantly. This protocol supports polling of the value of a process variable as well as its unit and status. Field devices usually supply their information after the master requests it. In newer revisions, it is also possible to transfer configuration data.

There are 2 different types of HART networks. In a *point-to-point* network, only one slave is connected to a HART master. Here, the analog signal and the HART signal can be transferred over the same line. Managing several slaves with HART requires what is known as a *multidrop* network. Here, each HART slave is assigned and identified by a unique address. Classic analog signals cannot be clearly traced in bus systems. As a result, the HART protocol does not support analog information transfers in multidrop networks up to and including HART Revision 5.

9.1.9.10.7.1 HART - Configuration

HART modules are analog modules equipped with a HART modem. For each channel, a separate HART network can be managed by the module, which acts as a primary master. Once configured successfully, the HART information is stored in the module where it can then be used by the PLC.

The number of HART slaves must be specified in the configuration.

If only one slave is connected to the HART channel, then it is part of a point-to-point network. The module can then prepare up to 4 process variables from the connected slave.

Multidrop mode allows up to 15 HART slaves to be connected. The primary process variable from each slave is then retrieved.

HartBurstNode

Name:

HartBurstNode_1 to HartBurstNode_2

In addition to the type of network, the user can also choose from 2 different types of communication behavior. Conventional HART communication relies on polling. The module queries the data from the HART slave individually and receives the corresponding information from the slave as a response. If a HART node should be queried in short time intervals, the user can configure burst mode for a node on each channel. In this case, the slave transmits the information from this node cyclically without a new request by the master.

The node numbers (short address) whose information should be queried using burst mode are entered by channel in the "HartBurstNode" registers. Burst mode is enabled using register "[HartMode](#)" on page 390.

| Data type | Value | Information |
|-----------|---------|--|
| USINT | 0 to 15 | Point-to-point. Bus controller default setting: 0 |

HartMode

Name:

HartMode_1 to HartMode_2

The user can use these registers to configure the communication behavior of each of the HART channels. Generally, the HART nodes are polled individually. This register can still be used to start or stop burst mode when needed. In burst mode, a node transmits its information cyclically instead of continuously. As a result, the HART standard allows the simultaneous usage of both burst mode and polling.

Information:

Register "[HartBurstNode](#)" on page 389 must be configured correctly for burst queries.

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| UINT | See bit structure. | 0 |

Bit structure:

| Bit | Name | Value | Information |
|-------|------------------------|-------|--|
| 0 | Slave polling mode | 0 | Polling mode enabled (bus controller default setting) |
| | | 1 | Polling mode disabled |
| 1 | Start slave burst mode | 0 | No response to burst (bus controller default setting) |
| | | 1 | Enables burst mode in the " HartBurstNode " on page 389 node |
| 2 | Stop slave burst mode | 0 | No response to burst (bus controller default setting) |
| | | 1 | Disables burst mode, if enabled |
| 3 - 7 | Reserved | - | |

HartNodeCnt

Name:

HartCodeCnt_1 to HartCodeCnt_2

These registers tell the module how many HART slaves are connected to a channel.

Information:

If a slave is not connected to one of the HART channels, the value "0" should be defined in this register. This shortens the I/O update time and avoids superfluous error messages.

| Data type | Value | Information |
|-----------|---------|---|
| USINT | 0 | HART communication disabled for this channel |
| | 1 | Point-to-point Standard HART communication (bus controller default setting) |
| | 2 to 15 | Multidrop Number of HART slave nodes |

9.1.9.10.7.2 HART - Communication

After the configuration is completed, the information is retrieved automatically and transferred to the module registers. A separate register is implemented in the module for each piece of information. HART modules are designed to query up to 15 pieces of information per channel. The module reads in the data, stores it in temporary memory and prepares it for retrieval. When the X2X master accesses the module registers, it is irrelevant whether the HART data originates from a point-to-point or multidrop network.

Overview of internal module mapping

| | <i>Point-to-point network (1 HART slave)</i> | <i>Multidrop network (2 to 15 HART slaves)</i> |
|--------------|--|--|
| (Pv)Input_01 | Primary piece of information from HART node 1 | Primary piece of information from HART node 1 |
| (Pv)Input_02 | Secondary piece of information from HART node 1 | Primary piece of information from HART node 2 |
| ... | ... | ... |
| (Pv)Input_04 | Quaternary piece of information from HART node 1 | Primary piece of information from HART node 4 |
| (Pv)Input_05 | Reserved | Primary piece of information from HART node 5 |
| ... | ... | ... |
| (Pv)Input_15 | Reserved | Primary piece of information from HART node 15 |

The HART specifications stipulates that information from a HART node be split into various pieces. The value of a process variable is stored to the respective "PvInput" on page 391 register and has a size of 4 bytes (REAL) per the HART specification. Due to the length limitation of 30 bytes on the X2X Link network, there are limitations to the number of possible cyclic variables. It is recommended to transfer a maximum of 2 "PvInput" on page 391 registers cyclically to the X2X master. All other information should be read in a different way. To access HART information, the user can choose between the following methods:

- **Acyclic:** If library AsIOAcc is used, information is queried acyclically only when it is needed, i.e. communication can be adapted to the program sequence of the X2X master. In this way, all of the necessary module registers on the X2X Link network can be queried despite the length limitation. This type of information exchange is not real-time capable.
- **Cyclic:** Data points configured for cyclic transfer are read once per bus cycle. This procedure allows real-time capable information exchange between the module and X2X master. The length limitation may prevent all data from being queried within one cycle, however.
- **Multiplexed:** A runtime driver can be used to transfer the HART data points in the I/O mapping. In this case, the HART process data points are transferred in an alternating pattern using time-division multiplexing. Communication remains real-time capable. Multiple bus cycles are needed to update all data points, however.

Information:

"Multiplexed" data transfer is used only for HART data points.

Information from the analog inputs/outputs is always transferred cyclically (see above).

- **Flatstream:** HART modules are equipped with a Flatstream interface. When using Flatstream communication, the module is used as a bridge between the X2X master and HART slave, i.e. the X2X master communicates directly with the HART slave (see "Flatstream communication" on page 3802). Flatstream communication is also not real-time capable. It allows unrestricted access to the HART slave. The user must have sufficient knowledge of the HART protocol command set as well as the capabilities of the corresponding HART slave.

PvInput

Name:

PvInput_01 to PvInput_15

PvInput_01_01 to PvInput_01_15

PvInput_02_01 to PvInput_02_15

These registers return the current value of the process variable that has been read.

Information:

These registers are of data type REAL, which means that the available bytes on the X2X Link are filled more quickly when operated cyclically. If information from several slave nodes is needed, it must be retrieved acyclically or using Flatstream .

| Data type | Value | Information |
|-----------|-------------|---------------------------------------|
| REAL | IEEE754 SPF | 32-bit data type with valid value |
| | 0x7FA00000 | Not a number (NaN) with invalid value |

PvUnit

Name:

PvUnit_01 to PvUnit_15

PvUnit_01_01 to PvUnit_01_15

PvUnit_02_01 to PvUnit_02_15

These registers return a HART-specific code that specifies the unit for the measured value. The coding for this is established in the HART specification.

| Data type | Value |
|-----------|---|
| USINT | See description of the HART slave See HART specification |

PvSampleTime

Name:

PvSampleTime01 to PvSampleTime02

PvSampleTime01_01 to PvSampleTime01_15

PvSampleTime02_01 to PvSampleTime02_15

These registers return the timestamp for when the module reads the current channel mapping. The values are provided as signed 2-byte or 4-byte values.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Values | Information |
|-----------|---------------------------|---|
| INT | -32,768 to 32767 | NetTime timestamp of the current input value in μs |
| DINT | -2147483648 to 2147483647 | NetTime timestamp of the current input value in μs |

This refers to the point in time when the HART master receives the slave's response. This is a way to check whether new HART information has been read since the last X2X cycle.

Information:

The cycle times of a HART network are relatively long so that it is not possible to reliably determine when the measured value is retrieved with just this information.

PvNodeComStatus

Name:

PvNodeComStatus01 to PvNodeComStatus02

PvNodeComStatus01_01 to PvNodeComStatus01_15

PvNodeComStatus02_01 to PvNodeComStatus02_15

These registers provide information about whether a read value is valid. Per the HART specification, this type of status register consists of 2 parts. The "response code" is stored in the high byte; the "field device status" is stored in the low byte. This makes it possible to check the current state of a read process variable.

These registers can be checked before further processing information in temporary storage. If the current value is 0x0000, an error was not detected during the HART transfer and the information from the checked node can be used. If a different value is present, the situation in the HART network should be checked. This can be done using an extension register, for example.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|--------|---|-------|---|
| 0 | Quality - Node information 2 to n | 0 | Digital measured value okay |
| | | 1 | Measured value outside the permitted range |
| 1 | Quality - Node information 1 | 0 | Digital measured value okay |
| | | 1 | Measured value outside the permitted range |
| 2 | Limit violation | 0 | Parameter okay |
| | | 1 | Invalid measured value(s) or encoder supply value |
| 3 | Static analog signal | 0 | Normal value change/fluctuation |
| | | 1 | Constant analog value of Node 1 slave |
| 4 | Additional status information (only supported by a few slaves) | 0 | Not available |
| | | 1 | Available (only using Flatstream command #48) |
| 5 | Restart | 0 | Normal operation |
| | | 1 | Field device restarts |
| 6 | Device ID | 0 | Unchanged |
| | | 1 | Changed |
| 7 | Device error | 0 | Measured value okay |
| | | 1 | Questionable measured value information |
| 8 - 14 | Response code, if relevant | x | See HART-specific response code |
| 15 | Error - Communication | 0 | Error-free communication (response code irrelevant) |
| | | 1 | Faulty communication (response code relevant) |

HART-specific response code (excerpt):

| | |
|------------------------------------|---|
| 0x82 ... Receive buffer overflow | If a HART communication error occurs, the response code is written. Bit 15 is always set. |
| 0x88 ... Checksum incorrect | |
| 0x90 ... Faulty protocol structure | |
| 0xA0 ... Overrun | |
| 0xC0 ... Parity not allowed | |
| 0xFF ... Timeout | |

Retrieving information that has been read

After the node data has been transferred to the module registers, the information can be retrieved from the module. A separate register in the module is implemented for each piece of information.

PvCountHartRequest

This register is increased as soon as the module is ready to transmit a message on the corresponding channel.

| Data type | Value |
|-----------|------------|
| UINT | 0 to 65535 |

PvCountHartTimeout

This register is increased if the slave exceeds the maximum permissible time to respond a request from the module.

| Data type | Value |
|-----------|------------|
| UINT | 0 to 65535 |

PvCountHartRxError

This register is increased if communication errors occur on layer 1 of the OSI model (e.g. transfer error according to the parity bit).

| Data type | Value |
|-----------|------------|
| UINT | 0 to 65535 |

PvCountHartFrameError

This register is increased if communication errors occur on layer 2 of the OSI model (e.g. invalid telegram structure).

| Data type | Value |
|-----------|------------|
| UINT | 0 to 65535 |

PvNodeFound

Name:

PvNodeFound01 to PvNodeFound02

These registers provide information about which nodes were detected on which channel (slave identified successfully).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|--------------------------|-------|-----------------------|
| 0 | Node 0 (default mode) | 0 | Not detected as valid |
| | Node 1 (multidrop mode) | 1 | Detected as valid |
| 1 | Node 2 (multidrop mode) | 0 | Not detected as valid |
| | | 1 | Detected as valid |
| ... | | ... | |
| 13 | Node 14 (multidrop mode) | 0 | Not detected as valid |
| | | 1 | Detected as valid |
| 14 | Node 15 (multidrop mode) | 0 | Not detected as valid |
| | | 1 | Detected as valid |
| 15 | Reserved | - | |

PvNodeError

Name:

PvNodeError01 to PvNodeError02

These registers contain the HART communications error bits. These bits are set if the connection to a node was established successfully but the node at some point no longer responds as it should (e.g. the HART slave exceeds the configured timeout / number of retries).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|--------------------------|-------|------------------------------|
| 0 | Node 0 (default mode) | 0 | Detected as having no errors |
| | Node 1 (multidrop mode) | 1 | Detected as having errors |
| 1 | Node 2 (multidrop mode) | 0 | Detected as having no errors |
| | | 1 | Detected as having errors |
| ... | | ... | |
| 13 | Node 14 (multidrop mode) | 0 | Detected as having no errors |
| | | 1 | Detected as having errors |
| 14 | Node 15 (multidrop mode) | 0 | Detected as having no errors |
| | | 1 | Detected as having errors |
| 15 | Reserved | - | |

9.1.9.10.7.3 Extended configuration

The additional configuration registers are specified values when the module is started. In most systems, the user does not need to make any adjustments here. Register values should only be changed if HART network communication is not taking place satisfactorily.

HartNodeDisable

Name:

HartNodeDisable_1 to HartNodeDisable_2

These registers are intended for things like maintenance. They make it possible to cut off configured HART nodes to suppress error messages for a certain period of time. During normal operation, the configured nodes must be switched active to guarantee that the procedure runs smoothly.

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| UINT | See bit structure. | 0x3FFF |

Bit structure:

| Bit | Name | Value | Information |
|-----|--------------------------|-------|---|
| 0 | Node 0 (default mode) | 0 | Enabled (bus controller default setting) |
| | Node 1 (multidrop mode) | 1 | Disabled |
| 1 | Node 2 (multidrop mode) | 0 | Enabled |
| | | 1 | Disabled (bus controller default setting) |
| ... | | ... | |
| 13 | Node 14 (multidrop mode) | 0 | Enabled |
| | | 1 | Disabled (bus controller default setting) |
| 14 | Node 15 (multidrop mode) | 0 | Enabled |
| | | 1 | Disabled (bus controller default setting) |
| 15 | Reserved | - | |

HartProtTimeOut

Name:

HartProtTimeOut_1 to HartProtTimeOut_2

These registers specify the time span within which the slave must respond for the response to be valid.

| Data type | Values [ms] | Information |
|-----------|-------------|--|
| UINT | 0 to 65535 | Bus controller default setting: 256 [ms] |

HartProtRetry

Name:

HartProtRetry_1 to HartProtRetry_2

These registers determine how many times the master retries a request if it receives an invalid response or no response at all.

| Data type | Value | Information |
|-----------|------------|--|
| UINT | 0 to 65535 | Bus controller default setting: 3 attempts |

HartPreamble

Name:

HartPreamble_1 to HartPreamble_2

The length of the preamble can be set in these registers. The preamble is used to synchronize the receiver to the transmitter. The longer the declared preamble, the less chance that a communication error will occur. Nevertheless, a useful signal is not transmitted during synchronization so the preamble should be kept as short as possible.

| Data type | Value | Information |
|-----------|---------|------------------------------------|
| UINT | 5 to 20 | Bus controller default setting: 20 |

9.1.9.10.8 Flatstream communication

For a description of Flatstream communication, see ["Flatstream communication" on page 3802](#)

9.1.9.10.9 HART with Flatstream

When using Flatstream communication, the module acts as a bridge between the X2X master and an intelligent field device connected to the module. Flatstream mode can be used for either point-to-point connections as well as for multidrop systems. Specific algorithms such as timeout and checksum monitoring are usually managed automatically. During normal operation, the user does not have access to these details.

HART is considered a master-slave network where half-duplex communication takes place asynchronously. Various features have been included to ensure that signals are transmitted without errors.

For example, the user can increase the length of the preamble, thus making the transmission more secure. However, this also has an effect on the percentage of payload data and overhead.

Additional information about HART can be found at www.HARTcomm.org.

How it works

The module has 2 independent channels. When using Flatstream, the channel number must therefore be specified. The general structure of a Flatstream frame is extended as follows.

| Input/Output sequence | Tx/Rx bytes | | |
|-----------------------|-----------------------------|----------------|---|
| (unchanged) | Control byte (unchanged) | Channel number | HART frame (without preamble and checksum) |

| HART frame with Flatstream | | | | | |
|----------------------------|------|-----|------|-------|--------|
| Startup | ADDR | CMD | BCNT | (STS) | (DATA) |

| | |
|---------|--|
| Startup | Start identification |
| ADDR | Address within the HART network |
| CMD | HART command |
| BCNT | Byte counters (number of remaining bytes) |
| *STS | Status of the last command received. Information about the working mode of the HART Slave and communication errors (if supported, return data from the HART Slave) |
| *DATA | Data (if necessary for the command) |

Examples of HART commands

| Command | Function |
|---------|--|
| 0x00 | Read slave ID |
| 0x03 | Read current value and up to 4 variables |
| 0x09 | Read up to 4 variables including status |
| 0x21 | Read variables |

9.1.9.10.10 NetTime Technology

For a description of NetTime Technology, see "[NetTime Technology](#)" on page 3035.

9.1.9.10.11 Minimum cycle time

The minimum cycle time defines how far the bus cycle can be reduced without causing a communication error or impaired functionality. It should be noted that very fast cycles decrease the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 µs |

9.1.9.10.12 Minimum I/O update time

The minimum I/O update time defines how far the bus cycle can be reduced while still allowing an I/O update to take place in each cycle.

| Minimum I/O update time | |
|-------------------------|------|
| Analog inputs | 1 ms |

| Minimum I/O update time for HART communication | |
|--|-----------------------------|
| Point-to-point | 500 ms |
| Multidrop | 500 ms * Number of stations |

9.1.10 X20AI2622

Data sheet version: 3.11

9.1.10.1 General information

The module is equipped with 2 inputs with 13-bit (including sign) digital converter resolution. It is possible to select between the current and voltage signal using different terminals.

This module is designed for X20 6-pin terminal blocks. If needed (e.g. for logistical reasons), the 12-pin terminal block can also be used.

- 2 analog inputs
- Either current or voltage signal possible
- 13-bit digital converter resolution

9.1.10.2 Order data


| Model number | Short description | Figure |
|--------------|--|--|
| | Analog inputs |  |
| X20AI2622 | X20 analog input module, 2 inputs, ± 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution, configurable input filter | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |

Table 58: X20AI2622 - Order data

9.1.10.3 Technical data

| Model number | X20AI2622 |
|--|--|
| Short description | |
| I/O module | 2 analog inputs ± 10 V or 0 to 20 mA / 4 to 20 mA |
| General information | |
| B&R ID code | 0x1B9E |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Inputs | Yes, using status LED and software |
| Channel type | Yes, using software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 0.8 W ¹⁾ |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| Analog inputs | |
| Input | ± 10 V or 0 to 20 mA / 4 to 20 mA, via different terminal connections |
| Input type | Differential input |
| Digital converter resolution | |
| Voltage | ± 12 -bit |
| Current | 12-bit |
| Conversion time | 300 μ s for all inputs |
| Output format | |
| Data type | INT |
| Voltage | INT 0x8001 - 0x7FFF / 1 LSB = 0x0008 = 2.441 mV |
| Current | INT 0x0000 - 0x7FFF / 1 LSB = 0x0008 = 4.883 μ A |
| Input impedance in signal range | |
| Voltage | 20 M Ω |
| Current | - |
| Load | |
| Voltage | - |
| Current | <400 Ω |
| Input protection | Protection against wiring with supply voltage |
| Permissible input signal | |
| Voltage | Max. ± 30 V |
| Current | Max. ± 50 mA |
| Output of digital value during overload | Configurable |
| Conversion procedure | SAR |
| Input filter | 3rd-order low pass / cutoff frequency 1 kHz |
| Max. error at 25°C | |
| Voltage | |
| Gain | 0.08% ²⁾ |
| Offset | 0.015% ³⁾ |
| Current | |
| Gain | 0 to 20 mA = 0.08 % / 4 to 20 mA = 0.1 % ²⁾ |
| Offset | 0 to 20 mA = 0.03 % / 4 to 20 mA = 0.16 % ⁴⁾ |
| Max. gain drift | |
| Voltage | 0.006 %/°C ²⁾ |
| Current | 0 to 20 mA = 0.009 %/°C 4 to 20 mA = 0.0113 %/°C ²⁾ |
| Max. offset drift | |
| Voltage | 0.002 %/°C ³⁾ |
| Current | 0 to 20 mA = 0.004 %/°C 4 to 20 mA = 0.005 %/°C ⁴⁾ |

Table 59: X20AI2622 - Technical data


| Model number | X20AI2622 | |
|---|---|--|
| Common-mode rejection | | |
| DC | 70 dB | |
| 50 Hz | 70 dB | |
| Common-mode range | ±12 V | |
| Crosstalk between channels | <-70 dB | |
| Nonlinearity | | |
| Voltage | <0.025% ³⁾ | |
| Current | <0.05% ⁴⁾ | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB06 or X20TB12 terminal block separately Order 1x X20BM11 bus module separately | |
| Pitch | 12.5 ^{+0.2} mm | |

Table 59: X20AI2622 - Technical data

- 1) To reduce power dissipation, B&R recommends bridging unused inputs on the terminals or configuring them as current signals.
- 2) Based on the current measured value.
- 3) Based on the 20 V measurement range.
- 4) Based on the 20 mA measurement range.

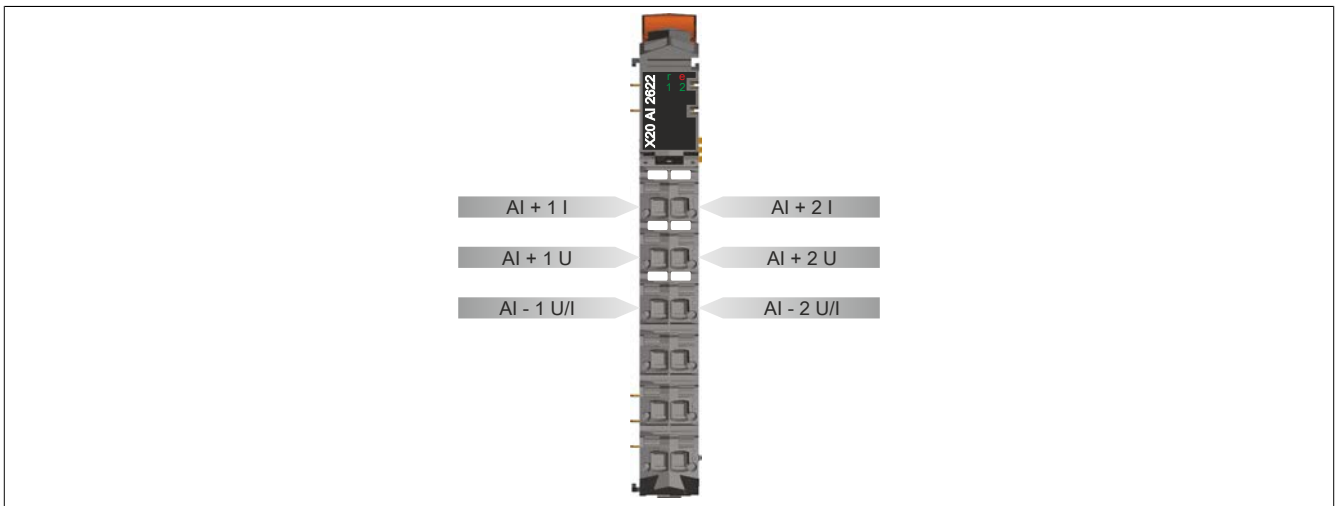
9.1.10.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

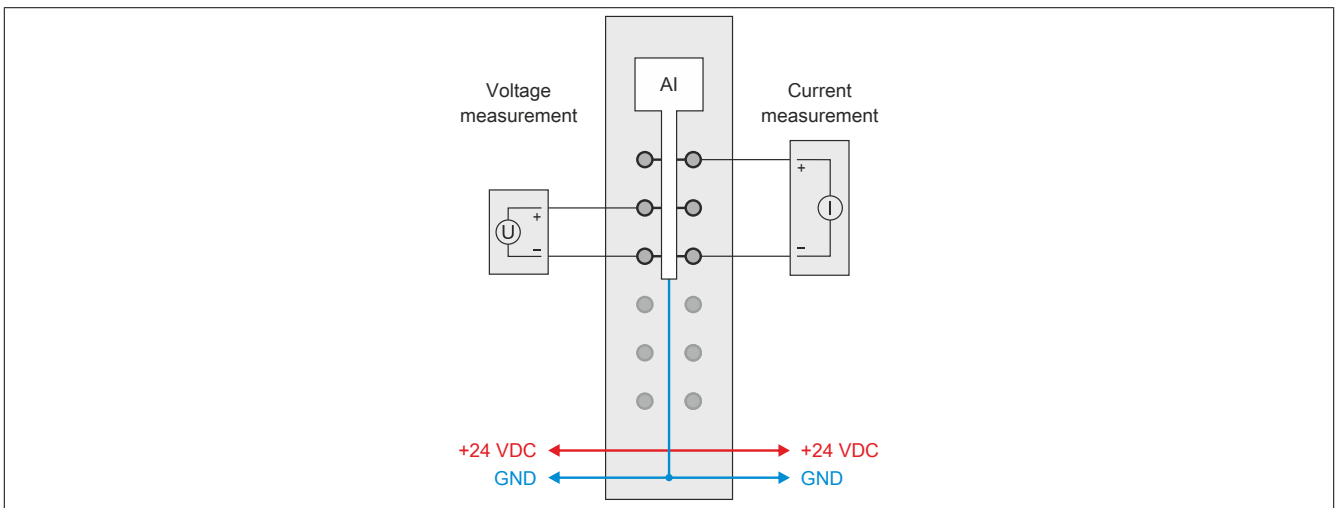
| Figure | LED | Color | Status | Description |
|---|-------|-------|-----------------------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | e + r | | Red on / Green single flash | Invalid firmware |
| | 1 - 2 | Green | Off | Open line ¹⁾ or sensor is disconnected |
| | | | Blinking | Input signal overflow or underflow |
| | | | On | Analog/digital converter running, value OK |

- 1) Open line detection only possible when measuring voltage.

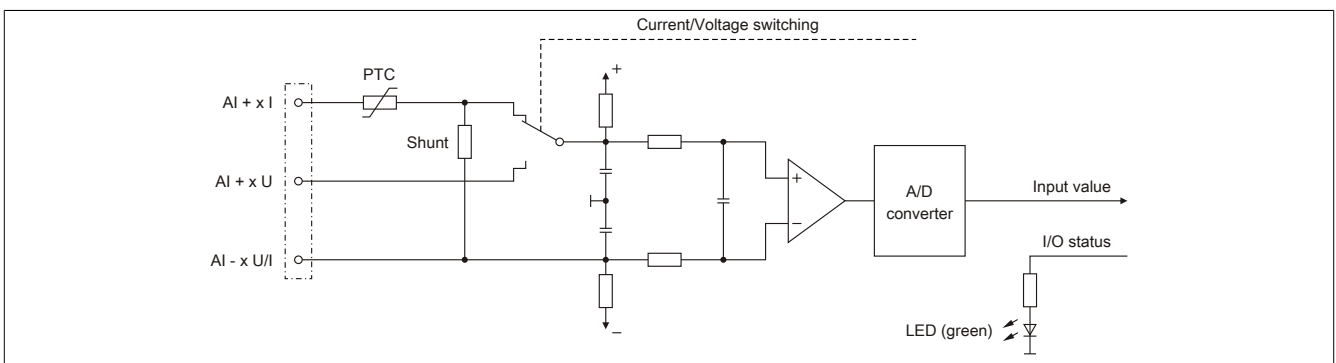
9.1.10.5 Pinout



9.1.10.6 Connection example



9.1.10.7 Input circuit diagram



9.1.10.8 Register description

9.1.10.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.1.10.8.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 16 | ConfigOutput01 (Input filter) | USINT | | | | • |
| 18 | ConfigOutput02 (Channel type) | USINT | | | | • |
| 20 | ConfigOutput03 (Lower value) | INT | | | | • |
| 22 | ConfigOutput04 (Upper limit value) | INT | | | | • |
| Communication | | | | | | |
| 0 | AnalogInput01 | INT | • | | | |
| 2 | AnalogInput02 | INT | • | | | |
| 30 | StatusInput01 | USINT | • | | | |

9.1.10.8.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 16 | - | ConfigOutput01 (Input filter) | USINT | | | | • |
| 18 | - | ConfigOutput02 (Channel type) | USINT | | | | • |
| 20 | - | ConfigOutput03 (Lower limit value) | INT | | | | • |
| 22 | - | ConfigOutput04 (Upper limit value) | INT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | AnalogInput01 | INT | • | | | |
| 2 | 2 | AnalogInput02 | INT | • | | | |
| 30 | - | StatusInput01 | USINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.1.10.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.1.10.8.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.1.10.8.4 Analog inputs

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

9.1.10.8.5 Analog input values

Name:

AnalogInput01 to AnalogInput02

The analog input value are mapped to this register depending on the configured operating mode.

| Data type | Value | Input signal: |
|-----------|-----------------|---|
| INT | -32768 to 32767 | Voltage signal -10 to 10 VDC |
| | 0 to 32767 | Current signal 0 to 20 mA |
| | -8192 to 32767 | Current signal 4 to 20 mA (value 0 corresponds to 4 mA) |

9.1.10.8.6 Input filter

This module is equipped with a configurable input filter. The minimum X2X cycle time must be $>500\ \mu\text{s}$. Filtering is disabled for shorter X2X cycle times.

If the input filter is active, then the channels are scanned in 1 ms cycles. The time offset between the channels is 200 μs . Conversion is performed acyclically to the X2X cycle.

Information:

The filter sampling time is fixed at 1 ms and is acyclic to the X2X cycle.

9.1.10.8.6.1 Input ramp limiting

Input ramp limiting can only be performed in conjunction with filtering. Input ramp limiting is performed before filtering.

The difference of the input value change is checked for exceeding the specified limit. In the event of overshoot, the tracked input value is equal to the old value \pm the limit value.

Configurable limit values:

| Value | Limit value |
|-------|---|
| 0 | The input value is used without limitation. |
| 1 | 0x3FFF = 16383 |
| 2 | 0x1FFF = 8191 |
| 3 | 0x0FFF = 4095 |
| 4 | 0x07FF = 2047 |
| 5 | 0x03FF = 1023 |
| 6 | 0x01FF = 511 |
| 7 | 0x00FF = 255 |

Input ramp limiting is well suited for suppressing disturbances (spikes). The following examples show the functionality of input ramp limiting based on an input step and a disturbance.

Example 1

The input value jumps from 8000 to 17000. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = 0x07FF = 2047

Filter level = 2

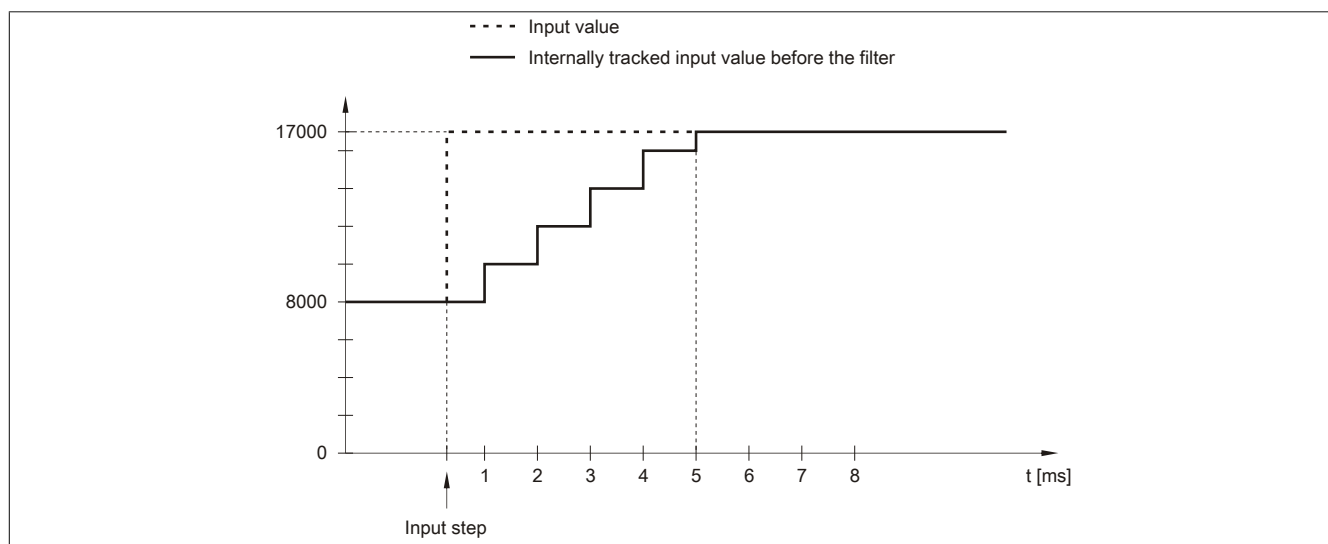


Figure 56: Tracked input value for input step

Example 2

A disturbance interferes with the input value. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = 0x07FF = 2047

Filter level = 2

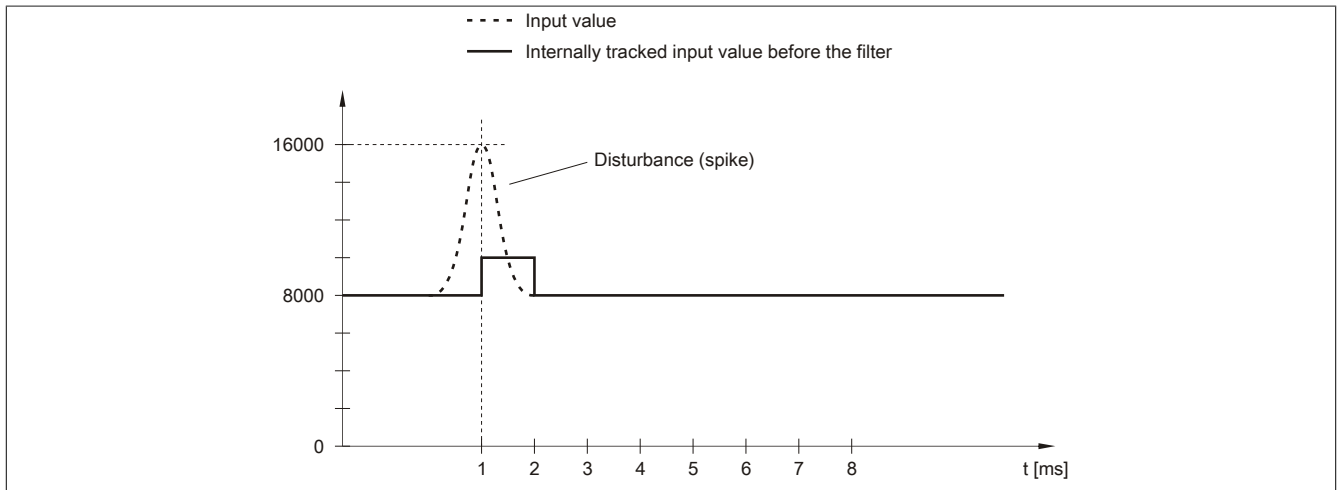


Figure 57: Tracked input value for disturbance

9.1.10.8.6.2 Filter level

A filter can be defined to prevent large input steps. This filter is used to bring the input value closer to the actual analog value over a period of several milliseconds.

Filtering takes place after any input ramp limiting has been carried out.

Formula for calculating the input value:

$$\text{Value}_{\text{New}} = \text{Value}_{\text{Old}} - \frac{\text{Value}_{\text{Old}}}{\text{Filter level}} + \frac{\text{Input value}}{\text{Filter level}}$$

Adjustable filter levels:

| Value | Filter level |
|-------|---------------------|
| 0 | Filter switched off |
| 1 | Filter level 2 |
| 2 | Filter level 4 |
| 3 | Filter level 8 |
| 4 | Filter level 16 |
| 5 | Filter level 32 |
| 6 | Filter level 64 |
| 7 | Filter level 128 |

The following examples show the functionality of the filter based on an input step and a disturbance.

Example 1

The input value jumps from 8000 to 16000. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

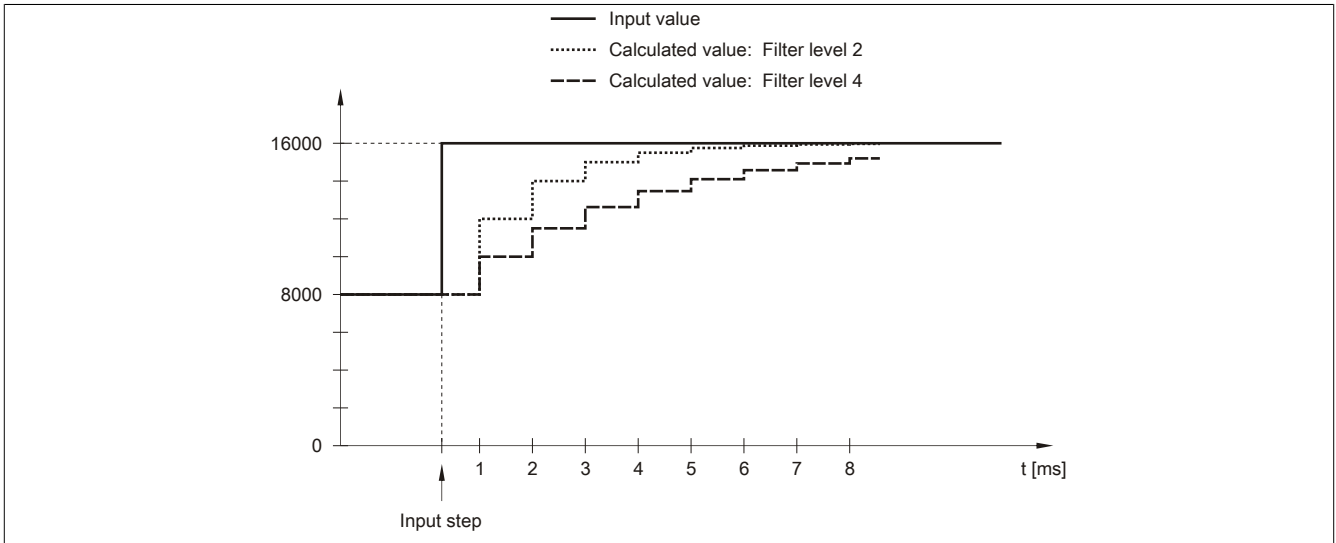


Figure 58: Calculated value during input step

Example 2

A disturbance interferes with the input value. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

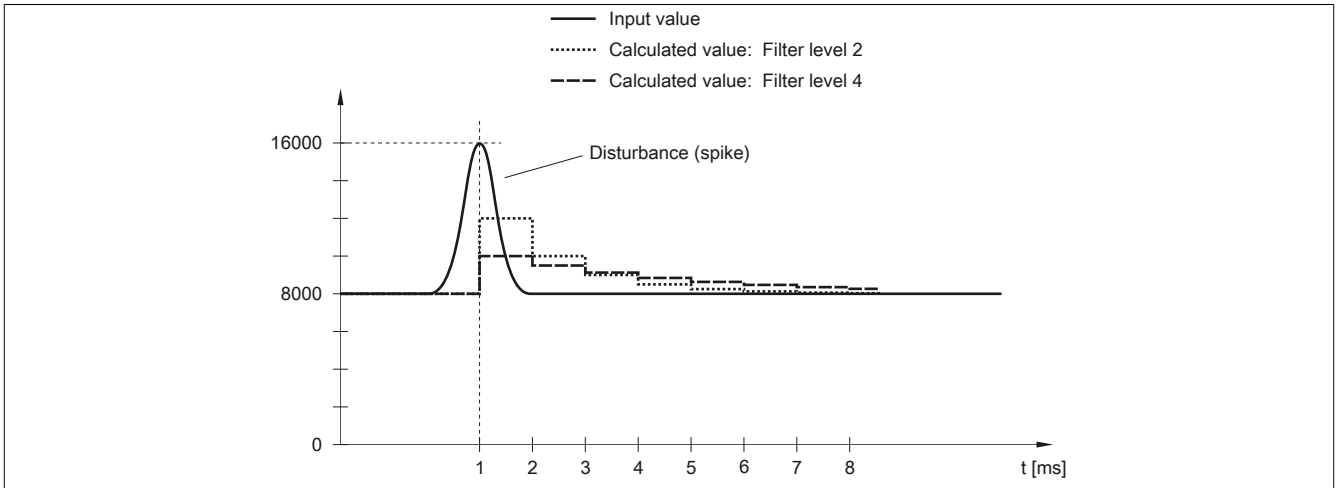


Figure 59: Calculated value during disturbance

9.1.10.8.7 Configuring the input filter

Name:

ConfigOutput01

The filter level and input ramp limiting of the input filter are set in this register.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------------|-------|--|
| 0 - 2 | Defines the filter level | 000 | Filter disabled (bus controller default setting) |
| | | 001 | Filter level 2 |
| | | 010 | Filter level 4 |
| | | 011 | Filter level 8 |
| | | 100 | Filter level 16 |
| | | 101 | Filter level 32 |
| | | 110 | Filter level 64 |
| | | 111 | Filter level 128 |
| 3 | Reserved | 0 | |
| 4 - 6 | Defines input ramp limiting | 000 | The input value is applied without limitation (bus controller default setting) |
| | | 001 | Limit value = 0x3FFF (16383) |
| | | 010 | Limit value = 0x1FFF (8191) |
| | | 011 | Limit value = 0x0FFF (4095) |
| | | 100 | Limit value = 0x07FF (2047) |
| | | 101 | Limit value = 0x03FF (1023) |
| | | 110 | Limit value = 0x01FF (511) |
| | | 111 | Limit value = 0x00FF (255) |
| 7 | Reserved | 0 | |

9.1.10.8.8 Channel type

Name:

ConfigOutput02

The type and range of signal measurement can be set in this register.

The individual channels are designed for current and voltage signals. This differentiation is made using different terminals and an integrated switch in the module. The switch is automatically activated by the module depending on the specified configuration. The following input signals can be set:

- ± 10 V voltage signal (default)
- 0 to 20 mA current signal
- 4 to 20 mA current signal

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------------------|-------|--|
| 0 | Channel 1 | 0 | Voltage signal (bus controller default setting) |
| | | 1 | Current signal, measurement range corresponding to bit 4 |
| 1 | Channel 2 | 0 | Voltage signal |
| | | 1 | Current signal, measurement range corresponding to bit 5 |
| 2 - 3 | Reserved | 0 | |
| 4 | Channel 1: Current measurement range | 0 | 0 to 20 mA current signal |
| | | 1 | 4 to 20 mA current signal |
| 5 | Channel 2: Current measurement range | 0 | 0 to 20 mA current signal |
| | | 1 | 4 to 20 mA current signal |
| 6 - 7 | Reserved | 0 | |

9.1.10.8.9 Limit values

The input signal is monitored at the upper and lower limit values. These must be defined according to the operating mode:

| Limit value (default) | Voltage signal ± 10 V | | Current signal 0 to 20 mA | | Current signal 4 to 20 mA | |
|---------------------------|---------------------------|-----------------|---------------------------|-----------------|---------------------------|-----------------|
| Upper maximum limit value | +10 V | +32767 (0x7FFF) | 20 mA | +32767 (0x7FFF) | 20 mA | +32767 (0x7FFF) |
| Lower minimum limit value | -10 V | -32767 (0x8001) | 0 mA | 0 ¹⁾ | 4 mA | 0 ²⁾ |

1) The analog value is limited down to 0.

2) The analog value is limited down to 0 at currents <4 mA. The status bit for the lower limit is set.

Other limit values can be defined if necessary. The limit values apply to all channels. These are enabled automatically by writing to the limit value registers. From this point on, the analog values will be monitored and limited according to the new limits. The results of monitoring are displayed in the status register.

Examples of limit value settings

| Use case | Limit value settings |
|----------------------------------|--|
| Current signal: 4 to 20 mA | If values <4 mA should be measured for a current signal with 4 to 20 mA, a negative limit value must be set: 0 mA corresponds to value -8192 (0xE000). |
| Mixed voltage and current signal | The set limit values apply to all channels. A compromise must therefore be made for mixed operation (voltage and current signal mixed). The following setting has proven to be effective: Upper limit value = +32767, lower limit value = -32767 This also allows negative voltage values to be measured. With a lower limit value of 0, the voltage value would be limited to 0. |
| Current signal on all channels | All channels are configured for current measurement. The limit value setting in Automation Studio is not adjusted automatically. This means that +32767 is set for the upper limit value and -32767 for the lower limit value. The necessary adjustments must be made by the user, e.g. lower limit value = 0 |

9.1.10.8.9.1 Lower limit value

Name:

ConfigOutput03

The lower limit value for analog values can be set in this register. If the analog value goes below the limit value, it is frozen at this value and the corresponding error status bit is set.

| Data type | Values | Information |
|-----------|-----------------|--|
| INT | -32768 to 32767 | Bus controller default setting: -32768 |

Information:

- The default value of **-32767** corresponds to the minimum default value of **-10 VDC**.
- For a 0 to 20 mA configuration, this value should be set to **0**.
- For a 4 to 20 mA configuration, this value can be set to **-8192** (corresponds to 0 mA) in order to display values <4 mA.

Information:

It is important to note that this setting applies to all channels!

9.1.10.8.9.2 Upper limit value

Name:

ConfigOutput04

The upper limit value for analog values can be set in this register. If the analog value goes above the limit value, it is frozen at this value and the corresponding error status bit is set.

| Data type | Values | Information |
|-----------|-----------------|---------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 32767 |

Information:

The default value **32767** corresponds to the maximum default value at **20 mA** or **+10 VDC**.

Information:

It is important to note that this setting applies to all channels!

9.1.10.8.10 Input status

Name:
StatusInput01

The module inputs are monitored in this register. A change in the monitoring status is actively transmitted as an error message. The following states are monitored depending on the settings:

| Value | Voltage signal ± 10 V | Current signal 0 to 20 mA | Current signal 4 to 20 mA |
|-------|-----------------------------|---|-----------------------------|
| 0 | No error | No error | No error |
| 1 | Lower limit value undershot | Default setting The input value has a lower limit of 0x0000. Underflow monitoring is therefore not necessary. After lower limit value change The input value is limited to the configured value. The status bit is set when the value falls below the lower limit. | Lower limit value undershot |
| 2 | Upper limit value overshoot | Upper limit value overshoot | Upper limit value overshoot |
| 3 | Open circuit | - | - |

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|----------------------------|
| 0 - 1 | Channel 1 | 00 | No error |
| | | 01 | Lower limit value exceeded |
| | | 10 | Upper limit value exceeded |
| | | 11 | Open line |
| 2 - 3 | Channel 2 | 00 | No error |
| | | 01 | Lower limit value exceeded |
| | | 10 | Upper limit value exceeded |
| | | 11 | Open line |
| 4 - 7 | Reserved | 0 | |

Limiting the analog value

In addition to the status information, the analog value is fixed to the values listed below by default in an error state. The analog value is limited to the new values if the limit values were changed.

| Error state | Digital value on error (default values) |
|-----------------------------|---|
| Open circuit | +32767 (0x7FFF) |
| Upper limit value overshoot | +32767 (0x7FFF) |
| Lower limit value undershot | -32767 (0x8001) |
| Invalid value | -32768 (0x8000) |

9.1.10.8.11 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------------|-------------|
| Inputs without filtering | 100 μ s |
| Inputs with filtering | 500 μ s |

9.1.10.8.12 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|--------------------------|----------------------------|
| Inputs without filtering | 300 μ s for all inputs |
| Inputs with filtering | 1 ms |

9.1.11 X20AI2632

Data sheet version: 3.12

9.1.11.1 General information

The module is equipped with 2 inputs with 16-bit digital converter resolution. It is possible to select between the current and voltage signal using different terminals.

This module is designed for X20 6-pin terminal blocks. If needed (e.g. for logistical reasons), the 12-pin terminal block can also be used.

- 2 analog inputs
- Either current or voltage signal possible
- 16-bit digital converter resolution
- Simultaneous input conversion
- Very fast conversion time

9.1.11.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Analog inputs |  |
| X20AI2632 | X20 analog input module, 2 inputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, configurable input filter, oscilloscope functions | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |

Table 60: X20AI2632 - Order data

9.1.11.3 Technical data

| Model number | X20AI2632 |
|--|--|
| Short description | |
| I/O module | 2 analog inputs ± 10 V or 0 to 20 mA |
| General information | |
| B&R ID code | 0x1BA0 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Inputs | Yes, using status LED and software |
| Channel type | Yes, using software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.2 W ¹⁾ |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| Analog inputs | |
| Input | ± 10 V or 0 to 20 mA, via different terminal connections |
| Input type | Differential input |
| Digital converter resolution | |
| Voltage | ± 15 -bit |
| Current | 15-bit |
| Conversion time | 50 μ s for all inputs |
| Output format | INT |
| Output format | |
| Voltage | INT 0x8001 - 0x7FFF / 1 LSB = 0x0001 = 305.176 μ V |
| Current | INT 0x0000 - 0x7FFF / 1 LSB = 0x0001 = 610.352 nA |
| Input impedance in signal range | |
| Voltage | 20 M Ω |
| Current | - |
| Load | |
| Voltage | - |
| Current | <400 Ω |
| Input protection | Protection against wiring with supply voltage |
| Permissible input signal | |
| Voltage | Max. ± 30 V |
| Current | Max. ± 50 mA |
| Output of digital value during overload | |
| Undershoot | |
| Voltage | 0x8001 |
| Current | 0x0000 |
| Overshoot | |
| Voltage | 0x7FFF |
| Current | 0x7FFF |
| Conversion procedure | SAR |
| Input filter | Hardware - 3rd-order low pass / cutoff frequency 10 kHz |
| Max. error at 25°C | |
| Voltage | |
| Gain | 0.08% ²⁾ |
| Offset | 0.01% ³⁾ |
| Current | |
| Gain | 0.08% ²⁾ |
| Offset | 0.02% ⁴⁾ |
| Max. gain drift | |
| Voltage | 0.01 %/°C ²⁾ |
| Current | 0.01 %/°C ²⁾ |

Table 61: X20AI2632 - Technical data


| Model number | X20AI2632 | |
|---|---|--|
| Max. offset drift | | |
| Voltage | 0.001 %/°C ³⁾ | |
| Current | 0.002 %/°C ⁴⁾ | |
| Common-mode rejection | | |
| DC | 70 dB | |
| 50 Hz | 70 dB | |
| Common-mode range | ±12 V | |
| Crosstalk between channels | <-70 dB | |
| Nonlinearity | | |
| Voltage | <0.01% ³⁾ | |
| Current | <0.015% ⁴⁾ | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB06 or X20TB12 terminal block separately Order 1x X20BM11 bus module separately | |
| Pitch | 12.5 ^{+0.2} mm | |

Table 61: X20AI2632 - Technical data

- 1) To reduce power dissipation, B&R recommends bridging unused inputs on the terminals or configuring them as current signals.
- 2) Based on the current measured value.
- 3) Based on the 20 V measurement range.
- 4) Based on the 20 mA measurement range.

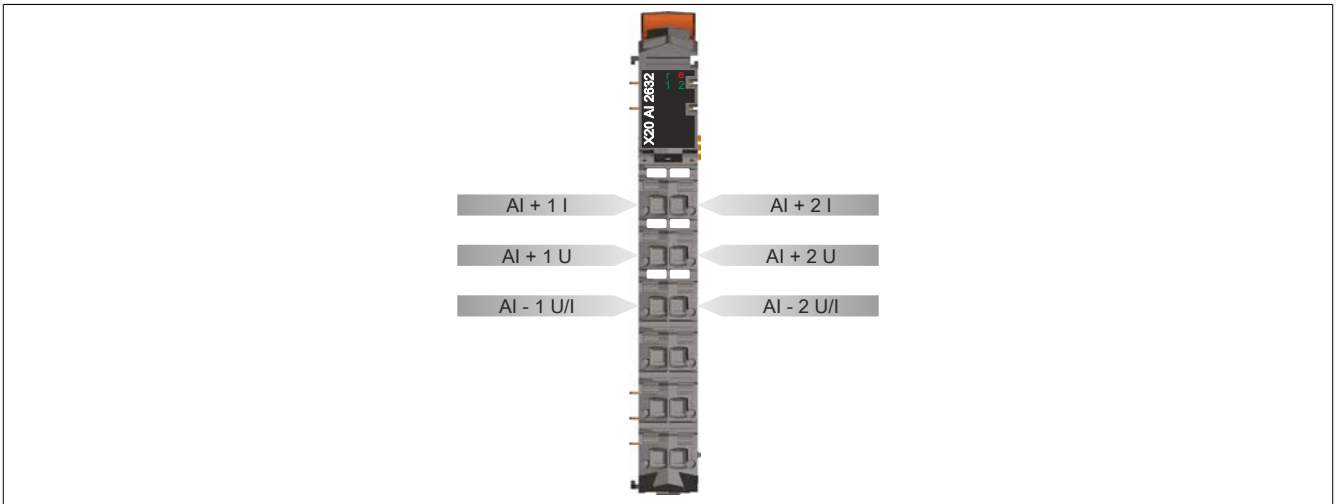
9.1.11.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|-------|--------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | | | Double flash | System error: <ul style="list-style-type: none"> • Violation of the scan time • Synchronization error |
| | 1 - 2 | Green | Off | Open line ²⁾ or sensor is disconnected |
| | | | On | Analog/digital converter running, value OK |

- 1) Depending on the configuration, a firmware update can take up to several minutes.
- 2) Open line detection only possible when measuring voltage.

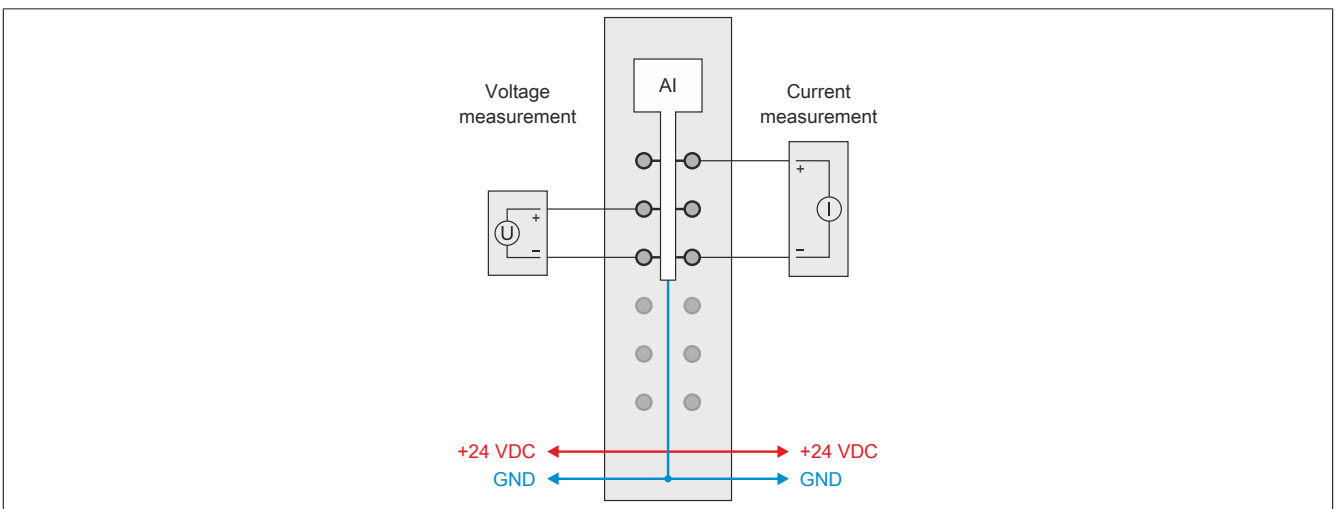
9.1.11.5 Pinout



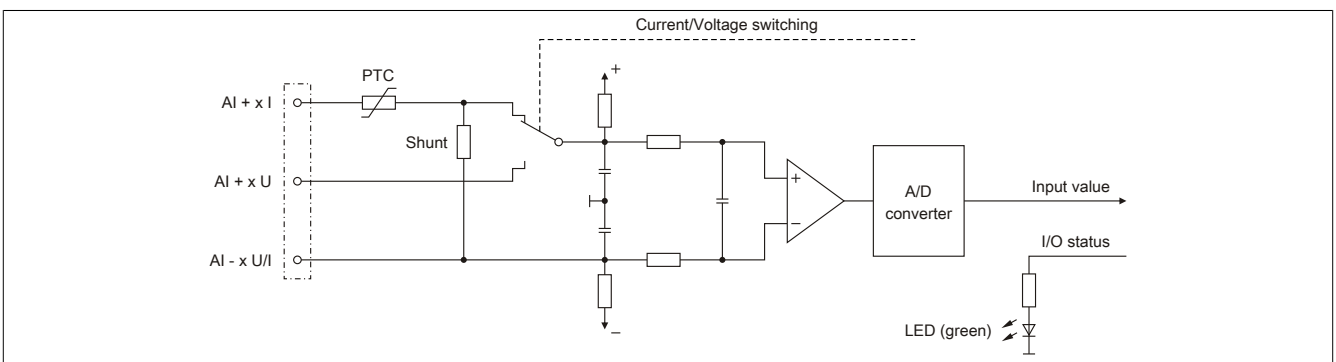
9.1.11.6 Connection example

To prevent disturbances, the following modules must be separated by at least one module:

- Bus receiver X20BR9300
- Supply module X20PS3300/X20PS3310
- Supply module X20PS9400/X20PS9402
- Supply module X20PS9500/X20PS9502
- CPU modules



9.1.11.7 Input circuit diagram



9.1.11.8 Register description

9.1.11.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.1.11.8.2 Function model 0 - default

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration - Frame size | | | | | | |
| - | AsynSize | - | | | | |
| Configuration | | | | | | |
| 257 | ConfigOutput01 (channel configuration) | USINT | | | | • |
| 289 | ConfigOutput06 (channel configuration) | USINT | | | | • |
| Sampling time | | | | | | |
| 390 | ConfigOutput24 (sampling time) | UINT | | | | • |
| Filtering | | | | | | |
| 259 | ConfigOutput26 (filter order) | USINT | | | | • |
| 291 | ConfigOutput28 (filter order) | USINT | | | | • |
| 262 | ConfigOutput27 (filter cutoff frequency) | UINT | | | | • |
| 294 | ConfigOutput29 (filter cutoff frequency) | UINT | | | | • |
| Scaling | | | | | | |
| 276 | ConfigOutput04 (user-defined gain) | DINT | | | | • |
| 308 | ConfigOutput09 (user-defined gain) | DINT | | | | • |
| 284 | ConfigOutput05 (user-defined offset) | DINT | | | | • |
| 316 | ConfigOutput10 (user-defined offset) | DINT | | | | • |
| User-defined limit values | | | | | | |
| 266 | ConfigOutput02 (minimum limit value) | UINT | | | | • |
| 298 | ConfigOutput07 (minimum limit value) | UINT | | | | • |
| 270 | ConfigOutput03 (maximum limit value) | UINT | | | | • |
| 302 | ConfigOutput08 (maximum limit value) | UINT | | | | • |
| Communication | | | | | | |
| 0 | AnalogInput01 | INT | • | | | |
| 4 | AnalogInput02 | INT | • | | | |
| 650 | SampleCycleCounter | UINT | | • | | |
| Error monitoring and counters | | | | | | |
| 641 | Channel status | USINT | • | | | |
| | Channel01OK | Bit 0 | | | | |
| | Channel02OK | Bit 1 | | | | |
| | SyncStatus | Bit 6 | | | | |
| | ConversionCycle | Bit 7 | | | | |
| 654 | SampleCycleViolationErrorCounter | UINT | | • | | |
| 658 | SynchronizationViolationErrorCounter | UINT | | • | | |
| 2097 | Range violation (neg. and pos.) | USINT | • | | | |
| | Channel01underflow | Bit 0 | | | | |
| | Channel02underflow | Bit 1 | | | | |
| | Channel01overflow | Bit 4 | | | | |
| | Channel02overflow | Bit 5 | | | | |
| 2099 | Working range violation (pos.) | USINT | • | | | |
| | Channel01outofrange | Bit 0 | | | | |
| | Channel02outofrange | Bit 1 | | | | |
| 518 | Ch01OutOfRange | UINT | | • | | |
| 550 | Ch02OutOfRange | UINT | | • | | |
| 522 | Ch01Underflow | UINT | | • | | |
| 554 | Ch02Underflow | UINT | | • | | |
| 526 | Ch01Overflow | UINT | | • | | |
| 558 | Ch02Overflow | UINT | | • | | |
| Additional analysis functions | | | | | | |
| 133 | ConfigOutput21 (trigger condition on falling edge) | USINT | | | | • |
| 135 | ConfigOutput22 (trigger condition on rising edge) | USINT | | | | • |
| 129 | Analysis control byte | USINT | | | • | |
| | TraceTrigger01 | Bit 0 | | | | |
| | MinMaxStart01 | Bit 4 | | | | |
| | MinMaxStart02 | Bit 5 | | | | |
| 129 | Analysis status byte | USINT | • | | | |
| | MinMaxStart01Readback | Bit 4 | | | | |
| | MinMaxStart02Readback | Bit 5 | | | | |
| Limit values | | | | | | |
| 530 | MinInput01 | INT | • | | | |
| 562 | MinInput02 | INT | • | | | |
| 534 | MaxInput01 | INT | • | | | |

| Register | Name | Data type | Read | | Write | |
|----------------------------|-------------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 566 | MaxInput02 | INT | • | | | |
| 538 | Ch01MinMaxLatchCounter | UINT | | • | | |
| 570 | Ch02MinMaxLatchCounter | UINT | | • | | |
| Trace configuration | | | | | | |
| 1026 | TraceChannelEnable | USINT | | | | • |
| 1030 | TraceSampleDepth | UINT | | | | • |
| 4157 | ConfigOutput25 (recording priority) | USINT | | | | • |
| 1037 | Starting a recording | USINT | | | • | |
| | TraceEnable01 | Bit 0 | | | | |
| 1089 | Recording status | USINT | • | | | |
| | TraceEnabled | Bit 0 | | | | |
| | TraceWriteActive | Bit 2 | | | | |
| | TraceReadActive | Bit 3 | | | | |
| | ReadyForTrigger | Bit 4 | | | | |
| | TriggerActive | Bit 5 | | | | |
| | TraceError | Bit 7 | | | | |
| 1094 | FreeBufferSize | UINT | • | | | |
| 1098 | TriggerCount | UINT | • | | | |
| 1102 | TriggerFailCount | UINT | • | | | |
| Comparator | | | | | | |
| 450 | cfgComp_LowLimitCh01 | INT | | | (•) | • |
| 458 | cfgComp_LowLimitCh02 | INT | | | (•) | • |
| 454 | cfgComp_HighLimitCh01 | INT | | | (•) | • |
| 462 | cfgComp_HighLimitCh02 | INT | | | (•) | • |
| 662 | CompStateCollection | UINT | • | | | |
| 490 | cfgComp_NominalState | UINT | | | | • |
| 482 | cfgComp_EnableMask | UINT | | | | • |
| 486 | cfgComp_ConditionTypeMask | UINT | | | | • |
| Time-offset trace | | | | | | |
| 1042 | TraceTriggerStart | INT | | | | • |
| 1046 | TraceTriggerStop | UINT | | | | • |

9.1.11.8.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration - Frame size | | | | | | | |
| - | - | AsynSize | - | | | | |
| Configuration | | | | | | | |
| 257 | - | ConfigOutput01 (channel configuration) | USINT | | | | • |
| 289 | - | ConfigOutput06 (channel configuration) | USINT | | | | • |
| Sampling time | | | | | | | |
| 390 | - | ConfigOutput24 (sampling time) | UINT | | | | • |
| Filtering | | | | | | | |
| 259 | - | ConfigOutput26 (filter order) | USINT | | | | • |
| 291 | - | ConfigOutput28 (filter order) | USINT | | | | • |
| 262 | - | ConfigOutput27 (filter cutoff frequency) | UINT | | | | • |
| 294 | - | ConfigOutput29 (filter cutoff frequency) | UINT | | | | • |
| Scaling | | | | | | | |
| 276 | - | ConfigOutput04 (user-defined gain) | DINT | | | | • |
| 308 | - | ConfigOutput09 (user-defined gain) | DINT | | | | • |
| 284 | - | ConfigOutput05 (user-defined offset) | DINT | | | | • |
| 316 | - | ConfigOutput10 (user-defined offset) | DINT | | | | • |
| User-defined limit values | | | | | | | |
| 266 | - | ConfigOutput02 (minimum limit value) | UINT | | | | • |
| 298 | - | ConfigOutput07 (minimum limit value) | UINT | | | | • |
| 270 | - | ConfigOutput03 (maximum limit value) | UINT | | | | • |
| 302 | - | ConfigOutput08 (maximum limit value) | UINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | AnalogInput01 | INT | • | | | |
| 4 | 2 | AnalogInput02 | INT | • | | | |
| 650 | - | SampleCycleCounter | UINT | | • | | |
| Error monitoring and counters | | | | | | | |
| 641 | - | Channel status | USINT | | • | | |
| | | Channel01OK | Bit 0 | | | | |
| | | Channel02OK | Bit 1 | | | | |
| | | SyncStatus | Bit 6 | | | | |
| | | ConversionCycle | Bit 7 | | | | |
| 654 | - | SampleCycleViolationErrorCounter | UINT | | • | | |
| 658 | - | SynchronizationViolationErrorCounter | UINT | | • | | |
| 2097 | - | Range violation (neg. and pos.) | USINT | | • | | |
| | | Channel01 underflow | Bit 0 | | | | |
| | | Channel02 underflow | Bit 1 | | | | |
| | | Channel01 overflow | Bit 4 | | | | |
| | | Channel02 overflow | Bit 5 | | | | |
| 2099 | - | Working range violation (pos.) | USINT | | • | | |
| | | Channel01 outofrange | Bit 0 | | | | |
| | | Channel02 outofrange | Bit 1 | | | | |
| 518 | - | Ch01OutOfRange | UINT | | • | | |
| 550 | - | Ch02OutOfRange | UINT | | • | | |
| 522 | - | Ch01Underflow | UINT | | • | | |
| 554 | - | Ch02Underflow | UINT | | • | | |
| 526 | - | Ch01Overflow | UINT | | • | | |
| 558 | - | Ch02Overflow | UINT | | • | | |
| Additional analysis functions | | | | | | | |
| 133 | - | ConfigOutput21 (trigger condition on falling edge) | USINT | | | | • |
| 135 | - | ConfigOutput22 (trigger condition on rising edge) | USINT | | | | • |
| 129 | - | Analysis control byte | USINT | | | | • |
| | | TraceTrigger01 | Bit 0 | | | | |
| | | MinMaxStart01 | Bit 4 | | | | |
| | | MinMaxStart02 | Bit 5 | | | | |
| 129 | - | Analysis status byte | USINT | | • | | |
| | | MinMaxStart01Readback | Bit 4 | | | | |
| | | MinMaxStart02Readback | Bit 5 | | | | |
| Limit values | | | | | | | |
| 530 | - | MinInput01 | INT | | • | | |
| 562 | - | MinInput02 | INT | | • | | |
| 534 | - | MaxInput01 | INT | | • | | |
| 566 | - | MaxInput02 | INT | | • | | |
| 538 | - | Ch01MinMaxLatchCounter | UINT | | • | | |
| 570 | - | Ch02MinMaxLatchCounter | UINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.1.11.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.1.11.8.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.1.11.8.4 Configuration

This module is equipped with analog inputs with connected 16-bit A/D converters. Each of the inputs can be configured separately from one another either on the voltage or current input for the following areas:

- Permitted voltage: ± 10 V
- Permitted current: 0 to 20 mA

9.1.11.8.4.1 Channel configuration

Name:

ConfigOutput01 for channel 01

ConfigOutput06 for channel 02

The individual inputs for processing the current or voltage signal are configured in these registers. This configuration must be made in addition to using suitable terminals.

Filtering, analysis and error monitoring (bits 4 to 6) can only be used if the channel is enabled (bit 7 = 0).

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------------------------|-------|--|
| 0 | Terminal selector | 0 | Voltage terminal for ± 10 VDC (bus controller default setting) |
| | | 1 | Current terminal for 0 to 20 mA |
| 1 | Gain selector | 0 | Voltage ± 10 VDC (bus controller default setting) |
| | | 1 | Current 0 to 20 mA |
| 2 - 3 | Reserved | - | |
| 4 | Filtering active | 0 | Inactive (bus controller default setting) |
| | | 1 | Active |
| 5 | Minimum/Maximum analysis active | 0 | Inactive (bus controller default setting) |
| | | 1 | Active |
| 6 | Error monitoring active | 0 | Inactive (bus controller default setting) |
| | | 1 | Active |
| 7 | Enables channel | 0 | Channel enabled (bus controller default setting) |
| | | 1 | Channel disabled |

9.1.11.8.4.2 Sampling and conversion

The analog signal is sampled in 2 steps.

- **Conversion task**

The A/D converter digitalizes the inputs signals for the enabled inputs once per conversion cycle. Then the results are available internally in the module. To ensure that this process is executed without delays, the corresponding task will be handled with very high priority.

The timespan needed for conversion results from the set sampling time.

- **Processing task**

The converted A/D converter values are further processed according to the user settings (filtering, scaling, limit values, error statistics, min/max analysis, hysteresis comparison). The task for this process has low priority. The timespan needed for further processing depends on the configured functions and is the second portion of the sampling time.

Cycle time violation

In normal operation, further processing is triggered after each conversion. The conversion and sampling tasks run synchronous to one another. If the predefined sampling time is not sufficient to convert all enabled channels and complete the configured functions, a cycle time violation occurs.

Sampling time

Name:

ConfigOutput24

The sampling time is set to μs in this register. This makes it possible to improve the sampling cycle (resolution = 1 μs). The lowest configurable cycle time is 50 μs .

| Data type | Value | Information |
|-----------|--------------|-------------------------------------|
| UINT | 50 to 10,000 | Bus controller default setting: 100 |

Information:

Values that are too low for the cycle time will result in cycle time violations.

9.1.11.8.4.3 Filtering (optional)

If filtering is enabled in the "Channel configuration" on page 415 register, the basic data of the A/D converter is filtered per channel. The following registers are available to specify the filter order and respective cutoff frequency for configuring the low-pass filter:

- "Filter order" on page 416
- "Filter cutoff frequency" on page 416

Filter order

Name:

ConfigOutput26 for channel 1

ConfigOutput28 for channel 2

The filter order is specified in this register. The "Filter cutoff frequency" on page 416 register is used to configure the respective cutoff frequency of the filter.

| Data type | Value | Information |
|-----------|--------|-----------------------------------|
| USINT | 1 to 4 | Bus controller default setting: 0 |

Internal filter orders greater than 1 are implemented as cascaded first-order filters.

Calculating the cutoff frequency of an nth-order filter:

$$\text{Cutoff frequency} = \text{Cutoff frequency}_N / ((2 \wedge (1 / n) - 1) \wedge 0.5)$$

Approximate calculation

$$y_n = a * x_n + b * y_{(n-1)}$$

$$a = \text{Sampling time}_{\text{Sec}} / (\text{Sampling time}_{\text{Sec}} + 1 / (2 \text{ Pi} * \text{Cutoff frequency}_{\text{Hz}}))$$

$$b = 1 - a$$

Information:

Since low-pass filtering takes place using an approximation procedure with fixed-point arithmetic, there are discrepancies to the effective cutoff frequency that depend on the sampling cycle and filter sequence.

Filter cutoff frequency

Name:

ConfigOutput27 for channel 1

ConfigOutput29 for channel 2

The cutoff frequency of the respective filter is configured in these registers.

| Data type | Value | Information |
|-----------|-------------|---|
| UINT | 1 to 65,535 | Cutoff frequency in hertz. Bus controller default setting: 0 |

Information:

The highest cutoff frequency is limited by the Nyquist Shannon sampling theorem (based on the sampling cycle time). The system does not check for violations of this sampling theorem.

9.1.11.8.4.4 Scaling (optional)

Scaling A/D converter data is an option for the user. The following registers are available for this:

- "User-defined gain" on page 417 (= ku)
- "User-defined offset" on page 417 (= du)

Scaling calculation:

Scaled value = $k * A/C \text{ value} + d$

Gain $k = k_{\text{Calibration}} * ku$

Offset $d = d_{\text{Calibration}} + du$

The value has to be limited since it can exceed the 16-bit constraints. To provide the greatest degree of flexibility, limiting is possible using the registers "Minimum limit value" on page 418 and "Maximum limit value" on page 418.

User-defined gain

Name:

ConfigOutput04 for channel 1

ConfigOutput09 for channel 2

The user-defined gain for the A/D converter data of the respective physical channel can be specified in these registers.

The value 65,536 (0x10000) corresponds to a gain of 1.

| Data type | Values | Information |
|-----------|------------------------------------|--|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: 65,536 |

User-defined offset

Name:

ConfigOutput05 for channel 1

ConfigOutput10 for channel 2

The user-defined offset for the A/D converter data of the respective physical channel can be specified in this register.

The value 65,536 (0x10000) corresponds to an offset of 1.

| Data type | Values | Information |
|-----------|------------------------------------|-----------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: 0 |

9.1.11.8.4.5 User-defined limit values

If the application requires a limitation of the range of values, then the user can define his own limit values. These values will also be use for the module's error statistics. The following registers are available for this:

- "Minimum limit value" on page 418
- "Maximum limit value" on page 418

Information:

32-bit numbers are used inside the module. A limit value violation can therefore also be determined if the permitted range of values was defined from -32768 to 32767.

Minimum limit value

Name:

ConfigOutput02 for channel 1

ConfigOutput07 for channel 2

The minimum limit value is configured in this register. This limit value is also used for the underflow error statistics (see register "Ch0xUnderflow" on page 421).

| Data type | Values | Information |
|-----------|-----------------|--|
| INT | -32768 to 32767 | Bus controller default setting: -32768 |

Maximum limit value

Name:

ConfigOutput03 for channel 1

ConfigOutput08 for channel 2

The maximum limit value is configured in this register. This limit value is also used for the overflow error statistics (see register "Ch0xOverflow" on page 421).

| Data type | Values | Information |
|-----------|-----------------|---------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 32767 |

9.1.11.8.5 Communication - General

The module's analog inputs convert current and voltage values with 16-bit resolution. This information can be used by the application with the help of the registers listed here.

9.1.11.8.5.1 Analog inputs

Name:

AnalogInput01 to AnalogInput02

The analog input value is mapped in this register depending on the configured operating mode.

| Data type | Value | Input signal: |
|-----------|-------------------|-----------------------------|
| INT | -32,768 to 32,767 | Voltage signal ± 10 VDC |
| | 0 to 32,767 | Current signal 0 to 20 mA |

9.1.11.8.5.2 Sampling cycle counter

Name:

SampleCycleCounter

The number of times the input signal has been sampled is provided in this register.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.1.11.8.5.3 Error monitoring and counters

Channel status

Name:

Channel01OK to Channel02OK

SyncStatus

ConversionCycle

This register collects error messages synchronously with the network cycle. Temporary error states that were registered in a conversion cycle remain active for at least 2 network cycles. In order to receive detailed error information, the corresponding error counters and X2X network events should also be observed.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------------------------|-------|------------------|
| 0 | Channel01OK | 0 | OK |
| | | 1 | Errors |
| 1 | Channel02OK | 0 | OK |
| | | 1 | Errors |
| 2 - 5 | Reserved | - | |
| 6 | SyncStatus ¹⁾ | 0 | OK |
| | | 1 | Not synchronized |
| 7 | ConversionCycle ²⁾ | 0 | OK |
| | | 1 | Errors |

1) Identical to bit 0 of the registers "[SynchronizationViolationErrorCounter](#)" on page 419.

2) Identical to bit 0 of the registers "[SampleCycleViolationErrorCounter](#)" on page 419.

Synchronization error counter

Name:

SynchronizationViolationErrorCounter

This register counts how often the conversion task was triggered more than 5 μ s after the next-coming X2X cycle. In this case, the module is considered being no longer synchronized with X2X Link.

The counters in this register follow the rules of the event error counter, i.e. the count increased each time an error occurs or is reset. The last bit of the counter indicates the error status:

- Last bit = 1 → Error pending
- Last bit = 0 → No error

| Data type | Value | Information |
|-----------|------------|---------------------|
| UINT | 0 to 65535 | Counter value |
| | 0 to 1 | Bit 0: Error status |

Counter for faulty sampling cycles

Name:

SampleCycleViolationErrorCounter

This register is used to indicate the number of cycle time violations that have occurred thus far. A cycle time violation occurs if the conversion tasks initiates a sampling task before the last sampling cycle has finished. See "[Sampling and conversion](#)" on page 415.

The counters in this register follow the rules of the event error counter, i.e. the count increased each time an error occurs or is reset. The last bit of the counter indicates the error status:

- Last bit = 1 → Error pending
- Last bit = 0 → No error

| Data type | Value | Information |
|-----------|------------|---------------------|
| UINT | 0 to 65535 | Counter value |
| | 0 to 1 | Bit 0: Error status |

Range violation (neg. and pos.)

Name:

Channel01underflow to Channel02underflow

Channel01overflow to Channel02overflow

This register indicates whether the limit values defined by registers "[Minimum limit value](#)" on page 418 and "[Maximum limit value](#)" on page 418 have been overshoot or undershot. The individual bits in this register are identical to the values of the lowest bits of registers "[Ch0xUnderflow](#)" on page 421 and "[Ch0xOverflow](#)" on page 421.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------|-------|------------------------------------|
| 0 | Channel01underflow | 0 | No error |
| | | 1 | Range exceeded (.neg) on channel 1 |
| 1 | Channel02underflow | 0 | No error |
| | | 1 | Range exceeded (.neg) on channel 2 |
| 2 - 3 | Reserved | - | |
| 4 | Channel01overflow | 0 | No error |
| | | 1 | Range exceeded (.pos) on channel 1 |
| 5 | Channel02overflow | 0 | No error |
| | | 1 | Range exceeded (.pos) on channel 2 |
| 6 - 7 | Reserved | - | |

Working range violation (pos.)

Name:

Channel01outofrange to Channel02outofrange

This register indicates whether the input value overshoots the module's maximum measurement range. The individual bits in this register are identical to the values of the lowest bits of register "[Ch0xOutOfRange](#)" on page 420.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------------|-------|---|
| 0 | Channel01outofrange | 0 | No error |
| | | 1 | Working range violation (pos.) of channel 1 |
| 1 | Channel02outofrange | 0 | No error |
| | | 1 | Working range violation (pos.) of channel 2 |
| 2 - 7 | Reserved | - | |

Counter for work range violations (pos.)

Name:

Ch01OutOfRange to Ch02OutOfRange

Errors outside of the module's maximum possible measurement range are indicated in this register. These errors lead to full-scale deflection of the A/D converter.

The counters in these registers follow the rules of the event error counter, i.e. the count increased each time an error occurs or is reset. The last bit of the counter indicates the error status:

- Last bit = 1 → Error pending
- Last bit = 0 → No error

This counter is only active if the static error counter is enabled (see register "[Channel configuration](#)" on page 415).

| Data type | Value | Information |
|-----------|------------|---------------------|
| UINT | 0 to 65535 | Counter value |
| | 0 to 1 | Bit 0: Error status |

Counter for range exceeded violations (neg.)

Name:

Ch01Underflow to Ch02Underflow

This register indicates range exceeded violations (neg.) of the value configured in the register "[Minimum limit value](#)" on page 418.

The counters in these registers follow the rules of the event error counter, i.e. the count increased each time an error occurs or is reset. The last bit of the counter indicates the error status:

- Last bit = 1 → Error pending
- Last bit = 0 → No error

This counter is only active if the static error counter is enabled (see register "[Channel configuration](#)" on page 415).

| Data type | Value | Information |
|-----------|------------|---------------------|
| UINT | 0 to 65535 | Counter value |
| | 0 to 1 | Bit 0: Error status |

Counter for range exceeded violations (pos.)

Name:

Ch01Overflow to Ch02Overflow

This register indicates range exceeded violations (pos.) of the value configured in the register "[Maximum limit value](#)" on page 418.

The counters in these registers follow the rules of the event error counter, i.e. the count increased each time an error occurs or is reset. The last bit of the counter indicates the error status:

- Last bit = 1 → Error pending
- Last bit = 0 → No error

This counter is only active if the static error counter is enabled (see register "[Channel configuration](#)" on page 415).

| Data type | Value | Information |
|-----------|------------|---------------------|
| UINT | 0 to 65535 | Counter value |
| | 0 to 1 | Bit 0: Error status |

9.1.11.8.6 Additional analysis functions

In addition to sampling the analog input signal, this module can also be used to perform additional analysis of the values obtained.

- **Limit value analysis**

If limit value analysis has been enabled for a channel, the sampled minimum and maximum values are latched internally in the module. A measurement period can be triggered using the control byte. When the respective configured edge is generated by the application, the limit values from the previous measurement period are displayed and the internal latch register is reset.

- **Recording sampled values**

If recording sampled values has been enabled for a channel, then the sampled values are additionally recorded in the module's internal FIFO memory. If the configured event occurs, the contents of the FIFO memory are transmitted to the application.

Information:

It is only possible to use the recording of sampled values if the module is operated on an X2X master that is an SG4 CPU.

9.1.11.8.6.1 Trigger condition on falling edge

Name:

ConfigOutput21

This register configures whether the falling edge is used to trigger the trace and determination of the input value in the register "Analysis control byte" on page 423.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------|-------|---|
| 0 | TraceTrigger01 | 0 | No trigger (bus controller default setting) |
| | | 1 | Falling edge active as trigger |
| 1 - 3 | Reserved | - | |
| 4 | MinMaxStart01 | 0 | No determination (bus controller default setting) |
| | | 1 | Falling edge determines input value of channel 1 |
| 5 | MinMaxStart02 | 0 | No determination (bus controller default setting) |
| | | 1 | Falling edge determines input value of channel 2 |
| 6 - 7 | Reserved | 0 | |

9.1.11.8.6.2 Trigger condition on rising edge

Name:

ConfigOutput22

This register configures whether the rising edge is used to trigger the trace and determination of the input value in the register "Analysis control byte" on page 423.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------|-------|---|
| 0 | TraceTrigger01 | 0 | Trigger not initiated on positive edge (bus controller default setting) |
| | | 1 | Rising edge active as trigger |
| 1 - 3 | Reserved | - | |
| 4 | MinMaxStart01 | 0 | No determination (bus controller default setting) |
| | | 1 | Rising edge determines input value of channel 1 |
| 5 | MinMaxStart02 | 0 | No determination (bus controller default setting) |
| | | 1 | Rising edge determines input value of channel 2 |
| 6 - 7 | Reserved | 0 | |

9.1.11.8.6.3 Analysis control byte

Name:

TraceTrigger01

MinMaxStart01 to MinMaxStart02

The trace function and determination of the minimum/maximum input values can be started in this register.

Whether the rising and/or falling edge is used to trigger the functions can be configured using the registers "[Trigger condition on falling edge](#)" on page 422 and "[Trigger condition on rising edge](#)" on page 422.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------|-------|--|
| 0 | TraceTrigger01 | 0 | Trigger/Trace not triggered (bus controller default setting) |
| | | 1 | Initiates trigger/trace |
| 1 - 3 | Reserved | - | |
| 4 | MinMaxStart01 | 0 | Determination not triggered (bus controller default setting) |
| | | 1 | Initiates determination of input value of channel 1 |
| 5 | MinMaxStart02 | 0 | Determination not triggered (bus controller default setting) |
| | | 1 | Initiates determination of input value of channel 2 |
| 6 - 7 | Reserved | - | |

Information:

To reduce the cyclic data transfer, this register combines the trace and limit value determination functions.

9.1.11.8.6.4 Analysis status byte

Name:

MinMaxStart01Readback to MinMaxStart02Readback

The currently requested module-internal analyses can be checked in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------|--------|---|
| 0 - 3 | Reserved | - | |
| 4 | MinMaxStart01Readback | 0 or 1 | Current state of the trigger bits for determining the limit values on the channel |
| 5 | MinMaxStart02Readback | 0 or 1 | Current state of the trigger bits for determining the limit values on the channel |
| 6 - 7 | Reserved | - | |

9.1.11.8.7 Limit values

Limit value analysis must be enabled for the desired channel. See "Channel configuration" on page 415. The sampled value of the channel is then compared to the [minimum](#) and [maximum values](#) that are stored internally in the module. If a new measurement period is initiated with the "Analysis control byte" on page 423 register, then the values of the previous measurement period can be read from the respective registers intended for this.

9.1.11.8.7.1 Minimum input values

Name:

MinInput01 to MinInput02

The minimum value of the preceding trigger period is saved in this register based on the filtered, scaled and user-defined limit values. The register value is 0 if the channel is inactive.

| Data type | Value |
|-----------|-------------------|
| INT | -32,768 to 32,767 |

9.1.11.8.7.2 Maximum input values

Name:

MaxInput01 to MaxInput02

The maximum value of the preceding trigger period is saved in this register based on the filtered, scaled and user-defined limit values. The register value is 0 if the channel is inactive.

| Data type | Value |
|-----------|-------------------|
| INT | -32,768 to 32,767 |

9.1.11.8.7.3 Limit value trigger counter

Name:

Ch01MinMaxLatchCounter to Ch02MinMaxLatchCounter

The number of valid events that trigger a new measurement period for the limit value analysis is counted in this register.

| Data type | Value |
|-----------|------------|
| UINT | 0 to 65535 |

9.1.11.8.8 Trace

If the module is operated on a SG4 CPU, the digitalized input values are recorded by the module. The module must be operated in "Supervised" mode in order to use the trace function.

Recording must be enabled for the desired channel. The enable bits can then control the recording at runtime. The sampled values are recorded in the module's internal FIFO memory.

If the previously defined state occurs on the channel, the contents of the FIFO memory are transmitted to the application. Whether the FIFO memory continued to be filled depends on how recording is configured.

Information:

The trace mechanism can only be used if the module is connected directly to the CPU, not if it is operated behind a bus controller.

9.1.11.8.8.1 Enable recording

Name:

TraceChannelEnable

The respective channel is enabled for the trace with this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|------------------|
| 0 | Channel 1 | 0 | Channel disabled |
| | | 1 | Channel enabled |
| 1 | Channel 2 | 0 | Channel disabled |
| | | 1 | Channel enabled |
| 2 - 7 | Reserved | - | |

9.1.11.8.8.2 Number of values to be recorded

Name:

TraceSampleDepth

16 kB are available on the module for the trace. The FIFO memory limitation means that a maximum of 8192 analog values can be recorded. This memory is divided up equally among the enabled channels. The actual number of maximum possible recordings therefore depends on the number of channels enabled for trace:

1 channel enabled: Up to 8192 recordings

2 channels enabled: Up to 4096 recordings per channel

| Data type | Value | Function |
|-----------|-----------|----------------------|
| UINT | 2 to 8192 | Default value = 1024 |

9.1.11.8.8.3 Recording priority

Name:

ConfigOutput25

The priority of the trace can be increased with this register.

| Data type | Value | Function |
|-----------|-------|---|
| USINT | 3 | Standard |
| | 6 | Trace priority higher than X2X Link communication |

9.1.11.8.8.4 Starting a recording

Name:

TraceEnable01

This register starts the recording according to the specifications for edge control or the comparator.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|-----------------------------|
| 0 | TraceEnable01 | 0 | Disables the trace function |
| | | 1 | Enables the trace function |
| 1 - 7 | Reserved | - | |

9.1.11.8.8.5 Recording status

Name:

TraceEnabled

TraceWriteActive

TraceReadActive

ReadyForTrigger

TriggerActive

TraceOk

TraceError

The status of the trace is represented in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|------------------|-------|---------------------------------------|
| 0 | TraceEnabled | 0 | Trace inactive |
| | | 1 | Trace active |
| 1 | Reserved | - | |
| 2 | TraceWriteActive | 0 | Data not recorded |
| | | 1 | Data recorded |
| 3 | TraceReadActive | 0 | Data not output/read |
| | | 1 | Data output/read |
| 4 | ReadyForTrigger | 0 | Not ready for triggering |
| | | 1 | Ready for triggering |
| 5 | TriggerActive | 0 | No trigger active or already executed |
| | | 1 | Trigger active |
| 6 | TraceOk | 0 | Overflow or inactive |
| | | 1 | No overflow |
| 7 | TraceError | 0 | No error or inactive |
| | | 1 | Trace buffer full |

9.1.11.8.8.6 Free trace buffer

Name:

FreeBufferSize

Specifies the available FIFO memory area in bytes for the trace

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.1.11.8.8.7 Counter for trace triggers

Name:

TriggerCount

The number of trigger events that have occurred since [starting the trace](#) is indicated in this register.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.1.11.8.8.8 Counter for faulty recording triggers

Name:

TriggerFailCount

Counts the trigger events for which the trace could not be performed.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.1.11.8.8.9 Comparator for trigger conditions

In order to adapt the trace as closely as possible to the requirements of the application, the trace function can also be controlled using the comparator. Threshold values (hysteresis) can be defined within the permitted range of values to do so. 2 status bits are then generated for each enabled channel:

- **InRange bit**

The InRange status is "1" if the measured value falls within the defined limits.

The InRange status is "0" if the measured value falls outside the defined limits.

- **Threshold value bit**

The threshold value bit is "1" if the measured value exceeds the upper threshold value.

The threshold value bit is "0" if the measured value falls below the lower threshold value.

The InRange and threshold value bits for all channels are grouped together in the lower-value byte of the "[CompStateCollection](#)" on page 428 register. In addition, the states of the previous sampling are stored in the higher-value byte.

The 4 status messages of each channel can be linked according to the following logic via a logical connective mask using AND or OR operators and used as a trace trigger:

```
delta = (Current_HysteresisStatus ^ NominalValues)// Different between current status and preset
cond = delta & Selected_HysteresisStatusBits// Eliminate irrelevant status messages
cond = Selected_HysteresisStatusBits (Current_HysteresisStatus ^ NominalValues)
if((0==(cond & ~LogicalOperators)) &&
(0!=(~cond & LogicalOperators))) {=> Generate trigger event}
```

Selected_HysteresisStatusBits
Current_HysteresisStatus
Nominal values
Logical operators

Corresponds to register:

"cfgComp_EnableMask" on page 429
"CompStateCollection" on page 428
"cfgComp_NominalState" on page 429
"cfgComp_ConditionTypeMask" on page 430

Lower limit value for hysteresis

Name:

cfgComp_LowLimitCh01 to cfgComp_LowLimitCh02

The lower limit value for hysteresis is configured in this register.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

Upper limit value for hysteresis

Name:

cfgComp_HighLimitCh01 to cfgComp_HighLimitCh02

The upper limit value for hysteresis is configured in this register.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

Hysteresis status of the channels

Name:

CompStateCollection

The hysteresis status of the input channels for the current and last cycle are represented in this register.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|---------|--|-------|---|
| 0 | Channel01 hysteresis status in the current cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 1 | Channel01 InRange status in the current cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| 2 | Channel02 hysteresis status in the current cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 3 | Channel02 InRange status in the current cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| 4 - 7 | Reserved | - | |
| 8 | Channel01 hysteresis status in the last cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 9 | Channel01 InRange status in the last cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| 10 | Channel02 hysteresis status in the last cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 11 | Channel02 InRange status in the last cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| 12 - 15 | Reserved | - | |

Comparison state of the channels

Name:

cfgComp_NominalState

The desired comparison state for the hysteresis status is indicated in this register.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|---------|--|-------|---|
| 0 | Channel01 hysteresis status in the current cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 1 | Channel01 InRange status in the current cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| 2 | Channel02 hysteresis status in the current cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 3 | Channel02 InRange status in the current cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| 4 - 7 | Reserved | - | |
| 8 | Channel01 hysteresis status in the last cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 9 | Channel01 InRange status in the last cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| 10 | Channel02 hysteresis status in the last cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 11 | Channel02 InRange status in the last cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| 12 - 15 | Reserved | - | |

Information:

This is a "whitelist", i.e. the trace starts as soon as the current status message takes on the state predefined here.

One or more matches will be necessary depending on the selection of the relevant hysteresis status bits and logical connective operators.

Selecting the relevant hysteresis status bits

Name:

cfgComp_EnableMask

This register selects which status bits of the hysteresis comparison should be used to generate the trigger.

For more information about using this register, see ["Comparator for trigger conditions" on page 427](#).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|---------|--|-------|--------------------|
| 0 | Channel01 hysteresis status in the current cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 1 | Channel01 InRange status in the current cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 2 | Channel02 hysteresis status in the current cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 3 | Channel02 InRange status in the current cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 4 - 7 | Reserved | - | |
| 8 | Channel01 hysteresis status in the last cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 9 | Channel01 InRange status in the last cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 10 | Channel02 hysteresis status in the last cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 11 | Channel02 InRange status in the last cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 12 - 15 | Reserved | - | |

Logical connective operators for hysteresis status bits

Name:

cfgComp_ConditionTypeMask

The desired state operators with which the status bits are linked to one another to generate a trigger are selected in this register.

At least one OR operation must be configured, but it does not necessarily have to be located on a channel configured with "1" in the "cfgComp_EnableMask" on page 429 register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|---------|--|-------|-------------------|
| 0 | Channel01 hysteresis status in the current cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 1 | Channel01 InRange status in the current cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 2 | Channel02 hysteresis status in the current cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 3 | Channel02 InRange status in the current cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 4 - 7 | Reserved | - | |
| 8 | Channel01 hysteresis status in the last cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 9 | Channel01 InRange status in the last cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 10 | Channel02 hysteresis status in the last cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 11 | Channel02 InRange status in the last cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 12 - 15 | Reserved | - | |

9.1.11.8.8.10 Time-offset trace

Additional conditions for shifting the starting and stopping points can be defined if the trace should be chronologically offset to the trigger.

Starting the trace

Name:

TraceTriggerStart

The starting position is defined relative to the configured trigger condition in this register. Positive values mean that the trace takes place x samples after the trigger condition. Negative values mean that the trace takes place x samples before the trigger condition.

The value -32768 performs the trace without regard for the configured trigger condition. If the trace memory is completely full, then the oldest recorded value is overwritten (FIFO principle).

"Trace start" in the I/O configuration or the registers "[Trigger condition on falling edge](#)" on page 422 and "[Trigger condition on rising edge](#)" on page 422 determine whether a positive, negative or any edge must be triggered.

| Data type | Value | Information |
|-----------|-----------------|---|
| INT | -32767 to 32767 | |
| | -32768 | Continuous trace without a stopping point |

Stopping the trace

Name:

TraceTriggerStop

The stopping position is defined relative to the configured trigger condition in this register.

- When configuring an early trigger event, this value refers to the trigger event.
- When configuring a delayed trigger event, this value refers to the starting event.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.1.11.8.9 Acyclic frame size

Name:
AsynSize

When the stream is used, data is exchanged internally between the module and CPU. For this purpose, a defined amount of acyclic bytes is reserved for this slot.

Increasing the acyclic frame size leads to increased data throughput on this slot.

Information:

This configuration involves a driver setting that cannot be changed during runtime!

| Data type | Value | Information |
|-----------|---------|---|
| - | 8 to 28 | Acyclic frame size in bytes. Default = 24 |

9.1.11.8.10 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|-----------------------------------|--------|
| Standard priority | 200 µs |
| High priority with trace function | 300 µs |

9.1.11.8.11 Minimum I/O update time

There is no limitation or dependency on the bus cycle time.

The I/O update time is defined using the "Sampling time" register. The fastest possible sampling time depends on the number of channels to be converted and the configuration.

9.1.12 X20AI2632-1

Data sheet version: 3.12

9.1.12.1 General information

The module is equipped with 2 inputs with 16-bit digital converter resolution. It is possible to select between the current and voltage signal using different terminals.

This module is designed for X20 6-pin terminal blocks. If needed (e.g. for logistical reasons), the 12-pin terminal block can also be used.

- 2 analog inputs
- Either current or voltage signal possible
- Extended signal range
- 16-bit digital converter resolution
- Simultaneous input conversion
- Very fast conversion time

9.1.12.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| X20AI2632-1 | X20 analog input module, 2 inputs, ± 11 V or 0 to 22 mA, 16-bit converter resolution, configurable input filter |  |
| | Analog inputs | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |

Table 62: X20AI2632-1 - Order data

9.1.12.3 Technical data

| Model number | X20AI2632-1 |
|--|--|
| Short description | |
| I/O module | 2 analog inputs ± 11 V or 0 to 22 mA |
| General information | |
| B&R ID code | 0xA29E |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Inputs | Yes, using status LED and software |
| Channel type | Yes, using software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.2 W ¹⁾ |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| Analog inputs | |
| Input | ± 11 V or 0 to 22 mA, via different terminal connections |
| Input type | Differential input |
| Digital converter resolution | |
| Voltage | ± 15 -bit |
| Current | 15-bit |
| Conversion time | 50 μ s for all inputs |
| Output format | INT |
| Output format | |
| Voltage | INT 0x8001 - 0x7FFF / 1 LSB = 0x0001 = 335.693 μ V |
| Current | INT 0x0000 - 0x7FFF / 1 LSB = 0x0001 = 671.387 nA |
| Input impedance in signal range | |
| Voltage | 20 M Ω |
| Current | - |
| Load | |
| Voltage | - |
| Current | <400 Ω |
| Input protection | Protection against wiring with supply voltage |
| Permissible input signal | |
| Voltage | Max. ± 30 V |
| Current | Max. ± 50 mA |
| Output of digital value during overload | |
| Undershoot | |
| Voltage | 0x8001 |
| Current | 0x0000 |
| Overshoot | |
| Voltage | 0x7FFF |
| Current | 0x7FFF |
| Conversion procedure | SAR |
| Input filter | Hardware - 3rd-order low pass / cutoff frequency 10 kHz |
| Max. error at 25°C | |
| Voltage | |
| Gain | 0.08% ²⁾ |
| Offset | 0.01% ³⁾ |
| Current | |
| Gain | 0.08% ²⁾ |
| Offset | 0.02% ⁴⁾ |
| Max. gain drift | |
| Voltage | 0.01 %/°C ²⁾ |
| Current | 0.01 %/°C ²⁾ |

Table 63: X20AI2632-1 - Technical data


| Model number | X20AI2632-1 | |
|---|---|--|
| Max. offset drift | | |
| Voltage | 0.001 %/°C ³⁾ | |
| Current | 0.002 %/°C ⁴⁾ | |
| Common-mode rejection | | |
| DC | 70 dB | |
| 50 Hz | 70 dB | |
| Common-mode range | ±12 V | |
| Crosstalk between channels | <-70 dB | |
| Nonlinearity | | |
| Voltage | <0.01% ³⁾ | |
| Current | <0.015% ⁴⁾ | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB06 or X20TB12 terminal block separately Order 1x X20BM11 bus module separately | |
| Pitch | 12.5 ^{+0.2} mm | |

Table 63: X20AI2632-1 - Technical data

- 1) To reduce power dissipation, B&R recommends bridging unused inputs on the terminals or configuring them as current signals.
- 2) Based on the current measured value.
- 3) Based on the 22 V measurement range.
- 4) Based on the 22 mA measurement range.

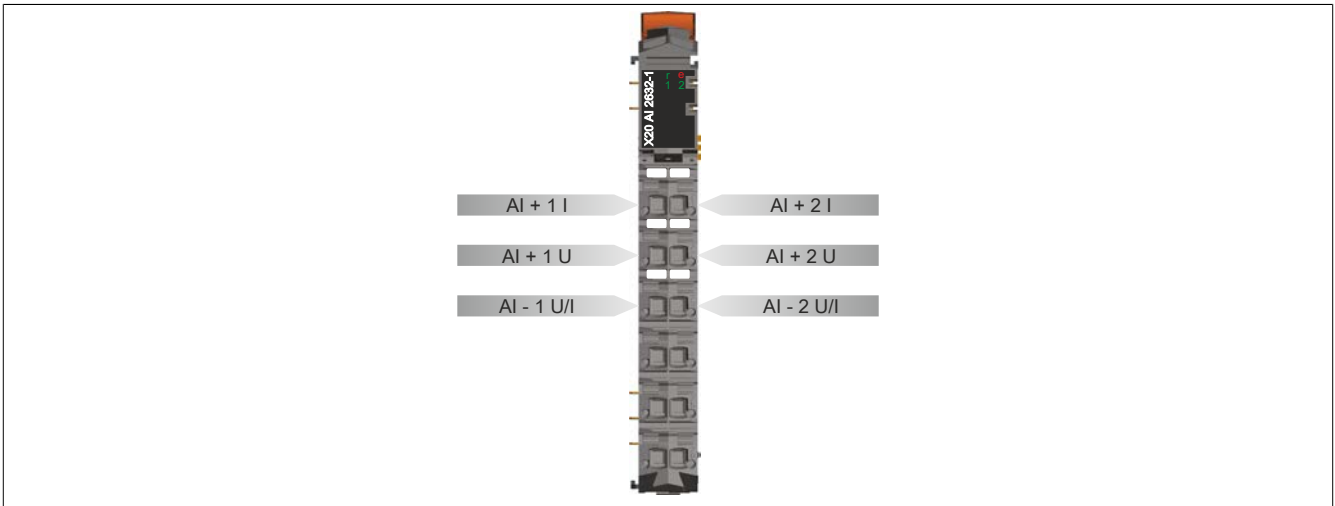
9.1.12.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|-------|--------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | | | Double flash | System error: <ul style="list-style-type: none"> • Violation of the scan time • Synchronization error |
| | 1 - 2 | Green | Off | Open line ²⁾ or sensor is disconnected |
| | | | On | Analog/digital converter running, value OK |

- 1) Depending on the configuration, a firmware update can take up to several minutes.
- 2) Open line detection only possible when measuring voltage.

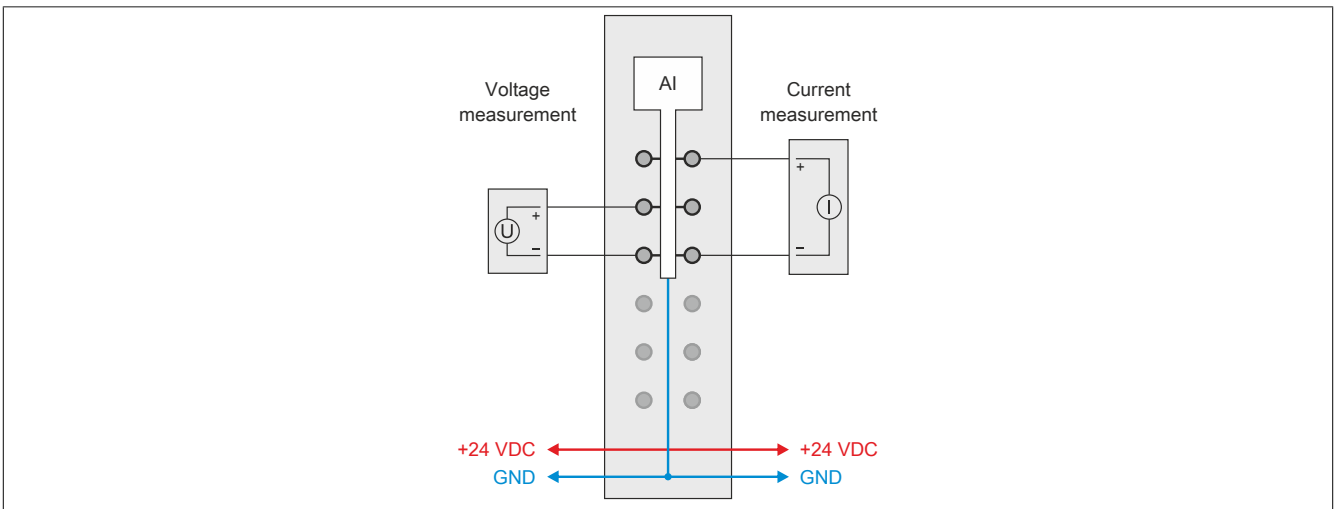
9.1.12.5 Pinout



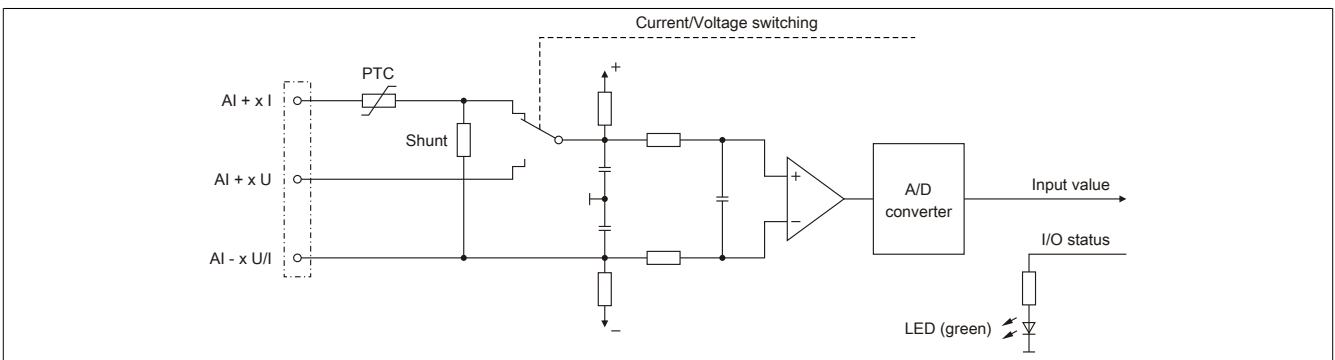
9.1.12.6 Connection example

To prevent disturbances, the following modules must be separated by at least one module:

- Bus receiver X20BR9300
- Supply module X20PS3300/X20PS3310
- Supply module X20PS9400/X20PS9402
- Supply module X20PS9500/X20PS9502
- CPU modules



9.1.12.7 Input circuit diagram



9.1.12.8 Register description

9.1.12.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.1.12.8.2 Function model 0 - default

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration - Frame size | | | | | | |
| - | AsynSize | - | | | | |
| Configuration | | | | | | |
| 257 | ConfigOutput01 (channel configuration) | USINT | | | | • |
| 289 | ConfigOutput06 (channel configuration) | USINT | | | | • |
| Sampling time | | | | | | |
| 390 | ConfigOutput24 (sampling time) | UINT | | | | • |
| Filtering | | | | | | |
| 259 | ConfigOutput26 (filter order) | USINT | | | | • |
| 291 | ConfigOutput28 (filter order) | USINT | | | | • |
| 262 | ConfigOutput27 (filter cutoff frequency) | UINT | | | | • |
| 294 | ConfigOutput29 (filter cutoff frequency) | UINT | | | | • |
| Scaling | | | | | | |
| 276 | ConfigOutput04 (user-defined gain) | DINT | | | | • |
| 308 | ConfigOutput09 (user-defined gain) | DINT | | | | • |
| 284 | ConfigOutput05 (user-defined offset) | DINT | | | | • |
| 316 | ConfigOutput10 (user-defined offset) | DINT | | | | • |
| User-defined limit values | | | | | | |
| 266 | ConfigOutput02 (minimum limit value) | UINT | | | | • |
| 298 | ConfigOutput07 (minimum limit value) | UINT | | | | • |
| 270 | ConfigOutput03 (maximum limit value) | UINT | | | | • |
| 302 | ConfigOutput08 (maximum limit value) | UINT | | | | • |
| Communication | | | | | | |
| 0 | AnalogInput01 | INT | • | | | |
| 4 | AnalogInput02 | INT | • | | | |
| 650 | SampleCycleCounter | UINT | | • | | |
| Error monitoring and counters | | | | | | |
| 641 | Channel status | USINT | • | | | |
| | Channel01OK | Bit 0 | | | | |
| | Channel02OK | Bit 1 | | | | |
| | SyncStatus | Bit 6 | | | | |
| | ConversionCycle | Bit 7 | | | | |
| 654 | SampleCycleViolationErrorCounter | UINT | | • | | |
| 658 | SynchronizationViolationErrorCounter | UINT | | • | | |
| 2097 | Range violation (neg. and pos.) | USINT | • | | | |
| | Channel01underflow | Bit 0 | | | | |
| | Channel02underflow | Bit 1 | | | | |
| | Channel01overflow | Bit 4 | | | | |
| | Channel02overflow | Bit 5 | | | | |
| 2099 | Working range violation (pos.) | USINT | • | | | |
| | Channel01outofrange | Bit 0 | | | | |
| | Channel02outofrange | Bit 1 | | | | |
| 518 | Ch01OutOfRange | UINT | | • | | |
| 550 | Ch02OutOfRange | UINT | | • | | |
| 522 | Ch01Underflow | UINT | | • | | |
| 554 | Ch02Underflow | UINT | | • | | |
| 526 | Ch01Overflow | UINT | | • | | |
| 558 | Ch02Overflow | UINT | | • | | |
| Additional analysis functions | | | | | | |
| 133 | ConfigOutput21 (trigger condition on falling edge) | USINT | | | | • |
| 135 | ConfigOutput22 (trigger condition on rising edge) | USINT | | | | • |
| 129 | Analysis control byte | USINT | | | • | |
| | TraceTrigger01 | Bit 0 | | | | |
| | MinMaxStart01 | Bit 4 | | | | |
| | MinMaxStart02 | Bit 5 | | | | |
| 129 | Analysis status byte | USINT | • | | | |
| | MinMaxStart01Readback | Bit 4 | | | | |
| | MinMaxStart02Readback | Bit 5 | | | | |
| Limit values | | | | | | |
| 530 | MinInput01 | INT | • | | | |
| 562 | MinInput02 | INT | • | | | |
| 534 | MaxInput01 | INT | • | | | |

| Register | Name | Data type | Read | | Write | |
|----------------------------|-------------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 566 | MaxInput02 | INT | • | | | |
| 538 | Ch01MinMaxLatchCounter | UINT | | • | | |
| 570 | Ch02MinMaxLatchCounter | UINT | | • | | |
| Trace configuration | | | | | | |
| 1026 | TraceChannelEnable | USINT | | | | • |
| 1030 | TraceSampleDepth | UINT | | | | • |
| 4157 | ConfigOutput25 (recording priority) | USINT | | | | • |
| 1037 | Starting a recording | USINT | | | • | |
| | TraceEnable01 | Bit 0 | | | | |
| 1089 | Recording status | USINT | • | | | |
| | TraceEnabled | Bit 0 | | | | |
| | TraceWriteActive | Bit 2 | | | | |
| | TraceReadActive | Bit 3 | | | | |
| | ReadyForTrigger | Bit 4 | | | | |
| | TriggerActive | Bit 5 | | | | |
| | TraceError | Bit 7 | | | | |
| 1094 | FreeBufferSize | UINT | • | | | |
| 1098 | TriggerCount | UINT | • | | | |
| 1102 | TriggerFailCount | UINT | • | | | |
| Comparator | | | | | | |
| 450 | cfgComp_LowLimitCh01 | INT | | | (•) | • |
| 458 | cfgComp_LowLimitCh02 | INT | | | (•) | • |
| 454 | cfgComp_HighLimitCh01 | INT | | | (•) | • |
| 462 | cfgComp_HighLimitCh02 | INT | | | (•) | • |
| 662 | CompStateCollection | UINT | • | | | |
| 490 | cfgComp_NominalState | UINT | | | | • |
| 482 | cfgComp_EnableMask | UINT | | | | • |
| 486 | cfgComp_ConditionTypeMask | UINT | | | | • |
| Time-offset trace | | | | | | |
| 1042 | TraceTriggerStart | INT | | | | • |
| 1046 | TraceTriggerStop | UINT | | | | • |

9.1.12.8.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration - Frame size | | | | | | | |
| - | - | AsynSize | - | | | | |
| Configuration | | | | | | | |
| 257 | - | ConfigOutput01 (channel configuration) | USINT | | | | • |
| 289 | - | ConfigOutput06 (channel configuration) | USINT | | | | • |
| Sampling time | | | | | | | |
| 390 | - | ConfigOutput24 (sampling time) | UINT | | | | • |
| Filtering | | | | | | | |
| 259 | - | ConfigOutput26 (filter order) | USINT | | | | • |
| 291 | - | ConfigOutput28 (filter order) | USINT | | | | • |
| 262 | - | ConfigOutput27 (filter cutoff frequency) | UINT | | | | • |
| 294 | - | ConfigOutput29 (filter cutoff frequency) | UINT | | | | • |
| Scaling | | | | | | | |
| 276 | - | ConfigOutput04 (user-defined gain) | DINT | | | | • |
| 308 | - | ConfigOutput09 (user-defined gain) | DINT | | | | • |
| 284 | - | ConfigOutput05 (user-defined offset) | DINT | | | | • |
| 316 | - | ConfigOutput10 (user-defined offset) | DINT | | | | • |
| User-defined limit values | | | | | | | |
| 266 | - | ConfigOutput02 (minimum limit value) | UINT | | | | • |
| 298 | - | ConfigOutput07 (minimum limit value) | UINT | | | | • |
| 270 | - | ConfigOutput03 (maximum limit value) | UINT | | | | • |
| 302 | - | ConfigOutput08 (maximum limit value) | UINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | AnalogInput01 | INT | • | | | |
| 4 | 2 | AnalogInput02 | INT | • | | | |
| 650 | - | SampleCycleCounter | UINT | | • | | |
| Error monitoring and counters | | | | | | | |
| 641 | - | Channel status | USINT | | • | | |
| | | Channel01OK | Bit 0 | | | | |
| | | Channel02OK | Bit 1 | | | | |
| | | SyncStatus | Bit 6 | | | | |
| | | ConversionCycle | Bit 7 | | | | |
| 654 | - | SampleCycleViolationErrorCounter | UINT | | • | | |
| 658 | - | SynchronizationViolationErrorCounter | UINT | | • | | |
| 2097 | - | Range violation (neg. and pos.) | USINT | | • | | |
| | | Channel01 underflow | Bit 0 | | | | |
| | | Channel02 underflow | Bit 1 | | | | |
| | | Channel01 overflow | Bit 4 | | | | |
| | | Channel02 overflow | Bit 5 | | | | |
| 2099 | - | Working range violation (pos.) | USINT | | • | | |
| | | Channel01 outofrange | Bit 0 | | | | |
| | | Channel02 outofrange | Bit 1 | | | | |
| 518 | - | Ch01OutOfRange | UINT | | • | | |
| 550 | - | Ch02OutOfRange | UINT | | • | | |
| 522 | - | Ch01Underflow | UINT | | • | | |
| 554 | - | Ch02Underflow | UINT | | • | | |
| 526 | - | Ch01Overflow | UINT | | • | | |
| 558 | - | Ch02Overflow | UINT | | • | | |
| Additional analysis functions | | | | | | | |
| 133 | - | ConfigOutput21 (trigger condition on falling edge) | USINT | | | | • |
| 135 | - | ConfigOutput22 (trigger condition on rising edge) | USINT | | | | • |
| 129 | - | Analysis control byte | USINT | | | | • |
| | | TraceTrigger01 | Bit 0 | | | | |
| | | MinMaxStart01 | Bit 4 | | | | |
| | | MinMaxStart02 | Bit 5 | | | | |
| 129 | - | Analysis status byte | USINT | | • | | |
| | | MinMaxStart01Readback | Bit 4 | | | | |
| | | MinMaxStart02Readback | Bit 5 | | | | |
| Limit values | | | | | | | |
| 530 | - | MinInput01 | INT | | • | | |
| 562 | - | MinInput02 | INT | | • | | |
| 534 | - | MaxInput01 | INT | | • | | |
| 566 | - | MaxInput02 | INT | | • | | |
| 538 | - | Ch01MinMaxLatchCounter | UINT | | • | | |
| 570 | - | Ch02MinMaxLatchCounter | UINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.1.12.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.1.12.8.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.1.12.8.4 Configuration

This module is equipped with analog inputs with connected 16-bit A/D converters. Each of the inputs can be configured separately from one another either on the voltage or current input for the following areas:

- Permitted voltage: ± 11 V at 20 Ω
- Permitted current: 22 mA (maximum 40 mA) (<400 Ω)

9.1.12.8.4.1 Channel configuration

Name:

ConfigOutput01 for channel 01

ConfigOutput06 for channel 02

The individual inputs for processing the current or voltage signal are configured in these registers. This configuration must be made in addition to using suitable terminals.

Filtering, analysis and error monitoring (bits 4 to 6) can only be used if the channel is enabled (bit 7 = 0).

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|---|-------|--|
| 0 | Terminal selector | 0 | Voltage terminal for ± 11 VDC (bus controller default setting) |
| | | 1 | Current terminal for 0 to 22 mA |
| 1 | Gain selector | 0 | Voltage ± 11 VDC (bus controller default setting) |
| | | 1 | Current 0 to 22 mA |
| 2 - 3 | Reserved | - | |
| 4 | Filtering active (only if bit 7 = 0) | 0 | Inactive (bus controller default setting) |
| | | 1 | Active |
| 5 | Minimum/Maximum analysis active (only if bit 7 = 0) | 0 | Inactive (bus controller default setting) |
| | | 1 | Active |
| 6 | Error monitoring active (only if bit 7 = 0) | 0 | Inactive (bus controller default setting) |
| | | 1 | Active |
| 7 | Enables channel | 0 | Channel enabled (bus controller default setting) |
| | | 1 | Channel disabled |

9.1.12.8.4.2 Sampling and conversion

The analog signal is sampled in 2 steps.

- **Conversion task**

The A/D converter digitalizes the inputs signals for the enabled inputs once per conversion cycle. Then the results are available internally in the module. To ensure that this process is executed without delays, the corresponding task will be handled with very high priority.

The timespan needed for conversion results from the set sampling time.

- **Processing task**

The converted A/D converter values are further processed according to the user settings (filtering, scaling, limit values, error statistics, min/max analysis, hysteresis comparison). The task for this process has low priority. The timespan needed for further processing depends on the configured functions and is the second portion of the sampling time.

Cycle time violation

In normal operation, further processing is triggered after each conversion. The conversion and sampling tasks run synchronous to one another. If the predefined sampling time is not sufficient to convert all enabled channels and complete the configured functions, a cycle time violation occurs.

Sampling time

Name:

ConfigOutput24

The sampling time is set to μs in this register. This makes it possible to improve the sampling cycle (resolution = 1 μs). The lowest configurable cycle time is 50 μs .

| Data type | Value | Information |
|-----------|--------------|-------------------------------------|
| UINT | 50 to 10,000 | Bus controller default setting: 100 |

Information:

Values that are too low for the cycle time will result in cycle time violations.

9.1.12.8.4.3 Filtering (optional)

If filtering is enabled in the "Channel configuration" on page 440 register, the basic data of the A/D converter is filtered per channel. The following registers are available to specify the filter order and respective cutoff frequency for configuring the low-pass filter:

- "Filter order" on page 441
- "Filter cutoff frequency" on page 441

Filter order

Name:

ConfigOutput26 for channel 1

ConfigOutput28 for channel 2

The filter order is specified in this register. The "Filter cutoff frequency" on page 441 register is used to configure the respective cutoff frequency of the filter.

| Data type | Value | Information |
|-----------|--------|-----------------------------------|
| USINT | 1 to 4 | Bus controller default setting: 0 |

Internal filter orders greater than 1 are implemented as cascaded first-order filters.

Calculating the cutoff frequency of an nth-order filter:

$$\text{Cutoff frequency} = \text{Cutoff frequency}_N / ((2 \wedge (1 / n) - 1) \wedge 0.5)$$

Approximate calculation

$$y_n = a * x_n + b * y_{(n-1)}$$

$$a = \text{Sampling time}_{\text{Sec}} / (\text{Sampling time}_{\text{Sec}} + 1 / (2 \text{ Pi} * \text{Cutoff frequency}_{\text{Hz}}))$$

$$b = 1 - a$$

Information:

Since low-pass filtering takes place using an approximation procedure with fixed-point arithmetic, there are discrepancies to the effective cutoff frequency that depend on the sampling cycle and filter sequence.

Filter cutoff frequency

Name:

ConfigOutput27 for channel 1

ConfigOutput29 for channel 2

The cutoff frequency of the respective filter is configured in these registers.

| Data type | Value | Information |
|-----------|-------------|---|
| UINT | 1 to 65,535 | Cutoff frequency in hertz. Bus controller default setting: 0 |

Information:

The highest cutoff frequency is limited by the Nyquist Shannon sampling theorem (based on the sampling cycle time). The system does not check for violations of this sampling theorem.

9.1.12.8.4.4 Scaling (optional)

Scaling A/D converter data is an option for the user. The following registers are available for this:

- "User-defined gain" on page 442 (= ku)
- "User-defined offset" on page 442 (= du)

Scaling calculation:

Scaled value = $k * A/C \text{ value} + d$

Gain $k = k_{\text{Calibration}} * ku$

Offset $d = d_{\text{Calibration}} + du$

The value has to be limited since it can exceed the 16-bit constraints. To provide the greatest degree of flexibility, limiting is possible using the registers "Minimum limit value" on page 443 and "Maximum limit value" on page 443.

User-defined gain

Name:

ConfigOutput04 for channel 1

ConfigOutput09 for channel 2

The user-defined gain for the A/D converter data of the respective physical channel can be specified in these registers.

The value 65,536 (0x10000) corresponds to a gain of 1.

| Data type | Values | Information |
|-----------|------------------------------------|--|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: 65,536 |

User-defined offset

Name:

ConfigOutput05 for channel 1

ConfigOutput10 for channel 2

The user-defined offset for the A/D converter data of the respective physical channel can be specified in this register.

The value 65,536 (0x10000) corresponds to an offset of 1.

| Data type | Values | Information |
|-----------|------------------------------------|-----------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: 0 |

9.1.12.8.4.5 User-defined limit values

If the application requires a limitation of the range of values, then the user can define his own limit values. These values will also be use for the module's error statistics. The following registers are available for this:

- "Minimum limit value" on page 443
- "Maximum limit value" on page 443

Information:

32-bit numbers are used inside the module. A limit value violation can therefore also be determined if the permitted range of values was defined from -32768 to 32767.

Minimum limit value

Name:

ConfigOutput02 for channel 1

ConfigOutput07 for channel 2

The minimum limit value is configured in this register. This limit value is also used for the underflow error statistics (see register "Ch0xUnderflow" on page 446).

| Data type | Values | Information |
|-----------|-----------------|--|
| INT | -32768 to 32767 | Bus controller default setting: -32768 |

Maximum limit value

Name:

ConfigOutput03 for channel 1

ConfigOutput08 for channel 2

The maximum limit value is configured in this register. This limit value is also used for the overflow error statistics (see register "Ch0xOverflow" on page 446).

| Data type | Values | Information |
|-----------|-----------------|---------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 32767 |

9.1.12.8.5 Communication - General

The module's analog inputs convert current and voltage values with 16-bit resolution. This information can be used by the application with the help of the registers listed here.

9.1.12.8.5.1 Analog input channels

Name:

AnalogInput01 to AnalogInput02

The analog input value is mapped in this register depending on the configured operating mode.

| Data type | Value | Input signal: |
|-----------|-------------------|-----------------------------|
| INT | -32,768 to 32,767 | Voltage signal ± 11 VDC |
| | 0 to 32,767 | Current signal 0 to 22 mA |

9.1.12.8.5.2 Sampling cycle counter

Name:

SampleCycleCounter

The number of times the input signal has been sampled is provided in this register.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.1.12.8.5.3 Error monitoring and counters

Channel status

Name:

Channel01OK to Channel02OK

SyncStatus

ConversionCycle

This register collects error messages synchronously with the network cycle. Temporary error states that were registered in a conversion cycle remain active for at least 2 network cycles. In order to receive detailed error information, the corresponding error counters and X2X network events should also be observed.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------------------------|-------|------------------|
| 0 | Channel01OK | 0 | OK |
| | | 1 | Errors |
| 1 | Channel02OK | 0 | OK |
| | | 1 | Errors |
| 2 - 5 | Reserved | - | |
| 6 | SyncStatus ¹⁾ | 0 | OK |
| | | 1 | Not synchronized |
| 7 | ConversionCycle ²⁾ | 0 | OK |
| | | 1 | Errors |

1) Identical to bit 0 of the registers "[SynchronizationViolationErrorCounter](#)" on page 444.

2) Identical to bit 0 of the registers "[SampleCycleViolationErrorCounter](#)" on page 444.

Synchronization error counter

Name:

SynchronizationViolationErrorCounter

This register counts how often the conversion task was triggered more than 5 μ s after the next-coming X2X cycle. In this case, the module is considered being no longer synchronized with X2X Link.

The counters in this register follow the rules of the event error counter, i.e. the count increased each time an error occurs or is reset. The last bit of the counter indicates the error status:

- Last bit = 1 → Error pending
- Last bit = 0 → No error

| Data type | Value | Information |
|-----------|------------|---------------------|
| UINT | 0 to 65535 | Counter value |
| | 0 to 1 | Bit 0: Error status |

Counter for faulty sampling cycles

Name:

SampleCycleViolationErrorCounter

This register is used to indicate the number of cycle time violations that have occurred thus far. A cycle time violation occurs if the conversion tasks initiates a sampling task before the last sampling cycle has finished. See "[Sampling and conversion](#)" on page 440.

The counters in this register follow the rules of the event error counter, i.e. the count increased each time an error occurs or is reset. The last bit of the counter indicates the error status:

- Last bit = 1 → Error pending
- Last bit = 0 → No error

| Data type | Value | Information |
|-----------|------------|---------------------|
| UINT | 0 to 65535 | Counter value |
| | 0 to 1 | Bit 0: Error status |

Range violation (neg. and pos.)

Name:

Channel01underflow to Channel02underflow

Channel01overflow to Channel02overflow

This register indicates whether the limit values defined by registers "Minimum limit value" on page 443 and "Maximum limit value" on page 443 have been overshoot or undershot. The individual bits in this register are identical to the values of the lowest bits of registers "Ch0xUnderflow" on page 446 and "Ch0xOverflow" on page 446.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------|-------|------------------------------------|
| 0 | Channel01underflow | 0 | No error |
| | | 1 | Range exceeded (.neg) on channel 1 |
| 1 | Channel02underflow | 0 | No error |
| | | 1 | Range exceeded (.neg) on channel 2 |
| 2 - 3 | Reserved | - | |
| 4 | Channel01overflow | 0 | No error |
| | | 1 | Range exceeded (.pos) on channel 1 |
| 5 | Channel02overflow | 0 | No error |
| | | 1 | Range exceeded (.pos) on channel 2 |
| 6 - 7 | Reserved | - | |

Working range violation (pos.)

Name:

Channel01outofrange to Channel02outofrange

This register indicates whether the input value overshoots the module's maximum measurement range. The individual bits in this register are identical to the values of the lowest bits of register "Ch0xOutOfRange" on page 445.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------------|-------|---|
| 0 | Channel01outofrange | 0 | No error |
| | | 1 | Working range violation (pos.) of channel 1 |
| 1 | Channel02outofrange | 0 | No error |
| | | 1 | Working range violation (pos.) of channel 2 |
| 2 - 7 | Reserved | - | |

Counter for work range violations (pos.)

Name:

Ch01OutOfRange to Ch02OutOfRange

Errors outside of the module's maximum possible measurement range are indicated in this register. These errors lead to full-scale deflection of the A/D converter.

The counters in these registers follow the rules of the event error counter, i.e. the count increased each time an error occurs or is reset. The last bit of the counter indicates the error status:

- Last bit = 1 → Error pending
- Last bit = 0 → No error

This counter is only active if the static error counter is enabled (see register "Channel configuration" on page 440).

| Data type | Value | Information |
|-----------|------------|---------------------|
| UINT | 0 to 65535 | Counter value |
| | 0 to 1 | Bit 0: Error status |

Counter for range exceeded violations (neg.)

Name:

Ch01Underflow to Ch02Underflow

This register indicates range exceeded violations (neg.) of the value configured in the register "[Minimum limit value](#)" on page 443.

The counters in these registers follow the rules of the event error counter, i.e. the count increased each time an error occurs or is reset. The last bit of the counter indicates the error status:

- Last bit = 1 → Error pending
- Last bit = 0 → No error

This counter is only active if the static error counter is enabled (see register "[Channel configuration](#)" on page 440).

| Data type | Value | Information |
|-----------|------------|---------------------|
| UINT | 0 to 65535 | Counter value |
| | 0 to 1 | Bit 0: Error status |

Counter for range exceeded violations (pos.)

Name:

Ch01Overflow to Ch02Overflow

This register indicates range exceeded violations (pos.) of the value configured in the register "[Maximum limit value](#)" on page 443.

The counters in these registers follow the rules of the event error counter, i.e. the count increased each time an error occurs or is reset. The last bit of the counter indicates the error status:

- Last bit = 1 → Error pending
- Last bit = 0 → No error

This counter is only active if the static error counter is enabled (see register "[Channel configuration](#)" on page 440).

| Data type | Value | Information |
|-----------|------------|---------------------|
| UINT | 0 to 65535 | Counter value |
| | 0 to 1 | Bit 0: Error status |

9.1.12.8.6 Additional analysis functions

In addition to sampling the analog input signal, this module can also be used to perform additional analysis of the values obtained.

- **Limit value analysis**

If limit value analysis has been enabled for a channel, the sampled minimum and maximum values are latched internally in the module. A measurement period can be triggered using the control byte. When the respective configured edge is generated by the application, the limit values from the previous measurement period are displayed and the internal latch register is reset.

- **Recording sampled values**

If recording sampled values has been enabled for a channel, then the sampled values are additionally recorded in the module's internal FIFO memory. If the configured event occurs, the contents of the FIFO memory are transmitted to the application.

Information:

It is only possible to use the recording of sampled values if the module is operated on an X2X master that is an SG4 CPU.

9.1.12.8.6.1 Trigger condition on falling edge

Name:

ConfigOutput21

This register configures whether the falling edge is used to trigger the trace and determination of the input value in the register "[Analysis control byte](#)" on page 448.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------|-------|---|
| 0 | TraceTrigger01 | 0 | No trigger (bus controller default setting) |
| | | 1 | Falling edge active as trigger |
| 1 - 3 | Reserved | - | |
| 4 | MinMaxStart01 | 0 | No determination (bus controller default setting) |
| | | 1 | Falling edge determines input value of channel 1 |
| 5 | MinMaxStart02 | 0 | No determination (bus controller default setting) |
| | | 1 | Falling edge determines input value of channel 2 |
| 6 - 7 | Reserved | 0 | |

9.1.12.8.6.2 Trigger condition on rising edge

Name:

ConfigOutput22

This register configures whether the rising edge is used to trigger the trace and determination of the input value in the register "[Analysis control byte](#)" on page 448.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------|-------|---|
| 0 | TraceTrigger01 | 0 | Trigger not initiated on positive edge (bus controller default setting) |
| | | 1 | Rising edge active as trigger |
| 1 - 3 | Reserved | - | |
| 4 | MinMaxStart01 | 0 | No determination (bus controller default setting) |
| | | 1 | Rising edge determines input value of channel 1 |
| 5 | MinMaxStart02 | 0 | No determination (bus controller default setting) |
| | | 1 | Rising edge determines input value of channel 2 |
| 6 - 7 | Reserved | 0 | |

9.1.12.8.6.3 Analysis control byte

Name:

TraceTrigger01

MinMaxStart01 to MinMaxStart02

The trace function and determination of the minimum/maximum input values can be started in this register. Whether the rising and/or falling edge is used to trigger the functions can be configured using the registers "[Trigger condition on falling edge](#)" on page 447 and "[Trigger condition on rising edge](#)" on page 447.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------|-------|--|
| 0 | TraceTrigger01 | 0 | Trigger/Trace not triggered (bus controller default setting) |
| | | 1 | Initiates trigger/trace |
| 1 - 3 | Reserved | - | |
| 4 | MinMaxStart01 | 0 | Determination not triggered (bus controller default setting) |
| | | 1 | Initiates determination of input value of channel 1 |
| 5 | MinMaxStart02 | 0 | Determination not triggered (bus controller default setting) |
| | | 1 | Initiates determination of input value of channel 2 |
| 6 - 7 | Reserved | - | |

Information:

To reduce the cyclic data transfer, this register combines the trace and limit value determination functions.

9.1.12.8.6.4 Analysis status byte

Name:

MinMaxStart01Readback to MinMaxStart02Readback

The currently requested module-internal analyses can be checked in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------|--------|---|
| 0 - 3 | Reserved | - | |
| 4 | MinMaxStart01Readback | 0 or 1 | Current state of the trigger bits for determining the limit values on the channel |
| 5 | MinMaxStart02Readback | 0 or 1 | Current state of the trigger bits for determining the limit values on the channel |
| 6 - 7 | Reserved | - | |

9.1.12.8.7 Limit values

Limit value analysis must be enabled for the desired channel. See "Channel configuration" on page 440. The sampled value of the channel is then compared to the [minimum](#) and [maximum values](#) that are stored internally in the module. If a new measurement period is initiated with the "Analysis control byte" on page 448 register, then the values of the previous measurement period can be read from the respective registers intended for this.

9.1.12.8.7.1 Maximum input values

Name:

MaxInput01 to MaxInput02

The maximum value of the preceding trigger period is saved in this register based on the filtered, scaled and user-defined limit values. The register value is 0 if the channel is inactive.

| Data type | Value |
|-----------|-------------------|
| INT | -32,768 to 32,767 |

9.1.12.8.7.2 Minimum input values

Name:

MinInput01 to MinInput02

The minimum value of the preceding trigger period is saved in this register based on the filtered, scaled and user-defined limit values. The register value is 0 if the channel is inactive.

| Data type | Value |
|-----------|-------------------|
| INT | -32,768 to 32,767 |

9.1.12.8.7.3 Limit value trigger counter

Name:

Ch01MinMaxLatchCounter to Ch02MinMaxLatchCounter

The number of valid events that trigger a new measurement period for the limit value analysis is counted in this register.

| Data type | Value |
|-----------|------------|
| UINT | 0 to 65535 |

9.1.12.8.8 Trace

If the module is operated on a SG4 CPU, the digitalized input values are recorded by the module. The module must be operated in "Supervised" mode in order to use the trace function.

Recording must be enabled for the desired channel. The enable bits can then control the recording at runtime. The sampled values are recorded in the module's internal FIFO memory.

If the previously defined state occurs on the channel, the contents of the FIFO memory are transmitted to the application. Whether the FIFO memory continued to be filled depends on how recording is configured.

Information:

The trace mechanism can only be used if the module is connected directly to the CPU, not if it is operated behind a bus controller.

9.1.12.8.8.1 Enable recording

Name:

TraceChannelEnable

The respective channel is enabled for the trace with this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|------------------|
| 0 | Channel 1 | 0 | Channel disabled |
| | | 1 | Channel enabled |
| 1 | Channel 2 | 0 | Channel disabled |
| | | 1 | Channel enabled |
| 2 - 7 | Reserved | - | |

9.1.12.8.8.2 Number of values to be recorded

Name:

TraceSampleDepth

16 kB are available on the module for the trace. The FIFO memory limitation means that a maximum of 8192 analog values can be recorded. This memory is divided up equally among the enabled channels. The actual number of maximum possible recordings therefore depends on the number of channels enabled for trace:

1 channel enabled: Up to 8192 recordings

2 channels enabled: Up to 4096 recordings per channel

| Data type | Value | Function |
|-----------|-----------|----------------------|
| UINT | 2 to 8192 | Default value = 1024 |

9.1.12.8.8.3 Recording priority

Name:

ConfigOutput25

The priority of the trace can be increased with this register.

| Data type | Value | Function |
|-----------|-------|---|
| USINT | 3 | Standard |
| | 6 | Trace priority higher than X2X Link communication |

9.1.12.8.8.4 Starting a recording

Name:

TraceEnable01

This register starts the recording according to the specifications for edge control or the comparator.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|-----------------------------|
| 0 | TraceEnable01 | 0 | Disables the trace function |
| | | 1 | Enables the trace function |
| 1 - 7 | Reserved | - | |

9.1.12.8.8.5 Recording status

Name:

TraceEnabled

TraceWriteActive

TraceReadActive

ReadyForTrigger

TriggerActive

TraceOk

TraceError

The status of the trace is represented in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|------------------|-------|---------------------------------------|
| 0 | TraceEnabled | 0 | Trace inactive |
| | | 1 | Trace active |
| 1 | Reserved | - | |
| 2 | TraceWriteActive | 0 | Data not recorded |
| | | 1 | Data recorded |
| 3 | TraceReadActive | 0 | Data not output/read |
| | | 1 | Data output/read |
| 4 | ReadyForTrigger | 0 | Not ready for triggering |
| | | 1 | Ready for triggering |
| 5 | TriggerActive | 0 | No trigger active or already executed |
| | | 1 | Trigger active |
| 6 | TraceOk | 0 | Overflow or inactive |
| | | 1 | No overflow |
| 7 | TraceError | 0 | No error or inactive |
| | | 1 | Trace buffer full |

9.1.12.8.8.6 Free trace buffer

Name:

FreeBufferSize

Specifies the available FIFO memory area in bytes for the trace

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.1.12.8.8.7 Counter for trace triggers

Name:

TriggerCount

The number of trigger events that have occurred since [starting the trace](#) is indicated in this register.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.1.12.8.8.8 Counter for faulty recording triggers

Name:

TriggerFailCount

Counts the trigger events for which the trace could not be performed.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.1.12.8.8.9 Comparator for trigger conditions

In order to adapt the trace as closely as possible to the requirements of the application, the trace function can also be controlled using the comparator. Threshold values (hysteresis) can be defined within the permitted range of values to do so. 2 status bits are then generated for each enabled channel:

- **InRange bit**

The InRange status is "1" if the measured value falls within the defined limits.

The InRange status is "0" if the measured value falls outside the defined limits.

- **Threshold value bit**

The threshold value bit is "1" if the measured value exceeds the upper threshold value.

The threshold value bit is "0" if the measured value falls below the lower threshold value.

The InRange and threshold value bits for all channels are grouped together in the lower-value byte of the "[CompStateCollection](#)" on page 453 register. In addition, the states of the previous sampling are stored in the high-value byte.

The 4 status messages of each channel can be linked according to the following logic via a logical connective mask using AND or OR operators and used as a trace trigger:

```
delta = (Current_HysteresisStatus ^ NominalValues)// Different between current status and preset
cond = delta & Selected_HysteresisStatusBits// Eliminate irrelevant status messages
cond = Selected_HysteresisStatusBits (Current_HysteresisStatus ^ NominalValues)
if((0==(cond & ~LogicalOperators)) &&
(0!=(~cond & LogicalOperators))) {=> Generate trigger event}
```

Selected_HysteresisStatusBits
Current_HysteresisStatus
Nominal values
Logical operators

Corresponds to register:

"cfgComp_EnableMask" on page 454
"CompStateCollection" on page 453
"cfgComp_NominalState" on page 454
"cfgComp_ConditionTypeMask" on page 455

Lower limit value for hysteresis

Name:

cfgComp_LowLimitCh01 to cfgComp_LowLimitCh02

The lower limit value for hysteresis is configured in this register.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

Upper limit value for hysteresis

Name:

cfgComp_HighLimitCh01 to cfgComp_HighLimitCh02

The upper limit value for hysteresis is configured in this register.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

Hysteresis status of the channels

Name:

CompStateCollection

The hysteresis status of the input channels for the current and last cycle are represented in this register.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|---------|--|-------|---|
| 0 | Channel01 hysteresis status in the current cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 1 | Channel01 InRange status in the current cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| 2 | Channel02 hysteresis status in the current cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 3 | Channel02 InRange status in the current cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| 4 - 7 | Reserved | - | |
| 8 | Channel01 hysteresis status in the last cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 9 | Channel01 InRange status in the last cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| 10 | Channel02 hysteresis status in the last cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 11 | Channel02 InRange status in the last cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| 12 - 15 | Reserved | - | |

Comparison state of the channels

Name:

cfgComp_NominalState

The desired comparison state for the hysteresis status is indicated in this register.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|---------|--|-------|---|
| 0 | Channel01 hysteresis status in the current cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 1 | Channel01 InRange status in the current cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| 2 | Channel02 hysteresis status in the current cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 3 | Channel02 InRange status in the current cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| 4 - 7 | Reserved | - | |
| 8 | Channel01 hysteresis status in the last cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 9 | Channel01 InRange status in the last cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| 10 | Channel02 hysteresis status in the last cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 11 | Channel02 InRange status in the last cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| 12 - 15 | Reserved | - | |

Information:

This is a "whitelist", i.e. the trace starts as soon as the current status message takes on the state predefined here.

One or more matches will be necessary depending on the selection of the relevant hysteresis status bits and logical connective operators.

Selecting the relevant hysteresis status bits

Name:

cfgComp_EnableMask

This register selects which status bits of the hysteresis comparison should be used to generate the trigger.

For more information about using this register, see ["Comparator for trigger conditions" on page 452](#).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|---------|--|-------|--------------------|
| 0 | Channel01 hysteresis status in the current cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 1 | Channel01 InRange status in the current cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 2 | Channel02 hysteresis status in the current cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 3 | Channel02 InRange status in the current cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 4 - 7 | Reserved | - | |
| 8 | Channel01 hysteresis status in the last cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 9 | Channel01 InRange status in the last cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 10 | Channel02 hysteresis status in the last cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 11 | Channel02 InRange status in the last cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 12 - 15 | Reserved | - | |

Logical connective operators for hysteresis status bits

Name:

cfgComp_ConditionTypeMask

The desired state operators with which the status bits are linked to one another to generate a trigger are selected in this register.

At least one OR operation must be configured, but it does not necessarily have to be located on a channel configured with "1" in the "cfgComp_EnableMask" on page 454 register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|---------|--|-------|-------------------|
| 0 | Channel01 hysteresis status in the current cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 1 | Channel01 InRange status in the current cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 2 | Channel02 hysteresis status in the current cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 3 | Channel02 InRange status in the current cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 4 - 7 | Reserved | - | |
| 8 | Channel01 hysteresis status in the last cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 9 | Channel01 InRange status in the last cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 10 | Channel02 hysteresis status in the last cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 11 | Channel02 InRange status in the last cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 12 - 15 | Reserved | - | |

9.1.12.8.8.10 Time-offset trace

Additional conditions for shifting the starting and stopping points can be defined if the trace should be chronologically offset to the trigger.

Starting the trace

Name:

TraceTriggerStart

The starting position is defined relative to the configured trigger condition in this register. Positive values mean that the trace takes place x samples after the trigger condition. Negative values mean that the trace takes place x samples before the trigger condition.

The value -32768 performs the trace without regard for the configured trigger condition. If the trace memory is completely full, then the oldest recorded value is overwritten (FIFO principle).

"Trace start" in the I/O configuration or the registers "[Trigger condition on falling edge](#)" on page 447 and "[Trigger condition on rising edge](#)" on page 447 determine whether a positive, negative or any edge must be triggered.

| Data type | Value | Information |
|-----------|-----------------|---|
| INT | -32767 to 32767 | |
| | -32768 | Continuous trace without a stopping point |

Stopping the trace

Name:

TraceTriggerStop

The stopping position is defined relative to the configured trigger condition in this register.

- When configuring an early trigger event, this value refers to the trigger event.
- When configuring a delayed trigger event, this value refers to the starting event.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.1.12.8.9 Acyclic frame size

Name:
AsynSize

When the stream is used, data is exchanged internally between the module and CPU. For this purpose, a defined amount of acyclic bytes is reserved for this slot.

Increasing the acyclic frame size leads to increased data throughput on this slot.

Information:

This configuration involves a driver setting that cannot be changed during runtime!

| Data type | Value | Information |
|-----------|---------|---|
| - | 8 to 28 | Acyclic frame size in bytes. Default = 24 |

9.1.12.8.10 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|-----------------------------------|--------|
| Standard priority | 200 µs |
| High priority with trace function | 300 µs |

9.1.12.8.11 Minimum I/O update time

There is no limitation or dependency on the bus cycle time.

The I/O update time is defined using the "Sampling time" register. The fastest possible sampling time depends on the number of channels to be converted and the configuration.

9.1.13 X20AI2636

Data sheet version: 2.11

9.1.13.1 General information

The module is equipped with 2 inputs with 16-bit digital converter resolution. It is possible to select between the current and voltage signal using different terminals. With the oversampling function, up to 16 analog values per channel can be recorded.

This module is designed for X20 6-pin terminal blocks. If needed (e.g. for logistical reasons), the 12-pin terminal block can also be used.

- 2 analog inputs
- Current or voltage signal configuration for the entire module
- 16-bit digital converter resolution
- Minimum conversion time of 40 μ s for all inputs
- The conversion time for the entire module can be configured in 0.02 μ s steps.
- Maximum 14 samples (16-bit) for the entire module per X2X Link cycle
- Oversampling: Up to 16 analog values per channel (internal)
- Timestamp for the last conversion of an X2X Link cycle

9.1.13.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Analog inputs |  |
| X20AI2636 | X20 analog input module, 2 inputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, configurable input filter, oversampling functions | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |

Table 64: X20AI2636 - Order data

9.1.13.3 Technical data

| Model number | X20AI2636 |
|--|--|
| Short description | |
| I/O module | 2 analog inputs ±10 V or 0 to 20 mA |
| General information | |
| B&R ID code | 0xB3A7 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Inputs | Yes, using status LED and software |
| Channel type | Yes, using software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.2 W ¹⁾ |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Analog inputs | |
| Input | ±10 V or 0 to 20 mA, via different terminal connections |
| Input type | Differential input |
| Digital converter resolution | |
| Voltage | ±15-bit |
| Current | 15-bit |
| Conversion time | 40 µs for all inputs |
| Output format | INT |
| Output format | |
| Voltage | INT 0x8001 - 0x7FFF / 1 LSB = 0x0001 = 305.176 µV |
| Current | INT 0x0000 - 0x7FFF / 1 LSB = 0x0001 = 610.352 nA |
| Input impedance in signal range | |
| Voltage | 20 MΩ |
| Current | - |
| Load | |
| Voltage | - |
| Current | <400 Ω |
| Input protection | Protection against wiring with supply voltage |
| Permissible input signal | |
| Voltage | Max. ±30 V |
| Current | Max. ±50 mA |
| Output of digital value during overload | |
| Undershoot | |
| Voltage | 0x8001 |
| Current | 0x0000 |
| Overshoot | |
| Voltage | 0x7FFF |
| Current | 0x7FFF |
| Conversion procedure | SAR |
| Input filter | Hardware - 3rd-order low pass / cutoff frequency 10 kHz |
| Max. error at 25°C | |
| Voltage | |
| Gain | 0.08% ²⁾ |
| Offset | 0.01% ³⁾ |
| Current | |
| Gain | 0.08% ²⁾ |
| Offset | 0.02% ⁴⁾ |

Table 65: X20AI2636 - Technical data


| Model number | X20AI2636 |
|---|---|
| Max. gain drift | |
| Voltage | 0.01 %/°C ²⁾ |
| Current | 0.01 %/°C ²⁾ |
| Max. offset drift | |
| Voltage | 0.001 %/°C ³⁾ |
| Current | 0.002 %/°C ⁴⁾ |
| Common-mode rejection | |
| DC | 70 dB |
| 50 Hz | 70 dB |
| Common-mode range | ±12 V |
| Crosstalk between channels | <-70 dB |
| Nonlinearity | |
| Voltage | <0.01% ³⁾ |
| Current | <0.015% ⁴⁾ |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB06 or X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 65: X20AI2636 - Technical data

- 1) To reduce power dissipation, B&R recommends bridging unused inputs on the terminals.
- 2) Based on the current measured value.
- 3) Based on the 20 V measurement range.
- 4) Based on the 20 mA measurement range.

9.1.13.4 LED status indicators

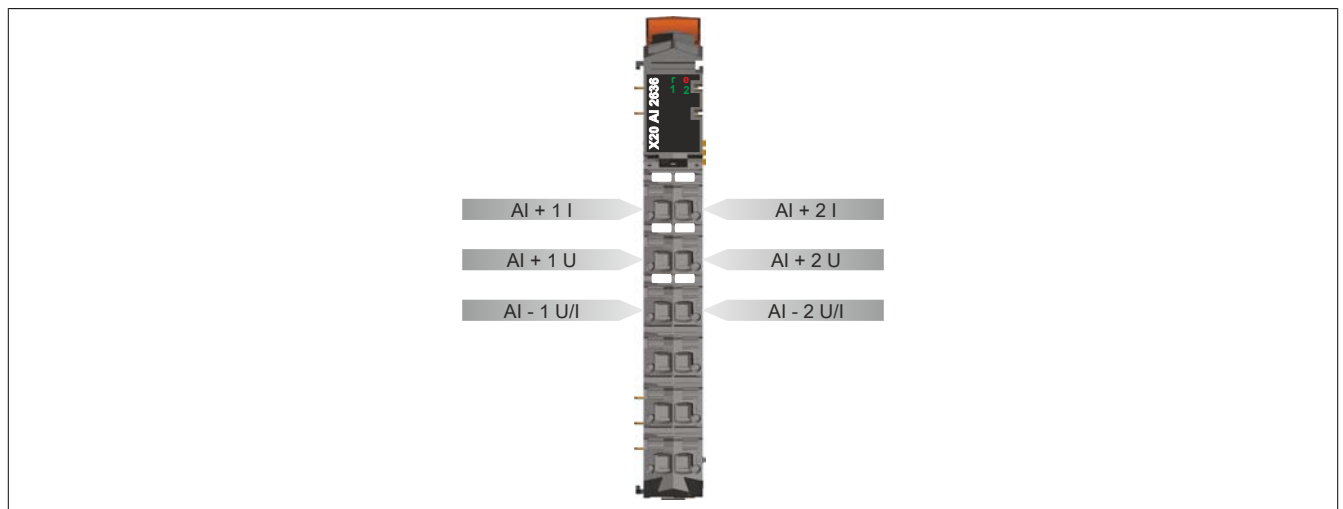
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|-------|--------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | | | Double flash | System error: <ul style="list-style-type: none"> Violation of the scan time Synchronization error |
| | 1 - 2 | Green | Off | Open line ²⁾ or sensor is disconnected |
| | | | Blinking | Channel error: Underflow, overflow or broken connection |
| | | | On | Analog/digital converter running, value OK |

1) Depending on the configuration, a firmware update can take up to several minutes.

2) Open line detection only possible when measuring voltage.

9.1.13.5 Pinout

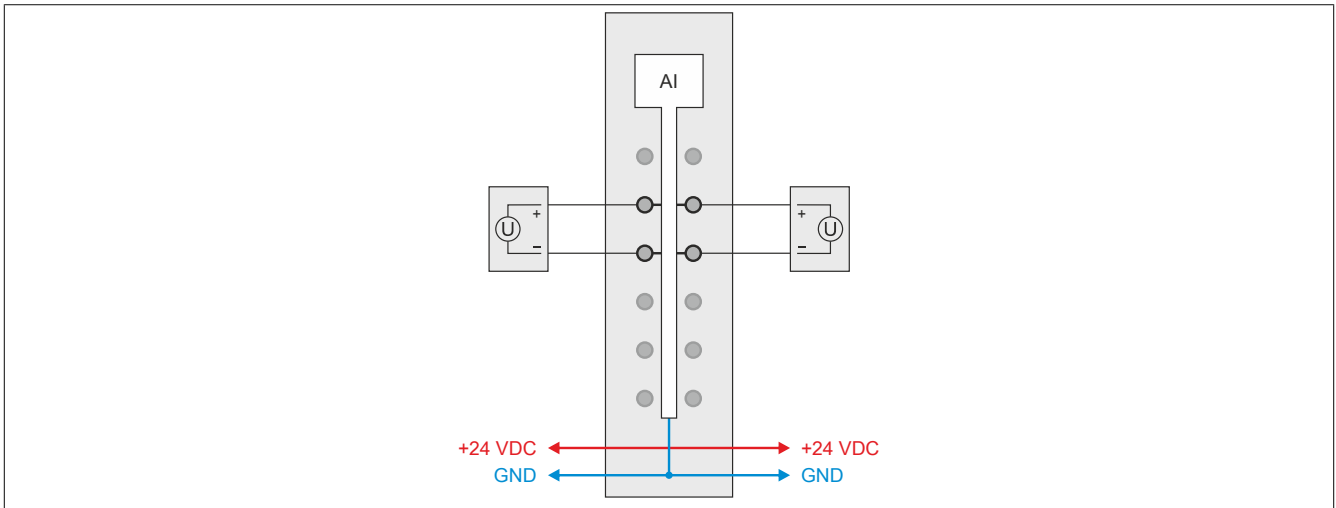


9.1.13.6 Connection example

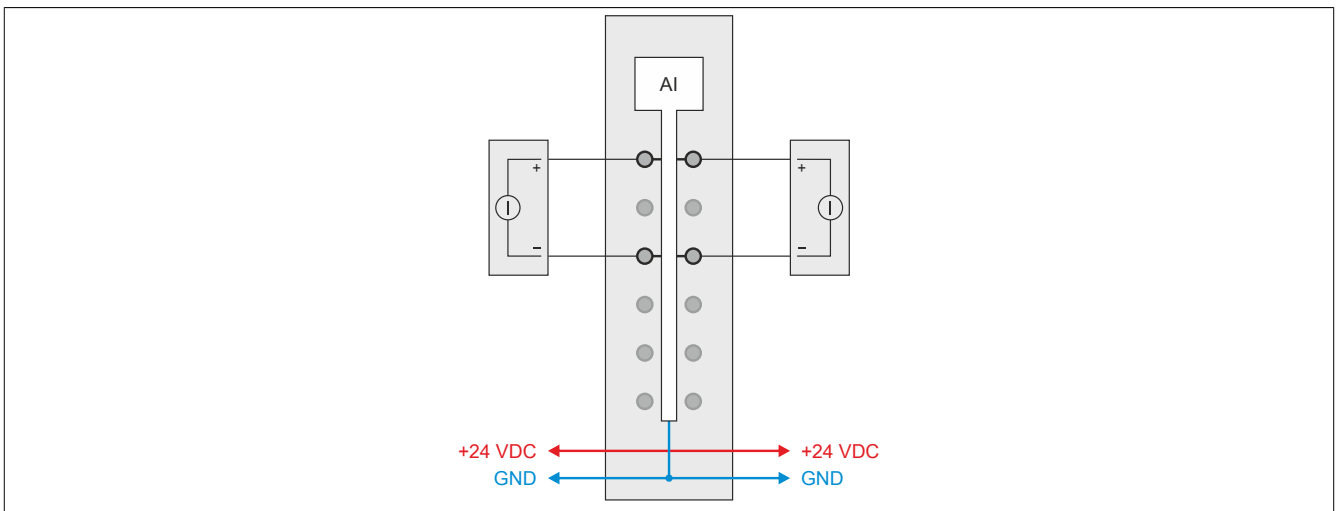
To prevent disturbances, the following modules must be separated by at least one module:

- Bus receiver X20BR9300
- Supply module X20PS3300/X20PS3310
- Supply module X20PS9400/X20PS9402
- Supply module X20PS9500/X20PS9502
- CPU modules

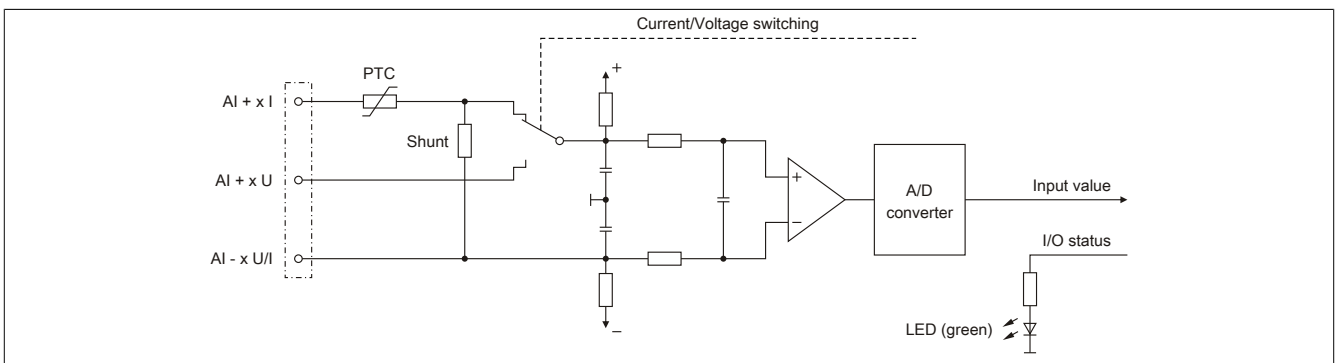
Voltage measurement



Current measurement



9.1.13.7 Input circuit diagram



9.1.13.8 Register description

9.1.13.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.1.13.8.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|---------------------------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| System configuration | | | | | | |
| 513 | CfO_BaseConfig | USINT | | | | • |
| 15364 | CfO_CycleTime | UDINT | | | | • |
| 15370 | CfO_SyncOffset | UINT | | | | • |
| 15374 | CfO_Prescaler | UINT | | | | • |
| Error messages - Configuration | | | | | | |
| 385 | CfO_ErrorID0007 | USINT | | | | • |
| 389 | CfO_ErrorID1017 | USINT | | | | • |
| Physical channel configuration | | | | | | |
| 8194 | CfO_ModeCh01 | UINT | | | | • |
| 8450 | CfO_ModeCh02 | | | | | • |
| 8204 | CfO_UserGainCh01 | DINT | | | | • |
| 8460 | CfO_UserGainCh02 | | | | | • |
| 8212 | CfO_UserOffsetCh01 | DINT | | | | • |
| 8468 | CfO_UserOffsetCh02 | | | | | • |
| 8220 | CfO_Alpha0Ch01 | DINT | | | | • |
| 8476 | CfO_Alpha0Ch02 | | | | | • |
| 8228 | CfO_Alpha1Ch01 | DINT | | | | • |
| 8484 | CfO_Alpha1Ch02 | | | | | • |
| 8236 | CfO_Alpha2Ch01 | DINT | | | | • |
| 8492 | CfO_Alpha2Ch02 | | | | | • |
| 8244 | CfO_Beta1Ch01 | DINT | | | | • |
| 8500 | CfO_Beta1Ch02 | | | | | • |
| 8252 | CfO_Beta2Ch01 | DINT | | | | • |
| 8508 | CfO_Beta2Ch02 | | | | | • |
| 8198 | CfO_CutOffFrequeCh01 | UINT | | | | • |
| 8454 | CfO_CutOffFrequeCh02 | | | | | • |
| Logical channel configuration | | | | | | |
| 10242 + (N-1) * 256 | CfO_LogCh0NMode (index N = 1 to 6) | UINT | | | | • |
| 10245 + (N-1) * 256 | CfO_LogCh0NSource00 (index N = 1 to 6) | USINT | | | | • |
| 10247 + (N-1) * 256 | CfO_LogCh0NSource01 (index N = 1 to 6) | USINT | | | | • |
| 10260 + (N-1) * 256 | CfO_LogCh0NFuncPar00 (index N = 1 to 6) | UDINT | | | | • |
| 10268 + (N-1) * 256 | CfO_LogCh0NFuncPar01 (index N = 1 to 6) | UDINT | | | | • |
| Analog inputs - Communication | | | | | | |
| 5062 | AnalogInput01 | INT | • | | | |
| 5070 | AnalogInput02 | | | | | |
| Error messages - Communication | | | | | | |
| 261 | "StandardErrors" registers | USINT | • | | | |
| | Channel01Error | Bit 0 | | | | |
| | Channel02Error | Bit 1 | | | | |
| | PhysicalError | Bit 4 | | | | |
| | LogicalError | Bit 5 | | | | |
| 325 | "AcknowledgeStandardErrors" registers | USINT | | | • | |
| | AckChannel01Error | Bit 0 | | | | |
| | AckChannel01Error | Bit 1 | | | | |
| | AckPhysicalError | Bit 4 | | | | |
| | AckLogicalError | Bit 5 | | | | |
| 257 | "ExtendedChannelErrorMessages" registers | USINT | • | | | |
| | Channel01OutOfRange | Bit 0 | | | | |
| | Channel01FilterError | Bit 1 | | | | |
| | Channel01Underflow | Bit 2 | | | | |
| | Channel01Overflow | Bit 3 | | | | |
| | Channel02OutOfRange | Bit 4 | | | | |
| | Channel02FilterError | Bit 5 | | | | |
| | Channel02Underflow | Bit 6 | | | | |
| Channel02Overflow | Bit 7 | | | | | |
| 321 | "AcknowledgeExtendedChannelErrorMessages" registers | USINT | | | • | |
| | AckChannel01OutOfRange | Bit 0 | | | | |
| | AckChannel01FilterError | Bit 1 | | | | |

| Register | Name | Data type | Read | | Write | |
|--|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| | AckChannel01Underflow | Bit 2 | | | | |
| | AckChannel01Overflow | Bit 3 | | | | |
| | AckChannel02OutOfRange | Bit 4 | | | | |
| | AckChannel02FilterError | Bit 5 | | | | |
| | AckChannel02Underflow | Bit 6 | | | | |
| | AckChannel02Overflow | Bit 7 | | | | |
| Physical analog sample display | | | | | | |
| 4102 + (16-N) * 64 | PhysCh01SampleN (index N = 1 to 16) | INT | • | | | |
| 4110 + (16-N) * 64 | PhysCh02SampleN (index N = 1 to 16) | INT | • | | | |
| 5106 | PhysTimestamp | INT | • | | | |
| 5108 | PhysTimestamp | DINT | • | | | |
| 5113 | PhysSampleCount | SINT | • | | | |
| 5114 | PhysSampleCount | INT | • | | | |
| Logical analog and digital sample display | | | | | | |
| 6148 + (16-N) * 64 | LogicCh01SampleN (index N = 1 to 16) (32-bit) | DINT | • | | | |
| 6150 + (16-N) * 64 | LogicCh01SampleN (index N = 1 to 16) (16-bit) | INT | • | | | |
| 6156 + (16-N) * 64 | LogicCh02SampleN (index N = 1 to 16) (32-bit) | DINT | • | | | |
| 6158 + (16-N) * 64 | LogicCh02SampleN (index N = 1 to 16) (16-bit) | INT | • | | | |
| 6164 + (16-N) * 64 | LogicCh03SampleN (index N = 1 to 16) (32-bit) | DINT | • | | | |
| 6166 + (16-N) * 64 | LogicCh03SampleN (index N = 1 to 16) (16-bit) | INT | • | | | |
| 6172 + (16-N) * 64 | LogicCh04SampleN (index N = 1 to 16) (32-bit) | DINT | • | | | |
| 6174 + (16-N) * 64 | LogicCh04SampleN (index N = 1 to 16) (16-bit) | INT | • | | | |
| 6180 + (16-N) * 64 | LogicCh05SampleN (index N = 1 to 16) (32-bit) | DINT | • | | | |
| 6182 + (N-16) * 64 | LogicCh05SampleN (index N = 1 to 16) (16-bit) | INT | • | | | |
| 6188 + (16-N) * 64 | LogicCh06SampleN (index N = 1 to 16) (32-bit) | DINT | • | | | |
| 6190 + (16-N) * 64 | LogicCh06SampleN (index N = 1 to 16) (16-bit) | INT | • | | | |
| 7109 + (N-1) * 8 | LogicCh0NSample16_9 (index N = 1 to 5) | USINT | • | | | |
| 7151 | LogicCh06Sample16_9 | USINT | • | | | |
| 7111 + (N-1) * 8 | LogicCh0NSample8_1 (index N = 1 to 5) | USINT | • | | | |
| 7149 | LogicCh06Sample8_1 | USINT | • | | | |
| 7154 | LogicTimestamp | INT | • | | | |
| 7156 | LogicTimestamp | DINT | • | | | |
| 7161 | LogicSampleCount | SINT | • | | | |
| 7162 | LogicSampleCount | INT | • | | | |

9.1.13.8.3 Function model 254

The "Bus controller" function model has the following limitations compared to the "Standard" function model:

- No oversampling function since consistency is not possible when operating CAN-based bus controllers due to the limited data range
- The sampling cycle time is set to 100 µs.
- No timestamp function
- A range of logical functions is available for processing the physical values right on the module:
 - Output of physical values (standard)
 - Addition of two channels with scaling
 - Integral addition of two channels with scaling
 - Multiplication of two channels with scaling
 - Integral multiplication of two channels with scaling

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|---------------------------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| System configuration | | | | | | | |
| 513 | - | CfO_BaseConfig | USINT | | | | • |
| 15364 | - | CfO_CycleTime | UDINT | | | | • |
| 15370 | - | CfO_SyncOffset | UINT | | | | • |
| 15374 | - | CfO_Prescaler | UINT | | | | • |
| Error messages - Configuration | | | | | | | |
| 385 | - | CfO_ErrorID0007 | USINT | | | | • |
| 389 | - | CfO_ErrorID1017 | USINT | | | | • |
| Physical channel configuration | | | | | | | |
| 8194 | - | CfO_ModeCh01 | UINT | | | | • |
| 8450 | - | CfO_ModeCh02 | UINT | | | | • |
| 8204 | - | CfO_UserGainCh01 | DINT | | | | • |
| 8460 | - | CfO_UserGainCh02 | DINT | | | | • |
| 8212 | - | CfO_UserOffsetCh01 | DINT | | | | • |
| 8468 | - | CfO_UserOffsetCh02 | DINT | | | | • |
| 8220 | - | CfO_Alpha0Ch01 | DINT | | | | • |
| 8476 | - | CfO_Alpha0Ch02 | DINT | | | | • |
| 8228 | - | CfO_Alpha1Ch01 | DINT | | | | • |
| 8484 | - | CfO_Alpha1Ch02 | DINT | | | | • |
| 8236 | - | CfO_Alpha2Ch01 | DINT | | | | • |
| 8492 | - | CfO_Alpha2Ch02 | DINT | | | | • |
| 8244 | - | CfO_Beta1Ch01 | DINT | | | | • |
| 8500 | - | CfO_Beta1Ch02 | DINT | | | | • |
| 8252 | - | CfO_Beta2Ch01 | DINT | | | | • |
| 8508 | - | CfO_Beta2Ch02 | DINT | | | | • |
| 8198 | - | CfO_CutOffFrequCh01 | UINT | | | | • |
| 8454 | - | CfO_CutOffFrequCh02 | UINT | | | | • |
| Logical channel configuration | | | | | | | |
| 10242 + (N-1) * 256 | - | CfO_LogCh0NMode (index N = 1 to 6) | UINT | | | | • |
| 10245 + (N-1) * 256 | - | CfO_LogCh0NSource00 (index N = 1 to 6) | USINT | | | | • |
| 10247 + (N-1) * 256 | - | CfO_LogCh0NSource01 (index N = 1 to 6) | USINT | | | | • |
| 10260 + (N-1) * 256 | - | CfO_LogCh0NFuncPar00 (index N = 1 to 6) | UDINT | | | | • |
| 10268 + (N-1) * 256 | - | CfO_LogCh0NFuncPar01 (index N = 1 to 6) | UDINT | | | | • |
| Analog inputs - Communication | | | | | | | |
| 5062 | 0 | AnalogInput01 | INT | • | | | |
| 5070 | 2 | AnalogInput02 | INT | | | | |
| Error messages - Communication | | | | | | | |
| 261 | - | "StandardErrors" registers | USINT | | • | | |
| | | Channel01Error | Bit 0 | | | | |
| | | Channel02Error | Bit 1 | | | | |
| | | PhysicalError | Bit 4 | | | | |
| | | LogicalError | Bit 5 | | | | |
| 325 | - | "AcknowledgeStandardErrors" registers | USINT | | | | • |
| | | AckChannel01Error | Bit 0 | | | | |
| | | AckChannel02Error | Bit 1 | | | | |
| | | AckPhysicalError | Bit 4 | | | | |
| | | AckLogicalError | Bit 5 | | | | |
| 257 | - | "ExtendedChannelErrorMessages" registers | USINT | | • | | |
| | | Channel01OutOfRange | Bit 0 | | | | |
| | | Channel01FilterError | Bit 1 | | | | |
| | | Channel01Underflow | Bit 2 | | | | |
| | | Channel01Overflow | Bit 3 | | | | |

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| | | Channel02OutOfRange | Bit 4 | | | | |
| | | Channel02FilterError | Bit 5 | | | | |
| | | Channel02Underflow | Bit 6 | | | | |
| | | Channel02Overflow | Bit 7 | | | | |
| 321 | - | "AcknowledgeExtendedChannelErrorMessages" registers | USINT | | | | • |
| | | AckChannel01OutOfRange | Bit 0 | | | | |
| | | AckChannel01FilterError | Bit 1 | | | | |
| | | AckChannel01Underflow | Bit 2 | | | | |
| | | AckChannel01Overflow | Bit 3 | | | | |
| | | AckChannel02OutOfRange | Bit 4 | | | | |
| | | AckChannel02FilterError | Bit 5 | | | | |
| | | AckChannel02Underflow | Bit 6 | | | | |
| | | AckChannel02Overflow | Bit 7 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.1.13.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.1.13.8.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.1.13.8.4 General information

There is a difference on the module between physical (default) and logical values:

Physical or default values

The conversion results are transferred to the higher-level system after being scaled and filtered. They are not processed further.

Logical values

The physical values can be further processed with mathematical functions and comparators. In addition, another logical channel can be used as a starting point to further process a logical function.

9.1.13.8.5 Operating mode - Oversampling

The input values are recorded with a configurable sampling cycle time and saved with timestamp to the internal physical data buffer. This data range can then be read out in the cyclic data transfer using a configurable data length.

The recording and transmission system for the logical channels is identical to that for the physical channels. The functions of the logical channels are also executed in the configured sampling cycle time and saved with timestamp to the logical data buffer. The values can also be read out from here using configurable cyclic data points.

The defined sampling cycle time may not be sufficient for the sum of all physical and logical functions if using fast X2X Link cycle times, however. If influencing the physical sampling is not permitted, then a prescaler can be used to slow down the logical processing.

Information:

The ability to adjust the sampling cycle time as needed on the module means there is basically no synchronization with X2X Link, regardless of whether standard inputs or an oversampling function is configured.

If synchronization is required, then the configured sampling cycle time must be a multiple of the X2X Link cycle time!

9.1.13.8.5.1 Analog oversampling

When using analog oversampling, the enabled channels are stored in the module within a configurable time frame independently of the X2X cycle. Space is available for 16 analog values per physical and logical channel.

These samplings are numbered from 1 to 16 for the registers. The conversions or calculations of individual channels with the same number (i.e. sample line 1 to 16, e.g. PhysCh01Sample10, PhysCh02Sample10, etc.) are derived from the same sampling cycle or logical computing cycle and therefore have the same timestamp.

The timestamp refers to the newest data value, i.e. always to sample line 1. If a timestamp for older data points is needed, it needs to be back-calculated in the application using the sampling cycle time configured on the module. The prescaler must also be taken into account for logical channels.

Calculation example

| Sample line | Calculation | |
|-------------|--------------------------------------|---------------------|
| 1 | Timestamp | Newest value |
| 2 | Timestamp - Sampling cycle time | |
| 3 | Timestamp - 2 * Sampling cycle time | |
| 4 | Timestamp - 3 * Sampling cycle time | |
| ... | ... | |
| 10 | Timestamp - 9 * Sampling cycle time | |
| ... | ... | |
| 16 | Timestamp - 15 * Sampling cycle time | Oldest value |

How the buffer is organized can be seen from this. This is not a FIFO buffer but a static buffer that the values are pushed through. Sample line 1 always contains the newest values, the next line the second newest, all the way up to sample line 16, which contains the oldest values.

The sample counter is a circular counter, with the number of new sample lines derived from the value of the last transfer cycle.

Example

A difference of 3 to the last transfer cycle means:

The data in sample line 1 and all subsequent data from the previous transfer cycle is now shifted in the current cycle beginning with sample line 4. Sample lines 1 through 3 contain the new values for further processing by the application. Sample lines 14 through 16 from the last transfer cycle are no longer in the buffer.

9.1.13.8.5.2 Comparator oversampling

When using comparator oversampling, the results of the enabled channels are stored in the module within a configurable time frame independently of the X2X cycle. 16 bits of memory space are available per logical channel.

These samplings (i.e. event bits) are consecutively numbered from 1 to 8 and 9 to 16 for the two registers. The results of individual channels with the same number (i.e. sample line 1 to 16, e.g. for channel 1 LogicCh01Sample16_9 and LogicCh01Sample8_1) are derived from the same sampling cycle or logical computing cycle and therefore have the same timestamp.

The timestamp refers to the newest data value, i.e. always to sample line 1 (i.e. bit 0 in the LogicCh01Sample8_1 register). If a timestamp for older comparator results is needed, it needs to be back-calculated in the application using the sampling cycle time configured on the module. The prescaler must also be taken into account.

Calculation example

| Sample line | (register name) | Calculation | |
|-------------|-----------------------------|--------------------------------------|---------------------|
| 1 | (LogicCh01Sample8_1 bit 0) | Timestamp | Newest value |
| 2 | (LogicCh01Sample8_1 bit 1) | Timestamp - Sampling cycle time | |
| 3 | (LogicCh01Sample8_1 bit 2) | Timestamp - 2 * Sampling cycle time | |
| 4 | (LogicCh01Sample8_1 bit 3) | Timestamp - 3 * Sampling cycle time | |
| ... | | | |
| 10 | (LogicCh01Sample16_9 bit 1) | Timestamp - 9 * Sampling cycle time | |
| ... | | | |
| 16 | (LogicCh01Sample16_9 bit 7) | Timestamp - 15 * Sampling cycle time | Oldest value |

How the buffer is organized can be seen from this. This is not a FIFO buffer but a static buffer that the values are pushed through. Sample line 1 always contains the newest values, the next line the second newest, all the way up to sample line 16, which contains the oldest values.

The sample counter is a circular counter, with the number of new sample lines derived from the value of the last transfer cycle.

Example

A difference of 3 to the last transfer cycle means:

The comparator result in sample line 1 and all subsequent data from the previous transfer cycle is now shifted in the current cycle beginning with sample line 4. Sample lines 1 through 3 contain the new bit values for further processing by the application. Sample lines 14 through 16 from the last transfer cycle are no longer in the buffer.

Data transfer

The analog conversion rate / sampling cycle time can be considerably faster than the X2X Link cycle. Saved analog or comparator data can be transferred to the higher-level system synchronously and consistently.

In the application, it's important that the relationship between cyclic data points, the sampling cycle time on the module and the transfer time is sufficient to read all of the new data points on the higher-level system.

The sample counter can be used to check how many data values are actually new since the last transfer cycle. If the counter difference to the previous cycle is larger than the number of existing cyclic data points, then values have been overlooked and the system needs to be adjusted.

The general guideline is that a cyclic data point should be configured more than is actually required computing-wise.

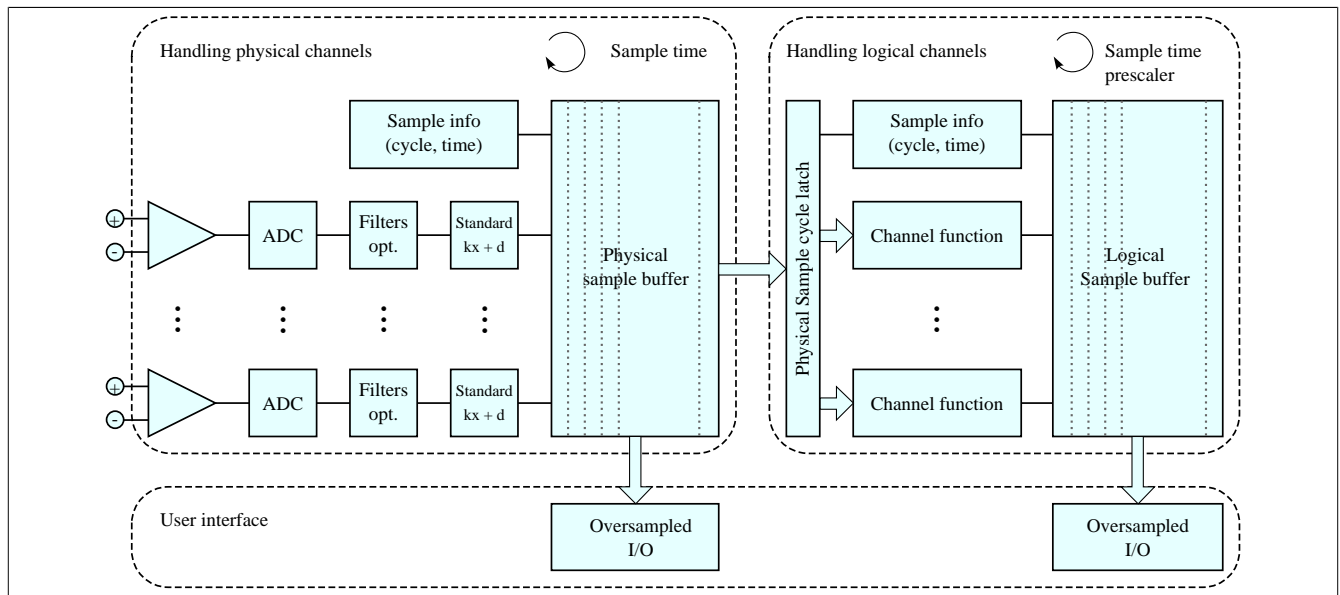
Example with synchronous settings

- Sampling cycle time = 50 μ s
- X2X Link cycle time = 500 μ s

Samples 1 to 10 of a channel are possible to calculate in this example. Sample 11 should also be configured as a cyclic data point, however.

The reason for this is the possible jitter in the module caused by interruptions, e.g. from the X2X Link transfer. For the current cycle, this can mean that only 9 new values are available and that 11 values will have to be transferred in the next cycle.

For logical comparator functions, this problem doesn't exist since the maximum number is always transferred in the cycle data range.



9.1.13.8.6 Bus controller operating mode

The input values are recorded with a configurable sampling cycle time and saved with timestamp to the internal physical data buffer. Only the newest value will be transferred in the next possible bus cycle.

Limitations in the bus controller function model:

- No oversampling function since consistency is not possible due to the limited data range
- Sampling cycle time configured to 100 µs by default
- Range of logical functions available for processing physical values directly on the module
- Timestamp not available

9.1.13.8.7 "AnalogInput" registers

Name:

AnalogInput01 to AnalogInput02

This module can be configured and operated as a normal analog input module without logical auxiliary functions. The physical values from the last sampling cycle are used as input values in this case.

The module is operated as a normal analog input module in the bus controller function model. Nevertheless, it is still possible to connect each input channel directly to a logical function. The analog data on the bus controller is mapped using the calculation abilities of the logical channels and configured automatically (see "[Operation in the bus controller function model](#)" on page 483).

Analog input values are displayed as signed 16-bit values depending on the configured operating mode.

| Data type | Value | Information |
|-----------|-------------------|------------------------------|
| INT | -32,768 to 32,767 | Voltage signal ±10 VDC |
| | 0 to 32,767 | Current signal 0 mA to 20 mA |

Information:

It is important to note that the oversampling function is not available in the bus controller function model due to the amount of data and lack of consistency!

9.1.13.8.8 Physical sampling

This module has a data buffer with 16 entries for each of the physical input channels. This buffer is processed according to the configured sampling cycle time.

A maximum of only 30 bytes is available for cyclic transfer on the X2X bus, however. Minus the status and sample counter, this allows only a selection of 14 samples (with a 16-bit data width) from the physical and logical buffer to be transferred.

Data loss can therefore occur with an imprecise selection and configuration.

Example

Displaying continuous sample lines.

- Sampling cycle time = 100 μ s
- X2X cycle time = 500 μ s

```
Sample line 1      PhysCh0xSample1
Sample line 2      PhysCh0xSample2
Sample line 3      PhysCh0xSample3
Sample line 4      PhysCh0xSample4
Sample line 5      PhysCh0xSample5
Sample line 6      PhysCh0xSample6
```

```
Difference SampleCount = 1  New value in sample line 1
Difference SampleCount = 2  New values in sample line 1 and sample line 2
...
Difference SampleCount = 5  New values in sample line 1 to sample line 5
```

Information:

It is important to note that the sample counter refers to the update of the sample lines in the data buffer and not to the number of values transferred cyclically.

Displaying each second sample line to bridge a higher recording duration:

- Sampling cycle time = 100 μ s
- X2X cycle time = 1000 μ s

```
Sample line 1      PhysCh0xSample1
Sample line 3      PhysCh0xSample3
Sample line 5      PhysCh0xSample5
Sample line 7      PhysCh0xSample7
Sample line 9      PhysCh0xSample9
Sample line 11     PhysCh0xSample11
```

```
Difference SampleCount = 1  New value in sample line 1
Difference SampleCount = 3  New values in sample line 1 and sample line 3
...
Difference SampleCount = 5  New values in sample line 1 to sample line 5
...
Difference SampleCount = 9  New values in sample line 1 to sample line 9
```

9.1.13.8.8.1 "PhysChSample" registers

Name:

PhysCh01Sample1 to PhysCh01Sample16

PhysCh02Sample1 to PhysCh02Sample16

These registers are the physical buffer registers of the analog channels. 16 registers are available for each channel. Sample 1 is the newest value; sample 16 is the oldest.

| Data type | Value | Information |
|-----------|-------------------|------------------------------|
| INT | -32,768 to 32,767 | Voltage signal \pm 10 VDC |
| | 0 to 32,767 | Current signal 0 mA to 20 mA |

9.1.13.8.8.2 "PhysSampleCount" register

Name:

PhysSampleCount

This register is an integer counter that is increased as soon as the module has saved a new physical sample line. The number of new sample lines is calculated from the difference to the previous cycle.

| Data type | Value |
|-----------|-------------------|
| SINT | -128 to 127 |
| INT | -32,768 to 32,767 |

9.1.13.8.8.3 "PhysTimestamp" register

Name:

PhysTimestamp

This register returns the timestamp of the values currently being determined as signed values in μs . This data point is the timestamp of the physical sample line 1.

| Data type | Value |
|-----------|---------------------------------|
| INT | -32768 to 32767 |
| DINT | -2,147,483,648 to 2,147,483,647 |

9.1.13.8.9 Logical sampling

The module has a data buffer with 16 entries for each of the 6 logical channels. This buffer is processed according to the configured sampling cycle time. In addition, it's also possible to adjust the logical execution cycle using a prescaler for the sampling cycle time.

A maximum of only 30 bytes is available for cyclic transfer on the X2X bus, however. Minus the status and sample counter, this allows only a selection of 14 samples (with a 16-bit data width) from the physical and logical buffer to be transferred. For the logical channels, it is also possible to configure a 32-bit data width. Data loss can therefore occur with an imprecise selection and configuration.

Example

Displaying continuous sample lines.

- Sampling cycle time = 100 μ s
- X2X cycle time = 500 μ s

```
Sample line 1      LogicCh0xSample1
Sample line 2      LogicCh0xSample2
Sample line 3      LogicCh0xSample3
Sample line 4      LogicCh0xSample4
Sample line 5      LogicCh0xSample5
Sample line 6      LogicCh0xSample6
```

```
Difference SampleCount = 1  New value in sample line 1
Difference SampleCount = 2  New values in sample line 1 and sample line 2
...
Difference SampleCount = 5  New values in sample line 1 to sample line 5
```

Information:

It is important to note that the sample counter refers to the update of the sample lines in the data buffer and not to the number of values transferred cyclically.

Displaying each second sample line to bridge a higher recording duration:

- Sampling cycle time = 100 μ s
- X2X cycle time = 1000 μ s

```
Sample line 1      LogicCh0xSample1
Sample line 3      LogicCh0xSample3
Sample line 5      LogicCh0xSample5
Sample line 7      LogicCh0xSample7
Sample line 9      LogicCh0xSample9
Sample line 11     LogicCh0xSample11
```

```
Difference SampleCount = 1  New value in sample line 1
Difference SampleCount = 3  New values in sample line 1 and sample line 3
...
Difference SampleCount = 5  New values in sample line 1 to sample line 5
...
Difference SampleCount = 9  New values in sample line 1 to sample line 9
```

9.1.13.8.9.1 "LogicChSample" registers

Name:

LogicCh01Sample1 to LogicCh01Sample16

...

LogicCh06Sample1 to LogicCh06Sample16

These registers are the buffer registers of the logical input channels. 16 registers are available for each channel. Sample 1 is the newest value; sample 16 is the oldest.

Calculated values are displayed as signed 16- or 32-bit values depending on the register being used.

| Data type | Value |
|-----------|---------------------------------|
| INT | -32768 to 32767 |
| DINT | -2,147,483,648 to 2,147,483,647 |

9.1.13.8.9.2 "LogicChSample16_9" registers

Name:

LogicCh01Sample16_9 to LogicCh06Sample16_9

These registers are used to represent the results of samples 9 to 16 of the logical digital comparator for the logical channels. Each of these bits corresponds to a sample line, with sample 9 the newest and Sample 16 the oldest comparator comparison. The results of samples 1 to 8 are represented in register "[LogicChSample8_1](#)" on page 474.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------------|-------|-------------|
| 0 | Comparator result | x | Sample 9 |
| ... | ... | | |
| 7 | Comparator result | x | Sample 16 |

9.1.13.8.9.3 "LogicChSample8_1" registers

Name:

LogicCh01Sample8_1 to LogicCh06Sample8_1

These registers are used to represent the results of samples 1 to 8 of the logical digital comparator for the logical channels. Each of these bits corresponds to a sample line, with sample 1 the newest and Sample 8 the oldest comparator comparison. The results of samples 9 to 16 are represented in register "[LogicSample16_9](#)" on page 474.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------------|-------|-------------|
| 0 | Comparator result | x | Sample 1 |
| ... | ... | | |
| 7 | Comparator result | x | Sample 8 |

9.1.13.8.9.4 "LogicSampleCount" register

Name:

LogicSampleCount

This register is an integer counter that is increased as soon as the module has saved a new logical sample line. The number of new sample lines is calculated from the difference to the previous cycle.

| Data type | Value |
|-----------|-------------------|
| SINT | -128 to 127 |
| INT | -32,768 to 32,767 |

9.1.13.8.9.5 "LogicTimestamp" register

Name:

LogicTimestamp

This register returns the timestamp of the values currently being determined as signed 2 or 4-byte values in μ s. This data point is the timestamp of the logical sample line 1.

| Data type | Value |
|-----------|---------------------------------|
| INT | -32768 to 32767 |
| DINT | -2,147,483,648 to 2,147,483,647 |

9.1.13.8.10 System configuration

The following registers are used to configure the module's system settings.

9.1.13.8.10.1 Register "CfO_BaseConfig"

Name:

CfO_BaseConfig

This register can be used to configure settings for handling logical oversampling and data acquisition.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 49 |

Bit structure:

| Bit | Description | Value | Information |
|-------|---|-------|--|
| 0 | "Display configuration for logical values active/inactive" in the Automation Studio I/O configuration | 0 | Inactive |
| | | 1 | Active (bus controller default setting) |
| 1 | "Logical handling priority" in the Automation Studio I/O configuration | 0 | Low (bus controller default setting) |
| | | 1 | High |
| 2 - 3 | Reserved | - | |
| 4 | "Physical input mode" in the Automation Studio I/O configuration | 0 | Newest value |
| | | 1 | Referenced value (reference = prescaled system timer) (bus controller default setting) |
| 5 | "Logical input mode" in the Automation Studio I/O configuration | 0 | Newest value |
| | | 1 | Referenced value (reference = prescaled system timer) (bus controller default setting) |
| 6 - 7 | Reserved | - | |

Priority of logical oversampling

- Low priority setting
Logical and physical buffers are not processed in the same context. If the calculation time that results in the logical oversampling is higher than the configured sampling cycle time, this setting and a prescaler > 1 can be used to split up the logical processing over several sampling cycles. In this way, the sample lines of the physical and logical oversampling are not automatically acquired or calculated at the same point in time. If the prescaler is configured incorrectly, the logical oversampling cannot be processed successfully.
- High priority setting
Logical and physical buffers are processed in the same context. The sample lines of the physical and logical oversampling are acquired and calculated at the same point in time. It must be possible to execute all configured functions in the configured sampling cycle time; otherwise, a cycle time violation will occur and the configuration must be changed accordingly. Configuring the logical prescaler doesn't have any effect here; only the data traffic in the logical oversampling is limited.

Current or referenced values for logical or physical oversampling

In a system being used to capacity, jitter in the sampling cycle on the module can also be caused by the necessary processing of functions (X2X Link operation, logical and physical oversampling) when the cycle time is set to synchronous. This results in a varying number of sample lines in the same time period. For this reason, more samples should also be configured in the cyclic image than are actually necessary to compute.

- Current values setting
Passing on the sample lines to the higher-level system takes place as quickly as possible, with fewer or more sample lines possibly occurring.
- Referenced values setting
This setting minimizes jitter and makes it possible to expect a constant number of new sample lines per cycle when configured optimally. With regard to response time, however, delays of several sampling cycles may occur.

9.1.13.8.10.2 Register "CfO_CycleTime"

Name:

CfO_CycleTime

"Physical sample time" in the Automation Studio I/O configuration.

This register configures the module's sampling cycle time. The format is a 16.16-bit unsigned 4-byte value, with the high word representing the integer part of the μs value and the low word the decimal places. The decimal places allow a closer alignment to the X2X cycle time. The absolute resolution is 1 μs .

Input value = Time in μs * 65536 data type

| Data type | Value | Information |
|-----------|----------------------------|---|
| UDINT | 2,621,440 to 2,147,483,647 | 40 μs to 32 ms sampling cycle time. Bus controller default setting: 6,553,600 = 100 μs |

9.1.13.8.10.3 Register "CfO_Prescaler"

Name:

CfO_Prescaler

This register contains the prescaler for configuring the logical channel processing time. The actual logical cycle time will be calculated from the multiple of the sampling cycle time that is defined here. If a very short sampling cycle time is required for physical samples, then the module load can be reduced using the second time base for the logical samples.

| Data type | Value | Information |
|-----------|---------|--|
| UINT | 1 to 10 | Multiples of the physical sampling cycle for logical processing Bus controller default setting: 2 |

9.1.13.8.10.4 Register "CfO_SyncOffset"

Name:

CfO_SyncOffset

"Synchronization offset" in the Automation Studio I/O configuration.

The system cycle can be offset in 1 μs steps in this register.

| Data type | Value | Information |
|-----------|-------------------|--|
| UINT | -32,768 to 32,767 | Synchronization offset in μs . Bus controller default setting: 0 |

9.1.13.8.11 Scaling

Analog input channels are naturally aligned and normalized when delivered (gain = k, offset = d). In addition, user-defined normalization is also available (gain = k_u , offset = d_u). The calculation is optimized by grouping the factors together.

Normalization calculation:

$$\text{nom} = k * \text{RawValue} + d$$

$$k = k * k_u$$

$$d = k * d + d_u$$

The values calculated here are limited to 16 bits.

9.1.13.8.11.1 "CfO_UserGainCh" registers

Name:

CfO_UserGainCh01 to CfO_UserGainCh02

"Configuration channel 0x / gain" in the Automation Studio I/O configuration

These registers are used to configure the gain for the respective channel. The format is a 16.16-bit signed 4-byte value, with the high word the integer part and the low word the decimal places.

Input value = Gain k_u * 65536

Value 65,535 corresponds to a gain of 1.

| Data type | Value | Information |
|-----------|------------------------------------|---|
| DINT | -2,147,483,648 to 2,147,483,647 | Gain. Bus controller default setting: 65,535 |

9.1.13.8.11.2 "CfO_UserOffsetCh" registers

Name:

CfO_UserOffsetCh01 to CfO_UserOffsetCh02

"Configuration channel 0x / offset" in the Automation Studio I/O configuration

These registers are used to configure the offset for the respective channel. The format is a 16.16-bit signed 4-byte value, with the high word the integer part and the low word the decimal places.

Input value = Offset du * 65536

Value 65536 corresponds to an offset of 1.

| Data type | Value | Information |
|-----------|------------------------------------|--|
| DINT | -2,147,483,648 to 2,147,483,647 | Offset. Bus controller default setting: 0 |

9.1.13.8.12 Input filter

This module is equipped with an individually configurable input filter for each channel. The following filters can be selected:

- 1st-order low pass
- 2nd-order low pass
- 2nd-order IIR

The cutoff frequency can be configured for the 1st-order and 2nd-order low pass filters. The coefficients Alpha0, Alpha1, Alpha2, Beta1 and Beta2 must be configured for the IIR filter.

9.1.13.8.12.1 "CfO_AlphaCh" and "CfO_BetaCh" registers

Name:

CfO_Alpha0Ch01 to CfO_Alpha0Ch02

CfO_Alpha1Ch01 to CfO_Alpha1Ch02

CfO_Alpha2Ch01 to CfO_Alpha2Ch02

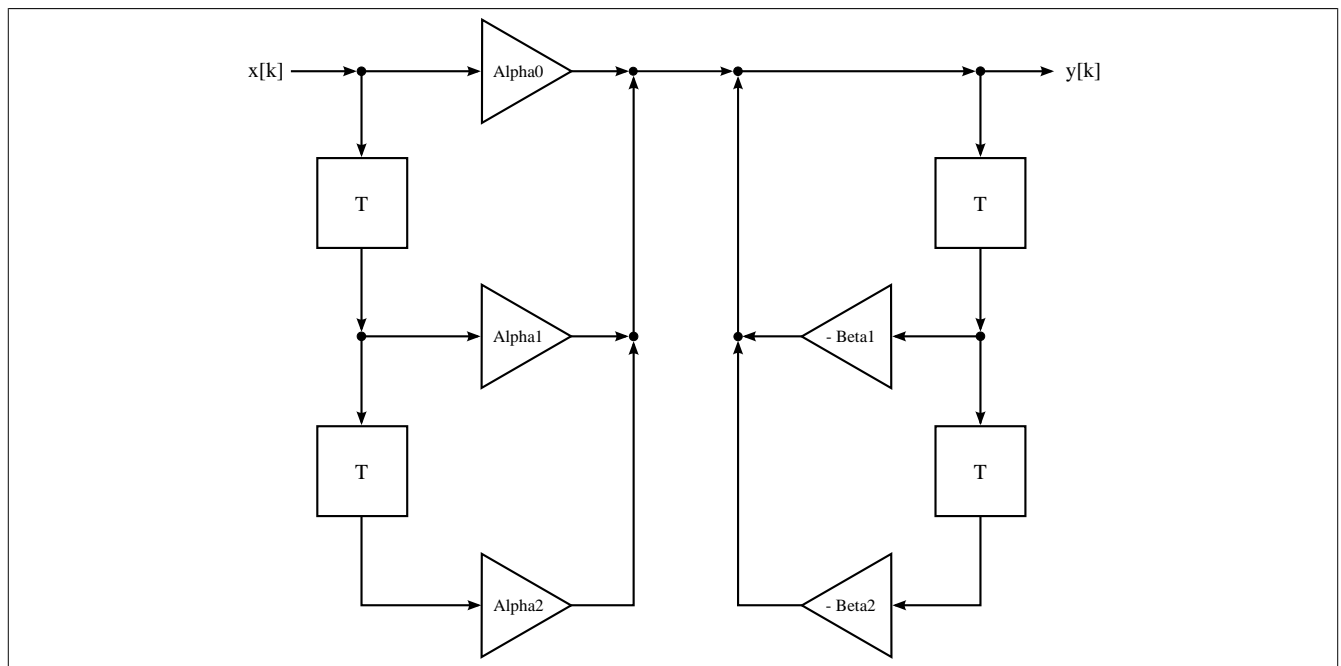
CfO_Beta1Ch01 to CfO_Beta1Ch02

CfO_Beta1Ch01 to CfO_Beta1Ch02

These registers set the coefficients for the IIR filter.

Image as a z-transfer function

The second-order z-transfer function is specified in coefficient form (denominator polynomial Beta1, Beta2 and numerator polynomial Alpha0, Alpha1, Alpha2). The transfer method is calculated with the sampling cycle time.



| Data type | Values | Information |
|-----------|------------------------------------|--|
| DINT | -2,147,483,648 to 2,147,483,647 | IIR filter coefficient. Bus controller default setting: 0 |

9.1.13.8.12.2 "CfO_CutOffFrequCh" register

Name:

CfO_CutOffFrequCh01 to CfO_CutOffFrequCh02

These registers are used to configure the limit frequency in hertz for a 1st- or 2nd-order low pass for the corresponding channel.

| Data type | Value | Information |
|-----------|------------|---|
| UINT | 0 to 65535 | Cutoff frequency for 1st- or 2nd-order low pass [Hz]. Bus controller default setting: 1000 |

9.1.13.8.13 Physical configuration

9.1.13.8.13.1 "CfO_ModeCh" registers

Name:

CfO_ModeCh01 to CfO_ModeCh02

The operating mode for each physical channel can be configured in this register.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 256 |

Bit structure:

| Bit | Description | Value | Information |
|---------|---|------------|--|
| 0 - 2 | Connection configuration This value must be set the same for each register! | 000 | Voltage signal (bus controller default setting) |
| | | 111 | Current signal |
| 3 - 7 | Reserved | 0 | |
| 8 - 10 | Operating mode | 000 | Channel disabled |
| | | 001 | No filtering (bus controller default setting) |
| | | 010 | 2nd-order IIR (configurable Alpha and Beta coefficients) |
| | | 011 | 1st-order low pass (configurable limit frequency) |
| | | 100 | 2nd-order low pass (configurable limit frequency) |
| | | 101 to 111 | Reserved |
| 11 - 15 | Reserved | 0 | |

9.1.13.8.14 Logical configuration

9.1.13.8.14.1 Operation in the standard function model

6 logical channels are available on the module. Each channel can be configured with one of the following functions:

- ["Addition of two channels with scaling" on page 479](#)
- ["Integral addition of two channels with scaling" on page 480](#)
- ["Multiplication of two channels with scaling" on page 481](#)
- ["Integral multiplication of two channels with scaling" on page 482](#)
- ["Comparator function of two channels" on page 482](#)
- ["Hysteresis comparator of one channel " on page 482](#)

With logical oversampling, 32-bit data points are available in addition to 16-bit data points due to the possible calculated results. The Automation Studio I/O configuration or data point mapping can be opened to select which one to use.

If there is no need to use 32-bit data points, or if this would lead to too large of a limitation in the number of data points, scaling can be used to limit the range to 16 bits.

The buffer depth for the digital comparator is also able to handle 16 results. Since these are Boolean results, these 16 bits are compressed into 2-byte data points and transferred that way.

Addition

This function can be used to determine the sum or difference of two channels. To determine the difference, negative scaling must be configured for the channel.

Calculation

Sample line = (Channel 1 * Scaling 1) + (Channel 2 * Scaling 2)

The addition calculation is handled internally as a 32-bit value in 16.16 format; the data from the source channels is evaluated as integers (applied to the high word), with decimal places possible as a result of scaling. When displayed as a logical 32-bit result, these decimal places are visible. When displayed as a 16-bit value, only the integral high word is used.

Example

Channel 1 = 2000

Channel 2 = 1000

Both scalings = 1

Results

$3000.x = (2000.x * 1.0) + (1000.x * 1.0)$

32-bit representation = 196608000 = 0xBB80000

16-bit representation = 3000 = 0xBB8

Information:

The maximum value for channels 1 and 2 can only be 32767; otherwise, an additional overflow occurs. If values greater than 32767 are possible, the range of values must be limited with scaling.

Integral of addition

This function can be used in the application to establish the average value of the channels or to calculate the deviation/difference between two channels over n samples. In each cycle, the channels are added together first; then the result is added to the previous value and saved in the current sample line. Depending on the result data type being used (16-bit or 32-bit), eventually the continuous integration will cause the calculation to overflow after n samples. Because of the signed result value, it must be ensured that the number n of samples is chosen small enough so that calculating the integral component is less than half the range of values. If this is done, determining the average value can be carried out despite an overflow.

Calculation

Result: Sample line = Integral ((Channel 1 * Scaling 1) + (Channel 2 * Scaling 2))

The addition calculation is handled internally as a 32-bit value in 16.16 format; the data from the source channels is evaluated as integers (applied to the high word), with decimal places possible as a result of scaling. When displayed as a logical 32-bit result, these decimal places are visible. When displayed as a 16-bit value, only the integral high word is used.

Example

Channel 1 = 2000

Channel 2 = 1000

Both scalings = 1

Results

$3000.x = (2000.x * 1.0) + (1000.x * 1.0)$

32-bit representation = 196608000 = 0xBB80000.

16-bit representation = 3000 = 0xBB8

The average value can now be calculated as follows:

n = Number of samples / sample lines

$Value_x$ = Value from sample line x → Newer value

$Value_{(x-n)}$ = Value from sample line $x-n$ → Older value, n samples back

Average value = $(Value_x - Value_{(x-n)}) / n$

Information:

The maximum value for channels 1 and 2 can only be 32767; otherwise, an additional overflow occurs. If values greater than 32767 are possible, the range of values must be limited with scaling.

Multiplication

This function can be used to calculate the current effective power $P = U * I$.

Calculation

Sample line = Channel 1 * Channel 2 * Scaling

Multiplication is calculated internally as a 32-bit value; the 16-bit data from the source channels is passed to the low word. When displayed as a logical 32-bit value, the entire result is visible (no multiplication overflow possible when scaling ≤ 1). When displayed as a 16-bit value, only the high word is used. Though there is a loss of precision, the 16-bit values allow more data points to be transferred.

Example

Channel 1 = 2000

Channel 2 = 1000

Scaling = 1

Results

2000000 = (2000 * 1000 * 1.0)

32-bit representation = 2000000 = 0x1E8480

16-bit representation = 30 = 0x1E

Information:

If more precision is needed with the 16-bit value, scaling in steps of 2^n (... , *128, *256, ...) can be employed to shift the bits. Of course, it's important again that the input values of the source channels be limited; otherwise, an overflow will occur in the multiplication operation.

Integral of multiplication

This function can be used in the application to establish the average value of the effective power. In each cycle, the channels are multiplied together first; then the result is added to the previous value and saved in the current sample line. Depending on the result data type being used (16-bit or 32-bit), eventually the continuous integration will cause the calculation to overflow after n samples. Because the result value is signed, it is important to set the number n of samples small enough so that the integration is less than half of the value range. If this is done, determining the average value can be carried out despite an overflow.

Calculation

Sample line = Integral (Channel 1 * Channel 2 * Scaling)

Multiplication is calculated internally as a 32-bit value; the 16-bit data from the source channels is passed to the low word. When displayed as a logical 32-bit value, the entire result is visible (no multiplication overflow possible when scaling ≤ 1). When displayed as a 16-bit value, only the high word is used. Though there is a loss of precision, the 16-bit values allow more data points to be transferred.

Example

Channel 1 = 2000

Channel 2 = 1000

Scaling = 1

Results

2000000 = (2000 * 1000 * 1.0)

32-bit representation = 2000000 = 0x1E8480

16-bit representation = 30 = 0x1E

The average value can now be calculated as follows:

n = Number of samples / sample lines

Value _{x} = Value from sample line x → Newer value

Value _{x} = Value from sample line x → Older value, n samples back

Average value = (Value _{x} - Value_($x-n$)) / n

Information:

If more precision is needed with the 16-bit value, scaling in steps of 2^n (... , *128, *256, ...) can be employed to shift the bits. Of course, it's important again that the input values of the source channels be limited; otherwise, an overflow will occur in the multiplication operation.

Channel comparator

This function can be used to compare channel values. The following applies:

- Channel 1 > Channel 2 = 1
- Channel 1 < Channel 2 = 0
- Channel 1 = Channel 2 = State before values are the same

Calculation

Sample line (bit) = Comparison (channel value 1 with channel value 2)

Hysteresis comparator

This function can be used to monitor range violations by channels. The following applies:

- Channel > Upper threshold value = 1
- Channel < Lower threshold value = 0
- Channel within threshold = Value before occurrence

Calculation

Sample line (bit) = Comparison (channel value with lower threshold value) and (channel value with upper threshold value))

9.1.13.8.14.2 Operation in the bus controller function model

When used on the bus controller, there are 4 logical functions available for each of the analog input channels in addition to the physical value output. Each channel can be configured with one of the following functions:

- "Output of physical values" on page 483 (default setting)
- "Addition of two channels with scaling" on page 479
- "Integral addition of two channels with scaling" on page 480
- "Multiplication of two channels with scaling" on page 481
- "Integral multiplication of two channels with scaling" on page 482
- "Comparator function of two channels" on page 482
- "Hysteresis comparator of one channel " on page 482

In contrast to the standard function model, oversampling and the two digital comparators are not supported. As a result, there is only one newly generated value per channel in each update cycle. Another difference is that there are only 4 logical calculation channels instead of 6.

The logical functions addition, integral of addition, multiplication and integral of multiplication do not differ from the standard function model in their configuration and function when operating on the bus controller.

Physical value display

The physical value display in the bus controller function model is initialized automatically and represents a special form of the logical function "Addition" with defined scaling factors.

Calculation

Result = Channel value

Formula used for addition: $\text{Result} = (\text{Channel value } 1 * 1) + (\text{Channel value } 2 * 0)$

Information:

In this function model, only the 4 physical input channels are available, and the scaling factors have defined values.

9.1.13.8.14.3 "CfO_LogChMode" register

Name:

CfO_LogCh01Mode to CfO_LogCh06Mode

"Logical configuration channel 0x / Addition" in the Automation Studio I/O configuration.

"Logical configuration channel 0x / Integral of addition" in the Automation Studio I/O configuration.

"Logical configuration channel 0x / Multiplication" in the Automation Studio I/O configuration.

"Logical configuration channel 0x / Integral of multiplication" in the Automation Studio I/O configuration.

"Logical configuration channel 0x / Channel comparator" in the Automation Studio I/O configuration.

"Logical configuration channel 0x / Hysteresis comparator" in the Automation Studio I/O configuration.

"Logical configuration channel 0x / Physical value display" in the Automation Studio I/O configuration.

The operating mode for each logical channel can be configured in this register.

The selection of the sources to be used for each logical channel is made using the register "CfO_LogCh0NSource0x" on page 484. Any additionally needed function parameters are configured in the "CfO_LogCh0NFuncPar0x" on page 485 registers. "N" stands for the logical channel to be used, while "x" stands for either the source or function 0 or 1.

The following links can be made:

- Addition: Result = (Source 0 * Function parameter 0) + (Source 1 * Function parameter 1)
- Integral of addition: Result = Σ (Source 0 * Function parameter 0) + (Source 1 * Function parameter 1)
- Multiplication: Result = Source 0 * Source 1 * Function parameter 0
- Integral of multiplication: Result = Σ (Source 0 * Source 1 * Function parameter 0)
- Channel comparator: Result = Comparison of source 0 with source 1
- Hysteresis comparator: Result = comparison of source 0 with (Lower threshold value = Function parameter 0) and (Upper threshold value = Function parameter 1)
- Physical value display: Result = (Source 0 * 1) + (Source 1 * 0)

| Data type | Value | Information |
|-----------|-------|--|
| UINT | 0 | Channel switched off. Bus controller default setting: Channel 3 to 6 |
| | 256 | Addition or physical value display ¹⁾ . Bus controller default setting: Channel 1 to 2 |
| | 257 | Integral of addition |
| | 512 | Multiplication |
| | 513 | Integral of multiplication |
| | 768 | Channel comparator |
| | 1024 | Hysteresis comparator |

1) Only registers CfO_LogCh01Mode to CfO_LogCh02Mode are used for physical value display.

9.1.13.8.14.4 "CfO_LogChSource" register

Name:

CfO_LogCh01Source00 to CfO_LogCh06Source00

CfO_LogCh01Source01 to CfO_LogCh06Source01

These registers can be used to select the source registers for the operating mode of the logical channel configured in the register "CfO_LogCh0NMode" on page 484.

In the name, "Source00" stands for source register 0; "Source01" stands for source register 1.

In **Physical value display** mode, the same channel number is written to both source registers.

| Data type | Value | Information |
|-----------|-------|--|
| USINT | 0 | Physical channel 01. Bus controller default setting ¹⁾ |
| | 1 | Physical channel 02. Bus controller default setting ¹⁾ |
| | 8 | Logical channel 01 ¹⁾ |
| | ... | ... |
| | 13 | Logical channel 06 |

1) **Values**

Channel 1: 0
Channel 2: 1
Channels 3 to 6: 0

2) Logical channels cannot be used in the bus controller function model.

9.1.13.8.14.5 "CfO_LogChFuncPar" register

Name:

CfO_LogCh01FuncPar00 to CfO_LogCh06FuncPar00

CfO_LogCh01FuncPar01 to CfO_LogCh06FuncPar01

These registers can be used to configure additional function parameters for the operating mode of the logical channel configured in the register "CfO_LogCh0NMode" on page 484.

The effect of the function parameters is different depending on the operating mode.

| Operating mode | Parameter 1 | Parameter 2 |
|------------------------------|---------------------------------|----------------------------|
| (Integral of) addition | Scaling factor | Scaling factor |
| (Integral of) multiplication | Scaling factor | - |
| Channel comparator | - | - |
| Hysteresis comparator | Upper threshold value | Lower threshold value |
| Output of physical values | Defined scaling factor = 65,536 | Defined scaling factor = 0 |

Value 65,536 corresponds to scaling or a threshold value of 1.

| Data type | Value | Information |
|-----------|--------------------|--|
| UDINT | 0 to 4,294,967,295 | Scaling factor or threshold value. Bus controller default setting: <u>Register "...FuncPar00"</u> Channels 1 to 4 65536 Channels 5 to 6 0 <u>Register "...FuncPar01"</u> All 0 |

9.1.13.8.15 Error registers

The registers for displaying and acknowledging errors are transferred either cyclically or acyclically depending on the function model.

9.1.13.8.15.1 "CfO_ErrorID1017" register

Name:

CfO_ErrorID1017

Automatic enabling by the Automation Studio I/O configuration.

This register can be used to enable standard error messages. The channels' composite errors are derived from the individual extended error status, e.g. overflow/underflow of the input range for the analog value. Oversampling error statuses result from a cycle time violation of the configured sampling cycle time.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 63 |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------------|-------|---|
| 0 | Composite errors on channel 01 | 0 | Error generation disabled |
| | | 1 | Error generation enabled (bus controller default setting) |
| 1 | Composite errors on channel 02 | 0 | Error generation disabled |
| | | 1 | Error generation enabled (bus controller default setting) |
| 2 - 3 | Reserved | 0 | |
| 4 | Physical sample error status | 0 | Error generation disabled |
| | | 1 | Error generation enabled (bus controller default setting) |
| 5 | Logical sample error status | 0 | Error generation disabled |
| | | 1 | Error generation enabled (bus controller default setting) |
| 6 - 7 | Reserved | 0 | |

9.1.13.8.15.2 "CfO_ErrorID0x0x" register

Name:

CfO_ErrorID0007

Automatic enabling in the Automation Studio I/O configuration by selecting "Extended error status information" and channel activation.

This register can be used to enable extended error messages for analog channels 1 and 2. Meaning of individual bits:

- **Range exceeded violation (pos.):** The analog input signal is outside of the specified working range.
- **Filter error:** The configured filter theorem cannot be calculated (parameter error).
- **Underflow:** The input signal is less than the lower limit value.
- **Overflow:** The input signal is greater than the upper limit value.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-----|--|-------|--|
| 0 | Channel 1: Range exceeded violation (pos.) | 0 | Error generation disabled (bus controller default setting) |
| | | 1 | Range exceeded violation (pos.) enabled |
| 1 | Channel 1: Filter error | 0 | Error generation disabled (bus controller default setting) |
| | | 1 | Filter error enabled |
| 2 | Channel 1: Underflow | 0 | Error generation disabled (bus controller default setting) |
| | | 1 | Underflow enabled |
| 3 | Channel 1: Overrun | 0 | Error generation disabled (bus controller default setting) |
| | | 1 | Overflow enabled |
| 4 | Channel 2: Range exceeded violation (pos.) | 0 | Error generation disabled (bus controller default setting) |
| | | 1 | Range exceeded violation (pos.) enabled |
| 5 | Channel 2: Filter error | 0 | Error generation disabled (bus controller default setting) |
| | | 1 | Filter error enabled |
| 6 | Channel 2: Underflow | 0 | Error generation disabled (bus controller default setting) |
| | | 1 | Underflow enabled |
| 7 | Channel 2: Overrun | 0 | Error generation disabled (bus controller default setting) |
| | | 1 | Overflow enabled |

9.1.13.8.15.3 "StandardErrors" registers

Name:

Channel01Error to Channel02Error

PhysicalError

LogicalError

Composite errors are mapped to this register.

All configured functions of the physical and logical oversampling must be able to be carried out in the configured sampling cycle time; otherwise, these error messages occur. Settings for processing priority and the prescaler can be used to additionally adjust the system for logical oversampling.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------|-------|--|
| 0 | Channel01Error | 0 | No error |
| | | 1 | Composite errors on channel 1 |
| 1 | Channel02Error | 0 | No error |
| | | 1 | Composite errors on channel 2 |
| 2 - 3 | Reserved | 0 | |
| 4 | PhysicalError | 0 | No error |
| | | 1 | Physical sample error status, sampling cycle time too short |
| 5 | LogicalError | 0 | No error |
| | | 1 | Logical sample error status, sampling cycle time too short or prescaler configured too low |
| 6 - 7 | Reserved | 0 | |

9.1.13.8.15.4 "AcknowledgeStandardErrors" registers

Name:

AckChannel01Error to AckChannel02Error

AckPhysicalError

AckLogicalError

Error messages from the "Standard errors" on page 486 register can be acknowledged by setting the corresponding bits in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------------|-------|-------------------|
| 0 | AckChannel01Error | 0 | No change |
| | | 1 | Acknowledge error |
| 1 | AckChannel02Error | 0 | No change |
| | | 1 | Acknowledge error |
| 2 - 3 | Reserved | 0 | |
| 4 | AckPhysicalError | 0 | No change |
| | | 1 | Acknowledge error |
| 5 | AckLogicalError | 0 | No change |
| | | 1 | Acknowledge error |
| 6 - 7 | Reserved | 0 | |

9.1.13.8.15.5 "ExtendedChannelErrorMessages" registers

Name:

Channel01OutOfRange to Channel02OutOfRange

Channel01FilterError to Channel02FilterError

Channel01Underflow to Channel02Underflow

Channel01Overflow to Channel02Overflow

The error states of input channels 1 and 2 are represented in these registers.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|----------------------|-------|--|
| 0 | Channel01OutOfRange | 0 | No error |
| | | 1 | Range exceeded violation (pos.) occurred |
| 1 | Channel01FilterError | 0 | No error |
| | | 1 | Filter error occurred |
| 2 | Channel01Underflow | 0 | No error |
| | | 1 | Underflow occurred |
| 3 | Channel01Overflow | 0 | No error |
| | | 1 | Overflow occurred |
| 4 | Channel02OutOfRange | 0 | No error |
| | | 1 | Range exceeded violation (pos.) occurred |
| 5 | Channel02FilterError | 0 | No error |
| | | 1 | Filter error occurred |
| 6 | Channel02Underflow | 0 | No error |
| | | 1 | Underflow occurred |
| 7 | Channel02Overflow | 0 | No error |
| | | 1 | Overflow occurred |

9.1.13.8.15.6 "AcknowledgeExtendedChannelErrorMessages" registers

Name:

AckChannel01OutOfRange to AckChannel02OutOfRange

AckChannel01FilterError to AckChannel02FilterError

AckChannel01Underflow to AckChannel02Underflow

AckChannel01Overflow to AckChannel02Overflow

These registers can be used to acknowledge the error messages from the "ExtendedChannelErrorMessages" on [page 487](#) registers by setting the corresponding bit.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------------------|-------|-------------------|
| 0 | AckChannel01OutOfRange | 0 | No change |
| | | 1 | Acknowledge error |
| 1 | AckChannel01FilterError | 0 | No change |
| | | 1 | Acknowledge error |
| 2 | AckChannel01Underflow | 0 | No change |
| | | 1 | Acknowledge error |
| 3 | AckChannel01Overflow | 0 | No change |
| | | 1 | Acknowledge error |
| 4 | AckChannel02OutOfRange | 0 | No change |
| | | 1 | Acknowledge error |
| 5 | AckChannel02FilterError | 0 | No change |
| | | 1 | Acknowledge error |
| 6 | AckChannel02Underflow | 0 | No change |
| | | 1 | Acknowledge error |
| 7 | AckChannel02Overflow | 0 | No change |
| | | 1 | Acknowledge error |

9.1.13.8.16 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μ s |

9.1.13.8.17 Minimum I/O update time

There is no limitation or dependency on the bus cycle time.

The I/O update time is defined using the "Sampling time" register. The fastest possible sampling time depends on the number of channels to be converted and the configuration.

9.1.14 X20AI4222

Data sheet version: 1.21

9.1.14.1 General information

The module is equipped with 4 inputs with 13-bit (including sign) digital converter resolution. It can be used to capture voltage signals in the range from ± 10 V.

- 4 analog inputs ± 10 V
- 13-bit digital converter resolution

9.1.14.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| X20AI4222 | X20 analog input module, 4 inputs, ± 10 V, 13-bit converter resolution, configurable input filter |  |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |

Table 66: X20AI4222 - Order data

9.1.14.3 Technical data

| | |
|--|--|
| Model number | X20AI4222 |
| Short description | |
| I/O module | 4 analog inputs ± 10 V |
| General information | |
| B&R ID code | 0xCAB1 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Inputs | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.1 W ¹⁾ |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Analog inputs | |
| Input | ± 10 V |
| Input type | Differential input |
| Digital converter resolution | ± 12 -bit |
| Conversion time | 400 μ s for all inputs |
| Output format | |
| Data type | INT |
| Voltage | 0x8001 - 0x7FFF / 1 LSB = 0x0008 = 2.441 mV |
| Input impedance in signal range | 20 M Ω |
| Input protection | Protection against wiring with supply voltage |
| Permissible input signal | Max. ± 30 V |
| Output of digital value during overload | Configurable |
| Conversion procedure | SAR |
| Input filter | 3rd-order low pass / cutoff frequency 1 kHz |
| Max. error at 25°C | |
| Gain | 0.08% ²⁾ |
| Offset | 0.015% ³⁾ |
| Max. gain drift | 0.006 %/°C ²⁾ |
| Max. offset drift | 0.002 %/°C ³⁾ |
| Common-mode rejection | |
| DC | 70 dB |
| 50 Hz | 70 dB |
| Common-mode range | ± 12 V |
| Crosstalk between channels | -70 dB |
| Nonlinearity | <0.025% ³⁾ |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |

Table 67: X20AI4222 - Technical data


| Model number | X20AI4222 |
|---------------------------------|--|
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 67: X20AI4222 - Technical data

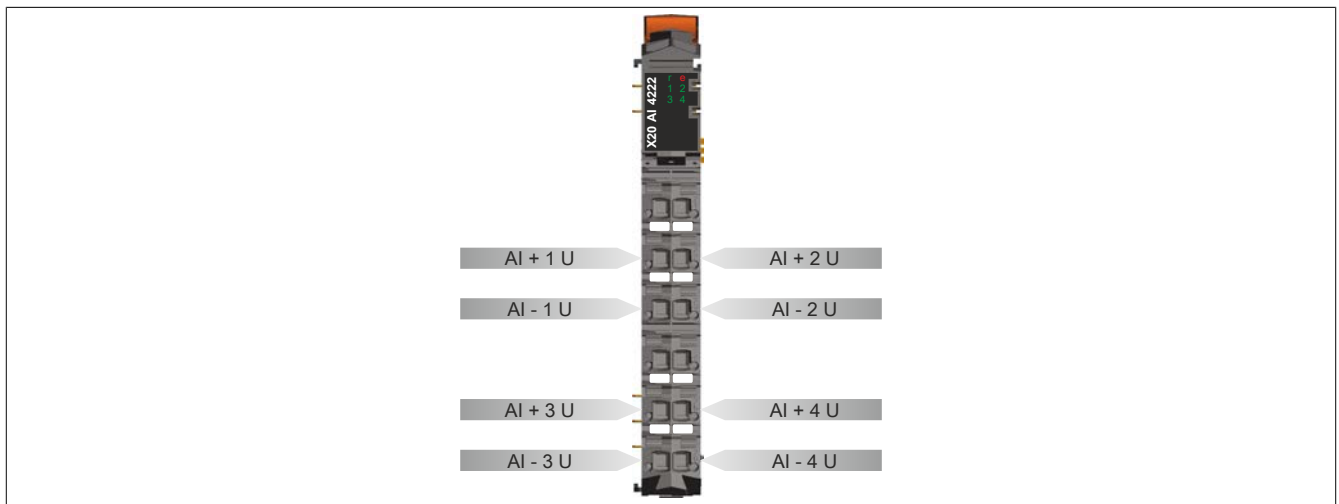
- 1) To reduce power dissipation, B&R recommends bridging unused inputs on the terminals.
- 2) Based on the current measured value.
- 3) Based on the 20 V measurement range.

9.1.14.4 LED status indicators

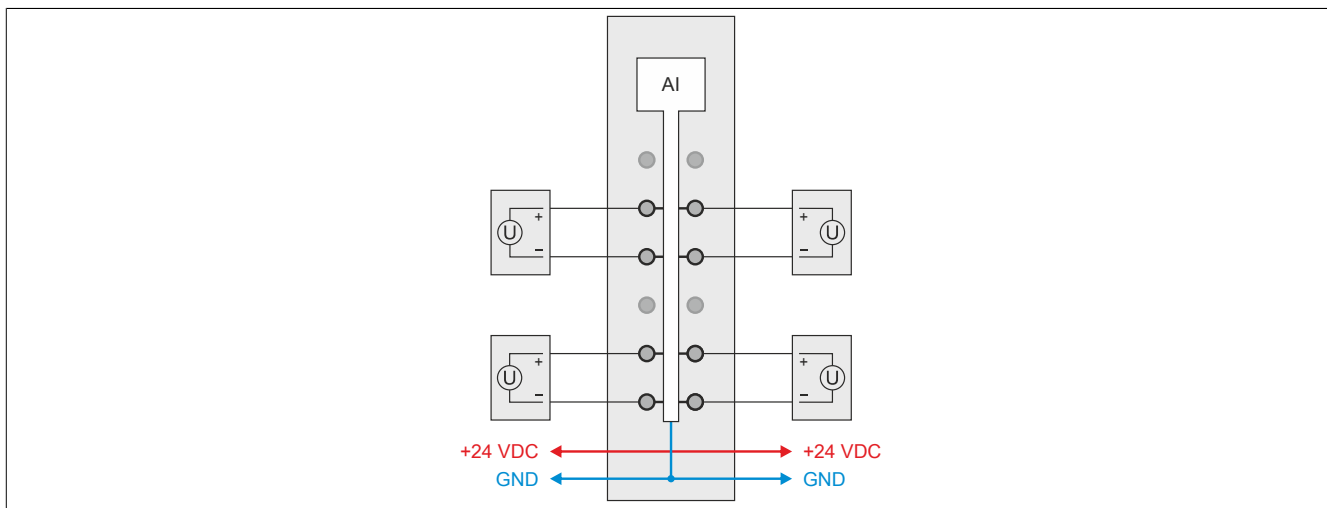
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|--|-------|-------|-----------------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | e + r | | Red on / Green single flash | Invalid firmware |
| | 1 - 4 | Green | Off | Open line or sensor is disconnected |
| | | | Blinking | Input signal overflow or underflow |
| | | | On | Analog/digital converter running, value OK |

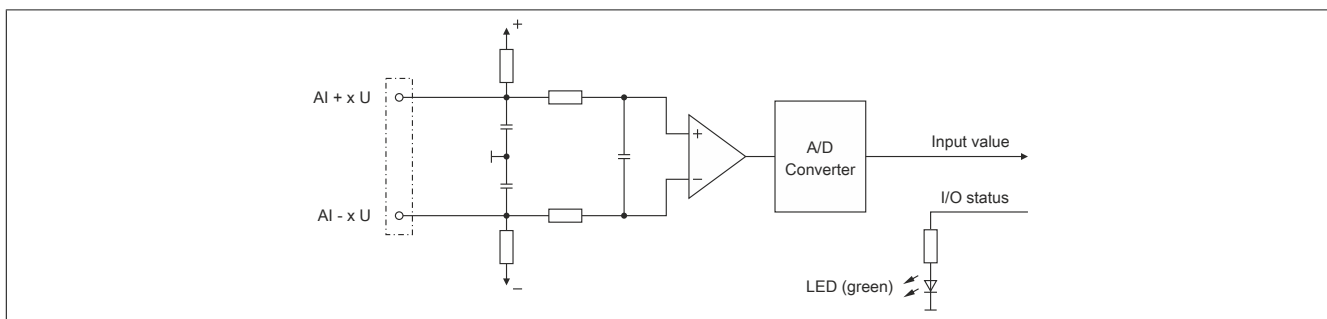
9.1.14.5 Pinout



9.1.14.6 Connection example



9.1.14.7 Input circuit diagram



9.1.14.8 Register description

9.1.14.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.1.14.8.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|------------------------------------|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog signal - Configuration | | | | | | |
| 16 | ConfigOutput01 (Input filter) | USINT | | | | • |
| 20 | ConfigOutput03 (Lower limit value) | INT | | | | • |
| 22 | ConfigOutput04 (Upper limit value) | INT | | | | • |
| Analog signal - Communication | | | | | | |
| Index * 2 - 2 | AnalogInput0N (Index N = 1 to 4) | INT | • | | | |
| 30 | StatusInput01 | USINT | • | | | |

9.1.14.8.3 Function model 254 - Bus controller

| Register | Offset | Name | Data type | Read | | Write | |
|--------------------------------------|---------------|------------------------------------|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog signal - Configuration | | | | | | | |
| 16 | - | ConfigOutput01 (Input filter) | USINT | | | | • |
| 20 | - | ConfigOutput03 (Lower limit value) | INT | | | | • |
| 22 | - | ConfigOutput04 (Upper limit value) | INT | | | | • |
| Analog signal - Communication | | | | | | | |
| Index * 2 - 2 | Index * 2 - 2 | AnalogInput0N (Index N = 1 to 4) | INT | • | | | |
| 30 | - | StatusInput01 | USINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.1.14.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.1.14.8.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.1.14.8.4 Analog inputs

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

9.1.14.8.5 Analog input values

Name:

AnalogInput01 to AnalogInput04

The analog input values are mapped to this register.

| Data type | Value | Input signal: |
|-----------|-------------------|------------------------------|
| INT | -32,768 to 32,767 | Voltage signal -10 to 10 VDC |

9.1.14.8.6 Input filter

This module is equipped with a configurable input filter. The minimum cycle time must be $>500 \mu\text{s}$. Filtering is disabled for shorter cycle times.

If the input filter is active, then the scan rate for the channels is measured in ms. The time offset between the channels is $200 \mu\text{s}$. The conversion takes place asynchronously to the network cycle.

9.1.14.8.6.1 Input ramp limiting

Input ramp limiting can only be performed in conjunction with filtering. Input ramp limiting is performed before filtering.

The difference of the input value change is checked for exceeding the specified limit. In the event of overshoot, the tracked input value is equal to the old value \pm the limit value.

Configurable limit values:

| Value | Limit value |
|-------|---|
| 0 | The input value is used without limitation. |
| 1 | $0x3FFF = 16383$ |
| 2 | $0x1FFF = 8191$ |
| 3 | $0x0FFF = 4095$ |
| 4 | $0x07FF = 2047$ |
| 5 | $0x03FF = 1023$ |
| 6 | $0x01FF = 511$ |
| 7 | $0x00FF = 255$ |

Input ramp limiting is well suited for suppressing disturbances (spikes). The following examples show the functionality of input ramp limiting based on an input step and a disturbance.

Example 1

The input value jumps from 8000 to 17000. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = $0x07FF = 2047$

Filter level = 2

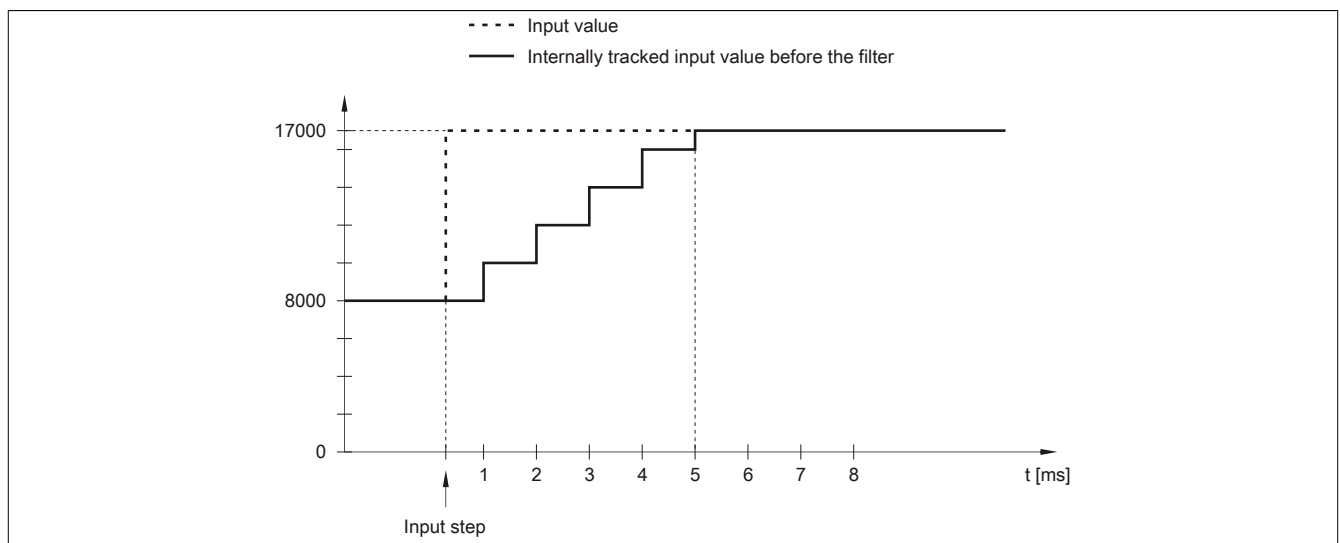


Figure 60: Tracked input value for input step

Example 2

A disturbance interferes with the input value. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = 0x07FF = 2047

Filter level = 2

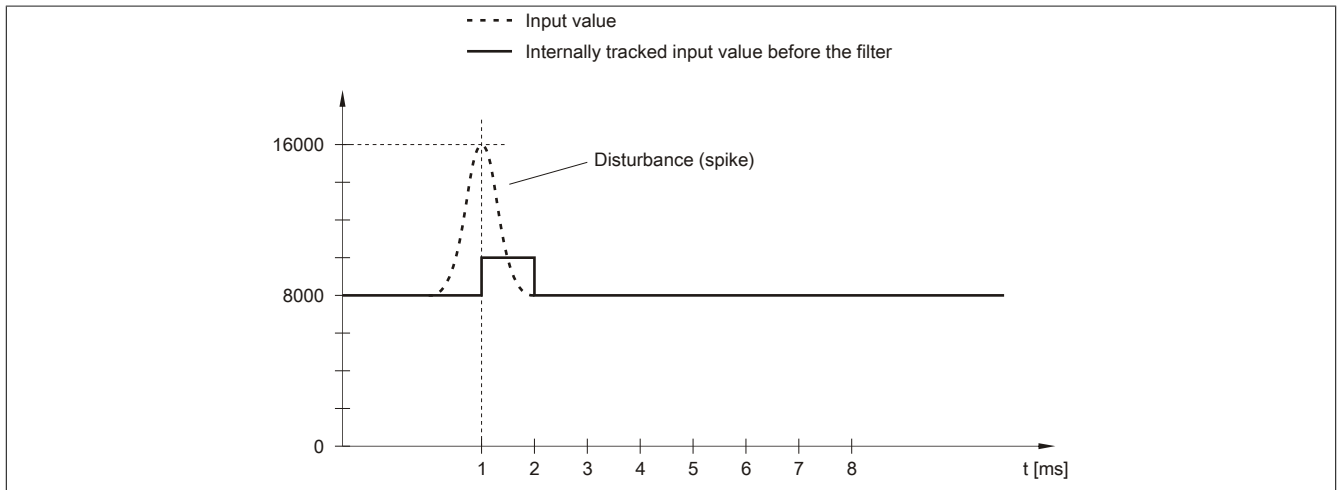


Figure 61: Tracked input value for disturbance

9.1.14.8.6.2 Filter level

A filter can be defined to prevent large input jumps. This filter is used to bring the input value closer to the actual analog value over a period of several bus cycles.

Filtering takes place after input ramp limitation.

Formula for calculating the input value:

$$\text{Value}_{\text{New}} = \text{Value}_{\text{Old}} - \frac{\text{Value}_{\text{Old}}}{\text{Filter level}} + \frac{\text{Input value}}{\text{Filter level}}$$

Adjustable filter levels:

| Value | Filter level |
|-------|---------------------|
| 0 | Filter switched off |
| 1 | Filter level 2 |
| 2 | Filter level 4 |
| 3 | Filter level 8 |
| 4 | Filter level 16 |
| 5 | Filter level 32 |
| 6 | Filter level 64 |
| 7 | Filter level 128 |

The following examples show how filtering works in the event of an input jump or disturbance.

Example 1

The input value jumps from 8000 to 16000. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

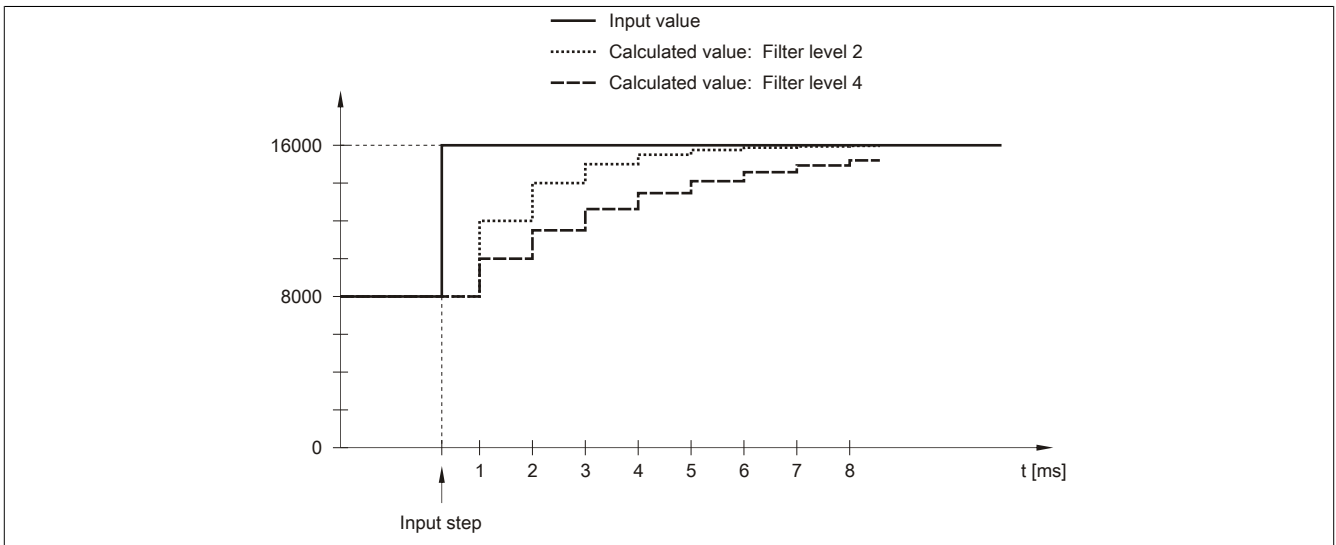


Figure 62: Calculated value during input step

Example 2

A disturbance interferes with the input value. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

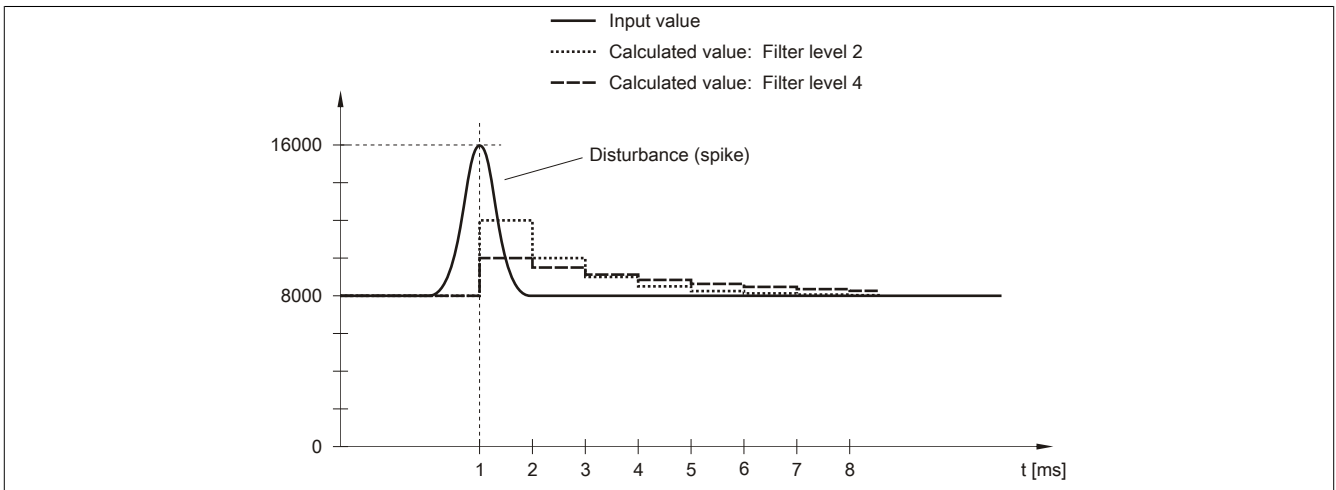


Figure 63: Calculated value during disturbance

9.1.14.8.7 Configuring the input filter

Name:

ConfigOutput01

The filter level and input ramp limiting of the input filter are set in this register.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------------|-------|--|
| 0 - 2 | Defines the filter level | 000 | Filter disabled (bus controller default setting) |
| | | 001 | Filter level 2 |
| | | 010 | Filter level 4 |
| | | 011 | Filter level 8 |
| | | 100 | Filter level 16 |
| | | 101 | Filter level 32 |
| | | 110 | Filter level 64 |
| | | 111 | Filter level 128 |
| 3 | Reserved | 0 | |
| 4 - 6 | Defines input ramp limiting | 000 | The input value is applied without limitation (bus controller default setting) |
| | | 001 | Limit value = 0x3FFF (16383) |
| | | 010 | Limit value = 0x1FFF (8191) |
| | | 011 | Limit value = 0x0FFF (4095) |
| | | 100 | Limit value = 0x07FF (2047) |
| | | 101 | Limit value = 0x03FF (1023) |
| | | 110 | Limit value = 0x01FF (511) |
| | | 111 | Limit value = 0x00FF (255) |
| 7 | Reserved | 0 | |

9.1.14.8.8 Lower limit value

Name:

ConfigOutput03

This register can be used to configure the lower limit for analog values. If the analog value goes below the limit value, it is frozen at this value and the corresponding error status bit is set.

| Data type | Values | Information |
|-----------|-----------------|--|
| INT | -32767 to 32767 | Bus controller default setting: -32767 |

Information:

The default value of -32767 corresponds to the minimum default value of -10 VDC.

Keep in mind that this setting applies to all channels!

9.1.14.8.9 Upper limit value

Name:

ConfigOutput04

This register can be used to configure the upper limit for analog values. If the analog value goes above the limit value, it is frozen at this value and the corresponding error status bit is set.

| Data type | Values | Information |
|-----------|-----------------|---------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 32767 |

Information:

The default value of 32767 corresponds to the maximum default value at +10 VDC.

Keep in mind that this setting applies to all channels!

9.1.14.8.10 Input status

Name:
StatusInput01

This register is used to monitor the module inputs. A change in the monitoring status generates an error message.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|----------------------------|
| 0 - 1 | Channel 1 | 00 | No error |
| | | 01 | Lower limit value exceeded |
| | | 10 | Upper limit value exceeded |
| | | 11 | Open line |
| ... | | ... | |
| 6 - 7 | Channel 4 | 00 | No error |
| | | 01 | Lower limit value exceeded |
| | | 10 | Upper limit value exceeded |
| | | 11 | Open line |

Limiting the analog value

In addition to the status information, the analog value is fixed to the values listed below by default in an error state. The analog value is limited to the new values if the limit values were changed.

| Error state | Digital value on error (default values) |
|-----------------------------|---|
| Open circuit | +32767 (0x7FFF) |
| Upper limit value overshoot | +32767 (0x7FFF) |
| Lower limit value undershot | -32767 (0x8001) |
| Invalid value | -32768 (0x8000) |

9.1.14.8.11 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------------|--------|
| Inputs without filtering | 100 µs |
| Inputs with filtering | 500 µs |

9.1.14.8.12 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|--------------------------|-----------------------|
| Inputs without filtering | 400 µs for all inputs |
| Inputs with filtering | 1 ms |

9.1.15 X20AI4322

Data sheet version: 1.21

9.1.15.1 General information

The module is equipped with 4 inputs with 12-bit digital converter resolution. It is possible to select between the two current ranges 0 to 20 mA and 4 to 20 mA.

- 4 analog inputs, 0 to 20 mA or 4 to 20 mA
- 12-bit digital converter resolution

9.1.15.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| X20AI4322 | X20 analog input module, 4 inputs, 0-20 mA / 4-20 mA, 12-bit converter resolution, configurable input filter |  |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 68: X20AI4322 - Order data

9.1.15.3 Technical data

| Model number | X20AI4322 |
|--|--|
| Short description | |
| I/O module | 4 analog inputs 0 to 20 mA / 4 to 20 mA |
| General information | |
| B&R ID code | 0xCAB3 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Inputs | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.1 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| Analog inputs | |
| Input | 0 to 20 mA/4 to 20 mA |
| Input type | Differential input |
| Digital converter resolution | 12-bit |
| Conversion time | 400 µs for all inputs |
| Output format | |
| Data type | INT |
| Current | 0x0000 - 0x7FFF / 1 LSB = 0x0008 = 4.883 µA |
| Load | <400 Ω |
| Input protection | Protection against wiring with supply voltage |
| Permissible input signal | Max. ±50 mA |
| Output of digital value during overload | Configurable |
| Conversion procedure | SAR |
| Input filter | 3rd-order low pass / cutoff frequency 1 kHz |
| Max. error at 25°C | |
| Gain | |
| 0 to 20 mA | 0.08% ¹⁾ |
| 4 to 20 mA | 0.1% ¹⁾ |
| Offset | |
| 0 to 20 mA | 0.03% ²⁾ |
| 4 to 20 mA | 0.16% ²⁾ |
| Max. gain drift | |
| 0 to 20 mA | 0.009 %/°C ¹⁾ |
| 4 to 20 mA | 0.0113 %/°C ¹⁾ |
| Max. offset drift | |
| 0 to 20 mA | 0.004 %/°C ²⁾ |
| 4 to 20 mA | 0.005 %/°C ²⁾ |
| Common-mode rejection | |
| DC | 70 dB |
| 50 Hz | 70 dB |
| Common-mode range | ±12 V |
| Crosstalk between channels | -70 dB |
| Nonlinearity | <0.05% ²⁾ |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |

Table 69: X20AI4322 - Technical data


| Model number | X20AI4322 |
|--|--|
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm |

Table 69: X20AI4322 - Technical data

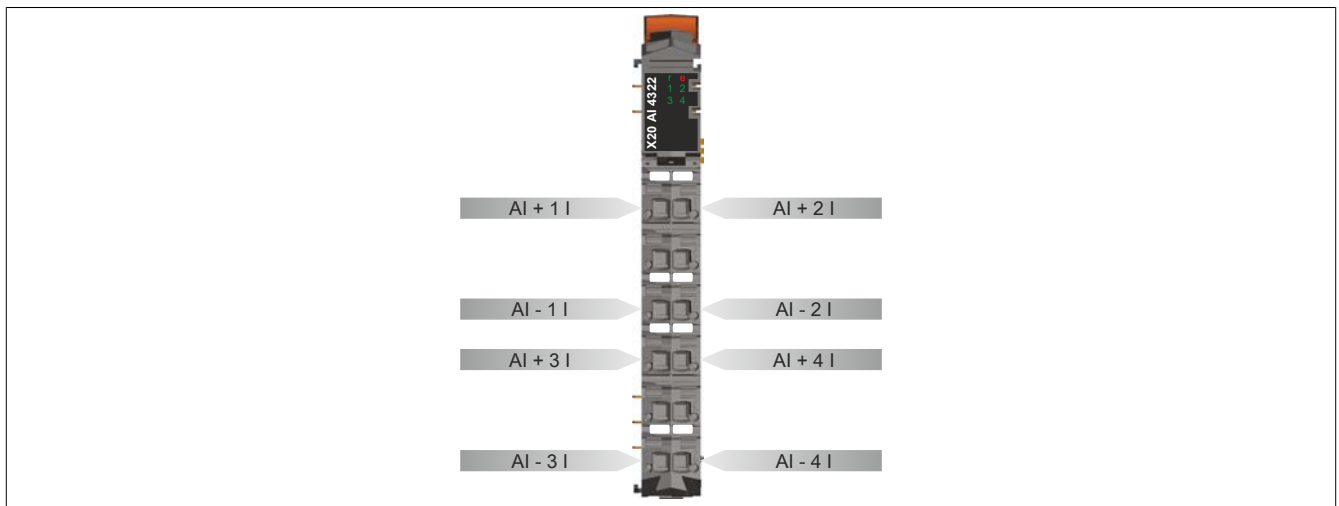
- 1) Based on the current measured value.
- 2) Based on the 20 mA measurement range.

9.1.15.4 LED status indicators

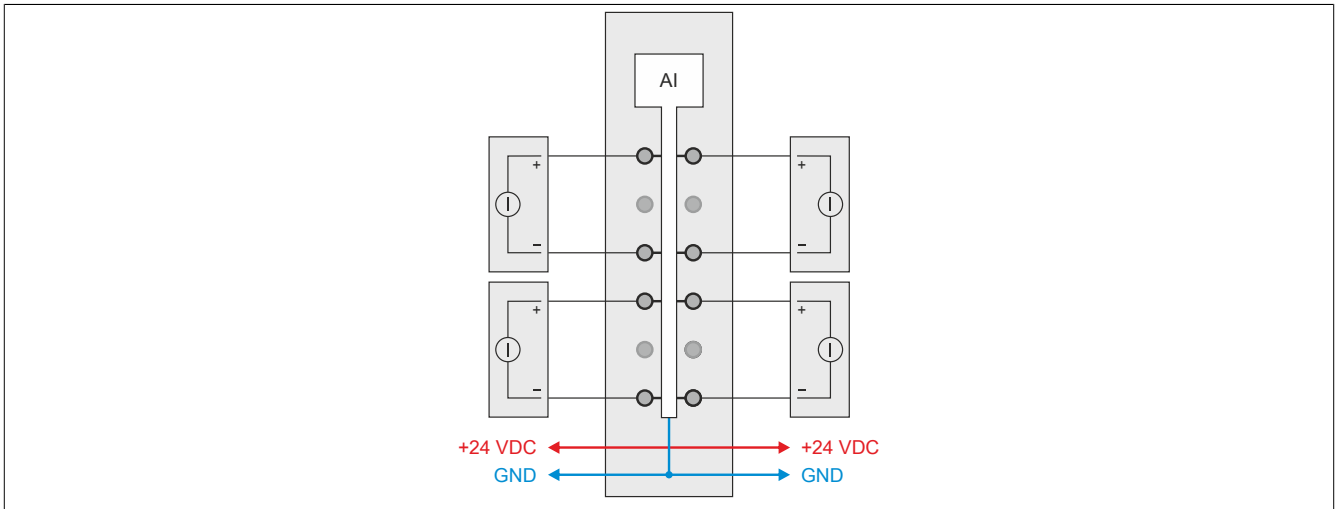
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|--|-------|-----------------------------|------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1 - 4 | Green | Blinking | Input signal overflow or underflow |
| | | | On | Analog/digital converter running, value OK |

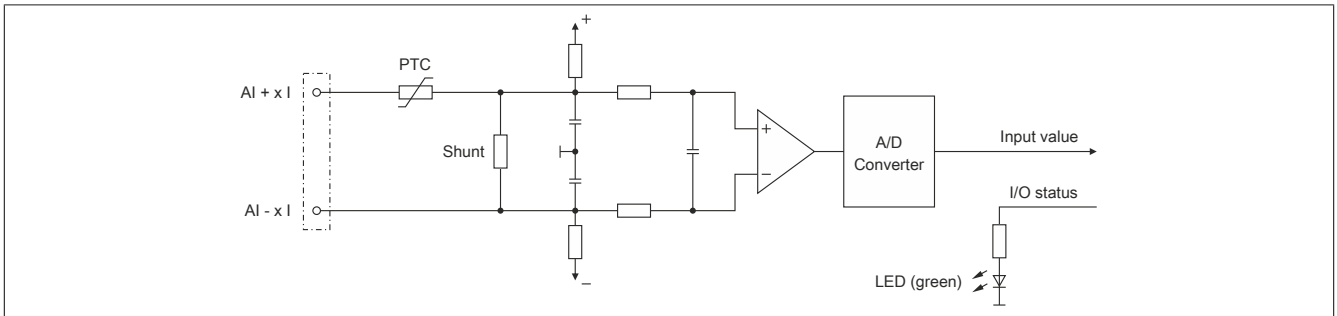
9.1.15.5 Pinout



9.1.15.6 Connection example



9.1.15.7 Input circuit diagram



9.1.15.8 Register description

9.1.15.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.1.15.8.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|--|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog signal - Configuration | | | | | | |
| 16 | ConfigOutput01 (Input filter) | USINT | | | | • |
| 18 | ConfigOutput02 (Channel type) | USINT | | | | • |
| 20 | ConfigOutput03 (Lower limit value) | INT | | | | • |
| 22 | ConfigOutput04 (Upper limit value) | INT | | | | • |
| Analog signal - Communication | | | | | | |
| Index * 2 - 2 | AnalogInput0N (Index N = 1 to 4) | INT | • | | | |
| 30 | StatusInput01 | USINT | • | | | |

9.1.15.8.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------------|----------------------|--|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog signal - Configuration | | | | | | | |
| 16 | - | ConfigOutput01 (Input filter) | USINT | | | | • |
| 18 | - | ConfigOutput02 (Channel type) | USINT | | | | • |
| 20 | - | ConfigOutput03 (Lower limit value) | INT | | | | • |
| 22 | - | ConfigOutput04 (Upper limit value) | INT | | | | • |
| Analog signal - Communication | | | | | | | |
| Index * 2 - 2 | Index * 2 - 2 | AnalogInput0N (Index N = 1 to 4) | INT | • | | | |
| 30 | - | StatusInput01 | USINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.1.15.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.1.15.8.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.1.15.8.4 Analog inputs

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

9.1.15.8.5 Analog input values

Name:

AnalogInput01 to AnalogInput04

The analog input values are mapped to this register.

| Data type | Value | Input signal: |
|-----------|----------------|---|
| INT | 0 to 32767 | Current signal 0 to 20 mA |
| | -8192 to 32767 | Current signal 4 to 20 mA (value 0 corresponds to 4 mA) |

9.1.15.8.6 Input filter

This module is equipped with a configurable input filter. The minimum cycle time must be $>500 \mu\text{s}$. Filtering is disabled for shorter cycle times.

If the input filter is active, then the scan rate for the channels is measured in ms. The time offset between the channels is $200 \mu\text{s}$. The conversion takes place asynchronously to the network cycle.

9.1.15.8.6.1 Input ramp limiting

Input ramp limiting can only be performed in conjunction with filtering. Input ramp limiting is performed before filtering.

The difference of the input value change is checked for exceeding the specified limit. In the event of overshoot, the tracked input value is equal to the old value \pm the limit value.

Configurable limit values:

| Value | Limit value |
|-------|---|
| 0 | The input value is used without limitation. |
| 1 | $0x3FFF = 16383$ |
| 2 | $0x1FFF = 8191$ |
| 3 | $0x0FFF = 4095$ |
| 4 | $0x07FF = 2047$ |
| 5 | $0x03FF = 1023$ |
| 6 | $0x01FF = 511$ |
| 7 | $0x00FF = 255$ |

Input ramp limiting is well suited for suppressing disturbances (spikes). The following examples show the functionality of input ramp limiting based on an input step and a disturbance.

Example 1

The input value jumps from 8000 to 17000. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = $0x07FF = 2047$

Filter level = 2

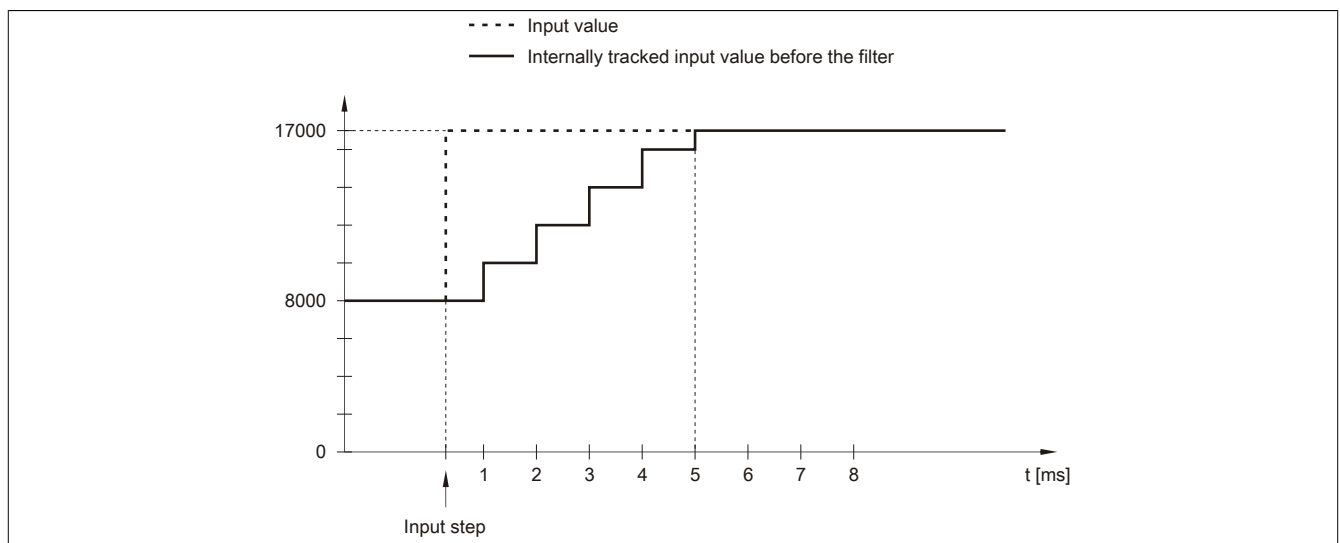


Figure 64: Tracked input value for input step

Example 2

A disturbance interferes with the input value. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = 0x07FF = 2047

Filter level = 2

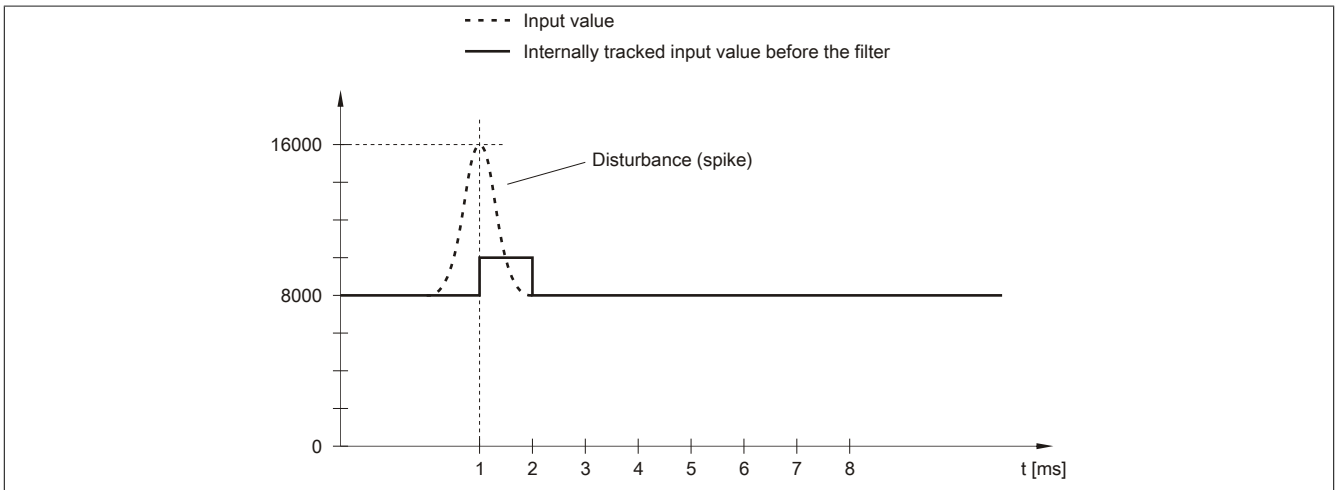


Figure 65: Tracked input value for disturbance

9.1.15.8.6.2 Filter level

A filter can be defined to prevent large input jumps. This filter is used to bring the input value closer to the actual analog value over a period of several bus cycles.

Filtering takes place after input ramp limitation.

Formula for calculating the input value:

$$\text{Value}_{\text{New}} = \text{Value}_{\text{Old}} - \frac{\text{Value}_{\text{Old}}}{\text{Filter level}} + \frac{\text{Input value}}{\text{Filter level}}$$

Adjustable filter levels:

| Value | Filter level |
|-------|---------------------|
| 0 | Filter switched off |
| 1 | Filter level 2 |
| 2 | Filter level 4 |
| 3 | Filter level 8 |
| 4 | Filter level 16 |
| 5 | Filter level 32 |
| 6 | Filter level 64 |
| 7 | Filter level 128 |

The following examples show how filtering works in the event of an input jump or disturbance.

Example 1

The input value jumps from 8000 to 16000. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

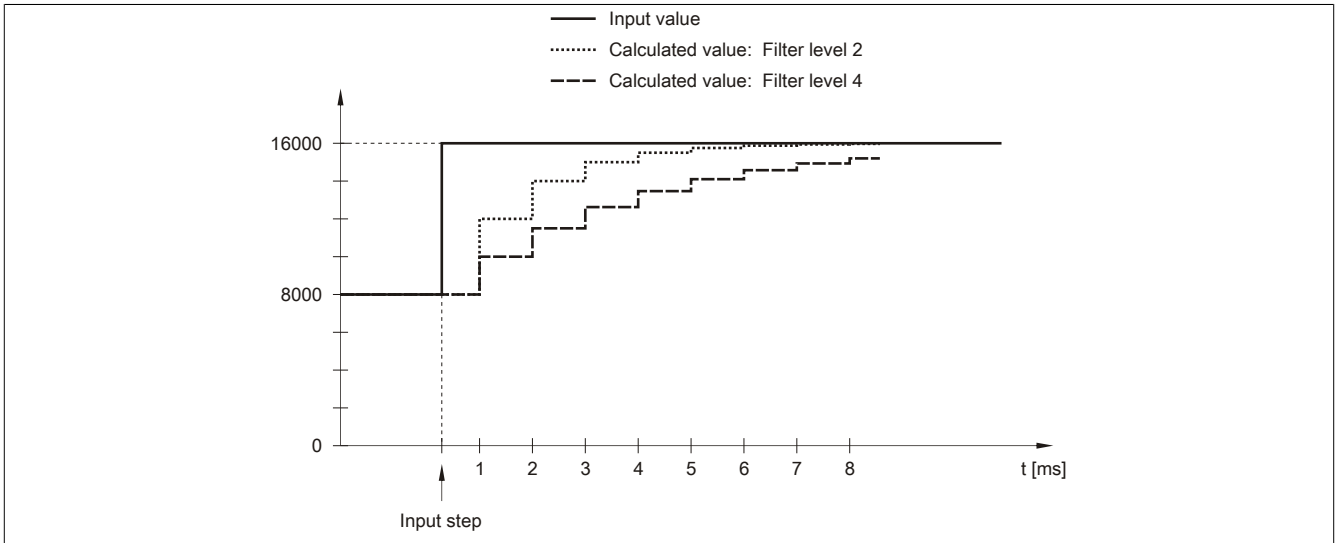


Figure 66: Calculated value during input step

Example 2

A disturbance interferes with the input value. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

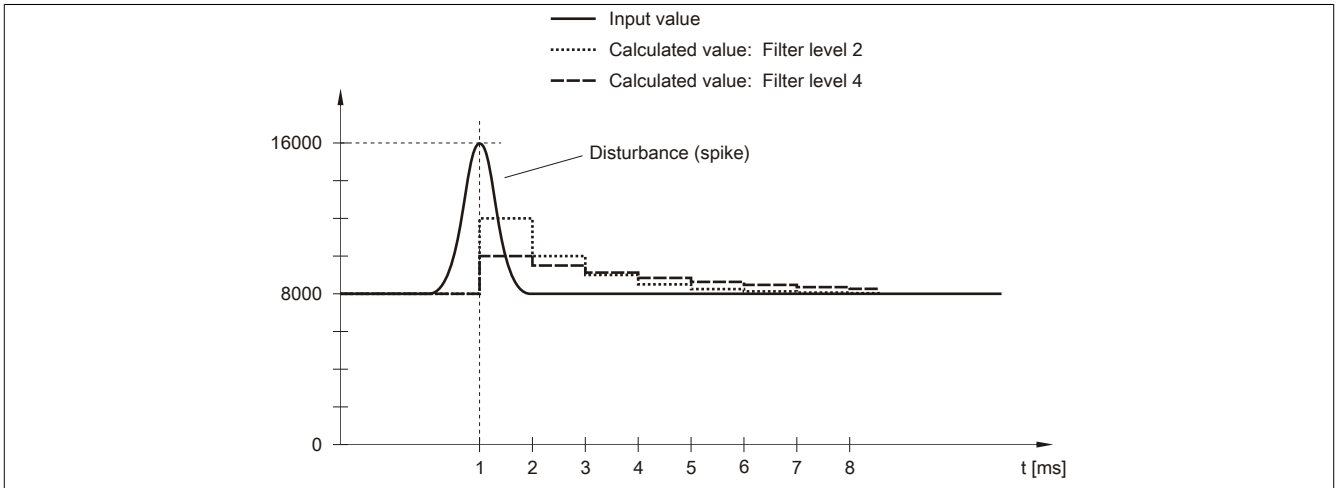


Figure 67: Calculated value during disturbance

9.1.15.8.7 Configuring the input filter

Name:

ConfigOutput01

The filter level and input ramp limiting of the input filter are set in this register.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------------|-------|--|
| 0 - 2 | Defines the filter level | 000 | Filter disabled (bus controller default setting) |
| | | 001 | Filter level 2 |
| | | 010 | Filter level 4 |
| | | 011 | Filter level 8 |
| | | 100 | Filter level 16 |
| | | 101 | Filter level 32 |
| | | 110 | Filter level 64 |
| | | 111 | Filter level 128 |
| 3 | Reserved | 0 | |
| 4 - 6 | Defines input ramp limiting | 000 | The input value is applied without limitation (bus controller default setting) |
| | | 001 | Limit value = 0x3FFF (16383) |
| | | 010 | Limit value = 0x1FFF (8191) |
| | | 011 | Limit value = 0x0FFF (4095) |
| | | 100 | Limit value = 0x07FF (2047) |
| | | 101 | Limit value = 0x03FF (1023) |
| | | 110 | Limit value = 0x01FF (511) |
| | | 111 | Limit value = 0x00FF (255) |
| 7 | Reserved | 0 | |

9.1.15.8.8 Channel type

Name:

ConfigOutput02

This register can be used to set the range of the current signal. This is determined by how they are configured. The following input signals can be set:

- 0 to 20 mA current signal
- 4 to 20 mA current signal

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 15 |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------------------|-------|--|
| 0 - 3 | Reserved | 1 | |
| 4 | Channel 1: Current measurement range | 0 | 0 to 20 mA current signal (bus controller default setting) |
| | | 1 | 4 to 20 mA current signal |
| ... | | ... | |
| 7 | Channel 4: Current measurement range | 0 | 0 to 20 mA current signal (bus controller default setting) |
| | | 1 | 4 to 20 mA current signal |

9.1.15.8.9 Lower limit value

Name:

ConfigOutput03

This register can be used to configure the lower limit for analog values. If the analog value goes below the limit value, it is frozen at this value and the corresponding error status bit is set.

| Data type | Values | Information |
|-----------|-----------------|--|
| INT | -32768 to 32767 | Bus controller default setting: -32767 |

Information:

- When configured as 0 to 20 mA, this value should be set to 0.
- When configured as 4 to 20 mA, this value can be set to -8192 (corresponds to 0 mA) in order to display values <4 mA.

Keep in mind that this setting applies to all channels!

9.1.15.8.10 Upper limit value

Name:

ConfigOutput04

This register can be used to configure the upper limit for analog values. If the analog value goes above the limit value, it is frozen at this value and the corresponding error status bit is set.

| Data type | Values | Information |
|-----------|-----------------|---------------------------------------|
| INT | -32768 to 32767 | Bus controller default setting: 32767 |

Information:

The default value of 32767 corresponds to the maximum default value at 20 mA.

Keep in mind that this setting applies to all channels!

9.1.15.8.11 Input status

Name:

StatusInput01

This register is used to monitor the module inputs. A change in the monitoring status generates an error message.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|----------------------------|
| 0 - 1 | Channel 1 | 00 | No error |
| | | 01 | Lower limit value exceeded |
| | | 10 | Upper limit value exceeded |
| ... | ... | ... | ... |
| 6 - 7 | Channel 4 | 00 | No error |
| | | 01 | Lower limit value exceeded |
| | | 10 | Upper limit value exceeded |

Limiting the analog value

In addition to the status information, the analog value is set to the values listed below by default when an error occurs. The analog value is limited to the new values if the limit values were changed.

| Error status | Digital value for error (default values) | |
|----------------------------|--|----------------|
| | 0 to 20 mA | 4 to 20 mA |
| Upper limit value exceeded | +32767 (0x7FFF) | |
| Lower limit value exceeded | 0 | -8191 (0xE001) |

9.1.15.8.12 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------------|--------|
| Inputs without filtering | 100 µs |
| Inputs with filtering | 500 µs |

9.1.15.8.13 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|--------------------------|-----------------------|
| Inputs without filtering | 400 µs for all inputs |
| Inputs with filtering | 1 ms |

9.1.16 X20(c)AI4622

Data sheet version: 3.32

9.1.16.1 General information

The module is equipped with 4 inputs with 13-bit (including sign) digital converter resolution. It is possible to select between the current and voltage signal using different terminals.

- 4 analog inputs
- Either current or voltage signal possible
- 13-bit digital converter resolution

9.1.16.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.1.16.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.1.16.3 Order data

| Model number | Short description | Figure |
|--------------|--|--------|
| | Analog inputs | |
| X20AI4622 | X20 analog input module, 4 inputs, ± 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution, configurable input filter | |
| X20cAI4622 | X20 analog input module, coated, 4 inputs, ± 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution, configurable input filter | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 70: X20AI4622, X20cAI4622 - Order data

9.1.16.4 Technical data

| Model number | X20AI4622 | X20cAI4622 |
|--|--|------------|
| Short description | | |
| I/O module | 4 analog inputs ± 10 V or 0 to 20 mA / 4 to 20 mA | |
| General information | | |
| B&R ID code | 0x1BAA | 0xE1EF |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Inputs | Yes, using status LED and software | |
| Channel type | Yes, using software | |
| Power consumption | | |
| Bus | 0.01 W | |
| Internal I/O | 1.1 W ¹⁾ | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Analog inputs | | |
| Input | ± 10 V or 0 to 20 mA / 4 to 20 mA, via different terminal connections | |
| Input type | Differential input | |
| Digital converter resolution | | |
| Voltage | ± 12 -bit | |
| Current | 12-bit | |
| Conversion time | 400 μ s for all inputs | |
| Output format | INT | |
| Output format | | |
| Voltage | INT 0x8001 - 0x7FFF / 1 LSB = 0x0008 = 2.441 mV | |
| Current | INT 0x0000 - 0x7FFF / 1 LSB = 0x0008 = 4.883 μ A | |
| Input impedance in signal range | | |
| Voltage | 20 M Ω | |
| Current | - | |
| Load | | |
| Voltage | - | |
| Current | <400 Ω | |
| Input protection | Protection against wiring with supply voltage | |
| Permissible input signal | | |
| Voltage | Max. ± 30 V | |
| Current | Max. ± 50 mA | |
| Output of digital value during overload | Configurable | |
| Conversion procedure | SAR | |
| Input filter | 3rd-order low pass / cutoff frequency 1 kHz | |
| Max. error | | |
| Voltage | | |
| Gain | 0.08% ²⁾ | |
| Offset | 0.015% ³⁾ | |
| Current | | |
| Gain | 0 to 20 mA = 0.08 % / 4 to 20 mA = 0.1 % ²⁾ | |
| Offset | 0 to 20 mA = 0.03 % / 4 to 20 mA = 0.16 % ⁴⁾ | |
| Max. gain drift | | |
| Voltage | 0.006 %/°C ²⁾ | |
| Current | 0 to 20 mA = 0.009 %/°C 4 to 20 mA = 0.0113 %/°C ²⁾ | |
| Max. offset drift | | |
| Voltage | 0.002 %/°C ³⁾ | |
| Current | 0 to 20 mA = 0.004 %/°C 4 to 20 mA = 0.005 %/°C ⁴⁾ | |

Table 71: X20AI4622, X20cAI4622 - Technical data


| Model number | X20AI4622 | X20cAI4622 |
|---|--|---|
| Common-mode rejection | | |
| DC | | 70 dB |
| 50 Hz | | 70 dB |
| Common-mode range | | ±12 V |
| Crosstalk between channels | | <-70 dB |
| Nonlinearity | | |
| Voltage | | <0.025% ³⁾ |
| Current | | <0.05% ⁴⁾ |
| Isolation voltage between channel and bus | | 500 V _{eff} |
| Electrical properties | | |
| Electrical isolation | | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | | Yes |
| Vertical | | Yes |
| Installation elevation above sea level | | |
| 0 to 2000 m | | No limitations |
| >2000 m | | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | | IP20 |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | | -25 to 60°C |
| Vertical mounting orientation | | -25 to 50°C |
| Derating | | - |
| Storage | | -40 to 85°C |
| Transport | | -40 to 85°C |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | | 5 to 95%, non-condensing |
| Transport | | 5 to 95%, non-condensing |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | 12.5 ^{+0.2} mm |

Table 71: X20AI4622, X20cAI4622 - Technical data

- 1) To reduce power dissipation, B&R recommends bridging unused inputs on the terminals or configuring them as current signals.
- 2) Based on the current measured value.
- 3) Based on the 20 V measurement range.
- 4) Based on the 20 mA measurement range.

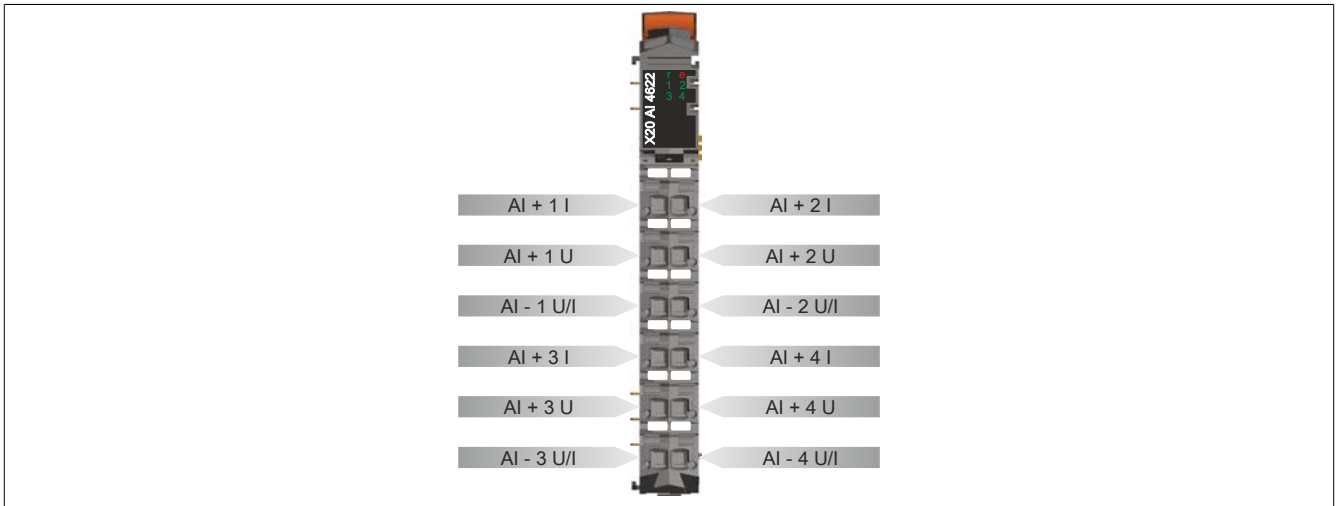
9.1.16.5 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

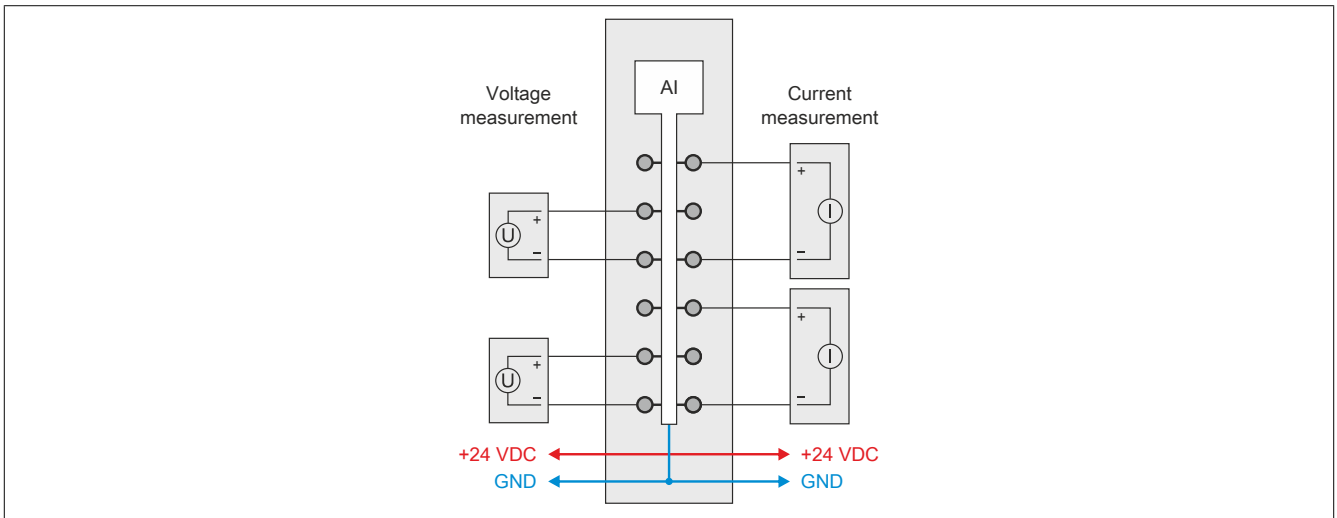
| Figure | LED | Color | Status | Description |
|---|-------|-------|-----------------------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | e + r | | Red on / Green single flash | Invalid firmware |
| | 1 - 4 | Green | Off | Open line ¹⁾ or sensor is disconnected |
| | | | Blinking | Input signal overflow or underflow |
| | | | On | Analog/digital converter running, value OK |

- 1) Open line detection only possible when measuring voltage.

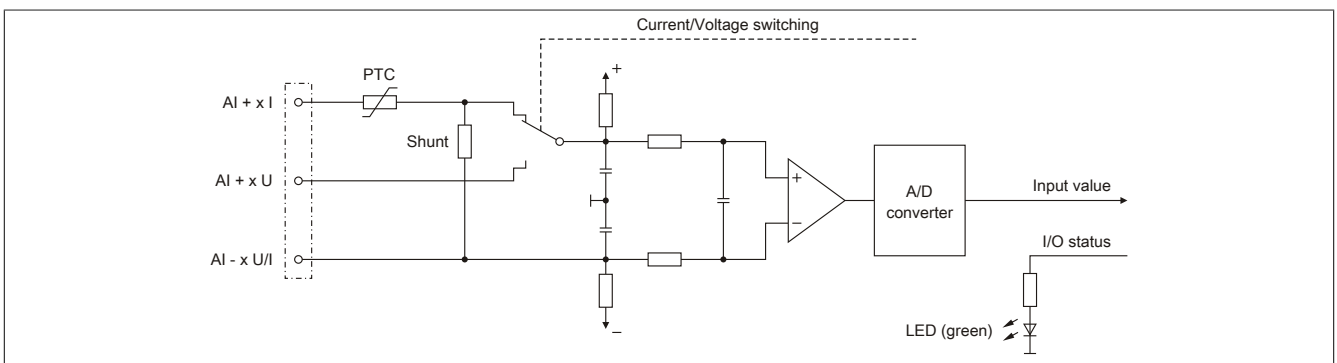
9.1.16.6 Pinout



9.1.16.7 Connection example



9.1.16.8 Input circuit diagram



9.1.16.9 Register description

9.1.16.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.1.16.9.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|------------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 16 | ConfigOutput01 (input filter) | USINT | | | | • |
| 18 | ConfigOutput02 (channel type) | USINT | | | | • |
| 20 | ConfigOutput03 (lower limit value) | INT | | | | • |
| 22 | ConfigOutput04 (upper limit value) | INT | | | | • |
| Communication | | | | | | |
| 0 | AnalogInput01 | INT | • | | | |
| 2 | AnalogInput02 | INT | • | | | |
| 4 | AnalogInput03 | INT | • | | | |
| 6 | AnalogInput04 | INT | • | | | |
| 30 | StatusInput01 | USINT | • | | | |

9.1.16.9.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|------------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 16 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| 18 | - | ConfigOutput02 (channel type) | USINT | | | | • |
| 20 | - | ConfigOutput03 (lower limit value) | INT | | | | • |
| 22 | - | ConfigOutput04 (upper limit value) | INT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | AnalogInput01 | INT | • | | | |
| 2 | 2 | AnalogInput02 | INT | • | | | |
| 4 | 4 | AnalogInput03 | INT | • | | | |
| 6 | 6 | AnalogInput04 | INT | • | | | |
| 30 | - | StatusInput01 | USINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.1.16.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.1.16.9.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.1.16.9.4 Analog inputs

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

9.1.16.9.5 Input values of analog inputs

Name:

AnalogInput01 to AnalogInput04

This register contains the analog input value depending on the configured operating mode.

| Data type | Values | Input signal: |
|-----------|-----------------|---|
| INT | -32768 to 32767 | Voltage signal -10 to 10 VDC |
| | 0 to 32767 | Current signal 0 to 20 mA |
| | -8192 to 32767 | Current signal 4 to 20 mA (value 0 corresponds to 4 mA) |

9.1.16.9.6 Input filter

This module is equipped with a configurable input filter. The minimum X2X cycle time must be $>500 \mu\text{s}$. Filtering is disabled for shorter X2X cycle times.

If the input filter is active, then the channels are scanned in 1 ms cycles. The time offset between the channels is 200 μs . Conversion is performed acyclically to the X2X cycle.

Information:

The filter sampling time is fixed at 1 ms and is acyclic to the X2X cycle.

9.1.16.9.6.1 Input ramp limiting

Input ramp limiting can only be performed in conjunction with filtering. Input ramp limiting is performed before filtering.

The difference of the input value change is checked for exceeding the specified limit. In the event of overshoot, the tracked input value is equal to the old value \pm the limit value.

Configurable limit values:

| Value | Limit value |
|-------|---|
| 0 | The input value is used without limitation. |
| 1 | 0x3FFF = 16383 |
| 2 | 0x1FFF = 8191 |
| 3 | 0x0FFF = 4095 |
| 4 | 0x07FF = 2047 |
| 5 | 0x03FF = 1023 |
| 6 | 0x01FF = 511 |
| 7 | 0x00FF = 255 |

Input ramp limiting is well suited for suppressing disturbances (spikes). The following examples show the functionality of input ramp limiting based on an input step and a disturbance.

Example 1

The input value jumps from 8000 to 17000. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = 0x07FF = 2047

Filter level = 2

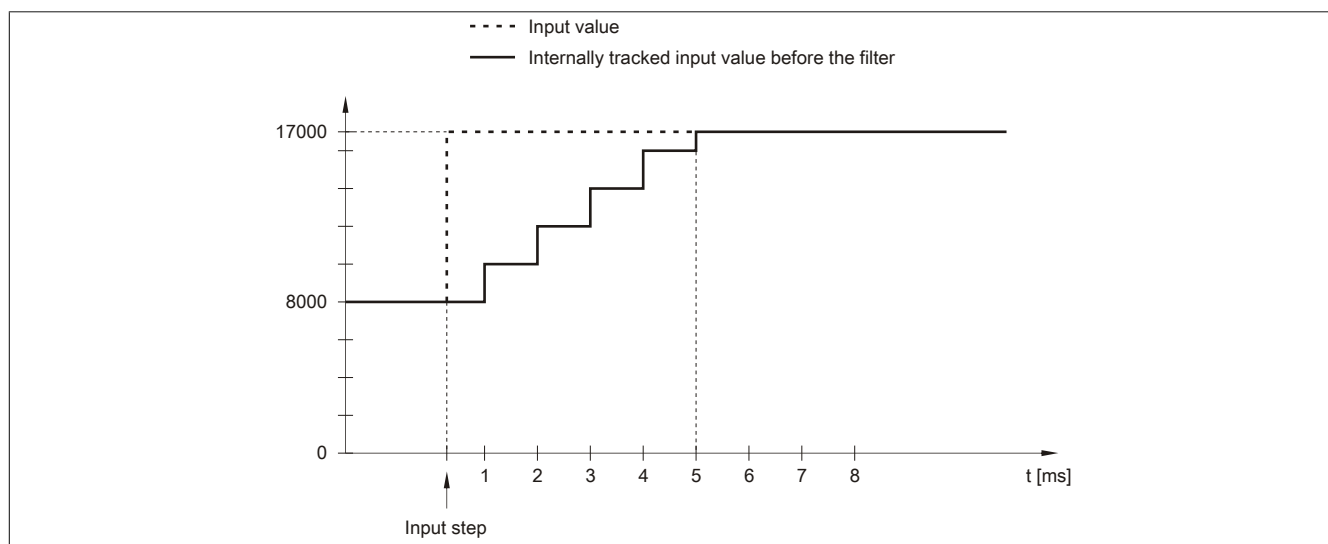


Figure 68: Tracked input value for input step

Example 2

A disturbance interferes with the input value. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = 0x07FF = 2047

Filter level = 2

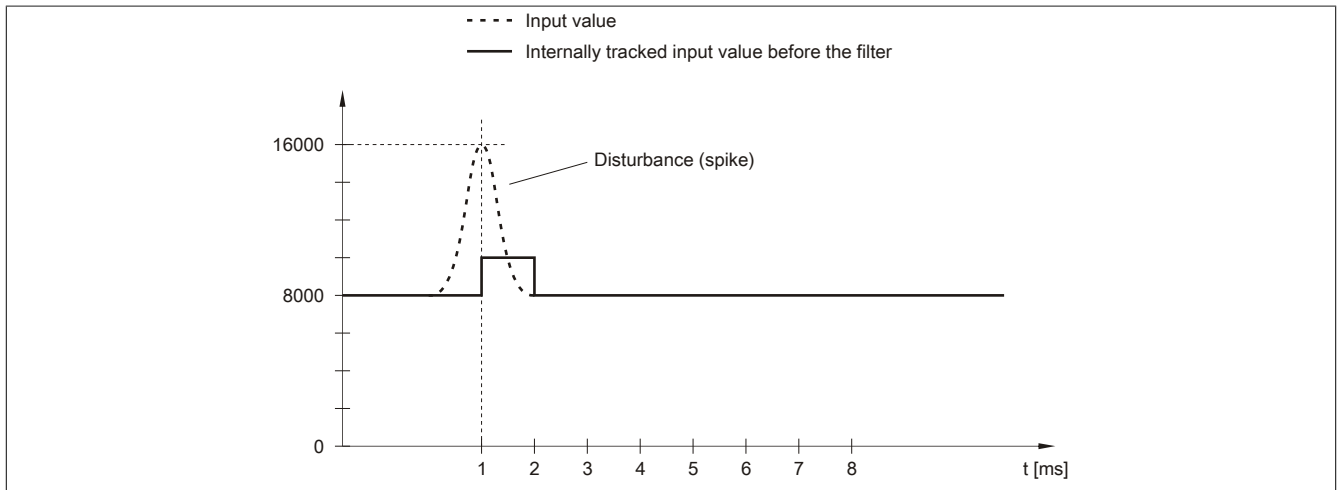


Figure 69: Tracked input value for disturbance

9.1.16.9.6.2 Filter level

A filter can be defined to prevent large input steps. This filter is used to bring the input value closer to the actual analog value over a period of several milliseconds.

Filtering takes place after any input ramp limiting has been carried out.

Formula for calculating the input value:

$$\text{Value}_{\text{New}} = \text{Value}_{\text{Old}} - \frac{\text{Value}_{\text{Old}}}{\text{Filter level}} + \frac{\text{Input value}}{\text{Filter level}}$$

Adjustable filter levels:

| Value | Filter level |
|-------|---------------------|
| 0 | Filter switched off |
| 1 | Filter level 2 |
| 2 | Filter level 4 |
| 3 | Filter level 8 |
| 4 | Filter level 16 |
| 5 | Filter level 32 |
| 6 | Filter level 64 |
| 7 | Filter level 128 |

The following examples show the functionality of the filter based on an input step and a disturbance.

Example 1

The input value jumps from 8000 to 16000. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

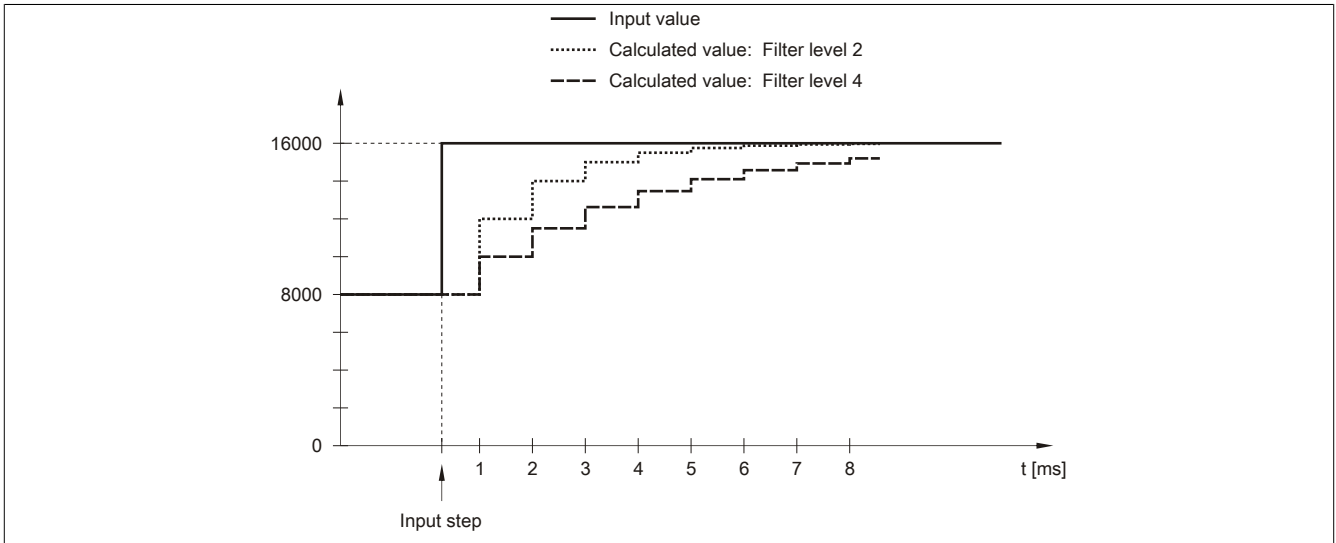


Figure 70: Calculated value during input step

Example 2

A disturbance interferes with the input value. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

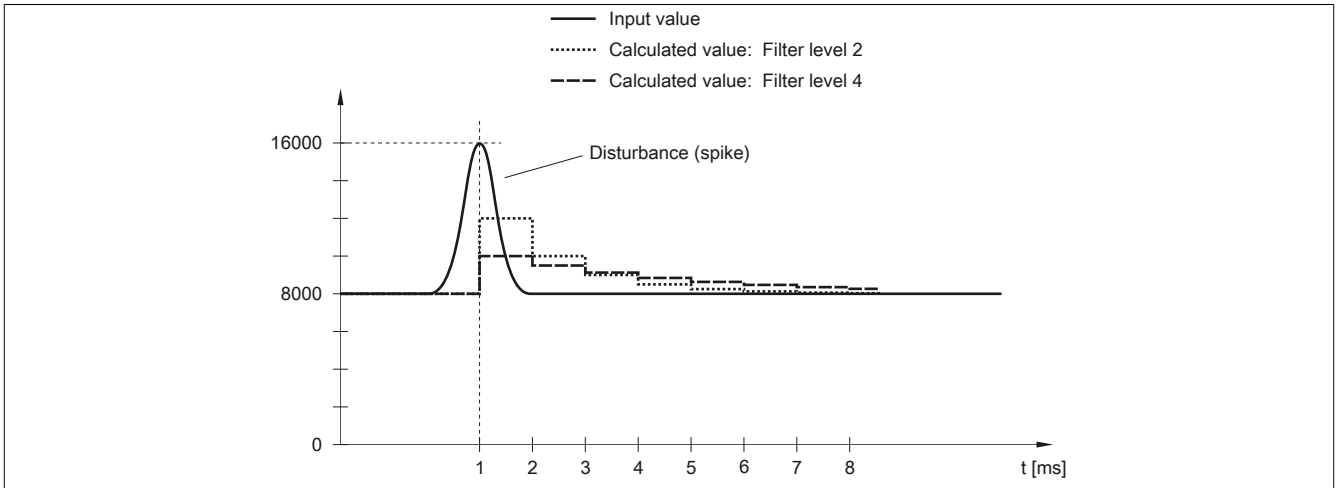


Figure 71: Calculated value during disturbance

9.1.16.9.7 Configuring the input filter

Name:

ConfigOutput01

The filter level and input ramp limiting of the input filter are set in this register.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------------|-------|--|
| 0 - 2 | Defines the filter level | 000 | Filter disabled (bus controller default setting) |
| | | 001 | Filter level 2 |
| | | 010 | Filter level 4 |
| | | 011 | Filter level 8 |
| | | 100 | Filter level 16 |
| | | 101 | Filter level 32 |
| | | 110 | Filter level 64 |
| | | 111 | Filter level 128 |
| 3 | Reserved | 0 | |
| 4 - 6 | Defines input ramp limiting | 000 | The input value is applied without limitation (bus controller default setting) |
| | | 001 | Limit value = 0x3FFF (16383) |
| | | 010 | Limit value = 0x1FFF (8191) |
| | | 011 | Limit value = 0x0FFF (4095) |
| | | 100 | Limit value = 0x07FF (2047) |
| | | 101 | Limit value = 0x03FF (1023) |
| | | 110 | Limit value = 0x01FF (511) |
| | | 111 | Limit value = 0x00FF (255) |
| 7 | Reserved | 0 | |

9.1.16.9.8 Channel type

Name:

ConfigOutput02

The type and range of signal measurement can be set in this register.

The individual channels are designed for current and voltage signals. This differentiation is made using different terminals and an integrated switch in the module. The switch is automatically activated by the module depending on the specified configuration. The following input signals can be set:

- ± 10 V voltage signal (default)
- 0 to 20 mA current signal
- 4 to 20 mA current signal

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-----|--------------------------------------|-------|--|
| 0 | Channel 1 | 0 | Voltage signal (bus controller default setting) |
| | | 1 | Current signal, measurement range corresponding to bit 4 |
| ... | | ... | |
| 3 | Channel 4 | 0 | Voltage signal (bus controller default setting) |
| | | 1 | Current signal, measurement range corresponding to bit 7 |
| 4 | Channel 1: Current measurement range | 0 | 0 to 20 mA current signal (bus controller default setting) |
| | | 1 | 4 to 20 mA current signal |
| ... | | ... | |
| 7 | Channel 4: Current measurement range | 0 | 0 to 20 mA current signal (bus controller default setting) |
| | | 1 | 4 to 20 mA current signal |

9.1.16.9.9 Limit values

The input signal is monitored at the upper and lower limit values. These must be defined according to the operating mode:

| Limit value (default) | Voltage signal ± 10 V | | Current signal 0 to 20 mA | | Current signal 4 to 20 mA | |
|---------------------------|---------------------------|-----------------|---------------------------|-----------------|---------------------------|-----------------|
| Upper maximum limit value | +10 V | +32767 (0x7FFF) | 20 mA | +32767 (0x7FFF) | 20 mA | +32767 (0x7FFF) |
| Lower minimum limit value | -10 V | -32767 (0x8001) | 0 mA | 0 ¹⁾ | 4 mA | 0 ²⁾ |

1) The analog value is limited down to 0.

2) The analog value is limited down to 0 at currents <4 mA. The status bit for the lower limit is set.

Other limit values can be defined if necessary. The limit values apply to all channels. These are enabled automatically by writing to the limit value registers. From this point on, the analog values will be monitored and limited according to the new limits. The results of monitoring are displayed in the status register.

Examples of limit value settings

| Use case | Limit value settings |
|----------------------------------|--|
| Current signal: 4 to 20 mA | If values <4 mA should be measured for a current signal with 4 to 20 mA, a negative limit value must be set: 0 mA corresponds to value -8192 (0xE000). |
| Mixed voltage and current signal | The set limit values apply to all channels. A compromise must therefore be made for mixed operation (voltage and current signal mixed). The following setting has proven to be effective: Upper limit value = +32767, lower limit value = -32767 This also allows negative voltage values to be measured. With a lower limit value of 0, the voltage value would be limited to 0. |
| Current signal on all channels | All channels are configured for current measurement. The limit value setting in Automation Studio is not adjusted automatically. This means that +32767 is set for the upper limit value and -32767 for the lower limit value. The necessary adjustments must be made by the user, e.g. lower limit value = 0 |

9.1.16.9.9.1 Lower limit value

Name:

ConfigOutput03

The lower limit value for analog values can be set in this register. If the analog value goes below the limit value, it is frozen at this value and the corresponding error status bit is set.

| Data type | Values | Information |
|-----------|-----------------|--|
| INT | -32768 to 32767 | Bus controller default setting: -32768 |

Information:

- The default value of **-32767** corresponds to the minimum default value of **-10 VDC**.
- For a **0 to 20 mA** configuration, this value should be set to **0**.
- For a **4 to 20 mA** configuration, this value can be set to **-8192** (corresponds to **0 mA**) in order to display values <4 mA.

Information:

It is important to note that this setting applies to all channels!

9.1.16.9.9.2 Upper limit value

Name:

ConfigOutput04

The upper limit value for analog values can be set in this register. If the analog value goes above the limit value, it is frozen at this value and the corresponding error status bit is set.

| Data type | Values | Information |
|-----------|-----------------|---------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 32767 |

Information:

The default value **32767** corresponds to the maximum default value at **20 mA** or **+10 VDC**.

Information:

It is important to note that this setting applies to all channels!

9.1.16.9.10 Status of the inputs

Name:
StatusInput01

The module inputs are monitored in this register. A change in the monitoring status is actively transmitted as an error message. The following states are monitored depending on the settings:

| Value | Voltage signal ± 10 V | Current signal 0 to 20 mA | Current signal 4 to 20 mA |
|-------|-----------------------------|---|-----------------------------|
| 0 | No error | No error | No error |
| 1 | Lower limit value undershot | Default setting The input value has a lower limit of 0x0000. Underflow monitoring is therefore not necessary. After lower limit value change The input value is limited to the configured value. The status bit is set when the value falls below the lower limit. | Lower limit value undershot |
| 2 | Upper limit value overshoot | Upper limit value overshoot | Upper limit value overshoot |
| 3 | Open circuit | - | - |

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|-----------------------------|
| 0 - 1 | Channel 1 | 00 | No error |
| | | 01 | Lower limit value undershot |
| | | 10 | Upper limit value overshoot |
| | | 11 | Open circuit |
| ... | | ... | |
| 6 - 7 | Channel 4 | 00 | No error |
| | | 01 | Lower limit value undershot |
| | | 10 | Upper limit value overshoot |
| | | 11 | Open circuit |

Limiting the analog value

In addition to the status information, the analog value is fixed to the values listed below by default in an error state. The analog value is limited to the new values if the limit values were changed.

| Error state | Digital value on error (default values) |
|-----------------------------|---|
| Open circuit | +32767 (0x7FFF) |
| Upper limit value overshoot | +32767 (0x7FFF) |
| Lower limit value undershot | -32767 (0x8001) |
| Invalid value | -32768 (0x8000) |

9.1.16.9.11 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------------|-------------|
| Inputs without filtering | 100 μ s |
| Inputs with filtering | 500 μ s |

9.1.16.9.12 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|--------------------------|----------------------------|
| Inputs without filtering | 300 μ s for all inputs |
| Inputs with filtering | 1 ms |

9.1.17 X20(c)AI4632

Data sheet version: 3.11

9.1.17.1 General information

The module is equipped with 4 inputs with 16-bit digital converter resolution. It is possible to select between the current and voltage signal using different terminals.

- 4 analog inputs
- Either current or voltage signal possible
- 16-bit digital converter resolution
- Simultaneous input conversion
- Very fast conversion time

9.1.17.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.1.17.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.1.17.3 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Analog inputs |  |
| X20AI4632 | X20 analog input module, 4 inputs, ±10 V or 0 to 20 mA, 16-bit converter resolution, configurable input filter, oscilloscope functions | |
| X20cAI4632 | X20 analog input module, coated, 4 inputs, ±10 V or 0 to 20 mA, 16-bit converter resolution, configurable input filter, oscilloscope functions | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 72: X20AI4632, X20cAI4632 - Order data

9.1.17.4 Technical data

| Model number | X20AI4632 | X20cAI4632 |
|--|--|------------|
| Short description | | |
| I/O module | 4 analog inputs ± 10 V or 0 to 20 mA | |
| General information | | |
| B&R ID code | 0x1BA1 | 0xE1F0 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Inputs | Yes, using status LED and software | |
| Channel type | Yes, using software | |
| Power consumption | | |
| Bus | 0.01 W | |
| Internal I/O | 1.5 W ¹⁾ | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations | |
| DNV GL | Class I, Division 2, Groups ABCD, T5 Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Analog inputs | | |
| Input | ± 10 V or 0 to 20 mA, via different terminal connections | |
| Input type | Differential input | |
| Digital converter resolution | | |
| Voltage | ± 15 -bit | |
| Current | 15-bit | |
| Conversion time | 50 μ s for all inputs | |
| Output format | INT | |
| Output format | | |
| Voltage | INT 0x8001 - 0x7FFF / 1 LSB = 0x0001 = 305.176 μ V | |
| Current | INT 0x0000 - 0x7FFF / 1 LSB = 0x0001 = 610.352 nA | |
| Input impedance in signal range | | |
| Voltage | 20 M Ω | |
| Current | - | |
| Load | | |
| Voltage | - | |
| Current | <400 Ω | |
| Input protection | Protection against wiring with supply voltage | |
| Permissible input signal | | |
| Voltage | Max. ± 30 V | |
| Current | Max. ± 50 mA | |
| Output of digital value during overload | | |
| Undershoot | | |
| Voltage | 0x8001 | |
| Current | 0x0000 | |
| Overshoot | | |
| Voltage | 0x7FFF | |
| Current | 0x7FFF | |
| Conversion procedure | SAR | |
| Input filter | Hardware - 3rd-order low pass / cutoff frequency 10 kHz | |
| Max. error | | |
| Voltage | | |
| Gain | 0.08% ²⁾ | |
| Offset | 0.01% ³⁾ | |
| Current | | |
| Gain | 0.08% ²⁾ | |
| Offset | 0.02% ⁴⁾ | |

Table 73: X20AI4632, X20cAI4632 - Technical data


| Model number | X20AI4632 | X20cAI4632 |
|---|--|---|
| Max. gain drift | | |
| Voltage | | 0.01 %/°C ²⁾ |
| Current | | 0.01 %/°C ²⁾ |
| Max. offset drift | | |
| Voltage | | 0.001 %/°C ³⁾ |
| Current | | 0.002 %/°C ⁴⁾ |
| Common-mode rejection | | |
| DC | | 70 dB |
| 50 Hz | | 70 dB |
| Common-mode range | | ±12 V |
| Crosstalk between channels | | <-70 dB |
| Nonlinearity | | |
| Voltage | | <0.01% ³⁾ |
| Current | | <0.015% ⁴⁾ |
| Isolation voltage between channel and bus | | 500 V _{eff} |
| Electrical properties | | |
| Electrical isolation | | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | | Yes |
| Vertical | | Yes |
| Installation elevation above sea level | | |
| 0 to 2000 m | | No limitations |
| >2000 m | | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | | IP20 |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | | -25 to 60°C |
| Vertical mounting orientation | | -25 to 50°C |
| Derating | | See section "Derating" |
| Storage | | -40 to 85°C |
| Transport | | -40 to 85°C |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | | 5 to 95%, non-condensing |
| Transport | | 5 to 95%, non-condensing |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | | 12.5 ^{+0.2} mm |

Table 73: X20AI4632, X20cAI4632 - Technical data

- 1) To reduce power dissipation, B&R recommends bridging unused inputs on the terminals or configuring them as current signals.
- 2) Based on the current measured value.
- 3) Based on the 20 V measurement range.
- 4) Based on the 20 mA measurement range.

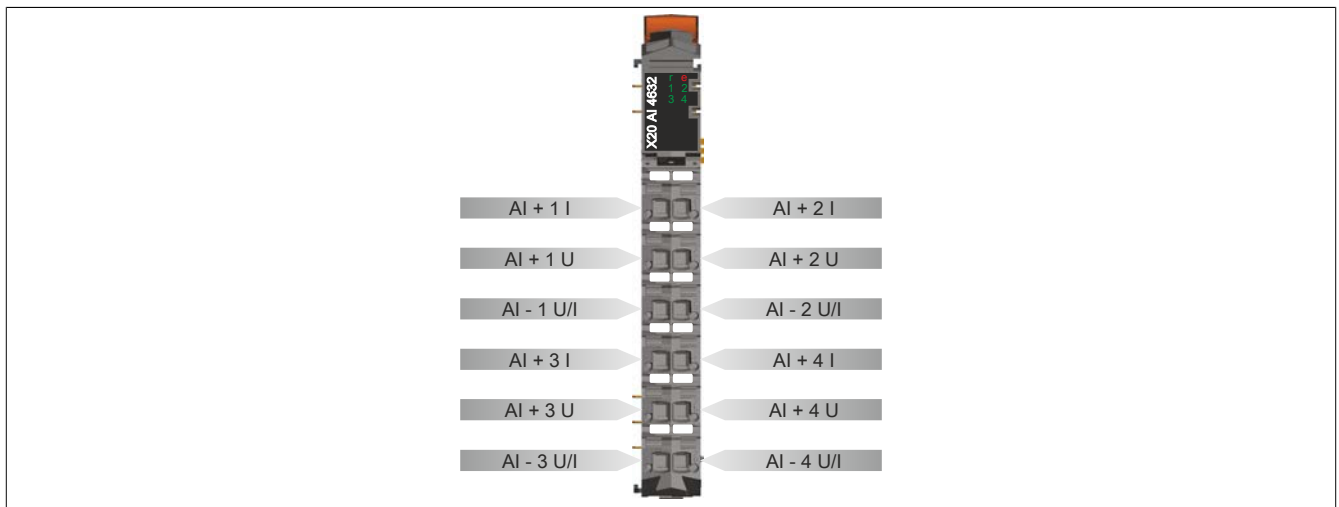
9.1.17.5 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|-------|--------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | e | Red | On | RUN mode |
| | | | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | | | Double flash | System error: <ul style="list-style-type: none"> • Violation of the scan time • Synchronization error |
| | 1 - 4 | Green | Off | Open line ²⁾ or sensor is disconnected |
| | | | On | Analog/digital converter running, value OK |

- 1) Depending on the configuration, a firmware update can take up to several minutes.
 2) Open line detection only possible when measuring voltage.

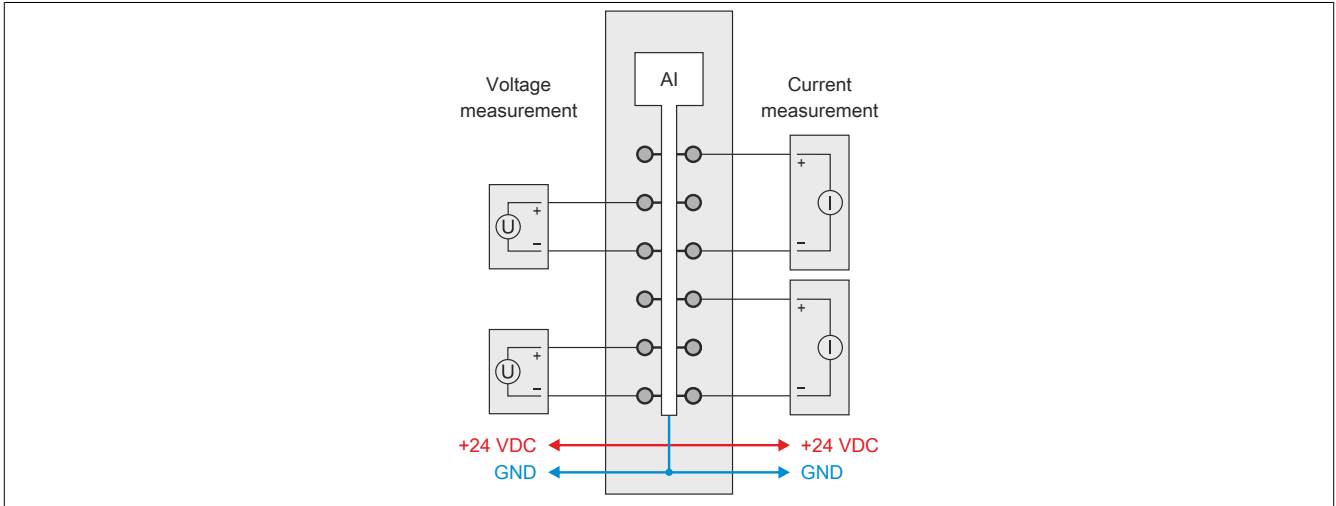
9.1.17.6 Pinout



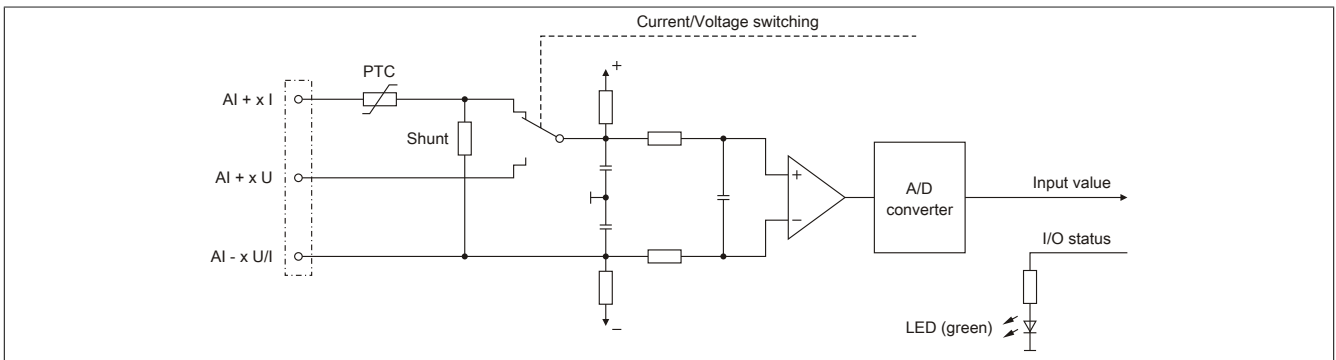
9.1.17.7 Connection example

To prevent disturbances, the following modules must be separated by at least one module:

- Bus receiver X20BR9300
- Supply module X20PS3300/X20PS3310
- Supply module X20PS9400/X20PS9402
- Supply module X20PS9500/X20PS9502
- CPU modules



9.1.17.8 Input circuit diagram

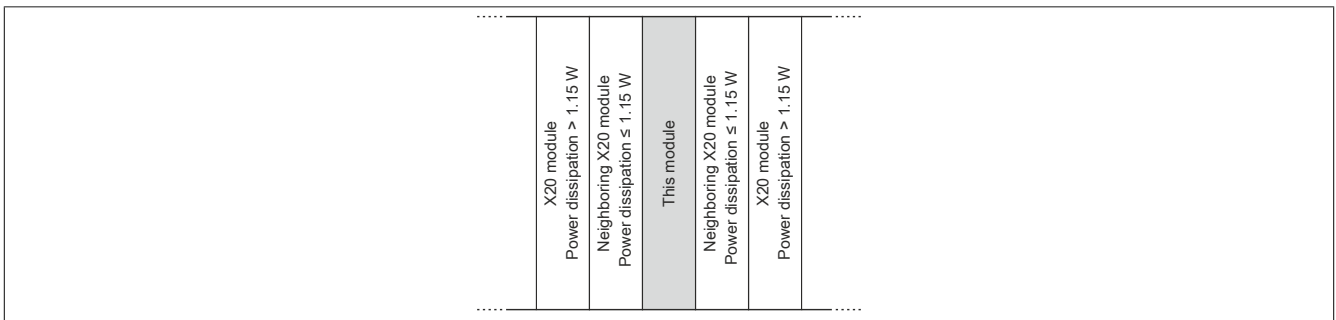


9.1.17.9 Derating

There is no derating when operated below 55°C.

During operation over 55°C, the power dissipation of the modules to the left and right of this module is not permitted to exceed 1.15 W!

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.



9.1.17.10 Register description

9.1.17.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.1.17.10.2 Function model 0 - default

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration - Frame size | | | | | | |
| - | AsynSize | - | | | | |
| Configuration | | | | | | |
| 257 289 321 353 | ConfigOutput01 (channel configuration) ConfigOutput06 ConfigOutput11 ConfigOutput16 | USINT | | | | • |
| Sampling time | | | | | | |
| 390 | ConfigOutput24 (sampling time) | UINT | | | | • |
| Filtering | | | | | | |
| 259 291 323 355 | ConfigOutput26 (order for low-pass filter) ConfigOutput28 ConfigOutput30 ConfigOutput32 | USINT | | | | • |
| 262 294 326 358 | ConfigOutput27 (cutoff frequency of low-pass filter) ConfigOutput29 ConfigOutput31 ConfigOutput33 | UINT | | | | • |
| Scaling | | | | | | |
| 276 308 340 372 | ConfigOutput04 (user-defined gain) ConfigOutput09 ConfigOutput14 ConfigOutput19 | DINT | | | | • |
| 284 316 348 380 | ConfigOutput05 (user-defined offset) ConfigOutput10 ConfigOutput15 ConfigOutput20 | DINT | | | | • |
| User-defined limit values | | | | | | |
| 266 298 330 362 | ConfigOutput02 (minimum limit value) ConfigOutput07 ConfigOutput12 ConfigOutput17 | UINT | | | | • |
| 270 302 334 366 | ConfigOutput03 (maximum limit value) ConfigOutput08 ConfigOutput13 ConfigOutput18 | UINT | | | | • |
| Communication | | | | | | |
| 0 + (N-1) * 4 | AnalogInput0N (index N = 1 to 4) | INT | • | | | |
| 650 | SampleCycleCounter | UINT | | • | | |
| Error monitoring and counters | | | | | | |
| 641 | Channel status | USINT | • | | | |
| | Channel01OK | Bit 0 | | | | |
| | ... | ... | | | | |
| | Channel04OK | Bit 3 | | | | |
| | SyncStatus | Bit 6 | | | | |
| | ConversionCycle | Bit 7 | | | | |
| 654 | SampleCycleViolationErrorCounter | UINT | | • | | |
| 658 | Synchronization error counter | UINT | | • | | |
| 2097 | Range violation (neg. and pos.) | USINT | • | | | |
| | Channel01underflow | Bit 0 | | | | |
| | ... | ... | | | | |
| | Channel04underflow | Bit 3 | | | | |
| | Channel01overflow | Bit 4 | | | | |
| | ... | ... | | | | |
| 2099 | Working range violation (pos.) | USINT | • | | | |
| | Channel01outofrange | Bit 0 | | | | |
| | ... | ... | | | | |
| | Channel04outofrange | Bit 3 | | | | |
| 518 + (N-1) * 32 | Ch0NOutOfRange (index N = 1 to 4) | UINT | | • | | |
| 522 + (N-1) * 32 | Ch0NUnderflow (index N = 1 to 4) | UINT | | • | | |
| 526 + (N-1) * 32 | Ch0NOverflow (index N = 1 to 4) | UINT | | • | | |

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Additional analysis functions | | | | | | |
| 133 | ConfigOutput21 (trigger reaction on falling edge) | USINT | | | | • |
| 135 | ConfigOutput22 (trigger reaction on rising edge) | USINT | | | | • |
| 129 | Analysis control byte | USINT | | | • | |
| | TraceTrigger01 | Bit 0 | | | | |
| | MinMaxStart01 | Bit 4 | | | | |
| | ... | ... | | | | |
| 129 | MinMaxStart04 | Bit 7 | | | | |
| | Analysis status byte | USINT | • | | | |
| | MinMaxStart01Readback | Bit 4 | | | | |
| | ... | ... | | | | |
| | MinMaxStart04Readback | Bit 7 | | | | |
| Limit values | | | | | | |
| 530 + (N-1) * 32 | MinInput0N (index N = 1 to 4) | INT | • | | | |
| 534 + (N-1) * 32 | MaxInput0N (index N = 1 to 4) | INT | • | | | |
| 538 + (N-1) * 32 | Ch0NMinMaxLatchCounter (index N = 1 to 4) | | UINT | • | | |
| Trace configuration | | | | | | |
| 1026 | TraceChannelEnable | USINT | | | | • |
| 1030 | TraceSampleDepth | UINT | | | | • |
| 4157 | ConfigOutput25 (trace priority) | USINT | | | | • |
| 1037 | Starting a recording | USINT | | | • | |
| | TraceEnable01 | Bit 0 | | | | |
| 1089 | Recording status | USINT | • | | | |
| | TraceEnabled | Bit 0 | | | | |
| | TraceWriteActive | Bit 2 | | | | |
| | TraceReadActive | Bit 3 | | | | |
| | ReadyForTrigger | Bit 4 | | | | |
| | TriggerActive | Bit 5 | | | | |
| | TraceOK | Bit 6 | | | | |
| | TraceError | Bit 7 | | | | |
| 1094 | FreeBufferSize | UINT | • | | | |
| 1098 | TriggerCount | UINT | • | | | |
| 1102 | TriggerFailCount | UINT | • | | | |
| Comparator | | | | | | |
| 450 + (N-1) * 8 | cfgComp_LowLimitCh0N (index N = 1 to 4) | INT | | | (•) | • |
| 454 + (N-1) * 8 | cfgComp_HighLimitCh0N (index N = 1 to 4) | INT | | | (•) | • |
| 662 | CompStateCollection | UINT | • | | | |
| 490 | cfgComp_NominalState | UINT | | | | • |
| 482 | cfgComp_EnableMask | UINT | | | | • |
| 486 | cfgComp_ConditionTypeMask | UINT | | | | • |
| Time-offset trace | | | | | | |
| 1042 | TraceTriggerStart | INT | | | | • |
| 1046 | TraceTriggerStop | UINT | | | | • |

9.1.17.10.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration - Frame size | | | | | | | |
| - | - | AsynSize | - | | | | |
| Configuration | | | | | | | |
| 257 289 321 353 | - | ConfigOutput01 (channel configuration) ConfigOutput06 ConfigOutput11 ConfigOutput16 | USINT | | | | • |
| Sampling time | | | | | | | |
| 390 | - | ConfigOutput24 (sampling time) | UINT | | | | • |
| Filtering | | | | | | | |
| 259 291 323 355 | - | ConfigOutput26 (order for low-pass filter) ConfigOutput28 ConfigOutput30 ConfigOutput32 | USINT | | | | • |
| 262 294 326 358 | - | ConfigOutput27 (cutoff frequency of low-pass filter) ConfigOutput29 ConfigOutput31 ConfigOutput33 | UINT | | | | • |
| Scaling | | | | | | | |
| 276 308 340 372 | - | ConfigOutput04 (user-defined gain) ConfigOutput09 ConfigOutput14 ConfigOutput19 | DINT | | | | • |
| 284 316 348 380 | - | ConfigOutput05 (user-defined offset) ConfigOutput10 ConfigOutput15 ConfigOutput20 | DINT | | | | • |
| User-defined limit values | | | | | | | |
| 266 298 330 362 | - | ConfigOutput02 (minimum limit value) ConfigOutput07 ConfigOutput12 ConfigOutput17 | UINT | | | | • |
| 270 302 334 366 | - | ConfigOutput03 (maximum limit value) ConfigOutput08 ConfigOutput13 ConfigOutput18 | UINT | | | | • |
| Communication | | | | | | | |
| $0 + (N-1) * 4$ | $0 + (N-1) * 2$ | AnalogInput0N (index N = 1 to 4) | INT | • | | | |
| 650 | - | SampleCycleCounter | UINT | | • | | |
| Error monitoring and counters | | | | | | | |
| 641 | - | Channel status | USINT | | • | | |
| | | Channel01OK | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | Channel04OK | Bit 3 | | | | |
| | | SyncStatus | Bit 6 | | | | |
| | | ConversionCycle | Bit 7 | | | | |
| 654 | - | SampleCycleViolationErrorCounter | UINT | | • | | |
| 658 | - | Synchronization error counter | UINT | | • | | |
| 2097 | - | Range violation (neg. and pos.) | USINT | | • | | |
| | | Channel01underflow | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | Channel04underflow | Bit 3 | | | | |
| | | Channel01overflow | Bit 4 | | | | |
| | | Channel04overflow | Bit 7 | | | | |
| 2099 | - | Working range violation (pos.) | USINT | | • | | |
| | | Channel01outofrange | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | Channel04outofrange | Bit 3 | | | | |
| $522 + (N-1) * 32$ | - | Ch0NUnderflow (index N = 1 to 4) | UINT | | • | | |
| $526 + (N-1) * 32$ | - | Ch0NOverflow (index N = 1 to 4) | UINT | | • | | |
| $518 + (N-1) * 32$ | - | Ch0NOutOfRange (index N = 1 to 4) | UINT | | • | | |
| Additional analysis functions | | | | | | | |
| 133 | - | Trigger reaction on falling edge | USINT | | | | • |
| 135 | - | Trigger reaction on rising edge | USINT | | | | • |
| 129 | - | Analysis control byte | USINT | | | | • |
| | | MinMaxStart01 | Bit 4 | | | | |
| | | ... | ... | | | | |
| | | MinMaxStart04 | Bit 7 | | | | |

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|---------------------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 129 | - | Analysis status byte | USINT | | | | |
| | | MinMaxStart01Readback | Bit 4 | | • | | |
| | | ... | ... | | | | |
| | | MinMaxStart04Readback | Bit 7 | | | | |
| Limit values | | | | | | | |
| 530 + (N-1) * 32 | - | MinInput0N (index N = 1 to 4) | INT | | • | | |
| 534 + (N-1) * 32 | - | MaxInput0N (index N = 1 to 4) | INT | | • | | |
| 538 + (N-1) * 32 | - | Ch0NMinMaxLatchCounter (index N = 1 to 4) | UINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.1.17.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "Using I/O modules on the bus controller" on page 3789.

9.1.17.10.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.1.17.10.4 Configuration

This module is equipped with analog inputs with connected 16-bit A/D converters. Each of the inputs can be configured separately from one another either on the voltage or current input for the following areas:

- Permitted voltage: ± 10 V
- Permitted current: 0 to 20 mA

9.1.17.10.4.1 Channel configuration

Name:

ConfigOutput01 for channel 1
 ConfigOutput06 for channel 2
 ConfigOutput11 for channel 3
 ConfigOutput16 for channel 4

The individual inputs for processing the current or voltage signal are configured in these registers. This configuration must be made in addition to using suitable terminals.

Filtering, analysis and error monitoring (bits 4 to 6) can only be used if the channel is enabled (bit 7 = 0).

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------------------------|-------|--|
| 0 | Terminal selector | 0 | Voltage terminal for ± 10 VDC (bus controller default setting) |
| | | 1 | Current terminal for 0 to 20 mA |
| 1 | Gain selector | 0 | Voltage ± 10 VDC (bus controller default setting) |
| | | 1 | Current 0 to 20 mA |
| 2 - 3 | Reserved | - | |
| 4 | Filtering active | 0 | Inactive (bus controller default setting) |
| | | 1 | Active |
| 5 | Minimum/Maximum analysis active | 0 | Inactive (bus controller default setting) |
| | | 1 | Active |
| 6 | Error monitoring active | 0 | Inactive (bus controller default setting) |
| | | 1 | Active |
| 7 | Enables channel | 0 | Channel enabled (bus controller default setting) |
| | | 1 | Channel disabled |

9.1.17.10.4.2 Sampling and conversion

The analog signal is sampled in 2 steps.

- **Conversion task**

The A/D converter digitalizes the inputs signals for the enabled inputs once per conversion cycle. Then the results are available internally in the module. To ensure that this process is executed without delays, the corresponding task will be handled with very high priority.

The timespan needed for conversion results from the set sampling time.

- **Processing task**

The converted A/D converter values are further processed according to the user settings (filtering, scaling, limit values, error statistics, min/max analysis, hysteresis comparison). The task for this process has low priority. The timespan needed for further processing depends on the configured functions and is the second portion of the sampling time.

Cycle time violation

In normal operation, further processing is triggered after each conversion. The conversion and sampling tasks run synchronous to one another. If the predefined sampling time is not sufficient to convert all enabled channels and complete the configured functions, a cycle time violation occurs.

Sampling time

Name:

ConfigOutput24

The sampling time is set to μs in this register. This makes it possible to improve the sampling cycle (resolution = $1 \mu\text{s}$). The lowest configurable cycle time is $50 \mu\text{s}$.

| Data type | Value | Information |
|-----------|--------------|-------------------------------------|
| UINT | 50 to 10,000 | Bus controller default setting: 100 |

Information:

Values that are too low for the cycle time will result in cycle time violations.

9.1.17.10.4.3 Filtering (optional)

If filtering is enabled in the "Channel configuration" on page 528 register, the basic data of the A/D converter is filtered per channel. The following registers are available to specify the filter order and respective cutoff frequency for configuring the low-pass filter:

- "Filter order" on page 530
- "Filter cutoff frequency" on page 530

Filter order

Name:

ConfigOutput26 for channel 1

ConfigOutput28 for channel 2

ConfigOutput30 for channel 3

ConfigOutput32 for channel 4

The filter order is specified in this register. The "Filter cutoff frequency" on page 530 register is used to configure the respective cutoff frequency of the filter.

| Data type | Value | Information |
|-----------|--------|-----------------------------------|
| USINT | 1 to 4 | Bus controller default setting: 0 |

Internal filter orders greater than 1 are implemented as cascaded first-order filters.

Calculating the cutoff frequency of an nth-order filter:

Cutoff frequency = Cutoff frequency_N / ((2 ^ (1 / n) - 1) ^ 0.5)

Approximate calculation

$y_n = a * x_n + b * y_{(n-1)}$

$a = \text{Sampling time}_{\text{Sec}} / (\text{Sampling time}_{\text{Sec}} + 1 / (2 \text{ Pi} * \text{Cutoff frequency}_{\text{Hz}}))$

$b = 1 - a$

Information:

Since low-pass filtering takes place using an approximation procedure with fixed-point arithmetic, there are discrepancies to the effective cutoff frequency that depend on the sampling cycle and filter sequence.

Filter cutoff frequency

Name:

ConfigOutput27 for channel 1

ConfigOutput29 for channel 2

ConfigOutput31 for channel 3

ConfigOutput33 for channel 4

The cutoff frequency of the respective filter is configured in these registers.

| Data type | Value | Information |
|-----------|-------------|---|
| UINT | 1 to 65,535 | Cutoff frequency in hertz. Bus controller default setting: 0 |

Information:

The highest cutoff frequency is limited by the Nyquist Shannon sampling theorem (based on the sampling cycle time). The system does not check for violations of this sampling theorem.

9.1.17.10.4.4 Scaling (optional)

Scaling A/D converter data is an option for the user. The following registers are available for this:

- "User-defined gain" on page 531 (= ku)
- "User-defined offset" on page 531 (= du)

Scaling calculation:

Scaled value = k * A/C value + d

Gain k = k_{Calibration} * ku

Offset d = d_{Calibration} + du

The value has to be limited since it can exceed the 16-bit constraints. To provide the greatest degree of flexibility, limiting is possible using the registers "Minimum limit value" on page 532 and "Maximum limit value" on page 532.

User-defined gain

Name:

ConfigOutput04 for channel 1

ConfigOutput09 for channel 2

ConfigOutput14 for channel 3

ConfigOutput19 for channel 4

The user-defined gain for the A/D converter data of the respective physical channel can be specified in these registers.

The value 65,536 (0x10000) corresponds to a gain of 1.

| Data type | Values | Information |
|-----------|------------------------------------|--|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: 65,536 |

User-defined offset

Name:

ConfigOutput05 for channel 1

ConfigOutput10 for channel 2

ConfigOutput15 for channel 3

ConfigOutput20 for channel 4

The user-defined offset for the A/D converter data of the respective physical channel can be specified in this register.

The value 65,536 (0x10000) corresponds to an offset of 1.

| Data type | Values | Information |
|-----------|------------------------------------|-----------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: 0 |

9.1.17.10.4.5 Limit values

If the application requires a limitation of the range of values, then the user can define his own limit values. These values will also be use for the module's error statistics. The following registers are available for this:

- "Minimum limit value" on page 532
- "Maximum limit value" on page 532

Information:

32-bit numbers are used inside the module. A limit value violation can therefore also be determined if the permitted range of values was defined from -32768 to 32767.

Minimum limit value

Name:

ConfigOutput02 for channel 1

ConfigOutput07 for channel 2

ConfigOutput12 for channel 3

ConfigOutput17 for channel 4

The minimum limit value is configured in this register. This limit value is also used for the underflow error statistics (see register "Ch0xUnderflow" on page 535).

| Data type | Values | Information |
|-----------|-----------------|--|
| INT | -32768 to 32767 | Bus controller default setting: -32768 |

Maximum limit value

Name:

ConfigOutput03 for channel 1

ConfigOutput08 for channel 2

ConfigOutput13 for channel 3

ConfigOutput18 for channel 4

The maximum limit value is configured in this register. This limit value is also used for the overflow error statistics (see register "Ch0xOverflow" on page 535).

| Data type | Values | Information |
|-----------|-----------------|---------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 32767 |

9.1.17.10.5 Communication - General

The module's analog inputs convert current and voltage values with 16-bit resolution. This information can be used by the application with the help of the registers listed here.

9.1.17.10.5.1 Analog input channels

Name:

AnalogInput01 to AnalogInput04

The analog input value is mapped in this register depending on the configured operating mode.

| Data type | Value | Input signal: |
|-----------|-------------------|-----------------------------|
| INT | -32,768 to 32,767 | Voltage signal ± 10 VDC |
| | 0 to 32,767 | Current signal 0 to 20 mA |

9.1.17.10.5.2 Sampling cycle counter

Name:

SampleCycleCounter

The number of times the input signal has been sampled is provided in this register.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.1.17.10.5.3 Error monitoring and counters

Channel status

Name:

Channel01OK to Channel04OK

SyncStatus

ConversionCycle

This register collects error messages synchronously with the network cycle. Temporary error states that were registered in a conversion cycle remain active for at least 2 network cycles. In order to receive detailed error information, the corresponding error counters and X2X network events should also be observed.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------------------------|-------|--|
| 0 | Channel01OK | 0 | OK |
| | | 1 | Errors <ul style="list-style-type: none"> Range overshoot Range undershot Working range overshoot |
| ... | | ... | |
| 3 | Channel04OK | 0 | OK |
| | | 1 | Errors See description for bit 0. |
| 4 - 5 | Reserved | - | |
| 6 | SyncStatus ¹⁾ | 0 | OK |
| | | 1 | Not synchronized |
| 7 | ConversionCycle ²⁾ | 0 | OK |
| | | 1 | Errors |

1) Identical to bit 0 of the registers "SynchronizationViolationErrorCounter" on page 533.

2) Identical to bit 0 of the registers "SampleCycleViolationErrorCounter" on page 533.

Synchronization error counter

Name:

SynchronizationViolationErrorCounter

This register counts how often the conversion task was triggered more than 5 μ s after the next-coming X2X cycle. In this case, the module is considered being no longer synchronized with X2X Link.

The counters in this register follow the rules of the event error counter, i.e. the count increased each time an error occurs or is reset. The last bit of the counter indicates the error status:

- Last bit = 1 → Error pending
- Last bit = 0 → No error

| Data type | Value | Information |
|-----------|------------|---------------------|
| UINT | 0 to 65535 | Counter value |
| | 0 to 1 | Bit 0: Error status |

Counter for faulty sampling cycles

Name:

SampleCycleViolationErrorCounter

This register is used to indicate the number of cycle time violations that have occurred thus far. A cycle time violation occurs if the conversion tasks initiates a sampling task before the last sampling cycle has finished. See "Sampling and conversion" on page 529.

The counters in this register follow the rules of the event error counter, i.e. the count increased each time an error occurs or is reset. The last bit of the counter indicates the error status:

- Last bit = 1 → Error pending
- Last bit = 0 → No error

| Data type | Value | Information |
|-----------|------------|---------------------|
| UINT | 0 to 65535 | Counter value |
| | 0 to 1 | Bit 0: Error status |

Range violation (neg. and pos.)

Name:

Channel01underflow to Channel04underflow

Channel01overflow to Channel04overflow

This register indicates whether the limit values defined by registers "Minimum limit value" on page 532 and "Maximum limit value" on page 532 have been overshoot or undershot. The individual bits in this register are identical to the values of the lowest bits of registers "Ch0xUnderflow" on page 535 and "Ch0xOverflow" on page 535.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|--------------------|-------|------------------------------------|
| 0 | Channel01underflow | 0 | No error |
| | | 1 | Range exceeded (.neg) on channel 1 |
| ... | | ... | |
| 3 | Channel04underflow | 0 | No error |
| | | 1 | Range exceeded (.neg) on channel 4 |
| 4 | Channel01overflow | 0 | No error |
| | | 1 | Range exceeded (.pos) on channel 1 |
| ... | | ... | |
| 7 | Channel04overflow | 0 | No error |
| | | 1 | Range exceeded (.pos) on channel 4 |

Working range violation (pos.)

Name:

Channel01outofrange to Channel04outofrange

This register indicates whether the input value overshoots the module's maximum measurement range. The individual bits in this register are identical to the values of the lowest bits of register "Ch0xOutOfRange" on page 534.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------------|-------|---|
| 0 | Channel01outofrange | 0 | No error |
| | | 1 | Working range violation (pos.) of channel 1 |
| ... | | ... | |
| 3 | Channel04outofrange | 0 | No error |
| | | 1 | Working range violation (pos.) of channel 4 |
| 4 - 7 | Reserved | - | |

Counter for work range violations (pos.)

Name:

Ch01OutOfRange to Ch04OutOfRange

Errors outside of the module's maximum possible measurement range are indicated in this register. These errors lead to full-scale deflection of the A/D converter.

The counters in these registers follow the rules of the event error counter, i.e. the count increased each time an error occurs or is reset. The last bit of the counter indicates the error status:

- Last bit = 1 → Error pending
- Last bit = 0 → No error

This counter is only active if the static error counter is enabled (see register "Channel configuration" on page 528).

| Data type | Value | Information |
|-----------|------------|---------------------|
| UINT | 0 to 65535 | Counter value |
| | 0 to 1 | Bit 0: Error status |

Counter for range exceeded violations (neg.)

Name:

Ch01Underflow to Ch04Underflow

This register indicates range exceeded violations (neg.) of the value configured in the register "[Minimum limit value](#)" on page 532.

The counters in these registers follow the rules of the event error counter, i.e. the count increased each time an error occurs or is reset. The last bit of the counter indicates the error status:

- Last bit = 1 → Error pending
- Last bit = 0 → No error

This counter is only active if the static error counter is enabled (see register "[Channel configuration](#)" on page 528).

| Data type | Value | Information |
|-----------|------------|---------------------|
| UINT | 0 to 65535 | Counter value |
| | 0 to 1 | Bit 0: Error status |

Counter for range exceeded violations (pos.)

Name:

Ch01Overflow to Ch04Overflow

This register indicates range exceeded violations (pos.) of the value configured in the register "[Maximum limit value](#)" on page 532.

The counters in these registers follow the rules of the event error counter, i.e. the count increased each time an error occurs or is reset. The last bit of the counter indicates the error status:

- Last bit = 1 → Error pending
- Last bit = 0 → No error

This counter is only active if the static error counter is enabled (see register "[Channel configuration](#)" on page 528).

| Data type | Value | Information |
|-----------|------------|---------------------|
| UINT | 0 to 65535 | Counter value |
| | 0 to 1 | Bit 0: Error status |

9.1.17.10.6 Additional analysis functions

In addition to sampling the analog input signal, this module can also be used to perform additional analysis of the values obtained.

- **Limit value analysis**

If limit value analysis has been enabled for a channel, the sampled minimum and maximum values are latched internally in the module. A measurement period can be triggered using the control byte. When the respective configured edge is generated by the application, the limit values from the previous measurement period are displayed and the internal latch register is reset.

- **Recording sampled values**

If recording sampled values has been enabled for a channel, then the sampled values are additionally recorded in the module's internal FIFO memory. If the configured event occurs, the contents of the FIFO memory are transmitted to the application.

Information:

It is only possible to use the recording of sampled values if the module is operated on an X2X master that is an SG4 CPU.

9.1.17.10.6.1 Trigger condition on falling edge

Name:

ConfigOutput21

This register configures whether the falling edge is used to trigger the trace and determination of the input value in the register "Analysis control byte" on page 537.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------|-------|---|
| 0 | TraceTrigger01 | 0 | No trigger (bus controller default setting) |
| | | 1 | Falling edge active as trigger |
| 1 - 3 | Reserved | - | |
| 4 | MinMaxStart01 | 0 | No determination (bus controller default setting) |
| | | 1 | Falling edge determines input value of channel 1 |
| ... | ... | ... | |
| 7 | MinMaxStart04 | 0 | No determination (bus controller default setting) |
| | | 1 | Falling edge determines input value of channel 4 |

9.1.17.10.6.2 Trigger condition on rising edge

Name:

ConfigOutput22

This register configures whether the rising edge is used to trigger the trace and determination of the input value in the register "Analysis control byte" on page 537.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------|-------|---|
| 0 | TraceTrigger01 | 0 | Trigger not initiated on positive edge (bus controller default setting) |
| | | 1 | Rising edge active as trigger |
| 1 - 3 | Reserved | - | |
| 4 | MinMaxStart01 | 0 | No determination (bus controller default setting) |
| | | 1 | Rising edge determines input value of channel 1 |
| ... | ... | ... | |
| 7 | MinMaxStart04 | 0 | No determination (bus controller default setting) |
| | | 1 | Rising edge determines input value of channel 4 |

9.1.17.10.6.3 Analysis control byte

Name:

TraceTrigger01

MinMaxStart01 to MinMaxStart04

The trace function and determination of the minimum/maximum input values can be started in this register. Whether the rising and/or falling edge is used to trigger the functions can be configured using the registers "[Trigger condition on falling edge](#)" on page 536 and "[Trigger condition on rising edge](#)" on page 536.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------|-------|--|
| 0 | TraceTrigger01 | 0 | Trigger/Trace not triggered (bus controller default setting) |
| | | 1 | Initiates trigger/trace |
| 1 - 3 | Reserved | - | |
| 4 | MinMaxStart01 | 0 | Determination not triggered (bus controller default setting) |
| | | 1 | Initiates determination of input value of channel 1 |
| ... | ... | ... | |
| 7 | MinMaxStart04 | 0 | Determination not triggered (bus controller default setting) |
| | | 1 | Initiates determination of input value of channel 4 |

Information:

To reduce the cyclic data transfer, this register combines the trace and limit value determination functions.

9.1.17.10.6.4 Analysis status byte

Name:

MinMaxStart01Readback to MinMaxStart04Readback

The currently requested module-internal analyses can be checked in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------|--------|---|
| 0 - 3 | Reserved | - | |
| 4 | MinMaxStart01Readback | 0 or 1 | Current state of the trigger bits for determining the limit values on the channel |
| ... | ... | ... | |
| 7 | MinMaxStart04Readback | 0 or 1 | Current state of the trigger bits for determining the limit values on the channel |

9.1.17.10.7 Limit values

Limit value analysis must be enabled for the desired channel (see "Channel configuration" on page 528). The sampled value of the channel is then compared to the minimum and maximum values that are stored internally in the module. If a new measurement period is initiated with the "Analysis control byte" on page 537 register, then the values determined from the previous measurement period can be taken from the respective registers intended for this.

9.1.17.10.7.1 Minimum input values

Name:

MinInput01 to MinInput04

The minimum value of the preceding trigger period is saved in this register based on the filtered, scaled and user-defined limit values. The register value is 0 if the channel is inactive.

| Data type | Value |
|-----------|-------------------|
| INT | -32,768 to 32,767 |

9.1.17.10.7.2 Maximum input values

Name:

MaxInput01 to MaxInput04

The maximum value of the preceding trigger period is saved in this register based on the filtered, scaled and user-defined limit values. The register value is 0 if the channel is inactive.

| Data type | Value |
|-----------|-------------------|
| INT | -32,768 to 32,767 |

9.1.17.10.7.3 Limit value trigger counter

Name:

Ch01MinMaxLatchCounter to Ch04MinMaxLatchCounter

The number of valid events that trigger a new measurement period for the limit value analysis is counted in this register.

| Data type | Value |
|-----------|------------|
| UINT | 0 to 65535 |

9.1.17.10.8 Trace

If the module is operated on a SG4 CPU, the digitalized input values are recorded by the module. The module must be operated in "Supervised" mode in order to use the trace function.

Recording must be enabled for the desired channel. The enable bits can then control the recording at runtime. The sampled values are recorded in the module's internal FIFO memory.

If the previously defined state occurs on the channel, the contents of the FIFO memory are transmitted to the application. Whether the FIFO memory continued to be filled depends on how recording is configured.

Information:

The trace mechanism can only be used if the module is connected directly to the CPU, not if it is operated behind a bus controller.

9.1.17.10.8.1 Enable recording

Name:

TraceChannelEnable

The respective channel is enabled for the trace with this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|------------------|
| 0 | Channel 1 | 0 | Channel disabled |
| | | 1 | Channel enabled |
| ... | ... | ... | |
| 3 | Channel 4 | 0 | Channel disabled |
| | | 1 | Channel enabled |
| 4 - 7 | Reserved | - | |

9.1.17.10.8.2 Number of values to be recorded

Name:

TraceSampleDepth

16 kB are available on the module for the trace. The FIFO memory limitation means that a maximum of 8192 analog values can be recorded. This memory is divided up equally among the enabled channels. The actual number of maximum possible recordings therefore depends on the number of channels enabled for trace:

- 1 channel enabled: Up to 8192 recordings
- 2 channels enabled: Up to 4096 recordings per channel
- 3 channels enabled: Up to 2730 recordings per channel
- 4 channels enabled: Up to 2048 recordings per channel

| Data type | Value |
|-----------|-----------|
| UINT | 2 to 8192 |

9.1.17.10.8.3 Recording priority

Name:

ConfigOutput25

The priority of the trace can be increased with this register.

| Data type | Value | Function |
|-----------|-------|---|
| USINT | 3 | Standard |
| | 6 | Trace priority higher than X2X Link communication |

9.1.17.10.8.4 Starting a recording

Name:

TraceEnable01

This register starts the recording according to the specifications for edge control or the comparator.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|-----------------------------|
| 0 | TraceEnable01 | 0 | Disables the trace function |
| | | 1 | Enables the trace function |
| 1 - 7 | Reserved | - | |

9.1.17.10.8.5 Recording status

Name:

TraceEnabled

TraceWriteActive

TraceReadActive

ReadyForTrigger

TriggerActive

TraceOk

TraceError

The status of the trace is represented in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|------------------|-------|---------------------------------------|
| 0 | TraceEnabled | 0 | Trace inactive |
| | | 1 | Trace active |
| 1 | Reserved | - | |
| 2 | TraceWriteActive | 0 | Data not recorded |
| | | 1 | Data recorded |
| 3 | TraceReadActive | 0 | Data not output/read |
| | | 1 | Data output/read |
| 4 | ReadyForTrigger | 0 | Not ready for triggering |
| | | 1 | Ready for triggering |
| 5 | TriggerActive | 0 | No trigger active or already executed |
| | | 1 | Trigger active |
| 6 | TraceOk | 0 | Overflow or inactive |
| | | 1 | No overflow |
| 7 | TraceError | 0 | No error or inactive |
| | | 1 | Trace buffer full |

9.1.17.10.8.6 Free trace buffer

Name:

FreeBufferSize

Specifies the available FIFO memory area in bytes for the trace

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.1.17.10.8.7 Counter for trace triggers

Name:

TriggerCount

This register indicates the number of triggers that have occurred since [starting the trace](#).

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.1.17.10.8.8 Counter for faulty recording triggers

Name:

TriggerFailCount

Counts the trigger events for which the trace could not be performed.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.1.17.10.8.9 Comparator for trigger conditions

In order to adapt the trace as closely as possible to the requirements of the application, the trace function can also be controlled using the comparator. Threshold values (hysteresis) can be defined within the permitted range of values to do so. 2 status bits are then generated for each enabled channel:

- **InRange bit**

The InRange status is "1" if the measured value falls within the defined limits.

The InRange status is "0" if the measured value falls outside the defined limits.

- **Threshold value bit**

The threshold value bit is "1" if the measured value exceeds the upper threshold value.

The threshold value bit is "0" if the measured value falls below the lower threshold value.

The InRange and threshold value bits for all channels are grouped together in the lower-value byte of the "[CompStateCollection](#)" on page 542 register. In addition, the states of the previous sampling are stored in the higher-value byte.

The 4 status messages of each channel can be linked according to the following logic via a logical connective mask using AND or OR operators and used as a trace trigger:

```
delta = (Current_HysteresisStatus ^ NominalValues)// Different between current status and preset
cond = delta & Selected_HysteresisStatusBits// Eliminate irrelevant status messages
ccond = Selected_HysteresisStatusBits (Current_HysteresisStatus ^ NominalValues)
if((0==(cond & ~LogicalOperators)) &&
(0!=(~cond & LogicalOperators))) {=> Generate trigger event}
```

| | |
|-------------------------------|--|
| Selected_HysteresisStatusBits | Corresponds to register: "cfgComp_EnableMask" on page 543 |
| Current_HysteresisStatus | "CompStateCollection" on page 542 |
| Nominal values | "cfgComp_NominalState" on page 542 |
| Logical operators | "cfgComp_ConditionTypeMask" on page 543 |

Lower limit value for hysteresis

Name:

cfgComp_LowLimitCh01 to cfgComp_LowLimitCh04

The lower limit value for hysteresis is configured in this register.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

Upper limit value for hysteresis

Name:

cfgComp_HighLimitCh01 to cfgComp_HighLimitCh04

The upper limit value for hysteresis is configured in this register.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

Hysteresis status of the channels

Name:

CompStateCollection

The hysteresis status of the input channels for the current and last cycle are represented in this register.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|--|-------|---|
| 0 | Channel01 hysteresis status in the current cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 1 | Channel01 InRange status in the current cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| ... | ... | ... | |
| 6 | Channel04 hysteresis status in the current cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 7 | Channel04 InRange status in the current cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| 8 | Channel01 hysteresis status in the last cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 9 | Channel01 InRange status in the last cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| ... | ... | ... | |
| 14 | Channel04 hysteresis status in the last cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 15 | Channel04 InRange status in the last cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |

Comparison state of the channels

Name:

cfgComp_NominalState

The desired comparison state for the hysteresis status is indicated in this register.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|--|-------|---|
| 0 | Channel01 hysteresis status in the current cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 1 | Channel01 InRange status in the current cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| ... | ... | ... | |
| 6 | Channel04 hysteresis status in the current cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 7 | Channel04 InRange status in the current cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| 8 | Channel01 hysteresis status in the last cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 9 | Channel01 InRange status in the last cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| ... | ... | ... | |
| 14 | Channel04 hysteresis status in the last cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 15 | Channel04 InRange status in the last cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |

Information:

This is a "whitelist", i.e. the trace starts as soon as the current status message takes on the state predefined here.

One or more matches will be necessary depending on the selection of the relevant hysteresis status bits and logical connective operators.

Selecting the relevant hysteresis status bits

Name:

cfgComp_EnableMask

This register selects which status bits of the hysteresis comparison should be used to generate the trigger.

For more information about using this register, see ["Comparator for trigger conditions"](#) on page 541.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|--|-------|--------------------|
| 0 | Channel01 hysteresis status in the current cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 1 | Channel01 InRange status in the current cycle | 0 | Do not use |
| | | 1 | Use for generation |
| ... | ... | ... | |
| 6 | Channel04 hysteresis status in the current cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 7 | Channel04 InRange status in the current cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 8 | Channel01 hysteresis status in the last cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 9 | Channel01 InRange status in the last cycle | 0 | Do not use |
| | | 1 | Use for generation |
| ... | ... | ... | |
| 14 | Channel04 hysteresis status in the last cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 15 | Channel04 InRange status in the last cycle | 0 | Do not use |
| | | 1 | Use for generation |

Logical connective operators for hysteresis status bits

Name:

cfgComp_ConditionTypeMask

The desired state operators with which the respective status bit is linked to others to generate a trigger are selected in this register.

At least one OR operation must be configured, but it does not necessarily have to be located on a channel configured with "1" in the ["cfgComp_EnableMask"](#) on page 543 register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|--|-------|-------------------|
| 0 | Channel01 hysteresis status in the current cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 1 | Channel01 InRange status in the current cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| ... | ... | ... | |
| 6 | Channel04 hysteresis status in the current cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 7 | Channel04 InRange status in the current cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 8 | Channel01 hysteresis status in the last cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 9 | Channel01 InRange status in the last cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| ... | ... | ... | |
| 14 | Channel04 hysteresis status in the last cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 15 | Channel04 InRange status in the last cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |

9.1.17.10.8.10 Time-offset trace

Additional conditions for shifting the starting and stopping points can be defined if the trace should be chronologically offset to the trigger.

Starting the trace

Name:

TraceTriggerStart

The starting position is defined relative to the configured trigger condition (rising/falling edge) in this register. Positive values mean that the trace takes place x samples after the trigger condition. Negative values mean that the trace takes place x samples before the trigger condition.

The value -32768 performs the trace without regard for the configured trigger condition. If the trace memory is completely full, then the oldest recorded value is overwritten (FIFO principle).

"Trace start" in the I/O configuration or the registers "[Trigger condition on falling edge](#)" on page 536 and "[Trigger condition on rising edge](#)" on page 536 determine whether a positive, negative or any edge must be triggered.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

Stopping the trace

Name:

TraceTriggerStop

The stopping position is defined relative to the configured trigger condition in this register.

- When configuring an early trigger event, this value refers to the trigger event.
- When configuring a delayed trigger event, this value refers to the starting event.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.1.17.10.9 Acyclic frame size

Name:

AsynSize

When the stream is used, data is exchanged internally between the module and CPU. For this purpose, a defined amount of acyclic bytes is reserved for this slot.

Increasing the acyclic frame size leads to increased data throughput on this slot.

Information:

This configuration involves a driver setting that cannot be changed during runtime!

| Data type | Value | Information |
|-----------|---------|---|
| - | 8 to 28 | Acyclic frame size in bytes. Default = 24 |

9.1.17.10.10 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|-----------------------------------|--------|
| Standard priority | 200 µs |
| High priority with trace function | 300 µs |

9.1.17.10.11 Minimum I/O update time

There is no limitation or dependency on the bus cycle time.

The I/O update time is defined using the "Sampling time" register. The fastest possible sampling time depends on the number of channels to be converted and the configuration.

9.1.18 X20(c)AI4632-1

Data sheet version: 3.11

9.1.18.1 General information

The module is equipped with 4 inputs with 16-bit digital converter resolution. It is possible to select between the current and voltage signal using different terminals.

- 4 analog inputs
- Either current or voltage signal possible
- Extended signal range
- 16-bit digital converter resolution
- Simultaneous input conversion
- Very fast conversion time

9.1.18.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.1.18.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C . During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.1.18.3 Order data

| Model number | Short description | Figure |
|--------------|--|--------|
| | Analog inputs | |
| X20AI4632-1 | X20 analog input module, 4 inputs, $\pm 11\text{ V}$ or 0 to 22 mA, 16-bit converter resolution, configurable input filter, oscilloscope functions | |
| X20cAI4632-1 | X20 analog input module, coated, 4 inputs, $\pm 11\text{ V}$ or 0 to 22 mA, 16-bit converter resolution, configurable input filter, oscilloscope functions | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 74: X20AI4632-1, X20cAI4632-1 - Order data

9.1.18.4 Technical data

| Model number | X20AI4632-1 | X20cAI4632-1 |
|--|--|--------------|
| Short description | | |
| I/O module | 4 analog inputs ± 11 V or 0 to 22 mA | |
| General information | | |
| B&R ID code | 0xA29D | 0xD57A |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Inputs | Yes, using status LED and software | |
| Channel type | Yes, using software | |
| Power consumption | | |
| Bus | 0.01 W | |
| Internal I/O | 1.5 W ¹⁾ | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations | |
| DNV GL | Class I, Division 2, Groups ABCD, T5 Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Analog inputs | | |
| Input | ± 11 V or 0 to 22 mA, via different terminal connections | |
| Input type | Differential input | |
| Digital converter resolution | | |
| Voltage | ± 15 -bit | |
| Current | 15-bit | |
| Conversion time | 50 μ s for all inputs | |
| Output format | INT | |
| Output format | | |
| Voltage | INT 0x8001 - 0x7FFF / 1 LSB = 0x0001 = 335.693 μ V | |
| Current | INT 0x0000 - 0x7FFF / 1 LSB = 0x0001 = 671.387 nA | |
| Input impedance in signal range | | |
| Voltage | 20 M Ω | |
| Current | - | |
| Load | | |
| Voltage | - | |
| Current | <400 Ω | |
| Input protection | Protection against wiring with supply voltage | |
| Permissible input signal | | |
| Voltage | Max. ± 30 V | |
| Current | Max. ± 50 mA | |
| Output of digital value during overload | | |
| Undershoot | | |
| Voltage | 0x8001 | |
| Current | 0x0000 | |
| Overshoot | | |
| Voltage | 0x7FFF | |
| Current | 0x7FFF | |
| Conversion procedure | SAR | |
| Input filter | Hardware - 3rd-order low pass / cutoff frequency 10 kHz | |
| Max. error | | |
| Voltage | | |
| Gain | 0.08% ²⁾ | |
| Offset | 0.01% ³⁾ | |
| Current | | |
| Gain | 0.08% ²⁾ | |
| Offset | 0.02% ⁴⁾ | |

Table 75: X20AI4632-1, X20cAI4632-1 - Technical data


| Model number | X20AI4632-1 | X20cAI4632-1 |
|---|--|---|
| Max. gain drift | | |
| Voltage | | 0.01 %/°C ²⁾ |
| Current | | 0.01 %/°C ²⁾ |
| Max. offset drift | | |
| Voltage | | 0.001 %/°C ³⁾ |
| Current | | 0.002 %/°C ⁴⁾ |
| Common-mode rejection | | |
| DC | | 70 dB |
| 50 Hz | | 70 dB |
| Common-mode range | | ±12 V |
| Crosstalk between channels | | <-70 dB |
| Nonlinearity | | |
| Voltage | | <0.01% ³⁾ |
| Current | | <0.015% ⁴⁾ |
| Isolation voltage between channel and bus | | 500 V _{eff} |
| Electrical properties | | |
| Electrical isolation | | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | | Yes |
| Vertical | | Yes |
| Installation elevation above sea level | | |
| 0 to 2000 m | | No limitations |
| >2000 m | | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | | IP20 |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | | -25 to 60°C |
| Vertical mounting orientation | | -25 to 50°C |
| Derating | | See section "Derating" |
| Starting temperature | - | Yes, -40°C |
| Storage | | -40 to 85°C |
| Transport | | -40 to 85°C |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | | 5 to 95%, non-condensing |
| Transport | | 5 to 95%, non-condensing |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | | 12.5 ^{+0.2} mm |

Table 75: X20AI4632-1, X20cAI4632-1 - Technical data

- 1) To reduce power dissipation, B&R recommends bridging unused inputs on the terminals or configuring them as current signals.
- 2) Based on the current measured value.
- 3) Based on the 22 V measurement range.
- 4) Based on the 22 mA measurement range.

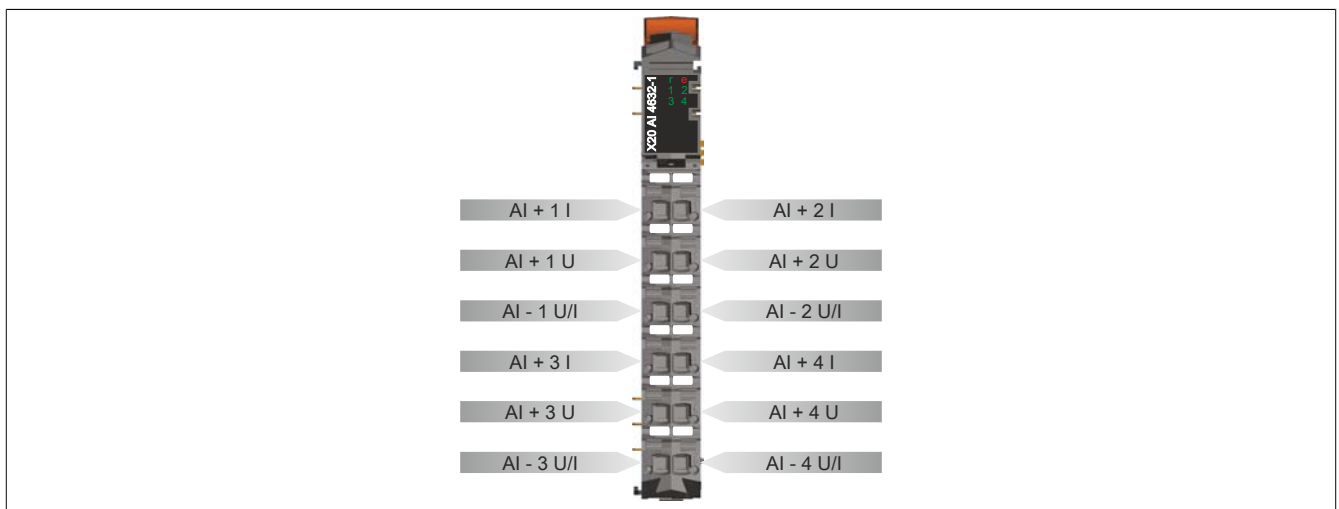
9.1.18.5 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|-------|--------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | e | Red | On | RUN mode |
| | | | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | | | Double flash | System error: <ul style="list-style-type: none"> • Violation of the scan time • Synchronization error |
| | 1 - 4 | Green | Off | Open line ²⁾ or sensor is disconnected |
| | | | On | Analog/digital converter running, value OK |

- 1) Depending on the configuration, a firmware update can take up to several minutes.
- 2) Open line detection only possible when measuring voltage.

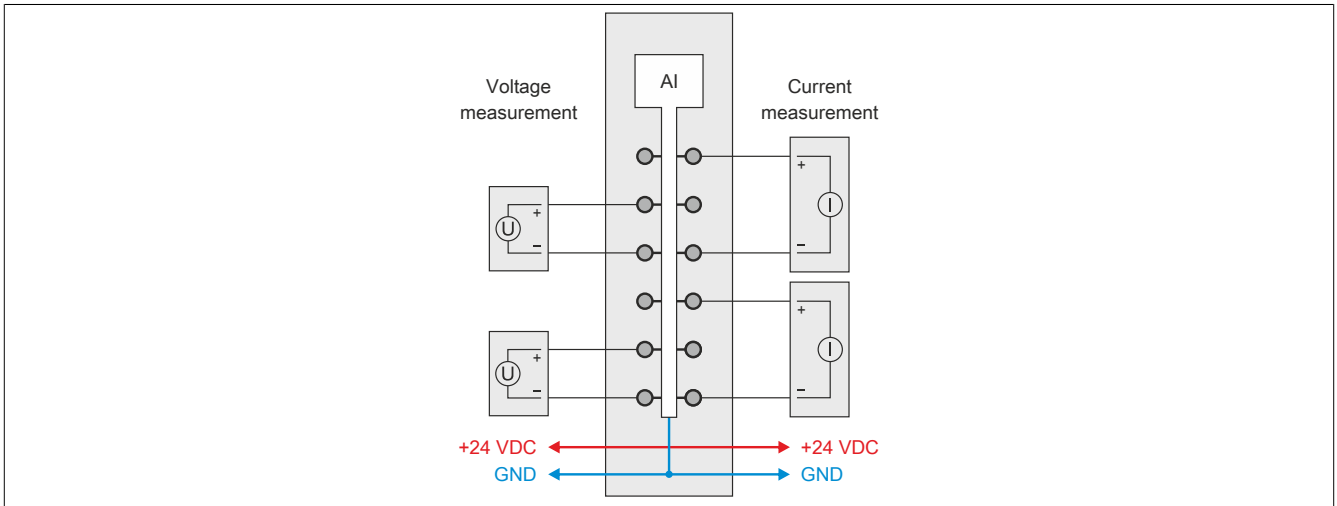
9.1.18.6 Pinout



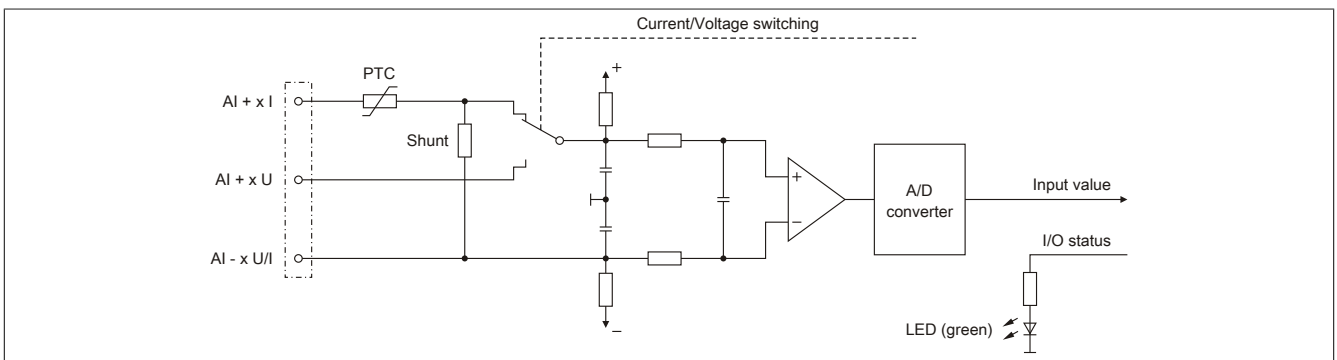
9.1.18.7 Connection example

To prevent disturbances, the following modules must be separated by at least one module:

- Bus receiver X20BR9300
- Supply module X20PS3300/X20PS3310
- Supply module X20PS9400/X20PS9402
- Supply module X20PS9500/X20PS9502
- CPU modules



9.1.18.8 Input circuit diagram

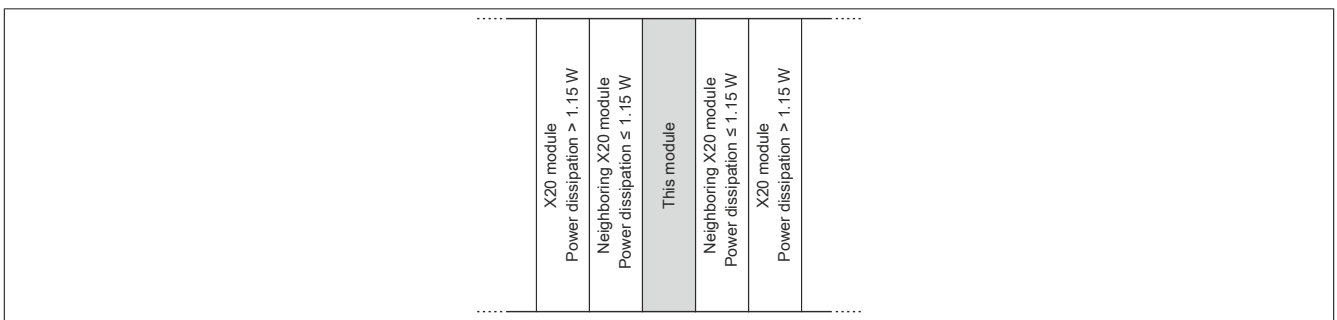


9.1.18.9 Derating

There is no derating when operated below 55°C.

During operation over 55°C, the power dissipation of the modules to the left and right of this module is not permitted to exceed 1.15 W!

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.



9.1.18.10 Register description

9.1.18.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.1.18.10.2 Function model 0 - default

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration - Frame size | | | | | | |
| - | AsynSize | - | | | | |
| Configuration | | | | | | |
| 257 289 321 353 | ConfigOutput01 (channel configuration) ConfigOutput06 ConfigOutput11 ConfigOutput16 | USINT | | | | • |
| Sampling time | | | | | | |
| 390 | ConfigOutput24 (sampling time) | UINT | | | | • |
| Filtering | | | | | | |
| 259 291 323 355 | ConfigOutput26 (order for low-pass filter) ConfigOutput28 ConfigOutput30 ConfigOutput32 | USINT | | | | • |
| 262 294 326 358 | ConfigOutput27 (cutoff frequency of low-pass filter) ConfigOutput29 ConfigOutput31 ConfigOutput33 | UINT | | | | • |
| Scaling | | | | | | |
| 276 308 340 372 | ConfigOutput04 (user-defined gain) ConfigOutput09 ConfigOutput14 ConfigOutput19 | DINT | | | | • |
| 284 316 348 380 | ConfigOutput05 (user-defined offset) ConfigOutput10 ConfigOutput15 ConfigOutput20 | DINT | | | | • |
| User-defined limit values | | | | | | |
| 266 298 330 362 | ConfigOutput02 (minimum limit value) ConfigOutput07 ConfigOutput12 ConfigOutput17 | UINT | | | | • |
| 270 302 334 366 | ConfigOutput03 (maximum limit value) ConfigOutput08 ConfigOutput13 ConfigOutput18 | UINT | | | | • |
| Communication | | | | | | |
| 0 + (N-1) * 4 | AnalogInput0N (index N = 1 to 4) | INT | • | | | |
| 650 | SampleCycleCounter | UINT | | • | | |
| Error monitoring and counters | | | | | | |
| 641 | Channel status | USINT | • | | | |
| | Channel01OK | Bit 0 | | | | |
| | ... | ... | | | | |
| | Channel04OK | Bit 3 | | | | |
| | SyncStatus | Bit 6 | | | | |
| | ConversionCycle | Bit 7 | | | | |
| 654 | SampleCycleViolationErrorCounter | UINT | | • | | |
| 658 | Synchronization error counter | UINT | | • | | |
| 2097 | Range violation (neg. and pos.) | USINT | • | | | |
| | Channel01underflow | Bit 0 | | | | |
| | ... | ... | | | | |
| | Channel04underflow | Bit 3 | | | | |
| | Channel01overflow | Bit 4 | | | | |
| | ... | ... | | | | |
| 2099 | Working range violation (pos.) | USINT | • | | | |
| | Channel01outofrange | Bit 0 | | | | |
| | ... | ... | | | | |
| | Channel04outofrange | Bit 3 | | | | |
| 518 + (N-1) * 32 | Ch0NOverflow (index N = 1 to 4) | UINT | | • | | |
| 522 + (N-1) * 32 | Ch0NUnderflow (index N = 1 to 4) | UINT | | • | | |
| 526 + (N-1) * 32 | Ch0NOutOfRange (index N = 1 to 4) | UINT | | • | | |

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Additional analysis functions | | | | | | |
| 133 | ConfigOutput21 (trigger reaction on falling edge) | USINT | | | | • |
| 135 | ConfigOutput22 (trigger reaction on rising edge) | USINT | | | | • |
| 129 | Analysis control byte | USINT | | | • | |
| | TraceTrigger01 | Bit 0 | | | | |
| | MinMaxStart01 | Bit 4 | | | | |
| | ... | ... | | | | |
| 129 | MinMaxStart04 | Bit 7 | | | | |
| | Analysis status byte | USINT | • | | | |
| | MinMaxStart01Readback | Bit 4 | | | | |
| | ... | ... | | | | |
| | MinMaxStart04Readback | Bit 7 | | | | |
| Limit values | | | | | | |
| 530 + (N-1) * 32 | MinInput0N (index N = 1 to 4) | INT | • | | | |
| 534 + (N-1) * 32 | MaxInput0N (index N = 1 to 4) | INT | • | | | |
| 538 + (N-1) * 32 | Ch0NMinMaxLatchCounter (index N = 1 to 4) | UINT | | • | | |
| Trace configuration | | | | | | |
| 1026 | TraceChannelEnable | USINT | | | | • |
| 1030 | TraceSampleDepth | UINT | | | | • |
| 4157 | ConfigOutput25 (trace priority) | USINT | | | | • |
| 1037 | Starting a recording | USINT | | | • | |
| | TraceEnable01 | Bit 0 | | | | |
| 1089 | Recording status | USINT | • | | | |
| | TraceEnabled | Bit 0 | | | | |
| | TraceWriteActive | Bit 2 | | | | |
| | TraceReadActive | Bit 3 | | | | |
| | ReadyForTrigger | Bit 4 | | | | |
| | TriggerActive | Bit 5 | | | | |
| | TraceOK | Bit 6 | | | | |
| TraceError | Bit 7 | | | | | |
| 1094 | FreeBufferSize | UINT | • | | | |
| 1098 | TriggerCount | UINT | • | | | |
| 1102 | TriggerFailCount | UINT | • | | | |
| Comparator | | | | | | |
| 450 + (N-1) * 8 | cfgComp_LowLimitCh0N (index N = 1 to 4) | INT | | | (•) | • |
| 454 + (N-1) * 8 | cfgComp_HighLimitCh0N (index N = 1 to 4) | INT | | | (•) | • |
| 662 | CompStateCollection | UINT | • | | | |
| 490 | cfgComp_NominalState | UINT | | | | • |
| 482 | cfgComp_EnableMask | UINT | | | | • |
| 486 | cfgComp_ConditionTypeMask | UINT | | | | • |
| Time-offset trace | | | | | | |
| 1042 | TraceTriggerStart | INT | | | | • |
| 1046 | TraceTriggerStop | UINT | | | | • |

9.1.18.10.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration - Frame size | | | | | | | |
| - | - | AsynSize | - | | | | |
| Configuration | | | | | | | |
| 257 289 321 353 | - | ConfigOutput01 (channel configuration) ConfigOutput06 ConfigOutput11 ConfigOutput16 | USINT | | | | • |
| Sampling time | | | | | | | |
| 390 | - | ConfigOutput24 (sampling time) | UINT | | | | • |
| Filtering | | | | | | | |
| 259 291 323 355 | - | ConfigOutput26 (order for low-pass filter) ConfigOutput28 ConfigOutput30 ConfigOutput32 | USINT | | | | • |
| 262 294 326 358 | - | ConfigOutput27 (cutoff frequency of low-pass filter) ConfigOutput29 ConfigOutput31 ConfigOutput33 | UINT | | | | • |
| Scaling | | | | | | | |
| 276 308 340 372 | - | ConfigOutput04 (user-defined gain) ConfigOutput09 ConfigOutput14 ConfigOutput19 | DINT | | | | • |
| 284 316 348 380 | - | ConfigOutput05 (user-defined offset) ConfigOutput10 ConfigOutput15 ConfigOutput20 | DINT | | | | • |
| User-defined limit values | | | | | | | |
| 266 298 330 362 | - | ConfigOutput02 (minimum limit value) ConfigOutput07 ConfigOutput12 ConfigOutput17 | UINT | | | | • |
| 270 302 334 366 | - | ConfigOutput03 (maximum limit value) ConfigOutput08 ConfigOutput13 ConfigOutput18 | UINT | | | | • |
| Communication | | | | | | | |
| $0 + (N-1) * 4$ | $0 + (N-1) * 2$ | AnalogInput0N (index N = 1 to 4) | INT | • | | | |
| 650 | - | SampleCycleCounter | UINT | | • | | |
| Error monitoring and counters | | | | | | | |
| 641 | - | Channel status | USINT | | • | | |
| | | Channel01OK | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | Channel04OK | Bit 3 | | | | |
| | | SyncStatus | Bit 6 | | | | |
| | | ConversionCycle | Bit 7 | | | | |
| 654 | - | SampleCycleViolationErrorCounter | UINT | | • | | |
| 658 | - | Synchronization error counter | UINT | | • | | |
| 2097 | - | Range violation (neg. and pos.) | USINT | | • | | |
| | | Channel01underflow | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | Channel01underflow | Bit 3 | | | | |
| | | Channel01overflow | Bit 4 | | | | |
| | | Channel04overflow | Bit 7 | | | | |
| 2099 | - | Working range violation (pos.) | USINT | | • | | |
| | | Channel01outofrange | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | Channel04outofrange | Bit 3 | | | | |
| $518 + (N-1) * 32$ | - | Ch0NOverflow (index N = 1 to 4) | UINT | | • | | |
| $522 + (N-1) * 32$ | - | Ch0NUnderflow (index N = 1 to 4) | UINT | | • | | |
| $526 + (N-1) * 32$ | - | Ch0NOutOfRange (index N = 1 to 4) | UINT | | • | | |
| Additional analysis functions | | | | | | | |
| 133 | - | ConfigOutput21 (trigger reaction on falling edge) | USINT | | | | • |
| 135 | - | ConfigOutput22 (trigger reaction on rising edge) | USINT | | | | • |
| 129 | - | Analysis control byte | USINT | | | | • |
| | | MinMaxStart01 | Bit 4 | | | | |
| | | ... | ... | | | | |
| | | MinMaxStart04 | Bit 7 | | | | |

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|---------------------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 129 | - | Analysis status byte | USINT | | | | |
| | | MinMaxStart01Readback | Bit 4 | | • | | |
| | | ... | ... | | | | |
| | | MinMaxStart04Readback | Bit 7 | | | | |
| Limit values | | | | | | | |
| 530 + (N-1) * 32 | - | MinInput0N (index N = 1 to 4) | INT | | • | | |
| 534 + (N-1) * 32 | - | MaxInput0N (index N = 1 to 4) | INT | | • | | |
| 538 + (N-1) * 32 | - | Ch0NMinMaxLatchCounter (index N = 1 to 4) | UINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.1.18.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "Using I/O modules on the bus controller" on page 3789.

9.1.18.10.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.1.18.10.4 Configuration

This module is equipped with analog inputs with connected 16-bit A/D converters. Each of the inputs can be configured separately from one another either on the voltage or current input for the following areas:

- Permitted voltage: ± 11 V at 20 Ω
- Permitted current: 22 mA (maximum 40 mA) (<400 Ω)

9.1.18.10.4.1 Channel configuration

Name:

ConfigOutput01 for channel 01

ConfigOutput06 for channel 02

ConfigOutput11 for channel 03

ConfigOutput16 for channel 04

The individual inputs for processing the current or voltage signal are configured in these registers. This configuration must be made in addition to using suitable terminals.

Filtering, analysis and error monitoring (bits 4 to 6) can only be used if the channel is enabled (bit 7 = 0).

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|---|-------|--|
| 0 | Terminal selector | 0 | Voltage terminal for ± 11 VDC (bus controller default setting) |
| | | 1 | Current terminal for 0 to 22 mA |
| 1 | Gain selector | 0 | Voltage ± 11 VDC (bus controller default setting) |
| | | 1 | Current 0 to 22 mA |
| 2 - 3 | Reserved | - | |
| 4 | Filtering active (only if bit 7 = 0) | 0 | Inactive (bus controller default setting) |
| | | 1 | Active |
| 5 | Minimum/Maximum analysis active (only if bit 7 = 0) | 0 | Inactive (bus controller default setting) |
| | | 1 | Active |
| 6 | Error monitoring active (only if bit 7 = 0) | 0 | Inactive (bus controller default setting) |
| | | 1 | Active |
| 7 | Enables channel | 0 | Channel enabled (bus controller default setting) |
| | | 1 | Channel disabled |

9.1.18.10.4.2 Sampling and conversion

The analog signal is sampled in 2 steps.

- **Conversion task**

The A/D converter digitalizes the inputs signals for the enabled inputs once per conversion cycle. Then the results are available internally in the module. To ensure that this process is executed without delays, the corresponding task will be handled with very high priority.

The timespan needed for conversion results from the set sampling time.

- **Processing task**

The converted A/D converter values are further processed according to the user settings (filtering, scaling, limit values, error statistics, min/max analysis, hysteresis comparison). The task for this process has low priority. The timespan needed for further processing depends on the configured functions and is the second portion of the sampling time.

Cycle time violation

In normal operation, further processing is triggered after each conversion. The conversion and sampling tasks run synchronous to one another. If the predefined sampling time is not sufficient to convert all enabled channels and complete the configured functions, a cycle time violation occurs.

Sampling time

Name:

ConfigOutput24

The sampling time is set to μs in this register. This makes it possible to improve the sampling cycle (resolution = 1 μs). The lowest configurable cycle time is 50 μs .

| Data type | Value | Information |
|-----------|--------------|-------------------------------------|
| UINT | 50 to 10,000 | Bus controller default setting: 100 |

Information:

Values that are too low for the cycle time will result in cycle time violations.

9.1.18.10.4.3 Filtering (optional)

If filtering is enabled in the "Channel configuration" on page 553 register, the basic data of the A/D converter is filtered per channel. The following registers are available to specify the filter order and respective cutoff frequency for configuring the low-pass filter:

- "Filter order" on page 555
- "Filter cutoff frequency" on page 555

Filter order

Name:

ConfigOutput26 for channel 1

ConfigOutput28 for channel 2

ConfigOutput30 for channel 3

ConfigOutput32 for channel 4

The filter order is specified in this register. The "Filter cutoff frequency" on page 555 register is used to configure the respective cutoff frequency of the filter.

| Data type | Value | Information |
|-----------|--------|-----------------------------------|
| USINT | 1 to 4 | Bus controller default setting: 0 |

Internal filter orders greater than 1 are implemented as cascaded first-order filters.

Calculating the cutoff frequency of an nth-order filter:

Cutoff frequency = Cutoff frequency_N / ((2 ^ (1 / n) - 1) ^ 0.5)

Approximate calculation

$y_n = a * x_n + b * y_{(n-1)}$

$a = \text{Sampling time}_{\text{Sec}} / (\text{Sampling time}_{\text{Sec}} + 1 / (2 \text{ Pi} * \text{Cutoff frequency}_{\text{Hz}}))$

$b = 1 - a$

Information:

Since low-pass filtering takes place using an approximation procedure with fixed-point arithmetic, there are discrepancies to the effective cutoff frequency that depend on the sampling cycle and filter sequence.

Filter cutoff frequency

Name:

ConfigOutput27 for channel 1

ConfigOutput29 for channel 2

ConfigOutput31 for channel 3

ConfigOutput33 for channel 4

The cutoff frequency of the respective filter is configured in these registers.

| Data type | Value | Information |
|-----------|-------------|---|
| UINT | 1 to 65,535 | Cutoff frequency in hertz. Bus controller default setting: 0 |

Information:

The highest cutoff frequency is limited by the Nyquist Shannon sampling theorem (based on the sampling cycle time). The system does not check for violations of this sampling theorem.

9.1.18.10.4.4 User-defined scaling

The raw and filtered A/D converter data is compared and normalized (gain = k, offset = d). In addition, user-defined normalization is available using the following registers:

- "User-defined gain" on page 556 (= ku)
- "User-defined offset" on page 556 (= du)

The execution time is optimized by grouping the factors together.

System scaling calculation:

$$\text{nom} = k * \text{RawValue} + d$$

$$k = k * k_u$$

$$d = k * d + d_u$$

The value has to be limited since it can exceed the 16-bit constraints. To provide the greatest degree of flexibility, limiting is possible using the registers "Minimum limit value" on page 557 and "Maximum limit value" on page 557.

User-defined gain

Name:

ConfigOutput04 for channel 1

ConfigOutput09 for channel 2

ConfigOutput14 for channel 3

ConfigOutput19 for channel 4

The user-defined gain for the A/D converter data of the respective physical channel can be specified in these registers.

The value 65,536 (0x10000) corresponds to a gain of 1.

| Data type | Values | Information |
|-----------|------------------------------------|--|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: 65,536 |

User-defined offset

Name:

ConfigOutput05 for channel 1

ConfigOutput10 for channel 2

ConfigOutput15 for channel 3

ConfigOutput20 for channel 4

The user-defined offset for the A/D converter data of the respective physical channel can be specified in this register.

The value 65,536 (0x10000) corresponds to an offset of 1.

| Data type | Values | Information |
|-----------|------------------------------------|-----------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: 0 |

9.1.18.10.4.5 Limit values

If the application requires a limitation of the range of values, then the user can define his own limit values. These values will also be use for the module's error statistics. The following registers are available for this:

- "Minimum limit value" on page 557
- "Maximum limit value" on page 557

Information:

32-bit numbers are used inside the module. A limit value violation can therefore also be determined if the permitted range of values was defined from -32768 to 32767.

Minimum limit value

Name:

ConfigOutput02 for channel 1
 ConfigOutput07 for channel 2
 ConfigOutput12 for channel 3
 ConfigOutput17 for channel 4

The minimum limit value is configured in this register. This limit value is also used for the underflow error statistics (see register "Ch0xUnderflow" on page 560).

| Data type | Values | Information |
|-----------|-----------------|--|
| INT | -32768 to 32767 | Bus controller default setting: -32768 |

Maximum limit value

Name:

ConfigOutput03 for channel 1
 ConfigOutput08 for channel 2
 ConfigOutput13 for channel 3
 ConfigOutput18 for channel 4

The maximum limit value is configured in this register. This limit value is also used for the overflow error statistics (see register "Ch0xOverflow" on page 560).

| Data type | Values | Information |
|-----------|-----------------|---------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 32767 |

9.1.18.10.5 Communication - General

The module's analog inputs convert current and voltage values with 16-bit resolution. This information can be used by the application with the help of the registers listed here.

9.1.18.10.5.1 Analog input channels

Name:

AnalogInput01 to AnalogInput04

The analog input value is mapped in this register depending on the configured operating mode.

| Data type | Value | Input signal: |
|-----------|-------------------|-----------------------------|
| INT | -32,768 to 32,767 | Voltage signal ± 11 VDC |
| | 0 to 32,767 | Current signal 0 to 22 mA |

9.1.18.10.5.2 Sampling cycle counter

Name:

SampleCycleCounter

The number of times the input signal has been sampled is provided in this register.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.1.18.10.5.3 Error monitoring and counters

Channel status

Name:

Channel01OK to Channel04OK

SyncStatus

ConversionCycle

This register collects error messages synchronously with the network cycle. Temporary error states that were registered in a conversion cycle remain active for at least 2 network cycles. In order to receive detailed error information, the corresponding error counters and X2X network events should also be observed.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------------------------|-------|--|
| 0 | Channel01OK | 0 | OK |
| | | 1 | Errors <ul style="list-style-type: none"> Range overshoot Range undershot Working range overshoot |
| ... | | ... | |
| 3 | Channel04OK | 0 | OK |
| | | 1 | Errors See description for bit 0. |
| 4 - 5 | Reserved | - | |
| 6 | SyncStatus ¹⁾ | 0 | OK |
| | | 1 | Not synchronized |
| 7 | ConversionCycle ²⁾ | 0 | OK |
| | | 1 | Errors |

1) Identical to bit 0 of the registers "SynchronizationViolationErrorCounter" on page 558.

2) Identical to bit 0 of the registers "SampleCycleViolationErrorCounter" on page 558.

Synchronization error counter

Name:

SynchronizationViolationErrorCounter

This register counts how often the conversion task was triggered more than 5 µs after the next-coming X2X cycle. In this case, the module is considered being no longer synchronized with X2X Link.

The counters in this register follow the rules of the event error counter, i.e. the count increased each time an error occurs or is reset. The last bit of the counter indicates the error status:

- Last bit = 1 → Error pending
- Last bit = 0 → No error

| Data type | Value | Information |
|-----------|------------|---------------------|
| UINT | 0 to 65535 | Counter value |
| | 0 to 1 | Bit 0: Error status |

Counter for faulty sampling cycles

Name:

SampleCycleViolationErrorCounter

This register is used to indicate the number of cycle time violations that have occurred thus far. A cycle time violation occurs if the conversion tasks initiates a sampling task before the last sampling cycle has finished. See "Sampling and conversion" on page 554.

The counters in this register follow the rules of the event error counter, i.e. the count increased each time an error occurs or is reset. The last bit of the counter indicates the error status:

- Last bit = 1 → Error pending
- Last bit = 0 → No error

| Data type | Value | Information |
|-----------|------------|---------------------|
| UINT | 0 to 65535 | Counter value |
| | 0 to 1 | Bit 0: Error status |

Range violation (neg. and pos.)

Name:

Channel01underflow to Channel04underflow

Channel01overflow to Channel04overflow

This register indicates whether the limit values defined by registers "Minimum limit value" on page 557 and "Maximum limit value" on page 557 have been overshoot or undershot. The individual bits in this register are identical to the values of the lowest bits of registers "Ch0xUnderflow" on page 560 and "Ch0xOverflow" on page 560.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|--------------------|-------|------------------------------------|
| 0 | Channel01underflow | 0 | No error |
| | | 1 | Range exceeded (.neg) on channel 1 |
| ... | | ... | |
| 3 | Channel04underflow | 0 | No error |
| | | 1 | Range exceeded (.neg) on channel 4 |
| 4 | Channel01overflow | 0 | No error |
| | | 1 | Range exceeded (.pos) on channel 1 |
| ... | | ... | |
| 7 | Channel04overflow | 0 | No error |
| | | 1 | Range exceeded (.pos) on channel 4 |

Working range violation (pos.)

Name:

Channel01outofrange to Channel04outofrange

This register indicates whether the input value overshoots the module's maximum measurement range. The individual bits in this register are identical to the values of the lowest bits of register "Ch0xOutOfRange" on page 559.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------------|-------|---|
| 0 | Channel01outofrange | 0 | No error |
| | | 1 | Working range violation (pos.) of channel 1 |
| ... | | ... | |
| 3 | Channel04outofrange | 0 | No error |
| | | 1 | Working range violation (pos.) of channel 4 |
| 4 - 7 | Reserved | - | |

Counter for work range violations (pos.)

Name:

Ch01OutOfRange to Ch04OutOfRange

Errors outside of the module's maximum possible measurement range are indicated in this register. These errors lead to full-scale deflection of the A/D converter.

The counters in these registers follow the rules of the event error counter, i.e. the count increased each time an error occurs or is reset. The last bit of the counter indicates the error status:

- Last bit = 1 → Error pending
- Last bit = 0 → No error

This counter is only active if the static error counter is enabled (see register "Channel configuration" on page 553).

| Data type | Value | Information |
|-----------|------------|---------------------|
| UINT | 0 to 65535 | Counter value |
| | 0 to 1 | Bit 0: Error status |

Counter for range exceeded violations (neg.)

Name:

Ch01Underflow to Ch04Underflow

This register indicates range exceeded violations (neg.) of the value configured in the register "[Minimum limit value](#)" on page 557.

The counters in these registers follow the rules of the event error counter, i.e. the count increased each time an error occurs or is reset. The last bit of the counter indicates the error status:

- Last bit = 1 → Error pending
- Last bit = 0 → No error

This counter is only active if the static error counter is enabled (see register "[Channel configuration](#)" on page 553).

| Data type | Value | Information |
|-----------|------------|---------------------|
| UINT | 0 to 65535 | Counter value |
| | 0 to 1 | Bit 0: Error status |

Counter for range exceeded violations (pos.)

Name:

Ch01Overflow to Ch04Overflow

This register indicates range exceeded violations (pos.) of the value configured in the register "[Maximum limit value](#)" on page 557.

The counters in these registers follow the rules of the event error counter, i.e. the count increased each time an error occurs or is reset. The last bit of the counter indicates the error status:

- Last bit = 1 → Error pending
- Last bit = 0 → No error

This counter is only active if the static error counter is enabled (see register "[Channel configuration](#)" on page 553).

| Data type | Value | Information |
|-----------|------------|---------------------|
| UINT | 0 to 65535 | Counter value |
| | 0 to 1 | Bit 0: Error status |

9.1.18.10.6 Additional analysis functions

In addition to sampling the analog input signal, this module can also be used to perform additional analysis of the values obtained.

- **Limit value analysis**

If limit value analysis has been enabled for a channel, the sampled minimum and maximum values are latched internally in the module. A measurement period can be triggered using the control byte. When the respective configured edge is generated by the application, the limit values from the previous measurement period are displayed and the internal latch register is reset.

- **Recording sampled values**

If recording sampled values has been enabled for a channel, then the sampled values are additionally recorded in the module's internal FIFO memory. If the configured event occurs, the contents of the FIFO memory are transmitted to the application.

Information:

It is only possible to use the recording of sampled values if the module is operated on an X2X master that is an SG4 CPU.

9.1.18.10.6.1 Trigger condition on falling edge

Name:

ConfigOutput21

This register configures whether the falling edge is used to trigger the trace and determination of the input value in the register "Analysis control byte" on page 562.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------|-------|---|
| 0 | TraceTrigger01 | 0 | No trigger (bus controller default setting) |
| | | 1 | Falling edge active as trigger |
| 1 - 3 | Reserved | - | |
| 4 | MinMaxStart01 | 0 | No determination (bus controller default setting) |
| | | 1 | Falling edge determines input value of channel 1 |
| ... | ... | ... | |
| 7 | MinMaxStart04 | 0 | No determination (bus controller default setting) |
| | | 1 | Falling edge determines input value of channel 4 |

9.1.18.10.6.2 Trigger condition on rising edge

Name:

ConfigOutput22

This register configures whether the rising edge is used to trigger the trace and determination of the input value in the register "Analysis control byte" on page 562.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------|-------|---|
| 0 | TraceTrigger01 | 0 | Trigger not initiated on positive edge (bus controller default setting) |
| | | 1 | Rising edge active as trigger |
| 1 - 3 | Reserved | - | |
| 4 | MinMaxStart01 | 0 | No determination (bus controller default setting) |
| | | 1 | Rising edge determines input value of channel 1 |
| ... | ... | ... | |
| 7 | MinMaxStart04 | 0 | No determination (bus controller default setting) |
| | | 1 | Rising edge determines input value of channel 4 |

9.1.18.10.6.3 Analysis control byte

Name:

TraceTrigger01

MinMaxStart01 to MinMaxStart04

The trace function and determination of the minimum/maximum input values can be started in this register. Whether the rising and/or falling edge is used to trigger the functions can be configured using the registers "[Trigger condition on falling edge](#)" on page 561 and "[Trigger condition on rising edge](#)" on page 561.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------|-------|--|
| 0 | TraceTrigger01 | 0 | Trigger/Trace not triggered (bus controller default setting) |
| | | 1 | Initiates trigger/trace |
| 1 - 3 | Reserved | - | |
| 4 | MinMaxStart01 | 0 | Determination not triggered (bus controller default setting) |
| | | 1 | Initiates determination of input value of channel 1 |
| ... | ... | ... | |
| 7 | MinMaxStart04 | 0 | Determination not triggered (bus controller default setting) |
| | | 1 | Initiates determination of input value of channel 4 |

Information:

To reduce the cyclic data transfer, this register combines the trace and limit value determination functions.

9.1.18.10.6.4 Analysis status byte

Name:

MinMaxStart01Readback to MinMaxStart04Readback

The currently requested module-internal analyses can be checked in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------|--------|---|
| 0 - 3 | Reserved | - | |
| 4 | MinMaxStart01Readback | 0 or 1 | Current state of the trigger bits for determining the limit values on the channel |
| ... | ... | ... | |
| 7 | MinMaxStart04Readback | 0 or 1 | Current state of the trigger bits for determining the limit values on the channel |

9.1.18.10.7 Limit values

Limit value analysis must be enabled for the desired channel (see "Channel configuration" on page 553). The sampled value of the channel is then compared to the minimum and maximum values that are stored internally in the module. If a new measurement period is initiated with the "Analysis control byte" on page 562 register, then the values determined from the previous measurement period can be taken from the respective registers intended for this.

9.1.18.10.7.1 Minimum input values

Name:

MinInput01 to MinInput04

The minimum value of the preceding trigger period is saved in this register based on the filtered, scaled and user-defined limit values. The register value is 0 if the channel is inactive.

| Data type | Value |
|-----------|-------------------|
| INT | -32,768 to 32,767 |

9.1.18.10.7.2 Maximum input values

Name:

MaxInput01 to MaxInput04

The maximum value of the preceding trigger period is saved in this register based on the filtered, scaled and user-defined limit values. The register value is 0 if the channel is inactive.

| Data type | Value |
|-----------|-------------------|
| INT | -32,768 to 32,767 |

9.1.18.10.7.3 Limit value trigger counter

Name:

Ch01MinMaxLatchCounter to Ch04MinMaxLatchCounter

The number of valid events that trigger a new measurement period for the limit value analysis is counted in this register.

| Data type | Value |
|-----------|------------|
| UINT | 0 to 65535 |

9.1.18.10.8 Trace

If the module is operated on a SG4 CPU, the digitalized input values are recorded by the module. The module must be operated in "Supervised" mode in order to use the trace function.

Recording must be enabled for the desired channel. The enable bits can then control the recording at runtime. The sampled values are recorded in the module's internal FIFO memory.

If the previously defined state occurs on the channel, the contents of the FIFO memory are transmitted to the application. Whether the FIFO memory continued to be filled depends on how recording is configured.

Information:

The trace mechanism can only be used if the module is connected directly to the CPU, not if it is operated behind a bus controller.

9.1.18.10.8.1 Enable recording

Name:

TraceChannelEnable

The respective channel is enabled for the trace with this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|------------------|
| 0 | Channel 1 | 0 | Channel disabled |
| | | 1 | Channel enabled |
| ... | ... | ... | |
| 3 | Channel 4 | 0 | Channel disabled |
| | | 1 | Channel enabled |
| 4 - 7 | Reserved | - | |

9.1.18.10.8.2 Number of values to be recorded

Name:

TraceSampleDepth

16 kB are available on the module for the trace. The FIFO memory limitation means that a maximum of 8192 analog values can be recorded. This memory is divided up equally among the enabled channels. The actual number of maximum possible recordings therefore depends on the number of channels enabled for trace:

- 1 channel enabled: Up to 8192 recordings
- 2 channels enabled: Up to 4096 recordings per channel
- 3 channels enabled: Up to 2730 recordings per channel
- 4 channels enabled: Up to 2048 recordings per channel

| Data type | Value |
|-----------|-----------|
| UINT | 2 to 8192 |

9.1.18.10.8.3 Recording priority

Name:

ConfigOutput25

The priority of the trace can be increased with this register.

| Data type | Value | Function |
|-----------|-------|---|
| USINT | 3 | Standard |
| | 6 | Trace priority higher than X2X Link communication |

9.1.18.10.8.4 Starting a recording

Name:

TraceEnable01

This register starts the recording according to the specifications for edge control or the comparator.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|-----------------------------|
| 0 | TraceEnable01 | 0 | Disables the trace function |
| | | 1 | Enables the trace function |
| 1 - 7 | Reserved | - | |

9.1.18.10.8.5 Recording status

Name:

TraceEnabled

TraceWriteActive

TraceReadActive

ReadyForTrigger

TriggerActive

TraceOk

TraceError

The status of the trace is represented in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|------------------|-------|---------------------------------------|
| 0 | TraceEnabled | 0 | Trace inactive |
| | | 1 | Trace active |
| 1 | Reserved | - | |
| 2 | TraceWriteActive | 0 | Data not recorded |
| | | 1 | Data recorded |
| 3 | TraceReadActive | 0 | Data not output/read |
| | | 1 | Data output/read |
| 4 | ReadyForTrigger | 0 | Not ready for triggering |
| | | 1 | Ready for triggering |
| 5 | TriggerActive | 0 | No trigger active or already executed |
| | | 1 | Trigger active |
| 6 | TraceOk | 0 | Overflow or inactive |
| | | 1 | No overflow |
| 7 | TraceError | 0 | No error or inactive |
| | | 1 | Trace buffer full |

9.1.18.10.8.6 Free trace buffer

Name:

FreeBufferSize

Specifies the available FIFO memory area in bytes for the trace

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.1.18.10.8.7 Counter for trace triggers

Name:

TriggerCount

This register indicates the number of triggers that have occurred since [starting the trace](#).

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.1.18.10.8.8 Counter for faulty recording triggers

Name:

TriggerFailCount

Counts the trigger events for which the trace could not be performed.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.1.18.10.8.9 Comparator for trigger conditions

In order to adapt the trace as closely as possible to the requirements of the application, the trace function can also be controlled using the comparator. Threshold values (hysteresis) can be defined within the permitted range of values to do so. 2 status bits are then generated for each enabled channel:

- **InRange bit**

The InRange status is "1" if the measured value falls within the defined limits.

The InRange status is "0" if the measured value falls outside the defined limits.

- **Threshold value bit**

The threshold value bit is "1" if the measured value exceeds the upper threshold value.

The threshold value bit is "0" if the measured value falls below the lower threshold value.

The InRange and threshold value bits for all channels are grouped together in the lower-value byte of the "[CompStateCollection](#)" on page 567 register. In addition, the states of the previous sampling are stored in the high-value byte.

The 4 status messages of each channel can be linked according to the following logic via a logical connective mask using AND or OR operators and used as a trace trigger:

```
delta = (Current_HysteresisStatus ^ NominalValues)// Different between current status and preset
cond = delta & Selected_HysteresisStatusBits// Eliminate irrelevant status messages
ccond = Selected_HysteresisStatusBits (Current_HysteresisStatus ^ NominalValues)
if((0==(cond & ~LogicalOperators)) &&
(0!=(~cond & LogicalOperators))) {=> Generate trigger event}
```

| | |
|-------------------------------|---|
| Selected_HysteresisStatusBits | Corresponds to register: "cfgComp_EnableMask" on page 568 |
| Current_HysteresisStatus | "CompStateCollection" on page 567 |
| Nominal values | "cfgComp_NominalState" on page 567 |
| Logical operators | "cfgComp_ConditionTypeMask" on page 568 |

Lower limit value for hysteresis

Name:

cfgComp_LowLimitCh01 to cfgComp_LowLimitCh04

The lower limit value for hysteresis is configured in this register.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

Upper limit value for hysteresis

Name:

cfgComp_HighLimitCh01 to cfgComp_HighLimitCh04

The upper limit value for hysteresis is configured in this register.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

Hysteresis status of the channels

Name:

CompStateCollection

The hysteresis status of the input channels for the current and last cycle are represented in this register.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|--|-------|---|
| 0 | Channel01 hysteresis status in the current cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 1 | Channel01 InRange status in the current cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| ... | ... | ... | |
| 6 | Channel04 hysteresis status in the current cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 7 | Channel04 InRange status in the current cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| 8 | Channel01 hysteresis status in the last cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 9 | Channel01 InRange status in the last cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| ... | ... | ... | |
| 14 | Channel04 hysteresis status in the last cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 15 | Channel04 InRange status in the last cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |

Comparison state of the channels

Name:

cfgComp_NominalState

The desired comparison state for the hysteresis status is indicated in this register.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|--|-------|---|
| 0 | Channel01 hysteresis status in the current cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 1 | Channel01 InRange status in the current cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| ... | ... | ... | |
| 6 | Channel04 hysteresis status in the current cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 7 | Channel04 InRange status in the current cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| 8 | Channel01 hysteresis status in the last cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 9 | Channel01 InRange status in the last cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |
| ... | ... | ... | |
| 14 | Channel04 hysteresis status in the last cycle | 0 | Lower limit value exceeded |
| | | 1 | Upper limit value exceeded |
| 15 | Channel04 InRange status in the last cycle | 0 | Value lies outside of range defined by the limit values |
| | | 1 | Value between lower and upper limit values |

Information:

This is a "whitelist", i.e. the trace starts as soon as the current status message takes on the state predefined here.

One or more matches will be necessary depending on the selection of the relevant hysteresis status bits and logical connective operators.

Selecting the relevant hysteresis status bits

Name:

cfgComp_EnableMask

This register selects which status bits of the hysteresis comparison should be used to generate the trigger.

For more information about using this register, see ["Comparator for trigger conditions" on page 566](#).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|--|-------|--------------------|
| 0 | Channel01 hysteresis status in the current cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 1 | Channel01 InRange status in the current cycle | 0 | Do not use |
| | | 1 | Use for generation |
| ... | ... | ... | |
| 6 | Channel04 hysteresis status in the current cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 7 | Channel04 InRange status in the current cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 8 | Channel01 hysteresis status in the last cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 9 | Channel01 InRange status in the last cycle | 0 | Do not use |
| | | 1 | Use for generation |
| ... | ... | ... | |
| 14 | Channel04 hysteresis status in the last cycle | 0 | Do not use |
| | | 1 | Use for generation |
| 15 | Channel04 InRange status in the last cycle | 0 | Do not use |
| | | 1 | Use for generation |

Logical connective operators for hysteresis status bits

Name:

cfgComp_ConditionTypeMask

The desired state operators with which the respective status bit is linked to others to generate a trigger are selected in this register.

At least one OR operation must be configured, but it does not necessarily have to be located on a channel configured with "1" in the ["cfgComp_EnableMask" on page 568](#) register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|--|-------|-------------------|
| 0 | Channel01 hysteresis status in the current cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 1 | Channel01 InRange status in the current cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| ... | ... | ... | |
| 6 | Channel04 hysteresis status in the current cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 7 | Channel04 InRange status in the current cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 8 | Channel01 hysteresis status in the last cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 9 | Channel01 InRange status in the last cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| ... | ... | ... | |
| 14 | Channel04 hysteresis status in the last cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |
| 15 | Channel04 InRange status in the last cycle | 0 | Use AND operation |
| | | 1 | Use OR operation |

9.1.18.10.8.10 Time-offset trace

Additional conditions for shifting the starting and stopping points can be defined if the trace should be chronologically offset to the trigger.

Starting the trace

Name:

TraceTriggerStart

The starting position is defined relative to the configured trigger condition (rising/falling edge) in this register. Positive values mean that the trace takes place x samples after the trigger condition. Negative values mean that the trace takes place x samples before the trigger condition.

The value -32768 performs the trace without regard for the configured trigger condition. If the trace memory is completely full, then the oldest recorded value is overwritten (FIFO principle).

"Trace start" in the I/O configuration or the registers "[Trigger condition on falling edge](#)" on page 561 and "[Trigger condition on rising edge](#)" on page 561 determine whether a positive, negative or any edge must be triggered.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

Stopping the trace

Name:

TraceTriggerStop

The stopping position is defined relative to the configured trigger condition in this register.

- When configuring an early trigger event, this value refers to the trigger event.
- When configuring a delayed trigger event, this value refers to the starting event.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.1.18.10.9 Acyclic frame size

Name:

AsynSize

When the stream is used, data is exchanged internally between the module and CPU. For this purpose, a defined amount of acyclic bytes is reserved for this slot.

Increasing the acyclic frame size leads to increased data throughput on this slot.

Information:

This configuration involves a driver setting that cannot be changed during runtime!

| Data type | Value | Information |
|-----------|---------|---|
| - | 8 to 28 | Acyclic frame size in bytes. Default = 24 |

9.1.18.10.10 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|-----------------------------------|--------|
| Standard priority | 200 µs |
| High priority with trace function | 300 µs |

9.1.18.10.11 Minimum I/O update time

There is no limitation or dependency on the bus cycle time.

The I/O update time is defined using the "Sampling time" register. The fastest possible sampling time depends on the number of channels to be converted and the configuration.

9.1.19 X20AI4636

Data sheet version: 2.11

9.1.19.1 General information

The module is equipped with 4 inputs with 16-bit digital converter resolution. It is possible to select between the current and voltage signal using different terminals. With the oversampling function, up to 16 analog values per channel can be recorded.

- 4 analog inputs
- Current or voltage signal configuration for the entire module
- 16-bit digital converter resolution
- Minimum conversion time of 40 μ s for all inputs
- The conversion time for the entire module can be configured in 0.02 μ s steps.
- Maximum 14 samples (16-bit) for the entire module per X2X Link cycle
- Oversampling: Up to 16 analog values per channel (internal)
- Timestamp for the last conversion of an X2X Link cycle

9.1.19.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| X20AI4636 | Analog inputs X20 analog input module, 4 inputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, configurable input filter, oversampling functions |  |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 76: X20AI4636 - Order data

9.1.19.3 Technical data

| Model number | X20AI4636 |
|--|--|
| Short description | |
| I/O module | 4 analog inputs ±10 V or 0 to 20 mA |
| General information | |
| B&R ID code | 0xB3A8 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Inputs | Yes, using status LED and software |
| Channel type | Yes, using software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.5 W ¹⁾ |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Analog inputs | |
| Input | ±10 V or 0 to 20 mA, via different terminal connections |
| Input type | Differential input |
| Digital converter resolution | |
| Voltage | ±15-bit |
| Current | 15-bit |
| Conversion time | 40 µs for all inputs |
| Output format | INT |
| Output format | |
| Voltage | INT 0x8001 - 0x7FFF / 1 LSB = 0x0001 = 305.176 µV |
| Current | INT 0x0000 - 0x7FFF / 1 LSB = 0x0001 = 610.352 nA |
| Input impedance in signal range | |
| Voltage | 20 MΩ |
| Current | - |
| Load | |
| Voltage | - |
| Current | <400 Ω |
| Input protection | Protection against wiring with supply voltage |
| Permissible input signal | |
| Voltage | Max. ±30 V |
| Current | Max. ±50 mA |
| Output of digital value during overload | |
| Undershoot | |
| Voltage | 0x8001 |
| Current | 0x0000 |
| Overshoot | |
| Voltage | 0x7FFF |
| Current | 0x7FFF |
| Conversion procedure | SAR |
| Input filter | Hardware - 3rd-order low pass / cutoff frequency 10 kHz |
| Max. error at 25°C | |
| Voltage | |
| Gain | 0.08% ²⁾ |
| Offset | 0.01% ³⁾ |
| Current | |
| Gain | 0.08% ²⁾ |
| Offset | 0.02% ⁴⁾ |

Table 77: X20AI4636 - Technical data


| Model number | X20AI4636 |
|---|--|
| Max. gain drift | |
| Voltage | 0.01 %/°C ²⁾ |
| Current | 0.01 %/°C ²⁾ |
| Max. offset drift | |
| Voltage | 0.001 %/°C ³⁾ |
| Current | 0.002 %/°C ⁴⁾ |
| Common-mode rejection | |
| DC | 70 dB |
| 50 Hz | 70 dB |
| Common-mode range | ±12 V |
| Crosstalk between channels | <-70 dB |
| Nonlinearity | |
| Voltage | <0.01% ³⁾ |
| Current | <0.015% ⁴⁾ |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating" |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 77: X20AI4636 - Technical data

- 1) To reduce power dissipation, B&R recommends bridging unused inputs on the terminals.
- 2) Based on the current measured value.
- 3) Based on the 20 V measurement range.
- 4) Based on the 20 mA measurement range.

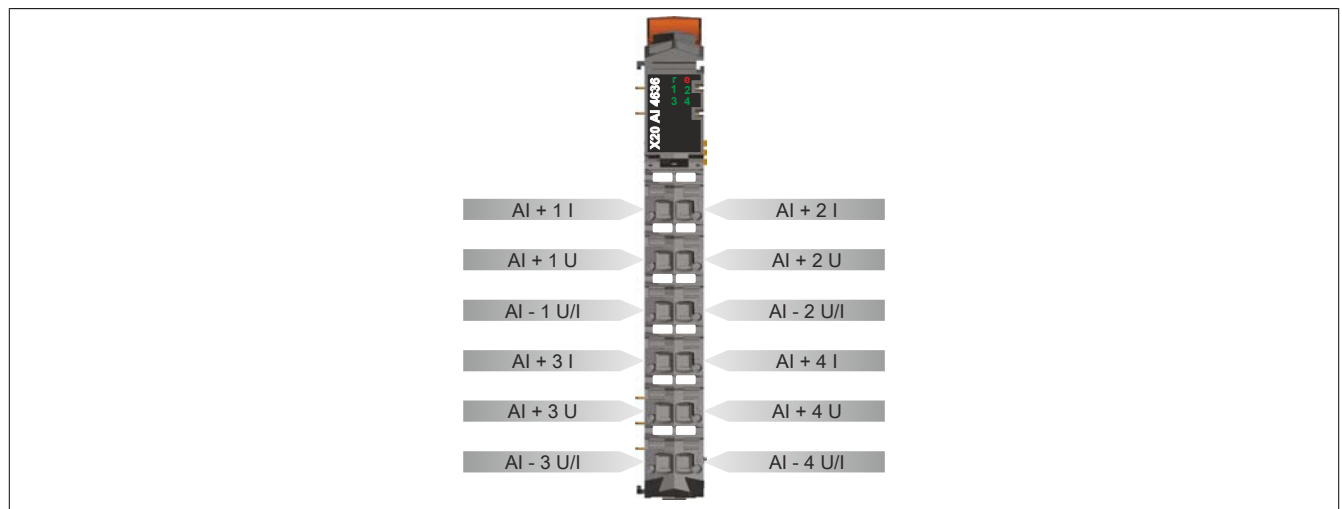
9.1.19.4 Status LEDs

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-----|-------|--------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | | | Double flash | System error: <ul style="list-style-type: none"> • Violation of the sampling cycle time • Synchronization error |
| | | Green | Off | Open line ²⁾ or sensor is disconnected |
| | | | Blinking | Channel error: Underflow, overflow or broken connection |
| | | | On | Analog/digital converter running, value OK |

- 1) Depending on the configuration, a firmware update can take up to several minutes.
 2) Open line detection only possible when measuring voltage.

9.1.19.5 Pinout

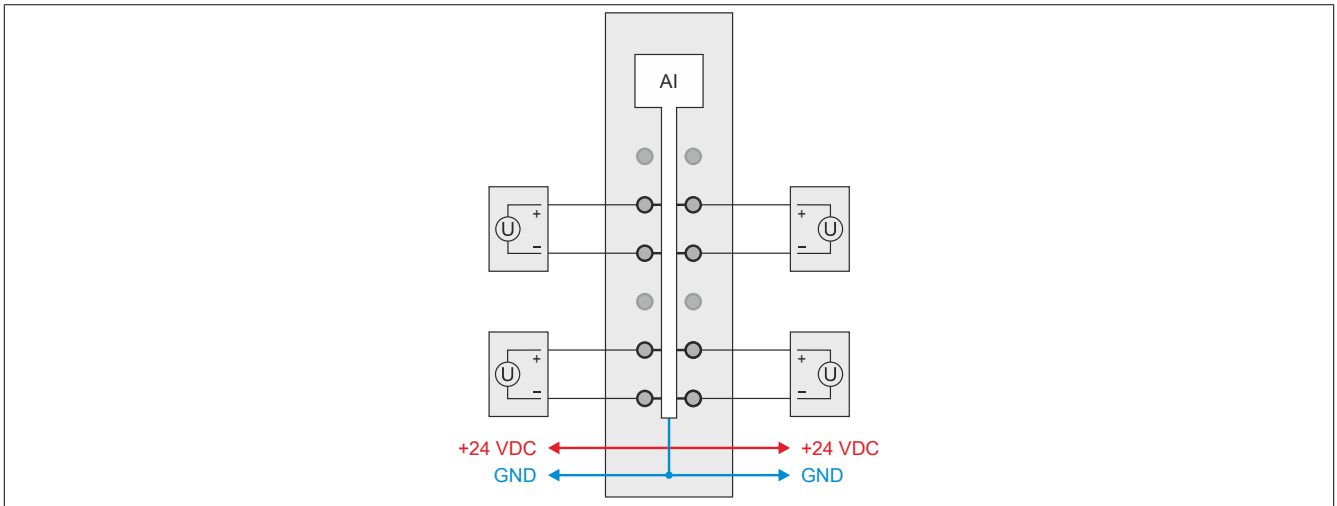


9.1.19.6 Connection example

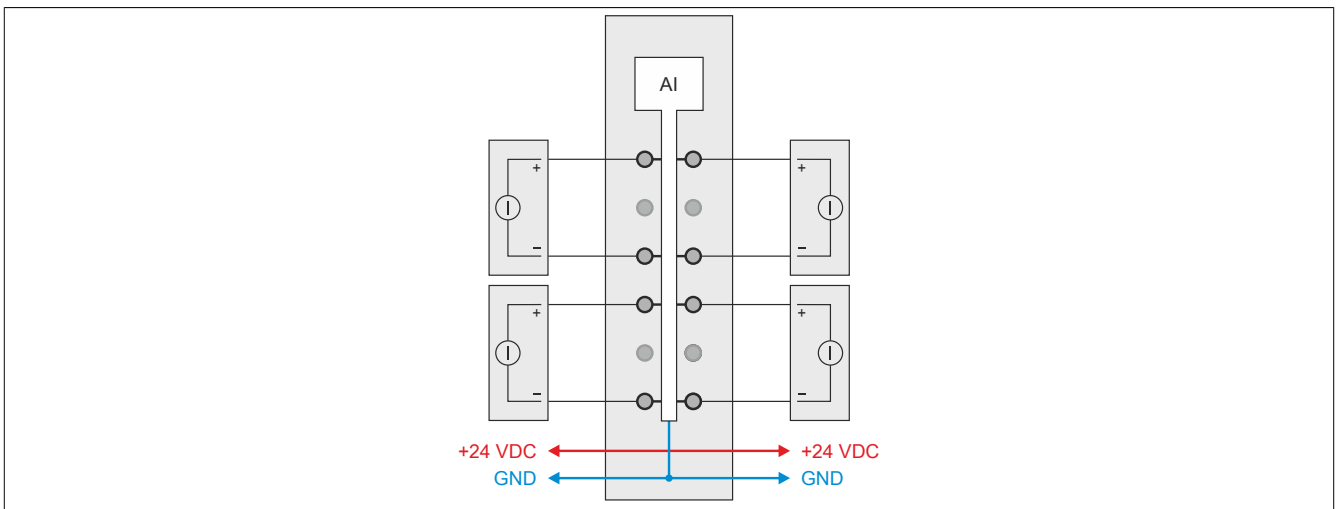
To prevent disturbances, the following modules must be separated by at least one module:

- Bus receiver X20BR9300
- Supply module X20PS3300/X20PS3310
- Supply module X20PS9400/X20PS9402
- Supply module X20PS9500/X20PS9502
- CPU modules

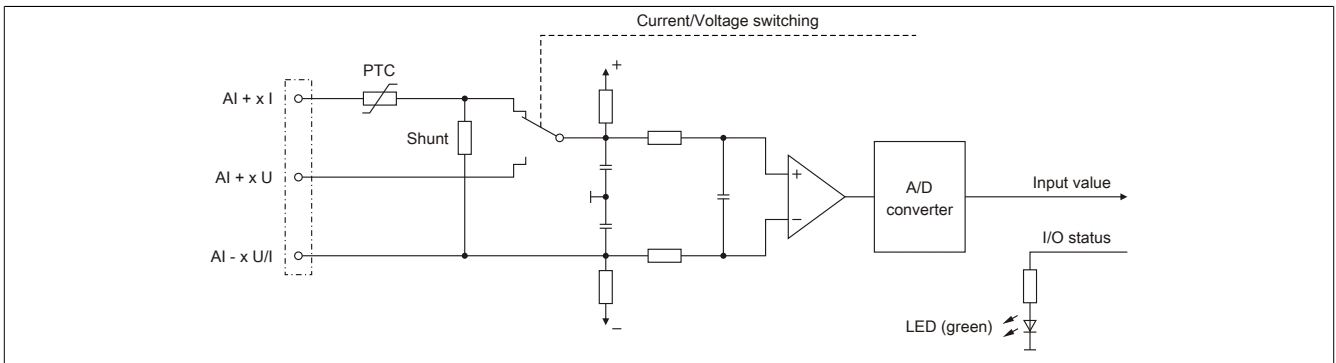
Voltage measurement



Current measurement



9.1.19.7 Input circuit diagram



9.1.19.8 Derating

There is no derating when operated below 55°C.

During operation over 55°C, the power dissipation of the modules to the left and right of this module is not permitted to exceed 1.15 W!

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.

| | | | | |
|--|--|-------------|--|--|
| X20 module Power dissipation > 1.15 W | Neighboring X20 module Power dissipation ≤ 1.15 W | This module | Neighboring X20 module Power dissipation ≤ 1.15 W | X20 module Power dissipation > 1.15 W |
|--|--|-------------|--|--|

9.1.19.9 Register description

9.1.19.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.1.19.9.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|---------------------------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| System configuration | | | | | | |
| 513 | CfO_BaseConfig | USINT | | | | • |
| 15364 | CfO_CycleTime | UDINT | | | | • |
| 15370 | CfO_SyncOffset | UINT | | | | • |
| 15374 | CfO_Prescaler | UINT | | | | • |
| Error messages - Configuration | | | | | | |
| 385 | CfO_ErrorID0007 | USINT | | | | • |
| 387 | CfO_ErrorID080F | USINT | | | | • |
| 389 | CfO_ErrorID1017 | USINT | | | | • |
| Physical channel configuration | | | | | | |
| 8194 + (N-1) * 256 | CfO_ModeCh0N (index N = 1 to 4) | UINT | | | | • |
| 8204 + (N-1) * 256 | CfO_UserGainCh0N (index N = 1 to 4) | DINT | | | | • |
| 8212 + (N-1) * 256 | CfO_UserOffsetCh0N (index N = 1 to 4) | DINT | | | | • |
| 8220 + (N-1) * 256 | CfO_Alpha0Ch0N (index N = 1 to 4) | DINT | | | | • |
| 8228 + (N-1) * 256 | CfO_Alpha1Ch0N (index N = 1 to 4) | DINT | | | | • |
| 8236 + (N-1) * 256 | CfO_Alpha2Ch0N (index N = 1 to 4) | DINT | | | | • |
| 8244 + (N-1) * 256 | CfO_Beta1Ch0N (index N = 1 to 4) | DINT | | | | • |
| 8252 + (N-1) * 256 | CfO_Beta2Ch0N (index N = 1 to 4) | DINT | | | | • |
| 8198 + (N-1) * 256 | CfO_CutOffFrequCh0N (index N = 1 to 4) | UINT | | | | • |
| Logical channel configuration | | | | | | |
| 10242 + (N-1) * 256 | CfO_LogCh0NMode (index N = 1 to 6) | UINT | | | | • |
| 10245 + (N-1) * 256 | CfO_LogCh0NSource00 (index N = 1 to 6) | USINT | | | | • |
| 10247 + (N-1) * 256 | CfO_LogCh0NSource01 (index N = 1 to 6) | USINT | | | | • |
| 10260 + (N-1) * 256 | CfO_LogCh0NFuncPar00 (index N = 1 to 6) | UDINT | | | | • |
| 10268 + (N-1) * 256 | CfO_LogCh0NFuncPar01 (index N = 1 to 6) | UDINT | | | | • |
| Analog inputs - Communication | | | | | | |
| 5062 + (N-1) * 8 | AnalogInput0N (index N = 1 to 4) | INT | • | | | |
| Error messages - Communication | | | | | | |
| 261 | "StandardErrors" registers | USINT | • | | | |
| | Channel01Error | Bit 0 | | | | |
| | ... | ... | | | | |
| | Channel04Error | Bit 3 | | | | |
| | PhysicalError | Bit 4 | | | | |
| 325 | "AcknowledgeStandardErrors" registers | USINT | | | • | |
| | AckChannel01Error | Bit 0 | | | | |
| | ... | ... | | | | |
| | AckChannel04Error | Bit 3 | | | | |
| | AckPhysicalError | Bit 4 | | | | |
| 257 | "ExtendedChannelErrorMessages" registers | USINT | • | | | |
| | Channel01OutOfRange | Bit 0 | | | | |
| | Channel01FilterError | Bit 1 | | | | |
| | Channel01Underflow | Bit 2 | | | | |
| | Channel01Overflow | Bit 3 | | | | |
| | Channel02OutOfRange | Bit 4 | | | | |
| | Channel02FilterError | Bit 5 | | | | |
| | Channel02Underflow | Bit 6 | | | | |
| Channel02Overflow | Bit 7 | | | | | |

| Register | Name | Data type | Read | | Write | |
|--|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 321 | "AcknowledgeExtendedChannelErrorMessages" registers | USINT | | | • | |
| | AckChannel01OutOfRange | Bit 0 | | | | |
| | AckChannel01FilterError | Bit 1 | | | | |
| | AckChannel01Underflow | Bit 2 | | | | |
| | AckChannel01Overflow | Bit 3 | | | | |
| | AckChannel02OutOfRange | Bit 4 | | | | |
| | AckChannel02FilterError | Bit 5 | | | | |
| | AckChannel02Underflow | Bit 6 | | | | |
| 259 | "ExtendedChannelErrorMessages" registers | USINT | • | | | |
| | Channel03OutOfRange | Bit 0 | | | | |
| | Channel03FilterError | Bit 1 | | | | |
| | Channel03Underflow | Bit 2 | | | | |
| | Channel03Overflow | Bit 3 | | | | |
| | Channel04OutOfRange | Bit 4 | | | | |
| | Channel04FilterError | Bit 5 | | | | |
| | Channel04Underflow | Bit 6 | | | | |
| 323 | "AcknowledgeExtendedChannelErrorMessages" registers | USINT | | | • | |
| | AckChannel03OutOfRange | Bit 0 | | | | |
| | AckChannel03FilterError | Bit 1 | | | | |
| | AckChannel03Underflow | Bit 2 | | | | |
| | AckChannel03Overflow | Bit 3 | | | | |
| | AckChannel04OutOfRange | Bit 4 | | | | |
| | AckChannel04FilterError | Bit 5 | | | | |
| | AckChannel04Underflow | Bit 6 | | | | |
| Physical analog sample display | | | | | | |
| 4102 + (16-N) * 64 | PhysCh01SampleN (index N = 1 to 16) | INT | • | | | |
| 4110 + (16-N) * 64 | PhysCh02SampleN (index N = 1 to 16) | INT | • | | | |
| 4118 + (16-N) * 64 | PhysCh03SampleN (index N = 1 to 16) | INT | • | | | |
| 4126 + (16-N) * 64 | PhysCh04SampleN (index N = 1 to 16) | INT | • | | | |
| 5106 | PhysTimestamp | INT | • | | | |
| 5108 | PhysTimestamp | DINT | • | | | |
| 5113 | PhysSampleCount | SINT | • | | | |
| 5114 | PhysSampleCount | INT | • | | | |
| Logical analog and digital sample display | | | | | | |
| 6148 + (16-N) * 64 | LogicCh01SampleN (index N = 1 to 16) (32-bit) | DINT | • | | | |
| 6150 + (16-N) * 64 | LogicCh01SampleN (index N = 1 to 16) (16-bit) | INT | • | | | |
| 6156 + (16-N)*64 | LogicCh02SampleN (index N = 1 to 16) (32-bit) | DINT | • | | | |
| 6158 + (16-N)*64 | LogicCh02SampleN (index N = 1 to 16) (16-bit) | INT | • | | | |
| 6164 + (16-N)*64 | LogicCh03SampleN (index N = 1 to 16) (32-bit) | DINT | • | | | |
| 6166 + (16-N)*64 | LogicCh03SampleN (index N = 1 to 16) (16-bit) | INT | • | | | |
| 6172 + (16-N)*64 | LogicCh04SampleN (index N = 1 to 16) (32-bit) | DINT | • | | | |
| 6174 + (16-N)*64 | LogicCh04SampleN (index N = 1 to 16) (16-bit) | INT | • | | | |
| 6180 + (16-N)*64 | LogicCh05SampleN (index N = 1 to 16) (32-bit) | DINT | • | | | |
| 6182 + (N-16)*64 | LogicCh05SampleN (index N = 1 to 16) (16-bit) | INT | • | | | |
| 6188 + (16-N)*64 | LogicCh06SampleN (index N = 1 to 16) (32-bit) | DINT | • | | | |
| 6190 + (16-N)*64 | LogicCh06SampleN (index N = 1 to 16) (16-bit) | INT | • | | | |
| 7109 + (N-1) * 8 | LogicCh0NSample16_9 (index N = 1 to 5) | USINT | • | | | |
| 7151 | LogicCh06Sample16_9 | USINT | • | | | |
| 7111 + (N-1) * 8 | LogicCh0NSample8_1 (index N = 1 to 5) | USINT | • | | | |
| 7149 | LogicCh06Sample8_1 | USINT | • | | | |
| 7154 | LogicTimestamp | INT | • | | | |
| 7156 | LogicTimestamp | DINT | • | | | |
| 7161 | LogicSampleCount | SINT | • | | | |
| 7162 | LogicSampleCount | INT | • | | | |

9.1.19.9.3 Function model 254 - Bus controller

The "Bus controller" function model has the following limitations compared to the "Standard" function model:

- No oversampling function since consistency is not possible when operating CAN-based bus controllers due to the limited data range
- The sampling cycle time is set to 100 µs.
- No timestamp function
- A range of logical functions is available for processing the physical values right on the module:
 - Output of physical values (standard)
 - Addition of two channels with scaling
 - Integral addition of two channels with scaling
 - Multiplication of two channels with scaling
 - Integral multiplication of two channels with scaling

| Register | Offset ⁽¹⁾ | Name | Data type | Read | | Write | |
|---------------------------------------|-----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| System configuration | | | | | | | |
| 513 | - | CfO_BaseConfig | USINT | | | | • |
| 15364 | - | CfO_CycleTime | UDINT | | | | • |
| 15370 | - | CfO_SyncOffset | UINT | | | | • |
| 15374 | - | CfO_Prescaler | UINT | | | | • |
| Error messages - Configuration | | | | | | | |
| 385 | - | CfO_ErrorID0007 | USINT | | | | • |
| 387 | - | CfO_ErrorID080F | USINT | | | | • |
| 389 | - | CfO_ErrorID1017 | USINT | | | | • |
| Physical channel configuration | | | | | | | |
| 8194 + (N-1) * 256 | - | CfO_ModeCh0N (index N = 1 to 4) | UINT | | | | • |
| 8204 + (N-1) * 256 | - | CfO_UserGainCh0N (index N = 1 to 4) | DINT | | | | • |
| 8212 + (N-1) * 256 | - | CfO_UserOffsetCh0N (index N = 1 to 4) | DINT | | | | • |
| 8220 + (N-1) * 256 | - | CfO_Alpha0Ch0N (index N = 1 to 4) | DINT | | | | • |
| 8236 + (N-1) * 256 | - | CfO_Alpha2Ch0N (index N = 1 to 4) | DINT | | | | • |
| 8244 + (N-1) * 256 | - | CfO_Beta1Ch0N (index N = 1 to 4) | DINT | | | | • |
| 8252 + (N-1) * 256 | - | CfO_Beta2Ch0N (index N = 1 to 4) | DINT | | | | • |
| 8198 + (N-1) * 256 | - | CfO_CutOffFrequCh0N (index N = 1 to 4) | UINT | | | | • |
| Logical channel configuration | | | | | | | |
| 10242 + (N-1) * 256 | - | CfO_LogCh0NMode (index N = 1 to (index N = 1 to 6) | UINT | | | | • |
| 10245 + (N-1) * 256 | - | CfO_LogCh0NSource00 (index N = 1 to 6) | USINT | | | | • |
| 10247 + (N-1) * 256 | - | CfO_LogCh0NSource01 (index N = 1 to 6) | USINT | | | | • |
| 10260 + (N-1) * 256 | - | CfO_LogCh0NFuncPar00 (index N = 1 to 6) | UDINT | | | | • |
| 10268 + (N-1) * 256 | - | CfO_LogCh0NFuncPar01 (index N = 1 to 6) | UDINT | | | | • |
| Analog inputs - Communication | | | | | | | |
| 5062 + (N-1) * 8 | (N-1) * 2 | AnalogInput0N (index N = 1 to 4) | INT | • | | | |
| Error messages - Communication | | | | | | | |
| 261 | - | "StandardErrors" registers | USINT | | • | | |
| | | Channel01Error | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | Channel04Error | Bit 3 | | | | |
| | | PhysicalError | Bit 4 | | | | |
| 325 | - | "AcknowledgeStandardErrors" registers | USINT | | | | • |
| | | AckChannel01Error | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | AckChannel04Error | Bit 3 | | | | |
| | | AckPhysicalError | Bit 4 | | | | |
| 257 | - | "ExtendedChannelErrorMessages" registers | USINT | | • | | |
| | | Channel01OutOfRange | Bit 0 | | | | |
| | | Channel01FilterError | Bit 1 | | | | |
| | | Channel01Underflow | Bit 2 | | | | |

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| | | Channel01Overflow | Bit 3 | | | | |
| | | Channel02OutOfRange | Bit 4 | | | | |
| | | Channel02FilterError | Bit 5 | | | | |
| | | Channel02Underflow | Bit 6 | | | | |
| | | Channel02Overflow | Bit 7 | | | | |
| 321 | - | "AcknowledgeExtendedChannelErrorMessages" registers | USINT | | | | • |
| | | AckChannel01OutOfRange | Bit 0 | | | | |
| | | AckChannel01FilterError | Bit 1 | | | | |
| | | AckChannel01Underflow | Bit 2 | | | | |
| | | AckChannel01Overflow | Bit 3 | | | | |
| | | AckChannel02OutOfRange | Bit 4 | | | | |
| | | AckChannel02FilterError | Bit 5 | | | | |
| | | AckChannel02Underflow | Bit 6 | | | | |
| | | AckChannel02Overflow | Bit 7 | | | | |
| 259 | - | "ExtendedChannelErrorMessages" registers | USINT | | • | | |
| | | Channel03OutOfRange | Bit 0 | | | | |
| | | Channel03FilterError | Bit 1 | | | | |
| | | Channel03underflow | Bit 2 | | | | |
| | | Channel03Overflow | Bit 3 | | | | |
| | | Channel04OutOfRange | Bit 4 | | | | |
| | | Channel04FilterError | Bit 5 | | | | |
| | | Channel04Underflow | Bit 6 | | | | |
| | | Channel04Overflow | Bit 7 | | | | |
| 323 | - | "AcknowledgeExtendedChannelErrorMessages" registers | USINT | | | | • |
| | | AckChannel03OutOfRange | Bit 0 | | | | |
| | | AckChannel03FilterError | Bit 1 | | | | |
| | | AckChannel03Underflow | Bit 2 | | | | |
| | | AckChannel03Overflow | Bit 3 | | | | |
| | | AckChannel04OutOfRange | Bit 4 | | | | |
| | | AckChannel04FilterError | Bit 5 | | | | |
| | | AckChannel04Underflow | Bit 6 | | | | |
| | | AckChannel04Overflow | Bit 7 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.1.19.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.1.19.9.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.1.19.9.4 General information

There is a difference on the module between physical (default) and logical values:

Physical or default values

The conversion results are transferred to the higher-level system after being scaled and filtered. They are not processed further.

Logical values

The physical values can be further processed with mathematical functions and comparators. In addition, another logical channel can be used as a starting point to further process a logical function.

9.1.19.9.5 Operating mode - Oversampling

The input values are recorded with a configurable sampling cycle time and saved with timestamp to the internal physical data buffer. This data range can then be read out in the cyclic data transfer using a configurable data length.

The recording and transmission system for the logical channels is identical to that for the physical channels. The functions of the logical channels are also executed in the configured sampling cycle time and saved with timestamp to the logical data buffer. The values can also be read out from here using configurable cyclic data points.

The defined sampling cycle time may not be sufficient for the sum of all physical and logical functions if using fast X2X Link cycle times, however. If influencing the physical sampling is not permitted, then a prescaler can be used to slow down the logical processing.

Information:

The ability to adjust the sampling cycle time as needed on the module means there is basically no synchronization with X2X Link, regardless of whether standard inputs or an oversampling function is configured.

If synchronization is required, then the configured sampling cycle time must be a multiple of the X2X Link cycle time!

9.1.19.9.5.1 Analog oversampling

When using analog oversampling, the enabled channels are stored in the module within a configurable time frame independently of the X2X cycle. Space is available for 16 analog values per physical and logical channel.

These samplings are numbered from 1 to 16 for the registers. The conversions or calculations of individual channels with the same number (i.e. sample line 1 to 16, e.g. PhysCh01Sample10, PhysCh02Sample10, etc.) are derived from the same sampling cycle or logical computing cycle and therefore have the same timestamp.

The timestamp refers to the newest data value, i.e. always to sample line 1. If a timestamp for older data points is needed, it needs to be back-calculated in the application using the sampling cycle time configured on the module. The prescaler must also be taken into account for logical channels.

Calculation example

| Sample line | Calculation | |
|-------------|--------------------------------------|---------------------|
| 1 | Timestamp | Newest value |
| 2 | Timestamp - Sampling cycle time | |
| 3 | Timestamp - 2 * Sampling cycle time | |
| 4 | Timestamp - 3 * Sampling cycle time | |
| ... | ... | |
| 10 | Timestamp - 9 * Sampling cycle time | |
| ... | ... | |
| 16 | Timestamp - 15 * Sampling cycle time | Oldest value |

How the buffer is organized can be seen from this. This is not a FIFO buffer but a static buffer that the values are pushed through. Sample line 1 always contains the newest values, the next line the second newest, all the way up to sample line 16, which contains the oldest values.

The sample counter is a circular counter, with the number of new sample lines derived from the value of the last transfer cycle.

Example

A difference of 3 to the last transfer cycle means:

The data in sample line 1 and all subsequent data from the previous transfer cycle is now shifted in the current cycle beginning with sample line 4. Sample lines 1 through 3 contain the new values for further processing by the application. Sample lines 14 through 16 from the last transfer cycle are no longer in the buffer.

9.1.19.9.5.2 Comparator oversampling

When using comparator oversampling, the results of the enabled channels are stored in the module within a configurable time frame independently of the X2X cycle. 16 bits of memory space are available per logical channel.

These samplings (i.e. event bits) are consecutively numbered from 1 to 8 and 9 to 16 for the two registers. The results of individual channels with the same number (i.e. sample line 1 to 16, e.g. for channel 1 LogicCh01Sample16_9 and LogicCh01Sample8_1) are derived from the same sampling cycle or logical computing cycle and therefore have the same timestamp.

The timestamp refers to the newest data value, i.e. always to sample line 1 (i.e. bit 0 in the LogicCh01Sample8_1 register). If a timestamp for older comparator results is needed, it needs to be back-calculated in the application using the sampling cycle time configured on the module. The prescaler must also be taken into account.

Calculation example

| Sample line | (register name) | Calculation | |
|-------------|-----------------------------|--------------------------------------|---------------------|
| 1 | (LogicCh01Sample8_1 bit 0) | Timestamp | Newest value |
| 2 | (LogicCh01Sample8_1 bit 1) | Timestamp - Sampling cycle time | |
| 3 | (LogicCh01Sample8_1 bit 2) | Timestamp - 2 * Sampling cycle time | |
| 4 | (LogicCh01Sample8_1 bit 3) | Timestamp - 3 * Sampling cycle time | |
| ... | | | |
| 10 | (LogicCh01Sample16_9 bit 1) | Timestamp - 9 * Sampling cycle time | |
| ... | | | |
| 16 | (LogicCh01Sample16_9 bit 7) | Timestamp - 15 * Sampling cycle time | Oldest value |

How the buffer is organized can be seen from this. This is not a FIFO buffer but a static buffer that the values are pushed through. Sample line 1 always contains the newest values, the next line the second newest, all the way up to sample line 16, which contains the oldest values.

The sample counter is a circular counter, with the number of new sample lines derived from the value of the last transfer cycle.

Example

A difference of 3 to the last transfer cycle means:

The comparator result in sample line 1 and all subsequent data from the previous transfer cycle is now shifted in the current cycle beginning with sample line 4. Sample lines 1 through 3 contain the new bit values for further processing by the application. Sample lines 14 through 16 from the last transfer cycle are no longer in the buffer.

Data transfer

The analog conversion rate / sampling cycle time can be considerably faster than the X2X Link cycle. Saved analog or comparator data can be transferred to the higher-level system synchronously and consistently.

In the application, it's important that the relationship between cyclic data points, the sampling cycle time on the module and the transfer time is sufficient to read all of the new data points on the higher-level system.

The sample counter can be used to check how many data values are actually new since the last transfer cycle. If the counter difference to the previous cycle is larger than the number of existing cyclic data points, then values have been overlooked and the system needs to be adjusted.

The general guideline is that a cyclic data point should be configured more than is actually required computing-wise.

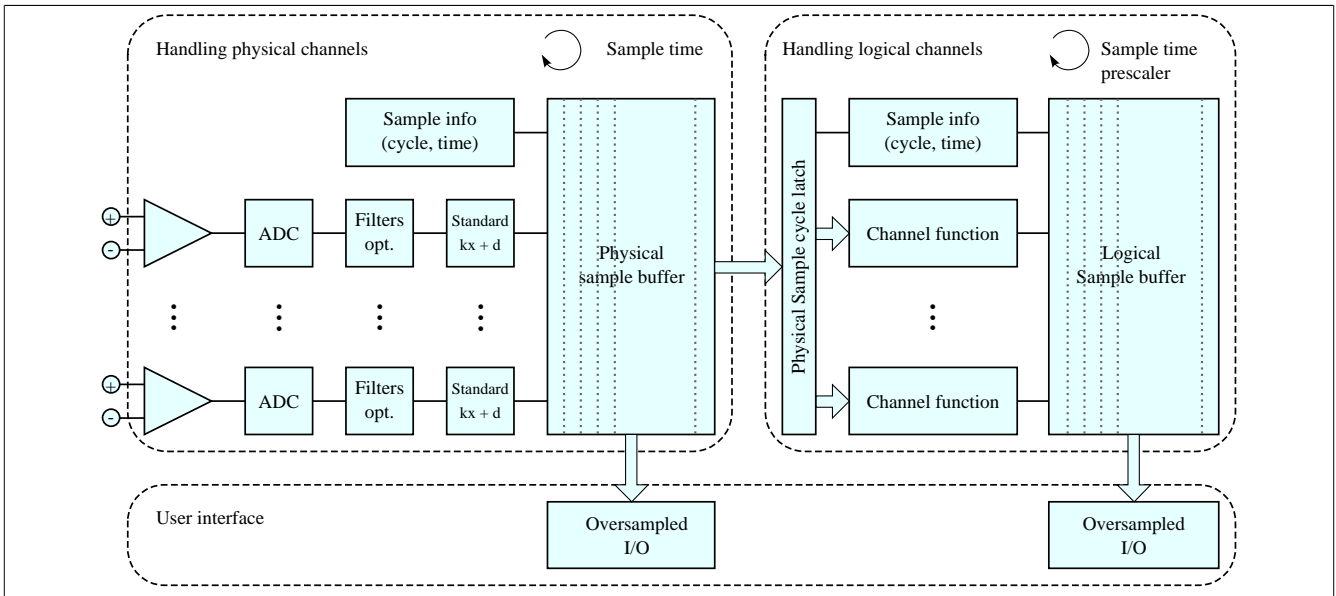
Example with synchronous settings

- Sampling cycle time = 50 µs
- X2X Link cycle time = 500 µs

Samples 1 to 10 of a channel are possible to calculate in this example. Sample 11 should also be configured as a cyclic data point, however.

The reason for this is the possible jitter in the module caused by interruptions, e.g. from the X2X Link transfer. For the current cycle, this can mean that only 9 new values are available and that 11 values will have to be transferred in the next cycle.

For logical comparator functions, this problem doesn't exist since the maximum number is always transferred in the cycle data range.



9.1.19.9.6 Bus controller operating mode

The input values are recorded with a configurable sampling cycle time and saved with timestamp to the internal physical data buffer. Only the newest value will be transferred in the next possible bus cycle.

Limitations in the bus controller function model:

- No oversampling function since consistency is not possible due to the limited data range
- Sampling cycle time configured to 100 µs by default
- Range of logical functions available for processing physical values directly on the module
- Timestamp not available

9.1.19.9.7 "AnalogInput" registers

Name:

AnalogInput01 to AnalogInput04

This module can be configured and operated as a normal analog input module without logical auxiliary functions. The physical values from the last sampling cycle are used as input values in this case.

The module is operated as a normal analog input module in the bus controller function model. Nevertheless, it is still possible to connect each input channel directly to a logical function. The analog data on the bus controller is mapped using the calculation abilities of the logical channels and configured automatically (see "[Operation in the bus controller function model](#)" on page 596).

Analog input values are displayed as signed 16-bit values depending on the configured operating mode.

| Data type | Value | Information |
|-----------|-------------------|------------------------------|
| INT | -32,768 to 32,767 | Voltage signal ±10 VDC |
| | 0 to 32,767 | Current signal 0 mA to 20 mA |

Information:

It is important to note that the oversampling function is not available in the bus controller function model due to the amount of data and lack of consistency!

9.1.19.9.8 Physical sampling

This module has a data buffer with 16 entries for each of the physical input channels. This buffer is processed according to the configured sampling cycle time.

A maximum of only 30 bytes is available for cyclic transfer on the X2X bus, however. Minus the status and sample counter, this allows only a selection of 14 samples (with a 16-bit data width) from the physical and logical buffer to be transferred.

Data loss can therefore occur with an imprecise selection and configuration.

Example

Displaying continuous sample lines.

- Sampling cycle time = 100 μ s
- X2X cycle time = 500 μ s

| | |
|---------------|-----------------|
| Sample line 1 | PhysCh0xSample1 |
| Sample line 2 | PhysCh0xSample2 |
| Sample line 3 | PhysCh0xSample3 |
| Sample line 4 | PhysCh0xSample4 |
| Sample line 5 | PhysCh0xSample5 |
| Sample line 6 | PhysCh0xSample6 |

| | |
|----------------------------|---|
| Difference SampleCount = 1 | New value in sample line 1 |
| Difference SampleCount = 2 | New values in sample line 1 and sample line 2 |
| ... | |
| Difference SampleCount = 5 | New values in sample line 1 to sample line 5 |

Information:

It is important to note that the sample counter refers to the update of the sample lines in the data buffer and not to the number of values transferred cyclically.

Displaying each second sample line to bridge a higher recording duration:

- Sampling cycle time = 100 μ s
- X2X cycle time = 1000 μ s

| | |
|----------------|------------------|
| Sample line 1 | PhysCh0xSample1 |
| Sample line 3 | PhysCh0xSample3 |
| Sample line 5 | PhysCh0xSample5 |
| Sample line 7 | PhysCh0xSample7 |
| Sample line 9 | PhysCh0xSample9 |
| Sample line 11 | PhysCh0xSample11 |

| | |
|----------------------------|---|
| Difference SampleCount = 1 | New value in sample line 1 |
| Difference SampleCount = 3 | New values in sample line 1 and sample line 3 |
| ... | |
| Difference SampleCount = 5 | New values in sample line 1 to sample line 5 |
| ... | |
| Difference SampleCount = 9 | New values in sample line 1 to sample line 9 |

9.1.19.9.8.1 "PhysChSample" registers

Name:

PhysCh01Sample1 to PhysCh01Sample16

...

PhysCh04Sample1 to PhysCh04Sample16

These registers are the physical buffer registers of the analog channels. 16 registers are available for each channel. Sample 1 is the newest value; sample 16 is the oldest.

Analog input values are displayed as signed 16-bit values.

| Data type | Value | Information |
|-----------|-------------------|------------------------------|
| INT | -32,768 to 32,767 | Voltage signal ± 10 VDC |
| | 0 to 32,767 | Current signal 0 mA to 20 mA |

9.1.19.9.8.2 "PhysSampleCount" register

Name:

PhysSampleCount

This register is an integer counter that is increased as soon as the module has saved a new physical sample line. The number of new sample lines is calculated from the difference to the previous cycle.

| Data type | Value |
|-----------|-------------------|
| SINT | -128 to 127 |
| INT | -32,768 to 32,767 |

9.1.19.9.8.3 "PhysTimestamp" register

Name:

PhysTimestamp

This register returns the timestamp of the values currently being determined as signed values in μs . This data point is the timestamp of the physical sample line 1.

| Data type | Value |
|-----------|---------------------------------|
| INT | -32768 to 32767 |
| DINT | -2,147,483,648 to 2,147,483,647 |

9.1.19.9.9 Logical sampling

The module has a data buffer with 16 entries for each of the 6 logical channels. This buffer is processed according to the configured sampling cycle time. In addition, it's also possible to adjust the logical execution cycle using a prescaler for the sampling cycle time.

A maximum of only 30 bytes is available for cyclic transfer on the X2X bus, however. Minus the status and sample counter, this allows only a selection of 14 samples (with a 16-bit data width) from the physical and logical buffer to be transferred. For the logical channels, it is also possible to configure a 32-bit data width. Data loss can therefore occur with an imprecise selection and configuration.

Example

Displaying continuous sample lines.

- Sampling cycle time = 100 μ s
- X2X cycle time = 500 μ s

```
Sample line 1      LogicCh0xSample1
Sample line 2      LogicCh0xSample2
Sample line 3      LogicCh0xSample3
Sample line 4      LogicCh0xSample4
Sample line 5      LogicCh0xSample5
Sample line 6      LogicCh0xSample6
```

```
Difference SampleCount = 1  New value in sample line 1
Difference SampleCount = 2  New values in sample line 1 and sample line 2
...
Difference SampleCount = 5  New values in sample line 1 to sample line 5
```

Information:

It is important to note that the sample counter refers to the update of the sample lines in the data buffer and not to the number of values transferred cyclically.

Displaying each second sample line to bridge a higher recording duration:

- Sampling cycle time = 100 μ s
- X2X cycle time = 1000 μ s

```
Sample line 1      LogicCh0xSample1
Sample line 3      LogicCh0xSample3
Sample line 5      LogicCh0xSample5
Sample line 7      LogicCh0xSample7
Sample line 9      LogicCh0xSample9
Sample line 11     LogicCh0xSample11
```

```
Difference SampleCount = 1  New value in sample line 1
Difference SampleCount = 3  New values in sample line 1 and sample line 3
...
Difference SampleCount = 5  New values in sample line 1 to sample line 5
...
Difference SampleCount = 9  New values in sample line 1 to sample line 9
```

9.1.19.9.9.1 "LogicChSample8_1" registers

Name:

LogicCh01Sample8_1 to LogicCh06Sample8_1

These registers are used to represent the results of samples 1 to 8 of the logical digital comparator for the logical channels. Each of these bits corresponds to a sample line, with sample 1 the newest and Sample 8 the oldest comparator comparison. The results of samples 9 to 16 are represented in register "[LogicSample16_9](#)" on page 587.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------------|-------|-------------|
| 0 | Comparator result | x | Sample 1 |
| ... | ... | | |
| 7 | Comparator result | x | Sample 8 |

9.1.19.9.2 "LogicChSample16_9" registers

Name:

LogicCh01Sample16_9 to LogicCh06Sample16_9

These registers are used to represent the results of samples 9 to 16 of the logical digital comparator for the logical channels. Each of these bits corresponds to a sample line, with sample 9 the newest and Sample 16 the oldest comparator comparison. The results of samples 1 to 8 are represented in register "[LogicChSample8_1](#)" on page 586.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------------|-------|-------------|
| 0 | Comparator result | x | Sample 9 |
| ... | ... | | |
| 7 | Comparator result | x | Sample 16 |

9.1.19.9.3 "LogicChSample" registers

Name:

LogicCh01Sample1 to LogicCh01Sample16

...

LogicCh06Sample1 to LogicCh06Sample16

These registers are the buffer registers of the logical input channels. 16 registers are available for each channel. Sample 1 is the newest value; sample 16 is the oldest.

Calculated values are displayed as signed 16- or 32-bit values depending on the register being used.

| Data type | Value |
|-----------|---------------------------------|
| INT | -32768 to 32767 |
| DINT | -2,147,483,648 to 2,147,483,647 |

9.1.19.9.4 "LogicSampleCount" register

Name:

LogicSampleCount

This register is an integer counter that is increased as soon as the module has saved a new logical sample line. The number of new sample lines is calculated from the difference to the previous cycle.

| Data type | Value |
|-----------|-------------------|
| SINT | -128 to 127 |
| INT | -32,768 to 32,767 |

9.1.19.9.5 "LogicTimestamp" register

Name:

LogicTimestamp

This register returns the timestamp of the values currently being determined as signed 2 or 4-byte values in μs . This data point is the timestamp of the logical sample line 1.

| Data type | Value |
|-----------|---------------------------------|
| INT | -32768 to 32767 |
| DINT | -2,147,483,648 to 2,147,483,647 |

9.1.19.9.10 System configuration

The following registers are used to configure the module's system settings.

9.1.19.9.10.1 Register "CfO_BaseConfig"

Name:

CfO_BaseConfig

This register can be used to configure settings for handling logical oversampling and data acquisition.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 49 |

Bit structure:

| Bit | Description | Value | Information |
|-------|---|-------|--|
| 0 | "Display configuration for logical values active/inactive" in the Automation Studio I/O configuration | 0 | Inactive |
| | | 1 | Active (bus controller default setting) |
| 1 | "Logical handling priority" in the Automation Studio I/O configuration | 0 | Low (bus controller default setting) |
| | | 1 | High |
| 2 - 3 | Reserved | - | |
| 4 | "Physical input mode" in the Automation Studio I/O configuration | 0 | Newest value |
| | | 1 | Referenced value (reference = prescaled system timer) (bus controller default setting) |
| 5 | "Logical input mode" in the Automation Studio I/O configuration | 0 | Newest value |
| | | 1 | Referenced value (reference = prescaled system timer) (bus controller default setting) |
| 6 - 7 | Reserved | - | |

Priority of logical oversampling

- Low priority setting
Logical and physical buffers are not processed in the same context. If the calculation time that results in the logical oversampling is higher than the configured sampling cycle time, this setting and a prescaler > 1 can be used to split up the logical processing over several sampling cycles. In this way, the sample lines of the physical and logical oversampling are not automatically acquired or calculated at the same point in time. If the prescaler is configured incorrectly, the logical oversampling cannot be processed successfully.
- High priority setting
Logical and physical buffers are processed in the same context. The sample lines of the physical and logical oversampling are acquired and calculated at the same point in time. It must be possible to execute all configured functions in the configured sampling cycle time; otherwise, a cycle time violation will occur and the configuration must be changed accordingly. Configuring the logical prescaler doesn't have any effect here; only the data traffic in the logical oversampling is limited.

Current or referenced values for logical or physical oversampling

In a system being used to capacity, jitter in the sampling cycle on the module can also be caused by the necessary processing of functions (X2X Link operation, logical and physical oversampling) when the cycle time is set to synchronous. This results in a varying number of sample lines in the same time period. For this reason, more samples should also be configured in the cyclic image than are actually necessary to compute.

- Current values setting
Passing on the sample lines to the higher-level system takes place as quickly as possible, with fewer or more sample lines possibly occurring.
- Referenced values setting
This setting minimizes jitter and makes it possible to expect a constant number of new sample lines per cycle when configured optimally. With regard to response time, however, delays of several sampling cycles may occur.

9.1.19.9.10.2 Register "CfO_CycleTime"

Name:

CfO_CycleTime

"Physical sample time" in the Automation Studio I/O configuration.

This register configures the module's sampling cycle time. The format is a 16.16-bit unsigned 4-byte value, with the high word representing the integer part of the μs value and the low word the decimal places. The decimal places allow a closer alignment to the X2X cycle time. The absolute resolution is 1 μs .

Input value = Time in μs * 65536 data type

| Data type | Value | Information |
|-----------|----------------------------|---|
| UDINT | 2,621,440 to 2,147,483,647 | 40 μs to 32 ms sampling cycle time. Bus controller default setting: 6,553,600 = 100 μs |

9.1.19.9.10.3 Register "CfO_Prescaler"

Name:

CfO_Prescaler

This register contains the prescaler for configuring the logical channel processing time. The actual logical cycle time will be calculated from the multiple of the sampling cycle time that is defined here. If a very short sampling cycle time is required for physical samples, then the module load can be reduced using the second time base for the logical samples.

| Data type | Value | Information |
|-----------|---------|--|
| UINT | 1 to 10 | Multiples of the physical sampling cycle for logical processing Bus controller default setting: 2 |

9.1.19.9.10.4 Register "CfO_SyncOffset"

Name:

CfO_SyncOffset

"Synchronization offset" in the Automation Studio I/O configuration.

The system cycle can be offset in 1 μs steps in this register.

| Data type | Value | Information |
|-----------|-------------------|--|
| UINT | -32,768 to 32,767 | Synchronization offset in μs . Bus controller default setting: 0 |

9.1.19.9.11 Scaling

Analog input channels are naturally aligned and normalized when delivered ($\text{gain} = k$; $\text{offset} = d$). In addition, user-defined standardization is also available ($\text{gain} = k_u$, $\text{offset} = d_u$). The calculation is optimized by grouping the factors together.

Normalization calculation:

$$\text{nom} = k * \text{RawValue} + d$$

$$k = k * k_u$$

$$d = k * d + d_u$$

The values calculated here are limited to 16 bits.

9.1.19.9.11.1 "CfO_UserGainCh" registers

Name:

CfO_UserGainCh01 to CfO_UserGainCh04

"Configuration channel 0x / gain" in the Automation Studio I/O configuration

These registers are used to configure the gain for the respective channel. The format is a 16.16-bit signed 4-byte value, with the high word the integer part and the low word the decimal places.

$$\text{Input value} = \text{Gain } k_u * 65536$$

Value 65,535 corresponds to a gain of 1.

| Data type | Value | Information |
|-----------|------------------------------------|---|
| DINT | -2,147,483,648 to 2,147,483,647 | Gain. Bus controller default setting: 65,535 |

9.1.19.9.11.2 "CfO_UserOffsetCh" registers

Name:

CfO_UserOffsetCh01 to CfO_UserOffsetCh04

"Configuration channel 0x / offset" in the Automation Studio I/O configuration

These registers are used to configure the offset for the respective channel. The format is a 16.16-bit signed 4-byte value, with the high word the integer part and the low word the decimal places.

$$\text{Input value} = \text{Offset } d_u * 65536$$

Value 65536 corresponds to an offset of 1.

| Data type | Value | Information |
|-----------|------------------------------------|--|
| DINT | -2,147,483,648 to 2,147,483,647 | Offset. Bus controller default setting: 0 |

9.1.19.9.12 Input filter

This module is equipped with an individually configurable input filter for each channel. The following filters can be selected:

- 1st-order low pass
- 2nd-order low pass
- 2nd-order IIR

The cutoff frequency can be configured for the 1st-order and 2nd-order low pass filters. The coefficients Alpha0, Alpha1, Alpha2, Beta1 and Beta2 must be configured for the IIR filter.

9.1.19.9.12.1 "CfO_CutOffFrequCh" register

Name:

CfO_CutOffFrequCh01 to CfO_CutOffFrequCh04

These registers are used to configure the limit frequency in hertz for a 1st- or 2nd-order low pass for the corresponding channel.

| Data type | Value | Information |
|-----------|------------|---|
| UINT | 0 to 65535 | Cutoff frequency for 1st- or 2nd-order low pass [Hz]. Bus controller default setting: 1000 |

9.1.19.9.12.2 "CfO_AlphaCh" and "CfO_BetaCh" registers

Name:

CfO_Alpha0Ch01 to CfO_Alpha0Ch04

CfO_Alpha1Ch01 to CfO_Alpha1Ch04

CfO_Alpha2Ch01 to CfO_Alpha2Ch04

CfO_Beta1Ch01 to CfO_Beta1Ch04

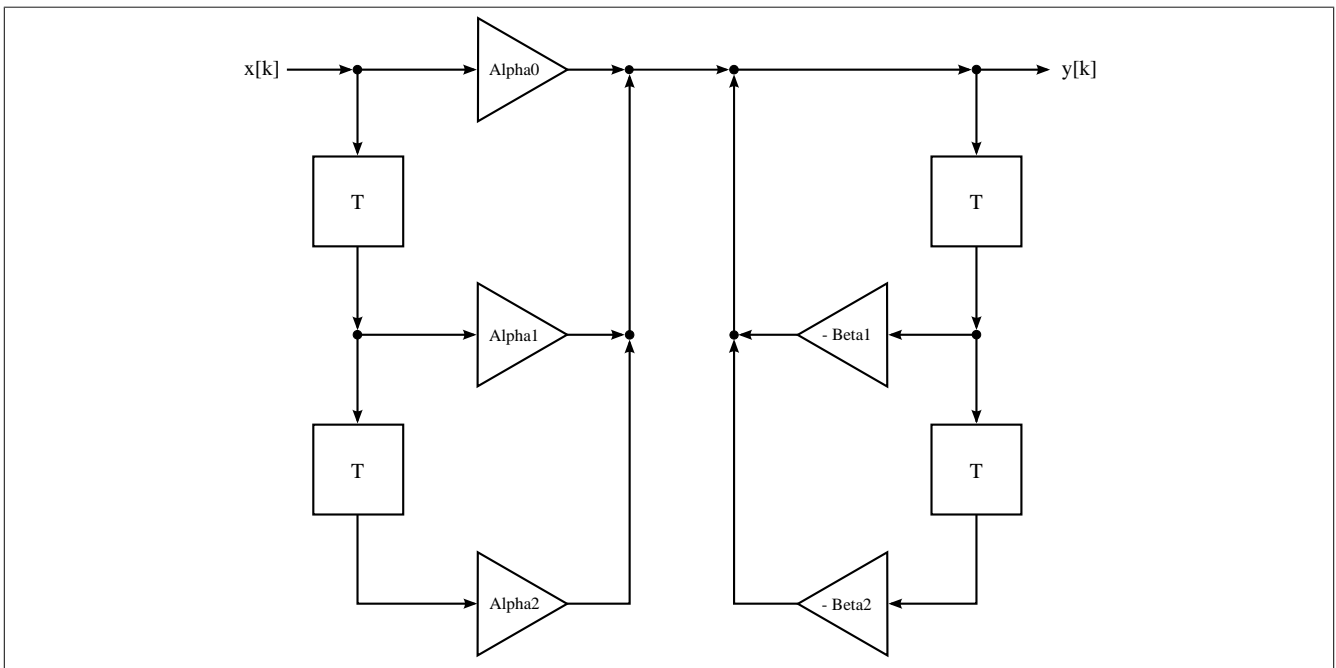
CfO_Beta2Ch01 to CfO_Beta2Ch04

These registers set the coefficients for the IIR filter.

Image as a z-transfer function

The second-order z-transfer function is specified in coefficient form (denominator polynomial Beta1, Beta2 and numerator polynomial Alpha0, Alpha1, Alpha2). The transfer method is calculated with the sampling cycle time.

$$S(Z) = \frac{a(Z)}{b(Z)} = \frac{\text{Alpha0} + \text{Alpha1} * Z^{-1} + \text{Alpha2} * Z^{-2}}{1 + \text{Beta1} * Z^{-1} + \text{Beta2} * Z^{-2}}$$



| Data type | Values | |
|-----------|------------------------------------|--|
| DINT | -2,147,483,648 to 2,147,483,647 | IIR filter coefficient. Bus controller default setting: 0 |

9.1.19.9.13 Physical configuration

9.1.19.9.13.1 "CfO_ModeCh" registers

Name:

CfO_ModeCh01 to CfO_ModeCh04

The operating mode for each physical channel can be configured in this register.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 256 |

Bit structure:

| Bit | Description | Value | Information |
|---------|---|------------|--|
| 0 - 2 | Connection configuration This value must be set the same for each register! | 000 | Voltage signal (bus controller default setting) |
| | | 111 | Current signal |
| 3 - 7 | Reserved | 0 | |
| 8 - 10 | Operating mode | 000 | Channel disabled |
| | | 001 | No filtering (bus controller default setting) |
| | | 010 | 2nd-order IIR (configurable Alpha and Beta coefficients) |
| | | 011 | 1st-order low pass (configurable limit frequency) |
| | | 100 | 2nd-order low pass (configurable limit frequency) |
| | | 101 to 111 | Reserved |
| 11 - 15 | Reserved | 0 | |

9.1.19.9.14 Logical configuration

9.1.19.9.14.1 Operation in the standard function model

6 logical channels are available on the module. Each channel can be configured with one of the following functions:

- "Addition of two channels with scaling" on page 592
- "Integral addition of two channels with scaling" on page 593
- "Multiplication of two channels with scaling" on page 594
- "Integral multiplication of two channels with scaling" on page 595
- "Comparator function of two channels" on page 595
- "Hysteresis comparator of one channel " on page 595

With logical oversampling, 32-bit data points are available in addition to 16-bit data points due to the possible calculated results. The Automation Studio I/O configuration or data point mapping can be opened to select which one to use.

If there is no need to use 32-bit data points, or if this would lead to too large of a limitation in the number of data points, scaling can be used to limit the range to 16 bits.

The buffer depth for the digital comparator is also able to handle 16 results. Since these are Boolean results, these 16 bits are compressed into 2-byte data points and transferred that way.

Addition

This function can be used to determine the sum or difference of two channels. To determine the difference, negative scaling must be configured for the channel.

Calculation

Sample line = (Channel 1 * Scaling 1) + (Channel 2 * Scaling 2)

The addition calculation is handled internally as a 32-bit value in 16.16 format; the data from the source channels is evaluated as integers (applied to the high word), with decimal places possible as a result of scaling. When displayed as a logical 32-bit result, these decimal places are visible. When displayed as a 16-bit value, only the integral high word is used.

Example

Channel 1 = 2000

Channel 2 = 1000

Both scalings = 1

Results

$3000.x = (2000.x * 1.0) + (1000.x * 1.0)$

32-bit representation = 196608000 = 0xBB80000

16-bit representation = 3000 = 0xBB8

Information:

The maximum value for channels 1 and 2 can only be 32767; otherwise, an additional overflow occurs. If values greater than 32767 are possible, the range of values must be limited with scaling.

Integral of addition

This function can be used in the application to establish the average value of the channels or to calculate the deviation/difference between two channels over n samples. In each cycle, the channels are added together first; then the result is added to the previous value and saved in the current sample line. Depending on the result data type being used (16-bit or 32-bit), eventually the continuous integration will cause the calculation to overflow after n samples. Because of the signed result value, it must be ensured that the number n of samples is chosen small enough so that calculating the integral component is less than half the range of values. If this is done, determining the average value can be carried out despite an overflow.

Calculation

Result: Sample line = Integral ((Channel 1 * Scaling 1) + (Channel 2 * Scaling 2))

The addition calculation is handled internally as a 32-bit value in 16.16 format; the data from the source channels is evaluated as integers (applied to the high word), with decimal places possible as a result of scaling. When displayed as a logical 32-bit result, these decimal places are visible. When displayed as a 16-bit value, only the integral high word is used.

Example

Channel 1 = 2000

Channel 2 = 1000

Both scalings = 1

Results

$3000.x = (2000.x * 1.0) + (1000.x * 1.0)$

32-bit representation = 196608000 = 0xBB80000.

16-bit representation = 3000 = 0xBB8

The average value can now be calculated as follows:

n = Number of samples / sample lines

$Value_x$ = Value from sample line x → Newer value

$Value_{(x-n)}$ = Value from sample line $x-n$ → Older value, n samples back

Average value = $(Value_x - Value_{(x-n)}) / n$

Information:

The maximum value for channels 1 and 2 can only be 32767; otherwise, an additional overflow occurs. If values greater than 32767 are possible, the range of values must be limited with scaling.

Multiplication

This function can be used to calculate the current effective power $P = U * I$.

Calculation

Sample line = Channel 1 * Channel 2 * Scaling

Multiplication is calculated internally as a 32-bit value; the 16-bit data from the source channels is passed to the low word. When displayed as a logical 32-bit value, the entire result is visible (no multiplication overflow possible when scaling ≤ 1). When displayed as a 16-bit value, only the high word is used. Though there is a loss of precision, the 16-bit values allow more data points to be transferred.

Example

Channel 1 = 2000

Channel 2 = 1000

Scaling = 1

Results

2000000 = (2000 * 1000 * 1.0)

32-bit representation = 2000000 = 0x1E8480

16-bit representation = 30 = 0x1E

Information:

If more precision is needed with the 16-bit value, scaling in steps of 2^n (... , *128, *256, ...) can be employed to shift the bits. Of course, it's important again that the input values of the source channels be limited; otherwise, an overflow will occur in the multiplication operation.

Integral of multiplication

This function can be used in the application to establish the average value of the effective power. In each cycle, the channels are multiplied together first; then the result is added to the previous value and saved in the current sample line. Depending on the result data type being used (16-bit or 32-bit), eventually the continuous integration will cause the calculation to overflow after n samples. Because the result value is signed, it is important to set the number n of samples small enough so that the integration is less than half of the value range. If this is done, determining the average value can be carried out despite an overflow.

Calculation

Sample line = Integral (Channel 1 * Channel 2 * Scaling)

Multiplication is calculated internally as a 32-bit value; the 16-bit data from the source channels is passed to the low word. When displayed as a logical 32-bit value, the entire result is visible (no multiplication overflow possible when scaling ≤ 1). When displayed as a 16-bit value, only the high word is used. Though there is a loss of precision, the 16-bit values allow more data points to be transferred.

Example

Channel 1 = 2000

Channel 2 = 1000

Scaling = 1

Results

$2000000 = (2000 * 1000 * 1.0)$

32-bit representation = $2000000 = 0x1E8480$

16-bit representation = $30 = 0x1E$

The average value can now be calculated as follows:

n = Number of samples / sample lines

$Value_x$ = Value from sample line $x \rightarrow$ Newer value

$Value_x$ = Value from sample line $x \rightarrow$ Older value, n samples back

Average value = $(Value_x - Value_{(x-n)}) / n$

Information:

If more precision is needed with the 16-bit value, scaling in steps of 2^n (... , *128, *256, ...) can be employed to shift the bits. Of course, it's important again that the input values of the source channels be limited; otherwise, an overflow will occur in the multiplication operation.

Channel comparator

This function can be used to compare channel values. The following applies:

- Channel 1 > Channel 2 = 1
- Channel 1 < Channel 2 = 0
- Channel 1 = Channel 2 = State before values are the same

Calculation

Sample line (bit) = Comparison (channel value 1 with channel value 2)

Hysteresis comparator

This function can be used to monitor range violations by channels. The following applies:

- Channel > Upper threshold value = 1
- Channel < Lower threshold value = 0
- Channel within threshold = Value before occurrence

Calculation

Sample line (bit) = Comparison (channel value with lower threshold value) and (channel value with upper threshold value))

9.1.19.9.14.2 Operation in the bus controller function model

When used on the bus controller, there are 4 logical functions available for each of the analog input channels in addition to the physical value output. Each channel can be configured with one of the following functions:

- "Output of physical values" on page 596 (default setting)
- "Addition of two channels with scaling" on page 592
- "Integral addition of two channels with scaling" on page 593
- "Multiplication of two channels with scaling" on page 594
- "Integral multiplication of two channels with scaling" on page 595
- "Comparator function of two channels" on page 595
- "Hysteresis comparator of one channel " on page 595

In contrast to the standard function model, oversampling and the two digital comparators are not supported. As a result, there is only one newly generated value per channel in each update cycle. Another difference is that there are only 4 logical calculation channels instead of 6.

The logical functions addition, integral of addition, multiplication and integral of multiplication do not differ from the standard function model in their configuration and function when operating on the bus controller.

Physical value display

The physical value display in the bus controller function model is initialized automatically and represents a special form of the logical function "Addition" with defined scaling factors.

Calculation

Result = Channel value

Formula used for addition: $\text{Result} = (\text{Channel value } 1 * 1) + (\text{Channel value } 2 * 0)$

Information:

In this function model, only the 4 physical input channels are available, and the scaling factors have defined values.

9.1.19.9.14.3 "CfO_LogChMode" register

Name:

CfO_LogCh01Mode to CfO_LogCh06Mode

"Logical configuration channel 0x / Addition" in the Automation Studio I/O configuration.

"Logical configuration channel 0x / Integral of addition" in the Automation Studio I/O configuration.

"Logical configuration channel 0x / Multiplication" in the Automation Studio I/O configuration.

"Logical configuration channel 0x / Integral of multiplication" in the Automation Studio I/O configuration.

"Logical configuration channel 0x / Channel comparator" in the Automation Studio I/O configuration.

"Logical configuration channel 0x / Hysteresis comparator" in the Automation Studio I/O configuration.

"Logical configuration channel 0x / Physical value display" in the Automation Studio I/O configuration.

The operating mode for each logical channel can be configured in this register.

The selection of the sources to be used for each logical channel is made using the register "CfO_LogCh0NSource0x" on page 597. Any additionally needed function parameters are configured in the "CfO_LogCh0NFuncPar0x" on page 598 registers. "N" stands for the logical channel to be used, while "x" stands for either the source or function 0 or 1.

The following links can be made:

- Addition: Result = (Source 0 * Function parameter 0) + (Source 1 * Function parameter 1)
- Integral of addition: Result = Σ (Source 0 * Function parameter 0) + (Source 1 * Function parameter 1)
- Multiplication: Result = Source 0 * Source 1 * Function parameter 0
- Integral of multiplication: Result = Σ (Source 0 * Source 1 * Function parameter 0)
- Channel comparator: Result = Comparison of source 0 with source 1
- Hysteresis comparator: Result = comparison of source 0 with (Lower threshold value = Function parameter 0) and (Upper threshold value = Function parameter 1)
- Physical value display: Result = (Source 0 * 1) + (Source 1 * 0)

| Data type | Value | Information |
|-----------|-------|--|
| UINT | 0 | Channel switched off. Bus controller default setting: Channel 5 to 6 |
| | 256 | Addition or physical value display ¹⁾ . Bus controller default setting: Channel 1 to 4 |
| | 257 | Integral of addition |
| | 512 | Multiplication |
| | 513 | Integral of multiplication |
| | 768 | Channel comparator |
| | 1024 | Hysteresis comparator |

1) Only registers CfO_LogCh01Mode to CfO_LogCh04Mode are used for physical value display.

9.1.19.9.14.4 "CfO_LogChSource" register

Name:

CfO_LogCh01Source00 to CfO_LogCh06Source00

CfO_LogCh01Source01 to CfO_LogCh06Source01

These registers can be used to select the source registers for the operating mode of the logical channel configured in the register "CfO_LogCh0NMode" on page 597.

In the name, "Source00" stands for source register 0; "Source01" stands for source register 1.

In **Physical value display** mode, the same channel number is written to both source registers.

| Data type | Value | Information |
|-----------|-------|--|
| USINT | 0 | Physical channel 01. Bus controller default setting ¹⁾ |
| | ... | ... |
| | 3 | Physical channel 04. Bus controller default setting ¹⁾ |
| | 8 | Logical channel 01 ¹⁾ |
| | ... | ... |
| | 13 | Logical channel 06 |

1) **Values**

Channels 1 to 4: Channel number - 1
Channels 5 to 6: 0

2) Logical channels cannot be used in the bus controller function model.

9.1.19.9.14.5 "CfO_LogChFuncPar" register

Name:

CfO_LogCh01FuncPar00 to CfO_LogCh06FuncPar00

CfO_LogCh01FuncPar01 to CfO_LogCh06FuncPar01

These registers can be used to configure additional function parameters for the operating mode of the logical channel configured in the register "CfO_LogCh0NMode" on page 597.

The effect of the function parameters is different depending on the operating mode.

| Operating mode | Parameter 1 | Parameter 2 |
|------------------------------|---------------------------------|----------------------------|
| (Integral of) addition | Scaling factor | Scaling factor |
| (Integral of) multiplication | Scaling factor | - |
| Channel comparator | - | - |
| Hysteresis comparator | Upper threshold value | Lower threshold value |
| Output of physical values | Defined scaling factor = 65,536 | Defined scaling factor = 0 |

Value 65,536 corresponds to scaling or a threshold value of 1.

| Data type | Value | Information |
|-----------|--------------------|--|
| UDINT | 0 to 4,294,967,295 | Scaling factor or threshold value. Bus controller default setting: <u>Register "...FuncPar00"</u> Channels 1 to 4 65536 Channels 5 to 6 0 <u>Register "...FuncPar01"</u> All 0 |

9.1.19.9.15 Error registers

The registers for displaying and acknowledging errors are transferred either cyclically or acyclically depending on the function model.

9.1.19.9.15.1 "CfO_ErrorID1017" register

Name:

CfO_ErrorID1017

Automatic enabling by the Automation Studio I/O configuration.

This register can be used to enable standard error messages. The channels' composite errors are derived from the individual extended error status, e.g. overflow/underflow of the input range for the analog value. Oversampling error statuses result from a cycle time violation of the configured sampling cycle time.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 63 |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------------|-------|---|
| 0 | Composite errors on channel 01 | 0 | Error generation disabled |
| | | 1 | Error generation enabled (bus controller default setting) |
| ... | | ... | |
| 3 | Composite errors on channel 04 | 0 | Error generation disabled |
| | | 1 | Error generation enabled (bus controller default setting) |
| 4 | Physical sample error status | 0 | Error generation disabled |
| | | 1 | Error generation enabled (bus controller default setting) |
| 5 | Logical sample error status | 0 | Error generation disabled |
| | | 1 | Error generation enabled (bus controller default setting) |
| 6 - 7 | Reserved | 0 | |

9.1.19.9.15.2 "CfO_ErrorID0x0x" register

Name:

CfO_ErrorID0007 (for channels 1 and 2)

CfO_ErrorID080F (for channels 3 and 4)

Automatic enabling in the Automation Studio I/O configuration by selecting "Extended error status information" and channel activation.

These registers can be used to enable extended error messages for analog channels 1 and 2 as well as channels 3 and 4. Meaning of individual bits:

- **Range exceeded violation (pos.):** The analog input signal is outside of the specified working range.
- **Filter error:** The configured filter theorem cannot be calculated (parameter error).
- **Underflow:** The input signal is less than the lower limit value.
- **Overflow:** The input signal is greater than the upper limit value.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-----|---|-------|--|
| 0 | Channel 1 or 3: Range exceeded violation (pos.) | 0 | Error generation disabled (bus controller default setting) |
| | | 1 | Range exceeded violation (pos.) enabled |
| 1 | Channel 1 or 3: Filter error | 0 | Error generation disabled (bus controller default setting) |
| | | 1 | Filter error enabled |
| 2 | Channel 1 or 3: Underflow | 0 | Error generation disabled (bus controller default setting) |
| | | 1 | Underflow enabled |
| 3 | Channel 1 or 3: Overrun | 0 | Error generation disabled (bus controller default setting) |
| | | 1 | Overflow enabled |
| 4 | Channel 2 or 4: Range exceeded violation (pos.) | 0 | Error generation disabled (bus controller default setting) |
| | | 1 | Range exceeded violation (pos.) enabled |
| 5 | Channel 2 or 4: Filter error | 0 | Error generation disabled (bus controller default setting) |
| | | 1 | Filter error enabled |
| 6 | Channel 2 or 4: Underflow | 0 | Error generation disabled (bus controller default setting) |
| | | 1 | Underflow enabled |
| 7 | Channel 2 or 4: Overrun | 0 | Error generation disabled (bus controller default setting) |
| | | 1 | Overflow enabled |

9.1.19.9.15.3 "StandardErrors" registers

Name:

Channel01Error to Channel04Error

PhysicalError

LogicalError

Composite errors are mapped to this register.

All configured functions of the physical and logical oversampling must be able to be carried out in the configured sampling cycle time; otherwise, these error messages occur. Settings for processing priority and the prescaler can be used to additionally adjust the system for logical oversampling.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|----------------|-------|--|
| 0 | Channel01Error | 0 | No error |
| | | 1 | Composite errors on channel 1 |
| ... | ... | ... | ... |
| 3 | Channel04Error | 0 | No error |
| | | 1 | Composite errors on channel 4 |
| 4 | PhysicalError | 0 | No error |
| | | 1 | Physical sample error status, sampling cycle time too short |
| 5 | LogicalError | 0 | No error |
| | | 1 | Logical sample error status, sampling cycle time too short or prescaler configured too low |

9.1.19.9.15.4 "AcknowledgeStandardErrors" registers

Name:

AckChannel01Error to AckChannel04Error

AckPhysicalError

AckLogicalError

Error messages from the "StandardErrors" on page 599 register can be acknowledged by setting the corresponding bits in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------------|-------|-------------------|
| 0 | AckChannel01Error | 0 | No change |
| | | 1 | Acknowledge error |
| ... | | ... | |
| 3 | AckChannel04Error | 0 | No change |
| | | 1 | Acknowledge error |
| 4 | AckPhysicalError | 0 | No change |
| | | 1 | Acknowledge error |
| 5 | AckLogicalError | 0 | No change |
| | | 1 | Acknowledge error |

9.1.19.9.15.5 "ExtendedChannelErrorMessages" registers

Name:

Channel01OutOfRange to Channel04OutOfRange

Channel01FilterError to Channel04FilterError

Channel01Underflow to Channel04Underflow

Channel01Overflow to Channel04Overflow

The error states of the input channels are represented in these registers. Input channels 1 and 2 as well as 3 and 4 are each grouped together in one register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|---|-------|--|
| 0 | Channel01OutOfRange or Channel03OutOfRange | 0 | No error |
| | | 1 | Range exceeded violation (pos.) occurred |
| 1 | Channel01FilterError or Channel03FilterError | 0 | No error |
| | | 1 | Filter error occurred |
| 2 | Channel01Underflow or Channel03underflow | 0 | No error |
| | | 1 | Underflow occurred |
| 3 | Channel01Overflow or Channel03Overflow | 0 | No error |
| | | 1 | Overflow occurred |
| 4 | Channel02OutOfRange or Channel04OutOfRange | 0 | No error |
| | | 1 | Range exceeded violation (pos.) occurred |
| 5 | Channel02FilterError or Channel04FilterError | 0 | No error |
| | | 1 | Filter error occurred |
| 6 | Channel02Underflow or Channel04Underflow | 0 | No error |
| | | 1 | Underflow occurred |
| 7 | Channel02Overflow or Channel04Overflow | 0 | No error |
| | | 1 | Overflow occurred |

9.1.19.9.15.6 "AcknowledgeExtendedChannelErrorMessages" registers

Name:

AckChannel01OutOfRange to AckChannel04OutOfRange

AckChannel01FilterError to AckChannel04FilterError

AckChannel01Underflow to AckChannel04Underflow

AckChannel01Overflow to AckChannel04Overflow

These registers can be used to acknowledge the error messages from the "ExtendedChannelErrorMessages" on page 600 registers by setting the corresponding bit. The acknowledgment of input channels 1 and 2 as well as 3 and 4 are each grouped together in one register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|---|-------|-------------------|
| 0 | AckChannel01OutOfRange or AckChannel03OutOfRange | 0 | No change |
| | | 1 | Acknowledge error |
| 1 | AckChannel01FilterError or AckChannel03FilterError | 0 | No change |
| | | 1 | Acknowledge error |
| 2 | AckChannel01Underflow or AckChannel03Underflow | 0 | No change |
| | | 1 | Acknowledge error |
| 3 | AckChannel01Overflow or AckChannel03Overflow | 0 | No change |
| | | 1 | Acknowledge error |
| 4 | AckChannel02OutOfRange or AckChannel04OutOfRange | 0 | No change |
| | | 1 | Acknowledge error |
| 5 | AckChannel02FilterError or AckChannel04FilterError | 0 | No change |
| | | 1 | Acknowledge error |
| 6 | AckChannel02Underflow or AckChannel04Underflow | 0 | No change |
| | | 1 | Acknowledge error |
| 7 | AckChannel02Overflow or AckChannel04Overflow | 0 | No change |
| | | 1 | Acknowledge error |

9.1.19.9.16 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 µs |

9.1.19.9.17 Minimum I/O update time

There is no limitation or dependency on the bus cycle time.

The I/O update time is defined using the "Sampling time" register. The fastest possible sampling time depends on the number of channels to be converted and the configuration.

9.1.20 X20AI8221

Data sheet version: 1.21

9.1.20.1 General information

The module is equipped with 8 inputs with 13-bit (including sign) digital converter resolution. It can be used to capture voltage signals in the range from ± 10 V.

- 8 analog inputs ± 10 V
- 13-bit digital converter resolution

9.1.20.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| X20AI8221 | X20 analog input module, 8 inputs, ± 10 V, 13-bit converter resolution |  |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB1F | X20 terminal block, 16-pin, 24 VDC keyed | |

Table 78: X20AI8221 - Order data

9.1.20.3 Technical data

| | |
|--|--|
| Model number | X20AI8221 |
| Short description | |
| I/O module | 8 analog inputs ± 10 V |
| General information | |
| B&R ID code | 0xD82F |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Inputs | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.04 W ¹⁾ |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Analog inputs | |
| Input | ± 10 V |
| Input type | Differential input |
| Digital converter resolution | ± 12 -bit |
| Conversion time | 1 ms for all inputs |
| Output format | |
| Data type | INT |
| Voltage | INT 0x8001 - 0x7FFF / 1 LSB = 0x0008 = 2.441 mV |
| Input impedance in signal range | 20 M Ω |
| Input protection | Protection against wiring with supply voltage |
| Open-circuit detection | Yes, using software |
| Reverse polarity protection | Yes |
| Permissible input signal | Max. ± 30 V |
| Output of digital value during overload | Configurable |
| Conversion procedure | SAR |
| Input filter | 3rd-order low pass / cutoff frequency 1 kHz |
| Max. error at 25°C | |
| Gain | 0.08% ²⁾ |
| Offset | 0.015% ³⁾ |
| Max. gain drift | 0.006 %/°C ²⁾ |
| Max. offset drift | 0.002 %/°C ³⁾ |
| Common-mode rejection | |
| DC | 70 dB |
| 50 Hz | 70 dB |
| Common-mode range | ± 12 V |
| Crosstalk between channels | -70 dB |
| Nonlinearity | <0.025% ³⁾ |
| Isolation voltage between channel and bus | 500 VDC, 1 min |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |

Table 79: X20AI8221 - Technical data


| | | |
|---------------------------------|--|--|
| Model number | X20AI8221 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB1F terminal block separately Order 1x X20BM11 bus module separately | |
| Spacing | 12.5 ^{+0.2} mm | |

Table 79: X20AI8221 - Technical data

- 1) To reduce power dissipation, B&R recommends bridging unused inputs on the terminals.
- 2) Based on the current measured value.
- 3) Based on the 20 V measurement range.

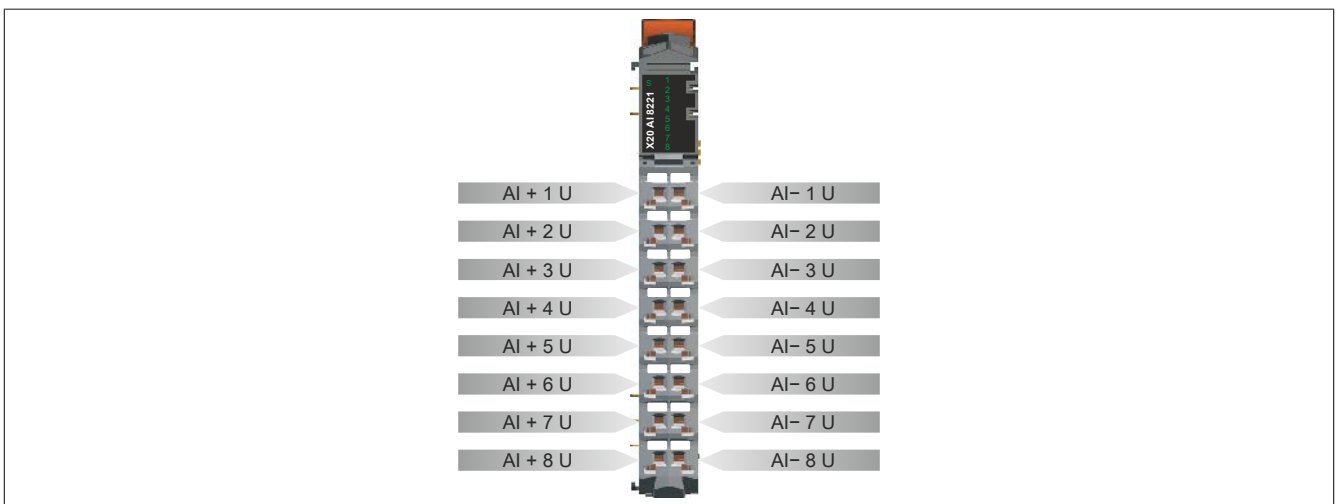
9.1.20.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

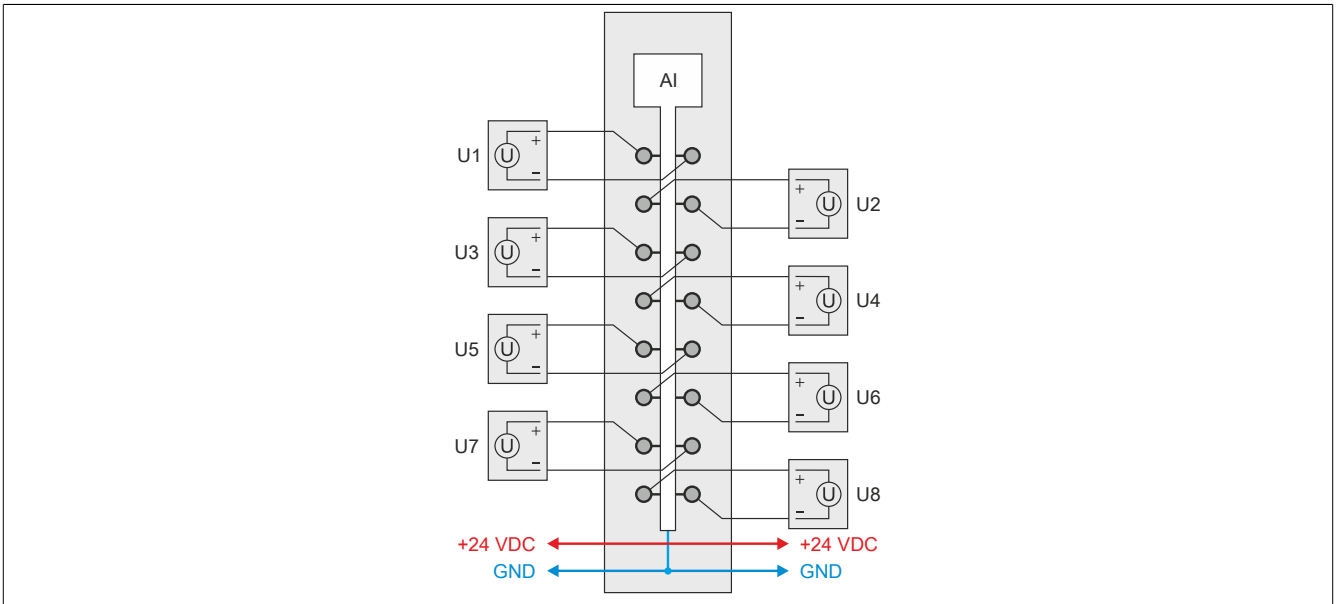
| Figure | LED | Color | Status | Description | |
|--|-------|-------|------------------|--|---|
|  | S | Green | Off | No power to module | |
| | | | Single flash | UNLINK mode | |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ | |
| | | | Blinking quickly | SYNC mode | |
| | | | Blinking slowly | PREOPERATIONAL mode | |
| | | | On | RUN mode | |
| | | | Red | Off | No power to module or everything OK |
| | | | | On | Error or reset status |
| | 1 - 8 | Green | | Off | Indicates one of the following cases: <ul style="list-style-type: none"> • No power to module • Open line |
| | | | | Single flash | Input signal overflow or underflow |
| On | | | | Analog/digital converter running, value OK | |

- 1) Depending on the configuration, a firmware update can take up to several minutes.

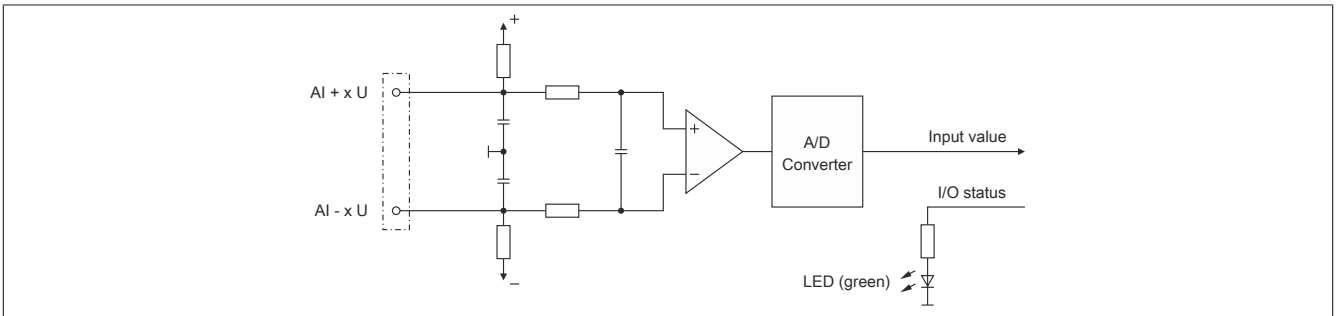
9.1.20.5 Pinout



9.1.20.6 Connection example



9.1.20.7 Input circuit diagram



9.1.20.8 Register description

9.1.20.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.1.20.8.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|--|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog signal - Configuration | | | | | | |
| 16 | ConfigOutput01 (Input filter) | USINT | | | | • |
| 20 | ConfigOutput03 (Lower limit value) | INT | | | | • |
| 22 | ConfigOutput04 (Upper limit value) | INT | | | | • |
| Analog signal - Communication | | | | | | |
| Index * 2 - 2 | AnalogInput0N (Index N = 1 to 8) | INT | • | | | |
| 30 | StatusInput01 | USINT | • | | | |
| 31 | StatusInput02 | USINT | • | | | |

9.1.20.8.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------------|----------------------|--|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog signal - Configuration | | | | | | | |
| 16 | - | ConfigOutput01 (Input filter) | USINT | | | | • |
| 20 | - | ConfigOutput03 (Lower limit value) | INT | | | | • |
| 22 | - | ConfigOutput04 (Upper limit value) | INT | | | | • |
| Analog signal - Communication | | | | | | | |
| Index * 2 - 2 | Index * 2 - 2 | AnalogInput0N (Index N = 1 to 8) | INT | • | | | |
| 30 | - | StatusInput01 | USINT | | • | | |
| 31 | - | StatusInput02 | USINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.1.20.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "[Using I/O modules on the bus controller](#)" on page 3789.

9.1.20.8.3.2 CAN I/O bus controller

The module occupies 2 analog logical slots on CAN I/O.

9.1.20.8.4 Analog inputs

Input signals are converted asynchronously in a 1 ms interval.

9.1.20.8.5 Analog input values

Name:

AnalogInput01 to AnalogInput08

The analog input values are mapped to this register.

| Data type | Value | Input signal: |
|-----------|-------------------|------------------------------|
| INT | -32,768 to 32,767 | Voltage signal -10 to 10 VDC |

9.1.20.8.6 Input filter

This module is equipped with a configurable input filter.

Information:

The filter sampling time is fixed at 1 ms and is acyclic to the X2X cycle.

9.1.20.8.6.1 Input ramp limiting

Input ramp limiting can only be performed in conjunction with filtering. Input ramp limiting is performed before filtering.

The difference of the input value change is checked for exceeding the specified limit. In the event of overshoot, the tracked input value is equal to the old value \pm the limit value.

Configurable limit values:

| Value | Limit value |
|-------|---|
| 0 | The input value is used without limitation. |
| 1 | 0x3FFF = 16383 |
| 2 | 0x1FFF = 8191 |
| 3 | 0x0FFF = 4095 |
| 4 | 0x07FF = 2047 |
| 5 | 0x03FF = 1023 |
| 6 | 0x01FF = 511 |
| 7 | 0x00FF = 255 |

Input ramp limiting is well suited for suppressing disturbances (spikes). The following examples show the functionality of input ramp limiting based on an input step and a disturbance.

Example 1

The input value jumps from 8000 to 17000. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = 0x07FF = 2047

Filter level = 2

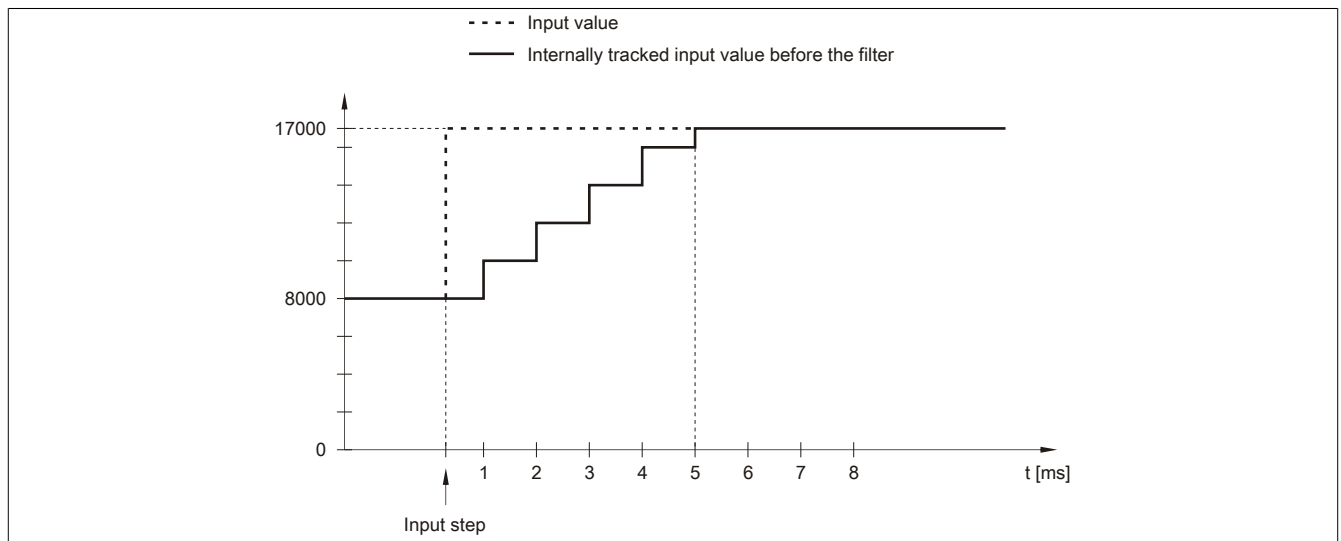


Figure 72: Tracked input value for input step

Example 2

A disturbance interferes with the input value. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = 0x07FF = 2047

Filter level = 2

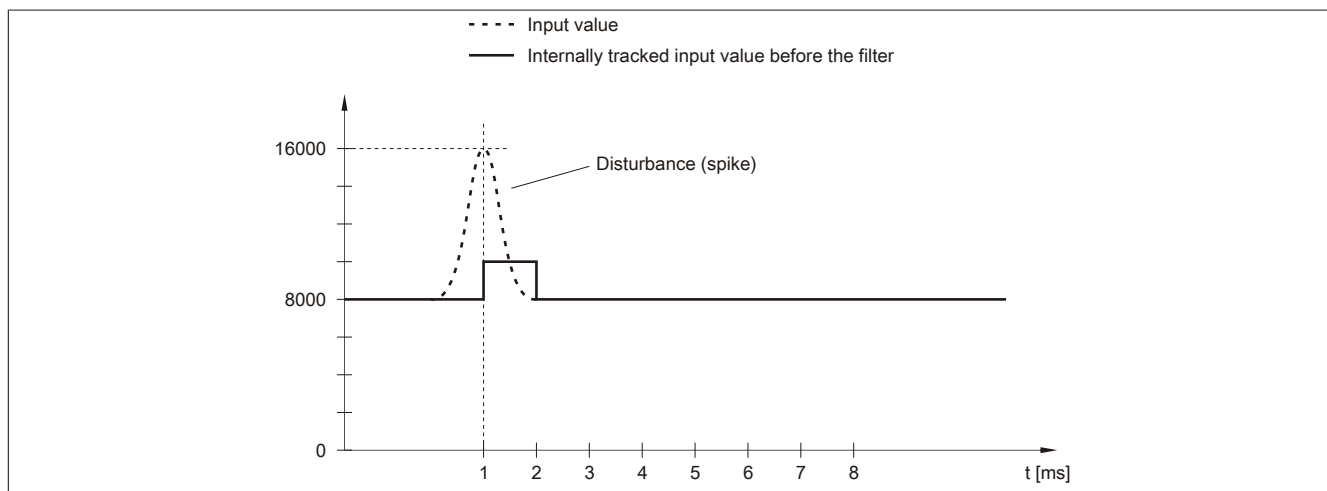


Figure 73: Tracked input value for disturbance

9.1.20.8.6.2 Filter level

A filter can be defined to prevent large input steps. This filter is used to bring the input value closer to the actual analog value over a period of several milliseconds.

Filtering takes place after any input ramp limiting has been carried out.

Formula for calculating the input value:

$$Value_{New} = Value_{Old} - \frac{Value_{Old}}{Filter\ level} + \frac{Input\ value}{Filter\ level}$$

Adjustable filter levels:

| Value | Filter level |
|-------|---------------------|
| 0 | Filter switched off |
| 1 | Filter level 2 |
| 2 | Filter level 4 |
| 3 | Filter level 8 |
| 4 | Filter level 16 |
| 5 | Filter level 32 |
| 6 | Filter level 64 |
| 7 | Filter level 128 |

The following examples show the functionality of the filter based on an input step and a disturbance.

Example 1

The input value jumps from 8000 to 16000. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

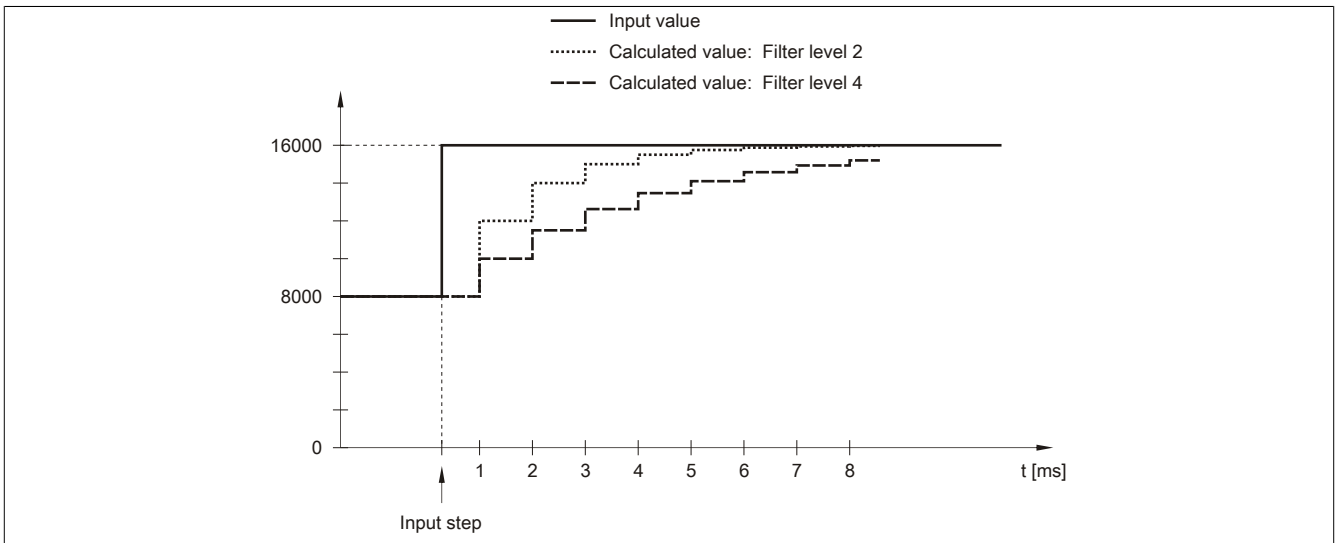


Figure 74: Calculated value during input step

Example 2

A disturbance interferes with the input value. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

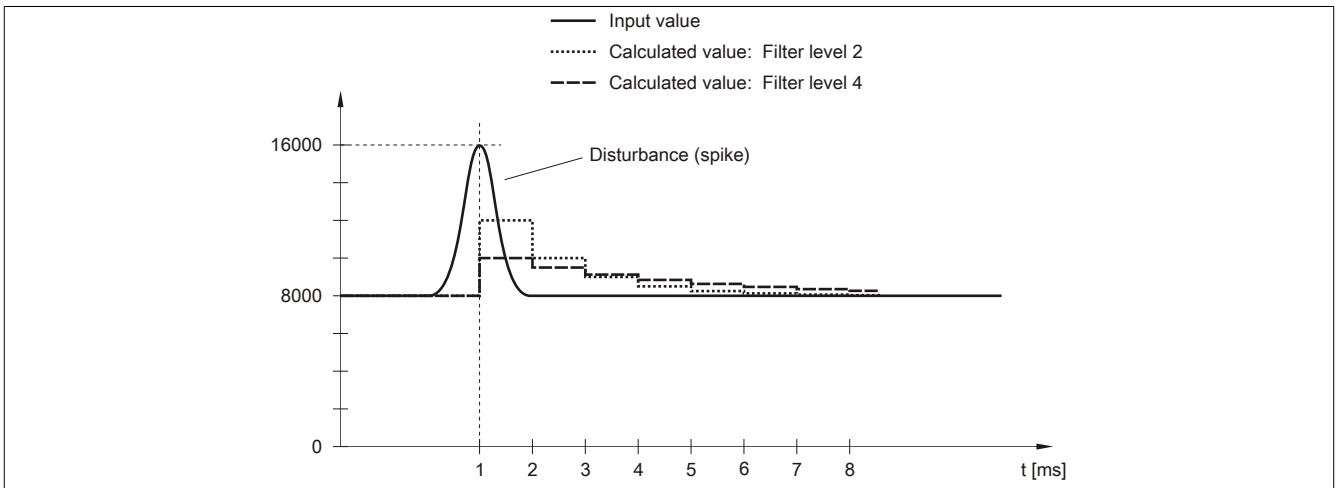


Figure 75: Calculated value during disturbance

9.1.20.8.7 Configuring the input filter

Name:

ConfigOutput01

This register is used to define the filter level and input ramp limitation of the input filter.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|--------|-----------------------------------|-------|--|
| 0 - 2 | Defines the filter level | 000 | Filter disabled (bus controller default setting) |
| | | 001 | Filter level 2 |
| | | 010 | Filter level 4 |
| | | 011 | Filter level 8 |
| | | 100 | Filter level 16 |
| | | 101 | Filter level 32 |
| | | 110 | Filter level 64 |
| | | 111 | Filter level 128 |
| 3 | Reserved | 0 | |
| 4 - 6 | Defines the input ramp limitation | 000 | The input value is applied without limitation (bus controller default setting) |
| | | 001 | Limit value = 0x3FFF (16383) |
| | | 010 | Limit value = 0x1FFF (8191) |
| | | 011 | Limit value = 0x0FFF (4095) |
| | | 100 | Limit value = 0x07FF (2047) |
| | | 101 | Limit value = 0x03FF (1023) |
| | | 110 | Limit value = 0x01FF (511) |
| | | 111 | Limit value = 0x00FF (255) |
| 7 - 15 | Reserved | 0 | |

9.1.20.8.8 Lower limit value

Name:

ConfigOutput03

This register can be used to configure the lower limit for analog values. If the analog value goes below the limit value, it is frozen at this value and the corresponding error status bit is set.

| Data type | Values | Information |
|-----------|-----------------|--|
| INT | -32767 to 32767 | Bus controller default setting: -32767 |

Information:

The default value of -32767 corresponds to the minimum default value of -10 VDC.

Keep in mind that this setting applies to all channels!

9.1.20.8.9 Upper limit value

Name:

ConfigOutput04

This register can be used to configure the upper limit for analog values. If the analog value goes above the limit value, it is frozen at this value and the corresponding error status bit is set.

| Data type | Values | Information |
|-----------|-----------------|---------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 32767 |

Information:

The default value of 32767 corresponds to the maximum default value at +10 VDC.

Keep in mind that this setting applies to all channels!

9.1.20.8.10 Input status

Name:

StatusInput01 to StatusInput02

This register is used to monitor the module inputs. A change in the monitoring status generates an error message.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

StatusInput01 monitors Channels 1 to 4

StatusInput02 monitors Channels 5 to 8

| Bit | Description | Value | Information |
|-------|----------------|-------|----------------------------|
| 0 - 1 | Channel 1 or 5 | 00 | No error |
| | | 01 | Lower limit value exceeded |
| | | 10 | Upper limit value exceeded |
| | | 11 | Open line |
| ... | | ... | |
| 6 - 7 | Channel 4 or 8 | 00 | No error |
| | | 01 | Lower limit value exceeded |
| | | 10 | Upper limit value exceeded |
| | | 11 | Open line |

Limiting the analog value

In addition to the status information, the analog value is fixed to the values listed below by default in an error state. The analog value is limited to the new values if the limit values were changed.

| Error state | Digital value on error (default values) |
|-----------------------------|---|
| Open circuit | +32767 (0x7FFF) |
| Upper limit value overshoot | +32767 (0x7FFF) |
| Lower limit value undershot | -32767 (0x8001) |
| Invalid value | -32768 (0x8000) |

9.1.20.8.11 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 150 μ s |

9.1.20.8.12 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 1 ms |

9.1.21 X20AI8321

Data sheet version: 1.21

9.1.21.1 General information

The module is equipped with 8 inputs with 12-bit digital converter resolution. It is possible to select between the two current ranges 0 to 20 mA and 4 to 20 mA.

- 8 analog inputs, 0 to 20 mA or 4 to 20 mA
- 12-bit digital converter resolution

9.1.21.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| X20AI8321 | X20 analog input module, 8 inputs, 0 to 20 mA, 12-bit converter resolution |  |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB1F | X20 terminal block, 16-pin, 24 VDC keyed | |

Table 80: X20AI8321 - Order data

9.1.21.3 Technical data

| | |
|--|--|
| Model number | X20AI8321 |
| Short description | |
| I/O module | 8 analog inputs 0 to 20 mA / 4 to 20 mA |
| General information | |
| B&R ID code | 0xD831 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Inputs | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.37 W (Rev. ≥ D0), 1.24 W (Rev. < D0) |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Analog inputs | |
| Input | 0 to 20 mA/4 to 20 mA |
| Input type | Differential input |
| Digital converter resolution | 12-bit |
| Conversion time | 1 ms for all inputs |
| Output format | |
| Data type | INT |
| Current | INT 0x0000 - 0x7FFF / 1 LSB = 0x0008 = 4.883 μA |
| Load | <300 Ω |
| Input protection | Protection against wiring with supply voltage |
| Reverse polarity protection | Yes |
| Permissible input signal | Max. ±50 mA |
| Output of digital value during overload | Configurable |
| Conversion procedure | SAR |
| Input filter | 3rd-order low pass / cutoff frequency 1 kHz |
| Max. error at 25°C | |
| Gain | 0.08% ¹⁾ |
| Offset | 0.03% ²⁾ |
| Max. gain drift | 0.009 %/°C ¹⁾ |
| Max. offset drift | 0.005 %/°C ²⁾ |
| Common-mode rejection | |
| DC | 70 dB |
| 50 Hz | 70 dB |
| Common-mode range | ±12 V |
| Crosstalk between channels | -70 dB |
| Nonlinearity | <0.05% ²⁾ |
| Isolation voltage between channel and bus | 500 VDC, 1 min |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |

Table 81: X20AI8321 - Technical data


| | |
|---------------------------------|--|
| Model number | X20AI8321 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB1F terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 81: X20AI8321 - Technical data

- 1) Based on the current measured value.
- 2) Based on the 20 mA measurement range.

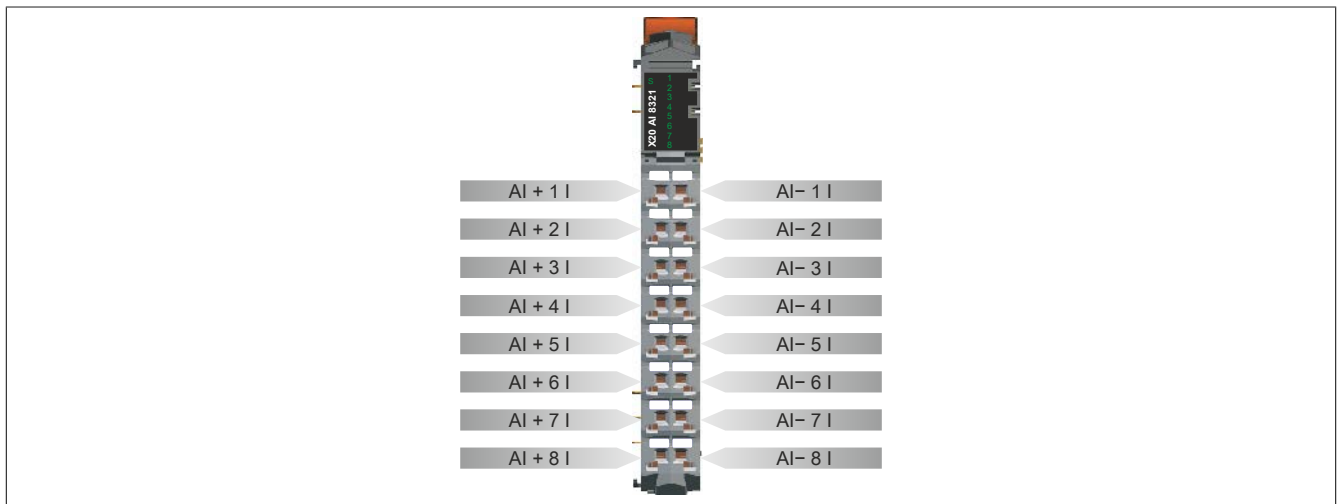
9.1.21.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

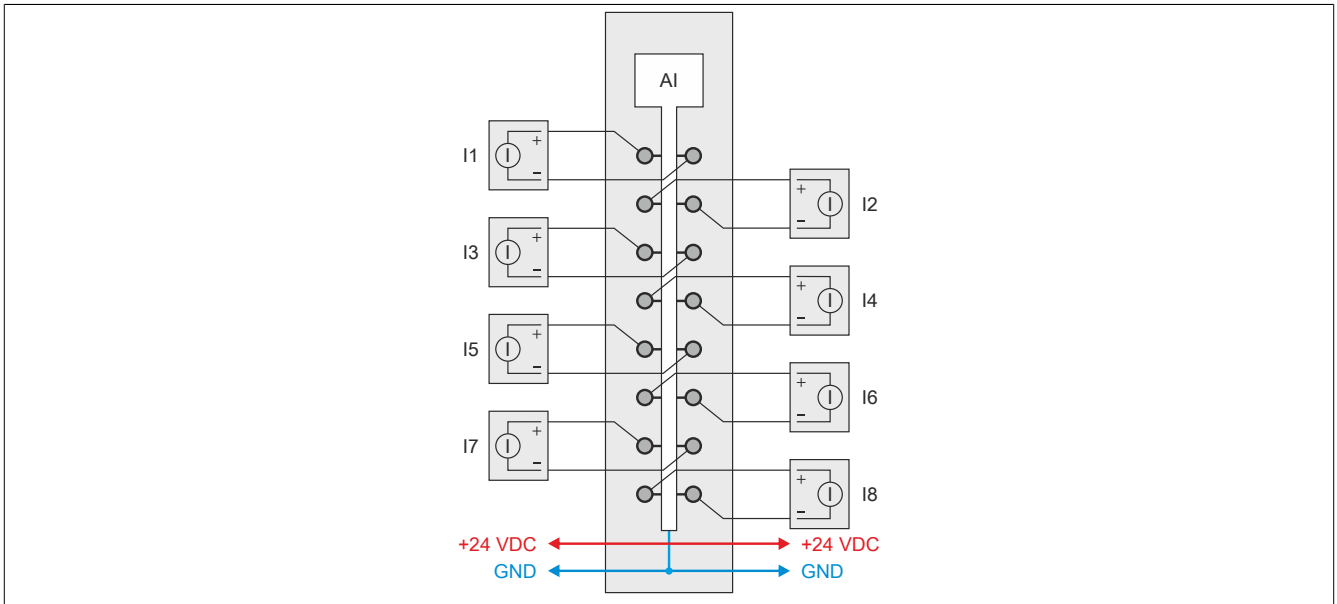
| Figure | LED | Color | Status | Description | |
|--|-------|-------|------------------|--|--|
|  | S | Green | Off | No power to module | |
| | | | Single flash | UNLINK mode | |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ | |
| | | | Blinking quickly | SYNC mode | |
| | | | Blinking slowly | PREOPERATIONAL mode | |
| | | | On | RUN mode | |
| | 1 - 8 | Green | Red | Off | No power to module or everything OK |
| | | | | On | Error or reset status |
| | | | Green | Off | No power to module |
| | | | | On | Analog/digital converter running, value OK |

- 1) Depending on the configuration, a firmware update can take up to several minutes.

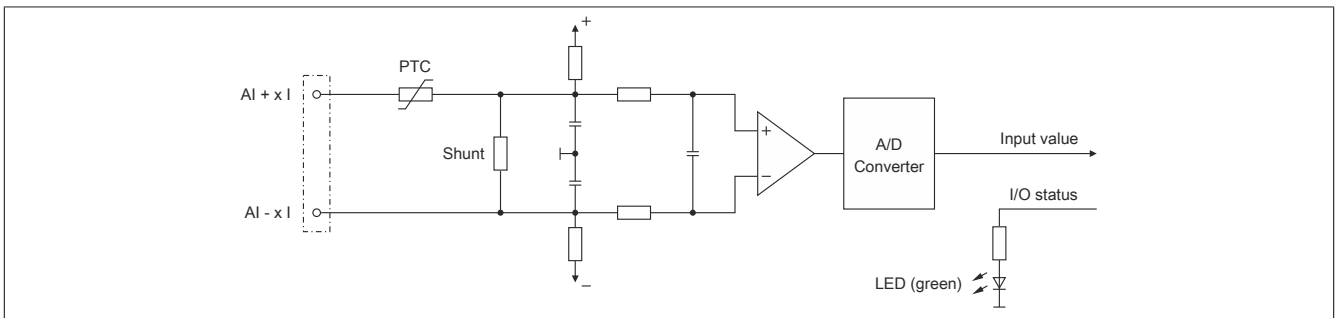
9.1.21.5 Pinout



9.1.21.6 Connection example



9.1.21.7 Input circuit diagram



9.1.21.8 Register description

9.1.21.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.1.21.8.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|------------------------------------|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog signal - Configuration | | | | | | |
| 16 | ConfigOutput01 (Input filter) | USINT | | | | • |
| 18 | ConfigOutput02 (Channel type) | UINT | | | | • |
| 20 | ConfigOutput03 (Lower limit value) | INT | | | | • |
| 22 | ConfigOutput04 (Upper limit value) | INT | | | | • |
| Analog signal - Communication | | | | | | |
| Index * 2 - 2 | AnalogInput0N (Index N = 1 to 8) | INT | • | | | |
| 30 | StatusInput01 | USINT | • | | | |
| 31 | StatusInput02 | USINT | • | | | |

9.1.21.8.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------------|----------------------|------------------------------------|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog signal - Configuration | | | | | | | |
| 16 | - | ConfigOutput01 (Input filter) | USINT | | | | • |
| 18 | - | ConfigOutput02 (Channel type) | UINT | | | | • |
| 20 | - | ConfigOutput03 (Lower limit value) | INT | | | | • |
| 22 | - | ConfigOutput04 (Upper limit value) | INT | | | | • |
| Analog signal - Communication | | | | | | | |
| Index * 2 - 2 | Index * 2 - 2 | AnalogInput0N (Index N = 1 to 8) | INT | • | | | |
| 30 | - | StatusInput01 | USINT | | • | | |
| 31 | - | StatusInput02 | USINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.1.21.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.1.21.8.3.2 CAN I/O bus controller

The module occupies 2 analog logical slots on CAN I/O.

9.1.21.8.4 Analog inputs

Input signals are converted asynchronously in a 1 ms interval.

9.1.21.8.5 Analog input values

Name:

AnalogInput01 to AnalogInput08

The analog input values are mapped to this register.

| Data type | Value | Input signal: |
|-----------|------------|---|
| INT | 0 to 32767 | Current signal 0 to 20 mA or 4 to 20 mA |

9.1.21.8.6 Input filter

This module is equipped with a configurable input filter.

Information:

The filter sampling time is fixed at 1 ms and is acyclic to the X2X cycle.

9.1.21.8.6.1 Input ramp limiting

Input ramp limiting can only be performed in conjunction with filtering. Input ramp limiting is performed before filtering.

The difference of the input value change is checked for exceeding the specified limit. In the event of overshoot, the tracked input value is equal to the old value \pm the limit value.

Configurable limit values:

| Value | Limit value |
|-------|---|
| 0 | The input value is used without limitation. |
| 1 | 0x3FFF = 16383 |
| 2 | 0x1FFF = 8191 |
| 3 | 0x0FFF = 4095 |
| 4 | 0x07FF = 2047 |
| 5 | 0x03FF = 1023 |
| 6 | 0x01FF = 511 |
| 7 | 0x00FF = 255 |

Input ramp limiting is well suited for suppressing disturbances (spikes). The following examples show the functionality of input ramp limiting based on an input step and a disturbance.

Example 1

The input value jumps from 8000 to 17000. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = 0x07FF = 2047

Filter level = 2

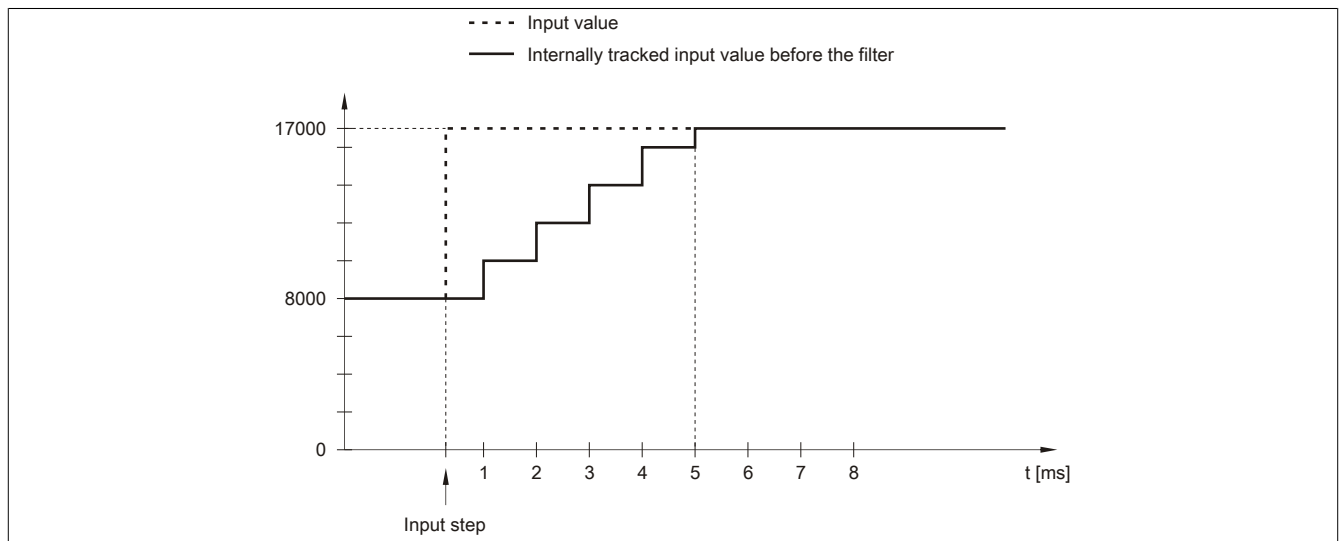


Figure 76: Tracked input value for input step

Example 2

A disturbance interferes with the input value. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = 0x07FF = 2047

Filter level = 2

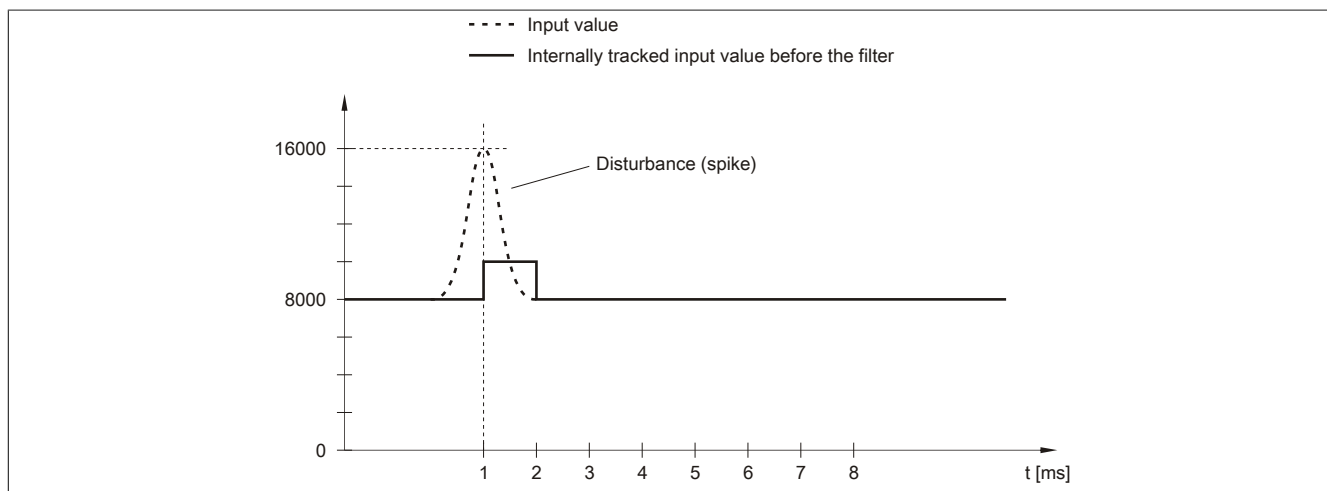


Figure 77: Tracked input value for disturbance

9.1.21.8.6.2 Filter level

A filter can be defined to prevent large input steps. This filter is used to bring the input value closer to the actual analog value over a period of several milliseconds.

Filtering takes place after any input ramp limiting has been carried out.

Formula for calculating the input value:

$$\text{Value}_{\text{New}} = \text{Value}_{\text{Old}} - \frac{\text{Value}_{\text{Old}}}{\text{Filter level}} + \frac{\text{Input value}}{\text{Filter level}}$$

Adjustable filter levels:

| Value | Filter level |
|-------|---------------------|
| 0 | Filter switched off |
| 1 | Filter level 2 |
| 2 | Filter level 4 |
| 3 | Filter level 8 |
| 4 | Filter level 16 |
| 5 | Filter level 32 |
| 6 | Filter level 64 |
| 7 | Filter level 128 |

The following examples show the functionality of the filter based on an input step and a disturbance.

Example 1

The input value jumps from 8000 to 16000. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

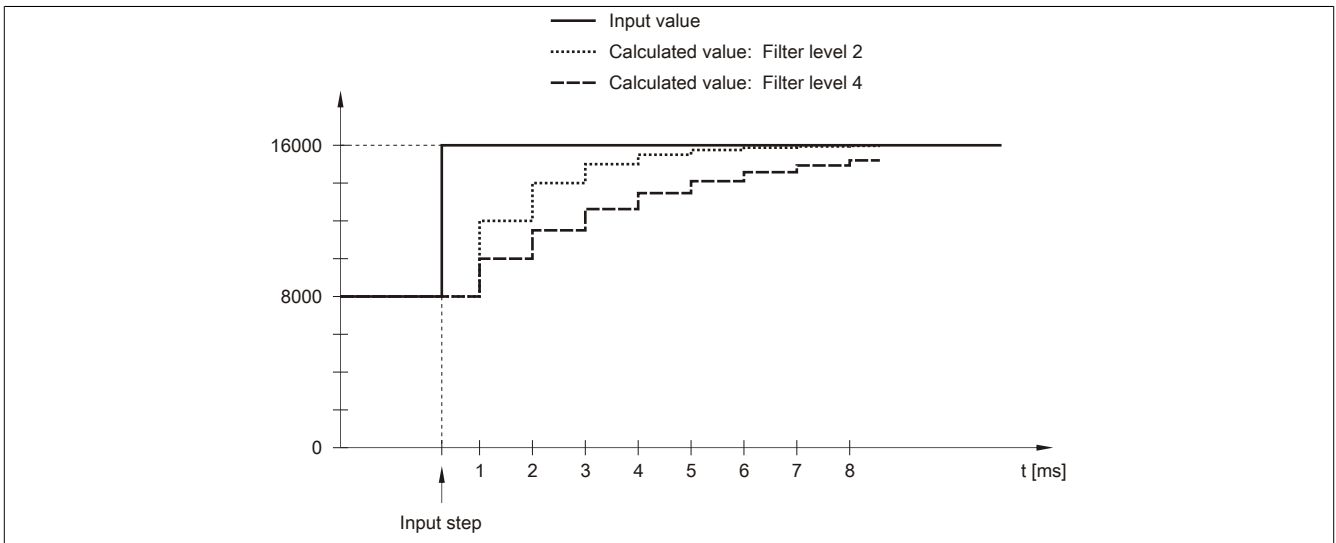


Figure 78: Calculated value during input step

Example 2

A disturbance interferes with the input value. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

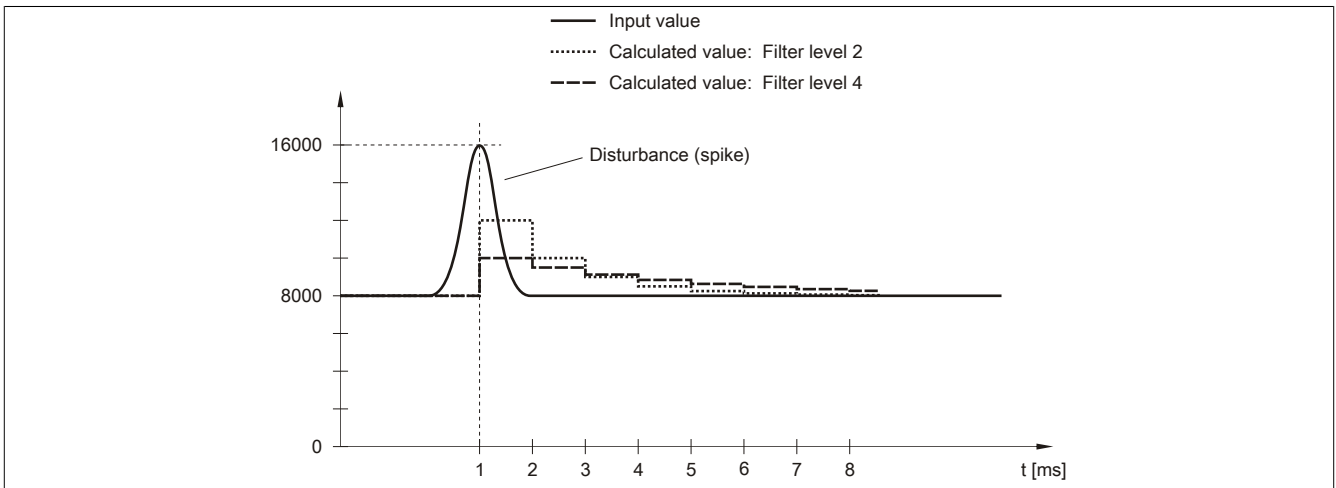


Figure 79: Calculated value during disturbance

9.1.21.8.7 Configuring the input filter

Name:

ConfigOutput01

This register is used to define the filter level and input ramp limitation of the input filter.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|--------|-----------------------------------|-------|--|
| 0 - 2 | Defines the filter level | 000 | Filter disabled (bus controller default setting) |
| | | 001 | Filter level 2 |
| | | 010 | Filter level 4 |
| | | 011 | Filter level 8 |
| | | 100 | Filter level 16 |
| | | 101 | Filter level 32 |
| | | 110 | Filter level 64 |
| | | 111 | Filter level 128 |
| 3 | Reserved | 0 | |
| 4 - 6 | Defines the input ramp limitation | 000 | The input value is applied without limitation (bus controller default setting) |
| | | 001 | Limit value = 0x3FFF (16383) |
| | | 010 | Limit value = 0x1FFF (8191) |
| | | 011 | Limit value = 0x0FFF (4095) |
| | | 100 | Limit value = 0x07FF (2047) |
| | | 101 | Limit value = 0x03FF (1023) |
| | | 110 | Limit value = 0x01FF (511) |
| | | 111 | Limit value = 0x00FF (255) |
| 7 - 15 | Reserved | 0 | |

9.1.21.8.8 Channel type

Name:

ConfigOutput02

This register can be used to set the range of the current signal. This is determined by how they are configured. The following input signals can be set:

- 0 to 20 mA current signal
- 4 to 20 mA current signal

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-----|--------------------------------------|-------|--|
| 0 | Channel 1: Current measurement range | 0 | 0 to 20 mA current signal (bus controller default setting) |
| | | 1 | 4 to 20 mA current signal |
| ... | | ... | |
| 7 | Channel 8: Current measurement range | 0 | 0 to 20 mA current signal (bus controller default setting) |
| | | 1 | 4 to 20 mA current signal |

9.1.21.8.9 Lower limit value

Name:

ConfigOutput03

This register can be used to configure the lower limit for analog values. If the analog value goes below the limit value, it is frozen at this value and the corresponding error status bit is set.

| Data type | Values | Information |
|-----------|-----------------|--|
| INT | -32768 to 32767 | Bus controller default setting: -32767 |

Information:

- When configured as 0 to 20 mA, this value should be set to 0.
- When configured as 4 to 20 mA, this value can be set to -8192 (corresponds to 0 mA) in order to display values <4 mA.

Keep in mind that this setting applies to all channels!

9.1.21.8.10 Upper limit value

Name:
ConfigOutput04

This register can be used to configure the upper limit for analog values. If the analog value goes above the limit value, it is frozen at this value and the corresponding error status bit is set.

| Data type | Values | Information |
|-----------|-----------------|---------------------------------------|
| INT | -32768 to 32767 | Bus controller default setting: 32767 |

Information:

The default value of 32767 corresponds to the maximum default value at 20 mA.

Keep in mind that this setting applies to all channels!

9.1.21.8.11 Input status

Name:
StatusInput01 to StatusInput02

This register is used to monitor the module inputs. A change in the monitoring status generates an error message.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

StatusInput01 monitors Channels 1 to 4

StatusInput02 monitors Channels 5 to 8

| Bit | Description | Value | Information |
|-------|----------------|-------|----------------------------|
| 0 - 1 | Channel 1 or 5 | 00 | No error |
| | | 01 | Lower limit value exceeded |
| | | 10 | Upper limit value exceeded |
| ... | | ... | |
| 6 - 7 | Channel 4 or 8 | 00 | No error |
| | | 01 | Lower limit value exceeded |
| | | 10 | Upper limit value exceeded |

Limiting the analog value

In addition to the status information, the analog value is set to the values listed below by default when an error occurs. The analog value is limited to the new values if the limit values were changed.

| Error status | Digital value for error (default values) | |
|----------------------------|--|----------------|
| | 0 to 20 mA | 4 to 20 mA |
| Upper limit value exceeded | +32767 (0x7FFF) | |
| Lower limit value exceeded | 0 | -8191 (0xE001) |

9.1.21.8.12 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 150 μ s |

9.1.21.8.13 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 1 ms |

9.1.22 X20AIA744

Data sheet version: 1.30

9.1.22.1 General information

This module works with 4-wire strain gauge load cells. The concept applied by the module requires compensation in the measurement system. This compensation eliminates the absolute uncertainty in the measurement circuit, such as component tolerances, effective bridge voltage or zero offset. The measurement precision refers to the absolute (compensated) value, which will only change as a result of changes in the operating temperature.

- 2 full-bridge strain gauge inputs
- 5 kHz data output rate for both channels
- Independently configurable strain gauge factor and filter level for each of the 2 channels

9.1.22.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Analog inputs |  |
| X20AIA744 | X20 analog input module, 2 full-bridge strain inputs, 24-bit converter resolution, 2.5 kHz input filter | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB1F | X20 terminal block, 16-pin, 24 VDC keyed | |
| | | |
| | | |

Table 82: X20AIA744 - Order data

9.1.22.3 Technical data

| Model number | X20AIA744 |
|--|--|
| Short description | |
| I/O module | 2 full-bridge strain gauge inputs |
| General information | |
| B&R ID code | 0xE50C |
| Status indicators | Channel status, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| Open circuit | Yes, using LED status indicator and software |
| Input | Yes, using LED status indicator and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 0.7 W |
| Additional power dissipation caused by actuators (resistive) [W] | +0.72 ¹⁾ |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| Full-bridge strain gauge | |
| Strain gauge factor | 2 to 256 mV/V, configurable using software |
| Connection | 4-wire connections |
| Input type | Differential, used to evaluate a full-bridge strain gauge |
| Digital converter resolution | 24-bit |
| Conversion time | 200 µs |
| Data output rate | 5000 samples per second and per channel (f _{DATA}) |
| Input filter | |
| Cutoff frequency | 2.5 kHz |
| Order | 3 |
| Slope | 60 dB |
| ADC filter characteristics | Sigma-delta, see section "Filter" |
| Operating range / Measurement sensor | 85 to 5000 Ω |
| Influence of cable length | Twisted and shielded conductors, cable length as short as possible, cable routing separate from load circuits, without intermediate terminal to sensor |
| Input protection | RC protection |
| Common-mode range | 0.6 to 3.8 VDC Permissible input voltage range (with regard to the potential strain gauge GND) on inputs "Input +" and "Input -" |
| Isolation voltage between input and bus | 500 V _{eff} |
| Conversion procedure | Sigma-delta |
| Output of digital value | |
| Broken bridge supply line | Value approaching 0 |
| Broken sensor line | Value approaching ±end value (status bit "Open circuit" set in register "Module status") |
| Valid range of values | 0xFF800001 to 0x007FFFFFFF (-8,388,607 to 8,388,607) |
| Strain gauge supply | |
| Voltage | 5.5 VDC / Max. 65 mA per channel |
| Short-circuit and overload resistant | Yes |
| Quantization ²⁾ | |
| LSB value | |
| 2 mV/V | 1.31 nV |
| 4 mV/V | 2.62 nV |
| 8 mV/V | 5.25 nV |
| 16 mV/V | 10.49 nV |
| 32 mV/V | 20.98 nV |
| 64 mV/V | 41.96 nV |
| 128 mV/V | 83.92 nV |
| 256 mV/V | 167.85 nV |
| Max. gain drift | 35 ppm/°C ³⁾ |
| Max. offset drift | 15 ppm/°C ⁴⁾ |
| Nonlinearity | <10 ppm ⁴⁾ |
| Electrical properties | |
| Electrical isolation | Bus isolated from analog input and strain gauge supply voltage Channel not isolated from channel and I/O power supply |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |

Table 83: X20AIA744 - Technical data


| Model number | X20AIA744 |
|--|--|
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Hardware configuration" |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB1F separately. Order 1x bus module X20BM11 separately. |
| Pitch | 12.5 ^{+0.2} mm |

Table 83: X20AIA744 - Technical data

- 1) Depends on the full-bridge strain gauge being used.
- 2) Quantization depends on the strain gauge factor.
- 3) Based on the current measured value.
- 4) Based on the entire measurement range.

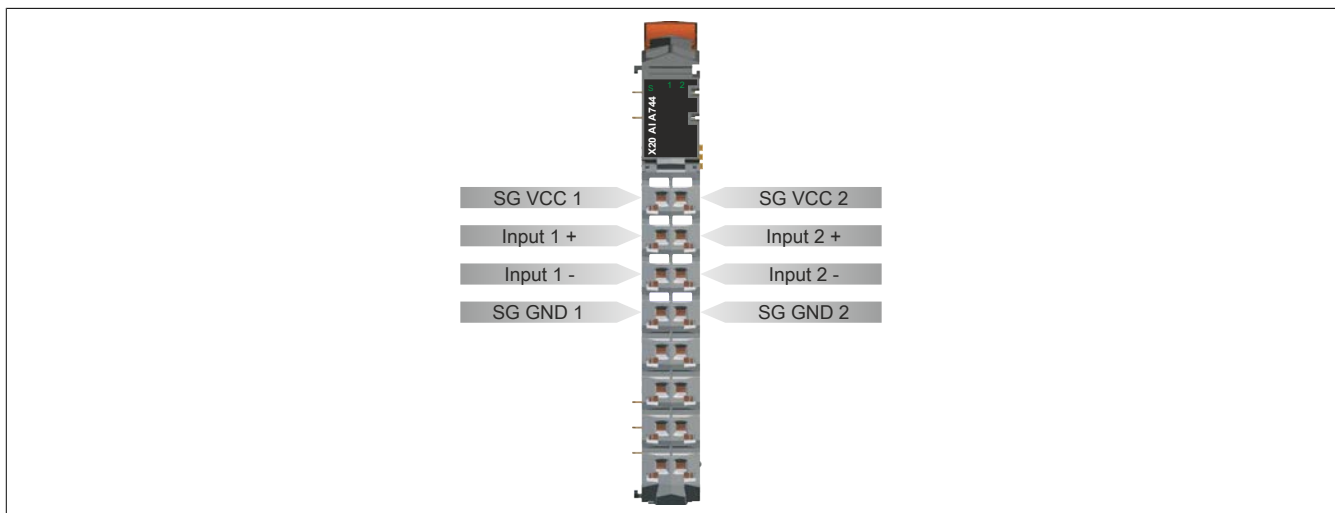
9.1.22.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

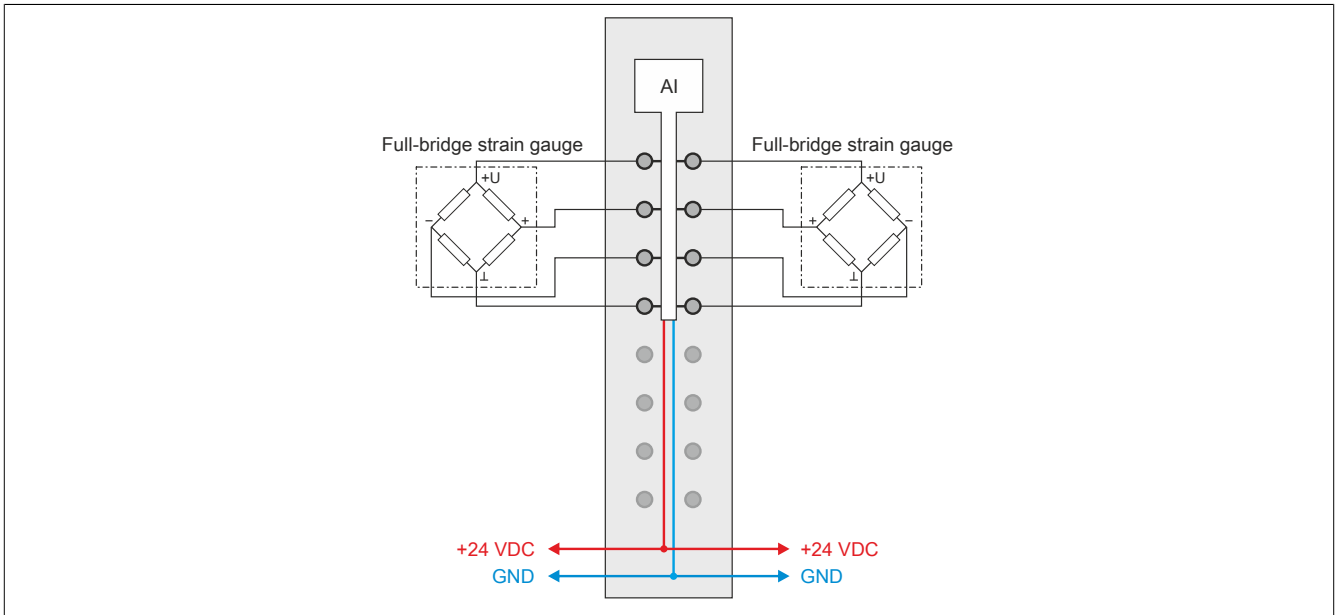
| Figure | LED | Color | Status | Description |
|---|--------------|-------|--|--|
|  | S | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | On | RUN mode | |
| | | Red | Off | No power to module or everything OK |
| | Double flash | | I/O supply outside limits | |
| | On | | Error or reset status | |
| | 1 - 2 | Green | Off | Possible causes: • Supply error • Channel not yet configured |
| | | | Blinking | Possible causes: • Open line • Overvoltage • Undervoltage |
| Green | | On | Analog/digital converter running, value OK | |

1) Depending on the configuration, a firmware update can take up to several minutes.

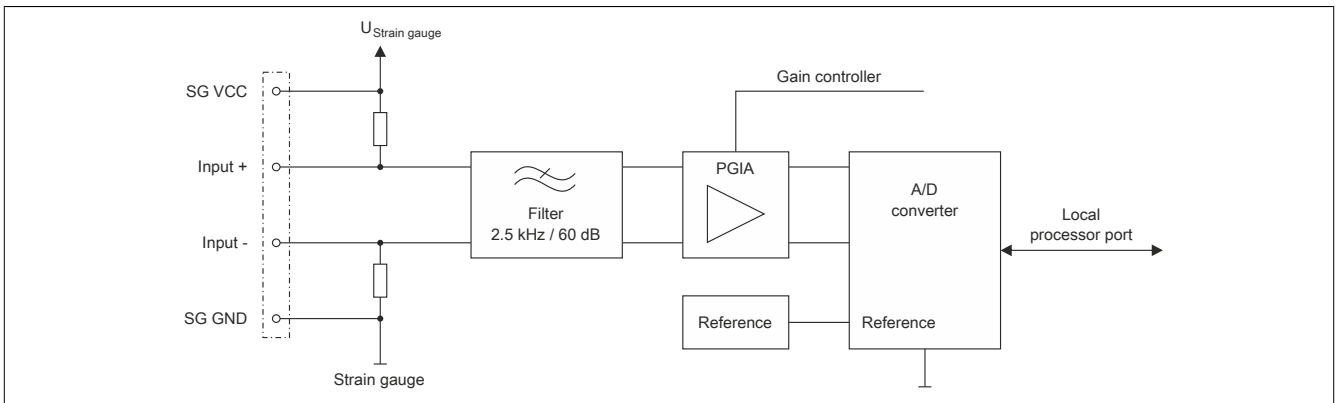
9.1.22.5 Pinout



9.1.22.6 Connection example



9.1.22.7 Input circuit diagram

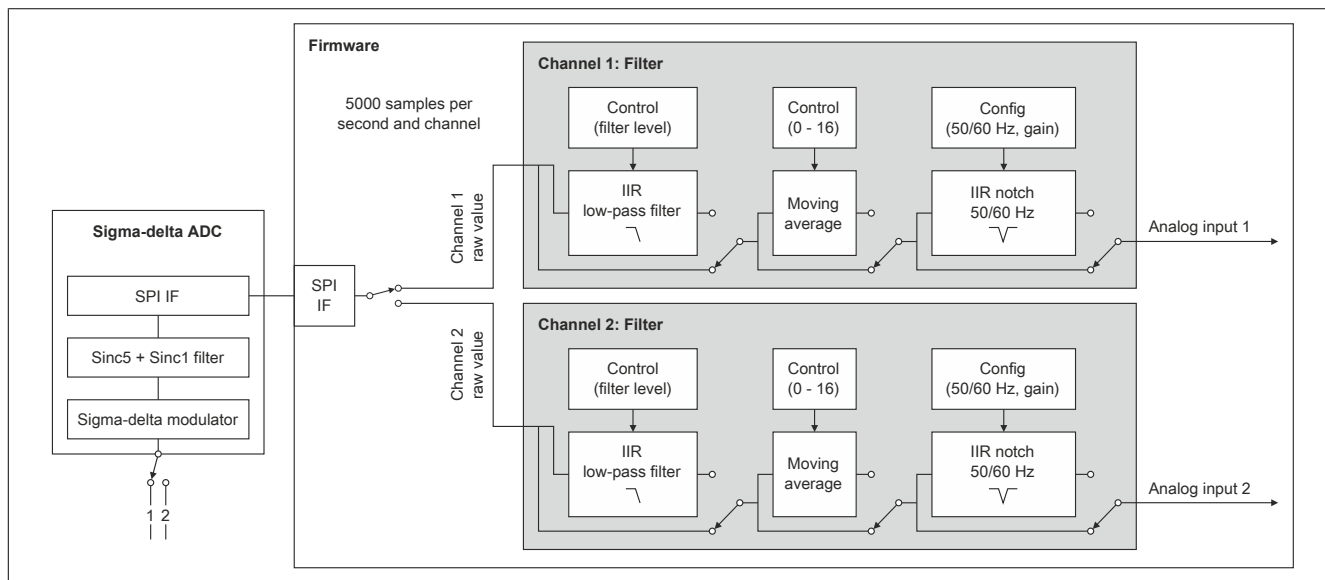


9.1.22.8 Software filters

An independent cascade of filters is available for each channel. They can be individually enabled and configured at runtime. By default, all filters are disabled when the device is switched on. Filters are controlled and configured using the "ControlPacked0N" on page 637 and "ConfigChannel0N" on page 638 (N = 1 to 2) registers.

In order to allow the filter behavior to be adapted to the measuring situation or machine cycle (high dynamics and low precision or low dynamics and high precision), the filter characteristics of both the IIR low-pass filter as well as the moving average filter can be changed synchronously at any time.

Filter diagram



9.1.22.8.1 IIR low-pass filter

9.1.22.8.1.1 General information

The IIR low-pass filter is used to generally smooth and increase the resolution of the analog value. The filter works according to the following formula:

$$y = y_{Old} + \frac{x - y_{Old}}{2^{Filter\ level}}$$

- x ... current filter input value
- y_{Old} ... old filter output value
- y ... new filter output value

The "Filter level" parameter in the formula above is configured with the help of the "ControlPacked0N" on page 637 register. "Filter level" = 0 if the IIR low-pass filter is disabled.

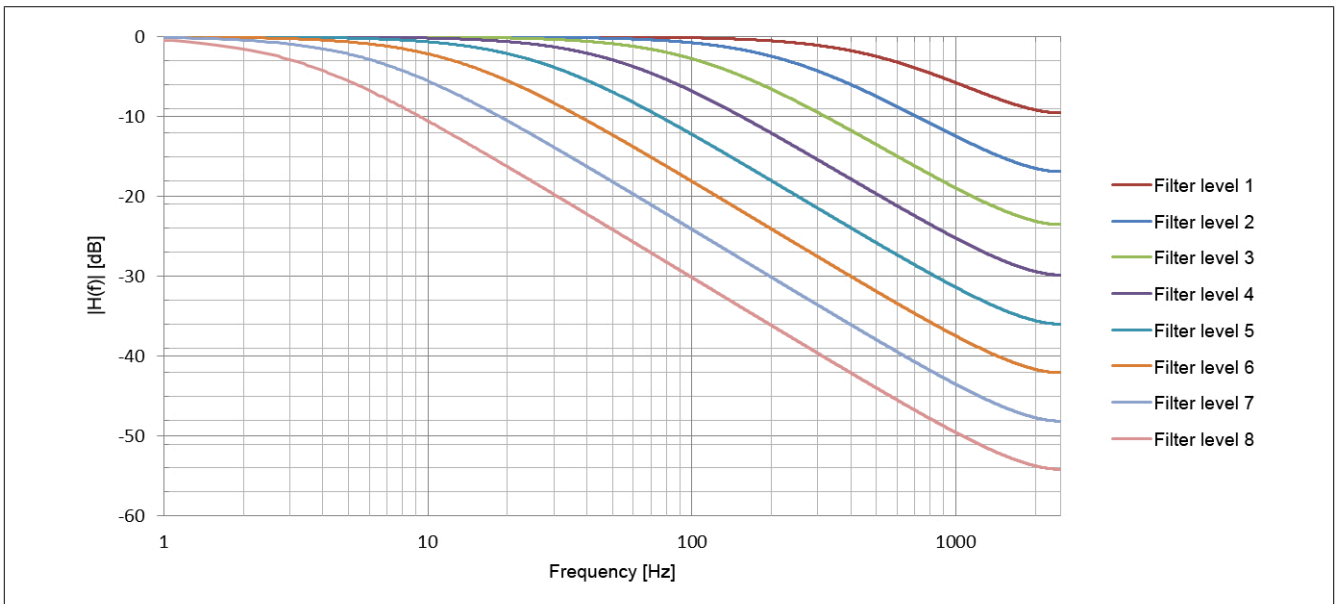
9.1.22.8.1.2 Filter characteristics of the 1st-order IIR low-pass filter

Limit frequency f_c

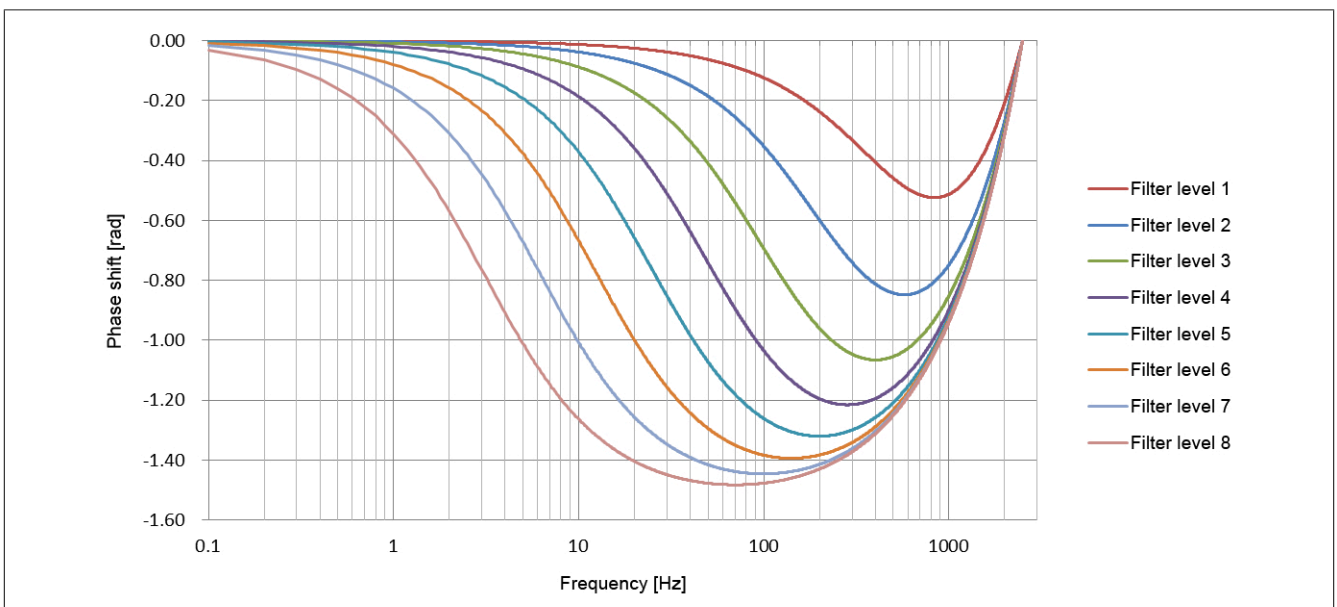
The following table provides an overview of the -3 dB limit frequency f_c depending on the configured filter level.

| IIR low-pass filter level | f _c [Hz] |
|---------------------------|---------------------|
| 1 | 575 |
| 2 | 230 |
| 3 | 106 |
| 4 | 51 |
| 5 | 25 |
| 6 | 12.5 |
| 7 | 6.2 |
| 8 | 3.1 |

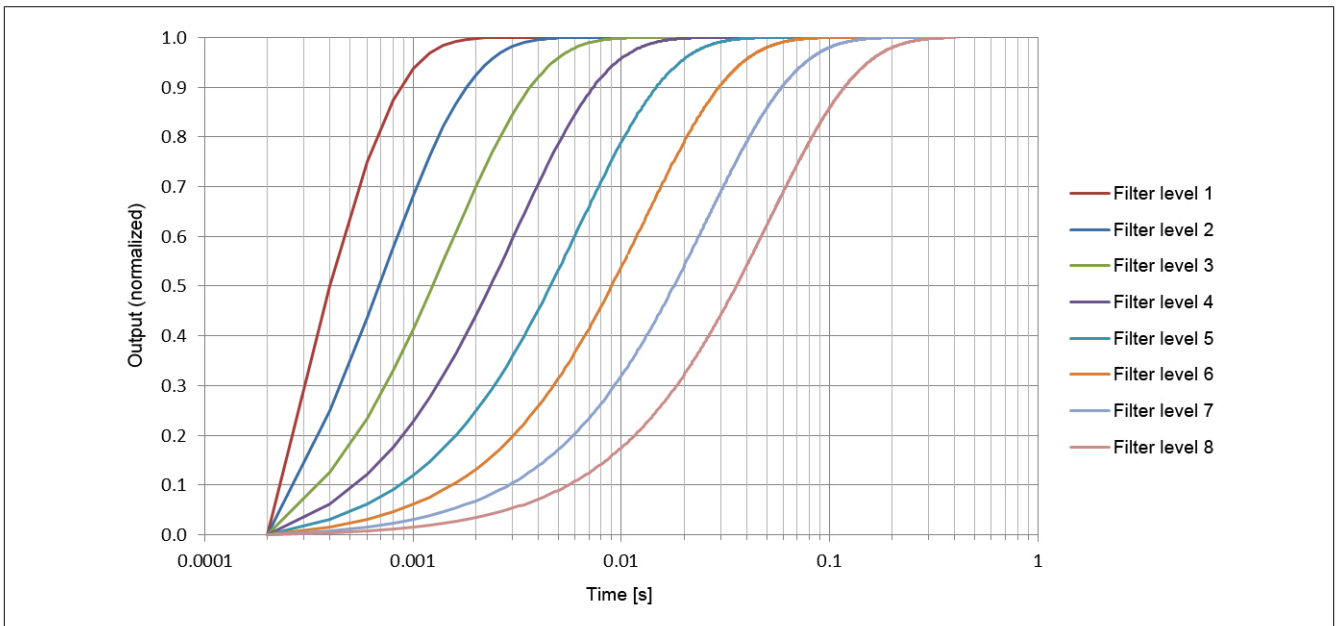
Gain of the IIR low-pass filter



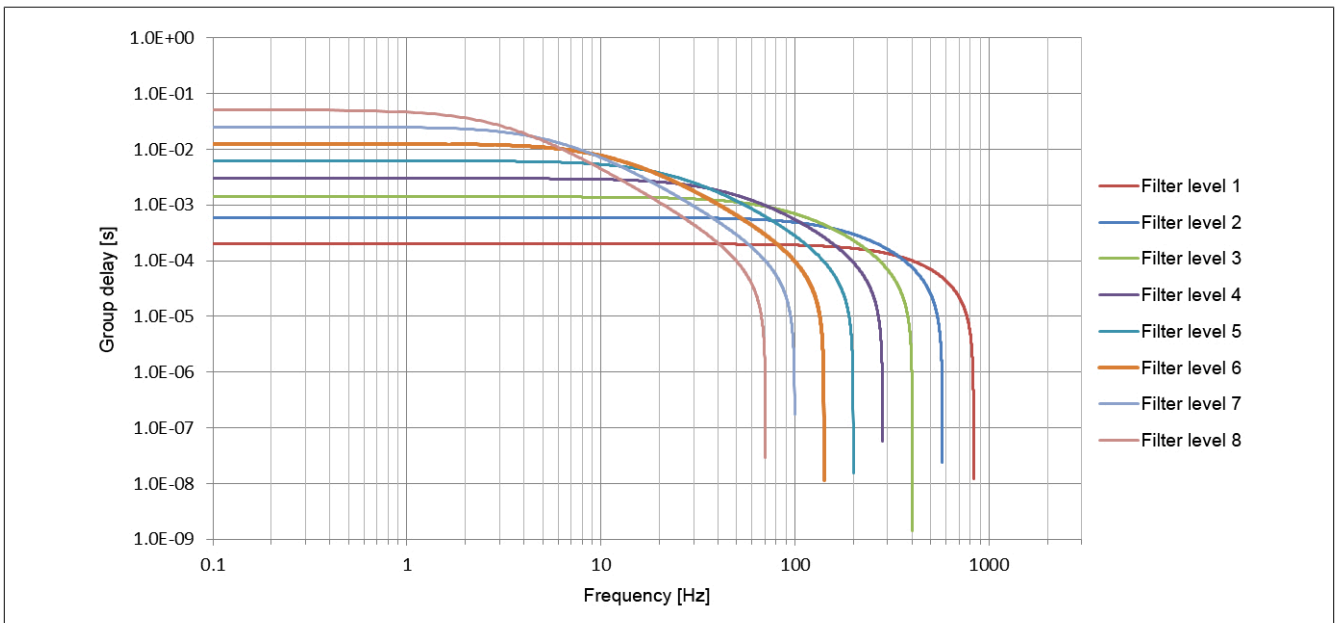
Phase shift of the IIR low-pass filter



Step response of the IIR low-pass filter



Group delay of the IIR low-pass filter



9.1.22.8.2 Sinc1 / Moving average filter

Like the low-pass filter, the moving average filter can also be used to smooth out the signal and increase its resolution. In addition, configuring the filter length accordingly makes it possible to target and efficiently filter out individual interference frequencies. The source of these interference frequencies may be mechanical or electromagnetic. Multiples of these are also filtered out (as long as they are a whole-number factor of the data output rate of 5000 samples per second and channel).

Example:

Data output rate = 5000 samples/s/channel, averaging over 4 values -> "Notch" at 1.25 kHz (and 2.5 kHz)

When reconfiguring the filter length from "n" to "m", it takes $|m-n| * 200 \mu\text{s}$ until the desired filter length setpoint is reached again. As long as the filter length setpoint is not reached, this situation will be indicated by the bit 7 status bit in the "StatusPacked0N" on page 639 register.

9.1.22.8.2.1 Filter characteristics of the moving average filter

| Filter configuration | Filter length | f_{Notch} [Hz] ¹⁾ | f_c [Hz] ²⁾ |
|----------------------|---------------|---------------------------------------|--------------------------|
| 0 | 1 | | |
| 1 | 2 | 2500 | 1244 |
| 2 | 4 | 1250 | 568 |
| 3 | 5 | 1000 | 450 |
| 4 | 10 | 500 | 222 |
| 5 | 20 | 250 | 111 |
| 6 | 25 | 200 | 88.4 |
| 7 | 50 | 100 | 44.0 |
| 8 | 83 | 60.24 | 26.5 |
| 9 | 100 | 50 | 21.9 |
| 10 | 125 | 40 | 17.5 |
| 11 | 167 | 29.94 | 13.0 |
| 12 | 200 | 25 | 10.9 |
| 13 | 250 | 20 | 8.6 |
| 14 | 300 | 16.67 | 7.1 |
| 15 | 500 | 10 | 4.3 |
| 16 | 1000 | 5 | 2.0 |

1) Mid-band frequency of the first attenuation maximum.

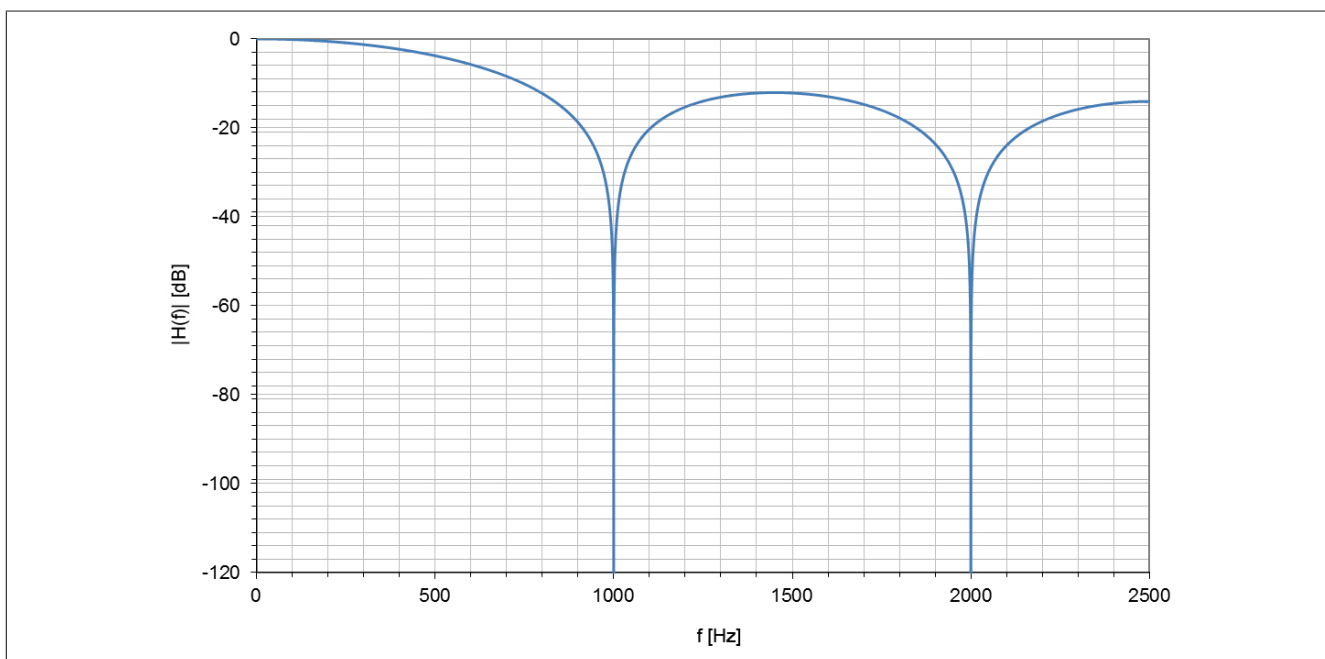
2) -3 dB limit frequency.

9.1.22.8.2.2 Examples for the gain of the moving average filter

Example 1

Filter setting = 3:

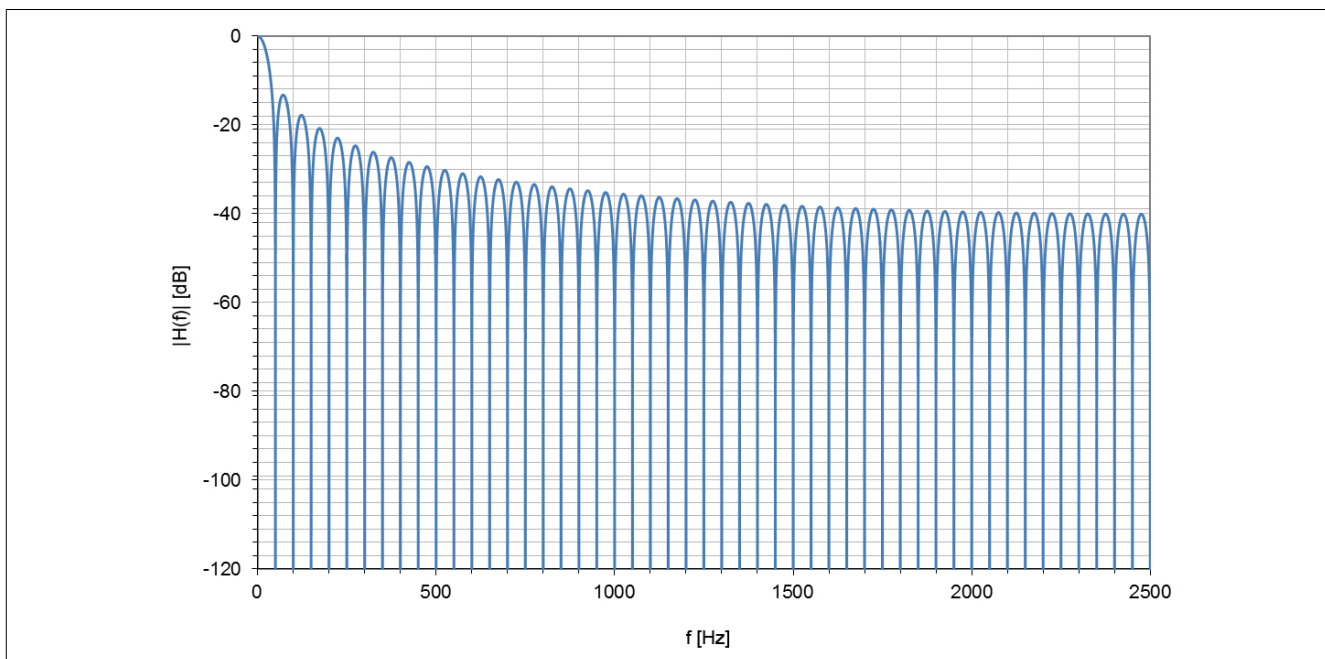
- $f_{\text{Notch}} = 1000 \text{ Hz}$
- $f_c = 449.6 \text{ Hz}$



Example 2

Filter setting = 9:

- $f_{\text{Notch}} = 50 \text{ Hz}$
- $f_c = 21.9 \text{ Hz}$



9.1.22.8.3 50/60 Hz IIR notch filter

The IIR notch filter is used for narrow-band suppression of interference caused by the mains frequency.

This is an 8th-order IIR notch filter implemented in the form of a cascade of 4 2nd-order IIR notch filters.

Information:

The IIR notch filter should only be enabled if there is actually interference being caused by the mains frequency. You should always check whether sufficiently low and sufficiently narrow band filtering at 50 Hz / 60 Hz can be implemented using a moving average filter (see "[Filter characteristics of the moving average filter](#)" on page 629).

This is because, like every higher-order IIR notch filter, this filter also has a tendency to respond to an input step with an attenuating vibration. The higher the dynamics of the expected measurement signal, the greater the potential interfering effect of this vibration tendency. In extreme cases, the vibration can temporarily be greater than the mains interference that is supposed to be filtered out.

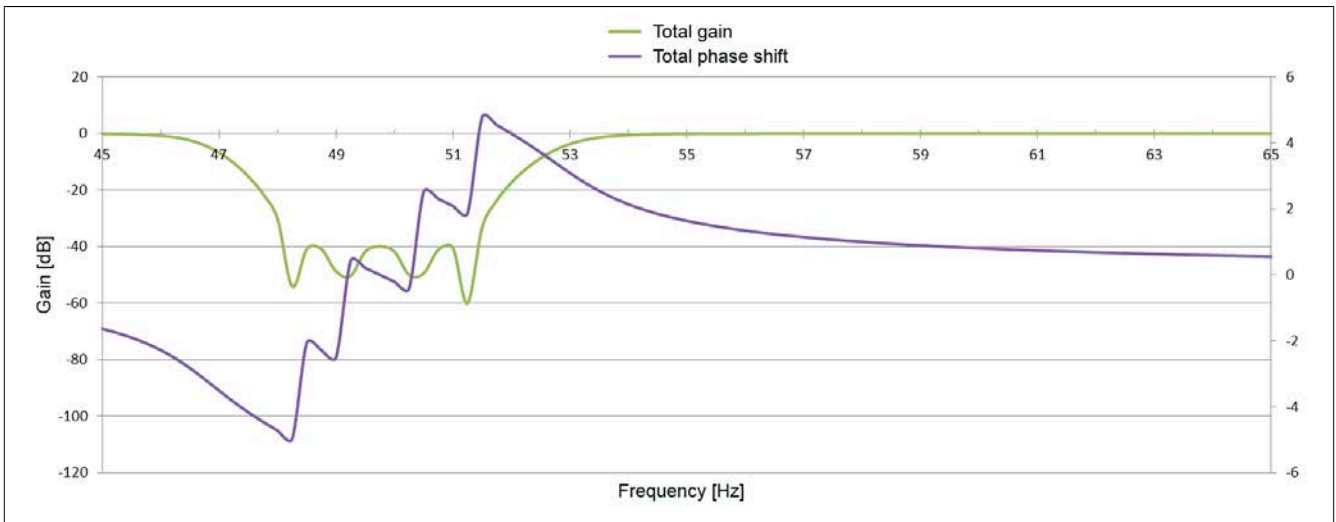
9.1.22.8.3.1 Filter characteristics of the IIR notch filter

There are 3 different filter characteristics that can be selected for both 50 Hz and 60 Hz (-40 dB, -60 dB and -80 dB). The higher the attenuation, the narrower the stopband.

Example 1

Filter characteristics for the following settings:

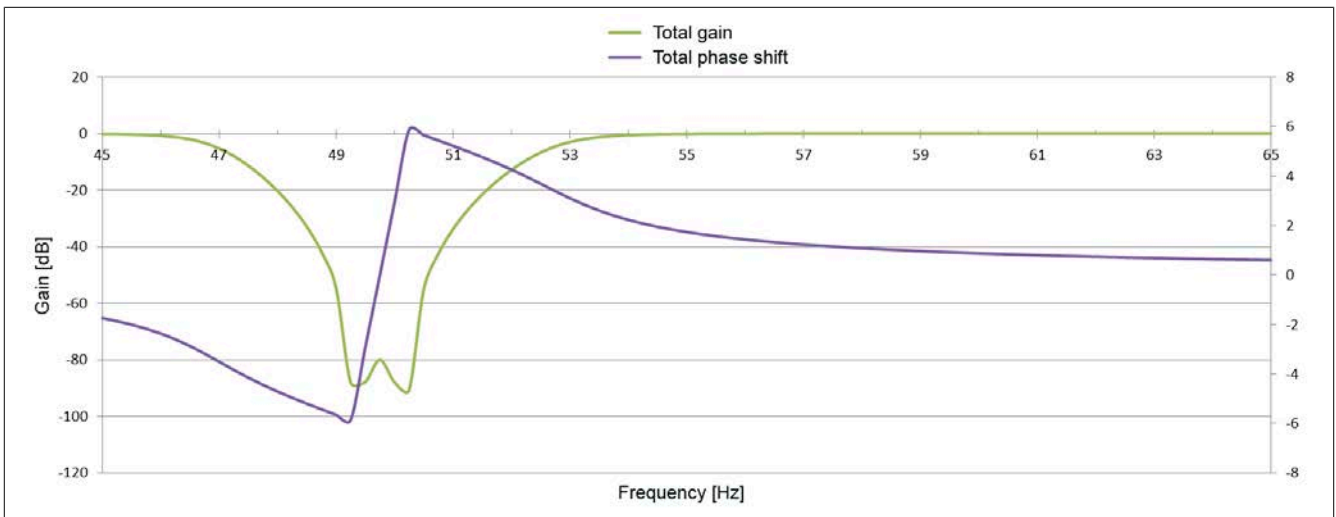
- Gain = -40 dB
- Frequency = 50 Hz
- Passband = 5 Hz
- Stopband = ± 1 Hz



Example 2

Filter characteristics for the following settings:

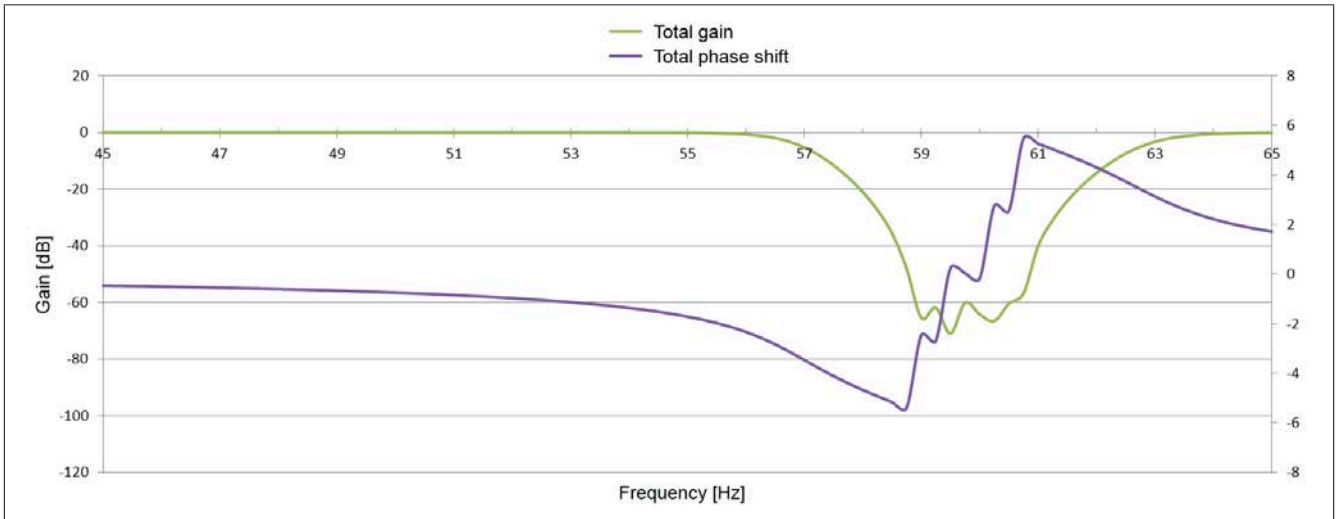
- Gain = -80 dB
- Frequency = 50 Hz
- Passband = 5 Hz
- Stopband = ± 0.25 Hz



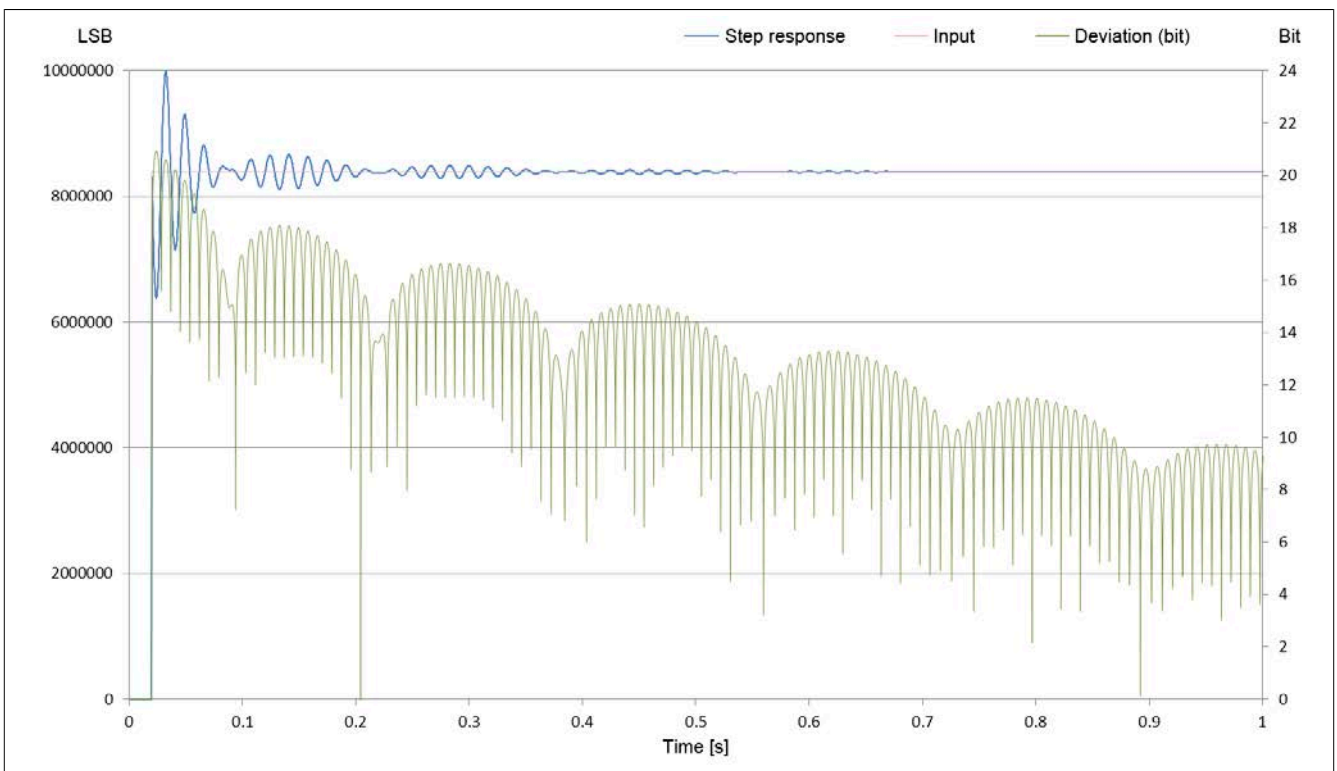
Example 3

Filter characteristics for the following settings:

- Gain = -60 dB
- Frequency = 60 Hz
- Passband = 5 Hz
- Stopband = ± 0.5 Hz



Step response of an 8th-order IIR notch filter, including the deviation in bits:

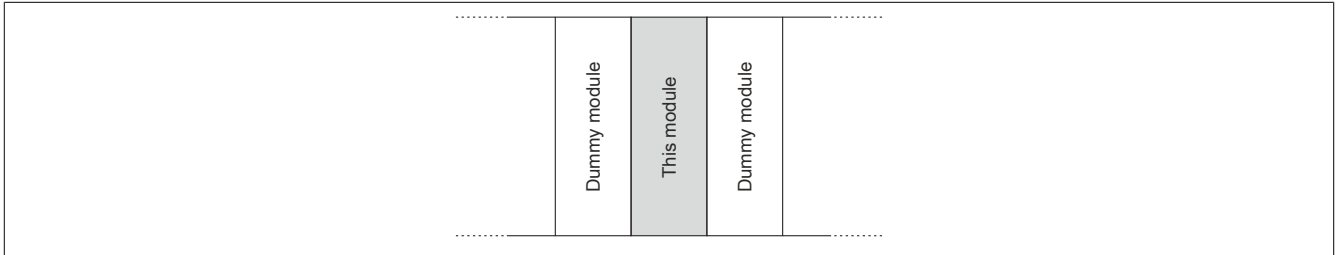


9.1.22.9 Hardware configuration

9.1.22.9.1 Hardware configuration for horizontal installation starting at 55°C ambient temperature

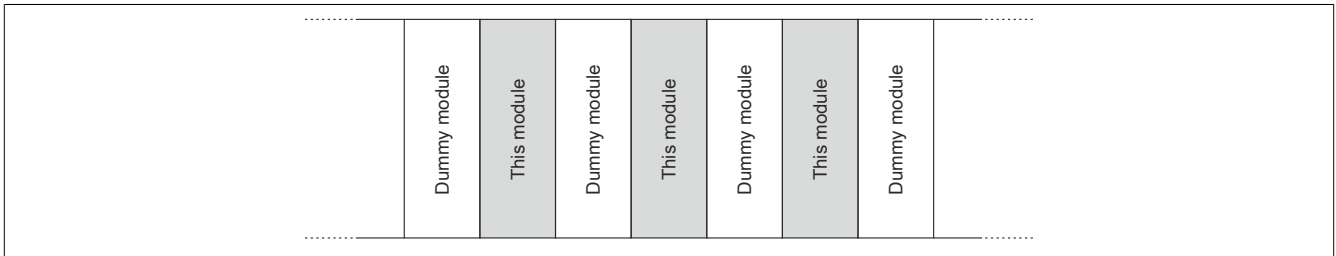
Operating a strain gauge module

Starting at an ambient temperature of 55°C, a dummy module must be connected to the left and right of the strain gauge module in a horizontal mounting orientation.



Operating multiple strain gauge modules side by side

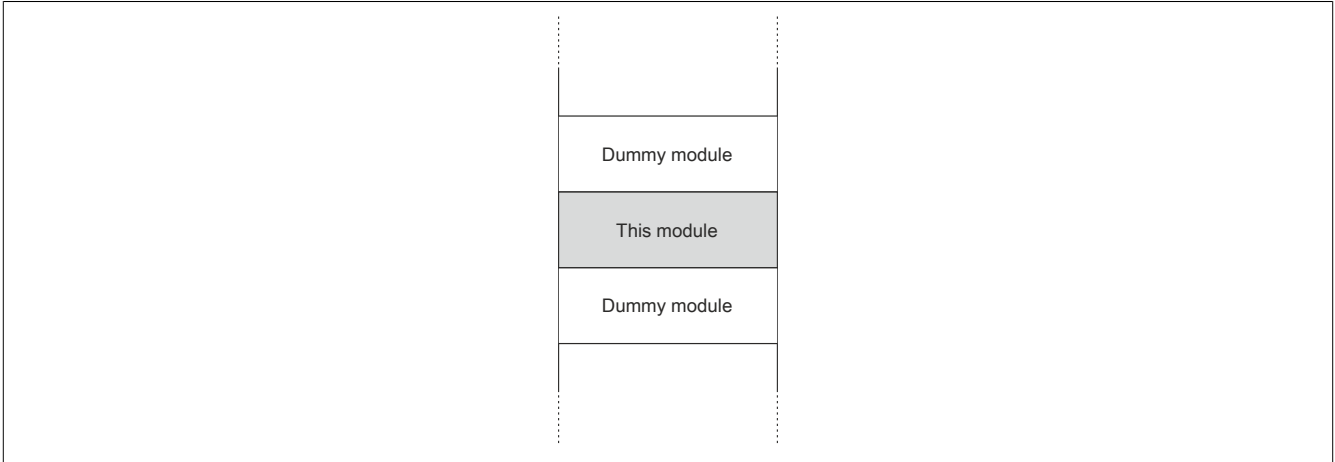
If 2 or more horizontal strain gauge modules are being operated in a cluster, the following arrangement of modules must be observed.



9.1.22.9.2 Hardware configuration for vertical installation starting at 45°C ambient temperature

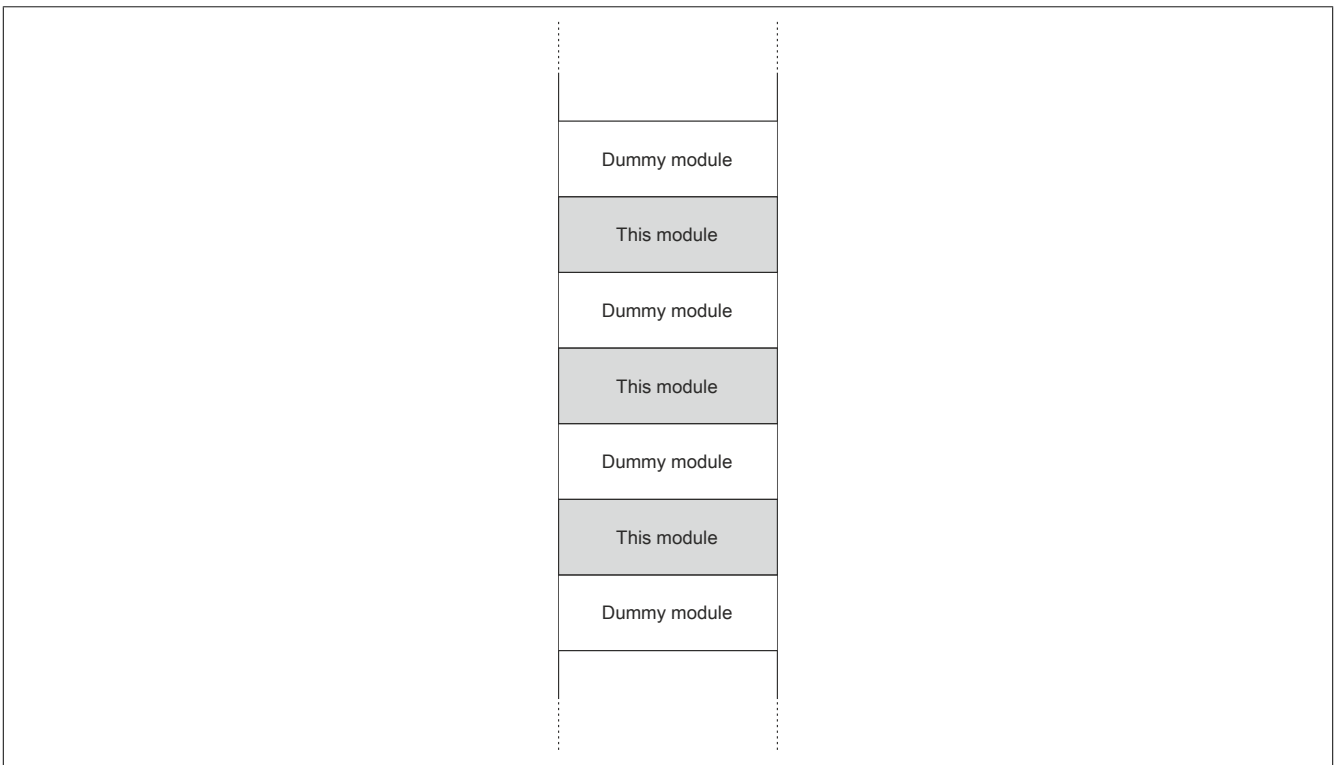
Operating a strain gauge module

Starting at an ambient temperature of 45°C, a dummy module must be connected to the left and right of the strain gauge module in a vertical mounting orientation.



Operating multiple strain gauge modules side by side

If 2 or more vertical strain gauge modules are being operated in a cluster, the following arrangement of modules must be observed.



9.1.22.10 Register description

9.1.22.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.1.22.10.2 Function model 0 - default

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog signal - Configuration | | | | | | |
| 2 | ControlPacked01 (configuration of strain gauge inputs) | UINT | | | • | |
| 6 | ControlPacked02 (configuration of strain gauge inputs) | UINT | | | • | |
| 514 | ConfigChannel01 (channel configuration) | UINT | | | | • |
| 578 | ConfigChannel02 (channel configuration) | UINT | | | | • |
| Analog signal - Communication | | | | | | |
| 4 | AnalogInput01 | DINT | • | | | |
| 12 | AnalogInput02 | DINT | • | | | |
| 33 | StatusPacked01 | USINT | • | | | |
| 35 | StatusPacked02 | USINT | • | | | |
| 257 | AdcConvCtr01 | SINT | • | | | |
| 268 | AdcConvTimeStamp01 | DINT | • | | | |

9.1.22.10.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog signal - Configuration | | | | | | | |
| 2 | 2 | ControlPacked01 (configuration of strain gauge inputs) | UINT | | | • | |
| 6 | 10 | ControlPacked02 (configuration of strain gauge inputs) | UINT | | | • | |
| 514 | 514 | ConfigChannel01 (channel configuration) | UINT | | | | • |
| 578 | 578 | ConfigChannel02 (channel configuration) | UINT | | | | • |
| Analog signal - Communication | | | | | | | |
| 4 | 4 | AnalogInput01 | DINT | • | | | |
| 12 | 12 | AnalogInput02 | DINT | • | | | |
| 33 | 0 | StatusPacked01 | USINT | • | | | |
| 35 | 8 | StatusPacked02 | USINT | • | | | |

1) The offset specifies the position of the register within the CAN object.

9.1.22.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.1.22.10.3.2 CAN I/O bus controller

The module occupies 4 analog logical slots on CAN I/O.

9.1.22.10.4 Configuration

9.1.22.10.4.1 Configuration of strain gauge inputs

Name:

ControlPacked01 and ControlPacked02

The strain gauge inputs are configured in these registers:

- Strain gauge factor of strain gauge load cell
- Enabling of filters

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information | |
|---------|-----------------------|-------------------------------------|---|-------------------------|
| 0 - 2 | Strain gauge factor | 000 | Default: 256 mV/V | |
| | | 001 | 128 mV/V | |
| | | 010 | 64 mV/V | |
| | | 011 | 32 mV/V | |
| | | 100 | 16 mV/V | |
| | | 101 | 8 mV/V | |
| | | 110 | 4 mV/V | |
| | | 111 | 2 mV/V | |
| 3 - 7 | Moving average | | Averaging | 1. Notch frequency [Hz] |
| | | 00000 | Default: Moving average disabled (bypass) | |
| | | 00001 | 2 | 2500 |
| | | 00010 | 4 | 1250 |
| | | 00011 | 5 | 1000 |
| | | 00100 | 10 | 500 |
| | | 00101 | 20 | 250 |
| | | 00110 | 25 | 200 |
| | | 00111 | 50 | 100 |
| | | 01000 | 83 | 60 |
| | | 01001 | 100 | 50 |
| | | 01010 | 125 | 40 |
| | | 01011 | 167 | 30 |
| | | 01100 | 200 | 25 |
| | | 01101 | 250 | 20 |
| | | 01110 | 300 | 16.66 |
| | | 01111 | 500 | 10 |
| 10000 | 1000 | 5 | | |
| | 10001 to 11111 | Reserved (firmware limited to 1000) | | |
| 8 | Notch filter | 0 | Default: IIR notch filter disabled (bypass) | |
| | | 1 | IIR notch filter enabled | |
| 9 | Reserved | 0 | | |
| 10 - 11 | Low-pass filter mode | 00 | IIR low-pass filter disabled (bypass) | |
| | | 01 | 1st-order IIR low-pass filter (see "IIR low-pass filter" on page 626) | |
| | | 10 - 11 | Reserved: No IIR low-pass filter active | |
| | | | Filter level | -3 db frequency [Hz] |
| 12 - 14 | Low-pass filter level | 000 | 1 | 575 |
| | | 001 | 2 | 230 |
| | | 010 | 3 | 106 |
| | | 011 | 4 | 51 |
| | | 100 | 5 | 25 |
| | | 101 | 6 | 12.5 |
| | | 110 | 7 | 6.2 |
| | | 111 | 8 | 3.1 |
| 15 | Reserved | 0 | | |

9.1.22.10.4.2 Channel configuration

Name:

ConfigChannel01 and ConfigChannel02

The IIR notch filter is configured individually for each channel in these registers.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|---------|--------------------------|-------|--|
| 0 - 11 | Reserved | 0 | |
| 12 - 13 | Notch filter attenuation | 00 | Gain: -40 dB Pass: ± 5 Hz Stop: ± 1 Hz (Bus controller default setting) |
| | | 01 | Gain: -60 dB Pass: ± 5 Hz Stop: ± 0.5 Hz |
| | | 10 | Gain: -80 dB Pass: ± 5 Hz Stop: ± 0.25 Hz |
| | | 11 | Reserved |
| 14 | Notch filter frequency | 0 | With 50 Hz (bus controller default setting) |
| | | 1 | At 60 Hz |
| 15 | Reserved | 0 | |

9.1.22.10.5 Communication

9.1.22.10.5.1 Analog input values

Name:

AnalogInput01 and AnalogInput02

The analog input value is mapped in this register.

| Data type | Value | Input signal: |
|-----------|-------------------------|---|
| DINT | -8,388,608 | Negative invalid value |
| | -8,388,607 | Negative full-scale deflection / Underflow |
| | -8,388,606 to 8,388,606 | Valid range |
| | 8,388,607 | Positive full-scale deflection / Overflow / Open line |

9.1.22.10.5.2 Module status

Name:

StatusPacked01 and StatusPacked02

These registers contain the current state of the module.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------------|-------|--|
| 0 | I/O power supply | 0 | No error |
| | | 1 | Error in power supply |
| 1 | Bypass current | 0 | No error |
| | | 1 | Overcurrent (sum from all sensors) |
| 2 - 3 | Reserved | 0 | |
| 4 | A/D converter configuration | 0 | Already configured |
| | | 1 | Not yet configured |
| 5 | Analog values | 0 | Analog value valid |
| | | 1 | Analog value invalid (analog value = -8,388,608 = 0xFF800000). Possible causes: <ul style="list-style-type: none"> Internal transfer error (XOR checksum verification) Error in strain gauge supply (bit 1) Error in I/O voltage supply (bit 0) A/D converter not (yet) configured |
| 6 | Analog value range overrun | 0 | Analog value valid |
| | | 1 | Analog value invalid. Possible causes: <ul style="list-style-type: none"> Overflow / Open circuit (analog value = 8,388,607 = 0x007FFFFFFF) Underflow (analog value = -8,388,607 = 0xFF800001) |
| 7 | Moving average filter | 0 | Moving average filter engaged |
| | | 1 | Moving average filter not engaged Possible causes: <ul style="list-style-type: none"> After changing the filter length Consequence of the filter being reset by another error |

9.1.22.10.5.3 A/D conversion counter

Name:

AdcConvCtr01

Instead of being measured simultaneously, the strain gauge channels of the module are measured according to the multiplexing procedure. The "[AdcConvTimestamp01](#)" on page 640 register contains the timestamp of the encoded last channel converted in the "AdcConvCtr01" register. The timestamp of the other channels can then be calculated later using this information.

| Data type | Value |
|-----------|--------------------|
| SINT | See bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------------------------------|-------|---|
| 0 - 1 | Index of the last converted channel | 0 | Analog input 1 |
| | | 1 | Analog input 2 |
| | | 2 | Reserved |
| | | 3 | Reserved |
| 2 - 7 | Rotating cycle counter | x | Incremented at the end of a conversion cycle. All channels are converted in a conversion cycle. |

9.1.22.10.5.4 ADC conversion timestamp

Name:

AdcConvTimestamp01

The timestamp of the last converted channel is stored in this register (see bits 0 and 1 in the "AdcConvCtr01" on page 639 register). This is always the point in time (in μs) at which the conversion of the latest A/D converter raw value is completed.

| Data type | Value | Function |
|-----------|---------------------------|--|
| DINT | -2147483648 to 2147483647 | Timestamp (in μs) of the last converted channel (see bits 0 and 1 in the A/D conversion counter) |

The timestamp of the remaining channels can be determined in the application using the number and timestamp of the last converted channel according to the following table.

| Channel | Age difference |
|---------|-------------------|
| 2 - 1 | 47 μs |
| 1 - 2 | 153 μs |

Example 1:

- Latest channel (bit 0 - 1 in the AdcConvCtr01 register) = 01 (analog input 2):
- Timestamp: "AdcConvTimestamp01" register = 0 μs

| Channel | Timestamp |
|---------|-------------------|
| 2 | 0 μs |
| 1 | -47 μs |

Example 2:

- Latest channel (bit 0 - 1 in the AdcConvCtr01 register) = 00 (analog input 1):
- Timestamp: "AdcConvTimestamp01" register = 0 μs

| Channel | Timestamp |
|---------|--------------------|
| 1 | 0 μs |
| 2 | -153 μs |

9.1.22.10.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μs |

9.1.22.10.7 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 200 μs |

9.1.23 X20AIB744

Data sheet version: 1.30

9.1.23.1 General information

This module works with 4-wire strain gauge load cells. The concept applied by the module requires compensation in the measurement system. This compensation eliminates the absolute uncertainty in the measurement circuit, such as component tolerances, effective bridge voltage or zero offset. The measurement precision refers to the absolute (compensated) value, which will only change as a result of changes in the operating temperature.

- 4 full-bridge strain gauge inputs
- 5 kHz data output rate for all 4 channels
- Independently configurable strain gauge factor and filter level for each of the 4 channels

9.1.23.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Analog inputs |  |
| X20AIB744 | X20 analog input module, 4 full-bridge strain inputs, 24-bit converter resolution, 2.5 kHz input filter | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB1F | X20 terminal block, 16-pin, 24 VDC keyed | |
| | | |
| | | |

Table 84: X20AIB744 - Order data

9.1.23.3 Technical data

| Model number | X20AIB744 |
|--|--|
| Short description | |
| I/O module | 4 full-bridge strain gauge inputs |
| General information | |
| B&R ID code | 0xE286 |
| Status indicators | Channel status, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| Open circuit | Yes, using LED status indicator and software |
| Input | Yes, using LED status indicator and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1 W |
| Additional power dissipation caused by actuators (resistive) [W] | +1.43 ¹⁾ |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| Full-bridge strain gauge | |
| Strain gauge factor | 2 to 256 mV/V, configurable using software |
| Connection | 4-wire connections |
| Input type | Differential, used to evaluate a full-bridge strain gauge |
| Digital converter resolution | 24-bit |
| Conversion time | 200 µs |
| Data output rate | 5000 samples per second and per channel (f _{DATA}) |
| Input filter | |
| Cutoff frequency | 2.5 kHz |
| Order | 3 |
| Slope | 60 dB |
| ADC filter characteristics | Sigma-delta, see section "Filter" |
| Operating range / Measurement sensor | 85 to 5000 Ω |
| Influence of cable length | Twisted and shielded conductors, cable length as short as possible, cable routing separate from load circuits, without intermediate terminal to sensor |
| Input protection | RC protection |
| Common-mode range | 0.6 to 3.8 VDC Permissible input voltage range (with regard to the potential strain gauge GND) on inputs "Input +" and "Input -" |
| Isolation voltage between input and bus | 500 V _{eff} |
| Conversion procedure | Sigma-delta |
| Output of digital value | |
| Broken bridge supply line | Value approaching 0 |
| Broken sensor line | Value approaching ±end value (status bit "Open circuit" set in register "Module status") |
| Valid range of values | 0xFF800001 to 0x007FFFFFFF (-8,388,607 to 8,388,607) |
| Strain gauge supply | |
| Voltage | 5.5 VDC / Max. 65 mA per channel |
| Short-circuit and overload resistant | Yes |
| Quantization ²⁾ | |
| LSB value | |
| 2 mV/V | 1.31 nV |
| 4 mV/V | 2.62 nV |
| 8 mV/V | 5.25 nV |
| 16 mV/V | 10.49 nV |
| 32 mV/V | 20.98 nV |
| 64 mV/V | 41.96 nV |
| 128 mV/V | 83.92 nV |
| 256 mV/V | 167.85 nV |
| Max. gain drift | 35 ppm/°C ³⁾ |
| Max. offset drift | 15 ppm/°C ⁴⁾ |
| Nonlinearity | <10 ppm ⁴⁾ |
| Electrical properties | |
| Electrical isolation | Bus isolated from analog input and strain gauge supply voltage Channel not isolated from channel and I/O power supply |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |

Table 85: X20AIB744 - Technical data


| Model number | X20AIB744 |
|--|--|
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Hardware configuration" |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB1F separately. Order 1x bus module X20BM11 separately. |
| Pitch | 12.5 ^{+0.2} mm |

Table 85: X20AIB744 - Technical data

- 1) Depends on the full-bridge strain gauge being used.
- 2) Quantization depends on the strain gauge factor.
- 3) Based on the current measured value.
- 4) Based on the entire measurement range.

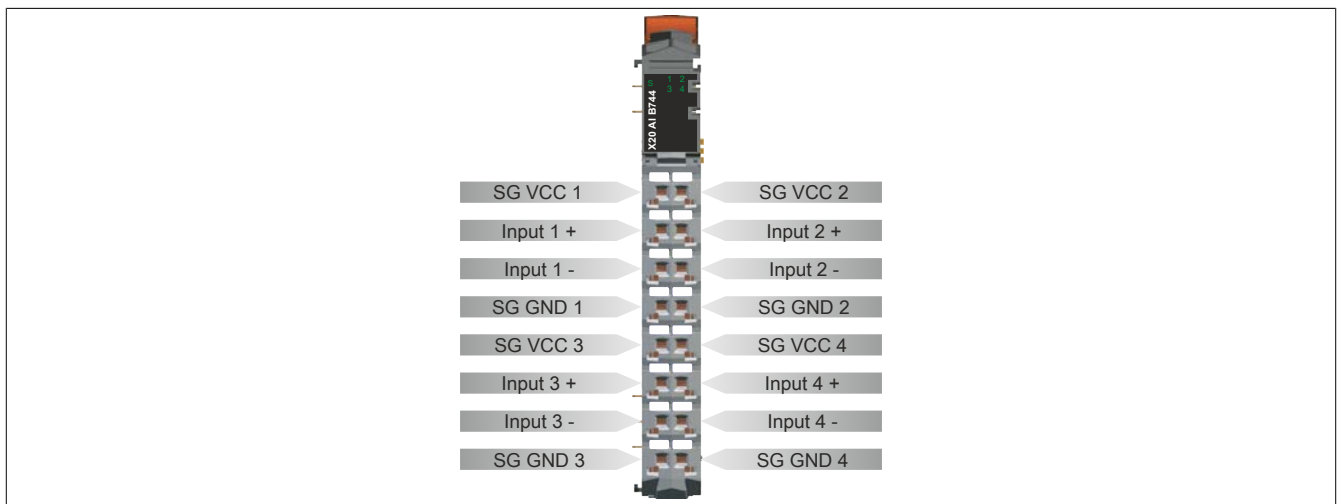
9.1.23.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

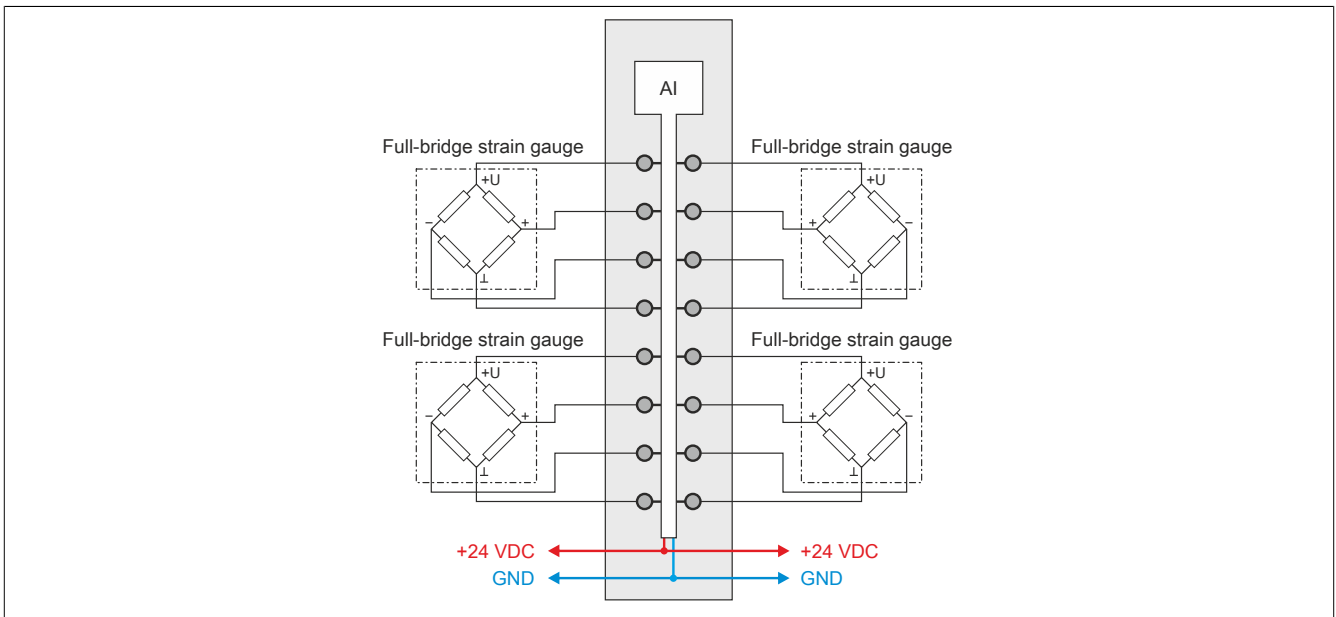
| Figure | LED | Color | Status | Description |
|---|--------------|-------|--|---|
|  | S | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | On | RUN mode | |
| | | Red | Off | No power to module or everything OK |
| | Double flash | | I/O power supply outside limits | |
| | On | | Error or reset status | |
| | 1 - 4 | Green | Off | Possible causes: <ul style="list-style-type: none"> • Supply error • Channel not yet configured |
| | | | Blinking | Possible causes: <ul style="list-style-type: none"> • Open line • Overvoltage • Undervoltage |
| Green | | On | Analog/digital converter running, value OK | |
| | | On | Analog/digital converter running, value OK | |

- 1) Depending on the configuration, a firmware update can take up to several minutes.

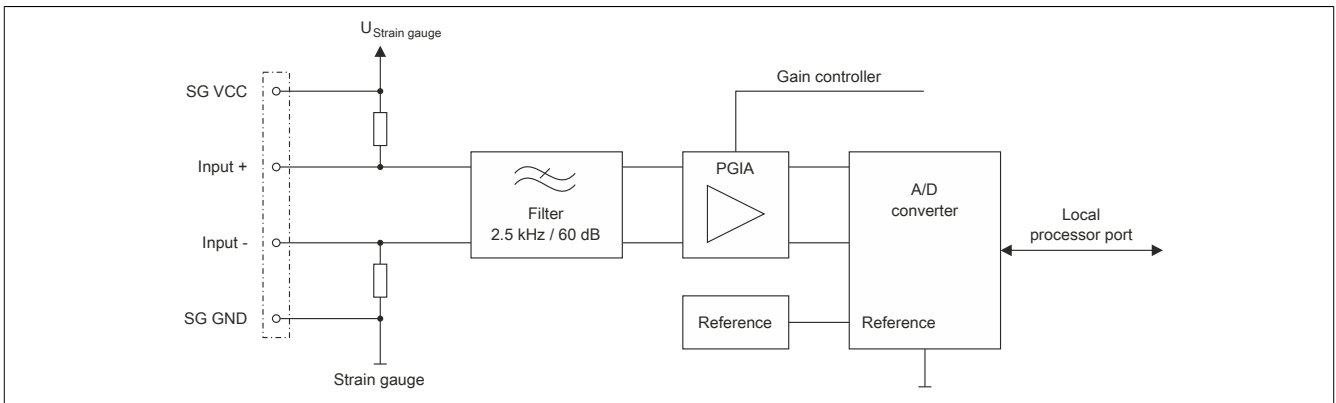
9.1.23.5 Pinout



9.1.23.6 Connection example



9.1.23.7 Input circuit diagram

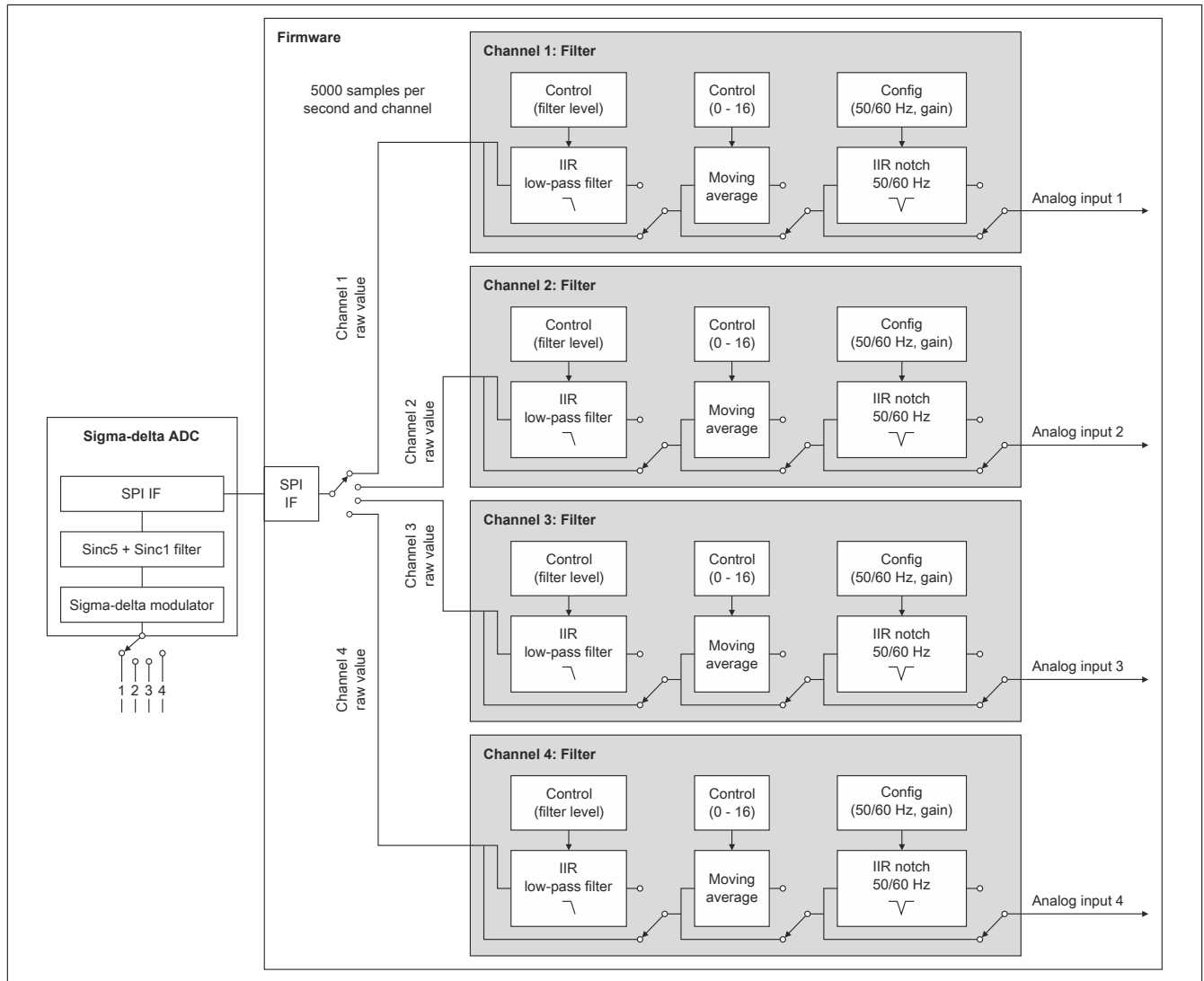


9.1.23.8 Software filters

An independent cascade of filters is available for each channel. They can be individually enabled and configured at runtime. By default, all filters are disabled when the device is switched on. Filters are controlled and configured using the "ControlPacked0N" on page 656 and "ConfigChannel0N" on page 657 (N = 1 to 4) registers.

In order to allow the filter behavior to be adapted to the measuring situation or machine cycle (high dynamics and low precision or low dynamics and high precision), the filter characteristics of both the IIR low-pass filter as well as the moving average filter can be changed synchronously at any time.

Filter diagram



9.1.23.8.1 IIR low-pass filter

9.1.23.8.1.1 General information

The IIR low-pass filter is used to generally smooth and increase the resolution of the analog value. The filter works according to the following formula:

$$y = y_{Old} + \frac{x - y_{Old}}{2^{Filter\ level}}$$

- x ... current filter input value
- y_{Old} ... old filter output value
- y ... new filter output value

The "Filter level" parameter in the formula above is configured with the help of the "ControlPacked0N" on page 656 register. "Filter level" = 0 if the IIR low-pass filter is disabled.

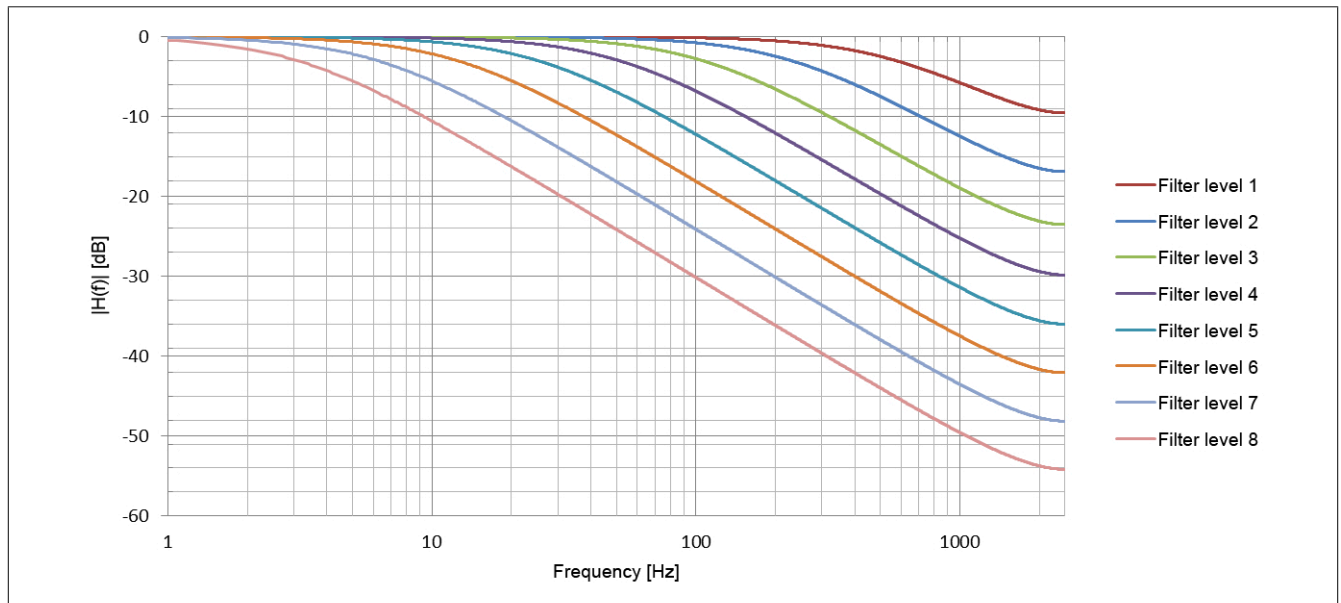
9.1.23.8.1.2 Filter characteristics of the 1st-order IIR low-pass filter

Limit frequency f_c

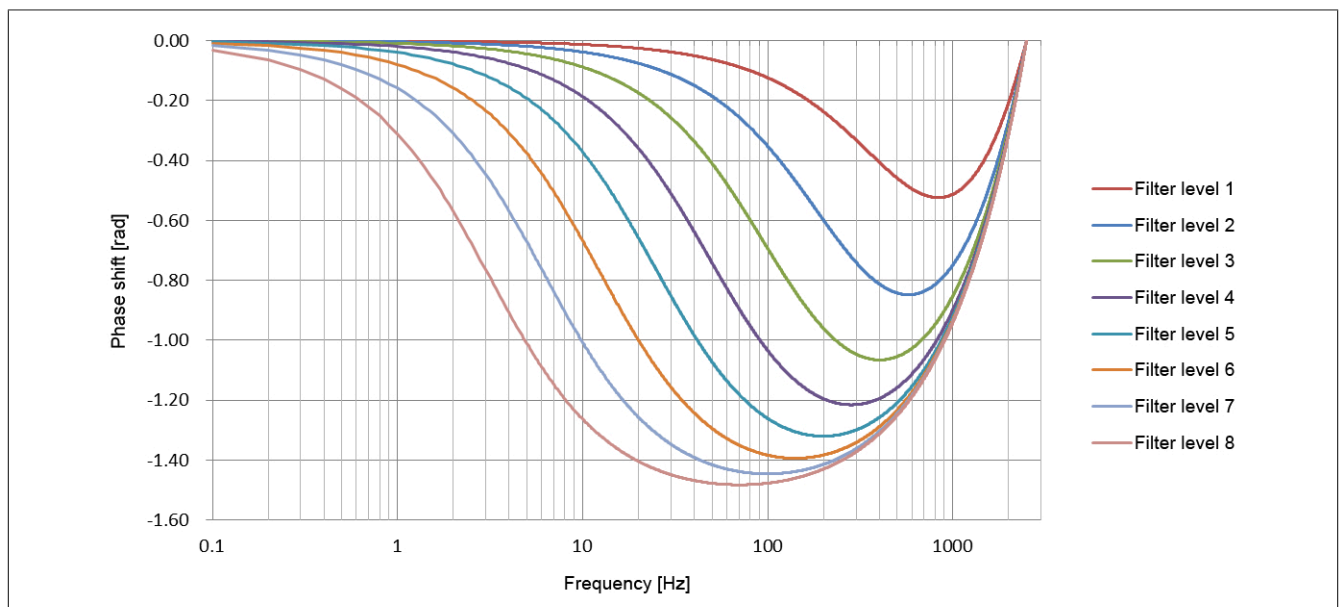
The following table provides an overview of the -3 dB limit frequency f_c depending on the configured filter level.

| IIR low-pass filter level | f_c [Hz] |
|---------------------------|------------|
| 1 | 575 |
| 2 | 230 |
| 3 | 106 |
| 4 | 51 |
| 5 | 25 |
| 6 | 12.5 |
| 7 | 6.2 |
| 8 | 3.1 |

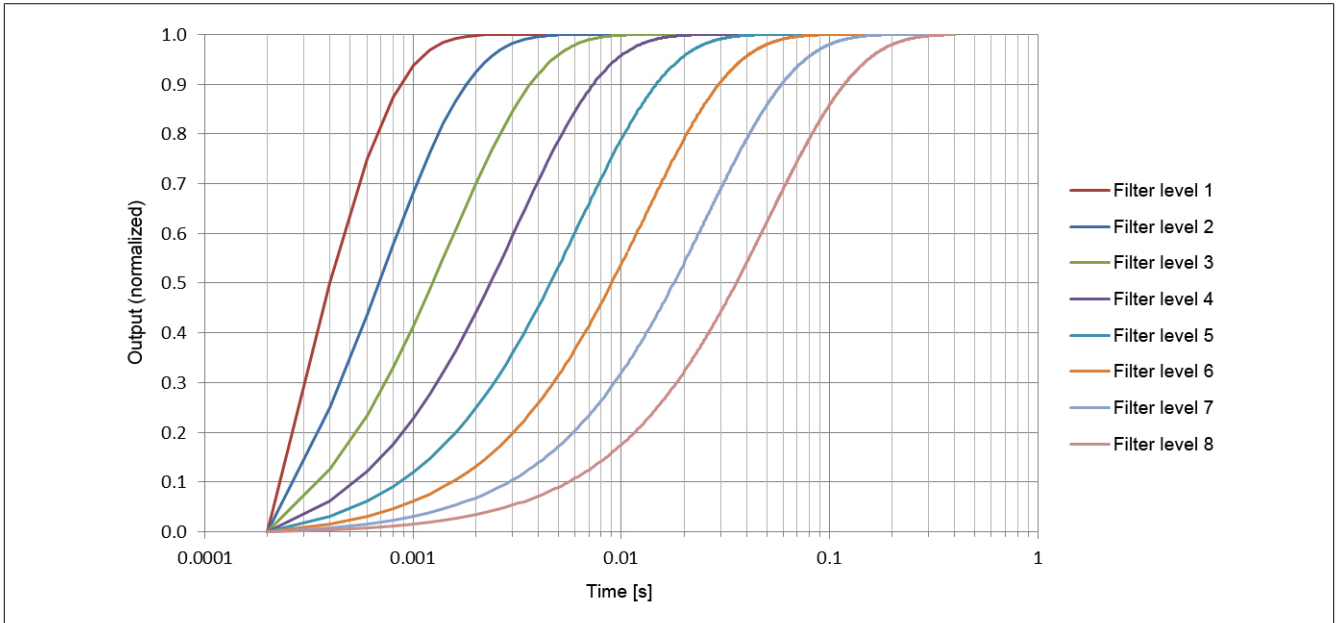
Gain of the IIR low-pass filter



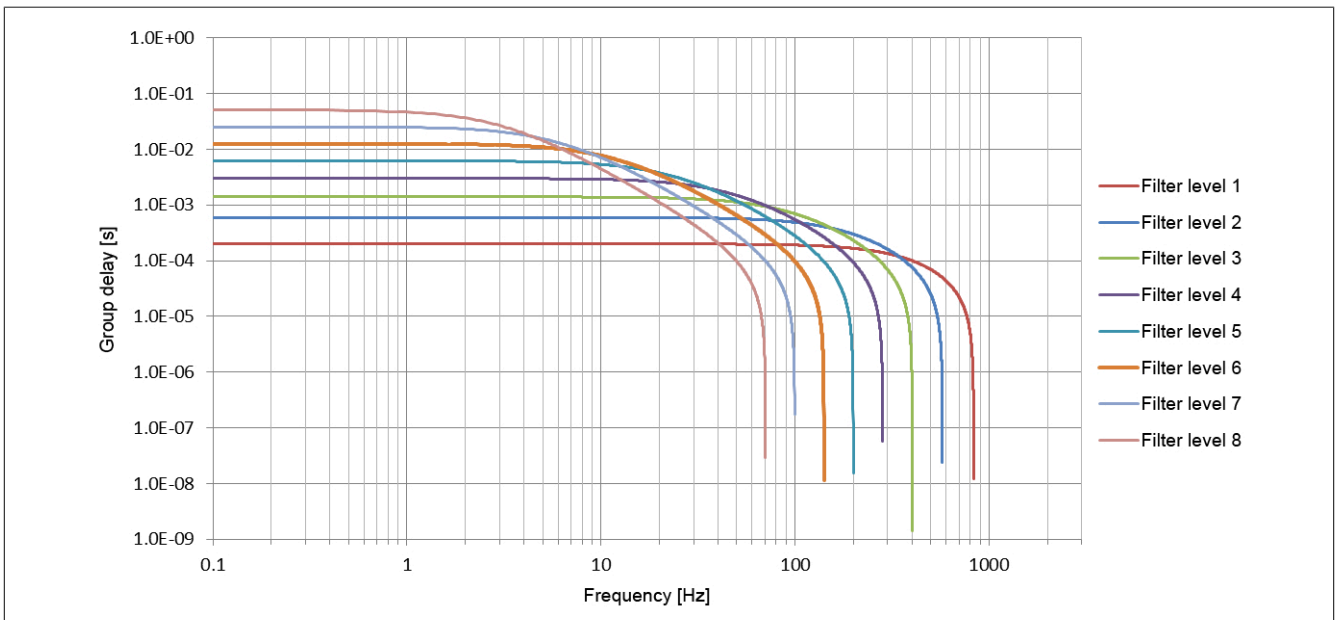
Phase shift of the IIR low-pass filter



Step response of the IIR low-pass filter



Group delay of the IIR low-pass filter



9.1.23.8.2 Sinc1 / Moving average filter

Like the low-pass filter, the moving average filter can also be used to smooth out the signal and increase its resolution. In addition, configuring the filter length accordingly makes it possible to target and efficiently filter out individual interference frequencies. The source of these interference frequencies may be mechanical or electromagnetic. Multiples of these are also filtered out (as long as they are a whole-number factor of the data output rate of 5000 samples per second and channel).

Example:

Data output rate = 5000 samples/s/channel, averaging over 4 values -> "Notch" at 1.25 kHz (and 2.5 kHz)

When reconfiguring the filter length from "n" to "m", it takes $|m-n| * 200 \mu\text{s}$ until the desired filter length setpoint is reached again. As long as the filter length setpoint is not reached, this situation will be indicated by the bit 7 status bit in the "StatusPacked0N" on page 658 register.

9.1.23.8.2.1 Filter characteristics of the moving average filter

| Filter configuration | Filter length | f_{Notch} [Hz] ¹⁾ | f_c [Hz] ²⁾ |
|----------------------|---------------|---------------------------------------|--------------------------|
| 0 | 1 | | |
| 1 | 2 | 2500 | 1244 |
| 2 | 4 | 1250 | 568 |
| 3 | 5 | 1000 | 450 |
| 4 | 10 | 500 | 222 |
| 5 | 20 | 250 | 111 |
| 6 | 25 | 200 | 88.4 |
| 7 | 50 | 100 | 44.0 |
| 8 | 83 | 60.24 | 26.5 |
| 9 | 100 | 50 | 21.9 |
| 10 | 125 | 40 | 17.5 |
| 11 | 167 | 29.94 | 13.0 |
| 12 | 200 | 25 | 10.9 |
| 13 | 250 | 20 | 8.6 |
| 14 | 300 | 16.67 | 7.1 |
| 15 | 500 | 10 | 4.3 |
| 16 | 1000 | 5 | 2.0 |

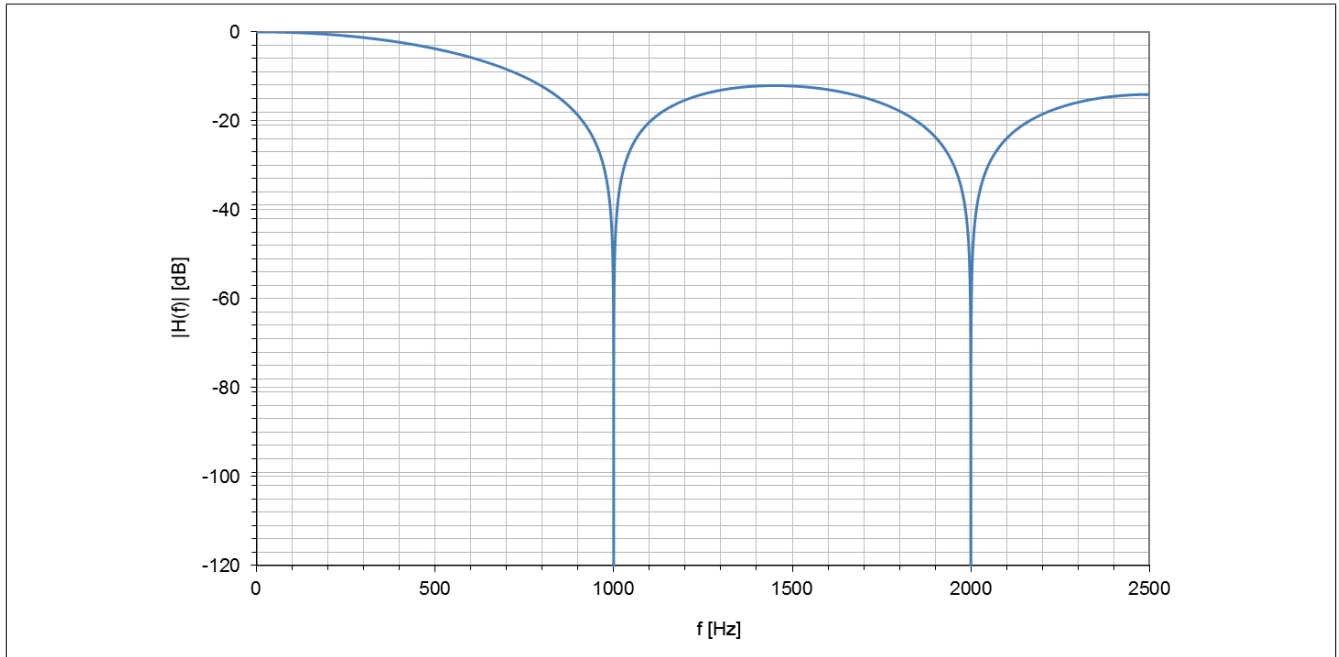
- 1) Mid-band frequency of the first attenuation maximum.
- 2) -3 dB limit frequency.

9.1.23.8.2.2 Examples for the gain of the moving average filter

Example 1

Filter setting = 3:

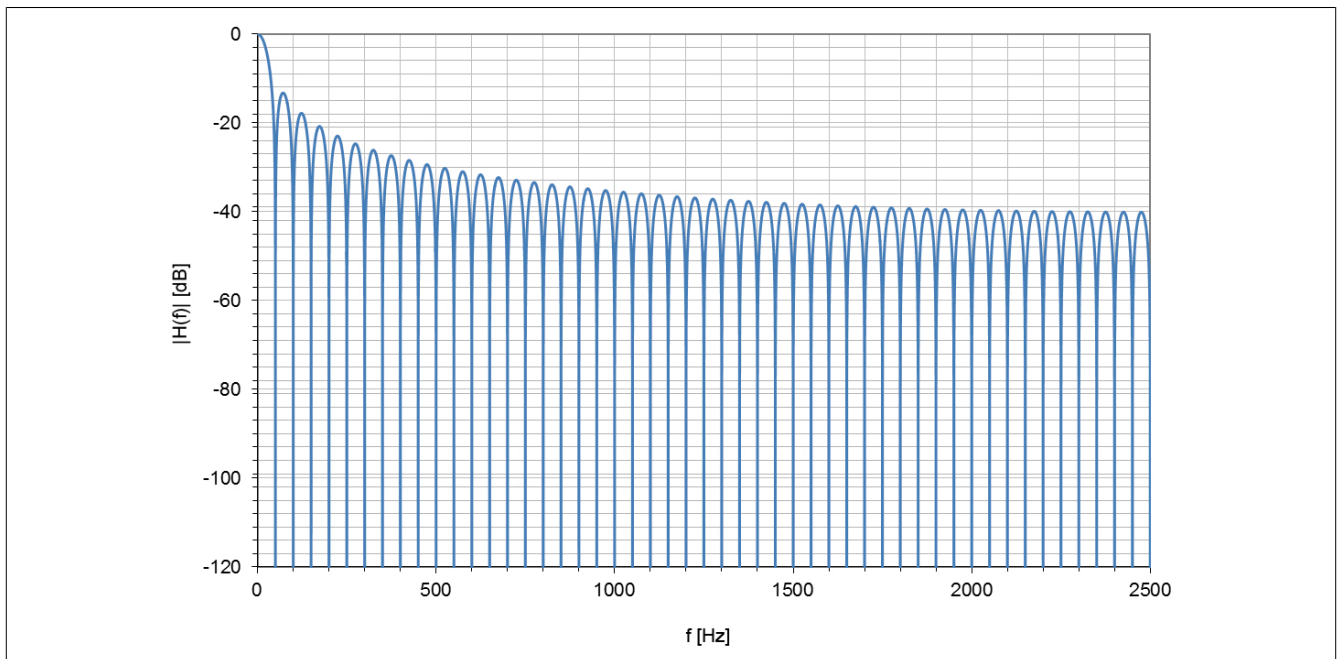
- $f_{\text{Notch}} = 1000 \text{ Hz}$
- $f_c = 449.6 \text{ Hz}$



Example 2

Filter setting = 9:

- $f_{\text{Notch}} = 50 \text{ Hz}$
- $f_c = 21.9 \text{ Hz}$



9.1.23.8.3 50/60 Hz IIR notch filter

The IIR notch filter is used for narrow-band suppression of interference caused by the mains frequency.

This is an 8th-order IIR notch filter implemented in the form of a cascade of 4 2nd-order IIR notch filters.

Information:

The IIR notch filter should only be enabled if there is actually interference being caused by the mains frequency. You should always check whether sufficiently low and sufficiently narrow band filtering at 50 Hz / 60 Hz can be implemented using a moving average filter (see "[Filter characteristics of the moving average filter](#)" on page 648).

This is because, like every higher-order IIR notch filter, this filter also has a tendency to respond to an input step with an attenuating vibration. The higher the dynamics of the expected measurement signal, the greater the potential interfering effect of this vibration tendency. In extreme cases, the vibration can temporarily be greater than the mains interference that is supposed to be filtered out.

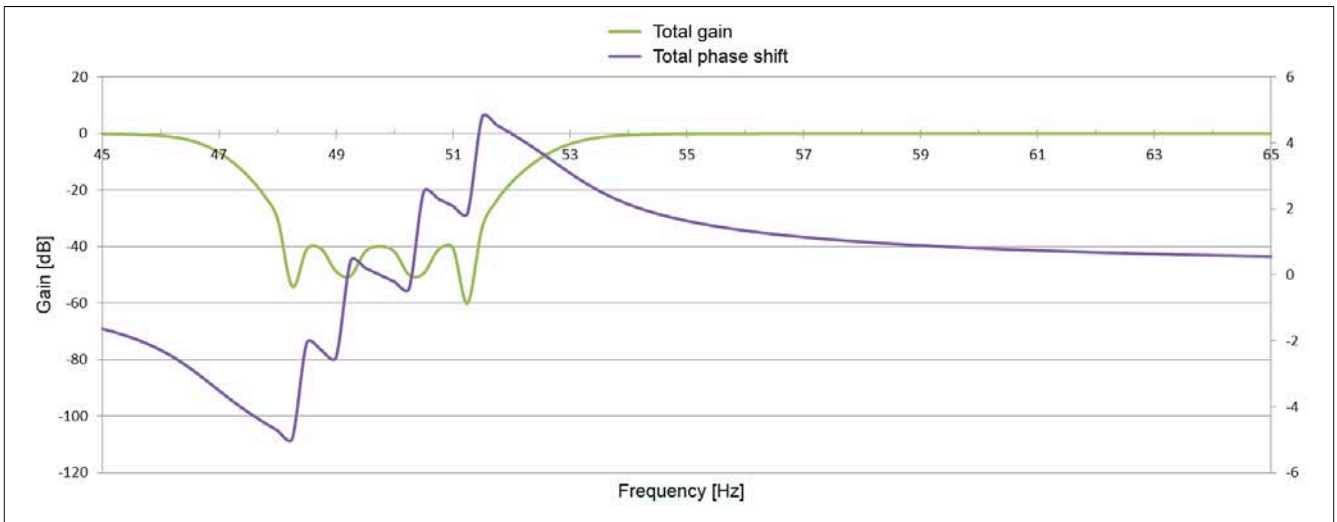
9.1.23.8.3.1 Filter characteristics of the IIR notch filter

There are 3 different filter characteristics that can be selected for both 50 Hz and 60 Hz (-40 dB, -60 dB and -80 dB). The higher the attenuation, the narrower the stopband.

Example 1

Filter characteristics for the following settings:

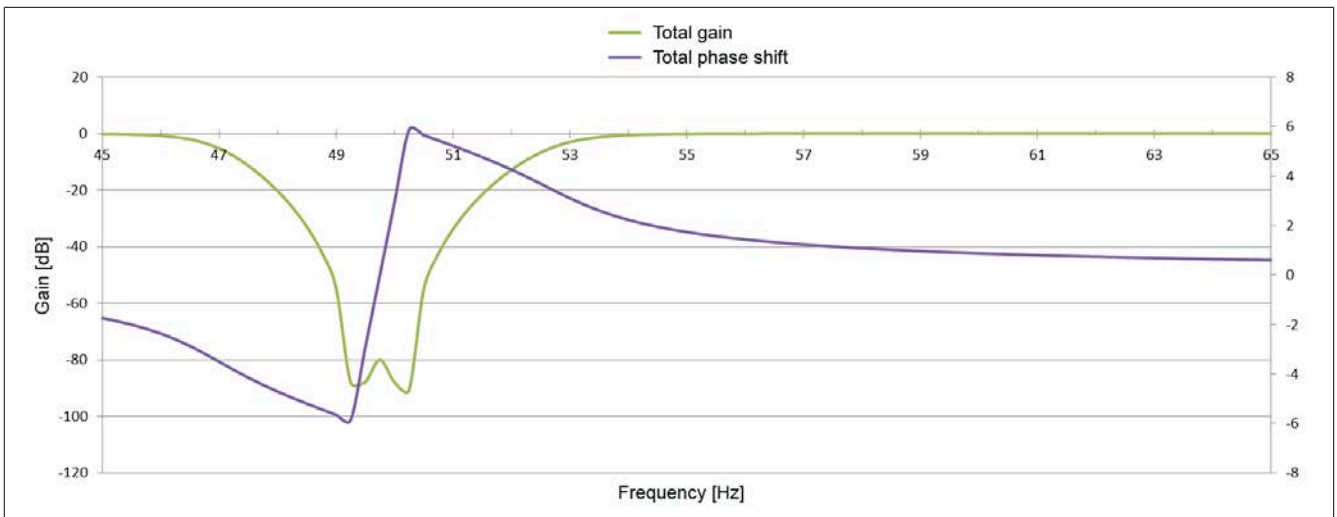
- Gain = -40 dB
- Frequency = 50 Hz
- Passband = 5 Hz
- Stopband = ± 1 Hz



Example 2

Filter characteristics for the following settings:

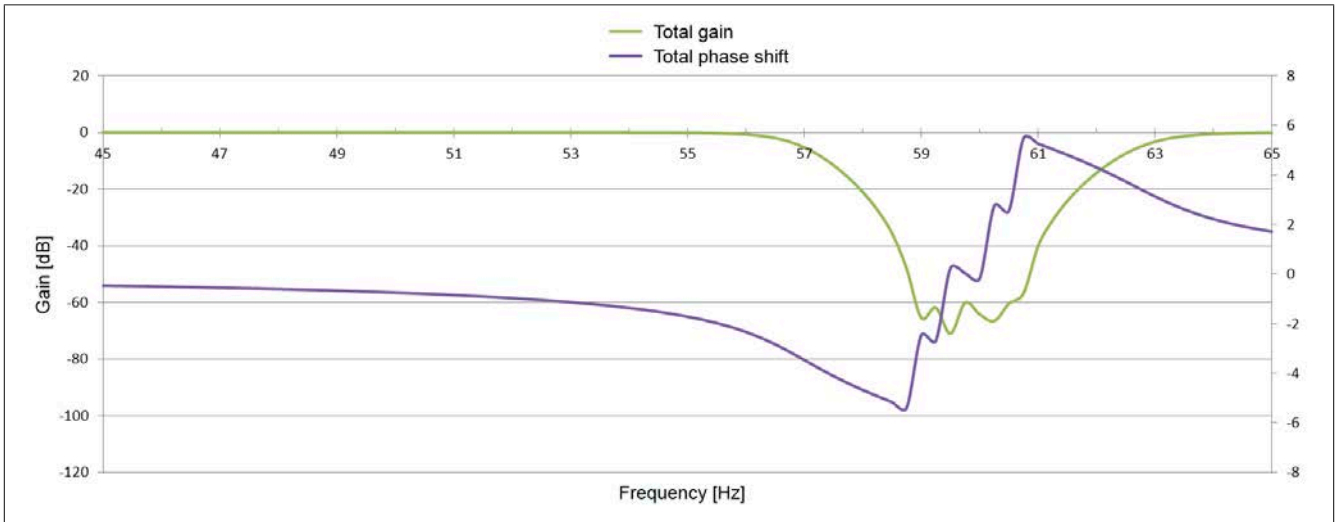
- Gain = -80 dB
- Frequency = 50 Hz
- Passband = 5 Hz
- Stopband = ± 0.25 Hz



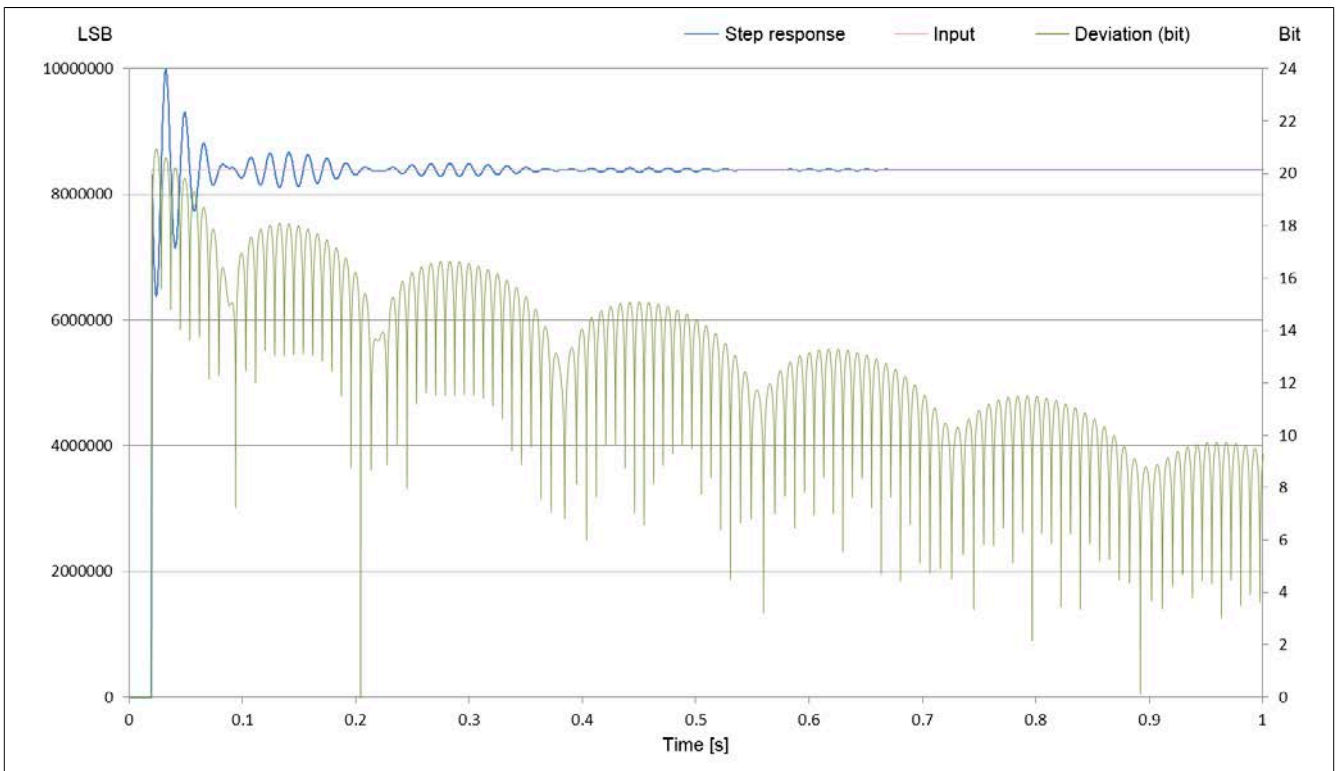
Example 3

Filter characteristics for the following settings:

- Gain = -60 dB
- Frequency = 60 Hz
- Passband = 5 Hz
- Stopband = ± 0.5 Hz



Step response of an 8th-order IIR notch filter, including the deviation in bits:

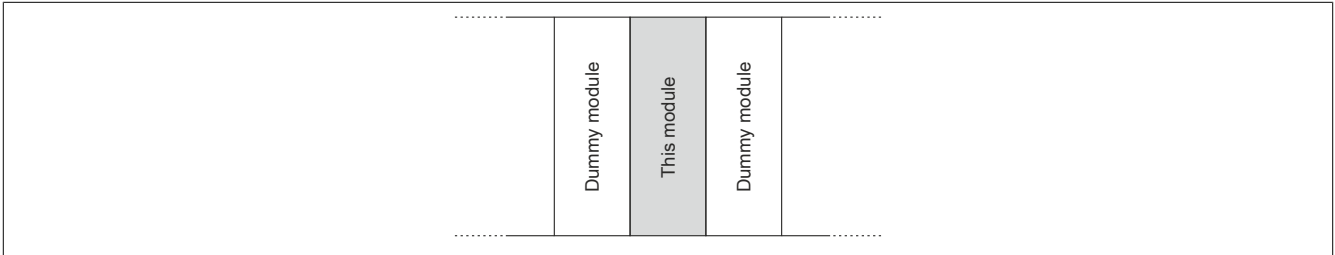


9.1.23.9 Hardware configuration

9.1.23.9.1 Hardware configuration for horizontal installation starting at 55°C ambient temperature

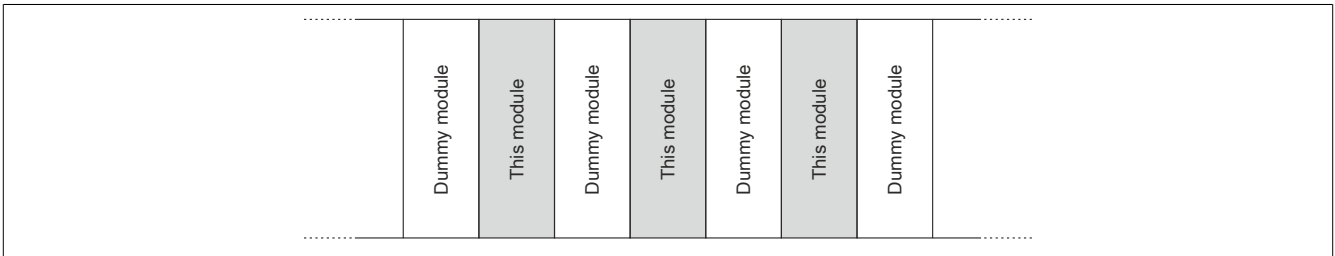
Operating a strain gauge module

Starting at an ambient temperature of 55°C, a dummy module must be connected to the left and right of the strain gauge module in a horizontal mounting orientation.



Operating multiple strain gauge modules side by side

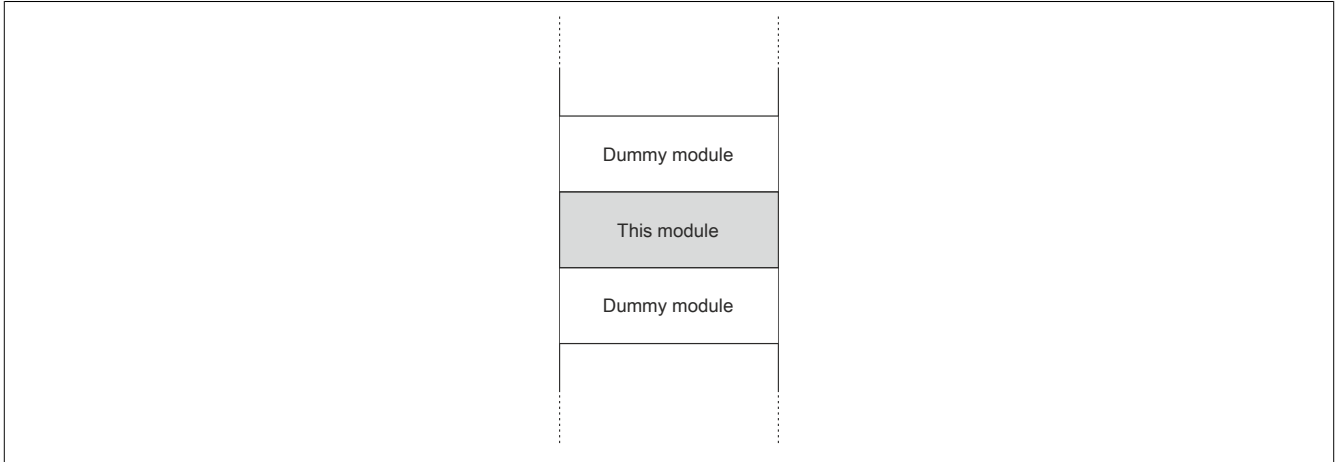
If 2 or more horizontal strain gauge modules are being operated in a cluster, the following arrangement of modules must be observed.



9.1.23.9.2 Hardware configuration for vertical installation starting at 45°C ambient temperature

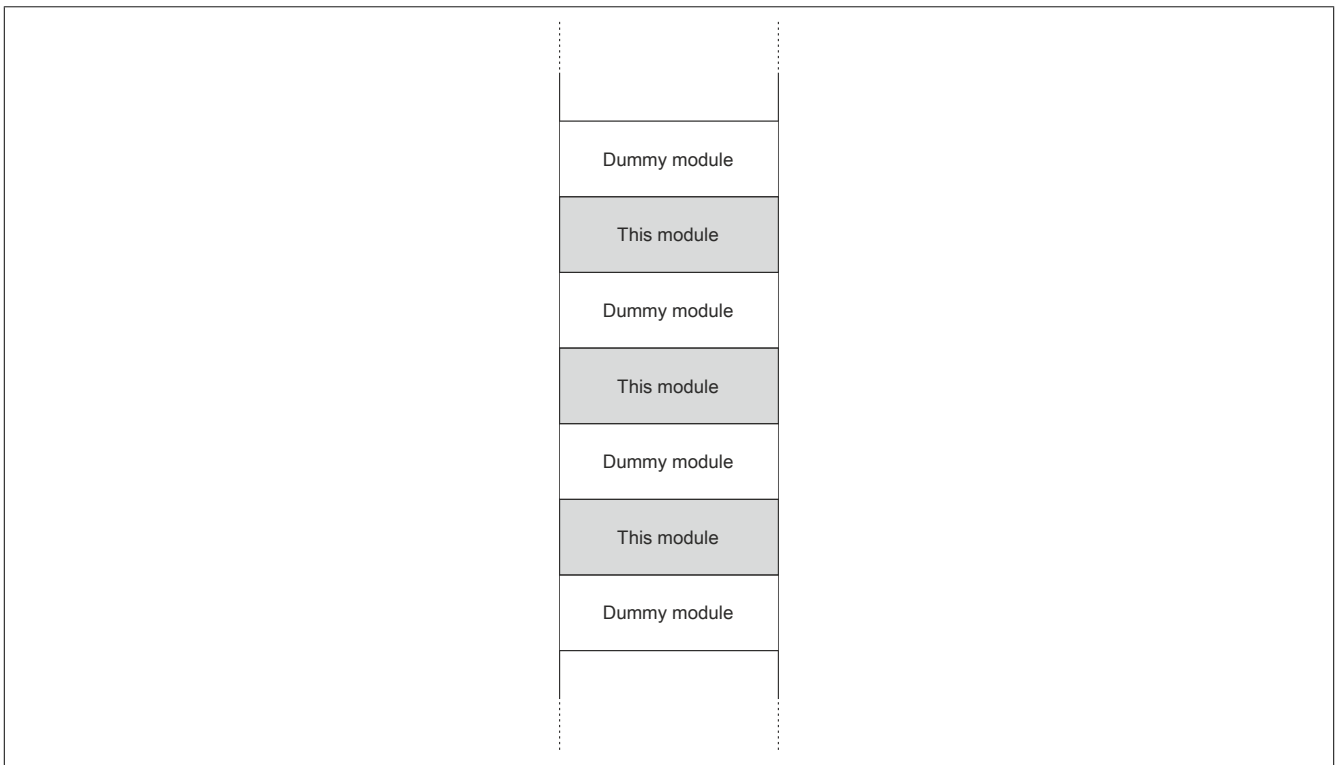
Operating a strain gauge module

Starting at an ambient temperature of 45°C, a dummy module must be connected to the left and right of the strain gauge module in a vertical mounting orientation.



Operating multiple strain gauge modules side by side

If 2 or more vertical strain gauge modules are being operated in a cluster, the following arrangement of modules must be observed.



9.1.23.10 Register description

9.1.23.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.1.23.10.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog signal - Configuration | | | | | | |
| 2 | ControlPacked01 (configuration of strain gauge inputs) | UINT | | | • | |
| 6 | ControlPacked02 (configuration of strain gauge inputs) | UINT | | | • | |
| 10 | ControlPacked03 (configuration of strain gauge inputs) | UINT | | | • | |
| 14 | ControlPacked04 (configuration of strain gauge inputs) | UINT | | | • | |
| 514 | ConfigChannel01 (channel configuration) | UINT | | | | • |
| 578 | ConfigChannel02 (channel configuration) | UINT | | | | • |
| 642 | ConfigChannel03 (channel configuration) | UINT | | | | • |
| 706 | ConfigChannel04 (channel configuration) | UINT | | | | • |
| Analog signal - Communication | | | | | | |
| 4 | AnalogInput01 | DINT | • | | | |
| 12 | AnalogInput02 | DINT | • | | | |
| 20 | AnalogInput03 | DINT | • | | | |
| 28 | AnalogInput04 | DINT | • | | | |
| 33 | StatusPacked01 | USINT | • | | | |
| 35 | StatusPacked02 | USINT | • | | | |
| 37 | StatusPacked03 | USINT | • | | | |
| 39 | StatusPacked04 | USINT | • | | | |
| 257 | AdcConvCtr01 | SINT | • | | | |
| 268 | AdcConvTimeStamp01 | DINT | • | | | |

9.1.23.10.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog signal - Configuration | | | | | | | |
| 2 | 2 | ControlPacked01 (configuration of strain gauge inputs) | UINT | | | • | |
| 6 | 10 | ControlPacked02 (configuration of strain gauge inputs) | UINT | | | • | |
| 10 | 18 | ControlPacked03 (configuration of strain gauge inputs) | UINT | | | • | |
| 14 | 26 | ControlPacked04 (configuration of strain gauge inputs) | UINT | | | • | |
| 514 | 514 | ConfigChannel01 (channel configuration) | UINT | | | | • |
| 578 | 578 | ConfigChannel02 (channel configuration) | UINT | | | | • |
| 642 | 642 | ConfigChannel03 (channel configuration) | UINT | | | | • |
| 706 | 706 | ConfigChannel04 (channel configuration) | UINT | | | | • |
| Analog signal - Communication | | | | | | | |
| 4 | 4 | AnalogInput01 | DINT | • | | | |
| 12 | 12 | AnalogInput02 | DINT | • | | | |
| 20 | 20 | AnalogInput03 | DINT | • | | | |
| 28 | 28 | AnalogInput04 | DINT | • | | | |
| 33 | 0 | StatusPacked01 | USINT | • | | | |
| 35 | 8 | StatusPacked02 | USINT | • | | | |
| 37 | 16 | StatusPacked03 | USINT | • | | | |
| 39 | 24 | StatusPacked04 | USINT | • | | | |

1) The offset specifies the position of the register within the CAN object.

9.1.23.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.1.23.10.3.2 CAN I/O bus controller

The module occupies 4 analog logical slots on CAN I/O.

9.1.23.10.4 Configuration

9.1.23.10.4.1 Configuration of strain gauge inputs

Name:

ControlPacked01 to ControlPacked04

The strain gauge inputs are configured in these registers:

- Strain gauge factor of strain gauge load cell
- Enabling of filters

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information | |
|---------|-----------------------|-------------------------------------|---|-------------------------|
| 0 - 2 | Strain gauge factor | 000 | Default: 256 mV/V | |
| | | 001 | 128 mV/V | |
| | | 010 | 64 mV/V | |
| | | 011 | 32 mV/V | |
| | | 100 | 16 mV/V | |
| | | 101 | 8 mV/V | |
| | | 110 | 4 mV/V | |
| | | 111 | 2 mV/V | |
| 3 - 7 | Moving average | | Averaging | 1. Notch frequency [Hz] |
| | | 00000 | Default: Moving average disabled (bypass) | |
| | | 00001 | 2 | 2500 |
| | | 00010 | 4 | 1250 |
| | | 00011 | 5 | 1000 |
| | | 00100 | 10 | 500 |
| | | 00101 | 20 | 250 |
| | | 00110 | 25 | 200 |
| | | 00111 | 50 | 100 |
| | | 01000 | 83 | 60 |
| | | 01001 | 100 | 50 |
| | | 01010 | 125 | 40 |
| | | 01011 | 167 | 30 |
| | | 01100 | 200 | 25 |
| | | 01101 | 250 | 20 |
| | | 01110 | 300 | 16.66 |
| | | 01111 | 500 | 10 |
| 10000 | 1000 | 5 | | |
| | 10001 to 11111 | Reserved (firmware limited to 1000) | | |
| 8 | Notch filter | 0 | Default: IIR notch filter disabled (bypass) | |
| | | 1 | IIR notch filter enabled | |
| 9 | Reserved | 0 | | |
| 10 - 11 | Low-pass filter mode | 00 | IIR low-pass filter disabled (bypass) | |
| | | 01 | 1st-order IIR low-pass filter (see "IIR low-pass filter" on page 645) | |
| | | 10 - 11 | Reserved: No IIR low-pass filter active | |
| | | | Filter level | -3 db frequency [Hz] |
| 12 - 14 | Low-pass filter level | 000 | 1 | 575 |
| | | 001 | 2 | 230 |
| | | 010 | 3 | 106 |
| | | 011 | 4 | 51 |
| | | 100 | 5 | 25 |
| | | 101 | 6 | 12.5 |
| | | 110 | 7 | 6.2 |
| | | 111 | 8 | 3.1 |
| 15 | Reserved | 0 | | |

9.1.23.10.4.2 Channel configuration

Name:

ConfigChannel01 to ConfigChannel04

The IIR notch filter is configured individually for each channel in these registers.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|---------|--------------------------|-------|--|
| 0 - 11 | Reserved | 0 | |
| 12 - 13 | Notch filter attenuation | 00 | Gain: -40 dB Pass: ± 5 Hz Stop: ± 1 Hz (Bus controller default setting) |
| | | 01 | Gain: -60 dB Pass: ± 5 Hz Stop: ± 0.5 Hz |
| | | 10 | Gain: -80 dB Pass: ± 5 Hz Stop: ± 0.25 Hz |
| | | 11 | Reserved |
| 14 | Notch filter frequency | 0 | With 50 Hz (bus controller default setting) |
| | | 1 | At 60 Hz |
| 15 | Reserved | 0 | |

9.1.23.10.5 Communication

9.1.23.10.5.1 Analog input values

Name:

AnalogInput01 to AnalogInput04

The analog input value is mapped in this register.

| Data type | Value | Input signal: |
|-----------|-------------------------|---|
| DINT | -8,388,608 | Negative invalid value |
| | -8,388,607 | Negative full-scale deflection / Underflow |
| | -8,388,606 to 8,388,606 | Valid range |
| | 8,388,607 | Positive full-scale deflection / Overflow / Open line |

9.1.23.10.5.2 Module status

Name:

StatusPacked01 to StatusPacked04

These registers contain the current state of the module.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------------|-------|--|
| 0 | I/O power supply | 0 | No error |
| | | 1 | Error in power supply |
| 1 | Bypass current | 0 | No error |
| | | 1 | Overcurrent (sum from all sensors) |
| 2 - 3 | Reserved | 0 | |
| 4 | A/D converter configuration | 0 | Already configured |
| | | 1 | Not yet configured |
| 5 | Analog values | 0 | Analog value valid |
| | | 1 | Analog value invalid (analog value = -8,388,608 = 0xFF800000). Possible causes: <ul style="list-style-type: none"> Internal transfer error (XOR checksum verification) Error in strain gauge supply (bit 1) Error in I/O voltage supply (bit 0) A/D converter not (yet) configured |
| 6 | Analog value range overrun | 0 | Analog value valid |
| | | 1 | Analog value invalid. Possible causes: <ul style="list-style-type: none"> Overflow / Open circuit (analog value = 8,388,607 = 0x007FFFFFFF) Underflow (analog value = -8,388,607 = 0xFF800001) |
| 7 | Moving average filter | 0 | Moving average filter engaged |
| | | 1 | Moving average filter not engaged Possible causes: <ul style="list-style-type: none"> After changing the filter length Consequence of the filter being reset by another error |

9.1.23.10.5.3 A/D conversion counter

Name:

AdcConvCtr01

Instead of being measured simultaneously, the strain gauge channels of the module are measured according to the multiplexing procedure. The "[AdcConvTimestamp01](#)" on page 659 register contains the timestamp of the encoded last channel converted in the "AdcConvCtr01" register. The timestamp of the other channels can then be calculated later using this information.

| Data type | Value |
|-----------|--------------------|
| SINT | See bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------------------------------|-------|---|
| 0 - 1 | Index of the last converted channel | 0 | Analog input 1 |
| | | 1 | Analog input 2 |
| | | 2 | Analog input 3 |
| | | 3 | Analog input 4 |
| 2 - 7 | Rotating cycle counter | x | Incremented at the end of a conversion cycle. All channels are converted in a conversion cycle. |

9.1.23.10.5.4 A/D conversion timestamp

Name:

AdcConvTimestamp01

The timestamp of the last converted channel is stored in this register (see bits 0 and 1 in the "AdcConvCtr01" on page 658 register). This is always the point in time (in μs) at which the conversion of the latest A/D converter raw value is completed.

| Data type | Value | Function |
|-----------|---------------------------|--|
| DINT | -2147483648 to 2147483647 | Timestamp (in μs) of the last converted channel (see bits 0 and 1 in the A/D conversion counter) |

The timestamp of the remaining channels can be determined in the application using the number and timestamp of the last converted channel according to the following table.

| Channel | Age difference |
|---------|------------------|
| 4 - 3 | 47 μs |
| 3 - 2 | 47 μs |
| 2 - 1 | 47 μs |
| 1 - 4 | 59 μs |

Example:

- Latest channel (bit 0 - 1 in the AdcConvCtr01 register) = 01 (analog input 2):
- Timestamp: "AdcConvTimestamp01" register = 0 μs

| Channel | Timestamp |
|---------|--------------------------------|
| 2 | 0 μs |
| 1 | -47 μs |
| 4 | -47-59 = -106 μs |
| 3 | -47-59-47 = -153 μs |

9.1.23.10.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μs |

9.1.23.10.7 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 200 μs |

9.1.24 X20(c)AP31xx

Data sheet version: 2.55

9.1.24.1 General information

Power monitoring

These modules measure active, reactive and apparent power individually for each of the 3 phases as well as all of them collectively. The power consumption of each phase is also recorded individually and in total. In addition, the modules provide the RMS values for voltage and current on the 3 phases. When measuring the current, the value of the current through the neutral conductor can also be detected and monitored. Measurement of the mains frequency and the phase angle of the 3 phases (current and voltage) complete the power measurement data.

Energy management

The integrated functions on the modules map the immediate power requirements of the machine in detail as well as record its total power consumption. For the user, all relevant data is prepared and made available in the process image.

The ability to measure currents and voltages up to the 31st harmonic enables higher precision recording of RMS values than is generally possible. This allows the modules to easily cope with irregular sine curves and makes them well-suited to renewable energy applications. In these types of applications, for example, being able to accurately measure the frequency at a resolution of 0.01 Hz between 45 and 65 Hz is a great advantage. In general, the modules are suitable for use with 1-phase, 2-phase or 3-phase networks.

Characteristics

- Calculates RMS values from currents and voltages
- Calculates active, reactive and apparent power
- Phasing detection
- Measures individual phases and calculates cumulative values
- Optional measurement of current through the neutral conductor
- Calculates frequency and harmonics with high precision
- NetTime timestamp: Moment when measured value groups are read

NetTime timestamp of readout moments

For many applications, not only the measured value is important, but also the exact moment when a group of measured values is read out. The module is equipped with a NetTime timestamp function for this that supplies a timestamp for the recorded position and trigger time with microsecond accuracy.

The timestamp function is based on synchronized timers. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

9.1.24.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.1.24.3 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Analog inputs |  |
| X20AP3111 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 20 mA AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | |
| X20AP3121 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 1 A AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | |
| X20AP3131 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 5 A AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | |
| X20AP3161 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 333 mV AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | |
| X20AP3171 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, Rogowski adjustable ($\mu\text{V/A}$), max. 52 mV, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | |
| X20AP3122 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 1 A AC, groundable, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | |
| X20AP3132 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 5 A AC, groundable, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | |
| X20cAP3121 | X20 energy metering module, coated, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 1 A AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | |
| X20cAP3131 | X20 energy metering module, coated, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 5 A AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function | |
| | Required accessories | |
| | Bus modules | |
| X20BM32 | X20 bus module for double-width modules, 240 VAC keyed, internal I/O supply continuous | |
| X20cBM32 | X20 bus module, coated, for double-width modules, 240 VAC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB32 | X20 terminal block, 12-pin, 240 VAC keyed | |

Table 86: X20AP3111, X20AP3121, X20AP3131, X20AP3161, X20AP3171, X20AP3122, X20AP3132, X20cAP3121, X20cAP3131 - Order data

9.1.24.4 Technical data

9.1.24.4.1 X20AP3111, X20(c)AP3121 and X20(c)AP3131

| Model number | X20AP3111 | X20AP3121 | X20cAP3121 | X20AP3131 | X20cAP3131 |
|---|--|--|--|---|--|
| Short description | 3-phase power and energy metering module for current transformers | | | | |
| I/O module | | | | | |
| General information | | | | | |
| B&R ID code | 0xC9DA | 0xC9DB | 0xE214 | 0xC9DC | 0xEB55 |
| Status indicators | I/O function per channel, operating state, module status | | | | |
| Diagnosics | | | | | |
| Module run/error | Yes, using LED status indicator and software | | | | |
| Inputs | Yes, using LED status indicator and software | | | | |
| Power consumption | | | | | |
| Bus | 0.85 W (Rev. < D0) 0.50 W (Rev. = D0) 0.45 W (Rev. > D0) | 0.85 W (Rev. < D0) 0.50 W (Rev. = D0) 0.45 W (Rev. > D0) | 0.85 W (Rev. < C0) 0.50 W (Rev. = C0) 0.45 W (Rev. > C0) | | 0.85 W (Rev. < E0) 0.50 W (Rev. = E0) 0.45 W (Rev. > E0) |
| Internal I/O | - | | | | |
| Additional module power dissipation [W] | 40 mW ¹⁾ | | | | 2 W ¹⁾ |
| Isolation voltages | | | | | |
| Inputs - Bus / I/O power supply | Tested at 5500 VDC, 1 min | | | | |
| Inputs - Ground | Tested at 5500 VDC, 1 min | | | | |
| Bus / I/O power supply - Ground | Tested at 510 VAC, 1 min | | | | |
| Certifications | | | | | |
| CE | Yes | | | | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | | | | |
| UL | cULus E115267 Industrial control equipment | | | | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | - | | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | | | | |
| KR | Yes | | | | |
| EAC | Yes | - | | Yes | - |
| Voltage inputs | | | | | |
| Number of phases | 3 | | | | |
| Input impedance | 1.68 MΩ | | | | |
| Nominal voltage U _N | | | | | |
| Between phases | Max. 480 VAC ²⁾ | | | | |
| Phase to N | Max. 277 VAC | | | | |
| Max. display value | 655 VAC | | | | |
| Resolution | 10 mV, with voltage connected directly | | | | |
| Rated frequency | 50 and 60 Hz | | | | |
| Measurable frequency | | | | | |
| Measurement range | 45 to 65 Hz | | | | |
| Accuracy | 0.01 Hz | | | | |
| Current inputs | | | | | |
| Quantity | 4 AC inputs | | | | |
| Nominal current I _N | | | | | |
| Secondary | 20 mA | 1 A | | 5 A | |
| Primary | 65 A directly configurable, larger values through conversion in the application ³⁾ | | | | |
| Max. overload current | 20 x I _N for 0.5 s | 8 x I _N for 0.5 s | | | |
| Max. measurement current | 20 mA | 1 A | | 5 A | |
| Resolution | 1 mA, based on the primary current ³⁾ | | | | |
| Load | 25 Ω | 500 mΩ | | 20 mΩ | |
| Measurement precision ⁴⁾ | | | | | |
| U _{RMS} | ±0.65% ⁵⁾ | | | | |
| I _{RMS} | ±0.65% ⁶⁾ | ±0.65% ⁷⁾ | | ±1.65% (Rev. <E0) ±0.70% (Rev. ≥E0) ⁸⁾ | ±0.70% ⁸⁾ |
| Effective, reactive and apparent power | ±0.80% ⁹⁾ | ±0.80% ¹⁰⁾ | | ±1.80% (Rev. <E0) ±0.85% (Rev. ≥E0) ¹¹⁾ | ±0.85% ¹¹⁾ |
| Frequency, power factor and phase angle | ±0.50% ¹²⁾ | | | | |
| Active energy per phase and total ¹³⁾ | ±0.40% ⁹⁾ | ±0.40% ¹⁰⁾ | | ±1.40% (Rev. <E0) ±0.45% (Rev. ≥E0) ¹¹⁾ | ±0.45% ¹¹⁾ |
| Active energy of fundamental frequency per phase and total ¹³⁾ | ±0.50% ⁹⁾ | ±0.50% ¹⁰⁾ | | ±1.50% (Rev. <E0) ±0.55% (Rev. ≥E0) ¹¹⁾ | ±0.55% ¹¹⁾ |
| Active energy of harmonics per phase and total ¹³⁾ | ±0.80% ⁹⁾ | ±0.80% ¹⁰⁾ | | ±1.80% (Rev. <E0) ±0.85% (Rev. ≥E0) ¹¹⁾ | ±0.85% ¹¹⁾ |

Table 87: X20AP3111, X20AP3121, X20cAP3121, X20AP3131, X20cAP3131 - Technical data

| Model number | X20AP3111 | X20AP3121 | X20cAP3121 | X20AP3131 | X20cAP3131 |
|--|--|---|---|---|---|
| Reactive energy per phase and total ¹⁴⁾ | ±0.50% ⁹⁾ | ±0.50% ¹⁰⁾ | | ±1.50% (Rev. <E0) ±0.55% (Rev. ≥E0) ¹¹⁾ | ±0.55% ¹¹⁾ |
| Apparent energy | | | | | |
| Per phase and arithmetic total | ±0.50% ⁹⁾ | ±0.50% ¹⁰⁾ | | ±1.50% (Rev. <E0) ±0.55% (Rev. ≥E0) ¹¹⁾ | ±0.55% ¹¹⁾ |
| Vector sum | ±0.80% ⁹⁾ | ±0.80% ¹⁰⁾ | | ±1.80% (Rev. <E0) ±0.85% (Rev. ≥E0) ¹¹⁾ | ±0.85% ¹¹⁾ |
| Electrical properties | | | | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | | | | |
| Operating conditions | | | | | |
| Mounting orientation | | | | | |
| Horizontal | Yes | | | | |
| Vertical | Yes | | | | |
| Installation elevation above sea level | | | | | |
| 0 to 2000 m | No limitation | | | | |
| >2000 m | Not permitted | | | | |
| Degree of protection per EN 60529 | IP20 | | | | |
| Ambient conditions | | | | | |
| Temperature | | | | | |
| Operation | | | | | |
| Horizontal mounting orientation | -25 to 60°C | | | | |
| Vertical mounting orientation | -25 to 50°C | | | | |
| Derating | - | See section "Derating". | | | |
| Storage | -40 to 85°C | | | | |
| Transport | -40 to 85°C | | | | |
| Relative humidity | | | | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing | 5 to 95%, non- condensing | Up to 100%, condensing | |
| Storage | 5 to 95%, non-condensing | | | | |
| Transport | 5 to 95%, non-condensing | | | | |
| Mechanical properties | | | | | |
| Note | Order 1x terminal block X20TB32 separately. Order 1x bus module X20BM32 separately. | Order 1x terminal block X20T-B32 separately. Order 1x bus module X20cB-M32 separately. | Order 1x terminal block X20T-B32 separately. Order 1x bus module X20cB-M32 separately. | Order 1x terminal block X20T-B32 separately. Order 1x bus module X20BM32 separately. | Order 1x terminal block X20T-B32 separately. Order 1x bus module X20cB-M32 separately. |
| Pitch | 25 ^{+0.2} mm | | | | |

Table 87: X20AP3111, X20AP3121, X20cAP3121, X20AP3131, X20cAP3131 - Technical data

- 1) Power dissipation of current measurement shunts
- 2) The design of the module allows 480 VAC to be applied to the terminal block.
- 3) For measuring higher current values, see section "Current transformer - Pinout".
- 4) Based on the current measured value.
The actual error value percentage may be larger due to the digital display.
- 5) With drift of 25 ppm/K
- 6) With drift of 50 ppm/K
- 7) With drift of 35 ppm/K
- 8) With drift of 225 ppm/K (Rev. < E0) or 100 ppm/K (Rev. ≥ E0)
- 9) With drift of 75 ppm/K
- 10) With drift of 60 ppm/K
- 11) With drift of 250 ppm/K (Rev. < E0) or 125 ppm/K (Rev. ≥ E0)
- 12) In power systems with approximately sinusoidal voltage starting at 10 VAC.
- 13) At power factor $\cos \phi = 1, 0.5L$ and $0.8C$
- 14) At reactive power factor $\sin \phi = 1, 0.5L$ and $0.8C$

9.1.24.4.2 X20AP3122 and X20AP3132

| Model number | X20AP3122 | X20AP3132 |
|---|---|----------------------------|
| Short description | 3-phase power and energy metering module for current transformers, groundable on one side | |
| General information | | |
| B&R ID code | 0xE7BF | 0xE7C0 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnosics | | |
| Module run/error | Yes, using LED status indicator and software | |
| Inputs | Yes, using LED status indicator and software | |
| Power consumption | | |
| Bus | 0.85 W (Rev. <C0) 0.50 W (Rev. =C0) 0.45 W (Rev. >C0) | |
| Internal I/O | - | |
| Additional module power dissipation [W] | 2 W ¹⁾ | |
| Isolation voltages | | |
| Voltage inputs - Current inputs | Tested at 1300 VAC, 1 min | |
| Inputs - Bus / I/O power supply | Tested at 5500 VDC, 1 min | |
| Inputs - Ground | Tested at 5500 VDC, 1 min | |
| Bus / I/O power supply - Ground | Tested at 510 VAC, 1 min | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| EAC | Yes | |
| Voltage inputs | | |
| Number of phases | 3 | |
| Input impedance | 1.68 M Ω | |
| Measurement category | CAT II | |
| Nominal voltage U _N | | |
| Between phases | Max. 480 VAC ²⁾ | |
| Phase to N | Max. 277 VAC | |
| Max. display value | 655 VAC | |
| Resolution | 10 mV, with voltage connected directly | |
| Rated frequency | 50 and 60 Hz | |
| Measurable frequency | | |
| Measurement range | 45 to 65 Hz | |
| Accuracy | 0.01 Hz | |
| Current inputs | | |
| Quantity | 4 AC inputs | |
| Measurement category | CAT II | |
| Nominal current I _N | | |
| Secondary | 1 A | 5 A |
| Primary | 65 A directly configurable, larger values through conversion in the application ³⁾ | |
| Max. overload current | 8 x I _N for 0.5 s | |
| Max. measurement current | 1 A | 5 A |
| Resolution | 1 mA, based on the primary current ³⁾ | |
| Load | 250 m Ω | 20 m Ω |
| Measurement precision ⁴⁾ | | |
| U _{RMS} | $\pm 0.65\%$ ⁵⁾ | |
| I _{RMS} | $\pm 0.65\%$ ⁶⁾ | $\pm 0.65\%$ ⁵⁾ |
| Effective, reactive and apparent power | $\pm 0.80\%$ ⁷⁾ | $\pm 0.80\%$ ⁸⁾ |
| Frequency, power factor and phase angle | $\pm 0.50\%$ ⁹⁾ | |
| Active energy per phase and total ¹⁰⁾ | $\pm 0.40\%$ ⁷⁾ | $\pm 0.40\%$ ⁸⁾ |
| Active energy of fundamental frequency per phase and total ¹⁰⁾ | $\pm 0.50\%$ ⁷⁾ | $\pm 0.50\%$ ⁸⁾ |
| Active energy of harmonics per phase and total ¹⁰⁾ | $\pm 0.80\%$ ¹¹⁾ | $\pm 0.80\%$ ⁸⁾ |
| Reactive energy per phase and total ¹²⁾ | $\pm 0.50\%$ ⁷⁾ | $\pm 0.50\%$ ⁸⁾ |
| Apparent energy | | |
| Per phase and arithmetic total | $\pm 0.50\%$ ⁷⁾ | $\pm 0.50\%$ ⁸⁾ |
| Vector sum | $\pm 0.80\%$ ⁷⁾ | $\pm 0.80\%$ ⁸⁾ |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |

Table 88: X20AP3122, X20AP3132 - Technical data

| Model number | X20AP3122 | X20AP3132 |
|--|-----------|--|
| Installation elevation above sea level | | |
| 0 to 2000 m | | No limitation |
| >2000 m | | Not permitted |
| Degree of protection per EN 60529 | | IP20 |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | | -25 to 60°C |
| Vertical mounting orientation | | -25 to 50°C |
| Derating | | - |
| Storage | | -40 to 85°C |
| Transport | | -40 to 85°C |
| Relative humidity | | |
| Operation | | 5 to 95%, non-condensing |
| Storage | | 5 to 95%, non-condensing |
| Transport | | 5 to 95%, non-condensing |
| Mechanical properties | | |
| Note | | Order 1x terminal block X20TB32 separately. Order 1x bus module X20BM32 separately. |
| Pitch | | 25 ^{+0.2} mm |

Table 88: X20AP3122, X20AP3132 - Technical data

- 1) Power dissipation of current measurement shunts
- 2) The design of the module allows 480 VAC to be applied to the terminal block.
- 3) For measuring higher current values, see section "Current transformer - Pinout".
- 4) Based on the current measured value.
The actual error value percentage may be larger due to the digital display.
- 5) With drift of 25 ppm/K
- 6) With drift of 100 ppm/K
- 7) With drift of 125 ppm/K
- 8) With drift of 50 ppm/K
- 9) In power systems with approximately sinusoidal voltage starting at 10 VAC.
- 10) At power factor $\cos \phi = 1, 0.5L$ and $0.8C$
- 11) With drift of 125 ppm/K (Rev. <D0) or 40 ppm/K (Rev. $\geq D0$)
- 12) At reactive power factor $\sin \phi = 1, 0.5L$ and $0.8C$

9.1.24.4.3 X20AP3161 and X20AP3171

| Model number | X20AP3161 | X20AP3171 |
|--|--|--|
| Short description | | |
| I/O module | 3-phase power and energy metering module for current/voltage transformers | 3-phase power and energy metering module for Rogowski current transformers |
| General information | | |
| B&R ID code | 0xE17B | 0xE7C1 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using LED status indicator and software | |
| Inputs | Yes, using LED status indicator and software | |
| Power consumption | | |
| Bus | 0.85 W (Rev. <D0) 0.50 W (Rev. =D0) 0.45 W (Rev. >D0) | 0.85 W (Rev. <C0) 0.50 W (Rev. =C0) 0.45 W (Rev. >C0) |
| Internal I/O | - | |
| Additional module power dissipation [W] | - 1) | |
| Isolation voltages | | |
| Current inputs / Neutral conductor - Ground | - | Tested at 2300 VAC, 1 min |
| Voltage inputs / Neutral conductor - Ground | - | Tested at 3700 VAC, 1 min |
| Current inputs / Neutral conductor - Bus / I/O power supply | - | Tested at 2300 VAC, 1 min |
| Voltage inputs / Neutral conductor - Bus / I/O power supply | - | Tested at 3700 VAC, 1 min |
| Inputs - Bus / I/O power supply | Tested at 5500 VDC, 1 min | |
| Inputs - Ground | Tested at 5500 VDC, 1 min | |
| Bus / I/O power supply - Ground | Tested at 510 VAC, 1 min | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | - |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | - |
| KR | Yes | - |
| EAC | | Yes |
| Voltage inputs | | |
| Number of phases | 3 | |
| Input impedance | 1.68 MΩ | |
| Measurement category | - | CAT II |
| Nominal voltage U _N | | |
| Between phases | Max. 480 VAC ²⁾ | |
| Phase to N | Max. 277 VAC | |
| Max. display value | 655 VAC | |
| Resolution | 10 mV, with voltage connected directly | |
| Rated frequency | 50 and 60 Hz | |
| Measurable frequency | | |
| Measurement range | 45 to 65 Hz | |
| Accuracy | 0.01 Hz | |
| Current inputs | | |
| Quantity | 4 AC inputs | |
| Measurement category | - | CAT II |
| Nominal voltage (secondary) | 333 mV | Configurable in μV/A |
| Nominal current (primary) | 65 A directly configurable, larger values through conversion in the application ³⁾ | |
| Max. overload current | - | |
| Max. measurement voltage | 333 mV | 52 mV |
| Resolution | 1 mA, based on the primary current ³⁾ | |
| Load | - | |
| Measurement precision ⁴⁾ | | |
| U _{RMS} | ±0.65% ⁵⁾ | |
| I _{RMS} | ±0.65% | ±0.85% ⁶⁾ |
| Effective, reactive and apparent power | ±0.80% ⁵⁾ | ±1.00% |
| Frequency, power factor and phase angle | ±0.50% ⁷⁾ | |
| Active energy per phase and total ⁸⁾ | ±0.40% ⁵⁾ | ±0.60% ⁵⁾ |
| Active energy of fundamental frequency per phase and total ⁸⁾ | ±0.50% ⁵⁾ | ±0.70% ⁵⁾ |

Table 89: X20AP3161, X20AP3171 - Technical data


| Model number | X20AP3161 | X20AP3171 |
|--|--|----------------------|
| Active energy of harmonics per phase and total ⁸⁾ | ±0.80% ⁵⁾ | ±1.00% ⁵⁾ |
| Reactive energy per phase and total ⁹⁾ | ±0.50% ⁵⁾ | ±0.70% ⁵⁾ |
| Apparent energy | | |
| Per phase and arithmetic total | ±0.50% ⁵⁾ | ±0.70% ⁵⁾ |
| Vector sum | ±0.80% ⁵⁾ | ±1.00% ⁵⁾ |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitation | |
| >2000 m | Not permitted | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x terminal block X20TB32 separately. Order 1x bus module X20BM32 separately. | |
| Pitch | 25 ^{+0.2} mm | |

Table 89: X20AP3161, X20AP3171 - Technical data

- 1) Shunts are external current transformers
- 2) The design of the module allows 480 VAC to be applied to the terminal block.
- 3) For measuring higher current values, see section "Current transformer - Pinout".
- 4) Based on the current measured value.
The actual error value percentage may be larger due to the digital display.
- 5) With drift of 25 ppm/K
- 6) At URogowski > 1 mVRMS
- 7) In power systems with approximately sinusoidal voltage starting at 10 VAC.
- 8) At power factor $\cos \phi = 1, 0.5L$ and $0.8C$
- 9) At reactive power factor $\sin \phi = 1, 0.5L$ and $0.8C$

9.1.24.5 LED status indicators

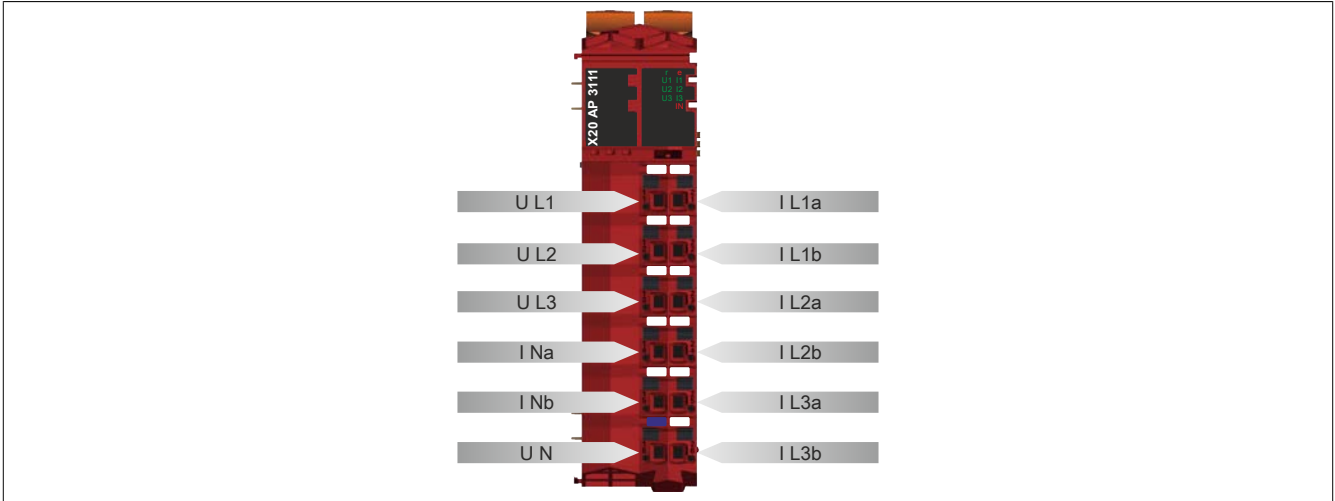
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-----------------------------|--------------|--|--|
|  | Operating state | | | |
| | r | Green | Off | No power to module |
| | | | Single flash | UNLINK mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking quickly | SYNC mode |
| | | | Blinking slowly | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | Module status | | | |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | Analog input voltage | | | |
| | U1 - U3 | Green/Yellow | Off | Display disabled or $U_{Eff} < \text{threshold value}$ "Failure" |
| | | | Blinking | Phase sequence is correct and $U_{Eff} < \text{threshold value}$ "Warning" |
| | | Green | On | Phase sequence is correct and $U_{Eff} > \text{threshold value}$ "Warning" |
| | | | Blinking | Phase sequence is incorrect and $U_{Eff} < \text{threshold value}$ "Warning" |
| | | | On | Phase sequence is incorrect and $U_{Eff} > \text{threshold value}$ "Warning" |
| | Yellow | Blinking | Phase sequence is incorrect and $U_{Eff} < \text{threshold value}$ "Warning" | |
| | | On | Phase sequence is incorrect and $U_{Eff} > \text{threshold value}$ "Warning" | |
| | Analog input current | | | |
| | I1 - I3 | Green/Yellow | Off | Display disabled or $I_{Eff} < \text{threshold value}$ "Display" |
| On | | | Active power positive | |
| Yellow | | On | Active power negative | |
| Analog input neutral current | | | | |
| IN | | Off | Neutral current < Threshold value | |
| | Green | On | Neutral current > Threshold value "Failure", within the tolerance of the calculated total current | |
| | Red | On | Neutral current > Threshold value "Failure", outside the tolerance of the calculated total current | |

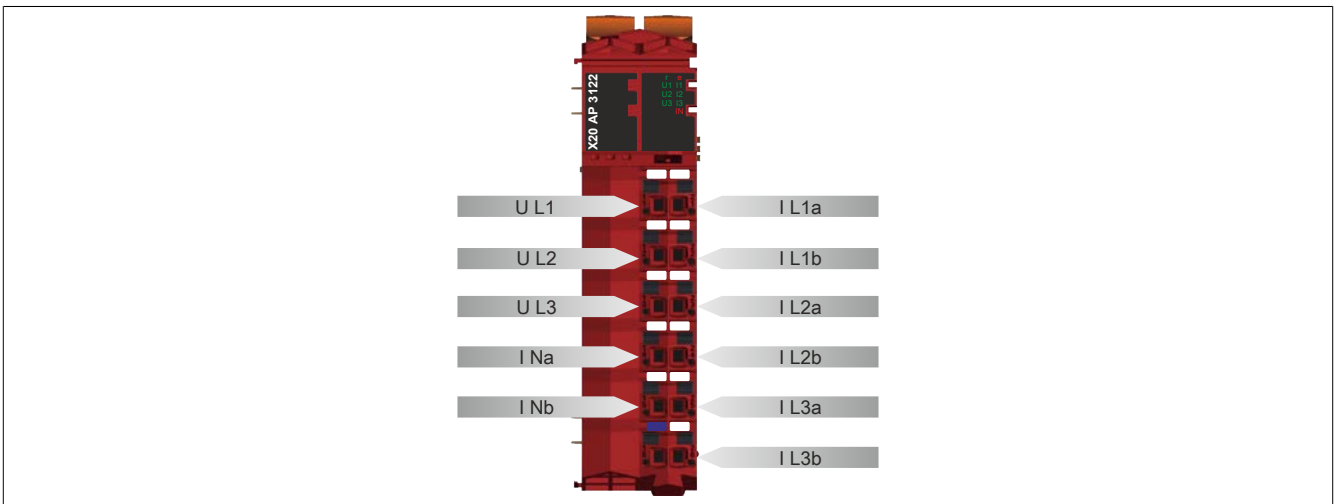
1) Depending on the configuration, a firmware update can take up to several minutes.

9.1.24.6 Pinout

X20AP31x1



X20AP31x2



Danger!

Risk of electric shock!

The terminal block is only permitted to conduct voltage when it is connected. It is not permitted to be disconnected or connected while voltage is applied or have voltage applied to it while it is removed under any circumstances.

This module is not permitted to be the last module connected on the X2X Link network. At least one subsequent X20ZF dummy module must provide protection against contact.

Shielding

Shielded cables must be used for the current channels of module X20AP3171 in order to maintain the specified accuracy. Cabling can either take place using one cable per channel or a multiple twisted pair cable for multiple channels.

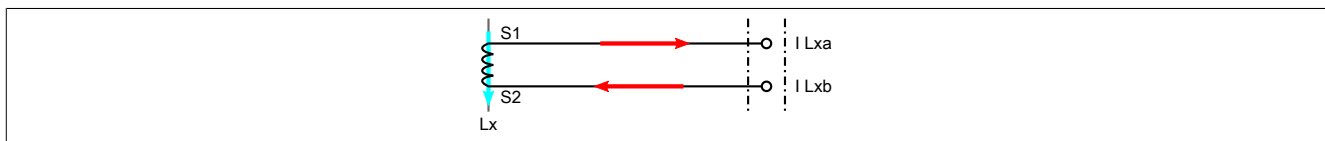
Information:

Shielded cables must be grounded on both sides.

9.1.24.6.1 Connecting current transformers

In order to be able to properly calculate values, it is important for the current transformer phases to be connected correctly (i.e. direction of the current flow).

- Output on the transformer (S1) to the respective ILxa input on the module.
- Input on the transformer (S2) to the respective ILxb output on the module.



9.1.24.7 Safety guidelines

General

Information:

If the maximum voltage value of 655 V is displayed, it is necessary to check whether the input measurement range has been exceeded.

Caution!

The insulation for all current inputs must be double or reinforced.

X20AP31x2

X20AP31x2 modules with current transformers that are groundable meet the requirement from the median voltage guideline that states that a current transformer connection must always be grounded in systems that exceed a certain system voltage.

Caution!

Only a connection labeled "ILxb" is permitted to be grounded.

Caution!

The use of modules with current transformers that groundable is only permitted in systems with grounded median voltage. Operating these modules without connected grounding is not permitted.

Information:

Because these modules do not feature a neutral conductor connection, the ground potential on the current transformer connections forms the central reference point. (See ["Input circuit diagram" on page 673.](#))

Danger!

In the event of a fault (e.g. a break in insulation), further insulating measures have to be taken in addition to the basic insulation between voltage and current inputs on the module.

To avoid electric shocks, the wiring to the module must have adequate insulation. The dielectric strength of the cable insulation **MUST** be designed for the level of phase-to-phase nominal voltage.

9.1.24.8 Current transformers

Since the current inputs are not floating, a current transformer is required for each current channel used. The current transformer is a transducer that delivers a secondary signal proportional to the primary current. This secondary signal is measured by the module. The maximum directly configurable primary current is 65 A. Values greater than 65 A can also be measured by implementing a conversion in the software application (see explanation and example provided below).

The maximum secondary signal depends on the module:

| Module | Secondary current/voltage |
|-----------|-----------------------------|
| X20AP3111 | 20 mA |
| X20AP3121 | 1 A |
| X20AP3122 | 1 A |
| X20AP3131 | 5 A |
| X20AP3132 | 5 A |
| X20AP3161 | 333 mV |
| X20AP3171 | Configurable, maximum 52 mV |

The rated transformation ratio is calculated using the following formula:

| | |
|--|--|
| X20AP3111 - X20AP3121 - X20AP3131 - X20AP3122 - X20AP3132 | Rated transformation ratio $K_n = \frac{\text{Primary nominal current}}{\text{Secondary nominal current}}$ |
| X20AP3161 | No transformation; the maximum primary current corresponds to the 333 mV. |
| X20AP3171 | Direct input of $\mu\text{V/A}$ |

A smaller transformation ratio should be defined for measuring higher primary currents. The values calculated by the module must be converted in the application according to the real rated transformation ratio that must be defined.

Examples

Information:

The same factor must be used for all power ratings and energy values when making the conversion.

All AP modules except for AP3171

Currents of up to 100 A flow on the primary side. A current transformer with a rated transformation ratio of 100 to 1 A or a measurement range of 100 A is used. A rated transformation ratio of 50 to 1 A or a measurement range of 50 A is defined in the module to match the current transformer. If the primary current calculated by the module is 40 A, then the actual value will be calculated as follows:

$$\text{Actual primary current} = 40 \text{ A} * 100 / 50 = 80 \text{ A}$$

$$\text{Actual resolution} = 1 \text{ mA} * 100 / 50 = 2 \text{ mA}$$

X20AP3171

Because the primary current can be up to 300 A, a Rogowski coil with a primary current range of up to 500 A is used. This exhibits a transformation ratio of 500 $\mu\text{V/A}$. Suitable for this, a transformation ratio of 5000 $\mu\text{V/A}$ is set in the module.

The module returns a value of 8155 mA.

$$\text{Actual primary current} = 5000 \mu\text{V/A} / 500 \mu\text{V/A} * 8.155 \text{ A} = 81.55 \text{ A}$$

$$\text{Actual resolution} = 1 \text{ mA} * 5000 \mu\text{V/A} / 500 \mu\text{V/A} = 10 \text{ mA}$$

Caution!

To avoid damage to the module, ensure that the current inputs are floating. A current transformer must therefore be connected to each current input used.

Any other devices connected to this secondary circuit must be galvanically isolated.

X20AP31x1:

The current inputs on the module are not galvanically isolated, so the secondary circuit between the transformer and the module is not permitted to be grounded. Grounding or making other conductive connections between the transformers distorts the measurement and results in current values that are too low!

X20AP31x2:

Because the "ILxb" connections on the current inputs are all on the same electric potential, all the transformers on the "Lxb" side groundable for these modules.

9.1.24.9 Voltage transformer

Voltage transformers are not provided in the configuration by default (e.g. by setting the transformation ratio).

However, voltage transformers can be used if higher voltages need to be measured than are specified under nominal voltages in the technical data.

In addition, as with current value correction, the rated transformation between primary and secondary current must be calculated and applied (see "[Current transformers](#)" on page 671)

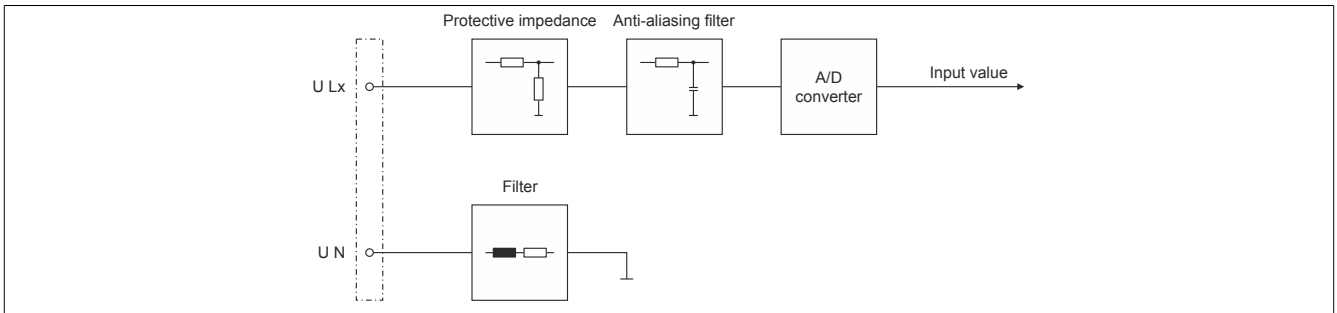
Information:

The same factor must be used for all voltage values, power ratings and energy values when making the transformation.

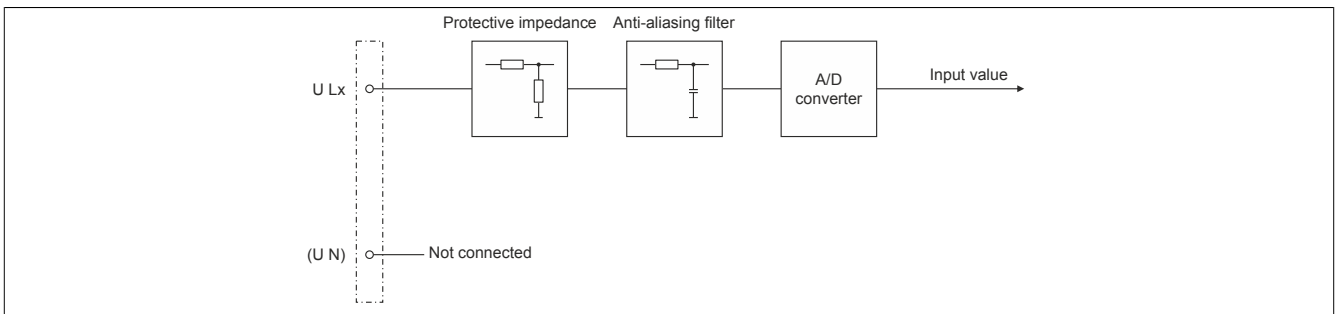
9.1.24.10 Input circuit diagram

AC voltage inputs

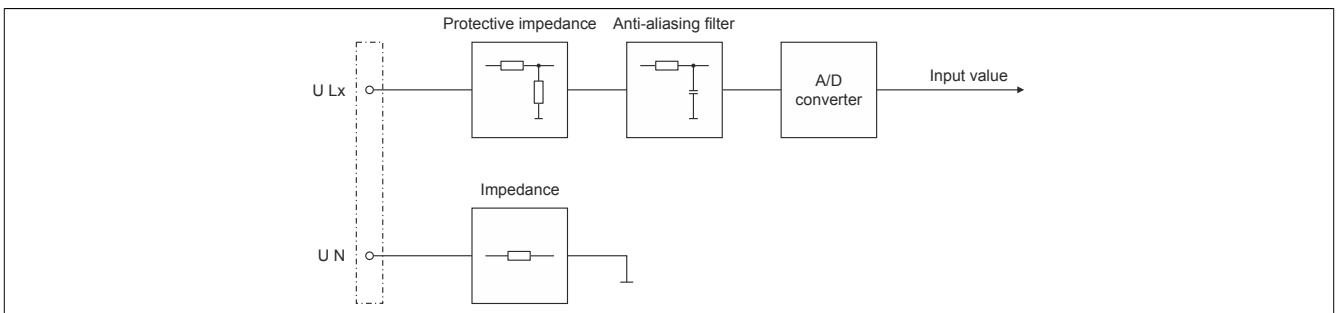
AP3111, AP3121, AP3131, AP3161



AP3122, AP3132

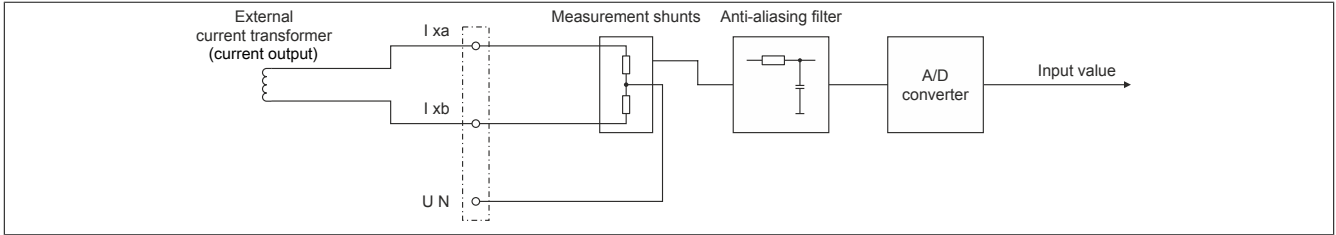


AP3171

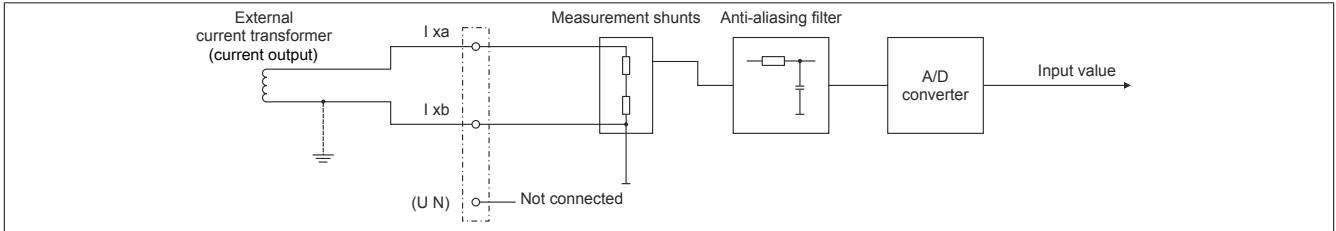


AC current inputs

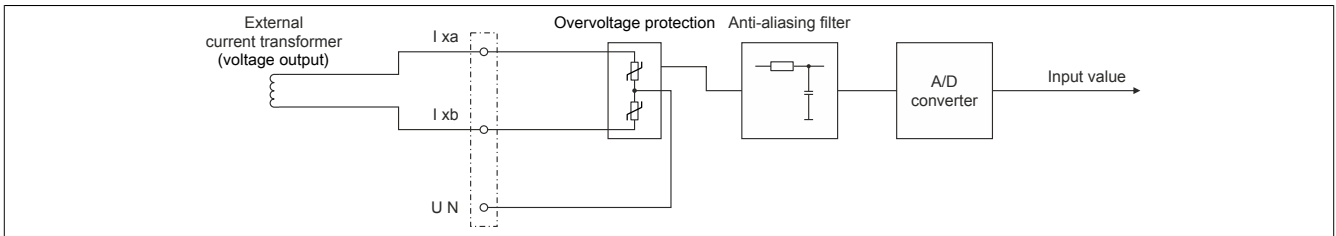
AP3111, AP3121, AP3131: (Current measurement)



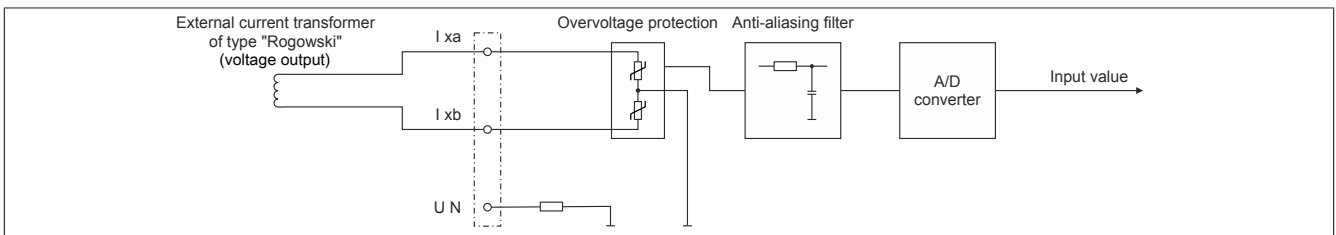
AP31x2: (Current measurement)



AP3161: (Voltage measurement)



AP3171: (Voltage measurement)



9.1.24.11 Typical connection examples for different network configurations

General information

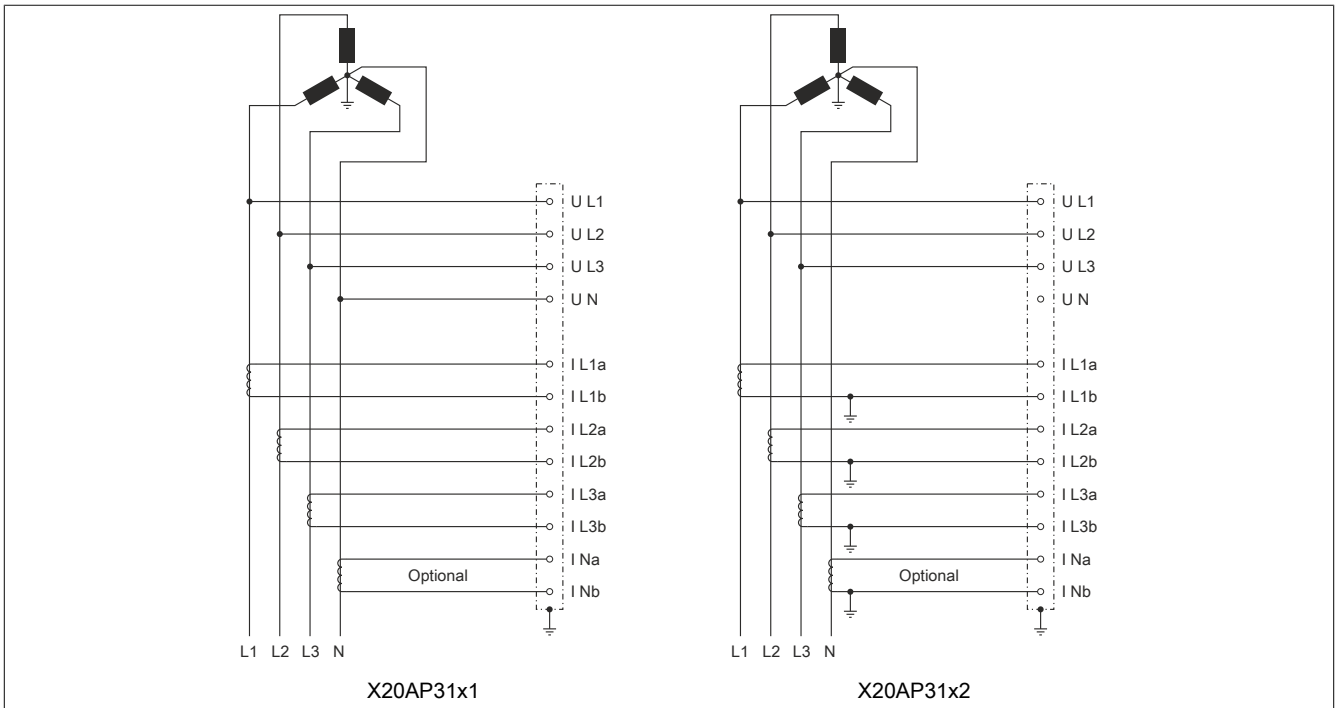
There are many different network configurations around the world. This section will present a few typical connection examples.

Notice!

The X20AP31x2 modules may not be used with network configurations B, D and F due to a lack of grounding.

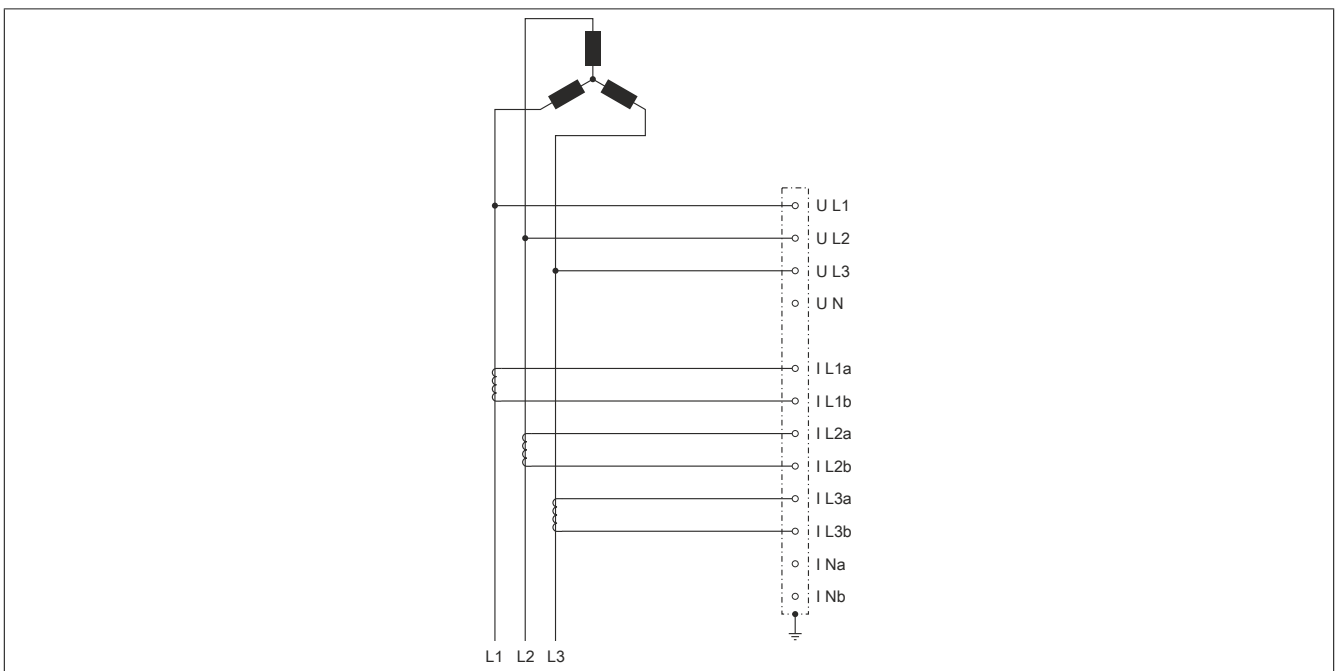
Connection example 1 - Network A

This example involves a 3-element, 3-phase, 4-line star measurement with grounded neutral conductor and optional fault current detection.



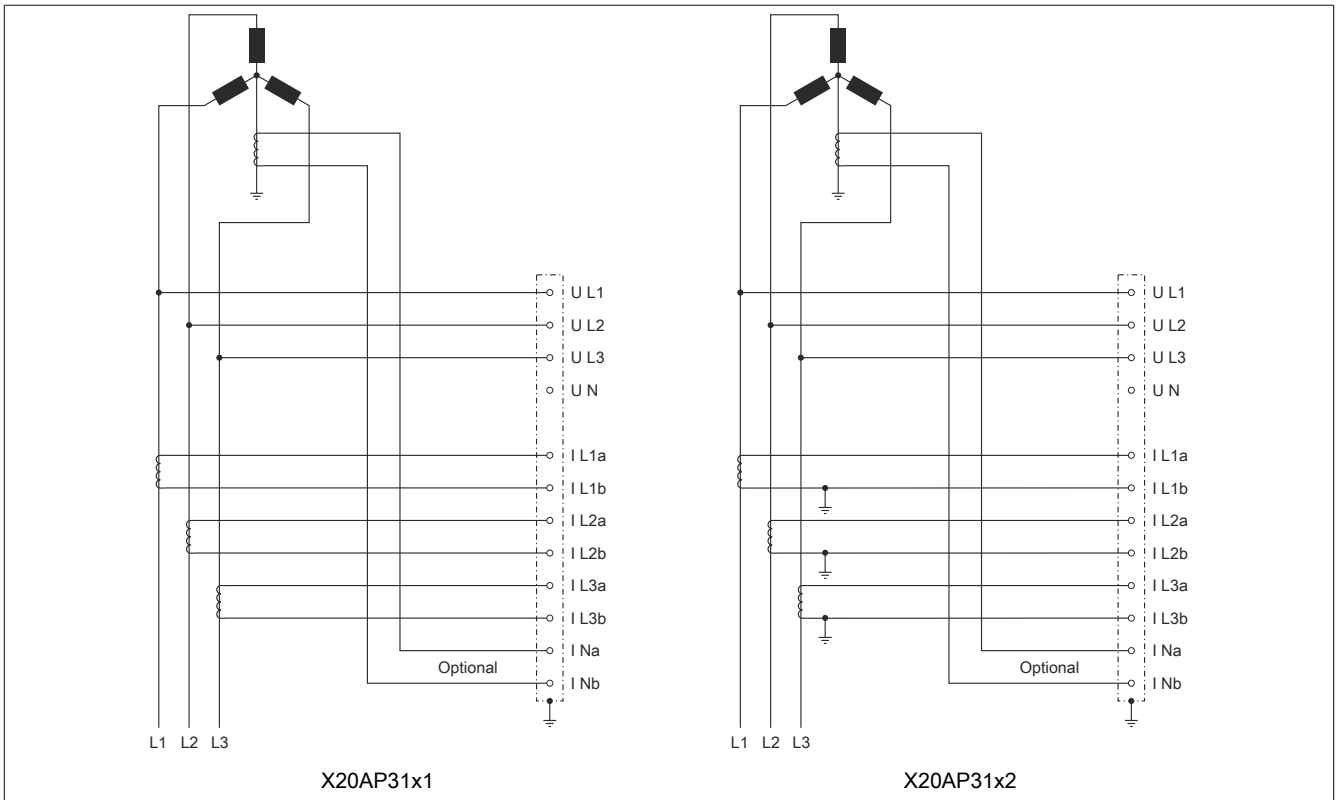
Connection example 2 - Network B

This example involves a 3-element, 3-phase, 3-line star measurement.



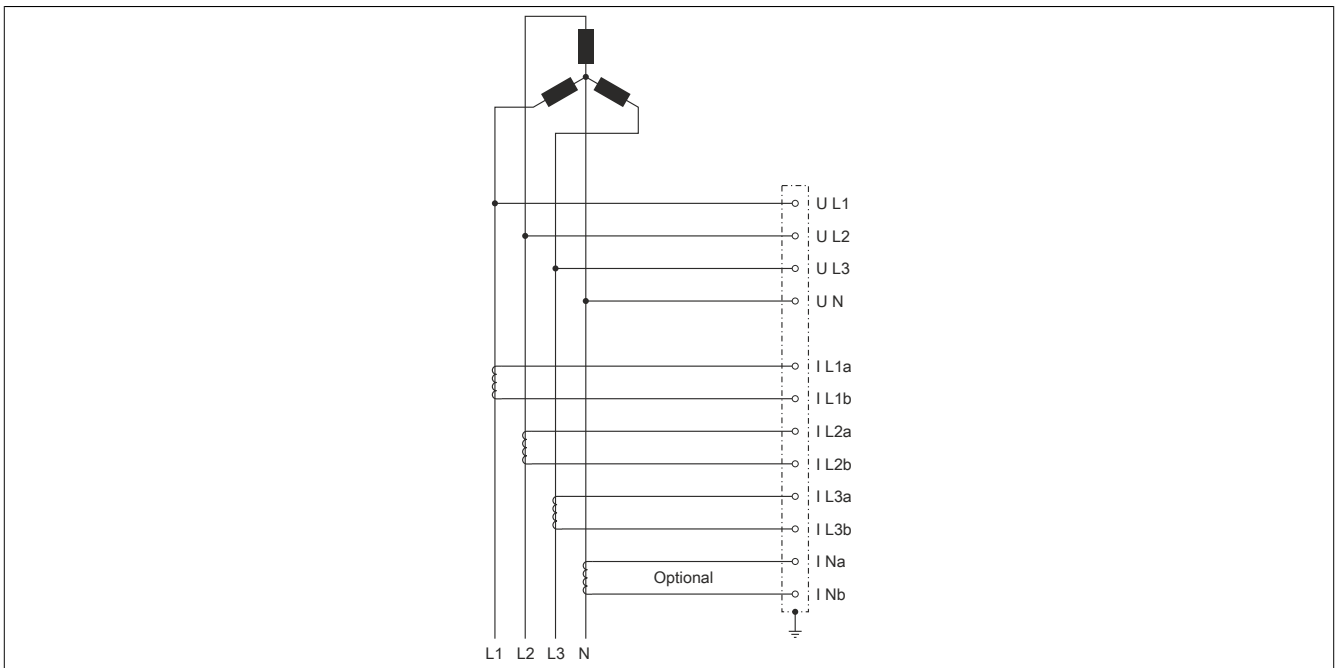
Connection example 3 - Network C

This example involves a 3-element, 3-phase, 3-line star measurement with grounded neutral conductor and optional fault current detection.



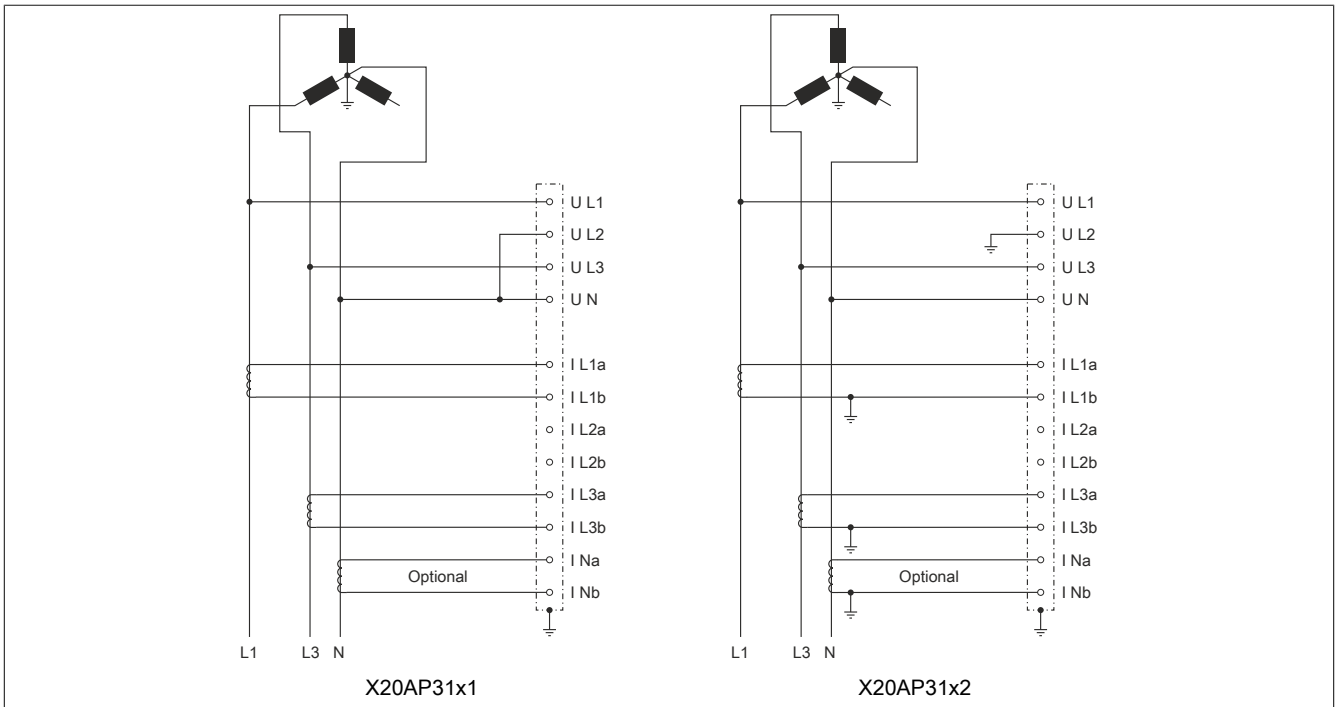
Connection example 4 - Network D

This example involves a 3-element, 3-phase, 4-line star measurement with optional fault current detection.



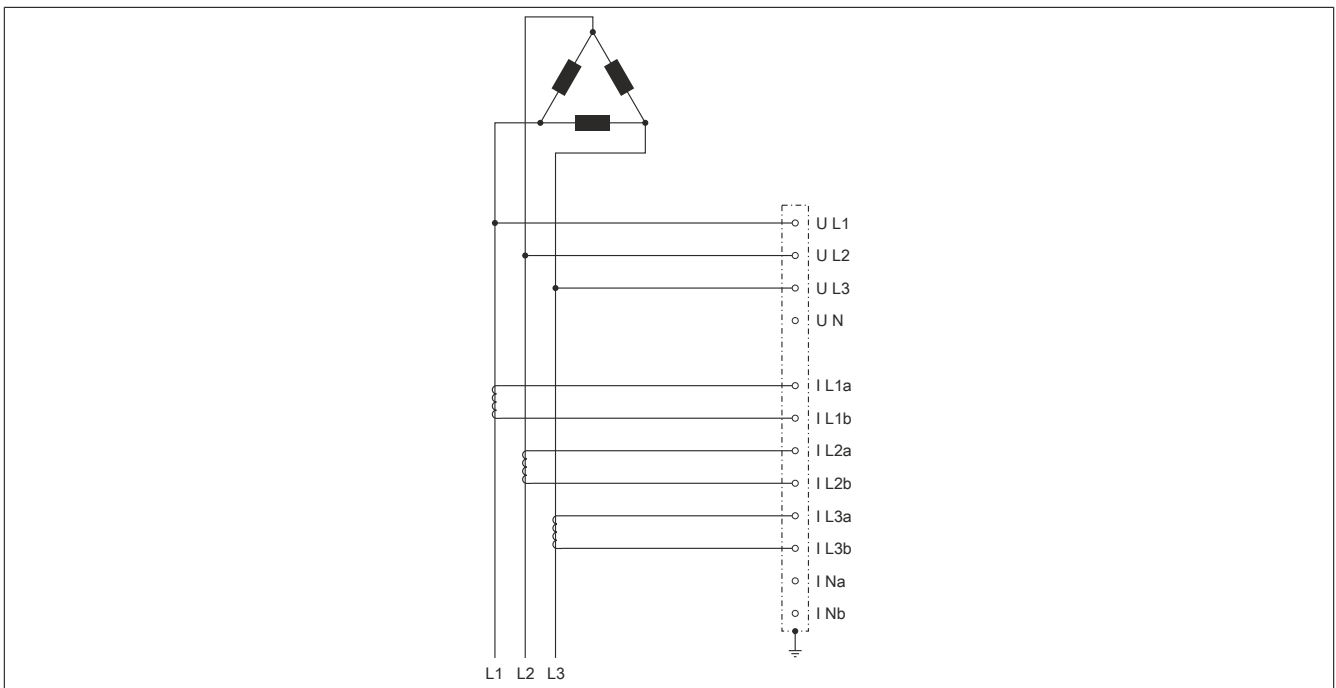
Connection example 5 - Network E

This example involves a 2-element, 2-phase, 3-line star measurement with grounded neutral conductor.



Connection example 6 - Network F

This example involves a 3-element, 3-phase, 3-line delta measurement.

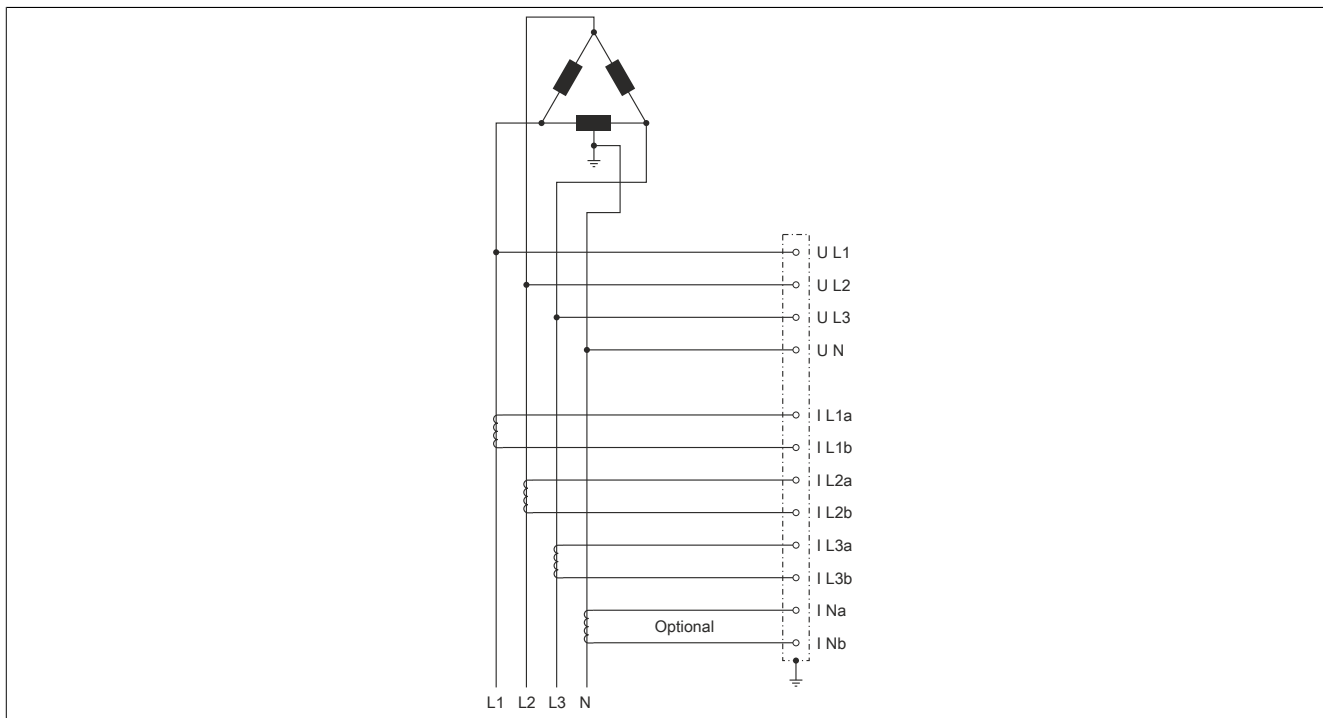


Connection example 7 - Network G

This example involves a 3-element, 3-phase, 4-line, delta measurement with grounded star point.

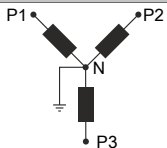
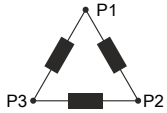
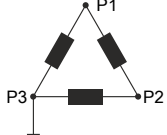

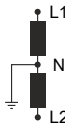
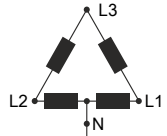
Information:

Exceeding the maximum voltage value specified in the data sheet is not permitted!



9.1.24.12 Permitted line-to-line nominal voltages (rated voltages)

The following table provides an overview of the maximum permitted line-to-line nominal voltage (rated voltage) depending on the used mains type and module.

| Network configuration | Network type | Modules | Permissible rated voltage | |
|-----------------------|---|---|---------------------------|-------|
| 1 | 3 phases 4 lines Grounded neutral conductor |  | All AP modules | 480 V |
| 2 | 3 phases 3 lines Not grounded |  | X20AP31x1 | 480 V |
| | | X20AP31x2 | Not permitted | |
| 3 | 3 phases 4 lines Grounded phase |  | X20AP31x1 | 480 V |
| | | X20AP21x2 | Not permitted | |
| 4 | 1 phase 2 lines Not grounded |  | X20AP31x1 | 480 V |
| | | X20AP31x2 | Not permitted | |
| 5 | 1 phase divided 3 lines Grounded neutral conductor |  | All AP modules | 480 V |
| 6 | 3 phases 4 lines Divided phase and grounded neutral conductor |  | All AP modules | 240 V |

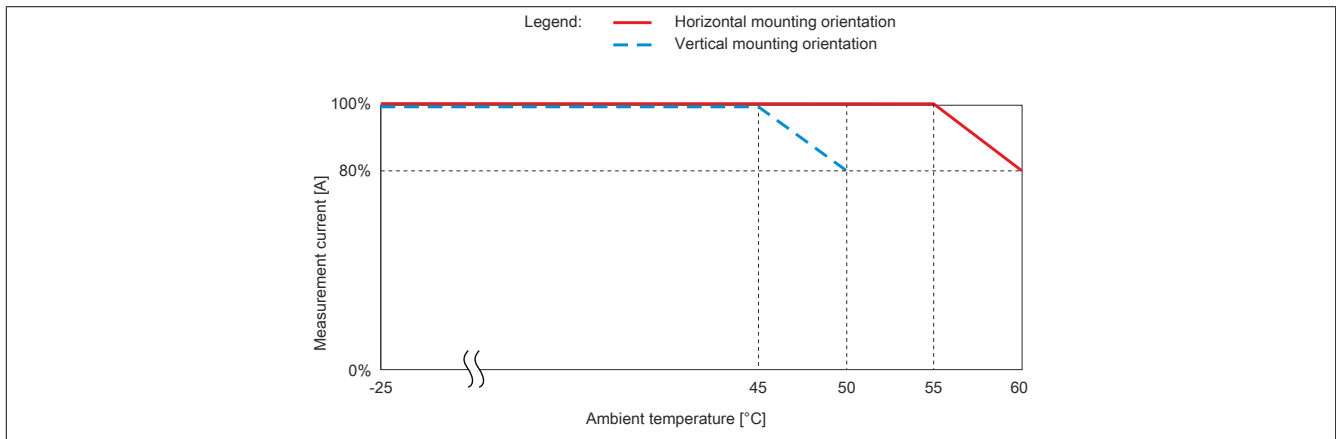
9.1.24.13 Derating

X20AP(c)3121, X20AP3131:

At high temperatures, the averaged measurement current is not permitted to exceed the percentage values of the diagram.

100% corresponds to 3x the nominal current of a channel. Averaging the measurement current is done in a time period of 10 minutes.

The derating listed below must be applied for the current:



9.1.24.14 UL certificate information

To install the module(s) according to the UL standard, the following rules must be observed.

Information:

- Use copper conductors only. Minimum temperature rating of the cable to be connected to the field wiring terminals: 76°C, xxx - xxx AWG.
- All models are intended to be used in a final safety enclosure that must conform with requirements for protection against the spread of fire and have adequate rigidity per UL 61010-1 and UL 61010-2-201.
- Repairs can only be made by B&R.

Information:

- For use with listed energy-monitoring current transformers only.
- The current transformers are not permitted to be installed in equipment where they exceed 75 percent of the wiring space of any cross-sectional area within the equipment
- Restrict installation of current transformer in an area where it would block ventilation openings.
- Restrict installation of current transformer in an area of breaker arc venting.
- Not suitable for Class 2 wiring methods.
- Not intended for connection to Class 2 equipment.
- Secure current transformer and route conductors so that they do not directly contact live terminals or bus.
- For use with listed energy-monitoring current transformers.
- Associated leads of the current transformers must be maintained within the same overall enclosure.
- Unless the current transformers and its leads have been evaluated for REINFORCED INSULATION, a statement to segregate or insulate the leads from different circuits must be provided.
- The current transformers are intended for installation within the same enclosure as the equipment. These are not permitted to be installed within switchgear and panel boards.

Danger!

- To reduce the risk of electric shock, always open or disconnect circuit from the power distribution system (or service) of the building before installing or servicing current-sensing transformers.

9.1.24.15 Register description

9.1.24.15.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.1.24.15.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|---------------------------------------|----------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Status register | | | | | | |
| 130 | StatusInput | UINT | • | | | |
| | CntPulseActive | Bit 0 | | | | |
| | CntPulseApparent | Bit 1 | | | | |
| | CntPulseActiveFund | Bit 2 | | | | |
| | CntPulseActiveHarm | Bit 3 | | | | |
| | ZeroCrossA | Bit 4 | | | | |
| | ZeroCrossB | Bit 5 | | | | |
| | ZeroCrossC | Bit 6 | | | | |
| | RBTrigDFT | Bit 8 | | | | |
| | RBUUpdateEnergy | Bit 9 | | | | |
| | RBClearEnergy | Bit 10 | | | | |
| RBForceEnergy | Bit 11 | | | | | |
| 194 | ControlOutput | UINT | | | • | |
| | TrigDFT | Bit 0 | | | | |
| | EnabEnergy | Bit 1 | | | | |
| | ClearEnergy | Bit 2 | | | | |
| | ForceEnergy | Bit 3 | | | | |
| 266 | SysStatus1 | UINT | • | | | |
| 270 | SysStatus2 | UINT | • | | | |
| 274 | SysStatus3 | UINT | • | | | |
| 278 | SysStatus4 | UINT | • | | | |
| 265 | SystemStatusSel01 | USINT | • | | | |
| | SumStatusPhaseLoss | Bit 2 | | | | |
| | SumStatusPhaseWarning | Bit 3 | | | | |
| | ErrOrderPhasecurrent | Bit 6 | | | | |
| | ErrOrderPhaseVoltage | Bit 7 | | | | |
| 271 | SystemStatusSel02 | USINT | • | | | |
| | SumStatusWarningTHDCurrent | Bit 2 | | | | |
| | SumStatusWarningTHDVoltage | Bit 3 | | | | |
| | ErrIrmsNCalc | Bit 6 | | | | |
| | ErrIrmsNMeas | Bit 7 | | | | |
| 278 | PhaseStatus | UINT | • | | | |
| | LossPhaseC | Bit 0 | | | | |
| | LossPhaseB | Bit 1 | | | | |
| | LossPhaseA | Bit 2 | | | | |
| | WarningPhaseC | Bit 4 | | | | |
| | WarningPhaseB | Bit 5 | | | | |
| | WarningPhaseA | Bit 6 | | | | |
| Analog RMS value registers | | | | | | |
| 290 | IrmsN (measured) | UINT | • | | | |
| 294 | UrmsA | UINT | • | | | |
| 298 | UrmsB | UINT | • | | | |
| 302 | UrmsC | UINT | • | | | |
| 306 | IrmsNcalc (calculated) | UINT | • | | | |
| 310 | IrmsA | UINT | • | | | |
| 314 | IrmsB | UINT | • | | | |
| 318 | IrmsC | UINT | • | | | |
| Analog THD and angle registers | | | | | | |
| 538 | Freq | UINT | • | | | |
| 542 | PAngleA | INT | • | | | |
| 546 | PAngleB | INT | • | | | |
| 550 | PAngleC | INT | • | | | |
| 554 | Temperature | INT | • | | | |
| 558 | UAngleA | INT | • | | | |
| 562 | UAngleB | INT | • | | | |
| 564 | UAngleC | INT | • | | | |
| Analog power registers | | | | | | |
| 778 | PmeanT | INT | • | | | |
| 782 | PmeanA | INT | • | | | |
| 786 | PmeanB | INT | • | | | |
| 790 | PmeanC | INT | • | | | |

| Register | Name | Data type | Read | | Write | |
|---|--------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 794 | QmeanT | INT | • | | | |
| 798 | QmeanA | INT | • | | | |
| 802 | QmeanB | INT | • | | | |
| 806 | QmeanC | INT | • | | | |
| 810 | SmeanT | INT | • | | | |
| 814 | SmeanA | INT | • | | | |
| 818 | SmeanB | INT | • | | | |
| 822 | SmeanC | INT | • | | | |
| 826 | PFmeanT | INT | • | | | |
| 830 | PFmeanA | INT | • | | | |
| 834 | PFmeanB | INT | • | | | |
| 838 | PFmeanC | INT | • | | | |
| Analog energy registers | | | | | | |
| 4108 | APenergyT | UDINT | • | | | |
| 4116 | APenergyA | UDINT | • | | | |
| 4124 | APenergyB | UDINT | • | | | |
| 4132 | APenergyC | UDINT | • | | | |
| 4140 | ANenergyT | UDINT | • | | | |
| 4148 | ANenergyA | UDINT | • | | | |
| 4156 | ANenergyB | UDINT | • | | | |
| 4164 | ANenergyC | UDINT | • | | | |
| 4172 | RPenergyT | UDINT | • | | | |
| 4180 | RPenergyA | UDINT | • | | | |
| 4188 | RPenergyB | UDINT | • | | | |
| 4196 | RPenergyC | UDINT | • | | | |
| 4204 | RNenergyT | UDINT | • | | | |
| 4212 | RNenergyA | UDINT | • | | | |
| 4220 | RNenergyB | UDINT | • | | | |
| 4228 | RNenergyC | UDINT | • | | | |
| 4236 | SAenergyT | UDINT | • | | | |
| 4244 | SEnergyA | UDINT | • | | | |
| 4252 | SEnergyB | UDINT | • | | | |
| 4260 | SEnergyC | UDINT | • | | | |
| 4268 | SVenergyT | UDINT | • | | | |
| 4404 | AEnergyT | DINT | • | | | |
| 4412 | REnergyT | DINT | • | | | |
| Module configuration | | | | | | |
| 1026 | ChanControl | UINT | | | | • |
| 1030 | IDispTh | UINT | | | | • |
| 1034 | I_RatioA | UINT | | | | • |
| 1038 | I_RatioB | UINT | | | | • |
| 1042 | I_RatioC | UINT | | | | • |
| 1046 | I_RatioN | UINT | | | | • |
| Update request | | | | | | |
| 1050 | CfgUpdate | UINT | | | | • |
| 1054 | Cs0Update | UINT | | | | • |
| 1058 | Cs1Update | UINT | | | | • |
| 1066 | Cs3Update | UINT | | | | • |
| 1570 | Cs1UpdateFB | UINT | | • | | |
| 1578 | Cs3UpdateFB | UINT | | • | | |
| A/D converter status configuration | | | | | | |
| 1090 | ZXConfig | UINT | | | | • |
| 1094 | SagTh | UINT | | | | • |
| 1098 | PhaseLoseTh | UINT | | | | • |
| 1102 | INWarnTh0 | UINT | | | | • |
| 1106 | INWarnTh1 | UINT | | | | • |
| 1110 | THDNUTH | UINT | | | | • |
| 1114 | THDNITh | UINT | | | | • |
| A/D converter measurement configuration checksum 0 | | | | | | |
| 1154 | PLconstH | UINT | | | | • |
| 1158 | PLconstL | UINT | | | | • |
| 1162 | MeteringMode | UINT | | | | • |
| A/D converter power calibration checksum 1 | | | | | | |
| 1246 | PhiA_W | UINT | | | | • |
| 1254 | PhiB_W | UINT | | | | • |
| 1262 | PhiC_W | UINT | | | | • |
| A/D converter RMS value synchronization checksum 3 | | | | | | |
| 1346 | UGainA_W | UINT | | | | • |
| 1350 | IGainA_W | UINT | | | | • |
| 1354 | UoffsetA_W | INT | | | | • |
| 1358 | IoffsetA_W | INT | | | | • |
| 1362 | UGainB_W | UINT | | | | • |
| 1366 | IGainB_W | UINT | | | | • |

| Register | Name | Data type | Read | | Write | |
|---|-----------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 1370 | UoffsetB_W | INT | | | | • |
| 1374 | IoffsetB_W | INT | | | | • |
| 1378 | UGainC_W | UINT | | | | • |
| 1382 | IGainC_W | UINT | | | | • |
| 1386 | UoffsetC_W | INT | | | | • |
| 1390 | IoffsetC_W | INT | | | | • |
| 1394 | IGainN_W | UINT | | | | • |
| 1398 | IoffsetN_W | INT | | | | • |
| A/D converter power calibration – read | | | | | | |
| 1758 | PhiA_R | UINT | | • | | |
| 1766 | PhiB_R | UINT | | • | | |
| 1774 | PhiC_R | UINT | | • | | |
| A/D converter RMS value synchronization – read | | | | | | |
| 1858 | UGainA_R | UINT | | • | | |
| 1862 | IGainA_R | UINT | | • | | |
| 1866 | UoffsetA_R | INT | | • | | |
| 1870 | IoffsetA_R | INT | | • | | |
| 1874 | UGainB_R | UINT | | • | | |
| 1878 | IGainB_R | UINT | | • | | |
| 1882 | UoffsetB_R | INT | | • | | |
| 1886 | IoffsetB_R | INT | | • | | |
| 1890 | UGainC_R | UINT | | • | | |
| 1894 | IGainC_R | UINT | | • | | |
| 1898 | UoffsetC_R | INT | | • | | |
| 1902 | IoffsetC_R | INT | | • | | |
| 1906 | IGainN_R | UINT | | • | | |
| 1910 | IoffsetN_R | INT | | • | | |
| Flatstream interface | | | | | | |
| 2049 | OutputMTU | USINT | | | | • |
| 2051 | InputMTU | USINT | | | | • |
| 2055 | FlatstreamMode | USINT | | | | • |
| 2057 | Forward | USINT | | | | • |
| 2059 | ForwardDelay | USINT | | | | • |
| 2113 | InputSequence | USINT | • | | | |
| 2113 + 2*N | RxByteN (index N = 1 to 27) | USINT | • | | | |
| 2177 | OutputSequence | USINT | | | • | |
| 2177 + 2*N | TxByteN (index N = 1 to 15) | USINT | | | • | |
| Force analog energy registers | | | | | | |
| 2316 | Frc_APenergyT | UDINT | | | | • |
| 2324 | Frc_APenergyA | UDINT | | | | • |
| 2332 | Frc_APenergyB | UDINT | | | | • |
| 2340 | Frc_APenergyC | UDINT | | | | • |
| 2348 | Frc_ANenergyT | UDINT | | | | • |
| 2356 | Frc_ANenergyA | UDINT | | | | • |
| 2364 | Frc_ANenergyB | UDINT | | | | • |
| 2372 | Frc_ANenergyC | UDINT | | | | • |
| 2380 | Frc_RPenergyT | UDINT | | | | • |
| 2388 | Frc_RPenergyA | UDINT | | | | • |
| 2396 | Frc_RPenergyB | UDINT | | | | • |
| 2404 | Frc_RPenergyC | UDINT | | | | • |
| 2412 | Frc_RNenergyT | UDINT | | | | • |
| 2420 | Frc_RNenergyA | UDINT | | | | • |
| 2428 | Frc_RNenergyB | UDINT | | | | • |
| 2436 | Frc_RNenergyC | UDINT | | | | • |
| 2444 | Frc_SAenergyT | UDINT | | | | • |
| 2452 | Frc_SenergyA | UDINT | | | | • |
| 2460 | Frc_SenergyB | UDINT | | | | • |
| 2468 | Frc_SenergyC | UDINT | | | | • |
| 2476 | Frc_SVenergyT | UDINT | | | | • |
| 2484 | Frc_APenergyTF | UDINT | | | | • |
| 2492 | Frc_APenergyAF | UDINT | | | | • |
| 2500 | Frc_APenergyBF | UDINT | | | | • |
| 2508 | Frc_APenergyCF | UDINT | | | | • |
| 2516 | Frc_ANenergyTF | UDINT | | | | • |
| 2524 | Frc_ANenergyAF | UDINT | | | | • |
| 2532 | Frc_ANenergyBF | UDINT | | | | • |
| 2540 | Frc_ANenergyCF | UDINT | | | | • |
| 2548 | Frc_APenergyTH | UDINT | | | | • |
| 2556 | Frc_APenergyAH | UDINT | | | | • |
| 2564 | Frc_APenergyBH | UDINT | | | | • |
| 2572 | Frc_APenergyCH | UDINT | | | | • |
| 2580 | Frc_ANenergyTH | UDINT | | | | • |
| 2588 | Frc_ANenergyAH | UDINT | | | | • |

| Register | Name | Data type | Read | | Write | |
|----------------------------|-----------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2596 | Frc_ANenergyBH | UDINT | | | | • |
| 2604 | Frc_ANenergyCH | UDINT | | | | • |
| Oversampling buffer | | | | | | |
| 6146 + ((16-N)*40) | lactN_SampleN (Index N = 1 to 16) | INT | • | | | |
| 6150 + ((16-N)*40) | lactA_SampleN (Index N = 1 to 16) | INT | • | | | |
| 6154 + ((16-N)*40) | UactA_SampleN (Index N = 1 to 16) | INT | • | | | |
| 6158 + ((16-N)*40) | lactB_SampleN (Index N = 1 to 16) | INT | • | | | |
| 6162 + ((16-N)*40) | UactB_SampleN (Index N = 1 to 16) | INT | • | | | |
| 6166 + ((16-N)*40) | lactC_SampleN (Index N = 1 to 16) | INT | • | | | |
| 6170 + ((16-N)*40) | UactC_SampleN (Index N = 1 to 16) | INT | • | | | |
| 6773 | SampleCountN | SINT | • | | | |
| 6774 | | INT | | | | |
| 6778 | Timestamp | INT | • | | | |
| 6780 | | DINT | | | | |
| Umgebungsvariablen | | | | | | |
| 15108 | OnTime | UDINT | | • | | |
| 15116 | UpCounter | UDINT | | • | | |
| 15122 | MinTemp | INT | | • | | |
| 15126 | MaxTemp | INT | | • | | |

9.1.24.15.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|---------------------------------------|----------------------|----------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Status register | | | | | | | |
| 130 | 0 | StatusInput | UINT | • | | | |
| | | CntPulseActive | Bit 0 | | | | |
| | | CntPulseApparent | Bit 1 | | | | |
| | | CntPulseActiveFund | Bit 2 | | | | |
| | | CntPulseActiveHarm | Bit 3 | | | | |
| | | ZeroCrossA | Bit 4 | | | | |
| | | ZeroCrossB | Bit 5 | | | | |
| | | ZeroCrossC | Bit 6 | | | | |
| | | RBTrigDFT | Bit 8 | | | | |
| | | RBUupdateEnergy | Bit 9 | | | | |
| | | RBClearEnergy | Bit 10 | | | | |
| | | RBForceEnergy | Bit 11 | | | | |
| 194 | 0 | ControlOutput | UINT | | | • | |
| | | TrigDFT | Bit 0 | | | | |
| | | EnabEnergy | Bit 1 | | | | |
| | | ClearEnergy | Bit 2 | | | | |
| | | ForceEnergy | Bit 3 | | | | |
| 266 | - | SysStatus1 | UINT | • | | | |
| 270 | - | SysStatus2 | UINT | • | | | |
| 274 | - | SysStatus3 | UINT | • | | | |
| 278 | - | SysStatus4 | UINT | • | | | |
| 265 | - | SystemStatusSel01 | USINT | • | | | |
| | | SumStatusPhaseLoss | Bit 2 | | | | |
| | | SumStatusPhaseWarning | Bit 3 | | | | |
| | | ErrOrderPhasecurrent | Bit 6 | | | | |
| | | ErrOrderPhaseVoltage | Bit 7 | | | | |
| 271 | - | SystemStatusSel02 | USINT | • | | | |
| | | SumStatusWarningTHDCurrent | Bit 2 | | | | |
| | | SumStatusWarningTHDVoltage | Bit 3 | | | | |
| | | ErrIrmsNCalc | Bit 6 | | | | |
| | | ErrIrmsNMeas | Bit 7 | | | | |
| 278 | - | PhaseStatus | UINT | • | | | |
| | | LossPhaseC | Bit 0 | | | | |
| | | LossPhaseB | Bit 1 | | | | |
| | | LossPhaseA | Bit 2 | | | | |
| | | WarningPhaseC | Bit 4 | | | | |
| | | WarningPhaseB | Bit 5 | | | | |
| | | WarningPhaseA | Bit 6 | | | | |
| Analog RMS value registers | | | | | | | |
| 290 | - | IrmsN (measured) | UINT | • | | | |
| 294 | - | UrmsA | UINT | • | | | |
| 298 | - | UrmsB | UINT | • | | | |
| 302 | - | UrmsC | UINT | • | | | |
| 306 | - | IrmsNcalc (calculated) | UINT | • | | | |
| 310 | - | IrmsA | UINT | • | | | |
| 314 | - | IrmsB | UINT | • | | | |
| 318 | - | IrmsC | UINT | • | | | |
| Analog THD and angle registers | | | | | | | |
| 538 | - | Freq | UINT | • | | | |
| 542 | - | PAngleA | INT | • | | | |
| 546 | - | PAngleB | INT | • | | | |
| 550 | - | PAngleC | INT | • | | | |
| 554 | - | Temperature | INT | • | | | |
| 558 | - | UAngleA | INT | • | | | |
| 562 | - | UAngleB | INT | • | | | |
| 564 | - | UAngleC | INT | • | | | |
| Analog power registers | | | | | | | |
| 778 | 2 | PmeanT | INT | • | | | |
| 782 | - | PmeanA | INT | • | | | |
| 786 | - | PmeanB | INT | • | | | |
| 790 | - | PmeanC | INT | • | | | |
| 794 | 4 | QmeanT | INT | • | | | |
| 798 | - | QmeanA | INT | • | | | |
| 802 | - | QmeanB | INT | • | | | |
| 806 | - | QmeanC | INT | • | | | |
| 810 | 6 | SmeanT | INT | • | | | |
| 814 | - | SmeanA | INT | • | | | |
| 818 | - | SmeanB | INT | • | | | |
| 822 | - | SmeanC | INT | • | | | |
| 826 | - | PFmeanT | INT | • | | | |

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|---|----------------------|--------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 830 | - | PFmeanA | INT | • | | | |
| 834 | - | PFmeanB | INT | • | | | |
| 838 | - | PFmeanC | INT | • | | | |
| Analog energy registers | | | | | | | |
| 4108 | - | APenergyT | UDINT | • | | | |
| 4116 | - | APenergyA | UDINT | • | | | |
| 4124 | - | APenergyB | UDINT | • | | | |
| 4132 | - | APenergyC | UDINT | • | | | |
| 4140 | - | ANenergyT | UDINT | • | | | |
| 4148 | - | ANenergyA | UDINT | • | | | |
| 4156 | - | ANenergyB | UDINT | • | | | |
| 4164 | - | ANenergyC | UDINT | • | | | |
| 4172 | - | RPenergyT | UDINT | • | | | |
| 4180 | - | RPenergyA | UDINT | • | | | |
| 4188 | - | RPenergyB | UDINT | • | | | |
| 4196 | - | RPenergyC | UDINT | • | | | |
| 4204 | - | RNenergyT | UDINT | • | | | |
| 4212 | - | RNenergyA | UDINT | • | | | |
| 4220 | - | RNenergyB | UDINT | • | | | |
| 4228 | - | RNenergyC | UDINT | • | | | |
| 4236 | - | SAenergyT | UDINT | • | | | |
| 4244 | - | SenenergyA | UDINT | • | | | |
| 4252 | - | SenenergyB | UDINT | • | | | |
| 4260 | - | SenenergyC | UDINT | • | | | |
| 4268 | - | SVenergyT | UDINT | • | | | |
| 4404 | 8 | AenergyT | DINT | • | | | |
| 4412 | 12 | REnergyT | DINT | • | | | |
| Module configuration | | | | | | | |
| 1026 | - | ChanControl | UINT | | | | • |
| 1030 | - | IDispTh | UINT | | | | • |
| 1034 | - | I_RatioA | UINT | | | | • |
| 1038 | - | I_RatioB | UINT | | | | • |
| 1042 | - | I_RatioC | UINT | | | | • |
| 1046 | - | I_RatioN | UINT | | | | • |
| Update request | | | | | | | |
| 1050 | - | CfgUpdate | UINT | | | | • |
| 1054 | - | Cs0Update | UINT | | | | • |
| 1058 | - | Cs1Update | UINT | | | | • |
| 1066 | - | Cs3Update | UINT | | | | • |
| 1570 | - | Cs1UpdateFB | UINT | | • | | |
| 1578 | - | Cs3UpdateFB | UINT | | • | | |
| A/D converter status configuration | | | | | | | |
| 1090 | - | ZXConfig | UINT | | | | • |
| 1094 | - | SagTh | UINT | | | | • |
| 1098 | - | PhaseLoseTh | UINT | | | | • |
| 1102 | - | INWarnTh0 | UINT | | | | • |
| 1106 | - | INWarnTh1 | UINT | | | | • |
| 1110 | - | THDNUTh | UINT | | | | • |
| 1114 | - | THDNITh | UINT | | | | • |
| A/D converter measurement configuration checksum 0 | | | | | | | |
| 1154 | - | PLconstH | UINT | | | | • |
| 1158 | - | PLconstL | UINT | | | | • |
| 1162 | - | MeteringMode | UINT | | | | • |
| A/D converter power calibration checksum 1 | | | | | | | |
| 1246 | - | PhiA_W | UINT | | | | • |
| 1254 | - | PhiB_W | UINT | | | | • |
| 1262 | - | PhiC_W | UINT | | | | • |
| A/D converter RMS value synchronization checksum 3 | | | | | | | |
| 1346 | - | UGainA_W | UINT | | | | • |
| 1350 | - | IGainA_W | UINT | | | | • |
| 1354 | - | UoffsetA_W | INT | | | | • |
| 1358 | - | IoffsetA_W | INT | | | | • |
| 1362 | - | UGainB_W | UINT | | | | • |
| 1366 | - | IGainB_W | UINT | | | | • |
| 1370 | - | UoffsetB_W | INT | | | | • |
| 1374 | - | IoffsetB_W | INT | | | | • |
| 1378 | - | UGainC_W | UINT | | | | • |
| 1382 | - | IGainC_W | UINT | | | | • |
| 1386 | - | UoffsetC_W | INT | | | | • |
| 1390 | - | IoffsetC_W | INT | | | | • |
| 1394 | - | IGainN_W | UINT | | | | • |
| 1398 | - | IoffsetN_W | INT | | | | • |

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|---|----------------------|----------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| A/D converter power calibration – read | | | | | | | |
| 1758 | - | PhiA_R | UINT | | • | | |
| 1766 | - | PhiB_R | UINT | | • | | |
| 1774 | - | PhiC_R | UINT | | • | | |
| A/D converter RMS value synchronization – read | | | | | | | |
| 1858 | - | UGainA_R | UINT | | • | | |
| 1862 | - | IGainA_R | UINT | | • | | |
| 1866 | - | UoffsetA_R | INT | | • | | |
| 1870 | - | IoffsetA_R | INT | | • | | |
| 1874 | - | UGainB_R | UINT | | • | | |
| 1878 | - | IGainB_R | UINT | | • | | |
| 1882 | - | UoffsetB_R | INT | | • | | |
| 1886 | - | IoffsetB_R | INT | | • | | |
| 1890 | - | UGainC_R | UINT | | • | | |
| 1894 | - | IGainC_R | UINT | | • | | |
| 1898 | - | UoffsetC_R | INT | | • | | |
| 1902 | - | IoffsetC_R | INT | | • | | |
| 1906 | - | IGainN_R | UINT | | • | | |
| 1910 | - | IoffsetN_R | INT | | • | | |
| Flatstream interface | | | | | | | |
| 2049 | - | OutputMTU | USINT | | | | • |
| 2051 | - | InputMTU | USINT | | | | • |
| 2055 | - | FlatstreamMode | USINT | | | | • |
| 2057 | - | Forward | USINT | | | | • |
| 2059 | - | ForwardDelay | USINT | | | | • |
| 2113 | 16 | InputSequence | USINT | • | | | |
| 2113 + 2*N | 16 + N | RxByteN (index N = 1 to 7) | USINT | • | | | |
| 2177 | 16 | OutputSequence | USINT | | | • | |
| 2177 + 2*N | 16 + N | TxByteN (index N = 1 to 7) | USINT | | | • | |
| Force analog energy registers | | | | | | | |
| 2316 | - | Frc_APenergyT | UDINT | | | | • |
| 2324 | - | Frc_APenergyA | UDINT | | | | • |
| 2332 | - | Frc_APenergyB | UDINT | | | | • |
| 2340 | - | Frc_APenergyC | UDINT | | | | • |
| 2348 | - | Frc_ANenergyT | UDINT | | | | • |
| 2356 | - | Frc_ANenergyA | UDINT | | | | • |
| 2364 | - | Frc_ANenergyB | UDINT | | | | • |
| 2372 | - | Frc_ANenergyC | UDINT | | | | • |
| 2380 | - | Frc_RPenergyT | UDINT | | | | • |
| 2388 | - | Frc_RPenergyA | UDINT | | | | • |
| 2396 | - | Frc_RPenergyB | UDINT | | | | • |
| 2404 | - | Frc_RPenergyC | UDINT | | | | • |
| 2412 | - | Frc_RNenergyT | UDINT | | | | • |
| 2420 | - | Frc_RNenergyA | UDINT | | | | • |
| 2428 | - | Frc_RNenergyB | UDINT | | | | • |
| 2436 | - | Frc_RNenergyC | UDINT | | | | • |
| 2444 | - | Frc_SAenergyT | UDINT | | | | • |
| 2452 | - | Frc_SenergyA | UDINT | | | | • |
| 2460 | - | Frc_SenergyB | UDINT | | | | • |
| 2468 | - | Frc_SenergyC | UDINT | | | | • |
| 2476 | - | Frc_SVenergyT | UDINT | | | | • |
| 2484 | - | Frc_APenergyTF | UDINT | | | | • |
| 2492 | - | Frc_APenergyAF | UDINT | | | | • |
| 2500 | - | Frc_APenergyBF | UDINT | | | | • |
| 2508 | - | Frc_APenergyCF | UDINT | | | | • |
| 2516 | - | Frc_ANenergyTF | UDINT | | | | • |
| 2524 | - | Frc_ANenergyAF | UDINT | | | | • |
| 2532 | - | Frc_ANenergyBF | UDINT | | | | • |
| 2540 | - | Frc_ANenergyCF | UDINT | | | | • |
| 2548 | - | Frc_APenergyTH | UDINT | | | | • |
| 2556 | - | Frc_APenergyAH | UDINT | | | | • |
| 2564 | - | Frc_APenergyBH | UDINT | | | | • |
| 2572 | - | Frc_APenergyCH | UDINT | | | | • |
| 2580 | - | Frc_ANenergyTH | UDINT | | | | • |
| 2588 | - | Frc_ANenergyAH | UDINT | | | | • |
| 2596 | - | Frc_ANenergyBH | UDINT | | | | • |
| 2604 | - | Frc_ANenergyCH | UDINT | | | | • |
| Umgebungsvariablen | | | | | | | |
| 15108 | - | OnTime | UDINT | | • | | |
| 15116 | - | UpCounter | UDINT | | • | | |
| 15122 | - | MinTemp | INT | | • | | |
| 15126 | - | MaxTemp | INT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.1.24.15.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.1.24.15.3.2 CAN I/O bus controller

The module occupies 3 analog logical slots with CAN I/O.

9.1.24.15.4 General information

The modules are used for power monitoring and for a machine's energy management. Examples of where this would be used:

- Multi-phase energy measurement for class 0.5S or class 1 for
 - 3-phase, 4-line applications with neutral conductor (with/without grounding)
 - 3-phase, 3-line applications (with/without grounding)
 - 2-phase networks with grounded phase B connection
- Single-phase measurement by disabling inputs that are not needed
- Mains analysis according to harmonic content
- Signal trace by 8 kHz recording of the 3 voltage channels and 4 current channels with FIFO

9.1.24.15.4.1 Measured value preparation

The modules provide the following possibilities for measured value preparation:

- Temperature coefficient of internal reference of 6 ppm/°C
- Energy registers for active, reactive and apparent energy, separated for forward and backward, fundamental waves and harmonics
- Threshold register for status signal generation and activation of power and energy measurement
- Determining the THD harmonic component
- Discrete Fourier Transformation (DFT) up to 31st harmonic component per phase for voltage and current
- Status signals for voltage dip, loss of voltage, phase sequence, energy flow, neutral current monitor, harmonic component monitor

9.1.24.15.4.2 Additional information

| Information | Description |
|-----------------------------|--|
| Measurement range limiting | Due to the majority of registers consisting of 16-bit values (exception: energy registers, which are interpolated to 32-bit by the firmware), the measurement ranges are subject to limitations, e.g. voltage 650.00 Vrms and current 65.000 Arms (after accounting for the transfer factor of the current transformer). |
| Extended measurement ranges | Extended measurement ranges can be achieved with the software application by upscaling the measured values. |
| Frozen values | Sample time register: If the group of measured values is read from the power meter, it is assigned a NetTime . Using this NetTime, a freezing of the values can be determined. |
| Environment variables | The values for duty cycle, boot counter, and minimum / maximum transformer temperature are recorded. |

9.1.24.15.4.3 Measurement function

The values measured for RMS, power, active power factor, phase angle and frequency are mean values over 16 full waves, the update rate is ~3 Hz.

The following represents the measurement time over 16 full waves at the corresponding frequency:

50 Hz → 320 ms

60 Hz → 267 ms

Energy measurement

The power measurement (energy measurement) is based on the integration of the measured values with a sampling rate of 1 MHz.

The gathered energy values are provided according to the set unit (1 Ws, 10 Ws, etc.) in the energy registers.

Automatic reading of the energy meter from the transformer must be enabled because valid values are only available after the transformer has been configured. It is possible to clear the energy registers or to configure them with a block of the register written in the software application.

Information:

When 1 Wh and 1 kWh are set, the energy pulses on the register "StatusInput" on page 697 may not be used.

Power measurement

The phase power ratings are calculated by the module and stored in the corresponding registers.

The total power ratings are equal to the sum of the phase power ratings. To prevent the number range from being exceeded, the value in the registers is equal to a fourth of the actual power. This value must be multiplied by 4 by the application.

The vector-based total apparent power (complex total apparent power) is calculated according to IEEE1459.

Power factor

The phase power factor is calculated by dividing the phase active power by the phase apparent power.

The total power factor is calculated by dividing the total active power by the total apparent power.

Neutral current

The neutral current can be measured or calculated. Both values are available.

The user can configure which one to use for displaying the status.

Phase angle

The phase angle is calculated based on the zero-crossing detection.

Frequency

Frequency measurement is based on Phase A. If A fails, then Phase C is used. If both A and C fail, then Phase B is used.

Temperature

The Chip-Junction temperature is measured approximately every 100 ms using the sensor integrated in the transformer.

THD+N - Sum of interference power of the harmonic (THD) + interference power of the noise (N)

The THD+N measurement is used to monitor the percentage of harmonics in the network.

If this percentage falls below 10%, then an accuracy of 0.01% can no longer be guaranteed.

This is calculated as follows: $(\text{SQR}(\text{RMS value}_{\text{Total}}^2 - \text{RMS value}_{\text{FundamentalWave}}^2)) / \text{RMS value}_{\text{FundamentalWave}}$

Fourier analysis

The harmonic component from the 2nd to the 31st harmonic is calculated for voltage and current and the THD (Total Harmonic Distortion) of each phase.

The DFT period (DFT = discrete Fourier Transformation) is 0.5 s. This corresponds to a resolution of 2 Hz. The input samples are recorded at a sampling rate of 8 kHz and can be optionally multiplied with a "Hann window" before being evaluated. This is initiated when requested by the application.

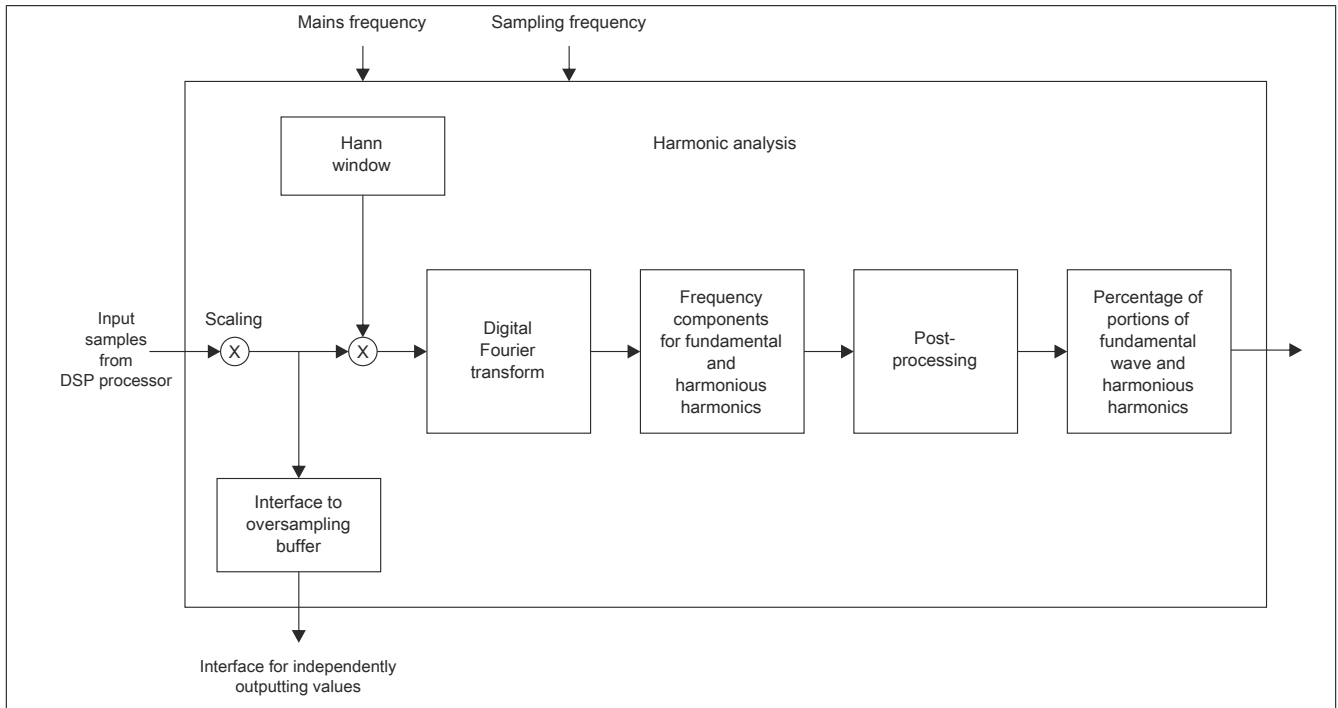


Figure 80: Diagram of Fourier analysis

9.1.24.15.4.4 Event generation

Zero-crossing detection

Zero-crossing detection can be configured for each phase for current or voltage and edge and forms the basis for frequency and angle measurements and subsequently also for active and reactive power calculations.

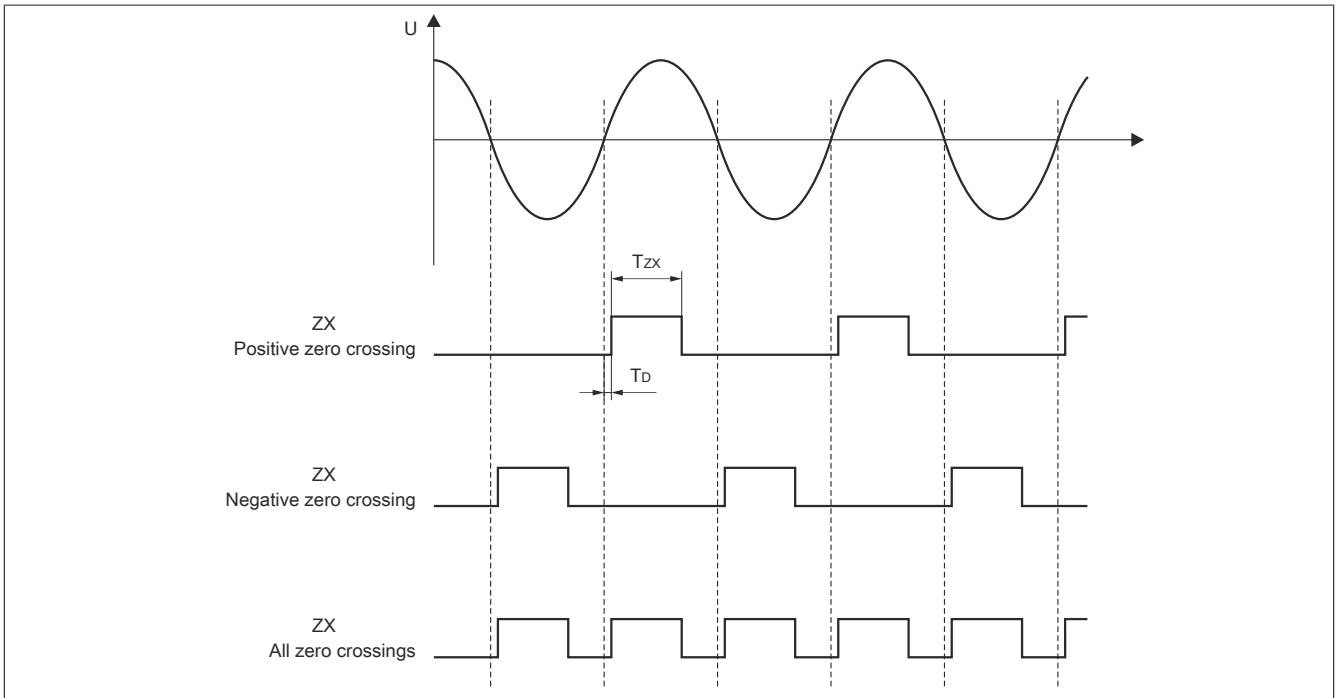


Figure 81: Timing diagram of zero-crossing detection per phase

| Symbol | Description | Minimum | Typical | Maximum | Unit |
|----------|-----------------------|---------|---------|---------|------|
| T_{ZX} | Length of high signal | | 5 | | ms |
| T_D | Delay time | | 0.2 | 0.5 | ms |

Voltage dip or power failure detection

| Event | Description |
|---------------|---|
| Voltage dip | The threshold for the voltage dip is typically set to 78% of the standard voltage (approx. 170 Vrms). The status flag is set if more than 3 8 kHz samples are below the threshold within 2 consecutive 11 ms windows. |
| Power failure | The threshold for the voltage dip is typically set to 10% of the standard voltage (approx. 22 Vrms). The status flag is set if more than three 8 kHz samples are below the threshold within 2 consecutive 11 ms windows. If a power failure is detected, zero crossing detection for voltage and current is disabled for this phase. |

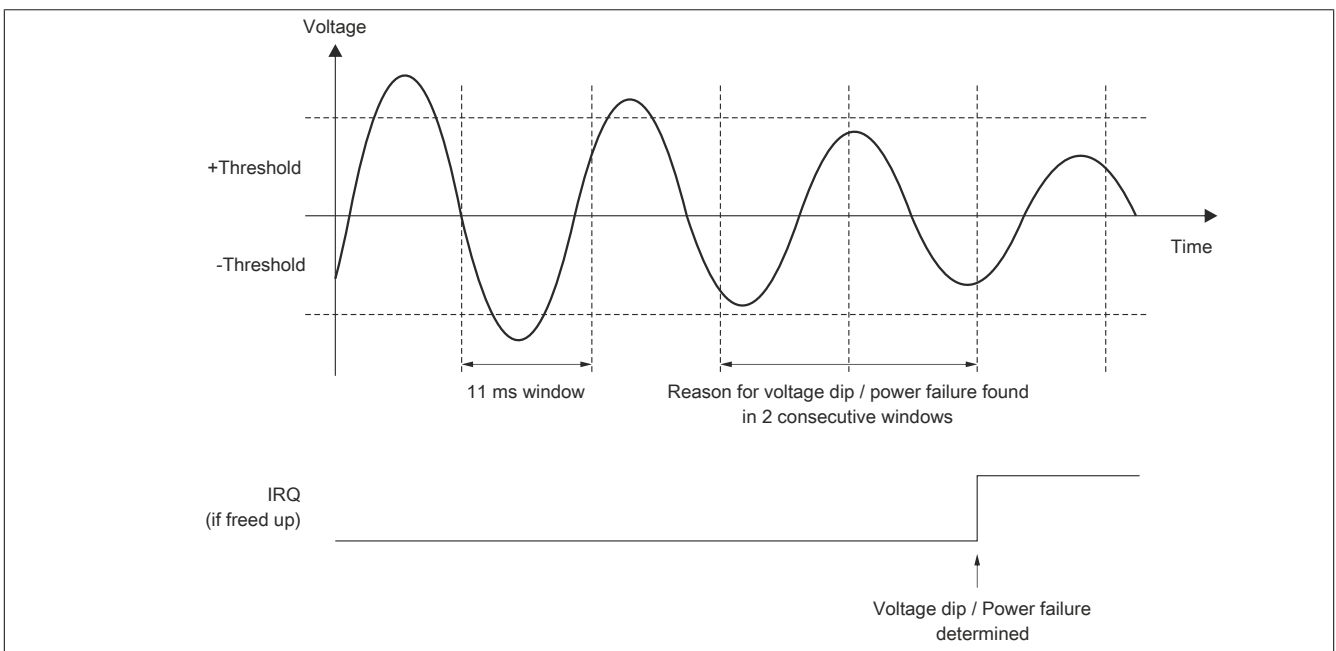


Figure 82: Timing diagram for detection of a voltage dip or power failure

Neutral current monitoring

Neutral current monitoring of the measured and the calculated value is done with separate threshold value registers and status flags.

Phase sequence monitoring

3 phase and 2 phase applications are handled differently:

| Application | Description |
|-------------|--|
| 3 phases | Zero cross-overs of voltage and current must follow the sequence Phase A before Phase B before Phase C |
| 2 phases | Zero cross-overs of voltage and current must follow the sequence Phase A at least 180° before Phase C |

9.1.24.15.4.5 Configuration registers

The configuration and calibration registers are each composed of blocks and employ a checksum feature to highlight undesired changes. In order to apply this register to the transformer, the respective transfer register must be changed after the data is transferred to the module (incrementing, bit toggling, etc.). The start value of the transfer register is 0 after startup.

9.1.24.15.4.6 Oversampling

The input values are measured with a configurable sampling cycle time and saved in the internal physical data buffer with **timestamp**. This data area can now be read out by means of configurable data length in cyclic data transfer.

The recording and transfer system of logical channels is identical to that of the physical channels. The functions of the logical channels are also executed in the configured sampling cycle time and saved in the logical data buffer with timestamp. From here, the values can also be read out via configurable cyclic data points.

With fast cycle times, however, it can happen that the set sampling cycle time is not sufficient for the sum of all physical and logical functions. If the physical sampling should remain unaffected, logical processing can be slowed down via a prescaler setting.

Information:

Due to the free configurability of the sampling cycle time on the module, there is no synchronicity to the X2X Link network, regardless of configuration as standard inputs or with the oversampling function.

If synchronicity is desired or required, then the configured sampling cycle time must be a multiple of the X2X Link cycle time!

9.1.24.15.5 Interface for transferring process variable mapping

Due to the amount of potential cyclic input data and the limitation to 30 byte cyclic X2X data, the extended Flat-stream Interface (DPS = Data Point Stream) has been defined as the mechanism for transferring the process variables. DPS is based on the Flat Streaming Interface for serial interface modules. The Flat Streaming Interface was expanded to include the block number as the first byte of the user data frame and implements the termination of a frame (data image of the channel) with a zero segment.

The data blocks are re-transferred if a read request is triggered after a transfer has been completed. A block number can be sent via the DPS to set a different block or transfer the entire image (default: block number 0).

It should be possible to adapt the DPS interface to the available buffer size. However, the higher-level fieldbus must be taken into account when doing so (e.g. CAN 8 byte object, InputMTU size 7). The block number is added to the front of the actual payload data as a means to differentiate the blocks.

```
#define ADC_BLK_ALL          0    // struct ADC_REG
#define ADC_BLK_STATUS      1    // long NetTimeReg + struct ADC_REG_STATUS
#define ADC_BLK_RMS         2    // struct ADC_REG_RMS
#define ADC_BLK_POWER       3    // struct ADC_REG_POWER
#define ADC_BLK_THD_ANGLE   4    // struct THD_ANGLE
#define ADC_BLK_ENERGY      5    // long NetTimeEnergy + struct ADC_REG_ENERGY
#define ADC_BLK_DFT         6    // long NetTimeDft + struct ADC_REG_DFT
#define ADC_BLK_CFGACT      7    // struct ADC_REG_CFGACT
#define ADC_BLK_ENVREG      8    // struct ENV_STATUS
```

Information:

- **Consistency of the data is only provided for the individual variables because the data is transferred from the A/D converter asynchronously to the conversion.**
- **Make sure that the byte sequence of the register is in accordance with the Little Endian model (Intel format).**

The **NetTime** timestamps are always updated after the blocks have been generated when a new alternating buffer is provided.

9.1.24.15.5.1 Data block structures

ADC_REG

```
typedef struct ADC_REG      ADC_REG;
struct ADC_REG
{
    long          NetTimeReg; // Time of Section copy to Buffer
    ADC_REG_STATUS Status;   // Status registers
    ADC_REG_RMS   Rms;       // RMS Registers
    ADC_REG_POWER Power;     // Power Registers
    ADC_REG_THD_ANGLE ThdAngle; // THD + Angle Registers

    // Regular Energy Registers
    long          NetTimeEnergy; // Time of Section copy to Buffer
    ADC_REG_ENERGY Energy;       // Energy Registers

    long          NetTimeDft;    // Time of Section copy to Buffer
    ADC_REG_DFT   Dft;          // DFT Registers
    // Read Back selected CFG Registers
    ADC_REG_CFGACT CfgAct;      // Config read back
    // Read Back Environment Registers
    ENV_STATUS     EnvReg;
};
```

ADC_REG_STATUS

```
typedef struct ADC_REG_STATUS  ADC_REG_STATUS;
struct ADC_REG_STATUS
{
    unsigned short SysStatus0;    // SysStatus 0
    unsigned short SysStatus1;    // SysStatus 1
    unsigned short EnStatus0;     // SysStatus 2
    unsigned short EnStatus1;     // SysStatus 3
};
```

ADC_REG_RMS

```
typedef struct ADC_REG_RMS  ADC_REG_RMS;
struct ADC_REG_RMS
{
    unsigned short IrmsN1;    // N Line Sampled current RMS
    unsigned short UrmsA;     // phase A voltage RMS
    unsigned short UrmsB;     // phase B voltage RMS
    unsigned short UrmsC;     // phase C voltage RMS
    unsigned short IrmsN0;    // N Line calculated current RMS
    unsigned short IrmsA;     // phase A current RMS
    unsigned short IrmsB;     // phase B current RMS
    unsigned short IrmsC;     // phase C current RMS
};
```

ADC_REG_POWER

```
typedef struct ADC_REG_POWER  ADC_REG_POWER;
struct ADC_REG_POWER
{
    unsigned short SVmeanTLSB; // LSB of (Vector Sum) Total Apparent Power
    unsigned short SVmeanT;    // (Vector Sum) Total Apparent Power

    // Power and Power Factor Register
    signed short PmeanT;    // Total Active Power
    signed short PmeanA;    // Phase A Active Power
    signed short PmeanB;    // Phase B Active Power
    signed short PmeanC;    // Phase C Active Power
    signed short QmeanT;    // Total Reactive Power
    signed short QmeanA;    // Phase A Reactive Power
    signed short QmeanB;    // Phase B Reactive Power
    signed short QmeanC;    // Phase C Reactive Power
    signed short SAmeanT;   // (Arithmetic Sum) Total apparent power
    signed short SmeanA;    // phase A apparent power
    signed short SmeanB;    // phase B apparent power
    signed short SmeanC;    // phase C apparent power
    signed short PFmeanT;   // Total power factor
    signed short PFmeanA;   // phase A power factor
    signed short PFmeanB;   // phase A power factor
    signed short PFmeanC;   // phase A power factor

    // Fundamental/ Harmonic Power and Voltage/ Current RMS Registers
    signed short PmeanTF;   // Total active fundamental power
    signed short PmeanAF;   // phase A active fundamental power
    signed short PmeanBF;   // phase B active fundamental power
    signed short PmeanCF;   // phase C active fundamental power
    signed short PmeanTH;   // Total active harmonic power
    signed short PmeanAH;   // phase A active harmonic power
    signed short PmeanBH;   // phase B active harmonic power
    signed short PmeanCH;   // phase C active harmonic power
};
```

ADC_REG_THD_ANGLE

```
typedef struct ADC_REG_THD_ANGLE  ADC_REG_THD_ANGLE;
struct ADC_REG_THD_ANGLE
{
    // THD+N, Frequency, Angle and Temperature Registers
    unsigned short THDNUA;    // phase A voltage THD+N
    unsigned short THDNUB;    // phase B voltage THD+N
    unsigned short THDNUC;    // phase C voltage THD+N
    unsigned short THDNIA;    // phase A current THD+N
    unsigned short THDNIB;    // phase B current THD+N
    unsigned short THDNIC;    // phase C current THD+N
    unsigned short Freq;      // Frequency
    signed short   PAngleA;    // phase A mean phase angle
    signed short   PAngleB;    // phase B mean phase angle
    signed short   PAngleC;    // phase C mean phase angle
    signed short   Temp;       // Measured temperature
    signed short   UangleA;    // phase A voltage phase angle
    signed short   UangleB;    // phase B voltage phase angle
    signed short   UangleC;    // phase C voltage phase angle
};
```

ADC_REG_ENERGY

```
typedef struct ADC_REG_ENERGY  ADC_REG_ENERGY;
struct ADC_REG_ENERGY
{
    unsigned long APenergyT;    // Total Forward Active Energy
    unsigned long APenergyA;    // Phase A Forward Active Energy
    unsigned long APenergyB;    // Phase B Forward Active Energy
    unsigned long APenergyC;    // Phase C Forward Active Energy
    unsigned long ANenergyT;    // Total Reverse Active Energy
    unsigned long ANenergyA;    // Phase A Reverse Active Energy
    unsigned long ANenergyB;    // Phase B Reverse Active Energy
    unsigned long ANenergyC;    // Phase C Reverse Active Energy
    unsigned long RPenergyT;    // Total Forward Reactive Energy
    unsigned long RPenergyA;    // Phase A Forward Reactive Energy
    unsigned long RPenergyB;    // Phase B Forward Reactive Energy
    unsigned long RPenergyC;    // Phase C Forward Reactive Energy
    unsigned long RNenergyT;    // Total Reverse Reactive Energy
    unsigned long RNenergyA;    // Phase A Reverse Reactive Energy
    unsigned long RNenergyB;    // Phase B Reverse Reactive Energy
    unsigned long RNenergyC;    // Phase C Reverse Reactive Energy
    unsigned long SAenergyT;    // (Arithmetic Sum) Total Apparent Energy
    unsigned long SenergyA;     // Phase A Apparent Energy
    unsigned long SenergyB;     // Phase B Apparent Energy
    unsigned long SenergyC;     // Phase C Apparent Energy
    unsigned long SVenergyT;    // (Vector Sum) Total Apparent Energy

    // Fundamental / Harmonic Energy Register
    unsigned long APenergyTF;   // Total Forward Active Fundamental Energy
    unsigned long APenergyAF;   // Phase A Forward Active Fundamental Energy
    unsigned long APenergyBF;   // Phase B Forward Active Fundamental Energy
    unsigned long APenergyCF;   // Phase C Forward Active Fundamental Energy
    unsigned long ANenergyTF;   // Total Reverse Active Fundamental Energy
    unsigned long ANenergyAF;   // Phase A Reverse Active Fundamental Energy
    unsigned long ANenergyBF;   // Phase B Reverse Active Fundamental Energy
    unsigned long ANenergyCF;   // Phase C Reverse Active Fundamental Energy
    unsigned long APenergyTH;   // Total Forward Active Harmonic Energy
    unsigned long APenergyAH;   // Phase A Forward Active Harmonic Energy
    unsigned long APenergyBH;   // Phase B Forward Active Harmonic Energy
    unsigned long APenergyCH;   // Phase C Forward Active Harmonic Energy
    unsigned long ANenergyTH;   // Total Reverse Active Harmonic Energy
    unsigned long ANenergyAH;   // Phase A Reverse Active Harmonic Energy
    unsigned long ANenergyBH;   // Phase B Reverse Active Harmonic Energy
    unsigned long ANenergyCH;   // Phase C Reverse Active Harmonic Energy

    signed long AenergyT;       // Total Active Energy
    signed long RenergyT;       // Total Reactive Energy
};
```

ADC_REG_DFT

```

typedef struct ADC_REG_DFT ADC_REG_DFT;
struct ADC_REG_DFT
{
    // Arithmetic ratio, 2 bits integer and 14 bits fractional;
    // That is: Harmonic Ratio (%) = Register Value / 163.84
    unsigned short DftAI[32]; // phase A, Current, Harmonic Ratio for 2nd to 32nd
                                // order componentand Total Harmonic DistortionRatio
    unsigned short DftBI[32]; // phase B, Current, Harmonic Ratio for 2nd to 32nd
                                // order componentand Total Harmonic DistortionRatio
    unsigned short DftCI[32]; // phase C, Current, Harmonic Ratio for 2nd to 32nd
                                // order componentand Total Harmonic DistortionRatio
    unsigned short DftAV[32]; // phase A, Voltage, Harmonic Ratio for 2nd to 32nd
                                // order componentand Total Harmonic DistortionRatio
    unsigned short DftBV[32]; // phase B, Voltage, Harmonic Ratio for 2nd to 32nd
                                // order componentand Total Harmonic DistortionRatio
    unsigned short DftCV[32]; // phase C, Voltage, Harmonic Ratio for 2nd to 32nd
                                // order componentand Total Harmonic DistortionRatio

    // Format: Need special scaling/conversion.
    //The register value * 147.62 = full-scale input signal RMS.
    // Current, Fundamental component value = Register Value * 209 * 65.535 / 8388608
    // Voltage, Fundamental component value = Register Value * 209 * 655.35 / 8388608

    unsigned short DftAI_Fund;
    unsigned short DftAV_Fund;
    unsigned short DftBI_Fund;
    unsigned short DftBV_Fund;
    unsigned short DftCI_Fund;
    unsigned short DftCV_Fund;
};

```

ADC_REG_CFACT

```

// Except of configuration registers used by APROL, readable only by FS-IF
// and with register numbers of registers with the same names.

```

```

typedef struct ADC_REG_CFGACTADC_REG_CFGACT;
struct ADC_REG_CFGACT
{
    unsigned short ChanControl;
    unsigned short IDispTh;
    unsigned short I_RatioA;
    unsigned short I_RatioB;
    unsigned short I_RatioC;
    unsigned short I_RatioN;
    unsigned short ZXConfig;
    unsigned short SagTh;
    unsigned short PhaseLoseTh;
    unsigned short INWarnTh0;
    unsigned short INWarnTh1;
    unsigned short THDNUTH;
    unsigned short THDNITH;
    unsigned short MeteringMode;
    unsigned short PLconstL;
    unsigned short PLconstH;
};

```

ENV_STATUS

```
// Environment Variables

typedef struct ENV_STATUSENV_STATUS;
struct ENV_STATUS
{
    unsigned long    ulUpTime;
    unsigned long    ulUpCnt;
    signed short     ssMinTemp;
    signed short     ssMaxTemp;
    unsigned long    ulRes[13];    // reserved
};
```

9.1.24.15.6 Status register

9.1.24.15.6.1 Status signals and responses

Name:

StatusInput

The signals are recorded in 200 µs intervals. The energy pulse values in this register are not valid when 1 kWh and 1 Wh are set.

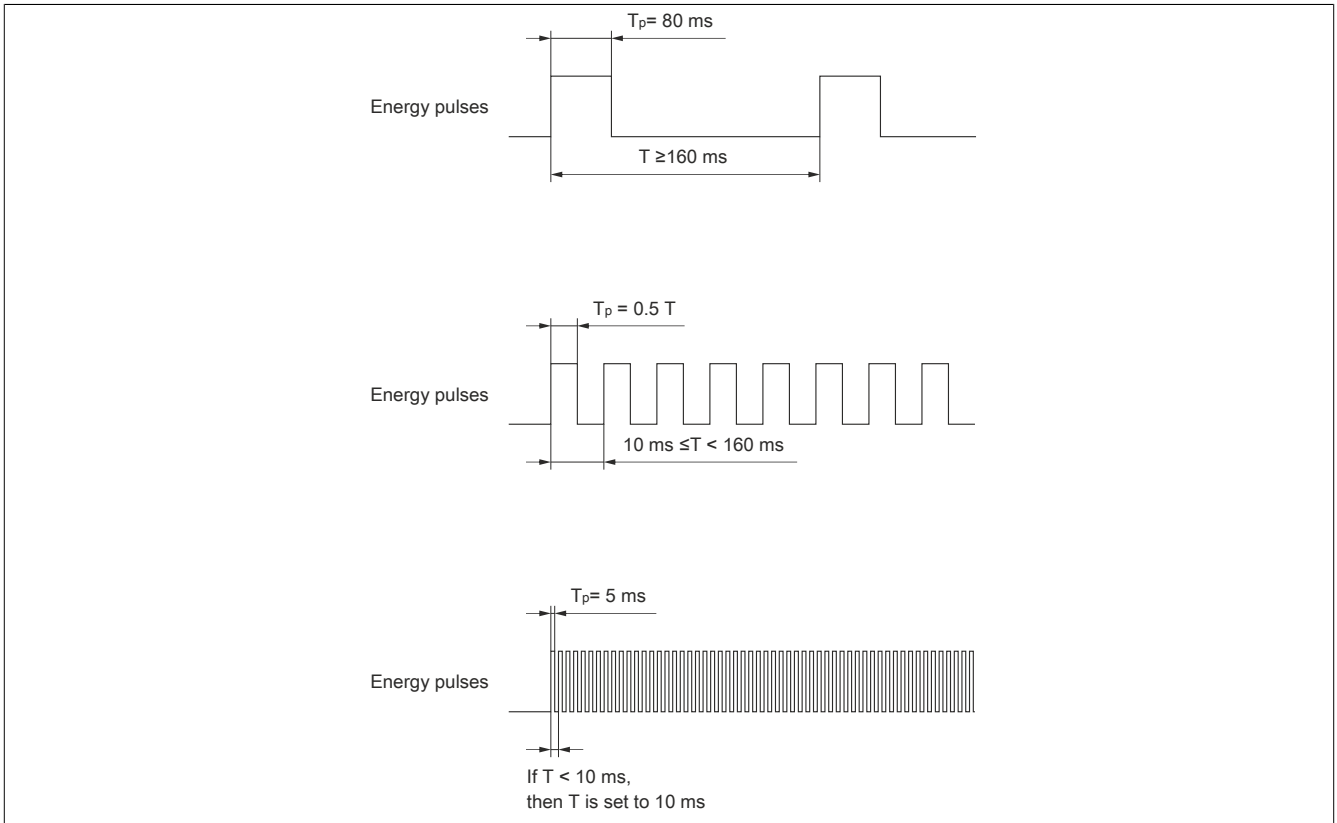
| Data type | Value |
|-----------|--------------------|
| UINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|---------|---|-------|---|
| 0 | Energy pulse total active energy | 0 | Energy increase too low |
| | | 1 | Energy threshold reached |
| 1 | Energy pulse total apparent energy Default: Arithmetic or vector sum (see register "MeteringMode" on page 724, bit 6) | 0 | Energy increase too low |
| | | 1 | Energy threshold reached |
| 2 | Energy pulse total active energy, fundamental wave | 0 | Energy increase too low |
| | | 1 | Energy threshold reached |
| 3 | Energy pulse total active energy, harmonics | 0 | Energy increase too low |
| | | 1 | Energy threshold reached |
| 4 | ZX1 zero cross signal (ZCS) – Phase A | 0 | Zero crossing not detected |
| | | 1 | Default: Pulse at rising edge of the zero cross signal of the voltage input, can be reconfigured via register "ZXConfig" on page 721 |
| 5 | ZX2 zero cross signal (ZCS) – Phase B | 0 | Zero crossing not detected |
| | | 1 | Default: Pulse at rising edge of the zero cross signal of the voltage input, can be reconfigured via register "ZXConfig" on page 721 |
| 6 | ZX3 zero cross signal (ZCS) – Phase C | 0 | Zero crossing not detected |
| | | 1 | Default: Pulse at rising edge of the zero cross signal of the voltage input, can be reconfigured via register "ZXConfig" on page 721 |
| 7 | Reserved | 0 | |
| 8 | DFT response sent | x | If the state in the register "ControlOutput" on page 698 corresponds with the response, then the action is complete |
| 9 | Energy value update response sent | 0 | No update |
| | | 1 | Update complete |
| 10 | Energy value response deleted | x | If the state in the register "ControlOutput" on page 698 corresponds with the response, then the action is complete |
| 11 | Energy value response set | x | If the state in the register "ControlOutput" on page 698 corresponds with the response, then the action is complete |
| 12 - 15 | Reserved | 0 | |

Energy measurement

The length of the energy pulses can vary according to the resulting output rate.



9.1.24.15.6.2 Control signals

Name:

ControlOutput

Control signals are evaluated in a $\sim 5 \text{ ms}$ interval.

| Data type | Value |
|-----------|--------------------|
| UINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|--------|----------------------------------|-------|---------------------------|
| 0 | DFT analysis | 0 | Don't start |
| | | 1 | Start ¹⁾ |
| 1 | Automatically read energy values | 0 | Do not automatically read |
| | | 1 | Automatically read |
| 2 | Clear energy values | 0 | Don't delete |
| | | 1 | Clear ¹⁾ |
| 3 | Set energy values | 0 | Don't start |
| | | 1 | Start ¹⁾ |
| 4 - 15 | Reserved | 0 | |

1) If the state in the register "ControlOutput" on page 698 corresponds with the response, then the action is complete.

9.1.24.15.6.3 Read timestamp for I/O register (+0x0022 = 16-bit)

Name:

SampleTime01_32bit

NetTime timestamp for the readout time of the status, effective value and power registers.

For more information about NetTime and timestamps, see "NetTime Technology" on page 3035.

| Data type | Value | Information |
|-----------|---------------------------------|------------------------------------|
| DINT | -2,147,483,647 to 2,147,483,647 | NetTime timestamp in μs |

9.1.24.15.6.4 A/D converter system status 1

Name:

SysStatus1

The register is read by the converter in a ~5 ms interval.

| Data type | Value |
|-----------|--------------------|
| UINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---|-------|--|
| 0 - 1 | Reserved | 0 | |
| 2 | SumStatusPhaseLoss Voltage of one or more phases < failure threshold in the register " PhaseLoseTh " on page 722 | 0 | Voltage within permitted range |
| | | 1 | Voltage lower than the failure threshold |
| 3 | SumStatusPhaseWarning Voltage of one or more phases < warning threshold in the register " SagTh " on page 722 | 0 | Voltage within permitted range |
| | | 1 | Voltage lower than the warning threshold |
| 4 - 5 | Reserved | 0 | |
| 6 | ErrOrderPhasecurrent Error in the order of phase currents | 0 | No error |
| | | 1 | Errors |
| 7 | ErrOrderPhaseVoltage Error in the order of phase voltages | 0 | No error |
| | | 1 | Errors |
| 8 | CS3Err Checksum error in configuration block 3 | 0 | No error |
| | | 1 | Errors |
| 9 | Reserved | 0 | |
| 10 | CS2Err Checksum error in configuration block 2 | 0 | No error |
| | | 1 | Errors |
| 11 | Reserved | 0 | |
| 12 | CS1Err Checksum error in configuration block 1 | 0 | No error |
| | | 1 | Errors |
| 13 | Reserved | 0 | |
| 14 | CS0Err Checksum error in configuration block 0 | 0 | No error |
| | | 1 | Errors |
| 15 | Reserved | 0 | |

9.1.24.15.6.5 A/D converter system status 2

Name:

SysStatus2

| Data type | Value |
|-----------|--------------------|
| UINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|---------|---|-------|--|
| 0 | RevPchgC Direction of the active energy for phase C has changed | 0 | No change of direction |
| | | 1 | Direction has changed |
| 1 | RevPchgB Direction of the active energy for phase B has changed | 0 | No change of direction |
| | | 1 | Direction has changed |
| 2 | RevPchgA Direction of the active energy for phase A has changed | 0 | No change of direction |
| | | 1 | Direction has changed |
| 3 | RevPchgT Direction of the active energy for the sum has changed | 0 | No change of direction |
| | | 1 | Direction has changed |
| 4 | RevQchgC Direction of the reactive energy for phase C has changed | 0 | No change of direction |
| | | 1 | Direction has changed |
| 5 | RevQchgB Direction of the reactive energy for phase B has changed | 0 | No change of direction |
| | | 1 | Direction has changed |
| 6 | RevQchgA Direction of the reactive energy for phase A has changed | 0 | No change of direction |
| | | 1 | Direction has changed |
| 7 | RevQchgT Direction of the reactive energy for the total has changed | 0 | No change of direction |
| | | 1 | Direction has changed |
| 8 | Reserved | 0 | |
| 9 | DFTDone DFT analysis complete (temporary bit) | 0 | DFT analysis not complete |
| | | 1 | DFT analysis complete |
| 10 | SumStatusWarningTHDCurrent THDIx value of one or more phases > warning threshold in register "THDNiTh" on page 722 | 0 | THDIx value within permitted range |
| | | 1 | THDIx value higher than warning threshold |
| 11 | SumStatusWarningTHDVoltage THDUx value of one or more phases > warning threshold in register "THDNUTh" on page 722 | 0 | THDUx value within permitted range |
| | | 1 | THDUx value higher than warning threshold |
| 12 - 13 | Reserved | 0 | |
| 14 | ErrIrmsNCalc Calculated value of the neutral conductor > warning threshold in register "INWarnTh0" on page 722 | 0 | Calculated value within permitted range |
| | | 1 | Calculated value higher than warning threshold |
| 15 | ErrIrmsNMeas Measured value of the neutral conductor > warning threshold in register "INWarnTh1" on page 722 | 0 | Measured value within permitted range |
| | | 1 | Measured value higher than warning threshold |

9.1.24.15.6.6 A/D converter system status 3

Name:

SysStatus3

| Data type | Value |
|-----------|--------------------|
| UINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|--------|---|-------|-----------------------|
| 0 | CF1RevFlag Direction of energy pulses | 0 | Forward ¹⁾ |
| | | 1 | Back ²⁾ |
| 1 | CF2RevFlag Direction of energy pulses | 0 | Forward ¹⁾ |
| | | 1 | Back ²⁾ |
| 2 | CF3RevFlag Direction of energy pulses | 0 | Forward ¹⁾ |
| | | 1 | Back ²⁾ |
| 3 | CF4RevFlag Direction of energy pulses | 0 | Forward ¹⁾ |
| | | 1 | Back ²⁾ |
| 4 - 11 | Reserved | 0 | |
| 12 | TVSNoload Vector based total apparent power of all phases in "No load" state | 0 | Status with load |
| | | 1 | State without load |
| 13 | TASNoload Total apparent power of all phases in "No load" state | 0 | Status with load |
| | | 1 | State without load |
| 14 | TPNoload Total active power of all phases in "No load" state | 0 | Status with load |
| | | 1 | State without load |
| 15 | TQNoload Total reactive power of all phases in "No load" state | 0 | Status with load |
| | | 1 | State without load |

1) Forward direction of energy pulses (positive sign of corresponding energy register)

2) Reverse direction of energy pulses (negative sign of corresponding energy register)

9.1.24.15.6.7 A/D converter system status 4

Name:

SysStatus4

| Data type | Value |
|-----------|--------------------|
| UINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|--------|---|-------|---|
| 0 | LossPhaseC Voltage < failure threshold in the register " PhaseLoseTh " on page 722 | 0 | Voltage within permitted range |
| | | 1 | Voltage less than the failure threshold |
| 1 | LossPhaseB Voltage < failure threshold in the register " PhaseLoseTh " on page 722 | 0 | Voltage within permitted range |
| | | 1 | Voltage less than the failure threshold |
| 2 | LossPhaseA Voltage < failure threshold in the register " PhaseLoseTh " on page 722 | 0 | Voltage within permitted range |
| | | 1 | Voltage less than the failure threshold |
| 3 | Reserved | 0 | |
| 4 | WarningPhaseC Voltage lower than warning threshold in the register " SagTh " on page 722 | 0 | Voltage within permitted range |
| | | 1 | Voltage less than the failure threshold |
| 5 | WarningPhaseB Voltage < warning threshold in the register " SagTh " on page 722 | 0 | Voltage within permitted range |
| | | 1 | Voltage less than the failure threshold |
| 6 | WarningPhaseA Voltage < warning threshold in the register " SagTh " on page 722 | 0 | Voltage within permitted range |
| | | 1 | Voltage less than the failure threshold |
| 7 - 15 | Reserved | 0 | |

9.1.24.15.6.8 Selection A/D converter system status 1

Name:

SystemStatusSel01

The most important bits of the "[SysStatus1](#)" on page 699 register are stored in this register.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---|-------|--|
| 0 - 1 | Reserved | 0 | |
| 2 | SumStatusPhaseLoss Voltage of one or more phases < failure threshold in the register " PhaseLoseTh " on page 722 | 0 | Voltage within permitted range |
| | | 1 | Voltage lower than the failure threshold |
| 3 | SumStatusPhaseWarning Voltage of one or more phases < warning threshold in the register " SagTh " on page 722 | 0 | Voltage within permitted range |
| | | 1 | Voltage lower than the warning threshold |
| 4 - 5 | Reserved | 0 | |
| 6 | ErrOrderPhasecurrent Error in the order of phase currents | 0 | No error |
| | | 1 | Errors |
| 7 | ErrOrderPhaseVoltage Error in the order of phase voltages | 0 | No error |
| | | 1 | Errors |

9.1.24.15.6.9 Selection A/D converter system status 2

Name:

SystemStatusSel02

The most important bits of the "SysStatus2" on page 700 register are stored in this register.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---|-------|--|
| 0 - 1 | Reserved | 0 | |
| 2 | SumStatusWarningTHDCurrent THDIx value of one or more phases > warning threshold in register "THDNITh" on page 722 | 0 | THDIx value within permitted range |
| | | 1 | THDIx value higher than warning threshold |
| 3 | SumStatusWarningTHDVoltage THDUx value of one or more phases > warning threshold in register "THDNUTh" on page 722 | 0 | THDUx value within permitted range |
| | | 1 | THDUx value higher than warning threshold |
| 4 - 5 | Reserved | 0 | |
| 6 | ErrIrmsNCalc The calculated value of the neutral line > warning threshold in the register "INWarnTh0" on page 722 | 0 | Calculated value within permitted range |
| | | 1 | Calculated value higher than warning threshold |
| 7 | ErrIrmsNMeas Measured value of the neutral line > warning threshold in the register "INWarnTh1" on page 722 | 0 | Measured value within permitted range |
| | | 1 | Measured value higher than warning threshold |

9.1.24.15.6.10 Phase status

Name:

PhaseStatus

This register corresponds to the "SysStatus4" on page 701 register. It contains the status of the 3 phases A, B and C.

| Data type | Value |
|-----------|--------------------|
| UINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|--------|---|-------|--------------------------------------|
| 0 | LossPhaseC Voltage < failure threshold in the register "PhaseLoseTh" on page 722 | 0 | Voltage within permitted range |
| | | 1 | Voltage lower than failure threshold |
| 1 | LossPhaseB Voltage < failure threshold in the register "PhaseLoseTh" on page 722 | 0 | Voltage within permitted range |
| | | 1 | Voltage lower than failure threshold |
| 2 | LossPhaseA Voltage < failure threshold in the register "PhaseLoseTh" on page 722 | 0 | Voltage within permitted range |
| | | 1 | Voltage lower than failure threshold |
| 3 | Reserved | 0 | |
| 4 | WarningPhaseC Voltage < warning threshold in the register "SagTh" on page 722 | 0 | Voltage within permitted range |
| | | 1 | Voltage lower than failure threshold |
| 5 | WarningPhaseB Voltage < warning threshold in the register "SagTh" on page 722 | 0 | Voltage within permitted range |
| | | 1 | Voltage lower than failure threshold |
| 6 | WarningPhaseA Voltage < warning threshold in the register "SagTh" on page 722 | 0 | Voltage within permitted range |
| | | 1 | Voltage lower than failure threshold |
| 7 - 15 | Reserved | 0 | |

9.1.24.15.7 Analog RMS value registers**9.1.24.15.7.1 Current RMS value neutral line measured**

Name:

IrmsN

Measured value of the neutral current between the P and N connections on the current terminal, multiplied with the transfer factor of the transformer.

| Data type | Value | Information |
|-----------|------------|---------------------------|
| UINT | 0 to 65535 | Measured value 0.001 Arms |

9.1.24.15.7.2 Voltage RMS value phase A/B/C

Name:

UrmsA

UrmsB

UrmsC

Measured value for N-terminal or virtual zero point.

| Data type | Value | Information |
|-----------|------------|--------------------------|
| UINT | 0 to 65535 | Measured value 0.01 Vrms |

9.1.24.15.7.3 Current RMS value neutral line calculated

Name:

IrmsNcalc

Calculated value of neutral current derived from the other 3 phases.

| Data type | Value | Information |
|-----------|------------|---------------------------|
| UINT | 0 to 65535 | Measured value 0.001 Arms |

9.1.24.15.7.4 Current RMS value phase A/B/C

Name:

IrmsA

IrmsB

IrmsC

Measured value of the phase current between the P and N connections on the current terminal, multiplied with the transfer factor of the transformer.

| Data type | Value | Information |
|-----------|------------|---------------------------|
| UINT | 0 to 65535 | Measured value 0.001 Arms |

9.1.24.15.8 Analog total harmonic distortion (THD) and angle registers**9.1.24.15.8.1 THD and N value voltage phase A/B/C**

Name:
THDNUA
THDNUB
THDNUC

$$\text{Harmonic ratio} = (\text{SQR}(\text{RMS value}_{\text{total}}^2 - \text{RMS value}_{\text{fundamental}}^2)) / \text{RMS value}_{\text{fundamental}}$$

| Data type | Value | Information |
|-----------|------------|------------------|
| UINT | 0 to 10000 | Resolution 0.01% |

9.1.24.15.8.2 THD and N value of current phase A/B/C

Name:
THDNIA
THDNIB
THDNIC

$$\text{Harmonics ratio} = (\text{SQR}(\text{RMS value}_{\text{total}}^2 - \text{RMS value}_{\text{fundamental}}^2)) / \text{RMS value}_{\text{fundamental}}$$

| Data type | Values | Information |
|-----------|------------|------------------|
| UINT | 0 to 10000 | Resolution 0.01% |

9.1.24.15.8.3 Fundamental frequency measured

Name:
Freq

Measured fundamental frequency of phases A, B and C.

| Data type | Value | Information |
|-----------|------------|--------------------|
| UINT | 0 to 10000 | Resolution 0.01 Hz |

9.1.24.15.8.4 Phase angle of power on phase A/B/C

Name:
PAngleA
PAngleB
PAngleC

Middle phase angle (power angle) of the current to the voltage based on the zero-crossing detection.

| Data type | Value | Information |
|-----------|---------------|-----------------|
| INT | -1800 to 1800 | Resolution 0.1° |

9.1.24.15.8.5 Temperature of the converter

Name:
Temperature

This register contains the internal temperature of the transformer component. The temperature is recorded in a 100 ms interval.

| Data type | Value | Information |
|-----------|-------------|----------------|
| INT | -200 to 200 | Resolution 1°C |

9.1.24.15.8.6 Phase angle of voltage on phase A/B/C

Name:
UAngleA
UAngleB
UAngleC

The value for phase A is always 0. On the other phases, the angle corresponds with the offset to A. This is based on the zero-crossing detection.

| Data type | Value | Information |
|-----------|---------------|-----------------|
| INT | -1800 to 1800 | Resolution 0.1° |

9.1.24.15.9 Analog power registers

9.1.24.15.9.1 Vector sum of the total apparent power LSW

Name:

SVmeanTLSB

The value in the register equals a fourth of the actual power.

This value must be multiplied by 4 by the application. Calculation formula for actual power:

$$\text{Actual vector sum of the total apparent power LSW} = \text{register value} * 4 \text{ (complex sum)}$$

| Data type | Value | Information |
|-----------|-----------------|---|
| INT | -32767 to 32767 | Resolution of units/LSB equals 4/65536 VA |

9.1.24.15.9.2 Vector sum of the total apparent power MSW

Name:

SVmeanT

The value in the register equals a fourth of the actual power. The calculation is made in accordance with IEEE 1459.

This value must be multiplied by 4 by the application. Calculation formula for actual power:

$$\text{Actual vector sum of the total apparent power MSW} = \text{register value} * 4 \text{ (complex sum)}$$

| Data type | Value | Information |
|-----------|------------|-----------------|
| INT | 0 to 32767 | Resolution 4 VA |

9.1.24.15.9.3 Total active power

Name:

PmeanT

The value in the register equals a fourth of the actual power. The calculation can be performed in either absolute or arithmetic mode (see register "[MeteringMode](#)" on page 724 <Bit 3>). Each phase can be separately enabled for the power calculation (see register "[MeteringMode](#)" on page 724 <Bits 0, 1 and 2>).

This value must be multiplied by 4 by the application. Calculation formula for actual power:

$$\text{Actual total active power} = \text{Register value} * 4$$

| Data type | Value | Information |
|-----------|-----------------|----------------|
| INT | -32767 to 32767 | Resolution 4 W |

9.1.24.15.9.4 Active power on phase A/B/C

Name:

PmeanA

PmeanB

PmeanC

Active power on the phase. Each phase can be separately enabled for the power calculation (see register "[MeteringMode](#)" on page 724 <Bits 0, 1 and 2>).

| Data type | Value | Information |
|-----------|-----------------|----------------|
| INT | -32767 to 32767 | Resolution 1 W |

9.1.24.15.9.5 Total reactive power

Name:

QmeanT

The value in the register equals a fourth of the actual power. The calculation can be performed in either absolute or arithmetic mode (see register "[MeteringMode](#)" on page 724 <Bit 4>). Each phase can be separately enabled for the power calculation (see register "[MeteringMode](#)" on page 724 <Bits 0, 1 and 2>).

This value must be multiplied by 4 by the application. Calculation formula for actual power:

$$\text{Actual total reactive power} = \text{Register value} * 4$$

| Data type | Value | Information |
|-----------|-----------------|------------------|
| INT | -32767 to 32767 | Resolution 4 var |

9.1.24.15.9.6 Reactive power on phase A/B/C

Name:

QmeanA

QmeanB

QmeanC

Reactive power on the phase. Each phase can be separately enabled for the power calculation (see register "[MeteringMode](#)" on page 724 <Bits 0, 1 and 2>).

| Data type | Value | Information |
|-----------|-----------------|------------------|
| INT | -32767 to 32767 | Resolution 1 var |

9.1.24.15.9.7 Total apparent power

Name:

SmeanT

The value in the register equals a fourth of the actual power. The power is calculated in arithmetic mode. Each phase can be separately enabled for the power calculation (see register "[MeteringMode](#)" on page 724 <Bits 0, 1 and 2>).

This value must be multiplied by 4 by the application. Calculation formula for actual power:

$$\text{Actual total apparent power} = \text{Register value} * 4$$

| Data type | Value | Information |
|-----------|------------|-----------------|
| INT | 0 to 32767 | Resolution 4 VA |

9.1.24.15.9.8 Apparent power on phase A/B/C

Name:

SmeanA

SmeanB

SmeanC

Apparent power on the phase. Each phase can be separately enabled for the power calculation (see register "[MeteringMode](#)" on page 724 <Bits 0, 1 and 2>).

| Data type | Value | Information |
|-----------|------------|-----------------|
| INT | 0 to 32767 | Resolution 1 VA |

9.1.24.15.9.9 Total power factor

Name:

PFmeanT

| Data type | Value | Information |
|-----------|---------------|------------------|
| INT | -1000 to 1000 | Resolution 0.001 |

9.1.24.15.9.10 Power factor on phase A/B/C

Name:

PFmeanA

PFmeanB

PFmeanC

| Data type | Value | Information |
|-----------|---------------|------------------|
| INT | -1000 to 1000 | Resolution 0.001 |

9.1.24.15.9.11 Total active power of fundamental wave

Name:

PmeanTF

The value in the register equals a fourth of the actual power.

This value must be multiplied by 4 by the application. Calculation formula for actual power:

$$\text{Actual total active power of fundamental wave} = \text{Register value} * 4$$

| Data type | Value | Information |
|-----------|-----------------|----------------|
| INT | -32767 to 32767 | Resolution 4 W |

9.1.24.15.9.12 Fundamental wave active power on phase A/B/C

Name:

PmeanAF

PmeanBF

PmeanCF

Active power of fundamental wave on the phase.

| Data type | Value | Information |
|-----------|-----------------|----------------|
| INT | -32767 to 32767 | Resolution 1 W |

9.1.24.15.9.13 Total active power of harmonics

Name:

PmeanTH

The value in the register equals a fourth of the actual power.

This value must be multiplied by 4 by the application. Calculation formula for actual power:

$$\text{Actual total active power of harmonics} = \text{Register value} * 4$$

| Data type | Value | Information |
|-----------|-----------------|----------------|
| INT | -32767 to 32767 | Resolution 4 W |

9.1.24.15.9.14 Harmonics active power on phase A/B/C

Name:

PmeanAH

PmeanBH

PmeanCH

Active power of harmonics on the phase.

| Data type | Value | Information |
|-----------|-----------------|----------------|
| INT | -32767 to 32767 | Resolution 1 W |

9.1.24.15.10 Analog energy registers**9.1.24.15.10.1 Read timestamp for energy register (+0x0022 = 16-bit)**

Name:

SampleTime02_32bit

NetTime timestamp for the readout time of the energy registers.

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

| Data type | Value | Information |
|-----------|---------------------------------|------------------------------|
| DINT | -2,147,483,647 to 2,147,483,647 | NetTime timestamp in μ s |

9.1.24.15.10.2 Forward total reactive energy

Name:

APenergyT

Total active energy in forward direction.

| Data type | Value | Information |
|-----------|-----------------|--|
| UDINT | 0 to 4294967295 | Resolution corresponding to setting in register "Power line constants" on page 723 . |

Notes:

- The register is updated automatically after being enabled, see register ["ControlOutput" on page 698 <bit 1>](#)
- The register is deleted upon request, see register ["ControlOutput" on page 698 <bit 2>](#)
- The register is set upon request, see register ["ControlOutput" on page 698 <bit 3>](#)
- For information about energy unit; see register ["Power line constants" on page 723](#)

9.1.24.15.10.3 Forward active energy on phase A/B/C

Name:

APenergyA

APenergyB

APenergyC

Active energy in forward direction of the phase.

| Data type | Value | Information |
|-----------|-----------------|--|
| UDINT | 0 to 4294967295 | Resolution corresponding to setting in register "Power line constants" on page 723 . |

Notes:

- The register is updated automatically after being enabled, see register ["ControlOutput" on page 698 <bit 1>](#)
- The register is deleted upon request, see register ["ControlOutput" on page 698 <bit 2>](#)
- The register is set upon request, see register ["ControlOutput" on page 698 <bit 3>](#)
- For information about energy unit; see register ["Power line constants" on page 723](#)

9.1.24.15.10.4 Reverse total active energy

Name:

ANenergyT

Total active energy in reverse direction.

| Data type | Value | Information |
|-----------|-----------------|--|
| UDINT | 0 to 4294967295 | Resolution corresponding to setting in register "Power line constants" on page 723 . |

Notes:

- The register is updated automatically after being enabled, see register ["ControlOutput" on page 698 <bit 1>](#)
- The register is deleted upon request, see register ["ControlOutput" on page 698 <bit 2>](#)
- The register is set upon request, see register ["ControlOutput" on page 698 <bit 3>](#)
- For information about energy unit; see register ["Power line constants" on page 723](#)

9.1.24.15.10.5 Reverse active energy on phase A/B/C

Name:

ANenergyA

ANenergyB

ANenergyC

Active energy in reverse direction of the phase.

| Data type | Value | Information |
|-----------|-----------------|---|
| UDINT | 0 to 4294967295 | Resolution corresponding to setting in register "Power line constants" on page 723. |

Notes:

- The register is updated automatically after being enabled, see register "ControlOutput" on page 698 <bit 1>
- The register is deleted upon request, see register "ControlOutput" on page 698 <bit 2>
- The register is set upon request, see register "ControlOutput" on page 698 <bit 3>
- For information about energy unit; see register "Power line constants" on page 723

9.1.24.15.10.6 Forward total reactive energy

Name:

RPenergyT

Total reactive energy in forward direction.

| Data type | Value | Information |
|-----------|-----------------|---|
| UDINT | 0 to 4294967295 | Resolution corresponding to setting in register "Power line constants" on page 723. |

Notes:

- The register is updated automatically after being enabled, see register "ControlOutput" on page 698 <bit 1>
- The register is deleted upon request, see register "ControlOutput" on page 698 <bit 2>
- The register is set upon request, see register "ControlOutput" on page 698 <bit 3>
- For information about energy unit; see register "Power line constants" on page 723

9.1.24.15.10.7 Forward reactive energy on phase A/B/C

Name:

RPenergyA

RPenergyB

RPenergyC

Reactive energy in forward direction of the phase.

| Data type | Value | Information |
|-----------|-----------------|---|
| UDINT | 0 to 4294967295 | Resolution corresponding to setting in register "Power line constants" on page 723. |

Notes:

- The register is updated automatically after being enabled, see register "ControlOutput" on page 698 <bit 1>
- The register is deleted upon request, see register "ControlOutput" on page 698 <bit 2>
- The register is set upon request, see register "ControlOutput" on page 698 <bit 3>
- For information about energy unit; see register "Power line constants" on page 723

9.1.24.15.10.8 Reverse total reactive energy

Name:

RNenergyT

Total reactive energy in reverse direction.

| Data type | Value | Information |
|-----------|-----------------|---|
| UDINT | 0 to 4294967295 | Resolution corresponding to setting in register "Power line constants" on page 723. |

Notes:

- The register is updated automatically after being enabled, see register "ControlOutput" on page 698 <bit 1>
- The register is deleted upon request, see register "ControlOutput" on page 698 <bit 2>
- The register is set upon request, see register "ControlOutput" on page 698 <bit 3>
- For information about energy unit; see register "Power line constants" on page 723

9.1.24.15.10.9 Reverse reactive energy of the phase A/B/C

Name:

RNenergyA

RNenergyB

RNenergyC

Reactive energy in reverse direction of the phase.

| Data type | Value | Information |
|-----------|-----------------|---|
| UDINT | 0 to 4294967295 | Resolution corresponding to setting in register "Power line constants" on page 723. |

Notes:

- The register is updated automatically after being enabled, see register "ControlOutput" on page 698 <bit 1>
- The register is deleted upon request, see register "ControlOutput" on page 698 <bit 2>
- The register is set upon request, see register "ControlOutput" on page 698 <bit 3>
- For information about energy unit; see register "Power line constants" on page 723

9.1.24.15.10.10 Arithmetic total apparent energy

Name:

SAenergyT

| Data type | Value | Information |
|-----------|-----------------|---|
| UDINT | 0 to 4294967295 | Resolution corresponding to setting in register "Power line constants" on page 723. |

Notes:

- The register is updated automatically after being enabled, see register "ControlOutput" on page 698 <bit 1>
- The register is deleted upon request, see register "ControlOutput" on page 698 <bit 2>
- The register is set upon request, see register "ControlOutput" on page 698 <bit 3>
- For information about energy unit; see register "Power line constants" on page 723

9.1.24.15.10.11 Apparent energy on phase A/B/C

Name:

SenenergyA

SenenergyB

SenenergyC

| Data type | Value | Information |
|-----------|-----------------|---|
| UDINT | 0 to 4294967295 | Resolution corresponding to setting in register "Power line constants" on page 723. |

Notes:

- The register is updated automatically after being enabled, see register "ControlOutput" on page 698 <bit 1>
- The register is deleted upon request, see register "ControlOutput" on page 698 <bit 2>
- The register is set upon request, see register "ControlOutput" on page 698 <bit 3>
- For information about energy unit; see register "Power line constants" on page 723

9.1.24.15.10.12 Vectorized total apparent energy

Name:
SVenergyT

| Data type | Value | Information |
|-----------|-----------------|---|
| UDINT | 0 to 4294967295 | Resolution corresponding to setting in register "Power line constants" on page 723. |

Notes:

- The register is updated automatically after being enabled, see register "ControlOutput" on page 698 <bit 1>
- The register is deleted upon request, see register "ControlOutput" on page 698 <bit 2>
- The register is set upon request, see register "ControlOutput" on page 698 <bit 3>
- For information about energy unit; see register "Power line constants" on page 723

9.1.24.15.10.13 Forward fundamental wave total active energy

Name:
APenergyTF

Fundamental wave of total active energy in forward direction.

| Data type | Value | Information |
|-----------|-----------------|---|
| UDINT | 0 to 4294967295 | Resolution corresponding to setting in register "Power line constants" on page 723. |

Notes:

- The register is updated automatically after being enabled, see register "ControlOutput" on page 698 <bit 1>
- The register is deleted upon request, see register "ControlOutput" on page 698 <bit 2>
- The register is set upon request, see register "ControlOutput" on page 698 <bit 3>
- For information about energy unit; see register "Power line constants" on page 723

9.1.24.15.10.14 Forward fundamental wave active energy on phase A/B/C

Name:
APenergyAF
APenergyBF
APenergyCF

Fundamental wave of active energy in forward direction of the phase.

| Data type | Value | Information |
|-----------|-----------------|---|
| UDINT | 0 to 4294967295 | Resolution corresponding to setting in register "Power line constants" on page 723. |

Notes:

- The register is updated automatically after being enabled, see register "ControlOutput" on page 698 <bit 1>
- The register is deleted upon request, see register "ControlOutput" on page 698 <bit 2>
- The register is set upon request, see register "ControlOutput" on page 698 <bit 3>
- For information about energy unit; see register "Power line constants" on page 723

9.1.24.15.10.15 Reverse fundamental wave total active energy

Name:
ANenergyTF

Fundamental wave of total active energy in reverse direction.

| Data type | Value | Information |
|-----------|-----------------|---|
| UDINT | 0 to 4294967295 | Resolution corresponding to setting in register "Power line constants" on page 723. |

Notes:

- The register is updated automatically after being enabled, see register "ControlOutput" on page 698 <bit 1>
- The register is deleted upon request, see register "ControlOutput" on page 698 <bit 2>
- The register is set upon request, see register "ControlOutput" on page 698 <bit 3>
- For information about energy unit; see register "Power line constants" on page 723

9.1.24.15.10.16 Reverse fundamental wave active energy on phase A/B/C

Name:

ANenergyAF

ANenergyBF

ANenergyCF

Fundamental wave of active energy in reverse direction of the phase.

| Data type | Value | Information |
|-----------|-----------------|---|
| UDINT | 0 to 4294967295 | Resolution corresponding to setting in register "Power line constants" on page 723. |

Notes:

- The register is updated automatically after being enabled, see register "ControlOutput" on page 698 <bit 1>
- The register is deleted upon request, see register "ControlOutput" on page 698 <bit 2>
- The register is set upon request, see register "ControlOutput" on page 698 <bit 3>
- For information about energy unit; see register "Power line constants" on page 723

9.1.24.15.10.17 Forward harmonics total active energy

Name:

APenergyTH

Harmonics of total active energy in forward direction.

| Data type | Value | Information |
|-----------|-----------------|---|
| UDINT | 0 to 4294967295 | Resolution corresponding to setting in register "Power line constants" on page 723. |

Notes:

- The register is updated automatically after being enabled, see register "ControlOutput" on page 698 <bit 1>
- The register is deleted upon request, see register "ControlOutput" on page 698 <bit 2>
- The register is set upon request, see register "ControlOutput" on page 698 <bit 3>
- For information about energy unit; see register "Power line constants" on page 723

9.1.24.15.10.18 Forward harmonics active energy on phase A/B/C

Name:

APenergyAH

APenergyBH

APenergyCH

Harmonics of active energy in forward direction of the phase.

| Data type | Value | Information |
|-----------|-----------------|---|
| UDINT | 0 to 4294967295 | Resolution corresponding to setting in register "Power line constants" on page 723. |

Notes:

- The register is updated automatically after being enabled, see register "ControlOutput" on page 698 <bit 1>
- The register is deleted upon request, see register "ControlOutput" on page 698 <bit 2>
- The register is set upon request, see register "ControlOutput" on page 698 <bit 3>
- For information about energy unit; see register "Power line constants" on page 723

9.1.24.15.10.19 Reverse harmonics total active energy

Name:

ANenergyTH

Harmonics of total active energy in forward direction.

| Data type | Value | Information |
|-----------|-----------------|---|
| UDINT | 0 to 4294967295 | Resolution corresponding to setting in register "Power line constants" on page 723. |

Notes:

- The register is updated automatically after being enabled, see register "ControlOutput" on page 698 <bit 1>
- The register is deleted upon request, see register "ControlOutput" on page 698 <bit 2>
- The register is set upon request, see register "ControlOutput" on page 698 <bit 3>
- For information about energy unit; see register "Power line constants" on page 723

9.1.24.15.10.20 Reverse harmonics active energy on phase A/B/C

Name:

ANenergyAH

ANenergyBH

ANenergyCH

Harmonics of active energy in reverse direction of the phase.

| Data type | Value | Information |
|-----------|-----------------|---|
| UDINT | 0 to 4294967295 | Resolution corresponding to setting in register "Power line constants" on page 723. |

Notes:

- The register is updated automatically after being enabled, see register "ControlOutput" on page 698 <bit 1>
- The register is deleted upon request, see register "ControlOutput" on page 698 <bit 2>
- The register is set upon request, see register "ControlOutput" on page 698 <bit 3>
- For information about energy unit; see register "Power line constants" on page 723

9.1.24.15.10.21 Total active energy combined

Name:

AenergyT

Total active energy in forward and backward direction.

Internal calculation formula for the total active energy:

$$AenergyT = (DINT)(APenergyT - ANenergyT)$$

Calculation overflows are ignored

| Data type | Value | Information |
|-----------|---------------------------------|---|
| DINT | -2,147,483,647 to 2,147,483,647 | Resolution corresponding to setting in register "Power line constants" on page 723. |

Notes:

- The register is updated automatically after being enabled, see register "ControlOutput" on page 698 <bit 1>
- The register is deleted upon request, see register "ControlOutput" on page 698 <bit 2>
- The register is set upon request, see register "ControlOutput" on page 698 <bit 3>
- For information about energy unit; see register "Power line constants" on page 723

9.1.24.15.10.22 Total reactive energy combined

Name:

REnergyT

Total reactive energy in forward and backward direction.

Internal calculation formula for the total reactive energy:

| Data type | Value | Information |
|-----------|---------------------------------|---|
| DINT | -2,147,483,647 to 2,147,483,647 | Resolution corresponding to setting in register "Power line constants" on page 723. |

Notes:

- The register is updated automatically after being enabled, see register "ControlOutput" on page 698 <bit 1>
- The register is deleted upon request, see register "ControlOutput" on page 698 <bit 2>
- The register is set upon request, see register "ControlOutput" on page 698 <bit 3>
- For information about energy unit; see register "Power line constants" on page 723

9.1.24.15.11 Analog discrete Fourier transformation register (DFT)**9.1.24.15.11.1 Read timestamp for DFT register (+0x0022 = 16-bit)**

Name:

SampleTime03_32bit

NetTime timestamp for the readout time of the DFT registers.

| Data type | Value | Information |
|-----------|---------------------------------|------------------------------|
| DINT | -2,147,483,647 to 2,147,483,647 | NetTime timestamp in μ s |

9.1.24.15.11.2 Harmonic distortion register (HD) current I and voltage V for phases A/B/C

Name:

DftAI0 to DftAI30

DftAV0 to DftAV30

DftBI0 to DftBI30

DftBV0 to DftBV30

DftCI0 to DftCI30

DftCV0 to DftCV30

Ratio of 2nd to 32nd order harmonic wave components.

Conversion from % = register value / 163.84

| Data type | Value | Information |
|-----------|------------|------------------------------|
| UINT | 0 to 32767 | Ratio of frequency component |

9.1.24.15.11.3 THD register current I and voltage V for phases A/B/C

Name:

DftAI31

DftAV31

DftBI31

DftBV31

DftCI31

DftCV31

Ratio of total harmonic distortion.

Conversion from % = register value / 163.84

| Data type | Value | Information |
|-----------|------------|--|
| UINT | 0 to 32767 | Total harmonic distortion on phase A current |

9.1.24.15.11.4 Fundamental wave current on phase A/B/C

Name:

DftAI_Fund

DftBI_Fund

DftCI_Fund

Calculation of the fundamental wave current

| Data type | Values | Information |
|-----------|------------|--------------------------------|
| UINT | 0 to 32767 | Fundamental wave current in mA |

The fundamental wave current is calculated according to the following formula:

Standard calculation

"Fundamental wave current"_{Current} = "Register value" * 3.2656^{-3} * {"Ratio"} over {"Ratio"_"Default"}}

$$\text{Fundamental wave current}_{\text{Current}} = \text{Register value} * 3.2656^{-3} * \frac{\text{Ratio}}{\text{Ratio}_{\text{Default}}}$$

Inverted calculation

"Fundamental wave current"_{Current} = "Register value" * 3.2656^{-3} * {"Ratio"_"Default"} over {"Ratio"}}

$$\text{Fundamental wave current}_{\text{Current}} = \text{Register value} * 3.2656^{-3} * \frac{\text{Ratio}_{\text{Default}}}{\text{Ratio}}$$

Legend

Register value The value of this register

Ratio Configured rated value (see ["Current transformer rating phase A/B/C/N" on page 719](#)).Ratio_{Default} The default rated value depends on the AP module being used:

| Module | Value |
|------------|------------------------------|
| X20AP3111 | 25000 |
| X20AP3121 | 500 |
| X20AP3131 | 100 |
| X20AP3161 | 500 |
| X20AP3171 | Default: 5000 Inverted: 1 |
| All others | 1 |

9.1.24.15.11.5 Fundamental wave voltage on phase A/B/C

Name:

DftAV_Fund

DftBV_Fund

DftCV_Fund

Calculation of the fundamental wave voltage

| Data type | Values | Information |
|-----------|------------|------------------------------------|
| UINT | 0 to 32767 | Fundamental value voltage in volts |

The fundamental wave voltage is calculated according to the following formula:

$$\text{Fundamental wave current}_{\text{Voltage}} = \text{Register value} * 3.2656^{-2}$$

9.1.24.15.12 Environment variables**9.1.24.15.12.1 Operating time**

Name:

ulUpTime

Total operating time of the module.

| Data type | Value | Information |
|-----------|--------------------|---------------------------|
| UDINT | 0 to 4,294,967,295 | Operating time in seconds |

9.1.24.15.12.2 Switch-on and reset counter

Name:

ulUpCount

Switch-on and reset counter of the module.

| Data type | Value | Information |
|-----------|--------------------|-----------------------------|
| UDINT | 0 to 4,294,967,295 | Switch-on and reset counter |

9.1.24.15.12.3 Minimum operating temperature

Name:

ssMinTemp

Lowest measured module temperature since the last time it was started.

| Data type | Value | Information |
|-----------|-------------|----------------|
| INT | -200 to 200 | Resolution 1°C |

9.1.24.15.12.4 Maximum operating temperature

Name:

ssMaxTemp

Highest measured module temperature since the last time it was started.

| Data type | Value | Information |
|-----------|-------------|----------------|
| INT | -200 to 200 | Resolution 1°C |

9.1.24.15.13 Module configuration

9.1.24.15.13.1 Mode register

Name:
ChanControl

| Data type | Value | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| UINT | See bit structure. | 15 |

Bit structure:

| Bit | Name | Value | Information |
|--------|--|---------|---|
| 0 | Channel status LED for phase A | 0 | Off |
| | | 1 | On (bus controller default setting) |
| 1 | Channel status LED for phase B | 0 | Off |
| | | 1 | On (bus controller default setting) |
| 2 | Channel status LED for phase C | 0 | Off |
| | | 1 | On (bus controller default setting) |
| 3 | Reserved | 0 | |
| 4 | Neutral current monitor and status LED | 0 | Off (bus controller default setting) |
| | | 1 | On |
| 5 | Neutral current status derived from the calculated or measured value | 0 | Derived from the calculated value (bus controller default setting) |
| | | 1 | Derived from the measured value |
| 6 | Conversion of energy register to Wh and kWh ²⁾ | 0 | Disabled (1 Ws, 10 Ws, 100 Ws, 1 kWh) (bus controller default setting) |
| | | 1 | Enabled (1 Wh and 1 kWh) |
| 7 | Display current values despite power failure ³⁾ | 0 | Off ³⁾ (bus controller default setting) |
| | | 1 | On |
| 8 - 15 | Oversampling with prescaler | 0 | Disabled (bus controller default setting) |
| | | 1 - 255 | Enabled Sample cycle time as a multiple of 125 µs; only in the "Oversampling" function model |

- 1) When 1 Wh and 1 kWh are set, the energy pulses on the register "Status signals and responses" on page 697 may not be used.
- 2) When a power failure occurs, all current values are held at 0 by default.
- 3) According to the power failure status of the individual phases, the following values are held at 0 by default.
 - Mains frequency, phase angle, power factor
 - Effective voltage and current values
 - Active, reactive and apparent power values

9.1.24.15.13.2 Analog minimum current for active current channel LEDs

Name:
IDispTh

The indicator threshold defines the RMS value of the current at which the status LED for the phase current is illuminated. The default values vary from module to module and should be adjusted to the maximum primary current.

Suggestion: 1% of maximum value

| Data type | Value | Information | |
|-----------|------------|---|----------------------------|
| UINT | 1 to 65000 | RMS indicator threshold in mA. Bus controller default setting: | |
| | | Module | Indicator threshold |
| | | X20AP3111 | 200 mA |
| | | X20AP3121/22 | 500 mA |
| | | X20AP3131/32 | 500 mA |
| | | X20AP3161 | 500 mA |
| | | X20AP3171 | 500 mA |

9.1.24.15.13.3 Current transformer rating phase A/B/C/N

Name:

I_RatioA

I_RatioB

I_RatioC

I_RatioN

The following current transformer measurements are applied in these registers. The permissible values are module-dependent (0.1 resolution).

- **X20AP3111, 3121/22 and 3131/32:** The measured current is multiplied by the current transformation ratio.
- **X20AP3161:** The maximum primary current of the transformer is configured.
- **X20AP3171:** The current transformation ratio of the Rogowski coil is entered. This is the voltage in μV that the coil provides at 10 A primary current (0.1 $\mu\text{V/A}$).

| Data type | Value | Information | |
|-----------|---|---|---|
| UINT | x | Current transformer measurement. Bus controller default setting: | |
| | | Module | |
| | | Rating | |
| | | X20AP3111 | Transformation ratio: 10 to 32500. Bus controller default setting: 25000 |
| | | X20AP3121/22 | Transformation ratio: 10 to 650. Bus controller default setting: 500 |
| | | X20AP3131/32 | Transformation ratio: 10 to 130. Bus controller default setting: 100 |
| | | X20AP3161 | Measurement range: 50 to 650. Bus controller default setting: 500 |
| X20AP3171 | Current transformation ratio (I_Ratio / 5000): 2550 to 8000. Bus controller default setting: 10000 | | |

Information:

The maximum resulting current must not exceed the value of 65000 mA.

9.1.24.15.14 Update requests

9.1.24.15.14.1 User configuration

The following procedure has to be complied with to apply the new values in a configuration change.

- 1) Writing update register
 - CfgUpdate = 0xFFFF
 - Cs0Update = 0xFFFF
- 2) Writing the desired configuration register
- 3) Writing update register
 - CfgUpdate = 0x1
 - Cs0Update = 0x1

9.1.24.15.14.2 Update request status configuration register

Name:

CfgUpdate

The registers in section "[A/D converter status configuration](#)" on page 721 are only applied after changing this register. Writing with 0xFFFF only resets this register without applying the values.

| Data type | Value | Information |
|-----------|------------|--|
| UINT | 0 to 65535 | Update request. Bus controller default setting: 65535 |

9.1.24.15.14.3 Update request A/D converter Cs0, Cs1 and Cs3 register

Name:

Cs0Update

Cs1Update

Cs3Update

The register of the respective section is only applied after changing the corresponding Cs_xUpdate register. These are:

- Cs0Update: 3 registers in section "[A/D converter measurement configuration checksum 0](#)" on page 723
- Cs1Update: 3 registers in "[A/D converter power calibration checksum 1](#)" on page 728
- Cs3Update: 14 registers in section "[A/D converter RMS value synchronization checksum 3](#)" on page 726

Writing with 0xFFFF only resets this register without applying the value.

| Data type | Value | Information |
|-----------|------------|--|
| UINT | 0 to 65535 | Update request. Bus controller default setting: 65535 |

9.1.24.15.14.4 Reading update request A/D converter Cs1 and Cs3 register

Name:

Cs1UpdateFB

Cs3UpdateFB

The A/D converter configuration registers in the sections "[A/D converter status configuration](#)" on page 721 and "[A/D converter measurement configuration checksum 0](#)" on page 723 are only transferred to the feedback buffer after transfer to the A/D converter is complete.

| Data type | Value | Information |
|-----------|------------|-------------|
| UINT | 0 to 65535 | |

9.1.24.15.15 A/D converter status configuration

Changes in the registers in this section are only applied after an update request in register "CfgUpdate" on page 719.

9.1.24.15.15.1 A/D converter hardware signal pinout

Name:
ZXConfig

| Data type | Value | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| UINT | See bit structure. | 0x4400 |

Bit structure:

| Bit | Name | Value | Information |
|---------|---|-------|---|
| 0 | Zero cross signals | 0 | Enabled (bus controller default setting) |
| | | 1 | Disabled |
| 1 - 2 | ZX20Con Trigger zero crossing | 00 | Positive zero crossing (bus controller default setting) |
| | | 01 | Negative zero crossing |
| | | 10 | Both zero cross-overs |
| | | 11 | No zero crossing |
| 3 - 4 | ZX1Con Trigger zero crossing | 00 | Positive zero crossing (bus controller default setting) |
| | | 01 | Negative zero crossing |
| | | 10 | Both zero cross-overs |
| | | 11 | No zero crossing |
| 5 - 6 | ZX2Con Trigger zero crossing | 00 | Positive zero crossing (bus controller default setting) |
| | | 01 | Negative zero crossing |
| | | 10 | Both zero cross-overs |
| | | 11 | No zero crossing |
| 7 - 9 | ZX0Src Signal source for ZX0 hardware signal | 000 | Voltage A (bus controller default setting) |
| | | 001 | Voltage B |
| | | 010 | Voltage C |
| | | 011 | Fix 0 |
| | | 100 | Current A |
| | | 101 | Current B |
| | | 110 | Current C |
| | | 111 | Fix 0 |
| 10 - 12 | ZX1Src Signal source for ZX1 hardware signal | 000 | Voltage A |
| | | 001 | Voltage B (bus controller default setting) |
| | | 010 | Voltage C |
| | | 011 | Fix 0 |
| | | 100 | Current A |
| | | 101 | Current B |
| | | 110 | Current C |
| | | 111 | Fix 0 |
| 13 - 15 | ZX2Src Signal source for ZX2 hardware signal | 000 | Voltage A |
| | | 001 | Voltage B |
| | | 010 | Voltage C (bus controller default setting) |
| | | 011 | Fix 0 |
| | | 100 | Current A |
| | | 101 | Current B |
| | | 110 | Current C |
| | | 111 | Fix 0 |

9.1.24.15.15.2 Voltage warning threshold

Name:

SagTh

This register defines an RMS voltage value for monitoring the voltage warning signals.

| Data type | Value | Information |
|-----------|---------------|---|
| UINT | 5000 to 50000 | Resolution 0.01 V. Bus controller default setting: 12368 |

9.1.24.15.15.3 Power failure threshold

Name:

PhaseLoseTh

This register defines an RMS voltage value for monitoring the power failure signals.

| Data type | Value | Information |
|-----------|--------------|--|
| UINT | 1000 to 6000 | Resolution 0.01 V. Bus controller default setting: 2420 |

9.1.24.15.15.4 Warning threshold for the calculated neutral current

Name:

INWarnTh0

Current value for monitoring the calculated neutral line current.

| Data type | Value | Information |
|-----------|------------|---|
| UINT | 0 to 65000 | Resolution 0.001 A. Bus controller default setting: 50 |

9.1.24.15.15.5 Warning threshold for the measured neutral current.

Name:

INWarnTh1

Current value for monitoring the measured neutral line current.

| Data type | Value | Information |
|-----------|------------|---|
| UINT | 0 to 65000 | Resolution 0.001 A. Bus controller default setting: 50 |

9.1.24.15.15.6 Warning threshold for exceeding voltage THD

Name:

THDNUTh

Percentage value defining warning threshold for THD ratio.

| Data type | Value | Information |
|-----------|------------|---|
| UINT | 0 to 10000 | Resolution 0.01%. Bus controller default setting: 1000 |

9.1.24.15.15.7 Warning threshold for exceeding current THD

Name:

THDNITh

Percentage value defining warning threshold for THD ratio.

| Data type | Value | Information |
|-----------|------------|---|
| UINT | 0 to 10000 | Resolution 0.01%. Bus controller default setting: 1000 |

9.1.24.15.16 A/D converter measurement configuration checksum 0

Changes in the registers in this section are only applied after an update request in register "Cs0Update" on page 720.

9.1.24.15.16.1 Power line constants

Name:

PLconstH

PLconstL

Base value for power line constant.

10 increments in the energy register result in 1 energy pulse. Base value 0x4A81 7C80 = 1,250,000,000 corresponds to 360 energy pulses per kWh or 0.1 energy pulses per kWh. In the energy registers, this results in 1 kWh per position.

The two registers can be set to the following values. Other values are not allowed

| Data type | PLConstH | PLConstL | 1 increment in the energy register corresponds to: |
|-----------|----------|----------|--|
| UINT | 0x0013 | 0x12D0 | 1 Ws ¹⁾ |
| | 0x00BE | 0xBC20 | 10 Ws ¹⁾ |
| | 0x0773 | 0x5940 | 100 Ws ¹⁾ |
| | 0x4A81 | 0x7C80 | 1 kWh ¹⁾ (bus controller default setting) |
| | 0x0010 | 0x0034 | 1 Wh ²⁾ |
| | 0x417B | 0xCE6C | 1 kWh ²⁾ |

1) Register "ChanControl" on page 718, bit 6 = 0

2) Register "ChanControl" on page 718, bit 6 = 1

Information:

When 1 Wh and 1 kWh are set, the energy pulses on the register "StatusInput" on page 697 may not be used.

9.1.24.15.16.2 Analog A/D converter measurement setting 1

Name:

MeteringMode

| Data type | Value | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| UINT | See bit structure. | 135 |

Bit structure:

| Bit | Name | Value | Information |
|---------|--|-------|--|
| 0 | Enables phase C for adding the power and energy values together | 0 | Not released |
| | | 1 | Enabled (bus controller default setting) |
| 1 | Enables phase B for adding the power and energy values together | 0 | Not released |
| | | 1 | Enabled (bus controller default setting) |
| 2 | Enables phase A for adding the power and energy values together | 0 | Not released |
| | | 1 | Enabled (bus controller default setting) |
| 3 | Calculation method for adding active power and active energy | 0 | Arithmetic sum (bus controller default setting) |
| | | 1 | Absolute sum |
| 4 | Calculation method for adding reactive power and reactive energy | 0 | Arithmetic sum (bus controller default setting) |
| | | 1 | Absolute sum |
| 5 | Reserved | 0 | |
| 6 | Selects apparent energy for Energypulse2-Source | 0 | Arithmetic sum (bus controller default setting) |
| | | 1 | Vector sum |
| 7 | Energypulse2-Source | 0 | Apparent energy |
| | | 1 | Reactive energy (bus controller default setting) |
| 8 | Measuring configuration | 0 | 3P4W (bus controller default setting) |
| | | 1 | 3P3W |
| 9 | Resolution of energy register | 0 | Must be 0! |
| 10 | Integrator for DIDT current transformer | 0 | Off (bus controller default setting) |
| | | 1 | On |
| 11 | High-pass filter | 0 | On (bus controller default setting) |
| | | 1 | Off |
| 12 | Basis frequency | 0 | 50 Hz (bus controller default setting) |
| | | 1 | 60 Hz |
| 13 | Phase assignment | 0 | I1 to phase A and I3 to phase C (bus controller default setting) |
| | | 1 | I1 to Phase C and I3 to Phase A |
| 14 - 15 | Reserved | 0 | |

Comments regarding measurement configurations:

| Measuring configuration | Note |
|-------------------------|--|
| 3P4W | Monitors the phasing of voltages and currents: Phase A before phase B before phase C |
| 3P3W | Measuring configuration: Phase A and phase C, N connection bridges to phase B or open |
| | Measurement: e.g. the 2 phases A and C and the 2 corresponding currents are measured, phase B disabled |
| | Monitors the phasing of voltages and currents: Phase difference between A and C >180° |

9.1.24.15.17 User calibration of current and voltage values

Use the following procedure to properly calculate gain and offset:

- Read out the predefined values:
See ["A/D converter RMS value synchronization – read"](#) on page 725.
- Calculate and set new values:
See ["A/D converter RMS value synchronization checksum 3"](#) on page 726.
- Update predefined values by setting the register ["Cs3Update"](#) on page 720. The predefined values have been updated when the value in the register ["Cs3UpdateFB"](#) on page 720 is equal to the value of <Cs3Update>.

9.1.24.15.18 A/D converter RMS value synchronization – read**9.1.24.15.18.1 General information**

The values in the registers specified in this section must be read at the beginning of the calibration. This is the only way to ensure that the gain and offset will be calculated correctly.

The values contained in the registers correspond to the value_{old} in the calculation formulas for gain and offset (see ["A/D converter RMS value synchronization checksum 3"](#) on page 726).

9.1.24.15.18.2 Voltage RMS value gain phase A/B/C

Name:

UGainA_R

UGainB_R

UGainC_R

| Data type | Value |
|-----------|------------|
| UINT | 0 to 65535 |

9.1.24.15.18.3 Current RMS value gain phase A/B/C/N

Name:

IGainA_R

IGainB_R

IGainC_R

IGainN_R

| Data type | Value |
|-----------|------------|
| UINT | 0 to 65535 |

9.1.24.15.18.4 Voltage RMS value offset phase A/B/C

Name:

UoffsetA_R

UoffsetB_R

UoffsetC_R

| Data type | Value |
|-----------|-----------------|
| INT | -32767 to 32767 |

9.1.24.15.18.5 Current RMS value offset phase A/B/C/N

Name:

loffsetA_R

loffsetB_R

loffsetC_R

loffsetN_R

| Data type | Value |
|-----------|-----------------|
| INT | -32767 to 32767 |

9.1.24.15.19 A/D converter RMS value synchronization checksum 3

Changes in the registers in this section are only applied after an update request in register "Cs3Update" on page 720.

9.1.24.15.19.1 Voltage RMS value gain phase A/B/C

Name:

UGainA_W

UGainB_W

UGainC_W

The resulting gain is calculated using the following formula:

$$\text{Value}_{\text{new}} = \text{Value}_{\text{old}} * \text{correction factor, determined when } U = U_n$$

| Data type | Value | Information |
|-----------|------------|---|
| UINT | 0 to 65535 | Voltage RMS value gain, phase-based. Bus controller default setting: 26400 |

9.1.24.15.19.2 Current RMS value gain phase A/B/C/N

Name:

IGainA_W

IGainB_W

IGainC_W

IGainN_W

The resulting gain is calculated using the following formula:

$$\text{Value}_{\text{new}} = \text{Value}_{\text{old}} * \text{correction factor, determined when } I = I_n$$

| Data type | Value | Information |
|-----------|------------|--|
| UINT | 0 to 65535 | Current RMS value gain, phase-based. Bus controller default setting: X20AP3111, X20AP312x: 31248 X20AP313x: 38704 X20AP3161: 23339 X20AP3171: 16653 |

9.1.24.15.19.3 Voltage RMS value offset phase A/B/C

Name:

UoffsetA_W

UoffsetB_W

UoffsetC_W

Corresponds to the negated value of the corresponding RMS value register when U = 0.

| Data type | Value | Information |
|-----------|-----------------|---|
| INT | -32767 to 32767 | RMS value voltage offset, phase-based. Bus controller default setting: 0 |

9.1.24.15.19.4 Current RMS value offset phase A/B/C/N

Name:

IoffsetA_W

IoffsetB_W

IoffsetC_W

IoffsetN_W

Corresponds to the negated value of the corresponding RMS value register when I = 0.

| Data type | Value | Information |
|-----------|-----------------|---|
| INT | -32767 to 32767 | RMS value current offset, phase-based. Bus controller default setting: 0 |

9.1.24.15.20 User calibration of power values

Use the following procedure to properly calculate the power angle correction:

- 1) Calculate the values
- 2) Write the value 0xFFFF to register "Cs1Update" on page 720
- 3) Read register "Cs1UpdateFB" on page 720 until 0xFFFF is returned
- 4) Write the calculated values to the registers "PhiA_W, PhiB_W, PhiC_W" on page 728
- 5) Write the value 0x0001 to register Cs1Update
- 6) Read register Cs1UpdateFB until 0x0001 is returned

Information:

These registers are NOT nonvolatile, and the process needs to be repeated after every PowerOn and every rising edge of the ModuleOK bit.

9.1.24.15.20.1 A/D converter power angle correction phase A/B/C

Name:

PhiA_R

PhiB_R

PhiC_R

These registers can be used to read out the configured values at runtime, but are not nonvolatile and have the value 0 after the system is started.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|---------|--|-------|---|
| 0 - 9 | Delay time for energy phase angle correction | x | The clock base is 2.048 MHz. Maximum 0.499 ms |
| 10 - 14 | Reserved | 0 | |
| 15 | Delay times | 0 | Effect on current channel |
| | | 1 | Effect on voltage channel |

9.1.24.15.20.2 A/D converter power calibration checksum 1

Name:
PhiA_W
PhiB_W
PhiC_W

These registers can be used to correct phase shifts at runtime. This can be necessary if the transformers used distort the phase shift.

Changes in these registers are only applied after an update request in register "Cs1Update" on page 720.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Name | Value | Information |
|---------|--|-----------|---|
| 0 - 9 | Delay time for energy phase angle correction | 0 to 1023 | See description for bits 0 to 9. Bus controller default setting: 0 |
| 10 - 14 | Reserved | 0 | |
| 15 | Delay times | 0 or 1 | See description for Bit 15 |

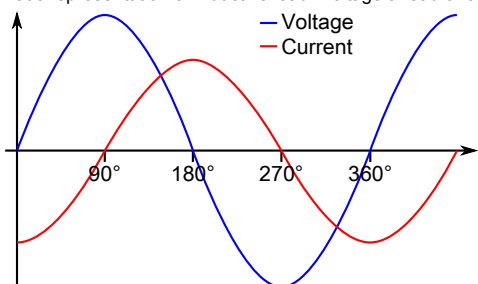
Description - Bits 0 to 9

The maximum correction 0x3FF = 1023 dec. corresponds to 0.49951 ms.

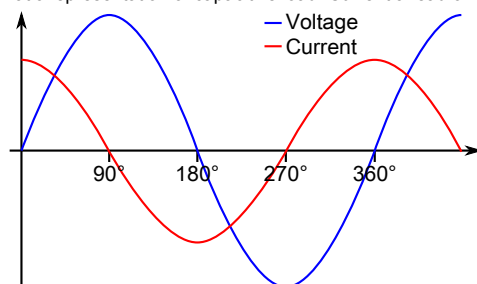
At 50 Hz mains this corresponds to a change of 8.99 degrees

At 60 Hz mains this corresponds to a change of 10.79 degrees

Schematic representation of inductive load: Voltage ahead of current



Schematic representation of capacitive load: Current ahead of voltage



Description - Bit 15

| | | |
|---|--|--|
| 0 | Delay affects current channel Effect with inductive load Effect with capacitive load | Reduced angle between I and U, and therefore an increased power factor Increased angle between U and I, and therefore an reduced power factor |
| 1 | Delay affects voltage channel Effect with inductive load Effect with capacitive load | Reduced angle between U and I, and therefore an increased power factor Increased angle between I and U, and therefore an reduced power factor |

9.1.24.15.21 Force analog energy registers

Name:

The registers are described under "[Analog energy registers](#)" on page 708. A corresponding comparison attached:

| Force registers | Read registers |
|---|----------------|
| Frc_APenergyT Frc_APenergyTF Frc_APenergyTH | "APenergyT" |
| Frc_APenergyA Frc_APenergyAF Frc_APenergyAH | "APenergyA" |
| Frc_APenergyB Frc_APenergyBF Frc_APenergyBH | "APenergyB" |
| Frc_APenergyC Frc_APenergyCF Frc_APenergyCH | "APenergyC" |
| Frc_ANenergyT Frc_ANenergyTF Frc_ANenergyTH | "ANenergyT" |
| Frc_ANenergyA Frc_ANenergyAF Frc_ANenergyAH | "ANenergyA" |
| Frc_ANenergyB Frc_ANenergyBF Frc_ANenergyBH | "ANenergyB" |
| Frc_ANenergyC Frc_ANenergyCF Frc_ANenergyCH | "ANenergyC" |
| Frc_RPenergyT | "RPenergyT" |
| Frc_RPenergyA | "RPenergyA" |
| Frc_RPenergyB | "RPenergyB" |
| Frc_RPenergyC | "RPenergyC" |
| Frc_RNenergyT | "RNenergyT" |
| Frc_RNenergyA | "RNenergyA" |
| Frc_RNenergyB | "RNenergyB" |
| Frc_RNenergyC | "RNenergyC" |
| Frc_SAenergyT | "SAenergyT" |
| Frc_SenergyA | "SenergyA" |
| Frc_SenergyB | "SenergyB" |
| Frc_SenergyC | "SenergyC" |
| Frc_SVenergyT | "SVenergyT" |

These registers can be used to set the energy counter to a specific value after a module has been replaced.

| Data type | Value | Information |
|-----------|-----------------|-----------------------------------|
| UDINT | 0 to 4294967295 | Bus controller default setting: 0 |

9.1.24.15.21.1 Force forward total active energy

Name:

FrcAPenergyT

The registers are described under "[Analog energy registers](#)" on page 708.

These registers can be used to set the energy counter to a specific value after a module has been replaced. The register is updated to the current values when triggered by register "[ControlOutput](#)" on page 698, bit 3.

| Data type | Value |
|-----------|-----------------|
| UDINT | 0 to 4294967295 |

9.1.24.15.22 Oversampling buffer

9.1.24.15.22.1 General information

A sample line contains the instantaneous values of currents (4 channels) and voltages (3 channels) as well as a sequential number and the **NetTime** at the time of transfer from the converter. These values are measured in a grid of 125 μ s * Prescaler.

The user must then normalize the values to the respective physical values:

$$\text{Voltage: } V_{\text{rms}} = (\text{INT32})V_{\text{s}} * 4 / \text{Sqrt}(2)$$

$$\text{Current: } I_{\text{rms}} = (\text{INT32})I_{\text{s}} * 4 / \text{Sqrt}(2)$$

9.1.24.15.22.2 Sample - Neutral current

Name:

lactN_Sample1 to lactN_Sample16

Current value of the neutral current

The value of these registers must be converted by the application: See ["General information" on page 730](#).

| Data type | Value | Information |
|-----------|-----------------|--------------------|
| INT | -32767 to 32767 | Resolution 0.001 A |

9.1.24.15.22.3 Sample - Current on phase A

Name:

lactA_Sample1 to lactA_Sample16

Present current value on phase A.

The value of these registers must be converted by the application: See ["General information" on page 730](#).

| Data type | Value | Information |
|-----------|-----------------|--------------------|
| INT | -32767 to 32767 | Resolution 0.001 A |

9.1.24.15.22.4 Sample - Voltage on phase A

Name:

UactA_Sample1 to UactA_Sample16

Present voltage value on phase A.

The value of these registers must be converted by the application: See ["General information" on page 730](#).

| Data type | Value | Information |
|-----------|-----------------|-------------------|
| INT | -32767 to 32767 | Resolution 0.01 V |

9.1.24.15.22.5 Sample - Current on phase B

Name:

lactB_Sample1 to lactB_Sample16

Present current value on phase B.

The value of these registers must be converted by the application: See ["General information" on page 730](#).

| Data type | Value | Information |
|-----------|-----------------|--------------------|
| INT | -32767 to 32767 | Resolution 0.001 A |

9.1.24.15.22.6 Sample - Current on phase B

Name:

UactB_Sample1 to UactB_Sample16

Present voltage value on phase B.

The value of these registers must be converted by the application: See ["General information" on page 730](#).

| Data type | Value | Information |
|-----------|-----------------|-------------------|
| INT | -32767 to 32767 | Resolution 0.01 V |

9.1.24.15.22.7 Sample - Current on phase C

Name:

lactC_Sample1 to lactC_Sample16

Present current value on phase C.

The value of these registers must be converted by the application: See ["General information"](#) on page 730.

| Data type | Value | Information |
|-----------|-----------------|--------------------|
| INT | -32767 to 32767 | Resolution 0.001 A |

9.1.24.15.22.8 Sample - Voltage on phase C

Name:

UactC_Sample1 to UactC_Sample16

Present voltage value on phase C.

The value of these registers must be converted by the application: See ["General information"](#) on page 730.

| Data type | Value | Information |
|-----------|-----------------|-------------------|
| INT | -32767 to 32767 | Resolution 0.01 V |

9.1.24.15.22.9 Sample number

Name:

SampleCount1 to Samplecount16

Sample line number, ascending, cyclic.

Number of new sample lines since last readout.

| Data type | Value |
|-----------|-----------------|
| SINT | -127 to 127 |
| INT | -32767 to 32767 |

9.1.24.15.22.10 Sample time

Name:

Timestamp

NetTime timestamp of sample line 1.

The older sample lines must be recalculated with 125 µs each.

For more information about NetTime and timestamps, see ["NetTime Technology"](#) on page 3035.

| Data type | Value |
|-----------|---------------------------------|
| INT | -32767 to 32767 |
| DINT | -2,147,483,647 to 2,147,483,647 |

9.1.24.15.23 Environment variables**9.1.24.15.23.1 Operating time in seconds**

Name:
OnTime

The operating time since startup is saved in seconds in this register.

| Data type | Value |
|-----------|-----------------|
| UDINT | 0 to 4294967295 |

9.1.24.15.23.2 Startup counter

Name:
UpCounter

The number of restarts since startup is saved in this register.

| Data type | Value |
|-----------|-----------------|
| UDINT | 0 to 4294967295 |

9.1.24.15.23.3 Minimum operating temperature

Name:
MinTemp

The lowest transformer temperature [°C] since startup is saved in this register.

| Data type | Value | Information |
|-----------|-------------|----------------|
| INT | -200 to 200 | Resolution 1°C |

9.1.24.15.23.4 Maximum operating temperature

Name:
MaxTemp

The highest transformer temperature [°C] since startup is saved in this register.

| Data type | Value | Information |
|-----------|-------------|----------------|
| INT | -200 to 200 | Resolution 1°C |

9.1.24.15.24 Flatstream communication

For a description of Flatstream communication, see ["Flatstream communication" on page 3802](#)

9.1.24.15.25 Flatstream communication with function blocks

As an additional option for Flatstream communication, communication with the module can be easily carried out with the "AsFitGen" library.

The library function blocks handle all incoming tasks with Flatstream mode, such as forwarding, sequencing, generation and evaluation of control bytes.

9.1.24.15.26 NetTime Technology

For a description of NetTime Technology, see ["NetTime Technology" on page 3035](#).

9.1.24.15.27 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|-------------|
| | 200 μ s |

9.1.24.15.28 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|---|--------------|
| Voltage and current sampling rate for calculation of RMS value, power and energy | 1 MHz |
| Derived values: RMS value, power, energy, power factor, phase angle, frequency (mean values over 16 full waves) | Approx. 3 Hz |
| FFT on request (sample rate: 8 kHz) | 2 Hz |

9.2 Analog output modules

Analog output modules convert PLC internal numerical values into voltages or currents. The numerical values which are to be converted must be in 16-bit 2s complement. The conversion takes place independently of the resolution of the output module used.

Every channel on an analog output module has a status LED.

9.2.1 Summary

| Model number | Short description | Page |
|--------------|---|------|
| X20AO2437 | X20 analog output module, 2 outputs, 4 to 20 mA / 0 to 20 mA or 0 to 24 mA, 16-bit converter resolution, single channel electrically isolated | 735 |
| X20AO2438 | X20 analog output module, 2 outputs, 4 to 20 mA / 0 to 20 mA or 0 to 24 mA, 16-bit converter resolution, single-channel isolation, supports the HART protocol, NetTime function | 748 |
| X20AO2622 | X20 analog output module, 2 outputs, 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution | 773 |
| X20AO2632 | X20 analog output module, 2 outputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, NetTime function | 780 |
| X20AO2632-1 | X20 analog output module, 2 outputs, ± 11 V or 0 to 22 mA, 16-bit converter resolution, NetTime function | 788 |
| X20AO4622 | X20 analog output module, 4 outputs, ± 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution | 796 |
| X20AO4632 | X20 analog output module, 4 outputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution | 805 |
| X20AO4632-1 | X20 analog output module, 4 outputs, ± 11 V or 0 to 22 mA, 16-bit converter resolution, NetTime function | 815 |
| X20AO4635 | X20 analog output module, 4 outputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, low temperature drift | 824 |
| X20cAO2437 | X20 analog output module, coated, 2 outputs, 4 to 20 mA / 0 to 20 mA or 0 to 24 mA, 16-bit converter resolution, single channel electrically isolated | 735 |
| X20cAO2438 | X20 analog output module, coated, 2 outputs, 4 to 20 mA / 0 to 20 mA or 0 to 24 mA, 16-bit converter resolution, single-channel isolation, supports the HART protocol, NetTime function | 748 |
| X20cAO4622 | X20 analog output module, coated, 4 outputs, ± 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution | 796 |
| X20cAO4632 | X20 analog output module, coated, 4 outputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, NetTime function | 805 |
| X20cAO4632-1 | X20 analog output module, coated, 4 outputs, ± 11 V or 0 to 22 mA, 16-bit converter resolution, NetTime function | 815 |

9.2.2 X20(c)AO2437

Data sheet version: 1.33

9.2.2.1 General information

The module is equipped with 2 current outputs with 16-bit digital converter resolution. The 2 channels are electrically isolated from each other. The user can select between the 3 output ranges 4 to 20 mA, 0 to 20 mA and 0 to 24 mA.

- 2 analog current outputs
- Electrically isolated analog channels
- 16-bit digital converter resolution

9.2.2.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.2.2.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C . During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.2.2.3 Order data

| Model number | Short description | Figure |
|--------------|---|--------|
| | Analog outputs | |
| X20AO2437 | X20 analog output module, 2 outputs, 4 to 20 mA / 0 to 20 mA or 0 to 24 mA, 16-bit converter resolution, single channel electrically isolated | |
| X20cAO2437 | X20 analog output module, coated, 2 outputs, 4 to 20 mA / 0 to 20 mA or 0 to 24 mA, 16-bit converter resolution, single channel electrically isolated | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 90: X20AO2437, X20cAO2437 - Order data

9.2.2.4 Technical data

| Model number | X20AO2437 | X20cAO2437 |
|--|--|------------|
| Short description | | |
| I/O module | 2 analog outputs 4 to 20 mA, 0 to 20 mA or 0 to 24 mA | |
| General information | | |
| B&R ID code | 0xB785 | 0xE1F2 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Outputs | Yes, using status LED and software | |
| Power consumption | | |
| Bus | 0.05 W | |
| Internal I/O | 1.6 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Analog outputs | | |
| Output | 4 to 20 mA, 0 to 20 mA or 0 to 24 mA, configurable using software | |
| Digital converter resolution | 16-bit | |
| Settling time on output change over entire range | 2 ms to 20 s, configurable using software | |
| Data output rate | 1 ms without ramp | |
| Max. error | | |
| Gain | | |
| 4 to 20 mA | 0.025% ¹⁾ | |
| 0 to 20 mA | 0.022% ¹⁾ | |
| 0 to 24 mA | 0.02% ¹⁾ | |
| Offset | | |
| 4 to 20 mA | 0.025% ²⁾ | |
| 0 to 20 mA | 0.022% ²⁾ | |
| 0 to 24 mA | 0.02% ²⁾ | |
| Output protection | Short circuit protection, overvoltage protection (up to 30 VDC) | |
| Open-circuit detection | Yes, using hardware and software | |
| Data format | INT | |
| Output format | | |
| 4 to 20 mA | INT 0x0000 to 0x7FFF / 1 LSB = 0x0001 = 488.281 nA | |
| 0 to 20 mA | INT 0x0000 bis 0x7FFF / 1 LSB = 0x0001 = 610.352 nA | |
| 0 to 24 mA | UINT 0x0000 to 0xFFFF / 1 LSB = 0x0001 = 305.176 nA | |
| 0 to 24 mA | INT 0x0000 to 0x5DC0 / 1 LSB = 0x0001 = 1000 nA | |
| Load per channel | Max. 600 Ω | |
| Short-circuit proof | Yes, continuous | |
| Output filter | Active 2nd-order low pass / cutoff frequency 4 kHz Configurable slew rate | |
| Max. gain drift | | |
| 4 to 20 mA | 0.0055 %/°C ¹⁾ | |
| 0 to 20 mA | 0.005 %/°C ¹⁾ | |
| 0 to 24 mA | 0.005 %/°C ¹⁾ | |
| Max. offset drift | | |
| 4 to 20 mA | 0.0035 %/°C ²⁾ | |
| 0 to 20 mA | 0.002 %/°C ²⁾ | |
| 0 to 24 mA | 0.002 %/°C ²⁾ | |
| Error caused by load change ³⁾ | | |
| 4 to 20 mA | 0.14% | |
| 0 to 20 mA | 0.1% | |
| 0 to 24 mA | 0.1% | |
| Nonlinearity | <0.003% ⁴⁾ | |

Table 91: X20AO2437, X20cAO2437 - Technical data


| Model number | X20AO2437 | X20cAO2437 |
|--|--|---|
| Test voltage | | |
| Channel - Channel | | 1000 VAC |
| Channel - Bus | | 1000 VAC |
| Channel - Ground | | 1000 VAC |
| Electrical properties | | |
| Electrical isolation | Channel isolated from channel and bus | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | | Yes |
| Vertical | | Yes |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating" | |
| Starting temperature | - | Yes, -40°C |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 91: X20AO2437, X20cAO2437 - Technical data

- 1) Based on the current output value.
- 2) Based on the respective output range
- 3) Load change from 1 Ω → 600 Ω, resistive
- 4) Based on the entire output range.

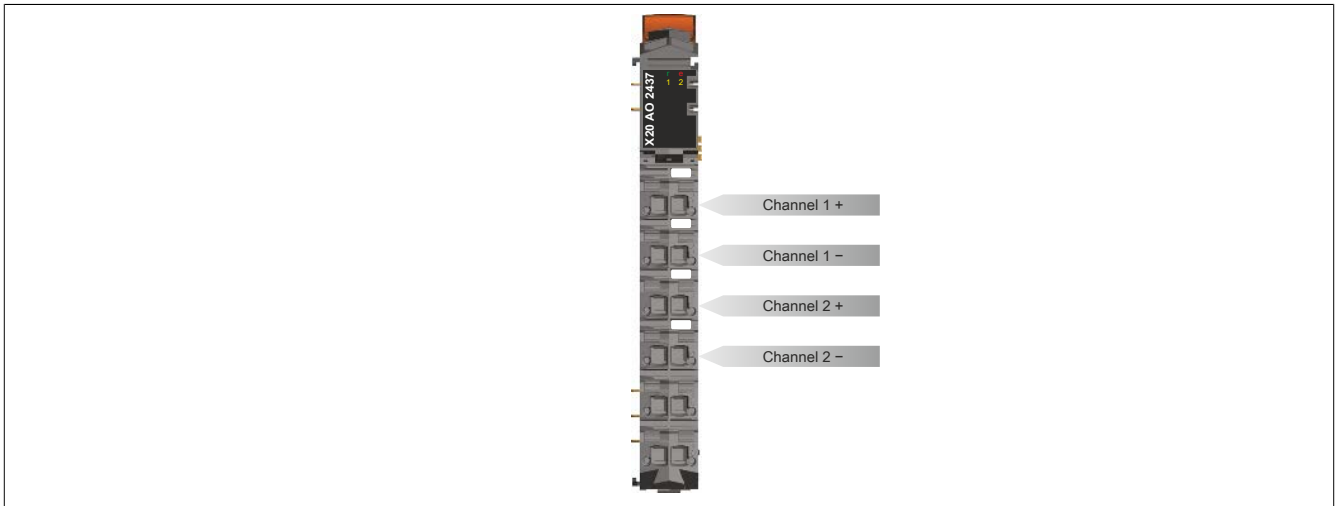
9.2.2.5 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

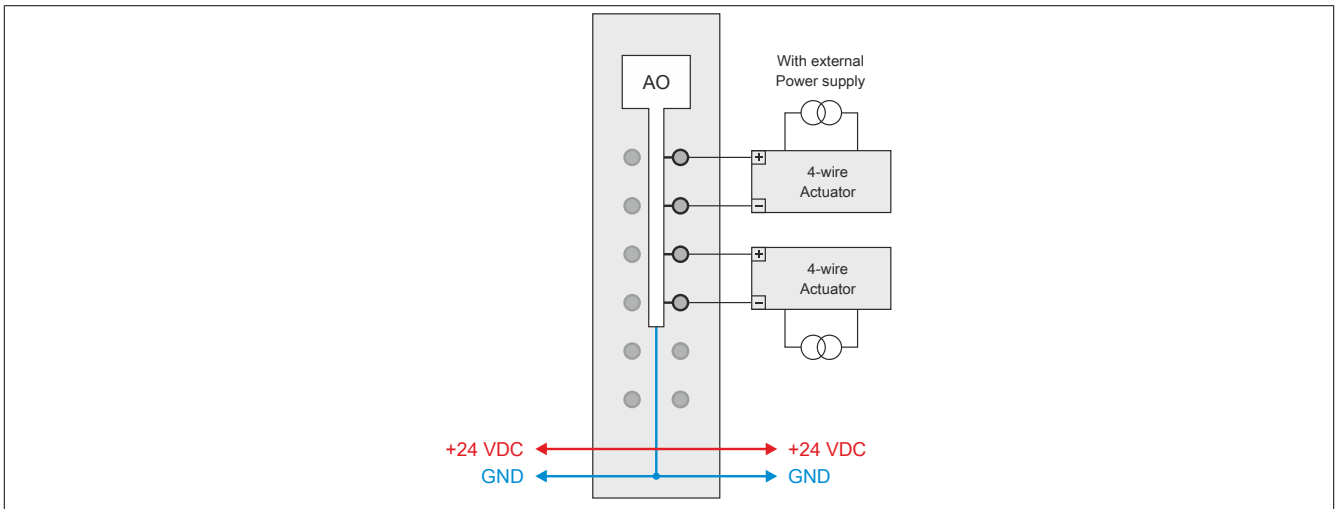
| Figure | LED | Color | Status | Description |
|---|-------------------------|--------------|---|--|
|  | Operating status | | | |
| | r | Green | Off | No power to module |
| | | | Single flash | UNLINK mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking quickly | SYNC mode |
| | | | Blinking slowly | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | | | Flickering (approx. 10 Hz) | Module is in OSP mode |
| | Module status | | | |
| | e | Red | Off | No power to module or everything OK |
| | | | Single flash | A conversion error has occurred. When an error occurs, the LED of the faulty analog output channel begins to double flash and this status is output. |
| | | | On | Error or reset status |
| | Analog output | | | |
| | 1 - 2 | Orange | Off | Indicates one of the following cases: <ul style="list-style-type: none"> • No power to module • Channel disabled |
| | | | Single flash | Open line |
| | | Double flash | A conversion error has occurred. A single flash is output on the red "e" module status LED. | |
| | | On | Digital/analog converter running, value OK | |

- 1) Depending on the configuration, a firmware update can take up to several minutes.

9.2.2.6 Pinout



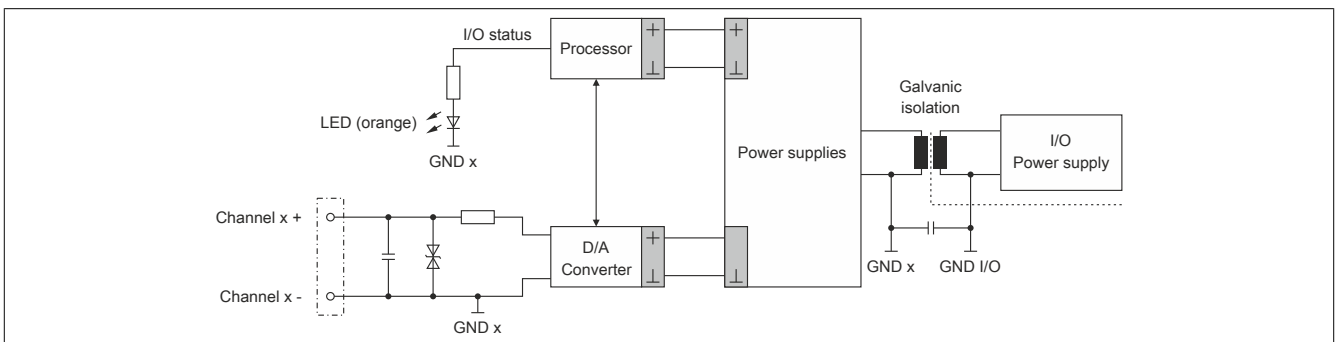
9.2.2.7 Connection example



9.2.2.8 OSP hardware requirements

In order to use OSP mode sensibly, it should be ensured that the power supply of the output module and CPU are independent of each other when the application is set up.

9.2.2.9 Output circuit diagram



9.2.2.10 Derating

To ensure proper operation, the derating values listed below must be adhered to:

Horizontal installation

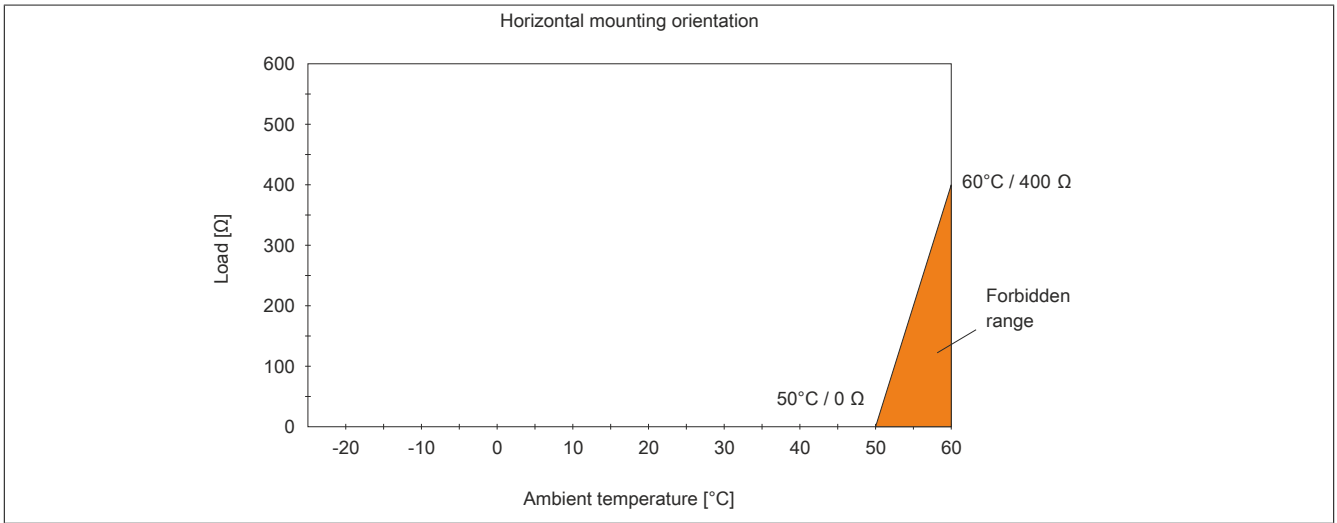


Figure 83: Derating the load with horizontal mounting

Vertical installation

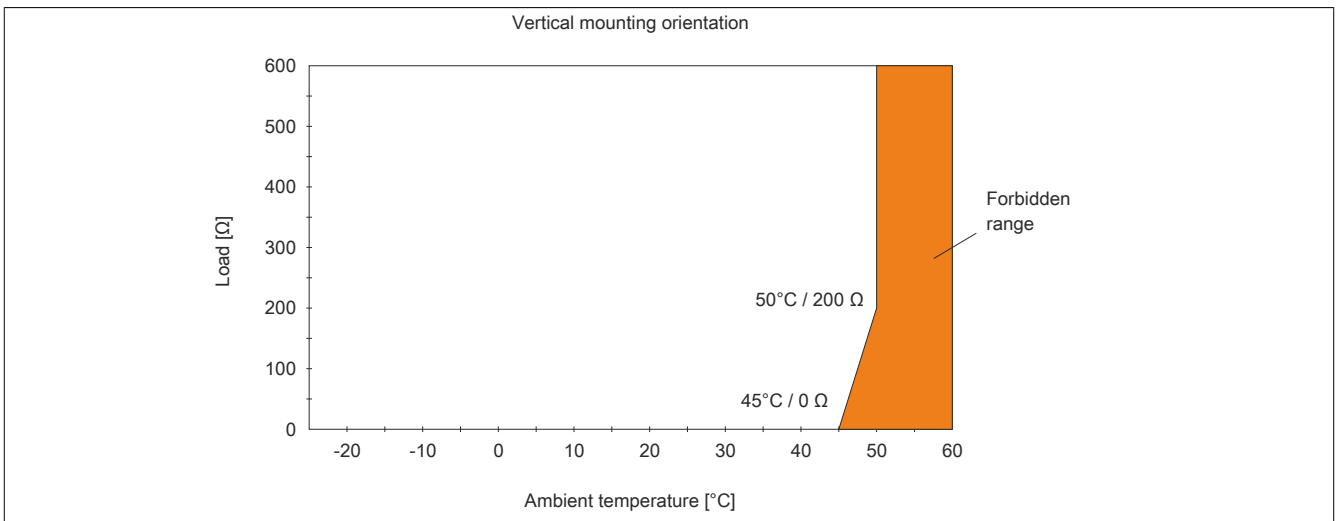


Figure 84: Derating the load with vertical mounting

9.2.2.11 Register description

9.2.2.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.2.2.11.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|---|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog signal - Configuration | | | | | | |
| 386 394 | AnalogMode01 AnalogMode02 | UINT | | | | • |
| 390 398 | DACSlewrate01 DACSlewrate02 | UINT | | | | • |
| Analog signal - Communication | | | | | | |
| 0 2 | AnalogOutput01 AnalogOutput02 | (U)INT | | | • | |
| 30 31 | AnalogStatus01 AnalogStatus02 | USINT | • | | | |
| | OpenLineAnalogOutput01 or OpenLineAnalogOutput02 | Bit 2 | | | | |
| | ConversionErrorAnalogOutput01 or ConversionErrorAnalogOutput02 | Bit 3 | | | | |
| | IoSuppErrorAnalogOutput01 or IoSuppErrorAnalogOutput02 | Bit 7 | | | | |

9.2.2.11.3 Function model 1 - OSP

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|---|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog signal - Configuration | | | | | | |
| 386 394 | AnalogMode01 AnalogMode02 | UINT | | | | • |
| 390 398 | DACSlewrate01 DACSlewrate02 | UINT | | | | • |
| Analog signal - Communication | | | | | | |
| 0 2 | AnalogOutput01 AnalogOutput02 | (U)INT | | | • | |
| 30 31 | AnalogStatus01 AnalogStatus02 | USINT | • | | | |
| | OpenLineAnalogOutput01 or OpenLineAnalogOutput02 | Bit 2 | | | | |
| | ConversionErrorAnalogOutput01 or ConversionErrorAnalogOutput02 | Bit 3 | | | | |
| | IoSuppErrorAnalogOutput01 or IoSuppErrorAnalogOutput02 | Bit 7 | | | | |
| The OSP function model | | | | | | |
| 32 | OSPComByte | USINT | | | • | |
| | OSPValid | Bit 0 | | | | |
| 401 403 | CfgOSPMODE01 CfgOSPMODE02 | USINT | | | | • |
| 34 36 | CfgOSPValue01 CfgOSPValue02 | INT | | | | • |

9.2.2.11.4 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------------|----------------------|---|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog signal - Configuration | | | | | | | |
| 386 394 | - | AnalogMode01 AnalogMode02 | UINT | | | | • |
| 390 398 | - | DACSlewwrate01 DACSlewwrate02 | UINT | | | | • |
| Analog signal - Communication | | | | | | | |
| 0 2 | 0 2 | AnalogOutput01 AnalogOutput02 | (U)INT | | | • | |
| 30 31 | - | AnalogStatus01 AnalogStatus02 | USINT | | • | | |
| | | OpenLineAnalogOutput01 or OpenLineAnalogOutput02 | Bit 2 | | | | |
| | | ConversionErrorAnalogOutput01 or ConversionErrorAnalogOutput02 | Bit 3 | | | | |
| | | IoSuppErrorAnalogOutput01 or IoSuppErrorAnalogOutput02 | Bit 7 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.2.2.11.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.2.2.11.4.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.2.2.11.5 Analog signal - Configuration

The module has 2 electrically isolated channels. All registers have a dual design. Channels can be configured and operated independently of one another.

Specific features

- Electrical isolation by channel
- Configurable output ramp DAC slew rate (Default: 210 ms full scale)

9.2.2.11.5.1 AnalogMode

Name:

AnalogMode01 to AnalogMode02

These registers are used to predefine the operating parameters that the module will be using for the respective channel. Each channel must be activated and configured separately.

Information:

When you select the operating mode "Scaling 0 to 20 mA (Resolution 0 to 65535)", then the corresponding "AnalogOutput" registers are interpreted internally as UINT instead of INT.

The entire program must be rebuilt for the data type change to take effect. The data type cannot be changed during runtime (e.g. using a library).

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 33 |

Bit structure:

| Bit | Name | Value | Information |
|--------|---|-------|--|
| 0 | Channel | 0 | Disabled |
| | | 1 | Enabled (bus controller default setting) |
| 1 | Check - D/A converter configuration/status | 0 | Enabled (bus controller default setting) |
| | | 1 | Disabled |
| 2 - 3 | Reserved | - | |
| 4 | Scaling 0 to 20 mA (Resolution 0 to 32767) | 0 | Disabled |
| | | 1 | Enabled |
| 5 | Scaling 4 to 20 mA (Resolution 0 to 32767) | 0 | Disabled |
| | | 1 | Enabled (bus controller default setting) |
| 6 | Scaling 0 to 24 mA (Resolution 0 to 24000) | 0 | Disabled |
| | | 1 | Enabled |
| 7 | Scaling 0 to 20 mA (Resolution 0 to 65535) | 0 | Disabled |
| | | 1 | Enabled |
| 8 - 15 | Reserved | - | |

9.2.2.11.5.2 DACSlewrates

Name:

DACSlewrates01 to DACSlewrates02

These registers limit the rate at which the analog signal is modified. This makes it possible to define a sort of upper limit frequency.

The following formula applies: $f(\text{Analog}) = f(\text{Output rate}) * \text{Permitted change} / \text{max. } \Delta(\text{standardized output value})$

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 514 |

Bit structure:

| Bit | Name | Value | Information |
|---------|---------------------------------------|-------|--|
| 0 - 2 | Permitted change per rate | 000 | 1-bit |
| | | 001 | 2-bit |
| | | 010 | 4-bit (bus controller default setting) |
| | | 011 | 8-bit |
| | | 100 | 16-bit |
| | | 101 | 32-bit |
| | | 110 | 64-bit |
| | | 111 | 128-bit |
| 3 - 7 | Reserved | - | |
| 8 - 11 | Output rate | 0000 | 257730 Hz |
| | | 0001 | 198410 Hz |
| | | 0010 | 152440 Hz (bus controller default setting) |
| | | 0011 | 131580 Hz |
| | | 0100 | 115740 Hz |
| | | 0101 | 69440 Hz |
| | | 0110 | 37590 Hz |
| | | 0111 | 25770 Hz |
| | | 1000 | 20160 Hz |
| | | 1001 | 16030 Hz |
| | | 1010 | 10290 Hz |
| | | 1011 | 8280 Hz |
| | | 1100 | 6900 Hz |
| | | 1101 | 5530 Hz |
| | | 1110 | 4240 Hz |
| | | 1111 | 3300 Hz |
| 12 - 14 | Reserved | - | |
| 15 | Slewrates enable (ramp functionality) | 0 | Disabled (undefined jump behavior) |
| | | 1 | Enabled (defined transitions) |

9.2.2.11.6 Analog signal - Communication

In order to output the desired current signal (default: 4 to 20 mA), the module must be provided with the normalized output value (default: 0 to 32767).

9.2.2.11.6.1 AnalogOutput

Name:

AnalogOutput01 to AnalogOutput02

These registers provide the normalized output values. Depending on the scaling selected (see register "[Analog-Mode](#)" on page 742), the range of values and the data type can be adapted to the requirements of the application. Once a permissible value is transferred, the module outputs the corresponding current.

Information:

The value "0" disables the channel status LED.

| Data type | Value |
|----------------|------------|
| INT | 0 to 32767 |
| Optional: UINT | 0 to 65535 |

9.2.2.11.6.2 AnalogStatus

Name:

AnalogStatus01 to AnalogStatus02

The status register gives the user feedback about whether the respective channel is functioning properly.

| Data type | Value |
|-----------|-------------------|
| USINT | See bit structure |

Bit structure:

| Bit | Name | Value | Information |
|-------|-----------------------------------|-------|---------------------------------|
| 0 - 1 | Reserved | - | |
| 2 | OpenLineAnalogOutput01, 02 | 0 | Line OK |
| | | 1 | Open line |
| 3 | ConversionErrorAnalogOutput01, 02 | 0 | Conversion temperature OK |
| | | 1 | Conversion temperature too high |
| 4 - 6 | Reserved | - | |
| 7 | IoSuppErrorAnalogOutput01, 02 | 0 | Module supply OK |
| | | 1 | Module supply error |

9.2.2.11.7 Function model "OSP"

In function model "OSP" (Operator Set Predefined), the user defines an analog value or digital pattern. This OSP value is output as soon as the communication between the module and master is aborted.

Functionality

The user has the choice between 2 OSP modes:

- Retain last valid value
- Replace with static value

In the first case, the module retains the last value recognized as a valid output status.

When selecting mode "Replace with static value", a plausible output value must be entered in the associated value register. When an OSP event occurs, this value is output instead of the value currently requested by the task.

9.2.2.11.7.1 Activating the OSP output in the module

Name:

OSPValid

This data point offers the possibility to start module output and request OSP operation during running operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|----------|-------|--|
| 0 | OSPValid | 0 | Request OSP operation (after initial start or module in Standby) |
| | | 1 | Request normal operation |
| 1 - 7 | Reserved | 0 | |

There is one OSPValid bit on the module, which is managed by the user task. It must be set when the enabled channels are started. As long as the OSPValid bit remains set in the module, the module behaves the same as the "Standard" function model.

If an OSP event occurs (e.g. communication between the module and master CPU interrupted) then the OSPValid bit will be reset on the module. The module enters OSP mode and the output occurs in the "OSPMode" on page 746 register according to the configuration.

The following applies:

The OSP replacement value remains even after the communication channel has recovered. OSP mode is only exited when a set OSPValid bit is transferred.

When the master CPU is restarted, the OSPValid bit is re-initialized on the master CPU. It must once more be set by the application and transferred via the bus.

When temporary communication errors occur between the module and master CPU (e.g. due to EMC), a few bus cycles will pass without refreshing the cyclic registers. The OSPValid bit is reset internally in the module - the bit in the CPU however remains set. Upon the next successful transfer, the OSPValid bit in the module is set again and the module returns to normal operation.

The ModulOK bit can be evaluated if the task in the master CPU needs to know which output mode the module is currently in.

Warning!

If the OSPValid bit is reset to "0" on the module, then the output state no longer depends on the relevant task in the master CPU. However, an output still occurs depending on the configuration of the OSP replacement value.

9.2.2.11.7.2 Setting the OSP mode

Name:

CfgOSPMODE01 to CfgOSPMODE02

This register essentially controls a channel's behavior when OSP is being used.

| Data type | Value | Description |
|-----------|-------|---------------------------|
| USINT | 0 | Replace with static value |
| | 1 | Retain last valid value |

9.2.2.11.7.3 Define the OSP analog output value

Name:

CfgOSPValue01 to CfgOSPValue02

This register contains the analog output value, which is output in "Replace with static value" mode during OSP operation.

| Data type | Value |
|-------------------------------|-------------------------------|
| Corresponds to AnalogOutput0x | Corresponds to AnalogOutput0x |

Warning!

"OSPValue" is only applied by the module if bit "OSPValid" has been set in the module.

9.2.2.11.8 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μ s |

9.2.2.11.9 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 200 μ s |

9.2.3 X20(c)AO2438

Data sheet version: 1.43

9.2.3.1 General information

The module is equipped with 2 current outputs with 16-bit digital converter resolution. It supports the HART communication standard for data transfer, parameter configuration and diagnostics.

The 2 channels are electrically isolated from each other. The user can select between the 3 output ranges 4 to 20 mA, 0 to 20 mA and 0 to 24 mA.

- 2 analog current outputs
- HART protocol integration
- Support for HART variables
- Electrically isolated analog channels
- 16-bit digital converter resolution
- OSP mode
- NetTime timestamp: HART image

NetTime timestamp of the HART image

For many applications, not only the HART values are important, but also the exact time of reception. For this purpose, the module has a NetTime timestamp function that provides the reception time with a timestamp with microsecond accuracy.

The timestamp function is based on synchronized timers. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

OSP mode

In function model "OSP" (Operator Set Predefined), the user defines an analog value. This OSP value is always output as soon as the communication between the module and master is interrupted. Alternatively, the last valid output value can also be obtained.

This ensures that the module does not fall into an undefined state in the event of communication failure.

9.2.3.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.2.3.3 Order data

| Model number | Short description | Figure |
|--------------|---|--------|
| | Analog outputs | |
| X20AO2438 | X20 analog output module, 2 outputs, 4 to 20 mA / 0 to 20 mA or 0 to 24 mA, 16-bit converter resolution, single-channel isolation, supports the HART protocol, NetTime function | |
| X20cAO2438 | X20 analog output module, coated, 2 outputs, 4 to 20 mA / 0 to 20 mA or 0 to 24 mA, 16-bit converter resolution, single-channel isolation, supports the HART protocol, NetTime function | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 92: X20AO2438, X20cAO2438 - Order data

9.2.3.4 Technical data

| Model number | X20AO2438 | X20cAO2438 |
|--|--|------------|
| Short description | | |
| I/O module | 2 analog outputs 4 to 20 mA, 0 to 20 mA or 0 to 24 mA | |
| General information | | |
| B&R ID code | 0xB3AA | 0xE211 |
| Status indicators | I/O function per channel, operating state, module status, HART | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Outputs | Yes, using status LED and software | |
| HART link | Yes, using status LED and software | |
| HART error | Yes, using status LED and software | |
| Power consumption | | |
| Bus | 0.05 W | |
| Internal I/O | 1.65 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Analog outputs | | |
| Output | 4 to 20 mA, 0 to 20 mA or 0 to 24 mA, configurable using software | |
| Digital converter resolution | 16-bit | |
| Settling time on output change over entire range | 2 ms to 20 s, configurable using software | |
| Data output rate | | |
| With HART | 210 ms (default) | |
| Analog | 1 ms without ramp | |
| Max. error | | |
| Gain | | |
| 4 to 20 mA | 0.025% ¹⁾ | |
| 0 to 20 mA | 0.022% ¹⁾ | |
| 0 to 24 mA | 0.02% ¹⁾ | |
| Offset | | |
| 4 to 20 mA | 0.025% ²⁾ | |
| 0 to 20 mA | 0.022% ²⁾ | |
| 0 to 24 mA | 0.02% ²⁾ | |
| Output protection | Short circuit protection, overvoltage protection (up to 30 VDC) | |
| Open-circuit detection | Yes, using hardware and software | |
| Data format | INT | |
| Output format | | |
| 4 to 20 mA | INT 0x0000 to 0x7FFF / 1 LSB = 0x0001 = 488.281 nA | |
| 0 to 20 mA | INT 0x0000 bis 0x7FFF / 1 LSB = 0x0001 = 610.352 nA UINT 0x0000 to 0xFFFF / 1 LSB = 0x0001 = 305.176 nA | |
| 0 to 24 mA | INT 0x0000 to 0x5DC0 / 1 LSB = 0x0001 = 1000 nA | |
| Load per channel | Max. 600 Ω | |
| Short-circuit proof | Yes, continuous | |
| Output filter | Active 2nd-order low pass / cutoff frequency 19 Hz Configurable slew rate | |
| Max. gain drift | | |
| 4 to 20 mA | 0.0055 %/°C ¹⁾ | |
| 0 to 20 mA | 0.005 %/°C ¹⁾ | |
| 0 to 24 mA | 0.005 %/°C ¹⁾ | |
| Max. offset drift | | |
| 4 to 20 mA | 0.0035 %/°C ²⁾ | |
| 0 to 20 mA | 0.002 %/°C ²⁾ | |
| 0 to 24 mA | 0.002 %/°C ²⁾ | |

Table 93: X20AO2438, X20cAO2438 - Technical data


| Model number | X20AO2438 | X20cAO2438 |
|---|--|---|
| Error caused by load change ³⁾ | | |
| 4 to 20 mA | | 0.14% |
| 0 to 20 mA | | 0.1% |
| 0 to 24 mA | | 0.1% |
| Nonlinearity | | <0.003% ⁴⁾ |
| Test voltage | | |
| Channel - Channel | | 1000 VAC |
| Channel - Bus | | 1000 VAC |
| Channel - Ground | | 1000 VAC |
| HART | | |
| Transfer rate | | 1200 bit/s |
| Operating frequencies | | 1200 Hz / 2200 Hz |
| Burst operation possible | | Yes |
| Multi-drop operation | | |
| Possible | | Yes |
| Stations | | Up to 15 |
| Transmission amplitude | | |
| Minimum | | 400 mV _{pp} |
| Typical | | 500 mV _{pp} |
| Maximum | | 600 mV _{pp} |
| Receiving amplitude | | |
| Minimum | | 120 mV _{pp} |
| Maximum | | 1500 mV _{pp} |
| Electrical properties | | |
| Electrical isolation | Channel isolated from channel and bus | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | | Yes |
| Vertical | | Yes |
| Installation elevation above sea level | | |
| 0 to 2000 m | | No limitations |
| >2000 m | | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | | IP20 |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | | -25 to 60°C |
| Vertical mounting orientation | | -25 to 50°C |
| Derating | | See section "Derating" |
| Storage | | -40 to 85°C |
| Transport | | -40 to 85°C |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 93: X20AO2438, X20cAO2438 - Technical data

- 1) Based on the current output value.
- 2) Based on the respective output range
- 3) Load change from 1 Ω → 600 Ω, resistive
- 4) Based on the entire output range.

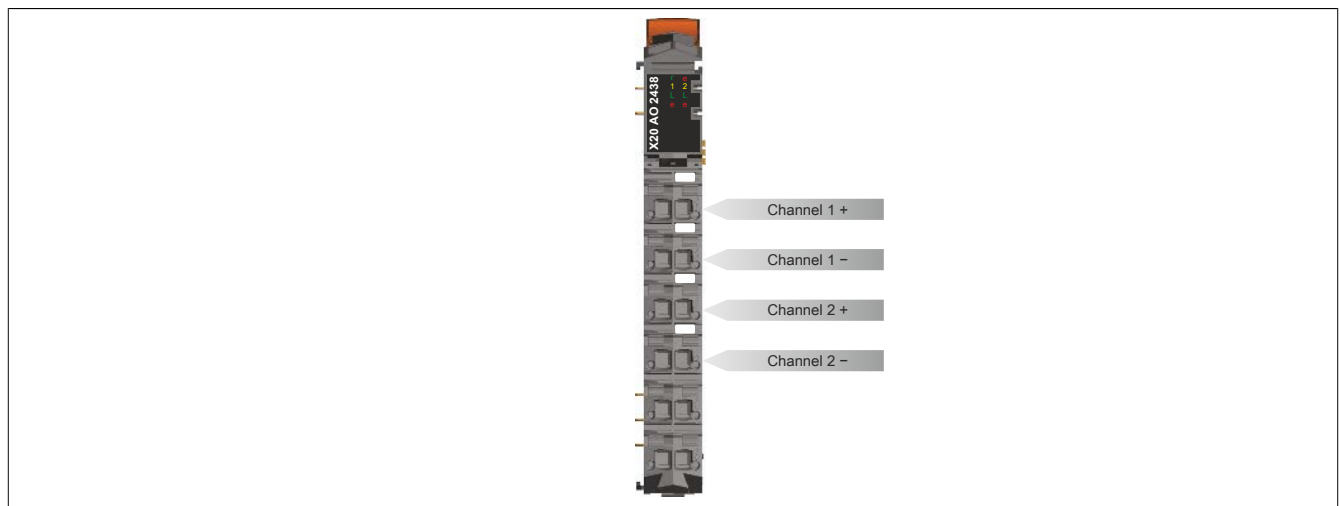
9.2.3.5 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

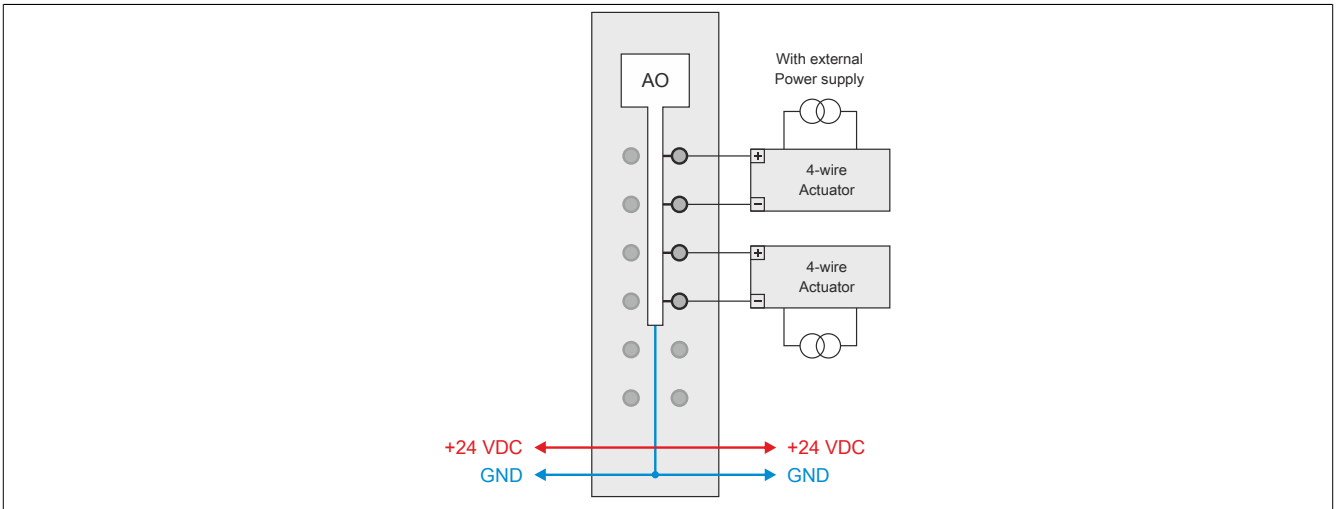
| Figure | LED | Color | Status | Description |
|---|-------------------------|--------|----------------------------|---|
|  | Operating status | | | |
| | r | Green | Off | No power to module |
| | | | Single flash | UNLINK mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking quickly | SYNC mode |
| | | | Blinking slowly | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | | | Flickering (approx. 10 Hz) | Module is in OSP mode |
| | Module status | | | |
| | e | Red | Off | No power to module or everything OK |
| | | | Single flash | A conversion error has occurred. When an error occurs, the LED of the faulty analog output channel begins to double flash and this status is output. |
| | | | On | Error or reset status |
| | Analog output | | | |
| | 1 - 2 | Orange | Off | Indicates one of the following cases: <ul style="list-style-type: none"> No power to module Channel disabled |
| | | | Single flash | Open line |
| | | | Double flash | A conversion error has occurred. A single flash is output on the red "e" module status LED. |
| | | | On | Digital/analog converter running, value OK |
| | HART link | | | |
| | L | Green | Off | Indicates one of the following cases: <ul style="list-style-type: none"> No power to module HART disabled for the respective channel |
| | | | Flickering | Carrier signal active (DCD or RTS) |
| | HART error | | | |
| | e | Red | Off | Indicates one of the following cases: <ul style="list-style-type: none"> Communication taking place without errors No power to module HART disabled for the respective channel |
| | | | On | Communication error |

1) Depending on the configuration, a firmware update can take up to several minutes.

9.2.3.6 Pinout



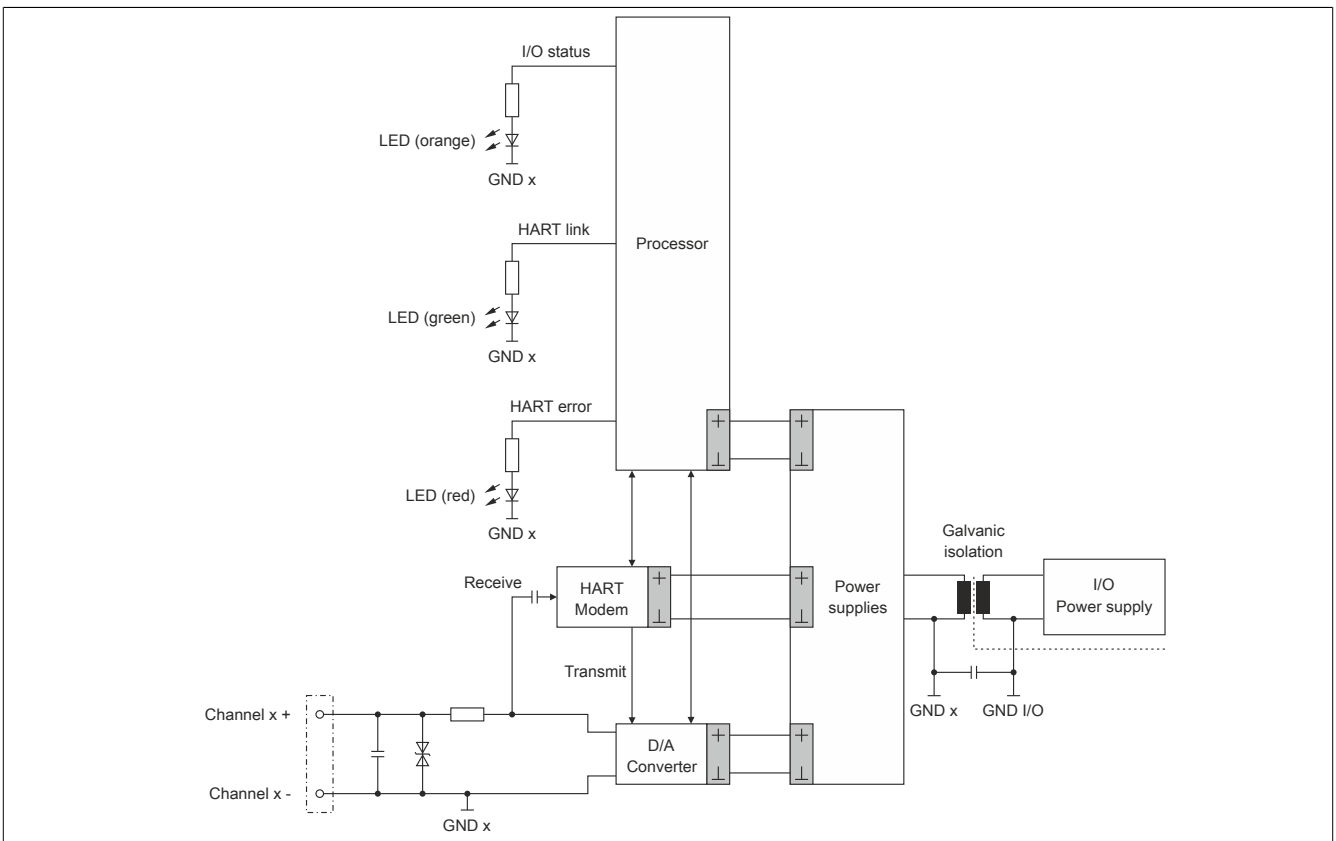
9.2.3.7 Connection example



9.2.3.8 OSP hardware requirements

In order to use OSP mode sensibly, it should be ensured that the power supply of the output module and CPU are independent of each other when the application is set up.

9.2.3.9 Output circuit diagram



9.2.3.10 Operation

9.2.3.10.1 Derating

To ensure proper operation, the derating values listed below must be adhered to:

Horizontal installation

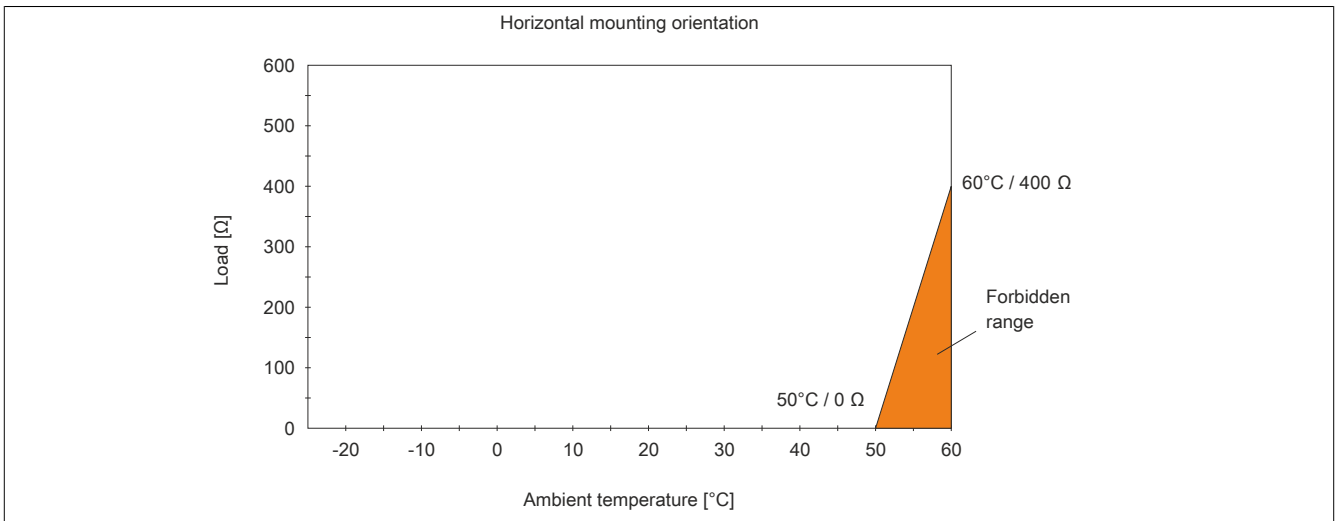


Figure 85: Derating the load with horizontal mounting

Vertical installation

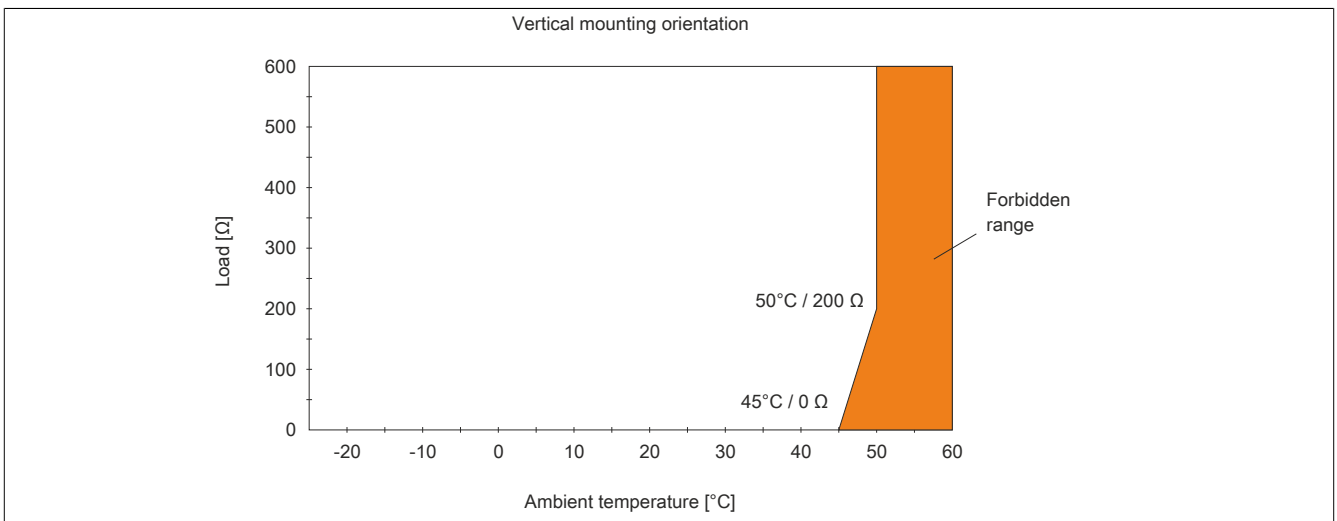


Figure 86: Derating the load with vertical mounting

9.2.3.10.2 HART communication standard

This module supports the HART communication standard for data transfer, parameter configuration and diagnostics. The HART standard is used for the current range 4 to 20 mA. Be aware that the load is not permitted to fall below 230 Ω .

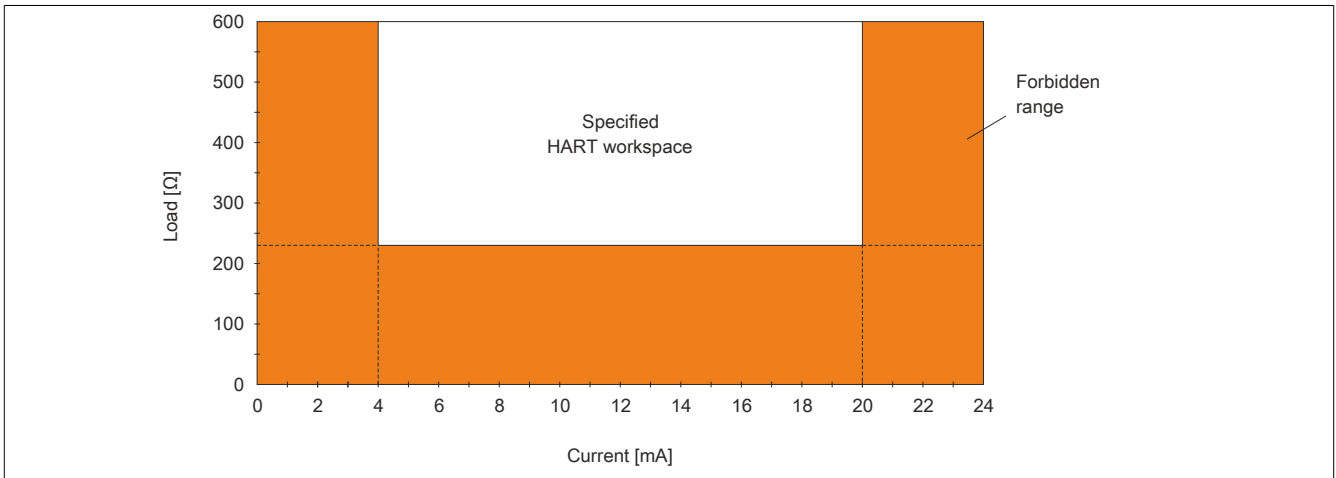


Figure 87: Specified HART operational range

Both current ranges 0 to 20 mA and 0 to 24 mA are supported by this module. HART communication can also be used in these ranges as well. It is important to make sure, however, that the output current lies within the specified HART operational range.

9.2.3.11 Register description

9.2.3.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.2.3.11.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|---|--|-----------|--------|-----------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog signal - Configuration | | | | | | |
| 386 394 | AnalogMode01 AnalogMode02 | UINT | | | | • |
| 390 398 | DACSlewrate01 DACSlewrate02 | UINT | | | | • |
| Analog signal - Communication | | | | | | |
| 0 2 | AnalogOutput01 AnalogOutput02 | (U)INT | | | • | |
| 30 31 | AnalogStatus01 AnalogStatus02 | USINT | • | | | |
| | OpenLineAnalogOutput01 or OpenLineAnalogOutput02 | Bit 2 | | | | |
| | ConversionErrorAnalogOutput01 or ConversionErrorAnalogOutput02 | Bit 3 | | | | |
| | IoSuppErrorAnalogOutput01 or IoSuppErrorAnalogOutput02 | Bit 7 | | | | |
| HART - Configuration | | | | | | |
| 1537 1665 | HartNodeCnt_1 HartNodeCnt_2 | USINT | | | | • |
| 1539 1667 | HartMode_1 HartMode_2 | USINT | | | | • |
| 1541 1669 | HartBurstNode_1 HartBurtNode_2 | USINT | | | | • |
| HART - Extended configuration | | | | | | |
| 1558 1668 | HartNodeDisable_1 HartNodeDisable_2 | UINT | | | | • |
| 1546 1674 | HartProtTimeOut_1 HartProtTimeOut_2 | UINT | | | | • |
| 1550 1678 | HartProtRetry_1 HartProtRetry_2 | UINT | | | | • |
| 1554 1682 | HartPreamble_1 HartPreamble_2 | UINT | | | | • |
| HART - Communication (P2P) | | | | | | |
| 612 + Index*24 1124 + Index*24 | PvInput01_N (Index N = 01 to 04) PvInput02_N (Index N = 01 to 04) | REAL | • | • ¹⁾ | | |
| 617 + Index*24 1129 + Index*24 | PvUnit01_N (Index N = 01 to 04) PvUnit02_N (Index N = 01 to 04) | USINT | • | • ¹⁾ | | |
| 628 1140 | PvSampleTime01 PvSampleTime02 | DINT | • | • ¹⁾ | | |
| 626 1138 | PvSampleTime01 PvSampleTime02 | INT | • | | | |
| 566 1078 | PvNodeComStatus01 PvNodeComStatus02 | UINT | | • | | |
| HART - Communication (multidrop) | | | | | | |
| 612 + Index*24 1124 + Index*24 | PvInput01_N (Index N = 01 to 15) PvInput02_N (Index N = 01 to 15) | REAL | • | • ¹⁾ | | |
| 617 + Index*24 1129 + Index*24 | PvUnit01_N (Index N = 01 to 15) PvUnit02_N (Index N = 01 to 15) | USINT | • | • ¹⁾ | | |
| 604 + Index*24 1116 + Index*24 | PvSampleTime01_N (Index N = 01 to 15) PvSampleTime02_N (Index N = 01 to 15) | DINT | • | • ¹⁾ | | |
| 602 + Index*24 1114 + Index*24 | PvSampleTime01_N (Index N = 01 to 15) PvSampleTime02_N (Index N = 01 to 15) | INT | • | | | |
| 562 + Index*4 1074 + Index*4 | PvNodeComStatus01_N (Index N = 01 to 15) PvNodeComStatus02_N (Index N = 01 to 15) | UINT | | • | | |
| HART - Extended communication | | | | | | |
| 522 1034 | PvCountHartRequest01 PvCountHartRequest02 | UINT | • | | | |
| 530 1042 | PvCountHartTimeout01 PvCountHartTimeout02 | UINT | • | | | |
| 538 1050 | PvCountHartRxError01 PvCountHartRxError02 | UINT | • | | | |
| 546 1058 | PvCountHartFrameError01 PvCountHartFrameError02 | UINT | • | | | |
| 554 1066 | PvNodeFound01 PvNodeFound02 | UINT | • | | | |
| 558 1070 | PvNodeError01 PvNodeError02 | UINT | • | | | |

| Register | Name | Data type | Read | | Write | |
|---|-----------------------------|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| FlatStream interface - Configuration | | | | | | |
| 1793 | OutputMTU | USINT | | | | • |
| 1795 | InputMTU | USINT | | | | • |
| 1797 | FlatstreamMode | USINT | | | | • |
| 1799 | Forward | USINT | | | | • |
| 1802 | ForwardDelay | UINT | | | | • |
| FlatStream interface - Communication | | | | | | |
| 1857 | InputSequence | USINT | • | | | |
| 1857 + Index*2 | RxByteN (Index N = 1 to 15) | USINT | • | | | |
| 1889 | OutputSequence | USINT | | | • | |
| 1889 + Index*2 | TxByteN (Index N = 1 to 15) | USINT | | | • | |

1) These HART registers are defined multiple times. Hence, they can be activated acyclically, if they are not registered during the cyclical phase of the X2X transmission.

9.2.3.11.3 Function model 1 - OSP

| Register | Name | Data type | Read | | Write | | |
|---|--|-----------|--------|-----------------|--------|------------|--|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic | |
| Analog signal - Configuration | | | | | | | |
| 386 | AnalogMode01 | UINT | | | | • | |
| 394 | AnalogMode02 | | | | | | |
| 390 | DACSlewrate01 | UINT | | | | • | |
| 398 | DACSlewrate02 | | | | | | |
| Analog signal - Communication | | | | | | | |
| 0 | AnalogOutput01 | (U)INT | | | • | | |
| 2 | AnalogOutput02 | | | | | | |
| 30 | AnalogStatus01 | USINT | • | | | | |
| 31 | AnalogStatus02 | | | | | | |
| | OpenLineAnalogOutput01 or OpenLineAnalogOutput02 | | Bit 2 | | | | |
| | ConversionErrorAnalogOutput01 or ConversionErrorAnalogOutput02 | | Bit 3 | | | | |
| | IoSuppErrorAnalogOutput01 or IoSuppErrorAnalogOutput02 | Bit 7 | | | | | |
| HART - Configuration | | | | | | | |
| 1537 | HartNodeCnt_1 | USINT | | | | • | |
| 1665 | HartNodeCnt_2 | | | | | | |
| 1539 | HartMode_1 | USINT | | | | • | |
| 1667 | HartMode_2 | | | | | | |
| 1541 | HartBurstNode_1 | USINT | | | | • | |
| 1669 | HartBurtNode_2 | | | | | | |
| HART - Extended configuration | | | | | | | |
| 1558 | HartNodeDisable_1 | UINT | | | | • | |
| 1668 | HartNodeDisable_2 | | | | | | |
| 1546 | HartProtTimeOut_1 | UINT | | | | • | |
| 1674 | HartProtTimeOut_2 | | | | | | |
| 1550 | HartProtRetry_1 | UINT | | | | • | |
| 1678 | HartProtRetry_2 | | | | | | |
| 1554 | HartPreamble_1 | UINT | | | | • | |
| 1682 | HartPreamble_2 | | | | | | |
| HART - Communication (P2P) | | | | | | | |
| 612 + Index*24 | PvInput01_N (Index N = 01 to 04) | REAL | • | • ¹⁾ | | | |
| 1124 + Index*24 | PvInput02_N (Index N = 01 to 04) | | | | | | |
| 617 + Index*24 | PvUnit01_N (Index N = 01 to 04) | USINT | • | • ¹⁾ | | | |
| 1129 + Index*24 | PvUnit02_N (Index N = 01 to 04) | | | | | | |
| 628 | PvSampleTime01 | DINT | • | • ¹⁾ | | | |
| 1140 | PvSampleTime02 | | | | | | |
| 626 | PvSampleTime01 | INT | • | | | | |
| 1138 | PvSampleTime02 | | | | | | |
| 566 | PvNodeComStatus01 | UINT | | • | | | |
| 1078 | PvNodeComStatus02 | | | | | | |
| HART - Communication (multidrop) | | | | | | | |
| 612 + Index*24 | PvInput01_N (Index N = 01 to 15) | REAL | • | • ¹⁾ | | | |
| 1124 + Index*24 | PvInput02_N (Index N = 01 to 15) | | | | | | |
| 617 + Index*24 | PvUnit01_N (Index N = 01 to 15) | USINT | • | • ¹⁾ | | | |
| 1129 + Index*24 | PvUnit02_N (Index N = 01 to 15) | | | | | | |
| 604 + Index*24 | PvSampleTime01_N (Index N = 01 to 15) | DINT | • | • ¹⁾ | | | |
| 1116 + Index*24 | PvSampleTime02_N (Index N = 01 to 15) | | | | | | |
| 602 + Index*24 | PvSampleTime01_N (Index N = 01 to 15) | INT | • | | | | |
| 1114 + Index*24 | PvSampleTime02_N (Index N = 01 to 15) | | | | | | |
| 562 + Index*4 | PvNodeComStatus01_N (Index N = 01 to 15) | UINT | | • | | | |
| 1074 + Index*4 | PvNodeComStatus02_N (Index N = 01 to 15) | | | | | | |
| HART - Extended communication | | | | | | | |
| 522 | PvCountHartRequest01 | UINT | • | | | | |
| 1034 | PvCountHartRequest02 | | | | | | |
| 530 | PvCountHartTimeout01 | UINT | • | | | | |
| 1042 | PvCountHartTimeout02 | | | | | | |

| Register | Name | Data type | Read | | Write | |
|---|--|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| 538 1050 | PvCountHartRxError01 PvCountHartRxError02 | UINT | • | | | |
| 546 1058 | PvCountHartFrameError01 PvCountHartFrameError02 | UINT | • | | | |
| 554 1066 | PvNodeFound01 PvNodeFound02 | UINT | • | | | |
| 558 1070 | PvNodeError01 PvNodeError02 | UINT | • | | | |
| FlatStream interface - Configuration | | | | | | |
| 1793 | OutputMTU | USINT | | | | • |
| 1795 | InputMTU | USINT | | | | • |
| 1797 | FlatstreamMode | USINT | | | | • |
| 1799 | Forward | USINT | | | | • |
| 1802 | ForwardDelay | UINT | | | | • |
| FlatStream interface - Communication | | | | | | |
| 1857 | InputSequence | USINT | • | | | |
| 1857 + Index*2 | RxByteN (Index N = 1 to 15) | USINT | • | | | |
| 1889 | OutputSequence | USINT | | | • | |
| 1889 + Index*2 | TxByteN (Index N = 1 to 15) | USINT | | | • | |
| The OSP function model | | | | | | |
| 32 | OSPComByte | USINT | | | • | |
| | OSPValid | Bit 0 | | | | |
| 401 403 | CfgOSPMode01 CfgOSPMode02 | USINT | | | | • |
| 34 36 | CfgOSPValue01 CfgOSPValue02 | INT | | | | • |

- 1) These HART registers are defined multiple times. Hence, they can be activated acyclically, if they are not registered during the cyclical phase of the X2X transmission.

9.2.3.11.4 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|---|----------------------|---|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog signal - Configuration | | | | | | | |
| 386 | - | AnalogMode01 | UINT | | | | • |
| 394 | - | AnalogMode02 | | | | | |
| 390 | - | DACSlewrate01 | UINT | | | | • |
| 398 | - | DACSlewrate02 | | | | | |
| Analog signal - Communication | | | | | | | |
| 0 | 0 | AnalogOutput01 | (U)INT | | | • | |
| 2 | 8 | AnalogOutput02 | | | | | |
| 30 | - | AnalogStatus01 | USINT | | • | | |
| 31 | - | AnalogStatus02 | | | | | |
| | | OpenLineAnalogOutput01 or OpenLineAnalogOutput02 | Bit 2 | | | | |
| | | ConversionErrorAnalogOutput01 or ConversionErrorAnalogOutput02 | Bit 3 | | | | |
| | | IoSuppErrorAnalogOutput01 or IoSuppErrorAnalogOutput02 | Bit 7 | | | | |
| HART - Configuration | | | | | | | |
| 1537 | - | HartNodeCnt_1 | USINT | | | | • |
| 1665 | - | HartNodeCnt_2 | | | | | |
| 1539 | - | HartMode_1 | USINT | | | | • |
| 1667 | - | HartMode_2 | | | | | |
| 1541 | - | HartBurstNode_1 | USINT | | | | • |
| 1669 | - | HartBurtNode_2 | | | | | |
| HART - Extended configuration | | | | | | | |
| 1558 | - | HartNodeDisable_1 | UINT | | | | • |
| 1668 | - | HartNodeDisable_2 | | | | | |
| 1546 | - | HartProtTimeOut_1 | UINT | | | | • |
| 1674 | - | HartProtTimeOut_2 | | | | | |
| 1550 | - | HartProtRetry_1 | UINT | | | | • |
| 1678 | - | HartProtRetry_2 | | | | | |
| 1554 | - | HartPreamble_1 | UINT | | | | • |
| 1682 | - | HartPreamble_2 | | | | | |
| HART - Communication (P2P) | | | | | | | |
| 636 | 4 | PvInput01_01 | REAL | • | | | |
| 1148 | 12 | PvInput02_01 | | | | | |
| 612 + Index*24 | - | PvInput01_N (Index N = 02 to 04) | REAL | | • | | |
| 1124 + Index*24 | - | PvInput02_N (Index N = 02 to 04) | | | | | |
| 641 | 2 | PvUnit01_01 | USINT | • | | | |
| 1153 | 10 | PvUnit02_01 | | | | | |
| 617 + Index*24 | - | PvUnit01_N (Index N = 02 to 04) | USINT | | • | | |
| 1129 + Index*24 | - | PvUnit02_N (Index N = 02 to 04) | | | | | |
| 566 | - | PvNodeComStatus01 | UINT | | • | | |
| 1078 | - | PvNodeComStatus02 | | | | | |
| HART - Communication (multidrop) | | | | | | | |
| 636 | 4 | PvInput01_01 | REAL | • | | | |
| 1148 | 12 | PvInput02_01 | | | | | |
| 612 + Index*24 | - | PvInput01_N (Index N = 02 to 15) | REAL | | • | | |
| 1124 + Index*24 | - | PvInput02_N (Index N = 02 to 15) | | | | | |
| 641 | 2 | PvUnit01_01 | USINT | • | | | |
| 1153 | 10 | PvUnit02_01 | | | | | |
| 617 + Index*24 | - | PvUnit01_N (Index N = 02 to 15) | USINT | | • | | |
| 1129 + Index*24 | - | PvUnit02_N (Index N = 02 to 15) | | | | | |
| 562 + Index*4 | - | PvNodeComStatus01_N (Index N = 01 to 15) | UINT | | • | | |
| 1074 + Index*4 | - | PvNodeComStatus02_N (Index N = 01 to 15) | | | | | |
| HART - Extended communication | | | | | | | |
| 522 | - | PvCountHartRequest01 | UINT | | • | | |
| 1034 | - | PvCountHartRequest02 | | | | | |
| 530 | - | PvCountHartTimeout01 | UINT | | • | | |
| 1042 | - | PvCountHartTimeout02 | | | | | |
| 538 | - | PvCountHartRxError01 | UINT | | • | | |
| 1050 | - | PvCountHartRxError02 | | | | | |
| 546 | - | PvCountHartFrameError01 | UINT | | • | | |
| 1058 | - | PvCountHartFrameError02 | | | | | |
| 554 | - | PvNodeFound01 | UINT | | • | | |
| 1066 | - | PvNodeFound02 | | | | | |
| 558 | - | PvNodeError01 | UINT | | • | | |
| 1070 | - | PvNodeError02 | | | | | |

1) The offset specifies the position of the register within the CAN object.

9.2.3.11.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.2.3.11.4.2 CAN I/O bus controller

The module occupies 2 analog logical slots on CAN I/O.

9.2.3.11.5 Analog signal - Configuration

The module has 2 independent electrically isolated channels with integrated HART modems. Both channels can be used to output an analog signal and handle HART communication. 2 registers need to be configured for one analog signal. The 2 channels operate independently, so 2 registers must be configured per channel to be used.

The current outputs (default: 4 to 20 mA) can be used as conventional analog signals. The integrated HART modems retrieve digital information from the memory on the HART slave using the same physical lines that modulate the HART signals.

Each channel can use one of the following connection variants:

- Point-to-point (connection of one HART node on the channel):
 - Evaluation of the analog signal
 - and
 - Recording of up to 4 HART values
- Multidrop (connection of up to 15 HART nodes on the channel):
 - Recording of one HART value per connected node

Specific features

- Electrical isolation by channel
- Up to 4 or 15 HART input variables per channel
- Configurable output rate (DAC slew rate) to transfer HART and analog signal without interference (default: 210 ms full scale)
- Selectable error strategy (static replacement value or retention of the last permitted value)
- Cyclic "HART status" polling (HART command 0), the status information received is made available for channel diagnostics
- Compatible with an additional secondary master in the HART network (module acts as the primary master)
- "HART communication error bit" (shows loss of HART connection if a connection had already been established successfully)
- Optional: BURST mode for one node per channel
- Optional: Cyclic polling of "HART variables" (HART command 3 or 9)
- Optional: FlatStream functionality (module acts as bridge for HART packets)

9.2.3.11.5.1 AnalogMode

Name:

AnalogMode01 to AnalogMode02

These registers are used to predefine the operating parameters that the module will be using for the respective channel. Each channel must be activated and configured separately.

Information:

When you select the operating mode "Scaling 0 to 20 mA (Resolution 0 to 65535)", then the corresponding "AnalogOutput" registers are interpreted internally as UINT instead of INT.

The entire program must be rebuilt for the data type change to take effect. The data type cannot be changed during runtime (e.g. using a library).

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 33 |

Bit structure:

| Bit | Name | Value | Information |
|--------|---|-------|--|
| 0 | Channel | 0 | Disabled |
| | | 1 | Enabled (bus controller default setting) |
| 1 | Check - D/A converter configuration/status | 0 | Enabled (bus controller default setting) |
| | | 1 | Disabled |
| 2 - 3 | Reserved | - | |
| 4 | Scaling 0 to 20 mA (Resolution 0 to 32767) | 0 | Disabled |
| | | 1 | Enabled |
| 5 | Scaling 4 to 20 mA (Resolution 0 to 32767) | 0 | Disabled |
| | | 1 | Enabled (bus controller default setting) |
| 6 | Scaling 0 to 24 mA (Resolution 0 to 24000) | 0 | Disabled |
| | | 1 | Enabled |
| 7 | Scaling 0 to 20 mA (Resolution 0 to 65535) | 0 | Disabled |
| | | 1 | Enabled |
| 8 - 15 | Reserved | - | |

Information:

The "AnalogMode" registers provide the option of avoiding the cyclic check of the D/A converter configuration. To manage communication reliably, this option should only be used if no HART communication is taking place on the channel.

9.2.3.11.5.2 DACSlewwrate

Name:

DACSlewwrate01 to DACSlewwrate02

These registers limit the rate at which the analog signal is modified. This makes it possible to define a sort of upper limit frequency.

The following formula applies: $f(\text{Analog}) = f(\text{Output rate}) * \text{Permitted change} / \text{max. } \Delta(\text{standardized output value})$

To ensure communication takes place without errors, it's important that the frequency range of the digital HART signal is not influenced by the analog output. HART communication takes place in the frequency range 950 to 2500 Hz.

Example (default): $f(\text{Analog}) = 152440 \text{ Hz} * 4 / (32767 - 0)$

Conclusion: $f(\text{Analog}) = \sim 20 \text{ Hz} \ll 950 \text{ Hz} = f(\text{HART})$

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 514 |

Bit structure:

| Bit | Name | Value | Information |
|---------|---------------------------------------|-------|--|
| 0 - 2 | Permitted change per rate | 000 | 1-bit |
| | | 001 | 2-bit |
| | | 010 | 4-bit (bus controller default setting) |
| | | 011 | 8-bit |
| | | 100 | 16-bit |
| | | 101 | 32-bit |
| | | 110 | 64-bit |
| | | 111 | 128-bit |
| 3 - 7 | Reserved | - | |
| 8 - 11 | Output rate | 0000 | 257730 Hz |
| | | 0001 | 198410 Hz |
| | | 0010 | 152440 Hz (bus controller default setting) |
| | | 0011 | 131580 Hz |
| | | 0100 | 115740 Hz |
| | | 0101 | 69440 Hz |
| | | 0110 | 37590 Hz |
| | | 0111 | 25770 Hz |
| | | 1000 | 20160 Hz |
| | | 1001 | 16030 Hz |
| | | 1010 | 10290 Hz |
| | | 1011 | 8280 Hz |
| | | 1100 | 6900 Hz |
| | | 1101 | 5530 Hz |
| | | 1110 | 4240 Hz |
| | | 1111 | 3300 Hz |
| 12 - 14 | Reserved | - | |
| 15 | Slewwrate enable (ramp functionality) | 0 | Disabled (undefined jump behavior) |
| | | 1 | Enabled (defined transitions) |

9.2.3.11.6 Analog signal - Communication

In order to output the desired current signal (default: 4 to 20 mA), the module must be provided with the normalized output value (default: 0 to 32767). In this way, the X20AO2438 can be used as a conventional output module. The integrated HART modem physically uses the same line. Using higher frequency signals, the module can communicate with the HART slave and retrieve additional information.

9.2.3.11.6.1 AnalogOutput

Name:

AnalogOutput01 to AnalogOutput02

These registers provide the standardized output values. Depending on the scaling selected (see register "[Analog-Mode](#)" on page 760), the value range and the data type can be adapted to the requirements of the application. Once a permitted value is determined, the module outputs the respective current.

Information:

The value "0" disables the channel status LED.

| Data type | Value |
|----------------|------------|
| INT | 0 to 32767 |
| Optional: UINT | 0 to 65535 |

9.2.3.11.6.2 AnalogStatus

Name:

AnalogStatus01 to AnalogStatus02

The status register gives the user feedback about whether the respective channel is functioning properly.

| Data type | Value |
|-----------|-------------------|
| USINT | See bit structure |

Bit structure:

| Bit | Name | Value | Information |
|-------|-----------------------------------|-------|---------------------------------|
| 0 - 1 | Reserved | - | |
| 2 | OpenLineAnalogOutput01, 02 | 0 | Line OK |
| | | 1 | Open line |
| 3 | ConversionErrorAnalogOutput01, 02 | 0 | Conversion temperature OK |
| | | 1 | Conversion temperature too high |
| 4 - 6 | Reserved | - | |
| 7 | IoSuppErrorAnalogOutput01, 02 | 0 | Module supply OK |
| | | 1 | Module supply error |

9.2.3.11.7 HART

HART (Highway Addressable Remote Transducer) is a protocol for communicating with intelligent field devices. It was developed in order to more efficiently use the infrastructure for transferring analog signals. The digital HART notifications are modulated to the analog signal using Frequency Shift Keying (FSK). HART can thus use the same physical line as the analog signal without influencing the original function.

HART slaves are able to determine different process data independently and prepare HART concordantly. This protocol supports polling of the value of a process variable as well as its unit and status. Field devices usually supply their information after the master requests it. In newer revisions, it is also possible to transfer configuration data.

There are 2 different types of HART networks. In a *point-to-point* network, only one slave is connected to a HART master. Here, the analog signal and the HART signal can be transferred over the same line. Managing several slaves with HART requires what is known as a *multidrop* network. Here, each HART slave is assigned and identified by a unique address. Classic analog signals cannot be clearly traced in bus systems. As a result, the HART protocol does not support analog information transfers in multidrop networks up to and including HART Revision 5.

Information:

Split range operation with HART AO modules

Beginning with HART revision 6, bus stations that use an analog signal according to the split range method are written to separately. The HART protocol supports multidrop addressing as well as the use of analog signals for these applications.

The module was designed based on HART-Revision 5. Only single-channel FSK scheme is available for transmitting the signals.

Since all HART frames are generated and evaluated in the application when using the FlatStream interface, information that isn't specified until later revisions can also be read.

9.2.3.11.7.1 HART - Configuration

HART modules are analog modules equipped with a HART modem. For each channel, a separate HART network can be managed by the module, which acts as a primary master. Once configured successfully, the HART information is stored in the module where it can then be used by the PLC.

The number of HART slaves must be specified in the configuration.

If only one slave is connected to the HART channel, then it is part of a point-to-point network. The module can then prepare up to 4 process variables from the connected slave.

Multidrop mode allows up to 15 HART slaves to be connected. The primary process variable from each slave is then retrieved.

HartNodeCnt

Name:

HartCodeCnt_1 to HartCodeCnt_2

These registers tell the module how many HART slaves are connected to a channel.

Information:

If a slave is not connected to one of the HART channels, the value "0" should be defined in this register. This shortens the I/O update time and avoids superfluous error messages.

| Data type | Value | Information |
|-----------|---------|--|
| USINT | 0 | HART communication disabled for this channel |
| | 1 | Point-to-point Standard HART communication (bus controller default setting) |
| | 2 to 15 | Multidrop Number of HART slave nodes |

HartBurstNode

Name:

HartBurstNode_1 to HartBurstNode_2

In addition to the type of network, the user can also choose from 2 different types of communication behavior. Conventional HART communication relies on polling. The module queries the data from the HART slave individually and receives the corresponding information from the slave as a response. If a HART node should be queried in short time intervals, the user can configure burst mode for a node on each channel. In this case, the slave transmits the information from this node cyclically without a new request by the master.

The node numbers (short address) whose information should be queried using burst mode are entered by channel in the "HartBurstNode" registers. Burst mode is enabled using register "HartMode" on page 764.

| Data type | Value | Information |
|-----------|---------|--|
| USINT | 0 to 15 | Point-to-point. Bus controller default setting: 0 |

HartMode

Name:

HartMode_1 to HartMode_2

The user can use these registers to configure the communication behavior of each of the HART channels. Generally, the HART nodes are polled individually. This register can still be used to start or stop burst mode when needed. In burst mode, a node transmits its information cyclically instead of continuously. As a result, the HART standard allows the simultaneous usage of both burst mode and polling.

Information:

Register "HartBurstNode" on page 764 must be configured correctly for burst queries.

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| UINT | See bit structure. | 0 |

Bit structure:

| Bit | Name | Value | Information |
|-------|------------------------|-------|--|
| 0 | Slave polling mode | 0 | Polling mode enabled (bus controller default setting) |
| | | 1 | Polling mode disabled |
| 1 | Start slave burst mode | 0 | No response to burst (bus controller default setting) |
| | | 1 | Enables burst mode in the "HartBurstNode" on page 764 node |
| 2 | Stop slave burst mode | 0 | No response to burst (bus controller default setting) |
| | | 1 | Disables burst mode, if enabled |
| 3 - 7 | Reserved | - | |

9.2.3.11.7.2 HART - Communication

After the configuration is completed, the information is retrieved automatically and transferred to the module registers. A separate register is implemented in the module for each piece of information. HART modules are designed to query up to 15 pieces of information per channel. The module reads in the data, stores it in temporary memory and prepares it for retrieval. When the X2X master accesses the module registers, it is irrelevant whether the HART data originates from a point-to-point or multidrop network.

Overview of internal module mapping

| | <i>Point-to-point network (1 HART slave)</i> | <i>Multidrop network (2 to 15 HART slaves)</i> |
|--------------|--|--|
| (Pv)Input_01 | Primary piece of information from HART node 1 | Primary piece of information from HART node 1 |
| (Pv)Input_02 | Secondary piece of information from HART node 1 | Primary piece of information from HART node 2 |
| ... | ... | ... |
| (Pv)Input_04 | Quaternary piece of information from HART node 1 | Primary piece of information from HART node 4 |
| (Pv)Input_05 | Reserved | Primary piece of information from HART node 5 |
| ... | ... | ... |
| (Pv)Input_15 | Reserved | Primary piece of information from HART node 15 |

The HART specifications stipulates that information from a HART node be split into various pieces. The value of a process variable is stored to the respective "PvInput" on page 765 register and has a size of 4 bytes (REAL) per the HART specification. Due to the length limitation of 30 bytes on the X2X Link network, there are limitations to the number of possible cyclic variables. It is recommended to transfer a maximum of 2 "PvInput" on page 765 registers cyclically to the X2X master. All other information should be read in a different way. To access HART information, the user can choose between the following methods:

- **Acyclic:** If library AsIOAcc is used, information is queried acyclically only when it is needed, i.e. communication can be adapted to the program sequence of the X2X master. In this way, all of the necessary module registers on the X2X Link network can be queried despite the length limitation. This type of information exchange is not real-time capable.
- **Cyclic:** Data points configured for cyclic transfer are read once per bus cycle. This procedure allows real-time capable information exchange between the module and X2X master. The length limitation may prevent all data from being queried within one cycle, however.
- **Multiplexed:** A runtime driver can be used to transfer the HART data points in the I/O mapping. In this case, the HART process data points are transferred in an alternating pattern using time-division multiplexing. Communication remains real-time capable. Multiple bus cycles are needed to update all data points, however.

Information:

"Multiplexed" data transfer is used only for HART data points.

Information from the analog inputs/outputs is always transferred cyclically (see above).

- **Flatstream:** HART modules are equipped with a Flatstream interface. When using Flatstream communication, the module is used as a bridge between the X2X master and HART slave, i.e. the X2X master communicates directly with the HART slave (see "Flatstream communication" on page 3802). Flatstream communication is also not real-time capable. It allows unrestricted access to the HART slave. The user must have sufficient knowledge of the HART protocol command set as well as the capabilities of the corresponding HART slave.

PvInput

Name:

PvInput_01 to PvInput_15

PvInput_01_01 to PvInput_01_15

PvInput_02_01 to PvInput_02_15

These registers return the current value of the process variable that has been read.

Information:

These registers are of data type REAL, which means that the available bytes on the X2X Link are filled more quickly when operated cyclically. If information from several slave nodes is needed, it must be retrieved acyclically or using Flatstream .

| Data type | Value | Information |
|-----------|-------------|---------------------------------------|
| REAL | IEEE754 SPF | 32-bit data type with valid value |
| | 0x7FA00000 | Not a number (NaN) with invalid value |

PvUnit

Name:

PvUnit_01 to PvUnit_15

PvUnit_01_01 to PvUnit_01_15

PvUnit_02_01 to PvUnit_02_15

These registers return a HART-specific code that specifies the unit for the measured value. The coding for this is established in the HART specification.

| Data type | Value |
|-----------|---|
| USINT | See description of the HART slave See HART specification |

PvSampleTime

Name:

PvSampleTime01 to PvSampleTime02

PvSampleTime01_01 to PvSampleTime01_15

PvSampleTime02_01 to PvSampleTime02_15

These registers return the timestamp for when the module reads the current channel mapping. The values are provided as signed 2-byte or 4-byte values.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Values | Information |
|-----------|---------------------------|---|
| INT | -32,768 to 32767 | NetTime timestamp of the current input value in μs |
| DINT | -2147483648 to 2147483647 | NetTime timestamp of the current input value in μs |

This refers to the point in time when the HART master receives the slave's response. This is a way to check whether new HART information has been read since the last X2X cycle.

Information:

The cycle times of a HART network are relatively long so that it is not possible to reliably determine when the measured value is retrieved with just this information.

PvNodeComStatus

Name:

PvNodeComStatus01 to PvNodeComStatus02

PvNodeComStatus01_01 to PvNodeComStatus01_15

PvNodeComStatus02_01 to PvNodeComStatus02_15

These registers provide information about whether a read value is valid. Per the HART specification, this type of status register consists of 2 parts. The "response code" is stored in the high byte; the "field device status" is stored in the low byte. This makes it possible to check the current state of a read process variable.

These registers can be checked before further processing information in temporary storage. If the current value is 0x0000, an error was not detected during the HART transfer and the information from the checked node can be used. If a different value is present, the situation in the HART network should be checked. This can be done using an extension register, for example.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|--------|---|-------|---|
| 0 | Quality - Node information 2 to n | 0 | Digital measured value okay |
| | | 1 | Measured value outside the permitted range |
| 1 | Quality - Node information 1 | 0 | Digital measured value okay |
| | | 1 | Measured value outside the permitted range |
| 2 | Limit violation | 0 | Parameter okay |
| | | 1 | Invalid measured value(s) or encoder supply value |
| 3 | Static analog signal | 0 | Normal value change/fluctuation |
| | | 1 | Constant analog value of Node 1 slave |
| 4 | Additional status information (only supported by a few slaves) | 0 | Not available |
| | | 1 | Available (only using Flatstream command #48) |
| 5 | Restart | 0 | Normal operation |
| | | 1 | Field device restarts |
| 6 | Device ID | 0 | Unchanged |
| | | 1 | Changed |
| 7 | Device error | 0 | Measured value okay |
| | | 1 | Questionable measured value information |
| 8 - 14 | Response code, if relevant | x | See HART-specific response code |
| 15 | Error - Communication | 0 | Error-free communication (response code irrelevant) |
| | | 1 | Faulty communication (response code relevant) |

HART-specific response code (excerpt):

| | |
|------------------------------------|---|
| 0x82 ... Receive buffer overflow | If a HART communication error occurs, the response code is written. Bit 15 is always set. |
| 0x88 ... Checksum incorrect | |
| 0x90 ... Faulty protocol structure | |
| 0xA0 ... Overrun | |
| 0xC0 ... Parity not allowed | |
| 0xFF ... Timeout | |

Retrieving information that has been read

After the node data has been transferred to the module registers, the information can be retrieved from the module. A separate register in the module is implemented for each piece of information.

PvCountHartRequest

Name:

PvCountHartRequest01 to PvCountHartRequest02

These registers are increased once the module is ready to transmit a message to the corresponding channel.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

PvCountHartTimeout

Name:

PvCountHartTimeout01 to PvCountHartTimeout02

These registers are increased if the slave exceeds the maximum permitted time before responding to the module's request.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

PvCountHartRxError

Name:

PvCountHartRxError01 to PvCountHartRxError02

These registers are increased if communication errors occur on Layer 1 of the OSI model (e.g. transmission error as per parity bit).

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

PvCountHartFrameError

Name:

PvCountHartFrameError01 to PvCountHartFrameError02

These registers are increased if communication errors occur on Layer 2 of the OSI model (e.g. faulty telegram structure).

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

PvNodeFound

Name:

PvNodeFound01 to PvNodeFound02

These registers provide information about which nodes were detected on which channel (slave identified successfully).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|--|-------|-----------------------|
| 0 | Node 0 (default mode) Node 1 (multidrop mode) | 0 | Not detected as valid |
| | | 1 | Detected as valid |
| 1 | Node 2 (multidrop mode) | 0 | Not detected as valid |
| | | 1 | Detected as valid |
| ... | | ... | |
| 13 | Node 14 (multidrop mode) | 0 | Not detected as valid |
| | | 1 | Detected as valid |
| 14 | Node 15 (multidrop mode) | 0 | Not detected as valid |
| | | 1 | Detected as valid |
| 15 | Reserved | - | |

PvNodeError

Name:

PvNodeError01 to PvNodeError02

These registers contain the HART communications error bits. These bits are set if the connection to a node was established successfully but the node at some point no longer responds as it should (e.g. the HART slave exceeds the configured timeout / number of retries).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|--|-------|------------------------------|
| 0 | Node 0 (default mode) Node 1 (multidrop mode) | 0 | Detected as having no errors |
| | | 1 | Detected as having errors |
| 1 | Node 2 (multidrop mode) | 0 | Detected as having no errors |
| | | 1 | Detected as having errors |
| ... | | ... | |
| 13 | Node 14 (multidrop mode) | 0 | Detected as having no errors |
| | | 1 | Detected as having errors |
| 14 | Node 15 (multidrop mode) | 0 | Detected as having no errors |
| | | 1 | Detected as having errors |
| 15 | Reserved | - | |

9.2.3.11.7.3 Extended configuration

The additional configuration registers are specified values when the module is started. In most systems, the user does not need to make any adjustments here. Register values should only be changed if HART network communication is not taking place satisfactorily.

HartNodeDisable

Name:

HartNodeDisable_1 to HartNodeDisable_2

These registers are intended for things like maintenance. They make it possible to cut off configured HART nodes to suppress error messages for a certain period of time. During normal operation, the configured nodes must be switched active to guarantee that the procedure runs smoothly.

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| UINT | See bit structure. | 0x3FFF |

Bit structure:

| Bit | Name | Value | Information |
|-----|--------------------------|-------|---|
| 0 | Node 0 (default mode) | 0 | Enabled (bus controller default setting) |
| | Node 1 (multidrop mode) | 1 | Disabled |
| 1 | Node 2 (multidrop mode) | 0 | Enabled |
| | | 1 | Disabled (bus controller default setting) |
| ... | | ... | |
| 13 | Node 14 (multidrop mode) | 0 | Enabled |
| | | 1 | Disabled (bus controller default setting) |
| 14 | Node 15 (multidrop mode) | 0 | Enabled |
| | | 1 | Disabled (bus controller default setting) |
| 15 | Reserved | - | |

HartProtTimeOut

Name:

HartProtTimeOut_1 to HartProtTimeOut_2

These registers specify the time span within which the slave must respond for the response to be valid.

| Data type | Values [ms] | Information |
|-----------|-------------|--|
| UINT | 0 to 65535 | Bus controller default setting: 256 [ms] |

HartProtRetry

Name:

HartProtRetry_1 to HartProtRetry_2

These registers determine how many times the master retries a request if it receives an invalid response or no response at all.

| Data type | Value | Information |
|-----------|------------|--|
| UINT | 0 to 65535 | Bus controller default setting: 3 attempts |

HartPreamble

Name:

HartPreamble_1 to HartPreamble_2

The length of the preamble can be set in these registers. The preamble is used to synchronize the receiver to the transmitter. The longer the declared preamble, the less chance that a communication error will occur. Nevertheless, a useful signal is not transmitted during synchronization so the preamble should be kept as short as possible.

| Data type | Value | Information |
|-----------|---------|------------------------------------|
| UINT | 5 to 20 | Bus controller default setting: 20 |

9.2.3.11.8 Flatstream communication

For a description of Flatstream communication, see ["Flatstream communication" on page 3802](#)

9.2.3.11.9 HART with Flatstream

When using Flatstream communication, the module acts as a bridge between the X2X master and an intelligent field device connected to the module. Flatstream mode can be used for either point-to-point connections as well as for multidrop systems. Specific algorithms such as timeout and checksum monitoring are usually managed automatically. During normal operation, the user does not have access to these details.

HART is considered a master-slave network where half-duplex communication takes place asynchronously. Various features have been included to ensure that signals are transmitted without errors.

For example, the user can increase the length of the preamble, thus making the transmission more secure. However, this also has an effect on the percentage of payload data and overhead.

Additional information about HART can be found at www.HARTcomm.org.

How it works

The module has 2 independent channels. When using Flatstream, the channel number must therefore be specified. The general structure of a Flatstream frame is extended as follows.

| Input/Output sequence | Tx/Rx bytes | | |
|-----------------------|-----------------------------|----------------|---|
| (unchanged) | Control byte (unchanged) | Channel number | HART frame (without preamble and checksum) |

| HART frame with Flatstream | | | | | |
|----------------------------|------|-----|------|-------|--------|
| Startup | ADDR | CMD | BCNT | (STS) | (DATA) |

| | |
|---------|--|
| Startup | Start identification |
| ADDR | Address within the HART network |
| CMD | HART command |
| BCNT | Byte counters (number of remaining bytes) |
| *STS | Status of the last command received. Information about the working mode of the HART Slave and communication errors (if supported, return data from the HART Slave) |
| *DATA | Data (if necessary for the command) |

Examples of HART commands

| Command | Function |
|---------|--|
| 0x00 | Read slave ID |
| 0x03 | Read current value and up to 4 variables |
| 0x09 | Read up to 4 variables including status |
| 0x21 | Read variables |

9.2.3.11.10 Function model "OSP"

In function model "OSP" (Operator Set Predefined), the user defines an analog value or digital pattern. This OSP value is output as soon as the communication between the module and master is aborted.

Functionality

The user has the choice between 2 OSP modes:

- Retain last valid value
- Replace with static value

In the first case, the module retains the last value recognized as a valid output status.

When selecting mode "Replace with static value", a plausible output value must be entered in the associated value register. When an OSP event occurs, this value is output instead of the value currently requested by the task.

9.2.3.11.10.1 Activating the OSP output in the module

Name:

OSPValid

This data point offers the possibility to start module output and request OSP operation during running operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|----------|-------|--|
| 0 | OSPValid | 0 | Request OSP operation (after initial start or module in Standby) |
| | | 1 | Request normal operation |
| 1 - 7 | Reserved | 0 | |

There is one OSPValid bit on the module, which is managed by the user task. It must be set when the enabled channels are started. As long as the OSPValid bit remains set in the module, the module behaves the same as the "Standard" function model.

If an OSP event occurs (e.g. communication between the module and master CPU interrupted) then the OSPValid bit will be reset on the module. The module enters OSP mode and the output occurs in the "OSPMoDe" on page 771 register according to the configuration.

The following applies:

The OSP replacement value remains even after the communication channel has recovered. OSP mode is only exited when a set OSPValid bit is transferred.

When the master CPU is restarted, the OSPValid bit is re-initialized on the master CPU. It must once more be set by the application and transferred via the bus.

When temporary communication errors occur between the module and master CPU (e.g. due to EMC), a few bus cycles will pass without refreshing the cyclic registers. The OSPValid bit is reset internally in the module - the bit in the CPU however remains set. Upon the next successful transfer, the OSPValid bit in the module is set again and the module returns to normal operation.

The ModulOK bit can be evaluated if the task in the master CPU needs to know which output mode the module is currently in.

Warning!

If the OSPValid bit is reset to "0" on the module, then the output state no longer depends on the relevant task in the master CPU. However, an output still occurs depending on the configuration of the OSP replacement value.

9.2.3.11.10.2 Setting the OSP mode

Name:

CfgOSPMoDe01 to CfgOSPMoDe02

This register essentially controls a channel's behavior when OSP is being used.

| Data type | Value | Description |
|-----------|-------|---------------------------|
| USINT | 0 | Replace with static value |
| | 1 | Retain last valid value |

9.2.3.11.10.3 Define the OSP analog output value

Name:

CfgOSPValue01 to CfgOSPValue02

This register contains the analog output value, which is output in "Replace with static value" mode during OSP operation.

| Data type | Value |
|-------------------------------|-------------------------------|
| Corresponds to AnalogOutput0x | Corresponds to AnalogOutput0x |

Warning!

"OSPValue" is only applied by the module if bit "OSPValid" has been set in the module.

9.2.3.11.11 NetTime Technology

For a description of NetTime Technology, see ["NetTime Technology" on page 3035](#).

9.2.3.11.12 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 µs |

9.2.3.11.13 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|------|
| Analog outputs | 1 ms |

| Minimum I/O update time Hart Communication | |
|--|-----------------------------|
| Point-to-point | 500 ms |
| Multidrop | 500 ms * number of stations |

9.2.4 X20AO2622

Data sheet version: 3.12

9.2.4.1 General information

The module is equipped with 2 outputs with 13-bit (including sign) digital converter resolution. It is possible to select between the current and voltage signal using different terminals.

This module is designed for X20 6-pin terminal blocks. If needed (e.g. for logistical reasons), the 12-pin terminal block can also be used.

- 2 analog outputs
- Either current or voltage signal possible
- 13-bit digital converter resolution

9.2.4.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Analog outputs |  |
| X20AO2622 | X20 analog output module, 2 outputs, 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |

Table 94: X20AO2622 - Order data

9.2.4.3 Technical data

| Model number | X20AO2622 |
|--|--|
| Short description | |
| I/O module | 2 analog outputs ± 10 V or 0 to 20 mA / 4 to 20 mA ¹⁾ |
| General information | |
| B&R ID code | 0x1BA2 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| Channel type | Yes, using software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.1 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| EAC | Yes |
| KC | Yes |
| Analog outputs | |
| Output | ± 10 V or 0 to 20 mA / 4 to 20 mA, via different terminal connections ¹⁾ |
| Max. output current | 10 mA at voltage >5 V 15 mA at voltage <5 V |
| Digital converter resolution | |
| Voltage | ± 12 -bit |
| Current | 12-bit |
| Conversion time | 200 μ s for all outputs |
| Settling time on output change over entire range | 1 ms |
| Switch on/off behavior | Internal enable relay for startup |
| Max. error | |
| Voltage | |
| Gain | 0.15% ²⁾ |
| Offset | 0.05% ³⁾ |
| Current | |
| Gain | 0.15% ²⁾ |
| Offset | 0.05% ³⁾ |
| Output protection | Short-circuit proof |
| Output format | |
| Voltage | INT 0x8001 - 0x7FFF / 1 LSB = 0x0008 = 2.441 mV |
| Current | INT 0x0000 - 0x7FFF / 1 LSB = 0x0008 = 4.883 μ A |
| Load per channel | |
| Voltage | Max. ± 10 mA, load ≥ 1 k Ω |
| Current | Load max. 600 Ω (Rev. \geq J0), 500 Ω (Rev. < J0) |
| Short-circuit proof | Current limiting ± 40 mA |
| Output filter | First-order low-pass filter / cutoff frequency 10 kHz |
| Max. gain drift | |
| Voltage | 0.02%/°C ²⁾ |
| Current | 0.02%/°C ²⁾ |
| Max. offset drift | |
| Voltage | 0.032%/°C ³⁾ |
| Current | 0.032%/°C ³⁾ |
| Error caused by load change | |
| Voltage | Max. 0.11%, from 10 M Ω \rightarrow 1 k Ω , resistive |
| Current | Max. 0.5%, from 1 Ω \rightarrow 600 Ω , resistive |
| Nonlinearity | <0.007% ⁴⁾ |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |

Table 95: X20AO2622 - Technical data


| Model number | X20AO2622 |
|--|--|
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB06 or X20TB12 separately Order 1x bus module X20BM11 separately. |
| Pitch | 12.5 ^{+0.2} mm |

Table 95: X20AO2622 - Technical data

- 1) 4 to 20 mA: Starting with upgrade version 1.0.2.0 or hardware revision "I0"
- 2) Based on the current output value.
- 3) Based on the entire output range.
- 4) Based on the output range.

9.2.4.4 LED status indicators

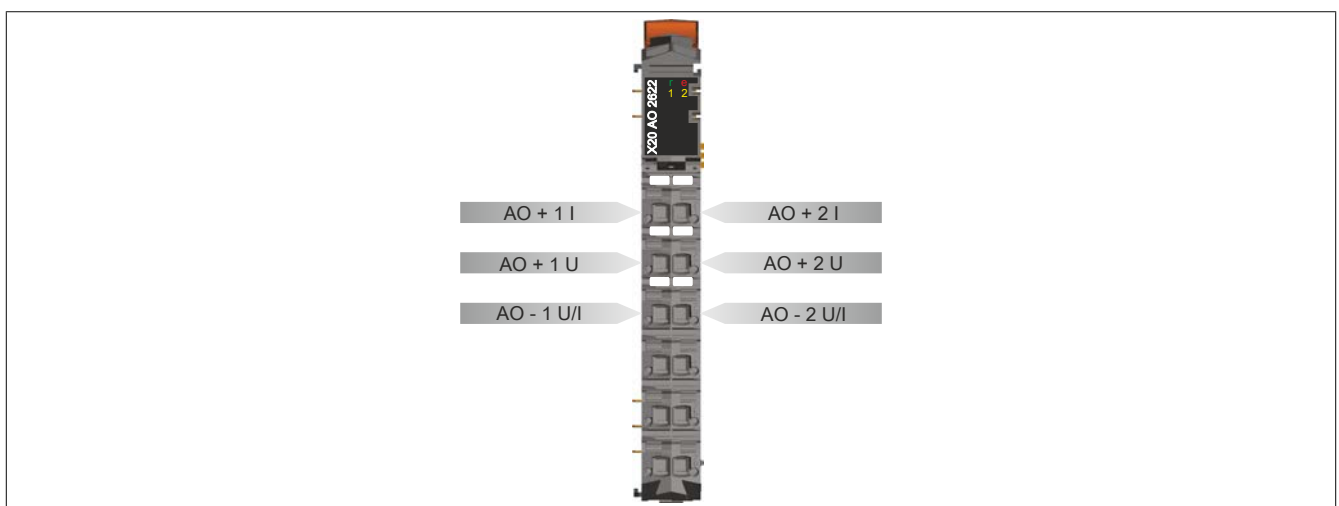
For a description of the various operating modes, see ["Diagnostic LEDs" on page 3787](#).

| Figure | LED | Color | Status | Description |
|---|-------|-----------------------------|------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1 - 2 | Orange | Off | Value = 0 |
| | | | On | Value ≠ 0 |

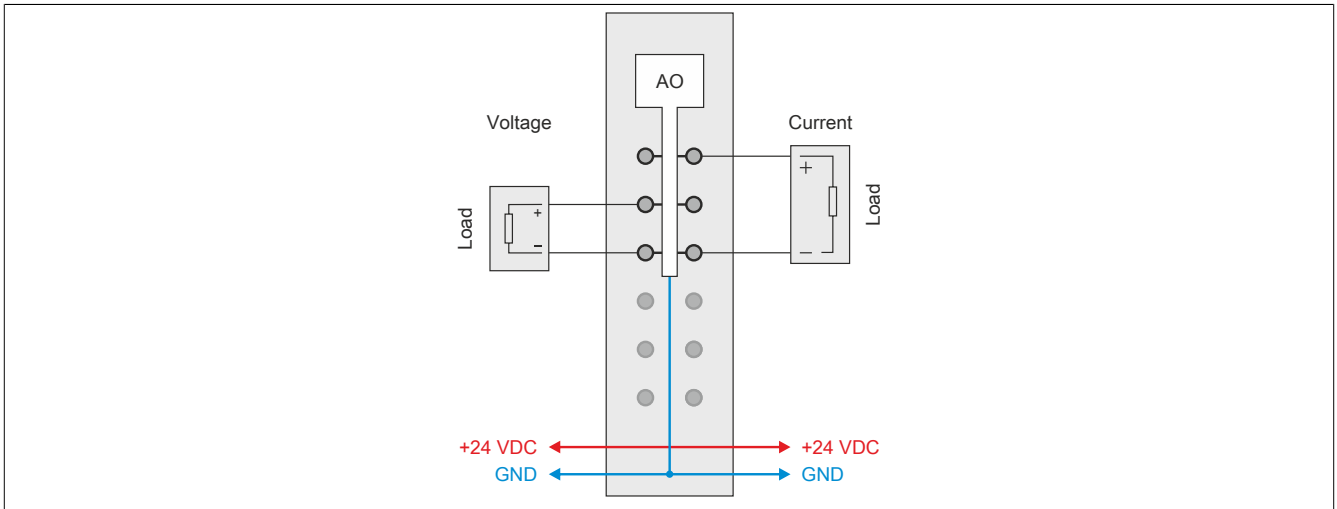
- 1) Depending on the configuration, a firmware update can take up to several minutes.

9.2.4.5 Pinout

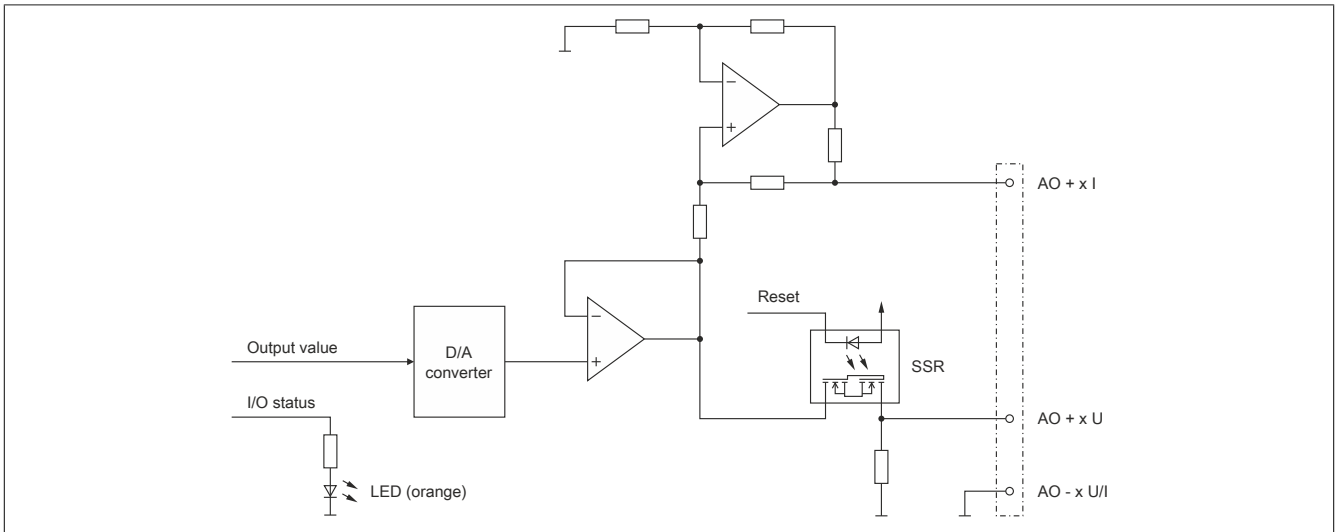
The individual channels can be configured for either current or voltage signals. The type of signal is also determined by the terminals used.



9.2.4.6 Connection example



9.2.4.7 Output circuit diagram



9.2.4.8 Register description

9.2.4.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.2.4.8.2 Function model 0 - Standard and function model 1 - I/O with fast reaction

| Register | Name | Data type | Read | | Write | |
|----------------------|--------------------------------|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration | | | | | | |
| 18 | ConfigOutput01 | USINT | | | | • |
| Communication | | | | | | |
| 0 | AnalogOutput01 | INT | | | • | |
| 2 | AnalogOutput02 | INT | | | • | |

9.2.4.8.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|---|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (channel type) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | AnalogOutput01 | INT | | | • | |
| 2 | 2 | AnalogOutput02 | INT | | | • | |

1) The offset specifies the position of the register within the CAN object.

9.2.4.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "[Using I/O modules on the bus controller](#)" on page 3789.

9.2.4.8.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.2.4.8.4 Function model comparison

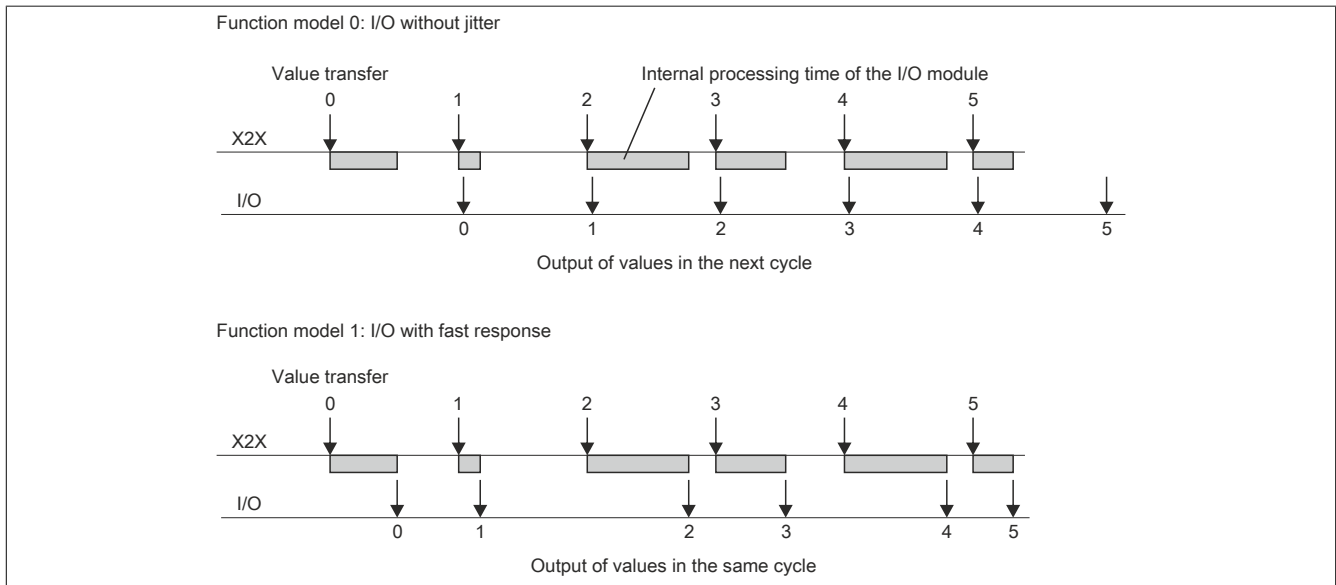
Function model 0: I/O without jitter (standard)

Corrected values are output in the next cycle if the minimum cycle is $\geq 300 \mu\text{s}$ in order to reduce jitter to a minimum.

Function model 1: I/O with fast reaction

Corrected values are output in the same cycle if the minimum cycle is $\geq 300 \mu\text{s}$ (optimized reactions).

Comparison of the two function models



9.2.4.8.5 Analog outputs

The individual channels can be configured for either current or voltage signals. The type of signal is also determined by the terminals used.

9.2.4.8.5.1 Output values of the analog outputs

Name:

AnalogOutput01 to AnalogOutput02

These registers provide the standardized output values. Once a permitted value is received the module outputs the respective current or voltage.

| Data type | Value | Information |
|-----------|-----------------|---|
| INT | -32768 to 32767 | Voltage signal -10 to 10 VDC |
| | 0 to 32767 | Current signal 0 to 20 mA |
| | 0 to 32767 | Current signal 4 to 20 mA ¹⁾ |

1) From upgrade version 1.0.2.0 or hardware revision "I0"

9.2.4.8.5.2 Setting the channel type

Name:

ConfigOutput01

This register can be used to set the channel type of the outputs.

Each channel is capable of handling either current or voltage signals. The type of signal is determined by the terminal connections used. Since current and voltage require different adjustment values, it is also necessary to configure the desired type of output signal. The following output signals can be set:

- ± 10 V voltage signal (default)
- 0 to 20 mA current signal
- 4 to 20 mA current signal

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Name | Value | Information |
|-------|--------------------------------------|-------|--|
| 0 | Channel 1 | 0 | Voltage signal (bus controller default setting) |
| | | 1 | Current signal, measurement range corresponding to bit 4 |
| 1 | Channel 2 | 0 | Voltage signal |
| | | 1 | Current signal, measurement range corresponding to bit 5 |
| 2 - 3 | Reserved | 0 | |
| 4 | Channel 1: Current measurement range | 0 | 0 to 20 mA current signal |
| | | 1 | 4 to 20 mA current signal |
| 5 | Channel 2: Current measurement range | 0 | 0 to 20 mA current signal |
| | | 1 | 4 to 20 mA current signal |
| 6 - 7 | Reserved | 0 | |

9.2.4.8.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 250 μ s |

9.2.4.8.7 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 300 μ s |

9.2.5 X20AO2632

Data sheet version: 3.20

9.2.5.1 General information

The module is equipped with 2 outputs with 16-bit (including sign) digital converter resolution. It is possible to select between the current and voltage signal using different terminals.

This module is designed for X20 6-pin terminal blocks. If needed (e.g. for logistical reasons), the 12-pin terminal block can also be used.

- 2 analog outputs
- Either current or voltage signal possible
- 16-bit digital converter resolution
- NetTime timestamp: Switch-off time

NetTime timestamp for output

For many applications, not only the output value is important, but also the exact switching time. The module is equipped with a NetTime timestamp function for this that can define a switching time to the nearest microsecond.

The timestamp function is based on synchronized timers. The CPU can predefine output events and provide them with a timestamp. After transferring the respective data, including the exact time, the module executes the predefined action at the exactly defined time.

9.2.5.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| X20AO2632 | Analog outputs X20 analog output module, 2 outputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, NetTime function |  |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 96: X20AO2632 - Order data

9.2.5.3 Technical data

| | |
|--|--|
| Model number | X20AO2632 |
| Short description | |
| I/O module | 2 analog outputs ± 10 V or 0 to 20 mA |
| General information | |
| B&R ID code | 0x1BA4 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Channel type | Yes, using software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.1 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 |
| HazLoc | Industrial control equipment cCSAus 244665 |
| ATEX | Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| DNV GL | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| LR | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| Analog outputs | |
| Output | ± 10 V or 0 to 20 mA, via different terminal connections |
| Digital converter resolution | |
| Voltage | ± 15 -bit |
| Current | 15-bit |
| Conversion time | 50 μ s for all outputs |
| Settling time on output change over entire range | 500 μ s (Rev. <H0: 1 ms) |
| Switch on/off behavior | Internal enable relay for booting |
| Max. error at 25°C | |
| Voltage | |
| Gain | 0.045% ¹⁾ |
| Offset | 0.025% ²⁾ |
| Current | |
| Gain | 0.09% ¹⁾ |
| Offset | 0.045% ²⁾ |
| Output protection | Short circuit protection |
| Output format | |
| Voltage | INT 0x8000 - 0x7FFF / 1 LSB = 0x0001 = 305.176 μ V |
| Current | INT 0x0000 - 0x7FFF / 1 LSB = 0x0001 = 610.352 nA |
| Load per channel | |
| Voltage | Max. ± 10 mA, load ≥ 1 k Ω |
| Current | Load max. 600 Ω (Rev. \geq J0); 500 Ω (Rev. < J0) |
| Short-circuit proof | Current limiting ± 40 mA |
| Output filter | 1st-order low pass / cutoff frequency 10 kHz |
| Max. gain drift | |
| Voltage | 0.015 %/°C ¹⁾ |
| Current | 0.02 %/°C ¹⁾ |
| Max. offset drift | |
| Voltage | 0.013 %/°C ²⁾ |
| Current | 0.013 %/°C ²⁾ |
| Error caused by load change | |
| Voltage | Max. 0.11%, from 10 M Ω \rightarrow 1 k Ω , resistive |
| Current | Max. 0.5%, from 1 Ω \rightarrow 600 Ω , resistive |
| Nonlinearity | <0.007% ³⁾ |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |

Table 97: X20AO2632 - Technical data


| Model number | X20AO2632 |
|--|---|
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB06 or X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm |

Table 97: X20AO2632 - Technical data

- 1) Based on the current output value.
- 2) Based on the entire output range.
- 3) Based on the output range.

9.2.5.4 LED status indicators

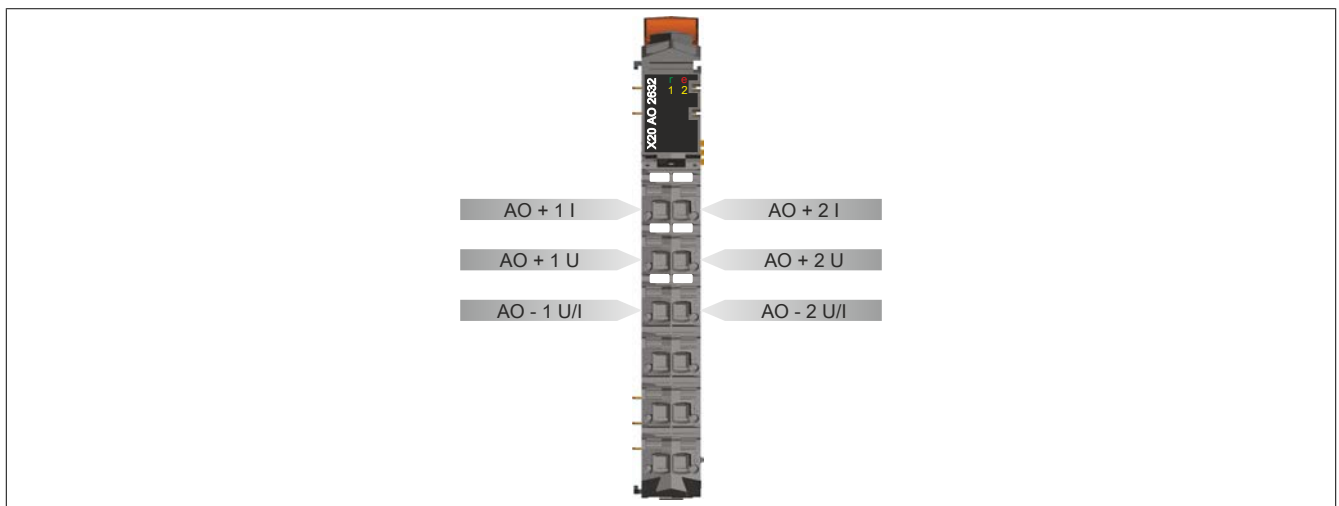
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|--------|--------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | 1 - 2 | Orange | Off | Value = 0 |
| | | | On | Value ≠ 0 |

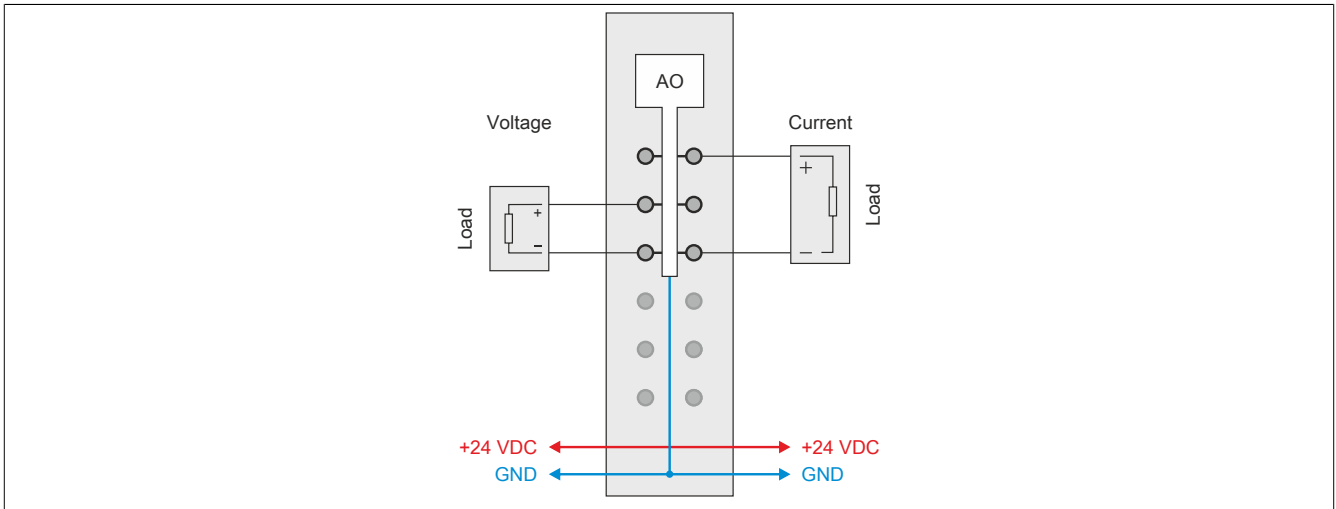
- 1) Depending on the configuration, a firmware update can take up to several minutes.

9.2.5.5 Pinout

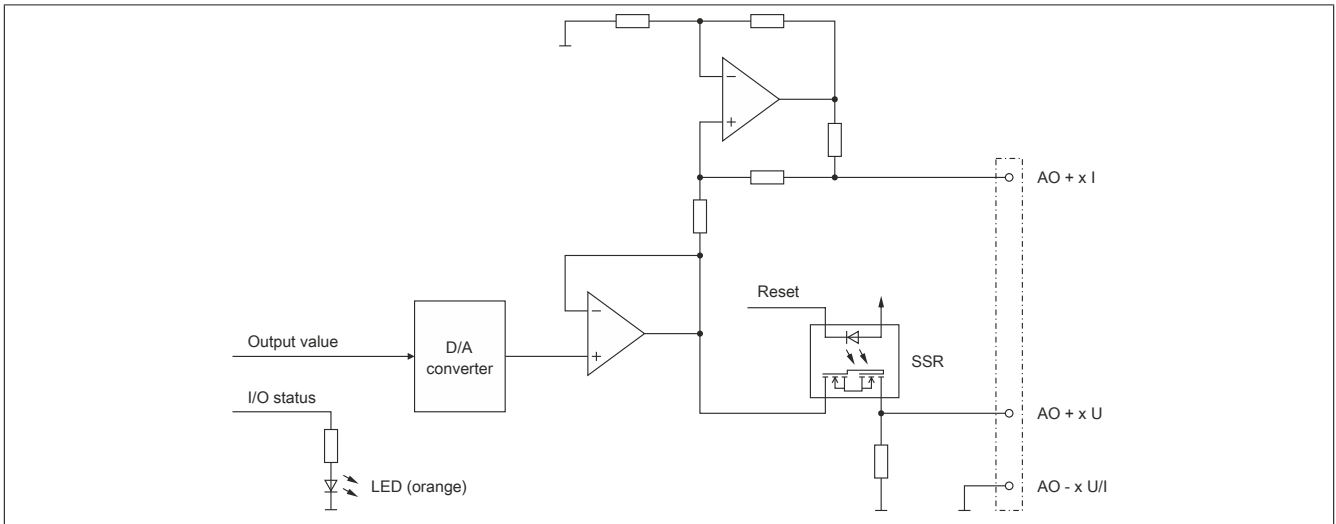
The individual channels can be configured for either current or voltage signals. The type of signal is also determined by the terminals used.



9.2.5.6 Connection example



9.2.5.7 Output circuit diagram



9.2.5.8 Register description

9.2.5.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.2.5.8.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|--|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog output - Configuration | | | | | | |
| 0 | ConfigOutput01 (channel type) | UINT | | | | • |
| 594 | Cfo_Channel01TimeMode | UINT | | | | • |
| 598 | Cfo_Channel02TimeMode | | | | | |
| Analog output - Communication | | | | | | |
| 2 | AnalogOutput01 | INT | | | • | |
| 4 | AnalogOutput02 | | | | | |
| 457 | SDCLifeCount | SINT | • | | | |
| 802 | ValidationTimer01 | INT | | | • | |
| 810 | ValidationTimer02 | | | | | |
| 804 | ValidationTimer01 | DINT | | | • | |
| 812 | ValidationTimer02 | | | | | |
| 833 | Enabling/disabling the output channels | USINT | • | | • | |
| | AnalogOutput01Enable, ~Readback | Bit 0 | | | | |
| | AnalogOutput02Enable, ~Readback | Bit 1 | | | | |
| 835 | Checking the output values | USINT | • | | | |
| | AnalogOutput01OK | Bit 0 | | | | |
| | AnalogOutput02OK | Bit 1 | | | | |

9.2.5.8.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------------|----------------------|---|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog output - Configuration | | | | | | | |
| 0 | - | ConfigOutput01 (channel type) | UINT | | | | • |
| Analog output - Communication | | | | | | | |
| 2 | 0 | AnalogOutput01 | INT | | | • | |
| 4 | 2 | AnalogOutput02 | | | | | |

1) The offset specifies the position of the register within the CAN object.

9.2.5.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.2.5.8.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.2.5.8.4 General information

The module provides 2 analog outputs. Each channel can output a voltage range of ± 10 V or a current range of 0 to 20 mA.

The module also has a time-based watchdog monitor. The user can activate this feature channel-by-channel as needed.

9.2.5.8.5 Analog output - Configuration

Each channel is configured independently. The user can also define an optional time-based monitor. To make this possible, 2 watchdog timers were implemented, which can be assigned to the outputs.

9.2.5.8.5.1 Setting the channel type

Name:

ConfigOutput01

This register can be used to set the channel type of the outputs.

Each channel is capable of handling either current or voltage signals. The type of signal is determined by the terminal connections used. Since current and voltage require different adjustment values, it is also necessary to configure the desired type of output signal. The following output signals can be set:

- ± 10 V voltage signal
- 0 to 20 mA current signal

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|---------|-------------|-------|---|
| 0 - 7 | Reserved | 0 | |
| 8 | Channel 1 | 0 | Voltage signal (bus controller default setting) |
| | | 1 | Current signal |
| 9 | Channel 2 | 0 | Voltage signal (bus controller default setting) |
| | | 1 | Current signal |
| 10 - 15 | Reserved | 0 | |

9.2.5.8.5.2 Configuring the time-based watchdog monitor

Name:

Cfo_Channel01TimeMode to Cfo_Channel02TimeMode

This register is used to activate or configure the time-based watchdog monitor for the analog output channels.

Possibilities per channel:

- Validation timer data type: General choice 16 or 32 bit
- Validation window: The maximum value can be further limited within the data type.
- Timer allocation: A separate timer is available for each channel. However, all channels can be configured with the same validation timer, whereby the same settings must be made for the data type and window in the TimeMode registers.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|--------|----------------------|-------|---|
| 0 - 4 | Max. validation time | 00000 | Disabled |
| | | 00001 | 2 μ s |
| | | 00010 | 4 μ s |
| | | 00011 | 8 μ s |
| | | ... | ... |
| | | 11111 | 2,147,483,648 μ s (~35 min) |
| 5 - 7 | Reserved | 0 | |
| 8 | Timer allocation | 0 | ValidationTimer01 (default for channel 1) |
| | | 1 | ValidationTimer02 (default for channel 2) |
| 9 - 14 | Reserved | 0 | |
| 15 | Time format | 0 | 16-bit |
| | | 1 | 32-bit |

9.2.5.8.6 Analog output - Communication

In standard mode, the module's outputs are enabled. Based on the configuration and AnalogOutput value, they output the corresponding current or voltage.

If the application requires time-controlled monitoring of the outputs, a validation timer can be assigned to each channel. The validation timer register assigns a validity period to the current output value. If validation is enabled, the module compares the validation time and the [NetTime](#) of the X2X Link. If the transmitted validity period is exceeded, the module switches off the channel and resets the output. State "Safety shutdown" is only exited again when a new valid validation time has been transmitted. If enabled, the module reports back which state it is currently in via the error state bit of the channel.

If the value of the validation timer is incremented in each task cycle, the valid validation time will be calculated as follows:

| | |
|---|--|
| NetTime of the X2X Link master (to which the module is connected) | |
| + | Timespan for transferring data from the X2X Link master to the CPU (higher-level system) |
| + | Cycle time of task class (including tolerance) |
| + | Timespan for transferring the data from the CPU to the module |
| + | Timespan allowed by the application (e.g. for tolerating failure of an X2X Link cycle) |
| = | Valid validation time |

The AnalogOutputEnableByte is enabled during time-based monitoring. If the timer expires prematurely, the corresponding bit in the AnalogOutputOkayByte is reset and the output drops out. This provides an easy way to achieve a defined state.

9.2.5.8.6.1 Output values of the analog outputs

Name:

AnalogOutput01 to AnalogOutput02

These registers provide the standardized output values. Once a permitted value is received, the module outputs the respective current or voltage.

Information:

The value "0" disables the channel status LED.

| Data type | Value | |
|-----------|-----------------|---------|
| INT | -32767 to 32767 | Voltage |
| | 0 to 32767 | Current |

9.2.5.8.6.2 SDC counter register

Name:

SDCLifeCount

The 8-bit counter register is needed for the SDC software package. It is incremented with the system clock to allow the SDC to check the validity of the data frame.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

9.2.5.8.6.3 Transfer of the timestamp

Name:

ValidationTimer01 to ValidationTimer02

When an output is being monitored, these registers must provide the timestamp which, when reached, will cause the output to shut down automatically. The values must be provided as signed 2-byte or 4-byte values.

For more information about NetTime and timestamps, see ["NetTime Technology"](#) on page 3035.

| Data type | Values [µs] | |
|-----------|---------------------------------|---|
| INT | -32768 to 32767 | NetTime timestamp of the current output value |
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime timestamp of the current output value |

9.2.5.8.6.4 Enabling/disabling the output channels

Name:

AnalogOutput01Enable to AnalogOutput02Enable

AnalogOutput01EnableReadback to AnalogOutput02EnableReadback

The "OutputEnable" byte is only needed for the channels with activated time-based monitoring. The individual bits are used to enable/disable the respective channels. To receive reliable feedback about the current state of the module, the byte was also implemented so that it can be read cyclically.

| Data type | Value |
|-----------|-------------------|
| USINT | See bit structure |

Bit structure:

| Bit | Name | Value | Information |
|-------|------------------------------|-------|--------------------|
| 0 | AnalogOutput01Enable | 0 | Output deactivated |
| | AnalogOutput01EnableReadback | 1 | Output activated |
| 1 | AnalogOutput02Enable | 0 | Output deactivated |
| | AnalogOutput02EnableReadback | 1 | Output activated |
| 2 - 7 | Reserved | 0 | |

9.2.5.8.6.5 Checking the output values

Name:

AnalogOutput01OK to AnalogOutput02OK

These registers are only needed for channels with activated time-based monitoring. The individual bits report whether the respective channel is actually generating the required voltage or current.

| Data type | Value |
|-----------|-------------------|
| USINT | See bit structure |

Bit structure:

| Bit | Name | Value | Information |
|-------|------------------|-------|-------------------------------|
| 0 | AnalogOutput01OK | 0 | Electrical signal deactivated |
| | | 1 | Electrical signal activated |
| 1 | AnalogOutput02OK | 0 | Electrical signal deactivated |
| | | 1 | Electrical signal activated |
| 2 - 7 | Reserved | 0 | |

9.2.5.8.7 NetTime Technology

For a description of NetTime Technology, see ["NetTime Technology" on page 3035](#).

9.2.5.8.8 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μ s |

9.2.5.8.9 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 200 μ s |

9.2.6 X20AO2632-1

Data sheet version: 1.30

9.2.6.1 General information

The module is equipped with 2 outputs with 16-bit (including sign) digital converter resolution. It is possible to select between the current and voltage signal using different terminals.

This module is designed for X20 6-pin terminal blocks. If needed (e.g. for logistical reasons), the 12-pin terminal block can also be used.

- 2 analog outputs
- Either current or voltage signal possible
- Extended signal range
- 16-bit digital converter resolution
- NetTime timestamp: Switch-off time

NetTime timestamp for output

For many applications, not only the output value is important, but also the exact switching time. The module is equipped with a NetTime timestamp function for this that can define a switching time to the nearest microsecond.

The timestamp function is based on synchronized timers. The CPU can predefine output events and provide them with a timestamp. After transferring the respective data, including the exact time, the module executes the predefined action at the exactly defined time.

9.2.6.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Analog outputs |  |
| X20AO2632-1 | X20 analog output module, 2 outputs, ± 11 V or 0 to 22 mA, 16-bit converter resolution, NetTime function | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |

Table 98: X20AO2632-1 - Order data

9.2.6.3 Technical data

| | |
|--|--|
| Model number | X20AO2632-1 |
| Short description | |
| I/O module | 2 analog outputs ± 11 V or 0 to 22 mA |
| General information | |
| B&R ID code | 0xC36E |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Channel type | Yes, using software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.25 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 |
| HazLoc | Industrial control equipment cCSAus 244665 |
| ATEX | Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| DNV GL | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| LR | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| Analog outputs | |
| Output | ± 11 V or 0 to 22 mA, via different terminal connections |
| Digital converter resolution | |
| Voltage | ± 15 -bit |
| Current | 15-bit |
| Conversion time | 50 μ s for all outputs |
| Settling time on output change over entire range | 500 μ s |
| Switch on/off behavior | Internal enable relay for booting |
| Max. error at 25°C | |
| Voltage | |
| Gain | 0.05% ¹⁾ |
| Offset | 0.015% ²⁾ |
| Current | |
| Gain | 0.08% ¹⁾ |
| Offset | 0.05% ²⁾ |
| Output protection | Short circuit protection |
| Output format | |
| Voltage | INT 0x8000 - 0x7FFF / 1 LSB = 0x0001 = 335.693 μ V |
| Current | INT 0x0000 - 0x7FFF / 1 LSB = 0x0001 = 671.386 nA |
| Load per channel | |
| Voltage | Max. ± 11 mA, load ≥ 1 k Ω |
| Current | Max. load is 600 Ω |
| Short-circuit proof | Current limiting ± 40 mA |
| Output filter | 1st-order low pass / cutoff frequency 10 kHz |
| Max. gain drift | |
| Voltage | 0.008 %/°C ¹⁾ |
| Current | 0.011 %/°C ¹⁾ |
| Max. offset drift | |
| Voltage | 0.003 %/°C ²⁾ |
| Current | 0.008 %/°C ²⁾ |
| Error caused by load change | |
| Voltage | Max. 0.1%, from 10 M Ω \rightarrow 1 k Ω , resistive |
| Current | Max. 0.5%, from 1 Ω \rightarrow 600 Ω , resistive |
| Nonlinearity | <0.007% ³⁾ |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |

Table 99: X20AO2632-1 - Technical data


| | |
|--|---|
| Model number | X20AO2632-1 |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB06 or X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm |

Table 99: X20AO2632-1 - Technical data

- 1) Based on the current output value.
- 2) Based on the entire output range.
- 3) Based on the output range.

9.2.6.4 LED status indicators

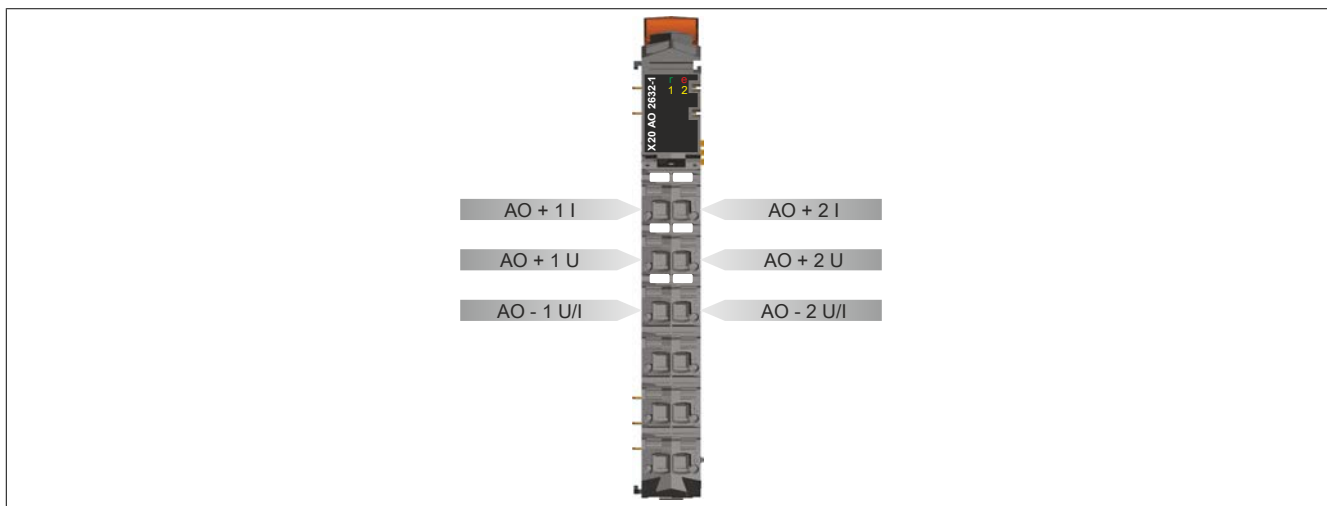
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|--------|--------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | 1 - 2 | Orange | Off | Value = 0 |
| | | | On | Value ≠ 0 |

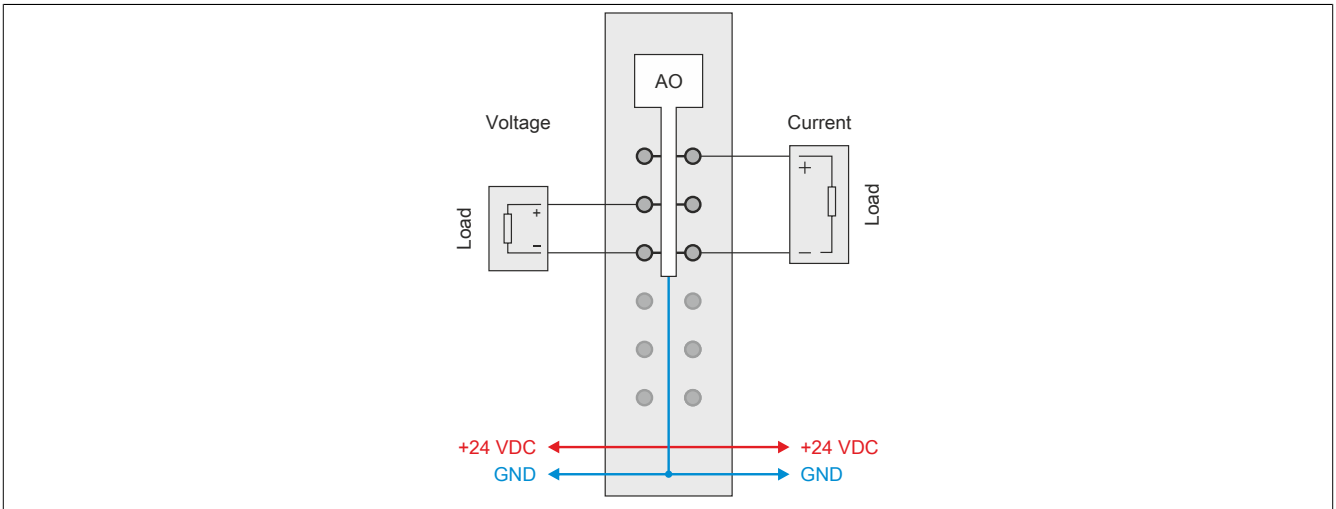
1) Depending on the configuration, a firmware update can take up to several minutes.

9.2.6.5 Pinout

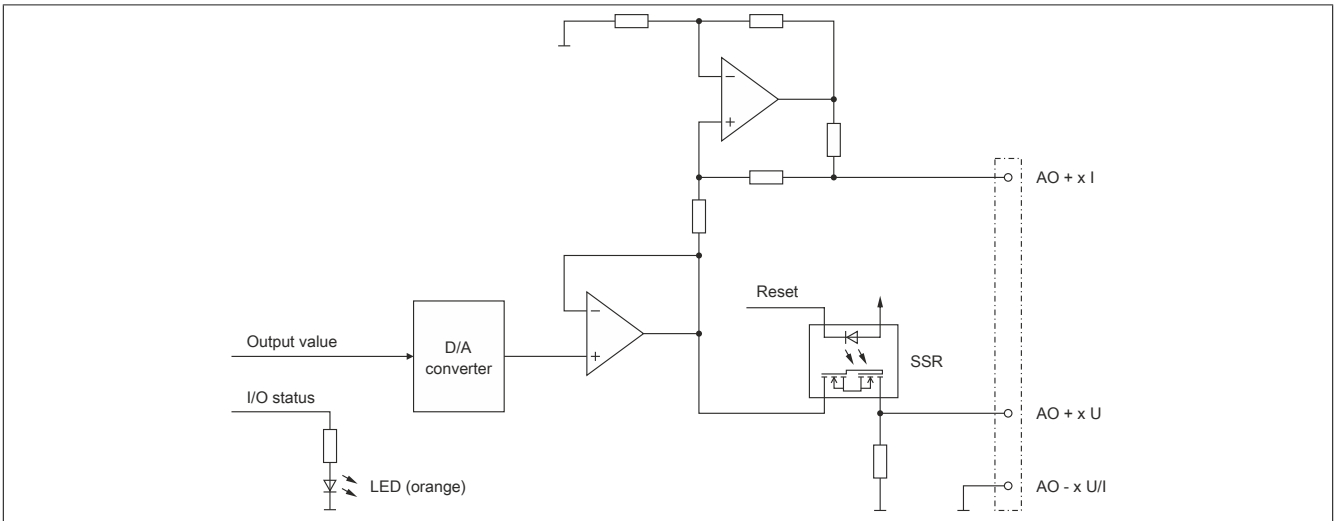
The individual channels can be configured for either current or voltage signals. The type of signal is also determined by the terminals used.



9.2.6.6 Connection example



9.2.6.7 Output circuit diagram



9.2.6.8 Register description

9.2.6.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.2.6.8.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|--|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog output - Configuration | | | | | | |
| 0 | ConfigOutput01 (channel type) | UINT | | | | • |
| 594 | Cfo_Channel01TimeMode | UINT | | | | • |
| 598 | Cfo_Channel02TimeMode | | | | | |
| Analog output - Communication | | | | | | |
| 2 | AnalogOutput01 | INT | | | • | |
| 4 | AnalogOutput02 | | | | | |
| 457 | SDCLifeCount | SINT | • | | | |
| 802 | ValidationTimer01 | INT | | | • | |
| 810 | ValidationTimer02 | | | | | |
| 804 | ValidationTimer01 | DINT | | | • | |
| 812 | ValidationTimer02 | | | | | |
| 833 | Enabling/disabling the output channels | USINT | • | | • | |
| | AnalogOutput01Enable, ~Readback | Bit 0 | | | | |
| | AnalogOutput02Enable, ~Readback | Bit 1 | | | | |
| 835 | Checking the output values | USINT | • | | | |
| | AnalogOutput01OK | Bit 0 | | | | |
| | AnalogOutput02OK | Bit 1 | | | | |

9.2.6.8.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------------|----------------------|---|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog output - Configuration | | | | | | | |
| 0 | - | ConfigOutput01 (channel type) | UINT | | | | • |
| Analog output - Communication | | | | | | | |
| 2 | 0 | AnalogOutput01 | INT | | | • | |
| 4 | 2 | AnalogOutput02 | | | | | |

1) The offset specifies the position of the register within the CAN object.

9.2.6.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.2.6.8.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.2.6.8.4 General information

The module provides 2 analog outputs. Each channel can output a voltage range of ± 11 V or a current range of 0 to 22 mA.

The module also has a time-based watchdog monitor. The user can activate this feature channel-by-channel as needed.

9.2.6.8.5 Analog output - Configuration

Each channel is configured independently. The user can also define an optional time-based monitor. To make this possible, 2 watchdog timers were implemented, which can be assigned to the outputs.

9.2.6.8.5.1 Setting the channel type

Name:

ConfigOutput01

This register can be used to set the channel type of the outputs.

Each channel is capable of handling either current or voltage signals. The type of signal is determined by the terminal connections used. Since current and voltage require different adjustment values, it is also necessary to configure the desired type of output signal. The following output signals can be set:

- ± 11 V voltage signal
- 0 to 22 mA current signal

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|---------|-------------|-------|---|
| 0 - 7 | Reserved | 0 | |
| 8 | Channel 1 | 0 | Voltage signal (bus controller default setting) |
| | | 1 | Current signal |
| 9 | Channel 2 | 0 | Voltage signal (bus controller default setting) |
| | | 1 | Current signal |
| 10 - 15 | Reserved | 0 | |

9.2.6.8.5.2 Configuring the time-based watchdog monitor

Name:

Cfo_Channel01TimeMode to Cfo_Channel02TimeMode

This register is used to activate or configure the time-based watchdog monitor for the analog output channels.

Possibilities per channel:

- Validation timer data type: General choice 16 or 32 bit
- Validation window: The maximum value can be further limited within the data type.
- Timer allocation: A separate timer is available for each channel. However, all channels can be configured with the same validation timer, whereby the same settings must be made for the data type and window in the TimeMode registers.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|--------|----------------------|-------|---|
| 0 - 4 | Max. validation time | 00000 | Disabled |
| | | 00001 | 2 μ s |
| | | 00010 | 4 μ s |
| | | 00011 | 8 μ s |
| | | ... | ... |
| | | 11111 | 2,147,483,648 μ s (~35 min) |
| 5 - 7 | Reserved | 0 | |
| 8 | Timer allocation | 0 | ValidationTimer01 (default for channel 1) |
| | | 1 | ValidationTimer02 (default for channel 2) |
| 9 - 14 | Reserved | 0 | |
| 15 | Time format | 0 | 16-bit |
| | | 1 | 32-bit |

9.2.6.8.6 Analog output - Communication

In standard mode, the module's outputs are enabled. Based on the configuration and AnalogOutput value, they output the corresponding current or voltage.

If the application requires time-controlled monitoring of the outputs, a validation timer can be assigned to each channel. The validation timer register assigns a validity period to the current output value. If validation is enabled, the module compares the validation time and the [NetTime](#) of the X2X Link. If the transmitted validity period is exceeded, the module switches off the channel and resets the output. State "Safety shutdown" is only exited again when a new valid validation time has been transmitted. If enabled, the module reports back which state it is currently in via the error state bit of the channel.

If the value of the validation timer is incremented in each task cycle, the valid validation time will be calculated as follows:

| | |
|---|--|
| NetTime of the X2X Link master (to which the module is connected) | |
| + | Timespan for transferring data from the X2X Link master to the CPU (higher-level system) |
| + | Cycle time of task class (including tolerance) |
| + | Timespan for transferring the data from the CPU to the module |
| + | Timespan allowed by the application (e.g. for tolerating failure of an X2X Link cycle) |
| = | Valid validation time |

The AnalogOutputEnableByte is enabled during time-based monitoring. If the timer expires prematurely, the corresponding bit in the AnalogOutputOkayByte is reset and the output drops out. This provides an easy way to achieve a defined state.

9.2.6.8.6.1 Output values of the analog outputs

Name:

AnalogOutput01 to AnalogOutput02

These registers provide the standardized output values. Once a permitted value is received, the module outputs the respective current or voltage.

Information:

The value "0" disables the channel status LED.

| Data type | Value | |
|-----------|-----------------|---------|
| INT | -32767 to 32767 | Voltage |
| | 0 to 32767 | Current |

9.2.6.8.6.2 SDC counter register

Name:

SDCLifeCount

The 8-bit counter register is needed for the SDC software package. It is incremented with the system clock to allow the SDC to check the validity of the data frame.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

9.2.6.8.6.3 Transfer of the timestamp

Name:

ValidationTimer01 to ValidationTimer02

When an output is being monitored, these registers must provide the timestamp which, when reached, will cause the output to shut down automatically. The values must be provided as signed 2-byte or 4-byte values.

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

| Data type | Values [µs] | |
|-----------|---------------------------------|---|
| INT | -32768 to 32767 | NetTime timestamp of the current output value |
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime timestamp of the current output value |

9.2.6.8.6.4 Enabling/disabling the output channels

Name:

AnalogOutput01Enable to AnalogOutput02Enable

AnalogOutput01EnableReadback to AnalogOutput02EnableReadback

The "OutputEnable" byte is only needed for the channels with activated time-based monitoring. The individual bits are used to enable/disable the respective channels. To receive reliable feedback about the current state of the module, the byte was also implemented so that it can be read cyclically.

| Data type | Value |
|-----------|-------------------|
| USINT | See bit structure |

Bit structure:

| Bit | Name | Value | Information |
|-------|------------------------------|-------|--------------------|
| 0 | AnalogOutput01Enable | 0 | Output deactivated |
| | AnalogOutput01EnableReadback | 1 | Output activated |
| 1 | AnalogOutput02Enable | 0 | Output deactivated |
| | AnalogOutput02EnableReadback | 1 | Output activated |
| 2 - 7 | Reserved | 0 | |

9.2.6.8.6.5 Checking the output values

Name:

AnalogOutput01OK to AnalogOutput02OK

These registers are only needed for channels with activated time-based monitoring. The individual bits report whether the respective channel is actually generating the required voltage or current.

| Data type | Value |
|-----------|-------------------|
| USINT | See bit structure |

Bit structure:

| Bit | Name | Value | Information |
|-------|------------------|-------|-------------------------------|
| 0 | AnalogOutput01OK | 0 | Electrical signal deactivated |
| | | 1 | Electrical signal activated |
| 1 | AnalogOutput02OK | 0 | Electrical signal deactivated |
| | | 1 | Electrical signal activated |
| 2 - 7 | Reserved | 0 | |

9.2.6.8.7 NetTime Technology

For a description of NetTime Technology, see "[NetTime Technology](#)" on page 3035.

9.2.6.8.8 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μ s |

9.2.6.8.9 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 200 μ s |

9.2.7 X20(c)AO4622

Data sheet version: 3.24

9.2.7.1 General information

The module is equipped with 4 outputs with 13-bit (including sign) digital converter resolution. It is possible to select between the current and voltage signal using different terminals.

- 4 analog outputs
- Either current or voltage signal possible
- 13-bit digital converter resolution

9.2.7.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.2.7.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C . During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.2.7.3 Order data

| Model number | Short description | Figure |
|--------------|---|--------|
| | Analog outputs | |
| X20AO4622 | X20 analog output module, 4 outputs, $\pm 10\text{ V}$ or 0 to 20 mA / 4 to 20 mA , 13-bit converter resolution | |
| X20cAO4622 | X20 analog output module, coated, 4 outputs, $\pm 10\text{ V}$ or 0 to 20 mA / 4 to 20 mA , 13-bit converter resolution | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 100: X20AO4622, X20cAO4622 - Order data

9.2.7.4 Technical data

| Model number | X20AO4622 | X20cAO4622 |
|--|--|--|
| Short description | | |
| I/O module | 4 analog outputs ± 10 V or 0 to 20 mA / 4 to 20 mA ¹⁾ | 4 analog outputs ± 10 V or 0 to 20 mA / 4 to 20 mA |
| General information | | |
| B&R ID code | 0x1BA3 | 0xE212 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Channel type | Yes, using software | |
| Power consumption | | |
| Bus | 0.01 W | |
| Internal I/O | 1.8 W (Rev. \geq J0), 2.2 W (Rev. $<$ J0) | 1.8 W |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Analog outputs | | |
| Output | ± 10 V or 0 to 20 mA / 4 to 20 mA, via different terminal connections ¹⁾ | ± 10 V or 0 to 20 mA / 4 to 20 mA, via different terminal connections |
| Max. output current | 10 mA at voltages > 5 V 15 mA at voltages < 5 V | |
| Digital converter resolution | | |
| Voltage | ± 12 -bit | |
| Current | 12-bit | |
| Conversion time | 300 μ s for all outputs | |
| Settling time on output change over entire range | 500 μ s | |
| Switch on/off behavior | Internal enable relay for booting | |
| Max. error | | |
| Voltage | | |
| Gain | 0.08% ²⁾ | |
| Offset | 0.05% ³⁾ | |
| Current | | |
| Gain | 0.09% ²⁾ | |
| Offset | 0.05% ³⁾ | |
| Output protection | Short circuit protection | |
| Output format | | |
| Voltage | INT 0x8001 - 0x7FFF / 1 LSB = 0x0008 = 2.441 mV | |
| Current | INT 0x0000 - 0x7FFF / 1 LSB = 0x0008 = 4.883 μ A | |
| Load per channel | | |
| Voltage | Max. ± 10 mA, load ≥ 1 k Ω | |
| Current | Load max. 600 Ω (Rev. \geq J0); 500 Ω (Rev. $<$ J0) | Max. load is 600 Ω |
| Short-circuit proof | Current limiting ± 40 mA | |
| Output filter | 1st-order low pass / cutoff frequency 10 kHz | |
| Max. gain drift | | |
| Voltage | 0.015 %/ $^{\circ}$ C ²⁾ | |
| Current | 0.02 %/ $^{\circ}$ C ²⁾ | |
| Max. offset drift | | |
| Voltage | 0.032 %/ $^{\circ}$ C ³⁾ | |
| Current | 0.032 %/ $^{\circ}$ C ³⁾ | |
| Error caused by load change | | |
| Voltage | Max. 0.11%, from 10 M Ω \rightarrow 1 k Ω , resistive | |
| Current | Max. 0.5%, from 1 Ω \rightarrow 600 Ω , resistive | |
| Nonlinearity | $< 0.005\%$ ⁴⁾ | |
| Isolation voltage between channel and bus | 500 V _{eff} | |

Table 101: X20AO4622, X20cAO4622 - Technical data


| Model number | X20AO4622 | | X20cAO4622 |
|--|--|--|---|
| Electrical properties | | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | | |
| Operating conditions | | | |
| Mounting orientation | | | |
| Horizontal | Yes | | |
| Vertical | Yes | | |
| Installation elevation above sea level | | | |
| 0 to 2000 m | No limitations | | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | | |
| Degree of protection per EN 60529 | IP20 | | |
| Ambient conditions | | | |
| Temperature | | | |
| Operation | | | |
| Horizontal mounting orientation | -25 to 60°C (Rev. ≥ J0); 0 to 55°C (Rev. < J0) | | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C (Rev. ≥ J0); 0 to 50°C (Rev. < J0) | | -25 to 50°C |
| Derating | See section "Derating" | | |
| Starting temperature | - | | Yes, -40°C |
| Storage | -40 to 85°C | | |
| Transport | -40 to 85°C | | |
| Relative humidity | | | |
| Operation | 5 to 95%, non-condensing | | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | | |
| Transport | 5 to 95%, non-condensing | | |
| Mechanical properties | | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | | |

Table 101: X20AO4622, X20cAO4622 - Technical data

- 1) 4 to 20 mA: From upgrade version 1.0.2.0 and hardware revision "I0"
- 2) Based on the current output value.
- 3) Based on the entire output range.
- 4) Based on the output range.

9.2.7.5 LED status indicators

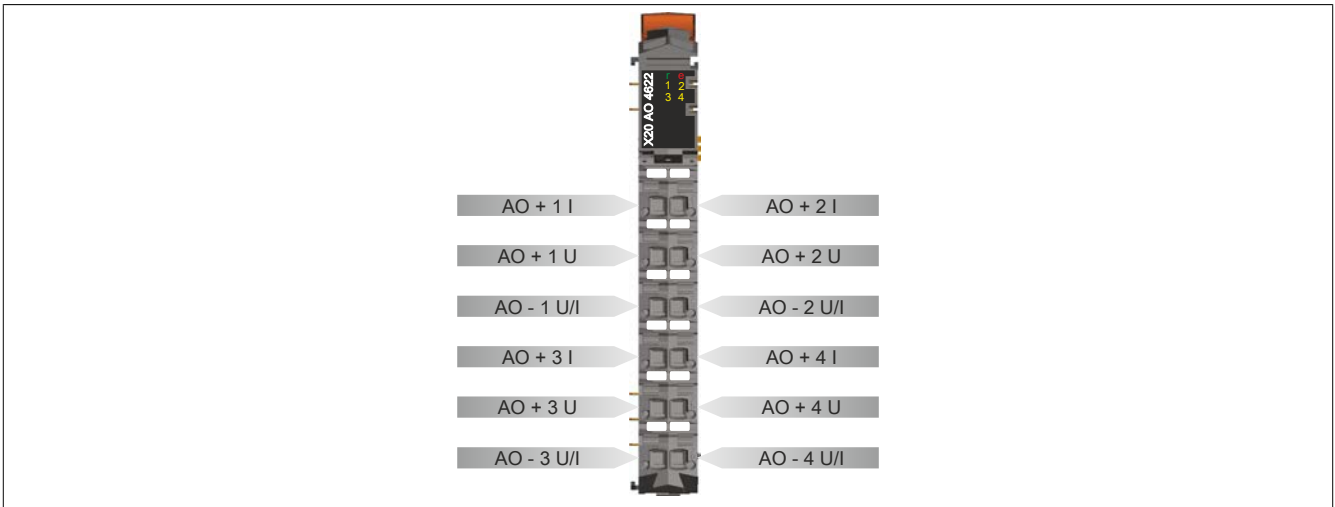
For a description of the various operating modes, see ["Diagnostic LEDs" on page 3787](#).

| Figure | LED | Color | Status | Description |
|---|-------|-----------------------------|------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1 - 4 | Orange | Off | Value = 0 |
| | | | On | Value ≠ 0 |

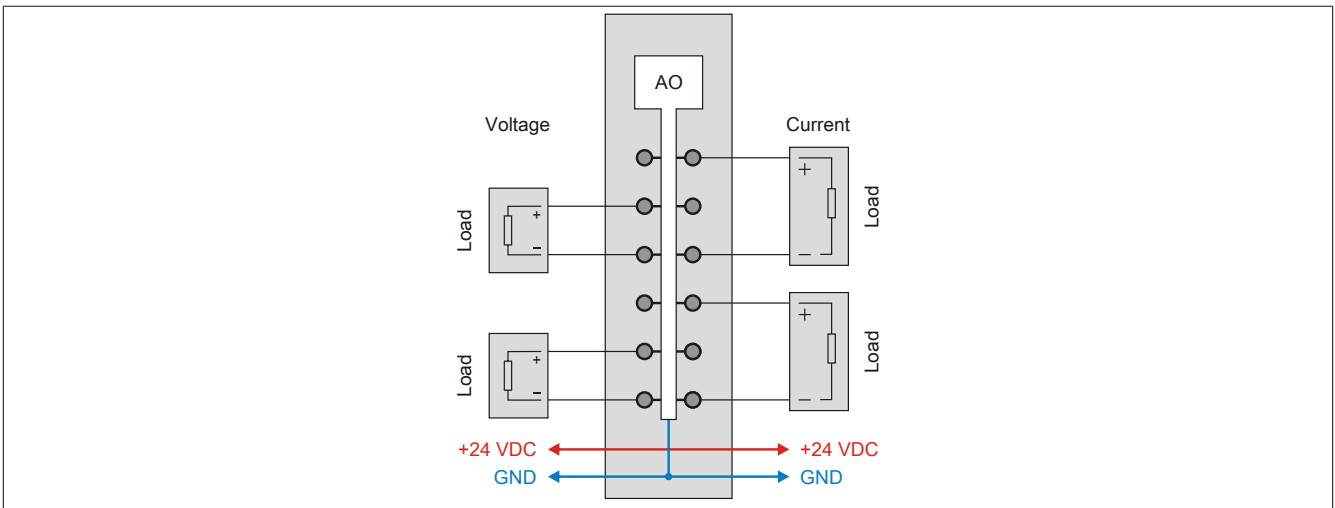
- 1) Depending on the configuration, a firmware update can take up to several minutes.

9.2.7.6 Pinout

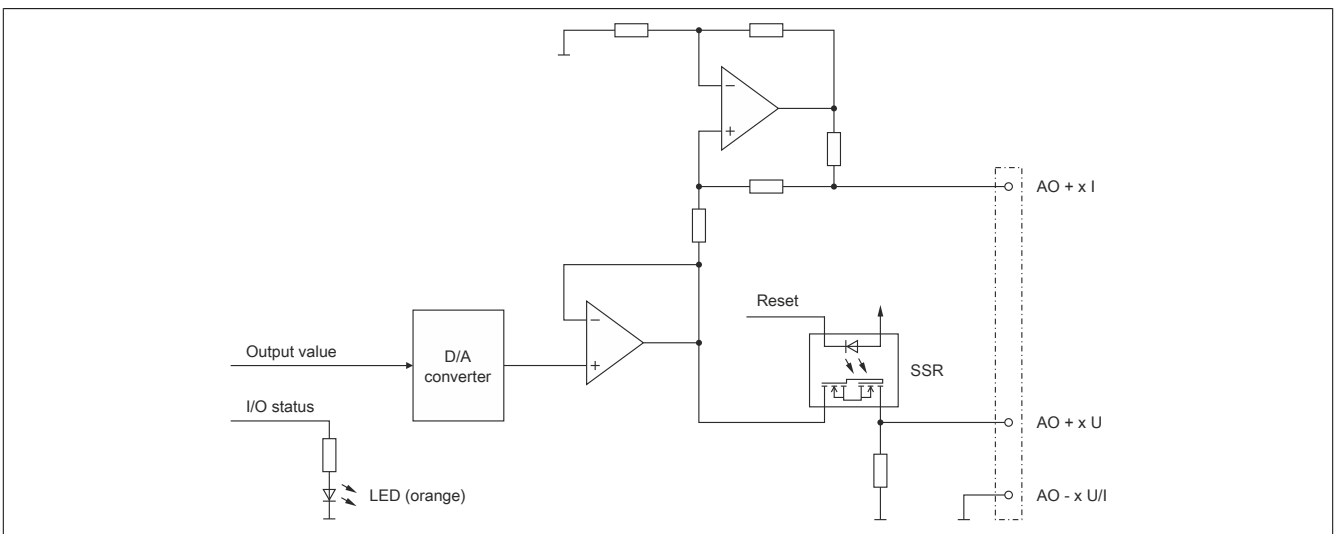
The individual channels can be configured for either current or voltage signals. The type of signal is also determined by the terminals used.



9.2.7.7 Connection example



9.2.7.8 Output circuit diagram

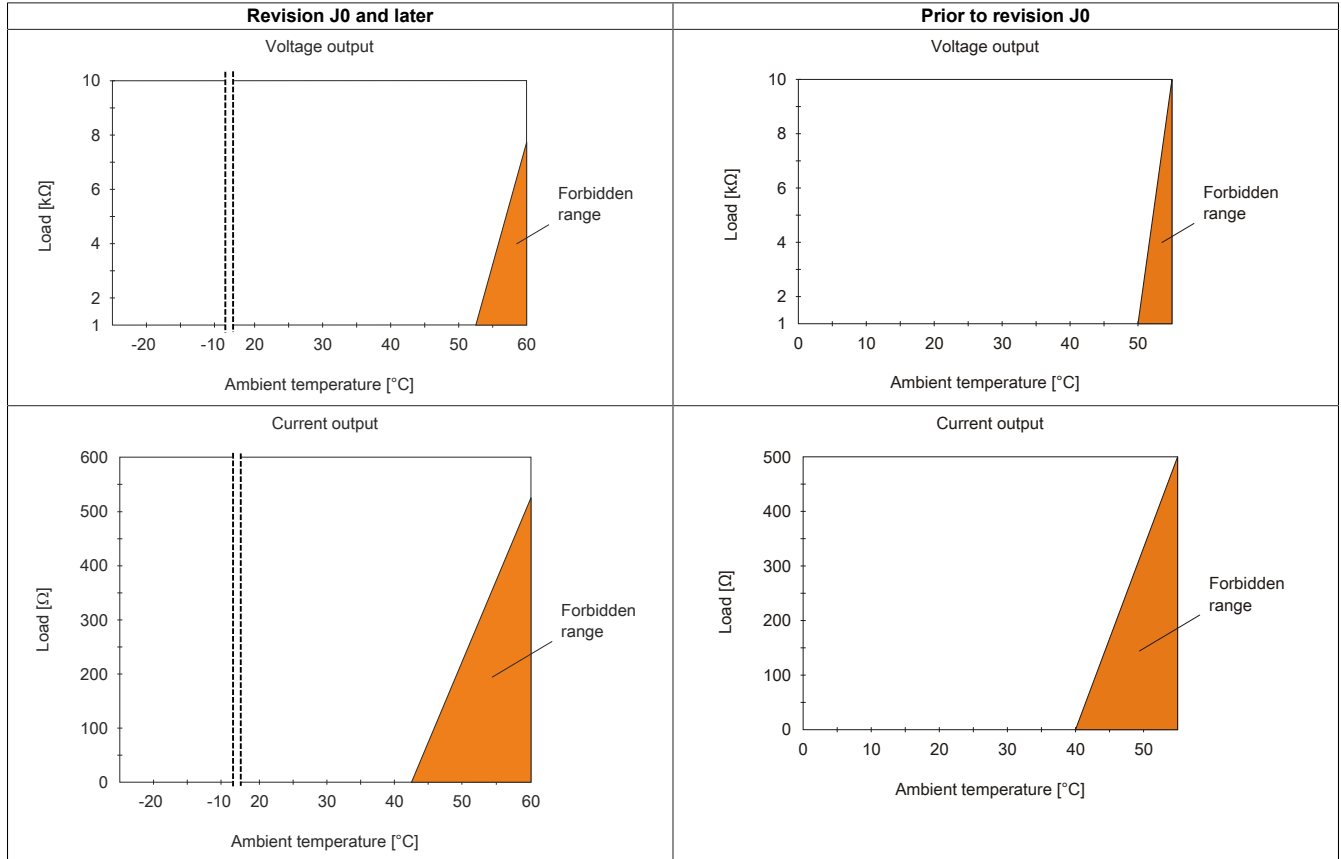


9.2.7.9 Derating

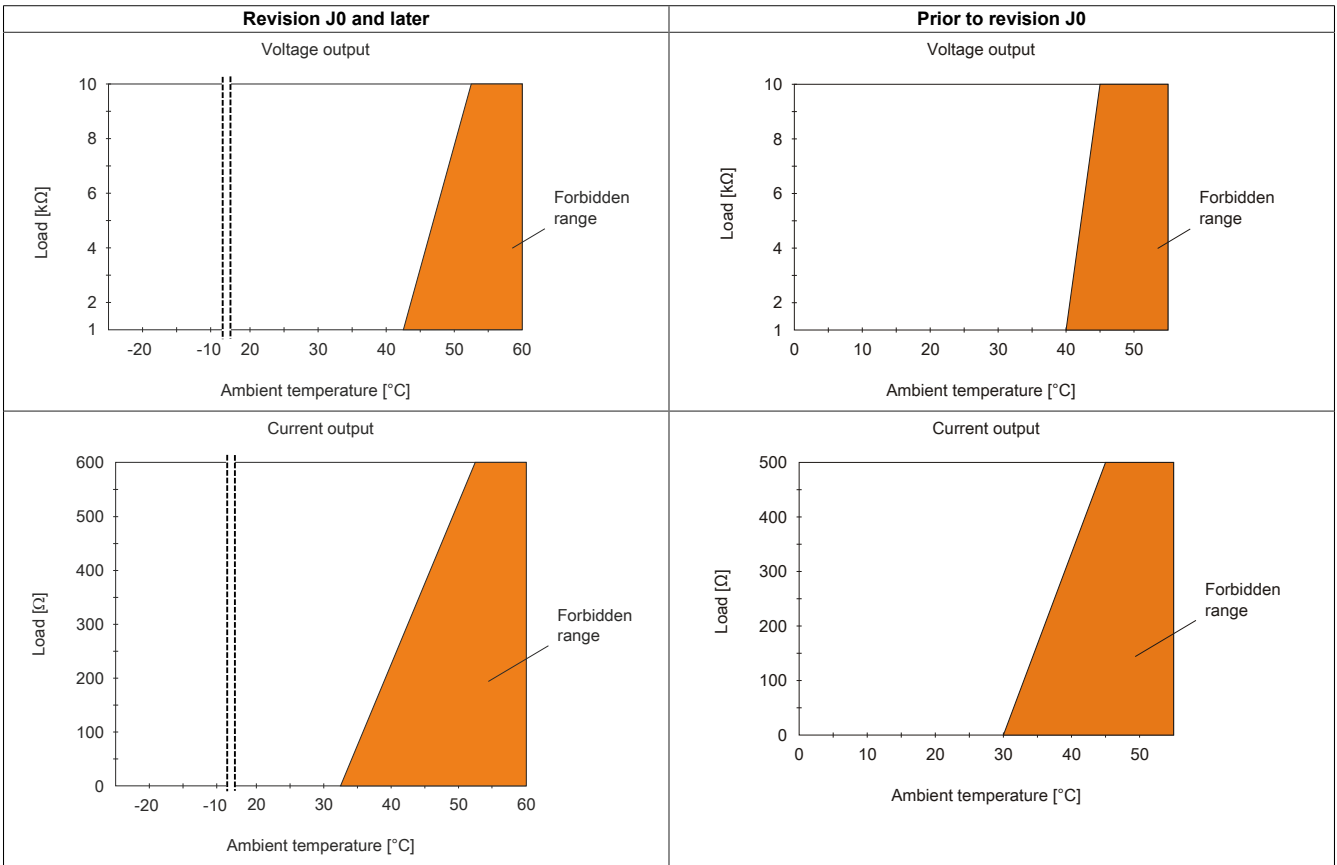
To ensure proper operation, the following points must be taken into account:

- The derating values listed below must be taken into account.
- In mixed operation with one current output, the mean value of both derating curves must be applied.
- In mixed operation with 2 or 3 current outputs, the derating of the current outputs must be applied.

Horizontal mounting orientation



Vertical mounting orientation



9.2.7.10 Register description

9.2.7.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.2.7.10.2 Function model 0 - Standard and function model 1 - I/O with fast response

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog signal - Configuration | | | | | | |
| 18 | ConfigOutput01 (channel type) | USINT | | | | • |
| Analog signal - Communication | | | | | | |
| 0 | AnalogOutput01 | INT | | | • | |
| 2 | AnalogOutput02 | INT | | | • | |
| 4 | AnalogOutput03 | INT | | | • | |
| 6 | AnalogOutput04 | INT | | | • | |

9.2.7.10.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Analog signal - Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (channel type) | USINT | | | | • |
| Analog signal - Communication | | | | | | | |
| 0 | 0 | AnalogOutput01 | INT | | | • | |
| 2 | 2 | AnalogOutput02 | INT | | | • | |
| 4 | 4 | AnalogOutput03 | INT | | | • | |
| 6 | 6 | AnalogOutput04 | INT | | | • | |

1) The offset specifies the position of the register within the CAN object.

9.2.7.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "[Using I/O modules on the bus controller](#)" on page 3789.

9.2.7.10.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.2.7.10.4 Function model comparison

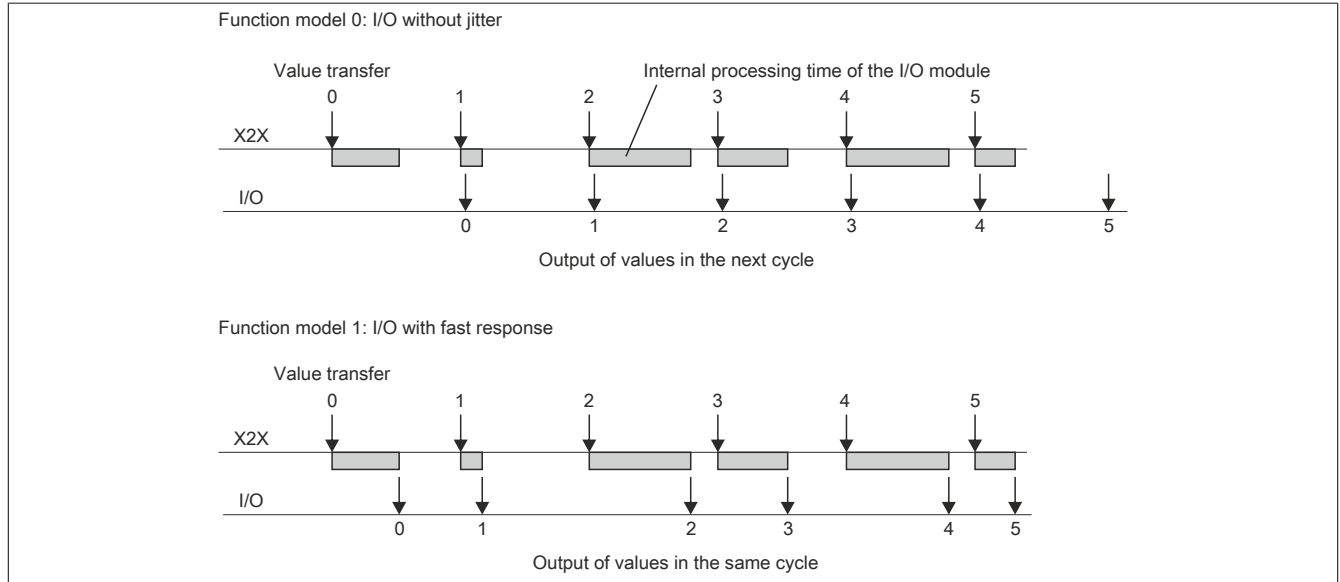
Function model 0: I/O without jitter (standard)

With a minimum cycle of $\geq 400 \mu\text{s}$, the corrected values are output in the next cycle. This reduces jitter to a minimum.

Function model 1: I/O with fast response

With a minimum cycle of $\geq 400 \mu\text{s}$, the corrected values are output in the same cycle (optimized response).

The two function models compared



9.2.7.10.5 Analog outputs

The individual channels can be configured for either current or voltage signals. The type of signal is also determined by the terminals used.

9.2.7.10.5.1 Output values of the analog output

Name:

AnalogOutput01 to AnalogOutput04

The normalized output values are specified via these registers. After a permissible value is transferred, the module outputs the corresponding current or voltage.

| Data type | Values | Information |
|-----------|-----------------|---|
| INT | -32768 to 32767 | Voltage signal -10 to 10 VDC |
| | 0 to 32767 | Current signal 0 to 20 mA |
| | 0 to 32767 | Current signal 4 to 20 mA ¹⁾ |

1) Starting with upgrade version 1.0.2.0 and hardware revision "I0"

9.2.7.10.5.2 Setting the channel type

Name:

ConfigOutput01

The channel type of the outputs can be defined in this register.

The individual channels are designed for current and voltage signals. The differentiation is made by different terminal connections; because of different adjustment values for current and voltage, the output signal must also be selected. The following output signals can be set:

- ± 10 V voltage signal
- 0 to 20 mA current signal
- 4 to 20 mA current signal

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-----|--------------------------------------|-------|--|
| 0 | Channel 1 | 0 | Voltage signal (bus controller default setting) |
| | | 1 | Current signal, measurement range corresponding to bit 4 |
| ... | | ... | |
| 3 | Channel 4 | 0 | Voltage signal |
| | | 1 | Current signal, measurement range corresponding to bit 7 |
| 4 | Channel 1: Current measurement range | 0 | 0 to 20 mA current signal |
| | | 1 | 4 to 20 mA current signal |
| ... | | ... | |
| 7 | Channel 4: Current measurement range | 0 | 0 to 20 mA current signal |
| | | 1 | 4 to 20 mA current signal |

9.2.7.10.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 250 μ s |

9.2.7.10.7 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 400 μ s |

9.2.8 X20(c)AO4632

Data sheet version: 3.22

9.2.8.1 General information

The module is equipped with 4 outputs with 16-bit (including sign) digital converter resolution. It is possible to select between the current and voltage signal using different terminals.

- 4 analog outputs
- Either current or voltage signal possible
- 16-bit digital converter resolution

9.2.8.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.2.8.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.2.8.3 Order data

| Model number | Short description | Figure |
|--------------|--|--------|
| | Analog outputs | |
| X20AO4632 | X20 analog output module, 4 outputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution | |
| X20cAO4632 | X20 analog output module, coated, 4 outputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, NetTime function | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 102: X20AO4632, X20cAO4632 - Order data

9.2.8.4 Technical data

| Model number | X20AO4632 | X20cAO4632 |
|--|--|--|
| Short description | | |
| I/O module | 4 analog outputs ± 10 V or 0 to 20 mA | |
| General information | | |
| B&R ID code | 0x1BA5 | 0xD575 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using LED status indicator and software | Yes, using status LED and software |
| Channel type | Yes, using software | |
| Power consumption | | |
| Bus | 0.01 W | |
| Internal I/O | 1.8 W (Rev. \geq J0), 2.2 W (Rev. $<$ J0) | 1.8 W |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Analog outputs | | |
| Output | ± 10 V or 0 to 20 mA, via different terminal connections | |
| Digital converter resolution | | |
| Voltage | ± 15 -bit | |
| Current | 15-bit | |
| Conversion time | 50 μ s for all outputs | |
| Settling time on output change over entire range | 500 μ s | |
| Switch on/off behavior | Internal enable relay for startup | Internal enable relay for booting |
| Max. error | | |
| Voltage | | |
| Gain | 0.04% ¹⁾ | |
| Offset | 0.022% ²⁾ | |
| Current | | |
| Gain | 0.09% ¹⁾ | |
| Offset | 0.045% ²⁾ | |
| Output protection | Short-circuit proof | Short circuit protection |
| Output format | | |
| Voltage | INT 0x8001 - 0x7FFF / 1 LSB = 0x0001 = 305.176 μ V | |
| Current | INT 0x0000 - 0x7FFF / 1 LSB = 0x0001 = 610.352 nA | |
| Load per channel | | |
| Voltage | Max. ± 10 mA, load ≥ 1 k Ω | Max. ± 10 mA, load ≥ 1 k Ω |
| Current | Load max. 600 Ω (Rev. \geq J0), 500 Ω (Rev. $<$ J0) | Max. load is 600 Ω |
| Short-circuit proof | Current limiting ± 40 mA | |
| Output filter | First-order low-pass filter / cutoff frequency 10 kHz | 1st-order low pass / cutoff frequency 10 kHz |
| Max. gain drift | | |
| Voltage | 0.01 %/ $^{\circ}$ C ¹⁾ | |
| Current | 0.02%/ $^{\circ}$ C ¹⁾ | 0.02 %/ $^{\circ}$ C ¹⁾ |
| Max. offset drift | | |
| Voltage | 0.012%/ $^{\circ}$ C ²⁾ | 0.012 %/ $^{\circ}$ C ²⁾ |
| Current | 0.012%/ $^{\circ}$ C ²⁾ | 0.012 %/ $^{\circ}$ C ²⁾ |
| Error caused by load change | | |
| Voltage | Max. 0.11%, from 10 M Ω \rightarrow 1 k Ω , resistive | |
| Current | Max. 0.5%, from 1 Ω \rightarrow 600 Ω , resistive | |
| Nonlinearity | $< 0.005\%$ ³⁾ | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |

Table 103: X20AO4632, X20cAO4632 - Technical data


| Model number | X20AO4632 | X20cAO4632 |
|--|--|---|
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | | Yes |
| Vertical | | Yes |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitation | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C (Rev. ≥ J0), 0 to 55°C (Rev. < J0) | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C (Rev. ≥ J0), 0 to 50°C (Rev. < J0) | -25 to 50°C |
| Derating | See section "Derating". | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x bus module X20BM11 separately. | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | 12.5 ^{+0.2} mm |

Table 103: X20AO4632, X20cAO4632 - Technical data

- 1) Based on the current output value.
- 2) Based on the entire output range.
- 3) Based on the output range.

9.2.8.5 LED status indicators

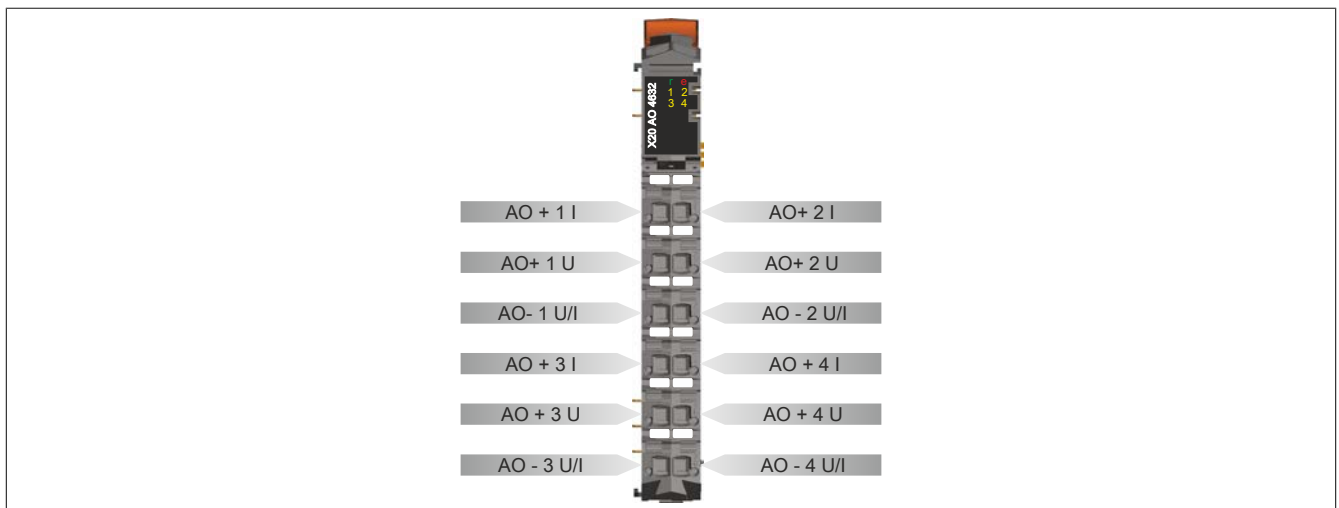
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description | |
|---|-------|--------|--------------|--|-----------|
|  | r | Green | Off | No power to module | |
| | | | Single flash | RESET mode | |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ | |
| | | | Blinking | PREOPERATIONAL mode | |
| | e | Red | On | RUN mode | |
| | | | Off | No power to module or everything OK | |
| | 1 - 4 | Orange | On | Error or reset status | |
| | | | Off | Value = 0 | |
| | | | | On | Value ≠ 0 |

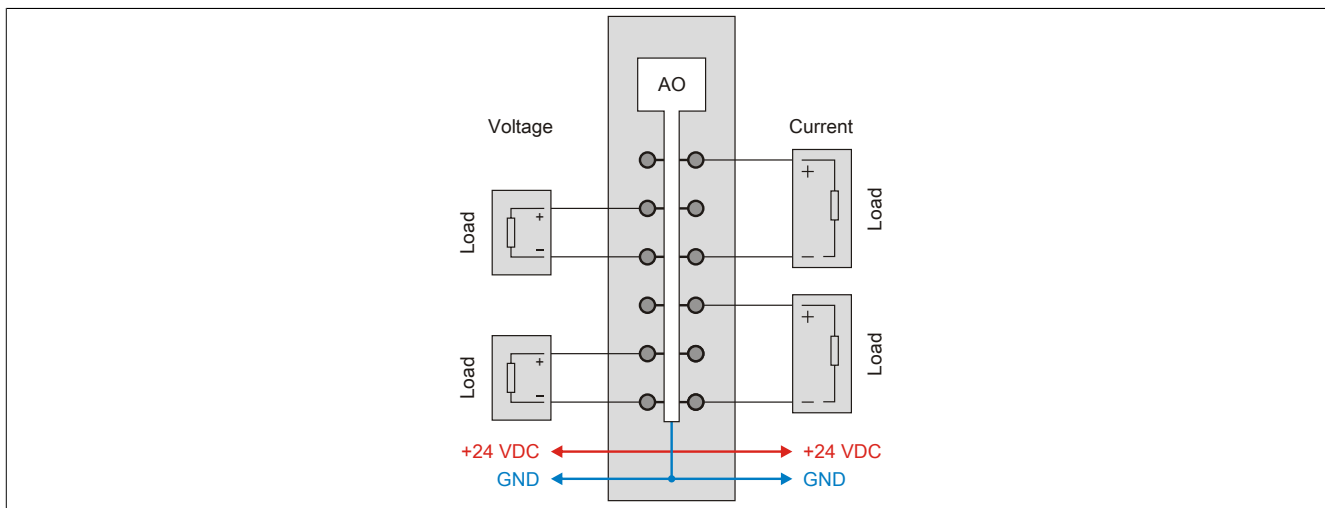
- 1) Depending on the configuration, a firmware update can take up to several minutes.

9.2.8.6 Pinout

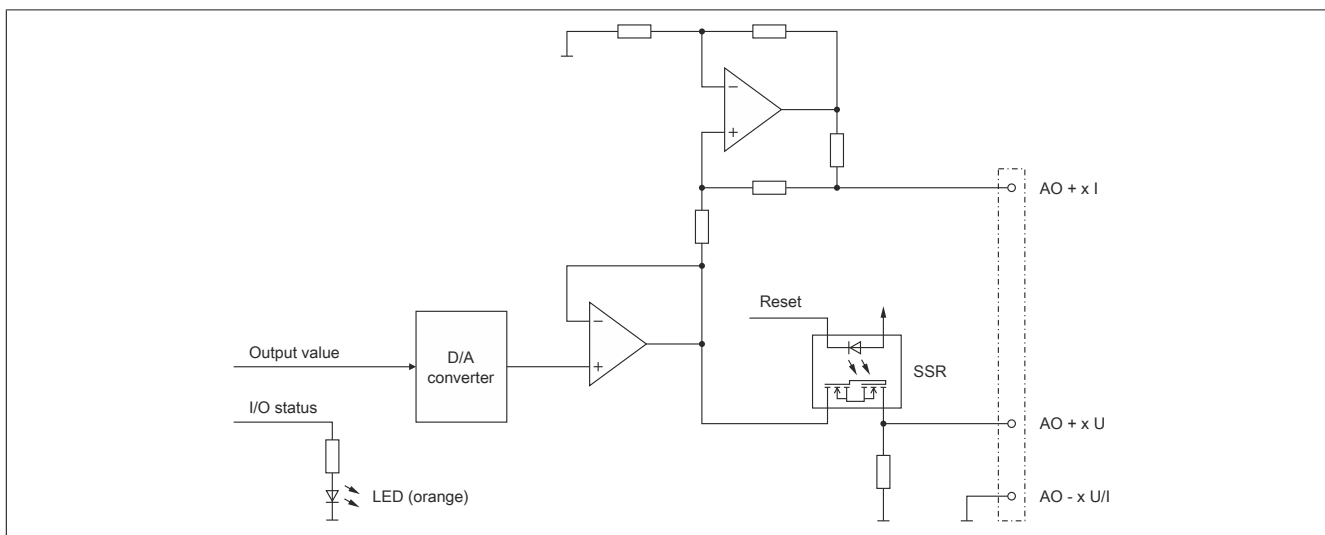
The individual channels can be configured for either current or voltage signals. The type of signal is also determined by the terminals used.



9.2.8.7 Connection example



9.2.8.8 Output circuit diagram

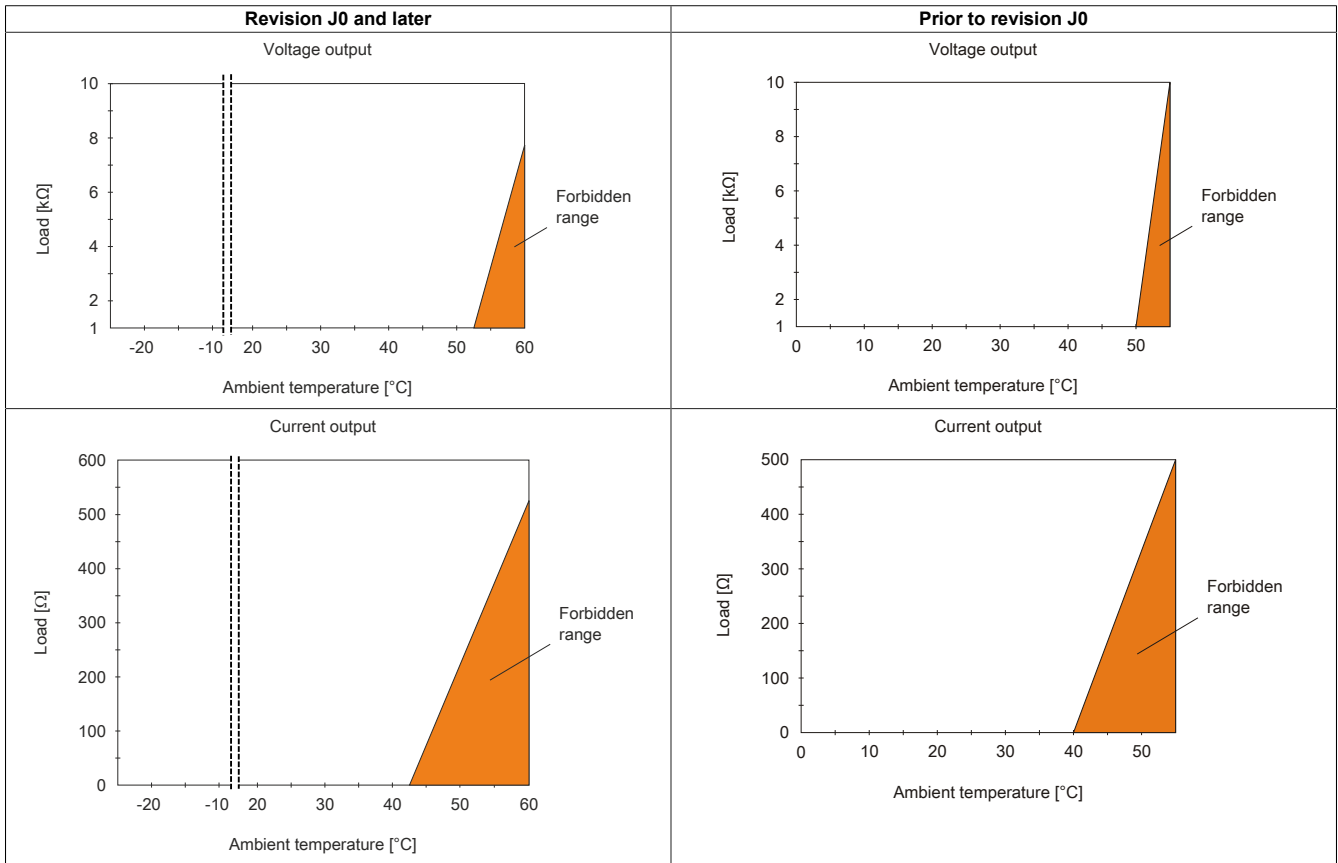


9.2.8.9 Derating

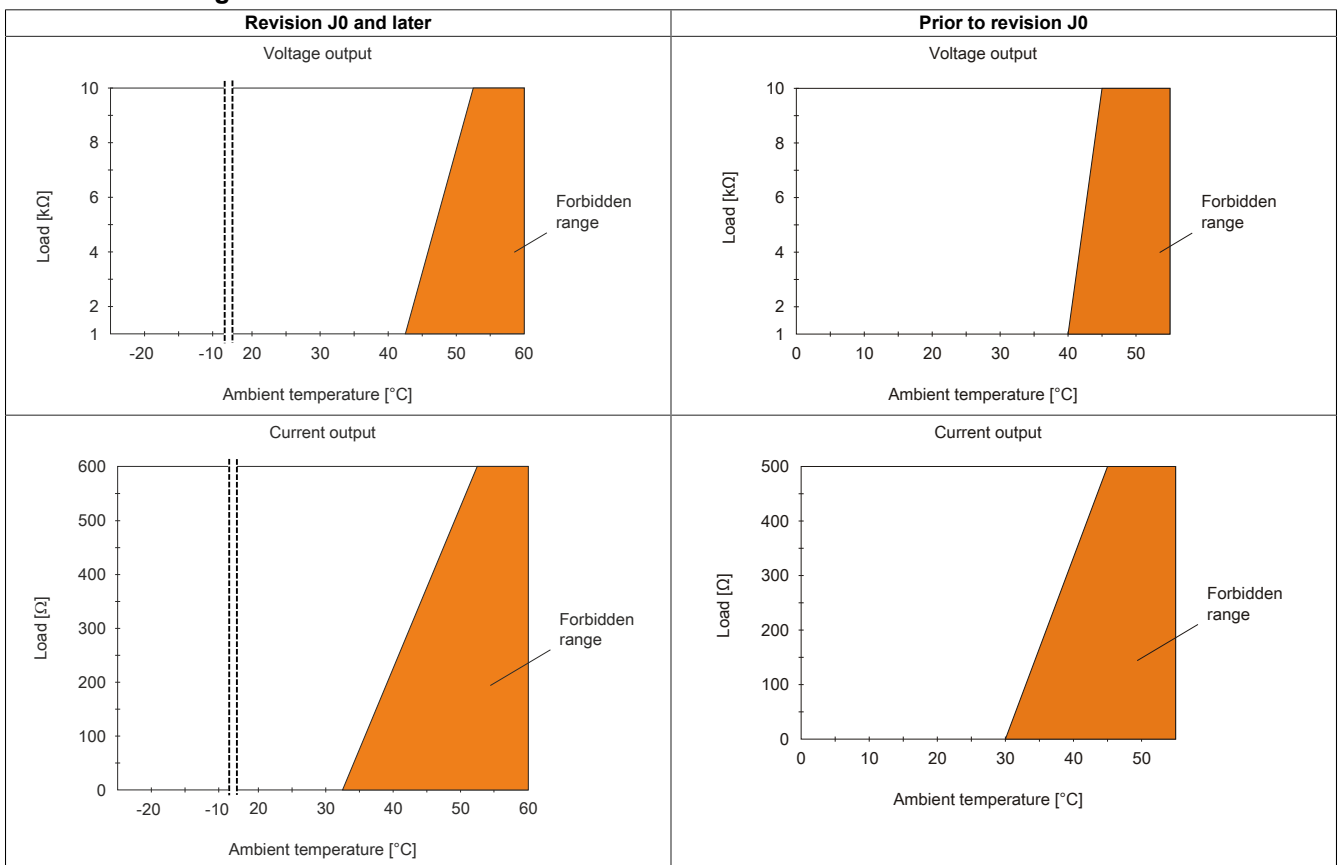
To ensure proper operation, the following points must be taken into account:

- The derating values listed below must be taken into account.
- In mixed operation with one current output, the mean value of both derating curves must be applied.
- In mixed operation with 2 or 3 current outputs, the derating of the current outputs must be applied.

Horizontal mounting orientation



Vertical mounting orientation



9.2.8.10 Register description

9.2.8.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.2.8.10.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|--|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog signal - Configuration | | | | | | |
| 0 | ConfigOutput01 (channel type) | UINT | | | | • |
| Analog signal - Communication | | | | | | |
| Index * 2 | AnalogOutput0N (Index N = 1 to 4) | INT | | | • | |
| 10 + Index * 4 | AnalogOutputDelayed0N (Index N = 0 to 3) | INT | | | • | |
| 12 | OutputDelayConfig00 | UINT | | | • | |
| 18 | OutputDelayConfig01 | UINT | | | • | |
| 14 | AnalogOutputLatchTime00 | UINT | • | | | |
| 22 | AnalogOutputLatchTime01 | UINT | • | | | |
| 20 | Error | UINT | • | | | |

9.2.8.10.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------------|----------------------|---|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog signal - Configuration | | | | | | | |
| 0 | - | ConfigOutput01 (channel type) | UINT | | | | • |
| Analog signal - Communication | | | | | | | |
| 10 + Index * 4 | Index * 2 - 2 | AnalogOutput0N (Index N = 1 to 4) | INT | | | • | |

1) The offset specifies the position of the register within the CAN object.

9.2.8.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.2.8.10.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.2.8.10.4 Analog output - Configuration

9.2.8.10.4.1 Setting the channel type

Name:

ConfigOutput01

This register can be used to set the channel type of the outputs.

Each channel is capable of handling either current or voltage signals. The type of signal is determined by the terminal connections used. Since current and voltage require different adjustment values, it is also necessary to configure the desired type of output signal. The following output signals can be set:

- ± 10 V voltage signal
- 0 to 20 mA current signal

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|---------|-------------|-------|---|
| 0 - 7 | Reserved | 0 | |
| 8 | Channel 1 | 0 | Voltage signal (bus controller default setting) |
| | | 1 | Current signal |
| ... | | ... | |
| 11 | Channel 4 | 0 | Voltage signal (bus controller default setting) |
| | | 1 | Current signal |
| 12 - 15 | Reserved | 0 | |

9.2.8.10.5 Analog output - Configuration

9.2.8.10.5.1 Output values of the analog outputs

Name:

AnalogOutput01 to AnalogOutput04

These registers provide the standardized output values. Once a permitted value is received, the module outputs the respective current or voltage.

Information:

The value "0" disables the channel status LED.

| Data type | Value | |
|-----------|-----------------|---------|
| INT | -32767 to 32767 | Voltage |
| | 0 to 32767 | Current |

9.2.8.10.5.2 Value for delayed output

Name:

AnalogOutputDelayed00 to AnalogOutputDelayed03

These registers contain the values with which the analog outputs are overwritten after the delay configured with "OutputDelayConfig0x" on page 812 has expired.

| Data type | Value | Output Signal |
|-----------|-----------------|----------------------------------|
| INT | -32768 to 32767 | Voltage signal -10 VDC to 10 VDC |
| | 0 to 32767 | Current signal 0 mA to 20 mA |

9.2.8.10.5.3 Configuration of the output delay

Name:

OutputDelayConfig00 to OutputDelayConfig01

2 configurations independent from each other can be created using these registers.

The delay time after which "AnalogOutputDelay0x" on page 811 should overwrite the channel can be configured using bits 0 to 13. Using bits 14 and 15, the channel is determined for which the configuration is valid.

Each channel can only be overwritten once. No additional channel can be overwritten while the respective time is running.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|-------------------------------------|-------|------------------|
| 0 - 13 | Delay time for the selected channel | x | Time in μ s |
| 14 - 15 | Channel | 00 | Analog output 01 |
| | | 01 | Analog output 02 |
| | | 10 | Analog output 03 |
| | | 11 | Analog output 04 |

9.2.8.10.5.4 Delay time for the output value

Name:

AnalogOutputLatchTime00 to AnalogOutputLatchTime01

These registers can be used to read when the respective overwrite value was actually written on the output.

| Data type | Value |
|-----------|-------------------|
| UINT | Actual delay time |

9.2.8.10.5.5 Error register for counter

Name:

Error

There are some limitations because 2 timers are used. This register is available to the user for reporting these potential errors.

The error bits are deleted as soon as a valid state is reset.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|------------------|-------|--|
| 0 | Analog output 01 | 0 | OK |
| | | 1 | Has already been overwritten |
| ... | ... | ... | ... |
| 3 | Analog output 04 | 0 | OK |
| | | 1 | Has already been overwritten |
| 4 | Timer 01 | 0 | OK |
| | | 1 | Already in use |
| 5 | Timer 02 | 0 | OK |
| | | 1 | Already in use |
| 6 | Timer 01 and 02 | 0 | OK |
| | | 1 | Both timers refer to the same channel number |
| 7 - 15 | Reserved | - | |

9.2.8.10.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μ s |

9.2.8.10.7 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 200 μ s |

9.2.9 X20(c)AO4632-1

Data sheet version: 1.41

9.2.9.1 General information

The module is equipped with 4 outputs with 16-bit (including sign) digital converter resolution. It is possible to select between the current and voltage signal using different terminals.

- 4 analog outputs
- Either current or voltage signal possible
- Extended signal range
- 16-bit digital converter resolution
- NetTime timestamp: Switch-off time

NetTime timestamp for output

For many applications, not only the output value is important, but also the exact switching time. The module is equipped with a NetTime timestamp function for this that can define a switching time to the nearest microsecond.

The timestamp function is based on synchronized timers. The CPU can predefine output events and provide them with a timestamp. After transferring the respective data, including the exact time, the module executes the predefined action at the exactly defined time.

9.2.9.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.2.9.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.2.9.3 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Analog outputs |  |
| X20AO4632-1 | X20 analog output module, 4 outputs, ± 11 V or 0 to 22 mA, 16-bit converter resolution, NetTime function | |
| X20cAO4632-1 | X20 analog output module, coated, 4 outputs, ± 11 V or 0 to 22 mA, 16-bit converter resolution, NetTime function | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 104: X20AO4632-1, X20cAO4632-1 - Order data

9.2.9.4 Technical data

| Model number | X20AO4632-1 | X20cAO4632-1 |
|--|--|--------------|
| Short description | 4 analog outputs ± 11 V or 0 to 22 mA | |
| I/O module | | |
| General information | | |
| B&R ID code | 0xC36F | 0xE213 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnosics | | |
| Module run/error | Yes, using status LED and software | |
| Channel type | Yes, using software | |
| Power consumption | | |
| Bus | 0.01 W | |
| Internal I/O | 2.15 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Analog outputs | | |
| Output | ± 11 V or 0 to 22 mA, via different terminal connections | |
| Digital converter resolution | | |
| Voltage | ± 15 -bit | |
| Current | 15-bit | |
| Conversion time | 50 μ s for all outputs | |
| Settling time on output change over entire range | 500 μ s | |
| Switch on/off behavior | Internal enable relay for booting | |
| Max. error | | |
| Voltage | | |
| Gain | 0.05% ¹⁾ | |
| Offset | 0.015% ²⁾ | |
| Current | | |
| Gain | 0.08% ¹⁾ | |
| Offset | 0.05% ²⁾ | |
| Output protection | Short circuit protection | |

Table 105: X20AO4632-1, X20cAO4632-1 - Technical data


| Model number | X20AO4632-1 | X20cAO4632-1 |
|---|--|---|
| Output format | | |
| Voltage | INT 0x8000 - 0x7FFF / 1 LSB = 0x0001 = 335.693 μ V | |
| Current | INT 0x0000 - 0x7FFF / 1 LSB = 0x0001 = 671.386 nA | |
| Load per channel | | |
| Voltage | Max. \pm 11 mA, load \geq 1 k Ω | |
| Current | Max. load is 600 Ω | |
| Short-circuit proof | Current limiting \pm 40 mA | |
| Output filter | 1st-order low pass / cutoff frequency 10 kHz | |
| Max. gain drift | | |
| Voltage | 0.008 %/ $^{\circ}$ C ¹⁾ | |
| Current | 0.011 %/ $^{\circ}$ C ¹⁾ | |
| Max. offset drift | | |
| Voltage | 0.003 %/ $^{\circ}$ C ²⁾ | |
| Current | 0.008 %/ $^{\circ}$ C ²⁾ | |
| Error caused by load change | | |
| Voltage | Max. 0.1%, from 10 M Ω \rightarrow 1 k Ω , resistive | |
| Current | Max. 0.5%, from 1 Ω \rightarrow 600 Ω , resistive | |
| Nonlinearity | <0.007% ³⁾ | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5 $^{\circ}$ C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60 $^{\circ}$ C | |
| Vertical mounting orientation | -25 to 50 $^{\circ}$ C | |
| Derating | See section "Derating" | |
| Storage | -40 to 85 $^{\circ}$ C | |
| Transport | -40 to 85 $^{\circ}$ C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 105: X20AO4632-1, X20cAO4632-1 - Technical data

- 1) Based on the current output value.
- 2) Based on the entire output range.
- 3) Based on the output range.

9.2.9.5 LED status indicators

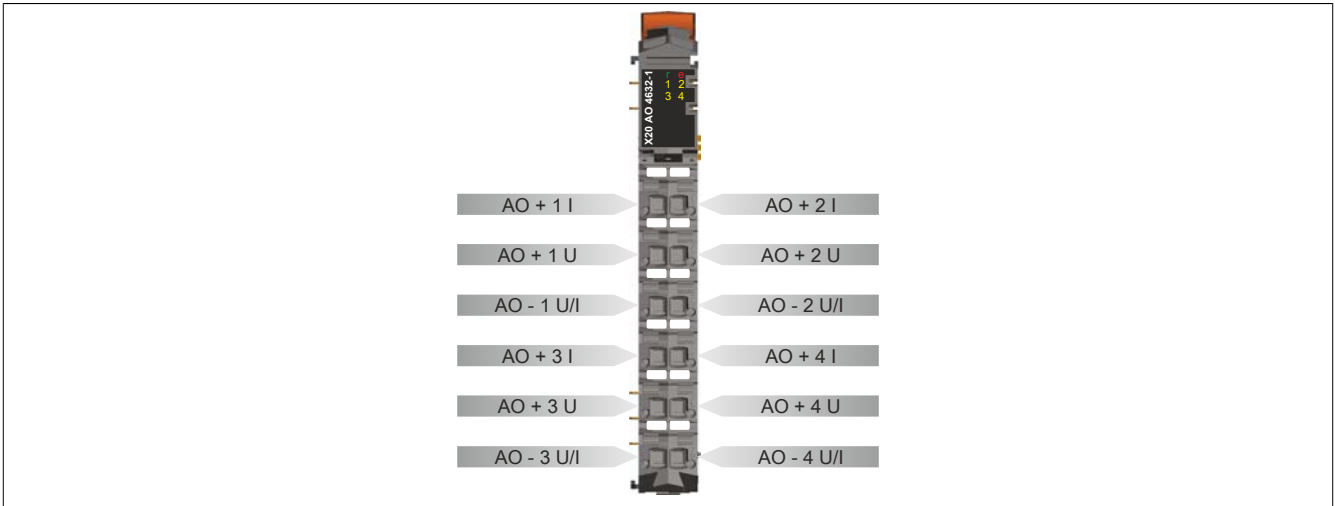
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|--------|--------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | 1 - 4 | Orange | Off | Value = 0 |
| | | | On | Value \neq 0 |

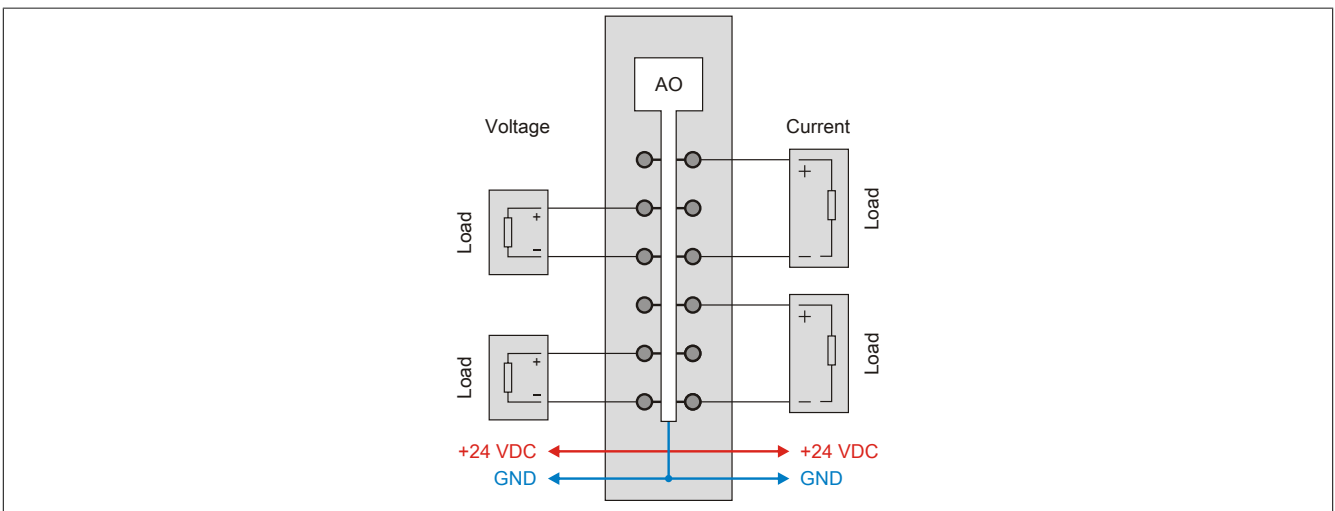
- 1) Depending on the configuration, a firmware update can take up to several minutes.

9.2.9.6 Pinout

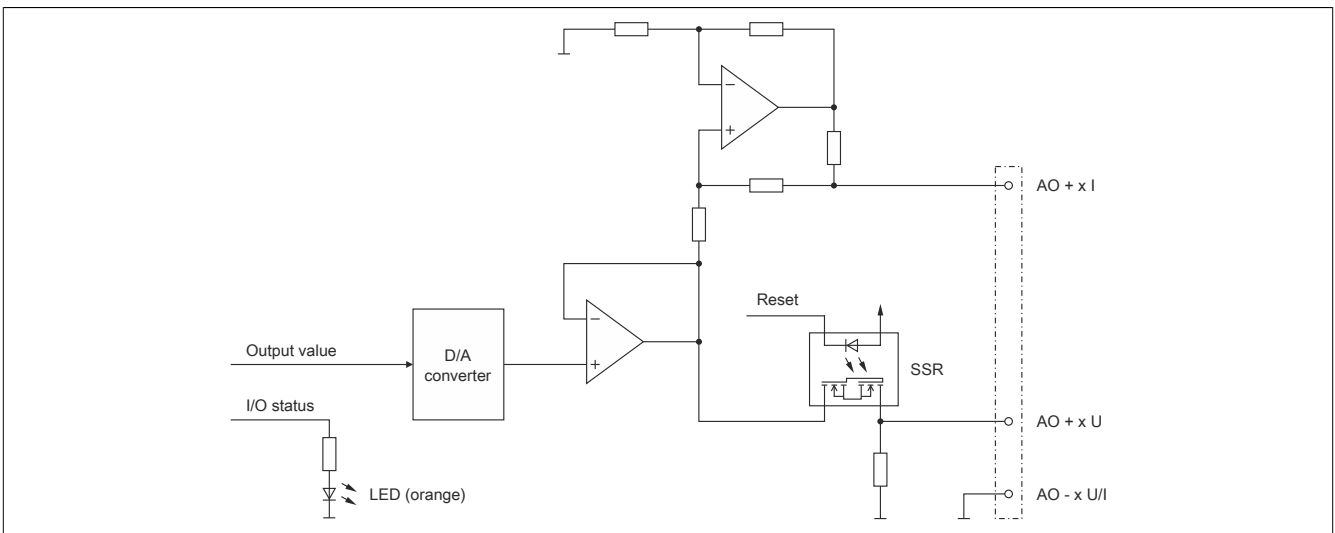
The individual channels can be configured for either current or voltage signals. The type of signal is also determined by the terminals used.



9.2.9.7 Connection example



9.2.9.8 Output circuit diagram



9.2.9.9 Derating

To ensure proper operation, the following items must be taken into consideration:

- The following derating listings must be taken into consideration
- For mixed operation with one current output, the average of both derating curves should be used
- For mixed operation with 2 or 3 current outputs, the derating for the current outputs should be used

Horizontal installation

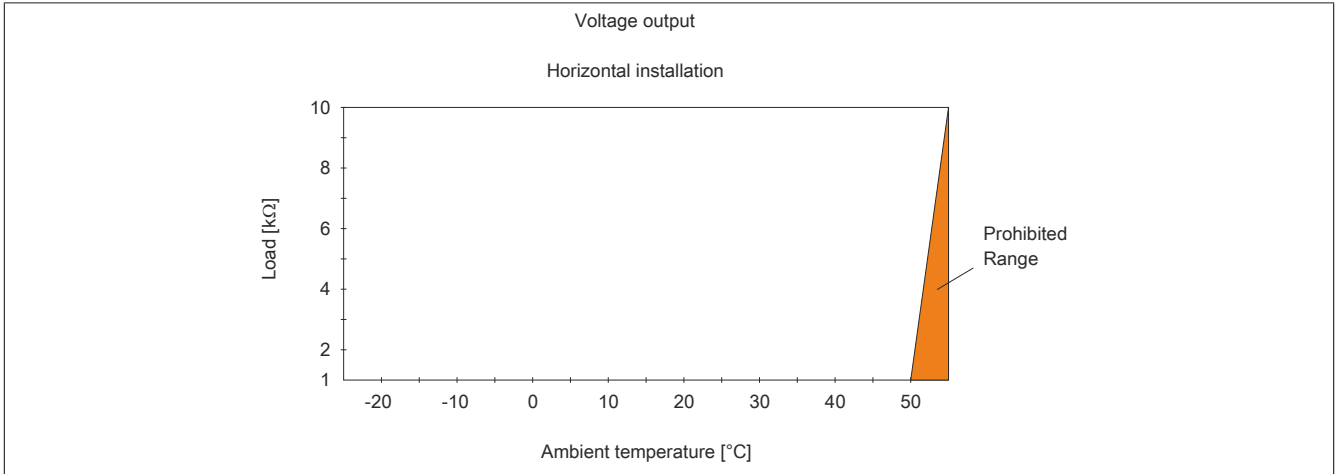


Figure 88: Derating the load with a voltage output and horizontal mounting

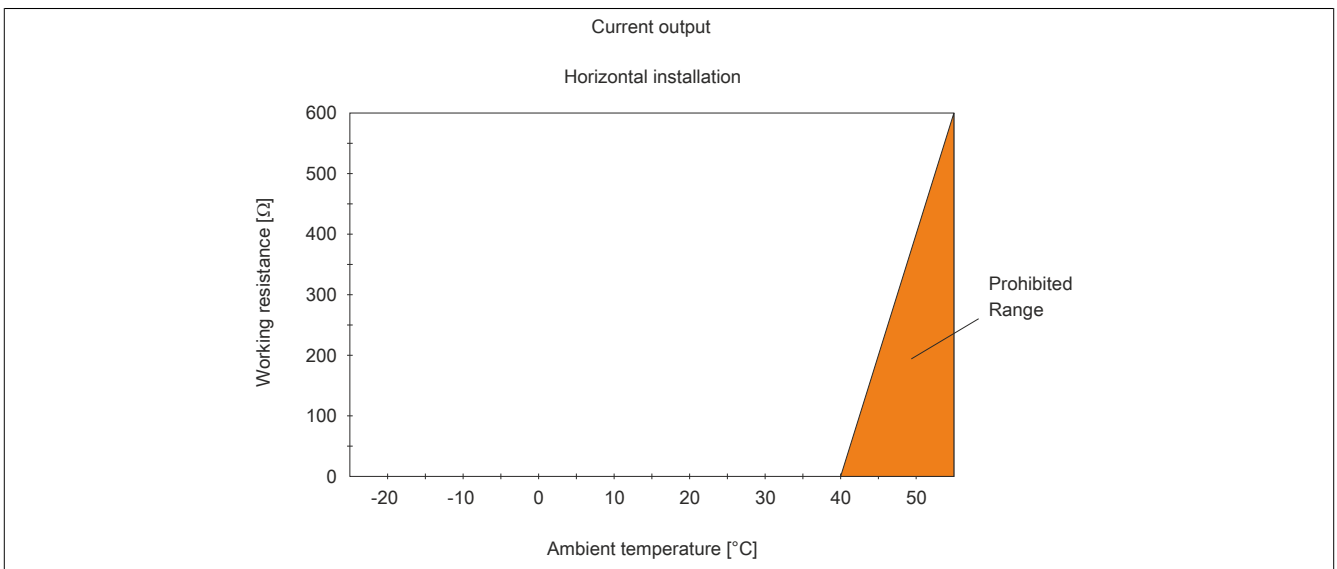


Figure 89: Derating the load with a current output and horizontal mounting

Vertical installation

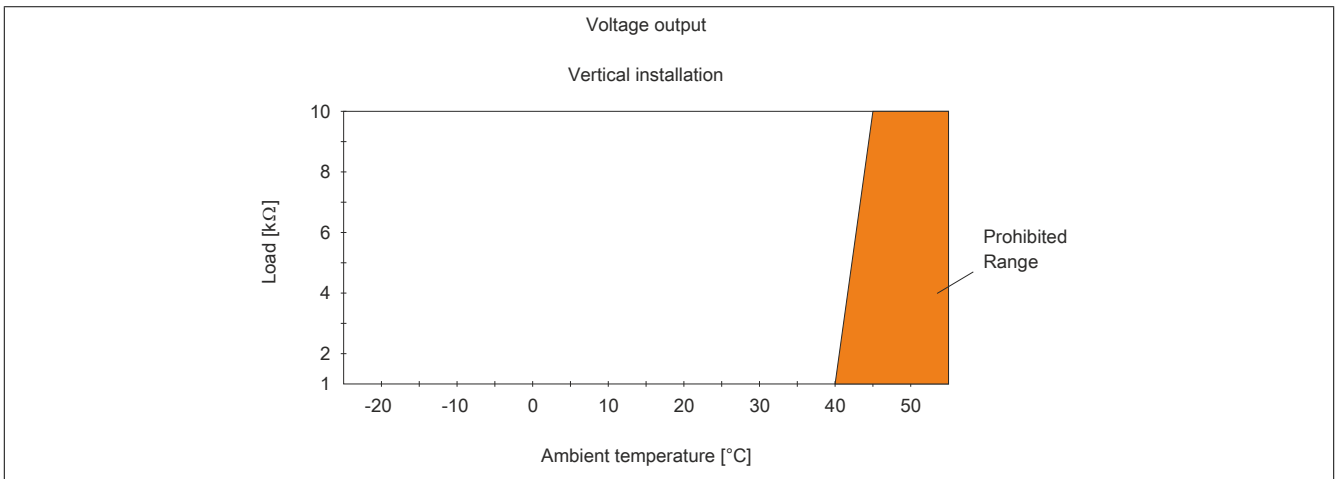


Figure 90: Derating the load with a voltage output and vertical mounting

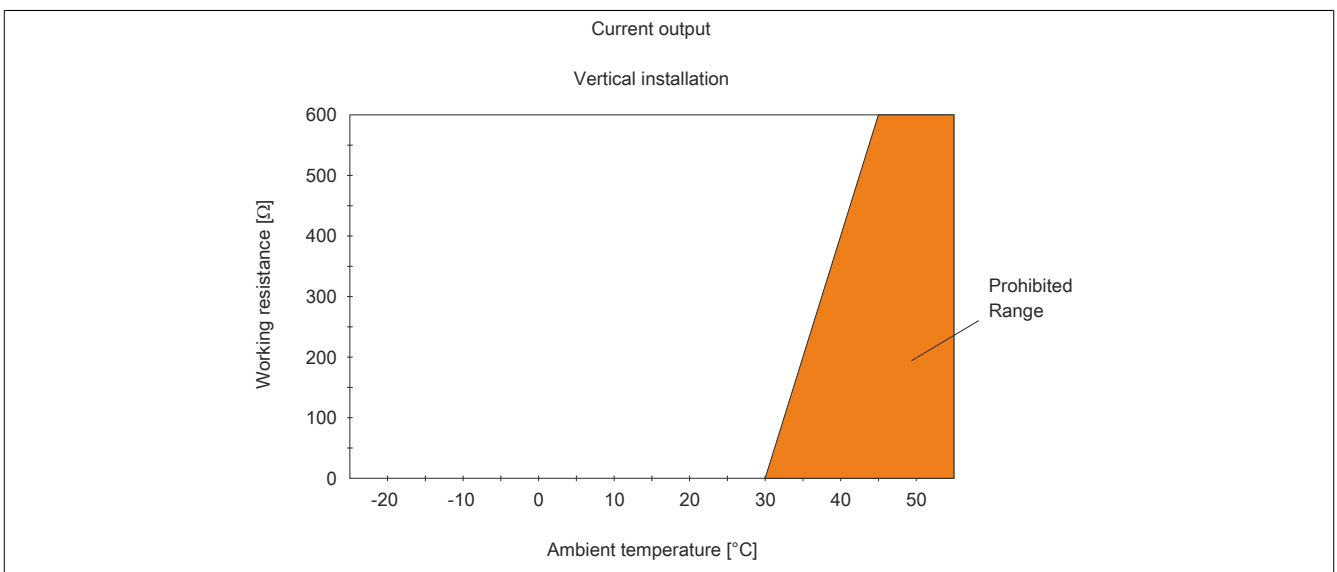


Figure 91: Derating the load with a current output and vertical mounting

9.2.9.10 Register description

9.2.9.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.2.9.10.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|--------------------------------------|--|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog output - Configuration | | | | | | |
| 0 | ConfigOutput01 (channel type) | UINT | | | | • |
| 590 + Index*4 | Cfo_Channel0NTimeMode (Index N = 1 to 4) | UINT | | | | • |
| Analog output - Communication | | | | | | |
| Index * 2 | AnalogOutput0N (Index N = 1 to 4) | INT | | | • | |
| 457 | SDCLifeCount | SINT | • | | | |
| 794 + Index*8 | ValidationTimer0N (Index N = 1 to 4) | INT | | | • | |
| 796 + Index*8 | ValidationTimer0N (Index N = 1 to 4) | DINT | | | • | |
| 833 | Enabling/disabling the output channels | USINT | • | | • | |
| | AnalogOutput01Enable, ~Readback | Bit 0 | | | | |
| | ... | ... | | | | |
| | AnalogOutput04Enable, ~Readback | Bit 3 | | | | |
| 835 | Checking the output values | USINT | • | | | |
| | AnalogOutput01OK | Bit 0 | | | | |
| | ... | ... | | | | |
| | AnalogOutput04OK | Bit 3 | | | | |

9.2.9.10.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------------|----------------------|-----------------------------------|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Analog output - Configuration | | | | | | | |
| 0 | - | ConfigOutput01 (channel type) | UINT | | | | • |
| Analog output - Communication | | | | | | | |
| 10 + Index * 4 | Index * 2 - 2 | AnalogOutput0N (Index N = 1 to 4) | INT | | | • | |

1) The offset specifies the position of the register within the CAN object.

9.2.9.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.2.9.10.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.2.9.10.4 General information

The module provides 4 analog outputs. Each channel can output a voltage range of ± 11 V or a current range of 0 to 22 mA.

The module also has a time-based watchdog monitor. The user can activate this feature on a channel-by-channel basis as needed.

9.2.9.10.5 Analog output - Configuration

Each channel is configured independently. The user can also define an optional time-based monitor. To make this possible, 4 watchdog timers were implemented, which can be assigned to the outputs.

9.2.9.10.5.1 Setting the channel type

Name:

ConfigOutput01

This register can be used to set the channel type of the outputs.

Each channel is capable of handling either current or voltage signals. The type of signal is determined by the terminal connections used. Since current and voltage require different adjustment values, it is also necessary to configure the desired type of output signal. The following output signals can be set:

- ± 11 V voltage signal
- 0 to 22 mA current signal

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|---------|-------------|-------|---|
| 0 - 7 | Reserved | 0 | |
| 8 | Channel 1 | 0 | Voltage signal (bus controller default setting) |
| | | 1 | Current signal |
| ... | | ... | |
| 11 | Channel 4 | 0 | Voltage signal (bus controller default setting) |
| | | 1 | Current signal |
| 12 - 15 | Reserved | 0 | |

9.2.9.10.5.2 Configuring the time-based watchdog monitor

Name:

Cfo_Channel01TimeMode to Cfo_Channel04TimeMode

This register is used to activate or configure the time-based watchdog monitor for the analog output channels.

Possibilities per channel:

- Validation timer data type: General choice 16 or 32 bit
- Validation window: The maximum value can be further limited within the data type.
- Timer allocation: A separate timer is available for each channel. However, all channels can be configured with the same validation timer, whereby the same settings must be made for the data type and window in the TimeMode registers.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|---------|----------------------|-------|---|
| 0 - 4 | Max. validation time | 00000 | Disabled |
| | | 00001 | 2 μ s |
| | | 00010 | 4 μ s |
| | | 00011 | 8 μ s |
| | | ... | ... |
| | | 11111 | 2,147,483,648 μ s (~35 min) |
| 5 - 7 | Reserved | 0 | |
| 8 - 9 | Timer allocation | 00 | ValidationTimer01 (default for channel 1) |
| | | 01 | ValidationTimer02 (default for channel 2) |
| | | 10 | ValidationTimer03 (default for channel 3) |
| | | 11 | ValidationTimer04 (default for channel 4) |
| 10 - 14 | Reserved | 0 | |
| 15 | Time format | 0 | 16-bit |
| | | 1 | 32-bit |

9.2.9.10.6 Analog output - Communication

In standard mode, the module's outputs are enabled. Based on the configuration and AnalogOutput value, they output the corresponding current or voltage.

If the application requires time-controlled monitoring of the outputs, a validation timer can be assigned to each channel. The validation timer register assigns a validity period to the current output value. If validation is enabled, the module compares the validation time and the [NetTime](#) of the X2X Link. If the transmitted validity period is exceeded, the module switches off the channel and resets the output. State "Safety shutdown" is only exited again when a new valid validation time has been transmitted. If enabled, the module reports back which state it is currently in via the error state bit of the channel.

If the value of the validation timer is incremented in each task cycle, the valid validation time will be calculated as follows:

| | |
|---|--|
| NetTime of the X2X Link master (to which the module is connected) | |
| + | Timespan for transferring data from the X2X Link master to the CPU (higher-level system) |
| + | Cycle time of task class (including tolerance) |
| + | Timespan for transferring the data from the CPU to the module |
| + | Timespan allowed by the application (e.g. for tolerating failure of an X2X Link cycle) |
| = | Valid validation time |

The AnalogOutputEnableByte is enabled during time-based monitoring. If the timer expires prematurely, the corresponding bit in the AnalogOutputOkayByte is reset and the output drops out. This provides an easy way to achieve a defined state.

9.2.9.10.6.1 Output values of the analog outputs

Name:

AnalogOutput01 to AnalogOutput04

These registers provide the standardized output values. Once a permitted value is received, the module outputs the respective current or voltage.

Information:

The value "0" disables the channel status LED.

| Data type | Value | |
|-----------|-----------------|---------|
| INT | -32767 to 32767 | Voltage |
| | 0 to 32767 | Current |

9.2.9.10.6.2 SDC counter register

Name:

SDCLifeCount

The 8-bit counter register is needed for the SDC software package. It is incremented with the system clock to allow the SDC to check the validity of the data frame.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

9.2.9.10.6.3 Transfer of the timestamp

Name:

ValidationTimer01 to ValidationTimer04

When an output is being monitored, these registers must provide the timestamp which, when reached, will cause the output to shut down automatically. The values must be provided as signed 2-byte or 4-byte values.

For more information about NetTime and timestamps, see ["NetTime Technology"](#) on page 3035.

| Data type | Values [µs] | |
|-----------|---------------------------------|---|
| INT | -32768 to 32767 | NetTime timestamp of the current output value |
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime timestamp of the current output value |

9.2.9.10.6.4 Enabling/disabling the output channels

Name:

AnalogOutput01Enable to AnalogOutput04Enable

AnalogOutput01EnableReadback to AnalogOutput04EnableReadback

The "OutputEnable" byte is only needed for the channels with activated time-based monitoring. The individual bits are used to enable/disable the respective channels. To receive reliable feedback about the current state of the module, the byte was also implemented so that it can be read cyclically.

| Data type | Value |
|-----------|-------------------|
| USINT | See bit structure |

Bit structure:

| Bit | Name | Value | Information |
|-------|------------------------------|-------|--------------------|
| 0 | AnalogOutput01Enable | 0 | Output deactivated |
| | AnalogOutput01EnableReadback | 1 | Output activated |
| ... | | ... | |
| 3 | AnalogOutput04Enable | 0 | Output deactivated |
| | AnalogOutput04EnableReadback | 1 | Output activated |
| 4 - 7 | Reserved | 0 | |

9.2.9.10.6.5 Checking the output values

Name:

AnalogOutput01OK to AnalogOutput04OK

These registers are only needed for channels with activated time-based monitoring. The individual bits report whether the respective channel is actually generating the required voltage or current.

| Data type | Value |
|-----------|-------------------|
| USINT | See bit structure |

Bit structure:

| Bit | Name | Value | Information |
|-------|------------------|-------|-------------------------------|
| 0 | AnalogOutput01OK | 0 | Electrical signal deactivated |
| | | 1 | Electrical signal activated |
| ... | | ... | |
| 3 | AnalogOutput04OK | 0 | Electrical signal deactivated |
| | | 1 | Electrical signal activated |
| 4 - 7 | Reserved | 0 | |

9.2.9.10.7 NetTime Technology

For a description of NetTime Technology, see ["NetTime Technology" on page 3035](#).

9.2.9.10.8 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μ s |

9.2.9.10.9 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 200 μ s |

9.2.10 X20AO4635

Data sheet version: 3.11

9.2.10.1 General information

The module is equipped with 4 outputs with 16-bit (including sign) digital converter resolution. It is possible to select between the current and voltage signal using different terminals.

- 4 analog outputs
- Either current or voltage signal possible
- 16-bit digital converter resolution
- Low temperature drift

9.2.10.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Analog outputs |  |
| X20AO4635 | X20 analog output module, 4 outputs, ± 10 V or 0 to 20 mA, 16-bit converter resolution, low temperature drift | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 106: X20AO4635 - Order data

9.2.10.3 Technical data

| Model number | X20AO4635 |
|--|--|
| Short description | |
| I/O module | 4 analog outputs, ± 10 V or 0 to 20 mA, low temperature drift |
| General information | |
| B&R ID code | 0xA7FE |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnosics | |
| Module run/error | Yes, using status LED and software |
| Channel type | Yes, using software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.5 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Analog outputs | |
| Output | ± 10 V or 0 to 20 mA, via different terminal connections |
| Digital converter resolution | |
| Voltage | ± 15 -bit |
| Current | 15-bit |
| Conversion time | 50 μ s for all outputs |
| Settling time for output changes over entire range | 500 μ s |
| Switch on/off behavior | Internal enable relay for booting |
| Max. error at 25°C | |
| Gain | 0.04% ¹⁾ |
| Offset | 0.022% ²⁾ |
| Output protection | Short circuit protection |
| Output format | |
| Voltage | INT 0x8000 - 0x7FFF / 1 LSB = 0x0001 = 305.176 μ V |
| Current | INT 0x0000 - 0x7FFF / 1 LSB = 0x0001 = 610.352 nA |
| Load per channel | |
| Voltage | Max. ± 10 mA, load ≥ 1 k Ω |
| Current | Max. load is 500 Ω |
| Short-circuit proof | Current limiting ± 40 mA |
| Output filter | 1st-order low pass / cutoff frequency 10 kHz |
| Error caused by load change | |
| Voltage | Max. 0.02%, from 10 M Ω \rightarrow 1 k Ω , resistive |
| Current | Max. 0.5%, from 1 Ω \rightarrow 500 Ω , resistive |
| Nonlinearity | <0.005% |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Signal | |
| 0 to 20 mA | |
| Max. gain drift | 0.01 %/°C ¹⁾ |
| Max. offset drift | 0.012 %/°C ²⁾ |
| ± 10 V | |
| Max. gain drift | 0.0025 %/°C ¹⁾ |
| Max. offset drift | 0.001 %/°C ²⁾ |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |

Table 107: X20AO4635 - Technical data


| Model number | X20AO4635 |
|--|--|
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 55°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Module operation" |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 107: X20AO4635 - Technical data

- 1) Based on the current output value.
- 2) Based on the entire output range.

9.2.10.4 LED status indicators

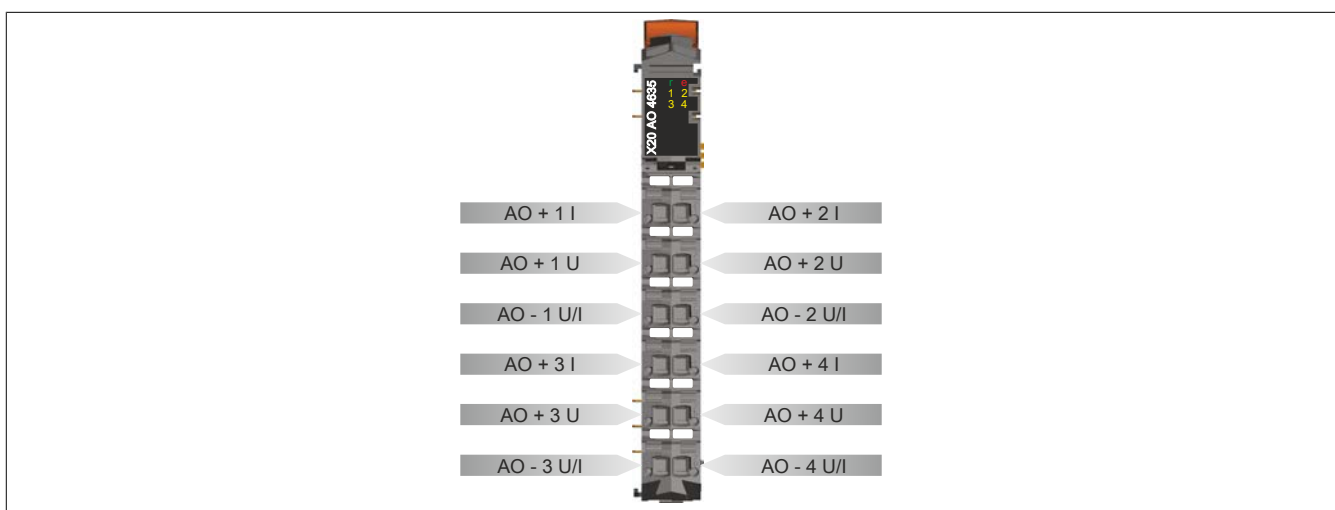
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|--|-------|--------|--------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | e | Red | On | RUN mode |
| | | | Off | No power to module or everything OK |
| | 1 - 4 | Orange | On | Error or reset status |
| | | | Off | Value = 0 |
| | | | On | Value ≠ 0 |

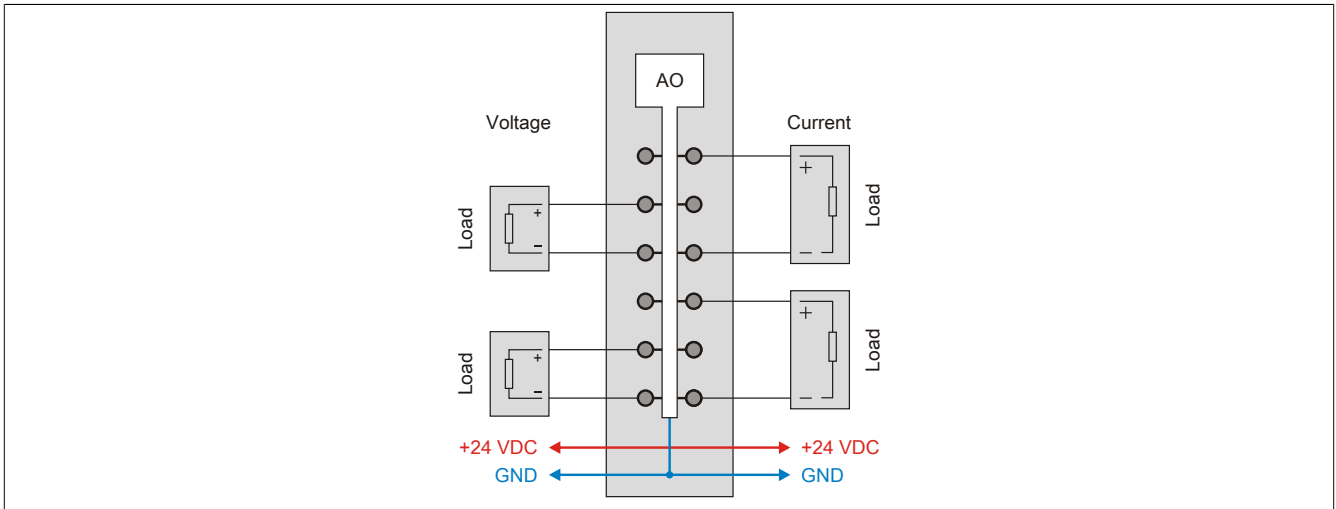
- 1) Depending on the configuration, a firmware update can take up to several minutes.

9.2.10.5 Pinout

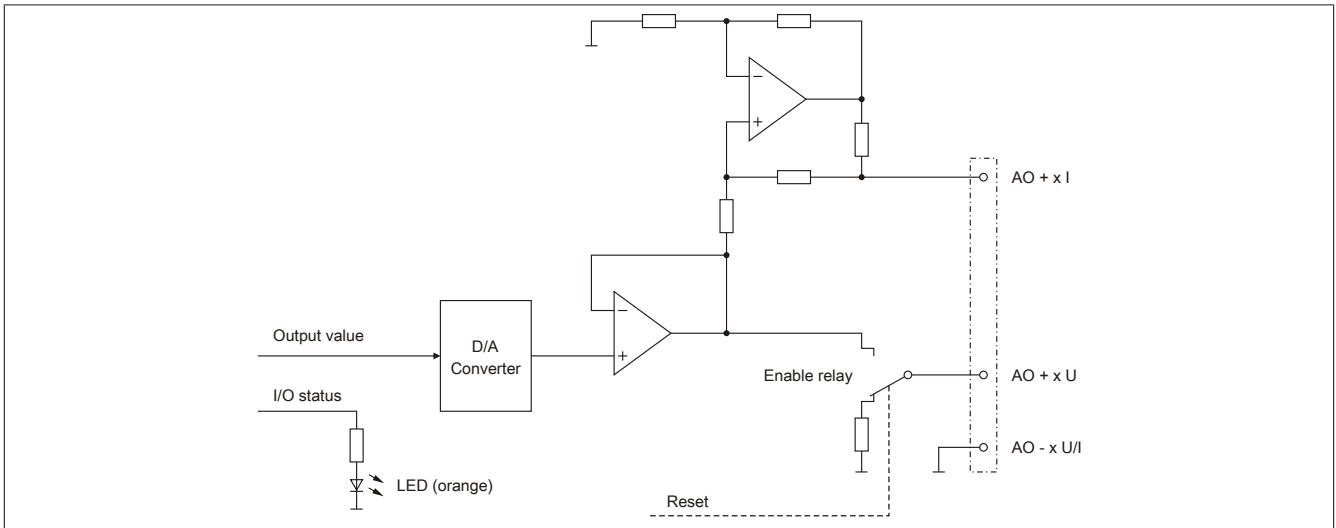
The individual channels can be configured for either current or voltage signals. The type of signal is also determined by the terminals used.



9.2.10.6 Connection example



9.2.10.7 Output circuit diagram



9.2.10.8 Module operation

To ensure proper operation, the following items must be taken into consideration:

- The following derating listings must be taken into consideration
- For mixed operation with one current output, the average of both derating curves should be used
- For mixed operation with 2 or 3 current outputs, the derating for the current outputs should be used

Horizontal installation

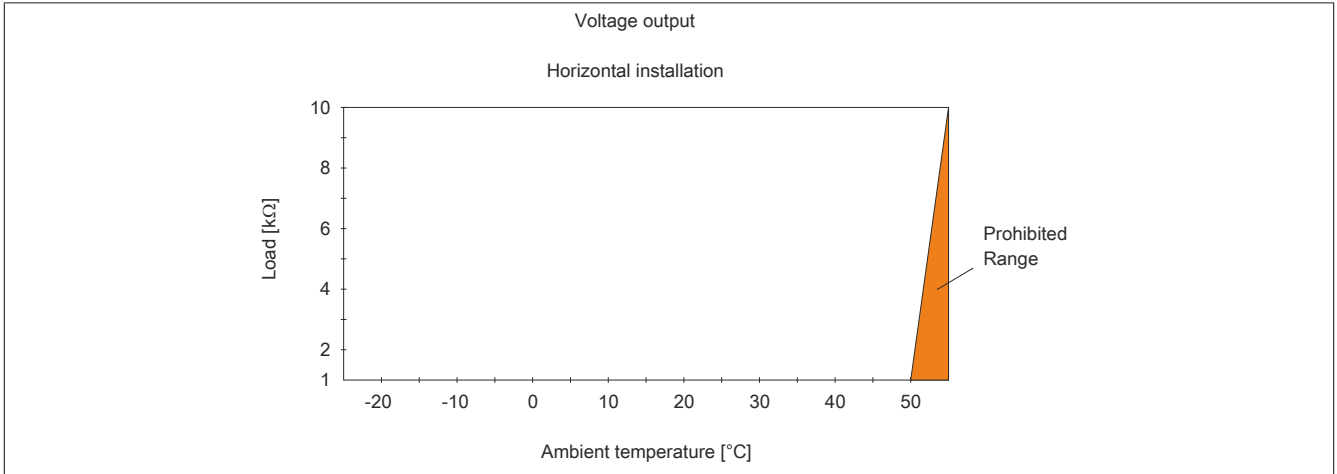
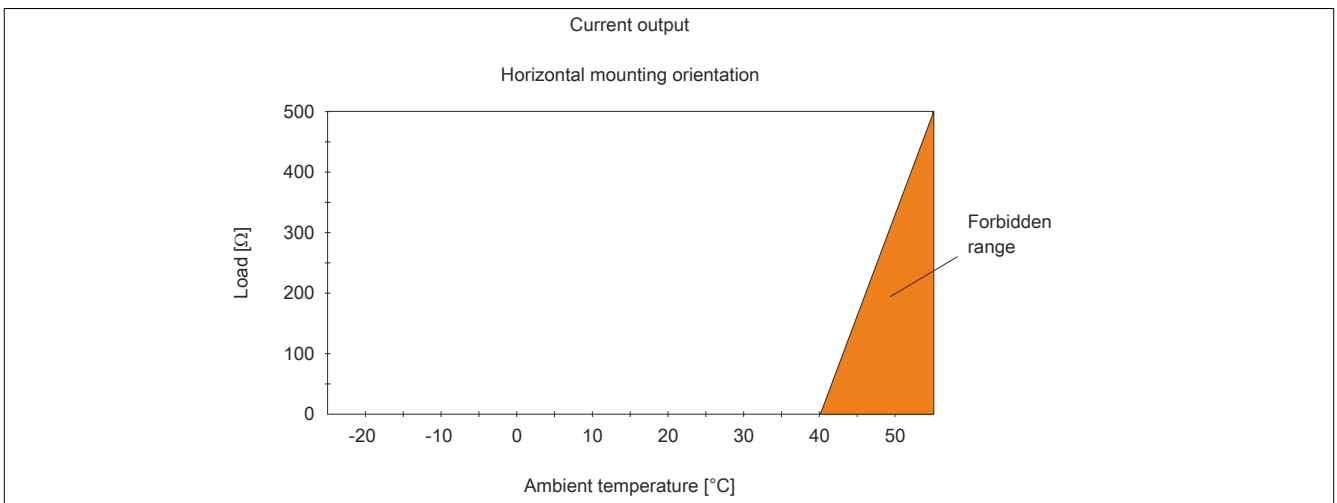


Figure 92: Derating the load with a voltage output and horizontal mounting



Vertical installation

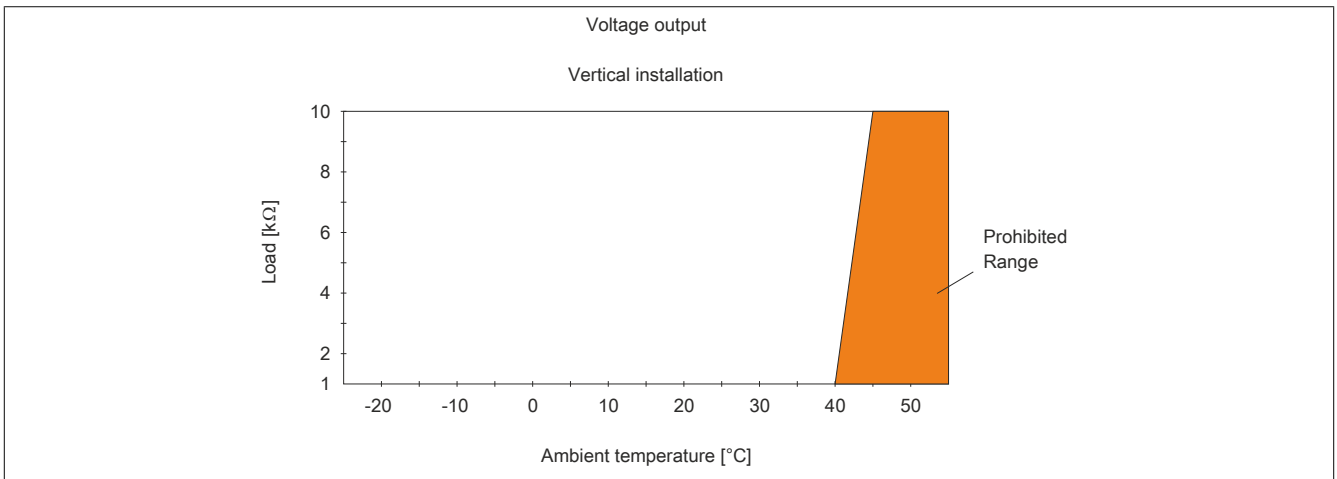
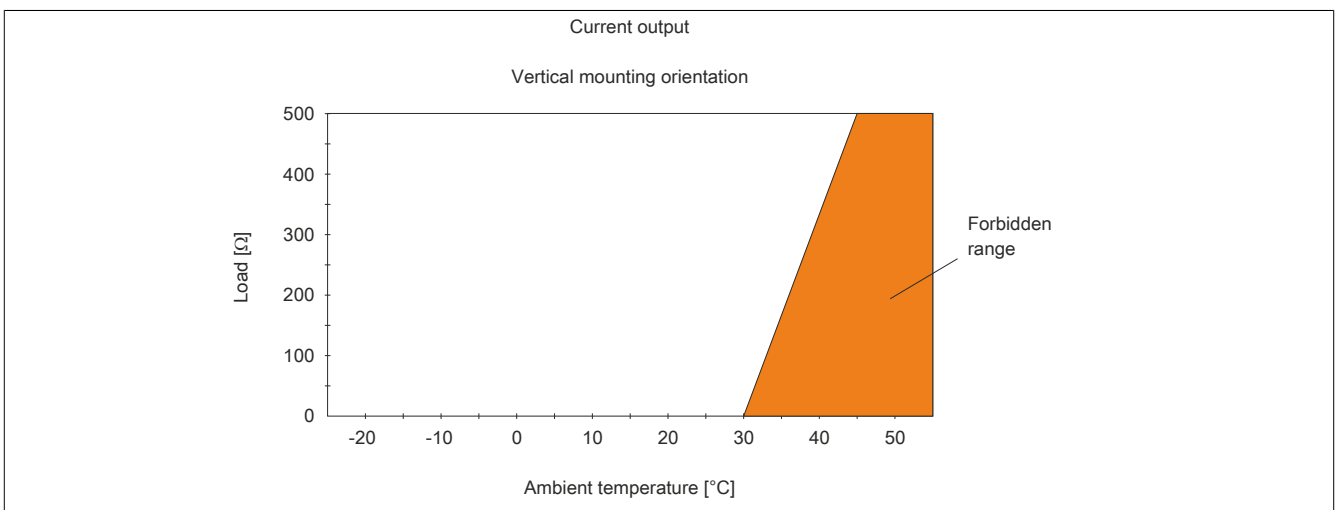


Figure 93: Derating the load with a voltage output and vertical mounting



9.2.10.9 Register description

9.2.10.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.2.10.9.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|---|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration | | | | | | |
| 0 | ConfigOutput01 (channel type) | UINT | | | | • |
| Communication | | | | | | |
| 2 | AnalogOutput01 | INT | | | • | |
| 4 | AnalogOutput02 | INT | | | • | |
| 6 | AnalogOutput03 | INT | | | • | |
| 8 | AnalogOutput04 | INT | | | • | |

9.2.10.9.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|---|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration | | | | | | | |
| 0 | - | ConfigOutput01 (channel type) | UINT | | | | • |
| Communication | | | | | | | |
| 2 | 0 | AnalogOutput01 | INT | | | • | |
| 4 | 2 | AnalogOutput02 | INT | | | • | |
| 6 | 4 | AnalogOutput03 | INT | | | • | |
| 8 | 6 | AnalogOutput04 | INT | | | • | |

1) The offset specifies the position of the register within the CAN object.

9.2.10.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.2.10.9.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.2.10.9.4 Analog outputs

The individual channels can be configured for either current or voltage signals. The type of signal is also determined by the terminals used.

9.2.10.9.4.1 Output values of the analog outputs

Name:

AnalogOutput01 to AnalogOutput04

These registers provide the standardized output values. Once a permitted value is received, the module outputs the respective current or voltage.

Information:

The value "0" disables the channel status LED.

| Data type | Value | |
|-----------|-----------------|---------|
| INT | -32767 to 32767 | Voltage |
| | 0 to 32767 | Current |

9.2.10.9.4.2 Setting the channel type

Name:

ConfigOutput01

This register can be used to set the channel type of the outputs.

Each channel is capable of handling either current or voltage signals. The type of signal is determined by the terminal connections used. Since current and voltage require different adjustment values, it is also necessary to configure the desired type of output signal. The following output signals can be set:

- ± 10 V voltage signal
- 0 to 20 mA current signal

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|---------|-------------|-------|---|
| 0 - 7 | Reserved | 0 | |
| 8 | Channel 1 | 0 | Voltage signal (bus controller default setting) |
| | | 1 | Current signal |
| ... | | ... | |
| 11 | Channel 4 | 0 | Voltage signal (bus controller default setting) |
| | | 1 | Current signal |
| 12 - 15 | Reserved | 0 | |

9.2.10.9.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μ s |

9.2.10.9.6 Minimum I/O update time

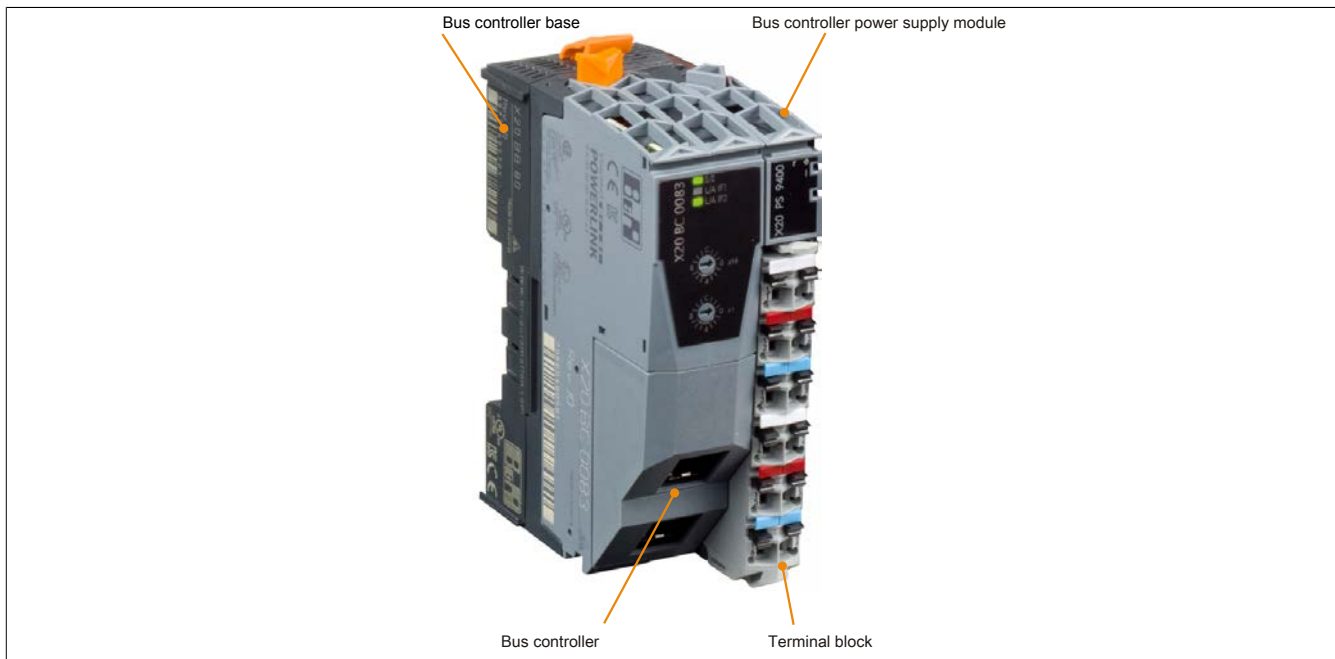
The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 200 μ s |

9.3 Bus controllers

Bus controllers consist of a base module, power supply module for providing power to the entire system and the fieldbus interface. This makes the bus controller an extremely flexible fieldbus interface.

Unlike a CPU with an integrated fieldbus connection, the bus controller does not need to be programmed in order to transfer or receive I/O data on the fieldbus. It works simply by configuring it on the fieldbus master.



Compact design

The supply for the bus controller, X2X Link network and I/O modules is part of the bus controller. No additional power supply modules are required.

9.3.1 Summary

| Model number | Short description | Page |
|--------------|---|------|
| X20BC0043-10 | X20 bus controller, 1 CANopen interface, order 1x terminal block TB2105 separately! Order bus base, power supply module and terminal block separately! | 834 |
| X20BC0053 | X20 bus controller, 1 DeviceNet interface, order 1x TB2105 terminal block separately Order bus base, power supply module and terminal separately | 841 |
| X20BC0063 | X20 bus controller, 1 PROFIBUS DP interface, 9-pin DSUB connection, order bus base, power supply module and terminal block separately | 847 |
| X20BC0073 | X20 bus controller, 1 CAN I/O interface, order 1x TB2105 terminal block separately Order bus base, power supply module and terminal separately | 851 |
| X20BC0083 | X20 bus controller, 1 POWERLINK interface, integrated 2-port hub, 2x RJ45, order bus base, power supply module and terminal block separately! | 859 |
| X20BC0087 | X20 bus controller, 1 Modbus TCP or Modbus UDP interface, integrated 2-port switch, 2x RJ45, order bus base, power supply module and terminal block separately. | 864 |
| X20BC0087-10 | X20 bus controller, 1 Modbus TCP or Modbus UDP interface, producer mode feature (via UDP), integrated switch, 2x RJ45, order bus base, power supply module and terminal block separately. | 870 |
| X20BC0088 | X20 bus controller, 1 EtherNet/IP interface, integrated switch, web interface, 2x RJ45, order bus base, power supply module and terminal block separately! | 877 |
| X20BC008U | X20 bus controller, 1 OPC UA Ethernet interface, integrated 2-port switch, 2x RJ45, order bus base, power supply module and terminal block separately. | 882 |
| X20BC00E3 | X20 bus controller, 1 PROFINET IO interface, integrated 2-port switch, 2x RJ45, order bus base, power supply module and terminal block separately! | 904 |
| X20BC00G3 | X20 bus controller, 1 EtherCAT interface, 2x RJ45, order bus base, power supply module and terminal block separately. | 910 |
| X20BC0143-10 | X20 bus controller, 1 CANopen interface, 9-pin DSUB, order 1x connector 7AC911.9 separately. Order bus base, power supply module and terminal block separately. | 914 |
| X20cBC0083 | X20 bus controller, coated, 1 POWERLINK interface, integrated 2-port hub, 2x RJ45, order bus base, power supply module and terminal block separately! | 859 |
| X20cBC0087 | X20 bus controller, coated, Modbus/TCP or Modbus/UDP interface, integrated 2-port switch, 2x RJ45, order bus base, power supply module and terminal block separately | 864 |
| X20cBC0088 | X20 bus controller, coated, 1 EtherNet/IP interface, integrated switch, web interface, 2x RJ45, order bus base, power supply module and terminal block separately! | 877 |
| X20cBC00E3 | X20 bus controller, coated, 1 PROFINET IO interface, integrated 2-port switch, 2x RJ45, order bus base, power supply module and terminal block separately! | 904 |

9.3.2 X20BC0043-10

Data sheet version: 1.16

9.3.2.1 General information

CAN (Controller Area Network) systems are widespread in the field of automation technology. CAN topology is based on a line structure and uses twisted wire pairs for data transfer. CANopen is a higher-layer protocol based on CAN. As a standardized protocol, it provides a high degree of flexibility for implementing a wide range of configurations.

The bus controller makes it possible to connect up to 253 X2X Link I/O modules to CANopen. A transition between IP20 and IP67 protection outside of the control cabinet is possible by aligning X20, X67 or XV modules one after the other as needed at distances up to 100m. All CANopen transmission types such as synchronous, event and polling modes are supported together with PDO linking, life/node guarding, emergency objects, and much more.

- Fieldbus: CANopen
- Auto-configuration of I/O modules
- I/O configuration via the fieldbus
- Constant response times even with large amounts of data (max. 32 Rx and 32 Tx PDOs)
- Configurable I/O cycle (0.5 to 4 ms)
- Possible to configure the transfer rate or have it detected automatically
- Heartbeat consumer and producer
- Emergency producer
- 2x SDO server, NMT slave
- Simple bootup (autostart)
- Terminal access via the serial interface on the X20PS9400
- Integrated terminating resistor

Information:

Only the standard function model (see the respective module description) is supported when the bus controller is used together with multi-function modules it has automatically configured itself.

Automation Studio V4.3 or later can be used to easily create configuration files (e.g. DCF files). All other function models are also supported by transferring configuration data to the bus controller (e.g. via the master environment with an SDO download).

Automation Studio can be downloaded at no cost from the B&R website (www.br-automation.com). The evaluation license is permitted to be used to create complete configurations for fieldbus bus controllers at no cost.

9.3.2.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Bus controllers |  |
| X20BC0043-10 | X20 bus controller, 1 CANopen interface, order 1x terminal block TB2105 separately! Order bus base, power supply module and terminal block separately! | |
| | Required accessories | |
| | System modules for bus controllers | |
| X20BB80 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/ X20AC0SR1 included | |
| X20PS9400 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply | |
| X20PS9402 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply, supply not electrically isolated | |
| | Terminal blocks | |
| 0TB2105.9010 | Accessory terminal block, 5-pin, screw clamps 2.5 mm ² | |
| 0TB2105.9110 | Accessory terminal block, 5-pin, push-in terminal block 2.5 mm ² | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 108: X20BC0043-10 - Order data

9.3.2.3 Technical data

| Model number | X20BC0043-10 |
|--|--|
| Short description | |
| Bus controller | CANopen slave |
| General information | |
| B&R ID code | 0xA8B8 |
| Status indicators | Module status, bus function, data transfer, terminating resistor |
| Diagnostics | |
| Module status | Yes, using LED status indicator and software |
| Bus function | Yes, using LED status indicator and software |
| Data transfer | Yes, using LED status indicator |
| Terminating resistor | Yes, using LED status indicator |
| Power consumption | |
| Bus | 1.5 W (rev. <H0: 2 W) |
| Certifications | |
| CE | Yes |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| EAC | Yes |
| Interfaces | |
| Fieldbus | CANopen slave |
| Variant | 5-pin male multipoint connector |
| Max. distance | 1000 m |
| Transfer rate | Max. 1 Mbit/s |
| Default transfer rate | Automatic transfer rate detection or fixed setting |
| Min. cycle time ¹⁾ | |
| Fieldbus | No limitation |
| X2X Link | 500 µs |
| Synchronization between bus systems possible | No |
| Terminating resistor | Integrated in module |
| Electrical properties | |
| Electrical isolation | CANopen isolated from I/O CANopen not isolated from bus |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |


Table 109: X20BC0043-10 - Technical data

| Model number | X20BC0043-10 | |
|--|--|--|
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitation | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x terminal block TB2105 separately. Order 1x terminal block X20TB12 separately. Order 1x power supply module X20PS9400 X20PS9402 separately. Order 1x bus base X20BB80 separately. | |
| Pitch ²⁾ | 37.5 ^{+0.2} mm | |

Table 109: X20BC0043-10 - Technical data

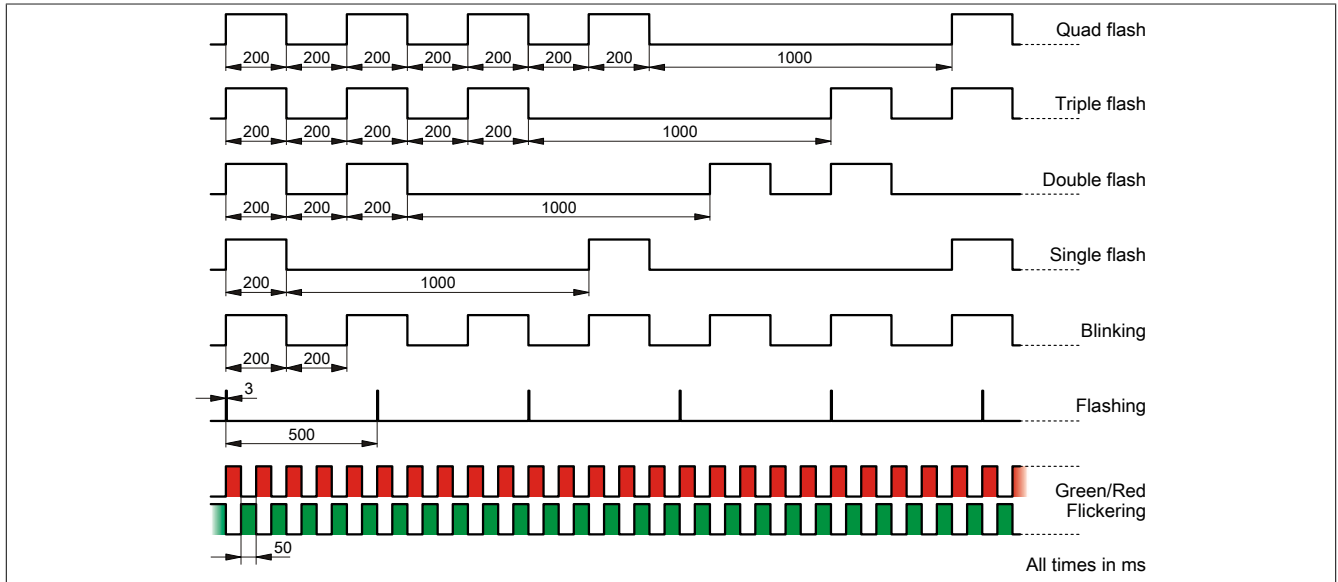
- 1) The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring.
- 2) Spacing is based on the width of bus base X20BB80. In addition, power supply module X20PS9400 or X20PS9402 is always required for the bus controller.

9.3.2.4 LED status indicators

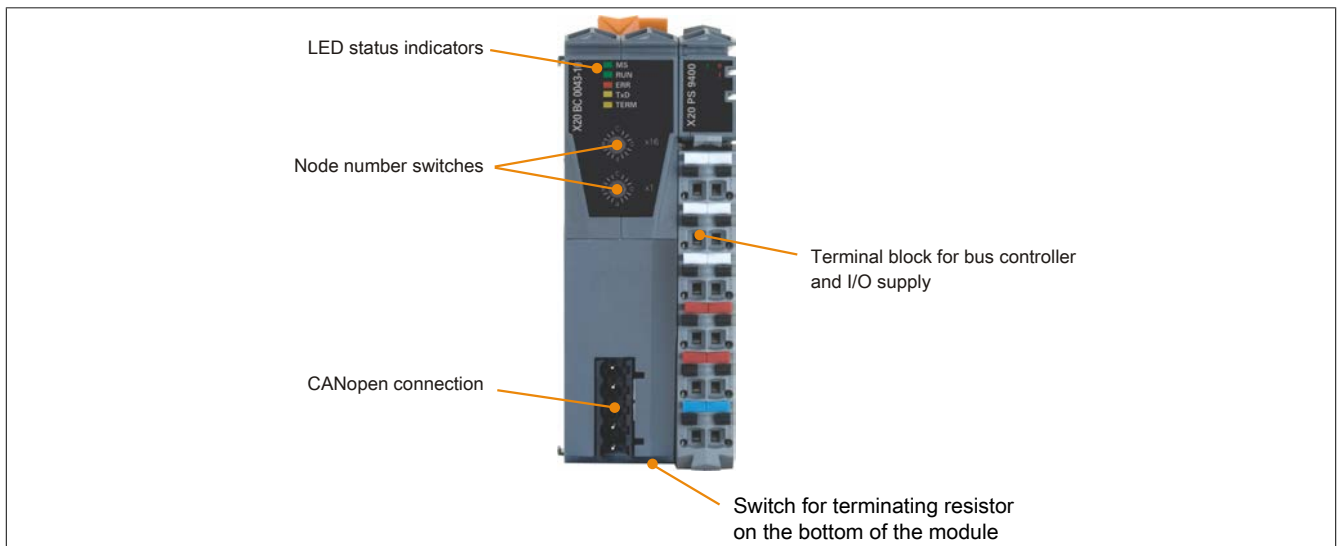
| Figure | LED | Color | Status | Description |
|--|------------------|-----------|--|--|
|  | MS ¹⁾ | Green | Off | No power supply |
| | | | Flashing | 5-second time window for deleting all configuration settings |
| | | | On | Boot procedure OK, I/O modules OK |
| | | Red | Double flash | Successfully erased flash memory |
| | | | Triple flash | Successfully saved transfer rate |
| | | | Quad flash | Successfully saved configuration |
| | On ²⁾ | | I/O modules: Error message or incorrect configuration | |
| | RUN | Green | Off | No power supply |
| | | | Single flash | STOP mode |
| | | | Triple flash | Firmware download in progress |
| | | | Blinking | Mode PREOPERATIONAL |
| | | | On | Mode OPERATIONAL |
| | ERR | Red | Off | No power supply or everything OK |
| | | | Single flash | CAN warning limit reached |
| | | | Double flash | Node guarding / Heartbeat error |
| | | | Blinking | Invalid node number or configuration |
| | | | On | Bus error: Bus off |
| | RUN/ERR | Green/Red | Flickering | Transfer rate detection in progress |
| | TxD | Yellow | Off | No data is being transmitted from the bus controller via the CANopen fieldbus. |
| | | | On | The bus controller is transmitting data via the CANopen fieldbus. |
| TERM | Yellow | Off | The terminating resistor integrated in the bus controller is switched off. | |
| | | On | The terminating resistor integrated in the bus controller is switched on. | |

- 1) LED "MS" is a green/red dual LED. Several red blinking signals are displayed immediately after the device is switched on. These are startup messages, however, and not errors.
- 2) The red "MS" LED can be cleared by writing to object 0x3001-Sub 0xA.

LED status indicators - Blink times



9.3.2.5 Operating and connection elements

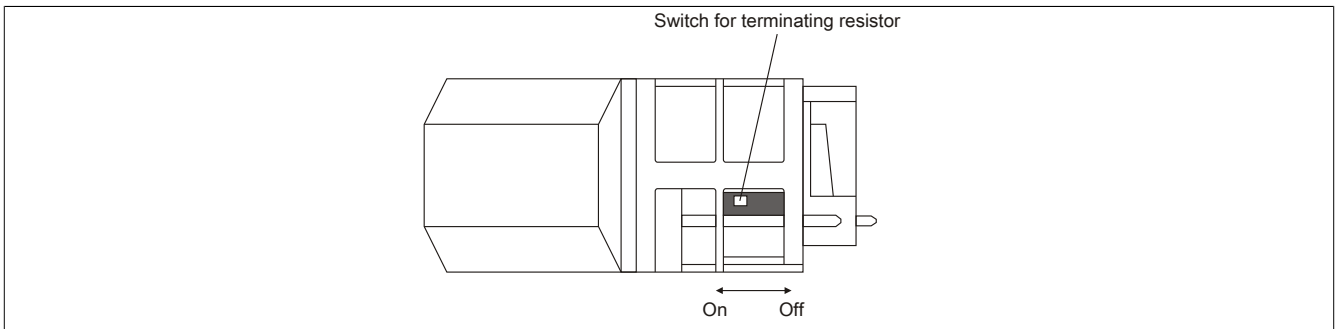


9.3.2.6 CAN bus interface

The interface is a 5-pin multipoint connector. Terminal block 0TB2105 must be ordered separately.

| Interface | Pinout | | |
|--|----------|------------------|------------|
| | Terminal | Function | |
| <p>5-pin male multipoint connector</p> | 1 | CAN _L | CAN ground |
| | 2 | CAN _L | CAN low |
| | 3 | SHLD | Shield |
| | 4 | CAN _H | CAN high |
| | 5 | NC | |

9.3.2.7 Terminating resistor



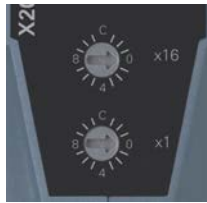
A terminating resistor is already integrated on the bus controller. It can be turned on and off with a switch on the bottom of the housing. An active terminating resistor is indicated by the "TERM" LED.

9.3.2.8 Node number and transfer rate

Node numbers and transfer rates are configured using the two bus controller number switches.

The transfer rate can be specified in two ways:

- Automatic detection by bus controller (see ["Automatic transfer rate detection" on page 838](#))
- Fixed definition by user (see ["Setting the transfer rate" on page 838](#))



| Switch position | Node number | Transfer rate |
|-----------------|--|--|
| 0x00 | Not allowed | - |
| 0x01 - 0x7F | 1 - 127 | Automatically set by the bus controller (default) or fixed setting by the user |
| 0x80 - 0x88 | - | Sets a fixed transfer rate |
| 0x89 | - | Sets automatic transfer rate detection |
| 0x8A - 0x8F | Not allowed | - |
| 0x90 | Clearing the parameters See "Clearing parameters" on page 840 | - |
| 0x91 | Not allowed | - |
| 0x92 | Save configuration ¹⁾ See "Save automatic configuration" on page 839 | - |
| 0x93 - 0xFF | Not allowed | - |

1) This function is available starting with Hardware version E0 or Firmware version V0001.0107.

9.3.2.9 Automatic transfer rate detection

After startup, the bus controller goes into "Listen only" mode. This means the bus controller behaves passively on the bus and only listens.

The bus controller attempts to receive valid objects. If receive errors occur, the controller switches to the next transfer rate in the lookup table.

If no objects are received, all transfer rates are tested cyclically. This procedure is repeated until valid objects are received.

Lookup table

The bus controller tests the transfer rate according to this table. Beginning with the starting transfer rate (1000 kbit/s), the controller switches to the next lower transfer rate. At the end of the table, the bus controller restarts the search from the beginning.

| Transfer rate |
|---------------|
| 1000 kbit/s |
| 800 kbit/s |
| 500 kbit/s |
| 250 kbit/s |
| 125 kbit/s |
| 100 kbit/s |
| 50 kbit/s |
| 20 kbit/s |
| 10 kbit/s |

9.3.2.10 Setting the transfer rate

The bus controller will detect the transfer rate automatically by default. Switch positions 0x80 to 0x88 can be used to set a fixed transfer rate, or 0x89 can be used to enable automatic transfer rate detection.

| Switch position | Transfer rate |
|-----------------|-----------------------------------|
| 0x80 | 1000 kbit/s |
| 0x81 | 800 kbit/s |
| 0x82 | 500 kbit/s |
| 0x83 | 250 kbit/s |
| 0x84 | 125 kbit/s |
| 0x85 | 100 kbit/s |
| 0x86 | 50 kbit/s |
| 0x87 | 20 kbit/s |
| 0x88 | 10 kbit/s |
| 0x89 | Automatic transfer rate detection |

Programming the transfer rate

1. Switch off the power supply to the bus controller.
2. Define the transfer rate by selecting the switch position (0x80 to 0x89).
3. Switch on the power supply to the bus controller.
4. Wait until LED "MS" blinks with a red triple flash (transfer rate is now programmed).
5. Switch off the power supply to the bus controller.
6. Set the desired node number (0x01 - 0x7F).
7. Switch on the power supply to the bus controller.
8. The bus controller now boots with the set node number and the programmed transfer rate.

9.3.2.11 Save automatic configuration

The node number position 0x92 can be used to save automatically generated configurations. This makes it possible to work with a standardized configuration without having to adapt the application to changes associated with service work or different development stages for example.

1. Turn off the power supply to the bus controller.
2. Set the node number to 0x90.
3. Turn on the power supply to the bus controller.
4. Wait until the "MS" LED flashes green.
5. The node number switch must be set to 0x00 and then back to 0x90 within this time window of 5 seconds (rotate the top switch).
6. Wait until the "MS" LED blinks with a red double-flash (parameters have been cleared).
7. Turn off the power supply to the bus controller.
8. Set the node number to 0x92.
9. Turn on the power supply to the bus controller.
10. Wait until the "MS" LED flashes green.
11. The node number switch must be set to 0x02 and then back to 0x092 within this time window of 5 seconds (rotate the top switch).
12. Wait until the "MS" LED blinks with a red quad-flash (parameters have been saved).
13. Turn off the power supply to the bus controller.
14. Set the desired node number (0x01 - 0x7F).
15. Turn on the power supply to the bus controller.
16. The bus controller boots with the set node number and automatic transfer rate detection.

Information:

A mapping tool for decoding the saved PDO mapping is available in the Download section of the B&R website (www.br-automation.com).

Information:

This function is available starting with Hardware version E0 or Firmware version V0001.0107.

9.3.2.12 Clearing parameters

Various parameters can be stored in the bus controller's flash memory:

- Communication parameters
- Vendor-specific parameters
- Application parameters (device profile)
- Programmed transfer rate

Clearing the parameters using switch position 0x90 returns the bus controller to its factory settings.

Clearing the parameters listed above

1. Turn off the power supply to the bus controller.
2. Set the node number to 0x90.
3. Turn on the power supply to the bus controller.
4. Wait until the "MS" LED flashes green. The node number switch must be set to 0x00 and then back to 0x090 within this time window of 5 seconds (rotate the top switch).
5. Wait until the "MS" LED blinks with a red double-flash (parameters have been cleared).
6. Turn off the power supply to the bus controller.
7. Set the desired node number (0x01 - 0x7F).
8. Turn on the power supply to the bus controller.
9. The bus controller boots with the set node number and automatic transfer rate detection.

9.3.2.13 Additional documentation and import files (EDS)

Additional documentation about bus controller functions as well as the necessary import files for the master engineering tool are available for download from the Downloads section of the B&R website (www.br-automation.com).

9.3.3 X20BC0053

Data sheet version: 2.36

9.3.3.1 General information

DeviceNet was developed by Allen-Bradley as a CAN bus based automation network. It is based on a producer/consumer protocol. From the user's point of view, all data is handled completely separately from the features of the CAN bus (e.g. longer data packets are fragmented automatically by DeviceNet). I/O messages with defined characteristics are used for access.

This bus controller makes it possible to connect X2X Link I/O nodes to DeviceNet. It has automatic transfer rate detection, auto scan, automatic mapping and automatic configuration of the I/O modules. Explicit messaging, change of state, cyclic, polled and bit strobe are supported as transfer modes.

In addition to the standard communication objects, there are vendor-specific objects to represent the modular X20 System in the best manner possible. X20 and other modules based on X2X Link can be connected to the bus controller.

The entire configuration of this type of modular system is supported by the DeviceNet standard. Allen Bradley developed the modular I/O configuration to simplify the necessary configuration steps. The DeviceNet bus controllers from B&R also support this type of configuration.

- Fieldbus: DeviceNet
- I/O configuration via the fieldbus
- Support of both linear and modular (Allen Bradley) configuration systems
- Auto scan, automatic I/O mapping of the I/Os
- Automatic I/O configuration
- Integrated terminating resistor

Information:

Only the standard function model (see the respective module description) is supported when the bus controller is used together with multi-function modules it has automatically configured itself.

9.3.3.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Bus controllers |  |
| X20BC0053 | X20 bus controller, 1 DeviceNet interface, order 1x TB2105 terminal block separately Order bus base, power supply module and terminal separately | |
| | Required accessories | |
| | System modules for bus controllers | |
| X20BB80 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20PS9400 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply | |
| X20PS9402 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply, supply not electrically isolated | |
| | Terminal blocks | |
| 0TB2105.9010 | Accessory terminal block, 5-pin, screw clamps 2.5 mm ² | |
| 0TB2105.9110 | Accessory terminal block, 5-pin, push-in terminal block 2.5 mm ² | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 110: X20BC0053 - Order data

9.3.3.3 Technical data

| Model number | X20BC0053 |
|----------------------------|--|
| Short description | |
| Bus controller | DeviceNet adapter (slave) |
| General information | |
| B&R ID code | 0x1F1B |
| Status indicators | Module status, bus function, 24V DeviceNet voltage, data transfer, terminating resistor. |


Table 111: X20BC0053 - Technical data

| Model number | X20BC0053 |
|--|---|
| Diagnostics | |
| 24 V DeviceNet voltage | Yes, with LED status indicators (MOD and NET) |
| Module status | Yes, using status LED and software |
| Bus function | Yes, using status LED |
| Data transfer | Yes, using status LED |
| Terminating resistor | Yes, using status LED |
| Power consumption | |
| Bus | 1.5 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Interfaces | |
| Fieldbus | DeviceNet adapter (slave) |
| Variant | 5-pin male multipoint connector |
| Max. distance | 500 m |
| Transfer rate | Max. 500 kbit/s |
| Default transfer rate | Automatic transfer rate detection |
| Min. cycle time ¹⁾ | |
| Fieldbus | No limitations |
| X2X Link | 400 µs |
| Synchronization between bus systems possible | No |
| Terminating resistor | Integrated in the module |
| Electrical properties | |
| Electrical isolation | DeviceNet isolated from I/O DeviceNet not isolated from bus |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x TB2105 terminal block separately Order 1x X20TB12 terminal block separately Order 1x X20PS9400 or X20PS9402 power supply module separately Order 1x X20BB80 bus base separately |
| Spacing ²⁾ | 37.5 ^{+0.2} mm |

Table 111: X20BC0053 - Technical data

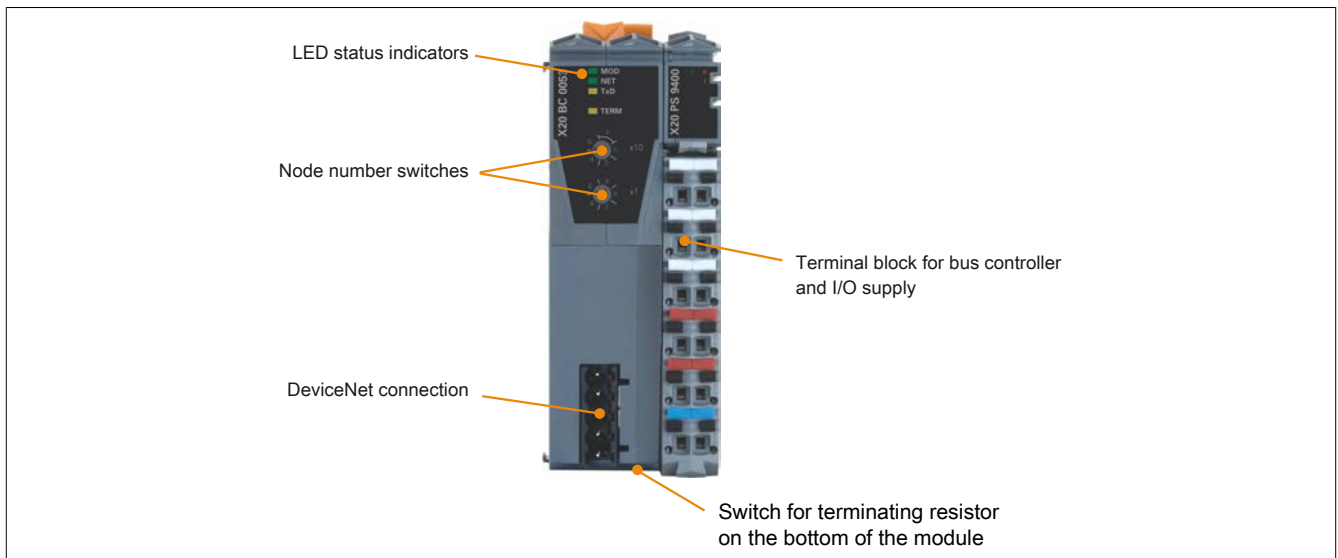
- 1) The minimum cycle time defines how far the bus cycle can be reduced without communication errors occurring.
- 2) Spacing is based on the width of the X20BB80 bus base. In addition, an X20PS9400 or X20PS9402 supply module is always required for the bus controller.

9.3.3.4 LED status indicators

| Figure | LED | Color | Status | Description |
|---|-------------------|-----------|----------|---|
|  | MOD ¹⁾ | Green | Off | Bus sense error: If the "NET" LED is also "off", there is no 24 V DeviceNet voltage. No transfer rate: If the PS9400's "RUN" LED is active (PREOPERATIONAL or RUN mode), the automatic transfer rate detection is still running or no transfer rate could be detected. |
| | | | On | RUN mode: The 24 V DeviceNet voltage is OK and the module is operating under normal conditions. |
| | | | Blinking | Standby mode: Configuration is missing, incomplete, or incorrect. |
| | | Red | Blinking | Recoverable Fault mode: |
| | | Green/red | Blinking | Module is performing a self test. |
| | NET ¹⁾ | Green | Off | No power, offline: <ul style="list-style-type: none"> • Bus sense error: If the "MOD" LED is also off, there is no 24 V DeviceNet voltage. • No transfer rate: If the PS9400's "RUN" LED is active (PREOPERATIONAL or RUN mode), the automatic transfer rate detection is still running or no transfer rate could be detected. • Module has not yet completed a duplicate MAC-ID test. |
| | | | Blinking | Online, not connected: <ul style="list-style-type: none"> • The module has carried out the duplicate MAC-ID test and is online. • There is no established connection to a master/scanner. |
| | | | On | Everything is OK: A connection to the master/scanner (explicit or I/O) is set up. |
| | | Red | Blinking | Connection timeout: The time for an I/O connection has expired. |
| | | | On | Critical connection error - fieldbus communication no longer possible: <ul style="list-style-type: none"> • Duplicate MAC ID error • Bus off • Receive/transmit overrun |
| | | TxD | Yellow | Off |
| | On | | | The bus controller is transmitting data via the DeviceNet fieldbus |
| | TERM | Yellow | Off | The terminating resistor integrated in the bus controller is turned off |
| | | | On | The terminating resistor integrated in the bus controller is turned on |

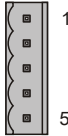
1) The "MOD" and "NET" LEDs are green/red dual LEDs.

9.3.3.5 Operating and connection elements



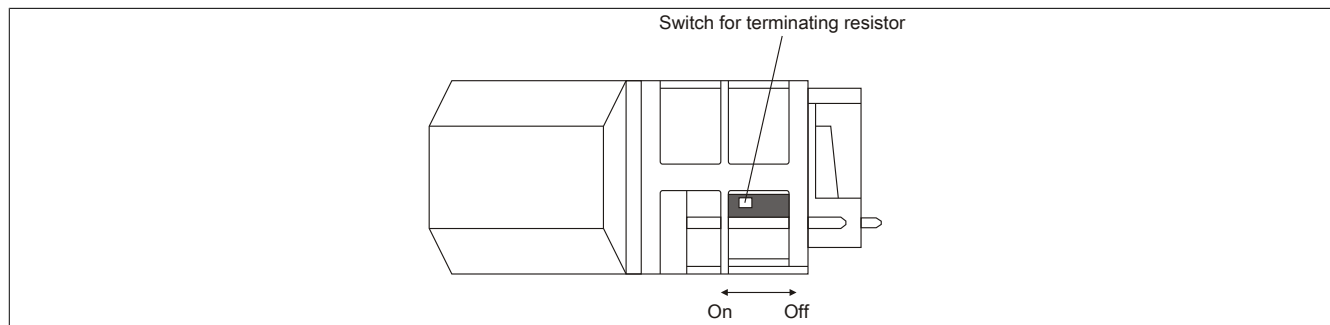
9.3.3.6 DeviceNet interface

The interface is a 5-pin multipoint connector. Terminal block 0TB2105 must be ordered separately.

| Interface | Pinout | | |
|--|----------|-----------------------|------------------------------|
| | Terminal | DeviceNet | |
|  5-pin male multipoint connector | 1 | CAN _⊥ (V-) | CAN ground |
| | 2 | CAN _L | CAN low |
| | 3 | SHLD | Shield |
| | 4 | CAN _H | CAN high |
| | 5 | V+ | Supply voltage ¹⁾ |

1) The 24 VDC in the DeviceNet network must be fed in externally in order to guarantee correct operation and data exchange. 24 VDC is not made available by the device.

9.3.3.7 Terminating resistor



A terminating resistor is already integrated on the bus controller. It can be turned on and off with a switch on the bottom of the housing. An active terminating resistor is indicated by the "TERM" LED.

9.3.3.8 Node number

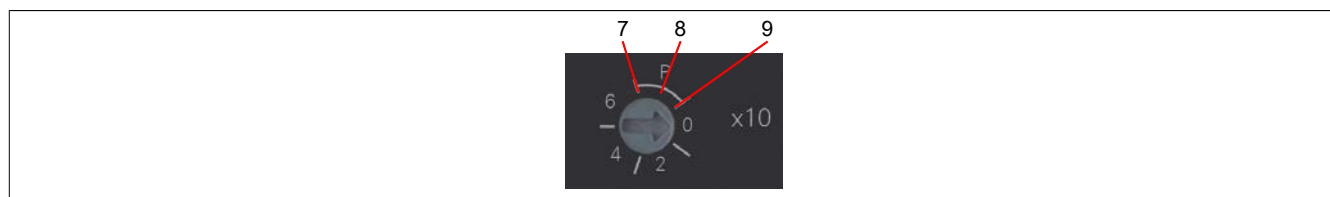
The MAC ID is configured using the two address switches on the bus controller.

The configurable range lies between 0 and 63. This value range is required in the DeviceNet specifications for a DeviceNet device.



| Switch position | MAC ID |
|-----------------|---|
| 00 - 63 | 0 to 63 |
| 64 | The MAC ID can be configured by setting the address switch using the master/scanner software. |
| 65 - 89 | Not permitted |
| 90 | See "Clearing parameters" on page 845 |
| 91 - 94 | Not permitted |
| 95 | See "Automatic configuration" on page 846 |
| 96 - 99 | Not permitted |

Number position in switch position "P"



9.3.3.9 Automatic transfer rate detection

After booting, the bus controller goes into "Listen only" mode. This means the bus controller behaves passively on the bus and only listens.

The bus controller attempts to receive valid objects. If receive errors occur, the controller switches to the next transfer rate in the lookup table.

If no objects are received, all transfer rates are tested cyclically. This procedure is repeated until valid objects are received, indicating that the correct transfer rate has been determined. Only transfer rates permitted by the DeviceNet specification are tested.

Lookup table

The controller tests the transfer rate according to this table. Beginning with the starting transfer rate (500 kbit/s), the controller switches to the next lower transfer rate. At the end of the table, the bus controller restarts the search from the beginning.

| Transfer rate |
|---------------|
| 500 kbit/s |
| 250 kbit/s |
| 125 kbit/s |

Information:

While automatic transfer rate recognition is running, both DeviceNet LEDs are switched off (because there is no LED status definition in the DeviceNet specifications for this status).

To ensure that the module has been supplied and booted, this manufacturer specific status definition requires the X20PS9400 RUN LED to be active.

9.3.3.10 Clearing parameters

Various parameters can be stored in the bus controller's flash memory. Deleting these parameters using switch position 90 returns the bus controller to its factory settings.

Deleting the parameters

1. Turn off the power supply to the bus controller.
2. Set the node number to 90
3. Turn on the power supply to the bus controller.
4. Wait until the "MOD" LED flashes green for 5 s (3 ms on / 500 ms off). The node number switch "x10" must be set to 0 and then back to 9 within this time window.
5. Wait until the "MOD" LED blinks with a red double-flash (parameters have been cleared).
6. Turn off the power supply to the bus controller.
7. Set the desired node number (00 to 63).
8. Turn on the power supply to the bus controller.
9. The bus controller boots with the set node number and automatic transfer rate detection.

9.3.3.11 Automatic configuration of the I/O modules

The automatic configuration of the connected I/O modules by the bus controller is supported starting with Rev. D0 (firmware \geq V1.23) of the bus controller.

To prevent the configuration data from being accidentally overwritten on the bus controller, the procedure described below must be followed when creating the configuration data. When doing this, it is important that all required I/O modules are also started when booting the bus controller (i.e. supplied with power). This is especially important when using potential groups (E-stop switches).

The automatic configuration sets the following attributes of class 0x65 on the individual I/O modules:

- Module type (0x01)
- Input length (0x03)
- Output length (0x05)

Additional parameters are not set. That means that the connected modules are configured with their standard settings and standard I/O lengths. This can be changed by editing the parameters in the respective master engineering tool.

Automatic configuration

1. Turn off the power supply to the bus controller.
2. Set node number switch to 95 (this is done by turning switch "x10" to position 9 and switch "x1" to 5).
3. Turn on the power supply to the bus controller.
4. Wait until the "MOD" LED starts blinking green (3 ms on / 500 ms off). This phase of green blinking lasts 5 s. The node number "x10" switch must be set to 0 within this time frame and then set back to 9.
5. Wait until the "MOD" LED blinks (4 red flashes). The old configuration data is now deleted completely and overwritten with the new values from the connected I/O modules.
6. Turn off the power supply to the bus controller.
7. Set the desired node number (00 to 63).
8. Turn on the power supply to the bus controller.
9. The bus controller boots using the set node number, automatic transfer rate recognition and standard settings from the connected I/O modules.

9.3.3.12 Additional documentation and import files (EDS)

Additional documentation about bus controller functions as well as the necessary import files for the master engineering tool are available for download from the Downloads section of the B&R website (www.br-automation.com).

9.3.4 X20BC0063

Data sheet version: 2.24

9.3.4.1 General information

PROFIBUS DP is based on the physics of the RS485 interface. Data transfer is controlled using a hybrid bus access procedure: Active stations receive communication rights via a token passing procedure and can then access all stations on the network according to the master-slave principle. The maximum time of circulation for a token can be configured, which results in a defined cycle time.

Access represents various services for the user for both cyclic and for acyclic data transfer.

This bus controller makes it possible to connect X2X Link I/O nodes to PROFIBUS DP. It supports PROFIBUS DP with all of its options and other additional properties. In addition to the device, module and channel diagnostics provided in the PROFIBUS standard, it is also possible, for example, to switch to the slot diagnostics option in S7 format.

X20 or other modules based on X2X Link can be connected to the bus controller. The configuration of the modular system is optimally supported by PROFIBUS DP.

- Fieldbus: PROFIBUS DP
- I/O configuration via the fieldbus
- Extensive device, module, and channel diagnosis according to PROFIBUS DP standard
- Communication with X2X Link I/O nodes even works when some nodes are missing or without power

Information:

Only the standard function model (see the respective module description) is supported when the bus controller is used together with multi-function modules it has automatically configured itself.

9.3.4.2 Order data


| Model number | Short description | Figure |
|---------------|--|---|
| | Bus controllers |  |
| X20BC0063 | X20 bus controller, 1 PROFIBUS DP interface, 9-pin DSUB connection, order bus base, power supply module and terminal block separately | |
| | Required accessories | |
| | System modules for bus controllers | |
| X20BB80 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20PS9400 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply | |
| X20PS9402 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply, supply not electrically isolated | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | Optional accessories | |
| | Infrastructure components | |
| 0G1000.00-090 | Bus connector, RS485, for PROFIBUS networks | |

Table 112: X20BC0063 - Order data


9.3.4.3 Technical data

| | |
|--|--|
| Model number | X20BC0063 |
| Short description | |
| Bus controller | PROFIBUS DP V0 slave |
| General information | |
| B&R ID code | 0x1F1C |
| Status indicators | Module status, bus function, data transfer |
| Diagnostics | |
| Module status | Yes, using status LED and software |
| Bus function | Yes, using status LED |
| Data transfer | Yes, using status LED |
| Power consumption | |
| Bus | 2.3 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations |
| ATEX | Class I, Division 2, Groups ABCD, T5 Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| Interfaces | |
| Fieldbus | PROFIBUS DP V0 slave |
| Variant | 9-pin female DSUB connector |
| Max. distance | 1200 m |
| Transfer rate | Max. 12 Mbit/s |
| Default transfer rate | Automatic transfer rate detection |
| Min. cycle time ¹⁾ | |
| Fieldbus | No limitations |
| X2X Link | 400 µs |
| Synchronization between bus systems possible | No |
| Electrical properties | |
| Electrical isolation | PROFIBUS isolated from I/O PROFIBUS not isolated from bus |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20PS9400 or X20PS9402 power supply module separately Order 1x X20BB80 bus base separately |
| Spacing ²⁾ | 37.5 ^{+0.2} mm |

Table 113: X20BC0063 - Technical data

- 1) The minimum cycle time defines how far the bus cycle can be reduced without communication errors occurring.
2) Spacing is based on the width of the X20BB80 bus base. In addition, an X20PS9400 or X20PS9402 supply module is always required for the bus controller.

9.3.4.4 LED status indicators

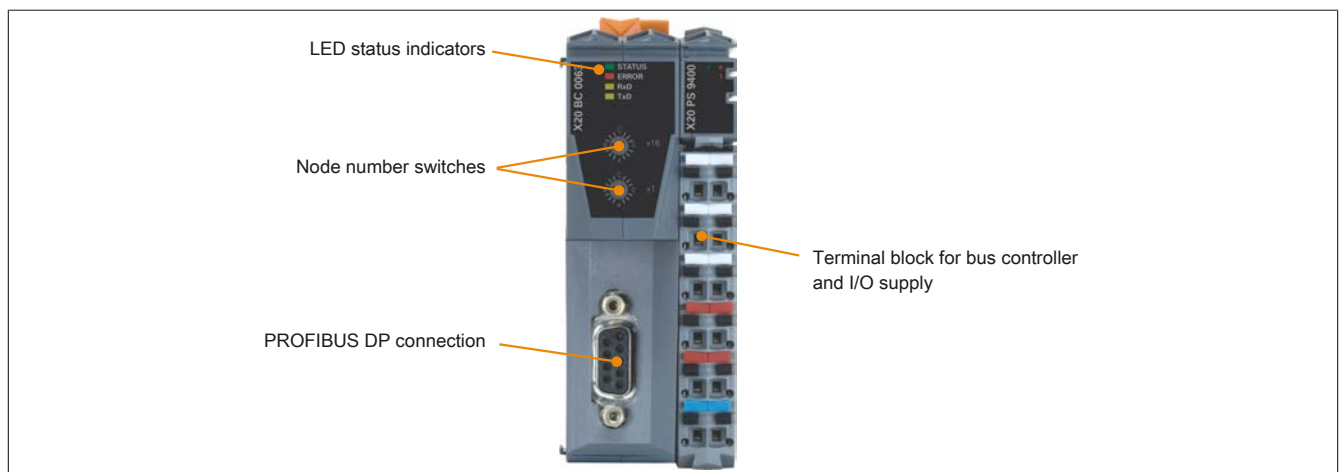
| Figure | LED | Description | | |
|---|------------------|--|--------------|-----------------------------|
|  | STATUS and ERROR | Status indicator for PROFIBUS DP bus controller. | | |
| | | STATUS (green) | ERROR (red) | Description |
| | | Off | Off | HARDWARE FAULT / POWER FAIL |
| | | On | On | BUS OFF |
| | | On | Blinking | WAIT FOR CONFIG |
| | | Blinking | Off | DATA EXCHANGE - DIAGNOSTICS |
| | | On | Off | DATA EXCHANGE - NO ERROR |
| | | Blinking | Blinking | CONFIG ERROR |
| | | Off | Blinking | SERVICE MODE - BOOT |
| | | Single flash | Single flash | HARDWARE FAULT |
| | | For a more detailed description see " State diagnostics via the Status/Error LEDs " on page 849. | | |
| | RxD | This yellow LED lights up when the bus controller is receiving data from the PROFIBUS DP fieldbus. | | |
| | TxD | This yellow LED lights up when the bus controller is sending data via the PROFIBUS DP fieldbus. | | |

9.3.4.5 State diagnostics via the Status/Error LEDs

The condition of the PROFIBUS DP bus controller is diagnosed using the LED status indicators "STATUS" and "ERROR".

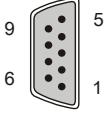
| STATUS (green) | ERROR (red) | Function | Solution |
|----------------|--------------|--|---|
| Off | Off | HARDWARE FAULT / POWER FAILURE | <ul style="list-style-type: none"> Check wiring of supply voltage. |
| On | On | BUS OFF <ul style="list-style-type: none"> Baud rate not detected No connection to the DP master DP master not active | <ul style="list-style-type: none"> Check the PROFIBUS network Check the PROFIBUS master |
| On | Blinking | WAIT FOR CONFIG <ul style="list-style-type: none"> Transfer rate has been detected, but the PROFIBUS master has not yet configured the bus controller | <ul style="list-style-type: none"> Check the node number switch Check the slave address in the master configuration |
| Blinking | Off | DATA EXCHANGE - DIAGNOSTICS <ul style="list-style-type: none"> The bus controller is still initializing the I/O modules The I/O modules configured by the master cannot be found An error has occurred on one or more I/O modules (short circuit, etc.) | <ul style="list-style-type: none"> Initialization can take a few seconds depending on the number of I/O modules connected Check the wiring and power supply for the I/O modules Read diagnostic messages in the respective PROFIBUS master's engineering tool |
| On | Off | DATA EXCHANGE <ul style="list-style-type: none"> Cyclic data exchange with the PROFIBUS DP master | |
| Blinking | Blinking | CONFIG ERROR <ul style="list-style-type: none"> One or more I/O modules found do not match with the configuration of the PROFIBUS DP master The configuration received from the PROFIBUS master is invalid | <ul style="list-style-type: none"> Check the wiring of the X2X Link and the order of I/O modules Check configuration of the PROFIBUS master Read diagnostic messages in the respective PROFIBUS master's engineering tool Check the configuration being used - it is possible that the number of configured I/O modules is too high |
| Off | Blinking | SERVICE MODE - BOOT <ul style="list-style-type: none"> The bus controller's node number has been set to 255 (0xFF) - after 2 s the bus controller starts in service mode | <ul style="list-style-type: none"> Set a valid node number |
| Single flash | Single flash | HARDWARE FAULT | |

9.3.4.6 Operating and connection elements



9.3.4.7 PROFIBUS DP interface

A shielded line must be used for the interface.

| Interface | Pinout | | |
|--|--------|-----------|--------------------|
| | Pin | RS485 | |
|  <p>9-pin female DSUB connector</p> | 1 | Reserved | |
| | 2 | Reserved | |
| | 3 | RxD/TxD-P | Data ¹⁾ |
| | 4 | CNTR-P | Transmit enable |
| | 5 | DGND | Power supply |
| | 6 | VP | Power supply |
| | 7 | Reserved | |
| | 8 | RxD/TxD-N | Data ²⁾ |
| | 9 | CNTR-N | Transmit enable\ |
| CNTR ... Direction switch for external repeaters | | | |

- 1) Cable color: Red
2) Cable color: Green

9.3.4.8 PROFIBUS DP node number switches

The PROFIBUS DP node number is configured using both number switches of the bus controller.



| Switch position | Node number |
|-----------------|-------------|
| 0x00 | Not allowed |
| 0x01 - 0x7D | 1 to 125 |
| 0x7E - 0xFF | Not allowed |

9.3.4.9 Automatic transfer rate detection

After booting or after a communication timeout, the bus controller goes into the status "Baud Search". This means the bus controller behaves passively on the bus.

The bus controller always begins the search for the configured transfer rate with the highest transfer rate. If a complete error-free telegram is not received during monitoring time, then the search is continued using the next lowest transfer rate.

| Transfer rate |
|---------------|
| 12 Mbit/s |
| 6 Mbit/s |
| 3 Mbit/s |
| 1.5 Mbit/s |
| 500 kbit/s |
| 187.5 kbit/s |
| 93.75 kbit/s |
| 45.45 kbit/s |
| 19.2 kbit/s |
| 9.6 kbit/s |

9.3.4.10 Additional documentation and import files (EDS)

Additional documentation about bus controller functions as well as the necessary import files for the master engineering tool are available for download from the Downloads section of the B&R website (www.br-automation.com).

9.3.5 X20BC0073

Data sheet version: 2.41

9.3.5.1 General information

The bus controller makes it possible to connect X2X Link I/O nodes to CAN I/O. CAN I/O is a transfer protocol based on standard CAN bus that is fully integrated in the B&R system.

Up to 44 logical I/O modules can be connected to the bus controller. Up to 16 of these can be analog modules including power supply module.

- Fieldbus: CAN bus
- Automatic firmware update via the fieldbus
- Integrated I/O access in B&R Automation Studio
- Integrated terminating resistor

Information:

The bus controller is unable to detect modules after a gap in the X2X Link station numbers. This can be caused by:

- X20 modules not being connected
- Modules with integrated node number switch, such as the X20BM05

Information:

Only the standard function model (see the respective module description) is supported when the bus controller is used together with multi-function modules it has automatically configured itself.

9.3.5.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Bus controllers |  |
| X20BC0073 | X20 bus controller, 1 CAN I/O interface, order 1x TB2105 terminal block separately Order bus base, power supply module and terminal separately | |
| | Required accessories | |
| | System modules for bus controllers | |
| X20BB80 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20PS9400 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply | |
| X20PS9402 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply, supply not electrically isolated | |
| | Terminal blocks | |
| 0TB2105.9010 | Accessory terminal block, 5-pin, screw clamps 2.5 mm ² | |
| 0TB2105.9110 | Accessory terminal block, 5-pin, push-in terminal block 2.5 mm ² | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 114: X20BC0073 - Order data


9.3.5.3 Technical data

| | |
|--|---|
| Model number | X20BC0073 |
| Short description | |
| Bus controller | CAN I/O slave |
| General information | |
| B&R ID code | 0x1F1D |
| Status indicators | Module status, bus function, data transfer, terminating resistor |
| Diagnostics | |
| Module status | Yes, using status LED and software |
| Bus function | Yes, using status LED |
| Data transfer | Yes, using status LED |
| Terminating resistor | Yes, using status LED |
| Power consumption | |
| Bus | 1.5 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| Interfaces | |
| Fieldbus | CAN I/O slave |
| Variant | 5-pin male multipoint connector |
| Max. distance | 1000 m |
| Transfer rate | Max. 1 Mbit/s |
| Default transfer rate | Automatic transfer rate detection or fixed rate setting |
| X2X Link cycle time | Permanently set to 1 ms ¹⁾ |
| Synchronization between bus systems possible | No |
| Terminating resistor | Integrated in the module |
| Electrical properties | |
| Electrical isolation | CAN IO isolated from I/O CAN IO not isolated from bus |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x TB2105 terminal block separately Order 1x X20TB12 terminal block separately Order 1x X20PS9400 or X20PS9402 power supply module separately Order 1x X20BB80 bus base separately |
| Pitch ²⁾ | 37.5 ^{+0.2} mm |

Table 115: X20BC0073 - Technical data

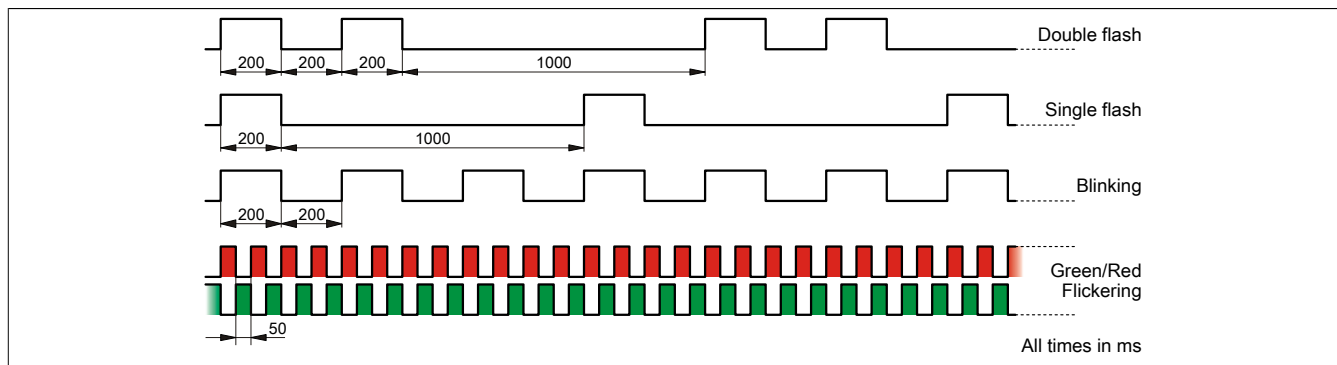
- 1) CAN I/O data points are processed in Automation Runtime in a separate cycle set to 10 ms (CAN I/O cycle).
- 2) Spacing is based on the width of the X20BB80 bus base. In addition, an X20PS9400 or X20PS9402 supply module is always required for the bus controller.

9.3.5.4 LED status indicators

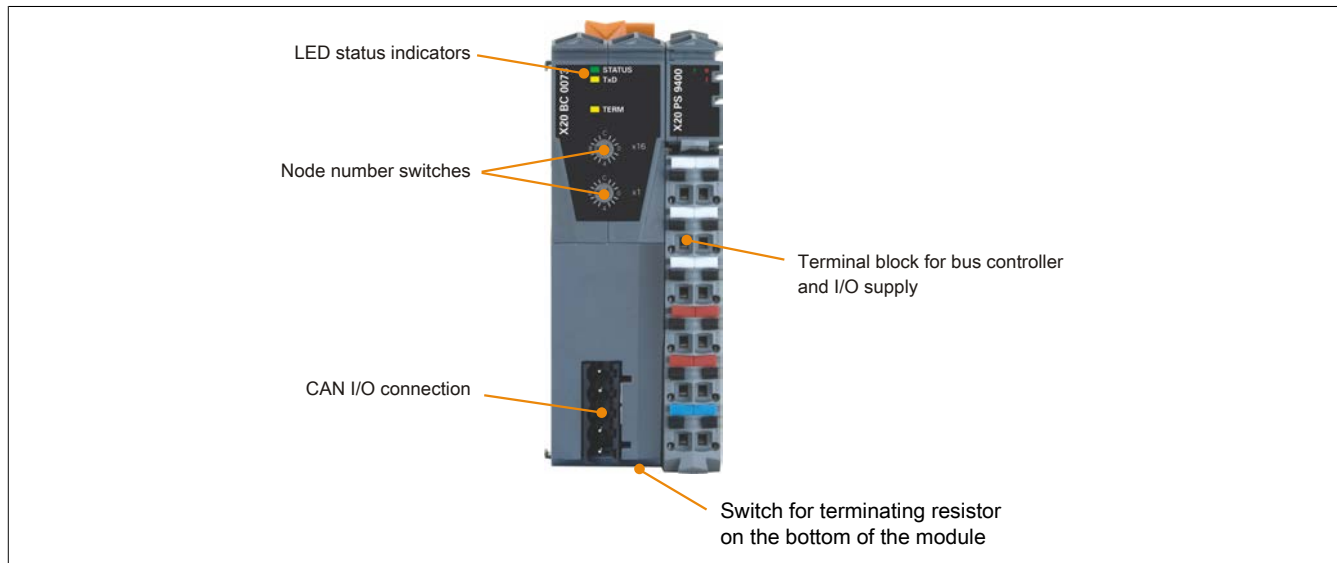
| Figure | LED | Color | Status | Description |
|---|----------------------|-----------------------------------|--|--|
|  | STATUS ¹⁾ | Green | Off | No power supply |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | | Red | On | CAN connection reports BusOff status |
| | | Green/red | Flickering | Transfer rate detection in progress |
| | | Green blinking / red single flash | | PREOPERATIONAL mode; CAN connection reports: Warning limit reached |
| | | Steady green / single red flash | | RUN mode; CAN connection reports: Warning limit reached |
| | TxD | Yellow | Off | The bus controller is not transmitting any data via the CAN I/O fieldbus |
| | | | On | The bus controller is transmitting data via the CAN I/O fieldbus |
| | TERM | Yellow | Off | The terminating resistor integrated in the bus controller is turned off |
| On | | | The terminating resistor integrated in the bus controller is turned on | |

1) The "STATUS" LED is a green/red dual LED.

LED status indicators - Blink times

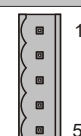


9.3.5.5 Operating and connection elements

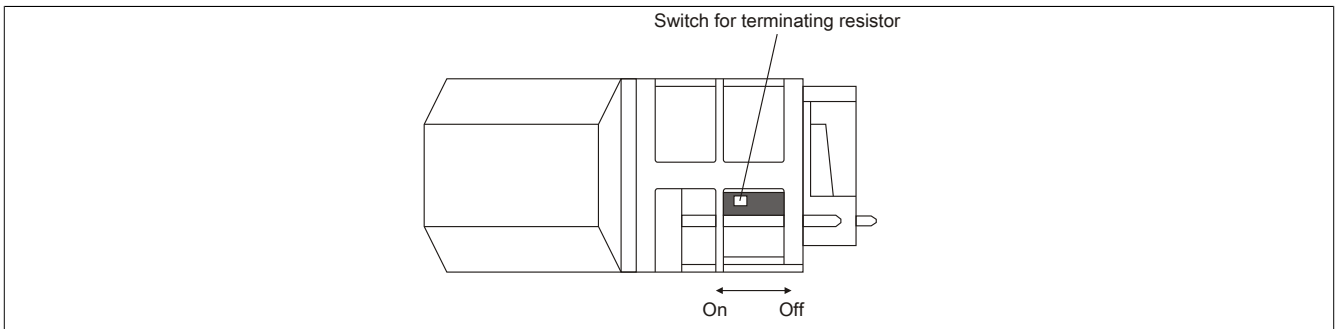


9.3.5.6 CAN bus interface

The interface is a 5-pin multipoint connector. Terminal block 0TB2105 must be ordered separately.

| Interface | Pinout | | |
|--|----------|------------------|------------|
| | Terminal | Function | |
|  5-pin male multipoint connector | 1 | CAN _L | CAN ground |
| | 2 | CAN _L | CAN low |
| | 3 | SHLD | Shield |
| | 4 | CAN _H | CAN high |
| | 5 | NC | |

9.3.5.7 Terminating resistor



A terminating resistor is already integrated on the bus controller. It can be turned on and off with a switch on the bottom of the housing. An active terminating resistor is indicated by the "TERM" LED.

9.3.5.8 Node number and transfer rate

The node number and transfer rate are configured using the two number switches on the bus controller. The switch positions 0x00 to 0x40 and 0x60 enable automatic transfer rate detection (see ["Automatic transfer rate detection" on page 855](#)). The rest of the switch positions have a fixed transfer rate (see table).



| Switch position | Node number | Transfer rate |
|--------------------|-------------|---------------|
| 0x00 ¹⁾ | From EEPROM | From EEPROM |
| 0x01 - 0x3F | 1 - 63 | Automatic |
| 0x40 ¹⁾ | From EEPROM | From EEPROM |
| 0x41 - 0x5F | 1 - 31 | 1000 kbit/s |
| 0x60 ¹⁾ | From EEPROM | From EEPROM |
| 0x61 - 0x7F | 1 - 31 | 800 kbit/s |
| 0x80 | Reserved | - |
| 0x81 - 0x9F | 1 - 31 | 500 kbit/s |
| 0xA0 | Reserved | - |
| 0xA1 - 0xBF | 1 - 31 | 250 kbit/s |
| 0xC0 | Reserved | - |
| 0xC1 - 0xDF | 1 - 31 | 125 kbit/s |
| 0xE0 | Reserved | - |
| 0xE1 - 0xFE | 1 - 31 | 20 kbit/s |
| 0xFF | Reserved | - |

1) When one of these numbers is configured, the bus controller uses the operating parameters from the internal EEPROM. The EEPROM is programmed using library CANIO.

9.3.5.9 Automatic transfer rate detection

After startup, the bus controller goes into "Listen only" mode. This means the bus controller behaves passively on the bus and only listens.

The bus controller attempts to receive valid objects. If receive errors occur, the controller switches to the next transfer rate in the lookup table.

If no objects are received, all transfer rates are tested cyclically. This procedure is repeated until valid objects are received.

Starting transfer rate

The bus controller begins the search with this transfer rate. The starting transfer rate can be defined in two different ways:

- Read from EEPROM
- The last detected transfer rate is used after a software reset (command code 20).

Lookup table

The controller tests the transfer rate according to this table. Beginning with the starting transfer rate, the controller switches to the next lower transfer rate. At the end of the table, the bus controller restarts the search from the beginning.

| Transfer rate |
|---------------|
| 1000 kbit/s |
| 500 kbit/s |
| 250 kbit/s |
| 125 kbit/s |
| 50 kbit/s |
| 20 kbit/s |
| 10 kbit/s |

9.3.5.10 SG4

The module comes with preinstalled firmware. The firmware is also part of the Automation Runtime operating system for the PLC. With different versions, the Automation Runtime firmware is loaded onto the module.

The latest firmware is made available automatically when updating Automation Runtime.

9.3.5.11 Logical I/O modules

Up to 44 I/O modules can be connected to the bus controller. A maximum of 28 digital and 16 analog modules including power supply module are possible. This value refers not to the physical but the logical I/O module slots.

Information:

Physical I/O modules can take up more than one digital or analog slot.

The following table lists all X20 modules capable of using CAN I/O and how many logical digital and analog slots are needed.

| Module | Digital module slots | Analog module slots |
|------------------------|----------------------|---------------------|
| X20AI1744, X20AI1744-3 | 0 | 1 |
| X20AI2222 | 0 | 1 |
| X20AI2237 | 0 | 1 |
| X20AI2322 | 0 | 1 |
| X20AI2437 | 0 | 1 |
| X20AI2438 | 0 | 2 |
| X20AI2622 | 0 | 1 |
| X20AI2632, X20AI2632-1 | 0 | 1 |
| X20AI2636 | 0 | 1 |
| X20AI4222 | 0 | 1 |
| X20AI4322 | 0 | 1 |
| X20AI4622 | 0 | 1 |
| X20AI4632, X20AI4632-1 | 0 | 1 |
| X20AI4636 | 0 | 1 |
| X20AI8221 | 0 | 2 |
| X20AI8321 | 0 | 2 |
| X20AI744 | 0 | 2 |
| X20AI744 | 0 | 4 |
| X20AO2437 | 0 | 1 |
| X20AO2438 | 0 | 2 |
| X20AO2622 | 0 | 1 |

| Module | Digital module slots | Analog module slots |
|------------------------|----------------------|--|
| X20AO2632, X20AO2632-1 | 0 | 1 |
| X20AO4622 | 0 | 1 |
| X20AO4632, X20AO4632-1 | 0 | 1 |
| X20AO4635 | 0 | 1 |
| X20AP31xx | 0 | 3 |
| X20AT2222 | 0 | 1 |
| X20AT2311 | 0 | 1 |
| X20AT2402 | 0 | 1 |
| X20AT4222 | 0 | 1 |
| X20AT4232 | 0 | 1 |
| X20AT6402 | 0 | 2 |
| X20ATA312 | 0 | 1 |
| X20ATA492 | 0 | 1 |
| X20ATB312 | 0 | Firmware version ≤1.1.3.0: 1 Firmware version >1.1.3.0: 2 |
| X20ATC402 | 0 | 2 |
| X20BR9300 | 0 | 1 |
| X20BT9100 | 0 | 1 |
| X20BT9400 | 0 | 1 |
| X20CM0985 | 0 | 8 |
| X20CM0985-2 | 0 | 8 |
| X20CM1201 | 0 | 1 |
| X20CM1941 | 0 | 1 |
| X20CM4323 | 0 | 1 |
| X20CM4810 | 0 | 2 |
| X20CM8281 | 0 | 1 |
| X20CM8323 | 0 | 1 |
| X20CMR010 | 0 | 1 |
| X20CMR100 | 0 | 1 |
| X20CMR111 | 0 | 4 |
| X20CS1011 | 0 | 2 |
| X20CS1012 | 0 | 3 |
| X20CS1013 | 0 | 1 |
| X20CS1020 | 0 | 1 |
| X20CS1030 | 0 | 1 |
| X20CS1070 | 0 | 1 |
| X20CS2770 | 0 | 2 |
| X20DC1073 | 0 | 1 |
| X20DC1176 | 0 | 1 |
| X20DC1178 | 0 | 1 |
| X20DC1196 | 0 | 1 |
| X20DC1198 | 0 | 1 |
| X20DC11A6 | 0 | 1 |
| X20DC1376 | 0 | 1 |
| X20DC137A | 0 | 1 |
| X20DC1396 | 0 | 1 |
| X20DC1398 | 0 | 1 |
| X20DC1976 | 0 | 1 |
| X20DC2190 | 0 | 4 |
| X20DC2395 | 0 | 1 |
| X20DC2396 | 0 | 1 |
| X20DC2398 | 0 | 2 |
| X20DC4395 | 0 | 2 |
| X20DI0471 | 2 | 0 |
| X20DI2371 | 1 | 0 |
| X20DI2372 | 1 | 0 |
| X20DI2377 | 0 | 1 |
| X20DI2653 | 1 | 0 |
| X20DI4371 | 1 | 0 |
| X20DI4372 | 1 | 0 |
| X20DI4375 | 1 | 0 |
| X20DI4653 | 1 | 0 |
| X20DI4760 | 1 | 0 |
| X20DI6371 | 1 | 0 |
| X20DI6372 | 1 | 0 |
| X20DI6373 | 1 | 0 |
| X20DI6553 | 1 | 0 |
| X20DI8371 | 1 | 0 |
| X20DI9371 | 2 | 0 |
| X20DI9372 | 2 | 0 |
| X20DID371 | 1 | 0 |
| X20DIF371 | 2 | 0 |
| X20DM9324 | 1 | 0 |
| X20DO2321 | 1 | 0 |
| X20DO2322 | 1 | 0 |

| Module | Digital module slots | Analog module slots |
|-------------|----------------------|---------------------|
| X20DO2623 | 0 | 1 |
| X20DO2633 | 0 | 1 |
| X20DO2649 | 1 | 0 |
| X20DO4321 | 1 | 0 |
| X20DO4322 | 1 | 0 |
| X20DO4331 | 1 | 0 |
| X20DO4332 | 1 | 0 |
| X20DO4332-1 | 0 | 1 |
| X20DO4529 | 1 | 0 |
| X20DO4613 | 0 | 1 |
| X20DO4623 | 0 | 1 |
| X20DO4633 | 0 | 1 |
| X20DO4649 | 1 | 0 |
| X20DO6321 | 1 | 0 |
| X20DO6322 | 1 | 0 |
| X20DO6325 | 1 | 0 |
| X20DO6529 | 1 | 0 |
| X20DO6639 | 1 | 0 |
| X20DO8232 | 1 | 0 |
| X20DO8322 | 1 | 0 |
| X20DO8331 | 1 | 0 |
| X20DO8332 | 1 | 0 |
| X20DO9321 | 2 | 0 |
| X20DO9322 | 2 | 0 |
| X20DOD322 | 1 | 0 |
| X20DOF322 | 2 | 0 |
| X20DS1828 | 0 | 2 |
| X20DS1928 | 0 | 2 |
| X20DS4387 | 0 | 2 |
| X20DS438A | 0 | 3 |
| X20MM2436 | 0 | 1 |
| X20MM3332 | 0 | 1 |
| X20MM4331 | 0 | 2 |
| X20MM4455 | 0 | 4 |
| X20MM4456 | 0 | 4 |
| X20PD0011 | 1 | 0 |
| X20PD0012 | 1 | 0 |
| X20PD0016 | 1 | 0 |
| X20PD2113 | 1 | 0 |
| X20PS2100 | 0 | 1 |
| X20PS2110 | 0 | 1 |
| X20PS3300 | 0 | 1 |
| X20PS3310 | 0 | 1 |
| X20PS4951 | 1 | 0 |
| X20PS9400 | 0 | 1 |
| X20PS9402 | 0 | 1 |
| X20SM1426 | 0 | 1 |
| X20SM1436 | 0 | 1 |
| X20SM1436-1 | 0 | 1 |
| X20SM1446-1 | 0 | 2 |

9.3.6 X20(c)BC0083

Data sheet version: 2.38

9.3.6.1 General information

The bus controller makes it possible to connect X2X Link I/O nodes to POWERLINK. It is also possible to operate the X2X Link cycle synchronously 1:1 or synchronous to POWERLINK using a prescaler.

POWERLINK is a standard protocol for Fast Ethernet with hard real-time characteristics. The POWERLINK Standardization Group (EPSSG) ensures openness and continuous advancement. www.ethernet-powerlink.org

- POWERLINK
- I/O configuration and Firmware update via the fieldbus
- Integrated hub for efficient cabling

9.3.6.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.3.6.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C . During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.3.6.3 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Bus controllers |  |
| X20BC0083 | X20 bus controller, 1 POWERLINK interface, integrated 2-port hub, 2x RJ45, order bus base, power supply module and terminal block separately! | |
| X20cBC0083 | X20 bus controller, coated, 1 POWERLINK interface, integrated 2-port hub, 2x RJ45, order bus base, power supply module and terminal block separately! | |
| | Required accessories | |
| | System modules for bus controllers | |
| X20BB80 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20PS9400 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply | |
| X20PS9402 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply, supply not electrically isolated | |
| X20cBB80 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cPS9400 | X20 power supply module, coated, for bus controller and internal I/O power supply, X2X Link power supply | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 116: X20BC0083, X20cBC0083 - Order data

9.3.6.4 Technical data

| Model number | X20BC0083 | X20cBC0083 |
|--|--|------------|
| Short description | POWERLINK (V1/V2) controlled node | |
| Bus controller | POWERLINK (V1/V2) controlled node | |
| General information | | |
| B&R ID code | 0x1F1E | 0xE216 |
| Status indicators | Module status, bus function | |
| Diagnostics | | |
| Module status | Yes, using LED status indicator and software | |
| Bus function | Yes, using LED status indicator and software | |
| Power consumption | | |
| Bus | 2 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Interfaces | | |
| Fieldbus | POWERLINK (V1/V2) controlled node | |
| Type | Type 2 ¹⁾ | |
| Variant | 2x shielded RJ45 (hub) | |
| Cable length | Max. 100 m between 2 stations (segment length) | |
| Transfer rate | 100 Mbit/s | |
| Transfer | | |
| Physical layer | 100BASE-TX | |
| Half-duplex | Yes | |
| Full-duplex | No | |
| Autonegotiation | Yes | |
| Auto-MDI/MDIX | Yes | |

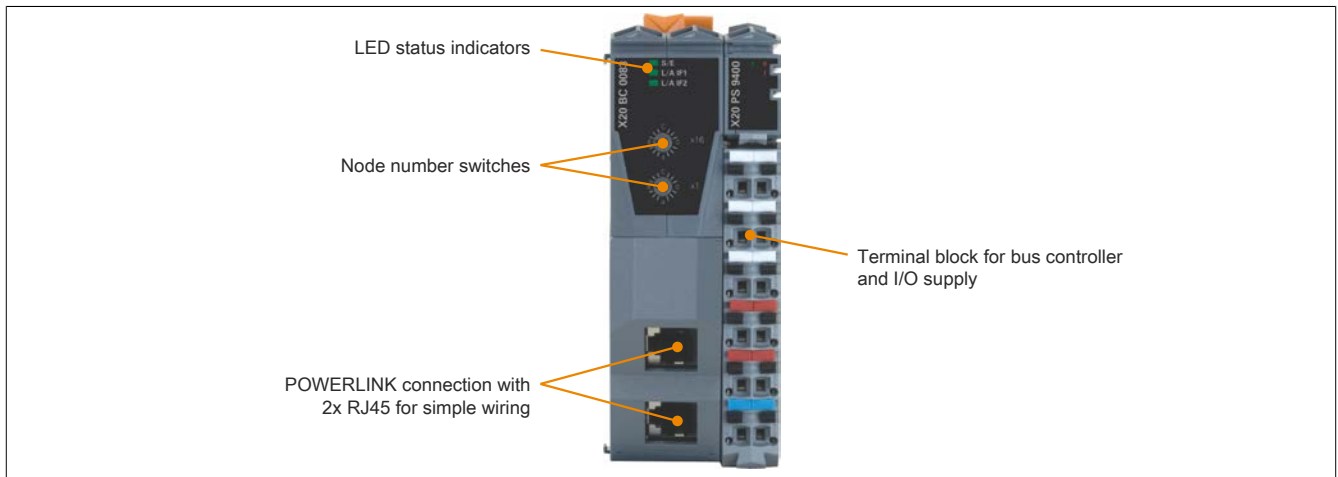
Table 117: X20BC0083, X20cBC0083 - Technical data

| Model number | X20BC0083 | X20cBC0083 |
|--|---|--|
| Hub propagation delay | 0.96 to 1 µs | |
| Min. cycle time ²⁾ | | |
| Fieldbus | 200 µs | |
| X2X Link | 200 µs | |
| Synchronization between bus systems possible | Yes | |
| Electrical properties | | |
| Electrical isolation | POWERLINK isolated from bus and I/O | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitation | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | | |
| Starting temperature | - | Yes, -40°C |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x power supply module X20PS9400 or X20PS9402 separately. Order 1x bus base X20BB80 separately. | Order 1x terminal block X20TB12 separately. Order 1x power supply module X20cPS9400 separately. Order 1x bus base X20cBB80 separately. |
| Pitch ³⁾ | 37.5 ^{+0.2} mm | |


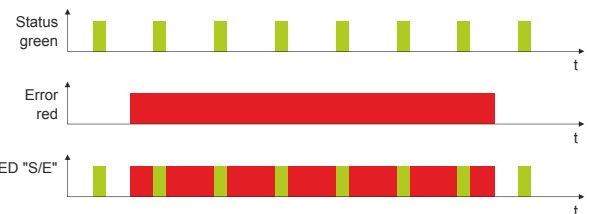
Table 117: X20BC0083, X20cBC0083 - Technical data

- 1) See Automation Help under "Communication / POWERLINK / General information / Hardware - CN" for more information.
- 2) The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring.
- 3) Spacing is based on the width of bus base X20BB80. In addition, power supply module X20PS9400 or X20PS9402 is always required for the bus controller.

9.3.6.5 Operating and connection elements

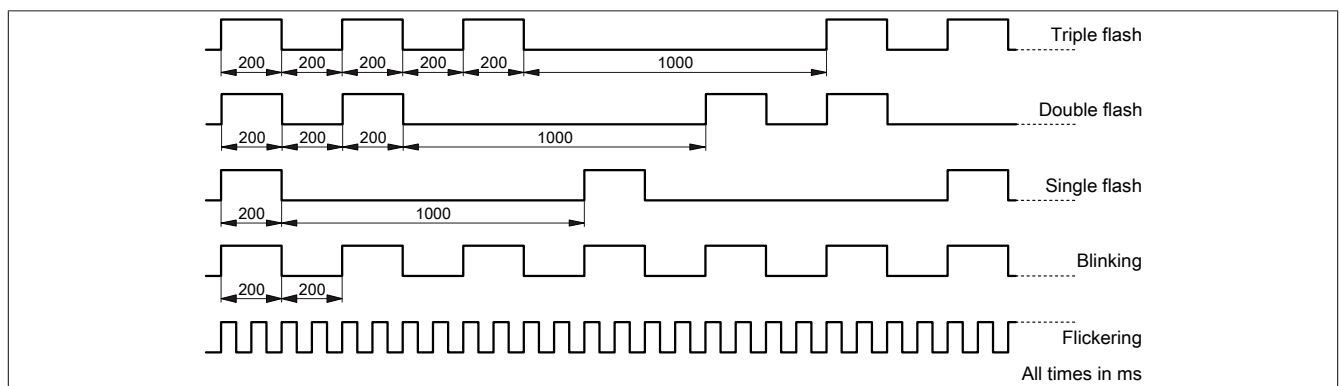


9.3.6.5.1 LED status indicators

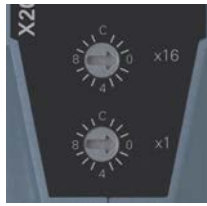
| Figure | LED | Color | Status | Description |
|---|-------------------|---------|--------------|---|
|  | S/E ¹⁾ | Green | Off | No power supply or mode NOT_ACTIVE. The controlled node (CN) is either not supplied with power, or it is in state NOT_ACTIVE. The CN waits in this state for about 5 seconds after a restart. Communication is not possible with the CN. If no POWERLINK communication is detected during these 5 seconds, the CN enters state BASIC_ETHERNET (flickering). If POWERLINK communication is detected before this time expires, however, the CN immediately enters state PRE_OPERATIONAL_1. |
| | | | Flickering | Mode BASIC_ETHERNET. The CN has not detected any POWERLINK communication. In this state, it is possible to communicate directly with the CN (e.g. with UDP, IP, etc.) If communication POWERLINK is detected in this state, the CN switches to PRE_OPERATIONAL_1. |
| | | | Single flash | Mode PRE_OPERATIONAL_1. When operating on a POWERLINK V1 manager, the CN switches directly to PRE_OPERATIONAL_2. When operated on a POWERLINK V2 manager, the CN waits until an SoC frame is received and then switches to the PRE_OPERATIONAL_2 state. |
| | | | Double flash | Mode PRE_OPERATIONAL_2. The CN is normally configured by the manager in this state. It is then switched to state READY_TO_OPERATE by command (POWERLINK V2) or by setting the "data valid" flag in the output data (POWERLINK V1). |
| | | | Triple flash | Mode READY_TO_OPERATE. In network POWERLINK V1, the CN switches automatically to OPERATIONAL as soon as input data is present. In a POWERLINK V2 network, the manager switches to the OPERATIONAL state by issuing a command. |
| | | | On | Mode OPERATIONAL. The PDO mapping is active and cyclic data is evaluated. |
| | | | Blinking | Mode STOPPED. Output data is not being output, and no input data is being provided. It is only possible to switch to or leave this state after the manager has given the appropriate command. |
| | | | On | The controlled node (CN) is in an error state (failed Ethernet frames, increased number of collisions on the network, etc.). If an error occurs in the following states, then the green LED blinks over the red LED: |
| | | Red | On | <ul style="list-style-type: none"> PRE_OPERATIONAL_1 PRE_OPERATIONAL_2 READY_TO_OPERATE  <p>Note:</p> <ul style="list-style-type: none"> Several red blinking signals are displayed immediately after the device is switched on. This is not an error, however. The LED is lit red for CNs with configured physical node number 0 but that have not yet been assigned a node number via dynamic node allocation (DNA). |
| | | L/A IFx | Green | On |
| | | | Blinking | The link to the remote station is established, and Ethernet activity is taking place on the bus. |

1) The Status/Error LED "S/E" is a green/red dual LED.

LED status indicators - Blink times



9.3.6.5.2 POWERLINK node number

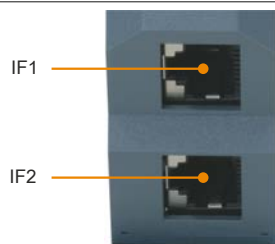


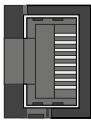
The node number for the POWERLINK node is set using the two number switches.

| Switch position | Description |
|-----------------|--|
| 0x00 | Only permitted when operating the POWERLINK node in DNA mode. |
| 0x01 - 0xEF | Node number of the POWERLINK node. Operation as a controlled node. |
| 0xF0 - 0xFF | Reserved, switch position not permitted. |

9.3.6.5.3 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see ["Cabling guidelines for X20 modules with an Ethernet cable" on page 58](#).



| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.3.6.6 Dynamic node allocation (DNA)

Most POWERLINK bus controllers have the ability to dynamically assign node numbers. This has the following advantages:

- No setting of the node number switch
- Easier installation
- Reduced error sources

For information regarding configuration as well as an example, see Automation Help → Communication → POWERLINK → General information → Dynamic node allocation (DNA)

Information:

Interface IF1 must always be used as the input from the preceding node.

9.3.6.7 SG3

This module is not supported on SG3 target systems.

9.3.6.8 SG4

The module comes with preinstalled firmware. The firmware is also part of the Automation Runtime operating system for the PLC. With different versions, the Automation Runtime firmware is loaded onto the module.

The latest firmware is made available automatically when updating Automation Runtime.

9.3.7 X20(c)BC0087

Data sheet version: 2.36

9.3.7.1 General information

Established in 1979, the Modbus protocol has approved the use of Ethernet with both Modbus TCP and Modbus/UDP. Today, Modbus TCP is an open Internet draft standard introduced by Schneider Automation to the Internet Engineering Task Force (IETF), the organization responsible for Internet standardization. The Modbus services and object model have been preserved since the original version and left unchanged for use with the TCP/IP transmission medium.

Modbus/UDP differs from Modbus TCP in that it uses connectionless communication via UDP/IP. The advantages of faster and easier communication with UDP/IP also brings with it the disadvantage of requiring error detection and correction in the application layer.

This bus controller makes it possible to connect X2X Link I/O nodes to Modbus via Ethernet. The bus controller can be operated on B&R controllers through the use of Automation Studio or on third-party systems with Modbus TCP or -UDP master functionality.

- Fieldbus: Modbus/TCP, Modbus/UDP
- I/O configuration via the fieldbus
- DHCP-capable
- Bootp-capable
- Integrated double switch for efficient cabling
- Configurable I/O cycle (0.5 to 4 ms)
- Response time: <1 to 8 ms (depending on the load on the integrated switch)
- Validity check for command sequences before execution

Information:

Only the standard function model (see the respective module description) is supported when the bus controller is used together with multi-function modules it has automatically configured itself.

All other function models are supported when configured accordingly in Automation Studio V4.3 or later.

Automation Studio can be downloaded at no cost from the B&R website (www.br-automation.com). The evaluation license is permitted to be used to create complete configurations for fieldbus bus controllers at no cost.

9.3.7.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.3.7.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C . During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.3.7.3 Order data

| Model number | Short description | Figure |
|--------------|--|--------|
| | Bus controllers | |
| X20BC0087 | X20 bus controller, 1 Modbus TCP or Modbus UDP interface, integrated 2-port switch, 2x RJ45, order bus base, power supply module and terminal block separately. | |
| X20cBC0087 | X20 bus controller, coated, Modbus/TCP or Modbus/UDP interface, integrated 2-port switch, 2x RJ45, order bus base, power supply module and terminal block separately | |
| | Required accessories | |
| | System modules for bus controllers | |
| X20BB80 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20PS9400 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply | |
| X20PS9402 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply, supply not electrically isolated | |
| X20cBB80 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cPS9400 | X20 power supply module, coated, for bus controller and internal I/O power supply, X2X Link power supply | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 118: X20BC0087, X20cBC0087 - Order data

9.3.7.4 Technical data

| Model number | X20BC0087 | X20cBC0087 |
|--|--|------------|
| Short description | | |
| Bus controller | Modbus TCP/UDP slave | |
| General information | | |
| B&R ID code | 0x227C | 0xD577 |
| Status indicators | Module status, bus function | |
| Diagnostics | | |
| Module status | Yes, using status LED and software | |
| Bus function | Yes, using status LED and software | |
| Power consumption | | |
| Bus | 2 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Interfaces | | |
| Fieldbus | Modbus TCP/UDP slave | |
| Variant | 2x shielded RJ45 (switch) | |
| Cable length | Max. 100 m between 2 stations (segment length) | |
| Transfer rate | 10/100 Mbit/s | |
| Transfer | | |
| Physical layer | 10BASE-T/100BASE-TX | |
| Half-duplex | Yes | |
| Full-duplex | Yes | |
| Autonegotiation | Yes | |
| Auto-MDI/MDIX | Yes | |
| Min. cycle time ¹⁾ | | |
| Fieldbus | 1 ms | |
| X2X Link | 500 µs | |
| Synchronization between bus systems possible | No | |
| Electrical properties | | |
| Electrical isolation | Modbus isolated from bus and I/O | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitation | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Starting temperature | - | Yes, -40°C |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |

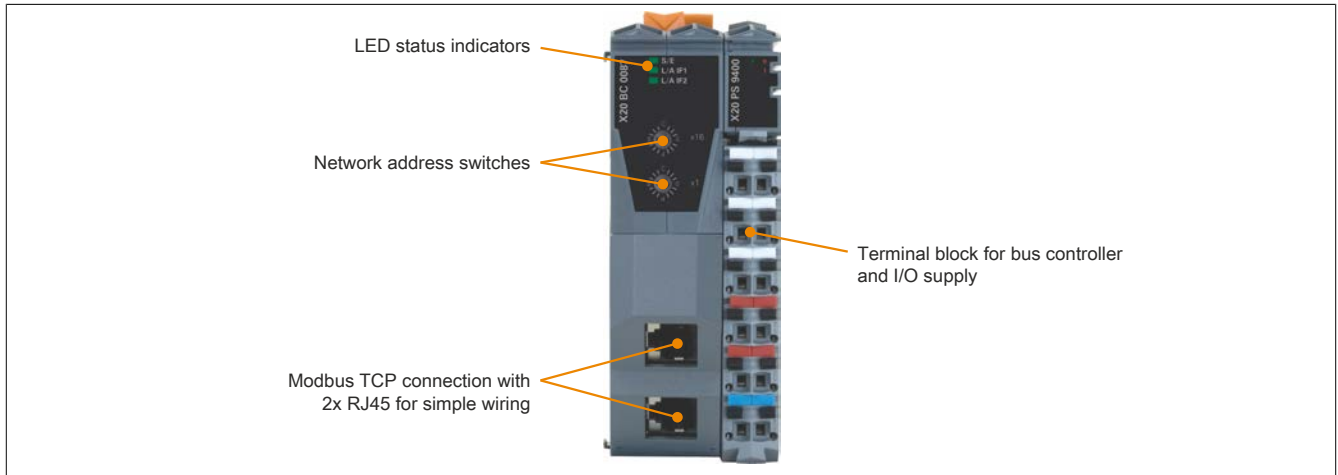
Table 119: X20BC0087, X20cBC0087 - Technical data

| Model number | X20BC0087 | X20cBC0087 |
|------------------------------|--|---|
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order terminal block 1x X20TB12 separately Order 1x power supply module X20PS9400 or X20PS9402 separately Order 1x bus base X20BB80 separately | Order 1x X20TB12 terminal block separately Order 1x X20cPS9400 power supply module separately Order 1x X20cBB80 bus base separately |
| Pitch ²⁾ | 37.5 ^{+0.2} mm | |

Table 119: X20BC0087, X20cBC0087 - Technical data

- 1) The minimum cycle time defines how far the bus cycle can be reduced without communication errors occurring.
- 2) Spacing is based on the width of bus base X20BB80. In addition, power supply module X20PS9400 or X20PS9402 is always required for the bus controller.

9.3.7.5 Operating and connection elements



9.3.7.5.1 LED status indicators

| Figure | LED | Color | Status | Description |
|----------|-------------------|-------|--|--|
| | S/E ¹⁾ | Green | On | Indicates that there is at least one client connection |
| | | | 2 pulses | Indicates that there are no client connections |
| | | | 4 pulses | Indicates that the controller is waiting for an address from the DHCP server |
| | | | Blinking | Initialization of connected I/O modules |
| | | Red | 2 pulses | Watchdog timeout |
| | | | 3 pulses | Faulty I/O module configuration data |
| | | | 4 pulses | Indicates that the controller has detected an IP address being used twice |
| | | | 5 pulses | Indicates a missing, defective or incorrect I/O module |
| | | | 6 pulses | Error reading flash memory. Last write operation was incomplete or contained errors. ²⁾ |
| | L/A IFx | Green | On | Indicates a major unrecoverable fault |
| Blinking | | | Ethernet activity taking place on the RJ45 port (IF1, IF2) indicated by the respective LED | |
| On | | | Indicates an established connection (link), but no communication is taking place | |
| | | | Off | Indicates that no physical Ethernet connection exists |

- 1) The Status/Error LED "S/E" is a green/red dual LED. The LED blinks red several times immediately after startup. This is a boot message, however, and not an error.
- 2) Possible cause: The bus controller received a command to save, but was switched off before saving was complete. In this case, the bus controller continues to use the old configuration and indicates the failed write operation with a blink code.

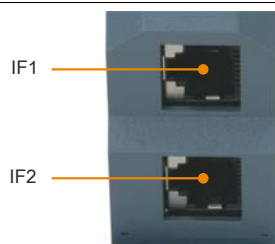
9.3.7.5.2 Modbus/TCP network address switch

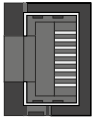


| Switch position | Description |
|-----------------|--|
| 0x00 | This switch position is the factory default setting. In this position, the address switches have no effect on system parameters. The bus controller parameters in flash memory are used (IP address or interface number). The bus controller is started with factory default values if valid flash data is not present. |
| 0x01 - 0x7F | The last position of the IP address saved in flash memory is changed to the address switch value. The IP address saved in flash memory is not changed. The interface number is read from flash memory. |
| 0x80 - 0xEF | Sets the bus controller to DHCP mode for this range. The DNS server is informed of the current hostname. A hostname is generated according to the setting of the address switch. Example The generated hostname is made up of 3 elements: "br" + "mb" + Address switch value (3 decimal places) This means, for example, that the following hostname is generated for address switch setting 0xD7 (dec. 215): "brmb215". |
| 0xF0 | Auto-store mode: The IP settings are obtained from the DHCP or BOOTP server. If the IP settings are different than the values stored in flash memory, then the current IP parameters are saved. This function is available in firmware version 1.39 and later. |
| 0xF1 - 0xFD | Reserved (same function as position 0xFF). |
| 0xFE | Initializes all bus controller parameters with default values during booting. No values are read from flash memory. The communication parameters correspond to the values assigned with switch setting 0xFF. |
| 0xFF | Initializes all communication parameters with default values. All other bus controller parameters are read from flash memory. Default parameters: <ul style="list-style-type: none"> • IP address: 192.168.100.1 • Subnet mask: 255.255.255.0 • Gateway: 192.168.100.254 • Primary NetBIOS name: "br" + MAC address • Secondary NetBIOS name: "br" + "mb" + address switch value (decimal) • Interface number: 502 • X2X Link configuration: 4 ms cycle time • X2X Link cable length: 0 m |

9.3.7.5.3 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see ["Cabling guidelines for X20 modules with an Ethernet cable"](#) on page 58.



| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.3.7.6 Setting the IP address (default value)

Changes to the network address switches are only applied after a restart. If the bus controller is restarted with the address switch value 0xFF, it is initialized with the IP address 192.168.100.1. This address is also the factory default setting. The interface number is set to 502 (reserved for Modbus).

This IP address can be used to establish a connection to the bus controller. The internationally unique MAC address is listed on the housing side of the bus controller. The combination of "br" and the MAC address results in a unique name (primary NetBIOS name) that also makes it possible to access the bus controller.

Example of the primary NetBIOS name:

| | |
|-------------------------|-------------------|
| MAC address: | 00-60-65-00-49-02 |
| Resulting NetBIOS name: | br006065004902 |

This means that, without additional parameter changes, either the default IP address 192.168.100.1 or the NetBIOS name "br+MAC" can be used to communicate with the bus controller.

Since NetBIOS is being used, the bus controller can only be accessed via this name if there are no intermediary routers or gateways in the way.

9.3.7.7 Automatic IP assignment by a DHCP server

If a network address switch setting between 0x80 and 0xEF is configured, the bus controller will attempt to request an IP address from the DHCP server. The assigned IP address can be queried with command "ping" together with the hostname. The bus controller registers this hostname on the DHCP server, which should forward it to a DNS server.

Example The hostname (DNS name) is made up of 3 elements:
 "br" + "mb" + Address switch value (3 decimal places)
 This means, for example, that the following hostname is generated for address switch setting 0xD7 (dec. 215): "brmb215".

If DNS service is not available on the network, the bus controller's two NetBIOS names can also be used for access. The secondary NetBIOS name is identical to the hostname. If the address switches are set to 0x00, it is identical to the primary NetBIOS name. The bus controller can only be reached via its NetBIOS name if no other routers or gateways are in the way.

9.3.7.8 Changing the IP address with the network address switches

The address switches can be used to change the last byte in the IP address configured on the bus controller. The IP address saved in flash memory is not changed. If the address switches are set to 0x00, the bus controller applies the IP address last saved to flash memory. Switch positions between 0x01 and 0x7F cause the last position of the IP address (the lowest byte) to be overwritten by the value of the address switch. This provides the user a quick and easy way to address a large number of bus controllers. In short, an IP address between 192.168.100.1 and 192.168.100.127 can be selected for a bus controller using the address switches without requiring any additional software configuration.

9.3.7.9 Information about NetBIOS names

In addition to the hostname used to register on the DHCP server, the bus controller also has so-called NetBIOS names. These are used to access the bus controller from a PC using its name (as opposed to its IP address). This is only possible if no routers or gateways are in the way, however.

The primary NetBIOS name is always composed of the prefix "br" and the MAC address from the bus controller (see ["Automatic IP assignment by a DHCP server" on page 868](#)).

The secondary NetBIOS name corresponds to the primary NetBIOS name at address switch position 0x00. This is necessary because several bus controllers with address switch value 0x00 are permitted to be located in one network segment. In this case, the IP address from flash memory is used.

For all other address switch positions, the secondary NetBIOS name is generated from the network address switch value (as in DHCP mode): "br" + "mb" + Address switch value (3 decimal places).

A hostname defined explicitly by the user will be used for the secondary NetBIOS name regardless of the address switch value.

This makes it possible to access the bus controller with the NetBIOS name configured using the address switches. This is also possible if the controller was not configured for use with a DHCP server (address switch setting between 0x01 and 0x7F).

9.3.7.10 Saving an IP address to flash memory

The IP parameters in flash memory can be changed via the Modbus protocol, the ModbusTCP Toolbox or the Telnet interface. The ModbusTCP Toolbox can be downloaded from the B&R website.

The IP address, subnet and gateway are all defined in the address range 0x1003 to 0x100E. Each has a length of 4 words. The data is applied by writing constant 0xC1 to address 0x1140 ("Write single register" fc6, addr. 0x1140, data 0xC1). The new settings are applied after the bus controller is restarted.

9.3.8 X20BC0087-10

Data sheet version: 1.03

9.3.8.1 General information

Established in 1979, the Modbus protocol has approved the use of Ethernet with both Modbus TCP and Modbus/UDP. Today, Modbus TCP is an open Internet draft standard introduced by Schneider Automation to the Internet Engineering Task Force (IETF), the organization responsible for Internet standardization. The Modbus services and object model have been preserved since the original version and left unchanged for use with the TCP/IP transmission medium.

Modbus/UDP differs from Modbus TCP in that it uses connectionless communication via UDP/IP. The advantages of faster and easier communication with UDP/IP also brings with it the disadvantage of requiring error detection and correction in the application layer.

This bus controller makes it possible to connect X2X Link I/O nodes to Modbus via Ethernet. The bus controller can be operated on B&R controllers through the use of Automation Studio or on third-party systems with Modbus TCP or -UDP master functionality.

- Fieldbus: Modbus/TCP, Modbus/UDP
- I/O configuration via the fieldbus
- DHCP-capable
- Bootp-capable
- Integrated double switch for efficient cabling
- Configurable I/O cycle (0.5 to 4 ms)
- Response time: <1 - 8 ms (depending on the load on the integrated switch)
- Validity check for command sequences before execution
- Producer mode

Information:

Only the standard function model (see the respective module description) is supported when the bus controller is used together with multi-function modules it has automatically configured itself.

All other function models are supported when configured accordingly in Automation Studio V4.3 or later.

Automation Studio kann kostenlos von der B&R Webseite www.br-automation.com heruntergeladen werden. Die Evaluierungslizenz darf unentgeltlich zur Erstellung vollständiger Konfigurationen der Feldbus Bus Controller benützt werden.

9.3.8.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Bus controllers |  |
| X20BC0087-10 | X20 bus controller, 1 Modbus TCP or Modbus UDP interface, producer mode feature (via UDP), integrated switch, 2x RJ45, order bus base, power supply module and terminal block separately. | |
| | Required accessories | |
| | System modules for bus controllers | |
| X20BB80 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20PS9400 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply | |
| X20PS9402 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply, supply not electrically isolated | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 120: X20BC0087-10 - Order data


9.3.8.3 Technical data

| | |
|--|--|
| Model number | X20BC0087-10 |
| Short description | |
| Bus controller | Modbus TCP/UDP slave |
| General information | |
| B&R ID code | 0xEA9F |
| Status indicators | Module status, bus function |
| Diagnostics | |
| Module status | Yes, using status LED and software |
| Bus function | Yes, using status LED and software |
| Power consumption | |
| Bus | 2 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| Interfaces | |
| Fieldbus | Modbus TCP/UDP slave |
| Variant | 2x shielded RJ45 (switch) |
| Cable length | Max. 100 m between 2 stations (segment length) |
| Transfer rate | 10/100 Mbit/s |
| Transfer | |
| Physical layer | 10BASE-T/100BASE-TX |
| Half-duplex | Yes |
| Full-duplex | Yes |
| Autonegotiation | Yes |
| Auto-MDI/MDIX | Yes |
| Min. cycle time ¹⁾ | |
| Fieldbus | 1 ms |
| X2X Link | 500 µs |
| Synchronization between bus systems possible | No |
| Electrical properties | |
| Electrical isolation | Modbus isolated from bus and I/O |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order terminal block 1x X20TB12 separately Order 1x power supply module X20PS9400 or X20PS9402 separately Order 1x bus base X20BB80 separately |
| Pitch ²⁾ | 37.5 ^{+0.2} mm |

Table 121: X20BC0087-10 - Technical data

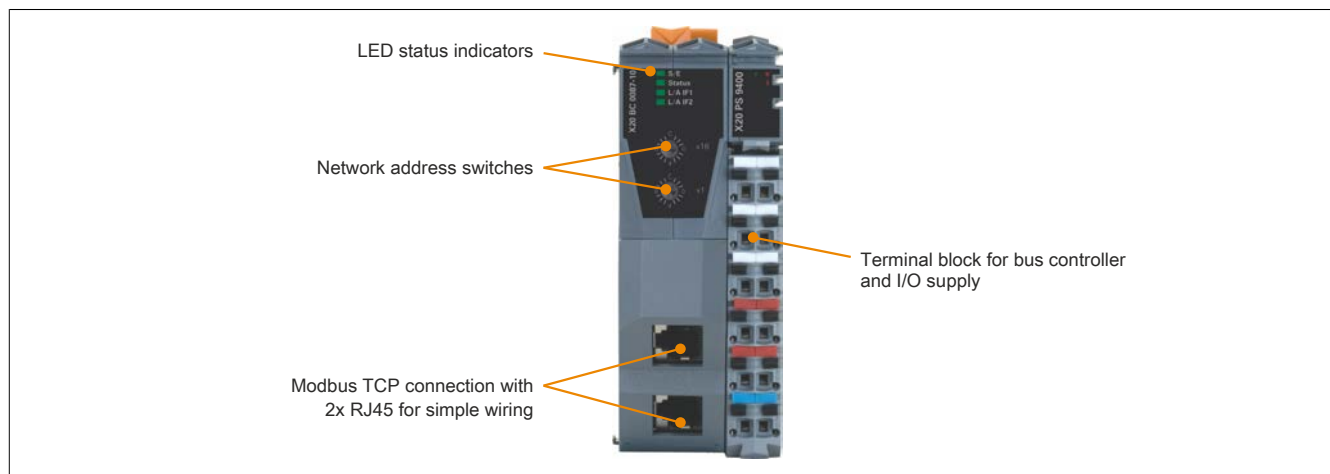
- 1) The minimum cycle time defines how far the bus cycle can be reduced without communication errors occurring.
- 2) Spacing is based on the width of bus base X20BB80. In addition, power supply module X20PS9400 or X20PS9402 is always required for the bus controller.

9.3.8.4 LED status indicators

| Figure | LED | Color | Status | Description |
|---|----------------------|----------|--|--|
|  | S/E ¹⁾ | Green | On | Indicates that there is at least one client connection |
| | | | 2 pulses | Indicates that there are no client connections |
| | | | 4 pulses | Indicates that the controller is waiting for an address from the DHCP server |
| | | | Blinking | Initialization of connected I/O modules |
| | | | Red | 2 pulses |
| | | 3 pulses | Faulty I/O module configuration data | |
| | | 4 pulses | Indicates that the controller has detected an IP address being used twice | |
| | | 5 pulses | Indicates a missing, defective or incorrect I/O module | |
| | | 6 pulses | Error reading flash memory. Last write operation was incomplete or contained errors. ²⁾ | |
| | | On | Indicates a major unrecoverable fault | |
| | L/A IFx | Green | Blinking | Ethernet activity taking place on the RJ45 port (IF1, IF2) indicated by the respective LED |
| | | | On | Indicates an established connection (link), but no communication is taking place |
| | | | Off | Indicates that no physical Ethernet connection exists |
| | Status ³⁾ | Green | On | Producer is active. |
| Off | | | Producer is inactive. | |
| Red | | On | Indicates an error on the producer. ⁴⁾ | |

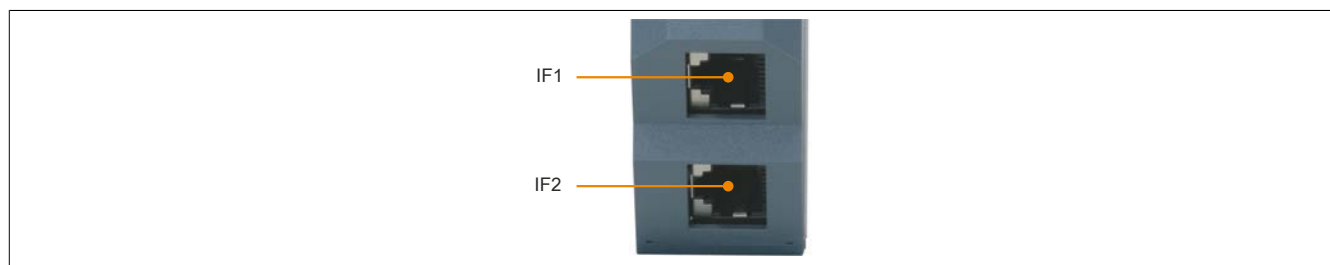
- 1) The Status/Error LED "S/E" is a green/red dual LED. The LED blinks red several times immediately after startup. This is a boot message, however, and not an error.
- 2) Possible cause: The bus controller received a command to save, but was switched off before saving was complete. In this case, the bus controller continues to use the old configuration and indicates the failed write operation with a blink code.
- 3) LED "Status" is a green/red dual LED.
- 4) For an error description, see the Modbus TCP user's manual.

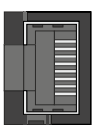
9.3.8.5 Operating and connection elements



9.3.8.6 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see "Cabling guidelines for X20 modules with an Ethernet cable" on page 58.



| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.3.8.7 Modbus/TCP network address switch



| Switch position | Description |
|-----------------|--|
| 0x00 | This switch position is the factory default setting. In this position, the address switches have no effect on system parameters. The bus controller parameters in flash memory are used (IP address or interface number). The bus controller is started with factory default values if valid flash data is not present. |
| 0x01 - 0x7F | The last position of the IP address saved in flash memory is changed to the address switch value. The IP address saved in flash memory is not changed. The interface number is read from flash memory. |
| 0x80 - 0xEF | Sets the bus controller to DHCP mode for this range. The DNS server is informed of the current hostname. A hostname is generated according to the setting of the address switch. Example The generated hostname is made up of 3 elements: "br" + "mb" + Address switch value (3 decimal places) This means, for example, that the following hostname is generated for address switch setting 0xD7 (dec. 215): "brmb215". |
| 0xF0 | Auto-store mode: The IP settings are obtained from the DHCP or BOOTP server. If the IP settings are different than the values stored in flash memory, then the current IP parameters are saved. This function is available in firmware version 1.39 and later. |
| 0xF1 - 0xFD | Reserved (same function as position 0xFF). |
| 0xFE | Initializes all bus controller parameters with default values during booting. No values are read from flash memory. The communication parameters correspond to the values assigned with switch setting 0xFF. |
| 0xFF | Initializes all communication parameters with default values. All other bus controller parameters are read from flash memory. Default parameters: <ul style="list-style-type: none"> • IP address: 192.168.100.1 • Subnet mask: 255.255.255.0 • Gateway: 192.168.100.254 • Primary NetBIOS name: "br" + MAC address • Secondary NetBIOS name: "br" + "mb" + address switch value (decimal) • Interface number: 502 • X2X Link configuration: 4 ms cycle time • X2X Link cable length: 0 m |

9.3.8.8 Setting the IP address (default value)

Changes to the network address switches are only applied after a restart. If the bus controller is restarted with the address switch value 0xFF, it is initialized with the IP address 192.168.100.1. This address is also the factory default setting. The interface number is set to 502 (reserved for Modbus).

This IP address can be used to establish a connection to the bus controller. The internationally unique MAC address is listed on the housing side of the bus controller. The combination of "br" and the MAC address results in a unique name (primary NetBIOS name) that also makes it possible to access the bus controller.

Example of the primary NetBIOS name:

MAC address: 00-60-65-00-49-02

Resulting NetBIOS name: br006065004902

This means that, without additional parameter changes, either the default IP address 192.168.100.1 or the NetBIOS name "br+MAC" can be used to communicate with the bus controller.

Since NetBIOS is being used, the bus controller can only be accessed via this name if there are no intermediary routers or gateways in the way.

9.3.8.9 Automatic IP assignment by a DHCP server

If a network address switch setting between 0x80 and 0xEF is configured, the bus controller will attempt to request an IP address from the DHCP server. The assigned IP address can be queried with command "ping" together with the hostname. The bus controller registers this hostname on the DHCP server, which should forward it to a DNS server.

Example The hostname (DNS name) is made up of 3 elements:
 "br" + "mb" + Address switch value (3 decimal places)
 This means, for example, that the following hostname is generated for address switch setting 0xD7 (dec. 215): "brmb215".

If DNS service is not available on the network, the bus controller's two NetBIOS names can also be used for access. The secondary NetBIOS name is identical to the hostname. If the address switches are set to 0x00, it is identical to the primary NetBIOS name. The bus controller can only be reached via its NetBIOS name if no other routers or gateways are in the way.

9.3.8.10 Changing the IP address with the network address switches

The address switches can be used to change the last byte in the IP address configured on the bus controller. The IP address saved in flash memory is not changed. If the address switches are set to 0x00, the bus controller applies the IP address last saved to flash memory. Switch positions between 0x01 and 0x7F cause the last position of the IP address (the lowest byte) to be overwritten by the value of the address switch. This provides the user a quick and easy way to address a large number of bus controllers. In short, an IP address between 192.168.100.1 and 192.168.100.127 can be selected for a bus controller using the address switches without requiring any additional software configuration.

9.3.8.11 Information about NetBIOS names

In addition to the hostname used to register on the DHCP server, the bus controller also has so-called NetBIOS names. These are used to access the bus controller from a PC using its name (as opposed to its IP address). This is only possible if no routers or gateways are in the way, however.

The primary NetBIOS name is always composed of the prefix "br" and the MAC address from the bus controller (see ["Automatic IP assignment by a DHCP server" on page 874](#)).

The secondary NetBIOS name corresponds to the primary NetBIOS name at address switch position 0x00. This is necessary because several bus controllers with address switch value 0x00 are permitted to be located in one network segment. In this case, the IP address from flash memory is used.

For all other address switch positions, the secondary NetBIOS name is generated from the network address switch value (as in DHCP mode): "br" + "mb" + Address switch value (3 decimal places).

A hostname defined explicitly by the user will be used for the secondary NetBIOS name regardless of the address switch value.

This makes it possible to access the bus controller with the NetBIOS name configured using the address switches. This is also possible if the controller was not configured for use with a DHCP server (address switch setting between 0x01 and 0x7F).

9.3.8.12 Saving an IP address to flash memory

The IP parameters in flash memory can be changed via the Modbus protocol, the ModbusTCP Toolbox or the Telnet interface. The ModbusTCP Toolbox can be downloaded from the B&R website.

The IP address, subnet and gateway are all defined in the address range 0x1003 to 0x100E. Each has a length of 4 words. The data is applied by writing constant 0xC1 to address 0x1140 ("Write single register" fc6, addr. 0x1140, data 0xC1). The new settings are applied after the bus controller is restarted.

9.3.9 X20(c)BC0088

Data sheet version: 2.36

9.3.9.1 General information

EtherNet/IP is an Ethernet-based fieldbus. EtherNet/IP was developed by Allen-Bradley (Rockwell Automation) and later transferred to the Open DeviceNet Vendor Association (ODVA) as an open standard. In 1998, a working group at ControlNet International developed a procedure for setting the published Common Industrial Protocol to Ethernet. EtherNet/IP was published in March 2000 as an open industrial automation standard based on this procedure.

This bus controller makes it possible to connect X2X Link I/O nodes to EtherNet/IP. The bus controller can be operated via interface module X20IF10D1-1 or by 3rd-party systems with EtherNet/IP scanner functionality.

- Fieldbus: EtherNet/IP
- Integrated 3-port switch for efficient cabling
- Auto-configuration of I/O modules
- Can be configured by the scanner (master) using configuration assembly
- Web interface
- DHCP-capable
- Configurable I/O cycle (0.5 to 4 ms)
- Minimum fieldbus cycle time (also requested packet interval or RPI): 1 ms

Information:

Only the standard function model (see the respective module description) is supported when the bus controller is used together with multi-function modules it has automatically configured itself.

Automation Studio V4.3 or later can be used to easily create configuration files (e.g. EDS files, binary files). All other function models are also supported by transferring configuration data to the bus controller (e.g. using the scanner via a "configuration assembly").

Automation Studio can be downloaded at no cost from the B&R website (www.br-automation.com). The evaluation license is permitted to be used to create complete configurations for fieldbus bus controllers at no cost.

9.3.9.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.3.9.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C . During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.3.9.3 Order data

| Model number | Short description | Figure |
|--------------|--|--------|
| | Bus controllers | |
| X20BC0088 | X20 bus controller, 1 EtherNet/IP interface, integrated switch, web interface, 2x RJ45, order bus base, power supply module and terminal block separately! | |
| X20cBC0088 | X20 bus controller, coated, 1 EtherNet/IP interface, integrated switch, web interface, 2x RJ45, order bus base, power supply module and terminal block separately! | |
| | Required accessories | |
| | System modules for bus controllers | |
| X20BB80 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20PS9400 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply | |
| X20PS9402 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply, supply not electrically isolated | |
| X20cBB80 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cPS9400 | X20 power supply module, coated, for bus controller and internal I/O power supply, X2X Link power supply | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 122: X20BC0088, X20cBC0088 - Order data

9.3.9.4 Technical data

| Model number | X20BC0088 | X20cBC0088 |
|--|---|------------|
| Short description | | |
| Bus controller | EtherNet/IP adapter (slave) | |
| General information | | |
| B&R ID code | 0x26D8 | 0xE67F |
| Status indicators | Module status, network status, bus function | |
| Diagnostics | | |
| Module status | Yes, using LED status indicator and software | |
| Bus function | Yes, using LED status indicator and software | |
| Network status | Yes, using LED status indicator and software | |
| Power consumption | | |
| Bus | 2 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| EAC | Yes | |
| KC | Yes | - |
| Interfaces | | |
| Fieldbus | EtherNet/IP adapter (slave) | |
| Variant | 2x shielded RJ45 (switch) | |
| Cable length | Max. 100 m between 2 stations (segment length) | |
| Transfer rate | 10/100 Mbit/s | |
| Transfer | | |
| Physical layer | 10BASE-T/100BASE-TX | |
| Half-duplex | Yes | |
| Full-duplex | Yes | |
| Autonegotiation | Yes | |
| Auto-MDI/MDIX | Yes | |
| Min. cycle time ¹⁾ | | |
| Fieldbus | 1 ms | |
| X2X Link | 500 µs | |
| Synchronization between bus systems possible | No | |
| Electrical properties | | |
| Electrical isolation | EtherNet/IP isolated from bus and I/O | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitation | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | | |
| Starting temperature | - | Yes, -40°C |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |

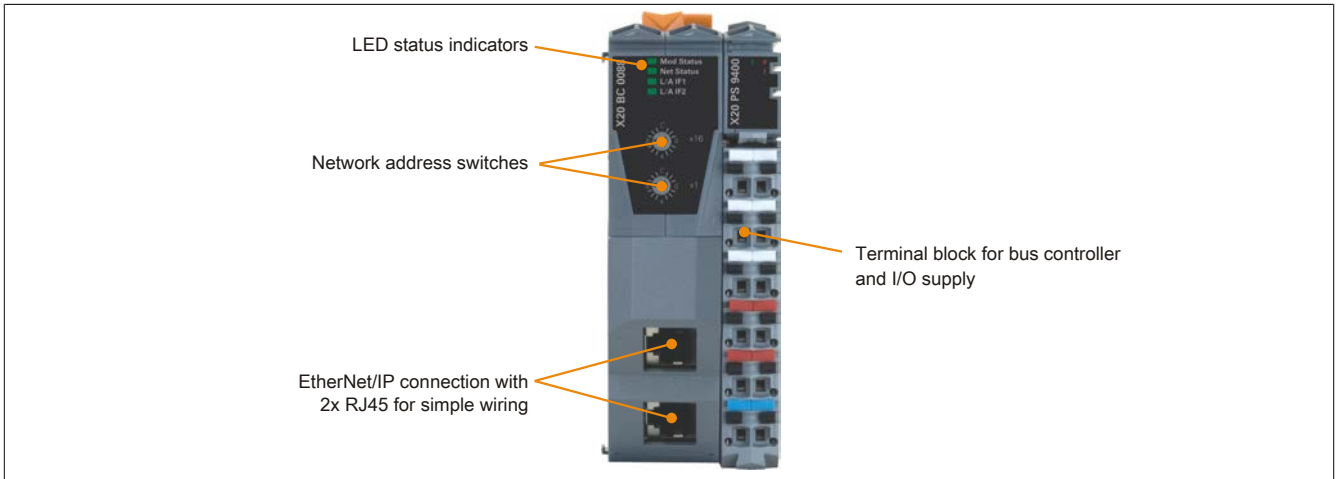
Table 123: X20BC0088, X20cBC0088 - Technical data

| Model number | X20BC0088 | X20cBC0088 |
|------------------------------|--|--|
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | | 5 to 95%, non-condensing |
| Transport | | 5 to 95%, non-condensing |
| Mechanical properties | | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x power supply module X20PS9400 or X20PS9402 separately. Order 1x bus base X20BB80 separately | Order 1x terminal block X20TB12 separately. Order 1x X20cPS9400 or X20cPS9402 power supply module separately Order 1x X20cBB80 bus base separately |
| Pitch ²⁾ | 37.5 ^{+0.2} mm | |

Table 123: X20BC0088, X20cBC0088 - Technical data

- 1) The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring.
- 2) Pitch is based on the width of bus base X20BB80. In addition, power supply module X20PS9400 or X20PS9402 is always required for the bus controller.

9.3.9.5 Operating and connection elements



9.3.9.5.1 LED status indicators

| Figure | LED | Color | Status | Description |
|---------|--------------------------|----------|---|---|
| | Mod status ¹⁾ | Green | On | Indicates that there is at least one client connection |
| | | | Blinking | Bus controller not yet configured. |
| | | | Flickering | HTTP file upload (firmware or configuration file) |
| | | Red | On | Major unrecoverable fault. |
| | | | Blinking | Major recoverable fault. |
| | | | Green/Red | Blinking |
| | Net status ¹⁾ | Green | On | Indicates at least one established active scanner (master) connection |
| | | | Blinking | Indicates no established active scanner (master) connection |
| | | | Off | Indicates no IP address has been assigned |
| | | Rot | On | Indicates an IP address has been used more than once |
| | | | Blinking | Indicates a timeout on at least one connection |
| | | | Green/Red | Blinking |
| L/A IFx | Green | Blinking | Ethernet activity taking place on the RJ45 interface (IF1, IF2) indicated by the respective LED | |
| | | On | Indicates an established connection (link), but no communication is taking place | |
| | | Off | Indicates that no physical Ethernet connection exists | |

- 1) The "Mod status" and "Net status" LEDs are green/red dual LEDs.

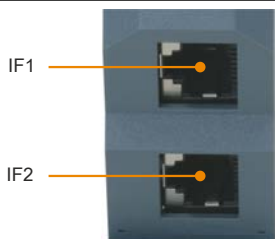
9.3.9.5.2 EtherNet/IP address switching positions

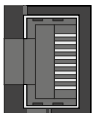


| Switch position | Description |
|-----------------|--|
| 0x00 | The IP address saved in flash memory is used. The adapter is started via DHCP if attribute 3 (configuration control) of the TCP/IP interface object was set to DHCP. |
| 0x01 to 0x7F | The last position of the IP address saved in flash memory is changed to the address switch value. The IP address saved in flash memory is not changed. All other adapter parameters are read from flash memory and used without being changed. |
| 0x80 to 0xEF | Sets the bus controller to DHCP mode for this range. The DNS server is informed of the current hostname. A hostname is generated according to how the network address switches are set. Example: The generated hostname is made up of three elements: "br" + "eip" + Address switch position (three decimal places) This means, for example, that the following hostname is generated for address switch position 0xD7 (dec. 215): "breip215". |
| 0xF0 to 0xFD | Reserved (same function as position 0xFF). |
| 0xFE | Initializes all bus controller parameters with default values during booting. No values are read from flash memory. The communication parameters correspond to the values assigned with switch setting 0xFF. |
| 0xFF | Initializes all communication parameters with default values. All other bus controller parameters are read from flash memory. Default parameters: <ul style="list-style-type: none"> • IP address: 192.168.100.1 • Subnet mask: 255.255.255.0 • Gateway: 192,168,100,254 • Primary NetBIOS name: "br" + MAC address • Secondary NetBIOS name: "br" + "eip" + address switch number (decimal) • X2X Link configuration: 1 ms cycle time • X2X Link cable length: 0 m |

9.3.9.5.3 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see ["Cabling guidelines for X20 modules with an Ethernet cable"](#) on page 58.



| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | Pinout |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.3.9.6 Setting the IP address (default value)

Changes to the network address switch are only applied after a restart (power cycle). If the bus controller is restarted with the address switch value 0xFF, it is initialized with IP address 192.168.100.1. This address is also the factory default setting.

This IP address can be used to establish a connection to the bus controller. The internationally unique MAC address is listed on the housing side of the bus controller. The combination of "br" and the MAC address results in a unique name (primary NetBIOS name) that also makes it possible to access the bus controller.

Example of the primary NetBIOS name:

| | |
|-------------------------|-------------------|
| MAC address: | 00-60-65-00-49-02 |
| Resulting NetBIOS name: | br006065004902 |

This means that, without additional parameter changes, either the default IP address 192.168.100.1 or the NetBIOS name "br+MAC" can be used to communicate with the controller.

Since NetBIOS is being used, the bus controller can only be accessed via this name if there are no intermediary routers or gateways in the way.

9.3.9.7 Automatic IP assignment by a DHCP server

If a address switch position between 0x80 and 0xEF is configured, the bus controller will attempt to request an IP address from the DHCP server. The assigned IP address can be queried with a "ping" command together with the hostname. The bus controller registers this hostname on the DHCP server, which should forward it to a DNS server.

Example: The hostname (DNS name) is made up of three elements:
 "br" + "eip" + Address switch value (three decimal places).
 This means, for example, that the following hostname is generated for address switch setting 0xD7 (dec. 215): "breip215".

If DNS service is not available on the network, the bus controller's two NetBIOS names can also be used for access. The secondary NetBIOS name is identical to the hostname; at address switch value 0x00, it is identical with the primary NetBIOS name. The bus controller can only be reached via its NetBIOS name if no other routers or gateways are in the way.

9.3.9.8 Changing the IP address with the network address switches

The address switches can be used to change the last byte in the IP address configured on the bus controller. The IP address saved in flash memory is not changed. If the address switches are set to 0x00, the bus controller applies the IP address last saved to flash memory. Switch positions between 0x01 and 0x7F cause the last position of the IP address (the lowest byte) to be overwritten by the value of the address switch. This provides the user a quick and easy way to address a large number of bus controllers. In short, an IP address between 192.168.100.1 and 192.168.100.127 can be selected for a bus controller using the address switches without requiring any additional software configuration.

9.3.9.9 Saving an IP address to flash memory

The IP parameters in the flash memory can be changed via the EtherNet/IP protocol or using the Telnet interface (see EtherNet/IP in the user's manual). If the IP address should be set via the TCP/IP object (class 0xF5), then the new address will only be saved to flash if instance attribute 3 (configuration control) of the TCP/IP object is set to 0 (see CIP specification).

9.3.10 X20BC008U

Data sheet version: 1.25

9.3.10.1 General information

This bus controller provides OPC UA server functions. This allows any OPC UA clients access to read or write data from I/O modules connected to the bus controller.

- Protocol: OPC UA
- I/O configuration via OPC UA
- 10 ms minimum cycle time
- Integrated switch for wiring multiple slaves
- 100 Mbit/s full-duplex mode
- Up to 1440 bytes of input data and up to 1440 bytes of output data possible
- Integrated web page for firmware updates
- OPC UA diagnostics and module diagnostics at runtime via OPC UA clients

9.3.10.2 Order data


| Model number | Short description | Figure |
|--------------|--|--|
| | Bus controllers |  |
| X20BC008U | X20 bus controller, 1 OPC UA Ethernet interface, integrated 2-port switch, 2x RJ45, order bus base, power supply module and terminal block separately. | |
| | Required accessories | |
| | System modules for bus controllers | |
| X20BB80 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/ X20AC0SR1 included | |
| X20PS9400 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply | |
| X20PS9402 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply, supply not electrically isolated | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 124: X20BC008U - Order data

9.3.10.3 Technical data


| | |
|--|--|
| Model number | X20BC008U |
| Short description | |
| Bus controller | OPC UA server |
| General information | |
| B&R ID code | 0xEAFB |
| Status indicators | Module status, bus function |
| Diagnostics | |
| Module status | Yes, using status LED and software |
| Bus function | Yes, using status LED and software |
| Power consumption | |
| Bus | 2.5 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| Interfaces | |
| Fieldbus | OPC UA server |
| Variant | 2x shielded RJ45 (switch) |
| Line length | Max. 100 m between 2 stations (segment length) |
| Transfer rate | 100 Mbit/s |
| Transfer | |
| Physical layer | 100BASE-TX |
| Half-duplex | Yes |
| Full-duplex | Yes |
| Autonegotiation | Yes |
| Auto-MDI/MDIX | Yes |
| Min. cycle time ¹⁾ | |
| Fieldbus | 10 ms |
| X2X Link | 2 ms |
| Synchronization between bus systems possible | Yes |
| Electrical properties | |
| Electrical isolation | OPC UA isolated from bus and I/O |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order terminal block 1x X20TB12 separately Order 1x power supply module X20PS9400 or X20PS9402 separately Order 1x bus base X20BB80 separately |
| Spacing ²⁾ | 37.5 ^{+0.2} mm |

Table 125: X20BC008U - Technical data

- 1) The minimum cycle time defines how far the bus cycle can be reduced without communication errors occurring.
2) Spacing is based on the width of bus base X20BB80. In addition, power supply module X20PS9400 or X20PS9402 is always required for the bus controller.

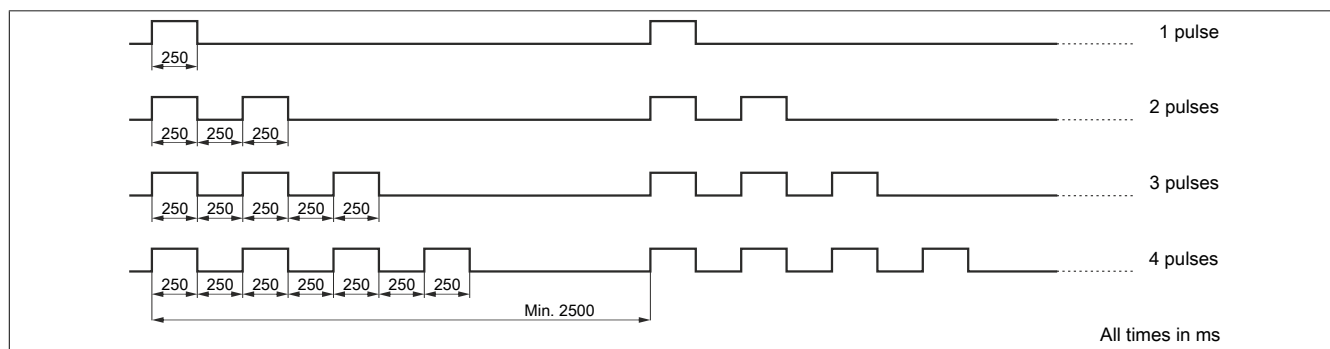
9.3.10.4 LED status indicators

The following table lists the LED status indicators available on the bus controller. Exact blink times are specified in the timing diagram in the next section.

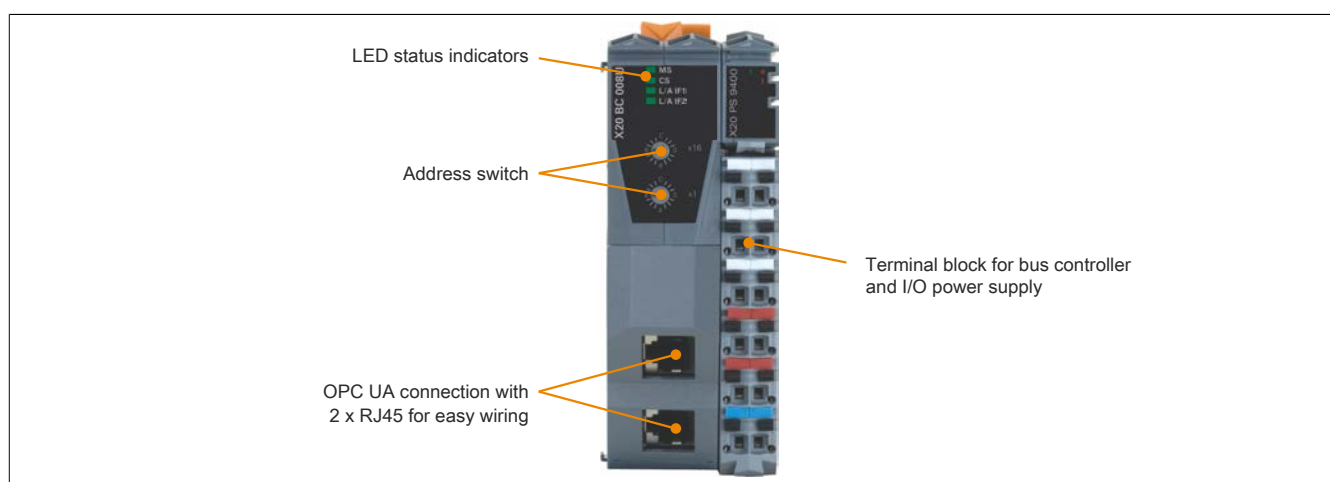
| Figure | LED | Color | Status | Description |
|---|------------------|------------------|---|--|
|  | MS ¹⁾ | Green | Off | X2X halted |
| | | | 3 pulses | Initializing X2X network |
| | | | On ²⁾ | Normal operation, X2X active |
| | | Red | 1 pulse | One or more modules missing since startup |
| | | | 2 pulses | I/O module missing that was already active |
| | | | 3 pulses | Mismatch of at least 1 I/O module with configuration |
| | | | 4 pulses | Watchdog timer expired |
| | | On | Corrupt configuration file in flash memory or hardware fault | |
| | | CS ¹⁾ | Green | Off |
| | 1 pulse | | | Waiting for DHCP server ³⁾ |
| | 2 pulses | | | Waiting for time synchronization ³⁾ |
| | Red | | On | At least 1 connection is active. |
| | | | 1 pulse | Waiting for DHCP server ³⁾ |
| | | | 2 pulses | Waiting for time synchronization ³⁾ |
| | | | 3 pulses | Error mode OutputKeepAlive is active. |
| | | | On | IP address conflict. Another network station used the same IP address. |
| | | | On | Indicates that no physical Ethernet connection exists |
| | L/A IFx | Green | Off | Indicates that no physical Ethernet connection exists |
| Blinking | | | Ethernet activity taking place on the RJ45 interface (IF1, IF2) indicated by the respective LED | |
| On | | | Indicates an established connection (link), but no communication is taking place | |

- 1) This LED is a green/red dual LED.
- 2) The red LED can be superimposed over the green LED, which results in a mixed color.
- 3) The waiting time is indicated by green pulses in the first 10 seconds of the search or synchronization; red pulses then follow.

LED status indicators - Blink times

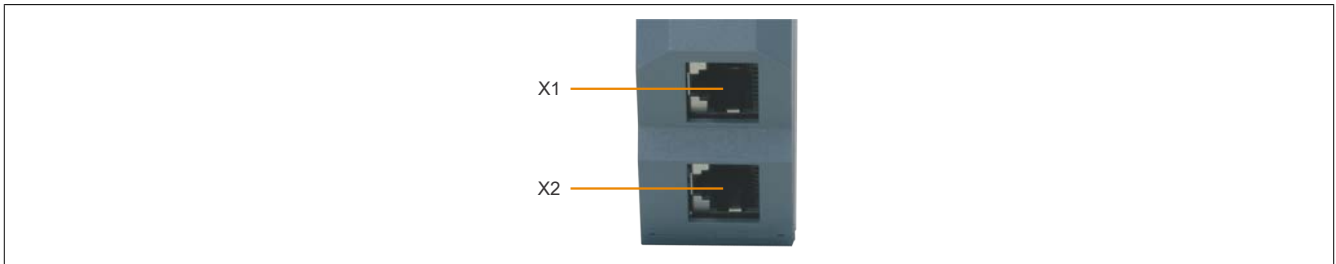


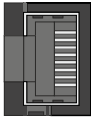
9.3.10.5 Operating and connection elements



9.3.10.6 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see "[Cabling guidelines for X20 modules with an Ethernet cable](#)" on page 58.



| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | Pinout |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.3.10.7 Address switch



The bus controller has 2 address switches. The bus controller can be set to different operating modes using certain, pre-defined switch positions.

| Switch position | Description |
|-----------------|--|
| 0x00 | All parameters are initialized from flash memory. The bus controller is started with its default values if valid flash data is not present. In this case the configuration is identical to switch position 0xFF. |
| 0x01 - 0x7F | Parameters are read from flash memory. The last position of the IP address saved in flash memory is changed to the address switch value, however. Example <ul style="list-style-type: none"> IP address stored in flash memory: 192.168.1.1 Switch position: 0x20 (decimal 32) Resulting IP address: 192.168.1.32 |
| 0x80 - 0xEF | In this range, the bus controller operates in DHCP mode. A hostname is generated according to the setting of the address switch. The generated hostname is composed of 3 elements: →"br" + "opc" + Address switch value (3 decimal positions) Example If the address switch value is 0xD7 (dec. 215), for example, then hostname "bropc215" will be generated. |
| 0xF0 | See " Restoring to factory settings " on page 886. |
| 0xF1 - 0xFE | Reserved, switch position not permitted |
| 0xFF | All parameters are set to their default values. Parameters in flash memory are not overwritten. The following default values are used: <ul style="list-style-type: none"> IP address: 192.168.1.1 Subnet mask: 255.255.255.0 Default gateway: 192.168.1.254 DNS server: 192.168.1.254 OPC UA server port: 4840 |

9.3.10.7.1 Restoring to factory settings

The following procedure is used to reset the bus controller to its default configuration.

- 1) Set the address switch to F0.
- 2) Switch on the power supply.
- 3) If LED "MS" is blinking red, it indicates that the deletion operation can be started.
- 4) To start the deletion procedure, set the address switch to 00 for 1 second and then set it back to F0.
- 5) If LED "MS" is solid red, it indicates that deletion is in progress; this lasts approximately 20 seconds. When deletion has completed, LED "MS" blinks red and green alternately.
- 6) Reset the address switch to the desired value and reboot the bus controller.

Information:

If the deletion procedure is interrupted due to a power failure, the operation must be restarted; otherwise, parts of the previous configuration may be retained.

9.3.10.8 Firmware update

Using the Ethernet interface and [configured IP address](#) of the bus controller, it is possible to connect to the integrated web page in a web browser. The update is started by selecting menu option "Firmware download".

The screenshot shows the web interface for the X20BC008U bus controller. The top navigation bar is orange with the text 'Perfection in Automation' and the website 'www.br-automation.com'. Below this, there is a breadcrumb trail: 'X20BC008U > Advanced > Firmware Download'. The main content area has a 'Firmware Download' section with a 'NOTE:' stating: 'After a firmware download, the buscontroller will still have full functionality. However, a reboot will be required to activate the new firmware and to resume webservice operation.' Below the note, there is a 'Firmware Version' input field containing '1.00'. There is a 'Choose File' button next to the text 'No file chosen'. At the bottom, there is a 'Start Download' button and a progress indicator showing '%'. The left sidebar contains navigation links for 'X20BC008U', 'Advanced', and 'Firmware Download'.

Notes about the firmware update

The current firmware version, as well as all previous versions, can be downloaded from the website. It is important to note that the firmware filename "60155_1.fw" stored in the ZIP file is identical for all firmware versions. It consists of the module ID (ModuleID=60155) and hardware variant (_1).

To better differentiate between firmware versions, the version number is included in the ZIP filename in version 1.18 and later.

Information:

The X20BC008U does not support automated firmware updates via hardware upgrade. The firmware update must be carried out manually by the user through downloading via the web server.

9.3.10.9 Supported OPC UA server facets

The bus controller supports the following server facets:

Core server facet

- Address space base
- Base info server capabilities
- Base info ValueAsText
- Discovery get endpoints
- Session general service behavior
- Session base
- Session minimum 5
- View basic
- View TranslateBrowsePath
- View RegisterNodes
- View minimum continuation point (the number of continuation points is unlimited)
- Attribute read
- Attribute write values

Data access

- Monitor basic
- Monitor value change
- Monitor items 1000
- Monitor QueueSize 100
- Subscription basic
- Subscription minimum 10

Generic features

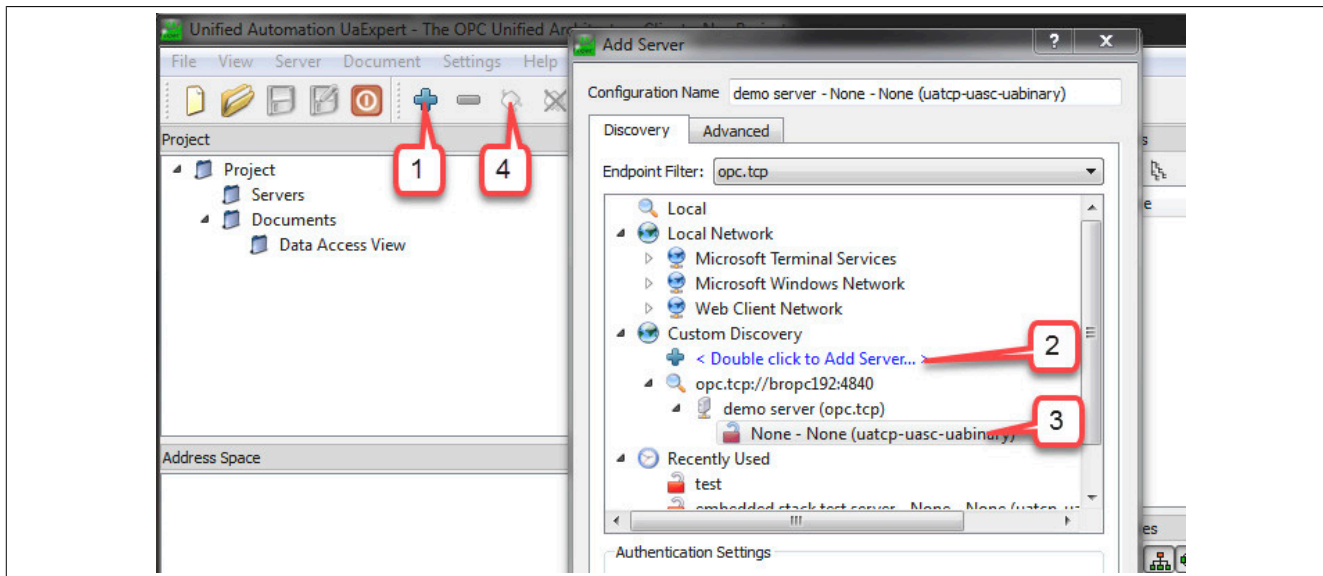
- Address space method
- Method call

Transport

- UA-TCP UA-SC UA-Binary

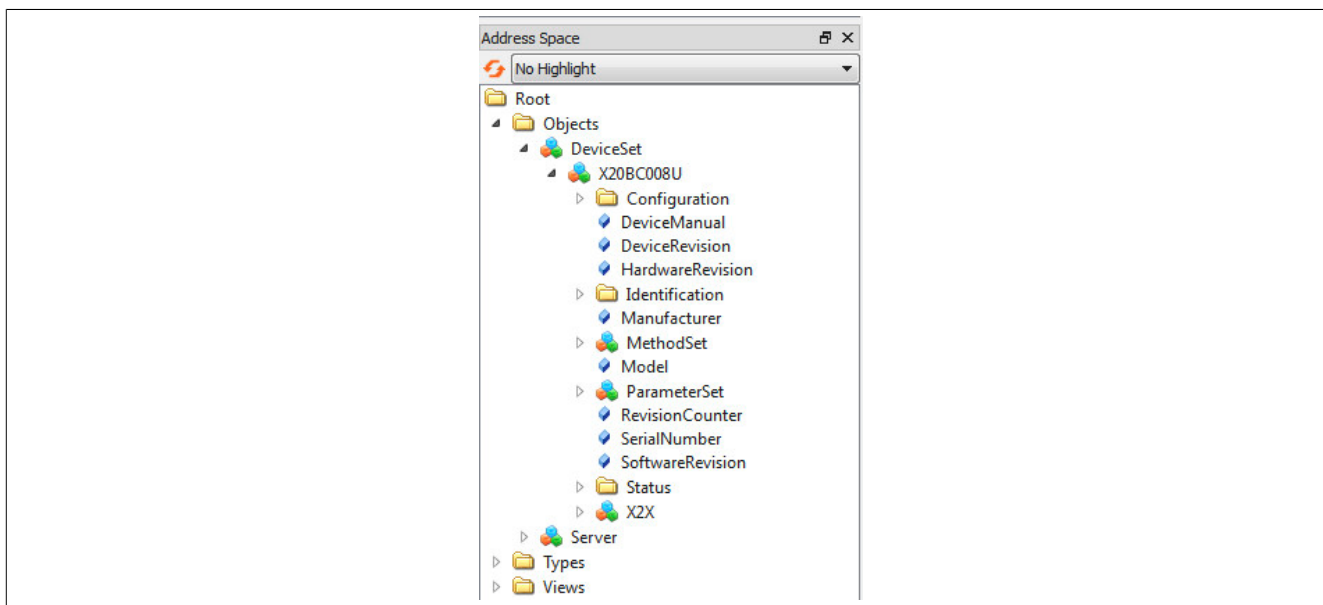
9.3.10.10 Connecting with UaExpert

This example shows how a bus controller can be connected to OPC UA client software UaExpert.



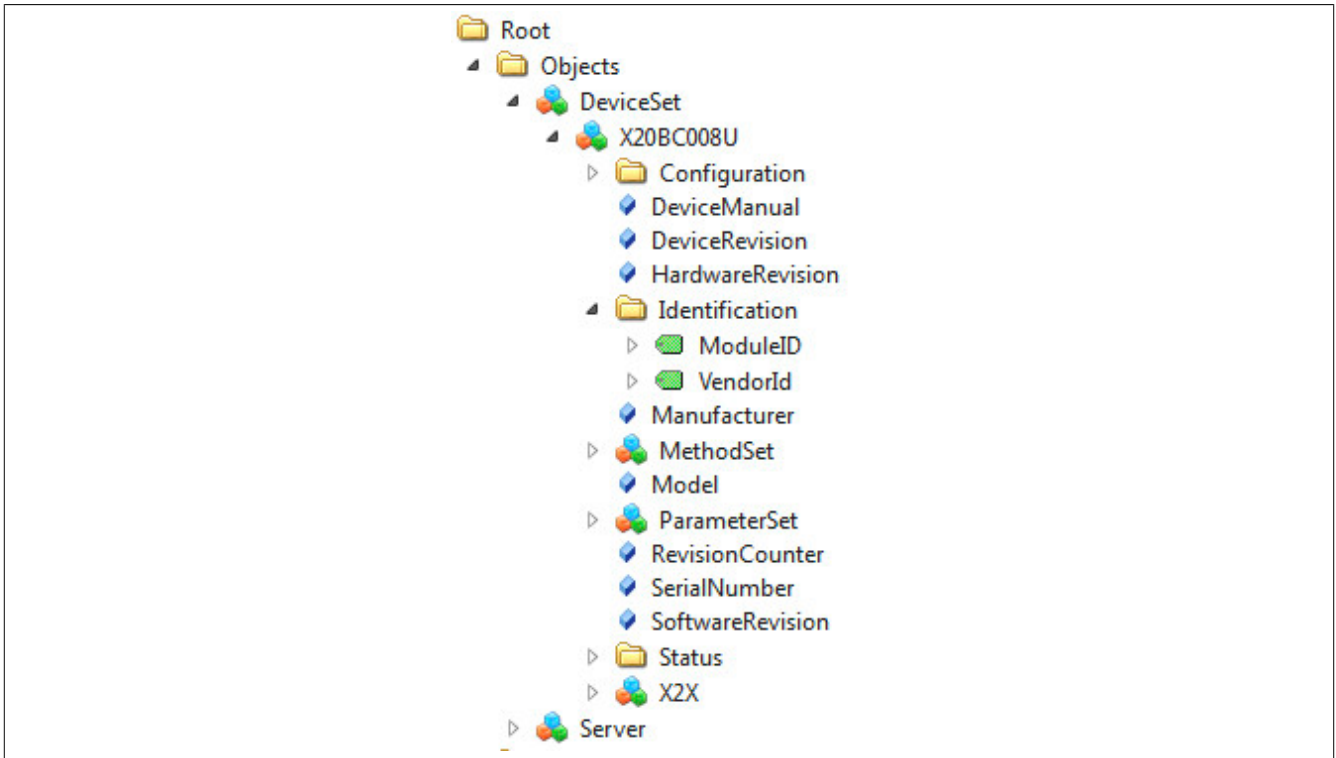
- 1) Click on "Add server" to add a server.
- 2) Double-click on "<Double-click to add server>" to enter the server's URL.
Example: "opc.tcp://bropc215:4840" or "opc.tcp://192.168.1.1:4840"
- 3) If the server can be reached over the network, double-click on "None - None (uatcp-uasc-uabinary)" to add it to the server list in the main window.
- 4) Click on "Connect server" to establish the connection.

As soon as the connection has been established, the structure of the "address space" provided by the bus controller will be shown in its own window. The bus controller is displayed under "DeviceSet" and contains all objects provided by the bus controller.



9.3.10.11 Bus controller information model

The bus controller uses the OPC UA information model to provide access to the configuration and data on the I/O modules and bus controller. This information model also enables OPC UA clients to access existing data.



Based on hierarchical references, all available nodes for the bus controller are defined as child nodes of head node `"/Root/Objects/DeviceSet/X20BC008U"`. These include nodes for configuration and access to I/O module process data.

9.3.10.11.1 Note regarding automated access

Nodes are actually accessed in the information model based on their specific node ID. For X20BC008U, this ID consists of a numerical 16-bit namespace index and 32-bit identifier.

When using a software library (e.g. AsOpcUac) to access nodes, the following points should be noted:

- First, the namespace strings should be translated into the namespace index. The necessary functions are provided by client libraries.
- Node IDs should be determined using service `"UA_TranslatePath"`.

Information:

Using hard-coded node IDs can cause problems since they may change if a new firmware version is installed.

9.3.10.11.2 Namespaces used

The following namespaces are used in the OPC UA bus controller:

| Namespace URI | Description |
|--|---|
| http://opcfoundation.org/UA/ | NamespaceIndex 0 ¹⁾ Types and objects specified by the OPC Foundation |
| urn:br-automation/BuR/UA/X20BC008U | B&R NamespaceIndex 1 ¹⁾ |
| http://br-automation.com/OpcUa/BC/io-system/ | B&R NamespaceIndex 2 ²⁾ Information model for the bus controller I/O system |

- 1) Standardized, NamespaceIndex cannot be changed.
- 2) This NamespaceIndex is not standardized and can therefore be changed. This means that the currently used index "2" could change in future firmware versions if necessary.
To avoid possible problems in applications, the namespace used should always be read with UA_GetNamespaceIndex() and added to the relative path name as a variable string (currently "2") before the directory or object name.

The namespaces used can also be read from the bus controller.

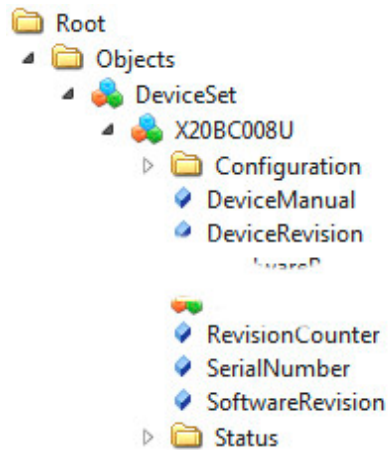
The screenshot displays the OPC UA Data Access View for the 'NamespaceArray' object. The left pane shows the Address Space tree with 'Server' and 'NamespaceArray' highlighted. The right pane shows the Data Access View for 'NamespaceArray' with a table of attributes and values. The 'Value' attribute is expanded to show an array of three namespace URIs: 'http://opcfoundation.org/UA/', 'urn:br-automation/BuR/UA/X20BC008U', and 'http://br-automation.com/OpcUa/BC/io-system/'.

| # | Server | Node Id | Display Name | Value | Datatype | urce Timestar |
|------------|-------------------|--|--------------|-------|----------|---------------|
| Attributes | | | | | | |
| Attribute | | Value | | | | |
| ▼ NodeId | | | | | | |
| | NamespaceIndex | 0 | | | | |
| | IdentifierType | Numeric | | | | |
| | Identifier | 2255 [Server_NamespaceArray] | | | | |
| | NodeClass | Variable | | | | |
| | BrowseName | 0, "NamespaceArray" | | | | |
| | DisplayName | ""; "NamespaceArray" | | | | |
| | Description | ""; "The list of namespace URIs used by the server." | | | | |
| | WriteMask | BadAttributeIdInvalid (0x80350000) | | | | |
| | UserWriteMask | BadAttributeIdInvalid (0x80350000) | | | | |
| ▼ Value | | | | | | |
| | SourceTimestamp | 01.01.1900 03:23:26.005 | | | | |
| | SourcePicoseconds | 0 | | | | |
| | ServerTimestamp | 01.01.1900 03:23:26.005 | | | | |
| | ServerPicoseconds | 0 | | | | |
| | StatusCode | Good (0x00000000) | | | | |
| | Value | String Array[3] | | | | |
| | [0] | http://opcfoundation.org/UA/ | | | | |
| | [1] | urn:br-automation/BuR/UA/X20BC008U | | | | |
| | [2] | http://br-automation.com/OpcUa/BC/io-system/ | | | | |
| | DataType | String | | | | |

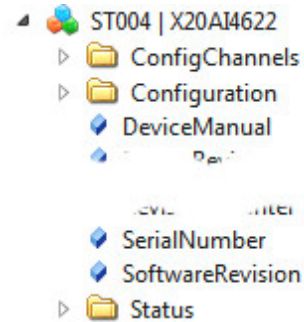
9.3.10.11.3 Device information

The bus controller object and all I/O module objects have multiple direct child nodes that allow information about the relevant modules to be exported.

Bus controller

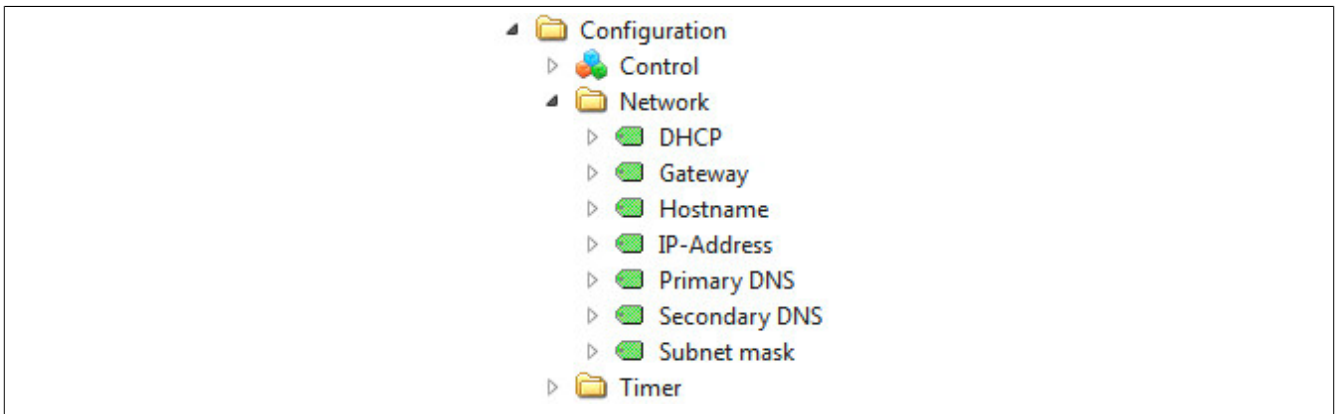


Example of an AI module



| Node name | Description |
|---------------------------|--|
| DeviceManual | URL providing further information about the module |
| DeviceRevision | Reserved |
| HardwareRevision | Current hardware revision |
| Manufacturer | Manufacturer of the module |
| Model | Module name |
| RevisionCounter | Reserved (always -1) |
| SerialNumber | Full serial number as a string |
| HardwareRevision | Current software revision |
| Identification → ModuleID | Numeric identification number for the module |
| Identification → VendorID | Numeric ID of the module manufacturer |

9.3.10.11.4 Network configuration



A valid network configuration is required in order for the bus controller to operate. The network configuration used is based on the address switch setting and the configuration stored in flash memory. For more information, see ["Address switch"](#) on page 885.

For new configuration data to be transferred, it must be saved in the control object by calling method [ApplyChanges](#) in the control object.

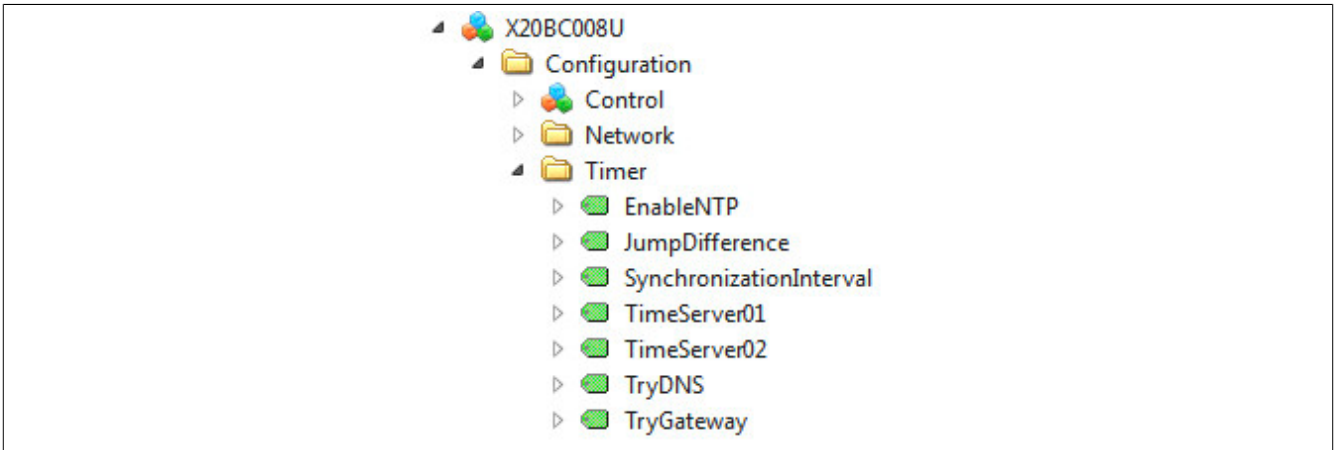
Information:

The network parameters will only be applied after the bus controller is restarted.

Position of the data in the information model: `"/ X20BC008U / Configuration / Network"`

| Node name | Description |
|-----------------------------|---|
| DHCP | Enables/Disables DHCP client functionality If the DHCP client is enabled, the gateway, IP address, subnet mask and DNS server parameters are obtained from the DHCP server. In this case, the configured values are not used. They can be read and modified, however. |
| Gateway | Configuration of the default gateway IP address |
| Hostname | Configuration of the hostname |
| IP address | Configuration of a static IP address |
| Primary DNS / Secondary DNS | Configuration of a primary or secondary DNS server |
| Subnet mask | Sets the subnet mask |

9.3.10.11.5 Time synchronization



OPC UA uses the UTC timestamp. It is possible to configure multiple NTP servers for use as time references.

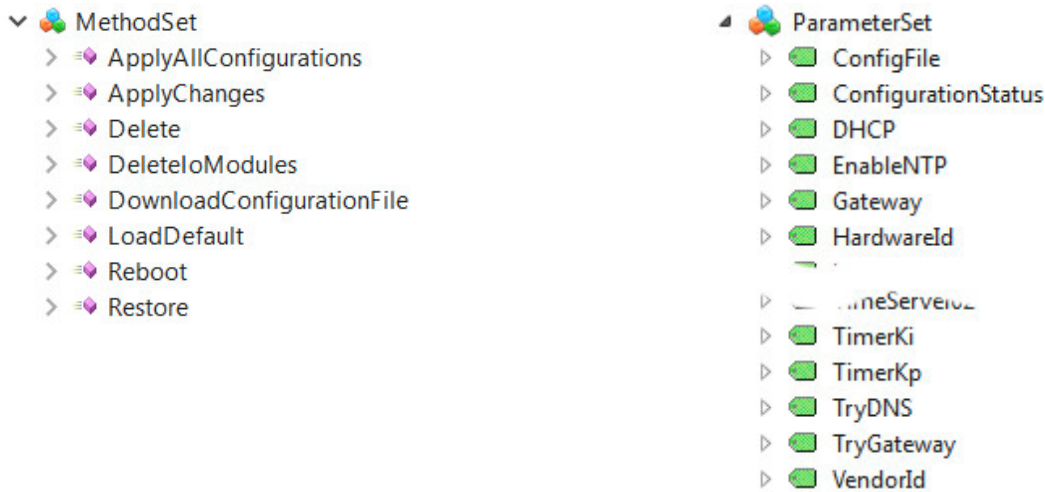
Information:

Both NTP and the OPC UA server transfer the UTC timestamp. If UTC time needs to be converted to a corresponding local time, the conversion must be carried out via the OPC UA client.

Position of the data in the information model: "../ X20BC008U / Configuration / Timer"

| Node name | Description |
|-----------------------------|---|
| EnableNTP | Enables/Disables time synchronization. |
| JumpDifference | Time difference from which a time jump occurs (in milliseconds). During normal operation, the internal timer synchronizes to the reference time of at least one time server. If a difference is detected that is greater than the value specified in this parameter, a time jump occurs. If the deviation is minimal, a time jump does not occur. Instead, the difference is corrected by adjusting the timer speed. |
| SynchronizationInterval | Interval at which the time is polled from the time server (in minutes). |
| TimerServer01/TimerServer02 | Hostnames or IP addresses of up to 2 time servers. If one of the servers is not available, the other will be used instead. |
| TryDNS | An attempt will be made to use the DNS server as the time server. This option can be useful if the network configuration is obtained via DHCP since network stations on which the DNS server is hosted will often host an NTP server as well. In this case, an NTP server does not need to be configured. |
| TryGateway | An attempt will be made to use the default gateway as the time server. This option can be useful if the network configuration is obtained via DHCP since the default gateway often hosts an NTP server as well. In this case, an NTP server does not need to be configured. |

9.3.10.11.6 MethodSet and ParameterSet



The bus controller object and the I/O module objects each contain objects "MethodSet" and "ParameterSet".

- "MethodSet" groups all methods for a given module into a flat list.
- "ParameterSet" groups all variable nodes into a flat list.

These sets should be used if variables and nodes are to be accessed automatically. The advantage of providing access via a set is that the location of the nodes is known from the start. It is then not necessary to take an additional structure into account. This allows the structure to be changed (e.g. due to new features, better clarity, etc.) without having to adapt automatic accesses.

Position of the data in the information model:

"./ X20BC008U / MethodSet"

"./ X20BC008U / ParameterSet"

9.3.10.11.6.1 Supported methods

Apply

There are 2 different methods for saving changed values.

- [ApplyChanges](#) - Save a single value
- [ApplyAllConfigurations](#) - Save all values

ApplyAllConfigurations

This method is in the [MethodSet](#) of the X20BC008U object. This means that all changed configurations can be applied at once. This replaces individual calls of method [ApplyChanges](#).

When method "ApplyAllConfigurations" is called, all changed configurations are initially saved. Then it is checked whether one of the configuration changes requires a restart of the bus controller. If so, this is indicated in the corresponding output argument for the method and the procedure is ended. The configuration is only applied after the bus controller has been restarted, e.g. by calling method [Reboot](#). If no restart of the bus controller is required, all I/O modules requiring a restart due to the configuration change are restarted automatically.

ApplyChanges

Changed values are only saved by calling method "ApplyChanges". The method has an output argument that indicates the [configuration status](#) at the end of the call.

If the new configuration leads to the creation of additional cyclic data on the X2X Link network, the new parameters will not be applied immediately. In this case, the bus controller must be restarted (see "[Reboot](#)" on [page 896](#)). This is indicated by configuration status "Reboot of bus controller required". The bus controller does not have to be restarted immediately, however. Further I/O modules can be configured first.

If the module has been reconfigured without increasing the size of the cyclic X2X frame, only the I/O module is restarted. This is indicated by configuration status "Module reboot triggered". After restarting the module, the changed configuration was applied. This is indicated by configuration status "Configuration OK".

As soon as method "ApplyChanges" has been called, the module is permanently assigned to a slot. From then on, the slot will only accept modules of the same type. If another module type is connected, this module does not boot up completely and remains in mode PREOPERATIONAL mode. Configuration status "Wrong ModuleId" is displayed.

Delete

When method "Delete" is called, the configuration file for the corresponding module is deleted. However, the currently active configuration is not modified.

Modules of any type can be connected in the slot used. After the bus controller has restarted, the module that is currently inserted is started with its default configuration.

DeleteloModules

This method deletes the configuration files of all configured X2X modules.

This method is only available with firmware versions $\geq V1.13$.

Information:

Each deletion of a configuration, i.e. both "[Delete](#)" and "[DeleteloModules](#)", requires a restart of the bus controller.

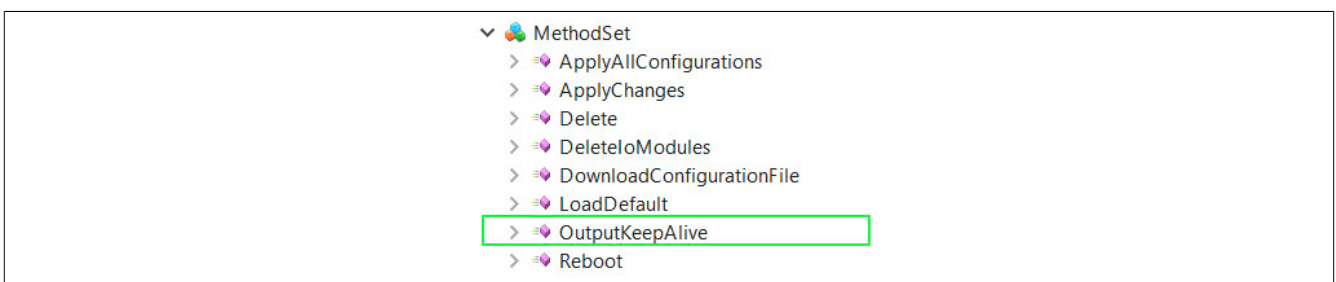
DownloadConfigurationFile

This method allows configuration data to be downloaded to the bus controller in XML format.

LoadDefault

This method loads the default configuration for the relevant module. All parameters are reset to their default setting. However, the configuration is only saved and transferred when method [Apply](#) is called.

OutputKeepAlive



This method defines the behavior of the digital outputs after connection loss. By default, the digital outputs maintain the current output states after connection loss. This means that outputs remain set if they were set.

This method is only available with firmware versions V1.18 or later.

RegisterRead

This method is located in the [method set](#) of the I/O module object. It allows I/O module registers to be read directly. As an input argument, this method requires the number corresponding to the register that is to be read. The read value is returned as an output argument.

Reboot

This method is in the [method set](#) of the X20BC008U object. It allows the bus controller to be restarted. If the method is called, all connected clients are disconnected and the bus controller and all I/O modules are restarted.

Starting with firmware version V1.13, it is possible to restart each connected X2X module individually by calling a method. This is normally not required since the bus controller automatically restarts the connected X2X modules if necessary. In addition, the NodeID of the reboot method has been modified.

- NodeID in firmware <V1.13: 120
- NodeID in firmware ≥V1.13: 240

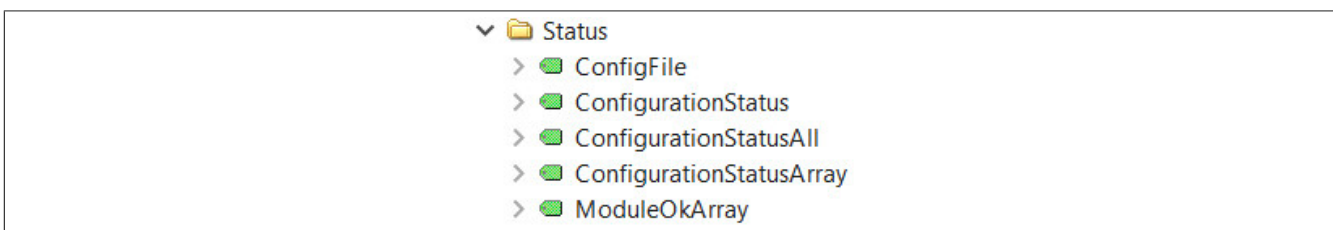
RegisterWrite

This method is located in the [method set](#) of the I/O module object. It is used to write registers to the relevant I/O module directly. The register number and the value to be written are transferred as input arguments.

Restore

Calling this method restores the last saved configuration.

9.3.10.11.7 Status



Position of the data in the information model: `../X20BC008U/Status"`

9.3.10.11.7.1 ConfigFile

This node allows the current configuration to be exported in XML format. Only parameters that deviate from the default setting are saved in the configuration file.

9.3.10.11.7.2 ConfigurationStatus

This node indicates the current configuration state.

| Value | EnumString | Description |
|-------|---------------------------------------|--|
| 0 | Not configured | Not configured |
| 1 | No configuration available | A module for which no configuration has been saved is inserted in the slot. In this case, the module runs with its default configuration. |
| 2 | Configuration ready | A configuration exists for a module in this slot, but the module is not available. |
| 3 | Configuration OK | The module is configured correctly. |
| 4 | Configuration changed but not applied | The configuration was changed. The modified parameters have not yet been applied or saved, however. |
| 5 | Module reboot triggered | A restart has been triggered for the module. |
| 6 | Wrong ModuleId | The module in the slot does not correspond to the module configured for this slot. |
| 7 | Reboot of bus controller required | The configuration was saved but could not be applied straightaway. In this case, the saved configuration will be applied after the bus controller has restarted. |
| 8 | Error during configuration | An error occurred during configuration. |

9.3.10.11.7.3 ModuleOK

This node also exists in folder [Process data](#). It indicates whether the I/O module is functioning correctly.

9.3.10.11.7.4 NetworkStatus

The network status provides information about the operating state of the X2X Link stations, i.e. the bus modules of the respective I/O modules.

| Bit | Description |
|-------|---------------------------------|
| 0 | I/O bus supply, 1 = OK |
| 1 | Reserved |
| 2 | I/O bus, 1 = OK |
| 3 | DataValid, 0 = OK, 1 = Old data |
| 4 - 7 | Always 1 |

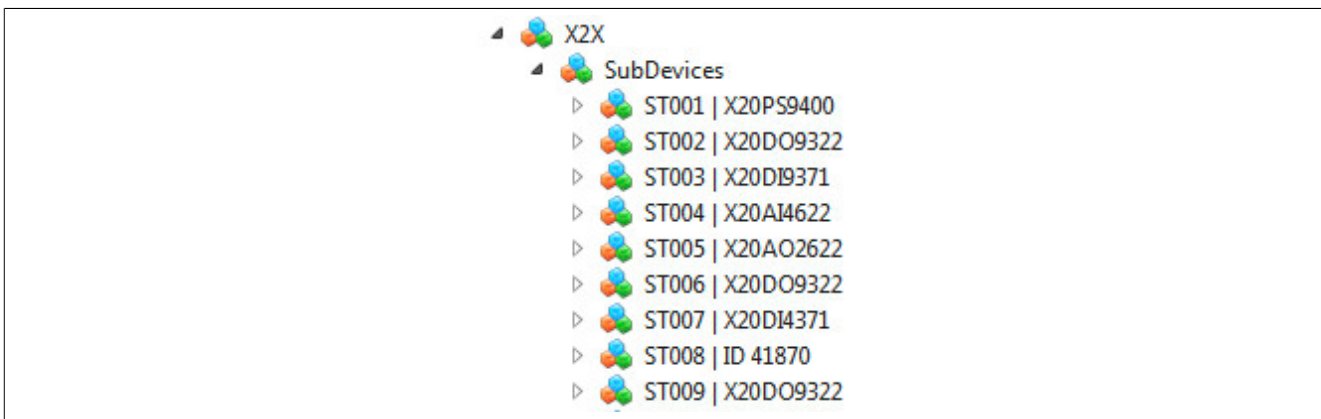
This results in the following values:

| Description | Value (decimal) | Value (hex) |
|---|-----------------|-------------|
| X2X Link station inactive (e.g. no X2X Link power supply) | 0 | 0x00 |
| Everything OK (I/O data valid) | 245 | 0xF5 |
| No communication with the electronics module (bits 7 to 3 invalid) | 249 | 0xF9 |
| I/O data invalid, communication between X2X ASIC and electronics module OK (ASIC carried out a valid "Sync in" transfer with the electronics module in the previous X2X Link cycle) | 253 | 0xFD |

Information:

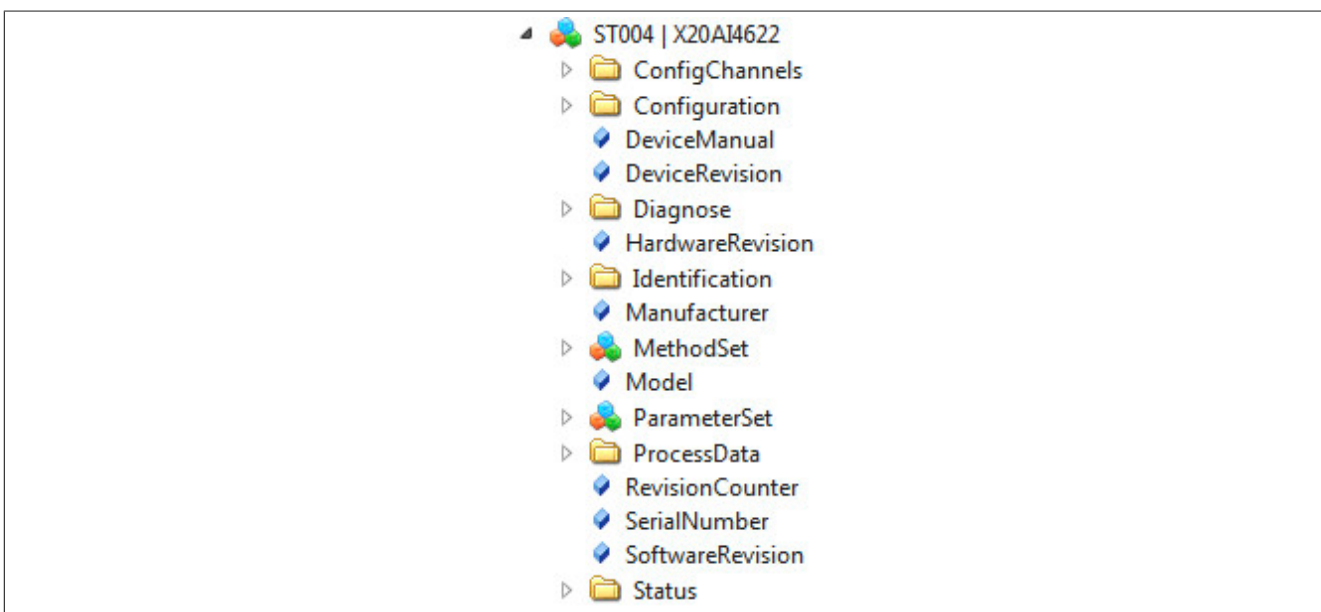
Any value unequal to 245 (0xF5) means that the I/O data of the corresponding module is invalid. This circumstance is usually taken into account or processed accordingly in the application.

9.3.10.11.8 X2X Link and I/O modules



All I/O modules detected on the X2X Link network are listed under "X20BC008U / X2X / SubDevices". All data, control and configuration nodes assigned to the respective module are located at a lower level.

Example of an AI module's nodes



Connected modules are automatically detected and started with their default configuration, provided that a corresponding configuration has not been saved. In order to fully map I/O module nodes, the bus controller contains a database with additional information for each module. The information model is updated accordingly, allowing the modules' full range of functions to be used. For a list of modules supported by the database, see "[Supported modules](#)" on page 899.

X2X modules not contained in the database can be used in function model 254. Since the bus controller does not know the product ID in this case, the modules are labeled "ID 'ModuleID>'" (see e.g. "ID 41870" in the image above). The configuration for these modules can only be modified using method "[RegisterWrite](#)" on page 896. The process data points are labeled "RegisterXX" in folder [Process data of the I/O modules](#). For the meaning of register numbers, see the relevant module documentation.

Information:

It is not possible to modify the process data image in this operating mode.

9.3.10.11.8.1 Supported modules

The following table shows all of the I/O modules that are stored in the bus controller's database. See "X2X Link and I/O modules" on page 898.

| Model number | Starting with firmware version | Description |
|--------------|--------------------------------|--|
| X20AI2222 | V1.13 | X20 analog input module, 2 inputs, ± 10 V, 13-bit converter resolution, configurable input filter |
| X20AI2322 | V1.13 | X20 analog input module, 2 inputs, 0 to 20 mA / 4 to 20 mA, 12-bit converter resolution, configurable input filter |
| X20AI2622 | V1.00 | X20 analog input module, 2 inputs, ± 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution, configurable input filter |
| X20AI4222 | V1.13 | X20 analog input module, 4 inputs, ± 10 V, 13-bit converter resolution, configurable input filter |
| X20AI4322 | V1.13 | X20 analog input module, 4 inputs, 0 to 20 mA / 4 to 20 mA, 12-bit converter resolution, configurable input filter |
| X20(c)AI4622 | V1.00 Coated module V1.18 | X20 analog input module, 4 inputs, ± 10 V or 0 to 20 mA / 4 to 20 mA, 13-bit converter resolution, configurable input filter |
| X20AI8221 | V1.13 | X20 analog input module, 8 inputs, ± 10 V, 13-bit converter resolution |
| X20AI8321 | V1.13 | X20 analog input module, 8 inputs, 0 to 20 mA, 12-bit converter resolution |
| X20AO2622 | V1.00 | X20 analog output module, 2 outputs, 10 V or 0 to 20 mA / 4 to 20 mA, 13 bit converter resolution |
| X20(c)AO4622 | V1.00 Coated module V1.18 | X20 analog output module, 4 outputs, 10 V or 0 to 20 mA / 4 to 20 mA, 13 bit converter resolution |
| X20AP3111 | V1.13 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 20 mA AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function |
| X20(c)AP3121 | V1.13 Coated module V1.18 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 1 A AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function |
| X20AP3122 | V1.13 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 1 A AC, groundable, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function |
| X20(c)AP3131 | V1.13 Coated module V1.18 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 5 A AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function |
| X20AP3132 | V1.13 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 5 A AC, groundable, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function |
| X20AP3161 | V1.13 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, 333 mV AC, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function |
| X20AP3171 | V1.13 | X20 energy metering module, 3 analog inputs, 480 VAC, 50/60 Hz, 4 analog inputs, Rogowski adjustable (μ V/A), max. 52 mV, calculates effective, reactive and apparent power/energy, calculates RMS values, 240 V keyed, NetTime function |
| X20AT2222 | V1.00 | X20 temperature input module, 2 inputs for resistance measurement, PT100, PT1000, resolution 0.1°C, 3-wire connections |
| X20AT2402 | V1.00 | X20 temperature input module, 2 thermocouple inputs, Type J, K, N, S, B, R, resolution 0.1°C |
| X20(c)AT4222 | V1.00 | X20 temperature input module, 4 inputs for resistance measurement, PT100, PT1000, resolution 0.1°C, 3-wire connections |
| X20(c)AT6402 | V1.00 | X20 temperature input module, 6 thermocouple inputs, Type J, K, N, S, B, R, resolution 0.1°C |
| X20(c)BR9300 | V1.18 | X20 bus receiver, X2X Link, supply for X2X Link and internal I/O power supply |
| X20(c)BT9100 | V1.18 | X20 bus receiver, X2X Link, supply for X2X Link and internal I/O power supply |
| X20BT9400 | V1.18 | X20 bus transmitter, X2X Link, supply for internal I/O power supply, X2X Link supply for X67 modules, reverse polarity protection, short-circuit proof, overload-proof, parallel connection possible, redundancy operation possible |
| X20CM8281 | V1.20 | X20 Universelles Mischmodul, 4 digitale Eingänge, 24 VDC, Sink, 1-Leitertechnik, 2 digitale Ausgänge, 0,5 A, Source, 1-Leitertechnik, 1 analoger Eingang, ± 10 V oder 0 bis 20 mA / 4 bis 20 mA, 12 Bit Wandlerauflösung, 1 analoger Ausgang, ± 10 V / 0 bis 20 mA, 12 Bit Wandlerauflösung, 2 Zähler als Ereigniszähler oder zur Torzeitmessung |
| X20(c)CS1020 | V1.13 Coated module V1.18 | X20 interface module, 1 RS232 interface, max. 115.2 kbit/s |
| X20(c)CS1030 | V1.13 Coated module V1.18 | X20 interface module, 1 RS422/485 interface, max. 115.2 kbit/s |
| X20DI2371 | V1.00 | X20 digital input module, 2 inputs, 24 VDC, sink, configurable input filter, 3-wire connections |
| X20DI2372 | V1.00 | X20 digital input module, 2 inputs, 24 VDC, source, configurable input filter, 3-wire connections |
| X20DI2377 | V1.20 | X20 Digitales Eingangsmodule, 2 Eingänge, 24 VDC, Sink, Eingangsfilter parametrierbar, 2 Ereigniszähler 50 kHz, 3-Leitertechnik |
| X20(c)DI4371 | V1.00 | X20 digital input module, 4 inputs, 24 VDC, sink, configurable input filter, 3-wire connections |
| X20DI4372 | V1.00 | X20 digital input module, 4 inputs, 24 VDC, source, configurable input filter, 3-wire connections |
| X20(c)DI6371 | V1.00 | X20 digital input module, 6 inputs, 24 VDC, sink, configurable input filter, 2-wire connections |
| X20(c)DI6372 | V1.00 | X20 digital input module, 6 inputs, 24 VDC, source, configurable input filter, 2-wire connections |
| X20DI8371 | V1.00 | X20 digital input module, 8 inputs, 24 VDC, sink, configurable input filter, 1-wire connections |
| X20(c)DI9371 | V1.00 | X20 digital input module, 12 inputs, 24 VDC, sink, configurable input filter, 1-wire connections |
| X20(c)DI9372 | V1.00 | X20 digital input module, 12 inputs, 24 VDC, source, configurable input filter, 1-wire connections |
| X20DID371 | V1.00 | X20 digital input module, 8 inputs, 24 VDC, sink, configurable input filter, 2-wire connections |
| X20(c)DIF371 | V1.00 Coated Modul V1.18 | X20 digital input module, 16 inputs, 24 VDC, sink, configurable input filter, 1-wire connections |
| X20DO2321 | V1.18 | X20 Digitales Ausgangsmodul, 2 Ausgänge, 24 VDC, 0,5 A, Sink, 3-Leitertechnik |
| X20DO2322 | V1.00 | X20 digital output module, 2 outputs, 24 VDC, 0.5 A, source, 3-wire connections |
| X20DO4321 | V1.18 | X20 digital output module, 4 outputs, 24 VDC, 0.5 A, sink, 3-wire connections |
| X20(c)DO4322 | V1.00 | X20 digital output module, 4 outputs, 24 VDC, 0.5 A, source, 3-wire connections |
| X20DO4331 | V1.18 | X20 digital output module, 4 outputs, 24 VDC, 2 A, sink, 3-wire connections |
| X20DO4332 | V1.00 Coated module V1.18 | X20 digital output module, 4 outputs, 24 VDC, 2 A, source, 3-wire connections |
| X20(c)DO6321 | V1.18 | X20 digital output module, 6 outputs, 24 VDC, 0.5 A, sink, 2-wire connections |
| X20(c)DO6322 | V1.00 | X20 digital output module, 6 outputs, 24 VDC, 0.5 A, source, 2-wire connections |
| X20DO8232 | V1.00 | X20 digital output module, 8 outputs, 12 VDC, 2 A, source, supply directly on module, 1-wire connections |
| X20DO8322 | V1.00 | X20 digital output module, 8 outputs, 24 VDC, 0.5 A, source, 1-wire connections |
| X20(c)DO8331 | V1.18 | X20 digital output module, 8 outputs, 24 VDC, 2 A, sink, supply directly on module, 1-wire connections |

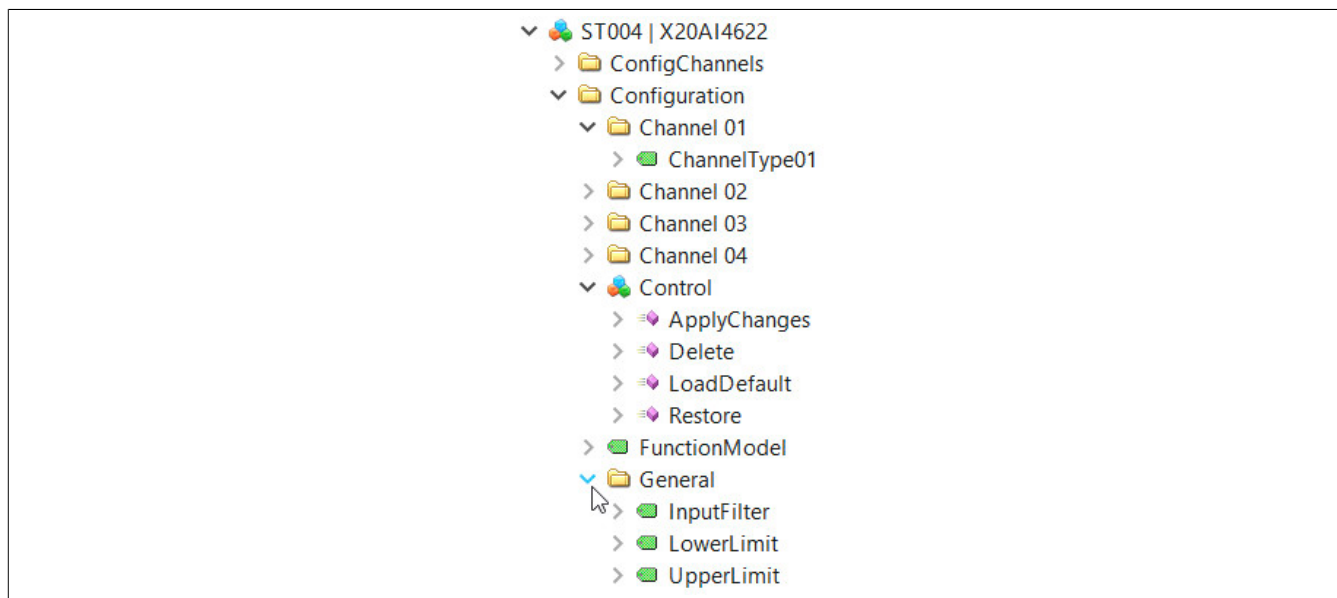
| Model number | Starting firmware version | Description |
|--------------|-----------------------------|--|
| X20(c)DO8332 | V1.00 | X20 digital output module, 8 outputs, 24 VDC, 2 A, source, supply directly on module, 1-wire connections |
| X20(c)DO9321 | V1.18 | X20 digital output module, 12 outputs, 24 VDC, 0.5 A, sink, 1-wire connections |
| X20(c)DO9322 | V1.00 | X20 digital output module, 12 outputs, 24 VDC, 0.5 A, source, 1-wire connections |
| X20DOD322 | V1.00 | X20 digital output module, 8 outputs, 24 VDC, 0.5 A, source, 2-wire connections |
| X20(c)DOF322 | V1.00 Coated Modul V1.18 | X20 digital output module, 16 outputs, 24 VDC, 0.5 A, source, 1-wire connections |
| X20(c)PS2100 | V1.00 | X20 power supply module, for internal I/O power supply |
| X20(c)PS3300 | V1.00 Coated Modul V1.18 | X20 power supply module, for X2X Link and internal I/O power supply |
| X20(c)PS3310 | V1.00 Coated Modul V1.18 | X20 power supply module, for X2X Link and internal I/O power supply, integrated fine-wire fuse |
| X20(c)PS9400 | V1.00 | X20 power supply module, for bus controller and internal I/O power supply X2X Link power supply |
| X20PS9402 | V1.00 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link supply, supply not electrically isolated |

9.3.10.11.8.2 Configuration of the I/O modules

I/O modules can be configured via the information model. The corresponding nodes are grouped in folder "Configuration", which exists for each module. The configuration parameters contained in this folder and the structure of these parameters are specific to each I/O module. For an explanation of parameters, see the respective module documentation. In addition to the configuration nodes, each configuration folder contains an object named "Control." The methods contained in this object are used to control the configuration process.

The current status of the configuration can be queried via node [ConfigurationStatus](#).

Example of a module configuration



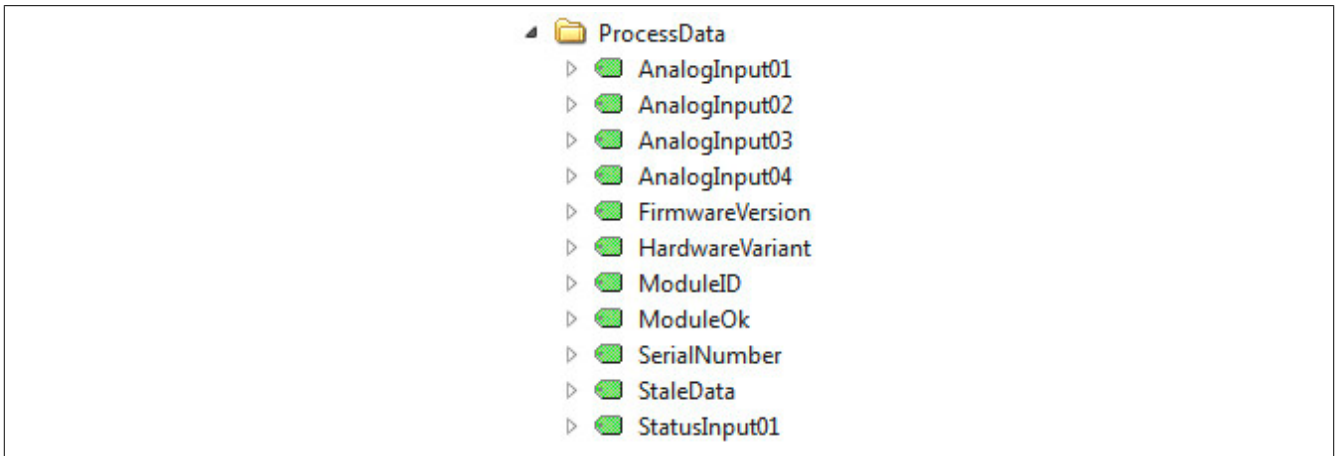
Information:

Modifying the configuration can lead to the addition or removal of configuration parameters. To detect this, the relevant higher-level node must be re-imported (browsed).

9.3.10.11.8.3 Process data of the I/O modules

The process data provided by an I/O module is grouped in folder "ProcessData". These nodes allow output process data to be written and input process data to be read. For the meaning of data points, see the relevant module documentation.

Example of an AI module's process data



Information:

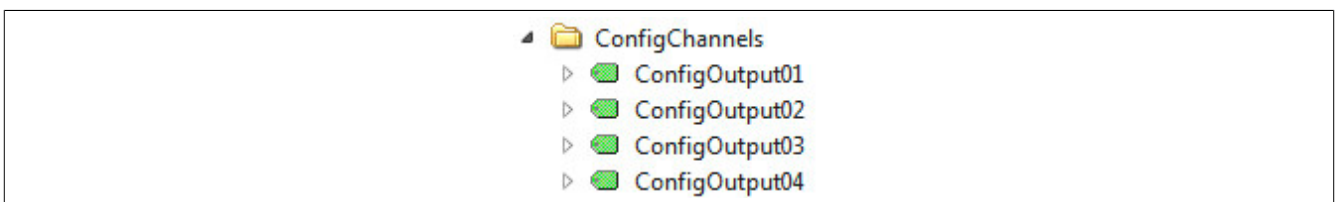
If the configuration is modified, the available process data nodes may change. To detect this, the relevant higher-level node must be re-imported (browsed).

Until the relevant configuration changes are applied, it may not be possible to feed data to recently enabled nodes. This is indicated via a corresponding state.

9.3.10.11.8.4 ConfigChannels

This folder groups nodes containing a copy of the values that were written to the relevant configuration register in the module. These values can only be read and are provided for troubleshooting purposes. They are automatically calculated on initialization or on applying the configuration. For more information about the meaning of these values, see the relevant module documentation.

Example of an AI module's ConfigChannel nodes



9.3.10.12 License information

The following open-source components are included in the firmware for this module:

- [LWIP](#)
- [qsort](#)
- [yxml](#)

9.3.10.12.1 LWIP

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9.3.10.12.2 qsort

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9.3.10.12.3 yxml

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9.3.11 X20(c)BC00E3

Data sheet version: 1.25

9.3.11.1 General information

PROFINET (Process Field Network) is an Industrial Ethernet protocol. It uses TCP/IP and is real-time capable.

PROFINET IO is specially designed for communication between a controller and decentralized field devices and describes the entire data exchange between controllers (masters) and devices (slaves) as well as configuration and diagnostics. It follows the producer-consumer model.

2 transfer variants are available:

- Real-time (RT) communication
- Isochronous real-time (IRT) communication

Within PROFINET IO, process data and alarms are always transferred in real time (RT). RT communication is the basis for data exchange with PROFINET IO. Clock-synchronous data exchange with PROFINET is defined in the isochronous real-time (IRT) concept. The difference to real-time communication lies essentially in the determinism, so that the start of a bus cycle is maintained with the highest precision.

X20 modules or other modules based on X2X Link can be connected to the bus controller. Modular system configurations are optimally supported by PROFINET. Using the device description file (GSDML format), it is very easy to handle project configuration in the respective engineering tool from the manufacturer of the master device.

- Fieldbus: PROFINET IO
- I/O configuration via the fieldbus
- Conformance Class B
- Minimum cycle time 1 ms
- Integrated switch for cabling multiple slaves
- 100 Mbit/s full duplex mode
- Up to 1440 bytes of input data and up to 1440 bytes of output data are possible
- Integrated website
- PROFINET diagnostics and module diagnostics during runtime from within the master environment
- Module and switch diagnostics during runtime using the website or SNMP

9.3.11.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.3.11.3 Order data

| Model number | Short description | Figure |
|--------------|--|--------|
| | Bus controllers | |
| X20BC00E3 | X20 bus controller, 1 PROFINET IO interface, integrated 2-port switch, 2x RJ45, order bus base, power supply module and terminal block separately! | |
| X20cBC00E3 | X20 bus controller, coated, 1 PROFINET IO interface, integrated 2-port switch, 2x RJ45, order bus base, power supply module and terminal block separately! | |
| | Required accessories | |
| | System modules for bus controllers | |
| X20BB80 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20PS9400 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply | |
| X20PS9402 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply, supply not electrically isolated | |
| X20cBB80 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cPS9400 | X20 power supply module, coated, for bus controller and internal I/O power supply, X2X Link power supply | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 126: X20BC00E3, X20cBC00E3 - Order data

9.3.11.4 Technical data


| Model number | X20BC00E3 | X20cBC00E3 |
|--|---|--|
| Short description | | |
| Bus controller | PROFINET IO slave | |
| General information | | |
| B&R ID code | 0xBB7D | 0xE4E0 |
| Status indicators | Module status, bus function | |
| Diagnosics | | |
| Module status | Yes, using status LED and software | |
| Bus function | Yes, using status LED and software | |
| Power consumption | | |
| Bus | 2.5 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations | |
| ATEX | Class I, Division 2, Groups ABCD, T5 Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | |
| Interfaces | | |
| Fieldbus | PROFINET IO slave | |
| Variant | 2x shielded RJ45 (switch) | |
| Line length | Max. 100 m between 2 stations (segment length) | |
| Transfer rate | 100 Mbit/s | |
| Transfer | | |
| Physical layer | 100BASE-TX | |
| Half-duplex | Yes | |
| Full-duplex | Yes | |
| Autonegotiation | Yes | |
| Auto-MDI/MDIX | Yes | |
| Min. cycle time ¹⁾ | | |
| Fieldbus | 1 ms | |
| X2X Link | 250 µs | |
| Synchronization between bus systems possible | Yes | |
| Electrical properties | | |
| Electrical isolation | PROFINET isolated from bus and I/O | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20PS9400 or X20PS9402 power supply module separately Order 1x X20BB80 bus base separately | Order 1x X20TB12 terminal block separately Order 1x X20cPS9400 pow- er supply module separately Order 1x X20cBB80 bus base separately |
| Spacing ²⁾ | 37.5 ^{+0.2} mm | |

Table 127: X20BC00E3, X20cBC00E3 - Technical data

- 1) The minimum cycle time defines how far the bus cycle can be reduced without communication errors occurring.
2) Spacing is based on the width of the X20BB80 bus base. In addition, an X20PS9400 or X20PS9402 supply module is always required for the bus controller.

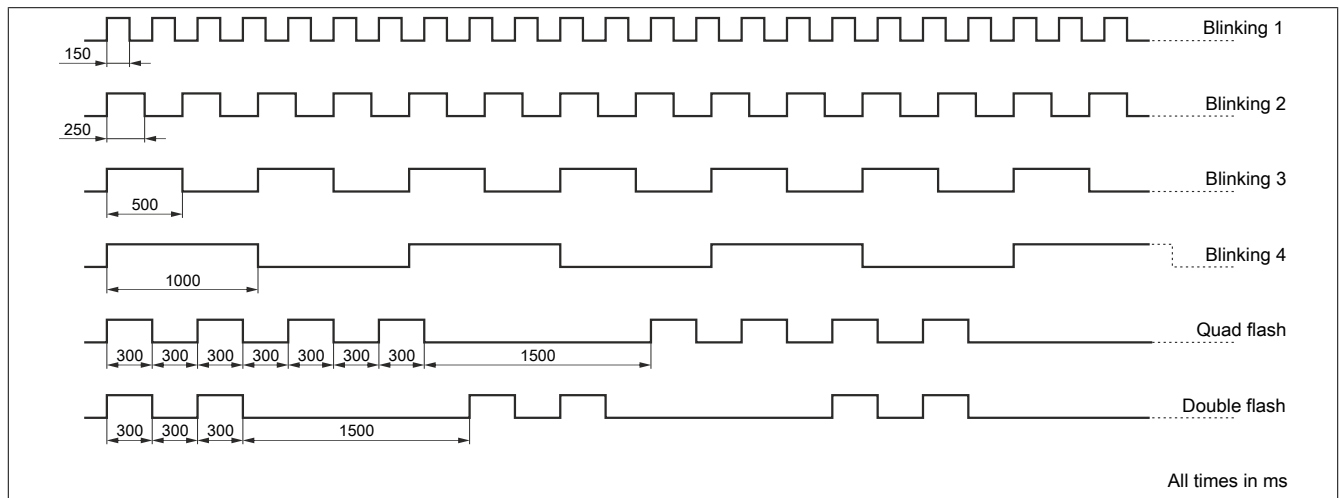
9.3.11.5 LED status indicators

The following table lists the LED status indicators available on the bus controller. Exact blink times are specified in the timing diagram in the next section.

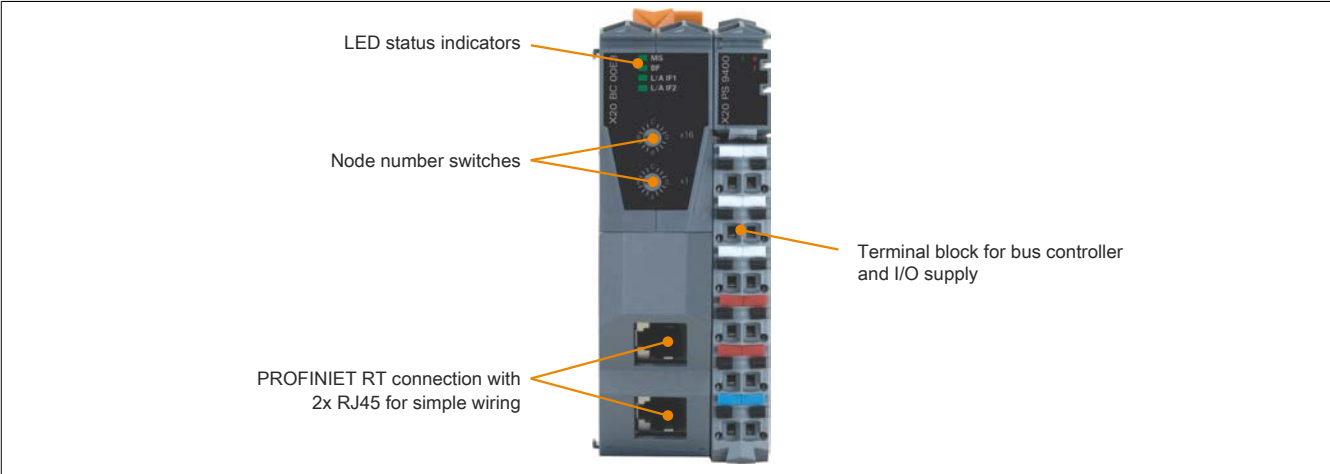
| Figure | LED | Color | Status | Description | |
|---|---|------------------|--------------|---|--|
|  | MS ¹⁾ | Green | Off | The PROFINET master is in "Stop" mode. | |
| | | | Quad flash | The bus controller does not have a valid IP address (0.0.0.0). It will wait in this state until it is assigned an IP address from the PROFINET master or from an external source. This state can also occur if the bus controller is being operated in DHCP mode. | |
| | | | Double flash | An unacknowledged alarm is pending on the bus controller. | |
| | | | Blinking 1 | The bus controller is in the initialization phase. This boot phase is where all connected I/O modules are initialized. | |
| | | | Blinking 3 | The bus controller is configuring the connected I/O modules. The configuration is transferred to the bus controller via the PROFINET master. | |
| | | | On | A connection to a PROFINET master has been established. The master and slave are both in OPERATIONAL mode and data is being exchanged between them. This mode also indicates that the master itself is in RUN mode. | |
| | | | Red | Blinking 4 | The bus controller has detected an error. However, it can still be corrected in the master environment during runtime. |
| | | | | Blinking 1 | The bus controller has detected an error. This error cannot be corrected during runtime; a restart is required. |
| | | BF ¹⁾ | Green | Blinking 2 | Device identification ("blink" function in step 7 when searching for existing Ethernet stations). |
| | | | | On | A connection to a PROFINET master has been established. |
| | | | Red | On | Not connected to a PROFINET Master |
| | | | | L/A IFx | Green |
| Blinking | Ethernet activity taking place on the RJ45 interface (IF1, IF2) indicated by the respective LED | | | | |
| On | Indicates an established connection (link), but no communication is taking place | | | | |

1) The "MS" and "BF" LEDs are green/red dual LEDs.

LED status indicators - Blinking patterns

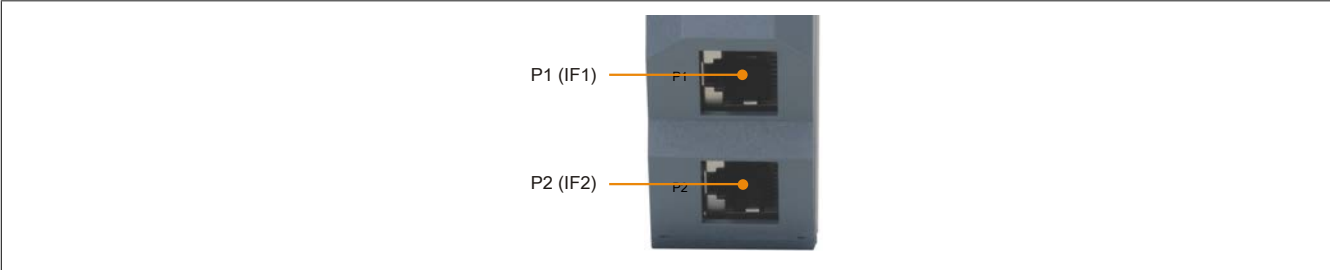


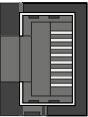
9.3.11.6 Operating and connection elements



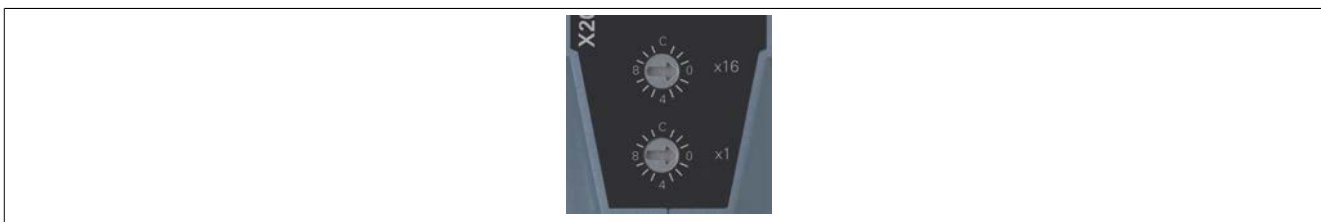
9.3.11.7 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see "Cabling guidelines for X20 modules with an Ethernet cable" on page 58.



| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.3.11.8 Node number switches



This bus controller is equipped with 2 node number switches. The bus controller can be set to various operating states with certain predefined switch positions. Various parameters (PROFINET device name, DHCP mode, etc.) can also be configured.

| Switch position | Description |
|-----------------|--|
| 0x00 | Initializes all parameters from flash memory: PROFINET-compliant initialization via the DCP protocol (factory setting) |
| 0x01 - 0xEF | These switch positions generate a valid PROFINET device name. This name is composed as follows: "brpnXXX". Number XXX corresponds to the decimal value of the node number switch position. The system automatically adds leading 0s. |
| 0xF0 | Erases flash memory (see "Erasing flash memory" on page 908) |
| 0xF1 - 0xFD | Reserved, switch position not permitted |
| 0xFE | IP address via DHCP server |
| 0xFF | Sets all parameters to default |

PROFINET-compliant factory setting - Node number switch position 0x00

| Parameter | Value |
|----------------------|-------------------------------|
| IP address | 0.0.0.0 |
| Subnet mask | 0.0.0.0 |
| Gateway | 0.0.0.0 |
| PROFINET device name | "" ... No name when delivered |

Default parameters - Node number switch position 0xFF

Parameters cannot be changed by the master in node switch position 0xFF.

| Parameter | Value |
|----------------------|-----------------|
| IP address | 192.168.100.1 |
| Subnet mask | 255.255.255.0 |
| Gateway | 192.168.100.254 |
| PROFINET device name | x20bc00e3 |

9.3.11.9 Erasing flash memory

Erasing flash memory using switch position 0xF0 returns the bus controller to its factory state.

Procedure

1. Turn off the power supply to the bus controller.
2. Set the node number to 0xF0.
3. Turn the power supply to the bus controller back on.
4. Wait until the "MS" LED flashes green for 5 s. The node number switch must be set to 0x00 and then back to 0xF0 within this time window of 5 seconds (rotate the top switch).
5. Wait until the "MS" LED blinks with a red double-flash (flash has been cleared).
6. Turn off the power supply to the bus controller.
7. Set the desired node number (0x00 - 0xEF)
8. Turn the power supply to the bus controller back on.
9. The bus controller boots with the configured node number.

9.3.11.10 Web interface

The integrated Web interface gives the user an overview of the bus controller's network parameters, the configured I/O modules and the switch configuration. The starting page includes information regarding specific bus controller settings such as IP address, host name and the PROFINET device name. In addition, the web page provides information about the current firmware version. Information concerning module diagnostics is incorporated into a tree structure. Expanding and collapsing the individual module nodes provides an overview of the configured I/O modules. In addition, various package counters are read from the integrated switch. This makes diagnosing errors on the network quick and easy.

Network parameters concerning the bus controller itself can be read, but they cannot be modified. The bus controller's IP configuration is handled during booting or by the PROFINET master when a connection is established.

Each page of the Web interface contains help information that describes the functions and parameters displayed on that page. The link to this information can be found in the upper right corner of the page in the form of a question mark.

A connection to the web interface is established by entering the **current IP address** or the unique **host name** in a Web browser. Some functions require authentication.

The host name is composed of a predefined text and a unique MAC address. For example, if the bus controller has the MAC address 00:60:65:11:22:33, this will result in the following host name: **br006065112233**.

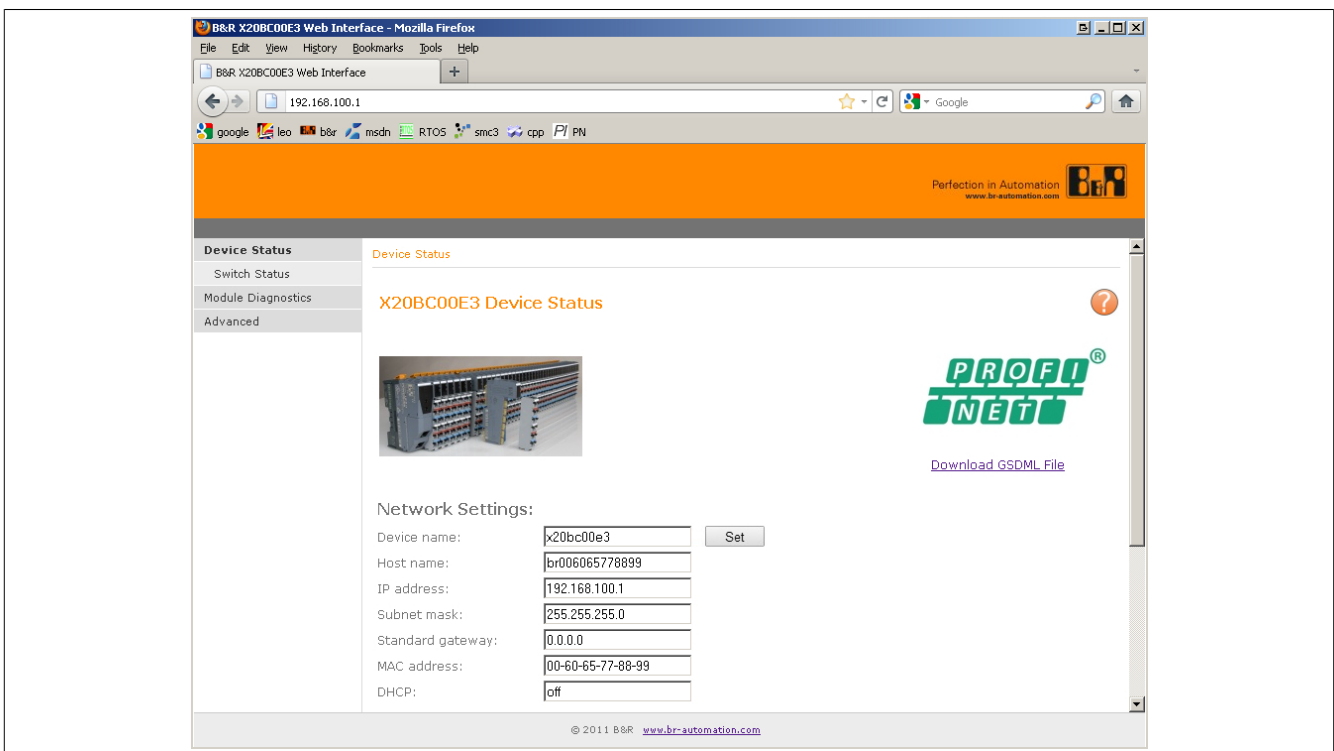
Default parameters for the web interface

| | |
|-------------|---------------|
| IP address: | 192.168.100.1 |
| Username: | admin |
| Password: | B&R |

Information:

Take note of the node number switch position.

Please note that authentication parameters are case-sensitive.



9.3.12 X20BC00G3

Data sheet version: 1.23

9.3.12.1 General information

EtherCAT is an Ethernet-based fieldbus developed by Beckhoff. This protocol is suitable for both hard and soft real-time requirements in automation technology. In addition to a ring structure, which becomes logically necessary because of the summation frame telegram used, the EtherCAT technology also physically supports topologies such as line, tree, star (limited) and combinations of these topologies. B&R's X20BC80G3 (expandable bus controller module) and X20HB88G0 (standalone junction base module) are available for implementing these topologies.

EtherCAT slave devices take the data designated for them from a telegram as it is passing through the device. Input data is also added to the telegram as it is passing through. The bus controller allows X2X Link I/O modules to be coupled to EtherCAT and operated on any EtherCAT master system. A transition between IP20 and IP67 protection outside of the control cabinet is possible by arranging X20, X67 or XV modules one after the other as needed at distances up to 100 m.

Master systems without FoE (File access over EtherCAT) support require an appropriate configuration tool to transfer the configuration (optional).

- Fieldbus: EtherCAT
- Auto-configuration of I/O modules
- I/O configuration and firmware update via the fieldbus (FoE)
- Full support of the modular slice concept via CoE (CANopen over EtherCAT)
- Configurable I/O cycle (0.2 to 4 ms)
- Synchronization between the fieldbus and X2X Link

Information:

Only the standard function model (see the respective module description) is supported when the bus controller is used together with multi-function modules it has automatically configured itself.

All other function models are supported when configured accordingly in Automation Studio V4.3 or later.

Automation Studio can be downloaded at no cost from the B&R website (www.br-automation.com). The evaluation license is permitted to be used to create complete configurations for fieldbus bus controllers at no cost.

9.3.12.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Bus controllers |  |
| X20BC00G3 | X20 bus controller, 1 EtherCAT interface, 2x RJ45, order bus base, power supply module and terminal block separately. | |
| | Required accessories | |
| | System modules for bus controllers | |
| X20BB80 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20PS9400 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply | |
| X20PS9402 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply, supply not electrically isolated | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 128: X20BC00G3 - Order data


9.3.12.3 Technical data

| | |
|--|--|
| Model number | X20BC00G3 |
| Short description | |
| Bus controller | EtherCAT slave |
| General information | |
| B&R ID code | 0xAC23 |
| Status indicators | Module status, bus function |
| Diagnostics | |
| Module status | Yes, using status LED and software |
| Bus function | Yes, using status LED and software |
| Power consumption | |
| Bus | 1.68 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| Interfaces | |
| Fieldbus | EtherCAT slave |
| Variant | 2x shielded RJ45 |
| Line length | Max. 100 m between 2 stations (segment length) |
| Transfer rate | 100 Mbit/s |
| Transfer | |
| Physical layer | 100BASE-TX |
| Half-duplex | Yes |
| Full-duplex | Yes |
| Autonegotiation | Yes |
| Auto-MDI/MDIX | Yes |
| Hub propagation delay | 750 ns |
| Min. cycle time ¹⁾ | |
| Fieldbus | 200 µs |
| X2X Link | 200 µs |
| Synchronization between bus systems possible | Yes |
| Electrical properties | |
| Electrical isolation | EtherCAT isolated from bus and I/O |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | 0 to 55°C |
| Vertical mounting orientation | 0 to 50°C |
| Derating | - |
| Storage | -25 to 70°C |
| Transport | -25 to 70°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately Order 1x power supply module X20PS9400 or X20PS9402 separately Order 1x bus base X20BB80 separately |
| Spacing ²⁾ | 37.5 ^{+0.2} mm |

Table 129: X20BC00G3 - Technical data

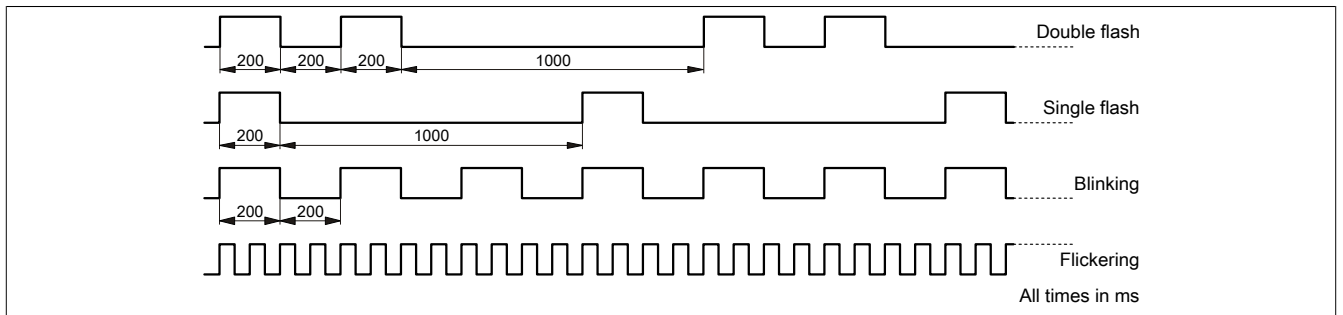
- 1) The minimum cycle time defines how far the bus cycle can be reduced without communication errors occurring.
- 2) Spacing is based on the width of bus base X20BB80. In addition, power supply module X20PS9400 or X20PS9402 is always required for the bus controller.

9.3.12.4 LED status indicators

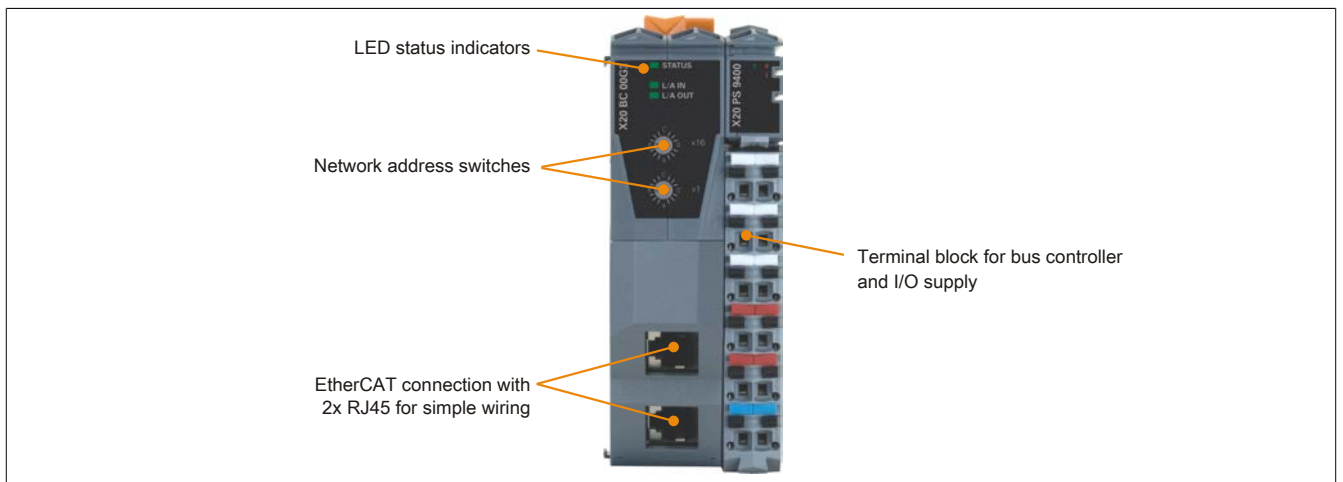
| Figure | LED | Color | Status | Description |
|---|----------------------|-------|--------------|---|
|  | STATUS ¹⁾ | Green | On | The bus controller is in state OPERATIONAL. |
| | | | Blinking | State PREOPERATIONAL |
| | | | Single flash | State SAFE-OPERATIONAL |
| | | | Flickering | The bus controller has started and is not yet in state INIT, or it is in state BOOTSTRAP (e.g. during firmware download). |
| | | | Off | State INIT |
| | | Red | On | A critical communication or application error has occurred. |
| | | | Blinking | Invalid configuration data |
| | | | Single flash | The bus controller has an internal error and has changed the EtherCAT state on its own. |
| | | | Double flash | Watchdog timeout (process data watchdog or EtherCAT watchdog) |
| | | | Flickering | Error in startup procedure (state INIT achieved, but the error indicator bit in the AL status register is set) |
| | L/A IN L/A OUT | Green | Off | No error |
| | | | Blinking | The respective LED blinks when Ethernet activity is taking place (PORT OPEN) on the corresponding RJ45 interface (IN, OUT). |
| | | | On | A connection (link) is established, but no communication is taking place (PORT OPEN). |
| | | | Off | No physical Ethernet connection exists (PORT CLOSED). |

1) LED "STATUS" is a green/red dual LED used to indicate EtherCAT states ERROR and RUN.

LED status indicators - Blink times

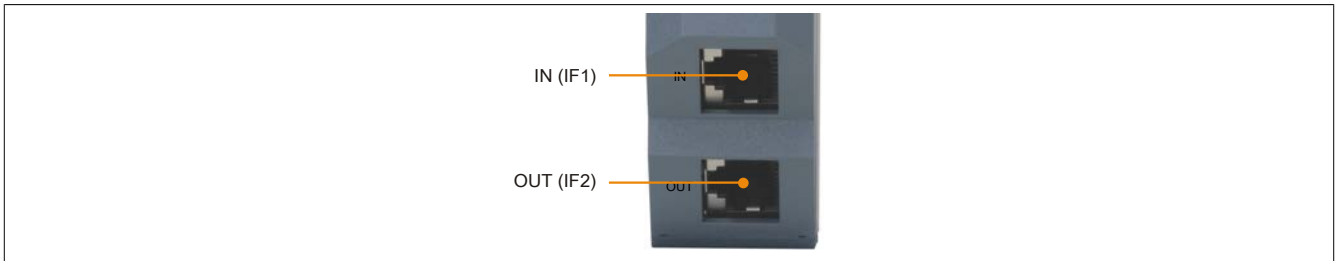


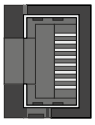
9.3.12.5 Operating and connection elements



9.3.12.6 RJ45 ports

For information about wiring X20 modules with an Ethernet interface, see "Cabling guidelines for X20 modules with an Ethernet cable" on page 58.



| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | TXD | Transmit data |
| | 2 | TXD\ | Transmit data\ |
| | 3 | RXD | Receive data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | RXD\ | Receive data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.3.12.7 EtherCAT network address switches



A slave alias address can be set using the 2 network address switches on the bus controller. During the initialization phase (during startup), the bus controller writes the value of the address switches to ESC register 0x12 or 0x13. However, this value is only applied in the corresponding registers if the switch value is between 0x00 and 0xFA (decimal 250).

| Switch position | Description |
|-----------------|--|
| 0x00 to 0xFA | Writes the address switch value to the "Station alias" register. |
| 0xFB to 0xFE | Does not apply the address switch value. ESC alias registers are not changed. |
| 0xFF | Does not apply the address switch value. ESC alias registers are not changed. If the address switches are set to value 0xFF and the bus controller is restarted, then it will boot with the default values. All set parameters remain unchanged in flash memory. |

The master determines whether the alias address is used to address the slave by setting the corresponding bit (bit 24) in the ESC DL control register.

9.3.12.8 Deleting parameters

Various parameters can be stored in the bus controller's flash memory. Deleting these parameters using switch position F0 returns the bus controller to its factory settings.

Deleting the parameters

1. Switch off the power supply to the bus controller.
2. Set the node number to F0.
3. Switch on the power supply to the bus controller.
4. Wait until LED "STATUS" flashes green.
5. Set the node number switch to 0 and then back to F0.
6. Wait until LED "STATUS" blinks (parameters have been deleted).
7. Switch the power supply to the bus controller off and then back on.
8. The bus controller boots with its default settings.

9.3.13 X20BC0143-10

Data sheet version: 1.16

9.3.13.1 General information

CAN (Controller Area Network) systems are widespread in the field of automation technology. CAN topology is based on a line structure and uses twisted wire pairs for data transfer. CANopen is a higher-layer protocol based on CAN. As a standardized protocol, it provides a high degree of flexibility for implementing a wide range of configurations.

The bus controller makes it possible to connect up to 253 X2X Link I/O modules to CANopen. A transition between IP20 and IP67 protection outside of the control cabinet is possible by aligning X20, X67 or XV modules one after the other as needed at distances up to 100m. All CANopen transmission types such as synchronous, event and polling modes are supported together with PDO linking, life/node guarding, emergency objects, and much more.

- Fieldbus: CANopen
- Auto-configuration of I/O modules
- I/O configuration via the fieldbus
- Constant response times even with large amounts of data (max. 32 Rx and 32 Tx PDOs)
- Configurable I/O cycle (0.5 to 4 ms)
- Possible to configure the transfer rate or have it detected automatically
- Heartbeat consumer and producer
- Emergency producer
- 2x SDO server, NMT slave
- Simple bootstrap (autostart)
- Terminal access via the serial interface on the X20PS9400

Information:

Only the standard function model (see the respective module description) is supported when the bus controller is used together with multi-function modules it has automatically configured itself.

Automation Studio V4.3 or later can be used to easily create configuration files (e.g. DCF files). All other function models are also supported by transferring configuration data to the bus controller (e.g. via the master environment with an SDO download).

Automation Studio can be downloaded at no cost from the B&R website (www.br-automation.com). The evaluation license is permitted to be used to create complete configurations for fieldbus bus controllers at no cost.

9.3.13.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Bus controllers |  |
| X20BC0143-10 | X20 bus controller, 1 CANopen interface, 9-pin DSUB, order 1x connector 7AC911.9 separately. Order bus base, power supply module and terminal block separately. | |
| | Required accessories | |
| | System modules for bus controllers | |
| X20BB80 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20PS9400 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply | |
| X20PS9402 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply, supply not electrically isolated | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | Optional accessories | |
| | Infrastructure components | |
| 0AC912.9 | Bus adapter, CAN, 1 CAN interface | |
| 0AC913.92 | Bus adapter, CAN, 2 CAN interfaces, including 30 cm attachment cable (DSUB) | |
| 7AC911.9 | Bus connector, CAN | |

Table 130: X20BC0143-10 - Order data


9.3.13.3 Technical data

| | |
|--|---|
| Model number | X20BC0143-10 |
| Short description | |
| Bus controller | CANopen slave |
| General information | |
| B&R ID code | 0xAD3E |
| Status indicators | Module status, bus function, data transfer |
| Diagnostics | |
| Module status | Yes, using LED status indicator and software |
| Bus function | Yes, using LED status indicator and software |
| Data transfer | Yes, using LED status indicator |
| Power consumption | |
| Bus | 2 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Interfaces | |
| Fieldbus | CANopen slave |
| Variant | 9-pin male DSUB connector |
| Max. distance | 1000 m |
| Transfer rate | Max. 1 Mbit/s |
| Default transfer rate | Automatic transfer rate detection or fixed setting |
| Min. cycle time ¹⁾ | |
| Fieldbus | No limitation |
| X2X Link | 500 µs |
| Synchronization between bus systems possible | No |
| Electrical properties | |
| Electrical isolation | CANopen isolated from I/O CANopen not isolated from bus |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x power supply module X20PS9400 or X20PS9402 separately. Order 1x bus base X20BB80 separately. |
| Spacing ²⁾ | 37.5 ^{+0.2} mm |

Table 131: X20BC0143-10 - Technical data

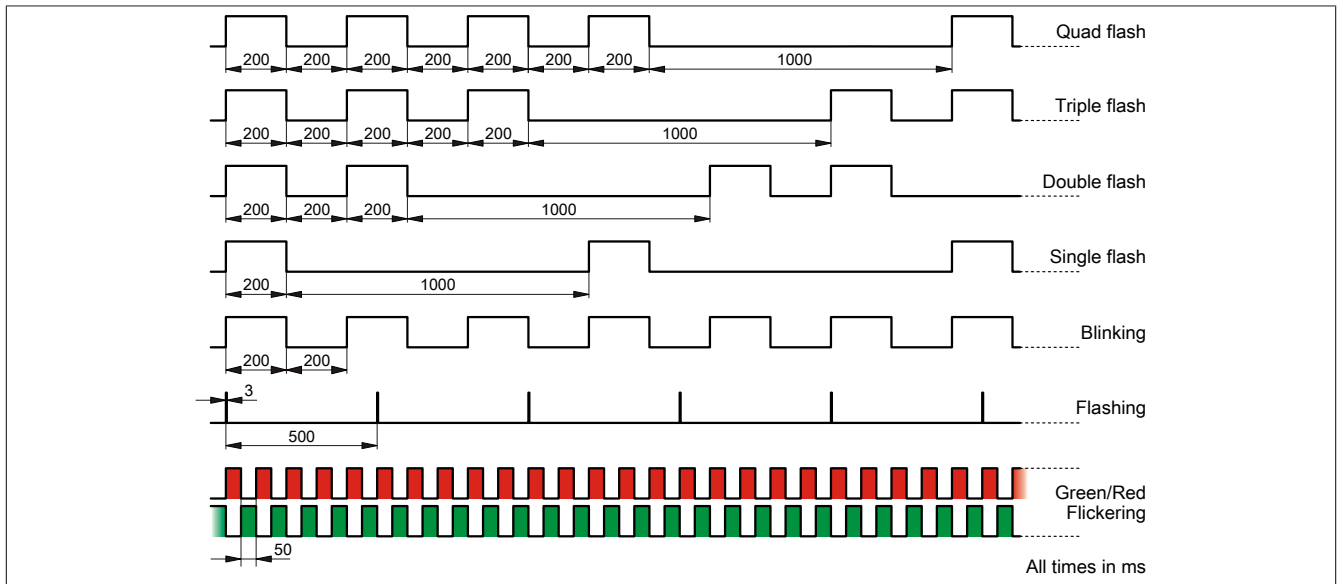
- 1) The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring.
2) Spacing is based on the width of bus base X20BB80. In addition, power supply module X20PS9400 or X20PS9402 is always required for the bus controller.

9.3.13.4 LED status indicators

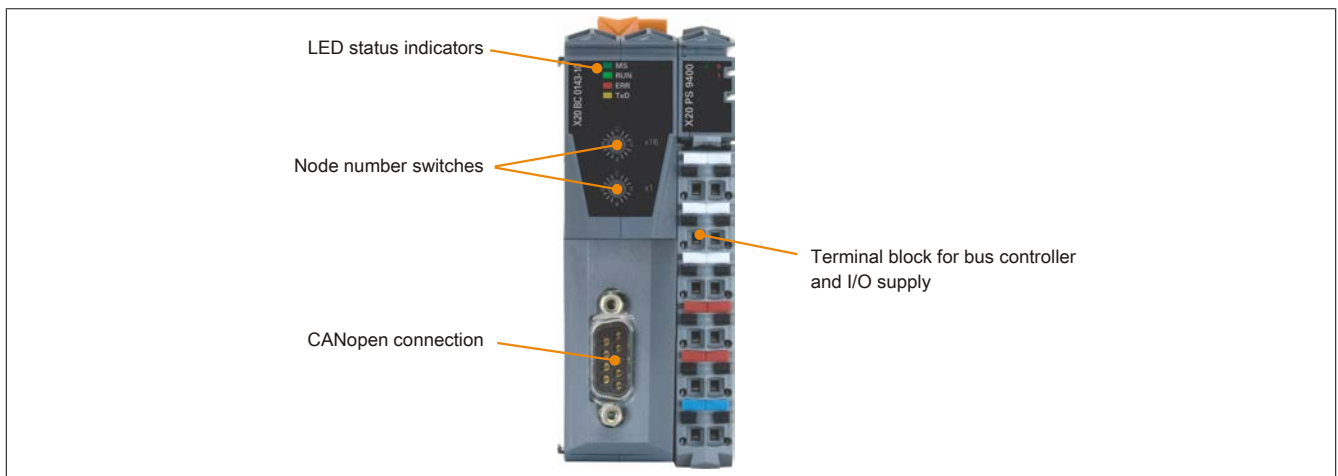
| Figure | LED | Color | Status | Description |
|---|------------------|--------------------------------------|--|--|
|  | MS ¹⁾ | Green | Off | No power supply |
| | | | Flashing | 5 s window for deleting all configuration settings |
| | | | On | Boot procedure OK, I/O modules OK |
| | | Red | Double flash | Successfully erased flash memory |
| | | | Triple flash | Successfully saved transfer rate |
| | | | Quad flash | Successfully saved configuration |
| | RUN | Green | Off | No power supply |
| | | | Single flash | STOP mode |
| | | | Triple flash | Firmware download in progress |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | OPERATIONAL mode |
| | | | ERR | Red |
| | Single flash | CAN warning limit reached | | |
| | Double flash | Node guarding / heartbeat error | | |
| | Blinking | Invalid node number or configuration | | |
| | On | Bus errors: Bus off | | |
| RUN/ERR | Green/red | Flickering | Transfer rate detection in progress | |
| TxD | Yellow | Off | The bus controller is not transmitting any data via the CANopen fieldbus | |
| | | On | The bus controller is transmitting data via the CANopen fieldbus | |

1) The "MS" LED is a green/red dual LED. The LED blinks red several times immediately after startup. This is a boot message, however, and not an error.

LED status indicators - Blink times

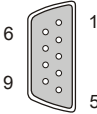


9.3.13.5 Operating and connection elements



9.3.13.6 CAN bus interface

The CAN bus interface is a 9-pin DSUB plug.

| Interface | Pin | CAN | |
|---|-----|----------|------------|
|  | 1 | Reserved | |
| | 2 | CAN_L | CAN low |
| | 3 | CAN_GND | CAN ground |
| | 4 | Reserved | |
| | 5 | Reserved | |
| | 6 | Reserved | |
| | 7 | CAN_H | CAN high |
| | 8 | Reserved | |
| | 9 | Reserved | |

9.3.13.7 Node number and transfer rate

Node numbers and transfer rates are configured using the two bus controller number switches.

The transfer rate can be specified in two ways:

- Automatic detection by bus controller (see ["Automatic transfer rate detection" on page 917](#))
- Fixed definition by user (see ["Setting the transfer rate" on page 918](#))



| Switch position | Node number | Transfer rate |
|-----------------|--|--|
| 0x00 | Not allowed | - |
| 0x01 - 0x7F | 1 - 127 | Automatically set by the bus controller (default) or fixed setting by the user |
| 0x80 - 0x88 | - | Sets a fixed transfer rate |
| 0x89 | - | Sets automatic transfer rate detection |
| 0x8A - 0x8F | Not allowed | - |
| 0x90 | Clearing the parameters See "Clearing parameters" on page 920 | - |
| 0x91 | Not allowed | - |
| 0x92 | Save configuration ¹⁾ See "Save automatic configuration" on page 919 | - |
| 0x93 - 0xFF | Not allowed | - |

1) This function is available starting with Hardware version E0 or Firmware version V0001.0107.

9.3.13.8 Automatic transfer rate detection

After startup, the bus controller goes into "Listen only" mode. This means the bus controller behaves passively on the bus and only listens.

The bus controller attempts to receive valid objects. If receive errors occur, the controller switches to the next transfer rate in the lookup table.

If no objects are received, all transfer rates are tested cyclically. This procedure is repeated until valid objects are received.

Lookup table

The bus controller tests the transfer rate according to this table. Beginning with the starting transfer rate (1000 kbit/s), the controller switches to the next lower transfer rate. At the end of the table, the bus controller restarts the search from the beginning.

| Transfer rate |
|---------------|
| 1000 kbit/s |
| 800 kbit/s |
| 500 kbit/s |
| 250 kbit/s |
| 125 kbit/s |
| 100 kbit/s |
| 50 kbit/s |
| 20 kbit/s |
| 10 kbit/s |

9.3.13.9 Setting the transfer rate

The bus controller will detect the transfer rate automatically by default. Switch positions 0x80 to 0x88 can be used to set a fixed transfer rate, or 0x89 can be used to enable automatic transfer rate detection.

| Switch position | Transfer rate |
|-----------------|-----------------------------------|
| 0x80 | 1000 kbit/s |
| 0x81 | 800 kbit/s |
| 0x82 | 500 kbit/s |
| 0x83 | 250 kbit/s |
| 0x84 | 125 kbit/s |
| 0x85 | 100 kbit/s |
| 0x86 | 50 kbit/s |
| 0x87 | 20 kbit/s |
| 0x88 | 10 kbit/s |
| 0x89 | Automatic transfer rate detection |

Programming the transfer rate

1. Switch off the power supply to the bus controller.
2. Define the transfer rate by selecting the switch position (0x80 to 0x89).
3. Switch on the power supply to the bus controller.
4. Wait until LED "MS" blinks with a red triple flash (transfer rate is now programmed).
5. Switch off the power supply to the bus controller.
6. Set the desired node number (0x01 - 0x7F).
7. Switch on the power supply to the bus controller.
8. The bus controller now boots with the set node number and the programmed transfer rate.

9.3.13.10 Save automatic configuration

The node number position 0x92 can be used to save automatically generated configurations. This makes it possible to work with a standardized configuration without having to adapt the application to changes associated with service work or different development stages for example.

1. Turn off the power supply to the bus controller.
2. Set the node number to 0x90.
3. Turn on the power supply to the bus controller.
4. Wait until the "MS" LED flashes green.
5. The node number switch must be set to 0x00 and then back to 0x90 within this time window of 5 seconds (rotate the top switch).
6. Wait until the "MS" LED blinks with a red double-flash (parameters have been cleared).
7. Turn off the power supply to the bus controller.
8. Set the node number to 0x92.
9. Turn on the power supply to the bus controller.
10. Wait until the "MS" LED flashes green.
11. The node number switch must be set to 0x02 and then back to 0x092 within this time window of 5 seconds (rotate the top switch).
12. Wait until the "MS" LED blinks with a red quad-flash (parameters have been saved).
13. Turn off the power supply to the bus controller.
14. Set the desired node number (0x01 - 0x7F).
15. Turn on the power supply to the bus controller.
16. The bus controller boots with the set node number and automatic transfer rate detection.

Information:

A mapping tool for decoding the saved PDO mapping is available in the Download section of the B&R website (www.br-automation.com).

Information:

This function is available starting with Hardware version E0 or Firmware version V0001.0107.

9.3.13.11 Clearing parameters

Various parameters can be stored in the bus controller's flash memory:

- Communication parameters
- Vendor-specific parameters
- Application parameters (device profile)
- Programmed transfer rate

Clearing the parameters using switch position 0x90 returns the bus controller to its factory settings.

Clearing the parameters listed above

1. Turn off the power supply to the bus controller.
2. Set the node number to 0x90.
3. Turn on the power supply to the bus controller.
4. Wait until the "MS" LED flashes green. The node number switch must be set to 0x00 and then back to 0x090 within this time window of 5 seconds (rotate the top switch).
5. Wait until the "MS" LED blinks with a red double-flash (parameters have been cleared).
6. Turn off the power supply to the bus controller.
7. Set the desired node number (0x01 - 0x7F).
8. Turn on the power supply to the bus controller.
9. The bus controller boots with the set node number and automatic transfer rate detection.

9.3.13.12 Additional documentation and import files (EDS)

Additional documentation about bus controller functions as well as the necessary import files for the master engineering tool are available for download from the Downloads section of the B&R website (www.br-automation.com).

9.4 Bus controllers system modules

The X20 system bus controllers are made up of a bus controller fieldbus interface, a bus controller system module and an X20TB12 terminal block.

Bus controller system modules include the base module and the supply modules.

9.4.1 Summary

| Model number | Short description | Page |
|--------------|--|------|
| X20BB80 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | 922 |
| X20PS9400 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply | 926 |
| X20PS9402 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply, supply not electrically isolated | 932 |
| X20cBB80 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | 922 |
| X20cPS9400 | X20 power supply module, coated, for bus controller and internal I/O power supply, X2X Link power supply | 926 |

9.4.2 X20(c)BB80

Data sheet version: 2.35

9.4.2.1 General information

The following modules are used on the bus module:

- Base module (BC, HB, etc.)
- Supply module

The left and right end plates are included in the delivery.

- Bus base

9.4.2.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.4.2.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.4.2.3 Order data

| Model number | Short description | Figure |
|--------------|--|--------|
| | System modules for bus controllers | |
| X20BB80 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cBB80 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |

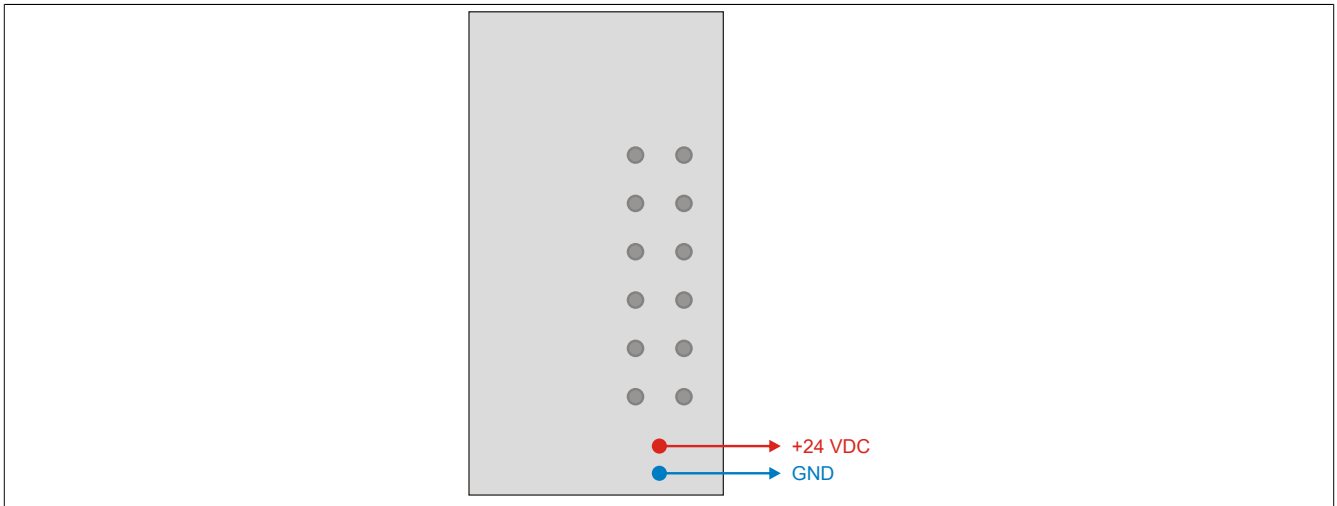
Table 132: X20BB80, X20cBB80 - Order data

9.4.2.4 Technical data

| Model number | X20BB80 | X20cBB80 |
|--|--|------------------------|
| Short description | | |
| Bus module | Bus base - Backplane for bus controller fieldbus interface and bus controller power supply module | |
| General information | | |
| Power consumption | | |
| Bus | 0.25 W | |
| Internal I/O | - | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations | |
| DNV GL | Class 1, Division 2, Groups ABCD, T5 Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| I/O power supply | | |
| Nominal voltage | 24 VDC | |
| Permissible contact load | 10 A | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Left and right X20 locking plates included in delivery | |
| Pitch | 37.5 ^{+0.2} mm | |

Table 133: X20BB80, X20cBB80 - Technical data

9.4.2.5 Voltage routing



9.4.3 X20(c)PS9400

Data sheet version: 3.17

9.4.3.1 General information

The supply module is used together with an X20 bus controller. It is equipped with a feed for the bus controller, the X2X Link and the internal I/O supply.

- Supply for the bus controller, X2X Link and internal I/O supply
- Feed and bus controller / X2X Link supply electrically isolated
- Redundancy of bus controller / X2X Link supply possible by operating multiple supply modules simultaneously
- Service interface (RS232)

9.4.3.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.4.3.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.4.3.3 Order data


| Model number | Short description | Figure |
|--|--|---|
| System modules for bus controllers | |  |
| X20PS9400 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply | |
| X20cPS9400 | X20 power supply module, coated, for bus controller and internal I/O power supply, X2X Link power supply | |
| Required accessories | | |
| System modules for bus controllers | | |
| X20BB80 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cBB80 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| System modules for expandable bus controllers | | |
| X20BB81 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with one expansion slot for an X20 add-on module (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB82 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with 2 expansion slots for 2 X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cBB81 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with one expansion slot for an X20 add-on module (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cBB82 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with two expansion slots for two X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| Terminal blocks | | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 134: X20PS9400, X20cPS9400 - Order data

9.4.3.4 Technical data

| Model number | X20PS9400 | X20cPS9400 |
|--|--|------------|
| Short description | 24 VDC supply module for bus controller, X2X Link power supply and I/O | |
| Power supply module | 24 VDC supply module for bus controller, X2X Link power supply and I/O | |
| Interfaces | 1x RS232 service interface | |
| General information | | |
| B&R ID code | 0x1F8C | 0xD579 |
| Status indicators | Overload, operating status, module status, RS232 | |
| Diagnosics | | |
| Module run/error | Yes, using status LED and software | |
| RS232 data transfer | Yes, using status LED | |
| Overload | Yes, using status LED and software | |
| Power consumption for X2X Link power supply ¹⁾ | 1.42 W | |
| Power consumption ¹⁾ | | |
| Internal I/O | 0.6 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Bus controller / X2X Link power supply input | | |
| Input voltage | 24 VDC -15% / +20% | |

Table 135: X20PS9400, X20cPS9400 - Technical data


| Model number | X20PS9400 | X20cPS9400 |
|--|---|---|
| Input current | Max. 0.7 A | |
| Fuse | Integrated, cannot be replaced | |
| Reverse polarity protection | Yes | |
| Bus controller / X2X Link power supply output | | |
| Nominal output power | 7 W | |
| Parallel connection | Yes ²⁾ | |
| Redundant operation | Yes | |
| Overload characteristics | Short circuit, temporary overload | |
| Input I/O power supply | | |
| Input voltage | 24 VDC -15% / +20% | |
| Fuse | Required line fuse: Max. 10 A, slow-blow | |
| Reverse polarity protection | No | |
| Output I/O power supply | | |
| Nominal output voltage | 24 VDC | |
| Behavior on short circuit | Required line fuse | |
| Permissible contact load | 10 A | |
| Interfaces | | |
| Service interface | | |
| Signal | RS232 | |
| Variant | Connection made using 12-pin terminal block X20TB12 | |
| Max. transfer rate | 115.2 kbit/s | |
| Electrical properties | | |
| Electrical isolation | BC/X2X Link supply isolated from BC/X2X Link power supply I/O supply not isolated from I/O power supply, and RS232 not isolated from bus | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating" | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BB8x bus base separately | Order 1x X20TB12 terminal block separately Order 1x X20cBB8x bus base separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 135: X20PS9400, X20cPS9400 - Technical data

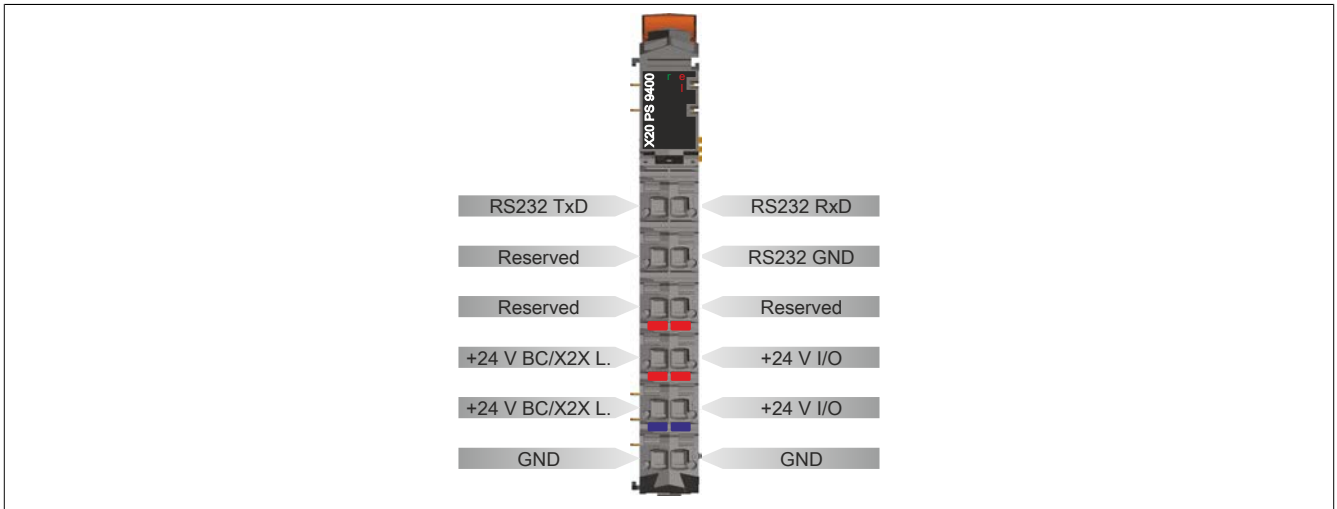
- The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- In parallel operation, only 75% of the rated power can be assumed. It is important to make sure that all power supplies operated in parallel are switched on and off at the same time.

9.4.3.5 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

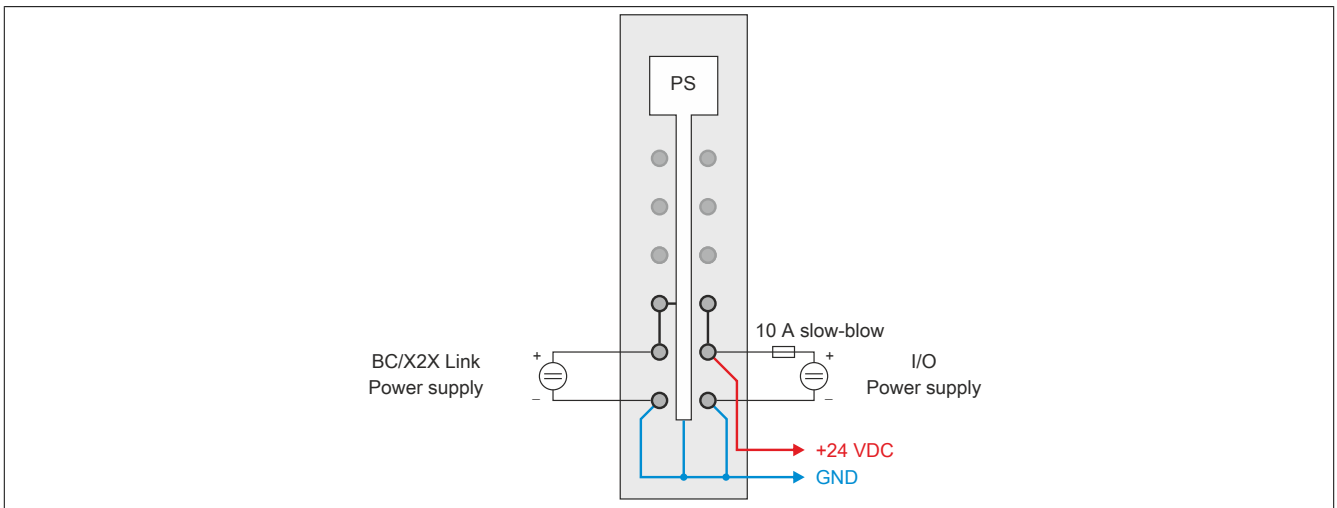
| Figure | LED | Color | Status | Description |
|---|-----|-----------------------------|---|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Double flash | LED indicates one of the following states: <ul style="list-style-type: none"> The bus controller / X2X Link supply for the power supply is overloaded I/O supply too low Input voltage for bus controller / X2X Link supply too low |
| e + r | | Red on / Green single flash | Invalid firmware | |
| l | Red | Off | The bus controller / X2X Link supply is within the valid limits | |
| | | On | The bus controller / X2X Link supply for the power supply is overloaded | |

9.4.3.6 Pinout

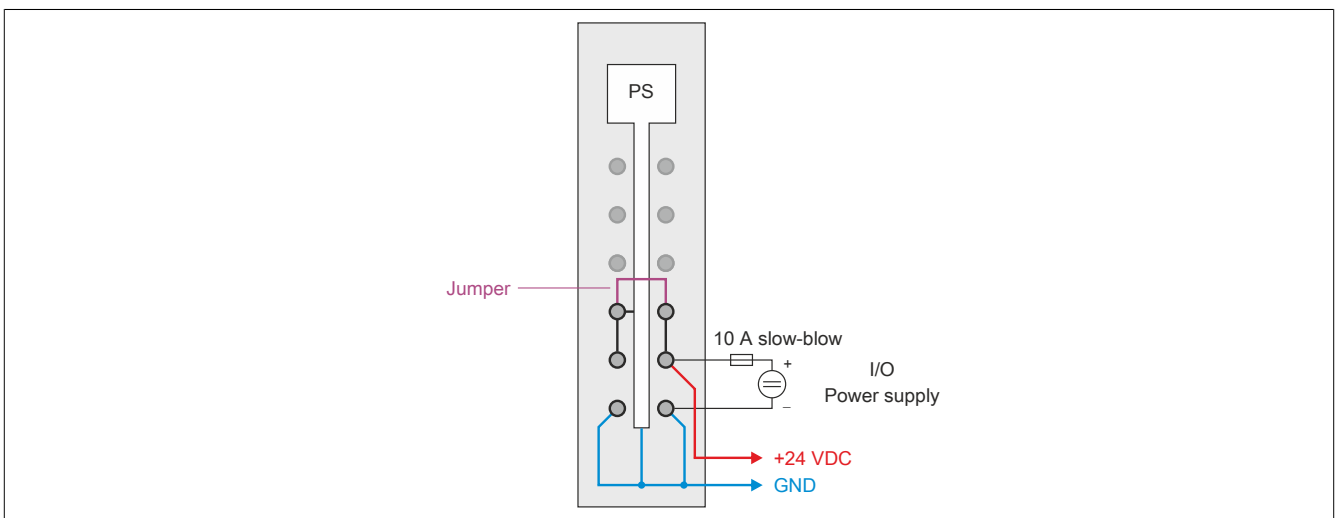


9.4.3.7 Connection examples

With 2 isolated power supplies

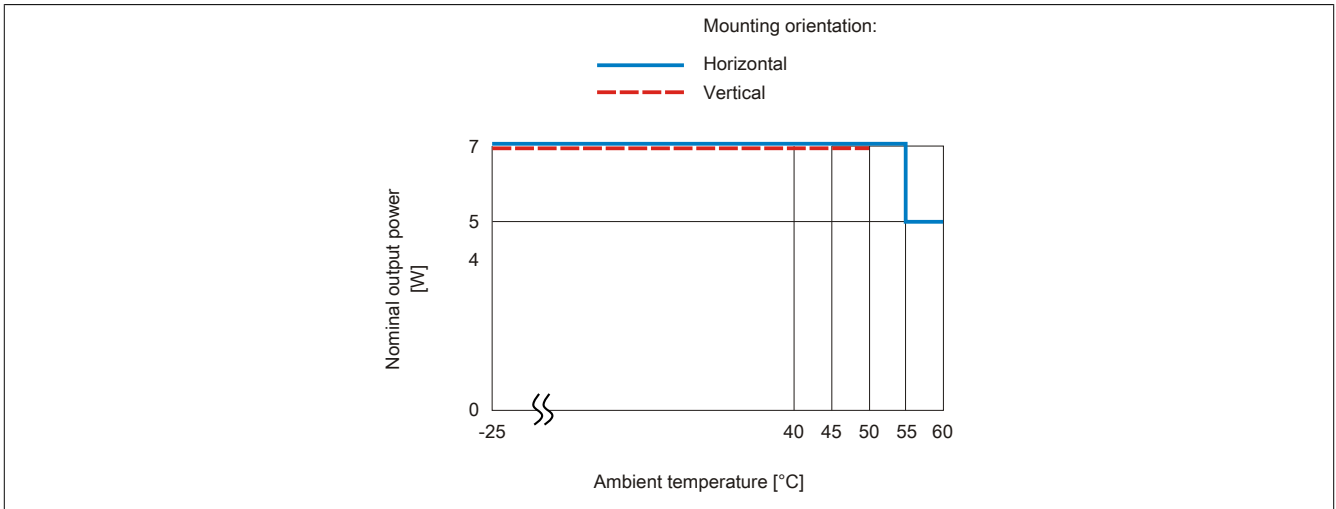


With 1 power supply and jumper



9.4.3.8 Derating

The nominal output power for the power supply is 7 W. Depending on the mounting orientation, derating must be taken into account.



9.4.3.9 Using the service interface

The RS232 service interface cannot be used for application purposes. It is only intended for upgrading the firmware of various bus controllers and X2X modules and for storing configurations.

9.4.3.10 Register description

9.4.3.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.4.3.10.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 0 | 1 | Status of the module | USINT | • | | | |
| | | StatusInput01 | Bit 0 | | | | |
| | | StatusInput02 | Bit 2 | | | | |
| 2 | 2 | SupplyCurrent | USINT | • | | | |
| 4 | 3 | SupplyVoltage | USINT | • | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.4.3.10.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 0 | 0 | Status of the module | UINT | • | | | |
| | | StatusInput01 | Bit 0 | | | | |
| | | StatusInput02 | Bit 2 | | | | |
| 2 | 2 | SupplyCurrent | UINT | • | | | |
| 4 | 4 | SupplyVoltage | UINT | • | | | |

1) The offset specifies the position of the register within the CAN object.

9.4.3.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "[Using I/O modules on the bus controller](#)" on page 3789.

9.4.3.10.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.4.3.10.4 Status of the module

Name:

Module status

The following voltage and current states of the module are monitored in this register:

| | |
|----------------------------|--|
| Bus power supply current: | Bus power supply current >2.3 A is displayed as a warning. |
| Bus supply voltage: | Bus supply voltage <4.7 V is displayed as a warning. |
| 24 VDC I/O supply voltage: | I/O supply voltage <20.4 V is displayed as a warning. |

| Function model | Data type | Values |
|----------------------|-----------|------------------------|
| 0 - Standard | USINT | See the bit structure. |
| 254 - Bus controller | UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|---|
| 0 | StatusInput01 | 0 | No error |
| | | 1 | Warning in the event of overcurrent (>2.3 A) or undervoltage (<4.7 V) |
| 1 | Reserved | 0 | |
| 2 | StatusInput02 | 0 | I/O power supply above the warning limit of 20.4 V |
| | | 1 | I/O power supply below the warning limit of 20.4 V |
| 3 - x | Reserved | 0 | |

9.4.3.10.5 Bus power supply current

Name:

SupplyCurrent

This register displays the bus power supply current measured at a resolution of 0.1 A.

| Function model | Data type |
|----------------------|-----------|
| 0 - Standard | USINT |
| 254 - Bus controller | UINT |

9.4.3.10.6 Bus supply voltage

Name:

SupplyVoltage

This register indicates the bus supply voltage measured at a resolution of 0.1 V.

| Function model | Data type |
|----------------------|-----------|
| 0 - Standard | USINT |
| 254 - Bus controller | UINT |

9.4.3.10.7 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.4.3.10.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 2 ms |

9.4.4 X20PS9402

Data sheet version: 3.05

9.4.4.1 General information

The supply module is used together with an X20 bus controller. It is equipped with a feed for the bus controller, the X2X Link and the internal I/O supply.

The module is designed to supply power for smaller X20 systems. Potential groups are able to be formed. An expansion or redundancy of the X2X Link with the X20PS3300 or X20PS3310 supply module is not possible. Expansion of the X20 system with a bus transmitter is not permitted either.

- Supply for the bus controller, X2X Link and internal I/O supply
- Low-cost supply module for small X20 system
- Feed and bus controller / X2X Link supply not electrically isolated
- Expansion or redundancy of bus controller / X2X Link supply not possible by operating multiple supply modules simultaneously

9.4.4.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | System modules for bus controllers |  |
| X20PS9402 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply, supply not electrically isolated | |
| | Required accessories | |
| | System modules for bus controllers | |
| X20BB80 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| | System modules for expandable bus controllers | |
| X20BB81 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with one expansion slot for an X20 add-on module (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB82 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with 2 expansion slots for 2 X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 136: X20PS9402 - Order data

9.4.4.3 Technical data

| Model number | X20PS9402 |
|--|--|
| Short description | |
| Power supply module | 24 VDC supply module for bus controller, X2X Link power supply and I/O |
| General information | |
| B&R ID code | 0xA389 |
| Status indicators | Operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Overload | Yes, using status LED and software |
| Power consumption for X2X Link power supply ¹⁾ | 1.64 W |
| Power consumption ¹⁾ | |
| Internal I/O | 0.6 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |

Table 137: X20PS9402 - Technical data


| Model number | X20PS9402 |
|--|--|
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| KR | Yes |
| Bus controller / X2X Link power supply input | |
| Input voltage | 24 VDC -15% / +20% |
| Input current | Max. 0.7 A |
| Fuse | Integrated, cannot be replaced |
| Reverse polarity protection | Yes |
| Bus controller / X2X Link power supply output | |
| Nominal output power | |
| Horizontal mounting orientation | 7 W at 45°C and 5 W at 55°C |
| Vertical mounting orientation | 7 W at 40°C and 5 W at 50°C |
| Parallel connection | No |
| Redundant operation | No |
| Overload characteristics | Short circuit, temporary overload |
| Input I/O power supply | |
| Input voltage | 24 VDC -15% / +20% |
| Fuse | Required line fuse: Max. 10 A, slow-blow |
| Reverse polarity protection | No |
| Output I/O power supply | |
| Nominal output voltage | 24 VDC |
| Behavior on short circuit | Required line fuse |
| Permissible contact load | 10 A |
| Electrical properties | |
| Electrical isolation | BC/X2X Link supply not isolated from BC/X2X Link power supply, and I/O supply not isolated from I/O power supply |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating" |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BB8x bus base separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 137: X20PS9402 - Technical data

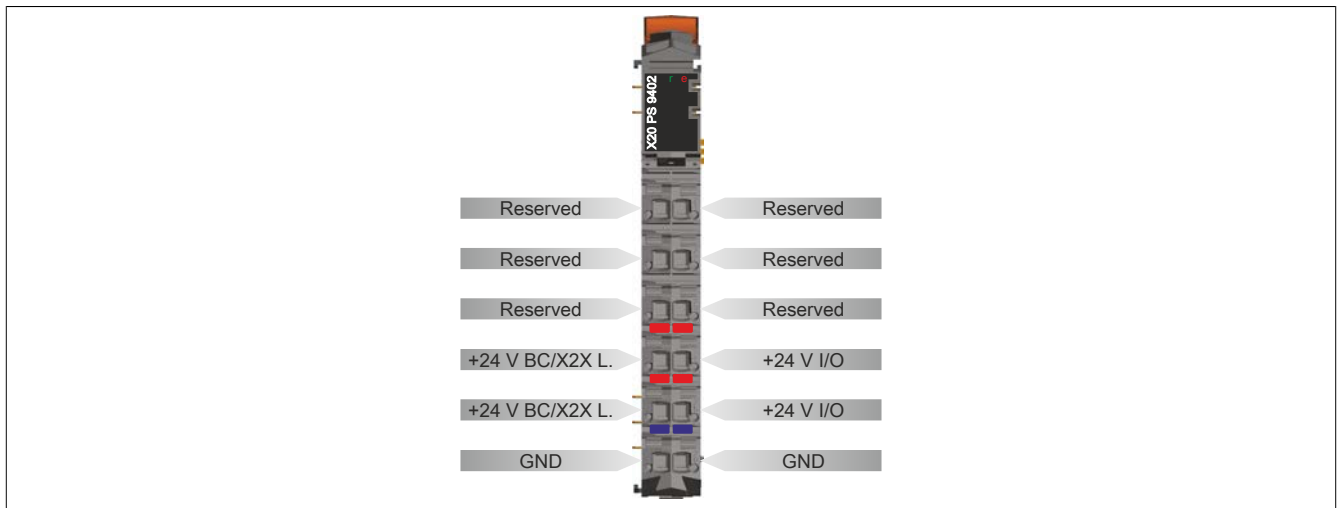
- 1) The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.

9.4.4.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

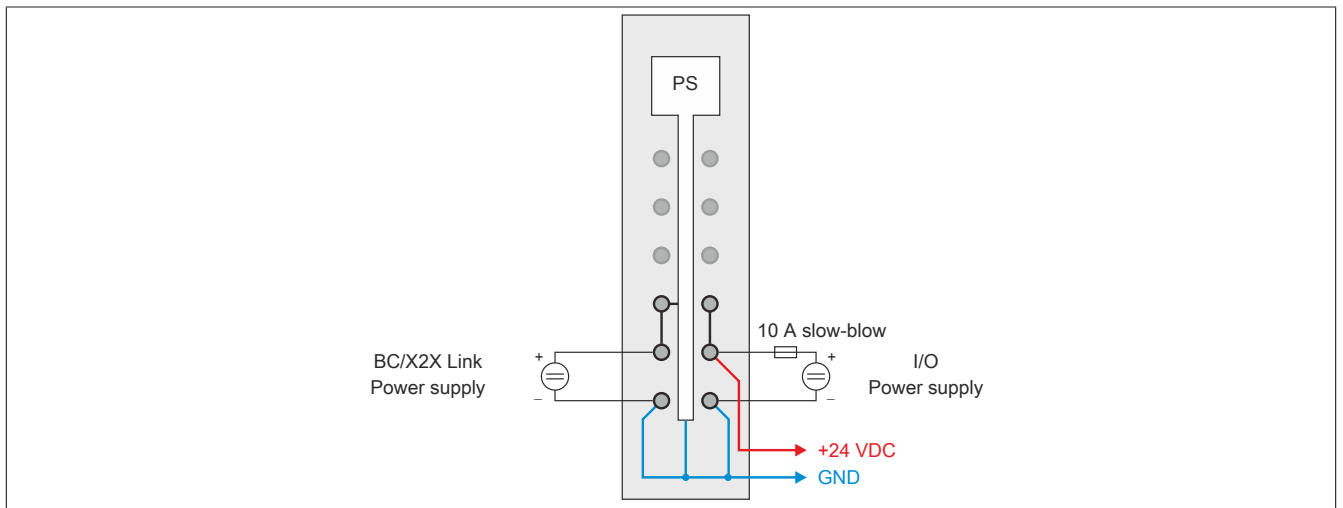
| Figure | LED | Color | Status | Description |
|---|-------|-------|-----------------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Double flash | LED indicates one of the following states: <ul style="list-style-type: none"> • The bus controller / X2X Link supply for the power supply is overloaded • I/O supply too low • Input voltage for bus controller / X2X Link supply too low |
| | e + r | | Red on / Green single flash | Invalid firmware |

9.4.4.5 Pinout

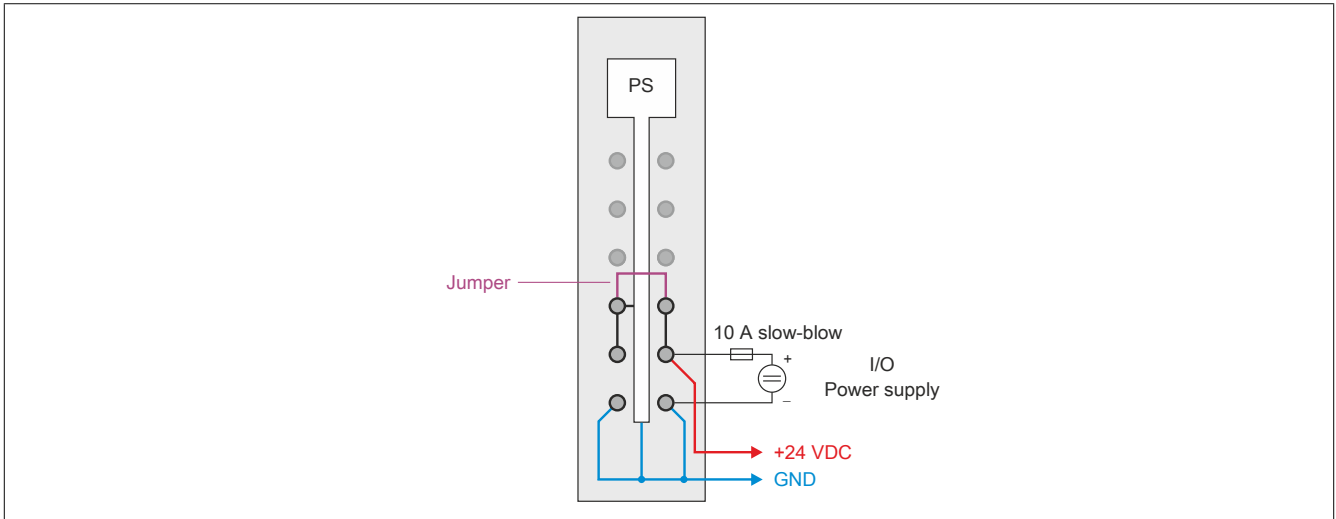


9.4.4.6 Connection examples

With 2 isolated power supplies

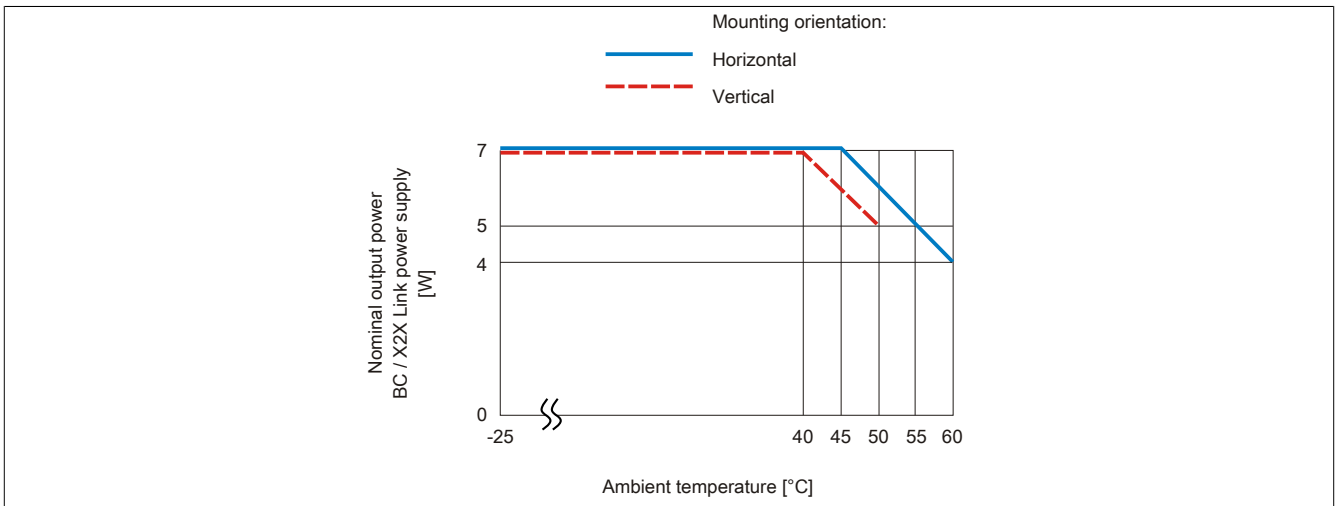


With 1 power supply and jumper



9.4.4.7 Derating for bus controller / X2X Link supply

The rated output current for the bus controller / X2X Link supply is 7.0 W. Derating must be taken into consideration based on mounting orientation.



9.4.4.8 Register description

9.4.4.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.4.4.8.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|-------------------------------|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| 0 | 1 | Module status | USINT | • | | | |
| | | StatusInput01 | Bit 0 | | | | |
| | | StatusInput02 | Bit 2 | | | | |
| 4 | 3 | SupplyVoltage | USINT | • | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.4.4.8.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|-------------------------------|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| 0 | 0 | Module status | UINT | • | | | |
| | | StatusInput01 | Bit 0 | | | | |
| | | StatusInput02 | Bit 2 | | | | |
| 4 | 4 | SupplyVoltage | UINT | • | | | |

1) The offset specifies the position of the register within the CAN object.

9.4.4.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.4.4.8.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.4.4.8.4 Module status

Name:

Module status

The following module supply voltages are monitored in this register:

Bus supply voltage: Bus supply voltage <4.7 V is displayed as a warning.

24 VDC I/O supply voltage: I/O supply voltage <20.4 V is displayed as a warning.

| Function model | Data type | Values |
|----------------------|-----------|------------------------|
| 0 - Standard | USINT | See the bit structure. |
| 254 - Bus controller | UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---------------|-------|--|
| 0 | StatusInput01 | 0 | No error |
| | | 1 | Bus supply warning - Undervoltage (<4.7 V) |
| 1 | Reserved | 0 | |
| 2 | StatusInput02 | 0 | I/O power supply above the warning limit of 20.4 V |
| | | 1 | I/O power supply below the warning limit of 20.4 V |
| 3 - x | Reserved | 0 | |

9.4.4.8.5 Bus supply voltage

Name:

SupplyVoltage

This register indicates the bus supply voltage measured at a resolution of 0.1 V.

| Function model | Data type |
|----------------------|-----------|
| 0 - Standard | USINT |
| 254 - Bus controller | UINT |

9.4.4.8.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.4.4.8.7 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 2 ms |

9.5 Bus modules

In the X20 system, a bus module takes the place of a rack.

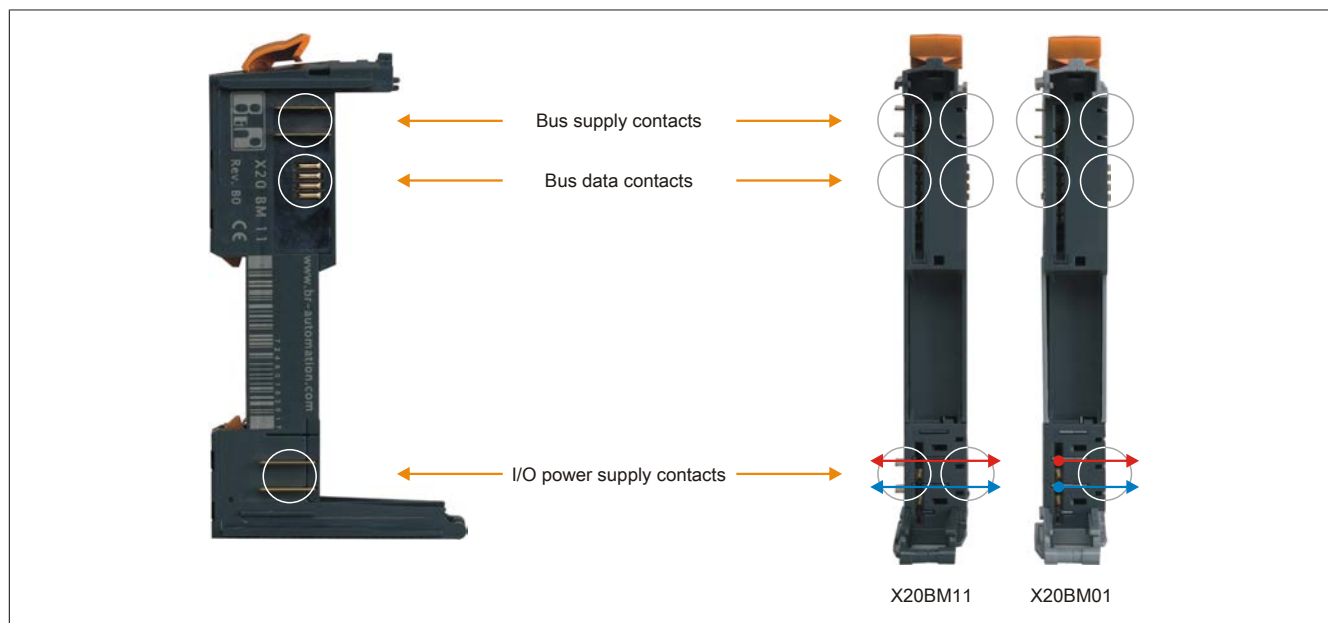


Figure 94: The bus module replaces the rack in the X20 system

The bus module is the backbone of the X20 system regarding the bus supply and bus data as well as the I/O supply for the electronics modules. Each bus module is an active bus station, even without an electronics module. There are two variations of the bus module:

- Interconnected I/O supply
- I/O supply isolated to the left (for power supply modules)

9.5.1 Summary

| Model number | Short description | Page |
|--------------|--|------|
| X20BM01 | X20 power supply bus module, 24 VDC keyed, internal I/O supply interrupted to the left | 939 |
| X20BM05 | X20 power supply bus module, with node number switch, 24 VDC keyed, internal I/O supply interrupted to the left | 942 |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | 945 |
| X20BM12 | X20 bus module, 240 VAC keyed, internal I/O power supply connected through | 948 |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | 951 |
| X20BM21 | X20 power supply bus module, for double-width modules, 24 VDC keyed, internal I/O supply interrupted to the left | 954 |
| X20BM31 | X20 bus module for double-width modules, 24 VDC keyed, internal I/O supply continuous | 956 |
| X20BM32 | X20 bus module for double-width modules, 240 VAC keyed, internal I/O supply continuous | 959 |
| X20cBM01 | X20 power supply bus module, coated, 24 VDC keyed, internal I/O supply interrupted to the left | 939 |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | 945 |
| X20cBM12 | X20 bus module, coated, 240 VAC keyed, internal I/O power supply connected through | 948 |
| X20cBM31 | X20 bus module, coated, for double-width modules, 24 VDC keyed, internal I/O supply continuous | 956 |
| X20cBM32 | X20 bus module, coated, for double-width modules, 240 VAC keyed, internal I/O supply continuous | 959 |

9.5.2 X20(c)BM01

Data sheet version: 2.35

9.5.2.1 General information

The bus module is the base for all power supply modules.

- Basis for all power supply modules
- For creating potential groups
- The internal I/O power supply is interrupted to the left.

9.5.2.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.5.2.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.5.2.3 Order data

| Model number | Short description | Figure |
|--------------|--|--------|
| X20BM01 | Bus modules X20 power supply bus module, 24 VDC keyed, internal I/O supply interrupted to the left | |
| X20cBM01 | X20 power supply bus module, coated, 24 VDC keyed, internal I/O supply interrupted to the left | |

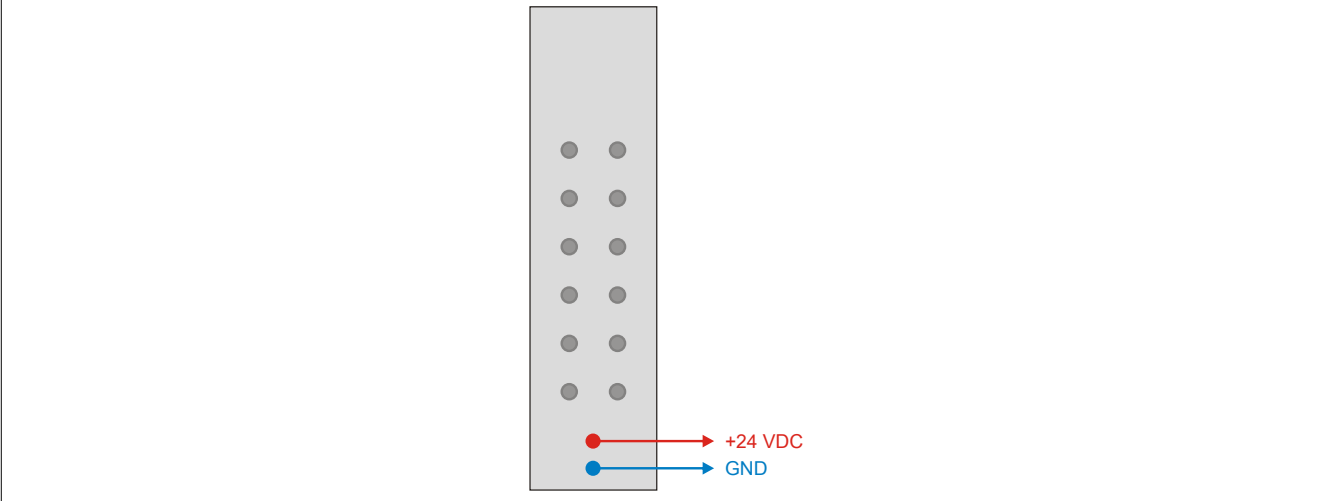
Table 138: X20BM01, X20cBM01 - Order data

9.5.2.4 Technical data

| Model number | X20BM01 | X20cBM01 |
|--|--|------------------------|
| Short description | | |
| Bus module | Power supply bus module, 24 VDC keyed, internal I/O supply interrupted to the left | |
| General information | | |
| Power consumption | | |
| Bus | 0.13 W | |
| Internal I/O | - | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations | |
| DNV GL | Class 1, Division 2, Groups ABCD, T5 Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| I/O power supply | | |
| Nominal voltage | 24 VDC | |
| Permissible contact load | 10 A | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Pitch | 12.5 ^{+0.2} mm | |

Table 139: X20BM01, X20cBM01 - Technical data

9.5.2.5 Voltage routing



9.5.3 X20BM05

Data sheet version: 2.31

9.5.3.1 General information

The bus modules have node number switches that can be used to set permanent addresses. Placing one of these modules at the beginning of an X20 block ensures a unique address. The addresses of subsequent modules are automatically set in ascending order starting at this address. This simple feature greatly increases the flexibility of applications.

Another advantage: Addresses can be set independently of which specific I/O modules are used. All that is required are the respective bus modules. This provides logistical advantages with respect to cost and the variety of parts.

- The bus module is the base for all X20 supply modules
- For creating voltage groups
- The internal I/O supply is isolated to the left
- Manual node number assignment
- Independent of electronics module
- Manual and automatic addressing can be combined as desired

9.5.3.2 Order data


| Model number | Short description | Figure |
|--------------|--|--|
| X20BM05 | <p>Bus modules</p> <p>X20 power supply bus module, with node number switch, 24 VDC keyed, internal I/O supply interrupted to the left</p> |  |

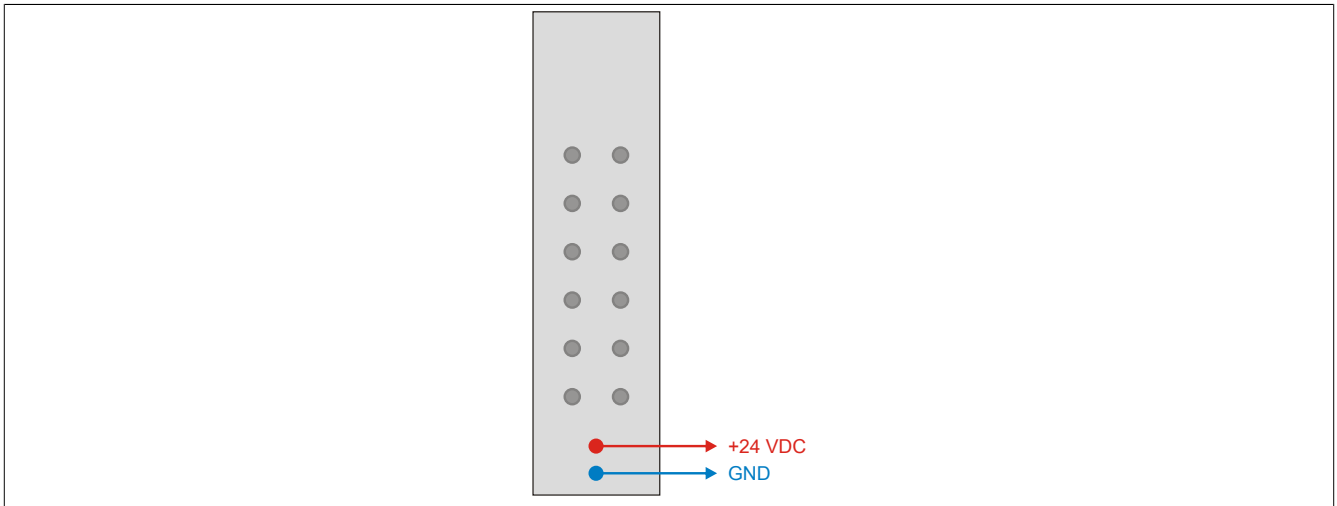
Table 140: X20BM05 - Order data

9.5.3.3 Technical data

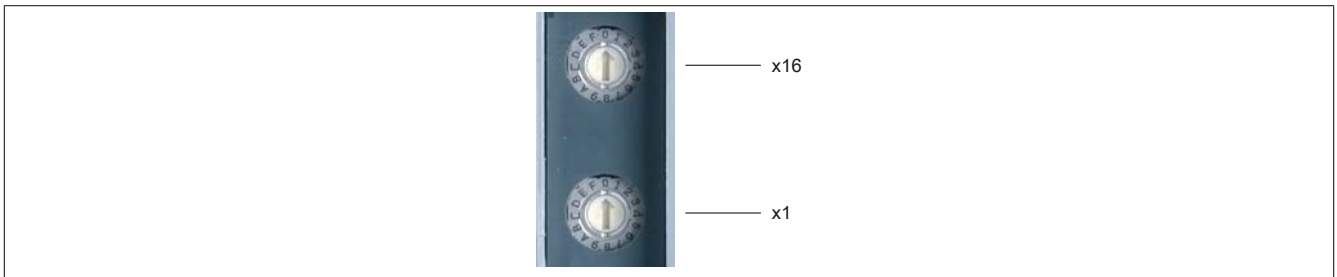
| Model number | X20BM05 |
|--|--|
| Short description | |
| Bus module | Power supply bus module with node number switch, 24 VDC keyed, internal I/O supply interrupted to the left |
| General information | |
| Power consumption | |
| Bus | 0.13 W |
| Internal I/O | - |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| I/O power supply | |
| Nominal voltage | 24 VDC |
| Permissible contact load | 10 A |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Spacing | 12.5 ^{+0.2} mm |

Table 141: X20BM05 - Technical data

9.5.3.4 Voltage routing



9.5.3.5 Node number switches



The X2X Link address of the module is set using the node number switches (0x01 to 0xFD).

Setting node number 0x00 causes the X2X Link address to be assigned automatically.

9.5.3.6 Bus modules with node number switches

Symbols are printed on the locking lever of bus modules with node number switches. This provides a way to see from outside that the X20 system mounted in this slot is using node number switches.



9.5.4 X20(c)BM11

Data sheet version: 2.35

9.5.4.1 General information

The bus module is the base for all 24 VDC I/O modules. The internal I/O power supply is connected through.

- Bus module for 24 VDC I/O modules
- The internal I/O power supply is connected through.

9.5.4.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.5.4.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.5.4.3 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous |  |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |

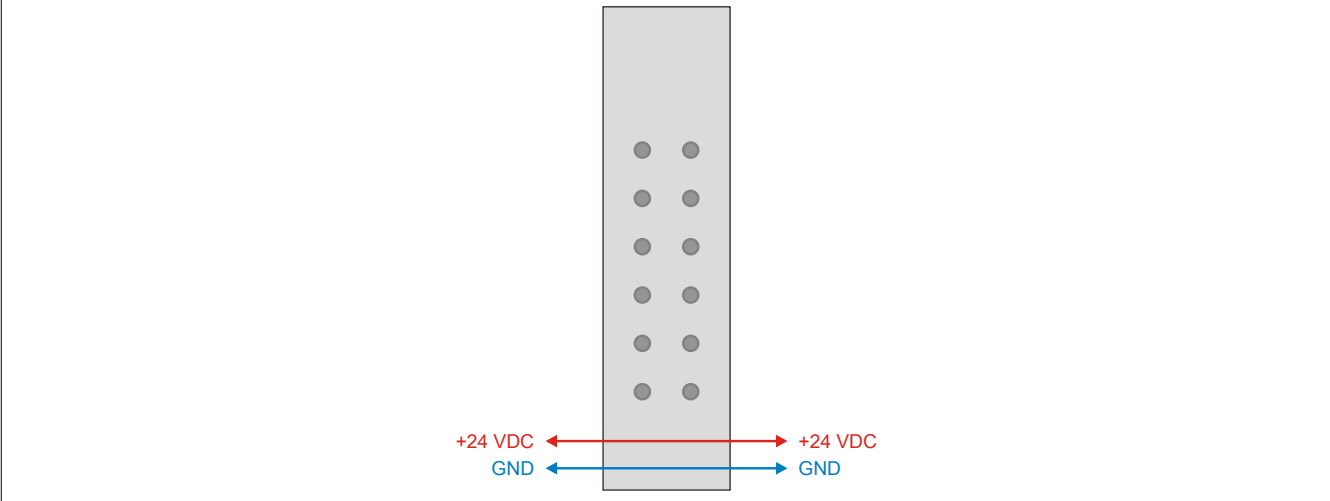
Table 142: X20BM11, X20cBM11 - Order data

9.5.4.4 Technical data

| Model number | X20BM11 | X20cBM11 |
|--|--|------------------------|
| Short description | | |
| Bus module | Bus module, 24 VDC keyed, internal I/O supply continuous | |
| General information | | |
| Power consumption | | |
| Bus | 0.13 W | |
| Internal I/O | - | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations | |
| DNV GL | Class 1, Division 2, Groups ABCD, T5 Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| I/O power supply | | |
| Nominal voltage | 24 VDC | |
| Permissible contact load | 10 A | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Pitch | 12.5 ^{+0.2} mm | |

Table 143: X20BM11, X20cBM11 - Technical data

9.5.4.5 Voltage routing



9.5.5 X20(c)BM12

Data sheet version: 2.35

9.5.5.1 General information

The bus module serves as the base for all 240 VAC X20 I/O modules. The internal I/O supply is interconnected.

- Bus module for 240 VAC I/O modules
- The internal I/O supply is interconnected
- 240 V coding for bus module, electronic module and terminal block

9.5.5.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.5.5.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C . During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.5.5.3 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| X20BM12 | Bus modules X20 bus module, 240 VAC keyed, internal I/O power supply connected through |  |
| X20cBM12 | X20 bus module, coated, 240 VAC keyed, internal I/O power supply connected through | |

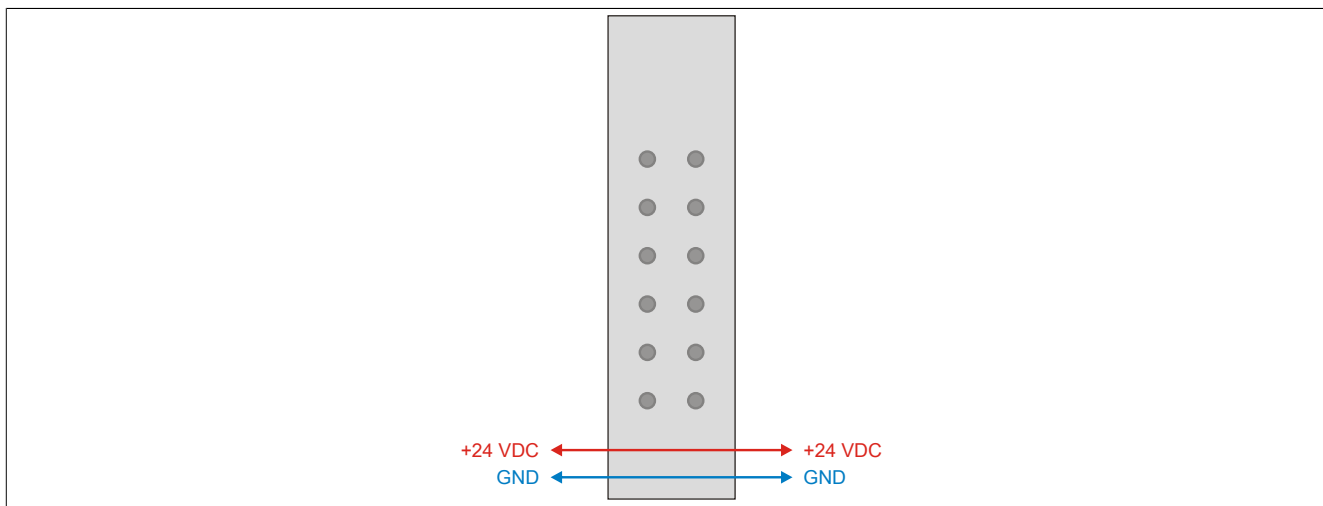
Table 144: X20BM12, X20cBM12 - Order data

9.5.5.4 Technical data

| Model number | X20BM12 | X20cBM12 |
|--|--|------------------------|
| Short description | | |
| Bus module | Bus module, 240 VAC keyed, internal I/O power supply connected through | |
| General information | | |
| Power consumption | | |
| Bus | 0.13 W | |
| Internal I/O | - | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations | |
| DNV GL | Class 1, Division 2, Groups ABCD, T5 Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| I/O power supply | | |
| Nominal voltage | 24 VDC | |
| Permissible contact load | 10 A | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitation | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Starting temperature | - | Yes, -40°C |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Pitch | 12.5 ^{+0.2} mm | |

Table 145: X20BM12, X20cBM12 - Technical data

9.5.5.5 Voltage routing



9.5.6 X20BM15

Data sheet version: 2.32

9.5.6.1 General information

The bus modules have node number switches that can be used to set permanent addresses. Placing one of these modules at the beginning of an X20 block ensures a unique address. The addresses of subsequent modules are automatically set in ascending order starting at this address. This simple feature greatly increases the flexibility of applications.

Another advantage: Addresses can be set independently of which specific I/O modules are used. All that is required are the respective bus modules. This provides logistical advantages with respect to cost and the variety of parts.

- The bus module is the base for all X20 24 VDC I/O modules
- The internal I/O supply is interconnected
- Manual node number assignment
- Independent of electronics module
- Manual and automatic addressing can be combined as desired

9.5.6.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous |  |

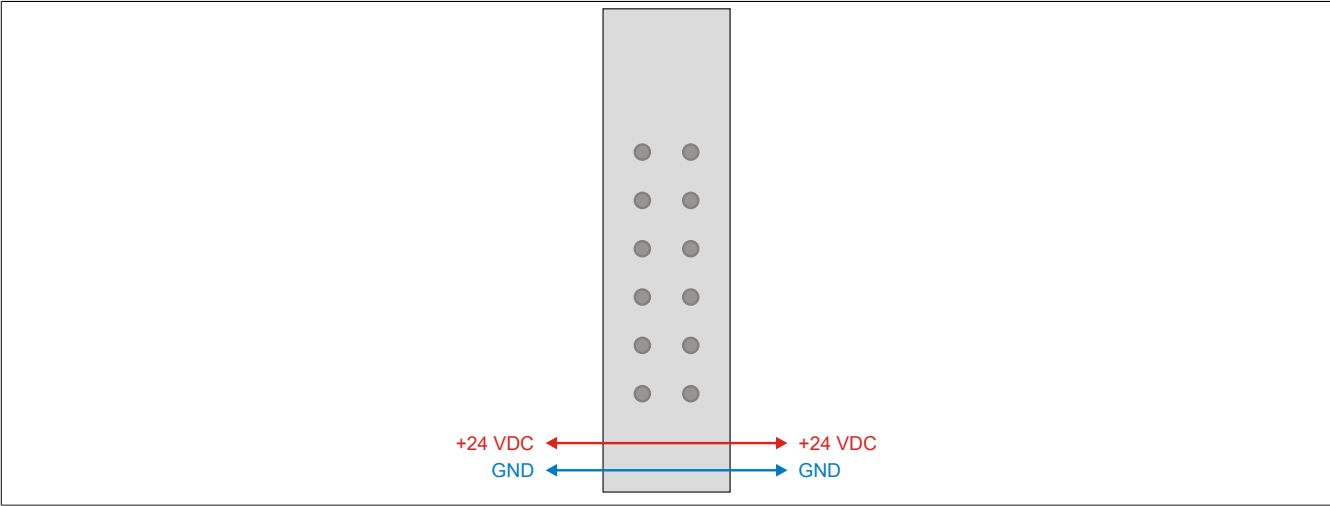
Table 146: X20BM15 - Order data

9.5.6.3 Technical data

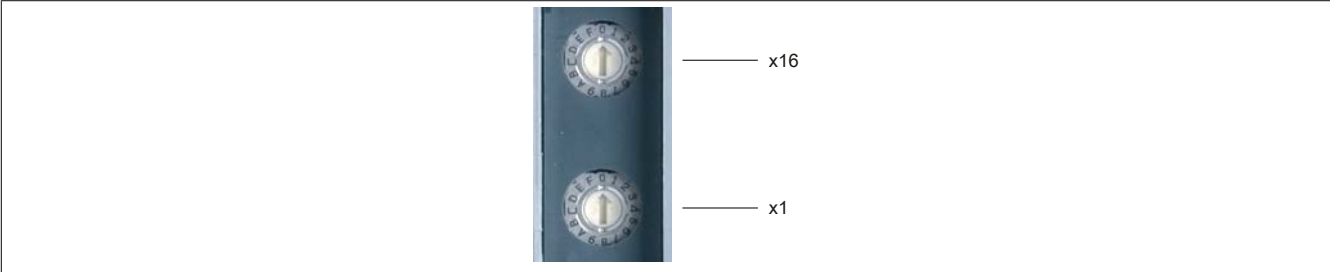
| Model number | X20BM15 |
|--|--|
| Short description | |
| Bus module | Bus module with node number switch, 24 VDC keyed, internal I/O supply continuous |
| General information | |
| Power consumption | |
| Bus | 0.13 W |
| Internal I/O | - |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| I/O power supply | |
| Nominal voltage | 24 VDC |
| Permissible contact load | 10 A |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Spacing | 12.5 ^{+0.2} mm |

Table 147: X20BM15 - Technical data

9.5.6.4 Voltage routing



9.5.6.5 Node number switches



The X2X Link address of the module is set using the node number switches (0x01 to 0xFD).
Setting node number 0x00 causes the X2X Link address to be assigned automatically.

9.5.6.6 Bus modules with node number switches

Symbols are printed on the locking lever of bus modules with node number switches. This provides a way to see from outside that the X20 system mounted in this slot is using node number switches.



9.5.7 X20BM21

Data sheet version: 2.22

9.5.7.1 General information

The bus module serves as a basis for all double-width X20 I/O modules. The internal I/O supply is isolated to the left. This allows the bus module to be used to set up a separate voltage group if the X20BT9100 bus transmitter is used for the supply.

- For creating voltage groups
- The internal I/O supply is isolated to the left

9.5.7.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| X20BM21 | X20 power supply bus module, for double-width modules, 24 VDC keyed, internal I/O supply interrupted to the left |  |

Table 148: X20BM21 - Order data

9.5.7.3 Technical data

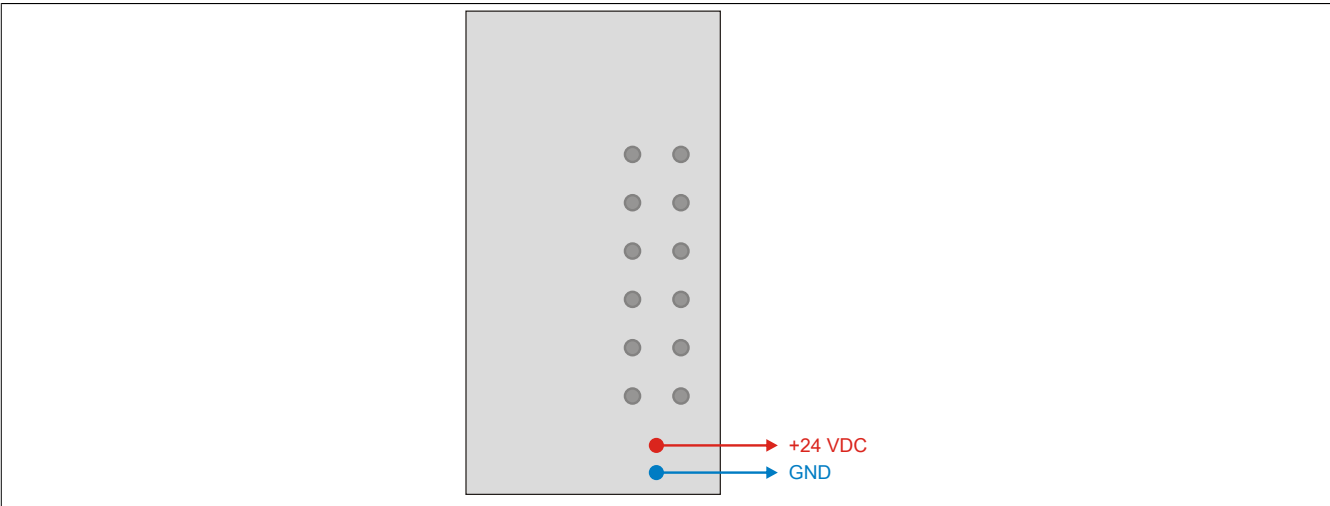
| Model number | X20BM21 |
|--|--|
| Short description | |
| Bus module | Power supply bus module for double-width modules, 24 VDC keyed, internal I/O supply interrupted to the left |
| General information | |
| Power consumption | |
| Bus | 0.13 W |
| Internal I/O | - |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| I/O power supply | |
| Nominal voltage | 24 VDC |
| Permissible contact load | 10 A |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |

Table 149: X20BM21 - Technical data

| | |
|--|---|
| Model number | X20BM21 |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Spacing | 25 ^{+0.2} mm |

Table 149: X20BM21 - Technical data

9.5.7.4 Voltage routing



9.5.8 X20(c)BM31

Data sheet version: 2.35

9.5.8.1 General information

The bus module serves as a basis for all double-width X20 I/O modules. The internal I/O supply is interconnected.

- Bus module for double-width I/O modules
- The internal I/O supply is interconnected

9.5.8.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.5.8.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.5.8.3 Order data

| Model number | Short description | Figure |
|--------------|--|--------|
| | Bus modules | |
| X20BM31 | X20 bus module for double-width modules, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM31 | X20 bus module, coated, for double-width modules, 24 VDC keyed, internal I/O supply continuous | |

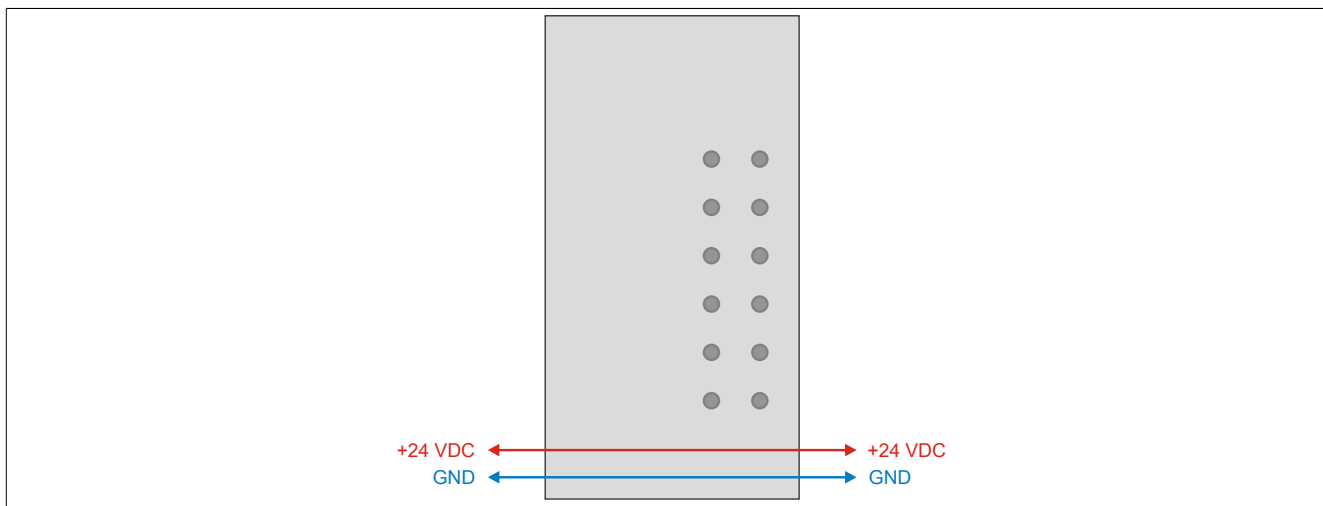
Table 150: X20BM31, X20cBM31 - Order data

9.5.8.4 Technical data

| Model number | X20BM31 | X20cBM31 |
|--|--|------------------------|
| Short description | Bus module for double-width modules, 24 VDC keyed, internal I/O supply continuous | |
| General information | | |
| Power consumption | | |
| Bus | 0.13 W | |
| Internal I/O | - | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations | |
| DNV GL | Class 1, Division 2, Groups ABCD, T5 Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| I/O power supply | | |
| Nominal voltage | 24 VDC | |
| Permissible contact load | 10 A | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Pitch | 25 ^{+0.2} mm | |

Table 151: X20BM31, X20cBM31 - Technical data

9.5.8.5 Voltage routing



9.5.9 X20(c)BM32

Data sheet version: 1.25

9.5.9.1 General information

The bus module serves as the base for all double-width 240 VAC X20 I/O modules. The internal I/O supply is interconnected.

- Bus module for double-width 240 VAC I/O modules
- The internal I/O supply is interconnected
- 240 V coding for bus module, electronic module and terminal block

9.5.9.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.5.9.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.5.9.3 Order data

| Model number | Short description | Figure |
|--------------|---|--------|
| X20BM32 | X20 bus module for double-width modules, 240 VAC keyed, internal I/O supply continuous | |
| X20cBM32 | X20 bus module, coated, for double-width modules, 240 VAC keyed, internal I/O supply continuous | |

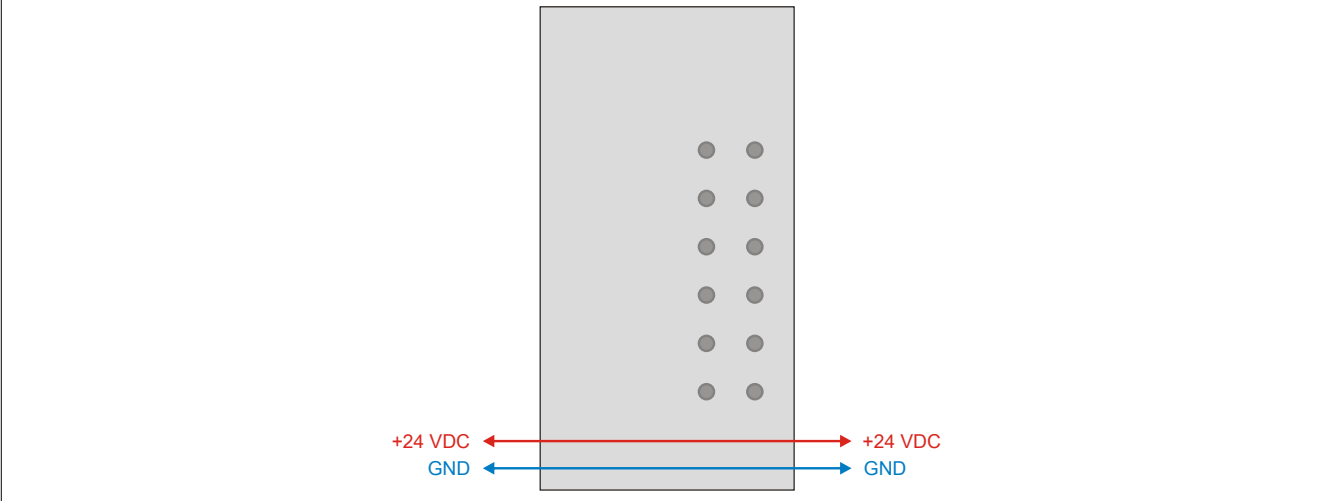
Table 152: X20BM32, X20cBM32 - Order data

9.5.9.4 Technical data

| Model number | X20BM32 | X20cBM32 |
|--|--|------------------------|
| Short description | | |
| Bus module | Bus module for double-width modules, 240 VAC keyed, internal I/O supply continuous | |
| General information | | |
| Power consumption | | |
| Bus | 0.13 W | |
| Internal I/O | - | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations | |
| DNV GL | Class 1, Division 2, Groups ABCD, T5 Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| I/O power supply | | |
| Nominal voltage | 24 VDC | |
| Permissible contact load | 10 A | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Pitch | 25 ^{+0.2} mm | |

Table 153: X20BM32, X20cBM32 - Technical data

9.5.9.5 Voltage routing



9.6 Bus receivers and Bus transmitters

The X20 system is connected directly to the remote X2X Link backplane via bus receiver X20BR9300. The connection to the next station is established with bus transmitter X20BT9100.

9.6.1 Summary

| Model number | Short description | Page |
|--------------|--|------|
| X20BR7300 | X20 bus receiver, CAN I/O, supply for X2X Link and internal I/O power supply, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 964 |
| X20BR9300 | X20 bus receiver, X2X Link, supply for X2X Link and internal I/O power supply, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 973 |
| X20BT9100 | X20 bus transmitter, X2X Link, supply for internal I/O supply | 980 |
| X20BT9400 | X20 bus transmitter X2X Link, feed for internal I/O supply, X2X Link supply for X67 modules, reverse polarity protection, short circuit protection, overload protection, parallel connection possible, redundancy operation possible | 986 |
| X20cBR9300 | X20 bus receiver, coated, X2X Link, supply for X2X Link and internal I/O power supply, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 973 |
| X20cBT9100 | X20 bus transmitter, coated, X2X Link, supply for internal I/O supply | 980 |

9.6.2 X20BR7300

Data sheet version: 1.07

9.6.2.1 General information

The bus receiver makes it possible to connect X2X Link I/O nodes to CAN I/O. CAN I/O is a transfer protocol based on standard CAN bus that is fully integrated in the B&R system.

Up to 43 logical I/O modules can be connected to the bus receiver. Up to 16 of these can be analog modules.

- Fieldbus: CAN bus
- Automatic firmware update via the fieldbus
- Integrated I/O access in B&R Automation Studio

Information:

Modules that follow a gap in X2X Link node numbers are not configured by the bus receiver. This gap results from unconnected X20 modules.

Information:

Dummy modules and bus modules with an integrated node number switch are not supported by the bus receiver.

Information:

Only the standard function model (see the respective module description) is supported when the bus receiver is used together with multi-function modules it has automatically configured itself.

Information:

A hardware upgrade $\geq 2.0.0.0$ for bus module X20BM01 is required in order to use the bus receiver.

The hardware upgrade is only permitted to be installed in the following versions of Automation Studio!

- Automation Studio 4.2.7.54 to 4.2.x.x
- Automation Studio $\geq 4.3.2.103$
- Automation Runtime ≥ 4.26

A hardware upgrade $\geq 2.0.0.0$ for bus module X20BM01 with Automation Studio versions $< 4.2.7.54$ and Automation Studio versions from 4.3.1.0 to 4.3.2.102 cause faulty behavior on bus module X20BM01.

Unconfigured X20 modules

A specific blinking behavior for LED "r" or "S" indicates X20 modules that are connected to the bus receiver but not configured.

The green LED blinks with a single or double flash. This blinking behavior depends on the respective X20 module.

Information:

In this case, a double flash indicates a missing configuration and not a firmware update.

9.6.2.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Bus receivers and transmitters |  |
| X20BR7300 | X20 bus receiver, CAN I/O, supply for X2X Link and internal I/O power supply, X20 end cover plates (left and right) X20AC0SL1/ X20AC0SR1 included | |
| | Required accessories | |
| | Bus modules | |
| X20BM01 | X20 power supply bus module, 24 VDC keyed, internal I/O supply interrupted to the left | |
| X20BM05 | X20 power supply bus module, with node number switch, 24 VDC keyed, internal I/O supply interrupted to the left | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 154: X20BR7300 - Order data

9.6.2.3 Technical data

| Model number | X20BR7300 |
|--|--|
| Short description | |
| Bus receiver | CAN I/O slave |
| General information | |
| B&R ID code | 0xEBED |
| Status indicators | Module status, bus function, data transfer, I/O power supply, bus power supply |
| Diagnostics | |
| Module status | Yes, using LED status indicator |
| Bus function | Yes, using LED status indicator |
| Data transfer | Yes, using LED status indicator |
| Overload | Yes, using LED status indicator and software |
| Power consumption for X2X Link power supply | 0.6 W |
| Power consumption | |
| Internal I/O | 0.6 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| X2X Link and I/O power supply | |
| Input voltage | 24 VDC -15% / +20% |
| Fuse | Required line fuse: Max. 16 A, slow-blow for wiring Integrated fuse for module, non-replaceable |
| Reverse polarity protection | Yes |
| X2X Link power supply output | |
| Nominal output power | 2 W |
| Parallel connection | No ¹⁾ |
| Redundant operation | No |
| Overload characteristics | Short-circuit proof, temporary overload |
| Output I/O power supply | |
| Nominal output voltage | 24 VDC |
| Behavior on short circuit | Required line fuse |
| Permissible contact load | 10 A |
| Interfaces | |
| Fieldbus | CAN I/O slave |
| Variant | Connection made using 12-pin terminal block X20TB12 |
| Max. distance | 1000 m |
| Transfer rate | Max. 1 Mbit/s |
| Default transfer rate | Automatic transfer rate detection |
| X2X Link cycle time | Permanently set to 1 ms ²⁾ |
| Synchronization between bus systems possible | No |
| Electrical properties | |
| Electrical isolation | X2X Link supply not isolated from X2X Link power supply I/O supply not isolated from I/O power supply CAN I/O not isolated from I/O or X2X Link power supply |


Table 155: X20BR7300 - Technical data

| | |
|--|---|
| Model number | X20BR7300 |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x power supply bus module X20BM01 separately, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included. |
| Pitch | 12.5 ^{+0.2} mm |

Table 155: X20BR7300 - Technical data

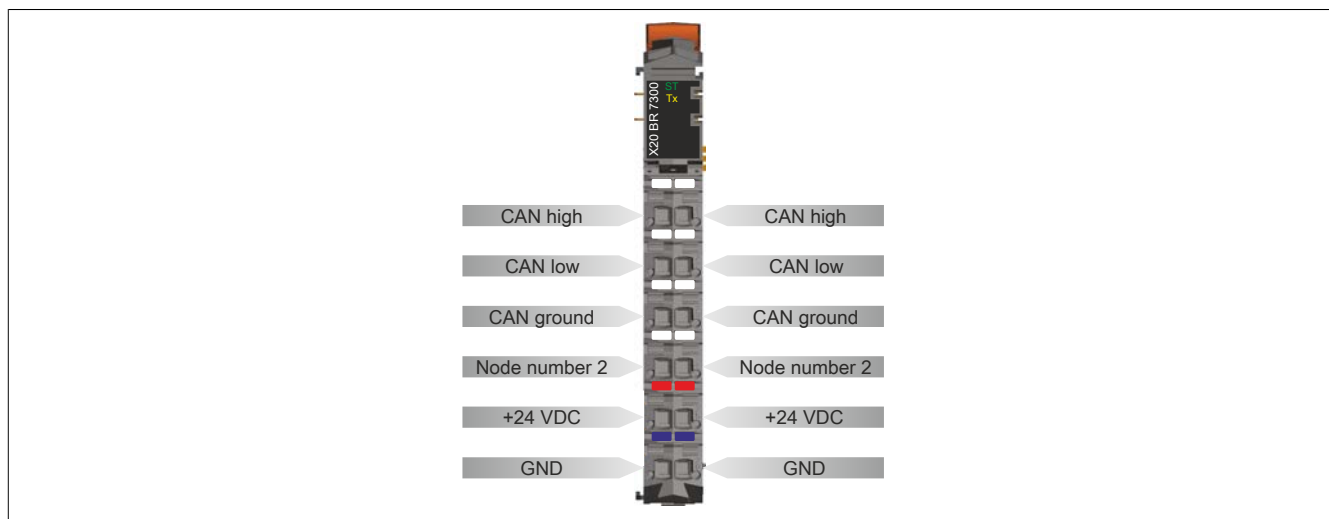
- 1) Power supply modules X20PS3300 and X20PS3310 can be used. The 2 W nominal output power of module X20BR7300 is not included in the calculation of the X2X Link power supply, however.
- 2) CAN I/O data points are processed in Automation Runtime in a separate cycle set to 10 ms (CAN I/O cycle).

9.6.2.4 LED status indicators

| Figure | LED | Color | Status | Description |
|---|---------------------------------|-----------|---|--|
|  | ST ¹⁾ | Green | Off | No power supply |
| | | | Double flash | Mode BOOT (during firmware update) ²⁾ |
| | | | Blinking | Mode PREOPERATIONAL |
| | | | On | Mode RUN |
| | | Red | Double flash | The LED indicates one of the following states: <ul style="list-style-type: none"> • The X2X Link power supply of the power supply is overloaded. • The input voltage for the X2X Link power supply is too low. |
| | | | On | CAN connection reports BusOff status |
| | | | Flickering | Transfer rate detection in progress |
| | | Green/Red | Blinking | I/O power supply too low |
| | | | Blinking green / Single red flash | PREOPERATIONAL mode: CAN connection reports warning limit reached |
| | Steady green / Single red flash | | RUN mode: CAN connection reports warning limit reached | |
| Tx | | Yellow | Off | Bus receiver not transmitting any data via CAN I/O fieldbus |
| | On | | Bus controller transmitting data via the CAN I/O fieldbus | |

- 1) LED "ST" is a green/red dual LED.
- 2) Depending on the configuration, a firmware update can take up to several minutes.

9.6.2.5 Pinout



9.6.2.6 Setting the module's node number

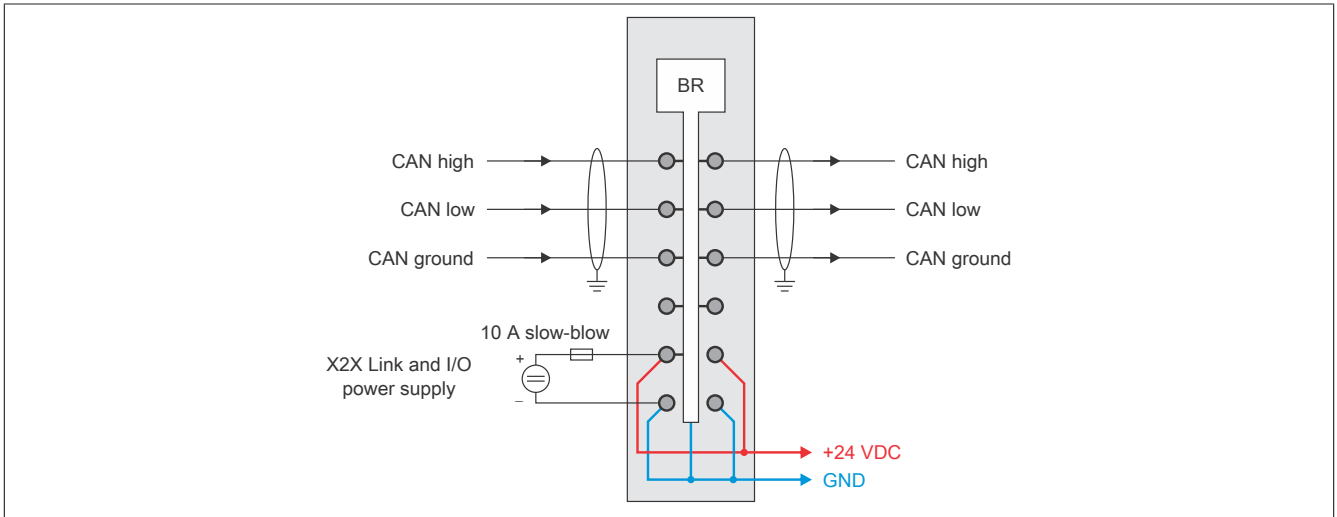
Node number 1 or 2 can be set on the module. By default, the module is set to node number 1. Node number 2 is set on the module by connecting terminal connections 14 and 24 using a jumper (see also "Connection examples", "Example 2: Node number 2" on page 966).

9.6.2.7 Terminating resistor

CAN networks are cabled using a bus structure where both ends of the bus must be wired with a terminating resistor. The terminating resistor must be wired externally (see also "Connection examples", "Example 3: With terminating resistor" on page 967).

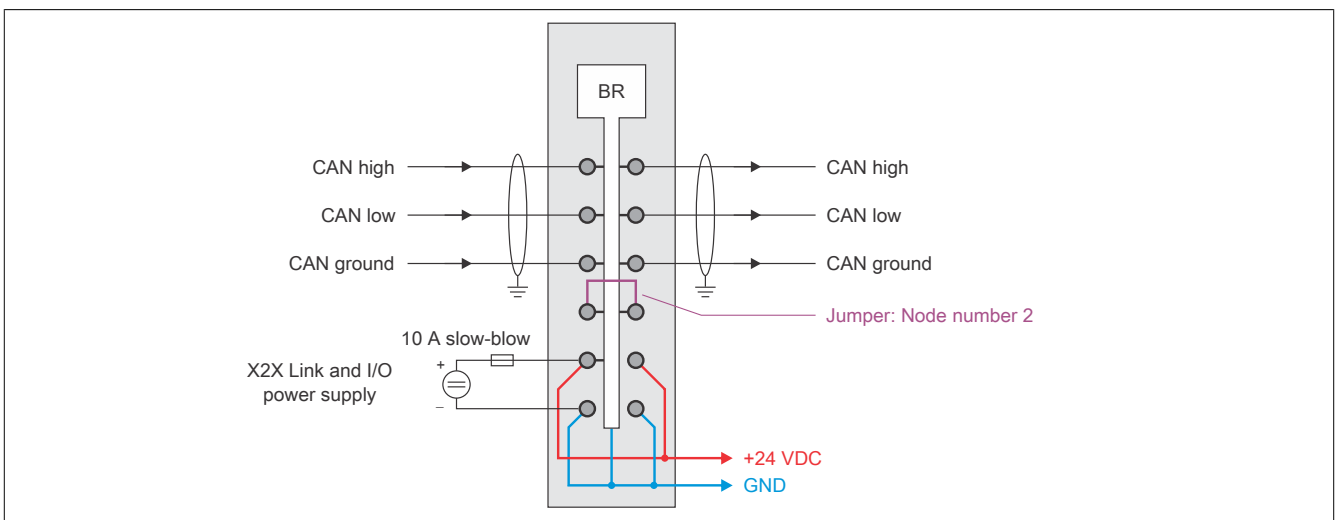
9.6.2.8 Connection examples

Example 1



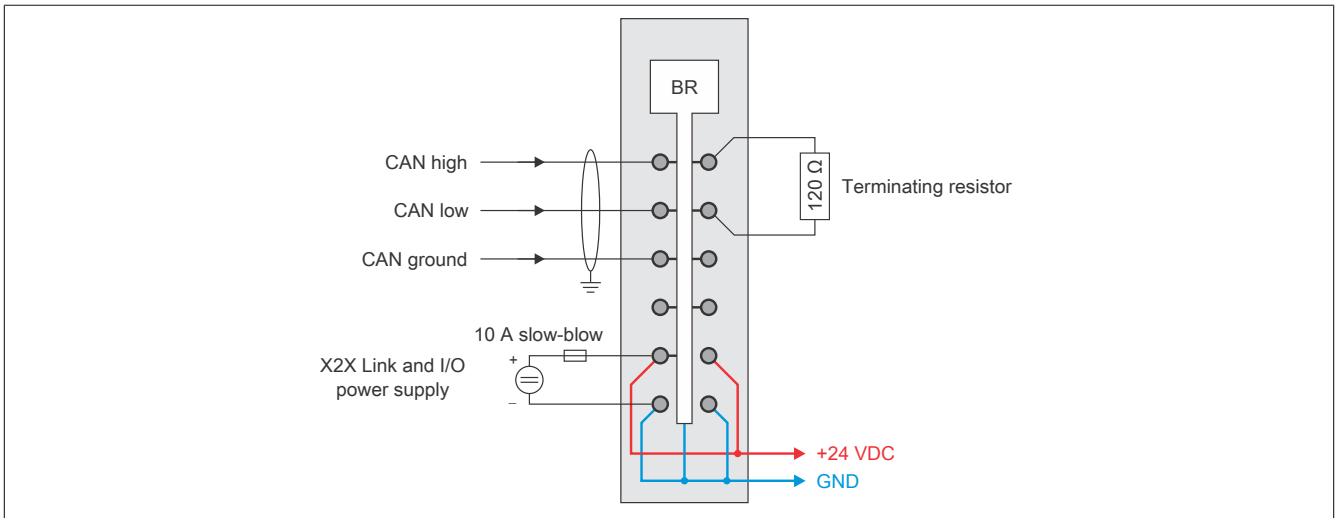
Example 2: Node number 2

By default, the module is set to node number 1. The module is set to node number 2 if terminal connection 14 is connected to 24 using a jumper.



Example 3: With terminating resistor

The terminating resistor must be wired externally.

**9.6.2.9 Automatic transfer rate detection**

After startup, the bus receiver goes into "Listen only" mode. This means the bus receiver behaves passively on the bus and only listens.

The bus receiver attempts to receive valid objects. If receive errors occur, the bus receiver switches to the next transfer rate in the lookup table.

If no objects are received, all transfer rates are tested cyclically. This procedure is repeated until valid objects are received.

Starting transfer rate

The bus receiver begins the search with this transfer rate. The last detected transfer rate is used after a software reset (command code 20).

Lookup table

The bus receiver tests the transfer rate according to this table. Beginning with the starting transfer rate, the controller switches to the next lower transfer rate. At the end of the table, the bus receiver restarts the search from the beginning.

| Transfer rate |
|---------------|
| 1000 kbit/s |
| 500 kbit/s |
| 250 kbit/s |
| 125 kbit/s |
| 50 kbit/s |
| 20 kbit/s |
| 10 kbit/s |

9.6.2.10 SG4

The module comes with preinstalled firmware. The firmware is also part of the Automation Runtime operating system for the PLC. With different versions, the Automation Runtime firmware is loaded onto the module.

The latest firmware is made available automatically when updating Automation Runtime.

9.6.2.11 Logical I/O modules

Up to 43 I/O modules can be connected to the bus receiver (up to 16 of these can be analog modules). This value refers not to the physical but the logical I/O module slots.

Information:

Physical I/O modules can take up more than one digital or analog slot.

The following table lists all X20 modules capable of using CAN I/O and how many logical digital and analog slots are needed.

| Module | Digital module slots | Analog module slots |
|------------------------|----------------------|---------------------|
| X20AI1744, X20AI1744-3 | 0 | 1 |
| X20AI2222 | 0 | 1 |
| X20AI2237 | 0 | 1 |
| X20AI2322 | 0 | 1 |
| X20AI2437 | 0 | 1 |
| X20AI2438 | 0 | 2 |
| X20AI2622 | 0 | 1 |
| X20AI2632, X20AI2632-1 | 0 | 1 |
| X20AI2636 | 0 | 1 |
| X20AI4222 | 0 | 1 |
| X20AI4322 | 0 | 1 |
| X20AI4622 | 0 | 1 |
| X20AI4632, X20AI4632-1 | 0 | 1 |
| X20AI4636 | 0 | 1 |
| X20AI8221 | 0 | 2 |
| X20AI8321 | 0 | 2 |
| X20AIA744 | 0 | 2 |
| X20AIB744 | 0 | 4 |
| X20AO2437 | 0 | 1 |
| X20AO2438 | 0 | 2 |
| X20AO2622 | 0 | 1 |
| X20AO2632, X20AO2632-1 | 0 | 1 |
| X20AO4622 | 0 | 1 |
| X20AO4632, X20AO4632-1 | 0 | 1 |
| X20AO4635 | 0 | 1 |
| X20AP31xx | 0 | 3 |
| X20AT2222 | 0 | 1 |
| X20AT2311 | 0 | 1 |
| X20AT2402 | 0 | 1 |
| X20AT4222 | 0 | 1 |
| X20AT4232 | 0 | 1 |
| X20AT6402 | 0 | 2 |
| X20ATA312 | 0 | 1 |
| X20ATA492 | 0 | 1 |
| X20ATB312 | 0 | 1 |
| X20ATC402 | 0 | 2 |
| X20BR9300 | 0 | 1 |
| X20BT9100 | 0 | 1 |
| X20BT9400 | 0 | 1 |
| X20CM0985 | 0 | 8 |
| X20CM0985-2 | 0 | 8 |
| X20CM1201 | 0 | 1 |
| X20CM1941 | 0 | 1 |
| X20CM4323 | 0 | 1 |
| X20CM4810 | 0 | 2 |
| X20CM8281 | 0 | 1 |
| X20CM8323 | 0 | 1 |
| X20CMR010 | 0 | 1 |
| X20CMR100 | 0 | 1 |
| X20CMR111 | 0 | 4 |
| X20CS1011 | 0 | 2 |
| X20CS1012 | 0 | 3 |
| X20CS1013 | 0 | 1 |
| X20CS1020 | 0 | 1 |
| X20CS1030 | 0 | 1 |
| X20CS1070 | 0 | 1 |
| X20CS2770 | 0 | 2 |
| X20DC1073 | 0 | 1 |
| X20DC1176 | 0 | 1 |
| X20DC1178 | 0 | 1 |
| X20DC1196 | 0 | 1 |
| X20DC1198 | 0 | 1 |

| Module | Digital module slots | Analog module slots |
|-------------|----------------------|---------------------|
| X20DC11A6 | 0 | 1 |
| X20DC1376 | 0 | 1 |
| X20DC137A | 0 | 1 |
| X20DC1396 | 0 | 1 |
| X20DC1398 | 0 | 1 |
| X20DC1976 | 0 | 1 |
| X20DC2190 | 0 | 4 |
| X20DC2395 | 0 | 1 |
| X20DC2396 | 0 | 1 |
| X20DC2398 | 0 | 2 |
| X20DC4395 | 0 | 2 |
| X20DI0471 | 2 | 0 |
| X20DI2371 | 1 | 0 |
| X20DI2372 | 1 | 0 |
| X20DI2377 | 0 | 1 |
| X20DI2653 | 1 | 0 |
| X20DI4371 | 1 | 0 |
| X20DI4372 | 1 | 0 |
| X20DI4375 | 1 | 0 |
| X20DI4653 | 1 | 0 |
| X20DI4760 | 1 | 0 |
| X20DI6371 | 1 | 0 |
| X20DI6372 | 1 | 0 |
| X20DI6373 | 1 | 0 |
| X20DI6553 | 1 | 0 |
| X20DI8371 | 1 | 0 |
| X20DI9371 | 2 | 0 |
| X20DI9372 | 2 | 0 |
| X20DID371 | 1 | 0 |
| X20DIF371 | 2 | 0 |
| X20DM9324 | 1 | 0 |
| X20DO2321 | 1 | 0 |
| X20DO2322 | 1 | 0 |
| X20DO2623 | 0 | 1 |
| X20DO2633 | 0 | 1 |
| X20DO2649 | 1 | 0 |
| X20DO4321 | 1 | 0 |
| X20DO4322 | 1 | 0 |
| X20DO4331 | 1 | 0 |
| X20DO4332 | 1 | 0 |
| X20DO4332-1 | 0 | 1 |
| X20DO4529 | 1 | 0 |
| X20DO4613 | 0 | 1 |
| X20DO4623 | 0 | 1 |
| X20DO4633 | 0 | 1 |
| X20DO4649 | 1 | 0 |
| X20DO6321 | 1 | 0 |
| X20DO6322 | 1 | 0 |
| X20DO6325 | 1 | 0 |
| X20DO6529 | 1 | 0 |
| X20DO6639 | 1 | 0 |
| X20DO8232 | 1 | 0 |
| X20DO8322 | 1 | 0 |
| X20DO8331 | 1 | 0 |
| X20DO8332 | 1 | 0 |
| X20DO9321 | 2 | 0 |
| X20DO9322 | 2 | 0 |
| X20DOD322 | 1 | 0 |
| X20DOF322 | 2 | 0 |
| X20DS1828 | 0 | 2 |
| X20DS1928 | 0 | 2 |
| X20DS4387 | 0 | 2 |
| X20DS438A | 0 | 3 |
| X20MM2436 | 0 | 1 |
| X20MM3332 | 0 | 1 |
| X20MM4331 | 0 | 2 |
| X20MM4455 | 0 | 4 |
| X20MM4456 | 0 | 4 |
| X20PD0011 | 1 | 0 |
| X20PD0012 | 1 | 0 |
| X20PD0016 | 1 | 0 |
| X20PD2113 | 1 | 0 |
| X20PS2100 | 0 | 1 |
| X20PS2110 | 0 | 1 |

| Module | Digital module slots | Analog module slots |
|---------------|-----------------------------|----------------------------|
| X20PS3300 | 0 | 1 |
| X20PS3310 | 0 | 1 |
| X20PS4951 | 1 | 0 |
| X20PS9400 | 0 | 1 |
| X20PS9402 | 0 | 1 |
| X20SM1426 | 0 | 1 |
| X20SM1436 | 0 | 1 |
| X20SM1436-1 | 0 | 1 |
| X20SM1446-1 | 0 | 2 |

9.6.2.12 Register description

9.6.2.12.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.6.2.12.2 Overview of registers

| Register | Name | Data type | Read | | Write | |
|----------|--------------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 0 | Status of the module | USINT | • | | | |
| | IF1.ST1.StatusInput01 | Bit 0 | | | | |
| | IF1.ST1.StatusInput02 | Bit 1 | | | | |

9.6.2.12.3 Status of the module

Name:

IF1.ST1.StatusInput01 and IF1.ST1.StatusInput02

The following voltage and current states of the module are monitored in this register:

- X2X Link supply current >0.4 A is indicated as a warning.
- X2X Link supply voltage <4.7 V is indicated as a warning.
- 24 VDC I/O supply voltage <20.4 V is indicated as a warning.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|---|
| 0 | IF1.ST1.StatusInput01 X2X Link supply current and X2X Link supply voltage | 0 | No error |
| | | 1 | Warning in the event of overcurrent (>0.4 A) or undervoltage (<4.7 V) |
| 1 | IF1.ST1.StatusInput02 I/O supply voltage | 0 | I/O supply voltage greater than or equal to the warning level of 20.4 V |
| | | 1 | I/O supply voltage less than the warning level of 20.4 V |
| 2 - x | Reserved | 0 | |

9.6.3 X20(c)BR9300

Data sheet version: 3.16

9.6.3.1 General information

The bus receiver is used to connect the X20 System to the X2X Link. The module is equipped with a feed for the X2X Link as well as the internal I/O supply.

- X2X Link bus receiver
- Feed for X2X Link and internal I/O supply
- Electrical isolation of feed and X2X Link supply
- Redundancy of X2X Link supply possible by operating multiple supply modules simultaneously
- Operation only on the slot to the far left

9.6.3.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.6.3.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.6.3.3 Order data


| Model number | Short description | Figure |
|----------------|---|---|
| | Bus receivers and transmitters |  |
| X20BR9300 | X20 bus receiver, X2X Link, supply for X2X Link and internal I/O power supply, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cBR9300 | X20 bus receiver, coated, X2X Link, supply for X2X Link and internal I/O power supply, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| | Required accessories | |
| | Bus modules | |
| X20BM01 | X20 power supply bus module, 24 VDC keyed, internal I/O supply interrupted to the left | |
| X20BM05 | X20 power supply bus module, with node number switch, 24 VDC keyed, internal I/O supply interrupted to the left | |
| X20cBM01 | X20 power supply bus module, coated, 24 VDC keyed, internal I/O supply interrupted to the left | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | Optional accessories | |
| | X2X Link cable | |
| X67CA0X99.1000 | Cable for custom assembly, 100 m | |
| X67CA0X99.5000 | Cable for custom assembly, 500 m | |

Table 156: X20BR9300, X20cBR9300 - Order data

Information:

This module is **NOT PERMITTED** to be used together with continuous power supply modules (e.g. X20BM11 or X20BM15) since this can result in problems with X2X Link!

9.6.3.4 Technical data

| Model number | X20BR9300 | X20cBR9300 |
|--|---|------------|
| Short description | X2X Link bus receiver with supply for I/O and bus | |
| Bus receiver | | |
| General information | | |
| B&R ID code | 0x1BC1 | 0xDD48 |
| Status indicators | X2X bus function, overload, operating status, module status | |
| Diagnosics | | |
| Module run/error | Yes, using status LED and software | |
| Overload | Yes, using status LED and software | |
| X2X bus function | Yes, using status LED | |
| Power consumption for X2X Link power supply ¹⁾ | 1.62 W | |
| Power consumption ¹⁾ | | |
| Internal I/O | 0.6 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| EAC | Yes | |
| KC | Yes | - |
| X2X Link power supply input | | |
| Input voltage | 24 VDC -15% / +20% | |
| Input current | Max. 0.7 A | |
| Fuse | Integrated, cannot be replaced | |
| Reverse polarity protection | Yes | |
| X2X Link power supply output | | |
| Nominal output power | 7 W | |
| Parallel connection | Yes ²⁾ | |
| Redundant operation | Yes | |
| Overload characteristics | Short circuit / temporary overload protection | |
| Input I/O power supply | | |
| Input voltage | 24 VDC -15% / +20% | |
| Fuse | Required line fuse: Max. 10 A, slow-blow | |

Table 157: X20BR9300, X20cBR9300 - Technical data


| Model number | X20BR9300 | X20cBR9300 |
|--|--|--|
| Reverse polarity protection | No | |
| Output I/O power supply | | |
| Nominal output voltage | 24 VDC | |
| Behavior on short circuit | Required line fuse | |
| Permissible contact load | 10 A | |
| Electrical properties | | |
| Electrical isolation | X2X Link supply isolated from X2X Link power supply I/O supply not isolated from I/O power supply | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating" | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM01 supply bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM01 supply bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 157: X20BR9300, X20cBR9300 - Technical data

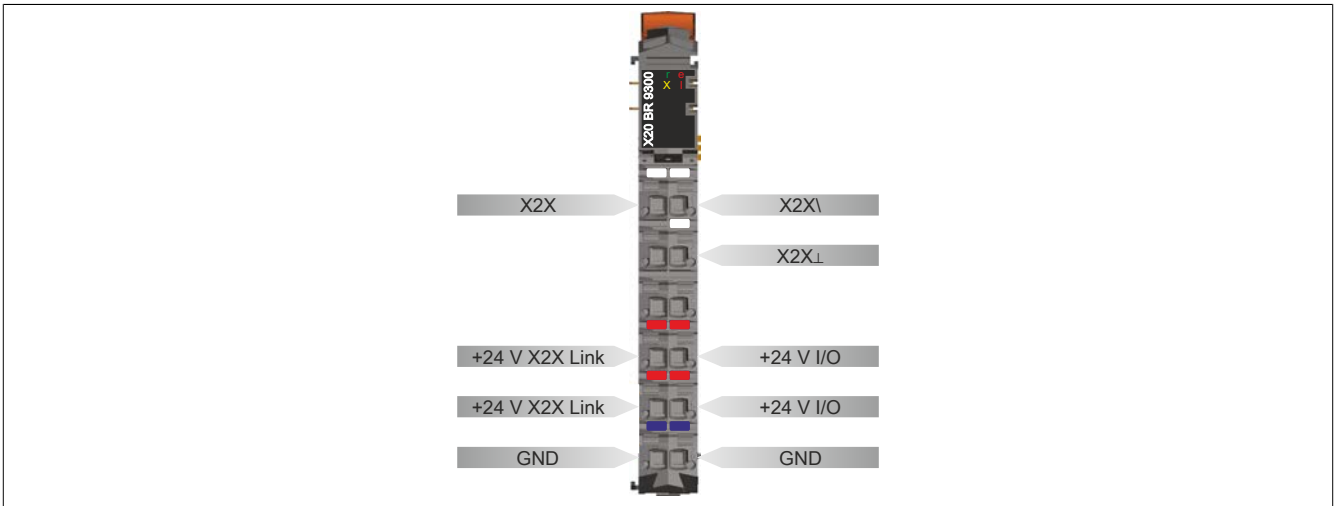
- The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- In parallel operation, only 75% of the rated power can be assumed. It is important to make sure that all power supplies operated in parallel are switched on and off at the same time.

9.6.3.5 LED status indicators

For a description of the various operating modes, see ["Diagnostic LEDs" on page 3787](#).

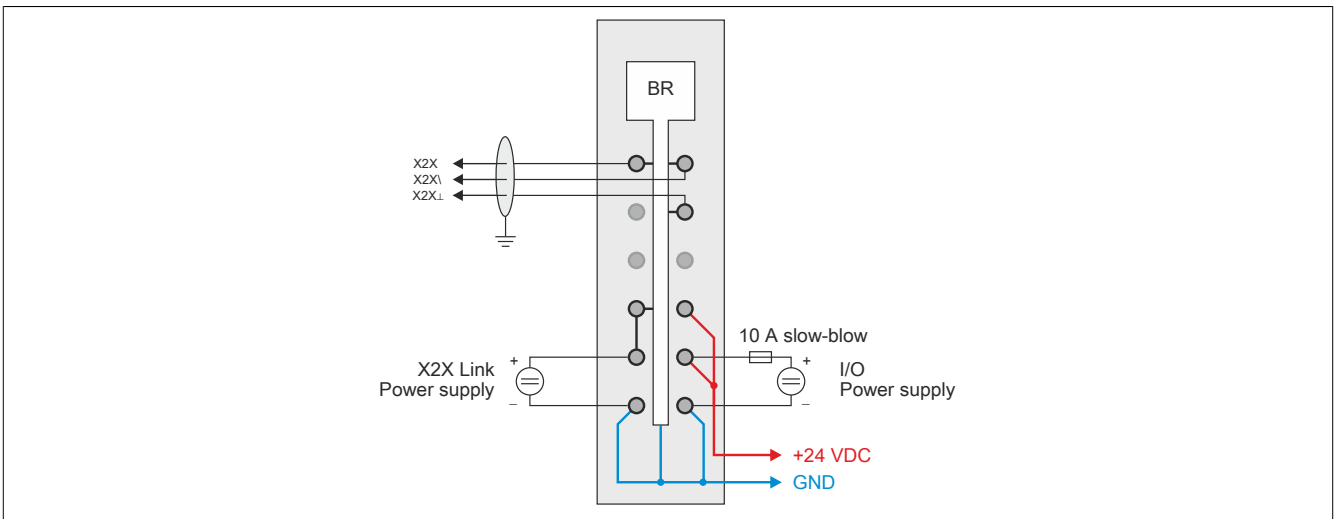
| Figure | LED | Color | Status | Description |
|---|-------|-----------------------------|--|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Double flash | LED indicates one of the following states: <ul style="list-style-type: none"> X2X Link power supply is overloaded I/O supply too low Input voltage for X2X Link supply too low |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | X | Orange | Off | No communication at the X2X Link |
| | | | On | X2X Link communication in progress |
| | l | Red | Off | X2X Link supply in the acceptable range |
| On | | | X2X Link power supply is overloaded Solution: Use an additional feed module X20PS3300 | |

9.6.3.6 Pinout

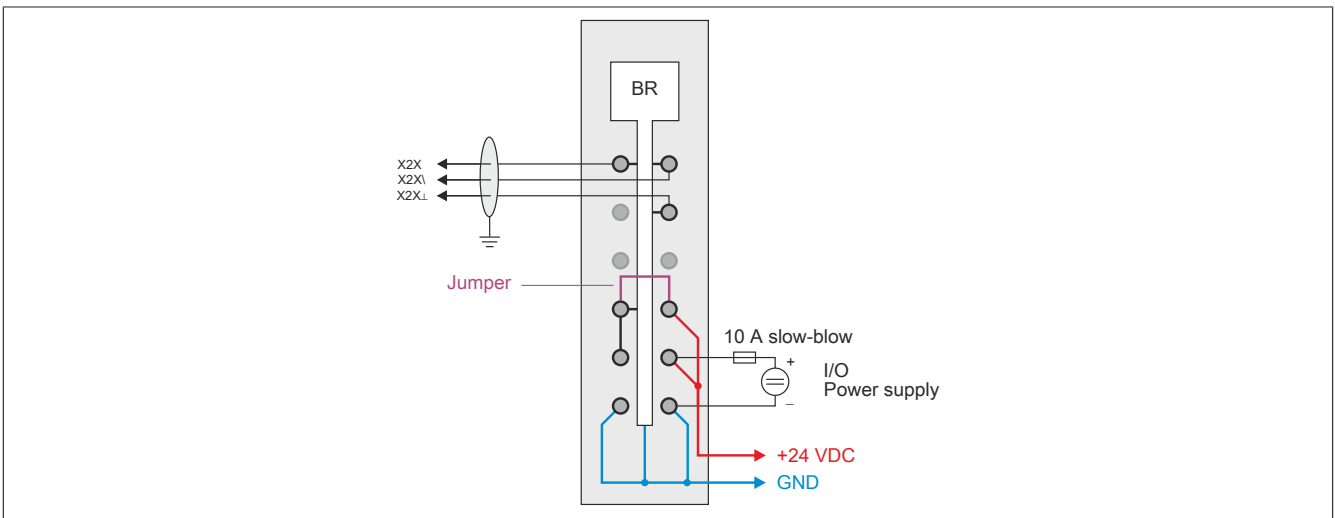


9.6.3.7 Connection examples

With two separate supplies

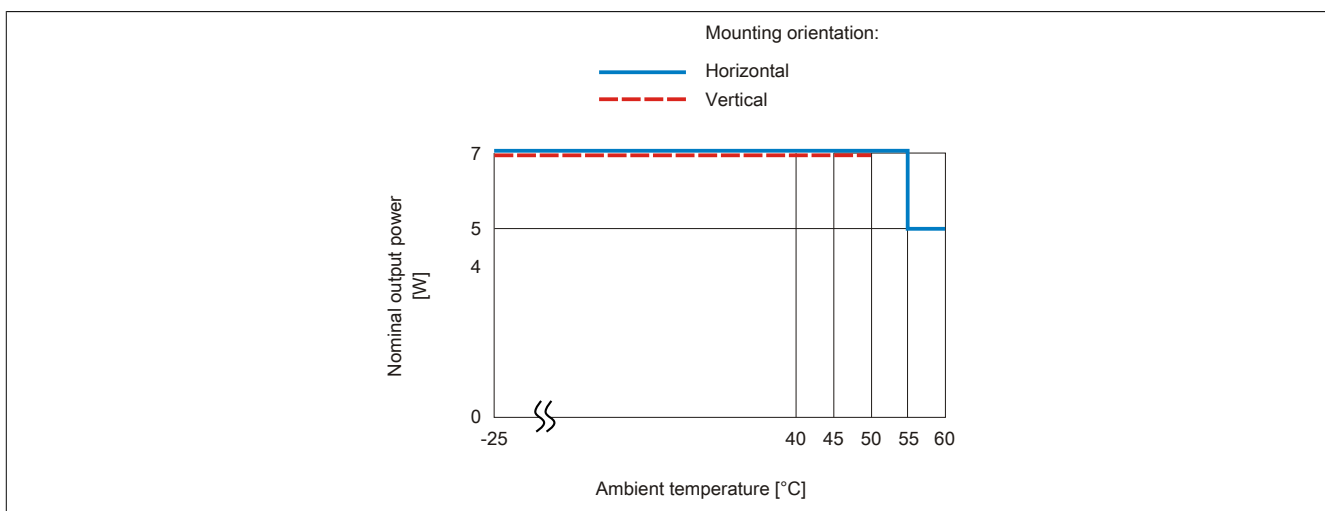


With a supply and jumper



9.6.3.8 Derating

The nominal output power for the power supply is 7 W. Depending on the mounting orientation, derating must be taken into account.



9.6.3.9 Register description

9.6.3.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.6.3.9.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 0 | 1 | Status of the module | USINT | • | | | |
| | | StatusInput01 | Bit 0 | | | | |
| | | StatusInput02 | Bit 2 | | | | |
| 2 | 2 | SupplyCurrent | USINT | • | | | |
| 4 | 3 | SupplyVoltage | USINT | • | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.6.3.9.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 0 | 0 | Status of the module | UINT | • | | | |
| | | StatusInput01 | Bit 0 | | | | |
| | | StatusInput02 | Bit 2 | | | | |
| 2 | 2 | SupplyCurrent | UINT | • | | | |
| 4 | 4 | SupplyVoltage | UINT | • | | | |

1) The offset specifies the position of the register within the CAN object.

9.6.3.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "[Using I/O modules on the bus controller](#)" on page 3789.

9.6.3.9.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.6.3.9.4 Status of the module

Name:

Module status

The following voltage and current states of the module are monitored in this register:

| | |
|----------------------------|--|
| Bus power supply current: | Bus power supply current >2.3 A is displayed as a warning. |
| Bus supply voltage: | Bus supply voltage <4.7 V is displayed as a warning. |
| 24 VDC I/O supply voltage: | I/O supply voltage <20.4 V is displayed as a warning. |

| Function model | Data type | Values |
|----------------------|-----------|------------------------|
| 0 - Standard | USINT | See the bit structure. |
| 254 - Bus controller | UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|---|
| 0 | StatusInput01 | 0 | No error |
| | | 1 | Warning in the event of overcurrent (>2.3 A) or undervoltage (<4.7 V) |
| 1 | Reserved | 0 | |
| 2 | StatusInput02 | 0 | I/O power supply above the warning limit of 20.4 V |
| | | 1 | I/O power supply below the warning limit of 20.4 V |
| 3 - x | Reserved | 0 | |

9.6.3.9.5 Bus power supply current

Name:

SupplyCurrent

This register displays the bus power supply current measured at a resolution of 0.1 A.

| Function model | Data type |
|----------------------|-----------|
| 0 - Standard | USINT |
| 254 - Bus controller | UINT |

9.6.3.9.6 Bus supply voltage

Name:

SupplyVoltage

This register indicates the bus supply voltage measured at a resolution of 0.1 V.

| Function model | Data type |
|----------------------|-----------|
| 0 - Standard | USINT |
| 254 - Bus controller | UINT |

9.6.3.9.7 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.6.3.9.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 2 ms |

9.6.4 X20(c)BT9100

Data sheet version: 3.18

9.6.4.1 General information

The bus transmitter provides for the seamless expansion of the X20 System. The stations can be up to 100 m away from each other.

- X2X Link bus transmitter
- For seamless expansion of the system
- Up to 100 m segment lengths
- Feed for internal I/O supply
- Operation only on the slot to the far right

Information:

The bus transmitter modules may only be operated with a bus module where the internal I/O supply is connected through (e.g. X20BM11).

If the incoming voltage is used for internal I/O supply, then this potential group must not be supplied by any other module. An I/O module with bus module X20BM01 should be used to separate the potential group.

9.6.4.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days




9.6.4.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.6.4.3 Order data

| Model number | Short description | Figure |
|----------------|---|---|
| | Bus receivers and transmitters |  |
| X20BT9100 | X20 bus transmitter, X2X Link, supply for internal I/O supply | |
| X20cBT9100 | X20 bus transmitter, coated, X2X Link, supply for internal I/O supply | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | Optional accessories | |
| | X2X Link cable | |
| X67CA0X99.1000 | Cable for custom assembly, 100 m | |
| X67CA0X99.5000 | Cable for custom assembly, 500 m | |

9.6.4.4 Technical data

| Model number | X20BT9100 | X20cBT9100 |
|--|---|------------|
| Short description | X2X Link bus transmitter with supply for I/O | |
| Bus transmitter | X2X Link bus transmitter with supply for I/O | |
| General information | | |
| B&R ID code | 0x1BC2 | 0xE219 |
| Status indicators | X2X bus function, operating status, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| X2X bus function | Yes, using status LED | |
| Power consumption ¹⁾ | | |
| Bus | 0.5 W | |
| Internal I/O | | |
| As bus transmitter | 0.1 W | |
| Additionally as supply module | 0.6 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| EAC | Yes | |
| KC | Yes | - |
| Input I/O power supply | | |
| Input voltage | 24 VDC -15% / +20% | |
| Fuse | Required line fuse: Max. 10 A, slow-blow | |
| Reverse polarity protection | No | |
| Output I/O power supply | | |
| Nominal output voltage | 24 VDC | |
| Behavior on short circuit | Required line fuse | |
| Permissible contact load | 10 A | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |

Table 159: X20BT9100, X20cBT9100 - Technical data


| Model number | X20BT9100 | X20cBT9100 |
|---------------------------------|--|---|
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | | -25 to 60°C |
| Vertical mounting orientation | | -25 to 50°C |
| Derating | | - |
| Storage | | -40 to 85°C |
| Transport | | -40 to 85°C |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB06 or X20T-B12 terminal block separately Order 1x X20BM11 or X20B-M15 bus module separately | Order 1x X20TB06 or X20T-B12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 159: X20BT9100, X20cBT9100 - Technical data

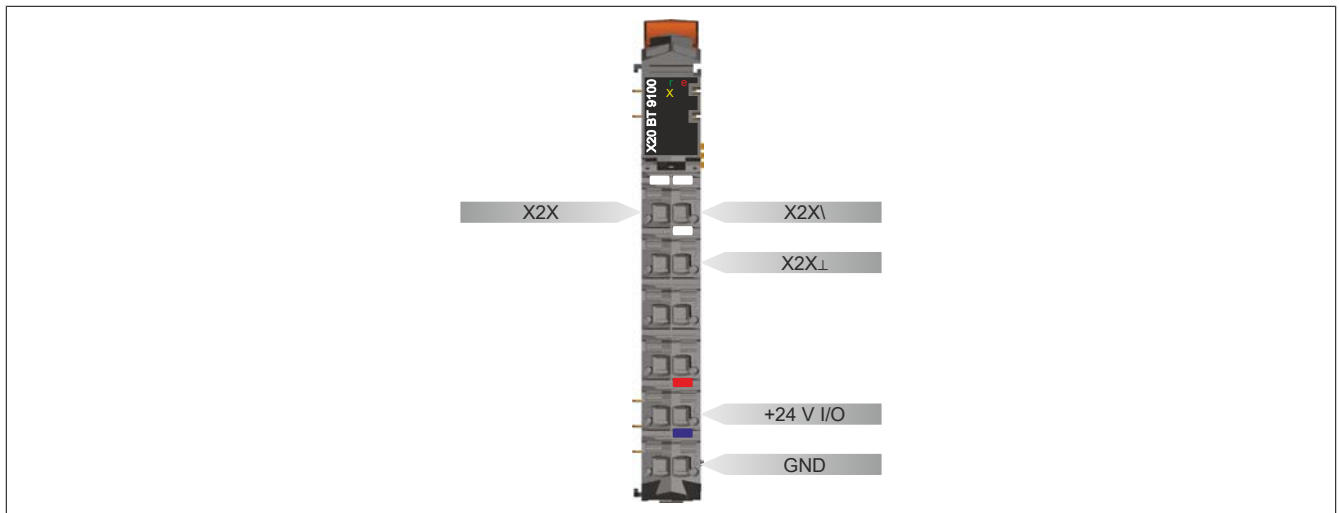
- 1) The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.

9.6.4.5 LED status indicators

For a description of the various operating modes, see ["Diagnostic LEDs" on page 3787](#).

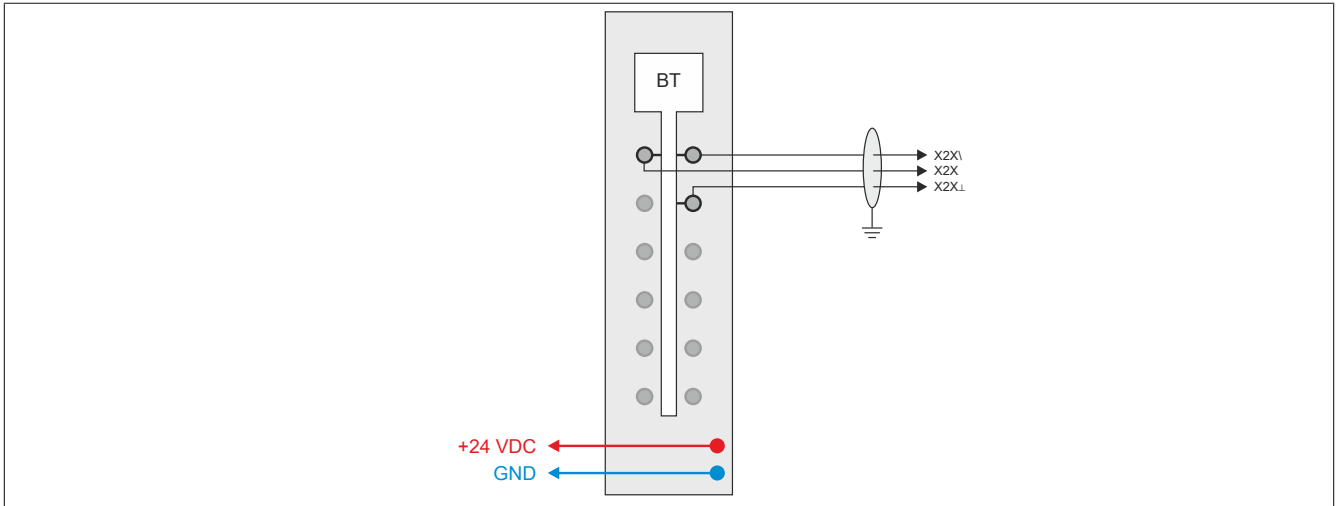
| Figure | LED | Color | Status | Description |
|--|-------|-----------------------------|------------------------------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Double flash | LED indicates one of the following states: <ul style="list-style-type: none"> I/O supply too low X2X bus supply too low |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | X | Orange | Off | No communication at the X2X Link |
| On | | | X2X Link communication in progress | |

9.6.4.6 Pinout



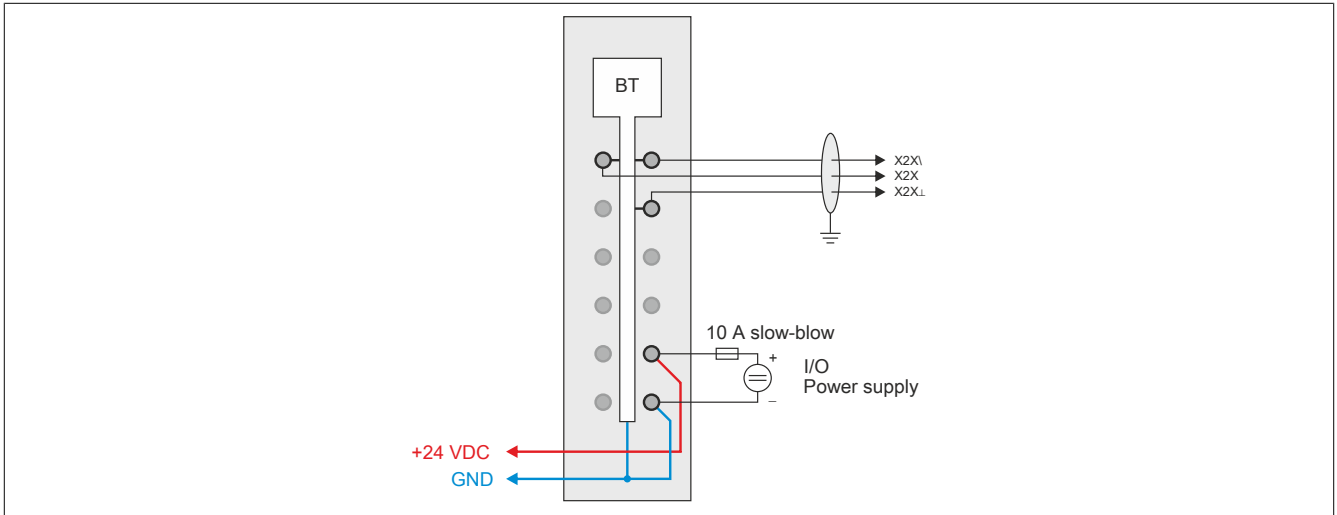
9.6.4.7 Connection examples

No feed for internal I/O supply



With feed for internal I/O supply

See also "Supply via bus transmitter" on page 983.



9.6.4.8 Supply via bus transmitter

The bus transmitter has an integrated internal I/O supply feed. This saves a power supply module for the last potential group.

Keep in mind: this potential group is separated from the rest of the potential groups by an I/O module with the x20(c)BM01 bus module.

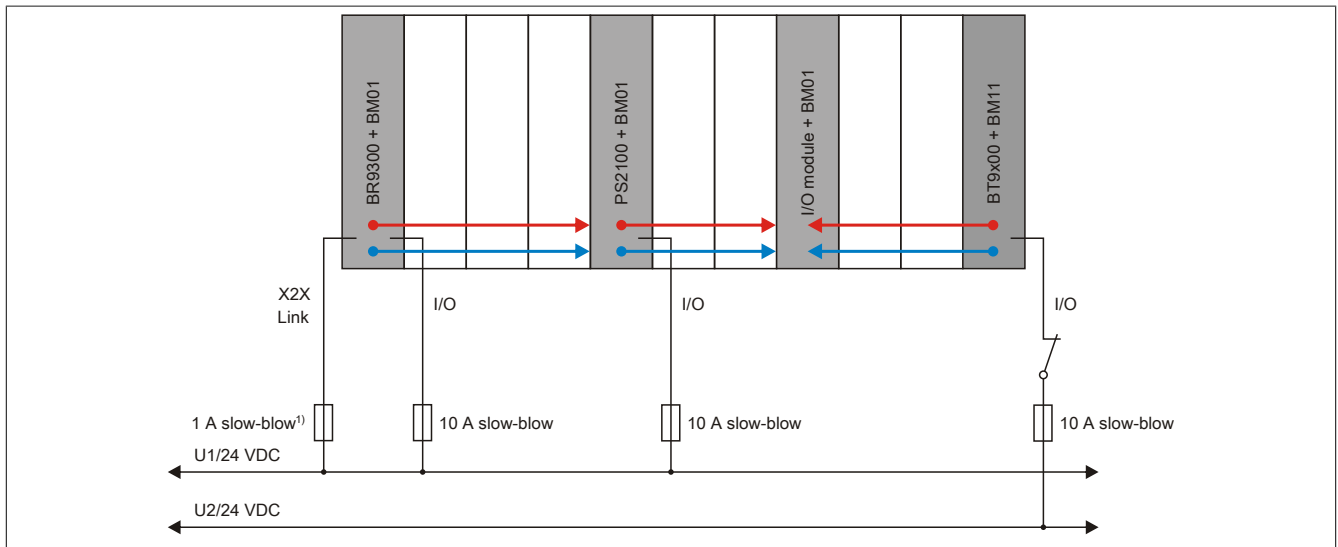


Figure 95: Protection when supplied via bus transmitter

1) Recommended for line protection.

9.6.4.9 Connection to next X2X Link I/O node

The bus transmitter establishes the connection to the next X2X Link based I/O node. It is important to be sure that only the data lines are connected on. X2X Link supply is system dependant.

| System | X2X Link supply |
|---|-------------------------|
| X67 system | System supply X67PS1300 |
| Remote I/O with X2X Link (XX modules) | 24 VDC external supply |
| Remote valve terminal connection (XV modules) | 24 VDC external supply |

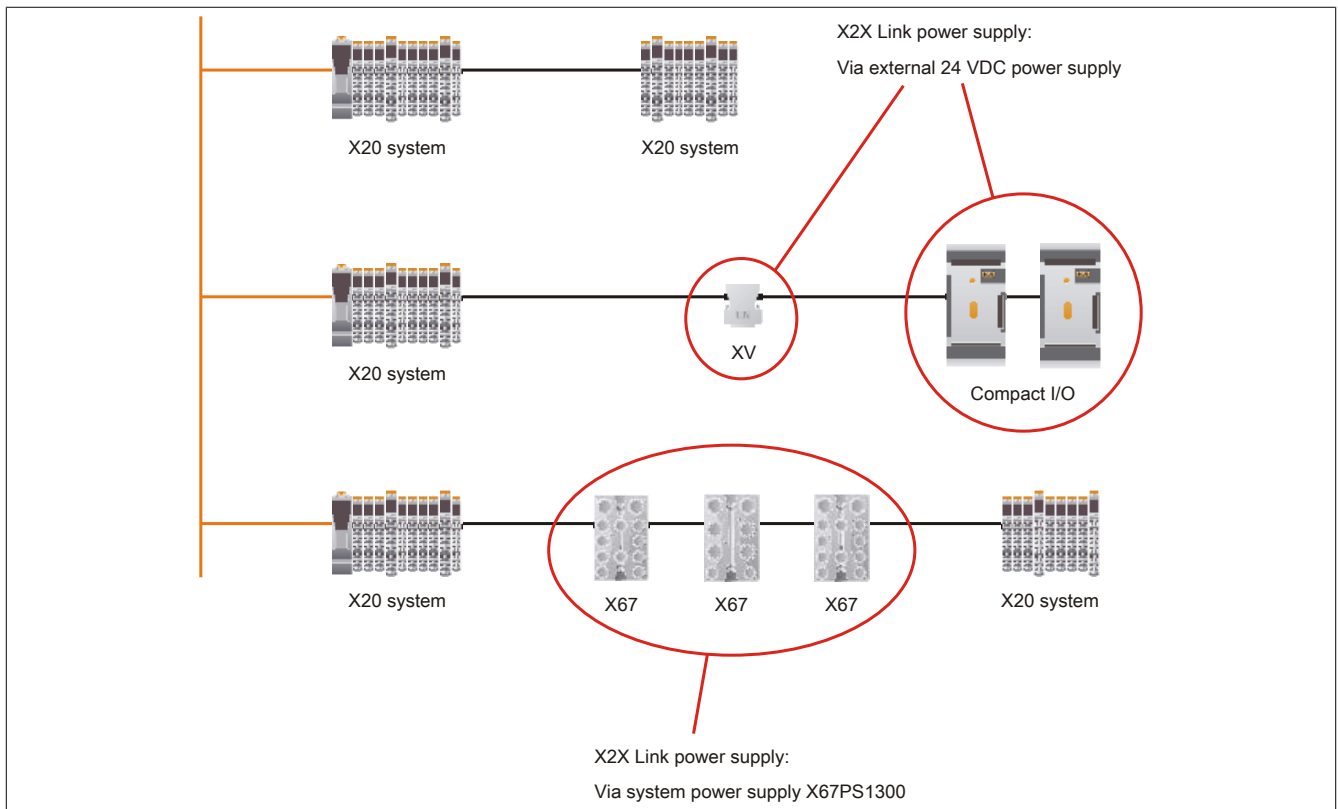


Figure 96: X2X Link supply depending on the system

9.6.4.10 Register description

9.6.4.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.6.4.10.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|-------------------------------|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| 0 | 1 | Module status | USINT | • | | | |
| | | StatusInput01 | Bit 0 | | | | |
| | | StatusInput02 | Bit 2 | | | | |
| 4 | 3 | SupplyVoltage | USINT | • | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.6.4.10.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|-------------------------------|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| 0 | 0 | Module status | UINT | • | | | |
| | | StatusInput01 | Bit 0 | | | | |
| | | StatusInput02 | Bit 2 | | | | |
| 4 | 4 | SupplyVoltage | UINT | • | | | |

1) The offset specifies the position of the register within the CAN object.

9.6.4.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.6.4.10.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.6.4.10.4 Module status

Name:

Module status

The following module supply voltages are monitored in this register:

Bus supply voltage: Bus supply voltage <4.7 V is displayed as a warning.

24 VDC I/O supply voltage: I/O supply voltage <20.4 V is displayed as a warning.

| Function model | Data type | Values |
|----------------------|-----------|------------------------|
| 0 - Standard | USINT | See the bit structure. |
| 254 - Bus controller | UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---------------|-------|--|
| 0 | StatusInput01 | 0 | No error |
| | | 1 | Bus supply warning - Undervoltage (<4.7 V) |
| 1 | Reserved | 0 | |
| 2 | StatusInput02 | 0 | I/O power supply above the warning limit of 20.4 V |
| | | 1 | I/O power supply below the warning limit of 20.4 V |
| 3 - x | Reserved | 0 | |

9.6.4.10.5 Bus supply voltage

Name:

SupplyVoltage

This register indicates the bus supply voltage measured at a resolution of 0.1 V.

| Function model | Data type |
|----------------------|-----------|
| 0 - Standard | USINT |
| 254 - Bus controller | UINT |

9.6.4.10.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.6.4.10.7 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 2 ms |

9.6.5 X20BT9400

Data sheet version: 3.08

9.6.5.1 General information

To connect an X20 system to an X67 system, a bus transmitter is simple added to the end of the X20 block, so that the X2X Link cable can be connected. The bus transmitter also provides the X2X supply voltage for the X67 system. There is no longer a need for an X67 system supply module.

- X2X Link bus transmitter
- For seamless expansion of the system
- Up to 100 m segment lengths
- Feed for internal I/O supply
- Integrated X2X Link supply for the X67 system
- Operation only on the slot to the far right

Information:

The bus transmitter modules may only be operated with a bus module where the internal I/O supply is connected through (e.g. X20BM11).

If the incoming voltage is used for internal I/O supply, then this potential group must not be supplied by any other module. An I/O module with bus module X20BM01 should be used to separate the potential group.

9.6.5.2 Order data


| Model number | Short description | Figure |
|----------------|--|---|
| | Bus receivers and transmitters |  |
| X20BT9400 | X20 bus transmitter X2X Link, feed for internal I/O supply, X2X Link supply for X67 modules, reverse polarity protection, short circuit protection, overload protection, parallel connection possible, redundancy operation possible | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | Optional accessories | |
| | X2X Link cable | |
| X67CA0X99.1000 | Cable for custom assembly, 100 m | |
| X67CA0X99.5000 | Cable for custom assembly, 500 m | |

Table 160: X20BT9400 - Order data

9.6.5.3 Technical data

| Model number | X20BT9400 |
|--|---|
| Short description | |
| Bus transmitter | X2X Link bus transmitter with supply for I/O and integrated supply for the X67 system |
| General information | |
| B&R ID code | 0xA238 |
| Status indicators | X2X bus function, operating status, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| X2X bus function | Yes, using status LED |
| Power consumption ¹⁾ | |
| Bus | 0.5 W |
| Internal X67 X2X Link | 1.38 W |
| Internal I/O | |
| As bus transmitter | 0.1 W |
| Additionally as supply module | 0.6 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations |
| ATEX | Class I, Division 2, Groups ABCD, T5 Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| X67 X2X Link power supply input | |
| Input voltage | 24 VDC -15% / +20% |
| Input current | Max. 0.5 A |
| Fuse | Integrated, cannot be replaced |
| Reverse polarity protection | Yes |
| X67 X2X Link power supply output | |
| Parallel connection with X67PS1300 | Yes ²⁾ |
| Overload characteristics | Temporarily protected against short circuit, overload Be aware of corresponding status message (LED "I") or evaluate software status |
| X67 modules supplied by BT9400 | |
| Horizontal mounting orientation | Max. 8 (Nominal output power: 6 W) |
| Vertical mounting orientation | Max. 6 (Nominal output power: 4.5 W) |
| Input I/O power supply | |
| Input voltage | 24 VDC -15% / +20% |
| Fuse | Required line fuse: Max. 10 A, slow-blow |
| Reverse polarity protection | No |
| Output I/O power supply | |
| Nominal output voltage | 24 VDC |
| Behavior on short circuit | Required line fuse |
| Permissible contact load | 10 A |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |

Table 161: X20BT9400 - Technical data


| Model number | X20BT9400 |
|------------------------------|--|
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 or 1x X20BM15 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 161: X20BT9400 - Technical data

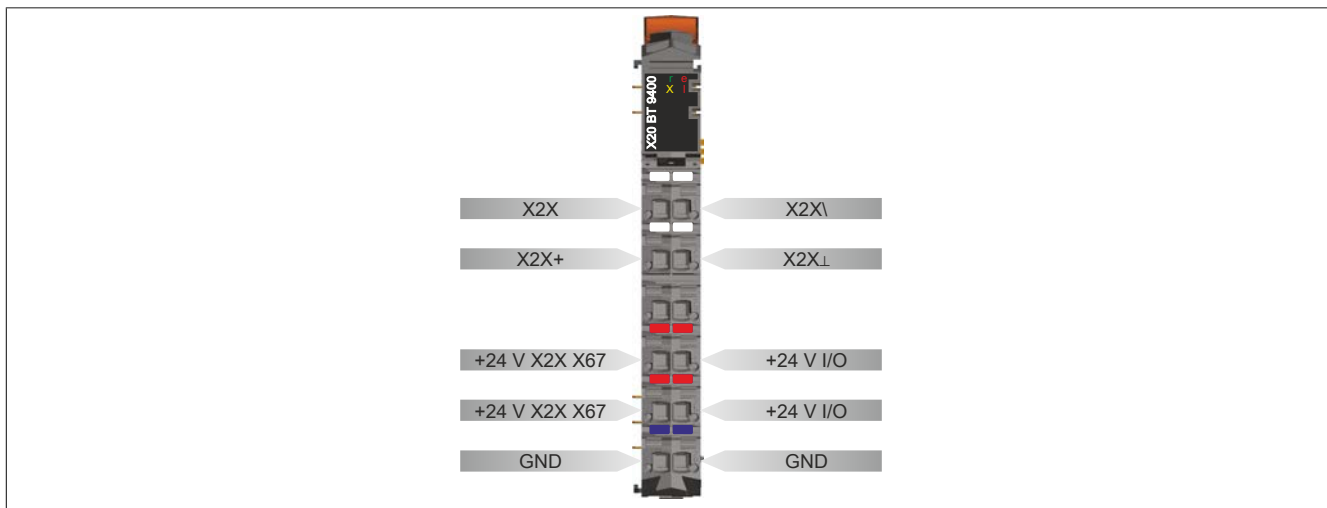
- 1) The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) In parallel operation with an X67 system supply module, the power rating of the bus transmitter is not permitted to be added to the total power. Only the power provided by system supply module X67PS1300 is permitted to be used to calculate the total number of X67 modules.

9.6.5.4 LED status indicators

For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

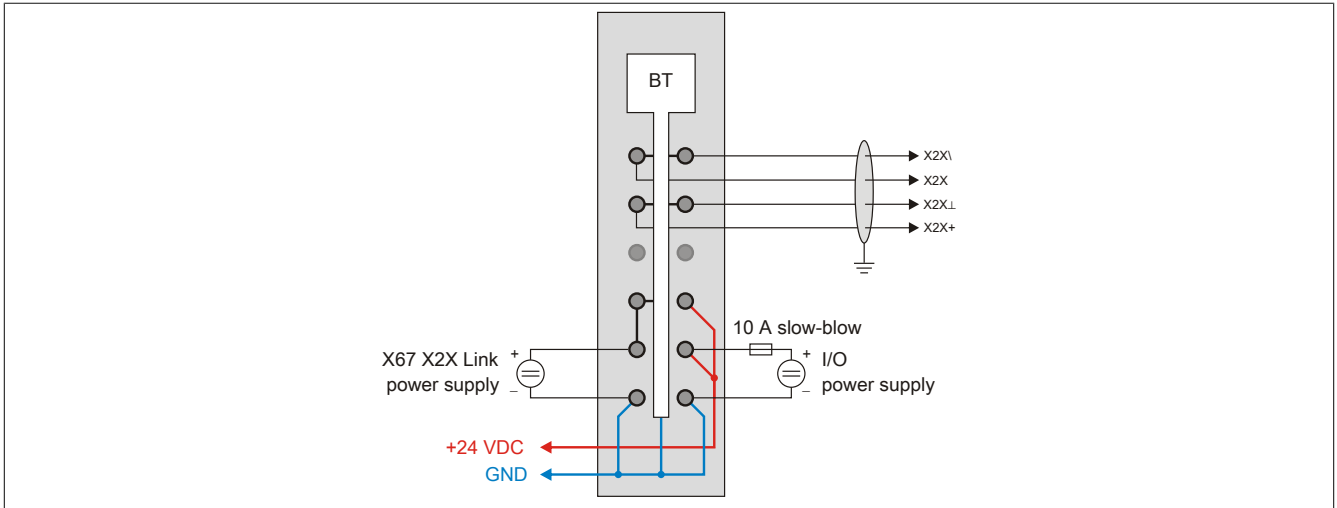
| Figure | LED | Color | Status | Description |
|---|-------|-----------------------------|--|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Double flash | LED indicates one of the following states: <ul style="list-style-type: none"> • I/O supply too low • X2X Link voltage too low |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | X | Orange | Off | No X2X Link communication |
| | | | On | X2X Link communication active |
| | l | Red | Off | The X67 / X2X Link supply is within the valid limits |
| On | | | The X67 / X2X Link supply for the power supply is overloaded Remedy: Use additional X67PS1300 supply modules | |

9.6.5.5 Pinout

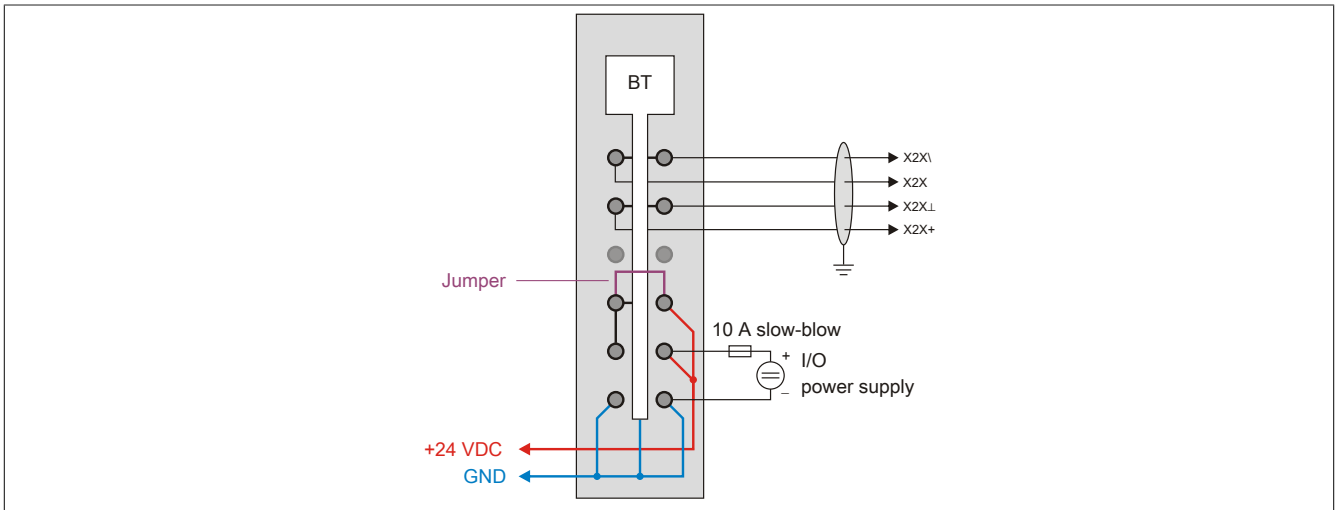


9.6.5.6 Connection examples

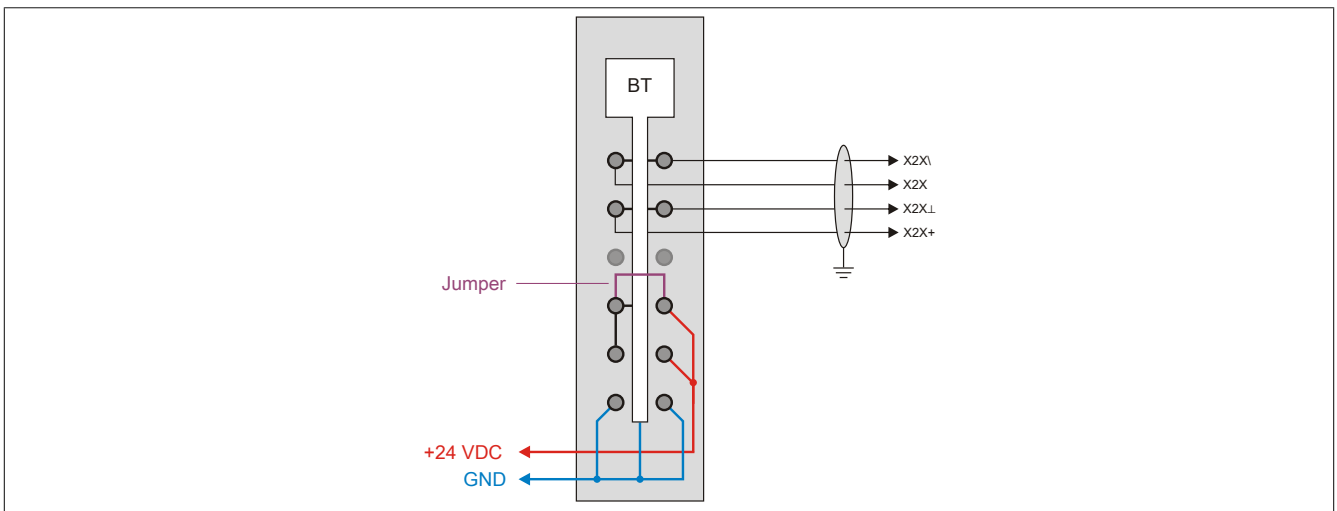
With 2 separate supplies



With a supply and jumper



No feed for internal I/O supply



9.6.5.7 Supply via bus transmitter

The bus transmitter has an integrated internal I/O supply feed. This saves a power supply module for the last potential group.

Keep in mind: this potential group is separated from the rest of the potential groups by an I/O module with the x20(c)BM01 bus module.

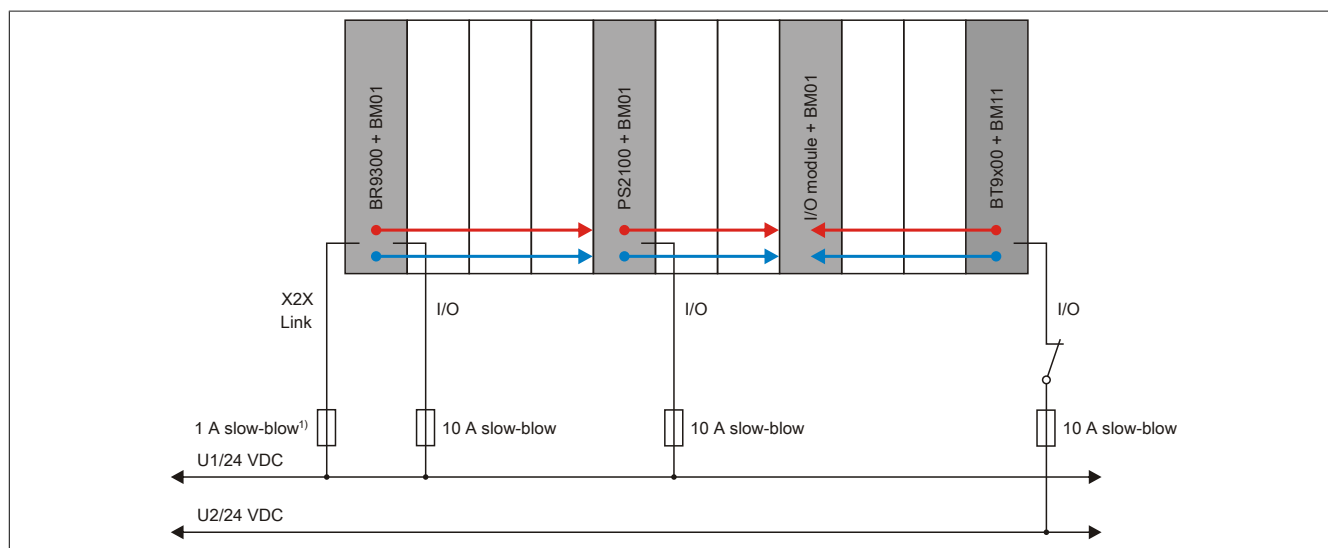


Figure 97: Protection when supplied via bus transmitter

1) Recommended for line protection.

9.6.5.8 Connection between X20 and X67 system

The bus transmitter establishes the link between the X20 system and the X67 system. In addition to the data lines, the X2X Link supply is also fed through. The module can supply up to 8 X67 modules. An additional X67 supply module is only needed if operating more than 8 X67 modules.

Information:

Only the X67PS1300 system supply module can be used for calculating the total number of X67 modules.

9.6.5.9 Register description

9.6.5.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.6.5.9.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|---------------|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| 0 | 1 | Module status | USINT | • | | | |
| | | StatusInput01 | Bit 0 | | | | |
| | | StatusInput02 | Bit 2 | | | | |
| 2 | 2 | SupplyCurrent | USINT | • | | | |
| 4 | 3 | SupplyVoltage | USINT | • | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.6.5.9.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---------------|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| 0 | 0 | Module status | UINT | • | | | |
| | | StatusInput01 | Bit 0 | | | | |
| | | StatusInput02 | Bit 2 | | | | |
| 2 | 2 | SupplyCurrent | UINT | • | | | |
| 4 | 4 | SupplyVoltage | UINT | • | | | |

1) The offset specifies the position of the register within the CAN object.

9.6.5.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.6.5.9.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.6.5.9.4 Module status

Name:

Module status

The following module supply voltages are monitored in this register:

| | |
|----------------------------|--|
| X67 bus supply current: | An X67 bus supply current of >0.4 A is displayed as a warning. |
| X67 bus supply voltage: | A bus supply voltage of <18 V is displayed as a warning. |
| 24 VDC I/O supply voltage: | An I/O supply voltage of <20.4 V is displayed as a warning. |

| Function model | Data type | Values |
|----------------------|-----------|------------------------|
| 0 - Standard | USINT | See the bit structure. |
| 254 - Bus controller | UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---------------|-------|---|
| 0 | StatusInput01 | 0 | No error |
| | | 1 | X67 bus supply warning for undervoltage (18 V) or when over-current (0.4 A) |
| 1 | Reserved | 0 | |
| 2 | StatusInput02 | 0 | I/O supply above the warning level of 20.4 V |
| | | 1 | I/O supply below the warning level of 20.4 V |
| 3 - x | Reserved | 0 | |

9.6.5.9.5 X67 bus supply current

Name:
SupplyCurrent

This register shows the X67 bus supply current with a resolution of 0.01 A.

| Function model | Data type |
|----------------------|-----------|
| 0 - Standard | USINT |
| 254 - Bus controller | UINT |

9.6.5.9.6 X67 bus supply voltage

Name:
SupplyVoltage

This register shows the X67 bus supply voltage with a resolution of 0.1 V.

| Function model | Data type |
|----------------------|-----------|
| 0 - Standard | USINT |
| 254 - Bus controller | UINT |

9.6.5.9.7 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

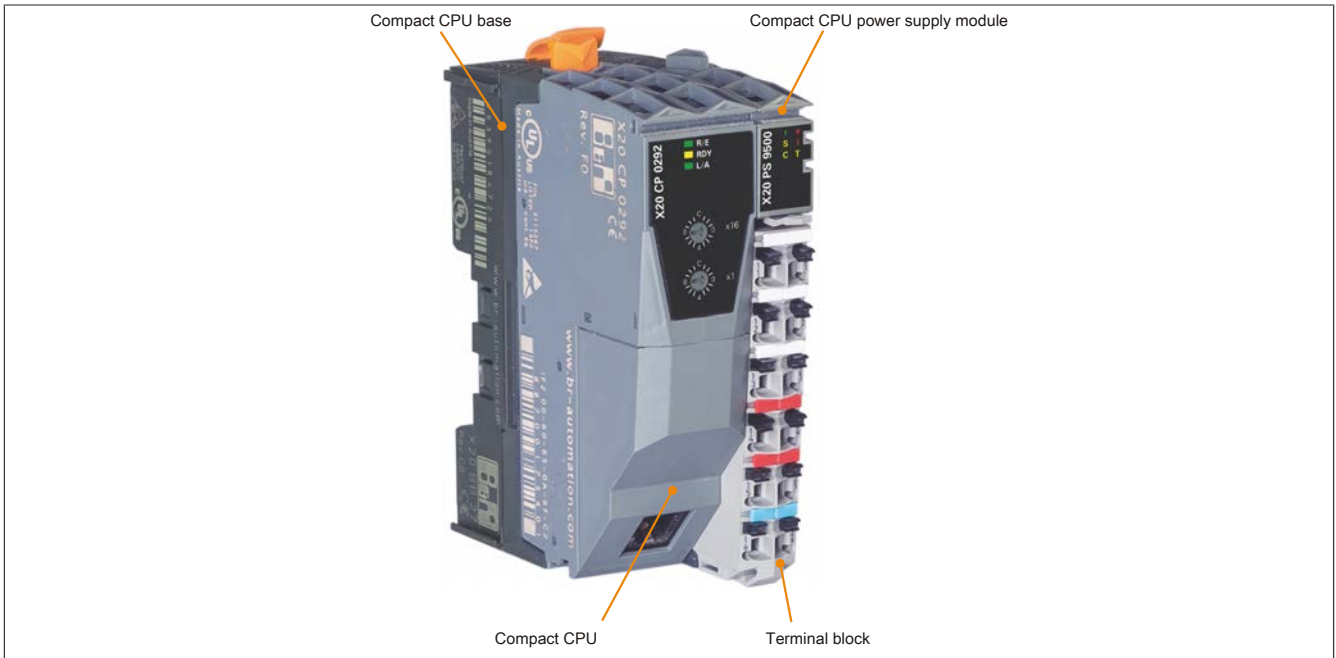
9.6.5.9.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 2 ms |

9.7 Compact CPUs

Compact CPUs have a modular design that allows them to be quickly and easily assembled according to the requirements of the respective application. All CPUs are based on embedded microprocessors and available in 2 performance classes.



Available interfaces

Communication takes place over an Ethernet interface and RS232. An optional CAN interface is also available.

Maintenance-free CPU

The CPUs were designed without fans or batteries in order to make them as easy as possible to service. This makes them completely maintenance-free.

Compact design

The supply for the CPU, X2X Link network and I/O modules is part of the CPU. No additional power supply modules are required.

9.7.1 Summary

| Model number | Short description | Page |
|--------------|---|------|
| X20CP0201 | X20 compact CPU, μ P 16, 100 kB SRAM, 1 MB FlashPROM, support of RS232, CAN bus according to compact CPU base, order bus base, power supply module and terminal block separately | 994 |
| X20CP0291 | X20 compact CPU, μ P 16, 100 kB SRAM, 1 MB FlashPROM, support of RS232, CAN bus according to compact CPU base, 1 Ethernet interface 100 Base-T, order bus base, power supply module and terminal block separately | 994 |
| X20CP0292 | X20 compact CPU, μ P 25, 100 kB SRAM, 1 MB FlashPROM, support of RS232, CAN bus according to compact CPU base, 3 Ethernet interface 750 Base-T, order bus base, power supply module and terminal block separately | 994 |

9.7.2 X20CP02xx

Data sheet version: 2.24

9.7.2.1 General information

Compact CPUs are ideal for situations where cycle times in the millisecond range are sufficient and a cost-benefit analysis plays a decisive role. A range of models with CAN and Ethernet can adapt optimally to all demands. The result: extremely sleek automation solutions.

- Embedded μ P 16 / μ P 25 with additional I/O processor
- 100/750 kB User SRAM
- 1/3 MB User FlashPROM
- X20CP0291 and X20CP0292: Onboard Ethernet
- Only 37.5 mm wide
- No battery

9.7.2.2 Order data


|  | |
|---|---|
| CP0201 | CP0291, CP0292 |
| Model number | Short description |
| Compact CPUs | |
| X20CP0201 | X20 compact CPU, μ P 16, 100 kB SRAM, 1 MB FlashPROM, support of RS232, CAN bus according to compact CPU base, order bus base, power supply module and terminal block separately |
| X20CP0291 | X20 compact CPU, μ P 16, 100 kB SRAM, 1 MB FlashPROM, support of RS232, CAN bus according to compact CPU base, 1 Ethernet interface 100 Base-T, order bus base, power supply module and terminal block separately |
| X20CP0292 | X20 compact CPU, μ P 25, 100 kB SRAM, 1 MB FlashPROM, support of RS232, CAN bus according to compact CPU base, 3 Ethernet interface 750 Base-T, order bus base, power supply module and terminal block separately |
| Required accessories | |
| System modules for compact CPUs | |
| X20BB22 | X20 compact CPU base, for compact CPU and compact CPU power supply module, base for integrated RS232 interface, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included |
| X20BB27 | X20 compact CPU base, for compact CPU and compact CPU power supply module, base for integrated RS232 and CAN bus interface, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included |
| X20PS9500 | X20 power supply module for Compact and Fieldbus CPUs and internal I/O power supply, X2X Link power supply |
| X20PS9502 | X20 power supply module, for Compact and Fieldbus CPUs and internal I/O power supply, X2X Link power supply, supply not electrically isolated |
| Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed |

Table 162: X20CP0201, X20CP0291, X20CP0292 - Order data

| Model number | Included in delivery |
|--------------|--------------------------|
| X20AC0SL1 | X20 locking plate, left |
| X20AC0SR1 | X20 locking plate, right |

9.7.2.3 Technical data

| Model number | X20CP0201 | X20CP0291 | X20CP0292 |
|--|--|--|---------------------------|
| Short description | | | |
| Interfaces | - | 1x Ethernet onboard | |
| System module | CPU | | |
| General information | | | |
| B&R ID code | 0x22A2 | 0x22A4 | 0x22A6 |
| Status indicators | CPU function | CPU function, Ethernet | |
| Diagnostics | | | |
| CPU function | Yes, using status LED | | |
| Ethernet | - | Yes, using status LED | |
| Overtemperature | - | Yes, using software | |
| Power consumption | 2.2 W | 2.7 W | 3 W |
| Temperature sensor | No | | |
| ACOPOS support | Restricted (user PROM) via CAN bus | | Yes, via CAN bus |
| Visual Components support | Limited (User PROM) | | Yes |
| Additional power dissipation caused by actuators (resistive) [W] | - | | |
| Certifications | | | |
| CE | Yes | | |
| KC | Yes | | |
| EAC | Yes | | |
| UL | cULus E115267 Industrial control equipment | | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | | |
| KR | Yes | | |
| Controller | | | |
| Real-time clock ¹⁾ | Yes, 1 s resolution, -18 to 28 ppm accuracy at 25°C | | |
| Processor | | | |
| Type | Embedded µP 16 | | Embedded µP 25 |
| Integrated I/O processor | Processes I/O data points in the background | | |
| Backup battery | No | | |
| Shortest task class cycle time | 4 ms | | 2 ms |
| Typical instruction cycle time | 0.8 µs | | 0.5 µs |
| Permanent variables | | | |
| Self-discharge time | >10 years | | |
| Memory | 2.75 kB FRAM ²⁾ | | |
| Standard memory | | | |
| User PROM | 1 MB FlashPROM | | 3 MB FlashPROM |
| User RAM | 100 kB SRAM ³⁾ | | 750 kB SRAM ³⁾ |
| Interfaces | | | |
| Interface IF2 | | | |
| Signal | - | Ethernet | |
| Variant | - | 1x RJ45 shielded | |
| Line length | - | Max. 100 m between 2 stations (segment length) | |
| Transfer rate | - | 100 Mbit/s | |
| Transfer | | | |
| Physical layer | - | 100BASE-TX | |
| Half-duplex | - | Yes | |
| Full-duplex | - | No | |
| Autonegotiation | - | No | |
| Auto-MDI/MDIX | - | Yes | |
| On base module | | | |
| X20BB22 ⁴⁾ | Compact CPU base module with integrated RS232 interface | | |
| X20BB27 ⁵⁾ | Compact CPU base module with integrated RS232 and CAN interfaces | | |
| Electrical isolation | - | PLC isolated from Ethernet (IF2) | |
| Operating conditions | | | |
| Mounting orientation | | | |
| Horizontal | Yes | | |
| Vertical | Yes | | |
| Installation elevation above sea level | | | |
| 0 to 2000 m | No limitations | | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | | |
| Degree of protection per EN 60529 | IP20 | | |

Table 163: X20CP0201, X20CP0291, X20CP0292 - Technical data


| Model number | X20CP0201 | X20CP0291 | X20CP0292 |
|---------------------------------|---|--------------------------|-----------|
| Ambient conditions | | | |
| Temperature | | | |
| Operation | | | |
| Horizontal mounting orientation | | -25 to 60°C | |
| Vertical mounting orientation | | -25 to 50°C | |
| Derating | | - | |
| Storage | | -40 to 85°C | |
| Transport | | -40 to 85°C | |
| Relative humidity | | | |
| Operation | | 5 to 95%, non-condensing | |
| Storage | | 5 to 95%, non-condensing | |
| Transport | | 5 to 95%, non-condensing | |
| Mechanical properties | | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20PS9500 or X20PS9502 power supply module separately Order 1x X20BB22 or X20BB27 compact CPU base separately | | |
| Spacing ⁶⁾ | 37.5 ^{+0.2} mm | | |

Table 163: X20CP0201, X20CP0291, X20CP0292 - Technical data

- 1) The real-time clock is buffered for approx. 1000 hours by a gold foil capacitor. The gold foil capacitor is completely charged after 18 continuous hours of operation.
- 2) This FRAM stores its contents ferroelectrically. Therefore, no backup battery is needed.
- 3) Not buffered.
- 4) For technical data, see the data sheet for the X20PS9500 power supply module.
- 5) For technical data, see the data sheet for the X20PS9502 power supply module.
- 6) Spacing is based on the width of the compact CPU base X20BB22 or X20BB27. An X20PS9500 or X20PS9502 supply module is also always required for the CPU.


9.7.2.4 LED status indicators

X20CP0201

| Figure | LED | Color | Status | Description |
|---|-----|--------|--------|---------------------|
|  <p>The image shows the front panel of the X20 CP 0201 compact CPU. It features two status LEDs: a green LED labeled 'R/E' and a yellow LED labeled 'RDY'. The model number 'X20 CP 0201' is printed on the panel.</p> | R/E | Green | On | Application running |
| | | Red | On | SERVICE mode |
| | | | Off | ¹⁾ |
| | RDY | Yellow | On | SERVICE mode |
| | | | Off | ¹⁾ |

- 1) BOOT mode: R/E and RDY LEDs are off and the power supply LED is blinking

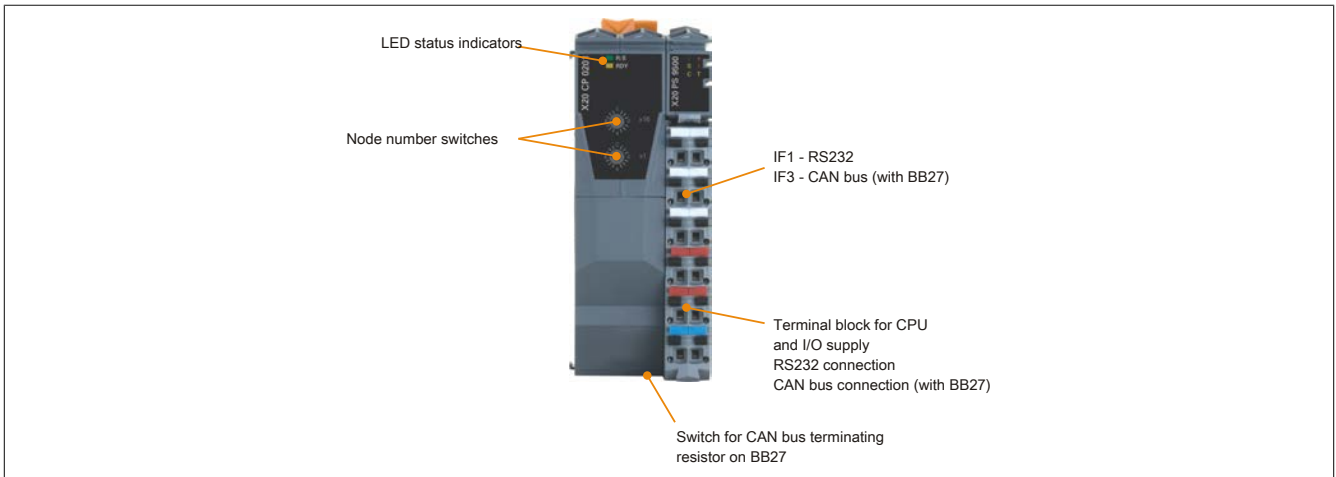
X20CP029x

| Figure | LED | Color | Status | Description |
|---|-----|--------|----------|--|
|  <p>The image shows the front panel of the X20 CP 0291 compact CPU. It features three status LEDs: a green LED labeled 'R/E', a yellow LED labeled 'RDY', and a green LED labeled 'L/A'. The model number 'X20 CP 0291' is printed on the panel.</p> | R/E | Green | On | Application running |
| | | Red | On | SERVICE mode |
| | | | Off | ¹⁾ |
| | RDY | Yellow | On | SERVICE mode |
| | | | Off | ¹⁾ |
| | L/A | Green | On | A link to the peer station has been established. |
| | | | Blinking | A link to the peer station has been established. Indicates Ethernet activity is taking place on the bus. |

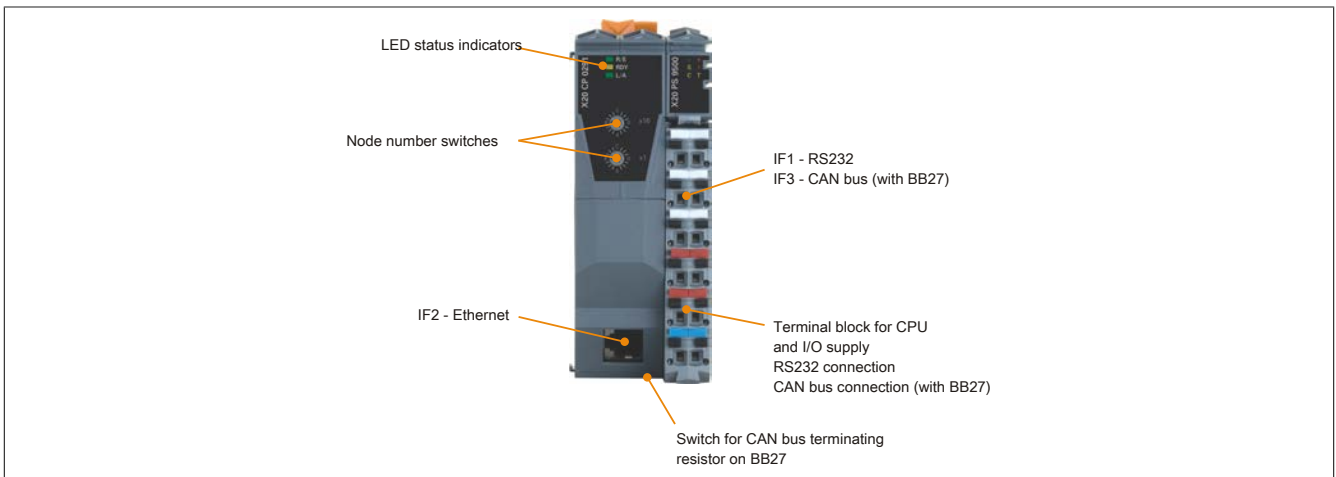
- 1) BOOT mode: R/E and RDY LEDs are off and the power supply LED is blinking

9.7.2.5 Operating and connection elements

X20CP0201



X20CP0291 and X20CP0292



9.7.2.6 Node number switches



The node number is set using the two hex switches. The switch setting can be evaluated by the application program at any time. The operating system only evaluates the switch position when the device is switched on.

| Switch position | Operating mode | Description |
|-----------------|----------------|---|
| 0x00 | BOOT | In this switch position, the operating system can be installed via the RS232 interface configured as the online interface. User Flash is deleted only after the update begins. |
| 0x01 - 0xFE | RUN | RUN mode, the application is running. |
| 0xFF | Diagnostics | Boots the CPU in Diagnostics mode. Program sections in User RAM and User FlashPROM are not initialized. Following diagnostics mode, the CPU always boots with a cold restart . |

X20CP0201

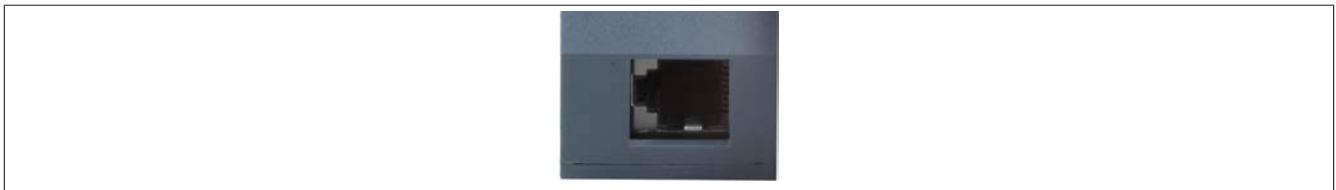
When used with the X20BB27 bus module, the X20CP0201 has access to a CAN bus interface. The INA2000 station number for CAN is set using the node number switches.

X20CP0291 and X20CP0292

Both of these CPUs are equipped with an onboard Ethernet interface. When used with the X20BB27 bus module, they also have access to a CAN bus interface.

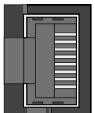
The number set using the two hex switches defines the INA2000 station number of both the CAN and the Ethernet interface.

9.7.2.7 Ethernet interface (IF2)



The X20CP0291 and X20CP0292 are equipped with an Ethernet interface. The connection is made using a 100 BASE-T twisted pair RJ45 socket.

Pinout

| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

For information about wiring X20 modules with an Ethernet interface, see "[Cabling guidelines for X20 modules with an Ethernet cable](#)" on page 58.

Information:

The Ethernet interface (IF2) is not suited for POWERLINK.

Starting with operating system version 1.07, CPUs have a default IP address.

IP address: 192.168.0.1
 Subnet mask: 255.255.0.0

9.7.2.8 Programming the system flash memory

General information

CPUs are delivered with a runtime system. When delivered, the node number switch is set to switch position 0x00 (bootstrap loader mode).

A suitable switch position must be set (0x01 to 0xFE) in order to boot the PLC in RUN mode. Updating the runtime system is only possible in RUN mode.

Runtime system update

The runtime system can be updated via the programming environment. When updating the runtime system via an online connection, the following procedure must be carried out:

1. An online runtime system update is only possible if the processor is in RUN mode. For this to be true, the node number must be set to a value in the range 0x01 to 0xFE.
2. Switch on the power.
3. The runtime system update is performed via the existing online connection. The online connection can be established via the onboard serial RS232 interface, for example. If a CPU has an Ethernet interface, then it too can be used to perform the update.
4. Start B&R Automation Studio.
5. Start the update procedure by selecting **Online** from the **Project** menu. Select **Transfer Automation Runtime** from the pop-up menu. Now follow the instructions given by B&R Automation Studio.
6. A window opens up for setting the runtime system version. The runtime system version is already pre-selected by the project settings made by the user. The drop-down menu can be used to select one of the runtime system versions stored in the project. Clicking on the **Browse** button allows a runtime system version to be loaded from the hard drive or CD.

Clicking on **Next** opens a pop-up window that allows the user to select whether modules with target memory SYSTEM ROM should be transferred during the subsequent runtime system update. If not, these modules can also be transferred later during an application download.

Clicking on **Next** opens a dialog box where the user can set the CAN transfer rate, CAN ID and CAN node number (the CAN node number set here is only relevant if an interface module does not have a CAN node number switch). The CAN node number must be between decimal 01 and 99. Assigning a unique node number is especially important with online communication over a CAN network (INA2000 protocol).

7. The update procedure is started by clicking on **Next**. Update progress is shown in a message box.

Information:

User flash memory is deleted.

8. When the update procedure is complete, the online connection is reestablished automatically.
9. The PLC is now ready for use.

Updating the runtime system is possible not only via an online connection, but also via a CAN network, serial network (INA2000 protocol) or Ethernet network, depending on the system configuration.

9.8 Compact CPUs system modules

The X20 system Compact CPUs consist of the Compact CPU, Compact CPU system modules and the X20TB12 terminal block.

The Compact CPU system modules also include the X20BB22 and X20BB27 base modules as well as the X20PS9500 supply module for supplying the entire system with voltage.

9.8.1 Summary

| Model number | Short description | Page |
|--------------|--|------|
| X20BB22 | X20 compact CPU base, for compact CPU and compact CPU power supply module, base for integrated RS232 interface, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 1001 |
| X20BB27 | X20 compact CPU base, for compact CPU and compact CPU power supply module, base for integrated RS232 and CAN bus interface, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 1003 |
| X20PS9500 | X20 power supply module for Compact and Fieldbus CPUs and internal I/O power supply, X2X Link power supply | 1006 |
| X20PS9502 | X20 power supply module, for Compact and Fieldbus CPUs and internal I/O power supply, X2X Link power supply, supply not electrically isolated | 1012 |

9.8.2 X20BB22

Data sheet version: 2.22

9.8.2.1 General information

The bus module is the base for all X20 Compact CPUs.

The left and right end plates are included in the delivery.

- Base for all X20 Compact CPUs
- RS232 connection

9.8.2.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | System modules for compact CPUs | |
| X20BB22 | X20 compact CPU base, for compact CPU and compact CPU power supply module, base for integrated RS232 interface, X20 connection, X20 locking plates (left and right) X20AC0SL1/ X20AC0SR1 included |  |

Table 164: X20BB22 - Order data

9.8.2.3 Technical data

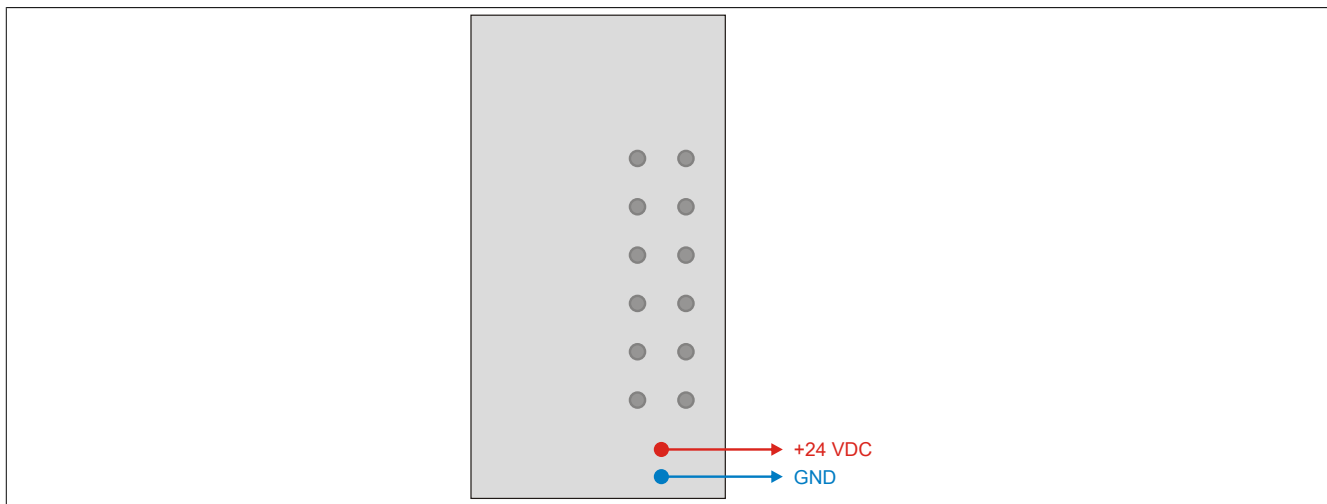
| Model number | X20BB22 |
|--|--|
| Short description | |
| Bus module | X20 compact CPU base - backplane for compact CPU and compact CPU supply module |
| Interfaces | 1x RS232 connection |
| General information | |
| Power consumption | |
| Bus | 0.32 W |
| Internal I/O | - |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| I/O power supply | |
| Nominal voltage | 24 VDC |
| Permissible contact load | 10 A |
| Electrical properties | |
| Electrical isolation | Bus not isolated from RS232 |

Table 165: X20BB22 - Technical data

| Model number | X20BB22 |
|--|--|
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Left and right X20 locking plates included in delivery |
| Spacing | 37.5 ^{+0.2} mm |

Table 165: X20BB22 - Technical data

9.8.2.4 Voltage routing



9.8.3 X20BB27

Data sheet version: 2.23

9.8.3.1 General information

The bus module is the base for all X20 Compact CPUs.

The left and right end plates are included in the delivery.

- Base for all X20 Compact CPUs
- RS232 connection
- CAN bus connection
- Integrated terminating resistor for CAN bus

9.8.3.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| X20BB27 | <p>System modules for compact CPUs</p> <p>X20 compact CPU base, for compact CPU and compact CPU power supply module, base for integrated RS232 and CAN bus interface, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included</p> |  |

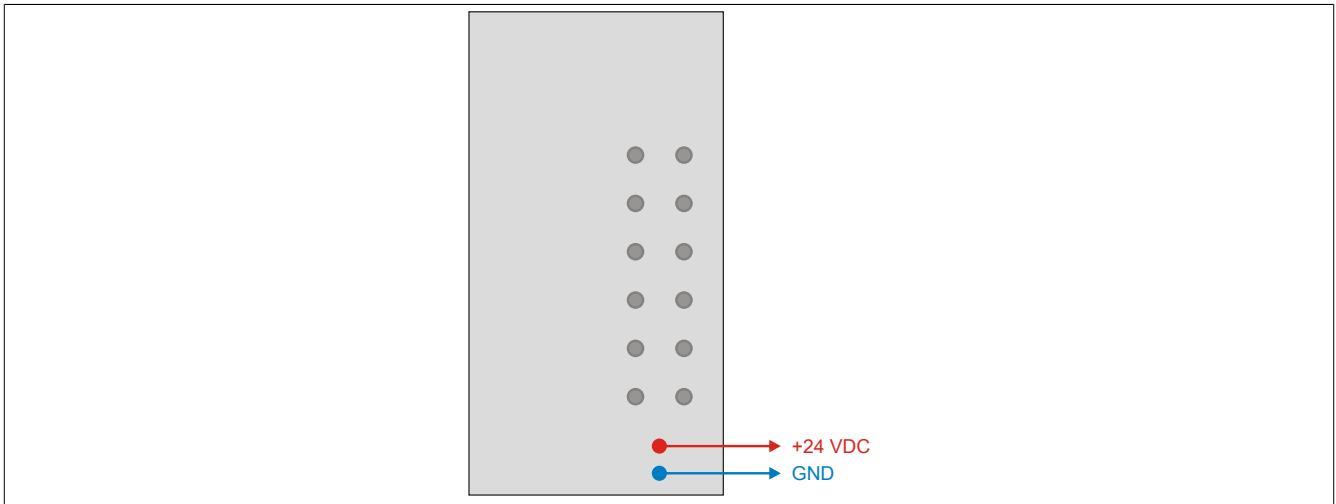
Table 166: X20BB27 - Order data

9.8.3.3 Technical data

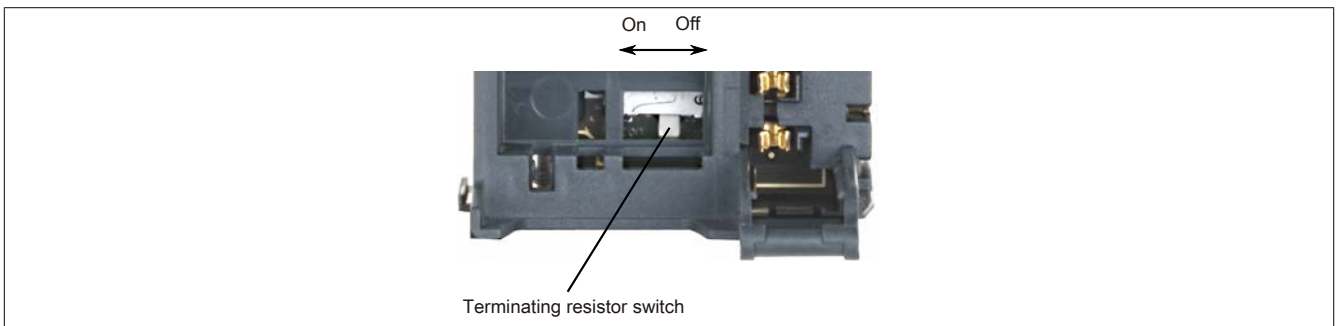
| Model number | X20BB27 |
|--|--|
| Short description | |
| Bus module | X20 compact CPU base - backplane for compact CPU and compact CPU supply module |
| Interfaces | 1x RS232 connection, 1x CAN bus connection |
| General information | |
| Power consumption | |
| Bus | 0.53 W |
| Internal I/O | - |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| I/O power supply | |
| Nominal voltage | 24 VDC |
| Permissible contact load | 10 A |
| Electrical properties | |
| Electrical isolation | Bus, CAN bus and RS232 not isolated from each other |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Left and right X20 locking plates included in delivery |
| Spacing | 37.5 ^{+0.2} mm |

Table 167: X20BB27 - Technical data

9.8.3.4 Voltage routing



9.8.3.5 Terminating resistor for CAN bus



The bus module has an integrated CAN bus terminating resistor. The terminating resistor is switched on or off using a switch. An enabled terminating resistor is indicated on the power supply module by LED "T".

9.8.4 X20PS9500

Data sheet version: 3.20

9.8.4.1 General information

The power supply module is used together with an X20 Compact or Fieldbus CPU. It is equipped with a supply for the Compact or Fieldbus CPU, X2X Link network and internal I/O power supply.

- Supply for Compact or Fieldbus CPU, X2X Link network and internal I/O power supply
- Electrical isolation of supply and CPU / X2X Link power supply
- Redundancy of CPU / X2X Link supply possible by operating multiple supply modules simultaneously
- RS232 configurable as an online interface
- CAN bus

9.8.4.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | System modules for compact CPUs |  |
| X20PS9500 | X20 power supply module for Compact and Fieldbus CPUs and internal I/O power supply, X2X Link power supply | |
| | Required accessories | |
| | System modules for compact CPUs | |
| X20BB22 | X20 compact CPU base, for compact CPU and compact CPU power supply module, base for integrated RS232 interface, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB27 | X20 compact CPU base, for compact CPU and compact CPU power supply module, base for integrated RS232 and CAN bus interface, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| | System modules for fieldbus CPUs | |
| X20BB32 | X20 Fieldbus CPU base, for Fieldbus CPU and Compact CPU power supply module, base for integrated RS232 interface, slot for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB37 | X20 Fieldbus CPU base, for Fieldbus CPU and Compact CPU power supply module, base for integrated RS232 and CAN bus interface, slot for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB42 | X20 fieldbus CPU base, for fieldbus CPU and compact CPU power supply module, base for integrated RS232 interface, 2 slots for X20 interface modules, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB47 | X20 fieldbus CPU base, for fieldbus CPU and compact CPU power supply module, base for integrated RS232 and CAN bus interface, 2 slots for X20 interface modules, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 168: X20PS9500 - Order data

9.8.4.3 Technical data

| Model number | X20PS9500 |
|--|--|
| Short description | |
| Power supply module | 24 VDC power supply module for Compact or Fieldbus CPU, X2X Link power supply and I/O |
| Interfaces | 1x RS232, 1x CAN bus ¹⁾ |
| General information | |
| B&R ID code | 0x2018 |
| Status indicators | Overload, operating state, module status, RS232, CAN bus ¹⁾ |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| CAN bus data transfer ¹⁾ | Yes, using status LED |
| RS232 data transfer | Yes, using status LED |
| Overload | Yes, using status LED and software |
| Power consumption for X2X Link power supply ²⁾ | 1.42 W |
| Power consumption ²⁾ | |
| Internal I/O | 0.6 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| EAC | Yes |
| KC | Yes |
| CPU / X2X Link power supply input | |
| Input voltage | 24 VDC -15% / +20% |
| Input current | Max. 0.7 A |
| Fuse | Integrated, cannot be replaced |
| Reverse polarity protection | Yes |
| CPU / X2X Link power supply output | |
| Nominal output power | 7 W |
| Parallel connection | Yes ³⁾ |
| Redundant operation | Yes |
| Overload characteristics | Short circuit protection, temporary overload |
| Input I/O power supply | |
| Input voltage | 24 VDC -15% / +20% |
| Fuse | Required line fuse: Max. 10 A, slow-blow |
| Reverse polarity protection | No |
| Output I/O power supply | |
| Nominal output voltage | 24 VDC |
| Behavior on short circuit | Required line fuse |
| Permissible contact load | 10 A |
| Interfaces | |
| Interface IF1 | |
| Signal | RS232 |
| Variant | Connection made using 12-pin terminal block X20TB12 |
| Transfer rate | Max. 115.2 kbit/s |
| Interface IF3 ¹⁾ | |
| Signal | CAN bus |
| Variant | Connection made using 12-pin terminal block X20TB12 |
| Transfer rate | Max. 1 Mbit/s |
| Electrical properties | |
| Electrical isolation | CPU/X2X Link supply isolated from CPU/X2X Link power supply I/O supply not isolated from I/O power supply |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |

Table 169: X20PS9500 - Technical data


| Model number | X20PS9500 |
|-----------------------------------|---|
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating" |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately Order 1x Compact CPU base X20BB22 or X20BB27 separately Order 1x Fieldbus CPU base X20BB3x/4x separately |
| Pitch | 12.5 ^{+0.2} mm |

Table 169: X20PS9500 - Technical data

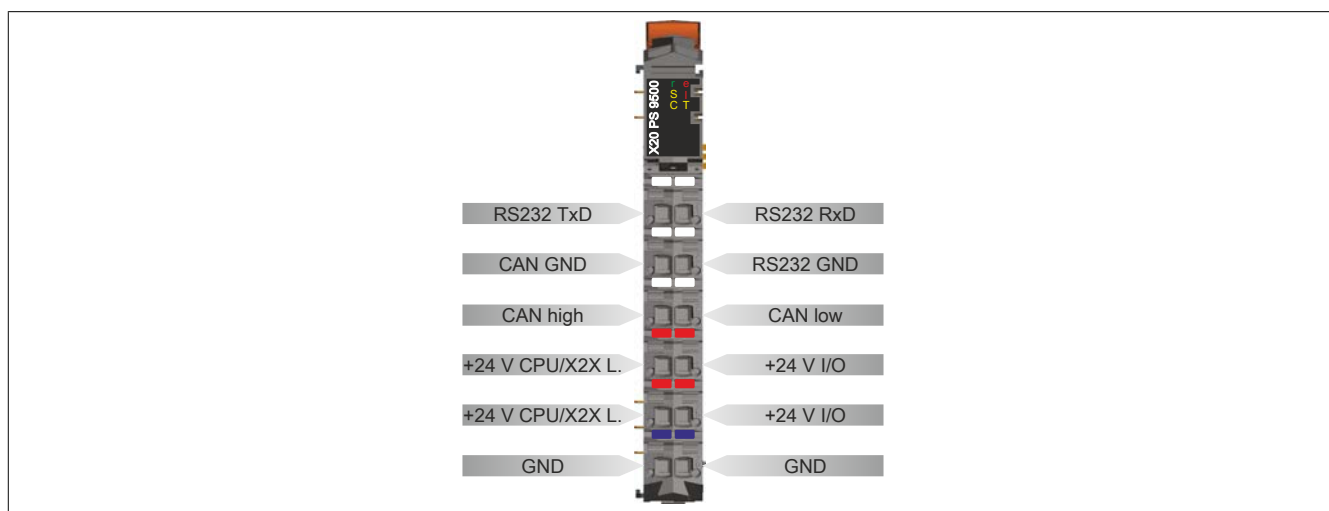
- 1) CAN bus only when used with bus module X20BB27, X20BB37 or X20BB47.
- 2) The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 3) In parallel operation, it is only permitted to assume 75% of the rated power. It is important to make sure that all power supplies operated in parallel are switched on and off at the same time.

9.8.4.4 LED status indicators

For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

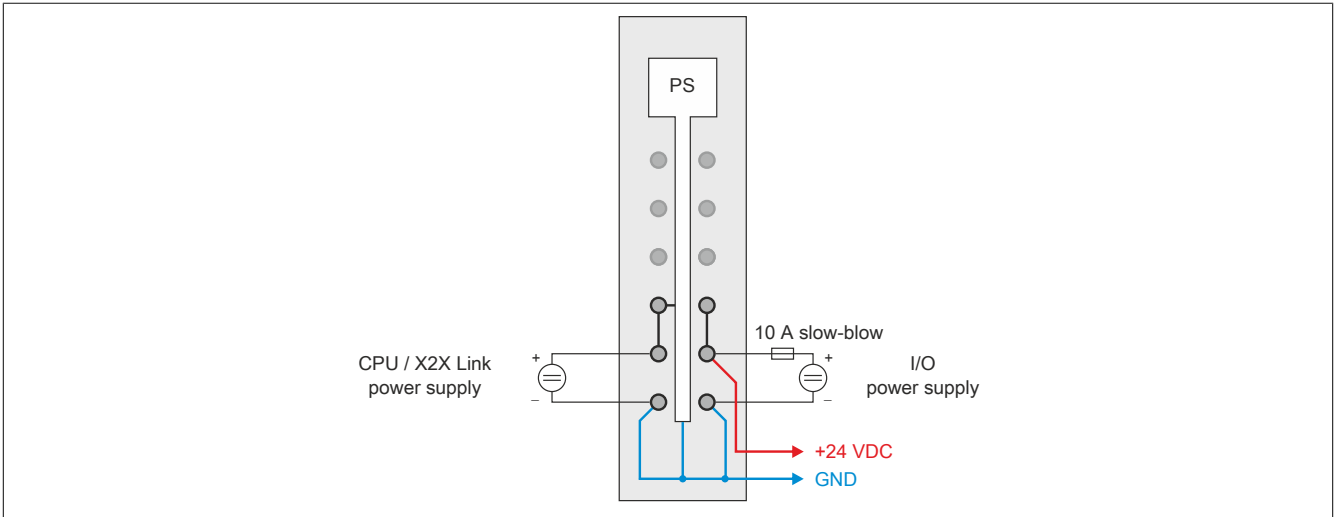
| Figure | LED | Color | Status | Description |
|---|-------|--------------------------------|---|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | Mode RESET |
| | | | Blinking | Mode PREOPERATIONAL |
| | | | On | Mode RUN |
| | e | Red | Off | No power to module or everything OK |
| | | | Double flash | LED indicates one of the following states: <ul style="list-style-type: none"> • Power supply for CPU / X2X Link overloaded • I/O power supply too low • Input voltage for CPU / X2X Link power supply too low |
| | e + r | Solid red / Single green flash | Invalid firmware | |
| | l | Red | Off | CPU / X2X Link power supply within valid range |
| | | | On | Power supply for CPU / X2X Link overloaded |
| | s | Yellow | Off | CPU not transmitting data via the RS232 interface |
| | | | On | CPU transmitting data via the RS232 interface |
| | c | Yellow | Off | CPU not transmitting data via the CAN bus interface |
| | | | On | CPU transmitting data via the CAN bus interface |
| | t | Yellow | Off | Terminating resistor integrated in bus module X20BB27, X20BB37 or X20BB47 switched off |
| On | | | Terminating resistor integrated in bus module X20BB27, X20BB37 or X20BB47 switched on | |

9.8.4.5 Pinout

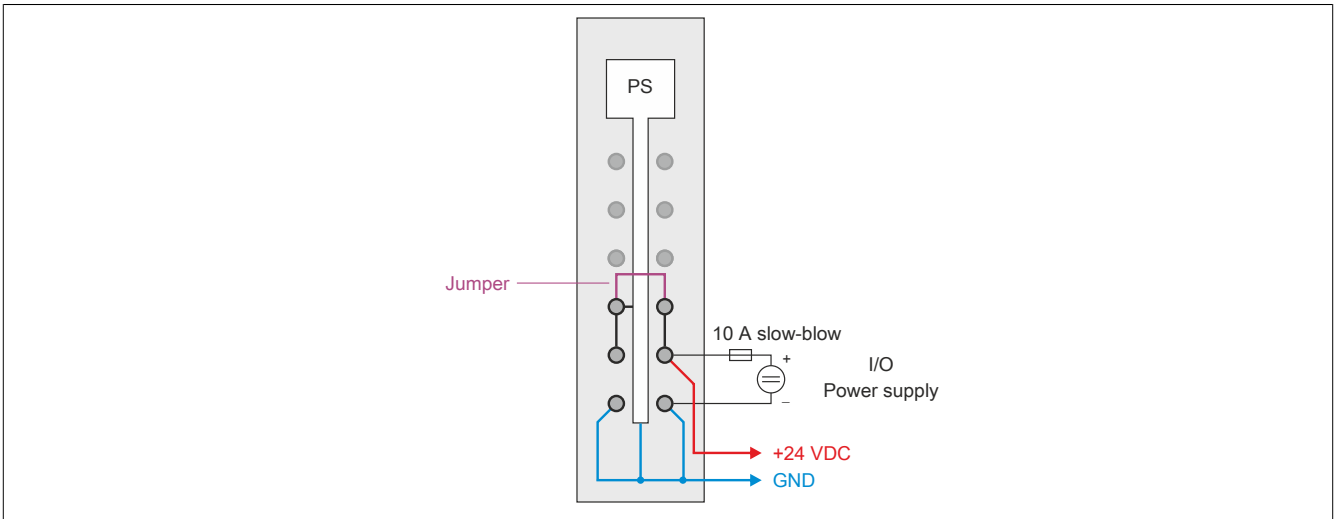


9.8.4.6 Connection examples

With 2 isolated power supplies

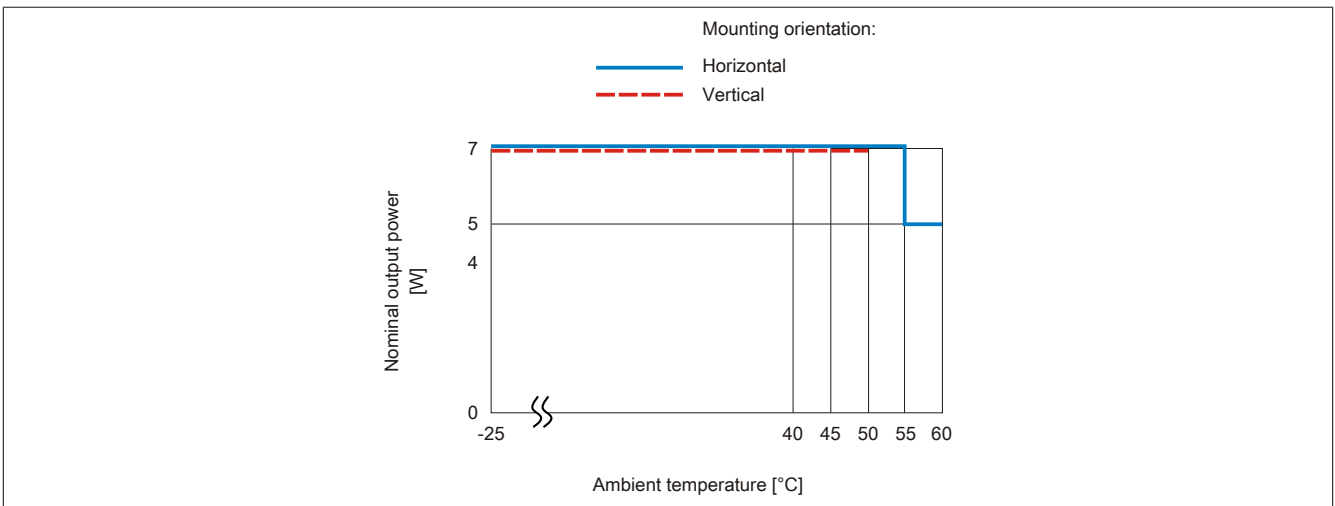


With 1 power supply and jumper



9.8.4.7 Derating

The nominal output power for the power supply is 7 W. Depending on the mounting orientation, derating must be taken into account.



9.8.4.8 Register description

9.8.4.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.8.4.8.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 0 | 1 | Status of the module | USINT | • | | | |
| | | StatusInput01 | Bit 0 | | | | |
| | | StatusInput02 | Bit 2 | | | | |
| 2 | 2 | SupplyCurrent | USINT | • | | | |
| 4 | 3 | SupplyVoltage | USINT | • | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.8.4.8.3 Status of the module

Name:

StatusInput01 to StatusInput02

The following module power supply voltages are monitored in this register:

| | |
|----------------------------|--|
| Bus power supply current: | Bus power supply current >2.3 A is displayed as a warning. |
| Bus supply voltage: | Bus supply voltage <4.7 V is displayed as a warning. |
| 24 VDC I/O supply voltage: | I/O supply voltage <20.4 V is displayed as a warning. |

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|---|
| 0 | StatusInput01 | 0 | No error |
| | | 1 | Warning in the event of overcurrent (>2.3 A) or undervoltage (<4.7 V) |
| 1 | Reserved | 0 | |
| 2 | StatusInput02 | 0 | I/O power supply above the warning limit of 20.4 V |
| | | 1 | I/O power supply below the warning limit of 20.4 V |
| 3 - x | Reserved | 0 | |

9.8.4.8.4 Bus power supply current

Name:

SupplyCurrent

This register displays the bus power supply current measured at a resolution of 0.1 A.

| Function model | Data type |
|----------------|-----------|
| 0 - Standard | USINT |

9.8.4.8.5 Bus supply voltage

Name:

SupplyVoltage

This register indicates the bus supply voltage measured at a resolution of 0.1 V.

| Function model | Data type |
|----------------|-----------|
| 0 - Standard | USINT |

9.8.4.8.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.8.4.8.7 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 2 ms |

9.8.5 X20PS9502

Data sheet version: 3.07

9.8.5.1 General information

The power supply module is used together with an X20 Compact or Fieldbus CPU. It is equipped with a supply for the Compact or Fieldbus CPU, X2X Link network and internal I/O power supply.

This module is intended as a cost-effective power supply module for small X20 systems. The use of potential groups is possible. Expansion or redundancy of the X2X Link network with power supply module X20PS3300 or X20PS3310 is not possible. Expanding the X20 system with a bus transmitter is also not permitted.

- Supply for Compact or Fieldbus CPU, X2X Link network and internal I/O power supply
- Cost-effective power supply module for small X20 systems
- No electrical isolation of supply and CPU / X2X Link power supply
- Expansion or redundancy of CPU / X2X Link power supply not possible by operating multiple power supply modules simultaneously
- RS232 configurable as an online interface
- CAN bus

9.8.5.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | System modules for compact CPUs |  |
| X20PS9502 | X20 power supply module, for Compact and Fieldbus CPUs and internal I/O power supply, X2X Link power supply, supply not electrically isolated | |
| | Required accessories | |
| | System modules for compact CPUs | |
| X20BB22 | X20 compact CPU base, for compact CPU and compact CPU power supply module, base for integrated RS232 interface, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB27 | X20 compact CPU base, for compact CPU and compact CPU power supply module, base for integrated RS232 and CAN bus interface, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| | System modules for fieldbus CPUs | |
| X20BB32 | X20 Fieldbus CPU base, for Fieldbus CPU and Compact CPU power supply module, base for integrated RS232 interface, slot for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB37 | X20 Fieldbus CPU base, for Fieldbus CPU and Compact CPU power supply module, base for integrated RS232 and CAN bus interface, slot for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB42 | X20 fieldbus CPU base, for fieldbus CPU and compact CPU power supply module, base for integrated RS232 interface, 2 slots for X20 interface modules, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB47 | X20 fieldbus CPU base, for fieldbus CPU and compact CPU power supply module, base for integrated RS232 and CAN bus interface, 2 slots for X20 interface modules, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 170: X20PS9502 - Order data

9.8.5.3 Technical data

| | |
|--|--|
| Model number | X20PS9502 |
| Short description | |
| Power supply module | 24 VDC power supply module for Compact or Fieldbus CPU, X2X Link power supply and I/O |
| Interfaces | 1x RS232, 1x CAN bus ¹⁾ |
| General information | |
| B&R ID code | 0xA38A |
| Status indicators | Operating state, module status, RS232, CAN bus ¹⁾ |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| CAN bus data transfer ¹⁾ | Yes, using status LED |
| RS232 data transfer | Yes, using status LED |
| Overload | Yes, using status LED and software |
| Power consumption for X2X Link power supply ²⁾ | 1.64 W |
| Power consumption ²⁾ | |
| Internal I/O | 0.6 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| KR | Yes |
| CPU / X2X Link power supply input | |
| Input voltage | 24 VDC -15% / +20% |
| Input current | Max. 0.7 A |
| Fuse | Integrated, cannot be replaced |
| Reverse polarity protection | Yes |
| CPU / X2X Link power supply output | |
| Nominal output power | |
| Horizontal mounting orientation | 7 W at 45°C and 5 W at 55°C |
| Vertical mounting orientation | 7 W at 40°C and 5 W at 50°C |
| Parallel connection | No |
| Redundant operation | No |
| Overload characteristics | Short circuit protection, temporary overload |
| Input I/O power supply | |
| Input voltage | 24 VDC -15% / +20% |
| Fuse | Required line fuse: Max. 10 A, slow-blow |
| Reverse polarity protection | No |
| Output I/O power supply | |
| Nominal output voltage | 24 VDC |
| Behavior on short circuit | Required line fuse |
| Permissible contact load | 10 A |
| Interfaces | |
| Interface IF1 | |
| Signal | RS232 |
| Variant | Connection made using 12-pin terminal block X20TB12 |
| Transfer rate | Max. 115.2 kbit/s |
| Interface IF3 ¹⁾ | |
| Signal | CAN bus |
| Variant | Connection made using 12-pin terminal block X20TB12 |
| Transfer rate | Max. 1 Mbit/s |
| Electrical properties | |
| Electrical isolation | CPU/X2X Link supply not isolated from CPU/X2X Link power supply, and I/O supply not isolated from I/O power supply |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |

Table 171: X20PS9502 - Technical data


| Model number | X20PS9502 |
|--|---|
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating" |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately Order 1x Compact CPU base X20BB22 or X20BB27 separately Order 1x Fieldbus CPU base X20BB32 or X20BB37 separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 171: X20PS9502 - Technical data

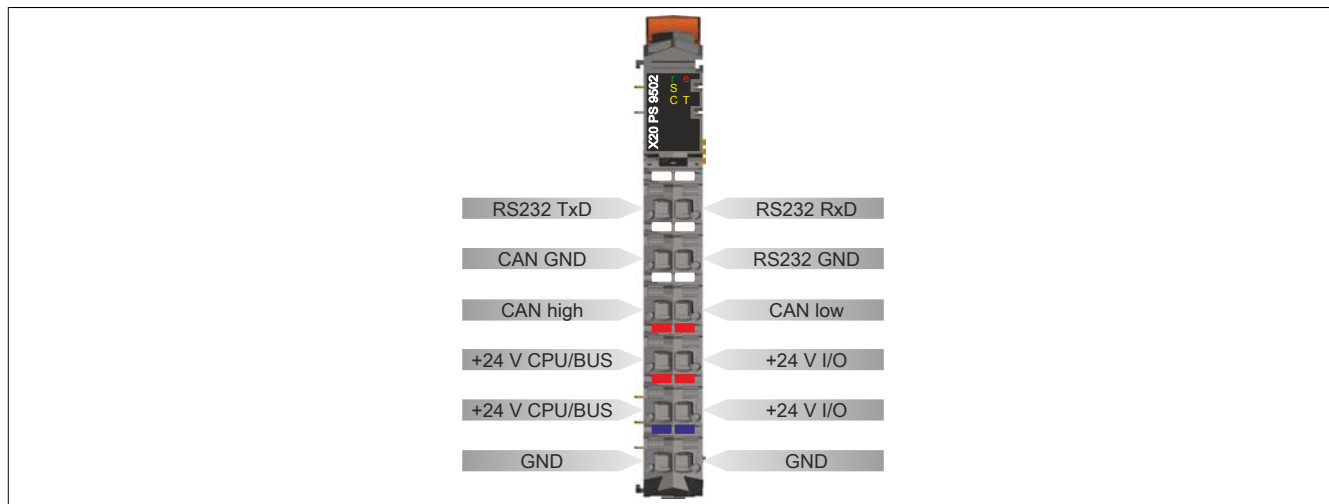
- 1) CAN bus only when used with bus module X20BB27 or X20BB37.
- 2) The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.

9.8.5.4 LED status indicators

For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

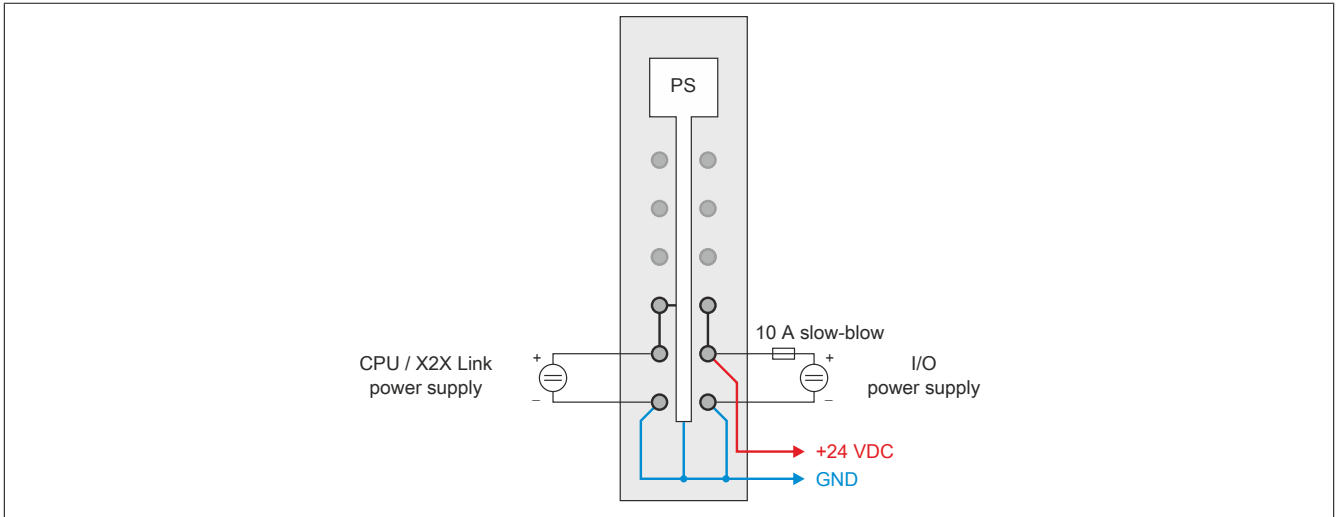
| Figure | LED | Color | Status | Description |
|---|-----|--------|---|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | Mode RESET |
| | | | Blinking | Mode PREOPERATIONAL |
| | | | On | Mode RUN |
| | e | Red | Off | No power to module or everything OK |
| | | | Double flash | LED indicates one of the following states: <ul style="list-style-type: none"> • Power supply for CPU / X2X Link overloaded • I/O power supply too low • Input voltage for CPU / X2X Link power supply too low |
| | | | Solid red / Single green flash | Invalid firmware |
| | S | Yellow | Off | CPU not transmitting data via the RS232 interface |
| | On | | CPU transmitting data via the RS232 interface | |
| | C | Yellow | Off | CPU not transmitting data via the CAN bus interface |
| | | | On | CPU transmitting data via the CAN bus interface |
| | T | Yellow | Off | Terminating resistor integrated in bus module X20BB27, X20BB37 or X20BB47 switched off |
| On | | | Terminating resistor integrated in bus module X20BB27, X20BB37 or X20BB47 switched on | |

9.8.5.5 Pinout

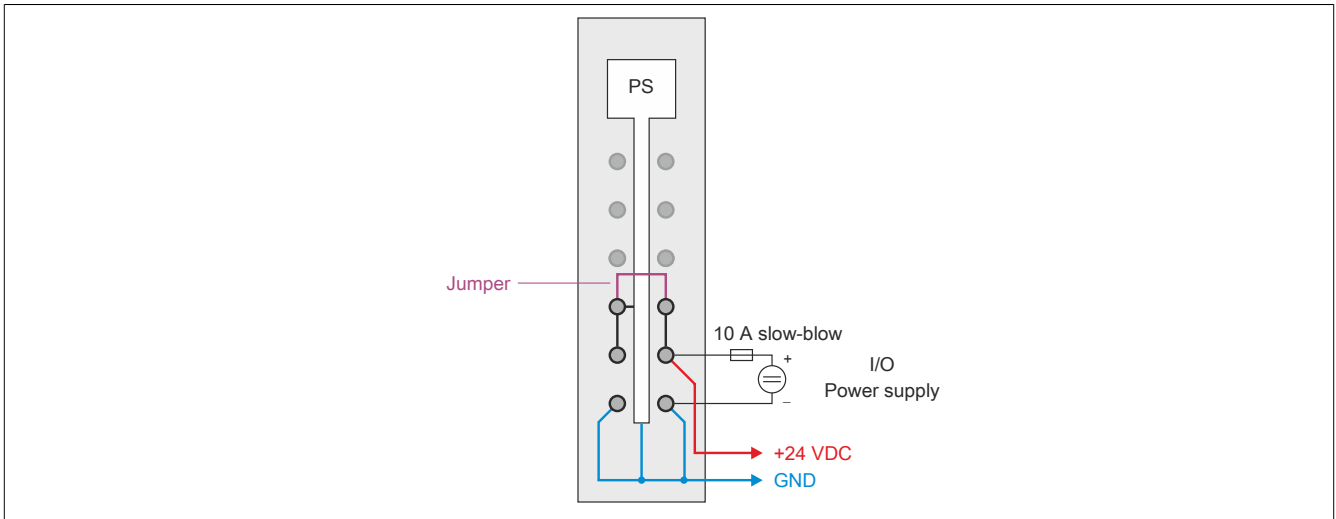


9.8.5.6 Connection examples

With 2 isolated power supplies

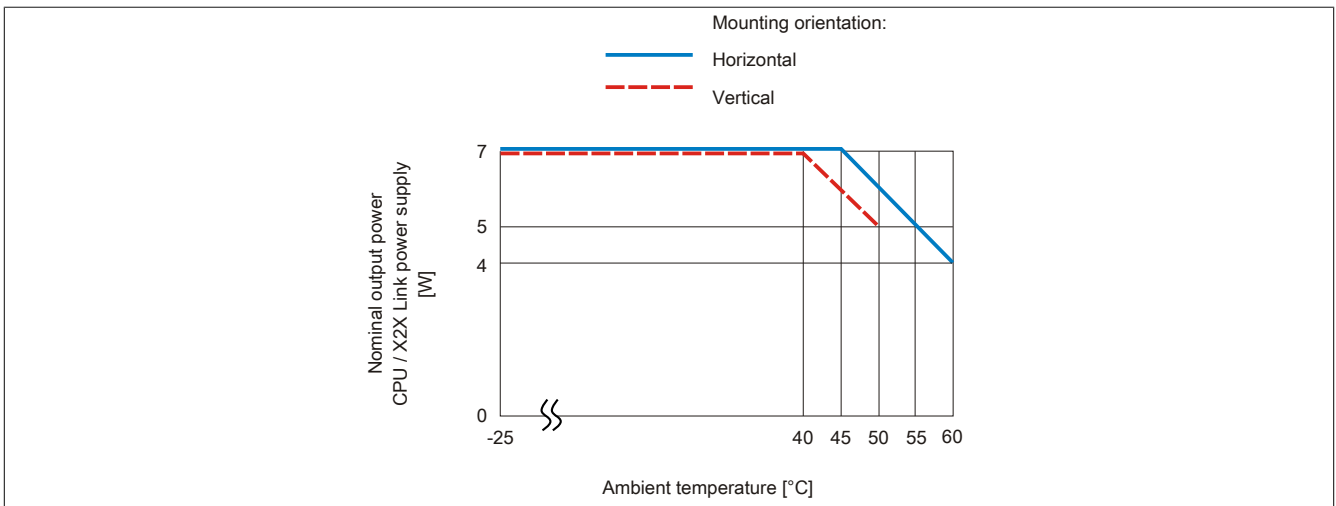


With 1 power supply and jumper



9.8.5.7 Derating for CPU / X2X Link power supply

The nominal output power for the CPU / X2X Link power supply is 7.0 W. Derating may need to be taken into account depending on the mounting orientation.



9.8.5.8 Register description

9.8.5.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.8.5.8.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|--------------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 0 | 1 | Status of the module | USINT | • | | | |
| | | StatusInput01 | Bit 0 | | | | |
| | | StatusInput02 | Bit 2 | | | | |
| 4 | 3 | SupplyVoltage | USINT | • | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.8.5.8.3 Status of the module

Name:

Module status

The following module power supply voltages are monitored in this register:

Bus supply voltage: Bus supply voltage <4.7 V is displayed as a warning.
24 VDC I/O supply voltage: I/O supply voltage <20.4 V is displayed as a warning.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---------------|-------|--|
| 0 | StatusInput01 | 0 | No error |
| | | 1 | Bus supply warning - Undervoltage (<4.7 V) |
| 1 | Reserved | 0 | |
| 2 | StatusInput02 | 0 | I/O power supply above the warning limit of 20.4 V |
| | | 1 | I/O power supply below the warning limit of 20.4 V |
| 3 - x | Reserved | 0 | |

9.8.5.8.4 Bus supply voltage

Name:

SupplyVoltage

This register indicates the bus supply voltage measured at a resolution of 0.1 V.

| Function model | Data type |
|----------------------|-----------|
| 0 - Standard | USINT |
| 254 - Bus controller | UINT |

9.8.5.8.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 µs |

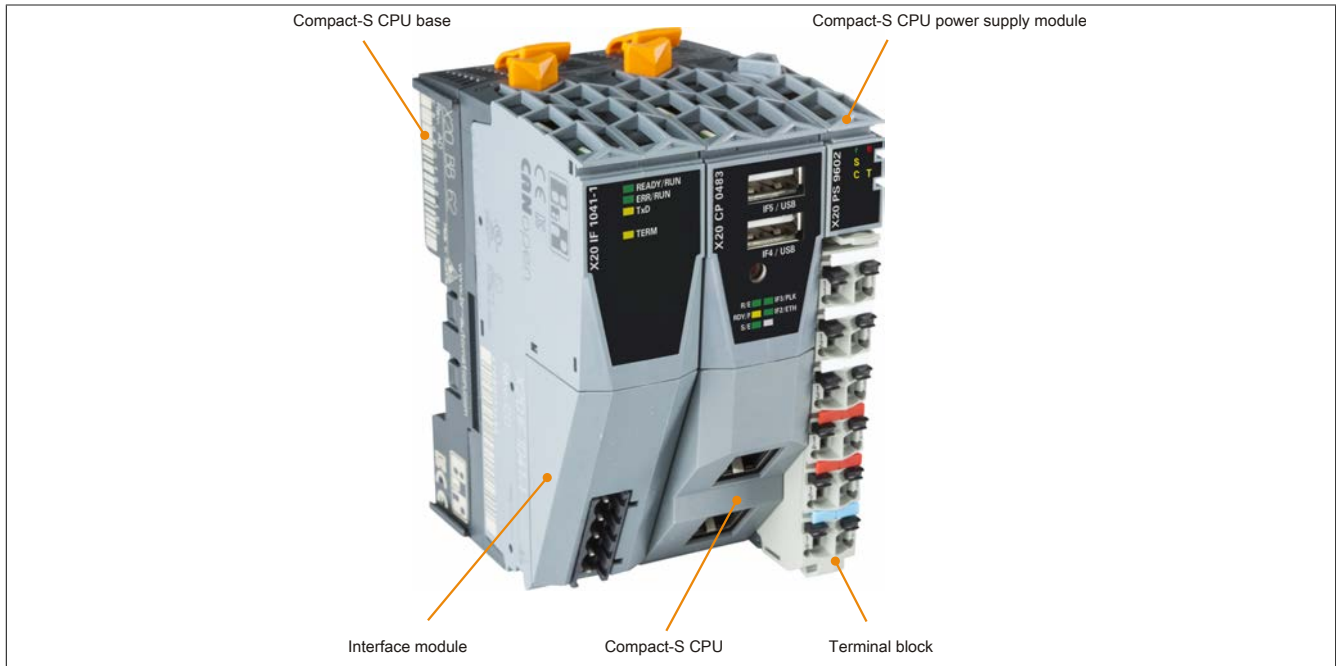
9.8.5.8.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 2 ms |

9.9 Compact-S CPUs

Compact-S CPUs have a modular design that allows them to be quickly and easily assembled according to the requirements of the respective application. All CPUs are based on the ARM Cortex-A9 processor and available in 2 performance classes.



Available interfaces

With POWERLINK, Ethernet, 2x USB and RS232, the CPUs offer a wide range of communication options. An optional CAN interface is also available. If needed, up to 2 slots are also available for modular interface expansion.

Maintenance-free CPU

The CPUs were designed without fans or batteries in order to make them as easy as possible to service. This makes them completely maintenance-free.

Compact design

The supply for the CPU, X2X Link network and I/O modules is part of the CPU. No additional power supply modules are required.

9.9.1 Summary

| Model number | Short description | Page |
|--------------|---|------|
| X20CP0410 | X20 Compact-S CPU, ARM Cortex-A9-166 (compatible), 128 MB DDR3 RAM, 8 kB FRAM, 256 MB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T. Order bus base, power supply module and terminal block separately! | 1019 |
| X20CP0411 | X20 Compact-S CPU, ARM Cortex-A9-240, 128 MB DDR3 RAM, 16 kB FRAM, 512 MB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T. Order bus base, power supply module and terminal block separately! | 1019 |
| X20CP0420 | X20 Compact-S CPU, ARM Cortex-A9-166 (compatible), 128 MB DDR3 RAM, 8 kB FRAM, 256 MB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 2 Ethernet interfaces 10/100BASE-T (switch). Order bus base, power supply module and terminal block separately! | 1019 |
| X20CP0482 | X20 Compact-S CPU, ARM Cortex-A9-300, 128 MB DDR3 RAM, 16 kB FRAM, 1 GB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, can be expanded with X20 interface slot. Order bus base, power supply module and terminal block separately! | 1019 |
| X20CP0483 | X20 Compact-S CPU, ARM Cortex-A9-500, 256 MB DDR3 RAM, 32 kB FRAM, 1 GB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, can be expanded with X20 interface slot. Order bus base, power supply module and terminal block separately! | 1019 |
| X20CP0484 | X20 Compact-S CPU, ARM Cortex-A9-667, 256 MB DDR3 RAM, 64 kB FRAM, 2 GB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, can be expanded with X20 interface slot. Order bus base, power supply module and terminal block separately! | 1019 |
| X20CP0484-1 | X20 Compact-S CPU, ARM Cortex-A9-667, 512 MB DDR3 RAM, 64 kB FRAM, 2 GB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, can be expanded with X20 interface slot. Order bus base, power supply module and terminal block separately! | 1019 |

9.9.2 X20CP041x, X20CP0420 and X20CP048x

Data sheet version: 2.04

9.9.2.1 General information

The CPUs in the X20 Compact-S family are available in different variants. This way, customers get the product that best meets the requirements of the machine – technically and economically.

The processor performance of the compact CPUs ranges from 166 MHz (compatible) to 667 MHz. The most economical variant is equipped with 128 MB RAM, 8 kB nonvolatile RAM and a 256 MB flash drive. The most powerful variant of the Compact-S CPUs achieves cycle times up to 400 μ s. It is equipped with 512 MB RAM, 64 kB nonvolatile RAM and a 2 GB internal flash drive.

With POWERLINK, Ethernet, USB and RS232, the CPUs offer a wide range of communication options. An optional CAN interface is also available. If the application requires additional interfaces, the CPU can be modularly expanded by one or two X20 interface slots. This allows the entire product range of X20 fieldbus interfaces to be used.

The fanless, battery-free design of Compact-S CPUs means they are completely maintenance-free.

- ARM Cortex-A9 processor with 166 MHz (compatible) to 667 MHz and integrated I/O processor
- Depending on the variant: POWERLINK with poll-response chaining
- 2x onboard USB
- Up to 2 slots for modular interface expansions
- 128 to 512 MB DDR3 SDRAM
- 256 MB to 2 GB onboard flash drive
- Fanless
- No battery
- Extremely compact

9.9.2.2 Order data


|  | |
|--|---|
| <p>X20CP0410, X20CP0411</p> <p>X20CP0420, X20CP0482, X20CP0483, X20CP0484, X20CP0484-1</p> | |
| Model number | Short description |
| Compact-S CPUs | |
| X20CP0410 | X20 Compact-S CPU, ARM Cortex-A9-166 (compatible), 128 MB DDR3 RAM, 8 kB FRAM, 256 MB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T. Order bus base, power supply module and terminal block separately! |
| X20CP0411 | X20 Compact-S CPU, ARM Cortex-A9-240, 128 MB DDR3 RAM, 16 kB FRAM, 512 MB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T. Order bus base, power supply module and terminal block separately! |
| X20CP0420 | X20 Compact-S CPU, ARM Cortex-A9-166 (compatible), 128 MB DDR3 RAM, 8 kB FRAM, 256 MB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 2 Ethernet interfaces 10/100BASE-T (switch). Order bus base, power supply module and terminal block separately! |
| X20CP0482 | X20 Compact-S CPU, ARM Cortex-A9-300, 128 MB DDR3 RAM, 16 kB FRAM, 1 GB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, can be expanded with X20 interface slot. Order bus base, power supply module and terminal block separately! |
| X20CP0483 | X20 Compact-S CPU, ARM Cortex-A9-500, 256 MB DDR3 RAM, 32 kB FRAM, 1 GB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, can be expanded with X20 interface slot. Order bus base, power supply module and terminal block separately! |
| X20CP0484 | X20 Compact-S CPU, ARM Cortex-A9-667, 256 MB DDR3 RAM, 64 kB FRAM, 2 GB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, can be expanded with X20 interface slot. Order bus base, power supply module and terminal block separately! |
| X20CP0484-1 | X20 Compact-S CPU, ARM Cortex-A9-667, 512 MB DDR3 RAM, 64 kB FRAM, 2 GB onboard flash drive, 2 USB interfaces, 1 RS232 interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, can be expanded with X20 interface slot. Order bus base, power supply module and terminal block separately! |
| Required accessories | |
| System modules for Compact-S CPUs | |
| X20BB52 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 interface, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included |
| X20BB57 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 and CAN bus interface, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included |
| X20BB62 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 interface, slots for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included |
| X20BB67 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 and CAN bus interface, slot for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included |
| X20BB72 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 interface, 2 slots for X20 interface modules, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included |
| X20BB77 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 and CAN bus interface, 2 slots for X20 interface modules, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included |
| X20PS9600 | X20 power supply module, for Compact-S CPU and internal I/O power supply, X2X Link power supply |
| X20PS9602 | X20 power supply module, for Compact-S CPU and internal I/O power supply, X2X Link power supply, power supply not electrically isolated |
| Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed |

Table 172: X20CP041x, X20CP0420 and X20CP048x - Order data

Included in delivery

X20 end cover plates are included with the delivery of the Compact-S CPU bus base.

| Model number | Short description |
|--------------|----------------------------|
| X20AC0SL1 | X20 end cover plate, left |
| X20AC0SR1 | X20 end cover plate, right |

9.9.2.3 X20CP041x and X20CP0420 - Technical data

| Model number | X20CP0410 | X20CP0411 | X20CP0420 |
|--|---|--|---|
| Short description | | | |
| Interfaces | 1x Ethernet, 2x USB, 1x X2X Link | | 2x Ethernet, 2x USB, 1x X2X Link |
| System module | CPU | | |
| General information | | | |
| Cooling | Fanless | | |
| B&R ID code | 0xE94F | 0xE950 | 0xF4D3 |
| Status indicators | CPU function, Ethernet | | |
| Diagnostics | | | |
| CPU function | Yes, using LED status indicator | | |
| Ethernet | Yes, using LED status indicator | | |
| Overtemperature | Yes, using software | | |
| Power consumption | 2.2 W ¹⁾ | | 2.5 W ¹⁾ |
| Controller redundancy possible | No | | |
| ACOPOS support | Yes | | |
| Visual Components support | Yes | | |
| Additional power dissipation caused by actuators (resistive) [W] | - | | |
| Certifications | | | |
| CE | Yes | | |
| UL | cULus E115267 Industrial control equipment | | - |
| EAC | Yes | | |
| Controller | | | |
| Real-time clock | Retention for at least 300 hours, typ. 1000 hours at 25°C, 1 s resolution, -18 to 28 ppm accuracy at 25°C | | |
| FPU | Yes | | |
| Processor | | | |
| Type | ARM Cortex-A9 | | |
| Clock frequency | 166 MHz (comp.) | 240 MHz | 166 MHz (comp.) |
| L1 cache | | | |
| Data code | 32 kB | | |
| Program code | 32 kB | | |
| L2 cache | 512 kB | | |
| Integrated I/O processor | Processes I/O data points in the background | | |
| Remanent variables | 8 kB FRAM, retention > 10 years ²⁾ | 16 kB FRAM, retention > 10 years ²⁾ | 8 kB FRAM, retention > 10 years ²⁾ |
| Shortest task class cycle time | 4 ms | 2 ms | 4 ms |
| Typical instruction cycle time | 0.0446 µs | 0.0309 µs | 0.0446 µs |
| Standard memory | | | |
| RAM | 128 MB DDR3 SDRAM | | |
| Application memory | | | |
| Type | 256 MB eMMC flash memory | 512 MB eMMC flash memory | 256 MB eMMC flash memory |
| Data retention | 10 years | | |
| Writable data amount | | | |
| Guaranteed | 40 TB | | |
| Results for 5 years | 21.9 GB/day | | |
| Guaranteed erase/write cycles | 20,000 | | |
| Error-correcting code (ECC) | Yes | | |
| Interfaces | | | |
| Interface IF2 | | | |
| Signal | Ethernet | | |
| Variant | 1x RJ45 shielded | 2x shielded RJ45 (switch) | |
| Cable length | Max. 100 m between 2 stations (segment length) | | |
| Transfer rate | 10/100 Mbit/s | | |
| Transfer | | | |
| Physical layer | 10BASE-T/100BASE-TX | | |
| Half-duplex | Yes | | |
| Full-duplex | Yes | | |
| Autonegotiation | Yes | | |
| Auto-MDI/MDIX | Yes | | |
| Interface IF4 | | | |
| Type | USB 1.1/2.0 | | |
| Variant | Type A | | |
| Max. output current | 0.2 A | | |

Table 173: X20CP041x and X20CP0420 - Technical data

| Model number | X20CP0410 | X20CP0411 | X20CP0420 |
|--|-----------|--|-----------|
| Interface IF5 | | | |
| Type | | USB 1.1/2.0 | |
| Variant | | Type A | |
| Max. output current | | 0.2 A | |
| Interface IF6 | | | |
| Fieldbus | | X2X Link master | |
| On base module | | | |
| X20BB52, X20BB62 and X20BB72 | | Compact-S CPU base module with integrated RS232 interface | |
| X20BB57, X20BB67 and X20BB77 | | Compact-S CPU base module with integrated RS232 and CAN bus interface | |
| Electrical properties | | | |
| Electrical isolation | | Ethernet (IF2) isolated from other interfaces and PLC X2X (IF6) isolated from other interfaces and PLC: Yes, with X20PS9600 / No, with X20PS9602 USB (IF4, IF5) not isolated from each other and PLC | |
| Operating conditions | | | |
| Mounting orientation | | | |
| Horizontal | | Yes | |
| Vertical | | Yes | |
| Installation elevation above sea level | | | |
| 0 to 2000 m | | No limitation | |
| >2000 m | | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | | IP20 | |
| Ambient conditions | | | |
| Temperature | | | |
| Operation | | | |
| Horizontal mounting orientation | | -25 to 60°C | |
| Vertical mounting orientation | | -25 to 50°C | |
| Derating | | See section "Derating" of the X20PS960x data sheet. | |
| Storage | | -40 to 85°C | |
| Transport | | -40 to 85°C | |
| Relative humidity | | | |
| Operation | | 5 to 95%, non-condensing | |
| Storage | | 5 to 95%, non-condensing | |
| Transport | | 5 to 95%, non-condensing | |
| Mechanical properties | | | |
| Note | | Order 1x terminal block X20TB12 separately. Order 1x power supply module X20PS9600 or X20PS9602 separately. Order 1x Compact-S CPU base X20BB5x separately. | |
| Pitch ³⁾ | | | |
| X20BB5x | | 37.5 ^{+0.2} mm | |

Table 173: X20CP041x and X20CP0420 - Technical data

- 1) Without USB interface.
- 2) The memory size for remanent variables is configurable in Automation Studio.
- 3) Spacing is based on the width of the Compact-S CPU base.

9.9.2.4 X20CP048x - Technical data

| Product ID | X20CP0482 | X20CP0483 | X20CP0484 | X20CP0484-1 |
|--|--|--|--|----------------------|
| Short description | | | | |
| Interfaces | 1x Ethernet, 1x POWERLINK V2, 2x USB, 1x X2X Link | | | |
| System module | CPU | | | |
| General information | | | | |
| Cooling | Fanless | | | |
| B&R ID code | 0xE951 | 0xE952 | 0xE953 | 0xFA24 |
| Status indicators | CPU function, Ethernet, POWERLINK | | | |
| Diagnostics | | | | |
| CPU function | Yes, using LED status indicator | | | |
| Ethernet | Yes, using LED status indicator | | | |
| POWERLINK | Yes, using LED status indicator | | | |
| Overtemperature | Yes, using software | | | |
| Power consumption | 2.7 W ¹⁾ | 2.9 W ¹⁾ | 2.95 W ¹⁾ | 2.97 W ¹⁾ |
| Controller redundancy possible | No | | | |
| ACOPOS support | Yes | | | |
| Visual Components support | Yes | | | |
| Additional power dissipation caused by actuators (resistive) [W] | - | | | |
| Certifications | | | | |
| CE | Yes | | | |
| EAC | Yes | | | |
| UL | cULus E115267 Industrial control equipment | | | - |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | | | - |
| KR | Yes | | | |
| Controller | | | | |
| Real-time clock | Retention for at least 300 hours, typ. 1000 hours at 25°C, 1 s resolution, -18 to 28 ppm accuracy at 25°C | | | |
| FPU | Yes | | | |
| Processor | | | | |
| Type | ARM Cortex-A9 | | | |
| Clock frequency | 300 MHz | 500 MHz | 667 MHz | |
| L1 cache | | | | |
| Data code | 32 kB | | | |
| Program code | 32 kB | | | |
| L2 cache | | | | |
| | 512 kB | | | |
| Integrated I/O processor | Processes I/O data points in the background | | | |
| Remanent variables | 16 kB FRAM, retention > 10 years ²⁾ | 32 kB FRAM, retention > 10 years ²⁾ | 64 kB FRAM, retention > 10 years ²⁾ | |
| Shortest task class cycle time | 1 ms | 0.8 ms | 0.4 ms | |
| Typical instruction cycle time | 0.0247 µs | 0.0145 µs | 0.0106 µs | |
| Standard memory | | | | |
| RAM | 128 MB DDR3 SDRAM | 256 MB DDR3 SDRAM | | 512 MB DDR3 SDRAM |
| Application memory | | | | |
| Type | 1 GB eMMC flash memory | | 2 GB eMMC flash memory | |
| Data retention | 10 years | | | |
| Writable data amount | | | | |
| Guaranteed | 40 TB | | | |
| Results for 5 years | 21.9 GB/day | | | |
| Guaranteed erase/write cycles | 20,000 | | | |
| Error-correcting code (ECC) | Yes | | | |
| Slots for interface modules | | | | |
| X20BB5x | 0 | | | |
| X20BB6x | 1 | | | |
| X20BB7x | 2 | | | |
| Interfaces | | | | |
| Interface IF2 | | | | |
| Signal | Ethernet | | | |
| Variant | 1x RJ45 shielded | | | |
| Line length | Max. 100 m between 2 stations (segment length) | | | |
| Transfer rate | 10/100 Mbit/s | | | |
| Transfer | | | | |
| Physical layer | 10BASE-T/100BASE-TX | | | |
| Half-duplex | Yes | | | |
| Full-duplex | Yes | | | |
| Autonegotiation | Yes | | | |
| Auto-MDI/MDIX | Yes | | | |

Table 174: X20CP048x - Technical data

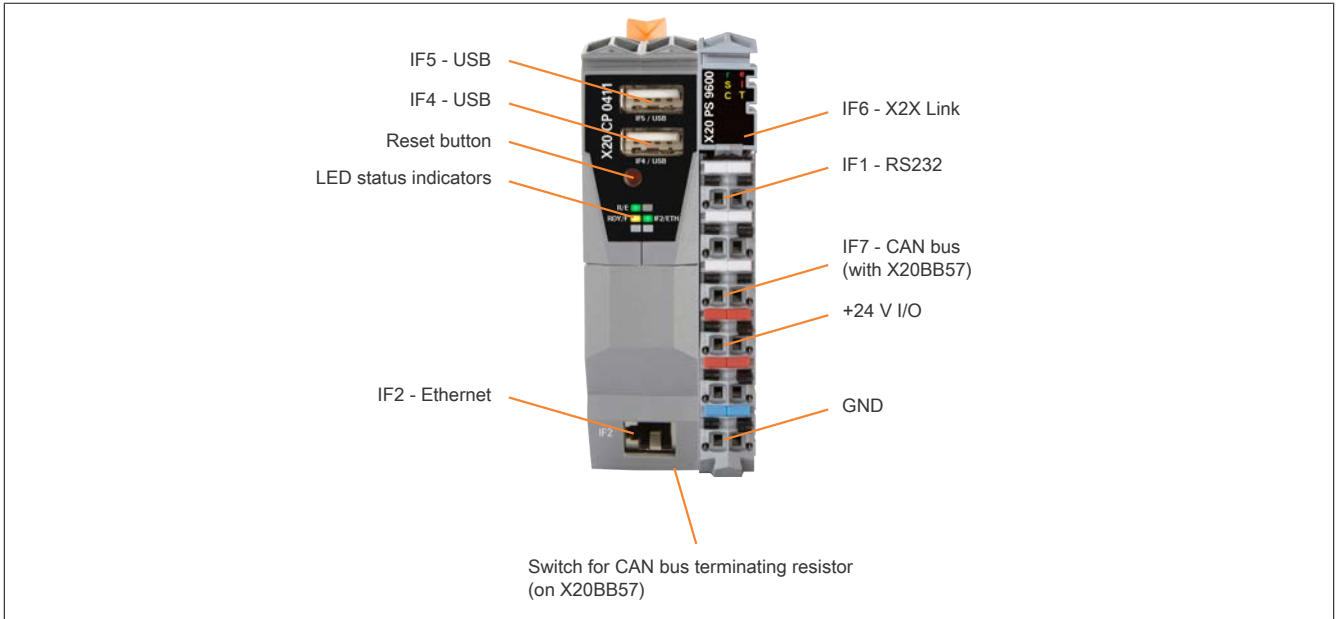
| Product ID | X20CP0482 | X20CP0483 | X20CP0484 | X20CP0484-1 |
|--|---|-----------|-----------|-------------|
| Interface IF3 | | | | |
| Fieldbus | POWERLINK V2 managing or controlled node | | | |
| Type | Type 4 ³⁾ | | | |
| Variant | 1x RJ45 shielded | | | |
| Line length | Max. 100 m between 2 stations (segment length) | | | |
| Transfer rate | 100 Mbit/s | | | |
| Transfer | | | | |
| Physical layer | 100BASE-TX | | | |
| Half-duplex | Yes | | | |
| Full-duplex | POWERLINK mode: No / Ethernet mode: Yes | | | |
| Autonegotiation | Yes | | | |
| Auto-MDI/MDIX | Yes | | | |
| Interface IF4 | | | | |
| Type | USB 1.1/2.0 | | | |
| Variant | Type A | | | |
| Max. output current | 0.2 A | | | |
| Interface IF5 | | | | |
| Type | USB 1.1/2.0 | | | |
| Variant | Type A | | | |
| Max. output current | 0.2 A | | | |
| Interface IF6 | | | | |
| Fieldbus | X2X Link master | | | |
| On base module | | | | |
| X20BB52, X20BB62 and X20BB72 | Compact-S CPU base module with integrated RS232 interface | | | |
| X20BB57, X20BB67 and X20BB77 | Compact-S CPU base module with integrated RS232 and CAN bus interface | | | |
| Electrical properties | | | | |
| Electrical isolation | Ethernet (IF2) and POWERLINK (IF3) isolated from each other, from other interfaces and from PLC X2X (IF6) isolated from other interfaces and from PLC: Yes, with X20PS9600 / No, with X20PS9602 USB (IF4, IF5) not isolated from each other or from PLC | | | |
| Operating conditions | | | | |
| Mounting orientation | | | | |
| Horizontal | Yes | | | |
| Vertical | Yes | | | |
| Installation elevation above sea level | | | | |
| 0 to 2000 m | No limitation | | | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | | | |
| Degree of protection per EN 60529 | IP20 | | | |
| Ambient conditions | | | | |
| Temperature | | | | |
| Operation | | | | |
| Horizontal mounting orientation | -25 to 60°C | | | |
| Vertical mounting orientation | -25 to 50°C | | | |
| Derating | See section "Derating" of the X20PS960x data sheet. | | | |
| Storage | -40 to 85°C | | | |
| Transport | -40 to 85°C | | | |
| Relative humidity | | | | |
| Operation | 5 to 95%, non-condensing | | | |
| Storage | 5 to 95%, non-condensing | | | |
| Transport | 5 to 95%, non-condensing | | | |
| Mechanical properties | | | | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x power supply module X20PS9600 or X20PS9602 separately. Order 1x X20BB5x, X20BB6x or X20BB7x Compact-S CPU base separately | | | |
| Spacing ⁴⁾ | | | | |
| X20BB5x | 37.5 ^{+0.2} mm | | | |
| X20BB6x | 62.5 ^{+0.2} mm ⁵⁾ | | | |
| X20BB7x | 87.5 ^{+0.2} mm ⁶⁾ | | | |

Table 174: X20CP048x - Technical data

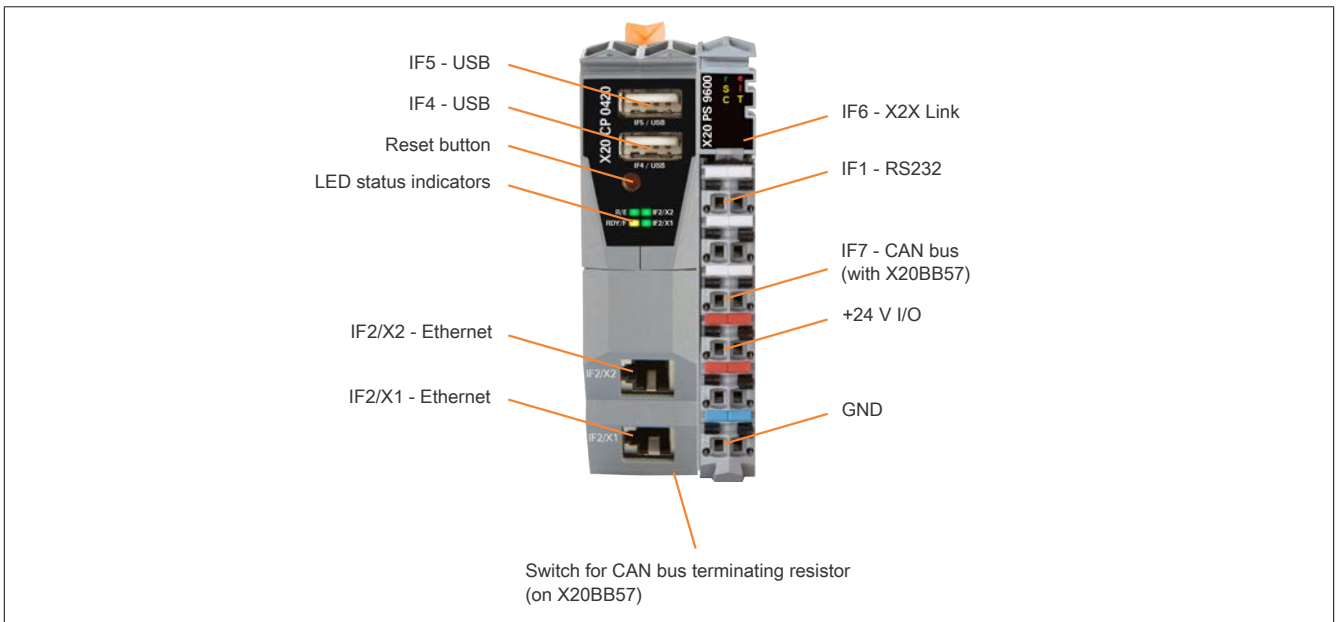
- 1) Without USB interface.
- 2) The memory size for remanent variables is configurable in Automation Studio.
- 3) See Automation Help under "Communication / POWERLINK / General information / Hardware - IF/LS" for more information.
- 4) Spacing is based on the width of the Compact-S CPU base.
- 5) X20CP048x CPUs can be used to operate 1 interface module.
- 6) X20CP048x CPUs can be used to operate 2 interface modules.

9.9.2.5 Operating and connection elements

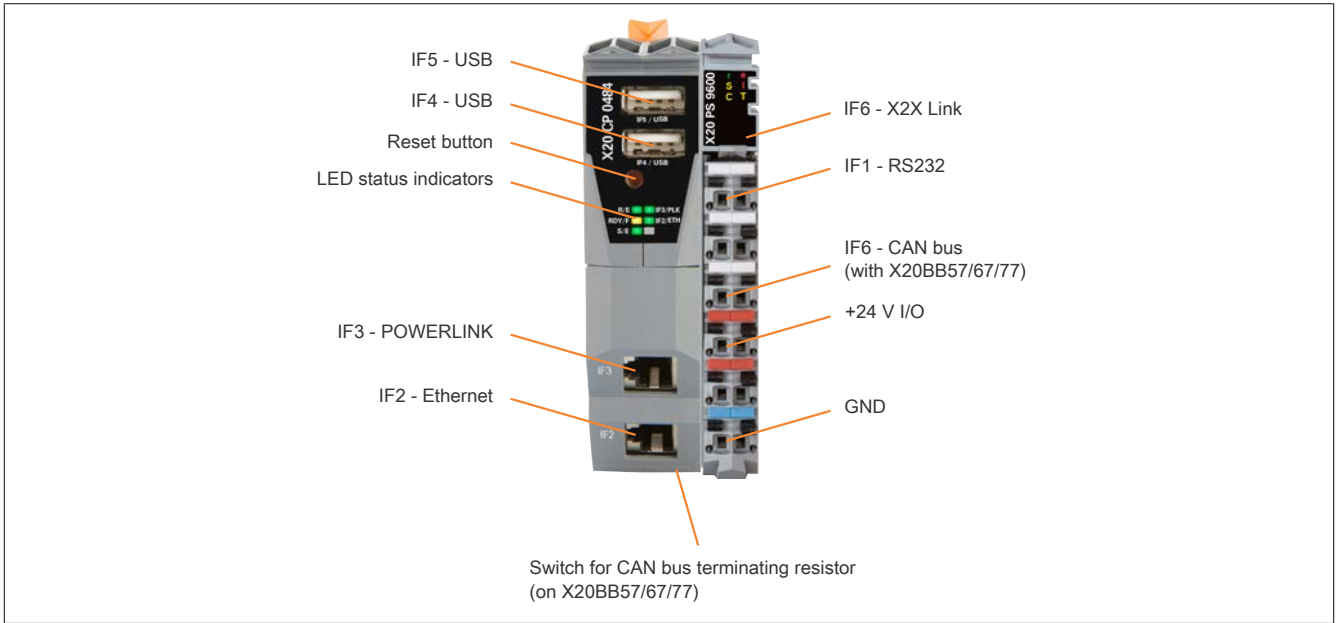
X20CP0410 and X20CP0411



X20CP0420



X20CP0482, X20CP0483, X20CP0484 and X20CP0484-1



9.9.2.5.1 LED status indicators

X20CP0410 and X20CP0411

| Figure | LED | Color | Status | Description |
|--------|---------|--------|--------------|---|
| | R/E | Green | On | Application running |
| | | | Blinking | System startup: The CPU is initializing the application, all bus systems and I/O modules. ¹⁾ |
| | | | Double flash | System startup during firmware update ¹⁾ |
| | RDY/F | Yellow | On | Mode SERVICE ²⁾ or BOOT ²⁾ |
| | | | Blinking | If LED "RDY/F" blinks yellow and LED "R/E" blinks red, a license violation has occurred. |
| | IF2/ETH | Green | On | The link to the Ethernet remote station is established. |
| | | | Blinking | The link to the Ethernet remote station is established. The LED blinks if Ethernet activity is taking place on the bus. |
| | | | Blinking | The link to the Ethernet remote station is established. The LED blinks if Ethernet activity is taking place on the bus. |


- 1) This process can take several minutes depending on the configuration.
- 2) The operating states are described in Automation Help under "Real-time operating system - Method of operation - Operating states".

X20CP0420

| Figure | LED | Color | Status | Description |
|--------|-----------|--------|--------------|---|
| | R/E | Green | On | Application running |
| | | | Blinking | System startup: The CPU is initializing the application, all bus systems and I/O modules. ¹⁾ |
| | | | Double flash | System startup during firmware update ¹⁾ |
| | RDY/F | Yellow | On | Mode SERVICE ²⁾ or BOOT ²⁾ |
| | | | Blinking | If LED "RDY/F" blinks yellow and LED "R/E" blinks red, a license violation has occurred. |
| | IF2 X1/X2 | Green | On | The link to the Ethernet remote station is established. |
| | | | Blinking | The link to the Ethernet remote station is established. The LED blinks if Ethernet activity is taking place on the bus. |
| | | | Blinking | The link to the Ethernet remote station is established. The LED blinks if Ethernet activity is taking place on the bus. |

- 1) This process can take several minutes depending on the configuration.
- 2) The operating states are described in Automation Help under "Real-time operating system - Method of operation - Operating states".

X20CP0482, X20CP0483, X20CP0484 and X20CP0484-1

| Figure | LED | Color | Status | Description |
|---|---------|-----------|---|--|
|  | R/E | Green | On | Application running |
| | | | Blinking | System startup: The CPU is initializing the application, all bus systems and I/O modules. ¹⁾ |
| | | | Double flash | System startup during firmware update ¹⁾ |
| | | Red | On | Mode SERVICE ²⁾ |
| | | | Blinking | If LED "R/E" blinks red and LED "RDY/F" blinks yellow, a license violation has occurred. |
| | | | | |
| | RDY/F | Yellow | On | Mode SERVICE ²⁾ or BOOT ²⁾ |
| | | | Blinking | If LED "RDY/F" blinks yellow and LED "R/E" blinks red, a license violation has occurred. |
| | S/E | Green/Red | | Status/Error LED. LED states are described in section "LED "S/E" (LED "Status/Error")" on page 1026. |
| | IF3/PLK | Green | On | The link to the POWERLINK remote station is established. |
| | | | Blinking | The link to the POWERLINK remote station is established. The LED blinks if Ethernet activity is taking place on the bus. |
| | IF2/ETH | Green | On | The link to the Ethernet remote station is established. |
| Blinking | | | The link to the Ethernet remote station is established. The LED blinks if Ethernet activity is taking place on the bus. | |

- 1) This process can take several minutes depending on the configuration.
- 2) The operating states are described in Automation Help under "Real-time operating system - Method of operation - Operating states".

9.9.2.5.1.1 LED "S/E" (LED "Status/Error")

This LED is a green/red dual LED and indicates the state of the POWERLINK interface. The LED states have a different meaning depending on the operating mode of the POWERLINK interface.

Ethernet mode

In this mode, the interface is operated as an Ethernet interface.

| LED "S/E" | | Description |
|-----------|-----|---|
| Green | Red | |
| On | Off | The interface is operated as an Ethernet interface. |

Table: LED "S/E": Interface in Ethernet mode

POWERLINK V2 mode

Error message

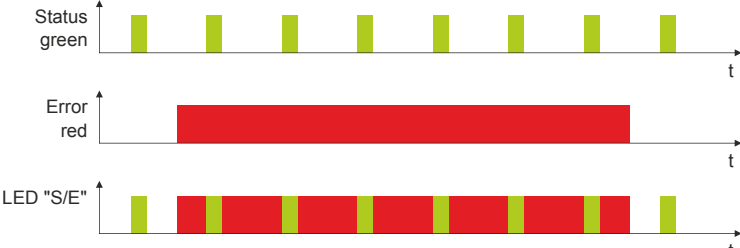
| LED "S/E" | | Description |
|-----------|-----|--|
| Green | Red | |
| Off | On | The interface is in error mode (failed Ethernet frames, increased number of collisions on the network, etc.). Note: Several red blinking signals are displayed immediately after the device is switched on. These are not errors, however. |
| Blinking | On | If an error occurs in the following modes, then the green LED blinks over the red LED: <ul style="list-style-type: none"> • PRE_OPERATIONAL_1 • PRE_OPERATIONAL_2 • READY_TO_OPERATE  |

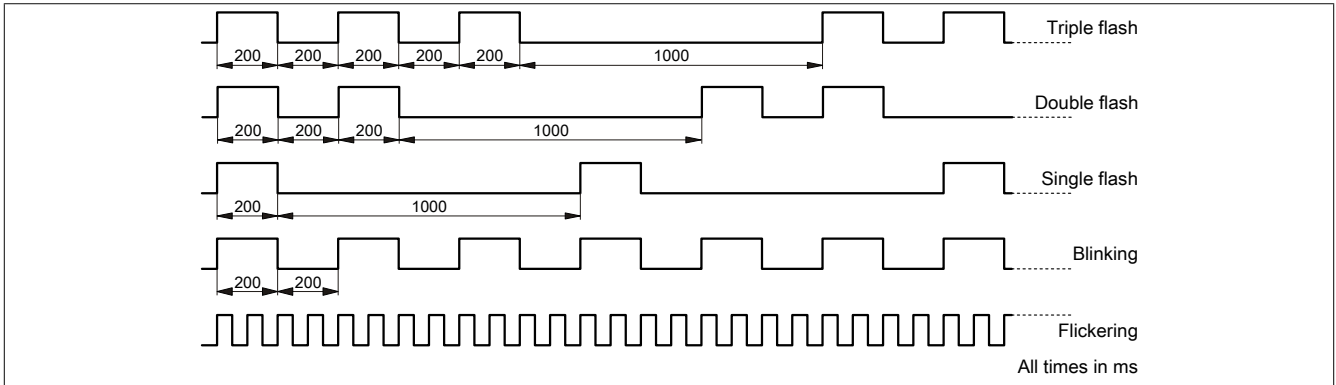
Table: LED "S/E" - Error message (interface in POWERLINK mode)

Interface status

| LED "S/E" | | Description |
|--------------------------------|-----|---|
| Green | Red | |
| Off | Off | <p>Mode: NOT_ACTIVE The interface is either in mode NOT_ACTIVE or one of the following modes or errors is present:</p> <ul style="list-style-type: none"> The device is switched off. The LED status indicator is disabled. The device is in the startup phase. The interface or device is not configured correctly in Automation Studio. The interface or device is defective. <p>Managing node (MN) The network is monitored for POWERLINK frames. If a frame is not received within the configured time window (timeout), the interface immediately enters mode PRE_OPERATIONAL_1. If POWERLINK communication is detected before the time has elapsed, however, the MN is not started.</p> <p>Controlled node (CN) The network is monitored for POWERLINK frames. If a frame is not received within the configured time window (timeout), the interface immediately enters mode BASIC_ETHERNET. If POWERLINK communication is detected before this time expires, however, the interface immediately enters mode PRE_OPERATIONAL_1.</p> |
| Flickering (approx. 10 Hz) | Off | <p>Mode: BASIC_ETHERNET The interface is in mode BASIC_ETHERNET. The interface is operated in Ethernet mode.</p> <p>Managing node (MN) This mode can only be exited by resetting the controller.</p> <p>Controlled node (CN) If POWERLINK communication is detected during this mode, the interface enters mode PRE_OPERATIONAL_1.</p> |
| Single flash (approx. 1 Hz) | Off | <p>Mode: PRE_OPERATIONAL_1 The interface is in mode PRE_OPERATIONAL_1.</p> <p>Managing node (MN) The MN is in "reduced cycle" operation. The CNs are configured in this mode. Cyclic communication is not yet taking place.</p> <p>Controlled node (CN) The CN can be configured by the MN in this mode. The CN waits until it receives an SoC frame and then switches to mode PRE_OPERATIONAL_2.</p> |
| | On | <p>Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed.</p> |
| Double flash (approx. 1 Hz) | Off | <p>Mode: PRE_OPERATIONAL_2 The interface is in mode PRE_OPERATIONAL_2.</p> <p>Managing node (MN) The MN starts cyclic communication (cyclic input data is not yet evaluated). The CNs are configured in this mode.</p> <p>Controlled node (CN) The CN can be configured by the MN in this mode. A command then switches the mode to READY_TO_OPERATE.</p> |
| | On | <p>Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed.</p> |
| Triple flash (approx. 1 Hz) | Off | <p>Mode: READY_TO_OPERATE The interface is in mode READY_TO_OPERATE.</p> <p>Managing node (MN) Cyclic and asynchronous communication. Received PDO data is ignored.</p> <p>Controlled node (CN) The configuration of the CN is completed. Normal cyclic and asynchronous communication. The transmitted PDO data corresponds to the PDO mapping. However, cyclic data is not yet evaluated.</p> |
| | On | <p>Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed.</p> |
| On | Off | <p>Mode: OPERATIONAL The interface is in mode OPERATIONAL. PDO mapping is active and cyclic data is evaluated.</p> |
| Blinking (approx. 2.5 Hz) | Off | <p>Mode: STOPPED The interface is in mode STOPPED.</p> <p>Managing node (MN) This mode does not occur for the MN.</p> <p>Controlled node (CN) Output data is not being output, and no input data is being provided. This mode can only be reached and exited by a corresponding command from the MN.</p> |

Table: LED "S/E" - Interface state (interface in POWERLINK mode)

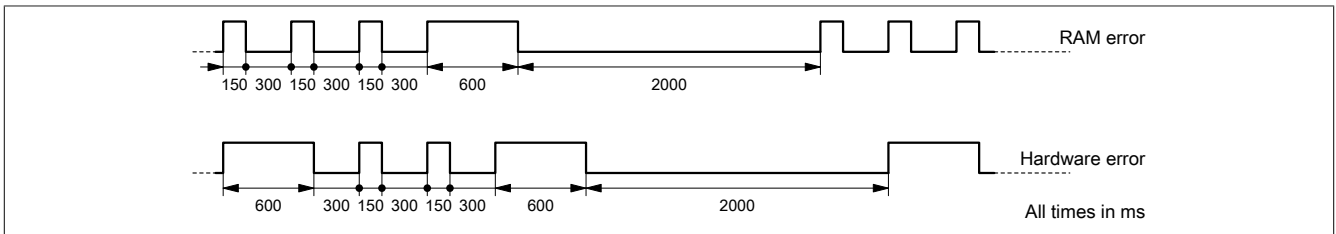
Blink times



9.9.2.5.1.2 System stop error codes

A system stop error can occur due to incorrect configuration or defective hardware.

The error code is indicated by LED "S/E" blinking red. The blinking signal of the error code consists of 4 switch-on phases with short (150 ms) or long (600 ms) duration. The error code is repeated every 2 seconds.



| Error | Error description |
|----------------|---|
| RAM error | The device is defective and must be replaced. |
| Hardware error | The device or a system component is defective and must be replaced. |

9.9.2.5.2 Button for reset and operating mode

9.9.2.5.2.1 Reset

The button must be pressed for less than 2 seconds to trigger a reset. This triggers a hardware reset on the CPU, which means that:

- All application programs are stopped.
- All outputs are set to zero.

The controller then boots into service mode by default. The startup mode that follows after pressing the reset button can be set in Automation Studio.

- Service mode (default)
- Warm restart
- Cold restart
- Diagnostic mode

9.9.2.5.2.2 Operating mode

3 operating modes can be set using different button sequences:

| Operating mode | Button sequence | Description |
|---------------------------|---|---|
| BOOT ¹⁾ | Boot mode is enabled by the following button sequence: <ul style="list-style-type: none"> • Press the button for less than 2 s. As soon as LED "Error" lights RED, the button can be released. • Then press the button within 2 s for longer than 2 s. As soon as LED "Error" goes dark, the button can be released. | Boot AR is started, and the runtime system can be installed via the online interface (Automation Studio). User flash memory is erased only when the download begins. |
| SERVICE/RUN ¹⁾ | Press the button for less than 2 s. As soon as LED "Error" lights RED , the button can be released. | Mode SERVICE/RUN: Triggering and startup behavior correspond to triggering a hardware reset (see "Reset" on page 1029). |
| DIAGNOSE ¹⁾ | Press the button for more than 2 s. LED "Error" lights RED and then goes dark. As soon as LED "Error" goes dark, the button can be released. | The CPU boots in diagnostic mode. Program sections in User RAM and User FlashPROM are not initialized. After diagnostic mode, the CPU always boots with a warm restart. |

1) The operating states are described in Automation Help under "Real-time operating system - Method of operation - Operating states".

9.9.2.5.3 Flash drive

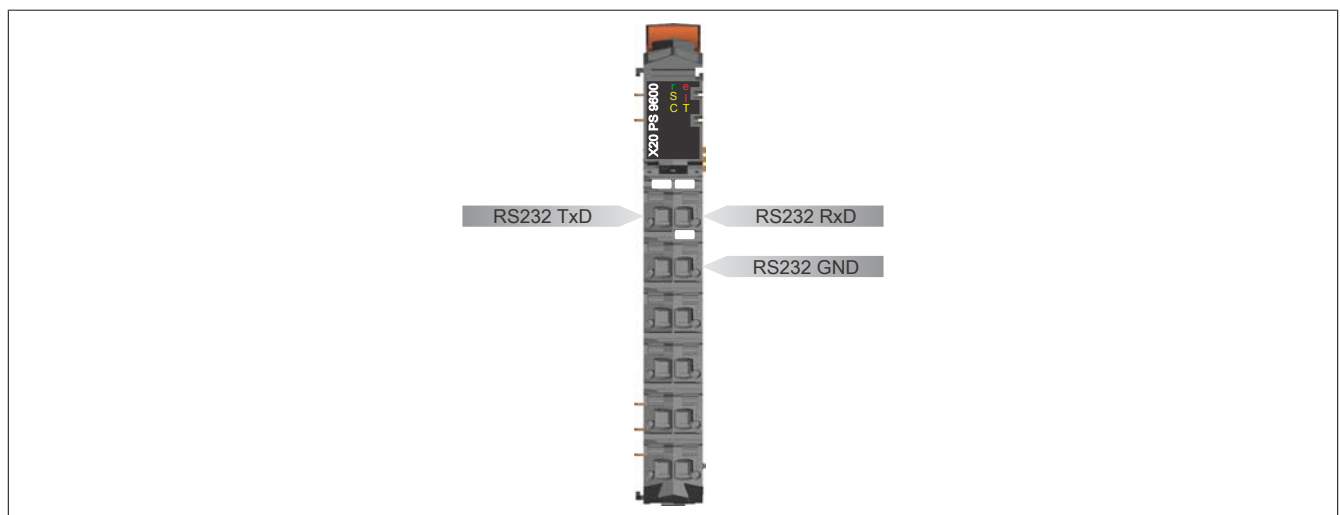
This application memory is implemented as an integrated flash drive.

9.9.2.5.4 Project installation

Project installation is described in Automation Help under "Project management / Project installation".

9.9.2.5.5 RS232 interface (IF1)

The non-galvanically isolated RS232 interface is designed as an online interface for communication with the programming device. The terminal connections for the signals are located on the power supply module.



9.9.2.5.6 Ethernet interface (IF2)

General information

IF2 is a 10BASE-T/100BASE-TX Ethernet interface.

The INA2000 node number is set using the B&R Automation Studio software.

For information about wiring X20 modules with an Ethernet interface, see ["Cabling guidelines for X20 modules with an Ethernet cable" on page 58](#).

Information:

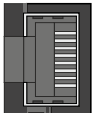
The Ethernet interface (IF2) is not suitable for POWERLINK.

X20CP0420

The interface is equipped with 2 female RJ45 connections. Both connections lead to an integrated switch. This makes daisy-chain wiring easy.

The X20CP0420 supports half-duplex and full-duplex communication. Mixed operation is not possible. Both interfaces must be operated in either half-duplex or full-duplex communication mode.

Pinout

| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.9.2.5.7 POWERLINK interface (IF3)

X20CP048x Compact-S CPUs are equipped with a POWERLINK V2 interface.

POWERLINK

By default, the POWERLINK interface is operated as a managing node (MN). In the managing node, the node number is set to a fixed value of 240.

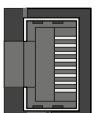
If the POWERLINK node is operated as a controlled node (CN), a node number from 1 to 239 can be set in the POWERLINK configuration in Automation Studio.

Ethernet mode

In this mode, the interface is operated as an Ethernet interface. The INA2000 station number is set using the B&R Automation Studio software.

Pinout

For information about wiring X20 modules with an Ethernet interface, see ["Cabling guidelines for X20 modules with an Ethernet cable" on page 58](#).

| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.9.2.5.8 USB interfaces (IF4 and IF5)

IF4 and IF5 are non-galvanically isolated USB interfaces. The abbreviation USB stands for "Universal Serial Bus". Both USB interfaces support the USB 1.1 and 2.0 standards.

Information:

USB peripheral devices can be connected to the USB interfaces. Due to the variety of USB devices available on the market, B&R cannot guarantee their functionality. The functionality of USB devices available from B&R is guaranteed.

Information:

- The USB interfaces cannot be used as online communication interfaces.
- Only devices isolated from GND are permitted to be connected to the USB interfaces.
- Current-carrying capacity is listed in the technical data.

9.9.2.5.9 CAN bus interface (IF7)

When used with bus base X20BB57, X20BB67 or X20BB77, the CPUs have access to a CAN bus interface. The terminal connections for the signals are located on the power supply module.



9.9.2.5.10 Slot for interface modules

Up to 2 interface modules can be connected to the left side of X20CP048x Compact-S CPUs. Different bus or network systems can be flexibly integrated into the X20 system by selecting the appropriate interface module.

| CPU base | Slots for interface modules |
|------------------|-----------------------------|
| X20BB62, X20BB67 | 1 |
| X20BB72, X20BB77 | 2 |

9.9.2.5.10.1 Information regarding operation of interface modules on the X20CP048x

Some X20 interface modules must have a certain minimum firmware version or minimum upgrade version for operation with an X20CP048x, but these are not included in the Automation Studio 4.3.3 release. A hardware upgrade may be necessary. This can be installed from Automation Studio by selecting **Tools/Upgrades** from the menu.

The following table contains a corresponding overview of affected interface modules. No special requirements apply to all other interface modules:

| Model number | Minimum upgrade version |
|--------------|-------------------------|
| X20IF1082-2 | 1.5.0.0 |
| X20IF1082 | 1.5.0.0 |
| X20IF1086-2 | 1.5.0.0 |
| X20IF2181-2 | 1.3.0.0 |
| X20clF1082-2 | 1.5.0.0 |
| X20clF2181-2 | 1.3.0.0 |
| X20IF1091 | 1.1.0.0 |
| X20IF2792 | 1.1.0.0 |

9.9.2.5.11 Data and real-time clock retention

The CPUs do not use a battery. This makes them completely maintenance-free. The following measures make operation without a backup battery possible.

| Data and real-time clock retention | Backup type | Note |
|------------------------------------|---------------------|---|
| Remanent variables | FRAM | This FRAM stores its contents ferroelectrically. Unlike normal SRAM, this does not require a battery. |
| Real-time clock | Gold foil capacitor | The real-time clock is backed up for approx. 1000 hours @ 25°C by a gold foil capacitor. The gold foil capacitor is completely charged after 3 continuous hours of operation. |

9.9.2.6 Overtemperature shutdown

To prevent damage, the CPU is shut down / reset at the following board temperature:

- X20CP041x and X20CP0420: 95°C
- X20CP048x: 105°C

The following errors are entered in the logbook in the event of shutdown:

| Error number | Short error text |
|--------------|--|
| 9204 | PLC restart triggered by the PLC CPU's temperature monitoring. |
| 9210 | Warning: Halt/Service after watchdog or manual reset. |

9.9.2.7 System requirements

X20CP041x and X20CP048x

The following minimum versions are recommended to generally be able to use all functions:

- Automation Studio 4.3.3
- Automation Runtime 4.34
- For error-free support by Automation Studio, **all** Compact-S hardware upgrades must be installed separately via the Automation Studio **Tools / Upgrades** menu:
 - X20CP04xx
 - X20BB5x/6x/7x
 - X20PS960x
- Starting with Automation Studio 4.4, all Compact-S components are included in the installation package.

X20CP0420

The following minimum versions are recommended to generally be able to use all functions:

- Automation Studio 4.7.1
- Automation Runtime 4.73

X20CP0484-1

The following minimum versions are recommended to generally be able to use all functions:

- Automation Studio 4.5
- Automation Runtime 4.5

9.9.2.8 General data points

This CPU is equipped with general data points. These are not CPU-specific; instead, they contain general information such as system time and heat sink temperature.

General data points are described in section ["General CPU data points" on page 3792](#).

9.10 Compact-S CPUs system modules

The X20 system Compact CPUs consist of the Compact-S CPU, Compact-S CPU system modules and the X20TB12 terminal block.

The Compact CPU system modules also include the X20BB5x, X20BB6x and X20BB7x base modules as well as the X20PS9602 supply module for supplying the entire system with voltage.

9.10.1 Summary

| Model number | Short description | Page |
|--------------|---|------|
| X20BB52 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 interface, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 1035 |
| X20BB57 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 and CAN bus interface, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 1037 |
| X20BB62 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 interface, slots for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 1039 |
| X20BB67 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 and CAN bus interface, slot for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 1041 |
| X20BB72 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 interface, 2 slots for X20 interface modules, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 1043 |
| X20BB77 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 and CAN bus interface, 2 slots for X20 interface modules, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 1045 |
| X20PS9600 | X20 power supply module, for Compact-S CPU and internal I/O power supply, X2X Link power supply | 1047 |
| X20PS9602 | X20 power supply module, for Compact-S CPU and internal I/O power supply, X2X Link power supply, power supply not electrically isolated | 1055 |

9.10.2 X20BB52

Data sheet version: 1.11

9.10.2.1 General information

The bus module is the base for all X20 Compact-S CPUs.

The left and right end plates are included in the delivery.

- Base for all X20 Compact-S CPUs
- RS232 connection

9.10.2.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | System modules for Compact-S CPUs | |
| X20BB52 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 interface, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included |  |

Table 175: X20BB52 - Order data

9.10.2.3 Technical data

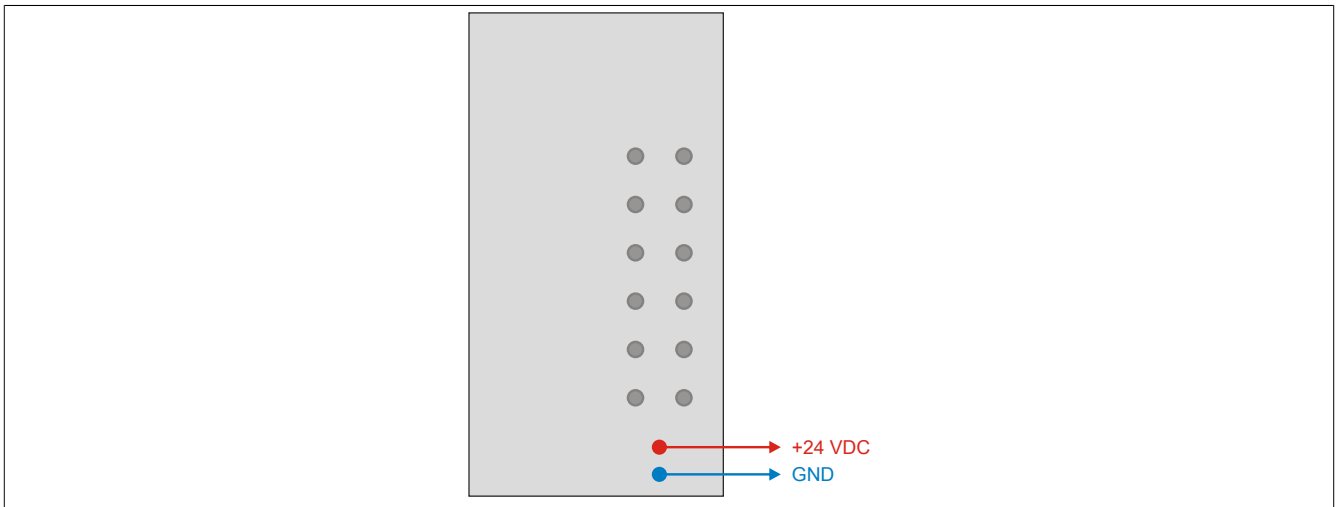
| Model number | X20BB52 |
|--|--|
| Short description | |
| Bus module | X20 Compact-S CPU base - backplane for Compact-S CPU and Compact-S CPU power supply module |
| Interfaces | 1x RS232 connection |
| General information | |
| B&R ID code | 0xEB0A |
| Power consumption | |
| Bus | 0.55 W |
| Internal I/O | - |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| KR | Yes |
| I/O power supply | |
| Nominal voltage | 24 VDC |
| Permissible contact load | 10 A |
| Electrical properties | |
| Electrical isolation | Bus not isolated from RS232 |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |

Table 176: X20BB52 - Technical data

| Model number | X20BB52 |
|---------------------------------|--|
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Left and right X20 end cover plates included in delivery |
| Spacing | 37.5 ^{+0.2} mm |

Table 176: X20BB52 - Technical data

9.10.2.4 Voltage routing



9.10.3 X20BB57

Data sheet version: 1.11

9.10.3.1 General information

The bus module is the base for all X20 Compact-S CPUs.

The left and right end plates are included in the delivery.

- Base for all X20 Compact-S CPUs
- RS232 connection
- CAN bus connection
- Integrated terminating resistor for CAN bus

9.10.3.2 Order data


| Model number | Short description | Figure |
|--------------|--|--|
| | System modules for Compact-S CPUs | |
| X20BB57 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 and CAN bus interface, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included |  |

Table 177: X20BB57 - Order data

9.10.3.3 Technical data

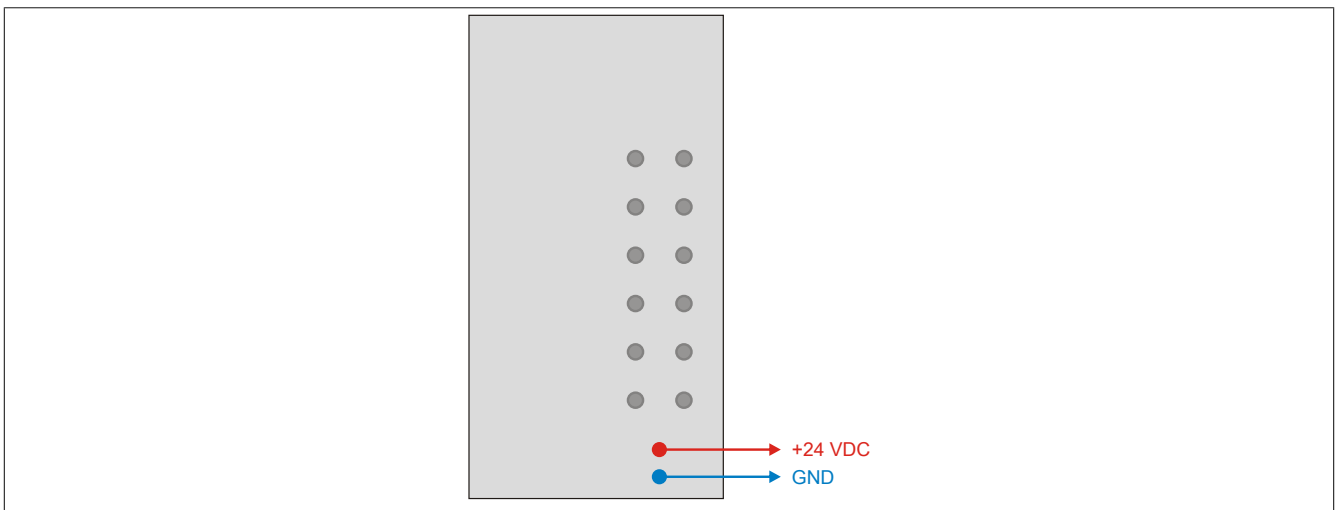
| Model number | X20BB57 |
|--|--|
| Short description | |
| Bus module | X20 Compact-S CPU base - backplane for Compact-S CPU and Compact-S CPU power supply module |
| Interfaces | 1x RS232 connection, 1x CAN bus connection |
| General information | |
| B&R ID code | 0xEB09 |
| Power consumption | |
| Bus | 0.55 W |
| Internal I/O | - |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| KR | Yes |
| I/O power supply | |
| Nominal voltage | 24 VDC |
| Permissible contact load | 10 A |
| Electrical properties | |
| Electrical isolation | Bus, CAN bus and RS232 not isolated from each other |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |

Table 178: X20BB57 - Technical data

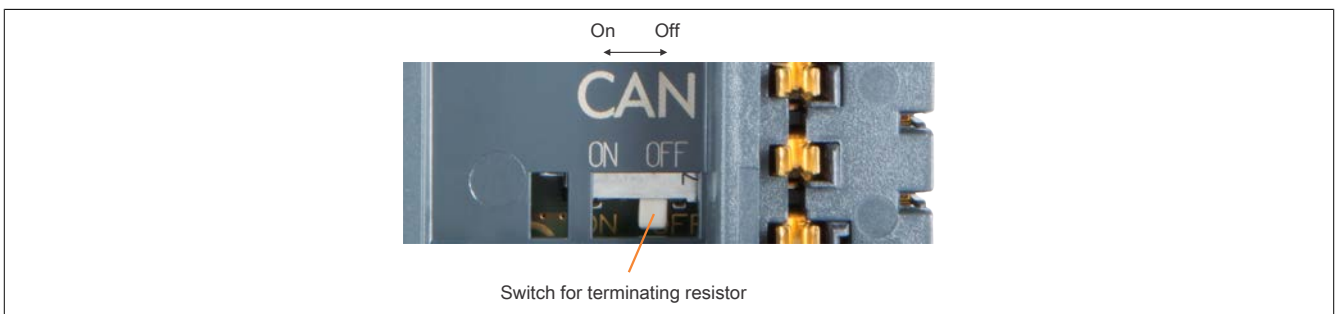
| | |
|-----------------------------------|--|
| Model number | X20BB57 |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Left and right X20 end cover plates included in delivery |
| Spacing | 37.5 ^{+0.2} mm |

Table 178: X20BB57 - Technical data

9.10.3.4 Voltage routing



9.10.3.5 Terminating resistor for CAN bus



The bus module has an integrated CAN bus terminating resistor. The terminating resistor is switched on or off using a switch. An enabled terminating resistor is indicated on the power supply module by LED "T".

9.10.4 X20BB62

Data sheet version: 1.13

9.10.4.1 General information

The bus module is the base for all X20CP048x Compact-S CPUs in the X20 family. It is equipped with 1 slot for X20 interface modules.

The left and right end plates are included in the delivery.

- Base for X20 Compact-S CPUs
- 1 slot for X20 interface modules
- RS232 connection

Information:

The Compact-S CPU must be connected in the rightmost slot.

9.10.4.2 Order data


| Model number | Short description | Figure |
|--------------|--|--|
| | System modules for Compact-S CPUs | |
| X20BB62 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 interface, slots for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included |  |

Table 179: X20BB62 - Order data

9.10.4.3 Technical data

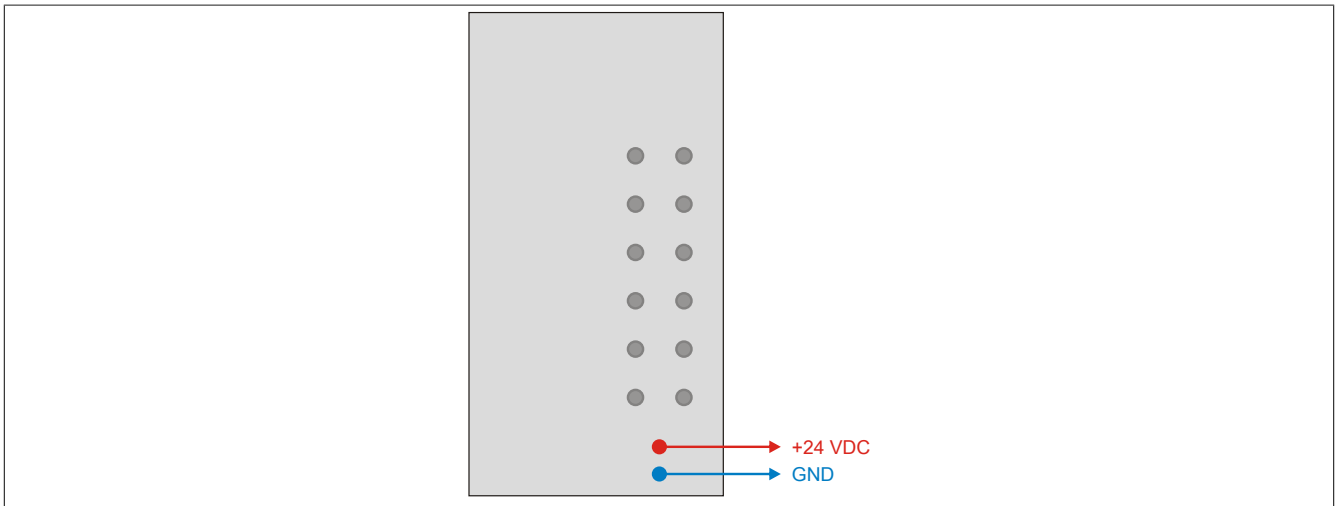
| Model number | X20BB62 |
|--|---|
| Short description | |
| Bus module | X20 Compact-S CPU base - backplane for Compact-S CPU and Compact-S CPU power supply module and X20 interface module |
| Interfaces | 1x RS232 connection |
| General information | |
| B&R ID code | 0xEB08 |
| Power consumption | |
| Bus | 0.94 W |
| Internal I/O | - |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| I/O power supply | |
| Nominal voltage | 24 VDC |
| Permissible contact load | 10 A |
| Electrical properties | |
| Electrical isolation | Bus not isolated from RS232 |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |

Table 180: X20BB62 - Technical data

| Model number | X20BB62 |
|--|--|
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Left and right X20 end cover plates included in delivery |
| Spacing | 62.5 ^{+0.2} mm |

Table 180: X20BB62 - Technical data

9.10.4.4 Voltage routing



9.10.5 X20BB67

Data sheet version: 1.13

9.10.5.1 General information

The bus module is the base for all X20CP048x Compact-S CPUs in the X20 family. It is equipped with 1 slot for X20 interface modules.

The left and right end plates are included in the delivery.

- Base for X20 Compact-S CPUs
- 1 slot for X20 interface modules
- RS232 connection
- CAN bus connection
- Integrated terminating resistor for CAN bus

Information:

The Compact-S CPU must be connected in the rightmost slot.

9.10.5.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | System modules for Compact-S CPUs | |
| X20BB67 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 and CAN bus interface, slot for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included |  |

Table 181: X20BB67 - Order data

9.10.5.3 Technical data

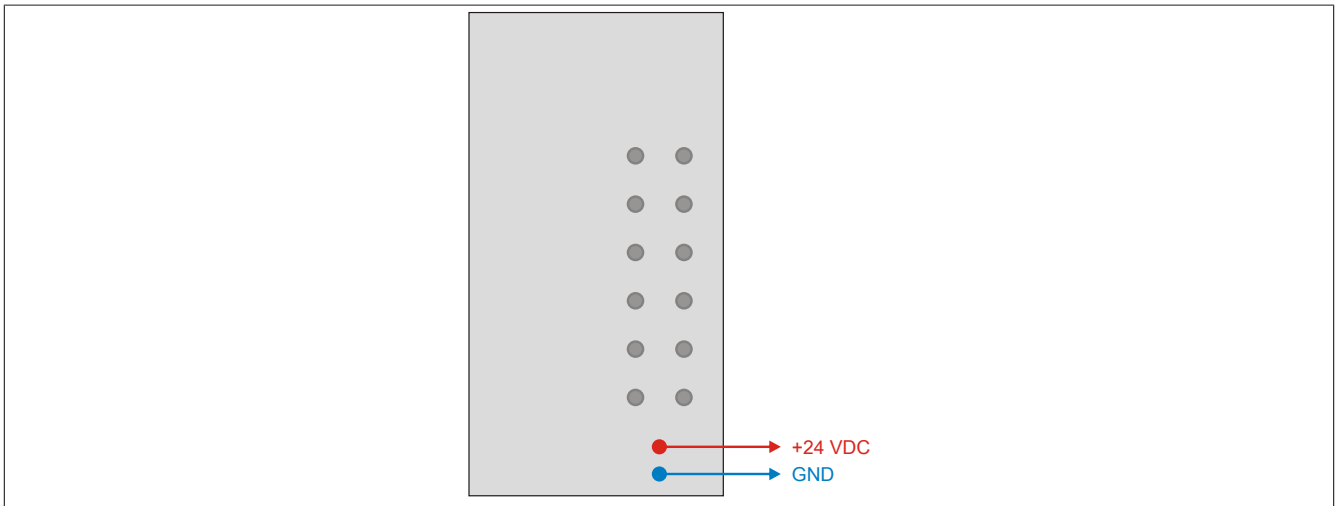
| Model number | X20BB67 |
|--|---|
| Short description | |
| Bus module | X20 Compact-S CPU base - backplane for Compact-S CPU and Compact-S CPU power supply module and X20 interface module |
| Interfaces | 1x RS232 connection, 1x CAN bus connection |
| General information | |
| B&R ID code | 0xEB07 |
| Power consumption | |
| Bus | 0.94 W |
| Internal I/O | - |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| I/O power supply | |
| Nominal voltage | 24 VDC |
| Permissible contact load | 10 A |
| Electrical properties | |
| Electrical isolation | Bus, CAN bus and RS232 not isolated from each other |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |

Table 182: X20BB67 - Technical data

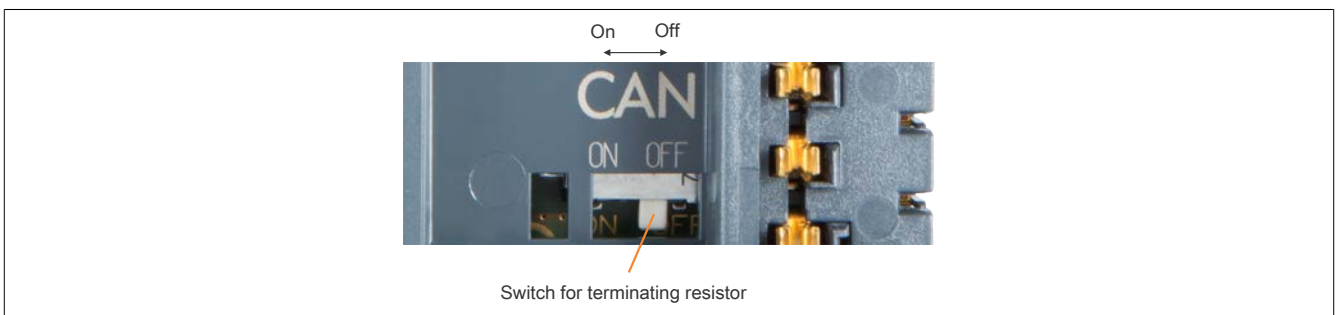
| Model number | X20BB67 |
|--|--|
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Left and right X20 end cover plates included in delivery |
| Spacing | 62.5 ^{+0.2} mm |

Table 182: X20BB67 - Technical data

9.10.5.4 Voltage routing



9.10.5.5 Terminating resistor for CAN bus



The bus module has an integrated CAN bus terminating resistor. The terminating resistor is switched on or off using a switch. An enabled terminating resistor is indicated on the power supply module by LED "T".

9.10.6 X20BB72

Data sheet version: 1.11

9.10.6.1 General information

The bus module is the base for all X20CP048x Compact-S CPUs in the X20 family. It is equipped with 2 slots for X20 interface modules.

The left and right end plates are included in the delivery.

- Base for X20 Compact-S CPUs
- 2 slots for X20 interface modules
- RS232 connection

Information:

The Compact-S CPU must be connected in the rightmost slot.

9.10.6.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| X20BB72 | System modules for Compact-S CPUs X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 interface, 2 slots for X20 interface modules, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included |  |

Table 183: X20BB72 - Order data

9.10.6.3 Technical data

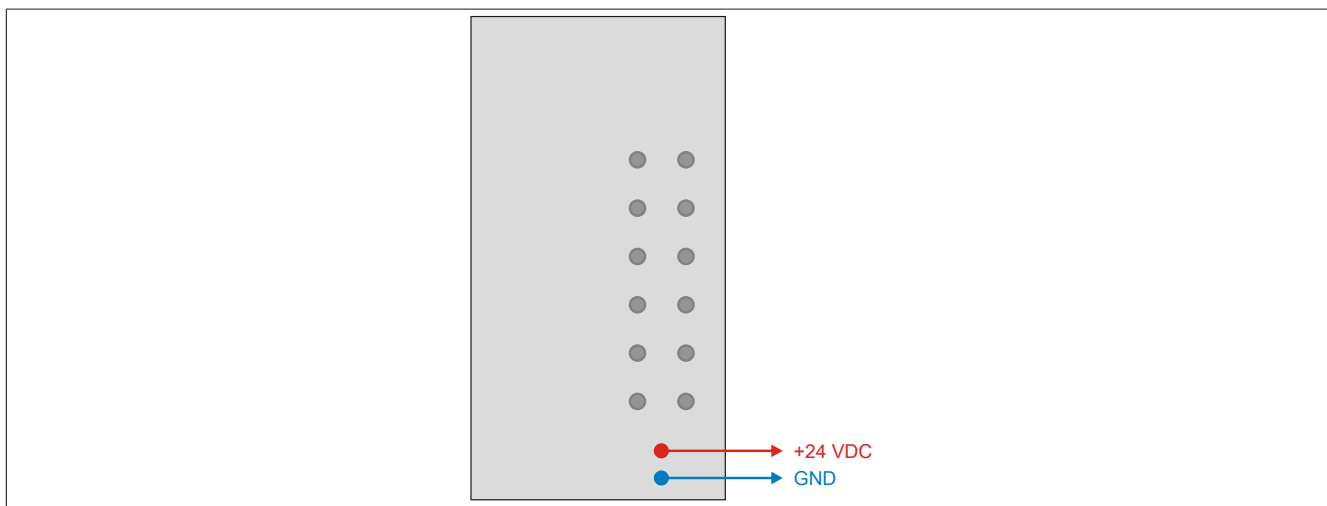
| Model number | X20BB72 |
|--|--|
| Short description | |
| Bus module | X20 Compact-S CPU base - backplane for Compact-S CPU and Compact-S CPU power supply module and 2 X20 interface modules |
| Interfaces | 1x RS232 connection |
| General information | |
| B&R ID code | 0xEB06 |
| Power consumption | |
| Bus | 1.17 W |
| Internal I/O | - |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| I/O power supply | |
| Nominal voltage | 24 VDC |
| Permissible contact load | 10 A |
| Electrical properties | |
| Electrical isolation | Bus not isolated from RS232 |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |

Table 184: X20BB72 - Technical data

| Model number | X20BB72 |
|--|--|
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Left and right X20 end cover plates included in delivery |
| Spacing | 87.5 ^{+0.2} mm |

Table 184: X20BB72 - Technical data

9.10.6.4 Voltage routing



9.10.7 X20BB77

Data sheet version: 1.11

9.10.7.1 General information

The bus module is the base for all X20CP048x Compact-S CPUs in the X20 family. It is equipped with 2 slots for X20 interface modules.

The left and right end plates are included in the delivery.

- Base for X20 Compact-S CPUs
- 2 slots for X20 interface modules
- RS232 connection
- CAN bus connection
- Integrated terminating resistor for CAN bus

Information:

The Compact-S CPU must be connected in the rightmost slot.

9.10.7.2 Order data

| Model number | Short description | Figure |
|--------------|---|--------|
| | System modules for Compact-S CPUs | |
| X20BB77 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 and CAN bus interface, 2 slots for X20 interface modules, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | |

Table 185: X20BB77 - Order data

9.10.7.3 Technical data

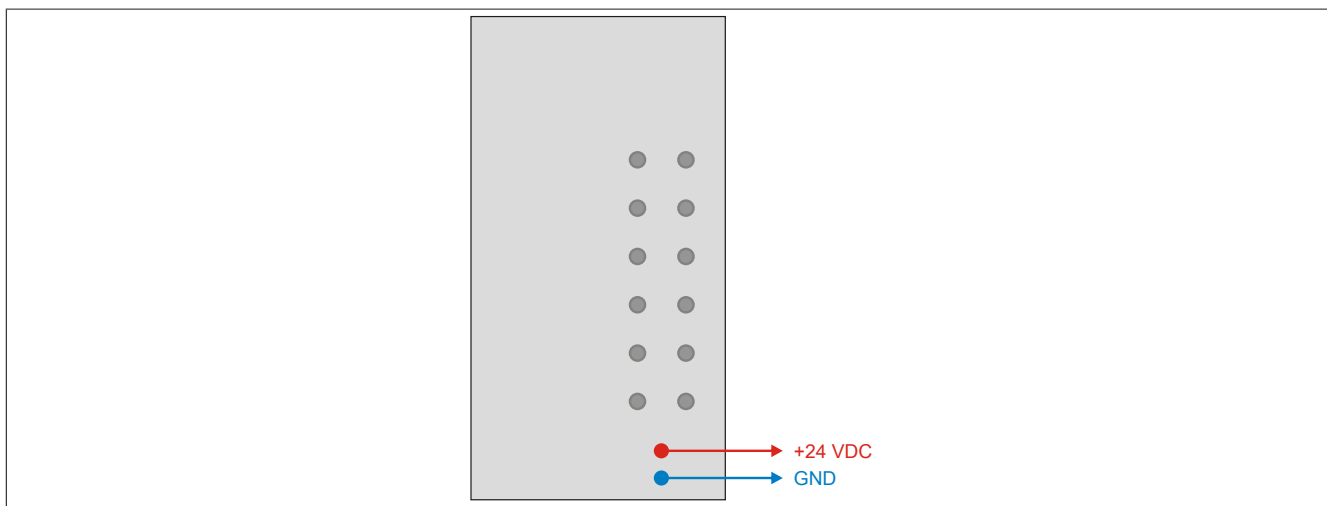
| Model number | X20BB77 |
|--|--|
| Short description | |
| Bus module | X20 Compact-S CPU base - backplane for Compact-S CPU and Compact-S CPU power supply module and 2 X20 interface modules |
| Interfaces | 1x RS232 connection, 1x CAN bus connection |
| General information | |
| B&R ID code | 0xEB05 |
| Power consumption | |
| Bus | 1.17 W |
| Internal I/O | - |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| I/O power supply | |
| Nominal voltage | 24 VDC |
| Permissible contact load | 10 A |
| Electrical properties | |
| Electrical isolation | Bus, CAN bus and RS232 not isolated from each other |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |

Table 186: X20BB77 - Technical data

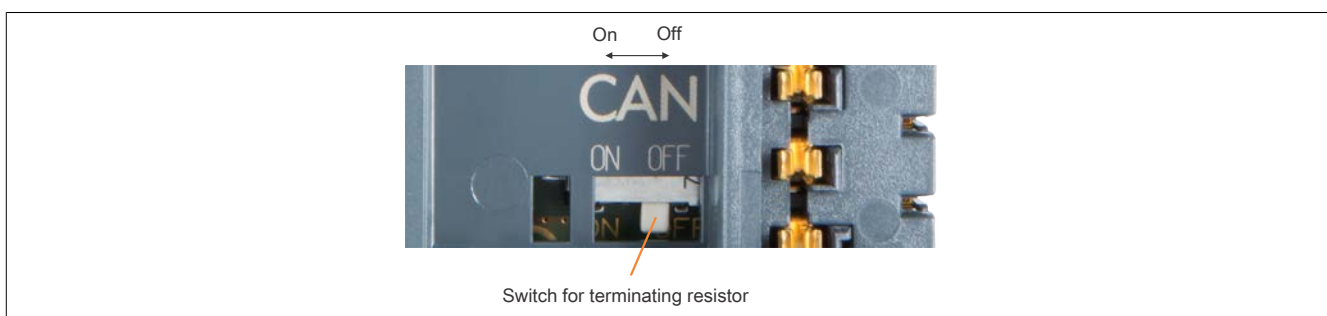
| Model number | X20BB77 |
|--|--|
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Left and right X20 end cover plates included in delivery |
| Spacing | 87.5 ^{+0.2} mm |

Table 186: X20BB77 - Technical data

9.10.7.4 Voltage routing



9.10.7.5 Terminating resistor for CAN bus



The bus module has an integrated CAN bus terminating resistor. The terminating resistor is switched on or off using a switch. An enabled terminating resistor is indicated on the power supply module by LED "T".

9.10.8 X20PS9600

Data sheet version: 1.06

9.10.8.1 General information

The power supply module is used together with an X20 Compact-S CPU. It has a feed for the Compact-S CPU, X2X Link and the internal I/O power supply.

- Supply for Compact-S CPU, X2X Link and internal I/O power supply
- Electrical isolation of supply and CPU / X2X Link power supply
- Redundancy of CPU / X2X Link supply possible by operating multiple supply modules simultaneously
- RS232 configurable as an online interface
- CAN bus

9.10.8.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | System modules for Compact-S CPUs |  |
| X20PS9600 | X20 power supply module, for Compact-S CPU and internal I/O power supply, X2X Link power supply | |
| | Required accessories | |
| | System modules for Compact-S CPUs | |
| X20BB52 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 interface, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB57 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 and CAN bus interface, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB62 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 interface, slots for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB67 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 and CAN bus interface, slot for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB72 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 interface, 2 slots for X20 interface modules, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB77 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 and CAN bus interface, 2 slots for X20 interface modules, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 187: X20PS9600 - Order data

9.10.8.3 Technical data

| | |
|--|--|
| Model number | X20PS9600 |
| Short description | |
| Power supply module | 24 VDC power supply module for Compact-S CPU, X2X Link power supply and I/O |
| Interfaces | 1x RS232, 1x CAN bus ¹⁾ |
| General information | |
| B&R ID code | 0xEB03 |
| Status indicators | Overload, operating state, module status, RS232, CAN bus ¹⁾ |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| CAN bus data transfer ¹⁾ | Yes, using status LED |
| RS232 data transfer | Yes, using status LED |
| Overload | Yes, using status LED and software |
| Power consumption for X2X Link power supply ²⁾ | 1.42 W |
| Power consumption ²⁾ | |
| Internal I/O | 0.6 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| KR | Yes |
| CPU / X2X Link power supply input | |
| Input voltage | 24 VDC -15% / +20% |
| Input current | Max. 0.7 A |
| Fuse | Integrated, cannot be replaced |
| Reverse polarity protection | Yes |
| CPU / X2X Link power supply output | |
| Nominal output power | 7 W |
| Parallel connection | Yes ³⁾ |
| Redundant operation | Yes |
| Overload characteristics | Short circuit protection, temporary overload |
| Input I/O power supply | |
| Input voltage | 24 VDC -15% / +20% |
| Fuse | Required line fuse: Max. 10 A, slow-blow |
| Reverse polarity protection | No |
| Output I/O power supply | |
| Nominal output voltage | 24 VDC |
| Behavior on short circuit | Required line fuse |
| Permissible contact load | 10 A |
| Interfaces | |
| Interface IF1 | |
| Signal | RS232 |
| Variant | Connection made using 12-pin terminal block X20TB12 |
| Transfer rate | Max. 115.2 kbit/s |
| Interface IF3 ¹⁾ | |
| Signal | CAN bus |
| Variant | Connection made using 12-pin terminal block X20TB12 |
| Transfer rate | Max. 1 Mbit/s |
| Electrical properties | |
| Electrical isolation | CPU/X2X Link supply isolated from CPU/X2X Link power supply I/O supply not isolated from I/O power supply |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |

Table 188: X20PS9600 - Technical data


| Model number | X20PS9600 |
|---------------------------------|--|
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating" |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately Order 1x X20BB5x, X20BB6x or X20BB7x Compact-S CPU base separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 188: X20PS9600 - Technical data

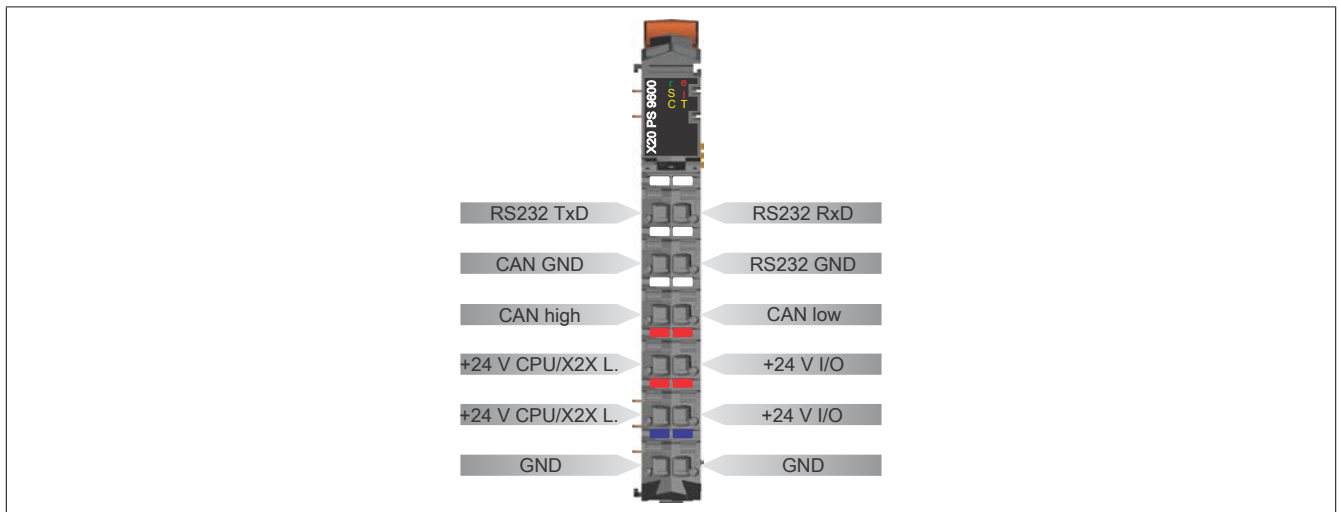
- 1) CAN bus only when used with bus module X20BB57, X20BB67 or X20BB77.
- 2) The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 3) In parallel operation, it is only permitted to assume 75% of the rated power. It is important to make sure that all power supplies operated in parallel are switched on and off at the same time.

9.10.8.4 LED status indicators

For a description of the various operating modes, see ["Diagnostic LEDs" on page 3787](#).

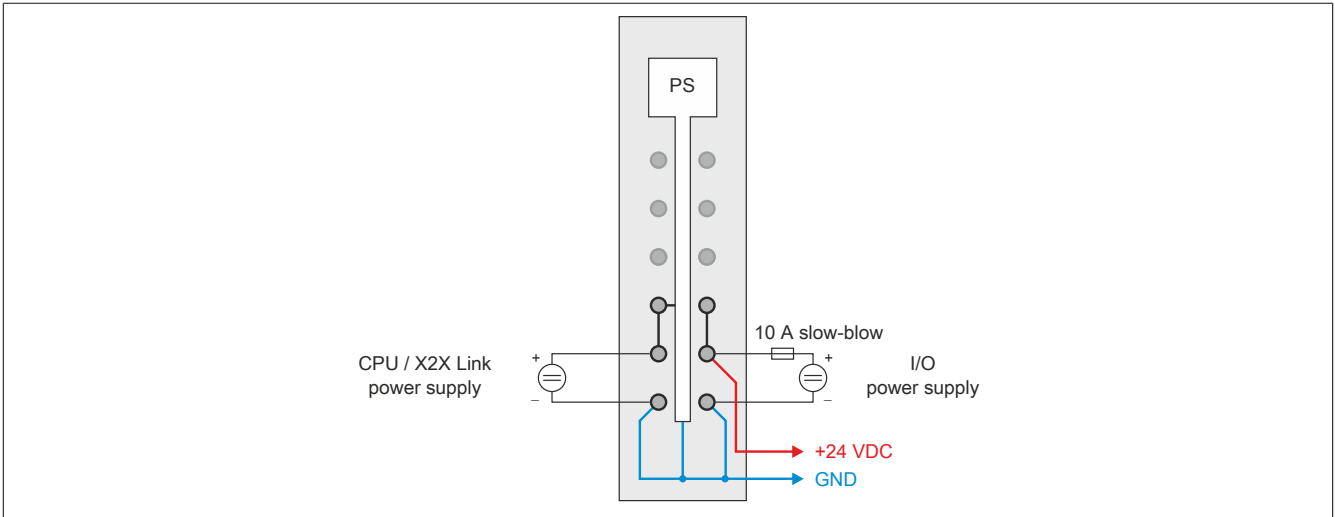
| Figure | LED | Color | Status | Description |
|--|-------|--------------------------------|---|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Double flash | LED indicates one of the following states: <ul style="list-style-type: none"> • Power supply for CPU / X2X Link overloaded • I/O power supply too low • Input voltage for CPU / X2X Link power supply too low |
| | e + r | Solid red / Single green flash | Invalid firmware | |
| | l | Red | Off | CPU / X2X Link power supply within valid range |
| | | | On | Power supply for CPU / X2X Link overloaded |
| | s | Yellow | Off | CPU not transmitting data via the RS232 interface |
| | | | On | CPU transmitting data via the RS232 interface |
| | c | Yellow | Off | CPU not transmitting data via the CAN bus interface |
| | | | On | CPU transmitting data via the CAN bus interface |
| | t | Yellow | Off | Terminating resistor integrated in bus module X20BB57, X20BB67 or X20BB77 switched off |
| On | | | Terminating resistor integrated in bus module X20BB57, X20BB67 or X20BB77 switched on | |

9.10.8.5 Pinout

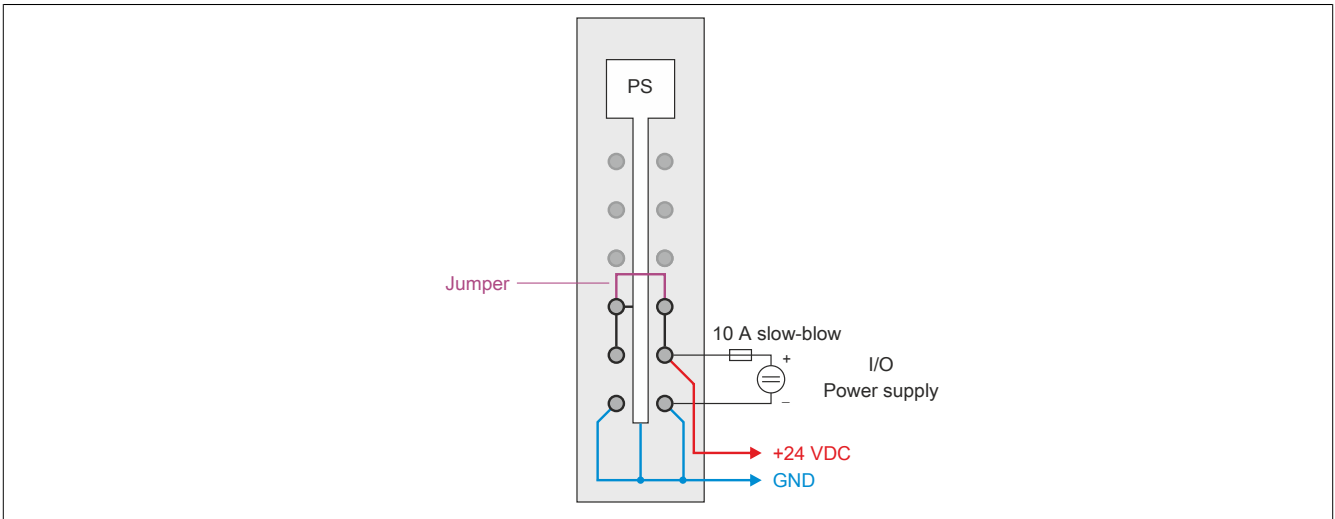


9.10.8.6 Connection examples

With 2 isolated power supplies



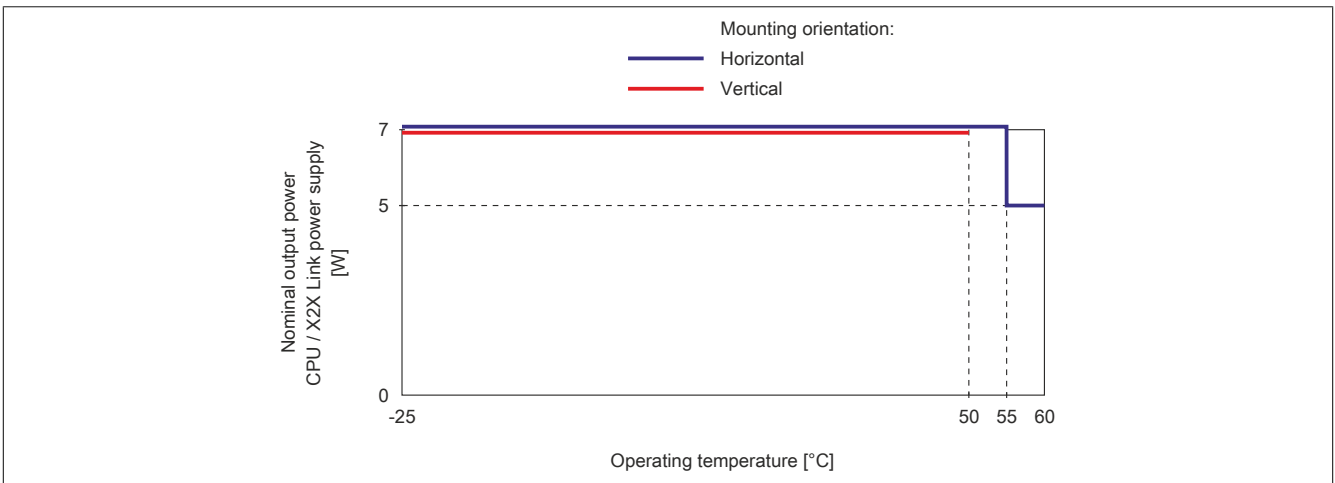
With 1 power supply and jumper



9.10.8.7 Derating

9.10.8.7.1 CPU / X2X Link power supply

The nominal output power for CPU / X2X Link power supply is 7 W. Derating may occur depending on the mounting orientation.



9.10.8.7.2 I/O power supply

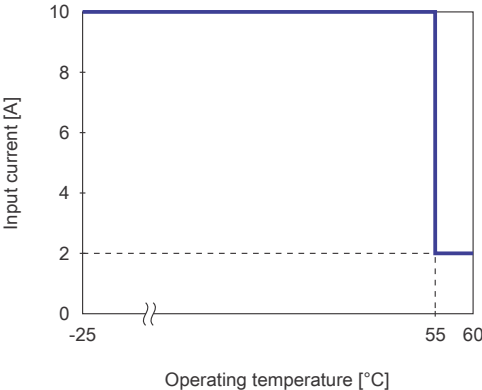
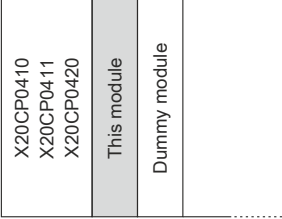
Information:

The specified maximum temperature and derating values are based on worst-case conditions. The CPU contains an internal temperature sensor that triggers a reset if 95°C is exceeded. Depending on the environmental conditions (artificial convection), maintaining the internal temperature at <90°C can prevent derating.

9.10.8.7.2.1 X20CP0410, X20CP0411 and X20CP0420

Horizontal installation

Derating is not required in the temperature range -25 to 55°C. 1 of the following 2 derating variants must be applied at temperatures above 55°C:

| Variant 1 | Variant 2 |
|---|--|
| <p>Max. 2 A input current on the I/O power supply.</p>  <p>The graph plots Input current [A] on the y-axis (0 to 10) against Operating temperature [°C] on the x-axis (-25 to 60). A horizontal line at 10 A spans from -25°C to 55°C. At 55°C, the current drops to 2 A and remains constant until 60°C. A dashed horizontal line is drawn at 2 A. A break symbol is shown on the x-axis between -25 and 55.</p> | <p>A dummy module must be connected next to the power supply module.</p>  <p>The diagram shows a horizontal row of five modules. The first three are labeled X20CP0410, X20CP0411, and X20CP0420. The fourth is shaded and labeled 'This module'. The fifth is labeled 'Dummy module'.</p> |

Vertical installation

Derating is not required in the vertical mounting orientation.

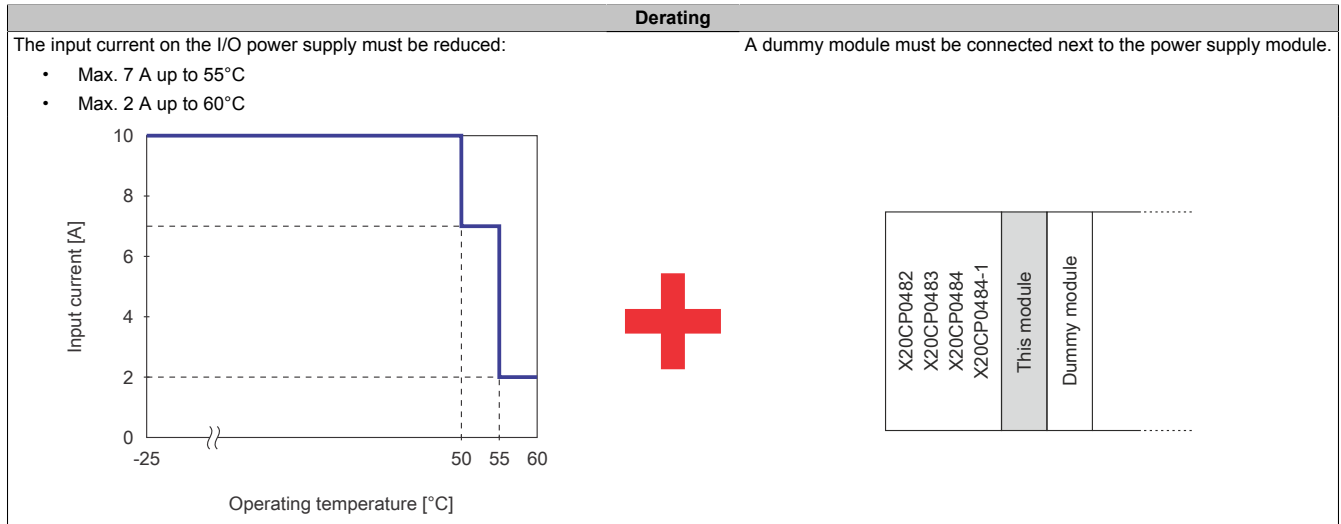
9.10.8.7.2.2 X20CP0482, X20CP0483, X20CP0484 and X20CP0484-1

Horizontal installation

Derating is not required in the temperature range -25 to 50°C. The following 2 derating variants must be applied at temperatures above 50°C:

Information:

Both derating variants must always be applied!

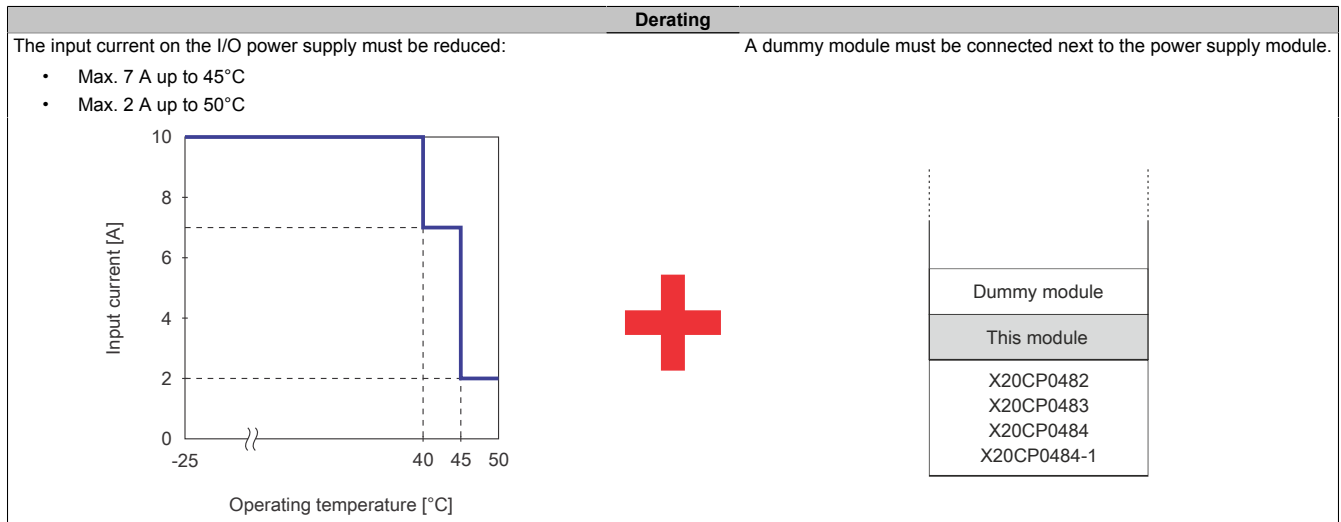


Vertical installation

Derating is not required in the temperature range -25 to 40°C. The following 2 derating variants must be applied at temperatures above 40°C:

Information:

Both derating variants must always be applied!



9.10.8.8 Register description

9.10.8.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.10.8.8.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 0 | 1 | Status of the module | USINT | • | | | |
| | | StatusInput01 | Bit 0 | | | | |
| | | StatusInput02 | Bit 2 | | | | |
| 2 | 2 | SupplyCurrent | USINT | • | | | |
| 4 | 3 | SupplyVoltage | USINT | • | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.10.8.8.3 Status of the module

Name:

Module status

The following module power supply voltages are monitored in this register:

| | |
|----------------------------|--|
| Bus power supply current: | Bus power supply current >2.3 A is displayed as a warning. |
| Bus supply voltage: | Bus supply voltage <4.7 V is displayed as a warning. |
| 24 VDC I/O supply voltage: | I/O supply voltage <20.4 V is displayed as a warning. |

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|---|
| 0 | StatusInput01 | 0 | No error |
| | | 1 | Warning in the event of overcurrent (>2.3 A) or undervoltage (<4.7 V) |
| 1 | Reserved | 0 | |
| 2 | StatusInput02 | 0 | I/O power supply above the warning limit of 20.4 V |
| | | 1 | I/O power supply below the warning limit of 20.4 V |
| 3 - x | Reserved | 0 | |

9.10.8.8.4 Bus power supply current

Name:

SupplyCurrent

This register displays the bus power supply current measured at a resolution of 0.1 A.

| Function model | Data type |
|----------------|-----------|
| 0 - Standard | USINT |

9.10.8.8.5 Bus supply voltage

Name:

SupplyVoltage

This register indicates the bus supply voltage measured at a resolution of 0.1 V.

| Function model | Data type |
|----------------|-----------|
| 0 - Standard | USINT |

9.10.8.8.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.10.8.8.7 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 2 ms |

9.10.9 X20PS9602

Data sheet version: 1.06

9.10.9.1 General information

The power supply module is used together with an X20 Compact-S CPU. It has a feed for the Compact-S CPU, X2X Link and the internal I/O power supply.

This module is intended as an inexpensive power supply module for small X20 systems. Potential groups are able to be formed. An expansion or redundancy of the X2X Link with the X20PS3300 or X20PS3310 supply module is not possible. Expansion of the X20 system with a bus transmitter is not permitted either.

- Supply for Compact-S CPU, X2X Link and internal I/O power supply
- Low-cost supply module for small X20 system
- No electrical isolation of supply and CPU / X2X Link power supply
- Expansion or redundancy of CPU / X2X Link supply not possible by operating multiple supply modules simultaneously
- RS232 configurable as an online interface
- CAN bus

9.10.9.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | System modules for Compact-S CPUs |  |
| X20PS9602 | X20 power supply module, for Compact-S CPU and internal I/O power supply, X2X Link power supply, power supply not electrically isolated | |
| | Required accessories | |
| | System modules for Compact-S CPUs | |
| X20BB52 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 interface, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB57 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 and CAN bus interface, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB62 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 interface, slots for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB67 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 and CAN bus interface, slot for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB72 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 interface, 2 slots for X20 interface modules, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB77 | X20 Compact-S bus base, for Compact-S CPU and Compact-S CPU power supply module, base for integrated RS232 and CAN bus interface, 2 slots for X20 interface modules, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 189: X20PS9602 - Order data

9.10.9.3 Technical data

| | |
|--|--|
| Model number | X20PS9602 |
| Short description | |
| Power supply module | 24 VDC power supply module for Compact-S CPU, X2X Link power supply and I/O |
| Interfaces | 1x RS232, 1x CAN bus ¹⁾ |
| General information | |
| B&R ID code | 0xEB04 |
| Status indicators | Operating state, module status, RS232, CAN bus ¹⁾ |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| CAN bus data transfer ¹⁾ | Yes, using status LED |
| RS232 data transfer | Yes, using status LED |
| Overload | Yes, using status LED and software |
| Power consumption for X2X Link power supply ²⁾ | 1.64 W |
| Power consumption ²⁾ | |
| Internal I/O | 0.6 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| KR | Yes |
| CPU / X2X Link power supply input | |
| Input voltage | 24 VDC -15% / +20% |
| Input current | Max. 0.7 A |
| Fuse | Integrated, cannot be replaced |
| Reverse polarity protection | Yes |
| CPU / X2X Link power supply output | |
| Nominal output power | 7 W |
| Parallel connection | No |
| Redundant operation | No |
| Overload characteristics | Short circuit protection, temporary overload |
| Input I/O power supply | |
| Input voltage | 24 VDC -15% / +20% |
| Fuse | Required line fuse: Max. 10 A, slow-blow |
| Reverse polarity protection | No |
| Output I/O power supply | |
| Nominal output voltage | 24 VDC |
| Behavior on short circuit | Required line fuse |
| Permissible contact load | 10 A |
| Interfaces | |
| Interface IF1 | |
| Signal | RS232 |
| Variants | Connection made using 12-pin terminal block X20TB12 |
| Transfer rate | Max. 115.2 kbit/s |
| Interface IF3 ¹⁾ | |
| Signal | CAN bus |
| Variants | Connection made using 12-pin terminal block X20TB12 |
| Transfer rate | Max. 1 Mbit/s |
| Electrical properties | |
| Electrical isolation | CPU/X2X Link supply not isolated from CPU/X2X Link power supply, and I/O supply not isolated from I/O power supply |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |

Table 190: X20PS9602 - Technical data


| | |
|---------------------------------|--|
| Model number | X20PS9602 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating" |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately Order 1x X20BB5x, X20BB6x or X20BB7x Compact-S CPU base separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 190: X20PS9602 - Technical data

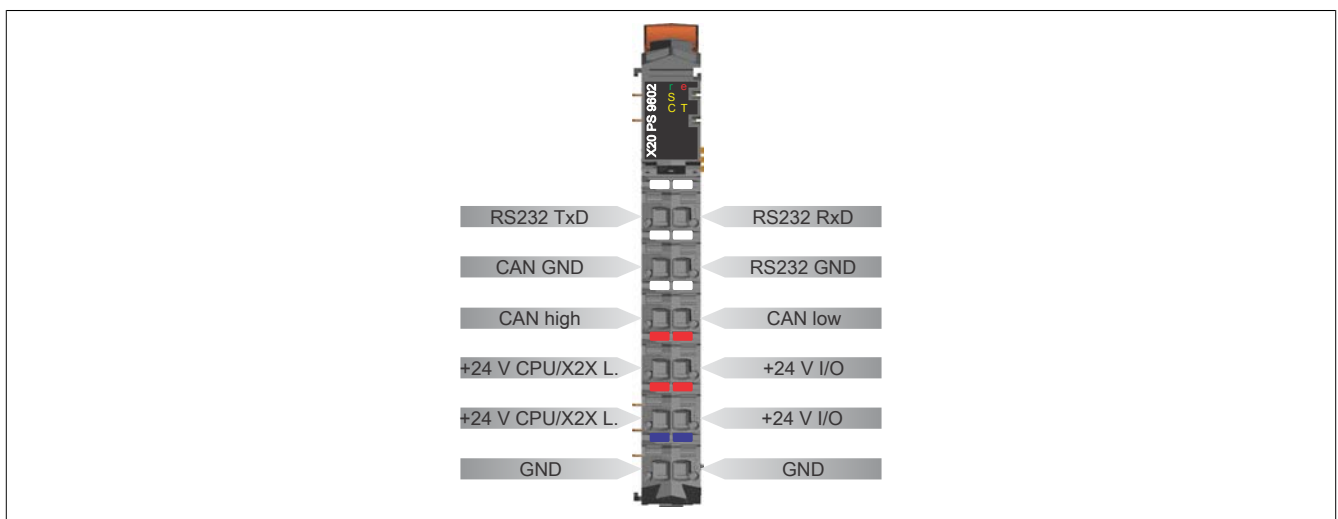
- 1) CAN bus only when used with bus module X20BB57, X20BB67 or X20BB77.
- 2) The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.

9.10.9.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

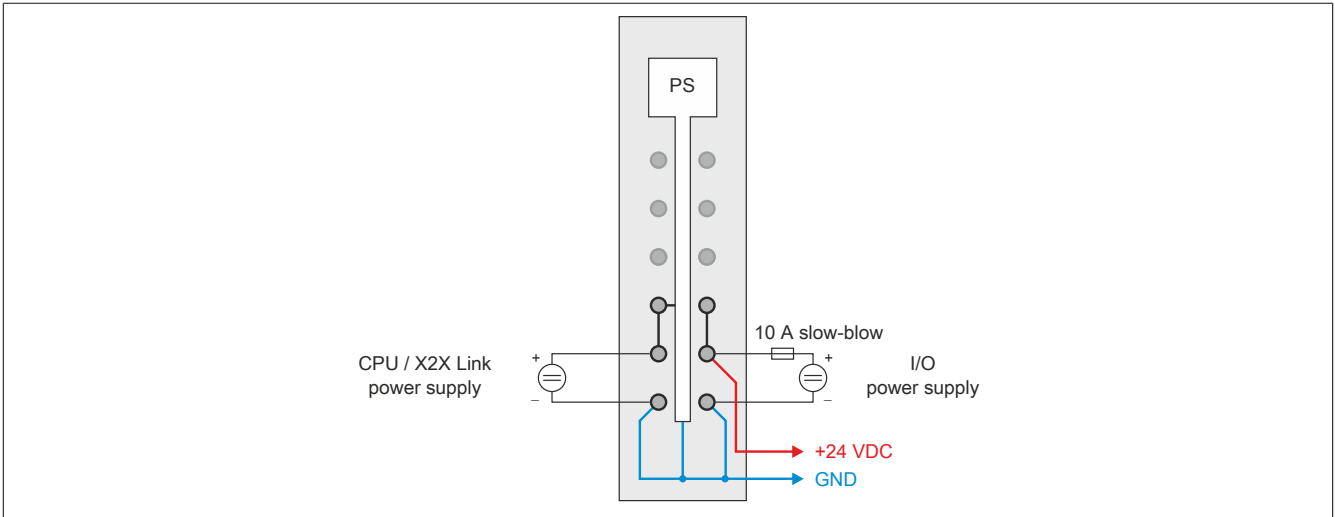
| Figure | LED | Color | Status | Description |
|--|-------|--------------------------------|---|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Double flash | LED indicates one of the following states: <ul style="list-style-type: none"> • Power supply for CPU / X2X Link overloaded • I/O power supply too low • Input voltage for CPU / X2X Link power supply too low |
| | e + r | Solid red / Single green flash | Invalid firmware | |
| | S | Yellow | Off | CPU not transmitting data via the RS232 interface |
| | | | On | CPU transmitting data via the RS232 interface |
| | C | Yellow | Off | CPU not transmitting data via the CAN bus interface |
| | | | On | CPU transmitting data via the CAN bus interface |
| | T | Yellow | Off | Terminating resistor integrated in bus module X20BB57, X20BB67 or X20BB77 switched off |
| On | | | Terminating resistor integrated in bus module X20BB57, X20BB67 or X20BB77 switched on | |

9.10.9.5 Pinout

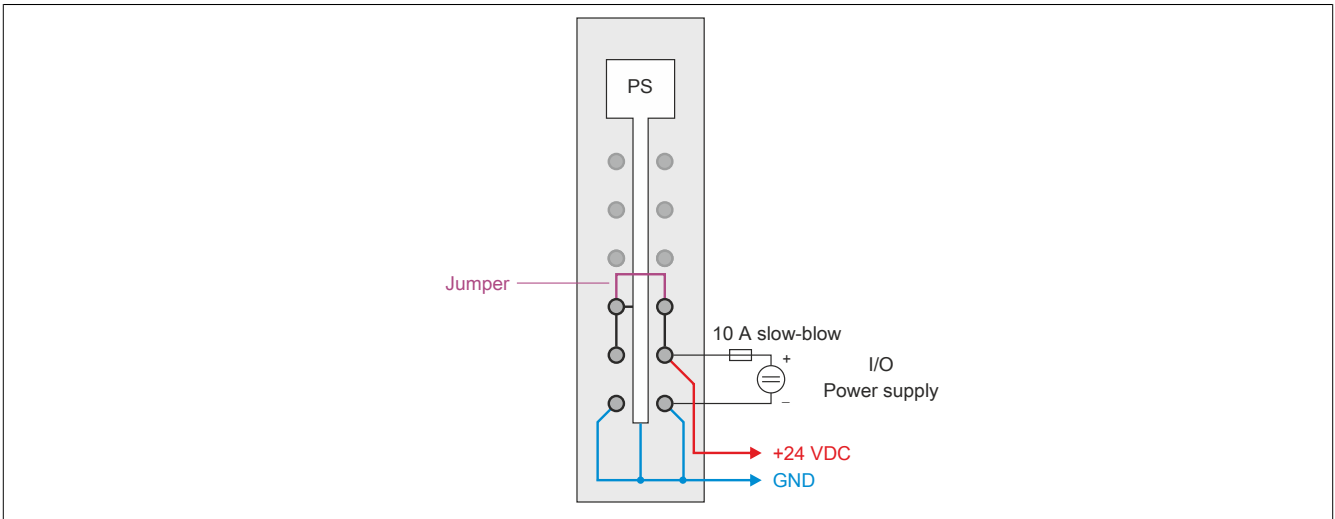


9.10.9.6 Connection examples

With 2 isolated power supplies



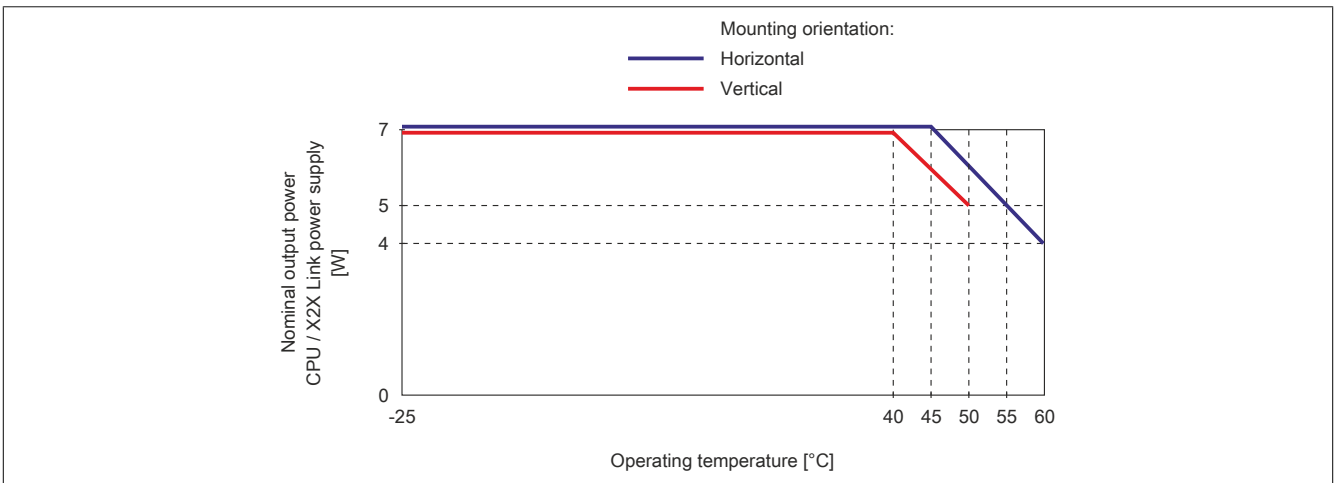
With 1 power supply and jumper



9.10.9.7 Derating

9.10.9.7.1 CPU / X2X Link power supply

The nominal output power for CPU / X2X Link power supply is 7 W. Derating may occur depending on the mounting orientation.



9.10.9.7.2 I/O power supply

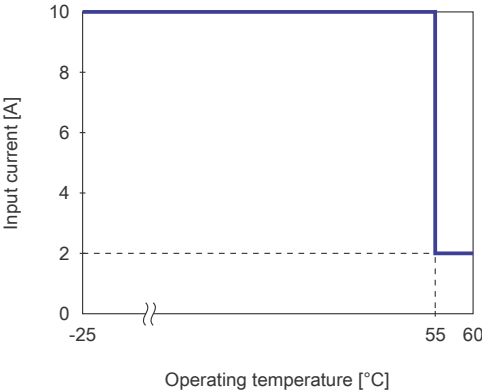
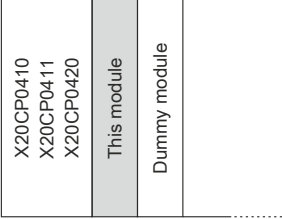
Information:

The specified maximum temperature and derating values are based on worst-case conditions. The CPU contains an internal temperature sensor that triggers a reset if 95°C is exceeded. Depending on the environmental conditions (artificial convection), maintaining the internal temperature at <90°C can prevent derating.

9.10.9.7.2.1 X20CP0410, X20CP0411 and X20CP0420

Horizontal installation

Derating is not required in the temperature range -25 to 55°C. 1 of the following 2 derating variants must be applied at temperatures above 55°C:

| Variant 1 | Variant 2 |
|---|--|
| <p>Max. 2 A input current on the I/O power supply.</p>  <p>The graph plots Input current [A] on the y-axis (0 to 10) against Operating temperature [°C] on the x-axis (-25 to 60). A horizontal line at 10 A spans from -25°C to 55°C. At 55°C, the current drops to 2 A and remains constant until 60°C. A dashed horizontal line is drawn at 2 A. A break symbol is shown on the x-axis between -25 and 55.</p> | <p>A dummy module must be connected next to the power supply module.</p>  <p>The diagram shows a horizontal row of five modules. The first three are labeled X20CP0410, X20CP0411, and X20CP0420. The fourth is shaded and labeled 'This module'. The fifth is labeled 'Dummy module'.</p> |

Vertical installation

Derating is not required in the vertical mounting orientation.

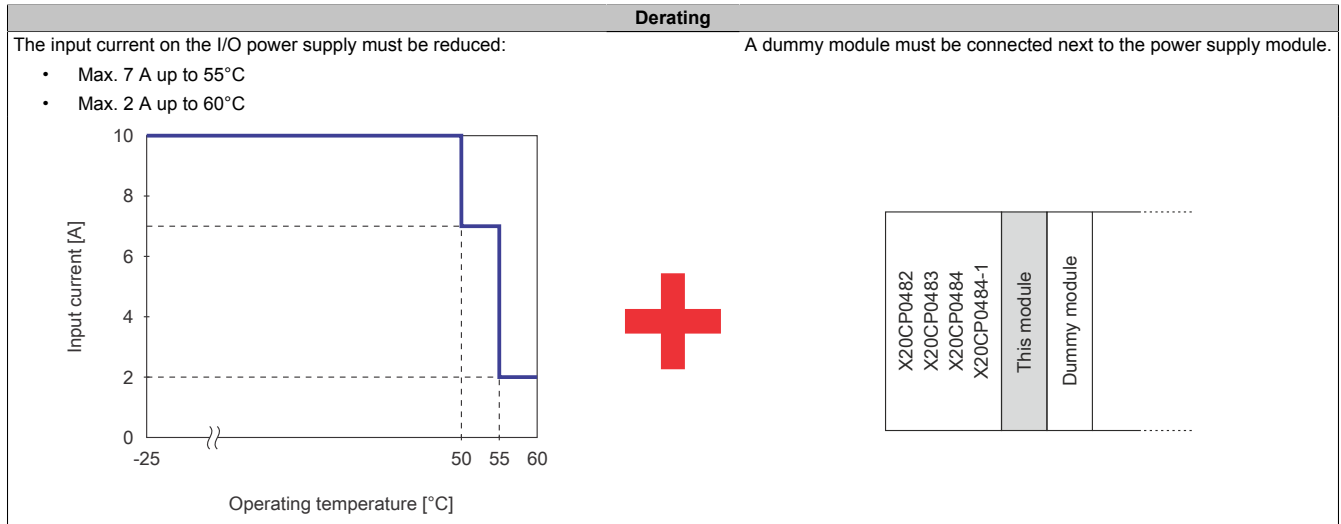
9.10.9.7.2.2 X20CP0482, X20CP0483, X20CP0484 and X20CP0484-1

Horizontal installation

Derating is not required in the temperature range -25 to 50°C. The following 2 derating variants must be applied at temperatures above 50°C:

Information:

Both derating variants must always be applied!

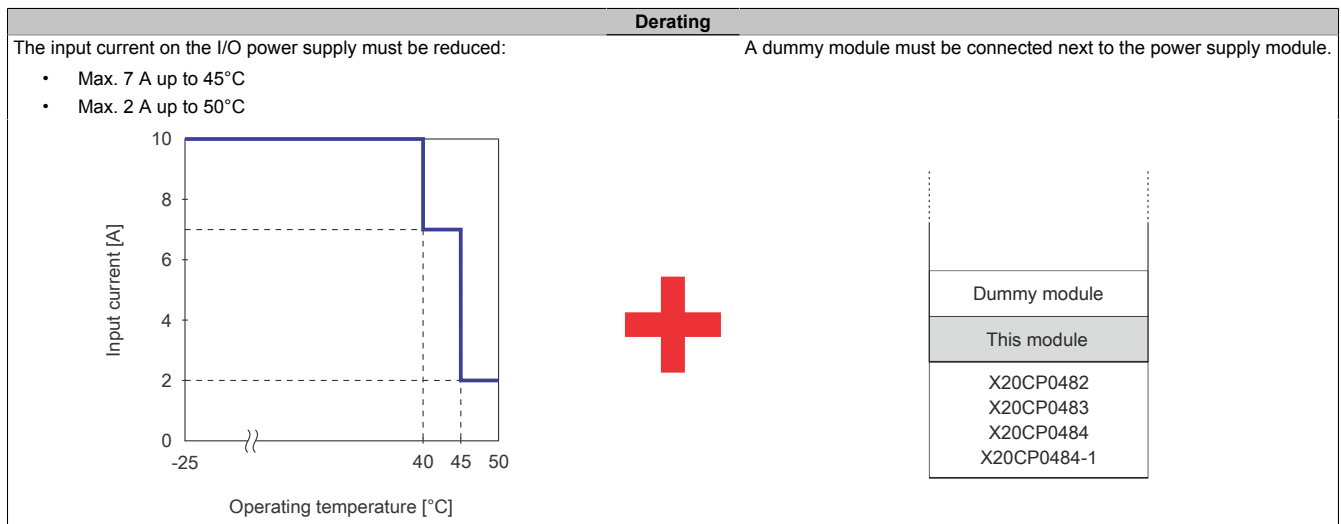


Vertical installation

Derating is not required in the temperature range -25 to 40°C. The following 2 derating variants must be applied at temperatures above 40°C:

Information:

Both derating variants must always be applied!



9.10.9.8 Register description

9.10.9.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.10.9.8.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 0 | 1 | Status of the module | USINT | • | | | |
| | | StatusInput01 | Bit 0 | | | | |
| | | StatusInput02 | Bit 2 | | | | |
| 4 | 3 | SupplyVoltage | USINT | • | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.10.9.8.3 Status of the module

Name:

Module status

The following module power supply voltages are monitored in this register:

Bus supply voltage: Bus supply voltage <4.7 V is displayed as a warning.
24 VDC I/O supply voltage: I/O supply voltage <20.4 V is displayed as a warning.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---------------|-------|--|
| 0 | StatusInput01 | 0 | No error |
| | | 1 | Bus supply warning - Undervoltage (<4.7 V) |
| 1 | Reserved | 0 | |
| 2 | StatusInput02 | 0 | I/O power supply above the warning limit of 20.4 V |
| | | 1 | I/O power supply below the warning limit of 20.4 V |
| 3 - x | Reserved | 0 | |

9.10.9.8.4 Bus supply voltage

Name:

SupplyVoltage

This register indicates the bus supply voltage measured at a resolution of 0.1 V.

| Function model | Data type |
|----------------------|-----------|
| 0 - Standard | USINT |
| 254 - Bus controller | UINT |

9.10.9.8.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 µs |

9.10.9.8.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 2 ms |

9.11 Counter modules

Counter modules are used for position detection. Each signal on a counter module is assigned to a status LED.

9.11.1 Summary

| Model number | Short description | Page |
|--------------|--|------|
| X20CM1941 | X20 resolver module, 14-bit resolver input, converter up to 12-bit ABR output | 1063 |
| X20DC1176 | X20 digital counter module, 1 ABR incremental encoder, 5 V, 600 kHz input frequency, 4x evaluation, encoder monitoring, NetTime function | 1071 |
| X20DC1178 | X20 digital counter module, 1 SSI absolute encoder, 5 V, 1 Mbit/s, 32-bit, encoder monitoring, NetTime function | 1087 |
| X20DC1196 | X20 digital counter module, 1 ABR incremental encoders, 5 V, 600 kHz input frequency, 4x resolution | 1105 |
| X20DC1198 | X20 digital counter module, 1 SSI absolute encoder, 5 V, 1 Mbit/s, 32-bit | 1115 |
| X20DC11A6 | X20 digital counter module, 1 ABR incremental encoder, 5 V, 5 MHz input frequency, 4x evaluation, encoder monitoring, NetTime function | 1122 |
| X20DC1376 | X20 digital counter module, 1 ABR incremental encoder, 24 V, 100 kHz input frequency, 4x evaluation, encoder monitoring, NetTime function | 1137 |
| X20DC137A | X20 digital counter module, 1 ABR incremental encoder, 24 V (differential), 300 kHz input frequency, 4x evaluation, encoder monitoring, NetTime function | 1153 |
| X20DC1396 | X20 digital counter module, 1 ABR incremental encoders, 24 V, 100 kHz input frequency, 4x evaluation | 1169 |
| X20DC1398 | X20 digital counter module, 1 SSI absolute encoder, 24 V, 125 kbit/s, 32-bit | 1179 |
| X20DC1976 | X20 digital counter module, 1 ABR incremental encoder, 5 V (single-ended), 250 kHz input frequency, 4x evaluation, encoder monitoring, NetTime function | 1186 |
| X20DC2190 | X20 digital counter module, ultrasonic transducer module, interfaces: EP start/stop, DPI/IP, 2 transducer rods, 4-position detection | 1202 |
| X20DC2395 | X20 digital counter module, 1 SSI absolute encoder, 24 V, 1 ABR incremental encoder, 24 V, 2 AB incremental encoders, 24 V, 4 event counters or 2 PWM, local time measurement function | 1216 |
| X20DC2396 | X20 digital counter module, 2 ABR incremental encoders, 24 V, 100 kHz input frequency, 4x evaluation | 1256 |
| X20DC2398 | X20 digital counter module, 2 SSI absolute encoder, 24 V, 125 kbit/s, 32-bit | 1267 |
| X20DC4395 | X20 digital counter module, 2 SSI absolute encoders, 24 V, 2 ABR incremental encoders, 24 V, 4 AB incremental encoders, 24 V, 8 event counters or 4 PWM, local time measurement functions | 1275 |
| X20cDC1196 | X20 digital counter module, coated, 1 ABR incremental encoder, 5 V, 600 kHz input frequency, 4x resolution | 1105 |
| X20cDC1198 | X20 digital counter module, coated, 1 SSI absolute encoders, 5 V, 1 Mbit/s, 32-bit | 1115 |
| X20cDC1396 | X20 digital counter module, coated, 1 ABR incremental encoders, 24 V, 100 kHz input frequency, 4x evaluation | 1169 |
| X20cDC2190 | X20 digital counter module, coated, ultrasonic transducer module, interfaces: EP start/stop, DPI/IP, 2 transducer rods, 4-position detection | 1202 |
| X20cDC2395 | X20 digital counter module, coated, 1 SSI absolute encoder, 24 V, 1 ABR incremental encoder, 24 V, 2 AB incremental encoders, 24 V, 4 event counters or 2 PWM, local time measurement function | 1216 |

9.11.2 X20CM1941

Data sheet version: 3.06

9.11.2.1 General information

The module is equipped with a resolver input and a configurable ABR output.

- Resolver input (differential), with angular position and cyclic counter
- 14-bit resolution for the angular position
- ABR output (configurable)

9.11.2.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Counter functions |  |
| X20CM1941 | X20 resolver module, 14-bit resolver input, converter up to 12-bit ABR output | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 191: X20CM1941 - Order data

9.11.2.3 Technical data

| Model number | X20CM1941 |
|--|---|
| Short description | |
| I/O module | 1 resolver input, 1 ABR output |
| General information | |
| B&R ID code | 0x1E85 |
| Status indicators | Input, output, operating status, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Resolver input (OK, open circuit) | Yes, using status LED and software |
| Resolver input (counting direction) | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.5 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| Resolver inputs | |
| Resolver transformation ratio | 0.5 (±10%) |
| Reference output | |
| Output voltage | 3.4 V _{eff} |
| Output current | Max. 50 mA _{eff} |
| Frequency | 10 kHz |
| Type | Differential |
| Angular position resolution | 14-bit |

Table 192: X20CM1941 - Technical data


| Model number | X20CM1941 |
|---|--|
| Short-circuit protection (reference output) | Yes |
| Input impedance | 10.4 kΩ - j 11.1 kΩ |
| Resolver type | BRX BRT with limitations |
| ABR output | |
| Encoder signal | RS422 |
| Type | ABR differential |
| ABR output (starting with firmware version 5) | |
| 8-bit to 12-bit | 3500 rpm |
| ABR output (up to firmware version 4) ¹⁾ | |
| 8-bit | Max. 2343 rpm |
| 9-bit | Max. 1171 rpm |
| 10-bit | Max. 585 rpm |
| Short-circuit proof | Yes (reference output) |
| Electrical properties | |
| Electrical isolation | Bus isolated from input/output Channel not isolated from channel, and input/output not isolated from I/O power supply |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | 0 to 55°C |
| Vertical mounting orientation | 0 to 50°C |
| Derating | - |
| Storage | -25 to 70°C |
| Transport | -25 to 70°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 192: X20CM1941 - Technical data

1) Configurable

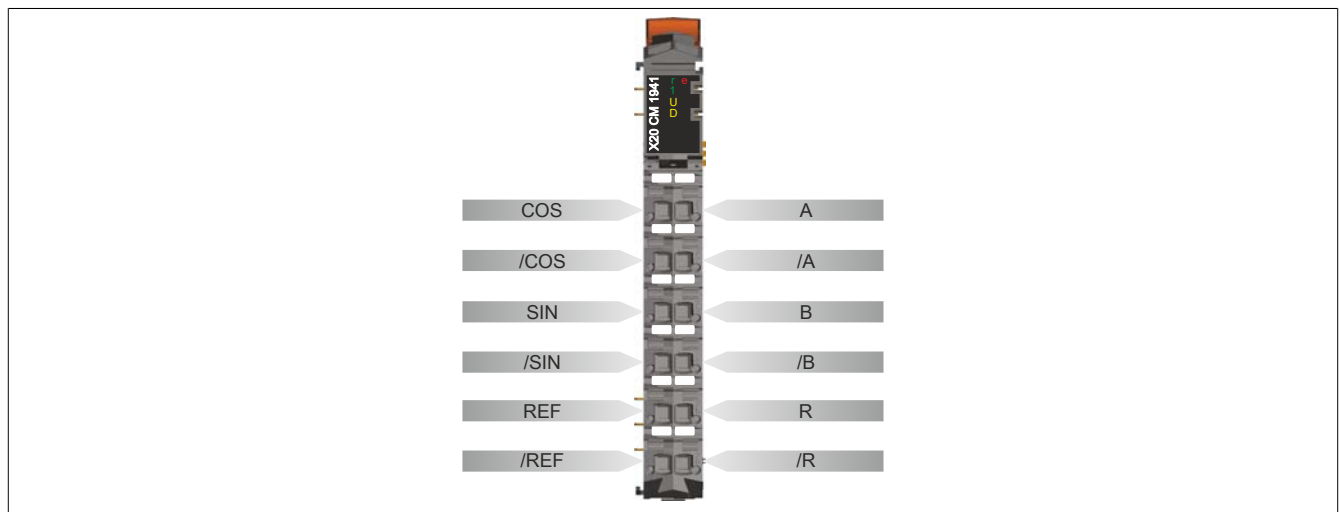
9.11.2.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

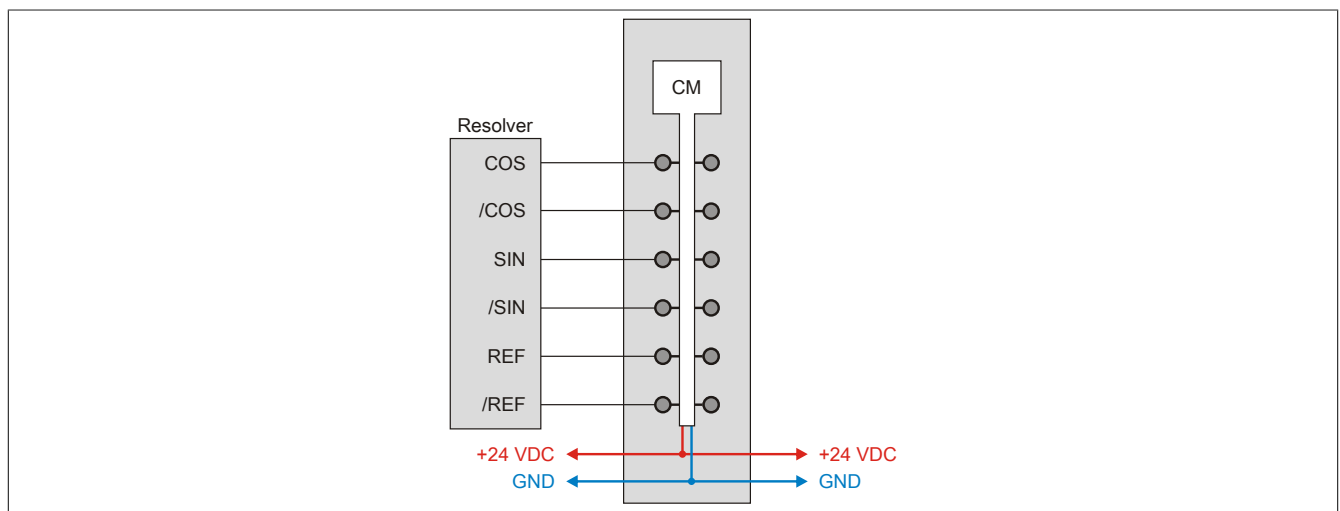
| Figure | LED | Color | Status | Description |
|---|-------|--------|-----------------------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | e | Red | On | RUN mode |
| | | | Off | No power to module or everything OK |
| | e + r | | Red on / Green single flash | Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. |
| | 1 | Green | On | Resolver connected and OK |
| | | | Off | Open line or no resolver connected |
| | U | | Orange | UP: Counts up |
| D | | Orange | DOWN: Counts down | |

1) Depending on the configuration, a firmware update can take up to several minutes.

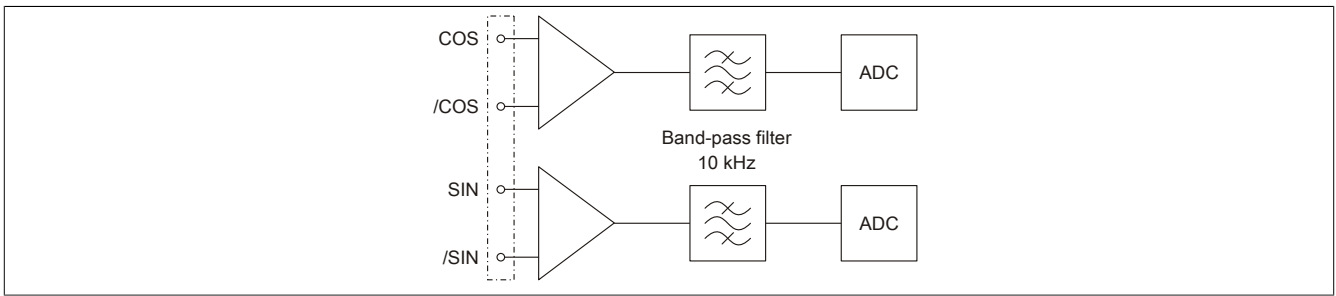
9.11.2.5 Pinout



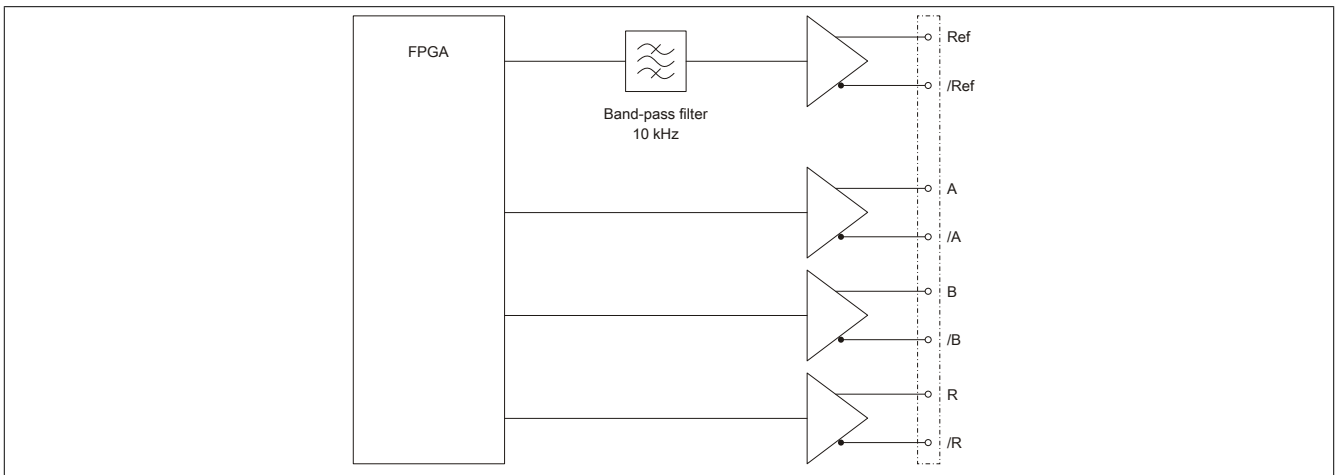
9.11.2.6 Connection example



9.11.2.7 Input circuit diagram



9.11.2.8 Output circuit diagram



9.11.2.9 ABR encoder

Up to firmware version 4

The module measures the resolver's current angular position every 100 μ s. The value for A, B or R is generated immediately from the highest value bits (depending on configuration bit 8 to 10).

Firmware version 5 or higher

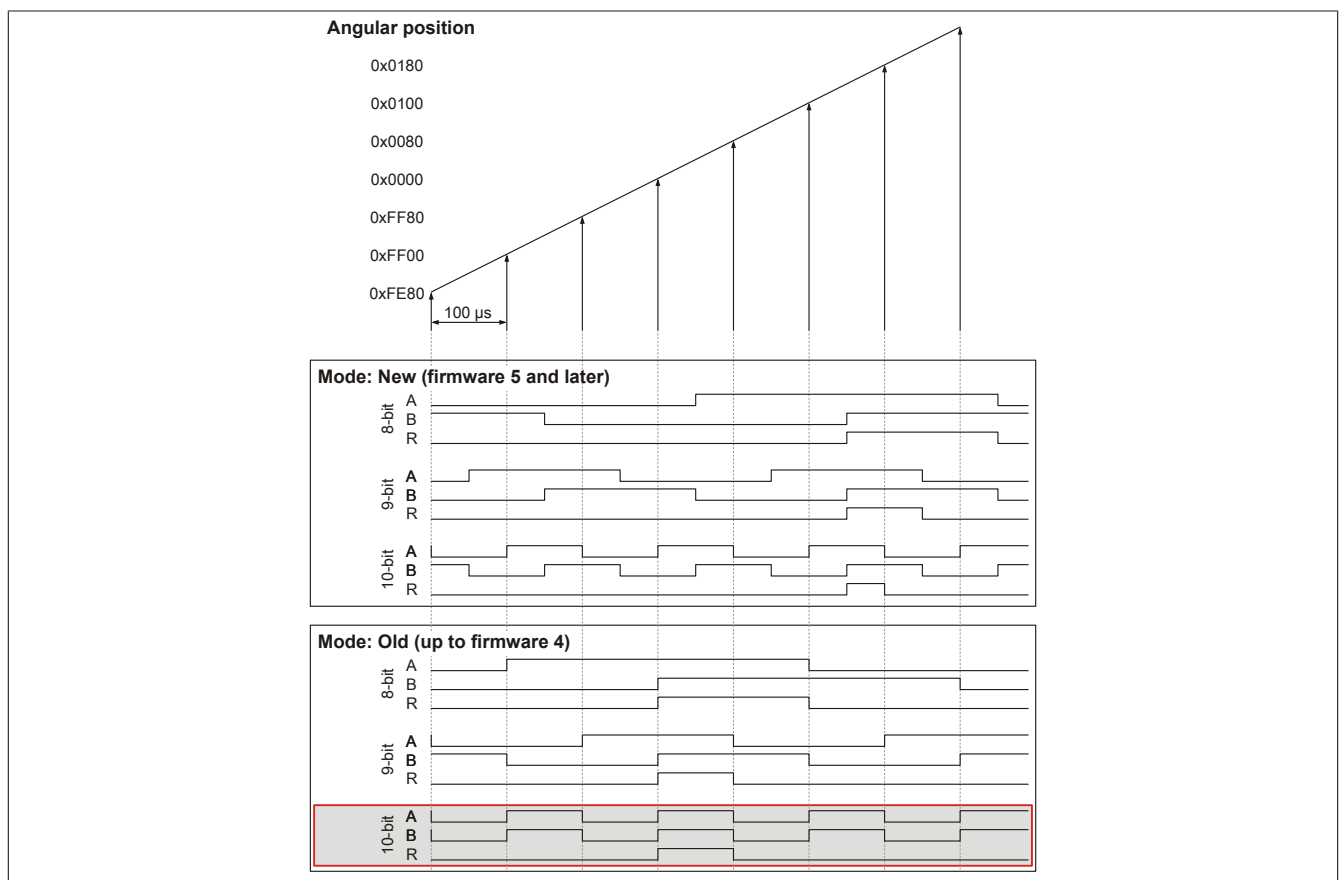
The procedure shown above reaches its limits as soon as more than one LSB difference occurs from one position measurement to the next since only one edge of A or B is possible every 100 μ s.

To achieve higher clock rates on the ABR encoder (and therefore higher rotational speeds) while simultaneously improving temporal jitter, the ABR signal is no longer derived directly from the most recent measurement value, but rather generated through interpolation between consecutive position measurements determined every 100 μ s.

Information:

In comparison to firmware versions ≤ 4 , the ABR outputs have a constant time offset of 250 μ s. See also "[Comparison of the timing of the ABR outputs between Firmware version 4 and 5](#)".

Comparison of the timing of the ABR outputs between Firmware version 4 and 5



9.11.2.10 Register description

9.11.2.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.11.2.10.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|--------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 20 | ConfigOutput01 | UINT | | | | • |
| 22 | ConfigOutput02 | USINT | | | | • |
| Communication | | | | | | |
| 0 | Position | DINT | • | | | |
| 10 | StatusInput | USINT | • | | | |

9.11.2.10.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 20 | - | ConfigOutput01 | UINT | | | | • |
| 22 | - | ConfigOutput02 | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | Position | DINT | • | | | |
| 10 | 4 | StatusInput | USINT | • | | | |

1) The offset specifies the position of the register within the CAN object.

9.11.2.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.11.2.10.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.11.2.10.4 Set the zero position

Name:

ConfigOutput01

"Offset" in the Automation Studio I/O configuration.

The zero position for the resolver can be defined or shifted in this register. The zero position/offset specification refers to the current resolver position.

| Data type | Values | Information |
|-----------|-------------|-----------------------------------|
| UINT | 0 to 65,535 | Bus controller default setting: 0 |

9.11.2.10.5 Encoder emulation configuration

Name:

ConfigOutput02

"ABR configuration" in the Automation Studio I/O configuration.

The resolution of ABR emulation can be configured in this register.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------|-------|---|
| 0 - 2 | Number of bits | 0 | 8 bits = 256 increments/rotation (bus controller default setting) |
| | | 1 | 9 bits = 512 increments/rotation |
| | | 2 | 10 bits = 1024 increments/rotation |
| | | 3 | 11 bits = 2048 increments/rotation |
| | | 4 | 12 bits = 4096 increments/rotation |
| | | 5 - 7 | Not permitted |
| 3 - 7 | Reserved | - | |

9.11.2.10.6 Current encoder position

Name:

Position

The current angle position of the resolver is shown in this register. The value consists of:

- The two upper bytes, which correspond to the number of rotations counted from -32768 (0x8000xxxx) to +32767 (0x7FFFxxxx)
- The two lower bytes, which correspond to the angle position within the current rotation 1 LSB = 360° / 65536

The position value can, however, be interpreted exactly as an individual 32-bit long angle with resolution 1 / 65536 * 360°.

| Data type | Value | Information |
|-----------|--------------------------|--|
| DINT | 0x0000xxxx to 0xFFFFxxxx | Number of rotations (cyclic) |
| | 0xxxxx0000 to 0xxxxxFFFF | Angle position within the current rotation |

Example

0x7FFF0080 corresponds to 32767 rotations, and $128 / 65536 * 360 = 0.703^\circ$.

9.11.2.10.7 Connection status

Name:

StatusInput

This register shows a potential open line between the module and the encoder.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|--------------|
| 0 | Open line | 0 | No open line |
| | | 1 | Open line |
| 1 - 7 | Reserved | - | |

9.11.2.10.8 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.11.2.10.9 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 200 μ s |

9.11.3 X20DC1176

Data sheet version: 2.41

9.11.3.1 General information

The module is equipped with 1 input for an ABR incremental encoder with RS422-based output signals and 5 V encoder supply. The encoder inputs are monitored (A, B, R, A\, B\, R\).

- 1 ABR incremental encoder 5 V
- Encoder input monitoring
- 2 additional inputs, e.g. for latch input
- 5 VDC, 24 VDC and GND for encoder supply
- NetTime timestamp: Counter change
- Can be used with a SafeLOGIC controller

NetTime timestamp of the counter

For many applications, not only the counter value is important, but also the exact time of the counter change. For this purpose, the module has a NetTime function that provides the recorded counter value with a timestamp accurate to microseconds.

The module provides the PLC with the counter value and timestamp as an absolute time value. The NetTime mechanisms ensure that the PLC NetTime clock and the local NetTime clock on the module have the same absolute time at all times.

9.11.3.2 Order data


| Model number | Short description | Figure |
|--------------|--|--|
| | Counter functions |  |
| X20DC1176 | X20 digital counter module, 1 ABR incremental encoder, 5 V, 600 kHz input frequency, 4x evaluation, encoder monitoring, NetTime function | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 193: X20DC1176 - Order data

9.11.3.3 Technical data

| | |
|--|--|
| Model number | X20DC1176 |
| Short description | |
| I/O module | 1 ABR incremental encoder 5 V |
| General information | |
| B&R ID code | 0xA706 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Type of signal lines | Shielded cables must be used for all signal lines. |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| Digital inputs | |
| Quantity | 2 |
| Nominal voltage | 24 VDC |
| Input characteristics per EN 61131-2 | Type 1 |
| Input voltage | 24 VDC -15% / +20% |
| Input current at 24 VDC | Approx. 3.3 mA |
| Input circuit | Sink |
| Input filter | |
| Hardware | ≤2 μs |
| Software | - |
| Connection type | 3-wire connections |
| Input resistance | 7.03 kΩ |
| Additional functions | Latch input |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| ABR incremental encoder | |
| Encoder inputs | 5 V, symmetrical |
| Counter size | 16/32-bit |
| Input frequency | Max. 600 kHz |
| Evaluation | 4x |
| Minimum diff. slew rate | 1 V/μs |
| Encoder power supply | |
| 5 VDC | ±5%, module-internal, max. 300 mA |
| 24 VDC | Module-internal, max. 300 mA |
| Input filter | |
| Hardware | ≤400 ns |
| Software | - |
| Switching threshold | |
| Low | >1 V |
| Common-mode range | -10 V ≤ V _{CM} ≤ +13.2 V |
| Overload characteristics of encoder power supply | Short-circuit proof, overload-proof |
| Isolation voltage between encoder and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |


Table 194: X20DC1176 - Technical data

| Model number | X20DC1176 |
|--|--|
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x bus module X20BM11 separately. |
| Spacing | 12.5 ^{+0.2} mm |

Table 194: X20DC1176 - Technical data

9.11.3.4 LED status indicators

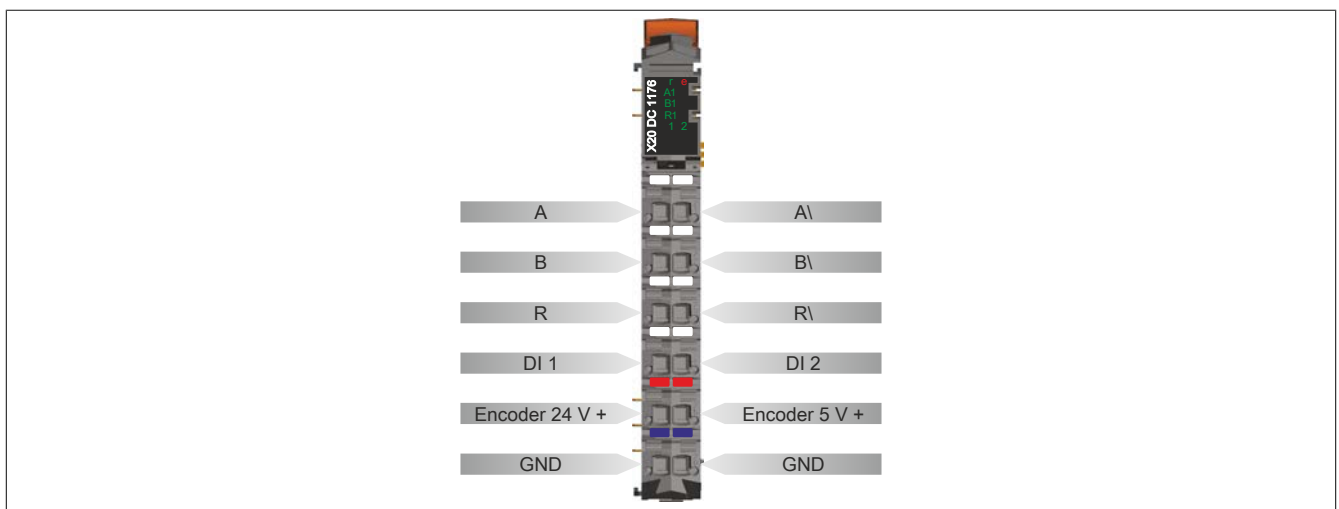
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|--|-------|-------|----------------------------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | e | Red | On | RUN mode |
| | | | Off | No power to module or everything OK |
| | | | Single flash | The encoder monitor has detected a line fault on the encoder inputs. The status bits must be evaluated in order to provide a more detailed definition of this error. The following error states are detected: <ul style="list-style-type: none"> • Open line • Short-circuit or voltage level too low |
| | A1 | Green | On | Error or reset status |
| | B1 | Green | | Input state of counter input A |
| | R1 | Green | | Input state of counter input B |
| 1 - 2 | Green | | Input state of reference pulse R | |
| | | | | Input state of the corresponding digital input |

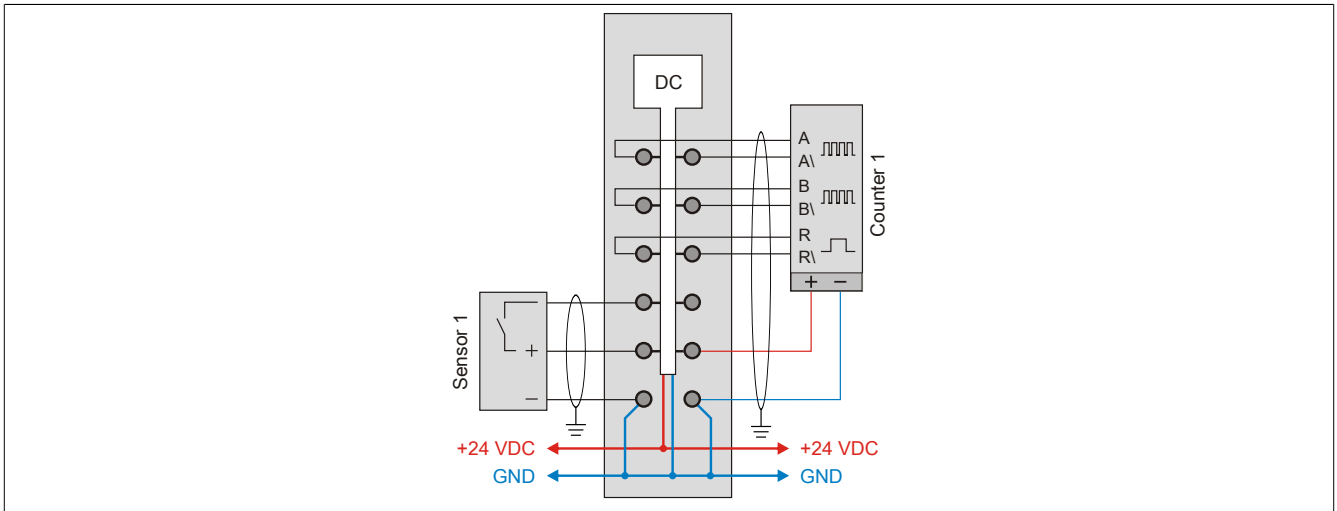
1) Depending on the configuration, a firmware update can take up to several minutes.

9.11.3.5 Pinout

Shielded cables must be used for all signal lines.

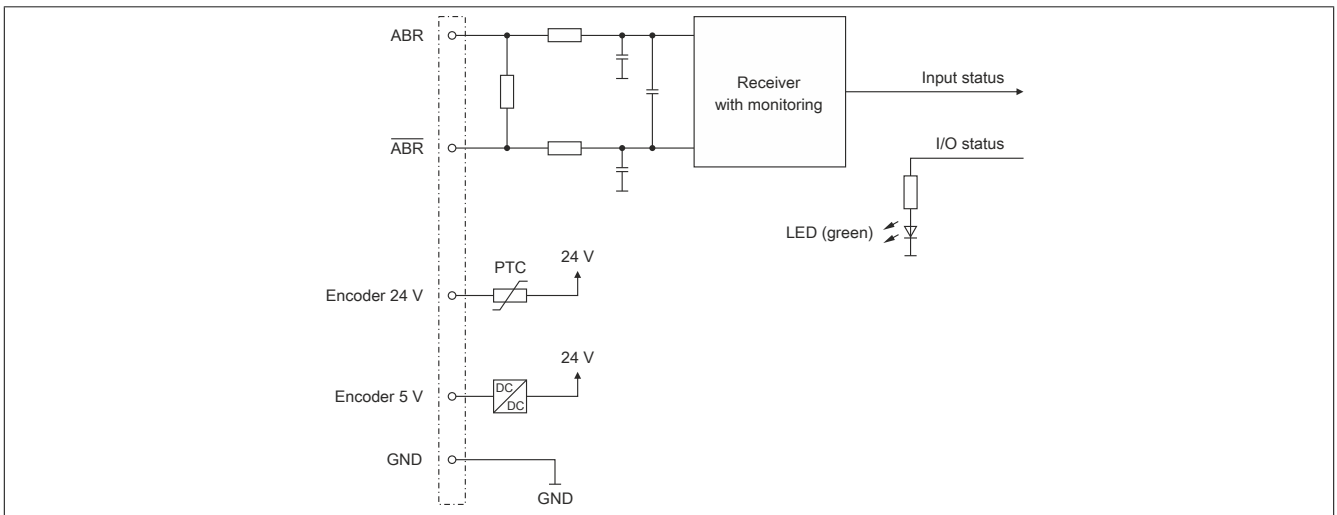


9.11.3.6 Connection example

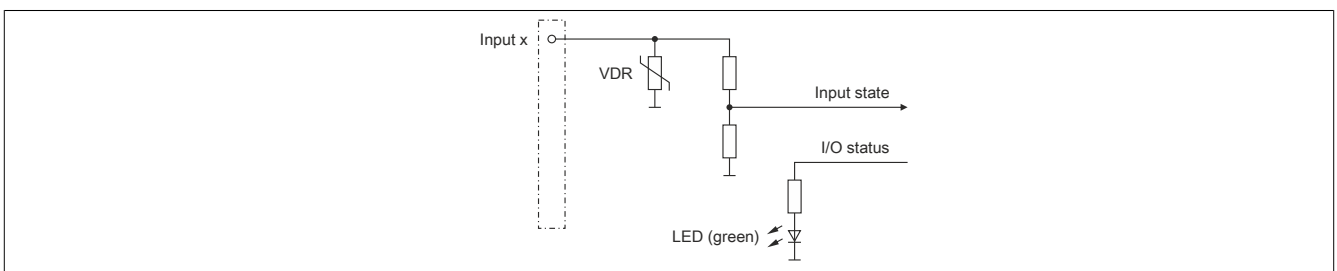


9.11.3.7 Input circuit diagram

Counter inputs



Standard inputs



9.11.3.8 Register description

9.11.3.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.11.3.8.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 513 | Cfo_SlframeGenID | USINT | | | | • |
| 642 | Cfo_SystemCycleTime | UINT | | | | • |
| 769 | Cfo_PhylIOConfigCh01 | USINT | | | | • |
| 771 | Cfo_PhylIOConfigCh02 | USINT | | | | • |
| 773 | Cfo_PhylIOConfigCh03 | USINT | | | | • |
| 777 | Cfo_PhylIOConfigCh04 | USINT | | | | • |
| 779 | Cfo_PhylIOConfigCh05 | USINT | | | | • |
| 815 | Cfo_BWQuitTimeSelChannel7_0 | USINT | | | | • |
| 820 | Cfo_BWQuitTime_0 | UDINT | | | | • |
| 6145 | Cfo_CounterCycleSelect | USINT | | | | • |
| 6147 | Cfo_CounterMode | USINT | | | | • |
| 6149 | Cfo_LatchMode | USINT | | | | • |
| 6151 | Cfo_LatchComparator | USINT | | | | • |
| 6159 | Cfo_BWCNTEnableMaskChannel7_0 | USINT | | | | • |
| Communication | | | | | | |
| 683 | SDCLifeCount | SINT | • | | | |
| 6342 | Encoder01 | INT | • | | | |
| 6340 | | DINT | | | | |
| 6310 | Encoder01TimeValid | INT | • | | | |
| 6308 | | DINT | | | | |
| 6358 | Encoder01Latch | INT | • | | | |
| 6356 | | DINT | | | | |
| 6153 | Encoder commands | USINT | | | • | |
| | Encoder01Reset | Bit 0 | | | | |
| | Encoder01LatchEnable | Bit 1 | | | | |
| 927 | Input status of signal lines | USINT | • | | | |
| | Encoder01_A | Bit 0 | | | | |
| | Encoder01_B | Bit 1 | | | | |
| | Encoder01_R | Bit 2 | | | | |
| | DigitalInput01 | Bit 4 | | | | |
| | DigitalInput02 | Bit 5 | | | | |
| 847 | Status of signal lines | USINT | • | | | |
| | BW_Channel_A | Bit 0 | | | | |
| | BW_Channel_B | Bit 1 | | | | |
| | BW_Channel_R | Bit 2 | | | | |
| 811 | Acknowledging error status of signal lines | USINT | | | • | |
| | BW_QuitChannel_A | Bit 0 | | | | |
| | BW_QuitChannel_B | Bit 1 | | | | |
| | BW_QuitChannel_R | Bit 2 | | | | |
| 6326 | Encoder01TimeChanged | INT | • | | | |
| 6324 | | DINT | | | | |
| 6303 | Encoder01LatchCount | SINT | • | | | |
| 843 | Status of encoder supplies | USINT | • | | | |
| | PowerSupply01 | Bit 0 | | | | |
| | PowerSupply02 | Bit 1 | | | | |

SafeLOGIC registers

This module contains additional registers that allow the module to be used with a SafeLOGIC controller.

| Register | Name | Data type | Read | | Write | |
|----------------------|---------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 7170 | Cfo_DTS_SourceRef | INT | | | | • |
| 7173 | Cfo_DTS_CycleSelect | USINT | | | | • |
| Communication | | | | | | |
| 7188 | Encoder01 | DINT | • | | | |
| 7196 | Encoder01TimeValid | DINT | • | | | |
| 7202 | DTS_SourceRef | INT | • | | | |
| 7206 | DTS_CheckSum | INT | • | | | |

9.11.3.8.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 513 | - | CfO_SlframeGenID | USINT | | | | • |
| 642 | - | CfO_SystemCycleTime | UINT | | | | • |
| 769 | - | CfO_PhylIOConfigCh01 | USINT | | | | • |
| 771 | - | CfO_PhylIOConfigCh02 | USINT | | | | • |
| 773 | - | CfO_PhylIOConfigCh03 | USINT | | | | • |
| 777 | - | CfO_PhylIOConfigCh04 | USINT | | | | • |
| 779 | - | CfO_PhylIOConfigCh05 | USINT | | | | • |
| 815 | - | CfO_BWQuitTimeSelChannel7_0 | USINT | | | | • |
| 820 | - | CfO_BWQuitTime_0 | UDINT | | | | • |
| 6145 | - | CfO_CounterCycleSelect | USINT | | | | • |
| 6147 | - | CfO_CounterMode | USINT | | | | • |
| 6149 | - | CfO_LatchMode | USINT | | | | • |
| 6151 | - | CfO_LatchComparator | USINT | | | | • |
| 6159 | - | CfO_BWCNTEnableMaskChannel7_0 | USINT | | | | • |
| Communication | | | | | | | |
| 6342 | 0 | Encoder01 | INT | • | | | |
| 6310 | 2 | Encoder01TimeValid | INT | • | | | |
| 6358 | 4 | Encoder01Latch | INT | • | | | |
| 6153 | 1 | Encoder commands | USINT | | | • | |
| | | Encoder01Reset | Bit 0 | | | | |
| | | Encoder01LatchEnable | Bit 1 | | | | |
| 927 | 7 | Input status of signal lines | USINT | • | | | |
| | | Encoder01_A | Bit 0 | | | | |
| | | Encoder01_B | Bit 1 | | | | |
| | | Encoder01_R | Bit 2 | | | | |
| | | DigitalInput01 | Bit 4 | | | | |
| | | DigitalInput02 | Bit 5 | | | | |
| 847 | 6 | Status of signal lines | USINT | • | | | |
| | | BW_Channel_A | Bit 0 | | | | |
| | | BW_Channel_B | Bit 1 | | | | |
| | | BW_Channel_R | Bit 2 | | | | |
| 811 | 0 | Acknowledging error status of signal lines | USINT | | | • | |
| | | BW_QuitChannel_A | Bit 0 | | | | |
| | | BW_QuitChannel_B | Bit 1 | | | | |
| | | BW_QuitChannel_R | Bit 2 | | | | |
| 6326 | - | Encoder01TimeChanged | INT | | • | | |
| 6303 | - | Encoder01LatchCount | SINT | | • | | |
| 843 | - | Status of encoder supplies | USINT | | • | | |
| | | PowerSupply01 | Bit 0 | | | | |
| | | PowerSupply02 | Bit 1 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.11.3.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.11.3.8.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.11.3.8.4 Encoder - Configuration

The following registers are used for setting functions and configuring the module.

9.11.3.8.4.1 Enabling error monitoring for the signal lines

Name:

CfO_BWCNTEnableMaskChannel7_0

This register requires individually enabling error monitoring for each of the signal channels. "Open line", "short circuit" and "voltage level too low" are reported as error states. Any errors that occur are reported in the error status registers "BW_Channel_x" on page 1081.

| Data type | Value | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| USINT | See bit structure. | 7 |

Bit structure:

| Bit | Name | Value | Information |
|-------|--|-------|--|
| 0 | Enable error monitoring for signal A lines | 0 | Error monitoring - Encoder Signal A disabled |
| | | 1 | Error monitoring - Encoder signal A enabled (bus controller default setting) |
| 1 | Enable error monitoring for signal B lines | 0 | Error monitoring - Encoder Signal B disabled |
| | | 1 | Error monitoring - Encoder signal B enabled (bus controller default setting) |
| 2 | Enable error monitoring for signal R lines | 0 | Error monitoring - Encoder Signal R disabled |
| | | 1 | Error monitoring - Encoder signal R enabled (bus controller default setting) |
| 3 - 7 | Reserved | 0 | |

9.11.3.8.4.2 Timing for automatic error acknowledgment

Name:

CfO_BWQuitTime_0

This register can be used to enable an additional [automatic acknowledgment](#) of the error status through timing. If a valid time is set, then the acknowledgment can still be made [manually](#), the only difference is that automatic acknowledgment will take place on the module after the defined amount of time has passed. If the error state has not yet been corrected, then the error status remains and the time is reset. Make sure that the time is set long enough for the higher-level system to reliably detect the status messages.

If the timing = 0, then acknowledgment is only possible using the cyclic acknowledgment registers.

| Data type | Value | Information |
|-----------|--------------------|--|
| UDINT | 0 | No automatic acknowledgment. Bus controller default setting |
| | 1 to 2.147.483.647 | Time for automatic acknowledgment [µs] |

9.11.3.8.4.3 Setting the latch mode

Name:

CfO_LatchMode

This register is used to set the latch mode:

- Single shot latch mode:
The latch function must be enabled/set. After a successful latch procedure, the activation must be reset in order for a new latch procedure to be activated.
- Continuous latch mode:
The latch function only has to be enabled/set as long as latching is desired.

A changed counter state on "[Encoder01LatchCount](#)" on page 1080 indicates that the latch procedure has been performed. The counter value is stored in the latch register "[Encoder01Latch](#)" on page 1080.

| Data type | Value | Information |
|-----------|-------|--|
| USINT | 0 | Single-shot latch procedure (bus controller default setting) |
| | 1 | Continuous latch procedure |

9.11.3.8.4.4 Signal channels for triggering latch procedure

Name:

CfO_LatchComparator

This register defines the signal channels and their level for triggering the latch procedure.

- This mainly configures which channels are linked to generate the latch event. All three signals from the encoder and digital input 1 can be used for the "AND" operation.
- The "active voltage level" needed for the latch procedure can now be used according to the physical signals.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Name | Value | Information |
|-----|---|-------|---|
| 0 | Defines signal level for encoder signal A | 0 | Low (bus controller default setting) |
| | | 1 | High |
| 1 | Defines signal level for encoder signal B | 0 | Low (bus controller default setting) |
| | | 1 | High |
| 2 | Defines signal level for encoder signal R | 0 | Low (bus controller default setting) |
| | | 1 | High |
| 3 | Defines signal level for digital input 1 | 0 | Low (bus controller default setting) |
| | | 1 | High |
| 4 | Use encoder signal A to trigger latch procedure | 0 | Disabled (bus controller default setting) |
| | | 1 | Latch function linked to encoder signal A |
| 5 | Use encoder signal B to trigger latch procedure | 0 | Disabled (bus controller default setting) |
| | | 1 | Latch function linked to encoder signal B |
| 6 | Use encoder signal R to trigger latch procedure | 0 | Disabled (bus controller default setting) |
| | | 1 | Latch function linked to encoder signal R |
| 7 | Use digital input 1 to trigger latch procedure | 0 | Disabled (bus controller default setting) |
| | | 1 | Latch function linked to digital input 1 |

9.11.3.8.4.5 Physical configuration

The following registers must be set to the specified constant value for correct physical configuration:

Constant register "CfO_SlframeGenID"

Name:

CfO_SlframeGenID

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 9 | Bus controller default setting |

Constant register "CfO_SystemCycleTime"

Name:

CfO_SystemCycleTime

Cycle time of encoder acquisition in 1/8 μ s steps. 1 encoder value is acquired as the counter value per cycle.

| Data type | Value | Information |
|-----------|-------|--|
| UINT | 800 | 800 = 100 μ s. Bus controller default setting |

Constant register "CfO_PhyIOConfigCh0x"

Name:

CfO_PhyIOConfigCh01 to CfO_PhyIOConfigCh05

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 0 | Bus controller default setting |

Constant register "CfO_BWQuitTimeSelChannel7_0"

Name:

CfO_BWQuitTimeSelChannel7_0

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 0 | Bus controller default setting |

Constant register "CfO_CounterCycleSelect"

Name:

CfO_CounterCycleSelect

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 2 | Bus controller default setting |

Constant register "CfO_CounterMode"

Name:

CfO_CounterMode

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 3 | Bus controller default setting |

9.11.3.8.5 Encoder - Communication**9.11.3.8.5.1 Counter for verifying the data frame**

Name:

SDCLifeCount

The 8-bit counter register is needed for the SDC software package. It is incremented with the system clock to allow the SDC to check the validity of the data frame.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

9.11.3.8.5.2 Display of the counter state

Name:

Encoder01

The counter state of the incremental encoder is displayed as a 16 or 32-bit counter value. Only the 16-bit value is available in the bus controller function model.

| Data type | Value |
|--------------------|----------------------------------|
| INT | -32768 to 32767 |
| DINT ¹⁾ | -2.147.483.648 bis 2.147.483.647 |

1) Can only be configured in the standard function model

9.11.3.8.5.3 NetTime of the last valid counter value

Name:

Encoder01TimeValid

The NetTime of the last valid counter value is the time of the last valid counter value recorded on the module (see register "[Cfo_SystemCycleTime](#)" on page 1078). The user is able to determine the validity of the counter value by evaluating its age in the program. This means that the module and error status bits do not have to be checked additionally to determine the validity of the value.

The NetTime of the last valid counter value that was read is displayed as a 16 or 32-bit value. Only the 16-bit value is available in the bus controller function model.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Value | Information |
|--------------------|---------------------------------|--------------------|
| INT | -32768 to 32767 | NetTime in μ s |
| DINT ¹⁾ | -2.147.483.648 to 2.147.483.647 | |

1) Can only be configured in the standard function model

9.11.3.8.5.4 NetTime of the last counter value change

Name:

Encoder01TimeChanged

For slow X2X Link cycles, the NetTime of the last counter value change can be used to determine the speed more accurately.

The NetTime of the last counter value change is displayed as a 16 or 32-bit value. Only the 16-bit value is available in the bus controller function model.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Value | Information |
|--------------------|---------------------------------|--------------------|
| INT | -32768 to 32767 | NetTime in μ s |
| DINT ¹⁾ | -2.147.483.648 to 2.147.483.647 | |

1) Can only be configured in the standard function model

9.11.3.8.5.5 Counter value at the time of the last latch

Name:

Encoder01Latch

The counter value at the time of the last latch is displayed as a 16 or 32-bit value. Only the 16-bit value is available in the bus controller function model.

| Data type | Value |
|--------------------|----------------------------------|
| INT | -32768 to 32767 |
| DINT ¹⁾ | -2.147.483.648 bis 2.147.483.647 |

1) Can only be configured in the standard function model

9.11.3.8.5.6 Counter value of latch event

Name:

Encoder01LatchCount

The latch events are counted and stored in a cyclic 8-bit counter. This counter is incremented with each latch event, thereby indicating a new occurrence. The new latched counter value is stored in the respective latch register.

| Data type | Value |
|-----------|-------------|
| SINT | -128 to 127 |

9.11.3.8.5.7 Encoder commands

Name:

Encoder01Command

This register can be used to

- 1) reset the counter value. The counter is kept at zero until this command is reset.
- 2) enable the latch procedure. If the latch configuration is valid and matches the hardware signals, then this activation causes the counter value to be saved in the latch register.

The two different latch configurations that are possible (see "[Setting the latch mode](#)" on page 1077) must be handled as follows:

- Single shot latch mode:
After successful latching, indicated by the latch event counter, activation must be reset before any more latching is possible. The activation must be set again if additional latching is needed.
- Continuous latch mode:
The latch function only has to be enabled/set as long as latching is desired. The latch event counter is incremented with each event.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|----------------------|-------|------------------------|
| 0 | Encoder01Reset | 0 | Do not reset |
| | | 1 | Set encoder value to 0 |
| 1 | Encoder01LatchEnable | 0 | Do not activate latch |
| | | 1 | Latching |
| 2 - 7 | Reserved | 0 | |

9.11.3.8.5.8 Input status of signal lines

Name:

Encoder01_A

Encoder01_B

Encoder01_R

DigitalInput01 to DigitalInput02

This register displays the input status of the signal lines from the encoder and the digital inputs.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|----------------|-------|---------------------------------|
| 0 | Encoder01_A | 0/1 | Input state of encoder signal A |
| 1 | Encoder01_B | 0/1 | Input state of encoder signal B |
| 2 | Encoder01_R | 0/1 | Input state of encoder signal R |
| 3 | Reserved | 0 | |
| 4 | DigitalInput01 | 0/1 | Input state - Digital input 1 |
| 5 | DigitalInput02 | 0/1 | Input state - Digital input 2 |
| 6 - 7 | Reserved | 0 | |

9.11.3.8.5.9 Error status of signal lines

The error states are latched when they occur and are maintained until acknowledged. The counter and time registers are not updated if there are pending or unacknowledged errors.

Status of signal lines

Name:

BW_Channel_A

BW_Channel_B

BW_Channel_R

This register displays the error states of the signal lines from the encoder. The error states are latched when they occur and are maintained until acknowledged. The counter and time registers are not updated if there are pending or unacknowledged errors.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|--------------|-------|---|
| 0 | BW_Channel_A | 0 | No error in encoder signal A |
| | | 1 | Open line, short circuit or voltage level too low |
| 1 | BW_Channel_B | 0 | No error in encoder signal B |
| | | 1 | Open line, short circuit or voltage level too low |
| 2 | BW_Channel_R | 0 | No error in encoder signal R |
| | | 1 | Open line, short circuit or voltage level too low |
| 3 - 7 | Reserved | 0 | |

Acknowledging error status of signal lines

Name:

BW_QuitChannel_A

BW_QuitChannel_B

BW_QuitChannel_R

This register can be used to acknowledge the latched error states of the signal lines from the encoder. However, if there are still pending errors remaining, then the error status remains active. After acknowledging the errors, the bits must also be reset or else any repetition of the error would be undetected.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|------------------|-------|---|
| 0 | BW_QuitChannel_A | 0 | No acknowledgment |
| | | 1 | Acknowledgment of error status - Encoder signal A |
| 1 | BW_QuitChannel_B | 0 | No acknowledgment |
| | | 1 | Acknowledgment of error status - Encoder signal B |
| 2 | BW_QuitChannel_R | 0 | No acknowledgment |
| | | 1 | Acknowledgment of error status - Encoder signal R |
| 3 - 7 | Reserved | 0 | |

Manual acknowledgment of latched error states

The latched error states of the signal lines from the encoder can be acknowledged manually. However, if there are still pending errors remaining, then the error status remains active. After successfully acknowledging the errors (latched error status = 0), the acknowledge bits must still be reset by the user or else a re-occurrence of an error could be overlooked by the user.

Example 1: Cause of error corrected before being acknowledged

An error has occurred on a signal line. The error state is detected and latched by the module. The error is acknowledged by the user after the cause of error has been corrected. The latched error status changes to zero.

The manual acknowledge must now be reset so that any new errors will be recognized by the user.

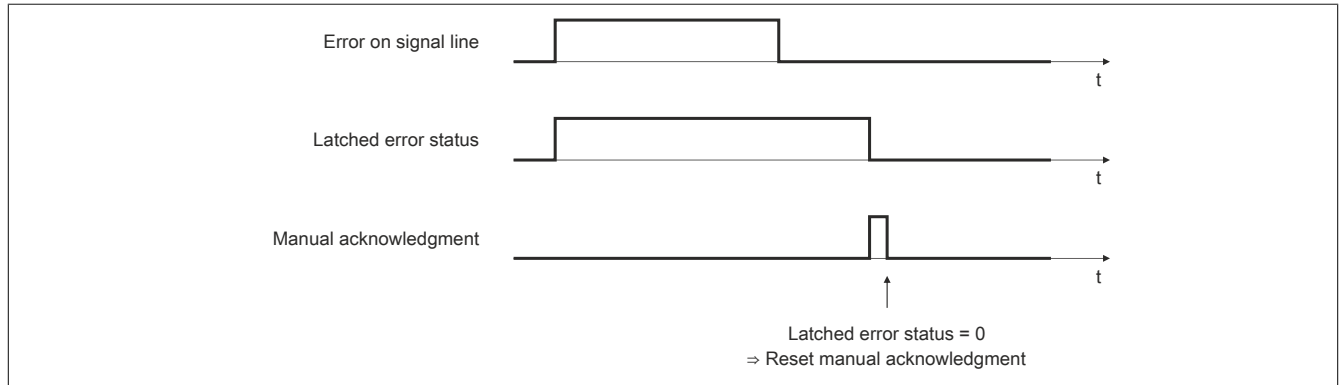


Figure 98: Cause of error corrected before being acknowledged

Example 2: Cause of error not yet corrected before being acknowledged

An error has occurred on a signal line. The error state is detected and latched by the module. The error is acknowledged by the user before the cause of error has been corrected. The latched error status remains set because the error is still remaining.

Acknowledgment is only successful after the cause of error has been corrected. The latched error status changes to zero. The manual acknowledge must now be reset so that any new errors will be recognized by the user.

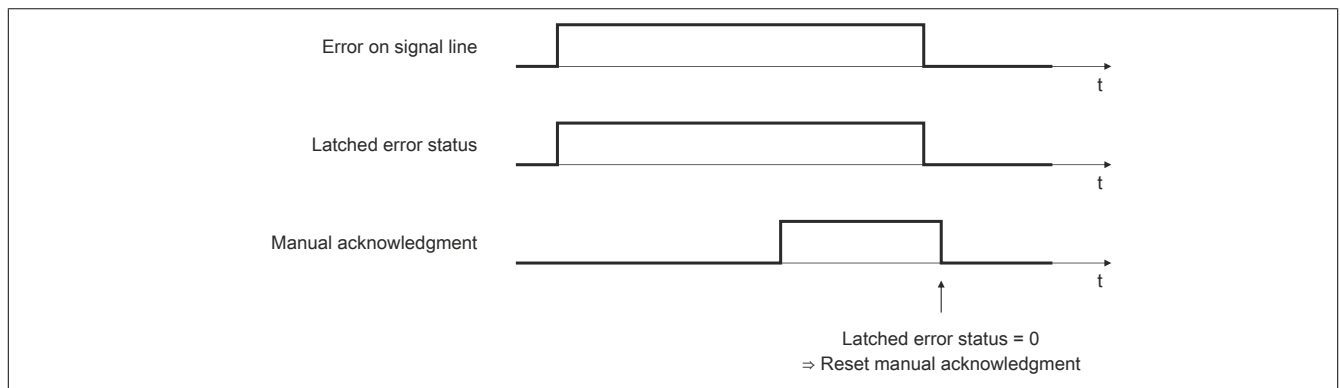


Figure 99: Cause of error not yet corrected before being acknowledged

Automatic acknowledgment of latched error states

In addition to manual acknowledgment, automatic acknowledgment of the latched error states after a specified amount of time can also be enabled. Make sure that the time is set long enough for the higher-level system to reliably detect the status messages and for the validity of the counter value to be determined using its age.

If the time specification = 0, then only manual acknowledgment is possible.

Example 1: An error has occurred on a signal line. The error state is detected and latched by the module. The time for automatic acknowledgment starts counting after the cause of error has been corrected. The error is acknowledged as soon as the time expires. The latched error status changes to zero.

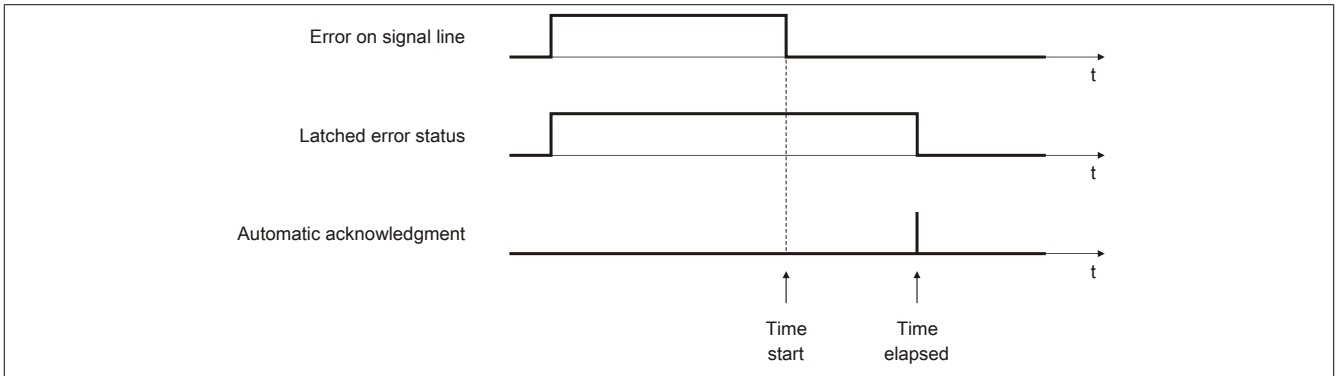


Figure 100: Latched error state acknowledged automatically

Example 2: Automatic and manual acknowledge used
 An error has occurred on a signal line. The error state is detected and latched by the module. The time for automatic acknowledgment starts counting after the cause of error has been corrected. The error is acknowledged manually by the user before the time expires. The latched error status changes to zero. The manual acknowledge must now be reset so that any new errors will be recognized by the user.

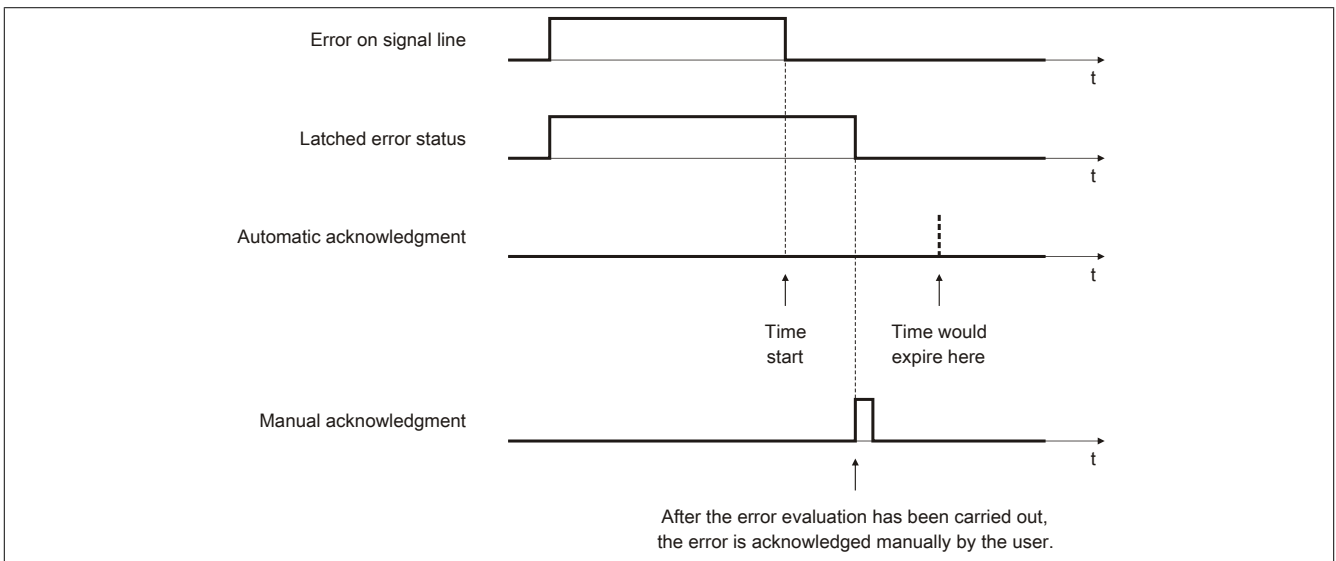


Figure 101: Automatic and manual acknowledge used

9.11.3.8.5.10 Status of encoder supplies

Name:

PowerSupply01 to PowerSupply02

This register shows the status of the integrated encoder supplies. A faulty encoder power supply is displayed as a warning.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---------------|-------|------------------------------------|
| 0 | PowerSupply01 | 0 | 24 VDC encoder power supply OK |
| | | 1 | 24 VDC encoder power supply faulty |
| 1 | PowerSupply02 | 0 | 5 VDC encoder power supply OK |
| | | 1 | 5 VDC encoder power supply faulty |
| 2 - 7 | Reserved | - | |

9.11.3.8.6 DATA_to_SafeDATA

Function DATA_to_SafeDATA determines a safe signal from 2 independent standard signals. For this purpose, the standard data of 2 I/O modules are transferred to the SafeLOGIC controller and compared with each other there. With the functions provided in SafeDESIGNER, the resulting data can be used for applications up to PL d.

Function DATA_to_SafeDATA is enabled and the register calls take place using SafeDESIGNER. For more detailed information about the calls, see library DATA_to_SafeDATA_SF contained in SafeDESIGNER.

9.11.3.8.6.1 Counter state of the encoder

Name:

Encoder01

This register represents the counter value of the encoder. The register is only active if function DATA_to_SafeDATA is enabled.

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

9.11.3.8.6.2 NetTime of the counter value

Name:

Encoder01TimeValid

This register represents the NetTime of the most recent valid counter value. The register is only active if function DATA_to_SafeDATA is enabled.

For a description of NetTime Technology, see ["NetTime Technology" on page 3035](#).

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

9.11.3.8.6.3 Displaying the SourceRef address

Name:

DTS_SourceRef

This register cyclically displays the SourceRef address set in the configuration. The register is only active if function DATA_to_SafeDATA is enabled.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

9.11.3.8.6.4 Checksum

Name:

DTS_CheckSum

This register contains a checksum formed from the 3 cyclic data points [Encoder01](#), [Encoder01TimeValid](#) and [DTS_SourceRef](#). The register is only active if function DATA_to_SafeDATA is enabled.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

9.11.3.8.6.5 SourceRef address

Name:

CfO_DTS_SourceRef

This register contains the acyclically configurable SourceRef address that is transmitted back by the module as a cyclic data point. The register is only active if function DATA_to_SafeDATA is enabled.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

9.11.3.8.6.6 Constant cycle register

Name:

CfO_DTS_CycleSelect

This register determines the cycle used internally and is not permitted to be changed.

| Data type | Value |
|-----------|-------|
| USINT | 2 |

9.11.3.8.7 NetTime Technology

For a description of NetTime Technology, see ["NetTime Technology" on page 3035](#).

9.11.3.8.8 Minimum cycle time

The minimum cycle time defines how far the bus cycle can be reduced without causing a communication error or impaired functionality. It should be noted that very fast cycles decrease the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 150 µs |

9.11.3.8.9 Minimum I/O update time

The minimum I/O update time defines how far the bus cycle can be reduced while still allowing an I/O update to take place in each cycle.

| Minimum I/O update time |
|-------------------------|
| 150 µs |

9.11.4 X20DC1178

Data sheet version: 2.21

9.11.4.1 General information

This module is equipped with one input for SSI absolute encoders with 5 V encoder signal. The data signal is monitored (Data, Data).

- 1 SSI absolute encoder 5 V
- Monitoring the data signal
- 2 additional inputs
- 5 VDC, 24 VDC and GND for encoder supply
- NetTime timestamp: Counter change
- Can be used with a SafeLOGIC controller

NetTime timestamp of the counter

For many applications, not only the counter value is important, but also the exact time of the counter change. For this purpose, the module has a NetTime function that provides the recorded counter value with a timestamp accurate to microseconds.

The module provides the PLC with the counter value and timestamp as an absolute time value. The NetTime mechanisms ensure that the PLC NetTime clock and the local NetTime clock on the module have the same absolute time at all times.

9.11.4.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Counter functions |  |
| X20DC1178 | X20 digital counter module, 1 SSI absolute encoder, 5 V, 1 Mbit/s, 32-bit, encoder monitoring, NetTime function | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 195: X20DC1178 - Order data

9.11.4.3 Technical data

| Model number | X20DC1178 |
|--|--|
| Short description | |
| I/O module | 1 SSI absolute encoder 5 V |
| General information | |
| B&R ID code | 0xA708 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.1 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Type of signal lines | Shielded cables must be used for all signal lines. |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| Digital inputs | |
| Quantity | 2 |
| Nominal voltage | 24 VDC |
| Input characteristics per EN 61131-2 | Type 1 |
| Input voltage | 24 VDC -15% / +20% |
| Input current at 24 VDC | Approx. 3.3 mA |
| Input circuit | Sink |
| Input filter | |
| Hardware | ≤2 μs |
| Software | - |
| Connection type | 3-wire connections |
| Input resistance | 7.03 kΩ |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| SSI absolute encoder | |
| Encoder inputs | 5 V, symmetrical |
| Counter size | Up to 32-bit depending on encoder |
| Max. transfer rate | 1 Mbit/s |
| Keying | Gray/Binary |
| Minimum diff. slew rate | 1 V/μs |
| Isolation voltage between encoder and bus | 500 V _{eff} |
| Overload characteristics of encoder power supply | Short-circuit proof, overload-proof |
| Transfer rate | 125 kbit/s / 250 kbit/s / 500 kbit/s / 1 Mbit/s |
| Encoder power supply | |
| 5 VDC | ±5%, module-internal, max. 300 mA |
| 24 VDC | Module-internal, max. 300 mA |
| Switching threshold | |
| Low | >1 V |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |


Table 196: X20DC1178 - Technical data

| | | | |
|---------------------------------|------------------|--|--|
| Model number | X20DC1178 | | |
| Ambient conditions | | | |
| Temperature | | | |
| Operation | | | |
| Horizontal mounting orientation | | | -25 to 60°C |
| Vertical mounting orientation | | | -25 to 50°C |
| Derating | | | - |
| Storage | | | -40 to 85°C |
| Transport | | | -40 to 85°C |
| Relative humidity | | | |
| Operation | | | 5 to 95%, non-condensing |
| Storage | | | 5 to 95%, non-condensing |
| Transport | | | 5 to 95%, non-condensing |
| Mechanical properties | | | |
| Note | | | Order 1x terminal block X20TB12 separately. Order 1x bus module X20BM11 separately. |
| Spacing | | | 12.5 ^{+0.2} mm |

Table 196: X20DC1178 - Technical data

9.11.4.4 LED status indicators

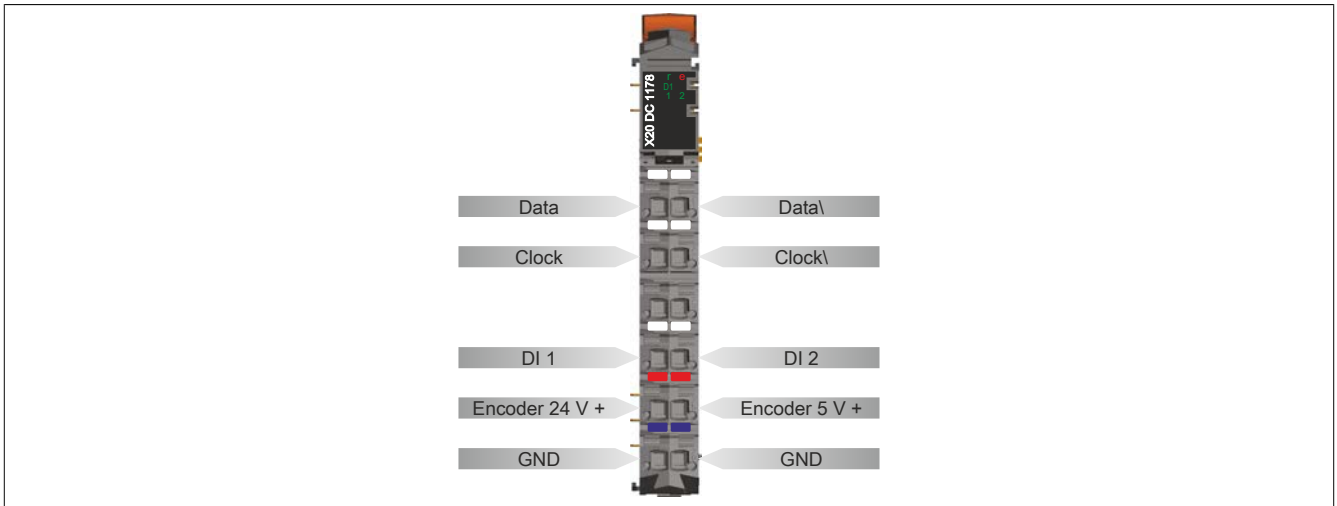
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|--|-------|-------|--------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Single flash | Either the encoder monitor has detected a line fault on the encoder inputs or a transfer error has occurred. The status bits must be evaluated in order to provide a more detailed definition of this error. The following error states are detected: <ul style="list-style-type: none"> • Open line • Short-circuit or voltage level too low • SSI cycle time violation • Parity error |
| | | | On | Error or reset status |
| | D1 | Green | | Input status - Data signal |
| | 1 - 2 | Green | | Input state of the corresponding digital input |

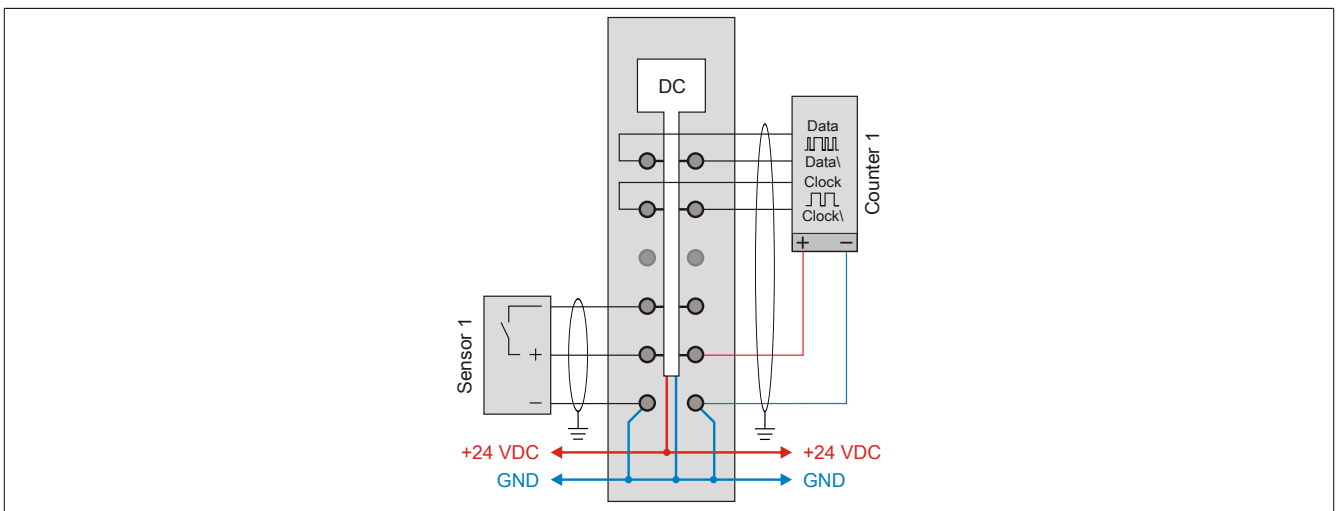
1) Depending on the configuration, a firmware update can take up to several minutes.

9.11.4.5 Pinout

Shielded cables must be used for all signal lines.

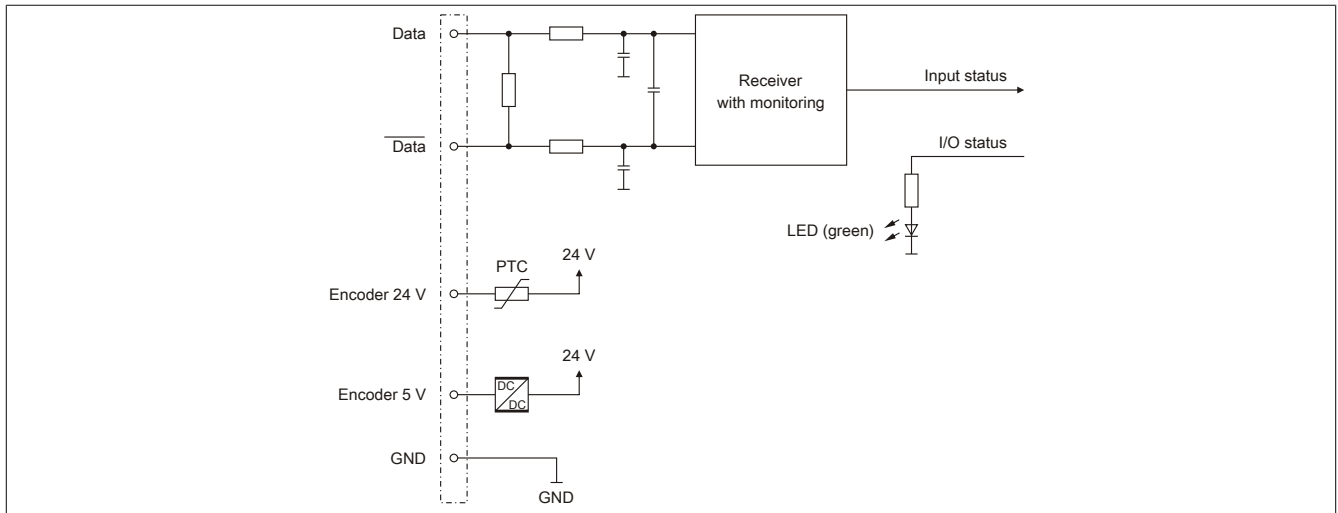


9.11.4.6 Connection example

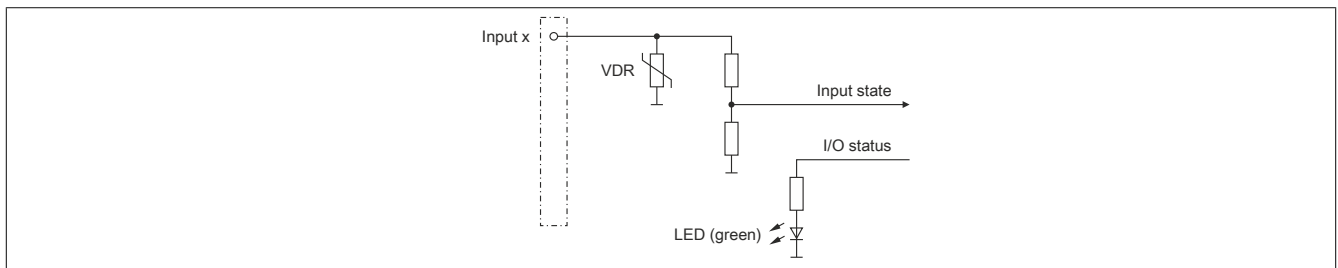


9.11.4.7 Input circuit diagram

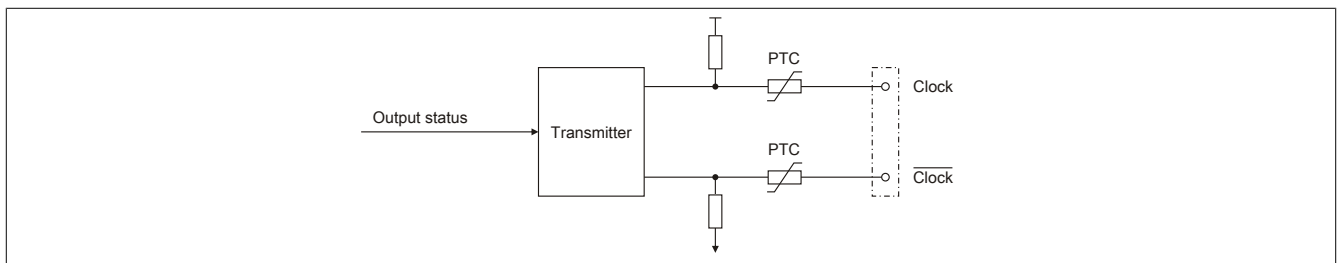
Counter input



Standard inputs



9.11.4.8 Output circuit diagram



9.11.4.9 Register description

9.11.4.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.11.4.9.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 650 | CfO_SystemCyclePrescaler | UINT | | | | • |
| 2049 | CfO_CycleSelect | USINT | | | | • |
| 2951 | CfO_PhysicalMode | USINT | | | | • |
| 2053 | CfO_DataBits | USINT | | | | • |
| 2055 | CfO_NullBits | USINT | | | | • |
| 820 | CfO_BWQuitTime_0 | UDINT | | | | • |
| 815 | CfO_BWQuitTimeSelChannel7_0 | USINT | | | | • |
| 2059 | CfO_BWSSIEnableMaskChannel7_0 | USINT | | | | • |
| Communication | | | | | | |
| 683 | SDCLifeCount | SINT | • | | | |
| 927 | Input status of signal lines | USINT | • | | | |
| | DigitalInput01 | Bit 4 | | | | |
| | DigitalInput02 | Bit 5 | | | | |
| 2100 | Encoder01 | (U)DINT | • | | | |
| 2102 | Encoder01 | UINT | • | | | |
| 2086 | Encoder01TimeValid | INT | • | | | |
| 2084 | Encoder01TimeValid | DINT | • | | | |
| 2094 | Encoder01TimeChanged | INT | • | | | |
| 2092 | Encoder01TimeChanged | DINT | • | | | |
| 259 | State of the encoder | USINT | • | | | |
| | EncoderCycleTimeViolation | Bit 0 | | | | |
| | EncoderDataError | Bit 1 | | | | |
| 323 | Acknowledging error status of the encoder | USINT | | | • | |
| | EncoderQuitCycleTimeViolation | Bit 0 | | | | |
| | EncoderQuitDataError | Bit 1 | | | | |
| 847 | Status of signal lines | USINT | • | | | |
| | BW_Channel_D | Bit 0 | | | | |
| 811 | Acknowledging error status of the signal line | USINT | | | • | |
| | BW_QuitChannel_D | Bit 0 | | | | |
| 843 | Status of encoder supplies | USINT | • | | | |
| | PowerSupply01 | Bit 0 | | | | |
| | PowerSupply02 | Bit 1 | | | | |

SafeLOGIC registers

This module contains additional registers that allow the module to be used with a SafeLOGIC controller.

| Register | Name | Data type | Read | | Write | |
|----------------------|-------------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 7234 | CfO_DTS_SourceRef | INT | | | | • |
| 7237 | CfO_DTS_CycleSelect | USINT | | | | • |
| Communication | | | | | | |
| 7252 | Encoder01 | DINT | • | | | |
| 7260 | Encoder01TimeValid | DINT | • | | | |
| 7266 | DTS_SourceRef | INT | • | | | |
| 7270 | DTS_CheckSum | INT | • | | | |

9.11.4.9.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 650 | - | CfO_SystemCyclePrescaler | UINT | | | | • |
| 2049 | - | CfO_CycleSelect | USINT | | | | • |
| 2051 | - | CfO_PhysicalMode | USINT | | | | • |
| 2053 | - | CfO_DataBits | USINT | | | | • |
| 2055 | - | CfO_NullBits | USINT | | | | • |
| 820 | - | CfO_BWQuitTime_0 | UDINT | | | | • |
| 815 | - | CfO_BWQuitTimeSelChannel7_0 | USINT | | | | • |
| 2059 | - | CfO_BWSSIEnableMaskChannel7_0 | USINT | | | | • |
| Communication | | | | | | | |
| 683 | | SDCLifeCount | SINT | • | | | |
| 927 | 7 | Input status of signal lines | USINT | • | | | |
| | | DigitalInput01 | Bit 4 | | | | |
| | | DigitalInput02 | Bit 5 | | | | |
| 2100 | - | Encoder01 | (U)DINT | • | | | |
| 2086 | 4 | Encoder01TimeValid | INT | • | | | |
| 2094 | - | Encoder01TimeChanged | INT | • | | | |
| 259 | - | State of the encoder | USINT | • | | | |
| | | EncoderCycleTimeViolation | Bit 0 | | | | |
| | | EncoderDataError | Bit 1 | | | | |
| 323 | - | Acknowledging error status of the encoder | USINT | | | • | |
| | | EncoderQuitCycleTimeViolation | Bit 0 | | | | |
| | | EncoderQuitDataError | Bit 1 | | | | |
| 847 | 6 | Status of signal lines | USINT | • | | | |
| | | BW_Channel_D | Bit 0 | | | | |
| 811 | 0 | Acknowledging error status of the signal line | USINT | | | • | |
| | | BW_QuitChannel_D | Bit 0 | | | | |
| 843 | - | Status of encoder supplies | USINT | • | | | |
| | | PowerSupply01 | Bit 0 | | | | |
| | | PowerSupply02 | Bit 1 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.11.4.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.11.4.9.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.11.4.9.4 Encoder - Configuration

The following registers are used for setting functions and configuring the module.

9.11.4.9.4.1 Setting the SSI sampling cycle time

The following two registers define the cycle time for SSI sampling.

Setting the interrupt

Name:

CfO_CycleSelect

This register assigns the principle interrupt setting:

- **Timer configuration (time setting with "CfO_SystemCyclePrescaler" on page 1094 register):** The SSI transfer can be started independently of the X2X cycle. The timer is synchronized with X2X Link.
- **AOAI:** Configuration with X2X interrupt, one-time start of the SSI transfer in the X2X cycle. The SSI transfer may require an entire X2X cycle.
- **SOSI:** Configuration with X2X interrupt, one-time start of the SSI transfer in the X2X cycle. The reaction time can be optimized with this setting if the SSI transfer doesn't exceed half of an X2X cycle.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 3 | Timer [µsec] ... Time setting with register "CfO_SystemCyclePrescaler" on page 1094 |
| | 10 | AOAI (bus controller default setting) |
| | 14 | SOSI |

Setting the cycle time

Name:

CfO_SystemCyclePrescaler

The desired cycle time must be configured additionally for the timer setting using this register.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 1 | 50 µs |
| | 2 | 100 µsec (bus controller default setting) |
| | 4 | 200 µs |
| | 8 | 400 µs |
| | 16 | 800 µs |
| | 0 | All other settings in the "CfO_CycleSelect" on page 1094 register |

9.11.4.9.4.2 Setting operating parameters

Name:

CfO_PhysicalMode

This register defines the operating parameters for the SSI encoder to correctly evaluate the data from the encoder.

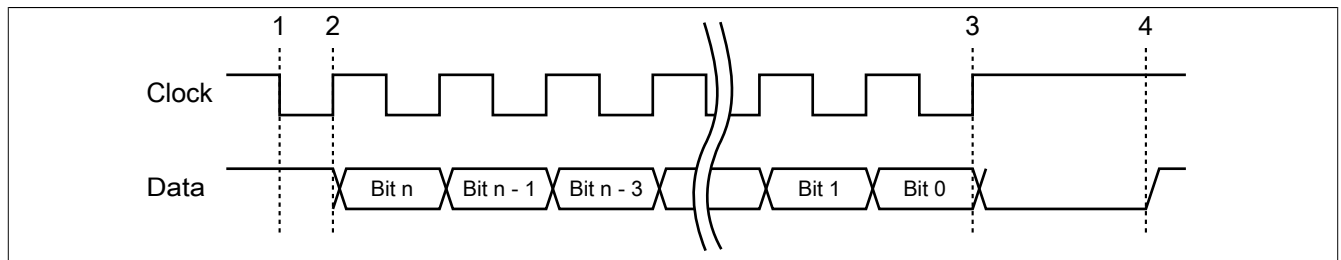
- **Parity:** Data with or without parity; an error is reported if there is an even or uneven parity mismatch.
- **Monoflop check:** The encoder uses the monoflop to signal the readiness to accept a new clock cycle.
- **Data coding:** Binary or gray coding of the data bits
- **Clock rate:** Speed of data transfer

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Name | Value | Information |
|-------|----------------------------------|-------|--|
| 0 - 1 | Parity bit | 00 | No parity bit (no clock bit output) (bus controller default setting) |
| | | 01 | Even parity bit |
| | | 10 | Uneven parity bit |
| | | 11 | Ignore parity bit (clock bit is output, but the result is ignored) |
| 2 - 3 | Monostable multivibrator testing | 00 | No monostable multivibrator check (no clock bit output) (bus controller default setting) |
| | | 01 | Check - Low level |
| | | 10 | Check - High level |
| | | 11 | Check - Ignore level (clock bit is output, but the result is ignored) |
| 4 | Data coding | 0 | Binary coding (bus controller default setting) |
| | | 1 | Gray coding |
| 5 | Reserved | 0 | |
| 6 - 7 | Clock rate | 00 | 1 MHz (bus controller default setting) |
| | | 01 | 500 kHz |
| | | 10 | 250 kHz |
| | | 11 | 125 kHz |

Transferring using Synchronous Serial Interface



Processing the measured value

- 1) Start bit ... The measured value is saved.
- 2) Output of the first data bit
- 3) All data bits are transferred; the monostable multivibrator time starts to run.
- 4) The monostable multivibrator returns to its initial state; a new transfer can be started.

9.11.4.9.4.3 Number of data bits

Name:

Cfo_DataBits

This register can be used to define the number of SSI encoder data bits.

| Data type | Value | Filter |
|-----------|---------|---|
| USINT | 1 to 32 | Number of SSI data bits; Bus controller default setting: 0 |

9.11.4.9.4.4 Leading zeros of the encoder

Name:

Cfo_NullBits

This register can be used to define the number of SSI encoder leading zeros.

| Data type | Value | Filter |
|-----------|---------|---|
| USINT | 1 to 32 | Number of leading zeros; Bus controller default setting: 0 |

9.11.4.9.4.5 Timing for automatic error acknowledgment

Name:

CfO_BWQuitTime_0

This register can be used to enable an additional [automatic acknowledgment](#) of the error status through timing. If a valid time is set, then the acknowledgment can still be made [manually](#), the only difference is that automatic acknowledgment will take place on the module after the defined amount of time has passed. If the error state has not yet been corrected, then the error status remains and the time is reset. Make sure that the time is set long enough for the higher-level system to reliably detect the status messages.

If the timing = 0, then acknowledgment is only possible using the cyclic acknowledgment registers.

| Data type | Value | Information |
|-----------|--------------------|--|
| UDINT | 0 | No automatic acknowledgment. Bus controller default setting |
| | 1 to 2.147.483.647 | Time for automatic acknowledgment [µs] |

Automatic acknowledgment of latched error states

In addition to manual acknowledgment, automatic acknowledgment of the latched error states after a specified amount of time can also be enabled. Make sure that the time is set long enough for the higher-level system to reliably detect the status messages and for the validity of the counter value to be determined using its age.

If the time specification = 0, then only manual acknowledgment is possible.

Example 1: An error has occurred on a signal line. The error state is detected and latched by the module. The time for automatic acknowledgment starts counting after the cause of error has been corrected. The error is acknowledged as soon as the time expires. The latched error status changes to zero.

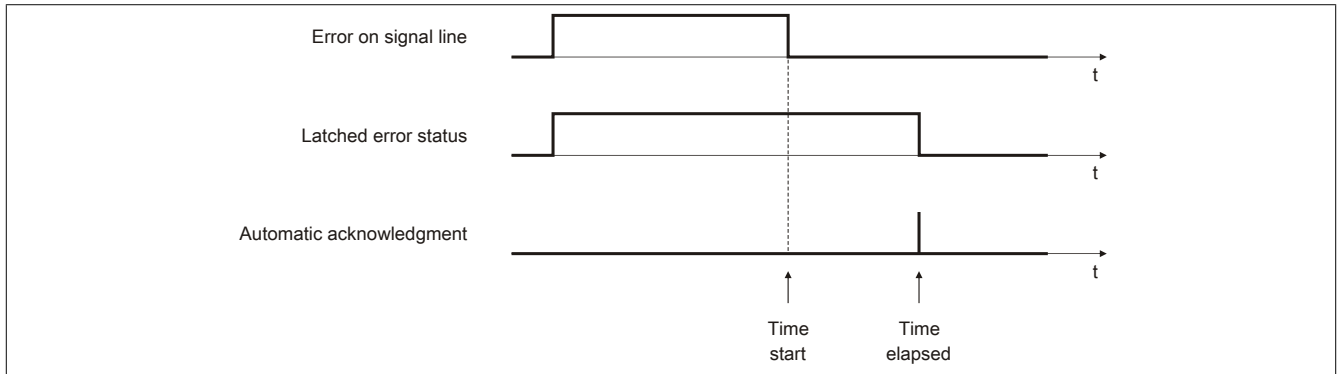


Figure 102: Latched error state acknowledged automatically

Example 2: Automatic and manual acknowledge used
An error has occurred on a signal line. The error state is detected and latched by the module. The time for automatic acknowledgment starts counting after the cause of error has been corrected. The error is acknowledged manually by the user before the time expires. The latched error status changes to zero. The manual acknowledge must now be reset so that any new errors will be recognized by the user.

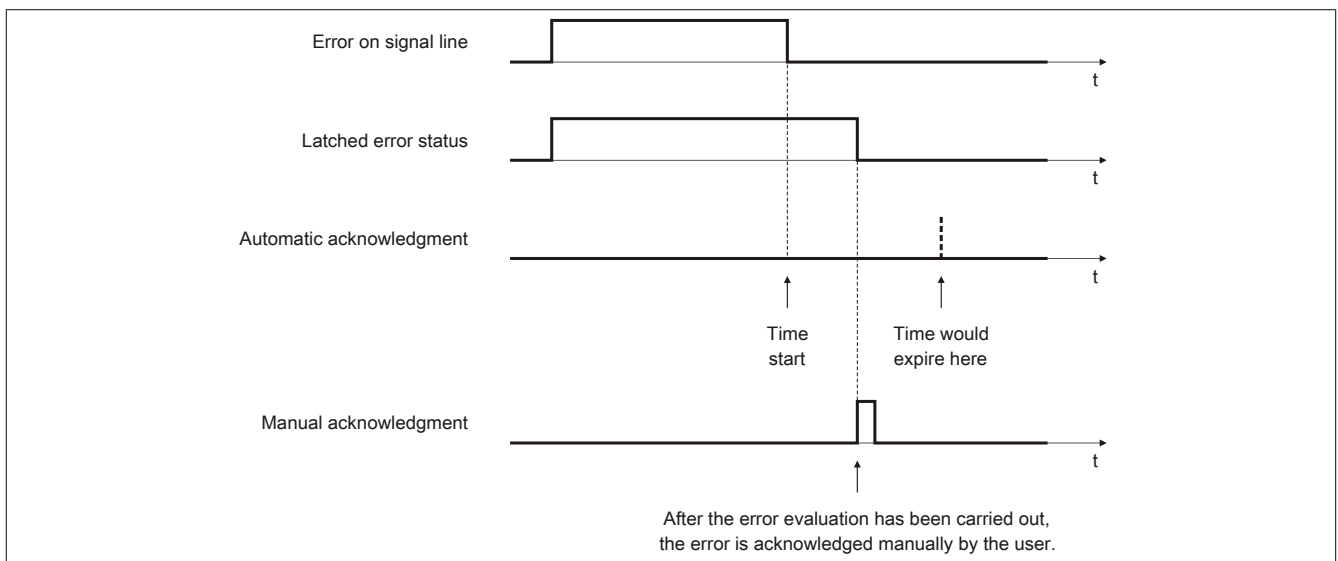


Figure 103: Automatic and manual acknowledge used

Manual acknowledgment of latched error states

The latched error states of the signal lines from the encoder can be acknowledged manually. However, if there are still pending errors remaining, then the error status remains active. After successfully acknowledging the errors (latched error status = 0), the acknowledge bits must still be reset by the user or else a re-occurrence of an error could be overlooked by the user.

Example 1: Cause of error corrected before being acknowledged

An error has occurred on a signal line. The error state is detected and latched by the module. The error is acknowledged by the user after the cause of error has been corrected. The latched error status changes to zero.

The manual acknowledge must now be reset so that any new errors will be recognized by the user.



Figure 104: Cause of error corrected before being acknowledged

Example 2: Cause of error not yet corrected before being acknowledged

An error has occurred on a signal line. The error state is detected and latched by the module. The error is acknowledged by the user before the cause of error has been corrected. The latched error status remains set because the error is still remaining.

Acknowledgment is only successful after the cause of error has been corrected. The latched error status changes to zero. The manual acknowledge must now be reset so that any new errors will be recognized by the user.

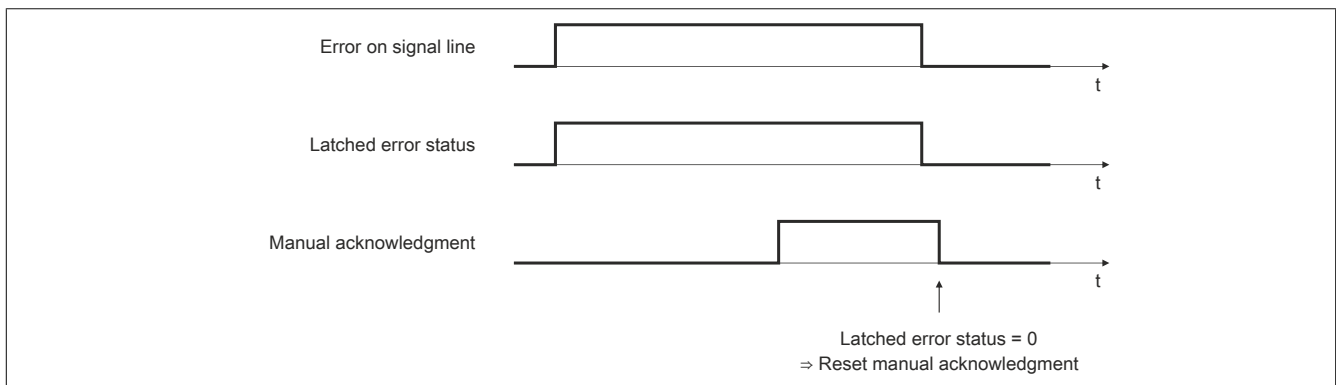


Figure 105: Cause of error not yet corrected before being acknowledged

9.11.4.9.4.6 Enable/disable error monitoring for the signal channels

Name:

CfO_BWSSIEnableMaskChannel7_0

This register allows error monitoring for each of the signal channels to be enabled individually. "Open line", "short circuit" and "voltage level too low" are reported as error states. Any errors that occur are reported in the error status registers.

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| USINT | See bit structure. | 1 |

Bit structure:

| Bit | Name | Value | Information |
|-------|------------------|-------|---|
| 0 | Encoder signal D | 0 | Error monitoring switched off |
| | | 1 | Error monitoring enabled (bus controller default setting) |
| 1 - 7 | Reserved | 0 | |

9.11.4.9.4.7 Physical configuration

The following registers must be set to the specified constant value for correct physical configuration:

Constant register "CfO_BWQuitTimeSelChannel7_0"

Name:

CfO_BWQuitTimeSelChannel7_0

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 0 | Bus controller default setting |

9.11.4.9.5 Encoder - Communication

9.11.4.9.5.1 Counter for verifying the data frame

Name:
SDCLifeCount

The 8-bit counter register is needed for the SDC software package. It is incremented with the system clock to allow the SDC to check the validity of the data frame.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

9.11.4.9.5.2 Input status of signal lines

Name:
DigitalInput0 to DigitalInput02

This register displays the input states for the digital inputs.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|----------------|--------|-------------------------------|
| 0 - 3 | Reserved | 0 | |
| 4 | DigitalInput01 | 0 or 1 | Input state - Digital input 1 |
| 5 | DigitalInput02 | 0 or 1 | Input state - Digital input 2 |
| 6 - 7 | Reserved | 0 | |

9.11.4.9.5.3 Display of the counter state

Name:
Encoder01

The counter state of the incremental encoder is displayed as a 16 or 32-bit counter value.

| Data type | Value |
|--------------------|---------------------------------|
| UDINT | 0 to 4.294.967.295 |
| DINT | -2.147.483.648 to 2.147.483.647 |
| UINT ¹⁾ | 0 to 65535 |

1) Only available in function model 0

9.11.4.9.5.4 NetTime of the last valid counter value

Name:
Encoder01TimeValid

The NetTime of the last valid counter value is the time of the last valid counter value recorded on the module. The user is able to determine the validity of the counter value by evaluating its age in the program. This means that the module and error status bits do not have to be checked additionally to determine the validity of the value.

The NetTime of the last valid counter value that was read is displayed as a 16 or 32-bit value. Only the 16-bit value is available in the bus controller function model.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Value | Information |
|--------------------|---------------------------------|--------------------|
| INT | -32768 to 32767 | NetTime in μ s |
| DINT ¹⁾ | -2.147.483.648 to 2.147.483.647 | |

1) Can only be configured in the standard function model

9.11.4.9.5.5 NetTime of the last counter value change

Name:

Encoder01TimeChanged

For slow X2X Link cycles, the NetTime of the last counter value change can be used to determine the speed more accurately.

The NetTime of the last counter value change is displayed as a 16 or 32-bit value. Only the 16-bit value is available in the bus controller function model.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Value | Information |
|--------------------|---------------------------------|--------------------|
| INT | -32768 to 32767 | NetTime in μ s |
| DINT ¹⁾ | -2.147.483.648 to 2.147.483.647 | |

1) Can only be configured in the standard function model

9.11.4.9.5.6 State of the encoder

Name:

EncoderCycleTimeViolation

EncoderDataError

This register displays the error states that occurred while determining the position. The error states are latched when they occur and are maintained until acknowledged.

A cycle time error is triggered if:

- Transfer is still active: This means that the defined cycle time is shorter than the time resulting from the sum of the data bits and stop bits and the clock rate.
- The monoflop level does not match the defined start level
- There is an error pending on the signal line (open line, short circuit).

A data error is triggered if:

- The parity bit does not match.
- An error occurs on the signal line (open line, short circuit) during transfer.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---------------------------|-------|-------------------------------------|
| 0 | EncoderCycleTimeViolation | 0 | No error |
| | | 1 | Error status - Cycle time violation |
| 1 | EncoderDataError | 0 | No error |
| | | 1 | Error status - Data error |
| 2 - 7 | Reserved | 0 | |

9.11.4.9.5.7 Acknowledging error status of the encoder

Name:

EncoderQuitCycleTimeViolation

EncoderQuitDataError

This register can be used to acknowledge the latched data error states from the encoder. However, if there are still pending errors remaining, then the error status remains active. After acknowledging the errors, the bits must also be reset or else any repetition of the error would be undetected.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|-------------------------------|-------|---|
| 0 | EncoderQuitCycleTimeViolation | 0 | No acknowledgment |
| | | 1 | Confirmation of error status - Cycle time violation |
| 1 | EncoderQuitDataError | 0 | No acknowledgment |
| | | 1 | Confirmation of error status - Data error |
| 2 - 7 | Reserved | 0 | |

9.11.4.9.5.8 Status of signal lines

Name:

BW_Channel_D

This register displays the error state of the signal line from the encoder. The error state is latched when it occurs and is maintained until acknowledged. The counter and time registers are not updated if there are pending or unacknowledged errors.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|--------------|-------|---|
| 0 | BW_Channel_D | 0 | No error - Encoder signal D |
| | | 1 | Error status - Open line or short circuit (voltage level too low) |
| 1 - 7 | Reserved | 0 | |

9.11.4.9.5.9 Acknowledging error status of the signal line

Name:

BW_QuitChannel_D

This register can be used to acknowledge the latched error states of the signal lines from the encoder. However, if there are still pending errors remaining, then the error status remains active. After acknowledging the errors, the bit must also be reset or else any repetition of the error will be undetected.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|------------------|-------|--------------------------------|
| 0 | BW_QuitChannel_D | 0 | No acknowledgment |
| | | 1 | Acknowledgment of error status |
| 1 - 7 | Reserved | 0 | |

9.11.4.9.5.10 Status of encoder supplies

Name:

PowerSupply01 to PowerSupply02

This register shows the status of the integrated encoder supplies. A faulty encoder power supply is displayed as a warning.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---------------|-------|------------------------------------|
| 0 | PowerSupply01 | 0 | 24 VDC encoder power supply OK |
| | | 1 | 24 VDC encoder power supply faulty |
| 1 | PowerSupply02 | 0 | 5 VDC encoder power supply OK |
| | | 1 | 5 VDC encoder power supply faulty |
| 2 - 7 | Reserved | - | |

9.11.4.9.6 DATA_to_SafeDATA

Function DATA_to_SafeDATA determines a safe signal from 2 independent standard signals. For this purpose, the standard data of 2 I/O modules are transferred to the SafeLOGIC controller and compared with each other there. With the functions provided in SafeDESIGNER, the resulting data can be used for applications up to PL d.

Function DATA_to_SafeDATA is enabled and the register calls take place using SafeDESIGNER. For more detailed information about the calls, see library DATA_to_SafeDATA_SF contained in SafeDESIGNER.

9.11.4.9.6.1 Counter state of the encoder

Name:

Encoder01

This register represents the counter value of the encoder. The register is only active if function DATA_to_SafeDATA is enabled.

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

9.11.4.9.6.2 NetTime of the counter value

Name:

Encoder01TimeValid

This register represents the NetTime of the most recent valid counter value. The register is only active if function DATA_to_SafeDATA is enabled.

For a description of NetTime Technology, see ["NetTime Technology" on page 3035](#).

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

9.11.4.9.6.3 Displaying the SourceRef address

Name:

DTS_SourceRef

This register cyclically displays the SourceRef address set in the configuration. The register is only active if function DATA_to_SafeDATA is enabled.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

9.11.4.9.6.4 Checksum

Name:

DTS_CheckSum

This register contains a checksum formed from the 3 cyclic data points [Encoder01](#), [Encoder01TimeValid](#) and [DTS_SourceRef](#). The register is only active if function DATA_to_SafeDATA is enabled.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

9.11.4.9.6.5 SourceRef address

Name:

CfO_DTS_SourceRef

This register contains the acyclically configurable SourceRef address that is transmitted back by the module as a cyclic data point. The register is only active if function DATA_to_SafeDATA is enabled.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

9.11.4.9.6.6 Constant cycle register

Name:

CfO_DTS_CycleSelect

This register determines the cycle used internally and is not permitted to be changed.

| Data type | Value |
|-----------|-------|
| USINT | 2 |

9.11.4.9.7 NetTime Technology

For a description of NetTime Technology, see ["NetTime Technology" on page 3035](#).

9.11.4.9.8 Minimum cycle time

The minimum cycle time defines how far the bus cycle can be reduced without causing a communication error or impaired functionality. It should be noted that very fast cycles decrease the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 150 μ s |

9.11.4.9.9 Minimum I/O update time

The minimum I/O update time defines how far the bus cycle can be reduced while still allowing an I/O update to take place in each cycle.

| Minimum I/O update time |
|-------------------------|
| 150 μ s |

9.11.5 X20(c)DC1196

Data sheet version: 3.23

9.11.5.1 General information

The module is equipped with 1 input for an ABR incremental encoder with 5 V encoder signal.

- 1 ABR incremental encoder 5 V
- 2 additional inputs e.g. for home enable switch
- 5 VDC, 24 VDC and GND for encoder supply

9.11.5.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.11.5.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C . During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.11.5.3 Order data

| Model number | Short description | Figure |
|--------------|--|--------|
| | Counter functions | |
| X20DC1196 | X20 digital counter module, 1 ABR incremental encoders, 5 V, 600 kHz input frequency, 4x resolution | |
| X20cDC1196 | X20 digital counter module, coated, 1 ABR incremental encoder, 5 V, 600 kHz input frequency, 4x resolution | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 197: X20DC1196, X20cDC1196 - Order data

9.11.5.4 Technical data

| Model number | X20DC1196 | X20cDC1196 |
|--|--|------------|
| Short description | | |
| I/O module | 1 ABR incremental encoder 5 V | |
| General information | | |
| B&R ID code | 0x1BAF | 0xEB54 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnosics | | |
| Module run/error | Yes, using status LED and software | |
| Power consumption | | |
| Bus | 0.01 W | |
| Internal I/O | 1.5 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Type of signal lines | Shielded cables must be used for all signal lines | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | - |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | - |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Digital inputs | | |
| Quantity | 2 | |
| Nominal voltage | 24 VDC | |
| Input characteristics per EN 61131-2 | Type 1 | |
| Input voltage | 24 VDC -15% / +20% | |
| Input current at 24 VDC | Approx. 3.3 mA | |
| Input circuit | Sink | |
| Input filter | | |
| Hardware | ≤2 µs | |
| Software | - | |
| Connection type | 3-wire connections | |
| Input resistance | 7.19 kΩ | |
| Additional functions | Home enable switch | |
| Switching threshold | | |
| Low | <5 VDC | |
| High | >15 VDC | |
| Isolation voltage between channel and bus | 500 V _{Eff} | |
| ABR incremental encoder | | |
| Encoder inputs | 5 V, symmetrical | |
| Counter size | 16/32-bit | |
| Input frequency | Max. 600 kHz | |
| Evaluation | 4x | |
| Encoder power supply | | |
| 5 VDC | ±5%, module-internal, max. 300 mA | |
| 24 VDC | Module-internal, max. 300 mA | |
| Input filter | | |
| Hardware | ≤200 ns | |
| Software | - | |
| Common-mode range | -7 V ≤ V _{CM} ≤ +12 V | |
| Overload characteristics of encoder power supply | Short circuit protection, overload protection | |
| Isolation voltage between encoder and bus | 500 V _{Eff} | |
| Electrical properties | | |
| Electrical isolation | Bus isolated from encoder and channel Channel not isolated from channel and encoder | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |


Table 198: X20DC1196, X20cDC1196 - Technical data

| Model number | X20DC1196 | X20cDC1196 |
|--|--|---|
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Starting temperature | - | Yes, -40°C |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 198: X20DC1196, X20cDC1196 - Technical data

9.11.5.5 LED status indicators

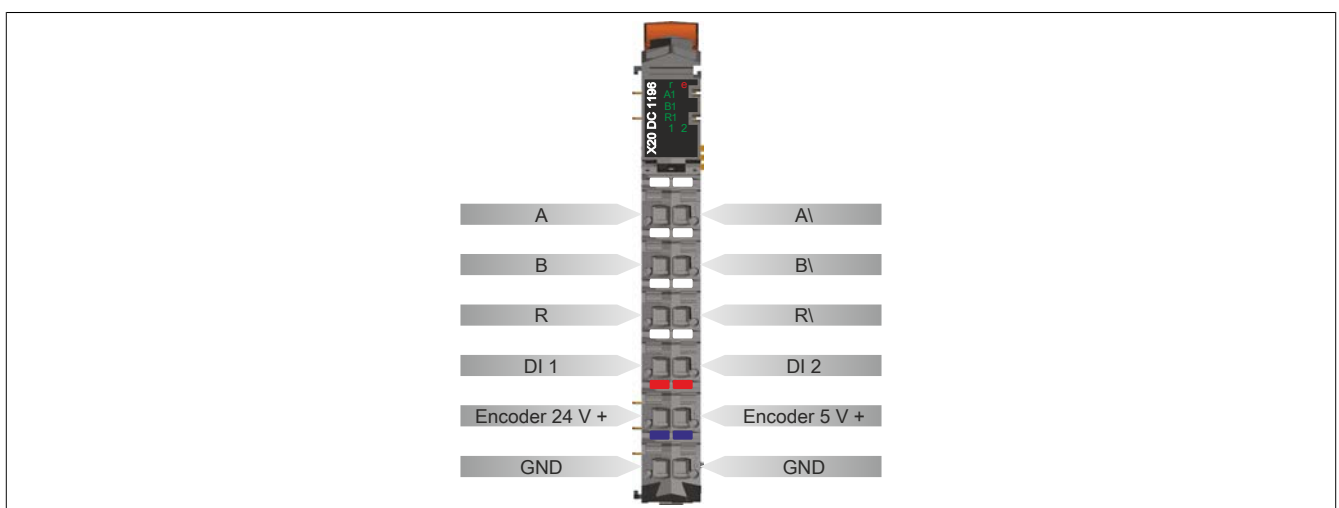
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|--|-------|-------|--|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | A1 | Green | | Input state of counter input A |
| | B1 | Green | | Input state of counter input B |
| | R1 | Green | | Input state of reference pulse R |
| 1 - 2 | Green | | Input state of the corresponding digital input | |

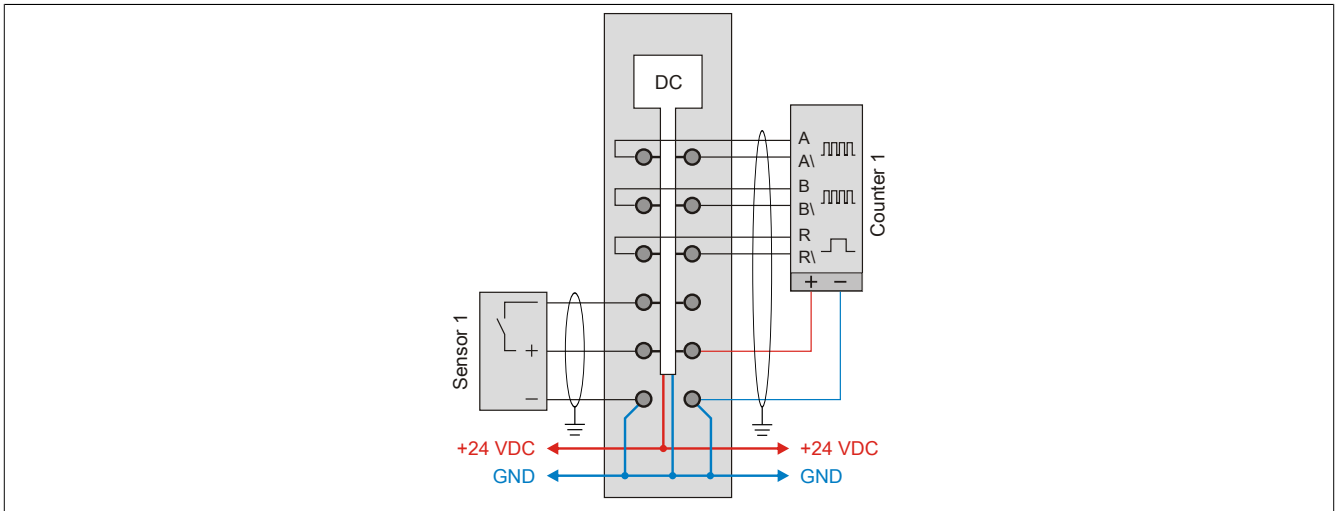
1) Depending on the configuration, a firmware update can take up to several minutes.

9.11.5.6 Pinout

Shielded cables must be used for all signal lines.

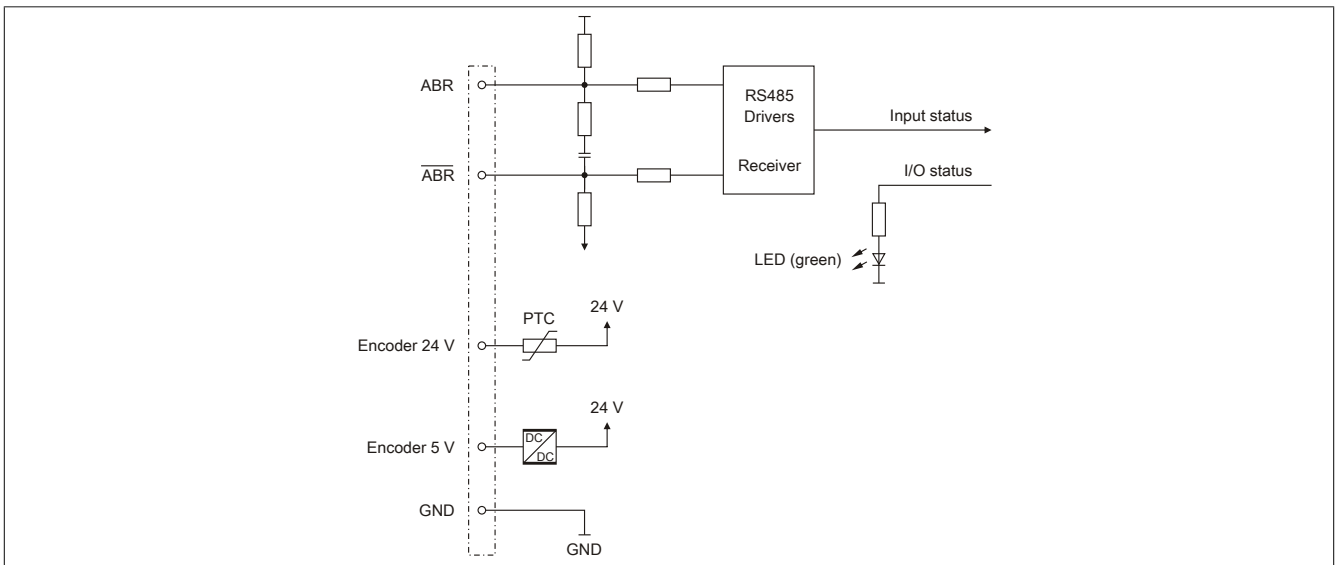


9.11.5.7 Connection example

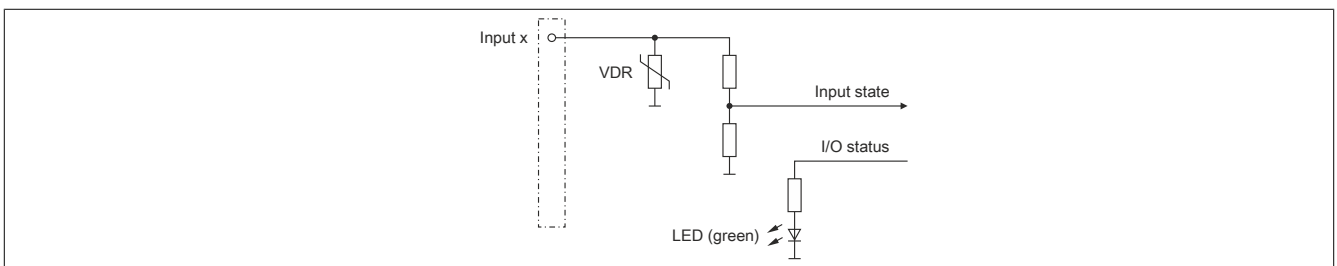


9.11.5.8 Input circuit diagram

Counter inputs



Standard inputs



9.11.5.9 Register description

9.11.5.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.11.5.9.2 Function model 0 - Standard and Function model 1 - Standard with 32-bit encoder counter value

The difference between function model 0 and function model 1 is the size of the data type for some registers.

- Function model 0 uses data type INT
- Function model 1 uses data type DINT (specified in parentheses)

| Register | Name | Data type | Read | | Write | |
|----------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 4104 | CfO_EdgeDetectFalling | USINT | | | | • |
| 4106 | CfO_EdgeDetectRising | USINT | | | | • |
| 2064 | CfO_PresetABR01_1_(32Bit) | (D)INT | | | | • |
| 2068 | CfO_PresetABR01_2_(32Bit) | (D)INT | | | | • |
| 512 | ConfigOutput24 | UINT | | | | • |
| 522 | ConfigOutput26 | USINT | | | | • |
| 520 | ConfigOutput27 | USINT | | | | • |
| Communication | | | | | | |
| 2116 | ReferenceModeEncoder01 | USINT | | | • | |
| 2080 | Encoder01 | (D)INT | • | | | |
| 264 | Input state of digital inputs 1 to 2 | USINT | • | | | |
| | DigitalInput01 | Bit 4 | | | | |
| | DigitalInput02 | Bit 5 | | | | |
| 2118 | StatusInput01 | USINT | • | | | |
| 40 | Status of encoder supplies | USINT | • | | | |
| | PowerSupply01 | Bit 0 | | | | |
| | PowerSupply02 | Bit 1 | | | | |

9.11.5.9.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 4104 | - | CfO_EdgeDetectFalling | USINT | | | | • |
| 4106 | - | CfO_EdgeDetectRising | USINT | | | | • |
| 2064 | - | CfO_PresetABR01_1 | INT | | | | • |
| 2068 | - | CfO_PresetABR01_2 | INT | | | | • |
| 512 | - | ConfigOutput24 | UINT | | | | • |
| 522 | - | ConfigOutput26 | USINT | | | | • |
| 520 | - | ConfigOutput27 | USINT | | | | • |
| Communication | | | | | | | |
| 2116 | 0 | ReferenceModeEncoder01 | USINT | | | • | |
| 2080 | 0 | Encoder01 | INT | • | | | |
| 264 | 2 | Input state of digital inputs 1 to 2 | USINT | • | | | |
| | | DigitalInput01 | Bit 4 | | | | |
| | | DigitalInput02 | Bit 5 | | | | |
| 2118 | 4 | StatusInput01 | USINT | • | | | |
| 40 | 3 | Status of encoder supplies | USINT | • | | | |
| | | PowerSupply01 | Bit 0 | | | | |
| | | PowerSupply02 | Bit 1 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.11.5.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.11.5.9.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.11.5.9.4 ABR encoder - Configuration registers**9.11.5.9.4.1 Reference pulse**

The following registers must be configured by a single acyclic write with the listed values so that the homing procedure is completed on the edge of the reference pulse.

The homing procedure can take place on:

- Rising edge
- Falling edge (default configuration)

Constant register "CfO_EdgeDetectFalling"

Name:

CfO_EdgeDetectFalling

| Data type | Value | Information |
|-----------|-------|---|
| USINT | 0x00 | Configuration value for rising edge |
| | 0x04 | Configuration value for falling edge (bus controller default setting) |

Constant register "CfO_EdgeDetectRising"

Name:

CfO_EdgeDetectRising

| Data type | Value | Information |
|-----------|-------|---|
| USINT | 0x04 | Configuration value for rising edge |
| | 0x00 | Configuration value for falling edge (bus controller default setting) |

Constant register "ConfigOutput24"

Name:

ConfigOutput24

This register contains the value for ABR encoder 1.

| Data type | Value | Information |
|-----------|--------|---|
| UINT | 0x1012 | Configuration value for rising edge |
| | 0x1002 | Configuration value for falling edge (bus controller default setting) |

9.11.5.9.4.2 Setting the home position

Name:

Cfo_PresetABR01_1 to Cfo_PresetABR01_2

CfO_PresetABR01_1_32Bit to CfO_PresetABR01_2_32Bit (only in function model 1)

It is possible to specify 2 home positions with these registers through a one-off acyclic write, for example. The configured values are applied to the counter values after a completed homing procedure.

| Data type | Value | Information |
|--------------------|---------------------------------|-----------------------------------|
| INT | -32,768 to 32,767 | Bus controller default setting: 0 |
| DINT ¹⁾ | -2,147,483,648 to 2,147,483,647 | |

1) Only in function model 1

9.11.5.9.4.3 Homing with reference enable input

Regardless of the referencing mode, it is possible using this register to prevent the home position from being applied when the corresponding reference input voltage level occurs (see ["Input state of digital inputs 1 to 2" on page 1112](#): bit 4). The desired setting can be configured by a one-off acyclic write.

Voltage level for reference enable activation

Name:

ConfigOutput26

The voltage level of the digital inputs to activate reference enable is configured with this register.

| Data type | Value | Information |
|-----------|-------|---|
| USINT | 0x00 | Reference enable is active at 0 VDC (bus controller default setting). |
| | 0x10 | Reference enable for digital input 1 is active at 24 VDC |
| | 0x20 | Reference enable for digital input 2 is active at 24 VDC |
| | 0x30 | Reference enable for both digital inputs is active at 24 VDC |

Reference enable of the input

Name:

ConfigOutput27

This register can be used to define whether the reference enable is activated.

| Data type | Value | Information |
|-----------|-------|--|
| USINT | 0x00 | Reference enable input disabled (bus controller default setting) |
| | 0x10 | Reference enable input 1 enabled |
| | 0x20 | Reference enable input 2 enabled |
| | 0x30 | Reference enable input 1 and 2 enabled |

9.11.5.9.5 ABR encoder - Configuration registers

9.11.5.9.5.1 Counter state of the encoder

Name:
Encoder01

The encoder values are represented as 16-bit or 32-bit counter values in this register.

| Data type | Value |
|--------------------|---------------------------------|
| INT | -32,768 to 32,767 |
| DINT ¹⁾ | -2,147,483,648 to 2,147,483,647 |

1) Only in function model 1

9.11.5.9.5.2 Input state of digital inputs 1 to 2

Name:
DigitalInput01 to DigitalInput02.

This register displays the input status of the encoders and the digital inputs.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

| Bit | Name | Value | Information |
|-----|----------------|--------|--------------------------------|
| 0 | Encoder A | 0 or 1 | Input state |
| 1 | Encoder B | 0 or 1 | Input state |
| 2 | Encoder A + B | 0 or 1 | Input state of reference pulse |
| 4 | DigitalInput01 | 0 or 1 | Input state - Digital input 1 |
| 5 | DigitalInput02 | 0 or 1 | Input state - Digital input 2 |

9.11.5.9.5.3 Reading the referencing mode

Name:
ReferenceModeEncoder01

This register determines the referencing mode.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|------|-------|--------------------------|
| 0 - 1 | | 00 | Referencing OFF |
| | | 01 | Single shot referencing |
| | | 11 | Continuous referencing |
| 2 - 5 | | 0 | Bits permanently set = 0 |
| 6 - 7 | | 00 | Referencing OFF |
| | | 11 | Bits permanently set = 1 |

This results in the following values:

| Binary | Hex | Function |
|----------|------|-------------------------|
| 00000000 | 0x00 | Referencing OFF |
| 11000001 | 0xC1 | Single shot referencing |

For a new start after the completed homing procedure:

- Write value 0x00
- Wait until bit 0 to bit 3 of the StatusInput01 register takes on the value 0. Counter bits 4 to 7 are not erased
- Switch homing procedure on again

| | | |
|----------|------|--|
| 11000011 | 0xC3 | Continuous referencing Referencing occurs at every reference pulse. |
|----------|------|--|

It is important to know how the optional reference enable is configured. See ["Homing with reference enable input" on page 1111](#)

9.11.5.9.5.4 Status of the homing procedure

Name:

StatusInput01

This register contains information regarding whether the referencing process is off, active or complete.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|--|--------|--|
| 0 | Reference pulse without homing ¹⁾ | 0 | No reference impulse without homing has occurred yet |
| | | 1 | At least a reference impulse without homing has occurred |
| 1 | State change | 0 or 1 | Changes with each reference pulse without homing |
| 2 | Reference pulse with homing ¹⁾ | 0 | No homing has occurred yet |
| | | 1 | At least one homing procedure has occurred |
| 3 | State change | 0 or 1 | Changes with each homing procedure that has taken place |
| 4 | Reference pulse | 0 | The last reference pulse didn't bring about a homing procedure |
| | | 1 | The last reference pulse brought about a homing procedure |
| 5 - 7 | Counter | x | Free-running counter, increased with each reference pulse |

1) Always 1 after the first reference pulse that has occurred

Examples of possible values:

| Binary | Hex | Function |
|------------|-------|---|
| 0x00000000 | 0x00 | Referencing OFF or homing procedure already active |
| 0x00111100 | 0x3CE | First homing procedure complete Reference value applied in the Encoder01 register |
| 0xxxx11100 | 0xxB | Bits 5 to 7 are changed with each reference pulse |
| 0xxxx1x100 | 0xxx | Continuously changing the bits with the "Continuous referencing" setting. The reference value is applied to the Encoder01 register on each reference pulse. |

It is important to know how the optional reference enable (see "[Homing with reference enable input](#)" on page 1111) is configured.

9.11.5.9.5.5 Status of encoder supplies

Name:

PowerSupply01 to PowerSupply02

This register shows the status of the integrated encoder supplies. A faulty encoder power supply is displayed as a warning.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---------------|-------|------------------------------------|
| 0 | PowerSupply01 | 0 | 24 VDC encoder power supply OK |
| | | 1 | 24 VDC encoder power supply faulty |
| 1 | PowerSupply02 | 0 | 5 VDC encoder power supply OK |
| | | 1 | 5 VDC encoder power supply faulty |
| 2 - 7 | Reserved | - | |

9.11.5.9.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 128 μ s |

9.11.5.9.7 Maximum cycle time

The maximum cycle time specifies the time up to which the bus cycle can be increased without internal counter overflows causing module malfunctions.

| Minimum cycle time |
|--------------------|
| 16 ms |

9.11.5.9.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 128 μ s |

9.11.6 X20(c)DC1198

Data sheet version: 3.23

9.11.6.1 General information

This module is equipped with one input for SSI absolute encoders with 5 V encoder signal.

- 1 SSI absolute encoder 5 V
- 2 additional inputs
- 5 VDC, 24 VDC and GND for encoder supply

9.11.6.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.11.6.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.11.6.3 Order data

| Model number | Short description | Figure |
|--------------|---|--------|
| | Counter functions | |
| X20DC1198 | X20 digital counter module, 1 SSI absolute encoder, 5 V, 1 Mbit/s, 32-bit | |
| X20cDC1198 | X20 digital counter module, coated, 1 SSI absolute encoders, 5 V, 1 Mbit/s, 32-bit | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 199: X20DC1198, X20cDC1198 - Order data

9.11.6.4 Technical data

| Model number | X20DC1198 | X20cDC1198 |
|--|--|------------|
| Short description | | |
| I/O module | 1 SSI absolute encoder 5 V | |
| General information | | |
| B&R ID code | 0x1BB0 | 0xE501 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnosics | | |
| Module run/error | Yes, using status LED and software | |
| Power consumption | | |
| Bus | 0.01 W | |
| Internal I/O | 1.5 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Type of signal lines | Shielded cables must be used for all signal lines | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Digital inputs | | |
| Quantity | 2 | |
| Nominal voltage | 24 VDC | |
| Input characteristics per EN 61131-2 | Type 1 | |
| Input voltage | 24 VDC -15 % / +20 % | |
| Input current at 24 VDC | Approx. 3.3 mA | |
| Input circuit | Sink | |
| Input filter | | |
| Hardware | ≤2 µs | |
| Software | - | |
| Connection type | 3-wire connections | |
| Input resistance | 7.19 kΩ | |
| Switching threshold | | |
| Low | <5 VDC | |
| High | >15 VDC | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| SSI absolute encoder | | |
| Encoder inputs | 5 V, symmetrical | |
| Counter size | 32-bit | |
| Max. transfer rate | 1 Mbit/s | |
| Keying | Gray/Binary | |
| Isolation voltage between encoder and bus | 500 V _{eff} | |
| Overload characteristics of encoder power supply | Short circuit protection, overload protection | |
| Transfer rate | 125 kbit/s / 250 kbit/s / 500 kbit/s / 1 Mbit/s | |
| Encoder power supply | | |
| 5 VDC | ±5%, module-internal, max. 300 mA | |
| 24 VDC | Module-internal, max. 300 mA | |
| Electrical properties | | |
| Electrical isolation | Bus isolated from encoder and channel Channel not isolated from channel and encoder | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |


Table 200: X20DC1198, X20cDC1198 - Technical data

| Model number | X20DC1198 | X20cDC1198 |
|---------------------------------|--|---|
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 200: X20DC1198, X20cDC1198 - Technical data

9.11.6.5 LED status indicators

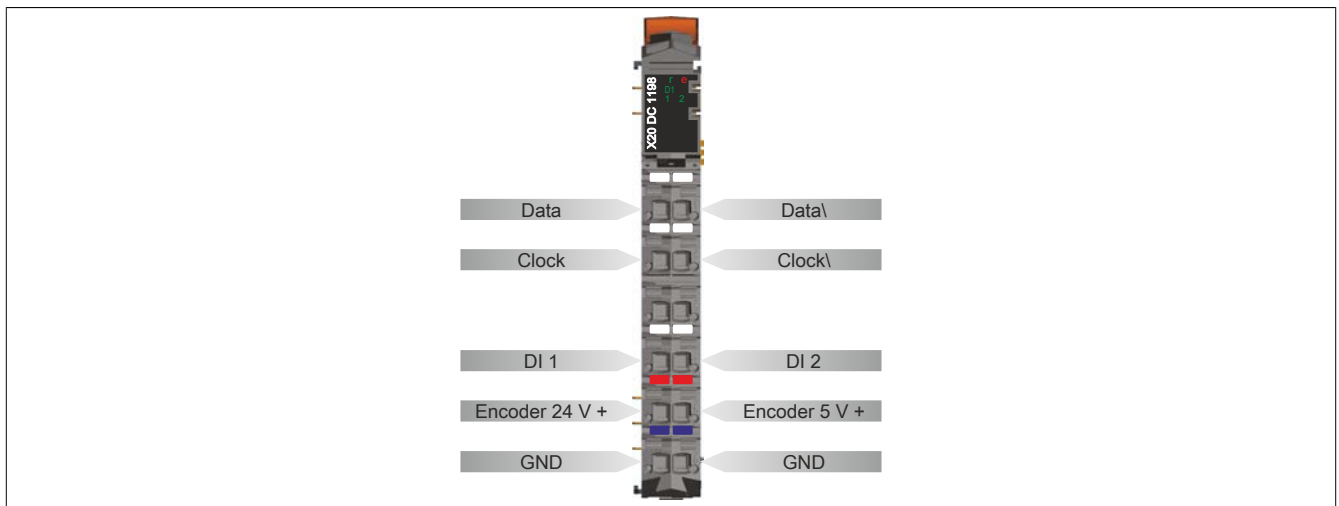
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|--|-------|-------|--------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | D1 | Green | | Input status - Data signal |
| | 1 - 2 | Green | | Input state of the corresponding digital input |

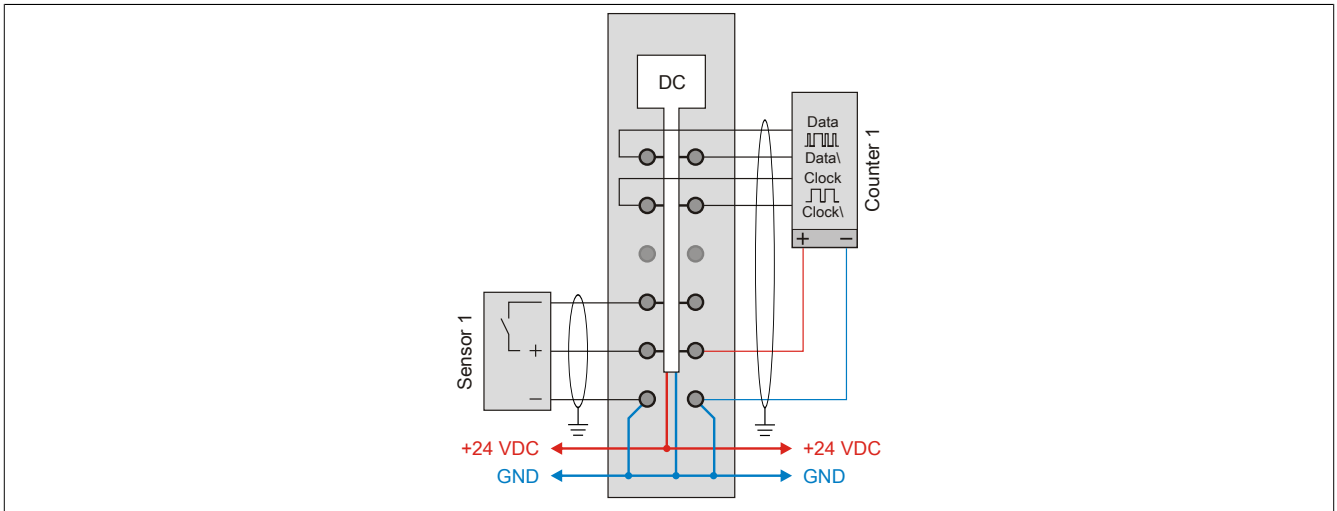
1) Depending on the configuration, a firmware update can take up to several minutes.

9.11.6.6 Pinout

Shielded cables must be used for all signal lines.

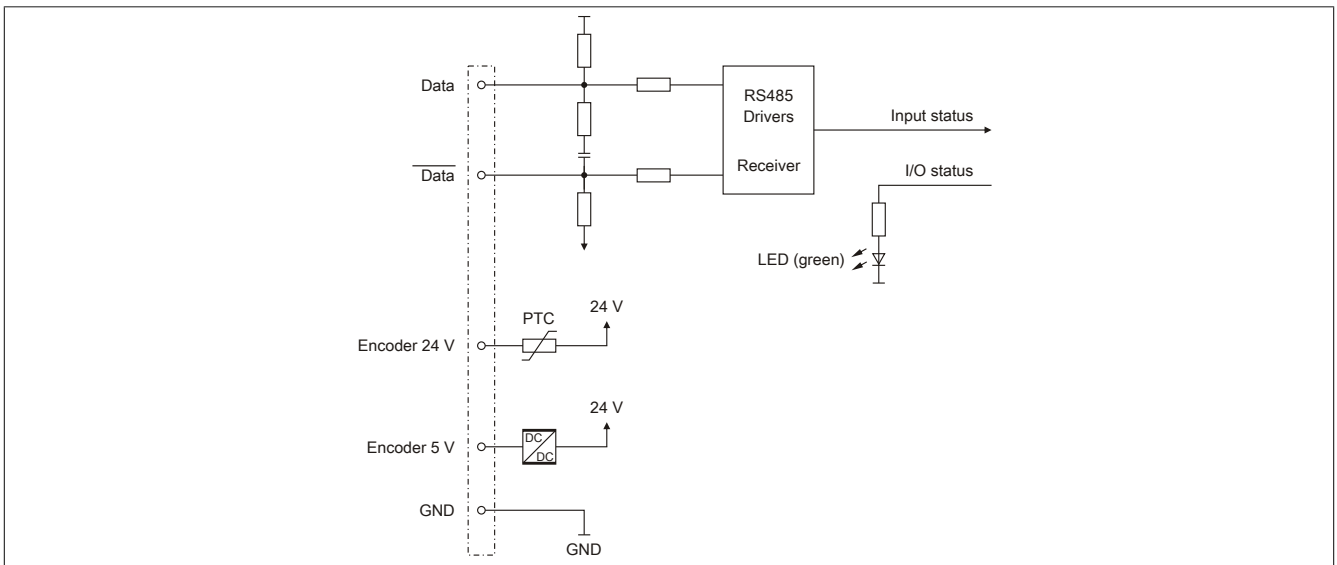


9.11.6.7 Connection example

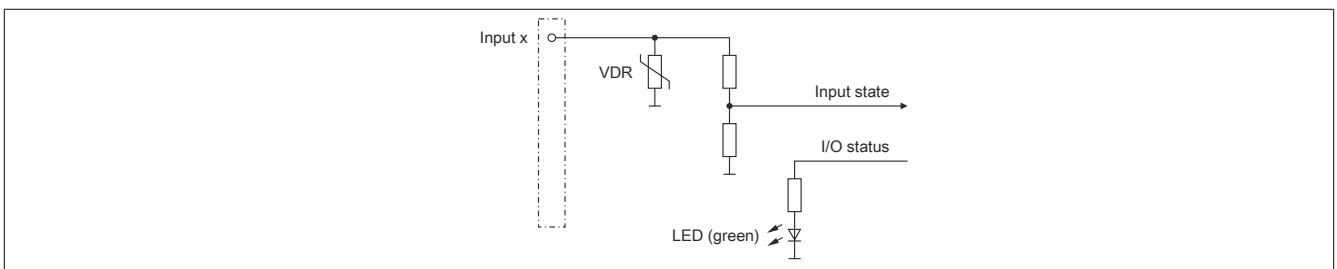


9.11.6.8 Input circuit diagram

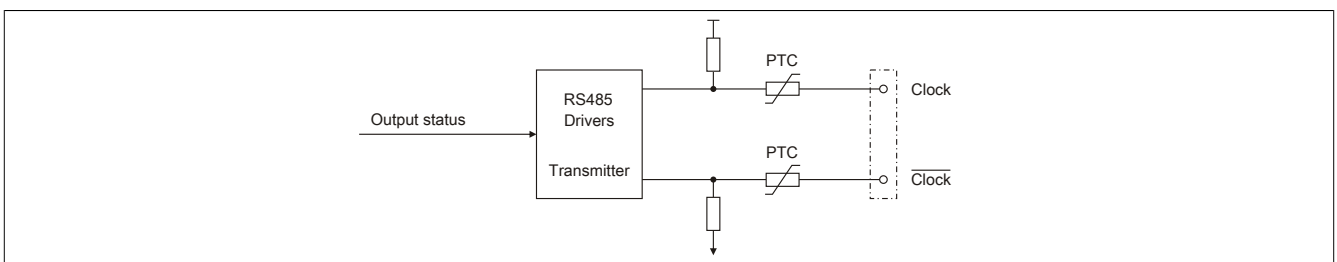
Counter input



Standard inputs



9.11.6.9 Output circuit diagram



9.11.6.10 Register description

9.11.6.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.11.6.10.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 7176 | ConfigOutput14 | UINT | | | | • |
| 7172 | ConfigAdvanced | UDINT | | | | • |
| Communication | | | | | | |
| 7184 | Encoder01 | UDINT | • | | | |
| 264 | Input state of digital inputs 1 to 2 | USINT | • | | | |
| | DigitalInput01 | Bit 4 | | | | |
| | DigitalInput02 | Bit 5 | | | | |
| 40 | Status of encoder supplies | USINT | • | | | |
| | PowerSupply01 | Bit 0 | | | | |
| | PowerSupply02 | Bit 1 | | | | |

9.11.6.10.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 7176 | - | ConfigOutput14 | UINT | | | | • |
| 7172 | - | ConfigAdvanced | UDINT | | | | • |
| Communication | | | | | | | |
| 7184 | 0 | Encoder01 | UDINT | • | | | |
| 264 | 4 | Input state of digital inputs 1 to 2 | USINT | • | | | |
| | | DigitalInput01 | Bit 4 | | | | |
| | | DigitalInput02 | Bit 5 | | | | |
| 40 | 5 | Status of encoder supplies | USINT | • | | | |
| | | PowerSupply01 | Bit 0 | | | | |
| | | PowerSupply02 | Bit 1 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.11.6.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.11.6.10.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.11.6.10.4 SSI encoder configuration registers

9.11.6.10.4.1 Standard configuration

Name:

ConfigOutput14

This configuration register sets the encoding, clock rate and number of bits. Default = 0. This must be set once using an acyclic write command.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Name | Value | Information |
|--------|----------------------|-------|--|
| 0 - 5 | SSI value valid bits | x | Bus controller default setting: 0 |
| 6 - 7 | Clock rate | 00 | 1 MHz (bus controller default setting) |
| | | 01 | 500 kHz |
| | | 10 | 250 kHz |
| | | 11 | 125 kHz |
| 8 - 13 | SSI number of bits | x | Number of bits including leading zeros. Bus controller default setting: 0 |
| 14 | Reserved | 0 | |
| 15 | Keying | 0 | Binary encoding (bus controller default setting) |
| | | 1 | Gray coding |

9.11.6.10.4.2 Extended configuration

Name:

ConfigAdvanced

This configuration register is used to set the encoding, clock rate, number of bits and monostable multivibrator settings. This must be set once using an acyclic write command.

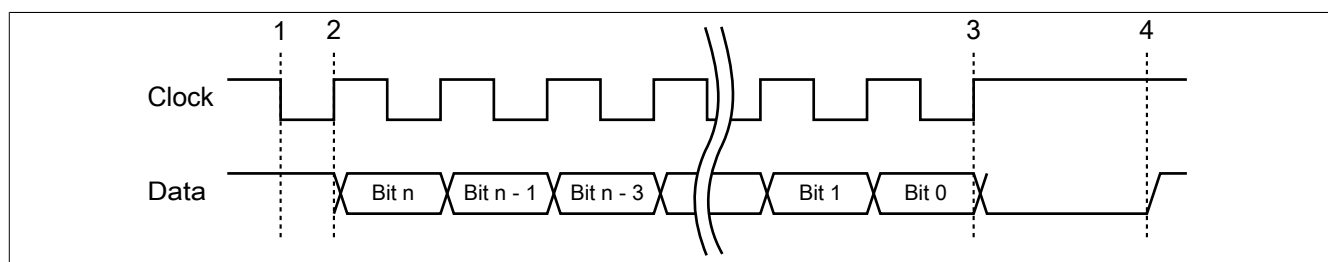
It only differs from "ConfigOutput14" on page 1120 by data length and additional monostable multivibrator testing.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UDINT | See the bit structure. | 65536 |

Bit structure:

| Bit | Name | Value | Information |
|---------|----------------------------------|-------|--|
| 0 - 5 | SSI value valid bits | x | Bus controller default setting: 0 |
| 6 - 7 | Clock rate | 00 | 1 MHz (bus controller default setting) |
| | | 01 | 500 kHz |
| | | 10 | 250 kHz |
| | | 11 | 125 kHz |
| 8 - 13 | SSI number of bits | x | Number of bits including leading zeros. Bus controller default setting: 0 |
| 14 | Reserved | 0 | |
| 15 | Keying | 0 | Binary encoding (bus controller default setting) |
| | | 1 | Gray coding |
| 16 - 17 | Monostable multivibrator testing | 00 | Check OFF, no additional clock bit |
| | | 01 | Check set to high level (bus controller default setting) |
| | | 10 | Check set to Low level |
| | | 11 | Level is clocked but ignored |
| 18 - 31 | Reserved | 0 | Reserved |

Transferring using Synchronous Serial Interface



Processing the measured value

- 1) Start bit ... The measured value is saved.
- 2) Output of the first data bit
- 3) All data bits are transferred; the monostable multivibrator time starts to run.
- 4) The monostable multivibrator returns to its initial state; a new transfer can be started.

9.11.6.10.5 SSI encoder communication registers

9.11.6.10.5.1 SSI position values

Name:
Encoder01

The SSI encoder value is displayed as a 32-bit position value. The SSI position value is generated synchronously with the X2X cycle.

| Data type | Value | Filter |
|-----------|--------------------|--------------|
| UDINT | 0 to 4,294,967,295 | SSI position |

9.11.6.10.5.2 Input state of digital inputs 1 to 2

Name:
DigitalInput01 to DigitalInput02

This register is used to indicate the input state of digital inputs 1 to 2.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|--------|-------------------------------|
| 4 | DigitalInput01 | 0 or 1 | Input state - Digital input 1 |
| 5 | DigitalInput02 | 0 or 1 | Input state - Digital input 2 |

9.11.6.10.5.3 Status of encoder supplies

Name:
PowerSupply01 to PowerSupply02

This register shows the status of the integrated encoder supplies. A faulty encoder power supply is displayed as a warning.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---------------|-------|------------------------------------|
| 0 | PowerSupply01 | 0 | 24 VDC encoder power supply OK |
| | | 1 | 24 VDC encoder power supply faulty |
| 1 | PowerSupply02 | 0 | 5 VDC encoder power supply OK |
| | | 1 | 5 VDC encoder power supply faulty |
| 2 - 7 | Reserved | - | |

9.11.6.10.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 128 μ s |

9.11.6.10.7 Maximum cycle time

The maximum cycle time specifies the time up to which the bus cycle can be increased without internal counter overflows causing module malfunctions.

| Minimum cycle time |
|--------------------|
| 16 ms |

9.11.6.10.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 128 μ s |

9.11.7 X20DC11A6

Data sheet version: 2.21

9.11.7.1 General information

The module is equipped with 1 input for an ABR incremental encoder with RS422-based output signals and 5 V encoder supply. The encoder inputs are monitored (A, B, R, A\, B\, R\).

- 1 ABR incremental encoder 5 V
- Encoder input monitoring (up to 250 kHz input frequency)
- 2 additional inputs, e.g. for latch input
- 5 VDC, 24 VDC and GND for encoder supply
- NetTime timestamp: Counter change

NetTime timestamp of the counter

For many applications, not only the counter value is important, but also the exact time of the counter change. For this purpose, the module has a NetTime function that provides the recorded counter value with a timestamp accurate to microseconds.

The module provides the PLC with the counter value and timestamp as an absolute time value. The NetTime mechanisms ensure that the PLC NetTime clock and the local NetTime clock on the module have the same absolute time at all times.

9.11.7.2 Order data


| Model number | Short description | Figure |
|--------------|--|--|
| | Counter functions |  |
| X20DC11A6 | X20 digital counter module, 1 ABR incremental encoder, 5 V, 5 MHz input frequency, 4x evaluation, encoder monitoring, NetTime function | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 201: X20DC11A6 - Order data

9.11.7.3 Technical data

| | |
|--|--|
| Model number | X20DC11A6 |
| Short description | |
| I/O module | 1 ABR incremental encoder 5 V |
| General information | |
| B&R ID code | 0xB76B |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Type of signal lines | Shielded cables must be used for all signal lines. |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| Digital inputs | |
| Quantity | 2 |
| Nominal voltage | 24 VDC |
| Input characteristics per EN 61131-2 | Type 1 |
| Input voltage | 24 VDC -15% / +20% |
| Input current at 24 VDC | Approx. 3.3 mA |
| Input circuit | Sink |
| Input filter | |
| Hardware | ≤2 μs |
| Software | - |
| Connection type | 3-wire connections |
| Input resistance | 7.03 kΩ |
| Additional functions | Latch input |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| ABR incremental encoder | |
| Encoder inputs | 5 V, symmetrical |
| Counter size | 16/32-bit |
| Input frequency | Max. 5 MHz |
| Evaluation | 4x |
| Minimum diff. slew rate | 1 V/μs |
| Encoder power supply | |
| 5 VDC | ±5%, module-internal, max. 300 mA |
| 24 VDC | Module-internal, max. 300 mA |
| Input filter | |
| Hardware | ≤30 ns |
| Software | - |
| Switching threshold | |
| Low | >1 V |
| Common-mode range | -10 V ≤ V _{CM} ≤ +13.2 V |
| Overload characteristics of encoder power supply | Short-circuit proof, overload-proof |
| Isolation voltage between encoder and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |


Table 202: X20DC11A6 - Technical data

| Model number | X20DC11A6 |
|--|--|
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x bus module X20BM11 separately. |
| Spacing | 12.5 ^{+0.2} mm |

Table 202: X20DC11A6 - Technical data

9.11.7.4 LED status indicators

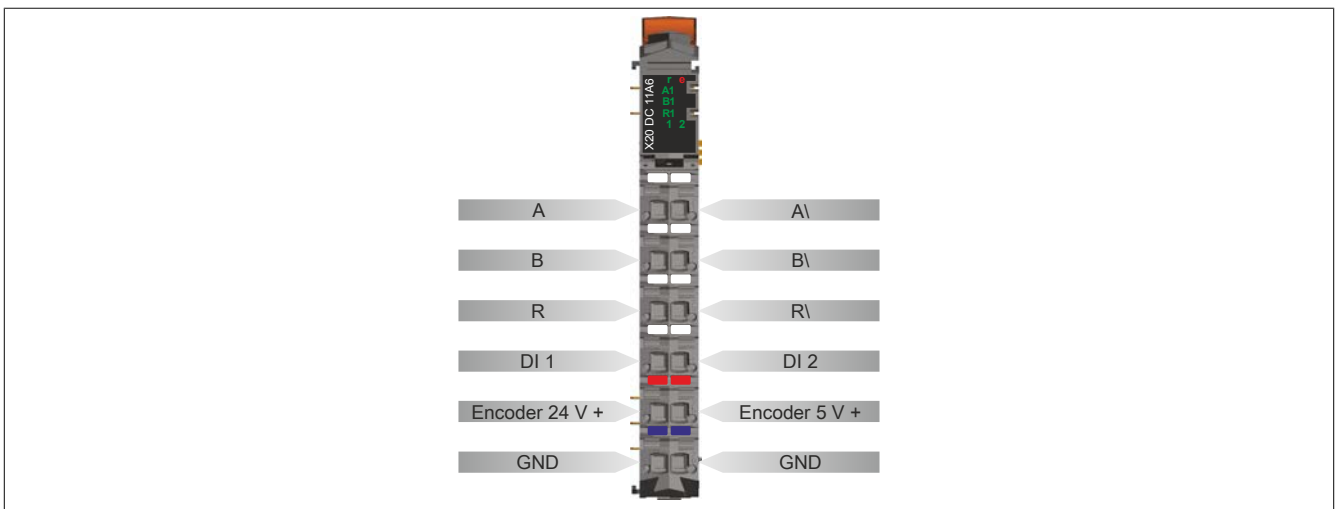
For a description of the various operating modes, see ["Diagnostic LEDs" on page 3787](#).

| Figure | LED | Color | Status | Description |
|--|-------|-------|--|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Single flash | The encoder monitor has detected a line fault on the encoder inputs. The status bits must be evaluated in order to provide a more detailed definition of this error. The following error states are detected: <ul style="list-style-type: none"> Broken connection (up to 250 kHz input frequency) Short-circuit or voltage level too low |
| | | | On | Error or reset status |
| | A1 | Green | | Input state of counter input A |
| | B1 | Green | | Input state of counter input B |
| R1 | Green | | Input state of reference pulse R | |
| 1 - 2 | Green | | Input state of the corresponding digital input | |

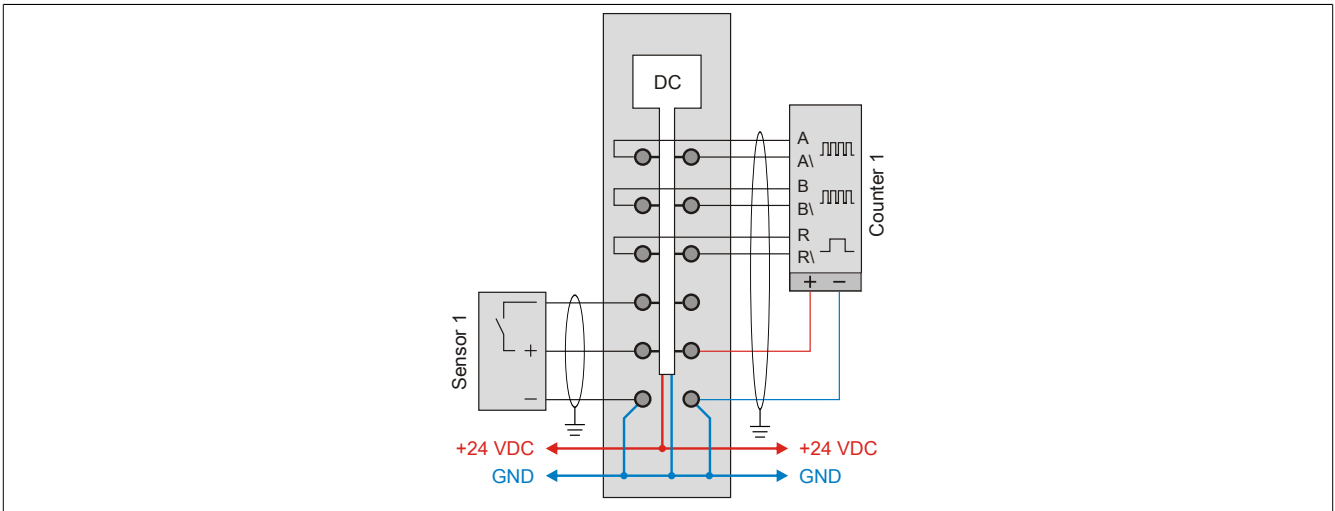
1) Depending on the configuration, a firmware update can take up to several minutes.

9.11.7.5 Pinout

Shielded cables must be used for all signal lines.

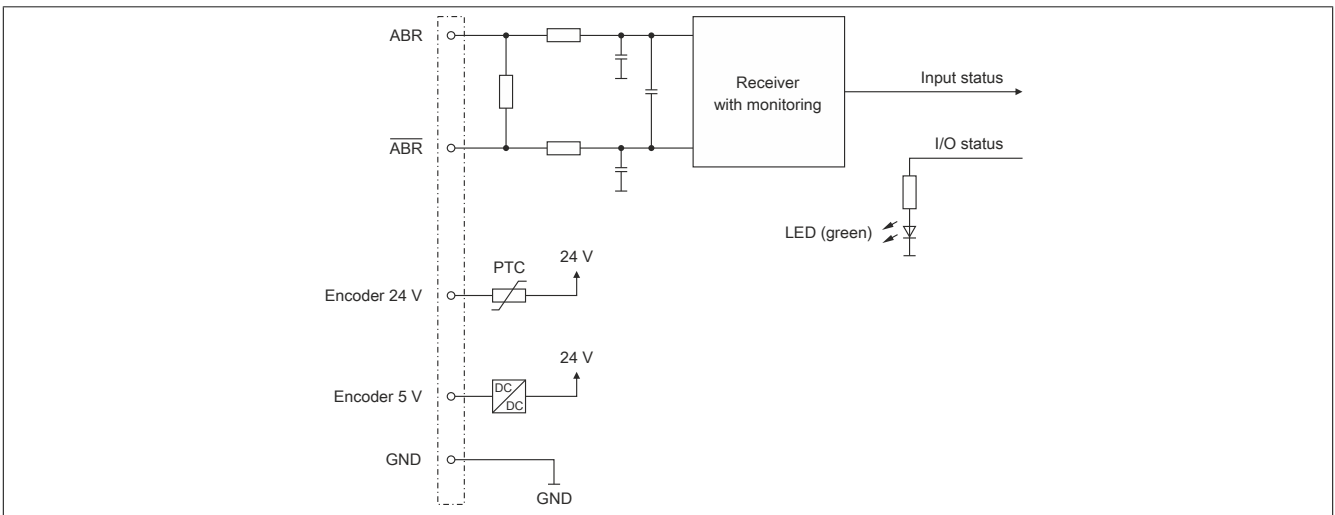


9.11.7.6 Connection example

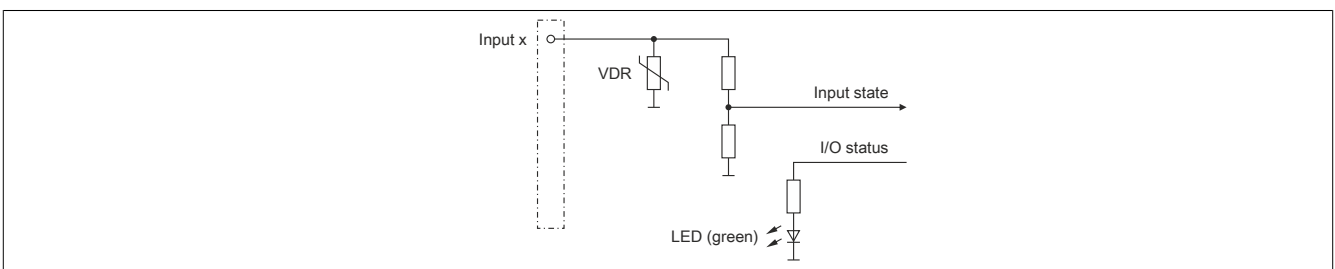


9.11.7.7 Input circuit diagram

Counter inputs



Standard inputs



9.11.7.8 Register description

9.11.7.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.11.7.8.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 513 | CfO_SlframeGenID | USINT | | | | • |
| 642 | CfO_SystemCycleTime | UINT | | | | • |
| 769 | CfO_PhylIOConfigCh01 | USINT | | | | • |
| 771 | CfO_PhylIOConfigCh02 | USINT | | | | • |
| 773 | CfO_PhylIOConfigCh03 | USINT | | | | • |
| 777 | CfO_PhylIOConfigCh04 | USINT | | | | • |
| 779 | CfO_PhylIOConfigCh05 | USINT | | | | • |
| 815 | CfO_BWQuitTimeSelChannel7_0 | USINT | | | | • |
| 820 | CfO_BWQuitTime_0 | UDINT | | | | • |
| 6145 | CfO_CounterCycleSelect | USINT | | | | • |
| 6147 | CfO_CounterMode | USINT | | | | • |
| 6149 | CfO_LatchMode | USINT | | | | • |
| 6151 | CfO_LatchComparator | USINT | | | | • |
| 6159 | CfO_BWCNTEnableMaskChannel7_0 | USINT | | | | • |
| Communication | | | | | | |
| 683 | SDCLifeCount | SINT | • | | | |
| 6342 | Encoder01 | INT | • | | | |
| 6340 | | DINT | | | | |
| 6310 | Encoder01TimeValid | INT | • | | | |
| 6308 | | DINT | | | | |
| 6358 | Encoder01Latch | INT | • | | | |
| 6356 | | DINT | | | | |
| 6153 | Encoder commands | USINT | | | • | |
| | Encoder01Reset | Bit 0 | | | | |
| | Encoder01LatchEnable | Bit 1 | | | | |
| 927 | Input status of signal lines | USINT | • | | | |
| | Encoder01_A | Bit 0 | | | | |
| | Encoder01_B | Bit 1 | | | | |
| | Encoder01_R | Bit 2 | | | | |
| | DigitalInput01 | Bit 4 | | | | |
| | DigitalInput02 | Bit 5 | | | | |
| 847 | Status of signal lines | USINT | • | | | |
| | BW_Channel_A | Bit 0 | | | | |
| | BW_Channel_B | Bit 1 | | | | |
| | BW_Channel_R | Bit 2 | | | | |
| 811 | Acknowledging error status of signal lines | USINT | | | • | |
| | BW_QuitChannel_A | Bit 0 | | | | |
| | BW_QuitChannel_B | Bit 1 | | | | |
| | BW_QuitChannel_R | Bit 2 | | | | |
| 6326 | Encoder01TimeChanged | INT | • | | | |
| 6324 | | DINT | | | | |
| 6303 | Encoder01LatchCount | SINT | • | | | |
| 843 | Status of encoder supplies | USINT | • | | | |
| | PowerSupply01 | Bit 0 | | | | |
| | PowerSupply02 | Bit 1 | | | | |

9.11.7.8.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 513 | - | CfO_SlframeGenID | USINT | | | | • |
| 642 | - | CfO_SystemCycleTime | UINT | | | | • |
| 769 | - | CfO_PhylIOConfigCh01 | USINT | | | | • |
| 771 | - | CfO_PhylIOConfigCh02 | USINT | | | | • |
| 773 | - | CfO_PhylIOConfigCh03 | USINT | | | | • |
| 777 | - | CfO_PhylIOConfigCh04 | USINT | | | | • |
| 779 | - | CfO_PhylIOConfigCh05 | USINT | | | | • |
| 815 | - | CfO_BWQuitTimeSelChannel7_0 | USINT | | | | • |
| 820 | - | CfO_BWQuitTime_0 | UDINT | | | | • |
| 6145 | - | CfO_CounterCycleSelect | USINT | | | | • |
| 6147 | - | CfO_CounterMode | USINT | | | | • |
| 6149 | - | CfO_LatchMode | USINT | | | | • |
| 6151 | - | CfO_LatchComparator | USINT | | | | • |
| 6159 | - | CfO_BWCNTEnableMaskChannel7_0 | USINT | | | | • |
| Communication | | | | | | | |
| 6342 | 0 | Encoder01 | INT | • | | | |
| 6310 | 2 | Encoder01TimeValid | INT | • | | | |
| 6358 | 4 | Encoder01Latch | INT | • | | | |
| 6153 | 1 | Encoder commands | USINT | | | • | |
| | | Encoder01Reset | Bit 0 | | | | |
| | | Encoder01LatchEnable | Bit 1 | | | | |
| 927 | 7 | Input status of signal lines | USINT | • | | | |
| | | Encoder01_A | Bit 0 | | | | |
| | | Encoder01_B | Bit 1 | | | | |
| | | Encoder01_R | Bit 2 | | | | |
| | | DigitalInput01 | Bit 4 | | | | |
| | | DigitalInput02 | Bit 5 | | | | |
| 847 | 6 | Status of signal lines | USINT | • | | | |
| | | BW_Channel_A | Bit 0 | | | | |
| | | BW_Channel_B | Bit 1 | | | | |
| | | BW_Channel_R | Bit 2 | | | | |
| 811 | 0 | Acknowledging error status of signal lines | USINT | | | • | |
| | | BW_QuitChannel_A | Bit 0 | | | | |
| | | BW_QuitChannel_B | Bit 1 | | | | |
| | | BW_QuitChannel_R | Bit 2 | | | | |
| 6326 | - | Encoder01TimeChanged | INT | | • | | |
| 6303 | - | Encoder01LatchCount | SINT | | • | | |
| 843 | - | Status of encoder supplies | USINT | | • | | |
| | | PowerSupply01 | Bit 0 | | | | |
| | | PowerSupply02 | Bit 1 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.11.7.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.11.7.8.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.11.7.8.4 Encoder - Configuration

The following registers are used for setting functions and configuring the module.

9.11.7.8.4.1 Enabling error monitoring for the signal lines

Name:

CfO_BWCNTEnableMaskChannel7_0

This register requires individually enabling error monitoring for each of the signal channels. "Open line", "short circuit" and "voltage level too low" are reported as error states. Any errors that occur are reported in the error status registers "BW_Channel_x" on page 1132.

| Data type | Value | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| USINT | See bit structure. | 7 |

Bit structure:

| Bit | Name | Value | Information |
|-------|--|-------|--|
| 0 | Enable error monitoring for signal A lines | 0 | Error monitoring - Encoder Signal A disabled |
| | | 1 | Error monitoring - Encoder signal A enabled (bus controller default setting) |
| 1 | Enable error monitoring for signal B lines | 0 | Error monitoring - Encoder Signal B disabled |
| | | 1 | Error monitoring - Encoder signal B enabled (bus controller default setting) |
| 2 | Enable error monitoring for signal R lines | 0 | Error monitoring - Encoder Signal R disabled |
| | | 1 | Error monitoring - Encoder signal R enabled (bus controller default setting) |
| 3 - 7 | Reserved | 0 | |

9.11.7.8.4.2 Timing for automatic error acknowledgment

Name:

CfO_BWQuitTime_0

This register can be used to enable an additional [automatic acknowledgment](#) of the error status through timing. If a valid time is set, then the acknowledgment can still be made [manually](#), the only difference is that automatic acknowledgment will take place on the module after the defined amount of time has passed. If the error state has not yet been corrected, then the error status remains and the time is reset. Make sure that the time is set long enough for the higher-level system to reliably detect the status messages.

If the timing = 0, then acknowledgment is only possible using the cyclic acknowledgment registers.

| Data type | Value | Information |
|-----------|--------------------|--|
| UDINT | 0 | No automatic acknowledgment. Bus controller default setting |
| | 1 to 2.147.483.647 | Time for automatic acknowledgment [µs] |

9.11.7.8.4.3 Setting the latch mode

Name:

CfO_LatchMode

This register is used to set the latch mode:

- Single shot latch mode:
The latch function must be enabled/set. After a successful latch procedure, the activation must be reset in order for a new latch procedure to be activated.
- Continuous latch mode:
The latch function only has to be enabled/set as long as latching is desired.

A changed counter state on "[Encoder01LatchCount](#)" on page 1131 indicates that the latch procedure has been performed. The counter value is stored in the latch register "[Encoder01Latch](#)" on page 1131.

| Data type | Value | Information |
|-----------|-------|--|
| USINT | 0 | Single-shot latch procedure (bus controller default setting) |
| | 1 | Continuous latch procedure |

9.11.7.8.4.4 Signal channels for triggering latch procedure

Name:

CfO_LatchComparator

This register defines the signal channels and their level for triggering the latch procedure.

- This mainly configures which channels are linked to generate the latch event. All three signals from the encoder and digital input 1 can be used for the "AND" operation.
- The "active voltage level" needed for the latch procedure can now be used according to the physical signals.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Name | Value | Information |
|-----|---|-------|---|
| 0 | Defines signal level for encoder signal A | 0 | Low (bus controller default setting) |
| | | 1 | High |
| 1 | Defines signal level for encoder signal B | 0 | Low (bus controller default setting) |
| | | 1 | High |
| 2 | Defines signal level for encoder signal R | 0 | Low (bus controller default setting) |
| | | 1 | High |
| 3 | Defines signal level for digital input 1 | 0 | Low (bus controller default setting) |
| | | 1 | High |
| 4 | Use encoder signal A to trigger latch procedure | 0 | Disabled (bus controller default setting) |
| | | 1 | Latch function linked to encoder signal A |
| 5 | Use encoder signal B to trigger latch procedure | 0 | Disabled (bus controller default setting) |
| | | 1 | Latch function linked to encoder signal B |
| 6 | Use encoder signal R to trigger latch procedure | 0 | Disabled (bus controller default setting) |
| | | 1 | Latch function linked to encoder signal R |
| 7 | Use digital input 1 to trigger latch procedure | 0 | Disabled (bus controller default setting) |
| | | 1 | Latch function linked to digital input 1 |

9.11.7.8.4.5 Physical configuration

The following registers must be set to the specified constant value for correct physical configuration:

Constant register "CfO_SlframeGenID"

Name:

CfO_SlframeGenID

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 9 | Bus controller default setting |

Constant register "CfO_SystemCycleTime"

Name:

CfO_SystemCycleTime

Cycle time of encoder acquisition in 1/8 μ s steps. 1 encoder value is acquired as the counter value per cycle.

| Data type | Value | Information |
|-----------|-------|--|
| UINT | 800 | 800 = 100 μ s. Bus controller default setting |

Constant register "CfO_PhyIOConfigCh0x"

Name:

CfO_PhyIOConfigCh01 to CfO_PhyIOConfigCh05

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 0 | Bus controller default setting |

Constant register "CfO_BWQuitTimeSelChannel7_0"

Name:

CfO_BWQuitTimeSelChannel7_0

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 0 | Bus controller default setting |

Constant register "CfO_CounterCycleSelect"

Name:

CfO_CounterCycleSelect

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 2 | Bus controller default setting |

Constant register "CfO_CounterMode"

Name:

CfO_CounterMode

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 3 | Bus controller default setting |

9.11.7.8.5 Encoder - Communication**9.11.7.8.5.1 Counter for verifying the data frame**

Name:

SDCLifeCount

The 8-bit counter register is needed for the SDC software package. It is incremented with the system clock to allow the SDC to check the validity of the data frame.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

9.11.7.8.5.2 Display of the counter state

Name:

Encoder01

The counter state of the incremental encoder is displayed as a 16 or 32-bit counter value. Only the 16-bit value is available in the bus controller function model.

| Data type | Value |
|--------------------|----------------------------------|
| INT | -32768 to 32767 |
| DINT ¹⁾ | -2.147.483.648 bis 2.147.483.647 |

1) Can only be configured in the standard function model

9.11.7.8.5.3 NetTime of the last valid counter value

Name:

Encoder01TimeValid

The NetTime of the last valid counter value is the time of the last valid counter value recorded on the module (see register "[Cfo_SystemCycleTime](#)" on page 1129). The user is able to determine the validity of the counter value by evaluating its age in the program. This means that the module and error status bits do not have to be checked additionally to determine the validity of the value.

The NetTime of the last valid counter value that was read is displayed as a 16 or 32-bit value. Only the 16-bit value is available in the bus controller function model.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Value | Information |
|--------------------|---------------------------------|--------------------|
| INT | -32768 to 32767 | NetTime in μ s |
| DINT ¹⁾ | -2.147.483.648 to 2.147.483.647 | |

1) Can only be configured in the standard function model

9.11.7.8.5.4 NetTime of the last counter value change

Name:

Encoder01TimeChanged

For slow X2X Link cycles, the NetTime of the last counter value change can be used to determine the speed more accurately.

The NetTime of the last counter value change is displayed as a 16 or 32-bit value. Only the 16-bit value is available in the bus controller function model.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Value | Information |
|--------------------|---------------------------------|--------------------|
| INT | -32768 to 32767 | NetTime in μ s |
| DINT ¹⁾ | -2.147.483.648 to 2.147.483.647 | |

1) Can only be configured in the standard function model

9.11.7.8.5.5 Counter value at the time of the last latch

Name:

Encoder01Latch

The counter value at the time of the last latch is displayed as a 16 or 32-bit value. Only the 16-bit value is available in the bus controller function model.

| Data type | Value |
|--------------------|----------------------------------|
| INT | -32768 to 32767 |
| DINT ¹⁾ | -2.147.483.648 bis 2.147.483.647 |

1) Can only be configured in the standard function model

9.11.7.8.5.6 Counter value of latch event

Name:

Encoder01LatchCount

The latch events are counted and stored in a cyclic 8-bit counter. This counter is incremented with each latch event, thereby indicating a new occurrence. The new latched counter value is stored in the respective latch register.

| Data type | Value |
|-----------|-------------|
| SINT | -128 to 127 |

9.11.7.8.5.7 Encoder commands

Name:

Encoder01Command

This register can be used to

- 1) reset the counter value. The counter is kept at zero until this command is reset.
- 2) enable the latch procedure. If the latch configuration is valid and matches the hardware signals, then this activation causes the counter value to be saved in the latch register.

The two different latch configurations that are possible (see "[Setting the latch mode](#)" on page 1128) must be handled as follows:

- Single shot latch mode:
After successful latching, indicated by the latch event counter, activation must be reset before any more latching is possible. The activation must be set again if additional latching is needed.
- Continuous latch mode:
The latch function only has to be enabled/set as long as latching is desired. The latch event counter is incremented with each event.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|----------------------|-------|------------------------|
| 0 | Encoder01Reset | 0 | Do not reset |
| | | 1 | Set encoder value to 0 |
| 1 | Encoder01LatchEnable | 0 | Do not activate latch |
| | | 1 | Latching |
| 2 - 7 | Reserved | 0 | |

9.11.7.8.5.8 Input status of signal lines

Name:

Encoder01_A

Encoder01_B

Encoder01_R

DigitalInput01 to DigitalInput02

This register displays the input status of the signal lines from the encoder and the digital inputs.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|----------------|-------|---------------------------------|
| 0 | Encoder01_A | 0/1 | Input state of encoder signal A |
| 1 | Encoder01_B | 0/1 | Input state of encoder signal B |
| 2 | Encoder01_R | 0/1 | Input state of encoder signal R |
| 3 | Reserved | 0 | |
| 4 | DigitalInput01 | 0/1 | Input state - Digital input 1 |
| 5 | DigitalInput02 | 0/1 | Input state - Digital input 2 |
| 6 - 7 | Reserved | 0 | |

9.11.7.8.5.9 Error status of signal lines

The error states are latched when they occur and are maintained until acknowledged. The counter and time registers are not updated if there are pending or unacknowledged errors.

Status of signal lines

Name:

BW_Channel_A

BW_Channel_B

BW_Channel_R

This register displays the error states of the signal lines from the encoder. The error states are latched when they occur and are maintained until acknowledged. The counter and time registers are not updated if there are pending or unacknowledged errors.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|--------------|-------|---|
| 0 | BW_Channel_A | 0 | No error in encoder signal A |
| | | 1 | Open line, short circuit or voltage level too low |
| 1 | BW_Channel_B | 0 | No error in encoder signal B |
| | | 1 | Open line, short circuit or voltage level too low |
| 2 | BW_Channel_R | 0 | No error in encoder signal R |
| | | 1 | Open line, short circuit or voltage level too low |
| 3 - 7 | Reserved | 0 | |

Acknowledging error status of signal lines

Name:

BW_QuitChannel_A

BW_QuitChannel_B

BW_QuitChannel_R

This register can be used to acknowledge the latched error states of the signal lines from the encoder. However, if there are still pending errors remaining, then the error status remains active. After acknowledging the errors, the bits must also be reset or else any repetition of the error would be undetected.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|------------------|-------|---|
| 0 | BW_QuitChannel_A | 0 | No acknowledgment |
| | | 1 | Acknowledgment of error status - Encoder signal A |
| 1 | BW_QuitChannel_B | 0 | No acknowledgment |
| | | 1 | Acknowledgment of error status - Encoder signal B |
| 2 | BW_QuitChannel_R | 0 | No acknowledgment |
| | | 1 | Acknowledgment of error status - Encoder signal R |
| 3 - 7 | Reserved | 0 | |

Manual acknowledgment of latched error states

The latched error states of the signal lines from the encoder can be acknowledged manually. However, if there are still pending errors remaining, then the error status remains active. After successfully acknowledging the errors (latched error status = 0), the acknowledge bits must still be reset by the user or else a re-occurrence of an error could be overlooked by the user.

Example 1: Cause of error corrected before being acknowledged

An error has occurred on a signal line. The error state is detected and latched by the module. The error is acknowledged by the user after the cause of error has been corrected. The latched error status changes to zero.

The manual acknowledge must now be reset so that any new errors will be recognized by the user.

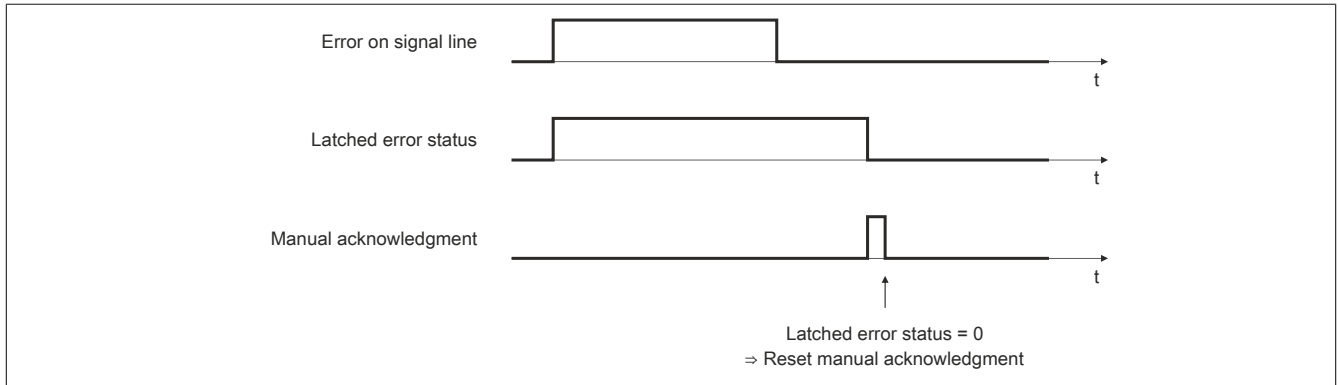


Figure 106: Cause of error corrected before being acknowledged

Example 2: Cause of error not yet corrected before being acknowledged

An error has occurred on a signal line. The error state is detected and latched by the module. The error is acknowledged by the user before the cause of error has been corrected. The latched error status remains set because the error is still remaining.

Acknowledgment is only successful after the cause of error has been corrected. The latched error status changes to zero. The manual acknowledge must now be reset so that any new errors will be recognized by the user.

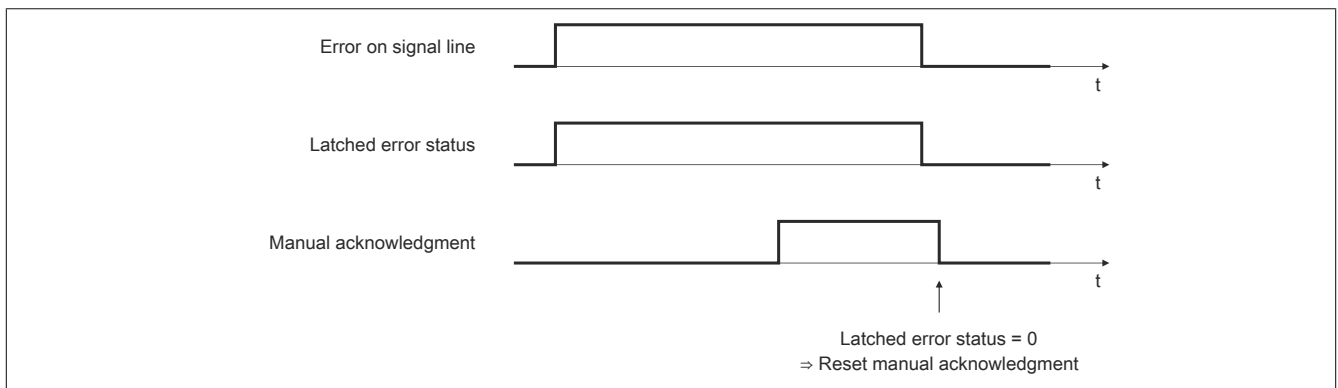


Figure 107: Cause of error not yet corrected before being acknowledged

Automatic acknowledgment of latched error states

In addition to manual acknowledgment, automatic acknowledgment of the latched error states after a specified amount of time can also be enabled. Make sure that the time is set long enough for the higher-level system to reliably detect the status messages and for the validity of the counter value to be determined using its age.

If the time specification = 0, then only manual acknowledgment is possible.

Example 1: An error has occurred on a signal line. The error state is detected and latched by the module. The time for automatic acknowledgment starts counting after the cause of error has been corrected. The error is acknowledged as soon as the time expires. The latched error status changes to zero.

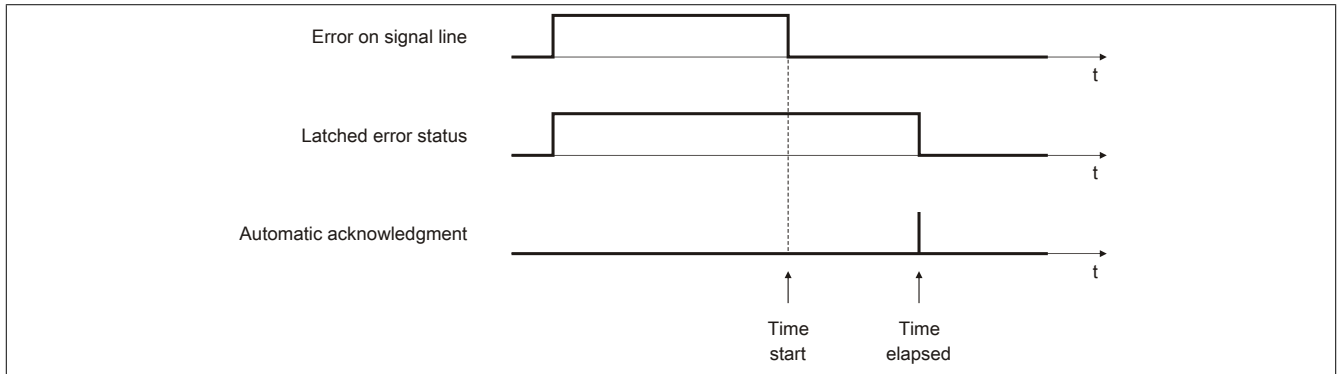


Figure 108: Latched error state acknowledged automatically

Example 2: Automatic and manual acknowledge used
An error has occurred on a signal line. The error state is detected and latched by the module. The time for automatic acknowledgment starts counting after the cause of error has been corrected. The error is acknowledged manually by the user before the time expires. The latched error status changes to zero. The manual acknowledge must now be reset so that any new errors will be recognized by the user.

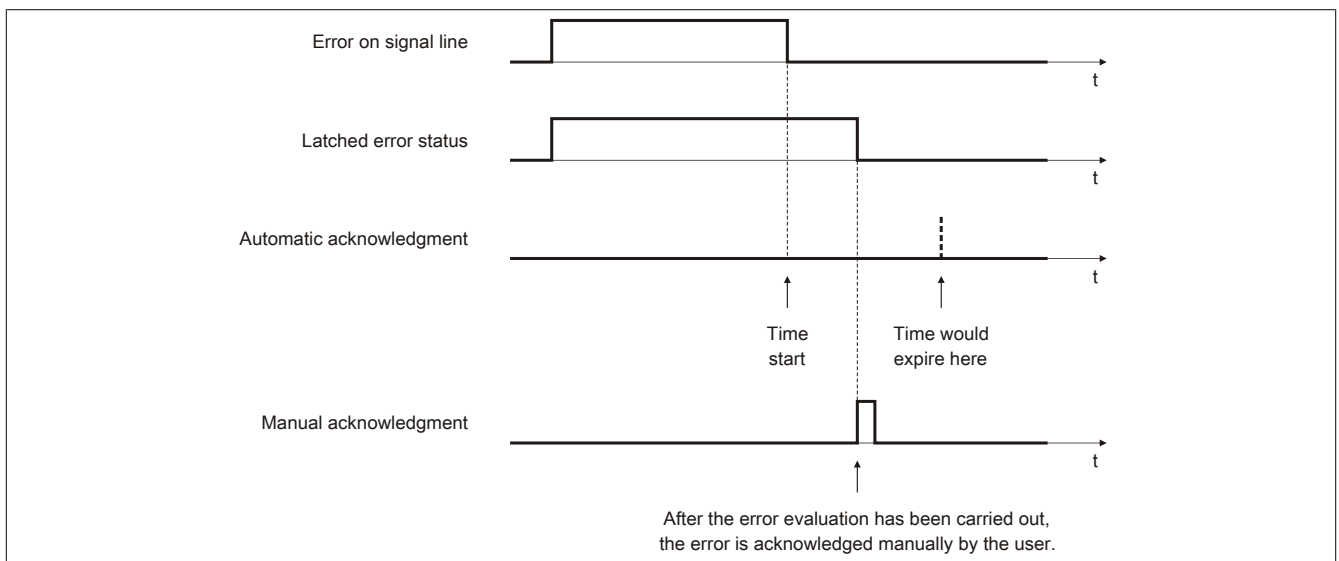


Figure 109: Automatic and manual acknowledge used

9.11.7.8.5.10 Status of encoder supplies

Name:

PowerSupply01 to PowerSupply02

This register shows the status of the integrated encoder supplies. A faulty encoder power supply is displayed as a warning.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---------------|-------|------------------------------------|
| 0 | PowerSupply01 | 0 | 24 VDC encoder power supply OK |
| | | 1 | 24 VDC encoder power supply faulty |
| 1 | PowerSupply02 | 0 | 5 VDC encoder power supply OK |
| | | 1 | 5 VDC encoder power supply faulty |
| 2 - 7 | Reserved | - | |

9.11.7.8.6 NetTime Technology

For a description of NetTime Technology, see ["NetTime Technology" on page 3035](#).

9.11.7.8.7 Minimum cycle time

The minimum cycle time defines how far the bus cycle can be reduced without causing a communication error or impaired functionality. It should be noted that very fast cycles decrease the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 150 µs |

9.11.7.8.8 Minimum I/O update time

The minimum I/O update time defines how far the bus cycle can be reduced while still allowing an I/O update to take place in each cycle.

| Minimum I/O update time |
|-------------------------|
| 150 µs |

9.11.8 X20DC1376

Data sheet version: 2.31

9.11.8.1 General information

The module is equipped with 1 input for an ABR incremental encoder with 24 V encoder supply. The encoder inputs are monitored (A, B, R). The module is suitable for incremental encoders with push-pull outputs with no complementary signal.

- 1 ABR incremental encoder 24 V, asymmetric
- Encoder input monitoring
- 2 additional inputs, e.g. for latch input
- 24 VDC and GND for encoder supply
- NetTime timestamp: Counter change

NetTime timestamp of the counter

For many applications, not only the counter value is important, but also the exact time of the counter change. For this purpose, the module has a NetTime function that provides the recorded counter value with a timestamp accurate to microseconds.

The module provides the PLC with the counter value and timestamp as an absolute time value. The NetTime mechanisms ensure that the PLC NetTime clock and the local NetTime clock on the module have the same absolute time at all times.

9.11.8.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Counter functions |  |
| X20DC1376 | X20 digital counter module, 1 ABR incremental encoder, 24 V, 100 kHz input frequency, 4x evaluation, encoder monitoring, NetTime function | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 203: X20DC1376 - Order data

9.11.8.3 Technical data

| | |
|--|--|
| Model number | X20DC1376 |
| Short description | |
| I/O module | 1 ABR incremental encoder 24 V |
| General information | |
| B&R ID code | 0xA705 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.3 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Type of signal lines | Shielded cables must be used for all signal lines. |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| Digital inputs | |
| Quantity | 2 |
| Nominal voltage | 24 VDC |
| Input characteristics per EN 61131-2 | Type 1 |
| Input voltage | 24 VDC -15% / +20% |
| Input current at 24 VDC | Approx. 3.3 mA |
| Input circuit | Sink |
| Input filter | |
| Hardware | ≤2 μs |
| Software | - |
| Connection type | 3-wire connections |
| Input resistance | 7.03 kΩ |
| Additional functions | Latch input |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| ABR incremental encoder | |
| Encoder inputs | 24 V, asymmetrical |
| Counter size | 16/32-bit |
| Input frequency | Max. 100 kHz |
| Evaluation | 4x |
| Minimum diff. slew rate | 1 V/μs |
| Encoder power supply | Module-internal, max. 600 mA |
| Input filter | |
| Hardware | ≤1 μs |
| Software | - |
| Switching threshold | |
| Low | >5 V |
| Overload characteristics of encoder power supply | Short-circuit proof, overload-proof |
| Isolation voltage between encoder and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |


Table 204: X20DC1376 - Technical data

| | |
|-----------------------------------|--|
| Model number | X20DC1376 |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating". |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x bus module X20BM11 separately. |
| Spacing | 12.5 ^{+0.2} mm |

Table 204: X20DC1376 - Technical data

9.11.8.4 LED status indicators

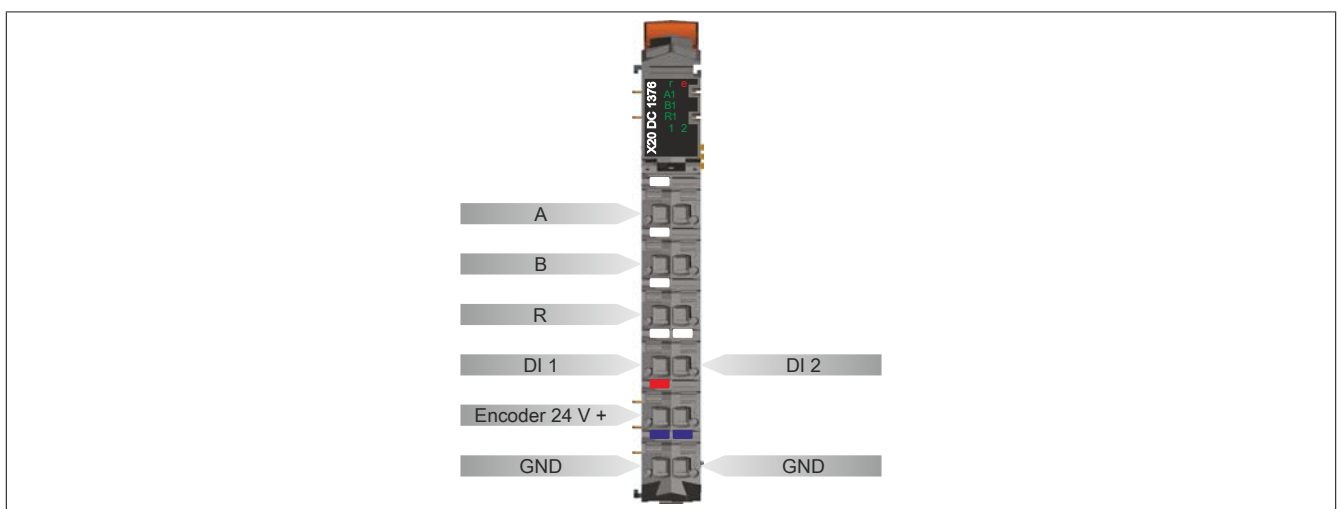
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|--|-------|-------|----------------------------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Single flash | The encoder monitor has detected a line fault on the encoder inputs. The status bits must be evaluated in order to provide a more detailed definition of this error. The following error states are detected: <ul style="list-style-type: none"> • Open line • Short-circuit or voltage level too low |
| | | | On | Error or reset status |
| | A1 | Green | | Input state of counter input A |
| | B1 | Green | | Input state of counter input B |
| R1 | Green | | Input state of reference pulse R | |
| 1 - 2 | Green | | Input status - digital input | |

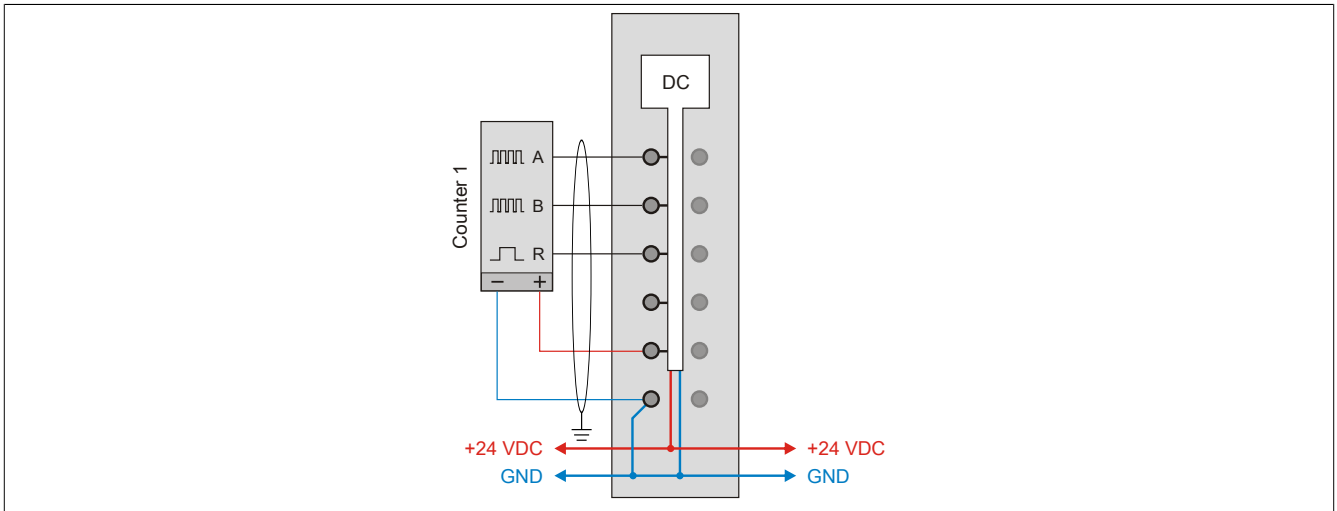
1) Depending on the configuration, a firmware update can take up to several minutes.

9.11.8.5 Pinout

Shielded cables must be used for all signal lines.

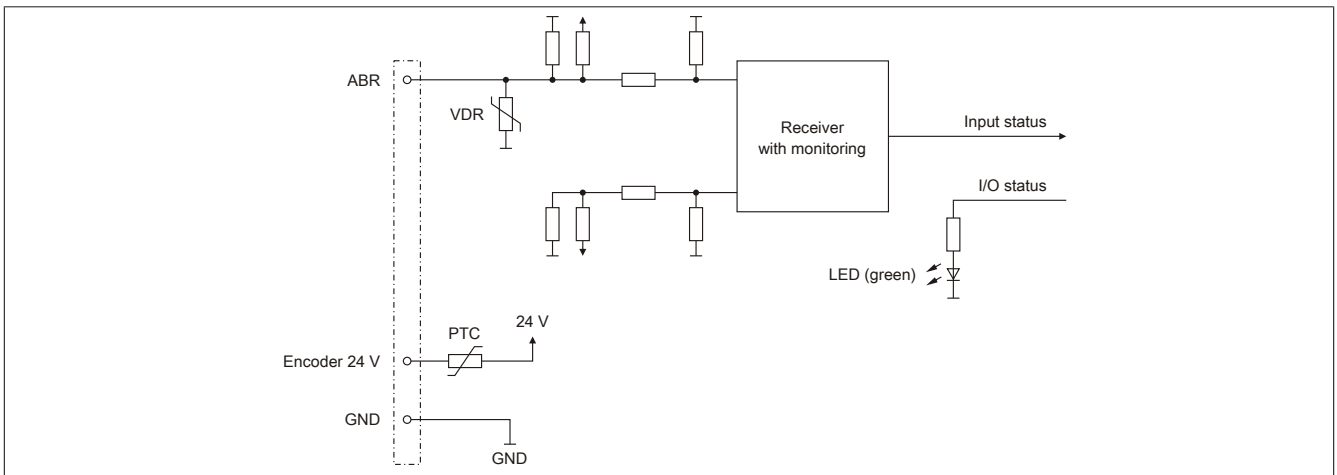


9.11.8.6 Connection example

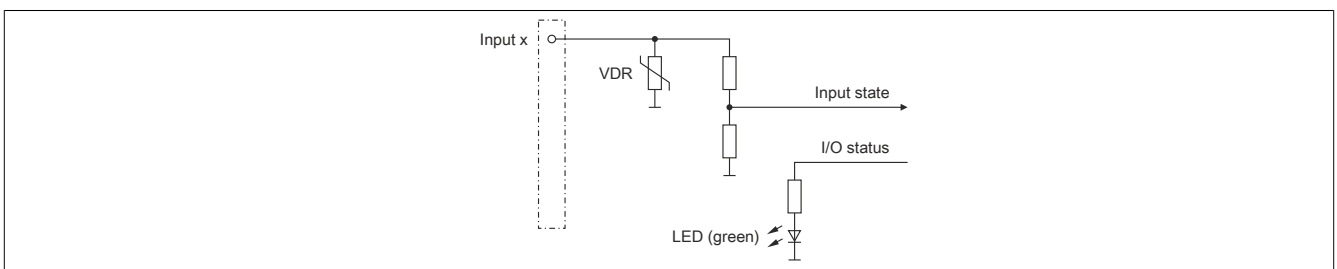


9.11.8.7 Input circuit diagram

Counter inputs



Standard inputs

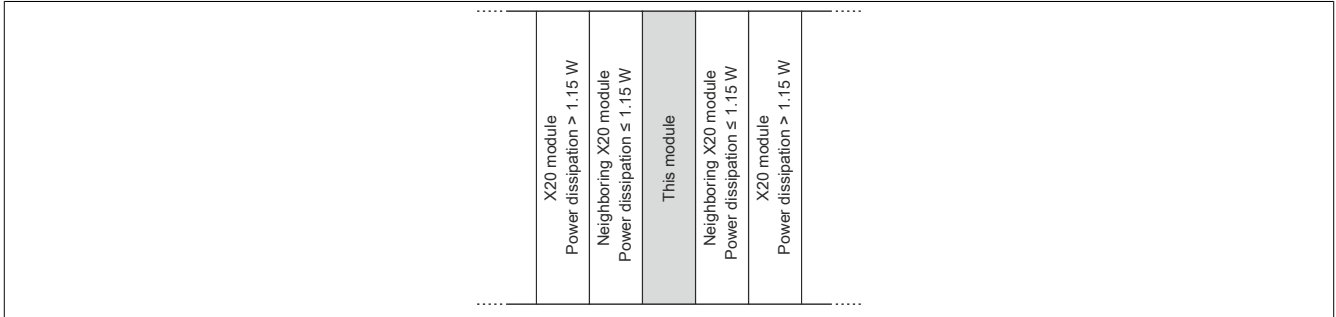


9.11.8.8 Derating

There is no derating when operated below 55°C.

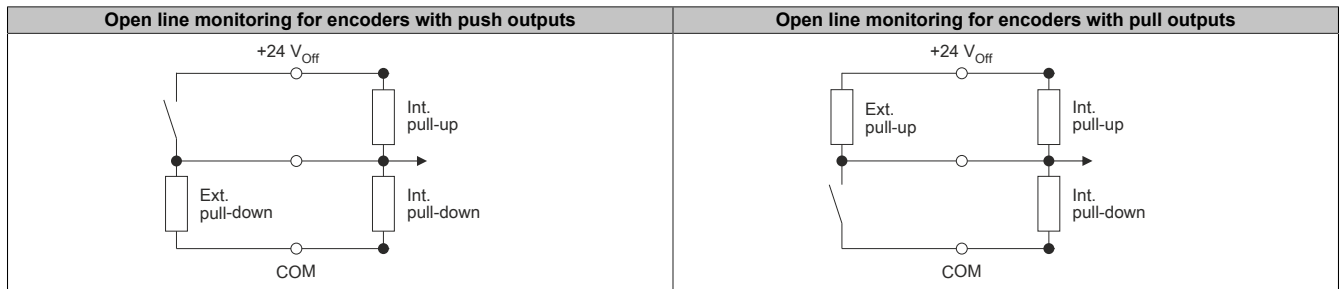
During operation over 55°C, the power dissipation of the modules to the left and right of this module is not permitted to exceed 1.15 W!

For an example of calculating the power dissipation of I/O modules, see section "Power dissipation calculation of I/O modules" on page 101.



9.11.8.9 Open line monitoring

Open line monitoring is only possible if the encoder itself is equipped with pull-up or pull-down resistances (pull-up: max. 5.6 kΩ, pull-down: max. 3.9 kΩ) and the module is configured for encoders with push-pull outputs.



9.11.8.10 Register description

9.11.8.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.11.8.10.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 513 | Cfo_SlframeGenID | USINT | | | | • |
| 642 | Cfo_SystemCycleTime | UINT | | | | • |
| 769 | Cfo_PhylIOConfigCh01 | USINT | | | | • |
| 771 | Cfo_PhylIOConfigCh02 | USINT | | | | • |
| 773 | Cfo_PhylIOConfigCh03 | USINT | | | | • |
| 777 | Cfo_PhylIOConfigCh04 | USINT | | | | • |
| 779 | Cfo_PhylIOConfigCh05 | USINT | | | | • |
| 815 | Cfo_BWQuitTimeSelChannel7_0 | USINT | | | | • |
| 820 | Cfo_BWQuitTime_0 | UDINT | | | | • |
| 6145 | Cfo_CounterCycleSelect | USINT | | | | • |
| 6147 | Cfo_CounterMode | USINT | | | | • |
| 6149 | Cfo_LatchMode | USINT | | | | • |
| 6151 | Cfo_LatchComparator | USINT | | | | • |
| 6159 | Cfo_BWCNTEnableMaskChannel7_0 | USINT | | | | • |
| Communication | | | | | | |
| 683 | SDCLifeCount | SINT | • | | | |
| 6342 | Encoder01 | INT | • | | | |
| 6340 | | DINT | | | | |
| 6310 | Encoder01TimeValid | INT | • | | | |
| 6308 | | DINT | | | | |
| 6358 | Encoder01Latch | INT | • | | | |
| 6356 | | DINT | | | | |
| 6153 | Encoder commands | USINT | | | • | |
| | Encoder01Reset | Bit 0 | | | | |
| | Encoder01LatchEnable | Bit 1 | | | | |
| 927 | Input status of signal lines | USINT | • | | | |
| | Encoder01_A | Bit 0 | | | | |
| | Encoder01_B | Bit 1 | | | | |
| | Encoder01_R | Bit 2 | | | | |
| | DigitalInput01 | Bit 4 | | | | |
| | DigitalInput02 | Bit 5 | | | | |
| 847 | Status of signal lines | USINT | • | | | |
| | BW_Channel_A | Bit 0 | | | | |
| | BW_Channel_B | Bit 1 | | | | |
| | BW_Channel_R | Bit 2 | | | | |
| 811 | Acknowledging error status of signal lines | USINT | | | • | |
| | BW_QuitChannel_A | Bit 0 | | | | |
| | BW_QuitChannel_B | Bit 1 | | | | |
| | BW_QuitChannel_R | Bit 2 | | | | |
| 6326 | Encoder01TimeChanged | INT | • | | | |
| 6324 | | DINT | | | | |
| 6303 | Encoder01LatchCount | SINT | • | | | |
| 843 | Status of encoder power supply | USINT | • | | | |
| | PowerSupply01 | Bit 0 | | | | |

9.11.8.10.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 513 | - | CfO_SlframeGenID | USINT | | | | • |
| 642 | - | CfO_SystemCycleTime | UINT | | | | • |
| 769 | - | CfO_PhylIOConfigCh01 | USINT | | | | • |
| 771 | - | CfO_PhylIOConfigCh02 | USINT | | | | • |
| 773 | - | CfO_PhylIOConfigCh03 | USINT | | | | • |
| 777 | - | CfO_PhylIOConfigCh04 | USINT | | | | • |
| 779 | - | CfO_PhylIOConfigCh05 | USINT | | | | • |
| 815 | - | CfO_BWQuitTimeSelChannel7_0 | USINT | | | | • |
| 820 | - | CfO_BWQuitTime_0 | UDINT | | | | • |
| 6145 | - | CfO_CounterCycleSelect | USINT | | | | • |
| 6147 | - | CfO_CounterMode | USINT | | | | • |
| 6149 | - | CfO_LatchMode | USINT | | | | • |
| 6151 | - | CfO_LatchComparator | USINT | | | | • |
| 6159 | - | CfO_BWCNTEnableMaskChannel7_0 | USINT | | | | • |
| Communication | | | | | | | |
| 6342 | 0 | Encoder01 | INT | • | | | |
| 6310 | 2 | Encoder01TimeValid | INT | • | | | |
| 6358 | 4 | Encoder01Latch | INT | • | | | |
| 6153 | 1 | Encoder commands | USINT | | | • | |
| | | Encoder01Reset | Bit 0 | | | | |
| | | Encoder01LatchEnable | Bit 1 | | | | |
| 927 | 7 | Input status of signal lines | USINT | • | | | |
| | | Encoder01_A | Bit 0 | | | | |
| | | Encoder01_B | Bit 1 | | | | |
| | | Encoder01_R | Bit 2 | | | | |
| | | DigitalInput01 | Bit 4 | | | | |
| | | DigitalInput02 | Bit 5 | | | | |
| 847 | 6 | Status of signal lines | USINT | • | | | |
| | | BW_Channel_A | Bit 0 | | | | |
| | | BW_Channel_B | Bit 1 | | | | |
| | | BW_Channel_R | Bit 2 | | | | |
| 811 | 0 | Acknowledging error status of signal lines | USINT | | | • | |
| | | BW_QuitChannel_A | Bit 0 | | | | |
| | | BW_QuitChannel_B | Bit 1 | | | | |
| | | BW_QuitChannel_R | Bit 2 | | | | |
| 6326 | - | Encoder01TimeChanged | INT | | • | | |
| 6303 | - | Encoder01LatchCount | SINT | | • | | |
| 843 | - | Status of encoder power supply | USINT | | • | | |
| | | PowerSupply01 | Bit 0 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.11.8.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.11.8.10.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.11.8.10.4 Encoder - Configuration

The following registers are used for setting functions and configuring the module.

9.11.8.10.4.1 Enabling error monitoring for the signal lines

Name:

CfO_BWCNTEnableMaskChannel7_0

This register requires individually enabling error monitoring for each of the signal channels. "Open line", "short circuit" and "voltage level too low" are reported as error states. Any errors that occur are reported in the error status registers "BW_Channel_x" on page 1148.

| Data type | Value | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| USINT | See bit structure. | 7 |

Bit structure:

| Bit | Name | Value | Information |
|-------|--|-------|--|
| 0 | Enable error monitoring for signal A lines | 0 | Error monitoring - Encoder Signal A disabled |
| | | 1 | Error monitoring - Encoder signal A enabled (bus controller default setting) |
| 1 | Enable error monitoring for signal B lines | 0 | Error monitoring - Encoder Signal B disabled |
| | | 1 | Error monitoring - Encoder signal B enabled (bus controller default setting) |
| 2 | Enable error monitoring for signal R lines | 0 | Error monitoring - Encoder Signal R disabled |
| | | 1 | Error monitoring - Encoder signal R enabled (bus controller default setting) |
| 3 - 7 | Reserved | 0 | |

9.11.8.10.4.2 Timing for automatic error acknowledgment

Name:

CfO_BWQuitTime_0

This register can be used to enable an additional [automatic acknowledgment](#) of the error status through timing. If a valid time is set, then the acknowledgment can still be made [manually](#), the only difference is that automatic acknowledgment will take place on the module after the defined amount of time has passed. If the error state has not yet been corrected, then the error status remains and the time is reset. Make sure that the time is set long enough for the higher-level system to reliably detect the status messages.

If the timing = 0, then acknowledgment is only possible using the cyclic acknowledgment registers.

| Data type | Value | Information |
|-----------|--------------------|--|
| UDINT | 0 | No automatic acknowledgment. Bus controller default setting |
| | 1 to 2.147.483.647 | Time for automatic acknowledgment [µs] |

9.11.8.10.4.3 Setting the latch mode

Name:

CfO_LatchMode

This register is used to set the latch mode:

- Single shot latch mode:
The latch function must be enabled/set. After a successful latch procedure, the activation must be reset in order for a new latch procedure to be activated.
- Continuous latch mode:
The latch function only has to be enabled/set as long as latching is desired.

A changed counter state on "[Encoder01LatchCount](#)" on page 1147 indicates that the latch procedure has been performed. The counter value is stored in the latch register "[Encoder01Latch](#)" on page 1147.

| Data type | Value | Information |
|-----------|-------|--|
| USINT | 0 | Single-shot latch procedure (bus controller default setting) |
| | 1 | Continuous latch procedure |

9.11.8.10.4.4 Signal channels for triggering latch procedure

Name:

CfO_LatchComparator

This register defines the signal channels and their level for triggering the latch procedure.

- This mainly configures which channels are linked to generate the latch event. All three signals from the encoder and digital input 1 can be used for the "AND" operation.
- The "active voltage level" needed for the latch procedure can now be used according to the physical signals.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Name | Value | Information |
|-----|---|-------|---|
| 0 | Defines signal level for encoder signal A | 0 | Low (bus controller default setting) |
| | | 1 | High |
| 1 | Defines signal level for encoder signal B | 0 | Low (bus controller default setting) |
| | | 1 | High |
| 2 | Defines signal level for encoder signal R | 0 | Low (bus controller default setting) |
| | | 1 | High |
| 3 | Defines signal level for digital input 1 | 0 | Low (bus controller default setting) |
| | | 1 | High |
| 4 | Use encoder signal A to trigger latch procedure | 0 | Disabled (bus controller default setting) |
| | | 1 | Latch function linked to encoder signal A |
| 5 | Use encoder signal B to trigger latch procedure | 0 | Disabled (bus controller default setting) |
| | | 1 | Latch function linked to encoder signal B |
| 6 | Use encoder signal R to trigger latch procedure | 0 | Disabled (bus controller default setting) |
| | | 1 | Latch function linked to encoder signal R |
| 7 | Use digital input 1 to trigger latch procedure | 0 | Disabled (bus controller default setting) |
| | | 1 | Latch function linked to digital input 1 |

9.11.8.10.4.5 Physical configuration

The following registers must be set to the specified constant value for correct physical configuration:

Constant register "CfO_SlframeGenID"

Name:

CfO_SlframeGenID

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 9 | Bus controller default setting |

Constant register "CfO_SystemCycleTime"

Name:

CfO_SystemCycleTime

Cycle time of encoder acquisition in 1/8 μ s steps. 1 encoder value is acquired as the counter value per cycle.

| Data type | Value | Information |
|-----------|-------|--|
| UINT | 800 | 800 = 100 μ s. Bus controller default setting |

Constant register "CfO_PhyIOConfigCh0x"

Name:

CfO_PhyIOConfigCh01 to CfO_PhyIOConfigCh05

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 0 | Bus controller default setting |

Constant register "CfO_BWQuitTimeSelChannel7_0"

Name:

CfO_BWQuitTimeSelChannel7_0

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 0 | Bus controller default setting |

Constant register "CfO_CounterCycleSelect"

Name:

CfO_CounterCycleSelect

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 2 | Bus controller default setting |

Constant register "CfO_CounterMode"

Name:

CfO_CounterMode

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 3 | Bus controller default setting |

9.11.8.10.5 Encoder - Communication**9.11.8.10.5.1 Counter for verifying the data frame**

Name:

SDCLifeCount

The 8-bit counter register is needed for the SDC software package. It is incremented with the system clock to allow the SDC to check the validity of the data frame.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

9.11.8.10.5.2 Display of the counter state

Name:

Encoder01

The counter state of the incremental encoder is displayed as a 16 or 32-bit counter value. Only the 16-bit value is available in the bus controller function model.

| Data type | Value |
|--------------------|----------------------------------|
| INT | -32768 to 32767 |
| DINT ¹⁾ | -2.147.483.648 bis 2.147.483.647 |

1) Can only be configured in the standard function model

9.11.8.10.5.3 NetTime of the last valid counter value

Name:

Encoder01TimeValid

The NetTime of the last valid counter value is the time of the last valid counter value recorded on the module (see register "[Cfo_SystemCycleTime](#)" on page 1145). The user is able to determine the validity of the counter value by evaluating its age in the program. This means that the module and error status bits do not have to be checked additionally to determine the validity of the value.

The NetTime of the last valid counter value that was read is displayed as a 16 or 32-bit value. Only the 16-bit value is available in the bus controller function model.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Value | Information |
|--------------------|---------------------------------|--------------------|
| INT | -32768 to 32767 | NetTime in μ s |
| DINT ¹⁾ | -2.147.483.648 to 2.147.483.647 | |

1) Can only be configured in the standard function model

9.11.8.10.5.4 NetTime of the last counter value change

Name:

Encoder01TimeChanged

For slow X2X Link cycles, the NetTime of the last counter value change can be used to determine the speed more accurately.

The NetTime of the last counter value change is displayed as a 16 or 32-bit value. Only the 16-bit value is available in the bus controller function model.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Value | Information |
|--------------------|---------------------------------|--------------------|
| INT | -32768 to 32767 | NetTime in μ s |
| DINT ¹⁾ | -2.147.483.648 to 2.147.483.647 | |

1) Can only be configured in the standard function model

9.11.8.10.5.5 Counter value at the time of the last latch

Name:

Encoder01Latch

The counter value at the time of the last latch is displayed as a 16 or 32-bit value. Only the 16-bit value is available in the bus controller function model.

| Data type | Value |
|--------------------|----------------------------------|
| INT | -32768 to 32767 |
| DINT ¹⁾ | -2.147.483.648 bis 2.147.483.647 |

1) Can only be configured in the standard function model

9.11.8.10.5.6 Counter value of latch event

Name:

Encoder01LatchCount

The latch events are counted and stored in a cyclic 8-bit counter. This counter is incremented with each latch event, thereby indicating a new occurrence. The new latched counter value is stored in the respective latch register.

| Data type | Value |
|-----------|-------------|
| SINT | -128 to 127 |

9.11.8.10.5.7 Encoder commands

Name:

Encoder01Command

This register can be used to

- 1) reset the counter value. The counter is kept at zero until this command is reset.
- 2) enable the latch procedure. If the latch configuration is valid and matches the hardware signals, then this activation causes the counter value to be saved in the latch register.

The two different latch configurations that are possible (see "[Setting the latch mode](#)" on page 1144) must be handled as follows:

- Single shot latch mode:
After successful latching, indicated by the latch event counter, activation must be reset before any more latching is possible. The activation must be set again if additional latching is needed.
- Continuous latch mode:
The latch function only has to be enabled/set as long as latching is desired. The latch event counter is incremented with each event.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|----------------------|-------|------------------------|
| 0 | Encoder01Reset | 0 | Do not reset |
| | | 1 | Set encoder value to 0 |
| 1 | Encoder01LatchEnable | 0 | Do not activate latch |
| | | 1 | Latching |
| 2 - 7 | Reserved | 0 | |

9.11.8.10.5.8 Input status of signal lines

Name:

Encoder01_A

Encoder01_B

Encoder01_R

DigitalInput01 to DigitalInput02

This register displays the input status of the signal lines from the encoder and the digital inputs.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|----------------|-------|---------------------------------|
| 0 | Encoder01_A | 0/1 | Input state of encoder signal A |
| 1 | Encoder01_B | 0/1 | Input state of encoder signal B |
| 2 | Encoder01_R | 0/1 | Input state of encoder signal R |
| 3 | Reserved | 0 | |
| 4 | DigitalInput01 | 0/1 | Input state - Digital input 1 |
| 5 | DigitalInput02 | 0/1 | Input state - Digital input 2 |
| 6 - 7 | Reserved | 0 | |

9.11.8.10.5.9 Error status of signal lines

The error states are latched when they occur and are maintained until acknowledged. The counter and time registers are not updated if there are pending or unacknowledged errors.

Status of signal lines

Name:

BW_Channel_A

BW_Channel_B

BW_Channel_R

This register displays the error states of the signal lines from the encoder. The error states are latched when they occur and are maintained until acknowledged. The counter and time registers are not updated if there are pending or unacknowledged errors.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|--------------|-------|---|
| 0 | BW_Channel_A | 0 | No error in encoder signal A |
| | | 1 | Open line, short circuit or voltage level too low |
| 1 | BW_Channel_B | 0 | No error in encoder signal B |
| | | 1 | Open line, short circuit or voltage level too low |
| 2 | BW_Channel_R | 0 | No error in encoder signal R |
| | | 1 | Open line, short circuit or voltage level too low |
| 3 - 7 | Reserved | 0 | |

Acknowledging error status of signal lines

Name:

BW_QuitChannel_A

BW_QuitChannel_B

BW_QuitChannel_R

This register can be used to acknowledge the latched error states of the signal lines from the encoder. However, if there are still pending errors remaining, then the error status remains active. After acknowledging the errors, the bits must also be reset or else any repetition of the error would be undetected.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|------------------|-------|---|
| 0 | BW_QuitChannel_A | 0 | No acknowledgment |
| | | 1 | Acknowledgment of error status - Encoder signal A |
| 1 | BW_QuitChannel_B | 0 | No acknowledgment |
| | | 1 | Acknowledgment of error status - Encoder signal B |
| 2 | BW_QuitChannel_R | 0 | No acknowledgment |
| | | 1 | Acknowledgment of error status - Encoder signal R |
| 3 - 7 | Reserved | 0 | |

Manual acknowledgment of latched error states

The latched error states of the signal lines from the encoder can be acknowledged manually. However, if there are still pending errors remaining, then the error status remains active. After successfully acknowledging the errors (latched error status = 0), the acknowledge bits must still be reset by the user or else a re-occurrence of an error could be overlooked by the user.

Example 1: Cause of error corrected before being acknowledged

An error has occurred on a signal line. The error state is detected and latched by the module. The error is acknowledged by the user after the cause of error has been corrected. The latched error status changes to zero.

The manual acknowledge must now be reset so that any new errors will be recognized by the user.

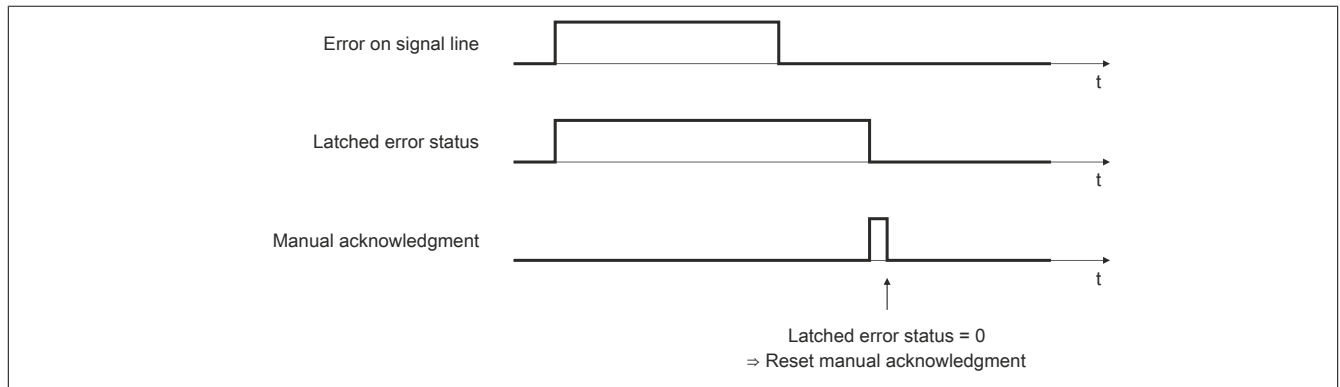


Figure 110: Cause of error corrected before being acknowledged

Example 2: Cause of error not yet corrected before being acknowledged

An error has occurred on a signal line. The error state is detected and latched by the module. The error is acknowledged by the user before the cause of error has been corrected. The latched error status remains set because the error is still remaining.

Acknowledgment is only successful after the cause of error has been corrected. The latched error status changes to zero. The manual acknowledge must now be reset so that any new errors will be recognized by the user.

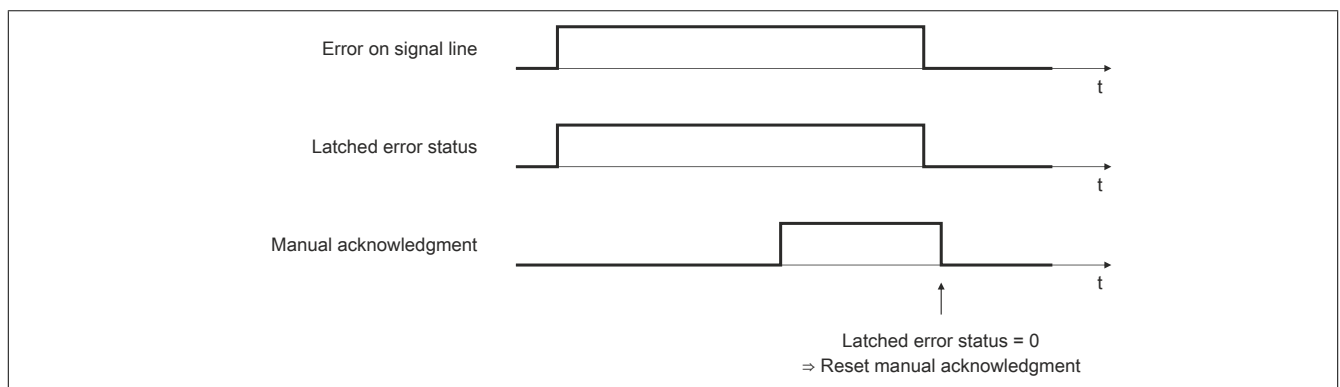


Figure 111: Cause of error not yet corrected before being acknowledged

Automatic acknowledgment of latched error states

In addition to manual acknowledgment, automatic acknowledgment of the latched error states after a specified amount of time can also be enabled. Make sure that the time is set long enough for the higher-level system to reliably detect the status messages and for the validity of the counter value to be determined using its age.

If the time specification = 0, then only manual acknowledgment is possible.

Example 1: An error has occurred on a signal line. The error state is detected and latched by the module. The time for automatic acknowledgment starts counting after the cause of error has been corrected. The error is acknowledged as soon as the time expires. The latched error status changes to zero.

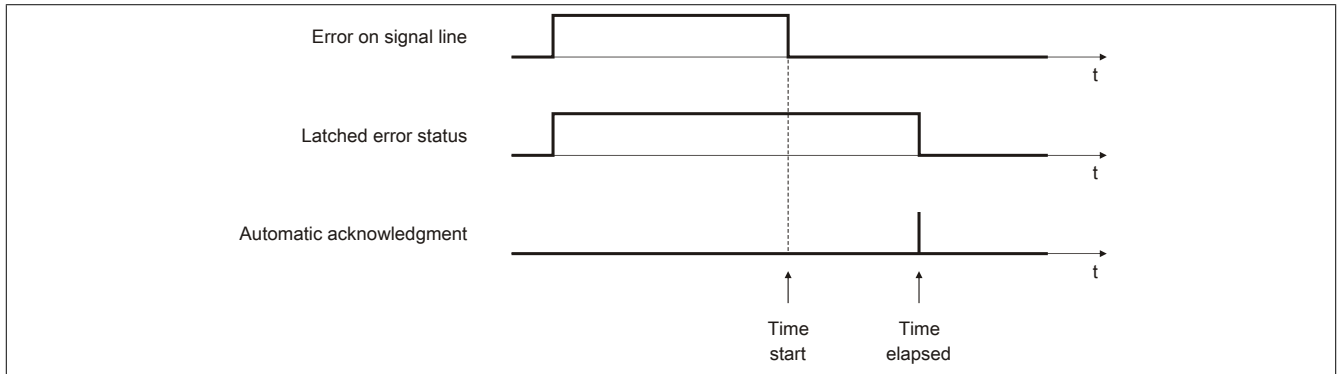


Figure 112: Latched error state acknowledged automatically

Example 2: Automatic and manual acknowledge used
 An error has occurred on a signal line. The error state is detected and latched by the module. The time for automatic acknowledgment starts counting after the cause of error has been corrected. The error is acknowledged manually by the user before the time expires. The latched error status changes to zero. The manual acknowledge must now be reset so that any new errors will be recognized by the user.

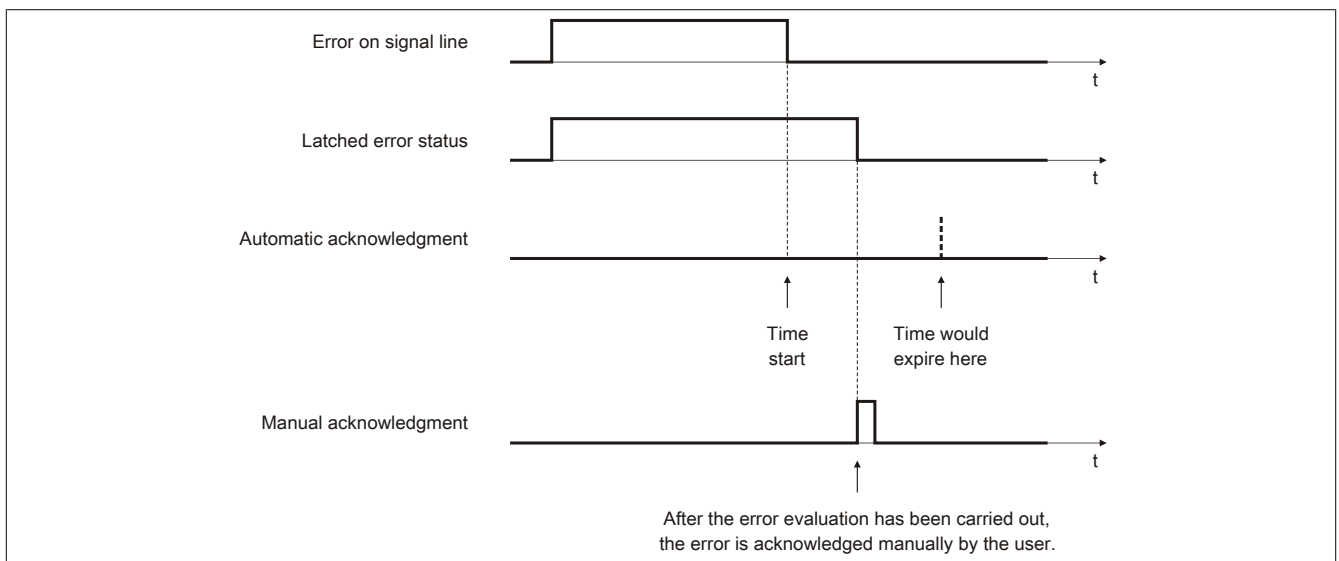


Figure 113: Automatic and manual acknowledge used

9.11.8.10.5.10 Status of encoder power supply

Name:

PowerSupply01

This register indicates the state of the integrated encoder power supply. A faulty encoder power supply is output as a warning.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|------------------------------------|
| 0 | PowerSupply01 | 0 | 24 VDC encoder power supply OK |
| | | 1 | 24 VDC encoder power supply faulty |
| 1 - 7 | Reserved | - | |

9.11.8.10.6 NetTime Technology

For a description of NetTime Technology, see ["NetTime Technology" on page 3035](#).

9.11.8.10.7 Minimum cycle time

The minimum cycle time defines how far the bus cycle can be reduced without causing a communication error or impaired functionality. It should be noted that very fast cycles decrease the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 150 µs |

9.11.8.10.8 Minimum I/O update time

The minimum I/O update time defines how far the bus cycle can be reduced while still allowing an I/O update to take place in each cycle.

| Minimum I/O update time |
|-------------------------|
| 150 µs |

9.11.9 X20DC137A

Data sheet version: 1.31

9.11.9.1 General information

The module is equipped with 1 input for an ABR incremental encoder with 24 V encoder supply. The encoder inputs are monitored (A, B, R, A\, B\, R\). The module is suitable for incremental encoders with symmetrical push-pull outputs.

The plug-in module does not come equipped with line terminating resistors. For this reason, it is possible to connect encoders with low output current; nevertheless, the module is suitable only for low counter frequencies or short encoder cables due to possible line reflections.

- 1 ABR incremental encoder 24 V, differential
- Encoder input monitoring
- 2 additional inputs, e.g. for latch input
- 24 VDC and GND for encoder supply
- NetTime timestamp: Counter change

NetTime timestamp of the counter

For many applications, not only the counter value is important, but also the exact time of the counter change. For this purpose, the module has a NetTime function that provides the recorded counter value with a timestamp accurate to microseconds.

The module provides the PLC with the counter value and timestamp as an absolute time value. The NetTime mechanisms ensure that the PLC NetTime clock and the local NetTime clock on the module have the same absolute time at all times.

9.11.9.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Counter functions |  |
| X20DC137A | X20 digital counter module, 1 ABR incremental encoder, 24 V (differential), 300 kHz input frequency, 4x evaluation, encoder monitoring, NetTime function | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 205: X20DC137A - Order data

9.11.9.3 Technical data

| Model number | X20DC137A |
|--|--|
| Short description | |
| I/O module | 1 ABR incremental encoder 24 V |
| General information | |
| B&R ID code | 0xDD28 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.2 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Type of signal lines | Shielded cables must be used for all signal lines. |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| Digital inputs | |
| Quantity | 2 |
| Nominal voltage | 24 VDC |
| Input characteristics per EN 61131-2 | Type 1 |
| Input voltage | 24 VDC -15% / +20% |
| Input current at 24 VDC | Approx. 3.3 mA |
| Input circuit | Sink |
| Input filter | |
| Hardware | ≤2 μs |
| Software | - |
| Connection type | 3-wire connections |
| Input resistance | 7.03 kΩ |
| Additional functions | Latch input |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| ABR incremental encoder | |
| Encoder inputs | 24 V, symmetrical |
| Counter size | 16/32-bit |
| Input frequency | Max. 300 kHz |
| Evaluation | 4x |
| Minimum diff. slew rate | 1 V/μs |
| Encoder power supply | Module-internal, max. 600 mA |
| Input filter | |
| Hardware | ≤0.5 μs |
| Software | - |
| Switching threshold | |
| Low | >5 V |
| Common-mode range | -10 V ≤ V _{CM} ≤ +13 V |
| Overload characteristics of encoder power supply | Short-circuit proof, overload-proof |
| Isolation voltage between encoder and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |


Table 206: X20DC137A - Technical data

| Model number | X20DC137A |
|-----------------------------------|--|
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating". |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x bus module X20BM11 separately. |
| Spacing | 12.5 ^{+0.2} mm |

Table 206: X20DC137A - Technical data

9.11.9.4 LED status indicators

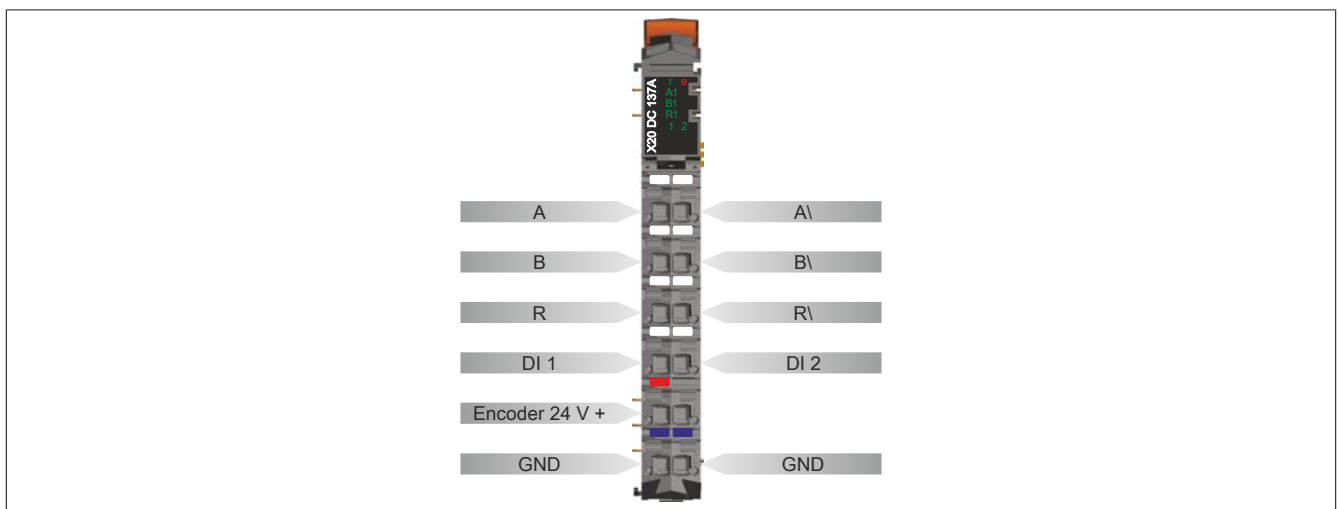
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|--|-------|-------|--|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Single flash | The encoder monitor has detected a line fault on the encoder inputs. The status bits must be evaluated in order to provide a more detailed definition of this error. The following error states are detected: <ul style="list-style-type: none"> • Open line • Short-circuit or voltage level too low |
| | | | On | Error or reset status |
| | A1 | Green | | Input state of counter input A |
| | B1 | Green | | Input state of counter input B |
| R1 | Green | | Input state of reference pulse R | |
| 1 - 2 | Green | | Input state of the corresponding digital input | |

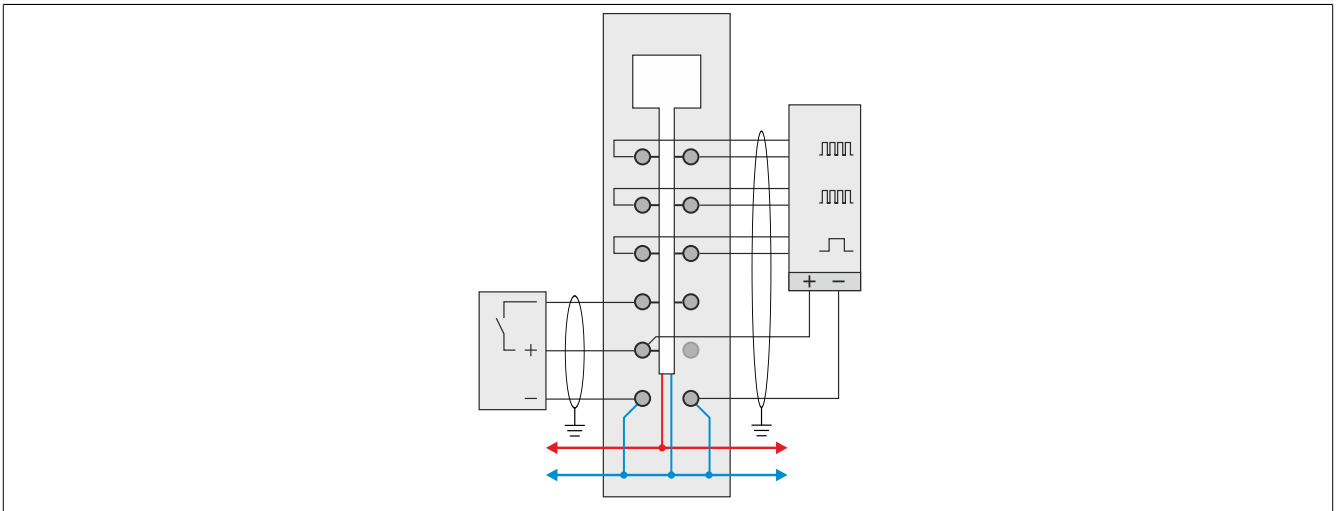
1) Depending on the configuration, a firmware update can take up to several minutes.

9.11.9.5 Pinout

Shielded cables must be used for all signal lines.

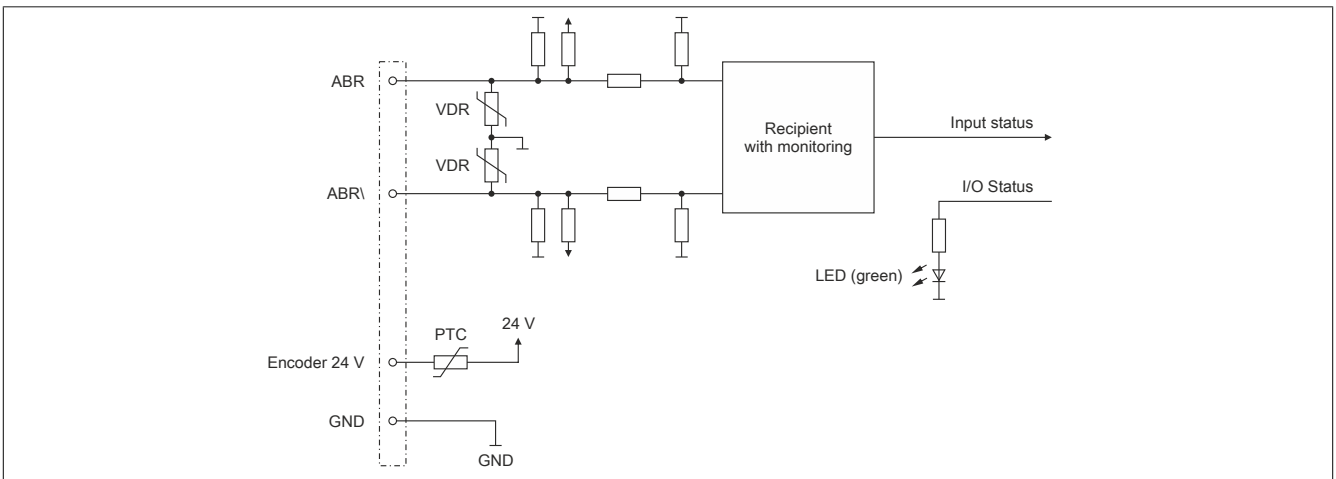


9.11.9.6 Connection example

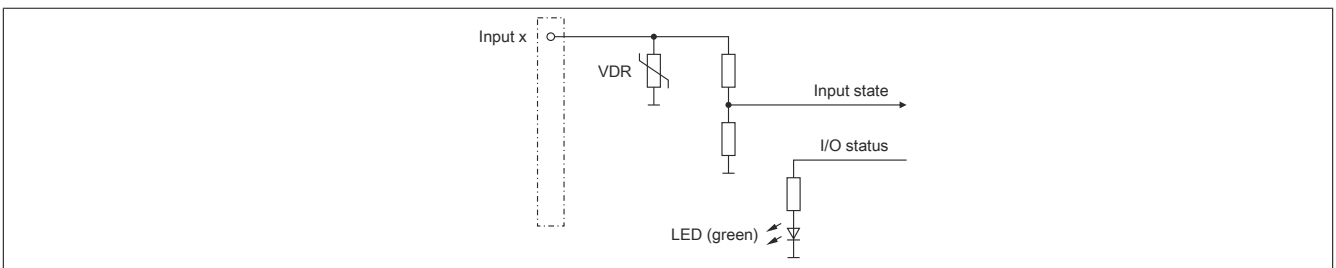


9.11.9.7 Input circuit diagram

Counter inputs



Standard inputs

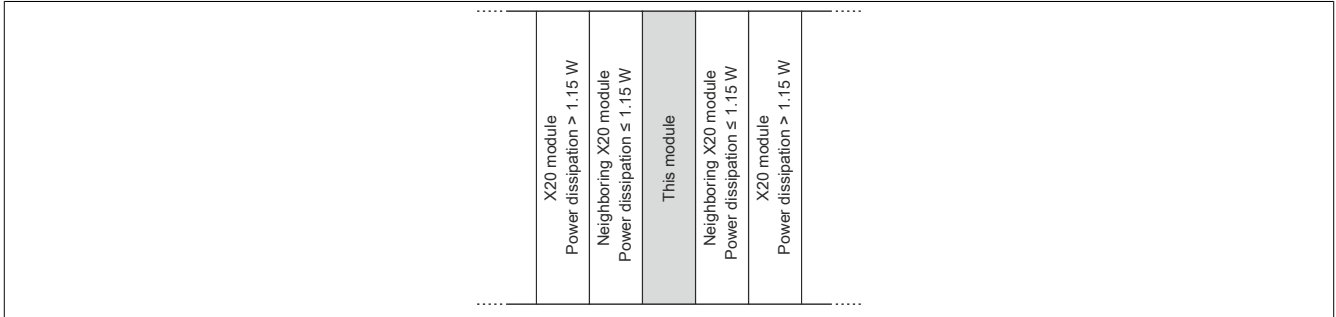


9.11.9.8 Derating

There is no derating when operated below 55°C.

During operation over 55°C, the power dissipation of the modules to the left and right of this module is not permitted to exceed 1.15 W!

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.



9.11.9.9 Register description

9.11.9.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.11.9.9.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 513 | Cfo_SlframeGenID | USINT | | | | • |
| 642 | Cfo_SystemCycleTime | UINT | | | | • |
| 769 | Cfo_PhylIOConfigCh01 | USINT | | | | • |
| 771 | Cfo_PhylIOConfigCh02 | USINT | | | | • |
| 773 | Cfo_PhylIOConfigCh03 | USINT | | | | • |
| 777 | Cfo_PhylIOConfigCh04 | USINT | | | | • |
| 779 | Cfo_PhylIOConfigCh05 | USINT | | | | • |
| 815 | Cfo_BWQuitTimeSelChannel7_0 | USINT | | | | • |
| 820 | Cfo_BWQuitTime_0 | UDINT | | | | • |
| 6145 | Cfo_CounterCycleSelect | USINT | | | | • |
| 6147 | Cfo_CounterMode | USINT | | | | • |
| 6149 | Cfo_LatchMode | USINT | | | | • |
| 6151 | Cfo_LatchComparator | USINT | | | | • |
| 6159 | Cfo_BWCNTEnableMaskChannel7_0 | USINT | | | | • |
| Communication | | | | | | |
| 683 | SDCLifeCount | SINT | • | | | |
| 6342 | Encoder01 | INT | • | | | |
| 6340 | | DINT | | | | |
| 6310 | Encoder01TimeValid | INT | • | | | |
| 6308 | | DINT | | | | |
| 6358 | Encoder01Latch | INT | • | | | |
| 6356 | | DINT | | | | |
| 6153 | Encoder commands | USINT | | | • | |
| | Encoder01Reset | Bit 0 | | | | |
| | Encoder01LatchEnable | Bit 1 | | | | |
| 927 | Input status of signal lines | USINT | • | | | |
| | Encoder01_A | Bit 0 | | | | |
| | Encoder01_B | Bit 1 | | | | |
| | Encoder01_R | Bit 2 | | | | |
| | DigitalInput01 | Bit 4 | | | | |
| | DigitalInput02 | Bit 5 | | | | |
| 847 | Status of signal lines | USINT | • | | | |
| | BW_Channel_A | Bit 0 | | | | |
| | BW_Channel_B | Bit 1 | | | | |
| | BW_Channel_R | Bit 2 | | | | |
| 811 | Acknowledging error status of signal lines | USINT | | | • | |
| | BW_QuitChannel_A | Bit 0 | | | | |
| | BW_QuitChannel_B | Bit 1 | | | | |
| | BW_QuitChannel_R | Bit 2 | | | | |
| 6326 | Encoder01TimeChanged | INT | • | | | |
| 6324 | | DINT | | | | |
| 6303 | Encoder01LatchCount | SINT | • | | | |
| 843 | Status of encoder power supply | USINT | • | | | |
| | PowerSupply01 | Bit 0 | | | | |

9.11.9.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 513 | - | CfO_SlframeGenID | USINT | | | | • |
| 642 | - | CfO_SystemCycleTime | UINT | | | | • |
| 769 | - | CfO_PhylIOConfigCh01 | USINT | | | | • |
| 771 | - | CfO_PhylIOConfigCh02 | USINT | | | | • |
| 773 | - | CfO_PhylIOConfigCh03 | USINT | | | | • |
| 777 | - | CfO_PhylIOConfigCh04 | USINT | | | | • |
| 779 | - | CfO_PhylIOConfigCh05 | USINT | | | | • |
| 815 | - | CfO_BWQuitTimeSelChannel7_0 | USINT | | | | • |
| 820 | - | CfO_BWQuitTime_0 | UDINT | | | | • |
| 6145 | - | CfO_CounterCycleSelect | USINT | | | | • |
| 6147 | - | CfO_CounterMode | USINT | | | | • |
| 6149 | - | CfO_LatchMode | USINT | | | | • |
| 6151 | - | CfO_LatchComparator | USINT | | | | • |
| 6159 | - | CfO_BWCNTEnableMaskChannel7_0 | USINT | | | | • |
| Communication | | | | | | | |
| 6342 | 0 | Encoder01 | INT | • | | | |
| 6310 | 2 | Encoder01TimeValid | INT | • | | | |
| 6358 | 4 | Encoder01Latch | INT | • | | | |
| 6153 | 1 | Encoder commands | USINT | | | • | |
| | | Encoder01Reset | Bit 0 | | | | |
| | | Encoder01LatchEnable | Bit 1 | | | | |
| 927 | 7 | Input status of signal lines | USINT | • | | | |
| | | Encoder01_A | Bit 0 | | | | |
| | | Encoder01_B | Bit 1 | | | | |
| | | Encoder01_R | Bit 2 | | | | |
| | | DigitalInput01 | Bit 4 | | | | |
| | | DigitalInput02 | Bit 5 | | | | |
| 847 | 6 | Status of signal lines | USINT | • | | | |
| | | BW_Channel_A | Bit 0 | | | | |
| | | BW_Channel_B | Bit 1 | | | | |
| | | BW_Channel_R | Bit 2 | | | | |
| 811 | 0 | Acknowledging error status of signal lines | USINT | | | • | |
| | | BW_QuitChannel_A | Bit 0 | | | | |
| | | BW_QuitChannel_B | Bit 1 | | | | |
| | | BW_QuitChannel_R | Bit 2 | | | | |
| 6326 | - | Encoder01TimeChanged | INT | | • | | |
| 6303 | - | Encoder01LatchCount | SINT | | • | | |
| 843 | - | Status of encoder power supply | USINT | | • | | |
| | | PowerSupply01 | Bit 0 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.11.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.11.9.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.11.9.9.4 Encoder - Configuration

The following registers are used for setting functions and configuring the module.

9.11.9.9.4.1 Enabling error monitoring for the signal lines

Name:

CfO_BWCNTEnableMaskChannel7_0

This register requires individually enabling error monitoring for each of the signal channels. "Open line", "short circuit" and "voltage level too low" are reported as error states. Any errors that occur are reported in the error status registers "BW_Channel_x" on page 1164.

| Data type | Value | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| USINT | See bit structure. | 7 |

Bit structure:

| Bit | Name | Value | Information |
|-------|--|-------|--|
| 0 | Enable error monitoring for signal A lines | 0 | Error monitoring - Encoder Signal A disabled |
| | | 1 | Error monitoring - Encoder signal A enabled (bus controller default setting) |
| 1 | Enable error monitoring for signal B lines | 0 | Error monitoring - Encoder Signal B disabled |
| | | 1 | Error monitoring - Encoder signal B enabled (bus controller default setting) |
| 2 | Enable error monitoring for signal R lines | 0 | Error monitoring - Encoder Signal R disabled |
| | | 1 | Error monitoring - Encoder signal R enabled (bus controller default setting) |
| 3 - 7 | Reserved | 0 | |

9.11.9.9.4.2 Timing for automatic error acknowledgment

Name:

CfO_BWQuitTime_0

This register can be used to enable an additional [automatic acknowledgment](#) of the error status through timing. If a valid time is set, then the acknowledgment can still be made [manually](#), the only difference is that automatic acknowledgment will take place on the module after the defined amount of time has passed. If the error state has not yet been corrected, then the error status remains and the time is reset. Make sure that the time is set long enough for the higher-level system to reliably detect the status messages.

If the timing = 0, then acknowledgment is only possible using the cyclic acknowledgment registers.

| Data type | Value | Information |
|-----------|--------------------|--|
| UDINT | 0 | No automatic acknowledgment. Bus controller default setting |
| | 1 to 2.147.483.647 | Time for automatic acknowledgment [µs] |

9.11.9.9.4.3 Setting the latch mode

Name:

CfO_LatchMode

This register is used to set the latch mode:

- Single shot latch mode:
The latch function must be enabled/set. After a successful latch procedure, the activation must be reset in order for a new latch procedure to be activated.
- Continuous latch mode:
The latch function only has to be enabled/set as long as latching is desired.

A changed counter state on "[Encoder01LatchCount](#)" on page 1163 indicates that the latch procedure has been performed. The counter value is stored in the latch register "[Encoder01Latch](#)" on page 1163.

| Data type | Value | Information |
|-----------|-------|--|
| USINT | 0 | Single-shot latch procedure (bus controller default setting) |
| | 1 | Continuous latch procedure |

9.11.9.9.4.4 Signal channels for triggering latch procedure

Name:

CfO_LatchComparator

This register defines the signal channels and their level for triggering the latch procedure.

- This mainly configures which channels are linked to generate the latch event. All three signals from the encoder and digital input 1 can be used for the "AND" operation.
- The "active voltage level" needed for the latch procedure can now be used according to the physical signals.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Name | Value | Information |
|-----|---|-------|---|
| 0 | Defines signal level for encoder signal A | 0 | Low (bus controller default setting) |
| | | 1 | High |
| 1 | Defines signal level for encoder signal B | 0 | Low (bus controller default setting) |
| | | 1 | High |
| 2 | Defines signal level for encoder signal R | 0 | Low (bus controller default setting) |
| | | 1 | High |
| 3 | Defines signal level for digital input 1 | 0 | Low (bus controller default setting) |
| | | 1 | High |
| 4 | Use encoder signal A to trigger latch procedure | 0 | Disabled (bus controller default setting) |
| | | 1 | Latch function linked to encoder signal A |
| 5 | Use encoder signal B to trigger latch procedure | 0 | Disabled (bus controller default setting) |
| | | 1 | Latch function linked to encoder signal B |
| 6 | Use encoder signal R to trigger latch procedure | 0 | Disabled (bus controller default setting) |
| | | 1 | Latch function linked to encoder signal R |
| 7 | Use digital input 1 to trigger latch procedure | 0 | Disabled (bus controller default setting) |
| | | 1 | Latch function linked to digital input 1 |

9.11.9.9.4.5 Physical configuration

The following registers must be set to the specified constant value for correct physical configuration:

Constant register "CfO_SlframeGenID"

Name:

CfO_SlframeGenID

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 9 | Bus controller default setting |

Constant register "CfO_SystemCycleTime"

Name:

CfO_SystemCycleTime

Cycle time of encoder acquisition in 1/8 μ s steps. 1 encoder value is acquired as the counter value per cycle.

| Data type | Value | Information |
|-----------|-------|--|
| UINT | 800 | 800 = 100 μ s. Bus controller default setting |

Constant register "CfO_PhyIOConfigCh0x"

Name:

CfO_PhyIOConfigCh01 to CfO_PhyIOConfigCh05

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 0 | Bus controller default setting |

Constant register "CfO_BWQuitTimeSelChannel7_0"

Name:

CfO_BWQuitTimeSelChannel7_0

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 0 | Bus controller default setting |

Constant register "CfO_CounterCycleSelect"

Name:

CfO_CounterCycleSelect

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 2 | Bus controller default setting |

Constant register "CfO_CounterMode"

Name:

CfO_CounterMode

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 3 | Bus controller default setting |

9.11.9.9.5 Encoder - Communication**9.11.9.9.5.1 Counter for verifying the data frame**

Name:

SDCLifeCount

The 8-bit counter register is needed for the SDC software package. It is incremented with the system clock to allow the SDC to check the validity of the data frame.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

9.11.9.9.5.2 Display of the counter state

Name:

Encoder01

The counter state of the incremental encoder is displayed as a 16 or 32-bit counter value. Only the 16-bit value is available in the bus controller function model.

| Data type | Value |
|--------------------|----------------------------------|
| INT | -32768 to 32767 |
| DINT ¹⁾ | -2.147.483.648 bis 2.147.483.647 |

1) Can only be configured in the standard function model

9.11.9.9.5.3 NetTime of the last valid counter value

Name:

Encoder01TimeValid

The NetTime of the last valid counter value is the time of the last valid counter value recorded on the module (see register "[Cfo_SystemCycleTime](#)" on page 1161). The user is able to determine the validity of the counter value by evaluating its age in the program. This means that the module and error status bits do not have to be checked additionally to determine the validity of the value.

The NetTime of the last valid counter value that was read is displayed as a 16 or 32-bit value. Only the 16-bit value is available in the bus controller function model.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Value | Information |
|--------------------|---------------------------------|--------------------|
| INT | -32768 to 32767 | NetTime in μ s |
| DINT ¹⁾ | -2.147.483.648 to 2.147.483.647 | |

1) Can only be configured in the standard function model

9.11.9.9.5.4 NetTime of the last counter value change

Name:

Encoder01TimeChanged

For slow X2X Link cycles, the NetTime of the last counter value change can be used to determine the speed more accurately.

The NetTime of the last counter value change is displayed as a 16 or 32-bit value. Only the 16-bit value is available in the bus controller function model.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Value | Information |
|--------------------|---------------------------------|--------------------|
| INT | -32768 to 32767 | NetTime in μ s |
| DINT ¹⁾ | -2.147.483.648 to 2.147.483.647 | |

1) Can only be configured in the standard function model

9.11.9.9.5.5 Counter value at the time of the last latch

Name:

Encoder01Latch

The counter value at the time of the last latch is displayed as a 16 or 32-bit value. Only the 16-bit value is available in the bus controller function model.

| Data type | Value |
|--------------------|----------------------------------|
| INT | -32768 to 32767 |
| DINT ¹⁾ | -2.147.483.648 bis 2.147.483.647 |

1) Can only be configured in the standard function model

9.11.9.9.5.6 Counter value of latch event

Name:

Encoder01LatchCount

The latch events are counted and stored in a cyclic 8-bit counter. This counter is incremented with each latch event, thereby indicating a new occurrence. The new latched counter value is stored in the respective latch register.

| Data type | Value |
|-----------|-------------|
| SINT | -128 to 127 |

9.11.9.9.5.7 Encoder commands

Name:

Encoder01Command

This register can be used to

- 1) reset the counter value. The counter is kept at zero until this command is reset.
- 2) enable the latch procedure. If the latch configuration is valid and matches the hardware signals, then this activation causes the counter value to be saved in the latch register.

The two different latch configurations that are possible (see "[Setting the latch mode](#)" on page 1160) must be handled as follows:

- Single shot latch mode:
After successful latching, indicated by the latch event counter, activation must be reset before any more latching is possible. The activation must be set again if additional latching is needed.
- Continuous latch mode:
The latch function only has to be enabled/set as long as latching is desired. The latch event counter is incremented with each event.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|----------------------|-------|------------------------|
| 0 | Encoder01Reset | 0 | Do not reset |
| | | 1 | Set encoder value to 0 |
| 1 | Encoder01LatchEnable | 0 | Do not activate latch |
| | | 1 | Latching |
| 2 - 7 | Reserved | 0 | |

9.11.9.9.5.8 Input status of signal lines

Name:

Encoder01_A

Encoder01_B

Encoder01_R

DigitalInput01 to DigitalInput02

This register displays the input status of the signal lines from the encoder and the digital inputs.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|----------------|-------|---------------------------------|
| 0 | Encoder01_A | 0/1 | Input state of encoder signal A |
| 1 | Encoder01_B | 0/1 | Input state of encoder signal B |
| 2 | Encoder01_R | 0/1 | Input state of encoder signal R |
| 3 | Reserved | 0 | |
| 4 | DigitalInput01 | 0/1 | Input state - Digital input 1 |
| 5 | DigitalInput02 | 0/1 | Input state - Digital input 2 |
| 6 - 7 | Reserved | 0 | |

9.11.9.9.5.9 Error status of signal lines

The error states are latched when they occur and are maintained until acknowledged. The counter and time registers are not updated if there are pending or unacknowledged errors.

Status of signal lines

Name:

BW_Channel_A

BW_Channel_B

BW_Channel_R

This register displays the error states of the signal lines from the encoder. The error states are latched when they occur and are maintained until acknowledged. The counter and time registers are not updated if there are pending or unacknowledged errors.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|--------------|-------|---|
| 0 | BW_Channel_A | 0 | No error in encoder signal A |
| | | 1 | Open line, short circuit or voltage level too low |
| 1 | BW_Channel_B | 0 | No error in encoder signal B |
| | | 1 | Open line, short circuit or voltage level too low |
| 2 | BW_Channel_R | 0 | No error in encoder signal R |
| | | 1 | Open line, short circuit or voltage level too low |
| 3 - 7 | Reserved | 0 | |

Acknowledging error status of signal lines

Name:

BW_QuitChannel_A

BW_QuitChannel_B

BW_QuitChannel_R

This register can be used to acknowledge the latched error states of the signal lines from the encoder. However, if there are still pending errors remaining, then the error status remains active. After acknowledging the errors, the bits must also be reset or else any repetition of the error would be undetected.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|------------------|-------|---|
| 0 | BW_QuitChannel_A | 0 | No acknowledgment |
| | | 1 | Acknowledgment of error status - Encoder signal A |
| 1 | BW_QuitChannel_B | 0 | No acknowledgment |
| | | 1 | Acknowledgment of error status - Encoder signal B |
| 2 | BW_QuitChannel_R | 0 | No acknowledgment |
| | | 1 | Acknowledgment of error status - Encoder signal R |
| 3 - 7 | Reserved | 0 | |

Manual acknowledgment of latched error states

The latched error states of the signal lines from the encoder can be acknowledged manually. However, if there are still pending errors remaining, then the error status remains active. After successfully acknowledging the errors (latched error status = 0), the acknowledge bits must still be reset by the user or else a re-occurrence of an error could be overlooked by the user.

Example 1: Cause of error corrected before being acknowledged

An error has occurred on a signal line. The error state is detected and latched by the module. The error is acknowledged by the user after the cause of error has been corrected. The latched error status changes to zero.

The manual acknowledge must now be reset so that any new errors will be recognized by the user.

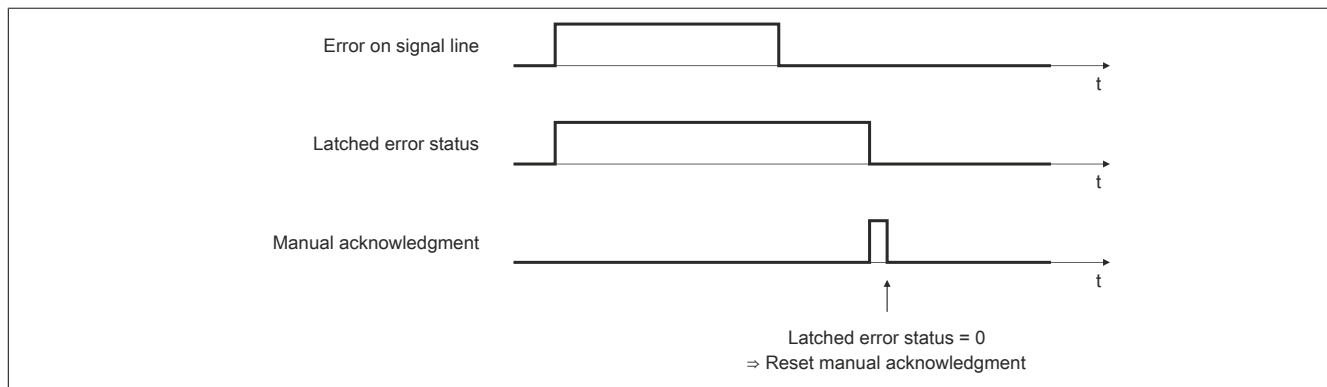


Figure 114: Cause of error corrected before being acknowledged

Example 2: Cause of error not yet corrected before being acknowledged

An error has occurred on a signal line. The error state is detected and latched by the module. The error is acknowledged by the user before the cause of error has been corrected. The latched error status remains set because the error is still remaining.

Acknowledgment is only successful after the cause of error has been corrected. The latched error status changes to zero. The manual acknowledge must now be reset so that any new errors will be recognized by the user.

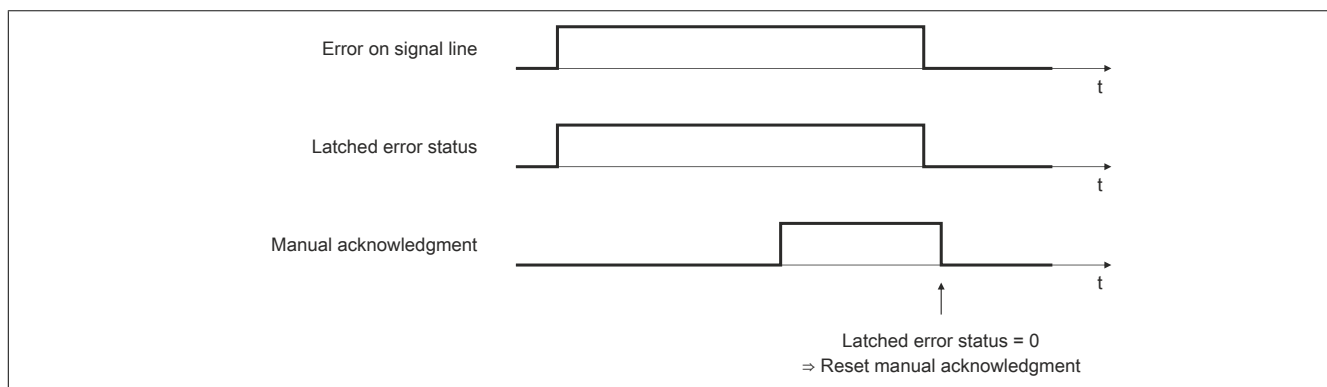


Figure 115: Cause of error not yet corrected before being acknowledged

Automatic acknowledgment of latched error states

In addition to manual acknowledgment, automatic acknowledgment of the latched error states after a specified amount of time can also be enabled. Make sure that the time is set long enough for the higher-level system to reliably detect the status messages and for the validity of the counter value to be determined using its age.

If the time specification = 0, then only manual acknowledgment is possible.

Example 1: An error has occurred on a signal line. The error state is detected and latched by the module. The time for automatic acknowledgment starts counting after the cause of error has been corrected. The error is acknowledged as soon as the time expires. The latched error status changes to zero.

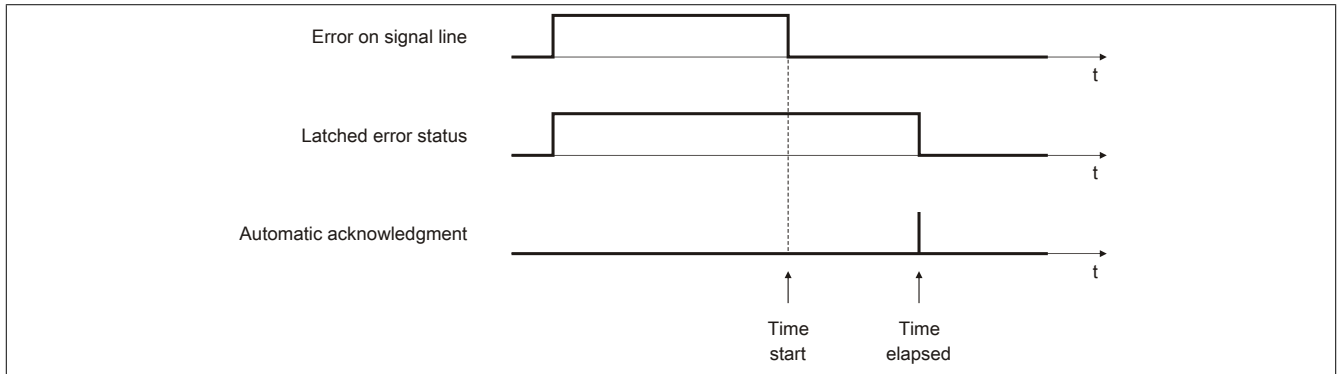


Figure 116: Latched error state acknowledged automatically

Example 2: Automatic and manual acknowledge used
 An error has occurred on a signal line. The error state is detected and latched by the module. The time for automatic acknowledgment starts counting after the cause of error has been corrected. The error is acknowledged manually by the user before the time expires. The latched error status changes to zero. The manual acknowledge must now be reset so that any new errors will be recognized by the user.

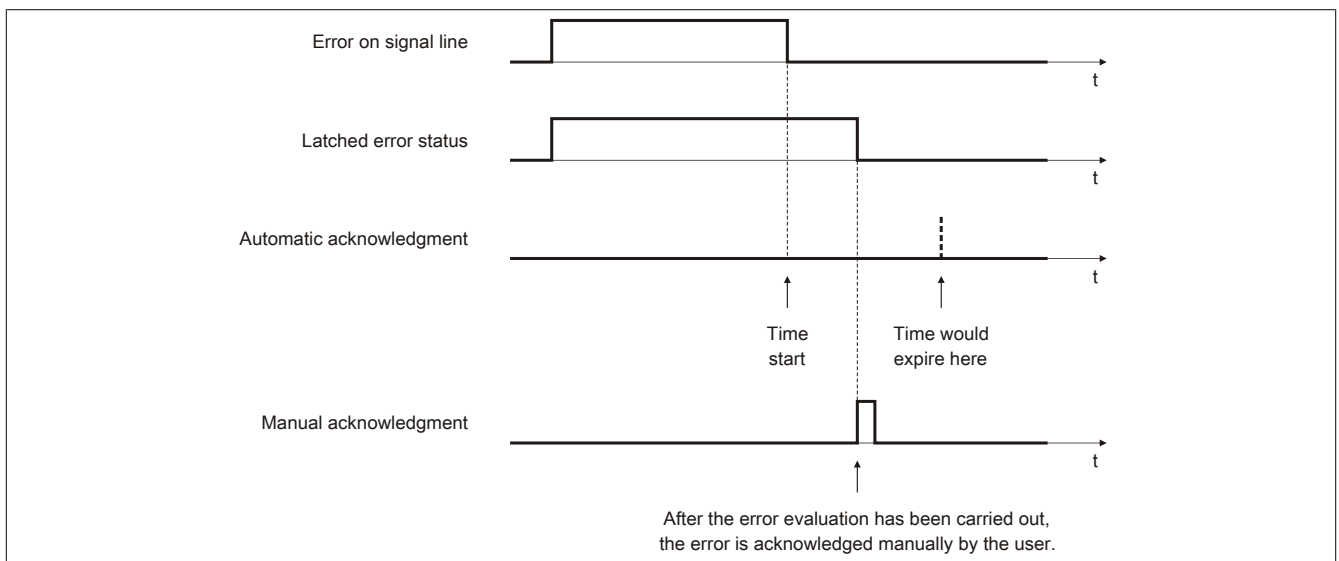


Figure 117: Automatic and manual acknowledge used

9.11.9.9.5.10 Status of encoder power supply

Name:

PowerSupply01

This register indicates the state of the integrated encoder power supply. A faulty encoder power supply is output as a warning.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|------------------------------------|
| 0 | PowerSupply01 | 0 | 24 VDC encoder power supply OK |
| | | 1 | 24 VDC encoder power supply faulty |
| 1 - 7 | Reserved | - | |

9.11.9.9.6 NetTime Technology

For a description of NetTime Technology, see ["NetTime Technology" on page 3035](#).

9.11.9.9.7 Minimum cycle time

The minimum cycle time defines how far the bus cycle can be reduced without causing a communication error or impaired functionality. It should be noted that very fast cycles decrease the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 150 μ s |

9.11.9.9.8 Minimum I/O update time

The minimum I/O update time defines how far the bus cycle can be reduced while still allowing an I/O update to take place in each cycle.

| Minimum I/O update time |
|-------------------------|
| 150 μ s |

9.11.10 X20(c)DC1396

Data sheet version: 3.21

9.11.10.1 General information

The module is equipped with 1 input for an ABR incremental encoder with 24 V encoder signal.

- 1 ABR incremental encoder 24 V
- 1 additional input e.g. for home enable switch
- 24 VDC and GND for encoder supply

9.11.10.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.11.10.3 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Counter functions |  |
| X20DC1396 | X20 digital counter module, 1 ABR incremental encoders, 24 V, 100 kHz input frequency, 4x evaluation | |
| X20cDC1396 | X20 digital counter module, coated, 1 ABR incremental encoders, 24 V, 100 kHz input frequency, 4x evaluation | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 207: X20DC1396, X20cDC1396 - Order data

9.11.10.4 Technical data

| Model number | X20DC1396 | X20cDC1396 |
|--|--|------------|
| Short description | | |
| I/O module | 1 ABR incremental encoder 24 V | |
| General information | | |
| Input voltage | 24 VDC -15 % / +20 % | |
| B&R ID code | 0x1BAC | 0xE502 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Power consumption | | |
| Bus | 0.01 W | |
| Internal I/O | 1.4 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Type of signal lines | Shielded cables must be used for all signal lines | |
| Certifications | | |
| CE | Yes | |
| KC | Yes | - |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| Digital inputs | | |
| Quantity | 1 | |
| Nominal voltage | 24 VDC | |
| Input characteristics per EN 61131-2 | Type 1 | |
| Input current at 24 VDC | Approx. 3.3 mA | |
| Input circuit | Sink | |
| Input filter | | |
| Hardware | ≤2 µs | |
| Software | - | |
| Connection type | 3-wire connections | |
| Input resistance | 7.19 kΩ | |
| Additional functions | Home enable switch | |
| Switching threshold | | |
| Low | <5 VDC | |
| High | >15 VDC | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| ABR incremental encoder | | |
| Encoder inputs | 24 V, asymmetrical | |
| Counter size | 16/32-bit | |
| Input frequency | Max. 100 kHz | |
| Evaluation | 4x | |
| Encoder power supply | Module-internal, max. 600 mA | |
| Input filter | | |
| Hardware | ≤2 µs | |
| Software | - | |
| Input current at 24 VDC | Approx. 1.3 mA | |
| Input resistance | 18.4 kΩ | |
| Switching threshold | | |
| Low | <5 VDC | |
| High | >15 VDC | |
| Overload characteristics of encoder power supply | Short circuit protection, overload protection | |
| Isolation voltage between encoder and bus | 500 V _{eff} | |
| Electrical properties | | |
| Electrical isolation | Bus isolated from encoder and reference enable switch Encoder not isolated from reference enable switch | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |


Table 208: X20DC1396, X20cDC1396 - Technical data

| Model number | X20DC1396 | X20cDC1396 |
|--|--|---|
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm | |

Table 208: X20DC1396, X20cDC1396 - Technical data

9.11.10.5 LED status indicators

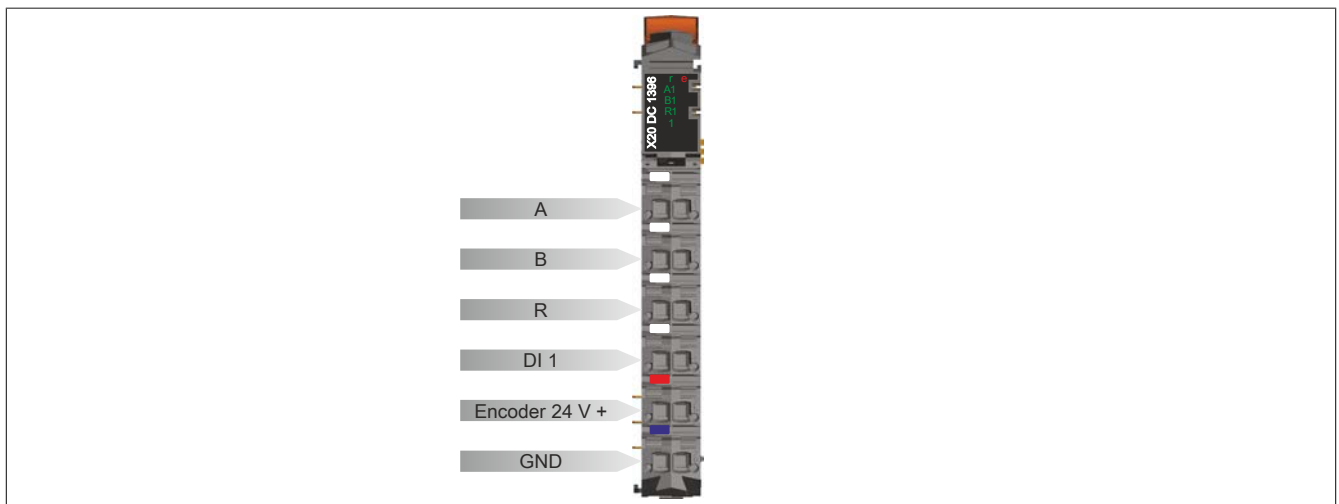
For a description of the various operating modes, see ["Diagnostic LEDs" on page 3787](#).

| Figure | LED | Color | Status | Description |
|--|-------|-------|-----------------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | e | Red | On | RUN mode |
| | | | Off | No power to module or everything OK |
| | A1 | Green | On | Error or reset status |
| | | | Off | Input state of counter input A |
| | B1 | Green | Off | Input state of counter input B |
| | R1 | Green | Off | Input state of reference pulse R |
| 1 | Green | Off | Input state - Digital input | |

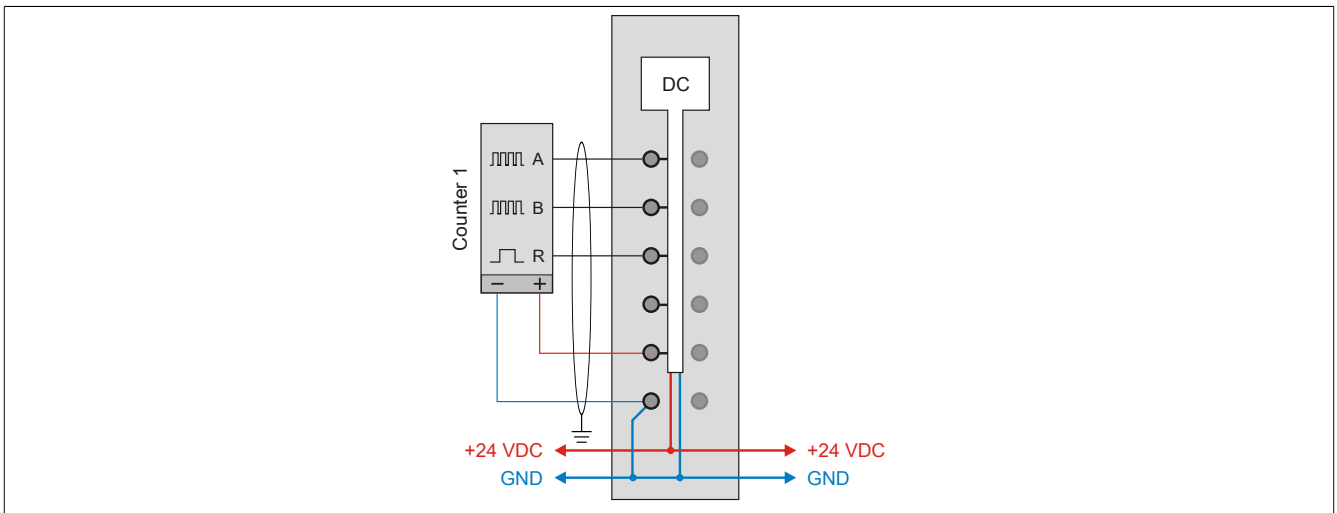
1) Depending on the configuration, a firmware update can take up to several minutes.

9.11.10.6 Pinout

Shielded cables must be used for all signal lines.

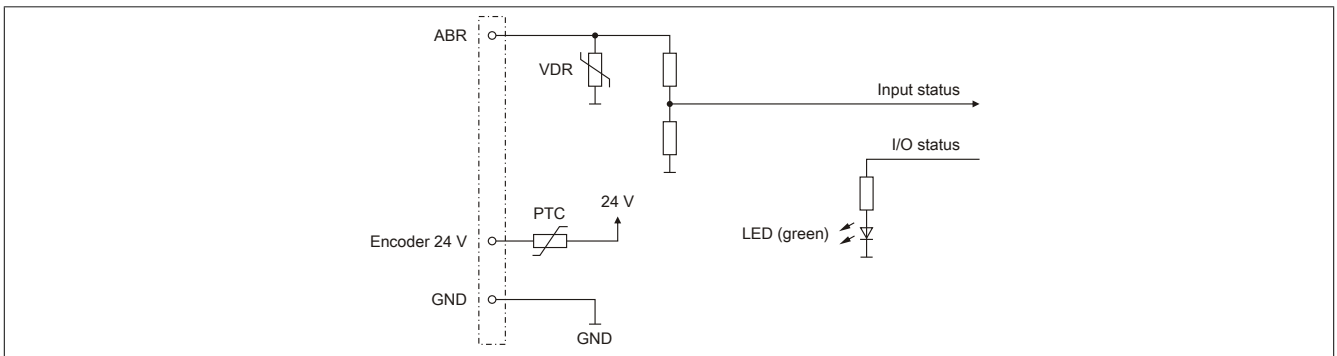


9.11.10.7 Connection example

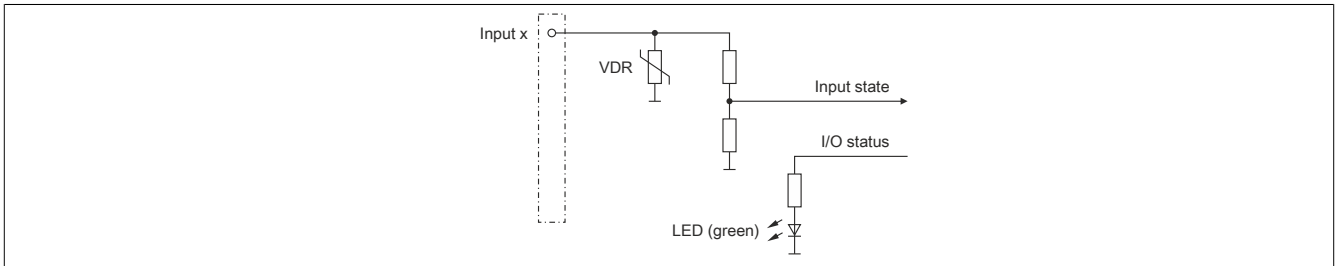


9.11.10.8 Input circuit diagram

Counter inputs



Standard input



9.11.10.9 Register description

9.11.10.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.11.10.9.2 Function model 0 - Standard and Function model 1 - Standard with 32-bit encoder counter value

The difference between function model 0 and function model 1 is the size of the data type for some registers.

- Function model 0 uses data type INT
- Function model 1 uses data type DINT (specified in parentheses)

| Register | Name | Data type | Read | | Write | |
|----------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 4104 | CfO_EdgeDetectFalling | USINT | | | | • |
| 4106 | CfO_EdgeDetectRising | USINT | | | | • |
| 2064 | CfO_PresetABR01_1(32Bit) | (D)INT | | | | • |
| 2068 | CfO_PresetABR01_2(32Bit) | (D)INT | | | | • |
| 512 | ConfigOutput24 | UINT | | | | • |
| 522 | ConfigOutput26 | USINT | | | | • |
| 520 | ConfigOutput27 | USINT | | | | • |
| Communication | | | | | | |
| 2116 | ReferenceModeEncoder01 | USINT | | | • | |
| 2080 | Encoder01 | (D)INT | • | | | |
| 264 | Input state of the digital input | USINT | • | | | |
| | DigitalInput01 | Bit 3 | | | | |
| 2118 | StatusInput01 | USINT | • | | | |
| 40 | Status of encoder power supply | USINT | • | | | |
| | PowerSupply01 | Bit 0 | | | | |

9.11.10.9.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 4104 | - | CfO_EdgeDetectFalling | USINT | | | | • |
| 4106 | - | CfO_EdgeDetectRising | USINT | | | | • |
| 2064 | - | CfO_PresetABR01_1 | INT | | | | • |
| 2068 | - | CfO_PresetABR01_2 | INT | | | | • |
| 512 | - | ConfigOutput24 | UINT | | | | • |
| 522 | - | ConfigOutput26 | USINT | | | | • |
| 520 | - | ConfigOutput27 | USINT | | | | • |
| Communication | | | | | | | |
| 2116 | 0 | ReferenceModeEncoder01 | USINT | | | • | |
| 2080 | 0 | Encoder01 | INT | • | | | |
| 264 | 2 | Input state of the digital input | USINT | • | | | |
| | | DigitalInput01 | Bit 3 | | | | |
| 2118 | 4 | StatusInput01 | USINT | • | | | |
| 40 | 3 | Status of encoder power supply | USINT | • | | | |
| | | PowerSupply01 | Bit 0 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.11.10.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.11.10.9.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.11.10.9.4 ABR encoder - Configuration registers

9.11.10.9.4.1 Reference pulse

The following registers must be configured by a single acyclic write with the listed values so that the homing procedure is completed on the edge of the reference pulse.

The homing procedure can take place on:

- Rising edge
- Falling edge (default configuration)

Constant register "CfO_EdgeDetectFalling"

Name:

CfO_EdgeDetectFalling

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0x00 | Configuration value for rising edge |
| | 0x04 | Configuration value for falling edge (bus controller default setting) |

Constant register "CfO_EdgeDetectRising"

Name:

CfO_EdgeDetectRising

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0x04 | Configuration value for rising edge |
| | 0x00 | Configuration value for falling edge (bus controller default setting) |

Constant register "ConfigOutput24"

Name:

ConfigOutput24

This register contains the value for ABR encoder 1.

| Data type | Value | Filter |
|-----------|--------|---|
| UINT | 0x1012 | Configuration value for rising edge |
| | 0x1002 | Configuration value for falling edge (bus controller default setting) |

9.11.10.9.4.2 Setting the home position

Name:

Cfo_PresetABR01_1 to Cfo_PresetABR01_2

CfO_PresetABR01_1_32Bit to CfO_PresetABR01_2_32Bit (only in function model 1)

It is possible to specify 2 home positions with these registers through a one-off acyclic write, for example. The configured values are applied to the counter values after a completed homing procedure.

| Data type | Value | Information |
|--------------------|---------------------------------|-----------------------------------|
| INT | -32,768 to 32,767 | Bus controller default setting: 0 |
| DINT ¹⁾ | -2,147,483,648 to 2,147,483,647 | |

1) Only in function model 1

9.11.10.9.4.3 Homing with reference enable input

Regardless of the referencing mode, it is possible using this register to prevent the home position from being applied when the corresponding reference input voltage level occurs (see ["Input state of the digital input" on page 1176](#): bit 3). The desired setting can be configured by a one-off acyclic write.

Voltage level for reference enable activation

Name:

ConfigOutput26

This register is used to configure the active voltage level of the digital input for the reference enable.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0x00 | Reference enable is active at 0 VDC (bus controller default setting). |
| | 0x08 | Reference enable is active at 24 VDC |

Reference enable of the input

Name:

ConfigOutput27

This register can be used to define whether the reference enable is activated.

| Data type | Value | Filter |
|-----------|-------|--|
| USINT | 0x00 | Reference enable input disabled (bus controller default setting) |
| | 0x08 | Reference enable input activated |

9.11.10.9.5 ABR encoder - Configuration registers

9.11.10.9.5.1 Counter state of the encoder

Name:
Encoder01

The encoder values are represented as 16-bit or 32-bit counter values in this register.

| Data type | Value |
|--------------------|---------------------------------|
| INT | -32,768 to 32,767 |
| DINT ¹⁾ | -2,147,483,648 to 2,147,483,647 |

1) Only in function model 1

9.11.10.9.5.2 Input state of the digital input

Name:
DigitalInput01

This register displays the input status of the encoder and the digital input.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

| Bit | Name | Value | Information |
|-------|----------------|--------|--------------------------------|
| 0 | Encoder A | 0 or 1 | Input state |
| 1 | Encoder B | 0 or 1 | Input state |
| 2 | Encoder A + B | 0 or 1 | Input state of reference pulse |
| 3 | DigitalInput01 | 0 or 1 | Input state - Digital input 1 |
| 4 - 7 | Reserved | - | |

9.11.10.9.5.3 Reading the referencing mode

Name:
ReferenceModeEncoder01

This register determines the referencing mode.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|------|-------|--------------------------|
| 0 - 1 | | 00 | Referencing OFF |
| | | 01 | Single shot referencing |
| | | 11 | Continuous referencing |
| 2 - 5 | | 0 | Bits permanently set = 0 |
| 6 - 7 | | 00 | Referencing OFF |
| | | 11 | Bits permanently set = 1 |

This results in the following values:

| Binary | Hex | Function |
|----------|------|-------------------------|
| 00000000 | 0x00 | Referencing OFF |
| 11000001 | 0xC1 | Single shot referencing |

For a new start after the completed homing procedure:

- Write value 0x00
- Wait until bit 0 to bit 3 of the StatusInput01 register takes on the value 0. Counter bits 4 to 7 are not erased
- Switch homing procedure on again

| | | |
|----------|------|--|
| 11000011 | 0xC3 | Continuous referencing Referencing occurs at every reference pulse. |
|----------|------|--|

It is important to know how the optional reference enable is configured. See ["Homing with reference enable input" on page 1175](#)

9.11.10.9.5.4 Status of the homing procedure

Name:

StatusInput01

This register contains information regarding whether the referencing process is off, active or complete.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|--|--------|--|
| 0 | Reference pulse without homing ¹⁾ | 0 | No reference impulse without homing has occurred yet |
| | | 1 | At least a reference impulse without homing has occurred |
| 1 | State change | 0 or 1 | Changes with each reference pulse without homing |
| 2 | Reference pulse with homing ¹⁾ | 0 | No homing has occurred yet |
| | | 1 | At least one homing procedure has occurred |
| 3 | State change | 0 or 1 | Changes with each homing procedure that has taken place |
| 4 | Reference pulse | 0 | The last reference pulse didn't bring about a homing procedure |
| | | 1 | The last reference pulse brought about a homing procedure |
| 5 - 7 | Counter | x | Free-running counter, increased with each reference pulse |

1) Always 1 after the first reference pulse that has occurred

Examples of possible values:

| Binary | Hex | Function |
|------------|-------|---|
| 0x00000000 | 0x00 | Referencing OFF or homing procedure already active |
| 0x00111100 | 0x3CE | First homing procedure complete Reference value applied in the Encoder01 register |
| 0xxxx11100 | 0xxB | Bits 5 to 7 are changed with each reference pulse |
| 0xxxx1x100 | 0xxx | Continuously changing the bits with the "Continuous referencing" setting. The reference value is applied to the Encoder01 register on each reference pulse. |

It is important to know how the optional reference enable (see ["Homing with reference enable input" on page 1175](#)) is configured.

9.11.10.9.5.5 Status of encoder power supply

Name:

PowerSupply01

This register indicates the state of the integrated encoder power supply. A faulty encoder power supply is output as a warning.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|------------------------------------|
| 0 | PowerSupply01 | 0 | 24 VDC encoder power supply OK |
| | | 1 | 24 VDC encoder power supply faulty |
| 1 - 7 | Reserved | - | |

9.11.10.9.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 128 μ s |

9.11.10.9.7 Maximum cycle time

The maximum cycle time specifies the time up to which the bus cycle can be increased without internal counter overflows causing module malfunctions.

| Minimum cycle time |
|--------------------|
| 16 ms |

9.11.10.9.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 128 μ s |

9.11.11 X20DC1398

Data sheet version: 3.11

9.11.11.1 General information

This module is equipped with one input for SSI absolute encoders with 24 V encoder signal.

- 1 SSI absolute encoder 24 V
- 1 additional input
- 24 VDC and GND for encoder supply

9.11.11.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Counter functions |  |
| X20DC1398 | X20 digital counter module, 1 SSI absolute encoder, 24 V, 125 kbit/s, 32-bit | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 209: X20DC1398 - Order data

9.11.11.3 Technical data

| Model number | X20DC1398 |
|--|--|
| Short description | |
| I/O module | 1 SSI absolute encoder 24 V |
| General information | |
| Input voltage | 24 VDC -15 % / +20 % |
| B&R ID code | 0x1BAE |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.3 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Type of signal lines | Shielded cables must be used for all signal lines |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| Digital inputs | |
| Quantity | 1 |
| Nominal voltage | 24 VDC |
| Input current at 24 VDC | Approx. 3.3 mA |


Table 210: X20DC1398 - Technical data

| Model number | X20DC1398 |
|--|--|
| Input characteristics per EN 61131-2 | Type 1 |
| Input filter | |
| Hardware | ≤2 μs |
| Software | - |
| Connection type | 3-wire connections |
| Input circuit | Sink |
| Input resistance | 7.19 kΩ |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| SSI absolute encoder | |
| Encoder inputs | 24 V, asymmetrical |
| Counter size | 32-bit |
| Max. transfer rate | 125 kbit/s |
| Encoder power supply | Module-internal, max. 600 mA |
| Keying | Gray/Binary |
| CLK: Output current | Max. 100 mA |
| DATA: Input resistance | 18.4 kΩ |
| Isolation voltage between encoder and bus | 500 V _{eff} |
| Overload characteristics of encoder power supply | Short circuit protection, overload protection |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Electrical properties | |
| Electrical isolation | Bus isolated from encoder and channel Channel not isolated from encoder |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm |

Table 210: X20DC1398 - Technical data

9.11.11.4 LED status indicators

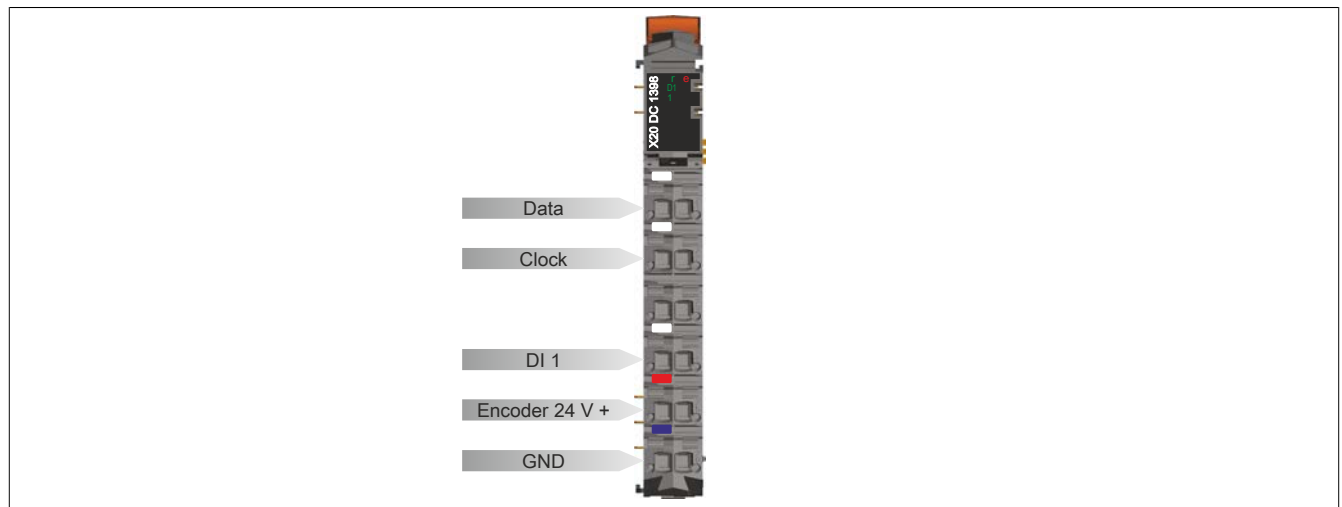
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|-------|-----------------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | e | Red | On | RUN mode |
| | | | Off | No power to module or everything OK |
| | D1 | Green | On | Error or reset status |
| Off | | | Input status - Data signal | |
| 1 | Green | On | Input state - Digital input | |

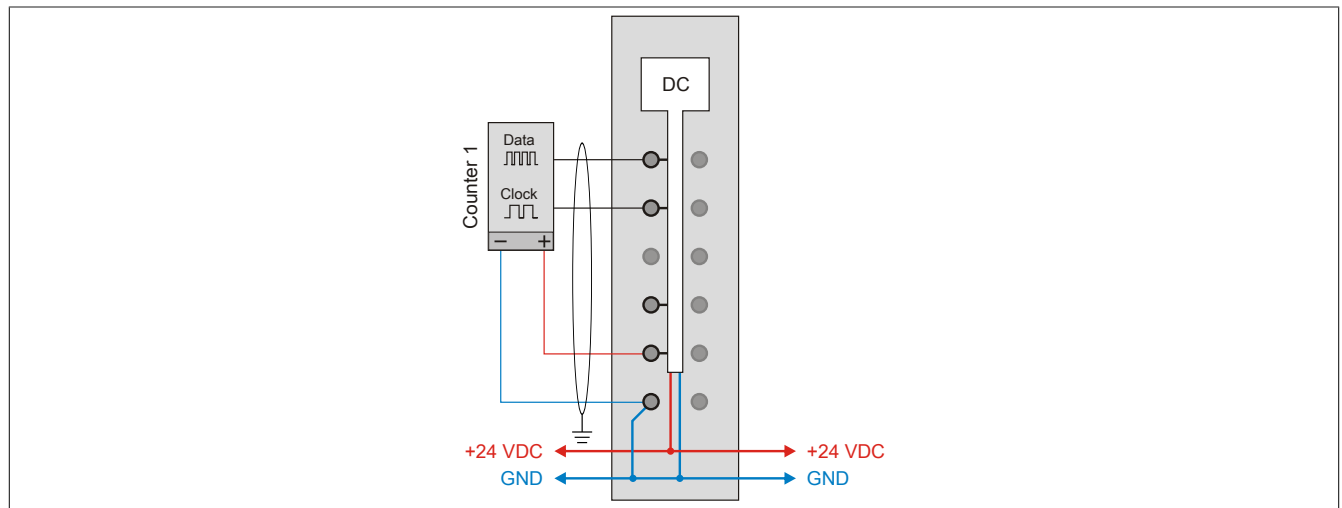
1) Depending on the configuration, a firmware update can take up to several minutes.

9.11.11.5 Pinout

Shielded cables must be used for all signal lines.

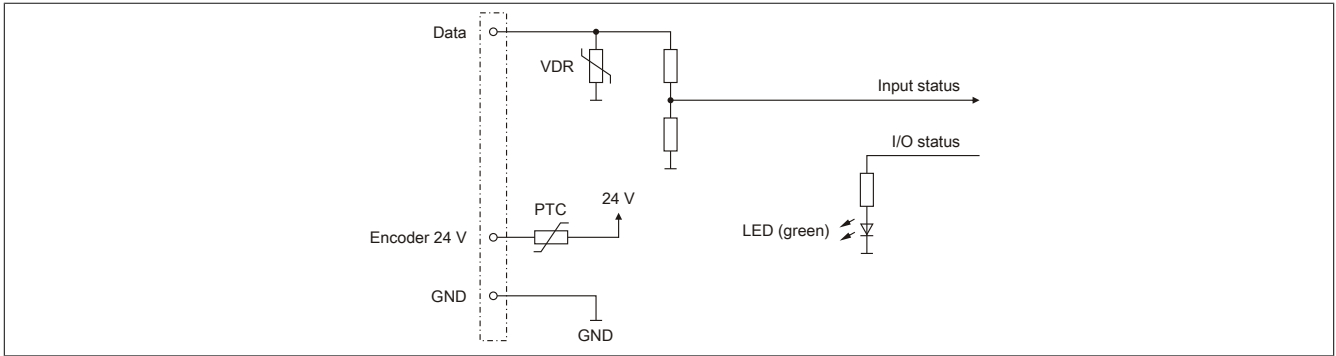


9.11.11.6 Connection example

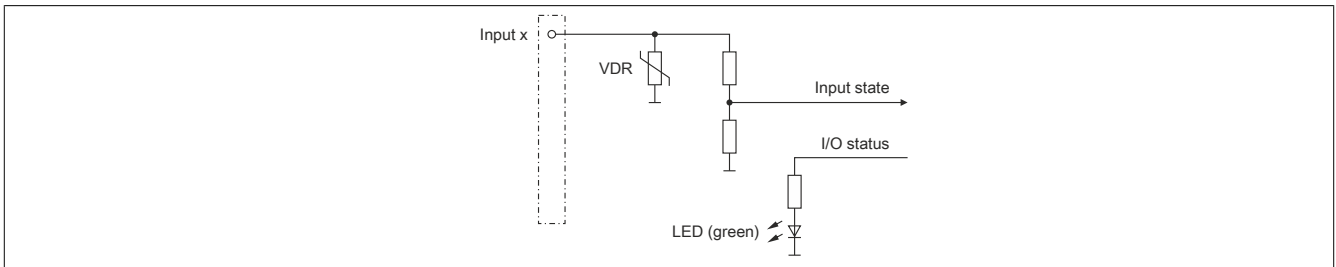


9.11.11.7 Input circuit diagram

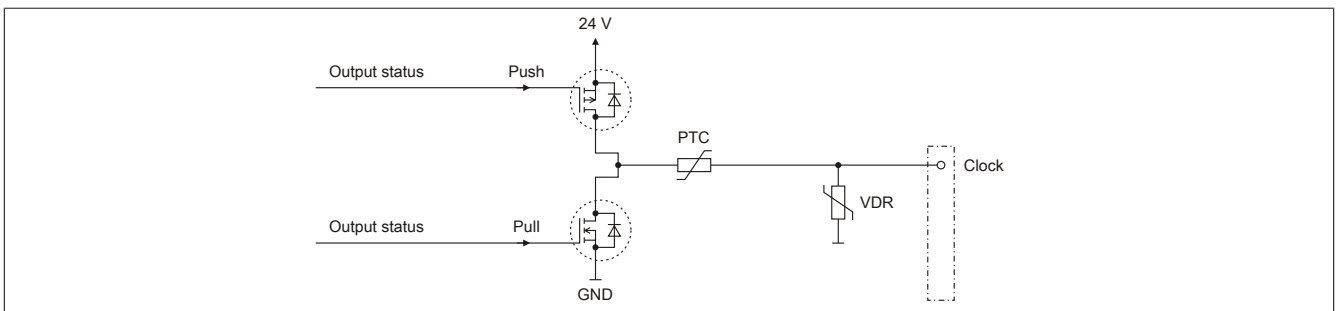
Counter input



Standard input



9.11.11.8 Output circuit diagram



9.11.11.9 Register description

9.11.11.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.11.11.9.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 7176 | ConfigOutput14 | UINT | | | | • |
| 7172 | ConfigAdvanced | UDINT | | | | • |
| Communication | | | | | | |
| 7184 | Encoder01 | UDINT | • | | | |
| 264 | Input state of the digital input 1 | USINT | • | | | |
| | DigitalInput01 | Bit 3 | | | | |
| 40 | Status of encoder power supply | USINT | • | | | |
| | PowerSupply01 | Bit 0 | | | | |

9.11.11.9.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 7176 | - | ConfigOutput14 | UINT | | | | • |
| 7172 | - | ConfigAdvanced | UDINT | | | | • |
| Communication | | | | | | | |
| 7184 | 0 | Encoder01 | UDINT | • | | | |
| 264 | 4 | Input state of the digital input 1 | USINT | • | | | |
| | | DigitalInput01 | Bit 3 | | | | |
| 40 | 5 | Status of encoder power supply | USINT | • | | | |
| | | PowerSupply01 | Bit 0 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.11.11.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "[Using I/O modules on the bus controller](#)" on page 3789.

9.11.11.9.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.11.11.9.4 SSI encoder configuration registers

9.11.11.9.4.1 Standard configuration

Name:

ConfigOutput14

This configuration register sets the encoding, clock rate and number of bits. Default = 0. This must be set once using an acyclic write command.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Name | Value | Information |
|--------|----------------------|-------|--|
| 0 - 5 | SSI value valid bits | x | Bus controller default setting: 0 |
| 6 - 7 | Clock rate | 11 | 125 kHz. Bus controller default setting: 0 |
| 8 - 13 | SSI number of bits | | Number of bits including leading zeros. Bus controller default setting: 0 |
| 14 | Reserved | 0 | |
| 15 | Keying | 0 | Binary encoding (bus controller default setting) |
| | | 1 | Gray coding |

9.11.11.9.4.2 Extended configuration

Name:

ConfigAdvanced

This configuration register is used to set the encoding, clock rate, number of bits and monostable multivibrator settings. This must be set once using an acyclic write command.

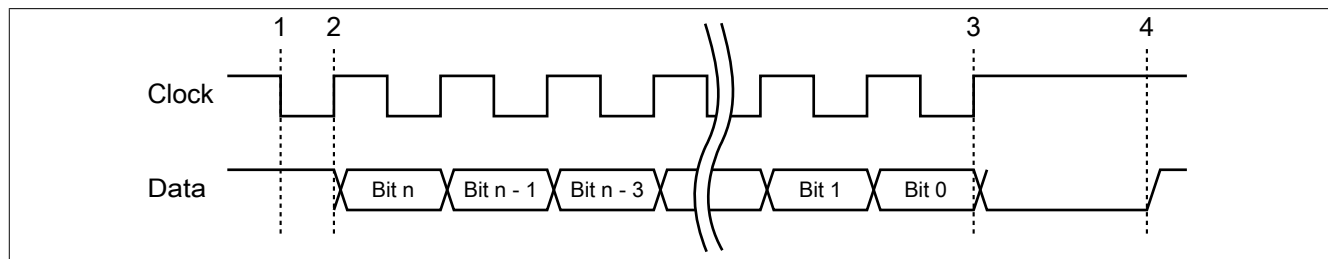
It only differs from "[ConfigOutput14](#)" on page 1184 by data length and additional monostable multivibrator testing.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UDINT | See the bit structure. | 65536 |

Bit structure:

| Bit | Name | Value | Information |
|---------|--------------------------------|-------|--|
| 0 - 5 | SSI value valid bits | x | Bus controller default setting: 0 |
| 6 - 7 | Clock rate | 11 | 125 kHz. Bus controller default setting: 0 |
| 8 - 13 | SSI number of bits | x | Number of bits including leading zeros. Bus controller default setting: 0 |
| 14 | Reserved | 0 | |
| 15 | Keying | 0 | Binary encoding (bus controller default setting) |
| | | 1 | Gray coding |
| 16 - 17 | Monostable multivibrator check | 00 | Check OFF, no additional clock bit |
| | | 01 | Check set to high level (bus controller default setting) |
| | | 10 | Check set to Low level |
| | | 11 | Level is clocked but ignored |
| 18 - 31 | Reserved | 0 | |

Transferring using Synchronous Serial Interface



Processing the measured value

- 1) Start bit ... The measured value is saved.
- 2) Output of the first data bit
- 3) All data bits are transferred; the monostable multivibrator time starts to run.
- 4) The monostable multivibrator returns to its initial state; a new transfer can be started.

9.11.11.9.5 SSI encoder communication registers

9.11.11.9.5.1 SSI position values

Name:
Encoder01

The SSI encoder value is displayed as a 32-bit position value. The SSI position value is generated synchronously with the X2X cycle.

| Data type | Value | Filter |
|-----------|--------------------|--------------|
| UDINT | 0 to 4,294,967,295 | SSI position |

9.11.11.9.5.2 Input state of the digital input 1

Name:
DigitalInput01

This register displays the input state of the digital input.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|--------|-------------------------------|
| 3 | DigitalInput01 | 0 or 1 | Input state - Digital input 1 |

9.11.11.9.5.3 Status of encoder power supply

Name:
PowerSupply01

This register indicates the state of the integrated encoder power supply. A faulty encoder power supply is output as a warning.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|------------------------------------|
| 0 | PowerSupply01 | 0 | 24 VDC encoder power supply OK |
| | | 1 | 24 VDC encoder power supply faulty |
| 1 - 7 | Reserved | - | |

9.11.11.9.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 128 μ s |

9.11.11.9.7 Maximum cycle time

The maximum cycle time specifies the time up to which the bus cycle can be increased without internal counter overflows causing module malfunctions.

| Minimum cycle time |
|--------------------|
| 16 ms |

9.11.11.9.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 128 μ s |

9.11.12 X20DC1976

Data sheet version: 2.21

9.11.12.1 General information

The module is equipped with 1 input for an ABR incremental encoder with 5 V encoder supply. The encoder inputs are monitored (A, B, R). The module is suitable for incremental encoders with push-pull outputs with no complementary signal.

- 1 ABR incremental encoder 5 V, asymmetric
- Encoder input monitoring
- 2 additional inputs, e.g. for latch input
- 5 VDC, 24 VDC and GND for encoder supply
- NetTime timestamp: Counter change

NetTime timestamp of the counter

For many applications, not only the counter value is important, but also the exact time of the counter change. For this purpose, the module has a NetTime function that provides the recorded counter value with a timestamp accurate to microseconds.

The module provides the PLC with the counter value and timestamp as an absolute time value. The NetTime mechanisms ensure that the PLC NetTime clock and the local NetTime clock on the module have the same absolute time at all times.

9.11.12.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Counter functions |  |
| X20DC1976 | X20 digital counter module, 1 ABR incremental encoder, 5 V (single-ended), 250 kHz input frequency, 4x evaluation, encoder monitoring, NetTime function | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 211: X20DC1976 - Order data

9.11.12.3 Technical data

| | |
|--|--|
| Model number | X20DC1976 |
| Short description | |
| I/O module | 1 ABR incremental encoder 5 V |
| General information | |
| B&R ID code | 0xA707 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.2 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Type of signal lines | Shielded cables must be used for all signal lines. |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| Digital inputs | |
| Quantity | 2 |
| Nominal voltage | 24 VDC |
| Input characteristics per EN 61131-2 | Type 1 |
| Input voltage | 24 VDC -15% / +20% |
| Input current at 24 VDC | Approx. 3.3 mA |
| Input circuit | Sink |
| Input filter | |
| Hardware | ≤2 μs |
| Software | - |
| Connection type | 3-wire connections |
| Input resistance | 7.03 kΩ |
| Additional functions | Latch input |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| ABR incremental encoder | |
| Encoder inputs | 5 V, asymmetrical |
| Counter size | 16/32-bit |
| Input frequency | Max. 250 kHz |
| Evaluation | 4x |
| Minimum diff. slew rate | 1 V/μs |
| Encoder power supply | |
| 5 VDC | ±5%, module-internal, max. 300 mA |
| 24 VDC | Module-internal, max. 300 mA |
| Input filter | |
| Hardware | ≤600 ns |
| Software | - |
| Switching threshold | |
| Low | >1 V |
| Overload characteristics of encoder power supply | Short-circuit proof, overload-proof |
| Isolation voltage between encoder and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |


Table 212: X20DC1976 - Technical data

| Model number | X20DC1976 |
|--|--|
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x bus module X20BM11 separately. |
| Spacing | 12.5 ^{+0.2} mm |

Table 212: X20DC1976 - Technical data

9.11.12.4 LED status indicators

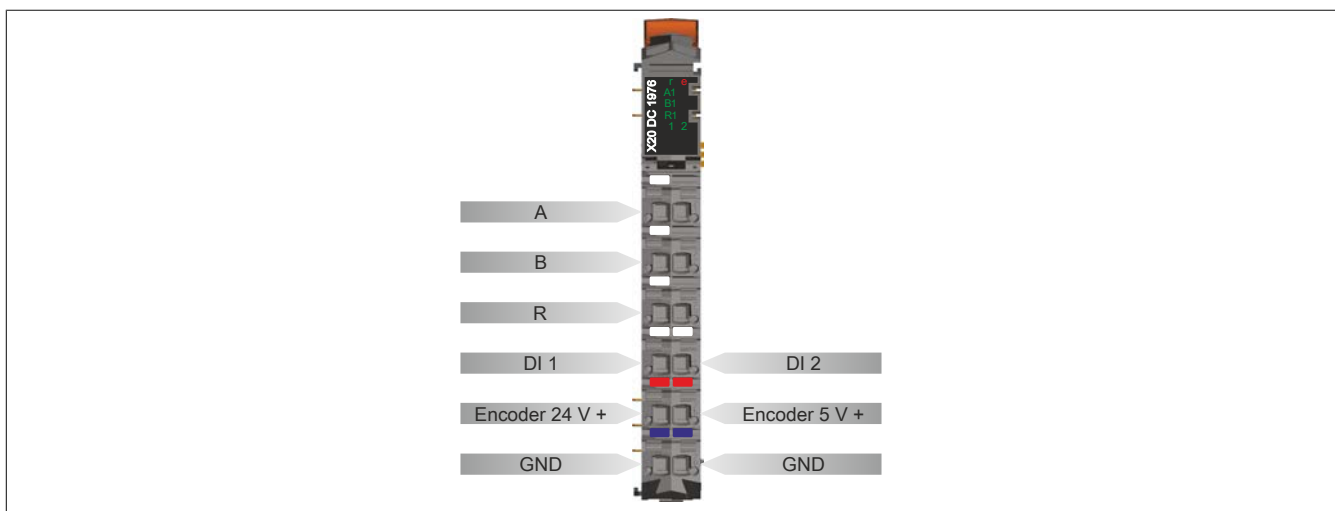
For a description of the various operating modes, see ["Diagnostic LEDs" on page 3787](#).

| Figure | LED | Color | Status | Description |
|--|-------|-------|--|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | e | Red | On | RUN mode |
| | | | Off | No power to module or everything OK |
| | | | Single flash | The encoder monitor has detected a line fault on the encoder inputs. The status bits must be evaluated in order to provide a more detailed definition of this error. The following error states are detected: <ul style="list-style-type: none"> • Open line • Short-circuit or voltage level too low |
| | | | On | Error or reset status |
| | A1 | Green | | Input state of counter input A |
| | B1 | Green | | Input state of counter input B |
| R1 | Green | | Input state of reference pulse R | |
| 1 - 2 | Green | | Input state of the corresponding digital input | |

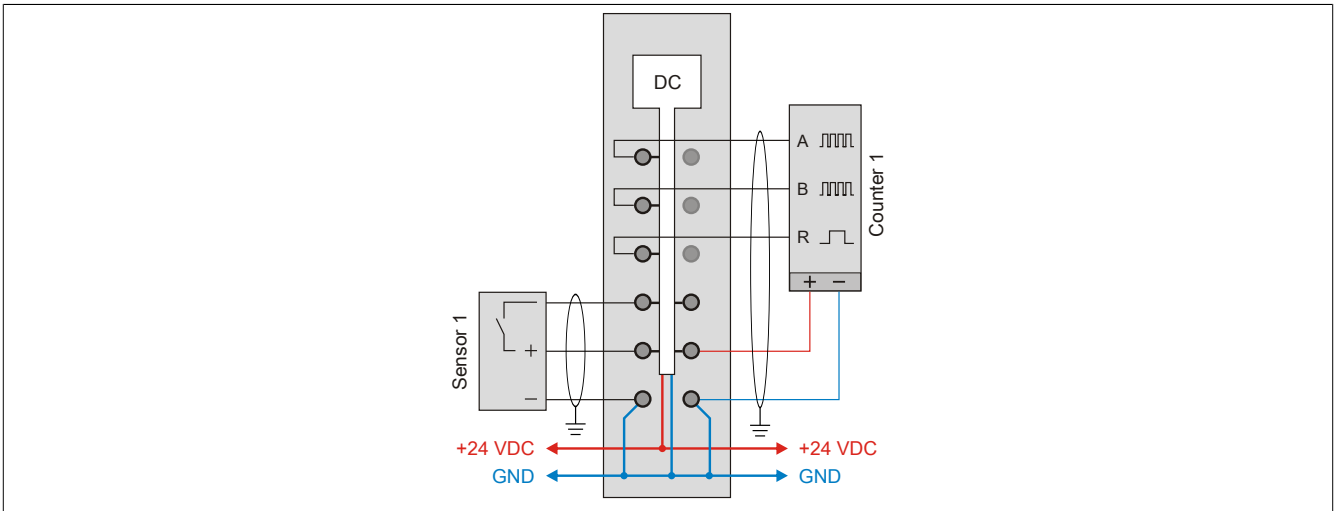
1) Depending on the configuration, a firmware update can take up to several minutes.

9.11.12.5 Pinout

Shielded cables must be used for all signal lines.

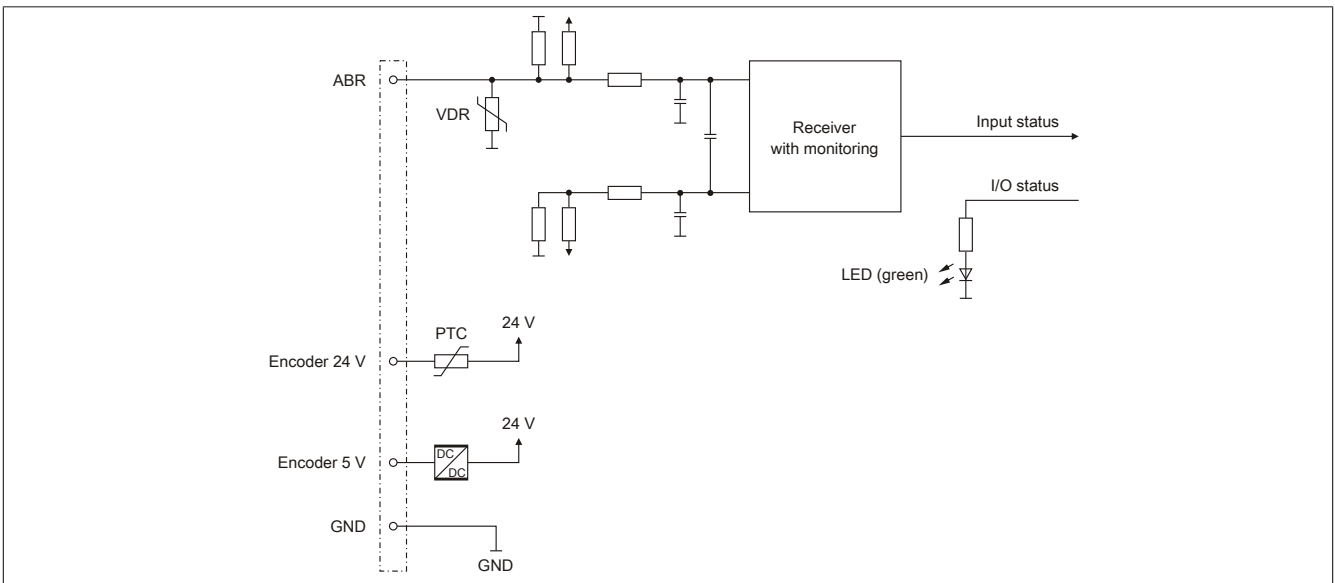


9.11.12.6 Connection example

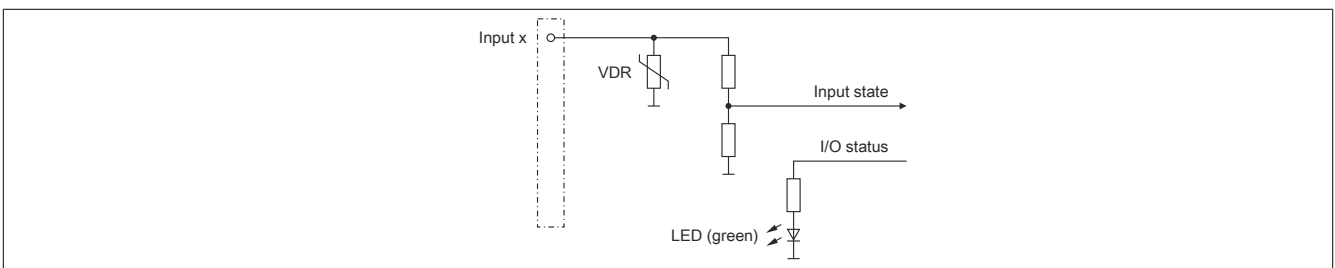


9.11.12.7 Input circuit diagram

Counter inputs

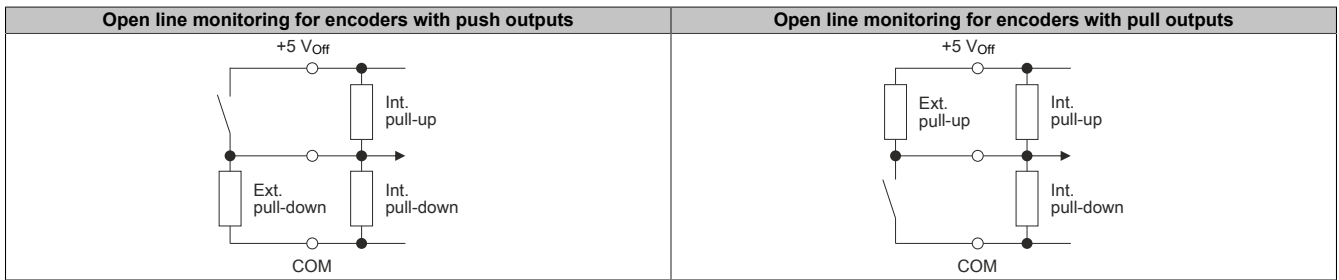


Standard inputs



9.11.12.8 Open line monitoring

Open line monitoring is only possible if the encoder itself is equipped with pull-up or pull-down resistances (pull-up: max. 2 k Ω , pull-down: max. 560 Ω) and the module is configured for encoders with push-pull outputs.



9.11.12.9 Register description

9.11.12.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.11.12.9.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 513 | Cfo_SlframeGenID | USINT | | | | • |
| 642 | Cfo_SystemCycleTime | UINT | | | | • |
| 769 | Cfo_PhylIOConfigCh01 | USINT | | | | • |
| 771 | Cfo_PhylIOConfigCh02 | USINT | | | | • |
| 773 | Cfo_PhylIOConfigCh03 | USINT | | | | • |
| 777 | Cfo_PhylIOConfigCh04 | USINT | | | | • |
| 779 | Cfo_PhylIOConfigCh05 | USINT | | | | • |
| 815 | Cfo_BWQuitTimeSelChannel7_0 | USINT | | | | • |
| 820 | Cfo_BWQuitTime_0 | UDINT | | | | • |
| 6145 | Cfo_CounterCycleSelect | USINT | | | | • |
| 6147 | Cfo_CounterMode | USINT | | | | • |
| 6149 | Cfo_LatchMode | USINT | | | | • |
| 6151 | Cfo_LatchComparator | USINT | | | | • |
| 6159 | Cfo_BWCNTEnableMaskChannel7_0 | USINT | | | | • |
| Communication | | | | | | |
| 683 | SDCLifeCount | SINT | • | | | |
| 6342 | Encoder01 | INT | • | | | |
| 6340 | | DINT | | | | |
| 6310 | Encoder01TimeValid | INT | • | | | |
| 6308 | | DINT | | | | |
| 6358 | Encoder01Latch | INT | • | | | |
| 6356 | | DINT | | | | |
| 6153 | Encoder commands | USINT | | | • | |
| | Encoder01Reset | Bit 0 | | | | |
| | Encoder01LatchEnable | Bit 1 | | | | |
| 927 | Input status of signal lines | USINT | • | | | |
| | Encoder01_A | Bit 0 | | | | |
| | Encoder01_B | Bit 1 | | | | |
| | Encoder01_R | Bit 2 | | | | |
| | DigitalInput01 | Bit 4 | | | | |
| | DigitalInput02 | Bit 5 | | | | |
| 847 | Status of signal lines | USINT | • | | | |
| | BW_Channel_A | Bit 0 | | | | |
| | BW_Channel_B | Bit 1 | | | | |
| | BW_Channel_R | Bit 2 | | | | |
| 811 | Acknowledging error status of signal lines | USINT | | | • | |
| | BW_QuitChannel_A | Bit 0 | | | | |
| | BW_QuitChannel_B | Bit 1 | | | | |
| | BW_QuitChannel_R | Bit 2 | | | | |
| 6326 | Encoder01TimeChanged | INT | • | | | |
| 6324 | | DINT | | | | |
| 6303 | Encoder01LatchCount | SINT | • | | | |
| 843 | Status of encoder supplies | USINT | • | | | |
| | PowerSupply01 | Bit 0 | | | | |
| | PowerSupply02 | Bit 1 | | | | |

9.11.12.9.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 513 | - | CfO_SlframeGenID | USINT | | | | • |
| 642 | - | CfO_SystemCycleTime | UINT | | | | • |
| 769 | - | CfO_PhylIOConfigCh01 | USINT | | | | • |
| 771 | - | CfO_PhylIOConfigCh02 | USINT | | | | • |
| 773 | - | CfO_PhylIOConfigCh03 | USINT | | | | • |
| 777 | - | CfO_PhylIOConfigCh04 | USINT | | | | • |
| 779 | - | CfO_PhylIOConfigCh05 | USINT | | | | • |
| 815 | - | CfO_BWQuitTimeSelChannel7_0 | USINT | | | | • |
| 820 | - | CfO_BWQuitTime_0 | UDINT | | | | • |
| 6145 | - | CfO_CounterCycleSelect | USINT | | | | • |
| 6147 | - | CfO_CounterMode | USINT | | | | • |
| 6149 | - | CfO_LatchMode | USINT | | | | • |
| 6151 | - | CfO_LatchComparator | USINT | | | | • |
| 6159 | - | CfO_BWCNTEnableMaskChannel7_0 | USINT | | | | • |
| Communication | | | | | | | |
| 6342 | 0 | Encoder01 | INT | • | | | |
| 6310 | 2 | Encoder01TimeValid | INT | • | | | |
| 6358 | 4 | Encoder01Latch | INT | • | | | |
| 6153 | 1 | Encoder commands | USINT | | | • | |
| | | Encoder01Reset | Bit 0 | | | | |
| | | Encoder01LatchEnable | Bit 1 | | | | |
| 927 | 7 | Input status of signal lines | USINT | • | | | |
| | | Encoder01_A | Bit 0 | | | | |
| | | Encoder01_B | Bit 1 | | | | |
| | | Encoder01_R | Bit 2 | | | | |
| | | DigitalInput01 | Bit 4 | | | | |
| | | DigitalInput02 | Bit 5 | | | | |
| 847 | 6 | Status of signal lines | USINT | • | | | |
| | | BW_Channel_A | Bit 0 | | | | |
| | | BW_Channel_B | Bit 1 | | | | |
| | | BW_Channel_R | Bit 2 | | | | |
| 811 | 0 | Acknowledging error status of signal lines | USINT | | | • | |
| | | BW_QuitChannel_A | Bit 0 | | | | |
| | | BW_QuitChannel_B | Bit 1 | | | | |
| | | BW_QuitChannel_R | Bit 2 | | | | |
| 6326 | - | Encoder01TimeChanged | INT | | • | | |
| 6303 | - | Encoder01LatchCount | SINT | | • | | |
| 843 | - | Status of encoder supplies | USINT | | • | | |
| | | PowerSupply01 | Bit 0 | | | | |
| | | PowerSupply02 | Bit 1 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.11.12.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.11.12.9.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.11.12.9.4 Encoder - Configuration

The following registers are used for setting functions and configuring the module.

9.11.12.9.4.1 Enabling error monitoring for the signal lines

Name:

CfO_BWCNTEnableMaskChannel7_0

This register requires individually enabling error monitoring for each of the signal channels. "Open line", "short circuit" and "voltage level too low" are reported as error states. Any errors that occur are reported in the error status registers "BW_Channel_x" on page 1197.

| Data type | Value | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| USINT | See bit structure. | 7 |

Bit structure:

| Bit | Name | Value | Information |
|-------|--|-------|--|
| 0 | Enable error monitoring for signal A lines | 0 | Error monitoring - Encoder Signal A disabled |
| | | 1 | Error monitoring - Encoder signal A enabled (bus controller default setting) |
| 1 | Enable error monitoring for signal B lines | 0 | Error monitoring - Encoder Signal B disabled |
| | | 1 | Error monitoring - Encoder signal B enabled (bus controller default setting) |
| 2 | Enable error monitoring for signal R lines | 0 | Error monitoring - Encoder Signal R disabled |
| | | 1 | Error monitoring - Encoder signal R enabled (bus controller default setting) |
| 3 - 7 | Reserved | 0 | |

9.11.12.9.4.2 Timing for automatic error acknowledgment

Name:

CfO_BWQuitTime_0

This register can be used to enable an additional [automatic acknowledgment](#) of the error status through timing. If a valid time is set, then the acknowledgment can still be made [manually](#), the only difference is that automatic acknowledgment will take place on the module after the defined amount of time has passed. If the error state has not yet been corrected, then the error status remains and the time is reset. Make sure that the time is set long enough for the higher-level system to reliably detect the status messages.

If the timing = 0, then acknowledgment is only possible using the cyclic acknowledgment registers.

| Data type | Value | Information |
|-----------|--------------------|--|
| UDINT | 0 | No automatic acknowledgment. Bus controller default setting |
| | 1 to 2.147.483.647 | Time for automatic acknowledgment [µs] |

9.11.12.9.4.3 Setting the latch mode

Name:

CfO_LatchMode

This register is used to set the latch mode:

- Single shot latch mode:
The latch function must be enabled/set. After a successful latch procedure, the activation must be reset in order for a new latch procedure to be activated.
- Continuous latch mode:
The latch function only has to be enabled/set as long as latching is desired.

A changed counter state on "[Encoder01LatchCount](#)" on page 1196 indicates that the latch procedure has been performed. The counter value is stored in the latch register "[Encoder01Latch](#)" on page 1196.

| Data type | Value | Information |
|-----------|-------|--|
| USINT | 0 | Single-shot latch procedure (bus controller default setting) |
| | 1 | Continuous latch procedure |

9.11.12.9.4.4 Signal channels for triggering latch procedure

Name:

CfO_LatchComparator

This register defines the signal channels and their level for triggering the latch procedure.

- This mainly configures which channels are linked to generate the latch event. All three signals from the encoder and digital input 1 can be used for the "AND" operation.
- The "active voltage level" needed for the latch procedure can now be used according to the physical signals.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Name | Value | Information |
|-----|---|-------|---|
| 0 | Defines signal level for encoder signal A | 0 | Low (bus controller default setting) |
| | | 1 | High |
| 1 | Defines signal level for encoder signal B | 0 | Low (bus controller default setting) |
| | | 1 | High |
| 2 | Defines signal level for encoder signal R | 0 | Low (bus controller default setting) |
| | | 1 | High |
| 3 | Defines signal level for digital input 1 | 0 | Low (bus controller default setting) |
| | | 1 | High |
| 4 | Use encoder signal A to trigger latch procedure | 0 | Disabled (bus controller default setting) |
| | | 1 | Latch function linked to encoder signal A |
| 5 | Use encoder signal B to trigger latch procedure | 0 | Disabled (bus controller default setting) |
| | | 1 | Latch function linked to encoder signal B |
| 6 | Use encoder signal R to trigger latch procedure | 0 | Disabled (bus controller default setting) |
| | | 1 | Latch function linked to encoder signal R |
| 7 | Use digital input 1 to trigger latch procedure | 0 | Disabled (bus controller default setting) |
| | | 1 | Latch function linked to digital input 1 |

9.11.12.9.4.5 Physical configuration

The following registers must be set to the specified constant value for correct physical configuration:

Constant register "CfO_SlframeGenID"

Name:

CfO_SlframeGenID

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 9 | Bus controller default setting |

Constant register "CfO_SystemCycleTime"

Name:

CfO_SystemCycleTime

Cycle time of encoder acquisition in 1/8 μ s steps. 1 encoder value is acquired as the counter value per cycle.

| Data type | Value | Information |
|-----------|-------|--|
| UINT | 800 | 800 = 100 μ s. Bus controller default setting |

Constant register "CfO_PhyIOConfigCh0x"

Name:

CfO_PhyIOConfigCh01 to CfO_PhyIOConfigCh05

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 0 | Bus controller default setting |

Constant register "CfO_BWQuitTimeSelChannel7_0"

Name:

CfO_BWQuitTimeSelChannel7_0

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 0 | Bus controller default setting |

Constant register "CfO_CounterCycleSelect"

Name:

CfO_CounterCycleSelect

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 2 | Bus controller default setting |

Constant register "CfO_CounterMode"

Name:

CfO_CounterMode

| Data type | Value | Information |
|-----------|-------|--------------------------------|
| USINT | 3 | Bus controller default setting |

9.11.12.9.5 Encoder - Communication**9.11.12.9.5.1 Counter for verifying the data frame**

Name:

SDCLifeCount

The 8-bit counter register is needed for the SDC software package. It is incremented with the system clock to allow the SDC to check the validity of the data frame.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

9.11.12.9.5.2 Display of the counter state

Name:

Encoder01

The counter state of the incremental encoder is displayed as a 16 or 32-bit counter value. Only the 16-bit value is available in the bus controller function model.

| Data type | Value |
|--------------------|----------------------------------|
| INT | -32768 to 32767 |
| DINT ¹⁾ | -2.147.483.648 bis 2.147.483.647 |

1) Can only be configured in the standard function model

9.11.12.9.5.3 NetTime of the last valid counter value

Name:

Encoder01TimeValid

The NetTime of the last valid counter value is the time of the last valid counter value recorded on the module (see register "[Cfo_SystemCycleTime](#)" on page 1194). The user is able to determine the validity of the counter value by evaluating its age in the program. This means that the module and error status bits do not have to be checked additionally to determine the validity of the value.

The NetTime of the last valid counter value that was read is displayed as a 16 or 32-bit value. Only the 16-bit value is available in the bus controller function model.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Value | Information |
|--------------------|---------------------------------|--------------------|
| INT | -32768 to 32767 | NetTime in μ s |
| DINT ¹⁾ | -2.147.483.648 to 2.147.483.647 | |

1) Can only be configured in the standard function model

9.11.12.9.5.4 NetTime of the last counter value change

Name:

Encoder01TimeChanged

For slow X2X Link cycles, the NetTime of the last counter value change can be used to determine the speed more accurately.

The NetTime of the last counter value change is displayed as a 16 or 32-bit value. Only the 16-bit value is available in the bus controller function model.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Value | Information |
|--------------------|---------------------------------|--------------------|
| INT | -32768 to 32767 | NetTime in μ s |
| DINT ¹⁾ | -2.147.483.648 to 2.147.483.647 | |

1) Can only be configured in the standard function model

9.11.12.9.5.5 Counter value at the time of the last latch

Name:

Encoder01Latch

The counter value at the time of the last latch is displayed as a 16 or 32-bit value. Only the 16-bit value is available in the bus controller function model.

| Data type | Value |
|--------------------|----------------------------------|
| INT | -32768 to 32767 |
| DINT ¹⁾ | -2.147.483.648 bis 2.147.483.647 |

1) Can only be configured in the standard function model

9.11.12.9.5.6 Counter value of latch event

Name:

Encoder01LatchCount

The latch events are counted and stored in a cyclic 8-bit counter. This counter is incremented with each latch event, thereby indicating a new occurrence. The new latched counter value is stored in the respective latch register.

| Data type | Value |
|-----------|-------------|
| SINT | -128 to 127 |

9.11.12.9.5.7 Encoder commands

Name:

Encoder01Command

This register can be used to

- 1) reset the counter value. The counter is kept at zero until this command is reset.
- 2) enable the latch procedure. If the latch configuration is valid and matches the hardware signals, then this activation causes the counter value to be saved in the latch register.

The two different latch configurations that are possible (see "[Setting the latch mode](#)" on page 1193) must be handled as follows:

- Single shot latch mode:
After successful latching, indicated by the latch event counter, activation must be reset before any more latching is possible. The activation must be set again if additional latching is needed.
- Continuous latch mode:
The latch function only has to be enabled/set as long as latching is desired. The latch event counter is incremented with each event.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|----------------------|-------|------------------------|
| 0 | Encoder01Reset | 0 | Do not reset |
| | | 1 | Set encoder value to 0 |
| 1 | Encoder01LatchEnable | 0 | Do not activate latch |
| | | 1 | Latching |
| 2 - 7 | Reserved | 0 | |

9.11.12.9.5.8 Input status of signal lines

Name:

Encoder01_A

Encoder01_B

Encoder01_R

DigitalInput01 to DigitalInput02

This register displays the input status of the signal lines from the encoder and the digital inputs.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|----------------|-------|---------------------------------|
| 0 | Encoder01_A | 0/1 | Input state of encoder signal A |
| 1 | Encoder01_B | 0/1 | Input state of encoder signal B |
| 2 | Encoder01_R | 0/1 | Input state of encoder signal R |
| 3 | Reserved | 0 | |
| 4 | DigitalInput01 | 0/1 | Input state - Digital input 1 |
| 5 | DigitalInput02 | 0/1 | Input state - Digital input 2 |
| 6 - 7 | Reserved | 0 | |

9.11.12.9.5.9 Error status of signal lines

The error states are latched when they occur and are maintained until acknowledged. The counter and time registers are not updated if there are pending or unacknowledged errors.

Status of signal lines

Name:

BW_Channel_A

BW_Channel_B

BW_Channel_R

This register displays the error states of the signal lines from the encoder. The error states are latched when they occur and are maintained until acknowledged. The counter and time registers are not updated if there are pending or unacknowledged errors.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|--------------|-------|---|
| 0 | BW_Channel_A | 0 | No error in encoder signal A |
| | | 1 | Open line, short circuit or voltage level too low |
| 1 | BW_Channel_B | 0 | No error in encoder signal B |
| | | 1 | Open line, short circuit or voltage level too low |
| 2 | BW_Channel_R | 0 | No error in encoder signal R |
| | | 1 | Open line, short circuit or voltage level too low |
| 3 - 7 | Reserved | 0 | |

Acknowledging error status of signal lines

Name:

BW_QuitChannel_A

BW_QuitChannel_B

BW_QuitChannel_R

This register can be used to acknowledge the latched error states of the signal lines from the encoder. However, if there are still pending errors remaining, then the error status remains active. After acknowledging the errors, the bits must also be reset or else any repetition of the error would be undetected.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|------------------|-------|---|
| 0 | BW_QuitChannel_A | 0 | No acknowledgment |
| | | 1 | Acknowledgment of error status - Encoder signal A |
| 1 | BW_QuitChannel_B | 0 | No acknowledgment |
| | | 1 | Acknowledgment of error status - Encoder signal B |
| 2 | BW_QuitChannel_R | 0 | No acknowledgment |
| | | 1 | Acknowledgment of error status - Encoder signal R |
| 3 - 7 | Reserved | 0 | |

Manual acknowledgment of latched error states

The latched error states of the signal lines from the encoder can be acknowledged manually. However, if there are still pending errors remaining, then the error status remains active. After successfully acknowledging the errors (latched error status = 0), the acknowledge bits must still be reset by the user or else a re-occurrence of an error could be overlooked by the user.

Example 1: Cause of error corrected before being acknowledged

An error has occurred on a signal line. The error state is detected and latched by the module. The error is acknowledged by the user after the cause of error has been corrected. The latched error status changes to zero.

The manual acknowledge must now be reset so that any new errors will be recognized by the user.

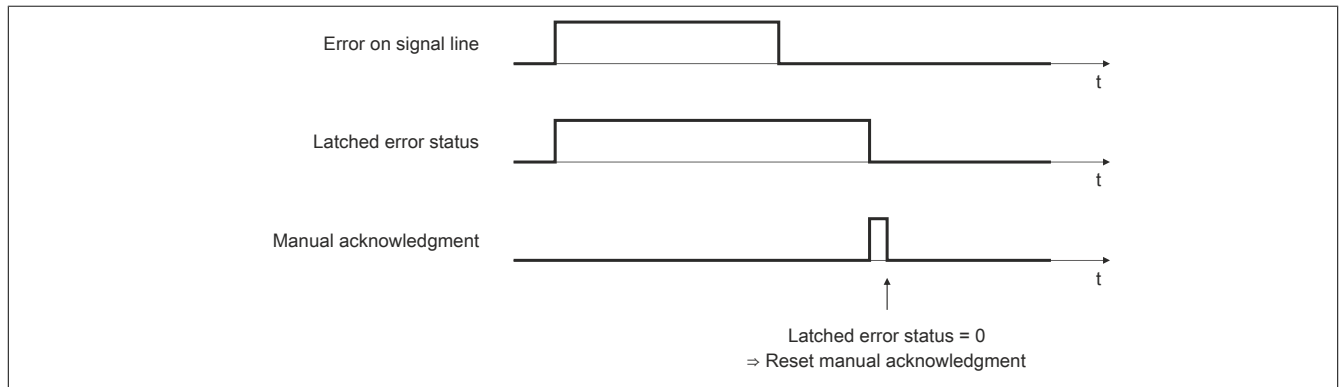


Figure 118: Cause of error corrected before being acknowledged

Example 2: Cause of error not yet corrected before being acknowledged

An error has occurred on a signal line. The error state is detected and latched by the module. The error is acknowledged by the user before the cause of error has been corrected. The latched error status remains set because the error is still remaining.

Acknowledgment is only successful after the cause of error has been corrected. The latched error status changes to zero. The manual acknowledge must now be reset so that any new errors will be recognized by the user.

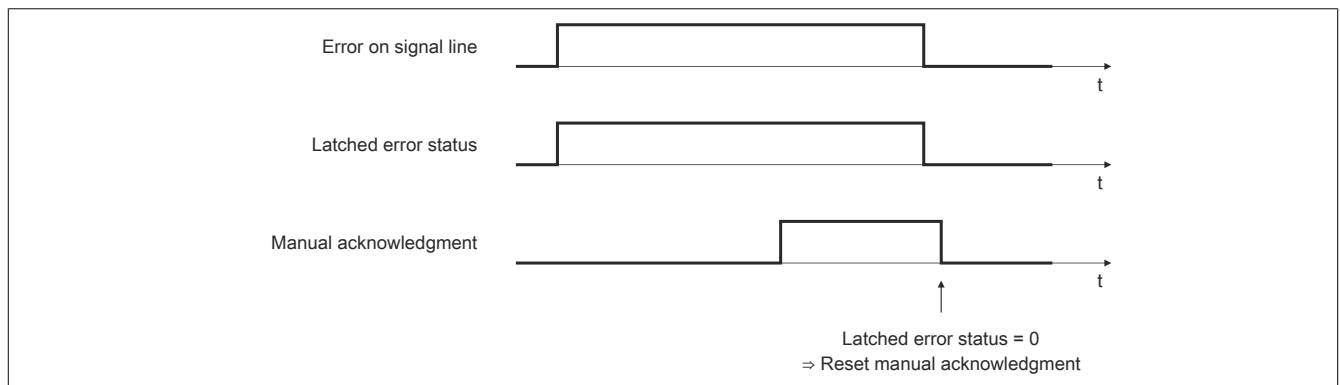


Figure 119: Cause of error not yet corrected before being acknowledged

Automatic acknowledgment of latched error states

In addition to manual acknowledgment, automatic acknowledgment of the latched error states after a specified amount of time can also be enabled. Make sure that the time is set long enough for the higher-level system to reliably detect the status messages and for the validity of the counter value to be determined using its age.

If the time specification = 0, then only manual acknowledgment is possible.

Example 1: An error has occurred on a signal line. The error state is detected and latched by the module. The time for automatic acknowledgment starts counting after the cause of error has been corrected. The error is acknowledged as soon as the time expires. The latched error status changes to zero.

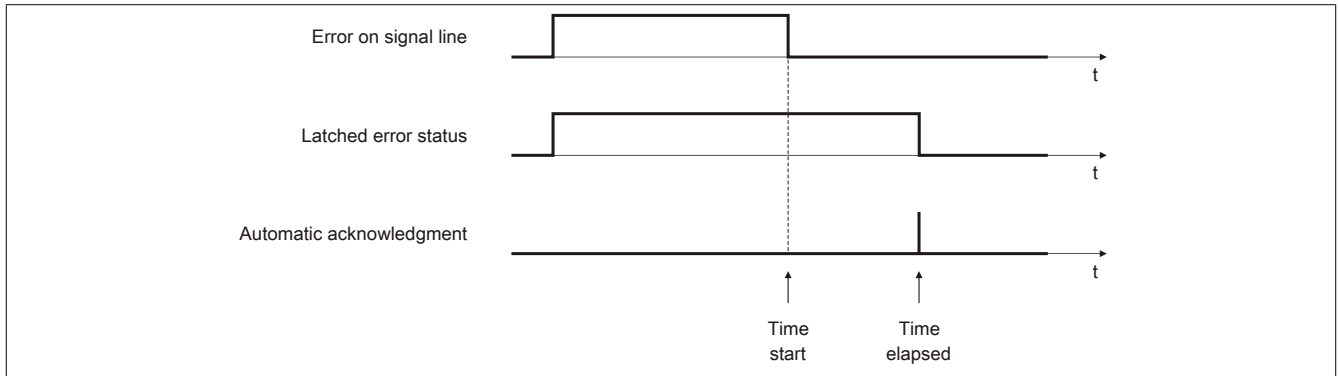


Figure 120: Latched error state acknowledged automatically

Example 2: Automatic and manual acknowledge used
 An error has occurred on a signal line. The error state is detected and latched by the module. The time for automatic acknowledgment starts counting after the cause of error has been corrected. The error is acknowledged manually by the user before the time expires. The latched error status changes to zero. The manual acknowledge must now be reset so that any new errors will be recognized by the user.

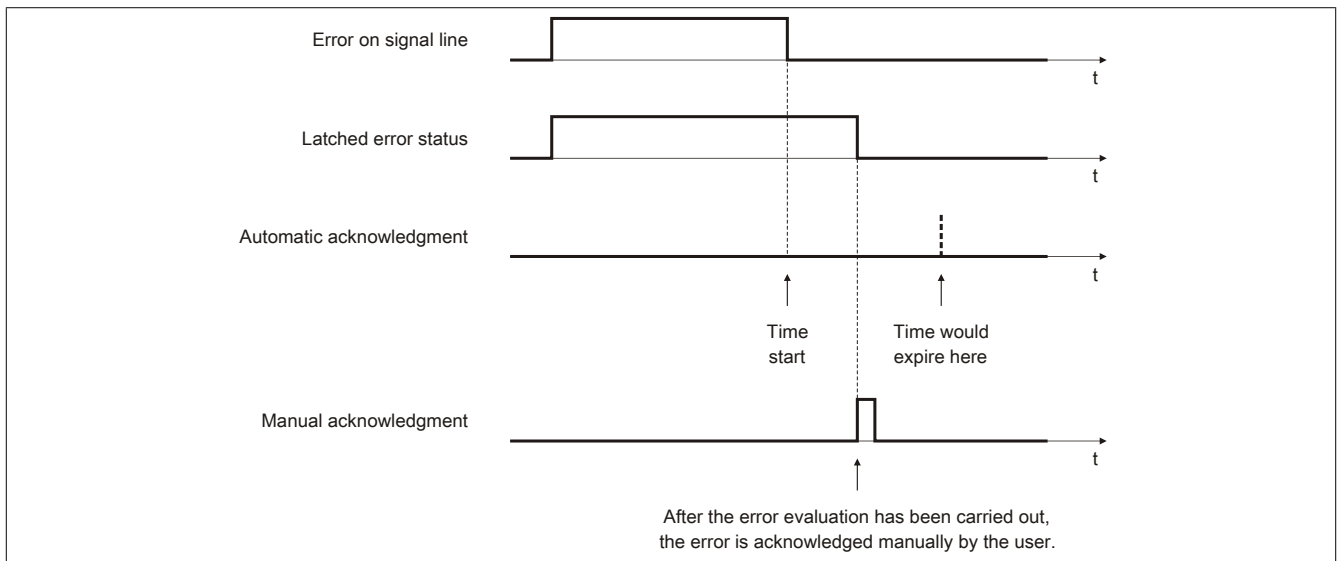


Figure 121: Automatic and manual acknowledge used

9.11.12.9.5.10 Status of encoder supplies

Name:

PowerSupply01 to PowerSupply02

This register shows the status of the integrated encoder supplies. A faulty encoder power supply is displayed as a warning.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---------------|-------|------------------------------------|
| 0 | PowerSupply01 | 0 | 24 VDC encoder power supply OK |
| | | 1 | 24 VDC encoder power supply faulty |
| 1 | PowerSupply02 | 0 | 5 VDC encoder power supply OK |
| | | 1 | 5 VDC encoder power supply faulty |
| 2 - 7 | Reserved | - | |

9.11.12.9.6 NetTime Technology

For a description of NetTime Technology, see ["NetTime Technology" on page 3035](#).

9.11.12.9.7 Minimum cycle time

The minimum cycle time defines how far the bus cycle can be reduced without causing a communication error or impaired functionality. It should be noted that very fast cycles decrease the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 150 μ s |

9.11.12.9.8 Minimum I/O update time

The minimum I/O update time defines how far the bus cycle can be reduced while still allowing an I/O update to take place in each cycle.

| Minimum I/O update time |
|-------------------------|
| 150 μ s |

9.11.13 X20(c)DC2190

Data sheet version: 2.31

9.11.13.1 General information

This module can be used to determine paths and to calculate speeds at the same time. The ultrasonic transducer rods are connected directly to the RS422 interface. Communication to the transducer rod takes place using start/stop signals. With the DPI/IP protocol, it is also possible, for example, to read operational properties directly from the transducer. During service (when a transducer is being exchanged) the machine can be started again quickly without additional configuration work.

The module is designed for connecting 2 transducer rods with a total of up to 4 paths. That means, for example, that 2 ultrasonic transducers with 2 magnets each or one with 4 magnets can be used. The combination 3/1 is also possible. The module provides 24 VDC as an external supply for the sensor.

- Ultrasonic transducer module
- Path measurement (resolution 10 µm)
- Speed measurement (resolution 100 µm/s)
- 1, 2, 3 and 4 magnetic rod measurements possible
- DPI/IP protocol supported

9.11.13.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.11.13.3 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Counter functions |  |
| X20DC2190 | X20 digital counter module, ultrasonic transducer module, interfaces: EP start/stop, DPI/IP, 2 transducer rods, 4-position detection | |
| X20cDC2190 | X20 digital counter module, coated, ultrasonic transducer module, interfaces: EP start/stop, DPI/IP, 2 transducer rods, 4-position detection | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 213: X20DC2190, X20cDC2190 - Order data


9.11.13.4 Technical data

| Model number | X20DC2190 | X20cDC2190 |
|--|---|---|
| Short description | | |
| I/O module | Ultrasonic transducer module, 2 transducer rods, 4 position detection, speed measurement | |
| General information | | |
| B&R ID code | 0x2188 | 0xEE9D |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnosics | | |
| Module run/error | Yes, using status LED and software | |
| Power consumption | | |
| Bus | 0.01 W | |
| Internal I/O | 1.1 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| KC | Yes | - |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | - |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | |
| Channels for path and speed measurements | | |
| Quantity | 2 | |
| Supported encoder types | Start/Stop interface EP start/stop interface DPI/IP interface | |
| Encoder power supply | | |
| Voltage | 24 VDC, module-internal, max. 150 mA | |
| Monitoring | Configurable overvoltage/undervoltage monitoring ($\pm 10\%$, $\pm 15\%$, $\pm 20\%$, $\pm 25\%$) | |
| Short-circuit proof | Rev. D0 and higher | Rev. D0 and later |
| Input and output level | RS422 differential level | |
| Multi-magnet measurement | Yes, in combination per rod, max. 4 magnets total | |
| Outputs | 1.6 μ s durational initialization pulse | |
| Inputs | | |
| Path measurement | Resolution = 0.01 mm, measurement range = ± 5.2 m | |
| Speed measurement | Resolution = 0.1 mm/s, measurement range = ± 3.2 m/s | |
| Accuracy | ± 50 ppm ± 5 ppm/year | |
| Short circuit protection | No | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x terminal block X20TB12 separately Order 1x bus module X20BM11 separately | Order 1x terminal block X20TB12 separately Order 1x bus module X20cBM11 separately |
| Spacing | 12.5 ^{+0.2} mm | |

Table 214: X20DC2190, X20cDC2190 - Technical data

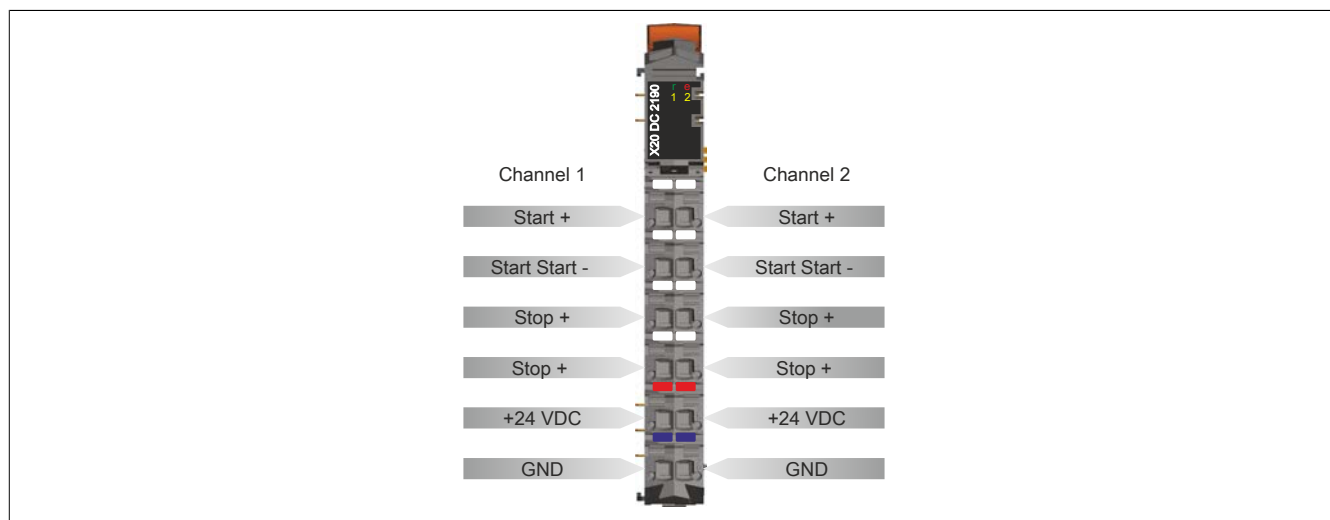
9.11.13.5 LED status indicators

For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|--------|--------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | Reset mode |
| | | | Double flash | Boot mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | 1 - 2 | Yellow | Off | No transducer rod connected |
| | | | On | Transducer rod is connected to the respective measurement channel |

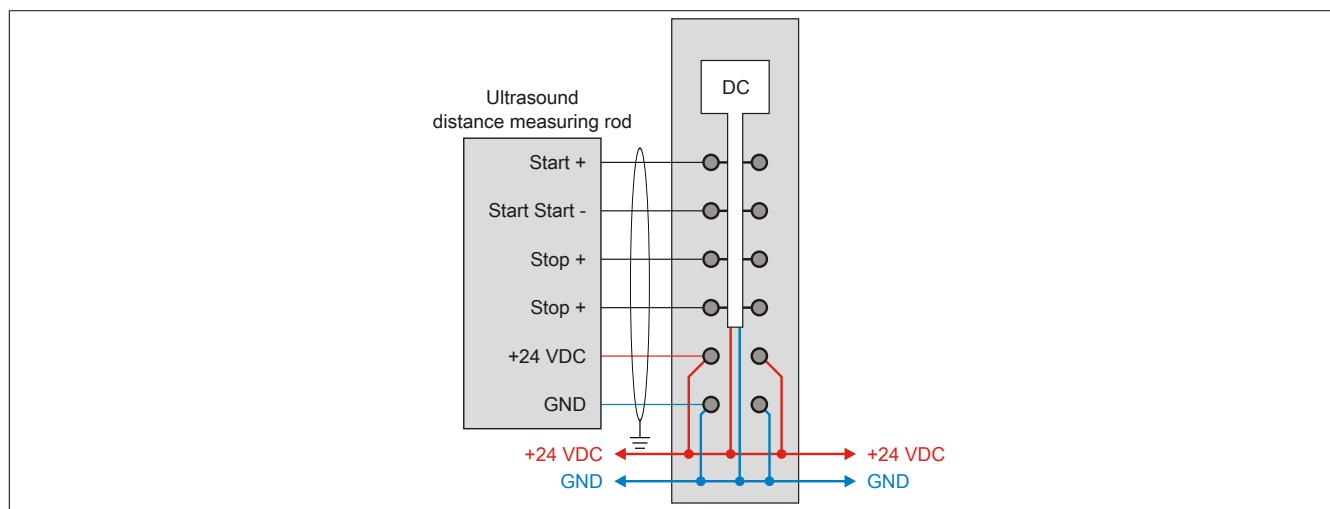
1) Depending on the configuration, a firmware update can take up to several minutes.

9.11.13.6 Pinout



The ultrasonic transducers should be connected using a shielded cable. The shield of the encoder cable is connected to the ground via the shield connection on the X20 bus module.

9.11.13.7 Connection example



9.11.13.8 Register description

9.11.13.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.11.13.8.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|------------------------------------|--------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Synchronous register | | | | | | |
| 0 | Position01 | DINT | • | | | |
| 4 | Position02 | DINT | • | | | |
| 8 | Position03 | DINT | • | | | |
| 12 | Position04 | DINT | • | | | |
| 16 | Speed01 | INT | • | | | |
| 18 | Speed02 | INT | • | | | |
| 20 | Speed03 | INT | • | | | |
| 22 | Speed04 | INT | • | | | |
| 24 | ErrorStatus01 | USINT | • | | | |
| 25 | ErrorStatus02 | USINT | • | | | |
| 26 | ErrorStatus03 | USINT | • | | | |
| 27 | ErrorStatus04 | USINT | • | | | |
| 28 | StatusInput01 | USINT | • | | | |
| 30 | USSpeed01 | UDINT | | | • | |
| 34 | USSpeed02 | UDINT | | | • | |
| 68 | StatusOutput01 | USINT | | | • | |
| Configuration registers | | | | | | |
| 38 | ConfigOutput01 | USINT | | | | • |
| 40 | ConfigOutput02 | UINT | | | | • |
| 60 | ConfigOutput03 | UDINT | | | | • |
| 64 | ConfigOutput04 | UDINT | | | | • |
| 134 | ConfigOutput07 | DINT | | | | • |
| 72 | ConfigOutput08 | DINT | | | | • |
| 84 | ConfigOutput09 | DINT | | | | • |
| 88 | ConfigOutput10 | DINT | | | | • |
| 92 | ConfigOutput11 | DINT | | | | • |
| 96 | ConfigOutput12 | DINT | | | | • |
| 100 | ConfigOutput13 | UDINT | | | | • |
| 104 | ConfigOutput14 | UDINT | | | | • |
| 76 | ConfigOutput15 | DINT | | | | • |
| 80 | ConfigOutput16 | DINT | | | | • |
| 138 | ConfigOutput17 | DINT | | | | • |
| 142 | ConfigOutput18 | DINT | | | | • |
| 146 | ConfigOutput19 | DINT | | | | • |
| 150 | ConfigOutput20 | DINT | | | | • |
| 154 | ConfigOutput21 | UDINT | | | | • |
| 158 | ConfigOutput22 | UDINT | | | | • |
| 42 | ConfigOutput23 | USINT | | | | • |
| 44 | ConfigOutput24 | USINT | | | | • |
| Read configuration register | | | | | | |
| 38 | ConfigOutput01Read | USINT | | • | | |
| 40 | ConfigOutput02Read | UINT | | • | | |
| 60 | ConfigOutput03Read | UDINT | | • | | |
| 64 | ConfigOutput04Read | UDINT | | • | | |
| 134 | ConfigOutput07Read | DINT | | • | | |
| 72 | ConfigOutput08Read | DINT | | • | | |
| 84 | ConfigOutput09Read | DINT | | • | | |
| 88 | ConfigOutput10Read | DINT | | • | | |
| 92 | ConfigOutput11Read | DINT | | • | | |
| 96 | ConfigOutput12Read | DINT | | • | | |
| 100 | ConfigOutput13Read | UDINT | | • | | |
| 104 | ConfigOutput14Read | UDINT | | • | | |
| 76 | ConfigOutput15Read | DINT | | • | | |
| 80 | ConfigOutput16Read | DINT | | • | | |
| 138 | ConfigOutput17Read | DINT | | • | | |
| 142 | ConfigOutput18Read | DINT | | • | | |
| 146 | ConfigOutput19Read | DINT | | • | | |
| 150 | ConfigOutput20Read | DINT | | • | | |
| 154 | ConfigOutput21Read | UDINT | | • | | |
| 158 | ConfigOutput22Read | UDINT | | • | | |
| 42 | ConfigOutput23Read | USINT | | • | | |

| Register | Name | Data type | Read | | Write | |
|------------------------|--------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 44 | ConfigOutput24Read | USINT | | • | | |
| Status register | | | | | | |
| 108 | StatusInput09 | UDINT | | • | | |
| 112 | StatusInput10 | UDINT | | • | | |
| 116 | StatusInput11 | UDINT | | • | | |
| 120 | StatusInput12 | UDINT | | • | | |
| 162 | StatusInput13 | UDINT | | • | | |
| 166 | StatusInput14 | UDINT | | • | | |
| 170 | StatusInput15 | UDINT | | • | | |
| 174 | StatusInput16 | UDINT | | • | | |
| 178 | StatusInput17 | UDINT | | • | | |
| 182 | StatusInput18 | UDINT | | • | | |
| 186 | StatusInput19 | UDINT | | • | | |
| 190 | StatusInput20 | UDINT | | • | | |
| 194 | StatusInput21 | UDINT | | • | | |
| 198 | StatusInput22 | UDINT | | • | | |
| 202 | StatusInput23 | UDINT | | • | | |
| 206 | StatusInput24 | UDINT | | • | | |
| 210 | StatusInput25 | UDINT | | • | | |
| 214 | StatusInput26 | UDINT | | • | | |
| 218 | StatusInput27 | UDINT | | • | | |
| 222 | StatusInput28 | UDINT | | • | | |
| 226 | StatusInput29 | UDINT | | • | | |
| 230 | StatusInput30 | UDINT | | • | | |
| 234 | StatusInput31 | UDINT | | • | | |
| 238 | StatusInput32 | UDINT | | • | | |
| 242 | StatusInput33 | UDINT | | • | | |
| 246 | StatusInput34 | UDINT | | • | | |
| 250 | StatusInput35 | UDINT | | • | | |
| 254 | StatusInput36 | UDINT | | • | | |

9.11.13.8.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Synchronous register | | | | | | | |
| 0 | 0 | Position01 | DINT | • | | | |
| 4 | 8 | Position02 | DINT | • | | | |
| 8 | 16 | Position03 | DINT | • | | | |
| 12 | 24 | Position04 | DINT | • | | | |
| 30 | 4 | Speed01 | INT | • | | | |
| 32 | 12 | Speed02 | INT | • | | | |
| 34 | 20 | Speed03 | INT | • | | | |
| 36 | 28 | Speed04 | INT | • | | | |
| 38 | - | LB: Error status of Magnet 1 HB: Module status | UINT | • | | | |
| | 6 | ErrorStatus01 | USINT | • | | | |
| | 7 | StatusInput01 | USINT | • | | | |
| 40 | 14 | ErrorStatus02 | USINT | • | | | |
| 42 | 22 | ErrorStatus03 | USINT | • | | | |
| 44 | 30 | ErrorStatus04 | USINT | • | | | |
| 100 | 0 | USSpeed01 | UDINT | | | • | |
| 109 | 8 | USSpeed02 | UDINT | | | • | |
| 150 | 16 | StatusOutput01 | USINT | | | • | |
| Configuration registers | | | | | | | |
| 2200 | - | ConfigOutput01 | USINT | | | | • |
| 2100 | - | ConfigOutput02 | UINT | | | | • |
| 2000 | - | ConfigOutput03 | UDINT | | | | • |
| 2004 | - | ConfigOutput04 | UDINT | | | | • |
| 2008 | - | ConfigOutput07 | DINT | | | | • |
| 2012 | - | ConfigOutput08 | DINT | | | | • |
| 2024 | - | ConfigOutput09 | DINT | | | | • |
| 2028 | - | ConfigOutput10 | DINT | | | | • |
| 2040 | - | ConfigOutput11 | DINT | | | | • |
| 2044 | - | ConfigOutput12 | DINT | | | | • |
| 2056 | - | ConfigOutput13 | UDINT | | | | • |
| 2060 | - | ConfigOutput14 | UDINT | | | | • |
| 2016 | - | ConfigOutput15 | DINT | | | | • |
| 2020 | - | ConfigOutput16 | DINT | | | | • |
| 2032 | - | ConfigOutput17 | DINT | | | | • |
| 2036 | - | ConfigOutput18 | DINT | | | | • |
| 2048 | - | ConfigOutput19 | DINT | | | | • |
| 2052 | - | ConfigOutput20 | DINT | | | | • |

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|------------------------------------|----------------------|--------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2064 | - | ConfigOutput21 | UDINT | | | | • |
| 2068 | - | ConfigOutput22 | UDINT | | | | • |
| 2201 | - | ConfigOutput23 | USINT | | | | • |
| 2202 | - | ConfigOutput24 | USINT | | | | • |
| Read configuration register | | | | | | | |
| 2200 | - | ConfigOutput01Read | USINT | | • | | |
| 2100 | - | ConfigOutput02Read | UINT | | • | | |
| 2000 | - | ConfigOutput03Read | UDINT | | • | | |
| 2004 | - | ConfigOutput04Read | UDINT | | • | | |
| 2008 | - | ConfigOutput07Read | DINT | | • | | |
| 2012 | - | ConfigOutput08Read | DINT | | • | | |
| 2024 | - | ConfigOutput09Read | DINT | | • | | |
| 2028 | - | ConfigOutput10Read | DINT | | • | | |
| 2040 | - | ConfigOutput11Read | DINT | | • | | |
| 2044 | - | ConfigOutput12Read | DINT | | • | | |
| 2056 | - | ConfigOutput13Read | UDINT | | • | | |
| 2060 | - | ConfigOutput14Read | UDINT | | • | | |
| 2016 | - | ConfigOutput15Read | DINT | | • | | |
| 2020 | - | ConfigOutput16Read | DINT | | • | | |
| 2032 | - | ConfigOutput17Read | DINT | | • | | |
| 2036 | - | ConfigOutput18Read | DINT | | • | | |
| 2048 | - | ConfigOutput19Read | DINT | | • | | |
| 2052 | - | ConfigOutput20Read | DINT | | • | | |
| 2064 | - | ConfigOutput21Read | UDINT | | • | | |
| 2068 | - | ConfigOutput22Read | UDINT | | • | | |
| 2201 | - | ConfigOutput23Read | USINT | | • | | |
| 2202 | - | ConfigOutput24Read | USINT | | • | | |
| Status register | | | | | | | |
| 2500 | - | StatusInput09 | UDINT | | • | | |
| 2556 | - | StatusInput10 | UDINT | | • | | |
| 2504 | - | StatusInput11 | UDINT | | • | | |
| 2560 | - | StatusInput12 | UDINT | | • | | |
| 2508 | - | StatusInput13 | UDINT | | • | | |
| 2564 | - | StatusInput14 | UDINT | | • | | |
| 2512 | - | StatusInput15 | UDINT | | • | | |
| 2568 | - | StatusInput16 | UDINT | | • | | |
| 2516 | - | StatusInput17 | UDINT | | • | | |
| 2572 | - | StatusInput18 | UDINT | | • | | |
| 2520 | - | StatusInput19 | UDINT | | • | | |
| 2524 | - | StatusInput20 | UDINT | | • | | |
| 2528 | - | StatusInput21 | UDINT | | • | | |
| 2532 | - | StatusInput22 | UDINT | | • | | |
| 2536 | - | StatusInput23 | UDINT | | • | | |
| 2540 | - | StatusInput24 | UDINT | | • | | |
| 2576 | - | StatusInput25 | UDINT | | • | | |
| 2580 | - | StatusInput26 | UDINT | | • | | |
| 2584 | - | StatusInput27 | UDINT | | • | | |
| 2588 | - | StatusInput28 | UDINT | | • | | |
| 2592 | - | StatusInput29 | UDINT | | • | | |
| 2596 | - | StatusInput30 | UDINT | | • | | |
| 2544 | - | StatusInput31 | UDINT | | • | | |
| 2548 | - | StatusInput32 | UDINT | | • | | |
| 2552 | - | StatusInput33 | UDINT | | • | | |
| 2600 | - | StatusInput34 | UDINT | | • | | |
| 2604 | - | StatusInput35 | UDINT | | • | | |
| 2608 | - | StatusInput36 | UDINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

In the bus controller function model, the measurements made from the module are not synchronized with the X2X Link. The time between two measurements is defined by the configured recovery time for the rod (see "[Channel configuration](#)" on page 1211) unlike on the X2X where it is the smallest multiple of the X2X cycle time that is larger than the configured recovery time.

9.11.13.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "[Using I/O modules on the bus controller](#)" on page 3789.

9.11.13.8.3.2 CAN I/O bus controller

The module occupies 4 analog logical slots on CAN I/O.

9.11.13.8.4 Commissioning a transducer rod

Two registers need to be configured to initialize an ultrasonic transducer rod and receive valid measurements. The first step is to enter the length of the rod (see "Rod length 1 and 2" on page 1211). The wave propagation speed for the rod must then be defined (see "Ultrasonic speed specification" on page 1209). This information can usually be found directly on the transducer rod itself or in its data sheet.

If the plausibility limits remain set to 0 (default value), one of the respective ErrorStatus registers will now indicate faulty readings or plausibility errors. If this is the case, plausibility mode can be disabled using the "ConfigOutput01" register (see "Module configuration" on page 1210). This will cause the positions of the magnets to be displayed on the rod.

9.11.13.8.5 Reading the magnet position

Name:

Position01 - Position04

These registers contain the position of the individual magnets on the transducer rods.

| Data type | Value | Information |
|-----------|------------------------------------|-----------------|
| DINT | -2,147,483,648 to 2,147,483,647 | Resolution 1 µm |

9.11.13.8.6 Reading the magnet speed

Name:

Speed01 to Speed04

These registers contain the speed of the individual magnets on the transducer rods. A resolution of 0.1 mm/s is achieved by calculating the speed from 2 position values within a 100 ms interval.

| Data type | Value | Information |
|-----------|-----------------|---------------------|
| INT | -32768 to 32767 | Resolution 0.1 mm/s |

9.11.13.8.7 Error status

Name:

ErrorStatus01 to ErrorStatus04

These registers can be used to indicate the error status for individual channels.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure

| Bit | Description |
|-------|--|
| 0 - 3 | Counter for plausibility errors (cyclic) |
| 4 - 7 | Counter for mis-measurements (cyclic) |

Possible reasons for plausibility errors:

- Configured max. or min. path of a magnet was exceeded
- Configured max. speed was exceeded

Possible reasons for faulty measurements:

- Configured rod length was exceeded
- Rod failure
- Missing measurement magnet

Information:

If the registers "USSpeed01 and USSpeed02" on page 1209 are unequal to 0 after the module starts up, the respective error counters on slower fieldbus systems (e.g. CAN I/O) may continue to count until the module configuration is completed. In some cases, this is due problems between the respective rod and the default configuration.

9.11.13.8.8 Status information about the transducer rods

Name:
StatusInput01

This register displays the status information for the transducer rods.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|-------------------------|-------|--------------------------------|
| 0 | Supply voltage too low | 0 | Supply voltage OK |
| | | 1 | Supply voltage too low |
| 1 | Supply voltage too high | 0 | Supply voltage OK |
| | | 1 | Supply voltage too high |
| 2 | Transducer Rod 1 | 0 | Ok |
| | | 1 | Deactivated or not initialized |
| 3 | Transducer Rod 2 | 0 | Ok |
| | | 1 | Deactivated or not initialized |
| 4 | Transducer Rod 1 | 0 | Protocol error (invalid data) |
| | | 1 | Protocol OK (valid data) |
| 5 | Transducer Rod 2 | 0 | Protocol error (invalid data) |
| | | 1 | Protocol OK (valid data) |
| 6 - 7 | Reserved | | |

Comment concerning bits 4 + 5

If this bit is set to "1", configuration data was successfully read from the measurement rod using DPI/IP or EP protocol. This data can now be read into the application using asynchronous access.

9.11.13.8.9 Ultrasonic speed specification

Name:
USSpeed01 to USSpeed02

The module does not perform any measurements on the respective rod while these registers have the value 0. Also disabled:

- Automatic check to determine whether a rod is connected
- Parameter upload via DPI/IP or EP protocol

If a value >0 but <1000cm/s is specified here, the module freezes all measurements and error counters of the corresponding rod, regardless of whether plausibility mode is enabled or not. Based on the default ultrasonic speed of 280,000 cm/s, however, periodic measurement start pulses continue to be generated according to the formula in "[Channel configuration](#)" on page 1211. In this case the rod check (inserted/not inserted and parameter upload) continues to be active.

As soon as a valid value (≥ 1000) is specified, the module recalculates the measurement rate (see "[Channel configuration](#)" on page 1211) and begins the position/speed measurement.

| Data type | Value | Information |
|-----------|--------------------|-------------------|
| UDINT | 0 to 4,294,967,296 | Resolution 1 cm/s |

9.11.13.8.10 Applying new magnet offsets

Name:

StatusOutput01

This register makes it easier to more quickly determine new offsets (= zero positions) for the individual magnets. This approach is an alternative or additional method to determining an offset via configuration registers (see "Offset position on the transducer" on page 1212).

If the respective bit changes from 0 to 1 in "StatusOutput01" (see following table) then the current mechanical position of the respective magnet becomes the calculated zero position (register "Position0x" = 0).

From that moment, the current mechanical position will be subtracted from all future measured positions. This is essentially a type of referencing. The max. and min. magnet paths (see "Plausibility check configuration" on page 1212) are now based on the new zero position.

This process can be repeated at any time by setting the bit again.

Information:

An offset position determined in this manner is **NOT** readable. Only the current contents of **ConfigOutput07**, **ConfigOutput08**, **ConfigOutput15** and **ConfigOutput16** can be read using registers **ConfigOutput07Read**, **ConfigOutput08Read**, **ConfigOutput15Read** and **ConfigOutput16Read**.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

| Bit | Name | Value | Information |
|-------|----------|-------|-----------------------|
| 0 | Magnet 1 | 0 | No effect |
| | | 1 | Apply offset magnet 1 |
| ... | | ... | |
| 3 | Magnet 4 | 0 | No effect |
| | | 1 | Apply offset magnet 4 |
| 4 - 7 | Reserved | | |

9.11.13.8.11 Module configuration

Name:

ConfigOutput01

This register configures the module.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Name | Value | Information |
|-------|---|-------|--|
| 0 | Plausibility mode | 0 | The plausibility error counter is incremented with each implausible measurement, and the last plausible measured value is "frozen" (bus controller default setting). |
| | | 1 | The plausibility error counter is incremented with each implausible measurement and the implausible measurement value is forwarded to the controller |
| 1 | Reserved | | |
| 2 - 3 | Tolerance for monitoring the supply voltage | 00 | 25% (bus controller default setting) |
| | | 01 | 20% |
| | | 10 | 15% |
| | | 11 | 10% |
| 4 - 7 | Magnet number | 0000 | 4 magnets on channel 1, channel 2 not available (bus controller default setting) |
| | | 0001 | 3 magnets on channel 1, 1 magnet on channel 2 |
| | | 0010 | 2 magnets on channel 1, 2 magnets on channel 2 |
| | | 0011 | 1 magnet on channel 1, 0 magnets on channel 2 |
| | | 0100 | 2 magnets on channel 1, 0 magnets on channel 2 |
| | | 0101 | 3 magnets on channel 1, 0 magnets on channel 2 |
| | | 0110 | 2 magnets on channel 1, 1 magnet on channel 2 |
| | | 0111 | 1 magnet on channel 1, 1 magnet on channel 2 |
| | | 1xxx | Reserved |

9.11.13.8.12 Channel configuration

Name:
ConfigOutput02

This register can be used to configure the individual channels.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|---------|--|-------|---|
| 0 - 2 | Transducer Rod 1 | 000 | User parameter (bus controller default setting) |
| | | 001 | DPI/IP (Balluf) |
| | | 010 | EP Start/Stop (MTS) |
| | | 011 | Reserved |
| | | 1xx | Reserved |
| 3 - 4 | Rod 1: Start/Stop IF type | 00 | Start/Stop signal: Rising edge - Rising edge (bus controller default setting) |
| | | 01 | Start/Stop Signal: Falling edge - falling edge |
| | | 10 | Start/Stop Signal: Rising edge - falling edge (gate time) |
| | | 11 | Only Stop Signal: Start when signal is triggered (initialization pulses) |
| 5 | Rod 1: Recovery time factor, minimum time between two measurements | 0 | 3 x USW runtime for rod (bus controller default setting) |
| | | 1 | 2 x USW runtime for rod |
| 6 - 7 | Reserved | | |
| 8 - 10 | Transducer Rod 2 | 000 | User parameter (bus controller default setting) |
| | | 001 | DPI/IP (Balluf) |
| | | 010 | EP Start/Stop (MTS) |
| | | 011 | Reserved |
| | | 1xx | Reserved |
| 11 - 12 | Rod 2: Start/Stop IF type | 00 | Start/Stop signal: Rising edge - Rising edge (bus controller default setting) |
| | | 01 | Start/Stop Signal: Falling edge - falling edge |
| | | 10 | Start/Stop Signal: Rising edge - falling edge (gate time) |
| | | 11 | Only Stop Signal: Start when signal is triggered (initialization pulses) |
| 13 | Rod 2: Recovery time factor, minimum time between two measurements | 0 | 3 x USW runtime for rod (bus controller default setting) |
| | | 1 | 2 x USW runtime for rod |
| 14 - 15 | Reserved | | |

Comment concerning bits 5 + 13

USW transducer rods require a certain recovery time between two measurements to allow the ultrasonic wave to fade. Otherwise there is a risk of interfering with the next measurement (especially when the rod has more than 1 magnet).

Depending on the setting, the module waits at least 2 or 3 times the runtime of the ultrasonic wave for the measurement rod (default = 3x). In the standard function module, the next measurement is then triggered synchronously with the next X2XLink cycle.

The runtime measurement is based on the settings for the rod length (plus a safety margin of 100mm) and the ultrasonic speed:

- $USW \text{ runtime} = (\text{rod length} + 100\text{mm}) / \text{ultrasonic speed}.$

For their rods, BALLUFF recommends a recovery time equal to 3 times the maximum runtime of the ultrasonic wave for the measurement rod. This is the default setting for the module.

The setting can be switched to 2 times the runtime if the measurement rate is otherwise too slow. This may only be done after consulting the manufacturer of the transducer rods!

9.11.13.8.13 Rod length 1 and 2

Name:
ConfigOutput03 to ConfigOutput04

These registers are used to configure the length of the respective rod.

- Rod length 1: ConfigOutput03
- Rod length 2: ConfigOutput04

| Data type | Value | Information |
|-----------|-------------------|---|
| UDINT | 0 to 4,294,967,29 | Resolution 1 mm. Bus controller default setting: 0 |

9.11.13.8.14 Offset position on the transducer

Name:

ConfigOutput07 to ConfigOutput08

ConfigOutput15 to ConfigOutput16

These registers are used to assign the respective magnet an offset position (= zero position) on the transducer. The max. and min. magnet paths refer to these specified offsets (see "[Plausibility check configuration](#)" on page 1212). If the offset is changed using the StatusOutput01 register, this becomes the new zero position. This does not affect the contents of the offset register.

- Offset magnet 1: ConfigOutput07
- Offset magnet 2: ConfigOutput08
- Offset magnet 3: ConfigOutput15
- Offset magnet 4: ConfigOutput16

| Data type | Value | Information |
|-----------|------------------------------------|---|
| DINT | -2,147,483,648 to 2,147,483,647 | Resolution 1 µm. Bus controller default setting: 0 |

9.11.13.8.15 Plausibility check configuration

These registers are used to configure the plausibility check (also see "[Error status](#)" on page 1208).

9.11.13.8.15.1 Min. plausible magnet position

Name:

ConfigOutput09 to ConfigOutput10

ConfigOutput17 to ConfigOutput18

These registers are used to assign the min. plausible magnet position based on the applicable offset.

- Min. path - magnet 1: ConfigOutput09
- Min. path - magnet 2: ConfigOutput10
- Min. path - magnet 3: ConfigOutput17
- Min. path - magnet 4: ConfigOutput18

| Data type | Value | Information |
|-----------|------------------------------------|---|
| DINT | -2,147,483,648 to 2,147,483,647 | Resolution 1 µm. Bus controller default setting: 0 |

9.11.13.8.15.2 Max. plausible magnet position

Name:

ConfigOutput11 to ConfigOutput12

ConfigOutput19 to ConfigOutput20

These registers assign the max. plausible magnet position relative to the valid offset.

- Max. path of magnet 1: ConfigOutput11
- Max. path of magnet 2: ConfigOutput12
- Max. path of magnet 3: ConfigOutput19
- Max. path of magnet 4: ConfigOutput20

| Data type | Values | Information |
|-----------|------------------------------------|---|
| DINT | -2,147,483,648 to 2,147,483,647 | Resolution 1 µm. Bus controller default setting: 0 |

9.11.13.8.15.3 Max. plausible magnet velocity

Name:

ConfigOutput13 to ConfigOutput14

ConfigOutput21 to ConfigOutput22

These registers assign the max. plausible magnet speed.

- Max. speed of magnet 1: ConfigOutput13
- Max. speed of magnet 2: ConfigOutput14
- Max. speed of magnet 3: ConfigOutput21
- Max. speed of magnet 4: ConfigOutput22

| Data type | Values | Information |
|-----------|--------------------|---|
| UDINT | 0 to 4,294,967,296 | Resolution 0.1 mm/s. Bus controller default setting: 0 |

9.11.13.8.16 Dead time for rods 1 and 2

Name:

ConfigOutput23 to ConfigOutput24

These registers configure the dead time of the respective rod.

- Dead time for rod 1: ConfigOutput23
- Dead time for rod 2: ConfigOutput24

To prevent the multiple pulses that occur with some encoders from affecting the measurement, all pulses received within a configurable timespan from the beginning of the measurement are not evaluated. The range for the dead time is between 0 and 255 μ s. The following figure illustrates the effects of defining a dead time:

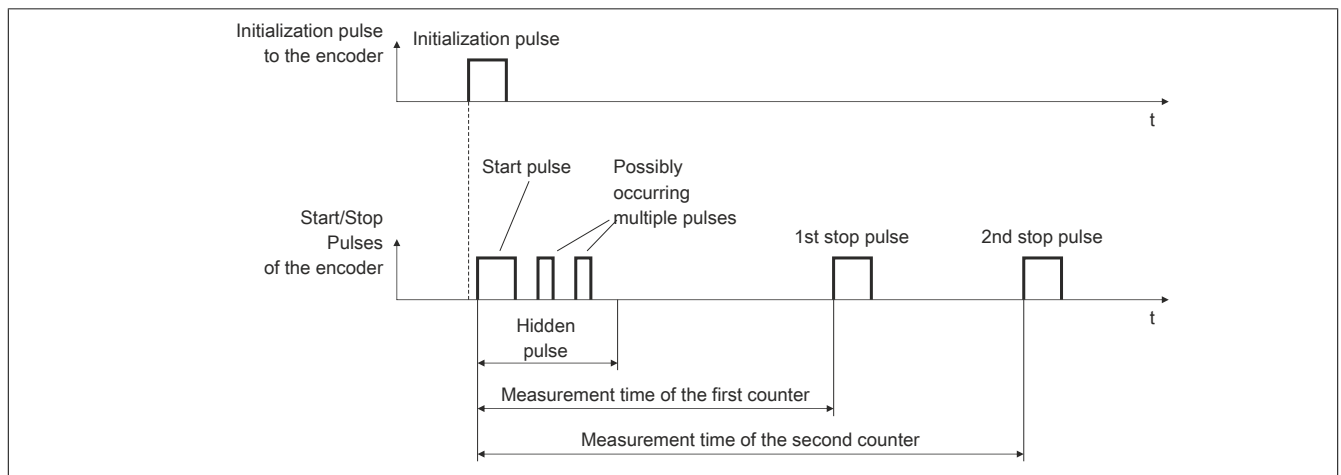


Figure 122: Pulse Ignored after Start Pulse

| Data type | Values | Information |
|-----------|----------|--|
| USINT | 0 to 255 | 1 μ s resolution. Bus controller default setting: 0 |

9.11.13.8.17 Read configuration register

Name:

ConfigOutput01Read to ConfigOutput04Read

ConfigOutput07Read to ConfigOutput24Read

These registers are used to read the states of the corresponding configuration registers.

9.11.13.8.18 Status register

Name:

StatusInput09 to StatusInput36

These registers are used to store the data read after a parameter upload from transducer rods with DPI/IP protocol or EP protocol. The registers "StatusInput19" to "StatusInput36" remain empty (0x0000) on transducer rods with EP protocol.

9.11.13.8.18.1 Parameter overview

The following parameters are stored in the status registers:

| Register | Description | Supported by the protocol | |
|---------------|--|---------------------------|--------|
| | | DPI/IP | EP |
| StatusInput09 | Rod length 1 [mm] | • | • |
| StatusInput10 | Rod length 2 [mm] | • | • |
| StatusInput11 | Ultrasonic speed 1 | • | • |
| StatusInput12 | Ultrasonic speed 2 | • | • |
| StatusInput13 | Rod 1: Zero point offset [µm] | • | • |
| StatusInput14 | Rod 2: Zero point offset [µm] | • | • |
| StatusInput15 | Rod 1: Vendor ID (see transducer rod data sheet) | • | • |
| StatusInput16 | Rod 2: Vendor ID (see transducer rod data sheet) | • | • |
| StatusInput17 | Rod 1: Serial number (Hex coded) | • | • |
| StatusInput18 | Rod 2: Serial number (Hex coded) | • | • |
| StatusInput19 | Rod 1: Type ID 1 (MSB = letter 1) | • | 0x0000 |
| StatusInput20 | Rod 1: Type ID 2 (MSB = letter 5) | • | 0x0000 |
| StatusInput21 | Rod 1: Type ID 3 (MSB = letter 9) | • | 0x0000 |
| StatusInput22 | Rod 1: Type ID 4 (MSB = letter 13) | • | 0x0000 |
| StatusInput23 | Rod 1: Type ID 5 (MSB = letter 17) | • | 0x0000 |
| StatusInput24 | Rod 1: Type ID 6 (MSB = letter 21) | • | 0x0000 |
| StatusInput25 | Rod 2: Type ID 1 (MSB = letter 1) | • | 0x0000 |
| StatusInput26 | Rod 2: Type ID 2 (MSB = letter 5) | • | 0x0000 |
| StatusInput27 | Rod 2: Type ID 3 (MSB = letter 9) | • | 0x0000 |
| StatusInput28 | Rod 2: Type ID 4 (MSB = letter 13) | • | 0x0000 |
| StatusInput29 | Rod 2: Type ID 5 (MSB = letter 17) | • | 0x0000 |
| StatusInput30 | Rod 2: Type ID 6 (MSB = letter 21) | • | 0x0000 |
| StatusInput31 | Rod 1: Serial number ASCII 1 (MSB = letter 1) | • | 0x0000 |
| StatusInput32 | Rod 1: Serial number ASCII 2 (MSB = letter 5) | • | 0x0000 |
| StatusInput33 | Rod 1: Serial number ASCII 3 (MSB = letter 9) | • | 0x0000 |
| StatusInput34 | Rod 2: Serial number ASCII 1 (MSB = letter 1) | • | 0x0000 |
| StatusInput35 | Rod 2: Serial number ASCII 2 (MSB = letter 5) | • | 0x0000 |
| StatusInput36 | Rod 2: Serial number ASCII 3 (MSB = letter 9) | • | 0x0000 |

9.11.13.8.18.2 DPI/IP protocol (BALLUFF) / EP protocol (MTS)

Requirements for a successful upload of the transducer rod parameters to the module:

1. Selection of the communication protocol (DPI/IP or EP). See "[Channel configuration](#)" on page 1211
2. Transducer rod must support the respective protocol.
3. If the transducer rod does not support the selected protocol, the module will detect this after a timeout of approx. 300 ms and will treat the rod as a "normal" transducer rod.

After the module is started or after a transducer rod is connected, the parameter upload should be complete within 200 to 400 ms.

A communication error causes the data upload to cancel. A new upload attempt can be initiated by the user by deactivating and reactivating the communication protocol using asynchronous access.

All rod parameters can be read to the controller using asynchronous access. The read parameters "rod length" and "ultrasonic speed" are **NOT** automatically uploaded to the module.

It is left up to the application whether the upload values for rod length 1 and rod length 2 or for ultrasonic speed 1 and ultrasonic speed 2 are uploaded.

Information:

Keep in mind that no position measurements can be performed on a rod while parameters are being uploaded. The module freezes all existing position/speed data for all magnets on the rod while the parameters are uploading. Parameters should therefore only be uploaded with the machine stopped, and this should be ensured by the application.

9.11.13.8.19 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 250 μ s |

9.11.14 X20(c)DC2395

Data sheet version: 3.21

9.11.14.1 General information

This module is a multifunctional counter module. It can be connected to one SSI encoder, one ABR encoder, two AB encoders or four event counters. Two outputs are available for pulse width modulation. The functions can also be mixed.

- 24 VDC encoder inputs
- SSI, ABR, AB or event counters for inputs
- Pulse width modulation for outputs
- 24 VDC and GND for encoder supply

Information:

This module is a multifunctional module. Some bus controllers only support the default function model.

Default function model:

- **2x event counter (24 V)**
- **2x PWM output (24 V)**

9.11.14.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.11.14.3 Order data

| Model number | Short description | Figure |
|--------------|--|--------|
| | Counter functions | |
| X20DC2395 | X20 digital counter module, 1 SSI absolute encoder, 24 V, 1 ABR incremental encoder, 24 V, 2 AB incremental encoders, 24 V, 4 event counters or 2 PWM, local time measurement function | |
| X20cDC2395 | X20 digital counter module, coated, 1 SSI absolute encoder, 24 V, 1 ABR incremental encoder, 24 V, 2 AB incremental encoders, 24 V, 4 event counters or 2 PWM, local time measurement function | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 215: X20DC2395, X20cDC2395 - Order data

9.11.14.4 Technical data

| Model number | X20DC2395 | X20cDC2395 |
|--|--|------------|
| Short description | | |
| I/O module | 1 SSI absolute encoder, 24 V, 1 ABR incremental encoder, 24 V, 2 AB incremental encoders, 24 V, 4x event counters or 2x pulse width modulation, time measurement, relative timestamp | |
| General information | | |
| Input voltage | 24 VDC -15 % / +20 % | |
| B&R ID code | 0x1CD4 | 0xE503 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Outputs | Yes, using the status LED and software (output error status) | |
| Power consumption | | |
| Bus | 0.01 W | |
| Internal I/O | 1.4 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Type of signal lines | Shielded cables must be used for all signal lines | |
| Certifications | | |
| CE | Yes | |
| KC | Yes | - |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| Incremental encoders | | |
| Quantity | 2 | |
| Encoder inputs | 24 V, asymmetrical | |
| Counter size | 16/32-bit | |
| Input frequency | Max. 100 kHz | |
| Evaluation | 4x | |
| Encoder power supply | Module-internal, max. 600 mA | |
| Overload characteristics of encoder power supply | Short circuit protection, overload protection | |
| SSI absolute encoder | | |
| Quantity | 1 | |
| Encoder inputs | 24 V, asymmetrical | |
| Counter size | 32-bit | |
| Max. transfer rate | 125 kbit/s | |
| Encoder power supply | Module-internal, max. 600 mA | |
| Keying | Gray/Binary | |
| CLK: Output current | Max. 100 mA | |
| Overload characteristics of encoder power supply | Short circuit protection, overload protection | |
| Event counters | | |
| Quantity | 4 | |
| Nominal voltage | 24 VDC | |
| Signal form | Square wave pulse | |
| Evaluation | Each edge, cyclic counter | |
| Input frequency | Max. 100 kHz | |
| Input current at 24 VDC | Approx. 1.3 mA | |
| Input resistance | 18.4 kΩ | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Counter frequency | 200 kHz | |
| Counter size | 16/32-bit | |
| Input filter | | |
| Hardware | ≤2 μs | |
| Software | - | |
| Switching threshold | | |
| Low | <5 VDC | |
| High | >15 VDC | |
| Edge detection / Time measurement | | |
| Possible measurements | Gate time, period duration, edge offset for various channels | |
| Measurements per module | Up to 9 | |

Table 216: X20DC2395, X20cDC2395 - Technical data


| Model number | X20DC2395 | X20cDC2395 |
|---|--|---|
| Measurements per channel | Up to 2 | |
| Counter size | 16-bit | |
| Counter frequency | | |
| Internal | 8 MHz, 4 MHz, 2 MHz, 1 MHz, 500 kHz, 250 kHz, 125 kHz, 62.5 kHz | |
| Signal form | Square wave pulse | |
| Measurement type | Continuous or triggered | |
| Digital outputs | | |
| Quantity | 2 | |
| Variant | Push / Pull / Push-Pull | |
| Nominal voltage | 24 VDC | |
| Switching voltage | 24 VDC -15 % / +20 % | |
| Nominal output current | 0.1 A | |
| Total nominal current | 0.2 A | |
| Output circuit | Sink or source | |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs, integrated protection for switching inductances | |
| Pulse width modulation ¹⁾ | | |
| Period duration | 41.6 µs to 1.36 s | |
| Factor for period duration | n/48000 s, n = 2 to 65535 | |
| Pulse duration | 0 to 100 % | |
| Resolution for pulse duration | 0.1% | |
| Actuator power supply | Module-internal, max. 600 mA | |
| Diagnostic status | Output monitoring | |
| Leakage current when switched off | Max. 25 µA | |
| Residual voltage | <0.9 V at 0.1 A rated current | |
| Peak short-circuit current | <10 A | |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms (depends on the module temperature) | |
| Switching delay | | |
| 0 → 1 | <2 µs | |
| 1 → 0 | <2 µs | |
| Switching frequency | | |
| Resistive load | Max. 24 kHz | |
| Inductive load | See section "Switching inductive loads" | |
| Braking voltage when switching off inductive loads | Switching voltage + 0.6 VDC | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Electrical properties | | |
| Electrical isolation | Bus isolated from encoder and output Output not isolated from output and encoder Encoder not isolated from encoder | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm | |

Table 216: X20DC2395, X20cDC2395 - Technical data

1) Dead time when switching between push and pull: max. 1.5 µs.

9.11.14.5 LED status indicators

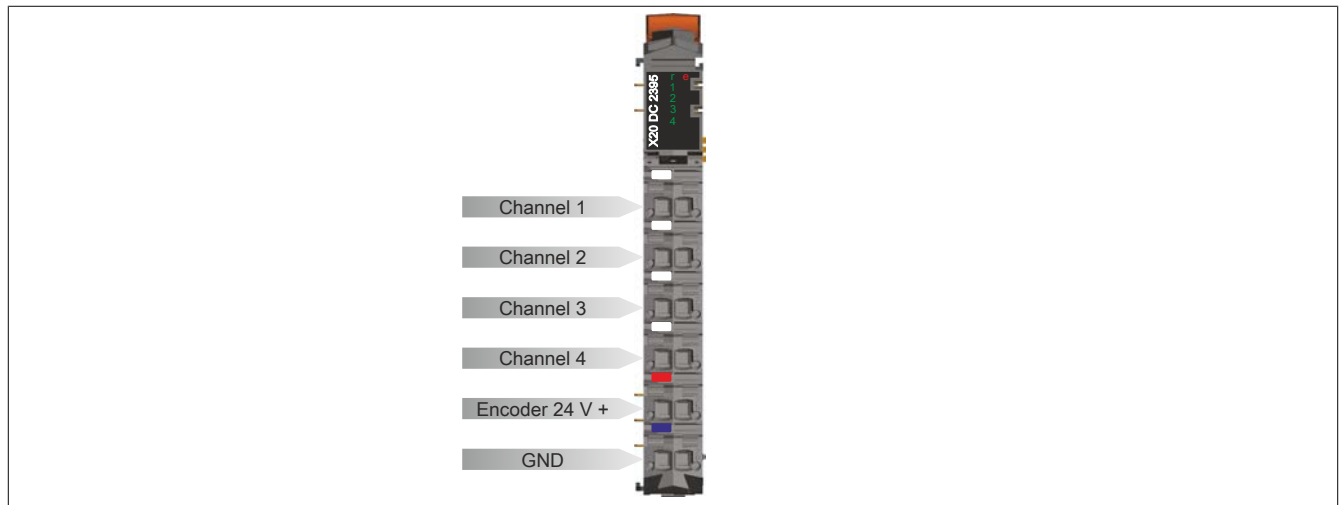
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|-------|--------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | e | Red | On | RUN mode |
| | | | Off | No power to module or everything OK |
| | 1 - 4 | Green | On | Error or reset status |
| | | | Off | Status of the corresponding digital signal |

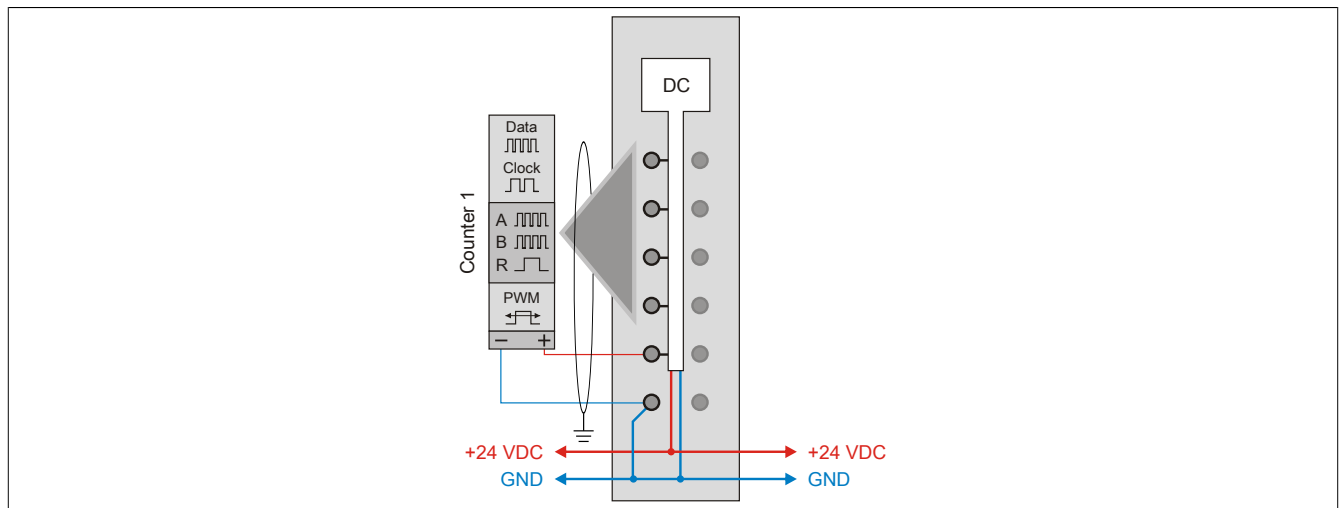
1) Depending on the configuration, a firmware update can take up to several minutes.

9.11.14.6 Pinout

Shielded cables must be used for all signal lines.



9.11.14.7 Connection example



9.11.14.8 Function overview

The following functions can be configured on the module. They cannot all be used at the same time due to the multiple use of the hardware channels and the limited cyclic data length.

- 4 digital channels, 2 of which can be configured as outputs
- 4 event counters with configurable counting direction and optional referencing via digital input
- 2 PWM outputs
- 2 up/down counters, each with optional latch inputs and comparator output
- 2 AB counters, each with optional latch inputs and comparator output
- 1 ABR encoder with configurable reference pulse edge and reference position, optional reference enable input, latch input and comparator output
- 1 SSI counter with optional latch input and comparator output
- 2 edge-triggered time measurement functions with configurable start edge based on current configuration settings

9.11.14.8.1 Description of channel assignments

The functions listed here are directly assigned to the respective hardware channels and cannot be changed:

| Channel | Signal connections |
|---------|--|
| 1 | <ul style="list-style-type: none"> • Digital input 1 • Event counter 1 • AB encoder 1 - signal line A • Up/down counter 1 - frequency • SSI encoder 1 - data line • ABR encoder 1 - signal line A |
| 2 | <ul style="list-style-type: none"> • Digital input 2 • Digital output 2 • Event counter 2 • PWM output 2 • AB encoder 1 - signal line B • Up/down counter 1 - direction • SSI encoder 1 - clock line • ABR encoder 1 - signal line B |
| 3 | <ul style="list-style-type: none"> • Digital input 3 • Event counter 3 • AB encoder 2 - signal line A • Up/down counter 2 - frequency • ABR encoder 1 - signal line R |
| 4 | <ul style="list-style-type: none"> • Digital input 4 • Digital output 4 • Event counter 4 • PWM output 4 • AB encoder 2 - signal line B • Up/down counter 2 - direction • ABR encoder 1 - reference enable input |

Options available in addition to these basic functions, such as comparator outputs or latch inputs, can be configured freely to unused input/output channels.

9.11.14.8.2 Connection options

Channels 1 to 4 can be connected as follows:

| Channel | Function | | | | | |
|---------|----------|---------------|---|------------------|-----------|-----|
| 1 | I | Event counter | A | A | SSI data | |
| 2 | I/O | Event counter | B | B | SSI cycle | PWM |
| 3 | I | Event counter | A | R | | |
| 4 | I/O | Event counter | B | Enable reference | | PWM |

The functions can also be mixed. For example:

| Example 1 | |
|-----------|---------------|
| Channel | Function |
| 1 | SSI data |
| 2 | SSI cycle |
| 3 | Event counter |
| 4 | PWM |

| Example 2 | |
|-----------|-----------|
| Channel | Function |
| 1 | SSI data |
| 2 | SSI cycle |
| 3 | A |
| 4 | B |

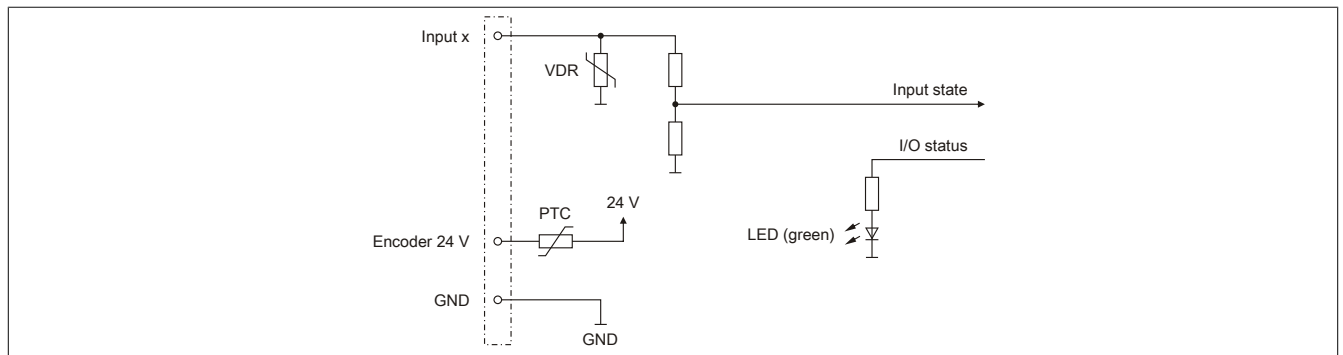
| Example 3 | |
|-----------|---------------|
| Channel | Function |
| 1 | Event counter |
| 2 | PWM |
| 3 | Event counter |
| 4 | PWM |

| Example 4 | |
|-----------|------------------|
| Channel | Function |
| 1 | A |
| 2 | B |
| 3 | R |
| 4 | Enable reference |

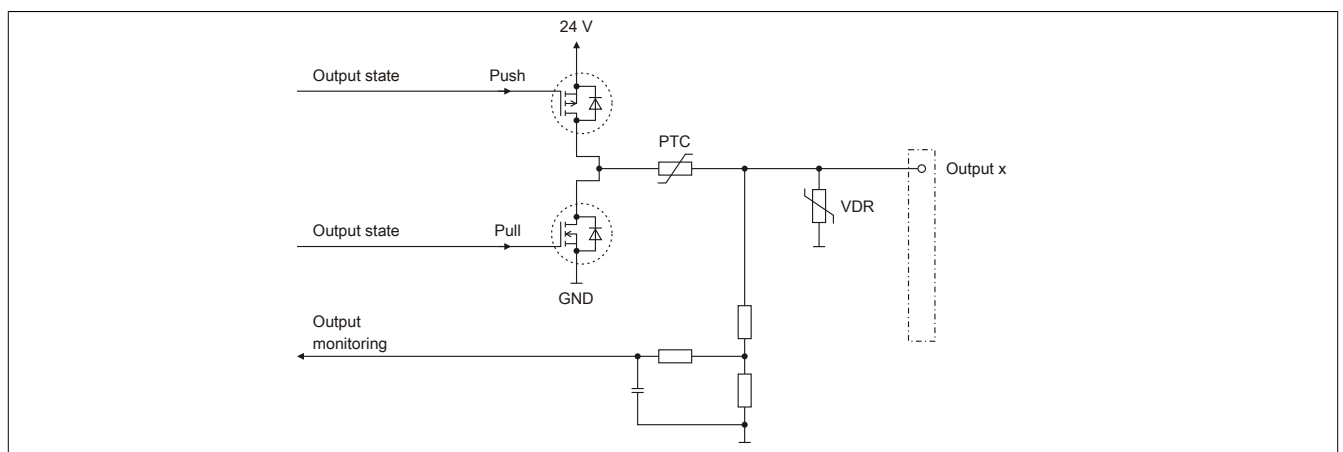
| Example 5 | |
|-----------|---------------|
| Channel | Function |
| 1 | A |
| 2 | B |
| 3 | Event counter |
| 4 | PWM |

| Example 6 | |
|-----------|---------------|
| Channel | Function |
| 1 | Event counter |
| 2 | PWM |
| 3 | A |
| 4 | B |

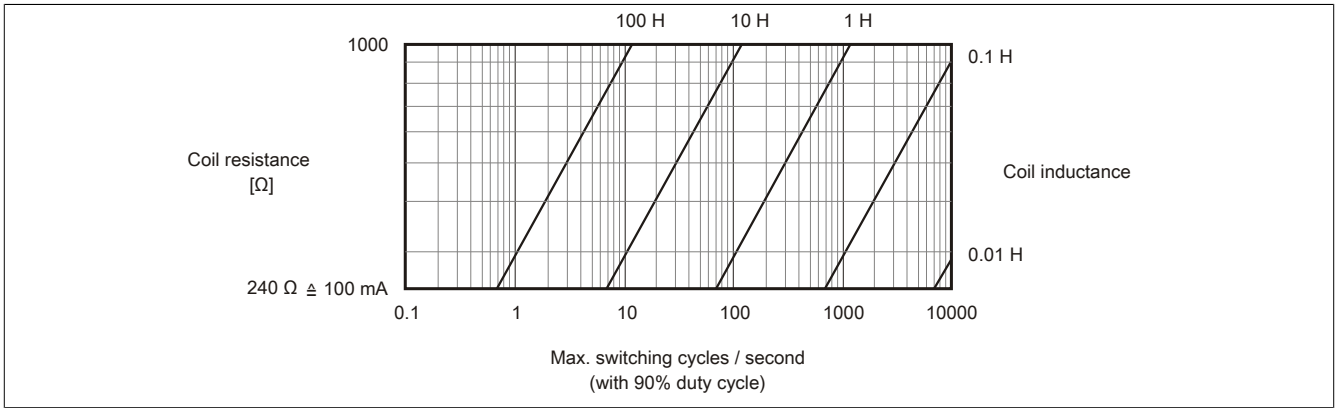
9.11.14.9 Input circuit diagram



9.11.14.10 Output circuit diagram



9.11.14.11 Switching inductive loads



9.11.14.12 Calculating the period duration

The outputs of the module can be operated as PWM outputs. The period duration is calculated using the following formula:

$$\text{Period duration} = \frac{n}{48000} \text{ s}$$

A value of 2 to 65535 can be defined for n.

Example

| n | Period duration | Frequency |
|-------|-----------------|-----------|
| 2 | 416 μs | 24 kHz |
| 24000 | 500 ms | 2 Hz |
| 48000 | 1 s | 1 Hz |
| 65535 | 1.36 s | 0.73 Hz |

9.11.14.13 Register description

9.11.14.13.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.11.14.13.2 Function model 0 - Standard and Function model 1 - 32-bit counter

The following 2 models can be selected:

- 16-bit counter, Function model 0
- 32-bit counter, Function model 1 (identified in the table with a "(D)" in the data type and "(_32Bit)" in the name.)

The only difference between these two models is that they use either 16-bit or 32-bit registers for incremental counter functions. These include:

- ABR encoders
- AB encoders
- Up/down counters
- Event counters

All other module functions e.g. SSI, PWM and time measurement, as well as their data types, are identical for the two models.

| Register | Name | Data type | Read | | Write | |
|--|-------------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module configuration - General | | | | | | |
| (N-1) * 2 | CfO_CFGchannel0N (Index N = 1 to 4) | USINT | | | | • |
| 64 + N * 2 | CfO_LEDNsource (Index N = 0 to 3) | USINT | | | | • |
| Configuration - Input for ABR encoders | | | | | | |
| 512 | CfO_DIREKTI0event0IDwr | UINT | | | | • |
| 516 | CfO_DIREKTI0event0mode | USINT | | | | • |
| 522 | CfO_DIREKTI0event0compState | UINT | | | | • |
| 520 | CfO_Ev0CompMask | USINT | | | | • |
| 2,064 | CfO_Counter1PresetValue1(_32Bit) | U(D)INT | | | | • |
| 2,068 | CfO_Counter1PresetValue2(_32Bit) | U(D)INT | | | | • |
| 2,320 | CfO_Counter2PresetValue1(_32Bit) | U(D)INT | | | | • |
| 2,324 | CfO_Counter2PresetValue2(_32Bit) | U(D)INT | | | | • |
| 2,048 | CfO_Counter1config | USINT | | | | • |
| 2,056 | CfO_Counter1configReg0 | USINT | | | | • |
| 2,058 | CfO_Counter1configReg1 | USINT | | | | • |
| 2,112 | CfO_Counter1event0IDwr | UDINT | | | | • |
| 2,120 | CfO_Counter1event0config | UINT | | | | • |
| 2,144 | CfO_Counter1event1IDwr | UINT | | | | • |
| 2,152 | CfO_Counter1event1config | UINT | | | | • |
| 2,148 | CfO_Counter1event1mode | USINT | | | | • |
| Configuration - Inputs for AB, up/down and event counters | | | | | | |
| 2,048 | CfO_Counter1config | USINT | | | | • |
| 2,056 | CfO_Counter1configReg0 | USINT | | | | • |
| 2,058 | CfO_Counter1configReg1 | USINT | | | | • |
| 2,112 | CfO_Counter1event0IDwr | UDINT | | | | • |
| 2,120 | CfO_Counter1event0config | UINT | | | | • |
| 2,116 | CfO_Counter1event0mode | USINT | | | | • |
| 2,144 | CfO_Counter1event1IDwr | UINT | | | | • |
| 2,152 | CfO_Counter1event1config | UINT | | | | • |
| 2,148 | CfO_Counter1event1mode | USINT | | | | • |
| 2,304 | CfO_Counter2config | USINT | | | | • |
| 2,312 | CfO_Counter2configReg0 | USINT | | | | • |
| 2,314 | CfO_Counter2configReg1 | USINT | | | | • |
| 2,368 | CfO_Counter2event0IDwr | UINT | | | | • |
| 2,376 | CfO_Counter2event0config | UINT | | | | • |
| 2,372 | CfO_Counter2event0mode | USINT | | | | • |
| 2,400 | CfO_Counter2event1IDwr | UINT | | | | • |
| 2,408 | CfO_Counter2event1config | UINT | | | | • |
| 2,404 | CfO_Counter2event1mode | USINT | | | | • |
| Configuration - Inputs for SSI encoders | | | | | | |
| 7,176 | CfO_SSI1cfg | UINT | | | | • |
| 7,180 | CfO_SSI1control | USINT | | | | • |
| 7,168 | CfO_SSI1eventIDwr | UINT | | | | • |

| Register | Name | Data type | Read | | Write | |
|---|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 7,232 | CfO_SSI1event0IDwr | UINT | | | | • |
| 7,240 | CfO_SSI1event0config | UINT | | | | • |
| 7,236 | CfO_SSI1event0mode | USINT | | | | • |
| 7,172 | ConfigAdvanced01 | UDINT | | | | • |
| Configuration - Comparator function for ABR, AB, SSI encoders and up/down counters | | | | | | |
| 256 | CfO_OutClearMask | USINT | | | | • |
| 258 | CfO_OutSetMask | USINT | | | | • |
| 1,024 | CfO_DIREKTI0outevent0IDwr | UINT | | | | • |
| 1,034 | CfO_DIREKTI0outsetmask0 | USINT | | | | • |
| 1,032 | CfO_DIREKTI0outclearmask0 | USINT | | | | • |
| 1,066 | CfO_DIREKTI0outsetmask1 | USINT | | | | • |
| 1,064 | CfO_DIREKTI0outclearmask1 | USINT | | | | • |
| 1,056 | CfO_DIREKTI0outevent1IDwr | UINT | | | | • |
| Configuration - Outputs for PWM (pulse width modulation) | | | | | | |
| 6,144 | CfO_PWM0prescaler | UINT | | | | • |
| 6,160 | CfO_PWM1prescaler | UINT | | | | • |
| Module communication - General | | | | | | |
| 40 | Status of encoder power supply | USINT | • | | | |
| | PowerSupply01 | Bit 0 | | | | |
| Communication - Digital inputs | | | | | | |
| 264 | Input states of the channels | USINT | • | | | |
| | DigitalInput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalInput04 | Bit 3 | | | | |
| Communication - Event counters | | | | | | |
| 2,080 | EventCounter01 | U(D)INT | • | | | |
| 2,084 | EventCounter02 | U(D)INT | • | | | |
| 2,336 | EventCounter03 | U(D)INT | • | | | |
| 2,340 | EventCounter04 | U(D)INT | • | | | |
| Communication - Input for ABR encoders (optionally with comparator) | | | | | | |
| 2,080 | ABREncoder01 | (D)INT | • | | | |
| 2,116 | ReferenceModeABR01 | USINT | | | • | |
| 2,160 | OriginComparator01 | (D)INT | | | • | |
| 2,164 | MarginComparator01 | U(D)INT | | | • | |
| 264 | Input states of the channels | USINT | • | | | |
| | ReferenceEnableSwitch01 (without comparator) ComparatorActualValue01 (with comparator) | Bit 3 | | | | |
| 2,172 | Latch01ABR01 | (D)INT | • | | | |
| 2,118 | StatusABR01 | USINT | • | | | |
| Communication - Input for AB | | | | | | |
| 2,080 | ABEncoder01 | (D)INT | • | | | |
| 2,336 | ABEncoder02 | (D)INT | • | | | |
| 2,160 | OriginComparator01 | (D)INT | | | • | |
| 2,164 | MarginComparator01 | U(D)INT | | | • | |
| 264 | Input states of the channels | USINT | • | | | |
| | ComparatorActualValue01 | Bit 3 | | | | |
| 2,140 | Latch01AB01 | (D)INT | • | | | |
| 2,172 | Latch02AB01 | (D)INT | • | | | |
| 2,396 | Latch01AB02 | (D)INT | • | | | |
| 2,428 | Latch02AB02 | (D)INT | • | | | |
| Communication - Up/down counters | | | | | | |
| 2,080 | Counter01 | U(D)INT | • | | | |
| 2,336 | Counter02 | U(D)INT | • | | | |
| 2,160 | OriginComparator01 | U(D)INT | | | • | |
| 2,164 | MarginComparator01 | U(D)INT | | | • | |
| 264 | Input states of the channels | USINT | • | | | |
| | ComparatorActualValue01 | Bit 3 | | | | |
| 2,140 | Latch01Counter01 | U(D)INT | • | | | |
| 2,172 | Latch02Counter01 | U(D)INT | • | | | |
| 2,396 | Latch01Counter02 | U(D)INT | • | | | |
| 2,428 | Latch02Counter02 | U(D)INT | • | | | |
| Communication - Input for SSI encoders | | | | | | |
| 7,184 | SSIEncoder01 | UDINT | • | | | |
| 7,248 | OriginComparator01 | UDINT | | | • | |
| 7,252 | MarginComparator01 | UDINT | | | • | |
| 264 | Input states of the channels | USINT | • | | | |
| | ComparatorActualValue01 | Bit 3 | | | | |
| 7,260 | Latch01SSI01 | UDINT | • | | | |
| Communication - Digital outputs | | | | | | |
| 260 | Output states of the channels | USINT | | | • | |
| | DigitalOutput02 | Bit 1 | | | | |
| | DigitalOutput04 | Bit 3 | | | | |
| 264 | Input states of the channels | USINT | • | | | |
| | StatusDigitalOutput02 | Bit 1 | | | | |

| Register | Name | Data type | Read | | Write | |
|---|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| | StatusDigitalOutput04 | Bit 3 | | | | |
| Communication - Outputs for PWM (pulse width modulation) | | | | | | |
| 6,146 | PWMOutput02 | UINT | | | • | |
| 6,162 | PWMOutput04 | UINT | | | • | |
| Configuration - Edge detection | | | | | | |
| 4,104 | CfO_EdgeDetectFalling | USINT | | | | • |
| 4,106 | CfO_EdeDetectRising | USINT | | | | • |
| 4,108 | CfO_FallingDisProtection | USINT | | | | • |
| 4,110 | CfO_RisingDisProtection | USINT | | | | • |
| Configuration - Time measurement | | | | | | |
| 4,336 | CfO_EdgeTimeglobalenable | USINT | | | | • |
| 4344 + N * 8 | CfO_EdgeTimeFallingMode0N (Index N = 1 to 4) | UINT | | | | • |
| 4472 + N * 8 | CfO_EdgeTimeRisingMode0N (Index N = 1 to 4) | UINT | | | | • |
| Communication - Time measurement | | | | | | |
| 4,342 | Trigger rising edge detection | USINT | | | • | |
| | TriggerRisingCH01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | TriggerRisingCH04 | Bit 3 | | | | |
| 4,350 | Show first rising trigger edge | USINT | • | | | |
| | BusyTriggerRisingCH01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | BusyTriggerRisingCH04 | Bit 3 | | | | |
| 4,340 | Trigger falling edge detection | USINT | | | • | |
| | TriggerFallingCH01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | TriggerFallingCH04 | Bit 3 | | | | |
| 4,348 | Show first falling trigger edge | USINT | • | | | |
| | BusyTriggerFallingCH01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | BusyTriggerFallingCH04 | Bit 3 | | | | |
| 4474 + N * 8 | CountRisingCH0N (Index N = 1 to 4) | USINT | • | | | |
| 4476 + N * 8 | TimeStampRisingCH0N (Index N = 1 to 4) | UINT | • | | | |
| 4478 + N * 8 | TimeDiffRisingCH0N (Index N = 1 to 4) | UINT | • | | | |
| 4346 + N * 8 | CountFallingCH0N (Index N = 1 to 4) | USINT | • | | | |
| 4348 + N * 8 | TimeStampFallingCH0N (Index N = 1 to 4) | UINT | • | | | |
| 4350 + N * 8 | TimeDiffFallingCH0N (Index N = 1 to 4) | UINT | • | | | |

9.11.14.13.3 Function model 254 - Bus controller

Unlike the function models 0 and 1, this model only offers a selection of functions with a limited scope of configuration on the module.

The following functions are provided and can be run at the same time:

- 2 event counter with configurable counting direction
- 2 PWM outputs

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|-------------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| (N-1) * 2 | - | CfO_CFGchannel0N (Index N = 1 to 4) | USINT | | | | • |
| 64 + N * 2 | - | CfO_LEDNsource (Index N = 0 to 3) | USINT | | | | • |
| 2,056 | - | CfO_Counter1configReg0 | USINT | | | | • |
| 2,312 | - | CfO_Counter2configReg0 | USINT | | | | • |
| Communication | | | | | | | |
| 2,080 | 0 | EventCounter01 | UINT | • | | | |
| 2,336 | 2 | EventCounter03 | UINT | • | | | |
| 6,146 | 0 | PWMOutput02 | UINT | | | • | |
| 6,162 | 2 | PWMOutput04 | UINT | | | • | |
| 40 | 4 | Status of encoder power supply | USINT | • | | | |
| | | PowerSupply01 | Bit 0 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.11.14.13.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.11.14.13.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.11.14.13.4 General module registers

9.11.14.13.4.1 Configuring LED status indicators

Name:

CfO_LED0source to CfO_LED3source

These registers can be used to define how the module's LED status indicators are used. Blinking patterns can be generated from the application, and the status of the physical inputs and outputs can be indicated.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|-------------------------------------|
| USINT | See the bit structure. | CfO_LEDNsource N(0 to 3): 32 + N |

Bit structure:

| Bit | Description | Value | Information | |
|----------|---------------------|--|---|--------------------------------------|
| 0 - 3 | MODE = 0 | 0 | LED off | |
| | | 1 | Blinking quickly | |
| | | 2 | Blinking | |
| | | 3 | Blinking slowly | |
| | | 4 | Single flash | |
| | | 5 | Double flash | |
| | MODE = 1 (inverted) | 6 to 15 | Reserved | |
| | | 0 | LED on | |
| | | 1 | Blinking quickly | |
| | | 2 | Blinking | |
| | | 3 | Blinking slowly | |
| | | 4 | Single flash | |
| | MODE = 2 | 4 to 15 | 0 to 3 | Number of the physical input channel |
| | | | 4 to 15 | Reserved |
| | | 0 to 3 | Number of the physical output channel | |
| MODE = 3 | 4 to 15 | Reserved | | |
| | 4 - 7 | Selection of the mode for the LED status indicator | 0 | LED blinking pattern |
| | | 1 | Inverted LED blinking pattern | |
| | | 2 | Displays a channel's physical input status | |
| | | 3 | Displays a channel's physical output status | |
| | | 4 to 15 | Reserved | |

9.11.14.13.4.2 Status of encoder power supply

Name:

PowerSupply01

This register indicates the state of the integrated encoder power supply. A faulty encoder power supply is output as a warning.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|------------------------------------|
| 0 | PowerSupply01 | 0 | 24 VDC encoder power supply OK |
| | | 1 | 24 VDC encoder power supply faulty |
| 1 - 7 | Reserved | - | |

9.11.14.13.5 Digital inputs and outputs

9.11.14.13.5.1 Configure physical channels

Name:

CfO_CFGchannel01 to CfO_CFGchannel04

This register can be used to configure physical I/O channels 1 to 4.

Information:

Except for bit 2 (inverted input), all other bits are only available for channels 2 and 4.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|---|
| USINT | See the bit structure. | CfO_CFGchannel0N N(1.3): 0 N(2.4): 99 |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------|--------|------------------------------|
| 0 | Push ¹⁾ | 0 | Disabled |
| | | 1 | Enabled |
| 1 | Pull ¹⁾ | 0 | Disabled |
| | | 1 | Enabled |
| 2 | Inverted input | 0 | Disabled |
| | | 1 | Enabled |
| 3 | Inverted output | 0 | Disabled |
| | | 1 | Enabled |
| 4 - 7 | Output type | 0 | Direct I/O |
| | | 1 to 5 | Reserved |
| | | 6 | PWM (channel-specific) |
| | | 7 | SSI clock (channel-specific) |

1) To configure a channel as an output, Push and/or Pull must be enabled.

9.11.14.13.5.2 Reset mask of the digital channels

Name:

CfO_OutClearMask

The settings in this register only affect the values written to registers "DigitalOutput02 and 04" on page 1229.

- 0 allows manual reset of digital outputs using registers DigitalOutput02 and 04
- 1 prevents manual reset of digital outputs using registers DigitalOutput02 and 04

When "1" is used, the [output event function](#) can be used to reset the outputs.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------|-------|---|
| 0 | Reserved | - | |
| 1 | DigitalOutput02 | 0 | Writing 0 to the DigitalOutput02 register resets the output |
| | | 1 | Writing 0 from the DigitalOutput02 register does not reset the output |
| 2 | Reserved | - | |
| 3 | DigitalOutput04 | 0 | Writing 0 to the DigitalOutput04 register resets the output |
| | | 1 | Writing 0 from the DigitalOutput04 register does not reset the output |
| 4 - 7 | Reserved | - | |

9.11.14.13.5.3 Set mask of the digital channels

Name:

CfO_OutSetMask

The settings in this register only affect the values written to registers "DigitalOutput02 and 04" on page 1229.

- 0 allows manual setting of digital outputs using registers DigitalOutput02 and 04
- 1 prevents manual setting of digital outputs using registers DigitalOutput02 and 04

When "1" is used, the [output event function](#) can be used to set the outputs.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------|-------|---|
| 0 | Reserved | - | |
| 1 | DigitalOutput02 | 0 | Writing 1 to the DigitalOutput02 register sets the output |
| | | 1 | Writing 1 from the DigitalOutput02 register does not set the output |
| 2 | Reserved | - | |
| 3 | DigitalOutput04 | 0 | Writing 1 to the DigitalOutput04 register sets the output |
| | | 1 | Writing 1 from the DigitalOutput04 register does not set the output |
| 4 - 7 | Reserved | - | |

9.11.14.13.5.4 Input states of the channels

Name:

see "Name in the Automation Studio I/O configuration"

This register reads the input status of a physical channel. The polarity settings are accounted for in the value (bit 2 in "CfO_CFGchannel[x]" on page 1227 register).

The bits in this register are shown in the Automation Studio I/O mapping table under different names based on the function used in order to improve readability.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Physical input channel | Value | Name in the Automation Studio I/O configuration |
|-------|------------------------|--------|---|
| 0 | Channel 1 | 0 or 1 | DigitalInput01 |
| 1 | Channel 2 | 0 or 1 | DigitalInput02 |
| | | | StatusDigitalOutput02 |
| 2 | Channel 3 | 0 or 1 | DigitalInput03 |
| 3 | Channel 4 | 0 or 1 | DigitalInput04 |
| | | | StatusDigitalOutput04 |
| | | | ReferenceEnableSwitch01 |
| | | | ComparatorActualValue01 |
| 4 - 7 | Reserved | - | |

9.11.14.13.5.5 Output states of the channels

Name:

DigitalOutput02 and DigitalOutput04

The output status of a physical channel can be written using this register. In order to configure a channel as an output:

- 1) Bit 0 "Push" and/or bit 1 "Pull" must be enabled in the "CfO_CFGchannel[x]" on page 1227 register.
- 2) Bits 4 to 7 in the "CfO_CFGchannel[x]" on page 1227 register must be set to Direct I/O.
- 3) 0 must be set for the respective channel in the "CfO_OutClearMask" on page 1227 and "CfO_OutSetMask" on page 1228 registers.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------|--------|----------------------------|
| 0 | Reserved | - | |
| 1 | DigitalOutput02 | 0 or 1 | Output status of channel 2 |
| 2 | Reserved | - | |
| 3 | DigitalOutput04 | 0 or 1 | Output status of channel 4 |
| 4 - 7 | Reserved | - | |

9.11.14.13.6 Event functions

The module provides configurable event functions. An event function can be connected to physical I/O and the values derived from them (e.g. counters) or be purely used for internal processing.

Every event function has event inputs and outputs. Event functions can also have only inputs or only outputs. Each event output has a unique event ID. It is possible to configure when an event is generated on an event output. The effect of an event is determined by the respective event function.

Event functions can also be linked to one another. The link takes place using the event input. Every event input has a 16-bit register to which the event number of the linked event output is written.

Information:

The module functions that can be configured in the Automation Studio I/O configuration are primarily based on these event functions and their links. Changes in the Automation Studio I/O configuration have multiple effects on event functions and their links.

9.11.14.13.6.1 List of event IDs

Various hardware and software functions send event IDs or require event IDs in order to start. The following table shows all of the IDs available to configure the module.

| Event ID | Description | |
|-------------------------------------|---|----------------------------------|
| Direct event inputs | | |
| 512 | Comparator condition | FALSE |
| 513 | Comparator condition | TRUE |
| Counter comparator functions | | |
| 2112 | Counter function 1 | Event function 1; FALSE |
| 2113 | | Event function 1; TRUE |
| 2144 | | Event function 2; FALSE |
| 2145 | | Event function 2; TRUE |
| 2368 | Counter function 2 | Event function 1; FALSE |
| 2369 | | Event function 1; TRUE |
| 2400 | | Event function 2; FALSE |
| 2401 | | Event function 2; TRUE |
| Edge events | | |
| 4096 | Falling edge on I/O channel | Channel 1 |
| ... | | ... |
| 4099 | | Channel 4 |
| 4112 | Rising edge on I/O channel | Channel 1 |
| ... | | ... |
| 4115 | | Channel 4 |
| 4128 | Rising or falling edge on I/O channel | Channel 1 |
| ... | | ... |
| 4131 | | Channel 4 |
| SSI counter events | | |
| 7168 | SSI valid | |
| 7169 | SSI ready | |
| SSI comparator events | | |
| 7232 | SSI 1 comparator condition | FALSE |
| 7233 | | TRUE |
| Timer events | | |
| 208 | Timer1 | 50 µs |
| 209 | Timer2 | 100 µs |
| 210 | Timer3 | 200 µs |
| 211 | Timer4 | 400 µs |
| 212 | Timer5 | 800 µs |
| 213 | Timer6 | 1600 µs |
| 214 | Timer7 | 3200 µs |
| 215 | Timer8 | 3200 µs (time offset to timer 7) |
| Network functions | | |
| 224 | SOAISOP (synchronous out asynchronous in start of protocol) | |
| 225 | AOSISOP (asynchronous out synchronous in start of protocol) | |
| 226 | SOAIEOP (synchronous out asynchronous in end of protocol) | |
| 227 | AOSIEOP (asynchronous out synchronous in end of protocol) | |
| Idle event | | |
| 192 | No-load operation | |

Timer

There are 8 timer events that the module can generate.

Information:

The timers have the highest event priority. All other system functions are interrupted when a timer event occurs, and jitter for the amount of time it takes to process the event.

Idle event

Idle time is the time that remains after the system has processed all higher priority events and operations. The module performs the following functions during idle time:

- Handling of the asynchronous protocol
- Mechanism for (re-)linking events
- Operation of LEDs
- Execution of event functions linked to the idle function

9.11.14.13.6.2 Edge events

For each physical input channel there are 3 event functions

- Falling edge
- Rising edge
- Falling and rising edge

The respective event is triggered when an edge is detected on the hardware input and the "[CfO_EdgeDetectRising](#)" on page 1231 and/or "[CfO_EdgeDetectFalling](#)" on page 1231 register has been configured for the respective channel.

Edges are detected by the hardware and processed for each interrupt. The interrupt handler uses an event distributor, which requires a specific amount of time for each edge to operate the hardware and execute linked event functions. To reduce this time, edge detection can be enabled/disabled individually for each channel. To optimize system load and I/O jitter, it is important to only enable edge detection where it is actually needed.

Information:

Edge detection can also be used for channels that are configured as outputs.

Event frequency limitation

To stabilize the system, there is a mechanism that limits the number of events created through edge recognition. At least one idle event must occur between two edge events for the same edge.

The "[CfO_FallingDisProtection](#)" on page 1232 and "[CfO_RisingDisProtection](#)" on page 1232 registers can be used to disable this limitation for each edge, and then an event will be generated for every edge. However, this can cause a system overload, i.e. I/O operation can fail for up to 100 ms before the module changes to the reset state.

Generate event on falling edge

Name:

CfO_EdgeDetectFalling

This register defines whether an event is generated on a falling edge.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|---|
| 0 | Channel 1 | 0 | No event generated on falling edge. |
| | | 1 | Events 4096 and 4128 are generated on falling edge. |
| ... | | ... | |
| 3 | Channel 4 | 0 | No event generated on falling edge. |
| | | 1 | Events 4099 and 4131 are generated on falling edge. |
| 4 - 7 | Reserved | - | |

Generate event on rising edge

Name:

CfO_EdgeDetectRising

This register defines whether an event is generated on a rising edge.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|--|
| 0 | Channel 1 | 0 | No event generated on rising edge. |
| | | 1 | Events 4112 and 4128 are generated on rising edge. |
| ... | | ... | |
| 3 | Channel 4 | 0 | No event generated on rising edge. |
| | | 1 | Events 4115 and 4131 are generated on rising edge. |
| 4 - 7 | Reserved | - | |

Enable limit for falling edges

Name:

CfO_FallingDisProtection

This register can be used to enable/disable the [event frequency limit](#) for falling edges on the respective channel.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|---------------------------------|
| 0 | Channel 1 | 0 | Event frequency limit enabled. |
| | | 1 | Event frequency limit disabled. |
| ... | | ... | |
| 3 | Channel 4 | 0 | Event frequency limit enabled. |
| | | 1 | Event frequency limit disabled. |
| 4 - 7 | Reserved | - | |

Enable limit for rising edges

Name:

CfO_RisingDisProtection

This register can be used to enable/disable the [event frequency limit](#) for rising edges on the respective channel.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|---------------------------------|
| 0 | Channel 1 | 0 | Event frequency limit enabled. |
| | | 1 | Event frequency limit disabled. |
| ... | | ... | |
| 3 | Channel 4 | 0 | Event frequency limit enabled. |
| | | 1 | Event frequency limit disabled. |
| 4 - 7 | Reserved | - | |

9.11.14.13.6.3 Direct input function

The module features a direct input function.

This event function is based on comparator functionality. If the event configured in the "CfO_DIREKTIOevent0IDwr" on page 1233 register occurs, the event function compares the status of all Direct I/O channels enabled in the "CfO_EvCompMask" on page 1234 register to a status defined in the "CfO_DIREKTIOeventcompState" on page 1233 register. The event that is generated depends on the results of this comparison.

- If the respective bits are the same, then event number 513 is generated
- If the respective bits are different, then event number 512 is generated

Configure event ID for input function

Name:

CfO_DIREKTIOevent0IDwr

This register holds the event ID generated by the direct input function. For a list of all possible event IDs, see "List of event IDs" on page 1230

| Data type | Value | Information |
|-----------|--------------|----------------------|
| INT | 192 to 7,233 | ID of event function |

Configure the mode of the input function

Name:

CfO_DIREKTIOevent0mode

The mode in which the direct input function operates can be set in this register.

Comparator functions can be operated in 4 different modes. For a description, see "Comparator modes" on page 1243.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------|-------|--------------|
| 0 - 1 | Comparator mode | 0 | Off |
| | | 1 | Individual |
| | | 2 | State change |
| | | 3 | Continuous |
| 2 - 7 | Reserved | - | |

Comparator status for comparator mask

Name:

CfO_DIREKTIOevent0compState

This register contains the status bits that are compared with the bits specified in the "CfO_Ev0CompMask" on page 1234 register, which contain the I/O input status, when an event is received.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------------|--------|-------------|
| 0 | Comparator status of channel 1 | 0 or 1 | |
| ... | | ... | |
| 3 | Comparator status of channel 4 | 0 or 1 | |
| 4 - 7 | Reserved | - | |

Configure the comparator mask for the input function

Name:

CfO_Ev0CompMask

If a bit is set, then the input status of the respective channel is compared with that bit in the "[CfO_DIREKTIOevent-compState](#)" on [page 1233](#) register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|-------------------------|
| 0 | Channel 1 | 0 | Do not compare bit |
| | | 1 | Compare bit in register |
| ... | | ... | |
| 3 | Channel 4 | 0 | Do not compare bit |
| | | 1 | Compare bit in register |
| 4 - 7 | Reserved | 0 | |

9.11.14.13.6.4 Direct output functions

The module has 2 of these event functions

The effect of executing this event function is similar to writing to the "[DigitalOutput02 and 04](#)" on [page 1229](#) registers. When this event function is triggered, however, the changed output states are passed on to the hardware immediately, regardless of the X2X cycle.

When this event function is used, the masks of the respective outputs (see "[CfO_OutClearMask](#)" on [page 1227](#) and "[CfO_OutSetMask](#)" on [page 1228](#) registers) must be set to 1. Otherwise the output status would constantly be overwritten by the values in the "[DigitalOutput02 and 04](#)" on [page 1229](#) registers.

Configure event ID for output function

Name:

CfO_DIREKTIOevent0IDwr to CfO_DIREKTIOevent1IDwr

These registers hold the event IDs that trigger the direct output function. For a list of all possible event IDs, see "[List of event IDs](#)" on [page 1230](#)

| Data type | Value | Information |
|-----------|--------------|----------------------|
| INT | 192 to 7,233 | ID of event function |

Configure channels for resetting

Name:

CfO_DIREKTIOoutclearmask0 to CfO_DIREKTIOoutclearmask1

Writing "1" to the bit position that corresponds to a channel resets the output if the [output event function](#) is being executed. This corresponds to writing "0" to the "[DigitalOutput 02 and 04](#)" on [page 1229](#) registers.

The bit that corresponds to channels that should be reset should be set to "1" in the "[CfO_OutClearMask](#)" on [page 1227](#) register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|------------------------|
| 0 | Reserved | - | |
| 1 | Channel 2 | 0 | Reset channel 2 |
| | | 1 | Do not reset channel 2 |
| 2 | Reserved | - | |
| 3 | Channel 4 | 0 | Reset channel 4 |
| | | 1 | Do not reset channel 4 |
| 4 - 7 | Reserved | - | |

Configure channels for setting

Name:

CfO_DIREKTIOoutsetmask0 to CfO_DIREKTIOoutsetmask1

Writing "1" to the bit position that corresponds to a channel sets the output if the [output event function](#) is being executed. This corresponds to writing "1" to the ["DigitalOutput 02 and 04" on page 1229](#) registers.

The bit that corresponds to channels that should be reset should be set to "1" in the ["CfO_OutSetMask" on page 1228](#) register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------|-------|----------------------|
| 0 | Reserved | - | |
| 1 | Channel 2 | 0 | Set channel 2 |
| | | 1 | Do not set channel 2 |
| 2 | Reserved | - | |
| 3 | Channel 4 | 0 | Set channel 4 |
| | | 1 | Do not set channel 4 |
| 4 | Reserved | - | |

9.11.14.13.7 Counters and encoders

The module has 2 internal counter functions, each with 2 event counter registers. Each of these 2 counters is permanently assigned to 2 physical inputs. This assignment cannot be changed.

The counter registers perform different functions based on how the event functions are connected. The counter registers can be configured in the following ways:

- ABR counter
- AB counter
- Up/down counters
- Event counters

Different names are used for them in Automation Studio and in the register description to improve clarity.

| Channel | Counter function | Counter register | Name in Automation Studio |
|---------|------------------|------------------|--|
| 1 | 1 | 1 | ABEncoder01 ABREncoder01 Counter01 EventCounter01 |
| 2 | | 2 | EventCounter02 |
| 3 | 2 | 1 | ABEncoder02 Counter02 EventCounter03 |
| 4 | | 2 | EventCounter04 |

9.11.14.13.7.1 Counter value calculation

There are 3 steps for calculating the state of any counter function

1. The counter value is based on the 2 absolute value counters "abs1" and "abs2". They are only used internally in the module and cannot be read. Depending on the **mode**, these registers show the respective physical input signals.

| | Mode | | |
|------|----------------------------|----------------------------------|--|
| | Edge counters | AB encoders | Up/down counter |
| abs1 | Edges of counter channel 1 | Increments in positive direction | Counter channel 2 = 0: Edges of counter channel 1 in up direction |
| abs2 | Edges of counter channel 2 | Increments in negative direction | Counter channel 2 = 1 Edges of counter channel 1 in down direction |

2. From the absolute value registers "abs1" and "abs2", 2 more counters are formed: "counter 1" and "counter 2". These are only used internally in the module and cannot be read. The following values are used for the calculation:

- Absolute value registers "abs1" and "abs2"
- SW_reference_counter 1 and 2: This reference value can be defined by the "[CfO_CounterPresetValue](#)" on page 1241 register to allow referencing $\lt \gt 0$.
- HW_reference_counter 1 and 2: In the "[CfO_CounterEventMode](#)" on page 1244 register, you can configure whether latched values should be copied to these registers when **counter events** occur.

$$\text{counter1} = \text{abs1} + \text{SW_reference_counter1} - \text{HW_reference_counter1}$$

$$\text{counter2} = \text{abs2} + \text{SW_reference_counter2} - \text{HW_reference_counter2}$$

3. The counter registers contain the sum of the two internal counters "counter 1" and "counter 2". The "[CfO_CounterConfigReg](#)" on page 1240 register allows you to define a sign for each "counter" register and define whether or not it should be used.

$$\text{Counter register} = \text{counter1} + \text{counter2}$$

9.11.14.13.7.2 Sample configurations

All of the settings available in Automation Studio for AB encoders, ABR encoders, up/down counters and event counters are based on the two counter functions.

The following configuration examples show the values with which Automation Studio initializes the module registers in order to implement these functions.

I/O configuration - AB encoder

The following table shows how the module's various event functions can be linked in order to configure an AB encoder.

[x] stands for the respective counter function, either 1 or 2

| Register | Value | Comment |
|----------------------------|------------------|--|
| For the function | | |
| CfO_Counter[x]config | 0x01 | Mode = Up/down counter |
| CfO_Counter[x]configReg0 | 0x0D | Configure the calculation of the internal "counter1" and "counter2" registers (see "Counter value calculation" on page 1236 and "Examples of calculation configurations" on page 1240) |
| For the latch | | |
| CfO_Counter[x]event0config | 0x000D | Configuration of the calculation of the first value used for the latch |
| CfO_Counter[x]event0mode | 0x03 | Mode of the first counter event function - Continuous |
| CfO_Counter[x]event0IDwr | (any) | Number of the event that should trigger Latch 1 ("Latch 01 - Channel" in the Automation Studio I/O configuration). |
| CfO_Counter[x]event1config | 0x0D | Configuration of the calculation of the second value used for the latch |
| CfO_Counter[x]event1mode | 0x03 | Mode of the second counter event function - Continuous |
| CfO_Counter[x]event1IDwr | (any) | Number of the event that should trigger Latch 2 |
| For the comparator | | |
| CfO_Counter1event1IDwr | 0x00D0 | Event number of Timer 1 (50 µs) Information: The latch and comparator must not have the same event number! |
| CfO_Counter1event1config | 0x900D or 0xA00D | Configuration of the comparator for the second counter event |
| CfO_Counter1event1mode | 0x03 | Mode of the second counter event function - Continuous |
| CfO_DIREKTIOoutevent0IDwr | 0x0861 | TRUE event output of the second counter to trigger the direct output function (set outputs). |
| CfO_DIREKTIOoutsetmask0 | 0x08, 0x20, 0x80 | Outputs that should be set when comparator condition = TRUE |
| CfO_DIREKTIOoutevent1IDwr | 0x0860 | FALSE event output of the second counter to trigger the direct output function (reset outputs). |
| CfO_DIREKTIOoutclearmask1 | 0x08, 0x20, 0x80 | Outputs that should be reset when comparator condition = FALSE |

I/O configuration - ABR encoder

The following table shows how the module's various event functions can be linked in order to configure an ABR encoder.

| Register | Value | Comment |
|-----------------------------|------------------|--|
| For the function | | |
| CfO_Counter1PresetValue1 | (any) | Desired offset value for referencing |
| CfO_Counter1event0IDwr | 0x0201 | Link between the first counter event and the direct input comparator condition TRUE |
| CfO_Counter1config | 0x01 | Mode = AB encoder |
| CfO_Counter1configReg0 | 0x0D | Configure the calculation of the internal "counter1" and "counter2" registers (see "Counter value calculation" on page 1236 and "Examples of calculation configurations" on page 1240) |
| CfO_DIREKTIOevent0IDwr | 0x1002 or 0x1012 | Selection of the desired input edge as trigger for the ABR encoder function |
| CfO_Counter1event0config | 0x0000 | Configuration of the first counter event (for referencing) |
| CfO_DIREKTIOevent0mode | 0x03 | Mode of the "direct input function" - Continuous |
| CfO_DIREKTIOevent0compState | 0x00 or 0x08 | Comparator status for the "direct input function" |
| CfO_Ev0CompMask | 0x08 | Comparator mask for the "direct input function" |
| For the latch | | |
| CfO_Counter1event0config | 0x000D | Configuration of the calculation of the value used for the latch |
| CfO_Counter1event0mode | 0x03 | Mode of the first counter event function - Continuous |
| CfO_Counter1event0IDwr | (any) | Number of the event that should trigger the latch |
| For the comparator | | |
| CfO_Counter1event1IDwr | 0x00D0 | Event number of Timer 1 (50 µs) Information: The latch and comparator must not have the same event number! |
| CfO_Counter1event1config | 0x900D or 0xA00D | Configuration of the comparator for the second counter event |
| CfO_Counter1event1mode | 0x03 | Mode of the second counter event function - Continuous |
| CfO_DIREKTIOoutevent0IDwr | 0x0861 | TRUE event output of the second counter to trigger the direct output function (set outputs). |
| CfO_DIREKTIOoutsetmask0 | 0x08, 0x20, 0x80 | Outputs that should be set when comparator condition = TRUE |
| CfO_DIREKTIOoutevent1IDwr | 0x0860 | FALSE event output of the second counter to trigger the direct output function (reset outputs). |
| CfO_DIREKTIOoutclearmask1 | 0x08, 0x20, 0x80 | Outputs that should be reset when comparator condition = FALSE |

I/O configuration - Up/down counter

The following table shows how the module's various event functions can be linked in order to configure an up/down counter.

[x] stands for the respective counter function, either 1 or 2

| Register | Value | Comment |
|----------------------------|----------------------------------|--|
| For the function | | |
| CfO_Counter[x]config | 0x03 | Counter mode = Up/down counter |
| CfO_Counter[x]configReg0 | 0x0D, 0x07 | Configure the calculation of the internal "counter1" and "counter2" registers (see "Counter value calculation" on page 1236 and "Examples of calculation configurations" on page 1240) |
| For the latch | | |
| CfO_Counter[x]event0config | 0x0D, 0x07 | Configuration of the calculation of the first value used for the latch |
| CfO_Counter[x]event0mode | 0x03 | Mode of the first counter function - Continuous |
| CfO_Counter[x]event0IDwr | (any) | Number of the event that should trigger Latch 1 |
| CfO_Counter[x]event1config | 0x0D, 0x07 | Configuration of the calculation of the second value used for the latch |
| CfO_Counter[x]event1mode | 0x03 | Mode of the second counter function - Continuous |
| CfO_Counter[x]event1IDwr | (any) | Number of the event that should trigger Latch 2 |
| For the comparator | | |
| CfO_Counter1event1IDwr | 0x00D0 | Event number of Timer 1 (50 µs) Information: The latch and comparator must not have the same event number! |
| CfO_Counter1event1config | 0x900D, 0xA00D or 0x9007, 0xA007 | Configuration of the comparator for the second counter event |
| CfO_Counter1event1mode | 0x03 | Mode of the second counter event function - Continuous |
| CfO_DIREKTIOoutevent0IDwr | 0x0861 | TRUE event output of the second counter to trigger the direct output function (set outputs). |
| CfO_DIREKTIOoutsetmask0 | 0x08, 0x20, 0x80 | Outputs that should be set when comparator condition = TRUE |
| CfO_DIREKTIOoutevent1IDwr | 0x0860 | FALSE event output of the second counter to trigger the direct output function (reset outputs). |
| CfO_DIREKTIOoutclearmask1 | 0x08, 0x20, 0x80 | Outputs that should be reset when comparator condition = FALSE |

I/O configuration - Event counter

The following table shows how the module's various event functions can be linked in order to configure an event counter.

[x] stands for the respective counter function, either 1 or 2

| Register | Value | Comment |
|---|--------------|--|
| For event counters on channels 1 and 3 | | |
| CfO_Counter[x]configReg0 | 0x01 or 0x03 | Configure the calculation of the internal "counter1" and "counter2" registers (see "Counter value calculation" on page 1236 and "Examples of calculation configurations" on page 1240) |
| CfO_Counter[x]event0mode | 0x43 | Mode of the first counter event function and referencing configuration |
| CfO_Counter[x]event0IDwr | (any) | Number of the event that should trigger referencing |
| For event counters on channels 2 and 4 | | |
| CfO_Counter[x]configReg1 | 0x04 or 0x08 | Configure the calculation of the internal "counter1" and "counter2" registers (see "Counter value calculation" on page 1236 and "Examples of calculation configurations" on page 1240) |
| CfO_Counter[x]event1mode | 0x83 | Mode of the second counter event function and referencing configuration |
| CfO_Counter[x]event1IDwr | (any) | Number of the event that should trigger referencing |

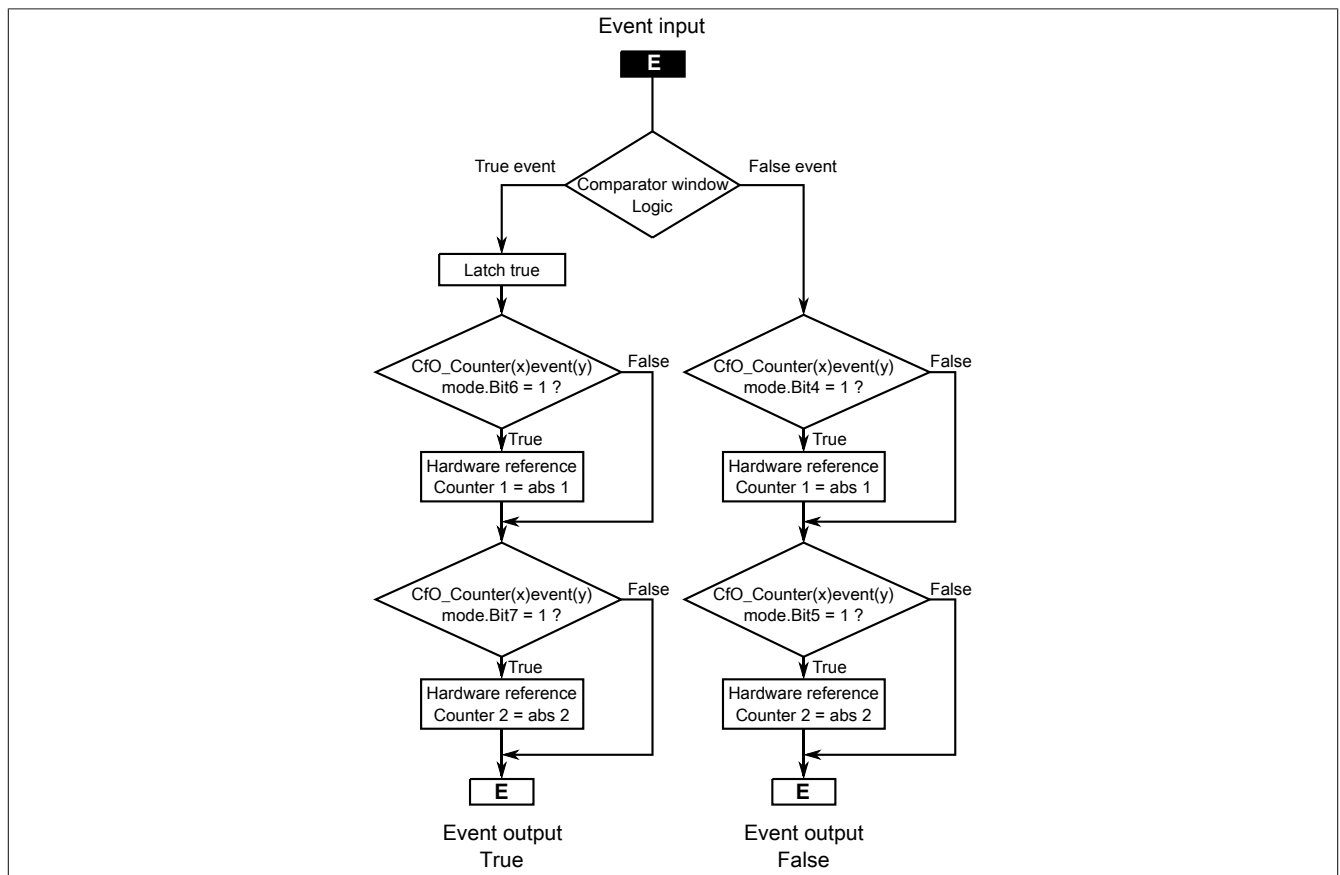
9.11.14.13.7.3 General event functions

Each of the 2 counter functions has 2 counter event functions. These consist of:

- Event ID that triggers the counter event function
- A window comparator
- Latch register for saving the counter value

When the counter event function is complete, a combined event ID in the range 2112 to 2401 (see "List of event IDs" on page 1230) is sent.

Each counter event function also has the option to copy the current counter value to the "HW reference counter" when an event occurs (see "Counter value calculation" on page 1236).



Configure counter mode

Name:

Counter function 1: CfO_Counter1config

Counter function 2: CfO_Counter2config

These registers are used to configure the mode of the counter function. Each counter function can be operated in 3 different modes.

| | Counter function mode | | |
|---------------------------------|---------------------------------|------------|---|
| | Edge counters | AB encoder | Up/down counter |
| Counter channel 1 ¹⁾ | Counting pulses, edge counter 1 | A | Metering pulses |
| Counter channel 2 ¹⁾ | Counting pulses, edge counter 2 | B | Counting direction (0 = positive, 1 = negative) |
| Counter register 1 | Counter value 1 | Position | Counter value |
| Counter register 2 | Counter value 2 | | |

1) Corresponds to the physical channels of the counter functions. See "Description of channel assignments" on page 1220.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------|-------|-----------------|
| 0 - 1 | Counter mode | 00 | Edge counters |
| | | 01 | AB encoder |
| | | 11 | Up/down counter |
| 2 - 7 | Reserved | - | |

Configure calculation of internal counters

Name:

Counter function 1: CfO_Counter1configReg0 to CfO_Counter2configReg0

Counter function 2: CfO_Counter1configReg1 to CfO_Counter2configReg1

The calculation of the internal "counter1" and "counter2" registers can be configured in these registers. For information on using these internal registers, see "Counter value calculation" on page 1236.

| Data type | Values | Bus controller default setting ¹⁾ |
|-----------|------------------------|--|
| USINT | See the bit structure. | 1 |

1) The bus controller default value applies only to the register numbers specified in function model 254.

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------|-------|--|
| 0 | counter 1 - use | 0 | 0 is added instead of "counter 1" |
| | | 1 | "counter 1" is used for addition |
| 1 | counter 1 - sign | 0 | The sign of the "counter 1" register is not changed for addition |
| | | 1 | The sign of the "counter 1" register is reversed for addition |
| 2 | counter 2 - use | 0 | 0 is added instead of "counter 2" |
| | | 1 | "counter 2" is used for addition |
| 3 | counter 2 - sign | 0 | The sign of the "counter 2" register is not changed for addition |
| | | 1 | The sign of the "counter 2" register is reversed for addition |
| 4 - 7 | Reserved | - | |

Examples of calculation configurations

| | | |
|------------|--------|--|
| 0b00000001 | = 0x01 | Only the "counter1 - use" bit is set, entering the contents of the "counter" (edge of counter event channel 1) directly in the counter register. |
| 0b00000011 | = 0x03 | "counter 1 - use" and "counter1 - sign" bits are set. The sign is changed so that the counter register counts in the negative direction. |
| 0b00001101 | = 0x0d | Edges on counter input channel 1 increase the value in the counter register. Edges on counter input channel 2 decrease the value in the counter register. This value is the best setting for modes "AB counter" and "Up/Down counter". |

Offset value for referencing

Name:

Counter function 1: CfO_Counter1PresetValue1 to CfO_Counter2PresetValue1

Counter function 1: CfO_Counter1PresetValue1_32Bit to CfO_Counter2PresetValue1_32Bit

Counter function 2: CfO_Counter1PresetValue2 to CfO_Counter1PresetValue2

Counter function 2: CfO_Counter1PresetValue2_32Bit to CfO_Counter1PresetValue2_32Bit

"Preset value" in the Automation Studio I/O configuration.

These registers can be used to define an offset value for referencing. This value is copied to the internal [SW_reference_counter](#) register of the respective counter register.

| Data type | Value |
|-----------|---------------------------------|
| INT | -32768 to 32767 |
| DINT | -2,147,483,648 to 2,147,483,647 |

Counter register

Name:

Different names are used for these 4 registers depending on their function.

These 4 registers show the results of the [counter value calculation](#) for the respective register. Depending on the function, this corresponds to either the encoder position or the counter value.

For information on the relationship between physical channels and counter registers, see ["Counters and encoders" on page 1236](#) and ["Description of channel assignments" on page 1220](#)

| Counter function 1 | | |
|--------------------|------------------|----------------|
| Counter register | Function | Name |
| 1 | AB encoders | ABEncoder01 |
| | ABR encoders | ABREncoder01 |
| | Up/down counters | Counter01 |
| | Event counters | EventCounter01 |
| 2 | Event counters | EventCounter02 |

| Counter function 2 | | |
|--------------------|------------------|----------------|
| Counter register | Function | Name |
| 1 | AB encoders | ABEncoder02 |
| | Up/down counters | Counter02 |
| | Event counters | EventCounter03 |
| 2 | Event counters | EventCounter04 |

| Data type | Value | Information |
|--------------------|---------------------------------|-----------------------------------|
| INT | -32,768 to 32,767 | Encoder position or counter value |
| DINT ¹⁾ | -2,147,483,648 to 2,147,483,647 | Encoder position or counter value |

1) Only in function model 1

Status of the ABR encoder

Name:

StatusABR01

The referencing status of the ABR encoder is shown in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|--------|---|
| 0 - 1 | Reserved | 0 | |
| 2 | Bit is always 1 after the first reference pulse. | 0 | No reference pulses have occurred since the start of referencing. |
| | | 1 | The first reference pulse has occurred. |
| 3 | State change when referencing is complete | 0 or 1 | |
| 4 | Bit is always 1 after the first reference pulse. | 0 | No reference pulses have occurred since the start of referencing. |
| | | 1 | The first reference pulse has occurred. |
| 5 - 7 | Continuous counter | xxx | Increased with each reference pulse |

Examples of possible values

| | | |
|------------|--------|--|
| 0b00000000 | = 0x00 | Referencing OFF or homing procedure already active |
| 0b00111100 | = 0x3C | First reference complete, reference value applied in the "ABREncoder0" on page 1241 register |
| 0bxxx11100 | = 0xxB | Bits 5 to 7 are changed with each reference pulse |
| 0bxxx1x100 | = 0xxx | Bits changed continuously with the setting continuous referencing. With every reference pulse, the reference value is applied to the "ABREncoder0" on page 1241 register |

Configure ABR referencing mode

Name:

ReferenceModeABR01

The bits in this register are used to configure the reaction to the configured reference pulse.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------------------|-------|-------------------------|
| 0 - 1 | Sets the referencing mode | 00 | Referencing OFF |
| | | 01 | Single shot referencing |
| | | 10 | Reserved |
| | | 11 | Continuous referencing |
| 2 - 5 | Reserved | - | |
| 6 - 7 | Reserved | 11 | Must always be 11! |

This results in the following values:

| | | |
|------------|--------|---|
| 0b00000000 | = 0x00 | Referencing OFF |
| 0b11000001 | = 0xC1 | Single shot referencing → When starting over after the referencing process is complete, the value 0x00 must be written to start again. Wait until the "StatusABR" on page 1242 register also takes on the value 0x00, then the value 0xC1 can be written again. |
| 0b11000011 | = 0xC3 | Continuous referencing → Referencing takes place automatically with every reference pulse |

9.11.14.13.7.4 Comparator functions

The ABR and AB counters and the up/down counter have a comparator function. It always works the same and is described here globally for all three.

The comparators are implemented in software form. They do not work actively but rather passively, i.e. the comparison is only carried out when an event is received. The event received is forwarded along the TRUE or FALSE branch depending on the status of the comparator condition. An event function like this generally also offers a latch for the TRUE and FALSE branch to save the value used for the comparator at the time of the event.

Comparator modes

Comparator functions can be operated in 4 different modes.

- **Off**
Events are ignored.
- **Individual**
The event function is executed once and then disables itself automatically. To re-enable it, the "event function mode" must be changed, preferably to "off" and then to the desired mode. This setting allows a hardware latch to be simulated.
- **State change**
The event function only responds when the comparator status has changed, i.e. from false to true (or vice versa). Only the first event for each status is processed, e.g. the first "true" of a sequence of events with the comparator condition "true". After the event function is enabled, the first incoming event is used to determine the starting status and therefore not forwarded. This setting allows a hardware comparator to be simulated.
- **Continuous**
Each incoming event is forwarded to the true or false branch depending on the comparator condition. This setting allows event filters to be created.

Configure event ID for comparator

Name:

Counter function 1: CfO_Counter1event0IDwr to CfO_Counter1event1IDwr

Counter function 2: CfO_Counter2event0IDwr to CfO_Counter2event1IDwr

This register holds the event ID that should trigger the counter event function. For a list of all possible event IDs, see "[List of event IDs](#)" on page 1230

| Data type | Value | Information |
|-----------|--------------|------------------------------|
| INT | 192 to 7,233 | ID of counter event function |

Configure calculation of comparator

Name:

Counter function 1: CfO_Counter1event0config to CfO_Counter1event1config

Counter function 2: CfO_Counter2event0config to CfO_Counter2event1config

These registers are used to configure the counter event function for the respective counter function.

Bits 0 to 3 configure the calculation of the comparison or to latch the value. This calculation is similar to the calculation of the counter register (see "[Counter value calculation](#)" on page 1236)

Bits 8 to 13 can be used to limit the number of bits used for the comparison. A mask is calculated as $2^n - 1$ and linked with an "AND" operation. This makes it possible to generate a comparator pulse every 2^n increments.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|------------------------------------|-------|--|
| 0 | counter 1 - use | 0 | 0 is added instead of "counter 1" |
| | | 1 | "counter 1" is used for addition |
| 1 | counter 1 - sign | 0 | The sign of the "counter 1" register is not changed for addition |
| | | 1 | The sign of the "counter 1" register is reversed for addition |
| 2 | counter 2 - use | 0 | 0 is added instead of "counter 2" |
| | | 1 | "counter 2" is used for addition |
| 3 | counter 1 - sign | 0 | The sign of the "counter 2" register is not changed for addition |
| | | 1 | The sign of the "counter 2" register is reversed for addition |
| 4 - 7 | Reserved | - | |
| 8 - 13 | Number of bits for comparator mask | x | The mask value is calculated as $2^n - 1$, where n is value set in these bits. Default: 0 |
| 14 | Reserved | - | |
| 15 | Margin comparator mode | 0 | <code>MarginComparator01 >= (Current position - OriginComparator01)</code> |
| | | 1 | <code>MarginComparator01 > (Current position - OriginComparator01)</code> |

Configure mode and latching of comparator function

Name:

Counter function 1: CfO_Counter1event0mode to CfO_Counter1event1mode

Counter function 2: CfO_Counter2event0mode to CfO_Counter2event1mode

In these registers you can set the mode for the comparator function and optional copying of the latched registers.

Comparator functions can be operated in 4 different modes. For a description, see "[Comparator modes](#)" on page 1243.

Bits 4 to 7 can be used to define hardware referencing actions.

Based on these bits, the values of the internal absolute value counters "abs1" and "abs2" can be copied to the respective "HW_reference_counter" register at every counter event (see "[Counter value calculation](#)" on page 1236). This function can be used to reference the counter values directly in the hardware.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------------------|-------|---|
| 0 - 1 | Comparator mode | 0 | Off |
| | | 1 | Individual |
| | | 2 | State change |
| | | 3 | Continuous |
| 2 - 3 | Reserved | - | |
| 4 | Copy abs1 counter value | 0 | No action |
| | | 1 | When event is FALSE → hardware reference counter 1 = abs1 |
| 5 | Copy abs2 counter value | 0 | No action |
| | | 1 | When event is FALSE → hardware reference counter 2 = abs2 |
| 6 | Copy abs1 counter value | 0 | No action |
| | | 1 | When event is TRUE → hardware reference counter 1 = abs1 |
| 7 | Copy abs2 counter value | 0 | No action |
| | | 1 | When event is TRUE → hardware reference counter 2 = abs2 |

Comparator origin

Name:

OriginComparator01

This register is available for the comparator function of the ABR encoder, AB counter and up/down counter.

It defines the position value at which the respective configured comparator output channel is set.

| Data type | Value | Information |
|-----------|------------------------------------|----------------------------------|
| INT | -32,768 to 32,767 | Comparator window origin, 16-bit |
| DINT | -2,147,483,648 to 2,147,483,647 | Comparator window origin, 32-bit |

Width of the comparator

Name:

MarginComparator01

This register is available for the AB and ABR encoders and the up/down counters.

It defines the width of the comparator window in the positive direction.

| Data type | Value | Information |
|-----------|------------------------------------|------------------------------------|
| INT | -32768 to 32767 | Width of comparator window, 16-bit |
| DINT | -2,147,483,648 to 2,147,483,647 | Width of comparator window, 32-bit |

Read latch position or counter value

Name:

Different names are used for these 4 registers depending on their function.

If the comparator returns "TRUE", then the current counter value is latched and copied to these registers. The calculation of the comparator value used for the latch can be configured in the ["Configure calculation of comparator" on page 1244](#) register.

| Counter function 1 | | |
|--------------------|------------------|------------------|
| Event function | Function | Name |
| 1 | AB encoders | Latch01AB01 |
| | Up/down counters | Latch01Counter01 |
| 2 | ABR encoders | Latch01ABR01 |
| | AB encoders | Latch02AB01 |
| | Up/down counters | Latch02Counter01 |

| Counter function 2 | | |
|--------------------|------------------|------------------|
| Event function | Function | Name |
| 1 | AB encoders | Latch01AB02 |
| | Up/down counters | Latch01Counter02 |
| | Event counters | Latch02AB02 |
| 2 | Event counters | Latch02Counter02 |

| Data type | Value | Information |
|--------------------|------------------------------------|---|
| INT | -32,768 to 32,767 | Latched encoder position or counter value |
| DINT ¹⁾ | -2,147,483,648 to 2,147,483,647 | Latched encoder position or counter value |

1) Only in function model 1

9.11.14.13.8 SSI encoder interface

The module has 1 SSI encoders available, supported directly in the hardware. Two 24 V output channels are set for the SSI encoder and cannot be changed. (See also "Description of channel assignments" on page 1220)

When using the SSI encoder, the corresponding clock channel can be configured in the "CfO_CFGchannel" on page 1227 register as "Channel-specific" and "Push/Pull".

| SSI encoders | Channel number |
|---------------|----------------|
| Data channel | 1 |
| Clock channel | 2 |

9.11.14.13.8.1 SSI event functions

The SSI counter consists of an event function and an event input. The SSI cycle is started when an event is received on this input.

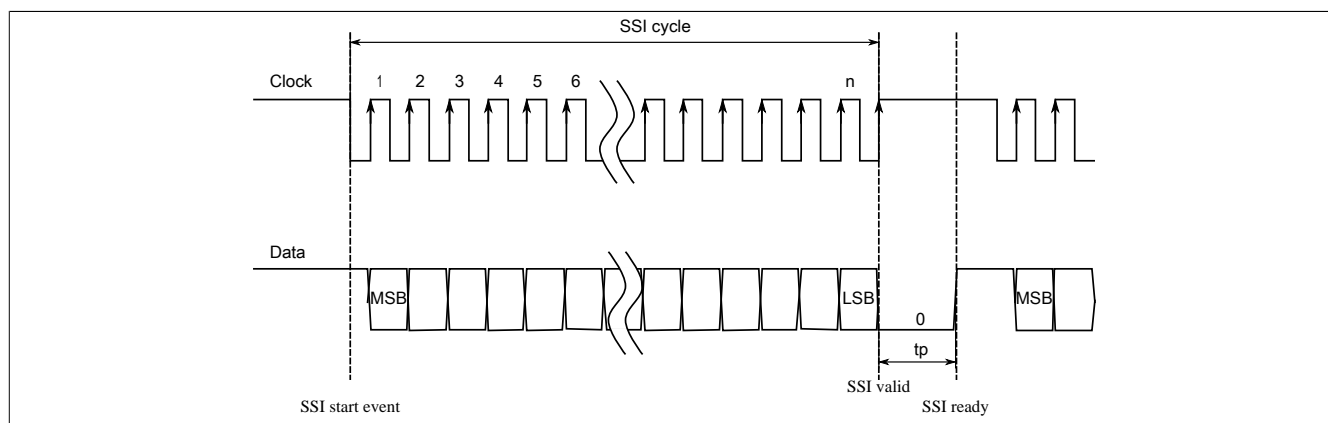
Information:

The SSI event function is not linked to an event by default, i.e. SSI functions are disabled.

2 events are transmitted from the SSI encoder interface.

- An "SSI valid" event is triggered immediately after the end of the SSI cycle if a new counter value is available.
- The "SSI ready" event then shows when the monoflop time has expired (t_p in SSI encoder timing diagram). This is the earliest that the next SSI cycle can be started.

SSI encoder - Timing diagram



Configure event ID for SSI

Name:

CfO_SSI1eventIDwr

This register holds the event ID that should start the SSI cycle. For a list of all possible event IDs, see "List of event IDs" on page 1230

Normally this register is set to network event 225 "AOSISOP"- This ensures that the new encoder position is available at the next "I/O → Synchronous Frame" transfer. Check the SSI transfer time and the X2X cycle time, because the SSI cycle must be completed within this time.

| Data type | Value | Information |
|-----------|--------------|----------------------|
| INT | 192 to 7,233 | ID of event function |

Configure SSI

Name:
CfO_SSI1cfg

This configuration register sets the encoding, clock rate and number of bits. Default = 0. This must be set once using an acyclic write command.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|--------|----------------------|-------|--|
| 0 - 5 | SSI value valid bits | x | |
| 6 - 7 | Clock rate | 00 | 1 MHz |
| | | 01 | 500 kHz |
| | | 10 | 250 kHz |
| | | 11 | 125 kHz |
| 8 - 13 | SSI number of bits | x | Number of bits including leading zeros |
| 14 | Reserved | 0 | |
| 15 | Keying | 0 | Binary coding |
| | | 1 | Gray coding |

SSI advanced configuration

Name:
ConfigAdvanced

This configuration register is used to set the encoding, clock rate, number of bits and monostable multivibrator settings. This must be set once using an acyclic write command.

It only differs from "CfO_SSI1cfg" on page 1247 by data length and additional monostable multivibrator testing.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|---------|--------------------------------|-------|--|
| 0 - 5 | SSI value valid bits | x | |
| 6 - 7 | Clock rate | 00 | 1 MHz |
| | | 01 | 500 kHz |
| | | 10 | 250 kHz |
| | | 11 | 125 kHz |
| 8 - 13 | SSI number of bits | x | Number of bits including leading zeros |
| 14 | Reserved | 0 | |
| 15 | Keying | 0 | Binary coding |
| | | 1 | Gray coding |
| 16 - 17 | Monostable multivibrator check | 00 | Check OFF, no additional clock bit |
| | | 01 | Check set to High level |
| | | 10 | Check set to Low level |
| | | 11 | Level is clocked but ignored |
| 18 - 31 | Reserved | 0 | |

Enable SSI event function

Name:
CfO_SSI1control

The two [SSI encoder events](#) can be enabled/disabled using this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------|-------|-------------|
| 0 | Event: "SSI valid" | 0 | Not sent |
| | | 1 | Sent |
| 1 | Event: "SSI ready" | 0 | Not sent |
| | | 1 | Sent |
| 2 - 7 | Reserved | - | |

Read SSI position

Name:

SSIEncoder01

The last transferred SSI position can be read out from this register. The SSI encoder value is displayed as a 32-bit position value. This position value is generated synchronously with the X2X cycle.

| Data type | Value | Information |
|-----------|--------------------|-------------------------------|
| UDINT | 0 to 4,294,967,295 | Last SSI position transferred |

9.11.14.13.8.2 SSI comparator condition

The module has an assigned comparator function for the SSI function. These consist of:

- Event ID that triggers the comparator function
- The window comparator
- Latch register for saving the counter value

When the comparator function is complete, event ID 7232 or 7233 (see ["List of event IDs" on page 1230](#)) is sent.

Configure event ID for SSI comparator

Name:

CfO_SSI1event0IDwr

This register holds the event ID that should start the SSI comparator function. For a list of all possible event IDs, see ["List of event IDs" on page 1230](#)

| Data type | Value | Information |
|-----------|--------------|---------------------------|
| INT | 192 to 7,233 | ID of comparator function |

Configure the mode of the SSI comparator function

Name:

CfO_SSI1event0mode

This register can be used to configure the mode of the comparator function.

Comparator functions can be operated in 4 different modes. For a description, see ["Comparator modes" on page 1243](#).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------|-------|--------------|
| 0 - 1 | Comparator mode | 0 | Off |
| | | 1 | Individual |
| | | 2 | State change |
| | | 3 | Continuous |
| 2 - 7 | Reserved | - | |

Configure calculation of SSI comparator

Name:

CfO_SSI1event0config

The calculation of the position value used for the comparator can be configured in this register.

The window comparator condition is calculated as follows:

```

counter_window_value = ssi_counter & (2^ssi_data_bits - 1)
diff = counter_window_value - origin_comparator
if ((diff & (2^(comparator_mask-1))) <= margin_comparator)
condition = True;
else
condition = False;

```

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|-----------------|-------|--|
| 0 - 5 | SSI data bits | x | Number of data bits used for masking |
| 6 - 7 | Reserved | - | |
| 8 - 13 | Comparator mask | x | The mask value is calculated from $2^n - 1$, where n is the value configured in SSI data bits. Default: 0 |
| 14 | Comparator mode | 0 | MarginComparator >= SSI position - OriginComparator |
| | | 1 | MarginComparator > SSI position - OriginComparator |

Origin of the SSI comparator

Name:

OriginComparator01_SSI

This register contains the origin of the window comparator.

| Data type | Value | Information |
|-----------|--------------------|----------------------------------|
| UDINT | 0 to 4,294,967,295 | Origin of the window comparator. |

Width of the SSI comparator

Name:

MarginComparator01_SSI

This register provides the width of the window comparator.

| Data type | Value | Information |
|-----------|--------------------|------------------------------------|
| UDINT | 0 to 4,294,967,295 | Width of the SSI window comparator |

Read SSI latch position

Name:

Latch01SSI01

If the SSI window comparator returns "True", then the current SSI position is latched and saved in this register.

| Data type | Value | Information |
|-----------|--------------------|----------------------|
| UDINT | 0 to 4,294,967,295 | Latched SSI position |

9.11.14.13.9 PWM - Pulse width modulation

The module has 2 PWM functions available, supported directly by the hardware. A 24 V output channel is set for each PWM encoder and cannot be changed. (See also "[Description of channel assignments](#)" on page 1220)

When using the PWM function, the corresponding channel can be configured in the "[CfO_CFGchannel](#)" on page 1227 register as "Channel-specific".

| PWM function | Channel |
|--------------|---------|
| PWM1 | 2 |
| PWM2 | 4 |

9.11.14.13.9.1 Configure PWM prescaler

Name:

CfO_PWM0prescaler to CfO_PWM1prescaler

The length of the PWM cycle is configured using this register. The base is a 48 MHz clock, which can be changed (divided) using the setting in this register. One PWM cycle consists of 1000 of the resulting clocks after they have been divided. The period duration of the PWM cycle is calculated as follows:

$$\text{PWM_cycle} = 1000 \frac{\text{prescale}}{48000000} \text{ [s]}$$

| Data type | Value | Information |
|-----------|------------|-------------------------|
| UINT | 2 to 65535 | Prescaler for PWM cycle |

9.11.14.13.9.2 Output PWM values

Name:

PWMOutput02 and PWMOutput04

In this register, a configuration is made for the percentage of the PWM cycle (in 1/10% steps) that the PWM output is logical 1, i.e. ON.

| Data type | Value | Information |
|-----------|----------|-----------------------------|
| UINT | 0 | PWM output always off |
| | 1 to 999 | Turn on time in 1/10% steps |
| | 1000 | PWM output always on |

9.11.14.13.10 Time measurement function

The module has a time measurement function for each I/O channel. It can be configured separately for rising and falling edges on each channel.

A starting edge can be configured for each time measurement function. When a configured starting edge occurs, the value of the internal timer is saved in a FIFO buffer. This FIFO buffer holds up to 16 elements. When the actual trigger edge occurs, the difference in time between the starting edge and the triggered edge is copied to the respective register.

Bits 8 to 11 "Previous start edge" of registers "[CfO_EdgeTimeFallingMode](#)" on page 1251 and "[CfO_EdgeTimeRisingMode](#)" on page 1252 can be used to define which detected starting edge from the FIFO buffer should be used to calculate the difference. In addition, when the trigger edge occurs, the current counter value of the counter internally clocked by bits 12 to 15 "Resolution of time measurement" is copied to registers "[TimeStampFallingCH](#)" on page 1254 and "[TimeStampRisingCH](#)" on page 1254.

Information:

The time measurement function is an extension of edge detection, so all of the channels used must be configured there.

9.11.14.13.10.1 Enable time measurement function

Name:

CfO_EdgeTimeglobalenable

This register enables/disables the time measurement function for the entire module.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------------------|-------|----------------------------|
| 0 | Time measurement function | 0 | Disabled for entire module |
| | | 1 | Enabled for entire module |
| 1 - 7 | Reserved | - | |

9.11.14.13.10.2 Configure time measurement function for the falling edge

Name:

CfO_EdgeTimeFallingMode01 to CfO_EdgeTimeFallingMode04

These registers can be used to configure the time measurement function for the falling edge of the respective channel.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|---|---------|---|
| 0 - 3 | Selects the channel for the starting edge | 0 | Channel 1 |
| | | ... | |
| | | 3 | Channel 4 |
| 4 | Selects the edge for the starting edge | 0 | The falling edge of the channel configured in bits 0 to 3 serves as the starting edge. |
| | | 1 | The rising edge of the channel configured in bits 0 to 3 serves as the starting edge. |
| 5 - 6 | Reserved | - | |
| 7 | Trigger | 0 | Triggered ¹⁾ |
| | | 1 | Continuous ²⁾ |
| 8 - 11 | Previous start edge | 0 to 15 | The value determines which entry in the starting edge FIFO should be used to calculate the time difference. |
| 12 - 15 | Time measurement resolution | 0 | 8 Mhz |
| | | 1 | 4 Mhz |
| | | 2 | 2 Mhz |
| | | 3 | 1 Mhz |
| | | 4 | 500 kHz |
| | | 5 | 250 kHz |
| | | 6 | 125 kHz |
| | | 7 | 625 kHz |

1) The time measurement is triggered by the corresponding bit in the "[TriggerRisingCH](#)" on page 1253 register.

2) Time measurement runs continuously and is triggered at every edge.

9.11.14.13.10.3 Configure time measurement function for the rising edge

Name:

CfO_EdgeTimeRisingMode01 to CfO_EdgeTimeRisingMode04

These registers can be used to configure the time measurement function for the rising edge of the respective channel.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|---|---------|---|
| 0 - 3 | Selects the channel for the starting edge | 0 | Channel 1 |
| | | ... | |
| | | 3 | Channel 4 |
| 4 | Selects the edge for the starting edge | 0 | The falling edge of the channel configured in bits 0 to 3 serves as the starting edge. |
| | | 1 | The rising edge of the channel configured in bits 0 to 3 serves as the starting edge. |
| 5 - 6 | Reserved | - | |
| 7 | Trigger | 0 | Triggered ¹⁾ |
| | | 1 | Continuous ²⁾ |
| 8 - 11 | Previous start edge | 0 to 15 | The value determines which entry in the starting edge FIFO should be used to calculate the time difference. |
| 12 - 15 | Time measurement resolution | 0 | 8 Mhz |
| | | 1 | 4 Mhz |
| | | 2 | 2 Mhz |
| | | 3 | 1 Mhz |
| | | 4 | 500 kHz |
| | | 5 | 250 kHz |
| | | 6 | 125 kHz |
| | | 7 | 625 kHz |

1) The time measurement is triggered by the corresponding bit in the "TriggerRisingCH" on page 1252 register.

2) Time measurement runs continuously and is triggered at every edge.

9.11.14.13.10.4 Trigger falling edge detection

Name:

TriggerFallingCH01 to TriggerFallingCH04

If bit 7 "Trigger" is cleared in the "CfO_EdgeTimeFallingMode" on page 1251 register, then detection of a falling edge on the respective input can be triggered using the respective bit in this register. After a bit has been set, the next falling edge on the corresponding channel is detected.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------|-------|---|
| 0 | TriggerFallingCH01 | 0 | Falling edges on channel 1 are not detected |
| | | 1 | The next falling edge on channel 1 will be detected |
| ... | | ... | |
| 3 | TriggerFallingCH04 | 0 | Falling edges on channel 4 are not detected |
| | | 1 | The next falling edge on channel 4 will be detected |
| 4 - 7 | Reserved | - | |

9.11.14.13.10.5 Trigger rising edge detection

Name:

TriggerRisingCH01 to TriggerRisingCH04

If bit 7 "Trigger" is cleared in the "[CfO_EdgeTimeRisingMode](#)" on page 1252 register, then detection of a rising edge on the respective input can be triggered using the respective bit in this register. After a bit has been set, the next rising edge on the corresponding channel is detected.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------------|-------|--|
| 0 | TriggerRisingCH01 | 0 | Rising edges on channel 1 are not detected |
| | | 1 | The next rising edge on channel 1 will be detected |
| ... | | ... | |
| 3 | TriggerRisingCH04 | 0 | Rising edges on channel 4 are not detected |
| | | 1 | The next rising edge on channel 4 will be detected |
| 4 - 7 | Reserved | - | |

9.11.14.13.10.6 Show first falling trigger edge

Name:

BusyTriggerFallingCH01 to BusyTriggerFallingCH04

If edges are triggered via the bits in the "[TriggerFallingCH](#)" on page 1252 register, then a set bit in this register indicates that no falling edges have been detected on the respective channel since the corresponding bit was set in the "TriggerFallingCH" register. If a falling edge occurs on the respective channel, then the corresponding BusyTriggerFalling bit is cleared.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------|-------|--|
| 0 | BusyTriggerFallingCH01 | 0 | Falling edge detected on channel 1 |
| | | 1 | Module waiting for a falling edge on channel 1 |
| ... | | ... | |
| 3 | BusyTriggerFallingCH04 | 0 | Falling edge detected on channel 4 |
| | | 1 | Module waiting for a falling edge on channel 4 |
| 4 - 7 | Reserved | - | |

9.11.14.13.10.7 Show first rising trigger edge

Name:

BusyTriggerRisingCH01 to BusyTriggerRisingCH04

If edges are triggered via the bits in the "[TriggerRisingCH](#)" on page 1253 register, then a set bit in this register indicates that no rising edges have been detected on the respective channel since the corresponding bit was set in the "TriggerRisingCH" register. If a rising edge occurs on the respective channel, then the corresponding BusyTriggerRising bit is cleared.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------|-------|---|
| 0 | BusyTriggerRisingCH01 | 0 | Rising edge detected on channel 1 |
| | | 1 | Module waiting for a rising edge on channel 1 |
| ... | | ... | |
| 3 | BusyTriggerRisingCH04 | 0 | Rising edge detected on channel 4 |
| | | 1 | Module waiting for a rising edge on channel 4 |
| 4 - 7 | Reserved | - | |

9.11.14.13.10.8 Count falling trigger edges

Name:

CountFallingCH01 to CountFallingCH04

These registers contain cyclic counters that are incremented with every detected falling edge on the respective channel.

| Data type | Value | Information |
|-----------|----------|---------------------------|
| USINT | 0 to 255 | Counter for falling edges |

9.11.14.13.10.9 Count rising trigger edges

Name:

CountRisingCH01 to CountRisingCH04

These registers contain cyclic counters that are incremented with every detected rising edge on the respective channel.

| Data type | Value | Information |
|-----------|----------|--------------------------|
| USINT | 0 to 255 | Counter for rising edges |

9.11.14.13.10.10 Timestamp of falling edge

Name:

TimeStampFallingCH01 to TimeStampFallingCH04

When a falling edge occurs on the respective channel, the current counter value of the module timer is copied to these registers.

| Data type | Value | Information |
|-----------|------------|----------------------------|
| UINT | 0 to 65535 | Timestamp for rising edges |

9.11.14.13.10.11 Timestamp of the rising edge

Name:

TimeStampRisingCH01 to TimeStampRisingCH04

When a rising edge occurs on the respective channel, the current counter value of the module timer is copied to these registers.

| Data type | Value | Information |
|-----------|-------------|----------------------------|
| UINT | 0 to 65,535 | Timestamp for rising edges |

9.11.14.13.10.12 Time difference of falling edge

Name:

TimeDiffFallingCH01 to TimeDiffFallingCH04

When a falling edge occurs on the respective channel, the time difference compared to the starting edge configured in bit 4 of the "[CfO_EdgeTimeFallingMode](#)" on page 1251 register is copied to this register.

| Data type | Value | Information |
|-----------|-------------|------------------------------------|
| UINT | 0 to 65,535 | Time difference from starting edge |

9.11.14.13.10.13 Time difference of rising edge

Name:

TimeDiffRisingCH01 to TimeDiffRisingCH04

When a rising edge occurs on the respective channel, the time difference compared to the starting edge configured in bit 4 of the "[CfO_EdgeTimeRisingMode](#)" on page 1252 register is copied to this register.

| Data type | Value | Information |
|-----------|-------------|------------------------------------|
| UINT | 0 to 65,535 | Time difference from starting edge |

9.11.14.13.11 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 128 μ s |

9.11.14.13.12 Maximum cycle time

The maximum cycle time specifies the time up to which the bus cycle can be increased without internal counter overflows causing module malfunctions.

| Minimum cycle time |
|--------------------|
| 16 ms |

9.11.14.13.13 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 128 μ s |

9.11.15 X20DC2396

Data sheet version: 3.11

9.11.15.1 General information

The module is equipped with two inputs for an ABR incremental encoder with 24 V encoder signal.

- 2 ABR incremental encoder 24 V
- 2 additional inputs e.g. for home enable switch
- 24 VDC and GND for encoder supply

9.11.15.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Counter functions |  |
| X20DC2396 | X20 digital counter module, 2 ABR incremental encoders, 24 V, 100 kHz input frequency, 4x evaluation | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 217: X20DC2396 - Order data

9.11.15.3 Technical data

| | |
|--|--|
| Model number | X20DC2396 |
| Short description | |
| I/O module | 2 ABR incremental encoder 24 V |
| General information | |
| Input voltage | 24 VDC -15 % / +20 % |
| B&R ID code | 0x1BAB |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.5 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Type of signal lines | Shielded cables must be used for all signal lines |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| Digital inputs | |
| Quantity | 2 |
| Nominal voltage | 24 VDC |
| Input current at 24 VDC | Approx. 3.3 mA |
| Input filter | |
| Hardware | ≤2 μs |
| Software | - |
| Connection type | 3-wire connections |
| Input circuit | Sink |
| Additional functions | Home enable switch |
| Input resistance | 7.19 kΩ |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| ABR incremental encoder | |
| Encoder inputs | 24 V, asymmetrical |
| Counter size | 16/32-bit |
| Input frequency | Max. 100 kHz |
| Evaluation | 4x |
| Encoder power supply | Module-internal, max. 600 mA |
| Input filter | |
| Hardware | ≤2 μs |
| Software | - |
| Input current at 24 VDC | Approx. 1.3 mA |
| Input resistance | 18.4 kΩ |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Overload characteristics of encoder power supply | Short circuit protection, overload protection |
| Isolation voltage between encoder and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Bus isolated from encoder and reference enable switch Encoder not isolated from reference enable switch and each other |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |


Table 218: X20DC2396 - Technical data

| Model number | X20DC2396 |
|--|--|
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm |

Table 218: X20DC2396 - Technical data

9.11.15.4 LED status indicators

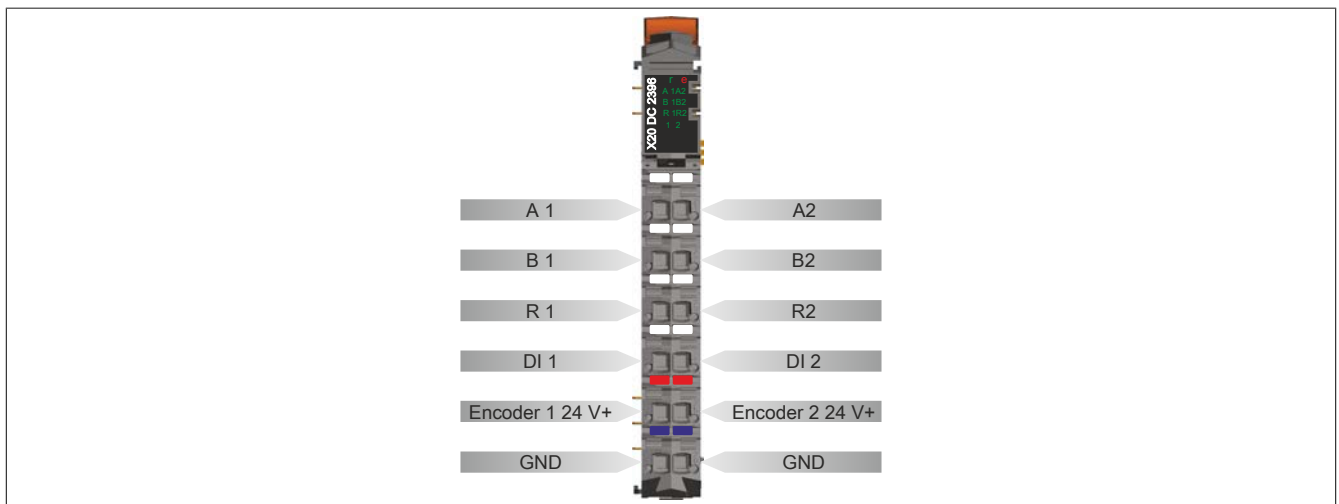
For a description of the various operating modes, see ["Diagnostic LEDs" on page 3787](#).

| Figure | LED | Color | Status | Description |
|--|--------|-------|--|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | e | Red | On | RUN mode |
| | | | Off | No power to module or everything OK |
| | A1, A2 | Green | On | Error or reset status |
| | | | Off | No power to module or everything OK |
| | | | On | Input state of counter input A1 or A2 |
| | | | Off | Input state of counter input A1 or A2 |
| B1, B2 | Green | On | Input state of counter input B1 or B2 | |
| | | Off | Input state of counter input B1 or B2 | |
| R1, R2 | Green | On | Input state of reference pulse R1 or R2 | |
| | | Off | Input state of reference pulse R1 or R2 | |
| 1 - 2 | Green | On | Input state of the corresponding digital input | |

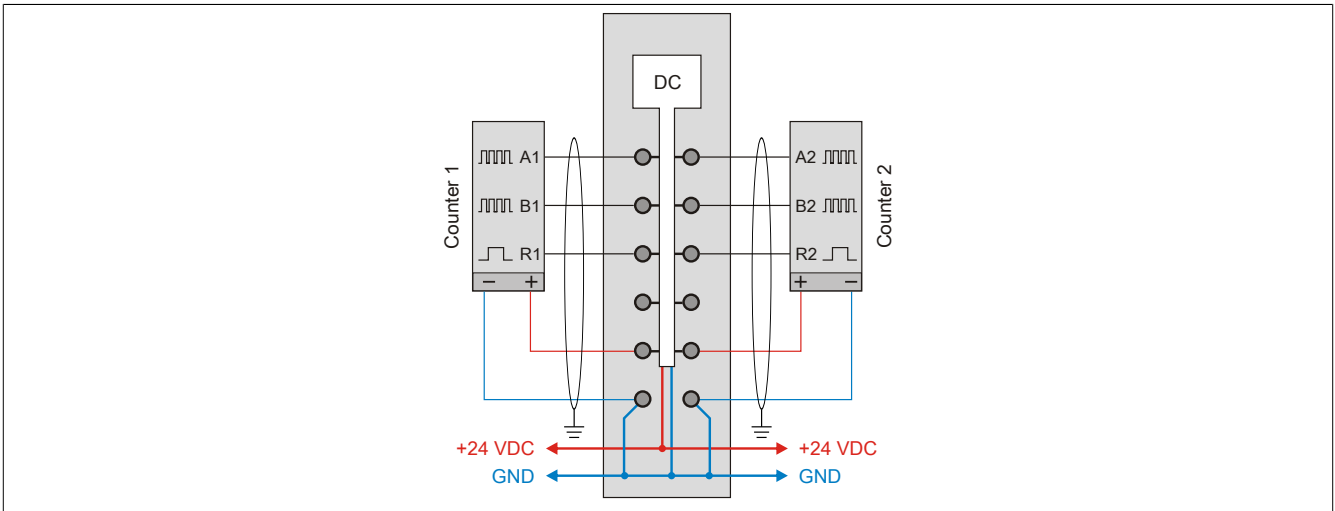
1) Depending on the configuration, a firmware update can take up to several minutes.

9.11.15.5 Pinout

Shielded cables must be used for all signal lines.

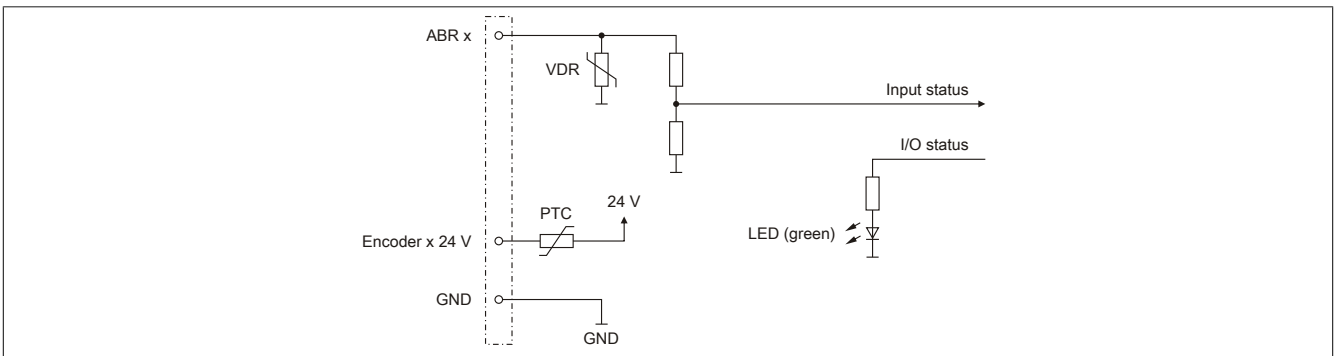


9.11.15.6 Connection example

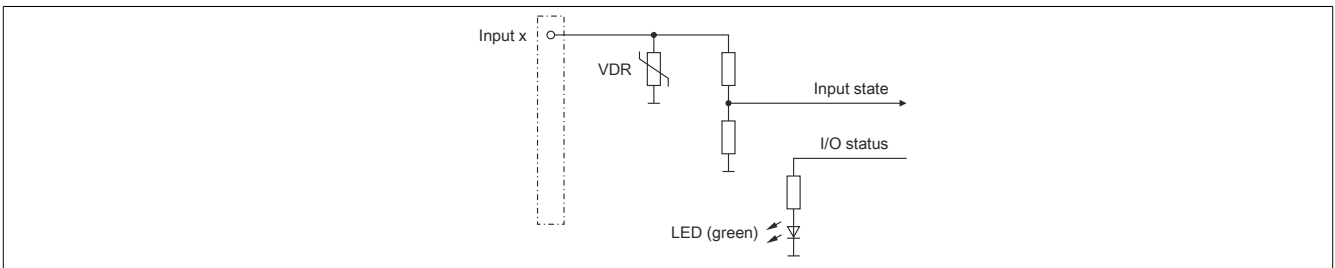


9.11.15.7 Input circuit diagram

Counter inputs



Standard inputs



9.11.15.8 Register description

9.11.15.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.11.15.8.2 Function model 0 - Standard and Function model 1 - Standard with 32-bit encoder counter value

The difference between function model 0 and function model 1 is the size of the data type for some registers.

- Function model 0 uses data type INT
- Function model 1 uses data type DINT (specified in parentheses)

| Register | Name | Data type | Read | | Write | |
|----------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 4104 | CfO_EdgeDetectFalling | USINT | | | | • |
| 4106 | CfO_EdgeDetectRising | USINT | | | | • |
| 2064 | CfO_PresetABR01_1(_32Bit) | (D)INT | | | | • |
| 2068 | CfO_PresetABR01_2(_32Bit) | (D)INT | | | | • |
| 2576 | CfO_PresetABR02_1(_32Bit) | (D)INT | | | | • |
| 2580 | CfO_PresetABR02_2(_32Bit) | (D)INT | | | | • |
| 512 | ConfigOutput24 | UINT | | | | • |
| 522 | ConfigOutput26 | USINT | | | | • |
| 520 | ConfigOutput27 | USINT | | | | • |
| 544 | ConfigOutput32 | UINT | | | | • |
| 554 | ConfigOutput34 | USINT | | | | • |
| 552 | ConfigOutput35 | USINT | | | | • |
| Communication | | | | | | |
| 2116 | ReferenceModeEncoder01 | USINT | | | • | |
| 2628 | ReferenceModeEncoder02 | USINT | | | • | |
| 2080 | Encoder01 | (D)INT | • | | | |
| 2592 | Encoder02 | (D)INT | • | | | |
| 264 | Input state of digital inputs 1 to 2 | USINT | • | | | |
| | DigitalInput01 | Bit 3 | | | | |
| | DigitalInput02 | Bit 7 | | | | |
| 2118 | StatusInput01 | USINT | • | | | |
| 2630 | StatusInput02 | USINT | • | | | |
| 40 | Status of encoder power supply | USINT | • | | | |
| | PowerSupply01 | Bit 0 | | | | |

9.11.15.8.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 4104 | - | CfO_EdgeDetectFalling | USINT | | | | • |
| 4106 | - | CfO_EdgeDetectRising | USINT | | | | • |
| 2064 | - | CfO_PresetABR01_1 | INT | | | | • |
| 2068 | - | CfO_PresetABR01_2 | INT | | | | • |
| 2576 | - | CfO_PresetABR02_1 | INT | | | | • |
| 2580 | - | CfO_PresetABR02_2 | INT | | | | • |
| 512 | - | ConfigOutput24 | UINT | | | | • |
| 522 | - | ConfigOutput26 | USINT | | | | • |
| 520 | - | ConfigOutput27 | USINT | | | | • |
| 544 | - | ConfigOutput32 | UINT | | | | • |
| 554 | - | ConfigOutput34 | USINT | | | | • |
| 552 | - | ConfigOutput35 | USINT | | | | • |
| Communication | | | | | | | |
| 2116 | 0 | ReferenceModeEncoder01 | USINT | | | • | |
| 2628 | 1 | ReferenceModeEncoder02 | USINT | | | • | |
| 2080 | 0 | Encoder01 | INT | • | | | |
| 2592 | 4 | Encoder02 | INT | • | | | |
| 264 | 2 | Input state of digital inputs 1 to 2 | USINT | • | | | |
| | | DigitalInput01 | Bit 3 | | | | |
| | | DigitalInput02 | Bit 7 | | | | |
| 2118 | 6 | StatusInput01 | USINT | • | | | |
| 2630 | 7 | StatusInput02 | USINT | • | | | |
| 40 | 3 | Status of encoder power supply | USINT | • | | | |
| | | PowerSupply01 | Bit 0 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.11.15.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.11.15.8.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.11.15.8.4 ABR encoder - Configuration registers**9.11.15.8.4.1 Reference pulse**

The following registers must be configured by a single acyclic write with the listed values so that the homing procedure is completed on the edge of the reference pulse.

The homing procedure can take place on:

- Rising edge
- Falling edge (default configuration)

Constant register "CfO_EdgeDetectFalling"

Name:

CfO_EdgeDetectFalling

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0x00 | Configuration value for rising edge |
| | 0x04 | Encoder 1 - Configuration value for falling edge |
| | 0x40 | Encoder 2 - Configuration value for falling edge |
| | 0x44 | Configuration value for falling edge on encoders 1 and 2 (bus controller default setting) |

Constant register "CfO_EdgeDetectRising"

Name:

CfO_EdgeDetectRising

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0x00 | Configuration value for falling edge (bus controller default setting) |
| | 0x04 | Encoder 1 - Configuration value for rising edge |
| | 0x40 | Encoder 2 - Configuration value for rising edge |
| | 0x44 | Encoders 1 and 2 - Configuration value for rising edge |

Constant register "ConfigOutput24"

Name:

ConfigOutput24

This register contains the value for ABR encoder 1.

| Data type | Value | Filter |
|-----------|--------|---|
| UINT | 0x1012 | Configuration value for rising edge |
| | 0x1002 | Configuration value for falling edge (bus controller default setting) |

Constant register "ConfigOutput32"

Name:

ConfigOutput32

This register contains the value for ABR encoder 2.

| Data type | Value | Filter |
|-----------|--------|---|
| UINT | 0x1016 | Configuration value for rising edge |
| | 0x1006 | Configuration value for falling edge (bus controller default setting) |

9.11.15.8.4.2 Setting the home position

Name:

CfO_PresetABR01_1 to CfO_PresetABR01_2

CfO_PresetABR02_1 to CfO_PresetABR02_2

CfO_PresetABR01_1_32Bit to CfO_PresetABR01_2_32Bit

CfO_PresetABR02_1_32Bit to CfO_PresetABR02_2_32Bit (only in function model 1)

It is possible to specify two home positions for each encoder with these registers through a one-off acyclic write, for example (default = 0). The configured values are applied to the counter values after a completed homing procedure.

| Data type | Value | Information |
|--------------------|---------------------------------|-----------------------------------|
| INT | -32,768 to 32,767 | Bus controller default setting: 0 |
| DINT ¹⁾ | -2,147,483,648 to 2,147,483,647 | |

1) Only in function model 1

9.11.15.8.4.3 Homing with reference enable input

Regardless of the referencing mode, it is possible using this register to prevent the home position from being applied when the corresponding reference input voltage level occurs (see "Input state of digital inputs 1 to 2" on page 1264: bit 7). The desired setting can be configured by a one-off acyclic write.

Voltage level for reference enable activation - ABR encoder 1

Name:

ConfigOutput26

The voltage level of the digital input 1 to activate reference enable is configured with this register.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0x00 | Reference enable is active at 0 VDC (bus controller default setting). |
| | 0x08 | Reference enable is active at 24 VDC |

Reference enable of the input - ABR encoder 1

Name:

ConfigOutput27

This register can be used to define whether the reference enable is activated.

| Data type | Value | Filter |
|-----------|-------|--|
| USINT | 0x00 | Reference enable input disabled (bus controller default setting) |
| | 0x08 | Reference enable input activated |

Voltage level for reference enable activation - ABR encoder 2

Name:

ConfigOutput34

The voltage level of the digital input 2 to activate reference enable is configured with this register.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0x00 | Reference enable is active at 0 VDC (bus controller default setting). |
| | 0x80 | Reference enable is active at 24 VDC |

Reference enable of the input - ABR encoder 2

Name:

ConfigOutput35

This register can be used to define whether the reference enable is activated.

| Data type | Value | Filter |
|-----------|-------|--|
| USINT | 0x00 | Reference enable input disabled (bus controller default setting) |
| | 0x80 | Reference enable input activated |

9.11.15.8.5 ABR encoder - Configuration registers**9.11.15.8.5.1 Counter state of the encoders**

Name:

Encoder01 to Encoder02

The encoder values are displayed in this register.

| Data type | Value |
|--------------------|---------------------------------|
| INT | -32,768 to 32,767 |
| DINT ¹⁾ | -2,147,483,648 to 2,147,483,647 |

1) Only in function model 1

9.11.15.8.5.2 Input state of digital inputs 1 to 2

Name:

DigitalInput01 to DigitalInput02.

This register displays the input status of the encoders and the digital inputs.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|--------|--------------------------------|
| 0 | Encoder 1 | 0 or 1 | Input state - Signal A |
| 1 | | 0 or 1 | Input state - Signal B |
| 2 | | 0 or 1 | Input state of reference pulse |
| 3 | DigitalInput01 | 0 or 1 | Input state - Digital input 1 |
| 4 | Encoder 2 | 0 or 1 | Input state - Signal A |
| 5 | | 0 or 1 | Input state - Signal B |
| 6 | | 0 or 1 | Input state of reference pulse |
| 7 | DigitalInput02 | 0 or 1 | Input state - Digital input 2 |

9.11.15.8.5.3 Reading the referencing mode

Name:

ReferenceModeEncoder01 to ReferenceModeEncoder02

This register determines the referencing mode.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|------|-------|--------------------------|
| 0 - 1 | | 00 | Referencing OFF |
| | | 01 | Single shot referencing |
| | | 11 | Continuous referencing |
| 2 - 5 | | 0 | Bits permanently set = 0 |
| 6 - 7 | | 00 | Referencing OFF |
| | | 11 | Bits permanently set = 1 |

This results in the following values:

| Binary | Hex | Function |
|----------|------|---|
| 00000000 | 0x00 | Referencing OFF |
| 11000001 | 0xC1 | Single shot referencing For a new start after the completed homing procedure: <ul style="list-style-type: none"> • Write value 0x00 • Wait until bit 0 to bit 3 of the StatusInput01 register takes on the value 0. Counter bits 4 to 7 are not erased • Switch homing procedure on again |
| 11000011 | 0xC3 | Continuous referencing Referencing occurs at every reference pulse. |

9.11.15.8.5.4 Status of the homing procedure

Name:

StatusInput01 (for encoder 1) to StatusInput02 (for encoder 2)

This register contains information regarding whether the referencing process is off, active or complete.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|--|--------|--|
| 0 | Reference pulse without homing ¹⁾ | 0 | No reference impulse without homing has occurred yet |
| | | 1 | At least a reference impulse without homing has occurred |
| 1 | State change | 0 or 1 | Changes with each reference pulse without homing |
| 2 | Reference pulse with homing ¹⁾ | 0 | No homing has occurred yet |
| | | 1 | At least one homing procedure has occurred |
| 3 | State change | 0 or 1 | Changes with each homing procedure that has taken place |
| 4 | Reference pulse | 0 | The last reference pulse didn't bring about a homing procedure |
| | | 1 | The last reference pulse brought about a homing procedure |
| 5 - 7 | Counter | x | Free-running counter, increased with each reference pulse |

1) Always 1 after the first reference pulse that has occurred

Examples of possible values:

| Binary | Hex | Function |
|------------|-------|---|
| 0x00000000 | 0x00 | Referencing OFF or homing procedure already active |
| 0x00111100 | 0x3CE | First homing procedure complete Reference value applied in the Encoder01 register |
| 0xxxx11100 | 0xxB | Bits 5 to 7 are changed with each reference pulse |
| 0xxxx1x100 | 0xxx | Continuously changing the bits with the "Continuous referencing" setting. The reference value is applied to the Encoder01 register on each reference pulse. |

9.11.15.8.5.5 Status of encoder power supply

Name:

PowerSupply01

This register indicates the state of the integrated encoder power supply. A faulty encoder power supply is output as a warning.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|------------------------------------|
| 0 | PowerSupply01 | 0 | 24 VDC encoder power supply OK |
| | | 1 | 24 VDC encoder power supply faulty |
| 1 - 7 | Reserved | - | |

9.11.15.8.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 128 μ s |

9.11.15.8.7 Maximum cycle time

The maximum cycle time specifies the time up to which the bus cycle can be increased without internal counter overflows causing module malfunctions.

| Minimum cycle time |
|--------------------|
| 16 ms |

9.11.15.8.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 128 μ s |

9.11.16 X20DC2398

Data sheet version: 3.11

9.11.16.1 General information

This module is equipped with two inputs for SSI absolute encoders with 24 V encoder signal.

- 2 SSI absolute encoder 24 V
- 2 additional inputs
- 24 VDC and GND for encoder supply

9.11.16.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Counter functions |  |
| X20DC2398 | X20 digital counter module, 2 SSI absolute encoder, 24 V, 125 kbit/s, 32-bit | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 219: X20DC2398 - Order data

9.11.16.3 Technical data

| Model number | X20DC2398 |
|--|--|
| Short description | |
| I/O module | 2 SSI absolute encoder 24 V |
| General information | |
| Input voltage | 24 VDC -15 % / +20 % |
| B&R ID code | 0x1BAD |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.4 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Type of signal lines | Shielded cables must be used for all signal lines |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| Digital inputs | |
| Quantity | 2 |
| Nominal voltage | 24 VDC |
| Input current at 24 VDC | Approx. 3.3 mA |


Table 220: X20DC2398 - Technical data

| Model number | X20DC2398 |
|--|---|
| Input characteristics per EN 61131-2 | Type 1 |
| Input filter | |
| Hardware | ≤2 μs |
| Software | - |
| Connection type | 3-wire connections |
| Input circuit | Sink |
| Input resistance | 7.19 kΩ |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| SSI absolute encoder | |
| Encoder inputs | 24 V, asymmetrical |
| Counter size | 32-bit |
| Max. transfer rate | 125 kbit/s |
| Encoder power supply | Module-internal, max. 600 mA |
| Keying | Gray/Binary |
| CLK: Output current | Max. 100 mA |
| DATA: Input resistance | 18.4 kΩ |
| Isolation voltage between encoder and bus | 500 V _{eff} |
| Overload characteristics of encoder power supply | Short circuit protection, overload protection |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Electrical properties | |
| Electrical isolation | Bus isolated from encoder and channel Channel not isolated from channel and encoder Encoder not isolated from encoder |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm |

Table 220: X20DC2398 - Technical data

9.11.16.4 LED status indicators

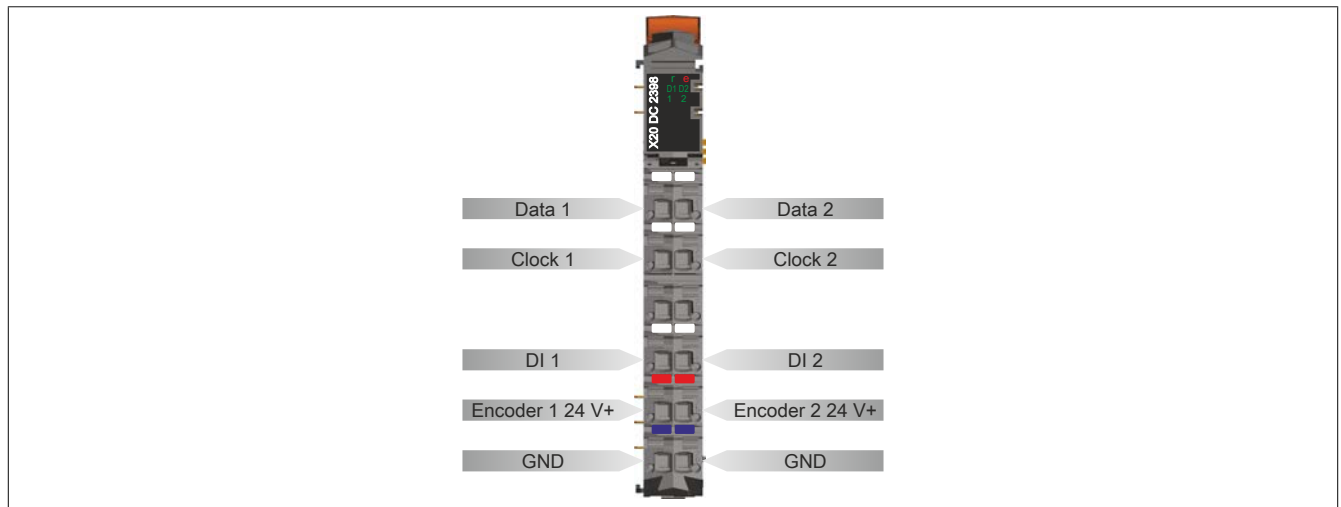
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|--------|-------|--------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | D1, D2 | Green | | Input state of data signal 1 or 2 |
| | 1 - 2 | Green | | Input state of the corresponding digital input |

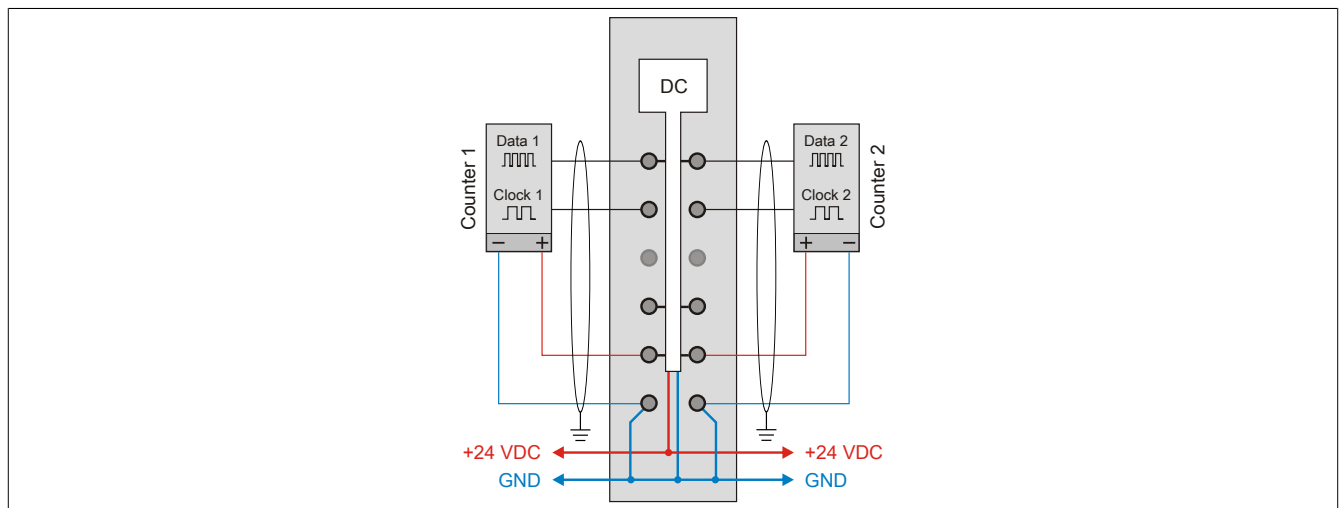
1) Depending on the configuration, a firmware update can take up to several minutes.

9.11.16.5 Pinout

Shielded cables must be used for all signal lines.

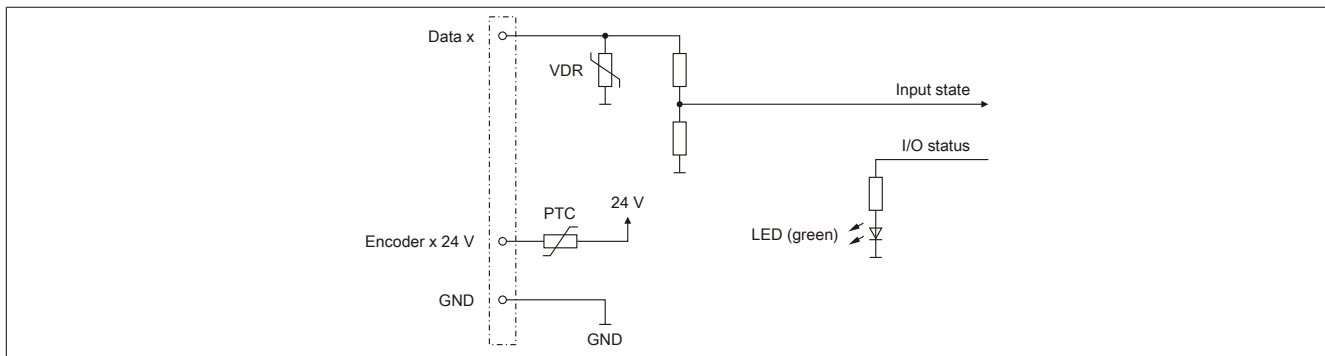


9.11.16.6 Connection example

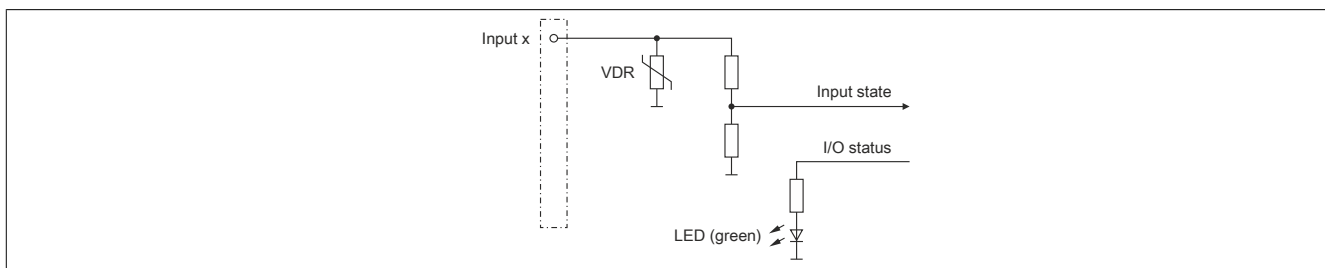


9.11.16.7 Input circuit diagram

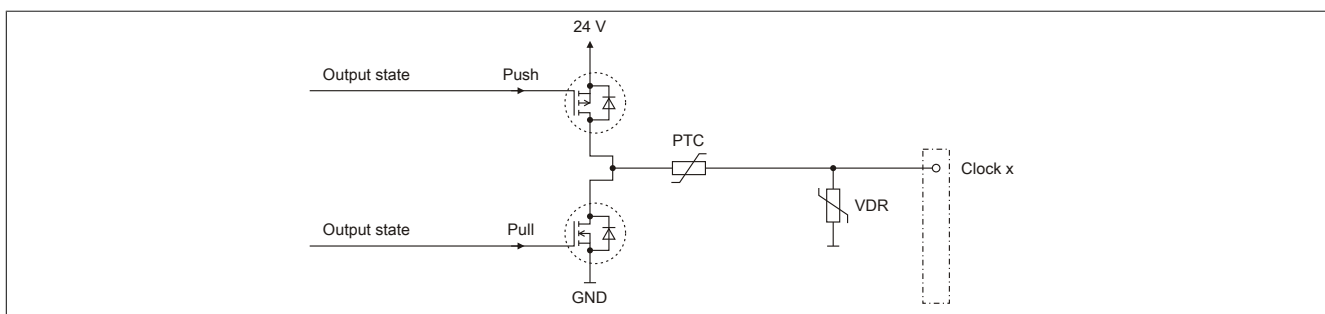
Counter inputs



Standard inputs



9.11.16.8 Output circuit diagram



9.11.16.9 Register description

9.11.16.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.11.16.9.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 7176 | ConfigOutput15 | UINT | | | | • |
| 7432 | ConfigOutput16 | UINT | | | | • |
| 7172 | ConfigAdvanced01 | UDINT | | | | • |
| 7428 | ConfigAdvanced02 | UDINT | | | | • |
| Communication | | | | | | |
| 7184 | Encode01 | UDINT | • | | | |
| 7440 | Encoder02 | UDINT | • | | | |
| 264 | Input state of digital inputs 1 to 2 | USINT | • | | | |
| | DigitalInput01 | Bit 3 | | | | |
| | DigitalInput02 | Bit 7 | | | | |
| 40 | Status of encoder power supply | USINT | • | | | |
| | PowerSupply01 | Bit 0 | | | | |

9.11.16.9.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 7176 | - | ConfigOutput15 | UINT | | | | • |
| 7432 | - | ConfigOutput16 | UINT | | | | • |
| 7172 | - | ConfigAdvanced01 | UDINT | | | | • |
| 7428 | - | ConfigAdvanced02 | UDINT | | | | • |
| Communication | | | | | | | |
| 7184 | 0 | Encode01 | UDINT | • | | | |
| 7440 | 8 | Encoder02 | UDINT | • | | | |
| 264 | 4 | Input state of digital inputs 1 to 2 | USINT | • | | | |
| | | DigitalInput01 | Bit 3 | | | | |
| | | DigitalInput02 | Bit 7 | | | | |
| 40 | 5 | Status of encoder power supply | USINT | • | | | |
| | | PowerSupply01 | Bit 0 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.11.16.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.11.16.9.3.2 CAN I/O bus controller

The module occupies 2 analog logical slots on CAN I/O.

9.11.16.9.4 SSI encoder configuration registers**9.11.16.9.4.1 Standard configuration**

Name:

ConfigOutput15 to ConfigOutput16

This configuration register sets the encoding, clock rate and number of bits. Default = 0. This must be set once using an acyclic write command.

"ConfigOutput15": Configuration register for SSI encoder 01 and

"ConfigOutput16": Configuration register for SSI encoder 02

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|--------|----------------------|-------|--|
| 0 - 5 | SSI value valid bits | x | Bus controller default setting: 0 |
| 6 - 7 | Clock rate | 11 | 125 kHz. Bus controller default setting: 0 |
| 8 - 13 | SSI number of bits | x | Number of bits including leading zeros. Bus controller default setting: 0 |
| 14 | Reserved | 0 | |
| 15 | Keying | 0 | Binary encoding (bus controller default setting) |
| | | 1 | Gray encoding |

9.11.16.9.4.2 Extended configuration

Name:

ConfigAdvanced01 to ConfigAdvanced02

This configuration register is used to set the encoding, clock rate, number of bits and monostable multivibrator settings. This must be set once using an acyclic write command.

It only differs from register "ConfigOutput15 + 16" on page 1272 by data length and additional monostable multivibrator testing.

"ConfigAdvanced01": Configuration register for SSI encoder 01 and

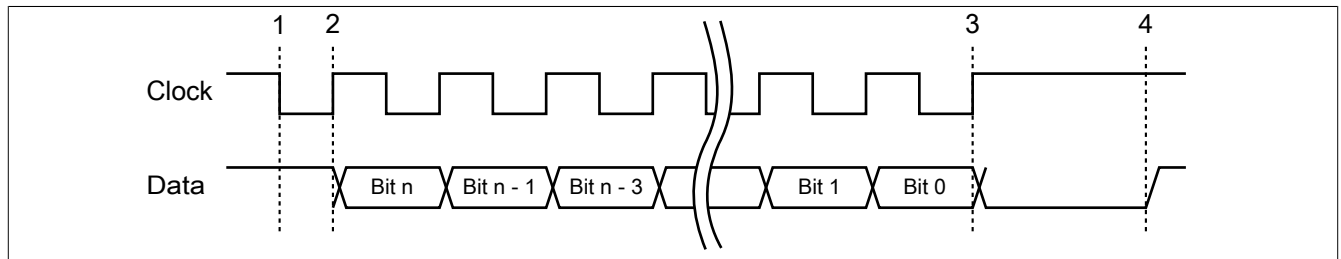
"ConfigAdvanced02": Configuration register for SSI encoder 02

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UDINT | See the bit structure. | 65536 |

Bit structure:

| Bit | Description | Value | Information |
|---------|--------------------------|-------|--|
| 0 - 5 | SSI value valid bits | x | Bus controller default setting: 0 |
| 6 - 7 | Clock rate | 11 | 125 kHz. Bus controller default setting: 0 |
| 8 - 13 | SSI number of bits | x | Number of bits including leading zeros. Bus controller default setting: 0 |
| 14 | Reserved | 0 | |
| 15 | Keying | 0 | Binary encoding (bus controller default setting) |
| | | 1 | Gray encoding |
| 16 - 17 | Monostable multivibrator | 00 | Check OFF, no additional clock bit |
| | | 01 | Check set to high level (bus controller default setting) |
| | | 10 | Check set to low level |
| | | 11 | Level is clocked but ignored. |
| 18 - 31 | Reserved | 0 | |

Transferring using Synchronous Serial Interface



Processing the measured value

- 1) Start bit ... The measured value is saved.
- 2) Output of the first data bit
- 3) All data bits are transferred; the monostable multivibrator time starts to run.
- 4) The monostable multivibrator returns to its initial state; a new transfer can be started.

9.11.16.9.5 SSI encoder communication registers

9.11.16.9.5.1 SSI position values

Name:

Encoder01 to Encoder02

The two SSI encoder values are displayed as 32-bit position values. The SSI position values are calculated synchronously with the X2X cycle.

| Data type | Values | Filter |
|-----------|--------------------|--------------|
| UDINT | 0 to 4,294,967,729 | SSI position |

9.11.16.9.5.2 Input state of digital inputs 1 to 2

Name:

DigitalInput01 to DigitalInput02

This register contains the input state of digital inputs 1 to 2.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|----------------|--------|-------------------------------|
| 3 | DigitalInput01 | 0 or 1 | Input state - Digital input 1 |
| 7 | DigitalInput02 | 0 or 1 | Input state - Digital input 2 |

9.11.16.9.5.3 Status of encoder power supply

Name:

PowerSupply01

This register indicates the state of the integrated encoder power supply. A faulty encoder power supply is output as a warning.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|------------------------------------|
| 0 | PowerSupply01 | 0 | 24 VDC encoder power supply OK |
| | | 1 | 24 VDC encoder power supply faulty |
| 1 - 7 | Reserved | - | |

9.11.16.9.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 128 μ s |

9.11.16.9.7 Maximum cycle time

The maximum cycle time specifies the time up to which the bus cycle can be increased without internal counter overflows causing module malfunctions.

| Minimum cycle time |
|--------------------|
| 16 ms |

9.11.16.9.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 128 μ s |

9.11.17 X20DC4395

Data sheet version: 3.22

9.11.17.1 General information

This module is a multifunctional counter module. It can be connected to two SSI encoders, two ABR encoders, four AB encoders or eight event counters. Four outputs are available for pulse width modulation. The functions can also be mixed.

- 24 VDC encoder inputs
- SSI, ABR, AB or event counters for inputs
- Pulse width modulation for outputs
- 24 VDC and GND for encoder supply

Information:

This module is a multifunctional module. Some bus controllers only support the default function model.

Default function model:

- **1x ABR incremental encoder (24 V)**
- **1x SSI absolute encoder (24 V)**
- **1x event counter (24 V)**
- **2x PWM output (24 V)**

9.11.17.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Counter functions |  |
| X20DC4395 | X20 digital counter module, 2 SSI absolute encoders, 24 V, 2 ABR incremental encoders, 24 V, 4 AB incremental encoders, 24 V, 8 event counters or 4 PWM, local time measurement functions | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 221: X20DC4395 - Order data

9.11.17.3 Technical data

| Model number | X20DC4395 |
|--|--|
| Short description | |
| I/O module | 2 SSI absolute encoders 24 V, 2 ABR incremental encoders 24 V, 4 AB incremental encoders 24 V, 8x event counter or 4x pulse width modulation, time measurement, relative timestamp |
| General information | |
| Input voltage | 24 VDC -15 % / +20 % |
| B&R ID code | 0x1CC5 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| Outputs | Yes, using LED status indicator and software (output state) |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.5 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Type of signal lines | Shielded cables must be used for all signal lines. |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Incremental encoders | |
| Quantity | 4 |
| Encoder inputs | 24 V, asymmetrical |
| Counter size | 16/32-bit |
| Input frequency | Max. 100 kHz |
| Evaluation | 4x |
| Encoder power supply | Module-internal, max. 600 mA |
| Overload characteristics of encoder power supply | Short-circuit proof, overload-proof |
| SSI absolute encoder | |
| Quantity | 2 |
| Encoder inputs | 24 V, asymmetrical |
| Counter size | 32-bit |
| Max. transfer rate | 125 kbit/s |
| Encoder power supply | Module-internal, max. 600 mA |
| Keying | Gray/Binary |
| CLK: Output current | Max. 100 mA |
| Overload characteristics of encoder power supply | Short-circuit proof, overload-proof |
| Event counters | |
| Quantity | 8 |
| Nominal voltage | 24 VDC |
| Signal form | Square wave pulse |
| Evaluation | Each edge, cyclic counter |
| Input frequency | Max. 100 kHz |
| Input current at 24 VDC | Approx. 1.3 mA |
| Input resistance | 18.4 kΩ |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Counter frequency | 200 kHz |
| Counter size | 16/32-bit |
| Input filter | |
| Hardware | ≤2 μs |
| Software | - |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Edge detection / Time measurement | |
| Possible measurements | Gate time, period duration, edge offset for various channels |
| Measurements per module | Up to 9 |

Table 222: X20DC4395 - Technical data


| Model number | X20DC4395 |
|---|--|
| Measurements per channel | Up to 2 |
| Counter size | 16-bit |
| Counter frequency | |
| Internal | 8 MHz, 4 MHz, 2 MHz, 1 MHz, 500 kHz, 250 kHz, 125 kHz, 62.5 kHz |
| Signal form | Square wave pulse |
| Measurement type | Continuous or triggered |
| Digital outputs | |
| Quantity | 4 |
| Variant | Push / Pull / Push-Pull |
| Nominal voltage | 24 VDC |
| Switching voltage | 24 VDC -15 % / +20 % |
| Nominal output current | 0.1 A |
| Total nominal current | 0.4 A |
| Output circuit | Sink or source |
| Output protection | Thermal shutdown in the event of overcurrent or short circuit, integrated protection for switching inductive loads |
| Pulse width modulation ¹⁾ | |
| Period duration | 41.6 µs to 1.36 s |
| Factor for period duration | n/48000 s, n = 2 to 65535 |
| Pulse duration | 0 to 100% |
| Resolution for pulse duration | 0.1% |
| Actuator power supply | Module-internal, max. 600 mA |
| Diagnostic status | Output monitoring |
| Leakage current when switched off | Max. 25 µA |
| Residual voltage | <0.9 V at 0.1 A nominal current |
| Peak short-circuit current | <10 A |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms (depends on the module temperature) |
| Switching delay | |
| 0 → 1 | <2 µs |
| 1 → 0 | <2 µs |
| Switching frequency | |
| Resistive load | Max. 24 kHz |
| Inductive load | See section "Switching inductive loads". |
| Braking voltage when switching off inductive loads | Switching voltage + 0.6 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Bus isolated from encoder and output Output not isolated from output and encoder Encoder not isolated from encoder |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x bus module X20BM11 separately. |
| Spacing | 12.5 ^{+0.2} mm |

Table 222: X20DC4395 - Technical data

1) Dead time when switching between push and pull: Max. 1.5 µs.

9.11.17.4 LED status indicators

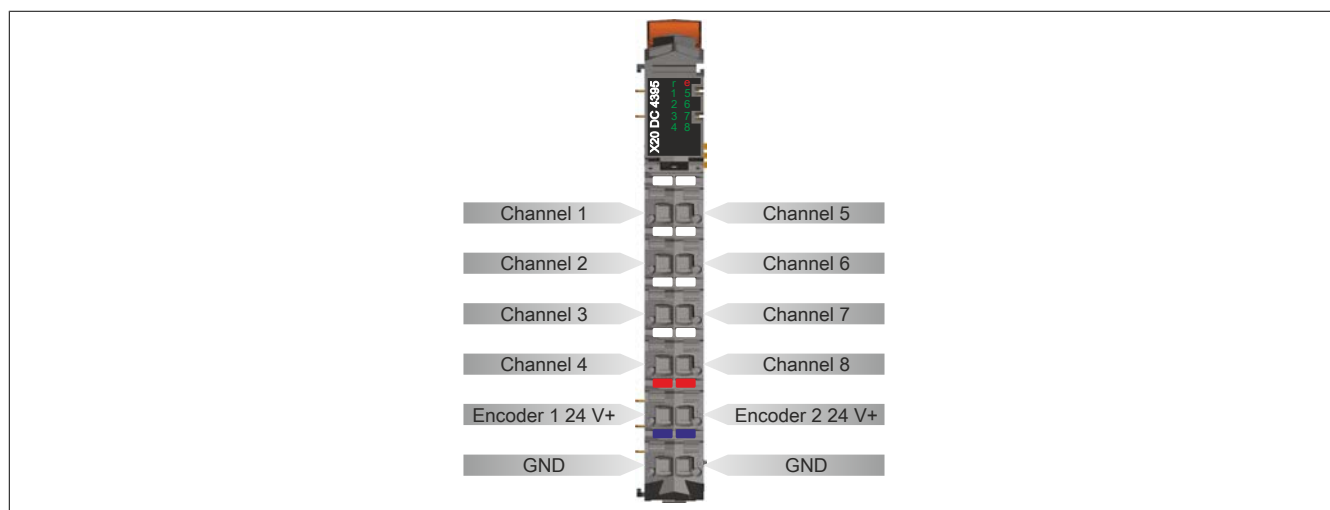
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|-------|--------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | e | Red | On | RUN mode |
| | | | Off | No power to module or everything OK |
| | 1 - 8 | Green | On | Error or reset status |
| | | | Off | Status of the corresponding digital signal |

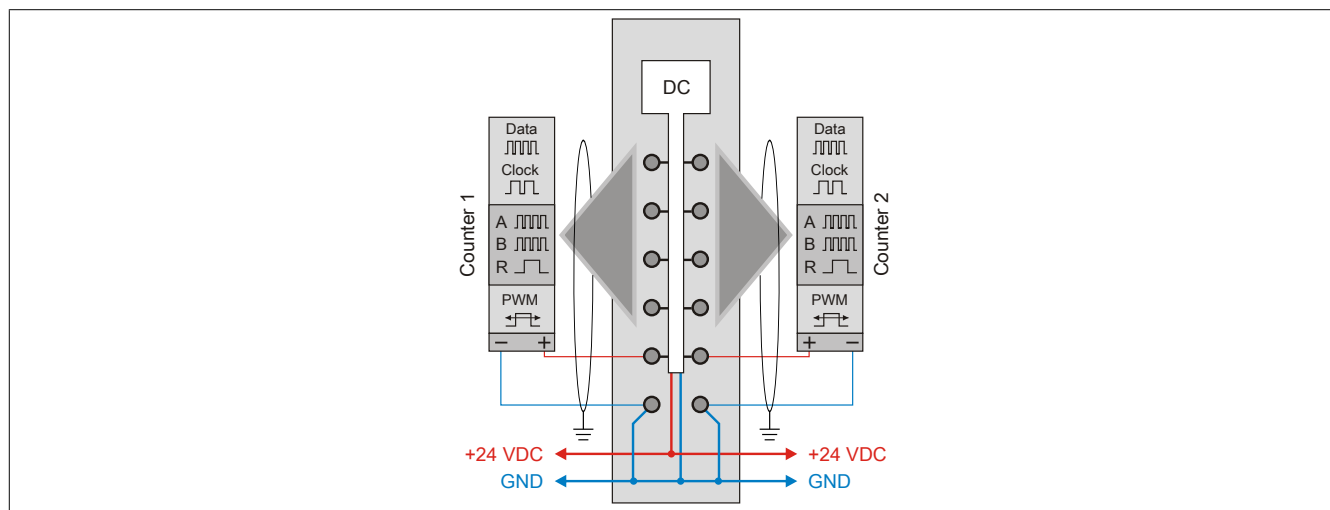
1) Depending on the configuration, a firmware update can take up to several minutes.

9.11.17.5 Pinout

Shielded cables must be used for all signal lines.



9.11.17.6 Connection example



9.11.17.7 Function overview

The following functions can be configured on the module. They cannot all be used at the same time due to the multiple use of the hardware channels and the limited cyclic data length.

- 8 digital channels, 4 of which can be configured as outputs
- 8 event counters with configurable counting direction and optional referencing via digital input
- 4 PWM outputs
- 4 up/down counters, each with optional latch inputs and comparator output
- 4 AB counters, each with optional latch inputs and comparator output
- 2 ABR encoder with configurable reference pulse edge and reference position, optional reference enable input, latch input and comparator output
- 2 SSI counter with optional latch input and comparator output
- 2 edge-triggered time measurement functions with configurable start edge based on current configuration settings

9.11.17.7.1 Description of channel assignments

The functions listed here are directly assigned to the respective hardware channels and cannot be changed:

| Channel | Signal connections |
|---------|--|
| 1 | <ul style="list-style-type: none"> • Digital input 1 • Event counter 1 • AB encoder 1 - signal line A • Up/down counter 1 - frequency • SSI encoder 1 - data line • ABR encoder 1 - signal line A |
| 2 | <ul style="list-style-type: none"> • Digital input 2 • Digital output 2 • Event counter 2 • PWM output 2 • AB encoder 1 - signal line B • Up/down counter 1 - direction • SSI encoder 1 - clock line • ABR encoder 1 - signal line B |
| 3 | <ul style="list-style-type: none"> • Digital input 3 • Event counter 3 • AB encoder 2 - signal line A • Up/down counter 2 - frequency • ABR encoder 1 - signal line R |
| 4 | <ul style="list-style-type: none"> • Digital input 4 • Digital output 4 • Event counter 4 • PWM output 4 • AB encoder 2 - signal line B • Up/down counter 2 - direction • ABR encoder 1 - reference enable input |
| 5 | <ul style="list-style-type: none"> • Digital input 5 • Event counter 5 • AB encoder 3 - signal line A • Up/down counter 3 - frequency • SSI encoder 2 - data line • ABR encoder 2 - signal line A |
| 6 | <ul style="list-style-type: none"> • Digital input 6 • Digital output 6 • Event counter 6 • PWM output 6 • AB encoder 3 - signal line B • Up/down counter 3 - direction • SSI encoder 2 - clock line • ABR encoder 2 - signal line B |
| 7 | <ul style="list-style-type: none"> • Digital input 7 • Event counter 7 • AB encoder 4 - signal line A • Up/down counter 4 - frequency • ABR encoder 2 - signal line R |
| 8 | <ul style="list-style-type: none"> • Digital input 8 • Digital output 8 • Event counter 8 • PWM output 8 • AB encoder 4 - signal line B • Up/down counter 4 - direction • ABR encoder 2 - reference enable input |

Options available in addition to these basic functions, such as comparator outputs or latch inputs, can be configured freely to unused input/output channels.

9.11.17.7.2 Connection options

Channels 1 to 8 can be connected as follows:

| Channel | Function | | | | | |
|---------|----------|---------------|---|------------------|-----------|-----|
| 1 | I | Event counter | A | A | SSI data | |
| 2 | I/O | Event counter | B | B | SSI cycle | PWM |
| 3 | I | Event counter | A | R | | |
| 4 | I/O | Event counter | B | Enable reference | | PWM |
| 5 | I | Event counter | A | A | SSI data | |
| 6 | I/O | Event counter | B | B | SSI cycle | PWM |
| 7 | I | Event counter | A | R | | |
| 8 | I/O | Event counter | B | Enable reference | | PWM |

The functions can also be mixed. For example:

| Example 1 | |
|-----------|---------------|
| Channel | Function |
| 1 | SSI data |
| 2 | SSI cycle |
| 3 | Event counter |
| 4 | PWM |
| 5 | A |
| 6 | B |
| 7 | Event counter |
| 8 | PWM |

| Example 2 | |
|-----------|---------------|
| Channel | Function |
| 1 | SSI data |
| 2 | SSI cycle |
| 3 | A |
| 4 | B |
| 5 | Event counter |
| 6 | Event counter |
| 7 | Event counter |
| 8 | Event counter |

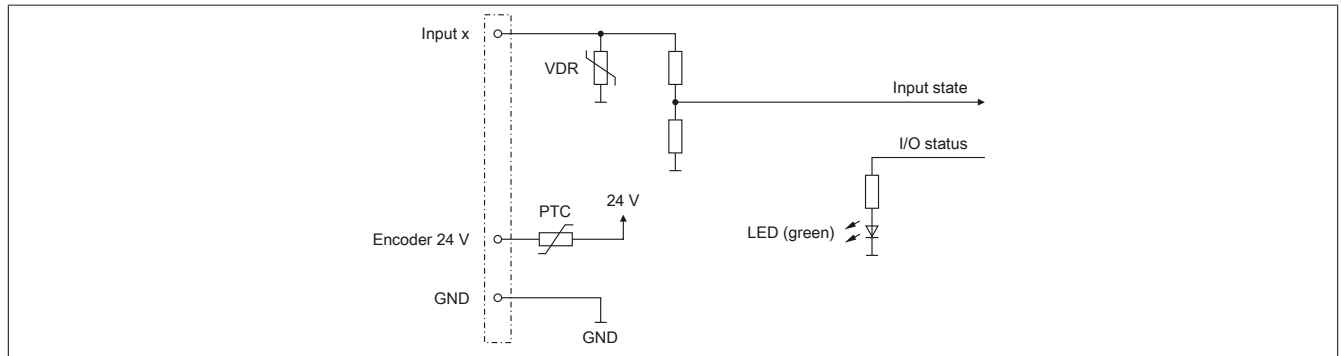
| Example 3 | |
|-----------|---------------|
| Channel | Function |
| 1 | Event counter |
| 2 | PWM |
| 3 | Event counter |
| 4 | PWM |
| 5 | SSI data |
| 6 | SSI cycle |
| 7 | A |
| 8 | B |

| Example 4 | |
|-----------|------------------|
| Channel | Function |
| 1 | A |
| 2 | B |
| 3 | R |
| 4 | Enable reference |
| 5 | A |
| 6 | B |
| 7 | R |
| 8 | Enable reference |

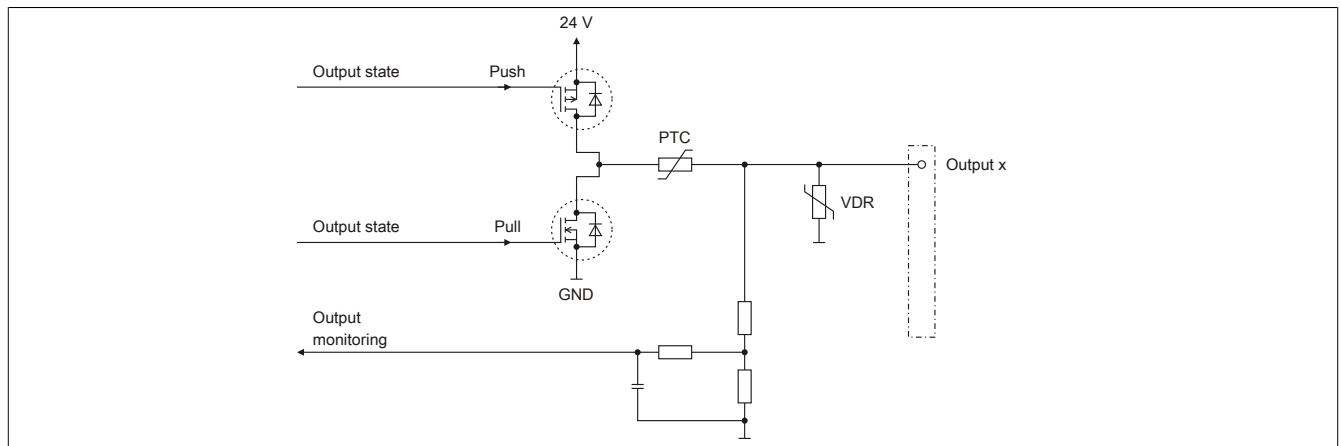
| Example 5 | |
|-----------|---------------|
| Channel | Function |
| 1 | A |
| 2 | B |
| 3 | Event counter |
| 4 | PWM |
| 5 | A |
| 6 | B |
| 7 | Event counter |
| 8 | Event counter |

| Example 6 | |
|-----------|---------------|
| Channel | Function |
| 1 | Event counter |
| 2 | Event counter |
| 3 | Event counter |
| 4 | PWM |
| 5 | SSI data |
| 6 | SSI cycle |
| 7 | A |
| 8 | B |

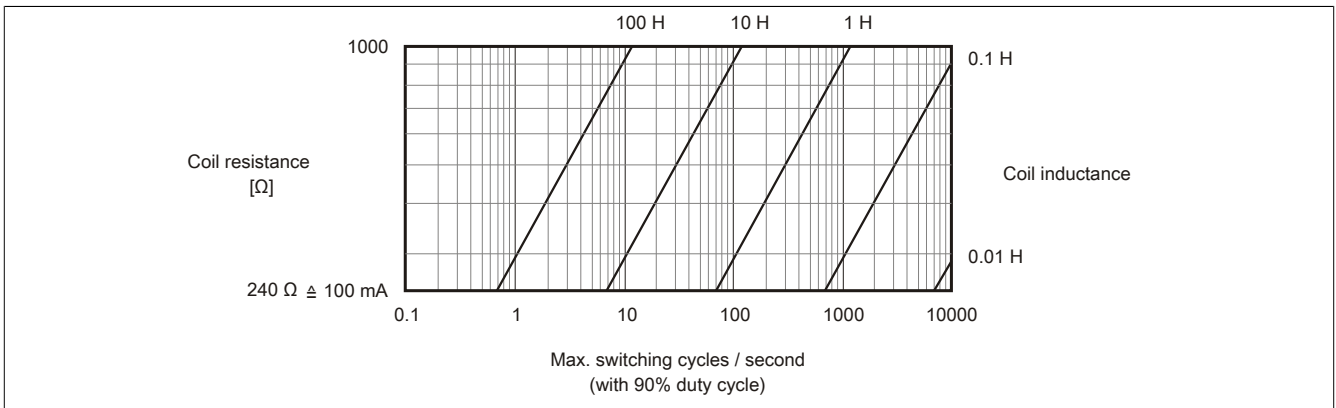
9.11.17.8 Input circuit diagram



9.11.17.9 Output circuit diagram



9.11.17.10 Switching inductive loads



9.11.17.11 Calculating the period duration

The outputs of the module can be operated as PWM outputs. The period duration is calculated using the following formula:

$$\text{Period duration} = \frac{n}{48000} \text{ s}$$

A value of 2 to 65535 can be defined for n.

Example

| n | Period duration | Frequency |
|-------|-----------------|-----------|
| 2 | 416 μs | 24 kHz |
| 24000 | 500 ms | 2 Hz |
| 48000 | 1 s | 1 Hz |
| 65535 | 1.36 s | 0.73 Hz |

9.11.17.12 Register description

9.11.17.12.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.11.17.12.2 Function model 0 - Standard and Function model 1 - 32-bit counter

The following 2 models can be selected:

- 16-bit counter, Function model 0
- 32-bit counter, Function model 1 (identified in the table with a "(D)" in the data type and "(_32Bit)" in the name.)

The only difference between these two models is that they use either 16-bit or 32-bit registers for incremental counter functions. These include:

- ABR encoders
- AB encoders
- Up/down counters
- Event counters

All other module functions e.g. SSI, PWM and time measurement, as well as their data types, are identical for the two models.

| Register | Name | Data type | Read | | Write | |
|--|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module configuration - General | | | | | | |
| (N-1) * 2 | CfO_CFGchannel0N (Index N = 1 to 8) | USINT | | | | • |
| 64 + N * 2 | CfO_LEDNsource (Index N = 0 to 7) | USINT | | | | • |
| Configuration - Input for ABR encoders | | | | | | |
| 512 | CfO_DIREKTIOevent0IDwr | UINT | | | | • |
| 544 | CfO_DIREKTIOevent1IDwr | UINT | | | | • |
| 516 | CfO_DIREKTIOevent0mode | USINT | | | | • |
| 548 | CfO_DIREKTIOevent1mode | USINT | | | | • |
| 522 | CfO_DIREKTIOevent0compState | UINT | | | | • |
| 544 | CfO_DIREKTIOevent1compState | UINT | | | | • |
| 520 | CfO_Ev0CompMask | USINT | | | | • |
| 552 | CfO_Ev1CompMask | USINT | | | | • |
| 2064 + (N-1) * 256 | CfO_CounterNPresetValue1(_32Bit) (Index N = 1 to 4) | U(D)INT | | | | • |
| 2068 + (N-1) * 256 | CfO_CounterNPresetValue2(_32Bit) (Index N = 1 to 4) | U(D)INT | | | | • |
| 2048 + (N-1) * 256 | CfO_CounterNconfig (Index N = 1 to 4) | USINT | | | | • |
| 2056 + (N-1) * 256 | CfO_CounterNconfigReg0 (Index N = 1 to 4) | USINT | | | | • |
| 2058 + (N-1) * 256 | CfO_CounterNconfigReg1 (Index N = 1 to 4) | USINT | | | | • |
| 2112 + (N-1) * 256 | CfO_CounterNevent0IDwr (Index N = 1 to 4) | UDINT | | | | • |
| 2120 + (N-1) * 256 | CfO_CounterNevent0config (Index N = 1 to 4) | UINT | | | | • |
| 2144 + (N-1) * 256 | CfO_CounterNevent1IDwr (Index N = 1 to 4) | UINT | | | | • |
| 2152 + (N-1) * 256 | CfO_CounterNevent1config (Index N = 1 to 4) | UINT | | | | • |
| 2148 + (N-1) * 256 | CfO_CounterNevent1mode (Index N = 1 to 4) | USINT | | | | • |
| Configuration - Inputs for AB, up/down and event counters | | | | | | |
| 2048 + (N-1) * 256 | CfO_CounterNconfig (Index N = 1 to 4) | USINT | | | | • |
| 2056 + (N-1) * 256 | CfO_CounterNconfigReg0 (Index N = 1 to 4) | USINT | | | | • |
| 2058 + (N-1) * 256 | CfO_CounterNconfigReg1 (Index N = 1 to 4) | USINT | | | | • |
| 2112 + (N-1) * 256 | CfO_CounterNevent0IDwr (Index N = 1 to 4) | UDINT | | | | • |
| 2120 + (N-1) * 256 | CfO_CounterNevent0config (Index N = 1 to 4) | UINT | | | | • |
| 2116 + (N-1) * 256 | CfO_CounterNevent0mode (Index N = 1 to 4) | USINT | | | | • |
| 2144 + (N-1) * 256 | CfO_CounterNevent1IDwr (Index N = 1 to 4) | UINT | | | | • |
| 2152 + (N-1) * 256 | CfO_CounterNevent1config (Index N = 1 to 4) | UINT | | | | • |
| 2148 + (N-1) * 256 | CfO_CounterNevent1mode (Index N = 1 to 4) | USINT | | | | • |
| Configuration - Inputs for SSI encoders | | | | | | |
| 7,176 | CfO_SSI1cfg | UINT | | | | • |
| 7,432 | CfO_SSI2cfg | UINT | | | | • |
| 7,180 | CfO_SSI1control | USINT | | | | • |
| 7,436 | CfO_SSI2control | USINT | | | | • |
| 7,168 | CfO_SSI1eventIDwr | UINT | | | | • |
| 7,424 | CfO_SSI2eventIDwr | UINT | | | | • |
| 7,232 | CfO_SSI1event0IDwr | UINT | | | | • |
| 7,488 | CfO_SSI2event0IDwr | UINT | | | | • |
| 7,240 | CfO_SSI1event0config | UINT | | | | • |
| 7,496 | CfO_SSI2event0config | UINT | | | | • |

| Register | Name | Data type | Read | | Write | |
|---|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 7,236 | CfO_SSI1event0mode | USINT | | | | • |
| 7,492 | CfO_SSI2event0mode | USINT | | | | • |
| 7,172 | ConfigAdvanced01 | UDINT | | | | • |
| 7,428 | ConfigAdvanced02 | UDINT | | | | • |
| Configuration - Comparator function for ABR, AB, SSI encoders and up/down counters | | | | | | |
| 256 | CfO_OutClearMask | USINT | | | | • |
| 258 | CfO_OutSetMask | USINT | | | | • |
| 1,024 | CfO_DIREKTIOoutevent0IDwr | UINT | | | | • |
| 1034 + N * 32 | CfO_DIREKTIOoutsetmaskN (Index N = 0 to 3) | USINT | | | | • |
| 1032 + N * 32 | CfO_DIREKTIOoutclearmaskN (Index N = 0 to 3) | USINT | | | | • |
| 1,066 | CfO_DIREKTIOoutsetmask1 | USINT | | | | • |
| 1,064 | CfO_DIREKTIOoutclearmask1 | USINT | | | | • |
| 1024 + N * 32 | CfO_DIREKTIOouteventNIDwr (Index N = 0 to 3) | UINT | | | | • |
| Configuration - Outputs for PWM (pulse width modulation) | | | | | | |
| 6144 + N * 16 | CfO_PWMNprescaler (Index N = 0 to 3) | UINT | | | | • |
| Module communication - General | | | | | | |
| 40 | Status of encoder power supply | USINT | • | | | |
| | PowerSupply01 | Bit 0 | | | | |
| Communication - Digital inputs | | | | | | |
| 264 | Input states of the channels | USINT | • | | | |
| | DigitalInput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalInput08 | Bit 7 | | | | |
| Communication - Event counters | | | | | | |
| 2,080 | EventCounter01 | U(D)INT | • | | | |
| 2,084 | EventCounter02 | U(D)INT | • | | | |
| 2,336 | EventCounter03 | U(D)INT | • | | | |
| 2,340 | EventCounter04 | U(D)INT | • | | | |
| 2,592 | EventCounter05 | U(D)INT | • | | | |
| 2,596 | EventCounter06 | U(D)INT | • | | | |
| 2,848 | EventCounter07 | U(D)INT | • | | | |
| 2,852 | EventCounter08 | U(D)INT | • | | | |
| Communication - Input for ABR encoders (optionally with comparator) | | | | | | |
| 2,080 | ABREncoder01 | (D)INT | • | | | |
| 2,592 | ABREncoder02 | (D)INT | • | | | |
| 2,116 | ReferenceModeABR01 | USINT | | | • | |
| 2,628 | ReferenceModeABR02 | USINT | | | • | |
| 2,160 | OriginComparator01 | (D)INT | | | • | |
| 2,164 | MarginComparator01 | U(D)INT | | | • | |
| 264 | Input states of the channels | USINT | • | | | |
| | ComparatorActualValue02 | Bit 1 | | | | |
| | ReferenceEnableSwitch01 (without comparator) ComparatorActualValue01 (with comparator) ComparatorActualValue02 (with comparator) | Bit 3 | | | | |
| | ComparatorActualValue01 | Bit 5 | | | | |
| | ReferenceEnableSwitch02 (without comparator) ComparatorActualValue01 (with comparator) ComparatorActualValue02 (with comparator) | Bit 7 | | | | |
| | ComparatorActualValue03 | Bit 3 | | | | |
| 2,172 | Latch01ABR01 | (D)INT | • | | | |
| 2,684 | Latch01ABR02 | (D)INT | • | | | |
| 2,118 | StatusABR01 | USINT | • | | | |
| 2,630 | StatusABR02 | USINT | • | | | |
| Communication - Input for AB | | | | | | |
| 2080 + (N-1) * 256 | ABEncoder0N (Index N = 1 to 4) | (D)INT | • | | | |
| 2,336 | ABEncoder02 | (D)INT | • | | | |
| 2,160 | OriginComparator01 | (D)INT | | | • | |
| 2,164 | MarginComparator01 | U(D)INT | | | • | |
| 264 | Input states of the channels | USINT | • | | | |
| | ComparatorActualValue03 | Bit 1 | | | | |
| | ComparatorActualValue01 | Bit 3 | | | | |
| | ComparatorActualValue03 | Bit 5 | | | | |
| | ComparatorActualValue01 | Bit 7 | | | | |
| | ComparatorActualValue03 | Bit 3 | | | | |
| 2140 + (N-1) * 256 | Latch01AB0N (Index N = 1 to 4) | (D)INT | • | | | |
| 2172 + (N-1) * 256 | Latch02AB0N (Index N = 1 to 4) | (D)INT | • | | | |
| Communication - Up/down counters | | | | | | |
| 2080 + (N-1) * 256 | Counter0N (Index N = 1 to 4) | U(D)INT | • | | | |
| 2,160 | OriginComparator01 | U(D)INT | | | • | |
| 2,164 | MarginComparator01 | U(D)INT | | | • | |
| 264 | Input states of the channels | USINT | • | | | |
| | ComparatorActualValue03 | Bit 1 | | | | |
| | ComparatorActualValue01 | Bit 3 | | | | |
| | ComparatorActualValue03 | Bit 3 | | | | |

| Register | Name | Data type | Read | | Write | |
|---|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| | ComparatorActualValue01 | Bit 5 | | | | |
| | ComparatorActualValue01 | Bit 7 | | | | |
| | ComparatorActualValue03 | | | | | |
| 2140 + (N-1) * 256 | Latch01Counter0N (Index N = 1 to 4) | U(D)INT | • | | | |
| 2172 + (N-1) * 256 | Latch02Counter0N (Index N = 1 to 4) | U(D)INT | • | | | |
| Communication - Input for SSI encoders | | | | | | |
| 7,184 | SSIEncoder01 | UDINT | • | | | |
| 7,440 | SSIEncoder02 | UDINT | • | | | |
| 7,248 | OriginComparator01 | UDINT | | | • | |
| 7,504 | OriginComparator02 | UDINT | | | • | |
| 7,252 | MarginComparator01 | UDINT | | | • | |
| 7,508 | MarginComparator02 | UDINT | | | • | |
| 264 | Input states of the channels | USINT | • | | | |
| | ComparatorActualValue02 | Bit 1 | | | | |
| | ComparatorActualValue01 | Bit 3 | | | | |
| | ComparatorActualValue02 | | | | | |
| | ComparatorActualValue01 | Bit 5 | | | | |
| | ComparatorActualValue01 | Bit 7 | | | | |
| | ComparatorActualValue02 | | | | | |
| 7,260 | Latch01SSI01 | UDINT | • | | | |
| 7,516 | Latch01SSI02 | UDINT | • | | | |
| Communication - Digital outputs | | | | | | |
| 260 | Output states of the channels | USINT | | | • | |
| | DigitalOutput02 | Bit 1 | | | | |
| | DigitalOutput04 | Bit 3 | | | | |
| | DigitalOutput06 | Bit 5 | | | | |
| | DigitalOutput08 | Bit 7 | | | | |
| 264 | Input states of the channels | USINT | • | | | |
| | StatusDigitalOutput02 | Bit 1 | | | | |
| | StatusDigitalOutput04 | Bit 3 | | | | |
| | StatusDigitalOutput06 | Bit 5 | | | | |
| | StatusDigitalOutput08 | Bit 7 | | | | |
| Communication - Outputs for PWM (pulse width modulation) | | | | | | |
| 6130 + N * 8 | PWMOutput0N (Index N = 2,4,6,8) | UINT | | | • | |
| Configuration - Edge detection | | | | | | |
| 4,104 | CfO_EdgeDetectFalling | USINT | | | | • |
| 4,106 | CfO_EdgeDetectRising | USINT | | | | • |
| 4,108 | CfO_FallingDisProtection | USINT | | | | • |
| 4,110 | CfO_RisingDisProtection | USINT | | | | • |
| Configuration - Time measurement | | | | | | |
| 4,336 | CfO_EdgeTimeglobalenable | USINT | | | | • |
| 4344 + N * 8 | CfO_EdgeTimeFallingMode0N (Index N = 1 to 8) | UINT | | | | • |
| 4472 + N * 8 | CfO_EdgeTimeRisingMode0N (Index N = 1 to 8) | UINT | | | | • |
| Communication - Time measurement | | | | | | |
| 4,342 | Trigger rising edge detection | USINT | | | • | |
| | TriggerRisingCH01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | TriggerRisingCH08 | Bit 7 | | | | |
| 4,350 | Show first rising trigger edge | USINT | • | | | |
| | BusyTriggerRisingCH01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | BusyTriggerRisingCH08 | Bit 7 | | | | |
| 4,340 | Trigger falling edge detection | USINT | | | • | |
| | TriggerFallingCH01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | TriggerFallingCH08 | Bit 7 | | | | |
| 4,348 | Show first falling trigger edge | USINT | • | | | |
| | BusyTriggerFallingCH01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | BusyTriggerFallingCH08 | Bit 7 | | | | |
| 4474 + N * 8 | CountRisingCH0N (Index N = 1 to 8) | USINT | • | | | |
| 4476 + N * 8 | TimeStampRisingCH0N (Index N = 1 to 8) | UINT | • | | | |
| 4478 + N * 8 | TimeDiffRisingCH0N (Index N = 1 to 8) | UINT | • | | | |
| 4346 + N * 8 | CountFallingCH0N (Index N = 1 to 8) | USINT | • | | | |
| 4348 + N * 8 | TimeStampFallingCH0N (Index N = 1 to 8) | UINT | • | | | |
| 4350 + N * 8 | TimeDiffFallingCH0N (Index N = 1 to 8) | UINT | • | | | |

9.11.17.12.3 Function model 254 - Bus controller

Unlike the function models 0 and 1, this model only offers a selection of functions with a limited scope of configuration on the module.

The following functions are provided and can be run at the same time:

- SSI encoders
- ABR encoder with configurable reference pulse edge and reference position
- 1 event counter with configurable counting direction
- 2 PWM outputs

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|---|----------------------|-------------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module configuration - General | | | | | | | |
| N * 2 - 2 | - | CfO_CFGchannel0N (Index N = 1 to 8) | USINT | | | | • |
| N * 2 + 64 | - | CfO_LEDNsource (Index N = 0 to 7) | USINT | | | | • |
| Configuration - ABR encoder | | | | | | | |
| 512 | - | CfO_DIREKTIOevent0IDwr | UINT | | | | • |
| 544 | - | CfO_DIREKTIOevent1IDwr | UINT | | | | • |
| 2,560 | - | CfO_Counter3config | USINT | | | | • |
| 2,568 | - | CfO_Counter3configReg0 | USINT | | | | • |
| 2,570 | - | CfO_Counter3configReg1 | USINT | | | | • |
| 2,576 | - | CfO_Counter3PresetValue1 | UINT | | | | • |
| 2,580 | - | CfO_Counter3PresetValue2 | UINT | | | | • |
| 2,624 | - | CfO_Counter3event0IDwr | UINT | | | | • |
| 2,632 | - | CfO_Counter3event0config | UINT | | | | • |
| 2,628 | - | CfO_Counter3event0mode | USINT | | | | • |
| 2,656 | - | CfO_Counter3event1IDwr | UINT | | | | • |
| 2,664 | - | CfO_Counter3event1config | UINT | | | | • |
| 2,660 | - | CfO_Counter3event1mode | USINT | | | | • |
| 4,104 | - | CfO_EdgeDetectFalling | USINT | | | | • |
| 4,106 | - | CfO_EdgeDetectRising | USINT | | | | • |
| Configuration - Event counter | | | | | | | |
| 2,304 | - | CfO_Counter2config | USINT | | | | • |
| 2,312 | - | CfO_Counter2configReg0 | USINT | | | | • |
| 2,314 | - | CfO_Counter2configReg1 | USINT | | | | • |
| 2,368 | - | CfO_Counter2event0IDwr | UINT | | | | • |
| 2,376 | - | CfO_Counter2event0config | UINT | | | | • |
| 2,372 | - | CfO_Counter2event0mode | USINT | | | | • |
| 2,400 | - | CfO_Counter2event1IDwr | UINT | | | | • |
| 2,408 | - | CfO_Counter2event1config | UINT | | | | • |
| 2,404 | - | CfO_Counter2event1mode | USINT | | | | • |
| Configuration - SSI encoder | | | | | | | |
| 7,176 | - | CfO_SSI1cfg | UINT | | | | • |
| 7,180 | - | CfO_SSI1control | USINT | | | | • |
| 7,168 | - | CfO_SSI1eventIDwr | UINT | | | | • |
| 7,232 | - | CfO_SSI1event0IDwr | UINT | | | | • |
| 7,240 | - | CfO_SSI1event0config | UINT | | | | • |
| 7,236 | - | CfO_SSI1event0mode | USINT | | | | • |
| 7,172 | - | ConfigAdvanced01 | UDINT | | | | • |
| Configuration - PWM (pulse width modulation) | | | | | | | |
| 6,160 | - | CfO_PWM1prescaler | UINT | | | | • |
| 6,192 | - | CfO_PWM3prescaler | UINT | | | | • |
| Module communication - General | | | | | | | |
| 40 | 6 | Status of encoder power supply | USINT | • | | | |
| | | PowerSupply01 | Bit 0 | | | | |
| Communication - Counters and encoders | | | | | | | |
| 2,336 | 4 | EventCounter03 | UINT | • | | | |
| 2,592 | 8 | ABREncoder02 | INT | • | | | |
| 2,628 | 10 | ReferenceModeABR02 | USINT | | | • | |
| 2,630 | 10 | StatusABR02 | USINT | • | | | |
| 7,184 | 0 | SSIEncoder01 | UDINT | • | | | |
| Communication - PWM (pulse width modulation) | | | | | | | |
| 6,162 | 0 | PWMOutput04 | UINT | | | • | |
| 6,194 | 8 | PWMOutput08 | UINT | | | • | |

1) The offset specifies the position of the register within the CAN object.

9.11.17.12.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "Using I/O modules on the bus controller" on page 3789.

9.11.17.12.3.2 CAN I/O bus controller

The module occupies 2 analog logical slots on CAN I/O.

9.11.17.12.4 General module registers

9.11.17.12.4.1 Configuring LED status indicators

Name:

CfO_LED0source to CfO_LED7source

These registers can be used to define how the module's LED status indicators are used. Blinking patterns can be generated from the application, and the status of the physical inputs and outputs can be indicated.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|---|
| USINT | See the bit structure. | CfO_LED0source = 0x20 ... CfO_LED7source = 0x27 |

Bit structure:

| Bit | Description | Values | Information |
|----------|--|---------------------------------------|--|
| 0 - 3 | MODE = 0 | 0 | LED off |
| | | 1 | Blinking quickly |
| | | 2 | Blinking |
| | | 3 | Blinking slowly |
| | | 4 | Single flash |
| | | 5 | Double flash |
| | | 6 to 15 | Reserved |
| | MODE = 1 (inverted) | 0 | LED on |
| | | 1 | Blinking quickly |
| | | 2 | Blinking |
| | | 3 | Blinking slowly |
| | | 4 | Single flash |
| | | 5 | Double flash |
| | | 6 to 15 | Reserved |
| | MODE = 2 | 0 to 7 | Number of the physical input channel (bus controller default setting) |
| | | 8 to 15 | Reserved |
| MODE = 3 | 0 to 7 | Number of the physical output channel | |
| | 8 to 15 | Reserved | |
| 4 - 7 | Selection of the mode for the status LED | 0 | LED blinking pattern |
| | | 1 | Inverted LED blinking pattern |
| | | 2 | Indicates the physical input state of a channel (bus controller default setting) |
| | | 3 | Indicates the physical output states of a channel |
| | | 4 to 15 | Reserved |

9.11.17.12.4.2 Status of encoder power supply

Name:

PowerSupply01

This register indicates the state of the integrated encoder power supply. A faulty encoder power supply is output as a warning.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|------------------------------------|
| 0 | PowerSupply01 | 0 | 24 VDC encoder power supply OK |
| | | 1 | 24 VDC encoder power supply faulty |
| 1 - 7 | Reserved | - | |

9.11.17.12.5 Digital inputs and outputs

9.11.17.12.5.1 Configuring physical channels

Name:

CfO_CFGchannel01 to CfO_CFGchannel08

This register can be used to configure physical I/O channels 1 to 8.

Information:

Except for bit 2 (inverted input), all other bits are only available for channels 2, 4, 6 and 8.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--|
| USINT | See the bit structure. | CfO_CFGchannel01 = 0x00 CfO_CFGchannel02 = 0x73 CfO_CFGchannel03 = 0x00 CfO_CFGchannel04 = 0x63 CfO_CFGchannel05 to 07 = 0x00 CfO_CFGchannel08 = 0x63 |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------|--------|------------------------------|
| 0 | Push ¹⁾ | 0 | Disabled |
| | | 1 | Enabled |
| 1 | Pull ¹⁾ | 0 | Disabled |
| | | 1 | Enabled |
| 2 | Inverted input | 0 | Disabled |
| | | 1 | Enabled |
| 3 | Inverted output | 0 | Disabled |
| | | 1 | Enabled |
| 4 - 7 | Output type | 0 | Direct I/O |
| | | 1 to 5 | Reserved |
| | | 6 | PWM (channel-specific) |
| | | 7 | SSI clock (channel-specific) |

1) To configure a channel as an output, Push and/or Pull must be enabled.

9.11.17.12.5.2 Reset mask of the digital channels

Name:

CfO_OutClearMask

The settings in this register only affect the values written to registers "DigitalOutput02 to 08" on page 1290.

- 0 allows manual reset of digital outputs using registers DigitalOutput02 to 08
- 1 prevents manual reset of digital outputs using registers DigitalOutput02 to 08

When "1" is used, the [output event function](#) can be used to reset the outputs.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------|-------|---|
| 0 | Reserved | - | |
| 1 | DigitalOutput02 | 0 | Writing 0 to the DigitalOutput02 register resets the output |
| | | 1 | Writing 0 from the DigitalOutput02 register does not reset the output |
| 2 | Reserved | - | |
| 3 | DigitalOutput04 | 0 | Writing 0 to the DigitalOutput04 register resets the output |
| | | 1 | Writing 0 from the DigitalOutput04 register does not reset the output |
| 4 | Reserved | - | |
| 5 | DigitalOutput06 | 0 | Writing 0 to the DigitalOutput06 register resets the output |
| | | 1 | Writing 0 from the DigitalOutput06 register does not reset the output |
| 6 | Reserved | - | |
| 7 | DigitalOutput08 | 0 | Writing 0 to the DigitalOutput08 register resets the output |
| | | 1 | Writing 0 from the DigitalOutput08 register does not reset the output |

9.11.17.12.5.3 Set mask of the digital channels

Name:

CfO_OutSetMask

The settings in this register only affect the values written to registers "DigitalOutput02 to 08" on page 1290.

- 0 allows manual setting of digital outputs using registers DigitalOutput02 to 04
- 1 prevents manual setting of digital outputs using registers DigitalOutput02 to 04

When "1" is used, the [output event function](#) can be used to reset the outputs.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Values | Information |
|-----|-----------------|--------|--|
| 0 | Reserved | - | |
| 1 | DigitalOutput02 | 0 | Writing 1 to register DigitalOutput02 sets the output. |
| | | 1 | Writing 1 from register DigitalOutput02 does not set the output. |
| 2 | Reserved | - | |
| 3 | DigitalOutput04 | 0 | Writing 1 to register DigitalOutput04 sets the output. |
| | | 1 | Writing 1 from register DigitalOutput04 does not set the output. |
| 4 | Reserved | - | |
| 5 | DigitalOutput06 | 0 | Writing 1 to register DigitalOutput06 sets the output. |
| | | 1 | Writing 1 from register DigitalOutput06 does not set the output. |
| 6 | Reserved | - | |
| 7 | DigitalOutput08 | 0 | Writing 1 to register DigitalOutput08 sets the output. |
| | | 1 | Writing 1 from register DigitalOutput08 does not set the output. |

9.11.17.12.5.4 Input states of the channels

Name:

see "Name in the Automation Studio I/O configuration"

This register reads the input status of a physical channel. The polarity settings are accounted for in the value (bit 2 in "CfO_CFGchannel[x]" on page 1288 register).

The bits in this register are shown in the Automation Studio I/O mapping table under different names based on the function used in order to improve readability.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Physical input channel | Value | Name in the Automation Studio I/O configuration |
|-----|------------------------|--------|---|
| 0 | Channel 1 | 0 or 1 | DigitalInput01 |
| 1 | Channel 2 | 0 or 1 | DigitalInput02 StatusDigitalOutput02 ComparatorActualValue02 ComparatorActualValue03 |
| 2 | Channel 3 | 0 or 1 | DigitalInput03 |
| 3 | Channel 4 | 0 or 1 | DigitalInput04 StatusDigitalOutput04 ReferenceEnableSwitch01 ComparatorActualValue01 ComparatorActualValue02 ComparatorActualValue03 |
| 4 | Channel 5 | 0 or 1 | DigitalInput05 |
| 5 | Channel 6 | 0 or 1 | DigitalInput06 StatusDigitalOutput06 ComparatorActualValue01 |
| 6 | Channel 7 | 0 or 1 | DigitalInput07 |
| 7 | Channel 8 | 0 or 1 | DigitalInput08 StatusDigitalOutput08 ReferenceEnableSwitch02 ComparatorActualValue01 ComparatorActualValue02 ComparatorActualValue03 |

9.11.17.12.5.5 Output states of the channels

Name:

DigitalOutput02 to DigitalOutput08

The output status of a physical channel can be written using this register. In order to configure a channel as an output:

- 1) Bit 0 "Push" and/or bit 1 "Pull" must be enabled in the "CfO_CFGchannel[x]" on page 1288 register.
- 2) Bits 4 to 7 in the "CfO_CFGchannel[x]" on page 1288 register must be set to Direct I/O.
- 3) 0 must be set for the respective channel in the "CfO_OutClearMask" on page 1288 and "CfO_OutSetMask" on page 1289 registers.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------|--------|----------------------------|
| 0 | Reserved | - | |
| 1 | DigitalOutput02 | 0 or 1 | Output status of channel 2 |
| 2 | Reserved | - | |
| 3 | DigitalOutput04 | 0 or 1 | Output status of channel 4 |
| 4 | Reserved | - | |
| 5 | DigitalOutput06 | 0 or 1 | Output status of channel 6 |
| 6 | Reserved | - | |
| 7 | DigitalOutput08 | 0 or 1 | Output status of channel 8 |

9.11.17.12.6 Event functions

The module provides configurable event functions. An event function can be connected to physical I/O and the values derived from them (e.g. counters) or be purely used for internal processing.

Every event function has event inputs and outputs. Event functions can also have only inputs or only outputs. Each event output has a unique event ID. It is possible to configure when an event is generated on an event output. The effect of an event is determined by the respective event function.

Event functions can also be linked to one another. The link takes place using the event input. Every event input has a 16-bit register to which the event number of the linked event output is written.

Information:

The module functions that can be configured in the Automation Studio I/O configuration are primarily based on these event functions and their links. Changes in the Automation Studio I/O configuration have multiple effects on event functions and their links.

9.11.17.12.6.1 List of event IDs

Various hardware and software functions send event IDs or require event IDs in order to start. The following table shows all of the IDs available to configure the module.

| Event ID | Description | |
|------------------------------------|---|----------------------------------|
| Direct event inputs | | |
| 512 | Comparator condition 1 | FALSE |
| 513 | | TRUE |
| 544 | Comparator condition 2 | FALSE |
| 545 | | TRUE |
| 576 | Comparator condition 3 | FALSE |
| 577 | | TRUE |
| 608 | Comparator condition 4 | FALSE |
| 609 | | TRUE |
| Counter comparator function | | |
| 2,112 | Counter function 1 | Event function 1; FALSE |
| 2,113 | | Event function 1; TRUE |
| 2,144 | | Event function 2; FALSE |
| 2,145 | | Event function 2; TRUE |
| 2,368 | Counter function 2 | Event function 1; FALSE |
| 2,369 | | Event function 1; TRUE |
| 2,400 | | Event function 2; FALSE |
| 2,401 | | Event function 2; TRUE |
| 2,624 | Counter function 3 | Event function 1; FALSE |
| 2,625 | | Event function 1; TRUE |
| 2,656 | | Event function 2; FALSE |
| 2,657 | | Event function 2; TRUE |
| 2,880 | Counter function 4 | Event function 1; FALSE |
| 2,881 | | Event function 1; TRUE |
| 2,912 | | Event function 2; FALSE |
| 2,913 | | Event function 2; TRUE |
| Edge events | | |
| 4,096 | Falling edge on I/O channel | Channel 1 |
| ... | | ... |
| 4,103 | | Channel 8 |
| 4,112 | Rising edge on I/O channel | Channel 1 |
| ... | | ... |
| 4,119 | | Channel 8 |
| 4,128 | Rising or falling edge on I/O channel | Channel 1 |
| ... | | ... |
| 4,135 | | Channel 8 |
| SSI counter events | | |
| 7,168 | SSI 1 | SSI valid |
| 7,169 | | SSI ready |
| 7,424 | SSI 2 | SSI valid |
| 7,425 | | SSI ready |
| SSI comparator events | | |
| 7,232 | SSI 1 comparator condition | FALSE |
| 7,233 | | TRUE |
| 7,488 | SSI 2 comparator condition | FALSE |
| 7,489 | | TRUE |
| Timerevents | | |
| 208 | Timer1 | 50 µs |
| 209 | Timer2 | 100 µs |
| 210 | Timer3 | 200 µs |
| 211 | Timer4 | 400 µs |
| 212 | Timer5 | 800 µs |
| 213 | Timer6 | 1600 µs |
| 214 | Timer7 | 3200 µs |
| 215 | Timer8 | 3200 µs (time offset to timer 7) |
| Network functions | | |
| 224 | SOAISOP (synchronous out asynchronous in start of protocol) | |
| 225 | AOSISOP (asynchronous out synchronous in start of protocol) | |
| 226 | SOAIEOP (synchronous out asynchronous in end of protocol) | |
| 227 | AOSIEOP (asynchronous out synchronous in end of protocol) | |
| Idle event | | |
| 192 | No-load operation | |

Timer

There are 8 timer events that the module can generate.

Information:

The timers have the highest event priority. All other system functions are interrupted when a timer event occurs, and jitter for the amount of time it takes to process the event.

Idle event

Idle time is the time that remains after the system has processed all higher priority events and operations. The module performs the following functions during idle time:

- Handling of the asynchronous protocol
- Mechanism for (re-)linking events
- Operation of LEDs
- Execution of event event functions linked to the idle function

9.11.17.12.6.2 Edge events

For each physical channel there are 3 event functions

- Falling edge
- Rising edge
- Falling and rising edge

The respective event is triggered when an edge is detected on the hardware input and the "[CfO_EdgeDetectRising](#)" on page 1294 and/or "[CfO_EdgeDetectFalling](#)" on page 1293 register has been configured for the respective channel.

Edges are detected by the hardware and processed for each interrupt. The interrupt handler uses an event distributor, which requires a specific amount of time for each edge to operate the hardware and execute linked event functions. To reduce this time, edge detection can be enabled/disabled individually for each channel. To optimize system load and I/O jitter, it is important to only enable edge detection where it is actually needed.

Information:

Edge detection can also be used for channels that are configured as outputs.

Event frequency limitation

To stabilize the system, there is a mechanism that limits the number of events created through edge recognition. At least one idle event must occur between two edge events for the same edge.

The "[CfO_FallingDisProtection](#)" on page 1294 and "[CfO_RisingDisProtection](#)" on page 1294 registers can be used to disable this limitation for each edge, and then an event will be generated for every edge. However, this can cause a system overload, i.e. I/O operation can fail for up to 100 ms before the module changes to the reset state.

Generate event on falling edge

Name:

CfO_EdgeDetectFalling

This register defines whether an event is generated on a falling edge.

| Data typ | Value | Bus controller default setting |
|----------|--------------------|--------------------------------|
| USINT | See bit structure. | 64 |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------|-------|--|
| 0 | Channel 1 | 0 | No event is generated on a falling edge (bus controller default setting). |
| | | 1 | Events 4096 and 4128 are generated on falling edge. |
| ... | ... | ... | ... |
| 6 | Channel 7 | 0 | No event is generated on a falling edge. |
| | | 1 | Events 4103 and 4135 are generated on a falling edge. (Bus controller default setting) |
| 7 | Channel 8 | 0 | No event is generated on a falling edge. (Bus controller default setting) |
| | | 1 | Events 4103 and 4135 are generated on a falling edge. |

Generate event on rising edge

Name:

CfO_EdgeDetectRising

This register defines whether an event is generated on a rising edge.

| Data type | Value | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| USINT | See bit structure. | 64 |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------|-------|---|
| 0 | Channel 1 | 0 | No event is generated on a rising edge. (Bus controller default setting) |
| | | 1 | Events 4112 and 4128 are generated on rising edge. |
| ... | | ... | |
| 6 | Channel 7 | 0 | No event is generated on a rising edge. |
| | | 1 | Events 4119 and 4135 are generated on a rising edge. (Bus controller default setting) |
| 7 | Channel 8 | 0 | No event is generated on a rising edge. (Bus controller default setting) |
| | | 1 | Events 4119 and 4135 are generated on a rising edge. |

Enable limit for falling edges

Name:

CfO_FallingDisProtection

This register can be used to enable/disable the [event frequency limit](#) for falling edges on the respective channel.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------|-------|---------------------------------|
| 0 | Channel 1 | 0 | Event frequency limit enabled. |
| | | 1 | Event frequency limit disabled. |
| ... | | ... | |
| 7 | Channel 7 | 0 | Event frequency limit enabled. |
| | | 1 | Event frequency limit disabled. |

Enable limit for rising edges

Name:

CfO_RisingDisProtection

This register can be used to enable/disable the [event frequency limit](#) for rising edges on the respective channel.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------|-------|---------------------------------|
| 0 | Channel 1 | 0 | Event frequency limit enabled. |
| | | 1 | Event frequency limit disabled. |
| ... | | ... | |
| 7 | Channel 8 | 0 | Event frequency limit enabled. |
| | | 1 | Event frequency limit disabled. |

9.11.17.12.6.3 Direct input functions

The module has 2 "direct input functions"

These event functions are based on comparator functionality. If the event configured in the "CfO_DIREKTIOevent0IDwr" on page 1295 register occurs, the event function compares the status of all Direct I/O channels enabled in the "CfO_EvCompMask" on page 1295 register to a status defined in the "CfO_DIREKTIOeventcompState" on page 1295 register. The event that is generated depends on the results of this comparison.

- If the respective bits are the same, then event number 513 or 545 is generated
- If the respective bits are different, then event number 512 or 544 is generated

Configure event ID for input function

Name:

CfO_DIREKTIOevent0IDwr to CfO_DIREKTIOevent1IDwr

This register holds the event ID generated by the direct input function. For a list of all possible event IDs, see ["List of event IDs" on page 1292](#)

| Data type | Value | Information |
|-----------|--------------|--|
| INT | 192 to 7,289 | ID of the event function. <u>Bus controller default setting:</u> CfO_DIREKTIOevent0IDwr: 0 CfO_DIREKTIOevent1IDwr: 4102 |

Configure the mode of the input function

Name:

CfO_DIREKTIOevent0mode to CfO_DIREKTIOevent1mode

The mode in which the direct input function operates can be set in this register.

Comparator functions can be operated in 4 different modes. For a description, see ["Comparator modes" on page 1306](#).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------|-------|--------------|
| 0 - 1 | Comparator mode | 0 | Off |
| | | 1 | Individual |
| | | 2 | State change |
| | | 3 | Continuous |
| 2 - 7 | Reserved | - | |

Comparator status for comparator mask

Name:

CfO_DIREKTIOevent0compState to CfO_DIREKTIOevent1compState

This register contains the status bits that are compared with the bits specified in the ["CfO_Ev0CompMask" on page 1295](#) register, which contain the I/O input status, when an event is received.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|--------------------------------|--------|-------------|
| 0 | Comparator status of channel 1 | 0 or 1 | |
| ... | | ... | |
| 7 | Comparator status of channel 8 | 0 or 1 | |

Configure the comparator mask for the input function

Name:

CfO_Ev0CompMask to CfO_Ev1CompMask

If a bit is set, then the input status of the respective channel is compared with that bit in the ["CfO_DIREKTIOevent-compState" on page 1295](#) register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------|-------|-------------------------|
| 0 | Channel 1 | 0 | Do not compare bit |
| | | 1 | Compare bit in register |
| ... | | ... | |
| 7 | Channel 8 | 0 | Do not compare bit |
| | | 1 | Compare bit in register |

9.11.17.12.6.4 Direct output functions

The module has 4 of these event functions

The effect of executing this event function is similar to writing to the ["DigitalOutput02 to 08" on page 1290](#) registers. When this event function is triggered, however, the changed output states are passed on to the hardware immediately, regardless of the X2X cycle.

When this event function is used, the masks of the respective outputs (see ["CfO_OutClearMask" on page 1288](#) and ["CfO_OutSetMask" on page 1289](#) registers) must be set to 1. Otherwise the output status would constantly be overwritten by the values in the ["DigitalOutput02 to 08" on page 1290](#) registers.

Configure event ID for output function

Name:

CfO_DIREKTIOevent0IDwr to CfO_DIREKTIOevent3IDwr

These registers hold the event IDs that trigger the direct output function. For a list of all possible event IDs, see ["List of event IDs" on page 1292](#)

| Data type | Value | Information |
|-----------|--------------|----------------------|
| INT | 192 to 7,489 | ID of event function |

Configure channels for resetting

Name:

CfO_DIREKTIOoutclearmask0 to CfO_DIREKTIOoutclearmask3

Writing "1" to the bit position that corresponds to a channel resets the output if the [output event function](#) is being executed. This corresponds to writing "0" to the ["DigitalOutput 02 to 08" on page 1290](#) registers.

The bit that corresponds to channels that should be reset should be set to "1" in the ["CfO_OutClearMask" on page 1288](#) register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------|-------|------------------------|
| 0 | Reserved | - | |
| 1 | Channel 2 | 0 | Reset channel 2 |
| | | 1 | Do not reset channel 2 |
| 2 | Reserved | - | |
| 3 | Channel 4 | 0 | Reset channel 4 |
| | | 1 | Do not reset channel 4 |
| 4 | Reserved | - | |
| 5 | Channel 6 | 0 | Reset channel 6 |
| | | 1 | Do not reset channel 6 |
| 6 | Reserved | - | |
| 7 | Channel 8 | 0 | Reset channel 8 |
| | | 1 | Do not reset channel 8 |

Configure channels for setting

Name:

CfO_DIREKTIOoutsetmask0 to CfO_DIREKTIOoutsetmask3

Writing "1" to the bit position that corresponds to a channel sets the output if the [output event function](#) is being executed. This corresponds to writing "1" to the ["DigitalOutput 02 to 08"](#) on page 1290 registers.

The bit that corresponds to channels that should be reset should be set to "1" in the ["CfO_OutSetMask"](#) on page 1289 register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------|-------|----------------------|
| 0 | Reserved | - | |
| 1 | Channel 2 | 0 | Set channel 2 |
| | | 1 | Do not set channel 2 |
| 2 | Reserved | - | |
| 3 | Channel 4 | 0 | Set channel 4 |
| | | 1 | Do not set channel 4 |
| 4 | Reserved | - | |
| 5 | Channel 6 | 0 | Set channel 6 |
| | | 1 | Do not set channel 6 |
| 6 | Reserved | - | |
| 7 | Channel 8 | 0 | Set channel 8 |
| | | 1 | Do not set channel 8 |

9.11.17.12.7 Counters and encoders

The module has 4 internal counter functions, each with 2 event counter registers. Each of these 4 counters is permanently assigned to 2 physical inputs. This assignment cannot be changed.

The counter registers perform different functions based on how the event functions are connected. The counter registers can be configured in the following ways:

- ABR counter
- AB counter
- Up/down counters
- Event counters

Different names are used for them in Automation Studio and in the register description to improve clarity.

| Channel | Counter function | Counter register | Name in Automation Studio |
|---------|------------------|------------------|--|
| 1 | 1 | 1 | ABEncoder01 ABREncoder01 Counter01 EventCounter01 |
| 2 | | 2 | EventCounter02 |
| 3 | 2 | 1 | ABEncoder02 Counter02 EventCounter03 |
| 4 | | 2 | EventCounter04 |
| 5 | 3 | 1 | ABEncoder03 ABREncoder02 Counter03 EventCounter05 |
| 6 | | 2 | EventCounter06 |
| 7 | 4 | 1 | ABEncoder04 Counter04 EventCounter07 |
| 8 | | 2 | EventCounter08 |

9.11.17.12.7.1 Counter value calculation

There are 3 steps for calculating the state of any counter function

1. The counter value is based on the 2 absolute value counters "abs1" and "abs2". These are only used internally in the module and cannot be read. Depending on the [mode](#), these registers show the respective physical input signals.

| | Mode | | |
|------|----------------------------|----------------------------------|---|
| | Edge counters | AB encoders | Up/down counter |
| abs1 | Edges of counter channel 1 | Increments in positive direction | Counter channel 2 = 0: Edges of counter channel 1 in up direction |
| abs2 | Edges of counter channel 2 | Increments in negative direction | Counter channel 2 = 1: Edges of counter channel 1 in down direction |

2. From the absolute value registers "abs1" and "abs2", 2 more counters are formed: "counter 1" and "counter 2". They are only used internally in the module and cannot be read. The following values are used for the calculation:

- Absolute value registers "abs1" and "abs2"
- SW_reference_counter 1 and 2: This reference value can be defined by the "[CfO_CounterPresetValue](#)" on [page 1304](#) register to allow referencing $\neq 0$.
- HW_reference_counter 1 and 2: In the "[CfO_CounterEventMode](#)" on [page 1308](#) register, you can configure whether latched values should be copied to these registers when [counter events](#) occur.

$$\begin{aligned} \text{counter1} &= \text{abs1} + \text{SW_reference_counter1} - \text{HW_reference_counter1} \\ \text{counter2} &= \text{abs2} + \text{SW_reference_counter2} - \text{HW_reference_counter2} \end{aligned}$$

3. The counter registers contain the sum of the two internal counters "counter 1" and "counter 2". The "[CfO_CounterConfigReg](#)" on [page 1303](#) register allows you to define a sign for each "counter" register and define whether or not it should be used.

$$\text{Counter register} = \text{counter1} + \text{counter2}$$

9.11.17.12.7.2 Sample configurations

All of the settings available in Automation Studio for ABR encoders, AB counters, up/down counters and event counters are based on the 2 counter functions.

The following configuration examples show the values with which Automation Studio initializes the module registers in order to implement these functions.

I/O configuration - AB encoder

The following table shows how the module's various event functions can be linked in order to configure an AB encoder.

[x] stands for the respective counter function, from 1 to 4

| Register | Value | Comment |
|--|--------------------------------------|--|
| For the function | | |
| CfO_Counter[x]config | 0x01 | Mode = Up/down counter |
| CfO_Counter[x]configReg0 | 0x0D | Configure the calculation of the internal "counter1" and "counter2" registers (see "Counter value calculation" on page 1298 and "Examples of calculation configurations" on page 1303) |
| For the latch | | |
| CfO_Counter[x]event0config | 0x000D | Configuration of the calculation of the first value used for the latch |
| CfO_Counter[x]event0mode | 0x03 | Mode of the first counter event function - Continuous |
| CfO_Counter[x]event0IDwr | (any) | Number of the event that should trigger Latch 1 ("Latch 01 - Channel" in the Automation Studio I/O configuration). |
| CfO_Counter[x]event1config | 0x0D | Configuration of the calculation of the second value used for the latch |
| CfO_Counter[x]event1mode | 0x03 | Mode of the second counter event function - Continuous |
| CfO_Counter[x]event1IDwr | (any) | Number of the event that should trigger Latch 2 |
| For the comparator | | |
| CfO_Counter1event1IDwr CfO_Counter3event1IDwr | 0x00D0 | Event number of Timer 1 (50 µs) Information: The latch and comparator must not have the same event number! |
| CfO_Counter1event1config CfO_Counter3event1config | 0x900D or 0xA00D | Configuration of the comparator for the second counter event |
| CfO_Counter1event1mode CfO_Counter3event1mode | 0x03 | Mode of the second counter event function - Continuous |
| CfO_DIREKTIOoutevent0IDwr CfO_DIREKTIOoutevent2IDwr | 0x0861 0x0A61 | TRUE event output of the second counter to trigger the direct output function (set outputs). |
| CfO_DIREKTIOoutsetmask0 CfO_DIREKTIOoutsetmask2 | 0x08, 0x20, 0x80 0x02, 0x08, 0x80 | Outputs that should be set when comparator condition = TRUE |
| CfO_DIREKTIOoutevent1IDwr CfO_DIREKTIOoutevent3IDwr | 0x0860 0x0A60 | FALSE event output of the second counter to trigger the direct output function (reset outputs). |
| CfO_DIREKTIOoutclearmask1 CfO_DIREKTIOoutclearmask3 | 0x08, 0x20, 0x80 0x02, 0x08, 0x80 | Outputs that should be reset when comparator condition = FALSE |

I/O configuration - ABR encoder

The following table shows how the module's various event functions can be linked in order to configure an ABR encoder.

| Register | Value | Comment |
|--|--------------------------------------|--|
| For the function | | |
| CfO_Counter1PresetValue1 CfO_Counter3PresetValue1 | (any) | Desired offset value for referencing |
| CfO_Counter1event0IDwr CfO_Counter3event0IDwr | 0x0201 | Link between the first counter event and the direct input comparator condition TRUE |
| CfO_Counter1config CfO_Counter3config | 0x01 | Mode = AB encoder |
| CfO_Counter1configReg0 CfO_Counter3configReg0 | 0x0D | Configure the calculation of the internal "counter1" and "counter2" registers (see "Counter value calculation" on page 1298 and "Examples of calculation configurations" on page 1303) |
| CfO_DIREKTIOevent0IDwr CfO_DIREKTIOevent1IDwr | 0x1002 or 0x1012 | Selection of the desired input edge as trigger for the ABR encoder function |
| CfO_Counter1event0config CfO_Counter3event0config | 0x0000 | Configuration of the first counter event (for referencing) |
| CfO_DIREKTIOevent0mode CfO_DIREKTIOevent1mode | 0x03 | Mode of the "direct input function" - Continuous |
| CfO_DIREKTIOevent0compState CfO_DIREKTIOevent1compState | 0x00 or 0x08 | Comparator status for the "direct input function" |
| CfO_Ev0CompMask CfO_Ev1CompMask | 0x08 | Comparator mask for the "direct input function" |
| For the latch | | |
| CfO_Counter1event0config CfO_Counter3event1config | 0x000D | Configuration of the calculation of the value used for the latch |
| CfO_Counter1event0mode CfO_Counter3event1mode | 0x03 | Mode of the first counter event function - Continuous |
| CfO_Counter1event0IDwr CfO_Counter3event1IDwr | (any) | Number of the event that should trigger the latch |
| For the comparator | | |
| CfO_Counter1event1IDwr CfO_Counter3event1IDwr | 0x00D0 | Event number of Timer 1 (50 µs) Information: The latch and comparator must not have the same event number! |
| CfO_Counter1event1config CfO_Counter3event1config | 0x900D or 0xA00D | Configuration of the comparator for the second counter event |
| CfO_DIREKTIOoutevent0IDwr CfO_DIREKTIOoutevent2IDwr | 0x0861 0x0A61 | TRUE event output of the second counter to trigger the direct output function (set outputs). |
| CfO_DIREKTIOoutsetmask0 CfO_DIREKTIOoutsetmask2 | 0x08, 0x20, 0x80 0x02, 0x08, 0x80 | Outputs that should be set when comparator condition = TRUE |
| CfO_DIREKTIOoutevent1IDwr CfO_DIREKTIOoutevent3IDwr | 0x0860 0x0A60 | FALSE event output of the second counter to trigger the direct output function (reset outputs). |
| CfO_DIREKTIOoutclearmask1 CfO_DIREKTIOoutclearmask3 | 0x08, 0x20, 0x80 0x02, 0x08, 0x80 | Outputs that should be reset when comparator condition = FALSE |

I/O configuration - Up/down counter

The following table shows how the module's various event functions can be linked in order to configure an up/down counter.

[x] stands for the respective counter function, from 1 to 4

| Register | Value | Comment |
|--|--------------------------------------|--|
| For the function | | |
| CfO_Counter[x]config | 0x03 | Counter mode = Up/down counter |
| CfO_Counter[x]configReg0 | 0x0D, 0x07 | Configure the calculation of the internal "counter1" and "counter2" registers (see "Counter value calculation" on page 1298 and "Examples of calculation configurations" on page 1303) |
| For the latch | | |
| CfO_Counter[x]event0config | 0x0D, 0x07 | Configuration of the calculation of the first value used for the latch |
| CfO_Counter[x]event0mode | 0x03 | Mode of the first counter function - Continuous |
| CfO_Counter[x]event0IDwr | (any) | Number of the event that should trigger Latch 1 |
| CfO_Counter[x]event1config | 0x0D, 0x07 | Configuration of the calculation of the second value used for the latch |
| CfO_Counter[x]event1mode | 0x03 | Mode of the second counter function - Continuous |
| CfO_Counter[x]event1IDwr | (any) | Number of the event that should trigger Latch 2 |
| For the comparator | | |
| CfO_Counter1event1IDwr CfO_Counter3event1IDwr | 0x00D0 | Event number of Timer 1 (50 µs) Information: The latch and comparator must not have the same event number! |
| CfO_Counter1event1config CfO_Counter3event1config | 0x900D, 0xA00d or 0x9007, 0xA007 | Configuration of the comparator for the second counter event |
| CfO_Counter1event1mode CfO_Counter3event1mode | 0x03 | Mode of the second counter event function - Continuous |
| CfO_DIREKTIOoutevent0IDwr CfO_DIREKTIOoutevent2IDwr | 0x0861 | TRUE event output of the second counter to trigger the direct output function (set outputs). |
| CfO_DIREKTIOoutsetmask0 CfO_DIREKTIOoutsetmask2 | 0x08, 0x20, 0x80 0x02, 0x08, 0x80 | Outputs that should be set when comparator condition = TRUE |
| CfO_DIREKTIOoutevent1IDwr CfO_DIREKTIOoutevent3IDwr | 0x0860 0x0A60 | FALSE event output of the second counter to trigger the direct output function (reset outputs). |
| CfO_DIREKTIOoutclearmask1 CfO_DIREKTIOoutclearmask3 | 0x08, 0x20, 0x80 0x02, 0x08, 0x80 | Outputs that should be reset when comparator condition = FALSE |

I/O configuration - Event counter

The following table shows how the module's various event functions can be linked in order to configure an event counter.

[x] stands for the respective counter function, from 1 to 4

| Register | Value | Comment |
|---|--------------|--|
| For event counters on channels 1, 3, 5 and 7 | | |
| CfO_Counter[x]configReg0 | 0x01 or 0x03 | Configure the calculation of the internal "counter1" and "counter2" registers (see "Counter value calculation" on page 1298 and "Examples of calculation configurations" on page 1303) |
| CfO_Counter[x]event0mode | 0x43 | Mode of the first counter event function and referencing configuration |
| CfO_Counter[x]event0IDwr | (any) | Number of the event that should trigger referencing |
| For event counters on channels 2, 4, 6 and 8 | | |
| CfO_Counter[x]configReg1 | 0x04 or 0x08 | Configure the calculation of the internal "counter1" and "counter2" registers (see "Counter value calculation" on page 1298 and "Examples of calculation configurations" on page 1303) |
| CfO_Counter[x]event1mode | 0x83 | Mode of the second counter event function and referencing configuration |
| CfO_Counter[x]event1IDwr | (any) | Number of the event that should trigger referencing |

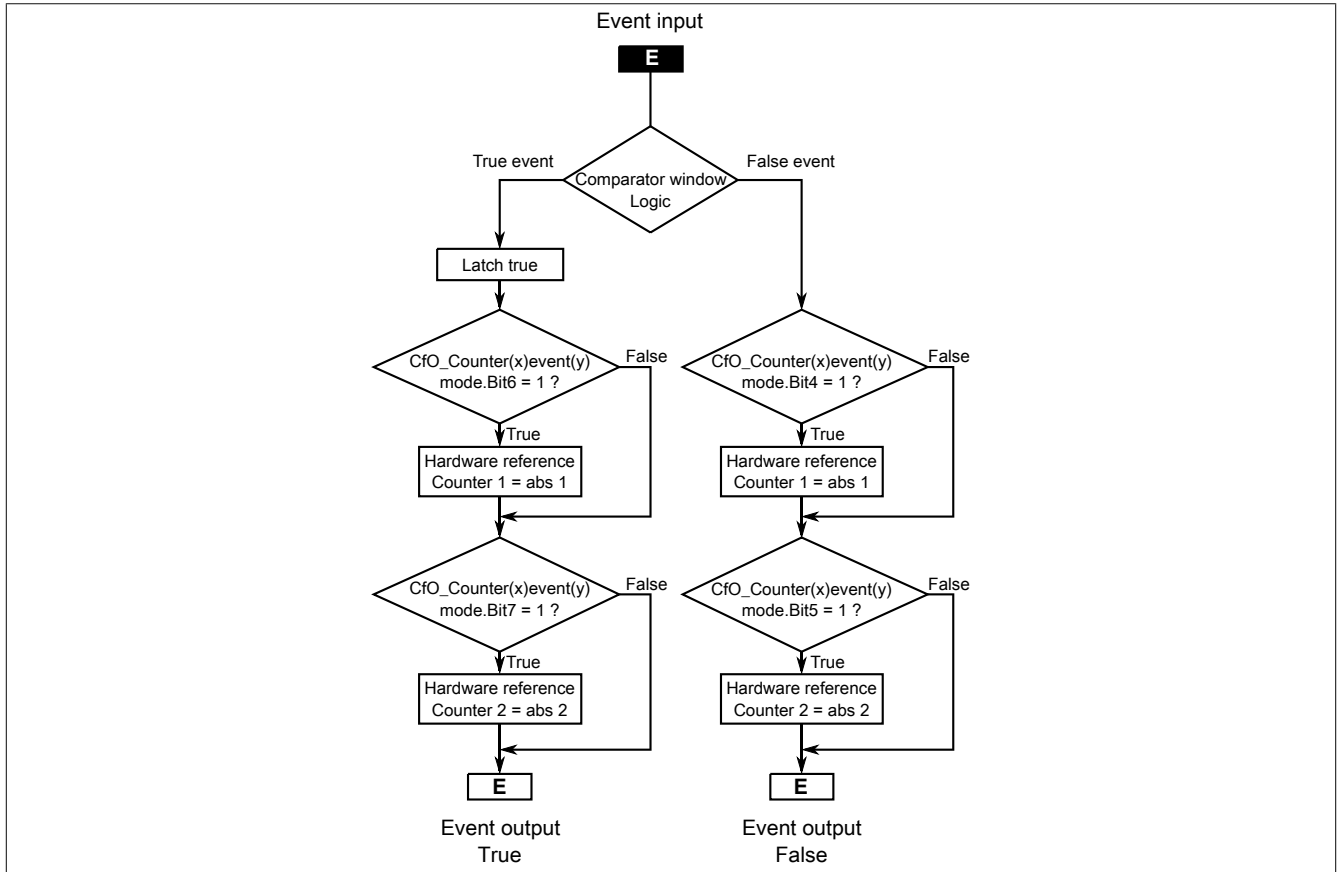
9.11.17.12.7.3 General event functions

Each of the 4 counter functions has 2 counter event functions. These consist of:

- Event ID that triggers the counter event function
- A window comparator
- Latch register for saving the counter value

When the counter event function is complete, a combined event ID in the range 2112 to 2913 (see "List of event IDs" on page 1292) is sent.

Each counter event function also has the option to copy the current counter value to the "HW reference counter" when an event occurs (see "Counter value calculation" on page 1298).



Configure counter mode

Name:

CfO_Counter1config to CfO_Counter4config

The counting mode for the counter function can be configured in these registers. Each counter function can be operated in 3 different modes.

| | Counter function mode | | |
|---------------------------------|-----------------------------------|------------|---|
| | Edge counter | AB encoder | Up/Down counter |
| Counter channel 1 ¹⁾ | Counting pulses of edge counter 1 | A | Metering pulses |
| Counter channel 2 ¹⁾ | Counting pulses of edge counter 2 | B | Counting direction (0 = Positive, 1 = Negative) |
| Counter register 1 | Counter value 1 | Position | Counter value |
| Counter register 2 | Counter value 2 | | |

1) Corresponds to the physical channels of the counter functions. See "Description of channel assignments" on page 1280.

| Data type | Values | Bus controller default setting ¹⁾ |
|-----------|------------------------|--|
| USINT | See the bit structure. | CfO_CounterNconfig N(2): 0 N(3): 1 |

1) The bus controller default value applies only to the register numbers specified in function model 254.

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------|-------|---|
| 0 - 1 | Counter mode | 00 | Edge counter |
| | | 01 | Encoder AB (bus controller default setting) |
| | | 11 | Up/Down counter |
| 2 - 7 | Reserved | - | |

Configuring the calculation of internal counters

Name:

CfO_Counter1configReg0 to CfO_Counter4configReg0 ("counter1")

CfO_Counter1configReg1 to CfO_Counter4configReg1 ("counter2")

The calculation of internal registers "counter1" and "counter2" can be configured in these registers. For information about using these internal registers, see "Counter value calculation" on page 1298.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--|
| USINT | See the bit structure. | CfO_CounterNconfigReg0 N(2): 1 N(3): 13 CfO_CounterNconfigReg1 N(2,3): 0 |

1) The bus controller default value applies only to the register numbers specified in function model 254.

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------|-------|--|
| 0 | counter 1 - use | 0 | 0 is added instead of "counter 1" |
| | | 1 | "counter 1" is used for addition |
| 1 | counter 1 - sign | 0 | The sign of the "counter 1" register is not changed for addition |
| | | 1 | The sign of the "counter 1" register is reversed for addition |
| 2 | counter 2 - use | 0 | 0 is added instead of "counter 2" |
| | | 1 | "counter 2" is used for addition |
| 3 | counter 2 - sign | 0 | The sign of the "counter 2" register is not changed for addition |
| | | 1 | The sign of the "counter 2" register is reversed for addition |
| 4 - 7 | Reserved | - | |

Examples of calculation configurations

| | | |
|------------|--------|--|
| 0b00000001 | = 0x01 | Only the "counter1 - use" bit is set, entering the contents of the "counter" (edge of counter event channel 1) directly in the counter register. |
| 0b00000011 | = 0x03 | "counter 1 - use" and "counter1 - sign" bits are set. The sign is changed so that the counter register counts in the negative direction. |
| 0b00001101 | = 0x0d | Edges on counter input channel 1 increase the value in the counter register. Edges on counter input channel 2 decrease the value in the counter register. This value is the best setting for modes "AB counter" and "Up/Down counter". |

Offset value for referencing

Name:

CfO_Counter1PresetValue1 to CfO_Counter4PresetValue1

CfO_Counter1PresetValue1_32Bit to CfO_Counter4PresetValue1_32Bit (SW_reference_counter1)

CfO_Counter1PresetValue2 to CfO_Counter4PresetValue2

CfO_Counter1PresetValue2_32Bit to CfO_Counter4PresetValue2_32Bit (SW_reference_counter2)

These registers can be used to define an offset value for referencing. This value is copied to the internal "SW_reference_counter" on page 1298 register of the respective counter register.

| Data type | Value | Information |
|-----------|---------------------------------|---|
| INT | -32768 to 32767 | Bus controller default setting: 0 ¹⁾ |
| DINT | -2,147,483,648 to 2,147,483,647 | |

1) The bus controller default value applies only to the register numbers specified in function model 254.

Counter register

Name:

Different names are used for these 8 registers depending on their function.

These 8 registers show the results of the [counter value calculation](#) for the respective register. Depending on the function, this corresponds to either the encoder position or the counter value.

For information on the relationship between physical channels and counter registers, see ["Counters and encoders" on page 1298](#) and ["Description of channel assignments" on page 1280](#)

| Counter 1 - Counter channel 1 | | |
|-------------------------------|------------------|----------------|
| Counter register | Function | Name |
| 1 | AB encoders | ABEncoder01 |
| | ABR encoders | ABREncoder01 |
| | Up/down counters | Counter01 |
| | Event counters | EventCounter01 |
| 2 | Event counters | EventCounter02 |

| Counter 1 - Counter channel 2 | | |
|-------------------------------|------------------|----------------|
| Counter register | Function | Name |
| 1 | AB encoders | ABEncoder02 |
| | Up/down counters | Counter02 |
| | Event counters | EventCounter03 |
| 2 | Event counters | EventCounter04 |

| Counter 2 - Counter channel 1 | | |
|-------------------------------|------------------|----------------|
| Counter register | Function | Name |
| 1 | AB encoders | ABEncoder03 |
| | ABR encoders | ABREncoder02 |
| | Up/down counters | Counter03 |
| | Event counters | EventCounter05 |
| 2 | Event counters | EventCounter06 |

| Counter 2 - Counter channel 2 | | |
|-------------------------------|------------------|----------------|
| Counter register | Function | Name |
| 1 | AB encoders | ABEncoder04 |
| | Up/down counters | Counter04 |
| | Event counters | EventCounter07 |
| | Event counters | EventCounter08 |
| 2 | Event counters | EventCounter08 |

| Data type | Value | Information |
|--------------------|---------------------------------|-----------------------------------|
| INT | -32,768 to 32,767 | Encoder position or counter value |
| DINT ¹⁾ | -2,147,483,648 to 2,147,483,647 | Encoder position or counter value |

1) Only in function model 1

Status of the ABR encoder

Name:

StatusABR01 to StatusABR02

The referencing status of the ABR encoder is shown in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|--------|---|
| 0 - 1 | Reserved | 0 | |
| 2 | Bit is always 1 after the first reference pulse. | 0 | No reference pulses have occurred since the start of referencing. |
| | | 1 | The first reference pulse has occurred. |
| 3 | State change when referencing is complete | 0 or 1 | State change when referencing is complete |
| 4 | Bit is always 1 after the first reference pulse. | 0 | No reference pulses have occurred since the start of referencing. |
| | | 1 | The first reference pulse has occurred. |
| 5 - 7 | Continuous counter | xxx | Increased with each reference pulse |

Examples of possible values

| | | |
|------------|--------|--|
| 0b00000000 | = 0x00 | Referencing OFF or homing procedure already active |
| 0b00111100 | = 0x3C | First reference complete, reference value applied in the "ABREncoder0" on page 1304 register |
| 0bxxx11100 | = 0xxB | Bits 5 to 7 are changed with each reference pulse |
| 0bxxx1x100 | = 0xxx | Bits changed continuously with the setting continuous referencing. With every reference pulse, the reference value is applied to the "ABREncoder0" on page 1304 register |

Configure ABR referencing mode

Name:

ReferenceModeABR01 to ReferenceModeABR02

The bits in this register are used to configure the reaction to the configured reference pulse.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------------------|-------|-------------------------|
| 0 - 1 | Sets the referencing mode | 00 | Referencing OFF |
| | | 01 | Single shot referencing |
| | | 10 | Reserved |
| | | 11 | Continuous referencing |
| 2 - 5 | Reserved | - | |
| 6 - 7 | Reserved | 11 | Must always be 11! |

This results in the following values:

| | | |
|------------|--------|---|
| 0b00000000 | = 0x00 | Referencing OFF |
| 0b11000001 | = 0xC1 | Single shot referencing → When starting over after the referencing process is complete, the value 0x00 must be written to start again. Wait until the "StatusABR" on page 1305 register also takes on the value 0x00, then the value 0xC1 can be written again. |
| 0b11000011 | = 0xC3 | Continuous referencing → Referencing takes place automatically with every reference pulse |

9.11.17.12.7.4 Comparator functions

The ABR and AB counters and the up/down counter have a comparator function. It always works the same and is described here globally for all three.

The comparators are implemented in software form. They do not work actively but rather passively, i.e. the comparison is only carried out when an event is received. The event received is forwarded along the TRUE or FALSE branch depending on the status of the comparator condition. An event function like this generally also offers a latch for the TRUE and FALSE branch to save the value used for the comparator at the time of the event.

Comparator modes

Comparator functions can be operated in 4 different modes.

- **Off**
Events are ignored.
- **Individual**
The event function is executed once and then disables itself automatically. To re-enable it, the "event function mode" must be changed, preferably to "off" and then to the desired mode. This setting allows a hardware latch to be simulated.
- **State change**
The event function only responds when the comparator status has changed, i.e. from false to true (or vice versa). Only the first event for each status is processed, e.g. the first "true" of a sequence of events with the comparator condition "true". After the event function is enabled, the first incoming event is used to determine the starting status and therefore not forwarded. This setting allows a hardware comparator to be simulated.
- **Continuous**
Each incoming event is forwarded to the true or false branch depending on the comparator condition. This setting allows event filters to be created.

Configure event ID for comparator

Name:

CfO_Counter1event0IDwr to CfO_Counter4event0IDwr (event function 1)

CfO_Counter1event1IDwr to CfO_Counter4event1IDwr (event function 2)

This register holds the event ID that should trigger the counter event function. For a list of all possible event IDs, see "[List of event IDs](#)" on page 1292

| Data type | Value | Information |
|-----------|--------------|---|
| INT | 192 to 7,489 | ID of counter event function Bus controller default setting: ¹⁾ CfO_Counter3event0IDwr: 545 All others: 0 |

1) The bus controller default value applies only to the register numbers specified in function model 254.

Configure calculation of comparator

Name:

CfO_Counter1event0config to CfO_Counter4event0config (event function 1)

CfO_Counter1event1config to CfO_Counter4event1config (event function 2)

The counter event function of the respective counter function can be configured in these registers.

Bits 0 to 3 configure the calculation of the comparison or latch the value used. This calculation is similar to the calculation of the counter registers (see "Counter value calculation" on page 1298)

Bits 8 to 13 can be used to limit the number of bits used for the comparison. A mask is created from $2^n - 1$ in which an AND operation is performed before the comparison. This makes it possible to generate a comparator pulse every 2^n increments.

| Data type | Values | Bus controller default setting ¹⁾ |
|-----------|------------------------|--|
| UINT | See the bit structure. | 0 |

1) The bus controller default value applies only to the register numbers specified in function model 254.

Bit structure:

| Bit | Description | Value | Information |
|--------|-------------------------------------|-------|---|
| 0 | counter1 - Use | 0 | 0 is added instead of register "counter1" (bus controller default setting). |
| | | 1 | "counter1" is used for addition. |
| 1 | counter1 - Sign | 0 | The sign of register "counter1" is not changed for addition (bus controller default setting). |
| | | 1 | The sign of register "counter1" is reversed for addition. |
| 2 | counter2 - Use | 0 | 0 is added instead of register "counter2" (bus controller default setting). |
| | | 1 | "counter2" is used for addition. |
| 3 | counter2 - Sign | 0 | The sign of register "counter2" is not changed for addition (bus controller default setting). |
| | | 1 | The sign of register "counter2" is reversed for addition. |
| 4 - 7 | Reserved | - | |
| 8 - 13 | Number of bits for comparator mask | x | The mask value is calculated as $2^n - 1$, where n is value set in these bits. (Bus controller default setting: 0) |
| 14 | Reserved | - | |
| 15 | Comparison mode of the window width | 0 | $\text{MarginComparator} \geq (\text{Current position} - \text{OriginComparator})$ (bus controller default setting) |
| | | 1 | $\text{MarginComparator} > (\text{Current position} - \text{OriginComparator})$ |

Configure mode and latching of comparator function

Name:

CfO_Counter1event0mode to CfO_Counter4event0mode (event function 1)

CfO_Counter1event1mode to CfO_Counter4event1mode (event function 2)

In these registers you can set the mode for the comparator function and optional copying of the latched registers.

Comparator functions can be operated in 4 different modes. For a description, see "Comparator modes" on page 1306.

Bits 4 to 7 can be used to define hardware referencing actions.

Based on these bits, the values of the internal absolute value counters "abs1" and "abs2" can be copied to the respective "HW_reference_counter" register at every counter event (see "Counter value calculation" on page 1298). This function can be used to reference the counter values directly in the hardware.

| Data type | Values | Bus controller default setting ¹⁾ |
|-----------|------------------------|--|
| USINT | See the bit structure. | 0 |

1) The bus controller default value applies only to the register numbers specified in function model 254.

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------------------|-------|---|
| 0 - 1 | Comparator mode | 0 | Off |
| | | 1 | Individual |
| | | 2 | State change |
| | | 3 | Continuous |
| 2 - 3 | Reserved | - | |
| 4 | Copy abs1 counter value | 0 | No action |
| | | 1 | When event is FALSE → hardware reference counter 1 = abs1 |
| 5 | Copy abs2 counter value | 0 | No action |
| | | 1 | When event is FALSE → hardware reference counter 2 = abs2 |
| 6 | Copy abs1 counter value | 0 | No action |
| | | 1 | When event is TRUE → hardware reference counter 1 = abs1 |
| 7 | Copy abs2 counter value | 0 | No action |
| | | 1 | When event is TRUE → hardware reference counter 2 = abs2 |

Comparator origin

Name:

OriginComparator01 to OriginComparator02 (ABR encoder)

OriginComparator01 and OriginComparator03 (AB encoder and up/down counter)

This register is available for the comparator function of the ABR encoder, AB counter and up/down counter.

It defines the position value at which the respective configured comparator output channel is set.

| Data type | Value | Information |
|-----------|---------------------------------|----------------------------------|
| INT | -32,768 to 32,767 | Comparator window origin, 16-bit |
| DINT | -2,147,483,648 to 2,147,483,647 | Comparator window origin, 32-bit |

Width of the comparator

Name:

MarginComparator01 to MarginComparator02 (ABR encoder)

MarginComparator01 and MarginComparator03 (AB encoder and up/down counter)

This register is available for the AB and ABR encoders and the up/down counters.

It defines the width of the comparator window in the positive direction.

| Data type | Value | Information |
|-----------|---------------------------------|------------------------------------|
| INT | -32768 to 32767 | Width of comparator window, 16-bit |
| DINT | -2,147,483,648 to 2,147,483,647 | Width of comparator window, 32-bit |

Read latch position or counter value

Name:

Different names are used for these 4 registers depending on their function.

If the comparator returns "TRUE", then the current counter value is latched and copied to these registers. The calculation of the comparator value used for the latch can be configured in the "[CfO_Counter\[x\]event\[y\]config](#)" on [page 1307](#) register.

| Counter 1 - Latch 1 | | |
|---------------------|------------------|------------------|
| Event function | Function | Name |
| 1 | AB encoders | Latch01AB01 |
| | Up/down counters | Latch01Counter01 |
| 2 | AB encoders | Latch02AB01 |
| | ABR encoders | Latch01ABR01 |
| | Up/down counters | Latch02Counter01 |

| Counter 1 - Latch 2 | | |
|---------------------|------------------|------------------|
| Event function | Function | Name |
| 1 | AB encoders | Latch01AB02 |
| | Up/down counters | Latch01Counter02 |
| 2 | AB encoders | Latch02AB02 |
| | Up/down counters | Latch02Counter02 |

| Counter 2 - Latch 1 | | |
|---------------------|------------------|------------------|
| Event function | Function | Name |
| 1 | AB encoders | Latch01AB03 |
| | Up/down counters | Latch01Counter03 |
| 2 | AB encoders | Latch02AB03 |
| | ABR encoders | Latch01ABR02 |
| | Up/down counters | Latch02Counter03 |

| Counter 2 - Latch 2 | | |
|---------------------|------------------|------------------|
| Event function | Function | Name |
| 1 | AB encoders | Latch01AB04 |
| | Up/down counters | Latch01Counter04 |
| 2 | AB encoders | Latch02AB04 |
| | Up/down counters | Latch02Counter04 |

| Data type | Value | Information |
|--------------------|---------------------------------|---|
| INT | -32,768 to 32,767 | Latched encoder position or counter value |
| DINT ¹⁾ | -2,147,483,648 to 2,147,483,647 | Latched encoder position or counter value |

1) Only in function model 1

9.11.17.12.8 SSI encoder interface

The module has 2 SSI encoders available, supported directly in the hardware. Two 24 V output channels are set for each SSI encoder and cannot be changed. (See also ["Description of channel assignments" on page 1280](#))

When using the SSI encoder, the corresponding clock channel can be configured in the ["CfO_CFGchannel" on page 1288](#) register as "Channel-specific" and "Push/Pull".

| Encoder | Data channel | Clock channel |
|---------|--------------|---------------|
| SSI1 | 1 | 2 |
| SSI2 | 5 | 6 |

9.11.17.12.8.1 SSI event functions

Each of the 2 SSI encoders consists of an event function and an event input. The SSI cycle is started when an event is received on this input.

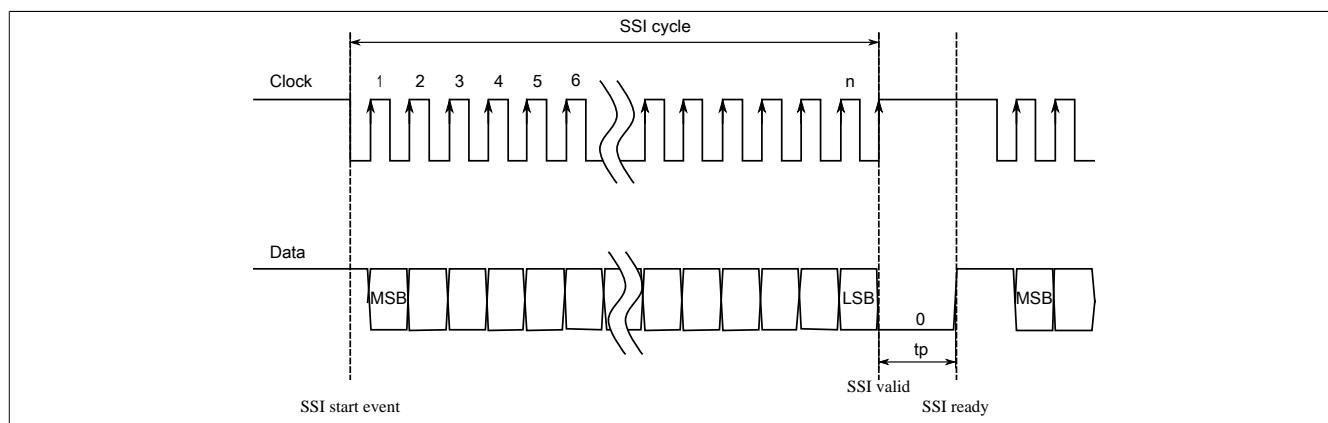
Information:

The SSI event function is not linked to an event by default, i.e. SSI functions are disabled.

2 events are transmitted from the SSI encoder interface.

- An "SSI valid" event is triggered immediately after the end of the SSI cycle if a new counter value is available.
- The "SSI ready" event then shows when the monoflop time has expired (t_p in SSI encoder timing diagram). This is the earliest that the next SSI cycle can be started.

SSI encoder - Timing diagram



Configure event ID for SSI

Name:

CfO_SSI1eventIDwr to CfO_SSI2eventIDwr

This register holds the event ID that should start the SSI cycle. For a list of all possible event IDs, see ["List of event IDs" on page 1292](#)

Normally this register is set to network event 225 "AOSISOP"- This ensures that the new encoder position is available at the next "I/O → Synchronous Frame" transfer. Check the SSI transfer time and the X2X cycle time, because the SSI cycle must be completed within this time.

| Data type | Value | Information |
|-----------|--------------|--|
| INT | 192 to 7,233 | ID of event function Bus controller default setting: 225¹⁾ |

1) The bus controller default value applies only to the register numbers specified in function model 254.

Configure SSI

Name:

CfO_SSI1cfg to CfO_SSI2cfg

This configuration register sets the encoding, clock rate and number of bits.

| Data type | Values | Bus controller default setting ¹⁾ |
|-----------|------------------------|--|
| UINT | See the bit structure. | 0 |

1) The bus controller default value applies only to the register numbers specified in function model 254.

Bit structure:

| Bit | Description | Value | Information |
|--------|----------------------|-------|--|
| 0 - 5 | SSI value valid bits | x | |
| 6 - 7 | Clock rate | 00 | 1 MHz (bus controller default setting) |
| | | 01 | 500 kHz |
| | | 10 | 250 kHz |
| | | 11 | 125 kHz |
| 8 - 13 | SSI number of bits | x | Number of bits including leading zeros |
| 14 | Reserved | 0 | |
| 15 | Keying | 0 | Binary encoding (bus controller default setting) |
| | | 1 | Gray encoding |

SSI advanced configuration

Name:

ConfigAdvanced01 to ConfigAdvanced02

This configuration register is used to set the coding, the clock rate, the number of bits and the monostable multi-vibrator settings.

It only differs from "[CfO_SSI1cfg](#)" on page 1311 by data length and additional monostable multivibrator testing.

| Data type | Value | Bus controller default setting ¹⁾ |
|-----------|--------------------|--|
| UDINT | See bit structure. | 0x10000 |

1) The bus controller default value applies only to the register number specified in function model 254.

Bit structure:

| Bit | Name | Value | Information |
|---------|--------------------------------|-------|--|
| 0 - 5 | SSI value valid bits | x | Bus controller default setting: 0 |
| 6 - 7 | Clock rate | 00 | 1 MHz (bus controller default setting) |
| | | 01 | 500 kHz |
| | | 10 | 250 kHz |
| | | 11 | 125 kHz |
| 8 - 13 | SSI number of bits | x | Number of bits including leading zeros. Bus controller default setting: 0 |
| 14 | Reserved | 0 | |
| 15 | Encoding | 0 | Binary encoding (bus controller default setting) |
| | | 1 | Gray encoding |
| 16 - 17 | Monostable multivibrator check | 00 | Check OFF, no additional clock bit |
| | | 01 | Check set to high level (bus controller default setting) |
| | | 10 | Check set to low level |
| | | 11 | Level is clocked but ignored |
| 18 - 31 | Reserved | 0 | |

Enable SSI event function

Name:

CfO_SSI1control to CfO_SSI2control

The 2 "[SSI encoder events](#)" on page 1310 can be enabled/disabled using this register.

| Data type | Values | Bus controller default setting ¹⁾ |
|-----------|------------------------|--|
| USINT | See the bit structure. | 0 |

1) The bus controller default value applies only to the register numbers specified in function model 254.

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------|-------|--|
| 0 | Event: "SSI valid" | 0 | Not transmitted (bus controller default setting) |
| | | 1 | Sent |
| 1 | Event: "SSI ready" | 0 | Not sent |
| | | 1 | Sent |
| 2 - 7 | Reserved | - | |

Read SSI position

Name:

SSIEncoder01 to SSIEncoder02

The last transferred SSI position can be read out from this register. The SSI encoder value is displayed as a 32-bit position value. This position value is generated synchronously with the X2X cycle.

| Data type | Value | Information |
|-----------|--------------------|-------------------------------|
| UDINT | 0 to 4,294,967,295 | Last SSI position transferred |

9.11.17.12.8.2 SSI comparator condition

The module has an assigned comparator function for the SSI function. These consist of:

- Event ID that triggers the comparator function
- The window comparator
- Latch register for saving the counter value

When the comparator function is complete, event ID 7232 to 7489 (see "[List of event IDs](#)" on page 1292) is sent.

Configure event ID for SSI comparator

Name:

CfO_SSI1event0IDwr to CfO_SSI2event0IDwr

This register holds the event ID that should start the SSI comparator function. For a list of all possible event IDs, see "[List of event IDs](#)" on page 1292

| Data type | Value | Information |
|-----------|--------------|--|
| INT | 192 to 7,233 | ID of comparator function Bus controller default setting: 0 ¹⁾ |

1) The bus controller default value applies only to the register numbers specified in function model 254.

Configure the mode of the SSI comparator function

Name:

CfO_SSI1event0mode to CfO_SSI2event0mode

This register can be used to configure the mode of the comparator function.

Comparator functions can be operated in 4 different modes. For a description, see "[Comparator modes](#)" on page 1306.

| Data type | Values | Bus controller default setting ¹⁾ |
|-----------|------------------------|--|
| USINT | See the bit structure. | 0 |

1) The bus controller default value applies only to the register numbers specified in function model 254.

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------|-------|--------------|
| 0 - 1 | Comparator mode | 0 | Off |
| | | 1 | Individual |
| | | 2 | State change |
| | | 3 | Continuous |
| 2 - 7 | Reserved | - | |

Configure calculation of SSI comparator

Name:

CfO_SSI1event0config and CfO_SSI2event0config

The calculation of the position value used for the comparator can be configured in this register.

The window comparator condition is calculated as follows:

```

counter_window_value = ssi_counter & (2^ssi_data_bits - 1)
diff = counter_window_value - origin_comparator
if ((diff & (2^(comparator_mask)-1)) <= margin_comparator)
condition = True;
else
condition = False;

```

| Data type | Values | Bus controller default setting ¹⁾ |
|-----------|------------------------|--|
| USINT | See the bit structure. | 0 |

1) The bus controller default value applies only to the register numbers specified in function model 254.

Bit structure:

| Bit | Description | Value | Information |
|--------|-----------------|-------|--|
| 0 - 5 | SSI data bits | x | Number of data bits used for masking |
| 6 - 7 | Reserved | - | |
| 8 - 13 | Comparator mask | x | The mask value is calculated from $2^n - 1$, where n is the value configured in SSI data bits. Default: 0 |
| 14 | Comparator mode | 0 | $\text{MarginComparator} \geq \text{SSI position} - \text{OriginComparator}$ |
| | | 1 | $\text{MarginComparator} > \text{SSI position} - \text{OriginComparator}$ |

Origin of the SSI comparator

Name:

OriginComparator01_SSI to OriginComparator02_SSI

This register contains the origin of the window comparator.

| Data type | Value | Information |
|-----------|--------------------|----------------------------------|
| UDINT | 0 to 4,294,967,295 | Origin of the window comparator. |

Width of the SSI comparator

Name:

MarginComparator01_SSI to MarginComparator02_SSI

This register provides the width of the window comparator.

| Data type | Value | Information |
|-----------|--------------------|------------------------------------|
| UDINT | 0 to 4,294,967,295 | Width of the SSI window comparator |

Read SSI latch position

Name:

Latch01SSI01 to Latch01SSI02

If the SSI window comparator returns "True", then the current SSI position is latched and saved in this register.

| Data type | Value | Information |
|-----------|--------------------|----------------------|
| UDINT | 0 to 4,294,967,295 | Latched SSI position |

9.11.17.12.9 PWM - Pulse width modulation

The module has 4 PWM functions available, supported directly by the hardware. A 24 V output channel is set for each PWM encoder and cannot be changed. (See also "[Description of channel assignments](#)" on page 1280)

When using the PWM function, the corresponding channel can be configured in the "[CfO_CFGchannel](#)" on page 1288 register as "Channel-specific".

| PWM function | Channel |
|--------------|---------|
| PWM1 | 2 |
| PWM2 | 4 |
| PWM3 | 6 |
| PWM4 | 8 |

9.11.17.12.9.1 Configure PWM prescaler

Name:

CfO_PWM0prescaler to CfO_PWM3prescaler

The length of the PWM cycle is configured using this register. The base is a 48 MHz clock, which can be changed (divided) using the setting in this register. One PWM cycle consists of 1000 of the resulting clocks after they have been divided. The period duration of the PWM cycle is calculated as follows:

$$\text{PWM_cycle} = 1000 \frac{\text{prescale}}{48000000} \text{ [s]}$$

| Data type | Value | Information |
|-----------|------------|--|
| UINT | 2 to 65535 | Prescaler for PWM cycle Bus controller default setting: 480 ¹⁾ |

1) The bus controller default value applies only to the register numbers specified in function model 254.

9.11.17.12.9.2 Output PWM values

Name:

PWMOutput02, PWMOutput04, PWMOutput06, PWMOutput08

In this register, a configuration is made for the percentage of the PWM cycle (in 1/10% steps) that the PWM output is logical 1, i.e. ON.

| Data type | Value | Information |
|-----------|----------|-----------------------------|
| UINT | 0 | PWM output always off |
| | 1 to 999 | Turn on time in 1/10% steps |
| | 1000 | PWM output always on |

9.11.17.12.10 Time measurement function

The module has a time measurement function for each I/O channel. It can be configured separately for rising and falling edges on each channel.

A starting edge can be configured for each time measurement function. When a configured starting edge occurs, the value of the internal timer is saved in a FIFO. This FIFO holds up to 16 elements. When the actual trigger edge occurs, the difference in time between the starting edge and the triggered edge is copied to the respective register. Bits 8 to 11 "Previous start edge" of the "CfO_EdgeTimeFallingMode" on page 1315 and "CfO_EdgeTimeRisingMode" on page 1316 registers can be used to define which detected starting edge from the FIFO should be used to calculate the difference. Additionally, when the trigger edge occurs, the counter clocked internally using bits 12 to 15 "Time measurement resolution" are copied to the "TimeStampFallingCH" on page 1317 and "TimeStampRisingCH" on page 1318 registers.

Information:

The time measurement function is an extension of edge detection, so all of the channels used must be configured there.

9.11.17.12.10.1 Enable time measurement function

Name:

CfO_EdgeTimeglobalenable

This register enables/disables the time measurement function for the entire module.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------------------|-------|----------------------------|
| 0 | Time measurement function | 0 | Disabled for entire module |
| | | 1 | Enabled for entire module |
| 1 - 7 | Reserved | - | |

9.11.17.12.10.2 Configure time measurement function for the falling edge

Name:

CfO_EdgeTimeFallingMode01 to CfO_EdgeTimeFallingMode08

These registers can be used to configure the time measurement function for the falling edge of the respective channel.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|---|---------|---|
| 0 - 3 | Selects the channel for the starting edge | 0 | Channel 1 |
| | | ... | |
| | | 7 | Channel 8 |
| 4 | Selects the edge for the starting edge | 0 | The falling edge of the channel configured in bits 0 to 3 serves as the starting edge. |
| | | 1 | The rising edge of the channel configured in bits 0 to 3 serves as the starting edge. |
| 5 - 6 | Reserved | - | |
| 7 | Trigger | 0 | Triggered ¹⁾ |
| | | 1 | Continuous ²⁾ |
| 8 - 11 | Previous start edge | 0 to 15 | The value determines which entry in the starting edge FIFO should be used to calculate the time difference. |
| 12 - 15 | Time measurement resolution | 0 | 8 Mhz |
| | | 1 | 4 Mhz |
| | | 2 | 2 Mhz |
| | | 3 | 1 Mhz |
| | | 4 | 500 kHz |
| | | 5 | 250 kHz |
| | | 6 | 125 kHz |
| | | 7 | 625 kHz |

1) The time measurement is triggered by the corresponding bit in the "TriggerRisingCH" on page 1316 register.

2) Time measurement runs continuously and is triggered at every edge.

9.11.17.12.10.3 Configure time measurement function for the rising edge

Name:

CfO_EdgeTimeRisingMode01 to CfO_EdgeTimeRisingMode08

These registers can be used to configure the time measurement function for the rising edge of the respective channel.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|---|---------|---|
| 0 - 3 | Selects the channel for the starting edge | 0 | Channel 1 |
| | | ... | |
| | | 7 | Channel 8 |
| 4 | Selects the edge for the starting edge | 0 | The falling edge of the channel configured in bits 0 to 3 serves as the starting edge. |
| | | 1 | The rising edge of the channel configured in bits 0 to 3 serves as the starting edge. |
| 5 - 6 | Reserved | - | |
| 7 | Trigger | 0 | Triggered ¹⁾ |
| | | 1 | Continuous ²⁾ |
| 8 - 11 | Previous start edge | 0 to 15 | The value determines which entry in the starting edge FIFO should be used to calculate the time difference. |
| 12 - 15 | Time measurement resolution | 0 | 8 Mhz |
| | | 1 | 4 Mhz |
| | | 2 | 2 Mhz |
| | | 3 | 1 Mhz |
| | | 4 | 500 kHz |
| | | 5 | 250 kHz |
| | | 6 | 125 kHz |
| | | 7 | 625 kHz |

1) The time measurement is triggered by the corresponding bit in the "TriggerRisingCH" on page 1316 register.

2) Time measurement runs continuously and is triggered at every edge.

9.11.17.12.10.4 Trigger falling edge detection

Name:

TriggerFallingCH01 to TriggerFallingCH08

If bit 7 "Trigger" is cleared in the "CfO_EdgeTimeFallingMode" on page 1315 register, then detection of a falling edge on the respective input can be triggered using the respective bit in this register. After a bit has been set, the next falling edge on the corresponding channel is detected.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|--------------------|-------|---|
| 0 | TriggerFallingCH01 | 0 | Falling edges on channel 1 are not detected |
| | | 1 | The next falling edge on channel 1 will be detected |
| ... | | ... | |
| 7 | TriggerFallingCH08 | 0 | Falling edges on channel 8 are not detected |
| | | 1 | The next falling edge on channel 8 will be detected |

9.11.17.12.10.5 Trigger rising edge detection

Name:

TriggerRisingCH01 to TriggerRisingCH08

If the "Continued/triggered" bit is cleared in the "CfO_EdgeTimeRisingMode" on page 1316 register, then detection of a rising edge on the respective input can be triggered using the respective bit in this register. After a bit has been set, the next rising edge on the corresponding channel is detected.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|---------------------------------|-------|--|
| 0 | Trigger rising edge - Channel 1 | 0 | Rising edges on channel 1 are not detected |
| | | 1 | The next rising edge on channel 1 will be detected |
| ... | | - | |
| 7 | Trigger rising edge - Channel 8 | 0 | Rising edges on channel 8 are not detected |
| | | 1 | The next rising edge on channel 8 will be detected |

9.11.17.12.10.6 Show first falling trigger edge

Name:

BusyTriggerFallingCH01 to BusyTriggerFallingCH08

If edges are triggered via the bits in the "TriggerFallingCH" on page 1316 register, then a set bit in this register indicates that no falling edges have been detected on the respective channel since the corresponding bit was set in the "TriggerFallingCH" register. If a falling edge occurs on the respective channel, then the corresponding BusyTriggerFalling bit is cleared.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|------------------------|-------|--|
| 0 | BusyTriggerFallingCH01 | 0 | Falling edge detected on channel 1 |
| | | 1 | Module waiting for a falling edge on channel 1 |
| ... | | ... | |
| 7 | BusyTriggerFallingCH08 | 0 | Falling edge detected on channel 8 |
| | | 1 | Module waiting for a falling edge on channel 8 |

9.11.17.12.10.7 Show first rising trigger edge

Name:

BusyTriggerRisingCH01 to BusyTriggerRisingCH08

If edges are triggered via the bits in the "TriggerRisingCH" on page 1316 register, then a set bit in this register indicates that no rising edges have been detected on the respective channel since the corresponding bit was set in the "TriggerRisingCH" register. If a rising edge occurs on the respective channel, then the corresponding BusyTriggerRising bit is cleared.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------------|-------|---|
| 0 | BusyTriggerRisingCH01 | 0 | Rising edge detected on channel 1 |
| | | 1 | Module waiting for a rising edge on channel 1 |
| ... | | ... | |
| 7 | BusyTriggerRisingCH08 | 0 | Rising edge detected on channel 8 |
| | | 1 | Module waiting for a rising edge on channel 8 |

9.11.17.12.10.8 Count falling trigger edges

Name:

CountFallingCH01 to CountFallingCH08

These registers contain cyclic counters that are incremented with every detected falling edge on the respective channel.

| Data type | Value | Information |
|-----------|----------|---------------------------|
| USINT | 0 to 255 | Counter for falling edges |

9.11.17.12.10.9 Count rising trigger edges

Name:

CountRisingCH01 to CountRisingCH08

These registers contain cyclic counters that are incremented with every detected rising edge on the respective channel.

| Data type | Value | Information |
|-----------|----------|--------------------------|
| USINT | 0 to 255 | Counter for rising edges |

9.11.17.12.10.10 Time stamp of falling edge

Name:

TimeStampFallingCH01 to TimeStampFallingCH08

When a falling edge occurs on the respective channel, the current counter value of the module timer is copied to these registers.

| Data type | Value | Information |
|-----------|------------|----------------------------|
| UINT | 0 to 65535 | Timestamp for rising edges |

9.11.17.12.10.11 Time stamp of the rising edge

Name:

TimeStampRisingCH01 to TimeStampRisingCH08

When a rising edge occurs on the respective channel, the current counter value of the module timer is copied to these registers.

| Data type | Value | Information |
|-----------|------------|----------------------------|
| UINT | 0 to 65535 | Timestamp for rising edges |

9.11.17.12.10.12 Time difference of falling edge

Name:

TimeDiffFallingCH01 to TimeDiffFallingCH08

When a falling edge occurs on the respective channel, the time difference compared to the starting edge configured in bit 4 of the "[CfO_EdgeTimeFallingMode](#)" on [page 1315](#) register is copied to this register.

| Data type | Value | Information |
|-----------|-------------|------------------------------------|
| UINT | 0 to 65,535 | Time difference from starting edge |

9.11.17.12.10.13 Time difference of rising edge

Name:

TimeDiffRisingCH01 to TimeDiffRisingCH08

When a rising edge occurs on the respective channel, the time difference compared to the starting edge configured in bit 4 of the "[CfO_EdgeTimeRisingMode](#)" on [page 1316](#) register is copied to this register.

| Data type | Value | Information |
|-----------|-------------|------------------------------------|
| UINT | 0 to 65,535 | Time difference from starting edge |

9.11.17.12.11 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 128 μ s |

9.11.17.12.12 Maximum cycle time

The maximum cycle time specifies the time up to which the bus cycle can be increased without internal counter overflows causing module malfunctions.

| Minimum cycle time |
|--------------------|
| 16 ms |

9.11.17.12.13 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 128 μ s |

9.12 CPUs

X20 CPUs are powerful components within the X20 system landscape. The CPUs are based on Intel processors and available in a wide range of performance classes and designs.

- Standard CPU
- CPU with integrated I/O



Available interfaces

In addition to onboard CompactFlash, 2x USB and RS232, there are also 2 independent Ethernet interfaces:

- 1 standard Gigabit Ethernet interface for TCP/IP data transfer
- 1 Fast Ethernet interface (100 Mbit/s) used as a POWERLINK interface

An additional 1 or 3 slots are also available for interface expansion.

Easy maintenance

All CPU modules are fanless. The CPU can be used across the full temperature range specified for the X20 system landscape. Derating may be required over 55°C depending on the model, however.

The built-in battery for retaining SRAM data can be exchanged during operation as long as this is permitted by local regulations. If the battery is exchanged with the power off, SRAM data will be retained for approximately 1 minute.

9.12.1 Summary

| Model number | Short description | Page |
|--------------|---|------|
| X20CP1301 | X20 CPU, with integrated I/O, x86-200, 128 MB DDR3 RAM, 16 kB FRAM, 1 GB onboard flash drive, 1 insert slot for X20 interface modules, 1 USB interface, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T, 14 digital inputs, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μs, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs ±10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included | 1324 |
| X20CP1381 | X20 CPU, with integrated I/O, x86-200, 128 MB DDR3 RAM, 16 kB FRAM, 1 GB onboard flash drive, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 CAN bus interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, 14 digital inputs, 24 VDC, sink, 4 digital outputs, 2 μs, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μs, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs ±10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included | 1324 |
| X20CP1382 | X20 CPU, with integrated I/O, x86-400, 256 MB DDR3 RAM, 32 kB FRAM, 2 GB onboard flash drive, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 CAN bus interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, 14 digital inputs, 24 VDC, sink, 4 digital outputs, 2 μs, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μs, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs ±10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included | 1324 |
| X20CP1483 | X20 CPU, x86 100 MHz Intel compatible, 32 MB DRAM, 128 kB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1380 |
| X20CP1483-1 | X20 CPU, x86 100 MHz Intel compatible, 64 MB DRAM, 128 kB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1380 |

| Model number | Short description | Page |
|--------------|---|------|
| X20CP1583 | X20 CPU, Atom 333 MHz Intel compatible, 128 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1397 |
| X20CP1584 | X20 CPU, Atom 0.6 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1397 |
| X20CP1585 | X20 CPU, Atom 1.0 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1397 |
| X20CP1586 | X20 CPU, Atom 1.6 GHz, 512 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1397 |
| X20CP1684 | X20 CPU, Atom 0.4 GHz (compatible), 512 MB DDR4 RAM, 1 MB SRAM, 1 GB onboard flash drive, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! | 1418 |
| X20CP1685 | X20 CPU, Atom 0.8 GHz, 512 MB DDR4 RAM, 1 MB SRAM, 1 GB onboard flash drive, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! | 1418 |
| X20CP1686X | X20 CPU, Atom 1.3 GHz, 1 GB DDR4 RAM, 1 MB SRAM, 2 GB onboard flash drive, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! | 1418 |
| X20CP3583 | X20 CPU, Atom 333 MHz Intel compatible, 128 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1401 |
| X20CP3584 | X20 CPU, Atom 0.6 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1401 |
| X20CP3585 | X20 CPU, Atom 1.0 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1401 |
| X20CP3586 | X20 CPU, Atom 1.6 GHz, 512 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1401 |
| X20CP3684 | X20 CPU, Atom 0.4 GHz (compatible), 512 MB DDR4 RAM, 1 MB SRAM, 1 GB onboard flash drive, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! | 1422 |
| X20CP3685 | X20 CPU, Atom 0.8 GHz, 512 MB DDR4 RAM, 1 MB SRAM, 1 GB onboard flash drive, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! | 1422 |
| X20CP3686X | X20 CPU, Atom 1.3 GHz, 1 GB DDR4 RAM, 1 MB SRAM, 2 GB onboard flash drive, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! | 1422 |
| X20CP3687X | X20 CPU, Atom 1.6 GHz, 2 GB DDR4 RAM, 1 MB SRAM, 2 GB onboard flash drive, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! | 1422 |
| X20cCP1301 | X20 CPU coated, with integrated I/O, x86-200, 128 MB DDR3 RAM, 16 kB FRAM, 1 GB onboard flash drive, 1 insert slot for X20 interface modules, 1 USB interface, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 μ s, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μ s, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs \pm 10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included | 1324 |
| X20cCP1584 | X20 CPU, coated, Atom 0.6 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1397 |
| X20cCP1586 | X20 CPU, coated, Atom 1.6 GHz, 512 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! | 1397 |

| Model number | Short description | Page |
|--------------|---|------|
| X20cCP3584 | X20 CPU, coated, ATOM 0.6 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000 Base-T, 1 POWERLINK interface, incl. supply module, 1 X20TB12 terminal block, slot covers and X20 end cover plate (right) X20AC0SR1 included, order application memory separately. | 1401 |
| X20cCP3586 | X20 CPU, coated, ATOM 1.6 GHz, 512 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000 Base-T, 1 POWERLINK interface, incl. supply module, 1 X20TB12 terminal block, slot covers and X20 end cover plate (right) X20AC0SR1 included, order application memory separately. | 1401 |

9.12.2 X20(c)CP1301, X20CP1381 and X20CP1382

Data sheet version: 1.23

9.12.2.1 General information

Compact CPUs are available with processor speeds of 200 MHz and 400 MHz. Depending on the variant, up to 256 MB RAM and up to 32 kB nonvolatile onboard RAM is available. A built-in flash drive is available to store up to 2 GB of application and other data.

All CPUs come equipped with Ethernet, USB and one RS232 interface. In both performance classes, integrated POWERLINK and CAN bus interfaces are also available. If additional fieldbus connections are needed, the CPU can be upgraded with an interface module from the standard X20 product range. These CPUs do not require fans or batteries and are therefore maintenance-free. 30 different digital inputs and outputs and 2 analog inputs are integrated in the devices. 1 analog input can be used for PT1000 resistance temperature measurement.

- CPU is Intel x86 200/400 MHz compatible with integrated I/O processor
- Ethernet, POWERLINK with poll-response chaining and USB onboard
- 1 slot for modular interface expansion
- 30 digital inputs/outputs and 2 analog inputs integrated in the device
- 1/2 GB flash drive onboard
- 128/256 MB DDR3 SDRAM
- Fanless
- No battery
- Battery-backed real-time clock

9.12.2.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.12.2.3 Order data



| Model number | Short description |
|--------------|---|
| | X20 CPUs |
| X20CP1301 | X20 CPU, with integrated I/O, x86-200, 128 MB DDR3 RAM, 16 kB FRAM, 1 GB onboard flash drive, 1 insert slot for X20 interface modules, 1 USB interface, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 μ s, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μ s, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs \pm 10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included |
| X20cCP1301 | X20 CPU coated, with integrated I/O, x86-200, 128 MB DDR3 RAM, 16 kB FRAM, 1 GB onboard flash drive, 1 insert slot for X20 interface modules, 1 USB interface, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 μ s, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μ s, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs \pm 10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included |
| X20CP1381 | X20 CPU, with integrated I/O, x86-200, 128 MB DDR3 RAM, 16 kB FRAM, 1 GB onboard flash drive, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 CAN bus interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 μ s, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μ s, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs \pm 10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included |
| X20CP1382 | X20 CPU, with integrated I/O, x86-400, 256 MB DDR3 RAM, 32 kB FRAM, 2 GB onboard flash drive, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 CAN bus interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 μ s, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μ s, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs \pm 10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included |

Table 223: Order data

Content of delivery

| Order number | Quantity | Short description |
|--------------|----------|--|
| - | 1 | Interface module slot cover |
| X20AC0SR1 | 1 | X20 end cover plate (right) |
| X20TB1F | 3 | X20 terminal block, 16-pin, 24 VDC keyed |

Table 224: Content of delivery

9.12.2.4 Technical data

| Model number | X20CP1301 | X20cCP1301 | X20CP1381 | X20CP1382 |
|--|--|---|---|-----------|
| Short description | | | | |
| Interfaces | 1x RS232, 1x Ethernet, 1x USB, 1x X2X Link | | 1x RS232, 1x Ethernet, 1x POWERLINK, 2x USB, 1x X2X Link, 1x CAN bus | |
| System module | CPU | | | |
| General information | | | | |
| Cooling | Fanless | | | |
| B&R ID code | 0xE35B | 0xEB58 | 0xE35C | 0xDABB |
| Status indicators | CPU function, Ethernet, RS232, CPU power supply, I/O power supply, I/O function per channel | | CPU function, Ethernet, POWERLINK, RS232, CAN bus, CAN bus terminating resistor, CPU power supply, I/O power supply, I/O function per channel | |
| Diagnostics | | | | |
| Outputs | Digital outputs: Yes, using status LED and software (output error status) | Digital outputs: Yes, using LED status indicator and software (output error status) | Digital outputs: Yes, using status LED and software (output error status) | |
| CPU function | Yes, using status LED | Yes, using LED status indicator | Yes, using status LED | |
| CAN bus data transfer | - | | Yes, using status LED | |
| RS232 data transfer | Yes, using status LED | Yes, using LED status indicator | Yes, using status LED | |
| Inputs | Analog inputs: Yes, using status LED and software | Analog inputs: Yes, using LED status indicator and software | Analog inputs: Yes, using status LED and software | |
| Ethernet | Yes, using status LED | Yes, using LED status indicator | Yes, using status LED | |
| I/O power supply | Yes, using status LED | Yes, using LED status indicator | Yes, using status LED | |
| POWERLINK | - | | Yes, using status LED | |
| Supply voltage monitoring | Yes, using status LED | Yes, using LED status indicator | Yes, using status LED | |
| Overtemperature | Yes, using software | | | |
| Terminating resistor | - | | Yes, using status LED | |
| Controller redundancy possible | No | | | |
| ACOPOS support | Yes | | | |
| reACTION-capable I/O channels | No | | | |
| Visual Components support | Yes | | | |
| Power consumption without interface module and USB | 4.3 W | | 4.8 W | 5.5 W |
| Power consumption for X2X Link power supply ¹⁾ | 0.8 W | | | |
| Power consumption ¹⁾ | | | | |
| Internal I/O | 0.8 W | | | |
| Additional power dissipation caused by actuators (resistive) [W] | - | | | |
| Type of signal lines | Shielded cables must be used for all high-speed digital inputs/outputs, cable length: Max. 20 m | | | |
| Certifications | | | | |
| CE | Yes | | | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | | | |
| UL | cULus E115267 Industrial control equipment | | | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | | | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | | | |
| KR | Yes | | | |
| EAC | Yes | | | |
| CPU and X2X Link power supply | | | | |
| Input voltage | 24 VDC -15% / +20% | | | |
| Input current | Max. 1 A | | | |
| Fuse | Integrated, cannot be replaced | | | |
| Reverse polarity protection | Yes | | | |
| X2X Link power supply output | | | | |
| Nominal output power | 2 W | | | |
| Parallel connection | Yes ²⁾ | | | |
| Redundant operation | Yes ³⁾ | | | |
| Input I/O power supply | | | | |
| Input voltage | 24 VDC -15% / +20% | | | |
| Fuse | Required line fuse: Max. 10 A, slow-blow | | | |

Table 225: Technical data

| Model number | X20CP1301 | X20cCP1301 | X20CP1381 | X20CP1382 |
|--------------------------------|---|---|---|---|
| Output I/O power supply | | | | |
| Nominal output voltage | 24 VDC | | | |
| Permissible contact load | 10 A | | | |
| Controller | | | | |
| Real-time clock | Backed up for at least 300 hours, typ. 1000 hours at 25°C, 1 s resolution, -18 to 28 ppm accuracy at 25°C | Retention for at least 300 hours, typ. 1000 hours at 25°C, 1 s resolution, -18 to 28 ppm accuracy at 25°C | Backed up for at least 300 hours, typ. 1000 hours at 25°C, 1 s resolution, -18 to 28 ppm accuracy at 25°C | |
| FPU | Yes | | | |
| Processor | | | | |
| Type | Vx86EX | | | |
| Clock frequency | 200 MHz | | 400 MHz | |
| L1 cache | | | | |
| Data code | 16 kB | | | |
| Program code | 16 kB | | | |
| L2 cache | | | | |
| | 128 kB | | | |
| Integrated I/O processor | Processes I/O data points in the background | | | |
| Modular interface slots | 1 | | | |
| Remanent variables | 16 kB FRAM, retention >10 years ⁴⁾ | 16 kB FRAM, retention > 10 years ⁵⁾ | 16 kB FRAM, retention >10 years ⁴⁾ | 32 kB FRAM, retention >10 years ⁴⁾ |
| Shortest task class cycle time | 2 ms | | | 1 ms |
| Typical instruction cycle time | 0.0419 µs | | | 0.0199 µs |
| Standard memory | | | | |
| RAM | 128 MB DDR3 SDRAM | | 256 MB DDR3 SDRAM | |
| Application memory | | | | |
| Type | 1 GB eMMC flash memory | | 2 GB eMMC flash memory | |
| Data retention | 10 years | | | |
| Writable data amount | | | | |
| Guaranteed | 40 TB | | | |
| Results for 5 years | 21.9 GB/day | | | |
| Guaranteed erase/write cycles | 20,000 | | | |
| Error-correcting code (ECC) | Yes | | | |
| Interfaces | | | | |
| Interface IF1 | | | | |
| Signal | RS232 | | | |
| Variant | Connection made using 16-pin X20TB1F terminal block | Connection made using 16-pin terminal block X20TB1F | Connection made using 16-pin X20TB1F terminal block | |
| Max. distance | 900 m | | | |
| Transfer rate | Max. 115.2 kbit/s | | | |
| Interface IF2 | | | | |
| Signal | Ethernet | | | |
| Variant | 1x RJ45 shielded | | | |
| Cable length | Max. 100 m between 2 stations (segment length) | | | |
| Transfer rate | 10/100 Mbit/s | | | |
| Transfer | | | | |
| Physical layer | 10BASE-T/100BASE-TX | | | |
| Half-duplex | Yes | | | |
| Full-duplex | Yes | | | |
| Autonegotiation | Yes | | | |
| Auto-MDI/MDIX | Yes | | | |
| Interface IF3 | | | | |
| Fieldbus | - | | POWERLINK managing or controlled node | |
| Type | - | | Type 4 ⁶⁾ | |
| Variant | - | | 1x RJ45 shielded | |
| Cable length | - | | Max. 100 m between 2 stations (segment length) | |
| Transfer rate | - | | 100 Mbit/s | |
| Transfer | | | | |
| Physical layer | - | | 100BASE-TX | |
| Half-duplex | - | | Yes | |
| Full-duplex | - | | POWERLINK mode: No / Ethernet mode: Yes | |
| Autonegotiation | - | | Yes | |
| Auto-MDI/MDIX | - | | Yes | |
| Interface IF4 | | | | |
| Type | USB 1.1/2.0 | | | |
| Variant | Type A | | | |
| Max. output current | 0.5 A | | | |
| Interface IF5 | | | | |
| Type | - | | USB 1.1/2.0 | |
| Variant | - | | Type A | |
| Max. output current | - | | 0.1 A | |
| Interface IF6 | | | | |
| Fieldbus | X2X Link master | | | |

Table 225: Technical data

| Model number | X20CP1301 | X20cCP1301 | X20CP1381 | X20CP1382 |
|--|---|---|--|-----------|
| Interface IF7 | | | | |
| Signal | - | | CAN bus | |
| Variant | - | | Connection made using 16-pin X20TB1F terminal block | |
| Max. distance | - | | 1000 m | |
| Transfer rate | - | | Max. 1 Mbit/s | |
| Terminating resistor | - | | Integrated in module | |
| Controller | - | | SJA 1000 | |
| Digital inputs | | | | |
| Quantity | 14 standard inputs, 4 high-speed inputs and 4 mixed channels, configuration as input or output using software | | | |
| Nominal voltage | 24 VDC | | | |
| Input voltage | 24 VDC -15% / +20% | | | |
| Input current at 24 VDC | X1 - Standard inputs: Typ. 3.5 mA X2 - Standard inputs: Typ. 2.68 mA X2 - High-speed inputs: Typ. 3.5 mA X3 - Mixed channels: Typ. 2.68 mA | | | |
| Input circuit | Sink | | | |
| Input filter | | | | |
| Hardware | Standard inputs and mixed channels: ≤200 µs High-speed inputs: ≤2 µs, when used as standard inputs: ≤200 µs | | | |
| Software | Default 1 ms, configurable between 0 and 25 ms in 0.1 ms intervals | Default 1 ms, configurable between 0 and 25 ms in 0.1 ms increments | Default 1 ms, configurable between 0 and 25 ms in 0.1 ms intervals | |
| Connection type | 1-wire connections | | | |
| Input resistance | X1 - Standard inputs: 6.8 kΩ X2 - Standard inputs: 8.9 kΩ X2 - High-speed inputs: 6.8 kΩ X3 - Mixed channels: 8.9 kΩ | | | |
| Additional functions | X2 - High-speed digital inputs: 2x 250 kHz event counting, 2x AB counter, ABR incremental encoder, direction/frequency, period measurement, gate measurement, differential time measurement, edge counters, edge times | | | |
| Switching threshold | | | | |
| Low | <5 VDC | | | |
| High | >15 VDC | | | |
| AB incremental encoder | | | | |
| Quantity | 2 | | | |
| Encoder inputs | 24 V, asymmetrical | | | |
| Counter size | 32-bit | | | |
| Input frequency | Max. 100 kHz | | | |
| Evaluation | 4x | | | |
| Encoder power supply | Module-internal, max. 300 mA | | | |
| Overload characteristics of encoder power supply | Short circuit protection, overload protection | Short-circuit proof, overload-proof | Short circuit protection, overload protection | |
| ABR incremental encoder | | | | |
| Quantity | 1 | | | |
| Encoder inputs | 24 V, asymmetrical | | | |
| Counter size | 32-bit | | | |
| Input frequency | Max. 100 kHz | | | |
| Evaluation | 4x | | | |
| Encoder power supply | Module-internal, max. 300 mA | | | |
| Overload characteristics of encoder power supply | Short circuit protection, overload protection | Short-circuit proof, overload-proof | Short circuit protection, overload protection | |
| Event counters | | | | |
| Quantity | 2 | | | |
| Signal form | Square wave pulse | | | |
| Evaluation | 1x | | | |
| Input frequency | Max. 250 kHz | | | |
| Counter frequency | 250 kHz | | | |
| Counter size | 32-bit | | | |
| Edge detection / Time measurement | | | | |
| Possible measurements | Period measurement, gate measurement, differential time measurement, edge counter, edge times | | | |
| Measurements per module | Each function up to 2x | | | |
| Counter size | 32-bit | | | |
| Input frequency | Max. 10 kHz | | | |
| Timestamp | 1 µs resolution | | | |
| Signal form | Square wave pulse | | | |
| Analog inputs | | | | |
| Input | ±10 V or 0 to 20 mA / 4 to 20 mA, via different terminal connections | | | |
| Input type | Differential input | | | |
| Digital converter resolution | | | | |
| Voltage | ±12-bit | | | |
| Current | 12-bit | | | |
| Conversion time | 1 channel enabled: 100 µs 2 channels enabled: 200 µs | | | |

Table 225: Technical data

| Model number | X20CP1301 | X20cCP1301 | X20CP1381 | X20CP1382 |
|--|--|--|---|-----------|
| Output format | | | | |
| Data type | INT | | | |
| Voltage | INT 0x8001 - 0x7FFF / 1 LSB = 0x0008 = 2.441 mV | | | |
| Current | INT 0x0000 - 0x7FFF / 1 LSB = 0x0008 = 4.883 μ A | | | |
| Input impedance in signal range | | | | |
| Voltage | 20 M Ω | | | |
| Current | - | | | |
| Load | | | | |
| Voltage | - | | | |
| Current | <300 Ω | | | |
| Input protection | Protection against wiring with supply voltage | | | |
| Permissible input signal | | | | |
| Voltage | Max. \pm 30 V | | | |
| Current | Max. \pm 50 mA | | | |
| Output of digital value during overload | Configurable | | | |
| Conversion procedure | SAR | | | |
| Input filter | 3rd-order low pass / cutoff frequency 1 kHz | Third-order low pass / cutoff frequency 1 kHz | 3rd-order low pass / cutoff frequency 1 kHz | |
| Max. error at 25°C | | | | |
| Voltage | | | | |
| Gain | 0.18% (Rev. <C0: 0.37%) ⁷⁾ | | | |
| Offset | 0.04% (Rev. <C0: 0.25%) ⁸⁾ | | | |
| Current | | | | |
| Gain | 0 to 20 mA = 0.15% (Rev. <C0: 0.52%) / 4 to 20 mA = 0.25% ⁷⁾ | | | |
| Offset | 0 to 20 mA = 0.1% (Rev. <C0: 0.4%) / 4 to 20 mA = 0.15% ⁹⁾ | | | |
| Max. gain drift | | | | |
| Voltage | 0.017 %/ $^{\circ}$ C ⁷⁾ | | | |
| Current | 0 to 20 mA = 0.015 %/ $^{\circ}$ C / 4 to 20 mA = 0.023 %/ $^{\circ}$ C ⁷⁾ | | | |
| Max. offset drift | | | | |
| Voltage | 0.008 %/ $^{\circ}$ C ⁸⁾ | | | |
| Current | 0 to 20 mA = 0.008 %/ $^{\circ}$ C / 4 to 20 mA = 0.012 %/ $^{\circ}$ C ⁹⁾ | | | |
| Common-mode rejection | | | | |
| DC | 70 dB | | | |
| 50 Hz | 70 dB | | | |
| Common-mode range | \pm 12 V | | | |
| Crosstalk between channels | <-70 dB | | | |
| Nonlinearity | | | | |
| Voltage | <0.025% ⁸⁾ | | | |
| Current | <0.05% ⁹⁾ | | | |
| Resistance measurement temperature inputs | | | | |
| Quantity | 1 | | | |
| Input | Resistance measurement with constant current supply for 2-wire connections | | | |
| Digital converter resolution | 13-bit | | | |
| Conversion time | Only temperature input enabled: 200 μ s Temperature and analog input enabled: 400 μ s | | | |
| Conversion procedure | SAR | | | |
| Output format | INT or UINT for resistance measurement | | | |
| Sensor | | | | |
| PT1000 | -200 to 850°C | | | |
| Resistance measurement range | 0.1 to 4000 Ω | | | |
| Temperature sensor resolution | 1 LSB = 0x0005 = 0.16°C | | | |
| Resistance measurement resolution | 1 LSB = 0x0005 = 0.49 Ω | | | |
| Input filter | 1st-order low pass / cutoff frequency 7 Hz | First-order low-pass fil- ter / cutoff frequency 7 Hz | 1st-order low pass / cutoff frequency 7 Hz | |
| Sensor standard | EN 60751 | | | |
| Common-mode range | 1 V | | | |
| Linearization method | Internal | | | |
| Measurement current | 1 mA | | | |
| Permissible input signal | Short-term max. \pm 30 V | | | |
| Max. error at 25°C | | | | |
| Gain | 0.3% (Rev. <C0: 1.93%) ¹⁰⁾ | 0.3% (Rev. <C0: 1.93%) ¹¹⁾ | 0.3% (Rev. <C0: 1.93%) ¹⁰⁾ | |
| Offset | 0.15% (Rev. <C0: 0.32%) ¹²⁾ | | | |
| Max. gain drift | 0.023 %/ $^{\circ}$ C ¹⁰⁾ | 0.023 %/ $^{\circ}$ C ¹¹⁾ | 0.023 %/ $^{\circ}$ C ¹⁰⁾ | |
| Max. offset drift | 0.012%/ $^{\circ}$ C ¹²⁾ | | | |
| Nonlinearity | <0.05% ¹²⁾ | | | |
| Standardized range of values for resis- tance measurement | 0.1 to 4000.0 Ω | | | |
| Crosstalk between channels | <-70 dB | | | |
| Common-mode rejection | | | | |
| 50 Hz | >60 dB | | | |
| Temperature sensor normalization | | | | |
| PT1000 | -200 to 850°C | | | |

Table 225: Technical data

| Model number | X20CP1301 | X20cCP1301 | X20CP1381 | X20CP1382 |
|---|--|---|--|-----------|
| Digital outputs | | | | |
| Quantity | 4 standard outputs, 4 high-speed outputs and 4 mixed channels, configuration as input or output using software | | | |
| Variant | Standard outputs and mixed channels: FET positive switching High-speed outputs: Push-Pull | Standard outputs and mixed channels: Current-sourcing FET High-speed outputs: Push-Pull | Standard outputs and mixed channels: FET positive switching High-speed outputs: Push-Pull | |
| Nominal voltage | 24 VDC | | | |
| Switching voltage | 24 VDC -15% / +20% | | | |
| Nominal output current | Standard outputs and mixed channels: 0.5 A High-speed outputs: 0.2 A | | | |
| Total nominal current | Standard outputs and mixed channels: 4 A High-speed outputs: 0.8 A | | | |
| Connection type | 1-wire connections | | | |
| Output circuit | Standard outputs and mixed channels: Source High-speed outputs: Sink or source | | | |
| Output protection ¹³⁾ | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short circuit current") Internal inverse diode for switching inductive loads (see section "Switching inductive loads") | Thermal shutdown in the event of overcurrent or short circuit (see "Short-circuit peak current" value) Internal freewheeling diode for switching inductive loads (see section "Switching inductive loads") | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short circuit current") Internal inverse diode for switching inductive loads (see section "Switching inductive loads") | |
| Pulse width modulation ¹⁴⁾ | | | | |
| Period duration | 5 to 65535 µs corresponds to 200 kHz to 15 Hz | | | |
| Pulse duration | 0 to 100%, minimum 2.5 µs | | | |
| Resolution for pulse duration | 0.1% of the configured frequency | | | |
| Diagnostic status | Standard outputs and mixed channels: Output monitoring with 10 ms delay High-speed outputs: Output monitoring with 10 µs delay | | | |
| Leakage current when the power is switched off | Standard outputs and mixed channels: 5 µA High-speed outputs: 25 µA | | | |
| R _{DS(on)} | 140 mΩ ¹⁵⁾ | | | |
| Residual voltage | Standard outputs and mixed channels: <0.1 V at nominal current 0.5 A High-speed outputs: <0.9 V at nominal current 0.1 A | | | |
| Peak short-circuit current | Standard outputs and mixed channels: <3 A High-speed outputs: <20 A | | | |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Standard outputs and mixed channels: Approx. 10 ms (depends on module temperature) High-speed outputs: No switch-on | | | |
| Switching delay | | | | |
| 0 → 1 | Standard outputs and mixed channels: <300 µs High-speed outputs: <3 µs | | | |
| 1 → 0 | Standard outputs and mixed channels: <300 µs High-speed outputs: <3 µs | | | |
| Switching frequency | | | | |
| Resistive load ¹⁶⁾ | Standard outputs and mixed channels: Max. 500 Hz High-speed outputs: 50 kHz, max. 200 kHz (see section "Switching frequency derating for high-speed digital outputs") | | | |
| Inductive load | See section "Switching inductive loads" | See section "Switching inductive loads" | See section "Switching inductive loads" | |
| Braking voltage when switching off inductive loads | Standard outputs and mixed channels: Typ. 45 VDC | | | |
| Electrical properties | | | | |
| Electrical isolation | Ethernet (IF2) and X2X (IF6) isolated from each other, from other interfaces and from PLC Channel isolated from bus Channel not isolated from channel or PLC | | Ethernet (IF2), POWERLINK (IF3) and X2X (IF6) isolated from each other, from other interfaces and from PLC Channel isolated from bus Channel not isolated from channel or PLC | |
| Operating conditions | | | | |
| Mounting orientation | | | | |
| Horizontal | Yes | | | |
| Vertical | Yes | | | |
| Installation elevation above sea level | | | | |
| 0 to 2000 m | No limitation | | | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | | | |
| Degree of protection per EN 60529 | IP20 | | | |
| Ambient conditions | | | | |
| Temperature | | | | |
| Operation | | | | |
| Horizontal mounting orientation | -25 to 60°C | | | |
| Vertical mounting orientation | -25 to 50°C | | | |
| Derating | See section "Switching frequency derating for high-speed digital outputs". | | | |
| Storage | -40 to 85°C | | | |
| Transport | -40 to 85°C | | | |
| Relative humidity | | | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing | 5 to 95%, non-condensing | |
| Storage | 5 to 95%, non-condensing | | | |
| Transport | 5 to 95%, non-condensing | | | |

Table 225: Technical data

| Model number | X20CP1301 | X20cCP1301 | X20CP1381 | X20CP1382 |
|------------------------------|---|---|---|-----------|
| Mechanical properties | | | | |
| Note | X20 end cover plate (right) included in delivery 3 X20 terminal blocks (16-pin) included in delivery Interface module slot cover included in delivery | X20 end cover plate (right) included in delivery 3 16-pin X20 terminal blocks included in delivery Cover for interface module slot included in delivery | X20 end cover plate (right) included in delivery 3 X20 terminal blocks (16-pin) included in delivery Interface module slot cover included in delivery | |
| Dimensions | | | | |
| Width | | | | 164 mm |
| Height | | | | 99 mm |
| Depth | | | | 75 mm |
| Weight | 300 g | | 310 g | |

Table 225: Technical data

- 1) The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) When operated in parallel, the nominal power of 2 W is not permitted to be added to the total power.
- 3) Up to 2 W bus load.
- 4) The size of the memory used for remanent variables is configurable in Automation Studio.
- 5) The memory size for remanent variables is configurable in Automation Studio.
- 6) See Automation Help under "Communication / POWERLINK / General information / Hardware - IF/LS" for more information.
- 7) Based on the current measured value.
- 8) Based on the 20 V measurement range.
- 9) Based on the 20 mA measurement range.
- 10) Based on the current resistance value.
- 11) Based on the current measured resistance value.
- 12) Based on the entire resistance measurement range.
- 13) For the high-speed digital outputs, derating must be taken into account at a switching frequency >50 kHz (see section "Derating for switching frequency of high-speed digital outputs"). Overtemperature protection is not provided.
- 14) The high-speed digital outputs can be used for pulse width modulation.
- 15) Only for standard outputs and mixed channels.
- 16) Standard outputs and mixed channels: At loads $\leq 1 \text{ k}\Omega$

9.12.2.5 LED status indicators

9.12.2.5.1 Slot X1


| Figure | LED | Color | Status | Description |
|---|---------|-----------|--|---|
|  | E | Red | On | Operating mode SERVICE ¹⁾ or BOOT ¹⁾ |
| | | | Blinking | The "E" LED blinks red and the "RF" LED blinks yellow when there is a license violation. |
| | | | Double flash | Firmware update ²⁾ |
| | R | Green | On | Application running |
| | | | Blinking | System startup: The CPU is initializing the application, all bus systems and I/O modules. ²⁾ |
| | RF | Yellow | On | Operating mode SERVICE ¹⁾ or BOOT ¹⁾ |
| | | | Blinking | The "RF" LED blinks yellow and the "E" LED blinks red when there is a license violation. |
| | SE | Green/Red | | Status/Error LED. LED states are described in section "LED "S/E" (LED "Status/Error")" on page 1331. |
| | ET | Green | On | A link to the Ethernet remote station has been established. |
| | | | Blinking | A link to the Ethernet remote station has been established. The LED blinks when Ethernet activity is taking place on the bus. |
| | PL | Green | On | A link to the POWERLINK peer station has been established. |
| | | | Blinking | A link to the POWERLINK peer station has been established. The LED blinks when Ethernet activity is taking place on the bus. |
| | A1 - A2 | Green | Off | Open circuit or disconnected sensor |
| | | | Blinking | Input signal overflow or underflow |
| | | | On | Analog/digital converter running, value OK |
| | 1 - 4 | Green | | Input state of the corresponding digital input |
| | C | Yellow | On | CPU transmitting or receiving data via the CAN bus interface |
| S | Yellow | On | CPU transmitting or receiving data via the RS232 interface | |
| T | Yellow | On | The terminating resistor integrated in the CPU is switched on. | |
| DC | Yellow | On | CPU power supply OK | |

Table 226: LED status indicators on the integrated X1 I/O slot

- 1) The operating states are described in Automation Help under "Real-time operating system - Method of operation - Operating states".
- 2) The process can take several minutes depending on the configuration.

9.12.2.5.1.1 LED "S/E" (LED "Status/Error")

This LED is a green/red dual LED and indicates the state of the POWERLINK interface. The LED states have a different meaning depending on the operating mode of the POWERLINK interface.

Ethernet mode

In this mode, the interface is operated as an Ethernet interface.

| LED "S/E" | | Description |
|-----------|-----|---|
| Green | Red | |
| On | Off | The interface is operated as an Ethernet interface. |

Table: LED "S/E": Interface in Ethernet mode

POWERLINK V2 mode

Error message

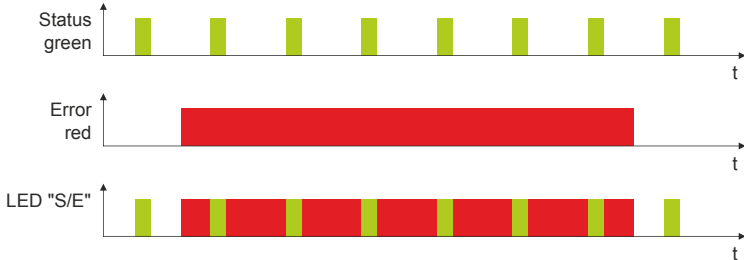
| LED "S/E" | | Description |
|-----------|-----|---|
| Green | Red | |
| Off | On | The interface is in error mode (failed Ethernet frames, increased number of collisions on the network, etc.). Note: Several red blinking signals are displayed immediately after the device is switched on. These are not errors, however. |
| Blinking | On | If an error occurs in the following modes, then the green LED blinks over the red LED: <ul style="list-style-type: none"> PRE_OPERATIONAL_1 PRE_OPERATIONAL_2 READY_TO_OPERATE  |

Table: LED "S/E" - Error message (interface in POWERLINK mode)

Interface status

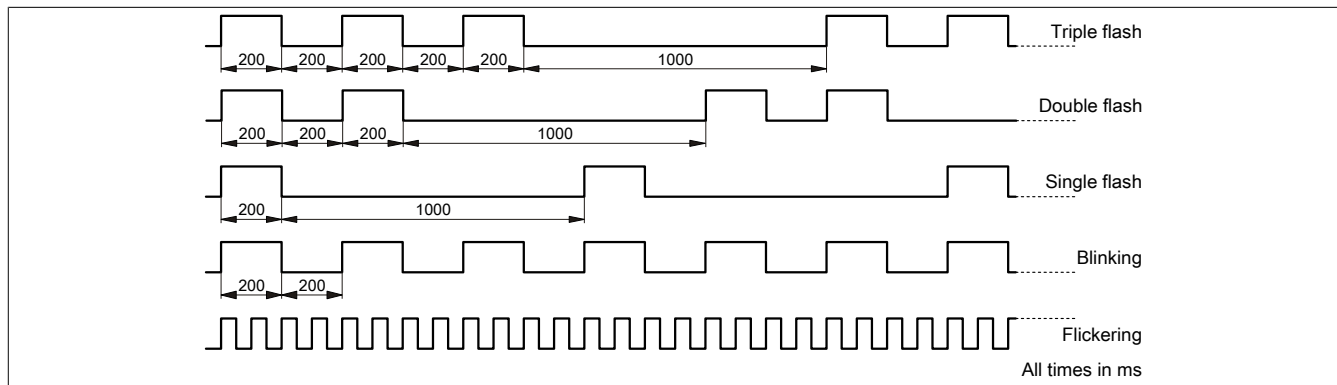
| LED "S/E" | | Description |
|----------------------------|-----|--|
| Green | Red | |
| Off | Off | Mode: NOT_ACTIVE The interface is either in mode NOT_ACTIVE or one of the following modes or errors is present: <ul style="list-style-type: none"> The device is switched off. The device is in the startup phase. The interface or device is not configured correctly in Automation Studio. The interface or device is defective. Managing node (MN) The network is monitored for POWERLINK frames. If a frame is not received within the configured time window (timeout), the interface immediately enters mode PRE_OPERATIONAL_1. If POWERLINK communication is detected before the time has elapsed, however, the MN is not started. |
| Flickering (approx. 10 Hz) | Off | Mode: BASIC_ETHERNET The interface is in mode BASIC_ETHERNET. The interface is operated in Ethernet mode . |
| | | Managing node (MN) This mode can only be exited by resetting the controller. |
| | | Controlled node (CN) If POWERLINK communication is detected during this mode, the interface enters mode PRE_OPERATIONAL_1. |

Table: LED "S/E" - Interface state (interface in POWERLINK mode)

| LED "S/E" | | Description |
|--------------------------------|-----|--|
| Green | Red | |
| Single flash (approx. 1 Hz) | Off | <p>Mode: PRE_OPERATIONAL_1 The interface is in mode PRE_OPERATIONAL_1.</p> <p>Managing node (MN) The MN is in "reduced cycle" operation. The CNs are configured in this mode. Cyclic communication is not yet taking place.</p> <p>Controlled node (CN) The CN can be configured by the MN in this mode. The CN waits until it receives an SoC frame and then switches to mode PRE_OPERATIONAL_2.</p> |
| | On | <p>Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed.</p> |
| Double flash (approx. 1 Hz) | Off | <p>Mode: PRE_OPERATIONAL_2 The interface is in mode PRE_OPERATIONAL_2.</p> <p>Managing node (MN) The MN starts cyclic communication (cyclic input data is not yet evaluated). The CNs are configured in this mode.</p> <p>Controlled node (CN) The CN can be configured by the MN in this mode. A command then switches the mode to READY_TO_OPERATE.</p> |
| | On | <p>Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed.</p> |
| Triple flash (approx. 1 Hz) | Off | <p>Mode: READY_TO_OPERATE The interface is in mode READY_TO_OPERATE.</p> <p>Managing node (MN) Cyclic and asynchronous communication. Received PDO data is ignored.</p> <p>Controlled node (CN) The configuration of the CN is completed. Normal cyclic and asynchronous communication. The transmitted PDO data corresponds to the PDO mapping. However, cyclic data is not yet evaluated.</p> |
| | On | <p>Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed.</p> |
| On | Off | <p>Mode: OPERATIONAL The interface is in mode OPERATIONAL. PDO mapping is active and cyclic data is evaluated.</p> |
| Blinking (approx. 2.5 Hz) | Off | <p>Mode: STOPPED The interface is in mode STOPPED.</p> <p>Managing node (MN) This mode does not occur for the MN.</p> <p>Controlled node (CN) Output data is not being output, and no input data is being provided. This mode can only be reached and exited by a corresponding command from the MN.</p> |

Table: LED "S/E" - Interface state (interface in POWERLINK mode)

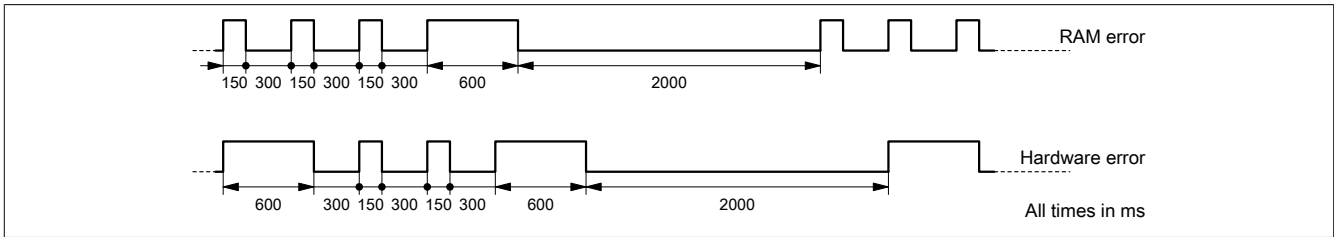
Blink times



9.12.2.5.1.2 System stop error codes

A system stop error can occur due to incorrect configuration or defective hardware.

The error code is indicated by LED "S/E" blinking red. The blinking signal of the error code consists of 4 switch-on phases with short (150 ms) or long (600 ms) duration. The error code is repeated every 2 seconds.



| Error | Error description |
|----------------|---|
| RAM error | The device is defective and must be replaced. |
| Hardware error | The device or a system component is defective and must be replaced. |

9.12.2.5.2 Slot X2


| Figure | LED | Color | Status | Description |
|---|--------|-------|--------|--|
|  | 1 - 14 | Green | | Input state of the corresponding digital input |

Table 227: LED status indicators on the integrated X2 I/O slot

9.12.2.5.3 Slot X3


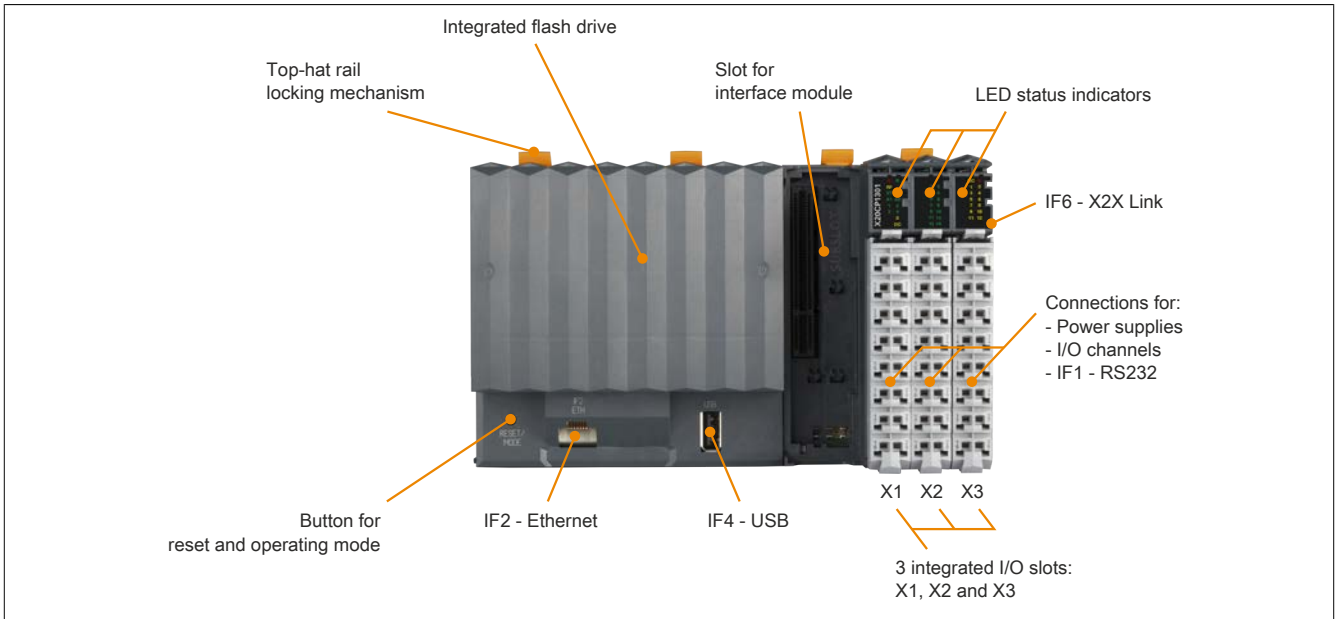
| Figure | LED | Color | Status | Description |
|---|--------|--------|--------------|---|
|  | DC | Yellow | On | I/O power supply OK |
| | E | Red | Off | Everything OK |
| | | | Double flash | No power to module |
| | 1 - 4 | Yellow | | Output status of the corresponding digital output |
| | 5 - 8 | Yellow | | Input or output status of the corresponding digital input or output |
| | 9 - 12 | Yellow | | Output status of the corresponding high-speed digital output |

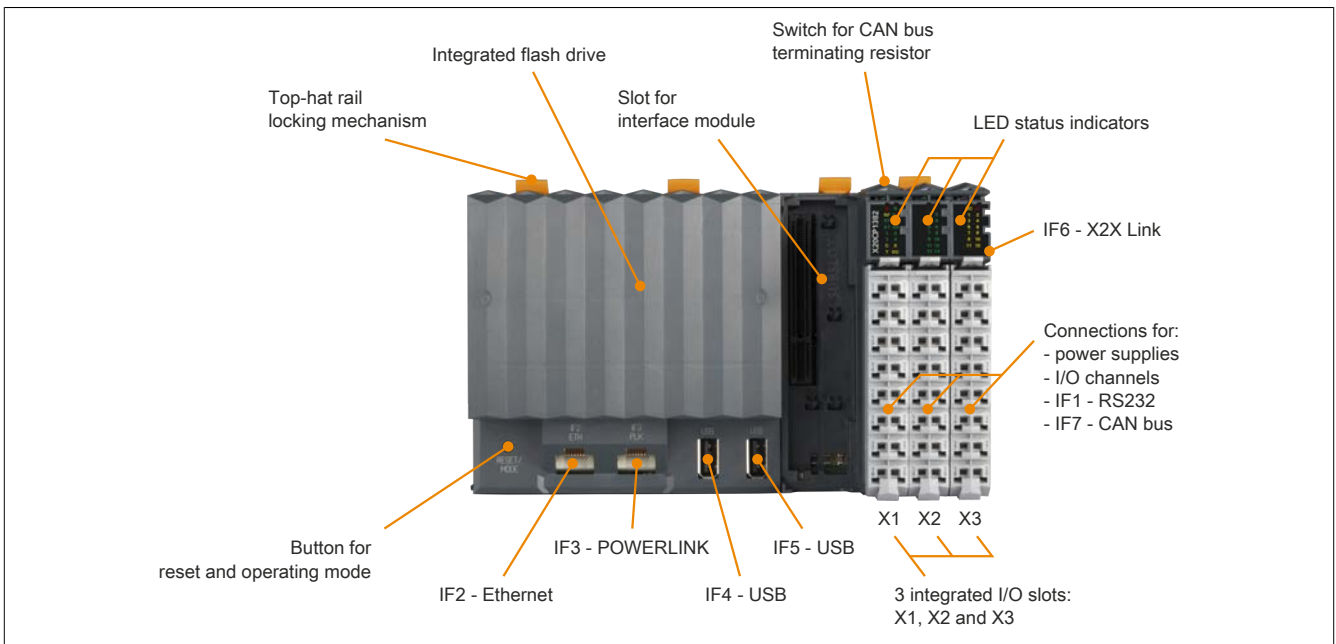
Table 228: LED status indicators on the integrated X3 I/O slot

9.12.2.6 Operating and connection elements

X20CP1301



X20CP1381 and X20CP1382



9.12.2.6.1 Button for reset and operating mode



9.12.2.6.1.1 Reset

The button must be pressed for less than 2 seconds to trigger a reset. This triggers a hardware reset on the CPU, which means that:

- All application programs are stopped.
- All outputs are set to zero.

The controller then boots into service mode by default. The startup mode that follows after pressing the reset button can be set in Automation Studio.

- Service mode (default)
- Warm restart
- Cold restart
- Diagnostic mode

9.12.2.6.1.2 Operating mode

3 operating modes can be configured using different button sequences:

| Operating mode | Button sequence | Description |
|---------------------------|---|---|
| BOOT ¹⁾ | Boot mode is enabled by the following button sequence: <ul style="list-style-type: none"> • Press the button for less than 2 seconds. As soon as the "R" LED on the X1 I/O slot is lit RED, the button can be released. • Then press the button within 2 seconds for longer than 2 seconds. As soon as the "R" LED is no longer lit, the button can be released. | The default Automation Runtime system is started and the runtime system can be installed via the online interface (Automation Studio). User flash memory is deleted only after the download begins. |
| SERVICE/RUN ¹⁾ | Press the button for less than 2 seconds. As soon as the "R" LED on the X1 I/O slot is lit RED , the button can be released. | Mode SERVICE/RUN: Triggering and startup behavior correspond to triggering a hardware reset (see "Reset" on page 1335). |
| DIAGNOSE ¹⁾ | Press the button for more than 2 seconds. The "R" LED on the X1 I/O slot lights up RED and then goes out. As soon as the "R" LED is no longer lit, the button can be released. | Boots the CPU in diagnostic mode. Program sections in User RAM and User FlashPROM are not initialized. After diagnostic mode, the CPU always boots with a cold restart. |

1) The operating states are described in Automation Help under "Real-time operating system - Method of operation - Operating states".

9.12.2.6.2 Flash drive

This application memory is implemented as an integrated flash drive.

9.12.2.6.3 Project installation

Project installation is described in Automation Help under "Project management / Project installation".

9.12.2.6.4 RS232 interface (IF1)

The non-electrically isolated RS232 interface is primarily intended to serve as an online interface for communication with the programming device. It is located on the X1 I/O slot.

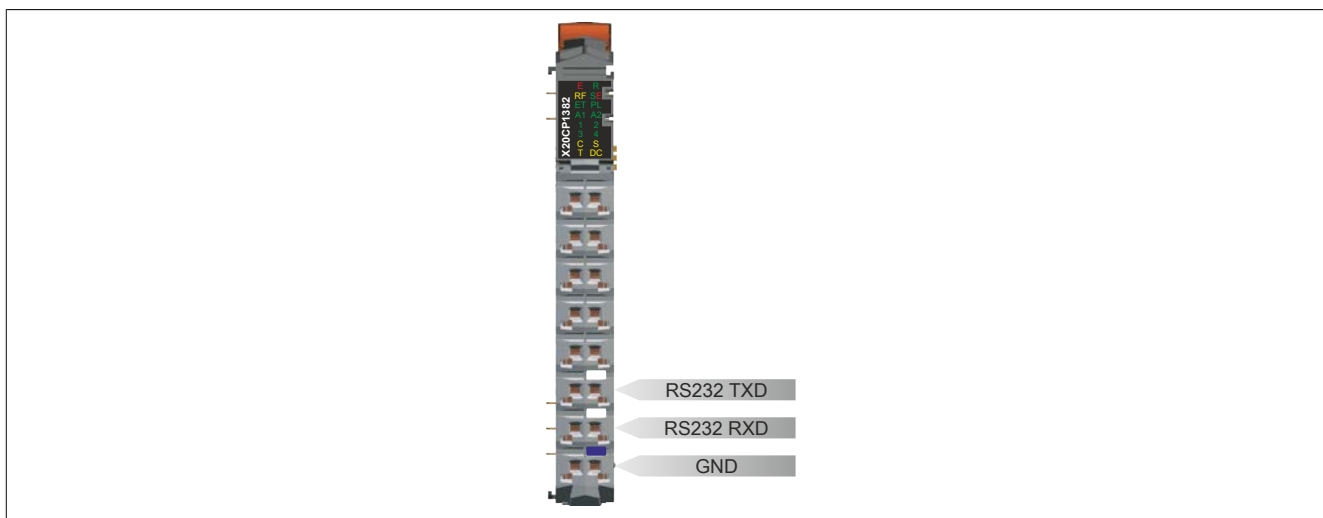
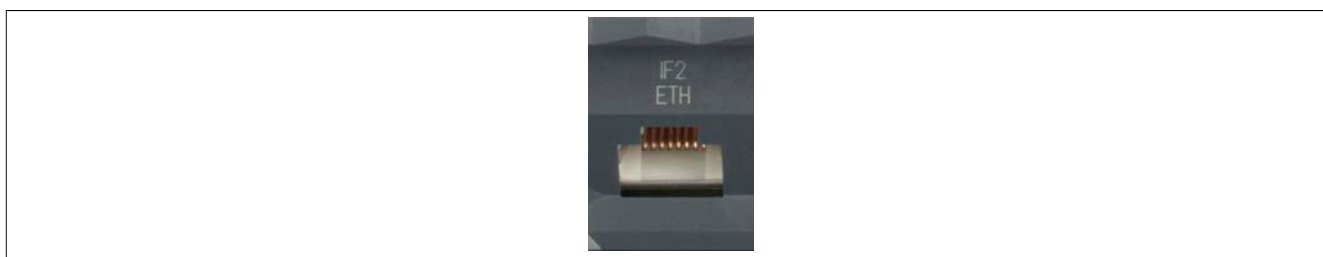


Figure 123: RS232 interface (IF1) on the X1 I/O slot - Pinout

9.12.2.6.5 Ethernet interface (IF2)



The IF2 interface is designed for 10BASE-T / 100BASE-TX transmission.

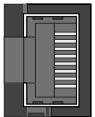
The INA2000 station number can be set using the Automation Studio software.

Information about cabling X20 modules with an Ethernet interface can be found in the module's download section at (www.br-automation.com).

Information:

The Ethernet interface (IF2) is not suitable for POWERLINK (see "POWERLINK interface (IF3)" on page 1337).

Pinout

| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | TXD | Transmit data |
| | 2 | TXD\ | Transmit data\ |
| | 3 | RXD | Receive data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | RXD\ | Receive data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.12.2.6.6 POWERLINK interface (IF3)

Compact CPUs X20CP1381 and X20CP1382 are equipped with a POWERLINK V2 interface.

POWERLINK

By default, the POWERLINK interface is operated as a managing node (MN). In the managing node, the node number is set to a fixed value of 240.

If the POWERLINK node is operated as a controlled node (CN), a node number from 1 to 239 can be set in the POWERLINK configuration in Automation Studio.

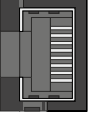
Ethernet mode

In this mode, the interface is operated as an Ethernet interface. The INA2000 station number is set using the B&R Automation Studio software.

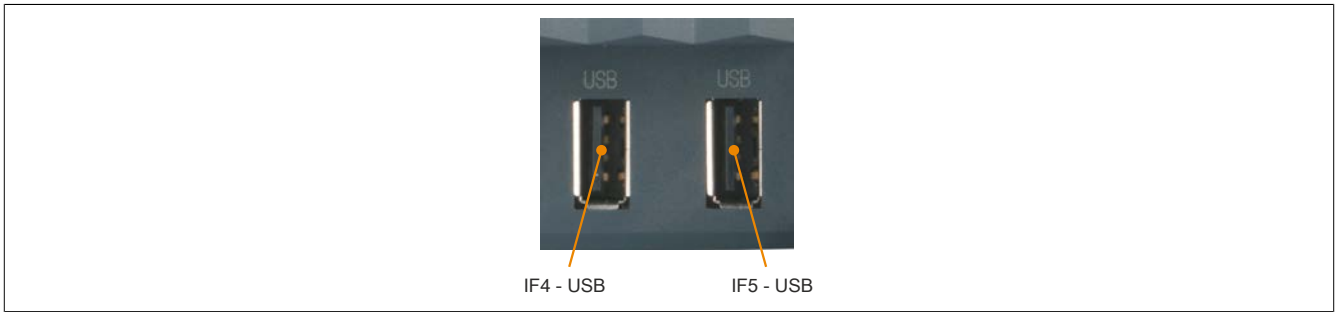
Pinout



For information about wiring X20 modules with an Ethernet interface, see ["Cabling guidelines for X20 modules with an Ethernet cable"](#) on page 58.

| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.12.2.6.7 USB interfaces (IF4 and IF5)



IF4 and IF5 are non-galvanically isolated USB interfaces. The abbreviation USB stands for "Universal Serial Bus". Both USB interfaces support the USB 1.1 and 2.0 standards.

Information:

USB peripheral devices can be connected to the USB interfaces. Due to the variety of USB devices available on the market, B&R cannot guarantee their functionality. The functionality of USB devices available from B&R is guaranteed.

Information:

- The USB interfaces cannot be used as online communication interfaces.
- Only devices isolated from GND are permitted to be connected to the USB interfaces.
- Current-carrying capacity is listed in the technical data.

Only interface IF4 is available on the entry level CPU.

9.12.2.6.8 CAN bus interface (IF7)

With the exception of the entry level CPU, all compact CPUs are equipped with a non-electrically isolated CAN bus interface. It is located on the X1 I/O slot.

9.12.2.6.8.1 Pinout

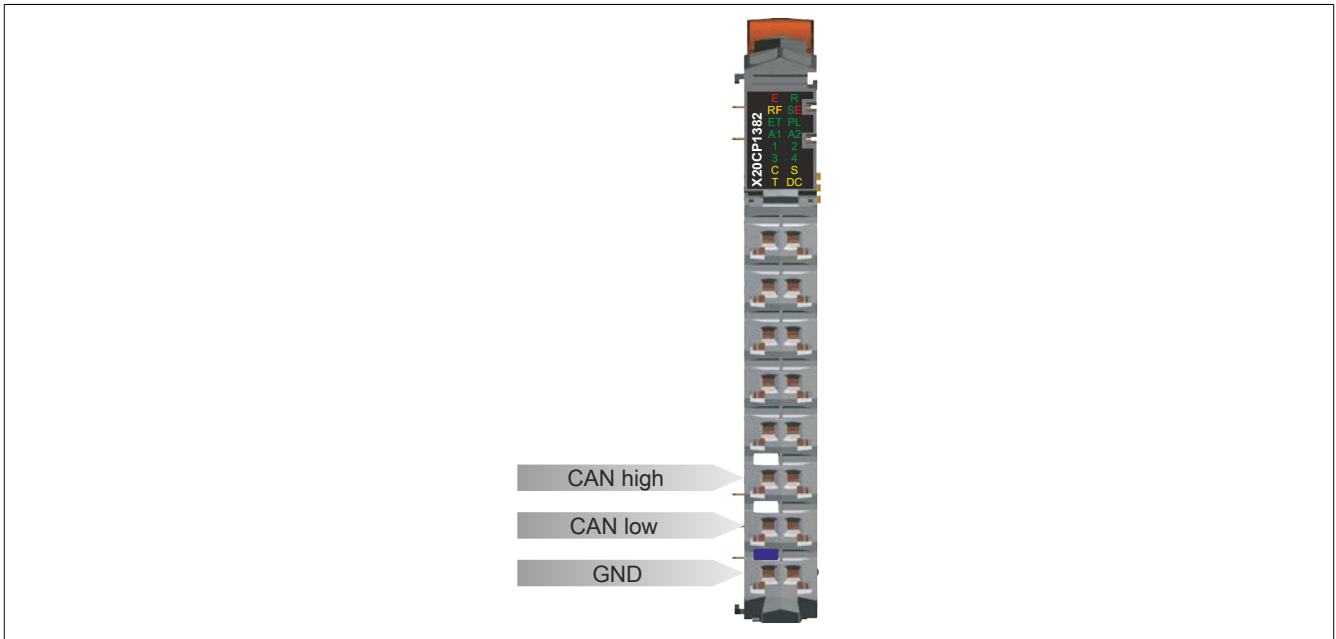


Figure 124: CAN bus interface (IF7) on the X1 I/O slot - Pinout

9.12.2.6.8.2 Terminating resistor

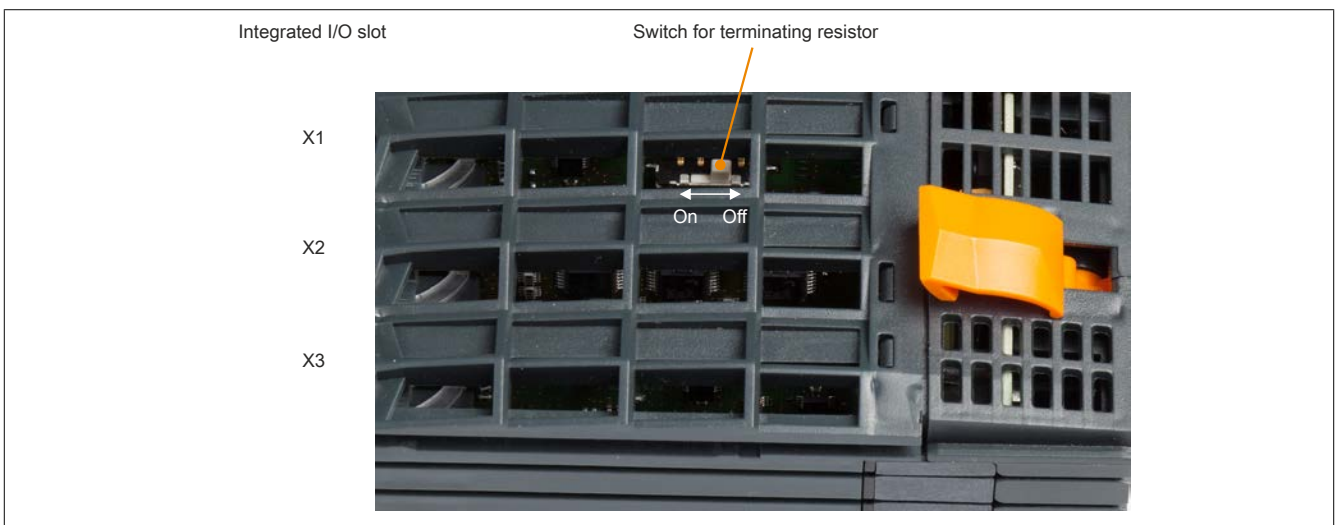


Figure 125: Switch positions for the CAN bus terminating resistor

A terminating resistor is already installed on the X1 I/O slot. It can be turned on and off with a switch on top of the housing. An active terminating resistor is indicated by the "T" LED.

9.12.2.6.9 Slot for interface modules

These CPUs are equipped with one slot for interface modules.

Various bus and network systems can easily be integrated into the X20 system by selecting the corresponding interface module.

9.12.2.6.10 Data and real-time clock retention

The CPUs do not use a battery. This makes them completely maintenance-free. The following measures make operation without a backup battery possible.

| Data and real-time clock retention | Backup type | Note |
|------------------------------------|---------------------|---|
| Remanent variables | FRAM | This FRAM stores its contents ferroelectrically. Unlike normal SRAM, this does not require a battery. |
| Real-time clock | Gold foil capacitor | The real-time clock is backed up for approx. 1000 hours @ 25°C by a gold foil capacitor. The gold foil capacitor is completely charged after 3 continuous hours of operation. |

9.12.2.7 CPU supply

A power supply is integrated in these compact CPUs. It has a feed for the CPU, X2X Link and the internal I/O power supply. The supply for the CPU and X2X Link is electrically isolated.

The connections are located on the X3 I/O slot.

Power supply concept of Compact CPUs

To ensure proper operation of compact CPUs, the following items must be taken into consideration:

| The supply concept | Description |
|-------------------------|--|
| CPU and I/O GND | The GND contact is provided 5 times on the terminal blocks of the integrated I/O slots. All GND contacts are connected to one another. The GND contacts of the CPU and I/O power supply therefore use the same voltage. |
| Plug-in X20 I/O modules | Supply of X20 I/O modules that can be connected to the compact CPU: <ul style="list-style-type: none"> X2X Link: Supplied by the CPU supply I/O channels: Supplied by the I/O power supply |
| Integrated X1 I/O slot | All digital and analog signals as well as the RS232 and CAN bus interface are supplied by the CPU supply. Their operation is therefore guaranteed even if there is no I/O power supply. |
| Integrated X2 I/O slot | <ul style="list-style-type: none"> All digital signals are supplied by the CPU supply. Their operation is therefore guaranteed even if there is no I/O power supply. The encoder supply is supplied by the I/O power supply. If the encoder is not to be connected to the E-stop chain, then it must be connected to an external power supply or it will be supplied by the CPU supply. |
| Integrated X3 I/O slot | <ul style="list-style-type: none"> All 12 digital signals are supplied by the I/O power supply. The status messages for each channel also work without an I/O power supply. This guarantees that status messages will continue to be transferred during an E-stop. The status of the I/O power supply is indicated by a separate status message. <p>Caution!</p> <p>Channels 5 to 8 are designed as mixed channels. If one of these channels is being used, it is absolutely essential to ensure that there is no external voltage present on the I/O channel when the I/O power supply is cut off. Otherwise, power will be regenerated back to the plus terminal of the I/O power supply via the I/O channel. This will result in defective components.</p> <p>The following solutions are available for preventing power regeneration from occurring:</p> <ul style="list-style-type: none"> The I/O power supply of the CPU is not permitted to be switched off, which allows the reference potential to be maintained. If the I/O power supply is switched off anyway (e.g. as part of the E-stop chain), then the sensor/actuator supplies must also be switched off. This prevents potential power regeneration and protects components from being destroyed. |

Pinout

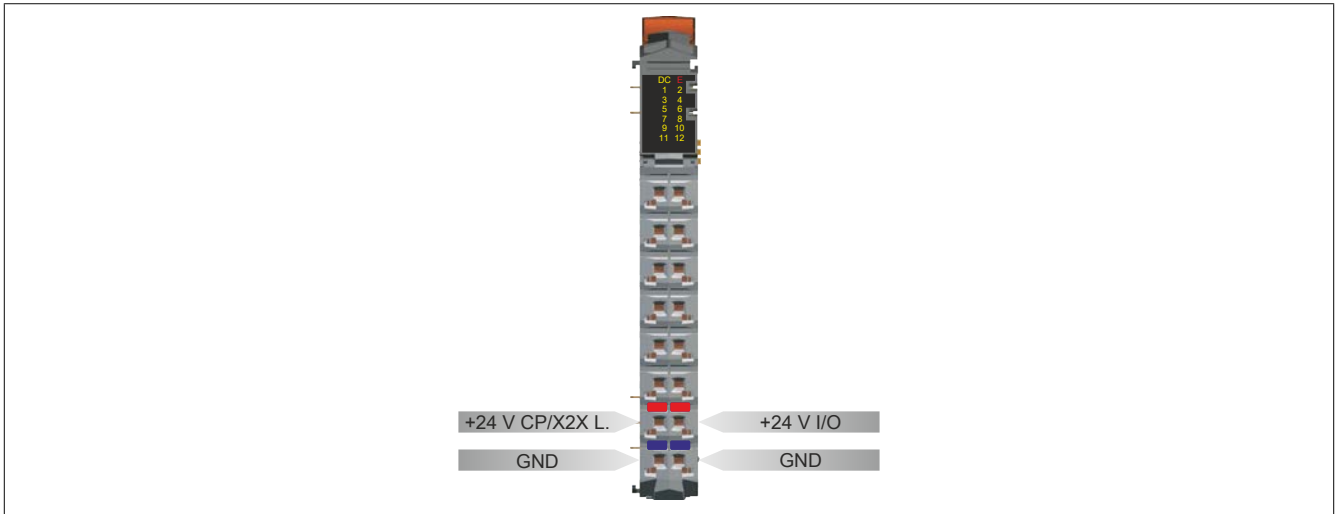


Figure 126: Integrated power supply - Pinout

Connection example

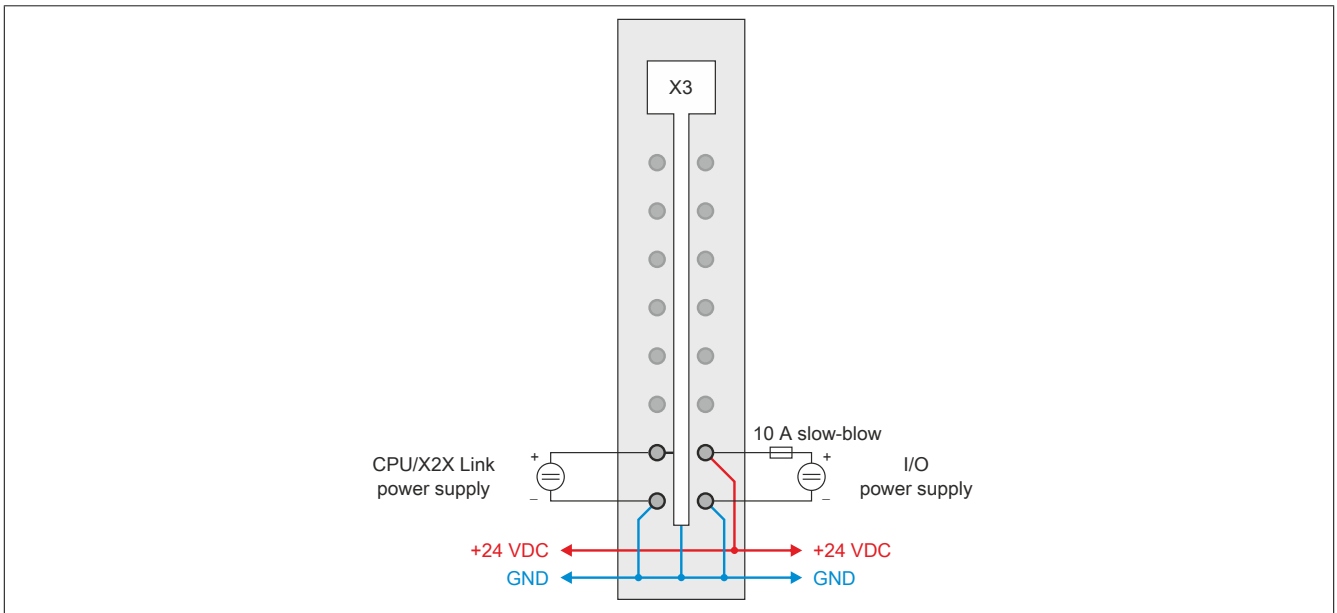


Figure 127: CPU supply - Connection example

9.12.2.8 Overtemperature cutoff

To prevent damage, a shutdown/reset is triggered on the CPU when the processor reaches 95°C.

The following errors are entered in the logbook in the event of shutdown:

| Error number | Short error text |
|--------------|--|
| 9204 | PLC restart triggered by the PLC CPU's temperature monitoring. |
| 9210 | Warning: Halt/Service after watchdog or manual reset. |

9.12.2.9 Local I/O channels

Compact CPUs are equipped with 3 integrated I/O slots. These devices have 30 digital inputs/outputs and 2 analog inputs.

Information about the functions of the high-speed digital inputs and outputs can be found in the section "[Functions of the high-speed digital inputs/outputs](#)" on page 1348.

The following table provides an overview of the connections to the I/O channels and their properties.

Digital inputs/outputs

| Connection | Terminal connection | Channel | Description |
|------------|---------------------|-------------|---|
| X1 | 14 | DI 1 | 24 VDC, sink, $\leq 200 \mu\text{s}$, configurable software filter |
| | 24 | DI 2 | 24 VDC, sink, $\leq 200 \mu\text{s}$, configurable software filter |
| | 15 | DI 3 | 24 VDC, sink, $\leq 200 \mu\text{s}$, configurable software filter |
| | 25 | DI 4 | 24 VDC, sink, $\leq 200 \mu\text{s}$, configurable software filter |
| X2 | 11 | DI 1 | 24 VDC, sink, $\leq 200 \mu\text{s}$, configurable software filter |
| | 21 | DI 2 | 24 VDC, sink, $\leq 200 \mu\text{s}$, configurable software filter |
| | ... | ... | ... |
| | 25 | DI 10 | 24 VDC, sink, $\leq 200 \mu\text{s}$, configurable software filter |
| | 16 | DI 11 | 24 VDC, sink, $\leq 2 \mu\text{s}$, configurable software filter |
| | 26 | DI 12 | 24 VDC, sink, $\leq 2 \mu\text{s}$, configurable software filter |
| | 17 | DI 13 | 24 VDC, sink, $\leq 2 \mu\text{s}$, configurable software filter |
| | 27 | DI 14 | 24 VDC, sink, $\leq 2 \mu\text{s}$, configurable software filter |
| X3 | 11 | DO 1 | 24 VDC, 0.5 A, source, $< 300 \mu\text{s}$ |
| | 21 | DO 2 | 24 VDC, 0.5 A, source, $< 300 \mu\text{s}$ |
| | 12 | DO 3 | 24 VDC, 0.5 A, source, $< 300 \mu\text{s}$ |
| | 22 | DO 4 | 24 VDC, 0.5 A, source, $< 300 \mu\text{s}$ |
| | 13 | DI 5 / DO 5 | DI: 24 VDC, sink, $\leq 200 \mu\text{s}$, configurable software filter DO: 24 VDC, 0.5 A, source, $< 300 \mu\text{s}$ |
| | 23 | DI 6 / DO 6 | DI: 24 VDC, sink, $\leq 200 \mu\text{s}$, configurable software filter DO: 24 VDC, 0.5 A, source, $< 300 \mu\text{s}$ |
| | 14 | DI 7 / DO 7 | DI: 24 VDC, sink, $\leq 200 \mu\text{s}$, configurable software filter DO: 24 VDC, 0.5 A, source, $< 300 \mu\text{s}$ |
| | 24 | DI 8 / DO 8 | DI: 24 VDC, sink, $\leq 200 \mu\text{s}$, configurable software filter DO: 24 VDC, 0.5 A, source, $< 300 \mu\text{s}$ |
| | 15 | DO 9 | 24 VDC, 0.2 A, push-pull, $< 3 \mu\text{s}$ |
| | 25 | DO 10 | 24 VDC, 0.2 A, push-pull, $< 3 \mu\text{s}$ |
| | 16 | DO 11 | 24 VDC, 0.2 A, push-pull, $< 3 \mu\text{s}$ |
| | 26 | DO 12 | 24 VDC, 0.2 A, push-pull, $< 3 \mu\text{s}$ |

Analog inputs

| Connection | Terminal connection | Channel | Description |
|------------|---------------------|---------|---|
| X1 | 11, 12, 13 | AI 1 | $\pm 10 \text{ V} / 0$ to 20 mA or 4 to 20 mA, 12-bit, 1 ms |
| | 21, 22, 23 | AI 2 | $\pm 10 \text{ V} / 0$ to 20 mA or 4 to 20 mA, 12-bit, 1 ms |

Analog input 1 can also be used for PT1000 resistance temperature measurement.

| Connection | Terminal connection | Channel | Description |
|------------|---------------------|---------|---|
| X1 | 11, 12, 13 | AI 1 | PT1000 resistance temperature measurement Measurement takes place using analog input A1. |

9.12.2.10 Pinouts

Slot X1

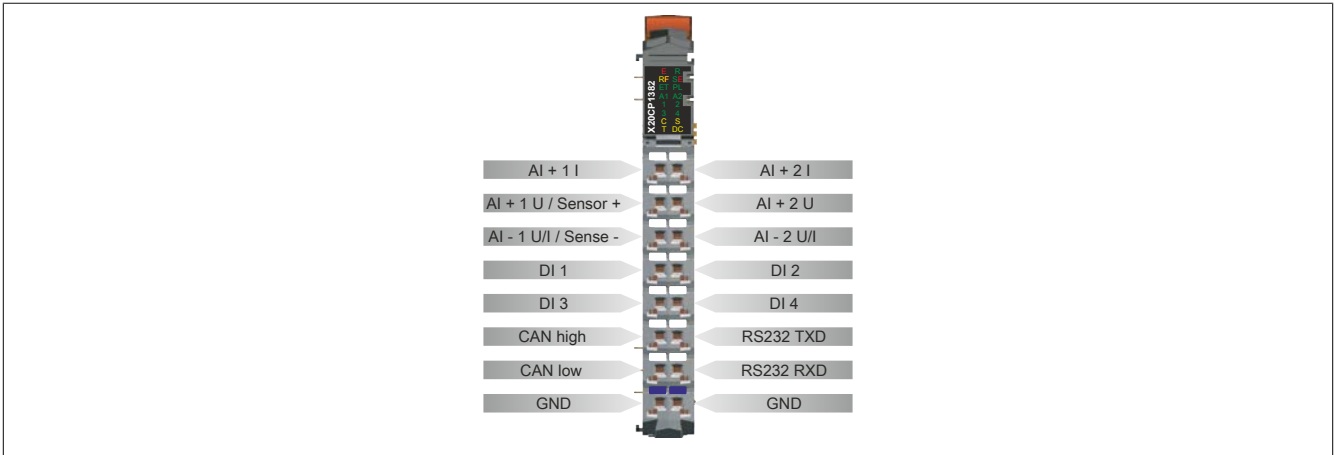


Figure 128: Pinout of the integrated X1 I/O slot

Slot X2

To prevent crosstalk, each signal line of the high-speed digital inputs should be shielded individually. The maximum cable length is 20 m.

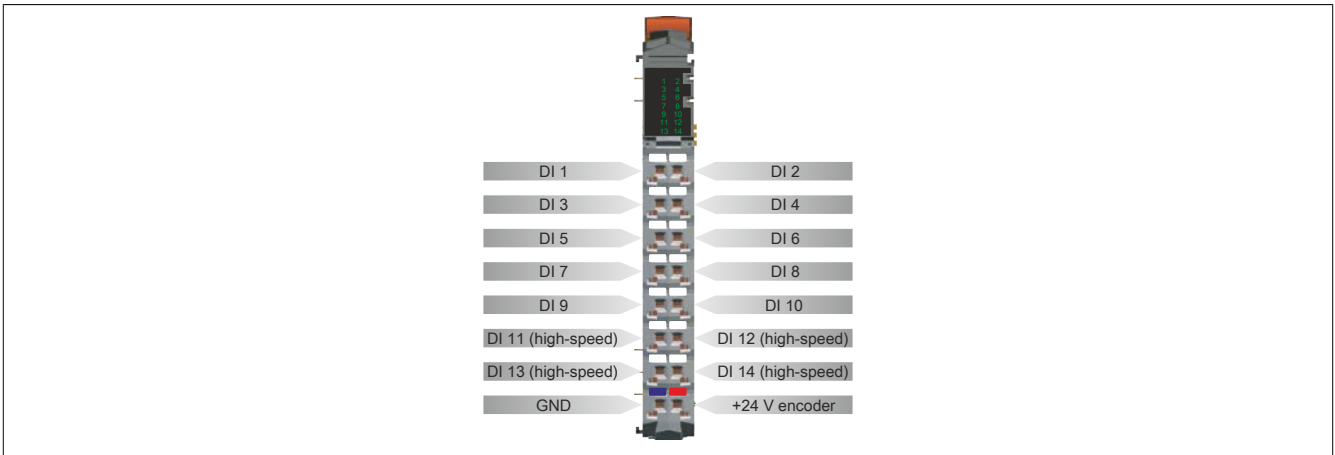


Figure 129: Pinout of the integrated X2 I/O slot

Slot X3

To ensure proper operation of the digital mixed channels (DI 5 / DO 5 to DI 8 / DO 8), it is important to observe the notes in section "Power supply concept of Compact CPUs" on page 1340.

To prevent crosstalk, each signal line of the high-speed digital outputs should be shielded individually. The maximum cable length is 20 m.

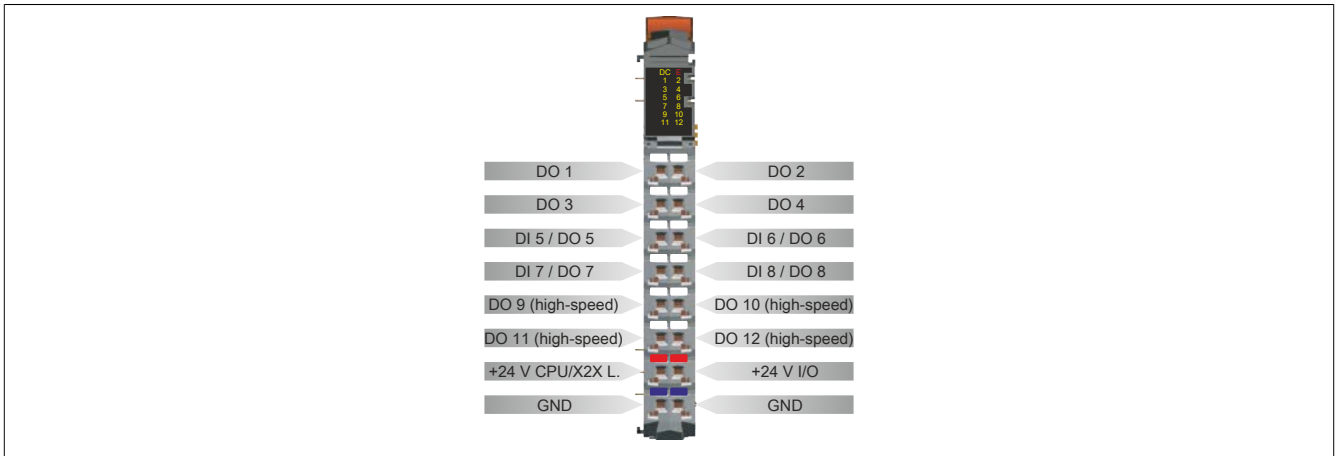


Figure 130: Pinout of the integrated X3 I/O slot

9.12.2.11 Connection examples

9.12.2.11.1 Slot X1

Voltage/Current measurement, digital inputs and CAN bus

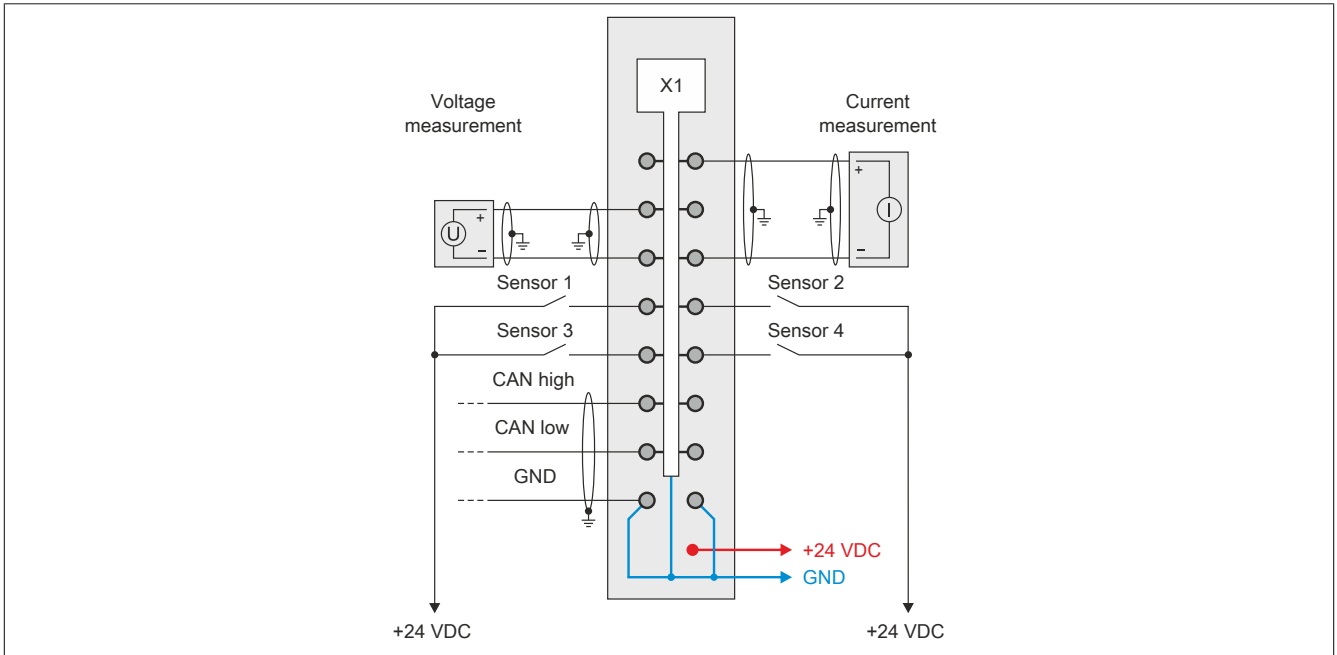


Figure 131: Connection example 1 for integrated I/O slot X1

PT1000 resistance temperature measurement, voltage measurement, digital inputs and RS232

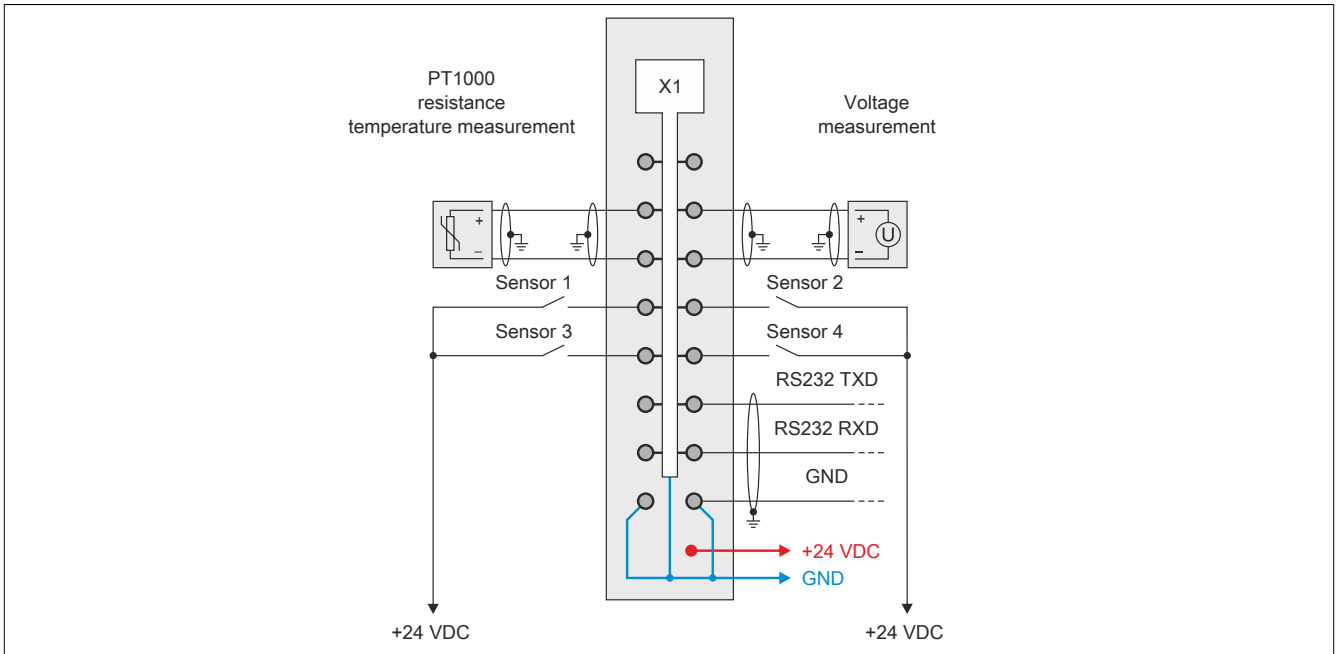


Figure 132: Connection example 2 for integrated I/O slot X1

9.12.2.11.2 Slot X2

Digital inputs and ABR incremental encoder

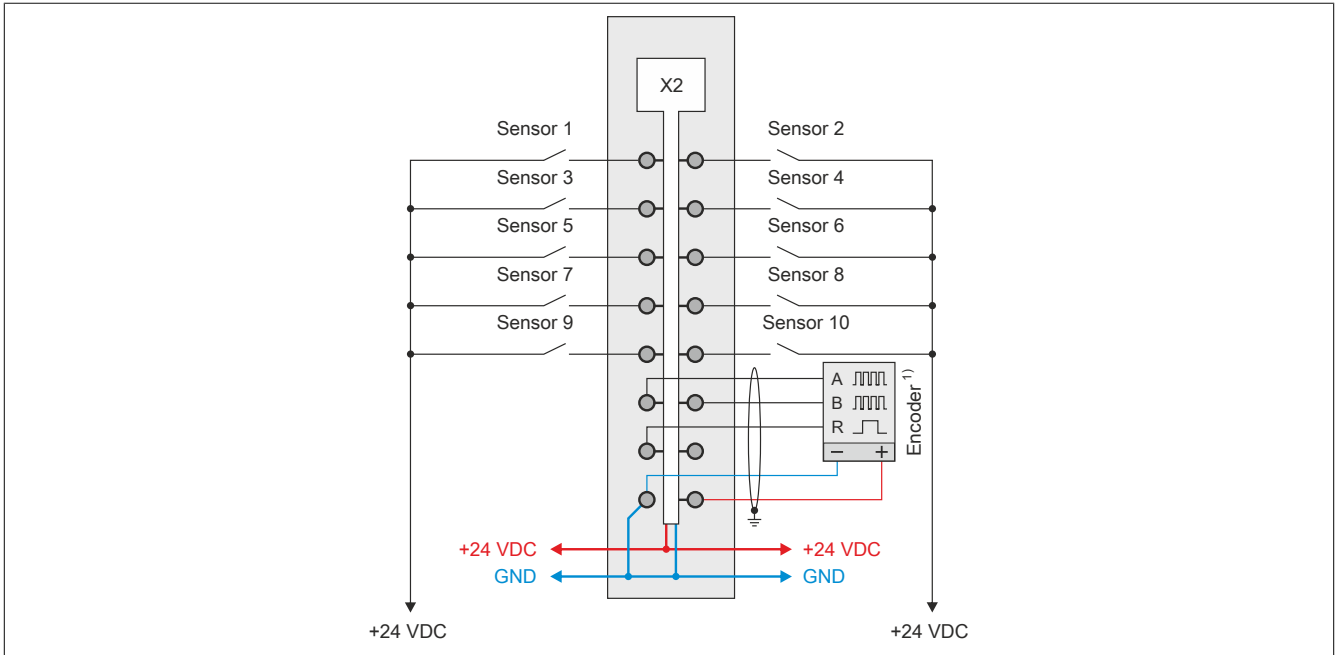


Figure 133: Connection example 1 for integrated X2 I/O slot

- 1) Observe the wiring guidelines from the encoder manufacturer.

DI11 to DI14 are used as high-speed digital inputs

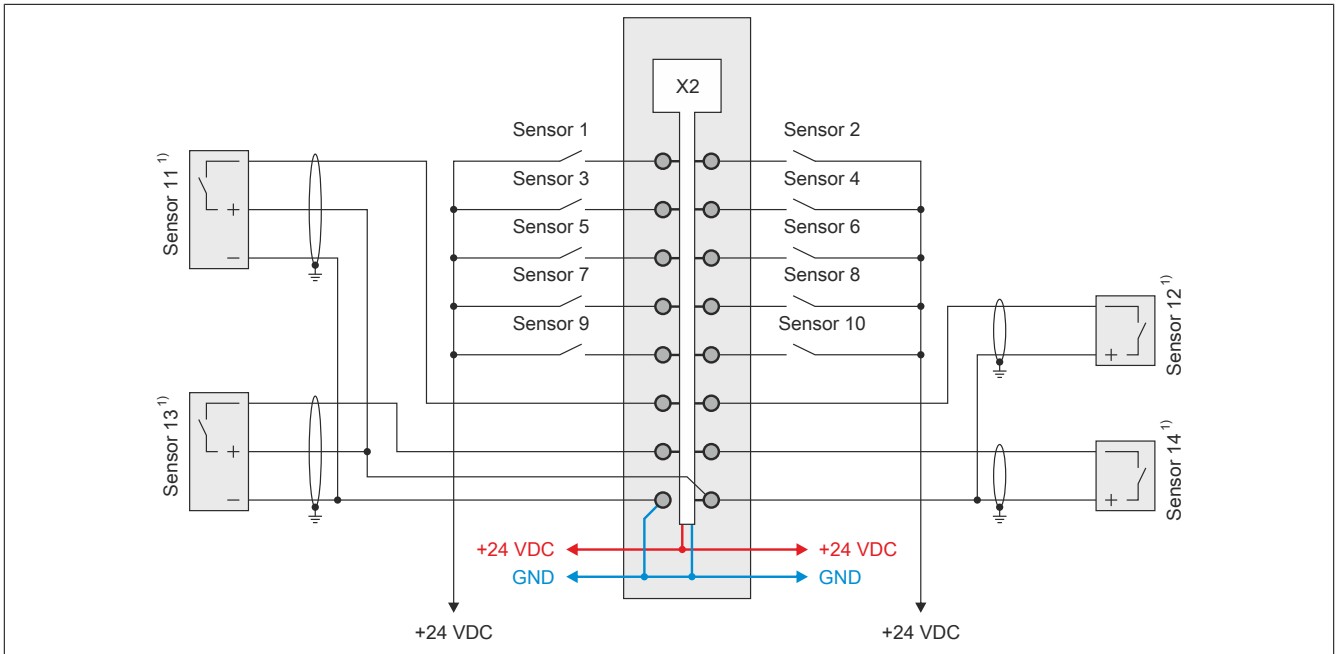


Figure 134: Anschlussbeispiel 2 für integrierten I/O-Steckplatz X2

- 1) Verdrahtungsvorschriften des Sensorherstellers beachten.

9.12.2.11.3 Slot X3

Digital inputs/outputs, direction/frequency (DF), PWM, CPU / X2X Link power supply and I/O power supply

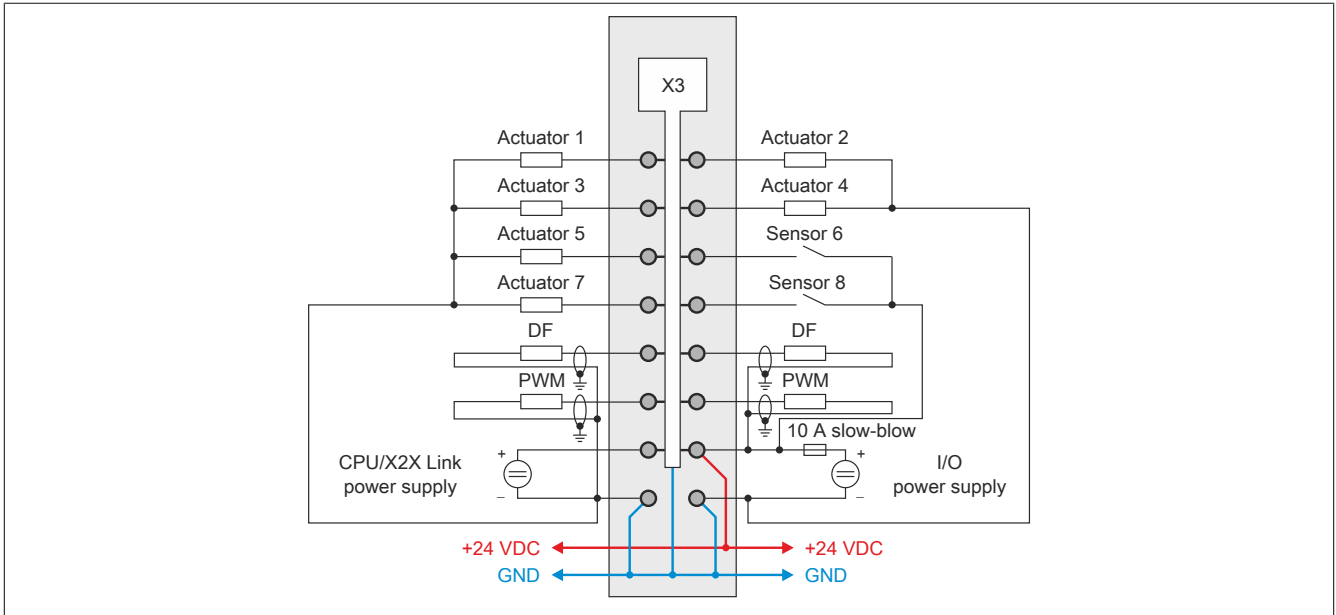


Figure 135: Connection example for integrated X3 I/O slot

9.12.2.12 Functions of the high-speed digital inputs/outputs

9.12.2.12.1 Functions of the high-speed digital inputs

Possible functions

The high-speed digital inputs DI 11 to DI 14 can be configured for the following functions: It is important to note that maximum 2 functions of the same type are possible with edge detection.

| Channel | Counter function | | | Edge detection ¹⁾ |
|---------|------------------|---|----------------------|--|
| DI 11 | Event counter 1 | A | A | D - Direction • Period measurement • Gate measurement • Differential time measurement • Edge counters • Edge times |
| DI 12 | | B | B | F - Frequency • Period measurement • Gate measurement • Differential time measurement • Edge counters • Edge times |
| DI 13 | Event counter 2 | A | R | R • Period measurement • Gate measurement • Differential time measurement • Edge counters • Edge times |
| DI 14 | | B | E - Reference enable | E - Reference enable • Period measurement • Gate measurement • Differential time measurement • Edge counters • Edge times |

Table 229: Possible functions of the high-speed digital inputs DI 11 to DI 14

1) Maximum 2 functions of the same type can be configured.

Please note

The following points must be taken into account to correctly configure the high-speed digital inputs:

- The counter functions are mutually exclusive. Only one type of counter function can be selected at a time. It is not possible to select 2 event counters (DI 11 and DI 13) at the same time together with an AB or DF counter (each on DI 13 and DI 14)!
- It is possible to select a counter function and edge detection at the same time.
- A position or counter latch is possible when configuring the high-speed inputs as a 2x event counter, ABR incremental encoder or DF function.

Examples of possible configurations

| Channel | Configuration 1 | Configuration 2 | Configuration 3 | Configuration 4 |
|---------|---|---------------------------------|----------------------|----------------------|
| DI 11 | Event counter 1 | • Edge counters • Edge times | A | D |
| DI 12 | • Period measurement • Gate measurement • Differential time measurement | • Edge counters • Edge times | B | F |
| DI 13 | Event counter 2 | A | R | R |
| DI 14 | • Period measurement • Gate measurement • Differential time measurement | B | E - Reference enable | E - Reference enable |

| Channel | Configuration 5 | Configuration 6 | Configuration 7 | Configuration 8 |
|---------|---|---|---|---|
| DI 11 | Event counter 1 | A | • Period measurement • Gate measurement • Differential time measurement | D - Direction |
| DI 12 | • Edge counters • Edge times | B | • Period measurement • Gate measurement • Differential time measurement | F - Frequency |
| DI 13 | Event counter 2 | • Period measurement • Gate measurement • Differential time measurement | • Edge counters • Edge times | • Edge counters • Edge times |
| DI 14 | • Period measurement • Gate measurement • Differential time measurement | • Edge counters • Edge times | • Edge counters • Edge times | • Period measurement • Gate measurement • Differential time measurement |

9.12.2.12.2 Functions of the high-speed digital outputs

Possible functions

The high-speed digital outputs DO 9 to DO 12 can be configured for the following functions:

| Channel | Function | |
|---------|------------------------------|---------------|
| DO 9 | PWM - Pulse width modulation | D - Direction |
| DO 10 | PWM - Pulse width modulation | F - Frequency |
| DO 11 | PWM - Pulse width modulation | D - Direction |
| DO 12 | PWM - Pulse width modulation | F - Frequency |

Table 230: Possible functions of the high-speed digital inputs DO 9 to DO 12

Examples of possible configurations

| Channel | Configuration 1 | Configuration 2 | Configuration 3 | Configuration 4 |
|---------|------------------------------|------------------------------|------------------------------|-----------------|
| DO 9 | PWM - Pulse width modulation | D - Direction | PWM - Pulse width modulation | D - Direction |
| DO 10 | PWM - Pulse width modulation | F - Frequency | PWM - Pulse width modulation | F - Frequency |
| DO 11 | D - Direction | PWM - Pulse width modulation | PWM - Pulse width modulation | D - Direction |
| DO 12 | F - Frequency | PWM - Pulse width modulation | PWM - Pulse width modulation | F - Frequency |

9.12.2.13 Input/Output circuit diagram

9.12.2.13.1 Digital inputs (X1) and high-speed digital inputs (X2)

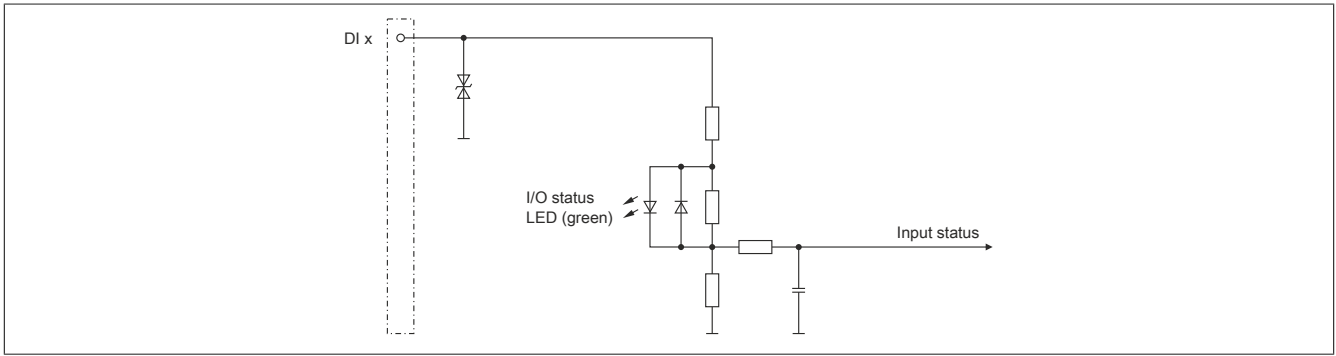


Figure 136: Input circuit diagram of the digital inputs on the integrated X1 I/O slot and the high-speed digital inputs on the integrated X2 I/O slot

9.12.2.13.2 Digital inputs (X2)

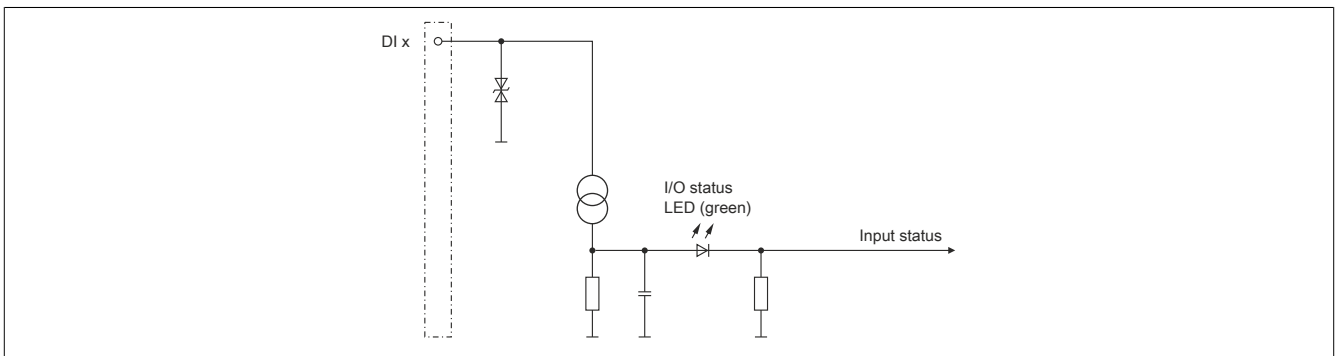


Figure 137: Input circuit diagram of the digital inputs on the integrated X2 I/O slot

9.12.2.13.3 Digital outputs (X3)

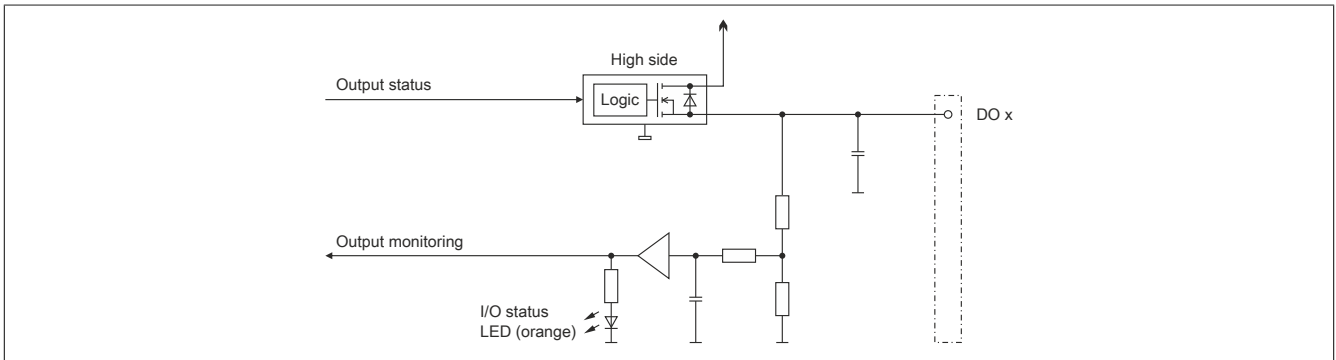


Figure 138: Output circuit diagram of the digital outputs on the integrated X3 I/O slot

9.12.2.13.4 High-speed digital outputs (X3)

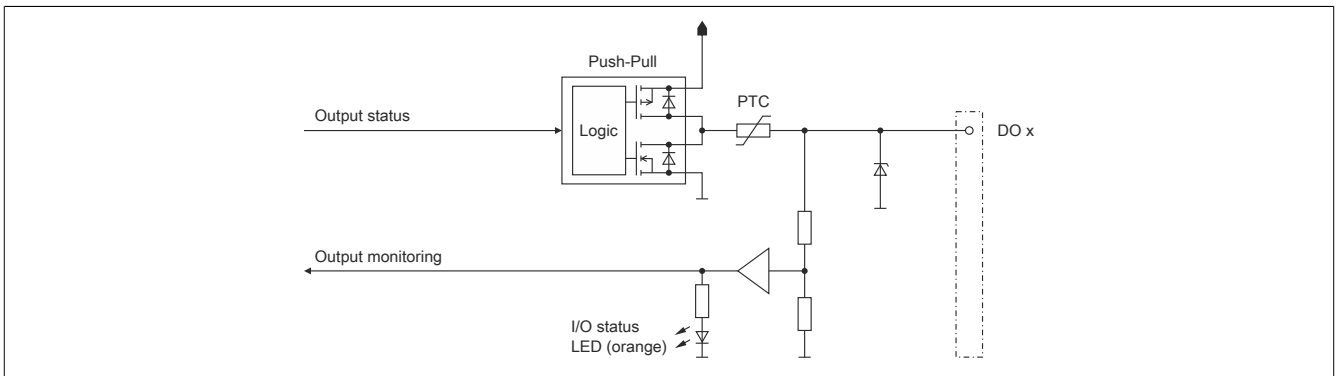


Figure 139: Output circuit diagram of the high-speed digital outputs on the integrated X3 I/O slot

9.12.2.13.5 Digital inputs/outputs (X3)

To ensure proper operation of the digital mixed channels (DI 5 / DO 5 to DI 8 / DO 8), it is important to observe the notes in section ["Power supply concept of Compact CPUs"](#) on page 1340.

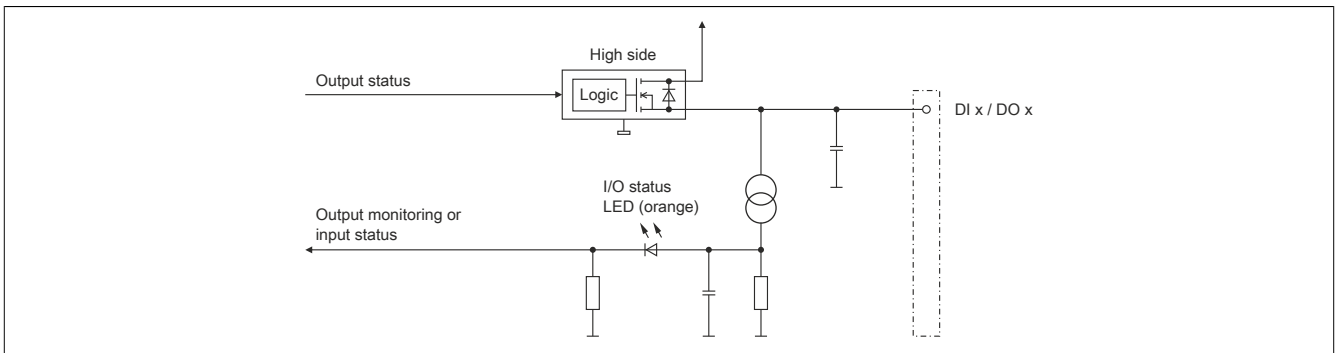


Figure 140: Input/Output circuit diagram of the digital mixed channels on the integrated X3 I/O slot

9.12.2.13.6 Analog inputs (X1)

A PT1000 resistance temperature sensor can be connected to analog input AI 1 and used for temperature measurement.

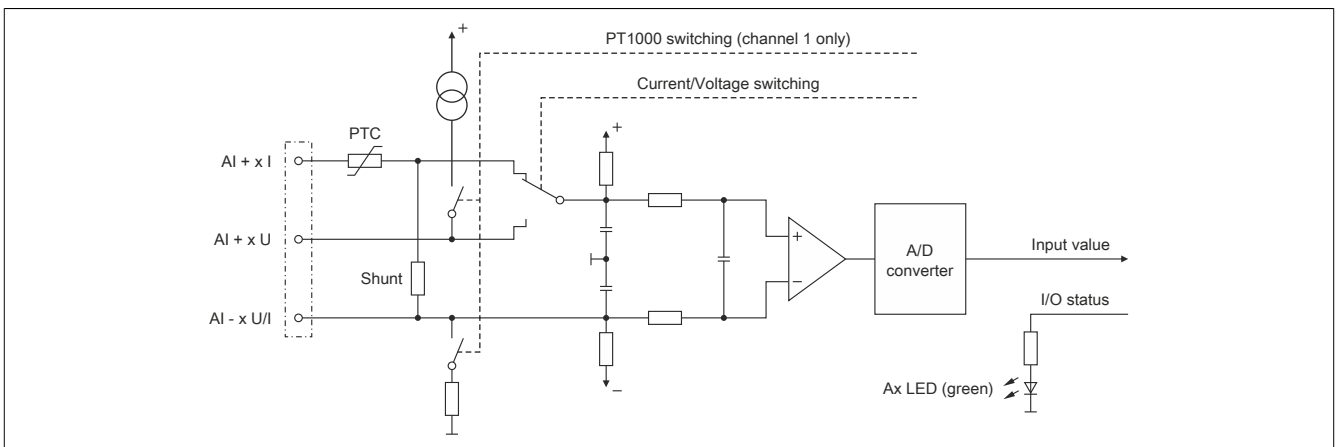


Figure 141: Input circuit diagram of the analog inputs and temperature input on the integrated X1 I/O slot

9.12.2.13.7 Encoder power supply (X2)

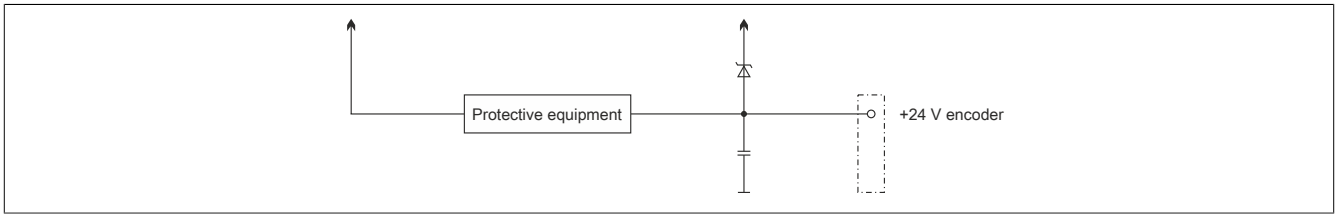


Figure 142: Circuit diagram of the encoder supply on the integrated X2 I/O slot

9.12.2.13.8 CPU, X2X Link and I/O power supply (X3)

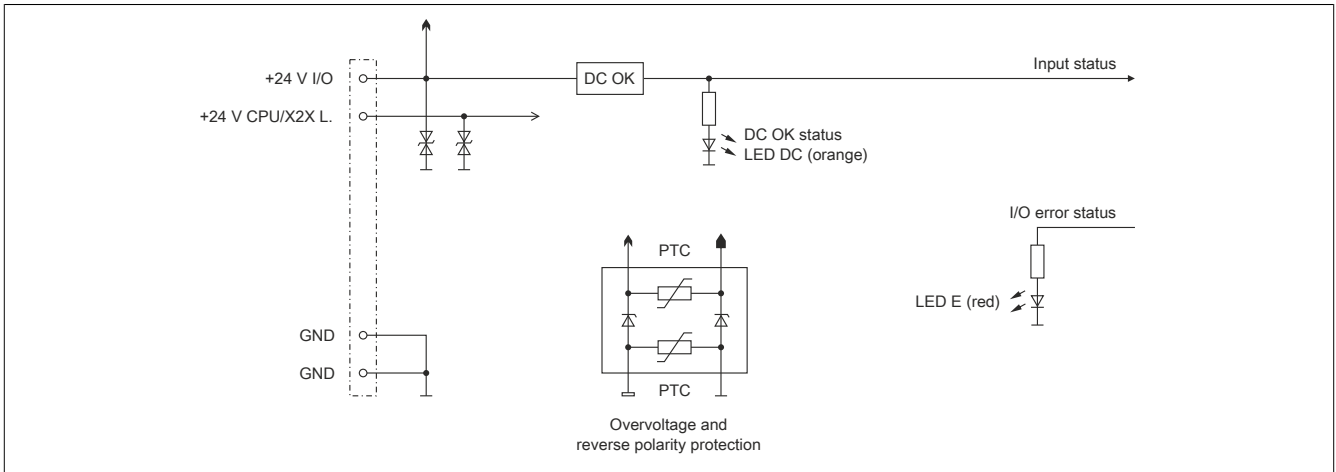


Figure 143: Circuit diagram of the CPU, X2X Link and I/O power supply on the integrated X3 I/O slot

9.12.2.14 Switching frequency derating for high-speed digital outputs

The high-speed digital outputs can be switched with a frequency of max. 200 kHz. Derating may be necessary depending on the mounting orientation and operating temperature.

Switching frequency derating for horizontal mounting orientations

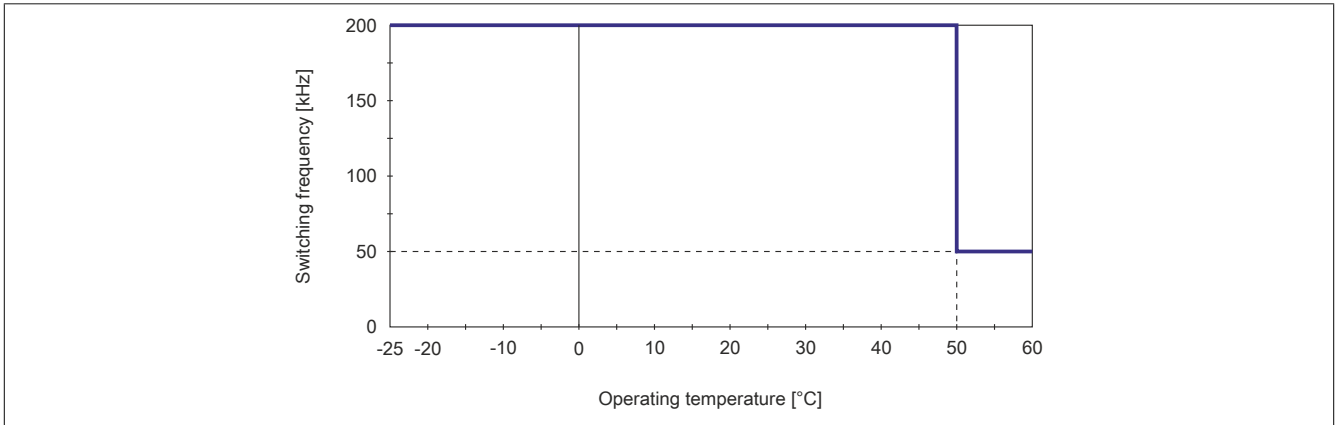


Figure 144: Switching frequency derating for high-speed digital outputs with horizontal mounting orientations

Switching frequency derating for vertical mounting orientations

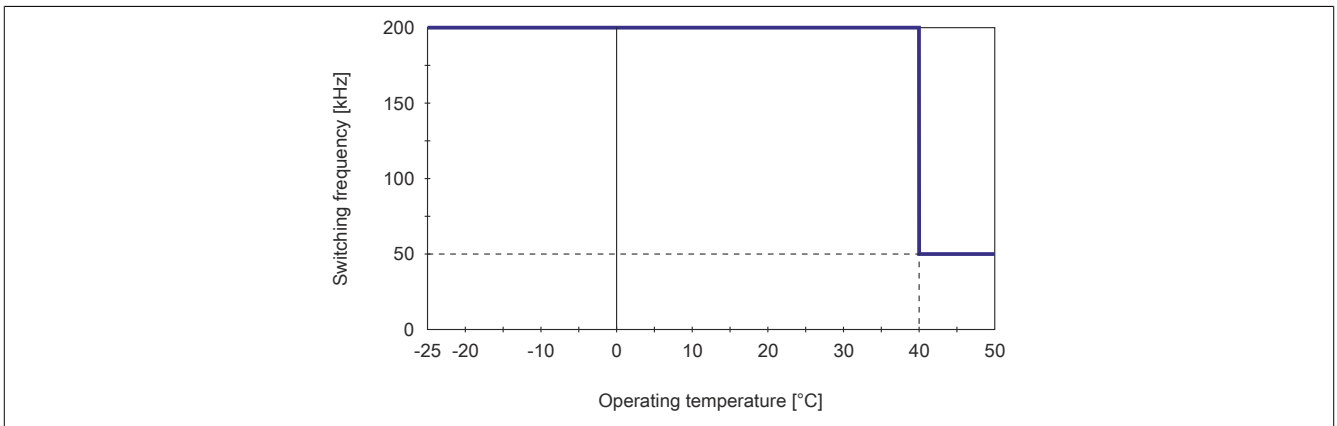
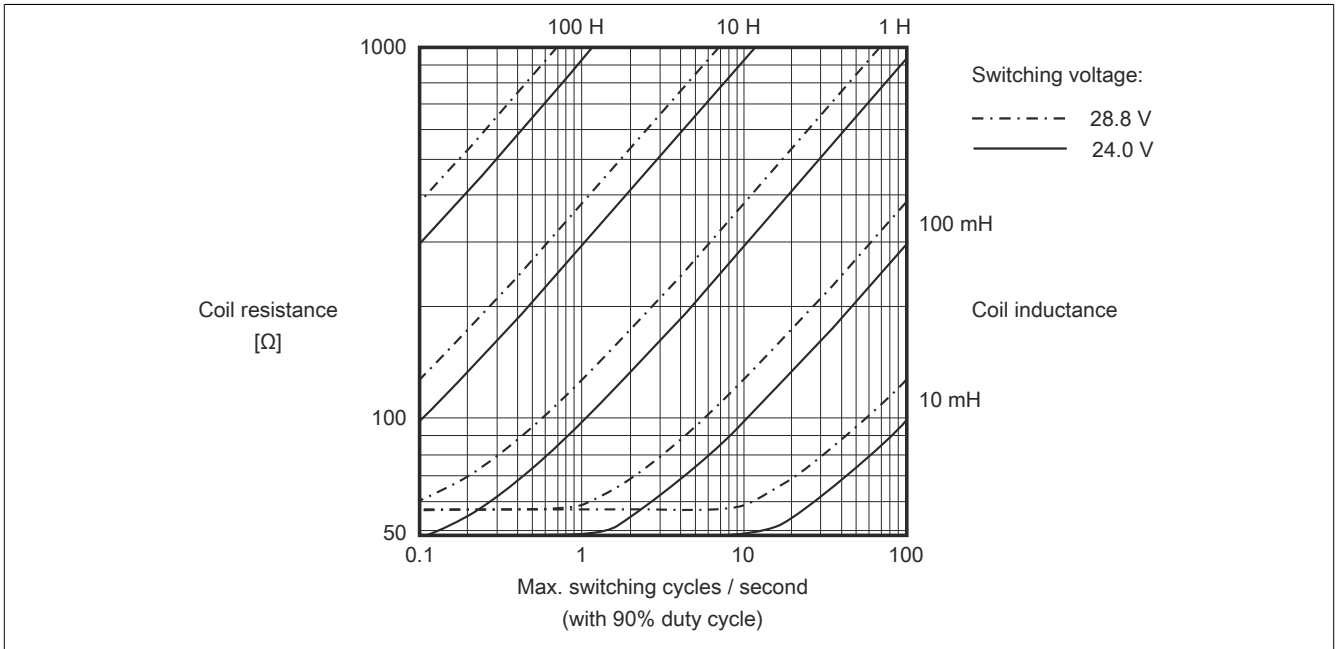


Figure 145: Switching frequency derating for high-speed digital outputs with vertical mounting orientations

9.12.2.15 Switching inductive loads



Information:

If the maximum number of operating cycles per second is exceeded, an external inverse diode must be used.

Operating conditions outside of the area in the diagram are not permitted!

9.12.2.16 Register description

9.12.2.16.1 System requirements

The following minimum versions are recommended to generally be able to use all functions:

- Automation Studio 4.1.4.96
- Automation Runtime M4.10 for X20cCP1301
- Automation Runtime D4.09 for all other variants

9.12.2.16.2 General data points

This CPU is equipped with general data points. These are not CPU-specific; instead, they contain general information such as system time and heat sink temperature.

General data points are described in section "[General CPU data points](#)" on page 3792.

9.12.2.16.3 Register overview of the I/O data points on the integrated X1 I/O slot

| Register | Name | Data type | Read | | Write | |
|---------------------------|--------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| X1 - Configuration | | | | | | |
| 2048 | X1CfO_DI_Filter | USINT | | | | • |
| 2128 | X1CfO_AI_Mode | USINT | | | | • |
| 2112 | X1CfO_AI1_Filter | USINT | | | | • |
| 2116 | X1CfO_AI1_LowerLim | INT | | | | • |
| 2118 | X1CfO_AI1_UpperLim | INT | | | | • |
| 2120 | X1CfO_AI2_Filter | USINT | | | | • |
| 2124 | X1CfO_AI2_LowerLim | INT | | | | • |
| 2126 | X1CfO_AI2_UpperLim | INT | | | | • |
| X1 - Communication | | | | | | |
| 0 | Digital inputs | USINT | • | | | |
| | DigitalInput01 | Bit 0 | | | | |
| | DigitalInput02 | Bit 1 | | | | |
| | DigitalInput03 | Bit 2 | | | | |
| | DigitalInput04 | Bit 3 | | | | |
| 64 | AnalogInput01 | INT | • | | | |
| | | UINT | • | | | |
| 66 | AnalogInput02 | INT | • | | | |
| 80 | StatusInput01 | USINT | • | | | |

9.12.2.16.3.1 Digital inputs

Unfiltered

The input status is recorded in a 100 µs cycle.

Filtered

The filtered status is transferred in a 100 µs cycle.

Filtering takes place asynchronously in an interval of 100 µs.

Digital input filter

Name:

X1CfO_DI_Filter

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 µs.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No SW filter |
| | 1 | 0.1 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

Input state of digital inputs 1 to 4

Name:

DigitalInput01 to DigitalInput04

This register indicates the input state of digital inputs 1 to 4.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|--------|---------------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input status of digital input 1 |
| ... | | ... | |
| 3 | DigitalInput04 | 0 or 1 | Input status of digital input 4 |

9.12.2.16.3.2 Analog inputs

Analog input values are recorded in a fixed interval. The time required for conversion/updating depends on the number of analog inputs and on the input signal:

| Input signal | Time required for conversion/updating |
|--|---------------------------------------|
| 1 current/voltage input | 100 µs |
| 1 temperature/resistance input | 200 µs |
| 2 current/voltage inputs | 200 µs |
| 1 current/voltage input and 1 temperature/resistance input | 400 µs |

Input values of analog inputs

Name:

AnalogInput01

The analog input value is mapped in this register depending on the configured operating mode.

| Data type | Value | Input signal |
|-----------|-----------------|---|
| INT | -32768 to 32767 | Voltage signal -10 to 10 VDC |
| | 0 to 32767 | Current signal 0 to 20 mA (with 0 to 20 mA configuration) |
| | -8192 to 32767 | Current signal 0 to 20 mA (with 4 to 20 mA configuration) |
| | -2000 to 8500 | PT1000 signal -200.0 to 850.0°C |
| UINT | 0 to 40000 | Resistance signal 0 to 4000.0 Ω |

Name:

AnalogInput02

The analog input value is mapped in this register depending on the configured operating mode.

| Data type | Value | Input signal |
|-----------|-----------------|---|
| INT | -32768 to 32767 | Voltage signal -10 to 10 VDC |
| | 0 to 32767 | Current signal 0 to 20 mA (with 0 to 20 mA configuration) |
| | -8192 to 32767 | Current signal 0 to 20 mA (with 4 to 20 mA configuration) |

Status of the inputs

Name:

StatusInput01

This register holds the status of the analog inputs. A change in the monitoring status generates an error message. The following states are monitored depending on the settings:

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|-------------------------|
| 0 - 1 | Channel 1 | 00 | No error |
| | | 01 | Below lower limit value |
| | | 10 | Above upper limit value |
| | | 11 | Open circuit |
| 2 - 3 | Channel 2 | 00 | No error |
| | | 01 | Below lower limit value |
| | | 10 | Above upper limit value |
| | | 11 | Open circuit |
| 4 - 7 | Reserved | 0 | |

Limiting the analog value

In addition to the status information, the analog value is set to the limit values listed below by default when an error occurs (see "Limit values" on page 1362). The analog value is limited to the new values if the limit values were changed.

Input filter

The analog inputs are equipped with a configurable input filter.

Input ramp limiting

Input ramp limiting can only be performed in conjunction with filtering. Input ramp limiting is performed before filtering.

The difference of the input value change is checked for exceeding the specified limit. In the event of overshoot, the tracked input value is equal to the old value \pm the limit value.

Configurable limit values:

| Value | Limit value |
|-------|---|
| 0 | The input value is used without limitation. |
| 1 | 0x3FFF = 16383 |
| 2 | 0x1FFF = 8191 |
| 3 | 0x0FFF = 4095 |
| 4 | 0x07FF = 2047 |
| 5 | 0x03FF = 1023 |
| 6 | 0x01FF = 511 |
| 7 | 0x00FF = 255 |

Input ramp limiting is well suited for suppressing disturbances (spikes). The following examples show the functionality of input ramp limiting based on an input step and a disturbance.

Example 1

The input value jumps from 8000 to 17000. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = 0x07FF = 2047

Filter level = 2

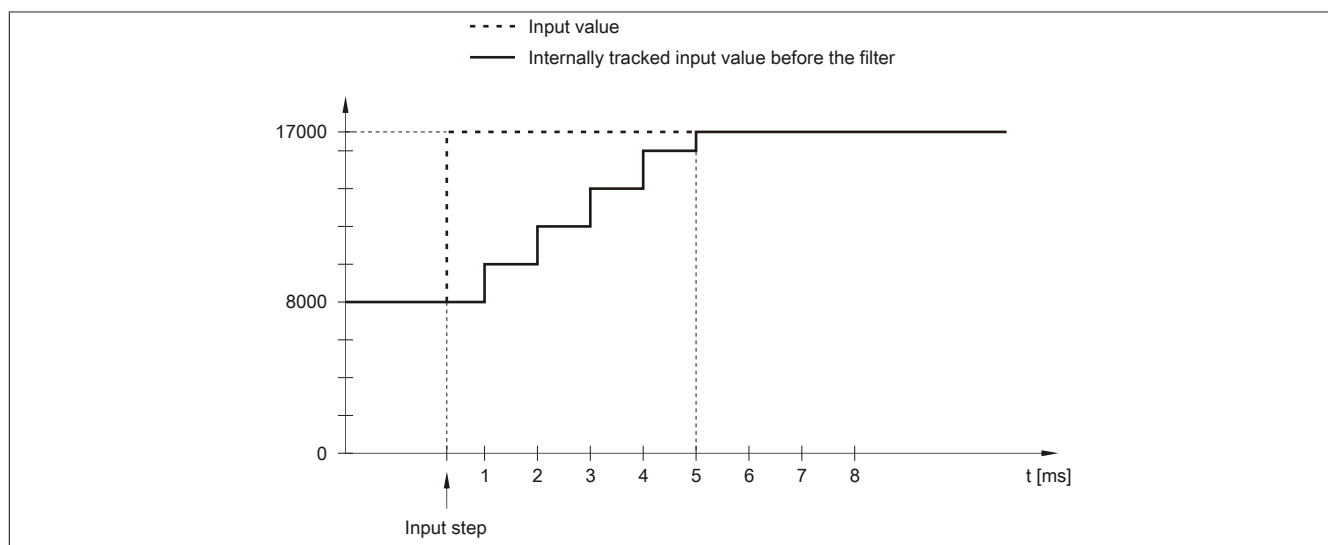


Figure 146: Tracked input value for input step

Example 2

A disturbance interferes with the input value. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = 0x07FF = 2047

Filter level = 2

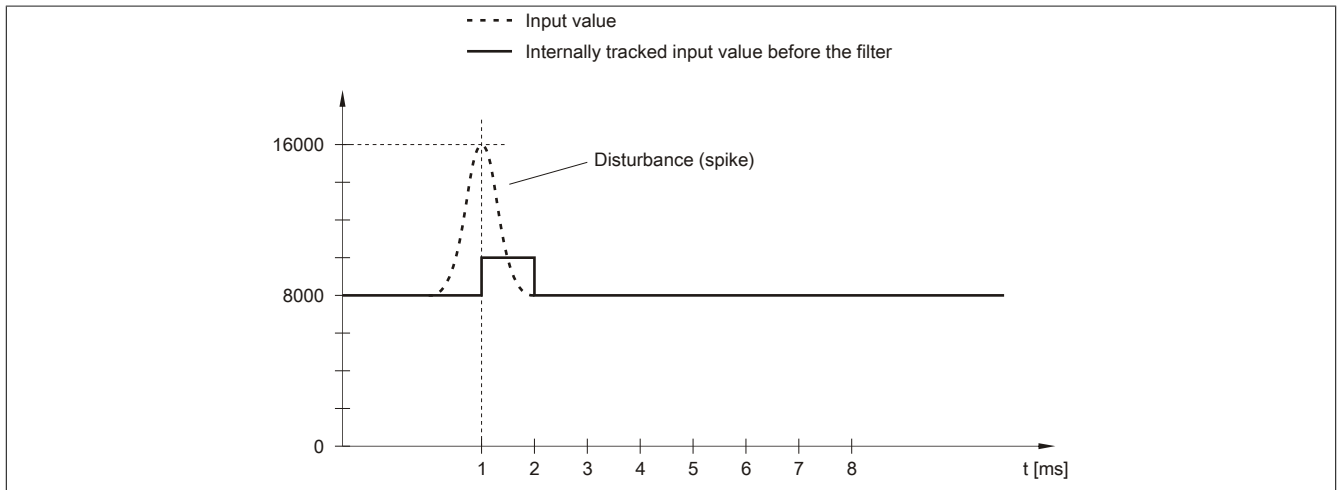


Figure 147: Tracked input value for disturbance

Filter level

A filter can be defined to prevent large input jumps. This filter is used to bring the input value closer to the actual analog value over a period of several bus cycles.

Filtering takes place after input ramp limitation.

Formula for calculating the input value:

$$\text{Value}_{\text{New}} = \text{Value}_{\text{Old}} - \frac{\text{Value}_{\text{Old}}}{\text{Filter level}} + \frac{\text{Input value}}{\text{Filter level}}$$

Adjustable filter levels:

| Value | Filter level |
|-------|---------------------|
| 0 | Filter switched off |
| 1 | Filter level 2 |
| 2 | Filter level 4 |
| 3 | Filter level 8 |
| 4 | Filter level 16 |
| 5 | Filter level 32 |
| 6 | Filter level 64 |
| 7 | Filter level 128 |

The following examples show how filtering works in the event of an input jump or disturbance.

Example 1

The input value jumps from 8000 to 16000. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

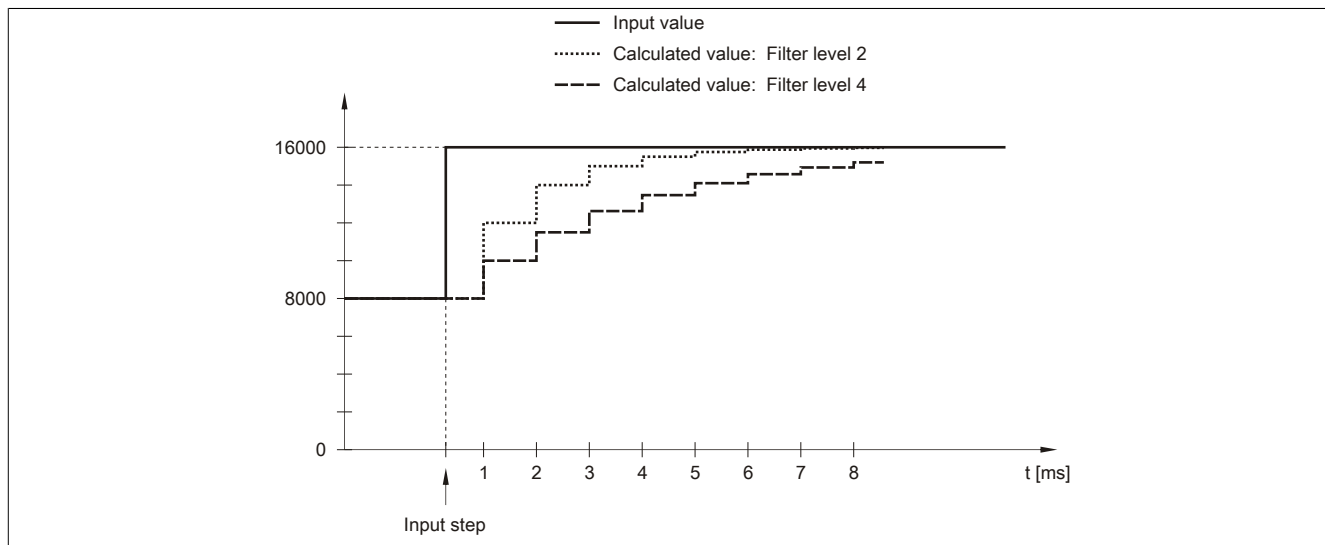


Figure 148: Calculated value during input step

Example 2

A disturbance interferes with the input value. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

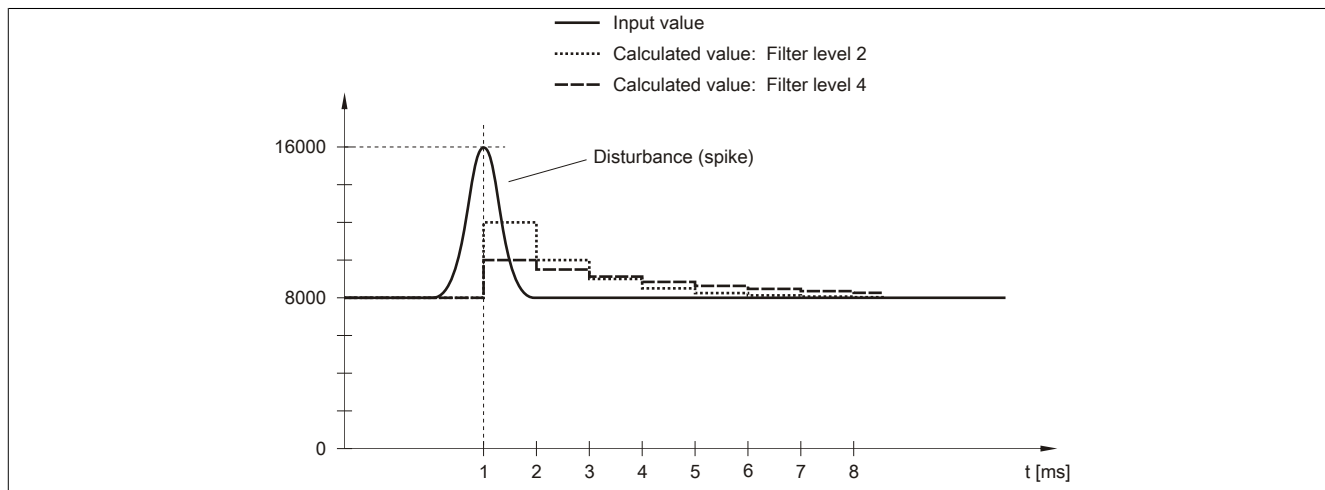


Figure 149: Calculated value during disturbance

Configuring the input filter

Name:

X1CfO_AI1_Filter

X1CfO_AI2_Filter

This register is used to define the filter level and input ramp limitation of the input filter.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------------|-------|--|
| 0 - 2 | Defines the filter level | 000 | Filter disabled (bus controller default setting) |
| | | 001 | Filter level 2 |
| | | 010 | Filter level 4 |
| | | 011 | Filter level 8 |
| | | 100 | Filter level 16 |
| | | 101 | Filter level 32 |
| | | 110 | Filter level 64 |
| | | 111 | Filter level 128 |
| 3 | Reserved | 0 | |
| 4 - 6 | Defines input ramp limiting | 000 | The input value is applied without limitation (bus controller default setting) |
| | | 001 | Limit value = 0x3FFF (16383) |
| | | 010 | Limit value = 0x1FFF (8191) |
| | | 011 | Limit value = 0x0FFF (4095) |
| | | 100 | Limit value = 0x07FF (2047) |
| | | 101 | Limit value = 0x03FF (1023) |
| | | 110 | Limit value = 0x01FF (511) |
| | | 111 | Limit value = 0x00FF (255) |
| 7 | Reserved | 0 | |

Channel type

Name:

X1CfO_AI_Mode

This register defines the type and range of signal measurement.

Each channel is capable of handling current, voltage or resistance signals. This differentiation is made using different terminal connections and an integrated switch. The switch is automatically activated depending on the specified configuration. The following input signals can be set:

| Input signal | On channel |
|--------------------------------|------------|
| ±10 V voltage signal (default) | 1 and 2 |
| 0 to 20 mA current signal | 1 and 2 |
| 4 to 20 mA current signal | 1 and 2 |
| PT1000 measurement | 1 |
| Resistance measurement | 1 |

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------|-------|---------------------------|
| 0 - 2 | Analog input - Channel 1 | 000 | Channel switched off |
| | | 001 | ±10 V voltage signal |
| | | 010 | 0 to 20 mA current signal |
| | | 011 | 4 to 20 mA current signal |
| | | 100 | PT1000 measurement |
| | | 101 | Resistance measurement |
| 3 | Reserved | 0 | |
| 4 - 5 | Analog input - Channel 2 | 00 | Channel switched off |
| | | 01 | ±10 V voltage signal |
| | | 10 | 0 to 20 mA current signal |
| | | 11 | 4 to 20 mA current signal |
| 6 - 7 | Reserved | 0 | |

Limit values

The input signal is monitored at the upper and lower limit values. By default the following limits are set for each mode:

| Limit value (default) | Voltage signal ± 10 V | | Current signal 0 to 20 mA | | Current signal 4 to 20 mA | |
|---------------------------|---------------------------|-----------------|---------------------------|-----------------|---------------------------|-----------------|
| Upper maximum limit value | 10 V | 32767 (0x7FFF) | 20 mA | 32767 (0x7FFF) | 20 mA | 32767 (0x7FFF) |
| Lower minimum limit value | -10 V | -32767 (0x8001) | 0 mA | 0 ¹⁾ | 4 mA | 0 ²⁾ |

Table 231: Limit values for voltage and current signals

- 1) The analog value is limited down to 0.
- 2) Due to the default limit value, the analog value is limited to a minimum of 0 at currents <4 mA.

| Limit value (default) | Temperature measurement | | Resistance measurement | |
|---------------------------|-------------------------|----------------|------------------------|----------------|
| Upper maximum limit value | 800.0°C | 8000 (0x1F40) | 4000.0 Ω | 32767 (0x7FFF) |
| Lower minimum limit value | -200.0°C | -2000 (0xF830) | 0 Ω | 0 |

Table 232: Limit values for temperature and resistance measurement

Other limit values can be defined if necessary. These are activated automatically by writing the limit value register (see "[Lower limit value](#)" on page 1362 and "[Upper limit value](#)" on page 1362). From this point on, the analog values will be monitored and limited according to the new limits. The results of monitoring are displayed in the status register (see "[Status of the inputs](#)" on page 1357).

Application example of setting limit values

A negative limit value must be configured in order to measure values <4 mA with a current signal of 4 to 20 mA: 0 mA corresponds to the value -8192 (0xE000).

Lower limit value

Name:

X1CfO_AI1_LowerLim

X1CfO_AI2_LowerLim

These registers can be used to configure the lower limit value for analog values. If the analog value goes below the limit value, it is frozen at this value and the corresponding error status bit is set (see "[Status of the inputs](#)" on page 1357).

| Data type | Value |
|-----------|-----------------|
| INT | -32768 to 32767 |
| UINT | 0 to 65535 |

Information:

When configured as 4 to 20 mA, this value can be set to -8192 (corresponds to 0 mA) in order to display values <4 mA.

Upper limit value

Name:

X1CfO_AI1_UpperLim

X1CfO_AI2_UpperLim

These registers can be used to configure the upper limit value for analog values. If the analog value goes above the limit value, it is frozen at this value and the corresponding error status bit is set (see "[Status of the inputs](#)" on page 1357).

| Data type | Value |
|-----------|------------|
| INT | 0 to 32767 |
| UINT | 0 to 65535 |

9.12.2.16.4 Register overview of the I/O data points on the integrated X2 I/O slot

| Register | Name | Data type | Read | | Write | |
|---------------------------|------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| X2 - Configuration | | | | | | |
| 7168 | X2CfO_EdgeDetectUnit01Mode | USINT | | | | • |
| 7169 | X2CfO_EdgeDetectUnit01Master | USINT | | | | • |
| 7170 | X2CfO_EdgeDetectUnit01Slave | USINT | | | | • |
| 7184 | X2CfO_EdgeDetectUnit02Mode | USINT | | | | • |
| 7185 | X2CfO_EdgeDetectUnit02Master | USINT | | | | • |
| 7186 | X2CfO_EdgeDetectUnit02Slave | USINT | | | | • |
| 6144 | X2CfO_DI_Filter | USINT | | | | • |
| 6528 | X2CfO_CounterMode | USINT | | | | • |
| 6400 | X2CfO_Latch01Mode | USINT | | | | • |
| 6401 | X2CfO_Latch01Comparator | USINT | | | | • |
| 6416 | X2CfO_Latch02Mode | USINT | | | | • |
| 6417 | X2CfO_Latch02Comparator | USINT | | | | • |
| X2 - Communication | | | | | | |
| 4096 | Digital inputs | USINT | • | | | |
| | DigitalInput01 | Bit 0 | | | | |
| | DigitalInput02 | Bit 1 | | | | |
| | DigitalInput03 | Bit 2 | | | | |
| | DigitalInput04 | Bit 3 | | | | |
| | DigitalInput05 | Bit 4 | | | | |
| | DigitalInput06 | Bit 5 | | | | |
| | DigitalInput07 | Bit 6 | | | | |
| | DigitalInput08 | Bit 7 | | | | |
| 4097 | Digital inputs | USINT | • | | | |
| | DigitalInput09 | Bit 0 | | | | |
| | DigitalInput10 | Bit 1 | | | | |
| | DigitalInput11 | Bit 2 | | | | |
| | DigitalInput12 | Bit 3 | | | | |
| | DigitalInput13 | Bit 4 | | | | |
| | DigitalInput14 | Bit 5 | | | | |
| 5120 | EdgeDetect01Mastertime | DINT | • | | | |
| 5124 | EdgeDetect01Difference | DINT | • | | | |
| 5128 | EdgeDetect01Mastercount | INT | • | | | |
| 5136 | EdgeDetect02Mastertime | DINT | • | | | |
| 5140 | EdgeDetect02Difference | DINT | • | | | |
| 5144 | EdgeDetect02Mastercount | INT | • | | | |
| 4384 | Counter 1 | USINT | | | • | |
| | Counter01Reset | Bit 0 | | | | |
| | Latch01Enable | Bit 1 | | | | |
| 4352 | Counter01Value | DINT | • | | | |
| 4356 | Counter01Latch | DINT | • | | | |
| 4360 | Counter01TimeChanged | DINT | • | | | |
| 4364 | Counter01TimeValid | DINT | • | | | |
| 4368 | Latch01Count | SINT | • | | | |
| 4448 | Counter 2 | USINT | | | • | |
| | Counter02Reset | Bit 0 | | | | |
| | Latch02Enable | Bit 1 | | | | |
| 4416 | Counter02Value | DINT | • | | | |
| 4420 | Counter02Latch | DINT | • | | | |
| 4424 | Counter02TimeChanged | DINT | • | | | |
| 4428 | Counter02TimeValid | DINT | • | | | |
| 4432 | Latch02Count | SINT | • | | | |

9.12.2.16.4.1 Digital inputs**Unfiltered**

The input status is recorded in a 100 µs cycle.

Filtered

The filtered status is transferred in a 100 µs cycle.

Filtering takes place asynchronously in an interval of 100 µs.

Digital input filter

Name:

X2CfO_DI_Filter

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 µs.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No SW filter |
| | 1 | 0.1 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

Input state of digital inputs 1 to 14

Name:

DigitalInput01 to DigitalInput14

These registers are used to indicate the input state of digital inputs 1 to 14.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure of register 4096:

| Bit | Name | Value | Information |
|-----|----------------|--------|---------------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input status of digital input 1 |
| ... | ... | ... | ... |
| 7 | DigitalInput08 | 0 or 1 | Input status of digital input 8 |

Bit structure of register 4097:

| Bit | Name | Value | Information |
|-----|----------------|--------|----------------------------------|
| 0 | DigitalInput09 | 0 or 1 | Input status of digital input 9 |
| ... | ... | ... | ... |
| 5 | DigitalInput14 | 0 or 1 | Input status of digital input 14 |

9.12.2.16.4.2 Edge detection

Digital inputs 11 to 14 can be used for high-speed edge detection. This runs parallel to all other functions such as counters, etc. This function does not use the digital input filter.

The edge detection function measures edges with μs precision. 2 units are available. A master and a slave edge can be configured for each unit. At each master edge, the timestamp of the master edge and the differential time to the previous slave edge (if present) are logged. A "Master count" can always be utilized to determine how many edges have been detected since the last task class cycle. The timestamp is based on the system time of the CPU.

The combination of rising/falling edges of each channel can be used to configure the following functions for each unit:

| Function | Description |
|-----------------|---|
| Edge time | Measure an edge time |
| Period duration | Measure the master and differential time |
| Gate time | Measure the master and differential time |
| Time offset | Measure the master and differential time of edges on different channels |

Edge detection unit - Mode settings

The edge detection unit needs to be configured according to the desired function.

| Function | Description |
|--|---|
| Basic timestamp, master edge mode | The current system time is saved as the master time at the time of the edge. |
| Timestamp and/or differential time, master and slave edge mode | The slave edge starts the measurement and the system time is saved temporarily. When the master edge occurs, the current system time is saved as the master time and the difference between the master and slave edges is calculated. |

Name:

X2CfO_EdgeDetectUnit01Mode

X2CfO_EdgeDetectUnit02Mode

These registers are used to configure the mode of the basic function for either just the master edge or both master and slave edges.

| Data type | Value | Information |
|-----------|-------|---|
| USINT | 0x00 | Edge detection disabled on Unit0x: Time measurement not possible |
| | 0x80 | Edge detection enabled on Unit0x: Reaction only possible for master edge, no differential measurement possible |
| | 0xC0 | Edge detection enabled on Unit0x: Reaction possible for configured master and slave edges |

Edge detection unit - Selection of master edge

Name:

X2CfO_EdgeDetectUnit01Master

X2CfO_EdgeDetectUnit02Master

These registers are used to select the source of the master edge for the respective unit. Either the rising or falling edge of one of the 4 high-speed digital input channels can be selected. Only one edge can be selected for each unit.

| Data type | Value | Information |
|-----------|-------|--|
| USINT | 0 | Digital input channel 11: Rising edge |
| | 2 | Digital input channel 12: Rising edge |
| | 4 | Digital input channel 13: Rising edge |
| | 6 | Digital input channel 14: Rising edge |
| | 1 | Digital input channel 11: Falling edge |
| | 3 | Digital input channel 12: Falling edge |
| | 5 | Digital input channel 13: Falling edge |
| | 7 | Digital input channel 14: Falling edge |

Edge detection unit - Selection of slave edge

Name:

X2CfO_EdgeDetectUnit01Slave

X2CfO_EdgeDetectUnit02Slave

These registers are used to select the source of the slave edge for the respective unit. Either the rising or falling edge of one of the 4 high-speed digital input channels can be selected. Only one edge can be selected for each unit.

| Data type | Value | Information |
|-----------|-------|--|
| USINT | 0 | Digital input channel 11: Rising edge |
| | 2 | Digital input channel 12: Rising edge |
| | 4 | Digital input channel 13: Rising edge |
| | 6 | Digital input channel 14: Rising edge |
| | 1 | Digital input channel 11: Falling edge |
| | 3 | Digital input channel 12: Falling edge |
| | 5 | Digital input channel 13: Falling edge |
| | 7 | Digital input channel 14: Falling edge |

Edge detection unit - Master edge counter

Name:

EdgeDetect01Mastercount

EdgeDetect02Mastercount

These registers hold the counter values of the detected master edges. The counter value is used to detect new measurements.

| Data type | Value | Information |
|-----------|-----------------|--|
| INT | -32768 to 32767 | Running counter: Number of detected master edges |

Edge detection unit - Master edge timestamp

Name:

EdgeDetect01Mastertime

EdgeDetect02Mastertime

The exact CPU system time of the respective unit is saved to these registers when a master edge occurs. If multiple master edges occur within a single cycle (task class), then the time of the last edge is shown.

| Data type | Value | Information |
|-----------|---------------------------------|---|
| DINT | -2,147,483,648 to 2,147,483,647 | CPU system time of master edge [μ s] |

Edge detection unit - Time difference

Name:

EdgeDetect01Difference

EdgeDetect02Difference

The difference between the master edge and the slave edge of the respective unit is saved to these registers. If multiple measurement periods are completed within a single cycle (task class), then the time difference from the last period is shown.

| Data type | Value | Information |
|-----------|---------------------------------|---|
| DINT | -2,147,483,648 to 2,147,483,647 | Time difference between master edge and slave edge [μ s] |

9.12.2.16.4.3 Counter functions

High-speed digital inputs 11 to 14 can be used for counter functions. This function does not use the digital input filter. The following functions are available. Only one of these basic configurations can be enabled at a time:

- 2x event counter with latch function
- 2x AB incremental counter without latch function
- DF counter function
- ABR counter function

Configuring the counter function

The following counter functions can be configured:

| Counter function | Description |
|--|--|
| 2x event counter with latch function | Input 11 for event counter 1 and input 13 for event counter 2 can be used simultaneously as event counters. Both rising and falling edges are counted. The latch function of all 4 inputs can be used. |
| 2x AB incremental counter without latch function | Inputs 11 and 12 as AB counter 1 and inputs 13 and 14 as AB counter 2. Since no more high-speed inputs are available, the latch function is not available. |
| DF counter: Direction/Frequency with latch function | The D, F and R signals are linked to inputs 11, 12 and 13. Signal D defines the positive (Level = 0) or negative (Level = 1) counting direction. The latch function of all 4 inputs can be used. |
| ABR counter with latch function | The A, B and R signals are linked to inputs 11, 12 and 13. The latch function of all 4 inputs can be used. |

Name:

X2CfO_CounterMode

This register configures the counter function:

| Data type | Value | Information |
|-----------|-------|--|
| USINT | 0 | 2x event counter with latch function |
| | 1 | 2x AB incremental counter without latch function |
| | 2 | DF counter with latch function |
| | 3 | ABR counter with latch function |

Configuring the mode of the latch function

Name:

X2CfO_Latch01Mode

X2CfO_Latch02Mode

This register sets the mode of the latch function. The following latch functions can be configured:

| Latch function | Description |
|------------------------|--|
| Single shot latch mode | The latch function must be enabled/set. After a successful latch procedure the function must first be reset. Then it can be enabled again. |
| Continuous latch mode | The latch function only has to be enabled/set as long as latching is desired. |

A changed counter value on "LatchCount" indicates that the latch procedure has been performed (see "[Counter value of latch events](#)" on page 1369). The counter value is stored in the latch register (see "[Latched counter value](#)" on page 1369).

| Data type | Value | Information |
|-----------|-------|------------------------|
| USINT | 0 | Single shot latch mode |
| | 1 | Continuous latch mode |

Configuring the latch signals

Name:

X2CfO_Latch01Comparator

X2CfO_Latch02Comparator

This register defines the inputs and their level for triggering the latch procedure.

- This defines which inputs are linked to generate the latch event. All 4 digital input signals can be used for an "AND" connection.
- The "active voltage level" needed for the latch procedure can be defined to adjust for the physical signals. It is not possible to configure a high and low level at the same time.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Value | Information |
|-----|-------|--|
| 0 | 0 | Input 11 high level disabled |
| | 1 | Input 11 high level enabled for comparator |
| 1 | 0 | Input 12 high level disabled |
| | 1 | Input 12 high level enabled for comparator |
| 2 | 0 | Input 13 high level disabled |
| | 1 | Input 13 high level enabled for comparator |
| 3 | 0 | Input 14 high level disabled |
| | 1 | Input 14 high level enabled for comparator |
| 4 | 0 | Input 11 low level disabled |
| | 1 | Input 11 low level enabled for comparator |
| 5 | 0 | Input 12 low level disabled |
| | 1 | Input 12 low level enabled for comparator |
| 6 | 0 | Input 13 low level disabled |
| | 1 | Input 13 low level enabled for comparator |
| 7 | 0 | Input 14 low level disabled |
| | 1 | Input 14 low level enabled for comparator |

Clear counter value and enable/disable latch function

Name:

Counter01Reset

Counter02Reset

Latch01Enable

Latch02Enable

The respective bits in these registers clear the counter value or start the latch procedure.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------|-------|--------------------------|
| 0 | Counter0xReset | 0 | Do not reset the counter |
| | | 1 | Reset the counter |
| 1 | Latch0xEnable | 0 | Do not latch the counter |
| | | 1 | Latch the counter |
| 2 - 7 | Reserved | 0 | |

Counter value

Name:

Counter01Value

Counter02Value

The current counter values are saved in these registers.

| Data type | Value | Information |
|-----------|---------------------------------|-----------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | Current counter value |

Latched counter value

Name:

Counter01Latch

Counter02Latch

As soon as the latch conditions have been met, the value of the respective counter is copied to these registers.

| Data type | Value | Information |
|-----------|---------------------------------|-----------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | Latched counter value |

Counter value of latch events

Name:

Latch01Count

Latch02Count

These registers hold the counter values of the latch events. This allows detection of whether a new latched counter value has been saved.

| Data type | Value | Information |
|-----------|-------------|--|
| SINT | -128 to 127 | Running counter: Number of detected latch events |

Timestamp of last counter change

Name:

Counter01TimeChanged

Counter02TimeChanged

The CPU system time at the time of the last change to the counter value is saved in these registers.

| Data type | Value | Information |
|-----------|---------------------------------|---|
| DINT | -2,147,483,648 to 2,147,483,647 | The CPU system time at the time of the last change to the counter value |

Timestamp of last valid counter value

Name:

Counter01TimeValid

Counter02TimeValid

The CPU system time at the time of the last valid counter value is saved in these registers.

| Data type | Value | Information |
|-----------|---------------------------------|--|
| DINT | -2,147,483,648 to 2,147,483,647 | CPU system time of current counter value |

9.12.2.16.5 Register overview of the I/O data points on the integrated X3 I/O slot

| Register | Name | Data type | Read | | Write | |
|---------------------------|------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| X3 - Configuration | | | | | | |
| 10240 | X3CfO_DI_Filter | USINT | | | | • |
| 10752 | X3CfO_Mov01Mode | USINT | | | | • |
| 10756 | X3CfO_Mov01SpeedLimit | UDINT | | | | • |
| 10768 | X3CfO_Mov02Mode | USINT | | | | • |
| 10772 | X3CfO_Mov02SpeedLimit | UDINT | | | | • |
| 12032 | X3CfO_PhylIOConfigCh01 | USINT | | | | • |
| 12033 | X3CfO_PhylIOConfigCh02 | USINT | | | | • |
| 12034 | X3CfO_PhylIOConfigCh03 | USINT | | | | • |
| 12035 | X3CfO_PhylIOConfigCh04 | USINT | | | | • |
| 12036 | X3CfO_PhylIOConfigCh05 | USINT | | | | • |
| 12037 | X3CfO_PhylIOConfigCh06 | USINT | | | | • |
| 12038 | X3CfO_PhylIOConfigCh07 | USINT | | | | • |
| 12039 | X3CfO_PhylIOConfigCh08 | USINT | | | | • |
| 12040 | X3CfO_PhylIOConfigCh09 | USINT | | | | • |
| 12041 | X3CfO_PhylIOConfigCh10 | USINT | | | | • |
| 12042 | X3CfO_PhylIOConfigCh11 | USINT | | | | • |
| 12043 | X3CfO_PhylIOConfigCh12 | USINT | | | | • |
| X3 - Communication | | | | | | |
| 8192 | Digital inputs | USINT | • | | | |
| | DigitalInput05 | Bit 0 | | | | |
| | DigitalInput06 | Bit 1 | | | | |
| | DigitalInput07 | Bit 2 | | | | |
| | DigitalInput08 | Bit 3 | | | | |
| 8208 | Digital outputs | USINT | | | • | |
| | DigitalOutput01 | Bit 0 | | | | |
| | DigitalOutput02 | Bit 1 | | | | |
| | DigitalOutput03 | Bit 2 | | | | |
| | DigitalOutput04 | Bit 3 | | | | |
| | DigitalOutput05 | Bit 4 | | | | |
| | DigitalOutput06 | Bit 5 | | | | |
| | DigitalOutput07 | Bit 6 | | | | |
| DigitalOutput08 | Bit 7 | | | | | |
| 8209 | Digital outputs | USINT | | | • | |
| | DigitalOutput09 | Bit 0 | | | | |
| | DigitalOutput10 | Bit 1 | | | | |
| | DigitalOutput11 | Bit 2 | | | | |
| | DigitalOutput12 | Bit 3 | | | | |
| 8193 | Status feedback | USINT | • | | | |
| | StatusDigitalOutput01 | Bit 0 | | | | |
| | StatusDigitalOutput02 | Bit 1 | | | | |
| | StatusDigitalOutput03 | Bit 2 | | | | |
| | StatusDigitalOutput04 | Bit 3 | | | | |
| | StatusDigitalOutput05 | Bit 4 | | | | |
| | StatusDigitalOutput06 | Bit 5 | | | | |
| | StatusDigitalOutput07 | Bit 6 | | | | |
| | StatusDigitalOutput08 | Bit 7 | | | | |
| 8194 | Status feedback | USINT | • | | | |
| | StatusDigitalOutput09 | Bit 0 | | | | |
| | StatusDigitalOutput10 | Bit 1 | | | | |
| | StatusDigitalOutput11 | Bit 2 | | | | |
| | StatusDigitalOutput12 | Bit 3 | | | | |
| 4864 | PWMPeriod09 | UINT | | | • | |
| 4866 | PWMOutput09 | INT | | | • | |
| 4880 | PWMPeriod10 | UINT | | | • | |
| 4882 | PWMOutput10 | INT | | | • | |
| 4896 | PWMPeriod11 | UINT | | | • | |
| 4898 | PWMOutput11 | INT | | | • | |
| 4912 | PWMPeriod12 | UINT | | | • | |
| 4914 | PWMOutput12 | INT | | | • | |
| 8704 | Movement 1 | USINT | | | • | |
| | Mov01Enable | Bit 1 | | | | |
| 8706 | Mov01Speed | INT | | | • | |
| 8708 | Mov01Position | DINT | • | | | |
| 8720 | Movement 2 | USINT | | | • | |
| | Mov02Enable | Bit 2 | | | | |
| 8722 | Mov02Speed | INT | | | • | |
| 8724 | Mov02Position | DINT | • | | | |
| 8196 | StatusInput01 | BOOL | • | | | |

9.12.2.16.5.1 Physical configuration of I/O channels

These registers are used to define the functionality of the channels. Depending on the desired configuration, the following assignments can be made with respect to the existing software and hardware:

- A physical configuration as input or output for mixed channels
- An explicit assignment as direct I/O channel: i.e. digital input or digital output
- An explicit assignment as PWM output
- An explicit assignment as D or F movement output

Physical configuration

Name:

X3CfO_PhyIOConfigCh01 to X3CfO_PhyIOConfigCh12

These registers are used to configure the functionality of the channels.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

Name:

X3CfO_PhyIOConfigCh01 to X3CfO_PhyIOConfigCh04

Channels 1 to 4 are digital outputs and can only be used as direct I/O channel.

| Bit | Description | Value | Information |
|-------|-------------|-------|--------------------------------|
| 0 - 7 | | 0 | Direct I/O operation of output |

Name:

X3CfO_PhyIOConfigCh05 to X3CfO_PhyIOConfigCh08

Channels 5 to 8 are digital mixed channels and can be configured as either input or output.

| Bit | Description | Value | Information |
|-------|-------------|-------|--------------------------------|
| 0 - 1 | | 00 | Configured as digital output |
| | | 01 | Reserved |
| | | 10 | Reserved |
| | | 11 | Configured as digital input |
| 2 - 7 | | 0 | Direct I/O operation of output |

Name:

X3CfO_PhyIOConfigCh09 to X3CfO_PhyIOConfigCh12

Channels 9 to 12 are high-speed digital outputs and can be configured as direct I/O, PWM or movement channels.

| Bit | Description | Value | Information |
|-------|-------------|-------|---------------------------------|
| 0 - 3 | Reserved | 0 | |
| 4 - 5 | | 00 | Direct I/O operation of output |
| | | 01 | Output operated as PWM |
| | | 10 | Reserved |
| | | 11 | Output operated as D/F movement |
| 6 - 7 | Reserved | 0 | |

9.12.2.16.5.2 Monitoring of the I/O power supply voltage

Name:

StatusInput01

The state of the I/O supply voltage is indicated in this register.

| Data type | Values | Information |
|-----------|--------|--|
| USINT | 0 | I/O power supply voltage within permissible range |
| | 1 | I/O power supply voltage not connected or outside of the permissible range |

9.12.2.16.5.3 Digital inputs**Unfiltered**

The input status is recorded in a 100 µs cycle.

Filtered

The filtered status is transferred in a 100 µs cycle.

Filtering takes place asynchronously in an interval of 100 µs.

Digital input filter

Name:

X3CfO_DI_Filter

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 µs.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No SW filter |
| | 1 | 0.1 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

Input state of digital inputs 5 to 8

Name:

DigitalInput05 to DigitalInput08

This register indicates the input state of digital inputs 5 to 8.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|--------|---------------------------------|
| 0 | DigitalInput05 | 0 or 1 | Input status of digital input 5 |
| ... | | ... | |
| 3 | DigitalInput08 | 0 or 1 | Input status of digital input 8 |

9.12.2.16.5.4 Digital outputs

The output status is processed in a 100 µs cycle.

Switching state of digital outputs 1 to 12

Name:

DigitalOutput01 to DigitalOutput12

These registers are used to store the switching state of digital outputs 1 to 12.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

Register 8208:

| Bit | Description | Value | Information |
|-----|-----------------|-------|------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 1 reset |
| | | 1 | Digital output 1 set |
| ... | | ... | |
| 7 | DigitalOutput08 | 0 | Digital output 8 reset |
| | | 1 | Digital output 8 set |

Register 8209:

| Bit | Description | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput09 | 0 | Digital output 9 reset |
| | | 1 | Digital output 9 set |
| ... | | ... | |
| 3 | DigitalOutput12 | 0 | Digital output 12 reset |
| | | 1 | Digital output 12 set |

9.12.2.16.5.5 Monitoring status of the digital outputs

The error states of the outputs must be programmed in the application. The status information that is read is the actual voltage state on the channel (set or reset). The error state is therefore determined by a difference between the data points "DigitalOutputxx" and the corresponding "StatusDigitalOutputxx".

At least 3 system ticks are needed internally to read the output status. This is the reason for the delay after which the earliest possible comparison can be made after a change in the status of the output.

The digital input filter is not applied to this status information.

Status of digital outputs 1 to 12

Name:

StatusDigitalOutput01 to StatusDigitalOutput12

These registers are used to indicate the status of digital outputs 1 to 12.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

Register 8193:

| Bit | Description | Value | Information |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput01 | 0 | Channel 1: Digital output reset or short circuit |
| | | 1 | Channel 1: Digital output set or voltage feedback |
| ... | | ... | |
| 7 | StatusDigitalOutput08 | 0 | Channel 8: Digital output reset or short circuit |
| | | 1 | Channel 8: Digital output set or voltage feedback |

Register 8194:

| Bit | Description | Value | Information |
|-----|-----------------------|-------|--|
| 0 | StatusDigitalOutput09 | 0 | Channel 9: Digital output reset or short circuit |
| | | 1 | Channel 9: Digital output set or voltage feedback |
| ... | | ... | |
| 3 | StatusDigitalOutput12 | 0 | Channel 12: Digital output reset or short circuit |
| | | 1 | Channel 12: Digital output set or voltage feedback |

9.12.2.16.5.6 Pulse width modulation (PWM) function

Digital inputs 9 to 12 can be configured as PWM outputs. 2 data points are available per channel for controlling the PWM signal.

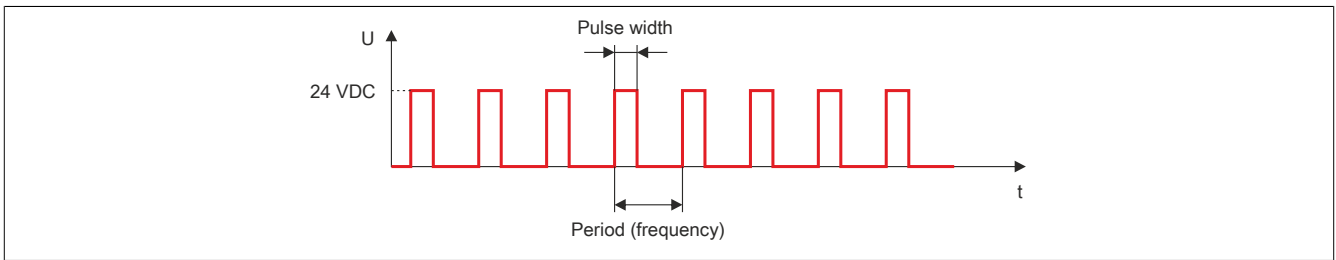


Figure 150: The PWM signal is controlled by setting the pulse width and period duration

Period duration of the PWM outputs

Name:

PWMPeriod09 to PWMPeriod12

These registers are used to define the duration of the period duration, i.e. the time base for the respective PWM output. This time represents the 100% value, which can be resolved to 0.1% through the duty cycle.

| Data type | Value | Information |
|-----------|------------|--|
| UINT | 5 to 65535 | Period duration, between 5 and 65535 μ s: Corresponds to a frequency of 200 kHz to \approx 15 Hz |

Duty cycle of the PWM outputs

Name:

PWMOutput09 to PWMOutput12

These registers output the duty cycle of the respective PWM output in a resolution of 0.1% of the period duration.

| Data type | Value | Information |
|-----------|-----------|---|
| INT | 0 to 1000 | Duty cycle of the output in 0 to 100.0% |

Example: Period duration T [μ s] with a duty cycle of 25% equals a duty time of t_1 [μ s].

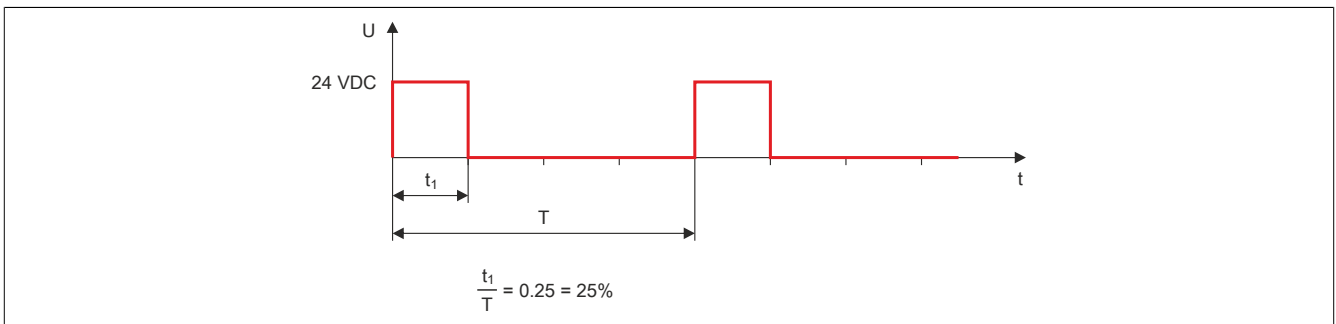


Figure 151: Switch-on time depending on the period duration and duty cycle

9.12.2.16.5.7 DF movement generator function

Digital output channels 9 to 12 can be configured as 2 independently functioning movement generators (Direction/Frequency) for stepper motor control. The movement generators are assigned to the following channels:

| Movement generator | Channel | Function |
|--------------------|---------|--------------|
| 1 | DO 9 | D: Direction |
| | DO 10 | F: Frequency |
| 2 | DO 11 | D: Direction |
| | DO 12 | F: Frequency |

The frequency is output via the respective F channel, and the direction is output via the respective D channel. The switchover between directions (movement/counter) takes place via the sign of the speed setpoint.

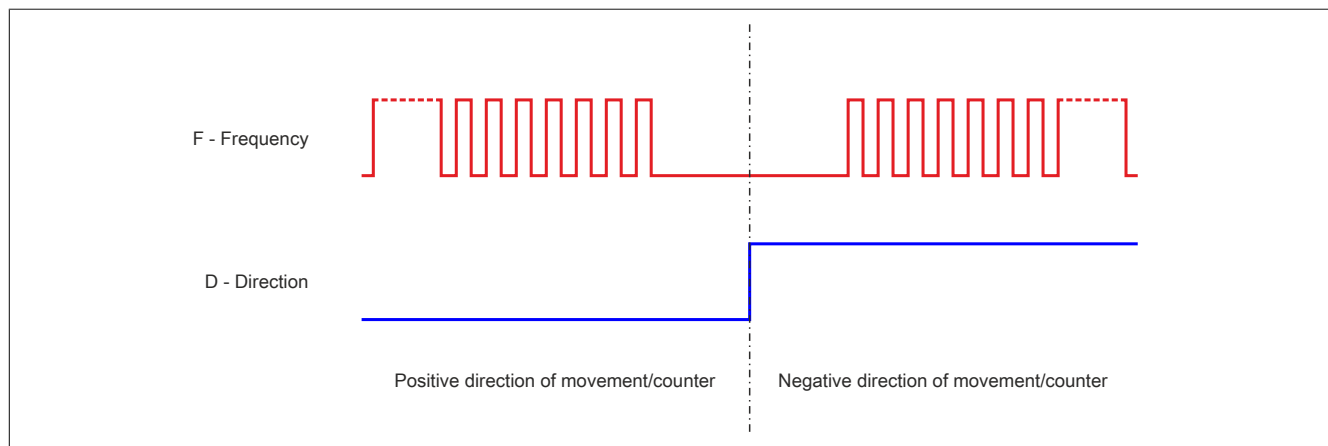


Figure 152: Frequency output via F channel, direction output via D channel

The respective output must be configured correctly in order to completely process the motion function (see ["Physical configuration" on page 1371](#)).

The data points described below are available for configuring and controlling the respective movements.

Configuring the movement mode

Name:

X3Cfo_Mov01Mode

X3Cfo_Mov02Mode

These registers are used to configure how the speed setpoint is interpreted. The difference between the two modes is whether edges or periods are output for each increment of the setpoint.

| Data type | Value | Information |
|-----------|-------|---|
| USINT | 0 | Edge mode: Each increment generates an edge on the output |
| | 1 | Pulse mode: Each increment generates a period on the output |

Edge mode

4 increments of the speed setpoint correspond to 2 periods on the output:

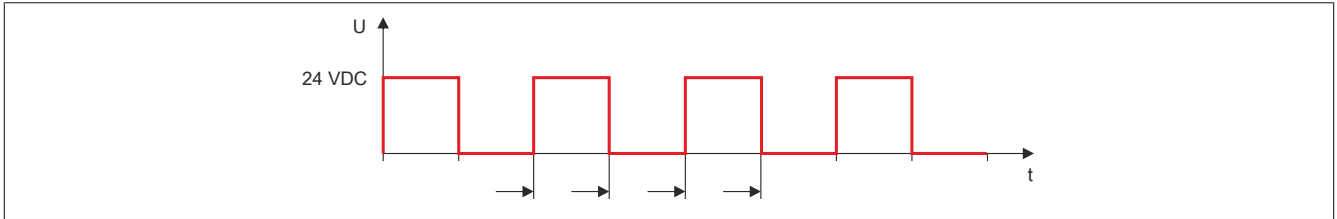


Figure 153: Interpretation of the speed setpoint with edge output for each increment

Pulse mode

2 increments of the speed setpoint correspond to 2 periods on the output:

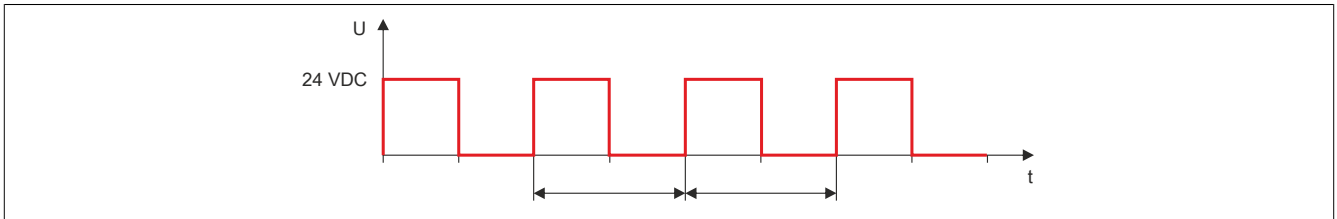


Figure 154: Interpretation of the speed setpoint with period output for each increment

Configuring the maximum speed of the movement

The maximum speed or output frequency of the movement is configured in order to protect the digital output, the actuator/drive being controlled and/or the mechanical system.

Name:

X3Cfo_Mov01SpeedLimit

X3Cfo_Mov02SpeedLimit

These registers are used to configure the maximum speed / output frequency permitted in the system. It is important that the limit values for edge and pulse mode are different.

Edge mode

| Data type | Value | Information |
|-----------|--------------|-------------------------------|
| UDINT | 10 to 400000 | Speed [increments per second] |

Pulse mode

| Data type | Value | Information |
|-----------|-------------|-------------------------------|
| UDINT | 5 to 200000 | Speed [increments per second] |

Activates the movement

When a movement is active, the two channels are operated according to the preset values.

Name:

Mov01Enable

Mov02Enable

These registers are used to enable or disable the motion function.

Mov01Enable

| Data type | Value | Information |
|-----------|-------|---|
| USINT | 0 | Movement 1 disabled |
| | 2 | Movement 1 enabled: The speed setpoint is evaluated |

Mov02Enable

| Data type | Value | Information |
|-----------|-------|---|
| USINT | 0 | Movement 2 disabled |
| | 4 | Movement 2 enabled: The speed setpoint is evaluated |

Speed and direction control of the movement

The following parameters are important for speed and direction control of the movement:

| Characteristic value | Description |
|----------------------------------|---|
| Speed control | The predefined speed is specified as a percentage of the configured maximum speed. 0 to ± 32767 correspond to 0 to $\pm 100\%$ of the configured maximum speed |
| Direction control | The direction of movement is defined by the sign of the speed setpoint: 0 to +32767 correspond to 0 to the maximum speed in the positive direction of movement 0 to -32767 correspond to 0 to the maximum speed in the negative direction of movement |
| Resolution of the speed setpoint | The resolution of the speed setpoint is: $\text{Maximum speed} / 32767$ |
| Relationship: Speed / Frequency | The relationship between speed and output frequency is: $(\text{Speed setpoint} / \text{Maximum speed}) * 32767$ |

Table 233: Parameters for speed and direction control of the movement

Name:

Mov01Speed

Mov02Speed

These registers are used to set the speed of the movement.

| Data type | Value | Information |
|-----------|-------------|--|
| INT | 0 to 32767 | Speed setpoint 0 to 100%: Movement output F = 0 to maximum speed Positive direction of movement: Movement output D = 0 |
| | 0 to -32767 | Speed setpoint 0 to 100%: Movement output F = 0 to maximum speed Negative direction of movement: Movement output D = 1 |

Position feedback for movement

The position feedback is represented by a fixed point value [16.16]:

- HighWord = whole number increments
- LowWord = positions after the decimal of the increments

Name:

Mov01Position

Mov02Position

These registers show the current position of the movement.

| Data type | Value | Information |
|-----------|---------------------------------|--|
| DINT | -2,147,483,648 to 2,147,483,647 | Position value in fixed point format [16.16] |

9.12.3 X20CP1483 and X20CP1483-1

Data sheet version: 2.37

9.12.3.1 General information

The x86 100 MHz-compatible X20CP1483 is the entry-level X20 CPU. With an optimal price/performance ratio, it has the same basic features as the larger CPUs and offers sufficient performance for most standard applications.

USB and Ethernet are included in every CPU. In addition, every CPU has a POWERLINK connection for real-time communication.

In addition, a multi-purpose slot is provided for an additional interface module.

- Intel x86 100 MHz-compatible with additional I/O processor
- Onboard Ethernet, POWERLINK V1/V2 and USB
- Modular expansion of interfaces
- CompactFlash as removable application memory
- Fanless

9.12.3.2 Order data - X20CP148x

|  | |
|--|---|
| Model number | Short description |
| | X20 CPUs |
| X20CP1483 | X20 CPU, x86 100 MHz Intel compatible, 32 MB DRAM, 128 kB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! |
| X20CP1483-1 | X20 CPU, x86 100 MHz Intel compatible, 64 MB DRAM, 128 kB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! |
| | Required accessories |
| | CompactFlash cards |
| 0CFCRD.0512E.01 | CompactFlash 512 MB extended temp. |
| 0CFCRD.2048E.01 | CompactFlash 2048 MB extended temp. |
| 5CFCRD.016G-06 | CompactFlash 16 GB B&R (SLC) |
| 5CFCRD.032G-06 | CompactFlash 32 GB B&R (SLC) |
| 5CFCRD.0512-06 | CompactFlash 512 MB B&R (SLC) |
| 5CFCRD.1024-06 | CompactFlash 1 GB B&R (SLC) |
| 5CFCRD.2048-06 | CompactFlash 2 GB B&R (SLC) |
| 5CFCRD.4096-06 | CompactFlash 4 GB B&R (SLC) |
| 5CFCRD.8192-06 | CompactFlash 8 GB B&R (SLC) |
| | Optional accessories |
| | Batteries |
| 0AC201.91 | Lithium batteries 4 pcs., 3 V / 950 mAh button cell |
| 4A0006.00-000 | Lithium battery, 3 V / 950 mAh, button cell |

Table 234: X20CP1483, X20CP1483-1 - Order data

Included in delivery

| Order number | Short description |
|---------------|--|
| 4A0006.00-000 | Backup battery (see also "Battery" on page 1393) |
| - | Interface module slot covers |
| X20AC0SR1 | X20 end cover plate (right) |
| X20TB12 | X20 terminal block, 12-pin, 24 V coding |

Table 235: X20 CPUs - Content of delivery

9.12.3.3 X20CP148x - Technical data

| Model number | X20CP1483 | X20CP1483-1 |
|--|--|-------------|
| Short description | | |
| Interfaces | 1x RS232, 1x Ethernet, 1x POWERLINK (V1/V2), 2x USB, 1x X2X Link | |
| System module | CPU | |
| General information | | |
| Cooling | Fanless | |
| B&R ID code | 0xA239 | 0xAEC5 |
| Status indicators | CPU function, overtemperature, Ethernet, POWERLINK, CompactFlash, battery | |
| Diagnostics | | |
| Battery | Yes, using status LED and software | |
| CPU function | Yes, using status LED | |
| CompactFlash | Yes, using status LED | |
| Ethernet | Yes, using status LED | |
| POWERLINK | Yes, using status LED | |
| Overtemperature | Yes, using status LED | |
| ACOPOS support | Yes | |
| Visual Components support | Yes | |
| Power consumption without memory card, interface module and USB | 6 W | |
| Power consumption for X2X Link power supply ¹⁾ | 1.42 W | |
| Power consumption ¹⁾ | | |
| Internal I/O | 0.6 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| KC | Yes | |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| KR | Yes | |
| CPU and X2X Link power supply | | |
| Input voltage | 24 VDC -15% / +20% | |
| Input current | Max. 2.2 A | |
| Fuse | Integrated, cannot be replaced | |
| Reverse polarity protection | Yes | |
| X2X Link power supply output | | |
| Nominal output power | 7 W ²⁾ | |
| Parallel connection | Yes ³⁾ | |
| Redundant operation | Yes | |
| Input I/O power supply | | |
| Input voltage | 24 VDC -15% / +20% | |
| Fuse | Required line fuse: Max. 10 A, slow-blow | |
| Output I/O power supply | | |
| Nominal output voltage | 24 VDC | |
| Permissible contact load | 10 A | |
| Power supply - General information | | |
| Status indicators | Overload, operating status, module status, RS232 data transfer | |
| Diagnostics | | |
| RS232 data transfer | Yes, using status LED | |
| Module run/error | Yes, using status LED and software | |
| Overload | Yes, using status LED and software | |
| Electrical isolation | | |
| I/O supply - I/O power supply | No | |
| CPU/X2X Link supply - CPU/X2X Link power supply | Yes | |
| Controller | | |
| CompactFlash slot | 1 | |
| Real-time clock | Nonvolatile, 1 s resolution, -10 to 10 ppm accuracy at 25°C | |
| FPU | Yes | |

Table 236: X20CP1483, X20CP1483-1 - Technical data

| Model number | X20CP1483 | X20CP1483-1 |
|--|--|-------------|
| Processor | | |
| Type | x86 100 comp. | |
| Clock frequency | 100 MHz | |
| L2 cache | - | |
| L1 cache for data and program code | 16 kB | |
| Integrated I/O processor | Processes I/O data points in the background | |
| Modular interface slots | 1 | |
| Remanent variables | Max. 32 kB ⁴⁾ | |
| Shortest task class cycle time | 1 ms | |
| Typical instruction cycle time | 0.09 µs | |
| Data buffering | | |
| Battery monitoring | Yes | |
| Lithium battery | At least 3 years | |
| Standard memory | | |
| RAM | 32 MB SDRAM | 64 MB SDRAM |
| User RAM | 128 kB SRAM ⁵⁾ | |
| Interfaces | | |
| Interface IF1 | | |
| Signal | RS232 | |
| Variant | Connection made using 12-pin X20TB12 terminal block | |
| Max. distance | 900 m | |
| Transfer rate | Max. 115.2 kbit/s | |
| Interface IF2 | | |
| Signal | Ethernet | |
| Variant | 1x RJ45 shielded | |
| Line length | Max. 100 m between 2 stations (segment length) | |
| Transfer rate | 10/100 Mbit/s | |
| Transfer | | |
| Physical layer | 10BASE-T/100BASE-TX | |
| Half-duplex | Yes | |
| Full-duplex | Yes | |
| Autonegotiation | Yes | |
| Auto-MDI/MDIX | Yes | |
| Interface IF3 | | |
| Fieldbus | POWERLINK (V1/V2) managing or controlled node | |
| Type | Type 4 ⁶⁾ | |
| Variant | 1x RJ45 shielded | |
| Line length | Max. 100 m between 2 stations (segment length) | |
| Transfer rate | 100 Mbit/s | |
| Transfer | | |
| Physical layer | 100BASE-TX | |
| Half-duplex | Yes | |
| Full-duplex | POWERLINK mode: No / Ethernet mode: Yes | |
| Autonegotiation | Yes | |
| Auto-MDI/MDIX | Yes | |
| Interface IF4 | | |
| Type | USB 1.1 | |
| Variant | Type A | |
| Max. output current | 0.5 A | |
| Interface IF5 | | |
| Type | USB 1.1 | |
| Variant | Type A | |
| Max. output current | 0.5 A | |
| Interface IF6 | | |
| Fieldbus | X2X Link master | |
| Electrical properties | | |
| Electrical isolation | Ethernet (IF2), POWERLINK (IF3) and X2X (IF6) isolated from each other, from other interfaces and from PLC | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |

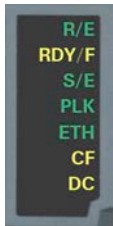
Table 236: X20CP1483, X20CP1483-1 - Technical data

| Model number | X20CP1483 | X20CP1483-1 |
|---------------------------------|-----------|--|
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | | -25 to 60°C |
| Vertical mounting orientation | | -25 to 50°C |
| Derating | | See section "Derating" |
| Storage | | -40 to 85°C |
| Transport | | -40 to 85°C |
| Relative humidity | | |
| Operation | | 5 to 95%, non-condensing |
| Storage | | 5 to 95%, non-condensing |
| Transport | | 5 to 95%, non-condensing |
| Mechanical properties | | |
| Note | | Order application memory (CompactFlash) separately Backup battery included in delivery X20 locking plate (right) included in delivery X20 terminal block (12-pin) included in delivery Interface module slot covers included in delivery |
| Dimensions | | |
| Width | | 150 mm |
| Height | | 99 mm |
| Depth | | 85 mm |
| Weight | | 300 g |

Table 236: X20CP1483, X20CP1483-1 - Technical data

- 1) The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) When operated at temperatures above 55°C, a derating of the nominal output power to 5 W for the X2X Link supply must be taken into consideration.
- 3) In parallel operation, only 75% of the rated power can be assumed. It is important to make sure that all power supplies operated in parallel are switched on and off at the same time.
- 4) The size of the memory used for remanent variables is adjustable in Automation Studio.
- 5) Minus configured remanent variables.
- 6) See Automation Help under "Communication / POWERLINK / General information / Hardware - IF/LS" for more information.

9.12.3.4 X20 CPUs - Status LEDs

| Figure | LED | Color | Status | Description |
|---|--------|-----------|----------------------|--|
|  | R/E | Green | On | Application running |
| | | | Blinking | Boot mode system start: CPU initializing the application, all bus systems and I/O modules ¹⁾ |
| | | | Double flash | Mode BOOT (during firmware update) ¹⁾ |
| | RDY/F | Yellow | On | SERVICE mode |
| | | | Blinking | The "R/E" LED blinks red and the "RDY/F" LED blinks yellow when there is a license violation. |
| | S/E | Green/Red | On | SERVICE or BOOT mode |
| | | | Blinking | The "RDY/F" LED blinks yellow and the "R/E" LED blinks red when there is a license violation. |
| | PLK | Green | On | A link to the POWERLINK peer station has been established. |
| | | | Blinking | A link to the POWERLINK peer station has been established. The LED blinks when Ethernet activity is taking place on the bus. |
| | ETH | Green | On | A link to the peer station has been established. |
| | | | Blinking | A link to the peer station has been established. Indicates Ethernet activity is taking place on the bus. |
| | CF | Green | On | CompactFlash inserted and detected |
| | | | Yellow | CompactFlash read/write access |
| DC | Yellow | On | CPU power supply OK | |
| | | Red | Backup battery empty | |

1) The process can take several minutes depending on the configuration.

9.12.3.4.1 LED "S/E" (LED "Status/Error")

This LED is a green/red dual LED and indicates the state of the POWERLINK interface. The LED states have a different meaning depending on the operating mode of the POWERLINK interface.

9.12.3.4.1.1 Ethernet mode

In this mode, the interface is operated as an Ethernet interface.

| LED "S/E" | | Description |
|-----------|-----|---|
| Green | Red | |
| On | Off | The interface is operated as an Ethernet interface. |

Table: LED "S/E": Interface in Ethernet mode

9.12.3.4.1.2 POWERLINK V1 mode

| LED "S/E" | | Current state of the POWERLINK node |
|----------------------|----------|--|
| Green | Red | |
| On | Off | The POWERLINK node is running with no errors. |
| Off | On | A system error occurred. The type of error can be read using the PLC logbook. An irreparable problem has occurred. The system can no longer properly carry out its tasks. This state can only be changed by resetting the module. |
| Blinking alternately | | The POWERLINK managing node has failed. This error code can only occur when operated as a controlled node. This means that the set node number lies within the range 0x01 - 0xFD. |
| Off | Blinking | System stop. The red blinking LED indicates an error code (see "System stop error codes" on page 1386). |
| Off | Off | The interface is either not active or one of the following states or errors is present: <ul style="list-style-type: none"> The device is switched off. The device is in the startup phase. The interface or device is not configured correctly in Automation Studio. The interface or device is defective. |

Table 237: LED "S/E": POWERLINK V1 mode

9.12.3.4.1.3 POWERLINK V2

| LED "S/E" | | Description |
|-----------|-----|--|
| Green | Red | |
| Off | On | The interface is in error mode (failed Ethernet frames, increased number of collisions on the network, etc.). Note: Several red blinking signals are displayed immediately after the device is switched on. These are not errors, however. |
| Blinking | On | <p>If an error occurs in the following modes, then the green LED blinks over the red LED:</p> <ul style="list-style-type: none"> PRE_OPERATIONAL_1 PRE_OPERATIONAL_2 READY_TO_OPERATE |

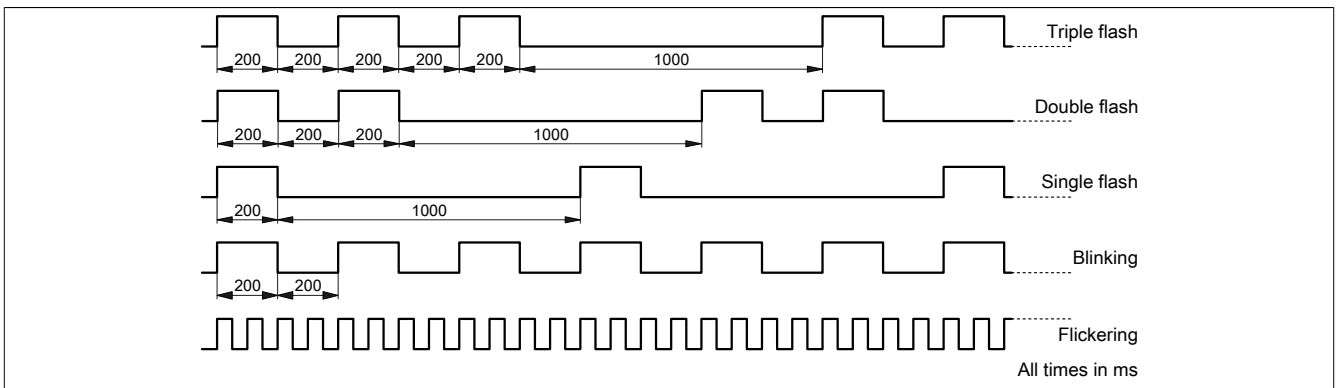
Table: LED "S/E" - Error message (interface in POWERLINK mode)

| LED "S/E" | | Description |
|----------------------------------|-----|--|
| Green | Red | |
| Off | Off | <p>Mode: NOT_ACTIVE The interface is either in mode NOT_ACTIVE or one of the following modes or errors is present:</p> <ul style="list-style-type: none"> The device is switched off. The device is in the startup phase. The interface or device is not configured correctly in Automation Studio. The interface or device is defective. <p>Managing node (MN) The network is monitored for POWERLINK frames. If a frame is not received within the configured time window (timeout), the interface immediately enters mode PRE_OPERATIONAL_1. If POWERLINK communication is detected before the time has elapsed, however, the MN is not started.</p> <p>Controlled node (CN) The network is monitored for POWERLINK frames. If a frame is not received within the configured time window (timeout), the interface immediately enters mode BASIC_ETHERNET. If POWERLINK communication is detected before this time expires, however, the interface immediately enters mode PRE_OPERATIONAL_1.</p> |
| Flickering (approx. 10 Hz) | Off | <p>Mode: BASIC_ETHERNET The interface is in mode BASIC_ETHERNET. The interface is operated in Ethernet mode.</p> <p>Managing node (MN) This mode can only be exited by resetting the controller.</p> <p>Controlled node (CN) If POWERLINK communication is detected during this mode, the interface enters mode PRE_OPERATIONAL_1.</p> |
| Single flash (approx. 1 Hz) | Off | <p>Mode: PRE_OPERATIONAL_1 The interface is in mode PRE_OPERATIONAL_1.</p> <p>Managing node (MN) The MN is in "reduced cycle" operation. The CNs are configured in this mode. Cyclic communication is not yet taking place.</p> <p>Controlled node (CN) The CN can be configured by the MN in this mode. The CN waits until it receives an SoC frame and then switches to mode PRE_OPERATIONAL_2.</p> |
| | On | <p>Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed.</p> |
| Double flash (approx. 1 Hz) | Off | <p>Mode: PRE_OPERATIONAL_2 The interface is in mode PRE_OPERATIONAL_2.</p> <p>Managing node (MN) The MN starts cyclic communication (cyclic input data is not yet evaluated). The CNs are configured in this mode.</p> <p>Controlled node (CN) The CN can be configured by the MN in this mode. A command then switches the mode to READY_TO_OPERATE.</p> |
| | On | <p>Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed.</p> |

Table: LED "S/E" - Interface state (interface in POWERLINK mode)

| LED "S/E" | | Description |
|--------------------------------|-----|--|
| Green | Red | |
| Triple flash (approx. 1 Hz) | Off | Mode: READY_TO_OPERATE The interface is in mode READY_TO_OPERATE. Managing node (MN) Cyclic and asynchronous communication. Received PDO data is ignored. Controlled node (CN) The configuration of the CN is completed. Normal cyclic and asynchronous communication. The transmitted PDO data corresponds to the PDO mapping. However, cyclic data is not yet evaluated. |
| | On | Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed. |
| On | Off | Mode: OPERATIONAL The interface is in mode OPERATIONAL. PDO mapping is active and cyclic data is evaluated. |
| Blinking (approx. 2.5 Hz) | Off | Mode: STOPPED The interface is in mode STOPPED. Managing node (MN) This mode does not occur for the MN. Controlled node (CN) Output data is not being output, and no input data is being provided. This mode can only be reached and exited by a corresponding command from the MN. |

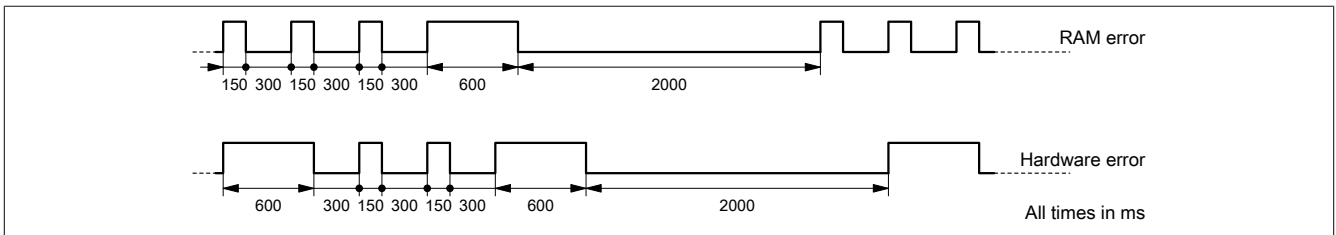
Table: LED "S/E" - Interface state (interface in POWERLINK mode)



9.12.3.4.2 System stop error codes

A system stop error can occur due to incorrect configuration or defective hardware.


The error code is indicated by LED "S/E" blinking red. The blinking signal of the error code consists of 4 switch-on phases with short (150 ms) or long (600 ms) duration. The error code is repeated every 2 seconds.



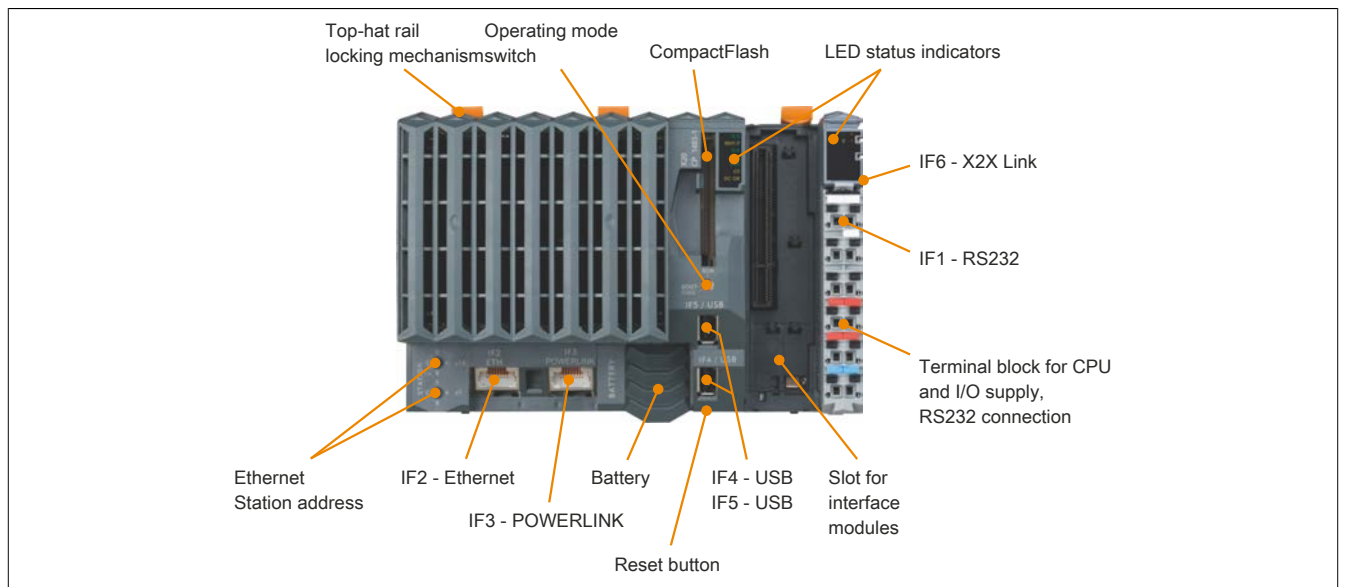
| Error | Error description |
|----------------|---|
| RAM error | The device is defective and must be replaced. |
| Hardware error | The device or a system component is defective and must be replaced. |

9.12.3.5 LED status indicators for the integrated power supply

For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|--------------------------------|--|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | Mode RESET |
| | | | Blinking | Mode PREOPERATIONAL |
| | | | On | Mode RUN |
| | e | Red | Off | Module not supplied with power or everything OK |
| | | | Double flash | The LED indicates one of the following states: <ul style="list-style-type: none"> The X2X Link power supply of the power supply is overloaded. I/O power supply too low The input voltage for the X2X Link power supply is too low. |
| | e + r | Solid red / Single green flash | | Invalid firmware |
| | S | Yellow | Off | No RS232 activity |
| | | | On | The LED lights up when data is being transmitted or received via the RS232 interface. |
| | l | Red | Off | The X2X Link power supply is within the valid range. |
| On | | | The X2X Link power supply of the power supply is overloaded. | |

9.12.3.6 Operating and connection elements



9.12.3.7 Slot for application memory

Program memory is required to operate the CPUs. The application memory is provided in the form of a CompactFlash card. It is not included with the CPUs, but must be ordered separately as an accessory.

Information:

The CompactFlash card must not be removed during operation.

9.12.3.8 Operating mode switch

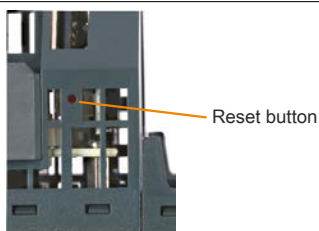
The operating mode switch is used to set the operating mode.



| Switch position | Operating mode | Description |
|-----------------|----------------|--|
| BOOT | BOOT | In this switch position, Boot AR is started and the runtime system can be installed via the online interface (B&R Automation Studio). User flash memory is erased only when the download begins. |
| RUN | RUN | Mode RUN |
| DIAG | DIAGNOSE | The CPU boots in diagnostic mode. Program sections in User RAM and User FlashPROM are not initialized. After diagnostic mode, the CPU always boots with a warm restart. |

Table 238: X20 CPUs - Operating mode

9.12.3.9 Reset button



The reset button is located below the USB interfaces on the bottom of the housing. It can be pressed with any small pointed object (e.g. paper clip). Pressing the reset button triggers a hardware reset, which means:

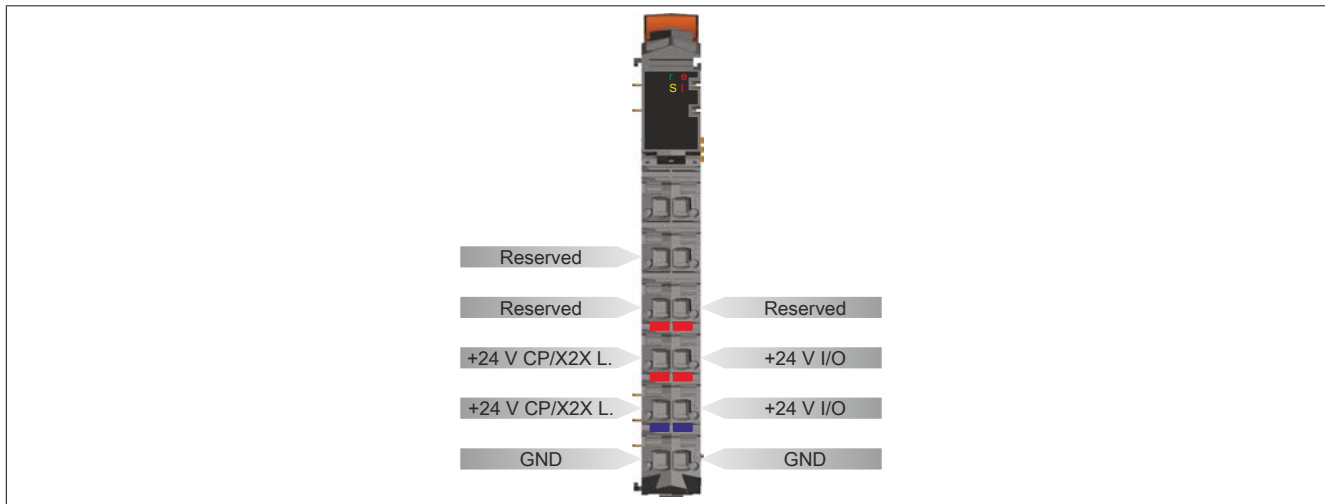
- All application programs are stopped.
- All outputs are set to zero.

The PLC then starts up in service mode by default. The startup mode that follows after pressing the reset button can be set in Automation Studio.

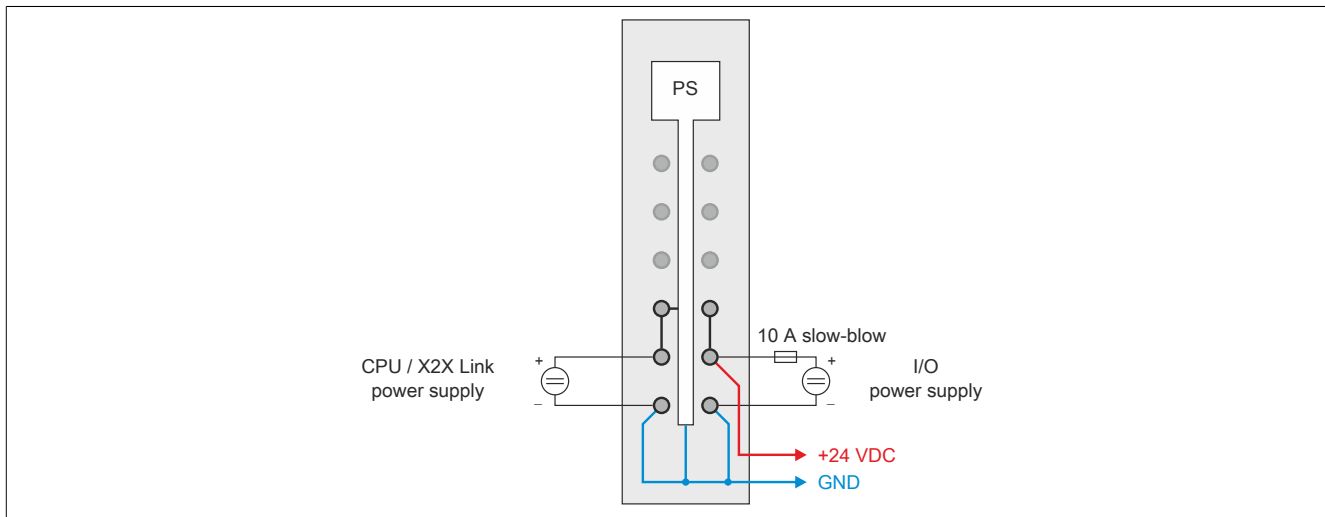
9.12.3.10 CPU power supply

A power supply is integrated in the X20 CPUs. It is equipped with a supply for the CPU, X2X Link and the internal I/O power supply. The bus power supply and internal I/O power supply are galvanically isolated from each other.

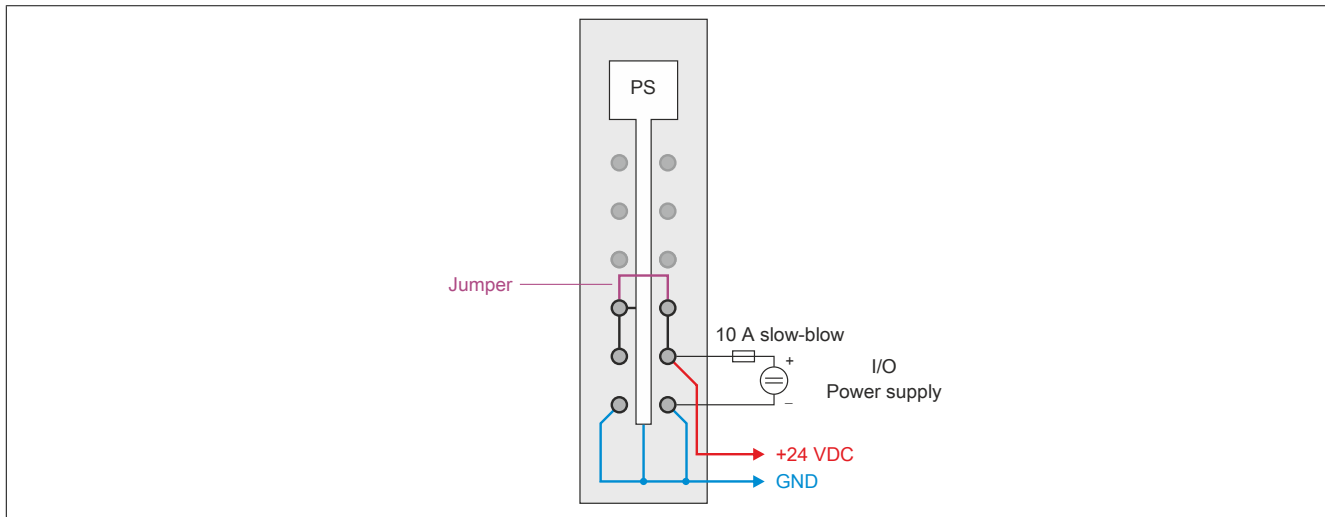
Integrated power supply - Pinout



Connection example with 2 separate supplies

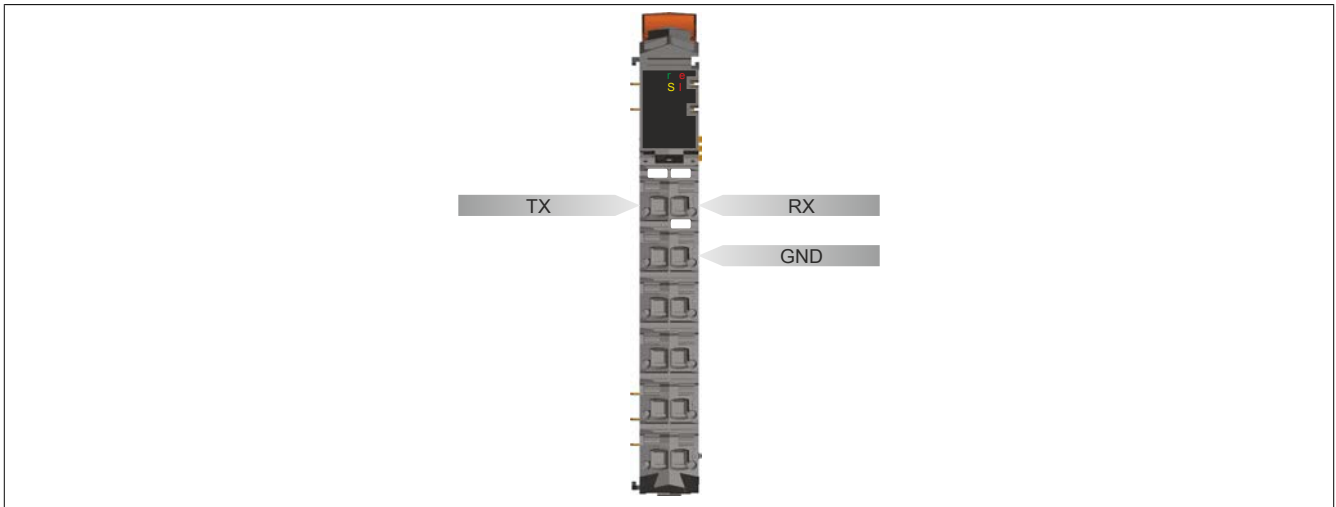


Connection example with power supply and jumper



9.12.3.11 RS232 interface (IF1)

The non-electrically isolated RS232 interface is designed as an online interface for communication with the programming device.



9.12.3.12 Ethernet interface (IF2)



IF2 is designed as a 10BASE-T/100BASE-TX interface.

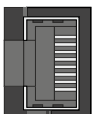
The INA2000 station number of the Ethernet interface is set using the two hex switches.

For information about wiring X20 modules with an Ethernet interface, see ["Cabling guidelines for X20 modules with an Ethernet cable"](#) on page 58.

Information:

The Ethernet interface (IF2) is not suitable for POWERLINK (see ["POWERLINK interface \(IF3\)"](#) on page 1391).

Pinout

| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | TXD | Transmit data |
| | 2 | TXD\ | Transmit data\ |
| | 3 | RXD | Receive data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | RXD\ | Receive data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.12.3.13 POWERLINK interface (IF3)

POWERLINK V1

| Switch position | Description |
|-----------------|--|
| 0x00 | Operation as managing node. |
| 0x01 - 0xFD | Node number of the POWERLINK node. Operation as controlled node. |
| 0xFE - 0xFF | Reserved, switch position not permitted |

POWERLINK V2

| Switch position | Description |
|-----------------|---|
| 0x00 | Reserved, switch position not permitted. |
| 0x01 - 0xEF | Node number of the POWERLINK node. Operation as a controlled node (CN). |
| 0xF0 | Operation as a managing node (MN). |
| 0xF1 - 0xFF | Reserved, switch position not permitted. |

Ethernet mode

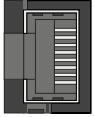
Starting with Automation Studio Version V2.5.3 and with Automation Runtime V2.90, the interface can be operated as an Ethernet interface.

The INA2000 station number can be set using the B&R Automation Studio software.

Pinout



For information about wiring X20 modules with an Ethernet interface, see ["Cabling guidelines for X20 modules with an Ethernet cable"](#) on page 58.

| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.12.3.14 USB interfaces (IF4 and IF5)



IF4 and IF5 are non-electrically isolated USB interfaces. The connection is made using a USB 1.1 interface.

The USB interfaces can only be used for devices approved by B&R (e.g. floppy disk drive, DiskOnKey or dongle).

Information:

- **USB interfaces cannot be used for online communication with a programming device.**
- **Only devices isolated from GND can be connected to the USB interfaces.**
- **Current-carrying capacity is listed in the technical data.**

9.12.3.15 Slots for interface modules

The CPUs have one or three slots for interface modules.

Different bus or network systems can be flexibly integrated into the X20 system by selecting the appropriate interface module.

9.12.3.16 Overtemperature cutoff

To prevent damage, a shut-off/reset is triggered on the CPU when the processor reaches 100°C.

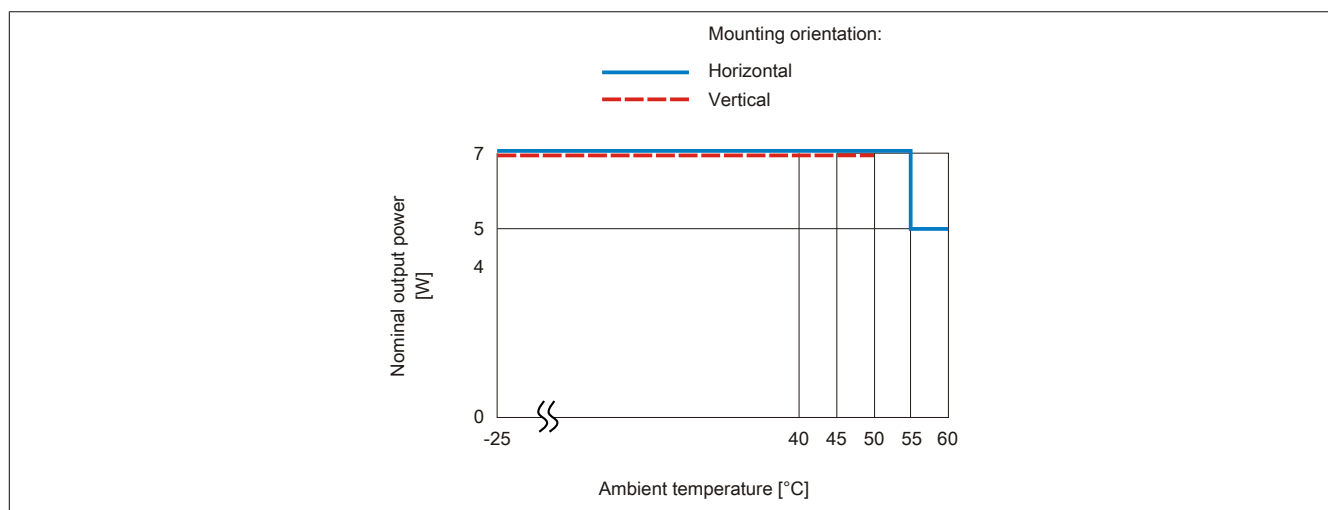
The following errors are entered in the logbook:

| Error number | Error description |
|--------------|---|
| 9204 | WARNING: System halted because of temperature check |
| 9210 | WARNING: Boot by watchdog or manual reset |

Table 239: X20 CPUs - Logbook entries after overtemperature cutoff

9.12.3.17 Derating

There is no derating when operated below 55°C. Above 55°C, the nominal output power for the X2X Link power supply must be reduced to 5 W.



9.12.3.18 Battery

X20 CPUs are equipped with a lithium battery. The lithium battery is located in a separate compartment and protected by a cover.

Backup battery data

| | |
|--|---|
| Order number 4A0006.00-000 0AC201.91 | 1 pcs. 4 pcs. |
| Short description | Lithium battery, 3 V / 950 mAh, button cell |
| Storage temperature | -40 to 85°C |
| Storage time | Max. 3 years at 30°C |
| Relative humidity | 0 to 95% (non-condensing) |

The following areas are buffered:

- Remanent variables
- User RAM
- System RAM
- Real-time clock

Battery monitoring

The battery voltage is checked cyclically. The cyclic load test of the battery does not considerably shorten its service life; instead, it gives an early warning of weakened buffer capacity.

Status information "Battery OK" is available from system library function "BatteryInfo" and the CPU's I/O mapping.

Replacement interval for battery

The battery should be replaced every 4 years. The replacement intervals recommended by B&R reflect the batteries' average service life and operating conditions. They do not correspond to the maximum buffer duration!

Important information about the battery exchange

The product design allows the battery to be changed when the power to the PLC is switched off as well as when the power to the PLC is switched on. In some countries, safety regulations do not allow batteries to be changed while the module is switched on. To prevent data loss, the battery must be changed within 1 min when the power is switched off.

Warning!

The battery is only permitted to be replaced by a Renata CR2477N battery. The use of another battery may present a fire or explosion hazard.

The battery can explode if handled improperly. Do not recharge, disassemble or dispose of the battery in fire.

Procedure for replacing the battery

1. Perform electrostatic discharge at the top-hat rail or at the ground connection (do not reach into the power supply!)
2. Remove the cover for the lithium battery. Do this by sliding it down and away from the CPU.

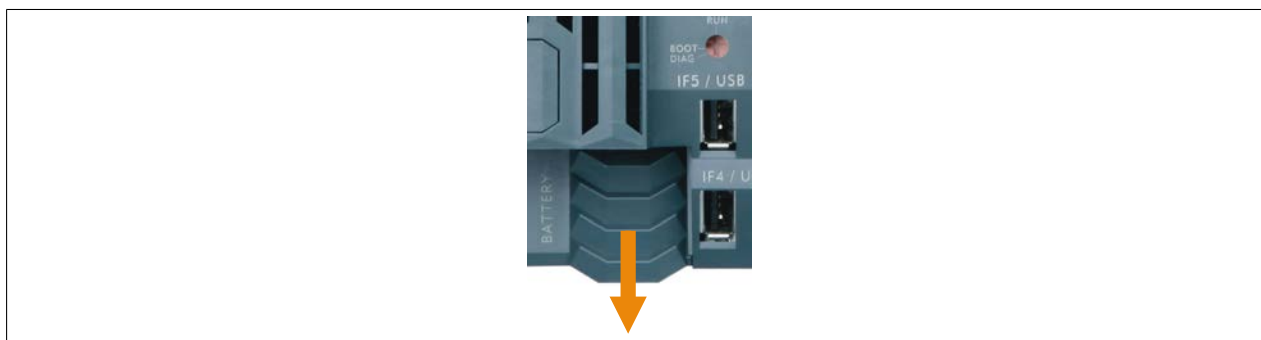


Figure 155: X20 CPUs - Remove lithium battery cover

3. Push the empty battery out of the holder.

4. It is important to ensure that the new battery is not handled with moist or greasy fingers. Plastic tweezers can also be used. Do not touch the battery with pliers or metal tweezers → short circuit!
5. To insert the battery into the holder, place it with the "+" side up on the right part of the battery holder. Then press the battery into the battery holder.
6. Replace the cover.

Information:

Lithium batteries are hazardous waste. Used batteries should be disposed of in accordance with applicable local regulations.

9.12.3.19 Programming the system flash memory

General information

In order for the application project to be executed on the CPU, the Automation Runtime operating system, the system components and the application project must be installed on the CompactFlash card.

Creating a CompactFlash using a USB card reader

The easiest way to perform an initial installation is by creating a fully programmed CompactFlash card using a USB card reader.

1. Creating and configuring a project in Automation Studio
2. In Automation Studio, select **Tools / Create CompactFlash**
3. In the dialog box that opens, select a CompactFlash card and then generate it
4. Insert the finished CompactFlash into the CPU and turn on the CPU's supply voltage
5. CPU booting

For details about commissioning: See help system under "Automation Software / Getting Started"

Installation over an online connection

The CPUs are delivered with a default B&R Automation Runtime system (with limited functions) already installed. This runtime system is started in Boot mode (operating mode switch in the BOOT position or no CompactFlash / invalid CompactFlash inserted). It initializes the Ethernet interface and onboard serial RS232 interface, making it possible to download a new runtime system.

1. Insert the CompactFlash card and switch on the power to the CPU. When the switch is in the BOOT position, a new or invalid CompactFlash card starts the CPU with the default B&R Automation Runtime system.
2. Establish a physical online connection between the programming device (PC or industrial PC) and the CPU (e.g. over an Ethernet network or the RS232 interface).
3. Before you can establish an online connection via Ethernet, the CPU must be assigned an IP address. In Automation Studio, select **Settings** from the Online menu and then click on the **Browse targets** button to search for B&R target systems on the local network. The CPU should appear in the list. If the CPU has not already received an IP address from a DHCP server, right-click on it and select **Set IP parameters** from the shortcut menu. All necessary network configurations can be made on a temporary basis in this dialog box (should be identical to the settings defined in the project).
4. Configure online connection in B&R Automation Studio. For details about the configuration: See help system under "Automation Software / Communication / Online communication"
5. Start the download procedure by selecting the **Services** command from the **Project** menu. Then select **Transfer Automation Runtime** from the pop-up menu. Now follow the instructions provided by B&R Automation Studio.

9.12.3.20 General data points

This CPU is equipped with general data points. These are not CPU-specific; instead, they contain general information such as system time and heat sink temperature.

General data points are described in section ["General CPU data points" on page 3792](#).

9.12.4 X20(c)CP158x and X20(c)CP358x

Data sheet version: 1.52

9.12.4.1 General information

Based on Intel ATOM processor technology, X20 CPUs cover a wide spectrum of requirements. They can be implemented in solutions ranging from standard applications to those requiring the high levels of performance.

The series starts with Intel ATOM processor 333 MHz compatible models – X20CP1583 and X20CP3583. With an optimum price/performance ratio, it has the same basic features as all of the larger CPUs.

The basic model includes USB, Ethernet, POWERLINK V1/V2 and replaceable CompactFlash card. The standard Ethernet interface is capable of handling communication in the gigabit range. For even more real-time network performance, the onboard POWERLINK interface supports poll response chaining mode (PRC).

Up to 3 more slots are available for additional interface modules to increase flexibility.

- Intel ATOM 1600/1000/600 Performance with integrated I/O processor
- Entry-level CPU is Intel ATOM 333 MHz-compatible with integrated I/O processor
- Onboard Ethernet, POWERLINK V1/V2 with poll response chaining and USB
- 1 or 3 slots for modular interface expansion
- CompactFlash as removable application memory
- Up to 512 MB DDR2-SRAM according to performance requirements
- CPU redundancy possible
- Fanless

9.12.4.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.12.4.3 Order data - X20CP158x

|  | |
|---|--|
| Model number | Short description |
| X20 CPUs | |
| X20CP1583 | X20 CPU, Atom 333 MHz Intel compatible, 128 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! |
| X20CP1584 | X20 CPU, Atom 0.6 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! |
| X20cCP1584 | X20 CPU, coated, Atom 0.6 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! |
| X20CP1585 | X20 CPU, Atom 1.0 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! |
| X20CP1586 | X20 CPU, Atom 1.6 GHz, 512 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! |
| X20cCP1586 | X20 CPU, coated, Atom 1.6 GHz, 512 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! |
| Required accessories | |
| CompactFlash cards | |
| 0CFCRD.0512E.01 | CompactFlash 512 MB extended temp. |
| 0CFCRD.2048E.01 | CompactFlash 2048 MB extended temp. |
| 5CFCRD.016G-06 | CompactFlash 16 GB B&R (SLC) |
| 5CFCRD.032G-06 | CompactFlash 32 GB B&R (SLC) |
| 5CFCRD.0512-06 | CompactFlash 512 MB B&R (SLC) |
| 5CFCRD.1024-06 | CompactFlash 1 GB B&R (SLC) |
| 5CFCRD.2048-06 | CompactFlash 2 GB B&R (SLC) |
| 5CFCRD.4096-06 | CompactFlash 4 GB B&R (SLC) |
| 5CFCRD.8192-06 | CompactFlash 8 GB B&R (SLC) |
| Optional accessories | |
| Batteries | |
| 0AC201.91 | Lithium batteries 4 pcs., 3 V / 950 mAh button cell |
| 4A0006.00-000 | Lithium battery, 3 V / 950 mAh, button cell |

Table 240: X20CP1583, X20CP1584, X20cCP1584, X20CP1585, X20CP1586, X20cCP1586 - Order data

Included in delivery

| Order number | Short description |
|---------------|--|
| 4A0006.00-000 | Backup battery (see also "Battery" on page 1412) |
| - | Interface module slot covers |
| X20AC0SR1 | X20 end cover plate (right) |
| X20TB12 | X20 terminal block, 12-pin, 24 V coding |

Table 241: X20 CPUs - Content of delivery

9.12.4.4 X20CP158x - Technical data

| Model number | X20CP1583 | X20CP1584 | X20cCP1584 | X20CP1585 | X20CP1586 | X20cCP1586 |
|--|--|-----------|------------|-----------|-----------|------------|
| Short description | | | | | | |
| Interfaces | 1x RS232, 1x Ethernet, 1x POWERLINK (V1/V2), 2x USB, 1x X2X Link | | | | | |
| System module | CPU | | | | | |
| General information | | | | | | |
| Cooling | Fanless | | | | | |
| B&R ID code | 0xD45B | 0xC370 | 0xE21B | 0xC3AE | 0xC3B0 | 0xE21C |
| Status indicators | CPU function, overtemperature, Ethernet, POWERLINK, CompactFlash, battery | | | | | |
| Diagnostics | | | | | | |
| Battery | Yes, using status LED and software | | | | | |
| CPU function | Yes, using status LED | | | | | |
| CompactFlash | Yes, using status LED | | | | | |
| Ethernet | Yes, using status LED | | | | | |
| POWERLINK | Yes, using status LED | | | | | |
| Overtemperature | Yes, using status LED | | | | | |
| Controller redundancy possible | No | | | | | |
| ACOPOS support | Yes | | | | | |
| Visual Components support | Yes | | | | | |
| Power consumption without interface module and USB | 8.2 W | 8.6 W | | 8.8 W | 9.7 W | |
| Power consumption for X2X Link power supply ¹⁾ | 1.42 W | | | | | |
| Power consumption ¹⁾ | | | | | | |
| Internal I/O | 0.6 W | | | | | |
| Additional power dissipation caused by actuators (resistive) [W] | - | | | | | |
| Certifications | | | | | | |
| CE | Yes | | | | | |
| EAC | Yes | | | | | |
| UL | cULus E115267 Industrial control equipment | | | | | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | | | | | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | | | | | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | | | | | |
| LR | ENV1 | | | | | |
| KC | - | Yes | - | Yes | - | - |
| CPU and X2X Link power supply | | | | | | |
| Input voltage | 24 VDC -15% / +20% | | | | | |
| Input current | Max. 1.5 A | | | | | |
| Fuse | Integrated, cannot be replaced | | | | | |
| Reverse polarity protection | Yes | | | | | |
| X2X Link power supply output | | | | | | |
| Nominal output power | 7 W ²⁾ | | | | | |
| Parallel connection | Yes ³⁾ | | | | | |
| Redundant operation | Yes | | | | | |
| Input I/O power supply | | | | | | |
| Input voltage | 24 VDC -15% / +20% | | | | | |
| Fuse | Required line fuse: Max. 10 A, slow-blow | | | | | |
| Output I/O power supply | | | | | | |
| Nominal output voltage | 24 VDC | | | | | |
| Permissible contact load | 10 A | | | | | |
| Power supply - General information | | | | | | |
| Status indicators | Overload, operating status, module status, RS232 data transfer | | | | | |
| Diagnostics | | | | | | |
| RS232 data transfer | Yes, using status LED | | | | | |
| Module run/error | Yes, using status LED and software | | | | | |
| Overload | Yes, using status LED and software | | | | | |
| Electrical isolation | | | | | | |
| I/O supply - I/O power supply | No | | | | | |
| CPU/X2X Link supply - CPU/X2X Link power supply | Yes | | | | | |
| Controller | | | | | | |
| CompactFlash slot | 1 | | | | | |
| Real-time clock | Nonvolatile, 1 s resolution, -10 to 10 ppm accuracy at 25°C | | | | | |
| FPU | Yes | | | | | |

Table 242: X20CP1583, X20CP1584, X20cCP1584, X20CP1585, X20CP1586, X20cCP1586 - Technical data

| Model number | X20CP1583 | X20CP1584 | X20cCP1584 | X20CP1585 | X20CP1586 | X20cCP1586 |
|--|--|---------------------------|------------|------------|-------------------------|------------|
| Processor | | | | | | |
| Type | Atom E620T | | | Atom E640T | Atom E680T | |
| Clock frequency | 333 MHz | 0.6 GHz | | 1 GHz | 1.6 GHz | |
| L1 cache | | | | | | |
| Data code | 24 kB | | | | | |
| Program code | 32 kB | | | | | |
| L2 cache | - | 512 kB | | | | |
| Integrated I/O processor | Processes I/O data points in the background | | | | | |
| Modular interface slots | 1 | | | | | |
| Remanent variables | Max. 64 kB ⁴⁾ | Max. 256 kB ⁴⁾ | | | Max. 1 MB ⁴⁾ | |
| Shortest task class cycle time | 800 µs | 400 µs | | 200 µs | 100 µs | |
| Typical instruction cycle time | 0.01 µs | 0.0075 µs | | 0.0044 µs | 0.0027 µs | |
| Data buffering | | | | | | |
| Battery monitoring | Yes | | | | | |
| Lithium battery | Min. 2 years at 23°C ambient temperature | | | | | |
| Standard memory | | | | | | |
| RAM | 128 MB DDR2 SDRAM | 256 MB DDR2 SDRAM | | | 512 MB DDR2 SDRAM | |
| User RAM | 1 MB SRAM ⁵⁾ | | | | | |
| Interfaces | | | | | | |
| Interface IF1 | | | | | | |
| Signal | RS232 | | | | | |
| Variant | Connection made using 12-pin terminal block X20TB12 | | | | | |
| Max. distance | 900 m | | | | | |
| Transfer rate | Max. 115.2 kbit/s | | | | | |
| Interface IF2 | | | | | | |
| Signal | Ethernet | | | | | |
| Variant | 1x RJ45 shielded | | | | | |
| Cable length | Max. 100 m between 2 stations (segment length) | | | | | |
| Transfer rate | 10/100/1000 Mbit/s | | | | | |
| Transfer | | | | | | |
| Physical layer | 10BASE-T/100BASE-TX/1000BASE-T | | | | | |
| Half-duplex | Yes | | | | | |
| Full-duplex | Yes | | | | | |
| Autonegotiation | Yes | | | | | |
| Auto-MDI/MDIX | Yes | | | | | |
| Interface IF3 | | | | | | |
| Fieldbus | POWERLINK (V1/V2) managing or controlled node | | | | | |
| Type | Type 4 ⁶⁾ | | | | | |
| Variant | 1x RJ45 shielded | | | | | |
| Cable length | Max. 100 m between 2 stations (segment length) | | | | | |
| Transfer rate | 100 Mbit/s | | | | | |
| Transfer | | | | | | |
| Physical layer | 100BASE-TX | | | | | |
| Half-duplex | Yes | | | | | |
| Full-duplex | POWERLINK mode: No / Ethernet mode: Yes | | | | | |
| Autonegotiation | Yes | | | | | |
| Auto-MDI/MDIX | Yes | | | | | |
| Interface IF4 | | | | | | |
| Type | USB 1.1/2.0 | | | | | |
| Variant | Type A | | | | | |
| Max. output current | 0.5 A | | | | | |
| Interface IF5 | | | | | | |
| Type | USB 1.1/2.0 | | | | | |
| Variant | Type A | | | | | |
| Max. output current | 0.5 A | | | | | |
| Interface IF6 | | | | | | |
| Fieldbus | X2X Link master | | | | | |
| Electrical properties | | | | | | |
| Electrical isolation | Ethernet (IF2), POWERLINK (IF3) and X2X (IF6) isolated from each other, from other interfaces and from PLC | | | | | |
| Operating conditions | | | | | | |
| Mounting orientation | | | | | | |
| Horizontal | Yes | | | | | |
| Vertical | Yes | | | | | |
| Installation elevation above sea level | | | | | | |
| 0 to 2000 m | No limitations | | | | | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | | | | | |
| Degree of protection per EN 60529 | IP20 | | | | | |

Table 242: X20CP1583, X20CP1584, X20cCP1584, X20CP1585, X20CP1586, X20cCP1586 - Technical data

| Model number | X20CP1583 | X20CP1584 | X20cCP1584 | X20CP1585 | X20CP1586 | X20cCP1586 |
|---------------------------------|--|-----------|---------------------------|-----------|--------------------------|---------------------------|
| Ambient conditions | | | | | | |
| Temperature | | | | | | |
| Operation | | | | | | |
| Horizontal mounting orientation | -25 to 60°C | | | | | |
| Vertical mounting orientation | -25 to 50°C | | | | | |
| Derating | See section "Derating" | | | | | |
| Storage | -40 to 85°C | | | | | |
| Transport | -40 to 85°C | | | | | |
| Relative humidity | | | | | | |
| Operation | 5 to 95%, non-condensing | | Up to 100%, condensing | | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | | | | | |
| Transport | 5 to 95%, non-condensing | | | | | |
| Mechanical properties | | | | | | |
| Note | Order application memory (CompactFlash) separately Backup battery included in delivery X20 end cover plate (right) included in delivery X20 12-pin terminal block included in delivery Interface module slot covers included in delivery | | | | | |
| Dimensions | | | | | | |
| Width | 150 mm | | | | | |
| Height | 99 mm | | | | | |
| Depth | 85 mm | | | | | |
| Weight | 400 g | | | | | |

Table 242: X20CP1583, X20CP1584, X20cCP1584, X20CP1585, X20CP1586, X20cCP1586 - Technical data

- 1) The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) When operated at temperatures above 55°C, a derating of the nominal output power to 5 W for the X2X Link power supply must be taken into consideration.
- 3) In parallel operation, only 75% of the rated power can be assumed. It is important to make sure that all power supplies operated in parallel are switched on and off at the same time.
- 4) The size of the memory used for remanent variables is adjustable in Automation Studio.
- 5) 1 MB SRAM minus the configured remanent variables.
- 6) See Automation Help under "Communication / POWERLINK / General information / Hardware - IF/LS" for more information.

9.12.4.5 Order data - X20CP358x


|  | |
|---|--|
| Model number | Short description |
| X20 CPUs | |
| X20CP3583 | X20 CPU, Atom 333 MHz Intel compatible, 128 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! |
| X20CP3584 | X20 CPU, Atom 0.6 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! |
| X20cCP3584 | X20 CPU, coated, ATOM 0.6 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000 Base-T, 1 POWERLINK interface, incl. supply module, 1 X20TB12 terminal block, slot covers and X20 end cover plate (right) X20AC0SR1 included, order application memory separately. |
| X20CP3585 | X20 CPU, Atom 1.0 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! |
| X20CP3586 | X20 CPU, Atom 1.6 GHz, 512 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included, order application memory separately! |
| X20cCP3586 | X20 CPU, coated, ATOM 1.6 GHz, 512 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000 Base-T, 1 POWERLINK interface, incl. supply module, 1 X20TB12 terminal block, slot covers and X20 end cover plate (right) X20AC0SR1 included, order application memory separately. |
| Required accessories | |
| CompactFlash cards | |
| 0CFCRD.0512E.01 | CompactFlash 512 MB extended temp. |
| 0CFCRD.2048E.01 | CompactFlash 2048 MB extended temp. |
| 5CFCRD.016G-06 | CompactFlash 16 GB B&R (SLC) |
| 5CFCRD.032G-06 | CompactFlash 32 GB B&R (SLC) |
| 5CFCRD.0512-06 | CompactFlash 512 MB B&R (SLC) |
| 5CFCRD.1024-06 | CompactFlash 1 GB B&R (SLC) |
| 5CFCRD.2048-06 | CompactFlash 2 GB B&R (SLC) |
| 5CFCRD.4096-06 | CompactFlash 4 GB B&R (SLC) |
| 5CFCRD.8192-06 | CompactFlash 8 GB B&R (SLC) |
| Optional accessories | |
| Batteries | |
| 0AC201.91 | Lithium batteries 4 pcs., 3 V / 950 mAh button cell |
| 4A0006.00-000 | Lithium battery, 3 V / 950 mAh, button cell |

Table 243: X20CP3583, X20CP3584, X20cCP3584, X20CP3585, X20CP3586, X20cCP3586 - Order data

Included in delivery

| Order number | Short description |
|---------------|--|
| 4A0006.00-000 | Backup battery (see also "Battery" on page 1412) |
| - | Interface module slot covers |
| X20AC0SR1 | X20 end cover plate (right) |
| X20TB12 | X20 terminal block, 12-pin, 24 V coding |

Table 244: X20 CPUs - Content of delivery

9.12.4.6 X20CP358x - Technical data

| Model number | X20CP3583 | X20CP3584 | X20cCP3584 | X20CP3585 | X20CP3586 | X20cCP3586 |
|--|--|-----------|------------|-----------|-----------|------------|
| Short description | | | | | | |
| Interfaces | 1x RS232, 1x Ethernet, 1x POWERLINK (V1/V2), 2x USB, 1x X2X Link | | | | | |
| System module | CPU | | | | | |
| General information | | | | | | |
| Cooling | Fanless | | | | | |
| B&R ID code | 0xD45C | 0xC3AD | 0xE21D | 0xC3AF | 0xBF2B | 0xE21E |
| Status indicators | CPU function, overtemperature, Ethernet, POWERLINK, CompactFlash, battery | | | | | |
| Diagnostics | | | | | | |
| Battery | Yes, using status LED and software | | | | | |
| CPU function | Yes, using status LED | | | | | |
| CompactFlash | Yes, using status LED | | | | | |
| Ethernet | Yes, using status LED | | | | | |
| POWERLINK | Yes, using status LED | | | | | |
| Overtemperature | Yes, using status LED | | | | | |
| Controller redundancy possible | No | Yes | | | | |
| ACOPOS support | Yes | | | | | |
| Visual Components support | Yes | | | | | |
| Power consumption without interface module and USB | 8.2 W | 8.6 W | | 8.8 W | 9.7 W | |
| Power consumption for X2X Link power supply ¹⁾ | 1.42 W | | | | | |
| Power consumption ¹⁾ | | | | | | |
| Internal I/O | 0.6 W | | | | | |
| Additional power dissipation caused by actuators (resistive) [W] | - | | | | | |
| Certifications | | | | | | |
| CE | Yes | | | | | |
| EAC | Yes | | | | | |
| UL | cULus E115267 Industrial control equipment | | | | | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | | | | | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | | | | | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | | | | | |
| KC | - | Yes | - | Yes | - | |
| CPU and X2X Link power supply | | | | | | |
| Input voltage | 24 VDC -15% / +20% | | | | | |
| Input current | Max. 1.5 A | | | | | |
| Fuse | Integrated, cannot be replaced | | | | | |
| Reverse polarity protection | Yes | | | | | |
| X2X Link power supply output | | | | | | |
| Nominal output power | 7 W ²⁾ | | | | | |
| Parallel connection | Yes ³⁾ | | | | | |
| Redundant operation | Yes | | | | | |
| Input I/O power supply | | | | | | |
| Input voltage | 24 VDC -15% / +20% | | | | | |
| Fuse | Required line fuse: Max. 10 A, slow-blow | | | | | |
| Output I/O power supply | | | | | | |
| Nominal output voltage | 24 VDC | | | | | |
| Permissible contact load | 10 A | | | | | |
| Power supply - General information | | | | | | |
| Status indicators | Overload, operating status, module status, RS232 data transfer | | | | | |
| Diagnostics | | | | | | |
| RS232 data transfer | Yes, using status LED | | | | | |
| Module run/error | Yes, using status LED and software | | | | | |
| Overload | Yes, using status LED and software | | | | | |
| Electrical isolation | | | | | | |
| I/O supply - I/O power supply | No | | | | | |
| CPU/X2X Link supply - CPU/X2X Link power supply | Yes | | | | | |
| Controller | | | | | | |
| CompactFlash slot | 1 | | | | | |
| Real-time clock | Nonvolatile, 1 s resolution, -10 to 10 ppm accuracy at 25°C | | | | | |
| FPU | Yes | | | | | |

Table 245: X20CP3583, X20CP3584, X20cCP3584, X20CP3585, X20CP3586, X20cCP3586 - Technical data

| Model number | X20CP3583 | X20CP3584 | X20cCP3584 | X20CP3585 | X20CP3586 | X20cCP3586 |
|--|--|---------------------------|------------|-----------|-------------------------|------------|
| Processor | | | | | | |
| Type | Atom E620T | | Atom E640T | | Atom E680T | |
| Clock frequency | 333 MHz | 0.6 GHz | | 1 GHz | 1.6 GHz | |
| L1 cache | | | | | | |
| Data code | 24 kB | | | | | |
| Program code | 32 kB | | | | | |
| L2 cache | - | 512 kB | | | | |
| Integrated I/O processor | Processes I/O data points in the background | | | | | |
| Modular interface slots | 3 | | | | | |
| Remanent variables | Max. 64 kB ⁴⁾ | Max. 256 kB ⁴⁾ | | | Max. 1 MB ⁴⁾ | |
| Shortest task class cycle time | 800 µs | 400 µs | | 200 µs | 100 µs | |
| Typical instruction cycle time | 0.01 µs | 0.0075 µs | | 0.0044 µs | 0.0027 µs | |
| Data buffering | | | | | | |
| Battery monitoring | Yes | | | | | |
| Lithium battery | Min. 2 years at 23°C ambient temperature | | | | | |
| Standard memory | | | | | | |
| RAM | 128 MB DDR2 SDRAM | 256 MB DDR2 SDRAM | | | 512 MB DDR2 SDRAM | |
| User RAM | 1 MB SRAM ⁵⁾ | | | | | |
| Interfaces | | | | | | |
| Interface IF1 | | | | | | |
| Signal | RS232 | | | | | |
| Variant | Connection made using 12-pin X20TB12 terminal block | | | | | |
| Max. distance | 900 m | | | | | |
| Transfer rate | Max. 115.2 kbit/s | | | | | |
| Interface IF2 | | | | | | |
| Signal | Ethernet | | | | | |
| Variant | 1x RJ45 shielded | | | | | |
| Cable length | Max. 100 m between 2 stations (segment length) | | | | | |
| Transfer rate | 10/100/1000 Mbit/s | | | | | |
| Transfer | | | | | | |
| Physical layer | 10BASE-T/100BASE-TX/1000BASE-T | | | | | |
| Half-duplex | Yes | | | | | |
| Full-duplex | Yes | | | | | |
| Autonegotiation | Yes | | | | | |
| Auto-MDI/MDIX | Yes | | | | | |
| Interface IF3 | | | | | | |
| Fieldbus | POWERLINK (V1/V2) managing or controlled node | | | | | |
| Type | Type 4 ⁶⁾ | | | | | |
| Variant | 1x RJ45 shielded | | | | | |
| Cable length | Max. 100 m between 2 stations (segment length) | | | | | |
| Transfer rate | 100 Mbit/s | | | | | |
| Transfer | | | | | | |
| Physical layer | 100BASE-TX | | | | | |
| Half-duplex | Yes | | | | | |
| Full-duplex | POWERLINK mode: No / Ethernet mode: Yes | | | | | |
| Autonegotiation | Yes | | | | | |
| Auto-MDI/MDIX | Yes | | | | | |
| Interface IF4 | | | | | | |
| Type | USB 1.1/2.0 | | | | | |
| Variant | Type A | | | | | |
| Max. output current | 0.5 A | | | | | |
| Interface IF5 | | | | | | |
| Type | USB 1.1/2.0 | | | | | |
| Variant | Type A | | | | | |
| Max. output current | 0.5 A | | | | | |
| Interface IF6 | | | | | | |
| Fieldbus | X2X Link master | | | | | |
| Electrical properties | | | | | | |
| Electrical isolation | Ethernet (IF2), POWERLINK (IF3) and X2X (IF6) isolated from each other, from other interfaces and from PLC | | | | | |
| Operating conditions | | | | | | |
| Mounting orientation | | | | | | |
| Horizontal | Yes | | | | | |
| Vertical | Yes | | | | | |
| Installation elevation above sea level | | | | | | |
| 0 to 2000 m | No limitations | | | | | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | | | | | |
| Degree of protection per EN 60529 | IP20 | | | | | |

Table 245: X20CP3583, X20CP3584, X20cCP3584, X20CP3585, X20CP3586, X20cCP3586 - Technical data


| Model number | X20CP3583 | X20CP3584 | X20cCP3584 | X20CP3585 | X20CP3586 | X20cCP3586 |
|---------------------------------|--|-----------|---------------------------|-----------|--------------------------|---------------------------|
| Ambient conditions | | | | | | |
| Temperature | | | | | | |
| Operation | | | | | | |
| Horizontal mounting orientation | -25 to 60°C | | | | | |
| Vertical mounting orientation | -25 to 50°C | | | | | |
| Derating | See section "Derating" | | | | | |
| Storage | -40 to 85°C | | | | | |
| Transport | -40 to 85°C | | | | | |
| Relative humidity | | | | | | |
| Operation | 5 to 95%, non-condensing | | Up to 100%, condensing | | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | | | | | |
| Transport | 5 to 95%, non-condensing | | | | | |
| Mechanical properties | | | | | | |
| Note | Order application memory (CompactFlash) separately Backup battery included in delivery X20 end cover plate (right) included in delivery X20 terminal block (12-pin) included in delivery Interface module slot covers included in delivery | | | | | |
| Dimensions | | | | | | |
| Width | 200 mm | | | | | |
| Height | 99 mm | | | | | |
| Depth | 85 mm | | | | | |
| Weight | 470 g | | | | | |

Table 245: X20CP3583, X20CP3584, X20cCP3584, X20CP3585, X20CP3586, X20cCP3586 - Technical data

- 1) The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) When operated at temperatures above 55°C, a derating of the nominal output power to 5 W for the X2X Link power supply must be taken into consideration.
- 3) In parallel operation, only 75% of the rated power can be assumed. It is important to make sure that all power supplies operated in parallel are switched on and off at the same time.
- 4) The size of the memory used for remanent variables is adjustable in Automation Studio.
- 5) 1 MB SRAM minus the configured remanent variables.
- 6) See Automation Help under "Communication / POWERLINK / General information / Hardware - IF/LS" for more information.

9.12.4.7 LED status indicators

9.12.4.7.1 X20 CPUs - LED status indicators

| Figure | LED | Color | Status | Description |
|---|--------|-----------|----------------------|--|
|  | R/E | Green | On | Application running |
| | | | Blinking | System startup boot mode: The CPU is initializing the application, all bus systems and I/O modules. ¹⁾ |
| | | | Double flash | Mode BOOT (during firmware update) ¹⁾ |
| | RDY/F | Red | On | Mode SERVICE |
| | | | Blinking | If LED "R/E" blinks red and LED "RDY/F" blinks yellow, a license violation has occurred. |
| | RDY/F | Yellow | On | Mode SERVICE or BOOT |
| | | | Blinking | If LED "RDY/F" blinks yellow and LED "R/E" blinks red, a license violation has occurred. |
| | S/E | Green/Red | | Status/Error LED. LED states are described in section " LED "S/E" (LED "Status/Error") " on page 1405. |
| | PLK | Green | On | The link to the POWERLINK remote station is established. |
| | | | Blinking | The link to the POWERLINK remote station is established. The LED blinks if Ethernet activity is taking place on the bus. |
| | ETH | Green | On | The link to the Ethernet remote station is established. |
| | | | Blinking | The link to the Ethernet remote station is established. The LED blinks if Ethernet activity is taking place on the bus. |
| | CF | Green | On | CompactFlash inserted and detected |
| | | Yellow | On | CompactFlash read/write access |
| DC | Yellow | On | CPU power supply OK | |
| | Red | On | Backup battery empty | |

- 1) This process can take several minutes depending on the configuration.

9.12.4.7.1.1 LED "S/E" (LED "Status/Error")

This LED is a green/red dual LED and indicates the state of the POWERLINK interface. The LED states have a different meaning depending on the operating mode of the POWERLINK interface.

Ethernet mode

In this mode, the interface is operated as an Ethernet interface.

| LED "S/E" | | Description |
|-----------|-----|---|
| Green | Red | |
| On | Off | The interface is operated as an Ethernet interface. |

Table: LED "S/E": Interface in Ethernet mode

POWERLINK V1 mode

| LED "S/E" | | Current state of the POWERLINK node |
|----------------------|----------|--|
| Green | Red | |
| On | Off | The POWERLINK node is running with no errors. |
| Off | On | A system error occurred. The type of error can be read using the PLC logbook. An irreparable problem has occurred. The system can no longer properly carry out its tasks. This state can only be changed by resetting the module. |
| Blinking alternately | | The POWERLINK managing node has failed. This error code can only occur when operated as a controlled node. This means that the set node number lies within the range 0x01 - 0xFD. |
| Off | Blinking | System stop. The red blinking LED indicates an error code (see "System stop error codes" on page 1407). |
| Off | Off | The interface is either not active or one of the following states or errors is present: <ul style="list-style-type: none"> • The device is switched off. • The device is in the startup phase. • The interface or device is not configured correctly in Automation Studio. • The interface or device is defective. |

Table 246: LED "S/E": POWERLINK V1 mode

POWERLINK V2 mode

Error message

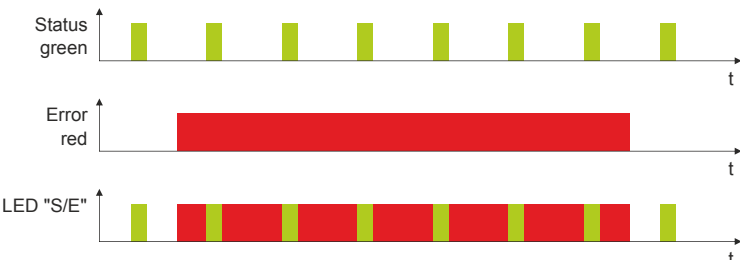
| LED "S/E" | | Description |
|-----------|-----|--|
| Green | Red | |
| Off | On | The interface is in error mode (failed Ethernet frames, increased number of collisions on the network, etc.). Note: Several red blinking signals are displayed immediately after the device is switched on. These are not errors, however. |
| Blinking | On | If an error occurs in the following modes, then the green LED blinks over the red LED: <ul style="list-style-type: none"> • PRE_OPERATIONAL_1 • PRE_OPERATIONAL_2 • READY_TO_OPERATE  |

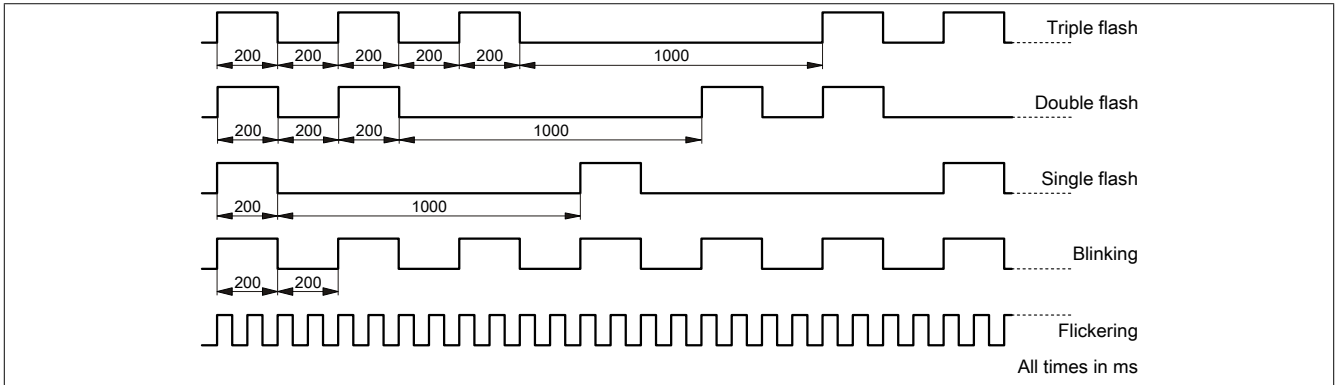
Table: LED "S/E" - Error message (interface in POWERLINK mode)

Interface status

| LED "S/E" | | Description |
|-----------------------------|-----|--|
| Green | Red | |
| Off | Off | <p>Mode: NOT_ACTIVE The interface is either in mode NOT_ACTIVE or one of the following modes or errors is present:</p> <ul style="list-style-type: none"> The device is switched off. The device is in the startup phase. The interface or device is not configured correctly in Automation Studio. The interface or device is defective. <p>Managing node (MN) The network is monitored for POWERLINK frames. If a frame is not received within the configured time window (timeout), the interface immediately enters mode PRE_OPERATIONAL_1. If POWERLINK communication is detected before the time has elapsed, however, the MN is not started.</p> <p>Controlled node (CN) The network is monitored for POWERLINK frames. If a frame is not received within the configured time window (timeout), the interface immediately enters mode BASIC_ETHERNET. If POWERLINK communication is detected before this time expires, however, the interface immediately enters mode PRE_OPERATIONAL_1.</p> |
| Flickering (approx. 10 Hz) | Off | <p>Mode: BASIC_ETHERNET The interface is in mode BASIC_ETHERNET. The interface is operated in Ethernet mode.</p> <p>Managing node (MN) This mode can only be exited by resetting the controller.</p> <p>Controlled node (CN) If POWERLINK communication is detected during this mode, the interface enters mode PRE_OPERATIONAL_1.</p> |
| Single flash (approx. 1 Hz) | Off | <p>Mode: PRE_OPERATIONAL_1 The interface is in mode PRE_OPERATIONAL_1.</p> <p>Managing node (MN) The MN is in "reduced cycle" operation. The CNs are configured in this mode. Cyclic communication is not yet taking place.</p> <p>Controlled node (CN) The CN can be configured by the MN in this mode. The CN waits until it receives an SoC frame and then switches to mode PRE_OPERATIONAL_2.</p> |
| | On | <p>Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed.</p> |
| Double flash (approx. 1 Hz) | Off | <p>Mode: PRE_OPERATIONAL_2 The interface is in mode PRE_OPERATIONAL_2.</p> <p>Managing node (MN) The MN starts cyclic communication (cyclic input data is not yet evaluated). The CNs are configured in this mode.</p> <p>Controlled node (CN) The CN can be configured by the MN in this mode. A command then switches the mode to READY_TO_OPERATE.</p> |
| | On | <p>Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed.</p> |
| Triple flash (approx. 1 Hz) | Off | <p>Mode: READY_TO_OPERATE The interface is in mode READY_TO_OPERATE.</p> <p>Managing node (MN) Cyclic and asynchronous communication. Received PDO data is ignored.</p> <p>Controlled node (CN) The configuration of the CN is completed. Normal cyclic and asynchronous communication. The transmitted PDO data corresponds to the PDO mapping. However, cyclic data is not yet evaluated.</p> |
| | On | <p>Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed.</p> |
| On | Off | <p>Mode: OPERATIONAL The interface is in mode OPERATIONAL. PDO mapping is active and cyclic data is evaluated.</p> |
| Blinking (approx. 2.5 Hz) | Off | <p>Mode: STOPPED The interface is in mode STOPPED.</p> <p>Managing node (MN) This mode does not occur for the MN.</p> <p>Controlled node (CN) Output data is not being output, and no input data is being provided. This mode can only be reached and exited by a corresponding command from the MN.</p> |

Table: LED "S/E" - Interface state (interface in POWERLINK mode)

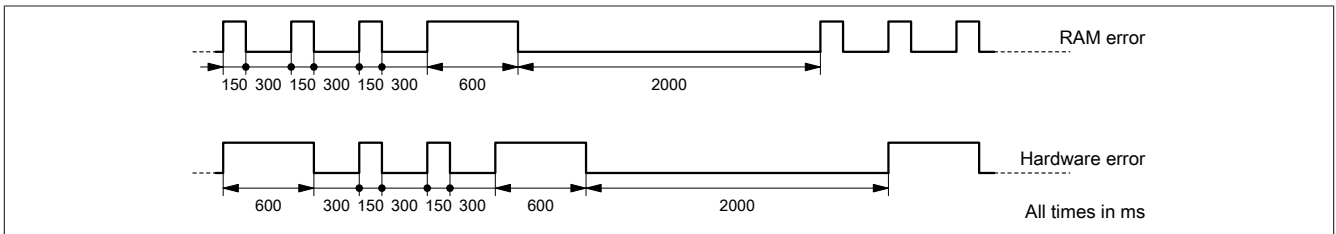
Blink times



9.12.4.7.1.2 System stop error codes

A system stop error can occur due to incorrect configuration or defective hardware.

The error code is indicated by LED "S/E" blinking red. The blinking signal of the error code consists of 4 switch-on phases with short (150 ms) or long (600 ms) duration. The error code is repeated every 2 seconds.



| Error | Error description |
|----------------|---|
| RAM error | The device is defective and must be replaced. |
| Hardware error | The device or a system component is defective and must be replaced. |

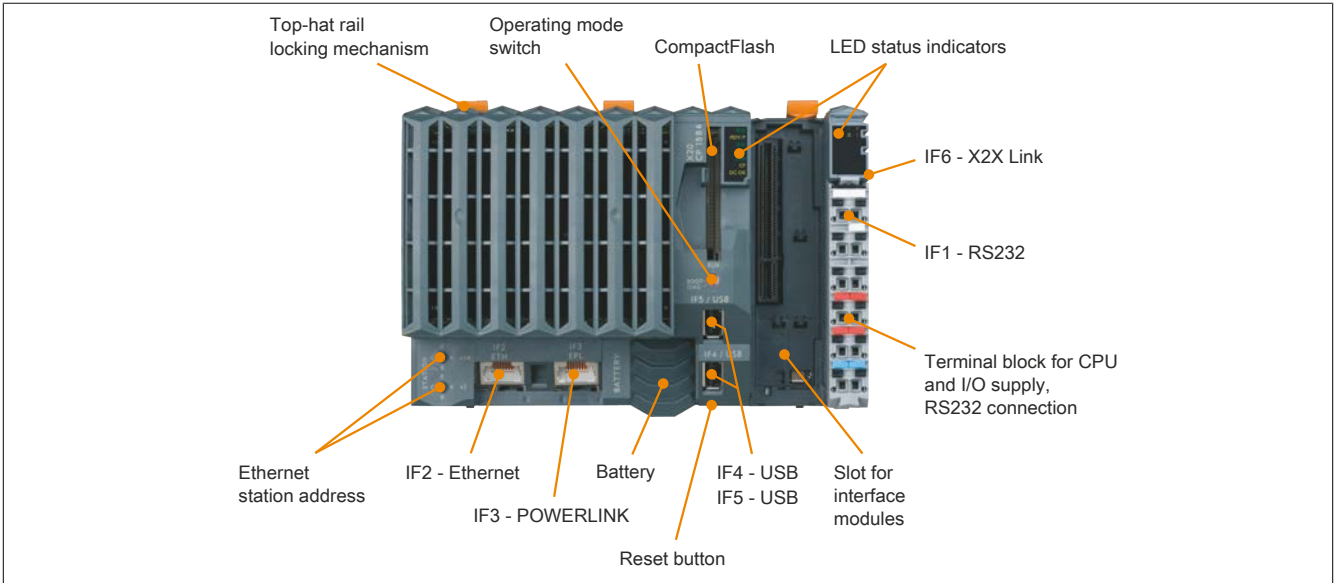
9.12.4.7.2 LED status indicators for the integrated power supply

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

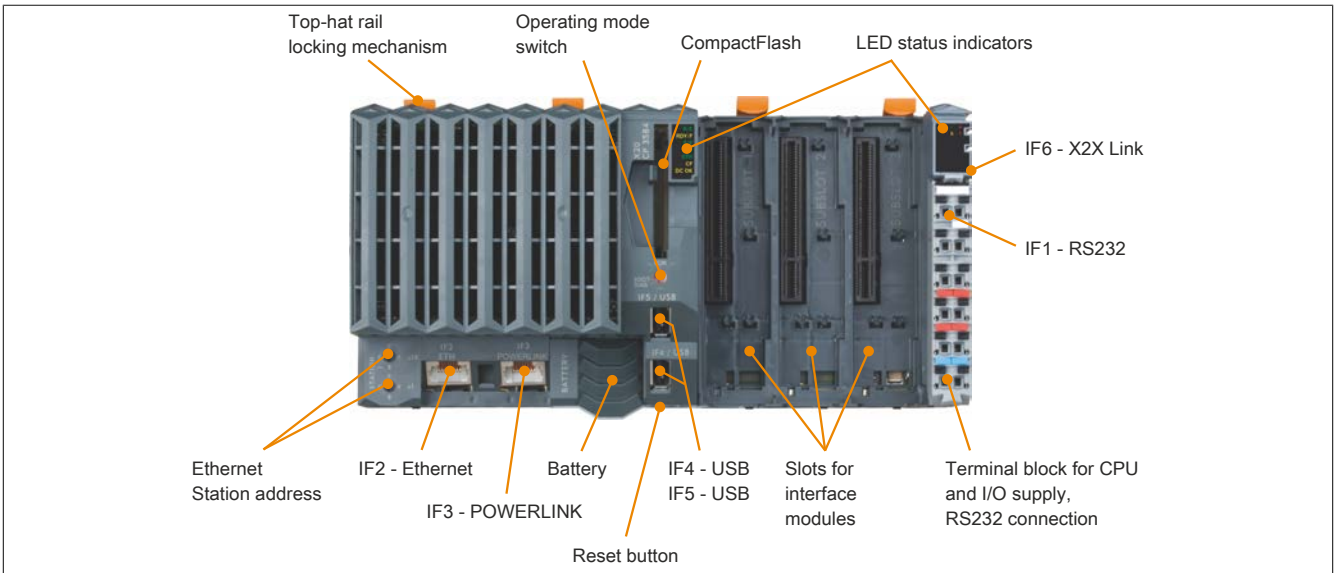
| Figure | LED | Color | Status | Description |
|--------|-------|--------------------------------|--|--|
| | r | Green | Off | No power to module |
| | | | Single flash | Mode RESET |
| | | | Blinking | Mode PREOPERATIONAL |
| | | | On | Mode RUN |
| | e | Red | Off | Module not supplied with power or everything OK |
| | | | Double flash | The LED indicates one of the following states: <ul style="list-style-type: none"> The X2X Link power supply of the power supply is overloaded. I/O power supply too low The input voltage for the X2X Link power supply is too low. |
| | e + r | Solid red / Single green flash | Invalid firmware | |
| | S | Yellow | Off | No RS232 activity |
| | | | On | The LED lights up when data is being transmitted or received via the RS232 interface. |
| | l | Red | Off | The X2X Link power supply is within the valid range. |
| On | | | The X2X Link power supply of the power supply is overloaded. | |

9.12.4.8 Operating and connection elements

X20CP158x



X20CP358x



9.12.4.8.1 Operating mode switch

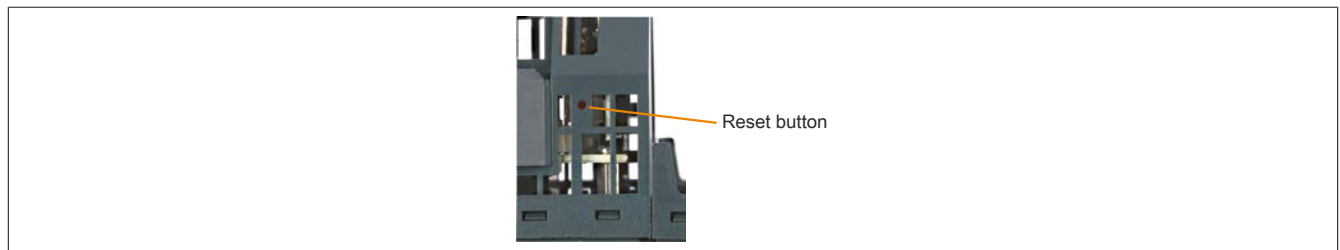
The operating mode switch is used to set the operating mode.



| Switch position | Operating mode | Description |
|-----------------|----------------|--|
| BOOT | BOOT | In this switch position, Boot AR is started and the runtime system can be installed via the online interface (B&R Automation Studio). User flash memory is erased only when the download begins. |
| RUN | RUN | Mode RUN |
| DIAG | DIAGNOSE | The CPU boots in diagnostic mode. Program sections in User RAM and User FlashPROM are not initialized. After diagnostic mode, the CPU always boots with a warm restart. |

Table 247: X20 CPUs - Operating mode

9.12.4.8.2 Reset button



The reset button is located below the USB interfaces on the bottom of the housing. It can be pressed with any small pointed object (e.g. paper clip). Pressing the reset button triggers a hardware reset, which means:

- All application programs are stopped.
- All outputs are set to zero.

The PLC then starts up in service mode by default. The startup mode that follows after pressing the reset button can be set in Automation Studio.

9.12.4.8.3 Slot for application memory

Program memory is required to operate the CPUs. The application memory is provided in the form of a CompactFlash card. It is not included with the CPUs, but must be ordered separately as an accessory.

Information:

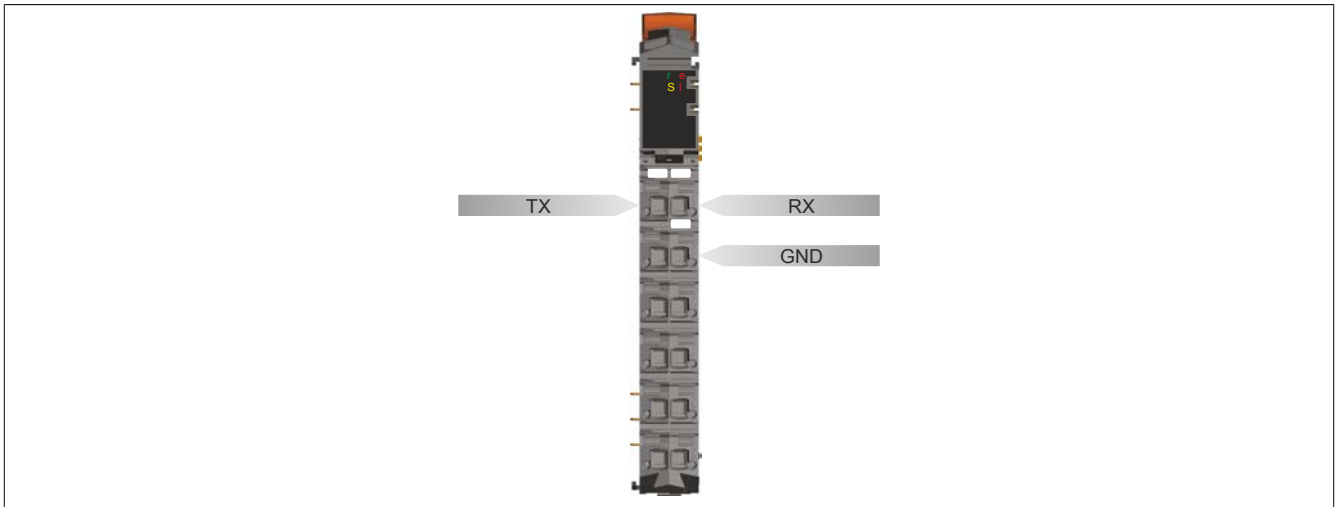
The CompactFlash card must not be removed during operation.

9.12.4.8.4 Project installation

Project installation is described in Automation Help under "Project management / Project installation".

9.12.4.8.5 RS232 interface (IF1)

The non-electrically isolated RS232 interface is designed as an online interface for communication with the programming device.



9.12.4.8.6 Ethernet interface (IF2)



The IF2 is executed as the 10 BASE-T / 100 BASE-TX / 1000 BASE-T gigabit Ethernet interface.

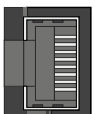
The INA2000 station number of the Ethernet interface is set using the two hex switches.

For information about wiring X20 modules with an Ethernet interface, see ["Cabling guidelines for X20 modules with an Ethernet cable"](#) on page 58.

Information:

The Ethernet interface (IF2) is not suitable for POWERLINK (see ["POWERLINK interface \(IF3\)"](#) on page 1411).

Pinout

| Interface | Pinout | | |
|---|--------|----------|---------|
| | Pin | Ethernet | |
|  Shielded RJ45 port | 1 | D1+ | Data 1+ |
| | 2 | D1- | Data 1- |
| | 3 | D2+ | Data 2+ |
| | 4 | D3+ | Data 3+ |
| | 5 | D3- | Data 3- |
| | 6 | D2- | Data 2- |
| | 7 | D4+ | Data 4+ |
| | 8 | D4- | Data 4- |

9.12.4.8.7 POWERLINK interface (IF3)

The CPUs are equipped with a POWERLINK V1/V2 interface.

POWERLINK V1

By default, the POWERLINK interface is operated as a managing node (MN). In the managing node, the node number is set to a fixed value of 0.

If the POWERLINK node is operated as a controlled node (CN), a node number from 1 to 253 can be set in the POWERLINK configuration in Automation Studio.

POWERLINK V2

Setting in Automation Studio

By default, the POWERLINK interface is operated as a managing node (MN). In the managing node, the node number is set to a fixed value of 240.

If the POWERLINK node is operated as a controlled node (CN), a node number from 1 to 239 can be set in the POWERLINK configuration in Automation Studio.

Setting with hex switches

The POWERLINK node number can also be set with the two onboard hex switches. These are normally used to set the INA2000 station number of the Ethernet interface. Switching takes place in the POWERLINK configuration in Automation Studio.

Node numbers from 0x01 to 0xF0 are permitted.

| Switch position | Description |
|-----------------|---|
| 0x00 | Reserved, switch position not permitted. |
| 0x01 - 0xEF | Node number of the POWERLINK node. Operation as a controlled node (CN). |
| 0xF0 | Operation as a managing node (MN). |
| 0xF1 - 0xFF | Reserved, switch position not permitted. |

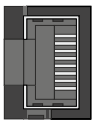
Ethernet mode

In this mode, the interface is operated as an Ethernet interface. The INA2000 station number is set using the B&R Automation Studio software.

Pinout



For information about wiring X20 modules with an Ethernet interface, see ["Cabling guidelines for X20 modules with an Ethernet cable" on page 58](#).

| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.12.4.8.8 USB interfaces (IF4 and IF5)



IF4 and IF5 are non-galvanically isolated USB interfaces. The connection is made via a USB interface (1.1/2.0). The USB interfaces can only be used for devices approved by B&R (e.g. floppy disk drive, DiskOnKey or dongle).

Information:

- The USB interfaces cannot be used as online communication interfaces.
- Only devices isolated from GND are permitted to be connected to the USB interfaces.
- Current-carrying capacity is listed in the technical data.

9.12.4.8.9 Slots for interface modules

The CPUs have one or three slots for interface modules.

Different bus or network systems can be flexibly integrated into the X20 system by selecting the appropriate interface module.

9.12.4.8.10 Battery

The CPUs are equipped with a lithium battery. The lithium battery is located in a separate compartment and protected by a cover.

Backup battery data

| | |
|---------------------|---|
| Model number | |
| 4A0006.00-000 | 1 pcs. |
| 0AC201.91 | 4 pcs. |
| Short description | Lithium battery, 3 V / 950 mAh, button cell |
| Storage temperature | -40 to 85°C |
| Storage time | Max. 3 years at 30°C |
| Relative humidity | 0 to 95% (non-condensing) |

The following areas are buffered:

- Remanent variables
- User RAM
- System RAM
- Real-time clock

Battery monitoring

The battery voltage is checked cyclically. The cyclic load test of the battery does not considerably shorten its service life; instead, it gives an early warning of weakened buffer capacity.

Status information "Battery OK" is available from system library function "BatteryInfo" and the CPU's I/O mapping.

Replacement interval for battery

The battery should be replaced every 4 years. The replacement intervals recommended by B&R reflect the batteries' average service life and operating conditions. They do not correspond to the maximum buffer duration!

Important information about the battery exchange

The product design allows the battery to be changed with the PLC switched either on or off. In some countries, safety regulations do not allow batteries to be changed while the module is switched on. To prevent data loss, the battery must be changed within 1 min. with the power off.

Warning!

The battery is only permitted to be replaced by a Renata CR2477N battery. The use of another battery may present a fire or explosion hazard.

The battery can explode if handled improperly. Do not recharge, disassemble or dispose of the battery in fire.

Procedure for replacing the battery

1. Perform electrostatic discharge at the top-hat rail or at the ground connection (do not reach into the power supply!)
2. Remove the cover for the lithium battery. Do this by sliding it down and away from the CPU.

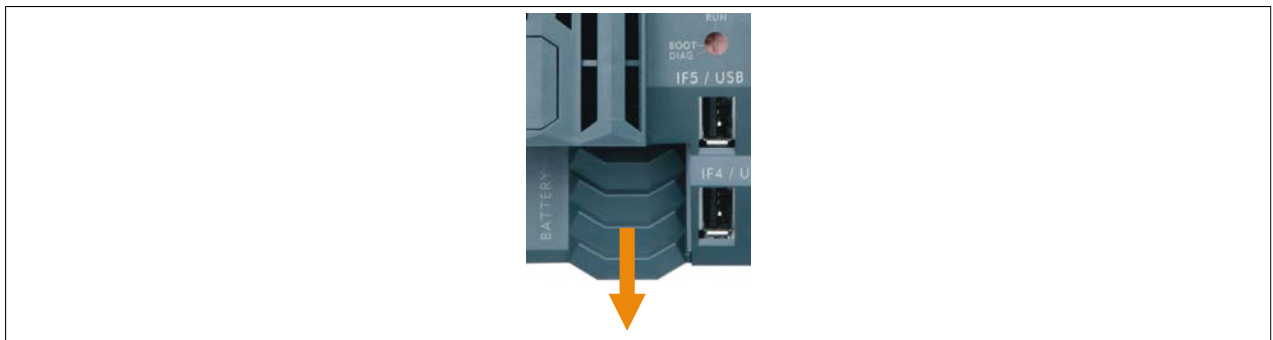


Figure 156: X20 CPUs - Remove lithium battery cover

3. Push the empty battery out of the holder.
4. It is important to ensure that the new battery is not handled with moist or greasy fingers. Plastic tweezers can also be used. Do not touch the battery with pliers or metal tweezers → short circuit!
5. To insert the battery into the holder, place it with the "+" side up on the right part of the battery holder. Then press the battery into the battery holder.
6. Replace the cover.

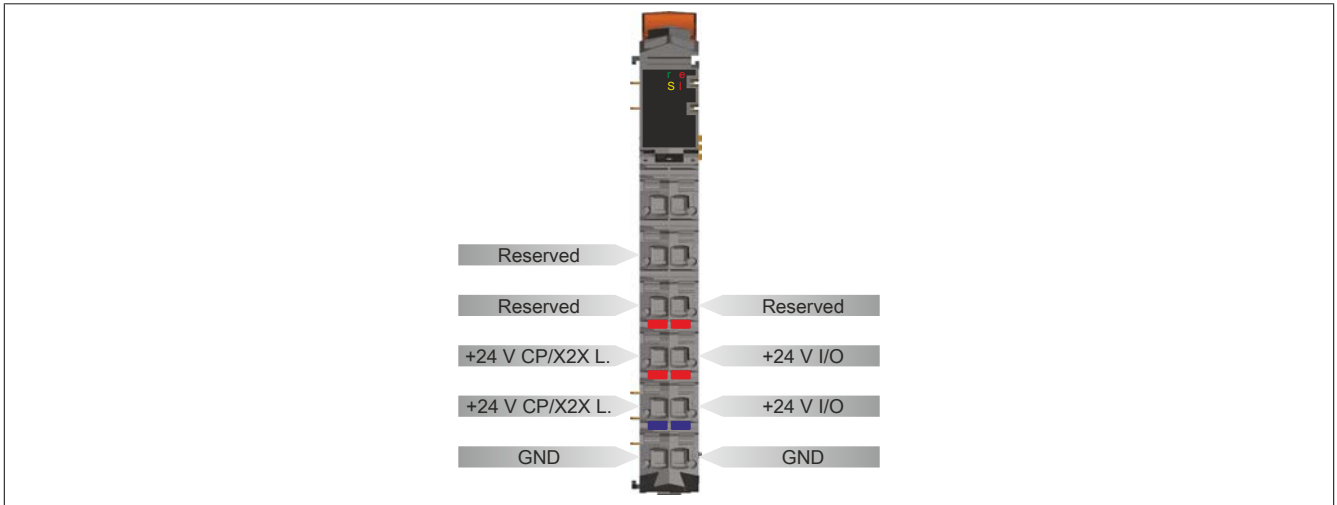
Information:

Lithium batteries are hazardous waste. Used batteries should be disposed of in accordance with applicable local regulations.

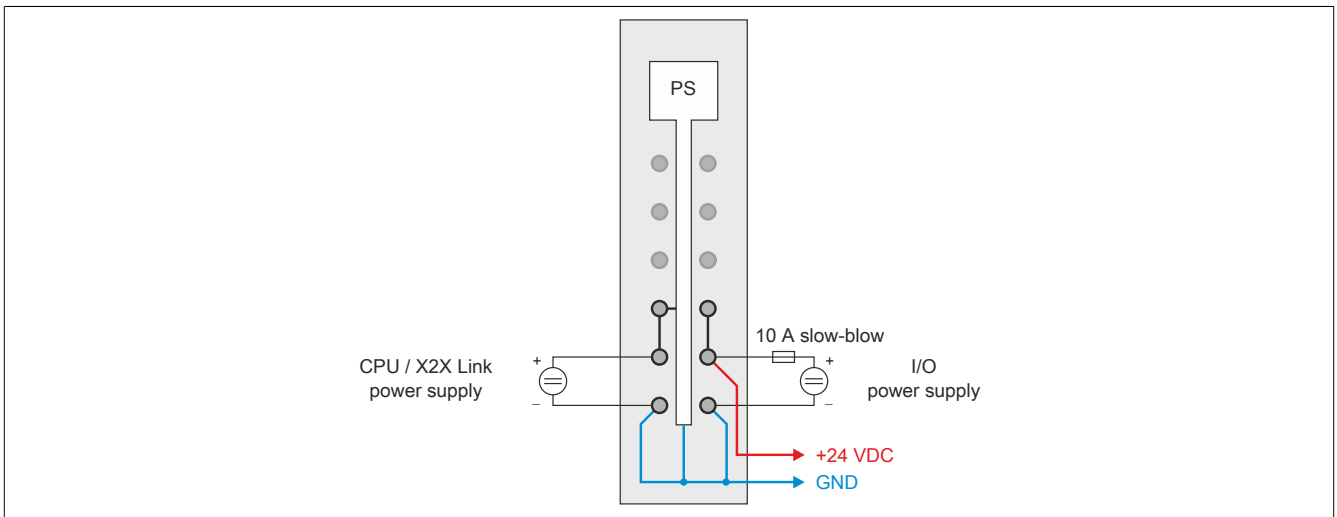
9.12.4.9 CPU power supply

A power supply is integrated in the X20 CPUs. It is equipped with a supply for the CPU, X2X Link and the internal I/O power supply. The bus power supply and internal I/O power supply are galvanically isolated from each other.

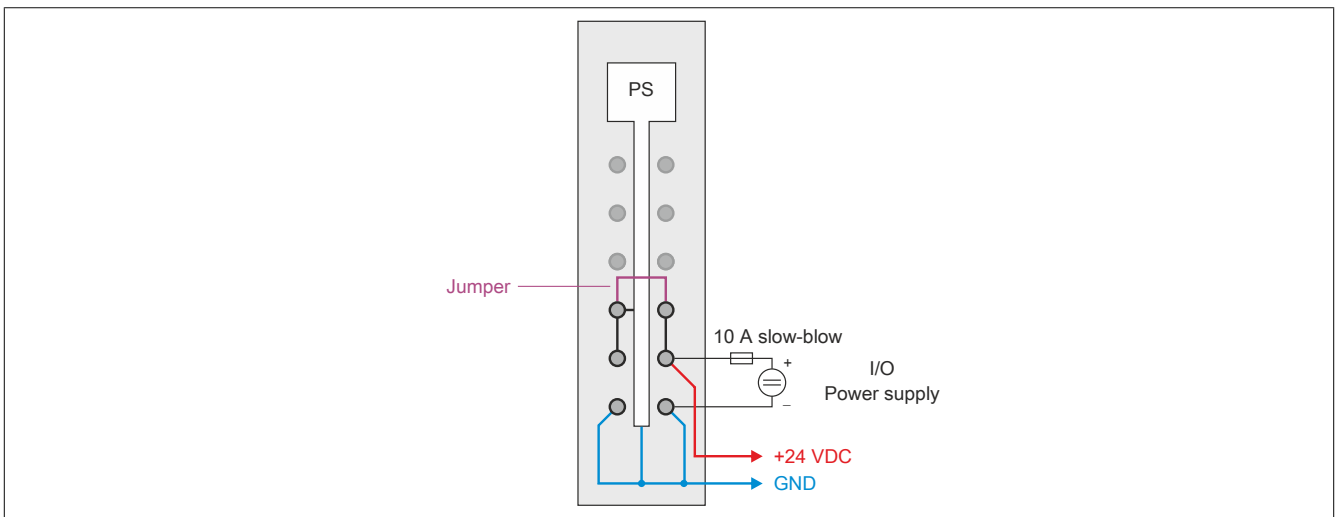
Integrated power supply - Pinout



Connection example with 2 separate supplies

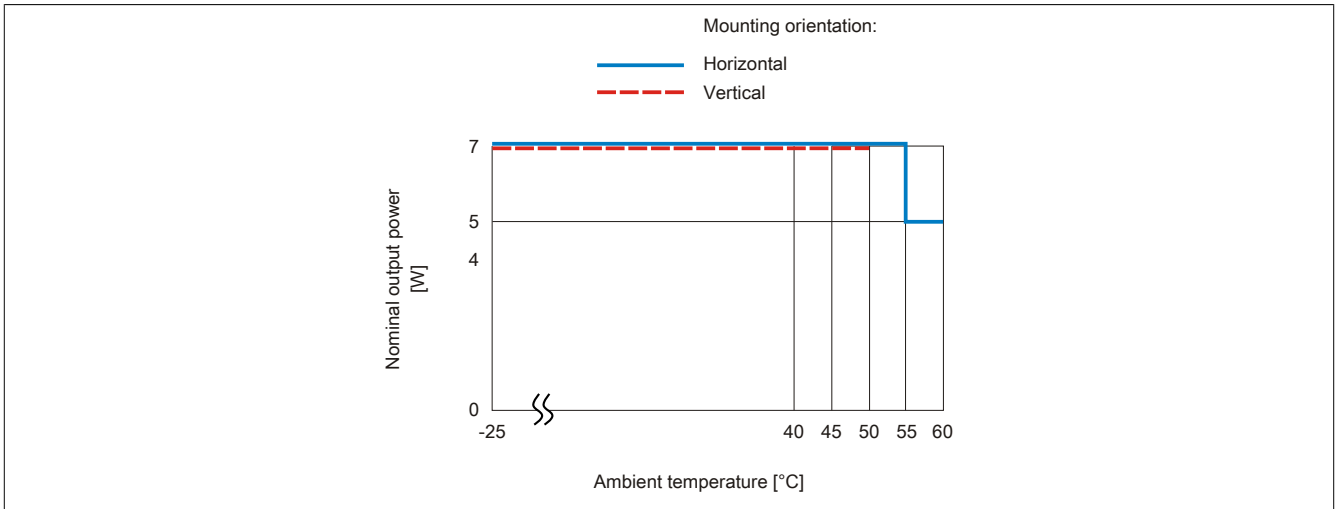


Connection example with power supply and jumper



9.12.4.10 Derating

There is no derating when operated below 55°C. Above 55°C, the nominal output power for the X2X Link power supply must be reduced to 5 W.



9.12.4.11 Overtemperature shutdown

To prevent damage, the CPU is switched off - reset state - at 110°C processor temperature or 95°C board temperature.

The following errors are entered in the logbook in the event of shutdown:

| Error number | Short error text |
|--------------|--|
| 9204 | PLC restart triggered by the PLC CPU's temperature monitoring. |
| 9210 | Warning: Halt/Service after watchdog or manual reset. |

9.12.4.12 Information about migrating from the X20CPx48x to the X20CPx58x

- A hardware upgrade is required for some X20 IFxxxx interface modules. This can be installed from Automation Studio by selecting **Tools / Upgrades** from the menu. In addition, a certain hardware revision is required for some modules. The following table provides an overview:

| Order number | Minimum upgrade version | Minimum hardware revision |
|--------------|-------------------------|---------------------------|
| X20IF1020 | 1.1.5.1 | H0 |
| X20IF1030 | 1.1.5.1 | I0 |
| X20IF1041-1 | - | - |
| X20IF1043-1 | - | - |
| X20IF1051-1 | - | - |
| X20IF1053-1 | - | - |
| X20IF1061 | - | E0 |
| X20IF1061-1 | - | - |
| X20IF1063 | 1.1.5.0 | - |
| X20IF1063-1 | - | - |
| X20IF1065 | - | - |
| X20IF1072 | 1.0.5.1 | - |
| X20IF1082 | 1.2.2.0 | - |
| X20IF1082-2 | 1.2.1.0 | - |
| X20IF1086-2 | 1.1.1.0 | - |
| X20IF1091 | 1.0.5.1 | - |
| X20IF10A1-1 | - | - |
| X20IF10D1-1 | - | - |
| X20IF10D3-1 | - | - |
| X20IF10E1-1 | - | - |
| X20IF10E3-1 | - | - |
| X20IF10G3-1 | - | - |
| X20IF10H3-1 | - | - |
| X20IF2772 | 1.0.6.1 | - |
| X20IF2792 | 1.0.5.1 | - |

Table 248: X20 CPUs - Minimum upgrade version and minimum hardware revision for X20 IFxxxx interface modules

- X20CPx58x CPUs are supported starting with B&R Automation Studio V3.0.90.20.
- If an X20CPx48x should be replaced by an X20CPx58x in an existing Automation Studio configuration, the X20CPx58x may not be listed as one of the available options even though the upgrade for the CPU has already been installed. In such a case, an upgrade of the X20CPx48x is required.
- Starting with Automation Runtime 4.x, USB devices are integrated in Automation Runtime dynamically so that they no longer must be configured in Automation Studio. In order to use a USB device, its internal device name must be obtained at runtime. For an example, see Automation Help for the library "AsUSB / Examples".

9.12.4.13 General data points

This CPU is equipped with general data points. These are not CPU-specific; instead, they contain general information such as system time and heat sink temperature.

General data points are described in section ["General CPU data points" on page 3792](#).

9.12.5 X20CP168x(X) and X20CP368x(X)

Data sheet version: 1.00

9.12.5.1 General information

This CPU is based on Intel Atom processor technology and used for applications with the highest performance requirements. It rounds off the top end of the X20 CPU product family.

Base equipment includes USB, Ethernet, POWERLINK V2, flash drive and removable CompactFlash. The standard Ethernet interface is capable of handling gigabit communication. For even more real-time network performance, the onboard POWERLINK interface supports poll-response chaining mode (PRC).

Up to 3 more slots are available for additional interface modules to increase flexibility.

- Intel Atom processor with 400 MHz (compatible) to 1.6 GHz with integrated I/O processor
- Ethernet, POWERLINK V2 with poll-response chaining and onboard USB
- 1 or 3 slots for modular interface expansion
- CompactFlash as removable application memory
- 512 MB to 2 GB LPDDR4 SDRAM
- 1 to 2 GB onboard flash drive
- Controller redundancy possible
- Fanless

9.12.5.2 X20CP168x(X) - Order data



| Model number | Short description |
|-----------------------------|---|
| X20 CPUs | |
| X20CP1684 | X20 CPU, Atom 0.4 GHz (compatible), 512 MB DDR4 RAM, 1 MB SRAM, 1 GB onboard flash drive, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! |
| X20CP1685 | X20 CPU, Atom 0.8 GHz, 512 MB DDR4 RAM, 1 MB SRAM, 1 GB onboard flash drive, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! |
| X20CP1686X | X20 CPU, Atom 1.3 GHz, 1 GB DDR4 RAM, 1 MB SRAM, 2 GB onboard flash drive, removable application memory: CompactFlash, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot cover and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! |
| Required accessories | |
| CompactFlash cards | |
| 0CFCRD.0512E.01 | CompactFlash 512 MB extended temp. |
| 0CFCRD.2048E.01 | CompactFlash 2048 MB extended temp. |
| 5CFCRD.016G-06 | CompactFlash 16 GB B&R (SLC) |
| 5CFCRD.032G-06 | CompactFlash 32 GB B&R (SLC) |
| 5CFCRD.0512-06 | CompactFlash 512 MB B&R (SLC) |
| 5CFCRD.1024-06 | CompactFlash 1 GB B&R (SLC) |
| 5CFCRD.2048-06 | CompactFlash 2 GB B&R (SLC) |
| 5CFCRD.4096-06 | CompactFlash 4 GB B&R (SLC) |
| 5CFCRD.8192-06 | CompactFlash 8 GB B&R (SLC) |
| Optional accessories | |
| Batteries | |
| 0AC201.91 | Lithium batteries 4 pcs., 3 V / 950 mAh button cell |
| 4A0006.00-000 | Lithium battery, 3 V / 950 mAh, button cell |

Table 249: X20CP168x(X) - Order data

Included in delivery

| Order number | Short description |
|---------------|--|
| 4A0006.00-000 | Backup battery (see also "Battery" on page 1434) |
| - | Interface module slot covers |
| X20AC0SR1 | X20 end cover plate (right) |
| X20TB12 | X20 terminal block, 12-pin, 24 V coding |

Table 250: X20 CPUs - Content of delivery

9.12.5.3 X20CP168x(X) - Technical data

| Model number | X20CP1684 | X20CP1685 | X20CP1686X |
|--|---|-----------|-------------------------|
| Short description | | | |
| Interfaces | 1x RS232, 1x Ethernet, 1x POWERLINK (V2), 2x USB, 1x X2X Link | | |
| System module | CPU | | |
| General information | | | |
| Cooling | Fanless | | |
| B&R ID code | 0xF9EA | 0xF9EB | 0xF9EC |
| Status indicators | CPU function, overtemperature, Ethernet, POWERLINK, CompactFlash, battery | | |
| Diagnostics | | | |
| Battery | Yes, using LED status indicator and software | | |
| CPU function | Yes, using LED status indicator | | |
| CompactFlash | Yes, using LED status indicator | | |
| Ethernet | Yes, using LED status indicator | | |
| POWERLINK | Yes, using LED status indicator | | |
| Overtemperature | Yes, using LED status indicator | | |
| Controller redundancy possible | Yes | | |
| ACOPOS support | Yes | | |
| Visual Components support | Yes | | |
| Power consumption without interface module and USB | 6.9 W | | 7.5 W |
| Power consumption for X2X Link power supply ¹⁾ | 1.42 W | | |
| Power consumption ¹⁾ | | | |
| Internal I/O | 0.6 W | | |
| Additional power dissipation caused by actuators (resistive) [W] | - | | |
| Certifications | | | |
| CE | In preparation | | |
| CPU and X2X Link power supply | | | |
| Input voltage | 24 VDC -15% / +20% | | |
| Input current | Max. 1.5 A | | |
| Fuse | Integrated, cannot be replaced | | |
| Reverse polarity protection | Yes | | |
| X2X Link power supply output | | | |
| Nominal output power | 7 W ²⁾ | | |
| Parallel connection | Yes ³⁾ | | |
| Redundant operation | Yes | | |
| Input I/O power supply | | | |
| Input voltage | 24 VDC -15% / +20% | | |
| Fuse | Required line fuse: Max. 10 A, slow-blow | | |
| Output I/O power supply | | | |
| Nominal output voltage | 24 VDC | | |
| Permissible contact load | 10 A | | |
| Power supply - General information | | | |
| Status indicators | Overload, operating status, module status, RS232 data transfer | | |
| Diagnostics | | | |
| RS232 data transfer | Yes, using LED status indicator | | |
| Module run/error | Yes, using LED status indicator and software | | |
| Overload | Yes, using LED status indicator and software | | |
| Electrical isolation | | | |
| I/O supply - I/O power supply | No | | |
| CPU/X2X Link supply - CPU/X2X Link power supply | Yes | | |
| Controller | | | |
| CompactFlash slot | 1 | | |
| Real-time clock | Nonvolatile, resolution 1 s, -10 to 10 ppm accuracy at 25°C | | |
| FPU | Yes | | |
| Processor | | | |
| Type | Atom E3915 | | Atom E3930 |
| Clock frequency | 400 MHz (compatible). | 800 MHz | 1.3 GHz |
| L1 cache | | | |
| Data code | 24 kB | | |
| Program code | 32 kB | | |
| L2 cache | | | |
| | 1 MB | | |
| Integrated I/O processor | Processes I/O data points in the background | | |
| Modular interface slots | 3 | | |
| Remanent variables | Max. 512 kB ⁴⁾ | | Max. 1 MB ⁴⁾ |
| Shortest task class cycle time | 400 µs | 200 µs | 100 µs |
| Typical instruction cycle time | 0.0044 µs | 0.0028 µs | 0.0015 µs |
| Data buffering | | | |
| Battery monitoring | Yes | | |
| Lithium battery | During operation: 4 years CPU switched off: Min. 2 years at 23°C ambient temperature | | |

Table 251: X20CP168x(X) - Technical data

| Model number | X20CP1684 | X20CP1685 | X20CP1686X |
|---|--|-----------|------------------------|
| Standard memory | | | |
| RAM | 512 MB LPDDR4 SDRAM | | 1 GB LPDDR4 SDRAM |
| User RAM | 1 MB SRAM ⁵⁾ | | |
| Application memory | | | |
| Type | 1 GB eMMC flash memory | | 2 GB eMMC flash memory |
| Data retention | 10 years | | |
| Writable data amount | | | |
| Guaranteed | 40 TB | | |
| Results for 5 years | 21.9 GB/day | | |
| Guaranteed erase/write cycles | 20,000 | | |
| Error-correcting code (ECC) | Yes | | |
| Interfaces | | | |
| Interface IF1 | | | |
| Signal | RS232 | | |
| Variant | Connection made using 12-pin terminal block X20TB12 | | |
| Max. distance | 900 m | | |
| Transfer rate | Max. 115.2 kbit/s | | |
| Interface IF2 | | | |
| Signal | Ethernet | | |
| Variant | 1x RJ45 shielded | | |
| Cable length | Max. 100 m between 2 stations (segment length) | | |
| Transfer rate | 10/100/1000 Mbit/s | | |
| Transfer | | | |
| Physical layer | 10BASE-T/100BASE-TX/1000BASE-T | | |
| Half-duplex | Yes | | |
| Full-duplex | Yes | | |
| Autonegotiation | Yes | | |
| Auto-MDI/MDIX | Yes | | |
| Interface IF3 | | | |
| Fieldbus | POWERLINK (V2) managing or controlled node | | |
| Type | Type 4 ⁶⁾ | | |
| Variant | 1x RJ45 shielded | | |
| Cable length | Max. 100 m between 2 stations (segment length) | | |
| Transfer rate | 100 Mbit/s | | |
| Transfer | | | |
| Physical layer | 100BASE-TX | | |
| Half-duplex | Yes | | |
| Full-duplex | POWERLINK mode: No / Ethernet mode: Yes | | |
| Autonegotiation | Yes | | |
| Auto-MDI/MDIX | Yes | | |
| Interface IF4 | | | |
| Type | USB 1.1/2.0 | | |
| Variant | Type A | | |
| Max. output current | 0.5 A | | |
| Interface IF5 | | | |
| Type | USB 1.1/2.0 | | |
| Variant | Type A | | |
| Max. output current | 0.5 A | | |
| Interface IF6 | | | |
| Fieldbus | X2X Link master | | |
| Electrical properties | | | |
| Electrical isolation | Ethernet (IF2), POWERLINK (IF3) and X2X (IF6) isolated from each other, from other interfaces and from PLC | | |
| Operating conditions | | | |
| Mounting orientation | | | |
| Horizontal | Yes | | |
| Vertical | Yes | | |
| Installation elevation above sea level | | | |
| 0 to 2000 m | No limitation | | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | | |
| Degree of protection per EN 60529 | IP20 | | |
| Ambient conditions | | | |
| Temperature | | | |
| Operation | | | |
| Horizontal mounting orientation | -25 to 60°C | | |
| Vertical mounting orientation | -25 to 50°C | | |
| Derating | See section "Derating". | | |
| Storage | -40 to 70°C | | |
| Transport | -40 to 70°C | | |
| Relative humidity | | | |
| Operation | 5 to 95%, non-condensing | | |
| Storage | 5 to 95%, non-condensing | | |
| Transport | 5 to 95%, non-condensing | | |

Table 251: X20CP168x(X) - Technical data

| Model number | X20CP1684 | X20CP1685 | X20CP1686X |
|------------------------------|---|-----------|------------|
| Mechanical properties | | | |
| Note | Order application memory (CompactFlash) separately. Backup battery included in delivery X20 end cover plate (right) included in delivery 12-pin X20 terminal block included in delivery Interface module slot covers included in delivery | | |
| Dimensions | | | |
| Width | 150 mm | | |
| Height | 99 mm | | |
| Depth | 85 mm | | |
| Weight | 480 g ⁷⁾ | | |

Table 251: X20CP168x(X) - Technical data

- 1) The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) When operated at temperatures above 55°C, a derating of the nominal output power to 5 W for the X2X Link power supply must be taken into account.
- 3) In parallel operation, it is only permitted to expect 75% of the nominal power. It is important to make sure that all power supplies operated in parallel are switched on and off at the same time.
- 4) The memory size for remanent variables is configurable in Automation Studio.
- 5) 1 MB SRAM minus the configured remanent variables.
- 6) See Automation Help under "Communication / POWERLINK / General information / Hardware - IF/LS" for more information.
- 7) The CPU was weighed with the battery and terminal block X20TB12. The CompactFlash card, cover for the interface module slot and the X20 end cover plate (right) were not included in the weighing.

9.12.5.4 X20CP368x(X) - Order data



| Model number | Short description |
|-----------------|---|
| | X20 CPUs |
| X20CP3684 | X20 CPU, Atom 0.4 GHz (compatible), 512 MB DDR4 RAM, 1 MB SRAM, 1 GB onboard flash drive, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! |
| X20CP3685 | X20 CPU, Atom 0.8 GHz, 512 MB DDR4 RAM, 1 MB SRAM, 1 GB onboard flash drive, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! |
| X20CP3686X | X20 CPU, Atom 1.3 GHz, 1 GB DDR4 RAM, 1 MB SRAM, 2 GB onboard flash drive, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! |
| X20CP3687X | X20 CPU, Atom 1.6 GHz, 2 GB DDR4 RAM, 1 MB SRAM, 2 GB onboard flash drive, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface (TSN) 10/100/1000BASE-T, 1 POWERLINK interface module, including supply module. 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included. Order CompactFlash separately! |
| | Required accessories |
| | CompactFlash cards |
| 0CFCRD.0512E.01 | CompactFlash 512 MB extended temp. |
| 0CFCRD.2048E.01 | CompactFlash 2048 MB extended temp. |
| 5CFCRD.016G-06 | CompactFlash 16 GB B&R (SLC) |
| 5CFCRD.032G-06 | CompactFlash 32 GB B&R (SLC) |
| 5CFCRD.0512-06 | CompactFlash 512 MB B&R (SLC) |
| 5CFCRD.1024-06 | CompactFlash 1 GB B&R (SLC) |
| 5CFCRD.2048-06 | CompactFlash 2 GB B&R (SLC) |
| 5CFCRD.4096-06 | CompactFlash 4 GB B&R (SLC) |
| 5CFCRD.8192-06 | CompactFlash 8 GB B&R (SLC) |
| | Optional accessories |
| | Batteries |
| 0AC201.91 | Lithium batteries 4 pcs., 3 V / 950 mAh button cell |
| 4A0006.00-000 | Lithium battery, 3 V / 950 mAh, button cell |

Table 252: X20CP368x(X) - Order data

Included in delivery

| Order number | Short description |
|---------------|--|
| 4A0006.00-000 | Backup battery (see also "Battery" on page 1434) |
| - | Interface module slot covers |
| X20AC0SR1 | X20 end cover plate (right) |
| X20TB12 | X20 terminal block, 12-pin, 24 V coding |

Table 253: X20 CPUs - Content of delivery

9.12.5.5 X20CP368x(X) - Technical data

| Model number | X20CP3684 | X20CP3685 | X20CP3686X | X20CP3687X |
|--|---|-----------|-------------------------|------------|
| Short description | | | | |
| Interfaces | 1x RS232, 1x Ethernet, 1x POWERLINK (V2), 2x USB, 1x X2X Link | | | |
| System module | CPU | | | |
| General information | | | | |
| Cooling | Fanless | | | |
| B&R ID code | 0xF9ED | 0xF9EE | 0xF9F9 | 0xF9FA |
| Status indicators | CPU function, overtemperature, Ethernet, POWERLINK, CompactFlash, battery | | | |
| Diagnostics | | | | |
| Battery | Yes, using LED status indicator and software | | | |
| CPU function | Yes, using LED status indicator | | | |
| CompactFlash | Yes, using LED status indicator | | | |
| Ethernet | Yes, using LED status indicator | | | |
| POWERLINK | Yes, using LED status indicator | | | |
| Overtemperature | Yes, using LED status indicator | | | |
| Controller redundancy possible | Yes | | | |
| ACOPOS support | Yes | | | |
| Visual Components support | Yes | | | |
| Power consumption without interface module and USB | 6.9 W | | 7.5 W | 8 W |
| Power consumption for X2X Link power supply ¹⁾ | 1.42 W | | | |
| Power consumption ¹⁾ | | | | |
| Internal I/O | 0.6 W | | | |
| Additional power dissipation caused by actuators (resistive) [W] | - | | | |
| Certifications | | | | |
| CE | Yes | | | |
| CPU and X2X Link power supply | | | | |
| Input voltage | 24 VDC -15% / +20% | | | |
| Input current | Max. 1.5 A | | | |
| Fuse | Integrated, cannot be replaced | | | |
| Reverse polarity protection | Yes | | | |
| X2X Link power supply output | | | | |
| Nominal output power | 7 W ²⁾ | | | |
| Parallel connection | Yes ³⁾ | | | |
| Redundant operation | Yes | | | |
| Input I/O power supply | | | | |
| Input voltage | 24 VDC -15% / +20% | | | |
| Fuse | Required line fuse: Max. 10 A, slow-blow | | | |
| Output I/O power supply | | | | |
| Nominal output voltage | 24 VDC | | | |
| Permissible contact load | 10 A | | | |
| Power supply - General information | | | | |
| Status indicators | Overload, operating status, module status, RS232 data transfer | | | |
| Diagnostics | | | | |
| RS232 data transfer | Yes, using LED status indicator | | | |
| Module run/error | Yes, using LED status indicator and software | | | |
| Overload | Yes, using LED status indicator and software | | | |
| Electrical isolation | | | | |
| I/O supply - I/O power supply | No | | | |
| CPU/X2X Link supply - CPU/X2X Link power supply | Yes | | | |
| Controller | | | | |
| CompactFlash slot | 1 | | | |
| Real-time clock | Nonvolatile, resolution 1 s, -10 to 10 ppm accuracy at 25°C | | | |
| FPU | Yes | | | |
| Processor | | | | |
| Type | Atom E3915 | | Atom E3930 | Atom E3940 |
| Clock frequency | 400 MHz (compatible). | 800 MHz | 1.3 GHz | 1.6 GHz |
| L1 cache | | | | |
| Data code | 24 kB | | | |
| Program code | 32 kB | | | |
| L2 cache | 1 MB | | | |
| Integrated I/O processor | Processes I/O data points in the background | | | |
| Modular interface slots | 3 | | | |
| Remanent variables | Max. 512 kB ⁴⁾ | | Max. 1 MB ⁴⁾ | |
| Shortest task class cycle time | 400 µs | 200 µs | 100 µs | |
| Typical instruction cycle time | 0.0044 µs | 0.0028 µs | 0.0015 µs | 0.0010 µs |

Table 254: X20CP368x(X) - Technical data

| Model number | X20CP3684 | X20CP3685 | X20CP3686X | X20CP3687X |
|--|--|-----------|------------------------|-------------------|
| Data buffering | | | | |
| Battery monitoring | Yes | | | |
| Lithium battery | During operation: 4 years CPU switched off: Min. 2 years at 23°C ambient temperature | | | |
| Standard memory | | | | |
| RAM | 512 MB LPDDR4 SDRAM | | 1 GB LPDDR4 SDRAM | 2 GB LPDDR4 SDRAM |
| User RAM | 1 MB SRAM ⁵⁾ | | | |
| Application memory | | | | |
| Type | 1 GB eMMC flash memory | | 2 GB eMMC flash memory | |
| Data retention | 10 years | | | |
| Writable data amount | | | | |
| Guaranteed | 40 TB | | | |
| Results for 5 years | 21.9 GB/day | | | |
| Guaranteed erase/write cycles | 20,000 | | | |
| Error-correcting code (ECC) | Yes | | | |
| Interfaces | | | | |
| Interface IF1 | | | | |
| Signal | RS232 | | | |
| Variant | Connection made using 12-pin terminal block X20TB12 | | | |
| Max. distance | 900 m | | | |
| Transfer rate | Max. 115.2 kbit/s | | | |
| Interface IF2 | | | | |
| Signal | Ethernet | | | |
| Variant | 1x RJ45 shielded | | | |
| Cable length | Max. 100 m between 2 stations (segment length) | | | |
| Transfer rate | 10/100/1000 Mbit/s | | | |
| Transfer | | | | |
| Physical layer | 10BASE-T/100BASE-TX/1000BASE-T | | | |
| Half-duplex | Yes | | | |
| Full-duplex | Yes | | | |
| Autonegotiation | Yes | | | |
| Auto-MDI/MDIX | Yes | | | |
| Interface IF3 | | | | |
| Fieldbus | POWERLINK (V2) managing or controlled node | | | |
| Type | Type 4 ⁶⁾ | | | |
| Variant | 1x RJ45 shielded | | | |
| Cable length | Max. 100 m between 2 stations (segment length) | | | |
| Transfer rate | 100 Mbit/s | | | |
| Transfer | | | | |
| Physical layer | 100BASE-TX | | | |
| Half-duplex | Yes | | | |
| Full-duplex | POWERLINK mode: No / Ethernet mode: Yes | | | |
| Autonegotiation | Yes | | | |
| Auto-MDI/MDIX | Yes | | | |
| Interface IF4 | | | | |
| Type | USB 1.1/2.0 | | | |
| Variant | Type A | | | |
| Max. output current | 0.5 A | | | |
| Interface IF5 | | | | |
| Type | USB 1.1/2.0 | | | |
| Variant | Type A | | | |
| Max. output current | 0.5 A | | | |
| Interface IF6 | | | | |
| Fieldbus | X2X Link master | | | |
| Electrical properties | | | | |
| Electrical isolation | Ethernet (IF2), POWERLINK (IF3) and X2X (IF6) isolated from each other, from other interfaces and from PLC | | | |
| Operating conditions | | | | |
| Mounting orientation | | | | |
| Horizontal | Yes | | | |
| Vertical | Yes | | | |
| Installation elevation above sea level | | | | |
| 0 to 2000 m | No limitation | | | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | | | |
| Degree of protection per EN 60529 | IP20 | | | |
| Ambient conditions | | | | |
| Temperature | | | | |
| Operation | | | | |
| Horizontal mounting orientation | -25 to 60°C | | | |
| Vertical mounting orientation | -25 to 50°C | | | |
| Derating | See section "Derating". | | | |
| Storage | -40 to 70°C | | | |
| Transport | -40 to 70°C | | | |

Table 254: X20CP368x(X) - Technical data

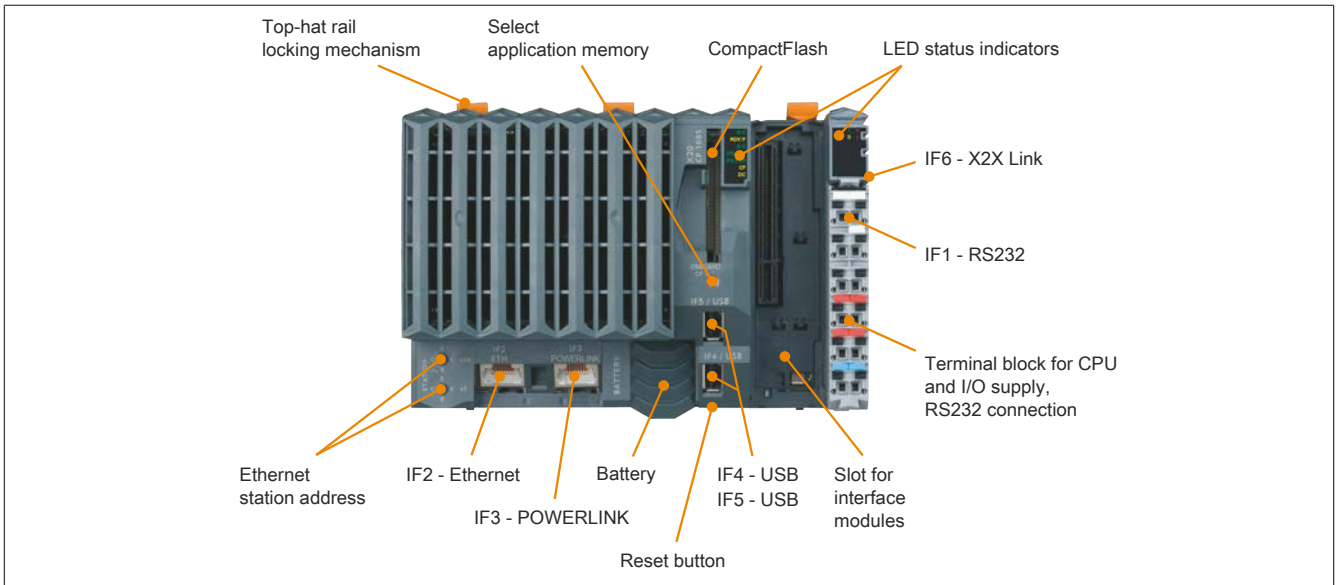
| Model number | X20CP3684 | X20CP3685 | X20CP3686X | X20CP3687X |
|------------------------------|---|-----------|------------|------------|
| Relative humidity | | | | |
| Operation | 5 to 95%, non-condensing | | | |
| Storage | 5 to 95%, non-condensing | | | |
| Transport | 5 to 95%, non-condensing | | | |
| Mechanical properties | | | | |
| Note | Order application memory (CompactFlash) separately. Backup battery included in delivery X20 end cover plate (right) included in delivery 12-pin X20 terminal block included in delivery Interface module slot covers included in delivery | | | |
| Dimensions | | | | |
| Width | 200 mm | | | |
| Height | 99 mm | | | |
| Depth | 85 mm | | | |
| Weight | 530 g ⁷⁾ | | | |

Table 254: X20CP368x(X) - Technical data

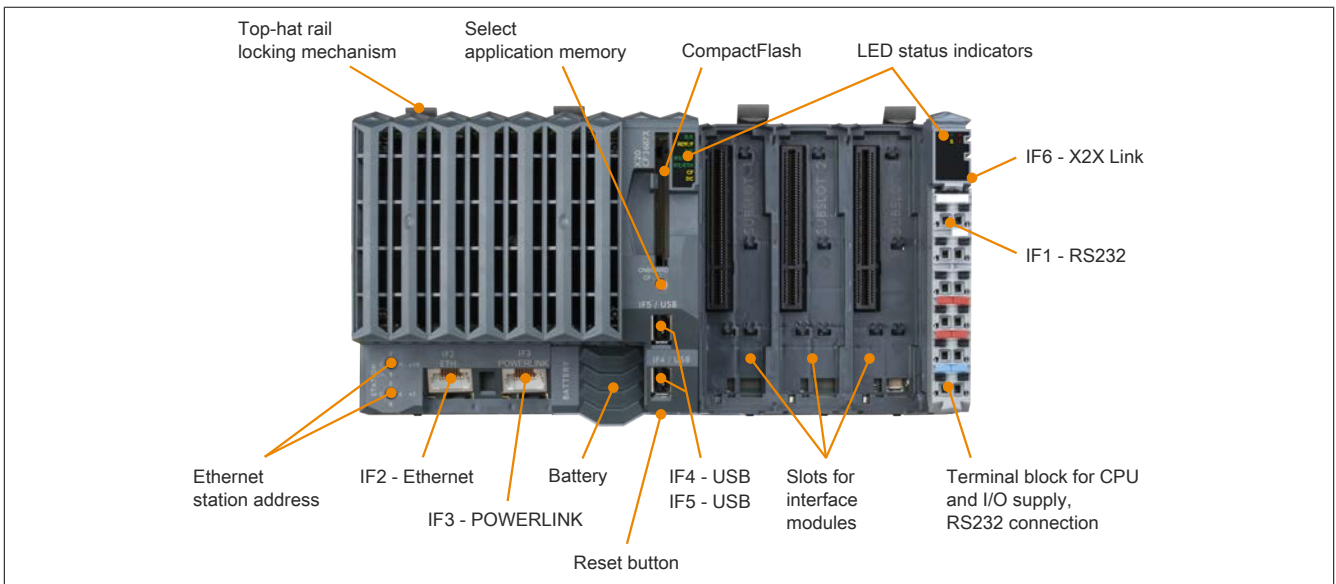
- 1) The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) When operated at temperatures above 55°C, a derating of the nominal output power to 5 W for the X2X Link power supply must be taken into account.
- 3) In parallel operation, it is only permitted to expect 75% of the nominal power. It is important to make sure that all power supplies operated in parallel are switched on and off at the same time.
- 4) The memory size for remanent variables is configurable in Automation Studio.
- 5) 1 MB SRAM minus the configured remanent variables.
- 6) See Automation Help under "Communication / POWERLINK / General information / Hardware - IF/LS" for more information.
- 7) The CPU was weighed with the battery and terminal block X20TB12. The CompactFlash card, covers for interface module slots and the X20 end cover plate (right) were not included in the weighing.

9.12.5.6 Operating and connection elements

X20CP168x(X)




X20CP368x(X)



9.12.5.6.1 LED status indicators

9.12.5.6.1.1 X20 CPUs - LED status indicators

| Figure | LED | Color | Status | Description |
|---|---------|-----------|----------------------|--|
|  | R/E | Green | On | Application running |
| | | | Blinking | System startup: The CPU is initializing the application, all bus systems and I/O modules. ¹⁾ |
| | | | Double flash | System startup during firmware update ¹⁾ |
| | RDY/F | Red | On | Mode SERVICE ²⁾ |
| | | | Blinking | If LED "R/E" blinks red and LED "RDY/F" blinks yellow, a license violation has occurred. |
| | RDY/F | Yellow | On | Mode SERVICE ²⁾ or BOOT ²⁾ |
| | | | Blinking | If LED "RDY/F" blinks yellow and LED "R/E" blinks red, a license violation has occurred. |
| | S/E | Green/Red | | Status/Error LED. LED states are described in section "LED "S/E" (LED "Status/Error")" on page 1427. |
| | IF3/PLK | Green | On | The link to the POWERLINK remote station is established. |
| | | | Blinking | The link to the POWERLINK remote station is established. The LED blinks if Ethernet activity is taking place on the bus. |
| | IF2/ETH | Green | On | The link to the Ethernet remote station is established. |
| | | | Blinking | The link to the Ethernet remote station is established. The LED blinks if Ethernet activity is taking place on the bus. |
| | CF | Green | On | CompactFlash inserted and detected |
| | | Yellow | On | CompactFlash read/write access |
| DC | Yellow | On | CPU power supply OK | |
| | Red | On | Backup battery empty | |

1) This process can take several minutes depending on the configuration.

2) The operating states are described in Automation Help under "Real-time operating system - Method of operation - Operating states".

LED "S/E" (LED "Status/Error")

This LED is a green/red dual LED and indicates the state of the POWERLINK interface. The LED states have a different meaning depending on the operating mode of the POWERLINK interface.

Ethernet mode

In this mode, the interface is operated as an Ethernet interface.

| LED "S/E" | | Description |
|-----------|-----|---|
| Green | Red | |
| On | Off | The interface is operated as an Ethernet interface. |

Table: LED "S/E": Interface in Ethernet mode

POWERLINK V2 mode

Error message

| LED "S/E" | | Description |
|-----------|-----|--|
| Green | Red | |
| Off | On | The interface is in error mode (failed Ethernet frames, increased number of collisions on the network, etc.). Note: Several red blinking signals are displayed immediately after the device is switched on. These are not errors, however. |
| Blinking | On | If an error occurs in the following modes, then the green LED blinks over the red LED: <ul style="list-style-type: none"> PRE_OPERATIONAL_1 PRE_OPERATIONAL_2 READY_TO_OPERATE |

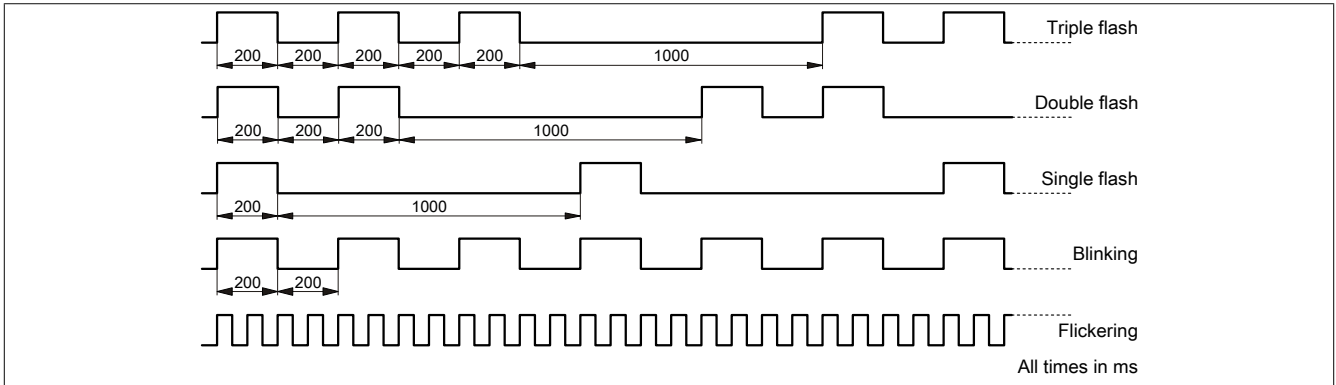
Table: LED "S/E" - Error message (interface in POWERLINK mode)

Interface status

| LED "S/E" | | Description |
|--------------------------------|-----|---|
| Green | Red | |
| Off | Off | <p>Mode: NOT_ACTIVE The interface is either in mode NOT_ACTIVE or one of the following modes or errors is present:</p> <ul style="list-style-type: none"> The device is switched off. The LED status indicator is disabled. The device is in the startup phase. The interface or device is not configured correctly in Automation Studio. The interface or device is defective. <p>Managing node (MN) The network is monitored for POWERLINK frames. If a frame is not received within the configured time window (timeout), the interface immediately enters mode PRE_OPERATIONAL_1. If POWERLINK communication is detected before the time has elapsed, however, the MN is not started.</p> <p>Controlled node (CN) The network is monitored for POWERLINK frames. If a frame is not received within the configured time window (timeout), the interface immediately enters mode BASIC_ETHERNET. If POWERLINK communication is detected before this time expires, however, the interface immediately enters mode PRE_OPERATIONAL_1.</p> |
| Flickering (approx. 10 Hz) | Off | <p>Mode: BASIC_ETHERNET The interface is in mode BASIC_ETHERNET. The interface is operated in Ethernet mode.</p> <p>Managing node (MN) This mode can only be exited by resetting the controller.</p> <p>Controlled node (CN) If POWERLINK communication is detected during this mode, the interface enters mode PRE_OPERATIONAL_1.</p> |
| Single flash (approx. 1 Hz) | Off | <p>Mode: PRE_OPERATIONAL_1 The interface is in mode PRE_OPERATIONAL_1.</p> <p>Managing node (MN) The MN is in "reduced cycle" operation. The CNs are configured in this mode. Cyclic communication is not yet taking place.</p> <p>Controlled node (CN) The CN can be configured by the MN in this mode. The CN waits until it receives an SoC frame and then switches to mode PRE_OPERATIONAL_2.</p> |
| | On | <p>Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed.</p> |
| Double flash (approx. 1 Hz) | Off | <p>Mode: PRE_OPERATIONAL_2 The interface is in mode PRE_OPERATIONAL_2.</p> <p>Managing node (MN) The MN starts cyclic communication (cyclic input data is not yet evaluated). The CNs are configured in this mode.</p> <p>Controlled node (CN) The CN can be configured by the MN in this mode. A command then switches the mode to READY_TO_OPERATE.</p> |
| | On | <p>Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed.</p> |
| Triple flash (approx. 1 Hz) | Off | <p>Mode: READY_TO_OPERATE The interface is in mode READY_TO_OPERATE.</p> <p>Managing node (MN) Cyclic and asynchronous communication. Received PDO data is ignored.</p> <p>Controlled node (CN) The configuration of the CN is completed. Normal cyclic and asynchronous communication. The transmitted PDO data corresponds to the PDO mapping. However, cyclic data is not yet evaluated.</p> |
| | On | <p>Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed.</p> |
| On | Off | <p>Mode: OPERATIONAL The interface is in mode OPERATIONAL. PDO mapping is active and cyclic data is evaluated.</p> |
| Blinking (approx. 2.5 Hz) | Off | <p>Mode: STOPPED The interface is in mode STOPPED.</p> <p>Managing node (MN) This mode does not occur for the MN.</p> <p>Controlled node (CN) Output data is not being output, and no input data is being provided. This mode can only be reached and exited by a corresponding command from the MN.</p> |

Table: LED "S/E" - Interface state (interface in POWERLINK mode)

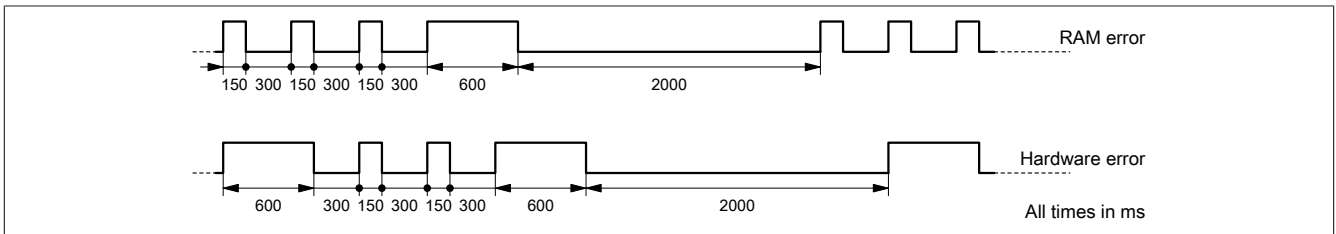
Blink times



System stop error codes

A system stop error can occur due to incorrect configuration or defective hardware.

The error code is indicated by LED "S/E" blinking red. The blinking signal of the error code consists of 4 switch-on phases with short (150 ms) or long (600 ms) duration. The error code is repeated every 2 seconds.



| Error | Error description |
|----------------|---|
| RAM error | The device is defective and must be replaced. |
| Hardware error | The device or a system component is defective and must be replaced. |

9.12.5.6.1.2 LED status indicators for the integrated power supply

For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|--------|-------|--------------------------------|--|--|
| | r | Green | Off | No power to module |
| | | | Single flash | Mode RESET |
| | | | Blinking | Mode PREOPERATIONAL |
| | | | On | Mode RUN |
| | e | Red | Off | Module not supplied with power or everything OK |
| | | | Double flash | The LED indicates one of the following states: <ul style="list-style-type: none"> The X2X Link power supply of the power supply is overloaded. I/O power supply too low The input voltage for the X2X Link power supply is too low. |
| | e + r | Solid red / Single green flash | Invalid firmware | |
| | S | Yellow | Off | No RS232 activity |
| | | | On | The LED lights up when data is being transmitted or received via the RS232 interface. |
| | l | Red | Off | The X2X Link power supply is within the valid range. |
| On | | | The X2X Link power supply of the power supply is overloaded. | |

9.12.5.6.2 Application memory

In order for the application project to be processed on the CPU, the Automation Runtime operating system, system components and application project must be installed on application memory. Either an integrated flash drive or removable CompactFlash card can be selected as the application memory.

9.12.5.6.2.1 Flash drive

This application memory is implemented as an integrated flash drive.

9.12.5.6.2.2 Removable CompactFlash card

The CompactFlash card is not included in delivery with the CPUs; it must be ordered separately as an accessory!

Information:

Removing the CompactFlash card during operation is not permitted.

9.12.5.6.2.3 Project installation

Project installation is described in Automation Help under "Project management / Project installation".

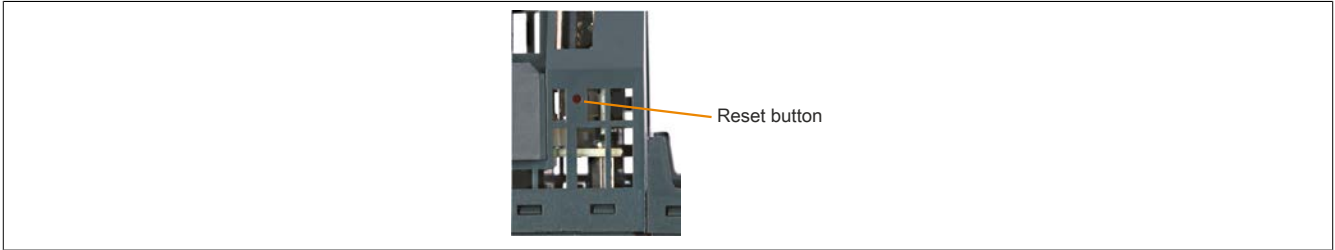
9.12.5.6.2.4 Selecting application memory

The application memory is selected via a switch on the CPU front.



| Application memory | Description |
|--------------------|--|
| ONBOARD | The flash drive integrated in the CPU is used as the application memory. |
| CF | The connected CompactFlash card is used as the application memory. |

9.12.5.6.3 Button for reset and operating mode



The reset button is located below the USB interfaces on the bottom of the housing. It can be pressed with any small pointed object (e.g. paper clip).

9.12.5.6.3.1 Reset

The button must be pressed for less than 2 seconds to trigger a reset. This triggers a hardware reset on the CPU, which means that:

- All application programs are stopped.
- All outputs are set to zero.

The controller then boots into service mode by default. The startup mode that follows after pressing the reset button can be set in Automation Studio.

- Service mode (default)
- Warm restart
- Cold restart
- Diagnostic mode

9.12.5.6.3.2 Operating mode

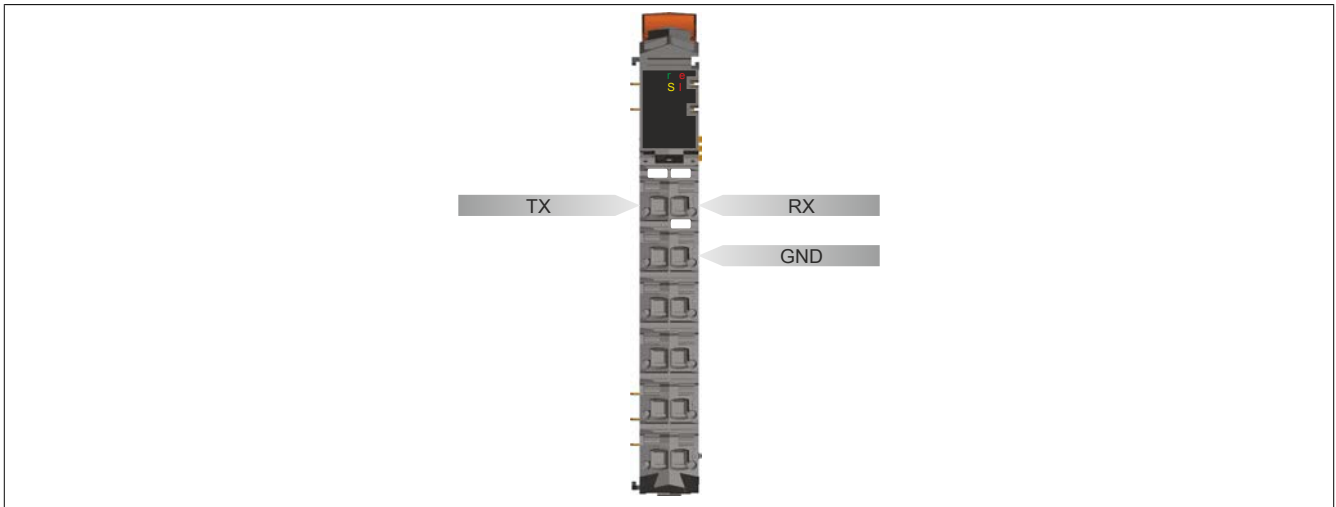
3 operating modes can be set using different button sequences:

| Operating mode | Button sequence | Description |
|---------------------------|---|---|
| BOOT ¹⁾ | Boot mode is enabled by the following button sequence: <ul style="list-style-type: none"> • Press the button for less than 2 s. As soon as LED "Error" lights RED, the button can be released. • Then press the button within 2 s for longer than 2 s. As soon as LED "Error" goes dark, the button can be released. | Boot AR is started, and the runtime system can be installed via the online interface (Automation Studio). User flash memory is erased only when the download begins. |
| SERVICE/RUN ¹⁾ | Press the button for less than 2 s. As soon as LED "Error" lights RED , the button can be released. | Mode SERVICE/RUN: Triggering and startup behavior correspond to triggering a hardware reset (see "Reset" on page 1431). |
| DIAGNOSE ¹⁾ | Press the button for more than 2 s. LED "Error" lights RED and then goes dark. As soon as LED "Error" goes dark, the button can be released. | The CPU boots in diagnostic mode. Program sections in User RAM and User FlashPROM are not initialized. After diagnostic mode, the CPU always boots with a warm restart. |

1) The operating states are described in Automation Help under "Real-time operating system - Method of operation - Operating states".

9.12.5.6.4 RS232 interface (IF1)

The non-electrically isolated RS232 interface is designed as an online interface for communication with the programming device.



9.12.5.6.5 Ethernet interface (IF2)



IF2 is designed as a 10BASE-T/100BASE-TX/1000BASE-T gigabit-capable Ethernet interface.

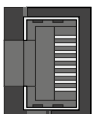
The INA2000 station number of the Ethernet interface is set using the two hex switches.

For information about wiring X20 modules with an Ethernet interface, see ["Cabling guidelines for X20 modules with an Ethernet cable"](#) on page 58.

Information:

The Ethernet interface (IF2) is not suitable for POWERLINK (see ["POWERLINK interface \(IF3\)"](#) on page 1433).

Pinout

| Interface | Pinout | | |
|---|--------|----------|---------|
| | Pin | Ethernet | |
|  Shielded RJ45 port | 1 | D1+ | Data 1+ |
| | 2 | D1- | Data 1- |
| | 3 | D2+ | Data 2+ |
| | 4 | D3+ | Data 3+ |
| | 5 | D3- | Data 3- |
| | 6 | D2- | Data 2- |
| | 7 | D4+ | Data 4+ |
| | 8 | D4- | Data 4- |

9.12.5.6.6 POWERLINK interface (IF3)

The CPUs are equipped with a POWERLINK V2 interface.

POWERLINK

Setting in Automation Studio

By default, the POWERLINK interface is operated as a managing node (MN). In the managing node, the node number is set to a fixed value of 240.

If the POWERLINK node is operated as a controlled node (CN), a node number from 1 to 239 can be set in the POWERLINK configuration in Automation Studio.

Setting with hex switches

The POWERLINK node number can also be set with the two onboard hex switches. These are normally used to set the INA2000 station number of the Ethernet interface. Switching takes place in the POWERLINK configuration in Automation Studio.

Node numbers from 0x01 to 0xF0 are permitted.

| Switch position | Description |
|-----------------|---|
| 0x00 | Reserved, switch position not permitted. |
| 0x01 - 0xEF | Node number of the POWERLINK node. Operation as a controlled node (CN). |
| 0xF0 | Operation as a managing node (MN). |
| 0xF1 - 0xFF | Reserved, switch position not permitted. |

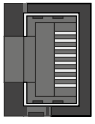
Ethernet mode

In this mode, the interface is operated as an Ethernet interface. The INA2000 station number is set using the B&R Automation Studio software.

Pinout



For information about wiring X20 modules with an Ethernet interface, see ["Cabling guidelines for X20 modules with an Ethernet cable"](#) on page 58.

| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.12.5.6.7 USB interfaces (IF4 and IF5)



IF4 and IF5 are non-galvanically isolated USB interfaces. The abbreviation USB stands for "Universal Serial Bus". Both USB interfaces support the USB 1.1 and 2.0 standards.

Information:

USB peripheral devices can be connected to the USB interfaces. Due to the variety of USB devices available on the market, B&R cannot guarantee their functionality. The functionality of USB devices available from B&R is guaranteed.

Information:

- The USB interfaces cannot be used as online communication interfaces.
- Only devices isolated from GND are permitted to be connected to the USB interfaces.
- Current-carrying capacity is listed in the technical data.

9.12.5.6.8 Slots for interface modules

The CPUs have one or three slots for interface modules.

Different bus or network systems can be flexibly integrated into the X20 system by selecting the appropriate interface module.

9.12.5.6.9 Battery

X20 CPUs are equipped with a lithium battery. The lithium battery is located in a separate compartment and protected by a cover.

Backup battery data

| | |
|---------------------|---|
| Order number | |
| 4A0006.00-000 | 1 pcs. |
| 0AC201.91 | 4 pcs. |
| Short description | Lithium battery, 3 V / 950 mAh, button cell |
| Storage temperature | -40 to 85°C |
| Storage time | Max. 3 years at 30°C |
| Relative humidity | 0 to 95% (non-condensing) |

The following areas are buffered:

- Remanent variables
- User RAM
- System RAM
- Real-time clock

Battery monitoring

The battery voltage is checked cyclically. The cyclic load test of the battery does not considerably shorten its service life; instead, it gives an early warning of weakened buffer capacity.

Status information "Battery OK" is available from system library function "BatteryInfo" and the CPU's I/O mapping.

Replacement interval for battery

The battery should be replaced every 4 years. The replacement intervals recommended by B&R reflect the batteries' average service life and operating conditions. They do not correspond to the maximum buffer duration!

Important information about the battery exchange

The product design allows the battery to be changed when the power to the PLC is switched off as well as when the power to the PLC is switched on. In some countries, safety regulations do not allow batteries to be changed while the module is switched on. To prevent data loss, the battery must be changed within 1 min when the power is switched off.

Warning!

The battery is only permitted to be replaced by a Renata CR2477N battery. The use of another battery may present a fire or explosion hazard.

The battery can explode if handled improperly. Do not recharge, disassemble or dispose of the battery in fire.

Procedure for replacing the battery

1. Perform electrostatic discharge at the top-hat rail or at the ground connection (do not reach into the power supply!)
2. Remove the cover for the lithium battery. Do this by sliding it down and away from the CPU.

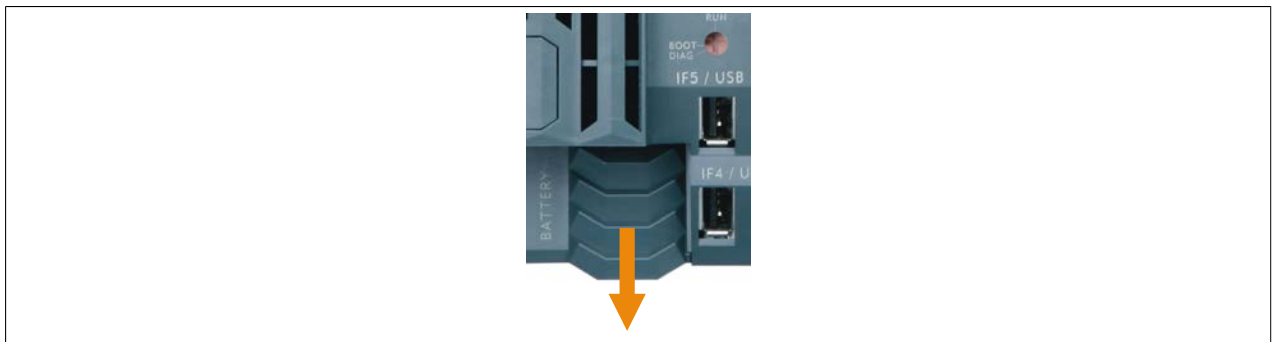


Figure 157: X20 CPUs - Remove lithium battery cover

3. Push the empty battery out of the holder.
4. It is important to ensure that the new battery is not handled with moist or greasy fingers. Plastic tweezers can also be used. Do not touch the battery with pliers or metal tweezers → short circuit!
5. To insert the battery into the holder, place it with the "+" side up on the right part of the battery holder. Then press the battery into the battery holder.
6. Replace the cover.

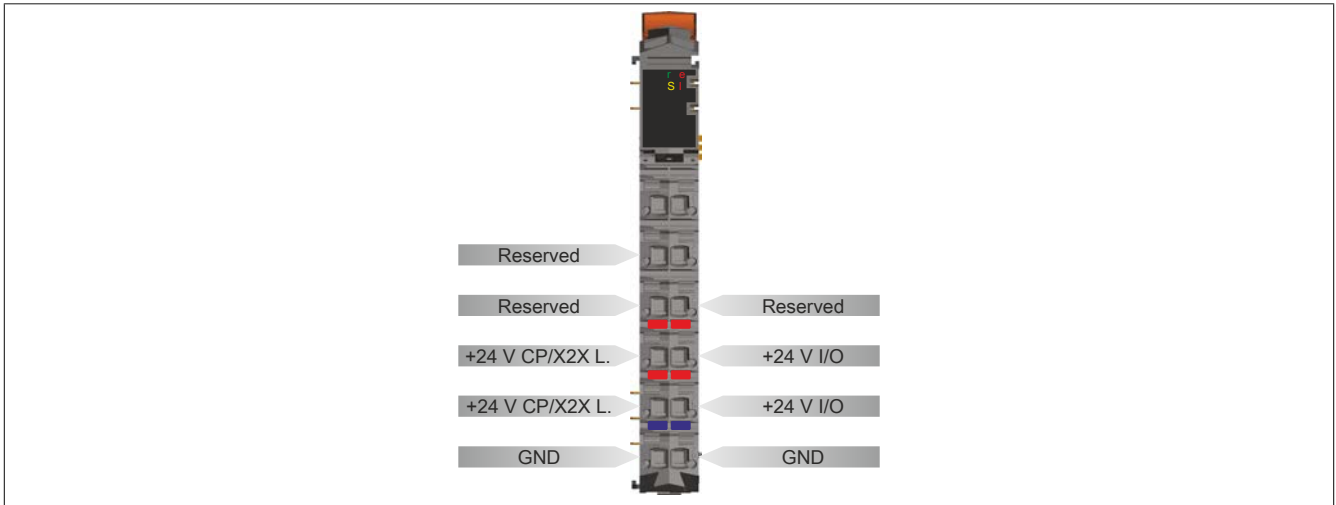
Information:

Lithium batteries are hazardous waste. Used batteries should be disposed of in accordance with applicable local regulations.

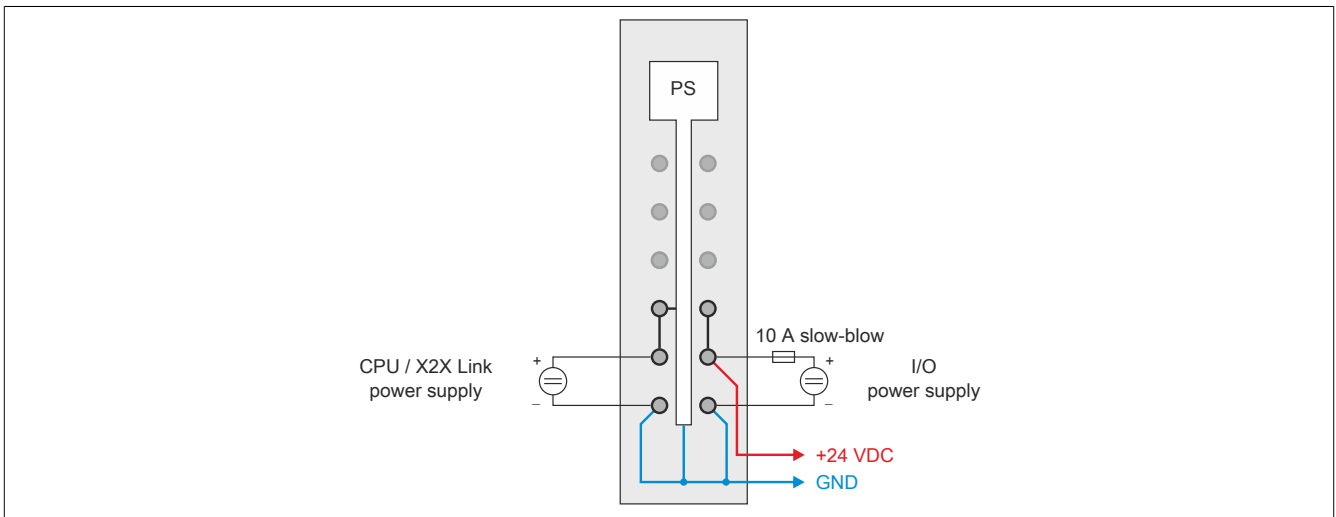
9.12.5.7 CPU power supply

A power supply is integrated in the X20 CPUs. It is equipped with a supply for the CPU, X2X Link and the internal I/O power supply. The bus power supply and internal I/O power supply are galvanically isolated from each other.

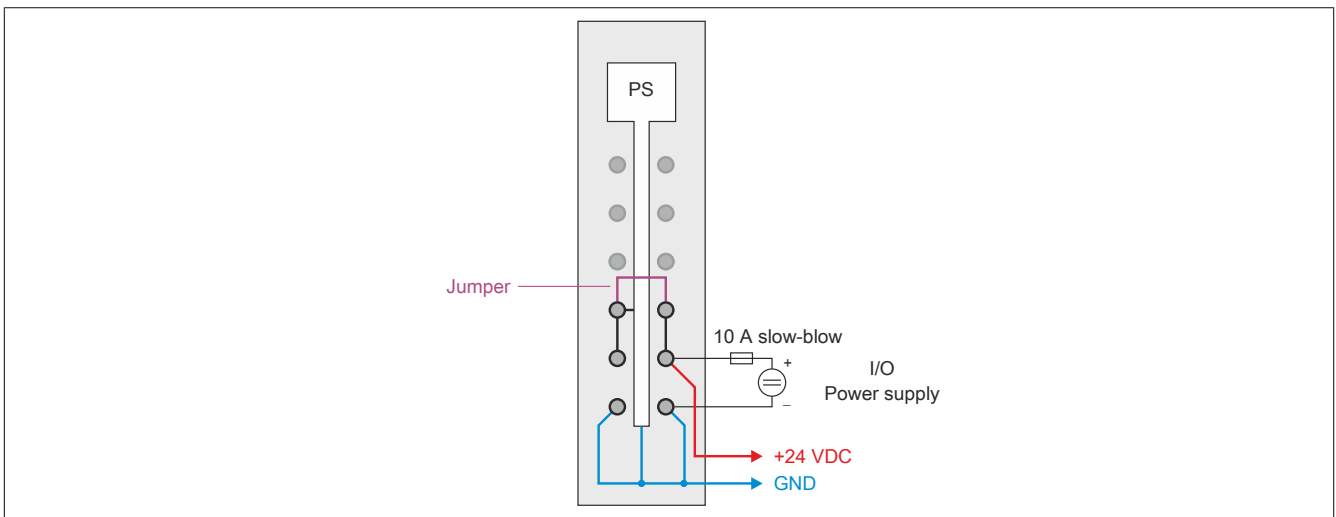
Integrated power supply - Pinout



Connection example with 2 separate supplies

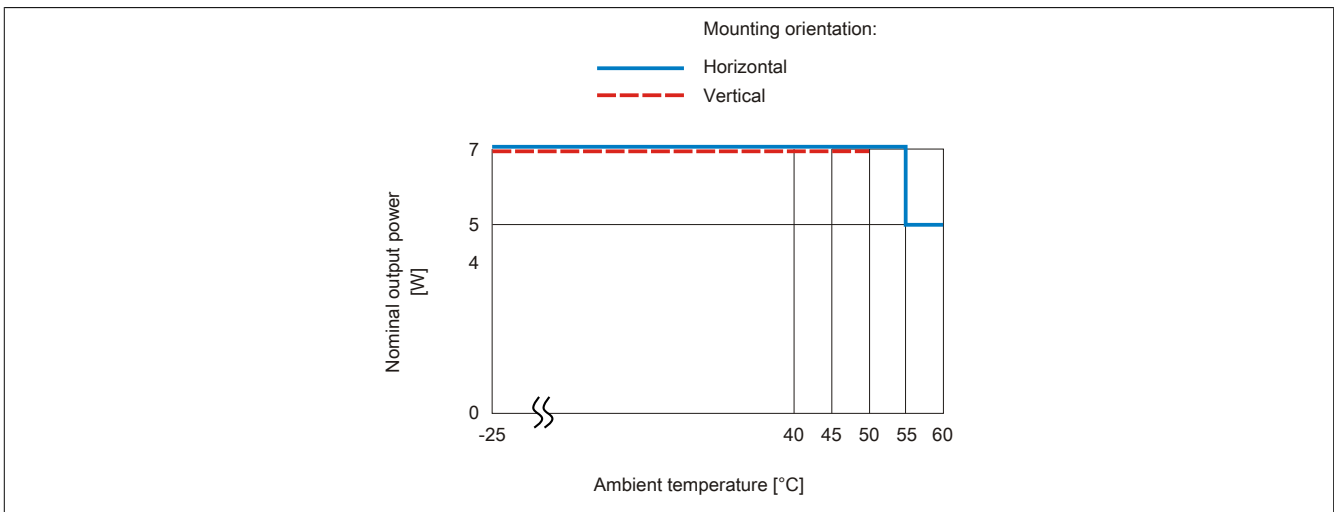


Connection example with power supply and jumper



9.12.5.8 Derating

There is no derating when operated below 55°C. Above 55°C, the nominal output power for the X2X Link power supply must be reduced to 5 W.



9.12.5.9 Overtemperature shutdown

To prevent damage, the CPU is switched off - reset state - at 110°C processor temperature or 95°C board temperature.

The following errors are entered in the logbook in the event of shutdown:

| Error number | Short error text |
|--------------|--|
| 9204 | PLC restart triggered by the PLC CPU's temperature monitoring. |
| 9210 | Warning: Halt/Service after watchdog or manual reset. |

9.12.5.10 System requirements

The following minimum versions are recommended to generally be able to use all functions:

- Automation Studio 4.7
- Automation Runtime A4.73

9.12.5.11 Information about migrating from the X20CPx58x to X20CPx68x(X)

The minimum hardware upgrade versions listed in the table are required to operate the following modules with X20CPx68x(X) CPUs. The upgrade can be installed from Automation Studio by selecting **Tools / Upgrades** from the menu.

| Order number | Minimum hardware upgrade version |
|--------------|----------------------------------|
| X20IF10X0 | 1.2.2.0 |
| X20SLXyyy | 1.10.10.4 |

9.12.5.12 General data points

This CPU is equipped with general data points. These are not CPU-specific; instead, they contain general information such as system time and heat sink temperature.

General data points are described in section ["General CPU data points" on page 3792](#).

9.13 Digital input modules

Digital input modules convert binary process signals into the internal signal level required by the PLC. The states of the digital inputs are indicated with status LEDs.

9.13.1 Summary

| Model number | Short description | Page |
|--------------|---|------|
| X20DI0471 | X20 digital input module, 10 inputs, 5-48 VDC, sink, configurable input filter, 1-wire connections | 1439 |
| X20DI2371 | X20 digital input module, 2 inputs, 24 VDC, sink, configurable input filter, 3-wire connections | 1446 |
| X20DI2372 | X20 digital input module, 2 inputs, 24 VDC, source, configurable input filter, 3-wire connections | 1452 |
| X20DI2377 | X20 digital input module, 2 inputs, 24 VDC, sink, configurable input filter, 2 event counters 50 kHz, 3-wire connections | 1458 |
| X20DI2653 | X20 digital input module, 2 inputs, 100 to 240 VAC, 240 V keyed, 3-wire connections | 1467 |
| X20DI4371 | X20 digital input module, 4 inputs, 24 VDC, sink, configurable input filter, 3-wire connections | 1473 |
| X20DI4372 | X20 digital input module, 4 inputs, 24 VDC, source, configurable input filter, 3-wire connections | 1480 |
| X20DI4375 | X20 digital input module, 4 inputs, 24 VDC, sink, configurable input filter, open-circuit and short-circuit detection, 3-wire connections | 1486 |
| X20DI4653 | X20 digital input module, 4 inputs, 100 to 240 VAC, 240 V keyed, 2-wire connections | 1499 |
| X20DI4760 | X20 digital input module, 4 NAMUR inputs, 8.05 V | 1505 |
| X20DI6371 | X20 digital input module, 6 inputs, 24 VDC, sink, configurable input filter, 2-wire connections | 1514 |
| X20DI6372 | X20 digital input module, 6 inputs, 24 VDC, source, configurable input filter, 2-wire connections | 1520 |
| X20DI6373 | X20 digital input module, 6 inputs, 24 VDC, sink/source, all inputs floating, configurable input filter, 2-wire connections | 1526 |
| X20DI6553 | X20 digital input module, 6 inputs, 100 to 120 VAC, 240 V keyed, 1-wire connections | 1532 |
| X20DI8371 | X20 digital input module, 8 inputs, 24 VDC, sink, configurable input filter, 1-wire connections | 1538 |
| X20DI9371 | X20 digital input module, 12 inputs, 24 VDC, sink, configurable input filter, 1-wire connections | 1544 |
| X20DI9372 | X20 digital input module, 12 inputs, 24 VDC, source, configurable input filter, 1-wire connections | 1551 |
| X20DID371 | X20 digital input module, 8 inputs, 24 VDC, sink, configurable input filter, 2-wire connections | 1558 |
| X20DIF371 | X20 digital input module, 16 inputs, 24 VDC, sink, configurable input filter, 1-wire connections | 1564 |
| X20cDI4371 | X20 digital input module, coated, 4 inputs, 24 VDC, sink, configurable input filter, 3-wire connections | 1473 |
| X20cDI4375 | X20 digital input module, coated, 4 inputs, 24 VDC, sink, configurable input filter, open-circuit and short-circuit detection, 3-wire connections | 1486 |
| X20cDI4760 | X20 digital input module, coated, 4 NAMUR inputs, 8.05 V | 1505 |
| X20cDI6371 | X20 digital input module, coated, 6 inputs, 24 VDC, sink, configurable input filter, 2-wire connections | 1514 |
| X20cDI6372 | X20 digital input module, coated, 6 inputs, 24 VDC, source, configurable input filter, 2-wire connections | 1520 |
| X20cDI9371 | X20 digital input module, coated, 12 inputs, 24 VDC, sink, configurable input filter, 1-wire connections | 1544 |
| X20cDI9372 | X20 digital input module, coated, 12 inputs, 24 VDC, source, configurable input filter, 1-wire connections | 1551 |
| X20cDIF371 | X20 digital input module, coated, 16 inputs, 24 VDC, sink, configurable input filter, 1-wire connections | 1564 |

9.13.2 X20DI0471

Data sheet version: 1.05

9.13.2.1 General information

The module is equipped with 10 inputs for 1-wire connections. It is designed for a nominal voltage of 5 to 48 VDC.

- 10 digital inputs
- Sink circuit
- 1-wire connections
- Configurable software input filter for entire module

9.13.2.2 Order data


| Model number | Short description | Figure |
|--------------|--|--|
| | Digital inputs |  |
| X20DI0471 | X20 digital input module, 10 inputs, 5-48 VDC, sink, configurable input filter, 1-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 255: X20DI0471 - Order data


9.13.2.3 Technical data

| Model number | X20DI0471 |
|--|--|
| Short description | |
| I/O module | 10 digital inputs 5 to 48 VDC for 1-wire connections |
| General information | |
| B&R ID code | 0xE7CE |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnosics | |
| Module run/error | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.3 W |
| Internal I/O | 0.6 W |
| External I/O | 0.94 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| Digital inputs | |
| Nominal voltage | 5 to 48 VDC |
| Input voltage | 4.75 to 60 VDC |
| Input current at 48 VDC | Typ. 0.96 mA |
| Reference voltage | 4.75 to 60 VDC |
| Input circuit | Sink |
| Input filter | |
| Hardware | ≤100 μs |
| Software | Default 1 ms, configurable between 0 and 25 ms in 0.2 ms intervals |
| Connection type | 1-wire connections |
| Reference voltage input resistance | 20 kΩ |
| Switching threshold | |
| Low | ≤0.2 × U _{ref} |
| High | ≥0.6 × U _{ref} |
| Reference voltage monitoring | Yes |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

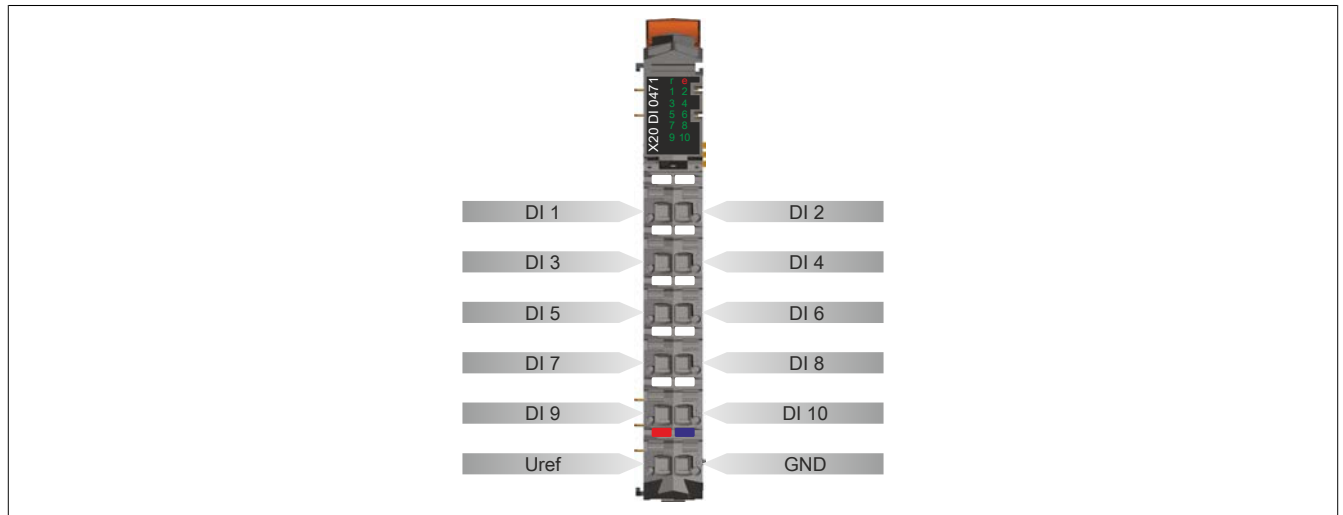
Table 256: X20DI0471 - Technical data

9.13.2.4 LED status indicators

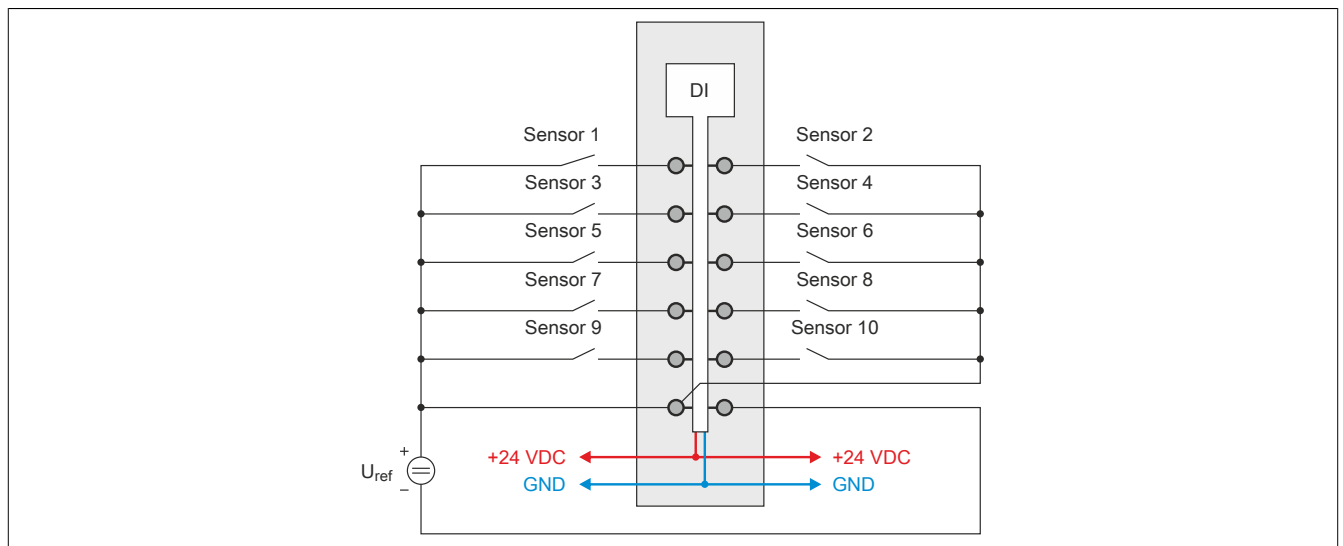
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description | |
|---|--------|-------|-----------------------------|-------------------------------------|--|
|  | r | Green | Off | No power to module | |
| | | | Single flash | RESET mode | |
| | | | Blinking | PREOPERATIONAL mode | |
| | | | On | RUN mode | |
| | e | Red | Off | No power to module or everything OK | |
| | | | On | Error or reset status | |
| | e + r | | Red on / Green single flash | Invalid firmware | |
| | 1 - 10 | | Green | | Input state of the corresponding digital input |

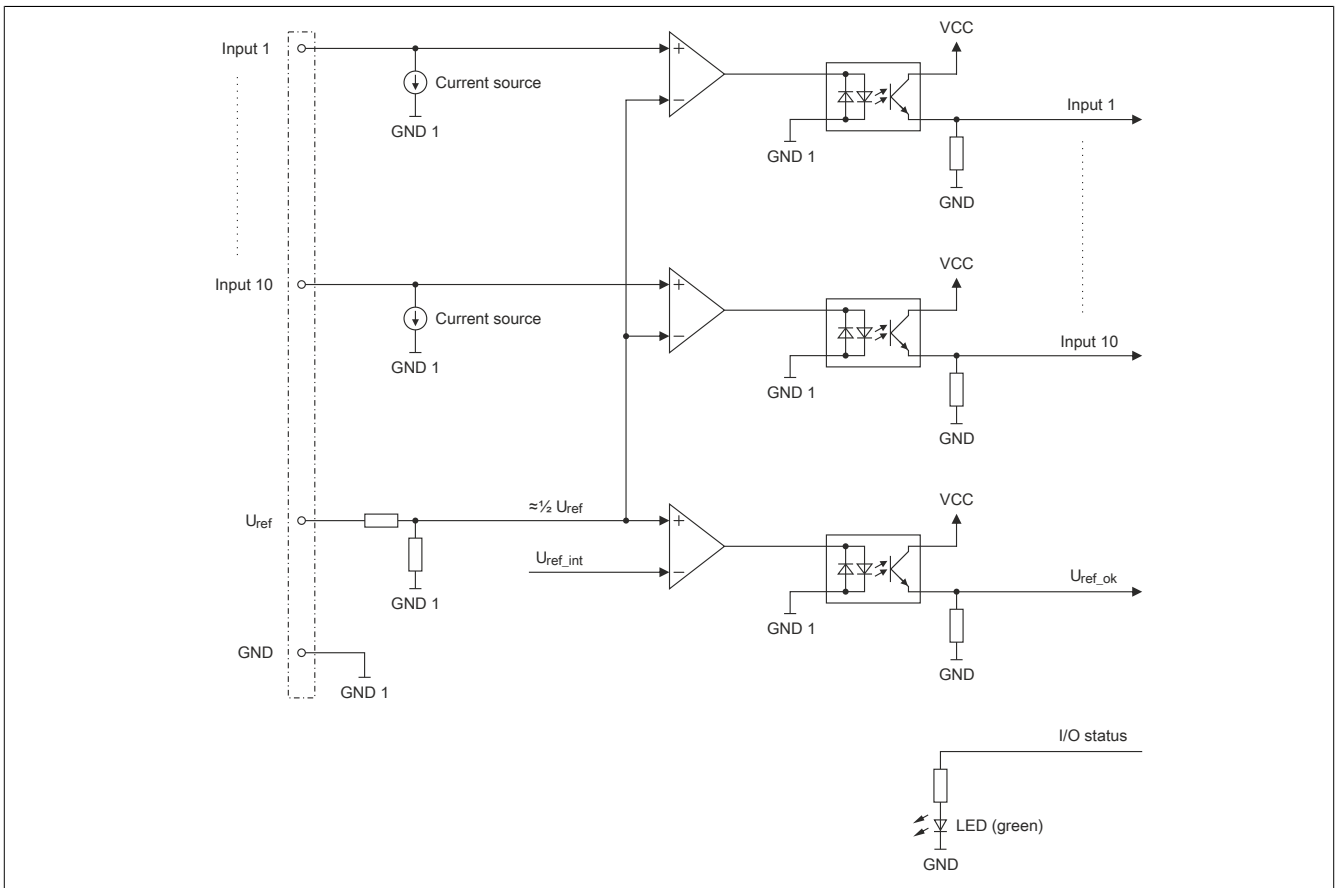
9.13.2.5 Pinout



9.13.2.6 Connection example

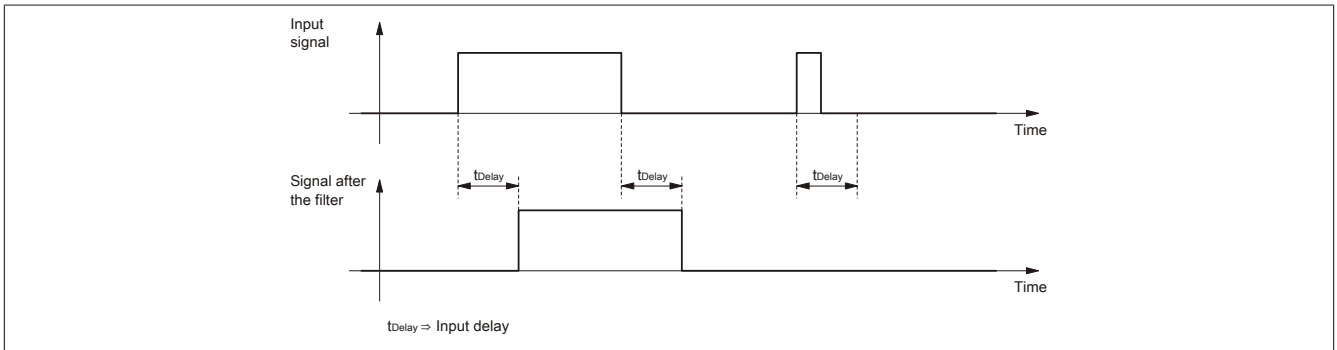


9.13.2.7 Input circuit diagram



9.13.2.8 Input filter

An input filter is available for each input. The input delay can be set using register "ConfigOutput01" on page 1444. Disturbance pulses which are shorter than the input delay are suppressed by the input filter.



9.13.2.9 Register description

9.13.2.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.13.2.9.2 Function model 0 - default

| Register | Fixed offset | Register name | Data type | Read | | Write | |
|----------------------|--------------|---------------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| - | 1 | DigitalInput | UINT | • | | | |
| 0 | 1 | Input state of digital inputs 1 to 8 | USINT | | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| 1 | 2 | DigitalInput08 | Bit 7 | | | | |
| | | Input state of digital inputs 9 to 10 | USINT | • | | | |
| | | DigitalInput09 | Bit 0 | | | | |
| | | DigitalInput10 | Bit 1 | | | | |
| | | ReferenceStatus | Bit 7 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.13.2.9.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Register name | Data type | Read | | Write | |
|----------------------|----------------------|---------------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | Input state of digital inputs 1 to 8 | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput08 | Bit 7 | | | | |
| 1 | 1 | Input state of digital inputs 9 to 10 | USINT | • | | | |
| | | DigitalInput09 | Bit 0 | | | | |
| | | DigitalInput10 | Bit 1 | | | | |
| | | ReferenceStatus | Bit 7 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.13.2.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "[Using I/O modules on the bus controller](#)" on page 3789.

9.13.2.9.3.2 CAN I/O bus controller

The module occupies 2 digital logical slots on CAN I/O.

9.13.2.9.4 Digital inputs

Unfiltered

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

Filtered

The filtered status is collected with a fixed offset to the network cycle and transferred in the same cycle. Filtering takes place asynchronously to the network in multiples of 200 µs with a network-related jitter of up to 50 µs.

9.13.2.9.5 Digital input filter

Name:

ConfigOutput01

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 μ s. It makes sense to enter values in steps of 2, however, since the input signals are sampled every 200 μ s.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No software filter (bus controller default setting) |
| | 2 | 0.2 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

9.13.2.9.5.1 Details related to use

The table shows how the register must be defined in relation to the function model and which parameter is available for this in the Automation Studio configuration.

| Function model | Value or path for the configuration parameter |
|----------------|---|
| All | General / Input filter [0.1 ms] |

9.13.2.9.6 Input state of digital inputs 1 to 10

Register name:

DigitalInput or

DigitalInput01 to DigitalInput10

This register indicates the input state of digital inputs 1 to 10 and the status of the reference voltage.

The reference voltage is monitored. The status is output in bit 7.

| Reference voltage | Status of the digital inputs in relation to the input voltage | |
|-----------------------|--|---|
| $U_{ref} < 4.75$ V | All digital inputs are in a low state regardless of the voltage on the inputs. | |
| $U_{ref} \geq 4.75$ V | $U_{in} \leq 0.2 * U_{ref}$ | The digital input is low |
| | $U_{in} \geq 0.6 * U_{ref}$ | The digital input is high |
| | $0.2 * U_{ref} < U_{in} < 0.6 * U_{ref}$ | This area is inconclusive. The digital input is either low or high. |

Example

The reference voltage $U_{ref} = 48$ VDC

Calculation of the switching threshold:

Switching threshold low = $48 * 0.2 = 9.6$ VDC

Switching threshold high = $48 * 0.6 = 28.8$ VDC

Status of the digital inputs in relation to the input voltage:

| Input voltage | State of the digital input |
|---------------------------------|---|
| $U_{in} \leq 9.6$ VDC | The digital input is low |
| 9.6 VDC $< U_{in} < 28.8$ VDC | The digital input is either low or high (inconclusive). |
| $U_{in} \geq 28.8$ VDC | The digital input is high |

Only function model 0 - Standard

The "Packed inputs" setting in the Automation Studio I/O configuration is used to determine whether all of the bits from this register should be set up individually as data points in the Automation Studio I/O mapping ("DigitalInput01" to "DigitalInput10") or whether this register should be displayed as an individual UINT data point ("DigitalInput").

| Data type | Value | Information | |
|-----------|--------------------|---|--|
| UINT | 0x0000 to 0x83FF | Packed inputs = On | |
| | | 0xy000 to 0xy3FF | Status of digital inputs 1 to 10 |
| | | 0x0yyy | Reference voltage $U_{ref} < 4.75\text{ V}$ |
| | | 0x8yyy | Reference voltage $U_{ref} \geq 4.75\text{ V}$ |
| USINT | See bit structure. | Packed inputs = Off or Function model $\neq 0$ - Standard | |

Bit structure:

Register 0

| Bit | Name | Value | Information |
|-----|----------------|--------|-------------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input state - Digital input 1 |
| ... | | ... | |
| 7 | DigitalInput08 | 0 or 1 | Input state - Digital input 8 |

Register 1

| Bit | Name | Value | Information |
|-------|-----------------|--------|--|
| 0 | DigitalInput09 | 0 or 1 | Input state - Digital input 9 |
| 1 | DigitalInput10 | 0 or 1 | Input state - Digital input 10 |
| 2 - 6 | Reserved | | |
| 7 | ReferenceStatus | 0 | Reference voltage $U_{ref} < 4.75\text{ V}$ |
| | | 1 | Reference voltage $U_{ref} \geq 4.75\text{ V}$ |

9.13.2.9.7 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|-------------------|
| Without filtering | 100 μs |
| With filtering | 150 μs |

9.13.2.9.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|-------------------|
| Without filtering | 100 μs |
| With filtering | 200 μs |

9.13.3 X20DI2371

Data sheet version: 3.07

9.13.3.1 General Information

The module is equipped with 2 inputs for 3-wire connections.

This module is designed for X20 6-pin terminal blocks. If needed (e.g. for logistical reasons), the 12-pin terminal block can also be used.

- 2 digital inputs
- Sink connection
- 3-wire connections
- 24 VDC and GND for sensor supply
- Software input filter can be configured for entire module

9.13.3.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Digital inputs |  |
| X20DI2371 | X20 digital input module, 2 inputs, 24 VDC, sink, configurable input filter, 3-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |

Table 257: X20DI2371 - Order data

9.13.3.3 Technical data

| Model number | X20DI2371 |
|--|--|
| Short description | |
| I/O module | 2 digital inputs 24 VDC for 3-wire connections |
| General information | |
| B&R ID code | 0x1B8D |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.12 W |
| Internal I/O | 0.29 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Digital inputs | |
| Nominal voltage | 24 VDC |
| Input characteristics per EN 61131-2 | Type 1 |
| Input voltage | 24 VDC -15 % / +20 % |
| Input current at 24 VDC | Typ. 3.75 mA |
| Input circuit | Sink |
| Input filter | |
| Hardware | ≤100 µs |
| Software | Default 1 ms, configurable between 0 and 25 ms in 0.2 ms intervals |
| Connection type | 3-wire connections |
| Input resistance | Typ. 6.4 kΩ |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Sensor power supply | |
| Power consumption | Max. 12 W ¹⁾ |
| Voltage | Module supply minus voltage drop for short circuit protection |
| Voltage drop for short-circuit protection at 500 mA | Max. 2 VDC |
| Summation current | 0.5 A |
| Short-circuit proof | Yes |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |

Table 258: X20DI2371 - Technical data


| Model number | X20DI2371 |
|------------------------------|---|
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB06 or X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 258: X20DI2371 - Technical data

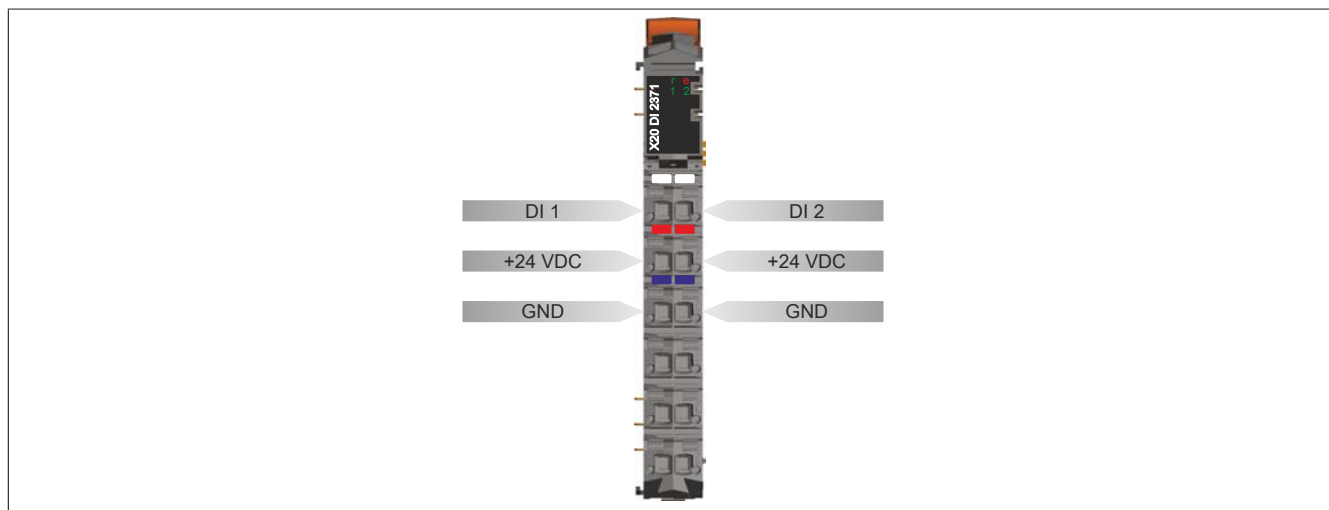
1) The power consumption of the sensors connected to the module is not permitted to exceed 12 W.

9.13.3.4 Status LEDs

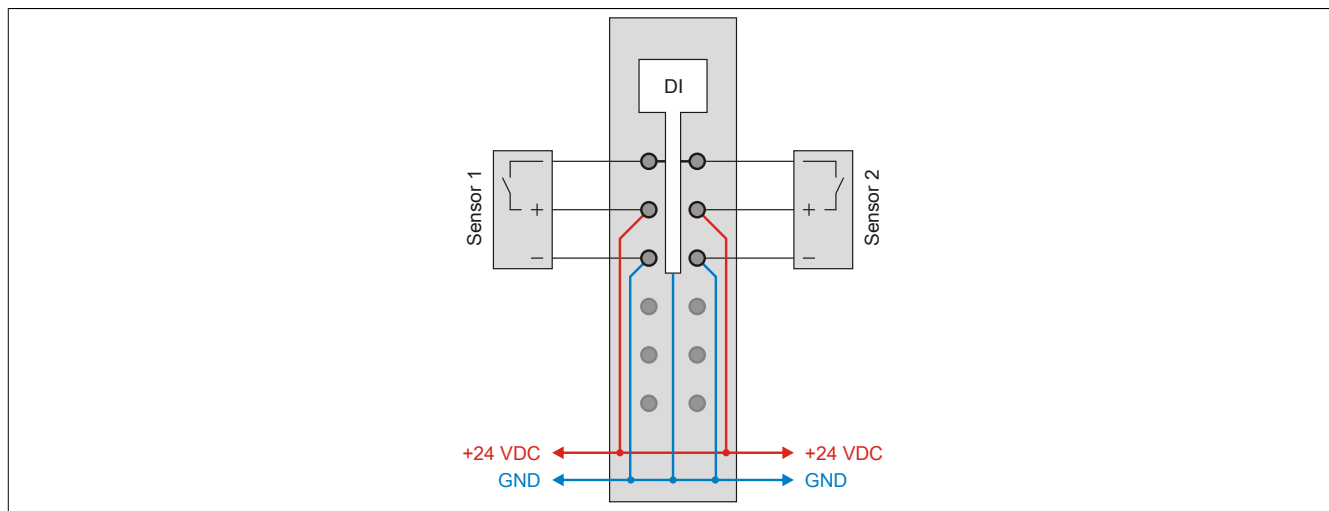
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Image | LED | Color | Status | Description |
|---|-------|-----------------------------|---|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | Module supply not connected or everything OK |
| | e + r | Red on / Green single flash | Invalid firmware | |
| 1 - 2 | Green | | Input status of the corresponding digital input | |

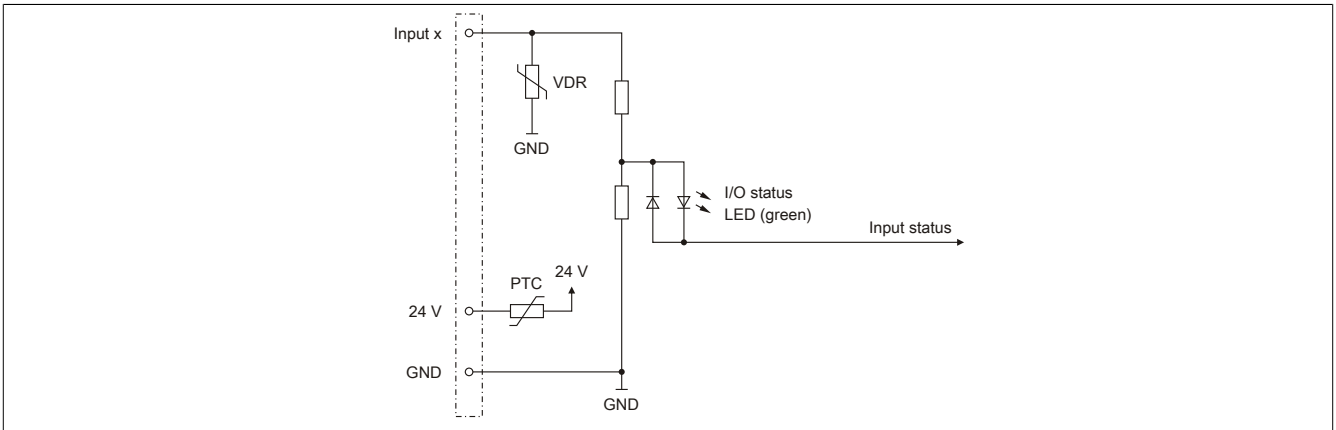
9.13.3.5 Pinout



9.13.3.6 Connection example

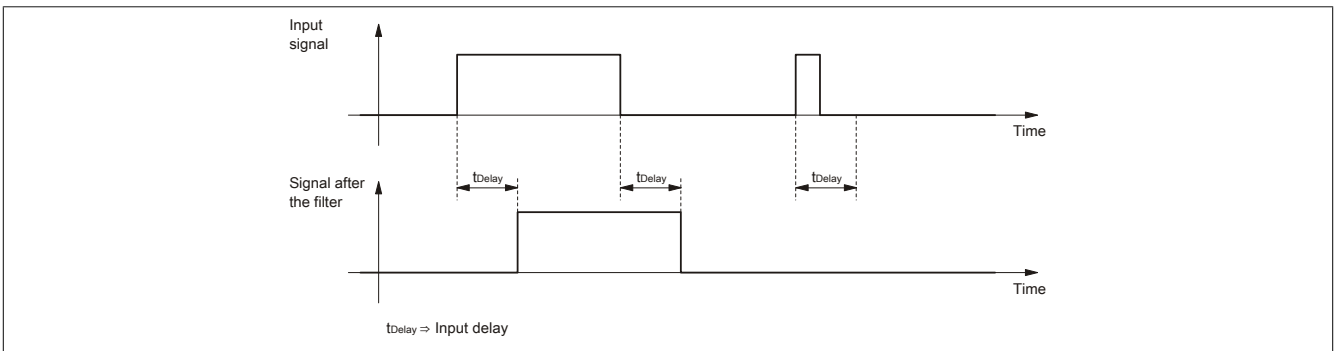


9.13.3.7 Input circuit diagram



9.13.3.8 Input filter

An input filter is available for each input. The input delay can be set using register "[ConfigOutput01](#)" on page 1451. Disturbance pulses which are shorter than the input delay are suppressed by the input filter.



9.13.3.9 Register description

9.13.3.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.13.3.9.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------------------|--------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 1 | DigitalInput | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | DigitalInput02 | Bit 1 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.13.3.9.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 1 | Input status of digital inputs 1 to 2 | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | DigitalInput02 | Bit 1 | | | | |

1) The offset specifies where the register is within the CAN object.

9.13.3.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.13.3.9.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.13.3.9.4 Digital inputs

Unfiltered

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

Filtered

The filtered status is collected with a fixed offset to the network cycle and transferred in the same cycle. Filtering takes place asynchronously to the network in multiples of 200 µs with a network-related jitter of up to 50 µs.

9.13.3.9.4.1 Digital input filter

Name:

ConfigOutput01

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 µs. It makes sense to enter values in steps of 2, however, since the input signals are sampled every 200 µs.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No software filter (bus controller default setting) |
| | 2 | 0.2 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

9.13.3.9.4.2 Input status of digital inputs 1 to 2

Name:

DigitalInput or

DigitalInput01 to DigitalInput02

The input status of digital inputs 1 to 2 is mapped in this register.

Only function model 0 - Standard:

The "packed inputs" setting in the Automation Studio I/O configuration is used to determine whether all of this register's bits should be set up individually as data points in the Automation Studio I/O mapping ("DigitalInput01" through "DigitalInput02") or whether this register should be displayed as an individual USINT data point ("DigitalInput").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 3 | Packed inputs = On |
| | See the bit structure. | Packed inputs = Off or function model ≠ 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|--------|--------------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input status - Digital input 1 |
| 1 | DigitalInput02 | 0 or 1 | Input state - Digital input 2 |

9.13.3.9.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|--------|
| Without filtering | 100 µs |
| With filtering | 150 µs |

9.13.3.9.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|--------|
| Without filtering | 100 µs |
| With filtering | 200 µs |

9.13.4 X20DI2372

Data sheet version: 3.07

9.13.4.1 General Information

The module is equipped with 2 inputs for 3-wire connections.

This module is designed for X20 6-pin terminal blocks. If needed (e.g. for logistical reasons), the 12-pin terminal block can also be used.

- 2 digital inputs
- Source connection
- 3-wire connections
- 24 VDC and GND for sensor supply
- Software input filter can be configured for entire module

9.13.4.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Digital inputs |  |
| X20DI2372 | X20 digital input module, 2 inputs, 24 VDC, source, configurable input filter, 3-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |

Table 259: X20DI2372 - Order data

9.13.4.3 Technical data

| Model number | X20DI2372 |
|--|--|
| Short description | |
| I/O module | 2 digital inputs 24 VDC for 3-wire connections |
| General information | |
| B&R ID code | 0x22A7 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.12 W |
| Internal I/O | 0.29 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Digital inputs | |
| Nominal voltage | 24 VDC |
| Input characteristics per EN 61131-2 | Type 1 |
| Input voltage | 24 VDC -15 % / +20 % |
| Input current at 24 VDC | Typ. 3.75 mA |
| Input circuit | Source |
| Input filter | |
| Hardware | ≤100 µs |
| Software | Default 1 ms, configurable between 0 and 25 ms in 0.2 ms intervals |
| Connection type | 3-wire connections |
| Input resistance | Typ. 6.4 kΩ |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Sensor power supply | |
| Power consumption | Max. 12 W ¹⁾ |
| Voltage | Module supply minus voltage drop for short circuit protection |
| Voltage drop for short-circuit protection at 500 mA | Max. 2 VDC |
| Summation current | 0.5 A |
| Short-circuit proof | Yes |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |

Table 260: X20DI2372 - Technical data


| Model number | X20DI2372 |
|------------------------------|---|
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB06 or X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 260: X20DI2372 - Technical data

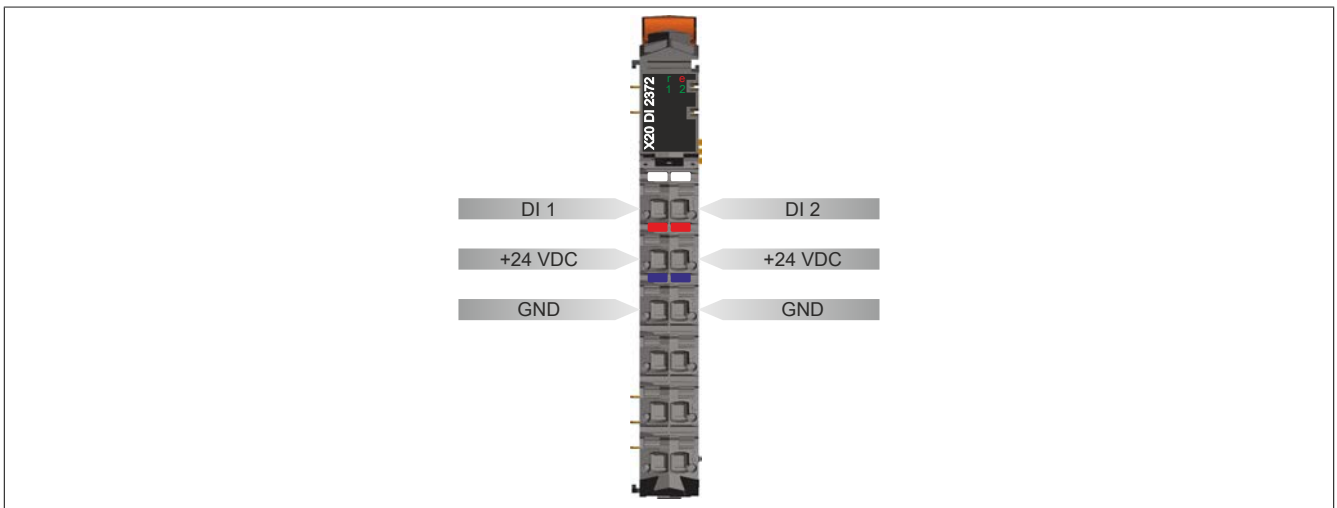
1) The power consumption of the sensors connected to the module is not permitted to exceed 12 W.

9.13.4.4 Status LEDs

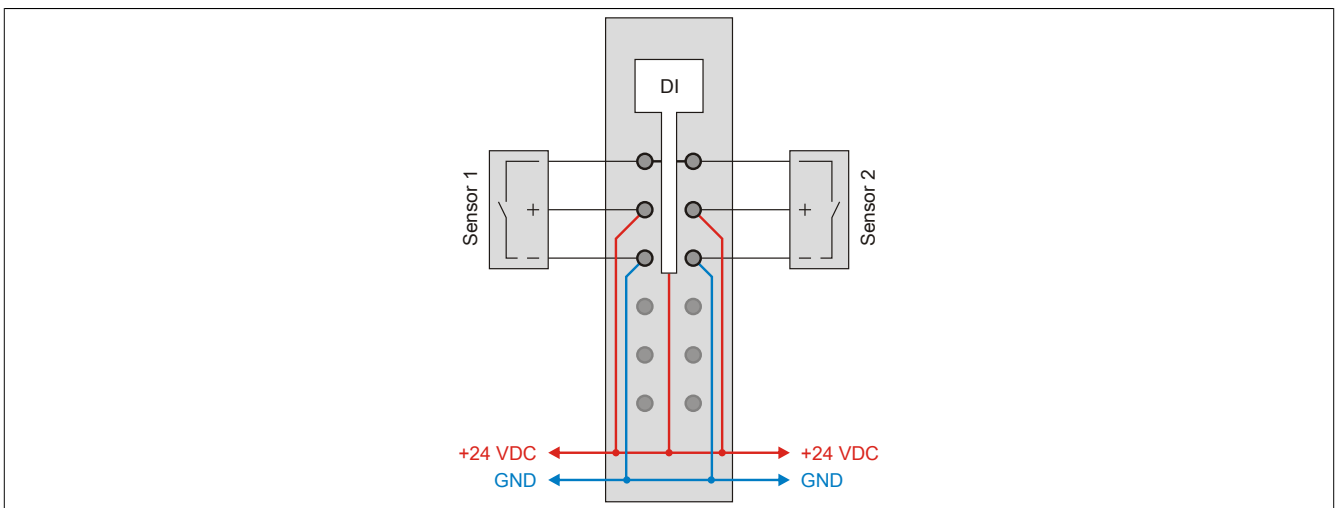
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Image | LED | Color | Status | Description |
|---|-------|-----------------------------|---|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | Module supply not connected or everything OK |
| | e + r | Red on / Green single flash | Invalid firmware | |
| 1 - 2 | Green | | Input status of the corresponding digital input | |

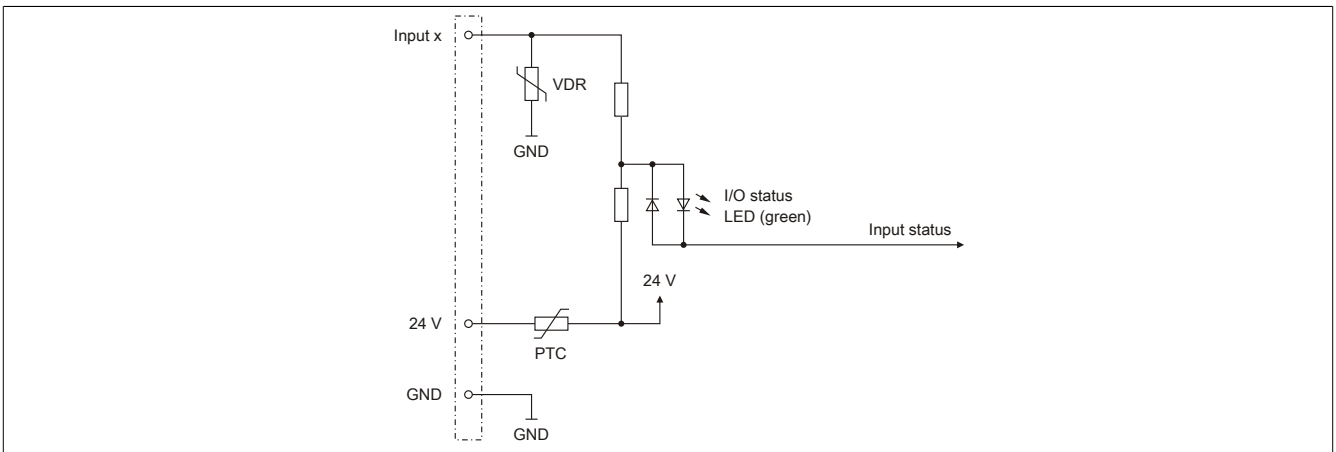
9.13.4.5 Pinout



9.13.4.6 Connection example

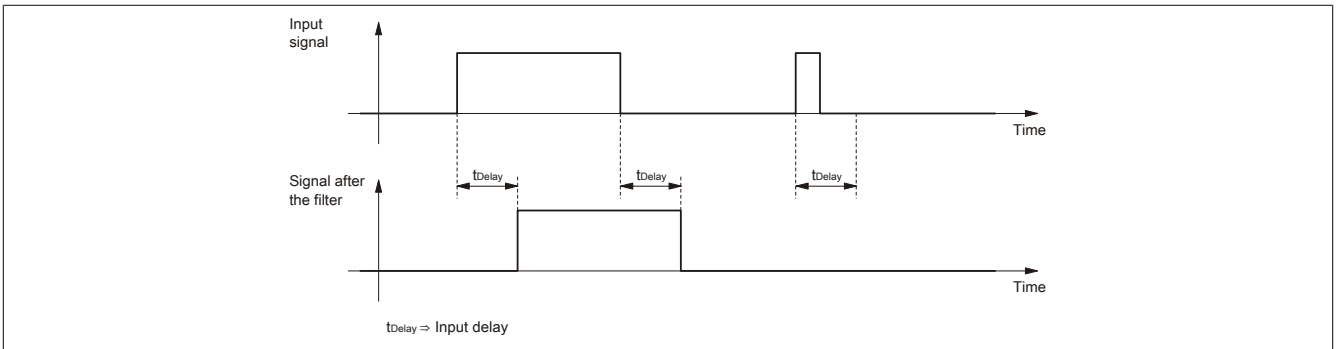


9.13.4.7 Input circuit diagram



9.13.4.8 Input filter

An input filter is available for each input. The input delay can be set using register "ConfigOutput01" on page 1457. Disturbance pulses which are shorter than the input delay are suppressed by the input filter.



9.13.4.9 Register description

9.13.4.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.13.4.9.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------------------|--------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 1 | DigitalInput | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | DigitalInput02 | Bit 1 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.13.4.9.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 1 | Input status of digital inputs 1 to 2 | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | DigitalInput02 | Bit 1 | | | | |

1) The offset specifies where the register is within the CAN object.

9.13.4.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.13.4.9.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.13.4.9.4 Digital inputs

Unfiltered

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

Filtered

The filtered status is collected with a fixed offset to the network cycle and transferred in the same cycle. Filtering takes place asynchronously to the network in multiples of 200 µs with a network-related jitter of up to 50 µs.

9.13.4.9.4.1 Digital input filter

Name:

ConfigOutput01

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 µs. It makes sense to enter values in steps of 2, however, since the input signals are sampled every 200 µs.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No software filter (bus controller default setting) |
| | 2 | 0.2 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

9.13.4.9.4.2 Input status of digital inputs 1 to 2

Name:

DigitalInput or

DigitalInput01 to DigitalInput02

The input status of digital inputs 1 to 2 is mapped in this register.

Only function model 0 - Standard:

The "packed inputs" setting in the Automation Studio I/O configuration is used to determine whether all of this register's bits should be set up individually as data points in the Automation Studio I/O mapping ("DigitalInput01" through "DigitalInput02") or whether this register should be displayed as an individual USINT data point ("DigitalInput").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 3 | Packed inputs = On |
| | See the bit structure. | Packed inputs = Off or function model ≠ 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|--------|--------------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input status - Digital input 1 |
| 1 | DigitalInput02 | 0 or 1 | Input state - Digital input 2 |

9.13.4.9.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|--------|
| Without filtering | 100 µs |
| With filtering | 150 µs |

9.13.4.9.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|--------|
| Without filtering | 100 µs |
| With filtering | 200 µs |

9.13.5 X20DI2377

Data sheet version: 3.12

9.13.5.1 General Information

The module is equipped with two inputs for 3-wire connections. Both inputs can be configured as event counters. Gate measurement is only ever possible on one channel.

This module is designed for X20 6-pin terminal blocks. If needed (e.g. for logistical reasons), the 12-pin terminal block can also be used.

- 2 digital inputs
- Sink connection
- 3-wire connections
- 2 counter inputs with 50 kHz counter frequency
- Gate measurement
- 24 VDC and GND for sensor supply
- Software input filter can be configured for entire module

9.13.5.2 Order data


| Model number | Short description | Figure |
|--------------|--|--|
| | Digital inputs |  |
| X20DI2377 | X20 digital input module, 2 inputs, 24 VDC, sink, configurable input filter, 2 event counters 50 kHz, 3-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |

Table 261: X20DI2377 - Order data

9.13.5.3 Technical data

| Model number | X20DI2377 |
|--|--|
| Short description | |
| I/O module | 2 digital inputs 24 VDC for 3-wire connections, special functions |
| General information | |
| B&R ID code | 0x1B8E |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnosics | |
| Module run/error | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.15 W |
| Internal I/O | 0.82 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| EAC | Yes |
| KC | Yes |
| Digital inputs | |
| Nominal voltage | 24 VDC |
| Input characteristics per EN 61131-2 | Type 1 |
| Input voltage | 24 VDC -15 % / +20 % |
| Input current at 24 VDC | Typ. 10.5 mA |
| Input circuit | Sink |
| Input filter | |
| Hardware | ≤10 µs |
| Software | Default 0 ms, configurable between 0 and 25 ms in 0.2 ms intervals |
| Connection type | 3-wire connections |
| Input resistance | Typ. 2.23 kΩ |
| Additional functions | 50 kHz event counting, gate measurement |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Event counters | |
| Quantity | 2 |
| Signal form | Square wave pulse |
| Evaluation | Every rising edge, cyclic counter |
| Input frequency | Max. 50 kHz |
| Counter 1 | Input 1 |
| Counter 2 | Input 2 |
| Counter frequency | Max. 50 kHz |
| Counter size | 16-bit |
| Gate measurement | |
| Number of gate measurements | 1 |
| Signal form | Square wave pulse |
| Evaluation | Rising edge - falling edge |
| Counter frequency | |
| Internal | 48 MHz, 24 MHz, 12 MHz, 6 MHz, 3 MHz, 1.5 MHz, 750 kHz, 375 kHz, 187.5 kHz |
| Counter size | 16-bit |
| Length of pause between pulses | ≥100 µs |
| Pulse length | ≥20 µs |
| Supported inputs | Input 1 or Input 2 |
| Sensor power supply | |
| Power consumption | Max. 12 W ¹⁾ |
| Voltage | Module supply minus voltage drop for short circuit protection |
| Voltage drop for short-circuit protection at 500 mA | Max. 2 VDC |
| Summation current | 0.5 A |
| Short-circuit proof | Yes |

Table 262: X20DI2377 - Technical data


| Model number | X20DI2377 | |
|--|---|--|
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB06 or X20TB12 terminal block separately Order 1x X20BM11 bus module separately | |
| Pitch | 12.5 ^{+0.2} mm | |

Table 262: X20DI2377 - Technical data

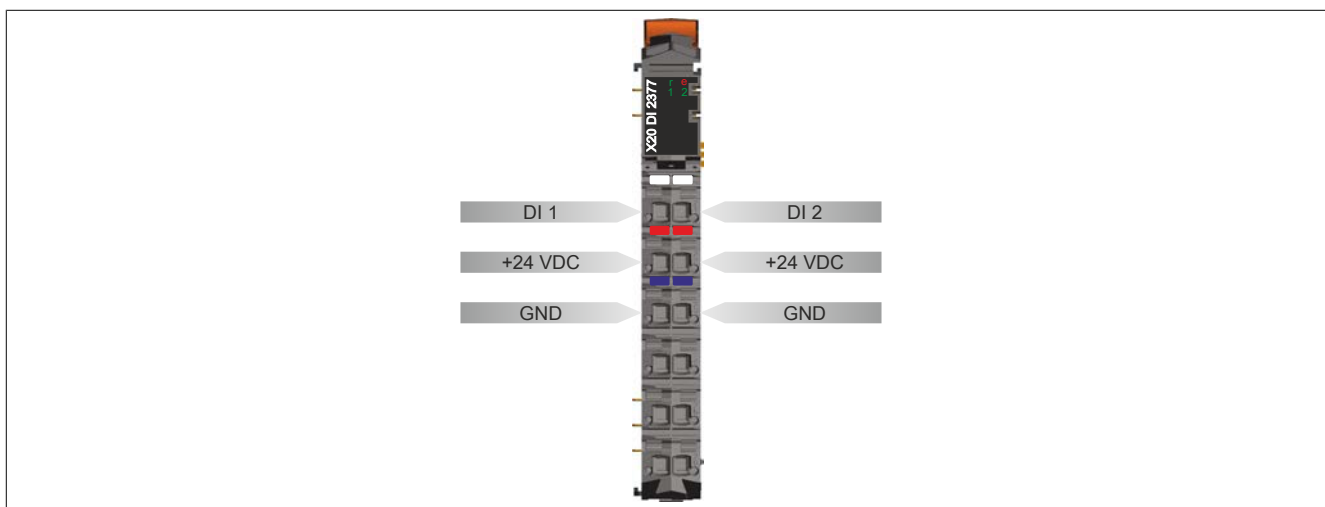
1) The power consumption of the sensors connected to the module is not permitted to exceed 12 W.

9.13.5.4 Status LEDs

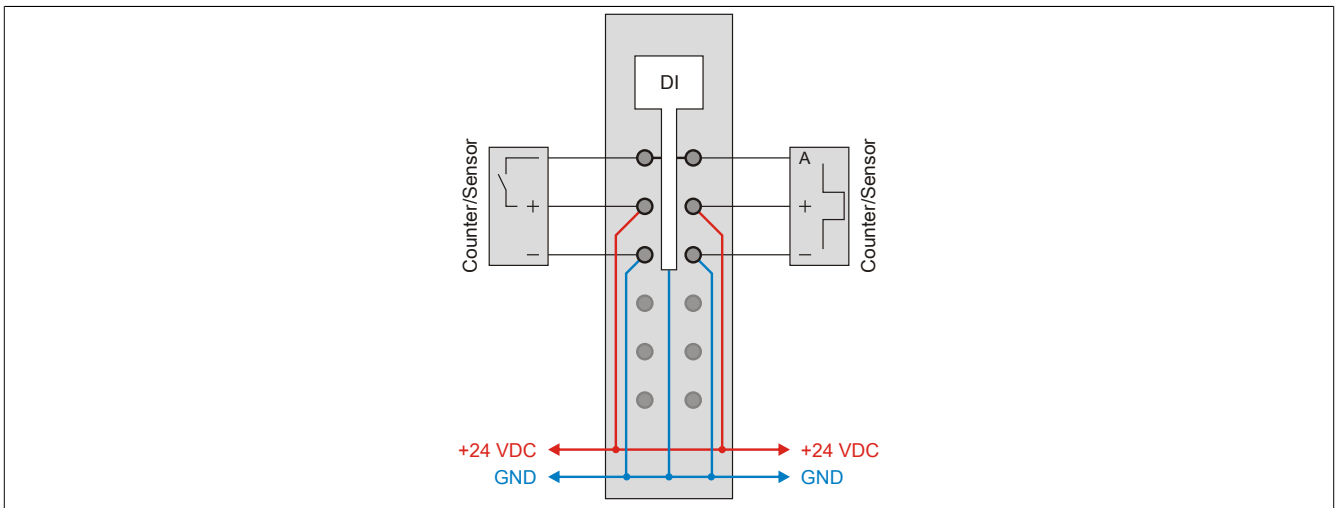
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Image | LED | Color | Status | Description |
|---|-------|-----------------------------|--------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | Module supply not connected or everything OK |
| | e + r | Red on / Green single flash | | Invalid firmware |
| | 1 - 2 | Green | | Input status of the corresponding digital input |

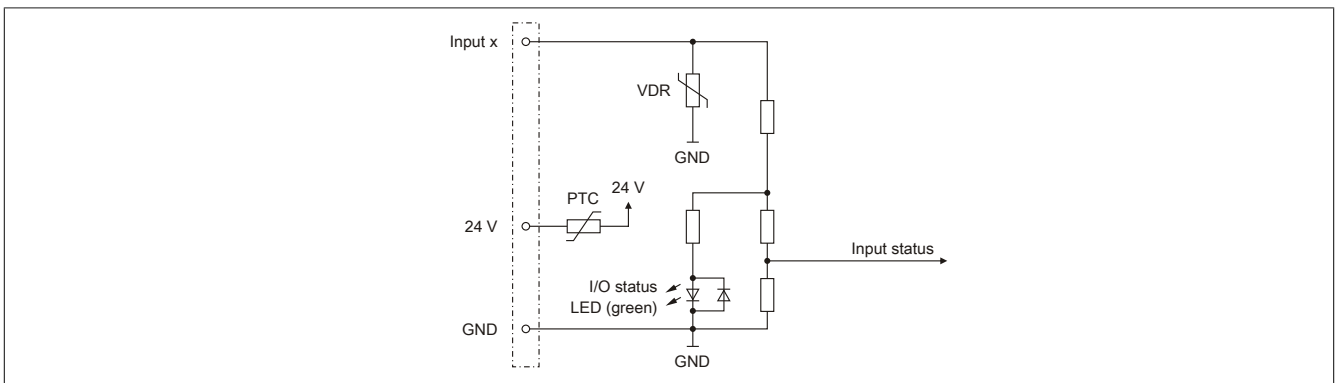
9.13.5.5 Pinout



9.13.5.6 Connection example

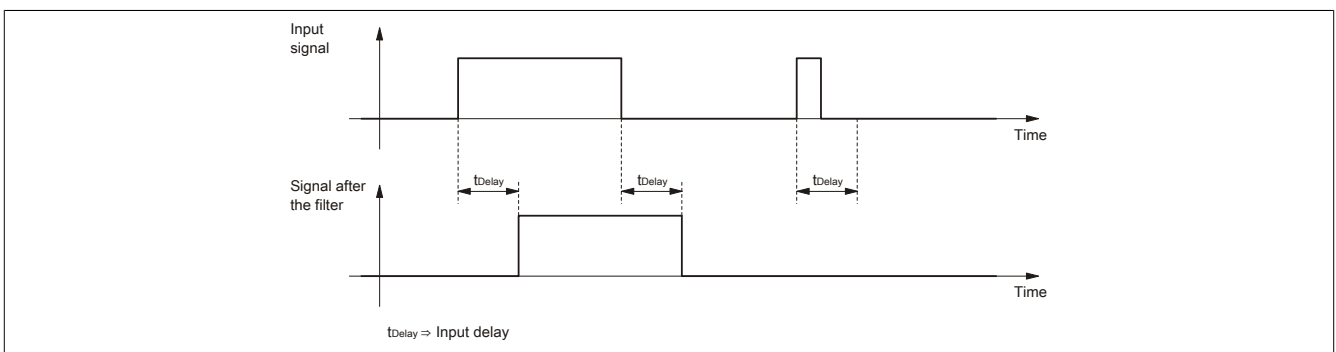


9.13.5.7 Input circuit diagram



9.13.5.8 Input filter

An input filter is available for each input. The input delay can be set using register "ConfigOutput01" on page 1463. Disturbance pulses which are shorter than the input delay are suppressed by the input filter.



Information:

The input filter is applied to **digital inputs in event counter mode with software**

The input filter is **NOT** applied in event counter mode without software.

9.13.5.9 Register description

9.13.5.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.13.5.9.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 18 | ConfigOutput01 (input filter) | USINT | | | | • |
| 20 | ConfigOutput02 (configuration counter 1) | USINT | | | | • |
| 22 | ConfigOutput03 (configuration counter 2) | USINT | | | | • |
| Communication | | | | | | |
| 0 | DigitalInput | USINT | • | | | |
| | DigitalInput01 | Bit 0 | | | | |
| | DigitalInput02 | Bit 1 | | | | |
| 4 | Counter01 | UINT | • | | | |
| 6 | Counter02 | UINT | • | | | |
| 20 | Counter configuration | USINT | | | • | |
| | ResetCounter01 | Bit 5 | | | | |
| 22 | Counter configuration | USINT | | | • | |
| | ResetCounter02 | Bit 5 | | | | |

9.13.5.9.3 Function model 1 - Input latch

| Register | Name | Data type | Read | | Write | |
|----------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 18 | ConfigOutput01 (input filter) | USINT | | | | • |
| 20 | ConfigOutput02 (configuration counter 1) | USINT | | | | • |
| 22 | ConfigOutput03 (configuration counter 2) | USINT | | | | • |
| Communication | | | | | | |
| 4 | Counter01 | UINT | • | | | |
| 6 | Counter02 | UINT | • | | | |
| 20 | Counter configuration | USINT | | | • | |
| | ResetCounter01 | Bit 5 | | | | |
| 22 | Counter configuration | USINT | | | • | |
| | ResetCounter02 | Bit 5 | | | | |
| 26 | Input status of digital latch inputs 1 - 2 | USINT | • | | | |
| | DigitalInputLatch01 | Bit 0 | | | | |
| | DigitalInputLatch02 | Bit 1 | | | | |
| 28 | Acknowledge digital inputs | USINT | | | • | |
| | DigitalInput01LatchQuitt | Bit 0 | | | | |
| | DigitalInput02LatchQuitt | Bit 1 | | | | |

9.13.5.9.4 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| 20 | - | ConfigOutput02 (configuration counter 1) | USINT | | | | • |
| 22 | - | ConfigOutput03 (configuration counter 2) | USINT | | | | • |
| Communication | | | | | | | |
| 4 | 0 | Counter01 | UINT | • | | | |
| 6 | 2 | Counter02 | UINT | • | | | |
| 20 | - | Counter configuration | USINT | | | | • |
| | | ResetCounter01 | Bit 5 | | | | |
| 22 | - | Counter configuration | USINT | | | | • |
| | | ResetCounter02 | Bit 5 | | | | |

1) The offset specifies where the register is within the CAN object.

9.13.5.9.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.13.5.9.4.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.13.5.9.5 Digital inputs

Unfiltered

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

Filtered

The filtered status is collected with a fixed offset to the network cycle and transferred in the same cycle. Filtering takes place asynchronously to the network in multiples of 200 μ s with a network-related jitter of up to 50 μ s.

9.13.5.9.5.1 Digital input filter

Name:

ConfigOutput01

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 μ s. It makes sense to enter values in steps of 2, however, since the input signals are sampled every 200 μ s.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No software filter (bus controller default setting) |
| | 2 | 0.2 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

9.13.5.9.5.2 Input status of digital inputs 1 to 2

Name:

DigitalInput or

DigitalInput01 to DigitalInput02

The input status of digital inputs 1 to 2 is mapped in this register.

Only function model 0 - Standard:

The "packed inputs" setting in the Automation Studio I/O configuration is used to determine whether all of this register's bits should be set up individually as data points in the Automation Studio I/O mapping ("DigitalInput01" through "DigitalInput02") or whether this register should be displayed as an individual USINT data point ("DigitalInput").

| Data type | Value | Information |
|-----------|------------------------|---|
| USINT | 0 to 3 | Packed inputs = On |
| | See the bit structure. | Packed inputs = Off or function model \neq 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|--------|--------------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input status - Digital input 1 |
| 1 | DigitalInput02 | 0 or 1 | Input state - Digital input 2 |

9.13.5.9.5.3 Input status of digital latch inputs 1 - 2

Name:

DigitalInputLatch01 to DigitalInputLatch02

The input status of digital inputs 1 to 2 after expiration of the input filter time is mapped in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|---------------------|--------|--|
| 0 | DigitalInputLatch01 | 0 or 1 | Input status of digital input 1 after expiration of the delay time |
| 1 | DigitalInputLatch02 | 0 or 1 | Input status of digital input 2 after expiration of the delay time |

9.13.5.9.6 Counter operation

The following operation modes can be selected:

- Event counter mode
- Event counter mode with software (processed after the input filter)
- Gate measurement

Event counter mode

The rising (positive) edges are registered on the counter input.

The counter state is registered with a fixed offset with respect to the network cycle and transferred in the same cycle.

Event counter mode with software

The rising (positive) edges are registered on the counter input. But the edges are first processed through the configured software filter.

The counter state is registered with a fixed offset with respect to the network cycle and transferred in the same cycle.

Gate measurement

The time of rising to falling edges for the gate input is registered using an internal frequency. The result is checked for overflow (0xFFFF) and corrected with the adjustable prescaler.

The recovery time between measurements must be >100 µs.

The measurement result is transferred with the falling edge to the result memory.

Information:

Only one of the counter channels at a time can be used for gate measurement.

9.13.5.9.6.1 Event or gate counter

Name:

Counter01 to Counter02

This register displays the results of the individual counters.

Event counter or gate measurement (16-bit counter value) depending on operating mode.

- **Configuration as an event counter**
This register contains the counter value of all positive edges on the input channel.
- **Configuration as gate measurement**
This register contains the counter value between positive and negative edges on the input channel. The absolute time duration depends on the set frequency.

| Data type | Value | Information |
|-----------|---------------|-------------------|
| UINT | Counter value | Default value = 0 |

Calculating the gate measurement

The measuring frequency can be set between 48 Mhz and 375 kHz (see "[Counter configuration](#)" on page 1465). The maximum time to be measured depends on the height of the measuring frequency. The higher the measuring frequency, the shorter the measurable time period.

Formula for converting the counter value into time

$$\text{Time}_{\text{ms}} = \text{Counter value} * \frac{1}{\text{Measuring frequency}_{\text{Hz}}}$$

Examples

$$3485 * (1 / 375000 \text{ Hz}) = 9.2933 \text{ ms}$$

$$10345 * (1 / 750000 \text{ Hz}) = 13.7933 \text{ ms}$$

$$33719 * (1 / 187500 \text{ Hz}) = 179.834 \text{ ms}$$

$$55760 * (1 / 6000000 \text{ Hz}) = 9.2933 \text{ ms}$$

9.13.5.9.6.2 Counter configuration

Name:

ConfigOutput02 to ConfigOutput03

This register can be used to configure the individual counters.

| Data type | Value | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| USINT | See bit structure. | 0 |

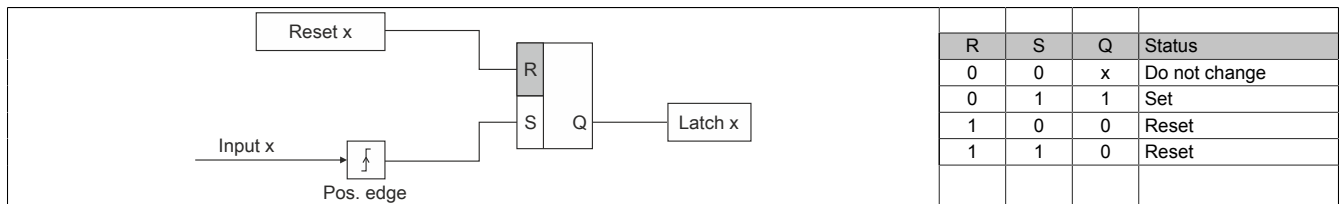
Bit structure:

| Bit | Name | Value | Information |
|-------|----------------------------------|-------|---|
| 0 - 3 | Counter frequency | 0 | 48 MHz (only for gate measurement) (bus controller default setting) |
| | | 1 | 3 MHz (only with gate measurement) |
| | | 1 | Event counter via software (only in event counter operation) |
| | | 2 | 187.5 kHz (only with gate measurement) |
| | | 3 | 24 MHz (only with gate measurement) |
| | | 4 | 12 MHz (only with gate measurement) |
| | | 5 | 6 MHz (only with gate measurement) |
| | | 6 | 1.5 MHz (only with gate measurement) |
| | | 7 | 750 kHz (only with gate measurement) |
| 4 | Reserved | 0 | |
| | | 8 | 375 kHz (only with gate measurement) |
| 5 | ResetCounter01 or ResetCounter02 | 0 | No influence on the counter |
| | | 1 | Clear counter (at rising edge) |
| 6 - 7 | | 0 | Event counter measurement (bus controller default setting) |
| | | 1 | Gate measurement |

9.13.5.9.7 Rising edge input latch

Using this function, the rising edges of the input signal can be latched with a resolution of 200 μ s. With the "Acknowledge - input latch" function, the input latch is either reset or prevented from latching.

It works in the same way as a dominant reset RS flip-flop.



9.13.5.9.7.1 Acknowledge digital inputs

Name:

DigitalInput01LatchQuitt to DigitalInput02LatchQuitt

This register is used to reset the input latches channel by channel.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|--------------------------|-------|----------------------------------|
| 0 | DigitalInput01LatchQuitt | 0 | No influence on the latch status |
| | | 1 | Resets the latch status |
| 1 | DigitalInput02LatchQuitt | 0 | No influence on the latch status |
| | | 1 | Resets the latch status |
| 2 - 7 | Reserved | - | |

9.13.5.9.8 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|--------|
| Without filtering | 100 µs |
| With filtering | 150 µs |

9.13.5.9.9 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|--------|
| Without filtering | 100 µs |
| With filtering | 200 µs |

9.13.6 X20DI2653

Data sheet version: 3.08

9.13.6.1 General Information

The module is equipped with 2 inputs for 3-wire connections. It is designed for an input voltage of 100 to 240 VAC.

- 2 digital inputs
- 100 to 240 VAC inputs
- 50 Hz or 60 Hz
- 3-wire connections
- 240 V coded

Danger!

Risk of electric shock!

The terminal block is only permitted to conduct voltage when it is connected. It is not permitted to be disconnected or connected while voltage is applied or have voltage applied to it while it is removed under any circumstances.

This module is not permitted to be the last module connected on the X2X Link network. At least one subsequent X20ZF dummy module must provide protection against contact.

9.13.6.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Digital inputs |  |
| X20DI2653 | X20 digital input module, 2 inputs, 100 to 240 VAC, 240 V keyed, 3-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM12 | X20 bus module, 240 VAC keyed, internal I/O power supply connected through | |
| | Terminal blocks | |
| X20TB32 | X20 terminal block, 12-pin, 240 VAC keyed | |
| | | |
| | | |
| | | |

Table 263: X20DI2653 - Order data

9.13.6.3 Technical data

| Model number | X20DI2653 |
|--|---|
| Short description | |
| I/O module | 2 digital inputs 100 to 240 VAC for 3-wire connections |
| General information | |
| B&R ID code | 0x2544 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| External I/O power supply | Yes, using software status (typ. threshold 85 VAC) |
| Power consumption | |
| Bus | 0.14 W |
| Internal I/O | - |
| External I/O | 0.55 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| Digital inputs | |
| Nominal voltage | 100 to 240 VAC |
| Input filter | |
| Software | Default 1 ms, configurable between 0 and 25 ms in 0.2 ms intervals |
| Hardware | |
| 1 → 0 | ≤30 ms |
| 0 → 1 | ≤40 ms |
| Connection type | 3-wire connections |
| Rated frequency | 47 to 63 Hz |
| Switching threshold | |
| Low | <40 VAC |
| High | >79 VAC |
| Isolation voltage between channel and bus | 1 minute 2500 VAC |
| Input voltage | |
| Maximum | 264 VAC |
| Input current | |
| 100 VAC / 60 Hz | 4 mA (Rev. ≥ E0), 5 mA (Rev. < E0) |
| 240 VAC / 50 Hz | 8.5 mA (Rev. ≥ E0), 11 mA (Rev. < E0) |
| Sensor power supply | |
| Voltage | Corresponds to the module power supply |
| Summation current | 2 A _{eff} |
| Short-circuit proof | No |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Not permitted |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |


Table 264: X20DI2653 - Technical data

| Model number | X20DI2653 |
|-----------------------|--|
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB32 separately. Order 1x bus module X20BM12 separately. |
| Spacing | 12.5 ^{+0.2} mm |

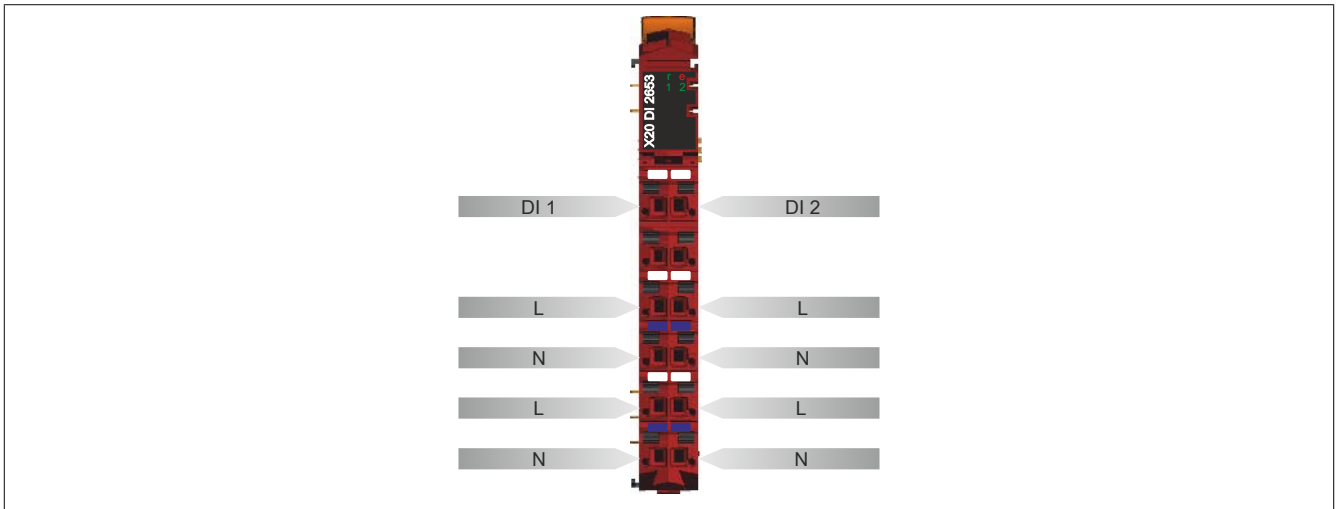
Table 264: X20DI2653 - Technical data

9.13.6.4 Status LEDs

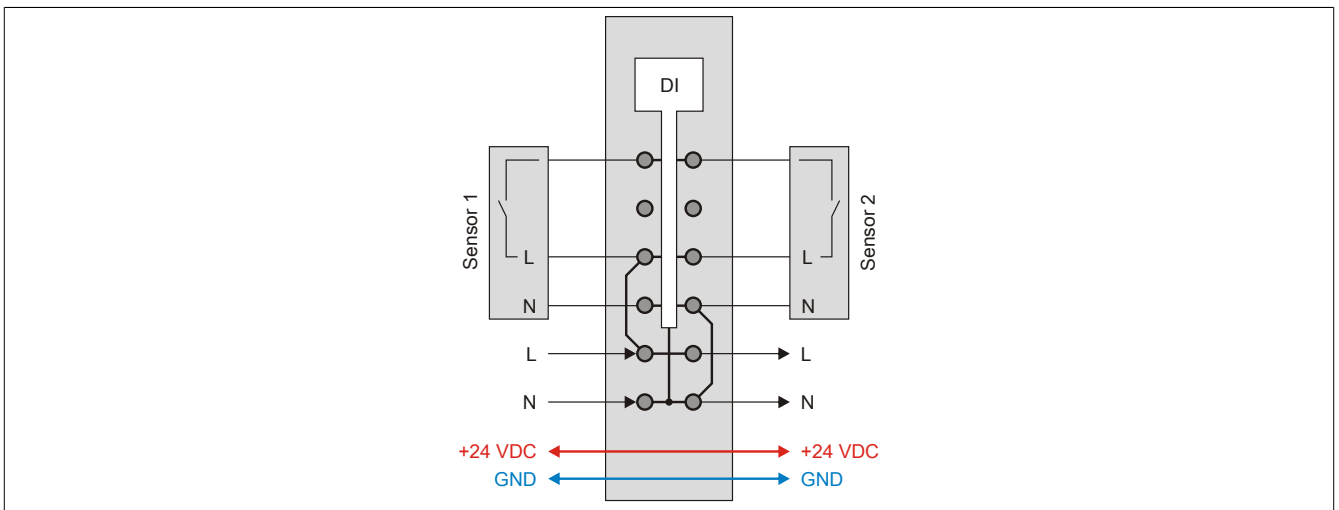
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Image | LED | Color | Status | Description |
|---|-------|-----------------------------|--------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | Module supply not connected or everything OK |
| | | | Double flash | External supply is too low or not connected |
| | e + r | Red on / Green single flash | | Invalid firmware |
| | 1 - 2 | Green | | Input status of the corresponding digital input |

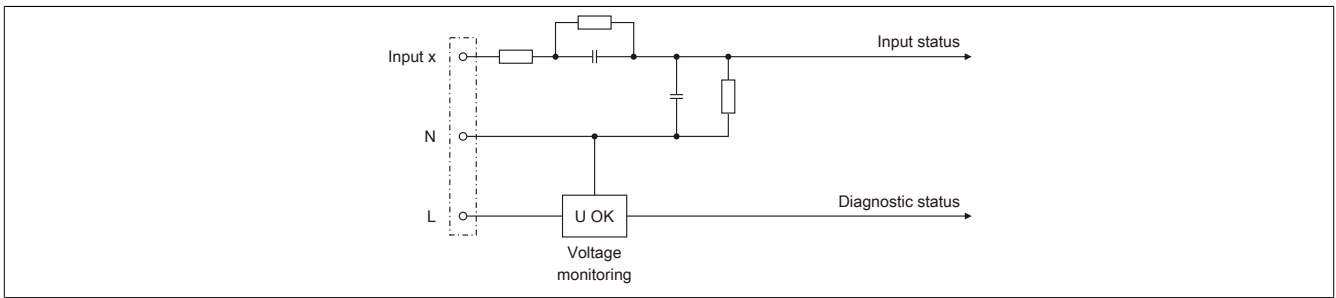
9.13.6.5 Pinout



9.13.6.6 Connection example

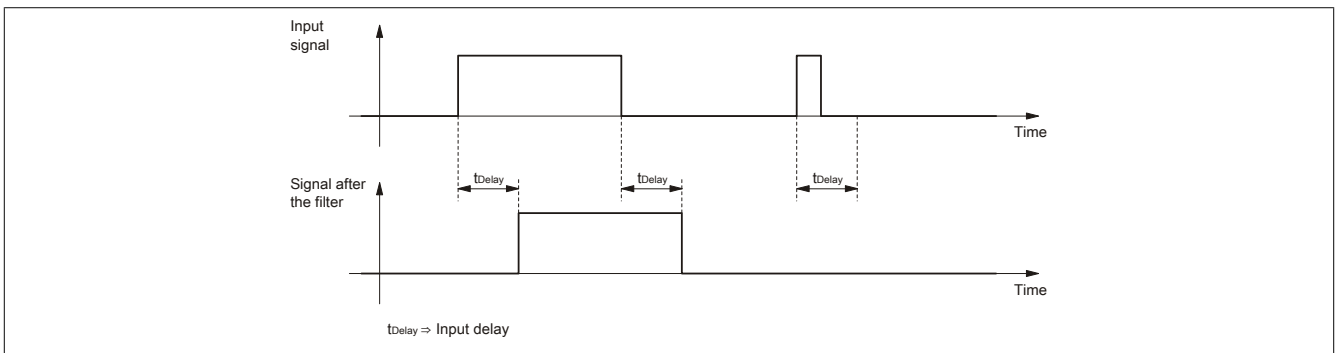


9.13.6.7 Input circuit diagram



9.13.6.8 Input filter

An input filter is available for each input. The input delay can be set using register "ConfigOutput01" on page 1472. Disturbance pulses which are shorter than the input delay are suppressed by the input filter.



9.13.6.9 Register description

9.13.6.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.13.6.9.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------------------|--------------|-------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 1 | DigitalInput | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | DigitalInput02 | Bit 1 | | | | |
| | | PowerSupply | Bit 7 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.13.6.9.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|---------------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | Input status of digital inputs 1 to 2 | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | DigitalInput02 | Bit 1 | | | | |
| | | PowerSupply | Bit 7 | | | | |

1) The offset specifies where the register is within the CAN object.

9.13.6.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.13.6.9.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.13.6.9.4 Digital inputs

Unfiltered

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

Filtered

The filtered status is collected with a fixed offset to the network cycle and transferred in the same cycle. Filtering takes place asynchronously to the network in multiples of 200 µs with a network-related jitter of up to 50 µs.

9.13.6.9.4.1 Digital input filter

Name:

ConfigOutput01

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 μ s. It makes sense to enter values in steps of 2, however, since the input signals are sampled every 200 μ s.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No software filter (bus controller default setting) |
| | 2 | 0.2 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

9.13.6.9.4.2 Input status of digital inputs 1 to 2

Name:

DigitalInput or

DigitalInput01 to DigitalInput02

PowerSupply

The input status of digital inputs 1 to 2 is mapped in this register.

Only function model 0 - Standard:

The "packed inputs" setting in the Automation Studio I/O configuration is used to determine whether all of this register's bits should be set up individually as data points in the Automation Studio I/O mapping ("DigitalInput01", "DigitalInput02" and "PowerSupply") or whether this register should be displayed as an individual USINT data point ("DigitalInput").

| Data type | Value | Information |
|-----------|------------------------|---|
| USINT | 0 to 255 | Packed inputs = On |
| | See the bit structure. | Packed inputs = Off or function model \neq 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-------|----------------|--------|--------------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input status - Digital input 1 |
| 1 | DigitalInput02 | 0 or 1 | Input state - Digital input 2 |
| 2 - 6 | Reserved | 0 | |
| 7 | PowerSupply | 0 | Supply voltage too low |
| | | 1 | Supply voltage >80 VAC |

9.13.6.9.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|-------------|
| Without filtering | 100 μ s |
| With filtering | 150 μ s |

9.13.6.9.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|-------------|
| Without filtering | 100 μ s |
| With filtering | 200 μ s |

9.13.7 X20(c)DI4371

Data sheet version: 3.19

9.13.7.1 General Information

The module is equipped with 4 inputs for 3-wire connections.

- 4 digital inputs
- Sink connection
- 3-wire connections
- 4 counter inputs with 1 kHz counter frequency
- 24 VDC and GND for sensor supply
- Software input filter can be configured for entire module

9.13.7.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.13.7.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.13.7.3 Order data

| Model number | Short description | Figure |
|--------------|---|--------|
| | Digital inputs | |
| X20DI4371 | X20 digital input module, 4 inputs, 24 VDC, sink, configurable input filter, 3-wire connections | |
| X20cDI4371 | X20 digital input module, coated, 4 inputs, 24 VDC, sink, configurable input filter, 3-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 265: X20DI4371, X20cDI4371 - Order data

9.13.7.4 Technical data

| Model number | X20DI4371 | X20cDI4371 |
|--|--|------------|
| Short description | | |
| I/O module | 4 digital inputs 24 VDC for 3-wire connections | |
| General information | | |
| B&R ID code | 0x1B92 | 0xE21F |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Power consumption | | |
| Bus | 0.14 W | |
| Internal I/O | 0.59 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Digital inputs | | |
| Nominal voltage | 24 VDC | |
| Input characteristics per EN 61131-2 | Type 1 | |
| Input voltage | 24 VDC -15 % / +20 % | |
| Input current at 24 VDC | Typ. 3.75 mA | |
| Input circuit | Sink | |
| Input filter | | |
| Hardware | ≤100 µs | |
| Software | Default 1 ms, configurable between 0 and 25 ms in 0.2 ms intervals | |
| Connection type | 3-wire connections | |
| Input resistance | Typ. 6.4 kΩ | |
| Switching threshold | | |
| Low | <5 VDC | |
| High | >15 VDC | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Event counters | | |
| Quantity | 4 | |
| Signal form | Square wave pulse | |
| Evaluation | Configurable edge event, cyclic counter | |
| Input frequency | Max. 1 kHz | |
| Counter 1 | Input 1 | |
| Counter 2 | Input 2 | |
| Counter 3 | Input 3 | |
| Counter 4 | Input 4 | |
| Counter frequency | Max. 1 kHz (when input filter switched off) | |
| Counter size | 16-bit | |
| Sensor power supply | | |
| Power consumption | Max. 12 W ¹⁾ | |
| Voltage | Module supply minus voltage drop for short circuit protection | |
| Voltage drop for short-circuit protection at 500 mA | Max. 2 VDC | |
| Summation current | 0.5 A | |
| Short-circuit proof | Yes | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |

Table 266: X20DI4371, X20cDI4371 - Technical data


| Model number | X20DI4371 | X20cDI4371 |
|--|--|---|
| Installation elevation above sea level | No limitations | |
| 0 to 2000 m | | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 266: X20DI4371, X20cDI4371 - Technical data

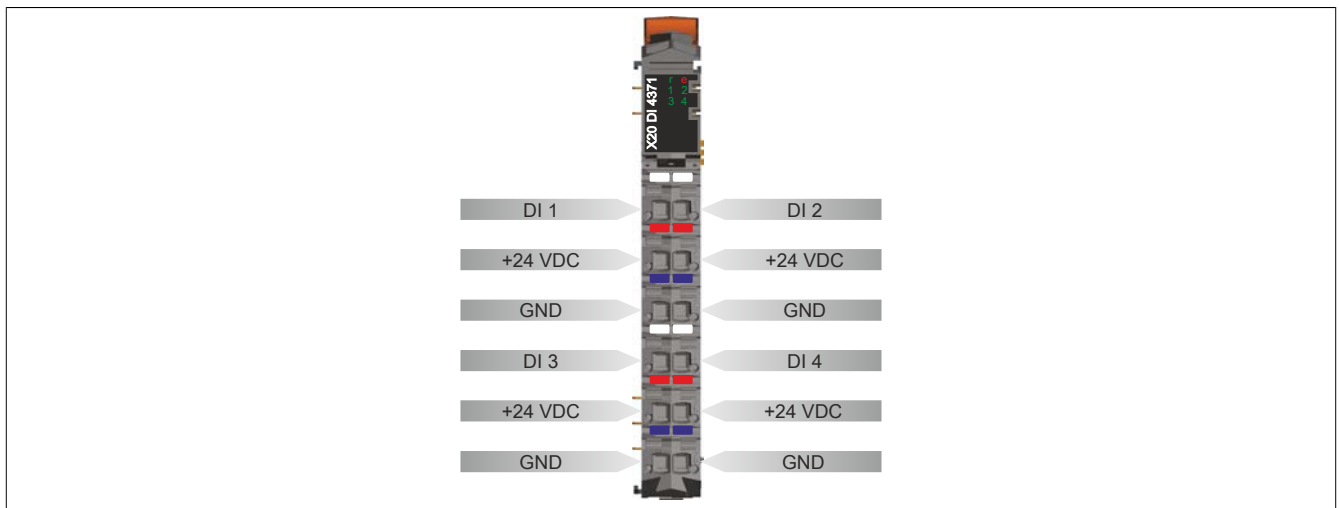
1) The power consumption of the sensors connected to the module is not permitted to exceed 12 W.

9.13.7.5 Status LEDs

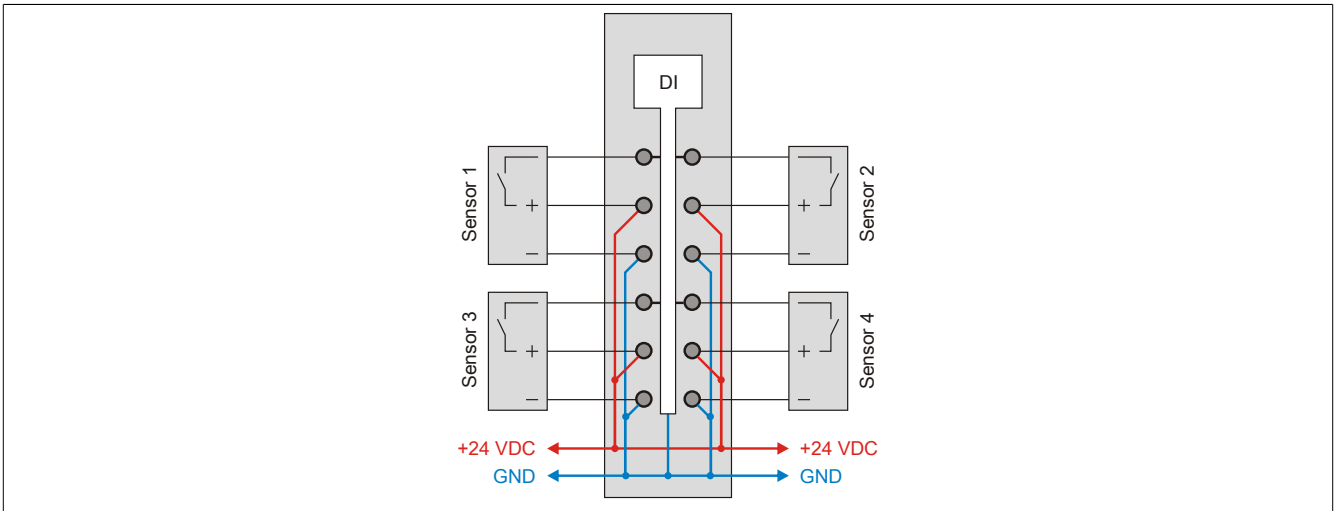
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Image | LED | Color | Status | Description |
|--|-------|-----------------------------|------------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | Module supply not connected or everything OK |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1 - 4 | Green | | Input status of the corresponding digital input |

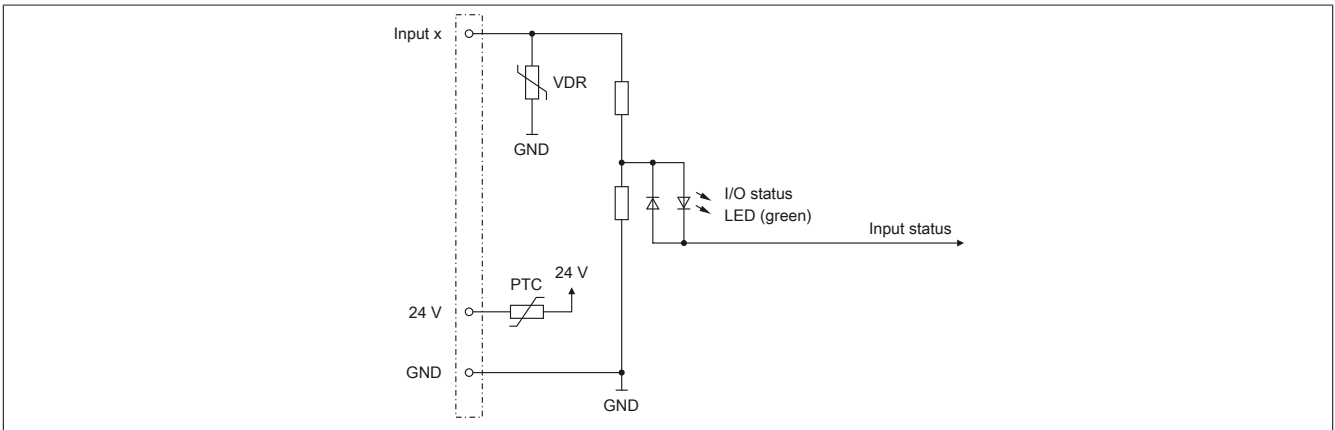
9.13.7.6 Pinout



9.13.7.7 Connection example

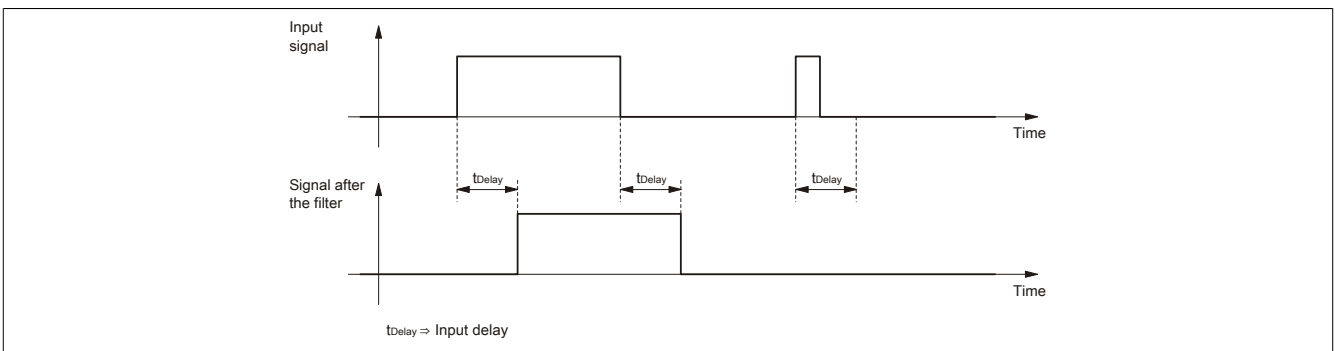


9.13.7.8 Input circuit diagram



9.13.7.9 Input filter

An input filter is available for each input. The input delay can be set using register "[ConfigOutput01](#)" on page 1478. Disturbance pulses which are shorter than the input delay are suppressed by the input filter.



9.13.7.10 Register description

9.13.7.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.13.7.10.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------------------|--------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 1 | DigitalInput | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput04 | Bit 3 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.13.7.10.3 Function model 1 - Event counter

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------------------|--------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 14 | - | ConfigOutput02 (edge configuration) | USINT | | | | • |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 1 | Input status of digital inputs 1 to 4 | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput04 | Bit 3 | | | | |
| 4 | 2 | Counter01 | UINT | • | | | |
| 6 | 4 | Counter02 | UINT | • | | | |
| 8 | 6 | Counter03 | UINT | • | | | |
| 10 | 8 | Counter04 | UINT | • | | | |
| 12 | 0 | Resets the counter registers | USINT | | | • | |
| | | ResetCounter01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | ResetCounter04 | Bit 3 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.13.7.10.4 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | Input status of digital inputs 1 to 4 | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput04 | Bit 3 | | | | |

1) The offset specifies where the register is within the CAN object.

9.13.7.10.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.13.7.10.4.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.13.7.10.5 Digital inputs

Unfiltered

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

Filtered

The filtered status is collected with a fixed offset to the network cycle and transferred in the same cycle. Filtering takes place asynchronously to the network in multiples of 200 μ s with a network-related jitter of up to 50 μ s.

9.13.7.10.5.1 Digital input filter

Name:

ConfigOutput01

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 μ s. It makes sense to enter values in steps of 2, however, since the input signals are sampled every 200 μ s.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No software filter (bus controller default setting) |
| | 2 | 0.2 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

9.13.7.10.5.2 Input status of digital inputs 1 to 4

Name:

DigitalInput or

DigitalInput01 to DigitalInput04

The input status of digital inputs 1 to 4 is mapped in this register.

Only function model 0 - Standard:

The "Packed inputs" setting in the Automation Studio I/O configuration is used to determine whether all of the bits from these registers should be set up individually as data points in the Automation Studio I/O mapping ("DigitalInput01" through "DigitalInput04") or whether this register should be displayed as an individual USINT data point ("DigitalInput").

| Data type | Value | Information |
|-----------|------------------------|---|
| USINT | 0 to 15 | Packed inputs = On |
| | See the bit structure. | Packed inputs = Off or function model \neq 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|--------|--------------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input status - Digital input 1 |
| ... | ... | ... | ... |
| 3 | DigitalInput04 | 0 or 1 | Input state - Digital input 4 |

9.13.7.10.6 The event counter function model

Starting with hardware variant F0 and firmware version 801, the module has four software counters for signal edges. Each counter register can be configured individually for falling, rising or both edges.

9.13.7.10.6.1 Counter register

Name:

Counter01 to Counter04

These registers provide the current counter value for the configured events.

| Data type | Value |
|-----------|------------|
| UINT | 0 to 65535 |

9.13.7.10.6.2 Resets the counter registers

Name:

ResetCounter01 to ResetCounter04

Using these data points, the corresponding counter registers can be reset to 0.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|-------|-----------------------------|
| 0 | ResetCounter01 | 0 | No change |
| | | 1 | Counter register 1 is reset |
| ... | | ... | |
| 3 | ResetCounter04 | 0 | No change |
| | | 1 | Counter register 4 is reset |

Information:

A counter is only reset if a positive edge is detected on the reset bit.

A continually set reset bit does not prevent counting in the counter register.

9.13.7.10.6.3 Configuration of the edges

Name:

ConfigOutput02

This register is used to configure which event will be assessed on the channel input for the respective counter.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-------------------------|-------|----------------------------|
| 0 | Rising edge on input 1 | 0 | Event is not counted |
| | | 1 | Event increments Counter01 |
| ... | | ... | |
| 3 | Rising edge on input 4 | 0 | Event is not counted |
| | | 1 | Event increments Counter04 |
| 4 | Falling edge on input 1 | 0 | Event is not counted |
| | | 1 | Event increments Counter01 |
| ... | | ... | |
| 7 | Falling edge on input 4 | 0 | Event is not counted |
| | | 1 | Event increments Counter04 |

9.13.7.10.7 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|--------|
| Without filtering | 100 µs |
| With filtering | 150 µs |

9.13.7.10.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|--------|
| Without filtering | 100 µs |
| With filtering | 200 µs |

9.13.8 X20DI4372

Data sheet version: 3.07

9.13.8.1 General Information

The module is equipped with 4 inputs for 3-wire connections.

- 4 digital inputs
- Source connection
- 3-wire connections
- 24 VDC and GND for sensor supply
- Software input filter can be configured for entire module

9.13.8.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Digital inputs |  |
| X20DI4372 | X20 digital input module, 4 inputs, 24 VDC, source, configurable input filter, 3-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 267: X20DI4372 - Order data

9.13.8.3 Technical data

| Model number | X20DI4372 |
|--|--|
| Short description | |
| I/O module | 4 digital inputs 24 VDC for 3-wire connections |
| General information | |
| B&R ID code | 0x22A8 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.14 W |
| Internal I/O | 0.59 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Digital inputs | |
| Nominal voltage | 24 VDC |
| Input characteristics per EN 61131-2 | Type 1 |
| Input voltage | 24 VDC -15 % / +20 % |
| Input current at 24 VDC | Typ. 3.75 mA |
| Input circuit | Source |
| Input filter | |
| Hardware | ≤100 µs |
| Software | Default 1 ms, configurable between 0 and 25 ms in 0.2 ms intervals |
| Connection type | 3-wire connections |
| Input resistance | Typ. 6.4 kΩ |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Sensor power supply | |
| Power consumption | Max. 12 W ¹⁾ |
| Voltage | Module supply minus voltage drop for short circuit protection |
| Voltage drop for short-circuit protection at 500 mA | Max. 2 VDC |
| Summation current | 0.5 A |
| Short-circuit proof | Yes |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |

Table 268: X20DI4372 - Technical data


| Model number | X20DI4372 |
|------------------------------|--|
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 268: X20DI4372 - Technical data

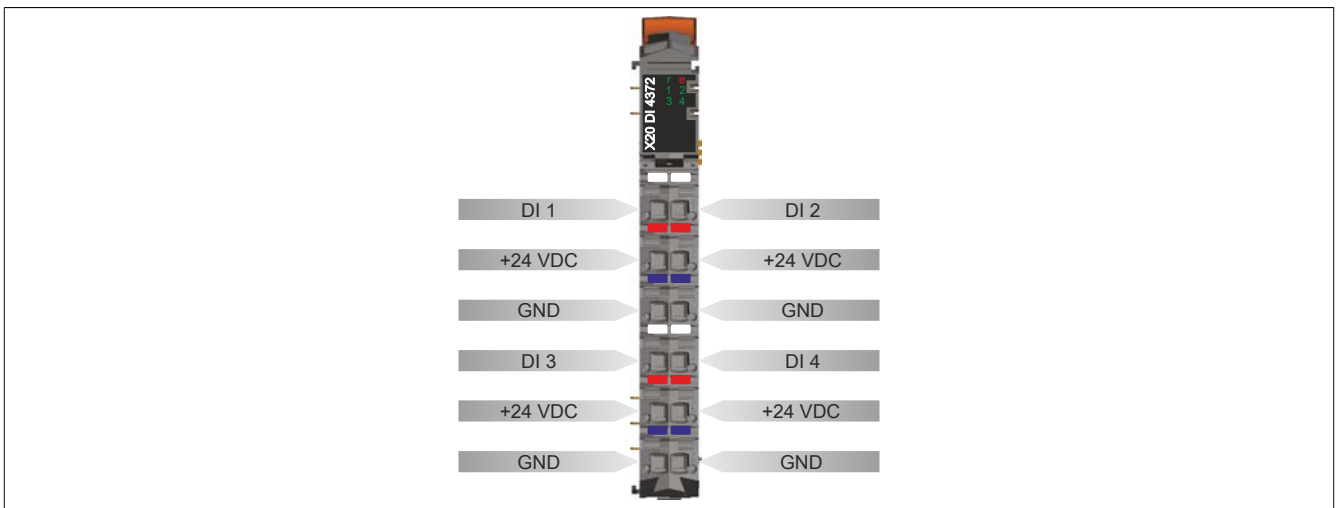
1) The power consumption of the sensors connected to the module is not permitted to exceed 12 W.

9.13.8.4 Status LEDs

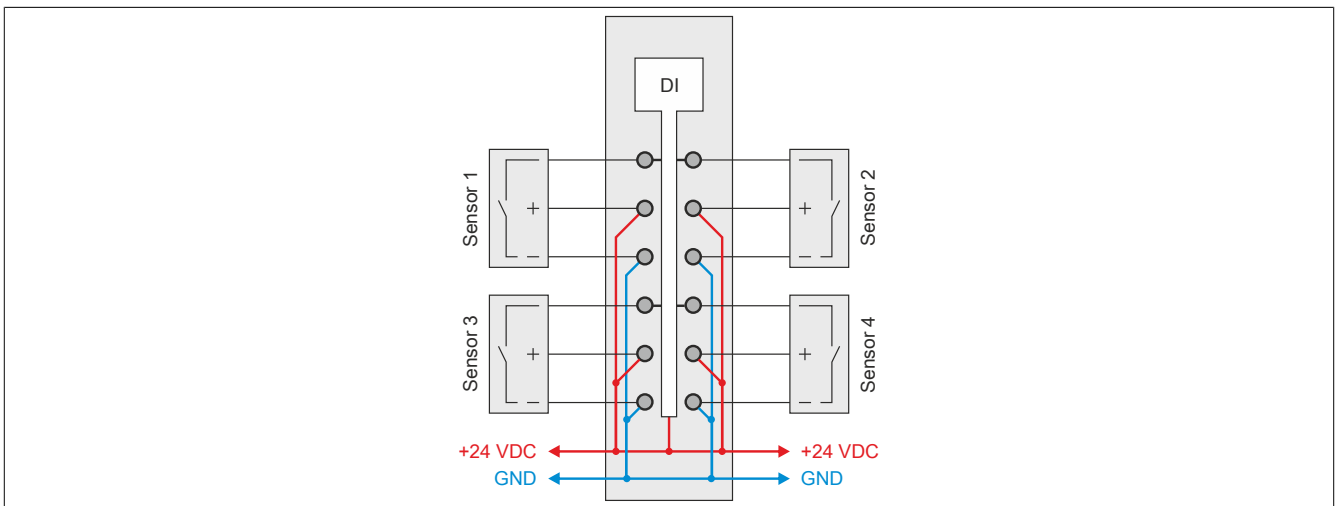
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Image | LED | Color | Status | Description |
|---|-------|-----------------------------|------------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | Module supply not connected or everything OK |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1 - 4 | Green | | Input status of the corresponding digital input |

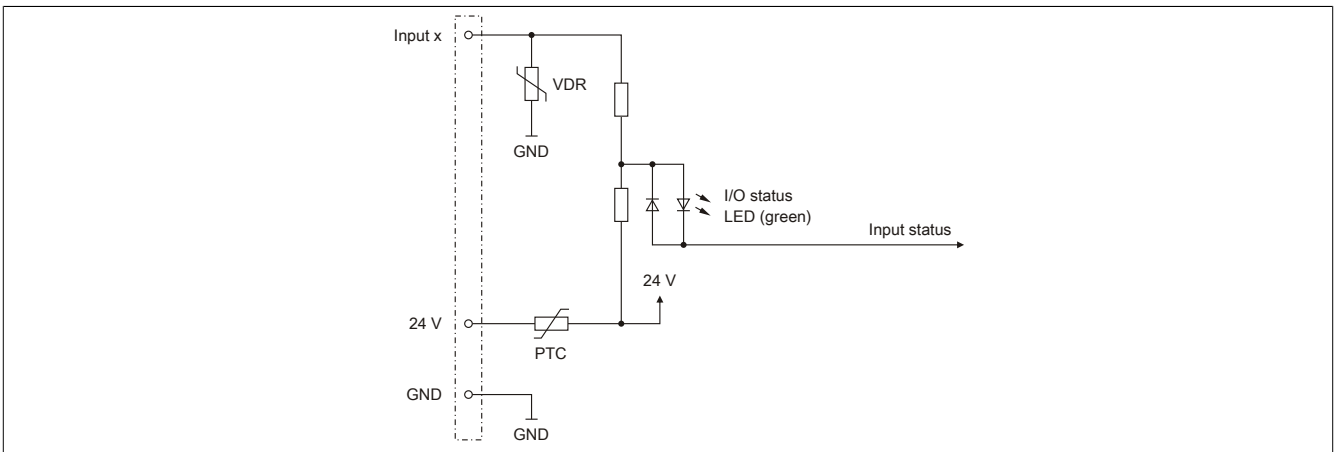
9.13.8.5 Pinout



9.13.8.6 Connection example

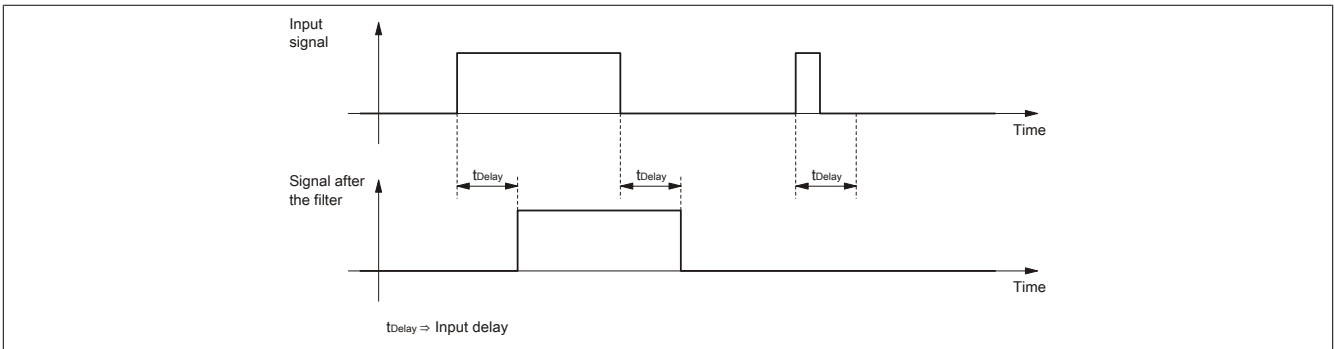


9.13.8.7 Input circuit diagram



9.13.8.8 Input filter

An input filter is available for each input. The input delay can be set using register "[ConfigOutput01](#)" on page 1485. Disturbance pulses which are shorter than the input delay are suppressed by the input filter.



9.13.8.9 Register description

9.13.8.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.13.8.9.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------------------|--------------|-------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 1 | DigitalInput | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput04 | Bit 3 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.13.8.9.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|---------------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | Input status of digital inputs 1 to 4 | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput04 | Bit 3 | | | | |

1) The offset specifies where the register is within the CAN object.

9.13.8.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "[Using I/O modules on the bus controller](#)" on page 3789.

9.13.8.9.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.13.8.9.4 Digital inputs

Unfiltered

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

Filtered

The filtered status is collected with a fixed offset to the network cycle and transferred in the same cycle. Filtering takes place asynchronously to the network in multiples of 200 µs with a network-related jitter of up to 50 µs.

9.13.8.9.4.1 Digital input filter

Name:

ConfigOutput01

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 μ s. It makes sense to enter values in steps of 2, however, since the input signals are sampled every 200 μ s.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No software filter (bus controller default setting) |
| | 2 | 0.2 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

9.13.8.9.4.2 Input status of digital inputs 1 to 4

Name:

DigitalInput or

DigitalInput01 to DigitalInput04

The input status of digital inputs 1 to 4 is mapped in this register.

Only function model 0 - Standard:

The "Packed inputs" setting in the Automation Studio I/O configuration is used to determine whether all of the bits from these registers should be set up individually as data points in the Automation Studio I/O mapping ("DigitalInput01" through "DigitalInput04") or whether this register should be displayed as an individual USINT data point ("DigitalInput").

| Data type | Value | Information |
|-----------|------------------------|---|
| USINT | 0 to 15 | Packed inputs = On |
| | See the bit structure. | Packed inputs = Off or function model \neq 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|--------|--------------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input status - Digital input 1 |
| ... | | ... | |
| 3 | DigitalInput04 | 0 or 1 | Input state - Digital input 4 |

9.13.8.9.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|-------------|
| Without filtering | 100 μ s |
| With filtering | 150 μ s |

9.13.8.9.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|-------------|
| Without filtering | 100 μ s |
| With filtering | 200 μ s |

9.13.9 X20(c)DI4375

Data sheet version: 2.20

9.13.9.1 General Information

The module is equipped with 4 inputs for 3-wire connections. It has open circuit and short circuit detection. This detection can be switched off individually for each channel.

- 4 digital inputs
- Sink connection
- 3-wire connections
- 24 VDC and GND for sensor supply
- Open circuit and short circuit detection, can be switched off individually for each channel
- Software input filter can be configured for entire module

9.13.9.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.13.9.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C . During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.13.9.3 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Digital inputs |  |
| X20DI4375 | X20 digital input module, 4 inputs, 24 VDC, sink, configurable input filter, open-circuit and short-circuit detection, 3-wire connections | |
| X20cDI4375 | X20 digital input module, coated, 4 inputs, 24 VDC, sink, configurable input filter, open-circuit and short-circuit detection, 3-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 269: X20DI4375, X20cDI4375 - Order data

9.13.9.4 Technical data

| Model number | X20DI4375 | X20cDI4375 |
|--|---|------------|
| Short description | | |
| I/O module | 4 digital inputs 24 VDC for 3-wire connections, open-circuit and short-circuit detection, possible to switch off detection for each channel | |
| General information | | |
| B&R ID code | 0xA911 | 0xE220 |
| Status indicators | I/O function per channel, operating state, module status, sensor line, sensor power supply | |
| Diagnostics | | |
| Module run/error | Yes, using LED status indicator and software | |
| Open circuit | Yes, using LED status indicator and software | |
| Short circuit | Yes, using LED status indicator and software | |
| Sensor power supply | Yes, using LED status indicator and software | |
| Other channel errors | Yes, using LED status indicator and software | |
| Power consumption | | |
| Bus | 0.01 W | |
| Internal I/O | 1.1 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Digital inputs | | |
| Nominal voltage | 24 VDC | |
| Input voltage | 24 VDC -15% / +20% | |
| Input current at 24 VDC | Typ. 4.8 mA (standard wiring) | |
| Input circuit | Sink | |
| Input filter | | |
| Hardware | 0.8 ms | |
| Software | Default 1 ms, configurable between 0 and 25 ms in 0.2 ms increments | |
| Connection type | 3-wire connections | |
| Sensor power supply | 4x 50 mA | |
| Open-circuit and short-circuit detection | Yes, possible to switch off for each channel | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitation | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Starting temperature | - | Yes, -40°C |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |


Table 270: X20DI4375, X20cDI4375 - Technical data

| Model number | X20DI4375 | X20cDI4375 |
|------------------------------|--|---|
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x bus module X20BM11 separately. | Order 1x terminal block X20TB12 separately. Order 1x bus module X20cBM11 separately. |
| Pitch | 12.5 ^{+0.2} mm | |

Table 270: X20DI4375, X20cDI4375 - Technical data

9.13.9.5 Status LEDs

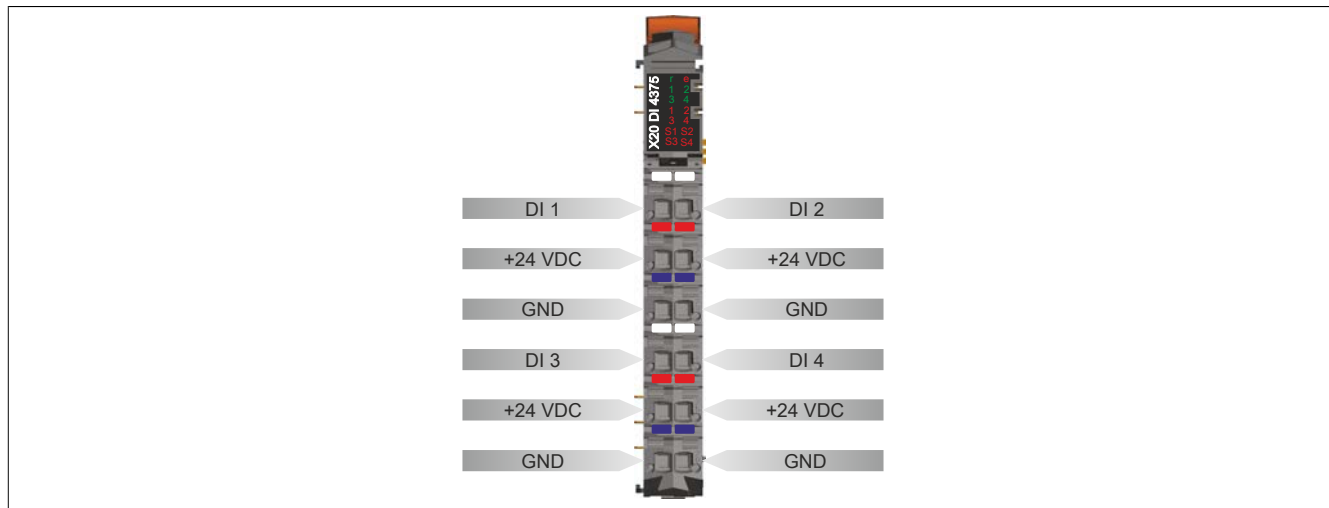
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Image | LED | Color | Status | Description |
|---|-------|-------|--|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | Module supply not connected or everything OK |
| | | | Single flash | Summary status for channel error → Check the red channel LEDs 1 - 4 |
| | | | Double flash | Module supply below lower limit |
| | 1 - 4 | Green | Off | Input status of the corresponding digital input |
| | | | On | Input status of the corresponding digital input |
| | 1 - 4 | Red | Off | No error detected |
| | | | Single flash | Short circuit of respective digital input with +24 VDC |
| | | | Blinking | Open circuit or the measured value is below the lower switch off threshold |
| | | | Single flash, inverse | Other channel error |
| | | | On | Other channel error |
| S1 - S4 | Red | Off | Sensor supply OK | |
| | | On | Sensor supply monitor has detected something | |

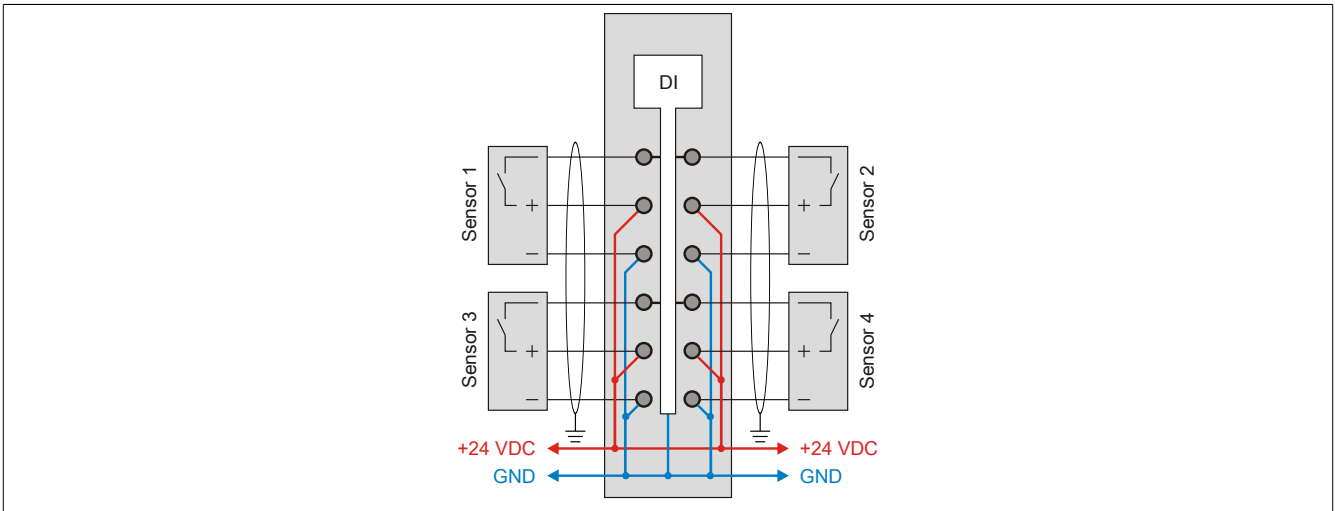
1) Depending on the configuration, a firmware update can take up to several minutes.

9.13.9.6 Pinout

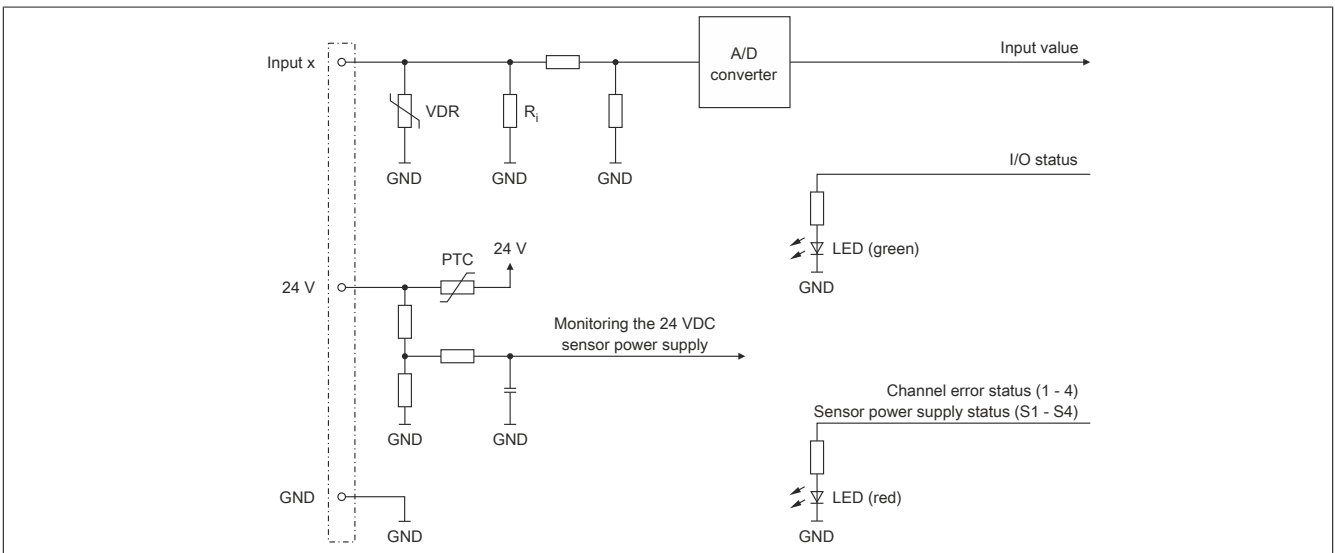
Shielded cables should be used for all connections.



9.13.9.7 Connection example

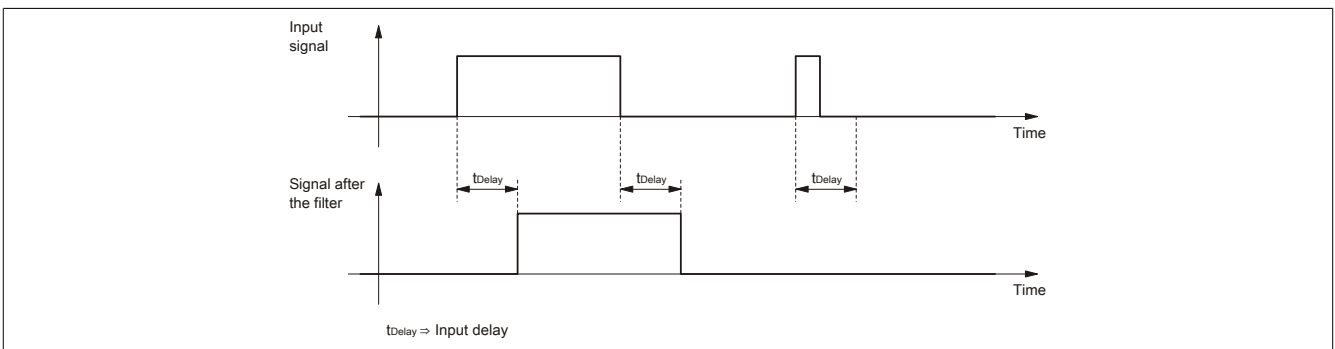


9.13.9.8 Input circuit diagram



9.13.9.9 Input filter

An input filter is available for each input. The input delay can be set using register "ConfigOutput02" on page 1494. Disturbance pulses which are shorter than the input delay are suppressed by the input filter.



9.13.9.10 Open circuit and short circuit detection

General Information

The X20DI4375 digital input module is equipped with open line and short circuit detection. To do this the sensor needs to be connected to the necessary resistances.


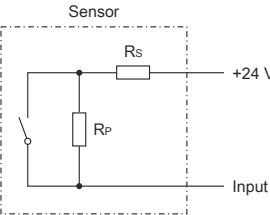
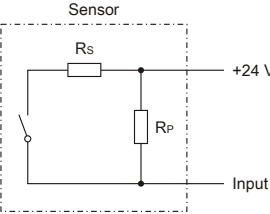
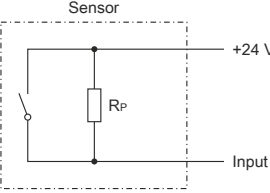
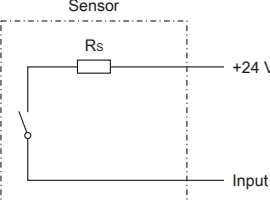
Sensor connections

The resistances are connected to the sensor parallel or in series. The following values are defined for the resistances:

| Resistance | Range |
|------------|--------------------------|
| Serial | 1 - 2 k Ω (10%) |
| Parallel | 10 - 20 k Ω (10%) |

Connection options

To guarantee error-free functionality of the open circuit and short circuit detection, the +24 VDC sensor supply from the module must absolutely be used.

| Sensor connections | Description | Detection | Setting in configuration register |
|---|--------------------------------|--------------------------------|-----------------------------------|
|  | Standard connection | - | 0 |
|  | Series and parallel resistance | Open circuit and short circuit | 1 |
|  | Parallel and series resistor | Open circuit and short circuit | 2 |
|  | Parallel resistance | Open line | 3 |
|  | Series resistor | Short circuit | 4 |

9.13.9.11 Error status

The following errors are detected by the module and can be evaluated separately for each channel:

- Sensor line short circuit
- Sensor line open circuit
- Sensor supply
- Other channel error

9.13.9.12 Timestamp

Each converted value is given a timestamp. The time of the last conversion can be read.

9.13.9.13 Configuration

The sensor connections and therefore the sensor monitoring are set in the configuration register. Sensor monitoring and the settings in the configuration register are described in section "[Open circuit and short circuit detection](#)" on [page 1490](#).

9.13.9.14 Register description

9.13.9.14.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.13.9.14.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 2050 | ConfigOutput01 (power monitoring) | UINT | | | | • |
| 2053 | ConfigOutput02 (input filter) | USINT | | | | • |
| Communication | | | | | | |
| 2305 | DigitalInput | USINT | • | | | |
| | DigitalInput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalInput04 | Bit 3 | | | | |
| | StateDigitalInput01 | Bit 4 | | | | |
| | ... | ... | | | | |
| 2307 | StatusInput01 | USINT | • | | | |
| | SC_DigitalInput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | SC_DigitalInput04 | Bit 3 | | | | |
| 2309 | StatusInput02 | USINT | • | | | |
| | WB_DigitalInput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | WB_DigitalInput04 | Bit 3 | | | | |
| 2311 | StatusInput03 | USINT | • | | | |
| | SM_DigitalInput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | SM_DigitalInput04 | Bit 3 | | | | |
| 2313 | StatusInput04 | USINT | • | | | |
| | IE_DigitalInput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | IE_DigitalInput01 | Bit 3 | | | | |
| 2324 | SampleTimeStamp | UDINT | • | | | |

9.13.9.14.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|---|-----------|-----------------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 2050 | - | ConfigOutput01 (power monitoring) | UINT | | | | • |
| 2053 | - | ConfigOutput02 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 2305 | 0 | Input status of digital inputs 1 to 4 | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput04 | Bit 3 | | | | |
| | | StateDigitalInput01 | Bit 4 | | | | |
| 2307 | - | Short circuit monitoring of channels 1 to 4 | USINT | | • | | |
| | | SC_DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | SC_DigitalInput04 | Bit 3 | | | | |
| | | Open line monitoring on channels 1 to 4 | USINT | | | | |
| WB_DigitalInput01 | Bit 0 | | | | | | |
| ... | ... | | | | | | |
| WB_DigitalInput04 | Bit 3 | | | | | | |
| 2311 | - | Voltage monitoring on channels 1 to 4 | USINT | | • | | |
| | | SM_DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | SM_DigitalInput04 | Bit 3 | | | | |
| | | 2313 | - | | | | |
| IE_DigitalInput01 | Bit 0 | | | | | | |
| ... | ... | | | | | | |
| IE_DigitalInput01 | Bit 3 | | | | | | |
| 2324 | - | | | SampleTimeStamp | UDINT | | • |

1) The offset specifies the position of the register within the CAN object.

9.13.9.14.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.13.9.14.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.13.9.14.4 Digital inputs

Unfiltered

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

Filtered

The filtered status is collected with a fixed offset to the network cycle and transferred in the same cycle. Filtering takes place asynchronously to the network in multiples of 200 µs with a network-related jitter of up to 50 µs.

9.13.9.14.4.1 Digital input filter

Name:

ConfigOutput02

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 μ s. It makes sense to enter values in steps of 2, however, since the input signals are sampled every 200 μ s.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No software filter (bus controller default setting) |
| | 2 | 0.2 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

9.13.9.14.4.2 Input status of digital inputs 1 to 4

Name:

DigitalInput or

DigitalInput01 to DigitalInput04

StateDigitalInput01 to StateDigitalInput04

The input status and status of digital inputs 1 to 4 are mapped in this register.

Only function model 0 - Standard:

The "Packed inputs" setting in the Automation Studio I/O configuration is used to determine whether all of the bits from these registers should be set up individually as data points in the Automation Studio I/O mapping ("DigitalInput01" through "DigitalInput04" and "StateDigitalInput01" through "StateDigitalInput04") or whether this register should be displayed as an individual USINT data point ("DigitalInput").

| Data type | Value | Information |
|-----------|------------------------|---|
| USINT | 0 to 255 | Packed inputs = On |
| | See the bit structure. | Packed inputs = Off or function model \neq 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-----|---------------------|--------|--|
| 0 | DigitalInput01 | 0 or 1 | Input status - Digital input 1 |
| ... | | ... | |
| 3 | DigitalInput04 | 0 or 1 | Input state - Digital input 4 |
| 4 | StateDigitalInput01 | 0 | No error |
| | | 1 | Short-circuit, open line, sensor monitoring error or other channel error |
| ... | | ... | |
| 7 | StateDigitalInput04 | 0 | No error |
| | | 1 | Short-circuit, open line, sensor monitoring error or other channel error |

9.13.9.14.5 Short circuit monitoring of channels 1 to 4

Name:

StatusInput01 or

SC_DigitalInput01 to SC_DigitalInput04

This register indicates whether a short circuit has occurred on the individual channels.

Function model 0 - Standard only:

The "Packed inputs" setting in the Automation Studio I/O configuration is used to determine whether all of the bits from these registers should be set up individually as data points in the Automation Studio I/O mapping ("SC_DigitalInput01" through "SC_DigitalInput04") or whether this register should be displayed as an individual USINT data point ("StatusInput01").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 15 | Packed inputs = On |
| | See the bit structure. | Packed inputs = Off or function model ≠ 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-------|-------------------|-------|----------------------------|
| 0 | SC_DigitalInput01 | 0 | No error |
| | | 1 | Short circuit on channel 1 |
| ... | | ... | |
| 3 | SC_DigitalInput04 | 0 | No error |
| | | 1 | Short circuit on channel 4 |
| 4 - 7 | Reserved | - | |

9.13.9.14.6 Open line monitoring on channels 1 to 4

Name:

StatusInput02 or

WB_DigitalInput01 to WB_DigitalInput04

This register indicates whether an open line has occurred on the individual channels.

Function model 0 - Standard only:

The "Packed inputs" setting in the Automation Studio I/O configuration is used to determine whether all of the bits from these registers should be set up individually as data points in the Automation Studio I/O mapping ("WB_DigitalInput01" through "WB_DigitalInput04") or whether this register should be displayed as an individual USINT data point ("StatusInput02").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 15 | Packed inputs = On |
| | See the bit structure. | Packed inputs = Off or function model ≠ 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-------|-------------------|-------|------------------------|
| 0 | WB_DigitalInput01 | 0 | No error |
| | | 1 | Open line on channel 1 |
| ... | | ... | |
| 3 | WB_DigitalInput04 | 0 | No error. |
| | | 1 | Open line on channel 4 |
| 4 - 7 | Reserved | - | |

9.13.9.14.7 Voltage monitoring on channels 1 to 4

Name:

StatusInput03 or
SM_DigitalInput01 to SM_DigitalInput04

This register monitors the voltage supply on the individual channels.

Function model 0 - Standard only:

The "Packed inputs" setting in the Automation Studio I/O configuration is used to determine whether all of the bits from these registers should be set up individually as data points in the Automation Studio I/O mapping ("SM_DigitalInput01" through "SM_DigitalInput04") or whether this register should be displayed as an individual USINT data point ("StatusInput03").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 15 | Packed inputs = On |
| | See the bit structure. | Packed inputs = Off or function model ≠ 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-------|-------------------|-------|----------------------------------|
| 0 | SM_DigitalInput01 | 0 | No error |
| | | 1 | Sensor supply error on channel 1 |
| ... | | ... | |
| 3 | SM_DigitalInput04 | 0 | No error |
| | | 1 | Sensor supply error on channel 4 |
| 4 - 7 | Reserved | - | |

9.13.9.14.8 Error monitoring on channels 1 to 4

Name:

StatusInput04 or
IE_DigitalInput01 to IE_DigitalInput04

This register indicates whether any other errors have occurred on the individual channels.

Function model 0 - Standard only:

The "Packed inputs" setting in the Automation Studio I/O configuration is used to determine whether all of the bits from these registers should be set up individually as data points in the Automation Studio I/O mapping ("IE_DigitalInput01" through "IE_DigitalInput04") or whether this register should be displayed as an individual USINT data point ("StatusInput04").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 15 | Packed inputs = On |
| | See the bit structure. | Packed inputs = Off or function model ≠ 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-------|-------------------|-------|--------------------------|
| 0 | IE_DigitalInput01 | 0 | No error |
| | | 1 | Other error on channel 1 |
| ... | | ... | |
| 3 | IE_DigitalInput04 | 0 | No error |
| | | 1 | Other error on channel 4 |
| 4 - 7 | Reserved | - | |

9.13.9.14.9 Timestamp of last conversion

Name:

SampleTimeStamp

This register shows the timestamp of the last conversion in μ s.

| Data type | Value |
|-----------|---|
| UDINT | Timestamp of the last conversion in μ s |

9.13.9.14.10 Configuration of line status monitoring

Name:

ConfigOutput01

This register is used to configure short circuit monitoring and line status monitoring on the inputs.

| Data type | Value | Bus controller default setting |
|-----------|-------------------|--------------------------------|
| UINT | See bit structure | 0 |

Bit structure:

| Bit | Name | Value | Information |
|---------|-----------------------------------|---------|---|
| 0 - 3 | Channel configuration - Channel 1 | 0 | Default (bus controller default setting) |
| | | 1 | Serial/Parallel: R-1k in series with (R-10k parallel to the switch) |
| | | 2 | Parallel/Serial: R-10k parallel to (R-1k in series with switch) |
| | | 3 | Parallel: R-10k parallel to switch |
| | | 4 | Serial: R-1k in series with switch |
| | | 5 to 15 | Inactive |
| 4 - 7 | Channel configuration - Channel 2 | 0 to 15 | See Channel configuration - Channel 1 |
| 8 - 11 | Channel configuration - Channel 3 | 0 to 15 | See Channel configuration - Channel 1 |
| 12 - 15 | Channel configuration - Channel 4 | 0 to 15 | See Channel configuration - Channel 1 |

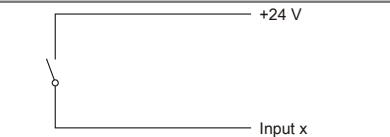
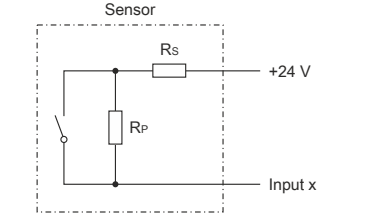
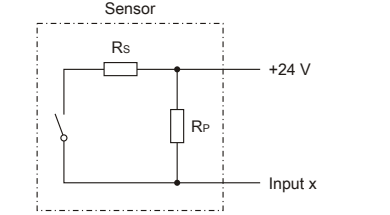
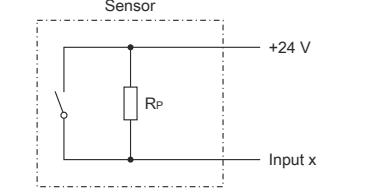
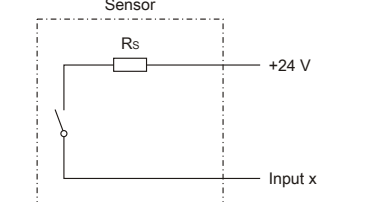
The name R-1k indicates a resistance in the permitted range of 1000 Ohm to 2000 Ohm with an accuracy of 10%.

The name R-10k indicates a resistance in the permitted range of 10000 Ohm to 20000 Ohm with an accuracy of 10%.

Information:

Inputs that are not being used should be set to the type "Standard" or "Serial" to prevent mistakes.

Configuration Possibilities:

| Value | Configuration | Diagram | Information |
|-------|-----------------|---|---|
| 0 | Standard |  | Short-circuit detection and line break monitoring is not possible when using this configuration. |
| 1 | Serial/parallel |  | Short-circuit detection and line break monitoring is possible with this configuration. |
| 2 | Parallel/serial |  | Short-circuit detection and line break monitoring is possible with this configuration. |
| 3 | Parallel |  | This configuration allows line break monitoring. Short-circuit detection is not possible when using this configuration. |
| 4 | Serial |  | This configuration allows short circuit detection. Line break monitoring is not possible when using this configuration. |

9.13.9.14.11 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|--------|
| All channels | 150 µs |

9.13.9.14.12 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|--------|
| All channels | 150 µs |

9.13.10 X20DI4653

Data sheet version: 3.08

9.13.10.1 General Information

The module is equipped with 4 inputs for 2-wire connections. It is designed for an input voltage of 100 to 240 VAC.

- 4 digital inputs
- 100 to 240 VAC inputs
- 50 Hz or 60 Hz
- 2-wire connections
- 240 V coded

Danger!

Risk of electric shock!

The terminal block is only permitted to conduct voltage when it is connected. It is not permitted to be disconnected or connected while voltage is applied or have voltage applied to it while it is removed under any circumstances.

This module is not permitted to be the last module connected on the X2X Link network. At least one subsequent X20ZF dummy module must provide protection against contact.

9.13.10.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Digital inputs |  |
| X20DI4653 | X20 digital input module, 4 inputs, 100 to 240 VAC, 240 V keyed, 2-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM12 | X20 bus module, 240 VAC keyed, internal I/O power supply connected through | |
| | Terminal blocks | |
| X20TB32 | X20 terminal block, 12-pin, 240 VAC keyed | |
| | | |
| | | |
| | | |

Table 271: X20DI4653 - Order data

9.13.10.3 Technical data

| | |
|--|---|
| Model number | X20DI4653 |
| Short description | |
| I/O module | 4 digital inputs 100 to 240 VAC for 2-wire connections |
| General information | |
| B&R ID code | 0x2545 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| External I/O power supply | Yes, using software status (typ. threshold 85 VAC) |
| Power consumption | |
| Bus | 0.17 W |
| Internal I/O | - |
| External I/O | 0.91 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| Digital inputs | |
| Nominal voltage | 100 to 240 VAC |
| Input filter | |
| Software | Default 1 ms, configurable between 0 and 25 ms in 0.2 ms intervals |
| Hardware | |
| 1 → 0 | ≤30 ms |
| 0 → 1 | ≤40 ms |
| Connection type | 2-wire connections |
| Rated frequency | 47 to 63 Hz |
| Switching threshold | |
| Low | <40 VAC |
| High | >79 VAC |
| Isolation voltage between channel and bus | 1 minute 2500 VAC |
| Input voltage | |
| Maximum | 264 VAC |
| Input current | |
| 100 VAC / 60 Hz | 4 mA (Rev. ≥ E0), 5 mA (Rev. < E0) |
| 240 VAC / 50 Hz | 8.5 mA (Rev. ≥ E0), 11 mA (Rev. < E0) |
| Sensor power supply | |
| Voltage | Corresponds to the module power supply |
| Short-circuit proof | No |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Not permitted |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |


Table 272: X20DI4653 - Technical data

| | |
|------------------------------|--|
| Model number | X20DI4653 |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB32 separately. Order 1x bus module X20BM12 separately. |
| Spacing | 12.5 ^{+0.2} mm |

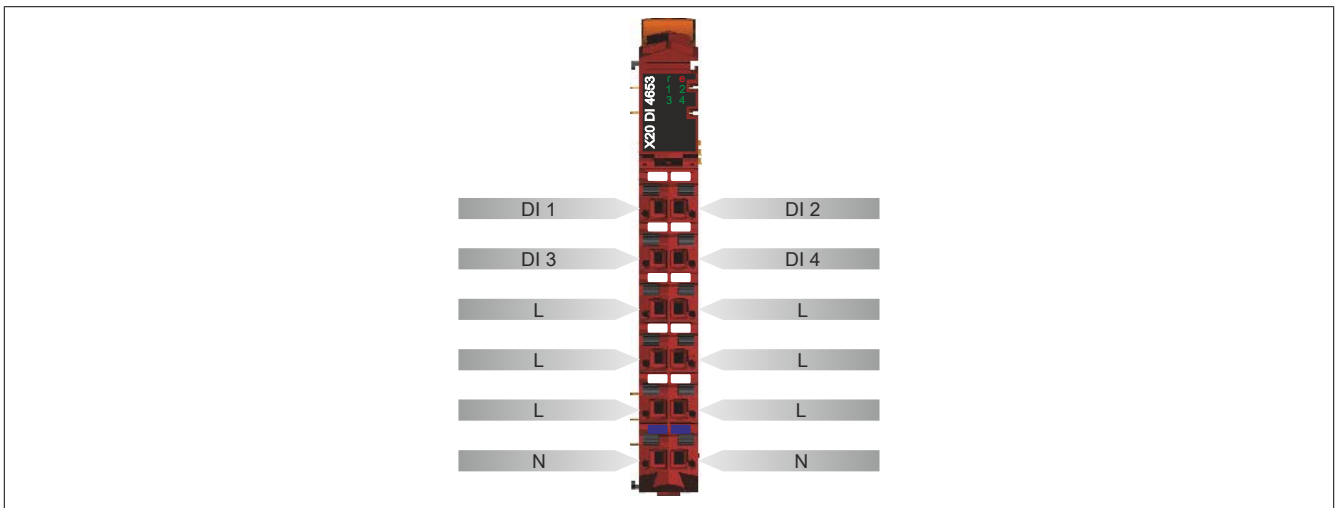
Table 272: X20DI4653 - Technical data

9.13.10.4 Status LEDs

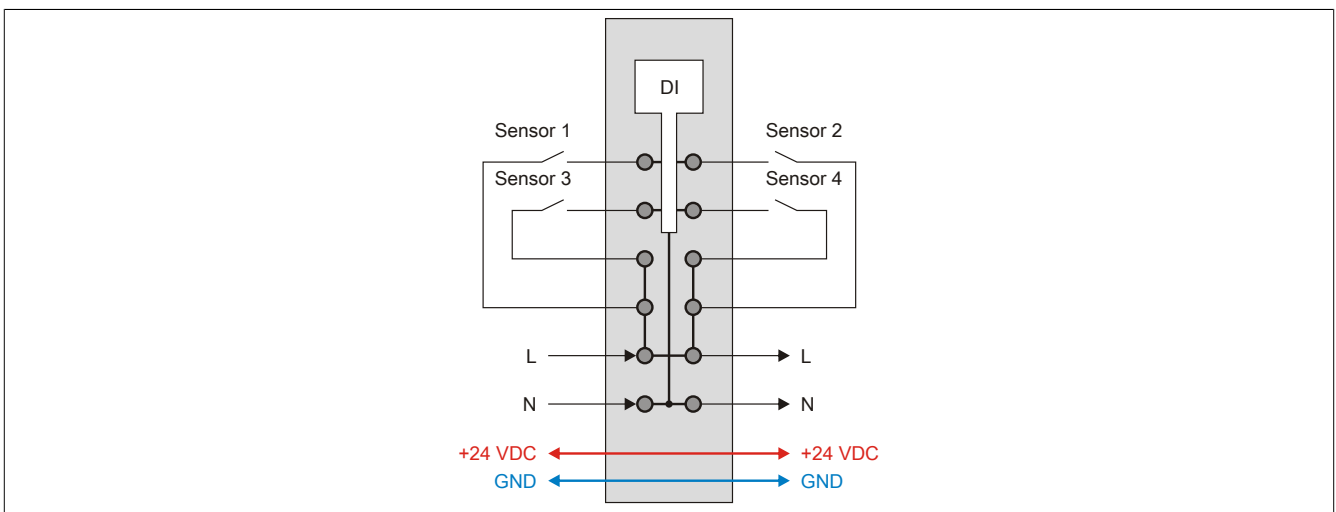
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Image | LED | Color | Status | Description |
|---|-------|-----------------------------|--------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | Module supply not connected or everything OK |
| | | | Double flash | External supply is too low or not connected |
| | e + r | Red on / Green single flash | | Invalid firmware |
| | 1 - 4 | Green | | Input status of the corresponding digital input |

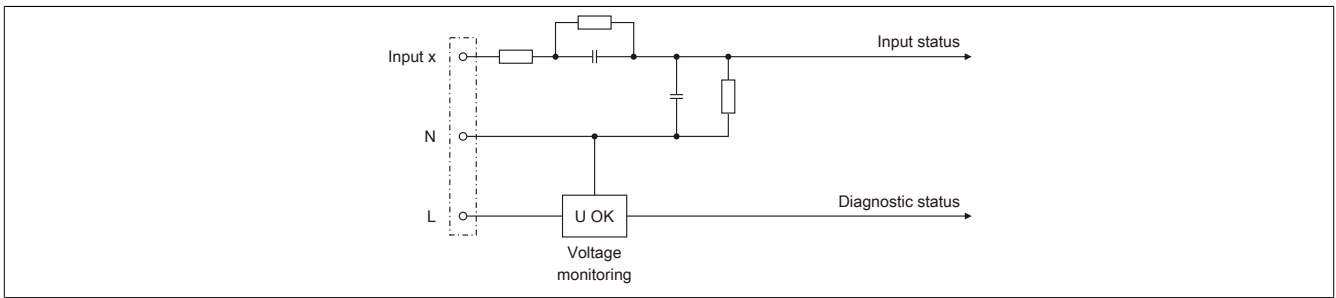
9.13.10.5 Pinout



9.13.10.6 Connection example

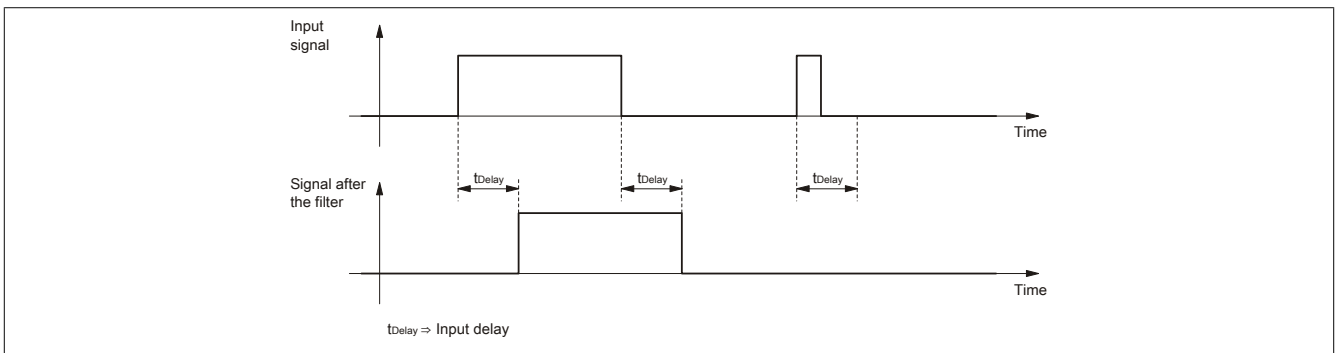


9.13.10.7 Input circuit diagram



9.13.10.8 Input filter

An input filter is available for each input. The input delay can be set using register "ConfigOutput01" on page 1504. Disturbance pulses which are shorter than the input delay are suppressed by the input filter.



9.13.10.9 Register description

9.13.10.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.13.10.9.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------------------|--------------|-------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 1 | DigitalInput | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput04 | Bit 3 | | | | |
| | | PowerSupply | Bit 7 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.13.10.9.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|---------------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | Input status of digital inputs 1 to 4 | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput04 | Bit 3 | | | | |
| | | PowerSupply | Bit 7 | | | | |

1) The offset specifies where the register is within the CAN object.

9.13.10.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "[Using I/O modules on the bus controller](#)" on page 3789.

9.13.10.9.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.13.10.9.4 Digital inputs

Unfiltered

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

Filtered

The filtered status is collected with a fixed offset to the network cycle and transferred in the same cycle. Filtering takes place asynchronously to the network in multiples of 200 µs with a network-related jitter of up to 50 µs.

9.13.10.9.4.1 Digital input filter

Name:

ConfigOutput01

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 μ s. It makes sense to enter values in steps of 2, however, since the input signals are sampled every 200 μ s.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No software filter (bus controller default setting) |
| | 2 | 0.2 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

9.13.10.9.4.2 Input status of digital inputs 1 to 4

Name:

DigitalInput or

DigitalInput01 to DigitalInput04

PowerSupply

The input status of digital inputs 1 to 4 is mapped in this register.

Only function model 0 - Standard:

The "Packed inputs" setting in the Automation Studio I/O configuration is used to determine whether all of the bits from these registers should be set up individually as data points in the Automation Studio I/O mapping ("DigitalInput01" through "DigitalInput04" and "PowerSupply") or whether this register should be displayed as an individual USINT data point ("DigitalInput").

| Data type | Value | Information |
|-----------|------------------------|---|
| USINT | 0 to 15 | Packed inputs = On |
| | See the bit structure. | Packed inputs = Off or function model \neq 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-------|----------------|--------|--------------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input status - Digital input 1 |
| ... | | ... | |
| 3 | DigitalInput04 | 0 or 1 | Input state - Digital input 4 |
| 4 - 6 | Reserved | 0 | |
| 7 | PowerSupply | 0 | Supply voltage too low |
| | | 1 | Supply voltage >80 VAC |

9.13.10.9.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|-------------|
| Without filtering | 100 μ s |
| With filtering | 150 μ s |

9.13.10.9.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|-------------|
| Without filtering | 100 μ s |
| With filtering | 200 μ s |

9.13.11 X20(c)DI4760

Data sheet version: 3.22

9.13.11.1 General Information

The module is used to transfer digital signals from NAMUR encoders according to EN 60947-5-6. In addition to NAMUR encoders, normal switches can also be used.

- 4 digital inputs
- Input module for NAMUR encoders
- Open line and short circuit detection
- Each input can be used as a counter input

9.13.11.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.13.11.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C . During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.13.11.3 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Digital inputs |  |
| X20DI4760 | X20 digital input module, 4 NAMUR inputs, 8.05 V | |
| X20cDI4760 | X20 digital input module, coated, 4 NAMUR inputs, 8.05 V | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 273: X20DI4760, X20cDI4760 - Order data

9.13.11.4 Technical data

| Model number | X20DI4760 | X20cDI4760 |
|--|--|------------|
| Short description | | |
| I/O module | 4 NAMUR inputs, special function | |
| General information | | |
| B&R ID code | 0x2105 | 0xE221 |
| Status indicators | I/O function by channel, open line and short circuit detection by channel, operating status, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Short circuit | Yes, using status LED and software | |
| Open circuit | Yes, using status LED and software | |
| Power consumption | | |
| Bus | 0.01 W | |
| Internal I/O | 1.5 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Event counters | | |
| Quantity | 4 | |
| Signal form | Symmetrical square wave pulse or corresponding minimum pulse duration ¹⁾ | |
| Evaluation | Every rising edge, cyclic counter | |
| Counter size | 8-bit | |
| Input frequency | | |
| 1 input active | Max. 1600 Hz | |
| 2 inputs active | Max. 1100 Hz | |
| 3 inputs active | Max. 870 Hz | |
| 4 inputs active | Max. 680 Hz | |
| NAMUR inputs | | |
| Open-circuit detection | <350 µA | |
| Input circuit | For NAMUR encoders in accordance with EN 60947-5-6 | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Short-circuit detection | >7 mA | |
| Open-circuit voltage | 8.05 V ±0.33% | |
| Switching amplifier internal resistance | 1 kΩ ±1% | |
| Max. short-circuit current | 8.2 mA | |
| Input delay | | |
| 1 input active | ≤310 µs | |
| 2 inputs active | ≤450 µs | |
| 3 inputs active | ≤570 µs | |
| 4 inputs active | ≤735 µs | |
| Switching threshold | | |
| Area | 1.2 mA to 2.1 mA | |
| Switching hysteresis | Typ. 300 µA | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |

Table 274: X20DI4760, X20cDI4760 - Technical data


| Model number | X20DI4760 | X20cDI4760 |
|---------------------------------|--|---|
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating" | |
| Starting temperature | - | Yes, -40°C |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 274: X20DI4760, X20cDI4760 - Technical data

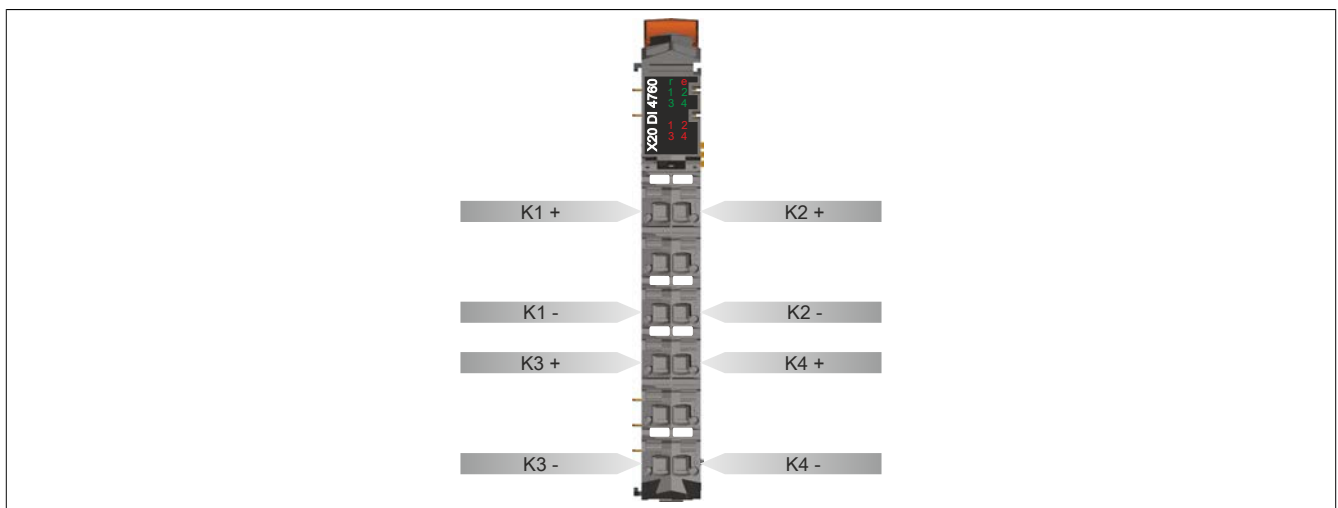
1) Minimum pulse duration: $t[s] \geq 1/(2 \times f_{max}[Hz])$

9.13.11.5 Status LEDs

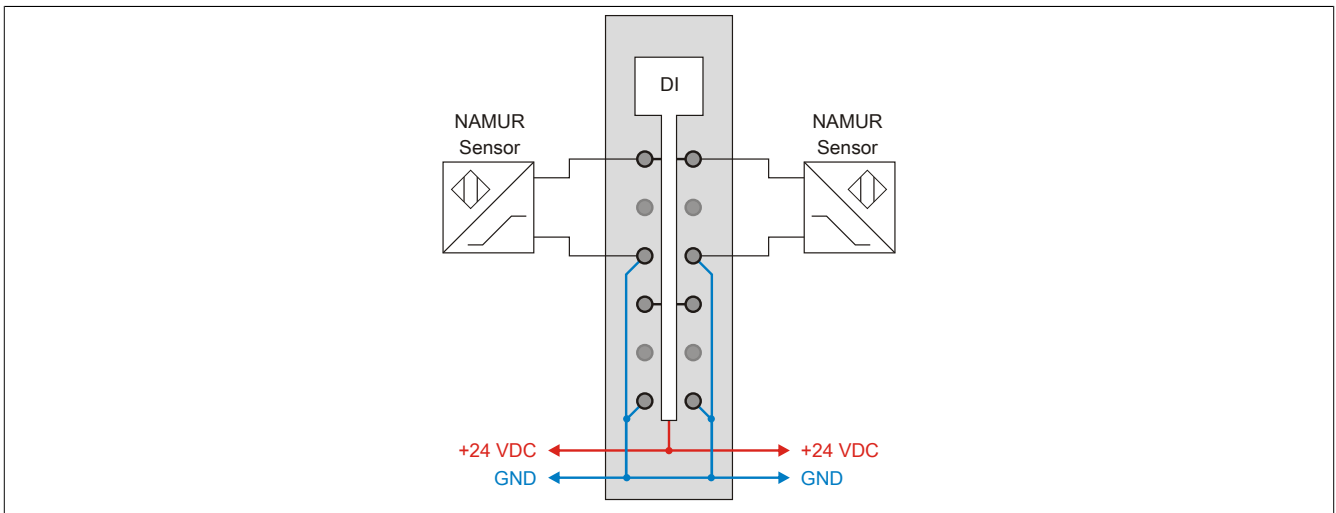
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Image | LED | Color | Status | Description |
|--|-------|-----------------------------|--|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | e | Red | On | RUN mode |
| | | | Off | Module supply not connected or everything OK |
| | | | On | Error or reset status |
| | e + r | Red on / Green single flash | Single flash | Error on at least one channel |
| | | | Invalid firmware | |
| | 1 - 4 | Green | Off | Open line or input status log. 0 |
| | | | On | Short circuit or input status log. 1 |
| | 1 - 4 | Red | Off | The sensor is ready for operation |
| | | | Blinking 1Hz | Open line on corresponding channel |
| On | | | Short circuit on corresponding channel | |

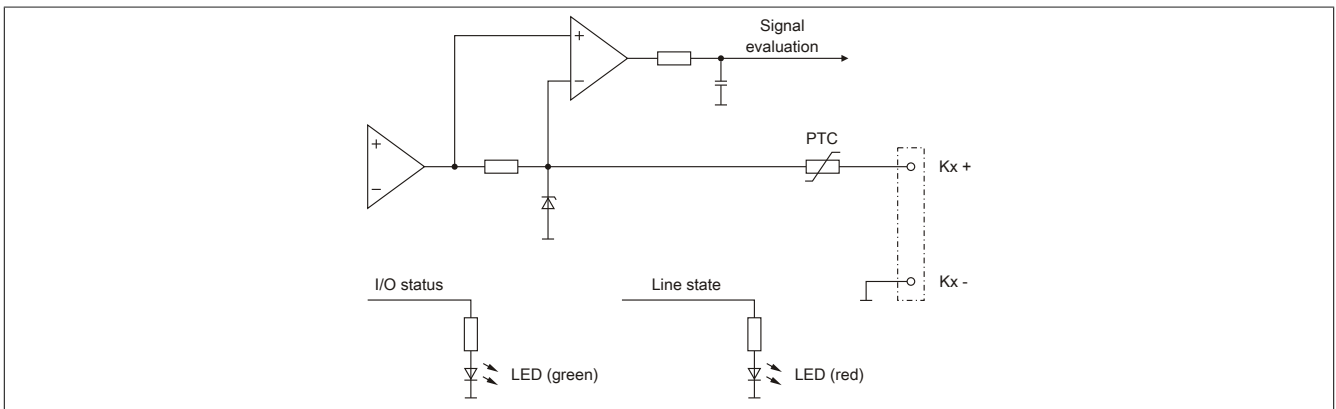
9.13.11.6 Pinout



9.13.11.7 Connection example

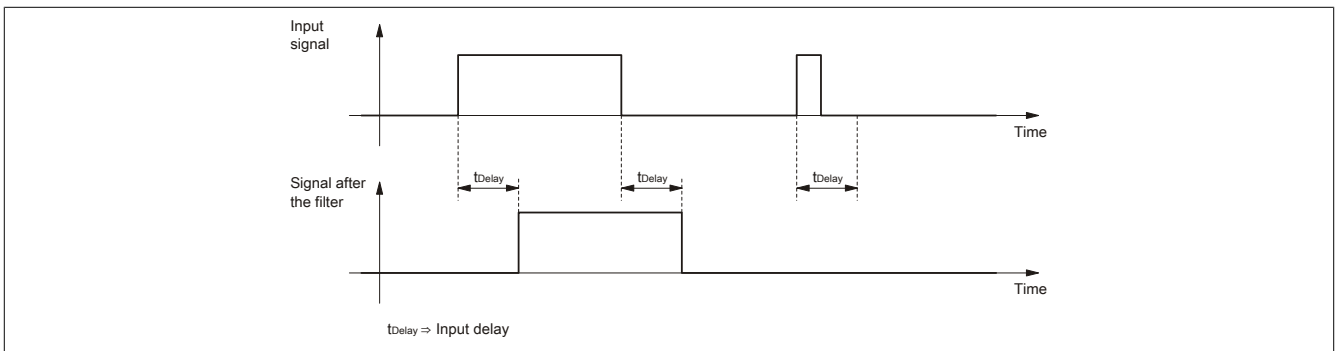


9.13.11.8 Input circuit diagram



9.13.11.9 Input filter

An input filter is available for each input. The input delay can be set using register "ConfigOutput03" on page 1511. Disturbance pulses which are shorter than the input delay are suppressed by the input filter.



9.13.11.10 Examples of possible signal generators

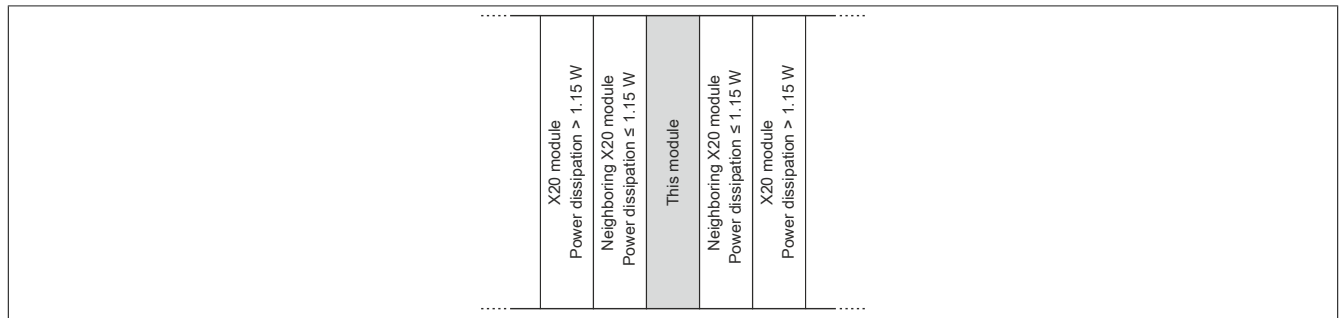
| Proximity switch | |
|---|--|
| Switch in accordance with EN 60947-5-6 (NAMUR) | |
| Mechanical contacts (instead of NAMUR encoders) | |
| Without open line detection and without short circuit detection | |
| Without open line detection and with short circuit detection | |
| With open line detection and without short circuit detection | |
| With open line detection and with short circuit detection | |

9.13.11.11 Derating

There is no derating when operated below 55°C.

During operation over 55°C, the power dissipation of the modules to the left and right of this module is not permitted to exceed 1.15 W!

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.



9.13.11.12 Register description

9.13.11.12.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.13.11.12.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 16 | ConfigOutput01 (channel/status configuration) | USINT | | | | • |
| 18 | ConfigOutput02 (replacement values) | USINT | | | | • |
| 20 | ConfigOutput03 (input filter) | USINT | | | | • |
| Communication | | | | | | |
| 0 | DigitalInput | USINT | • | | | |
| | DigitalInput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalInput04 | Bit 3 | | | | |
| 4 | Counter01 | USINT | • | | | |
| 6 | Counter02 | USINT | • | | | |
| 8 | Counter03 | USINT | • | | | |
| 10 | Counter04 | USINT | • | | | |
| 30 | StatusInput | USINT | • | | | |
| | ShortCircuit01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | ShortCircuit04 | Bit 3 | | | | |
| | OpenLine01 | Bit 4 | | | | |
| | ... | ... | | | | |
| | OpenLine04 | Bit 7 | | | | |

9.13.11.12.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 16 | - | ConfigOutput01 (channel/status configuration) | USINT | | | | • |
| 18 | - | ConfigOutput02 (replacement values) | USINT | | | | • |
| 20 | - | ConfigOutput03 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | Input status of digital inputs 1 to 4 | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput04 | Bit 3 | | | | |
| 4 | - | Counter01 | USINT | | • | | |
| 6 | - | Counter02 | USINT | | • | | |
| 8 | - | Counter03 | USINT | | • | | |
| 10 | - | Counter04 | USINT | | • | | |
| 30 | - | Status of channels 1 to 4 | USINT | • | | | |
| | | ShortCircuit01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | ShortCircuit04 | Bit 3 | | | | |
| | | OpenLine01 | Bit 4 | | | | |
| | | ... | ... | | | | |
| | | OpenLine04 | Bit 7 | | | | |

1) The offset specifies where the register is within the CAN object.

9.13.11.12.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.13.11.12.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.13.11.12.4 Digital inputs

Unfiltered

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

Filtered

The filtered status is collected with a fixed offset to the network cycle and transferred in the same cycle. Filtering takes place asynchronously to the network in multiples of 200 µs with a network-related jitter of up to 50 µs.

9.13.11.12.4.1 Digital input filter

Name:

ConfigOutput03

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 µs. It makes sense to enter values in steps of 2, however, since the input signals are sampled every 200 µs.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No software filter (bus controller default setting) |
| | 2 | 0.2 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

9.13.11.12.4.2 Input status of digital inputs 1 to 4

Name:

DigitalInput or

DigitalInput01 to DigitalInput04

PowerSupply

The input status of digital inputs 1 to 4 is mapped in this register.

Only function model 0 - Standard:

The "Packed inputs" setting in the Automation Studio I/O configuration is used to determine whether all of the bits from these registers should be set up individually as data points in the Automation Studio I/O mapping ("DigitalInput01" through "DigitalInput02" and "PowerSupply") or whether this register should be displayed as an individual USINT data point ("DigitalInput").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 15 | Packed inputs = On |
| | See the bit structure. | Packed inputs = Off or function model ≠ 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-------|----------------|--------|--------------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input status - Digital input 1 |
| ... | | ... | |
| 3 | DigitalInput04 | 0 or 1 | Input state - Digital input 4 |
| 4 - 6 | Reserved | 0 | |
| 7 | PowerSupply | 0 | Supply voltage too low |
| | | 1 | Supply voltage >80 VAC |

9.13.11.12.5 Positive edge counter on digital inputs

Name:

Counter01 to Counter04

These registers cyclically count the positive edges on the individual channels.

| Data type | Value |
|-----------|--|
| USINT | Positive edge counter on channel, cyclic |

9.13.11.12.6 Status of channels 1 to 4

Name:

StatusInput01 and

ShortCircuit01 to ShortCircuit04

OpenLine01 to OpenLine04

This register indicates whether an open line or overflow has occurred on the individual channels.

Only function model 0 - Standard:

The "Packed inputs" setting in the Automation Studio I/O configuration is used to determine whether all of the bits from these registers should be set up individually as data points in the Automation Studio I/O mapping ("ShortCircuit01" to "ShortCircuit04" and "OpenLine01" to "OpenLine04") or whether this register should be displayed as an individual USINT data point ("StatusInput01").

| Data type | Values | Information |
|-----------|--------------------|---|
| USINT | 0 to 255 | Packed inputs = On |
| | See bit structure. | Packed inputs = Off or Function model <> 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|-------|------------------------|
| 0 | ShortCircuit01 | 0 | No error |
| | | 1 | Overload on channel 1 |
| ... | | ... | |
| 3 | ShortCircuit04 | 0 | No error |
| | | 1 | Overload on channel 4 |
| 4 | OpenLine01 | 0 | No error |
| | | 1 | Open line on channel 1 |
| ... | | ... | |
| 7 | OpenLine04 | 0 | No error |
| | | 1 | Open line on channel 4 |

9.13.11.12.7 Function expansion

Firmware version 802 is offered for hardware variant 7 or higher of the module. This and subsequent firmware versions provide the user with new configuration possibilities.

9.13.11.12.7.1 Disabling channels and status messages

Name:

ConfigOutput01

This register can be used to (de)activate individual channels or just their status responses.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------------------|-------|---|
| 0 | Channel 1 | 0 | Channel enabled (bus controller default setting) |
| | | 1 | Channel disabled |
| ... | | ... | |
| 3 | Channel 4 | 0 | Channel enabled (bus controller default setting) |
| | | 1 | Channel disabled |
| 4 | Status message - Channel 1 | 0 | Status message enabled (bus controller default setting) |
| | | 1 | Status message deactivated |
| ... | | ... | |
| 7 | Status message - Channel 4 | 0 | Status message enabled (bus controller default setting) |
| | | 1 | Status message deactivated |

9.13.11.12.7.2 Replacement values during overload

Name:

ConfigOutput02

This register can be used to specify defined replacement values for the individual channels according to the error situation.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 15 |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------------|-------|---|
| 0 | Overload - Channel 1 | 0 | Replacement value when overload is FALSE |
| | | 1 | Replacement value if overload TRUE (bus controller default setting) |
| ... | | ... | |
| 3 | Overload - Channel 4 | 0 | Replacement value when overload is FALSE |
| | | 1 | Replacement value if overload TRUE (bus controller default setting) |
| 4 | Open line - Channel 1 | 0 | Replacement value when open line is FALSE |
| | | 1 | Replacement value if open circuit TRUE (bus controller default setting) |
| ... | | ... | |
| 7 | Open line - Channel 4 | 0 | Replacement value when open line is FALSE |
| | | 1 | Replacement value if open circuit TRUE (bus controller default setting) |

9.13.11.12.8 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|--------|
| Without filtering | 100 µs |
| With filtering | 150 µs |

9.13.11.12.9 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|--------|
| Without filtering | 100 µs |
| With filtering | 200 µs |

9.13.12 X20(c)DI6371

Data sheet version: 3.19

9.13.12.1 General Information

The module is equipped with 6 inputs for 1 or 2-wire connections. The X20 6-pin terminal block can be used for universal 1-line wiring. Two-line wiring can be implemented using the 12-pin terminal block. The inputs on the module are designed for sink connections.

- 6 digital inputs
- Sink connection
- 2-wire connections
- 24 VDC for sensor supply
- Software input filter can be configured for entire module
- 1-wire connection type with 6-pin terminal block

9.13.12.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.13.12.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.13.12.3 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Digital inputs |  |
| X20DI6371 | X20 digital input module, 6 inputs, 24 VDC, sink, configurable input filter, 2-wire connections | |
| X20cDI6371 | X20 digital input module, coated, 6 inputs, 24 VDC, sink, configurable input filter, 2-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 275: X20DI6371, X20cDI6371 - Order data

9.13.12.4 Technical data

| Model number | X20DI6371 | X20cDI6371 |
|--|--|------------|
| Short description | | |
| I/O module | 6 digital inputs 24 VDC for 1- or 2-wire connections | |
| General information | | |
| B&R ID code | 0x1B93 | 0xE222 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Power consumption | | |
| Bus | 0.15 W | |
| Internal I/O | 0.88 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Digital inputs | | |
| Nominal voltage | 24 VDC | |
| Input characteristics per EN 61131-2 | Type 1 | |
| Input voltage | 24 VDC -15 % / +20 % | |
| Input current at 24 VDC | Typ. 3.75 mA | |
| Input circuit | Sink | |
| Input filter | | |
| Hardware | ≤100 µs | |
| Software | Default 1 ms, configurable between 0 and 25 ms in 0.2 ms intervals | |
| Connection type | 1- or 2-wire connections | |
| Input resistance | Typ. 6.4 kΩ | |
| Switching threshold | | |
| Low | <5 VDC | |
| High | >15 VDC | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Sensor power supply | | |
| Voltage | Module supply minus voltage drop for short circuit protection | |
| Voltage drop for short-circuit protection at 500 mA | Max. 2 VDC | |
| Summation current | 0.5 A | |
| Short-circuit proof | Yes | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |


Table 276: X20DI6371, X20cDI6371 - Technical data

| Model number | X20DI6371 | X20cDI6371 |
|------------------------------|--|---|
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB06 or X20T-B12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB06 or X20T-B12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

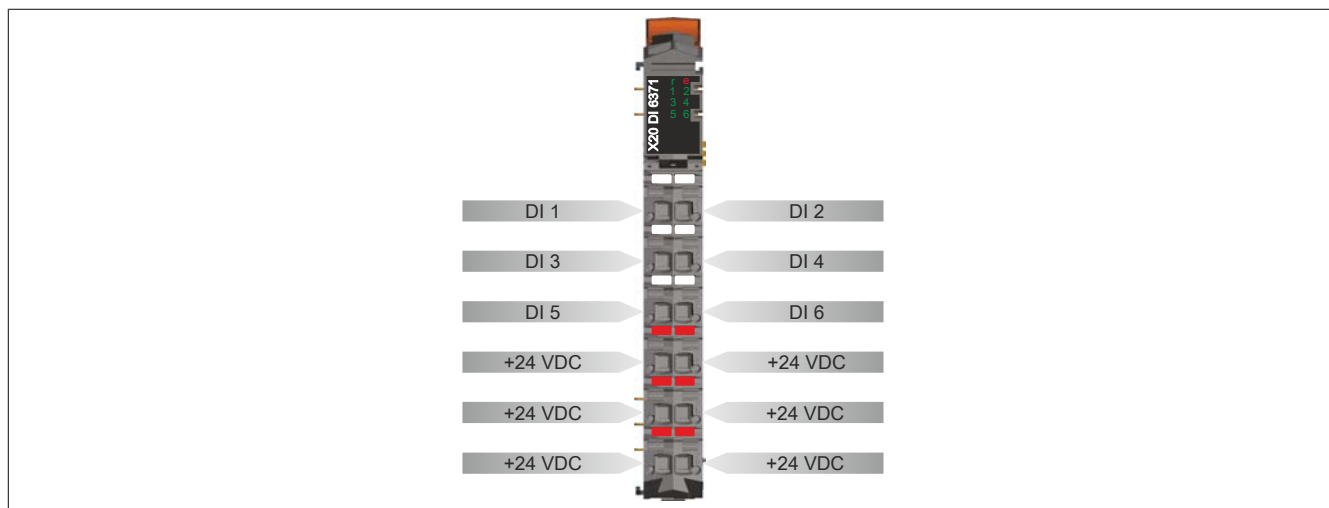
Table 276: X20DI6371, X20cDI6371 - Technical data

9.13.12.5 Status LEDs

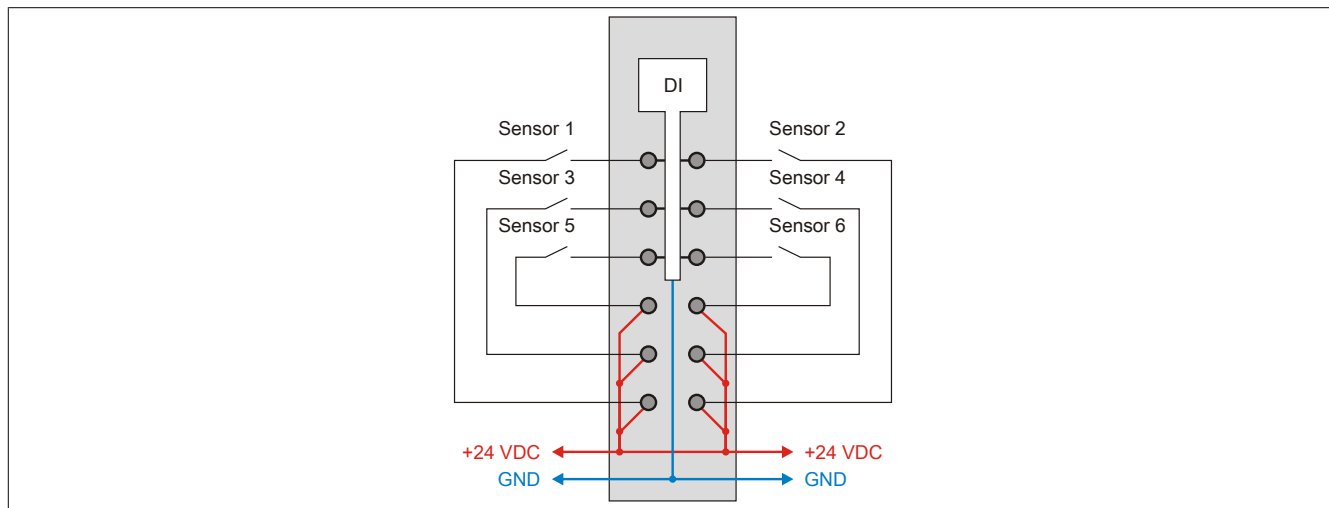
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Image | LED | Color | Status | Description |
|---|-------|-----------------------------|--------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | Module supply not connected or everything OK |
| | e + r | Red on / Green single flash | | Invalid firmware |
| | 1 - 6 | Green | | Input status of the corresponding digital input |

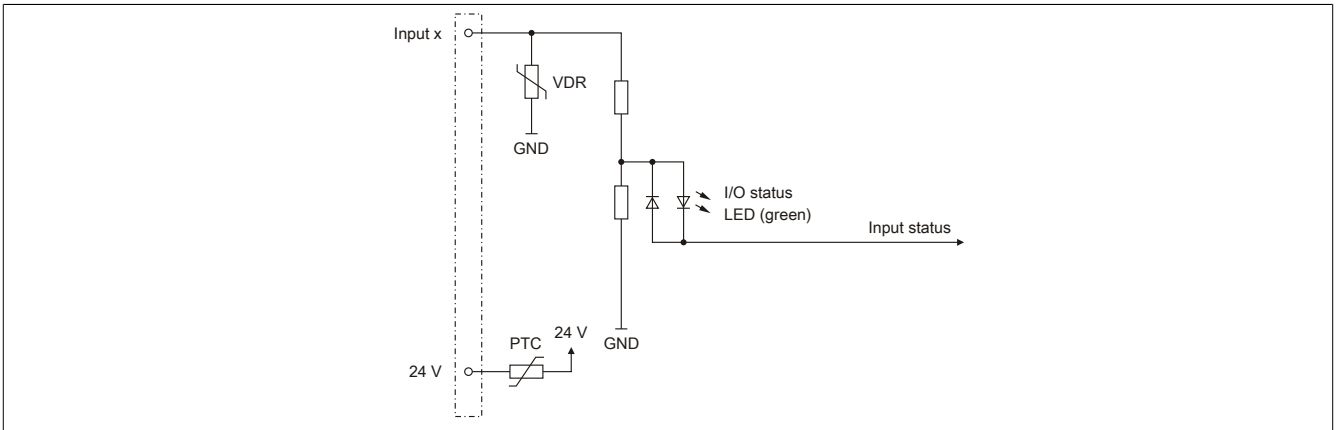
9.13.12.6 Pinout



9.13.12.7 Connection example

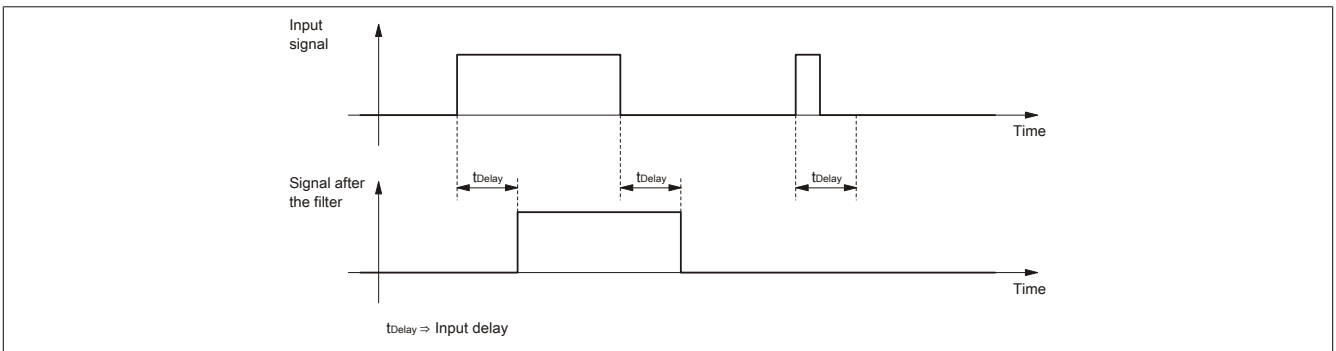


9.13.12.8 Input circuit diagram



9.13.12.9 Input filter

An input filter is available for each input. The input delay can be set using register "[ConfigOutput01](#)" on page 1519. Disturbance pulses which are shorter than the input delay are suppressed by the input filter.



9.13.12.10 Register description

9.13.12.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.13.12.10.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------------------|--------------|-------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 1 | DigitalInput | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput06 | Bit 5 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.13.12.10.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|---------------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | Input status of digital inputs 1 to 6 | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput06 | Bit 5 | | | | |

1) The offset specifies where the register is within the CAN object.

9.13.12.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.13.12.10.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.13.12.10.4 Digital inputs

Unfiltered

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

Filtered

The filtered status is collected with a fixed offset to the network cycle and transferred in the same cycle. Filtering takes place asynchronously to the network in multiples of 200 µs with a network-related jitter of up to 50 µs.

9.13.12.10.4.1 Digital input filter

Name:

ConfigOutput01

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 μ s. It makes sense to enter values in steps of 2, however, since the input signals are sampled every 200 μ s.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No software filter (bus controller default setting) |
| | 2 | 0.2 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

9.13.12.10.4.2 Input status of digital inputs 1 to 6

Name:

DigitalInput or

DigitalInput01 to DigitalInput06

The input status of digital inputs 1 to 6 is mapped in this register.

Only function model 0 - Standard:

The "Packed inputs" setting in the Automation Studio I/O configuration is used to determine whether all of the bits from these registers should be set up individually as data points in the Automation Studio I/O mapping ("DigitalInput01" through "DigitalInput06") or whether this register should be displayed as an individual USINT data point ("DigitalInput").

| Data type | Value | Information |
|-----------|------------------------|---|
| USINT | 0 to 63 | Packed inputs = On |
| | See the bit structure. | Packed inputs = Off or function model \neq 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|--------|--------------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input status - Digital input 1 |
| ... | | ... | |
| 5 | DigitalInput06 | 0 or 1 | Input state - Digital input 6 |

9.13.12.10.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|-------------|
| Without filtering | 100 μ s |
| With filtering | 150 μ s |

9.13.12.10.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|-------------|
| Without filtering | 100 μ s |
| With filtering | 200 μ s |

9.13.13 X20(c)DI6372

Data sheet version: 3.19

9.13.13.1 General Information

The module is equipped with 6 inputs for 1 or 2-wire connections. The X20 6-pin terminal block can be used for universal 1-line wiring. Two-line wiring can be implemented using the 12-pin terminal block. The inputs on the module are designed for source connections.

- 6 digital inputs
- Source connection
- 2-wire connections
- Software input filter can be configured for entire module
- 1-wire connection type with 6-pin terminal block

9.13.13.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.13.13.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.13.13.3 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Digital inputs |  |
| X20DI6372 | X20 digital input module, 6 inputs, 24 VDC, source, configurable input filter, 2-wire connections | |
| X20cDI6372 | X20 digital input module, coated, 6 inputs, 24 VDC, source, configurable input filter, 2-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 277: X20DI6372, X20cDI6372 - Order data

9.13.13.4 Technical data

| Model number | X20DI6372 | X20cDI6372 |
|--|--|------------|
| Short description | | |
| I/O module | 6 digital inputs 24 VDC for 1- or 2-wire connections | |
| General information | | |
| B&R ID code | 0x1B94 | 0xE223 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Power consumption | | |
| Bus | 0.15 W | |
| Internal I/O | 0.88 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Digital inputs | | |
| Nominal voltage | 24 VDC | |
| Input characteristics per EN 61131-2 | Type 1 | |
| Input voltage | 24 VDC -15% / +20% | |
| Input current at 24 VDC | Typ. 3.75 mA | |
| Input circuit | Source | |
| Input filter | | |
| Hardware | ≤100 µs | |
| Software | Default 1 ms, configurable between 0 and 25 ms in 0.2 ms intervals | |
| Connection type | 1- or 2-wire connections | |
| Input resistance | Typ. 6.4 kΩ | |
| Switching threshold | | |
| Low | <5 VDC | |
| High | >15 VDC | |
| Isolation voltage between channel and bus | 500 V _{Eff} | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |


Table 278: X20DI6372, X20cDI6372 - Technical data

| Model number | X20DI6372 | X20cDI6372 |
|------------------------------|--|---|
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB06 or X20T-B12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB06 or X20T-B12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

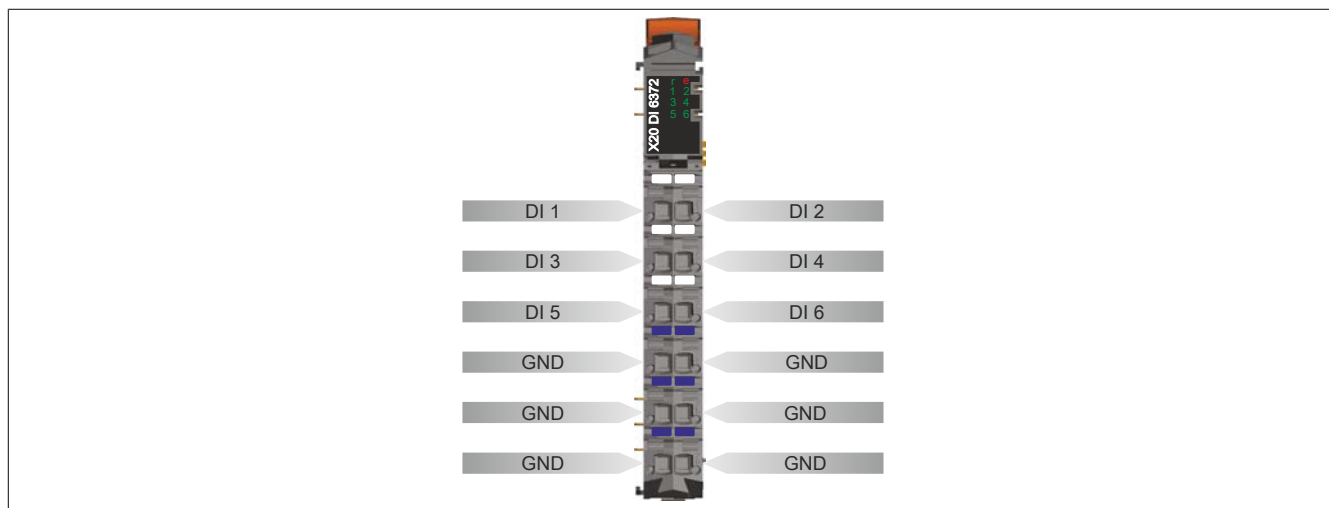
Table 278: X20DI6372, X20cDI6372 - Technical data

9.13.13.5 Status LEDs

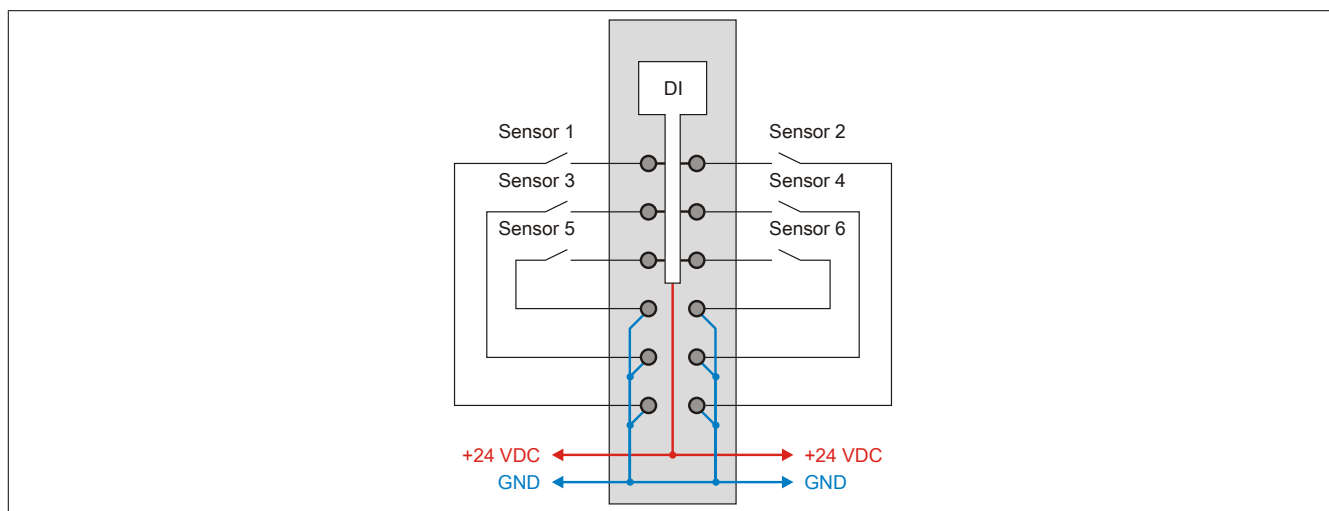
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Image | LED | Color | Status | Description |
|---|-------|-----------------------------|--------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | Module supply not connected or everything OK |
| | e + r | Red on / Green single flash | | Invalid firmware |
| | 1 - 6 | Green | | Input status of the corresponding digital input |

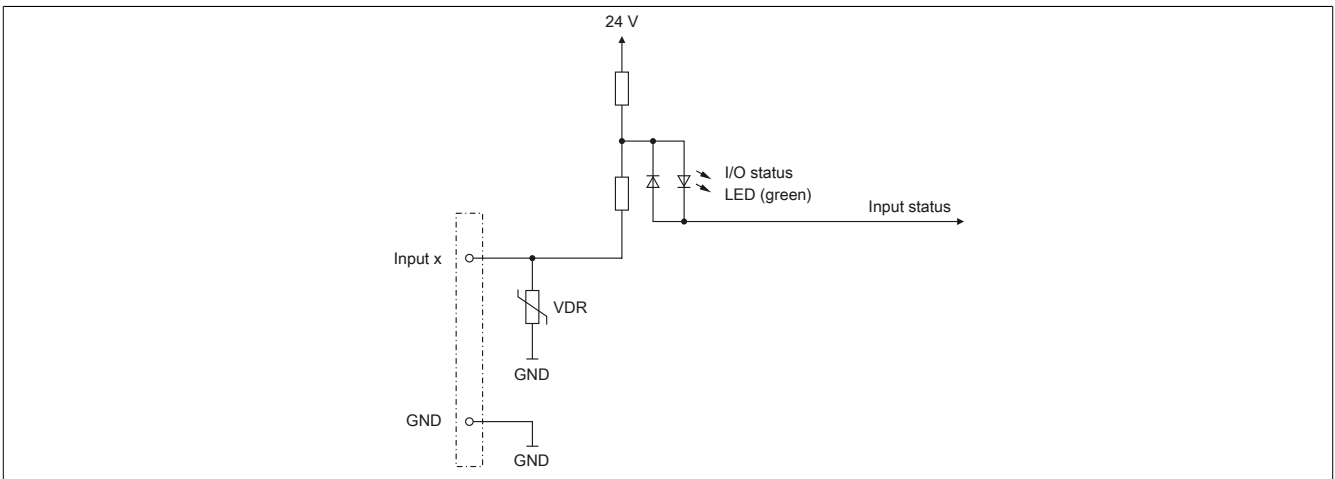
9.13.13.6 Pinout



9.13.13.7 Connection example

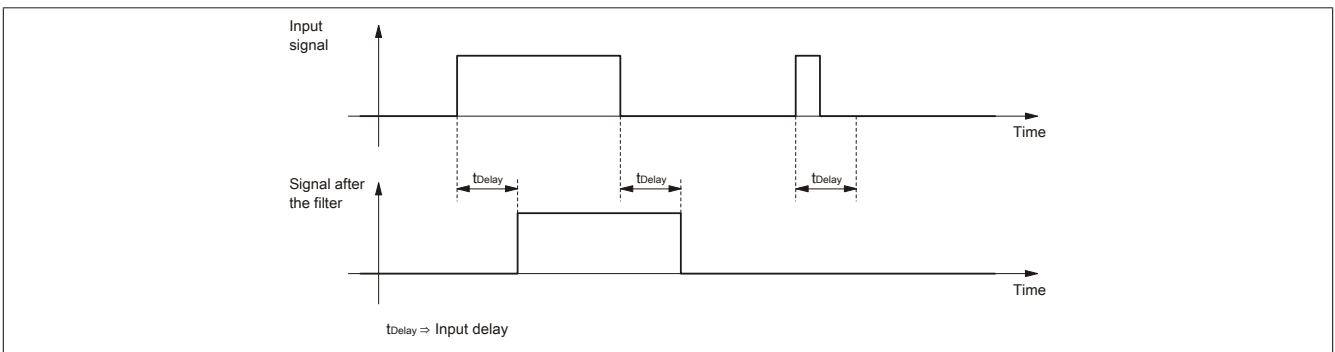


9.13.13.8 Input circuit diagram



9.13.13.9 Input filter

An input filter is available for each input. The input delay can be set using register "[ConfigOutput01](#)" on page 1525. Disturbance pulses which are shorter than the input delay are suppressed by the input filter.



9.13.13.10 Register description

9.13.13.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.13.13.10.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------------------|--------------|-------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 1 | DigitalInput | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput06 | Bit 5 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.13.13.10.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|---------------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | Input status of digital inputs 1 to 6 | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput06 | Bit 5 | | | | |

1) The offset specifies where the register is within the CAN object.

9.13.13.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.13.13.10.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.13.13.10.4 Digital inputs

Unfiltered

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

Filtered

The filtered status is collected with a fixed offset to the network cycle and transferred in the same cycle. Filtering takes place asynchronously to the network in multiples of 200 µs with a network-related jitter of up to 50 µs.

9.13.13.10.4.1 Digital input filter

Name:

ConfigOutput01

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 µs. It makes sense to enter values in steps of 2, however, since the input signals are sampled every 200 µs.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No software filter (bus controller default setting) |
| | 2 | 0.2 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

9.13.13.10.4.2 Input status of digital inputs 1 to 6

Name:

DigitalInput or

DigitalInput01 to DigitalInput06

The input status of digital inputs 1 to 6 is mapped in this register.

Only function model 0 - Standard:

The "Packed inputs" setting in the Automation Studio I/O configuration is used to determine whether all of the bits from these registers should be set up individually as data points in the Automation Studio I/O mapping ("DigitalInput01" through "DigitalInput06") or whether this register should be displayed as an individual USINT data point ("DigitalInput").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 63 | Packed inputs = On |
| | See the bit structure. | Packed inputs = Off or function model ≠ 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|--------|--------------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input status - Digital input 1 |
| ... | | ... | |
| 5 | DigitalInput06 | 0 or 1 | Input state - Digital input 6 |

9.13.13.10.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|--------|
| Without filtering | 100 µs |
| With filtering | 150 µs |

9.13.13.10.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|--------|
| Without filtering | 100 µs |
| With filtering | 200 µs |

9.13.14 X20DI6373

Data sheet version: 2.10

9.13.14.1 General Information

The module has 6 inputs. The input circuit can be sink or source thanks to the potential-free design of the inputs.

- 6 digital inputs
- Sink/Source connection
- Software input filter can be configured for entire module

9.13.14.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Digital inputs |  |
| X20DI6373 | X20 digital input module, 6 inputs, 24 VDC, sink/source, all inputs floating, configurable input filter, 2-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 279: X20DI6373 - Order data


9.13.14.3 Technical data

| | |
|--|--|
| Model number | X20DI6373 |
| Short description | |
| I/O module | 6 digital floating inputs - 24 VDC |
| General information | |
| B&R ID code | 0xA7A2 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.15 W |
| Internal I/O | 0.88 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Digital inputs | |
| Nominal voltage | 24 VDC |
| Input characteristics per EN 61131-2 | Type 1 |
| Input voltage | 24 VDC -15 % / +20 % |
| Input current at 24 VDC | Typ. 3.75 mA |
| Input circuit | Sink or source |
| Input filter | |
| Hardware | ≤100 µs |
| Software | Default 1 ms, configurable between 0 and 25 ms in 0.2 ms intervals |
| Input resistance | Typ. 6.4 kΩ |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from channel and bus |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately, Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

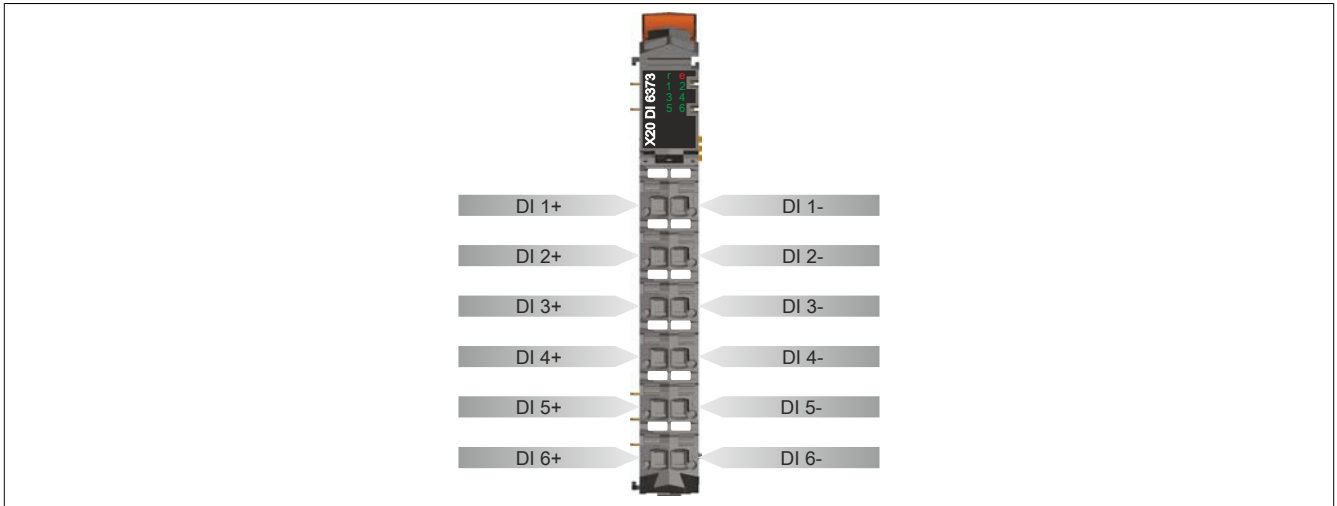
Table 280: X20DI6373 - Technical data

9.13.14.4 Status LEDs

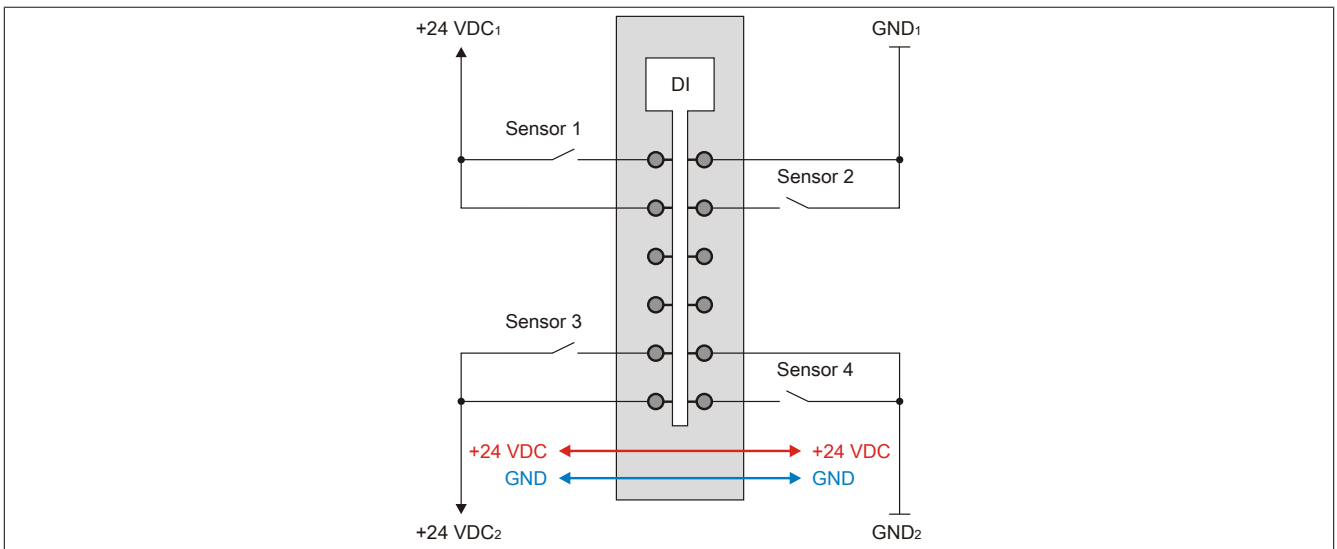
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Image | LED | Color | Status | Description |
|---|-------|-----------------------------|--------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | Module supply not connected or everything OK |
| | e + r | Red on / Green single flash | | Invalid firmware |
| | 1 - 6 | Green | | Input status of the corresponding digital input |

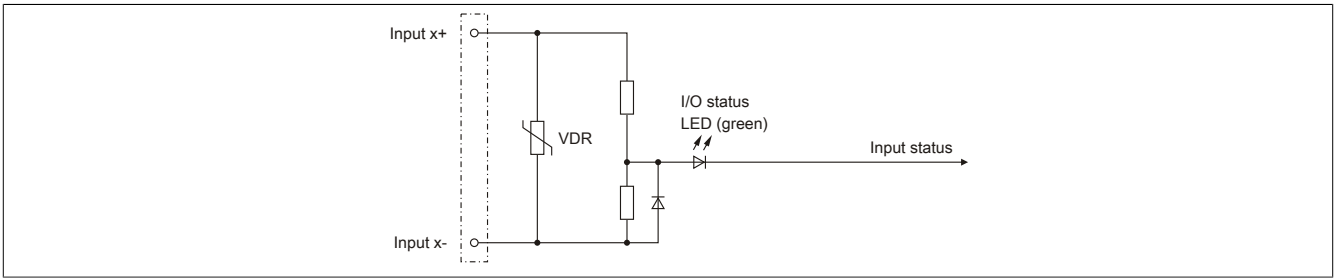
9.13.14.5 Pinout



9.13.14.6 Connection example

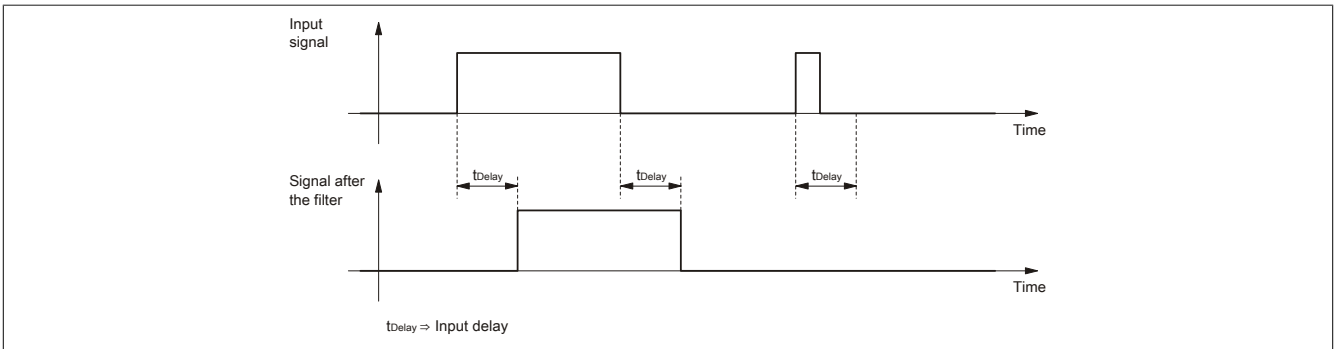


9.13.14.7 Input circuit diagram



9.13.14.8 Input filter

An input filter is available for each input. The input delay can be set using register "[ConfigOutput01](#)" on page 1531. Disturbance pulses which are shorter than the input delay are suppressed by the input filter.



9.13.14.9 Register description

9.13.14.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.13.14.9.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------------------|--------------|-------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 1 | DigitalInput | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput06 | Bit 5 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.13.14.9.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|---------------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | Input status of digital inputs 1 to 6 | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput06 | Bit 5 | | | | |

1) The offset specifies where the register is within the CAN object.

9.13.14.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.13.14.9.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.13.14.9.4 Digital inputs

Unfiltered

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

Filtered

The filtered status is collected with a fixed offset to the network cycle and transferred in the same cycle. Filtering takes place asynchronously to the network in multiples of 200 µs with a network-related jitter of up to 50 µs.

9.13.14.9.4.1 Digital input filter

Name:

ConfigOutput01

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 µs. It makes sense to enter values in steps of 2, however, since the input signals are sampled every 200 µs.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No software filter (bus controller default setting) |
| | 2 | 0.2 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

9.13.14.9.4.2 Input status of digital inputs 1 to 6

Name:

DigitalInput or

DigitalInput01 to DigitalInput06

The input status of digital inputs 1 to 6 is mapped in this register.

Only function model 0 - Standard:

The "Packed inputs" setting in the Automation Studio I/O configuration is used to determine whether all of the bits from these registers should be set up individually as data points in the Automation Studio I/O mapping ("DigitalInput01" through "DigitalInput06") or whether this register should be displayed as an individual USINT data point ("DigitalInput").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 63 | Packed inputs = On |
| | See the bit structure. | Packed inputs = Off or function model ≠ 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|--------|--------------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input status - Digital input 1 |
| ... | | ... | |
| 5 | DigitalInput06 | 0 or 1 | Input state - Digital input 6 |

9.13.14.9.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|--------|
| Without filtering | 100 µs |
| With filtering | 150 µs |

9.13.14.9.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|--------|
| Without filtering | 100 µs |
| With filtering | 200 µs |

9.13.15 X20DI6553

Data sheet version: 3.07

9.13.15.1 General Information

The module is equipped with 6 inputs for 1-wire connections. It is designed for an input voltage of 100 to 120 VAC.

- 6 digital inputs
- 100 to 120 VAC inputs
- 50 Hz or 60 Hz
- 1-wire connections
- 240 V coded

Danger!

Risk of electric shock!

The terminal block must only be allowed to conduct voltage when it is inserted. It must not under any circumstances be removed or inserted when voltage is applied or have voltage applied to it when it is removed.

9.13.15.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Digital inputs |  |
| X20DI6553 | X20 digital input module, 6 inputs, 100 to 120 VAC, 240 V keyed, 1-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM12 | X20 bus module, 240 VAC keyed, internal I/O power supply connected through | |
| | Terminal blocks | |
| X20TB32 | X20 terminal block, 12-pin, 240 VAC keyed | |

Table 281: X20DI6553 - Order data

9.13.15.3 Technical data

| | |
|--|---|
| Model number | X20DI6553 |
| Short description | |
| I/O module | 6 digital inputs 100 to 120 VAC for 1-wire connections |
| General information | |
| B&R ID code | 0x256F |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| External I/O power supply | Yes, using software (typical threshold 85 VAC) |
| Power consumption | |
| Bus | 0.21 W |
| Internal I/O | - |
| External I/O | 0.68 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| Digital inputs | |
| Nominal voltage | 100 to 120 VAC |
| Input filter | |
| Software | Default 1 ms, configurable between 0 and 25 ms in 0.2 ms intervals |
| Hardware | |
| 1 → 0 | ≤30 ms |
| 0 → 1 | ≤15 ms |
| Connection type | 1-wire connections |
| Rated frequency | 47 to 63 Hz |
| Switching threshold | |
| Low | <20 VAC |
| High | >79 VAC |
| Isolation voltage between channel and bus | 1 minute 1500 VAC |
| Input voltage | |
| Maximum | 132 VAC |
| Input current | |
| 120 VAC / 50 Hz | 8.5 mA |
| 120 VAC / 60 Hz | 10 mA |
| Sensor power supply | |
| Voltage | Equal to the module supply |
| Short-circuit proof | No |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |


Table 282: X20DI6553 - Technical data

| | |
|------------------------------|--|
| Model number | X20DI6553 |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB32 terminal block separately Order 1x X20BM12 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

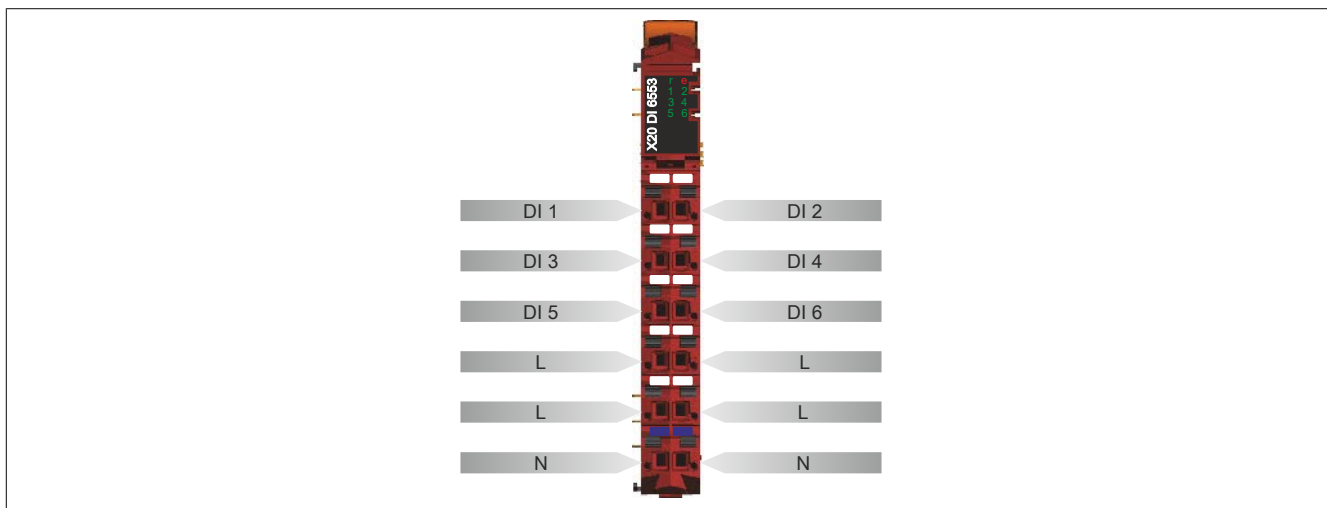
Table 282: X20DI6553 - Technical data

9.13.15.4 Status LEDs

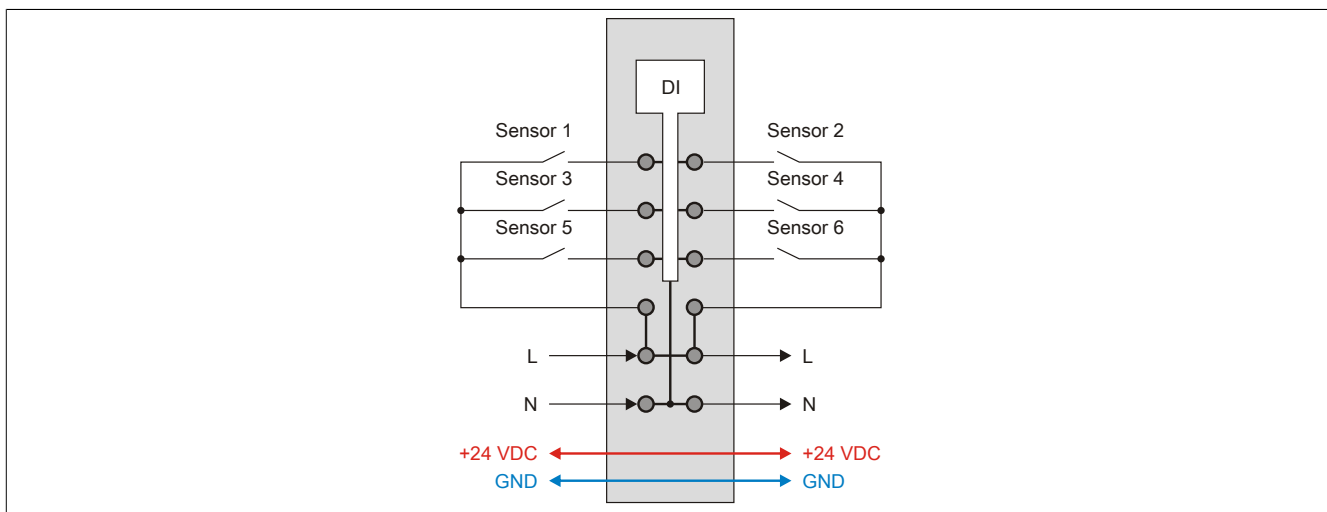
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Image | LED | Color | Status | Description |
|---|-------|-----------------------------|--------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | Module supply not connected or everything OK |
| | | | Double flash | External supply is too low or not connected |
| | e + r | Red on / Green single flash | | Invalid firmware |
| | 1 - 6 | Green | | Input status of the corresponding digital input |

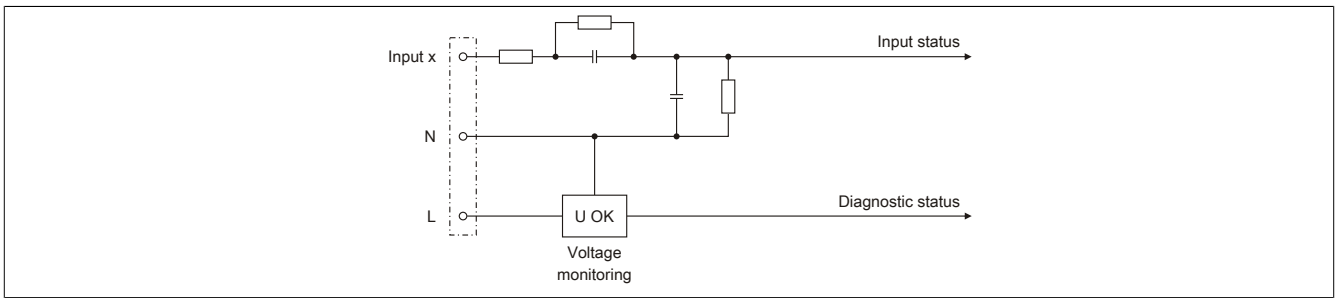
9.13.15.5 Pinout



9.13.15.6 Connection example

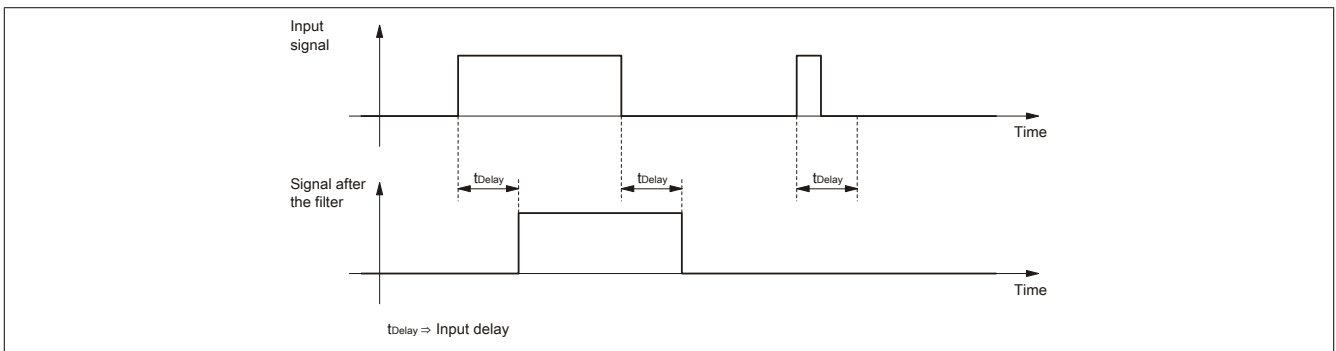


9.13.15.7 Input circuit diagram



9.13.15.8 Input filter

An input filter is available for each input. The input delay can be set using register "ConfigOutput01" on page 1537. Disturbance pulses which are shorter than the input delay are suppressed by the input filter.



9.13.15.9 Register description

9.13.15.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.13.15.9.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------------------|--------------|-------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 1 | DigitalInput | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput06 | Bit 5 | | | | |
| | | PowerSupply | Bit 7 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.13.15.9.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--------------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | Input state of digital inputs 1 to 6 | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput06 | Bit 5 | | | | |
| | | PowerSupply | Bit 7 | | | | |

1) The offset specifies where the register is within the CAN object.

9.13.15.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "[Using I/O modules on the bus controller](#)" on page 3789.

9.13.15.9.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.13.15.9.4 Digital inputs

Unfiltered

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

Filtered

The filtered status is collected with a fixed offset to the network cycle and transferred in the same cycle. Filtering takes place asynchronously to the network in multiples of 200 µs with a network-related jitter of up to 50 µs.

9.13.15.9.4.1 Digital input filter

Name:

ConfigOutput01

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 μ s. It makes sense to enter values in steps of 2, however, since the input signals are sampled every 200 μ s.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No software filter (bus controller default setting) |
| | 2 | 0.2 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

9.13.15.9.4.2 Input state of digital inputs 1 to 6

Name:

DigitalInput or

DigitalInput01 to DigitalInput06

PowerSupply

This register contains the input state of digital inputs 1 to 6.

Only function model 0 - Standard:

Setting "Packed inputs" in the Automation Studio I/O configuration can be used to determine whether all bits of this register should be applied individually as data points in the Automation Studio I/O mapping ("DigitalInput01" to "DigitalInput06" and "PowerSupply") or whether this register should be displayed as a single USINT data point ("DigitalInput").

| Data type | Values | Information |
|-----------|------------------------|---|
| USINT | 0 to 63 | Packed inputs = On |
| | See the bit structure. | Packed inputs = Off or function model \neq 0 - Standard |

Bit structure:

| Bit | Description | Value | Information |
|-----|----------------|--------|-------------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input state - Digital input 1 |
| ... | | ... | |
| 5 | DigitalInput04 | 0 or 1 | Input state - Digital input 6 |
| 6 | Reserved | 0 | |
| 7 | PowerSupply | 0 | Supply voltage too low |
| | | 1 | Supply voltage >80 VAC |

9.13.15.9.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|-------------|
| Without filtering | 100 μ s |
| With filtering | 150 μ s |

9.13.15.9.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|-------------|
| Without filtering | 100 μ s |
| With filtering | 200 μ s |

9.13.16 X20DI8371

Data sheet version: 3.07

9.13.16.1 General Information

The module is equipped with eight inputs for 1-wire connections. The module is designed for sink input wiring.

- 8 digital inputs
- Sink connection
- 1-wire connections
- Software input filter can be configured for entire module

9.13.16.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Digital inputs |  |
| X20DI8371 | X20 digital input module, 8 inputs, 24 VDC, sink, configurable input filter, 1-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 283: X20DI8371 - Order data

9.13.16.3 Technical data

| | |
|--|--|
| Model number | X20DI8371 |
| Short description | |
| I/O module | 8 digital inputs 24 VDC for 1-wire connections |
| General information | |
| B&R ID code | 0xA4AB |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.18 W |
| Internal I/O | - |
| External I/O | 1.2 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Digital inputs | |
| Nominal voltage | 24 VDC |
| Input characteristics per EN 61131-2 | Type 1 |
| Input voltage | 24 VDC -15 % / +20 % |
| Input current at 24 VDC | Typ. 3.75 mA |
| Input circuit | Sink |
| Input filter | |
| Hardware | ≤100 µs |
| Software | Default 1 ms, configurable between 0 and 25 ms in 0.2 ms intervals |
| Connection type | 1-wire connections |
| Input resistance | Typ. 6.4 kΩ |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |


Table 284: X20DI8371 - Technical data

| | |
|------------------------------|--|
| Model number | X20DI8371 |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 284: X20DI8371 - Technical data

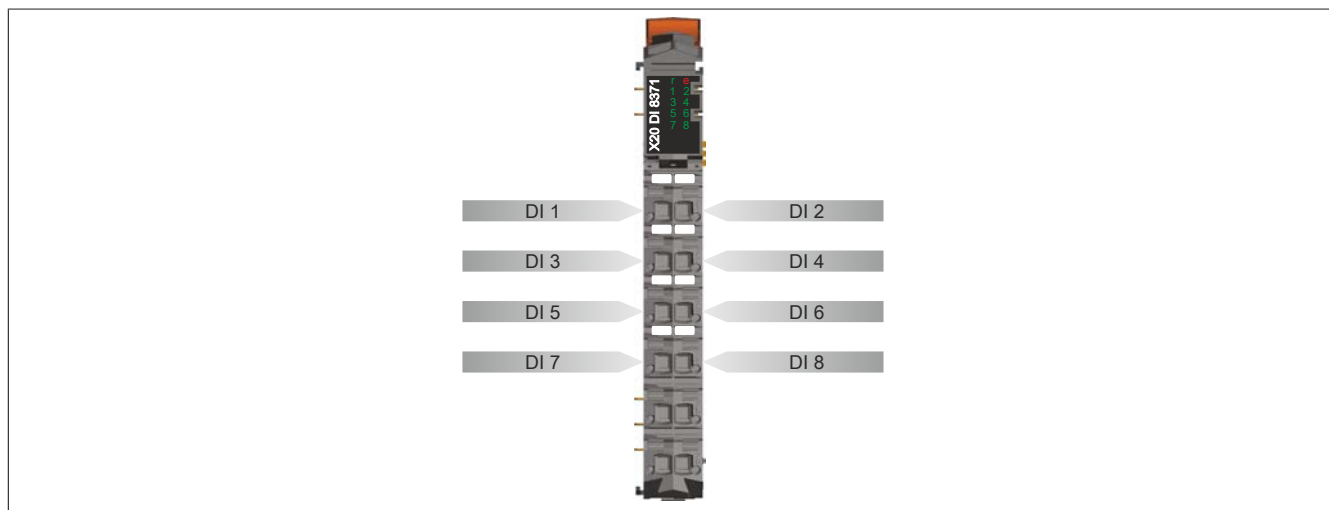
9.13.16.4 Status LEDs

For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

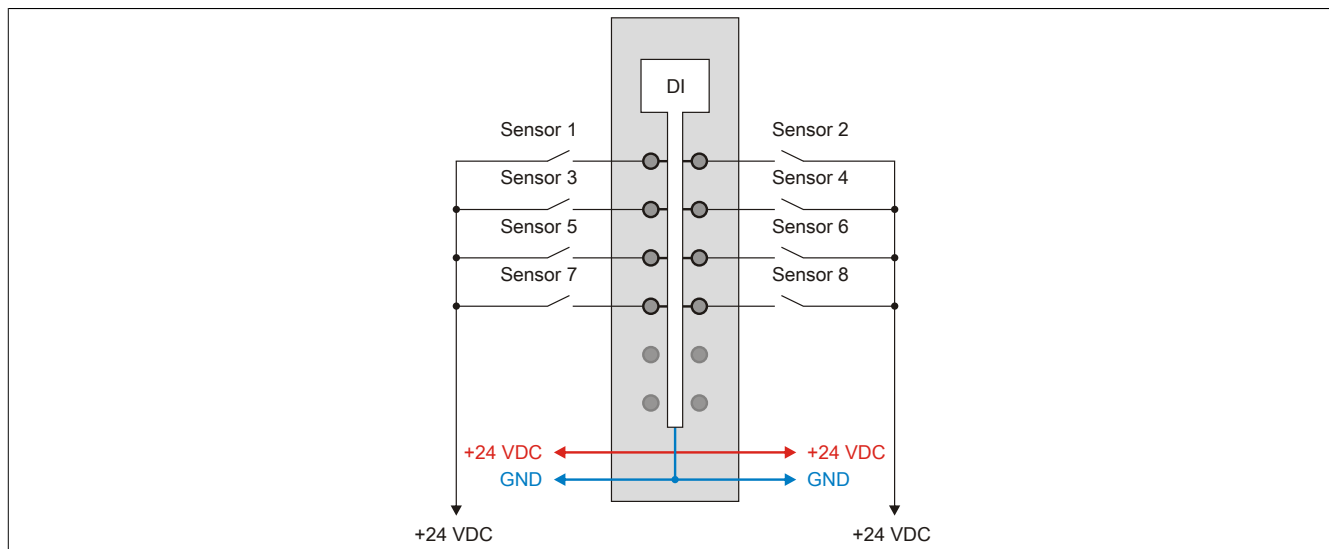
| Image | LED | Color | Status | Description |
|---|-------|-----------------------------|--------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | On | RUN mode |
| | e | Red | Off | Module supply not connected or everything OK |
| | e + r | Red on / Green single flash | | Invalid firmware |
| | 1 - 8 | Green | | Input status of the corresponding digital input |

1) Depending on the configuration, a firmware update can take up to several minutes.

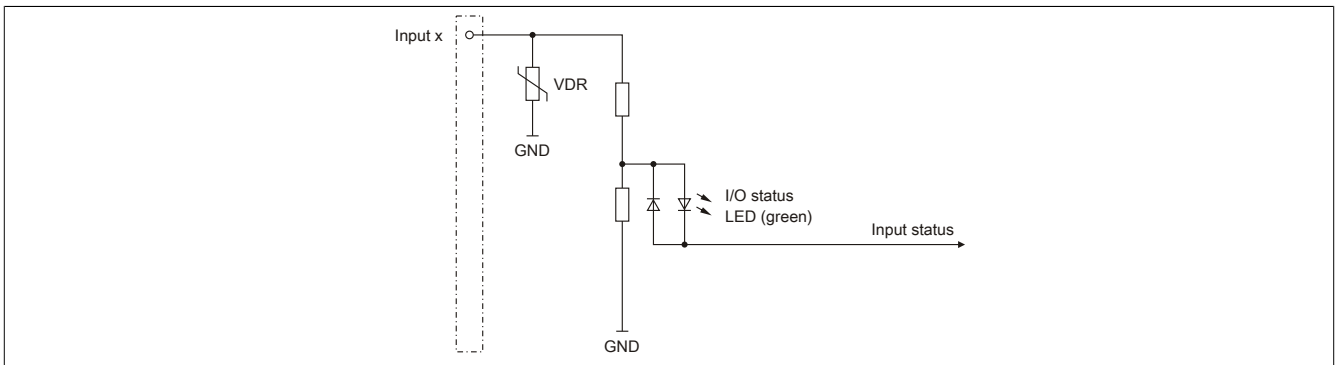
9.13.16.5 Pinout



9.13.16.6 Connection example

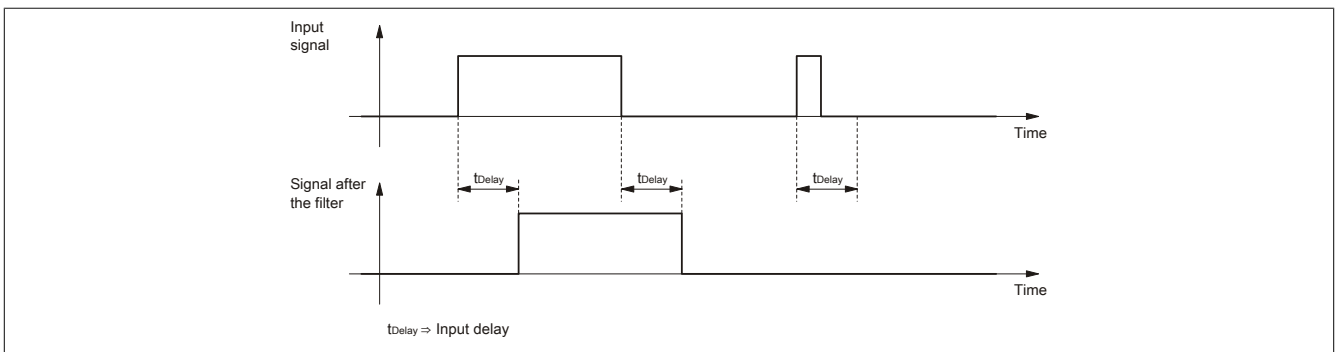


9.13.16.7 Input circuit diagram



9.13.16.8 Input filter

An input filter is available for each input. The input delay can be set using register "[ConfigOutput01](#)" on page 1543. Disturbance pulses which are shorter than the input delay are suppressed by the input filter.



9.13.16.9 Register description

9.13.16.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.13.16.9.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------------------|--------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 1 | DigitalInput | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput08 | Bit 7 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.13.16.9.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | DigitalInput | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput08 | Bit 7 | | | | |

1) The offset specifies where the register is within the CAN object.

9.13.16.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.13.16.9.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.13.16.9.4 Digital inputs

Unfiltered

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

Filtered

The filtered status is collected with a fixed offset to the network cycle and transferred in the same cycle. Filtering takes place asynchronously to the network in multiples of 200 µs with a network-related jitter of up to 50 µs.

9.13.16.9.4.1 Digital input filter

Name:

ConfigOutput01

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 μ s. It makes sense to enter values in steps of 2, however, since the input signals are sampled every 200 μ s.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No software filter (bus controller default setting) |
| | 2 | 0.2 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

9.13.16.9.4.2 Input state of digital inputs 1 to 8

Name:

DigitalInput or

DigitalInput01 to DigitalInput08

This register is used to indicate the input state of digital inputs 1 to 8.

Only function model 0 - Standard:

The "Packed inputs" setting in the Automation Studio I/O configuration is used to determine whether all of this register's bits should be set up individually as data points in the Automation Studio I/O mapping ("DigitalInput01" through "DigitalInput08") or whether this register should be displayed as an individual USINT data point ("DigitalInput").

| Data type | Value | Information |
|-----------|------------------------|---|
| USINT | 0 to 255 | Packed inputs = On |
| | See the bit structure. | Packed inputs = Off or function model \neq 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|--------|-------------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input state - Digital input 1 |
| ... | | ... | |
| 7 | DigitalInput08 | 0 or 1 | Input state - Digital input 8 |

9.13.16.9.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|-------------|
| Without filtering | 100 μ s |
| With filtering | 150 μ s |

9.13.16.9.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|-------------|
| Without filtering | 100 μ s |
| With filtering | 200 μ s |

9.13.17 X20(c)DI9371

Data sheet version: 3.20

9.13.17.1 General Information

The module is equipped with 12 inputs for 1-wire connections. The module is designed for sink input wiring.

- 12 digital inputs
- Sink connection
- 1-wire connections
- Software input filter can be configured for entire module

9.13.17.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.13.17.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.13.17.3 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Digital inputs |  |
| X20DI9371 | X20 digital input module, 12 inputs, 24 VDC, sink, configurable input filter, 1-wire connections | |
| X20cDI9371 | X20 digital input module, coated, 12 inputs, 24 VDC, sink, configurable input filter, 1-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 285: X20DI9371, X20cDI9371 - Order data

9.13.17.4 Technical data

| Model number | X20DI9371 | X20cDI9371 |
|--|--|------------|
| Short description | | |
| I/O module | 12 digital inputs 24 VDC for 1-wire connections | |
| General information | | |
| B&R ID code | 0x1B95 | 0xD574 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Power consumption | | |
| Bus | 0.18 W | |
| Internal I/O | - | |
| External I/O | 1.75 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations | |
| DNV GL | Class I, Division 2, Groups ABCD, T5 Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Digital inputs | | |
| Nominal voltage | 24 VDC | |
| Input characteristics per EN 61131-2 | Type 1 | |
| Input voltage | 24 VDC -15 % / +20 % | |
| Input current at 24 VDC | Typ. 3.75 mA | |
| Input circuit | Sink | |
| Input filter | | |
| Hardware | ≤100 µs | |
| Software | Default 1 ms, configurable between 0 and 25 ms in 0.2 ms intervals | |
| Connection type | 1-wire connections | |
| Input resistance | Typ. 6.4 kΩ | |
| Switching threshold | | |
| Low | <5 VDC | |
| High | >15 VDC | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating" | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |


Table 286: X20DI9371, X20cDI9371 - Technical data

| Model number | X20DI9371 | X20cDI9371 |
|------------------------------|--|---|
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

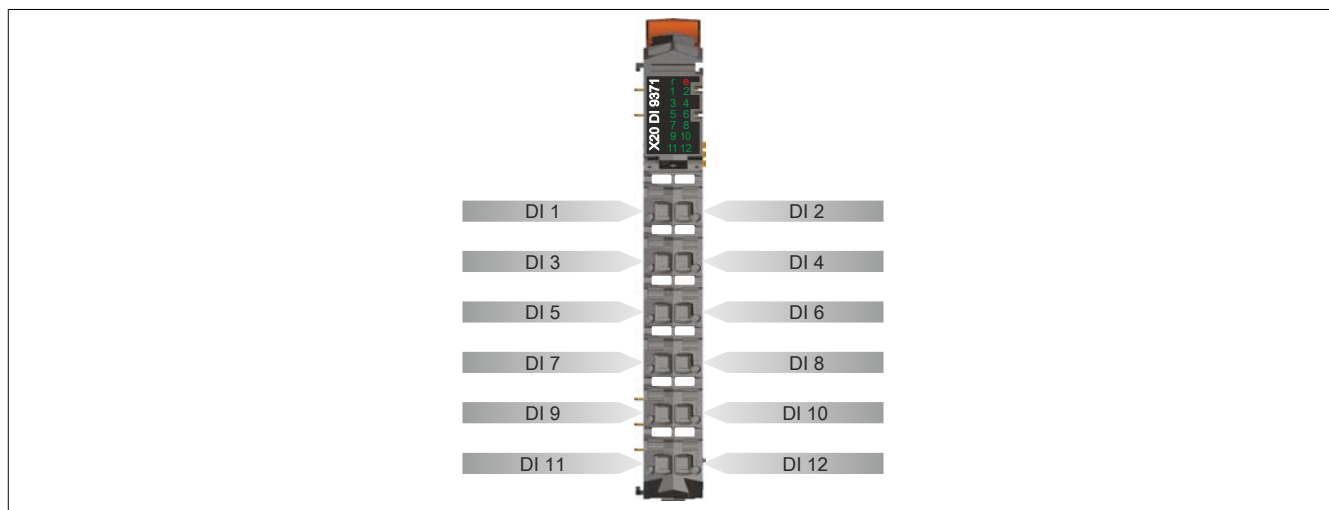
Table 286: X20DI9371, X20cDI9371 - Technical data

9.13.17.5 Status LEDs

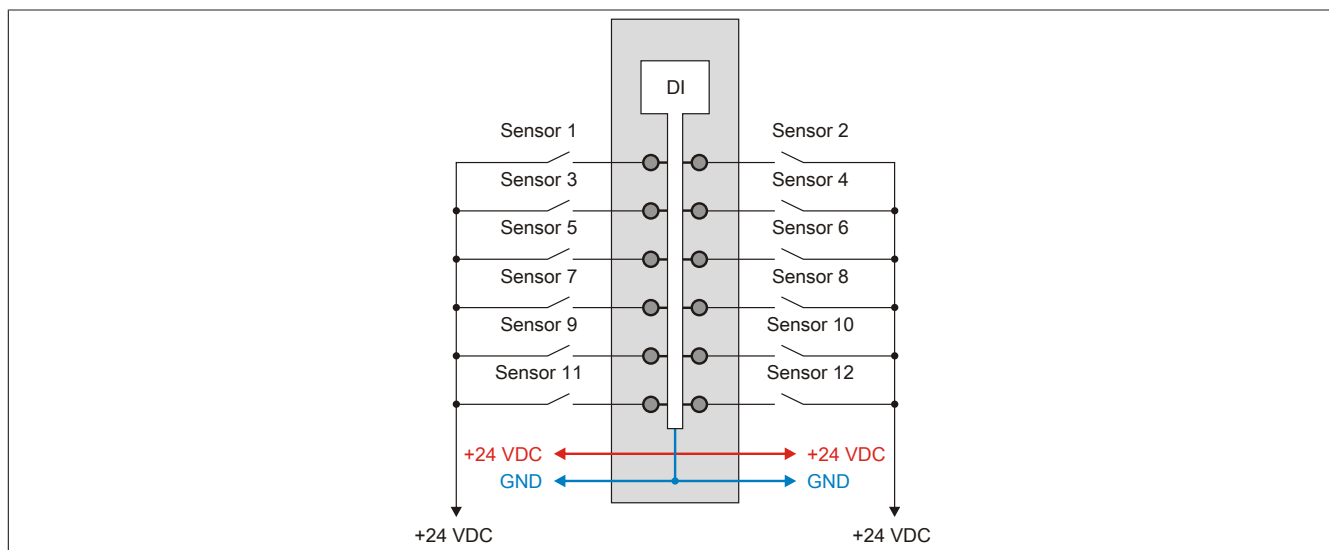
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Image | LED | Color | Status | Description |
|---|--------|-----------------------------|--------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | Module supply not connected or everything OK |
| | e + r | Red on / Green single flash | | Invalid firmware |
| | 1 - 12 | Green | | Input status of the corresponding digital input |

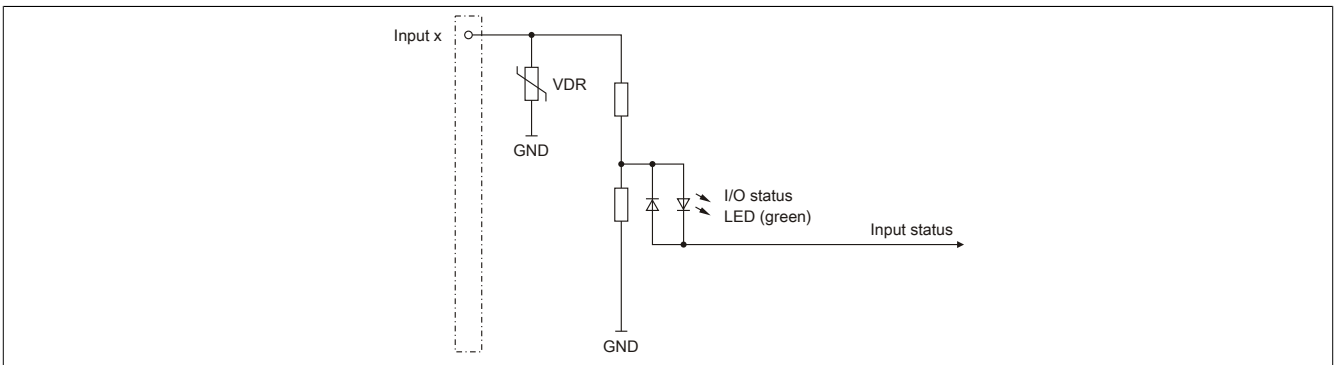
9.13.17.6 Pinout



9.13.17.7 Connection example

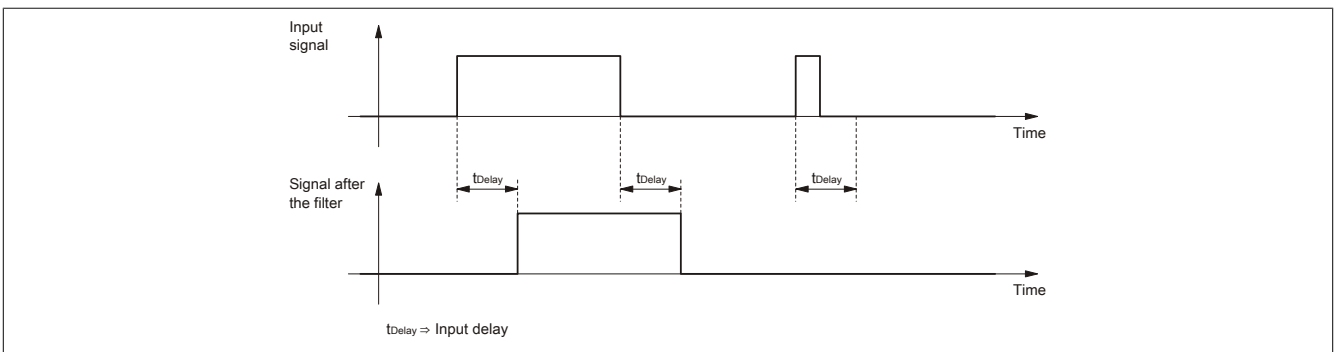


9.13.17.8 Input circuit diagram



9.13.17.9 Input filter

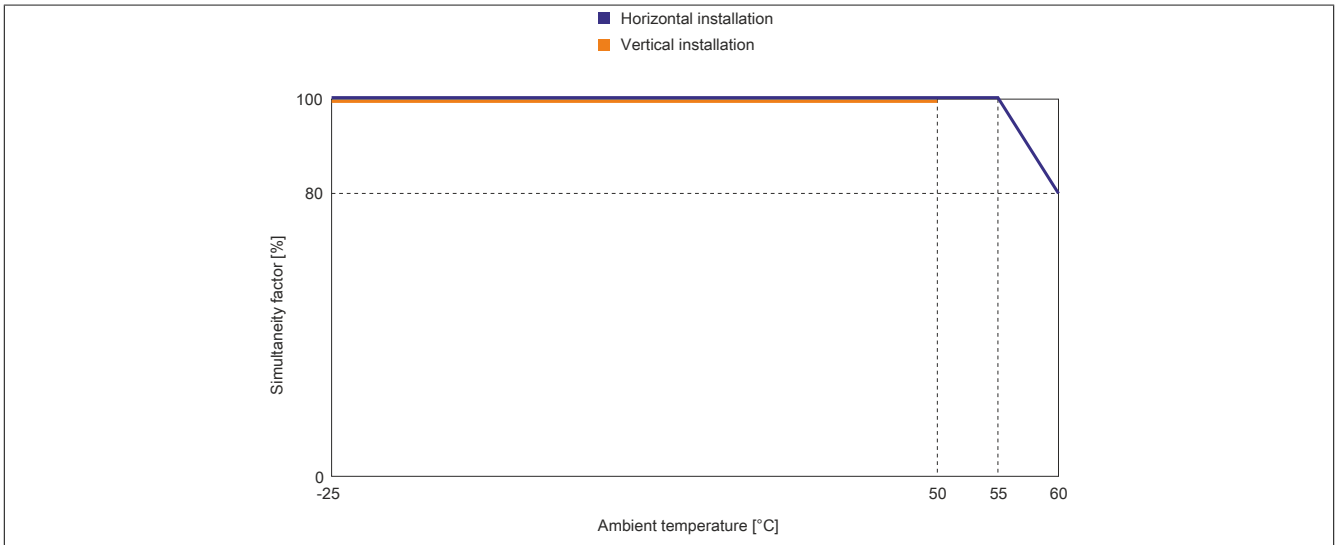
An input filter is available for each input. The input delay can be set using register "[ConfigOutput01](#)" on page 1550. Disturbance pulses which are shorter than the input delay are suppressed by the input filter.



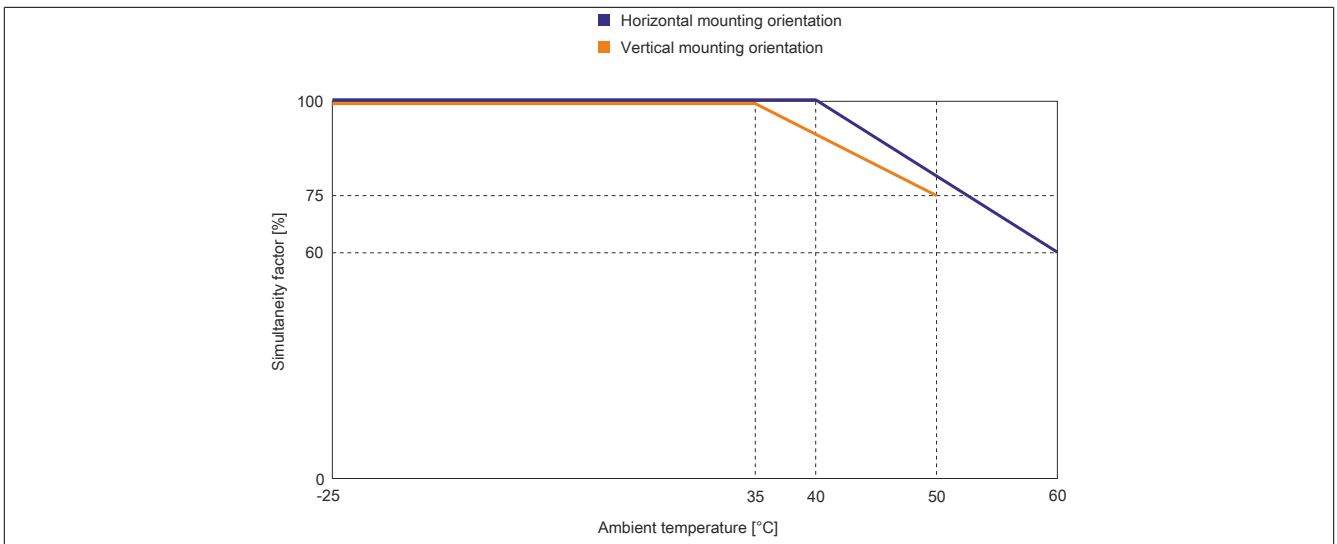
9.13.17.10 Derating

Be aware of the derating values below for the simultaneity factor.

Derating of simultaneity factor at 24 VDC input voltage



Derating of simultaneity factor at 28.8 VDC input voltage



9.13.17.11 Register description

9.13.17.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.13.17.11.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------------------|--------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| - | 1 | DigitalInput | UINT | • | | | |
| 0 | 1 | Input status of digital inputs 1 to 8 | USINT | | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput08 | Bit 7 | | | | |
| 1 | 2 | Input status of digital inputs 9 to 12 | USINT | • | | | |
| | | DigitalInput09 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput12 | Bit 3 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.13.17.11.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | Input status of digital inputs 1 to 8 | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput08 | Bit 7 | | | | |
| 1 | 1 | Input status of digital inputs 9 to 12 | USINT | • | | | |
| | | DigitalInput09 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput12 | Bit 3 | | | | |

1) The offset specifies where the register is within the CAN object.

9.13.17.11.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.13.17.11.3.2 CAN I/O bus controller

The module occupies 2 digital logical slots on CAN I/O.

9.13.17.11.4 Digital inputs

Unfiltered

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

Filtered

The filtered status is collected with a fixed offset to the network cycle and transferred in the same cycle. Filtering takes place asynchronously to the network in multiples of 200 µs with a network-related jitter of up to 50 µs.

9.13.17.11.4.1 Digital input filter

Name:

ConfigOutput01

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 μ s. It makes sense to enter values in steps of 2, however, since the input signals are sampled every 200 μ s.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No software filter (bus controller default setting) |
| | 2 | 0.2 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

9.13.17.11.4.2 Input state of digital inputs 1 to 12

Name:

DigitalInput or

DigitalInput01 to DigitalInput12

This register indicates the input state of digital inputs 1 to 12.

Only function model 0 - Standard

The "Packed inputs" setting in the Automation Studio I/O configuration is used to determine whether all of the bits from these registers should be set up individually as data points in the Automation Studio I/O mapping ("DigitalInput01" to "DigitalInput12") or whether this register should be displayed as an individual UINT data point ("DigitalInput").

| Data type | Values | Information |
|-----------|--------------------|---|
| UINT | 0 to 4095 | Packed inputs = On |
| USINT | See bit structure. | Packed inputs = Off or Function model <> 0 - Standard |

Bit structure:

Register 0

| Bit | Name | Value | Information |
|-----|----------------|--------|-------------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input state - Digital input 1 |
| ... | ... | ... | ... |
| 7 | DigitalInput08 | 0 or 1 | Input state - Digital input 8 |

Register 1

| Bit | Name | Value | Information |
|-----|----------------|--------|--------------------------------|
| 0 | DigitalInput09 | 0 or 1 | Input state - Digital input 9 |
| ... | ... | ... | ... |
| 3 | DigitalInput12 | 0 or 1 | Input state - Digital input 12 |

9.13.17.11.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|-------------|
| Without filtering | 100 μ s |
| With filtering | 150 μ s |

9.13.17.11.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|-------------|
| Without filtering | 100 μ s |
| With filtering | 200 μ s |

9.13.18 X20(c)DI9372

Data sheet version: 3.20

9.13.18.1 General Information

The module is equipped with 12 inputs for 1-wire connections. The module is designed for source input wiring.

- 12 digital inputs
- Source connection
- 1-wire connections
- Software input filter can be configured for entire module

9.13.18.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.13.18.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.13.18.3 Order data

| Model number | Short description | Figure |
|--------------|--|--------|
| | Digital inputs | |
| X20DI9372 | X20 digital input module, 12 inputs, 24 VDC, source, configurable input filter, 1-wire connections | |
| X20cDI9372 | X20 digital input module, coated, 12 inputs, 24 VDC, source, configurable input filter, 1-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 287: X20DI9372, X20cDI9372 - Order data

9.13.18.4 Technical data

| Model number | X20DI9372 | X20cDI9372 |
|--|--|------------|
| Short description | | |
| I/O module | 12 digital inputs 24 VDC for 1-wire connections | |
| General information | | |
| B&R ID code | 0x1D28 | 0xE224 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Power consumption | | |
| Bus | 0.18 W | |
| Internal I/O | 1.75 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Digital inputs | | |
| Nominal voltage | 24 VDC | |
| Input characteristics per EN 61131-2 | Type 1 | |
| Input voltage | 24 VDC -15 % / +20 % | |
| Input current at 24 VDC | Typ. 3.75 mA | |
| Input circuit | Source | |
| Input filter | | |
| Hardware | ≤100 µs | |
| Software | Default 1 ms, configurable between 0 and 25 ms in 0.2 ms intervals | |
| Connection type | 1-wire connections | |
| Input resistance | Typ. 6.4 kΩ | |
| Switching threshold | | |
| Low | <5 VDC | |
| High | >15 VDC | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating" | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |


Table 288: X20DI9372, X20cDI9372 - Technical data

| Model number | X20DI9372 | X20cDI9372 |
|------------------------------|--|---|
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

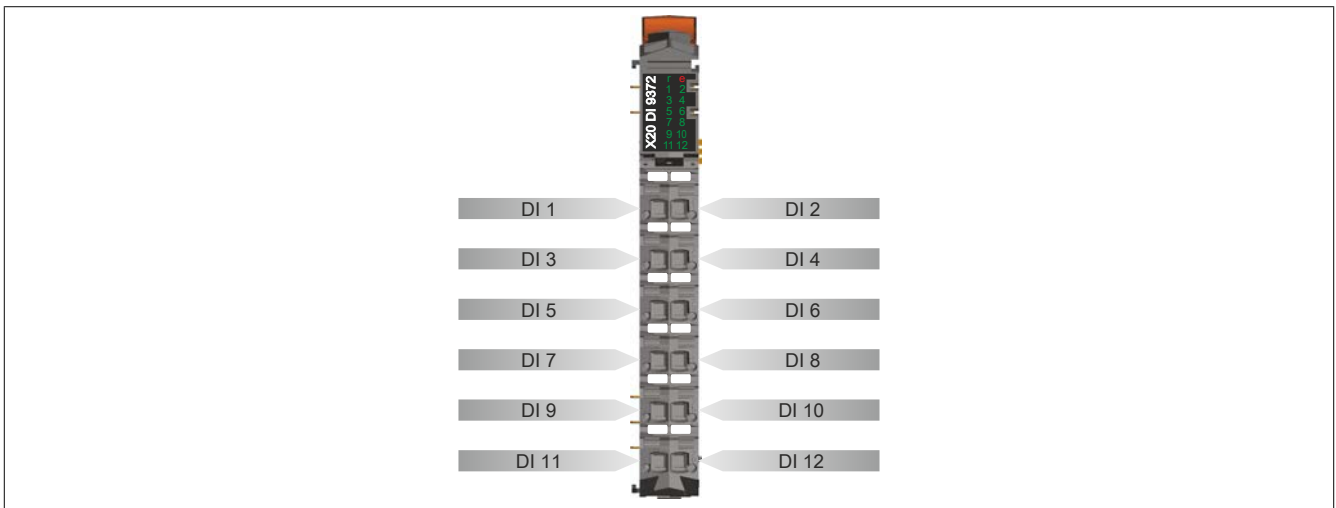
Table 288: X20DI9372, X20cDI9372 - Technical data

9.13.18.5 Status LEDs

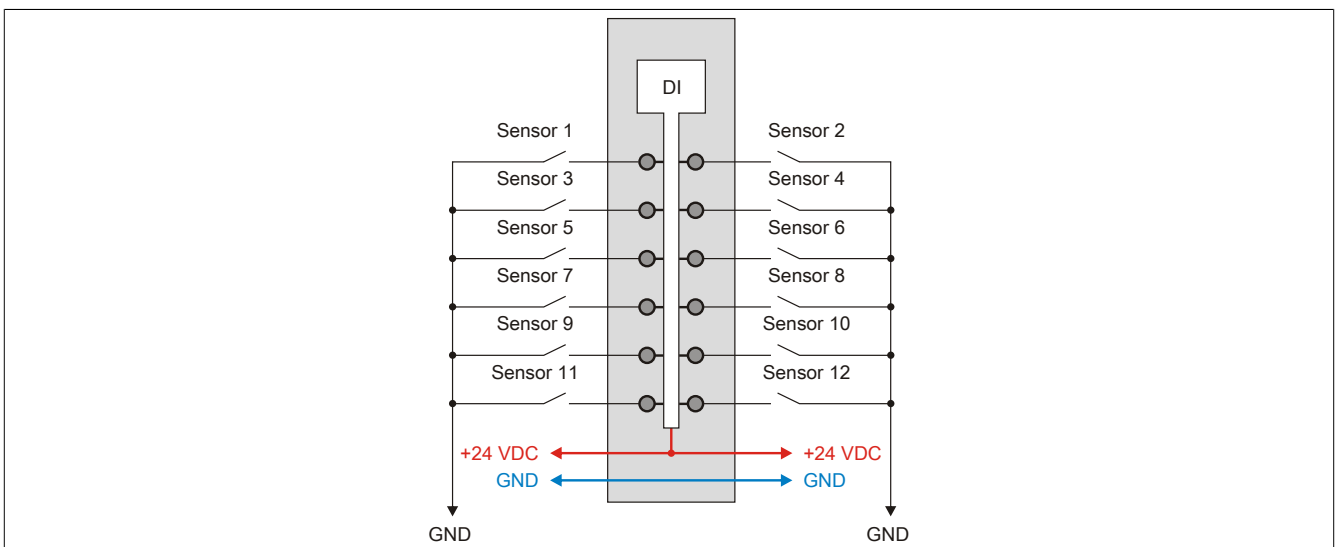
For a description of the various operating modes, see ["Diagnostic LEDs" on page 3787](#).

| Image | LED | Color | Status | Description | |
|---|--------|-----------------------------|--------------|---|--|
|  | r | Green | Off | No power to module | |
| | | | Single flash | RESET mode | |
| | | | Blinking | PREOPERATIONAL mode | |
| | | | On | RUN mode | |
| | e | Red | Off | Module supply not connected or everything OK | |
| | e + r | Red on / Green single flash | | Invalid firmware | |
| | 1 - 12 | Green | | Input status of the corresponding digital input | |
| | | | | | |
| | | | | | |
| | | | | | |

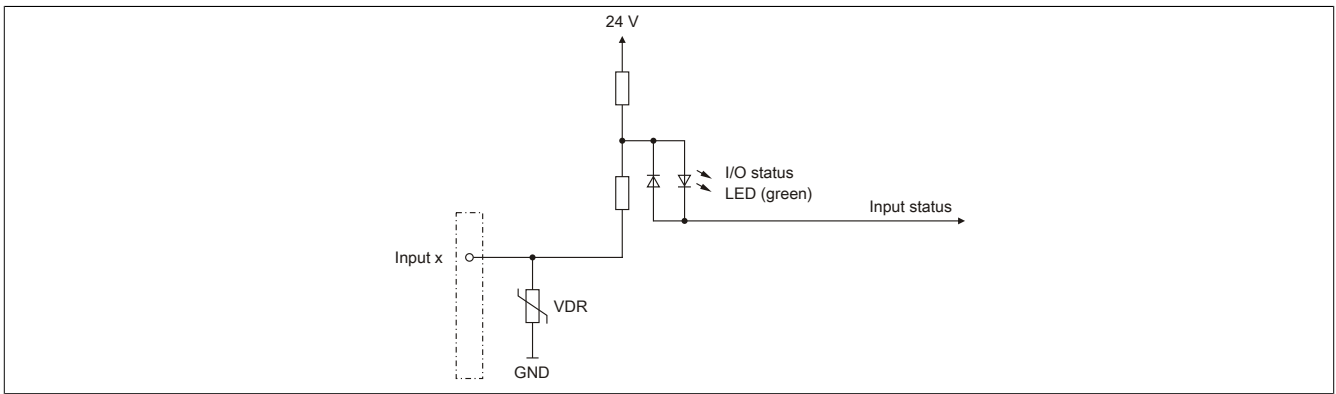
9.13.18.6 Pinout



9.13.18.7 Connection example

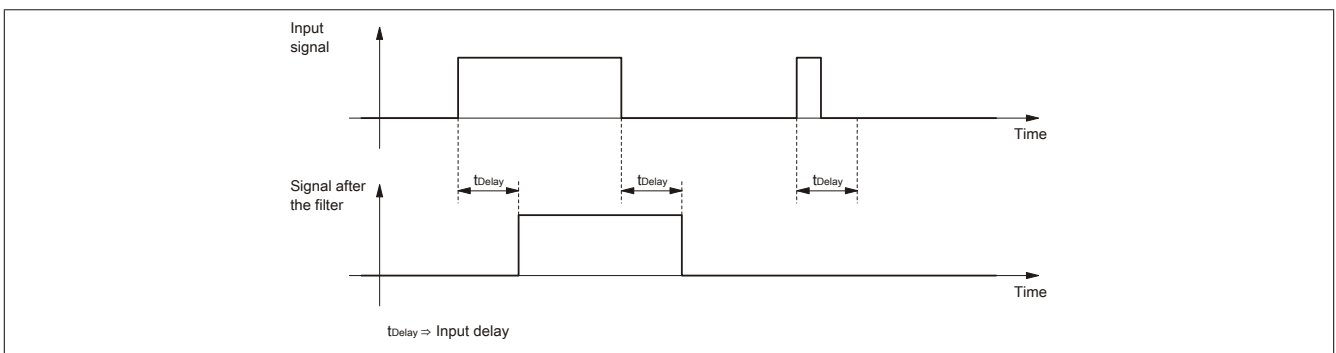


9.13.18.8 Input circuit diagram



9.13.18.9 Input filter

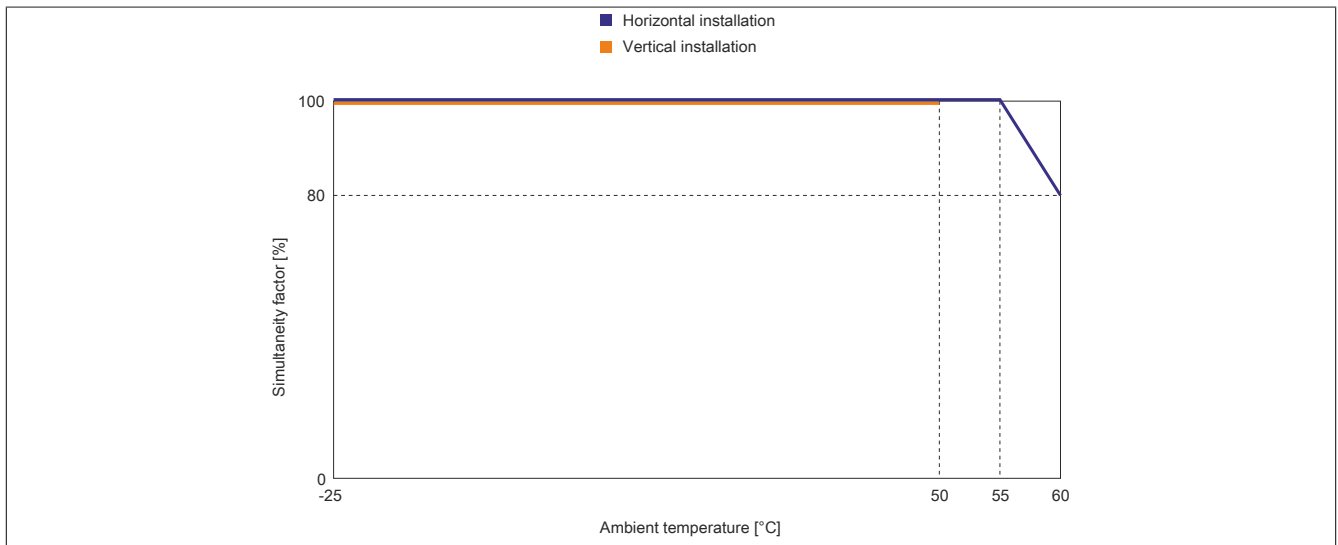
An input filter is available for each input. The input delay can be set using register "ConfigOutput01" on page 1557. Disturbance pulses which are shorter than the input delay are suppressed by the input filter.



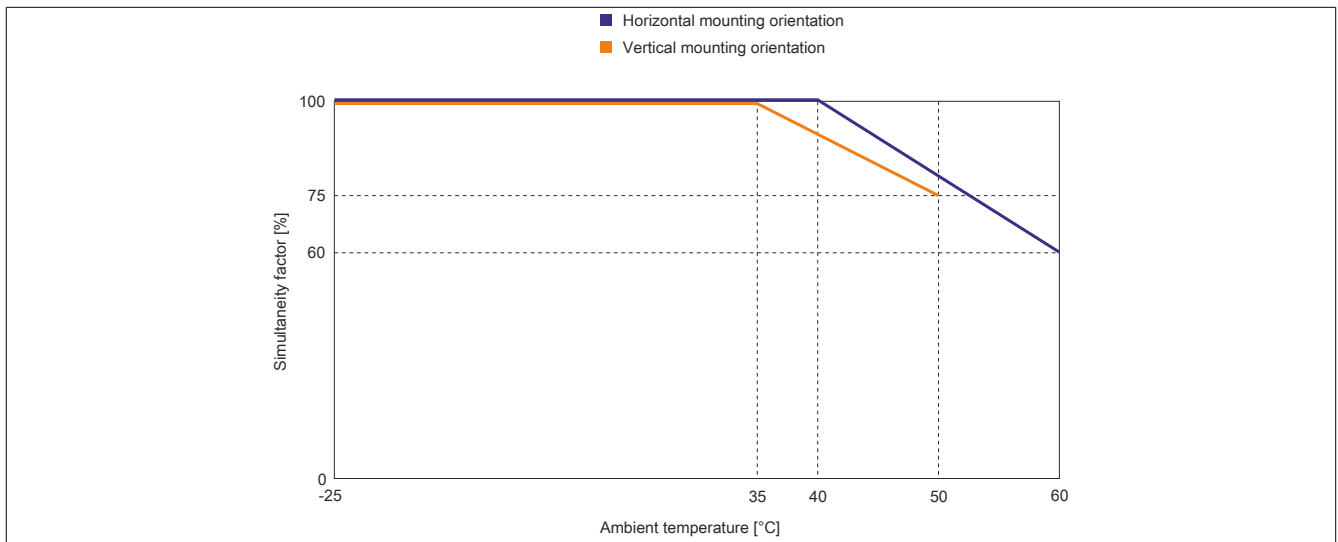
9.13.18.10 Derating

Be aware of the derating values below for the simultaneity factor.

Derating of simultaneity factor at 24 VDC input voltage



Derating of simultaneity factor at 28.8 VDC input voltage



9.13.18.11 Register description

9.13.18.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.13.18.11.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------------------|--------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| - | 1 | DigitalInput | UINT | • | | | |
| 0 | 1 | Input status of digital inputs 1 to 8 | USINT | | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput08 | Bit 7 | | | | |
| 1 | 2 | Input status of digital inputs 9 to 12 | USINT | • | | | |
| | | DigitalInput09 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput12 | Bit 3 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.13.18.11.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | Input status of digital inputs 1 to 8 | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput08 | Bit 7 | | | | |
| 1 | 1 | Input status of digital inputs 9 to 12 | USINT | • | | | |
| | | DigitalInput09 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput12 | Bit 3 | | | | |

1) The offset specifies where the register is within the CAN object.

9.13.18.11.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "[Using I/O modules on the bus controller](#)" on page 3789.

9.13.18.11.3.2 CAN I/O bus controller

The module occupies 2 digital logical slots on CAN I/O.

9.13.18.11.4 Digital inputs

Unfiltered

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

Filtered

The filtered status is collected with a fixed offset to the network cycle and transferred in the same cycle. Filtering takes place asynchronously to the network in multiples of 200 µs with a network-related jitter of up to 50 µs.

9.13.18.11.4.1 Digital input filter

Name:

ConfigOutput01

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 μ s. It makes sense to enter values in steps of 2, however, since the input signals are sampled every 200 μ s.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No software filter (bus controller default setting) |
| | 2 | 0.2 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

9.13.18.11.4.2 Input state of digital inputs 1 to 12

Name:

DigitalInput or

DigitalInput01 to DigitalInput12

This register indicates the input state of digital inputs 1 to 12.

Only function model 0 - Standard

The "Packed inputs" setting in the Automation Studio I/O configuration is used to determine whether all of the bits from these registers should be set up individually as data points in the Automation Studio I/O mapping ("DigitalInput01" to "DigitalInput12") or whether this register should be displayed as an individual UINT data point ("DigitalInput").

| Data type | Values | Information |
|-----------|--------------------|---|
| UINT | 0 to 4095 | Packed inputs = On |
| USINT | See bit structure. | Packed inputs = Off or Function model <> 0 - Standard |

Bit structure:

Register 0

| Bit | Name | Value | Information |
|-----|----------------|--------|-------------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input state - Digital input 1 |
| ... | ... | ... | ... |
| 7 | DigitalInput08 | 0 or 1 | Input state - Digital input 8 |

Register 1

| Bit | Name | Value | Information |
|-----|----------------|--------|--------------------------------|
| 0 | DigitalInput09 | 0 or 1 | Input state - Digital input 9 |
| ... | ... | ... | ... |
| 3 | DigitalInput12 | 0 or 1 | Input state - Digital input 12 |

9.13.18.11.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|-------------|
| Without filtering | 100 μ s |
| With filtering | 150 μ s |

9.13.18.11.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|-------------|
| Without filtering | 100 μ s |
| With filtering | 200 μ s |

9.13.19 X20DID371

Data sheet version: 2.07

9.13.19.1 General Information

The module is equipped with 8 inputs for 1-wire or 2-wire connections. The module is designed for sink input wiring.

- 8 digital inputs
- Sink connection
- 2-wire connections
- 24 VDC for sensor supply
- Software input filter can be configured for entire module

9.13.19.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Digital inputs |  |
| X20DID371 | X20 digital input module, 8 inputs, 24 VDC, sink, configurable input filter, 2-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB1F | X20 terminal block, 16-pin, 24 VDC keyed | |
| | | |
| | | |

Table 289: X20DID371 - Order data

9.13.19.3 Technical data

| Model number | X20DID371 |
|--|--|
| Short description | |
| I/O module | 8 digital inputs 24 VDC for 1- or 2-wire connections |
| General information | |
| B&R ID code | 0xC0E7 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.13 W |
| Internal I/O | 1.2 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Digital inputs | |
| Nominal voltage | 24 VDC |
| Input characteristics per EN 61131-2 | Type 1 |
| Input voltage | 24 VDC -15 % / +20 % |
| Input current at 24 VDC | Typ. 3.75 mA |
| Input circuit | Sink |
| Input filter | |
| Hardware | ≤100 μs |
| Software | Default 1 ms, configurable between 0 and 25 ms in 0.2 ms intervals |
| Connection type | 1- or 2-wire connections |
| Input resistance | Typ. 6.4 kΩ |
| Sensor power supply | 0.5 A summation current |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |


Table 290: X20DID371 - Technical data

| | |
|------------------------------|--|
| Model number | X20DID371 |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB1F terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

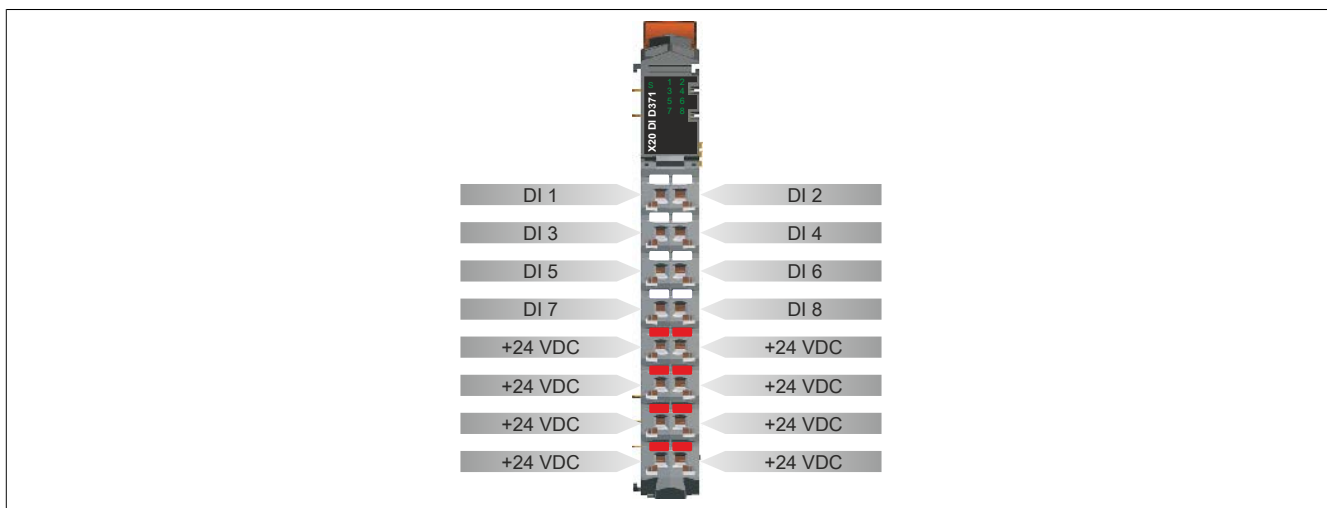
Table 290: X20DID371 - Technical data

9.13.19.4 Status LEDs

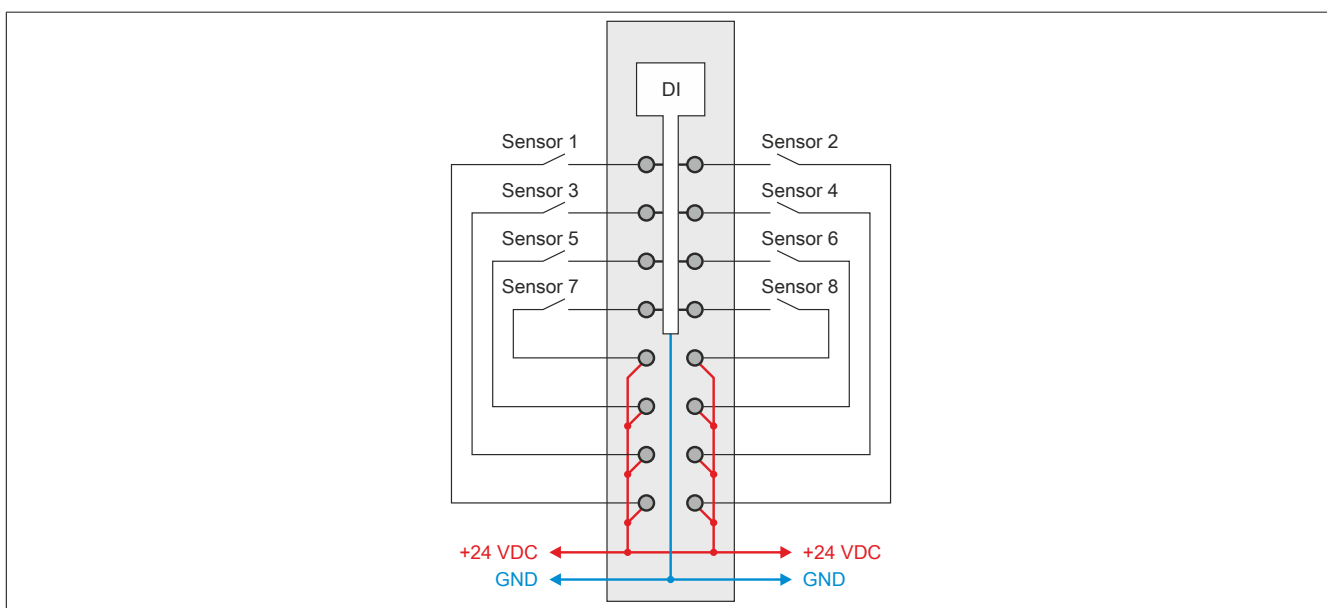
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Image | LED | Color | Status | Description | |
|---|-------|-------|-----------------------------|---------------------|---|
|  | S | Green | Off | No power to module | |
| | | | Single flash | RESET mode | |
| | | | Blinking | PREOPERATIONAL mode | |
| | | | On | RUN mode | |
| | 1 - 8 | Green | Red | Off | Module supply not connected or everything OK |
| | | | Red on / Green single flash | Invalid firmware | |
| | | | | | Input status of the corresponding digital input |
| | | | | | |

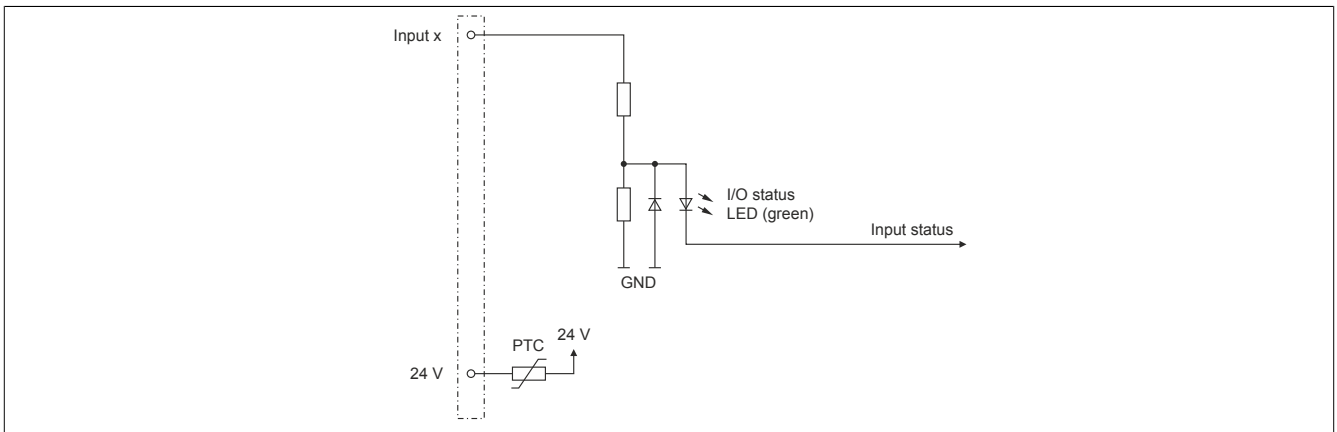
9.13.19.5 Pinout



9.13.19.6 Connection example

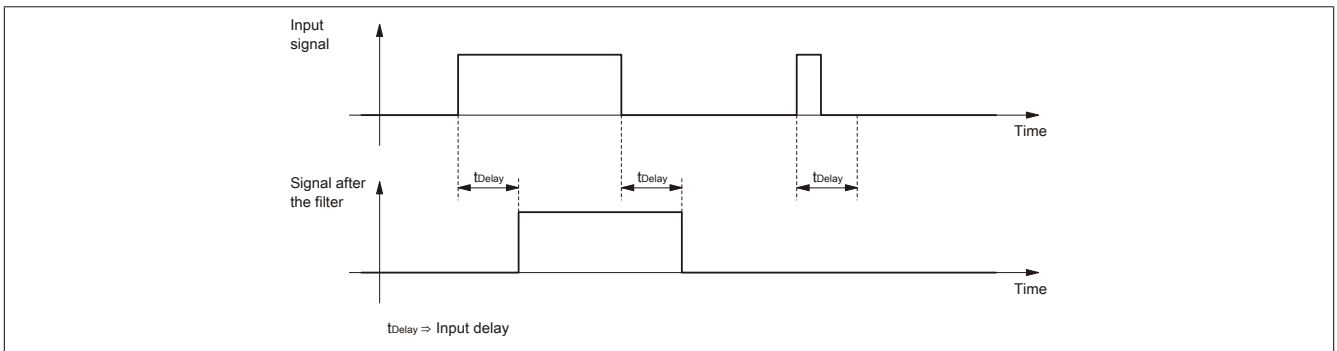


9.13.19.7 Input circuit diagram



9.13.19.8 Input filter

An input filter is available for each input. The input delay can be set using register "[ConfigOutput01](#)" on page 1563. Disturbance pulses which are shorter than the input delay are suppressed by the input filter.



9.13.19.9 Register description

9.13.19.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.13.19.9.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------------------|--------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 1 | DigitalInput | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput08 | Bit 7 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.13.19.9.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | Input state of digital inputs 1 to 8 | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput08 | Bit 7 | | | | |

1) The offset specifies where the register is within the CAN object.

9.13.19.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.13.19.9.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.13.19.9.4 Digital inputs

Unfiltered

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

Filtered

The filtered status is collected with a fixed offset to the network cycle and transferred in the same cycle. Filtering takes place asynchronously to the network in multiples of 200 µs with a network-related jitter of up to 50 µs.

9.13.19.9.4.1 Digital input filter

Name:

ConfigOutput01

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 μ s. It makes sense to enter values in steps of 2, however, since the input signals are sampled every 200 μ s.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No software filter (bus controller default setting) |
| | 2 | 0.2 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

9.13.19.9.4.2 Input state of digital inputs 1 to 8

Name:

DigitalInput or

DigitalInput01 to DigitalInput08

This register is used to indicate the input state of digital inputs 1 to 8.

Only function model 0 - Standard:

The "Packed inputs" setting in the Automation Studio I/O configuration is used to determine whether all of this register's bits should be set up individually as data points in the Automation Studio I/O mapping ("DigitalInput01" through "DigitalInput08") or whether this register should be displayed as an individual USINT data point ("DigitalInput").

| Data type | Value | Information |
|-----------|------------------------|---|
| USINT | 0 to 255 | Packed inputs = On |
| | See the bit structure. | Packed inputs = Off or function model \neq 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|--------|-------------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input state - Digital input 1 |
| ... | | ... | |
| 7 | DigitalInput08 | 0 or 1 | Input state - Digital input 8 |

9.13.19.9.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|-------------|
| Without filtering | 100 μ s |
| With filtering | 150 μ s |

9.13.19.9.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|-------------|
| Without filtering | 100 μ s |
| With filtering | 200 μ s |

9.13.20 X20(c)DIF371

Data sheet version: 2.17

9.13.20.1 General Information

The module is equipped with 16 inputs for 1-wire connections. The module is designed for sink input wiring.

- 16 digital inputs
- Sink connection
- 1-wire connections
- Software input filter can be configured for entire module

9.13.20.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.13.20.3 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Digital inputs |  |
| X20DIF371 | X20 digital input module, 16 inputs, 24 VDC, sink, configurable input filter, 1-wire connections | |
| X20cDIF371 | X20 digital input module, coated, 16 inputs, 24 VDC, sink, configurable input filter, 1-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB1F | X20 terminal block, 16-pin, 24 VDC keyed | |
| | | |
| | | |

Table 291: X20DIF371, X20cDIF371 - Order data

9.13.20.4 Technical data

| Model number | X20DIF371 | X20cDIF371 |
|--|--|------------|
| Short description | | |
| I/O module | 16 digital inputs 24 VDC for 1-wire connections | |
| General information | | |
| B&R ID code | 0xC0E8 | 0xDD44 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnosics | | |
| Module run/error | Yes, using status LED and software | |
| Power consumption | | |
| Bus | 0.18 W | |
| Internal I/O | - | |
| External I/O | 1.47 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| KC | Yes | - |
| EAC | Yes | |
| UL | cULus E115267 | |
| HazLoc | Industrial control equipment cCSAus 244665 | |
| ATEX | Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| LR | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| KR | ENV1 | - |
| Digital inputs | | |
| Nominal voltage | 24 VDC | |
| Input characteristics per EN 61131-2 | Type 1 | |
| Input voltage | 24 VDC -15% / +20% | |
| Input current at 24 VDC | Typ. 2.68 mA | |
| Input circuit | Sink | |
| Input filter | | |
| Hardware | ≤100 µs | |
| Software | Default 1 ms, configurable between 0 and 25 ms in 0.2 ms intervals | |
| Connection type | 1-wire connections | |
| Input resistance | Typ. 8.9 kΩ | |
| Simultaneity ¹⁾ | | |
| With 24 V I/O power supply | 100% (16 channels) ²⁾ | |
| With 28.8 V I/O power supply | 75% (12 channels) ²⁾ | |
| Switching threshold | | |
| Low | <5 VDC | |
| High | >15 VDC | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating" | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |

Table 292: X20DIF371, X20cDIF371 - Technical data


| Model number | X20DIF371 | X20cDIF371 |
|------------------------------|--|---|
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB1F terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB1F terminal block separately Order 1x X20cBM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm | |

Table 292: X20DIF371, X20cDIF371 - Technical data

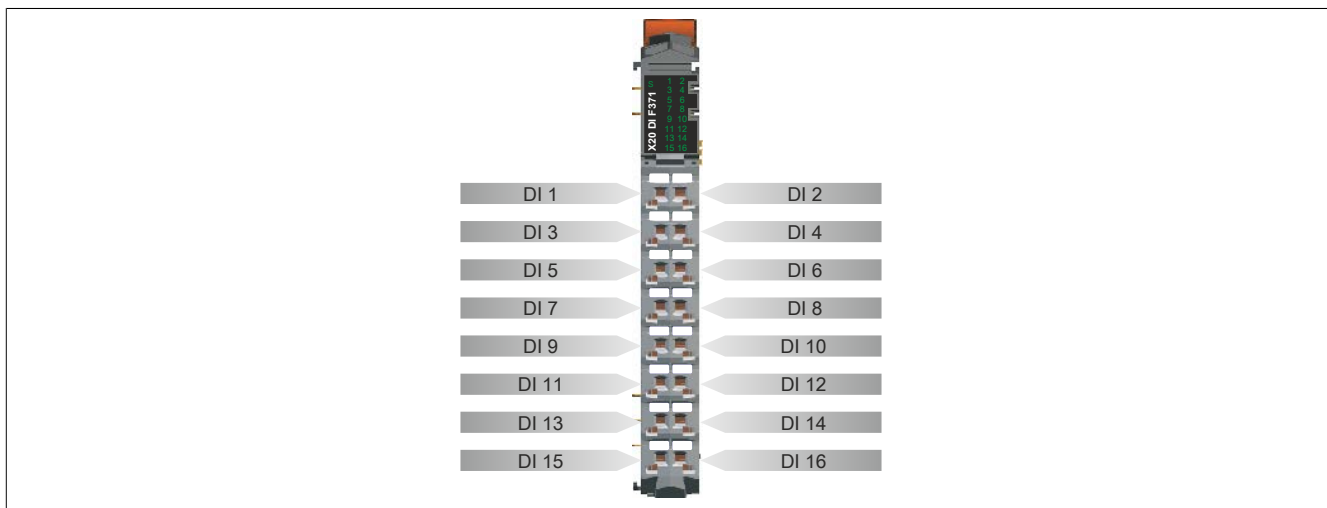
- 1) Maximum permitted number of simultaneously enabled inputs
- 2) Derating must be taken into consideration.

9.13.20.5 Status LEDs

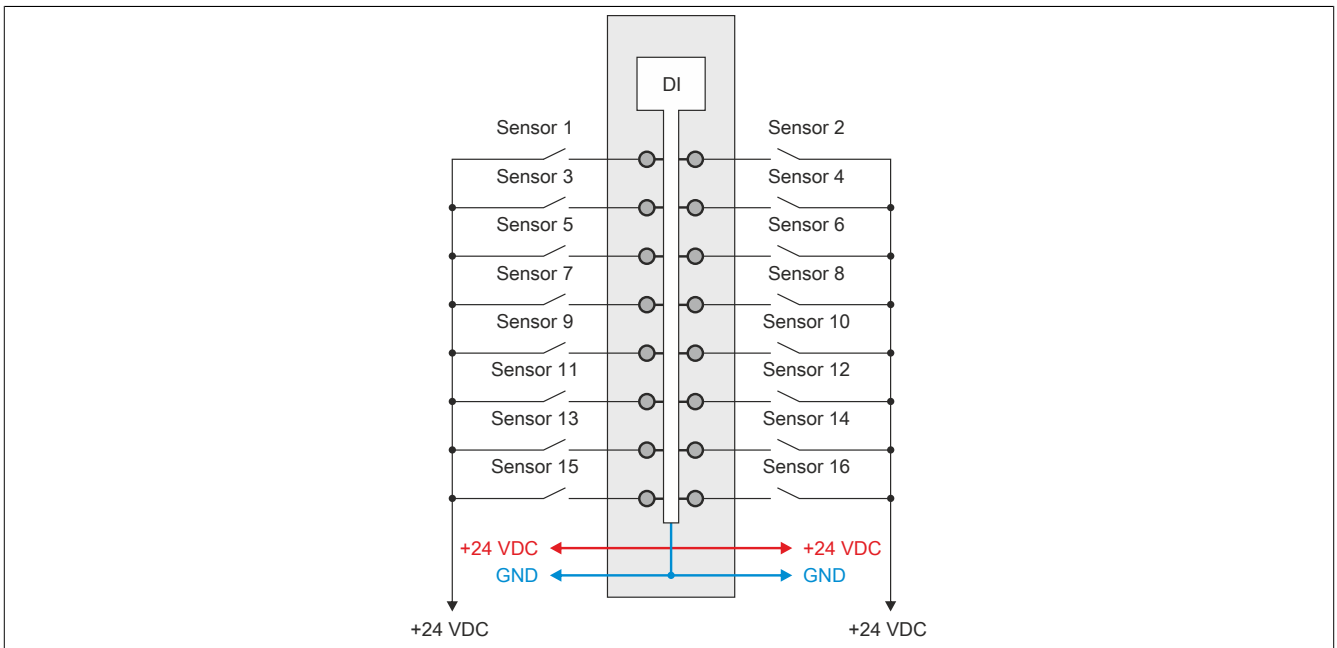
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Image | LED | Color | Status | Description |
|---|--------|-----------------------------|-----------------------------|--|
|  | S | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | Red | Red on / Green single flash | Off | Module supply not connected or everything OK |
| | | | Red on / Green single flash | Invalid firmware |
| | 1 - 16 | Green | | |

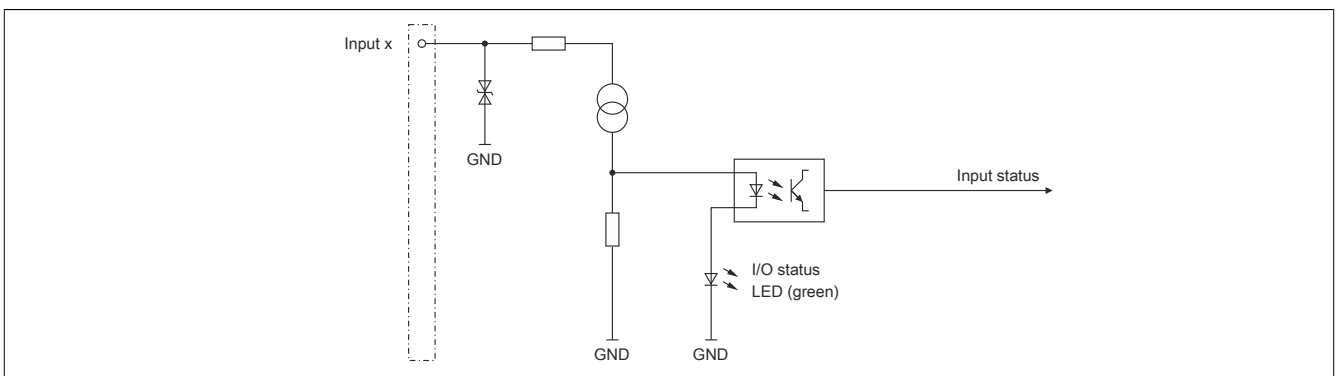
9.13.20.6 Pinout



9.13.20.7 Connection example

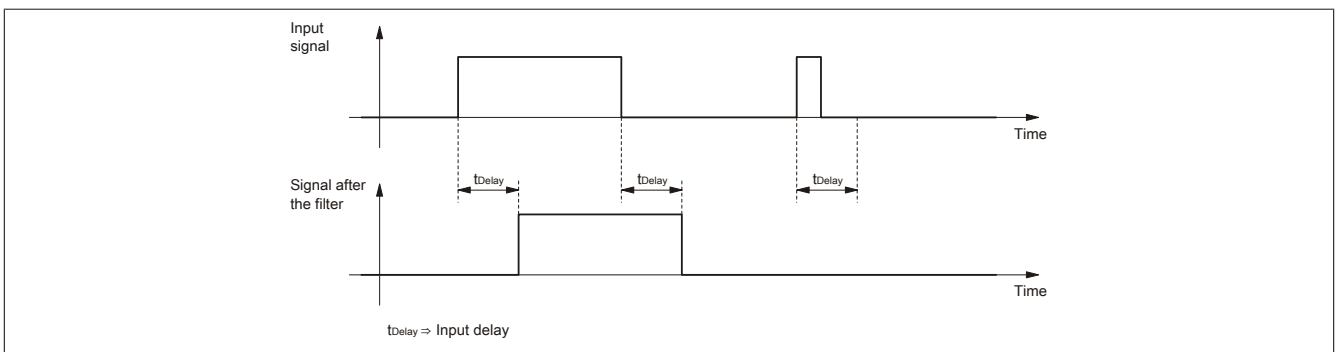


9.13.20.8 Input circuit diagram



9.13.20.9 Input filter

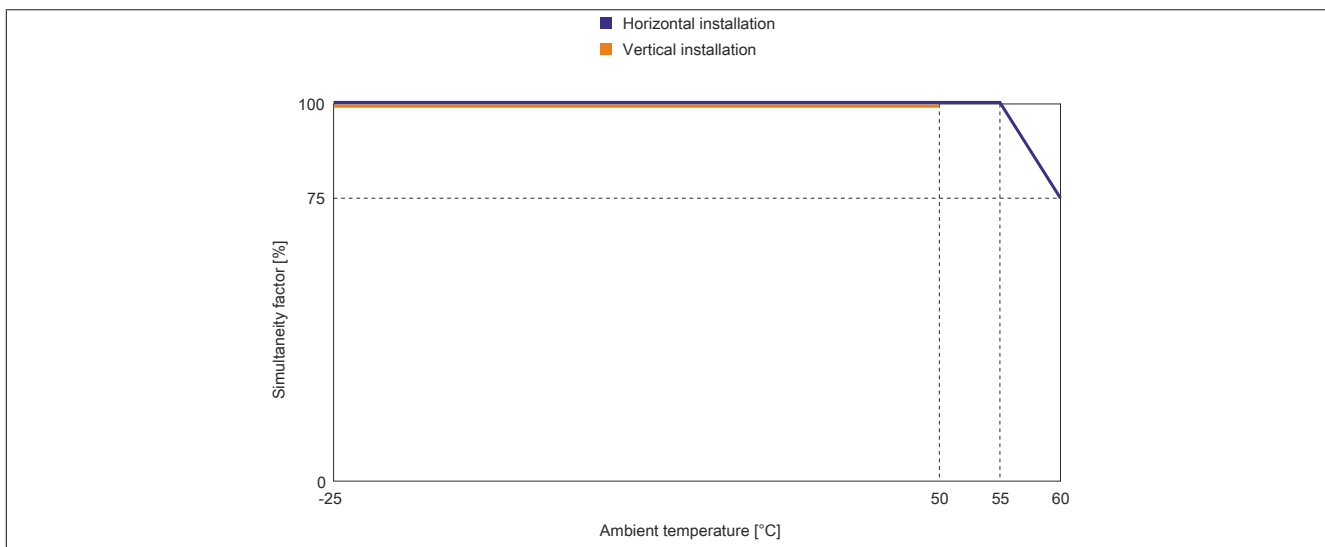
An input filter is available for each input. The input delay can be set using register "[ConfigOutput01](#)" on page 1570. Disturbance pulses which are shorter than the input delay are suppressed by the input filter.



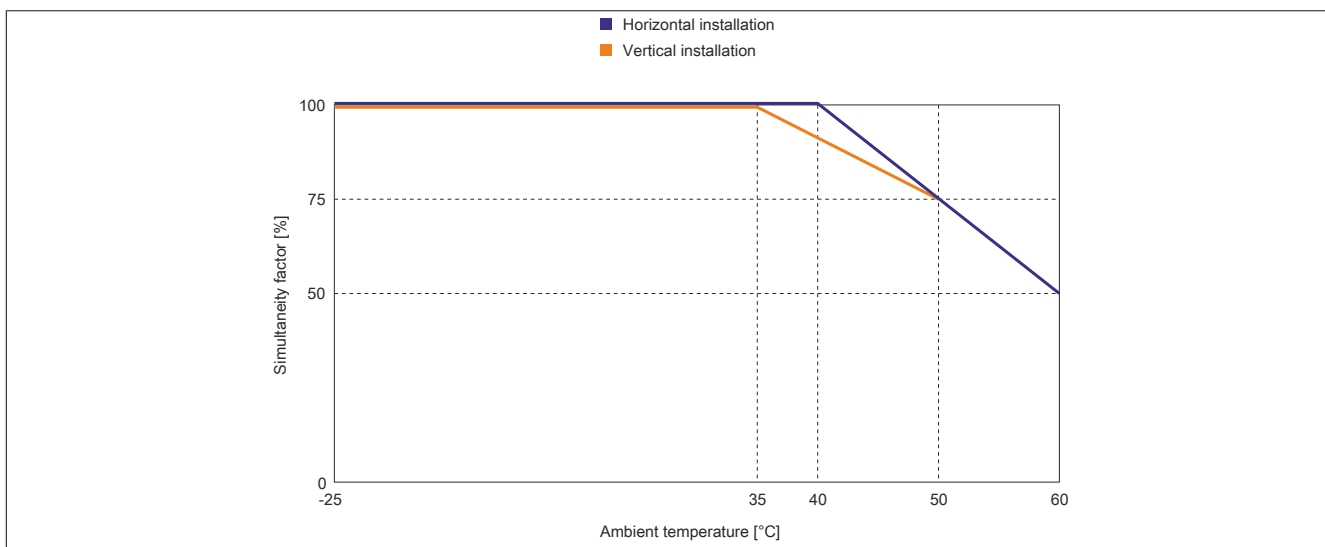
9.13.20.10 Derating

Be aware of the derating values below for the simultaneity factor.

Derating of simultaneity factor at 24 VDC input voltage



Derating of simultaneity factor at 28.8 VDC input voltage



9.13.20.11 Register description

9.13.20.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.13.20.11.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------------------|--------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| - | 1 | DigitalInput | UINT | • | | | |
| 0 | 1 | Input status of digital inputs 1 to 8 | USINT | | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| 1 | 2 | DigitalInput08 | Bit 7 | | | | |
| | | Input status of digital inputs 9 to 16 | USINT | • | | | |
| | | DigitalInput09 | Bit 0 | | | | |
| ... | ... | ... | ... | | | | |
| | | DigitalInput16 | Bit 7 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.13.20.11.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | Input status of digital inputs 1 to 8 | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| 1 | 1 | DigitalInput08 | Bit 7 | | | | |
| | | Input status of digital inputs 9 to 16 | USINT | • | | | |
| | | DigitalInput09 | Bit 0 | | | | |
| ... | ... | ... | ... | | | | |
| | | DigitalInput16 | Bit 7 | | | | |

1) The offset specifies where the register is within the CAN object.

9.13.20.11.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.13.20.11.3.2 CAN I/O bus controller

The module occupies 2 digital logical slots on CAN I/O.

9.13.20.11.4 Digital inputs

Unfiltered

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

Filtered

The filtered status is collected with a fixed offset to the network cycle and transferred in the same cycle. Filtering takes place asynchronously to the network in multiples of 200 µs with a network-related jitter of up to 50 µs.

9.13.20.11.4.1 Digital input filter

Name:

ConfigOutput01

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 μ s. It makes sense to enter values in steps of 2, however, since the input signals are sampled every 200 μ s.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No software filter (bus controller default setting) |
| | 2 | 0.2 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

9.13.20.11.4.2 Input status of digital inputs 1 to 16

Name:

DigitalInput or

DigitalInput01 to DigitalInput16

The input status of digital inputs 9 to 16 is mapped in this register.

Function model 0 - Standard only:

The "packed inputs" setting in the Automation Studio I/O configuration is used to determine whether all of this register's bits should be set up individually as data points in the Automation Studio I/O mapping ("DigitalInput01" through "DigitalInput16") or whether this register should be displayed as an individual UINT data point ("DigitalInput").

| Data type | Value | Information |
|-----------|------------------------|---|
| USINT | 0 to 65535 | Packed inputs = On |
| | See the bit structure. | Packed inputs = Off or function model \neq 0 - Standard |

Bit structure:

Register 0:

| Bit | Description | Value | Information |
|-----|----------------|--------|--------------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input status - Digital input 1 |
| ... | ... | ... | ... |
| 7 | DigitalInput08 | 0 or 1 | Input status - Digital input 8 |

Register 1:

| Bit | Name | Value | Information |
|-----|----------------|--------|---------------------------------|
| 0 | DigitalInput09 | 0 or 1 | Input status - Digital input 9 |
| ... | ... | ... | ... |
| 7 | DigitalInput16 | 0 or 1 | Input status - Digital input 16 |

9.13.20.11.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|-------------|
| Without filtering | 100 μ s |
| With filtering | 150 μ s |

9.13.20.11.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|-------------|
| Without filtering | 100 μ s |
| With filtering | 200 μ s |

9.14 Digital mixed modules

Digital mixed modules are a combination of digital input and output modules. The states of the digital inputs or outputs are shown by the LED status indicators.

9.14.1 Summary

| Model number | Short description | Page |
|--------------|---|------|
| X20DM9324 | X20 digital mixed module, 8 inputs, 24 VDC, sink, configurable input filter, 4 outputs, 24 VDC, 0.5 A, source 1-wire connections | 1572 |
| X20cDM9324 | X20 digital mixed module, coated, 8 inputs, 24 VDC, sink, configurable input filter, 4 outputs, 24 VDC, 0.5 A, source, 1-wire connections | 1572 |

9.14.2 X20(c)DM9324

Data sheet version: 3.18

9.14.2.1 General information

This module is equipped with 8 inputs and 4 outputs for 1-wire connections. The inputs are designed for sink connections, the outputs for source connections.

- 8 digital inputs, sink connections
- 4 digital outputs, source connections
- 1-wire connections
- Configurable software input filter for entire module
- Integrated output protection

9.14.2.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.14.2.3 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Digital inputs/outputs |  |
| X20DM9324 | X20 digital mixed module, 8 inputs, 24 VDC, sink, configurable input filter, 4 outputs, 24 VDC, 0.5 A, source 1-wire connections | |
| X20cDM9324 | X20 digital mixed module, coated, 8 inputs, 24 VDC, sink, configurable input filter, 4 outputs, 24 VDC, 0.5 A, source, 1-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 293: X20DM9324, X20cDM9324 - Order data

9.14.2.4 Technical data

| Model number | X20DM9324 | X20cDM9324 |
|--|--|------------|
| Short description | | |
| I/O module | 8 digital inputs 24 VDC for 1-wire connections, 4 digital outputs 24 VDC for 1-wire connections | |
| General information | | |
| Nominal voltage | 24 VDC | |
| B&R ID code | 0x20B9 | 0xE225 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Outputs | Yes, using status LED and software (output error status) | |
| Power consumption | | |
| Bus | 0.21 W | |
| Internal I/O | 0.5 W | |
| External I/O | 1.17 W | |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +0.21 | |
| Certifications | | |
| CE | Yes | |
| KC | Yes | - |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | |
| Digital inputs | | |
| Input characteristics per EN 61131-2 | Type 1 | |
| Input voltage | 24 VDC -15 % / +20 % | |
| Input current at 24 VDC | Typ. 3.75 mA | |
| Input circuit | Sink | |
| Input filter | | |
| Hardware | ≤100 μs | |
| Software | Default 1 ms, configurable between 0 and 25 ms in 0.2 ms intervals | |
| Connection type | 1-wire connections | |
| Input resistance | Typ. 6.4 kΩ | |
| Switching threshold | | |
| Low | <5 VDC | |
| High | >15 VDC | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Digital outputs | | |
| Variant | FET positive switching | |
| Switching voltage | 24 VDC -15 % / +20 % | |
| Nominal output current | 0.5 A | |
| Total nominal current | 2 A | |
| Connection type | 1-wire connections | |
| Output circuit | Source | |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short circuit current") Internal inverse diode for switching inductive loads (see section "Switching inductive loads") | |
| Diagnostic status | Output monitoring with 10 ms delay | |
| Leakage current when switched off | 5 μA | |
| R _{DS(on)} | 210 mΩ | |
| Peak short-circuit current | <12 A | |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms (depends on the module temperature) | |
| Switching delay | | |
| 0 → 1 | <300 μs | |
| 1 → 0 | <300 μs | |
| Switching frequency | | |
| Resistive load | Max. 500 Hz | |
| Inductive load | See section "Switching inductive loads" | |
| Braking voltage when switching off inductive loads | Typ. 50 VDC | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |

Table 294: X20DM9324, X20cDM9324 - Technical data


| Model number | X20DM9324 | X20cDM9324 |
|--|--|---|
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm | |

Table 294: X20DM9324, X20cDM9324 - Technical data

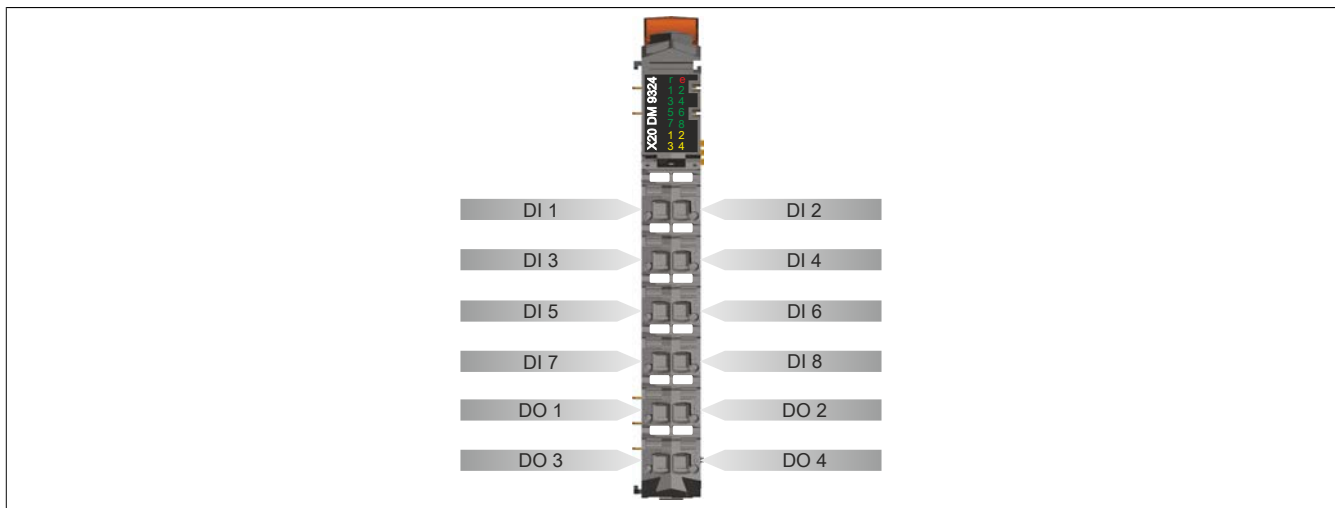
1) Number of outputs x $R_{DS(on)}$ x nominal output current²

9.14.2.5 Status LEDs

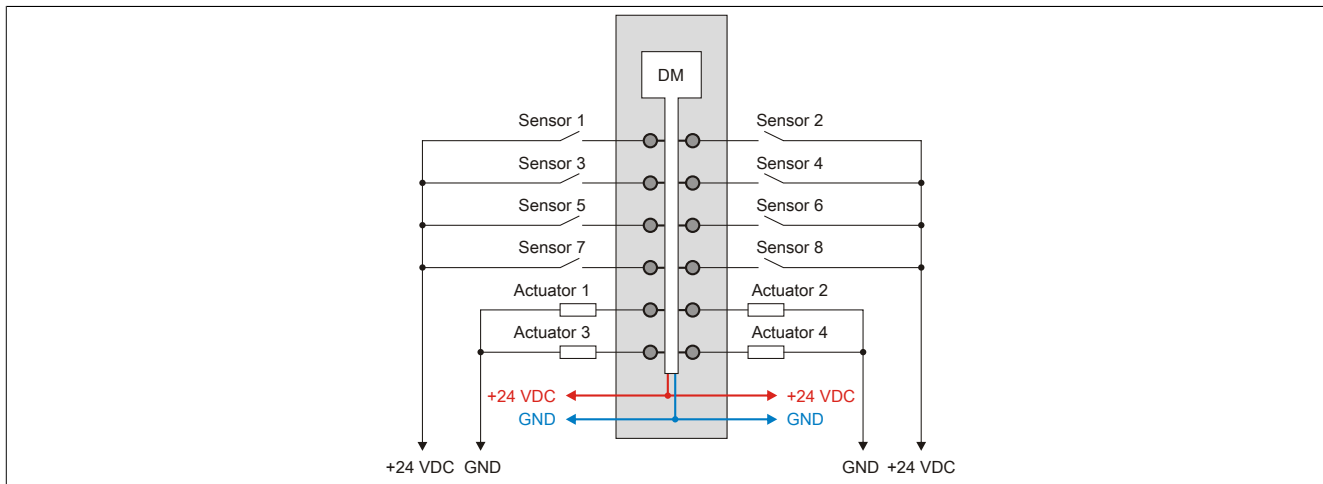
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|--|-------|-----------------------------|------------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1 - 8 | Green | | Input status of the corresponding digital input |
| | 1 - 4 | Orange | | Output status of the corresponding digital output |

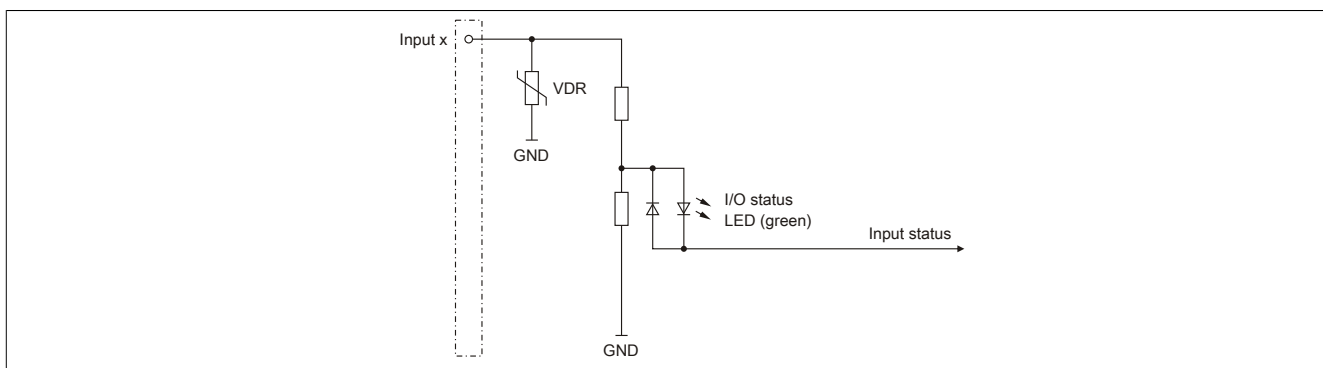
9.14.2.6 Pinout



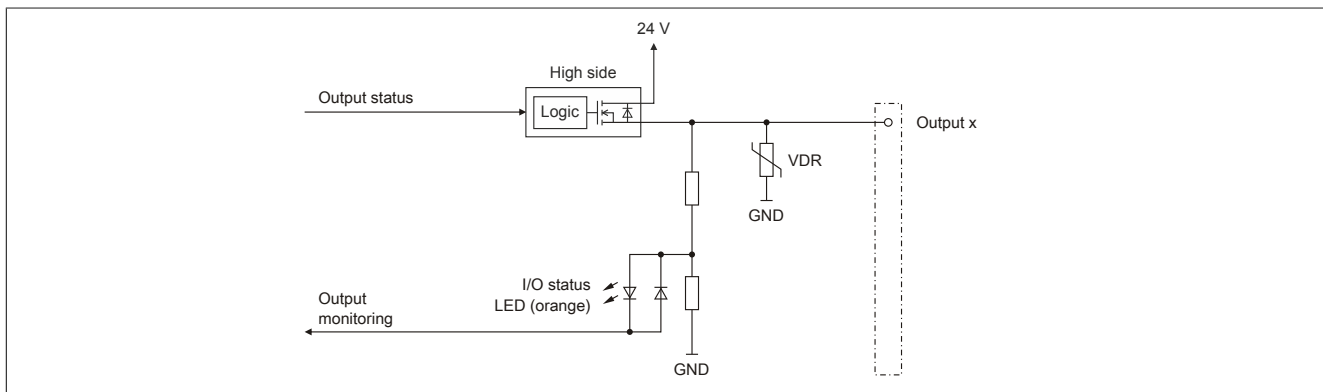
9.14.2.7 Connection example



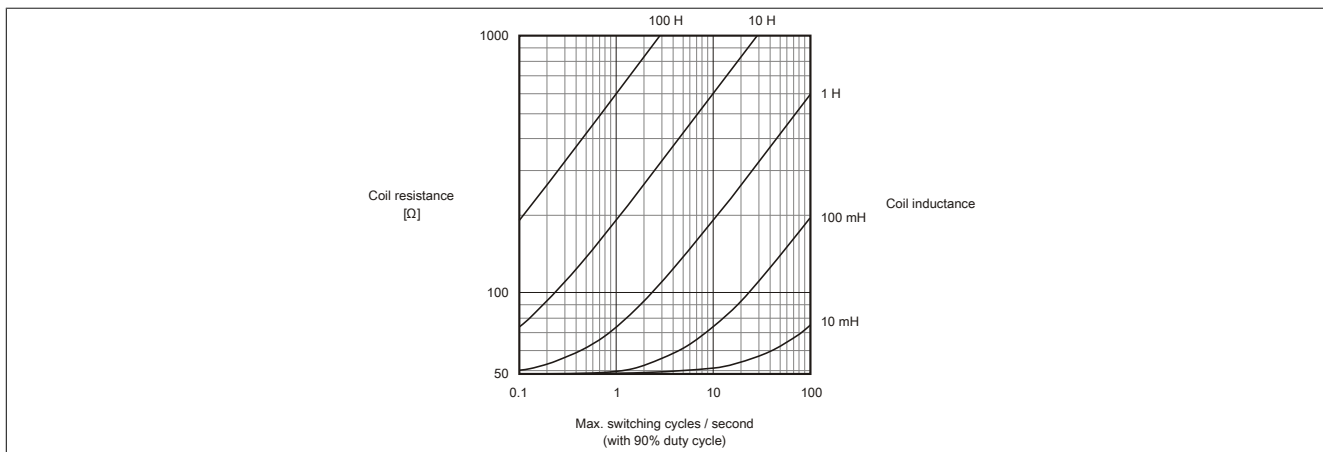
9.14.2.8 Input circuit diagram



9.14.2.9 Output circuit diagram



9.14.2.10 Switching inductive loads



9.14.2.11 Register description

9.14.2.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.14.2.11.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------------------|--------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 1 | DigitalInput | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput08 | Bit 7 | | | | |
| 2 | 0 | DigitalOutput | | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput04 | Bit 3 | | | | |
| 30 | 2 | StatusInput01 | USINT | • | | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput04 | Bit 3 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.14.2.11.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 18 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | Input state of digital inputs 1 to 8 | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput08 | Bit 7 | | | | |
| 2 | 0 | Switching state of digital outputs 1 to 4 | | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput04 | Bit 3 | | | | |
| 30 | - | Status of digital outputs 1 to 4 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput04 | Bit 3 | | | | |

1) The offset specifies where the register is within the CAN object.

9.14.2.11.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.14.2.11.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.14.2.11.4 Digital inputs

Unfiltered

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

Filtered

The filtered status is collected with a fixed offset to the network cycle and transferred in the same cycle. Filtering takes place asynchronously to the network in multiples of 200 μ s with a network-related jitter of up to 50 μ s.

9.14.2.11.4.1 Input state of digital inputs 1 to 8

Name:

DigitalInput or
DigitalInput01 to DigitalInput08

This register is used to indicate the input state of digital inputs 1 to 8.

Only function model 0 - Standard:

The "Packed inputs" setting in the Automation Studio I/O configuration is used to determine whether all of this register's bits should be set up individually as data points in the Automation Studio I/O mapping ("DigitalInput01" through "DigitalInput08") or whether this register should be displayed as an individual USINT data point ("DigitalInput").

| Data type | Value | Information |
|-----------|------------------------|---|
| USINT | 0 to 255 | Packed inputs = On |
| | See the bit structure. | Packed inputs = Off or function model \neq 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|--------|-------------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input state - Digital input 1 |
| ... | | ... | |
| 7 | DigitalInput08 | 0 or 1 | Input state - Digital input 8 |

9.14.2.11.4.2 Digital input filter

Name:

ConfigOutput01

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 μ s. It makes sense to enter values in steps of 2, however, since the input signals are sampled every 200 μ s.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No software filter (bus controller default setting) |
| | 2 | 0.2 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

9.14.2.11.5 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 μ s) based on the network cycle (SyncOut).

9.14.2.11.5.1 Switching state of digital outputs 1 to 4

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput04

This register is used to store the switching state of digital outputs 1 to 4.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Values | Information |
|-----------|------------------------|---|
| USINT | 0 to 15 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model \neq 0 - Standard. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 3 | DigitalOutput04 | 0 | Digital output 04 reset |
| | | 1 | Digital output 04 set |

9.14.2.11.6 Monitoring status of the digital outputs

On the module, the output states of the outputs are compared to the target states. The control of the output driver is used for the target state.

A change in the output state resets monitoring for that output. The status of each individual channel can be read. A change in the monitoring status is actively transmitted as an error message.

9.14.2.11.6.1 Status of digital outputs 1 to 4

Name:

StatusInput01

StatusDigitalOutput01 to StatusDigitalOutput04

This register contains the state of digital outputs 1 to 4.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("StatusDigitalOutput01" to "StatusDigitalOutput0x") or whether this register should be displayed as a single USINT data point ("StatusInput01").

| Data type | Values | Information |
|-----------|------------------------|---|
| USINT | 0 to 15 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model \neq 0 - Standard. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput01 | 0 | Channel 01: No error |
| | | 1 | Channel 01: <ul style="list-style-type: none"> Short circuit or overload Channel switched on and missing I/O power supply Channel switched off and external voltage applied on channel |
| ... | | ... | |
| 3 | StatusDigitalOutput04 | 0 | Channel 04: No error |
| | | 1 | Channel 04: For an error description, see channel 01. |

9.14.2.11.7 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|-------------|
| Without filtering | 100 μ s |
| With filtering | 150 μ s |

9.14.2.11.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|-------------|
| Without filtering | 100 μ s |
| With filtering | 200 μ s |

9.15 Digital output modules

Digital output modules are used to control external loads (relays, motors, solenoids). The states of the digital outputs are indicated by status LEDs.

9.15.1 Summary

| Model number | Short description | Page |
|--------------|---|------|
| X20DO2321 | X20 digital output module, 2 outputs, 24 VDC, 0.5 A, sink, 3-wire connections | 1581 |
| X20DO2322 | X20 digital output module, 2 outputs, 24 VDC, 0.5 A, source, 3-wire connections | 1590 |
| X20DO2623 | X20 digital output module, 2 outputs, 100 to 240 VAC, 1 A, source, 240 V keyed, 3-wire connections | 1599 |
| X20DO2633 | X20 digital output module, 2 triac outputs, 48 to 240 VAC, 2 A, L-switching, phase angle control, 240 V keyed | 1610 |
| X20DO2649 | X20 digital output module, 2 relays, changeover contacts, 240 VAC / 5 A, 24 VDC / 5 A | 1626 |
| X20DO4321 | X20 digital output module, 4 outputs, 24 VDC, 0.5 A, sink, 3-wire connections | 1632 |
| X20DO4322 | X20 digital output module, 4 outputs, 24 VDC, 0.5 A, source, 3-wire connections | 1641 |
| X20DO4331 | X20 digital output module, 4 outputs, 24 VDC, 2 A, sink, 3-wire connections | 1649 |
| X20DO4332 | X20 digital output module, 4 outputs, 24 VDC, 2 A, source, 3-wire connections | 1659 |
| X20DO4332-1 | X20 digital output module, 4 outputs, 24 VDC, 2 A, source, 3-wire connections, PWM output | 1669 |
| X20DO4529 | X20 digital output module, 4 relays, changeover contacts, 115 VAC / 0.5 A, 24 VDC / 1 A | 1679 |
| X20DO4613 | X20 digital output module, 4 triac coupler outputs, 48 to 240 VAC, 50 mA, zero-crossing detection, 240 V keyed | 1686 |
| X20DO4623 | X20 digital output module, 4 outputs, 100 to 240 VAC, 0.5 A, source, 240 V keyed, 2-wire connections | 1699 |
| X20DO4633 | X20 digital output module, 4 triac outputs, 48 to 240 VAC, 1 A, L-switching, phase angle control, 240 V keyed | 1709 |
| X20DO4649 | X20 digital output module, 4 relays, N.O. contacts, 240 VAC / 5 A | 1726 |
| X20DO4F49 | X20 digital output module, 4 relays, 2x normally open contacts, 2x changeover contacts, 240 VAC / 2 A, 250 VDC / 0.28 A | 1732 |
| X20DO6321 | X20 digital output module, 6 outputs, 24 VDC, 0.5 A, sink, 2-wire connections | 1739 |
| X20DO6322 | X20 digital output module, 6 outputs, 24 VDC, 0.5 A, source, 2-wire connections | 1746 |
| X20DO6325 | X20 digital output module, 6 outputs, 24 VDC, 0.5 A, source, open line and overload detection, 2-wire connections | 1755 |
| X20DO6529 | X20 digital output module, 6 relays, normally open contacts, 115 VAC / 0.5 A, 30 VDC / 1 A | 1766 |
| X20DO6639 | X20 digital output module, 6 relays, normally open contacts, 240 VAC / 2 A, 30 VDC / 2 A | 1773 |
| X20DO8232 | X20 digital output module, 8 outputs, 12 VDC, 2 A, source, supply directly on module, 1-wire connections | 1779 |
| X20DO8322 | X20 digital output module, 8 outputs, 24 VDC, 0.5 A, source, 1-wire connections | 1791 |
| X20DO8323 | X20 digital output module, 8 outputs, 12 to 24 V, 0.5 A, sink/source, 1-wire connections, full bridge, half bridge, thermal overload protection | 1799 |
| X20DO8331 | X20 digital output module, 8 outputs, 24 VDC, 2 A, sink, supply directly on module, 1-wire connections | 1808 |
| X20DO8332 | X20 digital output module, 8 outputs, 24 VDC, 2 A, source, supply directly on module, 1-wire connections | 1820 |
| X20DO8332-1 | X20 digital output module, 8 outputs, 24 VDC, 2 A, source, optimized for inductive loads, power supply directly on module, 1-wire connections | 1832 |
| X20DO9321 | X20 digital output module, 12 outputs, 24 VDC, 0.5 A, sink, 1-wire connections | 1843 |
| X20DO9322 | X20 digital output module, 12 outputs, 24 VDC, 0.5 A, source, 1-wire connections | 1851 |
| X20DOD322 | X20 digital output module, 8 outputs, 24 VDC, 0.5 A, source, 2-wire connections | 1859 |
| X20DOF322 | X20 digital output module, 16 output, 24 VDC, 0.5 A, source, 1-wire connections | 1866 |
| X20cDO2633 | X20 digital output module, coated, 2 triac outputs, 48 to 240 VAC, 2 A, L-switching, phase angle control, 240 V keyed | 1610 |
| X20cDO4322 | X20 digital output module, coated, 4 outputs, 24 VDC, 0.5 A, source, 3-wire connections | 1641 |
| X20cDO4332 | X20 digital output module, coated, 4 outputs, 24 VDC, 2 A, source, 3-wire connections | 1659 |
| X20cDO4633 | X20 digital output module, coated, 4 triac outputs, 48 to 240 VAC, 1 A, L-switching, phase angle control, 240 V keyed | 1709 |
| X20cDO4649 | X20 digital output module, coated, 4 relays, N.O. contacts, 240 VAC / 5 A | 1726 |
| X20cDO6321 | X20 digital output module, coated, 6 outputs, 24 VDC, 0.5 A, sink, 2-wire connections | 1739 |
| X20cDO6322 | X20 digital output module, coated, 6 outputs, 24 VDC, 0.5 A, source, 2-wire connections | 1746 |
| X20cDO6529 | X20 digital output module, coated, 6 relays, normally open contacts, 115 VAC / 0.5 A, 30 VDC / 1 A | 1766 |
| X20cDO6639 | X20 digital output module, coated, 6 relays, normally open contacts, 240 VAC / 2 A, 30 VDC / 2 A | 1773 |
| X20cDO8331 | X20 digital output module, coated, 8 outputs, 24 VDC, 2 A, sink, supply directly on module, 1-wire connections | 1808 |
| X20cDO8332 | X20 digital output module, coated, 8 outputs, 24 VDC, 2 A, source, supply directly on module, 1-wire connections | 1820 |
| X20cDO9321 | X20 digital output module, coated, 12 outputs, 24 VDC, 0.5 A, sink, 1-wire connections | 1843 |
| X20cDO9322 | X20 digital output module, coated, 12 outputs, 24 VDC, 0.5 A, source, 1-wire connections | 1851 |
| X20cDOF322 | X20 digital output module, coated, 16 output, 24 VDC, 0.5 A, source, 1-wire connections | 1866 |

9.15.2 X2ODO2321

Data sheet version: 3.16

9.15.2.1 General information

The module is equipped with 2 outputs for 3-wire connections. It is designed for X20 6-pin terminal blocks. If needed (e.g. for logistical reasons), the 12-pin terminal block can also be used.

- 2 digital outputs
- Sink connection
- 3-wire connections
- 24 VDC and GND for actuator supply
- Integrated output protection
- OSP mode

9.15.2.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Digital outputs |  |
| X2ODO2321 | X20 digital output module, 2 outputs, 24 VDC, 0.5 A, sink, 3-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |

Table 295: X2ODO2321 - Order data

9.15.2.3 Technical data

| | |
|--|--|
| Model number | X20DO2321 |
| Short description | |
| I/O module | 2 digital outputs 24 VDC for 3-wire connections |
| General information | |
| B&R ID code | 0x22B3 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Outputs | Yes, using status LED and software (output error status) |
| Power consumption | |
| Bus | 0.13 W |
| Internal I/O | 0.3 W |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +0.06 |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| Digital outputs | |
| Variant | FET negative switching |
| Nominal voltage | 24 VDC |
| Switching voltage | 24 VDC -15 % / +20 % |
| Nominal output current | 0.5 A |
| Total nominal current | 1 A |
| Connection type | 3-wire connections |
| Output circuit | Sink |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short circuit current") Internal inverse diode for switching inductive loads (see section "Switching inductive loads") |
| Actuator power supply | 0.5 A in total for output-independent actuator supply |
| Diagnostic status | Output monitoring with 10 ms delay |
| Leakage current when switched off | 75 µA |
| R _{DS(on)} | 120 mΩ |
| Peak short-circuit current | <7 A |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms (depends on the module temperature) |
| Switching delay | |
| 0 → 1 | <300 µs |
| 1 → 0 | <300 µs |
| Switching frequency | |
| Resistive load | Max. 500 Hz |
| Inductive load | See section "Switching inductive loads" |
| Braking voltage when switching off inductive loads | Typ. 50 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Actuator power supply | |
| Voltage | Module supply minus voltage drop for short circuit protection |
| Voltage drop for short-circuit protection at 500 mA | Max. 2 V |
| Short-circuit proof | Yes |
| Power consumption | |
| Actuator power supply | Max. 12 W ²⁾ |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |

Table 296: X20DO2321 - Technical data


| | | |
|---------------------------------|---|--|
| Model number | X20DO2321 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB06 or X20TB12 terminal block separately Order 1x X20BM11 bus module separately | |
| Spacing | 12.5 ^{+0.2} mm | |

Table 296: X20DO2321 - Technical data

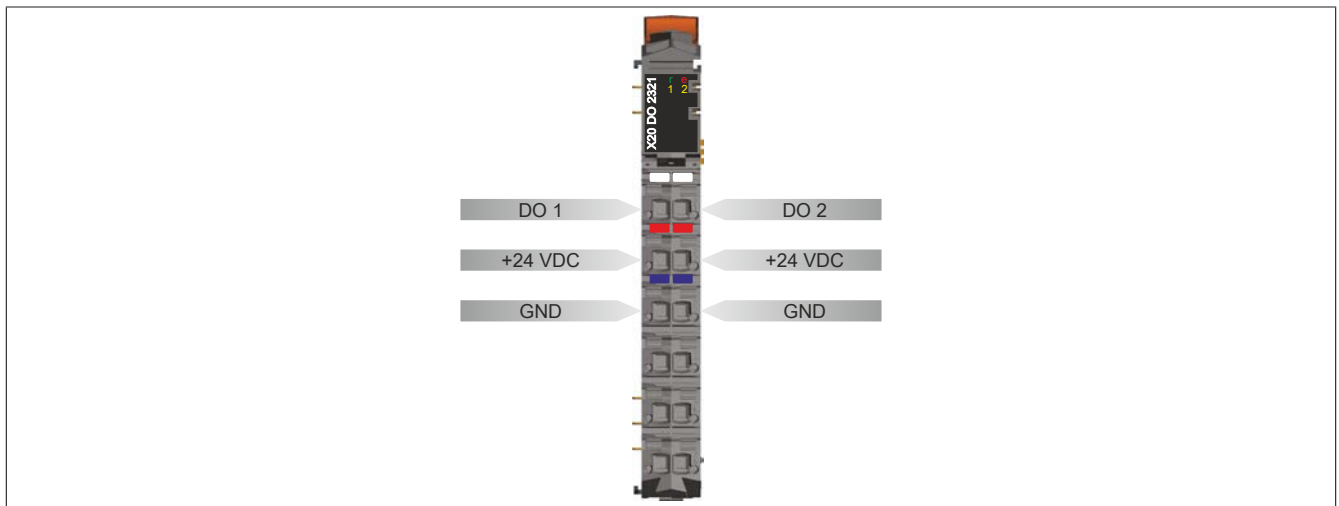
- 1) Number of outputs x $R_{DS(on)}$ x Nominal output current². For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) The power consumption of the sensors connected to the module is not permitted to exceed 12 W.

9.15.2.4 Status LEDs

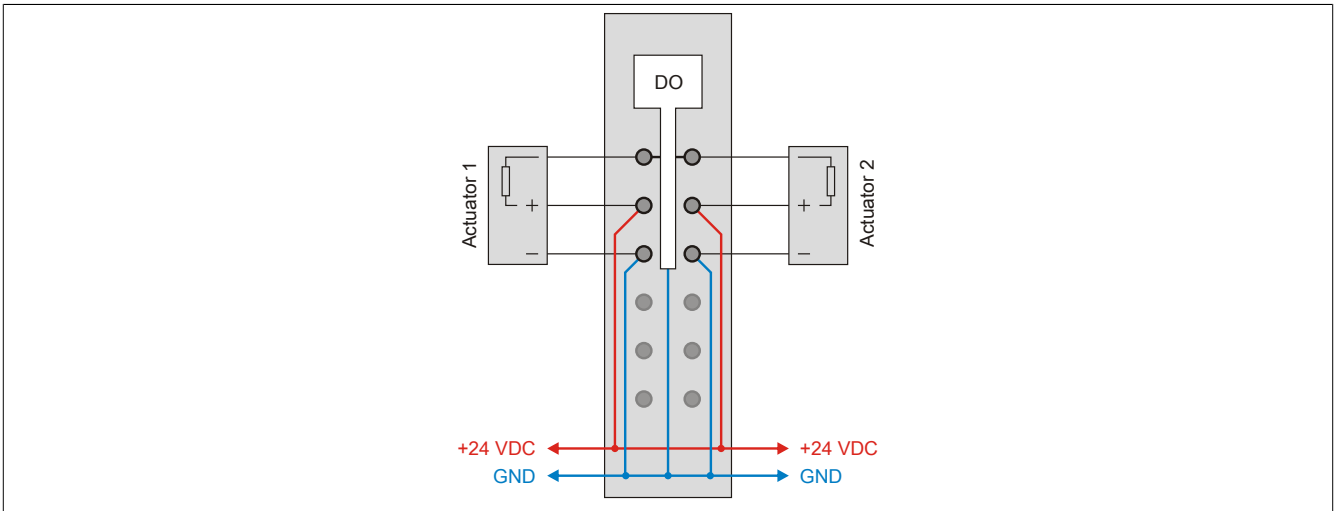
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|--|-------|-----------------------------|----------------------------|---|
|  | r | Green | Off | Module supply not connected |
| | | | Single flash | Reset mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | | | Flickering (approx. 10 Hz) | The module is in the OSP state. |
| | e | Red | Off | Module supply not connected or everything OK |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1 - 2 | Orange | | Output status of the corresponding digital output |

9.15.2.5 Pinout



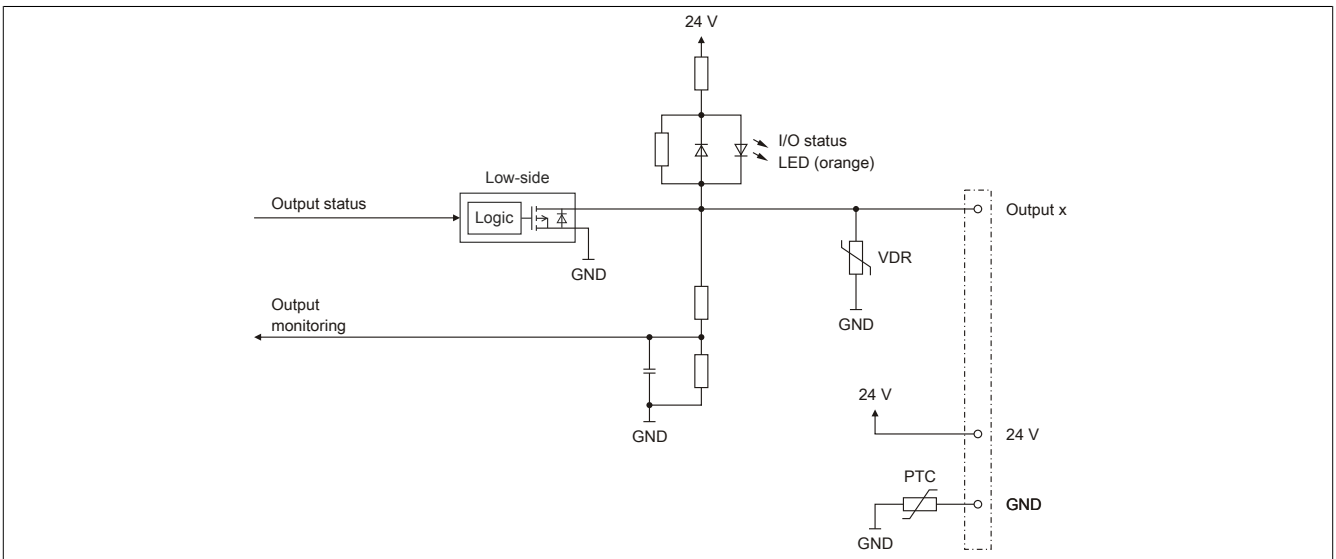
9.15.2.6 Connection example



9.15.2.7 OSP hardware requirements

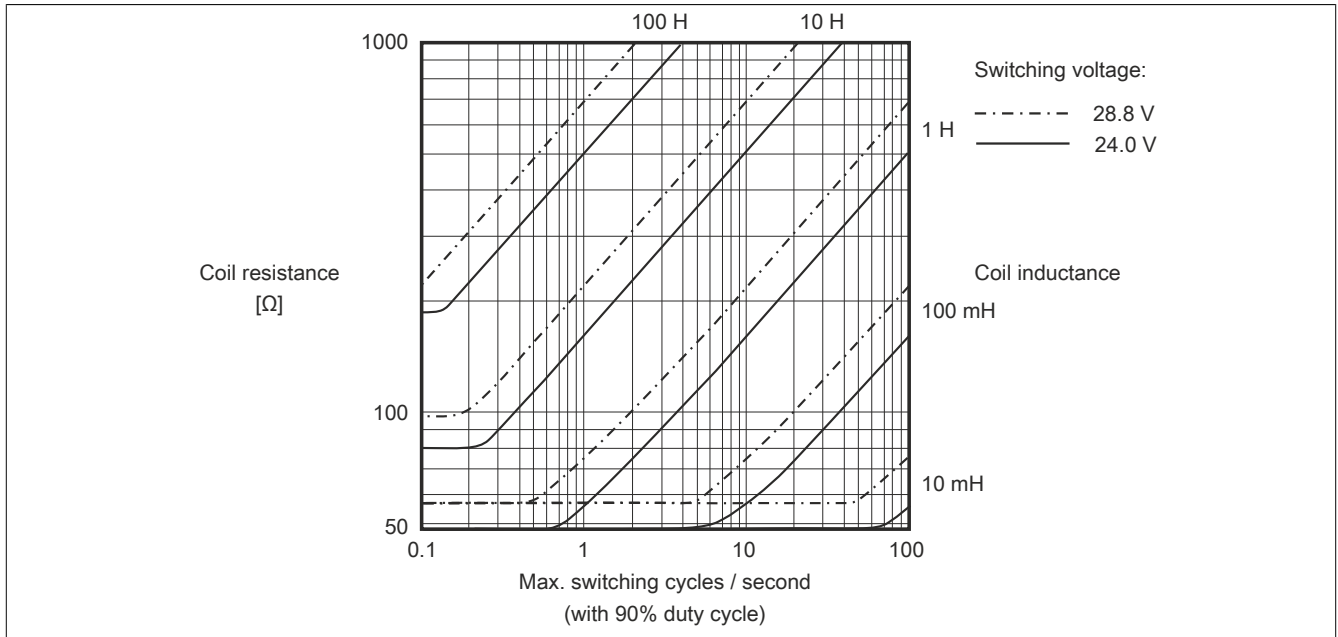
In order to use OSP mode sensibly, it should be ensured that the power supply of the output module and CPU are independent of each other when the application is set up.

9.15.2.8 Output circuit diagram



9.15.2.9 Switching inductive loads

Environmental temperature: 60°C, all outputs with the same load



Information:

If the maximum number of operating cycles per second is exceeded, an external inverse diode must be used.

Operating conditions outside of the area in the diagram are not permitted!

9.15.2.10 Register description

9.15.2.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.15.2.10.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|-----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | DigitalOutput | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | DigitalOutput02 | Bit 1 | | | | |
| 30 | 1 | StatusInput01 | USINT | • | | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | StatusDigitalOutput02 | Bit 1 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.2.10.3 Function model 1 - OSP

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 2 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | DigitalOutput02 | Bit 1 | | | | |
| 30 | 1 | Status of digital outputs 1 to 2 | USINT | • | | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | StatusDigitalOutput02 | Bit 1 | | | | |
| 34 | 1 | Enabling OPS output in the module | USINT | | | • | |
| | | OSPValid | Bit 0 | | | | |
| 32 | - | CfgOSPMode | USINT | | | | • |
| 36 | - | CfgOSPValue | USINT | | | | • |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.2.10.4 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 2 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | DigitalOutput02 | Bit 1 | | | | |
| 30 | - | Status of digital outputs 1 to 2 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | StatusDigitalOutput02 | Bit 1 | | | | |

1) The offset specifies where the register is within the CAN object.

9.15.2.10.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "[Using I/O modules on the bus controller](#)" on page 3789.

9.15.2.10.4.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.15.2.10.5 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 µs) based on the network cycle (SyncOut).

9.15.2.10.5.1 Switching state of digital outputs 1 to 2

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput02

This register is used to store the switching state of digital outputs 1 to 2.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 3 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| 1 | DigitalOutput02 | 0 | Digital output 02 reset |
| | | 1 | Digital output 02 set |

9.15.2.10.6 Monitoring status of the digital outputs

On the module, the output states of the outputs are compared to the target states. The control of the output driver is used for the target state.

A change in the output state resets monitoring for that output. The status of each individual channel can be read. A change in the monitoring status is actively transmitted as an error message.

9.15.2.10.6.1 Status of digital outputs 1 to 2

Name:

StatusInput01

StatusDigitalOutput01 to StatusDigitalOutput02

The status of digital outputs 1 to 2 is mapped in this register.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("StatusDigitalOutput01" to "StatusDigitalOutput0x") or whether this register should be displayed as a single USINT data point ("StatusInput01").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 3 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput01 | 0 | Channel 01: No error |
| | | 1 | Channel 01: <ul style="list-style-type: none"> • Short circuit or overload • Channel switched on and missing I/O power supply • Channel switched off and external voltage applied on channel |
| 1 | StatusDigitalOutput02 | 0 | Channel 02: No error |
| | | 1 | Channel 02: For error description, see channel 01 |

9.15.2.10.7 Function model "OSP"

In function model "OSP" (Operator Set Predefined), the user defines an analog value or digital pattern. This OSP value is output as soon as the communication between the module and master is aborted.

Functionality

The user has the choice between 2 OSP modes:

- Retain last valid value
- Replace with static value

In the first case, the module retains the last value recognized as a valid output status.

When selecting mode "Replace with static value", a plausible output value must be entered in the associated value register. When an OSP event occurs, this value is output instead of the value currently requested by the task.

9.15.2.10.7.1 Enabling OPS output in the module

Name:

OSPValid

This data point makes it possible to start the output of the module and request the use of OSP during operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|---|
| 0 | OSPValid | 0 | Request OSP operation (after initial startup or module in stand-by) |
| | | 1 | Request normal operation |
| 1 - 7 | Reserved | 0 | |

Bit OSPValid exists once on the module and is managed by the user task. It must be set to start the enabled channels. As long as bit OSPValid remains set in the module, the module behaves the same as in function model "Standard".

If an OSP event occurs, e.g. communication between the module and master CPU aborted, then bit OSPValid is reset on the module. The module enters the OSP state and output occurs according to the configuration in register "OSPMode" on page 1589.

The following generally applies:

Even after regeneration of the communication channel, the OSP replacement value is still pending. The OSP state is only exited again when a set OSPValid bit is transferred.

When the master CPU is restarted, bit OSPValid bit is reinitialized in the master CPU. It must be set once more by the application and transferred via the bus.

In the event of brief communication errors between the module and master CPU (e.g. due to EMC), the cyclic registers fail to refresh for several bus cycles. Within the module, bit OSPValid is reset; the set bit is retained in the CPU, however. During the next successful transfer, the module-internal OSPValid bit is set again and the module automatically returns to normal operation.

If the task in the master CPU needs the information about which output mode the module is currently in, bit ModulOK can be evaluated.

Warning!

If bit OSPValid bit is reset to "0" by the module, the output status no longer depends on the responsible task in the master CPU. Nevertheless, output is made depending on the configuration of the OSP replacement value.

9.15.2.10.7.2 Setting OSP mode

Name:

CfgOSPMode

This register controls the behavior of a channel when using OSP.

| Data type | Values | Explanation |
|-----------|--------|---------------------------|
| USINT | 0 | Replace with static value |
| | 1 | Retain last valid value |

9.15.2.10.7.3 Defining an OSP-digital output value

Name:

CfgOSPValue

This register contains the digital output value that is output in "Replace with static value" mode during OSP operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------|--------|--|
| 0 | | 0 or 1 | OSP output value for channel DigitalOutput00 |
| ... | | ... | |
| x | | 0 or 1 | OSP output value for channel DigitalOutput0x |

Warning!

"OSPValue" is only applied by the module if bit "OSPValid" has been set in the module.

9.15.2.10.8 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 µs |

9.15.2.10.9 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|---------------------------------|
| Equal to the minimum cycle time |

9.15.3 X20DO2322

Data sheet version: 3.16

9.15.3.1 General information

The module is equipped with 2 outputs for 3-wire connections. It is designed for X20 6-pin terminal blocks. If needed (e.g. for logistical reasons), the 12-pin terminal block can also be used.

- 2 digital outputs
- Source connection
- 3-wire connections
- 24 VDC and GND for actuator supply
- Integrated output protection
- OSP mode

9.15.3.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Digital outputs |  |
| X20DO2322 | X20 digital output module, 2 outputs, 24 VDC, 0.5 A, source, 3-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |

Table 297: X20DO2322 - Order data

9.15.3.3 Technical data

| | |
|--|--|
| Model number | X20DO2322 |
| Short description | |
| I/O module | 2 digital outputs 24 VDC for 3-wire connections |
| General information | |
| B&R ID code | 0x1B96 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Outputs | Yes, using status LED and software (output error status) |
| Power consumption | |
| Bus | 0.13 W |
| Internal I/O | 0.33 W |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +0.1 |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Digital outputs | |
| Variant | FET positive switching |
| Nominal voltage | 24 VDC |
| Switching voltage | 24 VDC -15 % / +20 % |
| Nominal output current | 0.5 A |
| Total nominal current | 1 A |
| Connection type | 3-wire connections |
| Output circuit | Source |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short circuit current") Internal inverse diode for switching inductive loads (see section "Switching inductive loads") |
| Actuator power supply | 0.5 A in total for output-independent actuator supply |
| Diagnostic status | Output monitoring with 10 ms delay |
| Leakage current when switched off | 5 µA |
| R _{DS(on)} | 210 mΩ |
| Peak short-circuit current | <12 A |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms (depends on the module temperature) |
| Switching delay ²⁾ | |
| 0 → 1 | <300 µs |
| 1 → 0 | <300 µs |
| Switching frequency | |
| Resistive load ²⁾ | Max. 500 Hz |
| Inductive load | See section "Switching inductive loads" |
| Braking voltage when switching off inductive loads | Typ. 50 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Actuator power supply | |
| Voltage | Module supply minus voltage drop for short circuit protection |
| Voltage drop for short-circuit protection at 500 mA | Max. 2 V |
| Short-circuit proof | Yes |
| Power consumption | |
| Actuator power supply | Max. 12 W ³⁾ |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |

Table 298: X20DO2322 - Technical data


| Model number | X20DO2322 |
|--|---|
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB06 or X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 298: X20DO2322 - Technical data

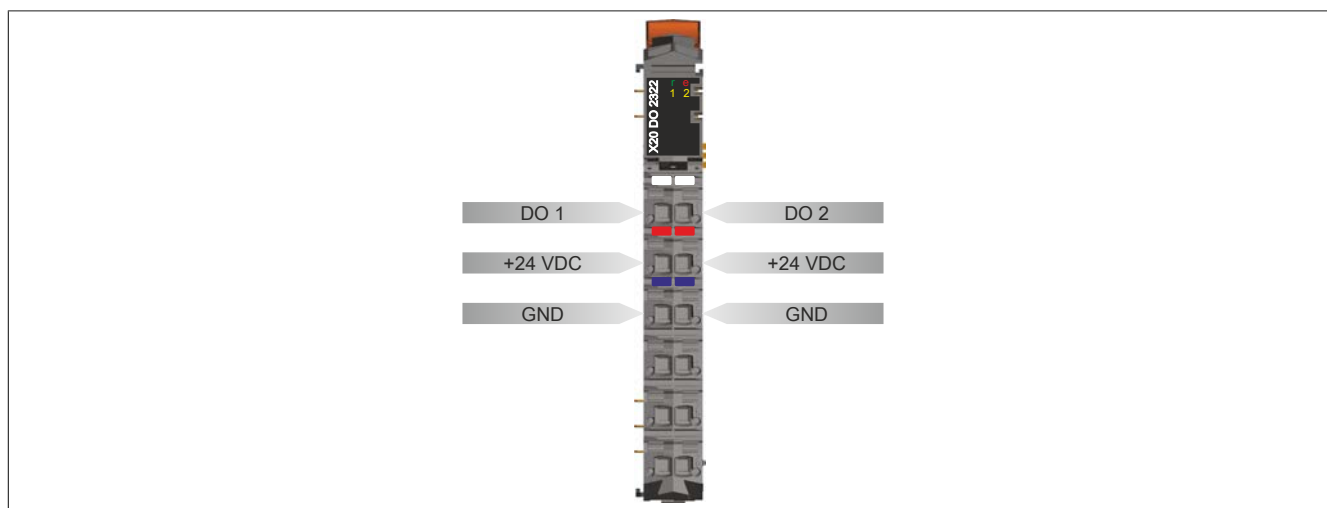
- 1) Number of outputs x $R_{DS(on)}$ x Nominal output current². For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) At loads ≤ 1 k Ω
- 3) The power consumption of the sensors connected to the module is not permitted to exceed 12 W.

9.15.3.4 Status LEDs

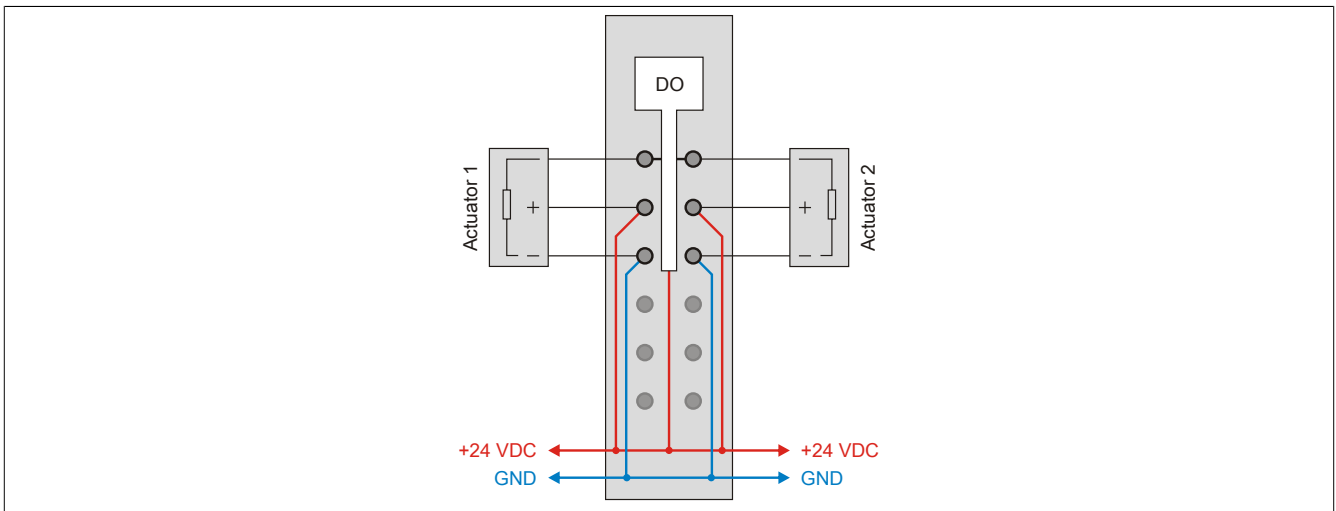
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|-----------------------------|----------------------------|---|
|  | r | Green | Off | Module supply not connected |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | | | Flickering (approx. 10 Hz) | The module is in the OSP state. |
| | e | Red | Off | Module supply not connected or everything OK |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1 - 2 | Orange | | Output status of the corresponding digital output |

9.15.3.5 Pinout



9.15.3.6 Connection example



Caution!

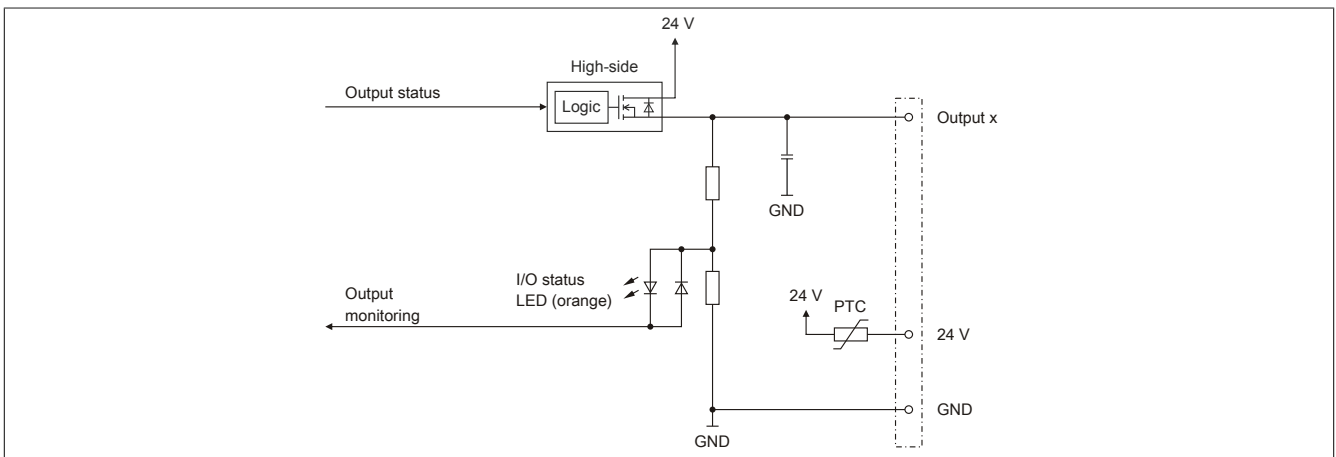
If the module is operated outside specifications, the output current may rise above the maximum permissible nominal current. This applies both to individual channels and to the summation current of the module.

Appropriate cable cross-sections or external safety measures must therefore be provided.

9.15.3.7 OSP hardware requirements

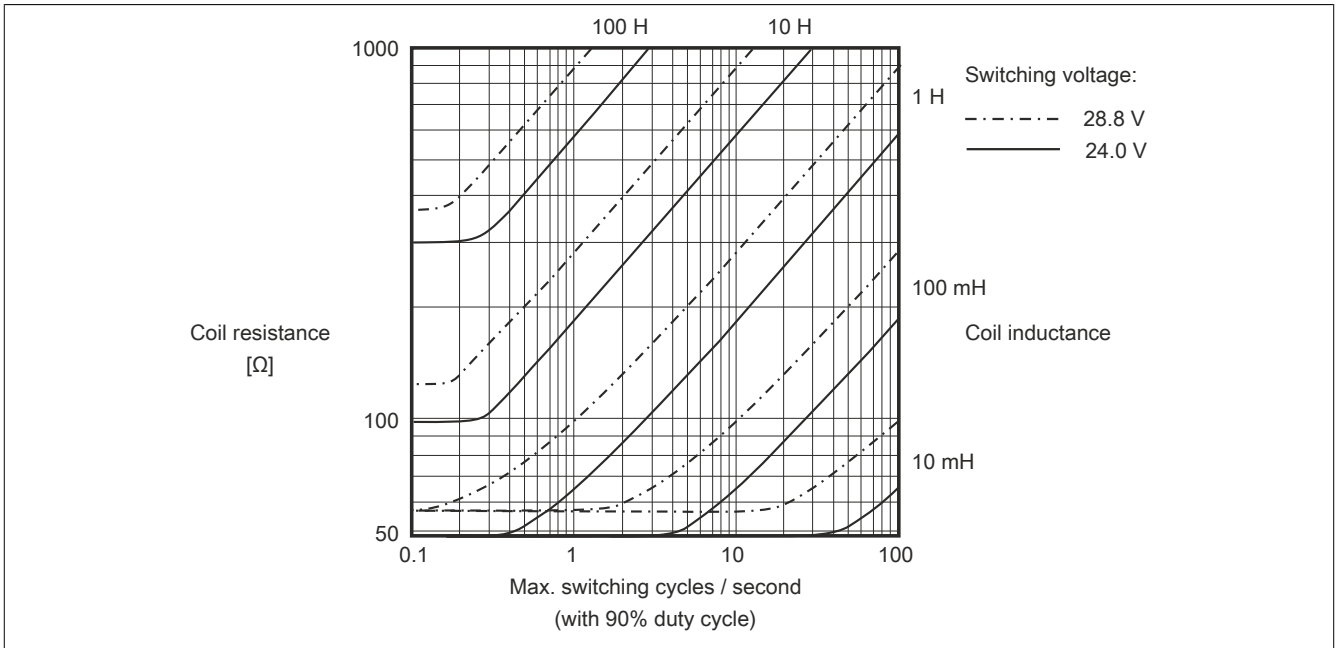
In order to use OSP mode sensibly, it should be ensured that the power supply of the output module and CPU are independent of each other when the application is set up.

9.15.3.8 Output circuit diagram



9.15.3.9 Switching inductive loads

Ambient temperature: 60°C, all outputs with the same load



Information:

If the maximum number of operating cycles per second is exceeded, an external inverse diode must be used.

Operating conditions outside of the area in the diagram are not permitted!

9.15.3.10 Register description

9.15.3.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.15.3.10.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|-----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | DigitalOutput | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | DigitalOutput02 | Bit 1 | | | | |
| 30 | 1 | StatusInput01 | USINT | • | | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | StatusDigitalOutput02 | Bit 1 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.3.10.3 Function model 1 - OSP

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 2 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | DigitalOutput02 | Bit 1 | | | | |
| 30 | 1 | Status of digital outputs 1 to 2 | USINT | • | | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | StatusDigitalOutput02 | Bit 1 | | | | |
| 34 | 1 | Enabling OPS output in the module | USINT | | | • | |
| | | OSPValid | Bit 0 | | | | |
| 32 | - | CfgOSPMODE | USINT | | | | • |
| 36 | - | CfgOSPValue | USINT | | | | • |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.3.10.4 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 2 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | DigitalOutput02 | Bit 1 | | | | |
| 30 | - | Status of digital outputs 1 to 2 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | StatusDigitalOutput02 | Bit 1 | | | | |

1) The offset specifies where the register is within the CAN object.

9.15.3.10.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "[Using I/O modules on the bus controller](#)" on page 3789.

9.15.3.10.4.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.15.3.10.5 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 µs) based on the network cycle (SyncOut).

9.15.3.10.5.1 Switching state of digital outputs 1 to 2

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput02

This register is used to store the switching state of digital outputs 1 to 2.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 3 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| 1 | DigitalOutput02 | 0 | Digital output 02 reset |
| | | 1 | Digital output 02 set |

9.15.3.10.6 Monitoring status of the digital outputs

On the module, the output states of the outputs are compared to the target states. The control of the output driver is used for the target state.

A change in the output state resets monitoring for that output. The status of each individual channel can be read. A change in the monitoring status is actively transmitted as an error message.

9.15.3.10.6.1 Status of digital outputs 1 to 2

Name:

StatusInput01

StatusDigitalOutput01 to StatusDigitalOutput02

The status of digital outputs 1 to 2 is mapped in this register.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("StatusDigitalOutput01" to "StatusDigitalOutput0x") or whether this register should be displayed as a single USINT data point ("StatusInput01").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 3 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput01 | 0 | Channel 01: No error |
| | | 1 | Channel 01: <ul style="list-style-type: none"> • Short circuit or overload • Channel switched on and missing I/O power supply • Channel switched off and external voltage applied on channel |
| 1 | StatusDigitalOutput02 | 0 | Channel 02: No error |
| | | 1 | Channel 02: For error description, see channel 01 |

9.15.3.10.7 Function model "OSP"

In function model "OSP" (Operator Set Predefined), the user defines an analog value or digital pattern. This OSP value is output as soon as the communication between the module and master is aborted.

Functionality

The user has the choice between 2 OSP modes:

- Retain last valid value
- Replace with static value

In the first case, the module retains the last value recognized as a valid output status.

When selecting mode "Replace with static value", a plausible output value must be entered in the associated value register. When an OSP event occurs, this value is output instead of the value currently requested by the task.

9.15.3.10.7.1 Enabling OPS output in the module

Name:

OSPValid

This data point makes it possible to start the output of the module and request the use of OSP during operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|---|
| 0 | OSPValid | 0 | Request OSP operation (after initial startup or module in stand-by) |
| | | 1 | Request normal operation |
| 1 - 7 | Reserved | 0 | |

Bit OSPValid exists once on the module and is managed by the user task. It must be set to start the enabled channels. As long as bit OSPValid remains set in the module, the module behaves the same as in function model "Standard".

If an OSP event occurs, e.g. communication between the module and master CPU aborted, then bit OSPValid is reset on the module. The module enters the OSP state and output occurs according to the configuration in register "OSPMode" on page 1598.

The following generally applies:

Even after regeneration of the communication channel, the OSP replacement value is still pending. The OSP state is only exited again when a set OSPValid bit is transferred.

When the master CPU is restarted, bit OSPValid bit is reinitialized in the master CPU. It must be set once more by the application and transferred via the bus.

In the event of brief communication errors between the module and master CPU (e.g. due to EMC), the cyclic registers fail to refresh for several bus cycles. Within the module, bit OSPValid is reset; the set bit is retained in the CPU, however. During the next successful transfer, the module-internal OSPValid bit is set again and the module automatically returns to normal operation.

If the task in the master CPU needs the information about which output mode the module is currently in, bit ModulOK can be evaluated.

Warning!

If bit OSPValid bit is reset to "0" by the module, the output status no longer depends on the responsible task in the master CPU. Nevertheless, output is made depending on the configuration of the OSP replacement value.

9.15.3.10.7.2 Setting OSP mode

Name:

CfgOSPMode

This register controls the behavior of a channel when using OSP.

| Data type | Values | Explanation |
|-----------|--------|---------------------------|
| USINT | 0 | Replace with static value |
| | 1 | Retain last valid value |

9.15.3.10.7.3 Defining an OSP-digital output value

Name:

CfgOSPValue

This register contains the digital output value that is output in "Replace with static value" mode during OSP operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------|--------|--|
| 0 | | 0 or 1 | OSP output value for channel DigitalOutput00 |
| ... | | ... | |
| x | | 0 or 1 | OSP output value for channel DigitalOutput0x |

Warning!

"OSPValue" is only applied by the module if bit "OSPValid" has been set in the module.

9.15.3.10.8 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 µs |

9.15.3.10.9 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|---------------------------------|
| Equal to the minimum cycle time |

9.15.4 X2ODO2623

Data sheet version: 3.22

9.15.4.1 General information

The module is a digital output module that is equipped with 2 SSR outputs with zero cross-over switches and uses 3-line connections. The module is also equipped with integrated full-wave control. The supply (L and N) is fed directly to the module.

- 2 digital outputs
- Outputs with integrated snubber circuit
- Outputs with 100 to 240 VAC
- L switching
- 50 Hz or 60 Hz
- 3-wire connections
- Integrated full-wave control
- 240 V coding

Danger!

Risk of electric shock!

The terminal block is only permitted to conduct voltage when it is connected. It is not permitted to be disconnected or connected while voltage is applied or have voltage applied to it while it is removed under any circumstances.

This module is not permitted to be the last module connected on the X2X Link network. At least one subsequent X20ZF dummy module must provide protection against contact.

9.15.4.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Digital outputs |  |
| X2ODO2623 | X20 digital output module, 2 outputs, 100 to 240 VAC, 1 A, source, 240 V keyed, 3-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM12 | X20 bus module, 240 VAC keyed, internal I/O power supply connected through | |
| | Terminal blocks | |
| X20TB32 | X20 terminal block, 12-pin, 240 VAC keyed | |
| | | |
| | | |
| | | |

Table 299: X2ODO2623 - Order data

9.15.4.3 Technical data

| | |
|--|---|
| Model number | X20DO2623 |
| Short description | |
| I/O module | 2 digital SSR outputs 100 to 240 VAC for 3-wire connections |
| General information | |
| B&R ID code | 0x267B |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| Outputs | Yes, using LED status indicator |
| Power consumption | |
| Bus | 0.35 W |
| Internal I/O | - |
| External I/O | 0.38 W |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +3 |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| Digital outputs | |
| Variant | SSR |
| Circuit | L-switching |
| Nominal voltage | 100 to 240 VAC |
| Max. voltage | 264 VAC |
| Rated frequency | 47 to 63 Hz |
| Nominal output current | 1 A |
| Total nominal current | 1 A |
| Surge current | 40 A (20 ms), 10 A (1 s) |
| Connection type | 3-wire connections |
| Zero-crossing switches | Yes |
| Leakage current | Max. 10 mA at 240 V |
| Residual voltage (on-state voltage) | 1.5 V |
| Switching delay | |
| At 50 Hz | |
| 0 → 1 | ≤11 ms |
| 1 → 0 | ≤11 ms |
| At 60 Hz | |
| 0 → 1 | ≤9.3 ms |
| 1 → 0 | ≤9.3 ms |
| Isolation voltage between channel and bus | Tested at 2500 VAC |
| Voltage monitoring L - N | No |
| Overvoltage protection between L and N | Yes |
| Output voltage | |
| Minimum | 80 VAC |
| Protective circuit | |
| External | Generally varistor or fuse |
| Internal | Snubber circuit (RC element) |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Not permitted |
| Degree of protection per EN 60529 | IP20 |

Table 300: X20DO2623 - Technical data


| | | | |
|---------------------------------|------------------|--|--|
| Model number | X20DO2623 | | |
| Ambient conditions | | | |
| Temperature | | | |
| Operation | | | |
| Horizontal mounting orientation | | | -25 to 60°C |
| Vertical mounting orientation | | | -25 to 50°C |
| Derating | | | See section "Derating". |
| Storage | | | -40 to 85°C |
| Transport | | | -40 to 85°C |
| Relative humidity | | | |
| Operation | | | 5 to 95%, non-condensing |
| Storage | | | 5 to 95%, non-condensing |
| Transport | | | 5 to 95%, non-condensing |
| Mechanical properties | | | |
| Note | | | Order 1x terminal block X20TB32 separately. Order 1x bus module X20BM12 separately. |
| Spacing | | | 12.5 ^{+0.2} mm |

Table 300: X20DO2623 - Technical data

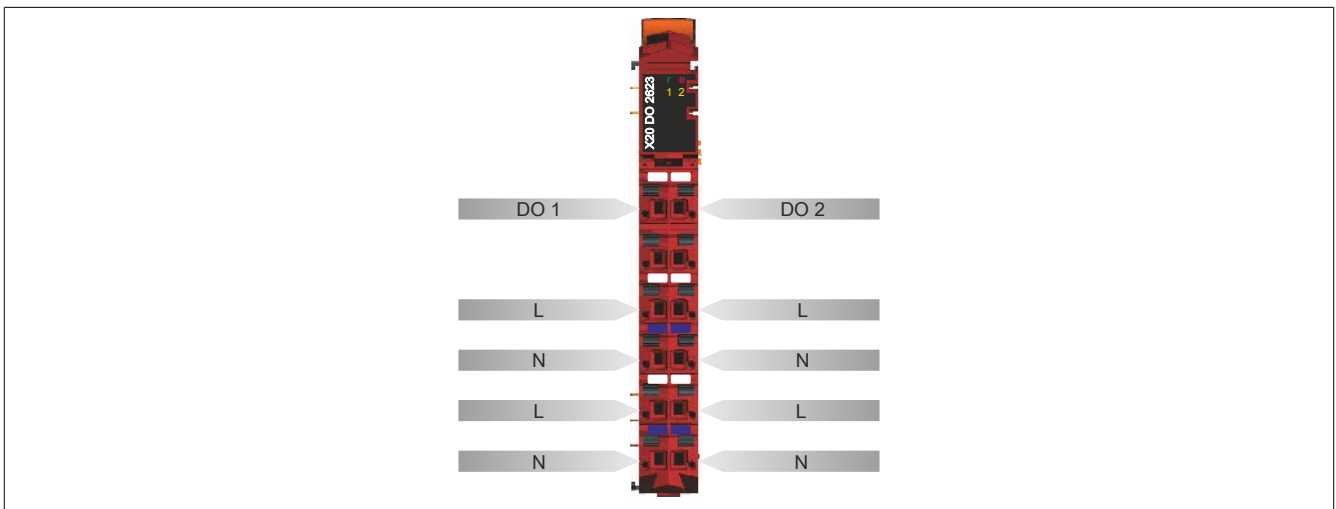
1) Number of outputs x Residual voltage (on-state voltage) x Nominal output current. For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.

9.15.4.4 Status LEDs

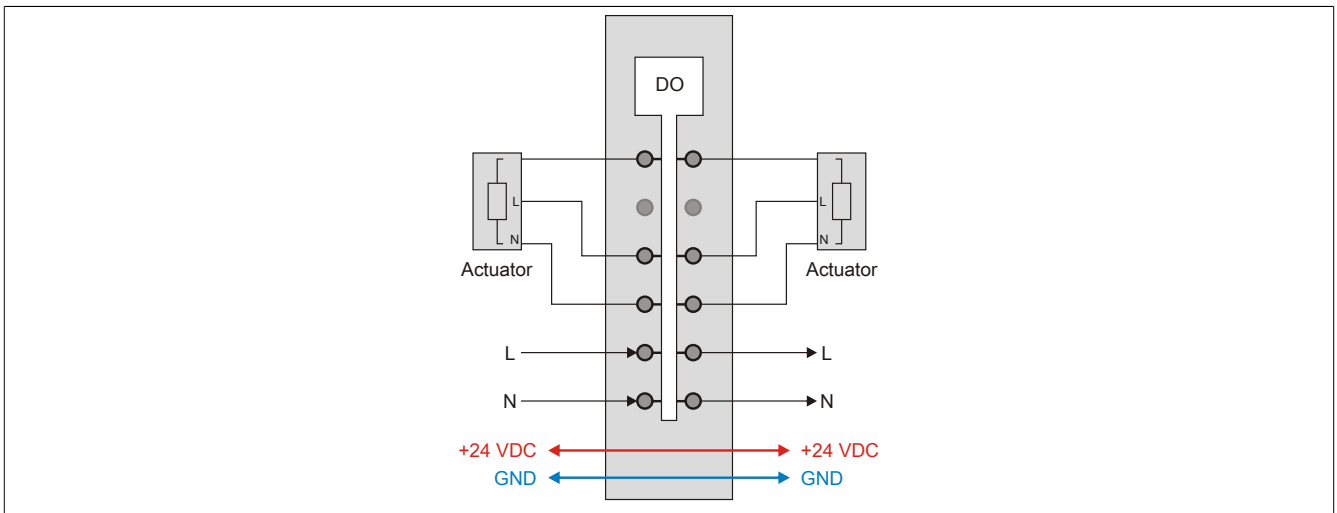
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|--|-------|-----------------------------|------------------|--|
|  | r | Green | Off | Module supply not connected |
| | | | Single flash | Reset mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | Module supply not connected or everything OK |
| | | | On | Error or reset status |
| | | | Single flash | Zero cross-over signal has dropped out |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1 - 2 | Orange | | Control status of the corresponding digital output |

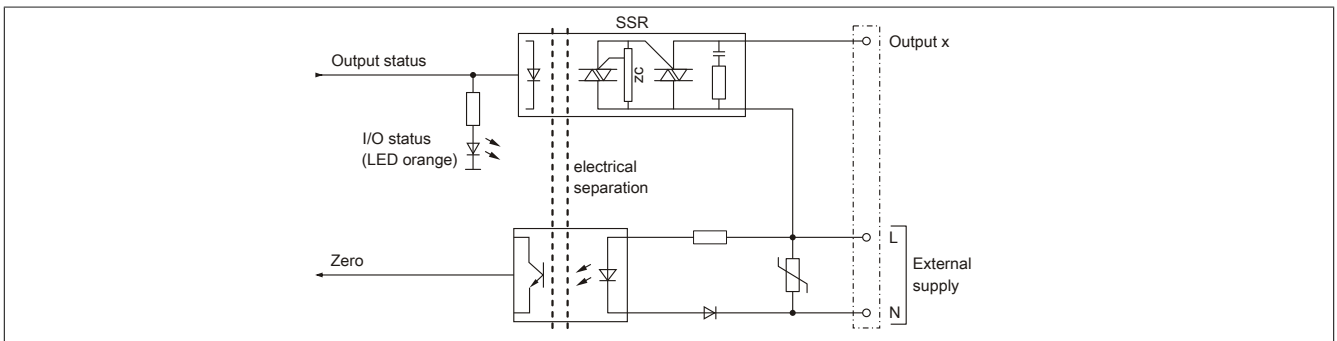
9.15.4.5 Pinout



9.15.4.6 Connection example



9.15.4.7 Output circuit diagram



9.15.4.8 Integrated full-wave control

Full-wave control is used to control power for electrical power consumers that are operated with AC voltage. Temperature control is a typical application

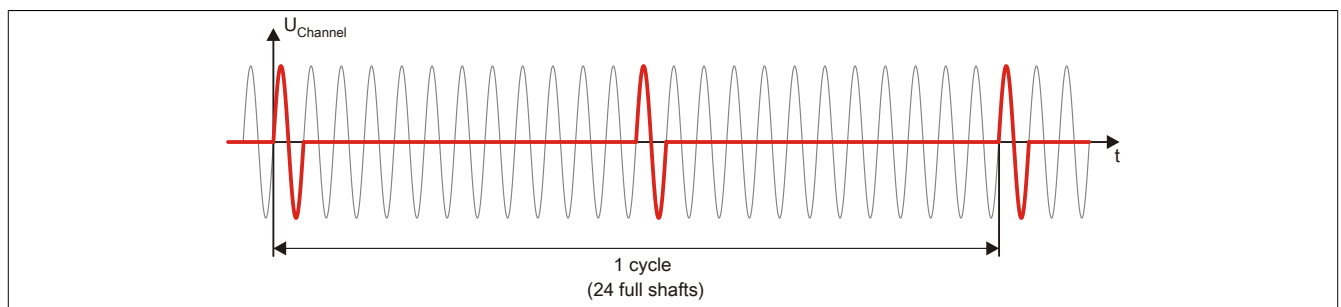
Unlike phase-angle control, the sine wave oscillation form of the mains voltage is not changed during full-wave control. This significantly reduces system perturbation.

The output voltage (channel) is switched on and off at a certain ratio. This switches the multi-cycle packets. A multi-cycle packet consists of a number of complete sine waves throughout a cycle. The relationship between the power-on duration and the cycle duration results in the desired effect of reduced power consumption by the connected power consumer.

With the full-wave control that is integrated in the module, a maximum of 24 full waves can be provided on the outputs per cycle. Control takes place in 4% steps.

| Settings | | Full waves | | | | | | | | | | | | | | | | | | | | | | | |
|----------|-----|------------|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| SW% | % | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | | • | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | | • | | | | | | | | | | | | • | | | | | | | | | | | |
| 12 | | • | | | | | | | | • | | | | | | | | | • | | | | | | |
| 16 | | • | | | | | | | • | | | | | • | | | | | | • | | | | | |
| 20 | | • | | | | | • | | | | | • | | | | | • | | | | • | | | | |
| 24 | 25 | • | | | | • | | | | • | | | | • | | | | • | | | | • | | | |
| 28 | | • | | | | • | | | | • | | | | • | | | | | • | | | • | | | |
| 32 | | • | | | • | | | | • | | | • | | | | | • | | | • | | | • | | |
| 36 | | • | | | • | | | | • | | | • | | | | | • | | | • | | | • | | |
| 40 | | • | | | • | | | | • | | | • | | | | | • | | | • | | | • | | |
| 44 | | • | | | • | | | | • | | | • | | | | | • | | | • | | | • | | |
| 48 | 50 | • | | | • | | | | • | | | • | | | | | • | | | • | | | • | | |
| 52 | | | • | | | • | | | • | | | • | | | | | • | | | • | | | • | | |
| 56 | | | • | | | • | | | • | | | • | | | | | • | | | • | | | • | | |
| 60 | | | • | | | • | | | • | | | • | | | | | • | | | • | | | • | | |
| 64 | | | • | | | • | | | • | | | • | | | | | • | | | • | | | • | | |
| 68 | | | • | | | • | | | • | | | • | | | | | • | | | • | | | • | | |
| 72 | 75 | | • | | | • | | | • | | | • | | | | | • | | | • | | | • | | |
| 76 | | | • | | | • | | | • | | | • | | | | | • | | | • | | | • | | |
| 80 | | | • | | | • | | | • | | | • | | | | | • | | | • | | | • | | |
| 84 | | | • | | | • | | | • | | | • | | | | | • | | | • | | | • | | |
| 88 | | | • | | | • | | | • | | | • | | | | | • | | | • | | | • | | |
| 92 | | | • | | | • | | | • | | | • | | | | | • | | | • | | | • | | |
| 96 | 100 | | • | | | • | | | • | | | • | | | | | • | | | • | | | • | | |

Example of full-wave control (8%):

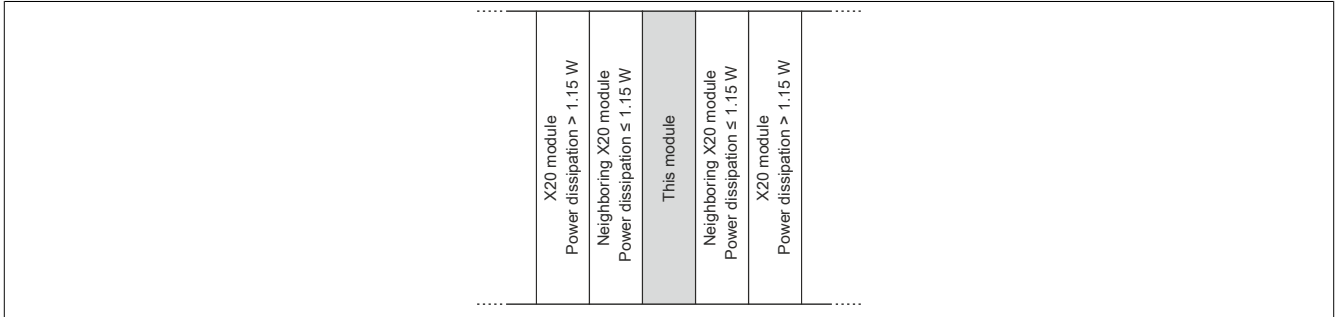


9.15.4.9 Derating

There is no derating when operated below 55°C.

During operation over 55°C, the power dissipation of the modules to the left and right of this module is not permitted to exceed 1.15 W!

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.



9.15.4.10 Register description

9.15.4.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.15.4.10.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------------------|--------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 12 | 3 | ShiftOutput01 ¹⁾ | USINT | | | • | |
| 14 | 4 | ShiftOutput02 ¹⁾ | USINT | | | • | |
| 28 | - | ConfigOutput01 | USINT | | | | • |
| Communication | | | | | | | |
| 2 | 0 | DigitalOutput | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | DigitalOutput02 | Bit 1 | | | | |
| 4 | 1 | AnalogOutput01 | USINT | | | • | |
| 6 | 2 | AnalogOutput02 | USINT | | | • | |
| 30 | 1 | StatusInput01 | USINT | • | | | |
| | | ZeroCrossingInput | Bit 0 | | | | |
| | | ZeroCrossingStatus | Bit 4 | | | | |

1) Firmware version 816 and up.

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.4.10.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 12 | - | ShiftOutput01 ²⁾ | USINT | | | | • |
| 14 | - | ShiftOutput02 ²⁾ | USINT | | | | • |
| 28 | - | ConfigOutput01 (output filter) | USINT | | | | • |
| Communication | | | | | | | |
| 4 | 0 | AnalogOutput01 | USINT | | | • | |
| 6 | 2 | AnalogOutput02 | USINT | | | • | |
| 30 | 0 | Zero crossing status | USINT | • | | | |
| | | ZeroCrossingInput | Bit 0 | | | | |
| | | ZeroCrossingStatus | Bit 4 | | | | |

1) The offset specifies where the register is within the CAN object.

2) Firmware version 816 and up.

9.15.4.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.4.10.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.15.4.10.4 Digital outputs

The output status is transferred to the control switch asynchronously to the connected network. The outputs switch on when the voltage crosses zero and switch off when the current crosses zero.

9.15.4.10.4.1 Switching state of digital outputs 1 to 2

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput02

This register is used to store the switching state of digital outputs 1 to 2.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 3 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| 1 | DigitalOutput02 | 0 | Digital output 02 reset |
| | | 1 | Digital output 02 set |

Information:

The states in this register are only applied when the channels are set to DIGITAL in "Setting the output configuration" on page 1607.

When using the setting "packed outputs" ALL channels must be set to DIGITAL. Mixed operation is not possible.

9.15.4.10.5 Analog outputs

The output value is transferred to the control circuit in sync with the connected power mains according to the firing pattern table (see "Integrated full-wave control" on page 1603). The analog value is output with a resolution of ~4% over a duration of 24 complete waves. Values > 96% result in full control. Changes to the output value within an interval are applied after the next zero crossover.

9.15.4.10.5.1 Setting the output value from the firing pattern table

Name:

AnalogOutput01 to AnalogOutput02

These registers are used to set the output value from the firing pattern table.

Values between 0 and 100 correspond to the output value for the respective channel in percent. Values above 100 correspond to 100%.

| Data type | Value |
|-----------|----------|
| USINT | 0 to 100 |

Information:

The states in these registers are only applied when the channels are set to ANALOG in "Setting the output configuration" on page 1607.

9.15.4.10.5.2 Setting the output configuration

Name:

ConfigOutput01

Each channel can be configured for either "digital" or "analog" operation in this register. The corresponding DigitalOutput or AnalogOutput registers must be written depending on the setting.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 3 |

Bit structure:

| Bit | Name | Value | Information |
|-------|-----------|-------|---|
| 0 | Channel 1 | 0 | Digital register is used |
| | | 1 | Analog register used (bus controller default setting) |
| 1 | Channel 2 | 0 | Digital register used |
| | | 1 | Analog register used (bus controller default setting) |
| 2 - 7 | Reserved | 0 | |

9.15.4.10.5.3 Shift switching pattern

Name:

ShiftOutput01 to ShiftOutput02

To prevent load peaks due to simultaneous switching of outputs, this register can be used to shift the switching pattern by a number of full waves. Due to the hardware used, it is not possible to shift by less than a full wave.

Values higher than 23 are limited to 23.

| Data type | Value | Information |
|-----------|---------|---|
| USINT | 0 | No shift (bus controller default setting) |
| | 1 to 23 | Size of the shift in number of full waves |

Example

Set 0 on Channel 1 and 1 on Channel 2. With the same control value (see "Integrated full-wave control" on page 1603) this delays the switching pattern of Channel 2 by one full wave.

9.15.4.10.6 Zero crossing status

Name:

ZeroCrossingInput

ZeroCrossingStatus

StatusInput01

Zero crossing detection uses a fixed filter time of 1 ms and a scanning frequency of 10 kHz. When a missing or too short period is detected, control is switched off until at least 2 periods are detected correctly, and the status flag is set accordingly. Control is offset by 2 ms from the negative half-wave until the next zero crossover is detected correctly or another error occurs. This is normally at least one complete wave.

Monitoring is activated at the first zero crossover after being switched on.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("ZeroCrossingInput" to "ZeroCrossingStatus") or whether this register should be displayed as a single USINT data point ("StatusInput01").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 17 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------------------------|-------|--------------------------------------|
| 0 | ZeroCrossingInput ¹⁾ | 0 | Signal during the negative half-wave |
| | | 1 | Signal during the positive half-wave |
| 1 - 3 | Reserved | 0 | |
| 4 | ZeroCrossingStatus | 0 | No error |
| | | 1 | Zero crossover failed |
| 5 - 7 | Reserved | 0 | |

1) Value is valid if no error has occurred (ZeroCrossingStatus= 0)

9.15.4.10.7 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|-------------------------|-------------|
| Digital mode | 100 μ s |
| Digital and analog mode | 150 μ s |

9.15.4.10.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|-------------|
| Digital mode | 100 μ s |
| Digital and analog mode | 150 μ s |

9.15.5 X20(c)DO2633

Data sheet version: 2.63

9.15.5.1 General information

The module is a digital output module with phase-angle control that is equipped with 2 Triac outputs using 3-line connections. The supply (L and N) is fed directly to the module.

- 2 digital outputs
- Outputs with integrated snubber circuit
- Outputs with 48 to 240 VAC
- L switching
- Zero-crossing detection
- Phase-angle control
- Open-circuit detection for each channel
- Negative half-waves can be switched off
- 50 Hz or 60 Hz
- 3-wire connections
- 240 V coding
- OSP mode
- Frequency mode

Danger!

Risk of electric shock!

The terminal block is only permitted to conduct voltage when it is connected. It is not permitted to be disconnected or connected while voltage is applied or have voltage applied to it while it is removed under any circumstances.

This module is not permitted to be the last module connected on the X2X Link network. At least one subsequent X20ZF dummy module must provide protection against contact.

9.15.5.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.15.5.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.15.5.3 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Digital outputs |  |
| X20DO2633 | X20 digital output module, 2 triac outputs, 48 to 240 VAC, 2 A, L-switching, phase angle control, 240 V keyed | |
| X20cDO2633 | X20 digital output module, coated, 2 triac outputs, 48 to 240 VAC, 2 A, L-switching, phase angle control, 240 V keyed | |
| | Required accessories | |
| | Bus modules | |
| X20BM32 | X20 bus module for double-width modules, 240 VAC keyed, internal I/O supply continuous | |
| X20cBM32 | X20 bus module, coated, for double-width modules, 240 VAC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB32 | X20 terminal block, 12-pin, 240 VAC keyed | |
| | | |

Table 301: X20DO2633, X20cDO2633 - Order data

9.15.5.4 Technical data

| Model number | X20DO2633 | X20cDO2633 |
|--|---|------------|
| Short description | 2 digital outputs 48 to 240 VAC for 3-wire connections | |
| General information | | |
| B&R ID code | 0xAC39 | 0xE680 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnosics | | |
| Module run/error | Yes, using LED status indicator and software | |
| Outputs | Yes, using LED status indicator and software | |
| Power consumption | | |
| Bus | 0.6 W | |
| Internal I/O | - | |
| External I/O | - | |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +6 W | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| EAC | Yes | |
| KC | Yes | - |
| Digital outputs | | |
| Variant | Triac | |
| Circuit | L-switching | |
| Nominal voltage | 48 to 240 VAC | |
| Max. voltage | 264 VAC | |
| Rated frequency | 47 to 63 Hz | |
| Nominal output current | 2 A | |
| Total nominal current | 4 A | |
| Maximum current | | |
| Output current | 2.5 A | |
| Summation current | 5 A | |
| Connection type | 3-wire connections | |
| Zero-crossing detection | Yes | |
| Minimum holding current I _H | 15 mA | |
| Leakage current | Max. 2 mA at 240 V at 50 Hz Max. 2.4 mA at 240 V at 60 Hz | |
| Residual voltage (on-state voltage) | 1.5 V | |
| Phase-angle control | | |
| Area | 5 to 95% | |
| Resolution | 1% | |
| Accuracy (60 to 240 VAC) | <100 µs | |

Table 302: X20DO2633, X20cDO2633 - Technical data


| Model number | X20DO2633 | X20cDO2633 |
|--|--|---|
| Voltage monitoring L - N | Yes | |
| Additional functions | Open-circuit detection | |
| Overvoltage protection between L and N | Yes, varistor | |
| Isolation voltages | | |
| Channel - Bus | Tested with 2300 VAC (Rev. <E0 1500 VAC) | Tested at 1500 VAC |
| Channel - Internal I/O | Tested with 2300 VAC (Rev. <E0 2000 VAC) | Tested at 2000 VAC |
| Channel - Ground | Tested with 2300 VAC (Rev. <E0 1500 VAC) | Tested at 1500 VAC |
| Protective circuit | | |
| External | See section "External fuses". | |
| Internal | Snubber circuit (RC element) and varistor | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel and I/O power supply | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitation | |
| >2000 m | Not permitted | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating". | |
| Starting temperature | - | Yes, -40°C |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x terminal block X20TB32 separately. Order 1x bus module X20BM32 separately. | Order 1x terminal block X20TB32 separately. Order 1x bus module X20cBM32 separately. |
| Pitch | 25 ^{+0.2} mm | |

Table 302: X20DO2633, X20cDO2633 - Technical data

- 1) Number of outputs x Residual voltage (on-state voltage) x Nominal output current. For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.

9.15.5.5 Status LEDs

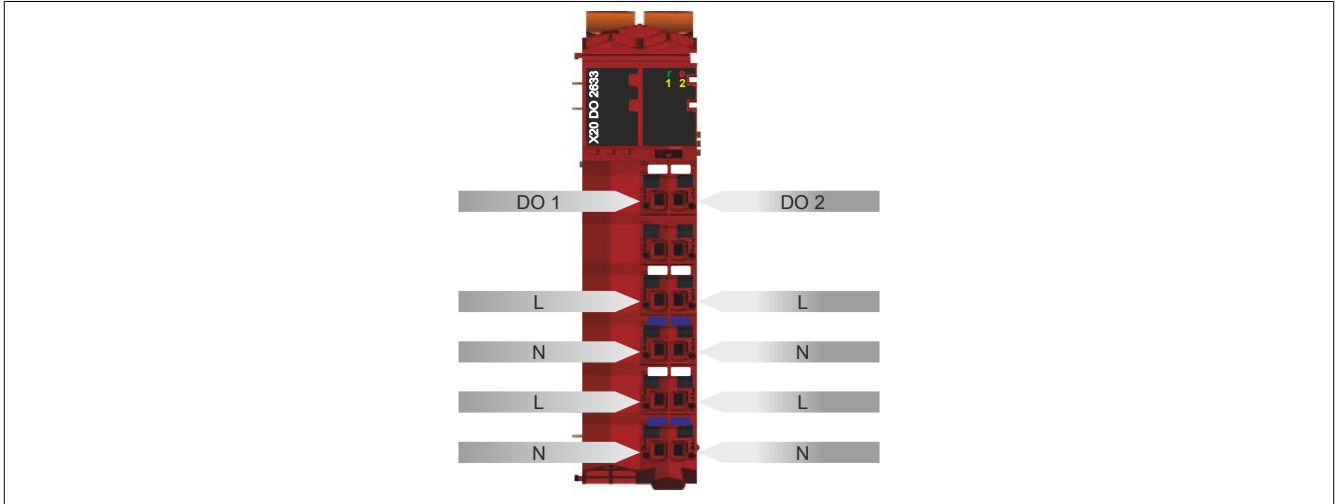
For a description of the various operating modes, see ["Diagnostic LEDs" on page 3787](#).

| Figure | LED | Color | Status | Description |
|---|-------|-------|-----------------------------|--|
|  | r | Green | Off | Module supply not connected |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | | | Flickering (approx. 10 Hz) | Module is in OSP state |
| | e | Red | Off | Module supply not connected or everything OK |
| | | | On | Error or reset status |
| | | | Single flash | Zero cross-over signal has dropped out |
| | e + r | | Red on / Green single flash | Invalid firmware |
| | 1 - 2 | | Orange | |

9.15.5.6 Pinout

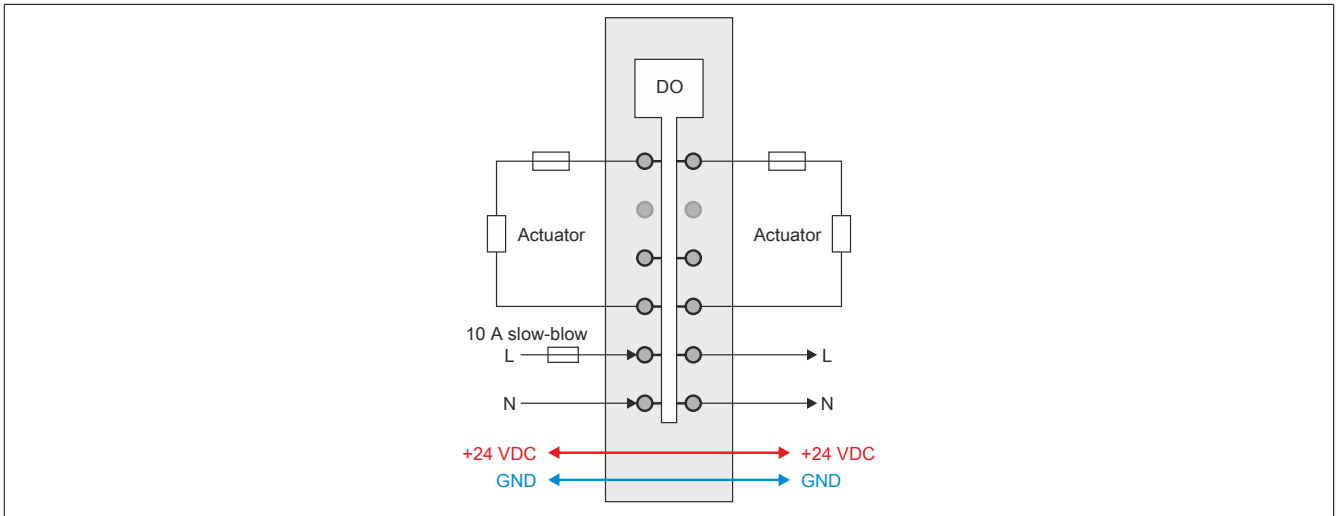
The following points must be taken into consideration when wiring the module:

- For thermal reasons, wires with a cross-section $\geq 1.5 \text{ mm}^2$ must be used to wire the module.
- The neutral return lines for the outputs must be wired to the terminal block separately for each channel and must not be bypassed in the field.
- A line filter must be used for the 240 V supply that provides $\geq 40 \text{ dB}$ attenuation at 150 kHz and works up to 5 MHz.

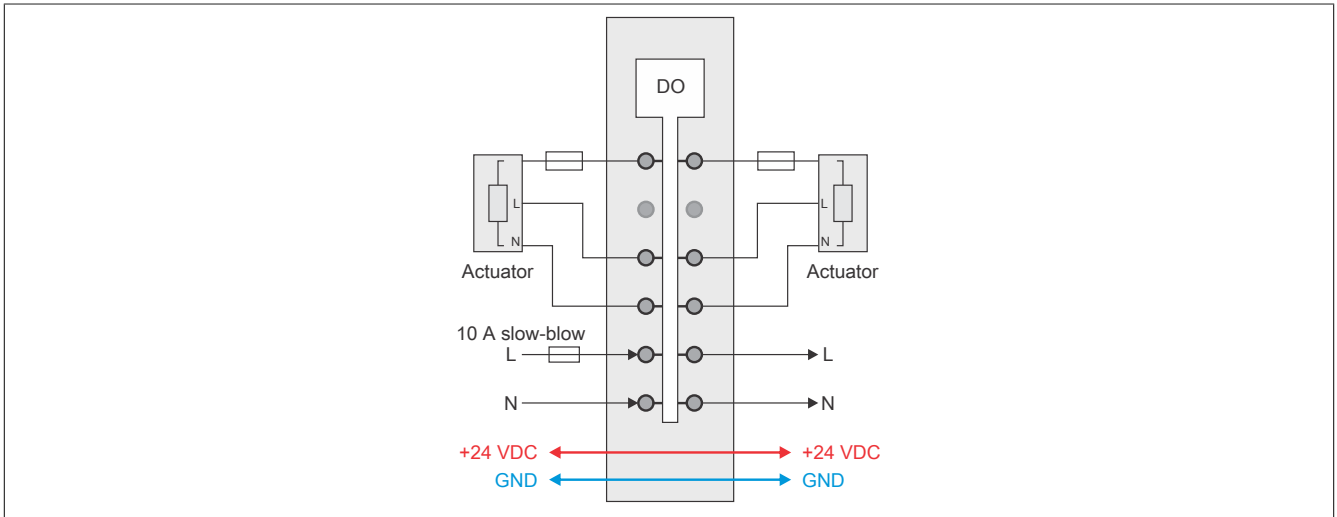


9.15.5.7 Connection example

2-wire connections



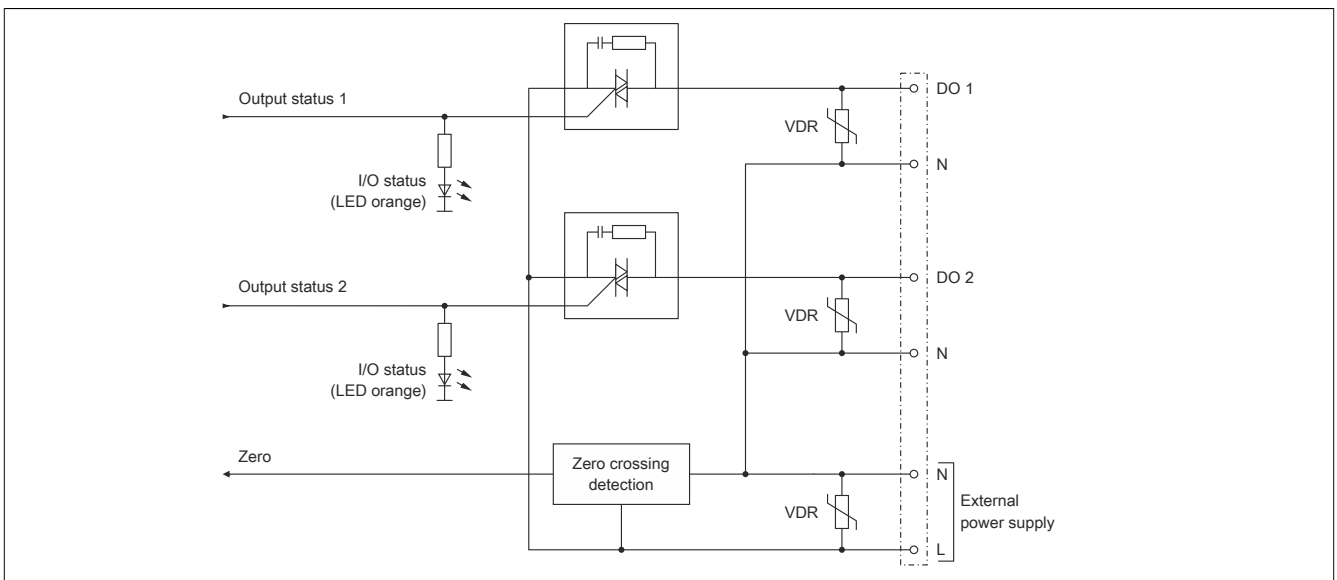
3-wire connections



9.15.5.8 OSP hardware requirements

In order to use OSP mode sensibly, it should be ensured that the power supply of the output module and CPU are independent of each other when the application is set up.

9.15.5.9 Output circuit diagram



9.15.5.10 External fuses

The following protective circuit must be used for safe operation:

| | Protective circuit | Value |
|------------------------|---------------------------|--|
| For the supply lines | Fuse | T 10 A |
| For the outputs | Fuse | Melting integral $I^2t \leq 78 \text{ A}^2\text{s}$ when $t_p = 10 \text{ ms}$ |
| With an inductive load | Varistor ¹⁾ | e.g. varistor with 275 V _{RMS} at 240 VAC |
| For the supply voltage | Line filter ²⁾ | Attenuation $\geq 40 \text{ dB}$ at 150 kHz, effective range up to 5 MHz |

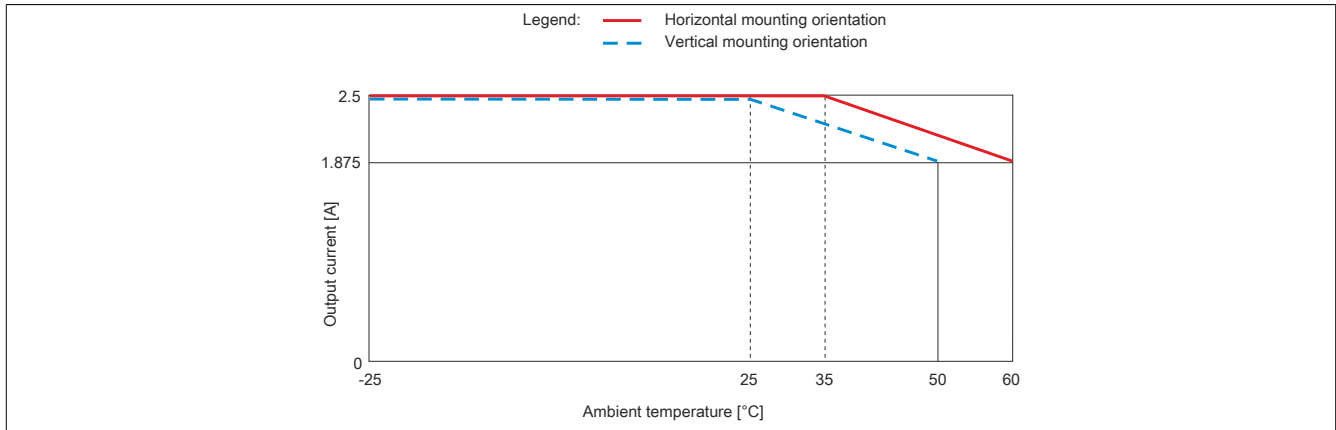
1) See also section "Operation with inductive loads" on page 1615

2) Meeting the limit values specified in the standards EN 61131, EN 55011 and EN 55022 (each Class A) requires installation of a line filter in the 240 V supply line. Line filters such as the Schaffner FN 2412-8-44 can be used.

If periodic ground transients occur on the supply lines (as can occur with upstream inverters), it is necessary to use an asymmetric filter that keeps these types of changes in potential below a few volts (e.g. "Sinus Plus" from Schaffner) in addition to the symmetric filter.

9.15.5.11 Derating

The derating listed below must be applied for the current:



9.15.5.12 Operating principle

The digital output module was designed for phase control of resistive and inductive loads. The triac outputs do not have short circuit protection. The integrated open-circuit detection makes it possible to recognize defects on the load or the cabling (see "Open line detection" on page 1614).

The module is equipped with internal zero-crossing detection. Zero-crossing detection is the basis for a software PLL that generates 200 times the zero-crossing frequency. The output signal of the PLL is the base timer for the PWM outputs in both digital and analog mode.

Upon detection of lost periods or periods that are too short, control to the outputs is cut until the PLL is tuned correctly. The tuning procedure can take several seconds. In addition, the "ZeroCrossingStatus" bit is set and the error LED enabled (valid frequency range for the supply is 45 to 65 Hz).

Information:

The jitter of the output signals generated by the PLL and communication can reach 0.5%.

9.15.5.13 Open line detection

The module is equipped with open-circuit detection. Note that open-circuit detection only works when the output is enabled. An open-circuit will not be detected if the output is turned off.

In addition, open-circuit detection is restricted or doesn't work at all for inductive loads. This depends on the inductance of the load and should be determined beforehand, if necessary.

9.15.5.14 Parallel connection of outputs

Parallel connection of outputs is possible. Both the channels as well as the neutral conductors must be wired in parallel for this.

Maximum current is calculated as follows: Maximum current = Sum of individual currents * 0.9.

Example

2.5 A maximum current per channel: $(2 * 2.5 \text{ A}) * 0.9 \rightarrow 4.5 \text{ A}$ maximum current

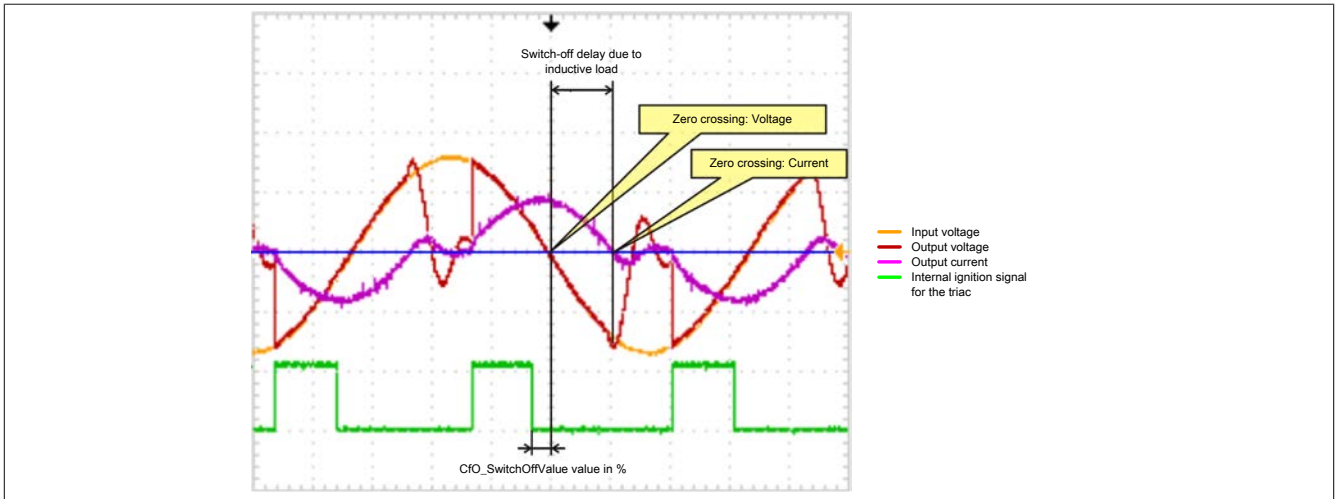
The derating curve shown in section "Derating" on page 1614 assumes that the current is split evenly between the channels.

9.15.5.15 Operation with inductive loads

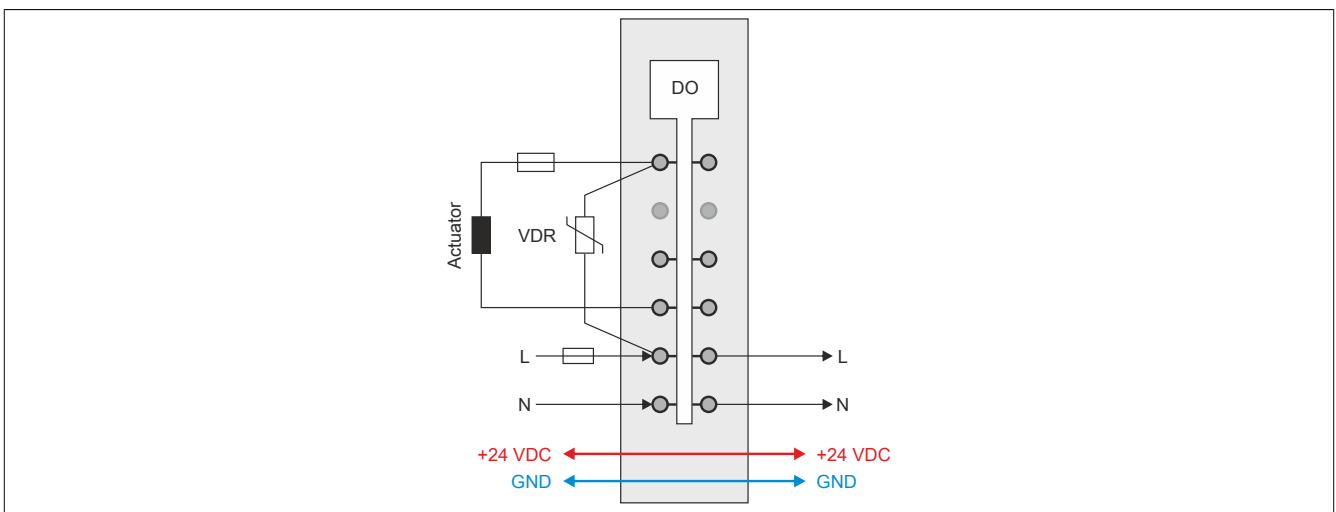
As inherent to its functional principal, the triac output is cleared when the current crosses zero. Because zero crossing for current is delayed with inductive loads, it is possible that the triac will be fired again even though it is not completely cleared at higher output values (between 50 and 100% depending on the inductance of the load). In this case, a full-wave is output. This causes the available control range (0 to 95%) to be changed.

For open line detection (LowCurrentStatus), a pause in control is required where the triac is not permitted to be fired. The full wave that is created with inductive loads causes open line detection to be triggered even though the load on the output is sufficient.

This behavior can be used to detect the full wave and properly adjust the control range (Example: If open line detection is triggered at a control value of 70%, that means that 0 to **70%** corresponds to 0 to **100%** output).



With inductive loads, a suitable varistor must be provided between the output DO x and the phase L (e.g. a varistor with 275 V_{RMS} at 240 VAC).



9.15.5.16 Register description

9.15.5.16.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.15.5.16.2 Function model 0 - Standard and Function model 2 - Frequency mode

The only difference between function model 2 and function model 0 is the possibility of generating half-wave patterns in various frequencies. Register 18 "CfO_Frequency" is an additional register for this.

| Register | Name | Data type | Read | | Write | |
|--------------------------------|-------------------------------------|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration - General | | | | | | |
| 4 | AnalogOutput01 | USINT | | | • | |
| 6 | AnalogOutput02 | USINT | | | • | |
| 18 | CfO_Frequency | UINT | | | | • |
| 20 | CfO_SwitchOffValue1 | USINT | | | | • |
| 22 | CfO_SwitchOffValue2 | USINT | | | | • |
| 28 | CfO_OutputConfig | USINT | | | | • |
| 29 | CfO_OutputTolerance | USINT | | | | • |
| Communication | | | | | | |
| 2 | DigitalOutput | USINT | | | • | |
| | DigitalOutput01 | Bit 0 | | | | |
| | DigitalOutput02 | Bit 1 | | | | |
| 30 | StatusInput01 | USINT | • | | | |
| | LowCurrentStatus1 | Bit 0 | | | | |
| | LowCurrentStatus2 | Bit 1 | | | | |
| | ZeroCrossingInput | Bit 4 | | | | |
| | ZeroCrossingStatus | Bit 7 | | | | |

9.15.5.16.3 Function model 1 - OSP

| Register | Name | Data type | Read | | Write | |
|--------------------------------|---|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration - General | | | | | | |
| 4 | AnalogOutput01 | USINT | | | • | |
| 6 | AnalogOutput02 | USINT | | | • | |
| 20 | CfO_SwitchOffValue1 | USINT | | | | • |
| 22 | CfO_SwitchOffValue2 | USINT | | | | • |
| 28 | CfO_OutputConfig | USINT | | | | • |
| 29 | CfO_OutputTolerance | USINT | | | | • |
| Configuration - OSP | | | | | | |
| 34 | Enabling OPS output in the module | USINT | | | • | |
| | OSPValid | Bit 0 | | | | |
| 32 | CfgOSPMode | USINT | | | | • |
| 36 | CfgOSPValue | USINT | | | | • |
| 38 | CfgOSPValue01 | USINT | | | | • |
| 40 | CfgOSPValue02 | USINT | | | | • |
| Communication | | | | | | |
| 2 | Switching state of digital outputs 1 to 2 | USINT | | | • | |
| | DigitalOutput01 | Bit 0 | | | | |
| | DigitalOutput02 | Bit 1 | | | | |
| 30 | Status of the outputs | USINT | • | | | |
| | LowCurrentStatus1 | Bit 0 | | | | |
| | LowCurrentStatus2 | Bit 1 | | | | |
| | ZeroCrossingInput | Bit 4 | | | | |
| | ZeroCrossingStatus | Bit 7 | | | | |

9.15.5.16.4 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------|----------------------|-----------------------|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration - General | | | | | | | |
| 4 | 0 | AnalogOutput01 | USINT | | | • | |
| 6 | 2 | AnalogOutput02 | USINT | | | • | |
| 20 | - | CfO_SwitchOffValue1 | USINT | | | | • |
| 22 | - | CfO_SwitchOffValue2 | USINT | | | | • |
| 28 | - | CfO_OutputConfig | USINT | | | | • |
| 29 | - | CfO_OutputTolerance | USINT | | | | • |
| Communication | | | | | | | |
| 30 | 0 | Status of the outputs | USINT | • | | | |
| | | LowCurrentStatus1 | Bit 0 | | | | |
| | | LowCurrentStatus2 | Bit 1 | | | | |
| | | ZeroCrossingInput | Bit 4 | | | | |
| | | ZeroCrossingStatus | Bit 7 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.15.5.16.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.5.16.4.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.15.5.16.5 General information

The digital output module was designed for phase control of resistive and inductive loads. The triac outputs do not have short circuit protection, but have open line detection that can be used to find defects in the consumer or the wiring.

The module is equipped with internal zero-crossing detection. Zero crossing detection is the basis for a software PLL that generates 200 times the zero crossing frequency. The output signal of the PLL is the base timer for the 2 PWM outputs in both digital and analog mode.

Upon detection of lost periods or periods that are too short, control of the outputs is cut until the PLL is tuned correctly (can take several seconds). In addition, the "ZeroCrossingStatus" bit is set and the Error LED is enabled (valid frequency range for the supply is 45 to 65 Hz).

Information:

The jitter of the output signals generated by the PLL and communication can reach 0.5%.

9.15.5.16.6 Digital outputs

The output state of the outputs defined as digital is transferred to the output ports of the control switch in sync with the connected power mains. The switch-on state is applied when the voltage crosses zero on the positive half-wave and the switch-off state at the zero crossing for current in each half wave.

9.15.5.16.6.1 Switching state of digital outputs 1 to 2

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput02

This register is used to store the switching state of digital outputs 1 to 2.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 3 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| 1 | DigitalOutput02 | 0 | Digital output 02 reset |
| | | 1 | Digital output 02 set |

Information:

The states in these registers are only applied when the channels are set to DIGITAL in ["Configuration of the output channels"](#) on page 1621.

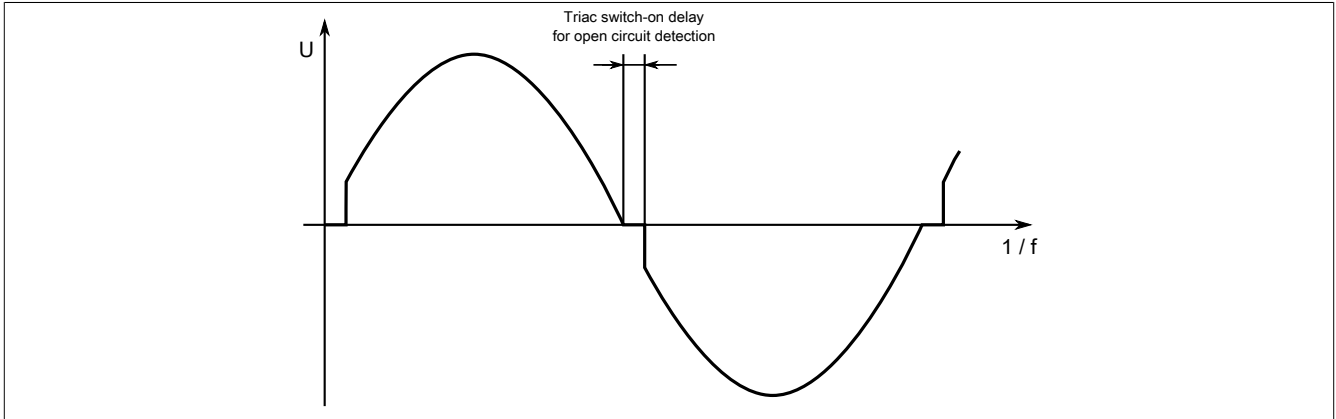
When using setting "Packed outputs", ALL channels must be set to DIGITAL. Mixed operation is not possible.

9.15.5.16.7 Analog outputs

The output value of the outputs defined as analog outputs (unit percent) is switched through to the control ports in sync with power mains. The analog value is output to the TRIAC control port in the range between (output value > SwitchOffValue) and (output value ≤ 95%) with a resolution of 1%.

A short triac turn-on delay is required for open line detection. Therefore even with output values ≥ 96%, there is a small pause in control.

Changes to the output value are applied at the next positive half-wave



9.15.5.16.7.1 Commutation angle for analog outputs 1 - 2

Name:

AnalogOutput01 to AnalogOutput02

These registers are used to set the commutation angle for phase angle control.

Values between 0 and 100 correspond to the output value for the respective channel in percent. Values above 100 correspond to 100%.

| Data type | Value |
|-----------|----------|
| USINT | 0 to 100 |

Information:

The commutation angle for phase angle control set in these registers are only applied when the channels are set to ANALOG in ["Configuration of the output channels"](#) on page 1621.

9.15.5.16.8 Output configuration

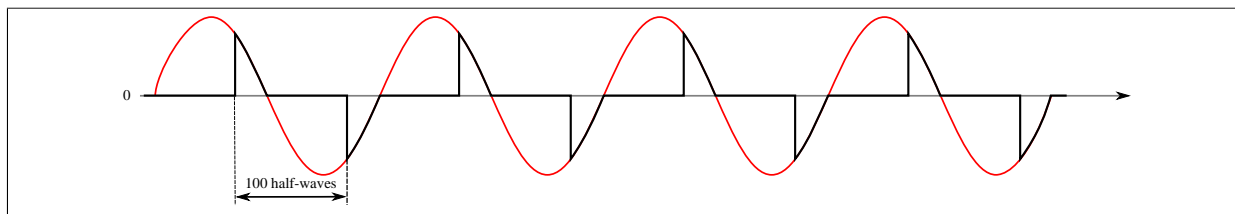
9.15.5.16.8.1 Configuring the half-wave pattern

Name:

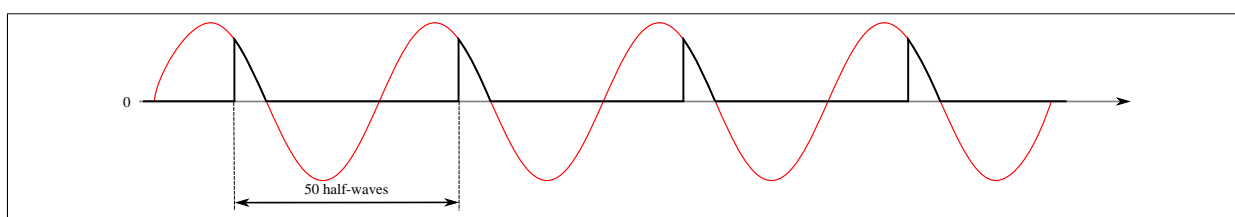
CfO_Frequency

This register can only be used in [function model 2 - Frequency mode](#) and makes it possible to configure the output of half-wave patterns in various frequencies. The [commutation angle of the outputs](#) is not affected by this. The following frequency patterns can be configured:

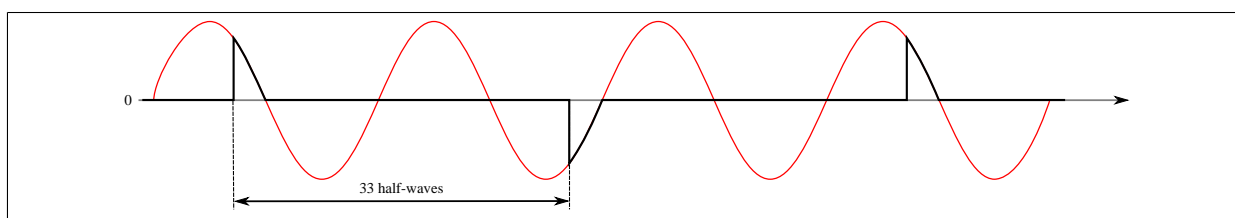
- 100 half-waves



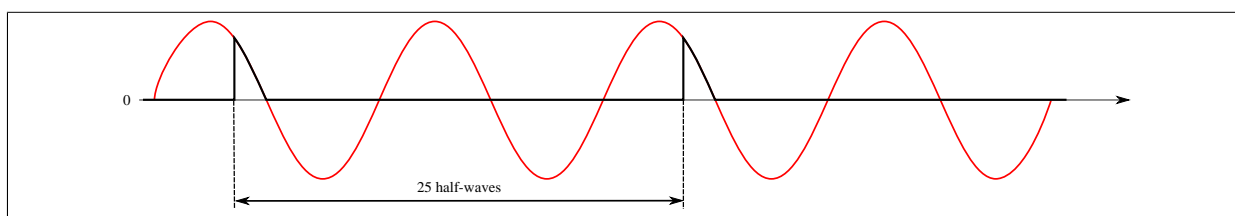
- 50 half-waves



- 33 half-waves



- 25 half-waves



With multichannel operation, the second channels should be operated with delayed half-waves in order to ensure that the load is placed evenly on the module.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|-------------|--------------|--|
| 0 - 3 | Channel 1 | 0000 | 100 half-waves/second |
| | | 0001 | 50 half-waves/second |
| | | 0010 | 25 half-waves/second |
| | | 0011 | 33 half-waves/second |
| | | 0101 | 50 half-waves/second delayed by 1 half-wave |
| | | 0110 | 25 half-waves/second delayed by 2 half-waves |
| | | 0111 | 33 half-waves/second delayed by 1 half-wave |
| 4 - 7 | Channel 2 | 0000 to 0111 | See channel 1 |
| 8 - 15 | Reserved | - | |

Information:

This function is available beginning with firmware version 940. This can be included beginning with hardware variant 8.

9.15.5.16.8.2 Setting the switch-off time

Name:

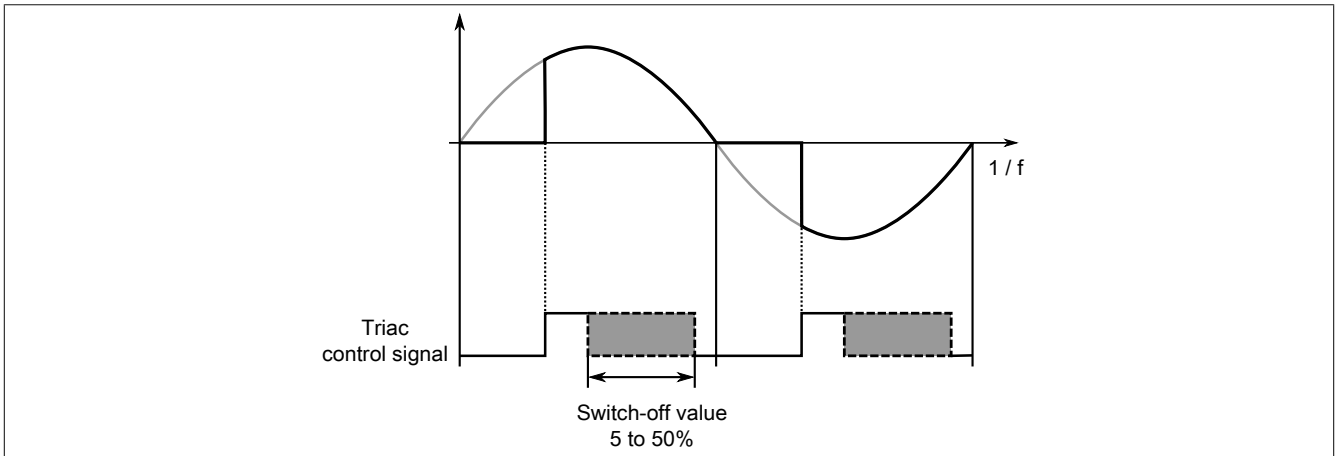
CfO_SwitchOffValue1 and CfO_SwitchOffValue2

This register defines how far in front of the zero cross-over the internal control signal for the TRIAC is switched off. Increasing this value may be necessary in order to prevent unwanted firing of the TRIAC in the event of a slight disturbance in the mains frequency.

With smaller loads, it is important to ensure that this switch off value is not set to large (too early) to prevent switching off prematurely.

The triac can of course only be fired before the set switch-off time.

"SwitchOffValue" in the Automation Studio I/O configuration.



| Data type | Value | Description |
|-----------|---------|--|
| USINT | 5 to 50 | Switch-off time in %. Bus controller default setting: 5 |

9.15.5.16.8.3 Configuration of the output channels

Name:

CfO_OutputConfig

The configuration of the output channels is stored in this register.

"Output type digital/analog" and "Output type full/half wave" in the Automation Studio I/O configuration

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 3 |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|--|
| 0 | Channel 1: Digital/Analog output | 0 | Output channel 1 is defined as a digital output. The output status is defined by bit 0 of "Switching state of digital outputs 1 to 2" on page 1618. |
| | | 1 | Output channel 1 is defined as an analog output. The output status is defined by "Commutation angle for analog outputs 1 - 2" on page 1619. (Bus controller default setting) |
| 1 | Channel 2: Digital/Analog output | 0 | Output channel 2 is defined as a digital output. The output status is defined by bit 1 of "Switching state of digital outputs 1 to 2" on page 1618. |
| | | 1 | Output channel 2 is defined as an analog output. The output status is defined by "Commutation angle for analog outputs 1 - 2" on page 1619. (Bus controller default setting) |
| 2 - 3 | Reserved | - | |
| 4 | Channel 1: Full-wave/Half-wave control ¹⁾ | 0 | Full-wave control on output channel 1 (bus controller default setting) |
| | | 1 | Negative half-wave on output channel 1 is suppressed. |
| 5 | Channel 2: Full-wave/Half-wave control ¹⁾ | 0 | Full-wave control on output channel 2 (bus controller default setting) |
| | | 1 | Negative half-wave on output channel 2 is suppressed. |
| 6 - 7 | Reserved | - | |

1) Not available in [function model 2 - Frequency mode](#).

9.15.5.16.8.4 Switching behavior for zero-crossing errors

Name:

CfO_OutputTolerance

This register can be used to set the switching behavior of the trigger. After the number of zero-crossing errors configured in Bit 0 to 4, the output is switched off for at least 3 periods. This is followed by synchronization with the zero signal according to Bit 7.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------|---------|--|
| 0 - 4 | Trigger for Resync | 0 to 30 | Number of zero crossing errors. Bus controller default setting: 0 |
| 5 - 6 | Reserved | - | |
| 7 | Fast settling | 0 | Quick adjustment (bus controller default setting) |
| | | 1 | PLL synchronization |

Fast synchronization

With this option, the trigger point is closed-loop controlled after each individual zero-crossover and input jitter.

- **Advantage:** Increased tolerance and faster response to deviations in mains frequency
- **Disadvantage:** Increased switch-on jitter for firing signal by zero cross signal $\pm 100 \mu\text{Sec}$

PLL synchronization

With this option the intervals between zero cross-overs are measured and the PLL frequency is updated accordingly.

- **Advantage:** Jitter-free firing signal
- **Disadvantage:** When the output is switched off, additional measurement phases are required before it can be switched back on.

Information:

This function is available starting with Firmware version 928. This can be installed with hardware version 8 and hardware revision B4 or higher.

9.15.5.16.9 Status of the outputs

Name:

LowCurrentStatus1 through LowCurrentStatus2

ZeroCrossingInput

ZeroCrossingStatus

StatusInput01

The operating status of the outputs is mapped in this register.

To determine "LowCurrentStatus", a check is made shortly before each triac ignition to determine whether there is a connection from the output via the consumer to the neutral conductor.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("LowCurrentStatus1" to "ZeroCrossingStatus") or whether this register should be displayed as a single USINT data point ("StatusInput01").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 255 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-------|--------------------|-------|---|
| 0 | LowCurrentStatus1 | 0 | Current flow on activated output 1 |
| | | 1 | No current flow on activated output 1 |
| 1 | LowCurrentStatus2 | 0 | Current flow on activated output 2 |
| | | 1 | No current flow on activated output 2 |
| 2 - 3 | Reserved | - | |
| 4 | ZeroCrossingInput | 0 | Zero cross signal during the negative half-wave |
| | | 1 | Zero cross signal during the positive half-wave |
| 5 - 6 | Reserved | - | |
| 7 | ZeroCrossingStatus | 0 | Zero cross signal OK |
| | | 1 | Zero cross signal has dropped out |

9.15.5.16.10 Function model "OSP"

In function model "OSP" (Operator Set Predefined), the user defines an analog value or digital pattern. This OSP value is output as soon as the communication between the module and master is aborted.

Functionality

The user has the choice between 2 OSP modes:

- Retain last valid value
- Replace with static value

In the first case, the module retains the last value recognized as a valid output status.

When selecting mode "Replace with static value", a plausible output value must be entered in the associated value register. When an OSP event occurs, this value is output instead of the value currently requested by the task.

9.15.5.16.10.1 Enabling OPS output in the module

Name:

OSPValid

This data point makes it possible to start the output of the module and request the use of OSP during operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|---|
| 0 | OSPValid | 0 | Request OSP operation (after initial startup or module in stand-by) |
| | | 1 | Request normal operation |
| 1 - 7 | Reserved | 0 | |

Bit OSPValid exists once on the module and is managed by the user task. It must be set to start the enabled channels. As long as bit OSPValid remains set in the module, the module behaves the same as in function model "Standard".

If an OSP event occurs, e.g. communication between the module and master CPU aborted, then bit OSPValid is reset on the module. The module enters the OSP state and output occurs according to the configuration in register "OSPMode" on page 1625.

The following generally applies:

Even after regeneration of the communication channel, the OSP replacement value is still pending. The OSP state is only exited again when a set OSPValid bit is transferred.

When the master CPU is restarted, bit OSPValid bit is reinitialized in the master CPU. It must be set once more by the application and transferred via the bus.

In the event of brief communication errors between the module and master CPU (e.g. due to EMC), the cyclic registers fail to refresh for several bus cycles. Within the module, bit OSPValid is reset; the set bit is retained in the CPU, however. During the next successful transfer, the module-internal OSPValid bit is set again and the module automatically returns to normal operation.

If the task in the master CPU needs the information about which output mode the module is currently in, bit ModulOK can be evaluated.

Warning!

If bit OSPValid bit is reset to "0" by the module, the output status no longer depends on the responsible task in the master CPU. Nevertheless, output is made depending on the configuration of the OSP replacement value.

9.15.5.16.10.2 Setting OSP mode

Name:

CfgOSPMode

This register controls the behavior of a channel when using OSP.

| Data type | Values | Explanation |
|-----------|--------|---------------------------|
| USINT | 0 | Replace with static value |
| | 1 | Retain last valid value |

9.15.5.16.10.3 Defining an OSP-digital output value

Name:

CfgOSPValue

This register contains the digital output value that is output in "Replace with static value" mode during OSP operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------|--------|--|
| 0 | | 0 or 1 | OSP output value for channel DigitalOutput00 |
| ... | | ... | |
| x | | 0 or 1 | OSP output value for channel DigitalOutput0x |

Warning!

"OSPValue" is only applied by the module if bit "OSPValid" has been set in the module.

9.15.5.16.10.4 Define the OSP analog output value

Name:

CfgOSPValue01 to CfgOSPValue02

This register contains the analog output value, which is output in "Replace with static value" mode during OSP operation.

| Data type | Value |
|-----------|----------|
| USINT | 0 to 100 |

Warning!

"OSPValue" is only applied by the module if bit "OSPValid" has been set in the module.

9.15.5.16.11 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|--------|
| All channels | 250 µs |

9.15.5.16.12 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|--------|
| All channels | 150 µs |

9.15.6 X20DO2649

Data sheet version: 3.17

9.15.6.1 General information

The module has 2 relay outputs.

- 2 digital outputs
- Relay module for 240 VAC / 30 VDC
- 2 change over contacts
- Single-channel isolated outputs

Danger!

Risk of electric shock!

The terminal block is only permitted to conduct voltage when it is connected. It is not permitted to be disconnected or connected while voltage is applied or have voltage applied to it while it is removed under any circumstances.

This module is not permitted to be the last module connected on the X2X Link network. At least one subsequent X20ZF dummy module must provide protection against contact.

Danger!

The voltage classes on the terminal block must not be mixed! Only operation at mains voltage (e.g. 230 VAC) OR safety extra-low voltage (e.g. 24 VDC SELV) is permitted.

9.15.6.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Digital outputs |  |
| X20DO2649 | X20 digital output module, 2 relays, changeover contacts, 240 VAC / 5 A, 24 VDC / 5 A | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 303: X20DO2649 - Order data

9.15.6.3 Technical data

| | |
|--|--|
| Model number | X20DO2649 |
| Short description | |
| I/O module | 2 digital outputs 30 VDC / 240 VAC, outputs single-channel isolated |
| General information | |
| B&R ID code | 0x20DA |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| Outputs | Yes, using LED status indicator |
| Power consumption | |
| Bus | 0.45 W |
| Internal I/O | - |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +2.5 |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Digital outputs | |
| Variant | Relay / Changeover contact Channels single-channel isolated |
| Nominal voltage | 30 VDC / 240 VAC |
| Max. voltage | 264 VAC |
| Switching voltage | Max. 110 VDC / 264 VAC |
| Rated frequency | DC / 45 to 63 Hz |
| Nominal output current | 5 A at 30 VDC / 5 A at 240 VAC |
| Total nominal current | 10 A at 30 VDC / 10 A at 240 VAC |
| Actuator power supply | External |
| Inrush current | Max. 6 A (per channel) |
| Contact resistance | 50 mΩ |
| Switching delay | |
| 0 → 1 | ≤10 ms |
| 1 → 0 | ≤10 ms |
| Isolation voltages | |
| Channel - Bus | Tested at 4000 VAC |
| Channel - Channel | Tested at 1000 VAC |
| Service life | |
| Electrical ²⁾ | Min. 60 x 10 ³ ops. (NC) at 6 A Min. 30 x 30 ³ ops. (NO) at 6 A |
| Mechanical | Min. 10 x 10 ⁶ ops. |
| Switching capacity | |
| Minimum | 10 mA / 5 VDC |
| Maximum | 180 W / 1500 VA |
| Protective circuit | |
| Internal | None |
| External | |
| AC | RC combination or VDR |
| DC | Inverse diode, RC combination or VDR |
| Electrical properties | |
| Electrical isolation | Channel isolated from channel and bus |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Not permitted |
| Degree of protection per EN 60529 | IP20 |

Table 304: X20DO2649 - Technical data


| | |
|---------------------------------|--|
| Model number | X20DO2649 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating". |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x bus module X20BM11 separately. |
| Spacing | 12.5 ^{+0.2} mm |

Table 304: X20DO2649 - Technical data

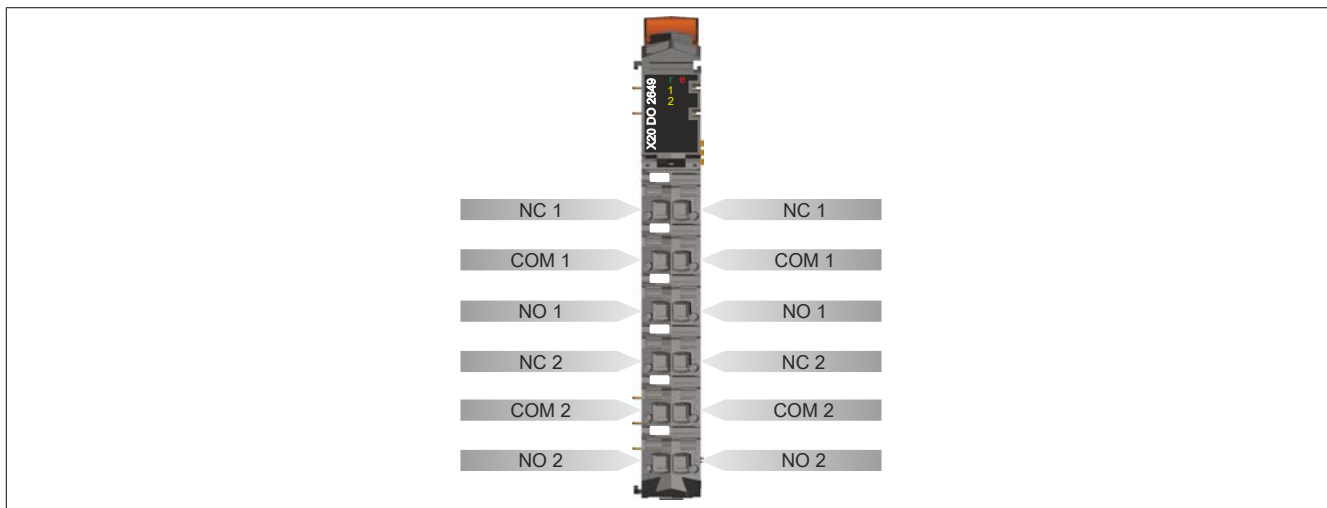
- 1) Number of outputs x Contact resistance x Nominal output current². For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) With resistive load. See also section "Electrical service life".

9.15.6.4 Status LEDs

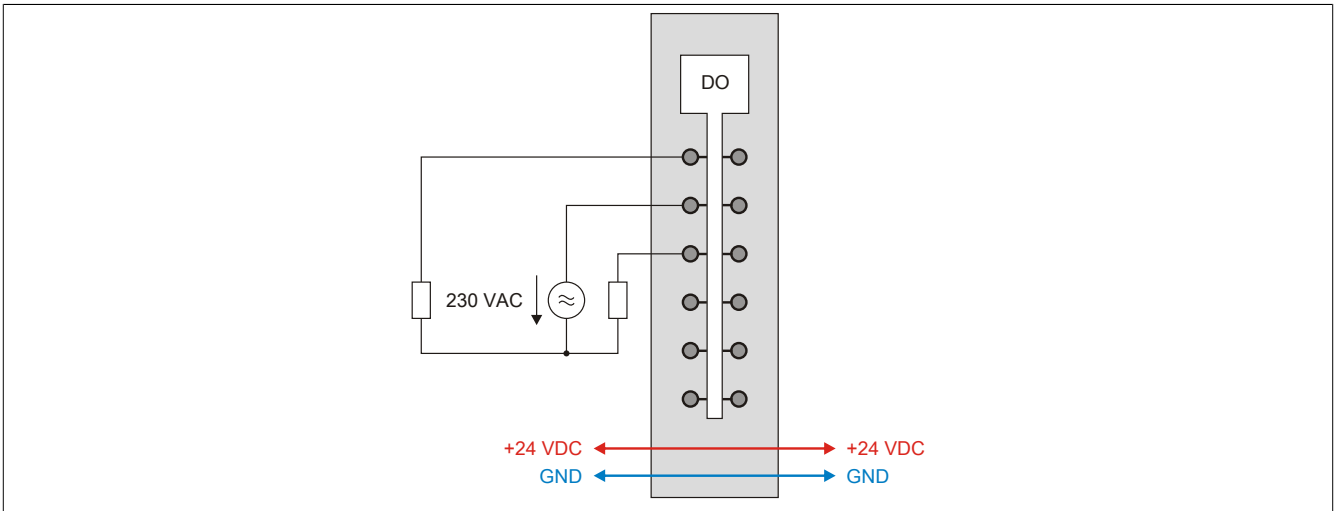
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description | |
|--|-------|-------|-----------------------------|--|---|
|  | r | Green | Off | Module supply not connected | |
| | | | Single flash | RESET mode | |
| | | | Blinking | PREOPERATIONAL mode | |
| | | | On | RUN mode | |
| | e | Red | Off | Module supply not connected or everything OK | |
| | | | On | Error or reset status | |
| | e + r | | Red on / Green single flash | Invalid firmware | |
| | 1 - 2 | | Orange | | Output status of the corresponding digital output |

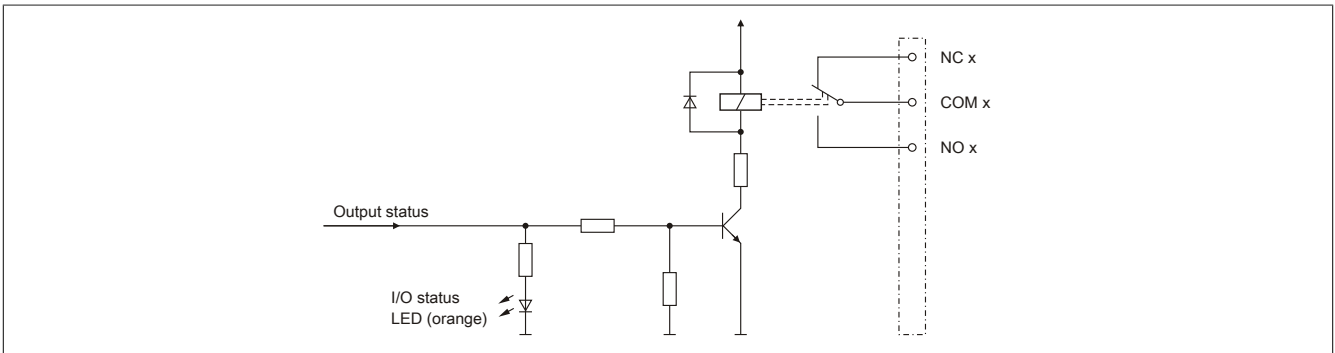
9.15.6.5 Pinout



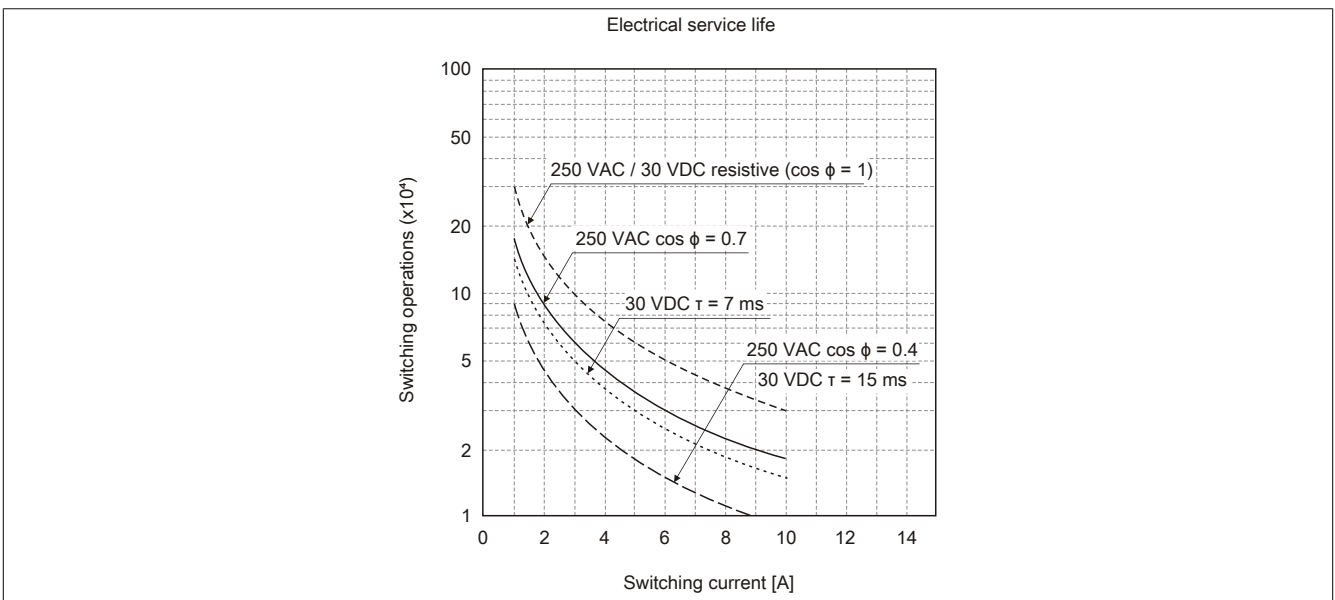
9.15.6.6 Connection example



9.15.6.7 Output circuit diagram



9.15.6.8 Electrical service life



9.15.6.9 Derating

There is no derating when operated below 55°C.

When operating above 55°C, the maximum current per channel is reduced to 4 A and the maximum summation current to 8 A!

9.15.6.10 Register description

9.15.6.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.15.6.10.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|-----------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | DigitalOutput | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | DigitalOutput02 | Bit 1 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.6.10.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 2 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | DigitalOutput02 | Bit 1 | | | | |

1) The offset specifies where the register is within the CAN object.

9.15.6.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.6.10.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.15.6.10.4 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 µs) based on the network cycle (SyncOut).

9.15.6.10.4.1 Switching state of digital outputs 1 to 2

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput02

This register is used to store the switching state of digital outputs 1 to 2.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 3 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| 1 | DigitalOutput02 | 0 | Digital output 02 reset |
| | | 1 | Digital output 02 set |

9.15.6.10.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.15.6.10.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|---------------------------------|
| Equal to the minimum cycle time |

9.15.7 X20DO4321

Data sheet version: 3.16

9.15.7.1 General information

The module is equipped with 4 outputs for 3-wire connections.

- 4 digital outputs
- Sink connection
- 3-wire connections
- 24 VDC and GND for actuator supply
- Integrated output protection
- OSP mode

9.15.7.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Digital outputs |  |
| X20DO4321 | X20 digital output module, 4 outputs, 24 VDC, 0.5 A, sink, 3-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 305: X20DO4321 - Order data

9.15.7.3 Technical data

| Model number | X20DO4321 |
|--|---|
| Short description | |
| I/O module | 4 digital outputs 24 VDC for 3-wire connections |
| General information | |
| B&R ID code | 0x22B4 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Outputs | Yes, using status LED and software (output error status) |
| Power consumption | |
| Bus | 0.16 W |
| Internal I/O | 0.49 W |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +0.12 |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| Digital outputs | |
| Variant | FET negative switching |
| Nominal voltage | 24 VDC |
| Switching voltage | 24 VDC -15 % / +20 % |
| Nominal output current | 0.5 A |

Table 306: X20DO4321 - Technical data


| Model number | X20DO4321 |
|---|--|
| Total nominal current | 2 A |
| Connection type | 3-wire connections |
| Output circuit | Sink |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short circuit current") Internal inverse diode for switching inductive loads (see section "Switching inductive loads") |
| Actuator power supply | 0.5 A in total for output-independent actuator supply |
| Diagnostic status | Output monitoring with 10 ms delay |
| Leakage current when switched off | 75 μ A |
| $R_{DS(on)}$ | 120 m Ω |
| Peak short-circuit current | <7 A |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms (depends on the module temperature) |
| Switching delay | |
| 0 \rightarrow 1 | <300 μ s |
| 1 \rightarrow 0 | <300 μ s |
| Switching frequency | |
| Resistive load | Max. 500 Hz |
| Inductive load | See section "Switching inductive loads" |
| Braking voltage when switching off inductive loads | Typ. 50 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Actuator power supply | |
| Voltage | Module supply minus voltage drop for short circuit protection |
| Voltage drop for short-circuit protection at 500 mA | Max. 2 V |
| Short-circuit proof | Yes |
| Power consumption | |
| Actuator power supply | Max. 12 W ²⁾ |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 306: X20DO4321 - Technical data

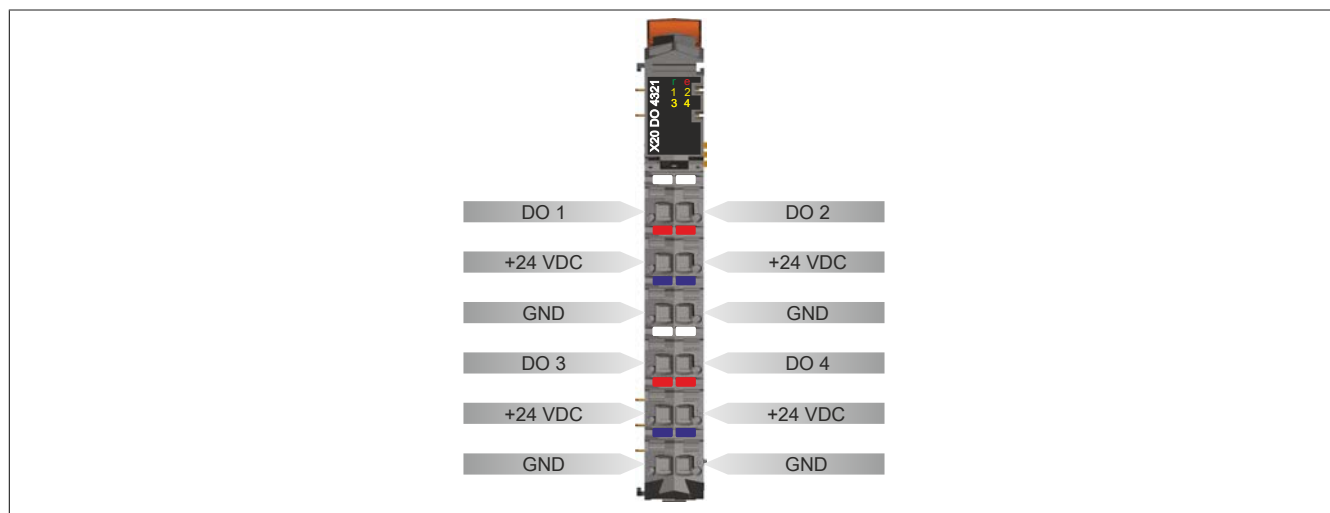
- 1) Number of outputs x $R_{DS(on)}$ x Nominal output current². For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) The power consumption of the sensors connected to the module is not permitted to exceed 12 W.

9.15.7.4 Status LEDs

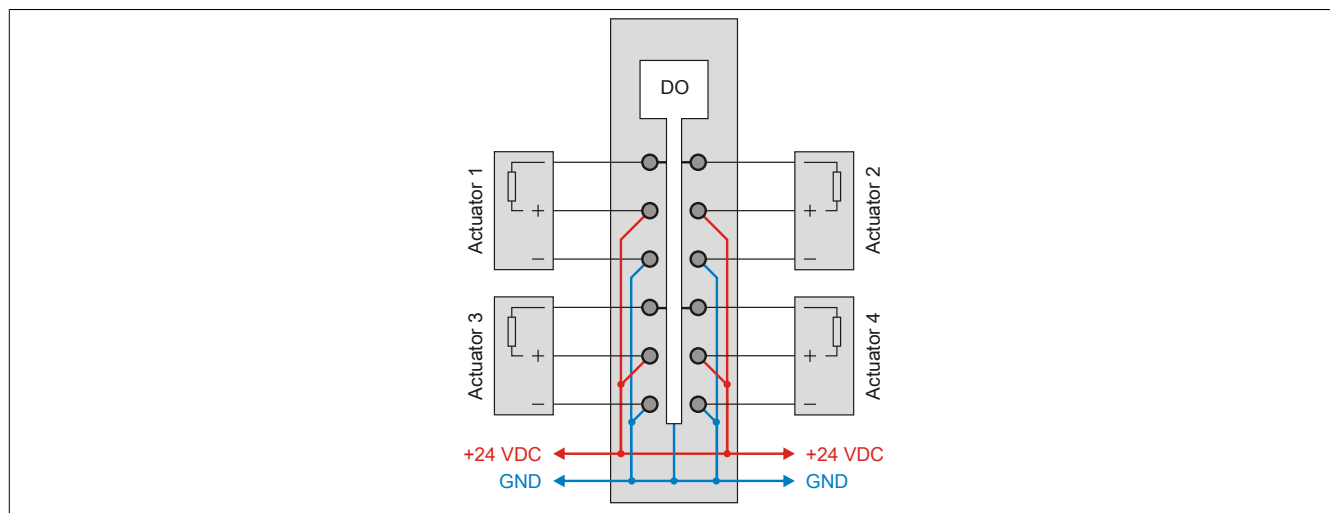
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description | |
|---|-------|-------|-----------------------------|---|---|
|  | r | Green | Off | Module supply not connected | |
| | | | Single flash | Reset mode | |
| | | | Blinking | PREOPERATIONAL mode | |
| | | | On | RUN mode | |
| | | | Flickering (approx. 10 Hz) | Module is in OSP state | |
| | e | Red | Off | Module supply not connected or everything OK | |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. | |
| | e + r | | Red on / Green single flash | Invalid firmware | |
| | 1 - 4 | | Orange | | Output status of the corresponding digital output |

9.15.7.5 Pinout



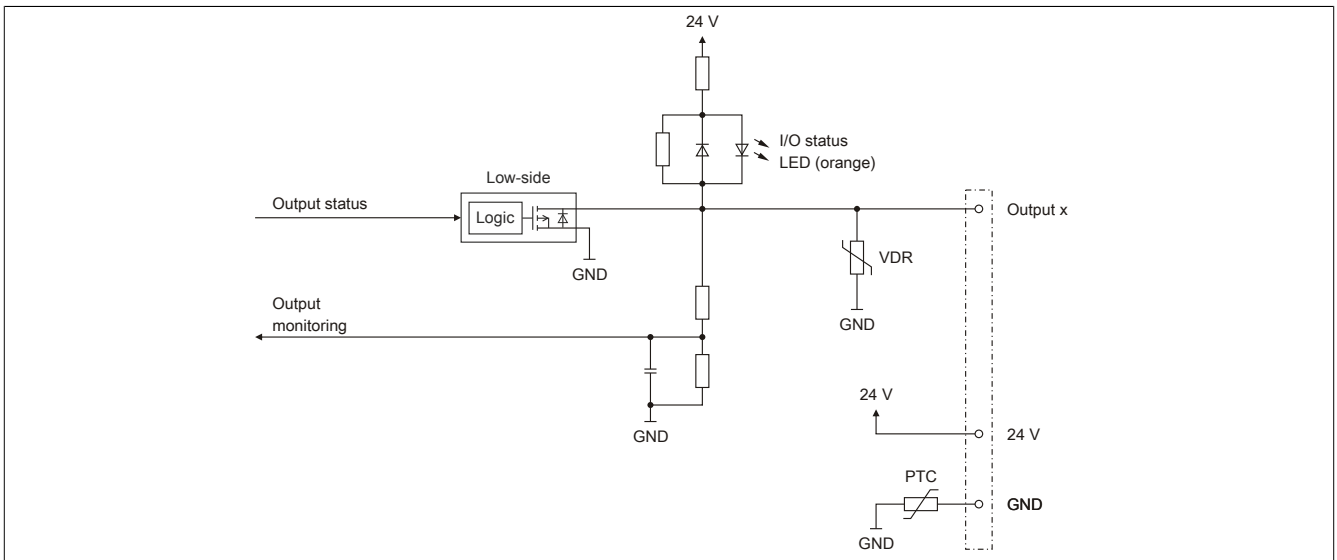
9.15.7.6 Connection example



9.15.7.7 OSP hardware requirements

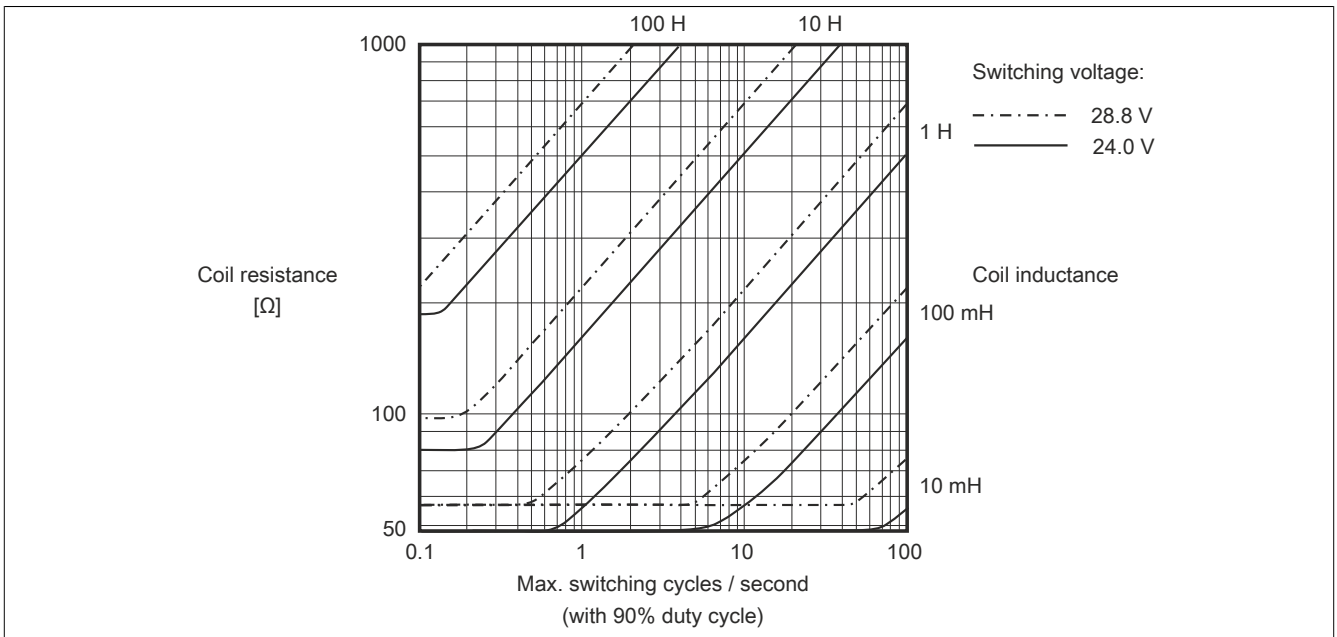
In order to use OSP mode sensibly, it should be ensured that the power supply of the output module and CPU are independent of each other when the application is set up.

9.15.7.8 Output circuit diagram



9.15.7.9 Switching inductive loads

Environmental temperature: 60°C, all outputs with the same load



Information:

If the maximum number of operating cycles per second is exceeded, an external inverse diode must be used.

Operating conditions outside of the area in the diagram are not permitted!

9.15.7.10 Register description

9.15.7.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.15.7.10.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|-----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | DigitalOutput | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput04 | Bit 3 | | | | |
| 30 | 1 | StatusInput01 | USINT | • | | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput04 | Bit 3 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.7.10.3 Function model 1 - OSP

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 4 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput04 | Bit 3 | | | | |
| 30 | 1 | Status of digital outputs 1 to 4 | USINT | • | | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput04 | Bit 3 | | | | |
| 34 | 1 | Enabling OPS output in the module | USINT | | | • | |
| | | OSPValid | Bit 0 | | | | |
| 32 | - | CfgOSPMODE | USINT | | | | • |
| 36 | - | CfgOSPValue | USINT | | | | • |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.7.10.4 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 4 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput04 | Bit 3 | | | | |
| 30 | - | Status of digital outputs 1 to 4 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput04 | Bit 3 | | | | |

1) The offset specifies where the register is within the CAN object.

9.15.7.10.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.7.10.4.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.15.7.10.5 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 µs) based on the network cycle (SyncOut).

9.15.7.10.5.1 Switching state of digital outputs 1 to 4

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput04

This register is used to store the switching state of digital outputs 1 to 4.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Values | Information |
|-----------|------------------------|--|
| USINT | 0 to 15 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 3 | DigitalOutput04 | 0 | Digital output 04 reset |
| | | 1 | Digital output 04 set |

9.15.7.10.6 Monitoring status of the digital outputs

On the module, the output states of the outputs are compared to the target states. The control of the output driver is used for the target state.

A change in the output state resets monitoring for that output. The status of each individual channel can be read. A change in the monitoring status is actively transmitted as an error message.

9.15.7.10.6.1 Status of digital outputs 1 to 4

Name:

StatusInput01

StatusDigitalOutput01 to StatusDigitalOutput04

This register contains the state of digital outputs 1 to 4.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("StatusDigitalOutput01" to "StatusDigitalOutput0x") or whether this register should be displayed as a single USINT data point ("StatusInput01").

| Data type | Values | Information |
|-----------|------------------------|--|
| USINT | 0 to 15 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput01 | 0 | Channel 01: No error |
| | | 1 | Channel 01: <ul style="list-style-type: none"> Short circuit or overload Channel switched on and missing I/O power supply Channel switched off and external voltage applied on channel |
| ... | | ... | |
| 3 | StatusDigitalOutput04 | 0 | Channel 04: No error |
| | | 1 | Channel 04: For an error description, see channel 01. |

9.15.7.10.7 Function model "OSP"

In function model "OSP" (Operator Set Predefined), the user defines an analog value or digital pattern. This OSP value is output as soon as the communication between the module and master is aborted.

Functionality

The user has the choice between 2 OSP modes:

- Retain last valid value
- Replace with static value

In the first case, the module retains the last value recognized as a valid output status.

When selecting mode "Replace with static value", a plausible output value must be entered in the associated value register. When an OSP event occurs, this value is output instead of the value currently requested by the task.

9.15.7.10.7.1 Enabling OPS output in the module

Name:

OSPValid

This data point makes it possible to start the output of the module and request the use of OSP during operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|---|
| 0 | OSPValid | 0 | Request OSP operation (after initial startup or module in stand-by) |
| | | 1 | Request normal operation |
| 1 - 7 | Reserved | 0 | |

Bit OSPValid exists once on the module and is managed by the user task. It must be set to start the enabled channels. As long as bit OSPValid remains set in the module, the module behaves the same as in function model "Standard".

If an OSP event occurs, e.g. communication between the module and master CPU aborted, then bit OSPValid is reset on the module. The module enters the OSP state and output occurs according to the configuration in register "OSPMode" on page 1639.

The following generally applies:

Even after regeneration of the communication channel, the OSP replacement value is still pending. The OSP state is only exited again when a set OSPValid bit is transferred.

When the master CPU is restarted, bit OSPValid bit is reinitialized in the master CPU. It must be set once more by the application and transferred via the bus.

In the event of brief communication errors between the module and master CPU (e.g. due to EMC), the cyclic registers fail to refresh for several bus cycles. Within the module, bit OSPValid is reset; the set bit is retained in the CPU, however. During the next successful transfer, the module-internal OSPValid bit is set again and the module automatically returns to normal operation.

If the task in the master CPU needs the information about which output mode the module is currently in, bit ModulOK can be evaluated.

Warning!

If bit OSPValid bit is reset to "0" by the module, the output status no longer depends on the responsible task in the master CPU. Nevertheless, output is made depending on the configuration of the OSP replacement value.

9.15.7.10.7.2 Setting OSP mode

Name:

CfgOSPMode

This register controls the behavior of a channel when using OSP.

| Data type | Values | Explanation |
|-----------|--------|---------------------------|
| USINT | 0 | Replace with static value |
| | 1 | Retain last valid value |

9.15.7.10.7.3 Defining an OSP-digital output value

Name:

CfgOSPValue

This register contains the digital output value that is output in "Replace with static value" mode during OSP operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------|--------|--|
| 0 | | 0 or 1 | OSP output value for channel DigitalOutput00 |
| ... | | ... | |
| x | | 0 or 1 | OSP output value for channel DigitalOutput0x |

Warning!

"OSPValue" is only applied by the module if bit "OSPValid" has been set in the module.

9.15.7.10.8 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 µs |

9.15.7.10.9 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|---------------------------------|
| Equal to the minimum cycle time |

9.15.8 X20(c)DO4322

Data sheet version: 3.27

9.15.8.1 General information

The module is equipped with 4 outputs for 3-wire connections.

- 4 digital outputs
- Source connection
- 3-wire connections
- 24 VDC and GND for actuator supply
- Integrated output protection
- OSP mode

9.15.8.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.15.8.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C . During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.15.8.3 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Digital outputs |  |
| X20DO4322 | X20 digital output module, 4 outputs, 24 VDC, 0.5 A, source, 3-wire connections | |
| X20cDO4322 | X20 digital output module, coated, 4 outputs, 24 VDC, 0.5 A, source, 3-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 307: X20DO4322, X20cDO4322 - Order data

9.15.8.4 Technical data

| Model number | X20DO4322 | X20cDO4322 |
|--|--|------------|
| Short description | 4 digital outputs 24 VDC for 3-wire connections | |
| General information | | |
| I/O module | | |
| B&R ID code | 0x1B97 | 0xE226 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Outputs | Yes, using status LED and software (output error status) | |
| Power consumption | | |
| Bus | 0.16 W | |
| Internal I/O | 0.49 W | |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +0.21 | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Digital outputs | | |
| Variant | FET positive switching | |
| Nominal voltage | 24 VDC | |
| Switching voltage | 24 VDC -15 % / +20 % | |
| Nominal output current | 0.5 A | |
| Total nominal current | 2 A | |
| Connection type | 3-wire connections | |
| Output circuit | Source | |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short circuit current") Internal inverse diode for switching inductive loads (see section "Switching inductive loads") | |
| Actuator power supply | 0.5 A in total for output-independent actuator supply | |
| Diagnostic status | Output monitoring with 10 ms delay | |
| Leakage current when the power is switched off | 5 µA | |
| R _{DS(on)} | 210 mΩ | |
| Peak short-circuit current | <12 A | |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms (depends on the module temperature) | |

Table 308: X20DO4322, X20cDO4322 - Technical data


| Model number | X20DO4322 | X20cDO4322 |
|---|--|---|
| Switching delay ²⁾ | | |
| 0 → 1 | | <300 µs |
| 1 → 0 | | <300 µs |
| Switching frequency | | |
| Resistive load ²⁾ | | Max. 500 Hz |
| Inductive load | | See section "Switching inductive loads" |
| Braking voltage when switching off inductive loads | | Typ. 50 VDC |
| Isolation voltage between channel and bus | | 500 V _{eff} |
| Actuator power supply | | |
| Voltage | Module supply minus voltage drop for short circuit protection | |
| Voltage drop for short-circuit protection at 500 mA | | Max. 2 V |
| Short-circuit proof | | Yes |
| Power consumption | | |
| Actuator power supply | | Max. 12 W ³⁾ |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel and I/O power supply | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | | Yes |
| Vertical | | Yes |
| Installation elevation above sea level | | |
| 0 to 2000 m | | No limitations |
| >2000 m | | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | | IP20 |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | | -25 to 60°C |
| Vertical mounting orientation | | -25 to 50°C |
| Derating | | - |
| Starting temperature | - | Yes, -40°C |
| Storage | | -40 to 85°C |
| Transport | | -40 to 85°C |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 308: X20DO4322, X20cDO4322 - Technical data

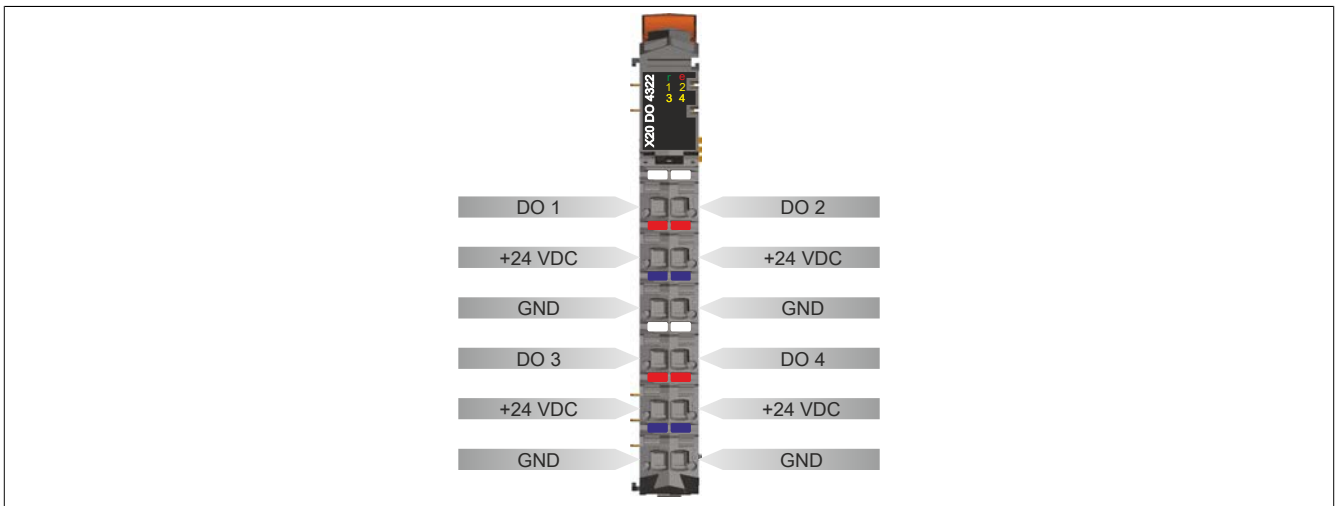
- 1) Number of outputs x R_{DS(on)} x Nominal output current². For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) At loads ≤ 1 kΩ
- 3) The power consumption of the sensors connected to the module is not permitted to exceed 12 W.

9.15.8.5 Status LEDs

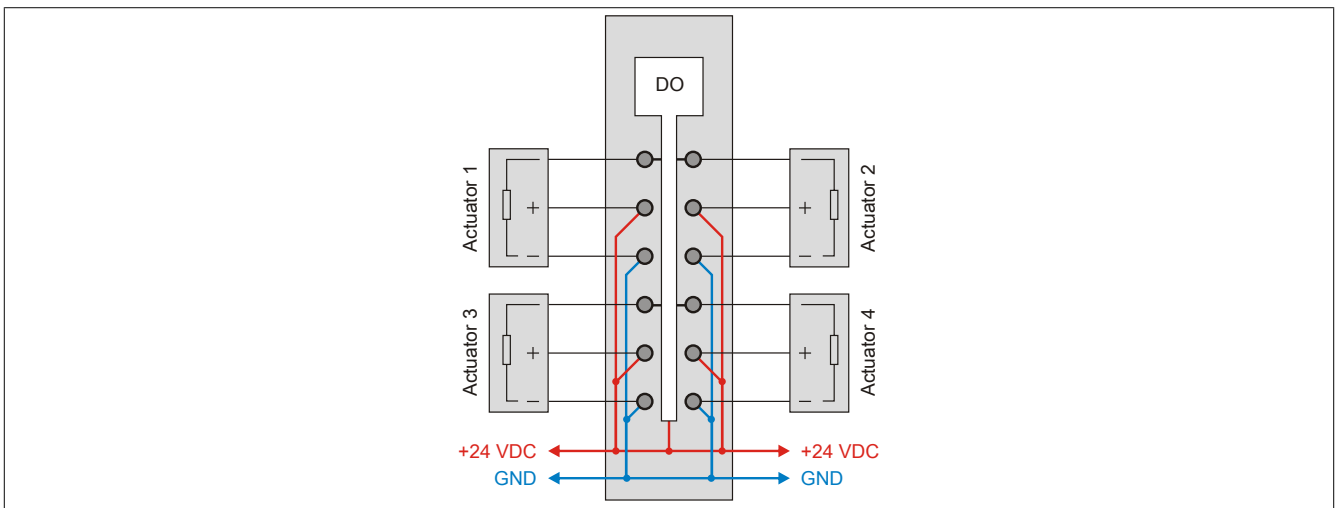
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description | |
|---|-------|-------|-----------------------------|---|---|
|  | r | Green | Off | Module supply not connected | |
| | | | Single flash | RESET mode | |
| | | | Blinking | PREOPERATIONAL mode | |
| | | | On | RUN mode | |
| | | | Flickering (approx. 10 Hz) | The module is in the OSP state. | |
| | e | Red | Off | Module supply not connected or everything OK | |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. | |
| | e + r | | Red on / Green single flash | Invalid firmware | |
| | 1 - 4 | | Orange | | Output status of the corresponding digital output |

9.15.8.6 Pinout



9.15.8.7 Connection example



Caution!

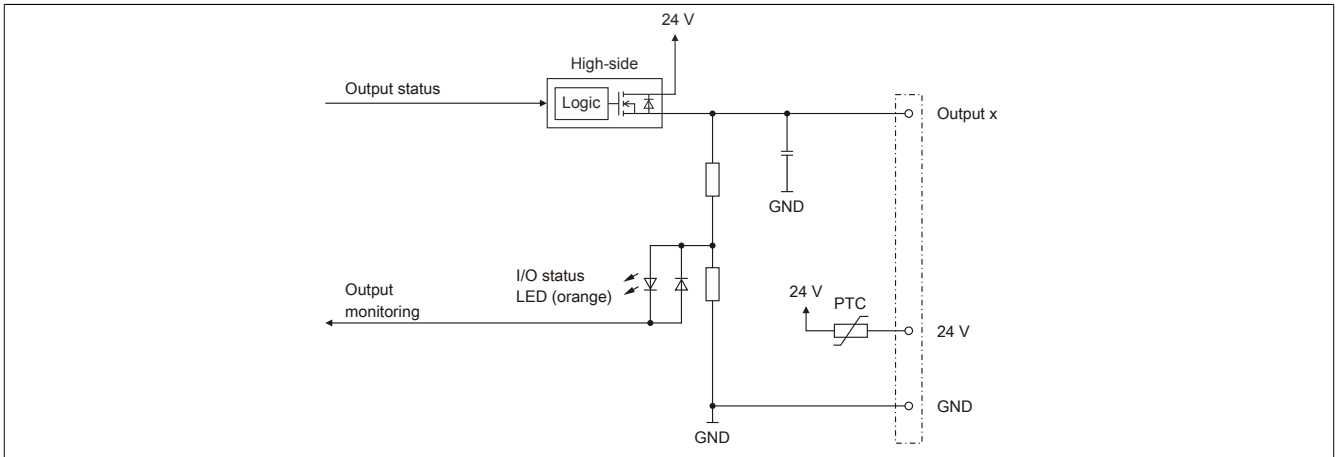
If the module is operated outside specifications, the output current may rise above the maximum permissible nominal current. This applies both to individual channels and to the summation current of the module.

Appropriate cable cross-sections or external safety measures must therefore be provided.

9.15.8.8 OSP hardware requirements

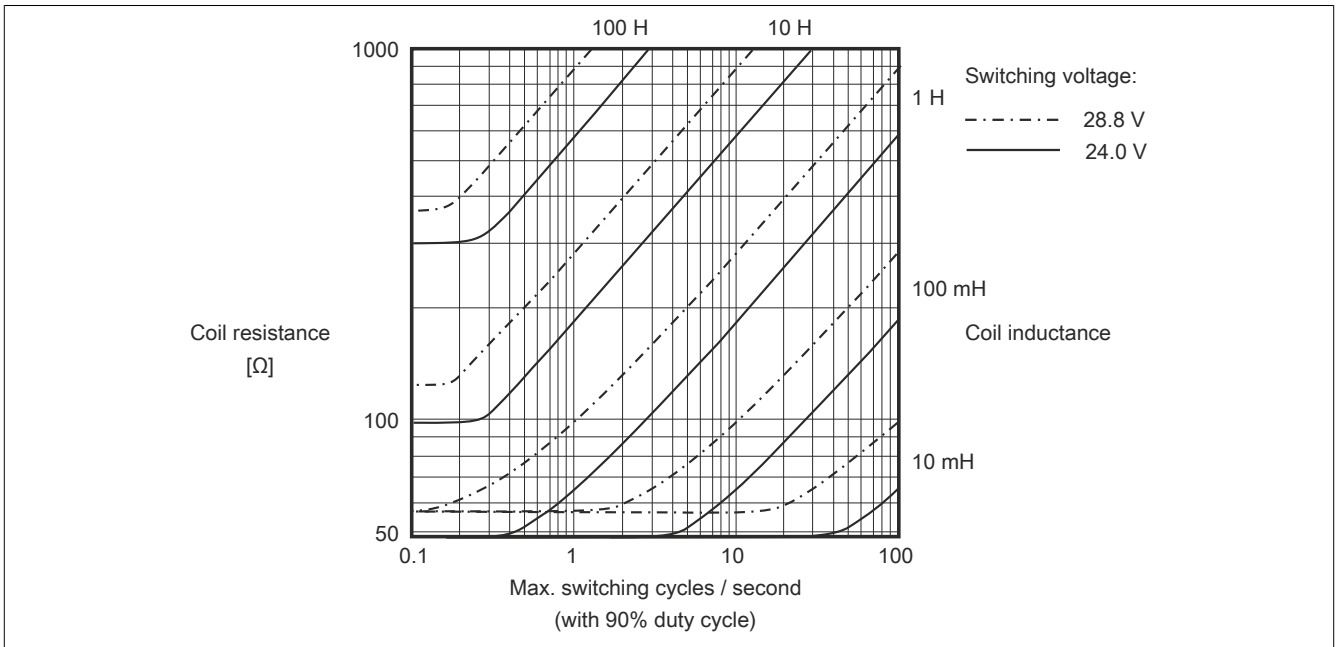
In order to use OSP mode sensibly, it should be ensured that the power supply of the output module and CPU are independent of each other when the application is set up.

9.15.8.9 Output circuit diagram



9.15.8.10 Switching inductive loads

Ambient temperature: 60°C, all outputs with the same load



Information:

If the maximum number of operating cycles per second is exceeded, an external inverse diode must be used.

Operating conditions outside of the area in the diagram are not permitted!

9.15.8.11 Register description

9.15.8.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.15.8.11.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|-----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | DigitalOutput | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput04 | Bit 3 | | | | |
| 30 | 1 | StatusInput01 | USINT | • | | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput04 | Bit 3 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.8.11.3 Function model 1 - OSP

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 4 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput04 | Bit 3 | | | | |
| 30 | 1 | Status of digital outputs 1 to 4 | USINT | • | | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput04 | Bit 3 | | | | |
| 34 | 1 | Enabling OPS output in the module | USINT | | | • | |
| | | OSPValid | Bit 0 | | | | |
| 32 | - | CfgOSPMODE | USINT | | | | • |
| 36 | - | CfgOSPValue | USINT | | | | • |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.8.11.4 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 4 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput04 | Bit 3 | | | | |
| 30 | - | Status of digital outputs 1 to 4 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput04 | Bit 3 | | | | |

1) The offset specifies where the register is within the CAN object.

9.15.8.11.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.8.11.4.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.15.8.11.5 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 µs) based on the network cycle (SyncOut).

9.15.8.11.5.1 Switching state of digital outputs 1 to 4

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput04

This register is used to store the switching state of digital outputs 1 to 4.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Values | Information |
|-----------|------------------------|--|
| USINT | 0 to 15 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 3 | DigitalOutput04 | 0 | Digital output 04 reset |
| | | 1 | Digital output 04 set |

9.15.8.11.6 Monitoring status of the digital outputs

On the module, the output states of the outputs are compared to the target states. The control of the output driver is used for the target state.

A change in the output state resets monitoring for that output. The status of each individual channel can be read. A change in the monitoring status is actively transmitted as an error message.

9.15.8.11.6.1 Status of digital outputs 1 to 4

Name:

StatusInput01

StatusDigitalOutput01 to StatusDigitalOutput04

This register contains the state of digital outputs 1 to 4.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("StatusDigitalOutput01" to "StatusDigitalOutput0x") or whether this register should be displayed as a single USINT data point ("StatusInput01").

| Data type | Values | Information |
|-----------|------------------------|--|
| USINT | 0 to 15 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput01 | 0 | Channel 01: No error |
| | | 1 | Channel 01: <ul style="list-style-type: none"> Short circuit or overload Channel switched on and missing I/O power supply Channel switched off and external voltage applied on channel |
| ... | | ... | |
| 3 | StatusDigitalOutput04 | 0 | Channel 04: No error |
| | | 1 | Channel 04: For an error description, see channel 01. |

9.15.8.11.7 Function model "OSP"

In function model "OSP" (Operator Set Predefined), the user defines an analog value or digital pattern. This OSP value is output as soon as the communication between the module and master is aborted.

Functionality

The user has the choice between 2 OSP modes:

- Retain last valid value
- Replace with static value

In the first case, the module retains the last value recognized as a valid output status.

When selecting mode "Replace with static value", a plausible output value must be entered in the associated value register. When an OSP event occurs, this value is output instead of the value currently requested by the task.

9.15.8.11.7.1 Enabling OPS output in the module

Name:

OSPValid

This data point makes it possible to start the output of the module and request the use of OSP during operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|---|
| 0 | OSPValid | 0 | Request OSP operation (after initial startup or module in stand-by) |
| | | 1 | Request normal operation |
| 1 - 7 | Reserved | 0 | |

Bit OSPValid exists once on the module and is managed by the user task. It must be set to start the enabled channels. As long as bit OSPValid remains set in the module, the module behaves the same as in function model "Standard".

If an OSP event occurs, e.g. communication between the module and master CPU aborted, then bit OSPValid is reset on the module. The module enters the OSP state and output occurs according to the configuration in register "OSPMode" on page 1648.

The following generally applies:

Even after regeneration of the communication channel, the OSP replacement value is still pending. The OSP state is only exited again when a set OSPValid bit is transferred.

When the master CPU is restarted, bit OSPValid bit is reinitialized in the master CPU. It must be set once more by the application and transferred via the bus.

In the event of brief communication errors between the module and master CPU (e.g. due to EMC), the cyclic registers fail to refresh for several bus cycles. Within the module, bit OSPValid is reset; the set bit is retained in the CPU, however. During the next successful transfer, the module-internal OSPValid bit is set again and the module automatically returns to normal operation.

If the task in the master CPU needs the information about which output mode the module is currently in, bit ModulOK can be evaluated.

Warning!

If bit OSPValid bit is reset to "0" by the module, the output status no longer depends on the responsible task in the master CPU. Nevertheless, output is made depending on the configuration of the OSP replacement value.

9.15.8.11.7.2 Setting OSP mode

Name:
CfgOSPMODE

This register controls the behavior of a channel when using OSP.

| Data type | Values | Explanation |
|-----------|--------|---------------------------|
| USINT | 0 | Replace with static value |
| | 1 | Retain last valid value |

9.15.8.11.7.3 Defining an OSP-digital output value

Name:
CfgOSPValue

This register contains the digital output value that is output in "Replace with static value" mode during OSP operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------|--------|--|
| 0 | | 0 or 1 | OSP output value for channel DigitalOutput00 |
| ... | | ... | |
| x | | 0 or 1 | OSP output value for channel DigitalOutput0x |

Warning!

"OSPValue" is only applied by the module if bit "OSPValid" has been set in the module.

9.15.8.11.8 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 µs |

9.15.8.11.9 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|---------------------------------|
| Equal to the minimum cycle time |

9.15.9 X20DO4331

Data sheet version: 3.16

9.15.9.1 General information

The module is equipped with 4 outputs for 3-wire connections. The rated output current is 2 A.

- 4 digital outputs with 2 A
- Sink connection
- 3-wire connections
- 24 VDC and GND for actuator supply
- Integrated output protection
- OSP mode

9.15.9.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Digital outputs |  |
| X20DO4331 | X20 digital output module, 4 outputs, 24 VDC, 2 A, sink, 3-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 309: X20DO4331 - Order data

9.15.9.3 Technical data

| | |
|--|--|
| Model number | X20DO4331 |
| Short description | |
| I/O module | 4 digital outputs 24 VDC for 3-wire connections |
| General information | |
| B&R ID code | 0x22B5 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Outputs | Yes, using status LED and software (output error status) |
| Power consumption | |
| Bus | 0.16 W |
| Internal I/O | 0.49 W |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +0.56 |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| Digital outputs | |
| Variant | FET negative switching |
| Nominal voltage | 24 VDC |
| Switching voltage | 24 VDC -15 % / +20 % |
| Nominal output current | 2 A |
| Total nominal current | 8 A |
| Connection type | 3-wire connections |
| Output circuit | Sink |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short circuit current") Internal inverse diode for switching inductive loads (see section "Switching inductive loads") |
| Actuator power supply | 0.5 A in total for output-independent actuator supply |
| Diagnostic status | Output monitoring with 10 ms delay |
| Leakage current when switched off | 75 µA |
| R _{DS(on)} | 35 mΩ |
| Peak short-circuit current | <24 A |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms (depends on the module temperature) |
| Switching delay | |
| 0 → 1 | <300 µs |
| 1 → 0 | <500 µs |
| Switching frequency | |
| Resistive load | Max. 500 Hz |
| Inductive load | See section "Switching inductive loads" |
| Braking voltage when switching off inductive loads | Typ. 50 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Additional functions | To increase the output current, outputs can be switched in parallel |
| Actuator power supply | |
| Voltage | Module supply minus voltage drop for short circuit protection |
| Voltage drop for short-circuit protection at 500 mA | Max. 2 V |
| Short-circuit proof | Yes |
| Power consumption | |
| Actuator power supply | Max. 12 W ²⁾ |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |

Table 310: X20DO4331 - Technical data


| | | |
|---------------------------------|--|--|
| Model number | X20DO4331 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating" | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | |
| Spacing | 12.5 ^{+0.2} mm | |

Table 310: X20DO4331 - Technical data

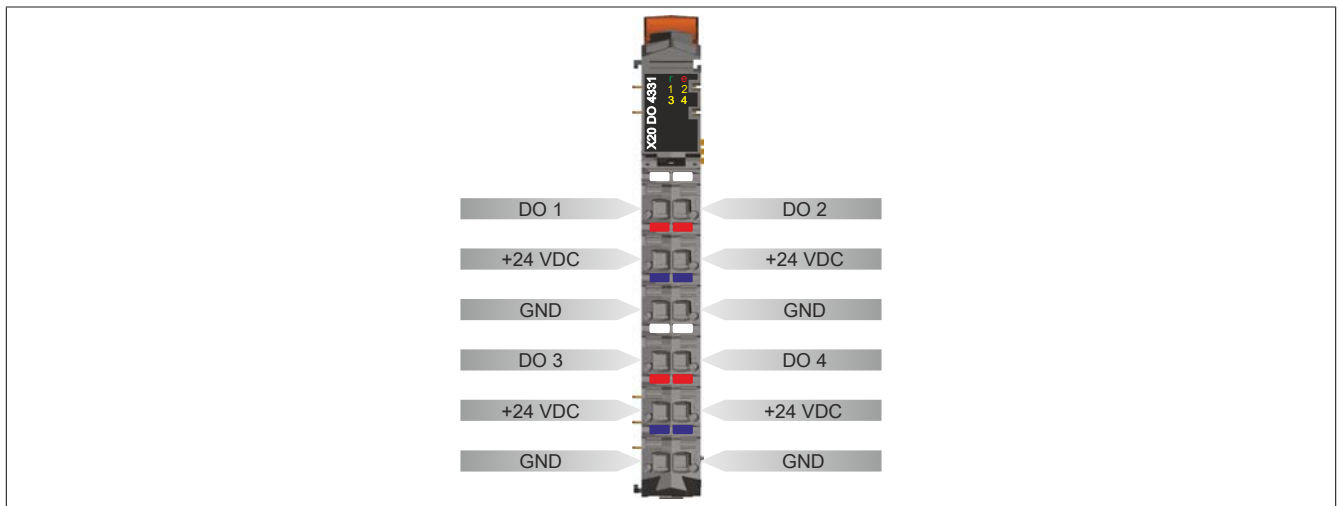
- 1) Number of outputs x $R_{DS(on)}$ x Nominal output current². For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) The power consumption of the sensors connected to the module is not permitted to exceed 12 W.

9.15.9.4 Status LEDs

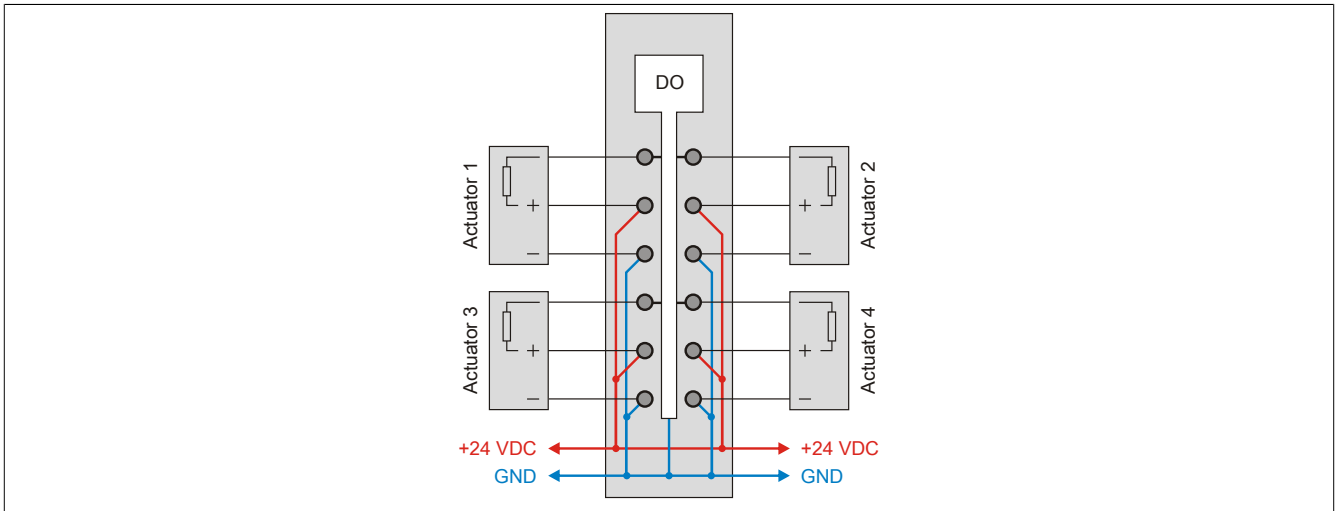
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|--|-------|-----------------------------|----------------------------|---|
|  | r | Green | Off | Module supply not connected |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | | | Flickering (approx. 10 Hz) | The module is in the OSP state. |
| | e | Red | Off | Module supply not connected or everything OK |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1 - 4 | Orange | | Output status of the corresponding digital output |

9.15.9.5 Pinout



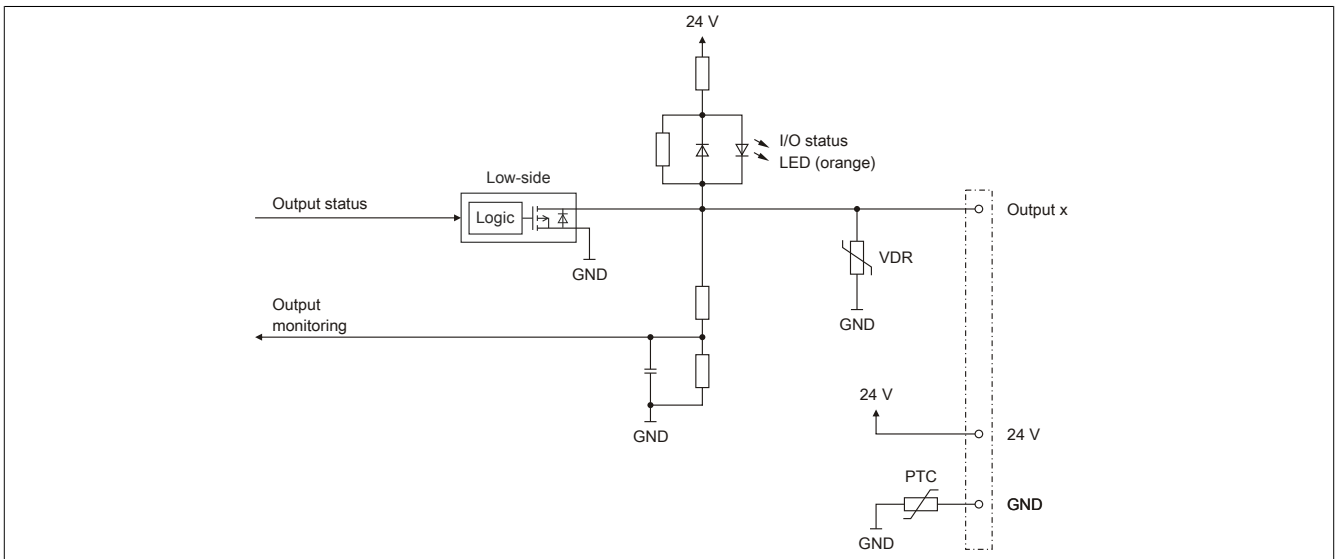
9.15.9.6 Connection example



9.15.9.7 OSP hardware requirements

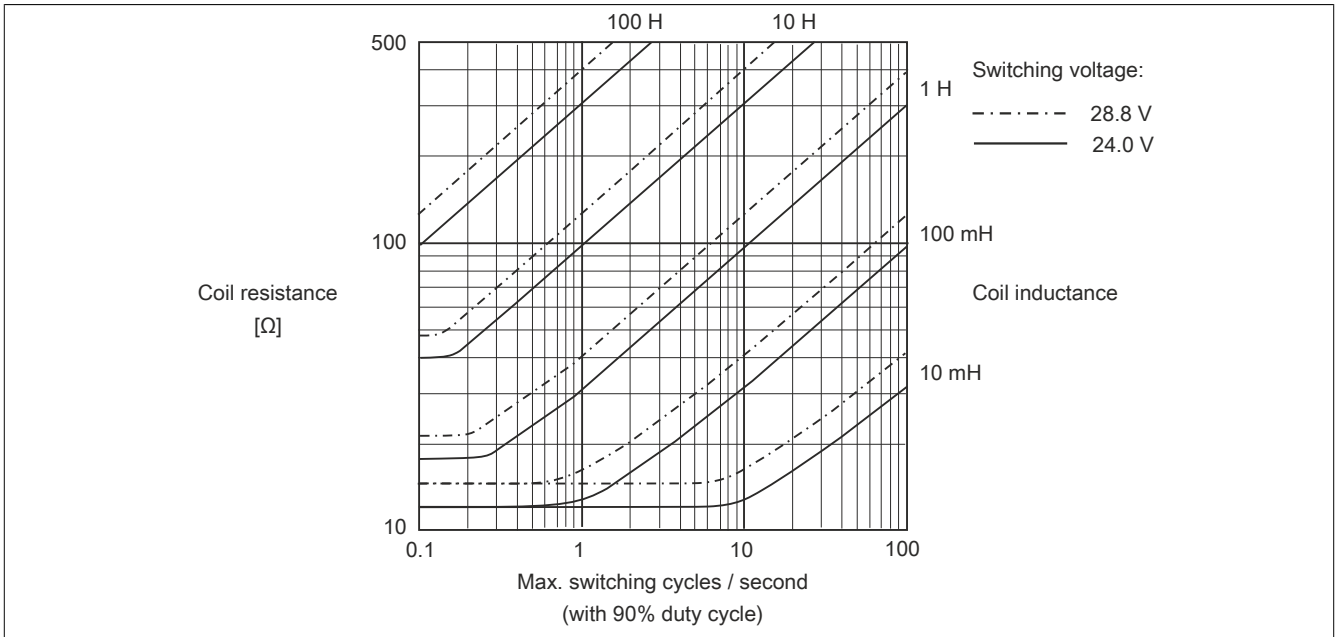
In order to use OSP mode sensibly, it should be ensured that the power supply of the output module and CPU are independent of each other when the application is set up.

9.15.9.8 Output circuit diagram

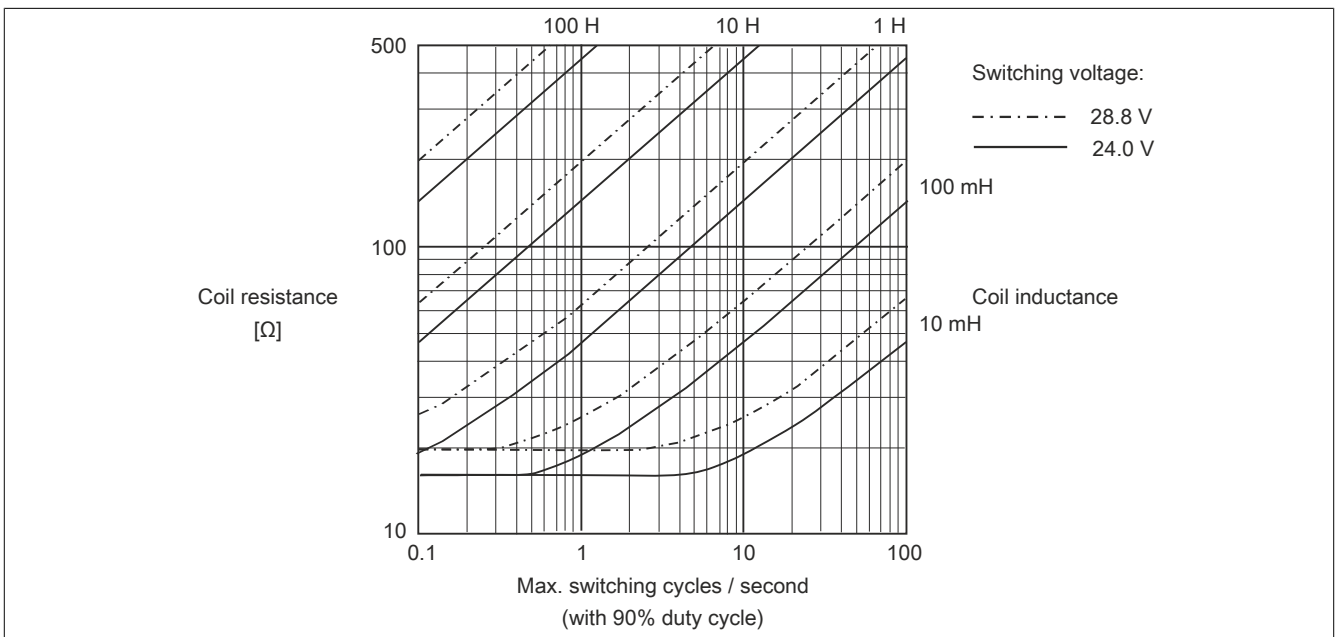


9.15.9.9 Switching inductive loads

Environmental temperature: 40°C, all outputs with the same load.



Environmental temperature: 60°C, all outputs with the same load.



Information:

If the maximum number of operating cycles per second is exceeded, an external inverse diode must be used.

Operating conditions outside of the area in the diagram are not permitted!

9.15.9.10 Derating

The outputs of the X20DO4331 can handle up to 2A. To ensure optimal use of the module, it is important to assign the channels properly, and to keep in mind a potential derating.

The following table provides an overview of the number of fully used channels, the resulting best distribution, and a potential derating.

| Number of channels using 2A | Division | Derating |
|-----------------------------|---|--------------|
| 1 | Any | No |
| 2 | Possible divisions: 1, 3 2, 4 | No |
| 3 | Possible divisions: 1, 2, 4 1, 3, 4 | No |
| 4 | 1 - 4 | All channels |

Table 311: Operation with 2 A

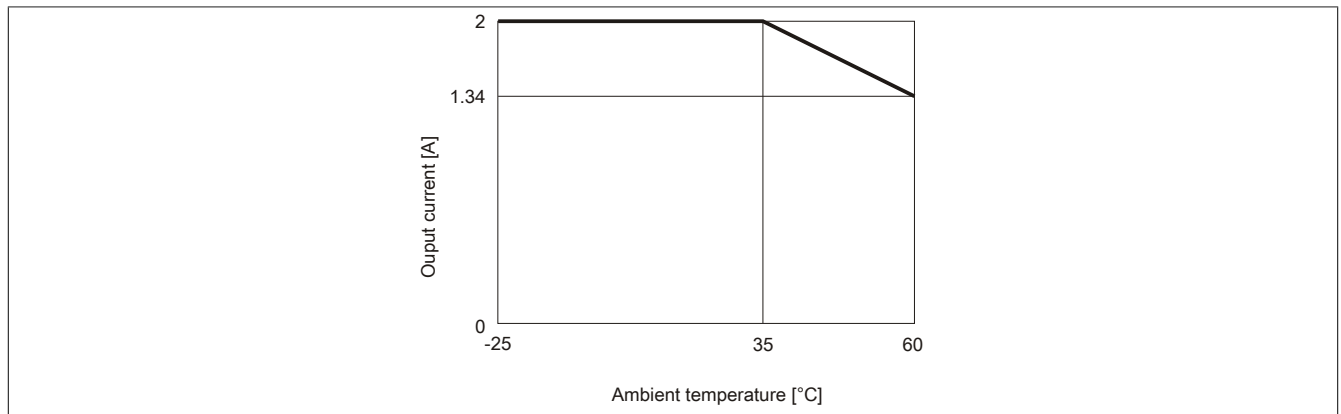


Figure 158: Derating when 4 channels are operated with 2 A

Modules next to the X20DO4331 can have a maximum power dissipation of 1.5 W.

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.

9.15.9.11 Register description

9.15.9.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.15.9.11.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|-----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | DigitalOutput | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput04 | Bit 3 | | | | |
| 30 | 1 | StatusInput01 | USINT | • | | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput04 | Bit 3 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.9.11.3 Function model 1 - OSP

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 4 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput04 | Bit 3 | | | | |
| 30 | 1 | Status of digital outputs 1 to 4 | USINT | • | | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput04 | Bit 3 | | | | |
| 34 | 1 | Enabling OPS output in the module | USINT | | | • | |
| | | OSPValid | Bit 0 | | | | |
| 32 | - | CfgOSPMODE | USINT | | | | • |
| 36 | - | CfgOSPValue | USINT | | | | • |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.9.11.4 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 4 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput04 | Bit 3 | | | | |
| 30 | - | Status of digital outputs 1 to 4 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput04 | Bit 3 | | | | |

1) The offset specifies where the register is within the CAN object.

9.15.9.11.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.9.11.4.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.15.9.11.5 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 µs) based on the network cycle (SyncOut).

9.15.9.11.5.1 Switching state of digital outputs 1 to 4

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput04

This register is used to store the switching state of digital outputs 1 to 4.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Values | Information |
|-----------|------------------------|--|
| USINT | 0 to 15 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 3 | DigitalOutput04 | 0 | Digital output 04 reset |
| | | 1 | Digital output 04 set |

9.15.9.11.6 Monitoring status of the digital outputs

On the module, the output states of the outputs are compared to the target states. The control of the output driver is used for the target state.

A change in the output state resets monitoring for that output. The status of each individual channel can be read. A change in the monitoring status is actively transmitted as an error message.

9.15.9.11.6.1 Status of digital outputs 1 to 4

Name:

StatusInput01

StatusDigitalOutput01 to StatusDigitalOutput04

This register contains the state of digital outputs 1 to 4.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("StatusDigitalOutput01" to "StatusDigitalOutput0x") or whether this register should be displayed as a single USINT data point ("StatusInput01").

| Data type | Values | Information |
|-----------|------------------------|--|
| USINT | 0 to 15 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput01 | 0 | Channel 01: No error |
| | | 1 | Channel 01: <ul style="list-style-type: none"> Short circuit or overload Channel switched on and missing I/O power supply Channel switched off and external voltage applied on channel |
| ... | | ... | |
| 3 | StatusDigitalOutput04 | 0 | Channel 04: No error |
| | | 1 | Channel 04: For an error description, see channel 01. |

9.15.9.11.7 Function model "OSP"

In function model "OSP" (Operator Set Predefined), the user defines an analog value or digital pattern. This OSP value is output as soon as the communication between the module and master is aborted.

Functionality

The user has the choice between 2 OSP modes:

- Retain last valid value
- Replace with static value

In the first case, the module retains the last value recognized as a valid output status.

When selecting mode "Replace with static value", a plausible output value must be entered in the associated value register. When an OSP event occurs, this value is output instead of the value currently requested by the task.

9.15.9.11.7.1 Enabling OPS output in the module

Name:

OSPValid

This data point makes it possible to start the output of the module and request the use of OSP during operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|---|
| 0 | OSPValid | 0 | Request OSP operation (after initial startup or module in stand-by) |
| | | 1 | Request normal operation |
| 1 - 7 | Reserved | 0 | |

Bit OSPValid exists once on the module and is managed by the user task. It must be set to start the enabled channels. As long as bit OSPValid remains set in the module, the module behaves the same as in function model "Standard".

If an OSP event occurs, e.g. communication between the module and master CPU aborted, then bit OSPValid is reset on the module. The module enters the OSP state and output occurs according to the configuration in register "OSPMode" on page 1658.

The following generally applies:

Even after regeneration of the communication channel, the OSP replacement value is still pending. The OSP state is only exited again when a set OSPValid bit is transferred.

When the master CPU is restarted, bit OSPValid bit is reinitialized in the master CPU. It must be set once more by the application and transferred via the bus.

In the event of brief communication errors between the module and master CPU (e.g. due to EMC), the cyclic registers fail to refresh for several bus cycles. Within the module, bit OSPValid is reset; the set bit is retained in the CPU, however. During the next successful transfer, the module-internal OSPValid bit is set again and the module automatically returns to normal operation.

If the task in the master CPU needs the information about which output mode the module is currently in, bit ModulOK can be evaluated.

Warning!

If bit OSPValid bit is reset to "0" by the module, the output status no longer depends on the responsible task in the master CPU. Nevertheless, output is made depending on the configuration of the OSP replacement value.

9.15.9.11.7.2 Setting OSP mode

Name:

CfgOSPMODE

This register controls the behavior of a channel when using OSP.

| Data type | Values | Explanation |
|-----------|--------|---------------------------|
| USINT | 0 | Replace with static value |
| | 1 | Retain last valid value |

9.15.9.11.7.3 Defining an OSP-digital output value

Name:

CfgOSPValue

This register contains the digital output value that is output in "Replace with static value" mode during OSP operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------|--------|--|
| 0 | | 0 or 1 | OSP output value for channel DigitalOutput00 |
| ... | | ... | |
| x | | 0 or 1 | OSP output value for channel DigitalOutput0x |

Warning!

"OSPValue" is only applied by the module if bit "OSPValid" has been set in the module.

9.15.9.11.8 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 µs |

9.15.9.11.9 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|---------------------------------|
| Equal to the minimum cycle time |

9.15.10 X20(c)DO4332

Data sheet version: 3.26

9.15.10.1 General information

The module is equipped with 4 outputs for 3-wire connections. The rated output current is 2 A.

- 4 digital outputs with 2 A
- Source connection
- 3-wire connections
- 24 VDC and GND for actuator supply
- Integrated output protection
- OSP mode

9.15.10.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.15.10.3 Order data

| Model number | Short description | Figure |
|--------------|---|--------|
| | Digital outputs | |
| X20DO4332 | X20 digital output module, 4 outputs, 24 VDC, 2 A, source, 3-wire connections | |
| X20cDO4332 | X20 digital output module, coated, 4 outputs, 24 VDC, 2 A, source, 3-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 312: X20DO4332, X20cDO4332 - Order data

9.15.10.4 Technical data

| Model number | X20DO4332 | X20cDO4332 |
|--|--|------------|
| Short description | | |
| I/O module | 4 digital outputs 24 VDC for 3-wire connections | |
| General information | | |
| B&R ID code | 0x1B9C | 0xE227 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Outputs | Yes, using status LED and software (output error status) | |
| Power consumption | | |
| Bus | 0.16 W | |
| Internal I/O | 0.49 W | |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +1.6 (Rev. <H0: +2.24) | |
| Certifications | | |
| CE | Yes | |
| KC | Yes | - |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| Digital outputs | | |
| Variant | FET positive switching | |
| Nominal voltage | 24 VDC | |
| Switching voltage | 24 VDC -15 % / +20 % | |
| Nominal output current | 2 A | |
| Total nominal current | 8 A (Rev. <H0: 4 A) | |
| Connection type | 3-wire connections | |
| Output circuit | Source | |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short circuit current") Internal inverse diode for switching inductive loads (see section "Switching inductive loads") | |
| Actuator power supply | 0.5 A in total for output-independent actuator supply | |
| Diagnostic status | Output monitoring with 10 ms delay | |
| Leakage current when switched off | 5 µA | |
| R _{DS(on)} | 100 mΩ (Rev. <H0: 140 mΩ) | |
| Peak short-circuit current | <4 A (Rev. <H0: <12 A) | |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms (depends on the module temperature) | |
| Switching delay ²⁾ | | |
| 0 → 1 | <300 µs | |
| 1 → 0 | <300 µs | |
| Switching frequency | | |
| Resistive load ²⁾ | Max. 500 Hz | |
| Inductive load | See section "Switching inductive loads" | |
| Braking voltage when switching off inductive loads | Typ. 50 VDC | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Additional functions | To increase the output current, outputs can be switched in parallel | |
| Actuator power supply | | |
| Voltage | Module supply minus voltage drop for short circuit protection | |
| Voltage drop for short-circuit protection at 500 mA | Max. 2 V | |
| Short-circuit proof | Yes | |
| Power consumption | | |
| Actuator power supply | Max. 12 W ³⁾ | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |

Table 313: X20DO4332, X20cDO4332 - Technical data


| Model number | X20DO4332 | X20cDO4332 |
|---------------------------------|--|---|
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating" | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm | |

Table 313: X20DO4332, X20cDO4332 - Technical data

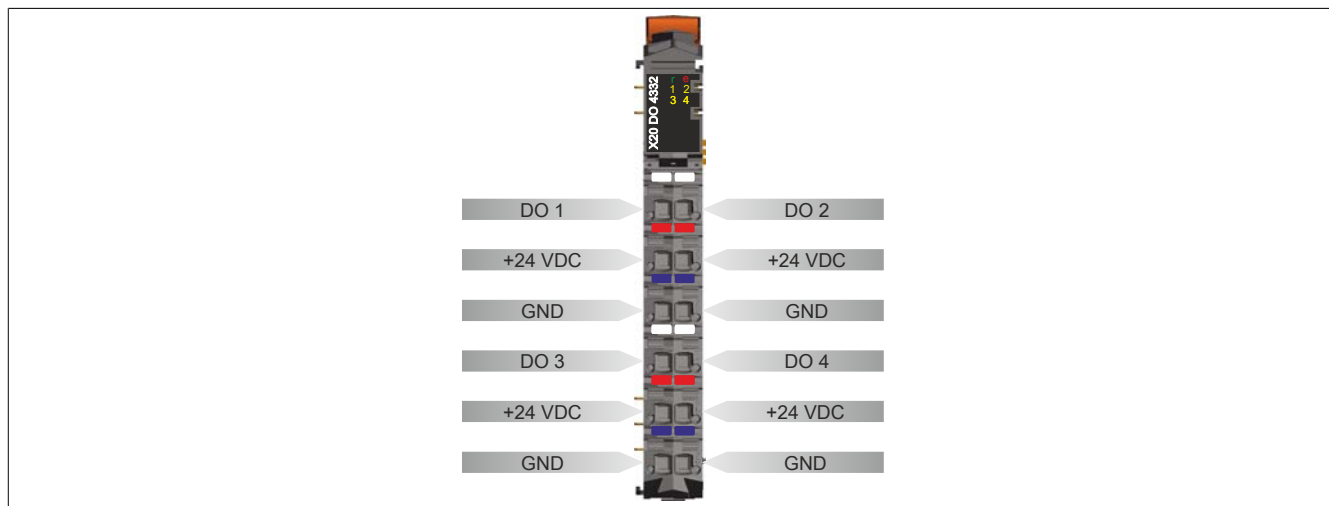
- 1) Number of outputs x $R_{DS(on)}$ x Nominal output current². For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) At loads ≤ 1 k Ω
- 3) The power consumption of the sensors connected to the module is not permitted to exceed 12 W.

9.15.10.5 Status LEDs

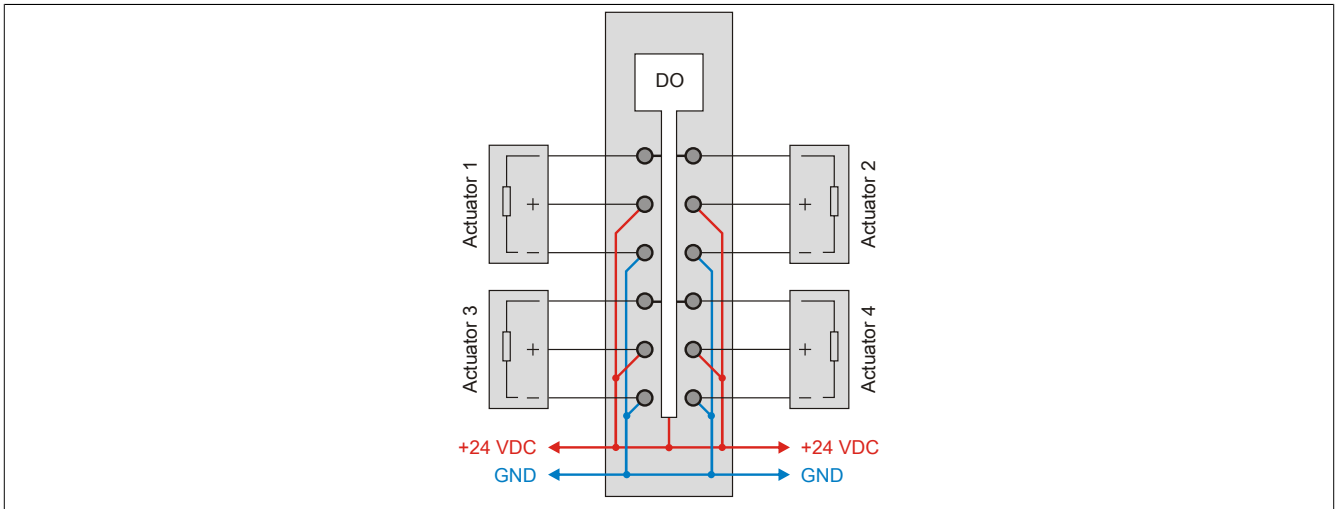
For a description of the various operating modes, see ["Diagnostic LEDs" on page 3787](#).

| Figure | LED | Color | Status | Description | |
|--|-------|-------|-----------------------------|---|---|
|  | r | Green | Off | Module supply not connected | |
| | | | Single flash | RESET mode | |
| | | | Blinking | PREOPERATIONAL mode | |
| | | | On | RUN mode | |
| | | | Flickering (approx. 10 Hz) | The module is in the OSP state. | |
| | e | Red | Off | Module supply not connected or everything OK | |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. | |
| | e + r | | Red on / Green single flash | Invalid firmware | |
| | 1 - 4 | | Orange | | Output status of the corresponding digital output |

9.15.10.6 Pinout



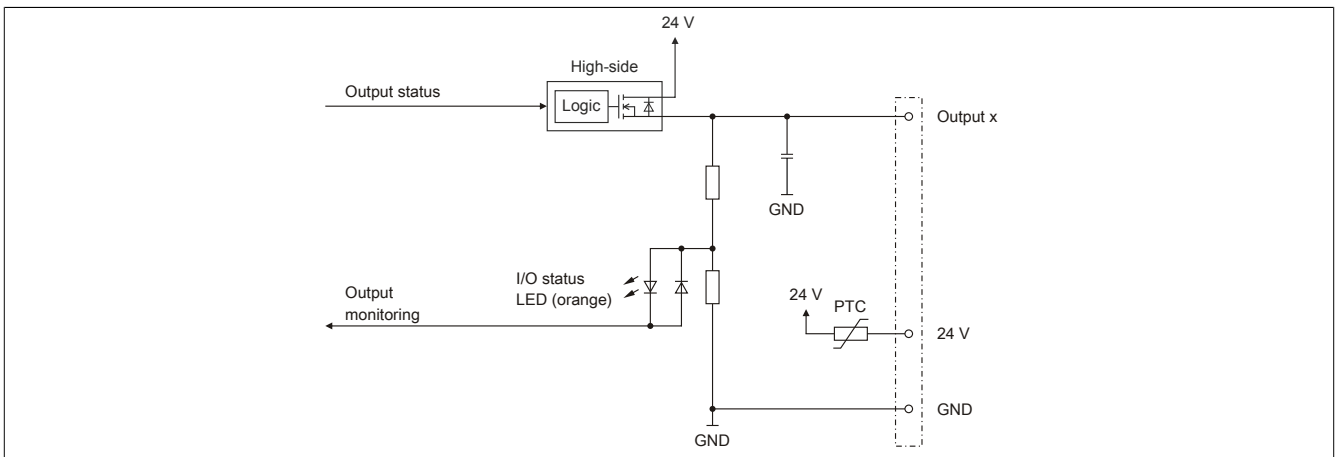
9.15.10.7 Connection example



9.15.10.8 OSP hardware requirements

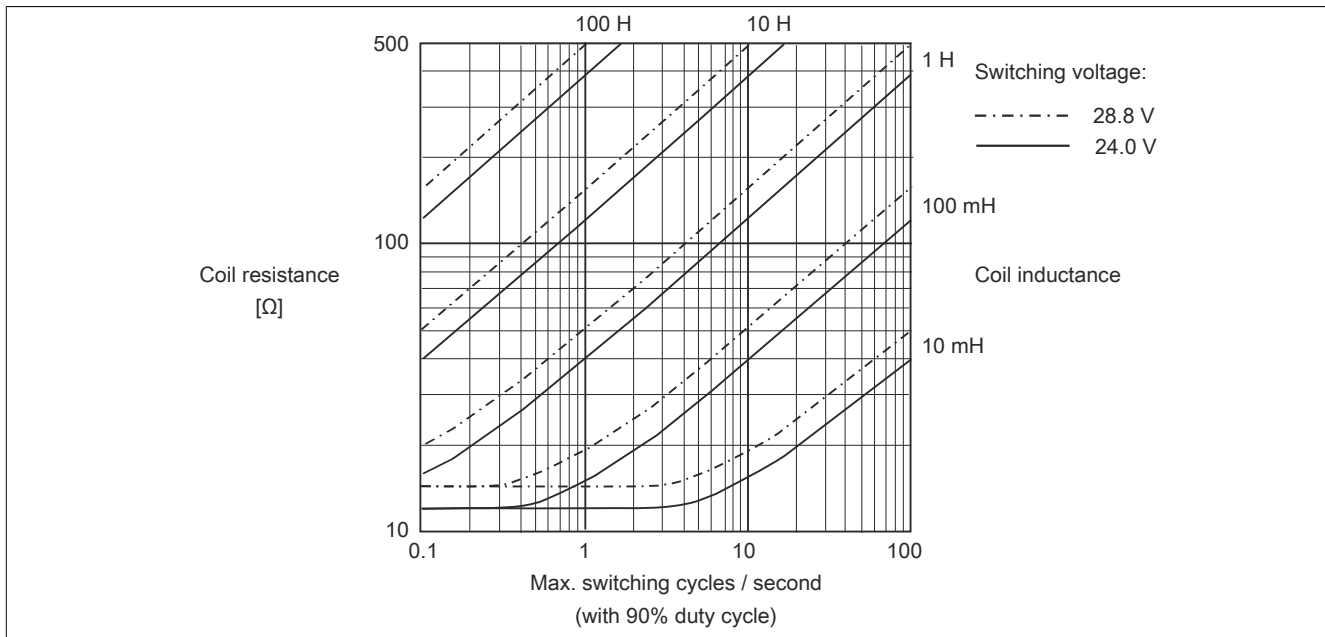
In order to use OSP mode sensibly, it should be ensured that the power supply of the output module and CPU are independent of each other when the application is set up.

9.15.10.9 Output circuit diagram

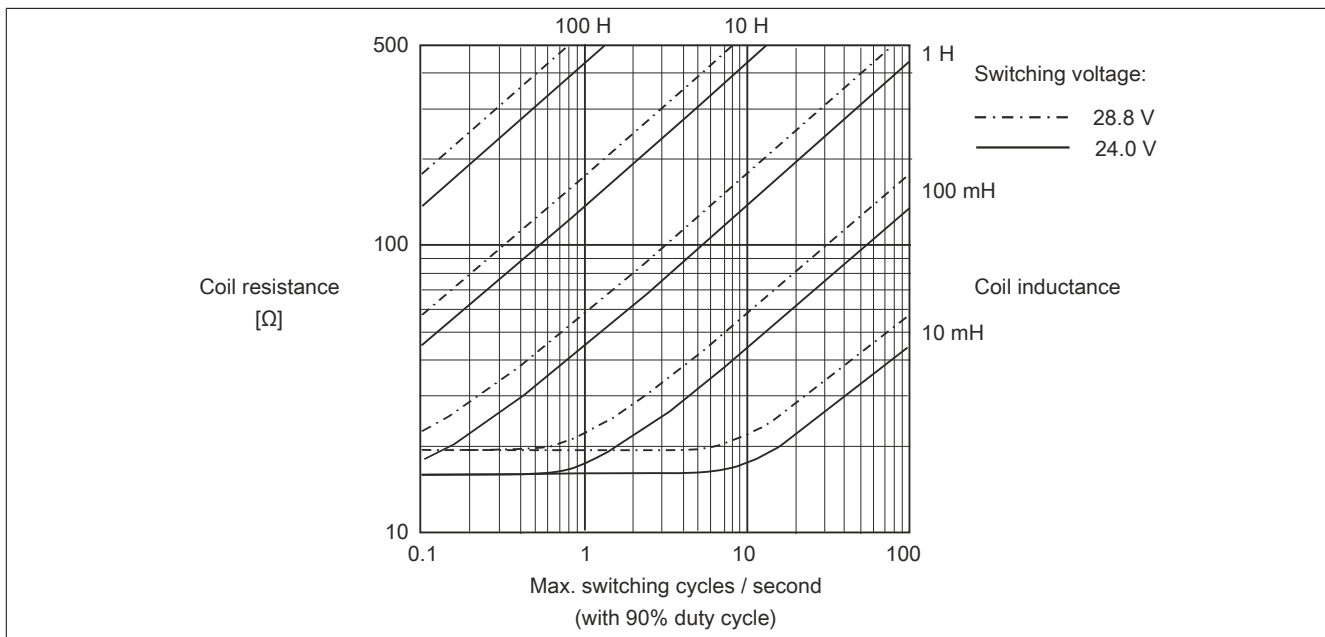


9.15.10.10 Switching inductive loads (Rev. H0 and higher)

Environmental temperature: 50°C, all outputs with the same load.



Environmental temperature: 60°C, all outputs with the same load.

**Information:**

If the maximum number of operating cycles per second is exceeded, an external inverse diode must be used.

Operating conditions outside of the area in the diagram are not permitted!

9.15.10.11 Operation with 2 A

The outputs of the module can handle up to 2 A. With a total current of 4 A, no more than 2 channels are operable at full load. Correct channel assignments are important for achieving optimal use of the module.

The following table provides an overview of the number of fully used channels and the resulting best distribution.

| Number of channels using 2A | Division |
|-----------------------------|--|
| 1 | Any |
| 2 | The following channel numbers can be assigned: 1, 3 1, 4 2, 4 |

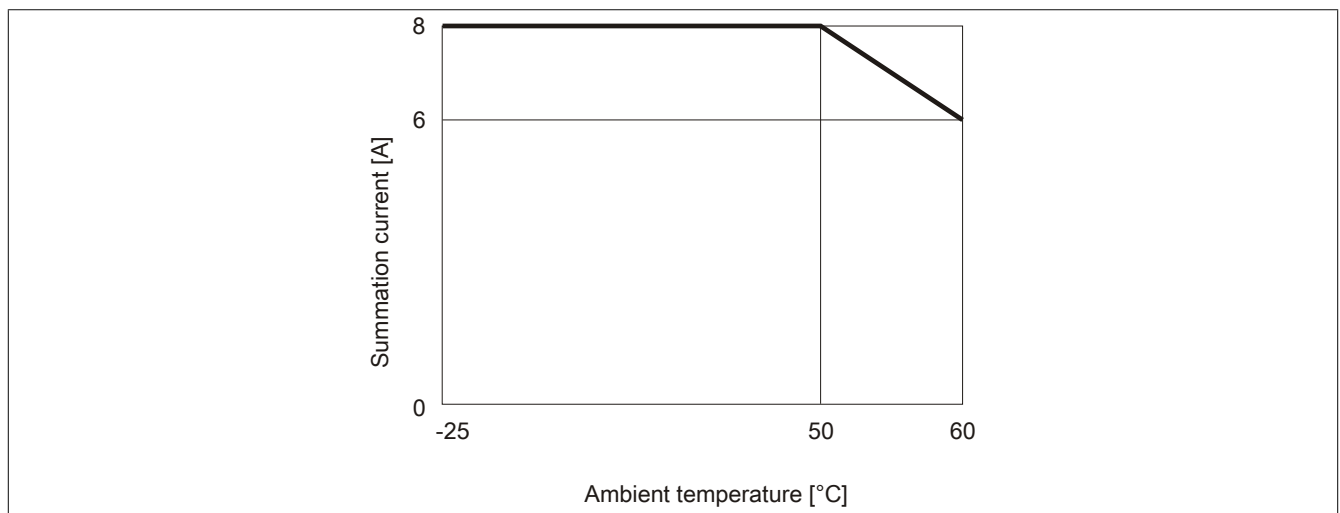
Information:

This section is only valid up to Rev. H0.

9.15.10.12 Derating

During operation over 55°C, the power dissipation of the modules to the left and right of this module is not permitted to exceed 1.15 W!

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.



Information:

This section is valid for Rev. H0 and later.

9.15.10.13 Register description

9.15.10.13.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.15.10.13.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|-----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | DigitalOutput | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput04 | Bit 3 | | | | |
| 30 | 1 | StatusInput01 | USINT | • | | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput04 | Bit 3 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.10.13.3 Function model 1 - OSP

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 4 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput04 | Bit 3 | | | | |
| 30 | 1 | Status of digital outputs 1 to 4 | USINT | • | | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput04 | Bit 3 | | | | |
| 34 | 1 | Enabling OPS output in the module | USINT | | | • | |
| | | OSPValid | Bit 0 | | | | |
| 32 | - | CfgOSPMODE | USINT | | | | • |
| 36 | - | CfgOSPValue | USINT | | | | • |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.10.13.4 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 4 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput04 | Bit 3 | | | | |
| 30 | - | Status of digital outputs 1 to 4 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput04 | Bit 3 | | | | |

1) The offset specifies where the register is within the CAN object.

9.15.10.13.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.10.13.4.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.15.10.13.5 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 µs) based on the network cycle (SyncOut).

9.15.10.13.5.1 Switching state of digital outputs 1 to 4

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput04

This register is used to store the switching state of digital outputs 1 to 4.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Values | Information |
|-----------|------------------------|--|
| USINT | 0 to 15 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 3 | DigitalOutput04 | 0 | Digital output 04 reset |
| | | 1 | Digital output 04 set |

9.15.10.13.6 Monitoring status of the digital outputs

On the module, the output states of the outputs are compared to the target states. The control of the output driver is used for the target state.

A change in the output state resets monitoring for that output. The status of each individual channel can be read. A change in the monitoring status is actively transmitted as an error message.

9.15.10.13.6.1 Status of digital outputs 1 to 4

Name:

StatusInput01

StatusDigitalOutput01 to StatusDigitalOutput04

This register contains the state of digital outputs 1 to 4.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("StatusDigitalOutput01" to "StatusDigitalOutput0x") or whether this register should be displayed as a single USINT data point ("StatusInput01").

| Data type | Values | Information |
|-----------|------------------------|--|
| USINT | 0 to 15 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput01 | 0 | Channel 01: No error |
| | | 1 | Channel 01: <ul style="list-style-type: none"> • Short circuit or overload • Channel switched on and missing I/O power supply • Channel switched off and external voltage applied on channel |
| ... | | ... | |
| 3 | StatusDigitalOutput04 | 0 | Channel 04: No error |
| | | 1 | Channel 04: For an error description, see channel 01. |

9.15.10.13.7 Function model "OSP"

In function model "OSP" (Operator Set Predefined), the user defines an analog value or digital pattern. This OSP value is output as soon as the communication between the module and master is aborted.

Functionality

The user has the choice between 2 OSP modes:

- Retain last valid value
- Replace with static value

In the first case, the module retains the last value recognized as a valid output status.

When selecting mode "Replace with static value", a plausible output value must be entered in the associated value register. When an OSP event occurs, this value is output instead of the value currently requested by the task.

9.15.10.13.7.1 Enabling OPS output in the module

Name:

OSPValid

This data point makes it possible to start the output of the module and request the use of OSP during operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|---|
| 0 | OSPValid | 0 | Request OSP operation (after initial startup or module in stand-by) |
| | | 1 | Request normal operation |
| 1 - 7 | Reserved | 0 | |

Bit OSPValid exists once on the module and is managed by the user task. It must be set to start the enabled channels. As long as bit OSPValid remains set in the module, the module behaves the same as in function model "Standard".

If an OSP event occurs, e.g. communication between the module and master CPU aborted, then bit OSPValid is reset on the module. The module enters the OSP state and output occurs according to the configuration in register "OSPMode" on page 1668.

The following generally applies:

Even after regeneration of the communication channel, the OSP replacement value is still pending. The OSP state is only exited again when a set OSPValid bit is transferred.

When the master CPU is restarted, bit OSPValid bit is reinitialized in the master CPU. It must be set once more by the application and transferred via the bus.

In the event of brief communication errors between the module and master CPU (e.g. due to EMC), the cyclic registers fail to refresh for several bus cycles. Within the module, bit OSPValid is reset; the set bit is retained in the CPU, however. During the next successful transfer, the module-internal OSPValid bit is set again and the module automatically returns to normal operation.

If the task in the master CPU needs the information about which output mode the module is currently in, bit ModulOK can be evaluated.

Warning!

If bit OSPValid bit is reset to "0" by the module, the output status no longer depends on the responsible task in the master CPU. Nevertheless, output is made depending on the configuration of the OSP replacement value.

9.15.10.13.7.2 Setting OSP mode

Name:
CfgOSPMode

This register controls the behavior of a channel when using OSP.

| Data type | Values | Explanation |
|-----------|--------|---------------------------|
| USINT | 0 | Replace with static value |
| | 1 | Retain last valid value |

9.15.10.13.7.3 Defining an OSP-digital output value

Name:
CfgOSPValue

This register contains the digital output value that is output in "Replace with static value" mode during OSP operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------|--------|--|
| 0 | | 0 or 1 | OSP output value for channel DigitalOutput00 |
| ... | | ... | |
| x | | 0 or 1 | OSP output value for channel DigitalOutput0x |

Warning!

"OSPValue" is only applied by the module if bit "OSPValid" has been set in the module.

9.15.10.13.8 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 µs |

9.15.10.13.9 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|---------------------------------|
| Equal to the minimum cycle time |

9.15.11 X20DO4332-1

Data sheet version: 1.01

9.15.11.1 General information

The module is equipped with 4 outputs for 3-wire connections. The nominal output current is 2 A.

- 4 digital outputs with 2 A
- Source circuit
- 3-wire connections
- 24 VDC and GND for actuator power supply
- Integrated output protection
- OSP mode
- PWM mode

9.15.11.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Digital outputs |  |
| X20DO4332-1 | X20 digital output module, 4 outputs, 24 VDC, 2 A, source, 3-wire connections, PWM output | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 314: X20DO4332-1 - Order data

9.15.11.3 Technical data

| Model number | X20DO4332-1 |
|--|---|
| Short description | |
| I/O module | 4 digital outputs 24 VDC for 3-wire connections |
| General information | |
| B&R ID code | 0xF5F9 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| Outputs | Yes, using LED status indicator and software (output error status) |
| Power consumption | |
| Bus | 0.16 W |
| Internal I/O | 0.49 W |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +1.6 |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| Digital outputs | |
| Variant | FET positive switching |
| Nominal voltage | 24 VDC |
| Switching voltage | 24 VDC -15% / +20% |
| Nominal output current | 2 A |
| Total nominal current | 8 A |
| Connection type | 3-wire connections |
| Output circuit | Source |
| Output protection | Thermal shutdown in the event of overcurrent or short circuit (see value "Short-circuit peak current") Internal freewheeling diode for switching inductive loads |
| Actuator power supply | 0.5 A in total for output-independent actuator power supply |
| Diagnostic status | Output monitoring with 10 ms delay |
| Leakage current when the power is switched off | 5 µA |

Table 315: X20DO4332-1 - Technical data


| Model number | X20DO4332-1 |
|---|---|
| $R_{DS(on)}$ | 100 m Ω |
| Peak short-circuit current | <4 A |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms (depends on the module temperature) |
| Switching delay ²⁾ | |
| 0 \rightarrow 1 | <300 μ s |
| 1 \rightarrow 0 | <300 μ s |
| Switching frequency | |
| Resistive load ²⁾ | Max. 500 Hz |
| Braking voltage when switching off inductive loads | 0.6 V ³⁾ |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Additional functions | Outputs can be connected in parallel to increase the output current. ⁴⁾ |
| PWM output | |
| Quantity | 4 |
| Nominal voltage | 24 VDC |
| Nominal current | 2 A |
| PWM frequency | 30.5 to 1000 Hz |
| Output protection | Thermal shutdown in the event of overcurrent or short circuit (see value "Short-circuit peak current") Internal freewheeling diode for switching inductive loads |
| Variant | FET positive switching |
| Configurable dither | 0 to 250 Hz, 1 to 25% of the period duration |
| Period duration resolution | 1000 to 65535 μ s in 1 μ s steps |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Actuator power supply | |
| Voltage | Module power supply minus voltage drop for short-circuit protection |
| Voltage drop for short-circuit protection at 500 mA | Max. 2 V |
| Short-circuit proof | Yes |
| Power consumption | |
| Actuator power supply | Max. 12 W ⁵⁾ |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating". |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x bus module X20BM11 separately. |
| Pitch | 12.5 ^{+0.2} mm |

Table 315: X20DO4332-1 - Technical data

- 1) Number of outputs x $R_{DS(on)}$ x Nominal output current²⁾. For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) At loads \leq 1 k Ω .
- 3) Due to the freewheeling diode integrated in the module.
- 4) A parallel connection is not possible in PWM mode.
- 5) The power consumption of the sensors connected to the module is not permitted to exceed 12 W.

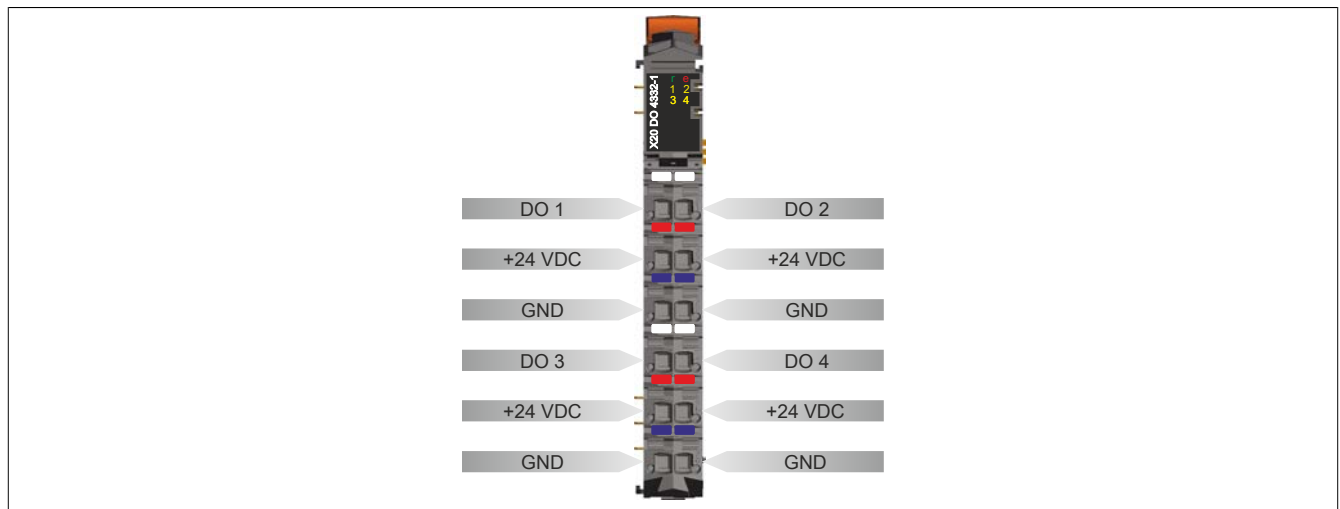
9.15.11.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

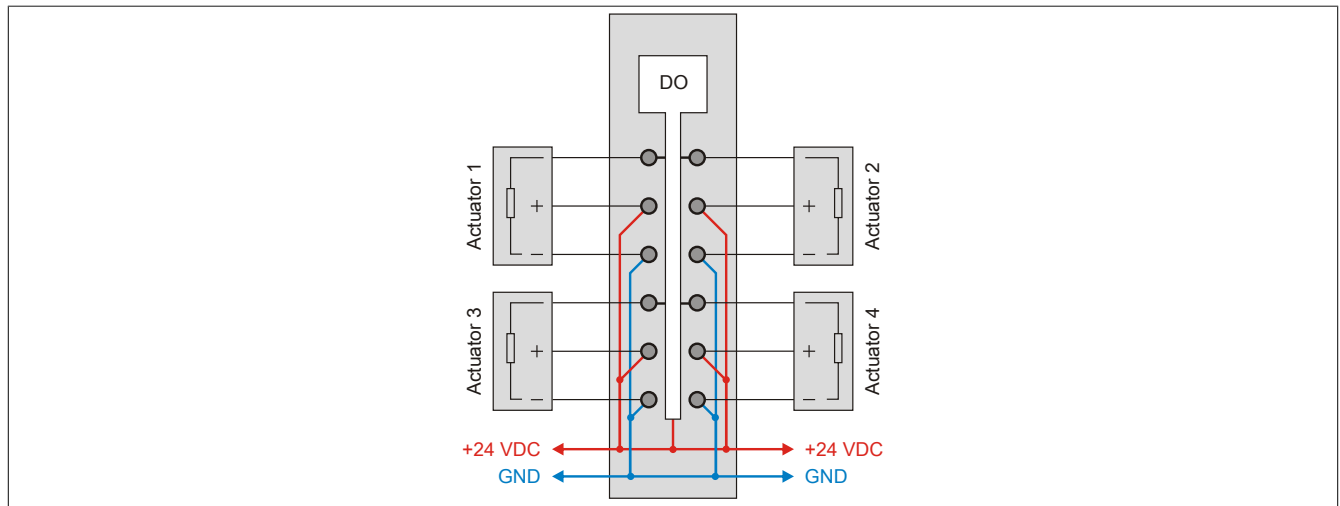
| Figure | LED | Color | Status | Description |
|---|-------|--------------------------------|----------------------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | Mode RESET |
| | | | Blinking | Mode PREOPERATIONAL |
| | | | On | Mode RUN |
| | | | Flickering (approx. 10 Hz) | The module is in the OSP state. |
| | e | Red | Off | Module not supplied with power or everything OK |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. |
| | e + r | Solid red / Single green flash | Invalid firmware | |
| | 1 - 4 | Orange | | Output state of the corresponding digital output. ¹⁾ |

1) Die Helligkeit der Anzeige kann sich im PWM-Modus abhängig von Frequenz und Tastverhältnis ändern.

9.15.11.5 Pinout



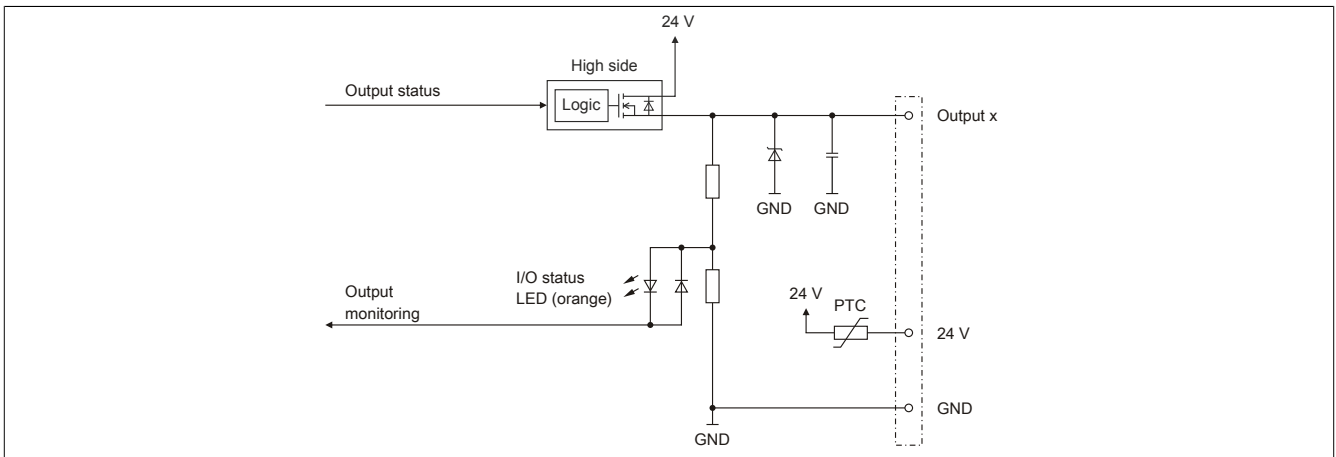
9.15.11.6 Connection example



9.15.11.7 OSP hardware requirements

In order to use OSP mode sensibly, it should be ensured that the power supply of the output module and CPU are independent of each other when the application is set up.

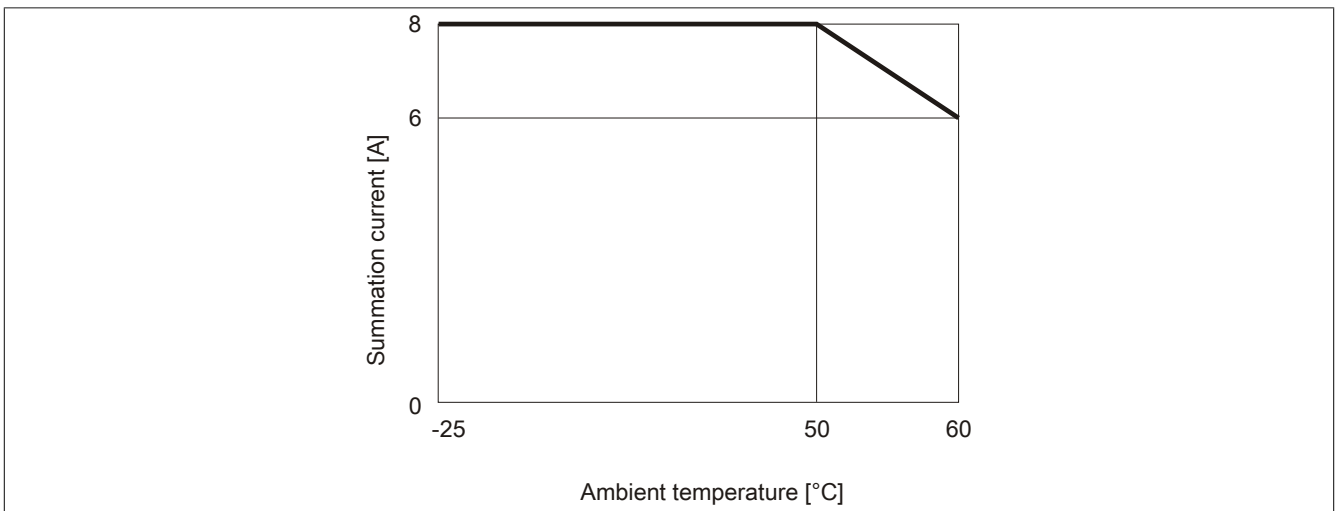
9.15.11.8 Output circuit diagram



9.15.11.9 Derating

During operation over 55°C, the power dissipation of the modules to the left and right of this module is not permitted to exceed 1.15 W!

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.



9.15.11.10 Register description

9.15.11.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.15.11.10.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|-----------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Communication | | | | | | |
| 2 | DigitalOutput | USINT | | | • | |
| | DigitalOutput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalOutput04 | Bit 3 | | | | |
| 30 | StatusInput01 | USINT | • | | | |
| | StatusDigitalOutput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | StatusDigitalOutput04 | Bit 3 | | | | |

9.15.11.10.3 Function model 1 - OSP

| Register | Name | Data type | Read | | Write | |
|----------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 32 | CfgOSPMODE | USINT | | (•) | | • |
| 36 | CfgOSPValue | USINT | | (•) | | • |
| Communication | | | | | | |
| 2 | Switching state of digital outputs 1 to 4 | USINT | | | • | |
| | DigitalOutput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalOutput04 | Bit 3 | | | | |
| 30 | Status of digital outputs 1 to 4 | USINT | • | | | |
| | StatusDigitalOutput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | StatusDigitalOutput04 | Bit 3 | | | | |
| 34 | Enabling OPS output in the module | USINT | | | • | |
| | OSPValid | Bit 0 | | | | |

9.15.11.10.4 Function model 3 - PWM

| Register | Name | Data type | Read | | Write | |
|----------------------|--------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 26 | CfgDitherFrequency | USINT | | | | • |
| 28 | CfgDitherAmplitude | USINT | | | | • |
| Communication | | | | | | |
| 2 * N + 2 | PwmOutput0N (index N = 1 to 4) | INT | | | • | |
| 12 | PwmPeriode | UINT | | | • | |
| 30 | StatusInput01 | USINT | • | | | |
| | StatusDigitalOutput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | StatusDigitalOutput04 | Bit 3 | | | | |

9.15.11.10.5 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 12 | - | PwmPeriode | UINT | | | | • |
| 26 | - | CfgDitherFrequency | USINT | | | | • |
| 28 | - | CfgDitherAmplitude | USINT | | | | • |
| Communication | | | | | | | |
| 2 * N + 2 | 2 * N | PwmOutput0N (index N = 1 to 4) | INT | | | • | |
| 30 | - | StatusInput01 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput04 | Bit 3 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.15.11.10.5.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.11.10.5.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.15.11.10.6 Digital outputs

The output status is transferred to the output channels with a fixed offset in relation to the network cycle (SyncOut).

9.15.11.10.6.1 Switching state of digital outputs 1 to 4

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput04

This register is used to store the switching state of digital outputs 1 to 4.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Values | Information |
|-----------|------------------------|--|
| USINT | 0 to 15 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 3 | DigitalOutput04 | 0 | Digital output 04 reset |
| | | 1 | Digital output 04 set |

9.15.11.10.7 Monitoring status of the digital outputs

On the module, the output states of the outputs are compared to the target states. The control of the output driver is used for the target state.

A change in the output state resets monitoring for that output. The status of each individual channel can be read. A change in the monitoring status is actively transmitted as an error message.

9.15.11.10.7.1 Status of digital outputs 1 to 4

Name:

StatusInput01

StatusDigitalOutput01 to StatusDigitalOutput04

This register contains the state of digital outputs 1 to 4.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("StatusDigitalOutput01" to "StatusDigitalOutput0x") or whether this register should be displayed as a single USINT data point ("StatusInput01").

| Data type | Values | Information |
|-----------|------------------------|--|
| USINT | 0 to 15 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | | Value | Information |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput01 | 0 | Channel 01: No error |
| | | 1 | Channel 01: <ul style="list-style-type: none"> • Short circuit or overload • Channel switched on and missing I/O power supply • Channel switched off and external voltage applied on channel |
| ... | | ... | |
| 3 | StatusDigitalOutput04 | 0 | Channel 04: No error |
| | | 1 | Channel 04: For an error description, see channel 01. |

9.15.11.10.8 Function model "OSP"

In function model "OSP" (Operator Set Predefined), the user defines an analog value or digital pattern. This OSP value is output as soon as the communication between the module and master is aborted.

Functionality

The user has the choice between 2 OSP modes:

- Retain last valid value
- Replace with static value

In the first case, the module retains the last value recognized as a valid output status.

When selecting mode "Replace with static value", a plausible output value must be entered in the associated value register. When an OSP event occurs, this value is output instead of the value currently requested by the task.

9.15.11.10.8.1 Enabling OPS output in the module

Name:

OSPValid

This data point makes it possible to start the output of the module and request the use of OSP during operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|---|
| 0 | OSPValid | 0 | Request OSP operation (after initial startup or module in stand-by) |
| | | 1 | Request normal operation |
| 1 - 7 | Reserved | 0 | |

Bit OSPValid exists once on the module and is managed by the user task. It must be set to start the enabled channels. As long as bit OSPValid remains set in the module, the module behaves the same as in function model "Standard".

If an OSP event occurs, e.g. communication between the module and master CPU aborted, then bit OSPValid is reset on the module. The module enters the OSP state and output occurs according to the configuration in register "OSPMode" on page 1677.

The following generally applies:

Even after regeneration of the communication channel, the OSP replacement value is still pending. The OSP state is only exited again when a set OSPValid bit is transferred.

When the master CPU is restarted, bit OSPValid bit is reinitialized in the master CPU. It must be set once more by the application and transferred via the bus.

In the event of brief communication errors between the module and master CPU (e.g. due to EMC), the cyclic registers fail to refresh for several bus cycles. Within the module, bit OSPValid is reset; the set bit is retained in the CPU, however. During the next successful transfer, the module-internal OSPValid bit is set again and the module automatically returns to normal operation.

If the task in the master CPU needs the information about which output mode the module is currently in, bit ModulOK can be evaluated.

Warning!

If bit OSPValid bit is reset to "0" by the module, the output status no longer depends on the responsible task in the master CPU. Nevertheless, output is made depending on the configuration of the OSP replacement value.

9.15.11.10.8.2 Setting OSP mode

Name:

CfgOSPMode

This register controls the behavior of a channel when using OSP.

| Data type | Values | Explanation |
|-----------|--------|---------------------------|
| USINT | 0 | Replace with static value |
| | 1 | Retain last valid value |

9.15.11.10.8.3 Defining an OSP-digital output value

Name:

CfgOSPValue

This register contains the digital output value that is output in "Replace with static value" mode during OSP operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------|--------|--|
| 0 | | 0 or 1 | OSP output value for channel DigitalOutput00 |
| ... | | ... | |
| x | | 0 or 1 | OSP output value for channel DigitalOutput0x |

Warning!

"OSPValue" is only applied by the module if bit "OSPValid" has been set in the module.

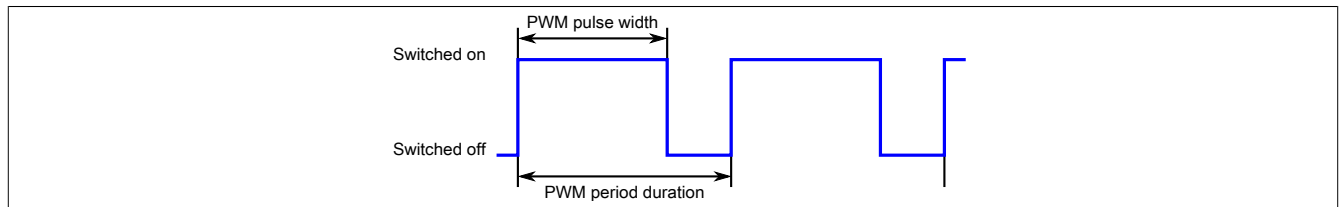
9.15.11.10.9 Function model "PWM"

9.15.11.10.9.1 Pulse width

Name:

PwmOutput01 to PwmOutput04

In this register, the PWM pulse width is specified as a percentage of the period duration. At the beginning of each period, the output is switched on for the percentage of time set in this register.



| Data type | Values | Information |
|-----------|------------|----------------------------------|
| INT | 0 to 32767 | 0 to 100% of the period duration |

9.15.11.10.9.2 Period duration

Name:

PwmPeriode

In this register, the PWM period duration is specified in μs .

| Data type | Values | Information |
|-----------|---------------|----------------------------------|
| UINT | 0 | PWM disabled |
| | 1000 to 65535 | Period duration in μs |

9.15.11.10.9.3 Dither

When the position setpoint for valves remains constant for a long period of time, especially in fluids, there is a risk that a valve will stick. This is normally prevented using "dithering". When doing so, the value is permitted to slightly oscillate around the position setpoint.

By default, dither is active for all outputs as soon as the following conditions are met:

- **Dither amplitude** and **dither frequency** are set to a value greater than 0.
- **Pulse width** is set to a value greater than 0 and less than 32767.

Dither is enabled or disabled for all outputs together.

Dither frequency

Name:

CfgDitherFrequency

The dither frequency for all 4 channels can be specified together in this register.

| Data type | Values | Information |
|-----------|----------|----------------------------|
| USINT | 0 to 250 | Corresponds to 0 to 250 Hz |

Dither amplitude

Name:

CfgDitherAmplitude

In this register, the change of the **pulse width** caused by the dither can be specified for all 4 channels together as a percentage. The change takes place in both the positive and negative direction.

If the **pulse width** is adjusted, the dithering is reset and reapplied in the direction of the change.

Example

Set **period duration**: 2000 μ s

DitherAmplitude: 10%

Result: The set pulse width oscillates by $\pm 100 \mu$ s (200μ s / 2).

| Data type | Values | Information |
|-----------|---------|---------------------------------|
| USINT | 0 | No dither |
| | 1 to 25 | 1 to 25% of the period duration |

9.15.11.10.10 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 250 μ s |

9.15.11.10.11 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|---------------------------------|
| Equal to the minimum cycle time |

9.15.12 X20DO4529

Data sheet version: 3.16

9.15.12.1 General information

The module is equipped with 4 relay outputs.

- 4 digital outputs
- Relay module for 115 VAC
- 4 change over contacts
- Single-channel isolated outputs

Danger!

Risk of electric shock!

The terminal block must only be allowed to conduct voltage when it is inserted. It must not under any circumstances be removed or inserted when voltage is applied or have voltage applied to it when it is removed.

Danger!

Die Spannungsclassen auf der Feldklemme dürfen nicht vermisch werden! Es ist ausschließlic der Betrieb bei Netzspannung (z. B. 115 VAC) ODER bei Sicherheitskleinspannung (z. B. 24 VDC SELV) erlaubt.

9.15.12.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Digital outputs |  |
| X20DO4529 | X20 digital output module, 4 relays, changeover contacts, 115 VAC / 0.5 A, 24 VDC / 1 A | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 316: X20DO4529 - Order data

9.15.12.3 Technical data

| Model number | X20DO4529 |
|--|--|
| Short description | |
| I/O module | 4 digital outputs 30 VDC / 115 VAC, outputs are single-channel isolated |
| General information | |
| B&R ID code | 0x20D9 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Outputs | Yes, using status LED |
| Power consumption | |
| Bus | 0.8 W |
| Internal I/O | - |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +0.3 |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 |
| HazLoc | Industrial control equipment cCSAus 244665 |
| ATEX | Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Digital outputs | |
| Variant | Relay / Changeover contact Channels are single-channel isolated |
| Nominal voltage | 30 VDC / 115 VAC |
| Max. voltage | 125 VAC |
| Switching voltage | Max. 110 VDC / 125 VAC |
| Rated frequency | DC / 45 to 63 Hz |
| Nominal output current | 1 A at 30 VDC / 0.5 A at 115 VAC |
| Total nominal current | 4 A at 30 VDC / 2 A at 115 VAC |
| Actuator power supply | External |
| Inrush current | Max. 2 A (per channel) |
| Contact resistance | 75 mΩ at 6 VDC / 1A |
| Switching delay | |
| 0 → 1 | ≤4 ms |
| 1 → 0 | ≤4 ms |
| Isolation voltages | |
| Channel - Bus | Tested at 1500 VAC |
| Channel - Channel | Tested at 1000 VAC |
| Service life | |
| Electrical ²⁾ | Min. 100 x 10 ³ ops. |
| Mechanical | Min. 50 x 10 ⁶ ops. (3 Hz) |
| Switching capacity | |
| Minimum | 0.01 mA / 10 mV DC |
| Maximum | 30 W / 62.5 VA |
| Protective circuit | |
| Internal | None |
| External | |
| AC | RC combination or VDR |
| DC | Inverse diode, RC combination or VDR |
| Electrical properties | |
| Electrical isolation | Channel isolated from channel and bus |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |

Table 317: X20DO4529 - Technical data


| | | |
|---------------------------------|--|--|
| Model number | X20DO4529 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | |
| Spacing | 12.5 ^{+0.2} mm | |

Table 317: X20DO4529 - Technical data

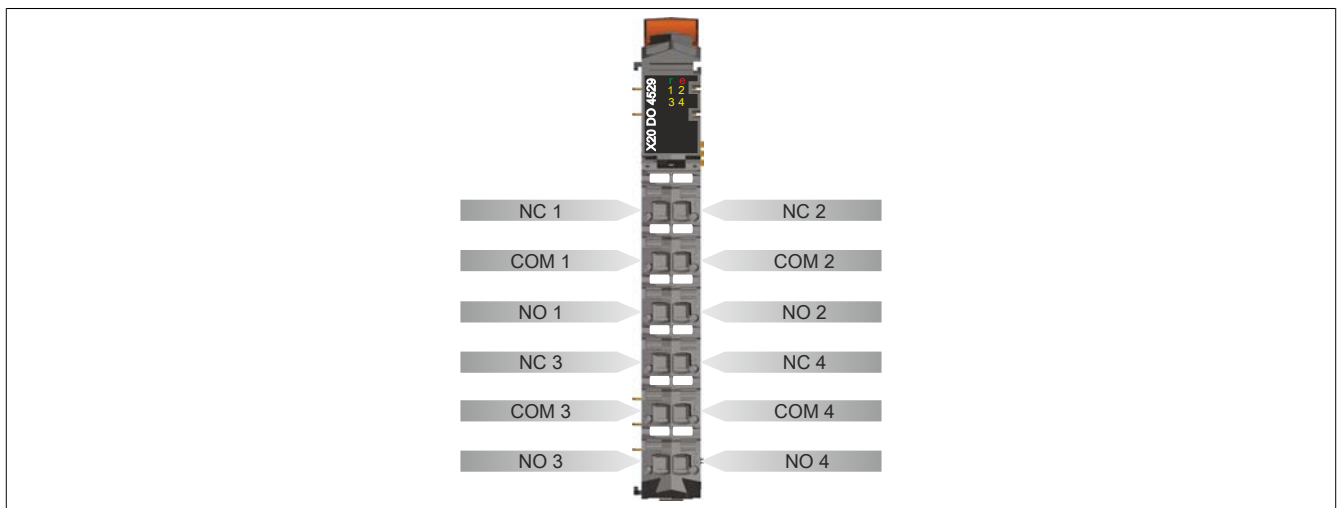
- Number of outputs x Contact resistance x Nominal output current². For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- With a resistive load. See also section "Electrical service life"

9.15.12.4 Status LEDs

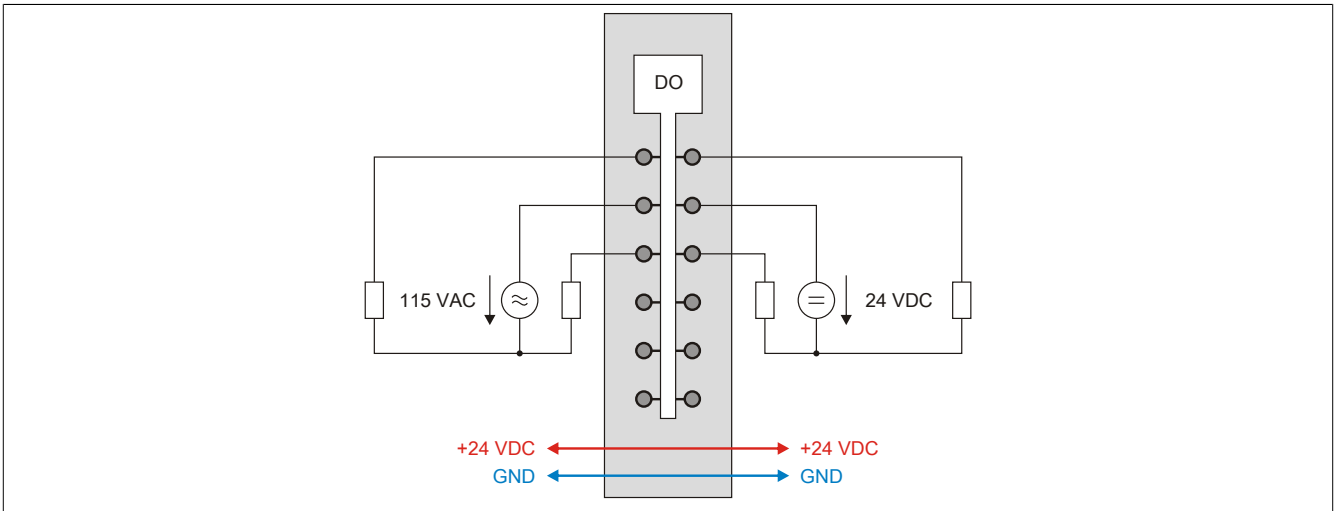
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|--|-------|-------|-----------------------------|--|
|  | r | Green | Off | Module supply not connected |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | Module supply not connected or everything OK |
| | | | On | Error or reset status |
| | e + r | | Red on / Green single flash | Invalid firmware |
| | 1 - 4 | | Orange | |

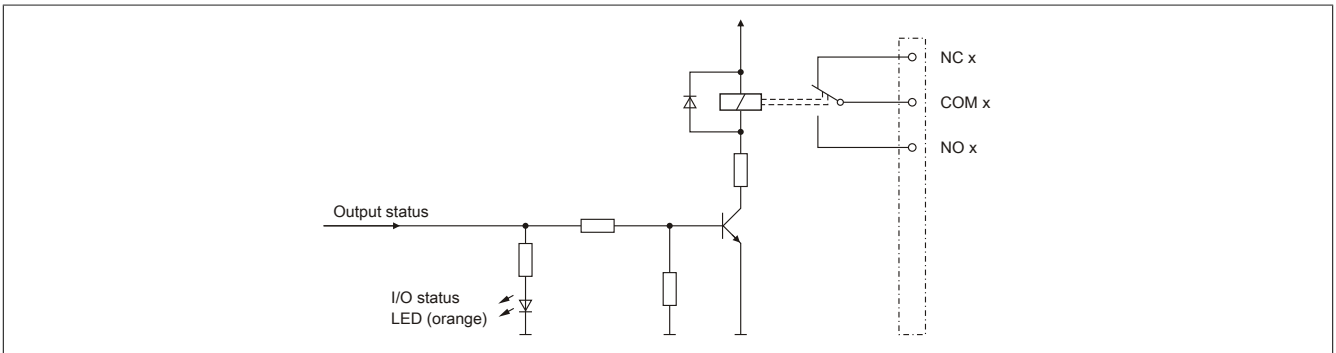
9.15.12.5 Pinout



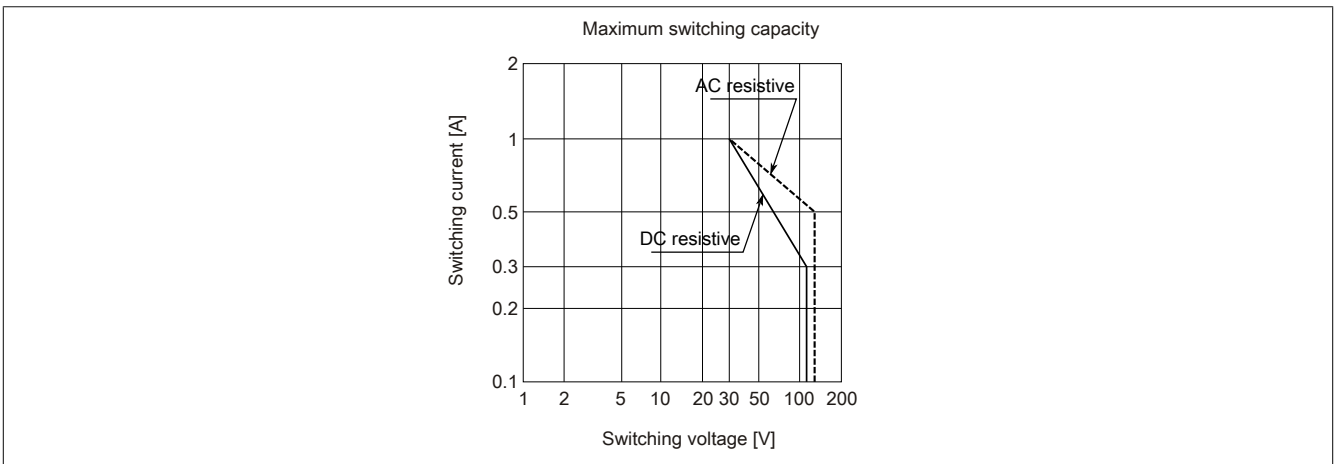
9.15.12.6 Connection example

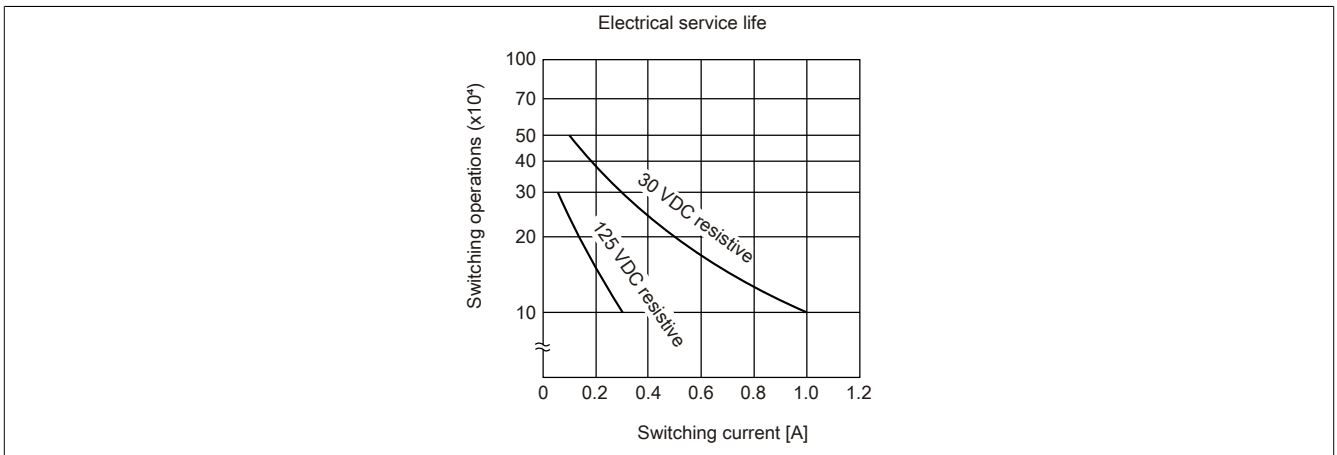


9.15.12.7 Output circuit diagram



9.15.12.8 Maximum switching power



9.15.12.9 Electrical service life

9.15.12.10 Register description

9.15.12.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.15.12.10.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|-------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | DigitalOutput | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput04 | Bit 3 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.12.10.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 4 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput04 | Bit 3 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.15.12.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.12.10.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.15.12.10.4 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 μ s) based on the network cycle (SyncOut).

9.15.12.10.4.1 Switching state of digital outputs 1 to 4

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput04

This register is used to store the switching state of digital outputs 1 to 4.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Values | Information |
|-----------|------------------------|---|
| USINT | 0 to 15 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model \neq 0 - Standard. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 3 | DigitalOutput04 | 0 | Digital output 04 reset |
| | | 1 | Digital output 04 set |

9.15.12.10.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.15.12.10.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|---------------------------------|
| Equal to the minimum cycle time |

9.15.13 X20DO4613

Data sheet version: 2.42

9.15.13.1 General information

The module is a digital output module that is equipped with 4 opto-triac outputs using phase-angle control. L and N are fed to the module for zero-crossing detection.

The 4 outputs are electrically isolated from one another and are used for controlling external power triacs or non-parallel thyristors.

- 4 digital outputs
- Controls external power triacs or non-parallel thyristors
- Outputs with 48 - 240 VAC
- 50 Hz or 60 Hz
- Outputs electrically isolated from one another
- Phase-angle control
- Zero-crossing detection
- Negative half-waves can be switched off
- 2-wire connections
- 240 V coding
- OSP mode
- Frequency mode

Danger!

Risk of electric shock!

The terminal block is only permitted to conduct voltage when it is connected. It is not permitted to be disconnected or connected while voltage is applied or have voltage applied to it while it is removed under any circumstances.

This module is not permitted to be the last module connected on the X2X Link network. At least one subsequent X20ZF dummy module must provide protection against contact.

9.15.13.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Digital outputs |  |
| X20DO4613 | X20 digital output module, 4 triac coupler outputs, 48 to 240 VAC, 50 mA, zero-crossing detection, 240 V keyed | |
| | Required accessories | |
| | Bus modules | |
| X20BM12 | X20 bus module, 240 VAC keyed, internal I/O power supply connected through | |
| | Terminal blocks | |
| X20TB32 | X20 terminal block, 12-pin, 240 VAC keyed | |
| | | |
| | | |
| | | |

Table 318: X20DO4613 - Order data

9.15.13.3 Technical data

| | |
|--|---|
| Model number | X20DO4613 |
| Short description | |
| I/O module | 4 digital outputs for controlling external power triacs or non-parallel thyristors |
| General information | |
| B&R ID code | 0xAD05 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| Outputs | Yes, using LED status indicator |
| Power consumption | |
| Bus | 0.8 W |
| Internal I/O | - |
| External I/O | - |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +1 W |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| Digital outputs | |
| Variant | Opto-triac |
| Circuit | Normally open contact |
| Nominal voltage | 48 to 240 VAC |
| Max. voltage | 264 VAC |
| Rated frequency | 47 to 63 Hz |
| Nominal current at 25°C | |
| Nominal output current | 80 mA |
| Total nominal current | 320 mA |
| Current over entire temperature range | |
| Output current | 50 mA |
| Summation current | 200 mA |
| Connection type | 2-wire connections |
| Zero-crossing detection | Yes |
| Holding current | Max. 3.5 mA |
| Leakage current | Max. 1.5 mA (per channel) |
| Residual voltage (on-state voltage) | Max. 3 V |
| Phase-angle control | |
| Area | 5 to 95% |
| Resolution | 1% |
| Accuracy (60 to 240 VAC) | <100 µs |
| Voltage monitoring L - N | No |
| Recommended wiring | Twisted pair cabling to the terminal pairs |
| Line length | Max. 10 m |
| Overvoltage protection between L and N | Yes |
| Isolation voltages | |
| Channel - Bus | Tested at 2300 VAC |
| Channel - Channel | Tested at 2300 VAC |
| Protective circuit | |
| External | Generally fuse |
| Internal | Snubber circuit (RC element) and varistor |
| Electrical properties | |
| Electrical isolation | Channel isolated from channel and bus |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Not permitted |
| Degree of protection per EN 60529 | IP20 |

Table 319: X20DO4613 - Technical data


| | | | |
|---------------------------------|------------------|--|--|
| Model number | X20DO4613 | | |
| Ambient conditions | | | |
| Temperature | | | |
| Operation | | | |
| Horizontal mounting orientation | | | -25 to 60°C |
| Vertical mounting orientation | | | -25 to 50°C |
| Derating | | | - |
| Storage | | | -40 to 85°C |
| Transport | | | -40 to 85°C |
| Relative humidity | | | |
| Operation | | | 5 to 95%, non-condensing |
| Storage | | | 5 to 95%, non-condensing |
| Transport | | | 5 to 95%, non-condensing |
| Mechanical properties | | | |
| Note | | | Order 1x terminal block X20TB32 separately. Order 1x bus module X20BM12 separately. |
| Spacing | | | 12.5 ^{+0.2} mm |

Table 319: X20DO4613 - Technical data

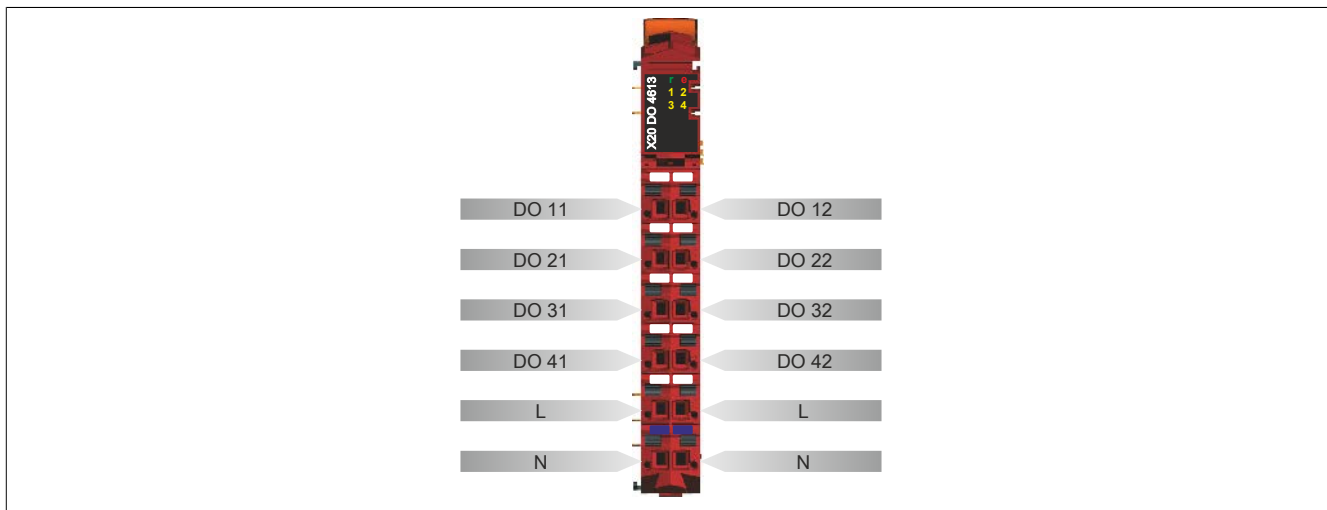
1) Number of outputs x Residual voltage (on-state voltage) x Nominal output current. For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.

9.15.13.4 Status LEDs

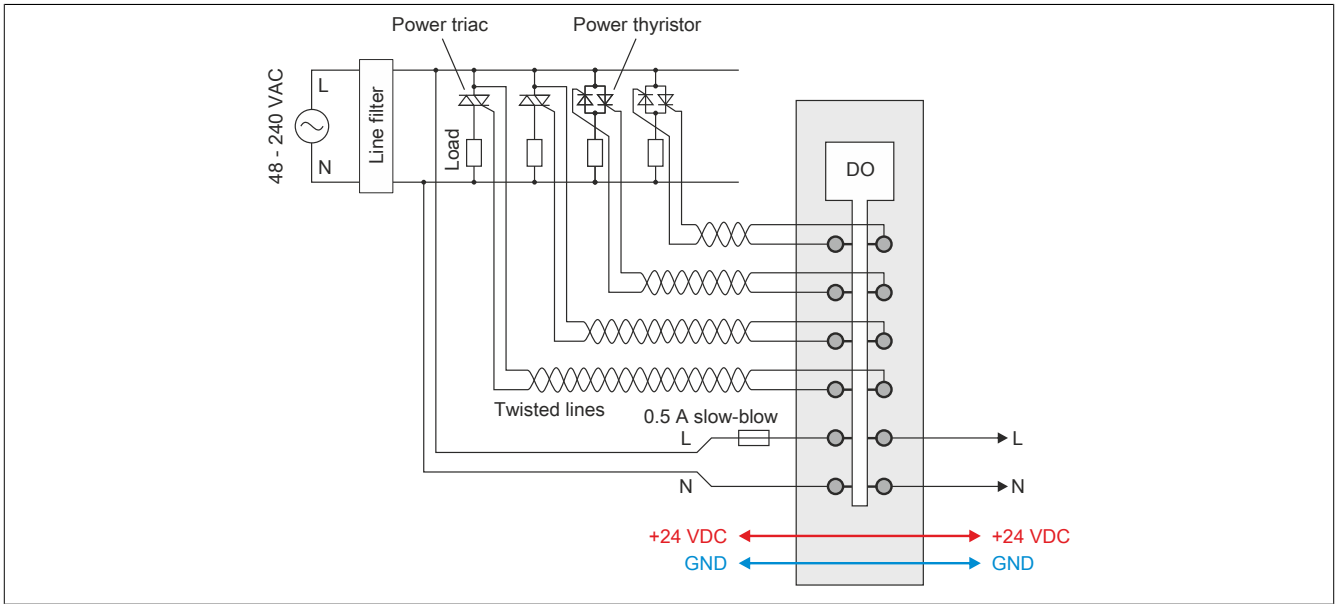
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|--|-------|-------|-----------------------------|--|
|  | r | Green | Off | Module supply not connected |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | | | Flickering (approx. 10 Hz) | Module is in OSP state |
| | e | Red | Off | Module supply not connected or everything OK |
| | | | On | Error or reset status |
| | | | Single flash | Loss of zero-crossing signal (input voltage absent or too low) |
| | e + r | | Red on / Green single flash | Invalid firmware |
| | 1 - 4 | | Orange | |

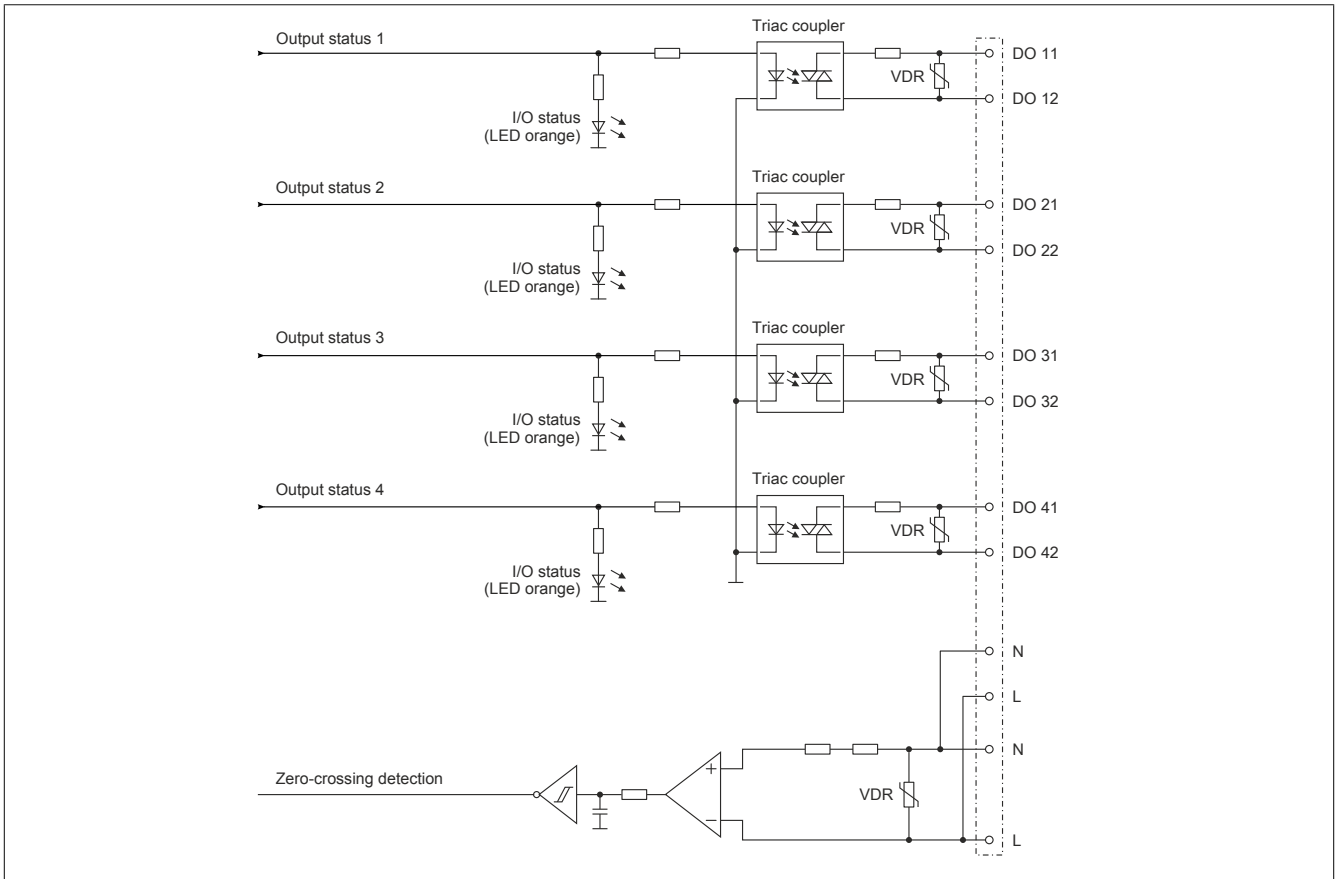
9.15.13.5 Pinout



9.15.13.6 Connection example



9.15.13.7 Output circuit diagram



9.15.13.8 Operating principle

The digital output module DO4613 was designed to control external triacs and thyristors.

The module is equipped with internal zero-crossing detection. Zero-crossing detection is the basis for a software PLL that generates 200 times the zero-crossing frequency. The output signal of the PLL is the base timer for the 4 PWM outputs in both digital and analog mode.

Upon detection of lost periods or periods that are too short, control to the outputs is cut until the PLL is tuned correctly. The tuning procedure can take several seconds. In addition, the "ZeroCrossingStatus" bit is set and the error LED enabled (valid frequency range for the supply is 47 to 63 Hz).

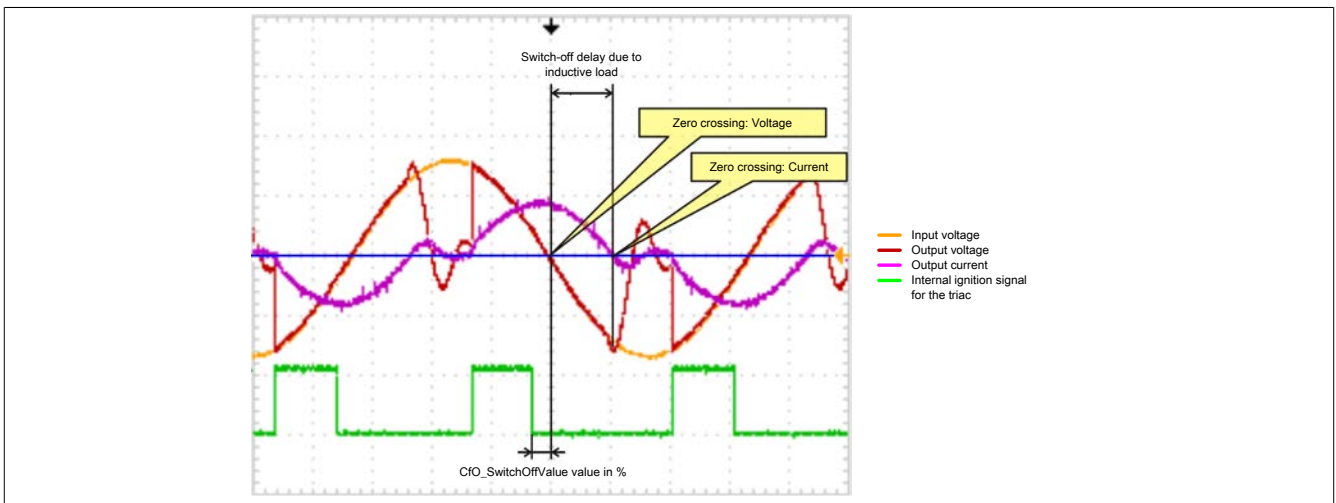
Information:

The jitter of the output signals generated by the PLL and communication can reach 0.5%.

9.15.13.9 Operation with inductive loads

As inherent to its functional principal, the triac output is cleared when the current crosses zero. Because zero crossing for current is delayed with inductive loads, it is possible that the triac will be fired again even though it is not completely cleared at higher output values (between 50 and 100% depending on the inductance of the load). In this case, a full-wave is output. This causes the available control range to be reduced (0 to 100%).

For control beyond the point of full-wave control (up to 100%), the value that is physically output no longer changes. However, this does not cause damage to the module.



9.15.13.10 Register description

9.15.13.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.15.13.10.2 Function model 0 - Standard and Function model 2 - Frequency mode

The only difference between function model 2 and function model 0 is the possibility of generating half-wave patterns in various frequencies. Register 18 "CfO_Frequency" is an additional register for this.

| Register | Name | Data type | Read | | Write | |
|--------------------------------|-----------------------------------|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration - General | | | | | | |
| 2 + N * 2 | AnalogOutput0N (Index N = 1 to 4) | USINT | | | • | |
| 18 | CfO_Frequency | UINT | | | | • |
| 18 + N * 2 | ConfigOutput0N (Index N = 1 to 4) | USINT | | | | • |
| 28 | ConfigOutput05 | USINT | | | | • |
| 29 | CfO_OutputTolerance | USINT | | | | • |
| Communication | | | | | | |
| 2 | DigitalOutput | USINT | | | • | |
| | DigitalOutput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalOutput04 | Bit 3 | | | | |
| 30 | StatusInput01 | USINT | • | | | |
| | ZeroCrossingInput | Bit 4 | | | | |
| | ZeroCrossingStatus | Bit 7 | | | | |

9.15.13.10.3 Function model 1 - OSP

| Register | Name | Data type | Read | | Write | |
|--------------------------------|---|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration - General | | | | | | |
| 2 + N * 2 | AnalogOutput0N (Index N = 1 to 4) | USINT | | | • | |
| 18 + N * 2 | ConfigOutput0N (Index N = 1 to 4) | USINT | | | | • |
| 28 | ConfigOutput05 | USINT | | | | • |
| 29 | CfO_OutputTolerance | USINT | | | | • |
| Configuration - OSP | | | | | | |
| 34 | Enabling OPS output in the module | USINT | | | • | |
| | OSPValid | Bit 0 | | | | |
| 32 | CfgOSPMode | USINT | | | | • |
| 36 | CfgOSPValue | USINT | | | | • |
| 36 + N * 2 | CfgOSPValue0N (Index N = 1 to 4) | USINT | | | | • |
| Communication | | | | | | |
| 2 | Switching state of digital outputs 1 to 4 | USINT | | | • | |
| | DigitalOutput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalOutput04 | Bit 3 | | | | |
| 30 | Status of the outputs | USINT | • | | | |
| | ZeroCrossingInput | Bit 4 | | | | |
| | ZeroCrossingStatus | Bit 7 | | | | |

9.15.13.10.4 Function model 254 - Bus controller

| Register | Offset | Name | Data type | Read | | Write | |
|--------------------------------|-------------|---|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration - General | | | | | | | |
| $2 + N * 2$ | $(N-1) * 2$ | AnalogOutput0N (Index N = 1 to 4) | USINT | | | • | |
| $18 + N * 2$ | - | ConfigOutput0N (Index N = 1 to 4) | USINT | | | | • |
| 28 | - | ConfigOutput05 | USINT | | | | • |
| 29 | - | CfO_OutputTolerance | USINT | | | | • |
| Communication | | | | | | | |
| 30 | 0 | Status of the outputs | USINT | • | | | |
| | | ZeroCrossingInput | Bit 4 | | | | |
| | | ZeroCrossingStatus | Bit 7 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.15.13.10.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "[Using I/O modules on the bus controller](#)" on page 3789.

9.15.13.10.4.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.15.13.10.5 General information

The digital output module was designed for phase control of resistive and inductive loads.

The module is equipped with internal zero-crossing detection. Zero crossing detection is the basis for a software PLL that generates 200 times the zero crossing frequency. The output signal of the PLL is the base timer for the 2 PWM outputs in both digital and analog mode.

Upon detection of lost periods or periods that are too short, control of the outputs is cut until the PLL is tuned correctly (can take several seconds). In addition, the "ZeroCrossingStatus" bit is set and the Error LED is enabled (valid frequency range for the supply is 45 to 65 Hz).

Information:

The jitter of the output signals generated by the PLL and communication can reach 0.5%.

9.15.13.10.6 Digital outputs

The output state of the outputs defined as digital is transferred to the output ports of the control switch in sync with the connected power mains. The switch-on state is applied when the voltage crosses zero on the positive half-wave and the switch-off state at the zero crossing for current in each half wave.

9.15.13.10.6.1 Switching state of digital outputs 1 to 4

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput04

This register is used to store the switching state of digital outputs 1 to 4.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Values | Information |
|-----------|------------------------|--|
| USINT | 0 to 15 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 3 | DigitalOutput04 | 0 | Digital output 04 reset |
| | | 1 | Digital output 04 set |

Information:

The states in these registers are only applied when the channels are set to DIGITAL in register "ConfigOutput05" on page 1695.

When using setting "Packed outputs", ALL channels must be set to DIGITAL. Mixed operation is not possible.

9.15.13.10.7 Analog outputs

The output value of the outputs defined as analog outputs (unit percent) is switched through to the control ports in sync with power mains. The analog value is output to the TRIAC control port in the range between (output value > SwitchOffValue) and (output value ≤ 95%) with a resolution of 1%.

Changes to the output value are applied at the next positive half-wave

9.15.13.10.7.1 Commutation angle for analog outputs 1 - 4

Name:

AnalogOutput01 to AnalogOutput04

These registers are used to set the commutation angle for phase angle control.

Values between 0 and 100 correspond to the output value for the respective channel in percent. Values above 100 correspond to 100%.

| Data type | Value |
|-----------|----------|
| USINT | 0 to 100 |

Information:

The commutation angle for phase angle control set in these registers are only applied when the channels are set to ANALOG in register "ConfigOutput05" on page 1695.

9.15.13.10.8 Output configuration

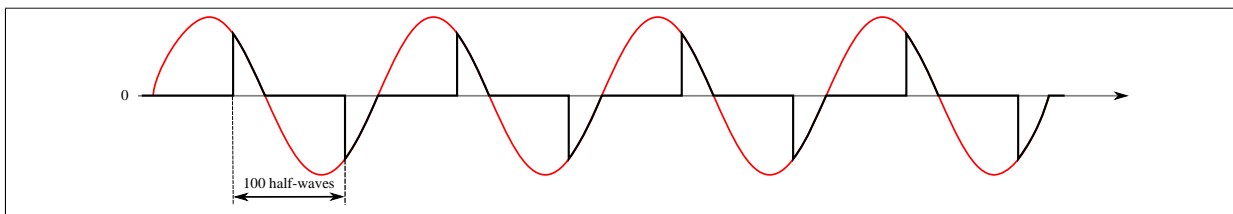
9.15.13.10.8.1 Configuring the half-wave pattern

Name:

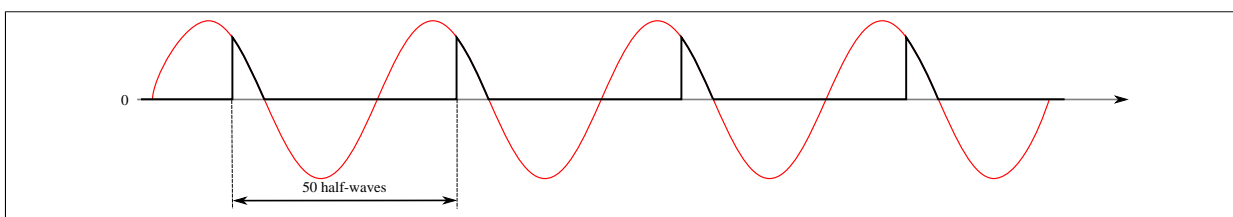
CfO_Frequency

This register can only be used in [function model 2 - Frequency mode](#) and makes it possible to configure the output of half-wave patterns in various frequencies. The [commutation angle of the outputs](#) is not affected by this. The following frequency patterns can be configured:

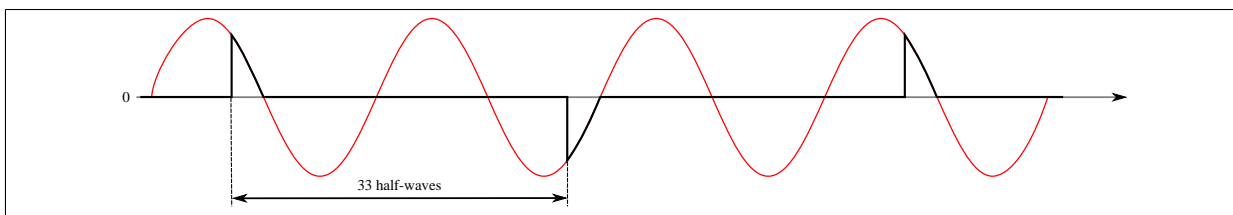
- 100 half-waves



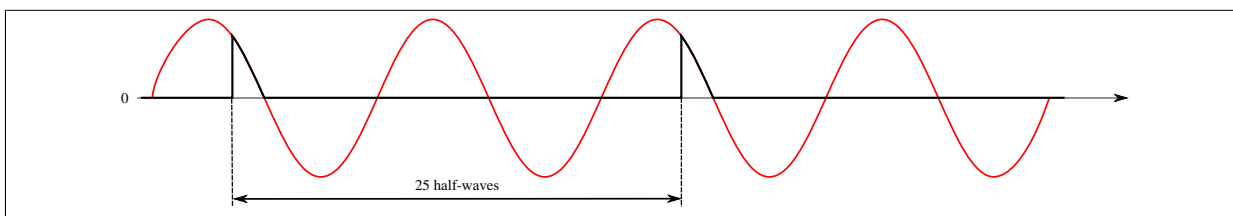
- 50 half-waves



- 33 half-waves



- 25 half-waves



With multichannel operation, the different channels should be operated with delayed half-waves in order to ensure that the load is placed evenly on the module.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|-------------|--------------|--|
| 0 - 3 | Channel 1 | 0000 | 100 half-waves/second |
| | | 0001 | 50 half-waves/second |
| | | 0010 | 25 half-waves/second |
| | | 0011 | 33 half-waves/second |
| | | 0101 | 50 half-waves/second delayed by 1 half-wave |
| | | 0110 | 25 half-waves/second delayed by 2 half-waves |
| | | 0111 | 33 half-waves/second delayed by 1 half-wave |
| 4 - 7 | Channel 2 | 0000 to 0111 | See channel 1. |
| 8 - 11 | Channel 3 | 0000 to 0111 | See channel 1. |
| 12 - 15 | Channel 4 | 0000 to 0111 | See channel 1. |

Information:

This function is available beginning with firmware version 940. This can be included beginning with hardware variant 8.

9.15.13.10.8.2 Setting the switch-off time

Name:

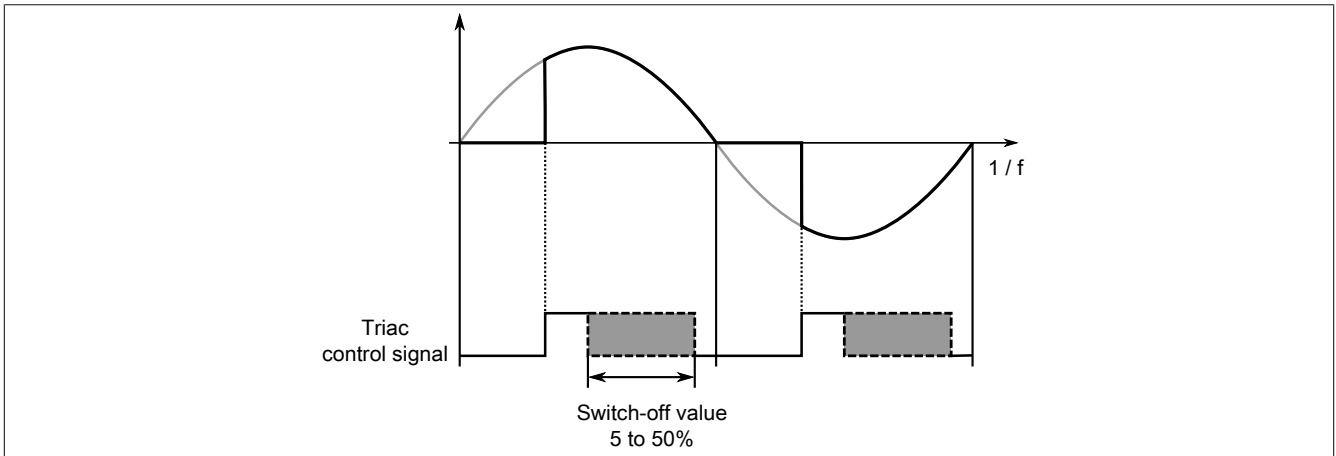
ConfigOutput01 to ConfigOutput04

This register defines how far in front of the zero cross-over the internal control signal for the TRIAC is switched off. Increasing this value may be necessary in order to prevent unwanted firing of the TRIAC in the event of a slight disturbance in the mains frequency.

With smaller loads, it is important to ensure that this switch off value is not set to large (too early) to prevent switching off prematurely.

The triac can of course only be fired before the set switch-off time.

"SwitchOffValue" in the Automation Studio I/O configuration.



| Data type | Value | Description |
|-----------|---------|--|
| USINT | 5 to 50 | Switch-off time in %. Bus controller default setting: 0 |

9.15.13.10.8.3 Configuration of the output channels

Name:

ConfigOutput05

The configuration of the output channels is stored in this register.

"Output type digital/analog" and "Output type full/half wave" in the Automation Studio I/O configuration

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 15 |

Bit structure:

| Bit | Description | Value | Information |
|-----|--|-------|---|
| 0 | Channel 1: Digital/Analog output | 0 | Output channel 1 is defined as a digital output. The output status is defined by bit 0 of register "DigitalOutput 1 - 4" on page 1693. |
| | | 1 | Output channel 1 is defined as an analog output. The output status is defined by register "AnalogOutput01" on page 1693 (bus controller default setting). |
| ... | ... | ... | ... |
| 3 | Channel 4: Digital/Analog output | 0 | Output channel 4 is defined as a digital output. The output status is defined by bit 1 of register "DigitalOutput 1 - 4" on page 1693. |
| | | 1 | Output channel 2 is defined as an analog output. The output status is defined by register "AnalogOutput04" on page 1693 (bus controller default setting). |
| 4 | Channel 1: Full-wave/Half-wave control ¹⁾ | 0 | Full-wave control on output channel 1 (bus controller default setting) |
| | | 1 | Negative half-wave on output channel 1 is suppressed. |
| ... | ... | ... | ... |
| 7 | Channel 4: Full-wave/Half-wave control ¹⁾ | 0 | Full-wave control on output channel 4 (bus controller default setting) |
| | | 1 | Negative half-wave on output channel 4 is suppressed. |

1) Not available in function model 2 - Frequency mode.

9.15.13.10.8.4 Switching behavior for zero-crossing errors

Name:

CfO_OutputTolerance

This register can be used to set the switching behavior of the trigger. After the number of zero-crossing errors configured in Bit 0 to 4, the output is switched off for at least 3 periods. This is followed by synchronization with the zero signal according to Bit 7.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------|---------|--|
| 0 - 4 | Trigger for Resync | 0 to 30 | Number of zero crossing errors. Bus controller default setting: 0 |
| 5 - 6 | Reserved | - | |
| 7 | Fast settling | 0 | Quick adjustment (bus controller default setting) |
| | | 1 | PLL synchronization |

Fast synchronization

With this option, the trigger point is closed-loop controlled after each individual zero-crossover and input jitter.

- **Advantage:** Increased tolerance and faster response to deviations in mains frequency
- **Disadvantage:** Increased switch-on jitter for firing signal by zero cross signal $\pm 100 \mu\text{Sec}$

PLL synchronization

With this option the intervals between zero cross-overs are measured and the PLL frequency is updated accordingly.

- **Advantage:** Jitter-free firing signal
- **Disadvantage:** When the output is switched off, additional measurement phases are required before it can be switched back on.

Information:

This function is available starting with Firmware version 928. This can be installed with hardware version 7 and hardware revision B4 or higher.

9.15.13.10.9 Status of the outputs

Name:

ZeroCrossingInput

ZeroCrossingStatus

StatusInput01

The operating status of the outputs is mapped in this register.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("ZeroCrossingInput" to "ZeroCrossingStatus") or whether this register should be displayed as a single USINT data point ("StatusInput01").

| Data type | Value | Information |
|-----------|------------------------|---|
| USINT | 0 to 255 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model \neq 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-------|--------------------|-------|---|
| 0 - 3 | Reserved | - | |
| 4 | ZeroCrossingInput | 0 | Zero cross signal during the negative half-wave |
| | | 1 | Zero cross signal during the positive half-wave |
| 5 - 6 | Reserved | - | |
| 7 | ZeroCrossingStatus | 0 | Zero cross signal OK |
| | | 1 | Zero cross signal has dropped out |

9.15.13.10.10 Function model "OSP"

In function model "OSP" (Operator Set Predefined), the user defines an analog value or digital pattern. This OSP value is output as soon as the communication between the module and master is aborted.

Functionality

The user has the choice between 2 OSP modes:

- Retain last valid value
- Replace with static value

In the first case, the module retains the last value recognized as a valid output status.

When selecting mode "Replace with static value", a plausible output value must be entered in the associated value register. When an OSP event occurs, this value is output instead of the value currently requested by the task.

9.15.13.10.10.1 Enabling OPS output in the module

Name:

OSPValid

This data point makes it possible to start the output of the module and request the use of OSP during operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|---|
| 0 | OSPValid | 0 | Request OSP operation (after initial startup or module in stand-by) |
| | | 1 | Request normal operation |
| 1 - 7 | Reserved | 0 | |

Bit OSPValid exists once on the module and is managed by the user task. It must be set to start the enabled channels. As long as bit OSPValid remains set in the module, the module behaves the same as in function model "Standard".

If an OSP event occurs, e.g. communication between the module and master CPU aborted, then bit OSPValid is reset on the module. The module enters the OSP state and output occurs according to the configuration in register "OSPMode" on page 1698.

The following generally applies:

Even after regeneration of the communication channel, the OSP replacement value is still pending. The OSP state is only exited again when a set OSPValid bit is transferred.

When the master CPU is restarted, bit OSPValid bit is reinitialized in the master CPU. It must be set once more by the application and transferred via the bus.

In the event of brief communication errors between the module and master CPU (e.g. due to EMC), the cyclic registers fail to refresh for several bus cycles. Within the module, bit OSPValid is reset; the set bit is retained in the CPU, however. During the next successful transfer, the module-internal OSPValid bit is set again and the module automatically returns to normal operation.

If the task in the master CPU needs the information about which output mode the module is currently in, bit ModulOK can be evaluated.

Warning!

If bit OSPValid bit is reset to "0" by the module, the output status no longer depends on the responsible task in the master CPU. Nevertheless, output is made depending on the configuration of the OSP replacement value.

9.15.13.10.10.2 Setting OSP mode

Name:
CfgOSPMode

This register controls the behavior of a channel when using OSP.

| Data type | Values | Explanation |
|-----------|--------|---------------------------|
| USINT | 0 | Replace with static value |
| | 1 | Retain last valid value |

9.15.13.10.10.3 Defining an OSP-digital output value

Name:
CfgOSPValue

This register contains the digital output value that is output in "Replace with static value" mode during OSP operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------|--------|--|
| 0 | | 0 or 1 | OSP output value for channel DigitalOutput00 |
| ... | | ... | |
| x | | 0 or 1 | OSP output value for channel DigitalOutput0x |

Warning!

"OSPValue" is only applied by the module if bit "OSPValid" has been set in the module.

9.15.13.10.10.4 Define the OSP analog output value

Name:
CfgOSPValue01 to CfgOSPValue04

This register contains the analog output value, which is output in "Replace with static value" mode during OSP operation.

| Data type | Value |
|-----------|----------|
| USINT | 0 to 100 |

Warning!

"OSPValue" is only applied by the module if bit "OSPValid" has been set in the module.

9.15.13.10.11 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|--------|
| All channels | 250 µs |

9.15.13.10.12 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|--------|
| All channels | 150 µs |

9.15.14 X20DO4623

Data sheet version: 3.23

9.15.14.1 General information

The module is a digital output module that is equipped with 4 SSR outputs with zero cross-over switches and uses 2-line connections. The module is also equipped with integrated full-wave control. The supply (L and N) is fed directly to the module.

- 4 digital outputs
- Outputs with integrated snubber circuit
- Outputs with 100 to 240 VAC
- L switching
- 50 Hz or 60 Hz
- 2-wire connections
- Integrated full-wave control
- 240 V coding

Danger!

Risk of electric shock!

The terminal block is only permitted to conduct voltage when it is connected. It is not permitted to be disconnected or connected while voltage is applied or have voltage applied to it while it is removed under any circumstances.

This module is not permitted to be the last module connected on the X2X Link network. At least one subsequent X20ZF dummy module must provide protection against contact.

9.15.14.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Digital outputs |  |
| X20DO4623 | X20 digital output module, 4 outputs, 100 to 240 VAC, 0.5 A, source, 240 V keyed, 2-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM12 | X20 bus module, 240 VAC keyed, internal I/O power supply connected through | |
| | Terminal blocks | |
| X20TB32 | X20 terminal block, 12-pin, 240 VAC keyed | |

Table 320: X20DO4623 - Order data

9.15.14.3 Technical data

| | |
|--|---|
| Model number | X20DO4623 |
| Short description | |
| I/O module | 4 digital SSR outputs 100 to 240 VAC for 2-wire connections |
| General information | |
| B&R ID code | 0x267C |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| Outputs | Yes, using LED status indicator |
| Power consumption | |
| Bus | 0.52 W |
| Internal I/O | - |
| External I/O | 0.38 W |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +3.2 |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| Digital outputs | |
| Variant | SSR |
| Circuit | L-switching |
| Nominal voltage | 100 to 240 VAC |
| Max. voltage | 264 VAC |
| Rated frequency | 47 to 63 Hz |
| Nominal output current | 0.5 A |
| Total nominal current | 1 A |
| Surge current | 7 A (20 ms), 2 A (1 s) |
| Connection type | 2-wire connections |
| Zero-crossing switches | Yes |
| Leakage current | Max. 1.5 mA at 240 V |
| Residual voltage (on-state voltage) | 1.6 V |
| Switching delay | |
| At 50 Hz | |
| 0 → 1 | ≤11 ms |
| 1 → 0 | ≤11 ms |
| At 60 Hz | |
| 0 → 1 | ≤9.3 ms |
| 1 → 0 | ≤9.3 ms |
| Isolation voltage between channel and bus | Tested at 2500 VAC |
| Voltage monitoring L - N | No |
| Overvoltage protection between L and N | Yes |
| Output voltage | |
| Minimum | 75 VAC |
| Protective circuit | |
| External | Generally varistor or fuse |
| Internal | Snubber circuit (RC element) |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Not permitted |
| Degree of protection per EN 60529 | IP20 |

Table 321: X20DO4623 - Technical data


| | | |
|---------------------------------|--|--|
| Model number | X20DO4623 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating". | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x terminal block X20TB32 separately. Order 1x bus module X20BM12 separately. | |
| Spacing | 12.5 ^{+0.2} mm | |

Table 321: X20DO4623 - Technical data

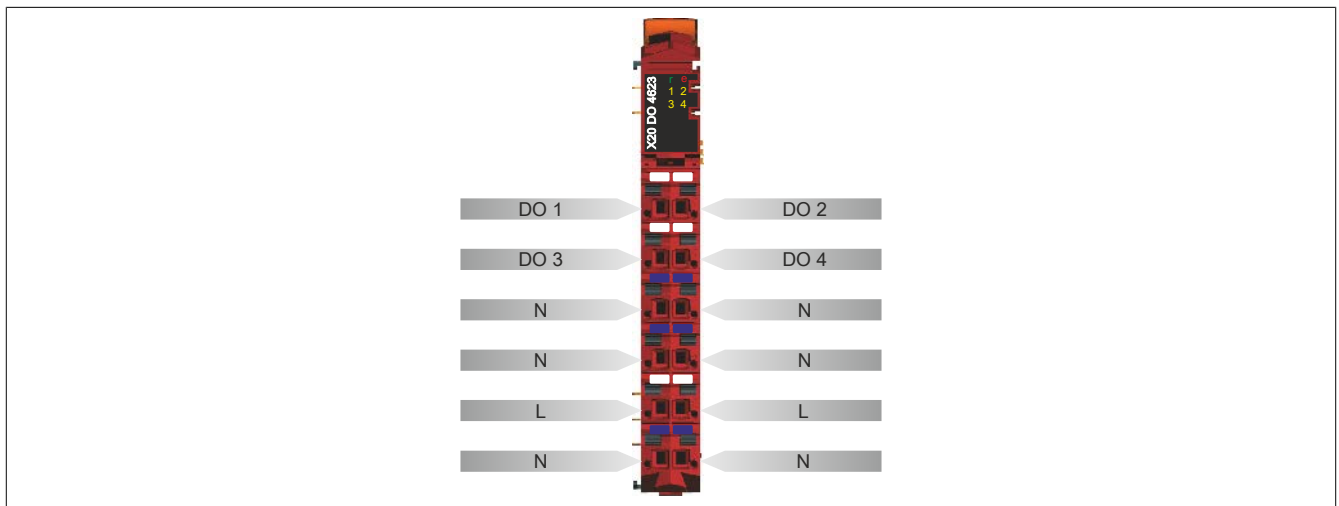
- 1) Number of outputs x Residual voltage (on-state voltage) x Nominal output current. For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.

9.15.14.4 Status LEDs

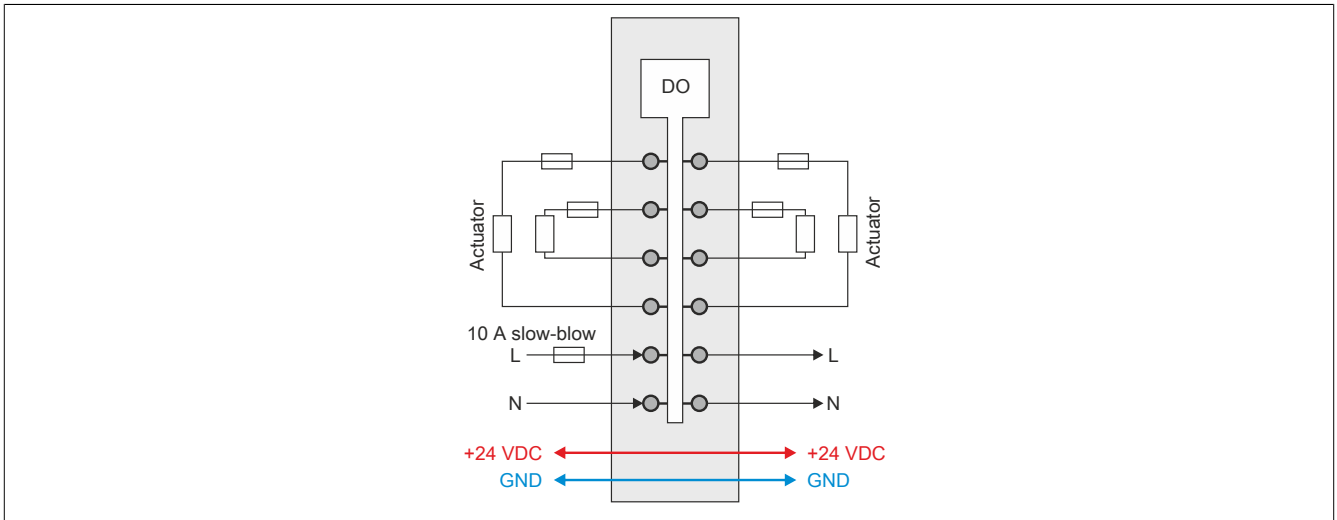
For a description of the various operating modes, see ["Diagnostic LEDs" on page 3787](#).

| Figure | LED | Color | Status | Description | |
|--|-------|-------|-----------------------------|--|--|
|  | r | Green | Off | Module supply not connected | |
| | | | Single flash | RESET mode | |
| | | | Blinking | PREOPERATIONAL mode | |
| | | | On | RUN mode | |
| | e | Red | Off | Module supply not connected or everything OK | |
| | | | On | Error or reset status | |
| | | | Single flash | Zero cross-over signal has dropped out | |
| | e + r | | Red on / Green single flash | Invalid firmware | |
| | 1 - 4 | | Orange | | Control status of the corresponding digital output |

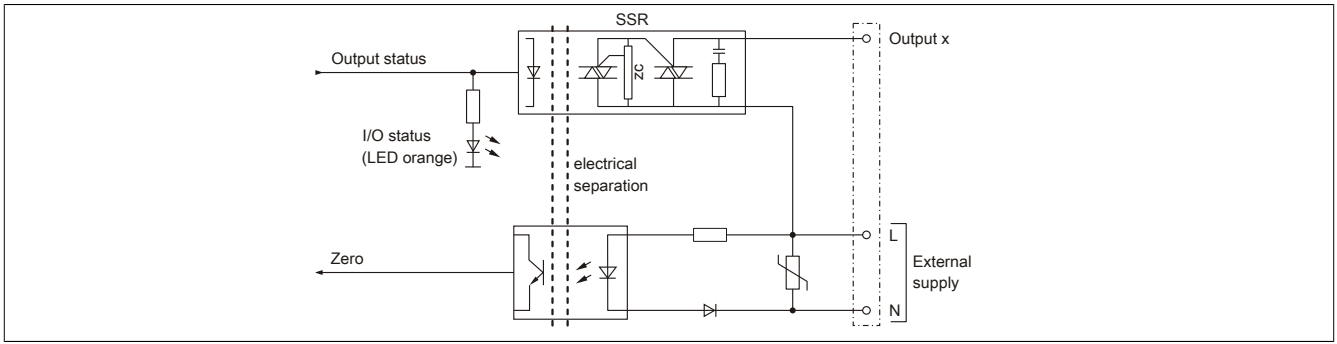
9.15.14.5 Pinout



9.15.14.6 Connection example



9.15.14.7 Output circuit diagram



9.15.14.8 Integrated full-wave control

Full-wave control is used to control power for electrical power consumers that are operated with AC voltage. Temperature control is a typical application

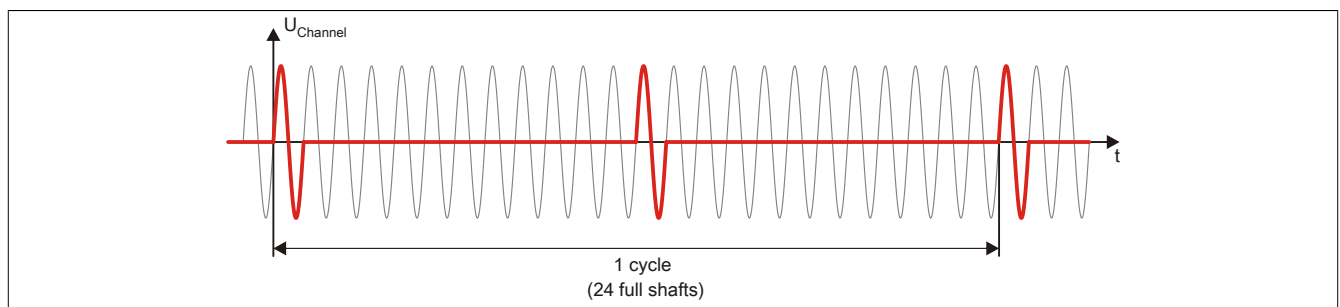
Unlike phase-angle control, the sine wave oscillation form of the mains voltage is not changed during full-wave control. This significantly reduces system perturbation.

The output voltage (channel) is switched on and off at a certain ratio. This switches the multi-cycle packets. A multi-cycle packet consists of a number of complete sine waves throughout a cycle. The relationship between the power-on duration and the cycle duration results in the desired effect of reduced power consumption by the connected power consumer.

With the full-wave control that is integrated in the module, a maximum of 24 full waves can be provided on the outputs per cycle. Control takes place in 4% steps.

| Settings | | Full waves | | | | | | | | | | | | | | | | | | | | | | | |
|----------|-----|------------|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| SW% | % | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | | • | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | | • | | | | | | | | | | | | • | | | | | | | | | | | |
| 12 | | • | | | | | | | | • | | | | | | | | | • | | | | | | |
| 16 | | • | | | | | | | • | | | | | • | | | | | | • | | | | | |
| 20 | | • | | | | | • | | | | | • | | | | | • | | | | • | | | | |
| 24 | 25 | • | | | | • | | | | • | | | | • | | | | • | | | | • | | | |
| 28 | | • | | | | • | | | • | | | | • | | | | • | | | • | | | | • | |
| 32 | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | |
| 36 | | • | | • | | | | • | | | • | | | • | | | • | | | • | | • | | | • |
| 40 | | • | | • | | | • | | | • | | | • | | | • | | | • | | | • | | • | |
| 44 | | • | | • | | | • | | | • | | | • | | | • | | | • | | | • | | • | |
| 48 | 50 | • | | • | | | • | | | • | | | • | | | • | | | • | | | • | | • | |
| 52 | | | • | | | • | | | • | | | • | | | • | | | • | | | • | | | • | |
| 56 | | | • | • | | | | | • | | | • | | | • | | | • | | | • | | | • | |
| 60 | | | • | • | | | • | | | • | | | • | | | • | | | • | | | • | | • | |
| 64 | | | • | • | | | • | | | • | | | • | | | • | | | • | | | • | | • | |
| 68 | | | • | • | • | | | • | | | • | | | • | | | • | | | • | | | • | | • |
| 72 | 75 | | • | • | • | | | • | | | • | | | • | | | • | | | • | | | • | | • |
| 76 | | | • | • | • | | | • | | | • | | | • | | | • | | | • | | | • | | • |
| 80 | | | • | • | • | | | • | | | • | | | • | | | • | | | • | | | • | | • |
| 84 | | | • | • | • | | | • | | | • | | | • | | | • | | | • | | | • | | • |
| 88 | | | • | • | • | | | • | | | • | | | • | | | • | | | • | | | • | | • |
| 92 | | | • | • | • | | | • | | | • | | | • | | | • | | | • | | | • | | • |
| 96 | 100 | • | • | • | • | | | • | | | • | | | • | | | • | | | • | | | • | | • |

Example of full-wave control (8%):

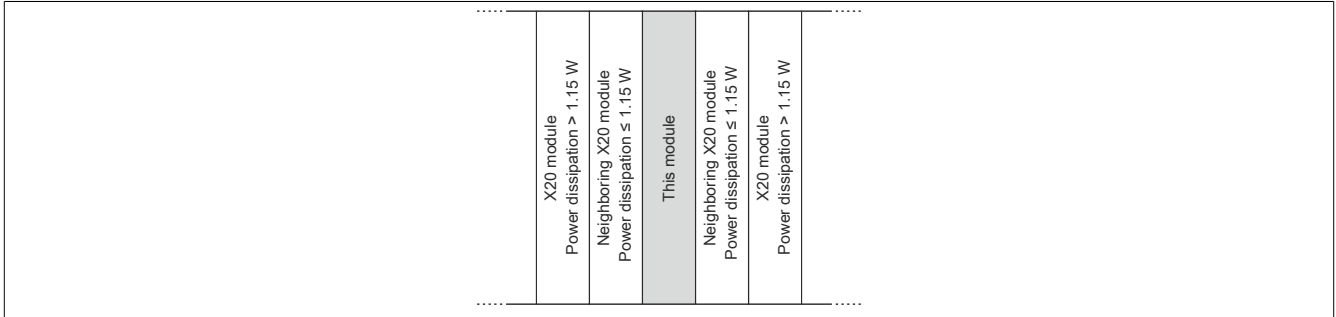


9.15.14.9 Derating

There is no derating when operated below 55°C.

During operation over 55°C, the power dissipation of the modules to the left and right of this module is not permitted to exceed 1.15 W!

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.



9.15.14.10 Register description

9.15.14.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.15.14.10.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------------------|--------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 28 | - | ConfigOutput01 (output filter) | USINT | | | | • |
| Communication | | | | | | | |
| 2 | 0 | DigitalOutput | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput04 | Bit 3 | | | | |
| 4 | 1 | AnalogOutput01 | USINT | | | • | |
| 6 | 2 | AnalogOutput02 | USINT | | | • | |
| 8 | 3 | AnalogOutput03 | USINT | | | • | |
| 10 | 4 | AnalogOutput04 | USINT | | | • | |
| 30 | 1 | StatusInput01 | USINT | • | | | |
| | | ZeroCrossingInput | Bit 0 | | | | |
| | | ZeroCrossingStatus | Bit 4 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.14.10.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 28 | - | ConfigOutput01 (output filter) | USINT | | | | • |
| Communication | | | | | | | |
| 4 | 0 | AnalogOutput01 | USINT | | | • | |
| 6 | 2 | AnalogOutput02 | USINT | | | • | |
| 8 | 4 | AnalogOutput03 | USINT | | | • | |
| 10 | 6 | AnalogOutput04 | USINT | | | • | |
| 30 | 0 | Zero crossing status | USINT | • | | | |
| | | ZeroCrossingInput | Bit 0 | | | | |
| | | ZeroCrossingStatus | Bit 4 | | | | |

1) The offset specifies where the register is within the CAN object.

9.15.14.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "[Using I/O modules on the bus controller](#)" on page 3789.

9.15.14.10.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.15.14.10.4 Digital outputs

The output status is transferred to the control switch asynchronously to the connected network. The outputs switch on when the voltage crosses zero and switch off when the current crosses zero.

9.15.14.10.4.1 Switching state of digital outputs 1 to 4

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput04

This register is used to store the switching state of digital outputs 1 to 4.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Values | Information |
|-----------|------------------------|--|
| USINT | 0 to 15 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 3 | DigitalOutput04 | 0 | Digital output 04 reset |
| | | 1 | Digital output 04 set |

Information:

The states are only applied when the channels are set to DIGITAL in ["Setting the output configuration" on page 1707](#).

When using the setting "packed outputs" ALL channels must be set to DIGITAL. Mixed operation is not possible.

9.15.14.10.5 Analog outputs

The output value is transferred to the control circuit in sync with the connected power mains according to the firing pattern table (see ["Integrated full-wave control" on page 1703](#)). The analog value is output with a resolution of ~4% over a duration of 24 complete waves. Values > 96% result in full control. Changes to the output value within an interval are applied after the next zero crossover.

9.15.14.10.5.1 Setting the output value from the firing pattern table

Name:

AnalogOutput01 to AnalogOutput04

These registers are used to set the output value from the firing pattern table.

Values between 0 and 100 correspond to the output value for the respective channel in percent. Values above 100 correspond to 100%.

| Data type | Value |
|-----------|----------|
| USINT | 0 to 100 |

Information:

The states in these registers are only applied when the channels are set to ANALOG in ["Setting the output configuration" on page 1707](#).

9.15.14.10.5.2 Setting the output configuration

Name:

ConfigOutput01

Each channel can be configured for either "digital" or "analog" operation in this register. Depending on the setting, the corresponding DigitalOutput or AnalogOutput registers must be written.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 15 |

Bit structure:

| Bit | Name | Value | Description |
|-------|-----------|-------|---|
| 0 | Channel 1 | 0 | Digital register is used |
| 1 | | 1 | Analog register used (bus controller default setting) |
| ... | | ... | |
| 3 | Channel 4 | 0 | Digital register is used |
| | | 1 | Analog register used (bus controller default setting) |
| 4 - 7 | Reserved | 0 | |

9.15.14.10.6 Zero crossing status

Name:

ZeroCrossingInput

ZeroCrossingStatus

StatusInput01

Zero crossing detection uses a fixed filter time of 1 ms and a scanning frequency of 10 kHz. When a missing or too short period is detected, control is switched off until at least 2 periods are detected correctly, and the status flag is set accordingly. Control is offset by 2 ms from the negative half-wave until the next zero crossover is detected correctly or another error occurs. This is normally at least one complete wave.

Monitoring is activated at the first zero crossover after being switched on.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("ZeroCrossingInput" to "ZeroCrossingStatus") or whether this register should be displayed as a single USINT data point ("StatusInput01").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 17 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------------------------|-------|--------------------------------------|
| 0 | ZeroCrossingInput ¹⁾ | 0 | Signal during the negative half-wave |
| | | 1 | Signal during the positive half-wave |
| 1 - 3 | Reserved | 0 | |
| 4 | ZeroCrossingStatus | 0 | No error |
| | | 1 | Zero crossover failed |
| 5 - 7 | Reserved | 0 | |

1) Value is valid if no error has occurred (ZeroCrossingStatus= 0)

9.15.14.10.7 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|-------------------------------|--------|
| Standard function model | 100 µs |
| Bus controller function model | 150 µs |

9.15.14.10.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|---------------------------------|
| Function model 0 | Equal to the minimum cycle time |
| Function model 1 | Equal to the minimum cycle time |

9.15.15 X20(c)DO4633

Data sheet version: 2.53

9.15.15.1 General information

The module is a digital output module with phase-angle control that is equipped with 4 Triac outputs using 2-line connections. The supply (L and N) is fed directly to the module.

- 4 digital outputs
- Outputs with integrated snubber circuit
- Outputs with 48 to 240 VAC
- L switching
- Zero-crossing detection
- Phase-angle control
- Open-circuit detection for each channel
- Negative half-waves can be switched off
- 50 Hz or 60 Hz
- 2-wire connections
- 240 V coding
- OSP mode
- Frequency mode

Danger!

Risk of electric shock!

The terminal block is only permitted to conduct voltage when it is connected. It is not permitted to be disconnected or connected while voltage is applied or have voltage applied to it while it is removed under any circumstances.

This module is not permitted to be the last module connected on the X2X Link network. At least one subsequent X20ZF dummy module must provide protection against contact.

9.15.15.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.15.15.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C . During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.15.15.3 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Digital outputs |  |
| X20DO4633 | X20 digital output module, 4 triac outputs, 48 to 240 VAC, 1 A, L-switching, phase angle control, 240 V keyed | |
| X20cDO4633 | X20 digital output module, coated, 4 triac outputs, 48 to 240 VAC, 1 A, L-switching, phase angle control, 240 V keyed | |
| | Required accessories | |
| | Bus modules | |
| X20BM32 | X20 bus module for double-width modules, 240 VAC keyed, internal I/O supply continuous | |
| X20cBM32 | X20 bus module, coated, for double-width modules, 240 VAC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB32 | X20 terminal block, 12-pin, 240 VAC keyed | |
| | | |

Table 322: X20DO4633, X20cDO4633 - Order data

9.15.15.4 Technical data

| Model number | X20DO4633 | X20cDO4633 |
|--|---|------------|
| Short description | 4 digital outputs 48 to 240 VAC for 2-wire connections | |
| General information | | |
| B&R ID code | 0xAC3A | 0xE67D |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnosics | | |
| Module run/error | Yes, using LED status indicator and software | |
| Outputs | Yes, using LED status indicator | |
| Power consumption | | |
| Bus | 0.6 W | |
| Internal I/O | - | |
| External I/O | - | |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +6.4 W | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| EAC | Yes | |
| KC | Yes | - |
| Digital outputs | | |
| Variant | Triac | |
| Circuit | L-switching | |
| Nominal voltage | 48 to 240 VAC | |
| Max. voltage | 264 VAC | |
| Rated frequency | 47 to 63 Hz | |
| Nominal output current | 1 A | |
| Total nominal current | 4 A | |
| Maximum current | | |
| Output current | 1.25 A | |
| Summation current | 5 A | |
| Connection type | 2-wire connections | |
| Zero-crossing detection | Yes | |
| Minimum holding current I _H | 15 mA | |
| Leakage current | Max. 2 mA at 240 V at 50 Hz Max. 2.4 mA at 240 V at 60 Hz | |
| Residual voltage (on-state voltage) | 1.6 V | |
| Phase-angle control | | |
| Area | 5 to 95% | |
| Resolution | 1% | |
| Accuracy (60 to 240 VAC) | <100 µs | |
| Voltage monitoring L - N | No | |

Table 323: X20DO4633, X20cDO4633 - Technical data


| Model number | X20DO4633 | X20cDO4633 |
|---|--|--|
| Additional functions | Open-circuit detection | |
| Oversvoltage protection between L and N | Yes | |
| Isolation voltages | | |
| Channel - Bus | Tested with 2300 VAC (Rev. <E0 1500 VAC) | Tested at 1500 VAC |
| Channel - Internal I/O | Tested with 2300 VAC (Rev. <E0 2000 VAC) | Tested at 2000 VAC |
| Channel - Ground | Tested with 2300 VAC (Rev. <E0 1500 VAC) | Tested at 1500 VAC |
| Protective circuit | | |
| External | See section "External fuses". | |
| Internal | Snubber circuit (RC element) and varistor | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel and I/O power supply | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitation | |
| >2000 m | Not permitted | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating". | |
| Starting temperature | - | Yes, -40°C |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x terminal block X20TB32 separately. Order 1x bus module X20BM32 separately. | Order 1x terminal block X20cTB32 separately. Order 1x bus module X20cBM32 separately. |
| Pitch | 25 ^{+0.2} mm | |

Table 323: X20DO4633, X20cDO4633 - Technical data

- 1) Number of outputs x Residual voltage (on-state voltage) x Nominal output current. For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.

9.15.15.5 Status LEDs

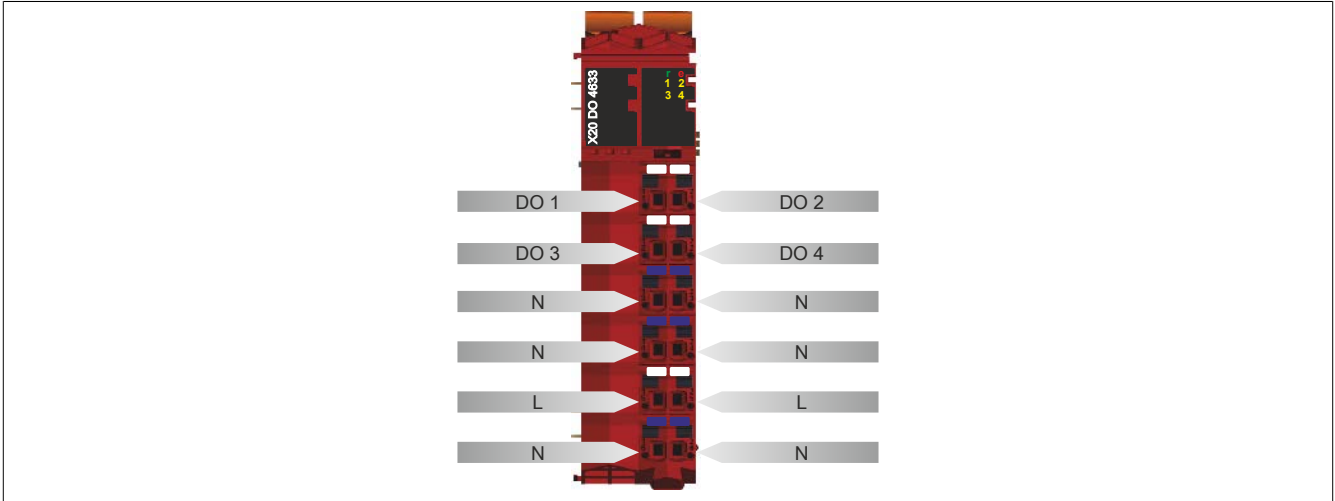
For a description of the various operating modes, see ["Diagnostic LEDs" on page 3787](#).

| Figure | LED | Color | Status | Description |
|---|-------|-----------------------------|----------------------------|--|
|  | r | Green | Off | Module supply not connected |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | | | Flickering (approx. 10 Hz) | Module is in OSP state |
| | e | Red | Off | Module supply not connected or everything OK |
| | | | On | Error or reset status |
| | | | Single flash | Loss of zero-crossing signal (I/O supply voltage not applied or too low) |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1 - 4 | Orange | | Control status of the corresponding digital output |

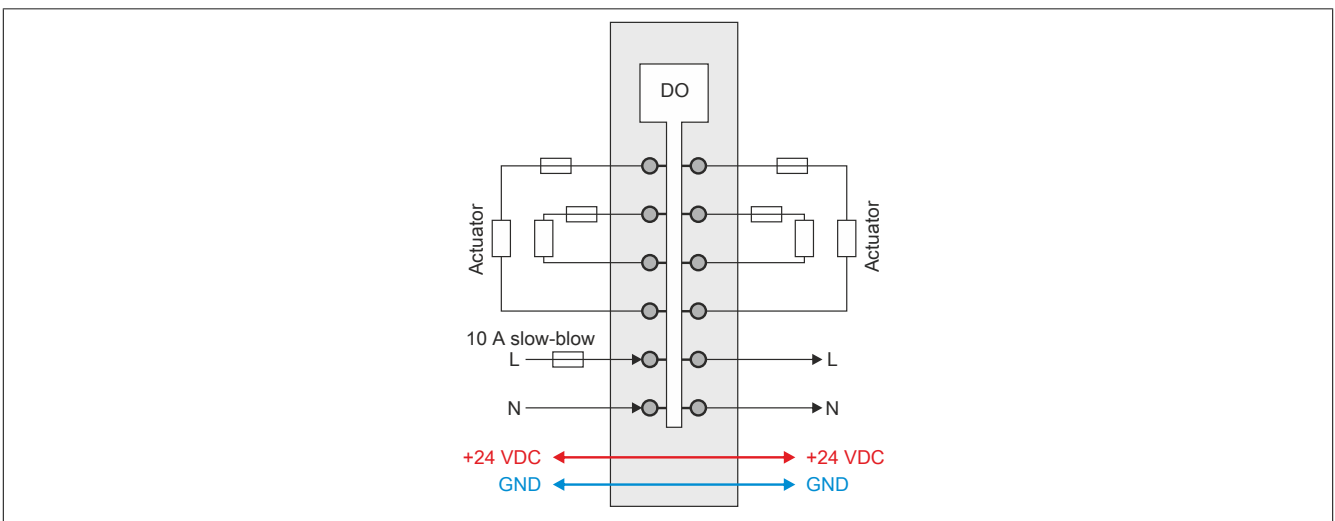
9.15.15.6 Pinout

The following points must be taken into consideration when wiring the module:

- For thermal reasons, wires with a cross-section $\geq 1.5 \text{ mm}^2$ must be used to wire the module.
- The neutral return lines for the outputs must be wired to the terminal block separately for each channel and must not be bypassed in the field.
- A line filter must be used for the 240 V supply that provides $\geq 40 \text{ dB}$ attenuation at 150 kHz and works up to 5 MHz.



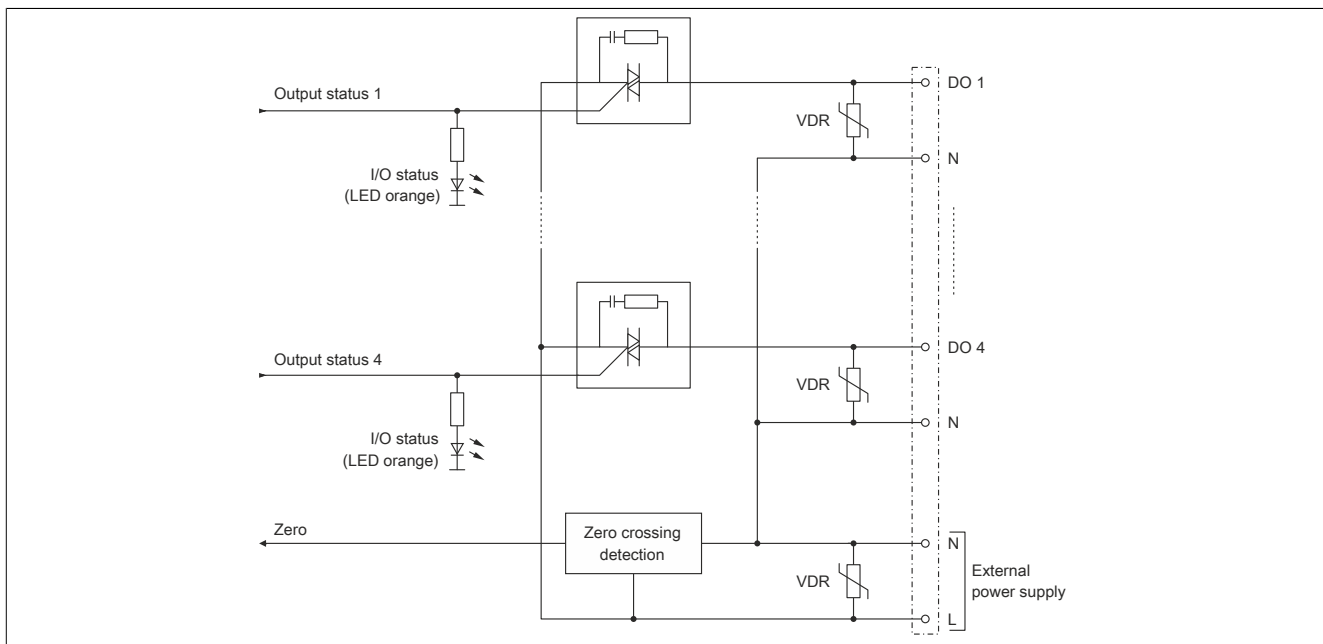
9.15.15.7 Connection example



9.15.15.8 OSP hardware requirements

In order to use OSP mode sensibly, it should be ensured that the power supply of the output module and CPU are independent of each other when the application is set up.

9.15.15.9 Output circuit diagram



9.15.15.10 External fuses

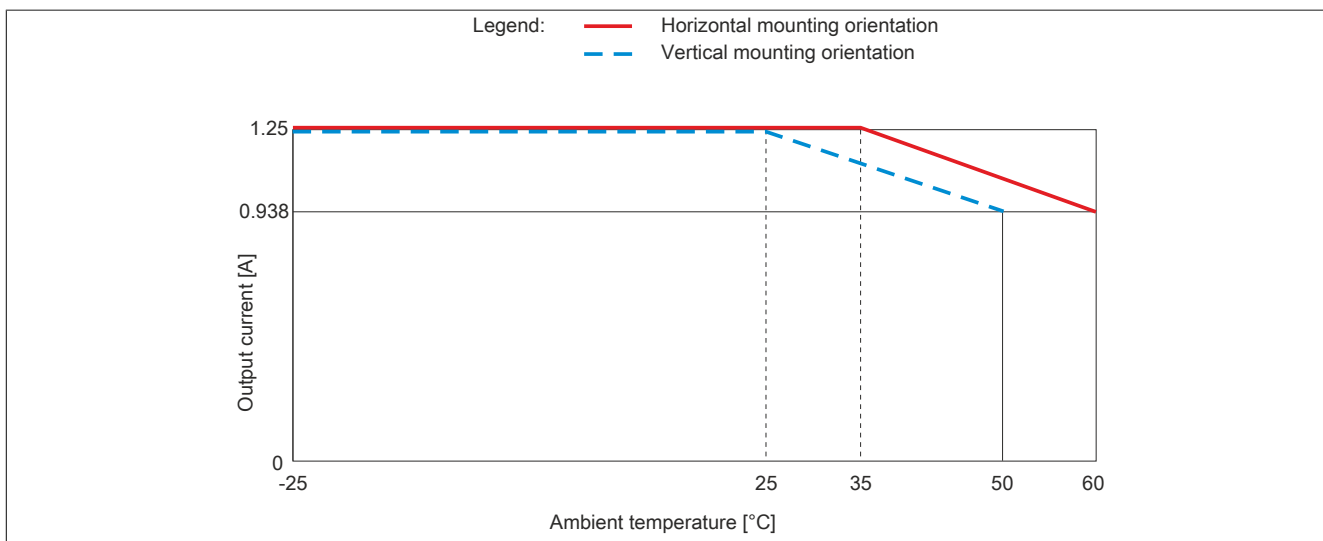
The following protective circuit must be used for safe operation:

| | Protective circuit | Value |
|------------------------|---------------------------|--|
| For the supply lines | Fuse | T 10 A |
| For the outputs | Fuse | Melting integral $I^2t \leq 36 \text{ A}^2\text{s}$ when $t_p = 10 \text{ ms}$ |
| With an inductive load | Varistor ¹⁾ | e.g. varistor with 275 V_{RMS} at 240 VAC |
| For the supply voltage | Line filter ²⁾ | Attenuation $\geq 40 \text{ dB}$ at 150 kHz, effective range up to 5 MHz |

- See also section "Operation with inductive loads" on page 1714
- Meeting the limit values specified in the standards EN 61131, EN 55011 and EN 55022 (each Class A) requires installation of a line filter in the 240 V supply line. Line filters such as the Schaffner FN 2412-8-44 can be used.
If periodic ground transients occur on the supply lines (as can occur with upstream inverters), it is necessary to use an asymmetric filter that keeps these types of changes in potential below a few volts (e.g. "Sinus Plus" from Schaffner) in addition to the symmetric filter.

9.15.15.11 Derating

The derating listed below must be applied for the current:



9.15.15.12 Operating principle

The digital output module was designed for phase control of resistive and inductive loads. The triac outputs do not have short circuit protection. The integrated open-circuit detection makes it possible to recognize defects on the load or the cabling (see "[Open line detection](#)" on page 1713).

The module is equipped with internal zero-crossing detection. Zero-crossing detection is the basis for a software PLL that generates 200 times the zero-crossing frequency. The output signal of the PLL is the base timer for the PWM outputs in both digital and analog mode.

Upon detection of lost periods or periods that are too short, control to the outputs is cut until the PLL is tuned correctly. The tuning procedure can take several seconds. In addition, the "ZeroCrossingStatus" bit is set and the error LED enabled (valid frequency range for the supply is 45 to 65 Hz).

Information:

The jitter of the output signals generated by the PLL and communication can reach 0.5%.

9.15.15.13 Open line detection

The module is equipped with open-circuit detection. Note that open-circuit detection only works when the output is enabled. An open-circuit will not be detected if the output is turned off.

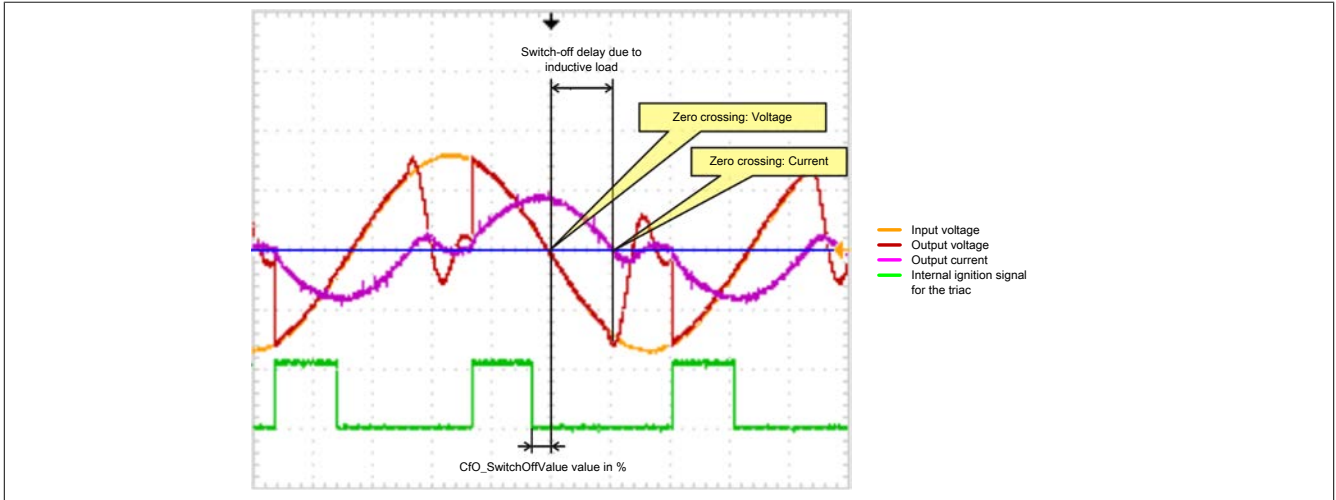
In addition, open-circuit detection is restricted or doesn't work at all for inductive loads. This depends on the inductance of the load and should be determined beforehand, if necessary.

9.15.15.14 Operation with inductive loads

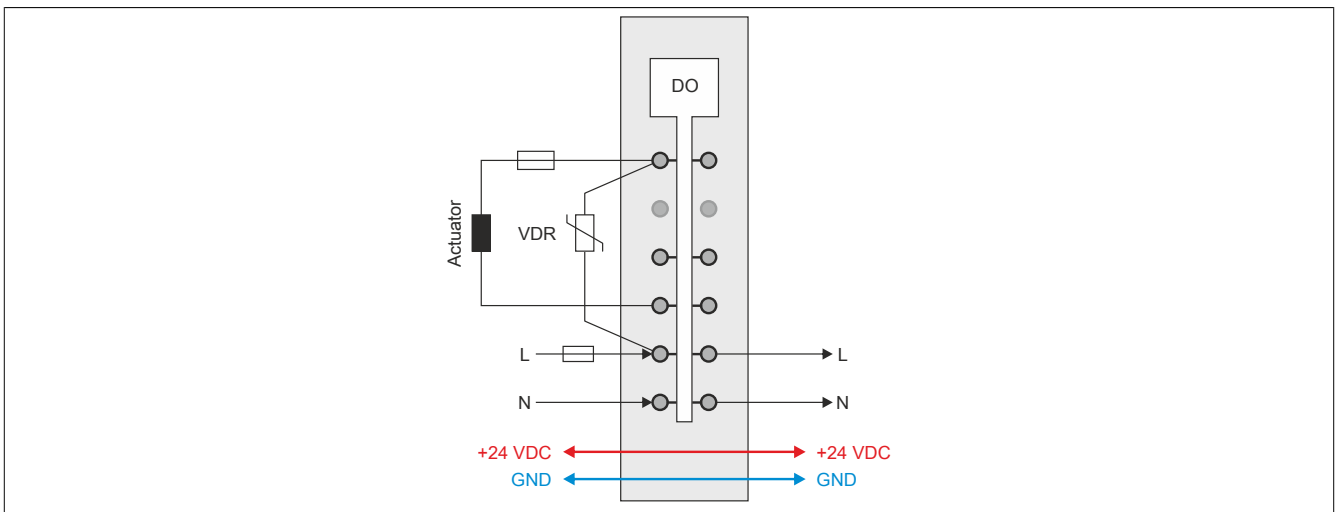
As inherent to its functional principal, the triac output is cleared when the current crosses zero. Because zero crossing for current is delayed with inductive loads, it is possible that the triac will be fired again even though it is not completely cleared at higher output values (between 50 and 100% depending on the inductance of the load). In this case, a full-wave is output. This causes the available control range (0 to 95%) to be changed.

For open line detection (LowCurrentStatus), a pause in control is required where the triac is not permitted to be fired. The full wave that is created with inductive loads causes open line detection to be triggered even though the load on the output is sufficient.

This behavior can be used to detect the full wave and properly adjust the control range (Example: If open line detection is triggered at a control value of 70%, that means that 0 to **70%** corresponds to 0 to **100%** output).



With inductive loads, a suitable varistor must be provided between the output DO x and the phase L (e.g. a varistor with 275 V_{RMS} at 240 VAC).



9.15.15.15 Register description

9.15.15.15.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.15.15.15.2 Function model 0 - Standard and Function model 2 - Frequency mode

The only difference between function model 2 and function model 0 is the possibility of generating half-wave patterns in various frequencies. Register 18 "CfO_Frequency" is an additional register for this.

| Register | Name | Data type | Read | | Write | |
|--------------------------------|--|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration - General | | | | | | |
| 2 + N * 2 | AnalogOutput0N (Index N = 1 to 4) | USINT | | | • | |
| 18 | CfO_Frequency | UINT | | | | • |
| 18 + N * 2 | CfO_SwitchOffValueN (Index N = 1 to 4) | USINT | | | | • |
| 28 | CfO_OutputConfig | USINT | | | | • |
| 29 | CfO_OutputTolerance | USINT | | | | • |
| Communication | | | | | | |
| 2 | DigitalOutput | USINT | | | • | |
| | DigitalOutput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalOutput04 | Bit 3 | | | | |
| 30 | StatusInput01 | USINT | • | | | |
| | LowCurrentStatus1 | Bit 0 | | | | |
| | ... | ... | | | | |
| | LowCurrentStatus4 | Bit 3 | | | | |
| | ZeroCrossingInput | Bit 4 | | | | |
| | ZeroCrossingStatus | Bit 7 | | | | |

9.15.15.15.3 Function model 1 - OSP

| Register | Name | Data type | Read | | Write | |
|--------------------------------|---|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration - General | | | | | | |
| 2 + N * 2 | AnalogOutput0N (Index N = 1 to 4) | USINT | | | • | |
| 18 + N * 2 | CfO_SwitchOffValueN (Index N = 1 to 4) | USINT | | | | • |
| 28 | CfO_OutputConfig | USINT | | | | • |
| 29 | CfO_OutputTolerance | USINT | | | | • |
| Configuration - OSP | | | | | | |
| 34 | Enabling OPS output in the module | USINT | | | • | |
| | OSPValid | Bit 0 | | | | |
| 32 | Setting OSP mode | USINT | | | | • |
| 36 | CfgOSPValue | USINT | | | | • |
| 36 + N * 2 | CfgOSPValue0N (Index N = 1 to 4) | USINT | | | | • |
| Communication | | | | | | |
| 2 | Switching state of digital outputs 1 to 4 | USINT | | | • | |
| | DigitalOutput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalOutput04 | Bit 3 | | | | |
| 30 | Status of the outputs | USINT | • | | | |
| | LowCurrentStatus1 | Bit 0 | | | | |
| | ... | ... | | | | |
| | LowCurrentStatus4 | Bit 3 | | | | |
| | ZeroCrossingInput | Bit 4 | | | | |
| | ZeroCrossingStatus | Bit 7 | | | | |

9.15.15.15.4 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------|----------------------|--|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration - General | | | | | | | |
| $2 + N * 2$ | $(N-1) * 2$ | AnalogOutput0N (Index N = 1 to 4) | USINT | | | • | |
| $18 + N * 2$ | - | CfO_SwitchOffValueN (Index N = 1 to 4) | USINT | | | | • |
| 28 | - | CfO_OutputConfig | USINT | | | | • |
| 29 | - | CfO_OutputTolerance | USINT | | | | • |
| Communication | | | | | | | |
| 30 | 0 | Status of the outputs | USINT | • | | | |
| | | LowCurrentStatus1 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | LowCurrentStatus4 | Bit 3 | | | | |
| | | ZeroCrossingInput | Bit 4 | | | | |
| | | ZeroCrossingStatus | Bit 7 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.15.15.15.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.15.15.4.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.15.15.15.5 General information

The digital output module was designed for phase control of resistive and inductive loads. The triac outputs do not have short circuit protection, but have open line detection that can be used to find defects in the consumer or the wiring.

The module is equipped with internal zero-crossing detection. Zero crossing detection is the basis for a software PLL that generates 200 times the zero crossing frequency. The output signal of the PLL is the base timer for the 2 PWM outputs in both digital and analog mode.

Upon detection of lost periods or periods that are too short, control of the outputs is cut until the PLL is tuned correctly (can take several seconds). In addition, the "ZeroCrossingStatus" bit is set and the Error LED is enabled (valid frequency range for the supply is 45 to 65 Hz).

Information:

The jitter of the output signals generated by the PLL and communication can reach 0.5%.

9.15.15.15.6 Digital outputs

The output state of the outputs defined as digital is transferred to the output ports of the control switch in sync with the connected power mains. The switch-on state is applied when the voltage crosses zero on the positive half-wave and the switch-off state at the zero crossing for current in each half wave.

9.15.15.15.6.1 Switching state of digital outputs 1 to 4

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput04

This register is used to store the switching state of digital outputs 1 to 4.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Values | Information |
|-----------|------------------------|--|
| USINT | 0 to 15 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 3 | DigitalOutput04 | 0 | Digital output 04 reset |
| | | 1 | Digital output 04 set |

Information:

The states in these registers are only applied when the channels are set to DIGITAL in register "[CfO_OutputConfig](#)" on page 1720.

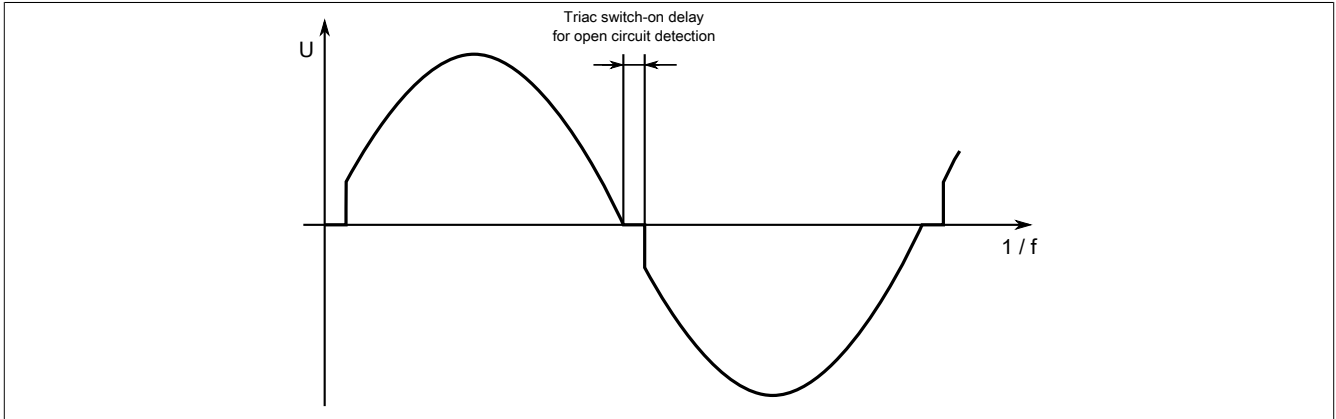
When using setting "Packed outputs", ALL channels must be set to DIGITAL. Mixed operation is not possible.

9.15.15.15.7 Analog outputs

The output value of the outputs defined as analog outputs (unit percent) is switched through to the control ports in sync with power mains. The analog value is output to the TRIAC control port in the range between (output value > SwitchOffValue) and (output value ≤ 95%) with a resolution of 1%.

A short triac turn-on delay is required for open line detection. Therefore even with output values ≥ 96%, there is a small pause in control.

Changes to the output value are applied at the next positive half-wave



9.15.15.15.7.1 Commutation angle for analog outputs 1 - 4

Name:

AnalogOutput01 to AnalogOutput04

These registers are used to set the commutation angle for phase angle control.

Values between 0 and 100 correspond to the output value for the respective channel in percent. Values above 100 correspond to 100%.

| Data type | Value |
|-----------|----------|
| USINT | 0 to 100 |

Information:

The commutation angle for phase angle control set in these registers are only applied when the channels are set to ANALOG in register "CfO_OutputConfig" on page 1720.

9.15.15.15.8 Output configuration

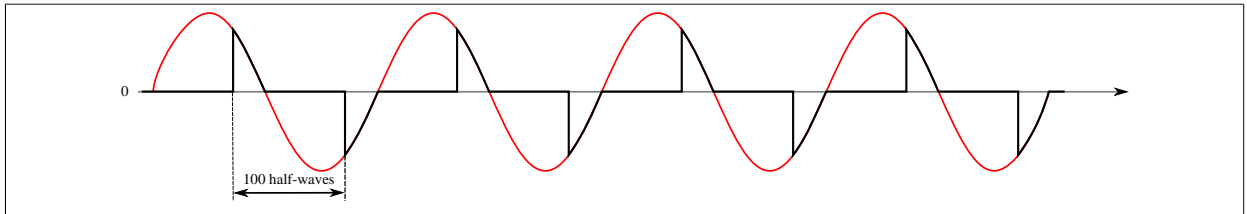
9.15.15.15.8.1 Configuring the half-wave pattern

Name:

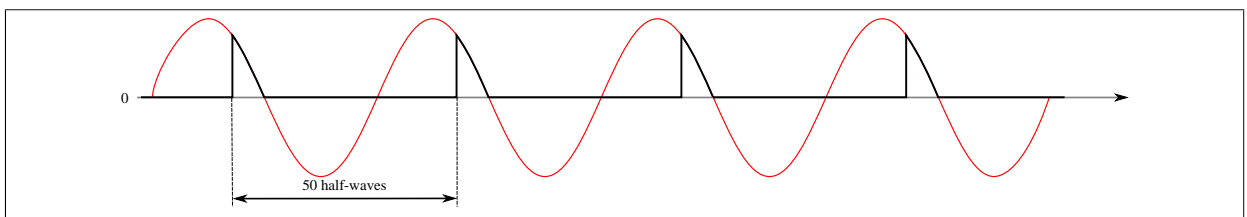
CfO_Frequency

This register can only be used in [function model 2 - Frequency mode](#) and makes it possible to configure the output of half-wave patterns in various frequencies. The [commutation angle of the outputs](#) is not affected by this. The following frequency patterns can be configured:

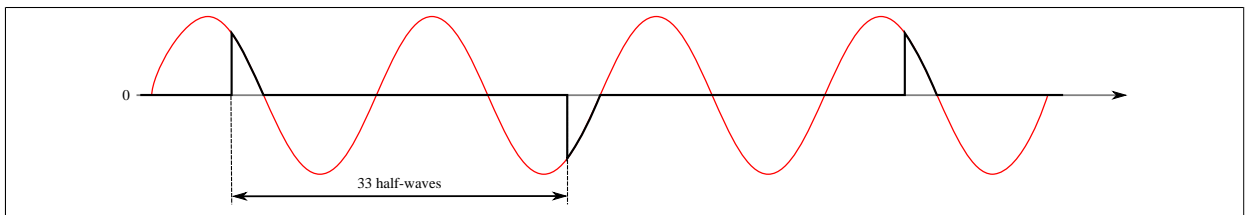
- 100 half-waves



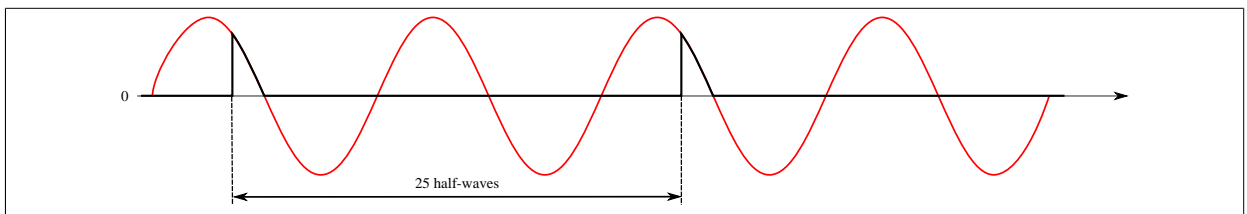
- 50 half-waves



- 33 half-waves



- 25 half-waves



With multichannel operation, the different channels should be operated with delayed half-waves in order to ensure that the load is placed evenly on the module.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|-------------|--------------|--|
| 0 - 3 | Channel 1 | 0000 | 100 half-waves/second |
| | | 0001 | 50 half-waves/second |
| | | 0010 | 25 half-waves/second |
| | | 0011 | 33 half-waves/second |
| | | 0101 | 50 half-waves/second delayed by 1 half-wave |
| | | 0110 | 25 half-waves/second delayed by 2 half-waves |
| | | 0111 | 33 half-waves/second delayed by 1 half-wave |
| | | 4 - 7 | Channel 2 |
| 8 - 11 | Channel 3 | 0000 to 0111 | See channel 1. |
| 12 - 15 | Channel 4 | 0000 to 0111 | See channel 1. |

Information:

This function is available beginning with firmware version 940. This can be included beginning with hardware variant 8.

9.15.15.15.8.2 Setting the switch-off time

Name:

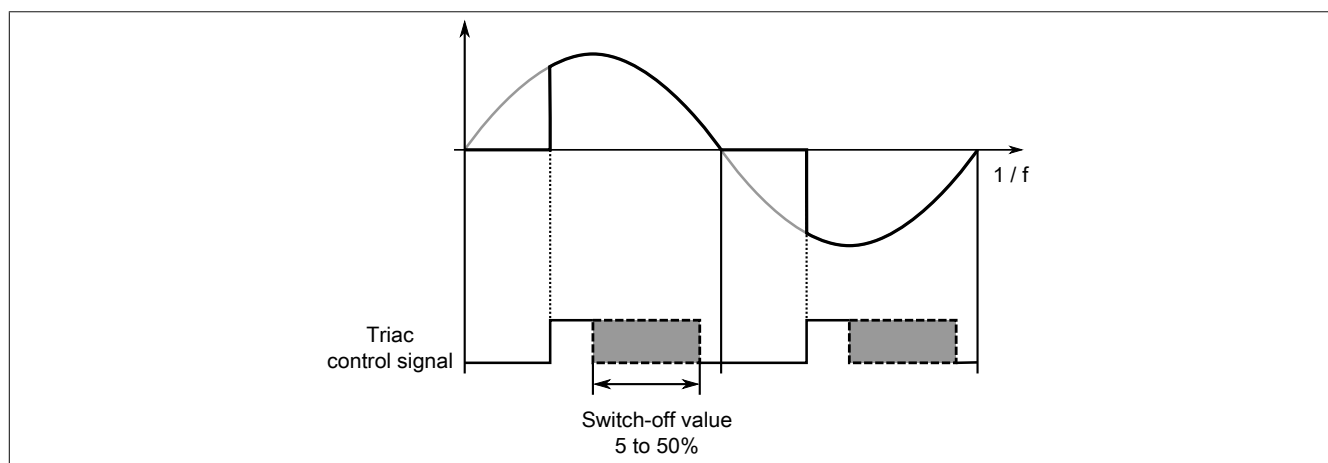
CfO_SwitchOffValue1 to CfO_SwitchOffValue4

This register defines how far in front of the zero cross-over the internal control signal for the TRIAC is switched off. Increasing this value may be necessary in order to prevent unwanted firing of the TRIAC in the event of a slight disturbance in the mains frequency.

With smaller loads, it is important to ensure that this switch off value is not set to large (too early) to prevent switching off prematurely.

The triac can of course only be fired before the set switch-off time.

"SwitchOffValue" in the Automation Studio I/O configuration.



| Data type | Value | Description |
|-----------|---------|--|
| USINT | 5 to 50 | Switch-off time in %. Bus controller default setting: 5 |

9.15.15.15.8.3 Configuration of the output channels

Name:

CfO_OutputConfig

The configuration of the output channels is stored in this register.

"Output type digital/analog" and "Output type full/half wave" in the Automation Studio I/O configuration

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 15 |

Bit structure:

| Bit | Description | Value | Information |
|-----|--|-------|---|
| 0 | Channel 1: Digital/Analog output | 0 | Output channel 1 is defined as a digital output. The output status is defined by bit 0 of register "DigitalOutput 1 - 4" on page 1717. |
| | | 1 | Output channel 1 is defined as an analog output. The output status is defined by register "AnalogOutput01" on page 1718 (bus controller default setting). |
| ... | ... | ... | ... |
| 3 | Channel 4: Digital/Analog output | 0 | Output channel 4 is defined as a digital output. The output status is defined by bit 3 of register "DigitalOutput 1 - 4" on page 1717. |
| | | 1 | Output channel 4 is defined as an analog output. The output status is defined by register "AnalogOutput04" on page 1718 (bus controller default setting). |
| 4 | Channel 1: Full-wave/Half-wave control ¹⁾ | 0 | Full-wave control on output channel 1 (bus controller default setting) |
| | | 1 | Negative half-wave on output channel 1 is suppressed. |
| ... | ... | ... | ... |
| 7 | Channel 4: Full-wave/Half-wave control ¹⁾ | 0 | Full-wave control on output channel 4 (bus controller default setting) |
| | | 1 | Negative half-wave on output channel 4 is suppressed. |

1) Not available in function model 2 - Frequency mode.

9.15.15.15.8.4 Switching behavior for zero-crossing errors

Name:

CfO_OutputTolerance

This register can be used to set the switching behavior of the trigger. After the number of zero-crossing errors configured in Bit 0 to 4, the output is switched off for at least 3 periods. This is followed by synchronization with the zero signal according to Bit 7.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------|---------|--|
| 0 - 4 | Trigger for Resync | 0 to 30 | Number of zero crossing errors. Bus controller default setting: 0 |
| 5 - 6 | Reserved | - | |
| 7 | Fast settling | 0 | Quick adjustment (bus controller default setting) |
| | | 1 | PLL synchronization |

Fast synchronization

With this option, the trigger point is closed-loop controlled after each individual zero-crossover and input jitter.

- **Advantage:** Increased tolerance and faster response to deviations in mains frequency
- **Disadvantage:** Increased switch-on jitter for firing signal by zero cross signal $\pm 100 \mu\text{Sec}$

PLL synchronization

With this option the intervals between zero cross-overs are measured and the PLL frequency is updated accordingly.

- **Advantage:** Jitter-free firing signal
- **Disadvantage:** When the output is switched off, additional measurement phases are required before it can be switched back on.

Information:

This function is available starting with Firmware version 928. This can be installed with hardware version 8 and hardware revision B2 or higher.

9.15.15.15.9 Status of the outputs

Name:

LowCurrentStatus1 through LowCurrentStatus4

ZeroCrossingInput

ZeroCrossingStatus

StatusInput01

The operating status of the outputs is mapped in this register.

In order to determine the "LowCurrentStatus", the system checks if there is a neutral connection from the output via the consumer shortly before each triac firing.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("LowCurrentStatus1" to "ZeroCrossingStatus") or whether this register should be displayed as a single USINT data point ("StatusInput01").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 255 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-------|--------------------|-------|---|
| 0 | LowCurrentStatus1 | 0 | Current flow on activated output 1 |
| | | 1 | No current flow on activated output 1 |
| ... | | ... | |
| 3 | LowCurrentStatus4 | 0 | Current flow on activated output 4 |
| | | 1 | No current flow on activated output 4 |
| 4 | ZeroCrossingInput | 0 | Zero cross signal during the negative half-wave |
| | | 1 | Zero cross signal during the positive half-wave |
| 5 - 6 | Reserved | - | |
| 7 | ZeroCrossingStatus | 0 | Zero cross signal OK |
| | | 1 | Zero cross signal has dropped out |

9.15.15.15.10 Function model "OSP"

In function model "OSP" (Operator Set Predefined), the user defines an analog value or digital pattern. This OSP value is output as soon as the communication between the module and master is aborted.

Functionality

The user has the choice between 2 OSP modes:

- Retain last valid value
- Replace with static value

In the first case, the module retains the last value recognized as a valid output status.

When selecting mode "Replace with static value", a plausible output value must be entered in the associated value register. When an OSP event occurs, this value is output instead of the value currently requested by the task.

9.15.15.15.10.1 Enabling OPS output in the module

Name:

OSPValid

This data point makes it possible to start the output of the module and request the use of OSP during operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|---|
| 0 | OSPValid | 0 | Request OSP operation (after initial startup or module in stand-by) |
| | | 1 | Request normal operation |
| 1 - 7 | Reserved | 0 | |

Bit OSPValid exists once on the module and is managed by the user task. It must be set to start the enabled channels. As long as bit OSPValid remains set in the module, the module behaves the same as in function model "Standard".

If an OSP event occurs, e.g. communication between the module and master CPU aborted, then bit OSPValid is reset on the module. The module enters the OSP state and output occurs according to the configuration in register "OSPMode" on page 1723.

The following generally applies:

Even after regeneration of the communication channel, the OSP replacement value is still pending. The OSP state is only exited again when a set OSPValid bit is transferred.

When the master CPU is restarted, bit OSPValid bit is reinitialized in the master CPU. It must be set once more by the application and transferred via the bus.

In the event of brief communication errors between the module and master CPU (e.g. due to EMC), the cyclic registers fail to refresh for several bus cycles. Within the module, bit OSPValid is reset; the set bit is retained in the CPU, however. During the next successful transfer, the module-internal OSPValid bit is set again and the module automatically returns to normal operation.

If the task in the master CPU needs the information about which output mode the module is currently in, bit ModulOK can be evaluated.

Warning!

If bit OSPValid bit is reset to "0" by the module, the output status no longer depends on the responsible task in the master CPU. Nevertheless, output is made depending on the configuration of the OSP replacement value.

9.15.15.15.10.2 Setting OSP mode

Name:

CfgOSPMode

This register controls the behavior of a channel when using OSP.

| Data type | Values | Explanation |
|-----------|--------|---------------------------|
| USINT | 0 | Replace with static value |
| | 1 | Retain last valid value |

9.15.15.15.10.3 Defining an OSP-digital output value

Name:

CfgOSPValue

This register contains the digital output value that is output in "Replace with static value" mode during OSP operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------|--------|--|
| 0 | | 0 or 1 | OSP output value for channel DigitalOutput00 |
| ... | | ... | |
| x | | 0 or 1 | OSP output value for channel DigitalOutput0x |

Warning!

"OSPValue" is only applied by the module if bit "OSPValid" has been set in the module.

9.15.15.15.10.4 Define the OSP analog output value

Name:

CfgOSPValue01 to CfgOSPValue04

This register contains the analog output value, which is output in "Replace with static value" mode during OSP operation.

| Data type | Value |
|-----------|----------|
| USINT | 0 to 100 |

Warning!

"OSPValue" is only applied by the module if bit "OSPValid" has been set in the module.

9.15.15.15.11 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|--------|
| All channels | 250 µs |

9.15.15.15.12 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|--------|
| All channels | 150 µs |

9.15.16 X20(c)DO4649

Data sheet version: 2.28

9.15.16.1 General information

The module is equipped with 4 relay outputs.

- 4 digital outputs
- Relay module for 240 VAC / 30 VDC
- 4 normally open contacts
- Single-channel isolated outputs

Danger!

Risk of electric shock!

The terminal block is only permitted to conduct voltage when it is connected. It is not permitted to be disconnected or connected while voltage is applied or have voltage applied to it while it is removed under any circumstances.

This module is not permitted to be the last module connected on the X2X Link network. At least one subsequent X20ZF dummy module must provide protection against contact.

Danger!

The voltage classes on the terminal block must not be mixed! Only operation at mains voltage (e.g. 230 VAC) OR safety extra-low voltage (e.g. 24 VDC SELV) is permitted.

9.15.16.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.15.16.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.15.16.3 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Digital outputs |  |
| X20DO4649 | X20 digital output module, 4 relays, N.O. contacts, 240 VAC / 5 A | |
| X20cDO4649 | X20 digital output module, coated, 4 relays, N.O. contacts, 240 VAC / 5 A | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 324: X20DO4649, X20cDO4649 - Order data

9.15.16.4 Technical data

| Model number | X20DO4649 | X20cDO4649 |
|--|--|------------|
| Short description | 4 digital outputs 30 VDC / 240 VAC, outputs are single-channel isolated | |
| I/O module | 4 digital outputs 30 VDC / 240 VAC, outputs are single-channel isolated | |
| General information | | |
| B&R ID code | 0xA704 | 0xE67E |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Outputs | Yes, using status LED | |
| Power consumption | | |
| Bus | 0.8 W | |
| Internal I/O | - | |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +1.5 | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Digital outputs | | |
| Variant | Relay / Normally open contact Channels are single-channel isolated | |
| Nominal voltage | 30 VDC / 240 VAC | |
| Max. voltage | 264 VAC | |
| Switching voltage | Max. 110 VDC / 264 VAC | |
| Rated frequency | DC / 45 to 63 Hz | |
| Nominal output current | 5 A at 30 VDC / 5 A at 240 VAC | |
| Total nominal current | 10 A at 30 VDC / 10 A at 240 VAC | |
| Actuator power supply | External | |
| Inrush current | Max. 5 A (per channel) | |
| Contact resistance | Max. 100 mΩ | |
| Switching delay | | |
| 0 → 1 | ≤10 ms | |
| 1 → 0 | ≤10 ms | |
| Isolation voltages | | |
| Channel - Bus | Tested at 2300 VAC | |
| Channel - Channel | Tested at 750 VAC | |

Table 325: X20DO4649, X20cDO4649 - Technical data


| Model number | X20DO4649 | X20cDO4649 |
|--|--|---|
| Service life | | |
| Electrical ²⁾ | Min. 5 x 10 ⁴ ops. (NO) at 5 A | |
| Mechanical | Min. 2 x 10 ⁷ ops. | |
| Switching capacity | | |
| Minimum | 0.05 W / 2.4 VA | |
| Maximum | 150 W / 1250 VA | |
| Protective circuit | | |
| Internal | None | |
| External | | |
| AC | RC combination or VDR | |
| DC | Inverse diode, RC combination or VDR | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from channel and bus | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Not permitted | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating" | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 325: X20DO4649, X20cDO4649 - Technical data

- 1) Number of outputs x Contact resistance x Nominal output current². For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) With a resistive load. See also section "Electrical service life"

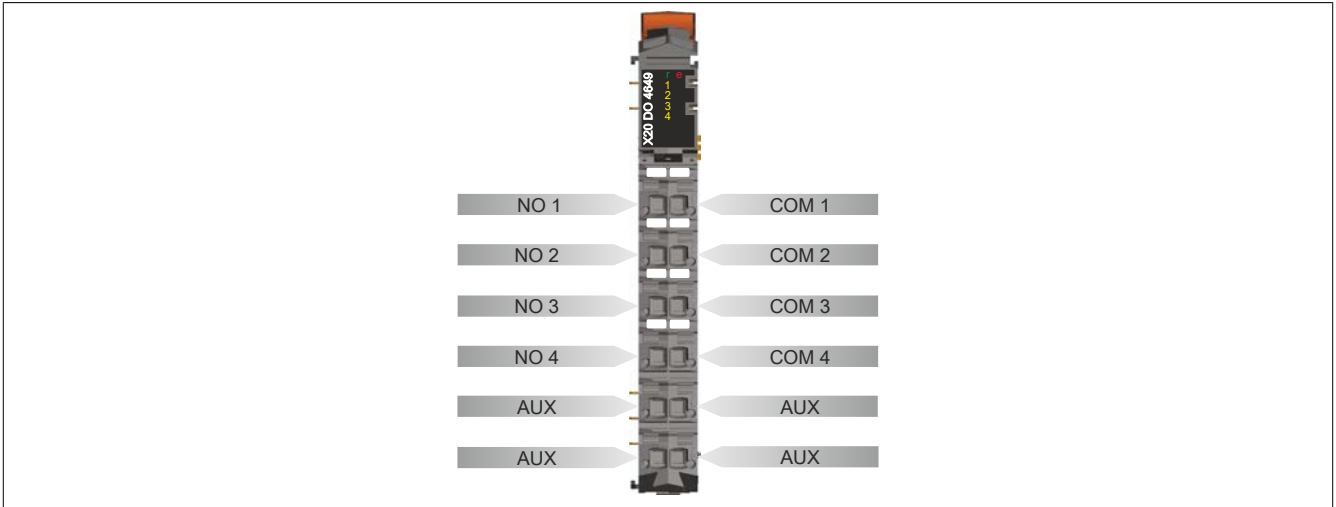
9.15.16.5 Status LEDs

For a description of the various operating modes, see ["Diagnostic LEDs" on page 3787](#).

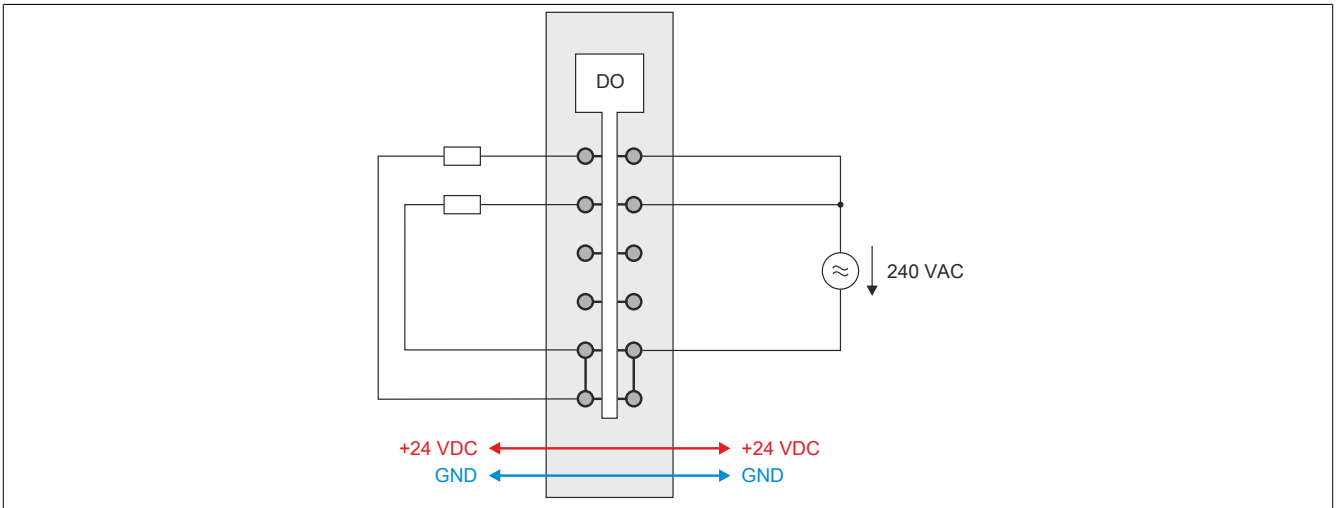
| Figure | LED | Color | Status | Description | |
|---|-------|-------|-----------------------------|--|---|
|  | r | Green | Off | Module supply not connected | |
| | | | Single flash | RESET mode | |
| | | | Blinking | PREOPERATIONAL mode | |
| | | | On | RUN mode | |
| | e | Red | Off | Module supply not connected or everything OK | |
| | | | On | Error or reset status | |
| | e + r | | Red on / Green single flash | Invalid firmware | |
| | 1 - 4 | | Orange | | Output status of the corresponding digital output |

9.15.16.6 Pinout

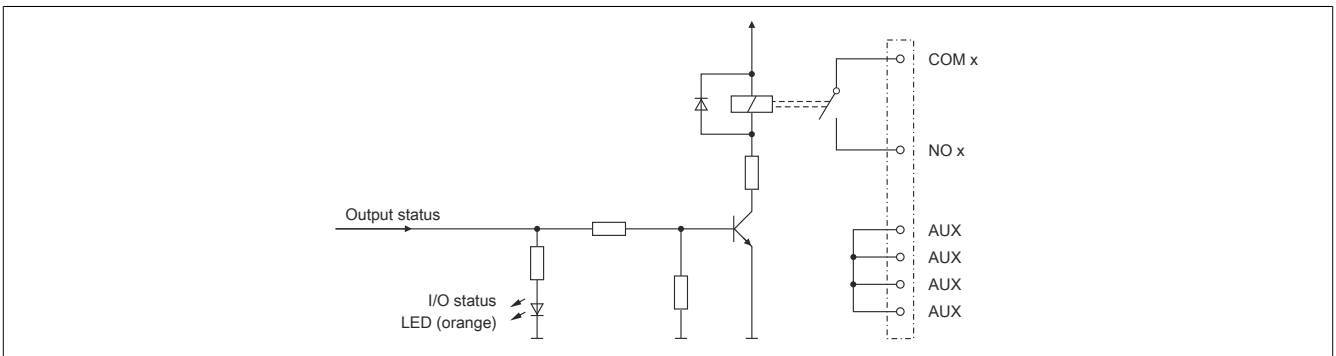
For easy wiring, 4 auxiliary contacts are available on the module starting with revision E0. They are connected together internally and can be loaded with a total of 10 A (see also section "Connection example" on page 1728).



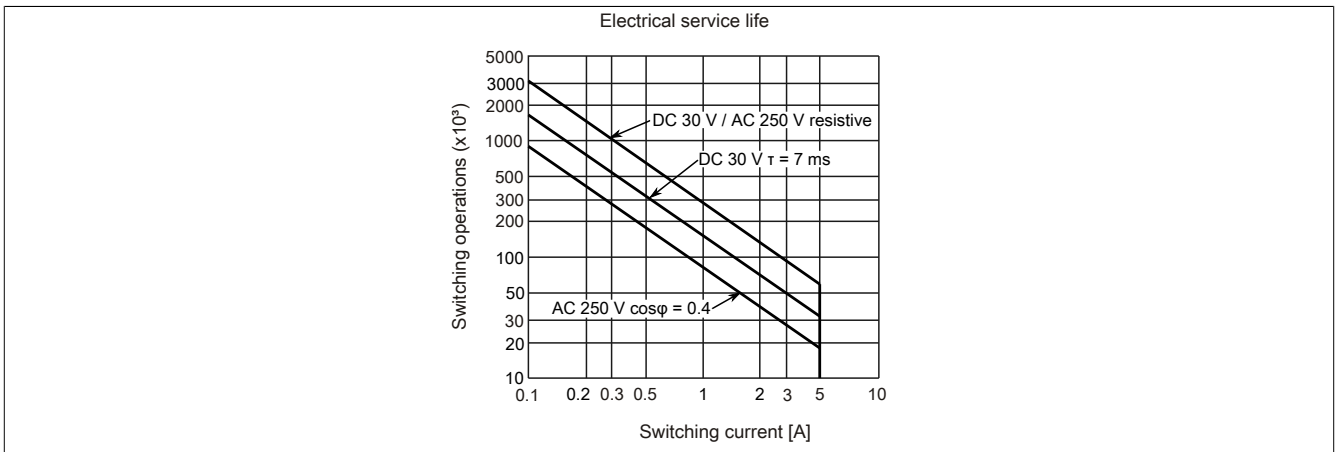
9.15.16.7 Connection example



9.15.16.8 Output circuit diagram



9.15.16.9 Electrical service life



9.15.16.10 Derating

There is no derating when operated below 55°C.

When operating above 55°C, the maximum current per channel is reduced to 4 A and the maximum summation current to 8 A!

9.15.16.11 Register description

9.15.16.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.15.16.11.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|-----------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | DigitalOutput | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput04 | Bit 3 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.16.11.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 4 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput04 | Bit 3 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.15.16.11.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.16.11.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.15.16.11.4 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 μ s) based on the network cycle (SyncOut).

9.15.16.11.4.1 Switching state of digital outputs 1 to 4

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput04

This register is used to store the switching state of digital outputs 1 to 4.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Values | Information |
|-----------|------------------------|---|
| USINT | 0 to 15 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model \neq 0 - Standard. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 3 | DigitalOutput04 | 0 | Digital output 04 reset |
| | | 1 | Digital output 04 set |

9.15.16.11.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.15.16.11.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|---------------------------------|
| Equal to the minimum cycle time |

9.15.17 X2DO4F49

Data sheet version: 1.05

9.15.17.1 General information

This module is equipped with 4 relay outputs. It can switch DC voltages up to 250 VDC and is therefore suitable for use in power generation systems.

- 4 digital outputs
- Relay module for 250 VDC / 240 VAC
- 2 normally open contacts and 2 changeover contacts
- Single-channel isolated outputs

Danger!

Risk of electric shock!

The terminal block is only permitted to conduct voltage when it is connected. It is not permitted to be disconnected or connected while voltage is applied or have voltage applied to it while it is removed under any circumstances.

This module is not permitted to be the last module connected on the X2X Link network. At least one subsequent X20ZF dummy module must provide protection against contact.

Danger!

The voltage classes on the terminal block must not be mixed! Only operation at mains voltage (e.g. 230 VAC) OR safety extra-low voltage (e.g. 24 VDC SELV) is permitted.

9.15.17.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Digital outputs |  |
| X2DO4F49 | X20 digital output module, 4 relays, 2x normally open contacts, 2x changeover contacts, 240 VAC / 2 A, 250 VDC / 0.28 A | |
| | Required accessories | |
| | Bus modules | |
| X20BM32 | X20 bus module for double-width modules, 240 VAC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB32 | X20 terminal block, 12-pin, 240 VAC keyed | |
| | | |
| | | |
| | | |

Table 326: X2DO4F49 - Order data

9.15.17.3 Technical data

| Model number | X20DO4F49 |
|--|---|
| Short description | |
| I/O module | 4 digital outputs 250 VDC / 240 VAC, outputs single-channel isolated |
| General information | |
| B&R ID code | 0xF76A |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| Outputs | Yes, using LED status indicator |
| Power consumption | |
| Bus | 1.1 W |
| Internal I/O | - |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +0.32 |
| Certifications | |
| CE | In preparation |
| Digital outputs | |
| Variant | Relays: 2 normally open contacts and 2 changeover contacts Channels are single-channel isolated. |
| Nominal voltage | 250 VDC / 240 VAC |
| Max. voltage | 250 VAC |
| Switching voltage | Max. 250 VDC / 250 VAC |
| Rated frequency | DC / 45 to 63 Hz |
| Nominal output current | DC: See section "DC switching capacity". AC: 2 A at 240 VAC |
| Total nominal current | DC: See section "DC switching capacity". AC: 8 A at 240 VAC |
| Actuator power supply | External |
| Inrush current | Max. 8 A (per channel) |
| Contact resistance | Max. 100 mΩ |
| Switching delay | |
| 0 → 1 | Normally open contact ≤15 ms / Changeover contact ≤19 ms |
| 1 → 0 | Normally open contact ≤11 ms / Changeover contact ≤15 ms |
| Isolation voltages | |
| Channel - Bus | Tested at 3500 VAC |
| Channel - Channel | Tested at 1700 VAC |
| Channel - Ground | Tested at 3500 VAC |
| Service life | |
| Electrical ²⁾ | 10 ⁵ at 2 A (normally open and changeover contact) |
| Mechanical | 30 x10 ⁶ cycles (normally open and changeover contact) |
| Switching capacity | |
| Minimum | 0.12 W DC / 2.4 W AC |
| Maximum | DC: See section "DC switching capacity". AC: 480 W |
| Protective circuit | |
| Internal | None |
| External | |
| AC | RC combination or VDR |
| DC | Inverse diode, RC combination or VDR |
| Electrical properties | |
| Electrical isolation | Channel isolated from channel and bus |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m ³⁾ |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |

Table 327: X20DO4F49 - Technical data

| Model number | X20DO4F49 |
|------------------------------|--|
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB32 separately. Order 1x bus module X20BM32 separately. |
| Pitch | 25 ^{+0.2} mm |

Table 327: X20DO4F49 - Technical data

- 1) Number of outputs x Contact resistance x Nominal output current². For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) With resistive load. See also section "Electrical service life".
- 3) Maximum permissible height: 4000 m

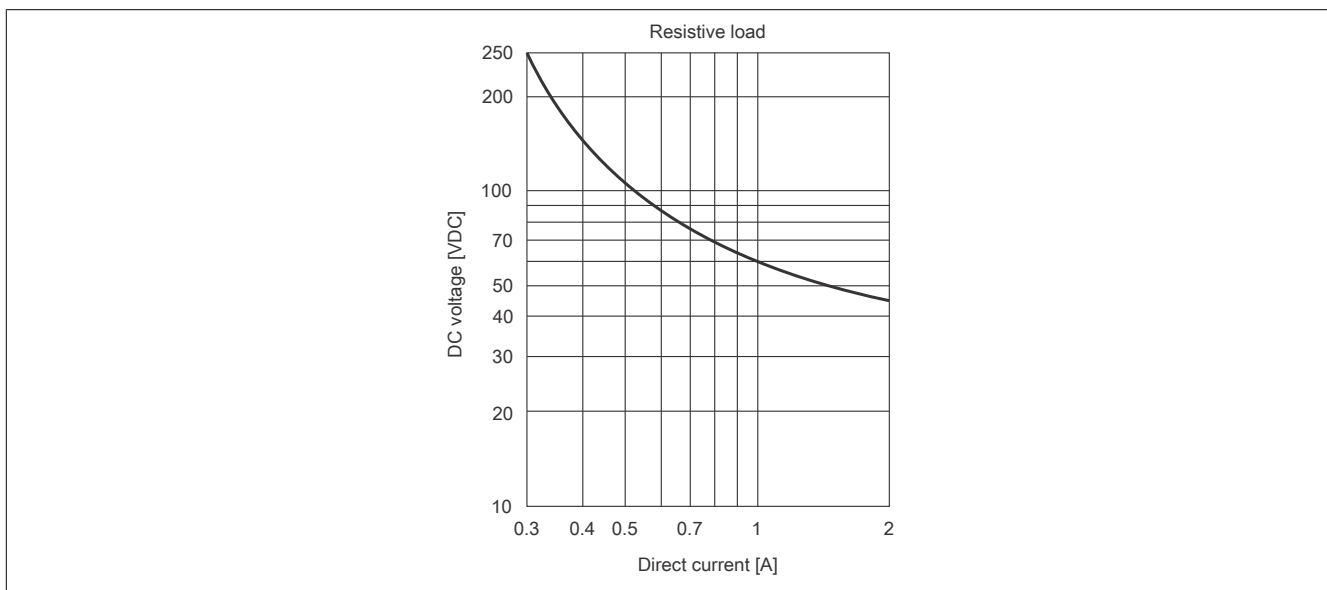
9.15.17.3.1 DC switching capacity

The following table shows the possible load on the outputs with resistive or inductive load based on the DC voltage applied.

| Voltage [VDC] | Resistive load [A] | Inductive load (L/R = 20 ms) [A] |
|---------------|--------------------|----------------------------------|
| 24 | 2 | 0.7 |
| 48 | 0.58 ¹⁾ | 0.3 |
| 72 | 0.38 ¹⁾ | 0.2 |
| 110 | 0.28 | 0.15 |
| 125 | 0.28 | 0.14 |
| 200 | 0.28 | 0.1 |
| 250 | 0.28 | - |


1) Based on R300 rating per UL 508

Switching capacity for resistive load

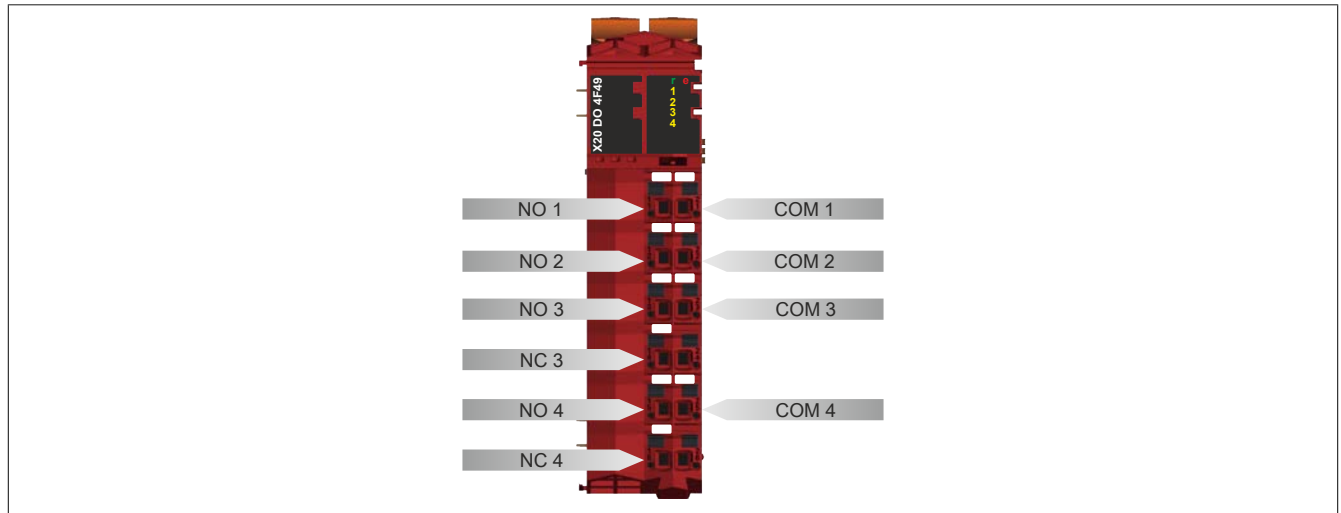


9.15.17.4 LED status indicators

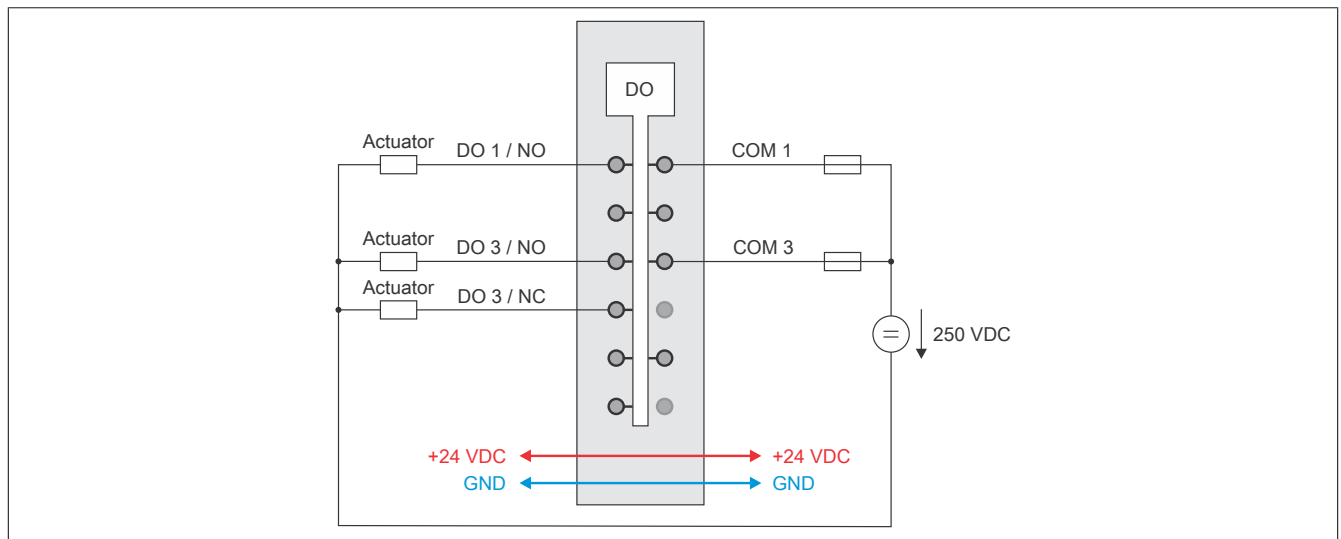
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|--------|--------------------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | Mode RESET |
| | | | Blinking | Mode PREOPERATIONAL |
| | | | On | Mode RUN |
| | e | Red | Off | Module not supplied with power or everything OK |
| | | | On | Error or reset state |
| | e + r | | Solid red / Single green flash | Invalid firmware |
| 1 - 4 | | Orange | | Output state of the corresponding digital output |

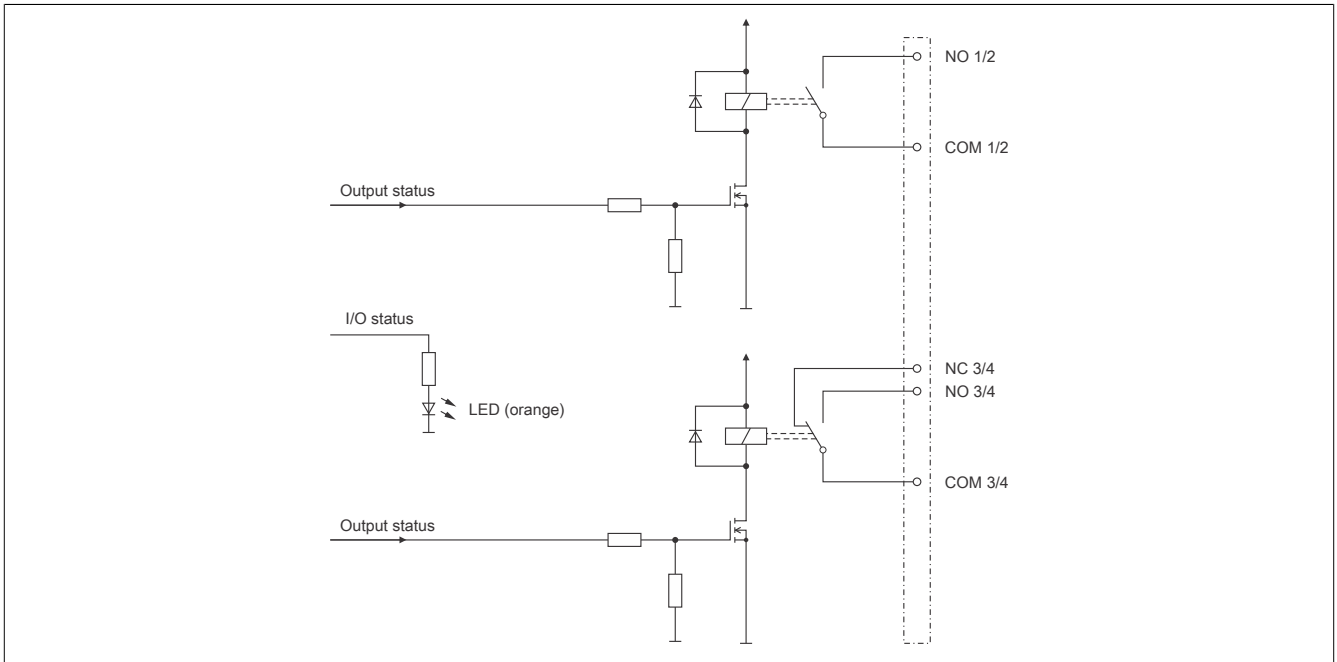
9.15.17.5 Pinout



9.15.17.6 Connection example

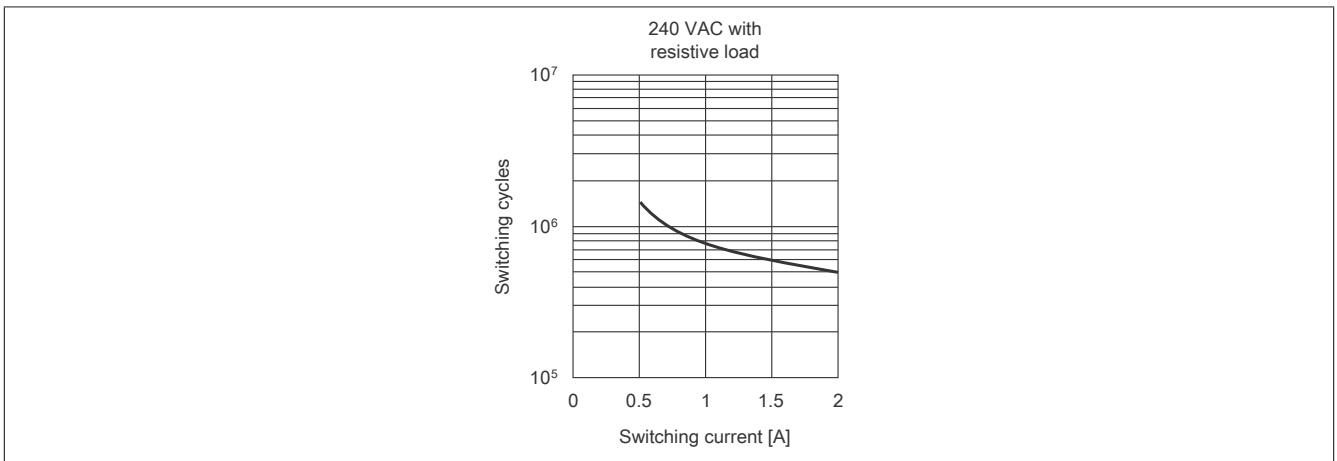


9.15.17.7 Output circuit diagram



9.15.17.8 Electrical service life

The diagram shows the number of switching cycles based on current at 240 VAC and with resistive load.



9.15.17.9 Register description

9.15.17.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.15.17.9.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|-----------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | DigitalOutput | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput04 | Bit 3 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.17.9.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 4 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput04 | Bit 3 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.15.17.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.17.9.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.15.17.9.4 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 μ s) based on the network cycle (SyncOut).

9.15.17.9.4.1 Switching state of digital outputs 1 to 4

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput04

This register is used to store the switching state of digital outputs 1 to 4.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Values | Information |
|-----------|------------------------|---|
| USINT | 0 to 15 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model \neq 0 - Standard. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 3 | DigitalOutput04 | 0 | Digital output 04 reset |
| | | 1 | Digital output 04 set |

9.15.17.9.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 250 μ s |

9.15.17.9.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|---------------------------------|
| Equal to the minimum cycle time |

9.15.18 X20(c)DO6321

Data sheet version: 3.27

9.15.18.1 General information

The module is equipped with 6 outputs for 1 or 2-wire connections. The X20 6-pin terminal block can be used for universal 1-line wiring. 2-line wiring can be implemented using the 12-pin terminal block. The X20DO6321 is designed for sink output wiring.

- 6 digital outputs
- Sink connection
- 2-wire connections
- 24 VDC for signal supply
- Integrated output protection
- 1-wire connection type with 6-pin terminal block

9.15.18.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.15.18.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C . During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.15.18.3 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Digital outputs |  |
| X20DO6321 | X20 digital output module, 6 outputs, 24 VDC, 0.5 A, sink, 2-wire connections | |
| X20cDO6321 | X20 digital output module, coated, 6 outputs, 24 VDC, 0.5 A, sink, 2-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 328: X20DO6321, X20cDO6321 - Order data

9.15.18.4 Technical data

| Model number | X20DO6321 | X20cDO6321 |
|--|--|------------|
| Short description | | |
| I/O module | 6 digital outputs 24 VDC for 1- or 2-wire connections | |
| General information | | |
| B&R ID code | 0x1B99 | 0xE228 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Outputs | Yes, using status LED and software (output error status) | |
| Power consumption | | |
| Bus | 0.2 W | |
| Internal I/O | 0.59 W | |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +0.18 | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| EAC | Yes | |
| KC | Yes | - |
| Digital outputs | | |
| Variant | FET negative switching | |
| Nominal voltage | 24 VDC | |
| Switching voltage | 24 VDC -15 % / +20 % | |
| Nominal output current | 0.5 A | |
| Total nominal current | 3 A | |
| Connection type | 1- or 2-wire connections | |
| Output circuit | Sink | |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short circuit current") Internal inverse diode for switching inductive loads (see section "Switching inductive loads") | |
| Diagnostic status | Output monitoring with 10 ms delay | |
| Leakage current when the power is switched off | 75 µA | |
| R _{DS(on)} | 120 mΩ | |
| Peak short-circuit current | <7 A | |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms (depends on the module temperature) | |
| Switching delay | | |
| 0 → 1 | <300 µs | |
| 1 → 0 | <300 µs | |
| Switching frequency | | |
| Resistive load | Max. 500 Hz | |
| Inductive load | See section "Switching inductive loads" | |
| Braking voltage when switching off inductive loads | Typ. 50 VDC | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel and I/O power supply | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Starting temperature | - | Yes, -40°C |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |

Table 329: X20DO6321, X20cDO6321 - Technical data


| Model number | X20DO6321 | X20cDO6321 |
|------------------------------|--|---|
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB06 or X20T-B12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB06 or X20T-B12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 329: X20DO6321, X20cDO6321 - Technical data

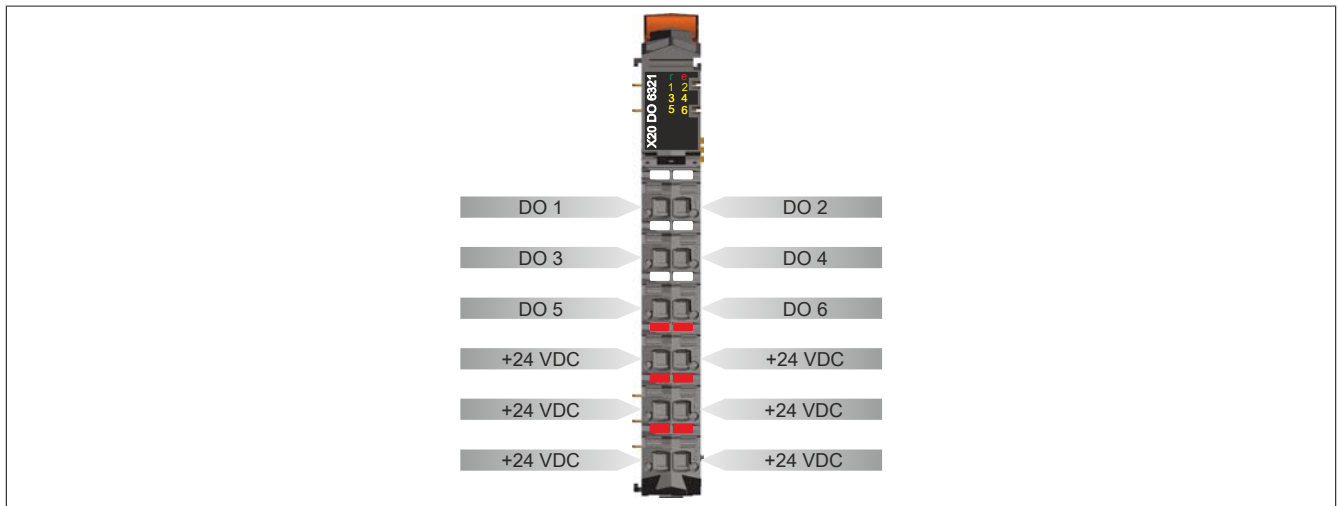
1) Number of outputs x $R_{DS(on)}$ x Nominal output current². For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.

9.15.18.5 Status LEDs

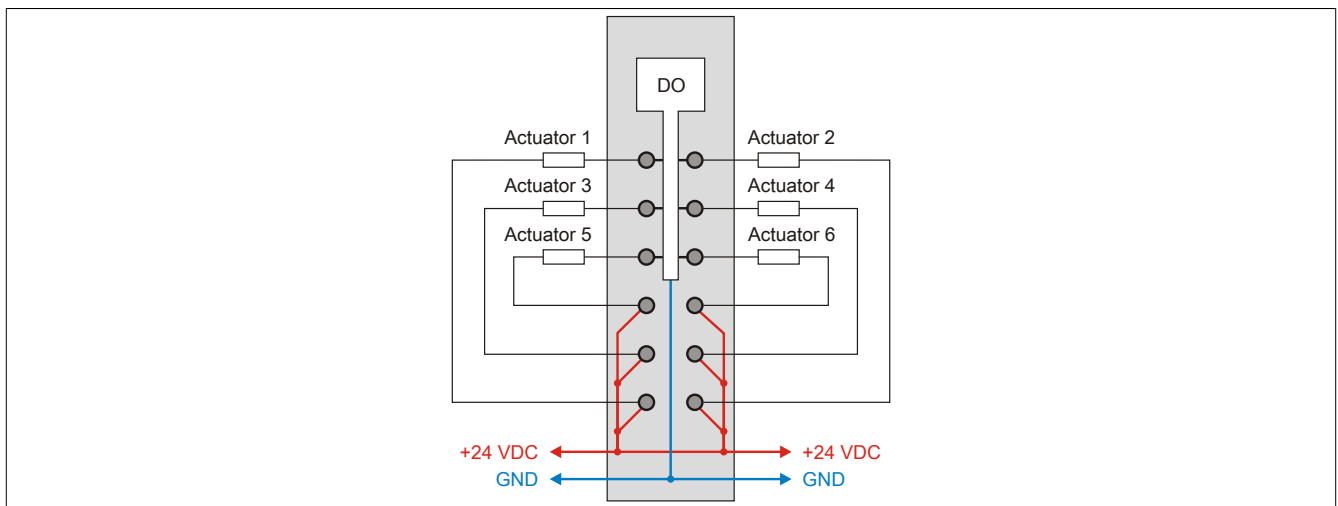
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|-----------------------------|------------------|---|
|  | r | Green | Off | Module supply not connected |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | e | Red | On | RUN mode |
| | | | Single flash | Module supply not connected or everything OK Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1 - 6 | Orange | | Output status of the corresponding digital output |

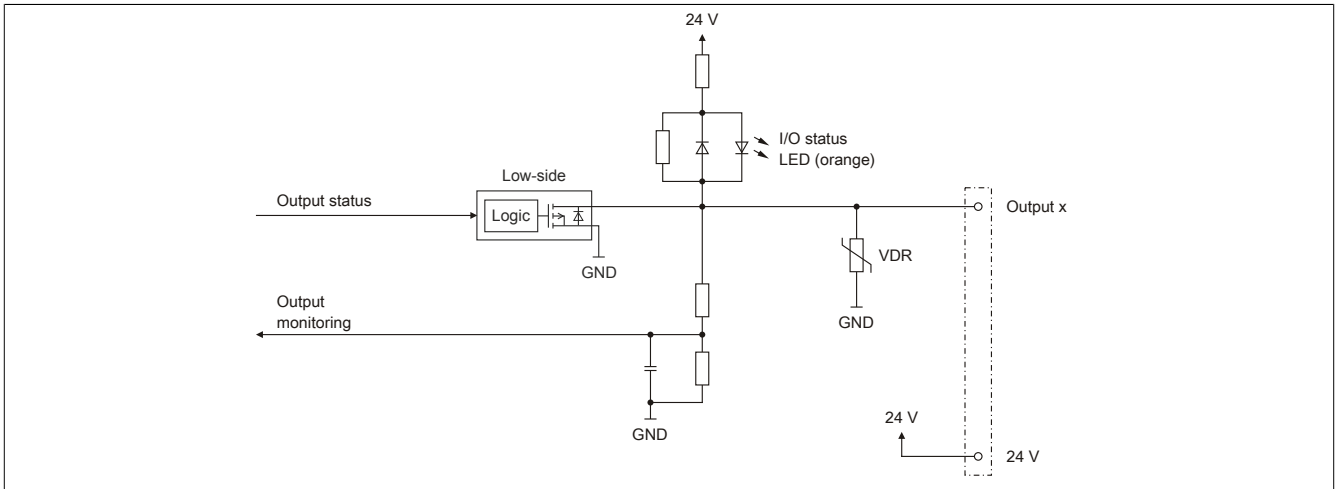
9.15.18.6 Pinout



9.15.18.7 Connection example

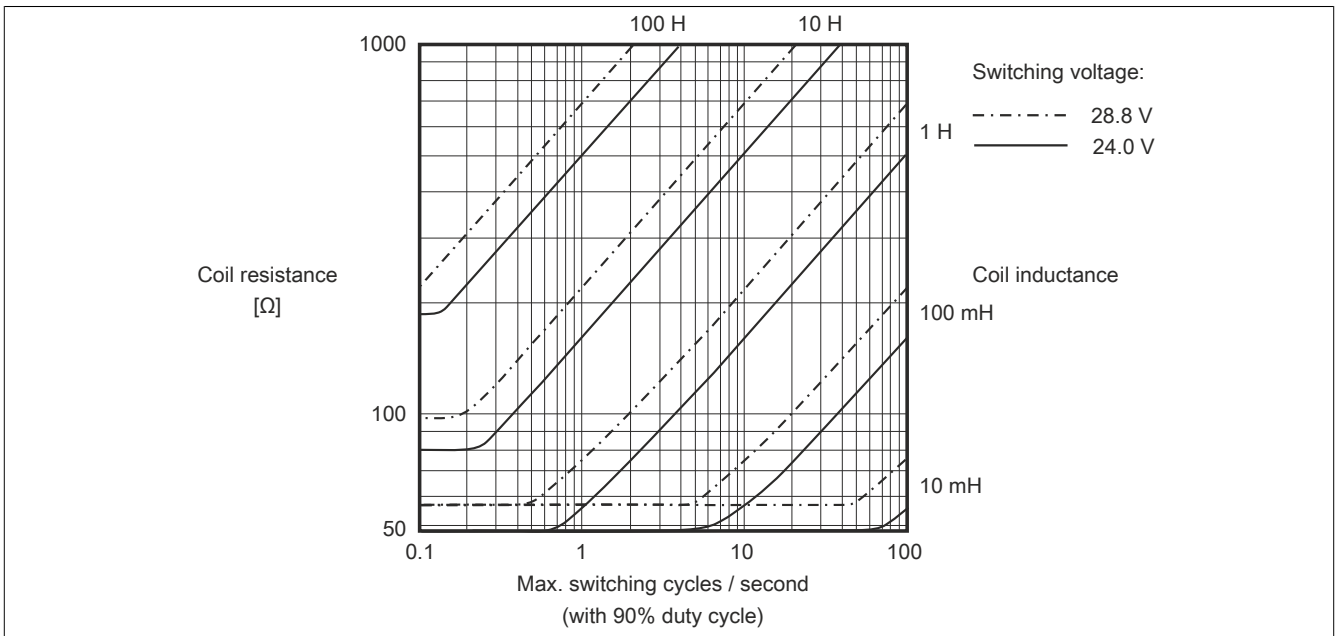


9.15.18.8 Output circuit diagram



9.15.18.9 Switching inductive loads

Environmental temperature: 60°C, all outputs with the same load



Information:

If the maximum number of operating cycles per second is exceeded, an external inverse diode must be used.

Operating conditions outside of the area in the diagram are not permitted!

9.15.18.10 Register description

9.15.18.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.15.18.10.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|-----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | DigitalOutput | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput06 | Bit 5 | | | | |
| 30 | 1 | StatusInput01 | USINT | • | | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput06 | Bit 5 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.18.10.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 6 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput06 | Bit 5 | | | | |
| 30 | - | Status of digital outputs 1 to 6 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput06 | Bit 5 | | | | |

1) The offset specifies where the register is within the CAN object.

9.15.18.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.18.10.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.15.18.10.4 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 µs) based on the network cycle (SyncOut).

9.15.18.10.4.1 Switching state of digital outputs 1 to 6

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput06

The switching state of digital outputs 1 to 6 are stored in this register.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Values | Information |
|-----------|--------------------|--|
| USINT | 0 to 63 | Packed outputs = On |
| | See bit structure. | Packed outputs = Off or Function model <> 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 5 | DigitalOutput06 | 0 | Digital output 06 reset |
| | | 1 | Digital output 06 set |

9.15.18.10.5 Monitoring status of the digital outputs

On the module, the output states of the outputs are compared to the target states. The control of the output driver is used for the target state.

A change in the output state resets monitoring for that output. The status of each individual channel can be read. A change in the monitoring status is actively transmitted as an error message.

9.15.18.10.5.1 Status of digital outputs 1 to 6

Name:

StatusInput01

StatusDigitalOutput01 to StatusDigitalOutput06

The status of digital outputs 1 to 6 is mapped in this register.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("StatusDigitalOutput01" to "StatusDigitalOutput0x") or whether this register should be displayed as a single USINT data point ("StatusInput01").

| Data type | Values | Information |
|-----------|--------------------|--|
| USINT | 0 to 63 | Packed outputs = On |
| | See bit structure. | Packed outputs = Off or Function model <> 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput01 | 0 | Channel 01: No error |
| | | 1 | Channel 01: <ul style="list-style-type: none"> Short circuit or overload Channel switched on and missing I/O power supply Channel switched off and external voltage applied on channel |
| ... | | ... | |
| 5 | StatusDigitalOutput06 | 0 | Channel 06: No error |
| | | 1 | Channel 06: For an error description, see channel 01. |

9.15.18.10.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.15.18.10.7 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|---------------------------------|
| Equal to the minimum cycle time |

9.15.19 X20(c)DO6322

Data sheet version: 3.27

9.15.19.1 General information

The module is equipped with 6 outputs for 1 or 2-wire connections. The X20 6-pin terminal block can be used for universal 1-line wiring. 2-line wiring can be implemented using the 12-pin terminal block. The module is designed for source output wiring.

- 6 digital outputs
- Source connection
- 2-wire connections
- GND for signal supply
- Integrated output protection
- 1-wire connection type with 6-pin terminal block
- OSP mode

9.15.19.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.15.19.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C . During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.15.19.3 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Digital outputs |  |
| X20DO6322 | X20 digital output module, 6 outputs, 24 VDC, 0.5 A, source, 2-wire connections | |
| X20cDO6322 | X20 digital output module, coated, 6 outputs, 24 VDC, 0.5 A, source, 2-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 330: X20DO6322, X20cDO6322 - Order data

9.15.19.4 Technical data

| Model number | X20DO6322 | X20cDO6322 |
|--|--|------------|
| Short description | | |
| I/O module | 6 digital outputs 24 VDC for 1- or 2-wire connections | |
| General information | | |
| B&R ID code | 0x1B98 | 0xE229 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Outputs | Yes, using status LED and software (output error status) | |
| Power consumption | | |
| Bus | 0.18 W | |
| Internal I/O | 0.71 W | |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +0.31 | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Digital outputs | | |
| Variant | FET positive switching | |
| Nominal voltage | 24 VDC | |
| Switching voltage | 24 VDC -15 % / +20 % | |
| Nominal output current | 0.5 A | |
| Total nominal current | 3 A | |
| Connection type | 1- or 2-wire connections | |
| Output circuit | Source | |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short circuit current") Internal inverse diode for switching inductive loads (see section "Switching inductive loads") | |
| Diagnostic status | Output monitoring with 10 ms delay | |
| Leakage current when the power is switched off | 5 µA | |
| R _{DS(on)} | 210 mΩ | |
| Peak short-circuit current | <12 A | |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms (depends on the module temperature) | |
| Switching delay ²⁾ | | |
| 0 → 1 | <300 µs | |
| 1 → 0 | <300 µs | |
| Switching frequency | | |
| Resistive load ²⁾ | Max. 500 Hz | |
| Inductive load | See section "Switching inductive loads" | |
| Braking voltage when switching off inductive loads | Typ. 50 VDC | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel and I/O power supply | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |

Table 331: X20DO6322, X20cDO6322 - Technical data


| Model number | X20DO6322 | X20cDO6322 |
|---------------------------------|--|---|
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | | -25 to 60°C |
| Vertical mounting orientation | | -25 to 50°C |
| Derating | | - |
| Starting temperature | - | Yes, -40°C |
| Storage | | -40 to 85°C |
| Transport | | -40 to 85°C |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | | 5 to 95%, non-condensing |
| Transport | | 5 to 95%, non-condensing |
| Mechanical properties | | |
| Note | Order 1x X20TB06 or X20T-B12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB06 or X20T-B12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 331: X20DO6322, X20cDO6322 - Technical data

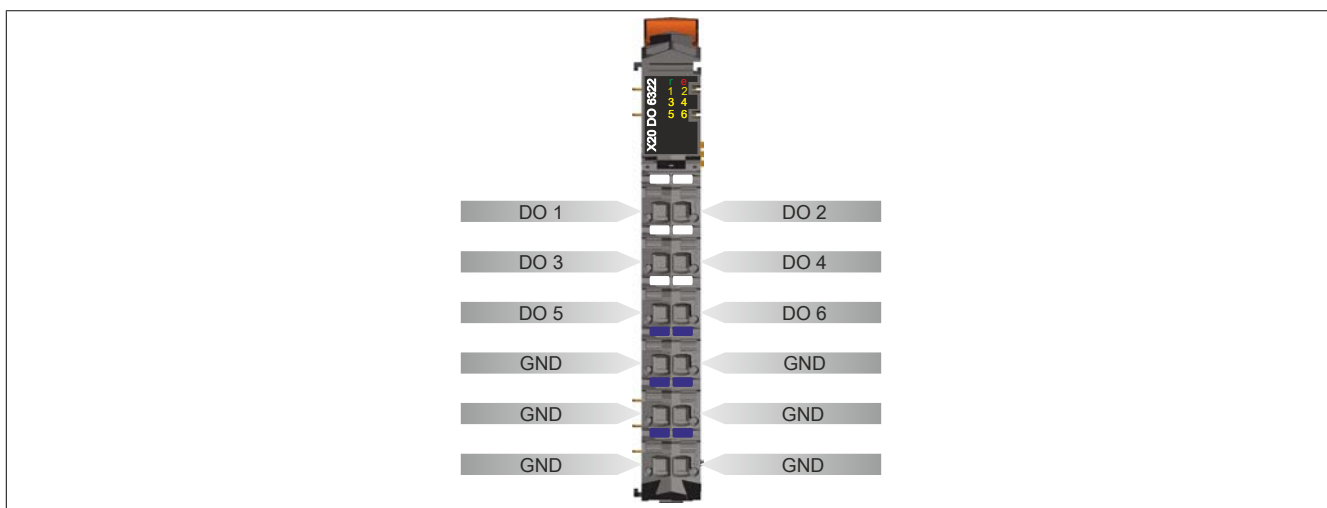
- 1) Number of outputs x R_{DS(on)} x Nominal output current². For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) At loads ≤ 1 kΩ

9.15.19.5 Status LEDs

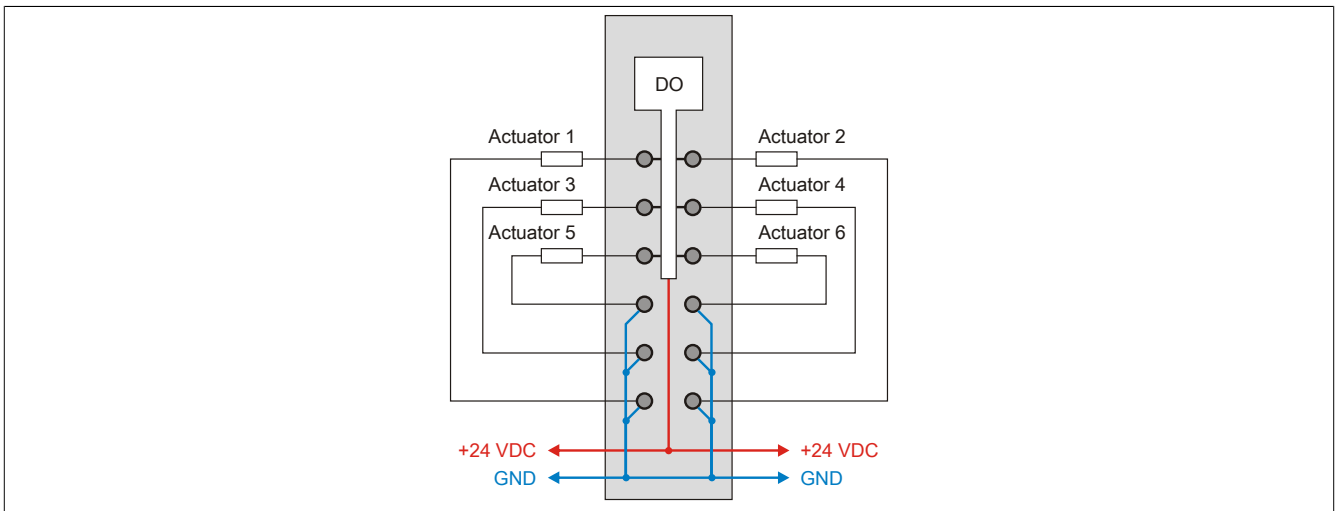
For a description of the various operating modes, see ["Diagnostic LEDs" on page 3787](#).

| Figure | LED | Color | Status | Description | |
|--|-------|-------|-----------------------------|---|---|
|  | r | Green | Off | Module supply not connected | |
| | | | Single flash | RESET mode | |
| | | | Blinking | PREOPERATIONAL mode | |
| | | | On | RUN mode | |
| | | | Flickering (approx. 10 Hz) | The module is in the OSP state. | |
| | e | Red | Off | Module supply not connected or everything OK | |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. | |
| | e + r | | Red on / Green single flash | Invalid firmware | |
| | 1 - 6 | | Orange | | Output status of the corresponding digital output |

9.15.19.6 Pinout



9.15.19.7 Connection example



Caution!

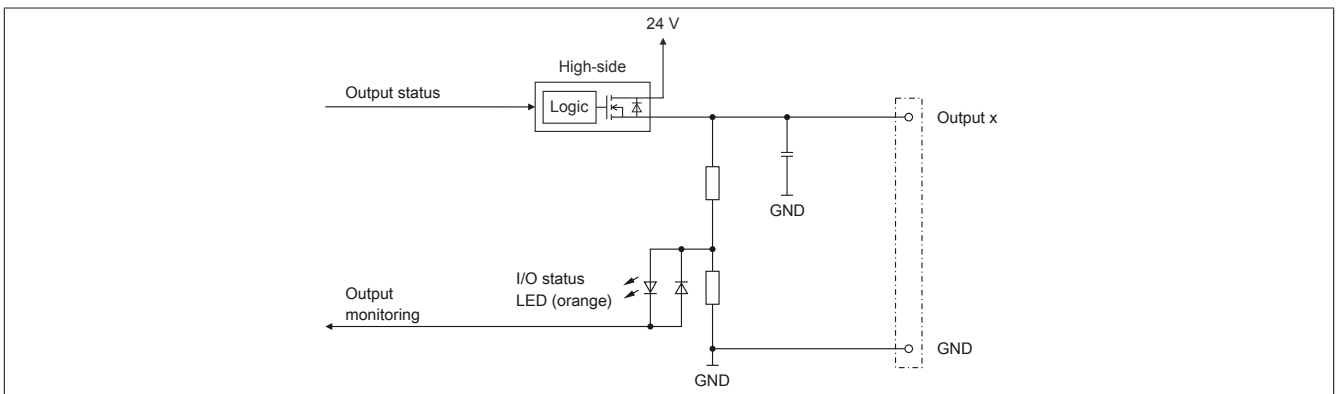
If the module is operated outside specifications, the output current may rise above the maximum permissible nominal current. This applies both to individual channels and to the summation current of the module.

Appropriate cable cross-sections or external safety measures must therefore be provided.

9.15.19.8 OSP hardware requirements

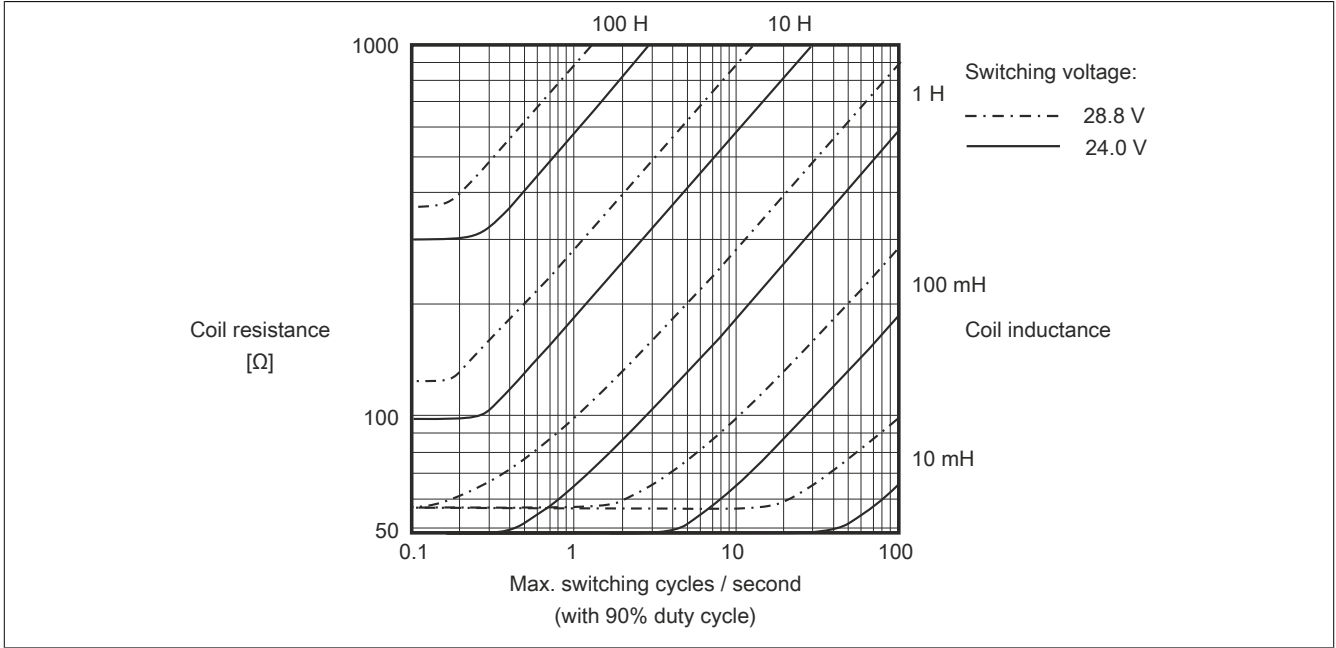
In order to use OSP mode sensibly, it should be ensured that the power supply of the output module and CPU are independent of each other when the application is set up.

9.15.19.9 Output circuit diagram



9.15.19.10 Switching inductive loads

Ambient temperature: 60°C, all outputs with the same load



Information:

If the maximum number of operating cycles per second is exceeded, an external inverse diode must be used.

Operating conditions outside of the area in the diagram are not permitted!

9.15.19.11 Register description

9.15.19.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.15.19.11.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|-----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | DigitalOutput | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput06 | Bit 5 | | | | |
| 30 | 1 | StatusInput01 | USINT | • | | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput06 | Bit 5 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.19.11.3 Function model 1 - OSP

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 6 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput06 | Bit 5 | | | | |
| 30 | 1 | Status of digital outputs 1 to 6 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput06 | Bit 5 | | | | |
| 34 | 1 | Enabling OPS output in the module | USINT | | | • | |
| | | OSPValid | Bit 0 | | | | |
| 32 | - | CfgOSPMODE | USINT | | | | • |
| 36 | - | CfgOSPValue | USINT | | | | • |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.19.11.4 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 6 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput06 | Bit 5 | | | | |
| 30 | - | Status of digital outputs 1 to 6 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput06 | Bit 5 | | | | |

1) The offset specifies where the register is within the CAN object.

9.15.19.11.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.19.11.4.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.15.19.11.5 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 µs) based on the network cycle (SyncOut).

9.15.19.11.5.1 Switching state of digital outputs 1 to 6

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput06

The switching state of digital outputs 1 to 6 are stored in this register.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Values | Information |
|-----------|--------------------|--|
| USINT | 0 to 63 | Packed outputs = On |
| | See bit structure. | Packed outputs = Off or Function model <> 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 5 | DigitalOutput06 | 0 | Digital output 06 reset |
| | | 1 | Digital output 06 set |

9.15.19.11.6 Monitoring status of the digital outputs

On the module, the output states of the outputs are compared to the target states. The control of the output driver is used for the target state.

A change in the output state resets monitoring for that output. The status of each individual channel can be read. A change in the monitoring status is actively transmitted as an error message.

9.15.19.11.6.1 Status of digital outputs 1 to 6

Name:

StatusInput01

StatusDigitalOutput01 to StatusDigitalOutput06

The status of digital outputs 1 to 6 is mapped in this register.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("StatusDigitalOutput01" to "StatusDigitalOutput0x") or whether this register should be displayed as a single USINT data point ("StatusInput01").

| Data type | Values | Information |
|-----------|--------------------|--|
| USINT | 0 to 63 | Packed outputs = On |
| | See bit structure. | Packed outputs = Off or Function model <> 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput01 | 0 | Channel 01: No error |
| | | 1 | Channel 01: <ul style="list-style-type: none"> Short circuit or overload Channel switched on and missing I/O power supply Channel switched off and external voltage applied on channel |
| ... | | ... | |
| 5 | StatusDigitalOutput06 | 0 | Channel 06: No error |
| | | 1 | Channel 06: For an error description, see channel 01. |

9.15.19.11.7 Function model "OSP"

In function model "OSP" (Operator Set Predefined), the user defines an analog value or digital pattern. This OSP value is output as soon as the communication between the module and master is aborted.

Functionality

The user has the choice between 2 OSP modes:

- Retain last valid value
- Replace with static value

In the first case, the module retains the last value recognized as a valid output status.

When selecting mode "Replace with static value", a plausible output value must be entered in the associated value register. When an OSP event occurs, this value is output instead of the value currently requested by the task.

9.15.19.11.7.1 Enabling OPS output in the module

Name:

OSPValid

This data point makes it possible to start the output of the module and request the use of OSP during operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|---|
| 0 | OSPValid | 0 | Request OSP operation (after initial startup or module in stand-by) |
| | | 1 | Request normal operation |
| 1 - 7 | Reserved | 0 | |

Bit OSPValid exists once on the module and is managed by the user task. It must be set to start the enabled channels. As long as bit OSPValid remains set in the module, the module behaves the same as in function model "Standard".

If an OSP event occurs, e.g. communication between the module and master CPU aborted, then bit OSPValid is reset on the module. The module enters the OSP state and output occurs according to the configuration in register "OSPMode" on page 1754.

The following generally applies:

Even after regeneration of the communication channel, the OSP replacement value is still pending. The OSP state is only exited again when a set OSPValid bit is transferred.

When the master CPU is restarted, bit OSPValid bit is reinitialized in the master CPU. It must be set once more by the application and transferred via the bus.

In the event of brief communication errors between the module and master CPU (e.g. due to EMC), the cyclic registers fail to refresh for several bus cycles. Within the module, bit OSPValid is reset; the set bit is retained in the CPU, however. During the next successful transfer, the module-internal OSPValid bit is set again and the module automatically returns to normal operation.

If the task in the master CPU needs the information about which output mode the module is currently in, bit ModulOK can be evaluated.

Warning!

If bit OSPValid bit is reset to "0" by the module, the output status no longer depends on the responsible task in the master CPU. Nevertheless, output is made depending on the configuration of the OSP replacement value.

9.15.19.11.7.2 Setting OSP mode

Name:

CfgOSPMode

This register controls the behavior of a channel when using OSP.

| Data type | Values | Explanation |
|-----------|--------|---------------------------|
| USINT | 0 | Replace with static value |
| | 1 | Retain last valid value |

9.15.19.11.7.3 Defining an OSP-digital output value

Name:

CfgOSPValue

This register contains the digital output value that is output in "Replace with static value" mode during OSP operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------|--------|--|
| 0 | | 0 or 1 | OSP output value for channel DigitalOutput00 |
| ... | | ... | |
| x | | 0 or 1 | OSP output value for channel DigitalOutput0x |

Warning!**"OSPValue" is only applied by the module if bit "OSPValid" has been set in the module.****9.15.19.11.8 Minimum cycle time**

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 µs |

9.15.19.11.9 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|---------------------------------|
| Equal to the minimum cycle time |

9.15.20 X20DO6325

Data sheet version: 1.21

9.15.20.1 General information

The module is equipped with six outputs for 1 or 2-wire connections with diagnostic functions. The X20 6-pin terminal block can be used for universal 1-line wiring. Two-line wiring can be implemented using the 12-pin terminal block. The outputs on the module are designed for source connections.

- 6 digital outputs
- Source connection
- 2-wire connections
- GND for signal supply
- Integrated output protection
- 1-wire connection type with 6-pin terminal block
- Diagnostic functions (open line, short circuit and overload/overtemperature)
- OSP mode

9.15.20.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| X20DO6325 | Digital outputs X20 digital output module, 6 outputs, 24 VDC, 0.5 A, source, open line and overload detection, 2-wire connections |  |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 332: X20DO6325 - Order data

9.15.20.3 Technical data

| Model number | X20DO6325 |
|--|---|
| Short description | |
| I/O module | 6 digital outputs 24 VDC for 1- or 2-wire connections with a diagnostics function |
| General information | |
| B&R ID code | 0xE284 |
| Status indicators | I/O function by channel, diagnostics by channel, operating status, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Status outputs | Yes, using status LED and software |
| Diagnostic outputs | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.15 W |
| Internal I/O | 0.4 W |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | Max. 0.225 W |

Table 333: X20DO6325 - Technical data


| Model number | X20DO6325 |
|---|--|
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| Digital outputs | |
| Variant | FET positive switching |
| Nominal voltage | 24 VDC |
| Switching voltage | 24 VDC -15 % / +20 % |
| Nominal output current | 0.5 A |
| Total nominal current | 3 A |
| Connection type | 1- or 2-wire connections |
| Output circuit | Source |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short circuit current") Internal inverse diode for switching inductive loads (see section "Switching inductive loads") |
| Diagnostic status | |
| Open circuit | Current is <1 mA (typ.): Detected if the output is OFF, delay approx. 10 ms |
| Short circuit to 24 VDC | Detected if the output is OFF, delay approx. 10 ms |
| Short circuit to GND | Detected if the output is ON, delay approx. 10 ms |
| Overload/Overtemperature | Detected if the output is ON, delay approx. 10 ms |
| Leakage current when the power is switched off | <160 µA |
| $R_{DS(on)}$ | 150 mΩ |
| Peak short-circuit current | <40 A |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Depends on the module temperature |
| Switching delay ²⁾ | |
| 0 → 1 | <100 µs |
| 1 → 0 | <300 µs |
| Switching frequency | |
| Resistive load ²⁾ | Max. 2000 Hz |
| Inductive load | See section "Switching inductive loads" |
| Braking voltage when switching off inductive loads | 45 to 52 VDC |
| Isolation voltage between channel and bus | 510 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB06 or X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm |

Table 333: X20DO6325 - Technical data

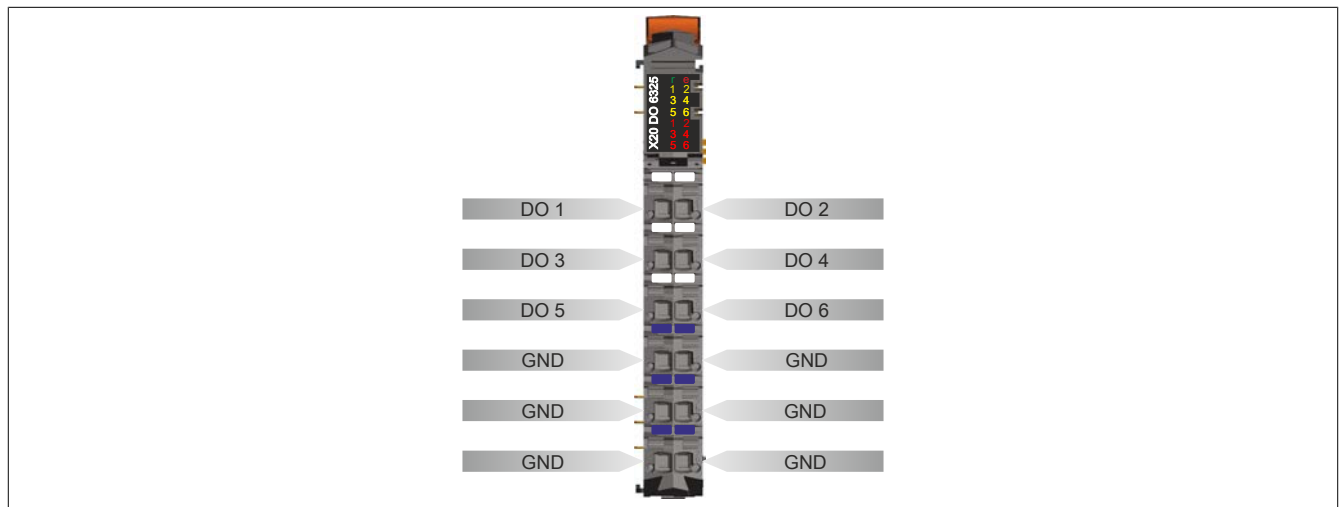
- 1) Number of outputs x $R_{DS(on)}$ x Nominal output current²⁾. For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.
2) At loads ≤ 1 kΩ

9.15.20.4 LED status indicators

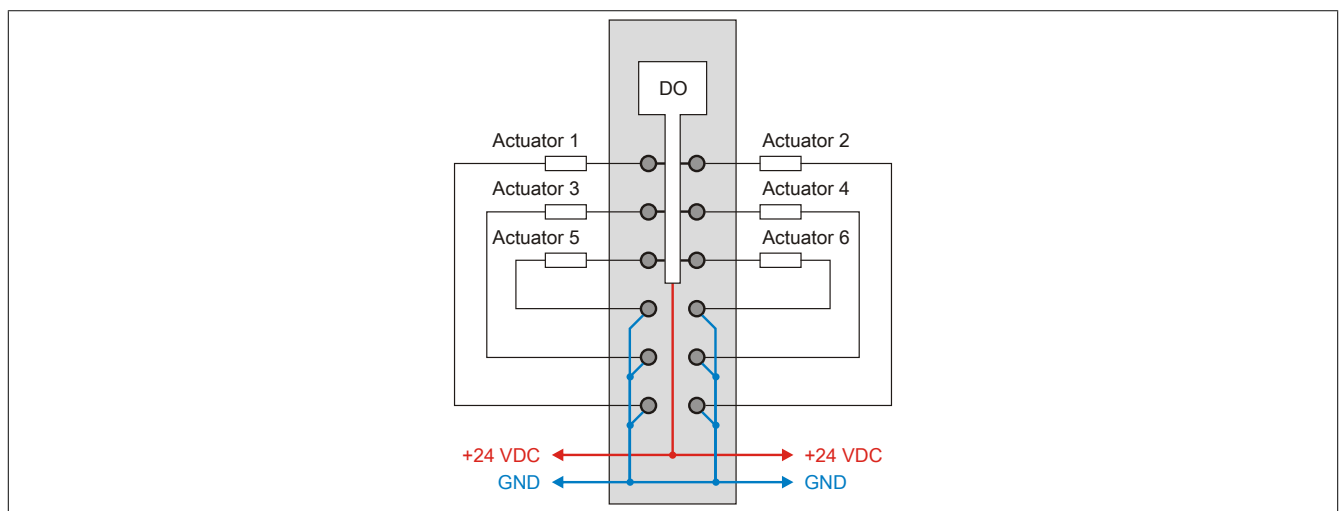
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|---------------|-------|-----------------------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | | | Flickering (approx. 10 Hz) | Module is in OSP mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. |
| | | | Double flash | I/O supply is outside valid range. |
| | e + r | | Red on / Green single flash | Invalid firmware |
| | Channel 1 - 6 | | Orange | |
| Diagnostics 1 - 6 | | Red | | Monitoring of the corresponding digital output was tripped (short circuit, open line or overload) |

9.15.20.5 Pinout



9.15.20.6 Connection example



Caution!

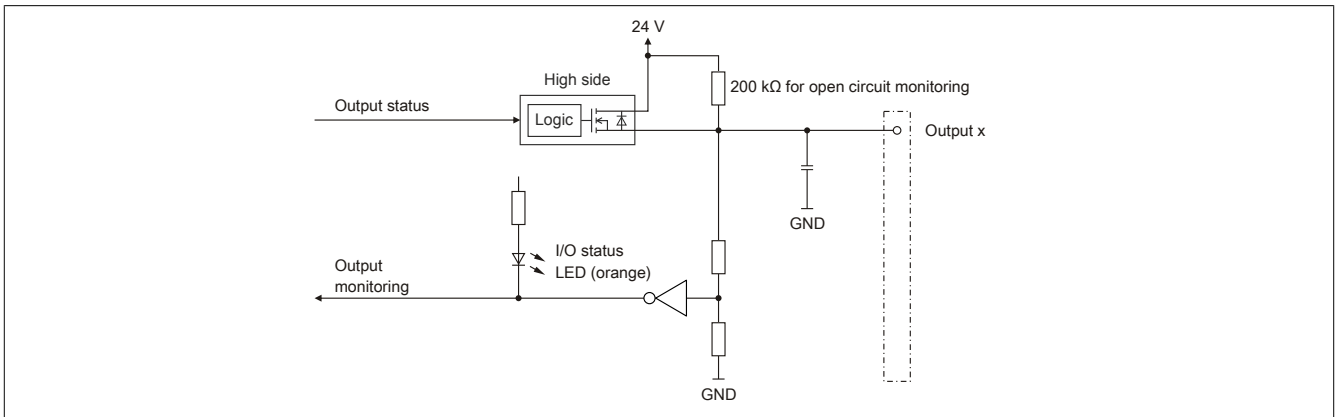
If the module is operated outside specifications, the output current may rise above the maximum permissible nominal current. This applies both to individual channels and to the summation current of the module.

Appropriate cable cross-sections or external safety measures must therefore be provided.

9.15.20.7 OSP hardware requirements

In order to use OSP mode sensibly, it should be ensured that the power supply of the output module and CPU are independent of each other when the application is set up.

9.15.20.8 Output circuit diagram



9.15.20.9 Open line detection

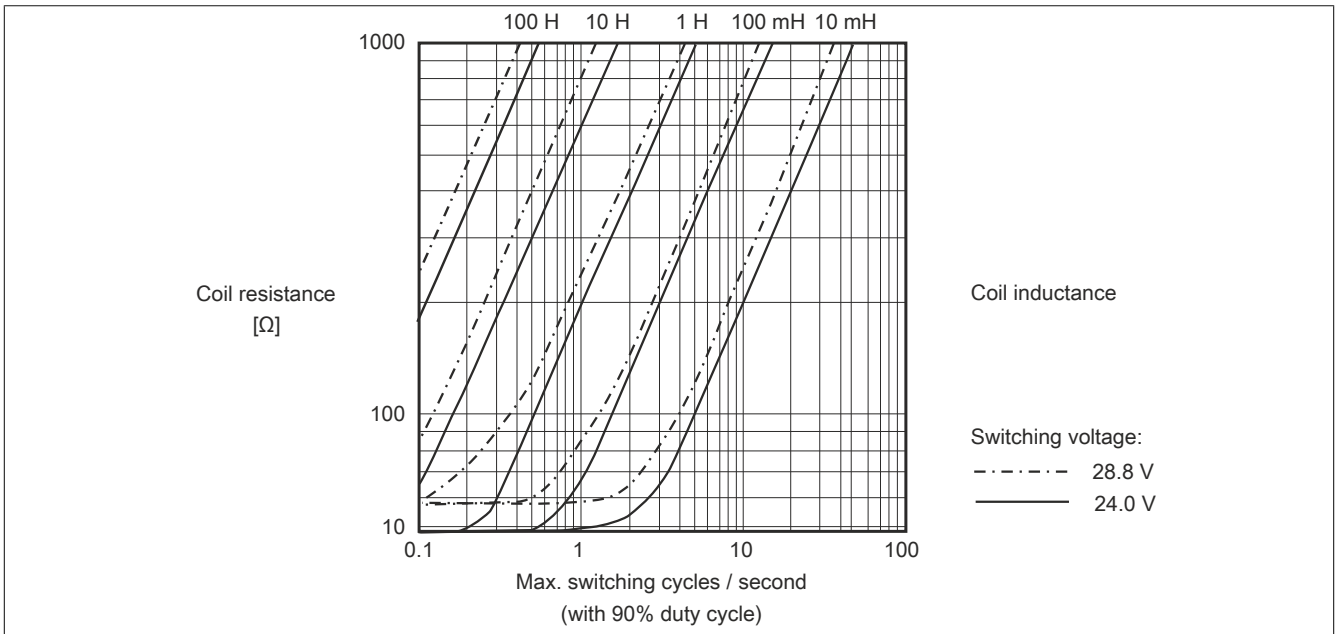
Each output is equipped with an internal 200 kOhm resistor to 24 V for open line detection.

If the charging resistance at the terminal is greater than 25 to 100 kOhm (tolerance range) an open line is therefore detected at 24 V. When switched on, this corresponds to a current of 0.2 to 1 mA with all tolerances taken into consideration.

| Supply voltage | Min. load | Max. load | Corresponds to load current when ON |
|----------------|-----------|-----------|-------------------------------------|
| 24 V | 100 kOhm | 25 kOhm | 0.2 to 1 mA |

9.15.20.10 Switching inductive loads

Environmental temperature: 60°C, all outputs with the same load



Information:

If the maximum number of operating cycles per second is exceeded, an external inverse diode must be used.

Operating conditions outside of the area in the diagram are not permitted!

9.15.20.11 Register description

9.15.20.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.15.20.11.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|------------------------------------|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration | | | | | | |
| 4 | CfgBwStatus | USINT | | | | • |
| Communication | | | | | | |
| 2 | DigitalOutput | USINT | | | • | |
| | DigitalOutput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| 28 | DigitalOutput06 | Bit 5 | | | | |
| | StatusInput01 | USINT | • | | | |
| | DigitalStatusGnd01 | Bit 0 | | | | |
| 29 | ... | ... | | | | |
| | DigitalStatusGnd06 | Bit 5 | | | | |
| | StatusInput02 | USINT | • | | | |
| 30 | DigitalStatusVcc01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalStatusVcc06 | Bit 5 | | | | |
| 31 | StatusInput03 | USINT | • | | | |
| | DigitalStatusBw01 | Bit 0 | | | | |
| | ... | ... | | | | |
| 31 | DigitalStatusBw06 | Bit 5 | | | | |
| | StatusInput04 | USINT | • | | | |
| | DigitalStatusSum01 | Bit 0 | | | | |
| | ... | ... | | | | |
| 31 | DigitalStatusSum06 | Bit 5 | | | | |
| | PowerSupply01 | Bit 7 | | | | |

9.15.20.11.3 Function model 1 - OSP

| Register | Name | Data type | Read | | Write | |
|----------------------|---|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration | | | | | | |
| 4 | CfgBwStatus | USINT | | | | • |
| 32 | CfgOSPMode | USINT | | | | • |
| Communication | | | | | | |
| 2 | Switching state of digital outputs 1 to 6 | USINT | | | • | |
| | DigitalOutput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| 28 | DigitalOutput06 | Bit 5 | | | | |
| | Short circuit to GND and overtemperature | USINT | • | | | |
| | DigitalStatusGnd01 | Bit 0 | | | | |
| 29 | ... | ... | | | | |
| | DigitalStatusGnd06 | Bit 5 | | | | |
| | Short circuit to voltage | USINT | • | | | |
| 30 | DigitalStatusVcc01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalStatusVcc06 | Bit 5 | | | | |
| 31 | Open circuit | USINT | • | | | |
| | DigitalStatusBw01 | Bit 0 | | | | |
| | ... | ... | | | | |
| 31 | DigitalStatusBw06 | Bit 5 | | | | |
| | Cumulative status | USINT | • | | | |
| | DigitalStatusSum01 | Bit 0 | | | | |
| | ... | ... | | | | |
| 31 | DigitalStatusSum06 | Bit 5 | | | | |
| | PowerSupply01 | Bit 7 | | | | |
| 34 | Enabling OPS output in the module | USINT | | | • | |
| | OSPValid | Bit 0 | | | | |
| 36 | CfgOSPValue | USINT | | | • | |

9.15.20.11.4 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|---|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration | | | | | | | |
| 4 | - | CfgBwStatus | USINT | | | | • |
| Communication | | | | | | | |
| 2 | 0 | Switching state of digital outputs 1 to 6 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| 28 | - | Short circuit to GND and overtemperature | USINT | | • | | |
| | | DigitalStatusGnd01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| 29 | - | Short circuit to voltage | USINT | | • | | |
| | | DigitalStatusVcc01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| 30 | - | Open circuit | USINT | | • | | |
| | | DigitalStatusBw01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| 31 | - | Cumulative status | USINT | | • | | |
| | | DigitalStatusSum01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalStatusSum06 | Bit 5 | | | | |
| | | PowerSupply01 | Bit 7 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.15.20.11.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.20.11.4.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.15.20.11.5 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 µs) based on the network cycle (SyncOut).

9.15.20.11.5.1 Switching state of digital outputs 1 to 6

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput06

The switching state of digital outputs 1 to 6 are stored in this register.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Values | Information |
|-----------|--------------------|--|
| USINT | 0 to 63 | Packed outputs = On |
| | See bit structure. | Packed outputs = Off or Function model <> 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | ... | ... | ... |
| 5 | DigitalOutput06 | 0 | Digital output 06 reset |
| | | 1 | Digital output 06 set |

9.15.20.11.6 Digital output status

The status of the outputs is checked every 4 ms. To suppress disturbances on the feedback inputs, two readings are compared.

The hardware diagnostics recognize the following states:

- Short circuit to ground GND (when output is ON)
- Short circuit to 24 VDC (when output is OFF)
- Open line (when output is OFF)
- Overtemperature / overload

The error is logged in the corresponding status registers and in the cumulative status register.

An open line error is also indicated by the corresponding LED. The LED indicator can be disabled so that an open (unused) channel does not constantly indicate an error.

9.15.20.11.6.1 Enabling the status LED

Name:

CfgBwStatus

For each output there is a corresponding enable bit. In this register, the bit can be set to define whether or not the status LED should be used to indicate an open line error. This allows the LED to be disabled for unused channels. In the bus controller function model the default value is 0xBF.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 191 |

Bit structure:

| Bit | Name | Value | Information |
|-----|---------------|-------|--|
| 0 | Channel 01 | 0 | Open line indicator 01 disabled |
| | | 1 | Open circuit indicator 01 enabled (bus controller default setting) |
| ... | | ... | |
| 5 | Channel 06 | 0 | Open line indicator 06 disabled |
| | | 1 | Open circuit indicator 06 enabled (bus controller default setting) |
| 6 | Reserved | 0 | |
| 7 | PowerSupply01 | 0 | No error status indicators |
| | | 1 | Monitor supply voltage (bus controller default setting) |

9.15.20.11.6.2 Short circuit to GND and overtemperature

Name:

StatusInput01

DigitalStatusGnd01 to DigitalStatusGnd06

In this register, a short circuit or overtemperature error is indicated by the corresponding channel bit being set. It is not possible to differentiate between short circuit to GND and overload/overtemperature.

Only function model 0 - Standard:

The "Packed outputs" setting in the Automation Studio I/O configuration is used to determine whether all of the bits from this register should be set up individually as data points in the Automation Studio I/O mapping ("DigitalStatusGnd01" to "DigitalStatusGnd06") or whether this register should be displayed as an individual USINT data point ("StatusInput01").

| Data type | Values | Information |
|-----------|--------------------|--|
| USINT | 0 to 63 | Packed outputs = On |
| | See bit structure. | Packed outputs = Off or Function model <> 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-------|--------------------|-------|--------------------------------------|
| 0 | DigitalStatusGnd01 | 0 | No error |
| | | 1 | Channel 1: Short circuit or overload |
| ... | | ... | |
| 5 | DigitalStatusGnd06 | 0 | No error |
| | | 1 | Channel 6: Short circuit or overload |
| 6 - 7 | Reserved | 0 | |

9.15.20.11.6.3 Short circuit to voltage

Name:

StatusInput02

DigitalStatusVcc01 to DigitalStatusVcc06

In this register, a short circuit is indicated by the corresponding channel bit being set.

Only function model 0 - Standard:

The "Packed outputs" setting in the Automation Studio I/O configuration is used to determine whether all of the bits from this register should be set up individually as data points in the Automation Studio I/O mapping ("DigitalStatusVcc01" to "DigitalStatusVcc06") or whether this register should be displayed as an individual USINT data point ("StatusInput02").

| Data type | Values | Information |
|-----------|--------------------|--|
| USINT | 0 to 63 | Packed outputs = On |
| | See bit structure. | Packed outputs = Off or Function model <> 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-------|--------------------|-------|-------------------------------------|
| 0 | DigitalStatusVcc01 | 0 | No error |
| | | 1 | Channel 1: Short circuit to voltage |
| ... | | ... | |
| 5 | DigitalStatusVcc06 | 0 | No error |
| | | 1 | Channel 6: Short circuit to voltage |
| 6 - 7 | Reserved | 0 | |

9.15.20.11.6.4 Open circuit

Name:

StatusInput03

DigitalStatusBw01 to DigitalStatusBw06

In this register, an open circuit is indicated by the corresponding channel bit being set.

Only function model 0 - Standard:

The "Packed outputs" setting in the Automation Studio I/O configuration is used to determine whether all of the bits from this register should be set up individually as data points in the Automation Studio I/O mapping ("DigitalStatusBw01" to "DigitalStatusBw06") or whether this register should be displayed as an individual USINT data point ("StatusInput03").

| Data type | Values | Information |
|-----------|--------------------|--|
| USINT | 0 to 63 | Packed outputs = On |
| | See bit structure. | Packed outputs = Off or Function model <> 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-------|-------------------|-------|-------------------------|
| 0 | DigitalStatusBw01 | 0 | No error |
| | | 1 | Channel 1: Open circuit |
| ... | | ... | |
| 5 | DigitalStatusBw06 | 0 | No error |
| | | 1 | Channel 6: Open circuit |
| 6 - 7 | Reserved | 0 | |

9.15.20.11.6.5 Cumulative status

Name:

StatusInput04

DigitalStatusSum01 to DigitalStatusSum06

PowerSupply01

Every error found in the other status registers is also shown in this register. This provides an easy way to check whether any errors have occurred.

If the I/O supply fails, Bit 7 is set and all status bits in the other status registers are reset to 0.

Only function model 0 - Standard:

The "packed outputs" setting in the Automation Studio I/O configuration is used to determine whether all of this registers' bits should be set up individually as data points ("DigitalStatusSum01 through DigitalStatusSum06", "PowerSupply01") in the Automation Studio I/O mapping or whether this register should be displayed as an individual USINT data point ("StatusInput04").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 255 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-----|--------------------|-------|------------------------------|
| 0 | DigitalStatusSum01 | 0 | No error |
| | | 1 | Channel 1: Error occurred |
| ... | | ... | |
| 5 | DigitalStatusSum06 | 0 | No error |
| | | 1 | Channel 6: Error occurred |
| 6 | Reserved | 0 | |
| 7 | PowerSupply01 | 0 | No error |
| | | 1 | Pending supply voltage error |

9.15.20.11.7 Function model "OSP"

In function model "OSP" (Operator Set Predefined), the user defines an analog value or digital pattern. This OSP value is output as soon as the communication between the module and master is aborted.

Functionality

The user has the choice between 2 OSP modes:

- Retain last valid value
- Replace with static value

In the first case, the module retains the last value recognized as a valid output status.

When selecting mode "Replace with static value", a plausible output value must be entered in the associated value register. When an OSP event occurs, this value is output instead of the value currently requested by the task.

9.15.20.11.7.1 Enabling OPS output in the module

Name:

OSPValid

This data point makes it possible to start the output of the module and request the use of OSP during operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|---|
| 0 | OSPValid | 0 | Request OSP operation (after initial startup or module in stand-by) |
| | | 1 | Request normal operation |
| 1 - 7 | Reserved | 0 | |

Bit OSPValid exists once on the module and is managed by the user task. It must be set to start the enabled channels. As long as bit OSPValid remains set in the module, the module behaves the same as in function model "Standard".

If an OSP event occurs, e.g. communication between the module and master CPU aborted, then bit OSPValid is reset on the module. The module enters the OSP state and output occurs according to the configuration in register "OSPMode" on page 1765.

The following generally applies:

Even after regeneration of the communication channel, the OSP replacement value is still pending. The OSP state is only exited again when a set OSPValid bit is transferred.

When the master CPU is restarted, bit OSPValid bit is reinitialized in the master CPU. It must be set once more by the application and transferred via the bus.

In the event of brief communication errors between the module and master CPU (e.g. due to EMC), the cyclic registers fail to refresh for several bus cycles. Within the module, bit OSPValid is reset; the set bit is retained in the CPU, however. During the next successful transfer, the module-internal OSPValid bit is set again and the module automatically returns to normal operation.

If the task in the master CPU needs the information about which output mode the module is currently in, bit ModulOK can be evaluated.

Warning!

If bit OSPValid bit is reset to "0" by the module, the output status no longer depends on the responsible task in the master CPU. Nevertheless, output is made depending on the configuration of the OSP replacement value.

9.15.20.11.7.2 Setting OSP mode

Name:

CfgOSPMode

This register controls the behavior of a channel when using OSP.

| Data type | Values | Explanation |
|-----------|--------|---------------------------|
| USINT | 0 | Replace with static value |
| | 1 | Retain last valid value |

9.15.20.11.7.3 Defining an OSP-digital output value

Name:

CfgOSPValue

This register contains the digital output value that is output in "Replace with static value" mode during OSP operation.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------|--------|--|
| 0 | | 0 or 1 | OSP output value for channel DigitalOutput00 |
| ... | | ... | |
| x | | 0 or 1 | OSP output value for channel DigitalOutput0x |

Warning!

"OSPValue" is only applied by the module if bit "OSPValid" has been set in the module.

9.15.20.11.8 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 150 µs |

9.15.20.11.9 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|---------------------------------|
| Equal to the minimum cycle time |

9.15.21 X20(c)DO6529

Data sheet version: 3.26

9.15.21.1 General information

The module is equipped with 6 relay outputs.

- 6 digital outputs
- Relay module for 115 VAC
- 6 normally open contacts
- Single-channel isolated outputs

Danger!

Risk of electric shock!

The terminal block must only be allowed to conduct voltage when it is inserted. It must not under any circumstances be removed or inserted when voltage is applied or have voltage applied to it when it is removed.

Danger!

Die Spannungsclassen auf der Feldklemme dürfen nicht vermisch werden! Es ist ausschließlich der Betrieb bei Netzspannung (z. B. 115 VAC) ODER bei Sicherheitskleinspannung (z. B. 24 VDC SELV) erlaubt.

9.15.21.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.15.21.3 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Digital outputs |  |
| X20DO6529 | X20 digital output module, 6 relays, normally open contacts, 115 VAC / 0.5 A, 30 VDC / 1 A | |
| X20cDO6529 | X20 digital output module, coated, 6 relays, normally open contacts, 115 VAC / 0.5 A, 30 VDC / 1 A | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 334: X20DO6529, X20cDO6529 - Order data

9.15.21.4 Technical data

| Model number | X20DO6529 | X20cDO6529 |
|--|--|------------|
| Short description | 6 digital outputs 30 VDC / 115 VAC, outputs are single-channel isolated | |
| General information | | |
| B&R ID code | 0x2019 | 0xE751 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnosics | | |
| Module run/error | Yes, using status LED and software | |
| Outputs | Yes, using status LED | |
| Power consumption | | |
| Bus | 1.1 W | |
| Internal I/O | - | |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +0.45 | |
| Certifications | | |
| CE | Yes | |
| KC | Yes | - |
| EAC | Yes | |
| UL | cULus E115267 | |
| HazLoc | Industrial control equipment cCSAus 244665 | |
| ATEX | Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| LR | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| KR | ENV1 | - |
| | Yes | |
| Digital outputs | | |
| Variant | Relay / Normally open contact Channels are single-channel isolated | |
| Nominal voltage | 30 VDC / 115 VAC | |
| Max. voltage | 125 VAC | |
| Switching voltage | Max. 110 VDC / 125 VAC | |
| Rated frequency | DC / 45 to 63 Hz | |
| Nominal output current | 1 A at 30 VDC / 0.5 A at 115 VAC | |
| Total nominal current | 6 A at 30 VDC / 3 A at 115 VAC | |
| Actuator power supply | External | |
| Inrush current | Max. 2 A (per channel) | |
| Contact resistance | 75 mΩ at 6 VDC / 1A | |
| Switching delay | | |
| 0 → 1 | ≤4 ms | |
| 1 → 0 | ≤4 ms | |
| Isolation voltages | | |
| Channel - Bus | Tested at 1500 VAC | |
| Channel - Channel | Tested at 1000 VAC | |
| Service life | | |
| Electrical ²⁾ | Min. 100 x 10 ³ ops. | |
| Mechanical | Min. 50 x 10 ⁶ ops. (3 Hz) | |
| Switching capacity | | |
| Minimum | 0.01 mA / 10 mV DC | |
| Maximum | 30 W / 62.5 VA | |
| Protective circuit | | |
| Internal | None | |
| External | | |
| AC | RC combination or VDR | |
| DC | Inverse diode, RC combination or VDR | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from channel and bus | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |

Table 335: X20DO6529, X20cDO6529 - Technical data


| Model number | X20DO6529 | X20cDO6529 |
|---------------------------------|--|---|
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating" | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm | |

Table 335: X20DO6529, X20cDO6529 - Technical data

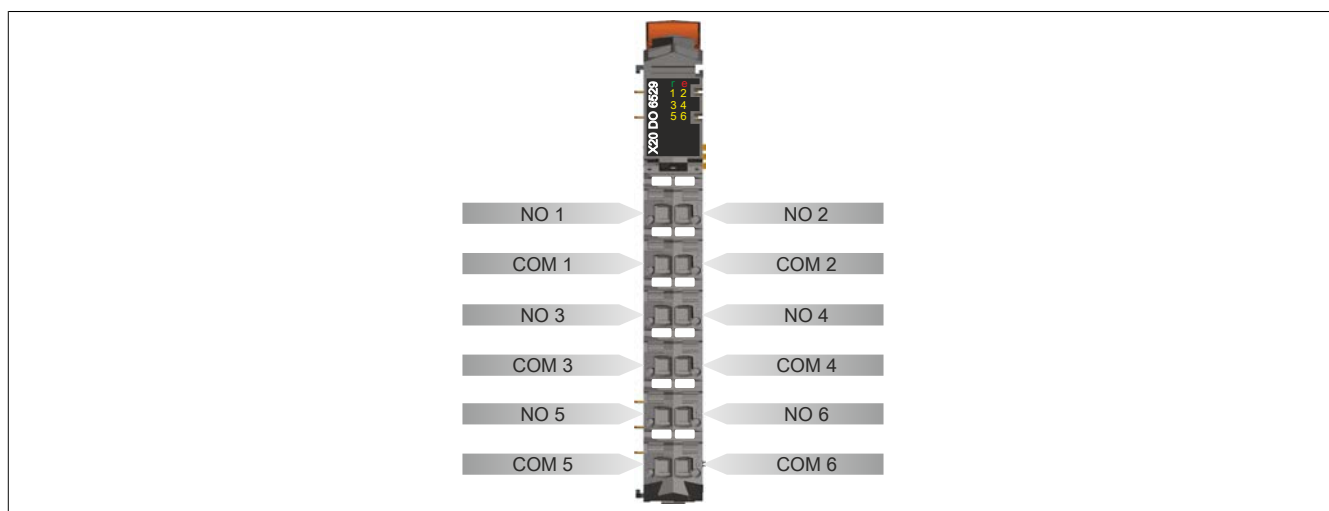
- 1) Number of outputs x Contact resistance x Nominal output current². For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) With a resistive load. See also section "Electrical service life"

9.15.21.5 Status LEDs

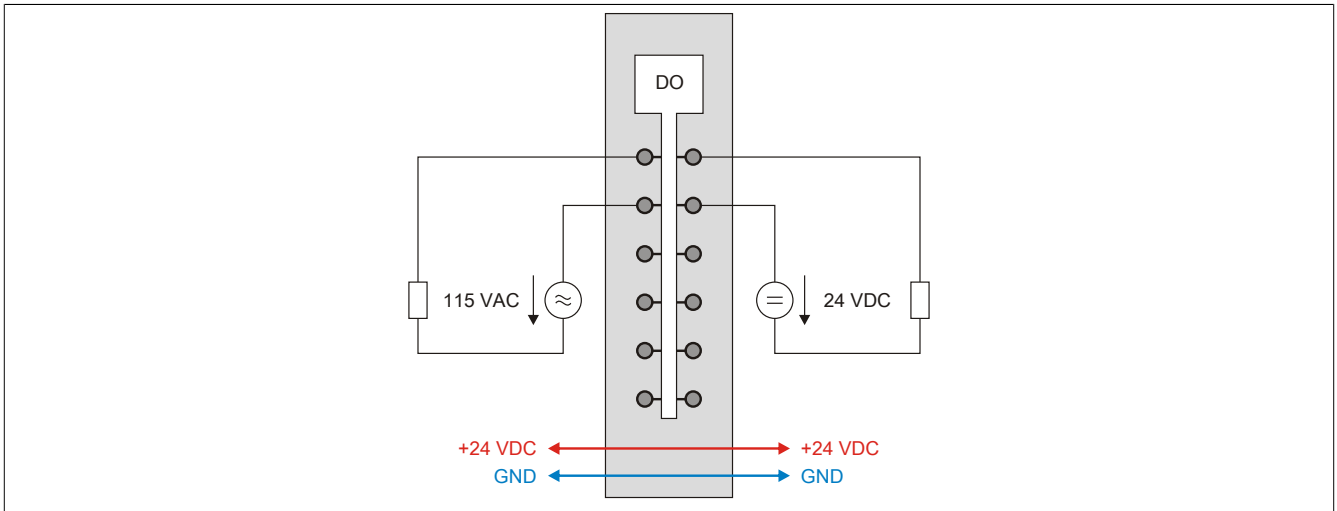
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|--|-------|-------|-----------------------------|--|
|  | r | Green | Off | Module supply not connected |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | Module supply not connected or everything OK |
| | | | On | Error or reset status |
| | e + r | | Red on / Green single flash | Invalid firmware |
| | 1 - 6 | | Orange | |

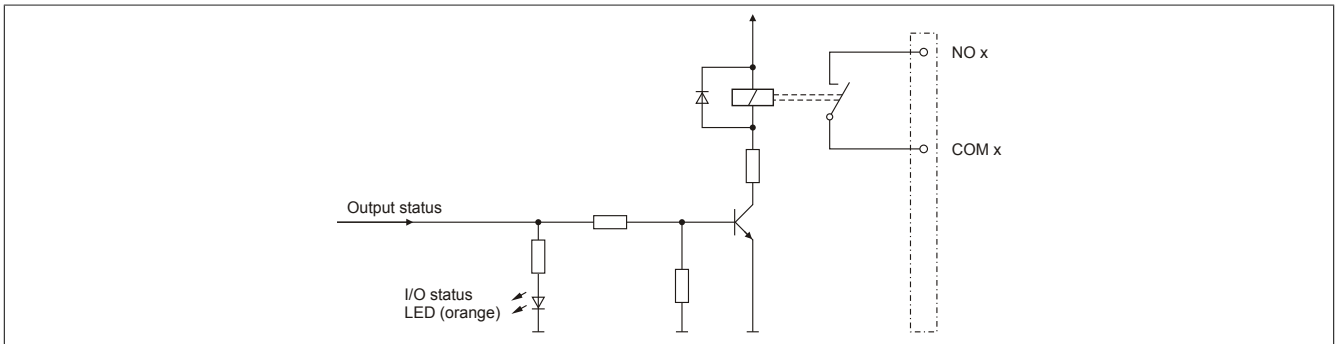
9.15.21.6 Pinout



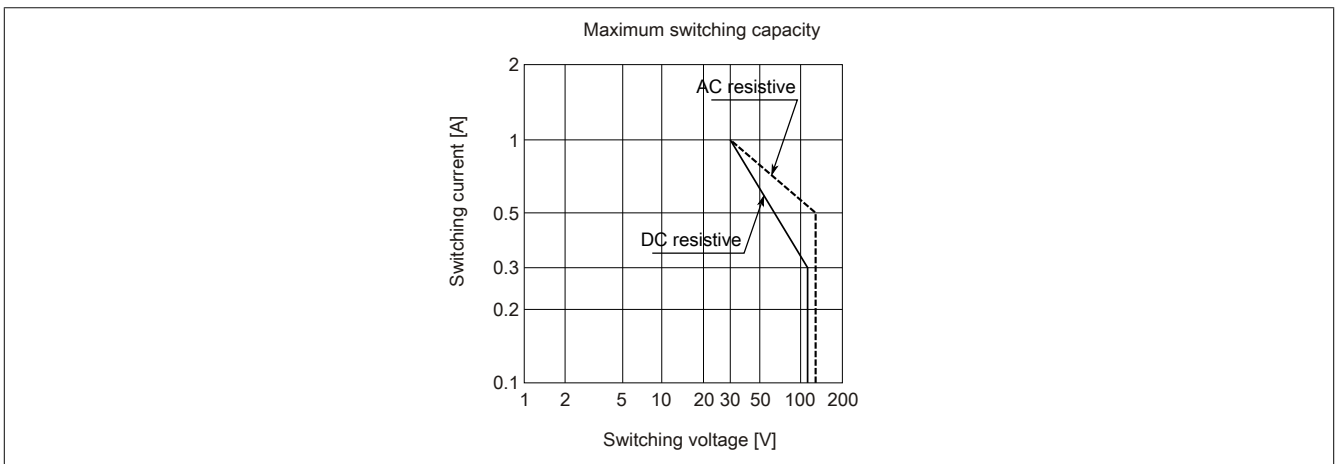
9.15.21.7 Connection example



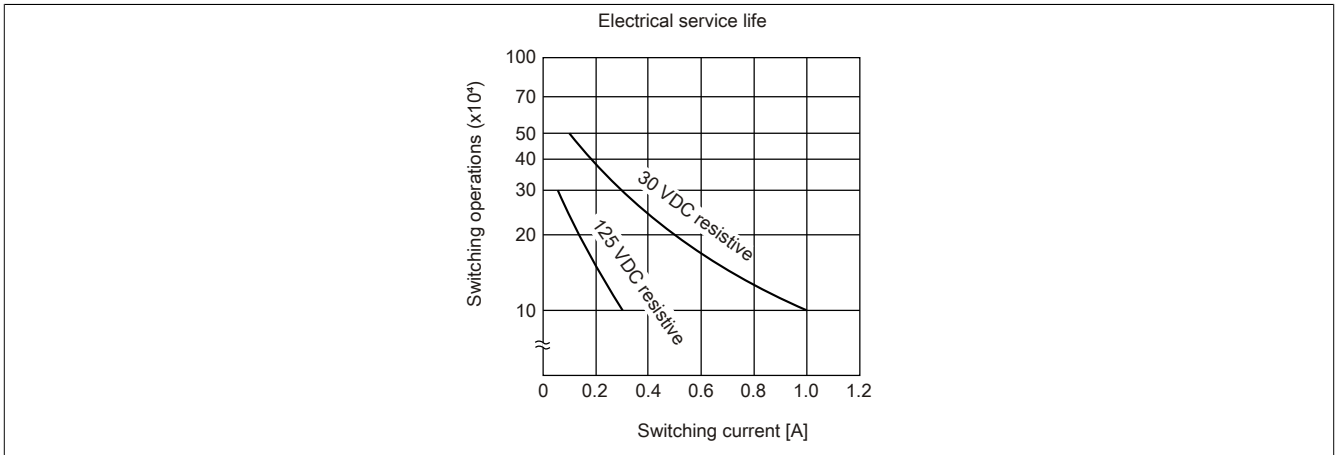
9.15.21.8 Output circuit diagram



9.15.21.9 Maximum switching power



9.15.21.10 Electrical service life

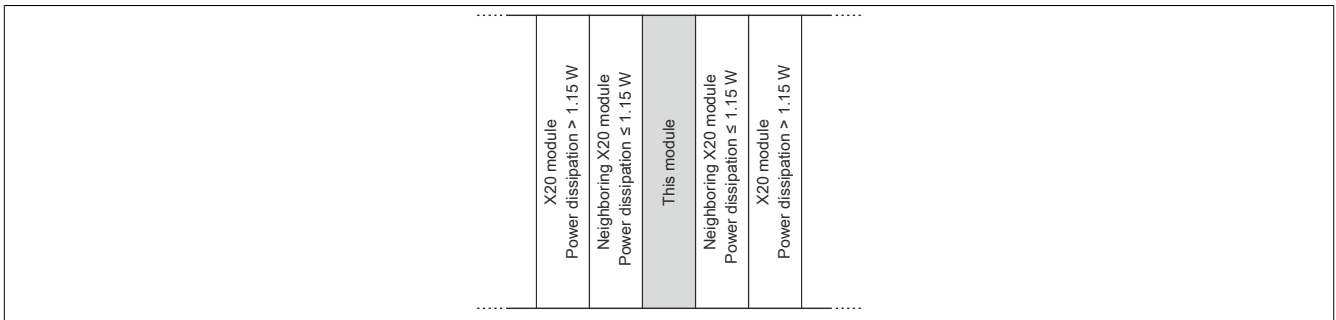


9.15.21.11 Derating

There is no derating when operated below 55°C.

During operation over 55°C, the power dissipation of the modules to the left and right of this module is not permitted to exceed 1.15 W!

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.



9.15.21.12 Register description

9.15.21.12.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.15.21.12.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|-----------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | DigitalOutput | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput06 | Bit 5 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.21.12.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 6 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput06 | Bit 5 | | | | |

1) The offset specifies where the register is within the CAN object.

9.15.21.12.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.21.12.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.15.21.12.4 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 μ s) based on the network cycle (SyncOut).

9.15.21.12.4.1 Switching state of digital outputs 1 to 6

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput06

The switching state of digital outputs 1 to 6 are stored in this register.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Values | Information |
|-----------|--------------------|--|
| USINT | 0 to 63 | Packed outputs = On |
| | See bit structure. | Packed outputs = Off or Function model <> 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 5 | DigitalOutput06 | 0 | Digital output 06 reset |
| | | 1 | Digital output 06 set |

9.15.21.12.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.15.21.12.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|---------------------------------|
| Equal to the minimum cycle time |

9.15.22 X20(c)DO6639

Data sheet version: 1.38

9.15.22.1 General information

The module is equipped with 6 relay outputs.

- 6 digital outputs
- Relay module for 240 VAC / 30 VDC
- Switching current 2 A
- 6 normally open contacts
- Single-channel isolated outputs

Danger!

Risk of electric shock!

The terminal block is only permitted to conduct voltage when it is connected. It is not permitted to be disconnected or connected while voltage is applied or have voltage applied to it while it is removed under any circumstances.

This module is not permitted to be the last module connected on the X2X Link network. At least one subsequent X20ZF dummy module must provide protection against contact.

Danger!

The voltage classes on the terminal block must not be mixed! Only operation at mains voltage (e.g. 230 VAC) OR safety extra-low voltage (e.g. 24 VDC SELV) is permitted.

9.15.22.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.15.22.3 Order data

| Model number | Short description | Figure |
|--------------|--|--------|
| | Digital outputs | |
| X20DO6639 | X20 digital output module, 6 relays, normally open contacts, 240 VAC / 2 A, 30 VDC / 2 A | |
| X20cDO6639 | X20 digital output module, coated, 6 relays, normally open contacts, 240 VAC / 2 A, 30 VDC / 2 A | |
| | Required accessories | |
| | Bus modules | |
| X20BM12 | X20 bus module, 240 VAC keyed, internal I/O power supply connected through | |
| X20cBM12 | X20 bus module, coated, 240 VAC keyed, internal I/O power supply connected through | |
| | Terminal blocks | |
| X20TB32 | X20 terminal block, 12-pin, 240 VAC keyed | |

Table 336: X20DO6639, X20cDO6639 - Order data

9.15.22.4 Technical data

| Model number | X20DO6639 | X20cDO6639 |
|--|--|------------|
| Short description | | |
| I/O module | 6 digital outputs 30 VDC / 240 VAC, outputs are single-channel isolated | |
| General information | | |
| B&R ID code | 0xDF50 | 0xE22A |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnosics | | |
| Module run/error | Yes, using status LED | |
| Outputs | Yes, using status LED | |
| Power consumption | | |
| Bus | 1 W | |
| Internal I/O | - | |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +0.36 | |
| Certifications | | |
| CE | Yes | |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| KR | Yes | |
| Digital outputs | | |
| Variant | Relay / Normally open contact Channels are single-channel isolated | |
| Nominal voltage | 30 VDC / 240 VAC | |
| Max. voltage | 264 VAC | |
| Switching voltage | Max. 110 VDC / 264 VAC | |
| Rated frequency | DC / 45 to 63 Hz | |
| Nominal output current | 2 A at 30 VDC / 2 A at 240 VAC | |
| Total nominal current | 10 A at 30 VDC / 10 A at 240 VAC | |
| Actuator power supply | External | |
| Contact resistance | Max. 100 mΩ | |
| Switching delay | | |
| 0 → 1 | ≤10 ms | |
| 1 → 0 | ≤10 ms | |
| Isolation voltages | | |
| Channel - Bus | Tested at 2300 VAC | |
| Channel - Channel | Tested at 750 VAC | |
| Service life | | |
| Electrical ²⁾ | Min. 120 x 10 ³ ops. (at 2 A / 240 VAC) | |
| Mechanical | Min. 2 x 10 ⁷ ops. | |
| Switching capacity | | |
| Minimum | 0.05 W DC / 2.4 W AC | |
| Maximum | 60 W DC / 480 W AC | |
| Total power of all channels | | |
| AC | 3000 W | |
| DC | 360 W | |
| Protective circuit | | |
| Internal | None | |
| External | | |
| AC | RC combination or VDR | |
| DC | Inverse diode, RC combination or VDR | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Not permitted | |
| Degree of protection per EN 60529 | IP20 | |

Table 337: X20DO6639, X20cDO6639 - Technical data


| Model number | X20DO6639 | X20cDO6639 |
|---------------------------------|---|--|
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB32 terminal block separately, Order 1x X20BM12 bus module separately | Order 1x X20TB32 terminal block separately, Order 1x X20cBM12 bus module separately |
| Spacing | 12.5 ^{+0.2} mm | |

Table 337: X20DO6639, X20cDO6639 - Technical data

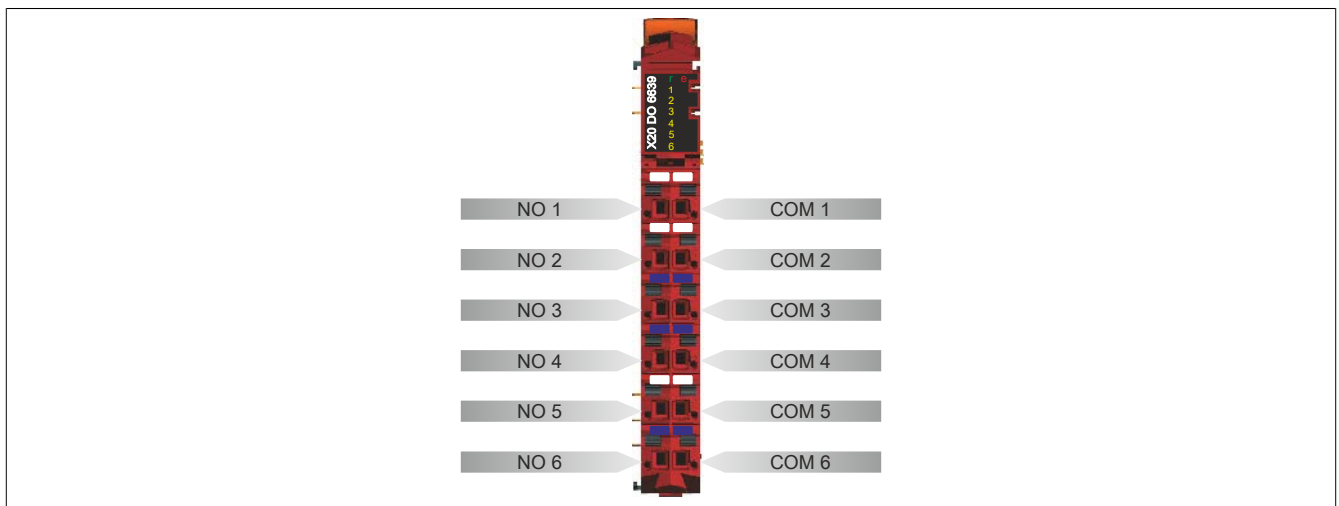
- Number of outputs x Contact resistance x Nominal output current². For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- With a resistive load. See also section "Electrical service life"

9.15.22.5 Status LEDs

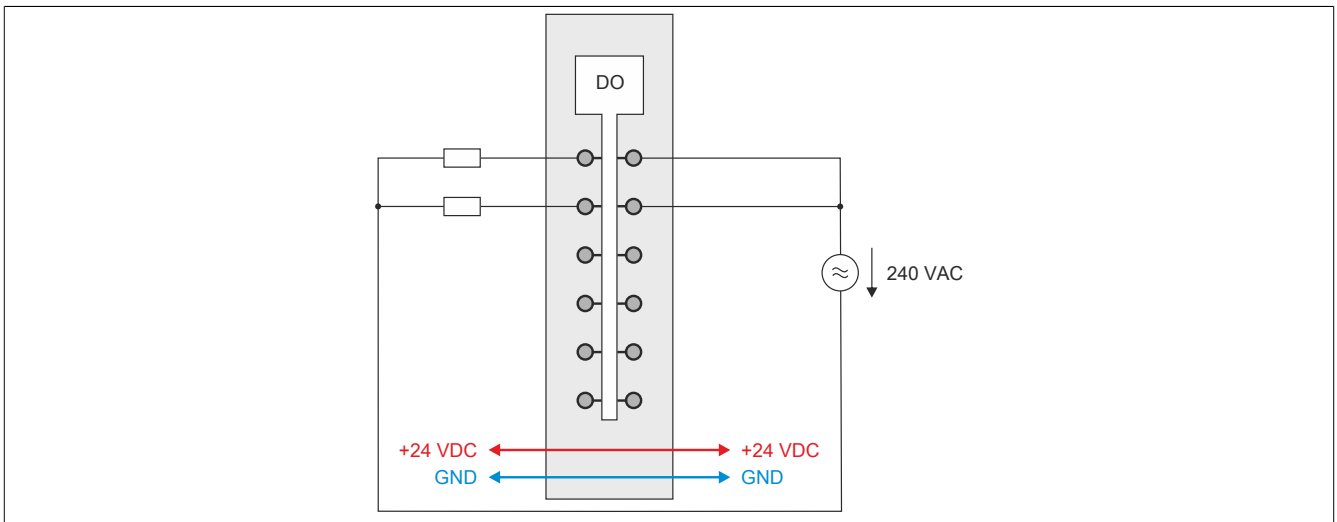
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description | |
|--|-------|-------|-----------------------------|--|---|
|  | r | Green | Off | Module supply not connected | |
| | | | Single flash | RESET mode | |
| | | | Blinking | PREOPERATIONAL mode | |
| | | | On | RUN mode | |
| | e | Red | Off | Module supply not connected or everything OK | |
| | | | On | Error or reset status | |
| | e + r | | Red on / Green single flash | Invalid firmware | |
| | 1 - 6 | | Orange | | Output status of the corresponding digital output |

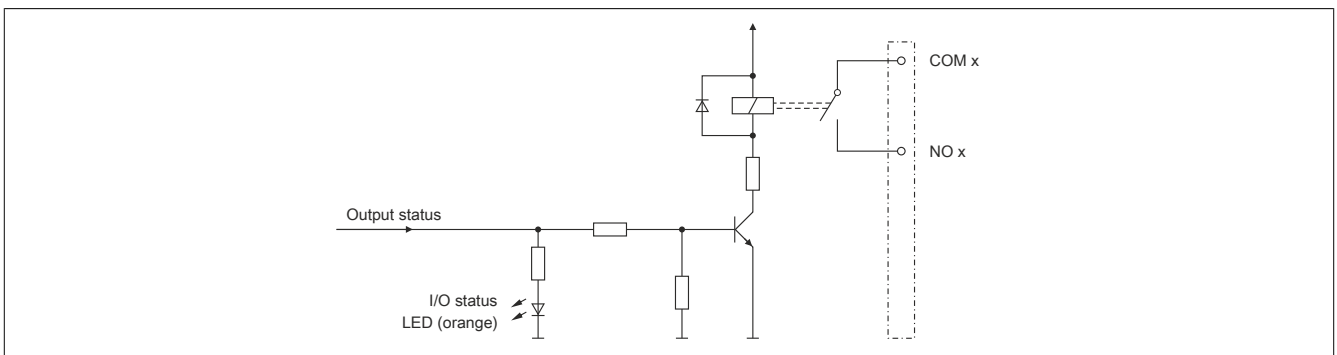
9.15.22.6 Pinout



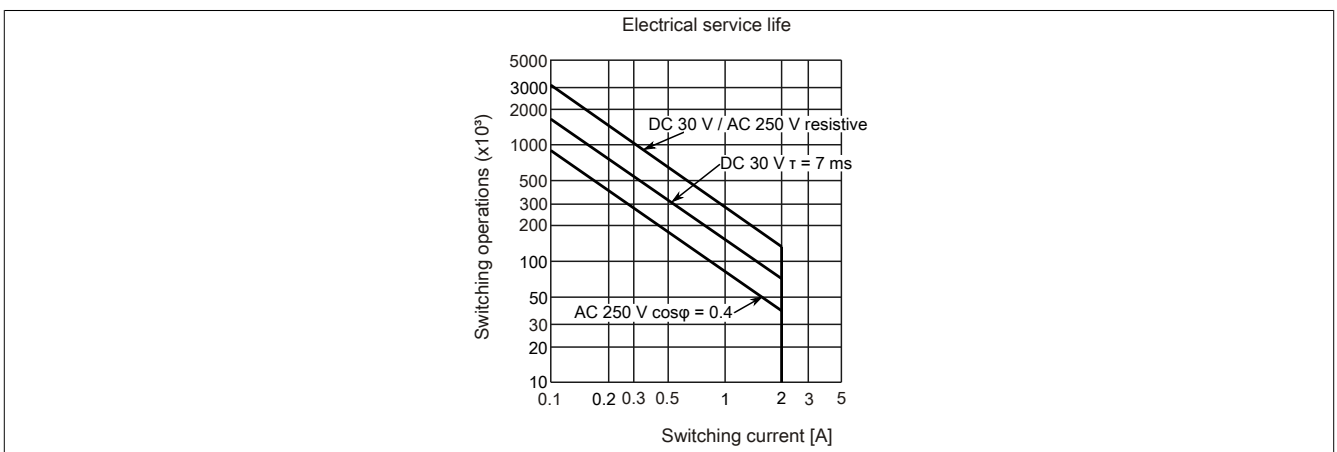
9.15.22.7 Connection example



9.15.22.8 Output circuit diagram



9.15.22.9 Electrical service life



9.15.22.10 Register description

9.15.22.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.15.22.10.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|-----------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | DigitalOutput | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput06 | Bit 5 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.22.10.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 6 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput06 | Bit 5 | | | | |

1) The offset specifies where the register is within the CAN object.

9.15.22.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.22.10.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.15.22.10.4 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 μ s) based on the network cycle (SyncOut).

9.15.22.10.4.1 Switching state of digital outputs 1 to 6

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput06

The switching state of digital outputs 1 to 6 are stored in this register.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Values | Information |
|-----------|--------------------|--|
| USINT | 0 to 63 | Packed outputs = On |
| | See bit structure. | Packed outputs = Off or Function model <> 0 - Standard |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 5 | DigitalOutput06 | 0 | Digital output 06 reset |
| | | 1 | Digital output 06 set |

9.15.22.10.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.15.22.10.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|---------------------------------|
| Equal to the minimum cycle time |

9.15.23 X20DO8232

Data sheet version: 2.16

9.15.23.1 General information

The module is equipped with 8 outputs for 1-wire connections. The nominal output current is 2 A and the nominal voltage is 12 VDC.

The output supply is fed directly to the module. An additional supply module is not needed. There is no connection between the module and the I/O supply potential on the bus module.

- 8 digital outputs with 2 A
- Rated voltage 12 VDC
- Source connection
- 1-wire connection
- Power feed integrated in the module
- Integrated output protection

9.15.23.2 Order data


| Model number | Short description | Figure |
|--------------|--|--|
| | Digital outputs |  |
| X20DO8232 | X20 digital output module, 8 outputs, 12 VDC, 2 A, source, supply directly on module, 1-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 338: X20DO8232 - Order data

9.15.23.3 Technical data

| Model number | X20DO8232 |
|--|---|
| Short description | |
| I/O module | Eight 12 VDC digital outputs for 1-wire connections |
| General information | |
| B&R ID code | 0xA4AD |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Outputs | Yes, using status LED and software (output error status) |
| Supply voltage monitoring | Yes, using software |
| Power consumption | |
| Bus | 0.22 W |
| Internal I/O | - |
| External I/O | 0.82 W |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +4.48 |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Digital outputs | |
| Variant | FET positive switching |
| Nominal voltage | 12 VDC |
| Switching voltage | 12 VDC (-15% / +20%) |
| Nominal output current | 2 A |
| Total nominal current | 8 A |
| Connection type | 1-wire connections |
| Output circuit | Source |
| Output protection | Thermal cutoff for overcurrent or short circuit (see value "Peak short circuit current") Internal inverse diode for switching ind. loads (see section "Switching inductive loads") Reverse polarity protection for supply voltage |
| Actuator power supply | |
| Supply | External |
| Fuse | Required line fuse max. 10 A (slow blow) |
| Diagnostic status | Output monitoring with 10 ms delay |
| Leakage current when switched off | 5 µA |
| R _{DS(on)} | 140 mΩ |
| Peak short-circuit current | <12 A |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Ca. 10 ms (depends on the module temperature) |
| Switching delay ²⁾ | |
| 0 → 1 | <300 µs |
| 1 → 0 | <300 µs |
| Switching frequency | |
| Resistive load ²⁾ | Max. 500 Hz; 600 Hz with max. 250 mA load |
| Inductive load | See section "Switching inductive loads" |
| Braking voltage when switching off inductive loads | Type 50 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Additional functions | To increase the output current, outputs can be switched in parallel |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |

Table 339: X20DO8232 - Technical data


| Model number | X20DO8232 |
|--|--|
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0,5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating" |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 339: X20DO8232 - Technical data

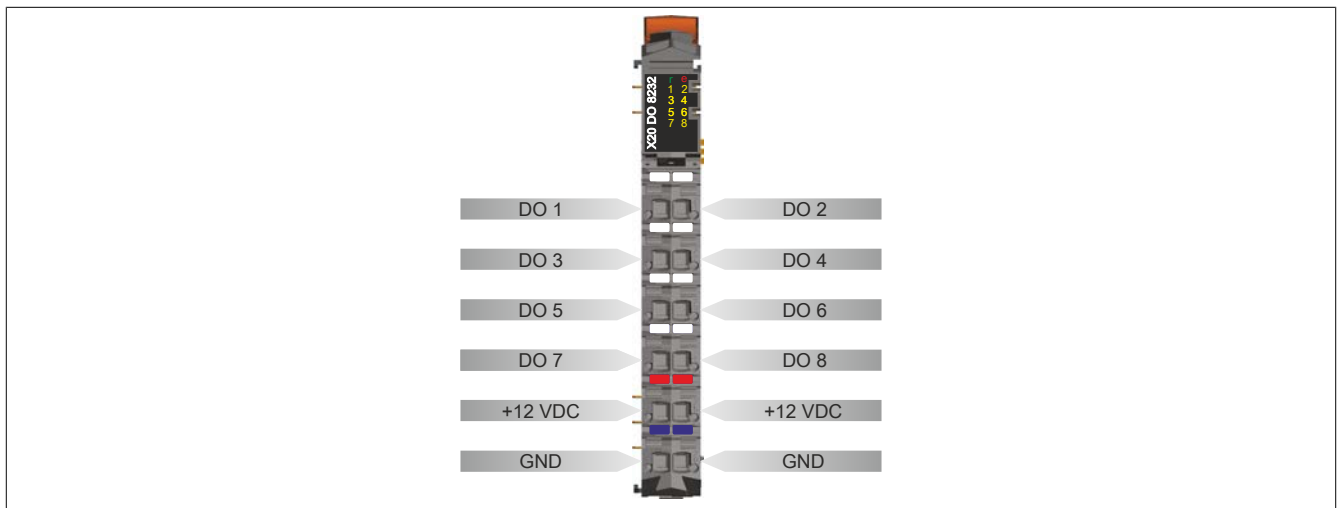
- 1) Number of outputs x $R_{DS(on)}$ x Nominal output current². For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) At loads ≤ 1 k Ω

9.15.23.4 Status LEDs

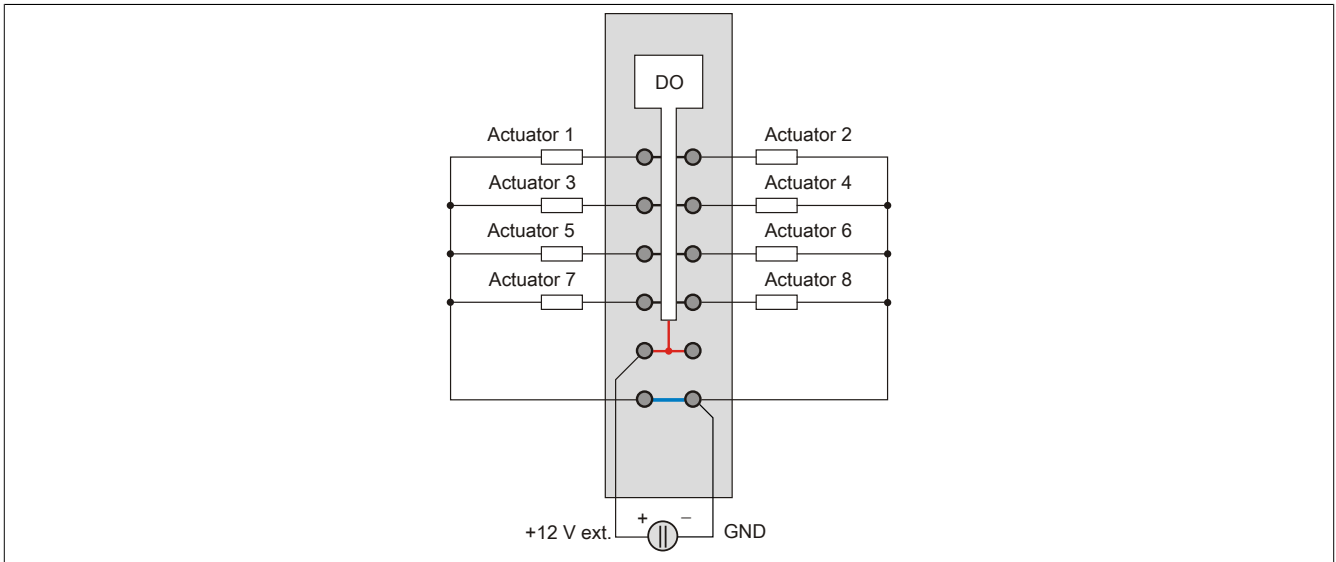
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|--|-------|--------|-----------------------------|---|
|  | r | Green | Off | Module supply not connected |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | Module supply not connected or everything OK |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. |
| | | | Double flash | External I/O power supply is outside the valid range: 12 VDC (-15% / +20%) |
| | e + r | | Red on / Green single flash | Invalid firmware |
| 1 - 8 | | Orange | | Output status of the corresponding digital output |

9.15.23.5 Pinout



9.15.23.6 Connection example

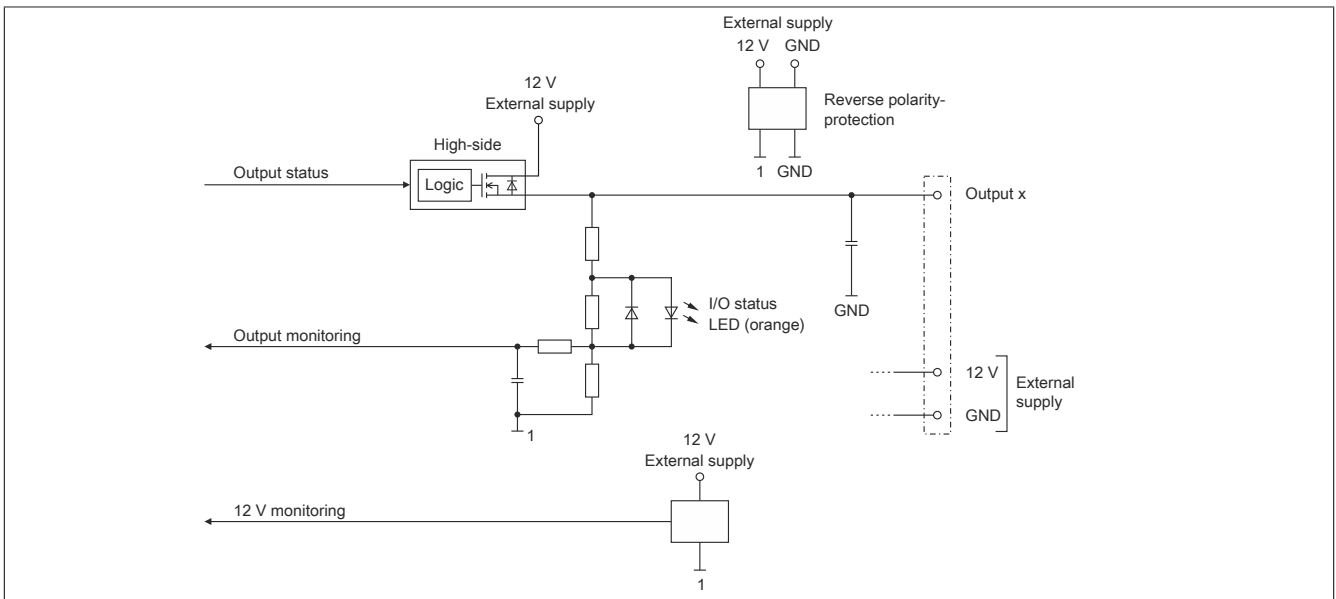


Caution!

If the module is operated outside specifications, the output current may rise above the maximum permissible nominal current. This applies both to individual channels and to the summation current of the module.

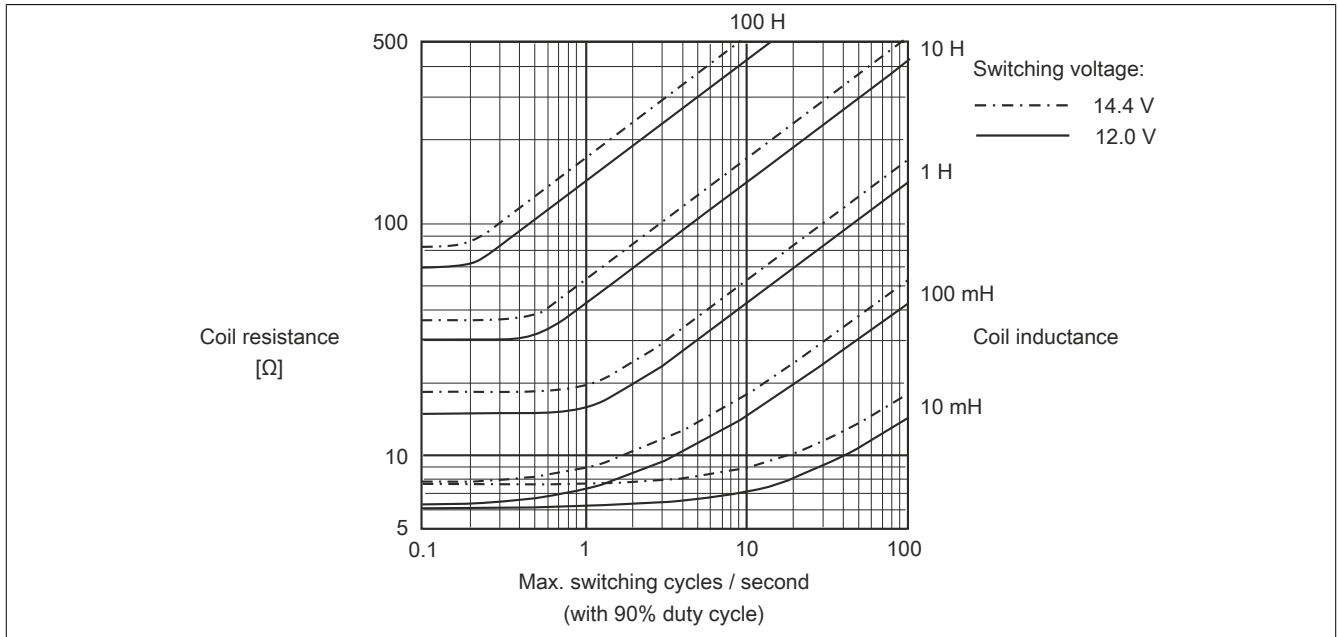
Appropriate cable cross-sections or external safety measures must therefore be provided.

9.15.23.7 Output circuit diagram

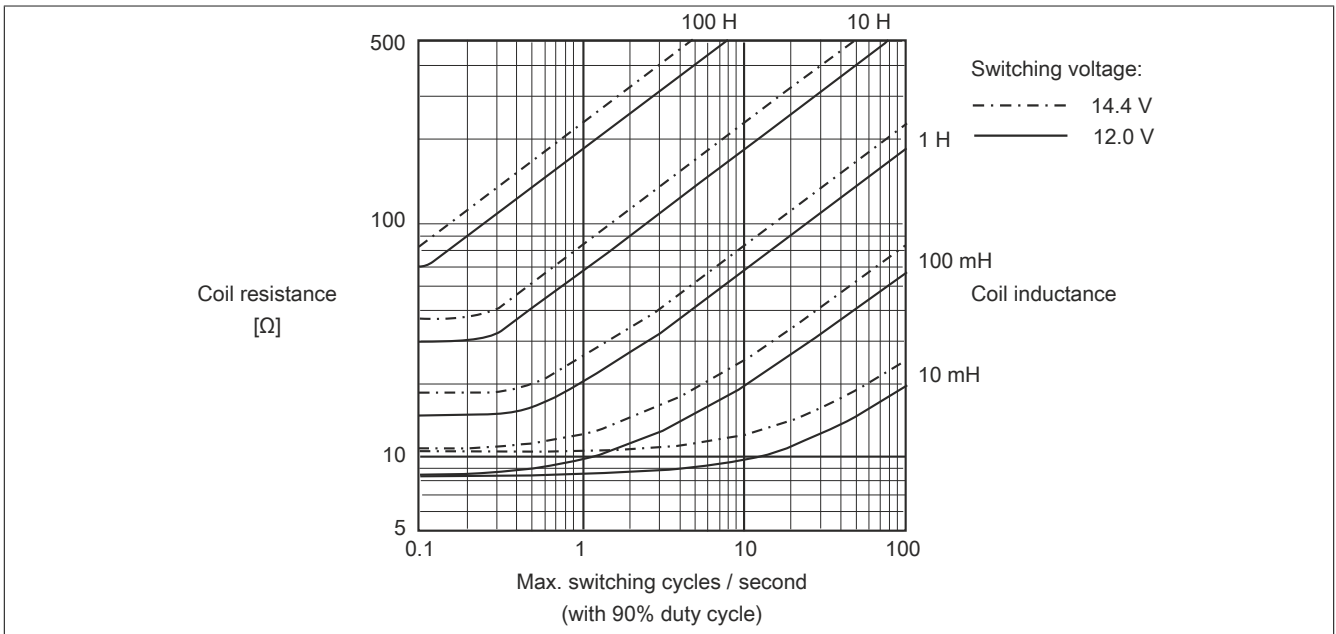


9.15.23.8 Switching inductive loads

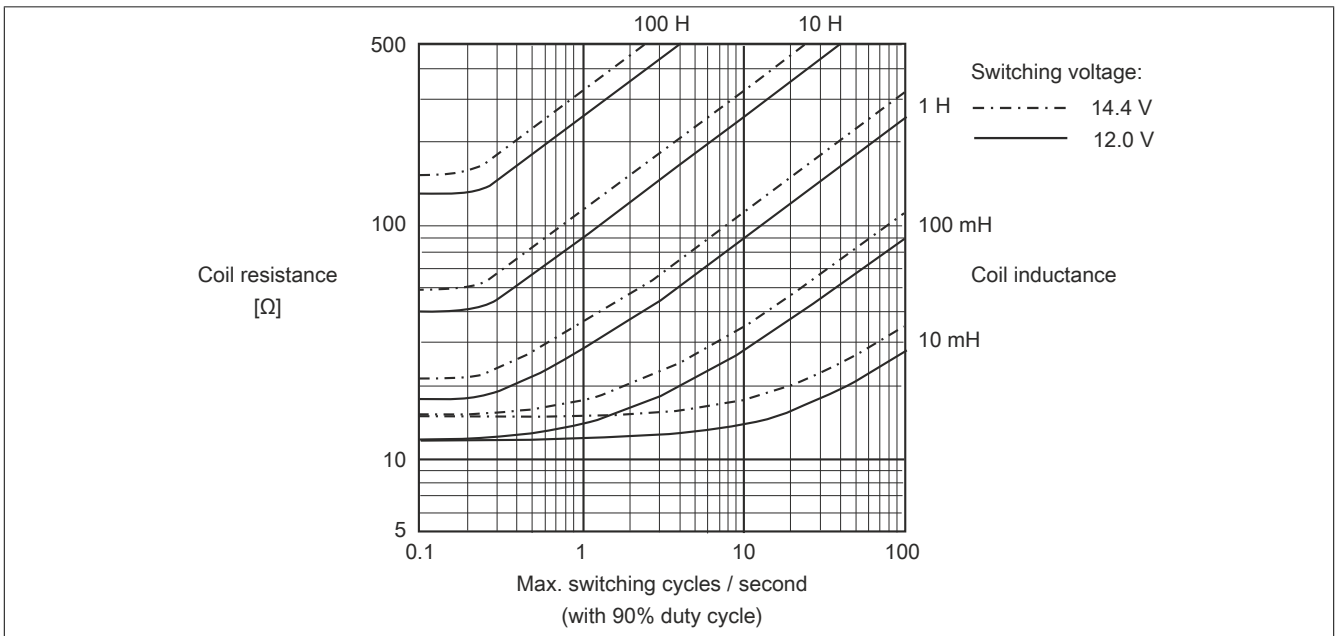
Environmental temperature: 35°C, 4 outputs (1,3,5,7 or 2,4,6,8) with the same load.



Environmental temperature: 60°C, 4 outputs (1,3,5,7 or 2,4,6,8) with the same load.



Environmental temperature: 60°C, all outputs with the same load.



Information:

If the maximum number of operating cycles per second is exceeded, an external inverse diode must be used.

Operating conditions outside of the area in the diagram are not permitted!

9.15.23.9 Derating

The outputs of the module can handle up to 2 A. With a summation current of 8 A, no more than 4 channels are operable at full load. To ensure optimal use of the module, it is important to assign the channels properly, and to keep in mind a potential derating.

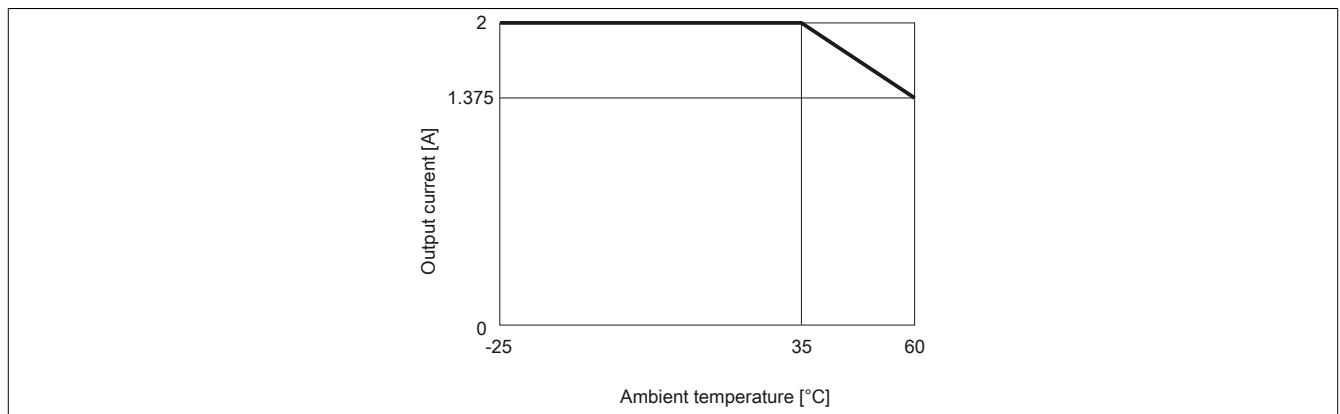
Correct channel assignment is important, since the 8 outputs are divided between 2 output drivers. The channels operated with 2 A must therefore be evenly divided between both output drivers.

Output driver 1: Channels 1 to 4
Output driver 2: Channels 5 to 8

The following table provides an overview of the number of fully used channels, the resulting best distribution, and a potential derating.

| Number of channels using 2 A | Division | Derating |
|------------------------------|--|--|
| 1 | Any | No |
| 2 | 1st channel with 2 A ... channel no. 1 to 4 2nd channel with 2 A ... channel no. 5 to 8 | No |
| 3 | Assign all even or all odd channel numbers. Examples: 1, 3, 5 2, 4, 6 3, 5, 7 4, 6, 8 | Channels 1 and 3 Channels 2 and 4 Channels 5 and 7 Channels 6 and 8 |
| 4 | Assign all even or all odd channel numbers. Possible divisions: 1, 3, 5, 7 2, 4, 6, 8 | On each channel On each channel |

Derating when 3 or 4 channels are operated with 2 A:



Information:

Only modules with a maximum power dissipation of 1 W are permitted to be operated next to the module.

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.

9.15.23.10 Register description

9.15.23.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.15.23.10.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | DigitalOutput | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08 | Bit 7 | | | | |
| 30 | 1 | StatusInput01 | USINT | • | | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput08 | Bit 7 | | | | |
| 8192 | - | Reading the module ID | UINT | | • | | |
| 8196 | - | Status of the supply voltage | USINT | | • | | |
| | | PowerSupply01 | Bit 2 | • | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.23.10.3 Function model 1 - Output switching

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 8 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08 | Bit 7 | | | | |
| 4 | 1 | Switching state of delayed digital outputs 1 to 8 | USINT | | | • | |
| | | DigitalOutput01Delayed | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08Delayed | Bit 7 | | | | |
| 6 | 2 | Switching mask after the delay time has expired | USINT | | | • | |
| | | DigitalOutput01DelayEnable | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08DelayEnable | Bit 7 | | | | |
| 8 | 3 | Setting the delay (OutputDelayTime) | USINT | | | • | |
| 30 | 1 | Status of digital outputs 1 to 8 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput08 | Bit 7 | | | | |
| 8192 | - | Reading the module ID | UINT | | • | | |
| 8196 | - | Status of the supply voltage | USINT | | • | | |
| | | PowerSupply01 | Bit 2 | • | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.23.10.4 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | - | Switching state of digital outputs 1 to 8 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08 | Bit 7 | | | | |
| 30 | - | Status of digital outputs 1 to 8 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput08 | Bit 7 | | | | |
| 8192 | - | Reading the module ID | UINT | | • | | |
| 8196 | - | Status of the supply voltage | USINT | | • | | |
| | | PowerSupply01 | Bit 2 | | • | | |

1) The offset specifies where the register is within the CAN object.

9.15.23.10.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.23.10.4.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.15.23.10.5 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 µs) based on the network cycle (SyncOut).

9.15.23.10.5.1 Switching state of digital outputs 1 to 8

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput08

The switching state of digital outputs 1 to 8 are stored in this register.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 255 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | ... | ... | ... |
| 7 | DigitalOutput08 | 0 | Digital output 08 reset |
| | | 1 | Digital output 08 set |

9.15.23.10.6 Reading the module ID

Name:

asy_ModulID

This register offers the possibility to read the module ID.

| Data type | Values |
|-----------|-----------|
| UINT | Module ID |

9.15.23.10.7 Monitoring status of the digital outputs

On the module, the output states of the outputs are compared to the target states. The control of the output driver is used for the target state.

A change in the output state resets monitoring for that output. The status of each individual channel can be read. A change in the monitoring status is actively transmitted as an error message.

9.15.23.10.7.1 Status of digital outputs 1 to 8

Name:

StatusInput01

StatusDigitalOutput01 to StatusDigitalOutput08

This register is used to indicate the status of digital outputs 1 to 8.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("StatusDigitalOutput01" to "StatusDigitalOutput0x") or whether this register should be displayed as a single USINT data point ("StatusIn-put01").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 255 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput01 | 0 | Channel 01: No error |
| | | 1 | Channel 01: <ul style="list-style-type: none"> Short circuit or overload Channel switched on and missing I/O power supply Channel switched off and external voltage applied on channel |
| ... | ... | ... | ... |
| 8 | StatusDigitalOutput08 | 0 | Channel 08: No error |
| | | 1 | Channel 08: For an error description, see channel 01. |

9.15.23.10.8 Operating limit monitoring

The module's output supply is monitored. An I/O supply voltage of <10.2 V is displayed as a warning.

9.15.23.10.8.1 Status of the supply voltage

Name:

asy_SupplyStatus

The status of the I/O supply voltage is mapped in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---------------|-------|--|
| 0 - 1 | Reserved | 0 | 0 |
| 2 | PowerSupply01 | 0 | I/O supply above the warning level of 10.2 V |
| | | 1 | I/O supply below the warning level of 10.2 V |
| 3 - 7 | Reserved | 0 | 0 |

9.15.23.10.9 Additional function - switch digital outputs w/ delay using switching mask

In function model 1 - Output switching, it is possible to control the digital outputs with a delay.

The OutputDelay mask can be used to activate the delay for each channel individually. The module is controlled here using a 100 µs-based timer and the Output or OutputDelayed register.

Behavior of function model 1 - Output switching

With a timer delay of 0:

Output: DigitalOutput0x bits

When the delay is changed:

The bit string for DigitalOutput0x bits is output. The timer restarts.

Output: DigitalOutput0x bits

After delay time has expired:

The channels whose bits are set in the mask for OutputDelay are adapted to the corresponding OutputDelayed bits.

Output: DigitalOutput0x bits (if Enable bit = FALSE)
OutputDelayed bits (if Enable bit = TRUE)

Information:

Adjusting the output and restarting the timer take place immediately after transferring the new delay, even if the previous time has not yet passed.

9.15.23.10.9.1 Switching state of delayed digital outputs 1 to 8

Name:

DigitalOutput01Delayed to Digital08Delayed

According to the corresponding bit in the OutputDelay mask, the switching state of all digital outputs 1 to 8 are stored in the OutputDelayed bits after the delay time has expired.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|------------------------|-------|-------------------------|
| 0 | DigitalOutput01Delayed | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 7 | DigitalOutput08Delayed | 0 | Digital output 08 reset |
| | | 1 | Digital output 08 set |

Information:

After the delay time has expired, only the channels with a bit set in the OutputDelay mask are adjusted to the OutputDelayed bits.

9.15.23.10.9.2 Switching mask after the delay time has expired

Name:

DigitalOutput01DelayEnable to DigitalOutput08DelayEnable

These registers create the mask for OutputDelay. They define which outputs are switched to the bit string for the OutputDelayed register after the delay time has expired.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------------------|-------|-------------------------------------|
| 0 | DigitalOutput01DelayEnable | 0 | Digital output 01 remains unchanged |
| | | 1 | Digital output 01 is toggled |
| ... | | ... | |
| 7 | DigitalOutput08DelayEnable | 0 | Digital output 08 remains unchanged |
| | | 1 | Digital output 08 is toggled |

9.15.23.10.9.3 Setting the delay

Name:

OutputDelayTime

This register can be used to set the delay in 100 µs steps.

After the delay time has expired, the digital outputs are adjusted according to the switching mask (register 6) and the delayed output pattern (register 4).

| Data type | Value |
|-----------|--|
| USINT | 0 to 255 (in 100 µs steps) ¹⁾ |

1) The value 0 disables processing

9.15.23.10.10 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

9.15.23.10.11 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

9.15.24 X20DO8322

Data sheet version: 3.16

9.15.24.1 General information

The module is equipped with 8 outputs for 1-wire connections and designed for source output wiring.

- 8 digital outputs
- Source connection
- 1-wire connections
- Integrated output protection

9.15.24.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Digital outputs |  |
| X20DO8322 | X20 digital output module, 8 outputs, 24 VDC, 0.5 A, source, 1-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 340: X20DO8322 - Order data

9.15.24.3 Technical data

| | |
|--|--|
| Model number | X20DO8322 |
| Short description | |
| I/O module | 8 digital outputs 24 VDC for 1-wire connections |
| General information | |
| B&R ID code | 0xA4AC |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Outputs | Yes, using status LED and software (output error status) |
| Power consumption | |
| Bus | 0.26 W |
| Internal I/O | 0.8 W |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +0.42 |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 |
| HazLoc | Industrial control equipment cCSAus 244665 |
| ATEX | Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| DNV GL | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| LR | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| KR | ENV1 |
| KR | Yes |
| Digital outputs | |
| Variant | FET positive switching |
| Nominal voltage | 24 VDC |
| Switching voltage | 24 VDC -15 % / +20 % |
| Nominal output current | 0.5 A |
| Total nominal current | 4 A |
| Connection type | 1-wire connections |
| Output circuit | Source |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short circuit current") Internal inverse diode for switching inductive loads (see section "Switching inductive loads") |
| Diagnostic status | Output monitoring with 10 ms delay |
| Leakage current when switched off | 5 µA |
| R _{DS(on)} | 210 mΩ |
| Peak short-circuit current | <12 A |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms (depends on the module temperature) |
| Switching delay | |
| 0 → 1 | <300 µs |
| 1 → 0 | <300 µs |
| Switching frequency | |
| Resistive load | Max. 500 Hz |
| Inductive load | See section "Switching inductive loads" |
| Braking voltage when switching off inductive loads | Typ. 50 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |

Table 341: X20DO8322 - Technical data


| Model number | X2DO8322 | |
|---------------------------------|--|--|
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | |
| Spacing | 12.5 ^{+0.2} mm | |

Table 341: X2DO8322 - Technical data

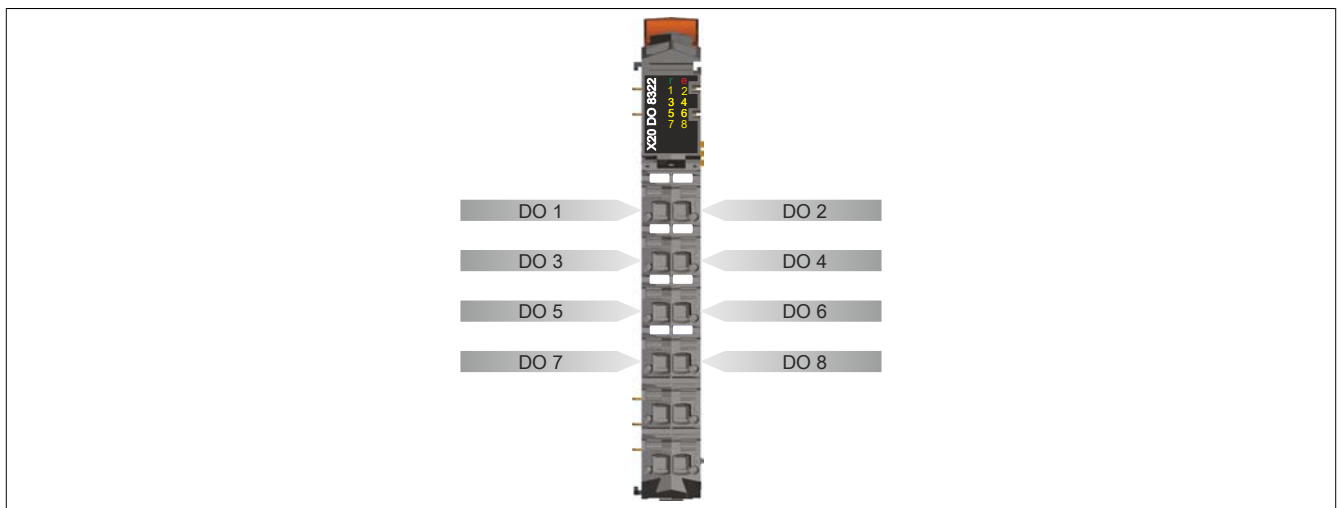
- 1) Number of outputs x $R_{DS(on)}$ x Nominal output current². For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.

9.15.24.4 Status LEDs

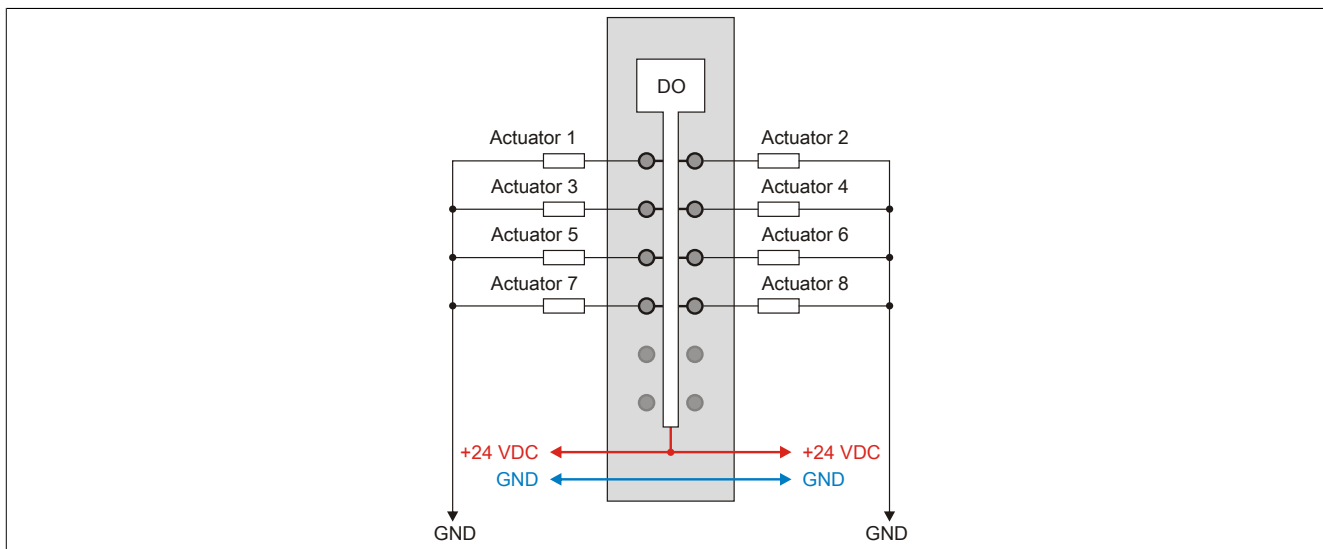
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|--|-------|-------|-----------------------------|---|
|  | r | Green | Off | Module supply not connected |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | Module supply not connected or everything OK |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. |
| | e + r | | Red on / Green single flash | Invalid firmware |
| | 1 - 8 | | Orange | |

9.15.24.5 Pinout



9.15.24.6 Connection example

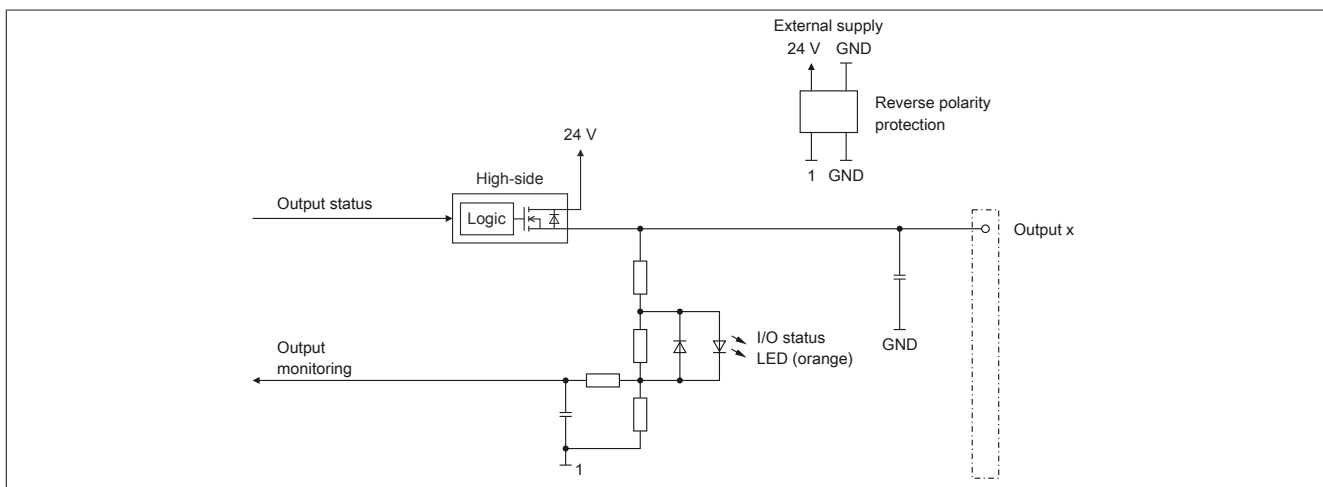


Caution!

If the module is operated outside specifications, the output current may rise above the maximum permissible nominal current. This applies both to individual channels and to the summation current of the module.

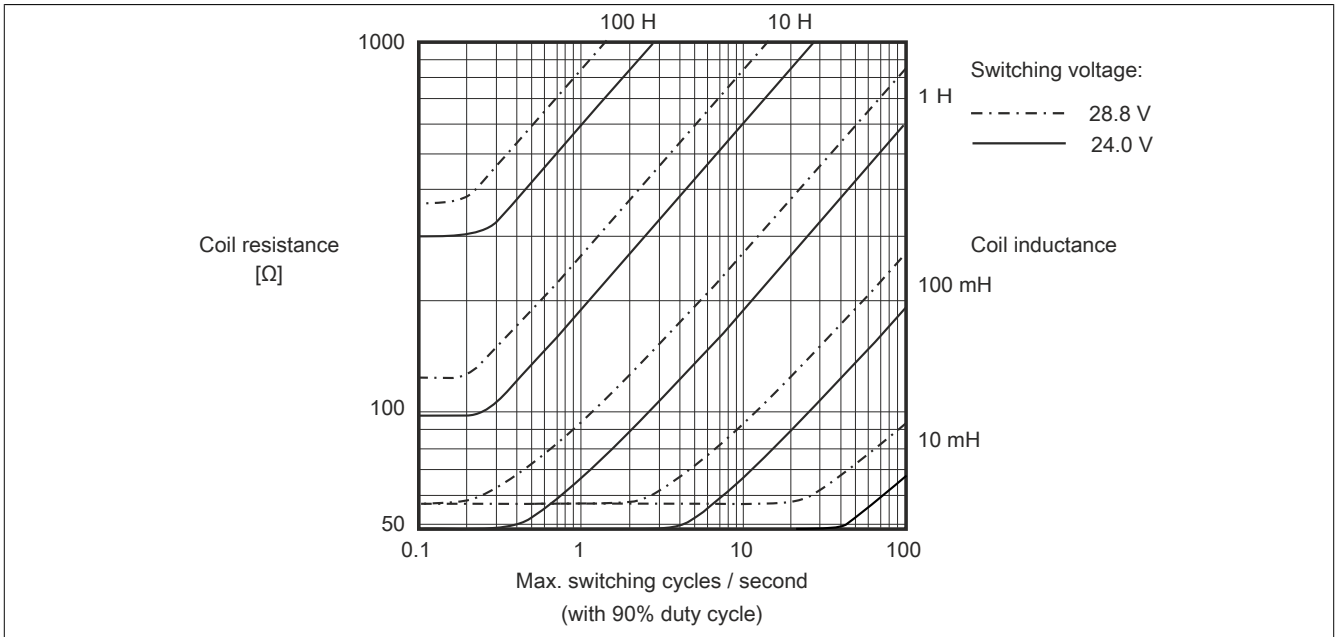
Appropriate cable cross-sections or external safety measures must therefore be provided.

9.15.24.7 Output circuit diagram

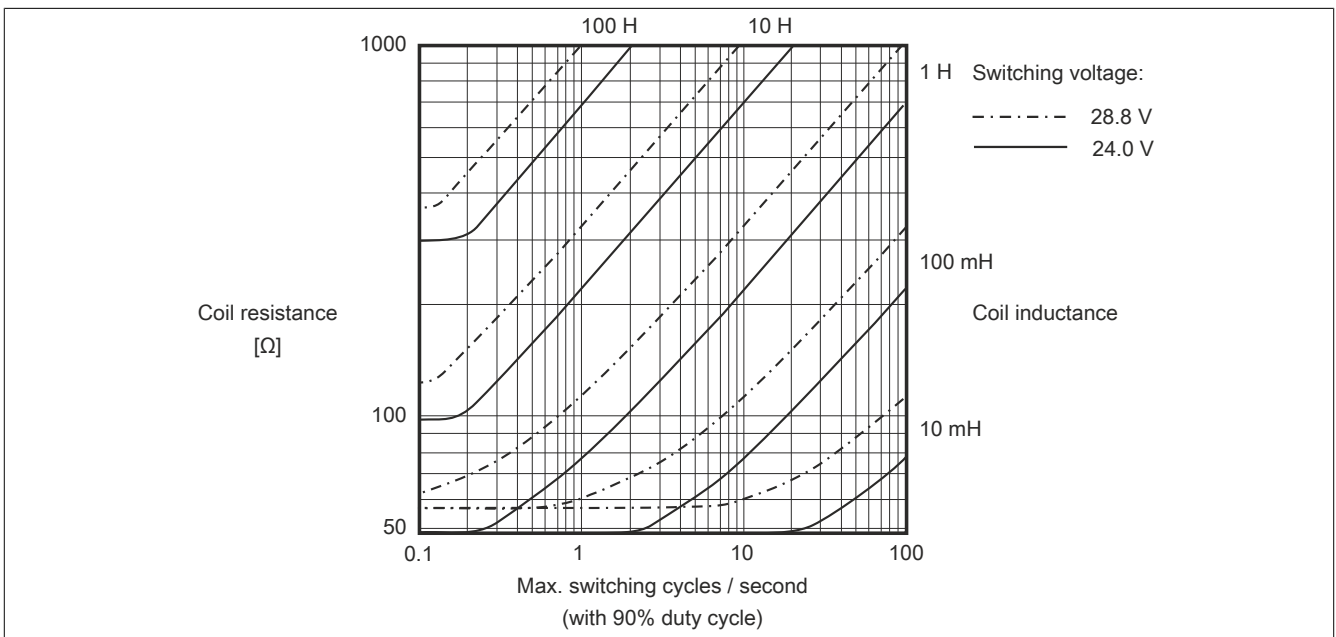


9.15.24.8 Switching inductive loads

Environmental temperature: 55°C, all outputs with the same load



Environmental temperature: 60°C, all outputs with the same load



Information:

If the maximum number of operating cycles per second is exceeded, an external inverse diode must be used.

Operating conditions outside of the area in the diagram are not permitted!

9.15.24.9 Register description

9.15.24.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.15.24.9.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|-----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | DigitalOutput | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08 | Bit 7 | | | | |
| 30 | 1 | StatusInput01 | USINT | • | | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput08 | Bit 7 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.24.9.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 8 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08 | Bit 7 | | | | |
| 30 | - | Status of digital outputs 1 to 8 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput08 | Bit 7 | | | | |

1) The offset specifies where the register is within the CAN object.

9.15.24.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.24.9.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.15.24.9.4 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 µs) based on the network cycle (SyncOut).

9.15.24.9.4.1 Switching state of digital outputs 1 to 8

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput08

The switching state of digital outputs 1 to 8 are stored in this register.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 255 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 7 | DigitalOutput08 | 0 | Digital output 08 reset |
| | | 1 | Digital output 08 set |

9.15.24.9.5 Monitoring status of the digital outputs

On the module, the output states of the outputs are compared to the target states. The control of the output driver is used for the target state.

A change in the output state resets monitoring for that output. The status of each individual channel can be read. A change in the monitoring status is actively transmitted as an error message.

9.15.24.9.5.1 Status of digital outputs 1 to 8

Name:

StatusInput01

StatusDigitalOutput01 to StatusDigitalOutput08

This register is used to indicate the status of digital outputs 1 to 8.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("StatusDigitalOutput01" to "StatusDigitalOutput0x") or whether this register should be displayed as a single USINT data point ("StatusInput01").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 255 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput01 | 0 | Channel 01: No error |
| | | 1 | Channel 01: <ul style="list-style-type: none"> Short circuit or overload Channel switched on and missing I/O power supply Channel switched off and external voltage applied on channel |
| ... | | ... | |
| 8 | StatusDigitalOutput08 | 0 | Channel 08: No error |
| | | 1 | Channel 08: For an error description, see channel 01. |

9.15.24.9.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.15.24.9.7 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|---------------------------------|
| Equal to the minimum cycle time |

9.15.25 X20DO8323

Data sheet version: 1.31

9.15.25.1 General Information

The module is an electrically isolated 8-channel digital output module. It can be configured as high-side or low-side or as a push/pull output for controlling 12 to 24 VDC DC motors.

- 8 digital outputs
- High-side or low-side connection
- Push/pull outputs
- 1-wire connections
- Integrated output protection

9.15.25.2 Order data


| Model number | Short description | Figure |
|--------------|--|--|
| | Digital outputs |  |
| X20DO8323 | X20 digital output module, 8 outputs, 12 to 24 V, 0.5 A, sink/source, 1-wire connections, full bridge, half bridge, thermal over-load protection | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 342: X20DO8323 - Order data

9.15.25.3 Technical data

| | |
|--|---|
| Model number | X20DO8323 |
| Short description | |
| I/O module | 8 digital outputs 11.5 to 30 V for 1-wire connections |
| General information | |
| B&R ID code | 0xDF4E |
| Status indicators | Operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Outputs | Yes, using software |
| Power consumption | |
| Bus | 160 mW |
| Internal I/O | 200 mW (without load) |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| Digital outputs | |
| Variant | FET push/pull (high resistance) |
| Nominal voltage | 11.5 to 30 V |
| Nominal output current | 0.5 A |
| Total nominal current | 4 A |
| Connection type | 1-wire connections |
| Output circuit | Sink / source |
| Diagnostic status | |
| Voltage monitoring ¹⁾ | 11.5 V < supply voltage < 30 V |
| Output monitoring | Output OK |
| Leakage current when switched off | 5 µA per channel |
| R _{DS(on)} | 120 mΩ (low-side), 140 mΩ (high-side) |
| Switching delay | |
| 0 → 1 | Max. 450 µs |
| 1 → 0 | Max. 450 µs |
| Switching frequency | |
| Resistive load | Max. 100 Hz |
| Isolation voltage between channel and bus | 500 V |
| Reverse polarity protection | Yes |
| Switching voltage | |
| Minimum | 11.5 VDC |
| Nominal | 12 to 24 VDC |
| Maximum | 30 VDC |
| Protective circuit | |
| External | 24 VDC voltage supply – Maximum current 5A (blow-out fuse) |
| Internal | Thermal cutoff, integrated protection for switching inductances |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |

Table 343: X20DO8323 - Technical data

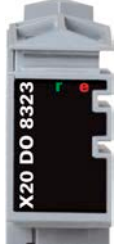
| Model number | X20DO8323 |
|-----------------------|--|
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 343: X20DO8323 - Technical data

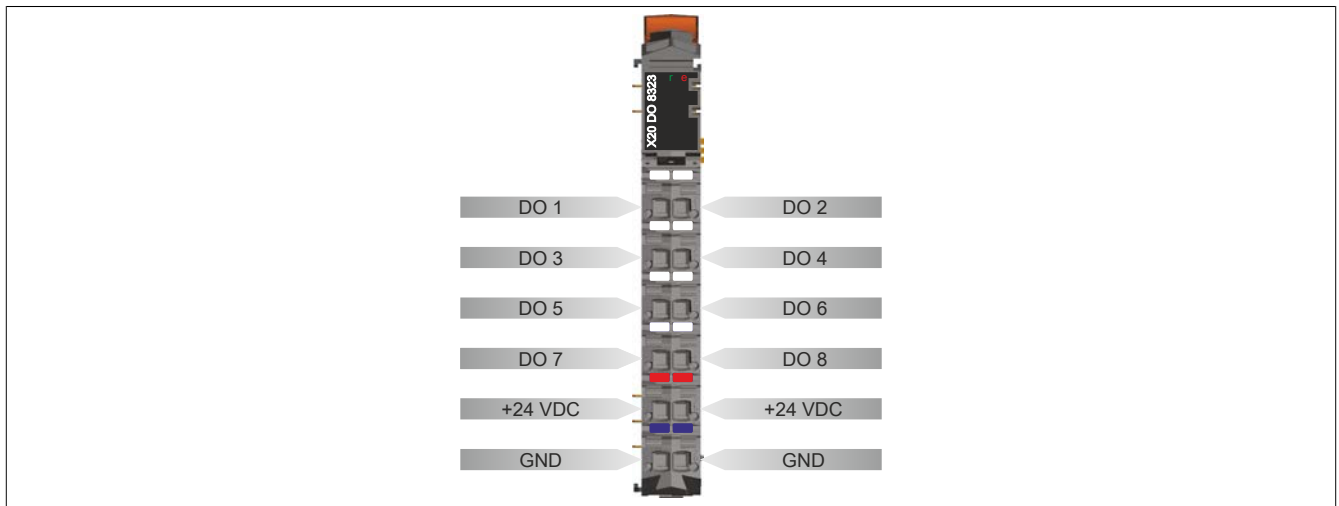
1) If the voltage is too low, the outputs are switched off.

9.15.25.4 Status LEDs

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

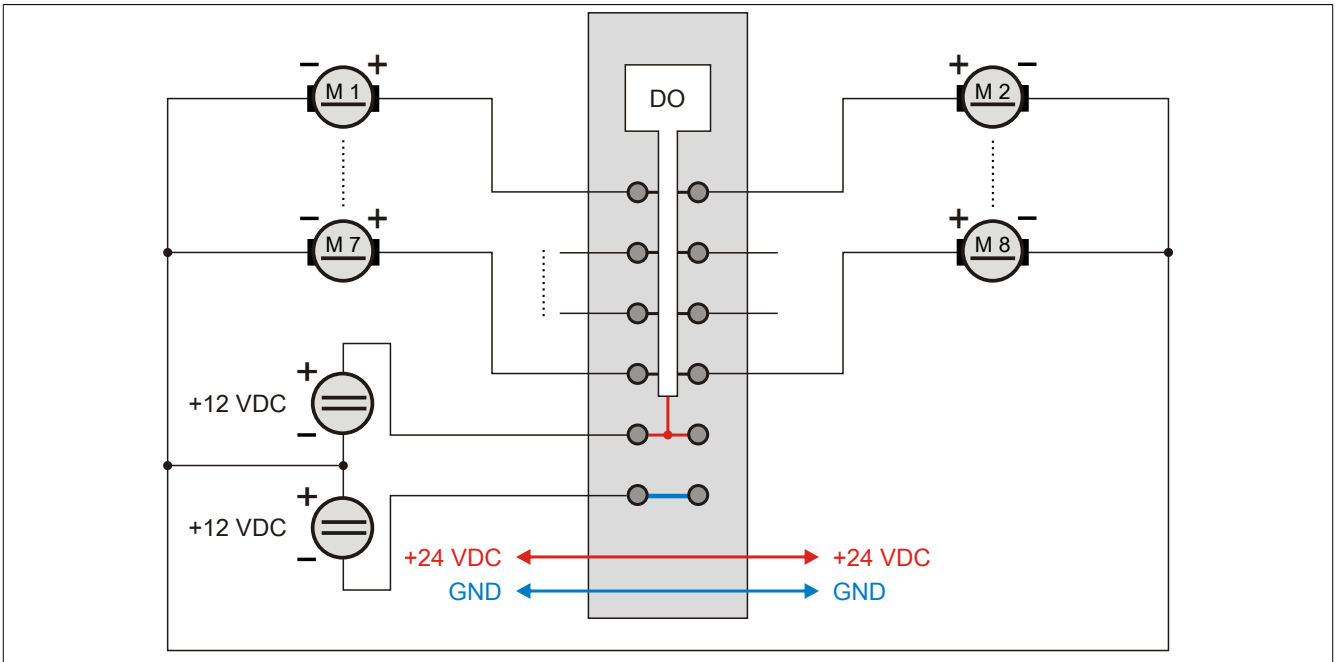
| Image | LED | Color | Status | Description |
|---|-----|-------|--------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | Module supply not connected or everything OK |
| | | | On | Error or reset status |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. |
| | | | Double flash | I/O supply too low |

9.15.25.5 Pinout

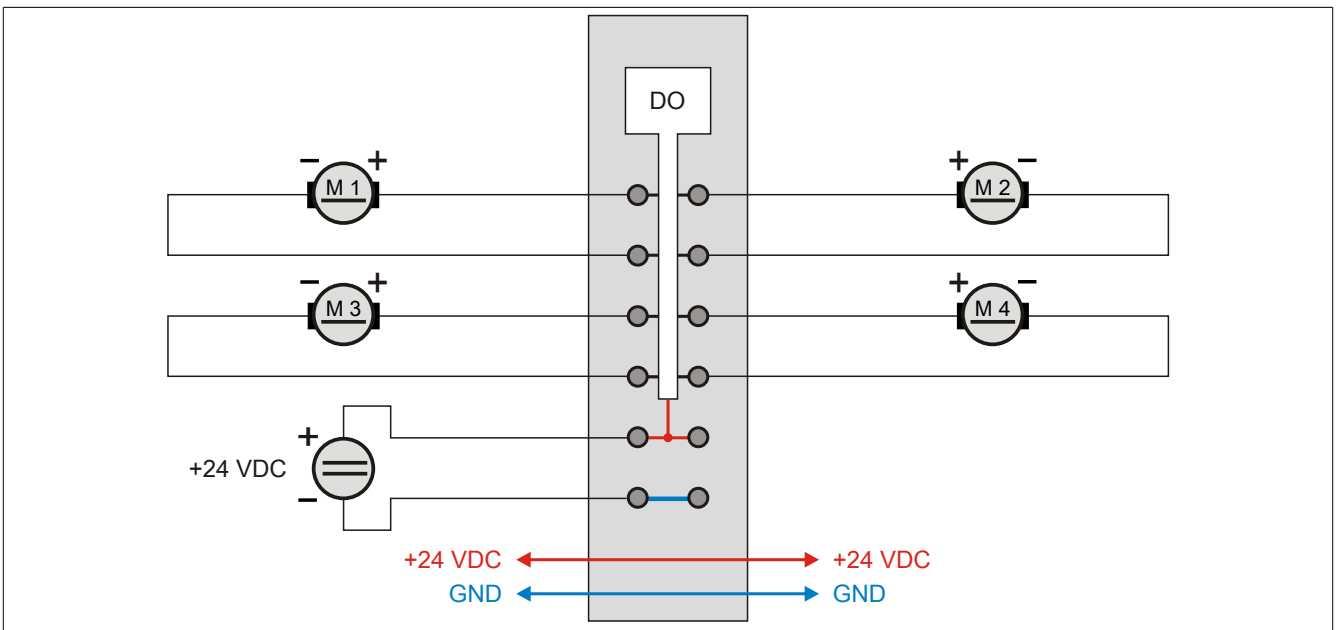


9.15.25.6 Connection example

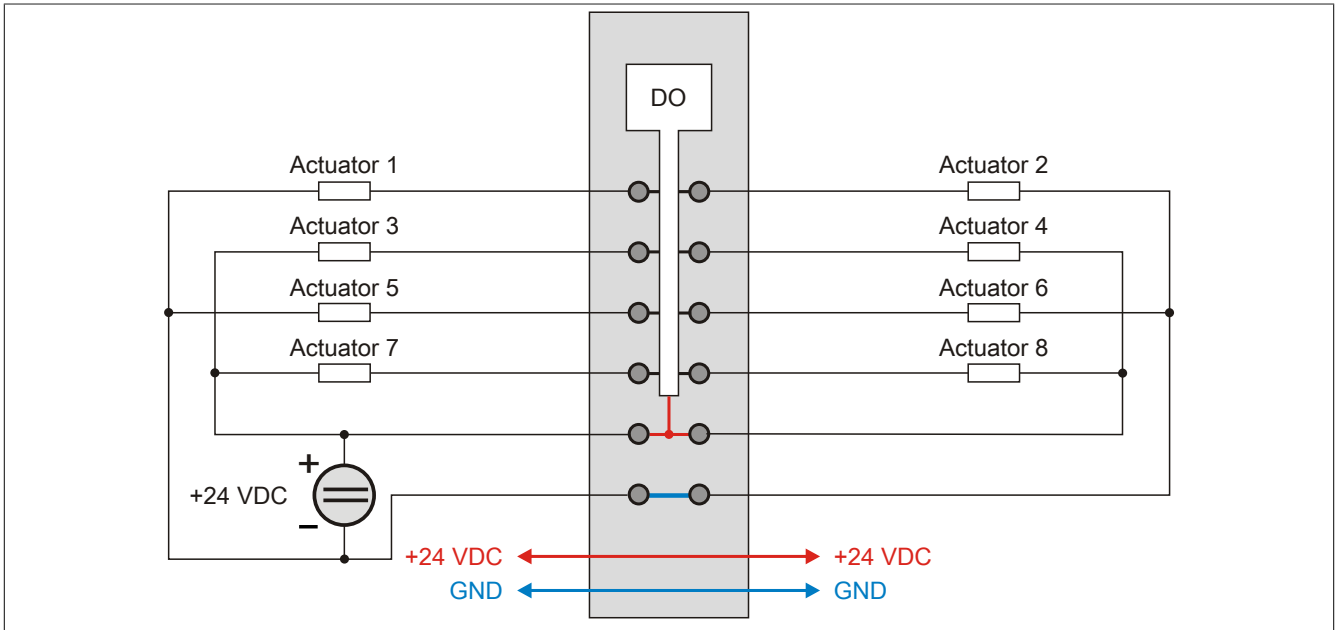
Half bridge connection:



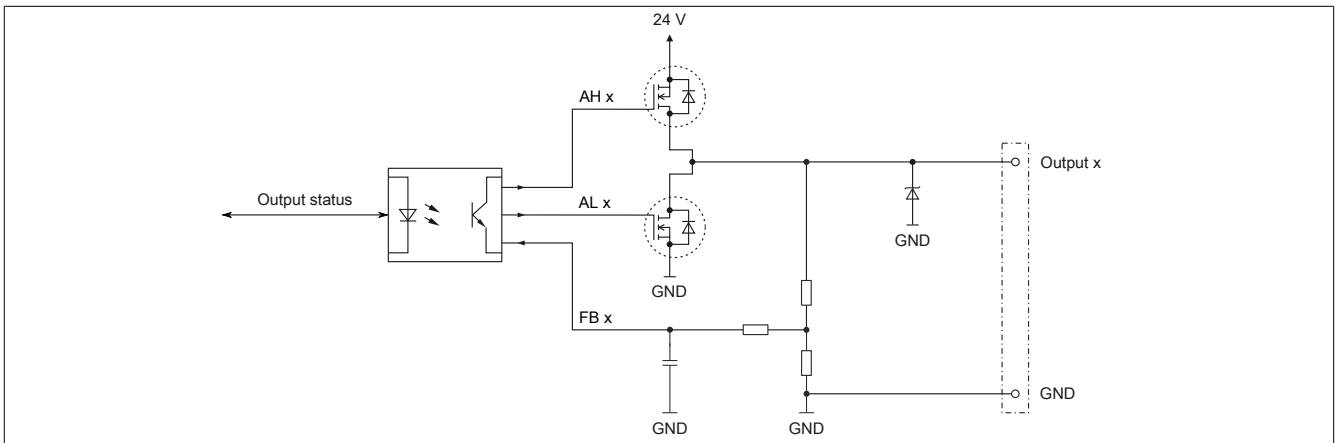
Full bridge connection:



Use as high-side or low-side:



9.15.25.7 Output circuit diagram



9.15.25.8 Register description

9.15.25.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.15.25.8.2 Function model 0 - Default

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------------------|--------------|-----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 4 | 1 | EnableDigitalOutput | USINT | | | • | |
| | | EnabDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | EnabDigitalOutput08 | Bit 7 | | | | |
| Communication | | | | | | | |
| 0 | 1 | DigitalInput | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput08 | Bit 7 | | | | |
| 2 | 0 | DigitalOutput | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08 | Bit 7 | | | | |
| 30 | 2 | StatusInput01 | USINT | • | | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput08 | Bit 7 | | | | |
| 31 | 3 | Cumulative status | USINT | • | | | |
| | | StatusDigitalOutputs | Bit 0 | | | | |
| | | StatusSupplyLO | Bit 4 | | | | |
| | | StatusSupplyHI | Bit 5 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.25.8.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 4 | - | Switching between inputs and outputs | USINT | | | | • |
| | | EnabDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | EnabDigitalOutput08 | Bit 7 | | | | |
| Communication | | | | | | | |
| 0 | 0 | Digital inputs | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput08 | Bit 7 | | | | |
| 2 | 0 | Switching state of digital outputs 1 to 8 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08 | Bit 7 | | | | |
| 30 | - | Status of digital outputs 1 to 8 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput08 | Bit 7 | | | | |
| 31 | - | Cumulative status | USINT | | • | | |
| | | StatusDigitalOutputs | Bit 0 | | | | |
| | | StatusSupplyLO | Bit 4 | | | | |
| | | StatusSupplyHI | Bit 5 | | | | |

1) The offset specifies where the register is within the CAN object.

9.15.25.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.25.8.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.15.25.8.4 Digital outputs

The output state is sent to the output ports acyclically to the network in the system timer (100 µsec). (max. switch off jitter: 50 µsec, max. switch on jitter: 150 µsec)

The output state must be switched with at least a 300 µsec delay in order to prevent the high-side and low-side drivers from switching together.

9.15.25.8.4.1 Switching state of digital outputs 1 to 8

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput08

The switching state of digital outputs 1 to 8 are stored in this register.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 255 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 7 | DigitalOutput08 | 0 | Digital output 08 reset |
| | | 1 | Digital output 08 set |

9.15.25.8.4.2 Status of digital outputs 1 to 8

Name:

StatusInput01

StatusDigitalOutput01 to StatusDigitalOutput08

This register is used to indicate the status of digital outputs 1 to 8.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("StatusDigitalOutput01" to "StatusDigitalOutput0x") or whether this register should be displayed as a single USINT data point ("StatusInput01").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 255 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput01 | 0 | Channel 01: No error |
| | | 1 | Channel 01: <ul style="list-style-type: none"> • Short circuit or overload • Channel switched on and missing I/O power supply • Channel switched off and external voltage applied on channel |
| ... | ... | ... | ... |
| 8 | StatusDigitalOutput08 | 0 | Channel 08: No error |
| | | 1 | Channel 08: For an error description, see channel 01. |

9.15.25.8.4.3 Switching between inputs and outputs

Name:

EnableDigitalOutput

EnabDigitalOutput01 through EnabDigitalOutput08

In this register, all channels can be connected as inputs or outputs. For each output there is a corresponding switching bit. Clearing this bit switches to tristate mode.

Function model 0 - Standard only:

The "packed outputs" setting in the Automation Studio I/O configuration is used to determine whether all of this registers' bits should be set up individually as data points in the Automation Studio I/O mapping ("EnabDigitalOutput01" through "EnabDigitalOutput08") or whether this register should be displayed as an individual USINT data point ("EnableDigitalOutput").

| Data type | Values | Information |
|-----------|------------------------|--|
| USINT | 0 to 255 | Packed outputs = On |
| | See the bit structure. | Packed outputs = off or function model <> 0 - Standard. Bus controller default setting: 255 |

Bit structure:

| Bit | Name | Value | Information |
|-----|---------------------|-------|---|
| 0 | EnabDigitalOutput01 | 0 | Channel 1 used as input |
| | | 1 | Channel 1 used as output (bus controller default setting) |
| ... | ... | ... | ... |
| 7 | EnabDigitalOutput08 | 0 | Channel 8 used as input |
| | | 1 | Channel 8 used as output (bus controller default setting) |

9.15.25.8.5 Digital inputs

Name:

DigitalInput

DigitalInput01 through DigitalInput08

The status of digital inputs 1 to 8 is mapped in this register.

The status of the digital inputs is read with a minimum update rate of 5 to 8 msec. according to the digital output status sample rate.

Only function model 0 - Standard:

The "packed outputs" setting in the Automation Studio I/O configuration is used to determine whether all of this registers' bits should be set up individually as data points in the Automation Studio I/O mapping ("DigitalInput01" through "DigitalInput0x") or whether this register should be displayed as an individual USINT data point ("DigitalInput").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 255 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|--------|--------------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input status - Digital input 1 |
| ... | ... | ... | ... |
| 7 | DigitalInput08 | 0 or 1 | Input status - Digital input 8 |

9.15.25.8.6 Cumulative status

Name:

StatusDigitalOutputs

StatusSupplyLO

StatusSupplyHI

The state of output monitoring and the supply voltage for all outputs are collected and mapped to this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|----------------------|-------|---|
| 0 | StatusDigitalOutputs | 0 | No output monitoring |
| | | 1 | Output monitoring active for at least one channel |
| 1 - 3 | Reserved | 0 | |
| 4 | StatusSupplyLO | 0 | No error |
| | | 1 | Supply voltage too low (≤ 11.5 VDC) |
| 5 | StatusSupplyHI | 0 | No error |
| | | 1 | Supply voltage too high (> 30 VDC) |
| 6 - 7 | Reserved | 0 | |

9.15.25.8.7 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.15.25.8.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|-------------|
| All channels | 400 μ s |

9.15.26 X20(c)DO8331

Data sheet version: 3.26

9.15.26.1 General information

The module is equipped with 8 outputs for 1-wire connections. The rated output current is 2 A.

The output supply is fed directly to the module. An additional supply module is not needed. There is no connection between the module and the I/O supply potential on the bus module.

- 8 digital outputs with 2 A
- Sink connection
- 1-wire connections
- Power feed integrated in the module
- Integrated output protection

9.15.26.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.15.26.3 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Digital outputs |  |
| X20DO8331 | X20 digital output module, 8 outputs, 24 VDC, 2 A, sink, supply directly on module, 1-wire connections | |
| X20cDO8331 | X20 digital output module, coated, 8 outputs, 24 VDC, 2 A, sink, supply directly on module, 1-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 344: X20DO8331, X20cDO8331 - Order data

9.15.26.4 Technical data

| Model number | X20DO8331 | X20cDO8331 |
|--|--|------------|
| Short description | 8 digital outputs 24 VDC for 1-wire connections | |
| General information | | |
| B&R ID code | 0x22EB | 0xE22B |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Outputs | Yes, using status LED and software (output error status) | |
| Supply voltage monitoring | Yes, using software | |
| Power consumption | | |
| Bus | 0.22 W | |
| Internal I/O | - | |
| External I/O | 0.9 W | |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +0.56 | |
| Certifications | | |
| CE | Yes | |
| KC | Yes | - |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | |
| Digital outputs | | |
| Variant | FET negative switching | |
| Nominal voltage | 24 VDC | |
| Switching voltage | 24 VDC -15 % / +20 % | |
| Nominal output current | 2 A | |
| Total nominal current | 8 A | |
| Connection type | 1-wire connections | |
| Output circuit | Sink | |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short circuit current") Internal inverse diode for switching inductive loads (see section "Switching inductive loads") Reverse polarity protection for supply voltage | |
| Actuator power supply | | |
| Supply | External | |
| Fuse | Required line fuse: Max. 10 A, slow-blow | |
| Diagnostic status | Output monitoring with 10 ms delay | |
| Leakage current when switched off | 75 µA | |
| R _{DS(on)} | 35 mΩ | |
| Peak short-circuit current | <24 A | |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms (depends on the module temperature) | |
| Switching delay | | |
| 0 → 1 | <300 µs | |
| 1 → 0 | <500 µs | |
| Switching frequency | | |
| Resistive load | Max. 500 Hz | |
| Inductive load | See section "Switching inductive loads" | |
| Braking voltage when switching off inductive loads | Typ. 50 VDC | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Additional functions | To increase the output current, outputs can be switched in parallel | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |

Table 345: X20DO8331, X20cDO8331 - Technical data

| Model number | X20DO8331 | X20cDO8331 |
|---------------------------------|--|---|
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating" | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm | |

Table 345: X20DO8331, X20cDO8331 - Technical data

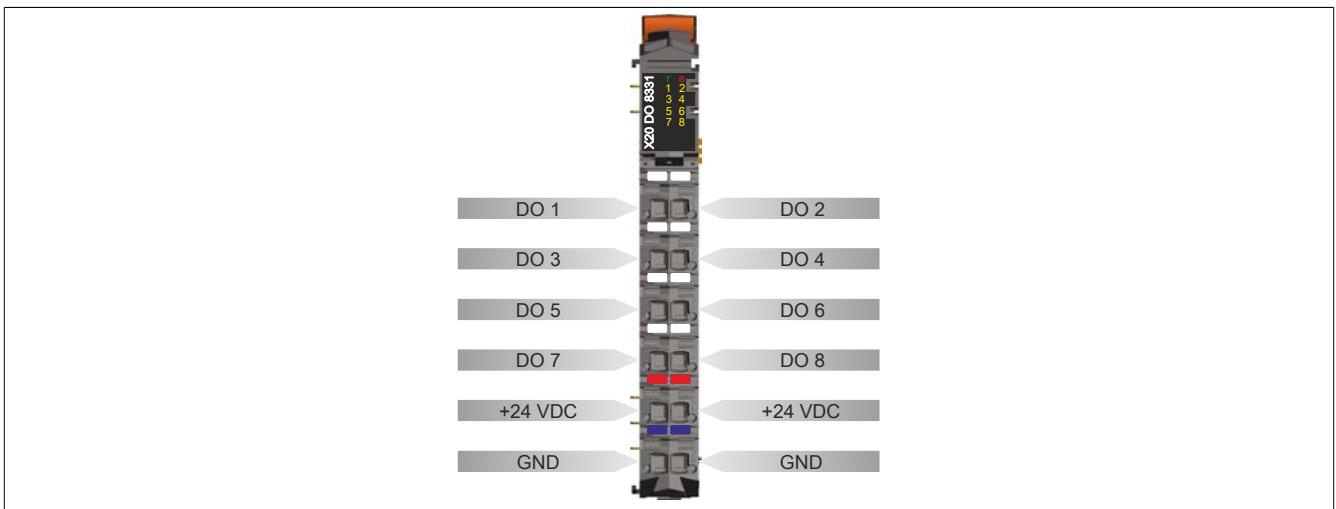
1) Number of outputs x R_{DS(on)} x Nominal output current². For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.

9.15.26.5 Status LEDs

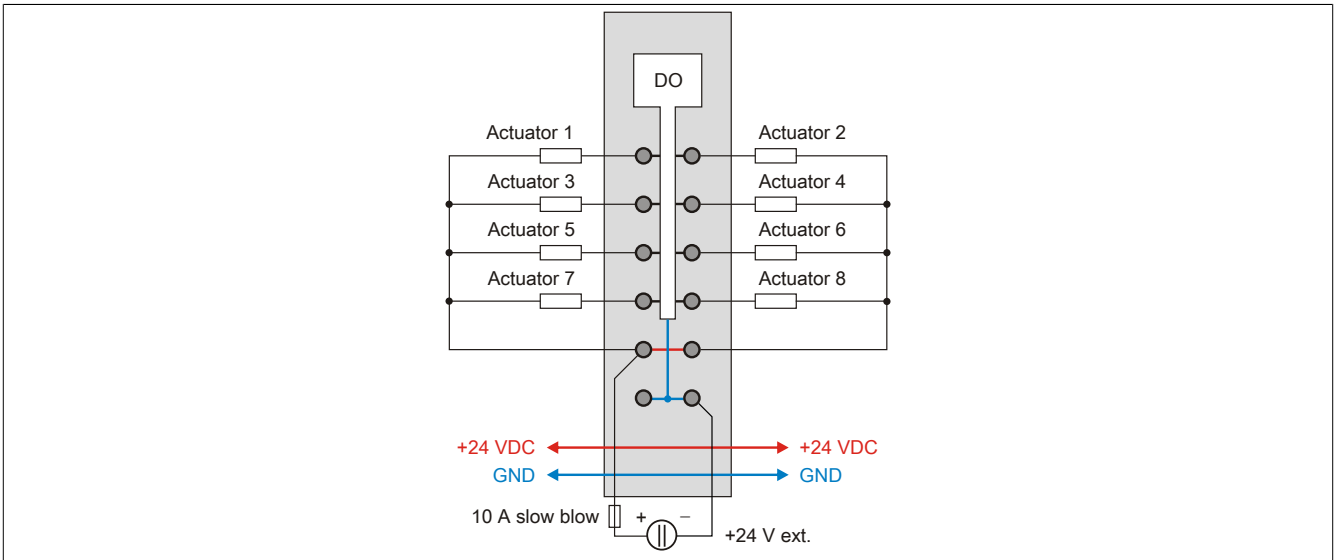
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description | |
|--------|-------|-----------------------------|------------------|---|---|
| | r | Green | Off | Module supply not connected | |
| | | | Single flash | RESET mode | |
| | | | Blinking | PREOPERATIONAL mode | |
| | e | Red | On | RUN mode | |
| | | | Off | Module supply not connected or everything OK | |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. | |
| | e + r | Red on / Green single flash | Double flash | I/O supply too low | |
| | | | Invalid firmware | | |
| | 1 - 8 | Orange | | | Output status of the corresponding digital output |

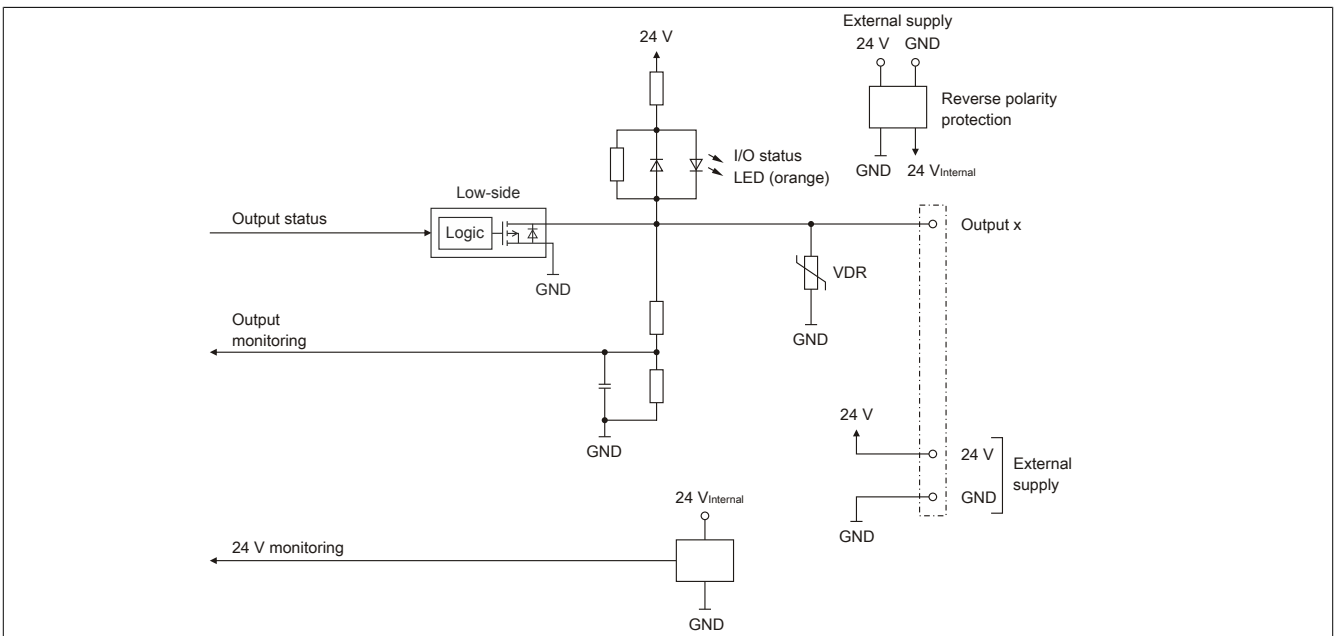
9.15.26.6 Pinout



9.15.26.7 Connection example

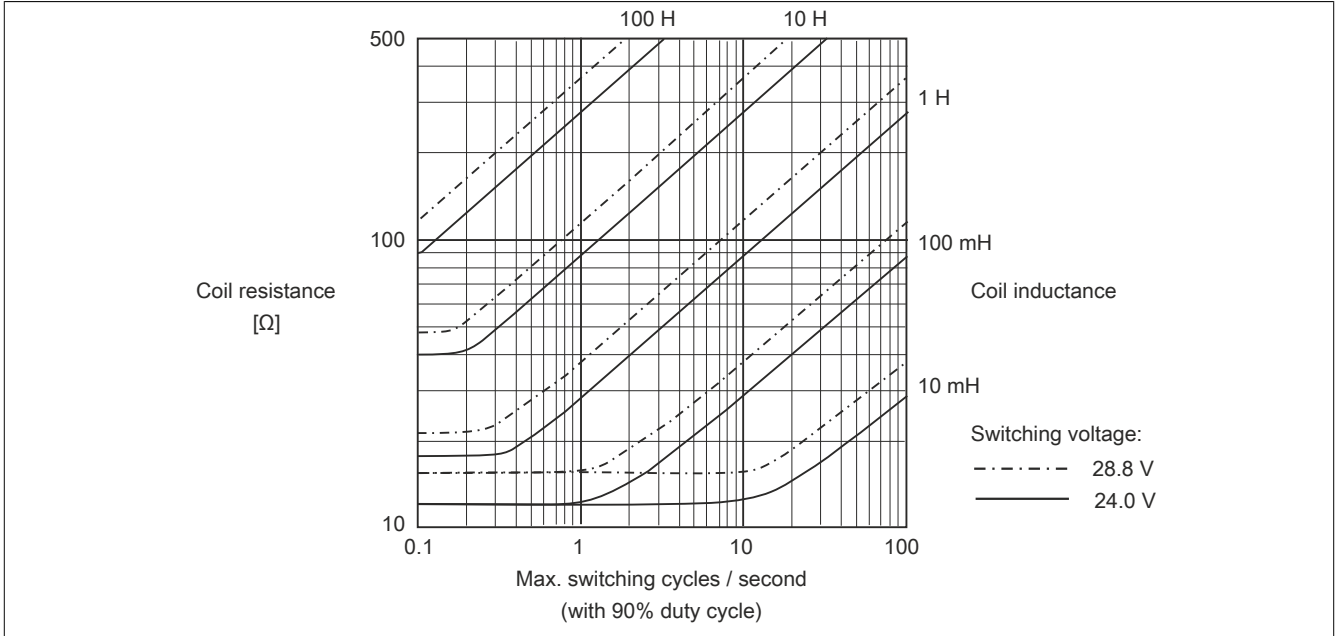


9.15.26.8 Output circuit diagram

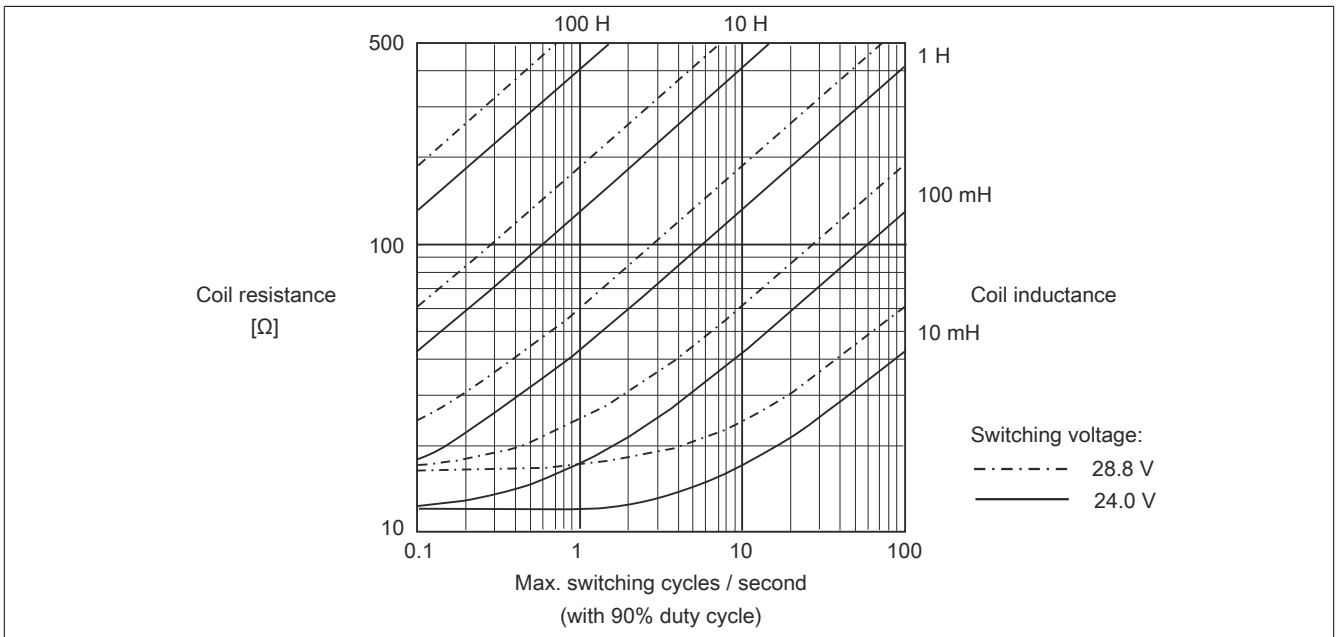


9.15.26.9 Switching inductive loads

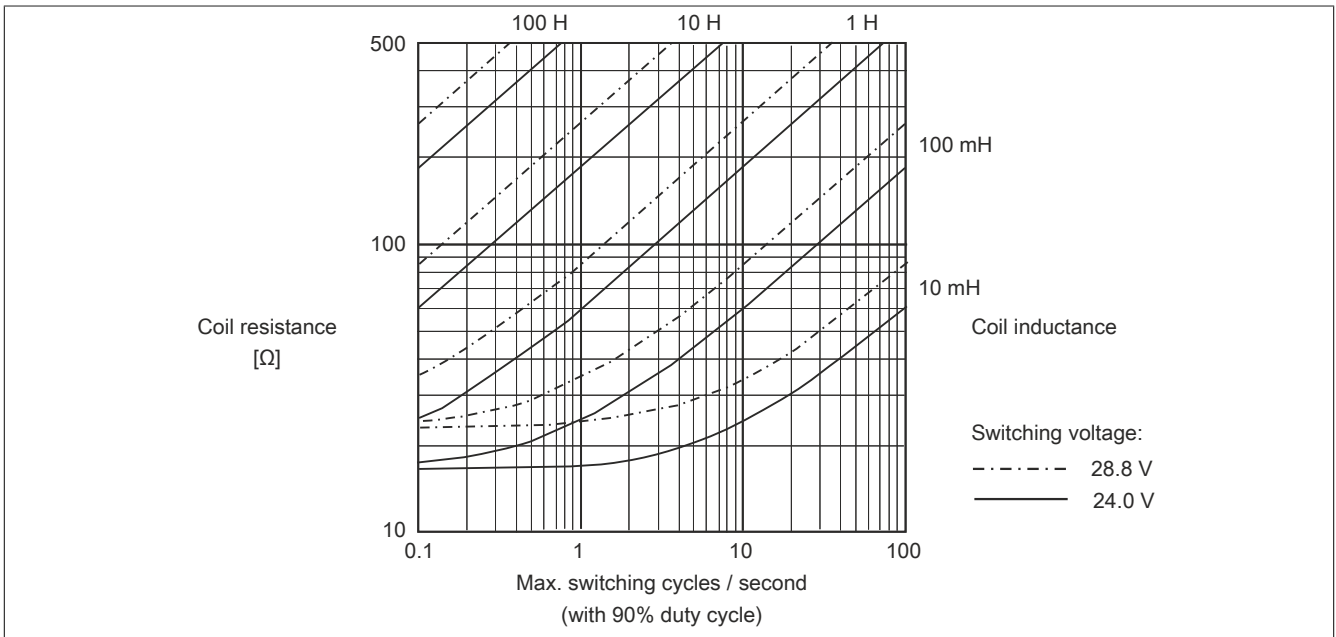
Environmental temperature: 35°C, 4 outputs (1,3,5,7 or 2,4,6,8) with the same load.



Environmental temperature: 60°C, 4 outputs (1,3,5,7 or 2,4,6,8) with the same load.



Environmental temperature: 60°C, all outputs with the same load.



Information:

If the maximum number of operating cycles per second is exceeded, an external inverse diode must be used.

Operating conditions outside of the area in the diagram are not permitted!

9.15.26.10 Derating

The outputs of the module can handle up to 2 A. With a summation current of 8 A, no more than 4 channels are operable at full load. To ensure optimal use of the module, it is important to assign the channels properly, and to keep in mind a potential derating.

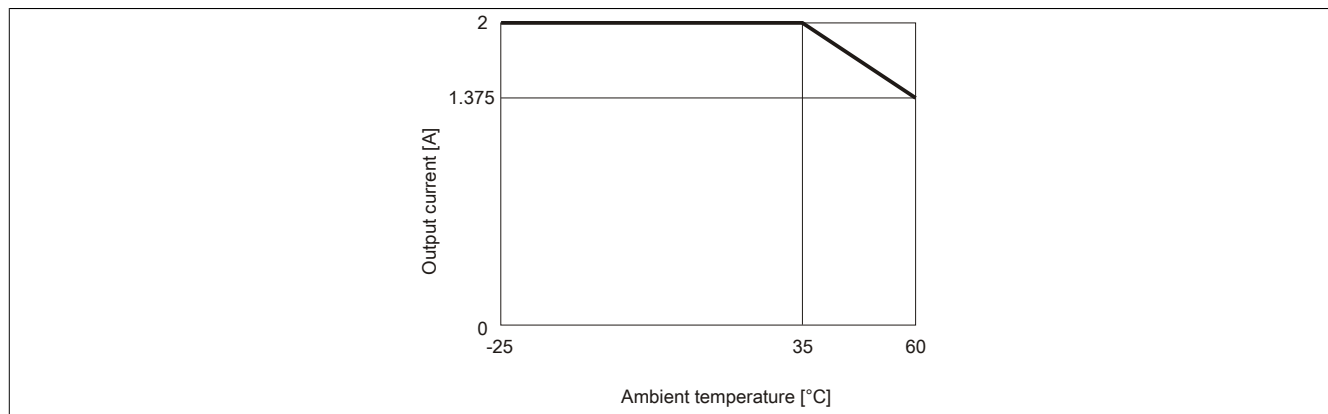
Correct channel assignment is important, since the 8 outputs are divided between 2 output drivers. The channels operated with 2 A must therefore be evenly divided between both output drivers.

Output driver 1: Channels 1 to 4
Output driver 2: Channels 5 to 8

The following table provides an overview of the number of fully used channels, the resulting best distribution, and a potential derating.

| Number of channels using 2 A | Division | Derating |
|------------------------------|--|--|
| 1 | Any | No |
| 2 | 1st channel with 2 A ... channel no. 1 to 4 2nd channel with 2 A ... channel no. 5 to 8 | No |
| 3 | Assign all even or all odd channel numbers. Examples: 1, 3, 5 2, 4, 6 3, 5, 7 4, 6, 8 | Channels 1 and 3 Channels 2 and 4 Channels 5 and 7 Channels 6 and 8 |
| 4 | Assign all even or all odd channel numbers. Possible divisions: 1, 3, 5, 7 2, 4, 6, 8 | On each channel On each channel |

Derating when 3 or 4 channels are operated with 2 A:



Information:

Modules next to this module can have a maximum power dissipation of 1.5 W.

For an example of calculating the power dissipation of I/O modules, see section ["Power dissipation calculation of I/O modules"](#) on page 101.

9.15.26.11 Register description

9.15.26.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.15.26.11.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | DigitalOutput | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08 | Bit 7 | | | | |
| 30 | 1 | StatusInput01 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput08 | Bit 7 | | | | |
| 8192 | - | Reading the module ID | UINT | | • | | |
| 8196 | - | Status of the supply voltage | USINT | | • | | |
| | | PowerSupply01 | Bit 2 | • | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.26.11.3 Function model 1 - Output switching

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 8 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08 | Bit 7 | | | | |
| 4 | 1 | Switching state of delayed digital outputs 1 to 8 | USINT | | | • | |
| | | DigitalOutput01Delayed | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08Delayed | Bit 7 | | | | |
| 6 | 2 | Switching mask after the delay time has expired | USINT | | | • | |
| | | DigitalOutput01DelayEnable | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08DelayEnable | Bit 7 | | | | |
| 8 | 3 | Setting the delay (OutputDelayTime) | USINT | | | • | |
| 30 | 1 | Status of digital outputs 1 to 8 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput08 | Bit 7 | | | | |
| 8192 | - | Reading the module ID | UINT | | • | | |
| 8196 | - | Status of the supply voltage | USINT | | • | | |
| | | PowerSupply01 | Bit 2 | • | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.26.11.4 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 8 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08 | Bit 7 | | | | |
| 30 | - | Status of digital outputs 1 to 8 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput08 | Bit 7 | | | | |
| 8192 | - | Reading the module ID | UINT | | • | | |
| 8196 | - | Status of the supply voltage | USINT | | • | | |
| | | Power Supply01 | Bit 2 | | • | | |

1) The offset specifies where the register is within the CAN object.

9.15.26.11.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.26.11.4.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.15.26.11.5 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 µs) based on the network cycle (SyncOut).

9.15.26.11.5.1 Switching state of digital outputs 1 to 8

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput08

The switching state of digital outputs 1 to 8 are stored in this register.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 255 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | ... | ... | ... |
| 7 | DigitalOutput08 | 0 | Digital output 08 reset |
| | | 1 | Digital output 08 set |

9.15.26.11.6 Reading the module ID

Name:

asy_ModulID

This register offers the possibility to read the module ID.

| Data type | Values |
|-----------|-----------|
| UINT | Module ID |

9.15.26.11.7 Monitoring status of the digital outputs

On the module, the output states of the outputs are compared to the target states. The control of the output driver is used for the target state.

A change in the output state resets monitoring for that output. The status of each individual channel can be read. A change in the monitoring status is actively transmitted as an error message.

9.15.26.11.7.1 Status of digital outputs 1 to 8

Name:

StatusInput01

StatusDigitalOutput01 to StatusDigitalOutput08

This register is used to indicate the status of digital outputs 1 to 8.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("StatusDigitalOutput01" to "StatusDigitalOutput0x") or whether this register should be displayed as a single USINT data point ("StatusIn-put01").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 255 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput01 | 0 | Channel 01: No error |
| | | 1 | Channel 01: <ul style="list-style-type: none"> • Short circuit or overload • Channel switched on and missing I/O power supply • Channel switched off and external voltage applied on channel |
| ... | ... | ... | ... |
| 8 | StatusDigitalOutput08 | 0 | Channel 08: No error |
| | | 1 | Channel 08: For an error description, see channel 01. |

9.15.26.11.8 Operating limit monitoring

The output supply of the module is monitored. I/O supply voltage <20.4 V is displayed as a warning.

9.15.26.11.8.1 Status of the supply voltage

Name:

asy_SupplyStatus

The status of the I/O supply voltage is mapped in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---------------|-------|--|
| 0 - 1 | Reserved | 0 | |
| 2 | PowerSupply01 | 0 | I/O supply above the warning level of 20.4 V |
| | | 1 | I/O supply below the warning level of 20.4 V |
| 3 - 7 | Reserved | 0 | |

9.15.26.11.9 Additional function - switch digital outputs w/ delay using switching mask

In function model 1 - Output switching, it is possible to control the digital outputs with a delay.

The OutputDelay mask can be used to activate the delay for each channel individually. The module is controlled here using a 100 µs-based timer and the Output or OutputDelayed register.

Behavior of function model 1 - Output switching

With a timer delay of 0:

Output: DigitalOutput0x bits

When the delay is changed:

The bit string for DigitalOutput0x bits is output. The timer restarts.

Output: DigitalOutput0x bits

After delay time has expired:

The channels whose bits are set in the mask for OutputDelay are adapted to the corresponding OutputDelayed bits.

Output: DigitalOutput0x bits (if Enable bit = FALSE)
OutputDelayed bits (if Enable bit = TRUE)

Information:

Adjusting the output and restarting the timer take place immediately after transferring the new delay, even if the previous time has not yet passed.

9.15.26.11.9.1 Switching state of delayed digital outputs 1 to 8

Name:

DigitalOutput01Delayed to Digital08Delayed

According to the corresponding bit in the OutputDelay mask, the switching state of all digital outputs 1 to 8 are stored in the OutputDelayed bits after the delay time has expired.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|------------------------|-------|-------------------------|
| 0 | DigitalOutput01Delayed | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 7 | DigitalOutput08Delayed | 0 | Digital output 08 reset |
| | | 1 | Digital output 08 set |

Information:

After the delay time has expired, only the channels with a bit set in the OutputDelay mask are adjusted to the OutputDelayed bits.

9.15.26.11.9.2 Switching mask after the delay time has expired

Name:

DigitalOutput01DelayEnable to DigitalOutput08DelayEnable

These registers create the mask for OutputDelay. They define which outputs are switched to the bit string for the OutputDelayed register after the delay time has expired.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------------------|-------|-------------------------------------|
| 0 | DigitalOutput01DelayEnable | 0 | Digital output 01 remains unchanged |
| | | 1 | Digital output 01 is toggled |
| ... | | ... | |
| 7 | DigitalOutput08DelayEnable | 0 | Digital output 08 remains unchanged |
| | | 1 | Digital output 08 is toggled |

9.15.26.11.9.3 Setting the delay

Name:

OutputDelayTime

This register can be used to set the delay in 100 µs steps.

After the delay time has expired, the digital outputs are adjusted according to the switching mask (register 6) and the delayed output pattern (register 4).

| Data type | Value |
|-----------|--|
| USINT | 0 to 255 (in 100 µs steps) ¹⁾ |

1) The value 0 disables processing

9.15.26.11.10 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|-------------------------------|--------|
| Standard function model | 100 µs |
| Bus controller function model | 150 µs |

9.15.26.11.11 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|---------------------------------|
| Function model 0 | Equal to the minimum cycle time |
| Function model 1 | Equal to the minimum cycle time |

9.15.27 X20(c)DO8332

Data sheet version: 3.27

9.15.27.1 General information

The module is equipped with 8 outputs for 1-wire connections. The rated output current is 2 A.

The output supply is fed directly to the module. An additional supply module is not needed. There is no connection between the module and the I/O supply potential on the bus module.

- 8 digital outputs with 2 A
- Source connection
- 1-wire connections
- Power feed integrated in the module
- Integrated output protection

9.15.27.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.15.27.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C . During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.15.27.3 Order data

| Model number | Short description | Figure |
|--------------|--|--------|
| | Digital outputs | |
| X20DO8332 | X20 digital output module, 8 outputs, 24 VDC, 2 A, source, supply directly on module, 1-wire connections | |
| X20cDO8332 | X20 digital output module, coated, 8 outputs, 24 VDC, 2 A, source, supply directly on module, 1-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 346: X20DO8332, X20cDO8332 - Order data

9.15.27.4 Technical data

| Model number | X20DO8332 | X20cDO8332 |
|--|--|------------|
| Short description | 8 digital outputs 24 VDC for 1-wire connections | |
| General information | | |
| B&R ID code | 0x1B9D | 0xE22C |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Outputs | Yes, using status LED and software (output error status) | |
| Supply voltage monitoring | Yes, using software | |
| Power consumption | | |
| Bus | 0.22 W | |
| Internal I/O | - | |
| External I/O | 0.92 W | |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +2.24 | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Digital outputs | | |
| Variant | FET positive switching | |
| Number of output groups | 2 | |
| Nominal voltage | 24 VDC | |
| Switching voltage | 24 VDC -15 % / +20 % | |
| Nominal output current | 2 A | |
| Total nominal current | | |
| Per group | 4 A | |
| Per module | 8 A ²⁾ | |
| Connection type | 1-wire connections | |
| Output circuit | Source | |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short circuit current") Internal inverse diode for switching inductive loads (see section "Switching inductive loads") Reverse polarity protection for supply voltage | |
| Actuator power supply | | |
| Supply | External | |
| Fuse | Required line fuse: Max. 10 A, slow-blow | |
| Diagnostic status | Output monitoring with 10 ms delay | |
| Leakage current when the power is switched off | 5 µA | |
| R _{DS(on)} | 140 mΩ | |
| Peak short-circuit current | <12 A | |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms (depends on the module temperature) | |
| Switching delay | | |
| 0 → 1 | <300 µs | |
| 1 → 0 | <300 µs | |
| Switching frequency | | |
| Resistive load | Max. 500 Hz | |
| Inductive load | See section "Switching inductive loads" | |
| Braking voltage when switching off inductive loads | Typ. 50 VDC | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Additional functions | To increase the output current, outputs can be switched in parallel | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel and I/O power supply | |

Table 347: X20DO8332, X20cDO8332 - Technical data


| Model number | X20DO8332 | X20cDO8332 |
|--|--|---|
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | | Yes |
| Vertical | | Yes |
| Installation elevation above sea level | | |
| 0 to 2000 m | | No limitations |
| >2000 m | | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | | IP20 |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | | -25 to 60°C |
| Vertical mounting orientation | | -25 to 50°C |
| Derating | | See section "Derating" |
| Starting temperature | - | Yes, -40°C |
| Storage | | -40 to 85°C |
| Transport | | -40 to 85°C |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | | 5 to 95%, non-condensing |
| Transport | | 5 to 95%, non-condensing |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 347: X20DO8332, X20cDO8332 - Technical data

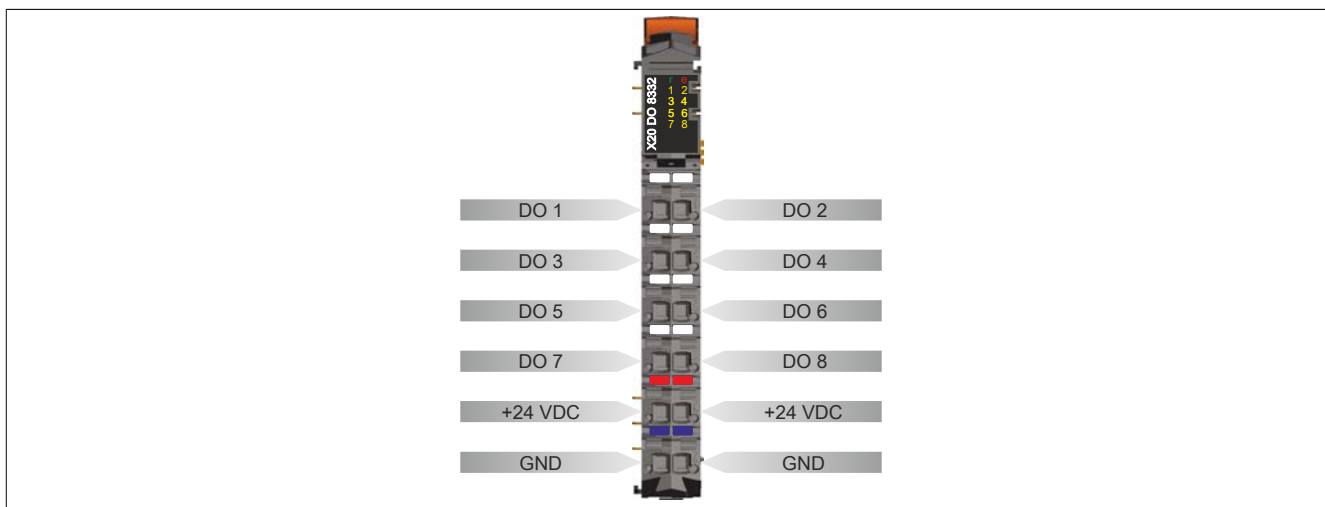
- 1) Number of outputs x $R_{DS(on)}$ x Nominal output current². For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) Derating may be necessary with more than 6 A summation current.

9.15.27.5 Status LEDs

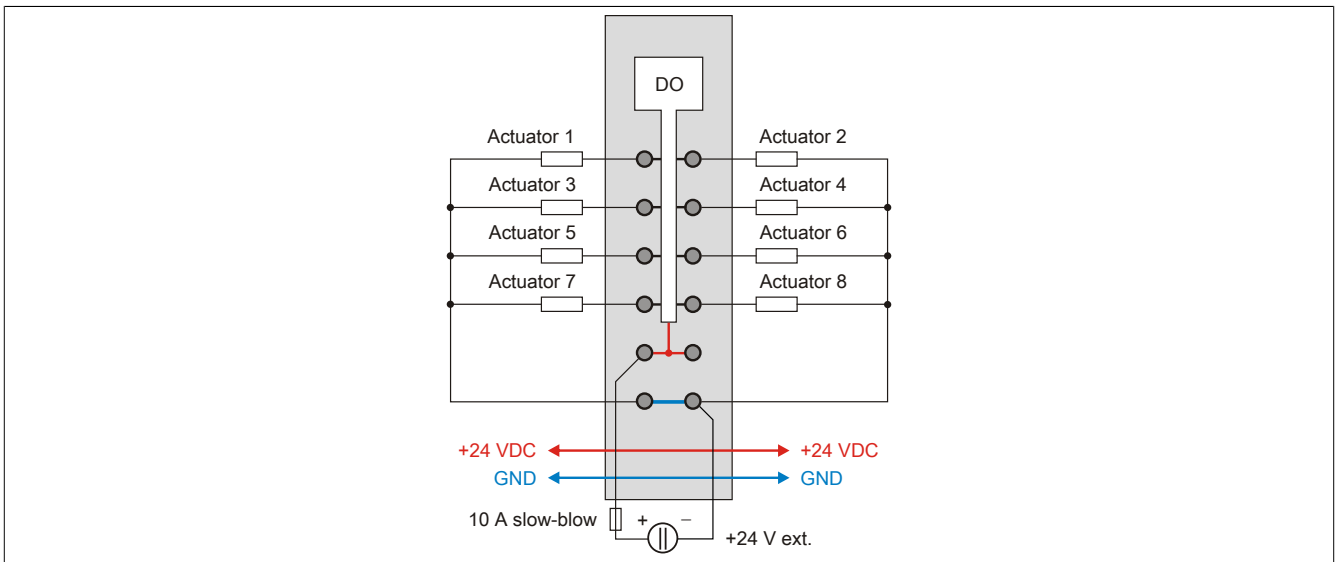
For a description of the various operating modes, see ["Diagnostic LEDs" on page 3787](#).

| Figure | LED | Color | Status | Description | |
|---|-------|-------|-----------------------------|---|---|
|  | r | Green | Off | Module supply not connected | |
| | | | Single flash | RESET mode | |
| | | | Blinking | PREOPERATIONAL mode | |
| | | | On | RUN mode | |
| | e | Red | Off | Module supply not connected or everything OK | |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. | |
| | | | Double flash | I/O supply too low | |
| | e + r | | Red on / Green single flash | Invalid firmware | |
| | 1 - 8 | | Orange | | Output status of the corresponding digital output |

9.15.27.6 Pinout



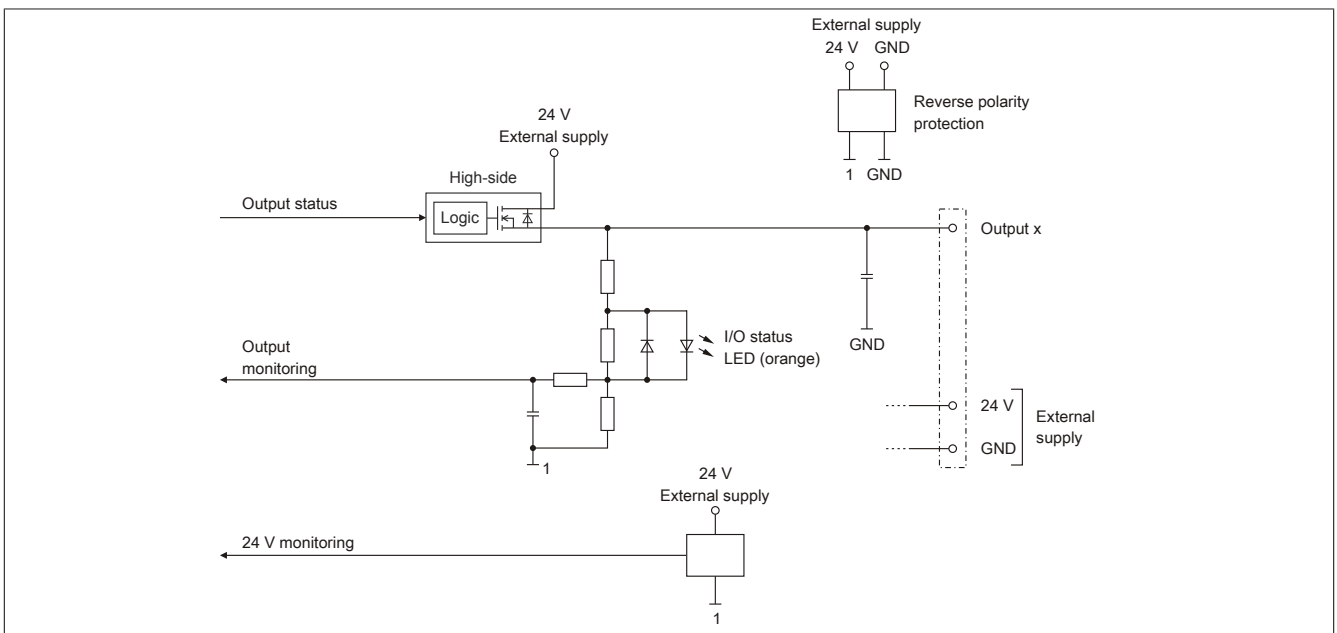
9.15.27.7 Connection example

**Caution!**

If the module is operated outside specifications, the output current may rise above the maximum permissible nominal current. This applies both to individual channels and to the summation current of the module.

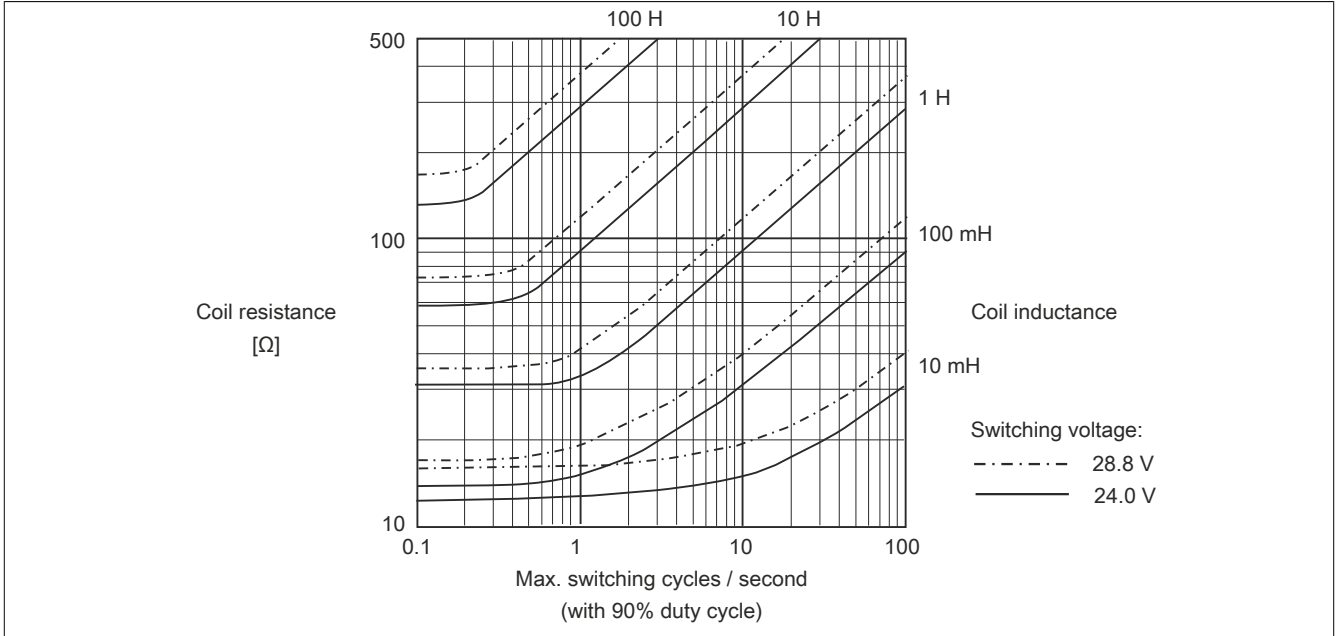
Appropriate cable cross-sections or external safety measures must therefore be provided.

9.15.27.8 Output circuit diagram

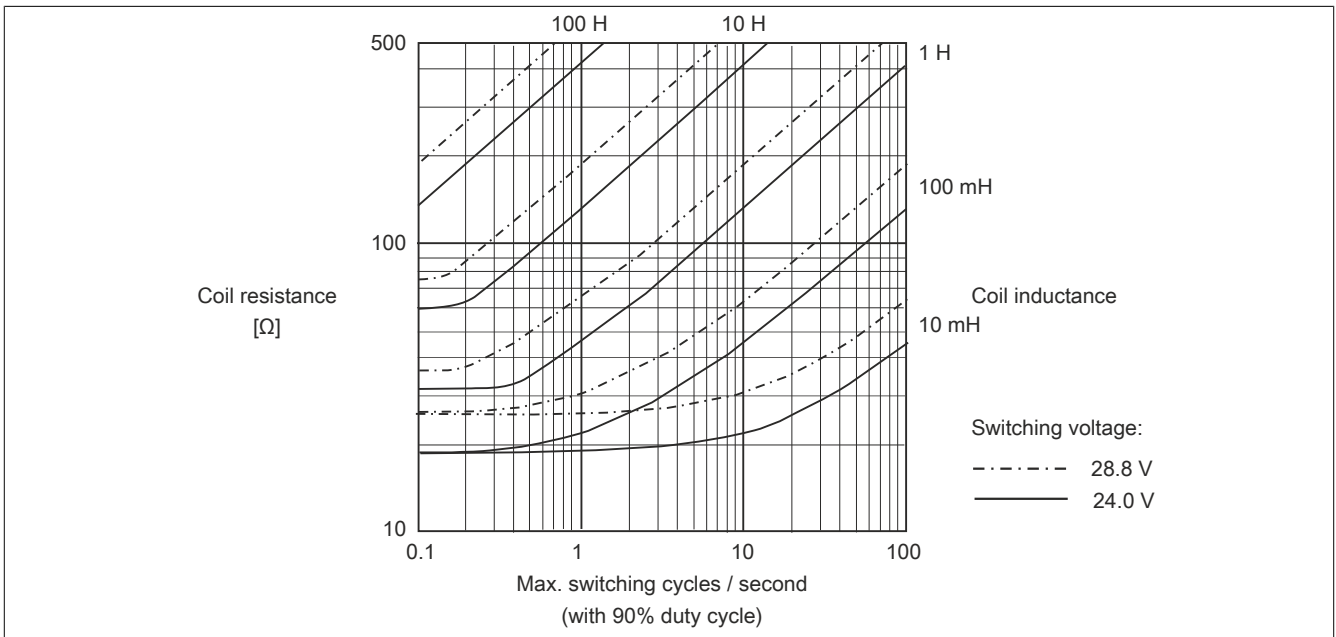


9.15.27.9 Switching inductive loads

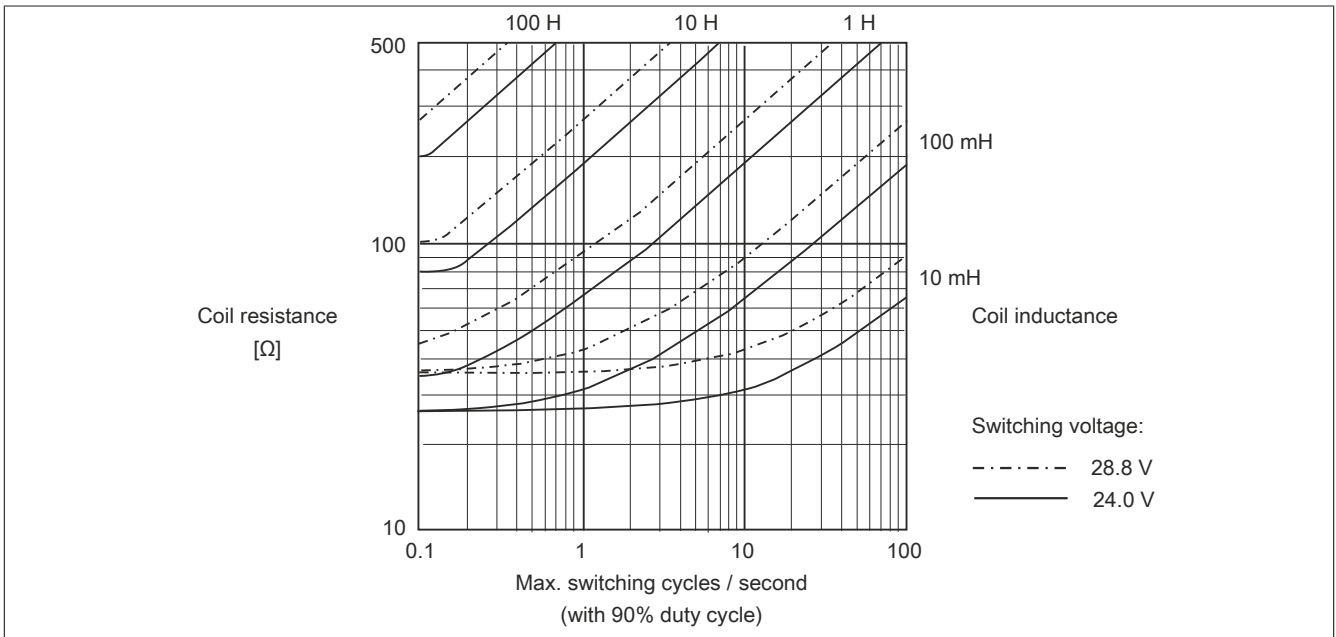
Environmental temperature: 35°C, 4 outputs (1,3,5,7 or 2,4,6,8) with the same load.



Environmental temperature: 60°C, 4 outputs (1,3,5,7 or 2,4,6,8) with the same load.



Environmental temperature: 60°C, all outputs with the same load.



Information:

If the maximum number of operating cycles per second is exceeded, an external inverse diode must be used.

Operating conditions outside of the area in the diagram are not permitted!

9.15.27.10 Derating

The outputs of the module can handle up to 2 A. With a summation current of 8 A, no more than 4 channels are operable at full load. To ensure optimal use of the module, it is important to assign the channels properly, and to keep in mind a potential derating.

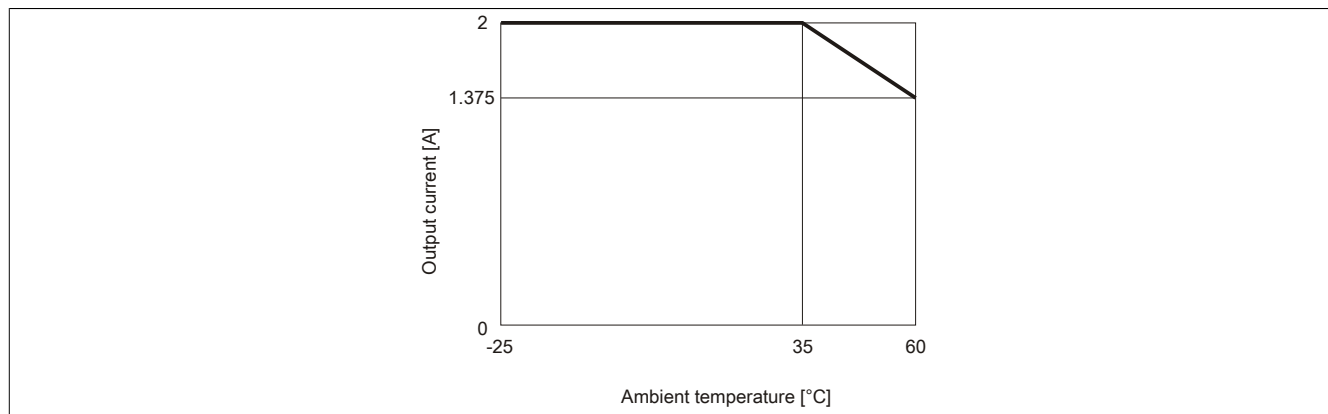
Correct channel assignment is important, since the 8 outputs are divided between 2 output drivers. The channels operated with 2 A must therefore be evenly divided between both output drivers.

Output driver 1: Channels 1 to 4
Output driver 2: Channels 5 to 8

The following table provides an overview of the number of fully used channels, the resulting best distribution, and a potential derating.

| Number of channels using 2 A | Division | Derating |
|------------------------------|--|--|
| 1 | Any | No |
| 2 | 1st channel with 2 A ... channel no. 1 to 4 2nd channel with 2 A ... channel no. 5 to 8 | No |
| 3 | Assign all even or all odd channel numbers. Examples: 1, 3, 5 2, 4, 6 3, 5, 7 4, 6, 8 | Channels 1 and 3 Channels 2 and 4 Channels 5 and 7 Channels 6 and 8 |
| 4 | Assign all even or all odd channel numbers. Possible divisions: 1, 3, 5, 7 2, 4, 6, 8 | On each channel On each channel |

Derating when 3 or 4 channels are operated with 2 A:



Information:

Modules next to this module can have a maximum power dissipation of 1.5 W.

For an example of calculating the power dissipation of I/O modules, see section ["Power dissipation calculation of I/O modules"](#) on page 101.

9.15.27.11 Register description

9.15.27.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.15.27.11.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | DigitalOutput | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08 | Bit 7 | | | | |
| 30 | 1 | StatusInput01 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput08 | Bit 7 | | | | |
| 8192 | - | Reading the module ID | UINT | | • | | |
| 8196 | - | Status of the supply voltage | USINT | | • | | |
| | | PowerSupply01 | Bit 2 | • | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.27.11.3 Function model 1 - Output switching

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 8 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08 | Bit 7 | | | | |
| 4 | 1 | Switching state of delayed digital outputs 1 to 8 | USINT | | | • | |
| | | DigitalOutput01Delayed | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08Delayed | Bit 7 | | | | |
| 6 | 2 | Switching mask after the delay time has expired | USINT | | | • | |
| | | DigitalOutput01DelayEnable | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08DelayEnable | Bit 7 | | | | |
| 8 | 3 | Setting the delay (OutputDelayTime) | USINT | | | • | |
| 30 | 1 | Status of digital outputs 1 to 8 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput08 | Bit 7 | | | | |
| 8192 | - | Reading the module ID | UINT | | • | | |
| 8196 | - | Status of the supply voltage | USINT | | • | | |
| | | PowerSupply01 | Bit 2 | • | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.27.11.4 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 8 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08 | Bit 7 | | | | |
| 30 | - | Status of digital outputs 1 to 8 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput08 | Bit 7 | | | | |
| 8192 | - | Reading the module ID | UINT | | • | | |
| 8196 | - | Status of the supply voltage | USINT | | • | | |
| | | Power Supply01 | Bit 2 | | • | | |

1) The offset specifies where the register is within the CAN object.

9.15.27.11.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.27.11.4.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.15.27.11.5 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 µs) based on the network cycle (SyncOut).

9.15.27.11.5.1 Switching state of digital outputs 1 to 8

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput08

The switching state of digital outputs 1 to 8 are stored in this register.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 255 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | ... | ... | ... |
| 7 | DigitalOutput08 | 0 | Digital output 08 reset |
| | | 1 | Digital output 08 set |

9.15.27.11.6 Reading the module ID

Name:

asy_ModulID

This register offers the possibility to read the module ID.

| Data type | Values |
|-----------|-----------|
| UINT | Module ID |

9.15.27.11.7 Monitoring status of the digital outputs

On the module, the output states of the outputs are compared to the target states. The control of the output driver is used for the target state.

A change in the output state resets monitoring for that output. The status of each individual channel can be read. A change in the monitoring status is actively transmitted as an error message.

9.15.27.11.7.1 Status of digital outputs 1 to 8

Name:

StatusInput01

StatusDigitalOutput01 to StatusDigitalOutput08

This register is used to indicate the status of digital outputs 1 to 8.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("StatusDigitalOutput01" to "StatusDigitalOutput0x") or whether this register should be displayed as a single USINT data point ("StatusIn-put01").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 255 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput01 | 0 | Channel 01: No error |
| | | 1 | Channel 01: <ul style="list-style-type: none"> • Short circuit or overload • Channel switched on and missing I/O power supply • Channel switched off and external voltage applied on channel |
| ... | ... | ... | ... |
| 8 | StatusDigitalOutput08 | 0 | Channel 08: No error |
| | | 1 | Channel 08: For an error description, see channel 01. |

9.15.27.11.8 Operating limit monitoring

The output supply of the module is monitored. I/O supply voltage < V is displayed as a warning.

9.15.27.11.8.1 Status of the supply voltage

Name:

asy_SupplyStatus

The status of the I/O supply voltage is mapped in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---------------|-------|--|
| 0 - 1 | Reserved | 0 | |
| 2 | PowerSupply01 | 0 | I/O supply above the warning level of 20.4 V |
| | | 1 | I/O supply below the warning level of 20.4 V |
| 3 - 7 | Reserved | 0 | |

9.15.27.11.9 Additional function - switch digital outputs w/ delay using switching mask

In function model 1 - Output switching, it is possible to control the digital outputs with a delay.

The OutputDelay mask can be used to activate the delay for each channel individually. The module is controlled here using a 100 µs-based timer and the Output or OutputDelayed register.

Behavior of function model 1 - Output switching

With a timer delay of 0:

Output: DigitalOutput0x bits

When the delay is changed:

The bit string for DigitalOutput0x bits is output. The timer restarts.

Output: DigitalOutput0x bits

After delay time has expired:

The channels whose bits are set in the mask for OutputDelay are adapted to the corresponding OutputDelayed bits.

Output: DigitalOutput0x bits (if Enable bit = FALSE)
OutputDelayed bits (if Enable bit = TRUE)

Information:

Adjusting the output and restarting the timer take place immediately after transferring the new delay, even if the previous time has not yet passed.

9.15.27.11.9.1 Switching state of delayed digital outputs 1 to 8

Name:

DigitalOutput01Delayed to Digital08Delayed

According to the corresponding bit in the OutputDelay mask, the switching state of all digital outputs 1 to 8 are stored in the OutputDelayed bits after the delay time has expired.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|------------------------|-------|-------------------------|
| 0 | DigitalOutput01Delayed | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 7 | DigitalOutput08Delayed | 0 | Digital output 08 reset |
| | | 1 | Digital output 08 set |

Information:

After the delay time has expired, only the channels with a bit set in the OutputDelay mask are adjusted to the OutputDelayed bits.

9.15.27.11.9.2 Switching mask after the delay time has expired

Name:

DigitalOutput01DelayEnable to DigitalOutput08DelayEnable

These registers create the mask for OutputDelay. They define which outputs are switched to the bit string for the OutputDelayed register after the delay time has expired.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------------------|-------|-------------------------------------|
| 0 | DigitalOutput01DelayEnable | 0 | Digital output 01 remains unchanged |
| | | 1 | Digital output 01 is toggled |
| ... | | ... | |
| 7 | DigitalOutput08DelayEnable | 0 | Digital output 08 remains unchanged |
| | | 1 | Digital output 08 is toggled |

9.15.27.11.9.3 Setting the delay

Name:

OutputDelayTime

This register can be used to set the delay in 100 µs steps.

After the delay time has expired, the digital outputs are adjusted according to the switching mask (register 6) and the delayed output pattern (register 4).

| Data type | Value |
|-----------|--|
| USINT | 0 to 255 (in 100 µs steps) ¹⁾ |

1) The value 0 disables processing

9.15.27.11.10 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

9.15.27.11.11 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

9.15.28 X20DO8332-1

Data sheet version: 1.03

9.15.28.1 General information

The module is equipped with 8 outputs for 1-wire connections. The nominal output current is 2 A.

The output power supply is fed directly into the module. An additional power supply module is therefore not necessary. There is no connection between the module and the I/O power supply potential on the bus module.

- 8 digital outputs with 2 A
- Source circuit
- 1-wire connections
- Power supply integrated in the module
- Integrated output protection

9.15.28.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Digital outputs |  |
| X20DO8332-1 | X20 digital output module, 8 outputs, 24 VDC, 2 A, source, optimized for inductive loads, power supply directly on module, 1-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 348: X20DO8332-1 - Order data

9.15.28.3 Technical data

| | |
|--|--|
| Model number | X20DO8332-1 |
| Short description | |
| I/O module | 8 digital outputs 24 VDC for 1-wire connections |
| General information | |
| B&R ID code | 0xF321 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Outputs | Yes, using status LED and software (output error status) |
| Supply voltage monitoring | Yes, using status LED and software (output error status) |
| Power consumption | |
| Bus | 0.26 W |
| Internal I/O | - |
| External I/O | 0.81 W |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +0.336 |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| Digital outputs | |
| Variant | FET positive switching |
| Number of output groups | 2 |
| Nominal voltage | 24 VDC |
| Switching voltage | 24 VDC -15% / +20% |
| Nominal output current | 2 A |
| Total nominal current | 8 A ²⁾ |
| Connection type | 1-wire connections |
| Output circuit | Source |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short-circuit current") Internal freewheeling diode for switching inductive loads (see section "Switching inductive loads") Reverse polarity protection of supply voltage |
| Actuator power supply | |
| Supply | External |
| Fuse | Required line fuse: Max. 10 A, slow-blow |
| Diagnostic status | Output monitoring with 18 ms delay |
| Leakage current when switched off | 5 µA |
| R _{DS(on)} | 21 mΩ |
| Peak short-circuit current | 90 A for 200 µs |
| Switch-on in the event of overload shutdown or short-circuit shutdown | 300 ms |
| Switching delay | |
| 0 → 1 | <300 µs |
| 1 → 0 | <300 µs |
| Switching frequency | |
| Resistive load | Max. 500 Hz |
| Inductive load | See section "Switching inductive loads" |
| Braking voltage when switching off inductive loads | Typ. 64 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Additional functions | Outputs can be connected in parallel to increase the output current. |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating". |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |

Table 349: X20DO8332-1 - Technical data


| Model number | X20DO8332-1 |
|------------------------------|--|
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately Order 1x bus module X20BM11 separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 349: X20DO8332-1 - Technical data

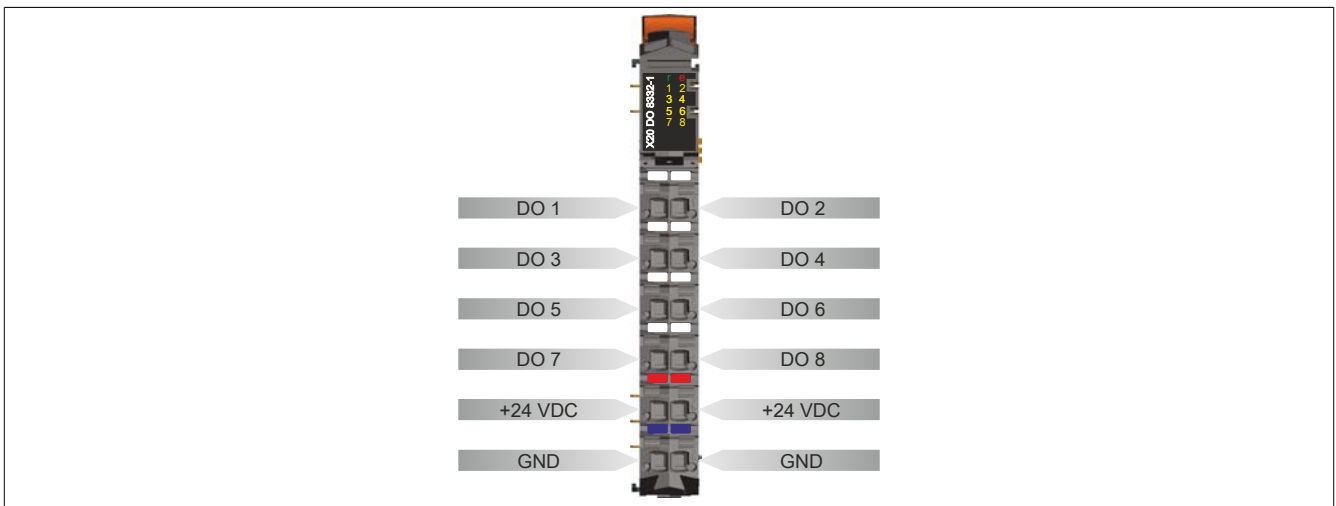
- 1) Number of outputs x $R_{DS(on)}$ x Nominal output current². For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) Derating must be observed for summation current starting at 6 A.

9.15.28.4 LED status indicators

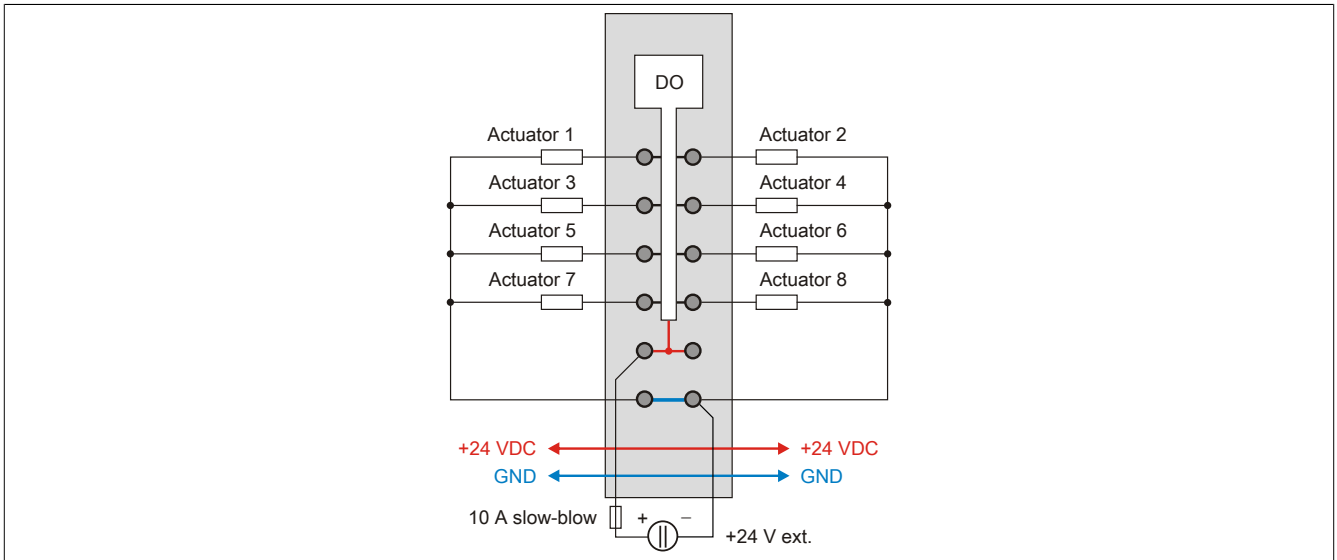
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description | |
|---|-------|-------|--------------------------------|---|--|
|  | r | Green | Off | No power to module | |
| | | | Single flash | Mode RESET | |
| | | | Blinking | Mode PREOPERATIONAL | |
| | | | On | Mode RUN | |
| | e | Red | Off | No power to module or everything OK | |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. | |
| | | | Double flash | I/O power supply too low | |
| | e + r | | Solid red / Single green flash | Invalid firmware | |
| | 1 - 8 | | Orange | | Output state of the corresponding digital output |

9.15.28.5 Pinout



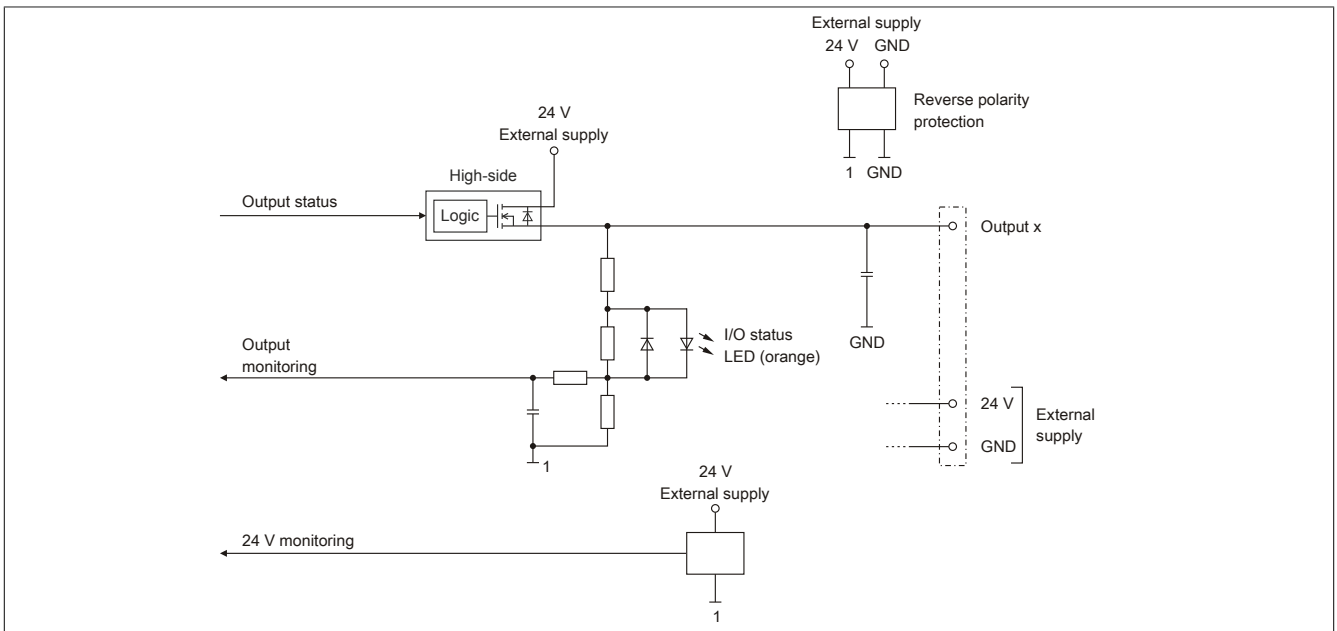
9.15.28.6 Connection example

**Caution!**

If the module is operated outside specifications, the output current may rise above the maximum permissible nominal current. This applies both to individual channels and to the summation current of the module.

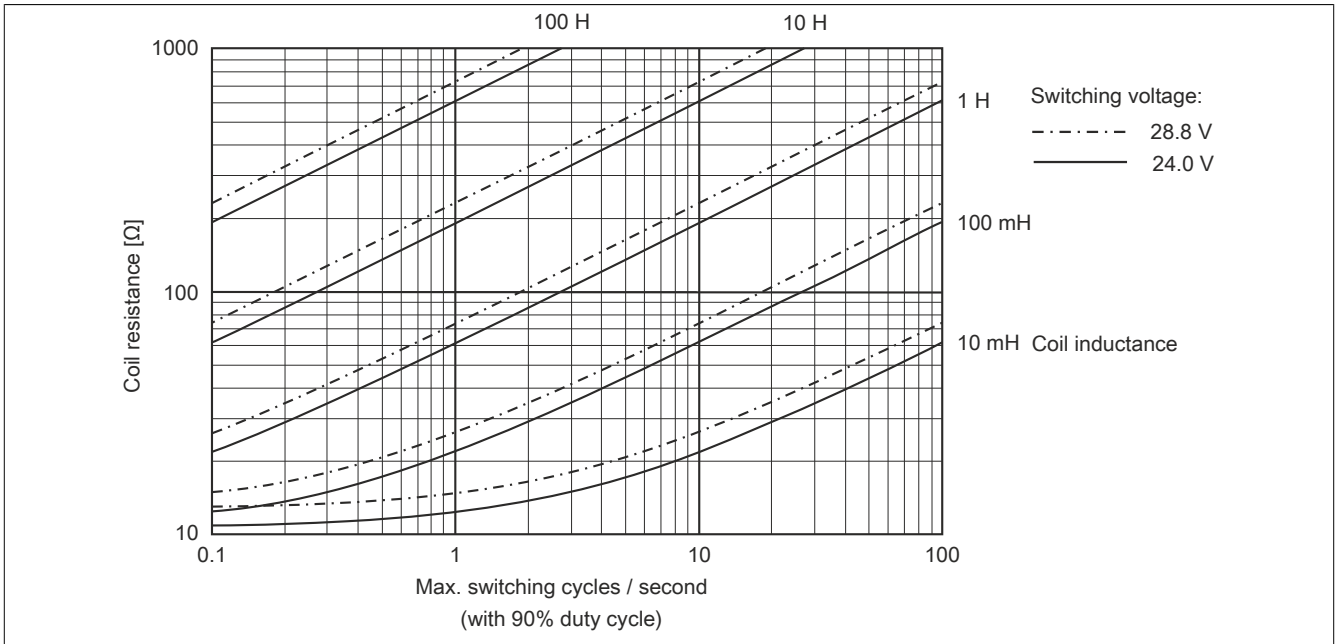
Appropriate cable cross-sections or external safety measures must therefore be provided.

9.15.28.7 Output circuit diagram

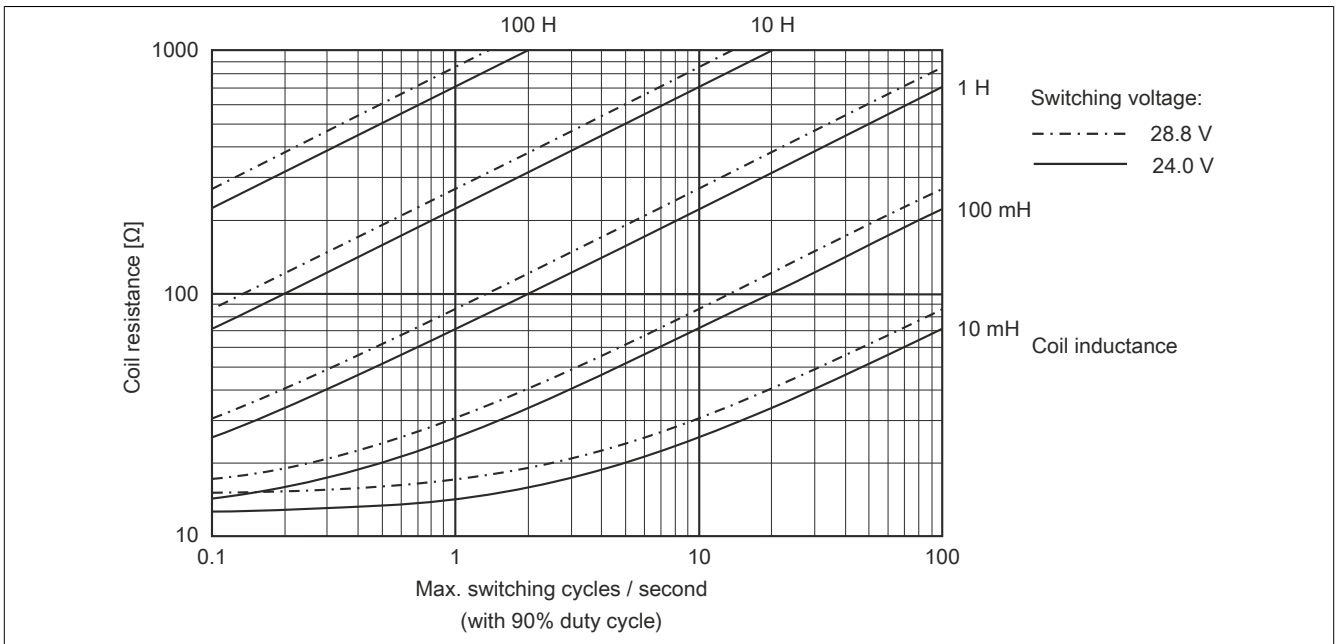


9.15.28.8 Switching inductive loads

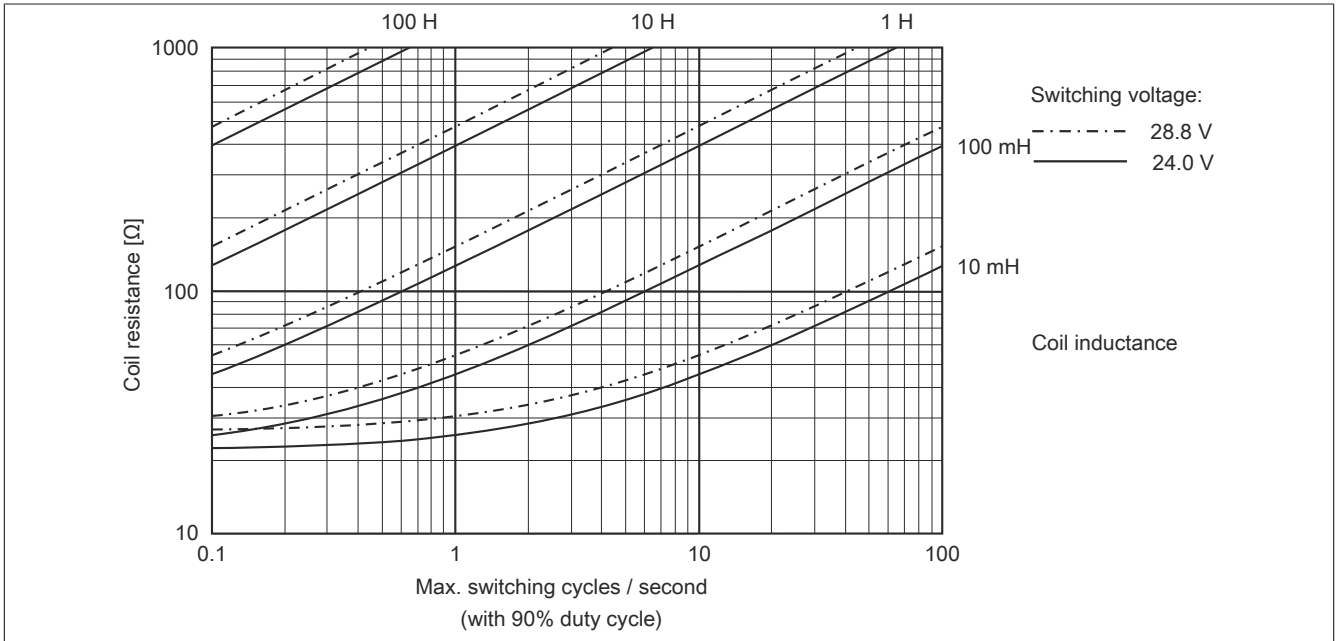
Ambient temperature: 35°C, 4 outputs with the same load.



Ambient temperature: 60°C, 4 outputs with the same load.



Ambient temperature: 60°C, all outputs with the same load.



Information:

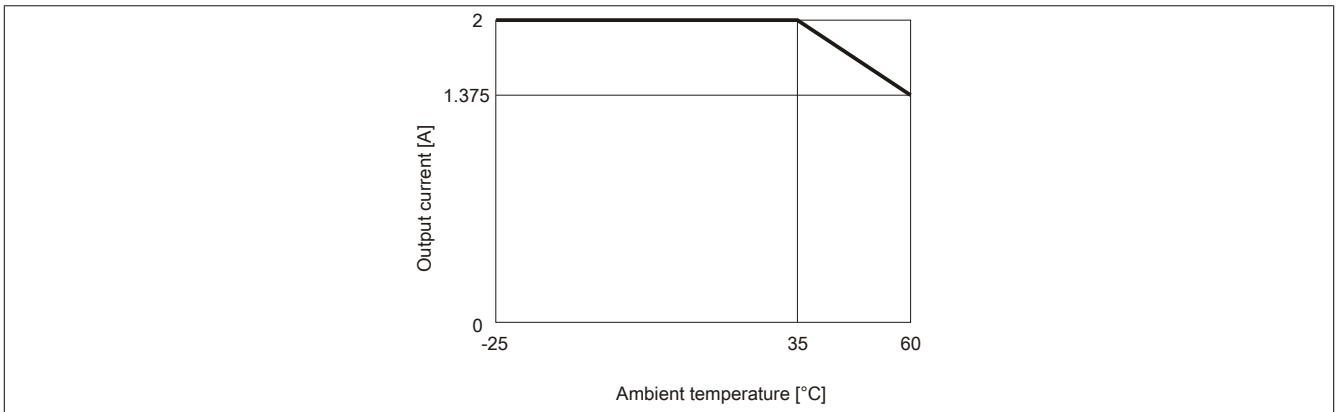
If the maximum number of operating cycles per second is exceeded, an external inverse diode must be used.

Operating conditions outside of the area in the diagram are not permitted!

9.15.28.9 Derating

The outputs of the module can handle up to 2 A. With a summation current of 8 A, no more than 4 channels are operable at full load.

Derating must be taken into account starting at 6 A.



Information:

Only modules with a maximum power consumption of 1.5 W are permitted to be operated next to the module.

For an example of calculating the power dissipation of I/O modules, see section ["Power dissipation calculation of I/O modules"](#) on page 101.

9.15.28.10 Register description

9.15.28.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.15.28.10.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | DigitalOutput | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08 | Bit 7 | | | | |
| 30 | 1 | StatusInput01 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput08 | Bit 7 | | | | |
| 8192 | - | Reading the module ID | UINT | | • | | |
| 8196 | - | Status of the supply voltage | USINT | | • | | |
| | | PowerSupply01 | Bit 2 | • | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.28.10.3 Function model 1 - Output switching

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 8 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08 | Bit 7 | | | | |
| 4 | 1 | Switching state of delayed digital outputs 1 to 8 | USINT | | | • | |
| | | DigitalOutput01Delayed | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08Delayed | Bit 7 | | | | |
| 6 | 2 | Switching mask after the delay time has expired | USINT | | | • | |
| | | DigitalOutput01DelayEnable | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08DelayEnable | Bit 7 | | | | |
| 8 | 3 | Setting the delay (OutputDelayTime) | USINT | | | • | |
| 30 | 1 | Status of digital outputs 1 to 8 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput08 | Bit 7 | | | | |
| 8192 | - | Reading the module ID | UINT | | • | | |
| 8196 | - | Status of the supply voltage | USINT | | • | | |
| | | PowerSupply01 | Bit 2 | • | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.28.10.4 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 8 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08 | Bit 7 | | | | |
| 30 | - | Status of digital outputs 1 to 8 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput08 | Bit 7 | | | | |
| 8192 | - | Reading the module ID | UINT | | • | | |
| 8196 | - | Status of the supply voltage | USINT | | • | | |
| | | Power Supply01 | Bit 2 | | • | | |

1) The offset specifies where the register is within the CAN object.

9.15.28.10.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.28.10.4.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.15.28.10.5 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 µs) based on the network cycle (SyncOut).

9.15.28.10.5.1 Switching state of digital outputs 1 to 8

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput08

The switching state of digital outputs 1 to 8 are stored in this register.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 255 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | ... | ... | ... |
| 7 | DigitalOutput08 | 0 | Digital output 08 reset |
| | | 1 | Digital output 08 set |

9.15.28.10.6 Reading the module ID

Name:

asy_ModulID

This register offers the possibility to read the module ID.

| Data type | Values |
|-----------|-----------|
| UINT | Module ID |

9.15.28.10.7 Monitoring status of the digital outputs

On the module, the output states of the outputs are compared to the target states. The control of the output driver is used for the target state.

A change in the output state resets monitoring for that output. The status of each individual channel can be read. A change in the monitoring status is actively transmitted as an error message.

9.15.28.10.7.1 Status of digital outputs 1 to 8

Name:

StatusInput01

StatusDigitalOutput01 to StatusDigitalOutput08

This register is used to indicate the status of digital outputs 1 to 8.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("StatusDigitalOutput01" to "StatusDigitalOutput0x") or whether this register should be displayed as a single USINT data point ("StatusInput01").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 255 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput01 | 0 | Channel 01: No error |
| | | 1 | Channel 01: <ul style="list-style-type: none"> Short circuit or overload Channel switched on and missing I/O power supply Channel switched off and external voltage applied on channel |
| ... | ... | ... | ... |
| 8 | StatusDigitalOutput08 | 0 | Channel 08: No error |
| | | 1 | Channel 08: For an error description, see channel 01. |

9.15.28.10.8 Operating limit monitoring

The output supply of the module is monitored. I/O supply voltage <19.2 V is displayed as a warning.

9.15.28.10.8.1 Status of the supply voltage

Name:

asy_SupplyStatus

The status of the I/O supply voltage is mapped in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---------------|-------|--|
| 0 - 1 | Reserved | 0 | |
| 2 | PowerSupply01 | 0 | I/O supply above the warning level of 20.4 V |
| | | 1 | I/O supply below the warning level of 20.4 V |
| 3 - 7 | Reserved | 0 | |

9.15.28.10.9 Additional function - switch digital outputs w/ delay using switching mask

In function model 1 - Output switching, it is possible to control the digital outputs with a delay.

The OutputDelay mask can be used to activate the delay for each channel individually. The module is controlled here using a 100 µs-based timer and the Output or OutputDelayed register.

Behavior of function model 1 - Output switching

With a timer delay of 0:

Output: DigitalOutput0x bits

When the delay is changed:

The bit string for DigitalOutput0x bits is output. The timer restarts.

Output: DigitalOutput0x bits

After delay time has expired:

The channels whose bits are set in the mask for OutputDelay are adapted to the corresponding OutputDelayed bits.

Output: DigitalOutput0x bits (if Enable bit = FALSE)
OutputDelayed bits (if Enable bit = TRUE)

Information:

Adjusting the output and restarting the timer take place immediately after transferring the new delay, even if the previous time has not yet passed.

9.15.28.10.9.1 Switching state of delayed digital outputs 1 to 8

Name:

DigitalOutput01Delayed to Digital08Delayed

According to the corresponding bit in the OutputDelay mask, the switching state of all digital outputs 1 to 8 are stored in the OutputDelayed bits after the delay time has expired.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|------------------------|-------|-------------------------|
| 0 | DigitalOutput01Delayed | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 7 | DigitalOutput08Delayed | 0 | Digital output 08 reset |
| | | 1 | Digital output 08 set |

Information:

After the delay time has expired, only the channels with a bit set in the OutputDelay mask are adjusted to the OutputDelayed bits.

9.15.28.10.9.2 Switching mask after the delay time has expired

Name:

DigitalOutput01DelayEnable to DigitalOutput08DelayEnable

These registers create the mask for OutputDelay. They define which outputs are switched to the bit string for the OutputDelayed register after the delay time has expired.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------------------|-------|-------------------------------------|
| 0 | DigitalOutput01DelayEnable | 0 | Digital output 01 remains unchanged |
| | | 1 | Digital output 01 is toggled |
| ... | | ... | |
| 7 | DigitalOutput08DelayEnable | 0 | Digital output 08 remains unchanged |
| | | 1 | Digital output 08 is toggled |

9.15.28.10.9.3 Setting the delay

Name:

OutputDelayTime

This register can be used to set the delay in 100 µs steps.

After the delay time has expired, the digital outputs are adjusted according to the switching mask (register 6) and the delayed output pattern (register 4).

| Data type | Value |
|-----------|--|
| USINT | 0 to 255 (in 100 µs steps) ¹⁾ |

1) The value 0 disables processing

9.15.28.10.10 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 150 µs |

9.15.28.10.11 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 150 µs |

9.15.29 X20(c)DO9321

Data sheet version: 3.17

9.15.29.1 General information

The module is equipped with 12 outputs for 1-wire connections. The module is designed for sink output wiring.

- 12 digital outputs
- Sink connection
- 1-wire connections
- Integrated output protection

9.15.29.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.15.29.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C . During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.15.29.3 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Digital outputs |  |
| X20DO9321 | X20 digital output module, 12 outputs, 24 VDC, 0.5 A, sink, 1-wire connections | |
| X20cDO9321 | X20 digital output module, coated, 12 outputs, 24 VDC, 0.5 A, sink, 1-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 350: X20DO9321, X20cDO9321 - Order data

9.15.29.4 Technical data

| Model number | X20DO9321 | X20cDO9321 |
|--|--|------------|
| Short description | | |
| I/O module | 12 digital outputs 24 VDC for 1-wire connections | |
| General information | | |
| B&R ID code | 0x1B9B | 0xE22D |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Outputs | Yes, using status LED and software (output error status) | |
| Power consumption | | |
| Bus | 0.26 W | |
| Internal I/O | 0.99 W | |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +0.36 | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| EAC | Yes | |
| KC | Yes | - |
| Digital outputs | | |
| Variant | FET negative switching | |
| Nominal voltage | 24 VDC | |
| Switching voltage | 24 VDC -15 % / +20 % | |
| Nominal output current | 0.5 A | |
| Total nominal current | 6 A | |
| Connection type | 1-wire connections | |
| Output circuit | Sink | |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short circuit current") Internal inverse diode for switching inductive loads (see section "Switching inductive loads") | |
| Diagnostic status | Output monitoring with 10 ms delay | |
| Leakage current when the power is switched off | 75 µA | |
| R _{DS(on)} | 120 mΩ | |
| Peak short-circuit current | <7 A | |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms (depends on the module temperature) | |
| Switching delay | | |
| 0 → 1 | <300 µs | |
| 1 → 0 | <300 µs | |
| Switching frequency | | |
| Resistive load | Max. 500 Hz | |
| Inductive load | See section "Switching inductive loads" | |
| Braking voltage when switching off inductive loads | Typ. 50 VDC | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel and I/O power supply | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating" | |
| Starting temperature | - | Yes, -40°C |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |

Table 351: X20DO9321, X20cDO9321 - Technical data


| Model number | X20DO9321 | X20cDO9321 |
|------------------------------|--|---|
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 351: X20DO9321, X20cDO9321 - Technical data

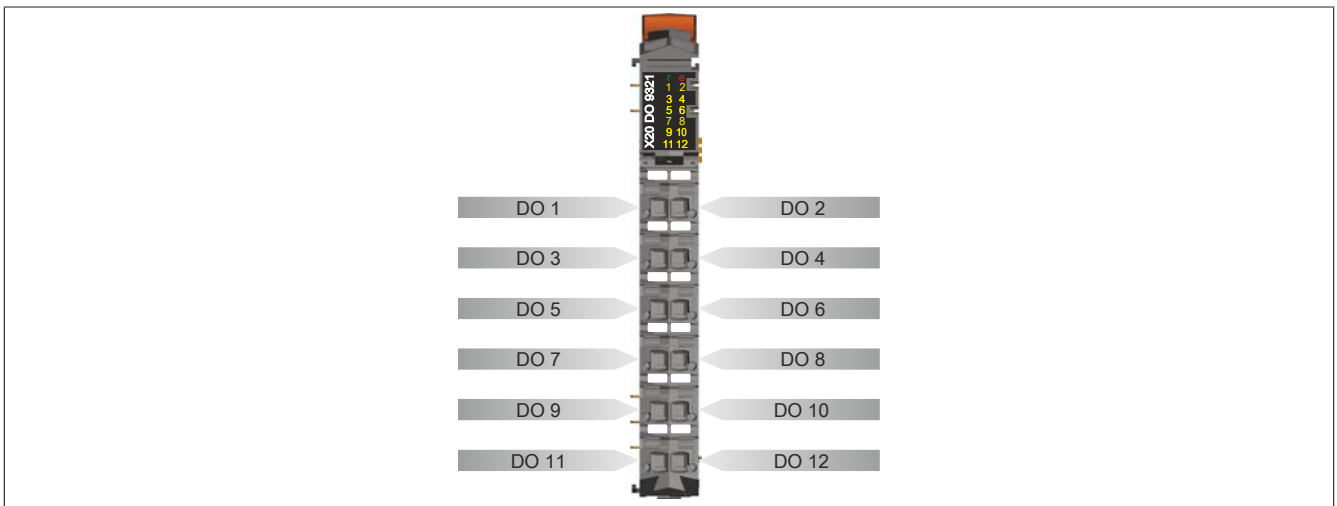
1) Number of outputs x $R_{DS(on)}$ x Nominal output current². For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.

9.15.29.5 Status LEDs

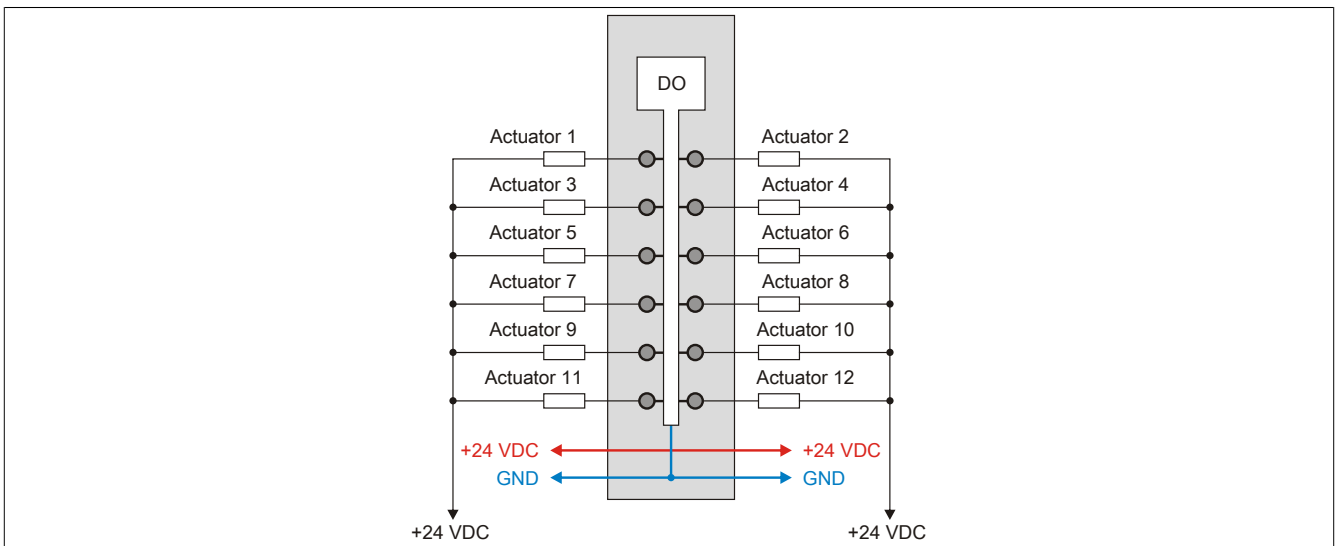
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

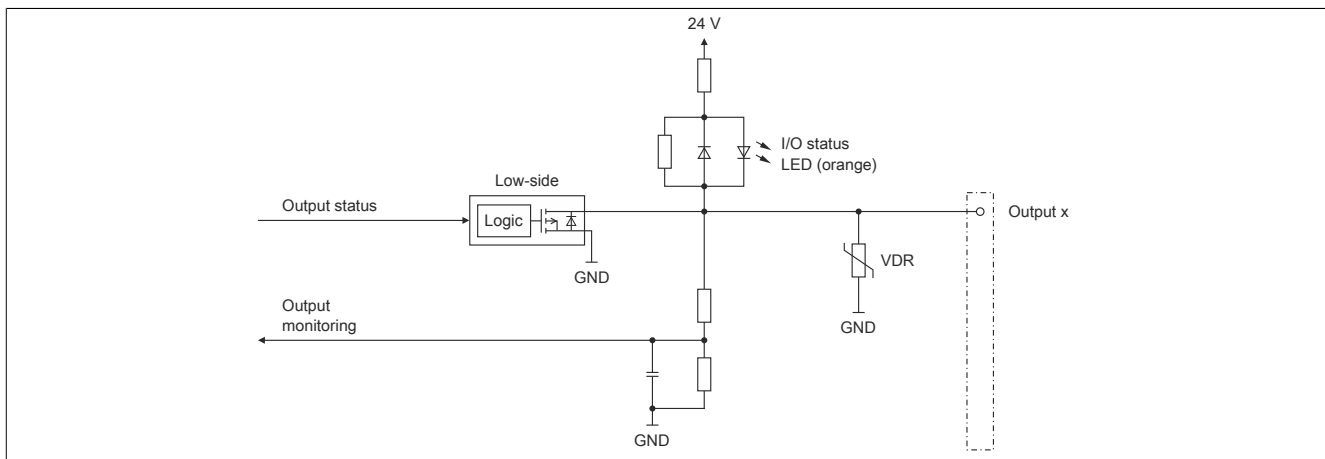
| Figure | LED | Color | Status | Description | |
|---|--------|-------|-----------------------------|---|---|
|  | r | Green | Off | Module supply not connected | |
| | | | Single flash | RESET mode | |
| | | | Blinking | PREOPERATIONAL mode | |
| | | | On | RUN mode | |
| | e | Red | Off | Module supply not connected or everything OK | |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. | |
| | e + r | | Red on / Green single flash | Invalid firmware | |
| | 1 - 12 | | Orange | | Output status of the corresponding digital output |

9.15.29.6 Pinout



9.15.29.7 Connection example



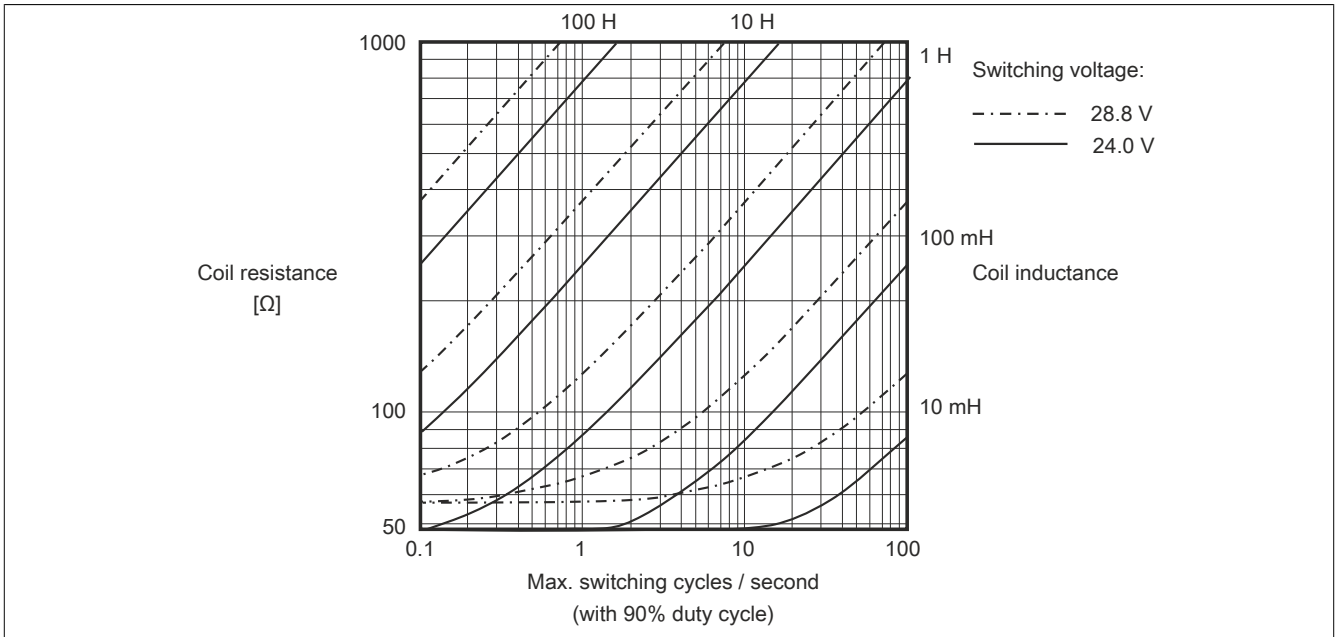
9.15.29.8 Output circuit diagram**9.15.29.9 Derating**

There is no derating when operated below 55°C.

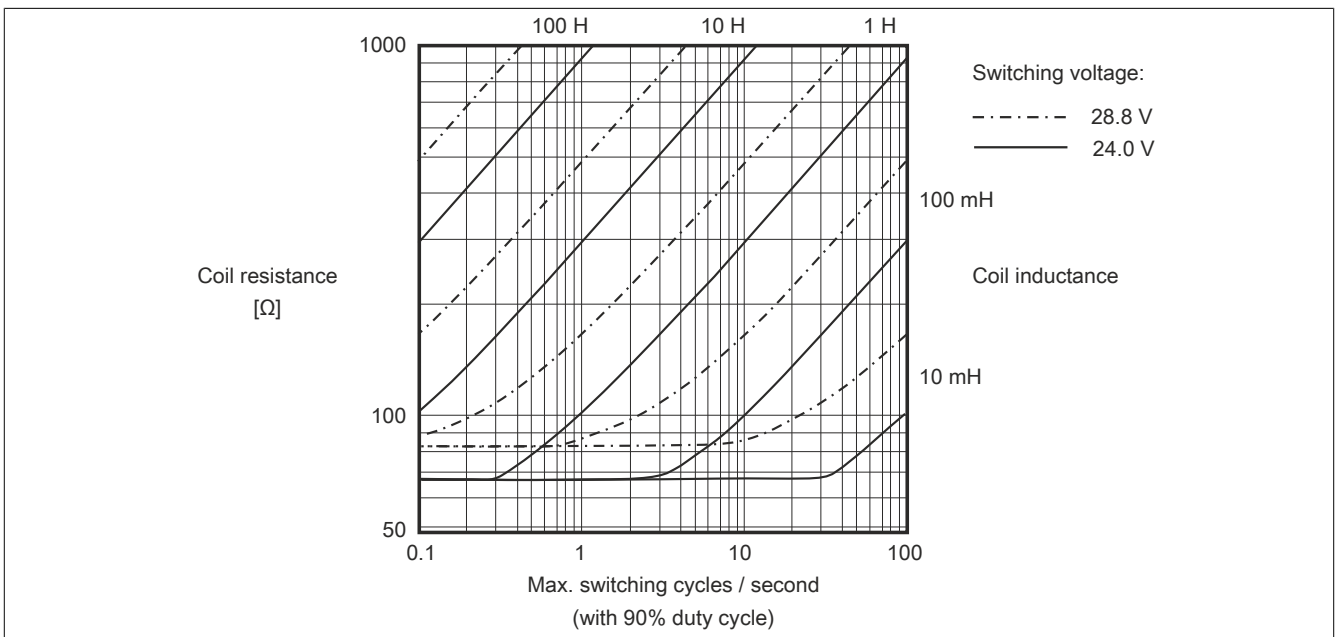
When operating above 55°C, the maximum current per channel is reduced to 0.35 A!

9.15.29.10 Switching inductive loads

Environmental temperature: 55°C, all outputs with the same load



Environmental temperature: 60°C, all outputs with the same load



Information:

If the maximum number of operating cycles per second is exceeded, an external inverse diode must be used.

Operating conditions outside of the area in the diagram are not permitted!

9.15.29.11 Register description

9.15.29.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.15.29.11.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| | 1 | DigitalOutput | UINT | | | • | |
| 2 | 0 | Switching state of digital outputs 1 to 8 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08 | Bit 7 | | | | |
| 3 | 1 | Switching state of digital outputs 9 to 12 | USINT | | | • | |
| | | DigitalOutput09 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput12 | Bit 3 | | | | |
| | 1 | StatusInput01 | UINT | • | | | |
| 30 | 1 | Status of digital outputs 1 to 8 | USINT | • | | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput08 | Bit 7 | | | | |
| 31 | 2 | Status of digital outputs 9 to 12 | USINT | • | | | |
| | | StatusDigitalOutput09 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput12 | Bit 3 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.29.11.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 8 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08 | Bit 7 | | | | |
| 3 | 1 | Switching state of digital outputs 9 to 12 | USINT | | | • | |
| | | DigitalOutput09 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput12 | Bit 3 | | | | |
| 30 | - | Status of digital outputs 1 to 8 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput08 | Bit 7 | | | | |
| 31 | - | Status of digital outputs 9 to 12 | USINT | | • | | |
| | | StatusDigitalOutput09 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput12 | Bit 3 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.15.29.11.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.29.11.3.2 CAN I/O bus controller

The module occupies 2 digital logical slots on CAN I/O.

9.15.29.11.4 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 µs) based on the network cycle (SyncOut).

9.15.29.11.4.1 Switching state of digital outputs 1 to 12

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput12

This register stores the switching state of digital outputs 1 to 12.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration can be used to determine whether all bits of these registers should be applied individually as data points in the Automation Studio I/O mapping ("DigitalOutput01" to "DigitalOutput12") or whether these registers should be displayed as a single UINT data point ("DigitalOutput").

| Data type | Values | Information |
|-----------|------------------------|--|
| UINT | 0 to 4095 | Packed outputs = On |
| USINT | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

Register 2, offset 0:

| Bit | Description | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 7 | DigitalOutput08 | 0 | Digital output 08 reset |
| | | 1 | Digital output 08 set |

Register 3, offset 1:

| Bit | Description | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput09 | 0 | Digital output 09 reset |
| | | 1 | Digital output 09 set |
| ... | | ... | |
| 3 | DigitalOutput12 | 0 | Digital output 12 reset |
| | | 1 | Digital output 12 set |

9.15.29.11.5 Monitoring status of the digital outputs

On the module, the output states of the outputs are compared to the target states. The control of the output driver is used for the target state.

A change in the output state resets monitoring for that output. The status of each individual channel can be read. A change in the monitoring status is actively transmitted as an error message.

9.15.29.11.5.1 Status of digital outputs 1 to 12

Name:

StatusInput01

StatusDigitalOutput01 to StatusDigitalOutput12

This register contains the state of digital outputs 1 to 12.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration can be used to determine whether all bits of these registers should be applied individually as data points in the Automation Studio I/O mapping ("StatusDigitalOutput01" to "StatusDigitalOutput12") or whether these registers should be displayed as a single UINT data point ("StatusInput01").

| Data type | Values | Information |
|-----------|------------------------|--|
| UINT | 0 to 4095 | Packed outputs = On |
| USINT | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

Register 30, (offset 1):

| Bit | Description | Value | Description |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput01 | 0 | Channel 01: No error |
| | | 1 | Channel 01: <ul style="list-style-type: none"> Short circuit or overload Channel switched on and missing I/O power supply Channel switched off and external voltage applied on channel |
| ... | ... | ... | ... |
| 7 | StatusDigitalOutput08 | 0 | Channel 08: No error |
| | | 1 | Channel 08: For an error description, see channel 01. |

Register 31, (offset 2):

| Bit | Description | Value | Information |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput09 | 0 | Channel 09: No error |
| | | 1 | Channel 09: <ul style="list-style-type: none"> Short circuit or overload Channel switched on and missing I/O power supply Channel switched off and external voltage applied on channel |
| ... | ... | ... | ... |
| 3 | StatusDigitalOutput12 | 0 | Channel 12: No error |
| | | 1 | Channel 12: For an error description, see channel 09. |

9.15.29.11.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 µs |

9.15.29.11.7 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|---------------------------------|
| Equal to the minimum cycle time |

9.15.30 X20(c)DO9322

Data sheet version: 3.17

9.15.30.1 General information

The module is equipped with 12 outputs for 1-wire connections. The module is designed for source output wiring.

- 12 digital outputs
- Source connection
- 1-wire connections
- Integrated output protection

9.15.30.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.15.30.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C . During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.15.30.3 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Digital outputs |  |
| X20DO9322 | X20 digital output module, 12 outputs, 24 VDC, 0.5 A, source, 1-wire connections | |
| X20cDO9322 | X20 digital output module, coated, 12 outputs, 24 VDC, 0.5 A, source, 1-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 352: X20DO9322, X20cDO9322 - Order data

9.15.30.4 Technical data

| Model number | X20DO9322 | X20cDO9322 |
|--|--|------------|
| Short description | 12 digital outputs 24 VDC for 1-wire connections | |
| General information | | |
| B&R ID code | 0x1B9A | 0xD578 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Outputs | Yes, using status LED and software (output error status) | |
| Power consumption | | |
| Bus | 0.26 W | |
| Internal I/O | 1.15 W | |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +0.63 | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Digital outputs | | |
| Variant | FET positive switching | |
| Nominal voltage | 24 VDC | |
| Switching voltage | 24 VDC -15 % / +20 % | |
| Nominal output current | 0.5 A | |
| Total nominal current | 6 A | |
| Connection type | 1-wire connections | |
| Output circuit | Source | |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short circuit current") Internal inverse diode for switching inductive loads (see section "Switching inductive loads") | |
| Diagnostic status | Output monitoring with 10 ms delay | |
| Leakage current when the power is switched off | 5 µA | |
| R _{DS(on)} | 210 mΩ | |
| Peak short-circuit current | <12 A | |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms (depends on the module temperature) | |
| Switching delay ²⁾ | | |
| 0 → 1 | <300 µs | |
| 1 → 0 | <300 µs | |
| Switching frequency | | |
| Resistive load ²⁾ | Max. 500 Hz | |
| Inductive load | See section "Switching inductive loads" | |
| Braking voltage when switching off inductive loads | Typ. 50 VDC | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel and I/O power supply | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |

Table 353: X20DO9322, X20cDO9322 - Technical data


| Model number | X20DO9322 | X20cDO9322 |
|---------------------------------|--|---|
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating" | |
| Starting temperature | - | Yes, -40°C |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 353: X20DO9322, X20cDO9322 - Technical data

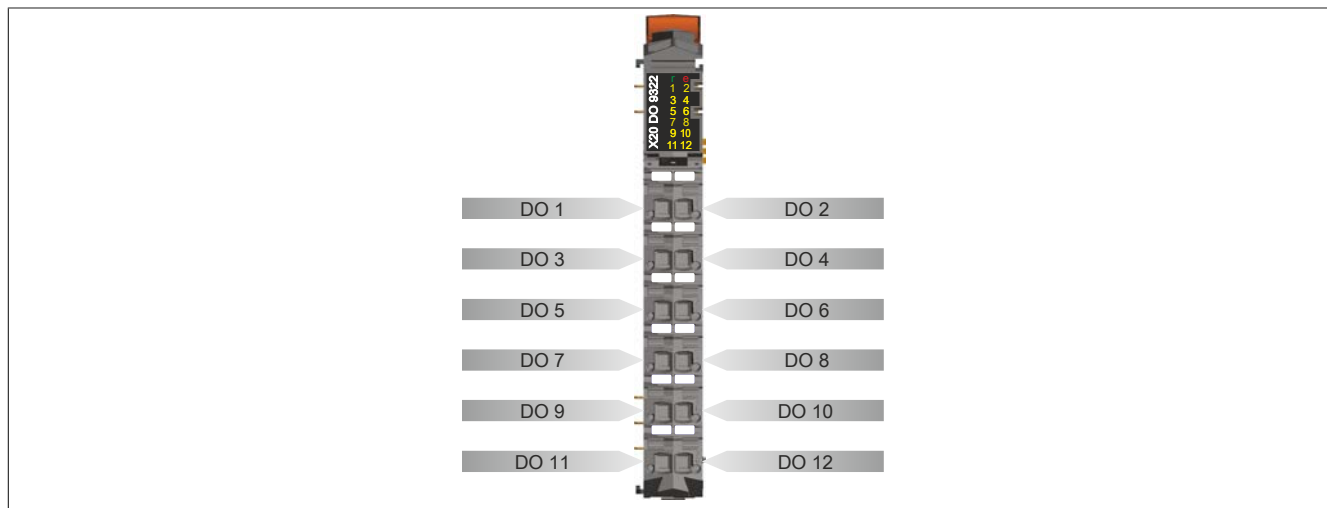
- Number of outputs x $R_{DS(on)}$ x Nominal output current². For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- @ ≤ 1 k Ω

9.15.30.5 Status LEDs

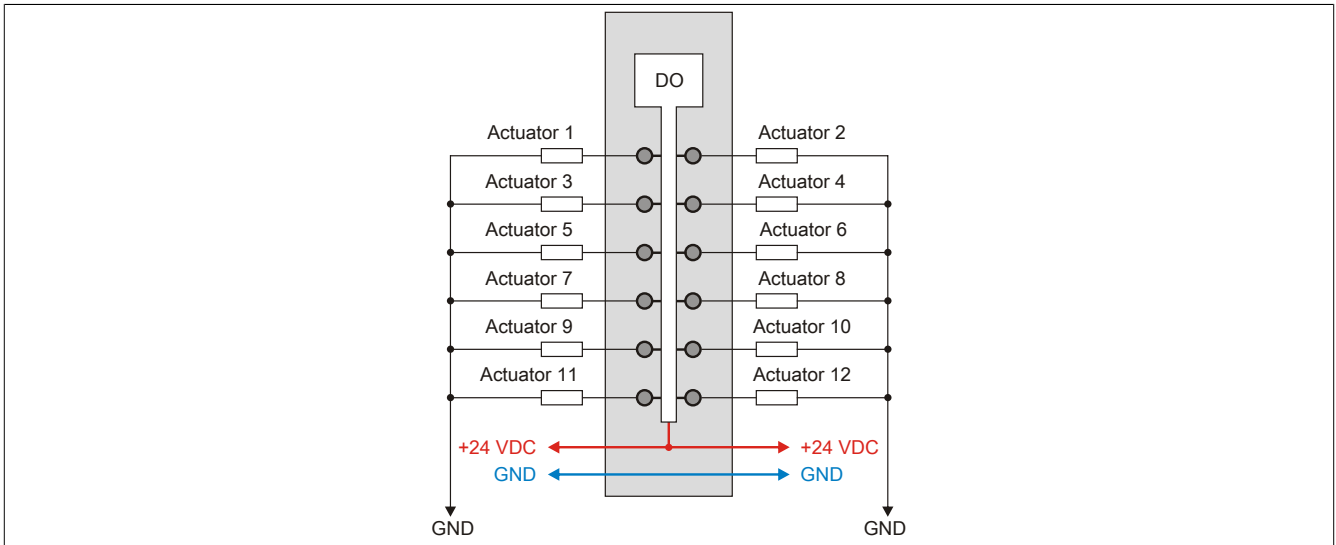
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description | |
|--|--------|-------|-----------------------------|---|---|
|  | r | Green | Off | Module supply not connected | |
| | | | Single flash | RESET mode | |
| | | | Blinking | PREOPERATIONAL mode | |
| | | | On | RUN mode | |
| | e | Red | Off | Module supply not connected or everything OK | |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. | |
| | e + r | | Red on / Green single flash | Invalid firmware | |
| | 1 - 12 | | Orange | | Output status of the corresponding digital output |

9.15.30.6 Pinout



9.15.30.7 Connection example

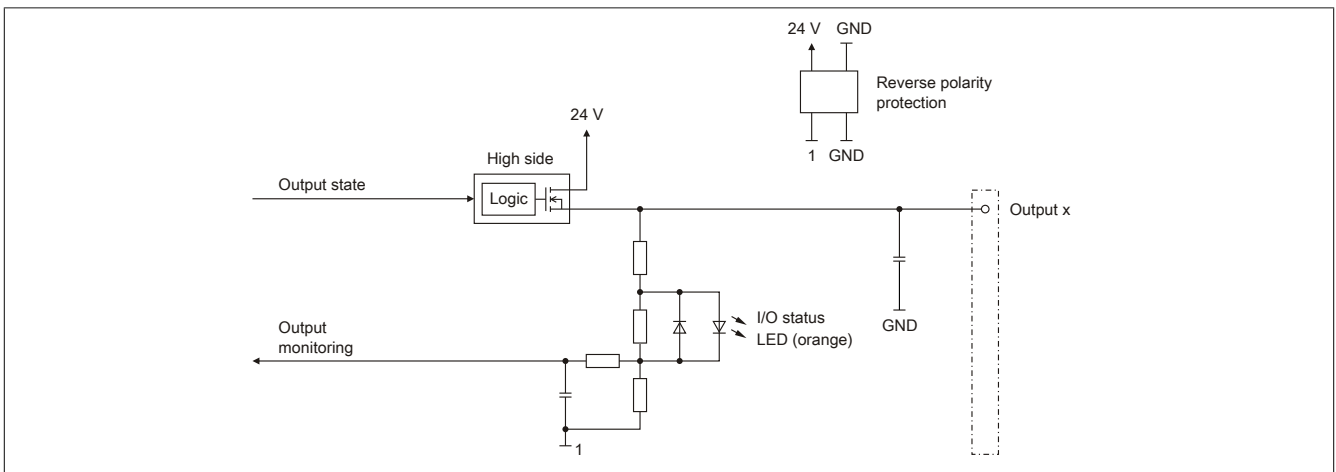


Caution!

If the module is operated outside specifications, the output current may rise above the maximum permissible nominal current. This applies both to individual channels and to the summation current of the module.

Appropriate cable cross-sections or external safety measures must therefore be provided.

9.15.30.8 Output circuit diagram



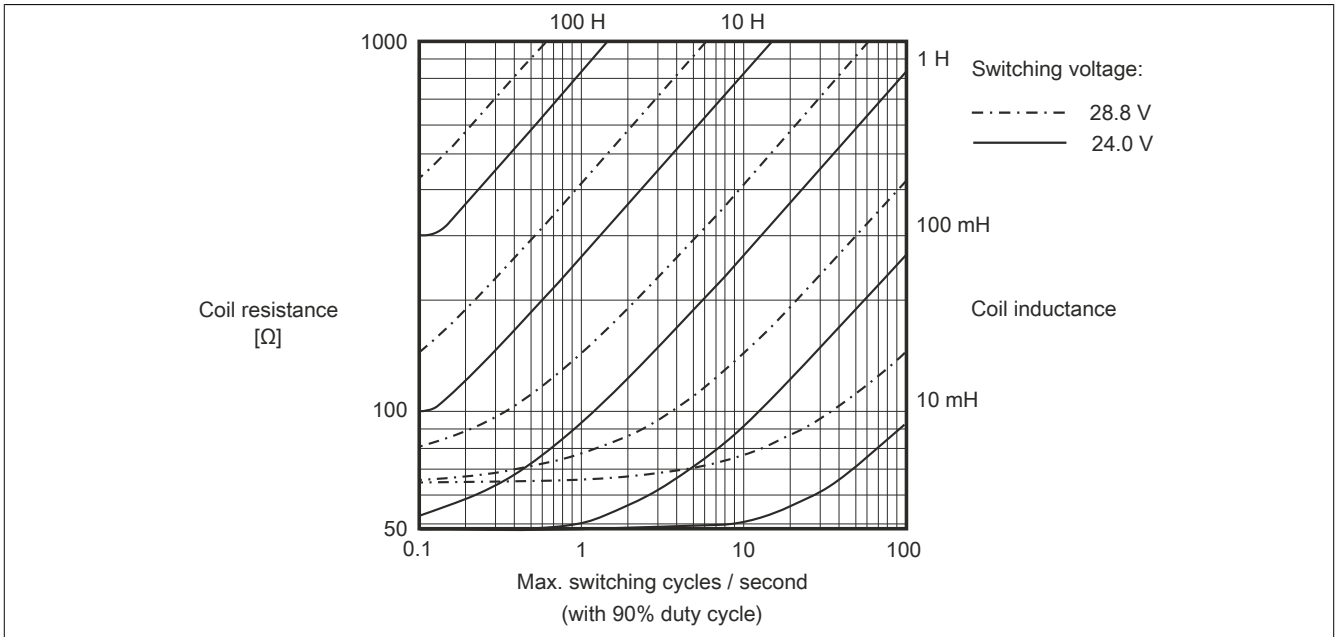
9.15.30.9 Derating

There is no derating when operated below 55°C.

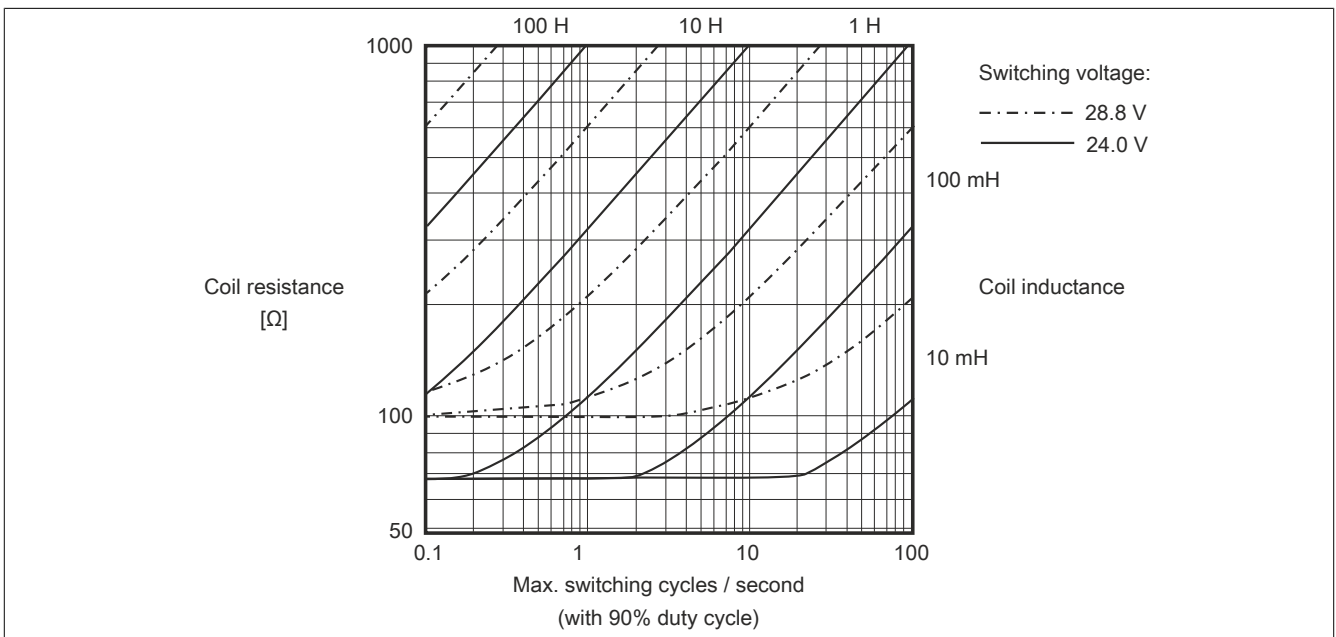
When operating above 55°C, the maximum current per channel is reduced to 0.35 A!

9.15.30.10 Switching inductive loads

Ambient temperature: 55°C, all outputs with the same load



Ambient temperature: 60°C, all outputs with the same load

**Information:**

If the maximum number of operating cycles per second is exceeded, an external inverse diode must be used.

Operating conditions outside of the area in the diagram are not permitted!

9.15.30.11 Register description

9.15.30.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.15.30.11.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| | 1 | DigitalOutput | UINT | | | • | |
| 2 | 0 | Switching state of digital outputs 1 to 8 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08 | Bit 7 | | | | |
| 3 | 1 | Switching state of digital outputs 9 to 12 | USINT | | | • | |
| | | DigitalOutput09 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput12 | Bit 3 | | | | |
| | 1 | StatusInput01 | UINT | • | | | |
| 30 | 1 | Status of digital outputs 1 to 8 | USINT | • | | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput08 | Bit 7 | | | | |
| 31 | 2 | Status of digital outputs 9 to 12 | USINT | • | | | |
| | | StatusDigitalOutput09 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput12 | Bit 3 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.30.11.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 8 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08 | Bit 7 | | | | |
| 3 | 1 | Switching state of digital outputs 9 to 12 | USINT | | | • | |
| | | DigitalOutput09 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput12 | Bit 3 | | | | |
| 30 | - | Status of digital outputs 1 to 8 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput08 | Bit 7 | | | | |
| 31 | - | Status of digital outputs 9 to 12 | USINT | | • | | |
| | | StatusDigitalOutput09 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput12 | Bit 3 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.15.30.11.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.30.11.3.2 CAN I/O bus controller

The module occupies 2 digital logical slots on CAN I/O.

9.15.30.11.4 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 µs) based on the network cycle (SyncOut).

9.15.30.11.4.1 Switching state of digital outputs 1 to 12

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput12

This register stores the switching state of digital outputs 1 to 12.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration can be used to determine whether all bits of these registers should be applied individually as data points in the Automation Studio I/O mapping ("DigitalOutput01" to "DigitalOutput12") or whether these registers should be displayed as a single UINT data point ("DigitalOutput").

| Data type | Values | Information |
|-----------|------------------------|--|
| UINT | 0 to 4095 | Packed outputs = On |
| USINT | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

Register 2, offset 0:

| Bit | Description | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 7 | DigitalOutput08 | 0 | Digital output 08 reset |
| | | 1 | Digital output 08 set |

Register 3, offset 1:

| Bit | Description | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput09 | 0 | Digital output 09 reset |
| | | 1 | Digital output 09 set |
| ... | | ... | |
| 3 | DigitalOutput12 | 0 | Digital output 12 reset |
| | | 1 | Digital output 12 set |

9.15.30.11.5 Monitoring status of the digital outputs

On the module, the output states of the outputs are compared to the target states. The control of the output driver is used for the target state.

A change in the output state resets monitoring for that output. The status of each individual channel can be read. A change in the monitoring status is actively transmitted as an error message.

9.15.30.11.5.1 Status of digital outputs 1 to 12

Name:

StatusInput01

StatusDigitalOutput01 to StatusDigitalOutput12

This register contains the state of digital outputs 1 to 12.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration can be used to determine whether all bits of these registers should be applied individually as data points in the Automation Studio I/O mapping ("StatusDigitalOutput01" to "StatusDigitalOutput12") or whether these registers should be displayed as a single UINT data point ("StatusInput01").

| Data type | Values | Information |
|-----------|------------------------|--|
| UINT | 0 to 4095 | Packed outputs = On |
| USINT | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

Register 30, (offset 1):

| Bit | Description | Value | Description |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput01 | 0 | Channel 01: No error |
| | | 1 | Channel 01: <ul style="list-style-type: none"> Short circuit or overload Channel switched on and missing I/O power supply Channel switched off and external voltage applied on channel |
| ... | ... | ... | ... |
| 7 | StatusDigitalOutput08 | 0 | Channel 08: No error |
| | | 1 | Channel 08: For an error description, see channel 01. |

Register 31, (offset 2):

| Bit | Description | Value | Information |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput09 | 0 | Channel 09: No error |
| | | 1 | Channel 09: <ul style="list-style-type: none"> Short circuit or overload Channel switched on and missing I/O power supply Channel switched off and external voltage applied on channel |
| ... | ... | ... | ... |
| 3 | StatusDigitalOutput12 | 0 | Channel 12: No error |
| | | 1 | Channel 12: For an error description, see channel 09. |

9.15.30.11.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 µs |

9.15.30.11.7 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|---------------------------------|
| Equal to the minimum cycle time |

9.15.31 X20DOD322

Data sheet version: 2.06

9.15.31.1 General information

The X20DOD322 module is equipped with eight outputs for 1-wire or 2-wire connections. The X20DOD322 is designed for source output wiring.

- 8 digital outputs
- Source connection
- 2-wire connections
- GND for signal supply
- Integrated output protection

9.15.31.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Digital outputs |  |
| X20DOD322 | X20 digital output module, 8 outputs, 24 VDC, 0.5 A, source, 2-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB1F | X20 terminal block, 16-pin, 24 VDC keyed | |

Table 354: X20DOD322 - Order data

9.15.31.3 Technical data

| Model number | X20DOD322 |
|--|--|
| Short description | |
| I/O module | 8 digital outputs 24 VDC for 1- or 2-wire connections |
| General information | |
| B&R ID code | 0xC0E9 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Outputs | Yes, using status LED and software (output error status) |
| Power consumption | |
| Bus | 0.19 W |
| Internal I/O | 0.8 W |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +0.28 W |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |

Table 355: X20DOD322 - Technical data


| Model number | X20DOD322 |
|---|--|
| Digital outputs | |
| Variant | FET positive switching |
| Nominal voltage | 24 VDC |
| Switching voltage | 24 VDC -15 % / +20 % |
| Nominal output current | 0.5 A |
| Total nominal current | 4 A |
| Connection type | 1- or 2-wire connections |
| Output circuit | Source |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short circuit current") Internal inverse diode for switching inductive loads (see section "Switching inductive loads") |
| Diagnostic status | Output monitoring with 10 ms delay |
| Leakage current when switched off | 5 μ A |
| $R_{DS(on)}$ | 140 m Ω |
| Peak short-circuit current | <3 A |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms (depends on the module temperature) |
| Switching delay ²⁾ | |
| 0 \rightarrow 1 | <300 μ s |
| 1 \rightarrow 0 | <300 μ s |
| Switching frequency | |
| Resistive load ²⁾ | Max. 500 Hz |
| Inductive load | See section "Switching inductive loads" |
| Braking voltage when switching off inductive loads | Typ. 45 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB1F terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 355: X20DOD322 - Technical data

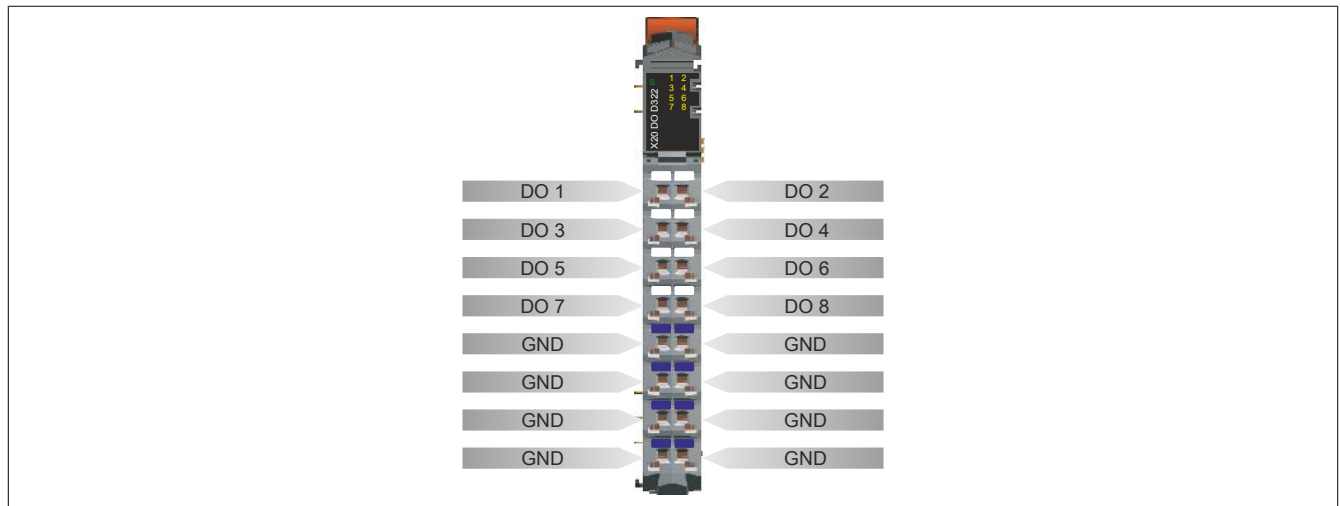
- 1) Number of outputs x $R_{DS(on)}$ x Nominal output current²⁾. For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) At loads \leq 1 k Ω

9.15.31.4 Status LEDs

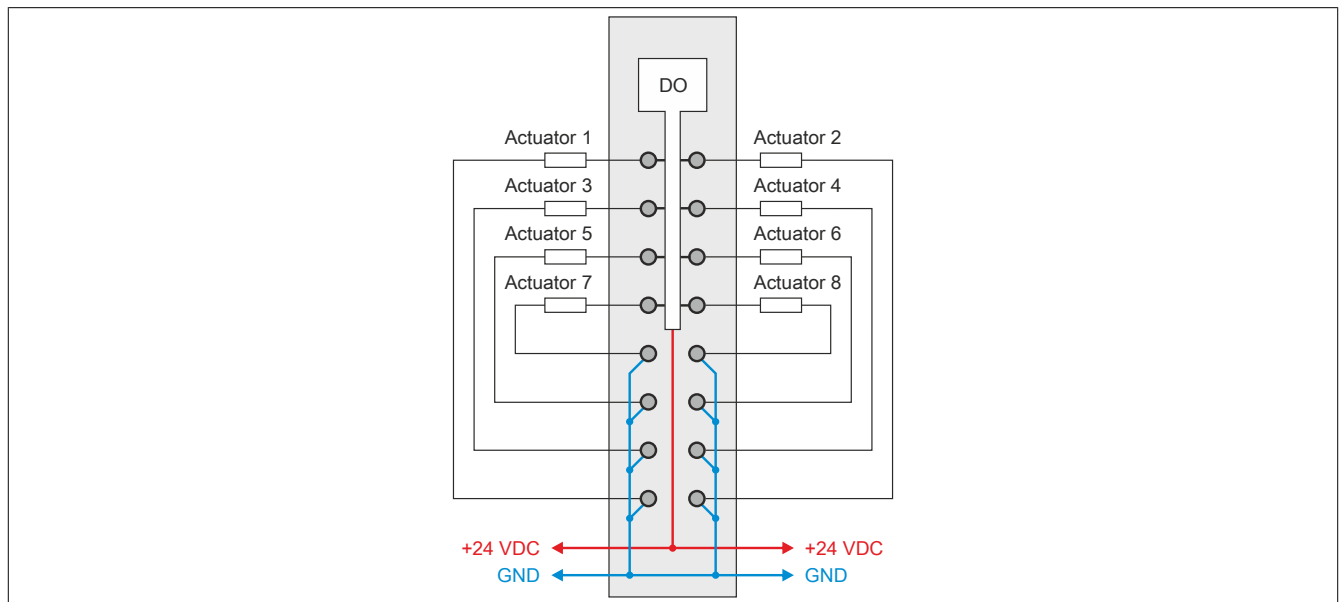
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|--------|-----------------------------|---|
|  | S | Green | Off | Module supply not connected |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | Red | Red | Off | Module supply not connected or everything OK |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. |
| | 1 - 8 | Orange | Red on / Green single flash | Invalid firmware |
| | | | | Output status of the corresponding digital output |

9.15.31.5 Pinout



9.15.31.6 Connection example

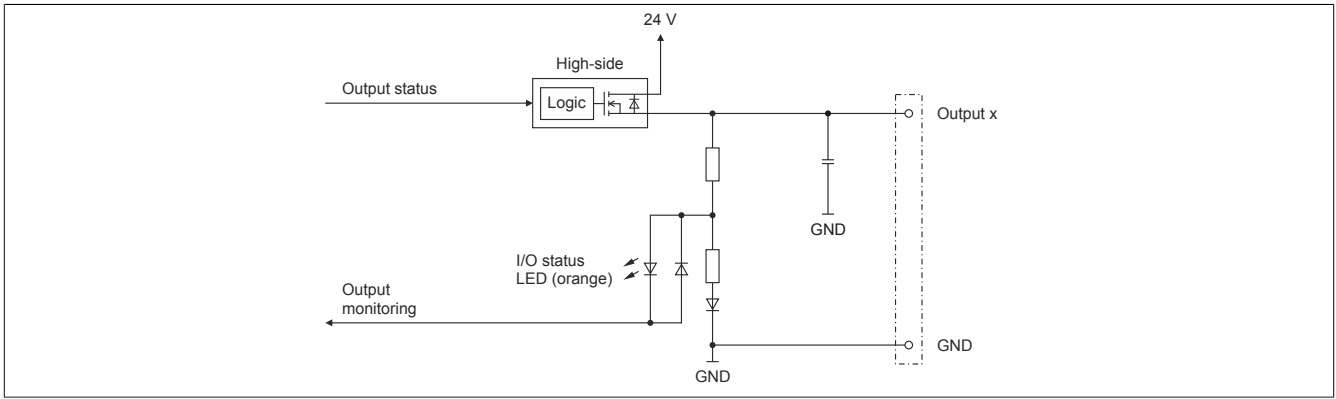


Caution!

If the module is operated outside specifications, the output current may rise above the maximum permissible nominal current. This applies both to individual channels and to the summation current of the module.

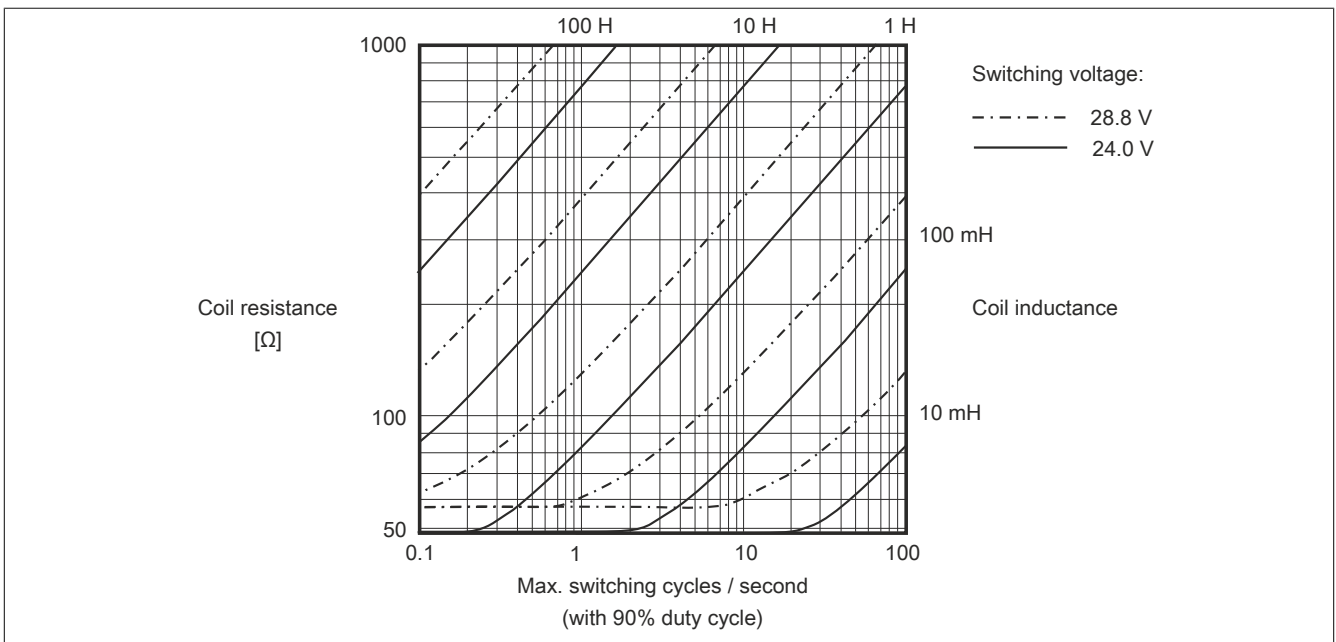
Appropriate cable cross-sections or external safety measures must therefore be provided.

9.15.31.7 Output circuit diagram



9.15.31.8 Switching inductive loads

Environmental temperature: 60°C, all outputs with the same load



Information:

If the maximum number of operating cycles per second is exceeded, an external inverse diode must be used.

Operating conditions outside of the area in the diagram are not permitted!

9.15.31.9 Register description

9.15.31.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.15.31.9.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|-------------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | DigitalOutput | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08 | Bit 7 | | | | |
| 30 | 1 | StatusDigitalOutput | USINT | • | | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput08 | Bit 7 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.31.9.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 8 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08 | Bit 7 | | | | |
| 30 | - | Status of digital outputs 1 to 8 | USINT | | • | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput08 | Bit 7 | | | | |

1) The offset specifies where the register is within the CAN object.

9.15.31.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.31.9.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.15.31.9.4 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 µs) based on the network cycle (SyncOut).

9.15.31.9.4.1 Switching state of digital outputs 1 to 8

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput08

The switching state of digital outputs 1 to 8 are stored in this register.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("DigitalOutput01" to "DigitalOutput0x") or whether this register should be displayed as a single USINT data point ("DigitalOutput").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 255 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 7 | DigitalOutput08 | 0 | Digital output 08 reset |
| | | 1 | Digital output 08 set |

9.15.31.9.5 Monitoring status of the digital outputs

On the module, the output states of the outputs are compared to the target states. The control of the output driver is used for the target state.

A change in the output state resets monitoring for that output. The status of each individual channel can be read. A change in the monitoring status is actively transmitted as an error message.

9.15.31.9.5.1 Status of digital outputs 1 to 8

Name:

StatusDigitalOutput

StatusDigitalOutput01 to StatusDigitalOutput08

The status of digital outputs 1 to 8 is mapped in this register.

Only function model 0 - Standard:

Setting "Packed outputs" in the Automation Studio I/O configuration determines whether all bits of this register should be applied individually as data points in the Automation Studio I/O assignment ("StatusDigitalOutput01" to "StatusDigitalOutput0x") or whether this register should be displayed as a single USINT data point ("StatusDigitalOutput").

| Data type | Value | Information |
|-----------|------------------------|--|
| USINT | 0 to 255 | Packed outputs = On |
| | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput01 | 0 | Channel 01: No error |
| | | 1 | Channel 01: <ul style="list-style-type: none"> Short circuit or overload Channel switched on and missing I/O power supply Channel switched off and external voltage applied on channel |
| ... | | ... | |
| 8 | StatusDigitalOutput08 | 0 | Channel 08: No error |
| | | 1 | Channel 08: For an error description, see channel 01. |

9.15.31.9.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.15.31.9.7 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|---------------------------------|
| Equal to the minimum cycle time |

9.15.32 X20(c)DOF322

Data sheet version: 2.28

9.15.32.1 General information

The module is equipped with 16 outputs for 1-wire connections. The module is designed for source output wiring.

- 16 digital outputs
- Source connection
- 1-wire connections
- Integrated output protection

9.15.32.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.15.32.3 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Digital outputs |  |
| X20DOF322 | X20 digital output module, 16 output, 24 VDC, 0.5 A, source, 1-wire connections | |
| X20cDOF322 | X20 digital output module, coated, 16 output, 24 VDC, 0.5 A, source, 1-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB1F | X20 terminal block, 16-pin, 24 VDC keyed | |
| | | |
| | | |

Table 356: X20DOF322, X20cDOF322 - Order data

9.15.32.4 Technical data

| Model number | X20DOF322 | X20cDOF322 |
|--|--|------------|
| Short description | 16 digital outputs 24 VDC for 1-wire connections | |
| General information | | |
| B&R ID code | 0xC0EA | 0xDD4C |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Outputs | Yes, using status LED and software (output error status) | |
| Power consumption | | |
| Bus | 0.28 W | |
| Internal I/O | 0.95 W | |
| Additional power dissipation caused by actuators (resistive) [W] ¹⁾ | +0.56 W | |
| Certifications | | |
| CE | Yes | |
| KC | Yes | - |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | - |
| KR | Yes | |
| Digital outputs | | |
| Variant | FET positive switching | |
| Nominal voltage | 24 VDC | |
| Switching voltage | 24 VDC -15% / +20% | |
| Nominal output current | 0.5 A | |
| Total nominal current | 8 A | |
| Connection type | 1-wire connections | |
| Output circuit | Source | |
| Output protection | Thermal cutoff on overcurrent or short circuit (see value "Peak short circuit current") Internal freewheeling diode for switching inductive loads (see section "Switching inductive loads") | |
| Diagnostic status | Output monitoring with 10 ms delay | |
| Leakage current when switched off | 5 µA | |
| R _{DS(on)} | 140 mΩ | |
| Peak short-circuit current | <3 A | |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms (depends on the module temperature) | |
| Switching delay ²⁾ | | |
| 0 → 1 | <300 µs | |
| 1 → 0 | <300 µs | |
| Switching frequency | | |
| Resistive load ²⁾ | Max. 500 Hz | |
| Inductive load | See section "Switching inductive loads" | |
| Braking voltage when switching off inductive loads | Typ. 45 VDC | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitation | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |

Table 357: X20DOF322, X20cDOF322 - Technical data


| Model number | X20DOF322 | X20cDOF322 |
|---------------------------------|--|--|
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating" | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x terminal block X20TB1F separately Order 1x bus module X20BM11 separately | Order 1x terminal block X20cTB1F separately Order 1x bus module X20cBM11 separately |
| Spacing | 12.5 ^{+0.2} mm | |

Table 357: X20DOF322, X20cDOF322 - Technical data

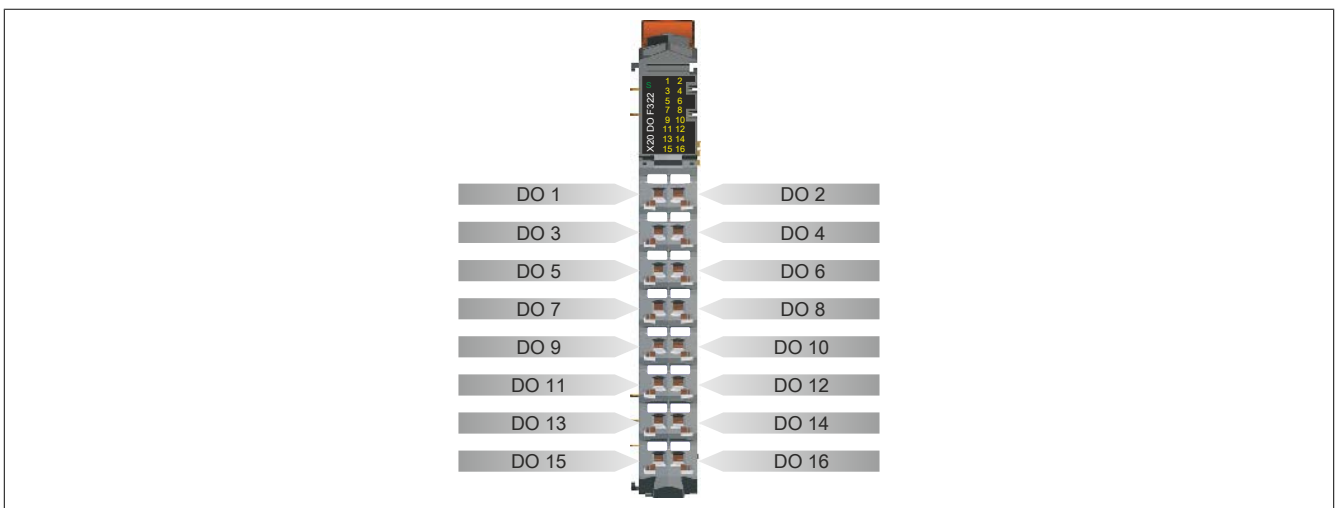
- 1) Number of outputs x R_{DS(on)} x Nominal output current². For a calculation example, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) At loads ≤1 kΩ.

9.15.32.5 Status LEDs

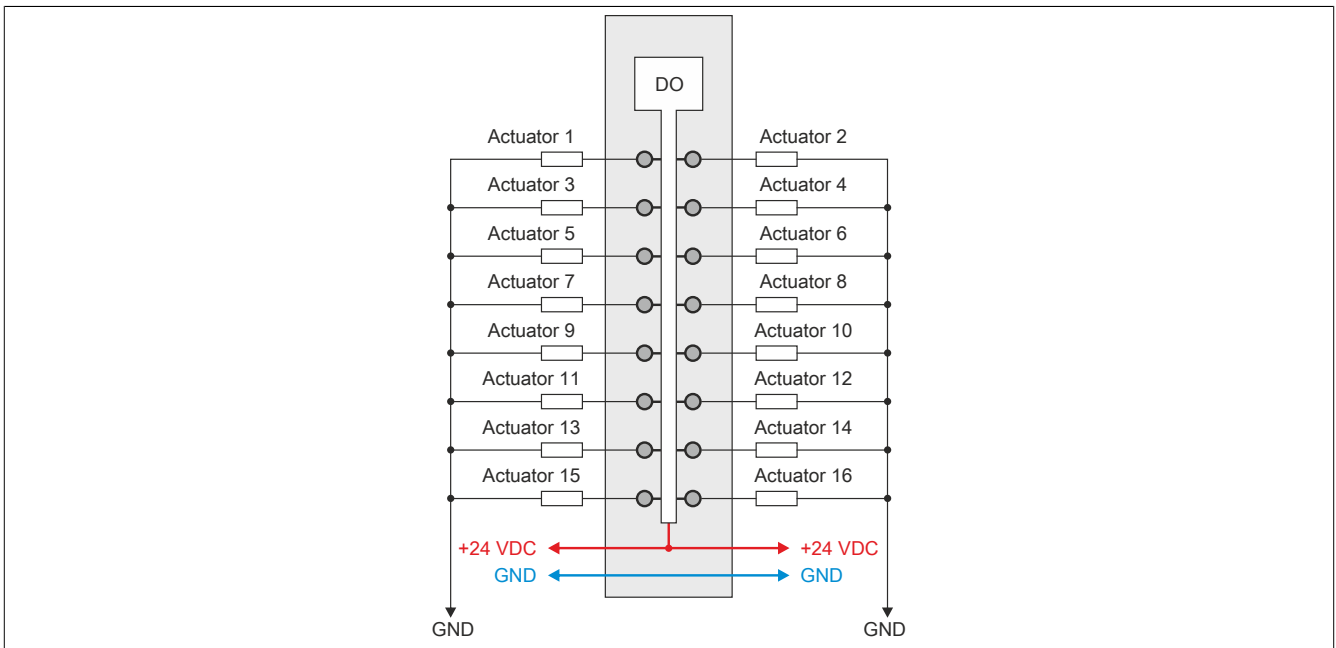
For a description of the various operating modes, see ["Diagnostic LEDs" on page 3787](#).

| Figure | LED | Color | Status | Description |
|--|-----------------------------|------------------|---|---|
|  | S | Green | Off | Module supply not connected |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | | Red | Off | Module supply not connected or everything OK |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. |
| | Red on / Green single flash | Invalid firmware | | |
| 1 - 16 | Orange | | Output status of the corresponding digital output | |

9.15.32.6 Pinout



9.15.32.7 Connection example

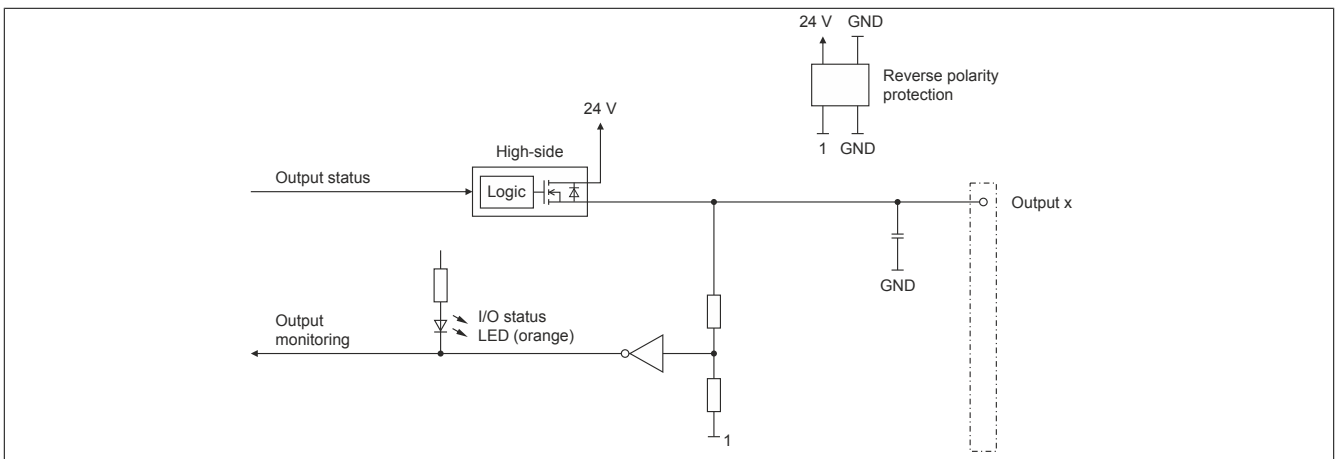


Caution!

If the module is operated outside specifications, the output current may rise above the maximum permissible nominal current. This applies both to individual channels and to the summation current of the module.

Appropriate cable cross-sections or external safety measures must therefore be provided.

9.15.32.8 Output circuit diagram



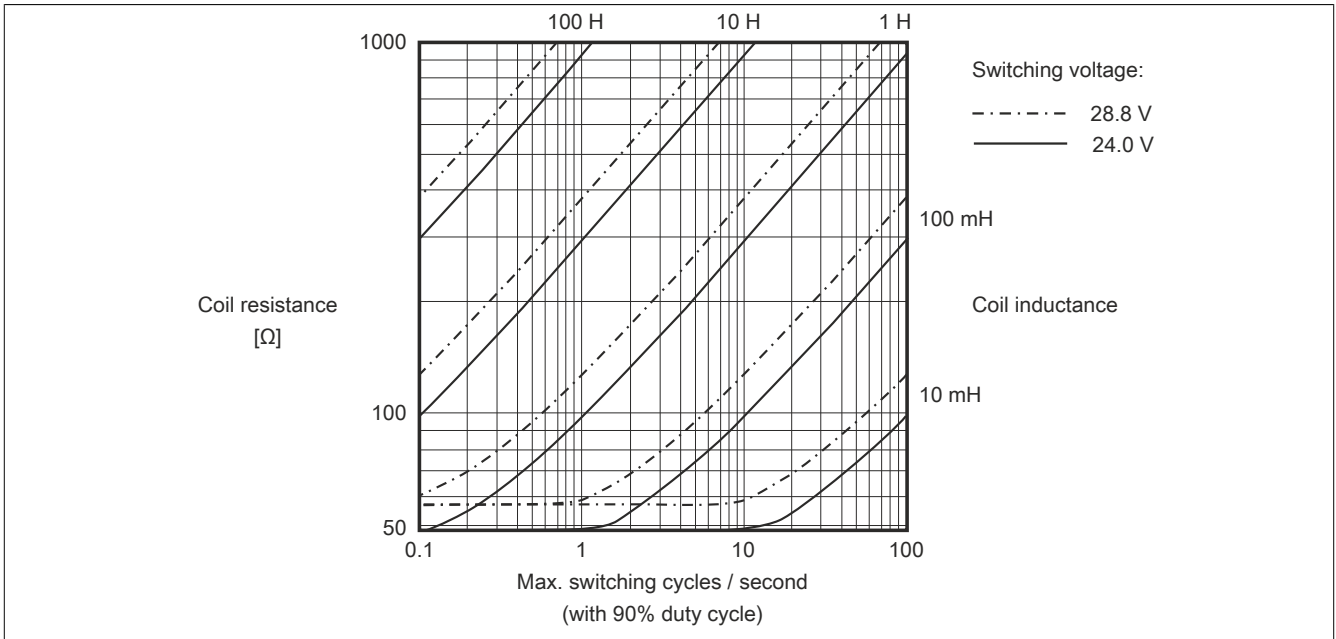
9.15.32.9 Derating

There is no derating when operated below 55°C.

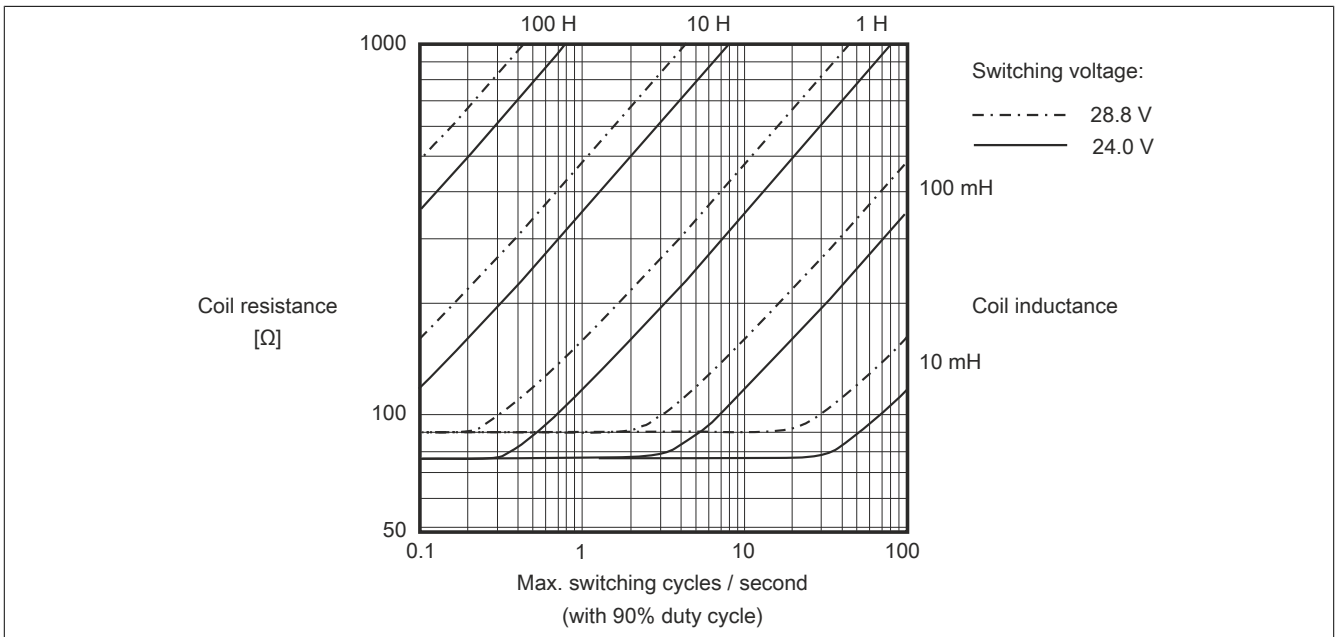
When operating above 55°C, the maximum current per channel is reduced to 0.35 A!

9.15.32.10 Switching inductive loads

Environmental temperature: 55°C, all outputs with the same load



Environmental temperature: 60°C, all outputs with the same load



Information:

If the maximum number of operating cycles per second is exceeded, an external inverse diode must be used.

Operating conditions outside of the area in the diagram are not permitted!

9.15.32.11 Register description

9.15.32.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.15.32.11.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|-----------------------|--------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | DigitalOutput | UINT | | | • | |
| | | Switching state of digital outputs 1 to 8 | USINT | | | | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| DigitalOutput08 | Bit 7 | | | | | | |
| 3 | 1 | Switching state of digital outputs 9 to 16 | USINT | | | | |
| | | DigitalOutput09 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput16 | Bit 7 | | | | |
| 30 | 2 | StatusDigitalOutput | UINT | | | | |
| | | Status of digital outputs 1 to 8 | USINT | | | • | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| StatusDigitalOutput08 | Bit 7 | | | | | | |
| 31 | 3 | Status of digital outputs 9 to 16 | USINT | | | | |
| | | StatusDigitalOutput09 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput16 | Bit 7 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.15.32.11.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2 | 0 | Switching state of digital outputs 1 to 8 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08 | Bit 7 | | | | |
| 3 | 1 | Switching state of digital outputs 9 to 16 | USINT | | | | |
| | | DigitalOutput09 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput16 | Bit 7 | | | | |
| 30 | - | Status of digital outputs 1 to 8 | USINT | | | • | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput08 | Bit 7 | | | | |
| 31 | - | Status of digital outputs 9 to 16 | USINT | | | | |
| | | StatusDigitalOutput09 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput16 | Bit 7 | | | | |

1) The offset specifies where the register is within the CAN object.

9.15.32.11.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.15.32.11.3.2 CAN I/O bus controller

The module occupies 2 digital logical slots on CAN I/O.

9.15.32.11.4 Digital outputs

The output state is transferred to the output channels with a fixed offset (<60 µs) based on the network cycle (SyncOut).

9.15.32.11.4.1 Switching state of digital outputs 1 to 16

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput16

The switching state of digital outputs 1 to 16 are stored in this register.

Function model 0 - Standard only:

The "Packed outputs" setting in the Automation Studio I/O configuration is used to determine whether all of these registers' bits should be set up individually as data points in the Automation Studio I/O mapping ("DigitalOutput01" through "DigitalOutput16") or whether these registers should be displayed as an individual UINT data point ("DigitalOutput").

| Data type | Values | Value |
|-----------|-------------------|--|
| UINT | 0 to 65535 | Packed outputs = on |
| USINT | See bit structure | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

Register 2, Offset 0:

| Bit | Name | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| ... | | ... | |
| 7 | DigitalOutput08 | 0 | Digital output 08 reset |
| | | 1 | Digital output 08 set |

Register 3, Offset 1:

| Bit | Name | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput09 | 0 | Digital output 09 reset |
| | | 1 | Digital output 09 set |
| ... | | ... | |
| 7 | DigitalOutput16 | 0 | Digital output 16 reset |
| | | 1 | Digital output 16 set |

9.15.32.11.5 Monitoring status of the digital outputs

On the module, the output states of the outputs are compared to the target states. The control of the output driver is used for the target state.

A change in the output state resets monitoring for that output. The status of each individual channel can be read. A change in the monitoring status is actively transmitted as an error message.

9.15.32.11.5.1 Status of digital outputs 1 to 16

Name:

StatusDigitalOutput

StatusDigitalOutput01 to StatusDigitalOutput16

The status of digital outputs 1 to 16 is mapped in this register.

Function model 0 - Standard only:

The "packed outputs" setting in the Automation Studio I/O configuration is used to determine whether all of these registers' bits should be set up individually as data points in the Automation Studio I/O mapping ("StatusDigitalOutput01" through "StatusDigitalOutput16") or whether these registers should be displayed as an individual UINT data point ("StatusDigitalOutput").

| Data type | Values | |
|-----------|------------------------|--|
| UINT | 0 to 65535 | Packed outputs = on |
| USINT | See the bit structure. | Packed outputs = Off or function model ≠ 0 - Standard. |

Bit structure:

Register 30, Offset 1:

| Bit | Name | Value | Description |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput01 | 0 | Channel 01: No error |
| | | 1 | Channel 01: <ul style="list-style-type: none"> Short circuit or overload Channel switched on and missing I/O power supply Channel switched off and external voltage applied on channel |
| ... | | ... | |
| 7 | StatusDigitalOutput08 | 0 | Channel 08: No error |
| | | 1 | Channel 08: For error description, see channel 01 |

Register 31, Offset 2:

| Bit | Name | Value | Information |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput09 | 0 | Channel 09: No error |
| | | 1 | Channel 09: <ul style="list-style-type: none"> Short circuit or overload Channel switched on and missing I/O power supply Channel switched off and external voltage applied on channel |
| ... | | ... | |
| 7 | StatusDigitalOutput16 | 0 | Channel 16: No error |
| | | 1 | Channel 16: For error description, see channel 09 |

9.15.32.11.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 µs |

9.15.32.11.7 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|---------------------------------|
| Equal to the minimum cycle time |

9.16 Digital signal processing modules

The highly flexible digital signal processor modules can be implemented for a wide range of tasks involving the creation or processing of digital signals.

9.16.1 Summary

| Model number | Short description | Page |
|--------------|---|------|
| X20CM1201 | X20 combination module, 1 AB incremental encoder, 24 V, 4 digital inputs 24 V, 4 channels 24 V configurable as inputs or outputs, flexible digital controller logic | 1875 |
| X20DC1073 | X20 digital counter module, 1x SinCos, 1 Vss, 400 kHz input frequency, encoder monitoring, NetTime function | 1899 |
| X20DS1119 | X20 multifunction digital signal processor, 3 digital channels 5 V (symmetrical) configurable as inputs or outputs, 2 digital input channels 24 V (asymmetrical), max. 2 event counters, 1 universal counter pair as AB counter or up/down counter, linear movement generator (A/B, direction/frequency) with 1 reference pulse, 1 SSI absolute encoder, NetTime function | 1914 |
| X20DS1319 | X20 multifunction digital signal processor, 4 digital input channels, 4 digital channels configurable as inputs or outputs, 2 event counters 1 universal counter pair as AB counter or up/down counter, linear movement generator (A/B, direction/frequency) with max. 2 reference pulses, SSI absolute encoder, NetTime function | 1957 |
| X20DS1828 | X20 digital signal module, 1 HIPERFACE interface, NetTime function | 1999 |
| X20DS1928 | X20 digital signal module, 1 EnDat 2.1/2.2 interface, NetTime function | 2031 |
| X20DS4389 | X20 digital signal module, 4 digital inputs, 24 VDC, 4 digital outputs, 24 VDC, 0.1 A, oversampling I/O functions, time-triggered I/O functions, NetTime function | 2056 |
| X20cDS1119 | X20 multifunction digital signal processor, coated, 3 digital channels 5 V (symmetrical) configurable as inputs or outputs, 2 digital input channels 24 V (asymmetrical), max. 2 event counters, 1 universal counter pair as AB counter or up/down counter, linear movement generator (A/B, direction/frequency) with 1 reference pulse, 1 SSI absolute encoder, NetTime function | 1914 |

9.16.2 X20CM1201

Data sheet version: 3.13

9.16.2.1 General information

The module can be used to configure and carry out simple movements. For this purpose, the module has one AB encoder input and a total of 8 digital channels. Four of them are inputs, and the other 4 can be set as either an input or an output. Various output bit patterns are stored directly in the module.

The module is perfectly suited for easy to create drive control tasks for program and event controlled motor movements. Feed movements using drives with 2 speeds and forward/reverse movement are created easily and efficiently.

- Command-dependent digital pattern output
- Counter-dependent output circuit
- Event-controlled abort criteria
- 4 digital inputs
- 4 digital channels, configurable as inputs or outputs

9.16.2.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Digital signal processing and preparation |  |
| X20CM1201 | X20 combination module, 1 AB incremental encoder, 24 V, 4 digital inputs 24 V, 4 channels 24 V configurable as inputs or outputs, flexible digital controller logic | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 358: X20CM1201 - Order data

9.16.2.3 Technical data

| Model number | X20CM1201 |
|---|---|
| Short description | |
| I/O module | 1 AB incremental encoder, 24 V, 4 digital inputs, 4 channels configurable as inputs or outputs |
| General information | |
| Input voltage | 24 VDC -15 % / +20 % |
| B&R ID code | 0x21EF |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Outputs | Yes, using the status LED and software (output error status) |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.5 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Type of signal lines | Shielded cables must be used for all signal lines. |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| Digital inputs | |
| Quantity | 4 + 4 additional channels, configurable as inputs or outputs |
| Nominal voltage | 24 VDC |
| Input voltage | 24 VDC -15 % / +20 % |
| Input current at 24 VDC | Approx. 1.3 mA |
| Input circuit | Sink |
| Input filter | |
| Hardware | ≤2 μs |
| Software | - |
| Connection type | 1-wire connections |
| Input resistance | 18.4 kΩ |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| AB incremental encoder | |
| Quantity | 1 |
| Encoder inputs | 24 V, asymmetrical |
| Counter size | 32-bit |
| Input frequency | Max. 100 kHz |
| Evaluation | 4x |
| Encoder power supply | Module-internal, max. 600 mA |
| Overload characteristics of encoder power supply | Short circuit protection, overload protection |
| Digital outputs | |
| Quantity | Up to 4, configurable as inputs or outputs using software |
| Variant | Push / Pull / Push-Pull |
| Nominal voltage | 24 VDC |
| Switching voltage | 24 VDC -15 % / +20 % |
| Nominal output current | 0.1 A |
| Total nominal current | 0.4 A |
| Connection type | 1-wire connections |
| Output circuit | Sink or source |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs, integrated protection for switching inductances |
| Actuator power supply | Module-internal, max. 600 mA |
| Diagnostic status | Output monitoring |
| Leakage current when switched off | Max. 25 μA |
| Residual voltage | <0.9 V at 0.1 A rated current |
| Peak short-circuit current | <10 A |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms (depends on the module temperature) |
| Switching delay | |
| 0 → 1 | <2 μs |
| 1 → 0 | <2 μs |


Table 359: X20CM1201 - Technical data

| Model number | X20CM1201 | |
|--|--|--|
| Switching frequency | | |
| Resistive load | Max. 24 kHz | |
| Inductive load | See section "Switching inductive loads" (at 90% duty cycle). | |
| Braking voltage when switching off inductive loads | Switching voltage + 0.6 VDC | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | |
| Spacing | 12.5 ^{+0.2} mm | |

Table 359: X20CM1201 - Technical data

9.16.2.4 LED status indicators

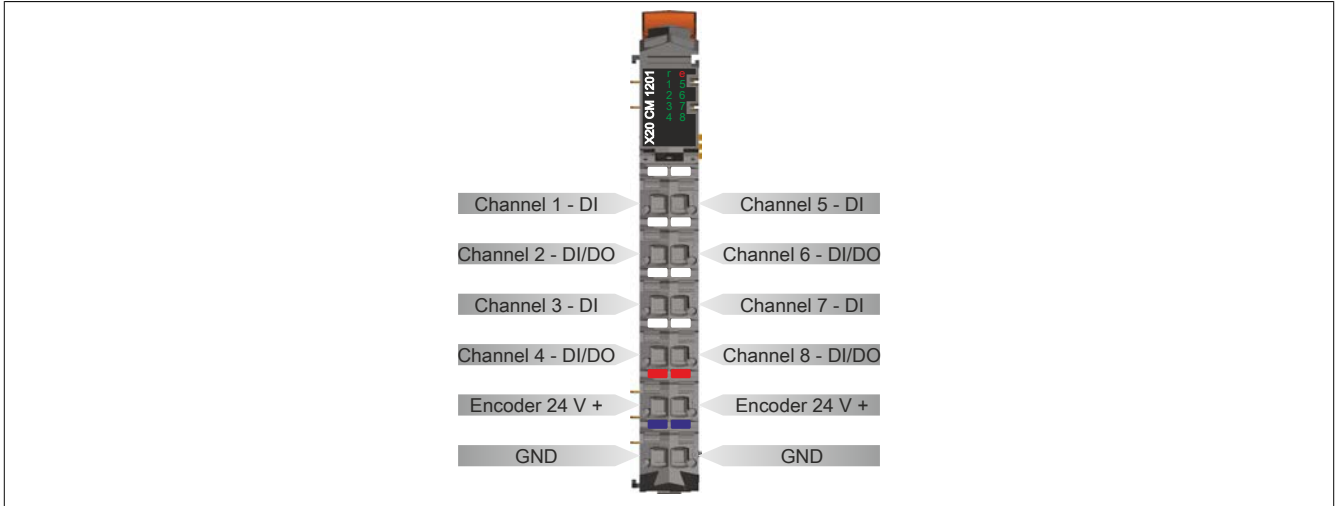
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|-------|--------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | e | Red | On | RUN mode |
| | | | Off | No power to module or everything OK |
| | 1 - 8 | Green | On | Error or reset status |
| | | | Off | Status of the corresponding digital signal |

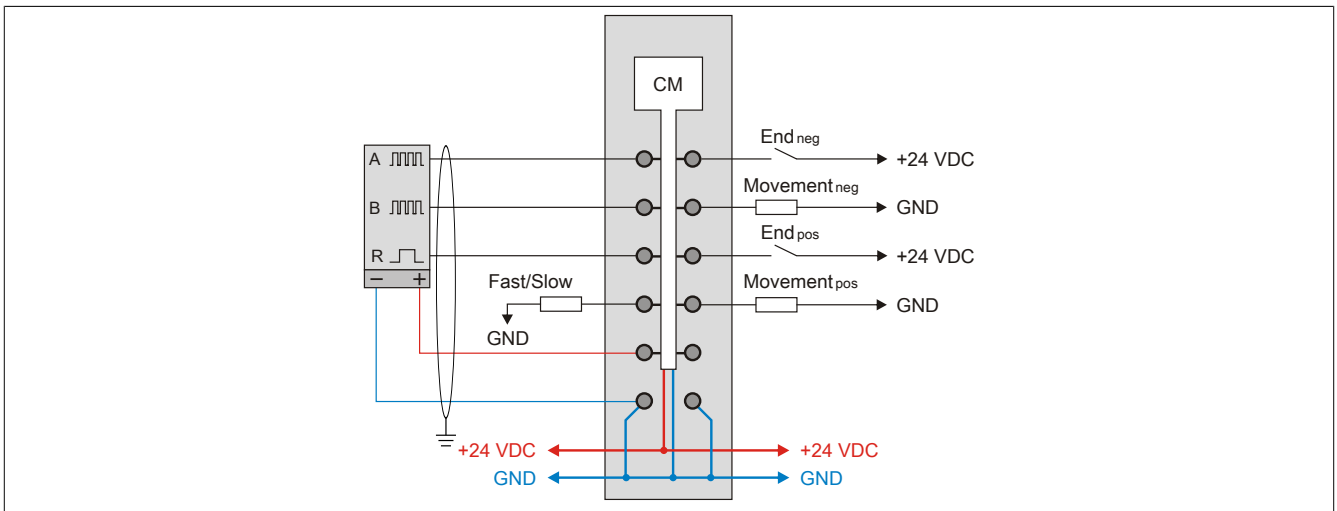
1) Depending on the configuration, a firmware update can take up to several minutes.

9.16.2.5 Pinout

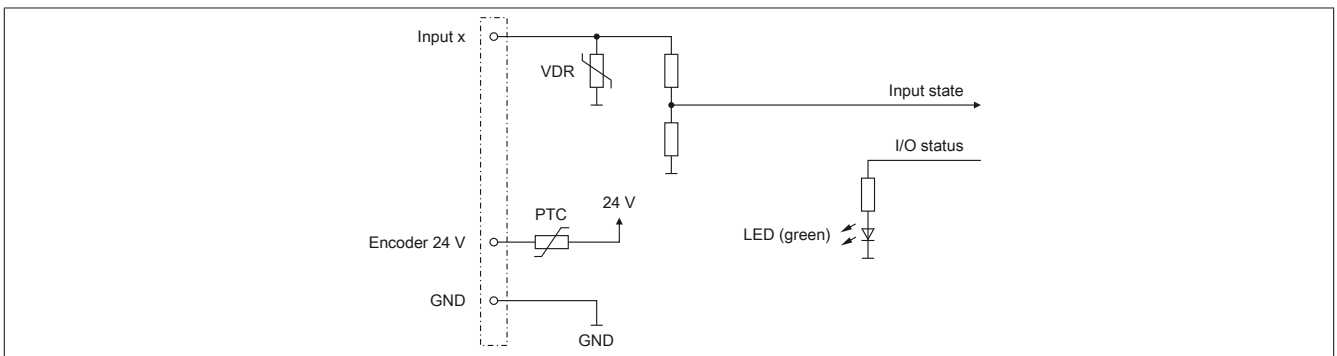
Shielded cables must be used for all signal lines.



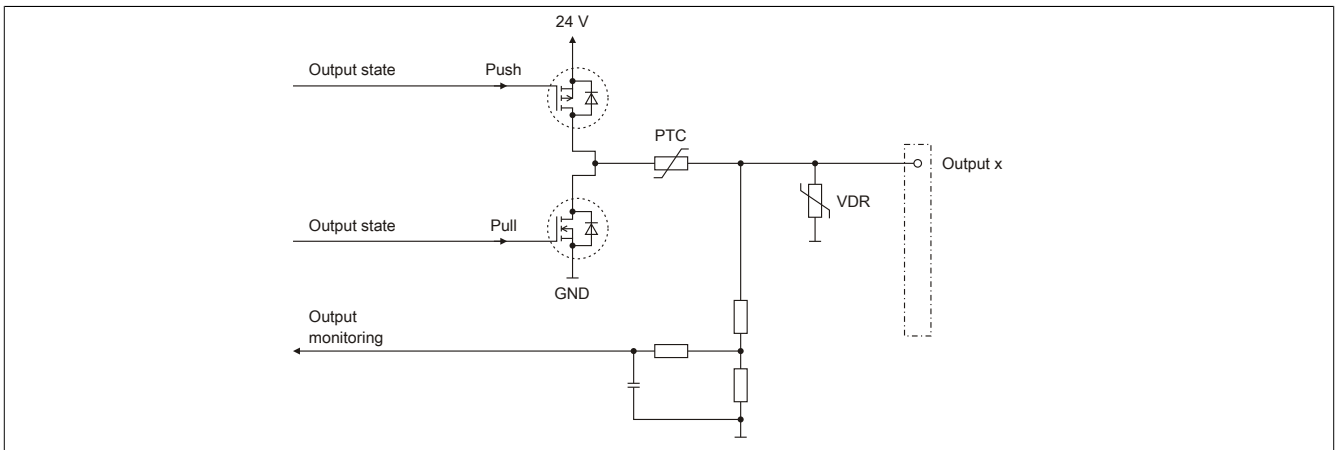
9.16.2.6 Connection example



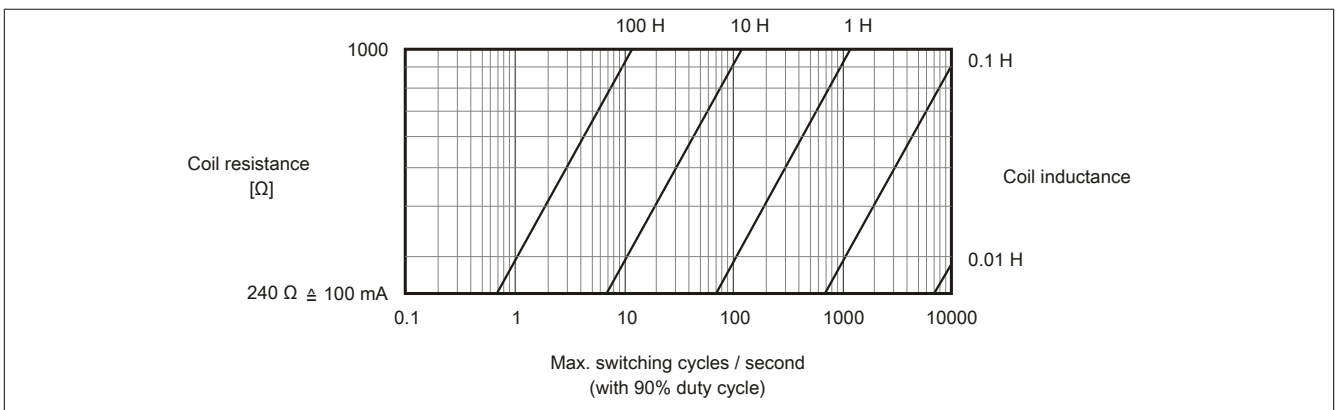
9.16.2.7 Input circuit diagram



9.16.2.8 Output circuit diagram



9.16.2.9 Switching inductive loads



9.16.2.10 Register description

9.16.2.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.16.2.10.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|--|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 130 | CycleTimeCff | | | | | • |
| Communication - Command interface | | | | | | |
| 1 | SendCommand | USINT | | | • | |
| 3 | SendCommandParam | USINT | | | • | |
| 12 | SendData | DINT | | | • | |
| 1 | ReadStatus | USINT | • | | | |
| 3 | ReadIndex | USINT | • | | | |
| 12 | ReadData | DINT | • | | | |
| Communication - Display register | | | | | | |
| 20 | ABRposition | DINT | • | | | |
| 28 | TargetARBposition | DINT | • | | | |
| 36 | ErrorInfo | UDINT | • | | | |
| 47 | Displaying the digital inputs | USINT | • | | | |
| | DigitalInput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalInput08 | Bit 7 | | | | |
| 55 | Status of encoder power supply | USINT | • | | | |
| | PowerSupply01 | Bit 0 | | | | |

9.16.2.10.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 130 | - | CycleTimeCff | | | | | • |
| Communication - Command interface | | | | | | | |
| 1 | 1 | SendCommand | USINT | | | • | |
| 3 | 0 | SendCommandParam | USINT | | | • | |
| 12 | 4 | SendData | DINT | | | • | |
| 1 | 1 | ReadStatus | USINT | • | | | |
| 3 | 0 | ReadIndex | USINT | • | | | |
| 12 | 4 | ReadData | DINT | • | | | |
| Communication - Display register | | | | | | | |
| 20 | - | ABRposition | DINT | | • | | |
| 28 | - | TargetABRposition | DINT | | • | | |
| 36 | - | ErrorInfo | UDINT | | • | | |
| 47 | - | Displaying the digital inputs | USINT | | • | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput08 | Bit 7 | | | | |
| 55 | - | Status of encoder power supply | USINT | | • | | |
| | | PowerSupply01 | Bit 0 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.16.2.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.16.2.10.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.16.2.10.4 General

This is a low-end positioning module that supports 2 speed movements in positive and negative directions. No active position check is performed. The movements are started using a command interface and stopped by the position comparator (target position) or user-defined trigger conditions (input edge/ comparison). Every movement step is time-monitored. Up to 8 movement steps can be linked to form one continuous movement.

Position, input states and timeout periods are checked during each system cycle.

9.16.2.10.4.1 Types of movement

The module supports the following types of movement:

- Negative direction - fast
- Negative direction - slow
- Stop
- Positive direction - slow
- Positive direction - fast

The initial state of each type of movement is defined by the user. In order to avoid false input levels on the motor (caused by signal runtimes), and ensure timing (e.g. during direction change), there are additional [command parameters](#) to describe a operating mode change:

- 0x93 Negative directional setup state
- 0x88 Negative directional setup time
- 0x8A Negative directional stop time
- 0x95 Positive direction setup state
- 0x89 Positive direction setup time
- 0x8B Positive direction stop time
- 0x94 Stop state

Information:

No directional stop state is defined. To allow error handling, the directional stop state must be the same as STOP. Speed changes in the same direction of movement are not evaluated as changes in the operating mode of the movement.

9.16.2.10.4.2 Movement blocks

The module supports 4 movement blocks: Each movement block contains up to 8 movement steps. Each step is comprised of the following parameters:

- Target position - relative or absolute
- Timeout or delay
- Trigger condition - edge or comparator value (signal level)
- Error information

A block's movement steps can be executed as one continuous movement. The following parameters must be configured before the movement start command is issued:

- Step activation
- Step target position interpolation - relative or absolute
- Step speed - slow or fast
- Trigger mode - off or "Comparator value = true" or "Comparator value = false"

9.16.2.10.4.3 Movement generator

When a movement start command is issued, the mode of the active movement step is calculated based on the preceding target position. Step parameters may also be changed after the start as long as the step direction is not changed. Otherwise a movement error occurs. To ensure correct directional interpretation, the movement step position/range is limited to ± 1073741824 .

The target position of a step configured with a trigger is evaluated as the end position (error position). This means the position at the time of the trigger condition becomes the effective target position. Because this position is unknown when the calculation is made by the movement generator, the set end position is used for calculating the next absolute movement step. As a result, it is recommended to proceed with a relative movement step following a triggered step. A successive absolute movement step must be outside the positioning range of the triggered step.

If a movement step is configured as a standstill, i.e. relative position = 0, or the new absolute position = previous target position, a delay has occurred. If no trigger is configured, the parameter step timeout is evaluated as a simple delay time and not as an error state.

9.16.2.10.4.4 Tolerance monitoring

The module constantly monitors the position tolerance, even when no movements are active. Jitter and overshoot tolerances must be configured for both directions. Depending on the previous movement direction, a tolerance window is calculated based on the current target position. Because the movement generator uses the last target position, movements within the tolerance window must be avoided to prevent errors from occurring.

9.16.2.10.4.5 Homing

Homing is not implemented in this module as a movement function. The target position of a completed movement can be applied as the home position via command.

9.16.2.10.4.6 Safety monitoring

Safety monitoring refers to the hardware limit switches and software limit positions.

A safe input status (masks and comparator values) for positive and negative movements must be configured. Software end positions – minimum and maximum positions – can also be configured for both directions.

The module monitors these two positions from the time the parameter 0x93 or 0x95 "Positive directional setup state" is set. Monitoring is ended when the parameter 0x94 "Stop state" is set.

Because a trigger condition aborts the movement step before a safety check, a hardware limit switch can also be used as a trigger condition without generating an error.

9.16.2.10.5 Command description

9.16.2.10.5.1 No action

This command can be used as a placeholder during development or to separate 2 identical commands.

| Code | 0x00 |
|-------------|------|
| Parameter | 0 |
| Data 0 to 3 | 0 |

9.16.2.10.5.2 Configure display mode

This command can be used to configure how the values in the "ReadIndex" on page 1892 and "ReadData" on page 1892 registers are displayed. Up to 4 display values can be displayed simultaneously. Possible selections include the command parameters 0xC0 = current position, to 0xC3 = I/O states.

| Code | 0x01 |
|-----------|--|
| Parameter | Display control: 0 Scheduler off; Data 0 used for display 1 Scheduler cycle = X2X cycle; The next display cycle starts with each X2X cycle 2 Scheduler cycle = Command cycle; The next display cycle starts with each completed command |
| Data 0 | Parameter number of display cycle 1 (Default: 0xC0 = current position) |
| ... | ... |
| Data 3 | Parameter number of display cycle 4 (Default: 0xC0 = current position) |

9.16.2.10.5.3 Enables the interface

This command activates the movement interface. The status of the interface is displayed in the "ReadStatus" on page 1891 register (bit 5). The interface is disabled following a reset. This is necessary to ensure a consistent parameter field.

| Code | 0x02 |
|-------------|------|
| Parameter | 0 |
| Data 0 to 3 | 0 |

9.16.2.10.5.4 Configure parameters

| Code | 0x03 |
|-------------|--------------------|
| Parameter | See parameter list |
| Data 0 to 3 | Parameter data |

Parameter list

| Address | Parameters | Information |
|--------------------------|------------------------|--|
| Movement blocks | | |
| 0x00 | "Motion block" | Block 1 |
| 0x20 | "Motion block" | Block 2 |
| 0x40 | "Motion block" | Block 3 |
| 0x60 | "Motion block" | Block 4 |
| Configuration | | |
| 0x80 | "Jitter tolerance" | Jitter tolerance, must be a negative value |
| 0x81 | "Jitter tolerance" | Jitter tolerance, must be a positive value |
| 0x82 | "Overshoot tolerance" | Overshoot tolerance, must be a negative value |
| 0x83 | "Overshoot tolerance" | Overshoot tolerance, must be a positive value |
| 0x84 - 0x87 | Reserved | |
| 0x88 | "Setup time" | Setup time: negative direction |
| 0x89 | "Setup time" | Setup time: positive direction |
| 0x8a | "Stop time" | Stop time: negative direction |
| 0x8b | "Stop time" | Stop time: positive direction |
| 0x8C - 0x8F | Reserved | |
| 0x90 | "Output configuration" | Output configuration |
| 0x91 | "Output states" | Output state: negative direction, high speed |
| 0x92 | "Output states" | Output state: negative direction, low speed |
| 0x93 | "Output states" | Output state: negative direction, setup |
| 0x94 | "Output states" | Output state: stop |
| 0x95 | "Output states" | Output state: positive direction, setup |
| 0x96 | "Output states" | Output state: positive direction, low speed |
| 0x97 | "Output states" | Output state: positive direction, high speed |
| 0x98 | "Safe inputs" | Safe input state: negative direction |
| 0x99 | "Safe inputs" | Safe input state: positive direction |
| 0x9A - 0x9B | Reserved | |
| 0x9C | "Safe position" | Safe minimum position: negative direction |
| 0x9D | "Safe position" | Safe maximum position: negative direction |
| 0x9E | "Safe position" | Safe minimum position: positive direction |
| 0x9F | "Safe position" | Safe maximum position: positive direction |
| 0xA0 - 0xBF | Reserved | |
| Status indicators | | |
| 0xC0 | Current position | See register "ABRPosition" on page 1892. |
| 0xC1 | Target position | See register "TargetABRposition" on page 1892. |
| 0xC2 | Error information | See register "ErrorInfo" on page 1893. |
| 0xC3 | I/O states | See register "DigitalInput0x" on page 1893. |
| 0xC4 - 0xFF | Reserved | |

Motion block

Parameter addresses: 0x00 to 0x7F

Each motion block contains 8 steps with 4 parameters each.

Calculating step addresses

Step address = Motion block address + Step address offset

| Step address offset Offset = (Step - 1) * 4 | Step number |
|--|-------------|
| + 0x0 | Step 1 |
| + 0x4 | Step 2 |
| ... | ... |
| + 0x18 | Step 7 |
| + 0x1B | Step 8 |

4 parameters per step

| Parameter address | Parameters |
|-------------------|--|
| Step address + 0 | "Position" (relative or absolute) |
| Step address + 1 | "Timeout or delay" |
| Step address + 2 | "Trigger condition" (edge or comparator value) |
| Step address + 3 | "Error information" (read-only) |

Example

Calculating the trigger parameter in the 5th step of the 3rd motion block.

Parameter address: 0x40 (motion block 3) + 0x10 (offset of step 5) + 0x02 (offset of parameter address) = 0x52

Position

This parameter specifies a position in steps.

| Data type | Value | Information |
|-----------|---------------------------|--|
| DINT | -1073741824 to 1073741823 | For a description of this, see "Movement generator" on page 1882 . |

Timeout or delay

This parameter sets the time within which a specified position must be reached. A corresponding error is output in the event of a timeout. In the stop state, this parameter specifies the duration of the stop state.

| Data type | Value | Information |
|-----------|--------------------|------------------------------|
| DINT | 0 to 2,147,483,647 | Default: 50, time in μ s |

Trigger condition

Depending on bits 2 and 3 in the data structure of each motion block (see ["Start a movement block" on page 1888](#)), either the "Edge" or "Comparator value" structure is selected as the trigger condition.

Edge

| Bit | Description | Value | Information |
|---------|---------------------------|-------|-------------|
| 0 | Falling edge - channel 01 | 0 | Disabled |
| | | 1 | Enabled |
| ... | ... | ... | ... |
| 7 | Falling edge - channel 08 | 0 | Disabled |
| | | 1 | Enabled |
| 8 - 15 | Reserved | 0 | |
| 16 | Rising edge - channel 01 | 0 | Disabled |
| | | 1 | Enabled |
| ... | ... | ... | ... |
| 23 | Rising edge - channel 08 | 0 | Disabled |
| | | 1 | Enabled |
| 24 - 31 | Reserved | 0 | |

Comparator value

| Bit | Description | Value | Information |
|---------|--------------------------------|--------|-------------|
| 0 | Enable mask - channel 01 | 0 | Disabled |
| | | 1 | Enabled |
| ... | ... | ... | ... |
| 7 | Enable mask - channel 08 | 0 | Disabled |
| | | 1 | Enabled |
| 8 - 15 | Reserved | 0 | |
| 15 | Comparative state - channel 01 | 0 or 1 | |
| ... | ... | ... | ... |
| 23 | Comparative state - channel 08 | 0 or 1 | |
| 24 - 31 | Reserved | 0 | |

Error information

This parameter contains the read back display value. For a description of the error information, see register "ErrorInfo" on page 1893.

The parameter for the display command is 0.

Jitter tolerance

Parameter addresses: 0x80 to 0x81

This parameter determines the jitter range of the encoder.

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

Overshoot tolerance

Parameter addresses: 0x82 to 0x83

This parameter specifies the permitted tolerance range between the planned stop position and the stop position that can actually be reached in practice.

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

Setup time

Parameter addresses: 0x0x88 to 0x89

This parameter determines the length of the setup state between the stop time and the next positive or negative motion step.

| Data type | Value | Information |
|-----------|--------------------|------------------------------|
| DINT | 0 to 2,147,483,647 | Default: 50, time in μ s |

Stop time

Parameter addresses: 0x8A to 0x8B

This parameter defines the time of the stop state between 2 active motion steps.

| Data type | Value | Information |
|-----------|--------------------|------------------------------|
| DINT | 0 to 2,147,483,647 | Default: 50, time in μ s |

Output configuration

Parameter address: 0x90

This parameter defines the configuration of the digital outputs.

| Bit | Description | Value | Information |
|---------|--------------------------|-------|-------------|
| 0 - 1 | Reserved | 0 | |
| 2 | Push driver - channel 02 | 0 | Disabled |
| | | 1 | Enabled |
| 3 | Pull driver - channel 02 | 0 | Disabled |
| | | 1 | Enabled |
| 4 - 5 | Reserved | 0 | |
| 6 | Push driver - channel 04 | 0 | Disabled |
| | | 1 | Enabled |
| 7 | Pull driver - channel 04 | 0 | Disabled |
| | | 1 | Enabled |
| 8 - 9 | Reserved | 0 | |
| 10 | Push driver - channel 06 | 0 | Disabled |
| | | 1 | Enabled |
| 11 | Pull driver - channel 06 | 0 | Disabled |
| | | 1 | Enabled |
| 12 - 13 | Reserved | 0 | |
| 14 | Push driver - channel 08 | 0 | Disabled |
| | | 1 | Enabled |
| 15 | Pull driver - channel 08 | 0 | Disabled |
| | | 1 | Enabled |
| 16 - 31 | Reserved | 0 | |

Output states

Parameter addresses: 0x91 to 0x97

The output states of channels can be configured individually for each motion state (see "Types of movement" on page 1881).

| Bit | Description | Value | Information |
|---------|-------------|-------|---------------|
| 0 | Reserved | 0 | |
| 1 | Channel 02 | 0 | No action |
| | | 1 | Clear channel |
| 2 | Reserved | 0 | |
| 3 | Channel 04 | 0 | No action |
| | | 1 | Clear channel |
| 4 | Reserved | 0 | |
| 5 | Channel 06 | 0 | No action |
| | | 1 | Clear channel |
| 6 | Reserved | 0 | |
| 7 | Channel 08 | 0 | No action |
| | | 1 | Clear channel |
| 8 - 16 | Reserved | 0 | |
| 17 | Channel 02 | 0 | No action |
| | | 1 | Set channel |
| 18 | Reserved | 0 | |
| 19 | Channel 04 | 0 | No action |
| | | 1 | Set channel |
| 20 | Reserved | 0 | |
| 21 | Channel 06 | 0 | No action |
| | | 1 | Set channel |
| 22 | Reserved | 0 | |
| 23 | Channel 08 | 0 | No action |
| | | 1 | Set channel |
| 24 - 31 | Reserved | 0 | |

Safe inputs

Parameter addresses: 0x98 to 0x99

This parameter enables the hardware limit switches according to their channel assignment and defines their logical state for starting a movement. The comparative state specifies the logical level on the input at which a motion is permitted or can be started.

| Bit | Description | Value | Information |
|---------|--------------------------------|--------|-------------|
| 0 | Enable mask - channel 01 | 0 | Disabled |
| | | 1 | Enabled |
| ... | | ... | |
| 7 | Enable mask - channel 08 | 0 | Disabled |
| | | 1 | Enabled |
| 8 - 15 | Reserved | 0 | |
| 15 | Comparative state - channel 01 | 0 or 1 | |
| ... | | | |
| 23 | Comparative state - channel 08 | 0 or 1 | |
| 24 - 31 | Reserved | 0 | |

Safe position

Parameter addresses: 0x9C to 0x9F

These parameters define the minimum and maximum software limit positions of the path to be moved.

| Data type | Value |
|-----------|---------------------------|
| DINT | -1073741824 to 1073741824 |

9.16.2.10.5.5 Configure counters

This command can be used to assign the hardware channels to the AB counter. With an ABR counter, the R input can be connected to any hardware channel as the trigger signal.

| Code | 0x04 |
|-------------|-------------------------|
| Parameter | See parameter structure |
| Data 0 | See data structure |
| Data 1 to 3 | 0 |

Parameter structure:

| Bit | Description | Value | Information |
|-------|-------------------------|-------|---------------------------------------|
| 0 - 1 | Counter connection pair | 00 | Pair 1 (A: channel 01, B: channel 02) |
| | | 01 | Pair 2 (A: channel 03, B: channel 04) |
| | | 10 | Pair 3 (A: channel 05, B: channel 06) |
| | | 11 | Pair 4 (A: channel 07, B: channel 08) |
| 2 - 7 | Reserved | 0 | |

Data structure:

| Bit | Description | Value | Information |
|-------|--------------------|-------|--|
| 0 - 1 | Counter mode | 00 | AB encoder |
| | | 01 | Up/down counter (A: timing, B: up/down signal) |
| | | 10 | Edge counter - channel A |
| | | 11 | Edge counter - channel B |
| 2 | Counting direction | 0 | Positive |
| | | 1 | Negative |
| 3 - 7 | Reserved | 0 | |

9.16.2.10.5.6 Homing

Assumes the target position of the last successful movement step as a reference position.

| Code | 0x05 |
|-------------|---------------|
| Parameter | 0 |
| Data 0 to 3 | Home position |

9.16.2.10.5.7 Stops the movement.

The movement step in progress is stopped. This command always results in a movement error.

| Code | 0x06 |
|-------------|------|
| Parameter | 0 |
| Data 0 to 3 | 0 |

9.16.2.10.5.8 Acknowledge movement error

The movement error is cleared. If this command is executed when the error is still present, the current position is assumed as the target position. The basis of the relative position becomes unclear.

| Code | 0x07 |
|-------------|------|
| Parameter | 0 |
| Data 0 to 3 | 0 |

9.16.2.10.5.9 Start a movement block

This command starts a movement block consisting of up to 8 steps.

| | |
|-------------|--|
| Code | 0x08 (Block 1) 0x09 (Block 2) 0x0A (Block 3) 0x0B (Block 4) |
| Parameter | See parameter structure |
| Data 0 to 3 | See data structure |

Parameter structure:

| Bit | Description | Value | Information |
|-----|-------------|-------|------------------------|
| 0 | Step 1 | 0 | No movement. |
| | | 1 | Perform movement step. |
| ... | | ... | |
| 7 | Step 8 | 0 | No movement. |
| | | 1 | Perform movement step. |

Data structure:

| Bit | Description | Value | Information |
|---------|--------------------------|-------|---------------------------|
| 0 | Step 1 position setting: | 0 | Relative |
| | | 1 | Absolute |
| 1 | Step 1 speed: | 0 | Slow |
| | | 1 | Fast |
| 2 - 3 | Step 1 trigger mode: | 00 | No trigger |
| | | 01 | Edge trigger |
| | | 10 | Comparator value "true" |
| | | 11 | Comparator value "false" |
| 4 - 7 | Step 2 | x | Like step 1 / Bits 0 to 2 |
| ... | | | |
| 28 - 31 | Step 8 | x | Like step 1 / Bits 0 to 2 |

9.16.2.10.5.10 Selecting error information

At the end of each movement step, the command parameter "Addr + 3" (see ["Motion blocks - Calculating the address" on page 1883](#)) can be used to read the error information selected in this register. This error information is displayed in registers ["ReadIndex" on page 1892](#) and ["ReadData" on page 1892](#).

| | |
|-------------|---|
| Code | 0x00 |
| Parameter | 0 Error information (default) 1 Timestamp 2 Current position 3 Target position |
| Data 0 to 3 | 0 |

9.16.2.10.6 Command interface

A command interface is available to the user. A command consists of:

- "Command" on page 1890 (in the command description: code)
- "Command parameter" on page 1890 (in the command description: parameters)
- "Command data" on page 1891 (in the command description: Data 0 to 3)

The following commands can be executed:

- "No action" on page 1882
- "Configure display mode" on page 1882
- "Enable the interface" on page 1883
- "Configure parameters" on page 1883
- "Configure counters" on page 1887
- "Perform homing" on page 1887
- "Stop the movement" on page 1887
- "Acknowledge movement error" on page 1887
- "Start a movement block" on page 1888
- "Select debug information" on page 1888

The module returns:

- "System status" on page 1891
- "Display parameter number" on page 1892
- "Display data content" on page 1892

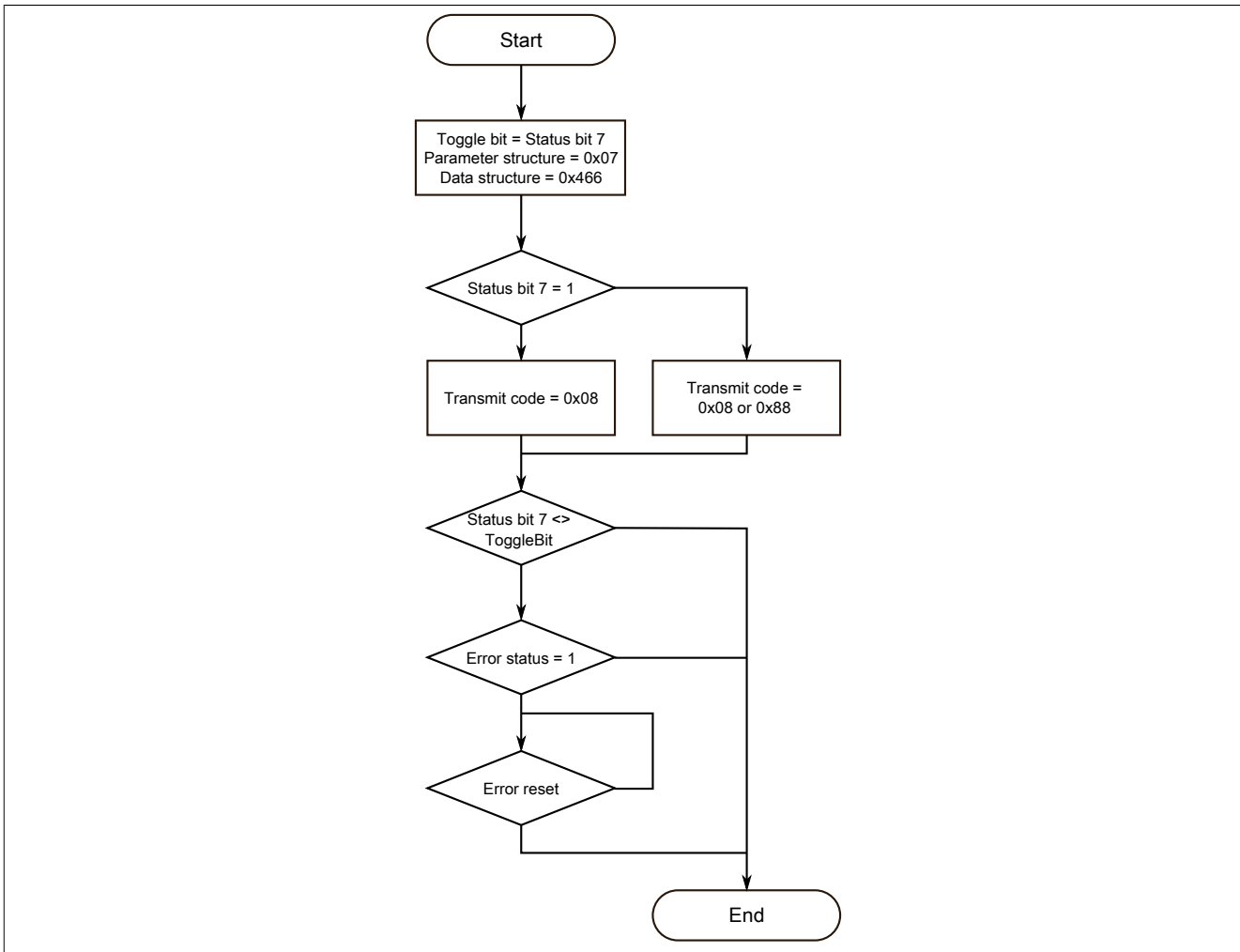
The module detects a new command through a change in the command register. The toggle bit must be changed in order to detect when the command issued in the "ReadStatus" on page 1891 register is applied. Identical commands can be executed immediately following one another simply by changing the toggle bit.

9.16.2.10.6.1 Execution of a command

Commands must be sent by the application using the command interface. Due to the simple structure of the command interface, it is also possible to send them via CAN.

All commands are executed as follows:

- 1) Write command parameters (register "SendCommandParam" on page 1890) and command data (register "SendData" on page 1891).
- 2) Write command with changed toggle bit.
When bit 7 in the command register (register "SendCommand" on page 1890) is toggled, the module executes the command with the command parameter and command data.
- 3) Wait until bit 7 in the response register (register "ReadStatus" on page 1891) matches bit 7 in the command register.
- 4) Read additional status information from the response register if necessary.
- 5) If additional commands should be sent, proceed with step 1.



9.16.2.10.6.2 Send command

Name:
SendCommand

The commands described under "Command description" on page 1882 can be sent from this register. Bit 7 must be toggled to apply the commands.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------------------------------|-------|-------------|
| 0 - 6 | Command code | x | |
| 7 | Toggle bit for applying a new command | x | |

9.16.2.10.6.3 Send command parameters

Name:
SendCommandParam

Specific parameters for the command to be sent must be entered in this register. The required parameters are listed under "Command description" on page 1882 for the respective commands.

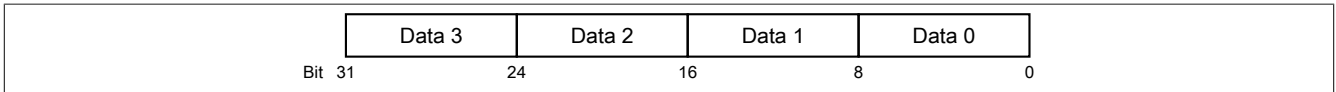
| Data type | Value | Information |
|-----------|-------|-------------------|
| USINT | x | Command parameter |

9.16.2.10.6.4 Send command data

Name:
SendData

Specific parameters for the command to be sent must be entered in this register. The required data is listed under "Command description" on page 1882 for the respective commands.

Data 0 to 3 are sent as a single DINT value. The following structure is used:



| Data type | Value | Information |
|-----------|-------|---------------------|
| DINT | x | Command data 0 to 3 |

9.16.2.10.6.5 Read status

Name:
ReadStatus

The commands and the current status can be checked in this register. Bit 7 can be used to check whether an issued command has been applied.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------|-------|---------------------|
| 0 - 1 | Reserved | 0 | |
| 2 | Position | 0 | Not yet reached |
| | | 1 | Reached |
| 3 | Motion | 0 | In motion |
| | | 1 | completed |
| 4 | Numerator | 0 | Not yet configured |
| | | 1 | Configured |
| 5 | Interface | 0 | Not enabled |
| | | 1 | Enabled |
| 6 | Command | 0 | No error |
| | | 1 | Error occurred |
| 7 | Command toggle bit | x | Value that was read |

9.16.2.10.6.6 Read parameter number

Name:

ReadIndex

This register displays the parameter number returned in response to a display command. See ["Configure display mode" on page 1882](#) and ["Selecting error information" on page 1888](#).

| Data type | Value | Information |
|-----------|-------|-------------------|
| USINT | x | Parameter numbers |

9.16.2.10.6.7 Read parameter data

Name:

ReadData

This register displays the parameter data returned in response to a display command. See ["Configure display mode" on page 1882](#) and ["Selecting error information" on page 1888](#).

| Data type | Value | Information |
|-----------|-------|----------------|
| DINT | x | Parameter data |

9.16.2.10.6.8 Special display parameters

The following 4 registers correspond to display parameters 0xC0 to 0xC3 in the command description ["Configure parameters" on page 1883](#). This frees up the ["ReadData" on page 1892](#) register for other data.

Indicates the current position.

Name:

ABRPosition

This register shows the current position in the current step. It corresponds with the parameter 0xC0 in ["Configure parameters" on page 1883](#).

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

Indicates the current target position

Name:

TargetABRposition

This register shows the target position of the current step. It corresponds with the parameter 0xC1 in ["Configure parameters" on page 1883](#).

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

Displays the error information

Name:

ErrorInfo

This register displays error information. It corresponds with the parameter 0xC2 in "Configure parameters" on page 1883.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|--|------------|--|
| 0 | Tolerance error - negative | 0 | No error |
| | | 1 | Error occurred |
| 1 | Tolerance error - positive | 0 | No error |
| | | 1 | Error occurred |
| 2 | Timeout | 0 | No timeout |
| | | 1 | Timeout |
| 3 - 7 | Reserved | 0 | |
| 8 | Safety monitoring error - Inputs (hardware limit switch) | 0 | No error |
| | | 1 | Error occurred |
| 9 | Safety monitoring error - Position (software limit position) | 0 | No error |
| | | 1 | Error occurred |
| 10 - 15 | Reserved | 0 | |
| 16 - 18 | Error status information | 000 | Reserved |
| | | 001 | Negative directional stop state |
| | | 010 | Negative movement |
| | | 011 | Negative directional setup state |
| | | 100 | Stop state |
| | | 101 | Positive directional setup state |
| | | 110 | Positive movement |
| | | 111 | Positive directional stop state |
| 19 | Reserved | 0 | |
| 20 - 24 | Invalid step number | 000 to 111 | Number of the step that does not contain any movement information. |
| | | 1000 | Inactive motion step (tolerance check) |
| 25 - 31 | Reserved | 0 | |

Displaying the digital inputs

Name:

DigitalInput01 to DigitalInput08

This register displays the status of the digital inputs or read back outputs. It corresponds with the parameter 0xC3 in "Configure parameters" on page 1883.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|----------------|--------|--------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input status - channel 1 |
| ... | | ... | |
| 7 | DigitalInput08 | 0 or 1 | Input status - channel 8 |

9.16.2.10.7 Sample configurations

9.16.2.10.7.1 Movement example

The channels have been set as follows for this example:

| Hardware channel | Direction | Function assignment |
|------------------|-----------|------------------------|
| 1 | Input | ABR encoder - signal A |
| 2 | Input | ABR encoder - signal B |
| 3 | Input | ABR encoder - signal R |
| 4 | Output | Fast speed |
| 5 | Input | Negative limit switch |
| 6 | Output | Negative direction |
| 7 | Input | Positive limit switch |
| 8 | Output | Positive direction |

Enable interface

| | Value | Description |
|-------------|-------|-------------|
| Code | 0x02 | |
| Parameter | 0 | |
| Data 0 to 3 | 0 | |

Configure parameters

| | Value | Description |
|-------------|-------------------|-------------|
| Code | 0x03 | |
| Parameter | Parameter numbers | |
| Data 0 to 3 | Parameter data | |

The following parameters must be configured:

| Code | Parameter | Data | Description |
|------|-----------|------------|---|
| 0x03 | 0x80 | APPL | Negative jitter tolerance [μs] (application-specific) |
| 0x03 | 0x81 | APPL | Positive jitter tolerance [μs] (application-specific) |
| 0x03 | 0x82 | APPL | Negative overshoot tolerance [μs] (application-specific) |
| 0x03 | 0x83 | APPL | Positive overshoot tolerance [μs] (application-specific) |
| 0x03 | 0x88 | APPL | Negative setup time [μs] (application-specific) |
| 0x03 | 0x89 | APPL | Positive setup time [μs] (application-specific) |
| 0x03 | 0x8A | APPL | Negative stop time [μs] (application-specific) |
| 0x03 | 0x8B | APPL | Positive stop time [μs] (application-specific) |
| 0x03 | 0x90 | 0x0000CCC0 | Output configuration: Channel 04, channel 06, channel 08 as push/pull outputs |
| 0x03 | 0x91 | 0x00280080 | Output states - fast negative movement: Set channels 04 and 06, clear channel 08 |
| 0x03 | 0x92 | 0x00200088 | Output states - slow negative movement: Set channel 06, clear channels 04 and 08 |
| 0x03 | 0x93 | 0x000000A8 | Output states - negative setup: Clear channels 04, 06 and 08 |
| 0x03 | 0x94 | 0x000000A8 | Output states - stop: Clear channels 04, 06 and 08 |
| 0x03 | 0x95 | 0x000000A8 | Output states - positive setup: Clear channels 04, 06 and 08 |
| 0x03 | 0x96 | 0x00800028 | Output states - slow positive movement: Set channel 08, clear channels 04 and 06 |
| 0x03 | 0x97 | 0x00880020 | Output states - fast positive movement: Set channels 04 and 08, clear channel 06 |
| 0x03 | 0x98 | 0x00000014 | Safe input state - negative: Channel 03 active, status of channel 03 (level) = 0, Channel 05 active, status of channel 05 (level) = 0 |
| 0x03 | 0x99 | 0x00000044 | Safe input state - positive: Channel 03 active, status of channel 03 (level) = 0, Channel 07 active, status of channel 07 (level) = 0 |

Configure counters

| | Value | Description |
|-------------|-------|--------------------------------|
| Code | 0x04 | |
| Parameter | 0x00 | Counter pair 1 |
| Data 0 | 0 | AB encoder, positive direction |
| Data 1 to 3 | 0 | |

9.16.2.10.7.2 Homing example

Configure parameters

| | Value |
|-------------|-------------------|
| Code | 0x03 |
| Parameter | Parameter numbers |
| Data 0 to 3 | Parameter data |

The following parameters must be configured:

| Code | Parameter | Data | Description |
|---------------|-----------|------------|--|
| Step 1 | | | |
| 0x03 | 0x00 | 0x3FFFFFFF | Position positive (relative) |
| 0x03 | 0x01 | 0x01C9C380 | Timeout (30 s) |
| 0x03 | 0x02 | 0x00400000 | Trigger condition (edge of channel 07 = 1) |
| Step 2 | | | |
| 0x03 | 0x04 | 0xC0000001 | Position negative (relative) |
| 0x03 | 0x05 | 0x01C9C380 | Timeout (30 s) |
| 0x03 | 0x06 | 0x00100000 | Trigger condition (edge of channel 05 = 1) |
| Step 3 | | | |
| 0x03 | 0x08 | 0x3FFFFFFF | Position positive (relative) |
| 0x03 | 0x09 | 0x01C9C380 | Timeout (30 s) |
| 0x03 | 0x0A | 0x00040000 | Trigger condition (edge of channel 03 = 1) |

Start movement

| | Value | Description |
|-------------|------------|---|
| Code | 0x08 | Block 1 |
| Parameter | 0x07 | Activate steps 1 to 3 |
| Data 0 to 3 | 0x00000466 | Step 1: Relative, fast, trigger on edge of channel 07 Step 2: Relative, fast, trigger on edge of channel 05 Step 3: Relative, slow, trigger on edge of channel 03 |

Wait until the movement is complete.

Homing

| | Value | Description |
|-------------|-------|---------------|
| Code | 0x05 | |
| Parameter | 0 | |
| Data 0 to 3 | x | Home position |

9.16.2.10.7.3 Standard positioning example

Configure parameters

| | Value |
|-------------|-------------------|
| Code | 0x03 |
| Parameter | Parameter numbers |
| Data 0 to 3 | Parameter data |

The following parameters must be configured:

| Code | Parameter | Data | Description |
|------|-----------|------|-------------------|
| 0x03 | 0x00 | X1 | Pre-stop position |
| 0x03 | 0x04 | X2 | Stop position |

Start movement

| | Value | Description |
|-------------|------------|--|
| Code | 0x08 | Block 1 |
| Parameter | 0x03 | Activate steps 1 and 2 |
| Data 0 to 3 | 0x00000011 | Step 1: absolute, slow, trigger off Step 2: absolute, slow, trigger off |

9.16.2.10.7.4 Standard positioning example with stop

Configure parameters

| | Value |
|-------------|-------------------|
| Code | 0x03 |
| Parameter | Parameter numbers |
| Data 0 to 3 | Parameter data |

The following parameters must be configured:

| Code | Parameter | Data | Description |
|------|-----------|--------|-----------------------|
| 0x03 | 0x00 | X1 | Pre-stop position |
| 0x03 | 0x04 | X2 | Stop position |
| 0x03 | 0x08 | 0 | Relative movement |
| 0x03 | 0x09 | T_STOP | Stop delay [μ s] |

Start movement

| Code | Value | Description |
|-------------|------------|---|
| Code | 0x08 | Block 1 |
| Parameter | 0x07 | Activate steps 1 to 3 |
| Data 0 to 3 | 0x00000011 | Step 1: absolute, slow, trigger off Step 2: absolute, slow, trigger off Step 3: relative, trigger off |

9.16.2.10.7.5 Example code for a basic configuration

```
(*****
* Data object file: X20CM1201
*****
; +-- Code
; |     +-- Parameter
; |     |     +-- Data
; |     |     |     +-- Description
; |     |     |     |
$0002, $0000, 00000000 ; Enable interface

;-----
;CONFIGURATION
;-----
;Movement tolerances
$0003, $0080, -00000100 ; Negative jitter tolerance [steps]
$0003, $0081, 00000100 ; Positive jitter tolerance [steps]
$0003, $0082, -00000100 ; Negative overshoot tolerance [steps]
$0003, $0083, 00000100 ; Positive overshoot tolerance [steps]

;Time for safe operating mode change
$0003, $0088, 01000000 ; Setup time for negative direction [ $\mu$ s]
$0003, $0089, 01000000 ; Setup time for positive direction [ $\mu$ s]
$0003, $008A, 01000000 ; Stop time for negative direction [ $\mu$ s]
$0003, $008B, 01000000 ; Stop time for positive direction [ $\mu$ s]

;Digital outputs
$0003, $0090, $0000CCC0 ; Channel04, Channel06, Channel08 as push/pull outputs

;Output states
$0003, $0091, $00280080 ; Negative movement, fast: Set Channel04 and 06, clear Channel08
$0003, $0092, $00200088 ; Negative movement, slow: Set Channel06, clear Channel04 and 08
$0003, $0093, $000000A8 ; Negative setup: Clear Channel04, Channel06 and Channel08
$0003, $0094, $000000A8 ; Stop: Clear Channel04, Channel06 and Channel08
$0003, $0095, $000000A8 ; Positive setup: Clear Channel04, Channel06 and Channel08
$0003, $0096, $00800028 ; Positive movement, slow: Set Channel08, clear Channel04 and 06
$0003, $0097, $00880020 ; Positive movement, fast: Set Channel04 and 08, clear Channel06

;Safe input states, Channel03 = (R)Trigger, Channel05 and Channel07 = Hardware limit switches
$0003, $0098, $00000014 ; Safe input state, negative:
; Channel03 active, Channel03 state (level) = 0,
; Channel05 active, Channel05 state (level) = 0
$0003, $0099, $00000044 ; Safe input state, positive:
; Channel03 active state Channel03 (level) = 0,
; Channel07 active, Channel07 state (level) = 0

;Software limit position
$0003, $009C, $C0000001 ; Safe minimum position in the negative direction (-1073741824)
```

```

$0003, $009D, $3FFFFFFF ; Safe maximum position in the negative direction (1073741823)
$0003, $009E, $C0000001 ; Safe minimum position in the positive direction (-1073741824)
$0003, $009F, $3FFFFFFF ; Safe maximum position in the positive direction (1073741823)

;Counter
$0004, $0000, $00000000 ; (Channel01 = A / Channel02 = B)
; (Function = AB encoder, positive direction of rotation)

;Display mode
$0001, $0001, $C3C2C1C0 ; I/O states, error information, target position, current position

;-----
;BLOCK and STEP sequence example
;-----
;Motion block 1 0x08 (homing with (R)Trigger)
;Step 1
$0003, $0000, $3FFFFFFF ; Position positive (relative)
$0003, $0001, $01C9C380 ; Timeout (30 s)
$0003, $0002, $00400000 ; Trigger condition (edge of Channel07 == 1)
;$0003, $0003, $00000000 ; Debug information (read-only)

;Step 2
$0003, $0004, $C0000001 ; Position negative (relative)
$0003, $0005, $01C9C380 ; Timeout (30 s)
$0003, $0006, $00100000 ; Trigger condition (edge of Channel05 == 1)
;$0003, $0007, $00000000 ; Debug information (read only)

;Step 3
$0003, $0008, $3FFFFFFF ; Position positive (relative)
$0003, $0009, $01C9C380 ; Timeout (30 s)
$0003, $000A, $00040000 ; Trigger condition (edge of Channel03 == 1)
;$0003, $000B, $00000000 ; Debug information (read-only)

;Motion block 2 0x09
;Step 1
$0003, $0020, $00000000
$0003, $0021, $00000000
$0003, $0022, $00000000
$0003, $0023, $00000000

;Step 2
$0003, $0024, $00000000
$0003, $0026, $00000000

;Motion block 3 0x0A
;Step 1
$0003, $0040, $00000000
$0003, $0041, $00000000
$0003, $0042, $00000000
$0003, $0043, $00000000

;Step 2
$0003, $0044, $00000000
$0003, $0046, $00000000

;Motion block 4 0x0B
;Step 1
$0003, $0060, $00000000
$0003, $0061, $00000000
$0003, $0062, $00000000
$0003, $0063, $00000000

;Step 2
$0003, $0064, $00000000
$0003, $0066, $00000000

$0000, $0000, $00000000 ; No action

```

9.16.2.10.8 General module register**9.16.2.10.8.1 Configures the system cycle time**

Name:

CycleTimeCff

This register configures the module's system cycle time.

| Data type | Value | Information |
|-----------|-----------|--|
| UINT | 25 to 255 | System cycle time in μs . Bus controller default setting: 50 μs |

9.16.2.10.8.2 Status of encoder power supply

Name:

PowerSupply01

This register indicates the state of the integrated encoder power supply. A faulty encoder power supply is output as a warning.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|------------------------------------|
| 0 | PowerSupply01 | 0 | 24 VDC encoder power supply OK |
| | | 1 | 24 VDC encoder power supply faulty |
| 1 - 7 | Reserved | - | |

9.16.2.10.9 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 100 μs |

9.16.2.10.10 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μs |

9.16.3 X20DC1073

Data sheet version: 1.40

9.16.3.1 General information

The module is equipped with a SinCos encoder interface. The input signals are monitored. This makes it possible to detect open or shorted lines as well as encoder supply failures.

- SinCos encoder interface
- Encoder input monitoring
- 5 VDC and GND for encoder supply
- NetTime timestamp: Position time
- Can be used with a SafeLOGIC controller

SinCos encoders

SinCos encoders with 1 V_{ss} are mostly used in linear drives and systems with high-resolution optical or magnetic position measurement systems. The module can process input signals with a frequency of up to 400 kHz.

NetTime timestamp for the position

It is not just the position value that is important for highly dynamic positioning tasks, but also the exact time the position is measured. The module is equipped with a NetTime function for this that supplies a timestamp for the recorded position with microsecond accuracy.

The timestamp function is based on synchronized timers. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

9.16.3.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Digital signal processing and preparation |  |
| X20DC1073 | X20 digital counter module, 1x SinCos, 1 V _{ss} , 400 kHz input frequency, encoder monitoring, NetTime function | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 360: X20DC1073 - Order data

9.16.3.3 Technical data

| | |
|--|---|
| Model number | X20DC1073 |
| Short description | |
| I/O module | 1x SinCos input |
| General information | |
| B&R ID code | 0xAEC6 |
| Status indicators | Counting direction, operating status, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Counting direction | Yes, using status LED |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.3 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Type of signal lines | Shielded cables must be used for all signal lines |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| Encoder inputs | |
| Type | SinCos |
| Angular position resolution | 13-bit, with a 1 V _{SS} signal |
| Encoder monitoring | Yes |
| Max. encoder cable length | Max. 20 m, see "Calculation of the maximum encoder cable length" |
| Sine/Cosine inputs | |
| Signal transmission | Differential signals, symmetrical |
| Signal frequency | DC up to 400 kHz |
| Differential voltage | 1 V _{SS} |
| Common-mode voltage | Max. ±10 V |
| Terminating resistor | 120 Ω |
| Encoder power supply | |
| Output voltage | 5 V |
| Min. output voltage at 300 mA | 4.86 V |
| Load capacity | 300 mA |
| Protective measures | |
| Overload-proof | Yes |
| Short-circuit proof | Yes |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating" |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |


Table 361: X20DC1073 - Technical data

| Model number | X20DC1073 |
|-----------------------|--|
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm |

Table 361: X20DC1073 - Technical data

9.16.3.4 LED status indicators

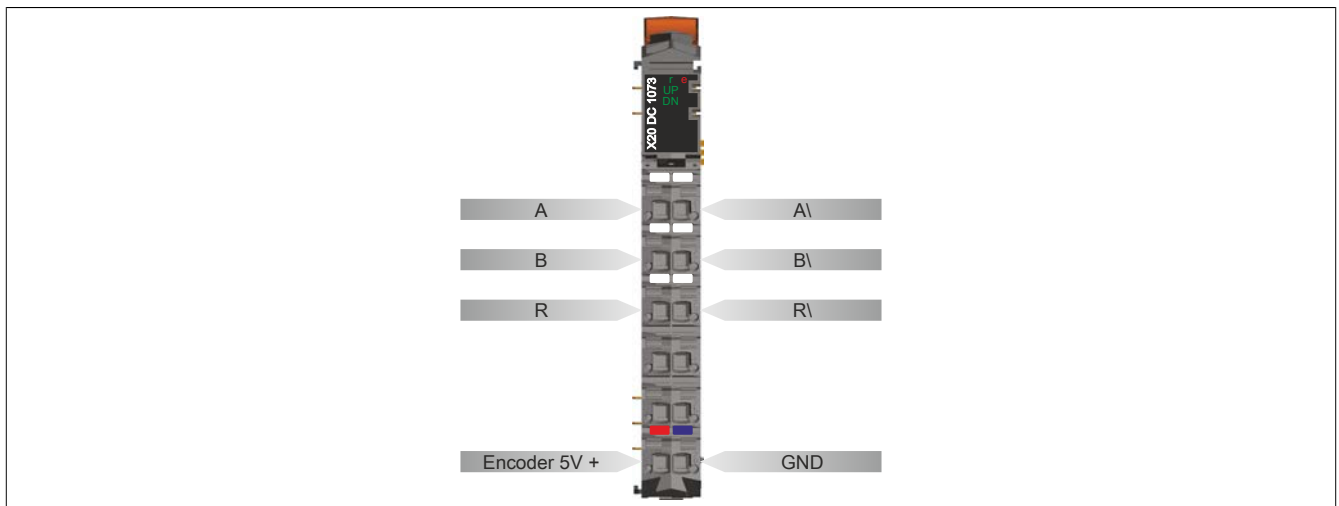
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description | |
|---|-----|-------|--------------|--|--|
|  | r | Green | Off | No power to module | |
| | | | Single flash | RESET mode | |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ | |
| | | | Blinking | PREOPERATIONAL mode | |
| | | | On | RUN mode | |
| | e | Red | Off | No power to module or everything OK | |
| | | | On | Error or reset state. Possible cause: <ul style="list-style-type: none"> Encoder supply error | |
| | | | Single flash | I/O error. Possible cause: <ul style="list-style-type: none"> Sine/Cosine relative position error (open line) | |
| | UP | Green | On | | The "UP/DN" LEDs are lit depending on the rotational direction and the speed of the connected encoder. The "UP" LED indicates when the encoder position changes in the positive direction. |
| | | | | | |

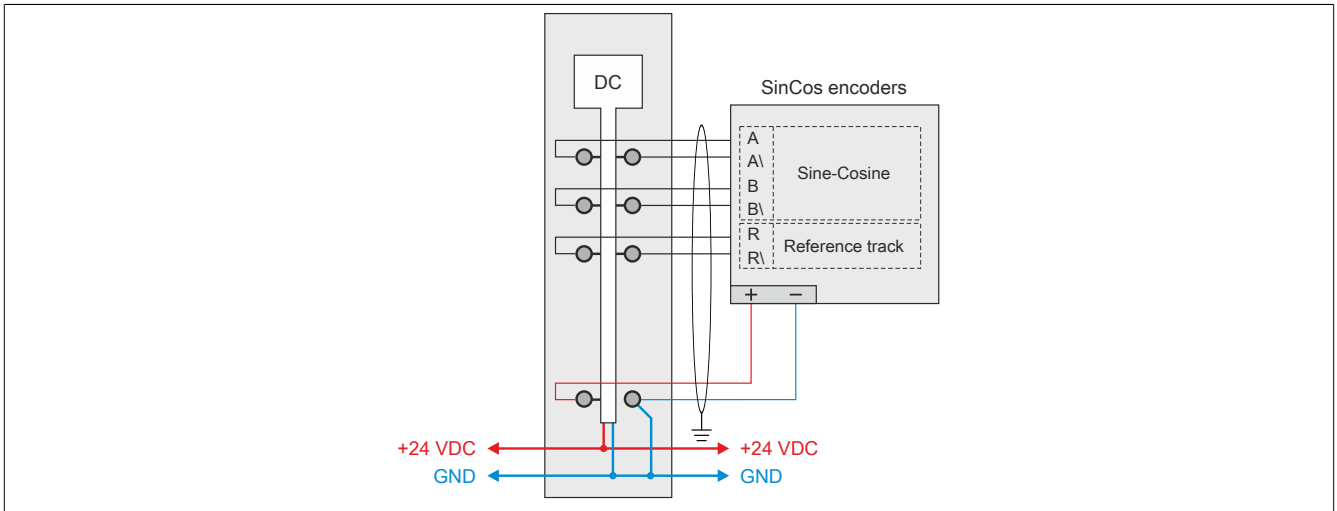
1) Depending on the configuration, a firmware update can take up to several minutes.

9.16.3.5 Pinout

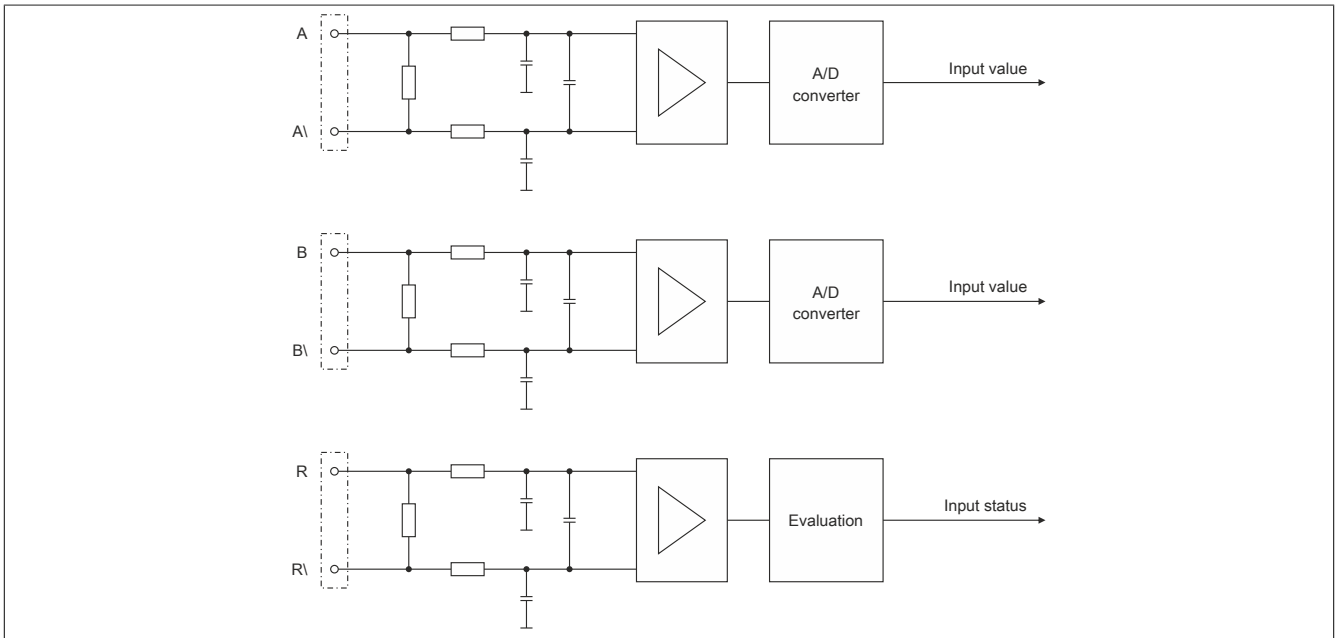
Shielded cables must be used for all signal lines.



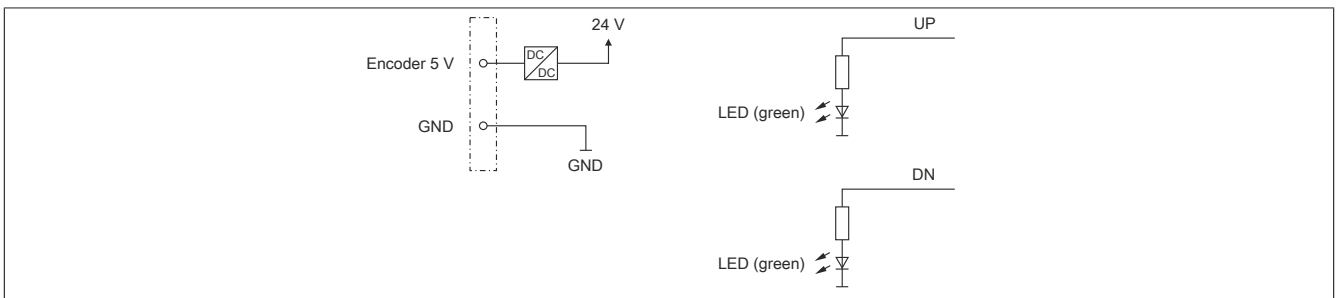
9.16.3.6 Connection example



9.16.3.7 Analog inputs - Input circuit diagram



9.16.3.8 Circuit diagram for the encoder supply and LEDs



9.16.3.9 Calculating the maximum encoder cable length

The following encoder data is assumed for this sample calculation:

| Encoder data | |
|-------------------------------|-----------------|
| Input voltage | 4.75 V – 5.25 V |
| Max. input current | 0.12 A |
| Module encoder output | |
| Min. output voltage at 300 mA | 4.86 V |

Calculation of the maximum voltage drop for the cable

The maximum permitted voltage drop is calculated using the minimum encoder output voltage for the module ($U_{\text{ModuleMin}}$) and the minimum encoder input voltage ($U_{\text{EncoderMin}}$) of the encoder being used.

$$U_{\text{CableMax}} = (U_{\text{ModuleMin}} - U_{\text{EncoderMin}}) / 2$$

Example: $U_{\text{CableMax}} = (4.86 \text{ V} - 4.75 \text{ V}) / 2 = 0.055 \text{ V}$

Calculation of the maximum cable length

$$\text{Cable length}_{\text{Max}} = U_{\text{CableMax}} * \text{Wire cross section (mm}^2\text{)} / (0.01786 * I_{\text{Encoder}})$$

This means:

I_{Encoder} Current consumption of encoder in amps
 U_{CableMax} Maximum permitted voltage drop in volts

Example with resolver cable "8BCR0xxxx.1111A-0"

Encoder with 120 mA max. current consumption

Resolver cable cross section = 0.25 mm²

Results in a total cable length of:

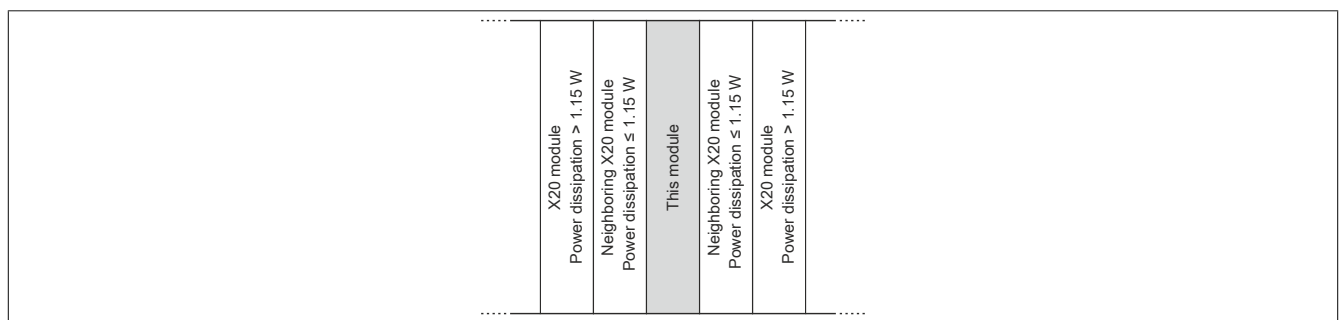
$$\text{Cable length}_{\text{Max}} = 0.055 \text{ V} * 0.25 \text{ mm}^2 / 0.01786 * 0.12 \text{ A} = 6.41 \text{ m}$$

9.16.3.10 Derating

There is no derating when operated below 55°C.

During operation over 55°C, the power dissipation of the modules to the left and right of this module is not permitted to exceed 1.15 W!

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.



9.16.3.11 Register description

9.16.3.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.16.3.11.2 Function model 0 - default

| Register | Name | Data type | Read | | Write | |
|---|-----------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module configuration | | | | | | |
| 513 | CfO_SlframeGenID | USINT | | | | • |
| Basic functions | | | | | | |
| 683 | SDCLifeCount | SINT | • | | | |
| 1172 | PositionHW | UDINT | • | | | |
| 1180 | PositionLW | UDINT | • | | | |
| | Position | DINT | | | | |
| 1164 | PosTime | DINT | • | | | |
| 1166 | PosTime | INT | • | | | |
| 1155 | PosCycle | SINT | • | | | |
| Error management | | | | | | |
| 389 | ErrorEnableID_1710 | USINT | | | | • |
| 261 | ErrorStateID_1710 | USINT | • | | | |
| | EncoderSupplyError | Bit 0 | | | | |
| | VssCheckError | Bit 2 | | | | |
| 325 | ErrorQuitID_1710 | USINT | | | • | |
| | AckEncoderSupplyError | Bit 0 | | | | |
| | AckVssCheckError | Bit 2 | | | | |
| Sin/Cos - Analog interface configuration | | | | | | |
| 1025 | SinCosEnable | USINT | | | | • |
| 1027 | SinCosRefSource | USINT | | | | • |
| 1034 | SinCosVssMin | UINT | | | | • |
| 1038 | SinCosVssMax | UINT | | | | • |
| 1044 | SinCosQuitTime | UDINT | | | | • |
| Additional encoder position | | | | | | |
| 1029 | SinCosCompMode | USINT | | | | • |
| 1204 | ReferenceHW | UDINT | • | | | |
| 1212 | ReferenceLW | UDINT | • | | | |
| | Reference | DINT | | | | |
| 1187 | RefCycle | SINT | • | | | |

SafeLOGIC registers

This module contains additional registers that allow the module to be used with a SafeLOGIC controller.

| Register | Name | Data type | Read | | Write | |
|----------------------|---------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 7170 | CfO_DTS_SourceRef | INT | | | | • |
| 7173 | CfO_DTS_CycleSelect | USINT | | | | • |
| Communication | | | | | | |
| 7188 | Position | DINT | • | | | |
| 7196 | PosTime | DINT | • | | | |
| 7202 | DTS_SourceRef | INT | • | | | |
| 7206 | DTS_CheckSum | INT | • | | | |

9.16.3.11.3 Function model 254 - Bus controller

| Register | Object ¹⁾ | Name | Data type | Read | | Write | |
|---|----------------------|-----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module configuration | | | | | | | |
| 513 | - | CfO_SlframeGenID | USINT | | | | • |
| Basic functions | | | | | | | |
| 1180 | 0 | Position | DINT | • | | | |
| 1155 | 4 | PosCycle | SINT | • | | | |
| Error management | | | | | | | |
| 389 | - | ErrorEnableID_1710 | USINT | | | | • |
| 325 | 15 | ErrorStateID_1710 | USINT | • | | | |
| | | EncoderSupplyError | Bit 0 | | | | |
| | | VssCheckError | Bit 2 | | | | |
| 261 | 6 | ErrorQuitID_1710 | USINT | | | • | |
| | | AckEncoderSupplyError | Bit 0 | | | | |
| | | AckVssCheckError | Bit 2 | | | | |
| Sin/Cos - Analog interface configuration | | | | | | | |
| 1025 | - | SinCosEnable | USINT | | | | • |
| 1027 | - | SinCosRefSource | USINT | | | | • |
| 1034 | - | SinCosVssMin | UINT | | | | • |
| 1038 | - | SinCosVssMax | UINT | | | | • |
| 1044 | - | SinCosQuitTime | UDINT | | | | • |
| Additional encoder position | | | | | | | |
| 1029 | - | SinCosCompMode | USINT | | | | • |
| 1212 | 8 | Reference | DINT | • | | | |
| 1187 | 12 | RefCycle | SINT | • | | | |

1) The offset specifies the position of the register within the CAN object.

9.16.3.11.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.16.3.11.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.16.3.11.4 Module configuration

The following configuration register can be used to configure different module settings. They can be used, for example, to modify the module's behavior on an X2X Link network. One configuration register is available for the user.

9.16.3.11.4.1 Data query

Name:

CfO_SlframeGenID

This register can be used to define when the synchronous/cyclic input data is generated. "X2X cycle optimized" should be set for jitter-free data acquisition. "Fast reaction" can be set for the best performance.

| Data type | Value | Information |
|-----------|-------|--|
| USINT | 9 | Fast reaction |
| | 14 | X2X cycle optimized; Bus controller default |

9.16.3.11.5 Basic functions

This module can import the position of a motor shaft when used together with a sin/cos encoder. The received position data is prepared in 2 different formats and given a [timestamp](#). 5 registers are available for further processing. This allows the user to choose which format is best suited for individual application.

9.16.3.11.5.1 SDC counter register

Name:
SDCLifeCount

The 8-bit counter register is needed for the SDC software package. It is incremented with the system clock to allow the SDC to check the validity of the data frame.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

9.16.3.11.5.2 Absolute position values

Name:
PositionHW
PositionLW

The absolute position of the encoder is defined using 64-bit resolution. The position value is stored in the PositionHW and PositionLW registers. The upper 32 bits are stored the PositionHW register, while the lower 32 bits are stored in the PositionLW register.

For SinCos signal evaluation, see ["Format of the SinCos signal" on page 1908](#) for information regarding the data format.

| Data type | Value |
|-----------|--------------------|
| 2x UDINT | 0 to 4,294,967,295 |

9.16.3.11.5.3 SDC position value

Name:
Position

The SDC library requires a signed 32-bit position value. The position's low word can be accessed separately for this. The value can also be used as default position value, however.

For SinCos signal evaluation, see ["Format of the SinCos signal" on page 1908](#) for information regarding the data format.

| Data type | Value |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

9.16.3.11.5.4 NetTime of the position values

Name:
PosTime

The current NetTime value is assigned to each determined position in this register. The NetTime is recorded with μ s accuracy.

The SDC library requires a 16 bit value. The NetTime value is therefore also prepared in this format.

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

| Data type | Value | Information |
|-----------|---------------------------------|--------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime in μ s |
| INT | -32,768 to 32,767 | |

9.16.3.11.5.5 Counter for position values

Name:
PosCycle

PosCycle is an integer counter that is incremented as soon as the module has saved a new valid position value.

| Data type | Value |
|-----------|-------------|
| SINT | -128 to 127 |

9.16.3.11.6 Error management

Module-based diagnostics

This module can detect errors on its own and differentiates between 2 different types of error.

- **Encoder supply:**
The encoder voltage supply is below the permitted limit.
- **V_{ss} Sin/Cos:**
The voltage value for the Sin/Cos track violates the configured limit values.
→ See register "[SinCosVssMin](#)" on page 1909 or "[SinCosVssMax](#)" on page 1909

9.16.3.11.6.1 Enabling/disabling error messages

Name:

ErrorEnableID_1710

The individual diagnostics can be separately enabled or disabled in this register.

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| USINT | See bit structure. | 255 |

Bit structure

| Bit | Name | Value | Information |
|-------|---|-------|--|
| 0 | Error detection - Encoder supply | 0 | Disabled |
| | | 1 | Enabled (bus controller default setting) |
| 1 | Reserved | - | |
| 2 | Error detection - V _{ss} Sin/Cos | 0 | Disabled |
| | | 1 | Enabled (bus controller default setting) |
| 3 - 7 | Reserved | - | |

9.16.3.11.6.2 Show error messages

Name:

ErrorStateID_1710

EncoderSupplyError

VssCheckError

This register indicates which error or warning is currently active. For the meaning of individual error messages, see "[Error management](#)" on page 1907.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure

| Bit | Name | Value | Information |
|-------|--------------------|-------|--|
| 0 | EncoderSupplyError | 0 | No error |
| | | 1 | Encoder supply error |
| 1 | Reserved | - | |
| 2 | VssCheckError | 0 | No error |
| | | 1 | V _{ss} error on the Sin/Cos track |
| 3 - 7 | Reserved | - | |

9.16.3.11.6.3 Acknowledge error messages

Name:

ErrorQuitID_1710

AckEncoderSupplyError

AckVssCheckError

This register is used to acknowledge an error message that occurred in the "Show error messages" on page 1907 register. For the meaning of individual error messages, see "Error management" on page 1907.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure

| Bit | Name | Value | Information |
|-------|-----------------------|-------|-------------------------|
| 0 | AckEncoderSupplyError | 0 | No error acknowledgment |
| | | 1 | Error acknowledgment |
| 1 | Reserved | - | |
| 2 | AckVssCheckError | 0 | No error acknowledgment |
| | | 1 | Error acknowledgment |
| 3 - 7 | Reserved | - | |

9.16.3.11.7 Sin/Cos - Analog interface configuration

The module is equipped with an analog interface for detecting a differential sine-, cosine- and reference signal.

9.16.3.11.7.1 Format of the SinCos signal

The SinCos signal is represented as a position value in the "Absolute position values" on page 1906 and "SDC position value" on page 1906 registers. The following relationships apply:

- PositionLW and Position are identical in the function.
- PositionHW extends the integer range of PositionLW by adding multi-turn functionality.

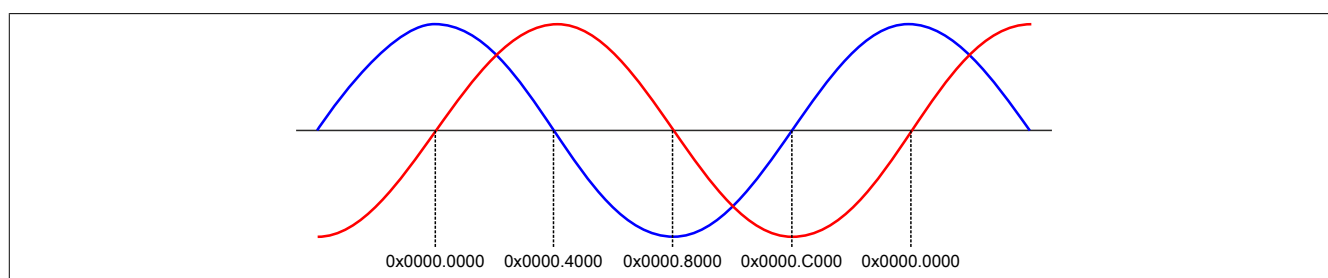
| 64-bit register | PositionHW (unsigned) | PositionLW (unsigned) |
|-----------------|----------------------------------|---|
| 32-bit register | - | Position (signed) |
| Format | Integer extension (to 48-bit) | Integer (16-bit) |
| Information | | Decimal places: (with 13-bit resolution) |
| Word/DWord | DWord | Word 1 |

| | | | | | | | | | | | | | | | |
|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| x | x | x | x | x | x | x | x | x | x | x | x | x | 0 | 0 | 0 |

Important: The lower 3 bits always contain the value 0.

Word 0

Relationship between sine curve (red) and decimal places:



9.16.3.11.7.2 Enabling SinCos

Name:

SinCosEnable

This register must always have the value 1 for configuration reasons.

| Data type | Value | Information |
|-----------|-------|---------------------------|
| USINT | 1 | Bus controller default: 1 |

9.16.3.11.7.3 Enabling SinCos reference source

Name:

SinCosRefSource

This register must always have the value 0 for configuration reasons.

| Data type | Value | Information |
|-----------|-------|-----------------------------------|
| USINT | 0 | Bus controller default setting: 0 |

9.16.3.11.7.4 Configuring the lower Vss value

Name:

SinCosVssMin

This register specifies the lower limit value for the peak-to-peak voltage of the sine/cosine track. The incoming signal is monitored in this way. If the incoming value falls below this specified limit, then the module reports the corresponding error.

| Data type | Value | Information |
|-----------|-----------|---|
| UINT | 0 to 1500 | Values in mV Bus controller default: 800 |

9.16.3.11.7.5 Configuring the upper Vss value

Name:

SinCosVssMax

This register specifies the upper limit value for the peak-to-peak voltage of the sine/cosine track. The incoming signal is monitored in this way. If the incoming value exceeds this specified limit, then the module reports the corresponding error.

| Data type | Value | Information |
|-----------|-----------|--|
| UINT | 0 to 1500 | Values in mV Bus controller default: 1200 |

9.16.3.11.7.6 Configuring the delay time after errors

Name:

SinCosQuitTime

If an error is detected on the analog interface, the last correctly read values remain valid. An interval can be defined in this register at which the module begins receiving correct values again after the error state without processing them further internally. Only then will newly sampled correct analog values be recognized as valid.

| Data type | Value | Information |
|-----------|---------------|---|
| UDINT | 0 to 20000000 | Values in μ s Bus controller default: 100000 |

9.16.3.11.8 Additional encoder position

In addition to the basic function, importing position values, the module can also copy an imported position to the reference register. The copy procedure is triggered by a configurable event.

9.16.3.11.8.1 Configuration

The position of the axis being measured is determined by 3 signals. The Z-signal is triggered exactly once during a single full rotation of the axis, which defines the reference point. The sine and cosine values are offset by 90° and undergo twofold evaluation by the module hardware. During "rough interpolation" the analog sine and cosine values are handled like digital signals. This works in the same way as a conventional ABR module. Fine interpolation takes place simultaneously in another part of the module. This is done using module-specific algorithms.

9.16.3.11.8.2 Configuring the copy procedure

Name:

SinCosCompMode

This register is used to determine when the current position should be copied to the reference register. The register is divided into 2 halves. The upper 4 bits determine which of the signal tracks are relevant for the trigger. The lower 4 bits determine which roughly interpolated states the individual signal tracks must demonstrate in order for the copying procedure to take place.

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| USINT | See bit structure. | 119 |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------------------------|-------|--|
| 0 | Latch - Sine track | 0 | Copy when sine is negative |
| | | 1 | Copy when sine is positive (bus controller default setting) |
| 1 | Latch - Cosine track | 0 | Copy when cosine is negative |
| | | 1 | Copy when cosine is positive (bus controller default setting) |
| 2 | Latch - Reference track (Z-track) | 0 | Copy when reference is negative |
| | | 1 | Copy when reference is positive (bus controller default setting) |
| 3 | Reserved | - | |
| 4 | Sine track | 0 | Irrelevant for latch |
| | | 1 | Relevant for latch (bus controller default setting) |
| 5 | Cosine track | 0 | Irrelevant for latch |
| | | 1 | Relevant for latch (bus controller default setting) |
| 6 | Reference track (Z-track) | 0 | Irrelevant for latch |
| | | 1 | Relevant for latch (bus controller default setting) |
| 7 | Reserved | - | |

Call

The reference registers can be called the same way as the registers for the current position.

9.16.3.11.8.3 Reference position (to 64-bit)

Name:
ReferenceHW
ReferenceLW

This register prepares the value of the encoder position at the time a specific event occurred.

The 64-bit position value is placed in the registers ReferenceHW and ReferenceLW. The upper 32 bits are in the ReferenceHW register and the lower 32 bits in the ReferenceLW register.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.16.3.11.8.4 Reference position (to 32-bit)

Name:
Reference
Reference

Just like the position registers, the lower 32 bits of the reference position can also be addressed separately. The result is interpreted as a signed value.

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

9.16.3.11.8.5 Counter for reference values

Name:
RefCycle

This register acts as an integer counter that is incremented as soon as the module has determined a new valid reference value.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

9.16.3.11.9 DATA_to_SafeDATA

Function DATA_to_SafeDATA determines a safe signal from 2 independent standard signals. For this purpose, the standard data of 2 I/O modules are transferred to the SafeLOGIC controller and compared with each other there. With the functions provided in SafeDESIGNER, the resulting data can be used for applications up to PL d.

Function DATA_to_SafeDATA is enabled and the register calls take place using SafeDESIGNER. For more detailed information about the calls, see library DATA_to_SafeDATA_SF contained in SafeDESIGNER.

9.16.3.11.9.1 Counter state of the encoder

Name:
Position

This register represents the counter value of the encoder. The register is only active if function DATA_to_SafeDATA is enabled.

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

9.16.3.11.9.2 NetTime of the counter value

Name:
PosTime

This register represents the NetTime of the most recent valid counter value. The register is only active if function DATA_to_SafeDATA is enabled.

For a description of NetTime Technology, see ["NetTime Technology" on page 3035](#).

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

9.16.3.11.9.3 Displaying the SourceRef address

Name:

DTS_SourceRef

This register cyclically displays the SourceRef address set in the configuration. The register is only active if function DATA_to_SafeDATA is enabled.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

9.16.3.11.9.4 Checksum

Name:

DTS_CheckSum

This register contains a checksum formed from the 3 cyclic data points [Position](#), [PosTime](#) and [DTS_SourceRef](#). The register is only active if function DATA_to_SafeDATA is enabled.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

9.16.3.11.9.5 SourceRef address

Name:

CfO_DTS_SourceRef

This register contains the acyclically configurable SourceRef address that is transmitted back by the module as a cyclic data point. The register is only active if function DATA_to_SafeDATA is enabled.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

9.16.3.11.9.6 Constant cycle register

Name:

CfO_DTS_CycleSelect

This register determines the cycle used internally and is not permitted to be changed.

| Data type | Value |
|-----------|-------|
| USINT | 2 |

9.16.3.11.10 NetTime Technology

For a description of NetTime Technology, see "[NetTime Technology](#)" on page 3035.

9.16.3.11.11 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 µs |

9.16.3.11.12 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 100 µs |

9.16.4 X20(c)DS1119

Data sheet version: 3.42

9.16.4.1 General information

This module is a multifunction digital signal processor module. It can be used extremely flexibly for a wide variety of tasks involving digital signal processing or digital signal generation. Two primary example applications include controlling stepper output stages with pulse and direction signals or using as encoder emulation. In this application, for example, frequency inverters or servo axes with the speed follow function can follow a real or virtual master axis.

- 3 digital 5 V channels, configurable as inputs or outputs
- 2 digital 24 V input channels
- 1 universal counter pair (2 event counters, AB counters or up/down counters)
- Linear motion generator (A/B, direction/frequency) with one reference pulse
- SSI absolute encoder
- NetTime timestamp: Input data, target position, position change, edge change, counter change

NetTime timestamp

An additional major feature is the module's integrated timestamp function. It allows counter ramps curves to be generated virtually independently of bus cycle times during encoder emulation, for example. Only the target counter value and moment when it should be reached are transferred. The module automatically generates the corresponding counter values at the appropriate time, precisely in microsecond resolution and independently of the bus clock.

9.16.4.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.16.4.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C . During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.16.4.3 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Digital signal processing and preparation |  |
| X20DS1119 | X20 multifunction digital signal processor, 3 digital channels 5 V (symmetrical) configurable as inputs or outputs, 2 digital input channels 24 V (asymmetrical), max. 2 event counters, 1 universal counter pair as AB counter or up/down counter, linear movement generator (A/B, direction/frequency) with 1 reference pulse, 1 SSI absolute encoder, NetTime function | |
| X20cDS1119 | X20 multifunction digital signal processor, coated, 3 digital channels 5 V (symmetrical) configurable as inputs or outputs, 2 digital input channels 24 V (asymmetrical), max. 2 event counters, 1 universal counter pair as AB counter or up/down counter, linear movement generator (A/B, direction/frequency) with 1 reference pulse, 1 SSI absolute encoder, NetTime function | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 362: X20DS1119, X20cDS1119 - Order data

9.16.4.4 Technical data

| Model number | X20DS1119 | X20cDS1119 |
|--|--|---|
| Short description | | |
| I/O module | 3 digital 5 V (symmetrical) channels configurable as inputs or outputs, 2 digital 24 V (asymmetrical) input channels, 1 universal counter pair (2 event counters, AB counter or up/down counter), linear motion generator (A/B, direction/frequency) with 1 reference pulse, SSI absolute encoder, relative or absolute moments of input edges with microsecond resolution, time-triggered I/O, I/O oversampling | |
| General information | | |
| B&R ID code | 0xA067 | 0xE20D |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using LED status indicator and software | |
| Inputs/Outputs | Yes, using LED status indicator | |
| Power consumption | | |
| Bus | 0.01 W | |
| Internal I/O | 1.5 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Type of signal lines | Shielded cables must be used for all signal lines. | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Linear motion generator | | |
| Quantity | 1 | |
| Encoder outputs | 5 V, symmetrical (A/B, direction/frequency) | |
| Counter size | 16/32-bit | |
| SSI absolute encoder | | |
| Quantity | 1 | |
| Counter size | Up to 32-bit depending on encoder | |
| Max. transfer rate | 1 Mbit/s | |
| Encoder signal | 5 V, symmetrical | |

Table 363: X20DS1119, X20cDS1119 - Technical data

| Model number | X20DS1119 | X20cDS1119 |
|--|--|-----------------------------------|
| Encoder power supply | | |
| 5 VDC | | ±5%, module-internal, max. 300 mA |
| 24 VDC | | Module-internal, max. 300 mA |
| Digital inputs 5 VDC | | |
| Quantity | Up to 3, configuration as input or output using software | |
| Nominal voltage | 5 VDC differential signal, EiA RS485 standard | |
| Input characteristics per EN 61131-2 | Type 1 | |
| Input frequency | 600 kHz | |
| Common-mode range | $-7\text{ V} \leq V_{CM} \leq +12\text{ V}$ | |
| Isolation voltage between encoder and bus | 500 V _{eff} | |
| Overload characteristics of encoder power supply | Short-circuit proof, overload-proof | |
| Input filter | | |
| Hardware | ≤200 ns | |
| Software | - | |
| Additional functions | SSI absolute encoder, universal counter pair | |
| Digital inputs 24 VDC | | |
| Quantity | 2 | |
| Nominal voltage | 24 VDC | |
| Input characteristics per EN 61131-2 | Type 1 | |
| Input circuit | Sink | |
| Input voltage | 24 VDC -15% / +20% | |
| Input filter | | |
| Hardware | ≤2 μs | |
| Software | - | |
| Input current at 24 VDC | Approx. 3.4 mA | |
| Input resistance | Approx. 7.19 kΩ | |
| Input frequency | 100 kHz | |
| Switching threshold | | |
| Low | <5 VDC | |
| High | >15 VDC | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Additional functions | Latch function for universal counter pair | |
| Universal counter pair | | |
| Quantity | 1 | |
| Operating modes | 2x event counter, up/down counter, AB counter | |
| Encoder inputs | 5 V, symmetrical | |
| Counter size | 16/32-bit | |
| Input frequency | Max. 600 kHz | |
| Evaluation | | |
| AB counter | 4x | |
| Event counters | 2x | |
| Up/Down counter | 2x | |
| Encoder power supply | | |
| 5 VDC | ±5%, module-internal, max. 300 mA | |
| 24 VDC | Module-internal, max. 300 mA | |
| Digital outputs 5 VDC | | |
| Quantity | Up to 3, configuration as input or output using software | |
| Type | 5 VDC differential signal, EiA RS485 standard | |
| Output circuit | Sink and/or source | |
| Output protection | Short circuit protection | |
| Variant | Push/Pull/Push-Pull | |
| Nominal voltage | 5 VDC | |
| Output current | Max. 65 mA | |
| Diagnostic status | Output is readable. | |
| Switching frequency | Max. 500 kHz | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Switching voltage | 5 VDC differential signal, EiA RS485 standard | |
| Additional functions | SSI absolute encoder, linear motion generator | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitation | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |


Table 363: X20DS1119, X20cDS1119 - Technical data

| Model number | X20DS1119 | X20cDS1119 |
|---------------------------------|--|---|
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | | -25 to 60°C |
| Vertical mounting orientation | | -25 to 50°C |
| Derating | | - |
| Starting temperature | - | Yes, -40°C |
| Storage | | -40 to 85°C |
| Transport | | -40 to 85°C |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | | 5 to 95%, non-condensing |
| Transport | | 5 to 95%, non-condensing |
| Mechanical properties | | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x bus module X20BM11 separately. | Order 1x terminal block X20TB12 separately. Order 1x bus module X20cBM11 separately. |
| Pitch | 12.5 ^{+0.2} mm | |

Table 363: X20DS1119, X20cDS1119 - Technical data

9.16.4.5 LED status indicators

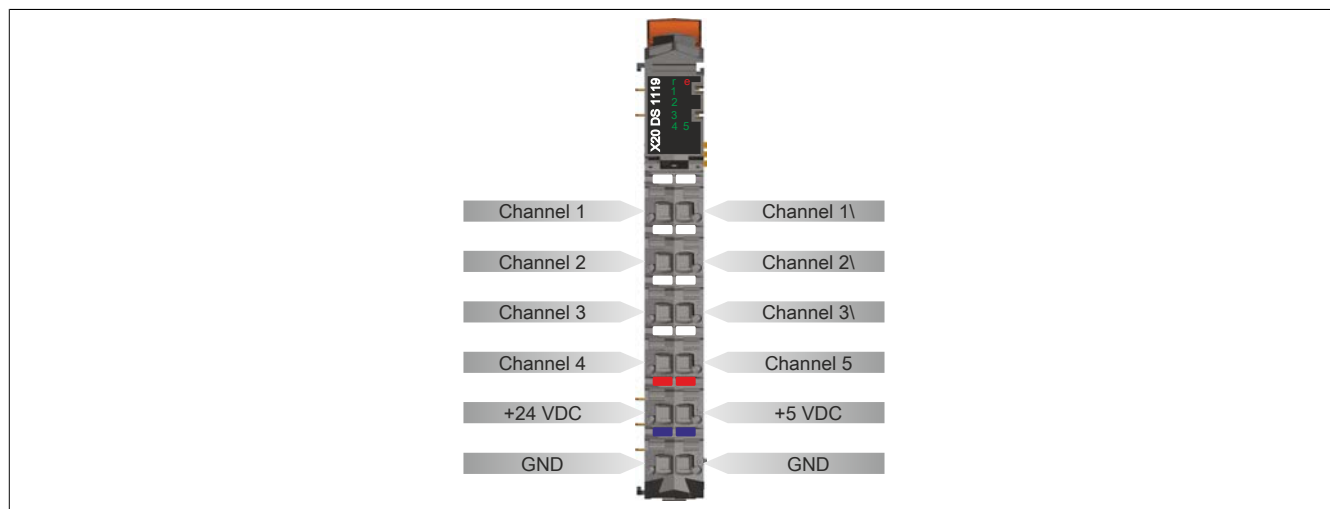
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description | |
|--|-------|-------|--------------|---|---|
|  | r | Green | Off | No power to module | |
| | | | Single flash | Mode RESET | |
| | | | Double flash | Mode BOOT (during firmware update) ¹⁾ | |
| | | | Blinking | Mode PREOPERATIONAL | |
| | | | On | Mode RUN | |
| | e | Red | Off | Module not supplied with power or everything OK | |
| | | | Single flash | I/O error. Possible causes: <ul style="list-style-type: none"> • SSI error²⁾ | |
| | | | Double flash | System error. Possible causes: <ul style="list-style-type: none"> • Motion function error³⁾ • I/O oversampling error⁴⁾ • Edge detection error⁴⁾ | |
| | | | Triple flash | I/O error and system error occur together | |
| | | | On | Error or reset state | |
| | 1 - 8 | Green | | | State of the corresponding digital signal |

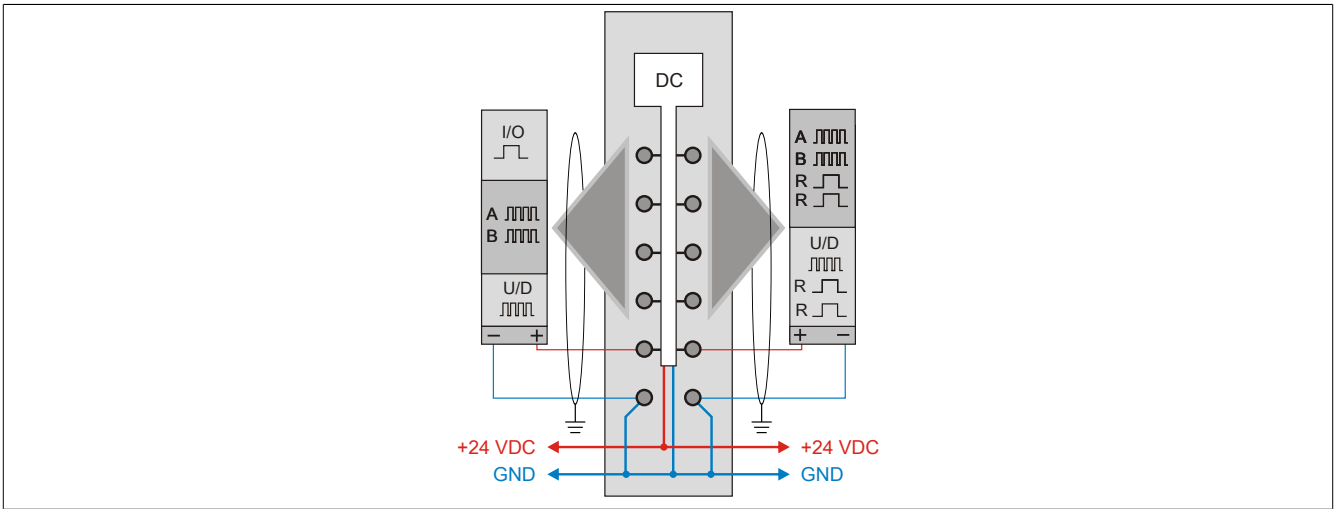
- 1) Depending on the configuration, a firmware update can take up to several minutes.
- 2) See register "[Error state - SSI](#)" on page 1925 for the exact error description.
- 3) See register "[Error state - Motion functions](#)" on page 1925 for the exact error description.
- 4) See register "[Error state - Output data and edge detection](#)" on page 1924 for the exact error description.

9.16.4.6 Pinout

Shielded cables must be used for all signal lines.

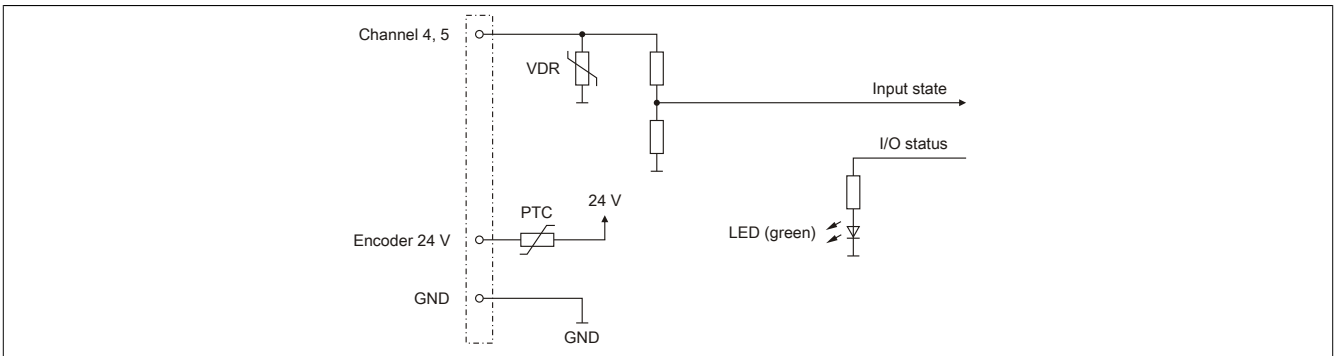


9.16.4.7 Connection example

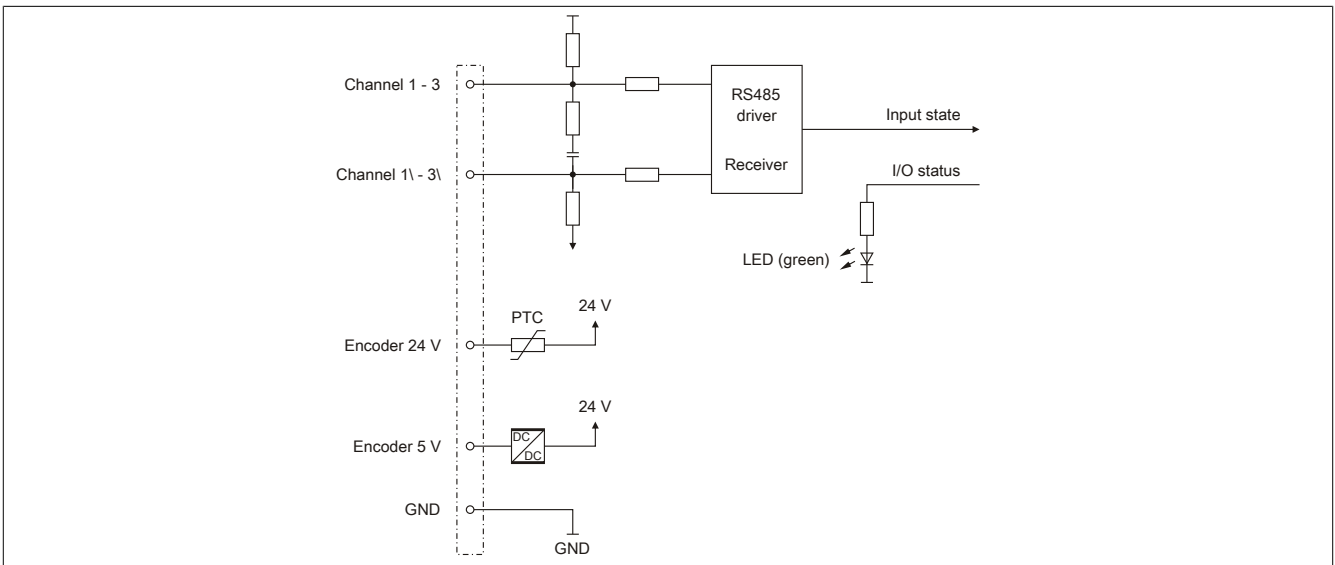


9.16.4.8 Input circuit diagram

Asymmetrical +24 VDC

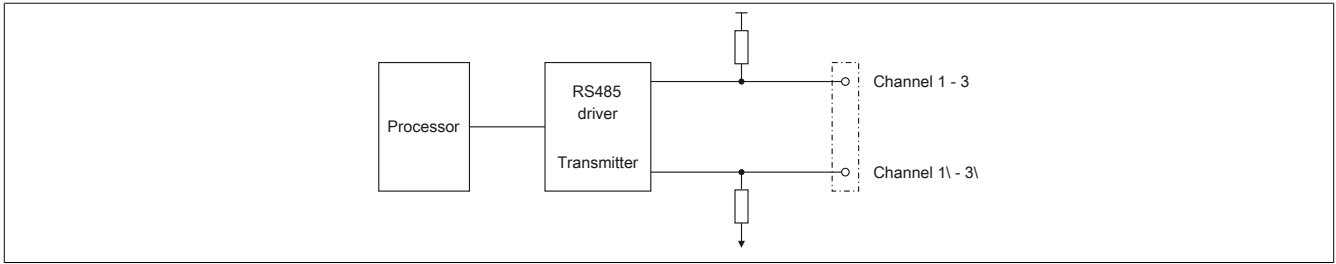


Symmetrical +5 VDC



9.16.4.9 Output circuit diagram

Symmetrical +5 VDC



9.16.4.10 Connection options

Digital input/output

| Channel | Function |
|---------|----------------------------------|
| 1 | Input / Output (5 V symmetrical) |
| 2 | Input / Output (5 V symmetrical) |
| 3 | Input / Output (5 V symmetrical) |
| 4 | Input (24 V asymmetrical) |
| 5 | Input (24 V asymmetrical) |

Wiring of the SSI absolute encoder

| Channel | Function |
|------------|----------|
| 1 (input) | Data |
| 2 (output) | Clock |

Wiring of the linear motion generator

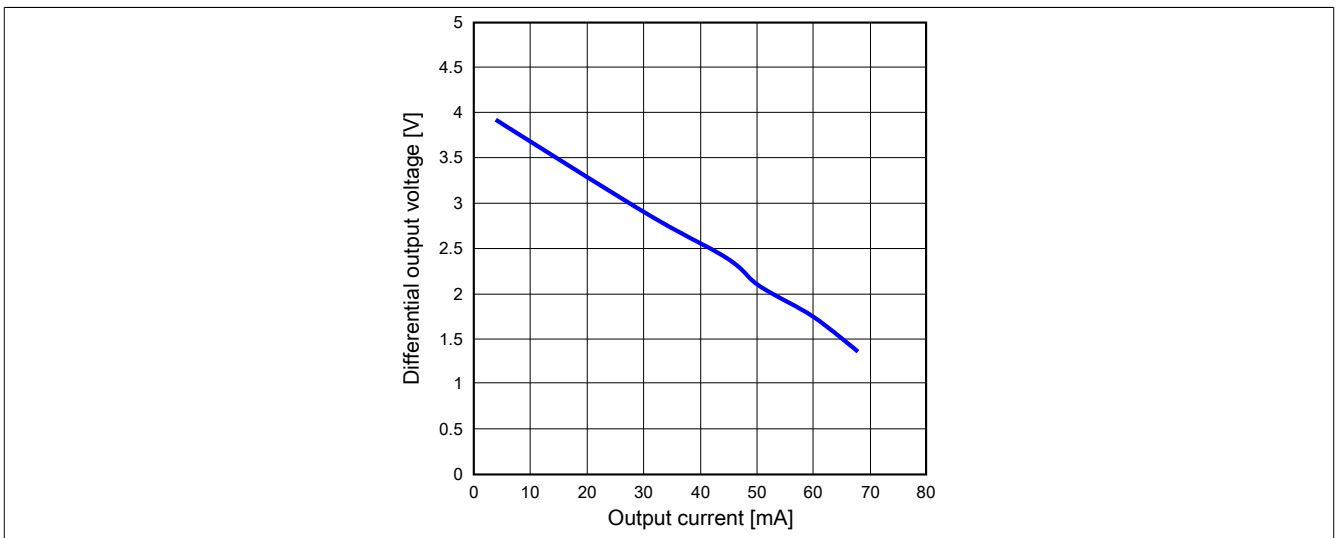
| Channel | Up/Down | AB |
|------------|-----------|-----------|
| 1 (output) | Direction | A |
| 2 (output) | Frequency | B |
| 3 (output) | | Reference |

Wiring of the universal counter pair

| Channel | Edge counter | Up/Down counter | Incremental |
|-----------|--------------|-------------------|-------------|
| 1 (input) | Input 1 | Direction | A |
| 2 (input) | Input 2 | Frequency | B |
| 3 (input) | | Latch input 1 (R) | |
| 5 (input) | | Latch input 2 (E) | |

9.16.4.11 Differential output

The following diagram shows that the differential output voltage sinks when the output current rises.



9.16.4.12 Register description

9.16.4.12.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.16.4.12.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|--|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration - General | | | | | | |
| 513 | CfO_SlframeGenID | USINT | | | | • |
| Configuration - System timer | | | | | | |
| 642 | CfO_SystemCycleTime | UINT | | | | • |
| 646 | CfO_SystemCycleOffset | INT | | | | • |
| 650 | CfO_SystemCyclePrescaler | UINT | | | | • |
| Configuration - Physical I/Os | | | | | | |
| 769 + (N-1) * 2 | CfO_PhylIOConfigCh0N (index N = 1 to 5) | USINT | | | | • |
| Configuration - Direct I/O | | | | | | |
| 899 | CfO_DirectIOClearMask0_7 | USINT | | | | • |
| 903 | CfO_DirectIOSetMask0_7 | USINT | | | | • |
| 905 | CfO_OutputUpdateCycle | USINT | | | | • |
| Configuration - Oversampled I/O | | | | | | |
| 1025 | CfO_OversampleMode | USINT | | | | • |
| 1027 | CfO_OversampleSampleCycleID | USINT | | | | • |
| 1029 | CfO_OversampleRelativeCycleID | USINT | | | | • |
| 1031 | CfO_OversampleConsumeCycleID | USINT | | | | • |
| 1033 | CfO_OversampleOutputBits | USINT | | | | • |
| 1035 | CfO_OversampleInputBits | USINT | | | | • |
| 1037 | CfO_OversampleOutputWindow | USINT | | | | • |
| 1039 | CfO_OversampleInputWindow | USINT | | | | • |
| 1041 + (N*2) | CfO_OversampleConfigInputN (index N = 0 to 3) | USINT | | | | • |
| 1049 + (N*2) | CfO_OversampleConfigOutputN (index N = 0 to 3) | USINT | | | | • |
| Configuration - Edge detection | | | | | | |
| 1537 | CfO_EdgeDetectPollCycleID | USINT | | | | • |
| 1548 | CfO_EdgeDetectEventEnable | UDINT | | | | • |
| 1665 + (N-1) * 16 | CfO_EdgeDetectUnit0NMode (index N = 1 to 4) | USINT | | | | • |
| 1667 + (N-1) * 16 | CfO_EdgeDetectUnit0NLeading (index N = 1 to 4) | USINT | | | | • |
| 1669 + (N-1) * 16 | CfO_EdgeDetectUnit0NMaster (index N = 1 to 4) | USINT | | | | • |
| 1671 + (N-1) * 16 | CfO_EdgeDetectUnit0NSlave (index N = 1 to 4) | USINT | | | | • |
| Configuration - Motion functions | | | | | | |
| 4097 | CfO_FifoSize | USINT | | | | • |
| 4099 | CfO_Mode | SINT | | | | • |
| 4101 | CfO_SpeedLimit | USINT | | | | • |
| 4103 | CfO_FormatAdjust | USINT | | | | • |
| 4105 | CfO_TimeStampRange | SINT | | | | • |
| 4107 | CfO_PositionRange | SINT | | | | • |
| 4109 | CfO_Reference0Range | SINT | | | | • |
| 4111 | CfO_Reference1Range | SINT | | | | • |
| 4116 | CfO_TimeStampDelay | DINT | | | | • |
| 4124 | CfO_SpeedCycleTime_32bit | UDINT | | | | • |
| 4129 | CfO_ResolPosition | SINT | | | | • |
| 4131 | CfO_ResolSpeed | SINT | | | | • |
| 4220 | CfO_AccelDataInit | UDINT | | | | • |
| 4260 | CfO_Reference0Start | DINT | | | | • |
| 4268 | CfO_Reference0StopMargin | DINT | | | | • |
| 4276 | CfO_Reference1Start | DINT | | | | • |
| 4284 | CfO_Reference1StopMargin | DINT | | | | • |
| Configuration - SSI | | | | | | |
| 2049 | CfO_CycleSelect | USINT | | | | • |
| 2051 | CfO_PhysicalMode | USINT | | | | • |
| 2053 | CfO_DataBits | USINT | | | | • |
| 2055 | CfO_NullBits | USINT | | | | • |
| Configuration - Universal counter | | | | | | |
| 6145 | CfO_CounterCycleSelect | USINT | | | | • |
| 6147 | CfO_CounterMode | USINT | | | | • |
| 6149 | CfO_LatchMode | USINT | | | | • |

| Register | Name | Data type | Read | | Write | |
|---|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 6151 | CfO_LatchComparator | USINT | | | | |
| 6153 | CounterControl | USINT | | | • | |
| | CounterReset | Bit 0 | | | | |
| | LatchEnable | Bit 1 | | | | • |
| Communication - General | | | | | | |
| 546 | ProtocolError (16-bit) | USINT | • | | | |
| 547 | ProtocolError (8-bit) | UINT | • | | | |
| 550 | ProtocolSequenceViolation (16-bit) | UINT | • | | | |
| 551 | ProtocolSequenceViolation (8-bit) | USINT | • | | | |
| Communication - Error register | | | | | | |
| 257 | Error state - Output data and edge detection | USINT | • | | | |
| | OutputControlError | Bit 4 | | | | |
| | OutputCopyError | Bit 5 | | | | |
| | EdgeDetectError | Bit 6 | | | | |
| 259 | Error state - SSI | USINT | • | | | |
| | SSICycleTimeViolation | Bit 0 | | | | |
| | SSIParityError | Bit 1 | | | | |
| 261 | Error state - Motion functions | USINT | • | | | |
| | MovFifoEmpty | Bit 0 | | | | |
| | MovFifoFull | Bit 1 | | | | |
| | MovTargetTimeViolation | Bit 2 | | | | |
| | MovMaxFrequencyViolation | Bit 3 | | | | |
| 321 | Acknowledging error messages - Output data and edge detection | USINT | | | • | |
| | QuitOutputControlError | Bit 4 | | | | |
| | QuitOutputCopyError | Bit 5 | | | | |
| | QuitEdgeDetectError | Bit 6 | | | | |
| 323 | Acknowledging error messages - SSI | USINT | | | • | |
| | SSIQuitCycleTimeViolation | Bit 0 | | | | |
| | SSIQuitParityError | Bit 1 | | | | |
| 325 | Acknowledging error messages - Motion functions | USINT | | | • | |
| | MovQuitFifoEmpty | Bit 0 | | | | |
| | MovQuitFifoFull | Bit 1 | | | | |
| | MovQuitTargetTimeViolation | Bit 2 | | | | |
| | MovQuitMaxFrequencyViolation | Bit 3 | | | | |
| Communication - System timer | | | | | | |
| 683 | SDCLifeCount | SINT | • | | | |
| Communication - Direct I/O | | | | | | |
| 915 | Output state | USINT | | | • | |
| | DigitalOutput03 | Bit 2 | | | | |
| | DigitalOutput04 | Bit 3 | | | | |
| | DigitalOutput07 | Bit 6 | | | | |
| | DigitalOutput08 | Bit 7 | | | | |
| 927 | Input state | USINT | • | | | |
| | DigitalInput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalInput08 | Bit 7 | | | | |
| Communication - Oversampled I/O (output) | | | | | | |
| 1059 | Oversampling configuration | USINT | | | • | |
| | OversampleEnable | Bit 0 | | | | |
| | OversampleOutputValidate | Bit 1 | | | | |
| 1063 | OversampleOutputCycle | USINT | | | • | |
| | OversampleSampleOffset | USINT | | | | |
| 1088 + N | OversampleOutput0NSample1_8 (index N = 1 to 4) | USINT | | | • | |
| 1092 + N | OversampleOutput0NSample9_16 (index N = 1 to 4) | USINT | | | • | |
| 1096 + N | OversampleOutput0NSample17_24 (index N = 1 to 4) | USINT | | | • | |
| 1100 + N | OversampleOutput0NSample25_32 (index N = 1 to 4) | USINT | | | • | |
| 1104 + N | OversampleOutput0NSample33_40 (index N = 1 to 4) | USINT | | | • | |
| 1108 + N | OversampleOutput0NSample41_48 (index N = 1 to 4) | USINT | | | • | |
| 1112 + N | OversampleOutput0NSample49_56 (index N = 1 to 4) | USINT | | | • | |
| 1116 + N | OversampleOutput0NSample57_64 (index N = 1 to 4) | USINT | | | • | |
| Communication - Oversampled I/O (input) | | | | | | |
| 1074 | OversampleInputTime | INT | • | | | |
| 1079 | OversampleInputCycle | USINT | • | | | |
| 1120 + N | OversampleInput0NSample64_57 (index N = 1 to 4) | USINT | • | | | |
| 1124 + N | OversampleInput0NSample56_49 (index N = 1 to 4) | USINT | • | | | |
| 1128 + N | OversampleInput0NSample48_41 (index N = 1 to 4) | USINT | • | | | |
| 1132 + N | OversampleInput0NSample40_33 (index N = 1 to 4) | USINT | • | | | |
| 1136 + N | OversampleInput0NSample32_25 (index N = 1 to 4) | USINT | • | | | |
| 1140 + N | OversampleInput0NSample24_17 (index N = 1 to 4) | USINT | • | | | |
| 1144 + N | OversampleInput0NSample16_9 (index N = 1 to 4) | USINT | • | | | |
| 1148 + N | OversampleInput0NSample8_1 (index N = 1 to 4) | USINT | • | | | |
| Communication - Edge detection | | | | | | |

| Register | Name | Data type | Read | | Write | |
|--|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 1794 + (N-1) * 32 | EdgeDetect0NMastercount (16-bit) (index N = 1 to 4) | INT | • | | | |
| 1795 + (N-1) * 32 | EdgeDetect0NMastercount (8-bit) (index N = 1 to 4) | SINT | • | | | |
| 1798 + (N-1) * 32 | EdgeDetect0NSlavecount (16-bit) (index N = 1 to 4) | INT | • | | | |
| 1799 + (N-1) * 32 | EdgeDetect0NSlavecount (8-bit) (index N = 1 to 4) | SINT | • | | | |
| 1804 + (N-1) * 32 | EdgeDetect0NDifference (32-bit) (index N = 1 to 4) | DINT | • | | | |
| 1806 + (N-1) * 32 | EdgeDetect0NDifference (16-bit) (index N = 1 to 4) | INT | • | | | |
| 1812 + (N-1) * 32 | EdgeDetect0NMastertime (32-bit) (index N = 1 to 4) | DINT | • | | | |
| 1814 + (N-1) * 32 | EdgeDetect0NMastertime (16-bit) (index N = 1 to 4) | INT | • | | | |
| 1820 + (N-1) * 32 | EdgeDetect0NSlavetime (32-bit) (index N = 1 to 4) | DINT | • | | | |
| 1822 + (N-1) * 32 | EdgeDetect0NSlavetime (16-bit) (index N = 1 to 4) | INT | • | | | |
| Communication - Motion functions | | | | | | |
| 4225 | MovementControl | USINT | | | • | |
| | MovEnable - For position control | Bit 0 | | | | |
| | MovEnable - For speed control | Bit 1 | | | | |
| | MovReset - Movement reset (immediate stop) | Bit 7 | | | | |
| 4244 | MovTargetTime (32-bit) | DINT | | | • | |
| 4246 | MovTargetTime (16-bit) | INT | | | • | |
| 4252 | MovTargetPosition (32-bit) | DINT | | | • | |
| 4254 | MovTargetPosition (16-bit) | INT | | | • | |
| 4260 | MovReference1Start (32-bit) | DINT | | | • | |
| 4262 | MovReference1Start (16-bit) | INT | | | • | |
| 4268 | MovReference1StopMargin (32-bit) | DINT | | | • | |
| 4270 | MovReference1StopMargin (16-bit) | INT | | | • | |
| 4276 | MovReference2Start (32-bit) | DINT | | | • | |
| 4278 | MovReference2Start (16-bit) | INT | | | • | |
| 4284 | MovReference2StopMargin (32-bit) | DINT | | | • | |
| 4286 | MovReference2StopMargin (16-bit) | INT | | | • | |
| 4212 | MovSpeed (32-bit) | DINT | | | • | |
| 4210 | MovSpeed (16-bit) | INT | | | • | |
| 4220 | MovAcceleration (32-bit) | UDINT | | | • | |
| 4218 | MovAcceleration (16-bit) | UINT | | | • | |
| 4292 | MovTimeValid (32-bit) | DINT | • | | | |
| 4294 | MovTimeValid (16-bit) | INT | • | | | |
| 4300 | MovPosition (32-bit) | DINT | • | | | |
| 4302 | MovPosition (16-bit) | INT | • | | | |
| Communication - SSI | | | | | | |
| 2084 | SSITimeValid (32-bit) | DINT | • | | | |
| 2086 | SSITimeValid (16-bit) | INT | • | | | |
| 2092 | SSITimeChanged (32-bit) | DINT | • | | | |
| 2094 | SSITimeChanged (16-bit) | INT | • | | | |
| 2100 | SSIPosition (32-bit) | (U)DINT | • | | | |
| 2102 | SSIPosition (16-bit) | UINT | • | | | |
| Communication - Universal counter | | | | | | |
| 6303 | LatchCount | SINT | • | | | |
| 6308 | CounterTimeValid (32-bit) | DINT | • | | | |
| 6310 | CounterTimeValid (16-bit) | INT | • | | | |
| 6324 | Counter01TimeChanged (32-bit) | DINT | • | | | |
| 6326 | Counter01TimeChanged (16-bit) | INT | • | | | |
| 6332 | Counter02TimeChanged (32-bit) | DINT | • | | | |
| 6334 | Counter02TimeChanged (16-bit) | INT | • | | | |
| 6340 | CounterValue01 (32-bit) | DINT | • | | | |
| 6342 | CounterValue01 (16-bit) | INT | • | | | |
| 6348 | CounterValue02 (32-bit) | DINT | • | | | |
| 6350 | CounterValue02 (16-bit) | INT | • | | | |
| 6356 | CounterLatch01 (32-bit) | DINT | • | | | |
| 6358 | CounterLatch01 (16-bit) | INT | • | | | |
| 6364 | CounterLatch02 (32-bit) | DINT | • | | | |
| 6366 | CounterLatch02 (16-bit) | INT | • | | | |
| 6372 | CounterRel01 (32-bit) | DINT | • | | | |
| 6374 | CounterRel01 (16-bit) | INT | • | | | |
| 6380 | CounterRel02 (32-bit) | DINT | • | | | |
| 6382 | CounterRel02 (16-bit) | INT | • | | | |

9.16.4.12.3 General

9.16.4.12.3.1 Use with Automation Studio

The module is supported via X2X Link and POWERLINK.

X2X Link supports a maximum of 28 bytes of synchronous cyclic data per module. To optimize use and avoid needless data transfer, data points can be adjusted as needed in Automation Studio, i.e. unnecessary data points can be disabled, and the bit width of data points can be set.

9.16.4.12.3.2 Timestamp function

The timestamp function is based on synchronized timers. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

Conversely, the CPU can predefine output events, apply a timestamp and transfer them to the module. The module then executes the predefined action at the precise moment defined by the CPU.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

The resolution of the timestamp is up to $1/8 \mu\text{s}$ in both directions.

Synchronization jitter

Because the CPU – which specifies the X2X NetTime – and the module have different clocks, the module's internal X2X NetTime must be synchronized with the CPU's NetTime. Due to this synchronization, the module's internal X2X NetTime is corrected by a maximum of $1/8 \mu\text{s}$ per system cycle if necessary. This synchronization jitter becomes noticeable when using the NetTime with $1/8 \mu\text{s}$ resolution (max. $\pm 1/8 \mu\text{s}$).

If a 100% exact $1/8 \mu\text{s}$ resolution without jitter is required, then the "localtime $1/8 \mu\text{s}$ " must be used (see register "[CfO_EdgeDetectUnitMode](#)" on page 1940).

9.16.4.12.4 General registers

9.16.4.12.4.1 Defining the moment for generating synchronous input data

Name:

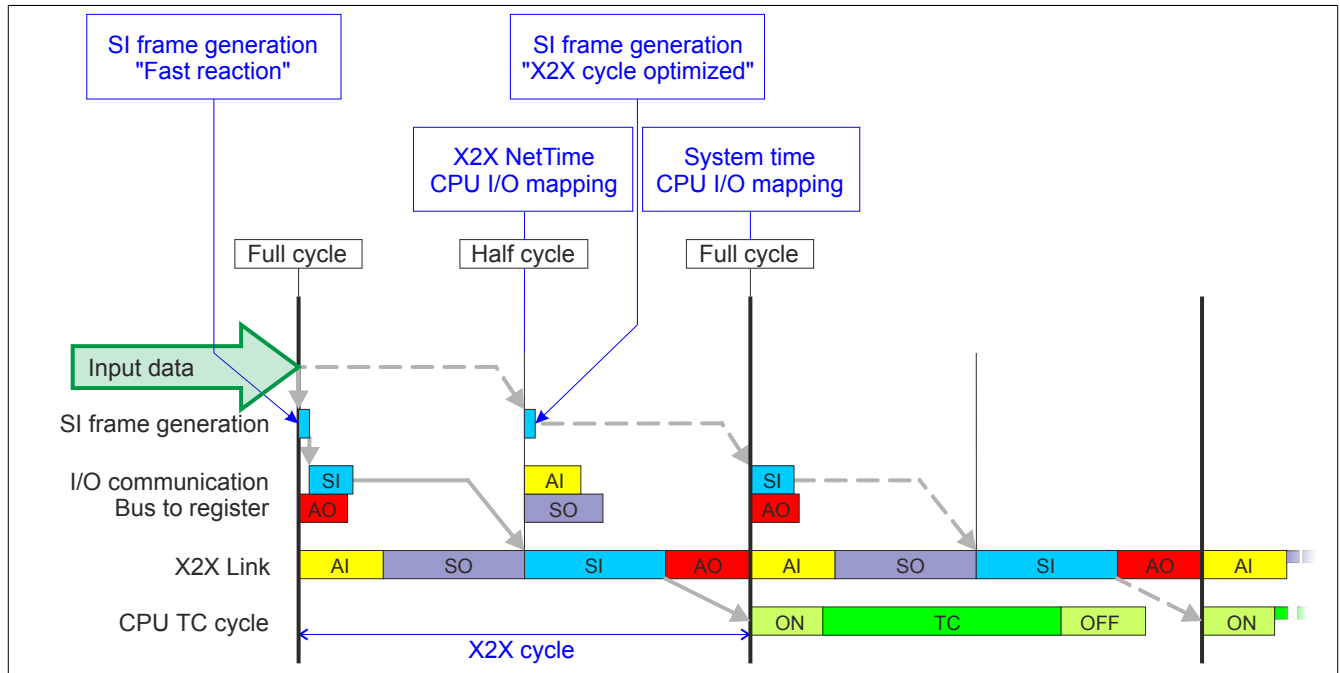
CfO_SlframeGenID

"SI frame generation" in the Automation Studio I/O configuration.

When the synchronous input data is generated for transfer is defined in this register. This has a decisive effect on the timing of the input data.

Setting "Fast reaction" causes the input data to be available one X2X cycle sooner in the CPU. However, this setting also has a negative effect on the minimum X2X cycle time.

| Data type | Values | Information |
|-----------|--------|---------------------|
| USINT | 9 | X2X cycle optimized |
| | 14 | Fast reaction |



9.16.4.12.4.2 Number of X2X protocol errors

Name:

ProtocolError

This register contains an error counter that specifies the number of X2X protocol errors. In the I/O configuration, parameter "Network information" can be used to help configure a data point for this register with a bit width of 8 or 16 bits in the I/O mapping.

| Data type | Values | Information |
|-----------|------------|------------------------|
| USINT | 0 to 255 | Error counter (8-bit) |
| UINT | 0 to 65535 | Error counter (16-bit) |

9.16.4.12.4.3 Number of X2X sequence violations

Name:

ProtocolSequenceViolation

This register contains an error counter that specifies the number of X2X sequence violations. In the I/O configuration, parameter "Network information" can be used to help configure a data point with a bit width of 8 or 16 bits in the I/O mapping.

| Data type | Values | Information |
|-----------|------------|------------------------|
| USINT | 0 to 255 | Error counter (8-bit) |
| UINT | 0 to 65535 | Error counter (16-bit) |

9.16.4.12.4.4 System clock counter for checking the validity of the data frame

Name:

SDCLifeCount

Counter that is incremented with each system timer cycle. "SDC information" in the Automation Studio I/O configuration can be used to enable this register in the I/O mapping as data point "SDCLifeCount".

The 8-bit counter register is needed for the SDC software package. It is incremented with the system clock to allow the SDC to check the validity of the data frame.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

9.16.4.12.5 Error handling

If one of the functions detects an error, then an error bit is set in one of the error state registers. The application is now able to react to this and acknowledge the errors by setting a respective bit in the "Acknowledge error message" registers. This causes the bit to be reset in the error state register. If the error source persists, then the error bit is set again as soon as the error is detected again (i.e. resetting is not possible).

Error acknowledgment has no effect on the functionality of the module. The module resumes processing, automatically if possible, as soon as the error source is eliminated.

If an error occurs (not a warning), this is indicated by the red "e" LED on the module (double flash). This signal is automatically acknowledged as soon as the error source has been eliminated.

9.16.4.12.5.1 Error state - Output data and edge detection

Name:

OutputControlError

OutputCopyError

EdgeDetectError

Data output errors and cycle time setting errors are indicated in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------|-------|---|
| 0 - 3 | Reserved | - | |
| 4 | OutputControlError | 0 | No error |
| | | 1 | The module did not receive new data in time when "Output control mode = Single", meaning that a bit that has already been output would have been output again by the output control buffer. |
| 5 | OutputCopyError | 0 | No error |
| | | 1 | Oversampling output data could not be copied to the output control buffer (attempted to write to an address outside the oversample output window , for example). |
| 6 | EdgeDetectError | 0 | No error |
| | | 1 | Edge detection cycle time violation: "EdgeDetectPollCycle" must be $\leq 255 \mu\text{s}$. This error is occurs if the cycle set in register "CfO_EdgeDetectPollCycleID" on page 1938 is $> 255 \mu\text{s}$. |
| 7 | Reserved | - | |

9.16.4.12.5.2 Error state - SSI

Name:

SSICycleTimeViolation

SSIParityError

SSI interface errors are indicated in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------|-------|---|
| 0 | SSICycleTimeViolation | 0 | No error |
| | | 1 | An error occurred. Possible causes: <ul style="list-style-type: none"> SSI transfer takes longer than the set "update cycle". Monostable multivibrator testing is enabled, and the SSI data line does not take on the defined level at the end of the transfer. |
| 1 | SSIParityError | 0 | No error |
| | | 1 | SSI parity error |
| 2 - 7 | Reserved | - | |

9.16.4.12.5.3 Error state - Motion functions

Name:

MovFifoEmpty

MovFifoFull

MovTargetTimeViolation

MovMaxFrequencyViolation

Motion function errors are indicated in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------|-------|---|
| 0 | MovFifoEmpty | 0 | No error |
| | | 1 | The position/timestamp FIFO buffer is empty. |
| 1 | MovFifoFull | 0 | No error |
| | | 1 | The position/timestamp FIFO buffer has overshot the size set in register "FifoSize" on page 1944. |
| 2 | MovTargetTimeViolation | 0 | No error |
| | | 1 | This occurs if the moment set in register "MovTargetTime" on page 1949 is already in the past. |
| 3 | MovMaxFrequencyViolation | 0 | No error |
| | | 1 | The maximum output frequency setpoint has overshot the maximum frequency set in register "CfO_SpeedLimit" on page 1945. |
| 4 - 7 | Reserved | - | |

9.16.4.12.5.4 Acknowledging error messages - Output data and edge detection

Name:

QuitOutputControlError

QuitOutputCopyError

QuitEdgeDetectError

Error messages from register "Error state - Output data and edge detection" on page 1924 can be acknowledged by setting the corresponding bits in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------|-------|-------------------|
| 0 - 3 | Reserved | - | |
| 4 | QuitOutputControlError | 0 | No change |
| | | 1 | Acknowledge error |
| 5 | QuitOutputCopyError | 0 | No change |
| | | 1 | Acknowledge error |
| 6 | QuitEdgeDetectError | 0 | No change |
| | | 1 | Acknowledge error |
| 7 | Reserved | - | |

9.16.4.12.5.5 Acknowledging error messages - SSI

Name:

SSIQuitCycleTimeViolation

SSIQuitParityError

Error messages from register "Error state - SSI" on page 1925 can be acknowledged by setting the corresponding bits in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------------------|-------|-------------------|
| 0 | SSIQuitCycleTimeViolation | 0 | No change |
| | | 1 | Acknowledge error |
| 1 | SSIQuitParityError | 0 | No change |
| | | 1 | Acknowledge error |
| 2 - 7 | Reserved | - | |

9.16.4.12.5.6 Acknowledging error messages - Motion functions

Name:

MovQuitFifoEmpty

MovQuitFifoFull

MovQuitTargetTimeViolation

MovQuitMaxFrequencyViolation

Error messages from register "Error state - Motion functions" on page 1925 can be acknowledged by setting the corresponding bits in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------------|-------|-------------------|
| 0 | MovQuitFifoEmpty | 0 | No change |
| | | 1 | Acknowledge error |
| 1 | MovQuitFifoFull | 0 | No change |
| | | 1 | Acknowledge error |
| 2 | MovQuitTargetTimeViolation | 0 | No change |
| | | 1 | Acknowledge error |
| 3 | MovQuitMaxFrequencyViolation | 0 | No change |
| | | 1 | Acknowledge error |
| 4 - 7 | Reserved | - | |

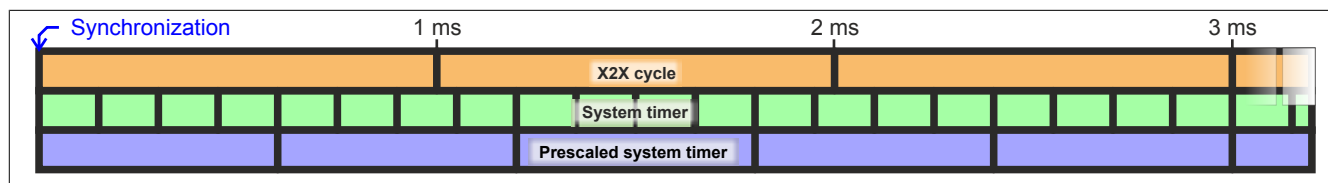
9.16.4.12.6 System timer

The module's individual functions all depend on a system timer. This internal "system cycle time" can be set from 25 to 255 μ s. The functions can also be run using a configurable "prescaled system timer" to minimize the load on the module, thereby making it possible to use the shortest possible X2X cycle time.

The cycle of the "prescaled system timer" (and system timer) is referenced with the X2X Link as soon as the module has been started up and the X2X Link has been initialized. Since the system timer and the module's internal **NetTime** use the same clock, the two run synchronously from that point on. An X2X cycle time that is not a multiple of the system cycle time results in an offset, which can be calculated, however.

The following values apply to the following example:

| | |
|------------------------|-------------|
| X2X cycle | 1 ms |
| System timer | 150 μ s |
| Prescaled system timer | 4 |



9.16.4.12.6.1 Setting the cycle time of the system timer

Name:

CfO_SystemCycleTime

"Cycle time" in the Automation Studio I/O configuration.

The cycle time of the system timer can be set in steps of $1/8 \mu\text{s}$ in this register. The value entered in the Automation Studio I/O configuration is automatically multiplied by 8.

Information:

A setting $<50 \mu\text{s}$ has a negative effect on the minimum X2X cycle time!

| Data type | Values | Information |
|-----------|-------------|--|
| UINT | 200 to 2047 | System timer cycle time in steps of $1/8 \mu\text{s}$ (25 to 255.875 μs) |

9.16.4.12.6.2 Offsetting the synchronization moment of the system cycle

Name:

CfO_SystemCycleOffset

"Cycle offset" in the Automation Studio I/O configuration.

The synchronization moment for the system cycle can be offset in steps of $1/8 \mu\text{s}$ in this register. The value entered in the Automation Studio I/O configuration is automatically multiplied by 8.

| Data type | Values | Information |
|-----------|-----------------|---|
| INT | -32768 to 32767 | Cycle offset in steps of $1/8 \mu\text{s}$ (-4096 to 4095.875 μs) |

9.16.4.12.6.3 Configuration of the cycle prescaler

Name:

CfO_SystemCyclePrescaler

"Cycle prescaler" in the Automation Studio I/O configuration.

The prescaler for setting the [prescaled system timer](#) can be configured in this register. The cycle time of the specified system timer is a product of the system timer multiple set in this register.

The "prescaled system timer" can be used as an alternative time source for the individual functions. This is useful if a function requires a very short system cycle. To reduce the load on the module in such a situation, other functions can be processed in a slow cycle.

| Data type | Values | Information |
|-----------|----------|------------------------------|
| UINT | 2 to 128 | Multiple of the system timer |

9.16.4.12.7 Physical I/O configuration

9.16.4.12.7.1 Configuring the I/O channels

Name:

CfO_PhyIOConfigCh01 to CfO_PhyIOConfigCh05

Each physical I/O channel can be configured individually in these registers.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------------------------|---------|--|
| 0 | Push driver ¹⁾ | 0 | Disabled |
| | | 1 | Enabled, see Output signals . |
| 1 | Pull driver ¹⁾ | 0 | Disabled |
| | | 1 | Enabled, see Output signals . |
| 2 | Input inverted | 0 | Not inverted |
| | | 1 | Inverted |
| 3 | Output inverted ¹⁾ | 0 | Not inverted |
| | | 1 | Inverted, see Output signals . |
| 4 - 7 | Output function ¹⁾ | 0 to 15 | See Overview of output channel functions . |

1) Only available for I/O channels 1 to 3

Overview of output channel functions

| Values of bits 4 to 7 | Output channel 1 | Output channel 2 | Output channel 3 |
|-----------------------|-------------------------------|-------------------------------|-------------------------------|
| 0 | Direct I/O | Direct I/O | Direct I/O |
| 1 | | SSI clock output | |
| 2 | ABR emulation (A) | ABR emulation (B) | ABR emulation (reference) |
| 3 | Up/Down emulation (direction) | Up/Down emulation (frequency) | Up/Down emulation (reference) |
| 4 - 15 | Reserved | | |

Output signals

For I/O channels 1 to 3, output signals can be operated in mode "Push", "Pull" and "Push-Pull". Output inversion is also available. This results in the following possibilities for the output signals of channels 1 to 3 and channels 1\ to 3\:

| Signal to be output | Signal on output channel x or x\ | | | | | |
|----------------------------|----------------------------------|----------|--------------------|----------|-------------------------|----|
| | Push ¹⁾ | | Pull ²⁾ | | Push-Pull ³⁾ | |
| | x | x\ | x | x\ | x | x\ |
| 0 | Tristate | Tristate | 0 | 1 | 0 | 1 |
| 1 | 1 | 0 | Tristate | Tristate | 1 | 0 |
| 0 (inverted) ⁴⁾ | 1 | 0 | Tristate | Tristate | 1 | 0 |
| 1 (inverted) ⁴⁾ | Tristate | Tristate | 0 | 1 | 0 | 1 |

- 1) Bit 0 = 1
- 2) Bit 1 = 1
- 3) Bits 0 and 1 = 1
- 4) Bit 3 = 1

9.16.4.12.8 Direct I/O

Direct I/O makes it possible to use the physical I/Os like normal I/Os. Additionally, the application can only set or reset I/Os (e.g. an output channel is set by the edge generator and manually reset by the application).

9.16.4.12.8.1 Direct operation of the output channel - Reset

Name:

CfO_DirectIOClearMask0_7

"Direct operation of output channel 01" to "Direct operation of output channel 03" in the Automation Studio I/O configuration.

If the bit for the respective channel is set in this register, then the output is reset as soon as its direct I/O output channel (register "DigitalOutput" on page 1929 or "DigitalOutput0x" in the Automation Studio I/O mapping) is reset.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------|-------|---------------|
| 0 | Output channel 0 | 0 | No change |
| | | 1 | Reset channel |
| 1 | Output channel 1 | 0 | No change |
| | | 1 | Reset channel |
| 2 | Output channel 2 | 0 | No change |
| | | 1 | Reset channel |
| 3 - 7 | Reserved | - | |

9.16.4.12.8.2 Direct operation of the output channel - Set

Name:

CfO_DirectIOSetMask0_7

"Direct operation of output channel 01" to "Direct operation of output channel 03" in the Automation Studio I/O configuration.

If the bit for the respective channel is set in this register, then the output is set as soon as its direct I/O output channel (register "[DigitalOutput](#)" on page 1929 or "[DigitalOutput0x](#)" in the Automation Studio I/O mapping) is set.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------|-------|-------------|
| 0 | Output channel 0 | 0 | No change |
| | | 1 | Set channel |
| 1 | Output channel 1 | 0 | No change |
| | | 1 | Set channel |
| 2 | Output channel 2 | 0 | No change |
| | | 1 | Set channel |
| 3 - 7 | Reserved | - | |

9.16.4.12.8.3 Direct operation of the output channel - Moment of data output

Name:

CfO_OutputUpdateCycle

The moment when data is output is set with this register.

| Data type | Values | Information |
|-----------|--------|-----------------------------------|
| USINT | 10 | X2X cycle optimized (jitter-free) |
| | 15 | Fast reaction (with jitter) |

9.16.4.12.8.4 Output state

Name:

DigitalOutput01 to DigitalOutput03

This register contains the bits for controlling the direct I/O output channels. Depending on the configuration of registers "[CfO_DirectIOClearMask0_7](#)" on page 1928 and "[CfO_DirectIOSetMask0_7](#)" on page 1929, the digital outputs are set to the status of the respective bit in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------|--------|-----------------------------|
| 0 | DigitalOutput01 | 0 or 1 | Output state of the channel |
| 1 | DigitalOutput02 | 0 or 1 | Output state of the channel |
| 2 | DigitalOutput03 | 0 or 1 | Output state of the channel |
| 3 - 7 | Reserved | - | |

9.16.4.12.8.5 Input state

Name:

DigitalInput01 to DigitalInput05

The state of the digital input channels is contained in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------|--------|--------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input state of channel 1 |
| 1 | DigitalInput02 | 0 or 1 | Input state of channel 2 |
| 2 | DigitalInput03 | 0 or 1 | Input state of channel 3 |
| 3 | Reserved | - | |
| 4 | DigitalInput04 | 0 or 1 | Input state of channel 4 |
| 5 | DigitalInput05 | 0 or 1 | Input state of channel 5 |
| 6 - 7 | Reserved | - | |

9.16.4.12.9 Oversampled I/O

"Oversampled I/O" is based on input status buffers and output control buffers. The input data acquisition and output control occur in one sample cycle (one sample cycle corresponds to one bit in the buffer). The precise moment of an input buffer entry is indicated by its position in the buffer and the **NetTime** assigned to the buffer.

When "Output control mode = Single", every output buffer entry is marked as invalid once it has been executed. This ensures that the outputs are not supplied with invalid data. In this mode, the application needs to ensure that the module is always supplied with valid data.

When using "Output control mode = Continuous" the contents of the buffer are output again if the module is not supplied with new oversample output data.

9.16.4.12.9.1 Addressing the output control buffer

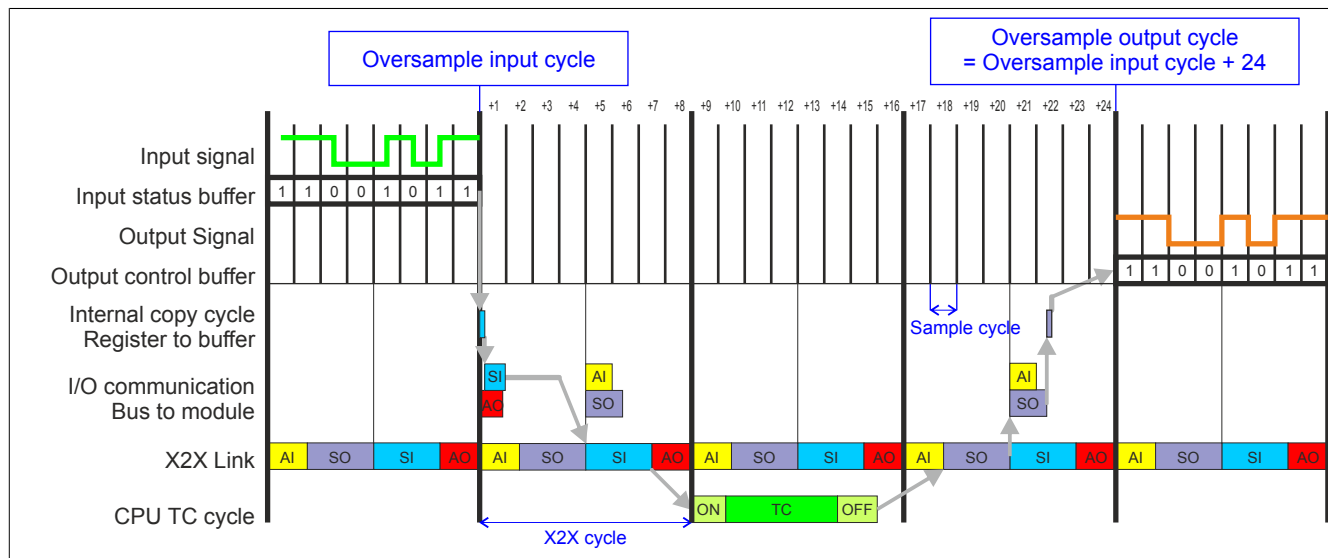
The module has one cyclic 256-bit output control buffer for each oversample channel. One bit is output from these buffers to the configured physical output channels in each "sample cycle". When new data is transferred to one of these buffers, the application must define where in the respective buffer the data should be written to. There are 2 possibilities available for this (absolute or relative "Output mode" in the Automation Studio I/O configuration).

Absolute addressing of the output control buffer

With absolute addressing, in each cycle where "OversampleOutputValidate = True", in addition to the oversample output sample data (in the "OversampleOutput0NSample" on page 1937 registers) an address must also be transferred in register "OversampleOutputCycle" on page 1936. This address defines where in the output control buffer the new data should be copied. In order to calculate this address, the contents of register "OversampleInputCycle" on page 1937, which contains the address of the most recently output data, and the transfer time to the module must be taken into account. To help avoid incorrect addressing of the output control buffer, the buffer section that is capable of being written to can be limited using register "OversampleOutputWindow" on page 1934. This window will always be shifted relative to the current sample address. An "OutputCopyError" will be triggered if an attempt is made to write to an address that is outside of this window.

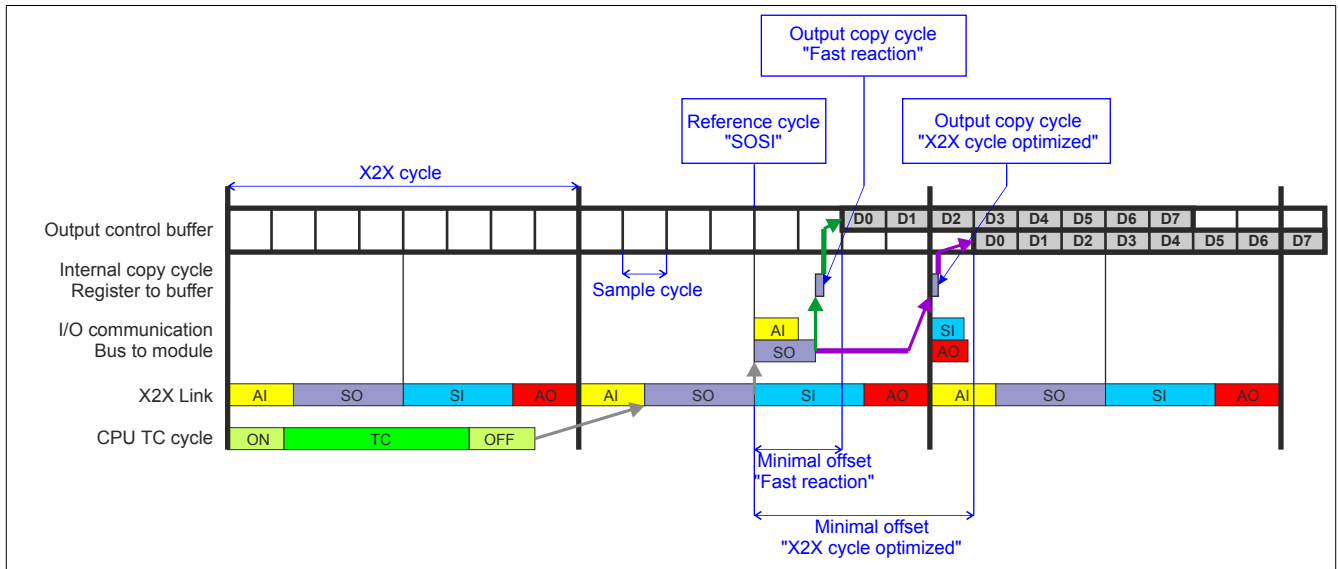
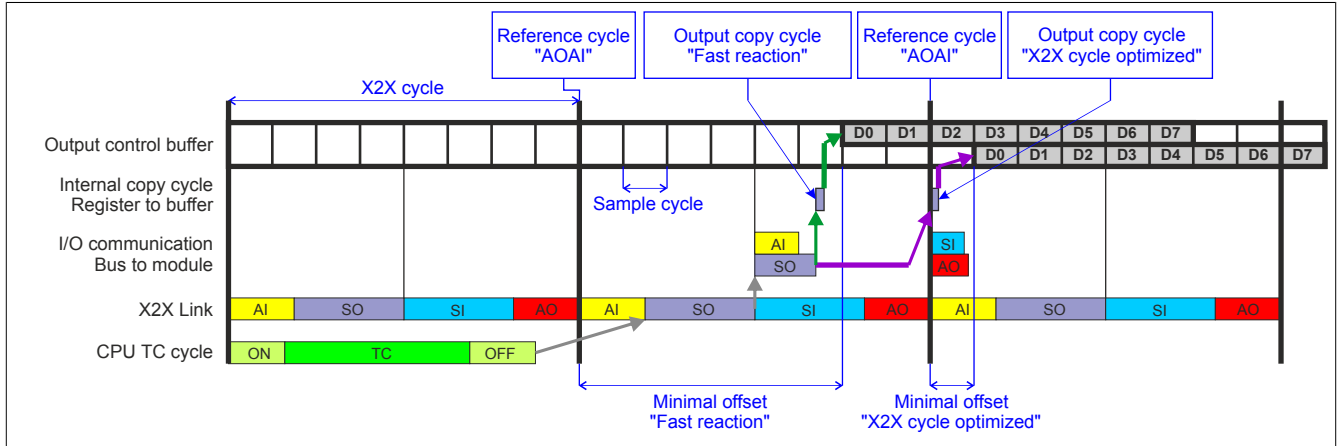
Example

Timing characteristics from the oversample input cycle to the oversample output cycle in absolute output mode ("SI frame generation = Fast reaction", "Output copy cycle = Fast reaction", 8 samples per X2X cycle):



Relative addressing of the output control buffer

When "OversampleOutputValidate = True", then the oversample output sample data is automatically copied to an address relative to the last referenced address at the set output copy cycle moment. Register "OversampleSampleOffset" on page 1936 serves as the offset. The new data cannot start being output immediately at the output copy cycle moment because it takes time to copy the data from the registers to the buffer. This means that an offset of 0 is not allowed. The relative output control buffer address + offset must point to an address within the "oversample output window". The oversample output window is always offset relative to the current sample address. An OutputCopyError is triggered if an attempt is made to write to an address that is outside of this window.



9.16.4.12.9.2 Configuring the output control buffers

Name:

CfO_OversampleMode

"Output mode" in the Automation Studio I/O configuration

"Output control mode" in the Automation Studio I/O configuration

The output control buffer can be configured globally for all channels in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---|-------|--|
| 0 | Addressing the output control buffer "Output mode" | 0 | Absolute addressing of the output control buffer |
| | | 1 | Relative addressing of the output control buffer |
| 1 | Cyclic output control "Output control mode" | 0 | One-time Output control buffer entry is marked invalid after execution. |
| | | 1 | Continuous Output control buffer entry is not changed. |
| 2 - 7 | Reserved | - | |

Cyclic output control

If cyclic output control is enabled, then all data in the output control buffer is marked invalid as soon as it is output ("Output control mode = Single"). An [OutputControlError](#) is generated if the module does not receive data in time, thereby causing a situation in which a bit that has already been output would be output in the buffer again. In this type of error situation, the output takes on the "Output default state" configured in register "[CfO_OversampleConfigOutput](#)" on page 1935.

If cyclic output control is disabled, then the data is output again if the output control buffer overflows ("Output control mode = Continuous").

Information:

All 256 bits of the output control buffer are always output.

9.16.4.12.9.3 Configuration of the source for the sample cycle

Name:

CfO_OversampleSampleCycleID

"Sample cycle" in the Automation Studio I/O configuration.

The source for the sample cycle is configured in this register. During each sample cycle, one bit from the output control buffers of the oversampled I/O channels is output to the configured physical output, and the status of the configured inputs is read into one bit of the respective input status buffer.

| Data type | Values | Information |
|-----------|--------|---|
| USINT | 2 | System timer The value set in register " CfO_SystemCycleTime " on page 1927 is used as the sample cycle. |
| | 3 | Prescaled system timer The "prescaled system timer" is used as sample cycle. |
| | 10 | AOAI The sample cycle is clocked with the AOAI interrupt of the X2X cycle. |
| | 14 | SOSI The sample cycle is clocked with the SOSI interrupt of the X2X cycle. |

9.16.4.12.9.4 Configuration of the source for the user interface reference cycle

Name:

CfO_OversampleRelativeCycleID

"Reference cycle" in the Automation Studio I/O configuration.

The source for the user interface reference cycle is configured in this register.

- The input data is referenced at the moment of the reference cycle. The referenced data is then copied to the "oversample input sample register" on page 1938 at the moment of SI frame generation, taking into account the oversample input window.
- With relative addressing of the output control buffer, the new sample data is copied to an address relative to the output control buffer address current to the "reference cycle".
- The reference cycle is also used to reference the sample cycle and thus the output data production and input data acquisition (e.g. to the X2X cycle).

| Data type | Values | Information |
|-----------|--------|--|
| USINT | 2 | System timer The value set in register "CfO_SystemCycleTime" on page 1927 is used as the reference cycle. |
| | 3 | Prescaled system timer The prescaled system timer is used as sample cycle. |
| | 10 | AOAI The sample cycle is referenced with the AOAI interrupt of the X2X cycle. |
| | 14 | SOSI The sample cycle is referenced with the SOSI interrupt of the X2X cycle. |

9.16.4.12.9.5 Defining the moment for copying the data to the output control buffer

Name:

CfO_OversampleConsumeCycleID

"Output copy cycle" in the Automation Studio I/O configuration.

At the time of the output copy cycle, data is copied from the "OversampleOutput0NSample" on page 1937 registers into the output control buffer.

When "Output copy cycle = Fast reaction", it is not possible to determine when the data is copied to the output control buffer in either of the two addressing modes. The copy cycles will experience a certain degree of jitter depending on the module load. However, this only affects the moment of the internal copy procedures and therefore the moment of the earliest possible output sample. This will not affect the quality of the output signal. However, "Output copy cycle = Fast reaction" also has a negative effect on the minimum X2X cycle time.

When using the setting "Output copy cycle = X2X cycle optimized", be aware that the sample data cannot start being output immediately at the "Output copy cycle" time due to the internal copy cycle to the output control buffers.

| Data type | Values | Information |
|-----------|--------|---|
| USINT | 10 | X2X cycle optimized The output data is copied to the output control buffer with the AOAI interrupt of the X2X cycle. |
| | 15 | Fast reaction The output data is copied to the output control buffer immediately after being received. |

9.16.4.12.9.6 Number of output bits to be transferred

Name:

CfO_OversampleOutputBits

"User interface size" in the Automation Studio I/O configuration.

Specifies how many bits are transferred from the "OversampleOutput0NSample" on page 1937 registers to the output control buffers at the output copy cycle moment.

| Data type | Values | Information |
|-----------|---------|-------------|
| USINT | 1 to 64 | Output bits |

9.16.4.12.9.7 Number of input bits to be transferred

Name:

CfO_OversampleInputBits

"User interface size" in the Automation Studio I/O configuration.

Specifies how many bits are transferred from the input status buffer to the "OversampleInput0NSample" on page 1938 registers during SI frame generation.

| Data type | Values | Information |
|-----------|---------|-------------|
| USINT | 1 to 64 | Input bits |

9.16.4.12.9.8 Write area in the output control buffer

Name:

CfO_OversampleOutputWindow

"Output control mode" in the Automation Studio I/O configuration.

Defines the area in the output control buffer to which data is permitted to be written. The window is always offset relative to the current sample position. (a value of 128, for example, means that the 128 bits following the current sample cycle can be written to). An [OutputCopyError](#) is triggered if an attempt is made to write output sample data to a location outside of this window.

In Automation Studio, the value for this register is set to 128 bits with "Output control mode = Single" and to 255 bits with "Output control mode = Continuous".

| Data type | Values | Information |
|-----------|----------|---------------|
| USINT | 0 to 255 | Output window |

9.16.4.12.9.9 Defining the moment for referencing input data

Name:

CfO_OversampleInputWindow

"Input mode" in the Automation Studio I/O configuration.

The "oversample input window" defines when the input data is referenced. It is located chronologically before [SI frame generation](#). If the reference moment ("reference cycle" on page 1933) is within this window, then the referenced data from the input status buffer is copied to register "OversampleInput0NSample" on page 1938. If the moment at which the reference occurs is outside the "oversample input window" then the data that is most recent at the moment of "SI frame generation" is copied from the input status buffer to register "OversampleInput0NSample" on page 1938.

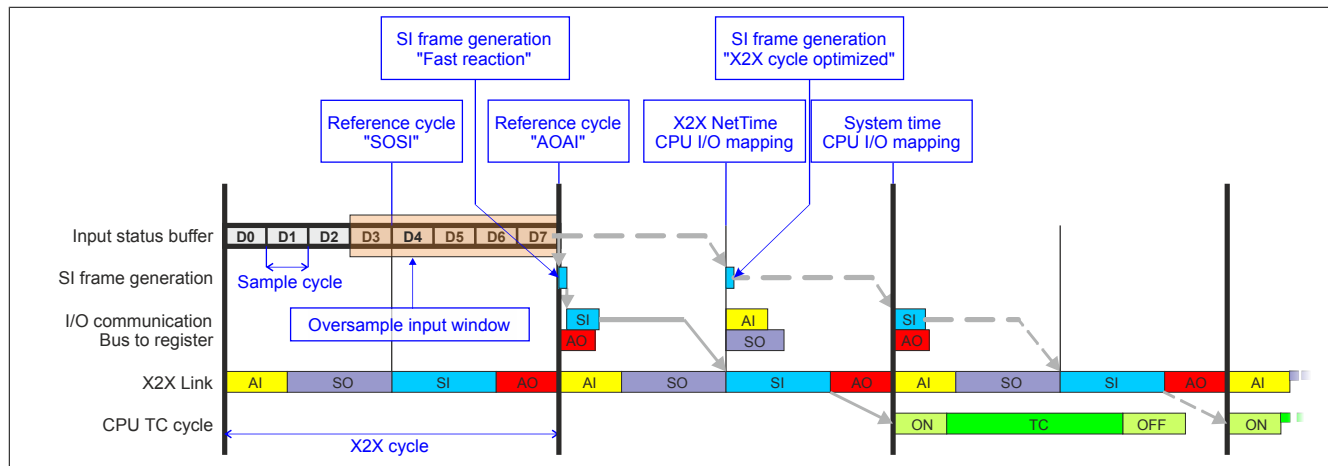
This register is limited internally to the value from register "CfO_OversampleInputBits" on page 1933.

Information:

As a result, the [oversample input time](#) and [oversample input cycle](#) are set either at the reference time or at the moment of "SI frame generation".

In Automation Studio, the value for this register is set to 63 with "Input mode = Referenced values" and to 0 with "Input mode = Most recent values".

| Data type | Values | Information |
|-----------|---------|--------------|
| USINT | 0 to 63 | Input window |



9.16.4.12.9.10 Configuring the outputs of the oversampling channels

Name:

CfO_OversampleConfigOutput

"Oversample I/O 01 → Output" to "Oversample I/O 04 → Output" in the Automation Studio I/O configuration

"Oversample I/O 01 → Output control" to "Oversample I/O 04 → Output control" in the Automation Studio I/O configuration

"Oversample I/O 01 → Output default value" to "Oversample I/O 04 → Output default value" in der Automation Studio I/O configuration

This register helps configure the outputs of the individual oversample channels.

The "Output default state" bits define which level the respective output takes on before oversampling is started. In addition, the output is set to the defined "Output default state" in the event of an error.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---|-------|---|
| 0 - 3 | Number of the physical output channel "Oversample I/O 0x → Output" | 0 | Output channel 1 |
| | | 1 | Output channel 2 |
| | | 2 | Output channel 3 |
| 4 | Output: Clear "Oversample I/O 0x → Output control" | 0 | Output cannot be reset by the oversample channel. |
| | | 1 | Output can be reset by the oversample channel. |
| 5 | Output: Set "Oversample I/O 0x → Output control" | 0 | Output cannot be set by the oversample channel. |
| | | 1 | Output can be set by the oversample channel. |
| 6 | Default output state: Clear "Oversample I/O 0x → Output default value" | 0 | Output not cleared by default |
| | | 1 | Output cleared by default |
| 7 | Default output state: Set "Oversample I/O 0x → Output default value" | 0 | Output not set by default |
| | | 1 | Output set by default |

9.16.4.12.9.11 Assigning between the physical input channel and oversample I/O input

Name:

CfO_OversampleConfigInput

"Oversample I/O 01 → Input" to "Oversample I/O 04 → Input" in the Automation Studio I/O configuration.

Which physical input channel an oversample I/O input should be linked to is defined in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------------------|-------|-----------------|
| 0 - 3 | Number of the physical input channel | 0 | Input channel 1 |
| | | 1 | Input channel 2 |
| | | 2 | Input channel 3 |
| | | 3 | Reserved |
| | | 4 | Input channel 4 |
| | | 5 | Input channel 5 |
| 4 - 7 | Reserved | - | |

9.16.4.12.9.12 Oversampling configuration

Name:

OversampleEnable

OversampleOutputValidate

The oversampling and copy process for the output buffer can be configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------|-------|--|
| 0 | OversampleEnable | 0 | Disables oversampling (with the next reference cycle) |
| | | 1 | Enables oversampling (with the next reference cycle) |
| 1 | OversampleOutputValidate | 0 | Disable the copy procedure to the output control buffer. |
| | | 1 | Enables the copy procedure to the output control buffer. <ul style="list-style-type: none"> Used to synchronize the oversampling procedure at startup. This makes it possible to prevent new data from being transferred to the "OversampleOutput0NSample" on page 1937 registers in each X2X cycle. |
| 2 - 7 | Reserved | - | |

9.16.4.12.9.13 Address of the new output sampling data in the output control buffer

Name:

OversampleOutputCycle

When absolute addressing of the output control buffer is being used, this register specifies the address from which the new output sample data should be copied to the output control buffer.

| Data type | Values | Information |
|-----------|----------|--------------------------------------|
| USINT | 0 to 255 | Address of the output control buffer |

9.16.4.12.9.14 Offset of new output sample data

Name:

OversampleSampleOffset

When relative addressing of the output control buffer is being used, this register serves as the offset for the new output sample data. (Sample address at the time of the [reference cycle](#) + Offset = Address to which the new output sample data is copied in the output control buffer).

| Data type | Values | Information |
|-----------|----------|------------------------------|
| USINT | 0 to 255 | Offset of output sample data |

9.16.4.12.9.15 Oversample output sample data

Name:

OversampleOutput01Sample1_8 to OversampleOutput04Sample1_8
 OversampleOutput01Sample9_16 to OversampleOutput04Sample9_16
 OversampleOutput01Sample17_24 to OversampleOutput04Sample17_24
 OversampleOutput01Sample25_32 to OversampleOutput04Sample25_32
 OversampleOutput01Sample33_40 to OversampleOutput04Sample33_40
 OversampleOutput01Sample41_48 to OversampleOutput04Sample41_48
 OversampleOutput01Sample49_56 to OversampleOutput04Sample49_56
 OversampleOutput01Sample57_64 to OversampleOutput04Sample57_64

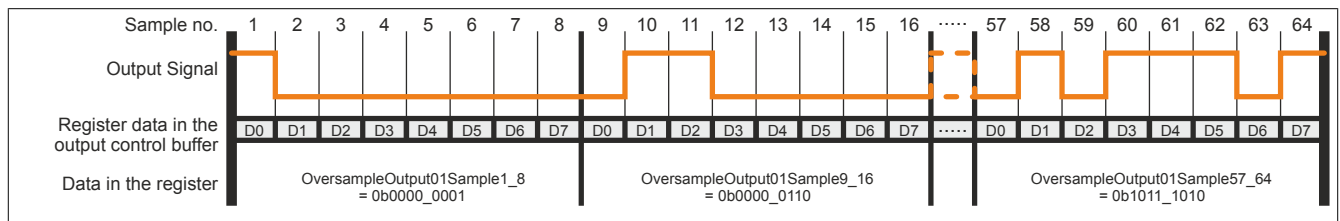
Contains the oversample output sample data. Up to 64 samples (8 bytes) for each oversample I/O channel can be synchronously transferred with a X2X cycle. This data is copied to the specified address (absolute or relative) in the output control buffer at the set [output copy cycle](#). 1 bit of this data is then output during each "sample cycle" to the physical output that is assigned to the oversample I/O channel.

Bit 0 of "OversampleOutputSample8_1" is copied to the output control buffer first, meaning that it is the first bit that is output. "OversampleOutputSample64_57" bit 7 is the last bit to be output.

| Data type | Values | Information |
|-----------|----------|--------------------|
| USINT | 0 to 255 | Output sample data |

Example

Assignment of "OversampleOutputSample" register data to output signal



9.16.4.12.9.16 X2X NetTime of the input data

Name:

OversampleInputTime

This register contains the 2 low-order bytes of the X2X NetTime from the moment at which the oversample input data was referenced. This provides an easy way to accurately calculate the moment of each individual input sample.

For more information about NetTime and timestamps, see ["NetTime Technology"](#) on page 3035.

| Data type | Values | Information |
|-----------|-----------------|---|
| INT | -32768 to 32767 | X2X NetTime of the input data in microseconds |

9.16.4.12.9.17 Input status buffer address of the input sample data

Name:

OversampleInputCycle

This register contains the input status buffer address of the input sample data.

In addition, the value in this register can be used to reference an absolute addressing of the output control buffer.

| Data type | Values | Information |
|-----------|----------|-----------------------------|
| USINT | 0 to 255 | Input status buffer address |

9.16.4.12.9.18 Input sample data

Name:

OversampleInput01Sample8_1 to OversampleInput04Sample8_1
 OversampleInput01Sample16_9 to OversampleInput04Sample16_9
 OversampleInput01Sample24_17 to OversampleInput04Sample24_17
 OversampleInput01Sample32_25 to OversampleInput04Sample32_25
 OversampleInput01Sample40_33 to OversampleInput04Sample40_33
 OversampleInput01Sample48_41 to OversampleInput04Sample48_41
 OversampleInput01Sample56_49 to OversampleInput04Sample56_49
 OversampleInput01Sample64_57 to OversampleInput04Sample64_57

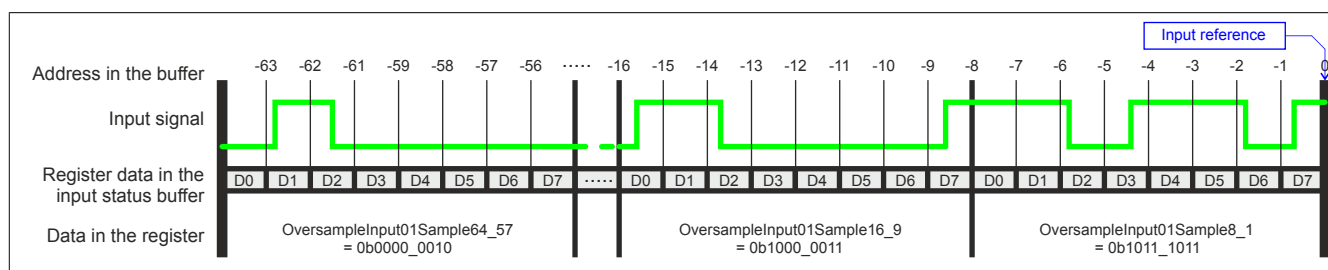
The data of the 4 oversample input status buffers are copied to this register at the moment of **SI frame generation**. A maximum of 64 samples (8 bytes) per oversample I/O channel can be synchronously retrieved from the oversample input status buffer with each X2X cycle.

The most recent input sample bit is stored in "OversampleInputSample8_1" bit 7. The oldest input sample is stored in "OversampleInputSample64_57" bit 0.

| Data type | Values | Information |
|-----------|----------|-------------------|
| USINT | 0 to 255 | Input sample data |

Example

Input signal and resulting data in "OversampleInputSample"



9.16.4.12.10 Edge detection

The module's edge detection function allows edges to be measured with microsecond precision. The concept is based on a maximum of 4 units. One master and one slave edge can be configured for each unit.

At the moment of each master edge, the **NetTime** of the master edge and the **NetTime** of a previous slave edge (if present) are logged. A "master counter" and a "slave counter" can always be used to determine how many edges have been detected since the last X2X cycle.

9.16.4.12.10.1 Configuring the source for the polling cycle

Name:

CfO_EdgeDetectPollCycleID

"Polling cycle" in the Automation Studio I/O configuration.

The source for the polling cycle can be configured in this register.

Information:

The polling cycle must be $\leq 255 \mu\text{s}$. If the configured cycle $> 255 \mu\text{s}$, **EdgeDetectError** occurs.

| Data type | Values | Information |
|-----------|--------|---|
| USINT | 2 | System timer The time set in register "CfO_SystemCycleTime" on page 1927 is used for the polling cycle. |
| | 3 | Prescaled system timer The time set in register "CfO_SystemCyclePrescaler" on page 1927 is used for the polling cycle. |

9.16.4.12.10.2 Edge detection mode

Name:

CfO_EdgeDetectEventEnable

"Edge detection mode" in the Automation Studio I/O configuration.

The bits in this register define on which edges of the individual input channels an interrupt should be triggered for edge detection.

In the Automation Studio I/O configuration, this register is initialized with 0x00000000 when "Edge detection mode = Polling" and with 0xFFFFFFFF when "Edge detection mode = Event-triggered".

In mode "Event-triggered", the [NetTime](#) of each edge is recorded as an interrupt immediately when the edge occurs. However, an extremely large amount of interrupts within a short amount of time can prevent the module from being able to process any other operations in time!

In mode "Polling", only the [NetTime](#) of the first edge that occurs within a polling cycle is recorded. This ensures that the module is not overloaded by too many edges.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|------------------|-------|--|
| 0 | Physical input 1 | 0 | No interrupt triggered on falling edge |
| | | 1 | Interrupt triggered on falling edge |
| 1 | Physical input 2 | 0 | No interrupt triggered on falling edge |
| | | 1 | Interrupt triggered on falling edge |
| 2 | Physical input 3 | 0 | No interrupt triggered on falling edge |
| | | 1 | Interrupt triggered on falling edge |
| 3 | Reserved | - | |
| 4 | Physical input 4 | 0 | No interrupt triggered on falling edge |
| | | 1 | Interrupt triggered on falling edge |
| 5 | Physical input 5 | 0 | No interrupt triggered on falling edge |
| | | 1 | Interrupt triggered on falling edge |
| 6 - 15 | Reserved | - | |
| 16 | Physical input 1 | 0 | No interrupt triggered on rising edge |
| | | 1 | Interrupt triggered on rising edge |
| 17 | Physical input 2 | 0 | No interrupt triggered on rising edge |
| | | 1 | Interrupt triggered on rising edge |
| 18 | Physical input 3 | 0 | No interrupt triggered on rising edge |
| | | 1 | Interrupt triggered on rising edge |
| 19 | Reserved | - | |
| 20 | Physical input 4 | 0 | No interrupt triggered on rising edge |
| | | 1 | Interrupt triggered on rising edge |
| 21 | Physical input 5 | 0 | No interrupt triggered on rising edge |
| | | 1 | Interrupt triggered on rising edge |
| 22 - 31 | Reserved | - | |

9.16.4.12.10.3 Setting the time base, slave edge and master edge

Name:

CfO_EdgeDetectUnit01Mode to CfO_EdgeDetectUnit04Mode

"Time base" in the Automation Studio I/O configuration

"Slave edge" in the Automation Studio I/O configuration

"Master edge" in the Automation Studio I/O configuration

When using a time base with 1/8 μ s resolution, keep in mind that the timestamps produced also have a resolution of exactly 1/8 μ s. The respective conversions must be made for calculating in combination with the CPU system time or X2X NetTime.

In addition, synchronization jitter also plays a role when using "Time base = Nettime resolution 1/8 usec" (see "Synchronization jitter" on page 1922). This means that exactly identical input edges can cause slight differences in the results. If 100% exact 1/8 μ s resolution is required, then "Local resolution 1/8 usec" must be used.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|---|
| 0 - 1 | "Time base" | 0 | Local time 1/8 μ s (Automation Studio: Local resolution 1/8 usec) |
| | | 1 | Local time 1 μ s (Automation Studio: Local resolution 1 usec) |
| | | 2 | NetTime 1/8 μ s (Automation Studio: Nettime resolution 1/8 usec) |
| | | 3 | NetTime 1 μ s (Automation Studio: Nettime resolution 1 usec) |
| 2 - 5 | Reserved | - | |
| 6 | "Slave edge" | 0 | Disabled |
| | | 1 | Enabled |
| 7 | "Master edge" | 0 | Disabled |
| | | 1 | Enabled |

9.16.4.12.10.4 Load position of the slave time from the FIFO buffer

Name:

CfO_EdgeDetectUnit01Leading to CfO_EdgeDetectUnit04Leading

"Slave leading" in the Automation Studio I/O configuration.

When a slave edge occurs, the current NetTime is always saved within the module. A FIFO buffer is provided inside the module that always stores the last 256 slave stamps (even when a master edge occurs).

This value defines the position from which the slave time should be retrieved from the FIFO buffer when a master edge occurs. This can be used to measure average periodic signals over multiple cycles.

| Data type | Values | Information |
|-----------|----------|---|
| USINT | 0 to 255 | Position in the FIFO buffer for slave edges |

9.16.4.12.10.5 Source of the master edge per edge detection unit

Name:

CfO_EdgeDetectUnit01Master to CfO_EdgeDetectUnit01Master

"Master edge" in the Automation Studio I/O configuration.

Defines the source of the master edge for the respective "edge detection unit".

| Data type | Values | Information |
|-----------|--------|----------------------------------|
| USINT | 0 | Rising edge on physical input 1 |
| | 1 | Rising edge on physical input 2 |
| | 2 | Rising edge on physical input 3 |
| | 4 | Rising edge on physical input 4 |
| | 5 | Rising edge on physical input 5 |
| | 16 | Falling edge on physical input 1 |
| | 17 | Falling edge on physical input 2 |
| | 18 | Falling edge on physical input 3 |
| | 20 | Falling edge on physical input 4 |
| | 21 | Falling edge on physical input 5 |

9.16.4.12.10.6 Source of the slave edge per edge detection unit

Name:

CfO_EdgeDetectUnit01Slave to CfO_EdgeDetectUnit04Slave

"Slave edge" in the Automation Studio I/O configuration.

Defines the source of the slave edge for the respective "edge detection unit".

| Data type | Values | Information |
|-----------|--------|----------------------------------|
| USINT | 0 | Rising edge on physical input 1 |
| | 1 | Rising edge on physical input 2 |
| | 2 | Rising edge on physical input 3 |
| | 4 | Rising edge on physical input 4 |
| | 5 | Rising edge on physical input 5 |
| | 16 | Falling edge on physical input 1 |
| | 17 | Falling edge on physical input 2 |
| | 18 | Falling edge on physical input 3 |
| | 20 | Falling edge on physical input 4 |
| | 21 | Falling edge on physical input 5 |

9.16.4.12.10.7 Number of detected master edges

Name:

EdgeDetect01Mastercount to EdgeDetect04Mastercount

Detected master edges are counted in this register.

| Data type | Values | Information |
|-----------|-----------------|--|
| SINT | -128 to 127 | Number of detected master edges (8-bit) |
| INT | -32768 to 32767 | Number of detected master edges (16-bit) |

9.16.4.12.10.8 Number of detected slave edges

Name:

EdgeDetect01Slavecount to EdgeDetect04Slavecount

Continuously counts the detected slave edges. The contents of this register are only updated on a master edge. This counter can detect if several slave edges occur before a master edge.

| Data type | Values | Information |
|-----------|-----------------|---|
| SINT | -128 to 127 | Number of detected slave edges (8-bit) |
| INT | -32768 to 32767 | Number of detected slave edges (16-bit) |

9.16.4.12.10.9 Difference between master and slave edge

Name:

EdgeDetect01Difference to EdgeDetect04Difference

This register contains the time difference between a master edge and the last slave edge addressed by "Slave leading" on page 1940.

| Data type | Values | Information |
|-----------|---------------------------------|---|
| INT | -32768 to 32767 | Slave edge / Master edge time difference (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | Slave edge / Master edge time difference (32-bit) |

9.16.4.12.10.10 NetTime when a master edge occurs

Name:

EdgeDetect01Mastertime to EdgeDetect04Mastertime

The exact NetTime is copied to this register when a master edge occurs.

For more information about NetTime and timestamps, see "NetTime Technology" on page 3035.

| Data type | Values | Information |
|-----------|---------------------------------|--|
| INT | -32768 to 32767 | NetTime master edge in microseconds (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime master edge in microseconds (32-bit) |

9.16.4.12.10.11 NetTime when a slave edge occurs

Name:

EdgeDetect01Slavetime to EdgeDetect04Slavetime

When a master edge occurs, the exact NetTime of any slave edge that may have occurred prior to the master edge and addressed by "Slave leading" on page 1940 is copied to this register. If multiple slave edges occur before a master edge, then only the NetTime of the last edge that was not ignored by "Slave leading" is stored. The occurrence of multiple edges can be determined by register "EdgeDetectSlavecount" on page 1941.

For more information about NetTime and timestamps, see "NetTime Technology" on page 3035.

| Data type | Values | Information |
|-----------|---------------------------------|---|
| INT | -32768 to 32767 | NetTime slave edge in microseconds (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime slave edge in microseconds (32-bit) |

9.16.4.12.11 Motion functions

Encoder emulation can be used to generate up/down counters (direction/frequency) and ABR encoder signals. The following conditions must be met to achieve an exact match of the position of the module with the remote station:

- Up/Down counter: The remote station must evaluate both rising and falling edges.
- ABR encoder: The remote station must employ 4x evaluation.

The motion function can be operated in 2 different operating modes:

- "Mode "Position control"" on page 1942
- "Mode "Speed control"" on page 1943

Minimizing jitter

Depending on the configuration of the module, unfavorable system-related jitter times can result in every motion function. In order to increase the smooth running of the motor, however, the flank switching times and thus the unfavorable jitter can be minimized using register "CfO_ResolPosition" on page 1947.

9.16.4.12.11.1 Mode "Position control"

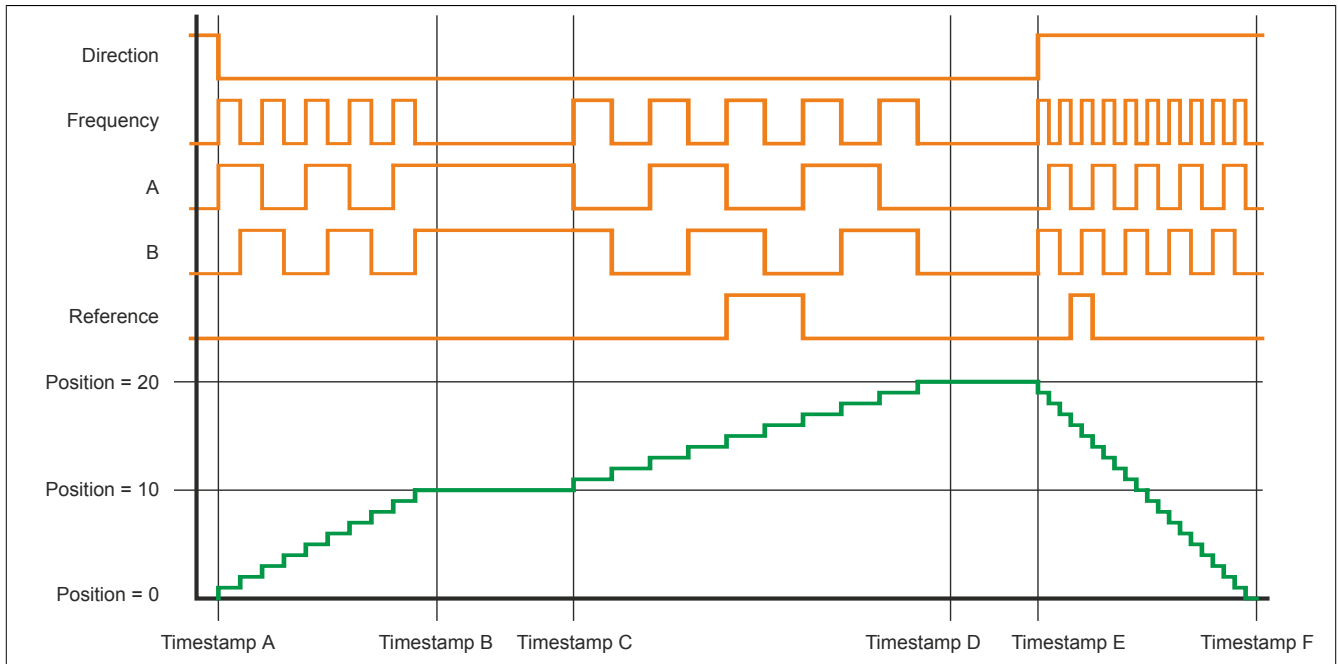
Each time register "MovTargetTime" on page 1949 changes, a new position setpoint is transferred from register "MovPosition" on page 1949 to the FIFO buffer. The time/position data in the FIFO buffer is then processed in such a manner that the positions are always reached at the moment of the respective timestamps. This means that the module internally ensures that the positions are reached by the set timestamps (number/frequency of the pulses is calculated automatically). The timestamps can be based on the X2X NetTime, the system time of the CPU or register "MovCurrentTime" on page 1950. Timestamps that are set in a manner that does not allow the required position change to be reached before the timestamp (output frequency of the pulse would exceed "CfO_SpeedLimit" on page 1945) cause a `MovMaxFrequencyViolation` error.

For more information about NetTime and timestamps, see "NetTime Technology" on page 3035.

Selected values for the example "Timing of movement":

| | |
|--|-------------------------------|
| Timestamp A = <code>MovTimeValid</code> + 40,000 | Position for timestamp A = 0 |
| Timestamp B = Timestamp A + 40,000 | Position for timestamp B = 10 |
| Timestamp C = Timestamp B + 25,000 | Position for timestamp C = 10 |
| Timestamp D = Timestamp C + 70,000 | Position for timestamp D = 20 |
| Timestamp E = Timestamp D + 15,000 | Position for timestamp E = 20 |
| Timestamp F = Timestamp E + 40,000 | Position for timestamp F = 0 |

Configuration: Reference pulse = Starting and end position, Starting position = 15, End position = 17



9.16.4.12.11.2 Mode "Speed control"

In mode "Speed control", the application only specifies the speed setpoint. The module returns the current position in register "MovPosition (32-bit)" on page 1950.

The default setting ($\text{resolSpeed} = 24$) is designed in such a way that a value of 16,777,216 (0x01000000) in register "MovSpeed" on page 1950 results in exactly one increment per "control period".

First, an internal speed value must be calculated:

$$v_{Intern} = v_{Out} * 2^{\text{resolPos}}$$

This results in the following correlation for a 32-bit speed specification (data format of the speed values = 32-bit):

$$\text{MovSpeed} = v_{Intern} * 2^{\text{resolSpeed}} * \text{period}$$

Atypically to other registers, when writing to register "MovSpeed (16-bit)", the 2 higher-order bytes of "MovSpeed (32-bit)" are written. This results in the following correlation for direct calculation with "MovSpeed (16-bit)".

$$\text{MovSpeed} = \frac{v_{Intern} * 2^{\text{resolSpeed}} * \text{period}}{2^{16}}$$

| Variable | Description | Unit |
|---|---|-------|
| MovSpeed | Value for register "MovSpeed" (16- or 32-bit) | |
| vIntern | Internally calculated speed value. | Inc/s |
| vOut | Desired output speed. Each edge (rising or falling) counts as an increment. | Inc/s |
| resolPos | Configured value of register "CfO_ResolPosition" on page 1947 | |
| resolSpeed | Configured value of register "CfO_ResolSpeed" on page 1948 | Bits |
| period | Configured value of register "CfO_SpeedCycleTime_32Bit" on page 1947 | s |
| <p>Information:</p> <p>Must be set in microseconds in Automation Studio. The calculation is performed in s, however.</p> | | |

9.16.4.12.11.3 Performing a movement in mode "Position control"

Several things must be kept in mind when operating the module in order to perform a movement without errors and avoid error messages.

Information:

The specified time/position pairs are not "movement commands", but position data that is continuously processed by the module.

- To allow the module to calculate movement pulses, the first time/position data pair (t, x) is interpreted as the home position. In this case, "t" represents the starting moment and "x" the current position. A movement is not yet performed.
- As long as bit 0 "MovEnable - For position control" on page 1949 is set to "1", time/position data pairs must be continuously transmitted to the module. As soon as the last data pair has been processed and the module does not find another data pair in the FIFO buffer, error message MovFifoEmpty is sent (see "Error state - Motion functions" on page 1925). In addition, error message MovTargetTimeViolation occurs because no "future moment" for another movement was found.
- To enable a standstill, the time/position data pairs must be specified with an unchanged position but future moments in time.
- Ending the movement with bit 0 = "0" "MovEnable - For position control" on page 1949
This only stops filling the FIFO buffer and subsequently suppresses error message MovFifoEmpty. All entries in the FIFO buffer are still processed. The last specified position is applied as the reference position. As soon as bit 0 = "1" again, all movements are performed relative to this position.
- Ending the movement with bit 7 = "1" "MovReset - Movement reset (immediate stop)" on page 1949
This stops the movement immediately. No more pulses are output. To restart the movement, bit 7 must be set to "0" and bit 0 must be set to "0" for a short time and then back to "1".

9.16.4.12.11.4 FIFO buffer size

Name:

FifoSize

"Number of FIFO buffer entries" in the Automation Studio I/O configuration.

Determines the size of the FIFO buffer for "MovTargetTime" on page 1949 and "MovTargetPosition" on page 1949. One timestamp and one position that should be reached by the timestamp can be transferred to the FIFO buffer per X2X cycle.

| Data type | Values | Information |
|-----------|--------|-----------------------|
| USINT | 0 | FIFO buffer disabled |
| | 3 | 8 entries (2^3) |
| | 4 | 16 entries (2^4) |
| | 5 | 32 entries (2^5) |
| | 6 | 64 entries (2^6) |
| | 7 | 128 entries (2^7) |
| | 8 | 256 entries (2^8) |

9.16.4.12.11.5 Motion function mode

Name:

CfO_Mode

The mode of the motion functions can be configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---|-------|---|
| 0 | Must be enabled when working without timestamps. Enabled in Automation Studio if: <ul style="list-style-type: none"> "Movement = Speed control" "Movement = Position control" and "Data format / Mode of the preset time value = Local time" | 0 | Disabled |
| | | 1 | Enabled |
| 1 | If this function is enabled, repositioning is triggered as soon as the value in register "MovPosition" on page 1949 changes. Enabled in Automation Studio if: <ul style="list-style-type: none"> "Movement = Position control" and "Data format / Mode of the preset time value = Local time" | 0 | No position control (speed control) |
| | | 1 | Position control enabled (position control) |
| 2 | Reference mode "Configuration of reference pulse #1" in the Automation Studio I/O configuration. | 0 | Starting/End position |
| | | 1 | Starting position and span |
| 3 - 7 | Reserved | - | |

9.16.4.12.11.6 Maximum output frequency

Name:

CfO_SpeedLimit

"Max. movement frequency" in the Automation Studio I/O configuration.

Configures the maximum permissible output frequency and the maximum internal computing frequency. The higher internal computing frequencies of 2, 4, 8, 16, 32 and 64 MHz can only be achieved by configuring n bits as decimal places (see register "CfO_ResolPosition" on page 1947).

| Data type | Values | Max. increment frequency | Max. frequency for frequency output channel | Max. frequency for A/B output channel |
|-----------|---------|--------------------------|---|---------------------------------------|
| USINT | 253 | 64 MHz | 500 kHz | 250 kHz |
| | 254 | 32 MHz | | |
| | 255 | 16 MHz | | |
| | 0 | 8 MHz | | |
| | 1 | 4 MHz | | |
| | 2 | 2 MHz | | |
| | 3 | 1 MHz (default) | | |
| | 4 | 500 kHz | 250 kHz | 125 kHz |
| | 5 | 250 kHz | 125 kHz | 62.5 kHz |
| 6 | 125 kHz | 62.5 kHz | 31.25 kHz | |

Information:

In Mode "Position control", increment frequencies 16, 32 and 64 MHz are not permitted to be used when 29-bit timestamps are set (see register "CfO_TimeStampRange" on page 1946) due to an internal range overrun.

9.16.4.12.11.7 Number of absolute bits that can be output

Name:

CfO_FormatAdjust

The number of bits that can be output absolutely on the signal output are determined in this register (e.g. for a direction/frequency signal, the least significant bit can be output directly on the frequency output; for an AB signal, 2 bits are possible).

| Data type | Values | Information |
|-----------|--------|--|
| USINT | 1 to 2 | Number of absolute bits (default value in Automation Studio = 1) |

9.16.4.12.11.8 Width of the transferred timestamp data

Name:

CfO_TimeStampRange

"Data format / Mode of the preset time value" in the Automation Studio I/O configuration.

The width of the transferred **timestamp data** in the module is configured in this register.**Information:**

Since the module works internally with 1/8 μ s resolution, timestamp data is processed internally with a maximum width of 29 bits.

| Data type | Values | Information |
|-----------|--------|--|
| SINT | 16 | 16-bit timestamp (selection "16-bit" in the Automation Studio I/O configuration) |
| | 24 | 24-bit timestamp (selection "Local time" or movement "Speed control" in the Automation Studio I/O configuration) |
| | 29 | 29-bit timestamp (selection "29-bit" in the Automation Studio I/O configuration) |

9.16.4.12.11.9 Number of bits for position control

Name:

CfO_PositionsRange

"Target position range" in the Automation Studio I/O configuration.

The number of bits for position control are configured in this register. "PositionRange" must be reduced if the motion function should follow the absolute value of a 12-bit SSI encoder, for example. In this case, the bit width of the movement position must also be limited to the number of bits of the encoder; otherwise, the movement position would not be overrun if the encoder overflows. In this case, the module would attempt (in the opposite direction) to reach the position of an encoder that had just overflow.

Example

The 12-bit SSI encoder overflows from 2047 to -2048. The module would generate 4096 negative increments if more than 12 bits were set for "CfO_PositionRange" in order to reach position -2048 from the position 2047.

Information:

If the 16-bit value of register **"MovPosition"** on page 1950 is used, then the number of bits of the position must also be limited to ≤ 16 ; otherwise, this would also result in incorrect overflow behavior.

| Data type | Values | Information |
|-----------|---------|-------------------------------------|
| SINT | 8 to 32 | Number of bits for position control |

9.16.4.12.11.10 Number of bits for reference position comparison

Name:

CfO_ReferenceRange

"Reference range" in the Automation Studio I/O configuration.

The number of bits used for the reference position comparison are configured in this register. This makes it possible to generate a reference pulse every 2^n increments.

Information:

The number of bits set in this register is not permitted to exceed the number of bits of registers **"MovReferenceStart"** on page 1948 and **"MovReferenceStopMargin"** on page 1949.

| Data type | Values | Information |
|-----------|---------|--|
| SINT | 4 to 32 | Number of bits for position comparison |

9.16.4.12.11.11 Timestamp delay

Name:

CfO_TimeStampDelay

"Default time delay" in the Automation Studio I/O configuration.

All **timestamps** are delayed by the value set in this register in microseconds.**Information:**

When setting to "Local time" in register "**CfO_TimeStampRange**" on page 1946, a value at least 2x the X2X cycle time in microseconds must be entered here.

| Data type | Values | Information |
|-----------|--------------|---------------------------------|
| DINT | 0 to 1000000 | Timestamp delay in microseconds |

9.16.4.12.11.12 Control period for mode "Speed control"

Name:

CfO_SpeedCycleTime_32Bit

"Control period" in the Automation Studio I/O configuration.

The control period for mode "Speed control" can be configured in 1/8 µs steps in this register.

Information:

The value set in the Automation Studio I/O configuration under "Control period" is automatically multiplied by 8 and then used as **CfO_SpeedCycleTime_32bit**.

| Data type | Values | Information |
|-----------|--------------|---|
| UDINT | 400 to 40000 | Control period for mode "Speed control" |

9.16.4.12.11.13 Minimizing jitter for the position

Name:

CfO_ResolPosition

"Position resolution" in the Automation Studio I/O configuration.

This register contains the number of bits as decimal place for jitter reduction. Internally, the module adds 2^n (n = number of decimal places) to the frequency, which results in edge switching times with a higher resolution. The output switching frequency is not increased from a hardware perspective, but the edge moment is more precise.

| Data type | Values | Information |
|-----------|---------|-------------------------------------|
| SINT | 0 | Default, no decimal places |
| | 1 to 14 | Selection of bits as decimal places |

Information:

It is important to note that each configured decimal place also limits the maximum number range by that number of bits.

For example: 0 decimal places → Maximum position range = 29-bit

3 decimal places → Maximum position range = 26-bit

It is also important to note that parameter "**CfO_SpeedLimit**" on page 1945 must be adjusted for these higher computing frequencies according to the number of configured decimal places.

9.16.4.12.11.14 Minimizing jitter for the speed

Name:

CfO_ResolSpeed

"Speed resolution" in the Automation Studio I/O configuration.

This register contains the number of bits for minimizing the jitter of the speed value as decimal places. Within the module, a 2^n (n = number of decimal places) higher frequency is calculated, resulting in speed values with higher resolution.

A 16-bit or 32-bit speed value is basically configured in the Automation Studio I/O configuration due to the bit limitation. Since the internal calculation is always based on a 32-bit configuration, offset 16 must always be added to the desired decimal places for 16-bit configurations.

| Data type | Values | Information |
|-----------|---------|---|
| SINT | 0 to 31 | Selection of bits as decimal places. Default value in Automation Studio = 24 |

Information:

It is important to note that each configured decimal place also limits the maximum number range by that number of bits.

9.16.4.12.11.15 Acceleration value

Name:

CfO_AccelDataInt

MovAcceleration

"Acceleration value" in the Automation Studio I/O configuration.

The acceleration value in increments per **control period**² is contained in this register.

- 32-bit: 16777216 (0x01000000) corresponds to 1 increment per control period²
- 16-bit: 256 (0x0100) corresponds to 1 increment per control period²

| Data type | Values | Information |
|-----------|--------------------|-----------------------------|
| UINT | 0 to 65535 | Acceleration value (16-bit) |
| UDINT | 0 to 4,294,967,296 | Acceleration value (32-bit) |

9.16.4.12.11.16 Starting position of the reference pulses

Name:

CfO_Reference0Start

MovReferenceStart

"Starting position" in the Automation Studio I/O configuration.

The starting position for the reference pulses is contained in these registers.

If the direction is positive, the output (R) is set when the starting position is reached. In the negative direction, the output is reset as soon as the starting position is undershot.

| Data type | Values | Information |
|-----------|------------------------------------|----------------------------|
| INT | -32768 to 32767 | Starting position (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | Starting position (32-bit) |

9.16.4.12.11.17 End position or range of the reference pulse output

Name:

CfO_Reference0StopMargin

MovReferenceStopMargin

"End position or range" in the Automation Studio I/O configuration.

The end position or range in which the reference pulse is output can be configured in these registers.

If setting "Reference mode = Starting/End position" is used in register "CfO_Mode" on page 1945, the output (R) is reset when the end position is reached if the direction is positive. In the negative direction, the output is set as soon as the end position is undershot.

When using "Reference mode = Starting position and span", the contents of this register are added to the starting position and the resulting sum is used as the end position.

| Data type | Values | Information |
|-----------|---------------------------------|-----------------------|
| INT | -32768 to 32767 | End position (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | End position (32-bit) |

9.16.4.12.11.18 Enabling position and speed control

Name:

MovEnable

MovEnable

MovReset

This register can be used to enable position and speed control.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|---------------------------|
| 0 | MovEnable - For position control | 0 | Position control disabled |
| | | 1 | Position control enabled |
| 1 | MovEnable - For speed control | 0 | Speed control disabled |
| | | 1 | Speed control enabled |
| 2 - 6 | Reserved | - | |
| 7 | MovReset - Movement reset (immediate stop) | 0 | No function |
| | | 1 | Reset active |

9.16.4.12.11.19 Timestamp data of the target position

Name:

MovTargetTime

The **timestamp data** is contained in this register. Each time this register changes, the new position data ("**MovTargetPosition**" on page 1949) and timestamp data are transferred to the FIFO buffer. If bit 1 for speed control "**MovEnable = True**", the module calculates the output speed (frequency) so that "**MovTargetPosition**" is reached based on "**MovTargetTime**".

| Data type | Values | Information |
|-----------|---------------------------------|------------------------------------|
| INT | -32768 to 32767 | Timestamp in microseconds (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | Timestamp in microseconds (32-bit) |

Information:

Only 29 bits are processed internally by this register.

9.16.4.12.11.20 Data of the target position

Name:

MovTargetPosition

The position data is contained in this register.

| Data type | Values | Information |
|-----------|---------------------------------|-------------------|
| INT | -32768 to 32767 | Position (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | Position (32-bit) |

9.16.4.12.11.21 Velocity setpoint

Name:

MovSpeed

The speed setpoint for mode "Speed control" in increments per [control period](#) is contained in this register.

- 32-bit: 16,777,216 (0x01000000) corresponds to 1 increment per control period
- 16-bit: 256 (0x0100) corresponds to 1 increment per control period

| Data type | Values | Information |
|-----------|------------------------------------|-------------------------|
| INT | -32768 to 32767 | Speed setpoint (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | Speed setpoint (32-bit) |

9.16.4.12.11.22 NetTime of the current position

Name:

MovTimeValid

The NetTime of the current position is contained in this register.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Values | Information |
|-----------|------------------------------------|--|
| INT | -32768 to 32767 | NetTime of the current position in microseconds (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime of the current position in microseconds (32-bit) |

9.16.4.12.11.23 Current position

Name:

MovPosition

The current position is contained in this register.

| Data type | Values | Information |
|-----------|------------------------------------|---------------------------|
| INT | -32768 to 32767 | Current position (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | Current position (32-bit) |

9.16.4.12.12 Synchronous Serial Interface

Synchronous Serial Interface makes it possible to receive data from SSI absolute encoders.

2 cables are required for data exchange:

SSI clock: Generated by the module on output 2 (if configured)
 SSI data: With each clock pulse, one data bit is transferred from the encoder to the module (input 1 can be used as the SSI input).

9.16.4.12.12.1 Procedure for SSI transfer

On the first edge on the SSI clock, a monostable multivibrator is triggered in the encoder and the value currently present in parallel is latched to the shift register (the low level of the monostable multivibrator prevents the transfer of additional values to the shift register during data transfer).

On the next edge, the most significant bit is transferred to the module.

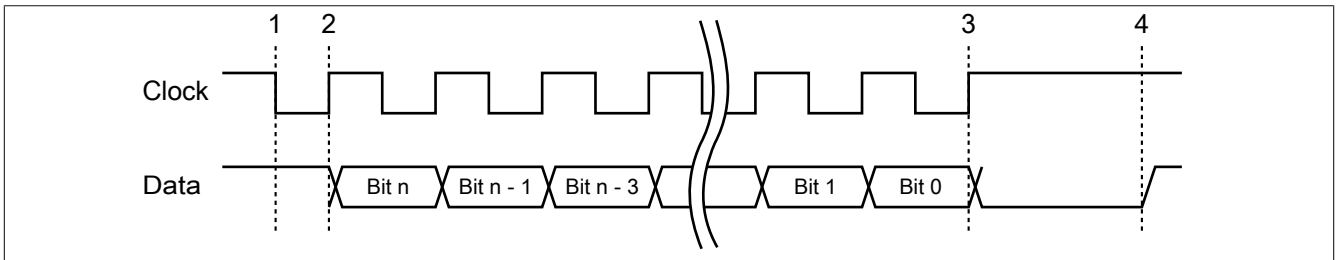
With each additional clock pulse, the next least significant bit is transferred. The clocks constantly retrigger the monostable multivibrator, which prevents its output from accepting new data.

If the number of data bits set in register "[CfO_DataBits](#)" on page 1952 have been received, the clock sequence is ended.

The monostable multivibrator is no longer triggered; after a time dependent on the encoder, the output of the monostable multivibrator accepts the output level again, thus allowing parallel data to be transferred to the encoder's shift register.

With monostable multivibrator testing, the data line is queried for the configured level before starting a new transfer. This makes it possible to ensure that the monostable multivibrator has really returned before a new transfer is started.

Transferring using Synchronous Serial Interface



Processing the measured value

- 1) Start bit ... The measured value is saved.
- 2) Output of the first data bit
- 3) All data bits are transferred; the monostable multivibrator time starts to run.
- 4) The monostable multivibrator returns to its initial state; a new transfer can be started.

9.16.4.12.12.2 Update cycle - Starting SSI transfer

Name:

CfO_CycleSelect

"Update cycle" in the Automation Studio I/O configuration.

SSI transfer is started at the update cycle. The clock sequence is generated on the SSI clock output. The first edge of the clock signal triggers the monoflop in the encoder and latches the current position. At the same time, the current [NetTime](#) is also logged in register "[SSITimeValid](#)" on page 1952. As soon as all bits have been transferred via the SSI, the position is passed on with the next "[SIframeGenCycle](#)" via the X2X Link. A [SSICycleTimeViolation](#) error is reported if the SSI transfer is not completed within the SSI update cycle (e.g. system timer as update cycle). The SSI transfer is still fully completed and then started again with the next update cycle.

| Data type | Values | Information |
|-----------|--------|------------------------|
| USINT | 2 | System timer |
| | 3 | Prescaled system timer |
| | 10 | AOAI |
| | 14 | SOSI |

9.16.4.12.12.3 Configuring the SSI interface

Name:

CfO_PhysicalMode

"Parity bit" in the Automation Studio I/O configuration

"Monostable multivibrator testing" in the Automation Studio I/O configuration

"Data format" in the Automation Studio I/O configuration

"Clock frequency" in the Automation Studio I/O configuration

The SSI interface is configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---|-------|--|
| 0 - 1 | "Parity bit" ⁽¹⁾ | 00 | Disabled |
| | | 01 | Even parity |
| | | 10 | Odd parity |
| | | 11 | Ignore (the parity bit is transferred but not evaluated) |
| 2 - 3 | "Monostable multivibrator testing" ⁽²⁾ | 00 | Disabled |
| | | 01 | Low level (the data signal is checked for a low level after the monostable multivibrator has returned to its stable state) |
| | | 10 | High level (data signal is checked for high level after the monostable multivibrator has returned to its stable state) |
| | | 11 | Ignore (the necessary clock is triggered but not evaluated) |
| 4 | "Data format" | 0 | Encoder with binary data output |
| | | 1 | Encoder with Gray code. The position data is converted into binary format by the module. |
| 5 | Reserved | - | |
| 6 - 7 | "Clock frequency" | 00 | 1 MHz |
| | | 01 | 500 kHz |
| | | 10 | 250 kHz |
| | | 11 | 125 kHz |

- 1) If the parity bit is not correct, `SSIParityError` is generated and the position data is not applied to register "`SSIPosition`" on page 1953.
- 2) As long as the data signal has not reached the level defined for monostable multivibrator testing after the transfer, no new SSI transfer is started. This will trigger error `SSICycleTimeViolation`.

9.16.4.12.12.4 Valid number of SSI data bits

Name:

CfO_DataBits

"Valid number of SSI data bits" in the Automation Studio I/O configuration.

Determines the number of valid data bits to be transferred via SSI. The valid data bits are used for "`SSIPosition`" on page 1953.

| Data type | Values | Information |
|-----------|---------|---------------------------|
| USINT | 1 to 32 | Number of valid data bits |

9.16.4.12.12.5 Number of leading zero bits

Name:

CfO_NullBits

"Number of leading zero bits" in the Automation Studio I/O configuration.

The number of leading zero bits can be configured in this register. The leading zero bits may be required before the valid data bits.

| Data type | Values | Information |
|-----------|---------|-----------------------------|
| USINT | 0 to 31 | Number of leading zero bits |

9.16.4.12.12.6 NetTime of the current position

Name:

SSITimeValid

The NetTime of the current position is contained in this register.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Values | Information |
|-----------|---------------------------------|--|
| INT | -32768 to 32767 | NetTime of the current position in microseconds (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime of the current position in microseconds (32-bit) |

9.16.4.12.12.7 NetTime of the last position change

Name:

SSITimeChanged

The NetTime at which the last position change took place is contained in this register.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Values | Information |
|-----------|---------------------------------|--|
| INT | -32768 to 32767 | NetTime of the last position change in microseconds (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime of the last position change in microseconds (32-bit) |

9.16.4.12.12.8 Current position

Name:

SSIPosition

The current position transferred via the SSI interface is contained in this register.

| Data type | Values | Information |
|-----------|---------------------------------|---------------------------|
| INT | -32768 to 32767 | Current position (16-bit) |
| UDINT | 0 to 4,294,967,295 | Current position (32-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | |

9.16.4.12.13 Counter

The universal counter pair can be used in 3 different modes. Signals up to 600 kHz are reliably detected, depending on the system timer. Up to 4 latch inputs can be configured in all modes. If required, the enabled latch inputs are negated and linked to a latch condition with a logical AND operator. If the latch condition is met, the current counter value is saved to a separate register.

Inputs

Depending on the function model, the physical inputs are permanently configured for the counter.

| Mode | Input 1 | Input 2 | Input 3 | Input 4 |
|----------------------|--|--|--------------------|--------------------|
| Edge counter | Counter input for counter 1 Latch input 1 | Counter input for counter 2 Latch input 2 | - Latch input 3 | - Latch input 4 |
| Up/Down counter | Counting direction Latch input 1 | Counter frequency Latch input 2 | - Latch input 3 | - Latch input 4 |
| Incremental encoders | A Latch input 1 | B Latch input 2 | - Latch input 3 | - Latch input 4 |

Latch function

As latch inputs, inputs 1 to 4 can each be queried for a high or low level.

With "Latch mode = Continuous", the counters are latched once as soon as "[LatchEnable](#) = True" and the configured latch condition is met. When the latch condition is met again, the counter content is latched again (i.e. a latch event is triggered on every rising edge of the output of the AND operator of all latch inputs).

With "Latch mode = Single", the counters are latched once as soon as "[LatchEnable](#) = True" and the configured latch condition is met. When the latch condition is met again, the counter content is not automatically recopied. Another latch event can only be processed after "[LatchEnable](#) = False" and another "[LatchEnable](#) = True".

9.16.4.12.13.1 Update cycle for counter values

Name:

CfO_CounterCycleSelect

"Update cycle" in the Automation Studio I/O configuration.

The update cycle for the counter values is configured in this register.

Information:

The maximum counting frequency depends on this cycle. The module can process a maximum of 200 increments (edges) within one counter cycle.

| Data type | Values | Information |
|-----------|--------|----------------------------|
| USINT | 2 | System timer |
| | 3 | Prescaled system timer |
| | 10 | AOAI moment from X2X cycle |
| | 14 | SOSI moment from X2X cycle |

9.16.4.12.13.2 Counter mode

Name:

CfO_CounterMode

"Counter mode" in the Automation Studio I/O configuration.

The counter mode is configured in this register.

| Data type | Values | Information |
|-----------|--------|---|
| USINT | 0 | Edge counter The two counters serve as edge counters in this mode. The counter input of counter 1 is permanently connected to input 1; the counter input of the second counter is permanently connected to input 2. Both rising and falling edges are counted. |
| | 2 | Up/Down counter The up/down counter works according to the direction/frequency principle. Input 1 sets the counting direction (LOW = positive, HIGH = negative); input 2 is used as the counter frequency input. Both rising and falling edges on the counter frequency input are counted. |
| | 3 | Incremental encoder (AB counter) When configured as an AB counter, input 1 is used as the A channel and input 2 is used as the B channel. All edges are evaluated (4x evaluation). |

9.16.4.12.13.3 Latch mode

Name:

CfO_LatchMode

"Latch mode" in the Automation Studio I/O configuration.

The latch mode is configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|-------------|
| 0 | LatchMode | 0 | One-time |
| | | 1 | Continuous |
| 1 - 7 | Reserved | - | |

9.16.4.12.13.4 Latch comparators for counter inputs

Name:

CfO_LatchComparator

"Latch level channel 01" to "Latch level channel 04" in the Automation Studio I/O configuration.

The latch comparators for the counter inputs are configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|--|-------|-------------|
| 0 | Comparison level for the latch comparator on input 1 | 0 | Low |
| | | 1 | High |
| ... | | ... | |
| 3 | Comparison level for the latch comparator on input 4 | 0 | Low |
| | | 1 | High |
| 4 | Enables the latch comparator on input 1 | 0 | Disabled |
| | | 1 | Enabled |
| ... | | ... | |
| 7 | Enables the latch comparator on input 4 | 0 | Disabled |
| | | 1 | Enabled |

9.16.4.12.13.5 Clearing counter values and enabling latching

Name:

CounterReset

LatchEnable

Counter values can be deleted or the latch enabled using this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------|-------|----------------|
| 0 | CounterReset | 0 | No action |
| | | 1 | Delete counter |
| 1 | LatchEnable | 0 | Disabled |
| | | 1 | Enabled |
| 2 - 7 | Reserved | - | |

9.16.4.12.13.6 Counter for latch events

Name:

LatchCount

Latch events that occur are counted in this register. This counter can be used to detect whether a new value has been latched, for example.

| Data type | Values | Information |
|-----------|-------------|---------------|
| SINT | -128 to 127 | Latch counter |

9.16.4.12.13.7 NetTime of the current counter value

Name:

CounterTimeValid

The X2X NetTime of the current counter value is contained in this register.

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

| Data type | Values | Information |
|-----------|---------------------------------|---|
| INT | -32768 to 32767 | NetTime of the current counter value in microseconds (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime of the current counter value in microseconds (32-bit) |

9.16.4.12.13.8 NetTime of the last counter value change

Name:

Counter01TimeChanged to Counter02TimeChanged

The NetTime at which the last change of the respective counter took place is contained in this register.

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

| Data type | Values | Information |
|-----------|---------------------------------|---|
| INT | -32768 to 32767 | NetTime of the last change of the respective counter in microseconds (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime of the last change of the respective counter in microseconds (32-bit) |

9.16.4.12.13.9 Current counter value

Name:

CounterValue01 to CounterValue02

The current counter value of the respective counter is contained in this register.

| Data type | Values | Information |
|-----------|---------------------------------|--|
| INT | -32768 to 32767 | Counter value of the respective counter (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | Counter value of the respective counter (32-bit) |

9.16.4.12.13.10 Latch counter

Name:

CounterLatch01 to CounterLatch02

As soon as the latch conditions set in register "[CfO_LatchComparator](#)" on page 1954 are met, the content of the relevant "[CounterValue register](#)" on page 1955 is copied to this register.

| Data type | Values | Information |
|-----------|------------------------------------|------------------------|
| INT | -32768 to 32767 | Latch counter (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | Latch counter (32-bit) |

9.16.4.12.13.11 Counter value relative to the last latch

Name:

CounterRel01 to CounterRel02

In this register, the counter value of the respective counter is calculated relative to the last latch of the respective counter.

| Data type | Values | Information |
|-----------|------------------------------------|---|
| INT | -32768 to 32767 | Counter value relative to the last latch (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | Counter value relative to the last latch (32-bit) |

9.16.4.12.14 NetTime Technology

For a description of NetTime Technology, see "[NetTime Technology](#)" on page 3035.

9.16.4.12.15 Minimum X2X cycle time

The minimum X2X cycle time is strongly dependent on the configured functions and the resulting load on the module. Setting "Fast reaction" and a very short system cycle (<50 μ s) generally have a negative effect on the minimum X2X cycle time. This can result in error behavior with short X2X cycle times.

9.16.5 X20DS1319

Data sheet version: 3.31

9.16.5.1 General information

This module is a multifunction digital signal processor module. It can be used extremely flexibly for a wide variety of tasks involving digital signal processing or digital signal generation. Two primary example applications include controlling stepper output stages with pulse and direction signals or using as encoder emulation. In this application, for example, frequency inverters or servo axes with the speed follow function can follow a real or virtual master axis.

- 4 digital input channels
- 4 digital channels, configurable as inputs or outputs
- 1 universal counter pair (2 event counters, AB counters or up/down counters)
- Linear movement generator (A/B, direction/frequency) with up to 2 reference pulses
- SSI absolute encoder
- NetTime timestamp: Input data, target position, position change, edge change, counter change

NetTime timestamp

An additional essential feature is the module's integrated timestamp function. It allows counter ramps curves to be generated virtually independently of bus cycle times during encoder emulation, for example. Only the target counter value and moment when it should be reached are transferred. The module automatically generates the corresponding counter values at the appropriate time, precisely in microsecond resolution and independently of the bus clock.

9.16.5.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Digital signal processing and preparation |  |
| X20DS1319 | X20 multifunction digital signal processor, 4 digital input channels, 4 digital channels configurable as inputs or outputs, 2 event counters 1 universal counter pair as AB counter or up/down counter, linear movement generator (A/B, direction/frequency) with max. 2 reference pulses, SSI absolute encoder, NetTime function | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 364: X20DS1319 - Order data

9.16.5.3 Technical data

| Model number | X20DS1319 |
|--|---|
| Short description | |
| I/O module | 4 digital input channels, 4 digital channels configurable as inputs or outputs, 1 universal counter pair (2 event counters, AB counter or up/down counter), linear movement generator (A/B, direction/frequency) with up to two reference pulses, SSI absolute encoder, relative or absolute moments of input edges with μs resolution, time-triggered I/O, I/O oversampling |
| General information | |
| B&R ID code | 0x2547 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| Outputs | Yes, using LED status indicator |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.5 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Type of signal lines | Shielded cables must be used for all signal lines. |
| Certifications | |
| CE | Yes |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations |
| DNV GL | Class I, Division 2, Groups ABCD, T5 Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| EAC | Yes |
| KC | Yes |
| Linear motion generator | |
| Quantity | 1 |
| Encoder outputs | 24 V, asymmetrical (A/B, direction/frequency) |
| Counter size | 16/32-bit |
| Digital inputs | |
| Quantity | 4 + 4, configuration as input or output using software |
| Nominal voltage | 24 VDC |
| Input voltage | 24 VDC -15% / +20% |
| Input current at 24 VDC | Approx. 1.3 mA |
| Input circuit | Sink |
| Input filter | |
| Hardware | $\leq 2 \mu\text{s}$ |
| Software | - |
| Input resistance | 18.4 k Ω |
| Additional functions | SSI absolute encoder, universal counter pair, latch function for universal counter pair |
| Input frequency | 100 kHz |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Overload characteristics of encoder power supply | Short-circuit proof, overload-proof |
| Isolation voltage between channel and bus | 500 V _{eff} |
| SSI absolute encoder | |
| Quantity | 1 |
| Counter size | Up to 32-bit depending on encoder |
| Max. transfer rate | 125 kbit/s |
| Encoder power supply | Module-internal, max. 600 mA |
| Nominal voltage | 24 V, asymmetrical |
| Universal counter pair | |
| Quantity | 1 |
| Operating modes | 2x event counter, up/down counter, AB counter |
| Encoder inputs | 24 V, asymmetrical |
| Counter size | 16/32-bit |
| Input frequency | Max. 100 kHz |


Table 365: X20DS1319 - Technical data

| Model number | X20DS1319 |
|---|--|
| Evaluation | |
| AB counter | 4x |
| Event counters | 2x |
| Up/Down counter | 2x |
| Signal form | Square wave pulse |
| Encoder power supply | Module-internal, max. 600 mA |
| Digital outputs | |
| Quantity | Up to 4, configuration as input or output using software |
| Variant | Push / Pull / Push-Pull |
| Nominal voltage | 24 VDC |
| Switching voltage | 24 VDC -15% / +20% |
| Nominal output current | 0.1 A |
| Total nominal current | 0.4 A |
| Output circuit | Sink and/or source |
| Output protection | Thermal shutdown in the event of overcurrent or short circuit, integrated protection for switching inductive loads |
| Diagnostic status | Output monitoring |
| Leakage current when the power is switched off | Max. 25 µA |
| Residual voltage | <0.9 V at 0.1 A nominal current |
| Peak short-circuit current | <10 A |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms (depends on the module temperature) |
| Switching delay | |
| 0 → 1 | <2 µs |
| 1 → 0 | <2 µs |
| Switching frequency | |
| Resistive load | Max. 125 kHz |
| Inductive load | See section "Switching inductive loads". |
| Braking voltage when switching off inductive loads | Switching voltage + 0.6 VDC |
| Additional functions | Clock for SSI absolute encoder, linear movement generator |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x bus module X20BM11 separately. |
| Pitch | 12.5 ^{+0.2} mm |

Table 365: X20DS1319 - Technical data

9.16.5.4 LED status indicators

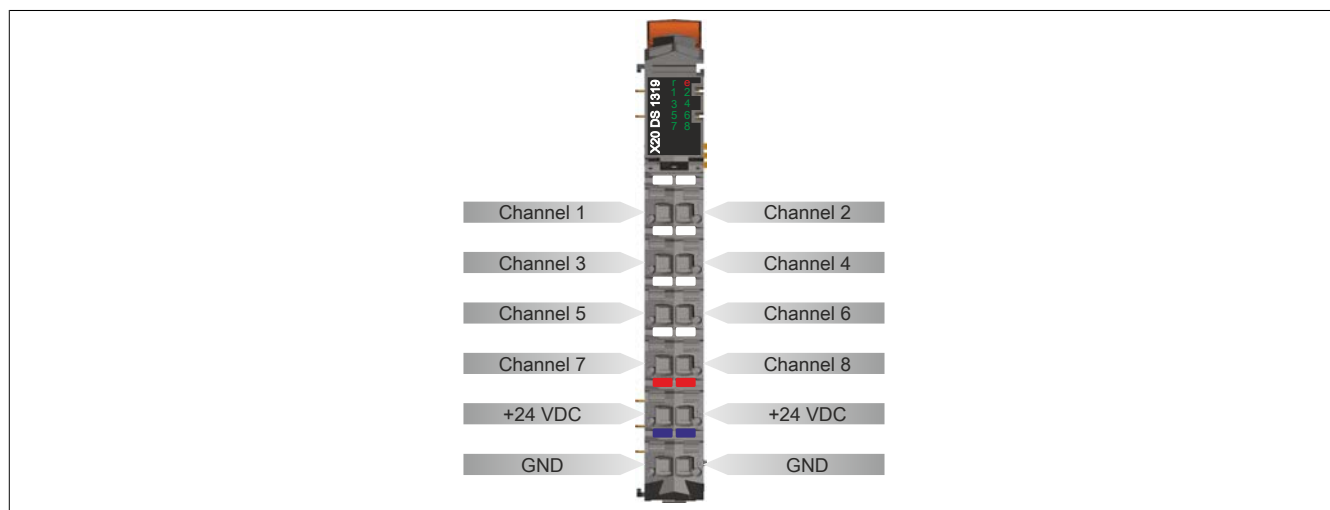
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|-------|--------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | Mode RESET |
| | | | Double flash | Mode BOOT (during firmware update) ¹⁾ |
| | | | Blinking | Mode PREOPERATIONAL |
| | | | On | Mode RUN |
| | e | Red | Off | Module not supplied with power or everything OK |
| | | | Single flash | I/O error. Possible causes: • SSI error ²⁾ |
| | | | Double flash | System error. Possible causes: • Motion function error ³⁾ • I/O oversampling error ⁴⁾ • Edge detection error ⁴⁾ |
| | | | Triple flash | I/O error and system error occur together |
| | | | On | Error or reset state |
| | 1 - 8 | Green | | State of the corresponding digital signal |

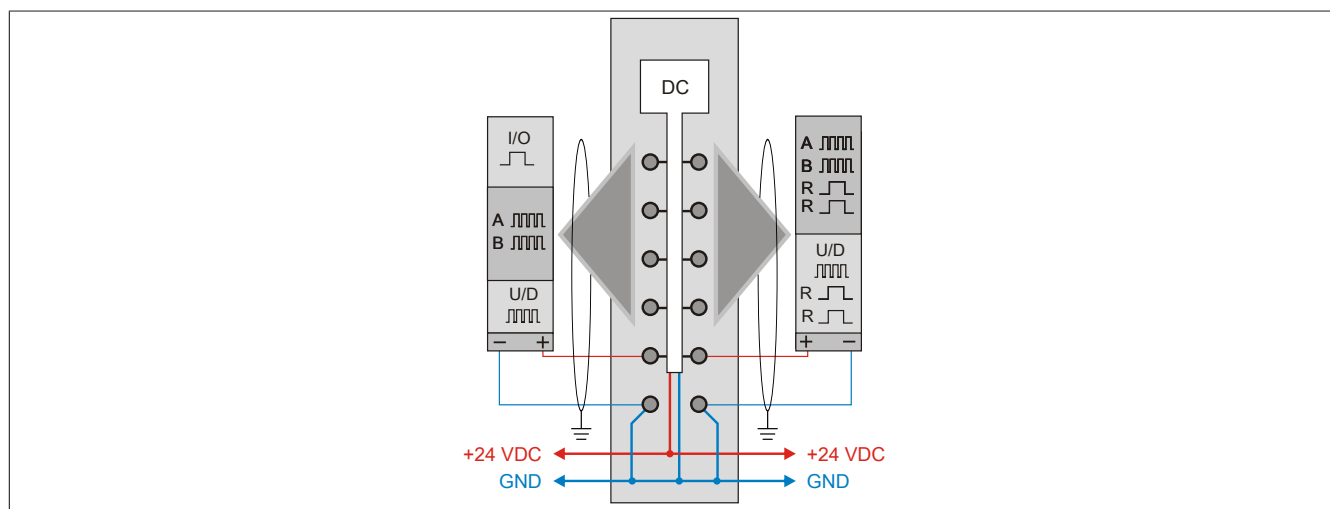
- 1) Depending on the configuration, a firmware update can take up to several minutes.
- 2) See register "Error state - SSI" on page 1969 for the exact error description.
- 3) See register "Error state - Motion functions" on page 1969 for the exact error description.
- 4) See register "Error state - Output data and edge detection" on page 1968 for the exact error description.

9.16.5.5 Pinout

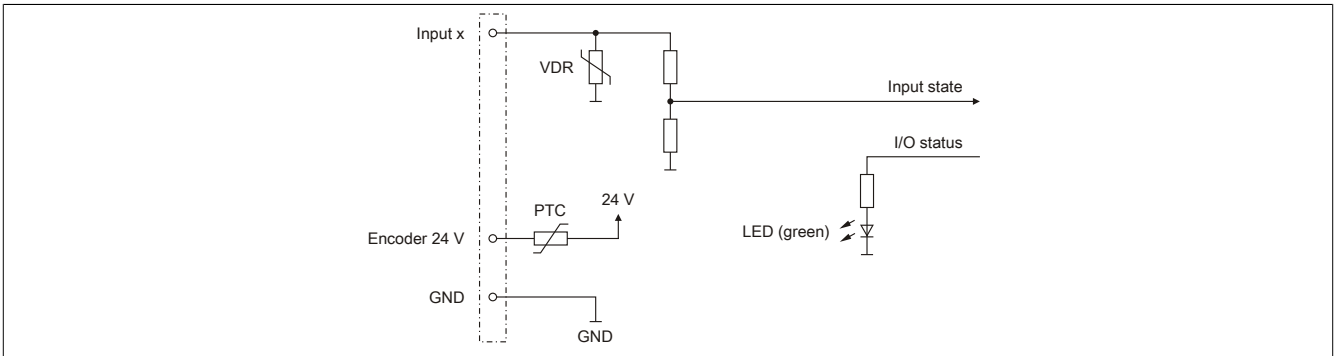
Shielded cables must be used for all signal lines.



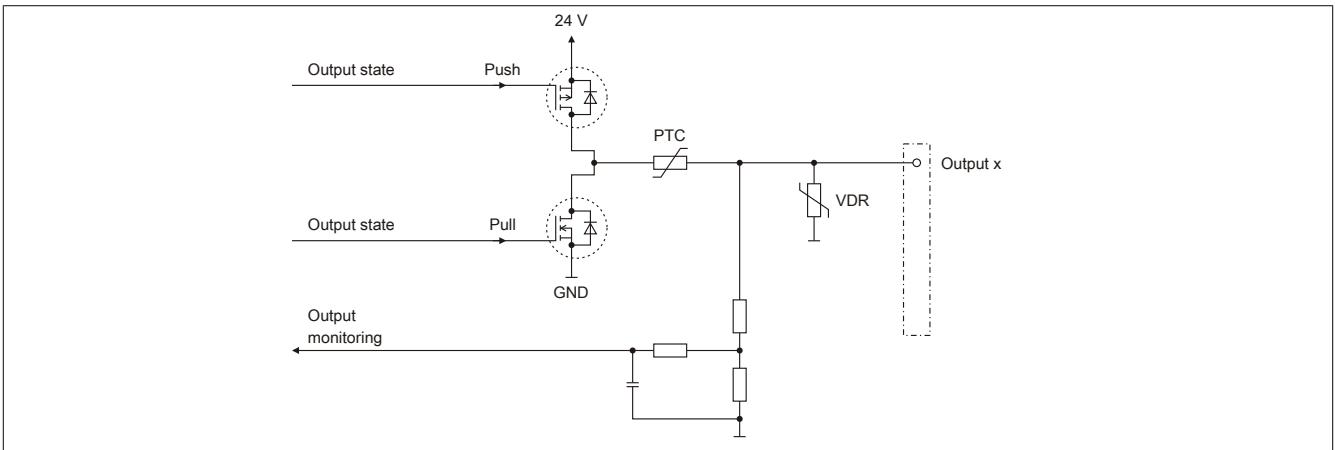
9.16.5.6 Connection example



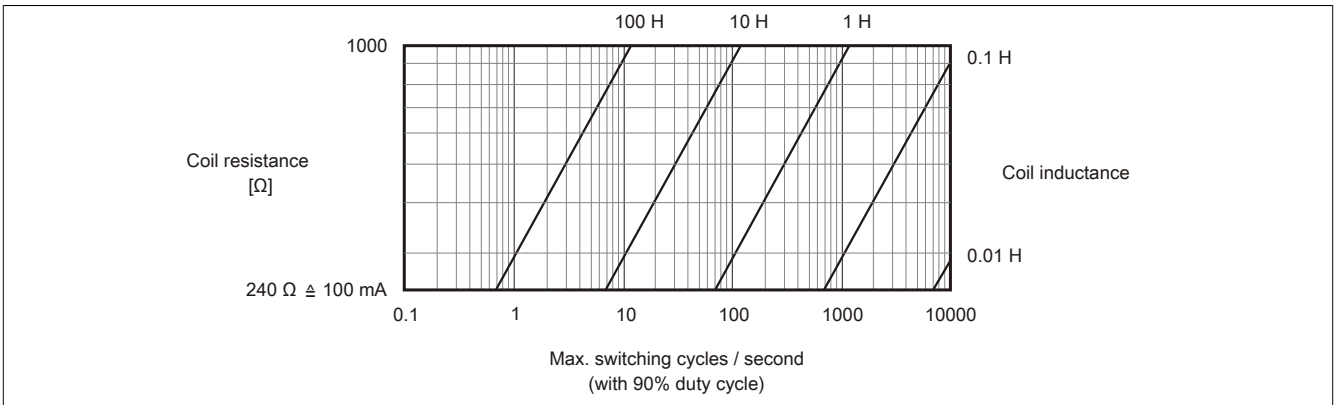
9.16.5.7 Input circuit diagram



9.16.5.8 Output circuit diagram



9.16.5.9 Switching inductive loads



9.16.5.10 Connection options**Digital input/output**

| Channel | Function |
|---------|----------------|
| 1 | Input |
| 2 | Input |
| 3 | Input / Output |
| 4 | Input / Output |
| 5 | Input |
| 6 | Input |
| 7 | Input / Output |
| 8 | Input / Output |

Wiring of the SSI absolute encoder

| Channel | Function |
|------------|----------|
| 5 (input) | Data |
| 7 (output) | Clock |

Wiring of the linear movement generator

| Channel | Up-Down | AB |
|------------|-------------|----|
| 3 (output) | Direction | A |
| 4 (output) | Frequency | B |
| 7 (output) | Reference 1 | |
| 8 (output) | Reference 2 | |

Wiring of the universal counter pair

| Channel | Edge counter | Up/Down counter | Incremental |
|-----------|-------------------|-----------------|-------------|
| 1 (input) | Input 1 | Direction | A |
| 2 (input) | Input 2 | Frequency | B |
| 5 (input) | Latch input 1 (R) | | |
| 6 (input) | Latch input 2 (E) | | |

9.16.5.11 Register description

9.16.5.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.16.5.11.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|--|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration - General | | | | | | |
| 513 | CfO_SlframeGenID | USINT | | | | • |
| Configuration - System timer | | | | | | |
| 642 | CfO_SystemCycleTime | UINT | | | | • |
| 646 | CfO_SystemCycleOffset | INT | | | | • |
| 650 | CfO_SystemCyclePrescaler | UINT | | | | • |
| Configuration - Physical I/Os | | | | | | |
| 769 + (N-1) * 2 | CfO_PhylIOConfigCh0N (index N = 1 to 8) | USINT | | | | • |
| Configuration - Direct I/O | | | | | | |
| 899 | CfO_DirectIOClearMask0_7 | USINT | | | | • |
| 903 | CfO_DirectIOSetMask0_7 | USINT | | | | • |
| 905 | CfO_OutputUpdateCycle | USINT | | | | • |
| Configuration - Oversampled I/O | | | | | | |
| 1025 | CfO_OversampleMode | USINT | | | | • |
| 1027 | CfO_OversampleSampleCycleID | USINT | | | | • |
| 1029 | CfO_OversampleRelativeCycleID | USINT | | | | • |
| 1031 | CfO_OversampleConsumeCycleID | USINT | | | | • |
| 1033 | CfO_OversampleOutputBits | USINT | | | | • |
| 1035 | CfO_OversampleInputBits | USINT | | | | • |
| 1037 | CfO_OversampleOutputWindow | USINT | | | | • |
| 1039 | CfO_OversampleInputWindow | USINT | | | | • |
| 1041 + (N*2) | CfO_OversampleConfigInputN (index N = 0 to 3) | USINT | | | | • |
| 1049 + (N*2) | CfO_OversampleConfigOutputN (index N = 0 to 3) | USINT | | | | • |
| Configuration - Edge detection | | | | | | |
| 1537 | CfO_EdgeDetectPollCycleID | USINT | | | | • |
| 1548 | CfO_EdgeDetectEventEnable | UDINT | | | | • |
| 1665 + (N-1) * 16 | CfO_EdgeDetectUnit0NMode (index N = 1 to 4) | USINT | | | | • |
| 1667 + (N-1) * 16 | CfO_EdgeDetectUnit0NLeading (index N = 1 to 4) | USINT | | | | • |
| 1669 + (N-1) * 16 | CfO_EdgeDetectUnit0NMaster (index N = 1 to 4) | USINT | | | | • |
| 1671 + (N-1) * 16 | CfO_EdgeDetectUnit0NSlave (index N = 1 to 4) | USINT | | | | • |
| Configuration - Motion functions | | | | | | |
| 4097 | CfO_FifoSize | USINT | | | | • |
| 4099 | CfO_Mode | SINT | | | | • |
| 4101 | CfO_SpeedLimit | USINT | | | | • |
| 4103 | CfO_FormatAdjust | USINT | | | | • |
| 4105 | CfO_TimeStampRange | SINT | | | | • |
| 4107 | CfO_PositionRange | SINT | | | | • |
| 4109 | CfO_Reference0Range | SINT | | | | • |
| 4111 | CfO_Reference1Range | SINT | | | | • |
| 4116 | CfO_TimeStampDelay | DINT | | | | • |
| 4124 | CfO_SpeedCycleTime_32bit | UDINT | | | | • |
| 4129 | CfO_ResolPosition | SINT | | | | • |
| 4131 | CfO_ResolSpeed | SINT | | | | • |
| 4220 | CfO_AccelDataInit | UDINT | | | | • |
| 4260 | CfO_Reference0Start | DINT | | | | • |
| 4268 | CfO_Reference0StopMargin | DINT | | | | • |
| 4276 | CfO_Reference1Start | DINT | | | | • |
| 4284 | CfO_Reference1StopMargin | DINT | | | | • |
| Configuration - SSI | | | | | | |
| 2049 | CfO_CycleSelect | USINT | | | | • |
| 2051 | CfO_PhysicalMode | USINT | | | | • |
| 2053 | CfO_DataBits | USINT | | | | • |
| 2055 | CfO_NullBits | USINT | | | | • |
| Configuration - Universal counter | | | | | | |
| 6145 | CfO_CounterCycleSelect | USINT | | | | • |
| 6147 | CfO_CounterMode | USINT | | | | • |
| 6149 | CfO_LatchMode | USINT | | | | • |

| Register | Name | Data type | Read | | Write | |
|---|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 6151 | CfO_LatchComparator | USINT | | | | |
| 6153 | CounterControl | USINT | | | • | |
| | CounterReset | Bit 0 | | | | |
| | LatchEnable | Bit 1 | | | | • |
| Communication - General | | | | | | |
| 546 | ProtocolError (16-bit) | USINT | • | | | |
| 547 | ProtocolError (8-bit) | UINT | • | | | |
| 550 | ProtocolSequenceViolation (16-bit) | UINT | • | | | |
| 551 | ProtocolSequenceViolation (8-bit) | USINT | • | | | |
| Communication - Error register | | | | | | |
| 257 | Error state - Output data and edge detection | USINT | • | | | |
| | OutputControlError | Bit 4 | | | | |
| | OutputCopyError | Bit 5 | | | | |
| | EdgeDetectError | Bit 6 | | | | |
| 259 | Error state - SSI | USINT | • | | | |
| | SSICycleTimeViolation | Bit 0 | | | | |
| | SSIParityError | Bit 1 | | | | |
| 261 | Error state - Motion functions | USINT | • | | | |
| | MovFifoEmpty | Bit 0 | | | | |
| | MovFifoFull | Bit 1 | | | | |
| | MovTargetTimeViolation | Bit 2 | | | | |
| | MovMaxFrequencyViolation | Bit 3 | | | | |
| 321 | Acknowledging error messages - Output data and edge detection | USINT | | | • | |
| | QuitOutputControlError | Bit 4 | | | | |
| | QuitOutputCopyError | Bit 5 | | | | |
| | QuitEdgeDetectError | Bit 6 | | | | |
| 323 | Acknowledging error messages - SSI | USINT | | | • | |
| | SSIQuitCycleTimeViolation | Bit 0 | | | | |
| | SSIQuitParityError | Bit 1 | | | | |
| 325 | Acknowledging error messages - Motion functions | USINT | | | • | |
| | MovQuitFifoEmpty | Bit 0 | | | | |
| | MovQuitFifoFull | Bit 1 | | | | |
| | MovQuitTargetTimeViolation | Bit 2 | | | | |
| | MovQuitMaxFrequencyViolation | Bit 3 | | | | |
| Communication - System timer | | | | | | |
| 683 | SDCLifeCount | SINT | • | | | |
| Communication - Direct I/O | | | | | | |
| 915 | Output state | USINT | | | • | |
| | DigitalOutput03 | Bit 2 | | | | |
| | DigitalOutput04 | Bit 3 | | | | |
| | DigitalOutput07 | Bit 6 | | | | |
| | DigitalOutput08 | Bit 7 | | | | |
| 927 | Input state | USINT | • | | | |
| | DigitalInput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalInput08 | Bit 7 | | | | |
| Communication - Oversampled I/O (output) | | | | | | |
| 1059 | Oversampling configuration | USINT | | | • | |
| | OversampleEnable | Bit 0 | | | | |
| | OversampleOutputValidate | Bit 1 | | | | |
| 1063 | OversampleOutputCycle | USINT | | | • | |
| | OversampleSampleOffset | USINT | | | | |
| 1088 + N | OversampleOutput0NSample1_8 (index N = 1 to 4) | USINT | | | • | |
| 1092 + N | OversampleOutput0NSample9_16 (index N = 1 to 4) | USINT | | | • | |
| 1096 + N | OversampleOutput0NSample17_24 (index N = 1 to 4) | USINT | | | • | |
| 1100 + N | OversampleOutput0NSample25_32 (index N = 1 to 4) | USINT | | | • | |
| 1104 + N | OversampleOutput0NSample33_40 (index N = 1 to 4) | USINT | | | • | |
| 1108 + N | OversampleOutput0NSample41_48 (index N = 1 to 4) | USINT | | | • | |
| 1112 + N | OversampleOutput0NSample49_56 (index N = 1 to 4) | USINT | | | • | |
| 1116 + N | OversampleOutput0NSample57_64 (index N = 1 to 4) | USINT | | | • | |
| Communication - Oversampled I/O (input) | | | | | | |
| 1074 | OversampleInputTime | INT | • | | | |
| 1079 | OversampleInputCycle | USINT | • | | | |
| 1120 + N | OversampleInput0NSample64_57 (index N = 1 to 4) | USINT | • | | | |
| 1124 + N | OversampleInput0NSample56_49 (index N = 1 to 4) | USINT | • | | | |
| 1128 + N | OversampleInput0NSample48_41 (index N = 1 to 4) | USINT | • | | | |
| 1132 + N | OversampleInput0NSample40_33 (index N = 1 to 4) | USINT | • | | | |
| 1136 + N | OversampleInput0NSample32_25 (index N = 1 to 4) | USINT | • | | | |
| 1140 + N | OversampleInput0NSample24_17 (index N = 1 to 4) | USINT | • | | | |
| 1144 + N | OversampleInput0NSample16_9 (index N = 1 to 4) | USINT | • | | | |
| 1148 + N | OversampleInput0NSample8_1 (index N = 1 to 4) | USINT | • | | | |
| Communication - Edge detection | | | | | | |

| Register | Name | Data type | Read | | Write | |
|--|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 1794 + (N-1) * 32 | EdgeDetect0NMastercount (16-bit) (index N = 1 to 4) | INT | • | | | |
| 1795 + (N-1) * 32 | EdgeDetect0NMastercount (8-bit) (index N = 1 to 4) | SINT | • | | | |
| 1798 + (N-1) * 32 | EdgeDetect0NSlavecount (16-bit) (index N = 1 to 4) | INT | • | | | |
| 1799 + (N-1) * 32 | EdgeDetect0NSlavecount (8-bit) (index N = 1 to 4) | SINT | • | | | |
| 1804 + (N-1) * 32 | EdgeDetect0NDifference (32-bit) (index N = 1 to 4) | DINT | • | | | |
| 1806 + (N-1) * 32 | EdgeDetect0NDifference (16-bit) (index N = 1 to 4) | INT | • | | | |
| 1812 + (N-1) * 32 | EdgeDetect0NMastertime (32-bit) (index N = 1 to 4) | DINT | • | | | |
| 1814 + (N-1) * 32 | EdgeDetect0NMastertime (16-bit) (index N = 1 to 4) | INT | • | | | |
| 1820 + (N-1) * 32 | EdgeDetect0NSlavetime (32-bit) (index N = 1 to 4) | DINT | • | | | |
| 1822 + (N-1) * 32 | EdgeDetect0NSlavetime (16-bit) (index N = 1 to 4) | INT | • | | | |
| Communication - Motion functions | | | | | | |
| 4225 | MovementControl | USINT | | | • | |
| | MovEnable - For position control | Bit 0 | | | | |
| | MovEnable - For speed control | Bit 1 | | | | |
| | MovReset - Movement reset (immediate stop) | Bit 7 | | | | |
| 4244 | MovTargetTime (32-bit) | DINT | | | • | |
| 4246 | MovTargetTime (16-bit) | INT | | | • | |
| 4252 | MovTargetPosition (32-bit) | DINT | | | • | |
| 4254 | MovTargetPosition (16-bit) | INT | | | • | |
| 4260 | MovReference1Start (32-bit) | DINT | | | • | |
| 4262 | MovReference1Start (16-bit) | INT | | | • | |
| 4268 | MovReference1StopMargin (32-bit) | DINT | | | • | |
| 4270 | MovReference1StopMargin (16-bit) | INT | | | • | |
| 4276 | MovReference2Start (32-bit) | DINT | | | • | |
| 4278 | MovReference2Start (16-bit) | INT | | | • | |
| 4284 | MovReference2StopMargin (32-bit) | DINT | | | • | |
| 4286 | MovReference2StopMargin (16-bit) | INT | | | • | |
| 4212 | MovSpeed (32-bit) | DINT | | | • | |
| 4210 | MovSpeed (16-bit) | INT | | | • | |
| 4220 | MovAcceleration (32-bit) | UDINT | | | • | |
| 4218 | MovAcceleration (16-bit) | UINT | | | • | |
| 4292 | MovTimeValid (32-bit) | DINT | • | | | |
| 4294 | MovTimeValid (16-bit) | INT | • | | | |
| 4300 | MovPosition (32-bit) | DINT | • | | | |
| 4302 | MovPosition (16-bit) | INT | • | | | |
| Communication - SSI | | | | | | |
| 2084 | SSITimeValid (32-bit) | DINT | • | | | |
| 2086 | SSITimeValid (16-bit) | INT | • | | | |
| 2092 | SSITimeChanged (32-bit) | DINT | • | | | |
| 2094 | SSITimeChanged (16-bit) | INT | • | | | |
| 2100 | SSIPosition (32-bit) | (U)DINT | • | | | |
| 2102 | SSIPosition (16-bit) | UINT | • | | | |
| Communication - Universal counter | | | | | | |
| 6303 | LatchCount | SINT | • | | | |
| 6308 | CounterTimeValid (32-bit) | DINT | • | | | |
| 6310 | CounterTimeValid (16-bit) | INT | • | | | |
| 6324 | Counter01TimeChanged (32-bit) | DINT | • | | | |
| 6326 | Counter01TimeChanged (16-bit) | INT | • | | | |
| 6332 | Counter02TimeChanged (32-bit) | DINT | • | | | |
| 6334 | Counter02TimeChanged (16-bit) | INT | • | | | |
| 6340 | CounterValue01 (32-bit) | DINT | • | | | |
| 6342 | CounterValue01 (16-bit) | INT | • | | | |
| 6348 | CounterValue02 (32-bit) | DINT | • | | | |
| 6350 | CounterValue02 (16-bit) | INT | • | | | |
| 6356 | CounterLatch01 (32-bit) | DINT | • | | | |
| 6358 | CounterLatch01 (16-bit) | INT | • | | | |
| 6364 | CounterLatch02 (32-bit) | DINT | • | | | |
| 6366 | CounterLatch02 (16-bit) | INT | • | | | |
| 6372 | CounterRel01 (32-bit) | DINT | • | | | |
| 6374 | CounterRel01 (16-bit) | INT | • | | | |
| 6380 | CounterRel02 (32-bit) | DINT | • | | | |
| 6382 | CounterRel02 (16-bit) | INT | • | | | |

9.16.5.11.3 General

9.16.5.11.3.1 Use with Automation Studio

The module is supported via X2X Link and POWERLINK.

X2X Link supports a maximum of 28 bytes of synchronous cyclic data per module. To optimize use and avoid needless data transfer, data points can be adjusted as needed in Automation Studio, i.e. unnecessary data points can be disabled, and the bit width of data points can be set.

9.16.5.11.3.2 Timestamp function

The timestamp function is based on synchronized timers. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

Conversely, the CPU can predefine output events, apply a timestamp and transfer them to the module. The module then executes the predefined action at the precise moment defined by the CPU.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

The resolution of the timestamp is up to $1/8 \mu\text{s}$ in both directions.

Synchronization jitter

Because the CPU – which specifies the X2X NetTime – and the module have different clocks, the module's internal X2X NetTime must be synchronized with the CPU's NetTime. Due to this synchronization, the module's internal X2X NetTime is corrected by a maximum of $1/8 \mu\text{s}$ per system cycle if necessary. This synchronization jitter becomes noticeable when using the NetTime with $1/8 \mu\text{s}$ resolution (max. $\pm 1/8 \mu\text{s}$).

If a 100% exact $1/8 \mu\text{s}$ resolution without jitter is required, then the "localtime $1/8 \mu\text{s}$ " must be used (see register "[CfO_EdgeDetectUnitMode](#)" on page 1982).

9.16.5.11.4 General registers

9.16.5.11.4.1 Defining the moment for generating synchronous input data

Name:

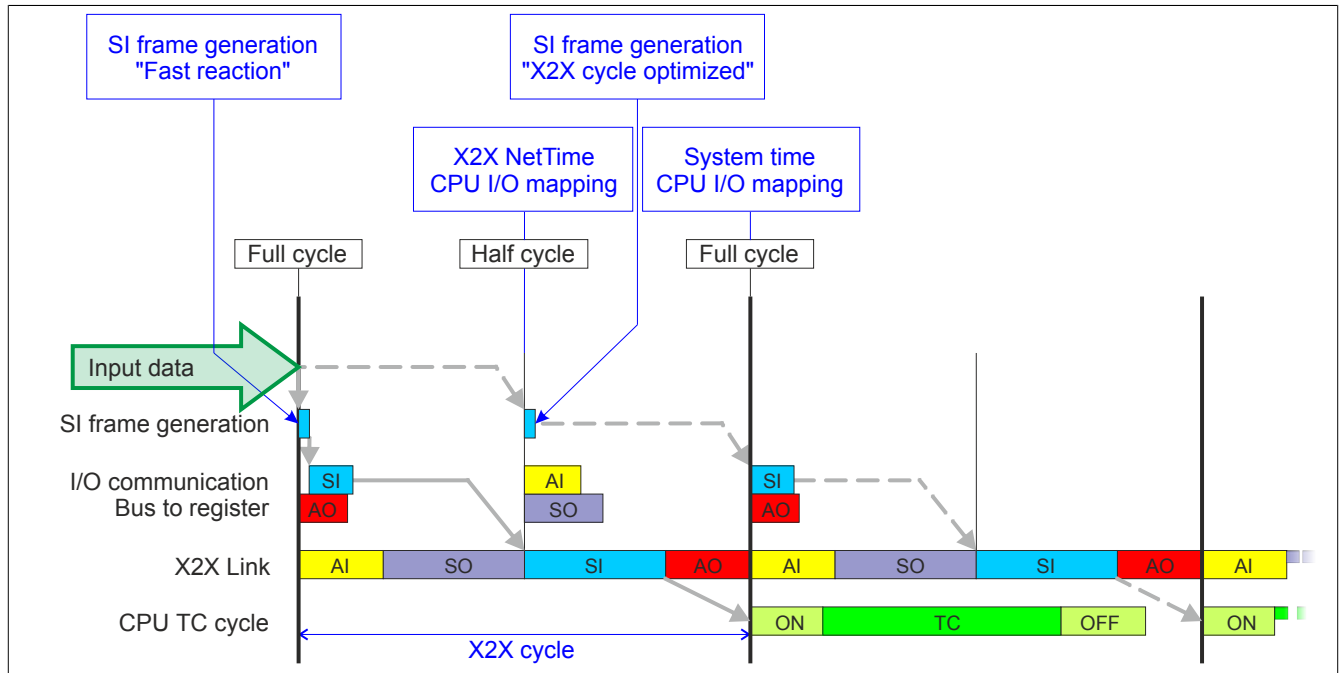
CfO_SlframeGenID

"SI frame generation" in the Automation Studio I/O configuration.

When the synchronous input data is generated for transfer is defined in this register. This has a decisive effect on the timing of the input data.

Setting "Fast reaction" causes the input data to be available one X2X cycle sooner in the CPU. However, this setting also has a negative effect on the minimum X2X cycle time.

| Data type | Values | Information |
|-----------|--------|---------------------|
| USINT | 9 | X2X cycle optimized |
| | 14 | Fast reaction |



9.16.5.11.4.2 Number of X2X protocol errors

Name:

ProtocolError

This register contains an error counter that specifies the number of X2X protocol errors. In the I/O configuration, parameter "Network information" can be used to help configure a data point for this register with a bit width of 8 or 16 bits in the I/O mapping.

| Data type | Values | Information |
|-----------|------------|------------------------|
| USINT | 0 to 255 | Error counter (8-bit) |
| UINT | 0 to 65535 | Error counter (16-bit) |

9.16.5.11.4.3 Number of X2X sequence violations

Name:

ProtocolSequenceViolation

This register contains an error counter that specifies the number of X2X sequence violations. In the I/O configuration, parameter "Network information" can be used to help configure a data point with a bit width of 8 or 16 bits in the I/O mapping.

| Data type | Values | Information |
|-----------|------------|------------------------|
| USINT | 0 to 255 | Error counter (8-bit) |
| UINT | 0 to 65535 | Error counter (16-bit) |

9.16.5.11.4 System clock counter for checking the validity of the data frame

Name:

SDCLifeCount

Counter that is incremented with each system timer cycle. "SDC information" in the Automation Studio I/O configuration can be used to enable this register in the I/O mapping as data point "SDCLifeCount".

The 8-bit counter register is needed for the SDC software package. It is incremented with the system clock to allow the SDC to check the validity of the data frame.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

9.16.5.11.5 Error handling

If one of the functions detects an error, then an error bit is set in one of the error state registers. The application is now able to react to this and acknowledge the errors by setting a respective bit in the "Acknowledge error message" registers. This causes the bit to be reset in the error state register. If the error source persists, then the error bit is set again as soon as the error is detected again (i.e. resetting is not possible).

Error acknowledgment has no effect on the functionality of the module. The module resumes processing, automatically if possible, as soon as the error source is eliminated.

If an error occurs (not a warning), this is indicated by the red "e" LED on the module (double flash). This signal is automatically acknowledged as soon as the error source has been eliminated.

9.16.5.11.5.1 Error state - Output data and edge detection

Name:

OutputControlError

OutputCopyError

EdgeDetectError

Data output errors and cycle time setting errors are indicated in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------|-------|---|
| 0 - 3 | Reserved | - | |
| 4 | OutputControlError | 0 | No error |
| | | 1 | The module did not receive new data in time when "Output control mode = Single", meaning that a bit that has already been output would have been output again by the output control buffer. |
| 5 | OutputCopyError | 0 | No error |
| | | 1 | Oversampling output data could not be copied to the output control buffer (attempted to write to an address outside the oversample output window , for example). |
| 6 | EdgeDetectError | 0 | No error |
| | | 1 | Edge detection cycle time violation: "EdgeDetectPollCycle" must be $\leq 255 \mu\text{s}$. This error is occurs if the cycle set in register "CfO_EdgeDetectPollCycleID" on page 1981 is $> 255 \mu\text{s}$. |
| 7 | Reserved | - | |

9.16.5.11.5.2 Error state - SSI

Name:

SSICycleTimeViolation

SSIParityError

SSI interface errors are indicated in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------|-------|---|
| 0 | SSICycleTimeViolation | 0 | No error |
| | | 1 | An error occurred. Possible causes: <ul style="list-style-type: none"> SSI transfer takes longer than the set "update cycle". Monostable multivibrator testing is enabled, and the SSI data line does not take on the defined level at the end of the transfer. |
| 1 | SSIParityError | 0 | No error |
| | | 1 | SSI parity error |
| 2 - 7 | Reserved | - | |

9.16.5.11.5.3 Error state - Motion functions

Name:

MovFifoEmpty

MovFifoFull

MovTargetTimeViolation

MovMaxFrequencyViolation

Motion function errors are indicated in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------|-------|---|
| 0 | MovFifoEmpty | 0 | No error |
| | | 1 | The position/timestamp FIFO buffer is empty. |
| 1 | MovFifoFull | 0 | No error |
| | | 1 | The position/timestamp FIFO buffer has overshot the size set in register "FifoSize" on page 1987. |
| 2 | MovTargetTimeViolation | 0 | No error |
| | | 1 | This occurs if the moment set in register "MovTargetTime" on page 1992 is already in the past. |
| 3 | MovMaxFrequencyViolation | 0 | No error |
| | | 1 | The maximum output frequency setpoint has overshot the maximum frequency set in register "CfO_SpeedLimit" on page 1988. |
| 4 - 7 | Reserved | - | |

9.16.5.11.5.4 Acknowledging error messages - Output data and edge detection

Name:

QuitOutputControlError

QuitOutputCopyError

QuitEdgeDetectError

Error messages from register "[Error state - Output data and edge detection](#)" on page 1968 can be acknowledged by setting the corresponding bits in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------|-------|-------------------|
| 0 - 3 | Reserved | - | |
| 4 | QuitOutputControlError | 0 | No change |
| | | 1 | Acknowledge error |
| 5 | QuitOutputCopyError | 0 | No change |
| | | 1 | Acknowledge error |
| 6 | QuitEdgeDetectError | 0 | No change |
| | | 1 | Acknowledge error |
| 7 | Reserved | - | |

9.16.5.11.5.5 Acknowledging error messages - SSI

Name:

SSIQuitCycleTimeViolation

SSIQuitParityError

Error messages from register "Error state - SSI" on page 1969 can be acknowledged by setting the corresponding bits in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------------------|-------|-------------------|
| 0 | SSIQuitCycleTimeViolation | 0 | No change |
| | | 1 | Acknowledge error |
| 1 | SSIQuitParityError | 0 | No change |
| | | 1 | Acknowledge error |
| 2 - 7 | Reserved | - | |

9.16.5.11.5.6 Acknowledging error messages - Motion functions

Name:

MovQuitFifoEmpty

MovQuitFifoFull

MovQuitTargetTimeViolation

MovQuitMaxFrequencyViolation

In this register, error messages from register "Error state - Motion functions" on page 1969 can be acknowledged by setting the corresponding bits.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------------|-------|-------------------|
| 0 | MovQuitFifoEmpty | 0 | No change |
| | | 1 | Acknowledge error |
| 1 | MovQuitFifoFull | 0 | No change |
| | | 1 | Acknowledge error |
| 2 | MovQuitTargetTimeViolation | 0 | No change |
| | | 1 | Acknowledge error |
| 3 | MovQuitMaxFrequencyViolation | 0 | No change |
| | | 1 | Acknowledge error |
| 4 - 7 | Reserved | - | |

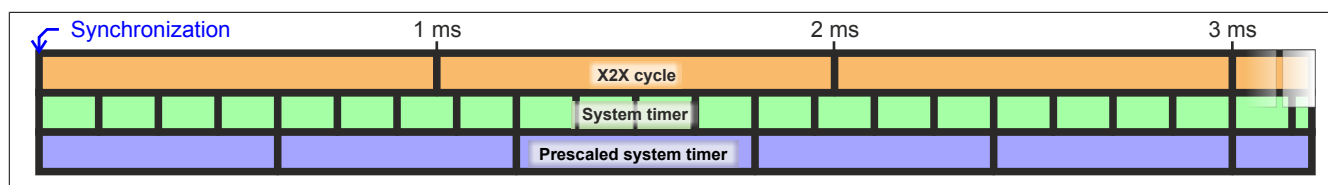
9.16.5.11.6 System timer

The module's individual functions all depend on a system timer. This internal "system cycle time" can be set from 25 to 255 μ s. The functions can also be run using a configurable "prescaled system timer" to minimize the load on the module, thereby making it possible to use the shortest possible X2X cycle time.

The cycle of the "prescaled system timer" (and system timer) is referenced with the X2X Link as soon as the module has been started up and the X2X Link has been initialized. Since the system timer and the module's internal **NetTime** use the same clock, the two run synchronously from that point on. An X2X cycle time that is not a multiple of the system cycle time results in an offset, which can be calculated, however.

The following values apply to the following example:

| | |
|------------------------|-------------|
| X2X cycle | 1 ms |
| System timer | 150 μ s |
| Prescaled system timer | 4 |



9.16.5.11.6.1 Setting the cycle time of the system timer

Name:

CfO_SystemCycleTime

"Cycle time" in the Automation Studio I/O configuration.

The cycle time of the system timer can be set in steps of $1/8 \mu\text{s}$ in this register. The value entered in the Automation Studio I/O configuration is automatically multiplied by 8.

Information:

A setting $<50 \mu\text{s}$ has a negative effect on the minimum X2X cycle time!

| Data type | Values | Information |
|-----------|-------------|--|
| UINT | 200 to 2047 | System timer cycle time in steps of $1/8 \mu\text{s}$ (25 to 255.875 μs) |

9.16.5.11.6.2 Offsetting the synchronization moment of the system cycle

Name:

CfO_SystemCycleOffset

"Cycle offset" in the Automation Studio I/O configuration.

The synchronization moment for the system cycle can be offset in steps of $1/8 \mu\text{s}$ in this register. The value entered in the Automation Studio I/O configuration is automatically multiplied by 8.

| Data type | Values | Information |
|-----------|-----------------|---|
| INT | -32768 to 32767 | Cycle offset in steps of $1/8 \mu\text{s}$ (-4096 to 4095.875 μs) |

9.16.5.11.6.3 Configuration of the cycle prescaler

Name:

CfO_SystemCyclePrescaler

"Cycle prescaler" in the Automation Studio I/O configuration.

The prescaler for setting the [prescaled system timer](#) can be configured in this register. The cycle time of the specified system timer is a product of the system timer multiple set in this register.

The "prescaled system timer" can be used as an alternative time source for the individual functions. This is useful if a function requires a very short system cycle. To reduce the load on the module in such a situation, other functions can be processed in a slow cycle.

| Data type | Values | Information |
|-----------|----------|------------------------------|
| UINT | 2 to 128 | Multiple of the system timer |

9.16.5.11.7 Physical I/O configuration

9.16.5.11.7.1 Configuring the I/O channels

Name:

CfO_PhylIOConfigCh01 to CfO_PhylIOConfigCh08

Each physical I/O channel can be configured individually in these registers.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------------------------|---------|---|
| 0 | Push driver ¹⁾ | 0 | Disabled |
| | | 1 | Enabled |
| 1 | Pull driver ¹⁾ | 0 | Disabled |
| | | 1 | Enabled |
| 2 | Input inverted | 0 | Not inverted |
| | | 1 | Inverted |
| 3 | Output inverted ¹⁾ | 0 | Not inverted |
| | | 1 | Inverted |
| 4 - 7 | Output function ¹⁾ | 0 to 15 | See "Overview of output channel functions". |

1) Only available for I/O channels 3, 4, 7 and 8

Overview of output channel functions

| Values of bits 4 to 7 | Output channel 3 | Output channel 4 | Output channel 7 | Output channel 8 |
|-----------------------|-------------------------------|-------------------------------|---------------------------------|---------------------------------|
| 0 | Direct I/O | | | |
| 1 | | | | SSI clock output |
| 2 | ABR emulation (A) | ABR emulation (B) | ABR emulation (reference 1) | ABR emulation (reference 2) |
| 3 | Up/Down emulation (direction) | Up/Down emulation (frequency) | Up/Down emulation (reference 1) | Up/Down emulation (reference 2) |
| 4 - 15 | Reserved | | | |

9.16.5.11.8 Direct I/O

Direct I/O makes it possible to use the physical I/Os like normal I/Os. Additionally, the application can only set or reset I/Os (e.g. an output channel is set by the edge generator and manually reset by the application).

9.16.5.11.8.1 Direct operation of the output channel - Reset

Name:

CfO_DirectIOClearMask0_7

"Direct operation of output channel 03" to "Direct operation of output channel 08" in the Automation Studio I/O configuration.

If the bit for the respective channel is set in this register, then the output is reset as soon as its direct I/O output channel (register "[DigitalOutput](#)" on page 1973 or "DigitalOutput0x" in the Automation Studio I/O mapping) is reset.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------|-------|---------------|
| 0 - 1 | Reserved | - | |
| 2 | Output channel 3 | 0 | No change |
| | | 1 | Reset channel |
| 3 | Output channel 4 | 0 | No change |
| | | 1 | Reset channel |
| 4 - 5 | Reserved | - | |
| 6 | Output channel 7 | 0 | No change |
| | | 1 | Reset channel |
| 7 | Output channel 8 | 0 | No change |
| | | 1 | Reset channel |

9.16.5.11.8.2 Direct operation of the output channel - Set

Name:

CfO_DirectIOSetMask0_7

"Direct operation of output channel 03" to "Direct operation of output channel 08" in the Automation Studio I/O configuration.

If the bit for the respective channel is set in this register, then the output is set as soon as its direct I/O output channel (register "DigitalOutput" on page 1973 or "DigitalOutput0x" in the Automation Studio I/O mapping) is set.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------|-------|-------------|
| 0 - 1 | Reserved | - | |
| 2 | Output channel 3 | 0 | No change |
| | | 1 | Set channel |
| 3 | Output channel 4 | 0 | No change |
| | | 1 | Set channel |
| 4 - 5 | Reserved | - | |
| 6 | Output channel 7 | 0 | No change |
| | | 1 | Set channel |
| 7 | Output channel 8 | 0 | No change |
| | | 1 | Set channel |

9.16.5.11.8.3 Direct operation of the output channel - Moment of data output

Name:

CfO_OutputUpdateCycle

The moment when data is output is set with this register.

| Data type | Values | Information |
|-----------|--------|-----------------------------------|
| USINT | 10 | X2X cycle optimized (jitter-free) |
| | 15 | Fast reaction (with jitter) |

9.16.5.11.8.4 Output state

Name:

DigitalOutput03 and DigitalOutput04, DigitalOutput07 and DigitalOutput08

This register contains the bits for controlling the direct I/O output channels. Depending on the configuration of registers "CfO_DirectIOClearMask0_7" on page 1972 and "CfO_DirectIOSetMask0_7" on page 1973, the digital outputs are set to the status of the respective bit in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------|--------|---------------------------|
| 0 - 1 | Reserved | - | |
| 2 | DigitalOutput03 | 0 or 1 | Output state of channel 3 |
| 3 | DigitalOutput04 | 0 or 1 | Output state of channel 4 |
| 4 - 5 | Reserved | - | |
| 6 | DigitalOutput07 | 0 or 1 | Output state of channel 7 |
| 7 | DigitalOutput08 | 0 or 1 | Output state of channel 8 |

9.16.5.11.8.5 Input state

Name:

DigitalInput01 to DigitalInput08

The state of the digital input channels is contained in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|----------------|--------|--------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input state of channel 1 |
| ... | ... | ... | |
| 7 | DigitalInput08 | 0 or 1 | Input state of channel 8 |

9.16.5.11.9 Oversampled I/O

"Oversampled I/O" is based on input status buffers and output control buffers. The input data acquisition and output control occur in one sample cycle (one sample cycle corresponds to one bit in the buffer). The precise moment of an input buffer entry is indicated by its position in the buffer and the **NetTime** assigned to the buffer.

When "Output control mode = Single", every output buffer entry is marked as invalid once it has been executed. This ensures that the outputs are not supplied with invalid data. In this mode, the application needs to ensure that the module is always supplied with valid data.

When using "Output control mode = Continuous" the contents of the buffer are output again if the module is not supplied with new oversample output data.

9.16.5.11.9.1 Addressing the output control buffer

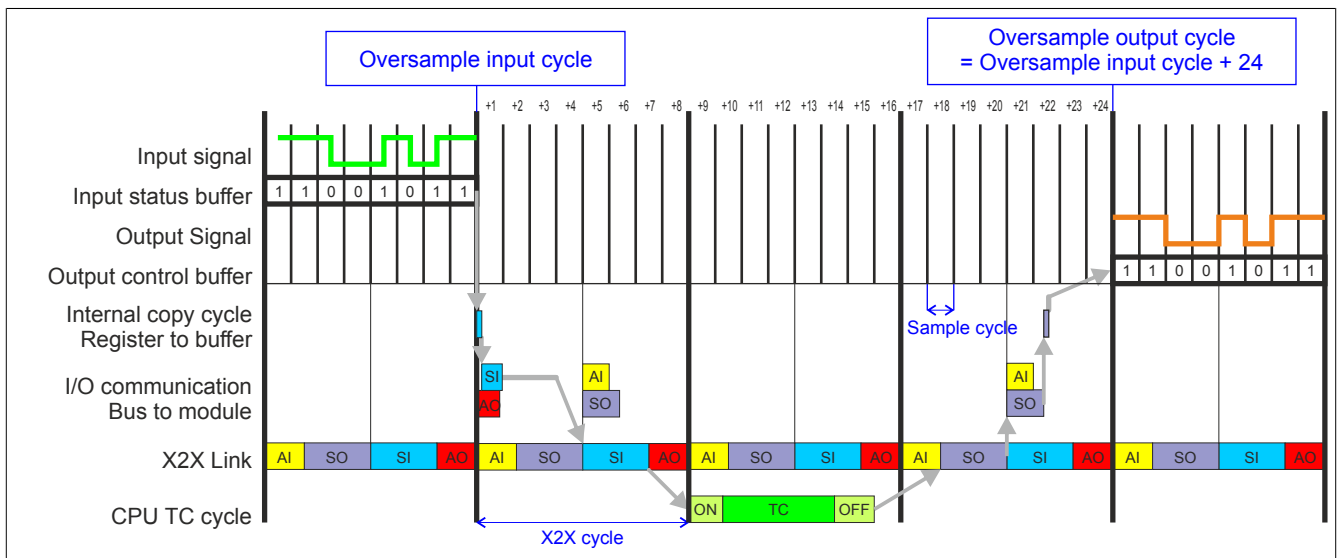
The module has one cyclic 256-bit output control buffer for each oversample channel. One bit is output from these buffers to the configured physical output channels in each "sample cycle". When new data is transferred to one of these buffers, the application must define where in the respective buffer the data should be written to. There are 2 possibilities available for this (absolute or relative "Output mode" in the Automation Studio I/O configuration).

Absolute addressing of the output control buffer

With absolute addressing, in each cycle where "OversampleOutputValidate = True", in addition to the oversample output sample data (in the "OversampleOutput0NSample" on page 1980 registers) an address must also be transferred in register "OversampleOutputCycle" on page 1980. This address defines where in the output control buffer the new data should be copied. In order to calculate this address, the contents of register "OversampleInputCycle" on page 1981, which contains the address of the most recently output data, and the transfer time to the module must be taken into account. To help avoid incorrect addressing of the output control buffer, the buffer section that is capable of being written to can be limited using register "OversampleOutputWindow" on page 1978. This window will always be shifted relative to the current sample address. An "OutputCopyError" will be triggered if an attempt is made to write to an address that is outside of this window.

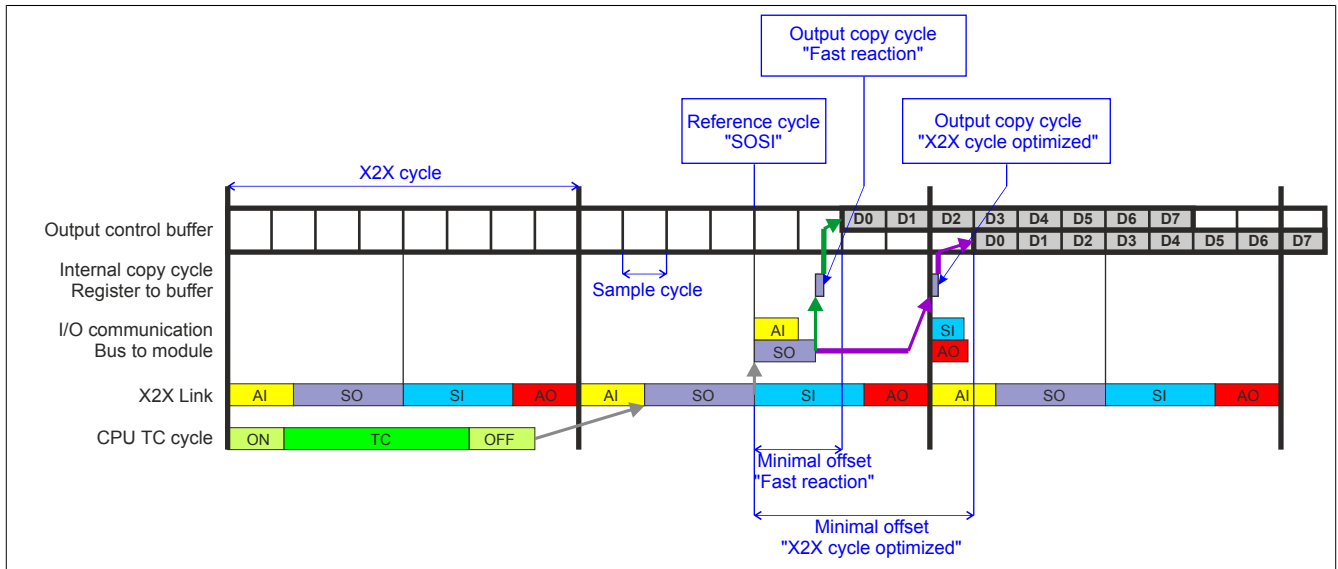
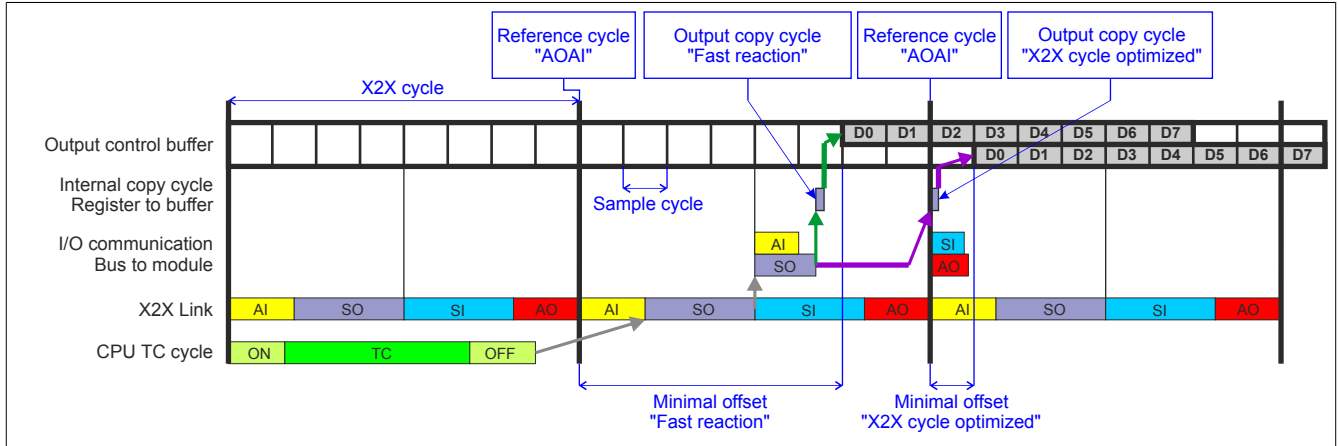
Example

Timing characteristics from the oversample input cycle to the oversample output cycle in absolute output mode ("SI frame generation = Fast reaction", "Output copy cycle = Fast reaction", 8 samples per X2X cycle):



Relative addressing of the output control buffer

When "OversampleOutputValidate = True", then the oversample output sample data is automatically copied to an address relative to the last referenced address at the set output copy cycle moment. Register "OversampleSampleOffset" on page 1980 serves as the offset. The new data cannot start being output immediately at the output copy cycle moment because it takes time to copy the data from the registers to the buffer. This means that an offset of 0 is not allowed. The relative output control buffer address + offset must point to an address within the "oversample output window". The oversample output window is always offset relative to the current sample address. An OutputCopyError is triggered if an attempt is made to write to an address that is outside of this window.



9.16.5.11.9.2 Configuration of the output control buffer

Name:

CfO_OversampleMode

"Output mode" in the Automation Studio I/O configuration

"Output control mode" in the Automation Studio I/O configuration

The output control buffer can be configured globally for all channels in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---|-------|---|
| 0 | Addressing the output control buffer "Output mode" | 0 | Absolute addressing of the output control buffer |
| | | 1 | Relative addressing of the output control buffer |
| 1 | Cyclic output control "Output control mode" | 0 | Single - Output control buffer entry is marked invalid after execution. |
| | | 1 | Continuous - Output control buffer entry is not changed. |
| 2 - 7 | Reserved | - | |

Cyclic output control

If cyclic output control is enabled, then all data in the output control buffer is marked invalid as soon as it is output ("Output control mode = Single"). An [OutputControlError](#) is generated if the module does not receive data in time, thereby causing a situation in which a bit that has already been output would be output in the buffer again. In this type of error situation, the output takes on the "Output default state" configured in register "[CfO_OversampleConfigOutput](#)" on page 1979.

If cyclic output control is disabled, then the data is output again if the output control buffer overflows ("Output control mode = Continuous").

Information:

All 256 bits of the output control buffer are always output.

9.16.5.11.9.3 Configuration of the source for the sample cycle

Name:

CfO_OversampleSampleCycleID

"Sample cycle" in the Automation Studio I/O configuration.

The source for the sample cycle is configured in this register. During each sample cycle, one bit from the output control buffers of the oversampled I/O channels is output to the configured physical output, and the status of the configured inputs is read into one bit of the respective input status buffer.

| Data type | Values | Information |
|-----------|--------|---|
| USINT | 2 | System timer The value set in register " CfO_SystemCycleTime " on page 1971 is used as the sample cycle. |
| | 3 | Prescaled system timer The "prescaled system timer" is used as sample cycle. |
| | 10 | AOAI The sample cycle is clocked with the AOAI interrupt of the X2X cycle. |
| | 14 | SOSI The sample cycle is clocked with the SOSI interrupt of the X2X cycle. |

9.16.5.11.9.4 Configuration of the source for the user interface reference cycle

Name:

CfO_OversampleRelativeCycleID

"Reference cycle" in the Automation Studio I/O configuration.

The source for the user interface reference cycle is configured in this register.

- The input data is referenced at the moment of the reference cycle. The referenced data is then copied to the "oversample input sample register" on page 1981 at the moment of SI frame generation, taking into account the oversample input window.
- With relative addressing of the output control buffer, the new sample data is copied to an address relative to the output control buffer address current to the "reference cycle".
- The reference cycle is also used to reference the sample cycle and thus the output data production and input data acquisition (e.g. to the X2X cycle).

| Data type | Values | Information |
|-----------|--------|--|
| USINT | 2 | System timer The value set in register "CfO_SystemCycleTime" on page 1971 is used as the reference cycle. |
| | 3 | Prescaled system timer The prescaled system timer is used as sample cycle. |
| | 10 | AOAI The sample cycle is referenced with the AOAI interrupt of the X2X cycle. |
| | 14 | SOSI The sample cycle is referenced with the SOSI interrupt of the X2X cycle. |

9.16.5.11.9.5 Defining the moment for copying the data to the output control buffer

Name:

CfO_OversampleConsumeCycleID

"Output copy cycle" in the Automation Studio I/O configuration.

At the time of the output copy cycle, data is copied from the "OversampleOutput0NSample" on page 1980 registers into the output control buffer.

When "Output copy cycle = Fast reaction", it is not possible to determine when the data is copied to the output control buffer in either of the two addressing modes. The copy cycles will experience a certain degree of jitter depending on the module load. However, this only affects the moment of the internal copy procedures and therefore the moment of the earliest possible output sample. This will not affect the quality of the output signal. However, "Output copy cycle = Fast reaction" also has a negative effect on the minimum X2X cycle time.

When using the setting "Output copy cycle = X2X cycle optimized", be aware that the sample data cannot start being output immediately at the "Output copy cycle" time due to the internal copy cycle to the output control buffers.

| Data type | Values | Information |
|-----------|--------|---|
| USINT | 10 | X2X cycle optimized The output data is copied to the output control buffer with the AOAI interrupt of the X2X cycle. |
| | 15 | Fast reaction The output data is copied to the output control buffer immediately after being received. |

9.16.5.11.9.6 Number of output bits to be transferred

Name:

CfO_OversampleOutputBits

"User interface size" in the Automation Studio I/O configuration.

Specifies how many bits are transferred from the "OversampleOutput0NSample" on page 1980 registers to the output control buffers at the output copy cycle moment.

| Data type | Values | Information |
|-----------|---------|-------------|
| USINT | 1 to 64 | Output bits |

9.16.5.11.9.7 Number of input bits to be transferred

Name:

CfO_OversampleInputBits

"User interface size" in the Automation Studio I/O configuration.

Specifies how many bits are transferred from the input status buffer to the "OversampleInput0NSample" on page 1981 registers during SI frame generation.

| Data type | Values | Information |
|-----------|---------|-------------|
| USINT | 1 to 64 | Input bits |

9.16.5.11.9.8 Write area in the output control buffer

Name:

CfO_OversampleOutputWindow

"Output control mode" in the Automation Studio I/O configuration.

Defines the area in the output control buffer to which data is permitted to be written. The window is always offset relative to the current sample position. (a value of 128, for example, means that the 128 bits following the current sample cycle can be written to). An [OutputCopyError](#) is triggered if an attempt is made to write output sample data to a location outside of this window.

In Automation Studio, the value for this register is set to 128 bits with "Output control mode = Single" and to 255 bits with "Output control mode = Continuous".

| Data type | Values | Information |
|-----------|----------|---------------|
| USINT | 0 to 255 | Output window |

9.16.5.11.9.9 Defining the moment for referencing input data

Name:

CfO_OversampleInputWindow

"Input mode" in the Automation Studio I/O configuration.

The "oversample input window" defines when the input data is referenced. It is located chronologically before [SI frame generation](#). If the reference moment ("reference cycle" on page 1977) is within this window, then the referenced data from the input status buffer is copied to register "OversampleInput0NSample" on page 1981. If the moment at which the reference occurs is outside the "oversample input window" then the data that is most recent at the moment of "SI frame generation" is copied from the input status buffer to register "OversampleInput0NSample" on page 1981.

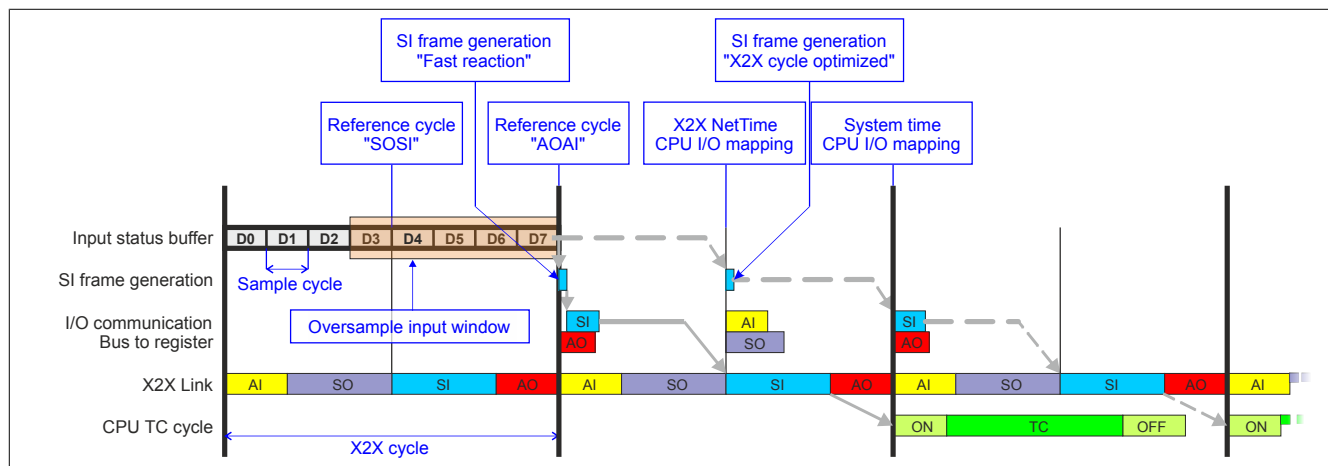
This register is limited internally to the value from register "CfO_OversampleInputBits" on page 1977.

Information:

As a result, the [oversample input time](#) and [oversample input cycle](#) are set either at the reference time or at the moment of "SI frame generation".

In Automation Studio, the value for this register is set to 63 with "Input mode = Referenced values" and to 0 with "Input mode = Most recent values".

| Data type | Values | Information |
|-----------|---------|--------------|
| USINT | 0 to 63 | Input window |



9.16.5.11.9.10 Assigning between the physical input channel and oversample I/O input

Name:

CfO_OversampleConfigInput

"Oversample I/O 01 → Input" to "Oversample I/O 04 input" in the Automation Studio I/O configuration.

Which physical input channel an oversample I/O input should be linked to is defined in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------------------|-------|-----------------|
| 0 - 3 | Number of the physical input channel | 0 | Input channel 1 |
| | | .. | |
| | | 7 | Input channel 8 |
| 4 - 7 | Reserved | - | |

9.16.5.11.9.11 Configuring the outputs of the oversampling channels

Name:

CfO_OversampleConfigOutput

"Oversample I/O 01 → Output" to "Oversample I/O 04 → Output" in the Automation Studio I/O configuration

"Oversample I/O 01 → Output control" to "Oversample I/O 04 → Output control" in the Automation Studio I/O configuration

"Oversample I/O 01 → Output default value" to "Oversample I/O 04 → Output default value" in the Automation Studio I/O configuration

This register helps configure the outputs of the individual oversample channels.

The "Output default state" bits define which level the respective output takes on before oversampling is started. In addition, the output is set to the defined "Output default state" in the event of an error.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---|-------|---|
| 0 - 3 | Number of the physical output channel "Oversample I/O 0x → Output" | 2 | Output channel 3 |
| | | 3 | Output channel 4 |
| | | 6 | Output channel 7 |
| | | 7 | Output channel 8 |
| 4 | Output: Clear "Oversample I/O 0x → Output control" | 0 | Output cannot be reset by the oversample channel. |
| | | 1 | Output can be reset by the oversample channel. |
| 5 | Output: Set "Oversample I/O 0x → Output control" | 0 | Output cannot be set by the oversample channel. |
| | | 1 | Output can be set by the oversample channel. |
| 6 | Default output state: Clear "Oversample I/O 0x → Output default value" | 0 | Output not cleared by default |
| | | 1 | Output cleared by default |
| 7 | Default output state: Set "Oversample I/O 0x → Output default value" | 0 | Output not set by default |
| | | 1 | Output set by default |

9.16.5.11.9.12 Oversampling configuration

Name:

OversampleEnable

OversampleOutputValidate

The oversampling and copy process for the output buffer can be configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------|-------|--|
| 0 | OversampleEnable | 0 | Disables oversampling (with the next reference cycle) |
| | | 1 | Enables oversampling (with the next reference cycle) |
| 1 | OversampleOutputValidate | 0 | Disable the copy procedure to the output control buffer. |
| | | 1 | Enables the copy procedure to the output control buffer. <ul style="list-style-type: none"> Used to synchronize the oversampling procedure at startup. This makes it possible to prevent new data from being transferred to the "OversampleOutput0NSample" on page 1980 registers in each X2X cycle. |
| 2 - 7 | Reserved | - | |

9.16.5.11.9.13 Address of the new output sampling data in the output control buffer

Name:

OversampleOutputCycle

When absolute addressing of the output control buffer is being used, this register specifies the address from which the new output sample data should be copied to the output control buffer.

| Data type | Values | Information |
|-----------|----------|--------------------------------------|
| USINT | 0 to 255 | Address of the output control buffer |

9.16.5.11.9.14 Offset of new output sample data

Name:

OversampleSampleOffset

When relative addressing of the output control buffer is being used, this register serves as the offset for the new output sample data. (Sample address at the time of the [reference cycle](#) + Offset = Address to which the new output sample data is copied in the output control buffer).

| Data type | Values | Information |
|-----------|----------|------------------------------|
| USINT | 0 to 255 | Offset of output sample data |

9.16.5.11.9.15 Oversample output sample data

Name:

OversampleOutput01Sample1_8 to OversampleOutput04Sample1_8
 OversampleOutput01Sample9_16 to OversampleOutput04Sample9_16
 OversampleOutput01Sample17_24 to OversampleOutput04Sample17_24
 OversampleOutput01Sample25_32 to OversampleOutput04Sample25_32
 OversampleOutput01Sample33_40 to OversampleOutput04Sample33_40
 OversampleOutput01Sample41_48 to OversampleOutput04Sample41_48
 OversampleOutput01Sample49_56 to OversampleOutput04Sample49_56
 OversampleOutput01Sample57_64 to OversampleOutput04Sample57_64

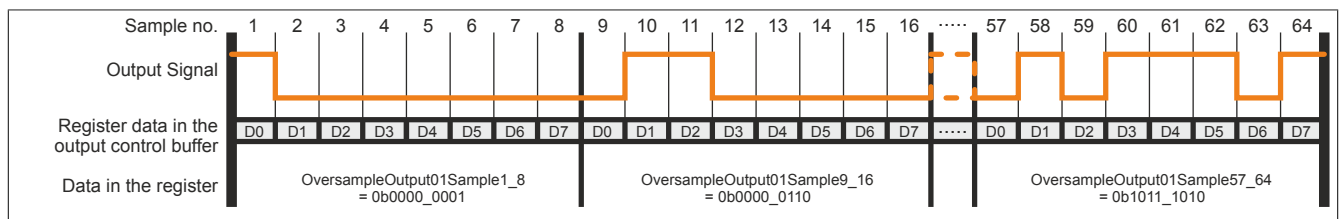
Contains the oversample output sample data. Up to 64 samples (8 bytes) for each oversample I/O channel can be synchronously transferred with a X2X cycle. This data is copied to the specified address (absolute or relative) in the output control buffer at the set [output copy cycle](#). 1 bit of this data is then output during each "sample cycle" to the physical output that is assigned to the oversample I/O channel.

Bit 0 of "OversampleOutputSample8_1" is copied to the output control buffer first, meaning that it is the first bit that is output. "OversampleOutputSample64_57" bit 7 is the last bit to be output.

| Data type | Values | Information |
|-----------|----------|--------------------|
| USINT | 0 to 255 | Output sample data |

Example

Assignment of "OversampleOutputSample" register data to output signal

**9.16.5.11.9.16 X2X NetTime of the input data**

Name:

OversampleInputTime

This register contains the 2 low-order bytes of the X2X NetTime from the moment at which the oversample input data was referenced. This provides an easy way to accurately calculate the moment of each individual input sample.

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

| Data type | Values | Information |
|-----------|-----------------|---|
| INT | -32768 to 32767 | X2X NetTime of the input data in microseconds |

9.16.5.11.9.17 Input status buffer address of the input sample data

Name:

OversampleInputCycle

This register contains the input status buffer address of the input sample data.

In addition, the value in this register can be used to reference an absolute addressing of the output control buffer.

| Data type | Values | Information |
|-----------|----------|-----------------------------|
| USINT | 0 to 255 | Input status buffer address |

9.16.5.11.9.18 Input sample data

Name:

OversampleInput01Sample8_1 to OversampleInput04Sample8_1

OversampleInput01Sample16_9 to OversampleInput04Sample16_9

OversampleInput01Sample24_17 to OversampleInput04Sample24_17

OversampleInput01Sample32_25 to OversampleInput04Sample32_25

OversampleInput01Sample40_33 to OversampleInput04Sample40_33

OversampleInput01Sample48_41 to OversampleInput04Sample48_41

OversampleInput01Sample56_49 to OversampleInput04Sample56_49

OversampleInput01Sample64_57 to OversampleInput04Sample64_57

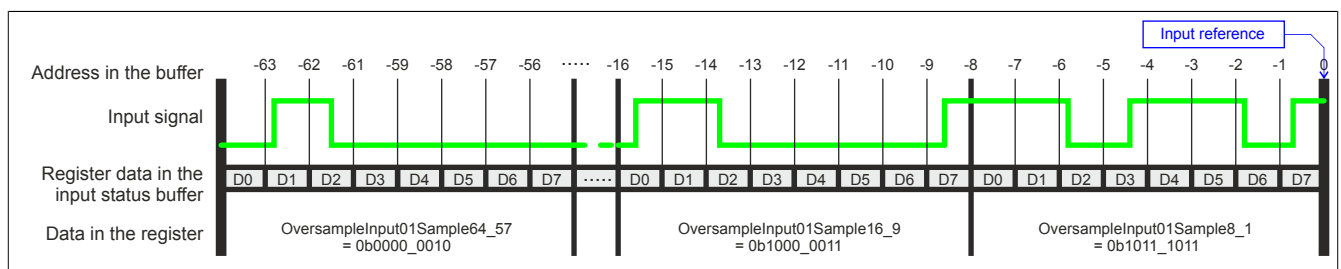
The data of the 4 oversample input status buffers are copied to this register at the moment of **SI frame generation**. A maximum of 64 samples (8 bytes) per oversample I/O channel can be synchronously retrieved from the oversample input status buffer with each X2X cycle.

The most recent input sample bit is stored in "OversampleInputSample8_1" bit 7. The oldest input sample is stored in "OversampleInputSample64_57" bit 0.

| Data type | Values | Information |
|-----------|----------|-------------------|
| USINT | 0 to 255 | Input sample data |

Example

Input signal and resulting data in "OversampleInputSample"



9.16.5.11.10 Edge detection

The module's edge detection function allows edges to be measured with microsecond precision. The concept is based on a maximum of 4 units. One master and one slave edge can be configured for each unit.

At the moment of each master edge, the **NetTime** of the master edge and the **NetTime** of a previous slave edge (if present) are logged. A "master counter" and a "slave counter" can always be used to determine how many edges have been detected since the last X2X cycle.

9.16.5.11.10.1 Configuring the source for the polling cycle

Name:

CfO_EdgeDetectPollCycleID

"Polling cycle" in the Automation Studio I/O configuration.

The source for the polling cycle can be configured in this register.

Information:

The polling cycle must be $\leq 255 \mu\text{s}$. If the configured cycle $> 255 \mu\text{s}$, **EdgeDetectError** occurs.

| Data type | Values | Information |
|-----------|--------|---|
| USINT | 2 | System timer The time set in register "CfO_SystemCycleTime" on page 1971 is used for the polling cycle. |
| | 3 | Prescaled system timer The time set in register "CfO_SystemCyclePrescaler" on page 1971 is used for the polling cycle. |

9.16.5.11.10.2 Edge detection mode

Name:

CfO_EdgeDetectEventEnable

"Edge detection mode" in the Automation Studio I/O configuration.

The bits in this register define on which edges of the individual input channels an interrupt should be triggered for edge detection.

In mode "Event-triggered", the [NetTime](#) of each edge is recorded immediately as interrupt. However, an extremely large amount of interrupts within a short amount of time can prevent the module from being able to process any other operations in time!

In mode "Polling", only the [NetTime](#) of the first edge that occurs within a polling cycle is recorded. This ensures that the module is not overloaded by too many edges.

In the Automation Studio I/O configuration, this register is initialized with 0x00000000 when "Edge detection mode = Polling" and with 0xFFFFFFFF when "Edge detection mode = Event-triggered".

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|------------------|-------|--|
| 0 | Physical input 1 | 0 | No interrupt triggered on falling edge |
| | | 1 | Interrupt triggered on falling edge |
| ... | | ... | |
| 7 | Physical input 8 | 0 | No interrupt triggered on falling edge |
| | | 1 | Interrupt triggered on falling edge |
| 8 - 15 | Reserved | - | |
| 16 | Physical input 1 | 0 | No interrupt triggered on rising edge |
| | | 1 | Interrupt triggered on rising edge |
| ... | | ... | |
| 23 | Physical input 8 | 0 | No interrupt triggered on rising edge |
| | | 1 | Interrupt triggered on rising edge |
| 24 - 31 | Reserved | - | |

9.16.5.11.10.3 Setting the time base, slave edge and master edge

Name:

CfO_EdgeDetectUnit01Mode to CfO_EdgeDetectUnit04Mode

"Time base" in the Automation Studio I/O configuration

"Slave edge" in the Automation Studio I/O configuration

"Master edge" in the Automation Studio I/O configuration

When using a time base with 1/8 μ s resolution, keep in mind that the timestamps produced also have a resolution of exactly 1/8 μ s. The respective conversions must be made for calculating in combination with the CPU system time or [X2X NetTime](#).

In addition, synchronization jitter also plays a role when using "Time base = Nettime resolution 1/8 usec" (see "[Synchronization jitter](#)" on page 1966). This means that exactly identical input edges can cause slight differences in the results. If 100% exact 1/8 μ s resolution is required, then "Local resolution 1/8 usec" must be used.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|---|
| 0 - 1 | "Time base" | 0 | Local time 1/8 μ s (Automation Studio: Local resolution 1/8 usec) |
| | | 1 | Local time 1 μ s (Automation Studio: Local resolution 1 usec) |
| | | 2 | NetTime 1/8 μ s (Automation Studio: Nettime resolution 1/8 usec) |
| | | 3 | NetTime 1 μ s (Automation Studio: Nettime resolution 1 usec) |
| 2 - 5 | Reserved | - | |
| 6 | "Slave edge" | 0 | Disabled |
| | | 1 | Enabled |
| 7 | "Master edge" | 0 | Disabled |
| | | 1 | Enabled |

9.16.5.11.10.4 Load position of the slave time from the FIFO buffer

Name:

CfO_EdgeDetectUnit01Leading to CfO_EdgeDetectUnit04Leading

"Slave leading" in the Automation Studio I/O configuration.

When a slave edge occurs, the current **NetTime** is always saved within the module. A FIFO buffer is provided inside the module that always stores the last 256 slave stamps (even when a master edge occurs).

This value defines the position from which the slave time should be retrieved from the FIFO buffer when a master edge occurs. This can be used to measure average periodic signals over multiple cycles.

| Data type | Values | Information |
|-----------|----------|---|
| USINT | 0 to 255 | Position in the FIFO buffer for slave edges |

9.16.5.11.10.5 Source of the master edge per edge detection unit

Name:

CfO_EdgeDetectUnit01Master to CfO_EdgeDetectUnit01Master

"Master edge" in the Automation Studio I/O configuration.

The source of the master edge for the respective "edge detection unit" is defined in this register.

| Data type | Values | Information |
|-----------|--------|----------------------------------|
| USINT | 0 | Rising edge on physical input 1 |
| | ... | ... |
| | 7 | Rising edge on physical input 8 |
| | 16 | Falling edge on physical input 1 |
| | ... | ... |
| | 23 | Falling edge on physical input 8 |

9.16.5.11.10.6 Source of the slave edge per edge detection unit

Name:

CfO_EdgeDetectUnit01Slave to CfO_EdgeDetectUnit04Slave

"Slave edge" in the Automation Studio I/O configuration.

The source of the slave edge for the respective "edge detection unit" is defined in this register.

| Data type | Values | Information |
|-----------|--------|----------------------------------|
| USINT | 0 | Rising edge on physical input 1 |
| | ... | ... |
| | 7 | Rising edge on physical input 8 |
| | 16 | Falling edge on physical input 1 |
| | ... | ... |
| | 23 | Falling edge on physical input 8 |

9.16.5.11.10.7 Number of detected master edges

Name:

EdgeDetect01Mastercount to EdgeDetect04Mastercount

Detected master edges are counted in this register.

| Data type | Values | Information |
|-----------|-----------------|--|
| SINT | -128 to 127 | Number of detected master edges (8-bit) |
| INT | -32768 to 32767 | Number of detected master edges (16-bit) |

9.16.5.11.10.8 Number of detected slave edges

Name:

EdgeDetect01Slavecount to EdgeDetect04Slavecount

Continuously counts the detected slave edges. The contents of this register are only updated on a master edge. This counter can detect if several slave edges occur before a master edge.

| Data type | Values | Information |
|-----------|-----------------|---|
| SINT | -128 to 127 | Number of detected slave edges (8-bit) |
| INT | -32768 to 32767 | Number of detected slave edges (16-bit) |

9.16.5.11.10.9 Difference between master and slave edge

Name:

EdgeDetect01Difference to EdgeDetect04Difference

This register contains the time difference between a master edge and the last slave edge addressed by "[Slave leading](#)" on page 1983.

| Data type | Values | Information |
|-----------|---------------------------------|---|
| INT | -32768 to 32767 | Slave edge / Master edge time difference (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | Slave edge / Master edge time difference (32-bit) |

9.16.5.11.10.10 NetTime when a master edge occurs

Name:

EdgeDetect01Mastertime to EdgeDetect04Mastertime

The exact NetTime is copied to this register when a master edge occurs.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Values | Information |
|-----------|---------------------------------|--|
| INT | -32768 to 32767 | NetTime master edge in microseconds (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime master edge in microseconds (32-bit) |

9.16.5.11.10.11 NetTime when a slave edge occurs

Name:

EdgeDetect01Slavetime to EdgeDetect04Slavetime

When a master edge occurs, the exact NetTime of any slave edge that may have occurred prior to the master edge and addressed by "[Slave leading](#)" on page 1983 is copied to this register. If multiple slave edges occur before a master edge, then only the NetTime of the last edge that was not ignored by "[Slave leading](#)" is stored. The occurrence of multiple edges can be determined by register "[EdgeDetectSlavecount](#)" on page 1983.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Values | Information |
|-----------|---------------------------------|---|
| INT | -32768 to 32767 | NetTime slave edge in microseconds (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime slave edge in microseconds (32-bit) |

9.16.5.11.11 Motion functions

Encoder emulation can be used to generate up/down counters (direction/frequency) and ABR encoder signals. The following conditions must be met to achieve an exact match of the position of the module with the remote station:

- Up/Down counter: The remote station must evaluate both rising and falling edges.
- ABR encoder: The remote station must employ 4x evaluation.

The motion function can be operated in 2 different operating modes:

- "Mode "Position control"" on page 1985
- "Mode "Speed control"" on page 1986

Minimizing jitter

Depending on the configuration of the module, unfavorable system-related jitter times can result in every motion function. In order to increase the smooth running of the motor, however, the flank switching times and thus the unfavorable jitter can be minimized using register "CfO_ResolPosition" on page 1990.

9.16.5.11.11.1 Mode "Position control"

Each time register "MovTargetTime" on page 1992 changes, a new position setpoint is transferred from register "MovPosition" on page 1992 to the FIFO buffer. The time/position data in the FIFO buffer is then processed in such a manner that the positions are always reached at the moment of the respective timestamps. This means that the module internally ensures that the positions are reached by the set timestamps (number/frequency of the pulses is calculated automatically). The timestamps can be based on the X2X NetTime, the system time of the CPU or register "MovCurrentTime" on page 1992. Timestamps that are set in a manner that does not allow the required position change to be reached before the timestamp (output frequency of the pulse would exceed "CfO_SpeedLimit" on page 1988) cause a *MovMaxFrequencyViolation* error.

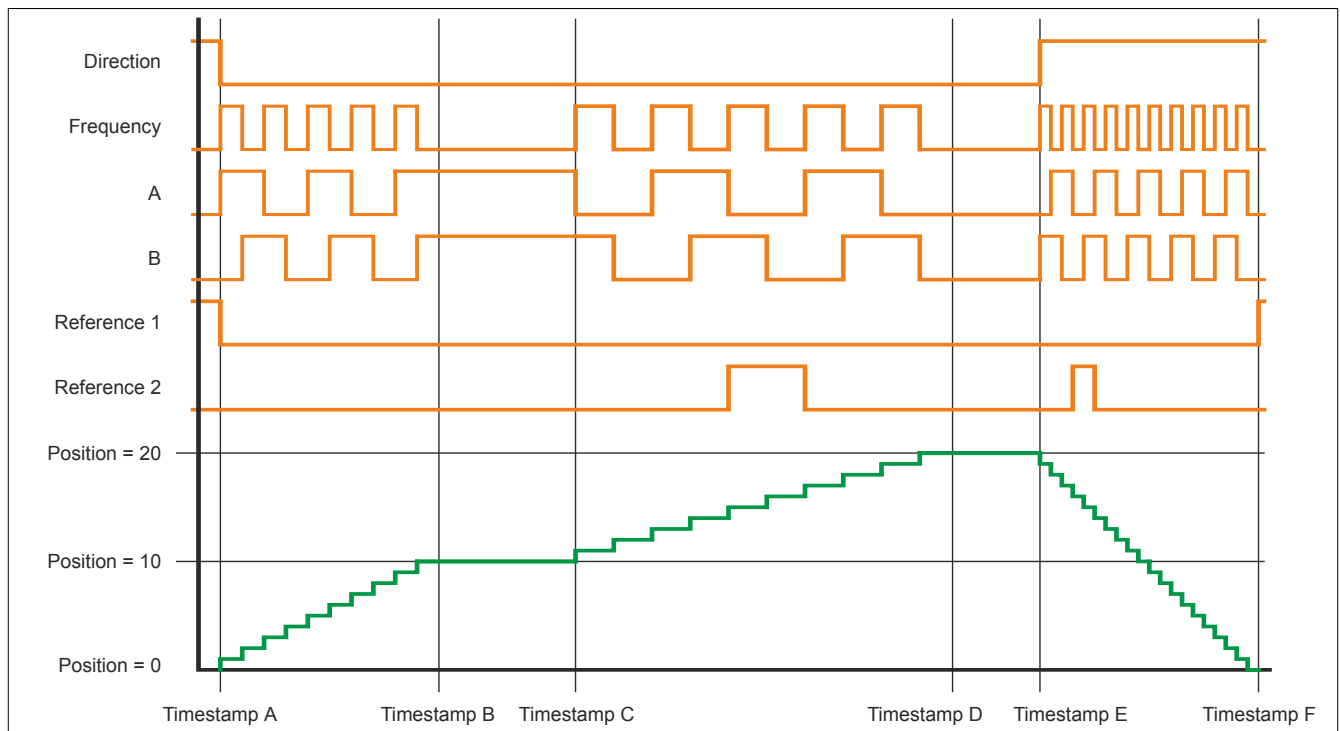
For more information about NetTime and timestamps, see "NetTime Technology" on page 3035.

Selected values for the example "Timing of movement":

| | |
|--|-------------------------------|
| Timestamp A = $\text{MovTimeValid} + 40,000$ | Position for timestamp A = 0 |
| Timestamp B = $\text{Timestamp A} + 40,000$ | Position for timestamp B = 10 |
| Timestamp C = $\text{Timestamp B} + 25,000$ | Position for timestamp C = 10 |
| Timestamp D = $\text{Timestamp C} + 70,000$ | Position for timestamp D = 20 |
| Timestamp E = $\text{Timestamp D} + 15,000$ | Position for timestamp E = 20 |
| Timestamp F = $\text{Timestamp E} + 40,000$ | Position for timestamp F = 0 |

Configuration: Reference pulse 1 = Start position and margin, Start position = 0, Margin = 1

Configuration: Reference pulse 2 = Starting and end position, Starting position = 15, End position = 17



9.16.5.11.11.2 Mode "Speed control"

In mode "Speed control", the application only specifies the speed setpoint. The module returns the current position in register "MovPosition (32-bit)" on page 1992.

The default setting (resolSpeed = 24) is designed in such a way that a value of 16,777,216 (0x01000000) in register "MovSpeed" on page 1992 results in exactly one increment per "control period".

First, an internal speed value must be calculated:

$$vIntern = vOut * 2^{resolPos}$$

This results in the following correlation for a 32-bit speed specification (data format of the speed values = 32-bit):

$$MovSpeed = vIntern * 2^{resolSpeed} * period$$

Atypically to other registers, when writing to register "MovSpeed (16-bit)", the 2 higher-order bytes of "MovSpeed (32-bit)" are written. This results in the following correlation for direct calculation with "MovSpeed (16-bit)".

$$MovSpeed = \frac{vIntern * 2^{resolSpeed} * period}{2^{16}}$$

| Variable | Description | Unit |
|---|---|-------|
| MovSpeed | Value for register "MovSpeed" (16- or 32-bit) | |
| vIntern | Internally calculated speed value. | Inc/s |
| vOut | Desired output speed. Each edge (rising or falling) counts as an increment. | Inc/s |
| resolPos | Configured value of register "CfO_ResolPosition" on page 1990 | |
| resolSpeed | Configured value of register "CfO_ResolSpeed" on page 1990 | Bits |
| period | Configured value of register "CfO_SpeedCycleTime_32Bit" on page 1989 | s |
| <p>Information:</p> <p>Must be set in microseconds in Automation Studio. The calculation is performed in s, however.</p> | | |

9.16.5.11.11.3 Performing a movement in mode "Position control"

Several things must be kept in mind when operating the module in order to perform a movement without errors and avoid error messages.

Information:

The specified time/position pairs are not "movement commands", but position data that is continuously processed by the module.

- To allow the module to calculate movement pulses, the first time/position data pair (t, x) is interpreted as the home position. In this case, "t" represents the starting moment and "x" the current position. A movement is not yet performed.
- As long as bit 0 "MovEnable - For position control" on page 1991 is set to "1", time/position data pairs must be continuously transmitted to the module. As soon as the last data pair has been processed and the module does not find another data pair in the FIFO buffer, error message MovFifoEmpty is sent (see "Error state - Motion functions" on page 1969). In addition, error message MovTargetTimeViolation occurs because no "future moment" for another movement was found.
- To enable a standstill, the time/position data pairs must be specified with an unchanged position but future moments in time.
- Ending the movement with bit 0 = "0" "MovEnable - For position control" on page 1991
This only stops filling the FIFO buffer and subsequently suppresses error message MovFifoEmpty. All entries in the FIFO buffer are still processed. The last specified position is applied as the reference position. As soon as bit 0 = "1" again, all movements are performed relative to this position.
- Ending the movement with bit 7 = "1" "MovReset - Movement reset (immediate stop)" on page 1991
This stops the movement immediately. No more pulses are output. To restart the movement, bit 7 must be set to "0" and bit 0 must be set to "0" for a short time and then back to "1".

9.16.5.11.11.4 FIFO buffer size

Name:

FifoSize

"Number of FIFO buffer entries" in the Automation Studio I/O configuration.

Determines the size of the FIFO buffer for "MovTargetTime" on page 1992 and "MovTargetPosition" on page 1992. One timestamp and one position that should be reached by the timestamp can be transferred to the FIFO buffer per X2X cycle.

| Data type | Values | Information |
|-----------|--------|-------------------------------|
| USINT | 0 | FIFO buffer disabled |
| | 3 | 8 entries (2 ³) |
| | 4 | 16 entries (2 ⁴) |
| | 5 | 32 entries (2 ⁵) |
| | 6 | 64 entries (2 ⁶) |
| | 7 | 128 entries (2 ⁷) |
| | 8 | 256 entries (2 ⁸) |

9.16.5.11.11.5 Motion function mode

Name:

CfO_Mode

The mode of the motion functions can be configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---|-------|---|
| 0 | Must be enabled when working without timestamps. Enabled in Automation Studio if: <ul style="list-style-type: none"> "Movement = Speed control" "Movement = Position control" and "Data format / Mode of the preset time value = Local time" | 0 | Disabled |
| | | 1 | Enabled |
| 1 | If this function is enabled, repositioning is triggered as soon as the value in register "MovPosition" on page 1992 changes. Enabled in Automation Studio if: <ul style="list-style-type: none"> "Movement = Position control" and "Data format / Mode of the preset time value = Local time" | 0 | No position control (speed control) |
| | | 1 | Position control enabled (position control) |
| 2 | Reference mode 1 "Configuration of reference pulse #1" in the Automation Studio I/O configuration. | 0 | Starting/Limit position |
| | | 1 | Starting position and span |
| 3 | Reference mode 2 "Configuration of reference pulse #1" in the Automation Studio I/O configuration. | 0 | Starting/End position |
| | | 1 | Starting position and span |
| 4 - 7 | Reserved | - | |

9.16.5.11.11.6 Maximum output frequency

Name:

CfO_SpeedLimit

"Max. movement frequency" in the Automation Studio I/O configuration.

Configures the maximum permissible output frequency and the maximum internal computing frequency. The higher internal computing frequencies of 500 kHz or 1, 2, 4, 8, 16, 32 and 64 MHz can only be achieved by configuring n bits as decimal places (see register "[CfO_ResolPosition](#)" on page 1990).

| Data type | Values | Max. increment frequency | Max. frequency for frequency output channel | Max. frequency for A/B output channel |
|-----------|---------|--------------------------|---|---------------------------------------|
| USINT | 253 | 64 MHz | 125 kHz | 62.5 kHz |
| | 254 | 32 MHz | | |
| | 255 | 16 MHz | | |
| | 0 | 8 MHz | | |
| | 1 | 4 MHz | | |
| | 2 | 2 MHz | | |
| | 3 | 1 MHz | | |
| | 4 | 500 kHz | | |
| | 5 | 250 kHz (default) | 62.5 kHz | 31.25 kHz |
| 6 | 125 kHz | | | |

Information:

In movement "Position control", increment frequencies 16, 32 and 64 MHz are not permitted to be used when 29-bit timestamps are set (see register "[CfO_TimeStampRange](#)" on page 1988) due to an internal range overrun.

9.16.5.11.11.7 Number of absolute bits that can be output

Name:

CfO_FormatAdjust

The number of bits that can be output absolutely on the signal output are determined in this register (e.g. for a direction/frequency signal, the least significant bit can be output directly on the frequency output; for an AB signal, 2 bits are possible).

| Data type | Values | Information |
|-----------|--------|--|
| USINT | 1 to 2 | Number of absolute bits (default value in Automation Studio = 1) |

9.16.5.11.11.8 Width of the transferred timestamp data

Name:

CfO_TimeStampRange

"Data format / Mode of the preset time value" in the Automation Studio I/O configuration.

The width of the transferred [timestamp data](#) in the module is configured in this register.

Information:

Since the module works internally with 1/8 µs resolution, timestamp data is processed internally with a maximum width of 29 bits.

| Data type | Values | Information |
|-----------|--------|--|
| SINT | 16 | 16-bit timestamp (selection "16-bit" in the Automation Studio I/O configuration) |
| | 24 | 24-bit timestamp (selection "Local time" or movement "Speed control" in the Automation Studio I/O configuration) |
| | 29 | 29-bit timestamp (selection "29-bit" in the Automation Studio I/O configuration) |

9.16.5.11.11.9 Number of bits for position control

Name:

CfO_PositionsRange

"Target position range" in the Automation Studio I/O configuration.

The number of bits for position control are configured in this register. "PositionRange" must be reduced if the motion function should follow the absolute value of a 12-bit SSI encoder, for example. In this case, the bit width of the movement position must also be limited to the number of bits of the encoder; otherwise, the movement position would not be overrun if the encoder overflows. In this case, the module would attempt (in the opposite direction) to reach the position of an encoder that had just overflow.

Example

The 12-bit SSI encoder overflows from 2047 to -2048. The module would generate 4096 negative increments if more than 12 bits were set for "CfO_PositionRange" in order to reach position -2048 from the position 2047.

Information:

If the 16-bit value of register "MovPosition" on page 1992 is used, then the number of bits of the position must also be limited to ≤ 16 ; otherwise, this would also result in incorrect overflow behavior.

| Data type | Values | Information |
|-----------|---------|-------------------------------------|
| SINT | 8 to 32 | Number of bits for position control |

9.16.5.11.11.10 Number of bits for reference position comparison

Name:

CfO_Reference0Range to CfO_Reference1Range

"Reference #1 range" to "Reference #2 range" in the Automation Studio I/O configuration.

The number of bits used for the reference position comparison are configured in this register. This makes it possible to generate a reference pulse every 2^n increments.

Information:

The number of bits set in this register is not permitted to exceed the number of bits of data points "MovReferenceStart" on page 1991 and "MovReferenceStopMargin" on page 1991.

| Data type | Values | Information |
|-----------|---------|--|
| SINT | 4 to 32 | Number of bits for position comparison |

9.16.5.11.11.11 Timestamp delay

Name:

CfO_TimeStampDelay

"Default time delay" in the Automation Studio I/O configuration.

All [timestamps](#) are delayed by the value set in this register in microseconds.

Information:

When setting to "Local time" in register "CfO_TimeStampRange" on page 1988, a value at least 2x the X2X cycle time in microseconds must be entered here.

| Data type | Values | Information |
|-----------|--------------|---------------------------------|
| DINT | 0 to 1000000 | Timestamp delay in microseconds |

9.16.5.11.11.12 Control period for mode "Speed control"

Name:

CfO_SpeedCycleTime_32Bit

"Control period" in the Automation Studio I/O configuration.

The control period for mode "Speed control" can be configured in $1/8 \mu\text{s}$ steps in this register.

Information:

The value set in the Automation Studio I/O configuration under "Control period" is automatically multiplied by 8 and then used as CfO_SpeedCycleTime_32bit.

| Data type | Values | Information |
|-----------|--------------|---|
| UDINT | 400 to 40000 | Control period for mode "Speed control" |

9.16.5.11.11.13 Minimizing jitter for the position

Name:

CfO_ResolPosition

"Position resolution" in the Automation Studio I/O configuration.

This register contains the number of bits as decimal place for jitter reduction. Internally, the module adds 2^n (n = number of decimal places) to the frequency, which results in edge switching times with a higher resolution. The output switching frequency is not increased from a hardware perspective, but the edge moment is more precise.

| Data type | Values | Information |
|-----------|---------|-------------------------------------|
| SINT | 0 | Default, no decimal places |
| | 1 to 14 | Selection of bits as decimal places |

Information:

It is important to note that each configured decimal place also limits the maximum number range by that number of bits.

For example: 0 decimal places → Maximum position range = 29-bit

3 decimal places → Maximum position range = 26-bit

It is also important to note that register "[CfO_SpeedLimit](#)" on page 1988 must be adjusted for these higher computing frequencies according to the number of configured decimal places.

9.16.5.11.11.14 Minimizing jitter for the speed

Name:

CfO_ResolSpeed

"Speed resolution" in the Automation Studio I/O configuration.

This register contains the number of bits for minimizing the jitter of the speed value as decimal places. Within the module, a 2^n (n = number of decimal places) higher frequency is calculated, resulting in speed values with higher resolution.

A 16-bit or 32-bit speed value is basically configured in the Automation Studio I/O configuration due to the bit limitation. Since the internal calculation is always based on a 32-bit configuration, offset 16 must always be added to the desired decimal places for 16-bit configurations.

| Data type | Values | Information |
|-----------|---------|---|
| SINT | 0 to 31 | Selection of bits as decimal places. Default value in Automation Studio = 24 |

Information:

It is important to note that each configured decimal place also limits the maximum number range by that number of bits.

9.16.5.11.11.15 Acceleration value

Name:

CfO_AccelDataInt

MovAcceleration

"Acceleration value" in the Automation Studio I/O configuration.

The acceleration value in increments per [control period](#)² is contained in this register.

- 32-bit: 16777216 (0x01000000) corresponds to 1 increment per control period²
- 16-bit: 256 (0x0100) corresponds to 1 increment per control period²

| Data type | Values | Information |
|-----------|--------------------|-----------------------------|
| UINT | 0 to 65535 | Acceleration value (16-bit) |
| UDINT | 0 to 4,294,967,296 | Acceleration value (32-bit) |

9.16.5.11.11.16 Starting position of the reference pulses

Name:

CfO_Reference0Start to CfO_Reference1Start

MovReference1Start to MovReference2Start

"Starting position" in the Automation Studio I/O configuration

The starting position for the reference pulses is contained in these registers.

If the direction is positive, the output (R) is set when the starting position is reached. In the negative direction, the output is reset as soon as the starting position is undershot.

| Data type | Values | Information |
|-----------|---------------------------------|----------------------------|
| INT | -32768 to 32767 | Starting position (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | Starting position (32-bit) |

9.16.5.11.11.17 End position or range of the reference pulse output

Name:

CfO_Reference0StopMargin to CfO_Reference1StopMargin

MovReference1StopMargin to MovReference2StopMargin

"End position or range" in the Automation Studio I/O configuration

The end position or range in which the reference pulse is output can be configured in these registers.

If setting "Reference mode x = Starting/End position" is used in register "CfO_Mode" on page 1987, the output (R) is reset when the end position is reached if the direction is positive. In the negative direction, the output is set as soon as the end position is undershot.

When using "Reference mode x = Starting position and span", the contents of this register are added to the starting position and the resulting sum is used as the end position.

| Data type | Values | Information |
|-----------|---------------------------------|-----------------------|
| INT | -32768 to 32767 | End position (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | End position (32-bit) |

9.16.5.11.11.18 Enabling position and speed control

Name:

MovEnable

MovEnable

MovReset

This register can be used to enable position and speed control.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|---------------------------|
| 0 | MovEnable - For position control | 0 | Position control disabled |
| | | 1 | Position control enabled |
| 1 | MovEnable - For speed control | 0 | Speed control disabled |
| | | 1 | Speed control enabled |
| 2 - 6 | Reserved | - | |
| 7 | MovReset - Movement reset (immediate stop) | 0 | No function |
| | | 1 | Reset active |

9.16.5.11.11.19 Timestamp data of the target position

Name:

MovTargetTime

The **timestamp data** is contained in this register. Each time this register changes, the new position data ("**MovTargetPosition**" on page 1992) and timestamp data are transferred to the FIFO buffer. If bit 1 for speed control "**MovEnable = True**", the module calculates the output speed (frequency) so that "**MovTargetPosition**" is reached based on "**MovTargetTime**".

| Data type | Values | Information |
|-----------|------------------------------------|------------------------------------|
| INT | -32768 to 32767 | Timestamp in microseconds (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | Timestamp in microseconds (32-bit) |

Information:

Only 29 bits are processed internally by this register.

9.16.5.11.11.20 Data of the target position

Name:

MovTargetPosition

The position data is contained in this register.

| Data type | Values | Information |
|-----------|------------------------------------|-------------------|
| INT | -32768 to 32767 | Position (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | Position (32-bit) |

9.16.5.11.11.21 Velocity setpoint

Name:

MovSpeed

The speed setpoint for mode "Speed control" in increments per **control period** is contained in this register.

- 32-bit: 16,777,216 (0x01000000) corresponds to 1 increment per control period
- 16-bit: 256 (0x0100) corresponds to 1 increment per control period

| Data type | Values | Information |
|-----------|------------------------------------|-------------------------|
| INT | -32768 to 32767 | Speed setpoint (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | Speed setpoint (32-bit) |

9.16.5.11.11.22 NetTime of the current position

Name:

MovTimeValid

The NetTime of the current position is contained in this register.

For more information about NetTime and timestamps, see "**NetTime Technology**" on page 3035.

| Data type | Values | Information |
|-----------|------------------------------------|--|
| INT | -32768 to 32767 | NetTime of the current position in microseconds (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime of the current position in microseconds (32-bit) |

9.16.5.11.11.23 Current position

Name:

MovPosition

The current position is contained in this register.

| Data type | Values | Information |
|-----------|------------------------------------|---------------------------|
| INT | -32768 to 32767 | Current position (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | Current position (32-bit) |

9.16.5.11.12 Synchronous Serial Interface (SSI)

Synchronous Serial Interface makes it possible to receive data from SSI absolute encoders.

2 cables are required for data exchange:

SSI clock: Generated by the module on output 7 (if configured)
 SSI data: With each clock pulse, one data bit is transferred from the encoder to the module (input 5 can be used as the SSI input).

9.16.5.11.12.1 Procedure for SSI transfer

On the first edge on the SSI clock, a monostable multivibrator is triggered in the encoder and the value currently present in parallel is latched to the shift register (the low level of the monostable multivibrator prevents the transfer of additional values to the shift register during data transfer).

On the next edge, the most significant bit is transferred to the module.

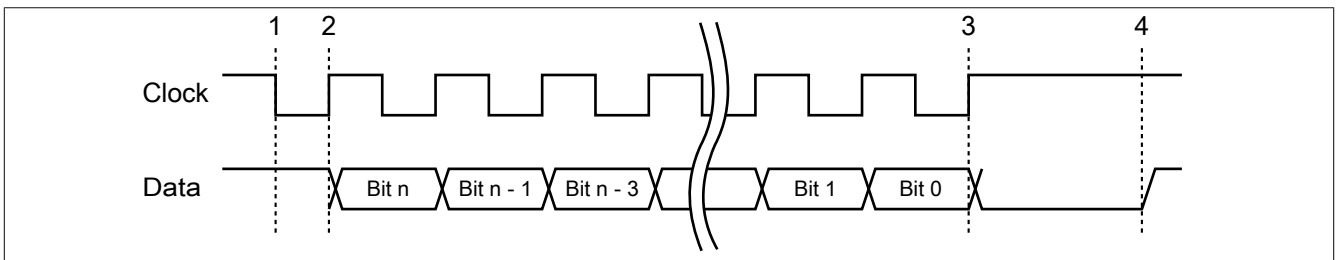
With each additional clock pulse, the next least significant bit is transferred. The clocks constantly retrigger the monostable multivibrator, which prevents its output from accepting new data.

If the number of data bits set in register "[CfO_DataBits](#)" on page 1994 have been received, the clock sequence is ended.

The monostable multivibrator is no longer triggered; after a time dependent on the encoder, the output of the monostable multivibrator accepts the output level again, thus allowing parallel data to be transferred to the encoder's shift register.

With monostable multivibrator testing, the data line is queried for the configured level before starting a new transfer. This makes it possible to ensure that the monostable multivibrator has really returned before a new transfer is started.

Transferring using Synchronous Serial Interface



Processing the measured value

- 1) Start bit ... The measured value is saved.
- 2) Output of the first data bit
- 3) All data bits are transferred; the monostable multivibrator time starts to run.
- 4) The monostable multivibrator returns to its initial state; a new transfer can be started.

9.16.5.11.12.2 Update cycle - Starting SSI transfer

Name:

CfO_CycleSelect

"Update cycle" in the Automation Studio I/O configuration.

SSI transfer is started at the update cycle. The clock sequence is generated on the SSI clock output. The first edge of the clock signal triggers the monoflop in the encoder and latches the current position. At the same time, the current [NetTime](#) is also logged in register "[SSITimeValid](#)" on page 1994. As soon as all bits have been transferred via the SSI, the position is passed on with the next "SIframeGenCycle" via the X2X Link. A [SSICycleTimeViolation](#) error is reported if the SSI transfer is not completed within the SSI update cycle (e.g. system timer as update cycle). The SSI transfer is still fully completed and then started again with the next update cycle.

| Data type | Values | Information |
|-----------|--------|------------------------|
| USINT | 2 | System timer |
| | 3 | Prescaled system timer |
| | 10 | AOAI |
| | 14 | SOSI |

9.16.5.11.12.3 Configuring the SSI interface

Name:

CfO_PhysicalMode

"Parity bit" in the Automation Studio I/O configuration

"Monostable multivibrator testing" in the Automation Studio I/O configuration

"Data format" in the Automation Studio I/O configuration

"Clock frequency" in the Automation Studio I/O configuration

The SSI interface is configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---|----------|--|
| 0 - 1 | "Parity bit" ⁽¹⁾ | 00 | Disabled |
| | | 01 | Even parity |
| | | 10 | Odd parity |
| | | 11 | Ignore (the parity bit is transferred but not evaluated) |
| 2 - 3 | "Monostable multivibrator testing" ⁽²⁾ | 00 | Disabled |
| | | 01 | Low level (the data signal is checked for a low level after the monostable multivibrator has returned to its stable state) |
| | | 10 | High level (data signal is checked for high level after the monostable multivibrator has returned to its stable state) |
| | | 11 | Ignore (the necessary clock is triggered but not evaluated) |
| 4 | "Data format" | 0 | Encoder with binary data output |
| | | 1 | Encoder with Gray code. The position data is converted into binary format by the module. |
| 5 | Reserved | - | |
| 6 - 7 | "Clock frequency" | 00 to 10 | Not permitted |
| | | 11 | 125 kHz |

- 1) If the parity bit is not correct, [SSIParityError](#) is generated and the position data is not applied to register ["SSIPosition"](#) on page 1995.
- 2) As long as the data signal has not reached the level defined for monostable multivibrator testing after the transfer, no new SSI transfer is started. This will trigger error [SSICycleTimeViolation](#).

9.16.5.11.12.4 Valid number of SSI data bits

Name:

CfO_DataBits

"Valid number of SSI data bits" in the Automation Studio I/O configuration.

Determines the number of valid data bits to be transferred via SSI. The valid data bits are used for ["SSIPosition"](#) on page 1995.

| Data type | Values | Information |
|-----------|---------|---------------------------|
| USINT | 1 to 32 | Number of valid data bits |

9.16.5.11.12.5 Number of leading zero bits

Name:

CfO_NullBits

"Number of leading zero bits" in the Automation Studio I/O configuration.

The number of leading zero bits can be configured in this register. The leading zero bits may be required before the valid data bits.

| Data type | Values | Information |
|-----------|---------|-----------------------------|
| USINT | 0 to 31 | Number of leading zero bits |

9.16.5.11.12.6 NetTime of the current position

Name:

SSITimeValid

The NetTime of the current position is contained in this register.

For more information about NetTime and timestamps, see ["NetTime Technology"](#) on page 3035.

| Data type | Values | Information |
|-----------|---------------------------------|--|
| INT | -32768 to 32767 | NetTime of the current position in microseconds (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime of the current position in microseconds (32-bit) |

9.16.5.11.12.7 NetTime of the last position change

Name:

SSITimeChanged

The NetTime at which the last position change took place is contained in this register.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Values | Information |
|-----------|---------------------------------|--|
| INT | -32768 to 32767 | NetTime of the last position change in microseconds (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime of the last position change in microseconds (32-bit) |

9.16.5.11.12.8 Current position

Name:

SSIPosition

The current position transferred via the SSI interface is contained in this register.

| Data type | Values | Information |
|-----------|---------------------------------|---------------------------|
| INT | -32768 to 32767 | Current position (16-bit) |
| UDINT | 0 to 4,294,967,295 | Current position (32-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | |

9.16.5.11.13 Counter

The universal counter pair can be used in 3 different modes. Signals up to 100 kHz are reliably detected. Up to 4 latch inputs can be configured in all modes. If required, the enabled latch inputs are negated and linked to a latch condition with a logical AND operator. If the latch condition is met, the current counter value is saved to a separate register.

Inputs

Depending on the function model, the physical inputs are permanently configured for the counter.

| Mode | Input 1 | Input 2 | Input 5 | Input 6 |
|----------------------|--|--|--------------------|--------------------|
| Edge counter | Counter input for counter 1 Latch input 1 | Counter input for counter 2 Latch input 2 | - Latch input 3 | - Latch input 4 |
| Up/Down counter | Counting direction Latch input 1 | Counter frequency Latch input 2 | - Latch input 3 | - Latch input 4 |
| Incremental encoders | A Latch input 1 | B Latch input 2 | - Latch input 3 | - Latch input 4 |

Latch function

As latch inputs, inputs 1, 2, 5 and 6 can each be queried for a high or low level.

With "Latch mode = Continuous", the counters are latched once as soon as "[LatchEnable](#) = True" and the configured latch condition is met. When the latch condition is met again, the counter content is latched again (i.e. a latch event is triggered on every rising edge of the output of the AND operator of all latch inputs).

With "Latch mode = Single", the counters are latched once as soon as "[LatchEnable](#) = True" and the configured latch condition is met. When the latch condition is met again, the counter content is not automatically recopied. Another latch event can only be processed after "[LatchEnable](#) = False" and another "[LatchEnable](#) = True".

9.16.5.11.13.1 Update cycle for counter values

Name:

CfO_CounterCycleSelect

"Update cycle" in the Automation Studio I/O configuration.

The update cycle for the counter values is configured in this register.

Information:

The maximum counting frequency depends on this cycle. The module can process a maximum of 200 increments (edges) within one counter cycle.

| Data type | Values | Information |
|-----------|--------|----------------------------|
| USINT | 2 | System timer |
| | 3 | Prescaled system timer |
| | 10 | AOAI moment from X2X cycle |
| | 14 | SOSI moment from X2X cycle |

9.16.5.11.13.2 Counter mode

Name:

CfO_CounterMode

"Counter mode" in the Automation Studio I/O configuration.

The counter mode is configured in this register.

| Data type | Values | Information |
|-----------|--------|---|
| USINT | 0 | Edge counter The two counters serve as edge counters in this mode. The counter input of counter 1 is permanently connected to input 1; the counter input of the second counter is permanently connected to input 2. Both rising and falling edges are counted. |
| | 2 | Up/Down counter The up/down counter works according to the direction/frequency principle. Input 1 sets the counting direction (LOW = positive, HIGH = negative); input 2 is used as the counter frequency input. Both rising and falling edges on the counter frequency input are counted. |
| | 3 | Incremental encoder (AB counter) When configured as an AB counter, input 1 is used as the A channel and input 2 is used as the B channel. All edges are evaluated (4x evaluation). |

9.16.5.11.13.3 Latch mode

Name:

CfO_LatchMode

"Latch mode" in the Automation Studio I/O configuration.

The latch mode is configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|-------------|
| 0 | LatchMode | 0 | One-time |
| | | 1 | Continuous |
| 1 - 7 | Reserved | - | |

9.16.5.11.13.4 Latch comparators for counter inputs

Name:

CfO_LatchComparator

"Latch level of channel 0x" in the Automation Studio I/O configuration.

The latch comparators for the counter inputs are configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|--|-------|-------------|
| 0 | Comparison level for the latch comparator on input 1 | 0 | LOW |
| | | 1 | HIGH |
| 1 | Comparison level for the latch comparator on input 2 | 0 | LOW |
| | | 1 | HIGH |
| 2 | Comparison level for the latch comparator on input 5 | 0 | LOW |
| | | 1 | HIGH |
| 3 | Comparison level for the latch comparator on input 6 | 0 | LOW |
| | | 1 | HIGH |
| 4 | Enables the latch comparator on input 1 | 0 | Disabled |
| | | 1 | Enabled |
| 5 | Enables the latch comparator on input 2 | 0 | Disabled |
| | | 1 | Enabled |
| 6 | Enables the latch comparator on input 5 | 0 | Disabled |
| | | 1 | Enabled |
| 7 | Enables the latch comparator on input 6 | 0 | Disabled |
| | | 1 | Enabled |

9.16.5.11.13.5 Clearing counter values and enabling latching

Name:

CounterReset

LatchEnable

Counter values can be deleted or the latch enabled using this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------|-------|----------------|
| 0 | CounterReset | 0 | No action |
| | | 1 | Delete counter |
| 1 | LatchEnable | 0 | Disabled |
| | | 1 | Enabled |
| 2 - 7 | Reserved | - | |

9.16.5.11.13.6 Counter for latch events

Name:

LatchCount

Latch events that occur are counted in this register. This counter can be used to detect whether a new value has been latched, for example.

| Data type | Values | Information |
|-----------|-------------|---------------|
| SINT | -128 to 127 | Latch counter |

9.16.5.11.13.7 NetTime of the current counter value

Name:

CounterTimeValid

The X2X NetTime of the current counter value is contained in this register.

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

| Data type | Values | Information |
|-----------|---------------------------------|---|
| INT | -32768 to 32767 | NetTime of the current counter value in microseconds (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime of the current counter value in microseconds (32-bit) |

9.16.5.11.13.8 NetTime of the last counter value change

Name:

Counter01TimeChanged to Counter02TimeChanged

The NetTime at which the last change of the respective counter took place is contained in this register.

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

| Data type | Values | Information |
|-----------|---------------------------------|---|
| INT | -32768 to 32767 | NetTime of the last change of the respective counter in microseconds (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime of the last change of the respective counter in microseconds (32-bit) |

9.16.5.11.13.9 Current counter value

Name:

CounterValue01 to CounterValue02

The current counter value of the respective counter is contained in this register.

| Data type | Values | Information |
|-----------|---------------------------------|--|
| INT | -32768 to 32767 | Counter value of the respective counter (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | Counter value of the respective counter (32-bit) |

9.16.5.11.13.10 Latch counter

Name:

CounterLatch01 to CounterLatch02

As soon as the latch conditions set in register "[CfO_LatchComparator](#)" on page 1996 are met, the content of the relevant "[CounterValue register](#)" on page 1997 is copied to this register.

| Data type | Values | Information |
|-----------|------------------------------------|------------------------|
| INT | -32768 to 32767 | Latch counter (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | Latch counter (32-bit) |

9.16.5.11.13.11 Counter value relative to the last latch

Name:

CounterRel01 to CounterRel02

In this register, the counter value of the respective counter is calculated relative to the last latch of the respective counter.

| Data type | Values | Information |
|-----------|------------------------------------|---|
| INT | -32768 to 32767 | Counter value relative to the last latch (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | Counter value relative to the last latch (32-bit) |

9.16.5.11.14 NetTime Technology

For a description of NetTime Technology, see "[NetTime Technology](#)" on page 3035.

9.16.5.11.15 Minimum X2X cycle time

The minimum X2X cycle time is strongly dependent on the configured functions and the resulting load on the module. Setting "Fast reaction" and a very short system cycle (<50 μ s) generally have a negative effect on the minimum X2X cycle time. This can result in error behavior with short X2X cycle times.

9.16.6 X20DS1828

Data sheet version: 1.20

9.16.6.1 General information

The module is equipped with 1 HIPERFACE encoder interface. This module can be used to evaluate encoders installed in motors from other manufacturers as well as encoders for external axes (encoders that sample any machine movement). The input signals are monitored. This makes it possible to detect open or shorted lines as well as encoder supply failures.

- HIPERFACE encoder interface
- Encoder input monitoring
- 11 VDC and GND for encoder supply
- NetTime timestamp: Position time

HIPERFACE

HIPERFACE is a standard developed by Max Stegmann GmbH (www.stegmann.de), which like EnDat incorporates the advantages of absolute and incremental position measurement while also offering a read/write parameter memory in the encoder. With absolute position measurement (the absolute position is sampled serially), a homing procedure for referencing is usually not required. Where necessary, a multi-turn encoder should be installed. To reduce costs, a single-turn encoder and a reference switch can also be used. In this case, a homing procedure must be carried out.

The incremental process allows the short deceleration periods necessary for position measurement when using drives with highly dynamic characteristics. With the sinusoidal incremental signal and the fine resolution in the HIPERFACE module, a very high positioning resolution is achieved in spite of the moderate signal frequencies used.

NetTime timestamp for the position

It is not just the position value that is important for highly dynamic positioning tasks, but also the exact time the position is measured. The module is equipped with a NetTime function for this that supplies a timestamp for the recorded position with microsecond accuracy.

The timestamp function is based on synchronized timers. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

9.16.6.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Digital signal processing and preparation |  |
| X20DS1828 | X20 digital signal module, 1 HIPERFACE interface, NetTime function | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 366: X20DS1828 - Order data

9.16.6.3 Technical data

| | |
|--|---|
| Model number | X20DS1828 |
| Short description | |
| I/O module | 1x HIPERFACE interface |
| General information | |
| B&R ID code | 0xAEC7 |
| Status indicators | Counting direction, operating status, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Counting direction | Yes, using status LED |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.3 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Type of signal lines | Shielded cables must be used for all signal lines |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| Encoder inputs | |
| Angular position resolution | 13-bit, with a 1 V _{SS} signal |
| Encoder monitoring | Yes |
| Max. encoder cable length | 10 m |
| Sine/Cosine inputs | |
| Signal transmission | Differential signals, symmetrical |
| Signal frequency | DC up to 200 kHz |
| Differential voltage | 1 V _{SS} |
| Common-mode voltage | Max. ±10 V |
| Terminating resistor | 120 Ω |
| Encoder power supply | |
| Output voltage | 11 V |
| Load capacity | 150 mA |
| Protective measures | |
| Overload-proof | Yes |
| Short-circuit proof | Yes |
| Parameter channel (RS485) | |
| Signal transmission | 5 VDC differential signal, EIA RS-485 standard |
| Transmission status | See HIPERFACE specification |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating" |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |


Table 367: X20DS1828 - Technical data

| Model number | X20DS1828 |
|-----------------------|--|
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm |

Table 367: X20DS1828 - Technical data

9.16.6.4 LED status indicators

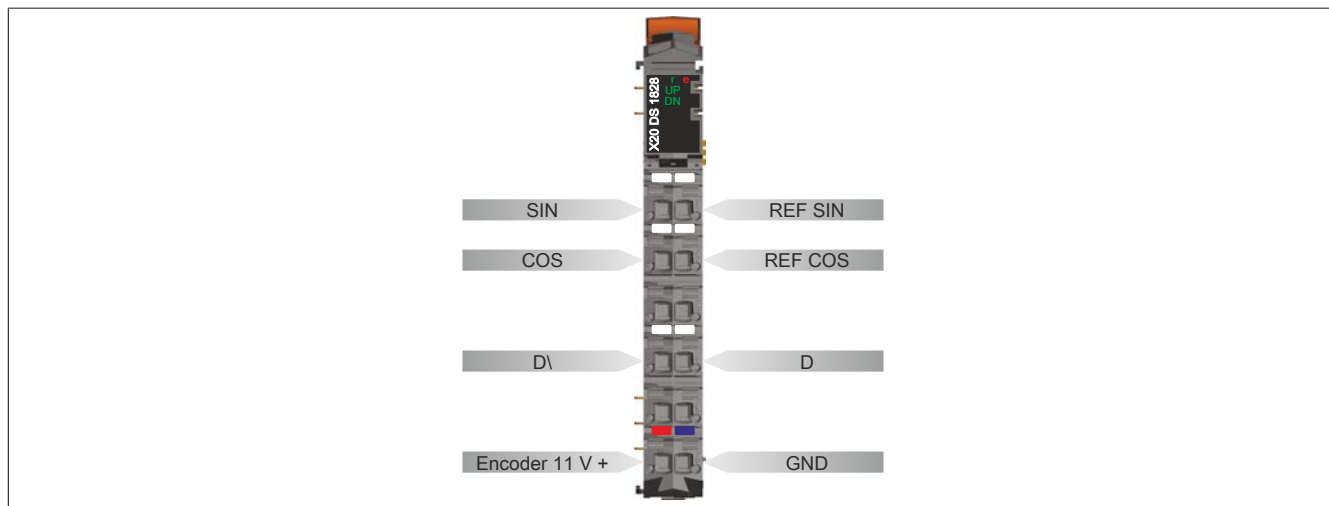
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|---|------------------------|--|---|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset state. Possible cause: <ul style="list-style-type: none"> Encoder supply error |
| | | | Single flash | I/O error - Possible causes: <ul style="list-style-type: none"> Sine/Cosine relative position error (open line) Sine/Cosine absolute position error (reference) |
| | | | Double flash | System error. Possible causes: <ul style="list-style-type: none"> HIPERFACE communication error |
| | | | Triple flash | I/O error and system error |
| | | | Single flash, inverted | Error or reset state and I/O error |
| | | | Double flash, inverted | Error or reset state and system error |
| | Triple flash, inverted | Error or reset state, I/O error and system error | | |
| | UP | Green | On | The "UP/DN" LEDs are lit depending on the rotational direction and the speed of the connected encoder. The "UP" LED indicates when the encoder position changes in the positive direction. |
| DN | Green | On | The "DN" LED indicates when the encoder position changes in the negative direction. | |

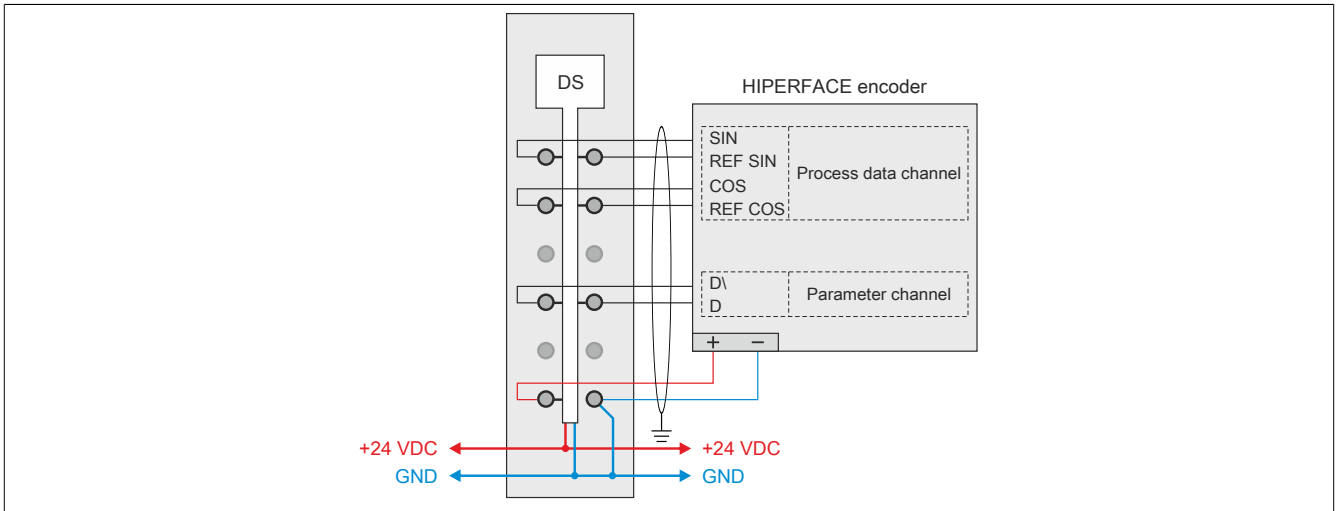
1) Depending on the configuration, a firmware update can take up to several minutes.

9.16.6.5 Pinout

Shielded cables must be used for all signal lines.

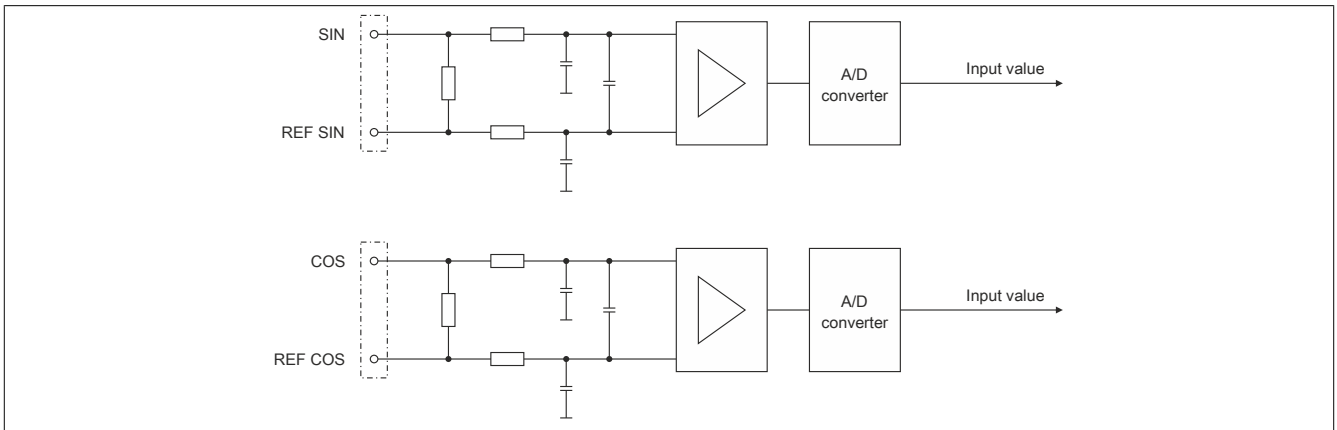


9.16.6.6 Connection example

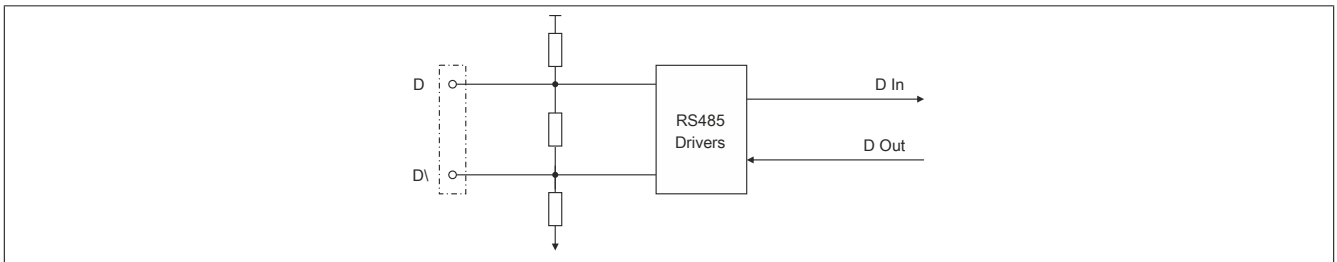


9.16.6.7 Input circuit diagram

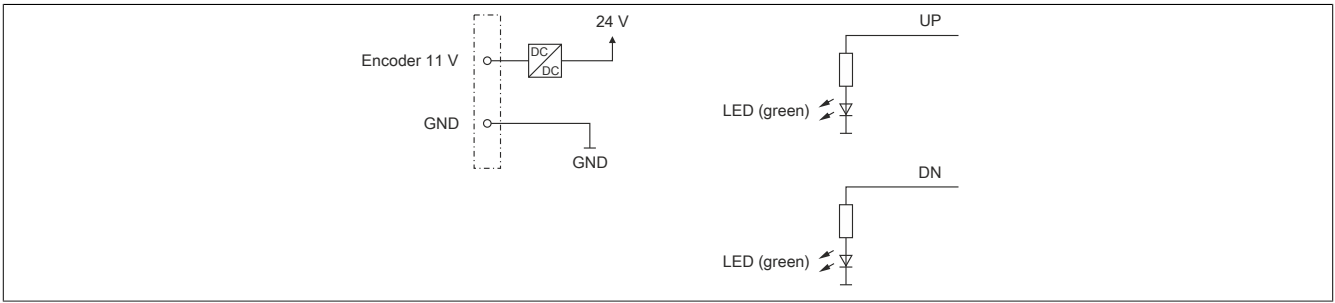
9.16.6.7.1 Diagram for the process data channel (sine-cosine track)



9.16.6.7.2 Circuit diagram for the parameter channel (RS485 interface)



9.16.6.7.3 Circuit diagram for the encoder supply and LEDs



9.16.6.8 Derating

There is no derating when operated below 55°C.

During operation over 55°C, the power dissipation of the modules to the left and right of this module is not permitted to exceed 1.15 W!

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.

| | | | | | | |
|--|--|--|-------------|--|--|--|
| | X20 module Power dissipation > 1.15 W | Neighboring X20 module Power dissipation ≤ 1.15 W | This module | Neighboring X20 module Power dissipation ≤ 1.15 W | X20 module Power dissipation > 1.15 W | |
|--|--|--|-------------|--|--|--|

9.16.6.9 Register description

9.16.6.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.16.6.9.2 Register overview - Function model 0 (standard)

| Register | Name | Data type | Read | | Write | |
|---|---------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module configuration | | | | | | |
| 513 | CfO_SframeGenID | USINT | | | | • |
| Basic functions | | | | | | |
| 683 | SDCLifeCount | SINT | • | | | |
| 1236 | PositionHW | UDINT | • | | | |
| 1244 | PositionLW | UDINT | • | | | |
| | Position | DINT | | | | |
| 1228 | PosTime (32-bit) | DINT | • | | | |
| 1230 | PosTime (16-bit) | INT | • | | | |
| 1219 | PosCycle | SINT | • | | | |
| Error management | | | | | | |
| 387 | ErrorEnableID_0F08 | USINT | | | | • |
| 259 | ErrorInfo | USINT | • | | | |
| | EncoderSupplyError | Bit 0 | | | | |
| | VssCheckError | Bit 2 | | | | |
| | PositionError | Bit 3 | | | | |
| | HfComError | Bit 4 | | | | |
| | HfRefWarning | Bit 5 | | | | |
| 323 | AckErrorInfo | USINT | | | • | |
| | AckEncoderSupplyError | Bit 0 | | | | |
| | AckVssCheckError | Bit 2 | | | | |
| | AckPositionError | Bit 3 | | | | |
| | AckHfComError | Bit 4 | | | | |
| | AckHfRefWarning | Bit 5 | | | | |
| 2116 | HfErrorCode | UDINT | • | | | |
| Sin/Cos - Configuration | | | | | | |
| 1025 | SinCosEnable | USINT | | | | • |
| 1027 | SinCosRefSource | USINT | | | | • |
| 1034 | SinCosVssMin | UINT | | | | • |
| 1038 | SinCosVssMax | UINT | | | | • |
| 1044 | SinCosQuitTime | UDINT | | | | • |
| HIPERFACE - Configuration | | | | | | |
| 2049 | HfMode | USINT | | | | • |
| 2053 | HfParity | USINT | | | | • |
| 2055 | HfCharTimeout | USINT | | | | • |
| 2060 | HfBaud | UDINT | | | | • |
| 2068 | HfRepressErrTime | UDINT | | | | • |
| 2073 | HfRefAdr | USINT | | | | • |
| 2075 | HfRefWidth | USINT | | | | • |
| HIPERFACE - Identification | | | | | | |
| 2561 | HfAdrIdent | USINT | | | | • |
| 2563 | HfSelectionIdent | USINT | | | | • |
| 2631 | HfIdentOk | USINT | | • | | |
| 2688 | HfRs485Settings | USINT | | • | | |
| 2689 | HfEncoderType | USINT | | • | | |
| 2690 | HfEepromSize | USINT | | • | | |
| 2691 | HfOptionFlags | USINT | | • | | |
| 2692 | HfFreeMemory | USINT | | • | | |
| 2693 | HfDataFields | USINT | | • | | |
| 2693 + N | HfExtByte0N (index N = 1 to 10) | USINT | | • | | |
| HIPERFACE - Additional positions | | | | | | |
| 2817 | AddPosAdr01 | USINT | | | | • |
| 2887 | AddPosOk (byte) | USINT | • | | | |
| | AddPosOk01 | Bit 0 | | | | |
| | AddPosOk02 | Bit 1 | | | | |
| 2956 | AddPosition01 | DINT | • | | | |
| 2958 | AddPosition01 | INT | • | | | |
| 2948 | AddPosTime01 | DINT | • | | | |
| 2950 | AddPosTime01 | INT | • | | | |
| 2825 | AddPosAdr02 | USINT | | | | • |
| 2972 | AddPosition02 | DINT | • | | | |
| 2974 | AddPosition02 | INT | • | | | |

| Register | Name | Data type | Read | | Write | |
|---|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2964 | AddPosTime02 | DINT | • | | | |
| 2966 | AddPosTime02 | INT | • | | | |
| HIPERFACE - Additional analog values | | | | | | |
| 3065 + N * 8 | AnalogAdrCh0N (index N = 1 to 4) | USINT | | | | • |
| 3067 + N * 8 | AnalogCh0N (index N = 1 to 4) | USINT | | | | • |
| 3143 | AnalogChOk (byte) | USINT | • | | | |
| | AnalogChOk01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | AnalogChOk04 | Bit 3 | | | | |
| 3194 + N * 16 | AnalogChValue0N (index N = 1 to 4) | (U)INT | • | | | |
| 3188 + N * 16 | AnalogChTime0N (index N = 1 to 4) (32-bit) | DINT | • | | | |
| 3190 + N * 16 | AnalogChTime0N (index N = 1 to 4) (16-bit) | INT | • | | | |
| Flatstream mode | | | | | | |
| 2305 | OutputMTU | USINT | | | | • |
| 2307 | InputMTU | USINT | | | | • |
| 2309 | FlatStreamMode | USINT | | | | • |
| 2311 | Forward | USINT | | | | • |
| 2316 | ForwardDelay | UINT | | | | • |
| 2368 | InputSequence | USINT | • | | | |
| 2368 + N | RxByteN (index N = 1 to 15) | USINT | • | | | |
| 2400 | OutputSequence | USINT | | | • | |
| 2400 + N | TxByteN (index N = 1 to 15) | USINT | | | • | |

9.16.6.9.3 Register overview - Function model 254 (bus controller)

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|---|----------------------|------------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module configuration | | | | | | | |
| 513 | - | CfO_SlframeGenID | USINT | | | | • |
| Basic functions | | | | | | | |
| 1236 | 0 | PositionHW | UDINT | • | | | |
| 1244 | 4 | PositionLW | UDINT | • | | | |
| 1219 | 15 | PosCycle | SINT | • | | | |
| Error management | | | | | | | |
| 387 | - | ErrorEnableID_0F08 | USINT | | | | • |
| 259 | 14 | ErrorInfo | USINT | • | | | |
| | | EncoderSupplyError | Bit 0 | | | | |
| | | VssCheckError | Bit 2 | | | | |
| | | PositionError | Bit 3 | | | | |
| | | HfComError | Bit 4 | | | | |
| 323 | 6 | HfRefWarning | Bit 5 | | | | |
| | | AckErrorInfo | USINT | | | • | |
| | | AckEncoderSupplyError | Bit 0 | | | | |
| | | AckVssCheckError | Bit 2 | | | | |
| | | AckPositionError | Bit 3 | | | | |
| 2116 | - | AckHfComError | Bit 4 | | | | |
| | | AckHfRefWarning | Bit 5 | | | | |
| | | HfErrorCode | UDINT | • | | | |
| Sin/Cos - Configuration | | | | | | | |
| 1025 | - | SinCosEnable | USINT | | | | • |
| 1027 | - | SinCosRefSource | USINT | | | | • |
| 1034 | - | SinCosVssMin | UINT | | | | • |
| 1038 | - | SinCosVssMax | UINT | | | | • |
| 1044 | - | SinCosQuitTime | UDINT | | | | • |
| HIPERFACE - Configuration | | | | | | | |
| 2049 | - | HfMode | USINT | | | | • |
| 2053 | - | HfParity | USINT | | | | • |
| 2055 | - | HfCharTimeout | USINT | | | | • |
| 2060 | - | HfBaud | UDINT | | | | • |
| 2068 | - | HfRepressErrTime | UDINT | | | | • |
| 2073 | - | HfRefAdr | USINT | | | | • |
| 2075 | - | HfRefWidth | USINT | | | | • |
| HIPERFACE - Identification | | | | | | | |
| 2561 | - | HfAdrIdent | USINT | | | | • |
| 2563 | - | HfSelectionIdent | USINT | | | | • |
| 2631 | - | HfIdentOk | USINT | | • | | |
| 2688 | - | HfRs485Settings | USINT | | • | | |
| 2689 | - | HfEncoderType | USINT | | • | | |
| 2690 | - | HfEepromSize | USINT | | • | | |
| 2691 | - | HfOptionFlags | USINT | | • | | |
| 2692 | - | HfFreeMemory | USINT | | • | | |
| 2693 | - | HfDataFields | USINT | | • | | |
| 2693 + N | - | HfExtByte0N (index N = 1 to 10) | USINT | | • | | |
| HIPERFACE - Additional positions | | | | | | | |
| 2817 | - | AddPosAdr01 | USINT | | | | • |
| 2887 | - | AddPosOk (byte) | USINT | • | | | |
| | | AddPosOk01 | Bit 0 | | | | |
| | | AddPosOk02 | Bit 1 | | | | |
| 2956 | - | AddPosition01 | DINT | • | | | |
| 2958 | - | AddPosition01 | INT | • | | | |
| 2825 | - | AddPosAdr02 | USINT | | | | • |
| 2972 | - | AddPosition02 | DINT | • | | | |
| 2974 | - | AddPosition02 | INT | • | | | |
| HIPERFACE - Additional analog values | | | | | | | |
| 3065 + N * 8 | - | AnalogAdrCh0N (index N = 1 to 4) | USINT | | | | • |
| 3067 + N * 8 | - | AnalogCh0N (index N = 1 to 4) | USINT | | | | • |
| 3143 | - | AnalogChOk (byte) | USINT | • | | | |
| | | AnalogChOk01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | AnalogChOk04 | Bit 3 | | | | |
| 3194 + N * 16 | - | AnalogChValue0N (index N = 1 to 4) | (U)INT | • | | | |
| Flatstream mode | | | | | | | |
| 2305 | - | OutputMTU | USINT | | | | • |
| 2307 | - | InputMTU | USINT | | | | • |
| 2309 | - | FlatStreamMode | USINT | | | | • |
| 2311 | - | Forward | USINT | | | | • |
| 2316 | - | ForwardDelay | UINT | | | | • |

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|----------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2368 | 8 | InputSequence | USINT | • | | | |
| 2368 + N | 9 to 13 | RxByteN (index N = 1 to 5) | USINT | • | | | |
| 2400 | 0 | OutputSequence | USINT | | | • | |
| 2400 + N | 1 to 5 | TxByteN (index N = 1 to 5) | USINT | | | • | |

1) The offset specifies the position of the register within the CAN object.

9.16.6.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.16.6.9.3.2 CAN I/O bus controller

The module occupies 2 analog logical slots on CAN I/O.

9.16.6.9.4 Module configuration

The following configuration register can be used to configure different module settings. They can be used, for example, to modify the module's behavior on an X2X Link network.

9.16.6.9.4.1 Data query

Name:

CfO_SlframeGenID

This register can be used to define when the synchronous/cyclic input data is generated. "X2X cycle optimized" should be set for jitter-free data acquisition. "Fast reaction" can be set for the best performance.

| Data type | Value | Information |
|-----------|-------|--|
| USINT | 9 | Fast reaction |
| | 14 | X2X cycle optimized; Bus controller default |

9.16.6.9.5 Basic functions

This module can import a position when used together with a HIPERFACE encoder. The received position data is prepared in 2 different formats and given a [timestamp](#). 6 registers are available for further processing. This allows the user to choose which format is best suited for individual application.

9.16.6.9.5.1 SDC counter register

Name:

SDCLifeCount

The 8-bit counter register is needed for the SDC software package. It is incremented with the system clock to allow the SDC to check the validity of the data frame.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

9.16.6.9.5.2 Absolute position values

Name:

PositionHW

PositionLW

The absolute position of the encoder is defined using 64-bit resolution. The position value is stored in the PositionHW and PositionLW registers. The upper 32 bits are stored the PositionHW register, while the lower 32 bits are stored in the PositionLW register.

For SinCos signal evaluation, see ["Format of the SinCos signal" on page 2012](#) for information regarding the data format.

| Data type | Value |
|-----------|--------------------|
| 2x UDINT | 0 to 4,294,967,295 |

9.16.6.9.5.3 SDC position value

Name:

Position

The SDC library requires a signed 32-bit position value. The position's low word can be accessed separately for this. The value can also be used as default position value, however.

For SinCos signal evaluation, see ["Format of the SinCos signal" on page 2012](#) for information regarding the data format.

| Data type | Value |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

9.16.6.9.5.4 NetTime of the position values

Name:

PosTime

The current NetTime value is assigned to each determined position in this register. The NetTime is recorded with μs accuracy.

The SDC library requires a 16 bit value. The NetTime value is therefore also prepared in this format.

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

| Data type | Value | Information |
|-----------|------------------------------------|--------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime in μs |
| INT | -32,768 to 32,767 | |

9.16.6.9.5.5 Counter for position values

Name:

PosCycle

PosCycle is an integer counter that is incremented as soon as the module has saved a new valid position value.

| Data type | Value |
|-----------|-------------|
| SINT | -128 to 127 |

9.16.6.9.6 Error management

This module can be used to diagnose error states. There are 2 ways this module performs error diagnostics:

- ["Module-based diagnostics" on page 2009](#)
- ["HIPERFACE-based diagnostics" on page 2011](#)

9.16.6.9.6.1 Module-based diagnostics

Like most B&R modules, this module is also able to detect errors on its own. It diagnoses 5 different errors or warnings. The error bits can be retrieved individually or grouped together.

Enabling/disabling error messages

Name:

ErrorEnableID_0F08

The implemented diagnostic algorithms can be enabled or disabled in this register.

| Data type | Value | Bus controller default |
|-----------|--------------------|------------------------|
| USINT | See bit structure. | 255 |

Bit structure:

| Bit | Name | Value | Information |
|-------|-----------------------------|-------|--|
| 0 | Encoder supply | 0 | Error detection disabled |
| | | 1 | Error detection enabled (bus controller default setting) |
| 1 | Reserved | - | |
| 2 | Vss Sin/Cos | 0 | Error detection disabled |
| | | 1 | Error detection enabled (bus controller default setting) |
| 3 | Position error | 0 | Error detection disabled |
| | | 1 | Error detection enabled (bus controller default setting) |
| 4 | HIPERFACE communication | 0 | Error detection disabled |
| | | 1 | Error detection enabled (bus controller default setting) |
| 5 | HIPERFACE reference warning | 0 | Warning disabled |
| | | 1 | Warning enabled (bus controller default setting) |
| 6 - 7 | Reserved | - | |

Encoder supply

The encoder voltage supply is below the permitted limit.

Vss Sin/Cos

The voltage value for the Sin/Cos track violates the configured limit values.

→ See register ["SinCosVssMin" on page 2013](#) or ["SinCosVssMax" on page 2013](#)

Position error

The position value determined violates internal requirements.

HIPERFACE communication

Communication error on the HIPERFACE interface (RS485)

→ See register ["HfErrorCode" on page 2011](#)

HIPERFACE reference warning

The digital interface provides an absolute position value that can be used to accurately describe the axis position. The position value is homed to this absolute value at the beginning of a measurement. The analog interface can be used to incrementally sample changes that occur very rapidly. This enables the module to continue sampling the position value at a high resolution. Both the analog and the digital signal are sampled cyclically. If the value read incrementally deviates from the absolute value during operation, then the warning is generated and the position must be homed again.

Show error messages

Name:
 ErrorInfo
 EncoderSupplyError
 VssCheckError
 PositionError
 HfComError
 HfRefWarning

This register indicates any errors or warnings that have not yet been acknowledged. For the meaning of individual error messages, see register "[Enabling/disabling error messages](#)" on page 2009.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|--------------------|-------|--------------------------------|
| 0 | EncoderSupplyError | 0 | No error |
| | | 1 | Encoder supply error |
| 1 | Reserved | - | |
| 2 | VssCheckError | 0 | No error |
| | | 1 | Vss error on the Sin/Cos track |
| 3 | PositionError | 0 | No error |
| | | 1 | Position error |
| 4 | HfComError | 0 | No error |
| | | 1 | HIPERFACE communication error |
| 5 | HfRefWarning | 0 | No warning |
| | | 1 | HIPERFACE reference warning |
| 6 - 7 | Reserved | - | |

Acknowledge error messages

Name:
 AckErrorInfo
 AckEncoderSupplyError
 AckVssCheckError
 AckPositionError
 AckHfComError
 AckHfRefWarning

This register is used to acknowledge an error or warning message that occurred in the "[Show error messages](#)" on page 2010 register. For the meaning of individual error messages, see register "[Enabling/disabling error messages](#)" on page 2009.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|-----------------------|-------|-------------------------|
| 0 | AckEncoderSupplyError | 0 | No error acknowledgment |
| | | 1 | Error acknowledgment |
| 1 | Reserved | - | |
| 2 | AckVssCheckError | 0 | No error acknowledgment |
| | | 1 | Error acknowledgment |
| 3 | AckPositionError | 0 | No error acknowledgment |
| | | 1 | Error acknowledgment |
| 4 | AckHfComError | 0 | No error acknowledgment |
| | | 1 | Error acknowledgment |
| 5 | AckHfRefWarning | 0 | No acknowledgment |
| | | 1 | Acknowledgment |
| 6 - 7 | Reserved | - | |

9.16.6.9.6.2 HIPERFACE-based diagnostics

Memory areas are provided in the HIPERFACE standard for error diagnostics. Error management has been adjusted in order to use error detection in accordance with the HIPERFACE standard. An additional register has been implemented in the module to provide this area in the encoder's memory. This error memory is mirrored in the module's registers and can be interpreted by the user. Detailed information regarding the errors that can be detected in this way can be found in the encoder's manual.

HfErrorCode

Name:

HfErrorCode

This register is used to store the error code that identifies the current problem with the HIPERFACE interface.

| Data type | Value |
|-----------|--------------------|
| UDINT | See bit structure. |

Internally, the register consists of 4 pieces of information.

Bit structure:

| Bit | Name | Information |
|---------|-----------------|--|
| 00 - 07 | Error ID | See below |
| 08 - 15 | Last command | Command that caused the error on the slave |
| 16 - 23 | Station address | Address of the faulty HIPERFACE slave |
| 24 - 31 | Error counter | Counts the number of errors that have occurred |

Bit 00-07 (error ID)

These 8 bits of this register specify the error that has occurred. The error ID is not a standard value, however, and must be looked up in the manual for the HIPERFACE slave. The module also diagnoses a timeout on the HIPERFACE interface. This triggers error ID 255.

9.16.6.9.7 Sin/Cos - Analog interface configuration

In addition to the digital HIPERFACE interface, this module is also equipped with an analog interface for sampling a differential sine-cosine signal. To increase the resolution, the EnDat standard supports cooperation between the analog and digital data. This enables a highly dynamic representation of the position while maintaining high resolution.

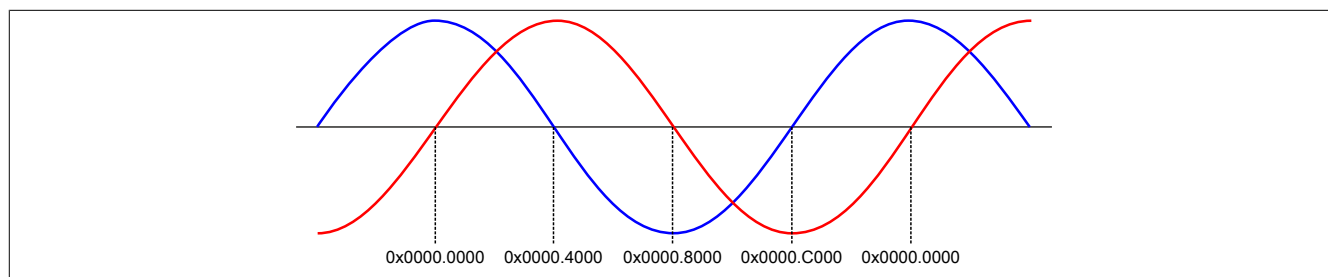
9.16.6.9.7.1 Format of the SinCos signal

The SinCos signal is represented as a position value in the "Absolute position values" on page 2007 and "SDC position value" on page 2008 registers. The following relationships apply:

- PositionLW and Position are identical in the function.
- PositionHW extends the integer range of PositionLW by adding multi-turn functionality.

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|------------------------|----------------------------------|---|---|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64-bit register | PositionHW (unsigned) | | PositionLW (unsigned) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 32-bit register | - | | Position (signed) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Format | Integer extension (to 48-bit) | Integer (16-bit) | Decimal places: (with 13-bit resolution) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Information | | A full sine wave corresponds to an increment of the integer. | <table border="1"> <tr> <td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td> </tr> <tr> <td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>0</td><td>0</td><td>0</td> </tr> </table> <p>Important: The lower 3 bits always contain the value 0.</p> | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | x | x | x | x | x | x | x | x | x | x | x | x | x | 0 | 0 | 0 |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | | | | | | | | | | | | | | | | | | | |
| x | x | x | x | x | x | x | x | x | x | x | x | x | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | | | |
| Word/DWord | DWord | Word 1 | Word 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Relationship between sine curve (red) and decimal places:



9.16.6.9.7.2 Enabling SinCos

Name:
SinCosEnable

This register must always have the value 1 for configuration reasons.

| Data type | Value | Information |
|-----------|-------|---------------------------|
| USINT | 1 | Bus controller default: 1 |

9.16.6.9.7.3 SinCosRefSource

Name:
SinCosRefSource

This register must always have the value 3 for configuration reasons.

| Data type | Value | Information |
|-----------|-------|---------------------------|
| USINT | 3 | Bus controller default: 3 |

9.16.6.9.7.4 Configuring the lower Vss value

Name:

SinCosVssMin

This register specifies the lower limit value for the peak-to-peak voltage of the sine/cosine track. The incoming signal is monitored in this way. If the incoming value falls below this specified limit, then the module reports the corresponding error.

| Data type | Value | Information |
|-----------|-----------|---|
| UINT | 0 to 1500 | Values in mV Bus controller default: 800 |

9.16.6.9.7.5 Configuring the upper Vss value

Name:

SinCosVssMax

This register specifies the upper limit value for the peak-to-peak voltage of the sine/cosine track. The incoming signal is monitored in this way. If the incoming value exceeds this specified limit, then the module reports the corresponding error.

| Data type | Value | Information |
|-----------|-----------|--|
| UINT | 0 to 1500 | Values in mV Bus controller default: 1200 |

9.16.6.9.7.6 Configuring the delay time after errors

Name:

SinCosQuitTime

If an error is detected on the analog interface, the last correctly read values remain valid. An interval can be defined in this register at which the module begins receiving correct values again after the error state without processing them further internally. Only then will newly sampled correct analog values be recognized as valid.

| Data type | Value | Information |
|-----------|---------------|---|
| UDINT | 0 to 20000000 | Values in μ s Bus controller default: 100000 |

9.16.6.9.8 HIPERFACE

9.16.6.9.8.1 HIPERFACE - Digital interface configuration

HIPERFACE builds upon the RS-485 (EIA-485) specification and permits communication with multiple HIPERFACE slaves.

There are 2 methods available to use the slave data in a PLC program. One is to store the necessary slave values temporarily in the module, where they can then be provided to the CPU. The other is to use the module's FlatStream mode, which supports the full range of commands defined in the HIPERFACE specification.

Additional information regarding the HIPERFACE specification is provided in the "Description of HIPERFACE" document.

HfMode

Name:
HfMode

This register is used to enable the HIPERFACE interface and must always be set to the value 1 for configuration reasons.

| Data type | Value | Information |
|-----------|-------|---------------------------|
| USINT | 1 | Bus controller default: 1 |

HfParity

Name:
HfParity

This register configures the parity bit for the interface.

| Data type | Values | Information |
|-----------|--------|---|
| USINT | 69 | E → even parity bit Bus controller default setting |
| | 78 | N → no parity bit |
| | 79 | O → odd parity bit |

HfCharTimeout

Name:
HfCharTimeout

This register configures the time that the module waits after receiving the last data block to add additional data to the current data packet (frame). When this time expires, the data received thus far is saved in a frame. The transfer is complete and the data can be evaluated.

Information:

Time is specified as a char value in order to ensure identical behavior regardless of the baud rate setting.

| Data type | Values | Information |
|-----------|----------|--|
| USINT | 1 to 255 | Char Bus controller default setting: 55 |

HfBaud

Name:
HfBaud

This register configures the baud rate (transfer rate) of the interface.
The module does not allow a transfer rate of 600 baud.

| Data type | Values | Information |
|-----------|---|--|
| UDINT | 1200, 2400, 4800, 9600, 19200, 38400 | Baud Bus controller default setting: 9600 |

HfRepressErrTime

Name:
HfRepressErrTime

This register configures the minimum time that an error code remains in the "HfErrorCode" register. This makes it possible to ensure that the CPU registers every error that occurs.

| Data type | Value | Information |
|-----------|---------------|--|
| UDINT | 1 to 20000000 | Time in μ s; Bus controller default: 100000 |

HfRefAdr

Name:
HfRefAdr

This module can manage up to 32 HIPERFACE slaves via its digital interface. High-resolution position sampling, however, requires information from both the digital and analog interfaces. The HIPERFACE address of the station whose sine/cosine track is being read by the module is entered in this register. If there is only one slave on the network, the broadcast address (255) can also be used.

| Data type | Values | Information |
|-----------|----------|--|
| USINT | 0 | Operation without sine/cosine track |
| | 64 to 95 | Open address range for max. 32 HIPERFACE slaves. Bus controller default setting: 64 |
| | 255 | Broadcast address |

HfRefWidth

Name:
HfRefWidth

This register is used to set the absolute width for the sampled position. The number of bits must be taken from the data provided by the encoder manufacturer and usually consists of three values:

- 5-bit: Resolution of the digital absolute position
- 2^y -bit: Number of sine/cosine periods per revolution
- x-bit: HIPERFACE data format, number of bits per revolution

The sum of the sampled values results in the HfRefWidth (i.e. $5+x+y$).

| Data type | Values | Information |
|-----------|---------|------------------------------------|
| USINT | 8 to 32 | Bus controller default setting: 32 |

Example:

The position width of the reference station must be 21 when using the 80MPH4.600S111-02 motor. This is because the HIPERFACE encoder being used measures the absolute position with 21-bit data width (the $x = 12$ most significant bits encode the multi-turn information, the next $y = 4$ bits count the sin/cos period within a mechanical revolution and the $z = 5$ least significant bits encode the absolute position within a sin/cos period). If a value > 21 is set (e.g. 32), then the module firmware detects a supposed jump in the absolute position on each zero crossing of the absolute position (i.e. overflow of 21-bit position value of from 0x00000000 to 0x0001FFFF, or vice versa).

9.16.6.9.8.2 HIPERFACE - Read ID

The digital interface provides the option of assigning a HIPERFACE slave a specific ID. Its parameter data can be queried when booting the PLC, for example. Any deviations from the previous hardware constellation can then be handled accordingly in the program.

Configuration

The parameter to be read is specified by 2 registers. One of the registers contains the address of the desired HIPERFACE slave; the other contains a code for the value to be read.

HfAdrIdent

Name:
HfAdrIdent

This register is used to set the HIPERFACE address of the slave with parameters that are to be processed in the module.

| Data type | Values | Information |
|-----------|----------|--|
| USINT | 0 | Identification deactivated Bus controller default setting |
| | 64 to 95 | Open address range for max. 32 HIPERFACE slaves |
| | 255 | Broadcast address (when operating with one slave) |

HfSelectionIdent

Name:
HfSelectionIdent

This register defines the parameters that should be provided in the slave response and buffered in the module's "HfExtByte" on page 2018 register.

| Data type | Values | Values |
|-----------|--------|---|
| USINT | 0 | Serial number Bus controller default setting |
| | 1 | Firmware date |
| | 2 | High part of firmware version |
| | 3 | Low part of firmware version |

Call

After being configured correctly, the selected parameter is transmitted cyclically to the module. There are 8 registers that serve as temporary storage. The module confirms successful receipt by setting the [HfIdentOkByte](#).

HfIdentOk

Name:
HfIdentOk

This register's bits provide information about the validity of the latest ID values in temporary storage.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|----------------------|
| 0 | HfIdentOk01 | 0 | Parameter 01 invalid |
| | | 1 | Parameter 01 valid |
| 1 - 7 | Reserved | - | |

HfRs485Settings

Name:

HfRs485Settings

This register is used to temporarily store the current network configuration expected by the slave. The register value is specifically structured for HIPERFACE.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|------------------------------|-------|------------------------|
| 0 - 2 | Speed code | 001 | 1200 baud |
| | | 010 | 2400 baud |
| | | 011 | 4800 baud |
| | | 100 | 9600 baud |
| | | 101 | 19200 baud |
| | | 110 | 38400 baud |
| 3 | Reserved | - | |
| 4 | Number of parity bits | 0 | No parity bit |
| | | 1 | 1 parity bit |
| 5 | Type of parity bit | 0 | Even |
| | | 1 | Odd |
| 6 | Behavior if a timeout occurs | 0 | Timeout 11/baudrate |
| | | 1 | Timeout 4*11/baud rate |
| 7 | Network behavior | 0 | Bus |
| | | 1 | Direct connection |

HfEncoderType

Name:

HfEncoderType

This register is used to temporarily store the ID of the current encoder. The register value is structured specifically for each slave and must be looked up in the encoder's data sheet.

| Data type | Values |
|-----------|----------|
| USINT | 0 to 255 |

HfEepromSize

Name:

HfEepromSize

This register is used to store the size of the EEPROM being used. The number of 16-byte blocks is specified.

| Data type | Values | Values |
|-----------|----------|----------------|
| USINT | 0 to 255 | 16-byte blocks |

HfOptionFlags

Name:

HfOptionFlags

This register is used to store slave-specific hardware and software settings.

| Data type | Values |
|-----------|----------|
| USINT | 0 to 255 |

HfFreeMemory

Name:

HfFreeMemory

This register is used to indicate the number of free 16-byte blocks remaining on the HIPERFACE slave.

| Data type | Values | Information |
|-----------|----------|----------------|
| USINT | 0 to 255 | 16-byte blocks |

HfDataFields

Name:

HfDataFields

This register is used to indicate the number of data fields that have been written thus far.

| Data type | Values |
|-----------|----------|
| USINT | 0 to 255 |

HfExtByte

Name:

HfExtByte01 to HfExtByte10

These registers provide the respective parameters according to how the "HfSelectionIdent" on page 2016 register is configured.

| Data type | Values |
|-----------|----------|
| USINT | 0 to 255 |

9.16.6.9.8.3 HIPERFACE - Reading additional encoder positions

This module can read up to 2 additional position values via the HIPERFACE interface and provide them to the PLC. Each position value is accompanied by a [timestamp](#).

Configuration

The address must be specified in order to read the position value from the respective HIPERFACE interface. One address register is provided for each position value.

AddPosAdr

Name:

AddPosAdr01 to AddPosAdr02

These registers are used to set the addresses of the HIPERFACE slaves with position values that should be processed in the module.

| Data type | Values | Information |
|-----------|----------|--|
| USINT | 0 | Additional encoder position disabled Bus controller default setting |
| | 64 to 95 | Open address range for max. 32 HIPERFACE slaves |
| | 255 | Broadcast address (when operating with one slave) |

Call

After being configured correctly, the position value is transferred cyclically to the module. Each slave has five registers that serve as temporary storage. The module automatically generates the [timestamp](#) and confirms successful transmission by setting the corresponding [AddPosOk0x](#) bit. The HIPERFACE specification does not specify in which format the parameters must be received. The module therefore provides the position value and time in two variants. Which of the position registers should be used for further processing depends on the HIPERFACE slave. The user is free to define the format of the timestamp.

AddPosOk (byte)

Name:

AddPosOk01 to AddPosOk02

This register's bits provide information about the validity of the last position values in temporary storage.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|---------------------------|
| 0 | AddPosOk01 | 0 | Position value 01 invalid |
| | | 1 | Position value 01 valid |
| 1 | AddPosOk02 | 0 | Position value 02 invalid |
| | | 1 | Position value 02 valid |
| 2 - 7 | Reserved | - | |

AddPosition

Name:

AddPosition01 to AddPosition02

These registers provide the current position values, depending on the register address, as signed 2-byte or 4-byte values.

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |
| INT | -32768 to 32767 |

AddPosTime

Name:

AddPosTime01 to AddPosTime02

These registers provide the timestamp of the most recently received position values, depending on the register address, as signed 2-byte or 4-byte values.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Values | Information |
|-----------|------------------------------------|--------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime in μ s |
| INT | -32768 to 32767 | |

9.16.6.9.8.4 HIPERFACE - Reading additional analog values

This module can read up to 4 analog values (16-bit) via the HIPERFACE interface and provide them to the PLC. Each analog value is accompanied by a [timestamp](#).

Configuration

The analog value to be read is specified by 2 registers. One of them contains the address of the desired station, and the other the channel of the parameter to be read. An overview of analog values that can be read is provided in the data sheet for the respective slave.

AnalogAdrCh

Name:

AnalogAdrCh01 to AnalogAdrCh04

These registers are used to set the addresses of the HIPERFACE slaves with analog values that should be processed in the module. To query multiple values from one HIPERFACE slave, it may make sense to write the same address to different AnalogAdrCh registers.

| Data type | Values | Information |
|-----------|----------|---|
| USINT | 0 | Additional analog values disabled Bus controller default setting |
| | 64 to 95 | Open address range for max. 32 HIPERFACE slaves |
| | 255 | Broadcast address (when operating with one slave) |

AnalogCh

Name:

AnalogCh01 to AnalogCh04

These registers define the channel to be read that is written by the bus station to the module's temporary storage.

| Data type | Values | Information |
|-----------|------------------------|-----------------------------------|
| USINT | See encoder data sheet | Bus controller default setting: 0 |

Call

After being configured correctly, the analog value is transferred cyclically to the module. There are 5 registers that serve as temporary storage. The module automatically generates the [timestamp](#) and confirms successful transmission by setting the corresponding [AnalogChOk0x](#) bit. The HIPERFACE specification does not specify in which format the parameters must be received. The module therefore provides the value and time in two variants. Which of the value registers should be used for further processing depends on the peripheral equipment. The user is free to define the format of the timestamp.

AnalogChOk (byte)

Name:

AnalogChOk01 to AnalogChOk04

This register's bits provide information about the validity of the values in temporary storage.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------|-------|-------------------------|
| 0 | AnalogChOk01 | 0 | Analog value 01 invalid |
| | | 1 | Analog value 01 valid |
| ... | | ... | |
| 3 | AnalogChOk04 | 0 | Analog value 04 invalid |
| | | 1 | Analog value 04 valid |
| 4 - 7 | Reserved | - | |

AnalogChValue

Name:

AnalogChValue01 to AnalogChValue04

These registers provide the current analog values, depending on the register address, as signed or unsigned 2-byte values.

| Data type | Values |
|-----------|-----------------|
| UINT | 0 to 65535 |
| INT | -32768 to 32767 |

AnalogChTime

Name:

AnalogChTime01 to AnalogChTime04

These registers provide the timestamp of the most recently received analog values, depending on the register address, as signed 2-byte or 4-byte values.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Values | Information |
|-----------|------------------------------------|--------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime in μ s |
| INT | -32768 to 32767 | |

9.16.6.9 Flatstream communicationFor a description of Flatstream communication, see "[Flatstream communication](#)" on page 3802

9.16.6.9.10 HIPERFACE with FlatStream

HIPERFACE is an asynchronous interface capable of half-duplex communication. Various features have been included to ensure that signals are transmitted without errors.

- The user can choose to have a parity bit added when transmitting a data block.
- A checksum is sent together with a signal and evaluated by the receiver.
- The command to which the encoder is responding is repeated at the start of a response.

In FlatStream mode, the module acts as a bridge between the CPU and the HIPERFACE slave. HIPERFACE-specific algorithms have been implemented to monitor timeouts and handle checksums. During normal operation, the user does not have access to these details.

Additional information is provided in the "Description of HIPERFACE" document.

9.16.6.9.10.1 Overview of conventional HIPERFACE commands for FlatStream mode

| Command byte [hex] | Command | Code0 |
|--------------------|--|-------|
| 0x42 | Read position | |
| 0x43 | Set position | • |
| 0x44 | Read analog value | |
| 0x46 | Read counter | |
| 0x47 | Increment counter | |
| 0x49 | Delete counter | • |
| 0x4A | Read data | |
| 0x4B | Save data | |
| 0x4C | Read status of a data field | |
| 0x4D | Create data field | |
| 0x4E | Read available memory area | |
| 0x4F | Change access key | |
| 0x50 | Read encoder status | |
| 0x52 | Read nameplate | |
| 0x53 | Reset encoder | |
| 0x55 | Allocate encoder address | • |
| 0x56 | Read serial number and program version | |
| 0x57 | Configure serial interface | • |

Code0 is a byte that was added to the transfer protocol for safety reasons. It protects important system parameters from being overwritten by mistake (default: Code0 = 0x55).

9.16.6.9.10.2 Read position (0x42)

Master command

| Protocol bytes | | Information |
|----------------|---------|--------------------------------|
| No. | Name | |
| Master | | |
| 1 | Address | Address of the HIPERFACE slave |
| 2 | 0x42 | Command byte (read position) |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|---------|--|
| No. | Name | |
| Slave | | |
| 1 | Address | Repeated address and command byte (safety) |
| 2 | 0x42 | |
| 3 | Pos_HH | Response (data bytes) |
| 4 | Pos_HL | |
| 5 | Pos_LH | |
| 6 | Pos_LL | |
| Master | | |

9.16.6.9.10.3 Set position (0x43)

Master command

| Protocol bytes | | Information |
|----------------|---------|--|
| No. | Name | |
| Master | | |
| 1 | Address | Address of the HIPERFACE slave |
| 2 | 0x43 | Command byte (set position) |
| 3 | Pos_HH | New position (data bytes) |
| 4 | Pos_HL | |
| 5 | Pos_LH | |
| 6 | Pos_LL | |
| 7 | Code0 | Safety byte in accordance with the HIPERFACE specification |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|---------|--|
| No. | Name | |
| Slave | | |
| 1 | Address | Repeated address and command byte (safety) |
| 2 | 0x43 | |
| Master | | |

9.16.6.9.10.4 Read analog value (0x44)

Master command

| Protocol bytes | | Information |
|----------------|---------|---|
| No. | Name | |
| Master | | |
| 1 | Address | Address of the HIPERFACE slave |
| 2 | 0x44 | Command byte (read analog value) |
| 3 | channel | Channel byte (selects desired analog value) |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|---------|--|
| No. | Name | |
| Slave | | |
| 1 | Address | Repeated address, command byte and channel byte (safety) |
| 2 | 0x44 | |
| 3 | channel | |
| 4 | Value_H | Value read |
| 5 | Value_L | |
| Master | | |

9.16.6.9.10.5 Read counter (0x46)

Master command

| Protocol bytes | | Information |
|----------------|---------|--------------------------------|
| No. | Name | |
| Master | | |
| 1 | Address | Address of the HIPERFACE slave |
| 2 | 0x46 | Command byte (read counter) |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|---------|--|
| No. | Name | |
| Slave | | |
| 1 | Address | Repeated address and command byte (safety) |
| 2 | 0x46 | |
| 3 | Ctr_H | Counter value |
| 4 | Ctr_M | |
| 5 | Ctr_L | |
| Master | | |

9.16.6.9.10.6 Increment counter (0x47)

Master command

| Protocol bytes | | Information |
|----------------|---------|----------------------------------|
| No. | Name | |
| Master | | |
| 1 | Address | Address of the HIPERFACE slave |
| 2 | 0x47 | Command byte (increment counter) |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|---------|--|
| No. | Name | |
| Slave | | |
| 1 | Address | Repeated address and command byte (safety) |
| 2 | 0x47 | |
| Master | | |

9.16.6.9.10.7 Clear counter (0x49)

Master command

| Protocol bytes | | Information |
|----------------|---------|--|
| No. | Name | |
| Master | | |
| 1 | Address | Address of the HIPERFACE slave |
| 2 | 0x49 | Command byte (clear counter) |
| 3 | Code0 | Safety byte in accordance with the HIPERFACE specification |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|---------|--|
| No. | Name | |
| Slave | | |
| 1 | Address | Repeated address and command byte (safety) |
| 2 | 0x49 | |
| Master | | |

9.16.6.9.10.8 Read data (0x4A)

Master command

| Protocol bytes | | Information |
|----------------|--------------|---|
| No. | Name | |
| Master | | |
| 1 | Address | Address of the HIPERFACE slave |
| 2 | 0x4A | Command byte (read data) |
| 3 | Data field | ID of data to be read: |
| 4 | Byte address | Number of the data field, start byte within the data field and number of bytes to be read |
| 5 | Count | |
| 6 | Access code | Access code in accordance with the HIPERFACE specification |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|--------------|---|
| No. | Name | |
| Slave | | |
| 1 | Address | Repeated address, command byte and ID of data to be read (safety) |
| 2 | 0x4A | |
| 3 | Data field | |
| 4 | Byte address | |
| 5 | Count | |
| 6...n | Data1...n | Data to be read |
| Master | | |

9.16.6.9.10.9 Save data (0x4B)

Master command

| Protocol bytes | | Information |
|----------------|--------------|--|
| No. | Name | |
| Master | | |
| 1 | Address | Address of the HIPERFACE slave |
| 2 | 0x4B | Command byte (save data) |
| 3 | Data field | ID of data to be saved: Number of the data field, start byte within the data field and number of bytes to be read |
| 4 | Byte address | |
| 5 | Count | |
| 6 | Access code | Access code in accordance with the HIPERFACE specification |
| 7...x | Data1...n | Data to be saved |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|--------------|--|
| No. | Name | |
| Slave | | |
| 1 | Address | Repeated address, command byte and ID of data to be saved (safety) |
| 2 | 0x4B | |
| 3 | Data field | |
| 4 | Byte address | |
| 5 | Count | |
| Master | | |

9.16.6.9.10.10 Read status of a data field (0x4C)

Master command

| Protocol bytes | | Information |
|----------------|------------|---|
| No. | Name | |
| Master | | |
| 1 | Address | Address of the HIPERFACE slave |
| 2 | 0x4C | Command byte (determine status of a data field) |
| 3 | Data field | Number of the data field |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|------------|--|
| No. | Name | |
| Slave | | |
| 1 | Address | Repeated address, command byte and number of the data field (safety) |
| 2 | 0x4C | |
| 3 | Data field | |
| 4 | Status | Access mode for queried data field |
| Master | | |

9.16.6.9.10.11 Create data field (0x4D)

Master command

| Protocol bytes | | Information |
|----------------|-------------|--|
| No. | Name | |
| Master | | |
| 1 | Address | Address of the HIPERFACE slave |
| 2 | 0x4D | Command byte (create data field) |
| 3 | Data field | Number of the data field |
| 4 | Status | Access mode for the data field |
| 5 | Access code | Access code in accordance with the HIPERFACE specification |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|------------|---|
| No. | Name | |
| Slave | | |
| 1 | Address | Repeated address, command byte, number of the data field and access mode of the data field (safety) |
| 2 | 0x4D | |
| 3 | Data field | |
| 4 | Status | |
| Master | | |

9.16.6.9.10.12 Read available memory area (0x4E)

Master command

| Protocol bytes | | Information |
|----------------|---------|---|
| No. | Name | |
| Master | | |
| 1 | Address | Address of the HIPERFACE slave |
| 2 | 0x4E | Command byte (read available memory area) |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|-----------------------|--|
| No. | Name | |
| Slave | | |
| 1 | Address | Repeated address and command byte (safety) |
| 2 | 0x4E | |
| 3 | Free memory | Number of available 16-byte blocks |
| 4 | Number of data fields | Number of data fields |
| Master | | |

9.16.6.9.10.13 Change access key (0x4F)

Master command

| Protocol bytes | | Information |
|----------------|-------------|---|
| No. | Name | |
| Master | | |
| 1 | Address | Address of the HIPERFACE slave |
| 2 | 0x4F | Command byte (change access key) |
| 3 | Code number | Safety code from the slave manufacturer |
| 4 | Old code | |
| 5 | New code | |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|-------------|---|
| No. | Name | |
| Slave | | |
| 1 | Address | Repeated address, command byte and code number (safety) |
| 2 | 0x4F | |
| 3 | Code number | |
| Master | | |

9.16.6.9.10.14 Read encoder status (0x50)

Master command

| Protocol bytes | | Information |
|----------------|---------|------------------------------------|
| No. | Name | |
| Master | | |
| 1 | Address | Address of the HIPERFACE slave |
| 2 | 0x50 | Command byte (read encoder status) |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|----------------|--|
| No. | Name | |
| Slave | | |
| 1 | Address | Repeated address and command byte (safety) |
| 2 | 0x50 | |
| 3 | Encoder status | Status byte as specified by the slave manufacturer |
| Master | | |

9.16.6.9.10.15 Read nameplate (0x52)

Master command

| Protocol bytes | | Information |
|----------------|---------|--------------------------------|
| No. | Name | |
| Master | | |
| 1 | Address | Address of the HIPERFACE slave |
| 2 | 0x52 | Command byte (read nameplate) |
| Slave | | |

Slave response

| Protocol bytes | | Information | |
|----------------|----------------|---|--|
| No. | Name | | |
| Slave | | | |
| 1 | Address | Repeated address and command byte (safety) | |
| 2 | 0x52 | | |
| 3 | RS485 settings | Nameplate in accordance with HIPERFACE specification: HIPERFACE configuration, type of encoder, size of memory and other options | |
| 4 | Encoder type | | |
| 5 | Size of EEPROM | | |
| 6 | Options | | |
| Master | | | |

9.16.6.9.10.16 Encoder reset (0x53)

Master command

| Protocol bytes | | Information |
|----------------|---------|--------------------------------|
| No. | Name | |
| Master | | |
| 1 | Address | Address of the HIPERFACE slave |
| 2 | 0x53 | Command byte (encoder reset) |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|------|-------------|
| No. | Name | |
| Slave | | |
| - | - | No response |
| Master | | |

9.16.6.9.10.17 Allocate encoder address (0x55)

Master command

| Protocol bytes | | Information |
|----------------|-------------|--|
| No. | Name | |
| Master | | |
| 1 | Address | Address of the HIPERFACE slave |
| 2 | 0x55 | Command byte (allocate encoder address) |
| 3 | New address | New HIPERFACE address |
| 4 | Code0 | Safety byte in accordance with the HIPERFACE specification |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|---------|--|
| No. | Name | |
| Slave | | |
| 1 | Address | Repeated address and command byte (safety) |
| 2 | 0x55 | |
| Master | | |

9.16.6.9.10.18 Read serial number and program version (0x56)

Master command

| Protocol bytes | | Information |
|----------------|---------|---|
| No. | Name | |
| Master | | |
| 1 | Address | Address of the HIPERFACE slave |
| 2 | 0x56 | Command byte (read serial number and program version) |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|------------------|--|
| No. | Name | |
| Slave | | |
| 1 | Address | Repeated address and command byte (safety) |
| 2 | 0x56 | |
| 3...11 | Serial number | 9 characters |
| 12...n | Firmware version | Max. 20 characters |
| ...n+8 | Firmware date | 8 characters (format: DD.MM.YY) |
| Master | | |

9.16.6.9.10.19 Configure serial interface (0x57)

Master command

| Protocol bytes | | Information |
|----------------|----------------|--|
| No. | Name | |
| Master | | |
| 1 | Address | Address of the HIPERFACE slave |
| 2 | 0x57 | Command byte (configure serial interface) |
| 3 | RS485 settings | New baud rate in accordance with the HIPERFACE specification |
| 4 | Code0 | Safety byte in accordance with the HIPERFACE specification |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|----------------|---|
| No. | Name | |
| Slave | | |
| 1 | Address | Repeated address, command byte and new baud rate (safety) |
| 2 | 0x57 | |
| 3 | RS485 settings | |
| Master | | |

9.16.6.9.11 NetTime TechnologyFor a description of NetTime Technology, see ["NetTime Technology" on page 3035](#).

9.16.6.9.12 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 100 μ s |

9.16.6.9.13 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.16.7 X20DS1928

Data sheet version: 1.30

9.16.7.1 General information

The module is equipped with an EnDat encoder interface. The module automatically detects whether an encoder is connected with EnDat 2.1 or EnDat 2.2. This module can be used to evaluate encoders installed in B&R servo motors as well as encoders for external axes (encoders that scan any machine movement). The input signals are monitored. This makes it possible to detect open or shorted lines as well as encoder supply failures.

- EnDat 2.1 and EnDat 2.2 encoder interface
- Encoder input monitoring
- 5 VDC and GND for encoder supply
- NetTime timestamp: Position time

EnDat encoders

EnDat is a standard developed by Johannes Heidenhain GmbH (www.heidenhain.de) that incorporates the advantages of absolute and incremental position measurement and also offers a read/write parameter memory in the encoder. With absolute position measurement, the homing procedure is generally not required. Where necessary a multi-turn encoder should be installed. To save costs, a single-turn encoder and a reference switch can also be used. In this case, a homing procedure must be carried out.

NetTime timestamp for the position

It is not just the position value that is important for highly dynamic positioning tasks, but also the exact time the position is measured. The module is equipped with a NetTime function for this that supplies a timestamp for the recorded position with microsecond accuracy.

The timestamp function is based on synchronized timers. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

9.16.7.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Digital signal processing and preparation |  |
| X20DS1928 | X20 digital signal module, 1 EnDat 2.1/2.2 interface, NetTime function | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 368: X20DS1928 - Order data

9.16.7.3 Technical data

| | |
|--|---|
| Model number | X20DS1928 |
| Short description | |
| I/O module | 1x EnDat interface |
| General information | |
| B&R ID code | 0xA912 |
| Status indicators | Counting direction, operating status, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Counting direction | Yes, using status LED |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.3 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Type of signal lines | Shielded cables must be used for all signal lines |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| Encoder inputs | |
| Type | EnDat 2.1/2.2 |
| Angular position resolution | 13-bit, with a 1 V _{SS} signal |
| Encoder monitoring | Yes |
| Max. encoder cable length | 10 m, with a line cross-section 4x 2x 0.14 mm ² and 1x 2x 0.5 mm ² |
| Sine/Cosine inputs | |
| Signal transmission | Differential signals, symmetrical |
| Signal frequency | DC up to 400 kHz |
| Differential voltage | 1 V _{SS} |
| Common-mode voltage | Max. ±10 V |
| Terminating resistor | 120 Ω |
| Encoder power supply | |
| Output voltage | 5 V (±5%) |
| Load capacity | 300 mA |
| Protective measures | |
| Overload-proof | Yes |
| Short-circuit proof | Yes |
| Serial EnDat interface | |
| Signal transmission | 5 VDC differential signal, EIA RS-485 standard |
| Transmission status | See EnDat specification |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating" |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |


Table 369: X20DS1928 - Technical data

| Model number | X20DS1928 |
|-----------------------|--|
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm |

Table 369: X20DS1928 - Technical data

9.16.7.4 Status LEDs

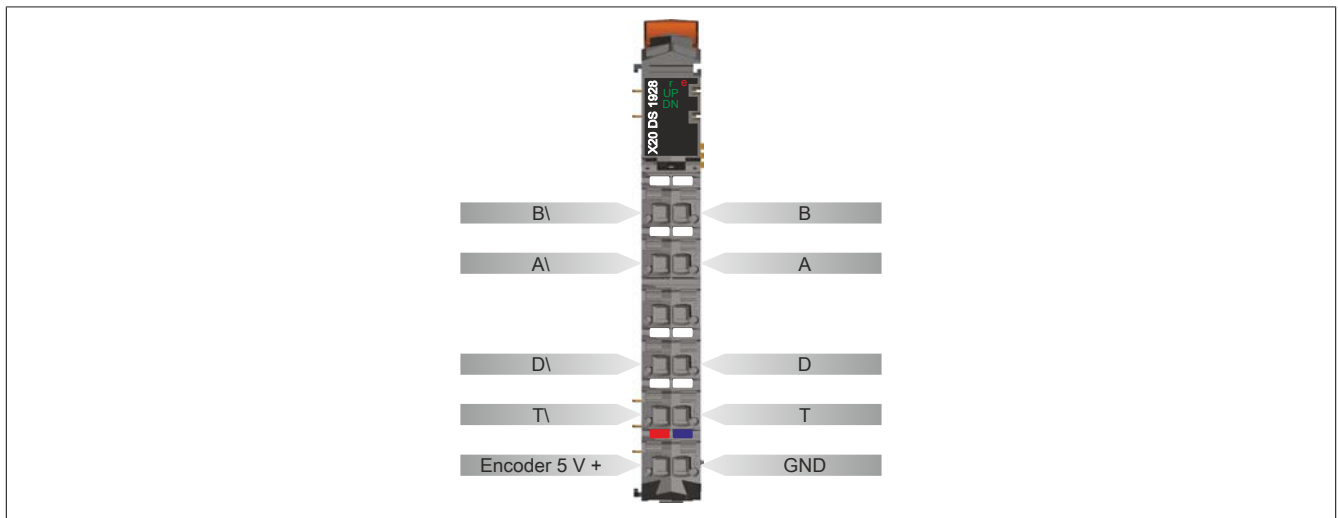
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Image | LED | Color | Status | Description |
|---|-----|-------|------------------------|--|
|  | r | Green | Off | Module supply not connected |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | Module supply not connected or everything is OK |
| | | | On | Error or reset state - Possible cause: <ul style="list-style-type: none"> Encoder supply error |
| | | | Single flash | I/O error - Possible causes: <ul style="list-style-type: none"> Sine/Cosine relative position error (open line) Sine/Cosine absolute position error (reference) |
| | | | Double flash | System error - Possible causes: <ul style="list-style-type: none"> EnDat communication error EnDat position error EnDat error defining parameters |
| | | | Triple flash | I/O error and system error |
| | | | Single flash, inverted | Error or reset state and I/O error |
| | | | Double flash, inverted | Error or reset state and system error |
| | UP | Green | On | The "UP/DN" LEDs are lit depending on the rotational direction and the speed of the connected encoder. The "UP" LED indicates when the encoder position changes in the positive direction. |
| | | | | |

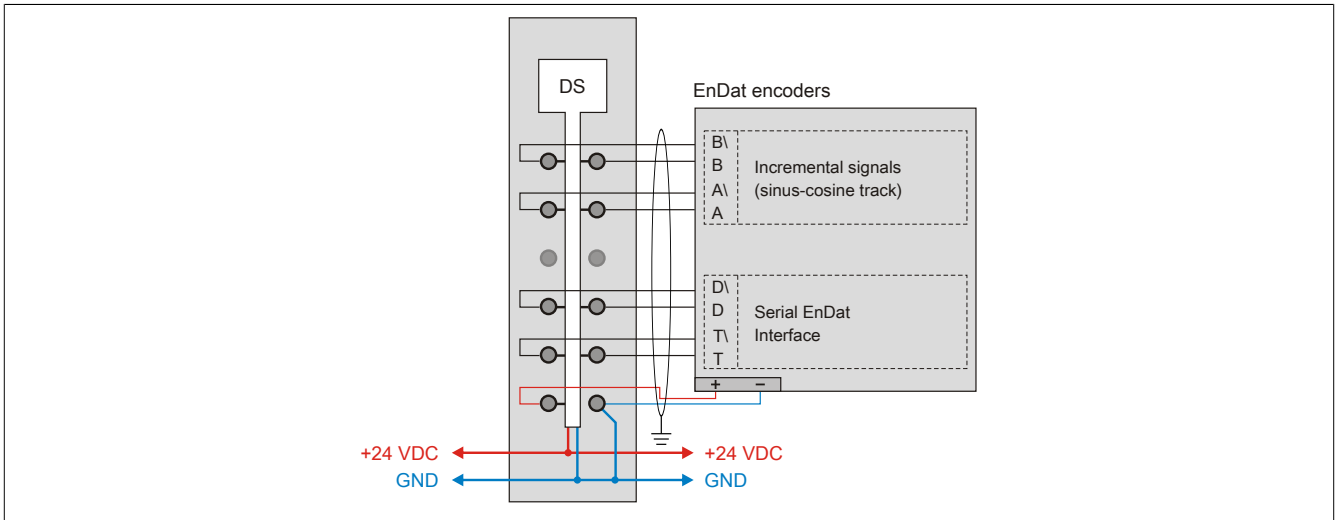
1) Depending on the configuration, a firmware update can take up to several minutes.

9.16.7.5 Pinout

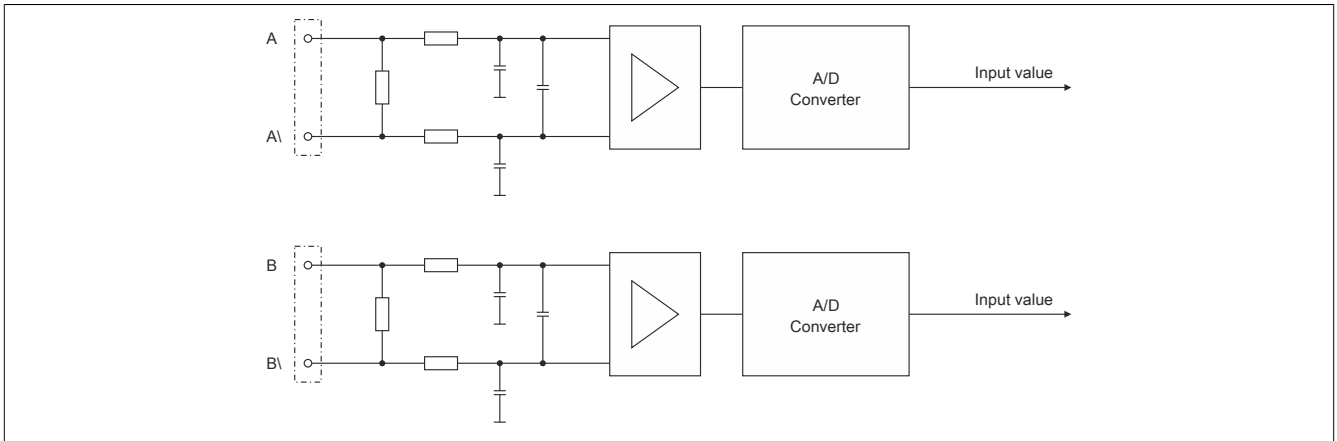
Shielded cables should be used for all signal lines.



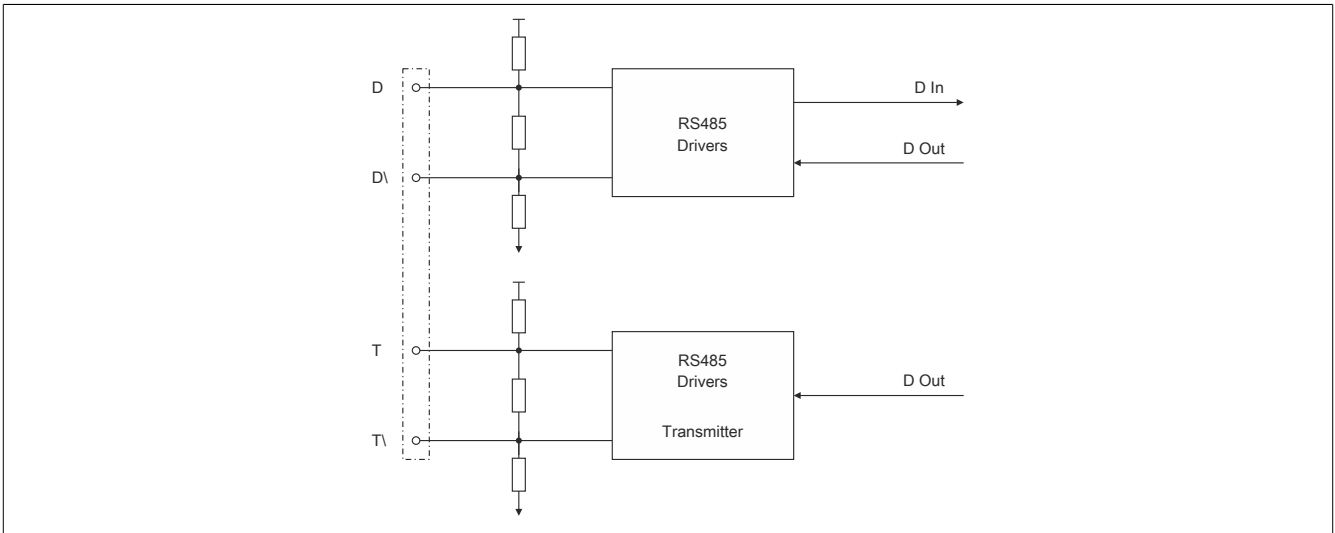
9.16.7.6 Connection example



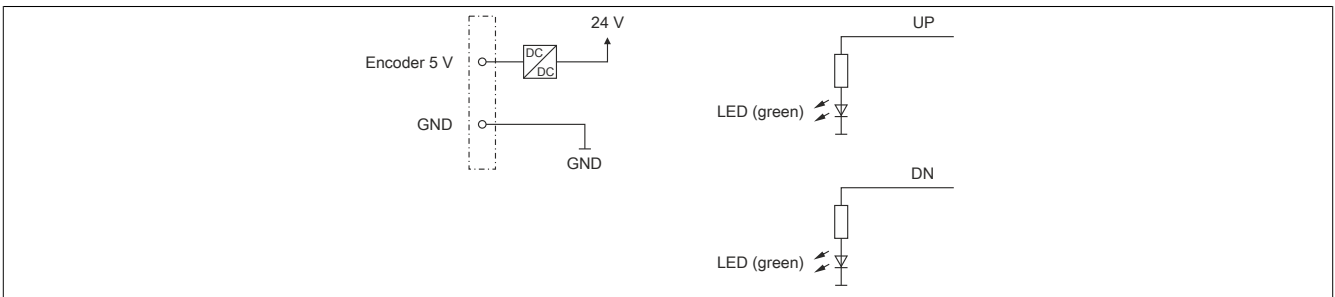
9.16.7.7 Input diagram for the incremental signals (sine-cosine track)



9.16.7.8 Input diagram for the serial EnDat interface



9.16.7.9 Encoder supply scheme and LEDs

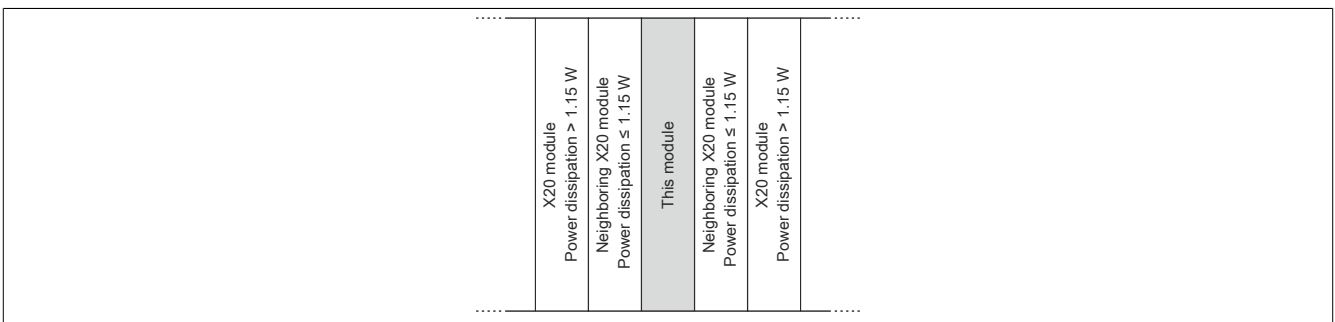


9.16.7.10 Derating

There is no derating when operated below 55°C.

During operation over 55°C, the power dissipation of the modules to the left and right of this module is not permitted to exceed 1.15 W!

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.



9.16.7.11 Register description

9.16.7.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.16.7.11.2 Register overview - Function model 0 (standard)

| Register | Name | Data type | Read | | Write | |
|--|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module configuration | | | | | | |
| 513 | CfO_SlframeGenID | USINT | | | | • |
| 654 | CfO_SystemCyclePrescaler | UINT | | | | • |
| Basic functions | | | | | | |
| 683 | SDCLifeCount | SINT | • | | | |
| 4180 | PositionHW | UDINT | • | | | |
| 4188 | PositionLW | UDINT | • | | | |
| | Position | DINT | | | | |
| 4172 | PosTime (32-Bit) | DINT | • | | | |
| 4174 | PosTime (16-Bit) | INT | • | | | |
| 4163 | PosCycle | SINT | • | | | |
| Error management | | | | | | |
| 389 | ErrorEnableID_1710 | USINT | | | | • |
| 261 | ErrorInfo | USINT | • | | | |
| | EncoderSupplyError | Bit 0 | | | | |
| | VssCheckError | Bit 2 | | | | |
| | SinCosPosError | Bit 3 | | | | |
| | EnDatComError | Bit 4 | | | | |
| | EnDatPosError | Bit 5 | | | | |
| | EnDatParSetError | Bit 6 | | | | |
| 325 | AckErrorInfo | USINT | | | • | |
| | AckEncoderSupplyError | Bit 0 | | | | |
| | AckVssCheckError | Bit 2 | | | | |
| | AckSinCosPosError | Bit 3 | | | | |
| | AckEnDatComError | Bit 4 | | | | |
| | AckEnDatPosError | Bit 5 | | | | |
| | AckEnDatParSetError | Bit 6 | | | | |
| | AckEnDatRefWarning | Bit 7 | | | | |
| 4352 | EnDatError | UINT | • | | | |
| 4353 | EnDatWarning | UINT | • | | | |
| 4099 | Acknowledging EnDat errors | USINT | | | • | |
| | EnDatAck | Bit 0 | | | | |
| Sin/Cos - Configuration | | | | | | |
| 1025 | SinCosEnable | USINT | | | | • |
| 1027 | SinCosRefSource | USINT | | | | • |
| 1034 | SinCosVssMin | UINT | | | | • |
| 1038 | SinCosVssMax | UINT | | | | • |
| 1044 | SinCosQuitTime | UDINT | | | | • |
| EnDat - Read ID | | | | | | |
| 4097 | EnDatMode | USINT | | | | • |
| 4400 + N | OperatingParam_N (index N = 00 to 15) | UINT | | • | | |
| 4352 + N | OperatingStatus_0N (index N = 0 to 3) | UINT | | • | | |
| 4352 + N | ParamManuf_N (index N = 04 to 47) | UINT | | • | | |
| 4416 + N | ParamManufEnDat22_N (index N = 01 to 63) | UINT | | • | | |
| EnDat - Read additional information | | | | | | |
| 4860 + N*8 | EnDatInfoCmd0N (index N = 1 to 4) | UDINT | | | | • |
| 4935 | Validity of info data | USINT | • | | | |
| | EnDatInfoOK01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | EnDatInfoOK04 | Bit 3 | | | | |
| 4978 + N*16 | EnDatInfo0N (index N = 1 to 4) | UINT | • | | | |
| | | INT | | | | |
| Flatstream mode | | | | | | |
| 4609 | OutputMTU | USINT | | | | • |
| 4611 | InputMTU | USINT | | | | • |
| 4613 | FlatStreamMode | USINT | | | | • |
| 4615 | Forward | USINT | | | | • |
| 4620 | ForwardDelay | UINT | | | | • |

| Register | Name | Data type | Read | | Write | |
|----------|-----------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 4672 | InputSequence | USINT | • | | | |
| 4672 + N | RxByteN (index N = 1 to 15) | USINT | • | | | |
| 4704 | OutputSequence | USINT | | | • | |
| 4704 + N | TxByteN (index N = 1 to 15) | USINT | | | • | |

9.16.7.11.3 Register overview - Function model 254 (bus controller)

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module configuration | | | | | | | |
| 513 | - | CfO_SlframeGenID | USINT | | | | • |
| 654 | - | CfO_SystemCyclePrescaler | UINT | | | | • |
| Basic functions | | | | | | | |
| 4180 | 0 | PositionHW | UDINT | • | | | |
| 4188 | 4 | PositionLW | UDINT | • | | | |
| 4163 | 15 | PosCycle | SINT | • | | | |
| Error management | | | | | | | |
| 389 | - | ErrorEnableID_1710 | USINT | | | | • |
| 261 | 14 | ErrorInfo | USINT | • | | | |
| | | EncoderSupplyError | Bit 0 | | | | |
| | | VssCheckError | Bit 2 | | | | |
| | | SinCosPosError | Bit 3 | | | | |
| | | EnDatComError | Bit 4 | | | | |
| | | EnDatPosError | Bit 5 | | | | |
| | | EnDatParSetError | Bit 6 | | | | |
| | | EnDatRefWarning | Bit 7 | | | | |
| 325 | 6 | AckErrorInfo | USINT | | | | • |
| | | AckEncoderSupplyError | Bit 0 | | | | |
| | | AckVssCheckError | Bit 2 | | | | |
| | | AckSinCosPosError | Bit 3 | | | | |
| | | AckEnDatComError | Bit 4 | | | | |
| | | AckEnDatPosError | Bit 5 | | | | |
| | | AckEnDatParSetError | Bit 6 | | | | |
| | | AckEnDatRefWarning | Bit 7 | | | | |
| 4352 | - | EnDatError | UINT | | • | | |
| 4353 | - | EnDatWarning | UINT | | • | | |
| 4099 | - | Acknowledging EnDat errors | USINT | | | | • |
| | | EnDatAck | Bit 0 | | | | |
| Sin/Cos - Configuration | | | | | | | |
| 1025 | - | SinCosEnable | USINT | | | | • |
| 1027 | - | SinCosRefSource | USINT | | | | • |
| 1034 | - | SinCosVssMin | UINT | | | | • |
| 1038 | - | SinCosVssMax | UINT | | | | • |
| 1044 | - | SinCosQuitTime | UDINT | | | | • |
| EnDat - Read ID | | | | | | | |
| 4097 | - | EnDatMode | USINT | | | | • |
| 4400 + N | - | OperatingParam_N (index N = 00 to 15) | UINT | | • | | |
| 4352 + N | - | OperatingStatus_0N (index N = 0 to 3) | UINT | | • | | |
| 4352 + N | - | ParamManuf_N (index N = 04 to 47) | UINT | | • | | |
| 4416 + N | - | ParamManufEnDat22_N (index N = 01 to 63) | UINT | | • | | |
| EnDat - Read additional information | | | | | | | |
| 4860 + N*8 | - | EnDatInfoCmd0N (index N = 1 to 4) | UDINT | | | | • |
| 4935 | - | Validity of info data | USINT | | • | | |
| | | EnDatInfoOK01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | EnDatInfoOK04 | Bit 3 | | | | |
| 4978 + N*16 | - | EnDatInfo0N (index N = 1 to 4) | UINT | | • | | |
| | | | INT | | | | |
| Flatstream mode | | | | | | | |
| 4609 | - | OutputMTU | USINT | | | | • |
| 4611 | - | InputMTU | USINT | | | | • |
| 4613 | - | FlatStreamMode | USINT | | | | • |
| 4615 | - | Forward | USINT | | | | • |
| 4620 | - | ForwardDelay | UINT | | | | • |
| 4672 | 8 | InputSequence | USINT | • | | | |
| 4672 + N | 9 - 13 | RxByteN (index N = 1 to 5) | USINT | • | | | |
| 4704 | 0 | OutputSequence | USINT | | | • | |
| 4704 + N | 1 - 5 | TxByteN (index N = 1 to 5) | USINT | | | • | |

1) The offset specifies the position of the register within the CAN object.

9.16.7.11.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.16.7.11.3.2 CAN I/O bus controller

The module occupies 2 analog logical slots on CAN I/O.

9.16.7.11.4 Module configuration

The following configuration registers can be used to define various module settings. They can be used, for example, to modify the module's behavior on an X2X Link network. The user can choose between 2 option registers.

9.16.7.11.4.1 Data query

Name:

CfO_SlframeGenID

This register can be used to define when the synchronous/cyclic input data is generated. "X2X cycle optimized" should be set for jitter-free data acquisition. "Fast reaction" can be set for the best performance.

| Data type | Value | Information |
|-----------|-------|--|
| USINT | 9 | Fast reaction |
| | 14 | X2X cycle optimized; Bus controller default |

9.16.7.11.4.2 Prescale factor

Name:

CfO_SystemCyclePrescaler

In order for the module to communicate with the CPU as well as the EnDat encoder, the EnDat cycle time must be at least twice the module cycle time. The actual EnDat cycle time is a result of multiplying the module cycle time by the value in this register.

| Data type | Value | Information |
|-----------|-------|---|
| UINT | 2 | EnDat cycle: 200 to 400 µs (bus controller default setting) |
| | 4 | EnDat cycle: 400 to 800 µs |
| | 8 | EnDat cycle: 800 to 1,600 µs |

9.16.7.11.5 Basic functions

This module can import a position when used together with an EnDat encoder. The received data is prepared in 2 different formats and given a [timestamp](#). 6 registers are available for further processing. This allows the user to choose which format is best suited for individual application.

9.16.7.11.5.1 SDC counter register

Name:

SDCLifeCount

The 8-bit counter register is needed for the SDC software package. It is incremented with the system clock to allow the SDC to check the validity of the data frame.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

9.16.7.11.5.2 Absolute position values

Name:

PositionHW

PositionLW

The absolute position of the encoder is defined using 64-bit resolution. The position value is stored in the PositionHW and PositionLW registers. The upper 32 bits are stored in the PositionHW register, while the lower 32 bits are stored in the PositionLW register.

For SinCos signal evaluation, see ["Format of the SinCos signal" on page 2045](#) for information regarding the data format.

| Data type | Value |
|-----------|--------------------|
| 2x UDINT | 0 to 4,294,967,295 |

9.16.7.11.5.3 SDC position value

Name:

Position

The SDC library requires a signed 32-bit position value. The position's low word can be accessed separately for this. The value can also be used as default position value, however.

For SinCos signal evaluation, see ["Format of the SinCos signal" on page 2045](#) for information regarding the data format.

| Data type | Value |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

9.16.7.11.5.4 NetTime of the position values

Name:

PosTime

The current NetTime value is assigned to each determined position in this register. The NetTime is recorded with μ s accuracy.

The SDC library requires a 16 bit value. The NetTime value is therefore also prepared in this format.

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

| Data type | Value | Information |
|-----------|------------------------------------|--------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime in μ s |
| INT | -32,768 to 32,767 | |

9.16.7.11.5.5 Counter for position values

Name:

PosCycle

PosCycle is an integer counter that is incremented as soon as the module has saved a new valid position value.

| Data type | Value |
|-----------|-------------|
| SINT | -128 to 127 |

9.16.7.11.6 Error management

This module can be used to diagnose error states. There are the following ways in which this is done:

- ["Module-based diagnostics" on page 2040](#)
- ["EnDat-based diagnostics" on page 2043](#)

9.16.7.11.6.1 Module-based diagnostics

The module diagnoses 7 different errors or warnings. Depending on the settings, the error bits can be called either individually or packed together.

Configuring errors and warnings

Name:

ErrorEnableID_1710

The implemented diagnostic algorithms can be enabled or disabled in this register.

| Data type | Value | Bus controller default |
|-----------|--------------------|------------------------|
| USINT | See bit structure. | 255 |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------------------|-------|--|
| 0 | Encoder supply: | 0 | Error detection disabled |
| | | 1 | Error detection enabled (bus controller default setting) |
| 1 | Reserved | - | |
| 2 | Vss Sin/Cos: | 0 | Error detection disabled |
| | | 1 | Error detection enabled (bus controller default setting) |
| 3 | Position error: | 0 | Error detection disabled |
| | | 1 | Error detection enabled (bus controller default setting) |
| 4 | EnDat - Communication: | 0 | Error detection disabled |
| | | 1 | Error detection enabled (bus controller default setting) |
| 5 | EnDat - Position: | 0 | Error detection disabled |
| | | 1 | Error detection enabled (bus controller default setting) |
| 6 | EnDat - Parameters: | 0 | Error detection disabled |
| | | 1 | Error detection enabled (bus controller default setting) |
| 7 | EnDat - Reference warning: | 0 | Warning disabled |
| | | 1 | Warning enabled (bus controller default setting) |

Encoder supply:

The encoder voltage supply is below the permitted limit.

Vss Sin/Cos:

The voltage value for the Sin/Cos track violates the configured limit values.

→ See register ["SinCosVssMin" on page 2046](#) or ["SinCosVssMax" on page 2046](#).

Position error:

The determined position value violates the requirements of the application.

EnDat - Communication:

Communication error on the EnDat interface (e.g. incorrect checksum)

EnDat - Position:

Encoder evaluates the determined position value as invalid.

EnDat - Parameters:

Inconsistent register values for encoder identification

→ Countermeasures: Check wiring or rescan (see ["EnDatAck" on page 2044](#))

EnDat - Reference warning:

The digital interface provides an absolute position value that can be used to accurately describe the axis position. The position value is homed to this absolute value at the beginning of a measurement. The analog interface can be used to incrementally sample changes that occur very rapidly. This enables the module to continue sampling the position value at a high resolution. Both the analog and the digital signal are sampled cyclically. If the value determined incrementally deviates from the absolute value during operation then the referencing warning is displayed and the position must be referenced again.

Status of errors and warnings

Name:

ErrorInfo

EncoderSupplyError

VssCheckError

PositionError

EnDatComError

EnDatPosError

EnDatParsetError

EnDatRefWarning

This register indicates which error or warning is currently active. For a description of errors, see "[Configuring errors and warnings](#)" on page 2040.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|--------------------|-------|----------------------------|
| 0 | EncoderSupplyError | 0 | No error |
| | | 1 | Encoder supply error |
| 1 | Reserved | - | |
| 2 | VssCheckError | 0 | No error |
| | | 1 | Vss error on Sin/Cos track |
| 3 | PositionError | 0 | No error |
| | | 1 | Position error |
| 4 | EnDatComError | 0 | No error |
| | | 1 | EnDat communication error |
| 5 | EnDatPosError | 0 | Error detection disabled |
| | | 1 | Error detection enabled |
| 6 | EnDatParsetError | 0 | Error detection disabled |
| | | 1 | Error detection enabled |
| 7 | EnDatRefWarning | 0 | Warning disabled |
| | | 1 | Warning enabled |

Acknowledging errors and warnings

Name:

AckErrorInfo

AckEncoderSupplyError

AckVssCheckError

AckPositionError

AckEnDatComError

AckEnDatPosError

AckEnDatParSetError

AckEnDatRefWarning

This register is used to acknowledge an error message that occurred in the "Status of errors and warnings" on page 2041 register. For a description of errors, see "Configuring errors and warnings" on page 2040.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------------|-------|-------------------------|
| 0 | AckEncoderSupplyError | 0 | No error acknowledgment |
| | | 1 | Error acknowledgment |
| 1 | Reserved | - | |
| | | | |
| 2 | AckVssCheckError | 0 | No error acknowledgment |
| | | 1 | Error acknowledgment |
| 3 | AckPositionError | 0 | No error acknowledgment |
| | | 1 | Error acknowledgment |
| 4 | AckEnDatComError | 0 | No error acknowledgment |
| | | 1 | Error acknowledgment |
| 5 | AckEnDatPosError | 0 | No error acknowledgment |
| | | 1 | Error acknowledgment |
| 6 | AckEnDatParSetError | 0 | No error acknowledgment |
| | | 1 | Error acknowledgment |
| 7 | AckEnDatRefWarning | 0 | No acknowledgment |
| | | 1 | Acknowledgment |

9.16.7.11.6.2 EnDat-based diagnostics

Memory areas are provided in the EnDat standard for error handling. Error management was tailored to utilize error detection according to the EnDat standard. Additional registers were implemented in the module which prepare these areas in the encoder memory.

The module allows access to all previously defined memory areas for error handling. The memory areas are mirrored in the module registers and can be interpreted by the user.

Detailed information regarding the errors that can be detected in this way can be found in the encoder's manual.

EnDat errors

Name:

EnDatError

This register is used to indicate critical conditions on the EnDat encoder. The system has generally ceased to work and requires service.

| Data type | Value |
|-----------|--------------------|
| UINT | See bit structure. |

The bit structure described below is designed according to the general recommendations of the EnDat standard. The specification does not limit which trigger algorithms to use or which of the listed messages must be supported. Please refer to the encoder's manual for further details.

Bit structure:

| Bit | Name | Value | Information |
|--------|------------------|-------|---------------------------|
| 0 | Illumination | 0 | OK |
| | | 1 | Failed |
| 1 | Signal amplitude | 0 | OK |
| | | 1 | Detected as having errors |
| 2 | Position value | 0 | OK |
| | | 1 | Detected as having errors |
| 3 | Overvoltage | 0 | No |
| | | 1 | Yes |
| 4 | Undervoltage | 0 | No |
| | | 1 | Yes |
| 5 | Overcurrent | 0 | No |
| | | 1 | Yes |
| 6 | Battery | 0 | OK |
| | | 1 | Must be changed |
| 7 - 15 | Reserved | - | |

EnDat warnings

Name:

EnDatWarning

This register is used to indicate critical conditions on the EnDat encoder. Encoder still functional, but must be checked immediately. This generally means that defined tolerances have been exceeded.

| Data type | Value |
|-----------|--------------------|
| UINT | See bit structure. |

The bit structure described below is designed according to the general recommendations of the EnDat standard. The specification does not limit which trigger algorithms to use or which of the listed messages must be supported. Please refer to the encoder's manual for further details.

Bit structure:

| Bit | Name | Value | Information |
|--------|----------------------------|-------|--------------|
| 0 | Frequency collision | 0 | No |
| | | 1 | Yes |
| 1 | Temperature exceeded | 0 | No |
| | | 1 | Yes |
| 2 | Control reserve - Lighting | 0 | Not required |
| | | 1 | Required |
| 3 | Charge - Battery | 0 | OK |
| | | 1 | Low |
| 4 | Reference point | 0 | Reached |
| | | 1 | Not reached |
| 5 - 15 | Reserved | - | |

Acknowledging EnDat errors

Name:

EnDatAck

"EnDatAck" acknowledges all errors and warnings from the "EnDatError" on page 2043 and "EnDatWarning" on page 2044 registers. It can also instruct the module to re-import the parameters for identification.

If one of the bits in this register is set, the system automatically resets it and the respective algorithm is run.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|----------------------------------|-------|------------------------------|
| 0 | EnDatAck | 0 | No acknowledgment |
| | | 1 | Acknowledge |
| 1 | Rescan - Identification register | 0 | Imported parameters retained |
| | | 1 | Reimport parameters |
| 2 - 7 | Reserved | - | |

9.16.7.11.7 Sin/Cos - Analog interface configuration

In addition to the digital EnDat interface, this module is also equipped with an analog interface for sampling a differential sine-cosine signal. To increase the resolution, the EnDat standard specifies a cooperation between the analog and digital information. This enables a highly dynamic representation of the position while maintaining high resolution.

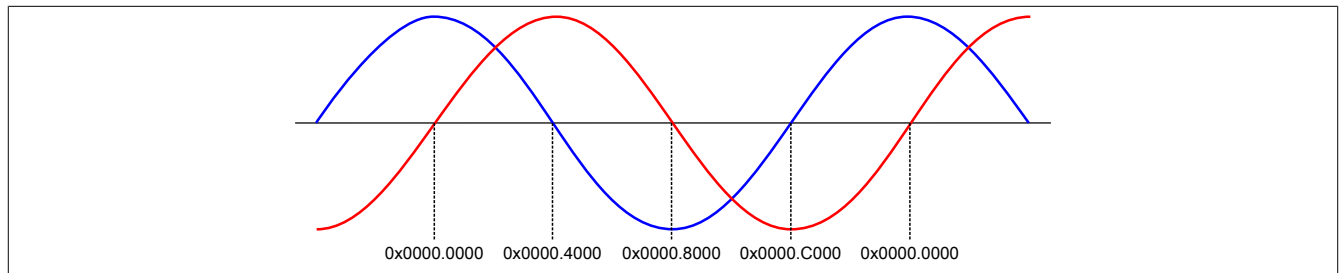
9.16.7.11.7.1 Format of the SinCos signal

The SinCos signal is represented as a position value in the "Absolute position values" on page 2039 and "SDC position value" on page 2039 registers. The following relationships apply:

- PositionLW and Position are identical in the function.
- PositionHW extends the integer range of PositionLW by adding multi-turn functionality.

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|------------------------|----------------------------------|---|---|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64-bit register | PositionHW (unsigned) | | PositionLW (unsigned) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 32-bit register | - | | Position (signed) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Format | Integer extension (to 48-bit) | Integer (16-bit) | Decimal places: (with 13-bit resolution) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Information | | A full sine wave corresponds to an increment of the integer. | <table border="1"> <tr> <td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td> </tr> <tr> <td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>0</td><td>0</td><td>0</td> </tr> </table> <p>Important: The lower 3 bits always contain the value 0.</p> | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | x | x | x | x | x | x | x | x | x | x | x | x | x | 0 | 0 | 0 |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | | | | | | | | | | | | | | | | | | | |
| x | x | x | x | x | x | x | x | x | x | x | x | x | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | | | |
| Word/DWord | DWord | Word 1 | Word 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Relationship between sine curve (red) and decimal places:



9.16.7.11.7.2 Enabling SinCos

Name:

SinCosEnable

This register must always have the value 1 for configuration reasons.

| Data type | Value | Information |
|-----------|-------|---------------------------|
| USINT | 1 | Bus controller default: 1 |

9.16.7.11.7.3 Enabling SinCos reference source

Name:

SinCosRefSource

This register must always have the value 1 for configuration reasons.

| Data type | Value | Information |
|-----------|-------|---------------------------|
| USINT | 1 | Bus controller default: 1 |

9.16.7.11.7.4 Configuring the lower Vss value

Name:

SinCosVssMin

This register specifies the lower limit value for the peak-to-peak voltage of the sine/cosine track. The incoming signal is monitored in this way. If the incoming value falls below this specified limit, then the module reports the corresponding error.

| Data type | Value | Information |
|-----------|-----------|---|
| UINT | 0 to 1500 | Values in mV Bus controller default: 800 |

9.16.7.11.7.5 Configuring the upper Vss value

Name:

SinCosVssMax

This register specifies the upper limit value for the peak-to-peak voltage of the sine/cosine track. The incoming signal is monitored in this way. If the incoming value exceeds this specified limit, then the module reports the corresponding error.

| Data type | Value | Information |
|-----------|-----------|--|
| UINT | 0 to 1500 | Values in mV Bus controller default: 1200 |

9.16.7.11.7.6 Configuring the delay time after errors

Name:

SinCosQuitTime

If an error is detected on the analog interface, the last correctly read values remain valid. An interval can be defined in this register at which the module begins receiving correct values again after the error state without processing them further internally. Only then will newly sampled correct analog values be recognized as valid.

| Data type | Value | Information |
|-----------|---------------|---|
| UDINT | 0 to 20000000 | Values in μ s Bus controller default: 100000 |

9.16.7.11.8 EnDat

9.16.7.11.8.1 EnDat - Digital interface configuration

The EnDat interface allows you to establish a point-to-point connection with exactly one EnDat encoder.

There are 2 ways to use the encoder data in the PLC program. One is to store the necessary encoder values temporarily in the module, where they can then be provided to the CPU. The other is to use the module's FlatStream mode, which supports the full range of commands defined in the EnDat specification.

Detailed information about the EnDat specification can be found in the document, "Technical Information – EnDat 2.2".

Configuring EnDat module properties

Name:

EnDatMode

This register is used to define various module properties.

| Data type | Value | Bus controller default |
|-----------|--------------------|------------------------|
| USINT | See bit structure. | 0 |

Bit structure:

| Bit | Name | Value | Information |
|-------|----------------------------------|-------|--|
| 0 | EnDat interface | 0 | Disabled (bus controller default setting) |
| | | 1 | Enabled |
| 1 | Format of imported position data | 0 | Unsigned (bus controller default setting) |
| | | 1 | Signed |
| 2 | Fast EnDat cycle (6 MHz) | 0 | Enabled if encoder compatible (bus controller default setting) |
| | | 1 | Disabled |
| 3 | Sin/Cos track | 0 | Enabled (bus controller default setting) |
| | | 1 | Disabled |
| 4 - 7 | Reserved | - | |

9.16.7.11.8.2 EnDat - Read ID

The EnDat interface does more than just help the user specify axis positions. It can also be used to readout certain data stored in the encoder memory.

The EnDat specification divides the encoder memory into logical groups. These include memory areas for the operating parameters, operating status, manufacturer parameters and manufacturer parameters according to EnDat 2.2.

The 4 most important memory areas are mirrored in the module registers. The information can be accessed in the application and used to identify a particular encoder.

Information:

There are different types of EnDat. Please keep this in mind. EnDat has been continuously expanded to include new technical possibilities while maintaining backward compatibility. Several advancements have been made to the standard, which has resulted in a non-uniform structure.

In general, data is queried from memory for identification purposes when the module is started. In addition, the data can be reimported using the "EnDatAck" on page 2044 register. The module reads the data from the encoder, which is then mapped for the PLC.

Operating Parameters

Name:

OperatingParam_00 to OperatingParam_15

These registers can be used to read out the current operating parameters. The data in these registers correspond exactly to the values on the encoder. More detailed information can be found in the encoder's manual or by referring to the latest EnDat specification.

| Data type | Value |
|-----------|--------------------|
| 16x UINT | See encoder manual |

Operating state

Name:

OperatingStatus_00 to OperatingStatus_03

This register can be used to read the encoder's current operating state. The first 2 registers from this group are identical to the "EnDatError" on page 2043 and "EnDatWarning" on page 2044 registers. A special setting is provided because they are update cyclically.

Information about write protection and other configuration settings is managed in registers 02 and 03. The data in these registers correspond exactly to the values on the encoder.

More detailed information can be found in the encoder's manual or by referring to the latest EnDat specification.

| Data type | Value |
|-----------|--------------------|
| 4x UINT | See encoder manual |

Manufacturer parameters

Name:

ParamManuf_04 to ParamManuf_47

These registers are used to prepare the manufacturer parameters according to the EnDat standard 2.1. The exact arrangement of information can be found in the documentation "Technical Information - EnDat 2.2".

| Data type | Value |
|-----------|--|
| 44x UINT | see "Technical Information - EnDat 2.2" or encoder manufacturer data |

Additional manufacturer parameters according to EnDat 2.2

Name:

ParamManufEnDat22_00 to ParamManufEnDat22_63

These registers are used to prepare the manufacturer parameters according to the EnDat standard 2.2. The exact arrangement of information can be found in the documentation "Technical Information - EnDat 2.2".

| Data type | Value |
|-----------|--|
| 64x UINT | see "Technical Information - EnDat 2.2" or encoder manufacturer data |

9.16.7.11.8.3 EnDat - Read additional information

In addition to the identification data, other information can also be accessed from the encoder. However, the following algorithm requires exact knowledge of the encoder's memory structure and the EnDat specification.

Configuration

There are 4 different channels that can be operated during a cycle. One register per channel each is used for configuration, (i.e. determines which data is read from the encoder and mirrored on the respective Info byte).

Transmitting EnDat commands

Name:

EnDatInfoCmd01 to EnDatInfoCmd04

This register controls which data is processed on the corresponding Info byte for each channel. The register consists of up to 4 separate 8-bit values.

| Data type | Value | Bus controller default |
|-----------|--------------------|------------------------|
| 4x UDINT | See bit structure. | 0 |

Bit structure:

| Bit | Name | Information | |
|---------|-------------------|------------------------------|-------------------------------|
| 0 - 7 | Command | Selects the response section | |
| 8 - 15 | Memory area codes | MRS code | |
| | | Parameters not in blocks | Parameters arranged in blocks |
| 16 - 23 | Memory ID | Parameter numbers | Block number |
| 24 - 31 | Memory ID | - | Parameter numbers |

There is a difference when querying data from an encoder using an EnDat 2.1 command or an EnDat 2.2 command. When querying encoder data with an EnDat 2.1 command (0x04 and 0x06), the parameter number and (optionally) the block number must be specified in addition to the MRS code.

When querying the memory with an EnDat 2.2 command, the parameter number and block number are not required. The module consecutively transmits all 4 words of the memory area, which was selected using the MRS code. The right command must be selected depending on which of the 4 response bytes is needed.

Memory area codes

The code to be defined is identical to the MRS code for the encoder memory. The EnDat specification has left a few of the encoders memory areas undefined and available for future developments. This is why a clear and reliable explanation cannot be provided here.

More detailed information can be found in the encoder's manual or by referring to the latest EnDat specification.

Parameter numbers

EnDat 2.1 requires the corresponding parameter number to be entered in order to specifically address the desired parameter in the encoder memory. Older EnDat versions did not divide the encoder memory into blocks. This is why there are memory areas that can be selected without specifying a block number. In this case, the parameter number must be entered on the third byte.

More detailed information can be found in the encoder's manual or by referring to the latest EnDat specification.

Block number

To expand the address range of the encoder memory, additional block numbers were added starting at the second section. If the desired parameter is located in this blocked area, then the block number must be specified on the third byte. In this case, the parameter number is entered on the fourth byte.

More detailed information can be found in the encoder's manual or by referring to the latest EnDat specification.

Call

After being configured correctly, the position value is transmitted cyclically to the module. Each channel has 2 registers that serve as temporary storage. The module confirms successful receipt by setting an OK bit. The EnDat specification does not specify in which format the parameters must be received. Therefore, the module provides the information in 2 ways. Which of the two registers should be used for further processing depends on the parameters being read.

Validity of info data

Name:

EnDatInfoOK01 to EnDatInfoOK04

This register's bits provide information about the validity of the current info data in temporary storage.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---------------|-------|------------------|
| 0 | EnDatInfoOK01 | 0 | Value 01 invalid |
| | | 1 | Value 01 valid |
| ... | ... | ... | |
| 3 | EnDatInfoOK04 | 0 | Value 04 invalid |
| | | 1 | Value 04 valid |
| 4 - 7 | Reserved | - | |

Reading EnDat information

Name:

EnDatInfo01 to EnDatInfo04

These registers provide the corresponding requested information as a signed or unsigned 2-byte value.

The EnDat specification does not specify the format of the received parameters. Which of the two data types should be used for further processing therefore depends on the parameter being read.

| Data type | Value |
|-----------|-------------------|
| UINT | 0 to 65535 |
| INT | -32,768 to 32,767 |

9.16.7.11.9 Flatstream communication

For a description of Flatstream communication, see ["Flatstream communication" on page 3802](#)

9.16.7.11.10 EnDat with FlatStream

EnDat is a synchronous interface capable of half-duplex communication. Various features have been included to ensure that signals are transmitted without errors.

- An automatically generated checksum is sent together with a signal and evaluated by the recipient.
- The command which the encoder is responding to is repeated at the start of a response.

In Flatstream mode, the module acts as a bridge between the CPU and the EnDat slave. EnDat-specific algorithms were implemented to monitor timeouts and handle checksums. During normal operation, the user does not have access to these details.

More detailed information can be found in the documentation "Technical Information - EnDat 2.2" and the encoder's manufacturer data.

9.16.7.11.10.1 Overview of conventional EnDat commands for the Flatstream mode

| Command byte [hex] | Command | EnDat 2.2 only |
|--------------------|---|----------------|
| 0x00 | Reset | |
| 0x01 | Acknowledge error | |
| 0x04 | Read parameter | |
| 0x05 | Write parameter | |
| 0x06 | Read parameter from memory block | • |
| 0x07 | Write parameter to memory block | • |
| 0x08 | Read word 1 from additional information | • |
| 0x09 | Read word 2 from additional information | • |
| 0x0A | Read word 3 from additional information | • |
| 0x0B | Read word 4 from additional information | • |

9.16.7.11.10.2 Reset (0x00)

Master command

| Protocol bytes | | Information |
|----------------|------|-----------------|
| No. | Name | |
| Master | | |
| 1 | 0x00 | Command (Reset) |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|------|---------------------|
| No. | Name | |
| Slave | | |
| 1 | 0x00 | Repetition (safety) |
| Master | | |

9.16.7.11.10.3 Acknowledge error (0x01)

Master command

| Protocol bytes | | Information |
|----------------|------|-----------------------------|
| No. | Name | |
| Master | | |
| 1 | 0x01 | Command (Acknowledge error) |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|------|---------------------|
| No. | Name | |
| Slave | | |
| 1 | 0x01 | Repetition (safety) |
| Master | | |

9.16.7.11.10.4 Read parameter (0x04)

Master command

| Protocol bytes | | Information |
|----------------|---------------|--------------------------|
| No. | Name | |
| Master | | |
| 1 | 0x04 | Command (read parameter) |
| 2 | MRS code | Memory area to read |
| 3 | Parameter no. | |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|---------------|---------------------|
| No. | Name | |
| Slave | | |
| 1 | 0x04 | Repetition (safety) |
| 2 | MRS code | |
| 3 | Parameter no. | |
| 4 | Value_L | Value read |
| 5 | Value_H | |
| Master | | |

9.16.7.11.10.5 Write parameter (0x05)

Master command

| Protocol bytes | | Information |
|----------------|---------------|---------------------------|
| No. | Name | |
| Master | | |
| 1 | 0x05 | Command (write parameter) |
| 2 | MRS code | Memory area to write to |
| 3 | Parameter no. | |
| 4 | Value_L | Value to be written |
| 5 | Value_H | |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|---------------|---------------------|
| No. | Name | |
| Slave | | |
| 1 | 0x05 | Repetition (safety) |
| 2 | MRS code | |
| 3 | Parameter no. | |
| Master | | |

9.16.7.11.10.6 Read parameter from memory block (0x06)

Master command

| Protocol bytes | | Information |
|----------------|---------------|--|
| No. | Name | |
| Master | | |
| 1 | 0x06 | Command (read parameter from memory block) |
| 2 | MRS code | Memory area to read |
| 3 | Block no. | |
| 4 | Parameter no. | |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|---------------|---------------------|
| No. | Name | |
| Slave | | |
| 1 | 0x06 | Repetition (safety) |
| 2 | MRS code | |
| 3 | Block no. | |
| 4 | Parameter no. | |
| 5 | Value_L | Value read |
| 6 | Value_H | |
| Master | | |

9.16.7.11.10.7 Write parameter in memory block (0x07)

Master command

| Protocol bytes | | Information |
|----------------|---------------|---|
| No. | Name | |
| Master | | |
| 1 | 0x07 | Command (write parameter in memory block) |
| 2 | MRS code | Memory area to write to |
| 3 | Block no. | |
| 4 | Parameter no. | |
| 5 | Value_L | Value to be written |
| 6 | Value_H | |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|---------------|---------------------|
| No. | Name | |
| Slave | | |
| 1 | 0x07 | Repetition (safety) |
| 2 | MRS code | |
| 3 | Block no. | |
| 4 | Parameter no. | |
| Master | | |

9.16.7.11.10.8 Read word 1 from additional information (0x08)

Master command

| Protocol bytes | | Information |
|----------------|----------|---|
| No. | Name | |
| Master | | |
| 1 | 0x08 | Command (read word 1 from additional information) |
| 2 | MRS code | Memory area to read |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|----------|------------------------------------|
| No. | Name | |
| Slave | | |
| 1 | 0x08 | Repetition (safety) |
| 2 | MRS code | |
| 3 | Value_L | Word 1 from additional information |
| 4 | Value_H | |
| Master | | |

9.16.7.11.10.9 Read word 2 from additional information (0x09)

Master command

| Protocol bytes | | Information |
|----------------|----------|---|
| No. | Name | |
| Master | | |
| 1 | 0x09 | Command (read word 2 from additional information) |
| 2 | MRS code | Memory area to read |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|----------|--|
| No. | Name | |
| Slave | | |
| 1 | 0x09 | Repetition (safety) |
| 2 | MRS code | |
| 3 | Value_L | Read word 1 from additional information (overhead) |
| 4 | Value_H | |
| 5 | Value_L | Word 2 from additional information |
| 6 | Value_H | |
| Master | | |

9.16.7.11.10.10 Read word 3 from additional information (0x0A)

Master command

| Protocol bytes | | Information |
|----------------|----------|---|
| No. | Name | |
| Master | | |
| 1 | 0x0A | Command (read word 3 from additional information) |
| 2 | MRS code | Memory area to read |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|----------|--|
| No. | Name | |
| Slave | | |
| 1 | 0x0A | Repetition (safety) |
| 2 | MRS code | |
| 3 | Value_L | Read word 1 from additional information (overhead) |
| 4 | Value_H | |
| 5 | Value_L | Read word 2 from additional information (overhead) |
| 6 | Value_H | |
| 7 | Value_L | Word 3 from additional information |
| 8 | Value_H | |
| Master | | |

9.16.7.11.10.11 Read word 4 from additional information (0x0B)

Master command

| Protocol bytes | | Information |
|----------------|----------|---|
| No. | Name | |
| Master | | |
| 1 | 0x0B | Command (read word 4 from additional information) |
| 2 | MRS code | Memory area to read |
| Slave | | |

Slave response

| Protocol bytes | | Information |
|----------------|----------|--|
| No. | Name | |
| Slave | | |
| 1 | 0x0B | Repetition (safety) |
| 2 | MRS code | |
| 3 | Value_L | Read word 1 from additional information (overhead) |
| 4 | Value_H | |
| 5 | Value_L | Read word 2 from additional information (overhead) |
| 6 | Value_H | |
| 7 | Value_L | Read word 3 from additional information (overhead) |
| 8 | Value_H | |
| 9 | Value_L | Word 4 from additional information |
| 10 | Value_H | |
| Master | | |

9.16.7.11.11 NetTime Technology

For a description of NetTime Technology, see ["NetTime Technology" on page 3035](#).

9.16.7.11.12 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 100 μ s |

9.16.7.11.13 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.16.8 X20DS4389

Data sheet version: 2.11

9.16.8.1 General information

This module is a digital signal processor module that is used for detecting and evaluating input edges and for creating edges.

In oversampling mode, the module acquires very short input patterns whose low or high phases are shorter than the X2X Link cycle time. Similarly, output patterns (e.g. drum sequencers) can also be output with extremely short high/low times. Oversampling can take place with a scan rate of up to 25 μ s.

If necessary, up to 4 events per edge detection unit are stored in a buffer (history elements).

Other functions include pulse duration measuring and differential time measuring.

- 4 digital input channels
- 4 digital channels, configurable as inputs or outputs
- 4 edge detection units with timestamp function (each can be used to measure pulse duration or differential time, 4 history elements per unit)
- 4x precise edge generation down to the μ s (up to four edges per unit in each case)
- 4x oversampling (input and output signal)
- 24 VDC and GND for sensor/actuator supply
- NetTime timestamp: Input data, edge detection, edge generation

NetTime-Zeitstempel

An additional essential feature is the module's integrated timestamp function. This allows fast input edges such as registration marks to be detected independently of the system's X2X Link cycle time and provided with a precise input stamp. In the other direction, the module sets outputs at exactly specified times. This is done with a resolution up to 125 ns.

9.16.8.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| X20DS4389 | X20 digital signal module, 4 digital inputs, 24 VDC, 4 digital outputs, 24 VDC, 0.1 A, oversampling I/O functions, time-triggered I/O functions, NetTime function |  |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 370: X20DS4389 - Order data

9.16.8.3 Technical data

| Model number | X20DS4389 |
|---|---|
| Short description | |
| I/O module | 4 digitale Eingangskanäle, 4 digitale Kanäle wahlweise als Ein- oder Ausgang parametrierbar, 4 Flankenerkennungseinheiten mit Zeitstempelfunktion (jeweils nutzbar als Impulsdauer- oder Differenzzeitmessung, 4 Historyelemente pro Einheit), 4 mal μ s genaue Flankenerzeugung (jeweils bis zu 4 Flanken pro Einheit), 4 mal Oversampling (Ein- und Ausgangssignal) |
| General information | |
| B&R ID code | 0xA93B |
| Status indicators | I/O-Funktion pro Kanal, Betriebszustand, Modulstatus |
| Diagnostics | |
| Module run/error | Ja, per Status-LED und SW-Status |
| Outputs | Ja, per Status-LED und SW-Status (Ausgangszustandsstatus) |
| Power consumption | |
| Bus | 0,01 W |
| Internal I/O | 1,5 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Type of signal lines | Für alle Signalleitungen sind geschirmte Leitungen zu verwenden |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Digital inputs | |
| Quantity | 4 + 4, Konfiguration als Ein- oder Ausgang erfolgt über Software |
| Nominal voltage | 24 VDC |
| Input voltage | 24 VDC -15% / +20% |
| Input current at 24 VDC | ca. 1,3 mA |
| Input circuit | Sink |
| Input resistance | 18,4 k Ω |
| Additional functions | 4 Flankenerkennungseinheiten mit Zeitstempelfunktion, 4x Eingangsoversampling |
| Input frequency | 40 kHz |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Digital outputs | |
| Quantity | Bis zu 4, Konfiguration als Ein- oder Ausgang erfolgt über Software |
| Variant | Push / Pull / Push-Pull |
| Nominal voltage | 24 VDC |
| Switching voltage | 24 VDC -15% / +20% |
| Nominal output current | 0,1 A |
| Total nominal current | 0,4 A |
| Output circuit | Sink und/oder Source |
| Output protection | Thermische Abschaltung bei Überstrom oder Kurzschluss, integrierter Schutz zum Schalten von Induktivitäten |
| Diagnostic status | Ausgangsüberwachung |
| Leakage current when switched off | max. 25 μ A |
| R _{DS(on)} | 150 m Ω |
| Residual voltage | <0,9 V bei Nennstrom 0,1 A |
| Peak short-circuit current | <10 A |
| Switch-on in the event of overload shutdown or short-circuit shutdown | ca. 10 ms (abhängig von der Modultemperatur) |
| Switching delay | |
| 0 \rightarrow 1 | <2 μ s |
| 1 \rightarrow 0 | <2 μ s |
| Switching frequency | |
| Resistive load | max. 24 kHz |
| Inductive load | Siehe Abschnitt "Schalten induktiver Lasten" |


Table 371: X20DS4389 - Technical data

| Model number | X20DS4389 | |
|--|--|--|
| Braking voltage when switching off inductive loads | Schaltspannung + 0,6 VDC | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Additional functions | 4x µs genaue Flankenerzeugung, 4x Ausgangsoversampling | |
| Edge detection units | | |
| Quantity | 4 | |
| Operating mode | 4 Impulsdauermessungen, Relativ- oder Absolutzeitpunkte von Eingangsflanken in µs Auflösung, 4 Historyelemente pro Einheit | |
| Counter size | 16/32 Bit | |
| Input frequency (max.) | 40 kHz | |
| Resolution | 125 ns Zeitstempelfunktion | |
| Signal form | Rechteckimpulse | |
| Sensor power supply | Modulintern, max. 600 mA | |
| Edge generation units | | |
| Quantity | 4 | |
| Edge generation | | |
| Absolute | Absolut zur NetTime | |
| Relative | Relativ zu anderen Flanken | |
| Offset at relative edge generation | | |
| Range of values | 16 oder 32 Bit Wert | |
| Resolution | 1 µs | |
| Actuator power supply | Modulintern, max. 600 mA | |
| Oversampling | | |
| Quantity | 4 | |
| Sample time | 25 bis 255 µs | |
| Data volume | Bis zu 64 Bit pro X2X Link Zyklus in Ein- und Ausgangsrichtung | |
| Electrical properties | | |
| Electrical isolation | Kanal zu Bus getrennt Kanal zu Kanal nicht getrennt | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Ja | |
| Vertical | Ja | |
| Installation elevation above sea level | | |
| 0 to 2000 m | Keine Einschränkung | |
| >2000 m | Reduktion der Umgebungstemperatur um 0,5°C pro 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 bis 60°C | |
| Vertical mounting orientation | -25 bis 50°C | |
| Derating | Siehe Abschnitt "Derating" | |
| Storage | -40 bis 85°C | |
| Transport | -40 bis 85°C | |
| Relative humidity | | |
| Operation | 5 bis 95%, nicht kondensierend | |
| Storage | 5 bis 95%, nicht kondensierend | |
| Transport | 5 bis 95%, nicht kondensierend | |
| Mechanical properties | | |
| Note | Feldklemme 1x X20TB12 gesondert bestellen Busmodul 1x X20BM11 gesondert bestellen | |
| Spacing | 12,5 ^{+0,2} mm | |

Table 371: X20DS4389 - Technical data

9.16.8.4 LED status indicators

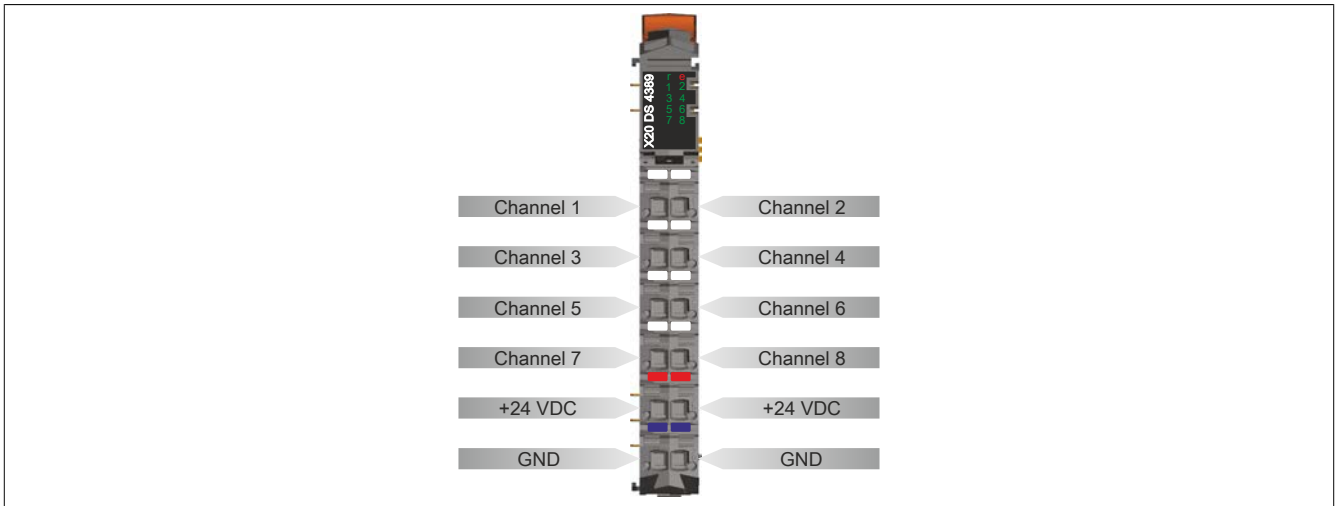
For a description of the various operating modes, see ["Diagnostic LEDs" on page 3787](#).

| Figure | LED | Color | Status | Description |
|---|-------|-------|--------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | Double flash | Mode BOOT (during firmware update) ¹⁾ |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | | | Double flash | One of the following errors occurred: <ul style="list-style-type: none"> Oversample output control error Oversample output copy error Edge detect poll cycle violation Error on edge generator unit 1 - 4 |
| | 1 - 8 | Green | | Status of the corresponding digital signal |

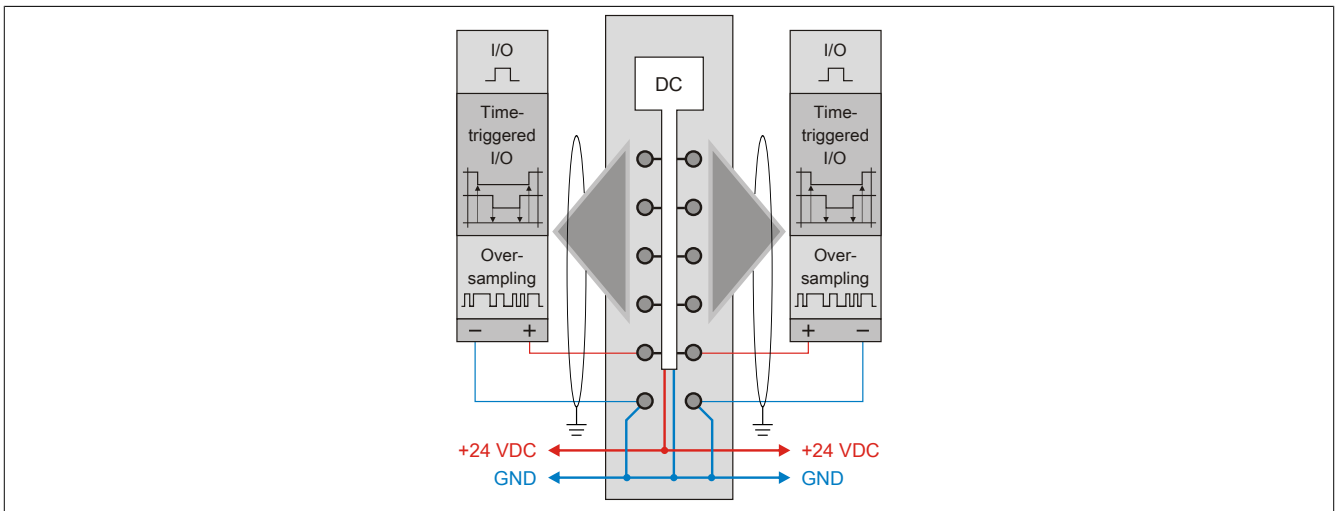
1) Depending on the configuration, a firmware update can take up to several minutes.

9.16.8.5 Pinout

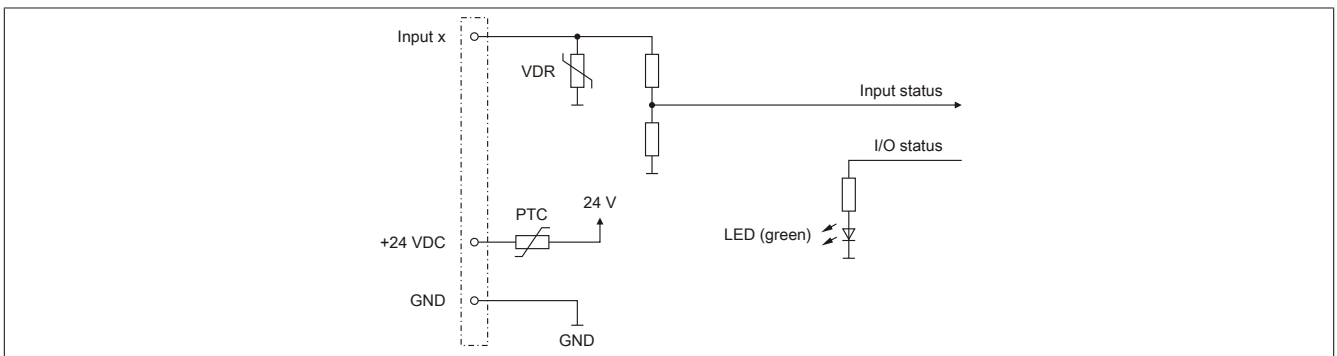
Shielded cables must be used for all signal lines.



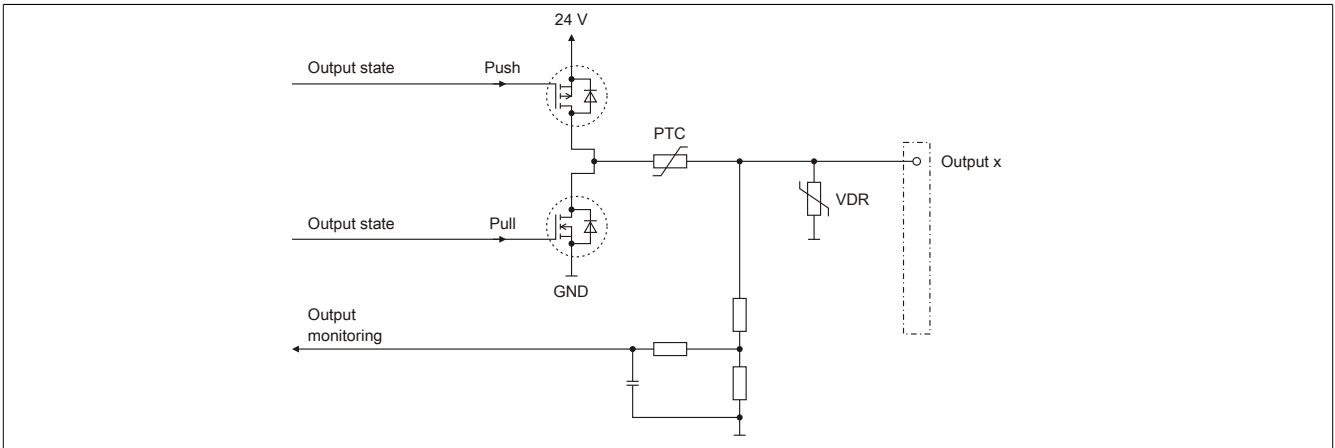
9.16.8.6 Connection example



9.16.8.7 Input circuit diagram



9.16.8.8 Output circuit diagram

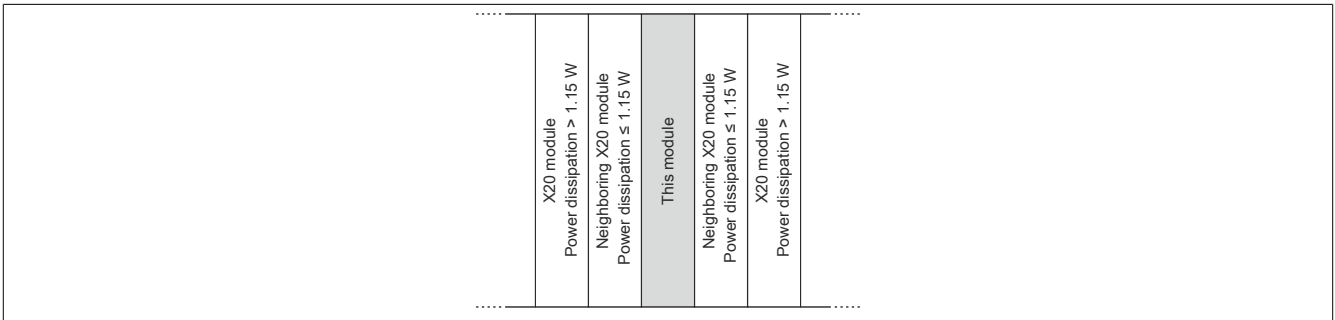


9.16.8.9 Derating

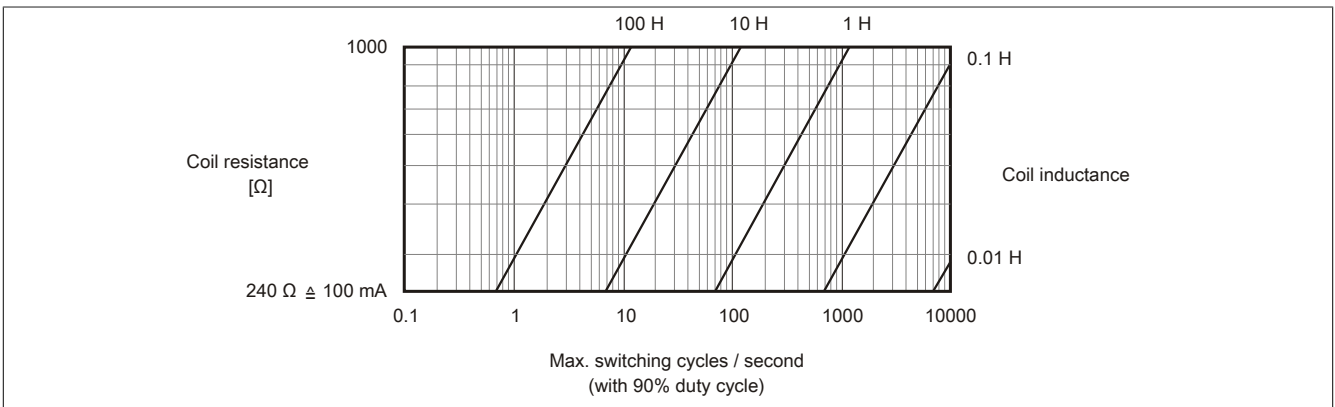
There is no derating when operated below 55°C.

During operation over 55°C, the power dissipation of the modules to the left and right of this module is not permitted to exceed 1.15 W!

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.



9.16.8.10 Switching inductive loads



9.16.8.11 Register description

9.16.8.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.16.8.11.2 Function model 0 - default

| Register | Name | Data type | Read | | Write | |
|--|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration - General | | | | | | |
| 513 | CfO_SlframeGenID | USINT | | | | • |
| Configuration - System timer | | | | | | |
| 642 | CfO_SystemCycleTime | UINT | | | | • |
| 646 | CfO_SystemCycleOffset | INT | | | | • |
| 650 | CfO_SystemCyclePrescaler | UINT | | | | • |
| Configuration - Physical I/O | | | | | | |
| 769 + (N-1) * 2 | CfO_PhylIOConfigCh0N (Index N = 1 to 8) | USINT | | | | • |
| Configuration - Direct I/O | | | | | | |
| 899 | CfO_DirectIOClearMask0_7 | USINT | | | | • |
| 903 | CfO_DirectIOSetMask0_7 | USINT | | | | • |
| 905 | CfO_OutputUpdateCycle | USINT | | | | • |
| Configuration - Oversampled I/O | | | | | | |
| 1025 | CfO_OversampleMode | USINT | | | | • |
| 1027 | CfO_OversampleSampleCycleID | USINT | | | | • |
| 1029 | CfO_OversampleRelativeCycleID | USINT | | | | • |
| 1031 | CfO_OversampleConsumeCycleID | USINT | | | | • |
| 1033 | CfO_OversampleOutputBits | USINT | | | | • |
| 1035 | CfO_OversampleInputBits | USINT | | | | • |
| 1037 | CfO_OversampleOutputWindow | USINT | | | | • |
| 1039 | CfO_OversampleInputWindow | USINT | | | | • |
| 1041 + (N*2) | CfO_OversampleConfigInputN (Index N = 0 to 3) | USINT | | | | • |
| 1049 + (N*2) | CfO_OversampleConfigOutputN (Index N = 0 to 3) | USINT | | | | • |
| Configuration - Edge detection | | | | | | |
| 2817 | CfO_EdgeDetectPollCycleID | USINT | | | | • |
| 2828 | CfO_EdgeDetectEventEnable | UDINT | | | | • |
| 3073 + (N-1) * 16 | CfO_EdgeDetectUnit0NMode (Index N = 1 to 4) | USINT | | | | • |
| 3075 + (N-1) * 16 | CfO_EdgeDetectUnit0NLeading (Index N = 1 to 4) | USINT | | | | • |
| 3077 + (N-1) * 16 | CfO_EdgeDetectUnit0NMaster (Index N = 1 to 4) | USINT | | | | • |
| 3079 + (N-1) * 16 | CfO_EdgeDetectUnit0NSlave (Index N = 1 to 4) | USINT | | | | • |
| Configuration - Edge generator | | | | | | |
| 2945 | CfO_EdgeGenPollCycleEventID | USINT | | | | • |
| 2947 | CfO_EdgeGenConsumeCycleEventID | USINT | | | | • |
| 3585 + (N-1) * 64 | CfO_EdgeGenUnit0NMode (Index N = 1 to 4) | USINT | | | | • |
| 3589 + (N-1) * 64 | CfO_EdgeGenUnit0NTimestampFifoLim (Index N = 1 to 4) | USINT | | | | • |
| 3591 + (N-1) * 64 | CfO_EdgeGenUnit0NTimestampRegCount (Index N = 1 to 4) | USINT | | | | • |
| 3596 + (N-1) * 64 | CfO_EdgeGenUnit0NPickupDiff | UDINT | | | | • |
| 3602 + (N-1) * 64 | CfO_EdgeGenUnit0NConfigEdge0 (Index N = 1 to 4) | UINT | | | | • |
| 3606 + (N-1) * 64 | CfO_EdgeGenUnit0NConfigEdge1 (Index N = 1 to 4) | UINT | | | | • |
| 3610 + (N-1) * 64 | CfO_EdgeGenUnit0NConfigEdge2 (Index N = 1 to 4) | UINT | | | | • |
| 3614 + (N-1) * 64 | CfO_EdgeGenUnit0NConfigEdge3 (Index N = 1 to 4) | UINT | | | | • |
| Communication - General | | | | | | |
| 546 | ProtocolError (16-bit) | UINT | • | | | |
| 547 | ProtocolError (8-bit) | USINT | • | | | |
| 550 | ProtocolSequenceViolation (16-bit) | UINT | • | | | |
| 551 | ProtocolSequenceViolation (8-bit) | USINT | • | | | |
| Communication - Error register | | | | | | |
| 257 | Error state - Output data and edge detection | USINT | • | | | |
| | OutputControlError | Bit 4 | | | | |
| | OutputCopyError | Bit 5 | | | | |
| | EdgeDetectError | Bit 6 | | | | |

| Register | Name | Data type | Read | | Write | |
|---|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 259 | Error messages - Edge generator | USINT | • | | | |
| | EdgeGen01Error | Bit 0 | | | | |
| | EdgeGen01Warning | Bit 1 | | | | |
| | EdgeGen02Error | Bit 2 | | | | |
| | EdgeGen02Warning | Bit 3 | | | | |
| | EdgeGen03Error | Bit 4 | | | | |
| | EdgeGen03Warning | Bit 5 | | | | |
| | EdgeGen04Error | Bit 6 | | | | |
| EdgeGen04Warning | Bit 7 | | | | | |
| 321 | Acknowledge error messages - Output data and edge detection | USINT | | | • | |
| | QuitOutputControlError | Bit 4 | | | | |
| | QuitOutputCopyError | Bit 5 | | | | |
| | QuitEdgeDetectError | Bit 6 | | | | |
| 323 | Acknowledge error messages - Edge generator | USINT | | | • | |
| | QuitEdgeGen01Error | Bit 0 | | | | |
| | QuitEdgeGen01Warning | Bit 1 | | | | |
| | QuitEdgeGen02Error | Bit 2 | | | | |
| | QuitEdgeGen02Warning | Bit 3 | | | | |
| | QuitEdgeGen03Error | Bit 4 | | | | |
| | QuitEdgeGen03Warning | Bit 5 | | | | |
| | QuitEdgeGen04Error | Bit 6 | | | | |
| QuitEdgeGen04Warning | Bit 7 | | | | | |
| Communication - System timer | | | | | | |
| 683 | SDCLifeCount | SINT | • | | | |
| Communication - Direct I/O | | | | | | |
| 915 | "DigitalOutput" register | USINT | | | • | |
| | DigitalOutput03 | Bit 2 | | | | |
| | DigitalOutput04 | Bit 3 | | | | |
| | DigitalOutput07 | Bit 6 | | | | |
| | DigitalOutput08 | Bit 7 | | | | |
| 927 | Input state | USINT | • | | | |
| | DigitalInput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalInput08 | Bit 7 | | | | |
| Communication - Oversampled I/O (output) | | | | | | |
| 1059 | Oversampling configuration | USINT | | | • | |
| | OversampleEnable | Bit 0 | | | | |
| | OversampleOutputValidate | Bit 1 | | | | |
| 1063 | OversampleOutputCycle | USINT | | | • | |
| | OversampleSampleOffset | USINT | | | | |
| 1088 + N | OversampleOutput0NSample1_8 (Index N = 1 to 4) | USINT | | | • | |
| 1092 + N | OversampleOutput0NSample9_16 (Index N = 1 to 4) | USINT | | | • | |
| 1096 + N | OversampleOutput0NSample17_24 (Index N = 1 to 4) | USINT | | | • | |
| 1100 + N | OversampleOutput0NSample25_32 (Index N = 1 to 4) | USINT | | | • | |
| 1104 + N | OversampleOutput0NSample33_40 (Index N = 1 to 4) | USINT | | | • | |
| 1108 + N | OversampleOutput0NSample41_48 (Index N = 1 to 4) | USINT | | | • | |
| 1112 + N | OversampleOutput0NSample49_56 (Index N = 1 to 4) | USINT | | | • | |
| 1116 + N | OversampleOutput0NSample57_64 (Index N = 1 to 4) | USINT | | | • | |
| Communication - Oversampled I/O (input) | | | | | | |
| 1074 | OversampleInputTime | INT | • | | | |
| 1079 | OversampleInputCycle | USINT | • | | | |
| 1120 + N | OversampleInput0NSample64_57 (Index N = 1 to 4) | USINT | • | | | |
| 1124 + N | OversampleInput0NSample56_49 (Index N = 1 to 4) | USINT | • | | | |
| 1128 + N | OversampleInput0NSample48_41 (Index N = 1 to 4) | USINT | • | | | |
| 1132 + N | OversampleInput0NSample40_33 (Index N = 1 to 4) | USINT | • | | | |
| 1136 + N | OversampleInput0NSample32_25 (Index N = 1 to 4) | USINT | • | | | |
| 1140 + N | OversampleInput0NSample24_17 (Index N = 1 to 4) | USINT | • | | | |
| 1144 + N | OversampleInput0NSample16_9 (Index N = 1 to 4) | USINT | • | | | |
| 1148 + N | OversampleInput0NSample8_1 (Index N = 1 to 4) | USINT | • | | | |
| Communication - Edge detection | | | | | | |
| 4098 + (N-1) * 32 | EdgeDetect0NMastercount (16-bit) (Index N = 1 to 4) | INT | • | | | |
| 4099 + (N-1) * 32 | EdgeDetect0NMastercount (8-bit) (Index N = 1 to 4) | SINT | • | | | |
| 4102 + (N-1) * 32 | EdgeDetect0NSlavecount (16-bit) (Index N = 1 to 4) | INT | • | | | |
| 4103 + (N-1) * 32 | EdgeDetect0NSlavecount (8-bit) (Index N = 1 to 4) | SINT | • | | | |
| 4108 + (N-1) * 32 | EdgeDetect0NDifference (32-bit) (Index N = 1 to 4) | DINT | • | | | |
| 4110 + (N-1) * 32 | EdgeDetect0NDifference (16-bit) (Index N = 1 to 4) | INT | • | | | |
| 4116 + (N-1) * 32 | EdgeDetect0NMastertime (32-bit) (Index N = 1 to 4) | DINT | • | | | |

| Register | Name | Data type | Read | | Write | |
|---------------------------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 4118 + (N-1) * 32 | EdgeDetect0NMasterTime (16-bit) (Index N = 1 to 4) | INT | • | | | |
| 4124 + (N-1) * 32 | EdgeDetect0NSlaveTime (32-bit) (Index N = 1 to 4) | DINT | • | | | |
| 4126 + (N-1) * 32 | EdgeDetect0NSlaveTime (16-bit) (Index N = 1 to 4) | INT | • | | | |
| Communication - Edge generator | | | | | | |
| 6145 + (N-1) * 256 | Enabling units | USINT | | | • | |
| | EdgeGen0NEnable EdgeGen0NEnableReadback (Index N = 1 to 4) | Bit 0 | | | | |
| 6147 + (N-1) * 256 | EdgeGenSequence | USINT | | | • | |
| | EdgeGenSequenceReadback | USINT | • | | | |
| 6180 + (N-1) * 256 | EdgeGen0NOffset1 (Index N = 1 to 4) (32-bit) | UDINT | | | • | |
| | CfO_EdgeGen0NOffset_32bit1 (Index N = 1 to 4) | | | | | • |
| 6182 + (N-1) * 256 | EdgeGen0NOffset1 (Index N = 1 to 4) (16-bit) | UINT | | | • | |
| 6188 + (N-1) * 256 | EdgeGen0NOffset2 (Index N = 1 to 4) (32-bit) | UDINT | | | • | |
| | CfO_EdgeGen0NOffset_32bit2 (Index N = 1 to 4) | | | | | • |
| 6190 + (N-1) * 256 | EdgeGen0NOffset2 (Index N = 1 to 4) (16-bit) | UINT | | | • | |
| 6196 + (N-1) * 256 | EdgeGen0NOffset3 (Index N = 1 to 4) (32-bit) | UDINT | | | • | |
| | CfO_EdgeGen0NOffset_32bit3 (Index N = 1 to 4) | | | | | • |
| 6198 + (N-1) * 256 | EdgeGen0NOffset3 (Index N = 1 to 4) (16-bit) | UINT | | | • | |
| 6204 + (N-1) * 256 | EdgeGen0NOffset4 (Index N = 1 to 4) (32-bit) | UDINT | | | • | |
| | CfO_EdgeGen0NOffset_32bit4 (Index N = 1 to 4) | | | | | • |
| 6206 + (N-1) * 256 | EdgeGen0NOffset4 (Index N = 1 to 4) (16-bit) | UINT | | | • | |
| 6212 + (N-1) * 256 | EdgeGen0NTimestamp1 (Index N = 1 to 4) (32-bit) | UDINT | | | • | |
| 6214 + (N-1) * 256 | EdgeGen0NTimestamp1 (Index N = 1 to 4) (16-bit) | UINT | | | • | |
| 6220 + (N-1) * 256 | EdgeGen0NTimestamp2 (Index N = 1 to 4) (32-bit) | UDINT | | | • | |
| 6222 + (N-1) * 256 | EdgeGen0NTimestamp2 (Index N = 1 to 4) (16-bit) | UINT | | | • | |
| 6228 + (N-1) * 256 | EdgeGen0NTimestamp3 (Index N = 1 to 4) (32-bit) | UDINT | | | • | |
| 6230 + (N-1) * 256 | EdgeGen0NTimestamp3 (Index N = 1 to 4) (16-bit) | UINT | | | • | |
| 6236 + (N-1) * 256 | EdgeGen0NTimestamp4 (Index N = 1 to 4) (32-bit) | UDINT | | | • | |
| 6238 + (N-1) * 256 | EdgeGen0NTimestamp4 (Index N = 1 to 4) (16-bit) | UINT | | | • | |

9.16.8.11.3 General

9.16.8.11.3.1 Use with Automation Studio

The module is only supported by SG4 target systems via X2X and POWERLINK!

X2X Link supports the following synchronous cyclic data per module:

- 31 bytes input data consisting of 30 input bytes and X2X status byte
- 30 bytes output data

To optimize use and prevent needless data transfer, data points can be adjusted as needed in Automation Studio. Unnecessary data points can be disabled, and the bit width of the data points can be defined.

9.16.8.11.3.2 Timestamp function

The timestamp function is based on synchronized timers. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

Conversely, the CPU can predefine output events, apply a timestamp and transfer them to the module. The module then executes the predefined action at the precise moment defined by the CPU.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

The resolution of the timestamp is up to 1/8 μ s in both directions.

Synchronization jitter

Because the CPU – which specifies the X2X NetTime – and the module have different clocks, the module's internal X2X NetTime must be synchronized with the CPU's NetTime. Due to this synchronization, the module's internal X2X NetTime is corrected by a maximum of 1/8 μ s per system cycle if necessary. This synchronization jitter becomes noticeable when using the NetTime with 1/8 μ s resolution (max. \pm 1/8 μ s).

If a 100% exact 1/8 μ s resolution without jitter is required, then the "localtime 1/8 μ s" must be used (see register "[CfO_EdgeDetectUnitMode](#)" on page 2081).

9.16.8.11.4 General registers

9.16.8.11.4.1 Defining the moment for generating synchronous input data

Name:

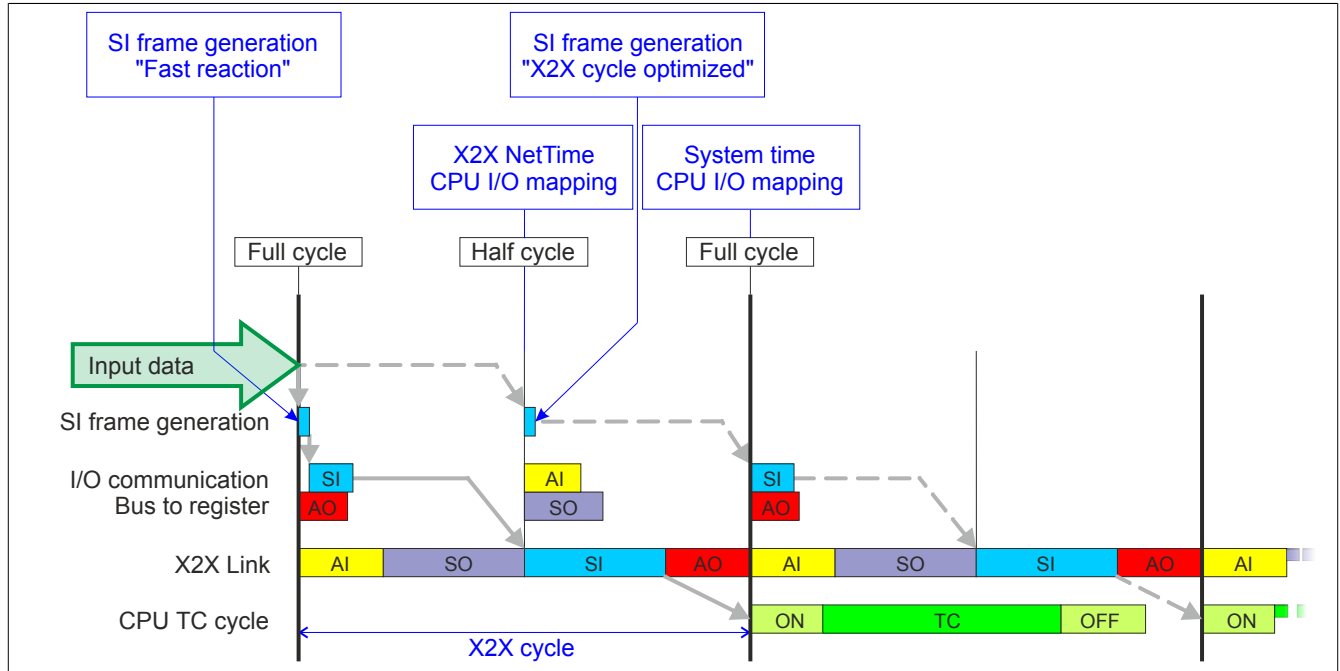
CfO_SlframeGenID

"SI frame generation" in the Automation Studio I/O configuration.

When the synchronous input data is generated for transfer is defined in this register. This has a decisive effect on the timing of the input data.

Setting "Fast reaction" causes the input data to be available one X2X cycle sooner in the CPU. However, this setting also has a negative effect on the minimum X2X cycle time.

| Data type | Values | Information |
|-----------|--------|---------------------|
| USINT | 9 | X2X cycle optimized |
| | 14 | Fast reaction |



9.16.8.11.4.2 Number of X2X protocol errors

Name:

ProtocolError

This register contains an error counter that specifies the number of X2X protocol errors. In the I/O configuration, parameter "Network information" can be used to help configure a data point for this register with a bit width of 8 or 16 bits in the I/O mapping.

| Data type | Values | Information |
|-----------|------------|------------------------|
| USINT | 0 to 255 | Error counter (8-bit) |
| UINT | 0 to 65535 | Error counter (16-bit) |

9.16.8.11.4.3 Number of X2X sequence violations

Name:

ProtocolSequenceViolation

This register contains an error counter that specifies the number of X2X sequence violations. In the I/O configuration, parameter "Network information" can be used to help configure a data point with a bit width of 8 or 16 bits in the I/O mapping.

| Data type | Values | Information |
|-----------|------------|------------------------|
| USINT | 0 to 255 | Error counter (8-bit) |
| UINT | 0 to 65535 | Error counter (16-bit) |

9.16.8.11.4 System clock counter for checking the validity of the data frame

Name:

SDCLifeCount

Counter that is incremented with each system timer cycle. "SDC information" in the Automation Studio I/O configuration can be used to enable this register in the I/O mapping as data point "SDCLifeCount".

The 8-bit counter register is needed for the SDC software package. It is incremented with the system clock to allow the SDC to check the validity of the data frame.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

9.16.8.11.5 Error handling

If one of the functions detects an error, then an error bit is set in one of the error state registers. The application is now able to react to this and acknowledge the errors by setting a respective bit in the "Acknowledge error message" registers. This causes the bit to be reset in the error state register. If the error source persists, then the error bit is set again as soon as the error is detected again (i.e. resetting is not possible).

Error acknowledgment has no effect on the functionality of the module. The module resumes processing, automatically if possible, as soon as the error source is eliminated.

If an error occurs (not a warning), this is indicated by the red "e" LED on the module (double flash). This signal is automatically acknowledged as soon as the error source has been eliminated.

9.16.8.11.5.1 Error state - Output data and edge detection

Name:

OutputControlError

OutputCopyError

EdgeDetectError

Data output errors and cycle time setting errors are indicated in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------|-------|---|
| 0 - 3 | Reserved | - | |
| 4 | OutputControlError | 0 | No error |
| | | 1 | The module did not receive new data in time when "Output control mode = Single", meaning that a bit that has already been output would have been output again by the output control buffer. |
| 5 | OutputCopyError | 0 | No error |
| | | 1 | Oversampling output data could not be copied to the output control buffer (attempted to write to an address outside the oversample output window , for example). |
| 6 | EdgeDetectError | 0 | No error |
| | | 1 | Edge detection cycle time violation: "EdgeDetectPollCycle" must be $\leq 255 \mu\text{s}$. This error is occurs if the cycle set in register "CfO_EdgeDetectPollCycleID" on page 2080 is $> 255 \mu\text{s}$. |
| 7 | Reserved | - | |

9.16.8.11.5.2 Error messages - Edge generator

Name:

EdgeGen01Error to EdgeGen04Error

EdgeGen01Warning to EdgeGen04Warning

This register indicates edge detection errors.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|------------------|-------|------------------------------|
| 0 | EdgeGen01Error | 0 | No error |
| | | 1 | Unit 1 error ¹⁾ |
| 1 | EdgeGen01Warning | 0 | No error |
| | | 1 | Unit 1 warning ²⁾ |
| 2 | EdgeGen02Error | 0 | No error |
| | | 1 | Unit 2 error ¹⁾ |
| 3 | EdgeGen02Warning | 0 | No error |
| | | 1 | Unit 2 warning ²⁾ |
| 4 | EdgeGen03Error | 0 | No error |
| | | 1 | Unit 3 error ¹⁾ |
| 5 | EdgeGen03Warning | 0 | No error |
| | | 1 | Unit 3 warning ²⁾ |
| 6 | EdgeGen04Error | 0 | No error |
| | | 1 | Unit 4 error ¹⁾ |
| 7 | EdgeGen04Warning | 0 | No error |
| | | 1 | Unit 4 warning ²⁾ |

1) Possible errors

- Due to "EdgeGenPollCycle", one or more timestamps from the edge generator of a unit were not able to be processed in time, and it was not possible to catch back up (see register "CfO_EdgeGenUnitPickupDiff" on page 2087).
- A branched ring-shaped chain of edges in a unit is attempting to set the timestamp for an edge even though the FIFO buffer of the configured physical channel is already full (see register "CfO_EdgeGenUnitConfigEdge" on page 2088 → - Ring-shaped chain of edges).

- 2) Due to "EdgeGenPollCycle", one or more timestamps from the edge generator of a unit were not able to be processed in time, and it was possible to catch back up (see register "CfO_EdgeGenUnitPickupDiff" on page 2087).

9.16.8.11.5.3 Acknowledging error messages - Output data and edge detection

Name:

QuitOutputControlError

QuitOutputCopyError

QuitEdgeDetectError

Error messages from register "Error state - Output data and edge detection" on page 2066 can be acknowledged by setting the corresponding bits in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------|-------|-------------------|
| 0 - 3 | Reserved | - | |
| 4 | QuitOutputControlError | 0 | No change |
| | | 1 | Acknowledge error |
| 5 | QuitOutputCopyError | 0 | No change |
| | | 1 | Acknowledge error |
| 6 | QuitEdgeDetectError | 0 | No change |
| | | 1 | Acknowledge error |
| 7 | Reserved | - | |

9.16.8.11.5.4 Acknowledge error messages - Edge generator

Name:

QuitEdgeGen01Error to QuitEdgeGen04Error

QuitEdgeGen01Warning to QuitEdgeGen04Warning

The error message from register "[Error messages - Edge generator](#)" on page 2067 can be acknowledged in this register by setting the respective bit.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|----------------------|-------|---------------------|
| 0 | QuitEdgeGen01Error | 0 | No change |
| | | 1 | Acknowledge error |
| 1 | QuitEdgeGen01Warning | 0 | No change |
| | | 1 | Acknowledge warning |
| 2 | QuitEdgeGen02Error | 0 | No change |
| | | 1 | Acknowledge error |
| 3 | QuitEdgeGen02Warning | 0 | No change |
| | | 1 | Acknowledge warning |
| 4 | QuitEdgeGen03Error | 0 | No change |
| | | 1 | Acknowledge error |
| 5 | QuitEdgeGen03Warning | 0 | No change |
| | | 1 | Acknowledge warning |
| 6 | QuitEdgeGen04Error | 0 | No change |
| | | 1 | Acknowledge error |
| 7 | QuitEdgeGen04Warning | 0 | No change |
| | | 1 | Acknowledge warning |

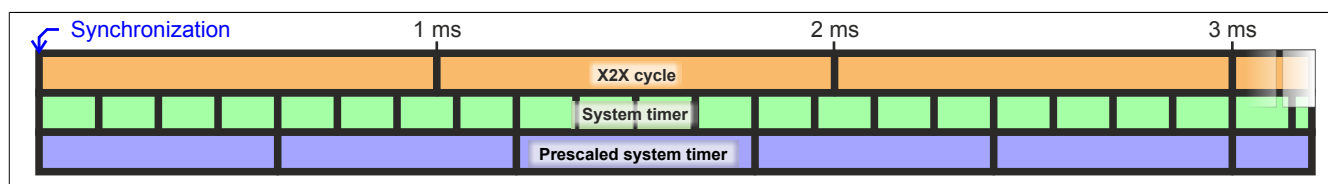
9.16.8.11.6 System timer

The module's individual functions all depend on a system timer. This internal "system cycle time" can be set from 25 to 255 μ s. The functions can also be run using a configurable "prescaled system timer" to minimize the load on the module, thereby making it possible to use the shortest possible X2X cycle time.

The cycle of the "prescaled system timer" (and system timer) is referenced with the X2X Link as soon as the module has been started up and the X2X Link has been initialized. Since the system timer and the module's internal [NetTime](#) use the same clock, the two run synchronously from that point on. An X2X cycle time that is not a multiple of the system cycle time results in an offset, which can be calculated, however.

The following values apply to the following example:

| | |
|------------------------|-------------|
| X2X cycle | 1 ms |
| System timer | 150 μ s |
| Prescaled system timer | 4 |



9.16.8.11.6.1 Setting the cycle time of the system timer

Name:

CfO_SystemCycleTime

"Cycle time" in the Automation Studio I/O configuration.

The cycle time of the system timer can be set in steps of $1/8 \mu$ s in this register. The value entered in the Automation Studio I/O configuration is automatically multiplied by 8.

Information:

A setting $<50 \mu$ s has a negative effect on the minimum X2X cycle time!

| Data type | Values | Information |
|-----------|-------------|---|
| UINT | 200 to 2047 | System timer cycle time in steps of $1/8 \mu$ s (25 to 255.875 μ s) |

9.16.8.11.6.2 Offsetting the synchronization moment of the system cycle

Name:

CfO_SystemCycleOffset

"Cycle offset" in the Automation Studio I/O configuration.

The synchronization moment for the system cycle can be offset in steps of $1/8 \mu\text{s}$ in this register. The value entered in the Automation Studio I/O configuration is automatically multiplied by 8.

| Data type | Values | Information |
|-----------|-----------------|---|
| INT | -32768 to 32767 | Cycle offset in steps of $1/8 \mu\text{s}$ (-4096 to 4095.875 μs) |

9.16.8.11.6.3 Configuration of the cycle prescaler

Name:

CfO_SystemCyclePrescaler

"Cycle prescaler" in the Automation Studio I/O configuration.

The prescaler for setting the [prescaled system timer](#) can be configured in this register. The cycle time of the specified system timer is a product of the system timer multiple set in this register.

The "prescaled system timer" can be used as an alternative time source for the individual functions. This is useful if a function requires a very short system cycle. To reduce the load on the module in such a situation, other functions can be processed in a slow cycle.

| Data type | Values | Information |
|-----------|----------|------------------------------|
| UINT | 2 to 128 | Multiple of the system timer |

9.16.8.11.7 Physical I/O configuration

9.16.8.11.7.1 "CfO_PhyIOConfigCh" registers

Name:

CfO_PhyIOConfigCh01 to CfO_PhyIOConfigCh08

The physical I/O channels can each be configured individually in these registers.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------------------------|---------|--------------|
| 0 | Push driver ¹⁾ | 0 | Disabled |
| | | 1 | Enabled |
| 1 | Pull driver ¹⁾ | 0 | Disabled |
| | | 1 | Enabled |
| 2 | Input inverted | 0 | Not inverted |
| | | 1 | Inverse |
| 3 | Output inverted ¹⁾ | 0 | Not inverted |
| | | 1 | Inverse |
| 4 - 7 | Output function ¹⁾ | 0 | Direct I/O |
| | | 1 to 15 | Reserved |

1) Only available for the I/O channels 3, 4, 7 and 8.

9.16.8.11.8 Direct I/O

Direct I/O makes it possible to use the physical I/Os like normal I/Os. Additionally, the application can only set or reset I/Os (e.g. an output channel is set by the edge generator and manually reset by the application).

9.16.8.11.8.1 Direct operation of the output channel - Reset

Name:

CfO_DirectIOClearMask0_7

"Direct operation of output channel 03" to "Direct operation of output channel 08" in the Automation Studio I/O configuration.

If the bit for the respective channel is set in this register, then the output is reset as soon as its direct I/O output channel (register "[DigitalOutput](#)" on page 2071 or "DigitalOutput0x" in the Automation Studio I/O mapping) is reset.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------|-------|---------------|
| 0 - 1 | Reserved | - | |
| 2 | Output channel 3 | 0 | No change |
| | | 1 | Reset channel |
| 3 | Output channel 4 | 0 | No change |
| | | 1 | Reset channel |
| 4 - 5 | Reserved | - | |
| 6 | Output channel 7 | 0 | No change |
| | | 1 | Reset channel |
| 7 | Output channel 8 | 0 | No change |
| | | 1 | Reset channel |

9.16.8.11.8.2 Direct operation of the output channel - Set

Name:

CfO_DirectIOSetMask0_7

"Direct operation of output channel 03" to "Direct operation of output channel 08" in the Automation Studio I/O configuration.

If the bit for the respective channel is set in this register, then the output is set as soon as its direct I/O output channel (register "[DigitalOutput](#)" on page 2071 or "DigitalOutput0x" in the Automation Studio I/O mapping) is set.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------|-------|-------------|
| 0 - 1 | Reserved | - | |
| 2 | Output channel 3 | 0 | No change |
| | | 1 | Set channel |
| 3 | Output channel 4 | 0 | No change |
| | | 1 | Set channel |
| 4 - 5 | Reserved | - | |
| 6 | Output channel 7 | 0 | No change |
| | | 1 | Set channel |
| 7 | Output channel 8 | 0 | No change |
| | | 1 | Set channel |

9.16.8.11.8.3 Direct operation of the output channel - Moment of data output

Name:

CfO_OutputUpdateCycle

The moment when data is output is set with this register.

| Data type | Values | Information |
|-----------|--------|-----------------------------------|
| USINT | 10 | X2X cycle optimized (jitter-free) |
| | 15 | Fast reaction (with jitter) |

9.16.8.11.8.4 "DigitalOutput" register

Name:

DigitalOutput03 and DigitalOutput04, DigitalOutput07 and DigitalOutput08

This register contains the bits for controlling the direct I/O output channels. Depending on how the "[CfO_DirectIO-ClearMask0_7](#)" on page 2070 and "[CfO_DirectIOSetMask0_7](#)" on page 2070 registers are configured, the digital outputs are set to the status of the respective bits in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------|--------|----------------------------|
| 0 - 1 | Reserved | - | |
| 2 | DigitalOutput03 | 0 or 1 | Output status of channel 3 |
| 3 | DigitalOutput04 | 0 or 1 | Output status of channel 4 |
| 4 - 5 | Reserved | - | |
| 6 | DigitalOutput07 | 0 or 1 | Output status of channel 7 |
| 7 | DigitalOutput08 | 0 or 1 | Output status of channel 8 |

9.16.8.11.8.5 Input state

Name:

DigitalInput01 to DigitalInput08

The state of the digital input channels is contained in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|----------------|--------|--------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input state of channel 1 |
| ... | ... | ... | |
| 7 | DigitalInput08 | 0 or 1 | Input state of channel 8 |

9.16.8.11.9 Oversampled I/O

"Oversampled I/O" is based on input status buffers and output control buffers. The input data acquisition and output control occur in one sample cycle (one sample cycle corresponds to one bit in the buffer). The precise moment of an input buffer entry is indicated by its position in the buffer and the **NetTime** assigned to the buffer.

When "Output control mode = Single", every output buffer entry is marked as invalid once it has been executed. This ensures that the outputs are not supplied with invalid data. In this mode, the application needs to ensure that the module is always supplied with valid data.

When using "Output control mode = Continuous" the contents of the buffer are output again if the module is not supplied with new oversample output data.

9.16.8.11.9.1 Addressing the output control buffer

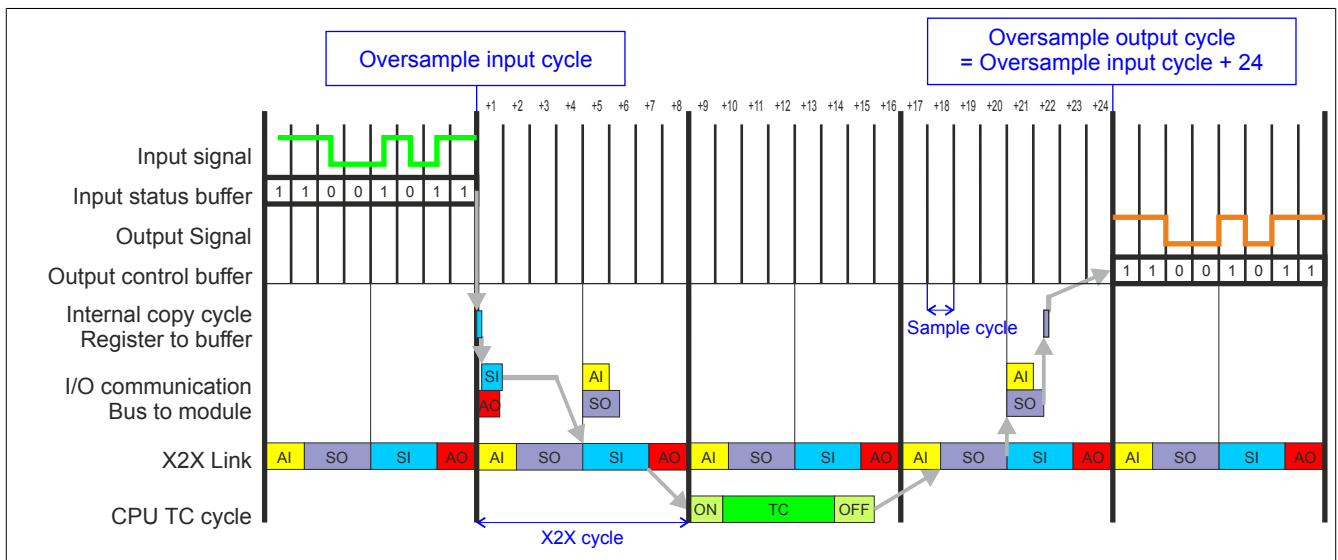
The module has one cyclic 256-bit output control buffer for each oversample channel. One bit is output from these buffers to the configured physical output channels in each "sample cycle". When new data is transferred to one of these buffers, the application must define where in the respective buffer the data should be written to. There are 2 possibilities available for this (absolute or relative "Output mode" in the Automation Studio I/O configuration).

9.16.8.11.9.2 Absolute addressing of the output control buffer

With absolute addressing, in each cycle where "OversampleOutputValidate = True", in addition to the oversample output sample data (in the "OversampleOutput0NSample" on page 2078 registers) an address must also be transferred in register "OversampleOutputCycle" on page 2078. This address defines where in the output control buffer the new data should be copied. In order to calculate this address, the contents of register "OversampleInputCycle" on page 2079, which contains the address of the most recently output data, and the transfer time to the module must be taken into account. To help avoid incorrect addressing of the output control buffer, the buffer section that is capable of being written to can be limited using register "OversampleOutputWindow" on page 2076. This window will always be shifted relative to the current sample address. An "OutputCopyError" will be triggered if an attempt is made to write to an address that is outside of this window.

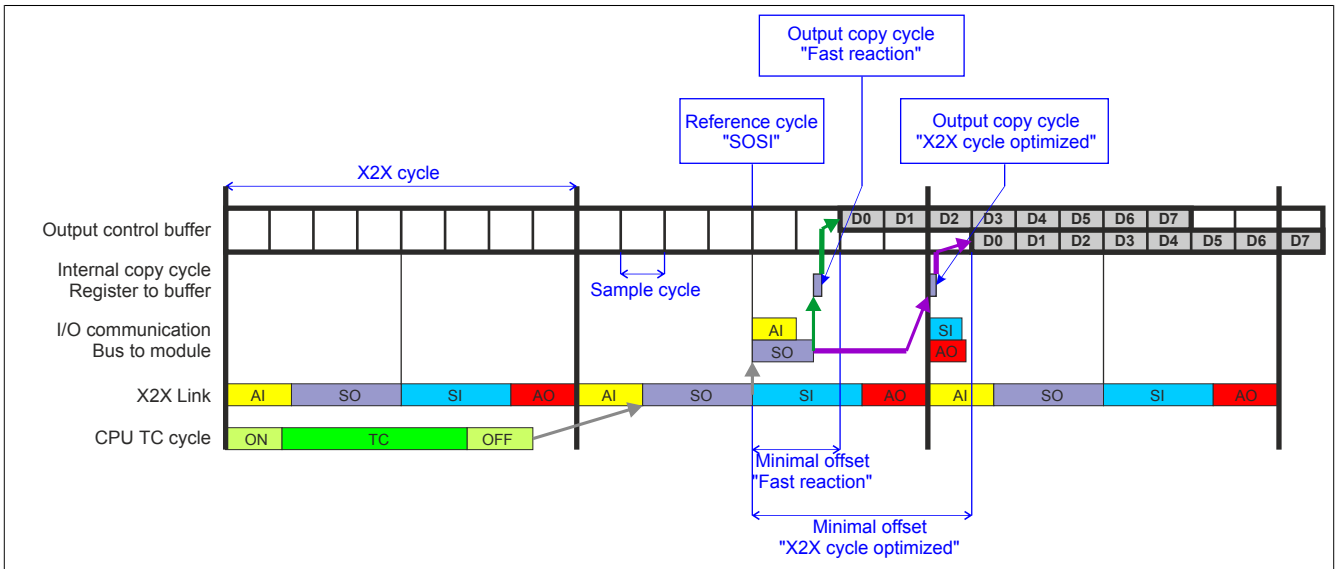
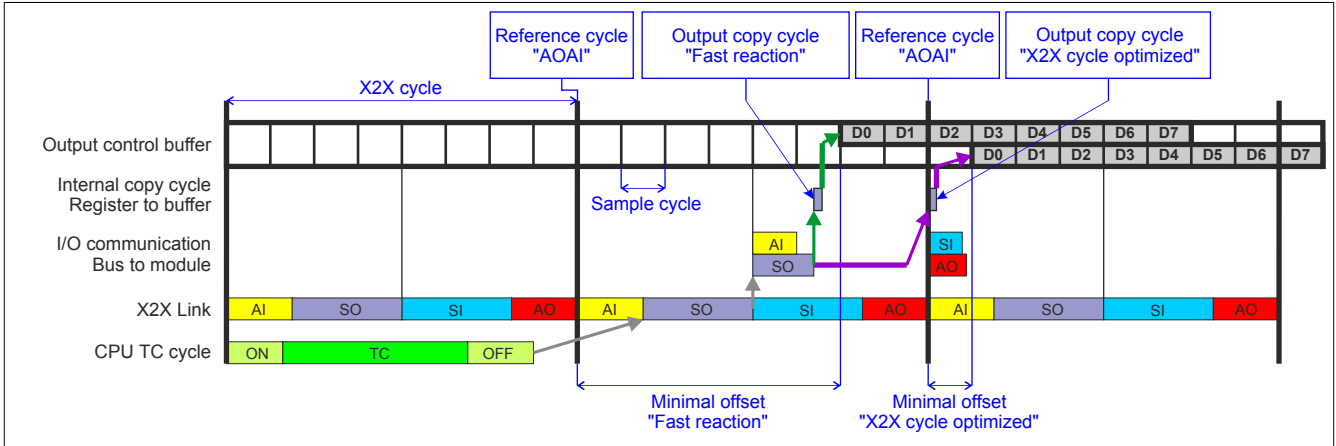
Example

Timing characteristics from the oversample input cycle to the oversample output cycle in absolute output mode ("SI frame generation = Fast reaction", "Output copy cycle = Fast reaction", 8 samples per X2X cycle):



9.16.8.11.9.3 Relative addressing of the output control buffer

When "OversampleOutputValidate = True", then the oversample output sample data is automatically copied to an address relative to the last referenced address at the set **output copy cycle** moment. Register "OversampleSampleOffset" on page 2078 serves as the offset. The new data cannot start being output immediately at the **output copy cycle** moment because it takes time to copy the data from the registers to the buffer. This means that an offset of 0 is not allowed. The relative output control buffer address + offset must point to an address within the "oversample output window". The **oversample output window** is always offset relative to the current sample address. An **OutputCopyError** is triggered if an attempt is made to write to an address that is outside of this window.



9.16.8.11.9.4 Configuration of the output control buffer

Name:

CfO_OversampleMode

"Output mode" in the Automation Studio I/O configuration

"Output control mode" in the Automation Studio I/O configuration

The output control buffer can be configured globally for all channels in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---|-------|---|
| 0 | Addressing the output control buffer "Output mode" | 0 | Absolute addressing of the output control buffer |
| | | 1 | Relative addressing of the output control buffer |
| 1 | Cyclic output control "Output control mode" | 0 | Single - Output control buffer entry is marked invalid after execution. |
| | | 1 | Continuous - Output control buffer entry is not changed. |
| 2 - 7 | Reserved | - | |

Cyclic output control

If cyclic output control is enabled, then all data in the output control buffer is marked invalid as soon as it is output ("Output control mode = Single"). An [OutputControlError](#) is generated if the module does not receive data in time, thereby causing a situation in which a bit that has already been output would be output in the buffer again. In this type of error situation, the output takes on the "Output default state" configured in register "[CfO_OversampleConfigOutput](#)" on page 2077.

If cyclic output control is disabled, then the data is output again if the output control buffer overflows ("Output control mode = Continuous").

Information:

All 256 bits of the output control buffer are always output.

9.16.8.11.9.5 Configuration of the source for the sample cycle

Name:

CfO_OversampleSampleCycleID

"Sample cycle" in the Automation Studio I/O configuration.

The source for the sample cycle is configured in this register. During each sample cycle, one bit from the output control buffers of the oversampled I/O channels is output to the configured physical output, and the status of the configured inputs is read into one bit of the respective input status buffer.

| Data type | Values | Information |
|-----------|--------|---|
| USINT | 2 | System timer The value set in register " CfO_SystemCycleTime " on page 2068 is used as the sample cycle. |
| | 3 | Prescaled system timer The "prescaled system timer" is used as sample cycle. |
| | 10 | AOAI The sample cycle is clocked with the AOAI interrupt of the X2X cycle. |
| | 14 | SOSI The sample cycle is clocked with the SOSI interrupt of the X2X cycle. |

9.16.8.11.9.6 Configuration of the source for the user interface reference cycle

Name:

CfO_OversampleRelativeCycleID

"Reference cycle" in the Automation Studio I/O configuration.

The source for the user interface reference cycle is configured in this register.

- The input data is referenced at the moment of the reference cycle. The referenced data is then copied to the "oversample input sample register" on page 2079 at the moment of SI frame generation, taking into account the oversample input window.
- With relative addressing of the output control buffer, the new sample data is copied to an address relative to the output control buffer address current to the "reference cycle".
- The reference cycle is also used to reference the sample cycle and thus the output data production and input data acquisition (e.g. to the X2X cycle).

| Data type | Values | Information |
|-----------|--------|--|
| USINT | 2 | System timer The value set in register "CfO_SystemCycleTime" on page 2068 is used as the reference cycle. |
| | 3 | Prescaled system timer The prescaled system timer is used as sample cycle. |
| | 10 | AOAI The sample cycle is referenced with the AOAI interrupt of the X2X cycle. |
| | 14 | SOSI The sample cycle is referenced with the SOSI interrupt of the X2X cycle. |

9.16.8.11.9.7 Defining the moment for copying the data to the output control buffer

Name:

CfO_OversampleConsumeCycleID

"Output copy cycle" in the Automation Studio I/O configuration.

At the time of the output copy cycle, data is copied from the "OversampleOutput0NSample" on page 2078 registers into the output control buffer.

When "Output copy cycle = Fast reaction", it is not possible to determine when the data is copied to the output control buffer in either of the two addressing modes. The copy cycles will experience a certain degree of jitter depending on the module load. However, this only affects the moment of the internal copy procedures and therefore the moment of the earliest possible output sample. This will not affect the quality of the output signal. However, "Output copy cycle = Fast reaction" also has a negative effect on the minimum X2X cycle time.

When using the setting "Output copy cycle = X2X cycle optimized", be aware that the sample data cannot start being output immediately at the "Output copy cycle" time due to the internal copy cycle to the output control buffers.

| Data type | Values | Information |
|-----------|--------|---|
| USINT | 10 | X2X cycle optimized The output data is copied to the output control buffer with the AOAI interrupt of the X2X cycle. |
| | 15 | Fast reaction The output data is copied to the output control buffer immediately after being received. |

9.16.8.11.9.8 Number of output bits to be transferred

Name:

CfO_OversampleOutputBits

"User interface size" in the Automation Studio I/O configuration.

Specifies how many bits are transferred from the "OversampleOutput0NSample" on page 2078 registers to the output control buffers at the output copy cycle moment.

| Data type | Values | Information |
|-----------|---------|-------------|
| USINT | 1 to 64 | Output bits |

9.16.8.11.9.9 Number of input bits to be transferred

Name:

CfO_OversampleInputBits

"User interface size" in the Automation Studio I/O configuration.

Specifies how many bits are transferred from the input status buffer to the "OversampleInput0NSample" on page 2079 registers during SI frame generation.

| Data type | Values | Information |
|-----------|---------|-------------|
| USINT | 1 to 64 | Input bits |

9.16.8.11.9.10 Write area in the output control buffer

Name:

CfO_OversampleOutputWindow

"Output control mode" in the Automation Studio I/O configuration.

Defines the area in the output control buffer to which data is permitted to be written. The window is always offset relative to the current sample position. (a value of 128, for example, means that the 128 bits following the current sample cycle can be written to). An [OutputCopyError](#) is triggered if an attempt is made to write output sample data to a location outside of this window.

In Automation Studio, the value for this register is set to 128 bits with "Output control mode = Single" and to 255 bits with "Output control mode = Continuous".

| Data type | Values | Information |
|-----------|----------|---------------|
| USINT | 0 to 255 | Output window |

9.16.8.11.9.11 Defining the moment for referencing input data

Name:

CfO_OversampleInputWindow

"Input mode" in the Automation Studio I/O configuration.

The "oversample input window" defines when the input data is referenced. It is located chronologically before [SI frame generation](#). If the reference moment ("reference cycle" on page 2075) is within this window, then the referenced data from the input status buffer is copied to register "OversampleInput0NSample" on page 2079. If the moment at which the reference occurs is outside the "oversample input window" then the data that is most recent at the moment of "SI frame generation" is copied from the input status buffer to register "OversampleInput0NSample" on page 2079.

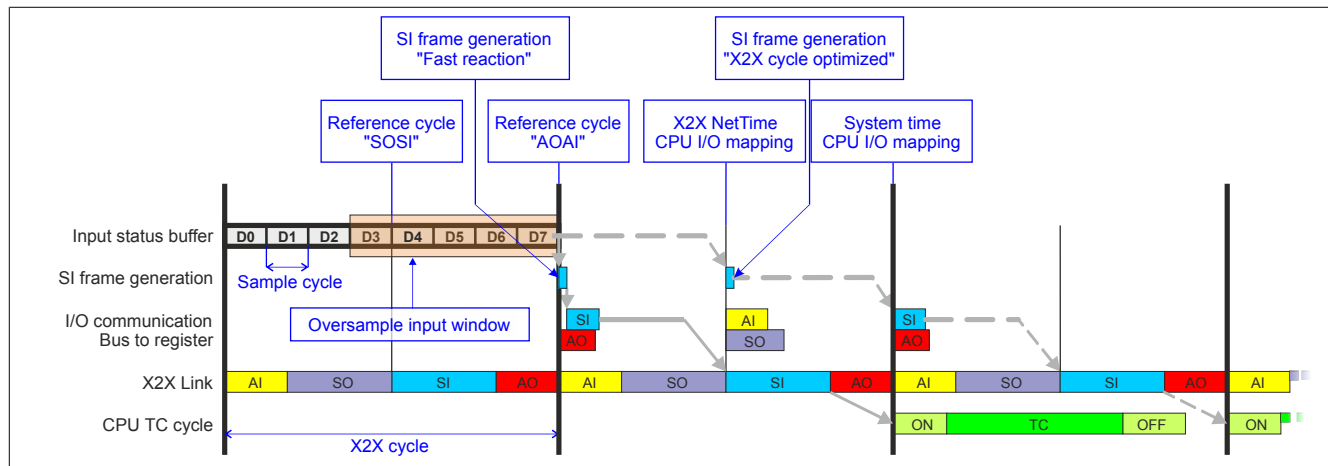
This register is limited internally to the value from register "CfO_OversampleInputBits" on page 2075.

Information:

As a result, the [oversample input time](#) and [oversample input cycle](#) are set either at the reference time or at the moment of "SI frame generation".

In Automation Studio, the value for this register is set to 63 with "Input mode = Referenced values" and to 0 with "Input mode = Most recent values".

| Data type | Values | Information |
|-----------|---------|--------------|
| USINT | 0 to 63 | Input window |



9.16.8.11.9.12 Assigning between the physical input channel and oversample I/O input

Name:

CfO_OversampleConfigInput

"Oversample I/O 01 → Input" to "Oversample I/O 04 input" in the Automation Studio I/O configuration.

Which physical input channel an oversample I/O input should be linked to is defined in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------------------|-------|-----------------|
| 0 - 3 | Number of the physical input channel | 0 | Input channel 1 |
| | | .. | |
| | | 7 | Input channel 8 |
| 4 - 7 | Reserved | - | |

9.16.8.11.9.13 Configuring the outputs of the oversampling channels

Name:

CfO_OversampleConfigOutput

"Oversample I/O 01 → Output" to "Oversample I/O 04 → Output" in the Automation Studio I/O configuration

"Oversample I/O 01 → Output control" to "Oversample I/O 04 → Output control" in the Automation Studio I/O configuration

"Oversample I/O 01 → Output default value" to "Oversample I/O 04 → Output default value" in the Automation Studio I/O configuration

This register helps configure the outputs of the individual oversample channels.

The "Output default state" bits define which level the respective output takes on before oversampling is started. In addition, the output is set to the defined "Output default state" in the event of an error.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---|-------|---|
| 0 - 3 | Number of the physical output channel "Oversample I/O 0x → Output" | 2 | Output channel 3 |
| | | 3 | Output channel 4 |
| | | 6 | Output channel 7 |
| | | 7 | Output channel 8 |
| 4 | Output: Clear "Oversample I/O 0x → Output control" | 0 | Output cannot be reset by the oversample channel. |
| | | 1 | Output can be reset by the oversample channel. |
| 5 | Output: Set "Oversample I/O 0x → Output control" | 0 | Output cannot be set by the oversample channel. |
| | | 1 | Output can be set by the oversample channel. |
| 6 | Default output state: Clear "Oversample I/O 0x → Output default value" | 0 | Output not cleared by default |
| | | 1 | Output cleared by default |
| 7 | Default output state: Set "Oversample I/O 0x → Output default value" | 0 | Output not set by default |
| | | 1 | Output set by default |

9.16.8.11.9.14 Oversampling configuration

Name:

OversampleEnable

OversampleOutputValidate

The oversampling and copy process for the output buffer can be configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------|-------|--|
| 0 | OversampleEnable | 0 | Disables oversampling (with the next reference cycle) |
| | | 1 | Enables oversampling (with the next reference cycle) |
| 1 | OversampleOutputValidate | 0 | Disable the copy procedure to the output control buffer. |
| | | 1 | Enables the copy procedure to the output control buffer. <ul style="list-style-type: none"> Used to synchronize the oversampling procedure at startup. This makes it possible to prevent new data from being transferred to the "OversampleOutput0NSample" on page 2078 registers in each X2X cycle. |
| 2 - 7 | Reserved | - | |

9.16.8.11.9.15 Address of the new output sampling data in the output control buffer

Name:

OversampleOutputCycle

When absolute addressing of the output control buffer is being used, this register specifies the address from which the new output sample data should be copied to the output control buffer.

| Data type | Values | Information |
|-----------|----------|--------------------------------------|
| USINT | 0 to 255 | Address of the output control buffer |

9.16.8.11.9.16 Offset of new output sample data

Name:

OversampleSampleOffset

When relative addressing of the output control buffer is being used, this register serves as the offset for the new output sample data. (Sample address at the time of the [reference cycle](#) + Offset = Address to which the new output sample data is copied in the output control buffer).

| Data type | Values | Information |
|-----------|----------|------------------------------|
| USINT | 0 to 255 | Offset of output sample data |

9.16.8.11.9.17 Oversample output sample data

Name:

OversampleOutput01Sample1_8 to OversampleOutput04Sample1_8
 OversampleOutput01Sample9_16 to OversampleOutput04Sample9_16
 OversampleOutput01Sample17_24 to OversampleOutput04Sample17_24
 OversampleOutput01Sample25_32 to OversampleOutput04Sample25_32
 OversampleOutput01Sample33_40 to OversampleOutput04Sample33_40
 OversampleOutput01Sample41_48 to OversampleOutput04Sample41_48
 OversampleOutput01Sample49_56 to OversampleOutput04Sample49_56
 OversampleOutput01Sample57_64 to OversampleOutput04Sample57_64

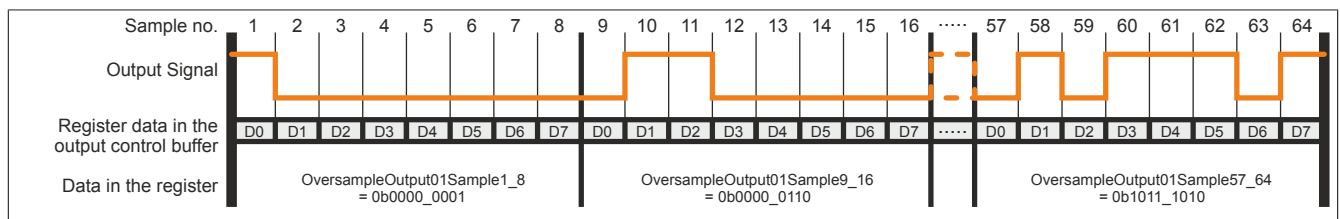
Contains the oversample output sample data. Up to 64 samples (8 bytes) for each oversample I/O channel can be synchronously transferred with a X2X cycle. This data is copied to the specified address (absolute or relative) in the output control buffer at the set [output copy cycle](#). 1 bit of this data is then output during each "sample cycle" to the physical output that is assigned to the oversample I/O channel.

Bit 0 of "OversampleOutputSample8_1" is copied to the output control buffer first, meaning that it is the first bit that is output. "OversampleOutputSample64_57" bit 7 is the last bit to be output.

| Data type | Values | Information |
|-----------|----------|--------------------|
| USINT | 0 to 255 | Output sample data |

Example

Assignment of "OversampleOutputSample" register data to output signal

**9.16.8.11.9.18 X2X NetTime of the input data**

Name:

OversampleInputTime

This register contains the 2 low-order bytes of the X2X NetTime from the moment at which the oversample input data was referenced. This provides an easy way to accurately calculate the moment of each individual input sample.

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

| Data type | Values | Information |
|-----------|-----------------|---|
| INT | -32768 to 32767 | X2X NetTime of the input data in microseconds |

9.16.8.11.9.19 Input status buffer address of the input sample data

Name:

OversampleInputCycle

This register contains the input status buffer address of the input sample data.

In addition, the value in this register can be used to reference an absolute addressing of the output control buffer.

| Data type | Values | Information |
|-----------|----------|-----------------------------|
| USINT | 0 to 255 | Input status buffer address |

9.16.8.11.9.20 Input sample data

Name:

OversampleInput01Sample8_1 to OversampleInput04Sample8_1

OversampleInput01Sample16_9 to OversampleInput04Sample16_9

OversampleInput01Sample24_17 to OversampleInput04Sample24_17

OversampleInput01Sample32_25 to OversampleInput04Sample32_25

OversampleInput01Sample40_33 to OversampleInput04Sample40_33

OversampleInput01Sample48_41 to OversampleInput04Sample48_41

OversampleInput01Sample56_49 to OversampleInput04Sample56_49

OversampleInput01Sample64_57 to OversampleInput04Sample64_57

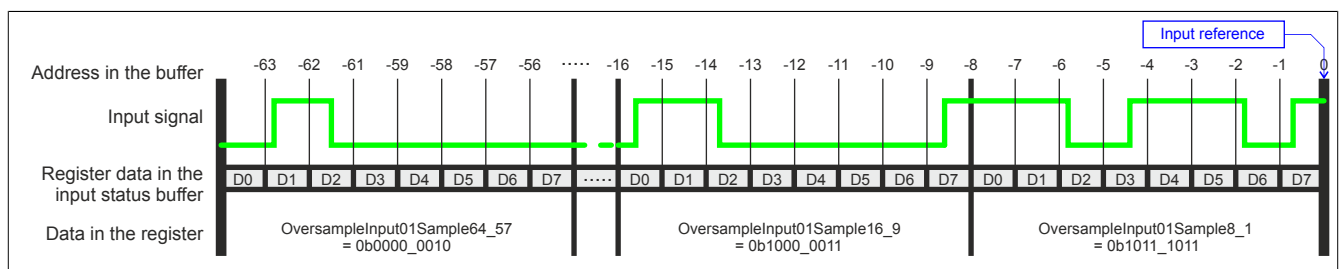
The data of the 4 oversample input status buffers are copied to this register at the moment of **SI frame generation**. A maximum of 64 samples (8 bytes) per oversample I/O channel can be synchronously retrieved from the oversample input status buffer with each X2X cycle.

The most recent input sample bit is stored in "OversampleInputSample8_1" bit 7. The oldest input sample is stored in "OversampleInputSample64_57" bit 0.

| Data type | Values | Information |
|-----------|----------|-------------------|
| USINT | 0 to 255 | Input sample data |

Example

Input signal and resulting data in "OversampleInputSample"



9.16.8.11.10 Edge detection

The module's edge detection function allows edges to be measured with microsecond precision. The concept is based on a maximum of 4 units. One master and one slave edge can be configured for each unit.

At the moment of each master edge, the **NetTime** of the master edge and the **NetTime** of a previous slave edge (if present) are logged. A "master counter" and a "slave counter" can always be used to determine how many edges have been detected since the last X2X cycle.

The module has a history for the timestamp and counters, which can store up to 4 elements per unit. This makes it possible to measure multiple edges precisely within a single X2X cycle.

9.16.8.11.10.1 Configuring the source for the polling cycle

Name:

CfO_EdgeDetectPollCycleID

"Polling cycle" in the Automation Studio I/O configuration.

The source for the polling cycle can be configured in this register.

Information:**The polling cycle must be $\leq 255 \mu\text{s}$. If the configured cycle $> 255 \mu\text{s}$, **EdgeDetectError** occurs.**

| Data type | Values | Information |
|-----------|--------|---|
| USINT | 2 | System timer The time set in register "CfO_SystemCycleTime" on page 2068 is used for the polling cycle. |
| | 3 | Prescaled system timer The time set in register "CfO_SystemCyclePrescaler" on page 2069 is used for the polling cycle. |

9.16.8.11.10.2 Edge detection mode

Name:

CfO_EdgeDetectEventEnable

"Edge detection mode" in the Automation Studio I/O configuration.

The bits in this register define on which edges of the individual input channels an interrupt should be triggered for edge detection.

In mode "Event-triggered", the **NetTime** of each edge is recorded immediately as interrupt. However, an extremely large amount of interrupts within a short amount of time can prevent the module from being able to process any other operations in time!In mode "Polling", only the **NetTime** of the first edge that occurs within a polling cycle is recorded. This ensures that the module is not overloaded by too many edges.

In the Automation Studio I/O configuration, this register is initialized with 0x00000000 when "Edge detection mode = Polling" and with 0xFFFFFFFF when "Edge detection mode = Event-triggered".

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|------------------|-------|--|
| 0 | Physical input 1 | 0 | No interrupt triggered on falling edge |
| | | 1 | Interrupt triggered on falling edge |
| ... | | ... | |
| 7 | Physical input 8 | 0 | No interrupt triggered on falling edge |
| | | 1 | Interrupt triggered on falling edge |
| 8 - 15 | Reserved | - | |
| 16 | Physical input 1 | 0 | No interrupt triggered on rising edge |
| | | 1 | Interrupt triggered on rising edge |
| ... | | ... | |
| 23 | Physical input 8 | 0 | No interrupt triggered on rising edge |
| | | 1 | Interrupt triggered on rising edge |
| 24 - 31 | Reserved | - | |

9.16.8.11.10.3 Setting the time base, slave edge and master edge

Name:

CfO_EdgeDetectUnit01Mode to CfO_EdgeDetectUnit04Mode

"Time base" in the Automation Studio I/O configuration

"Slave edge" in the Automation Studio I/O configuration

"Master edge" in the Automation Studio I/O configuration

When using a time base with 1/8 μ s resolution, keep in mind that the timestamps produced also have a resolution of exactly 1/8 μ s. The respective conversions must be made for calculating in combination with the CPU system time or X2X NetTime.

In addition, synchronization jitter also plays a role when using "Time base = Nettime resolution 1/8 usec" (see "Synchronization jitter" on page 2064). This means that exactly identical input edges can cause slight differences in the results. If 100% exact 1/8 μ s resolution is required, then "Local resolution 1/8 usec" must be used.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|---|
| 0 - 1 | "Time base" | 0 | Local time 1/8 μ s (Automation Studio: Local resolution 1/8 usec) |
| | | 1 | Local time 1 μ s (Automation Studio: Local resolution 1 usec) |
| | | 2 | NetTime 1/8 μ s (Automation Studio: Nettime resolution 1/8 usec) |
| | | 3 | NetTime 1 μ s (Automation Studio: Nettime resolution 1 usec) |
| 2 - 5 | Reserved | - | |
| 6 | "Slave edge" | 0 | Disabled |
| | | 1 | Enabled |
| 7 | "Master edge" | 0 | Disabled |
| | | 1 | Enabled |

9.16.8.11.10.4 "CfO_EdgeDetectUnitLeading" register

Name:

CfO_EdgeDetectUnit01Leading to CfO_EdgeDetectUnit04Leading

"Slave leading" in the Automation Studio I/O configuration.

When a slave edge occurs, the current NetTime is always saved within the module. A FIFO buffer is provided inside the module that always stores the last 16 slave stamps (even when a master edge occurs).

This value determines from which position the slave time should be retrieved from the FIFO when a master edge occurs. This can be used to measure average periodic signals over multiple cycles.

| Data type | Value | Information |
|-----------|---------|---------------------------------|
| USINT | 0 to 15 | Position in the slave edge FIFO |

9.16.8.11.10.5 Source of the master edge per edge detection unit

Name:

CfO_EdgeDetectUnit01Master to CfO_EdgeDetectUnit04Master

"Master edge" in the Automation Studio I/O configuration.

The source of the master edge for the respective "edge detection unit" is defined in this register.

| Data type | Values | Information |
|-----------|--------|----------------------------------|
| USINT | 0 | Rising edge on physical input 1 |
| | ... | ... |
| | 7 | Rising edge on physical input 8 |
| | 16 | Falling edge on physical input 1 |
| | ... | ... |
| | 23 | Falling edge on physical input 8 |

9.16.8.11.10.6 Source of the slave edge per edge detection unit

Name:

CfO_EdgeDetectUnit01Slave to CfO_EdgeDetectUnit04Slave

"Slave edge" in the Automation Studio I/O configuration.

The source of the slave edge for the respective "edge detection unit" is defined in this register.

| Data type | Values | Information |
|-----------|--------|----------------------------------|
| USINT | 0 | Rising edge on physical input 1 |
| | ... | ... |
| | 7 | Rising edge on physical input 8 |
| | 16 | Falling edge on physical input 1 |
| | ... | ... |
| | 23 | Falling edge on physical input 8 |

9.16.8.11.10.7 "EdgeDetectSlavecount" register

Name:

EdgeDetect01Slavecount to EdgeDetect04Slavecount

The reference pulses of the detected slave edges are counted continuously in this register. The contents of this register are only updated when a master edge occurs. Up to 4 history elements can be enabled for these counters in the Automation Studio I/O configuration. These counters can detect if multiple slave edges occur before a master edge.

| Data type | Value | Information |
|-----------|-------------------|---|
| SINT | -128 to 127 | Number of detected slave edges (8-bit) |
| INT | -32,768 to 32,767 | Number of detected slave edges (16-bit) |

9.16.8.11.10.8 "EdgeDetectDifference" register

Name:

EdgeDetect01Difference to EdgeDetect04Difference

Contains the time difference between a master edge and the last slave edge addressed via "Slave leading".

| Data type | Value | Information |
|-----------|---------------------------------|--|
| INT | -32,768 to 32,767 | Time difference between master/slave edge (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | Time difference between master/slave edge (32-bit) |

9.16.8.11.10.9 Number of detected master edges

Name:

EdgeDetect01Mastercount to EdgeDetect04Mastercount

Detected master edges are counted in this register.

| Data type | Values | Information |
|-----------|-----------------|--|
| SINT | -128 to 127 | Number of detected master edges (8-bit) |
| INT | -32768 to 32767 | Number of detected master edges (16-bit) |

9.16.8.11.10.10 NetTime when a master edge occurs

Name:

EdgeDetect01Mastertime to EdgeDetect04Mastertime

The exact NetTime is copied to this register when a master edge occurs.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Values | Information |
|-----------|---------------------------------|--|
| INT | -32768 to 32767 | NetTime master edge in microseconds (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime master edge in microseconds (32-bit) |

9.16.8.11.10.11 "EdgeDetectSlavetime" register

Name:

EdgeDetect01Slavetime to EdgeDetect04Slavetime

In dieses Register wird beim Auftreten einer Masterflanke die exakte NetTime einer eventuell vorher aufgetretenen und durch "Slavevorlauf" adressierten, Slaveflanke kopiert. Pro Masterflanke kann nur eine Slavetime aus dem "Slavevorlauf FIFO" geholt werden. Das Auftreten mehrerer Flanken vor einer Masterflanke kann also nur durch den "EdgeDetectSlavecount" festgestellt werden.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Values | Information |
|-----------|------------------------------------|--|
| INT | -32768 to 32767 | NetTime slave edge in μs (16-bit) |
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime slave edge in μs (32-bit) |

History:

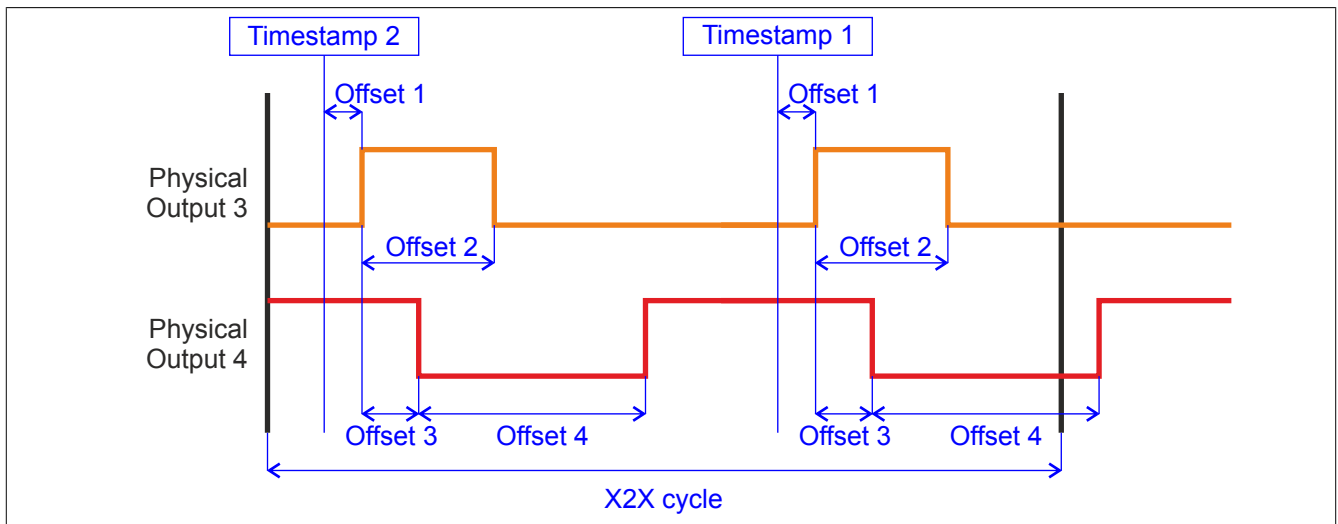
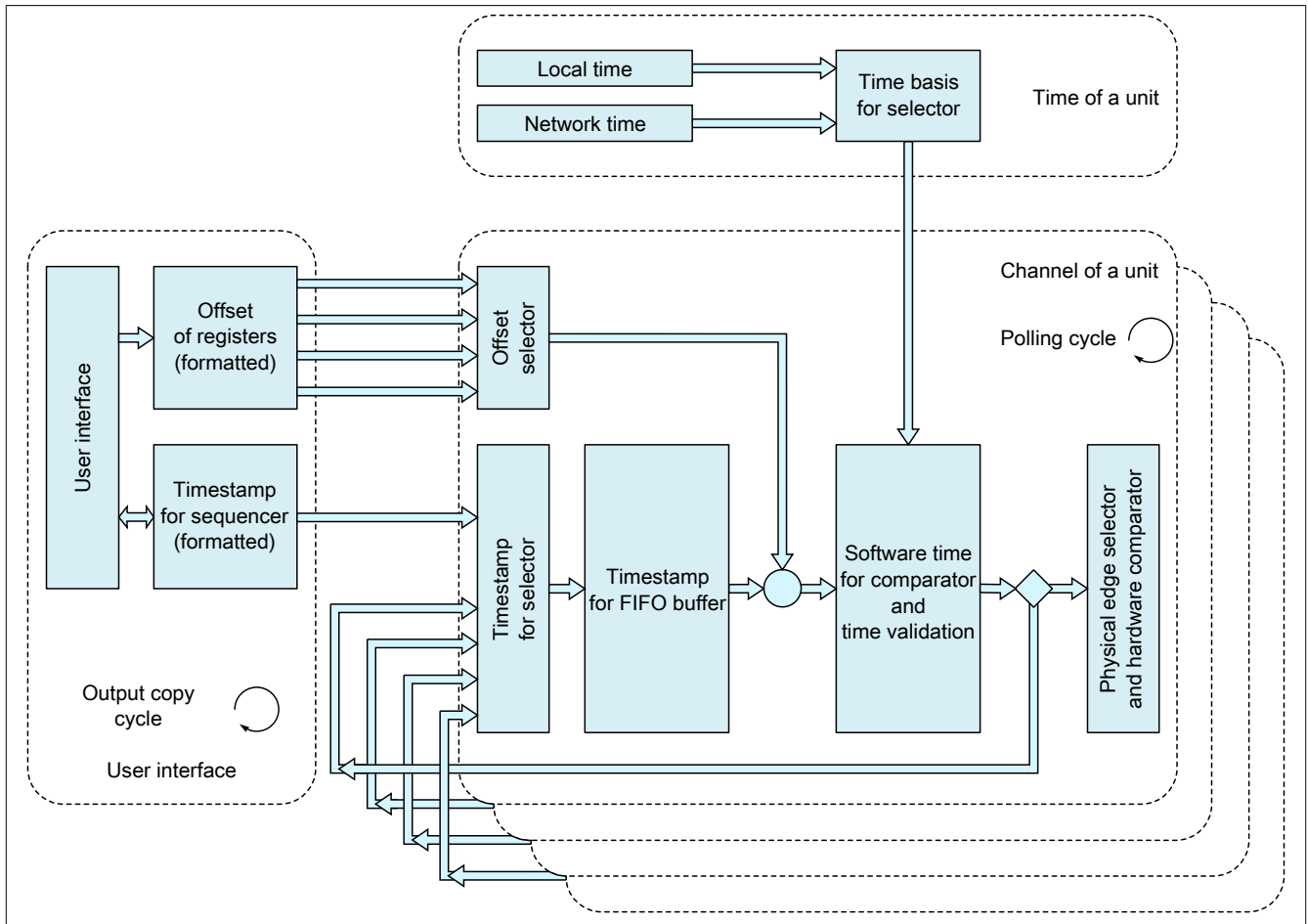
In Automation Studio, a history of up to 4 elements can be enabled in the I/O configuration for the following registers: "[EdgeDetectSlavecount](#)" on page 2082, "[EdgeDetectDifference](#)" on page 2082, "[EdgeDetectMastertime](#)" on page 2082 and "[EdgeDetectSlavetime](#)" on page 2083. Configured history elements are all transferred synchronously with each X2X cycle. This makes it possible to measure multiple edges precisely within a single X2X cycle.

Information:

When the history is enabled, the maximum number of data bytes (28 bytes) that can be transferred synchronously via the X2X Link is reached quickly (especially if 32-bit data points are used).

9.16.8.11.11 Edge generator

The edge generator is based on 4 units. The units are able to generate edges independently of the X2X cycle. For each unit, up to 4 timestamps can be set per X2X cycle. The individual edges can then be referenced to this timestamp or to other edges using an offset.



9.16.8.11.11.1 Mode "DigitalCamSwitch"

"Unit 0x" in Automation Studio I/O configuration.

Starting with upgrade 1.1.0.2, "DigitalCamSwitch" mode can also be selected for each unit when configuring the edge generator in Automation Studio.

In this mode, the entire configuration and operation take place exclusively with the function blocks from the "ASM-cDcs" motion library. For more information, see the corresponding ASM-cDcs function block descriptions.

9.16.8.11.11.2 Preparing data for edge generation by hardware comparators

Name:

CfO_EdgeGenPollCycleEventID

"Generation cycle" in the Automation Studio I/O configuration.

To ensure edge output with μs precision, edge generation is based on internal hardware components. One such comparator is available for one rising and one falling edge respectively for each physical output channel. The data for the comparators is prepared in "EdgeGenPollCycle". Therefore, a maximum of one rising and one falling edge can be generated for each physical output channel per "EdgeGenPollCycle". If **timestamps** are set that cannot be processed in time due to this limitation, then an **EdgeGenWarning** is generated. Processing of such timestamps is made up for as quickly as possible, as long as they are within **EdgeGenUnitPickupDiff**.

A shorter "Generation cycle" means that an enabled edge generator function has a less negative effect on the minimum X2X cycle time.

| Data type | Value | Information |
|-----------|-------|------------------------|
| USINT | 2 | System timer |
| | 3 | Prescaled system timer |

9.16.8.11.11.3 Moment when output data is applied for edge generation

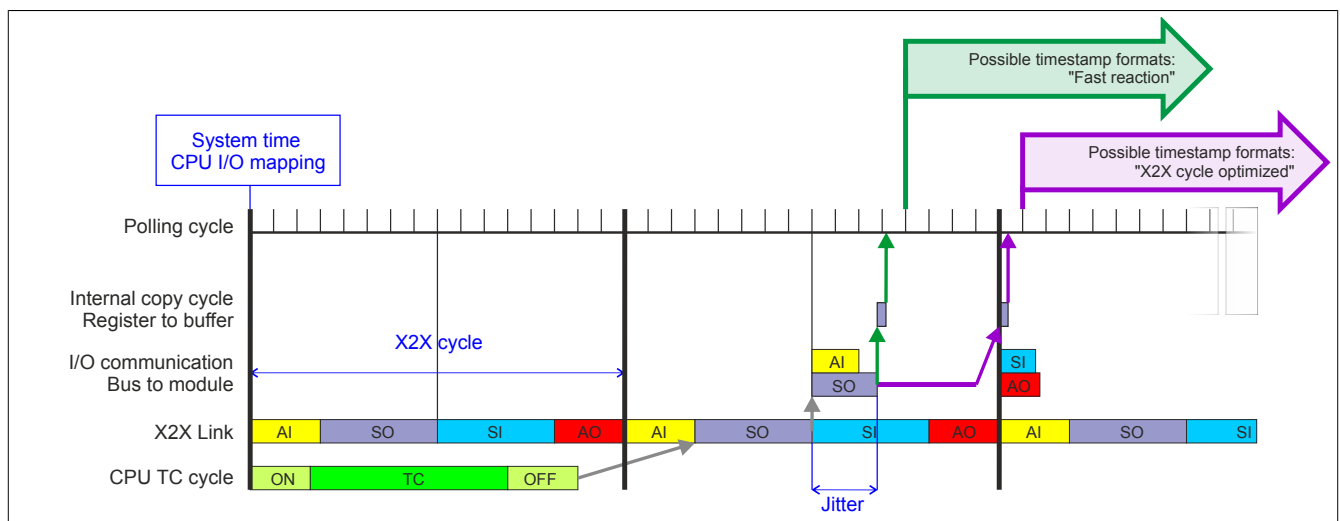
Name:

CfO_EdgeGenConsumeCycleEventID

This register determines when the output data for edge generation is applied within the X2X cycle.

| Data type | Value | Information |
|-----------|-------|--|
| USINT | 10 | "X2X cycle optimized" The data is force-applied between the periods ASYNC IN (AI) and ASYNC OUT (AO). |
| | 15 | "Fast reaction (with jitter)" The data is applied immediately after SYNC OUT (SO) processing. |

Setting "Fast reaction" results in jitter because the copy cycle of the SYNC OUT data can take different amounts of time. However, this only affects the moment at which the internal copy cycle takes place and therefore possibly also the earliest possible timestamp. **Timestamps** that are set outside of this jitter range are not affected by this.



9.16.8.11.11.4 Configuration of units

Name:

CfO_EdgeGenUnit01Mode to CfO_EdgeGenUnit04Mode

"Time base" in the Automation Studio I/O configuration

"Timestamp format" in the Automation Studio I/O configuration

"Offset format" in the Automation Studio I/O configuration

"Unit 01" to "Unit 04" in the Automation Studio I/O configuration

These registers contain the configuration bits for the respective units.

If "Timestamp resolution = 1/8 μ s" is used, it is important to ensure that the timestamp data also has a resolution of 1/8 μ s. Because the CPU system time and the X2X NetTime only have μ s resolution, the system time or the NetTime must be offset by 3 bits to the left or multiplied by 8 in the application. This value can then be used as reference for timestamps with a resolution of 1/8 μ s. It is also possible to use 1/8 μ s timestamps from input edges as a reference.

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

When using the NetTime with 1/8 μ s resolution, the synchronization jitter affects the output results (see ["Synchronization jitter" on page 2064](#)).

Because the local time is not synchronized with the CPU system time or the X2X NetTime, this can only be used effectively together with a time source from the module (e.g. input edge timestamp on "local time").

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|-------------|
| 0 | Resolution of the timestamp | 0 | 1 μ s |
| | "Time base" in the Automation Studio I/O configuration. | 1 | 1/8 μ s |
| 1 | Number of bits in the timestamp register | 0 | 16-bit |
| | "Timestamp format" in the Automation Studio I/O configuration. | 1 | 32-bit |
| 2 | Offset resolution | 0 | 1 μ s |
| | "Time base" in the Automation Studio I/O configuration. | 1 | 1/8 μ s |
| 3 | Number of bits in the offset register | 0 | 16-bit |
| | "Offset format" in the Automation Studio I/O configuration. | 1 | 32-bit |
| 4 | Time base | 0 | NetTime |
| | "Time base" in the Automation Studio I/O configuration. | 1 | Local time |
| 5 - 6 | Reserved | - | |
| 7 | Enable/disable units | 0 | Disabled |
| | "Unit 0x" in the Automation Studio I/O configuration. | 1 | Enabled |

9.16.8.11.11.5 Number of timestamps for FIFO

Name:

CfO_EdgeGenUnit01TimestampFifoLim to CfO_EdgeGenUnit04TimestampFifoLim

These registers define how many timestamps can be transferred to the FIFO buffer of a unit. The FIFO buffer serves as a memory buffer for timestamps in the future. Timestamps must be entered in the FIFO buffer in the same order in which they should be output. This means it is not possible to set a timestamp in the future followed by an earlier timestamp. The ["EdgeGenSequenceReadback" on page 2089](#) register can be used to indicate if the defined limit has been reached.

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

| Data type | Value | Information |
|-----------|---------|-------------|
| USINT | 1 to 12 | FIFO limit |

9.16.8.11.11.6 Number of timestamps per X2X cycle

Name:

CfO_EdgeGenUnit01TimestampRegCount to CfO_EdgeGenUnit04TimestampRegCount
"Timestamp elements" in the Automation Studio I/O configuration.

This register determines how many timestamps can be transferred per X2X cycle.

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

| Data type | Value | Information |
|-----------|--------|------------------------------------|
| USINT | 1 to 4 | Number of timestamps per X2X cycle |

9.16.8.11.11.7 Pickup difference to be regained for timestamps

Name:

CfO_EdgeGenUnit01PickupDiff to CfO_EdgeGenUnit04PickupDiff

These registers determine how far in the past timestamps can be so that they can still be picked up. Timestamps in the past are processed as quickly as possible as long as they fall within the pickup difference specified in this register. [EdgeGenWarning](#) is triggered if a timestamp was not able to be processed in time and its difference had to be regained. If a timestamp could not be picked up because it was outside the pickup difference window, then both "EdgeGenWarning" and "EdgeGenError" are reported.

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

In Automation Studio, if "Timestamp format = 16-bit" this register is initialized with 65535 (0xFFFF), and if "Timestamp format = 32-bit" it is initialized with 134,217,728 (0x8000000).

| Data type | Value | Information |
|-----------|------------------|--|
| UDINT | 0 to 65535 | Difference to be regained in μ s when "Offset format = 16-bit" |
| | 0 to 134,217,728 | Difference to be regained in μ s when "Offset format = 32-bit" |

9.16.8.11.11.8 "CfO_EdgeGenUnitConfigEdge" register

Name:

CfO_EdgeGenUnit01ConfigEdge to CfO_EdgeGenUnit04ConfigEdge

"Unit 01→ Edge" to "Unit 04→ Edge" in the Automation Studio I/O configuration.

"Unit 01→ Mode" to "Unit 04→ Mode" in the Automation Studio I/O configuration.

"Unit 01→ Offset" to "Unit 04→ Offset" in the Automation Studio I/O configuration.

"Unit 01→ Unit 01" to "Unit 04→ Unit 04" in the Automation Studio I/O configuration.

The properties of each of the 4 edges of a unit can be configured in this register.

Ring-shaped chain of edges:

If the individual edges are linked together in a ring shape (e.g. edge 2 is relative to edge 1 and edge 1 is relative to edge 2) then a header must be determined for the ring using bit 11 "ring head enable" bit so that this type of cycle can start without timestamp. In Automation Studio, the "ring head enable" bit (bit 11) is set for edge 1 in all units by default. If this type of ring is branched (e.g. a third edge is relative to an edge within the ring) then you must make sure that the internal FIFO, which is available to every physical I/O edge, does not overflow. This happens if more than 12 edges are created by the ring, but should not be output until much later. If this situation occurs, whereby a ring creates edges even though the FIFO is full, then an [EdgeGenError](#) error is generated.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|---|--------|--------------------------|
| 0 - 4 | Physical edge "Unit 0x →Edge" in the Automation Studio I/O configuration. | 2 | Channel 3 rising edge |
| | | 3 | Channel 4 rising edge |
| | | 6 | Channel 7 rising edge |
| | | 7 | Channel 8 rising edge |
| | | 18 | Channel 3 falling edge |
| | | 19 | Channel 4 falling edge |
| | | 22 | Channel 7 falling edge |
| | | 23 | Channel 8 falling edge |
| 5 - 7 | Reserved | - | |
| 8 - 10 | Timestamp of FIFO source "Unit 0x →Mode" in the Automation Studio I/O configuration. | 0 | User interface, absolute |
| | | 1 to 3 | Reserved |
| | | 4 | Edge 1, relative |
| | | 5 | Edge 2, relative |
| | | 6 | Edge 3, relative |
| | | 7 | Edge 4, relative |
| 11 | Ring-shaped chain Default in Automation Studio for "Edge 01 = 1", "Edge 02 = 0", "Edge 03 = 0", "Edge 04 = 0" | 0 | Disabled |
| | | 1 | Enabled |
| 12 - 13 | Offset register numbers "Unit 0x →Offset" in the Automation Studio I/O configuration. | 0 | Offset register 0 |
| | | | |
| | | 1 | Offset register 1 |
| | | 2 | Offset register 2 |
| 14 | Reserved | - | |
| | | | |
| 15 | Switch edge on/off. "Unit 0x →Unit 0x" in the Automation Studio I/O configuration. | 0 | Disabled |
| | | 1 | Enabled |

9.16.8.11.11.9 Enabling units

Name:

EdgeGen01Enable to EdgeGen04Enable

EdgeGen01EnableReadback to EdgeGen04EnableReadback

"Unit 01" to "Unit 04" in the Automation Studio I/O configuration

The different units of the edge generator can be enabled/disabled using this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------------------|-------|-------------|
| 0 | EdgeGen01Enable | 0 | Disabled |
| | EdgeGen01EnableReadback | 1 | Enabled |
| 1 - 7 | Reserved | - | |

9.16.8.11.11.10 Sequence number for generating switching edges

Name:

EdgeGen01Sequence to EdgeGen04Sequence

If new timestamp data is to be applied to the module, then the sequence number must be increased by the number of timestamp elements that must be applied. If multiple elements are transferred within one X2X cycle, then you must make sure that the individual **timestamps** are placed in the FIFO buffer in the same order in which they occur chronologically. Data from **EdgeGenTimestamp** arrives in the FIFO buffer first; data from "EdgeGenTimestamp1" arrives last.

| Data type | Value | Information |
|-----------|-------------|--|
| SINT | -128 to 127 | Sequence number for generating switching edges |

9.16.8.11.11.11 Last sequence number applied by the module for edge generation.

Name:

EdgeGen01SequenceReadback to EdgeGen04SequenceReadback

The sequence number is read back in this register. Like register "**EdgeGenSequence**" on page 2089, this register is incremented if the specified **timestamps** can also be recorded by the module. If the module is not able to record any new timestamps (e.g. because **EdgeGenUnitTimestampFifoLim** has been reached), then this register indicates the number of the last sequence recorded by the module.

| Data type | Value | Information |
|-----------|-------------|--|
| SINT | -128 to 127 | Last sequence number accepted by the module for edge generation. |

9.16.8.11.11.12 Offset formats

Automation Studio provides 3 different parameters for setting offsets.

- **Offset format:** This parameter allows you to select the file type (16- or 32-bit) for cyclic transfer and only affects "**EdgeGenOffset**" on page 2089 registers.
Acyclic transfer of offset values with register "**CfO_EdgeGenOffset_32bit**" on page 2090 is not affected by this parameter and always remains 32 bits wide.
- **Offset 01 to Offset 04:** This parameter has 2 possible settings:
 - Initial configuration: The offset value is only written once during configuration.
 - Cyclic data: A data point is created in the Automation Studio I/O mapping and the offset value is written cyclically.
- **Offset 01 value to Offset 04 value:** The actual offset value.

"EdgeGenOffset" register

Name:

EdgeGen01Offset1 to EdgeGen04Offset1

...

EdgeGen01Offset4 to EdgeGen04Offset4

"Offset 01 value" to "Offset 04 value" in the Automation Studio I/O configuration

The 4 offsets of an edge generator unit are written in this register. Depending on the configuration in register "**Edge generator unit mode**" on page 2086, the offset values are handled in μs or $1/8 \mu\text{s}$ steps.

For information regarding how to use the register and set the offset formats in Automation Studio, see "**Offset formats**" on page 2089.

| Data type | Value | Information |
|-----------|--------------------|--|
| UINT | 0 to 65535 | 16-bit offset |
| UDINT | 0 to 134217728 | Offset when "Offset format = 32-bit" and "Time base" = 1 μs |
| | 0 to 1,073,741,824 | Offset when "Offset format = 32-bit" and "Time base" = $1/8 \mu\text{s}$ |

"CfO_EdgeGenOffset_32bit" register

Name:

CfO_EdgeGen01Offset_32bit1 to CfO_EdgeGen04Offset_32bit1

...

CfO_EdgeGen01Offset_32bit4 to CfO_EdgeGen04Offset_32bit4

The 4 offsets of an edge generator unit can be written acyclically using these registers. Depending on the configuration in register ["Edge generator unit mode"](#) on page 2086, the offset values are handled in μs or $1/8 \mu\text{s}$ steps.

For information regarding how to use the register and set the offset formats in Automation Studio, see ["Offset formats"](#) on page 2089.

| Data type | Value | Information |
|-----------|--------------------|--|
| UDINT | 0 to 134217728 | Offset when "Offset format = 32-bit" and "Time base" = $1 \mu\text{s}$ |
| | 0 to 1,073,741,824 | Offset when "Offset format = 32-bit" and "Time base" = $1/8 \mu\text{s}$ |

9.16.8.11.11.13 Timestamp registers

Name:

EdgeGen01Timestamp1 to EdgeGen04Timestamp1

...

EdgeGen01Timestamp4 to EdgeGen04Timestamp4

Registers for the timestamps to which edges pending generation are referenced. Up to 4 timestamp elements can be transferred per X2X cycle. Between 1 and 4 of these timestamp elements are placed in the FIFO, depending on how much the sequence number is increased by. If an attempt is made to set timestamps to a time that has already passed, then [EdgeGenWarning](#) is generated (see register ["CfO_EdgeGenUnitPickupDiff"](#) on page 2087).

For more information about NetTime and timestamps, see ["NetTime Technology"](#) on page 3035.

| Data type | Value |
|-----------|---------------------------------|
| INT | -32768 to 32767 |
| DINT | -2,147,483,648 to 2,147,483,647 |

9.16.8.11.12 NetTime Technology

For a description of NetTime Technology, see ["NetTime Technology"](#) on page 3035.

9.16.8.11.13 Minimum X2X cycle time

The minimum X2X cycle time is strongly dependent on the configured functions and the resulting load on the module. Setting "Fast reaction" and a very short system cycle ($<50 \mu\text{s}$) generally have a negative effect on the minimum X2X cycle time. This can result in error behavior with short X2X cycle times.

9.17 Dummy modules

The dummy module is used as a placeholder to prevent configuration errors caused by empty slots.

9.17.1 Summary

| Model number | Short description | Page |
|--------------|---|------|
| X20IF0000 | X20 dummy interface module (non-functional) | 2092 |
| X20ZF0000 | Dummy X20 module (non-functional) | 2094 |
| X20ZF0002 | X20 dummy module (no function), 240 VAC coded | 2096 |
| X20ZF000F | Dummy X20 module (non-functional) | 2098 |

9.17.2 X20IF0000

Data sheet version: 1.03

9.17.2.1 General information

Covers for unused interface module slots are included with X20 CPUs. If an X20 system is used in a maritime environment, then the system will be subjected to increased vibration fatigue. In order to achieve the stability necessary for operation, the X20IF0000 dummy interface module from the X20 series is used instead of the covers.

- Cover for unused interface module slots
- IF dummy modules required if the X20 system is subjected to increased vibration fatigue
- Module with no electrical function

9.17.2.2 Order data


| Model number | Short description | Figure |
|--------------|--|--|
| X20IF0000 | <p>Dummy modules</p> <p>X20 dummy interface module (non-functional)</p> |  |

Table 372: X20IF0000 - Order data

9.17.2.3 Technical data

| | |
|--|--|
| Model number | X20IF0000 |
| Short description | |
| Accessories | Non-functional dummy module |
| General information | |
| Certifications | |
| CE | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta = 0 - Max. 60°C FTZÜ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Slot | In X20 CPU, X20BB3x and X20BB8x |

Table 373: X20IF0000 - Technical data

9.17.3 X20ZF0000

Data sheet version: 2.12

9.17.3.1 General information

The module is used as a place holder for later system expansion.

- Place holder for later system expansion
- Used as a terminal holder
- Module with no electrical function

9.17.3.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Dummy modules |  |
| X20ZF0000 | Dummy X20 module (non-functional) | |
| | Required accessories | |
| | Bus modules | |
| X20BM01 | X20 power supply bus module, 24 VDC keyed, internal I/O supply interrupted to the left | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM01 | X20 power supply bus module, coated, 24 VDC keyed, internal I/O supply interrupted to the left | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 374: X20ZF0000 - Order data

9.17.3.3 Technical data

| Model number | X20ZF0000 |
|--|--|
| Short description | |
| Accessories | Non-functional dummy module |
| General information | |
| Certifications | |
| CE | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta = 0 - Max. 60°C FTZÜ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |

Table 375: X20ZF0000 - Technical data

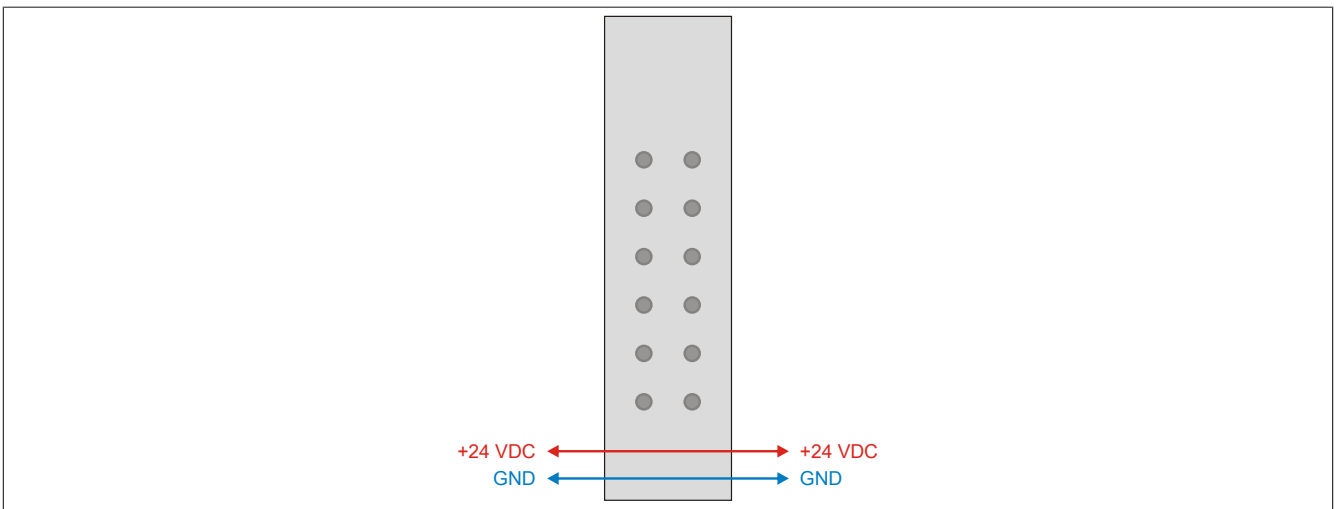
| Model number | X20ZF0000 |
|------------------------------|--|
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB06 or 1x X20TB12 terminal block separately Order 1x X20BM11 bus module or 1x X20BM01 supply bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 375: X20ZF0000 - Technical data

9.17.3.4 Pinout



9.17.3.5 Connection example



9.17.4 X20ZF0002

Data sheet version: 1.0

9.17.4.1 General information

The module is used as a placeholder for later system expansion.

- Placeholder for later system expansion
- Use as terminal carrier
- Module without electrical function
- 240 V encoding

9.17.4.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Dummy modules |  |
| X20ZF0002 | X20 dummy module (no function), 240 VAC coded | |
| | Required accessories | |
| | Bus modules | |
| X20BM12 | X20 bus module, 240 VAC keyed, internal I/O power supply connected through | |
| | Terminal blocks | |
| X20TB32 | X20 terminal block, 12-pin, 240 VAC keyed | |

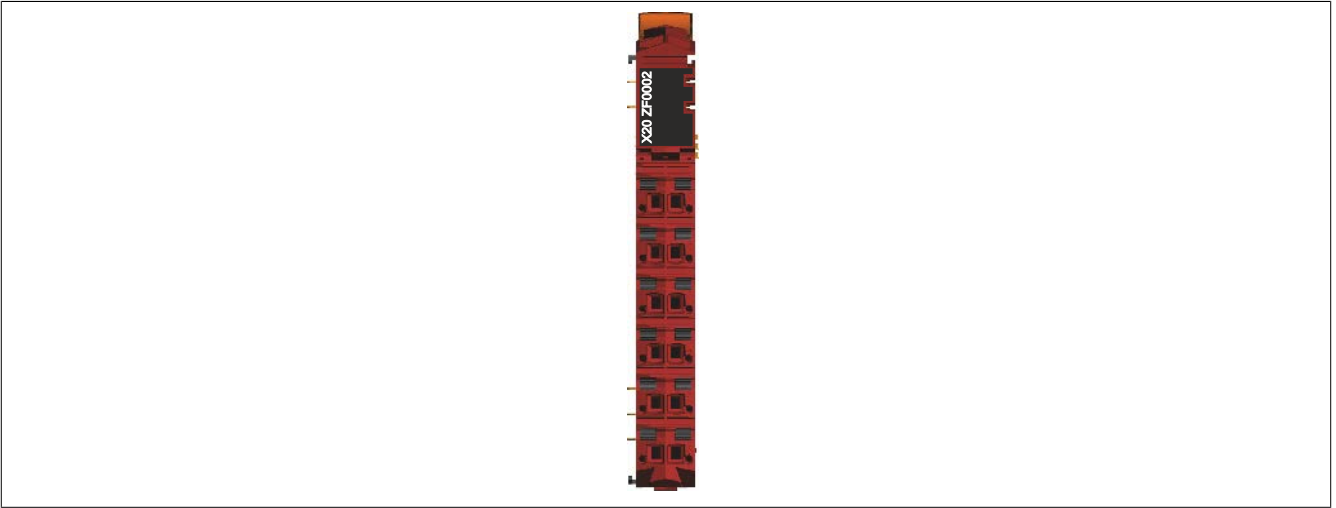
Table 376: X20ZF0002 - Order data

9.17.4.3 Technical data

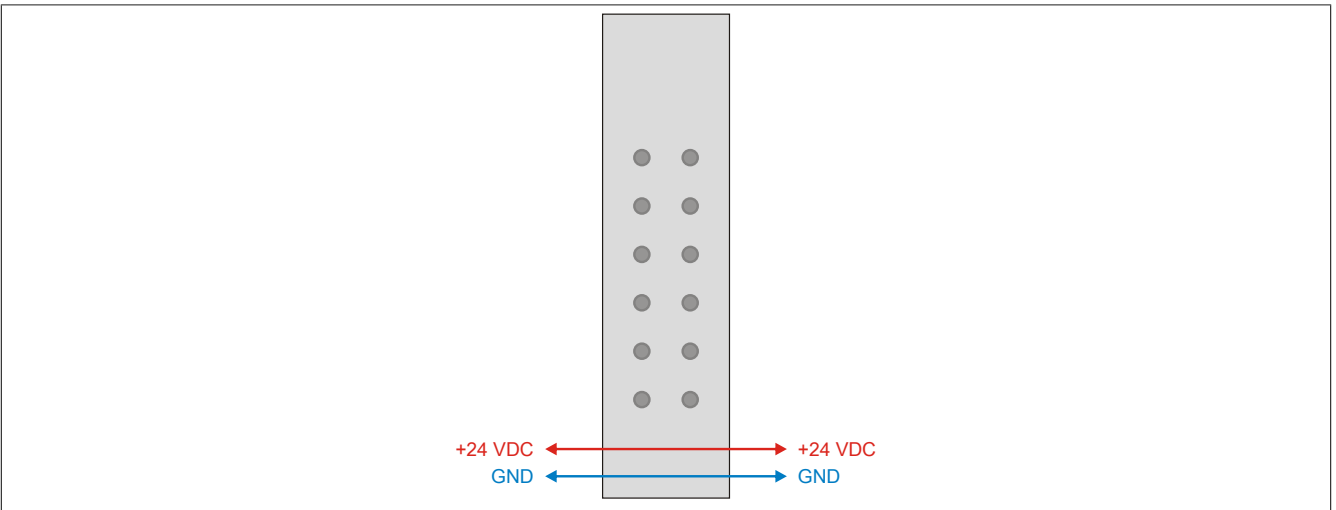
| Model number | X20ZF0002 |
|--|--|
| Short description | |
| Accessories | Dummy module without function |
| General information | |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB32 separately. Order 1x bus module X20BM12 separately. |
| Spacing | 12.5 ^{+0.2} mm |

Table 377: X20ZF0002 - Technical data

9.17.4.4 Pinout



9.17.4.5 Connection example



9.17.5 X20ZF000F

Data sheet version: 1.03

9.17.5.1 General information

The module is used as a placeholder for later system expansion.

- Placeholder for later system expansion
- Used as a terminal holder
- Module with no electrical function

9.17.5.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Dummy modules |  |
| X20ZF000F | Dummy X20 module (non-functional) | |
| | Required accessories | |
| | Bus modules | |
| X20BM01 | X20 power supply bus module, 24 VDC keyed, internal I/O supply interrupted to the left | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM01 | X20 power supply bus module, coated, 24 VDC keyed, internal I/O supply interrupted to the left | |
| | Terminal blocks | |
| X20TB1E | X20 terminal block, 12-pin, 24 VDC keyed, 2x PT1000 integrated for terminal temperature compensation | |
| X20TB1F | X20 terminal block, 16-pin, 24 VDC keyed | |

Table 378: X20ZF000F - Order data

9.17.5.3 Technical data

| Model number | X20ZF000F |
|--|---|
| Short description | |
| Accessories | Non-functional dummy module |
| General information | |
| Certifications | |
| CE | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta = 0 - Max. 60°C FTZÚ 09 ATEX 0083X |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |

Table 379: X20ZF000F - Technical data

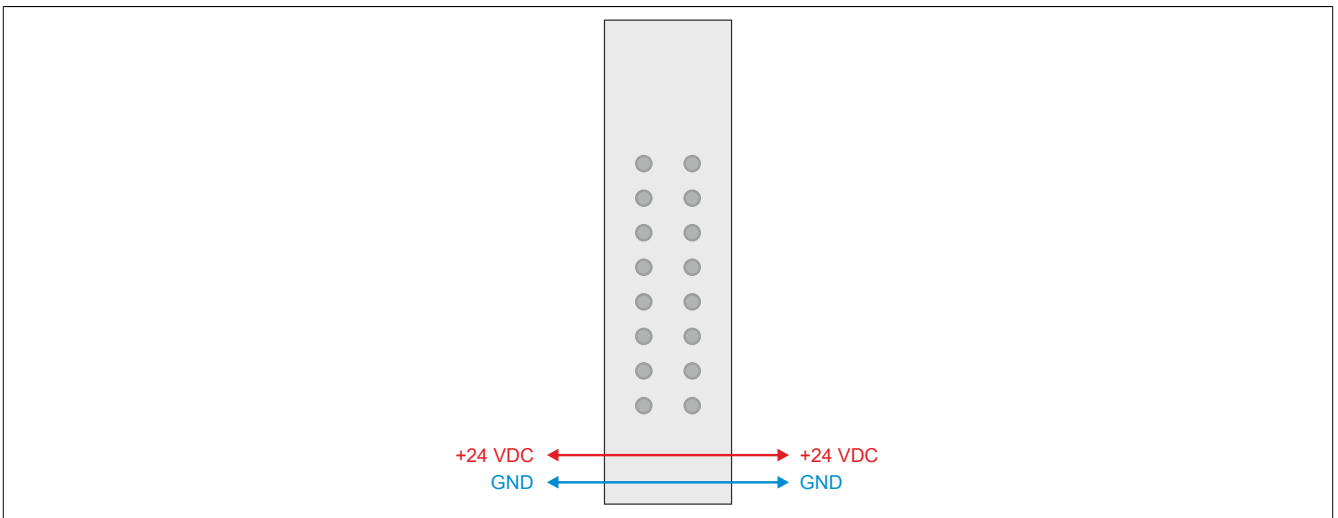
| Model number | X20ZF000F |
|------------------------------|--|
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB1E or 1x X20TB1F terminal block separately Order 1x X20BM11 bus module or 1x X20BM01 supply bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 379: X20ZF000F - Technical data

9.17.5.4 Pinout



9.17.5.5 Connection example



9.18 X20 electronics module communication

The CS modules allow complex devices to be remotely connected to the X20 system via a serial interface.

9.18.1 Summary

| Model number | Short description | Page |
|--------------|---|------|
| X20CS1011 | X20 interface module, 1 Moeller SmartWire interface | 2101 |
| X20CS1012 | X20 interface module, 1 M-Bus master interface, integrated slave supply | 2116 |
| X20CS1013 | X20 interface module, 1 DALI master interface | 2136 |
| X20CS1020 | X20 interface module, 1 RS232 interface, max. 115.2 kbit/s | 2147 |
| X20CS1030 | X20 interface module, 1 RS422/485 interface, max. 115.2 kbit/s | 2162 |
| X20CS1070 | X20 interface module, 1 CAN bus interface, max. 1 Mbit/s, object buffers in both send and receive directions | 2177 |
| X20CS2770 | X20 interface module, 2 CAN bus interfaces, max. 1 Mbit/s, object buffers in both send and receive directions | 2194 |
| X20cCS1020 | X20 interface module, coated, 1 RS232 interface, max. 115.2 kbit/s | 2147 |
| X20cCS1030 | X20 interface module, coated, 1 RS422/485 interface, max. 115.2 kbit/s | 2162 |

9.18.2 X20CS1011

Data sheet version: 3.04

9.18.2.1 General information

SmartWire from the company Moeller makes it possible to very easily integrate switching devices such as contactors or motor protection switches in the X20 system without extensive wiring. It replaces the control circuit wiring between the controller and switching devices with pluggable, pre-assembled connection cables.

Although SmartWire is an intelligent connection, this changes almost nothing for the machine programmer. Integration in the X20 system via the interface module cuts down on overall communication. The individual switching devices can simply be viewed as digital inputs and outputs.

Practical applications

SmartWire allows up to 16 switching devices to be connected using pre-assembled cables and attached to the X20 SmartWire interface module. The system can configure itself completely at the push of a button without additional intervention or effort. This replaces the wiring test that was previously necessary.

At the same time, the device configuration is known to the system. If a device is no longer available due to an error or intervention, it will be detected immediately. Once corrected, the system continues to run.

The interface module is designed as a normal electronic module, which means it can be placed anywhere on the remote backplane.

- X2X SmartWire master for controlling up to 16 SmartWire slaves
- Simple connection using pre-assembled connection cables
- Moeller SmartWire modules for Moeller standard switching devices
- Replaces control circuit wiring
- Contactor activation
- Contactor switching status
- Motor circuit breaker status
- 24 VDC control voltage via SmartWire connection cable

9.18.2.2 Order data


| Model number | Short description | Figure |
|----------------|---|---|
| | X20 electronics module communication |  |
| X20CS1011 | X20 interface module, 1 Moeller SmartWire interface | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Others | |
| X20CA4S00.0005 | SmartWire attachment cable, X20TB12 to SmartWire connector, 0.5 m | |
| X20CA4S00.0015 | SmartWire attachment cable, X20TB12 to SmartWire connector, 1.5 m | |

Table 380: X20CS1011 - Order data

9.18.2.3 Technical data

| Model number | X20CS1011 |
|--|---|
| Short description | |
| Communication module | 1 SmartWire master for controlling up to 16 slaves |
| General information | |
| B&R ID code | 0xA38D |
| Status indicators | SmartWire bus function, external supply voltage, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| SmartWire operating state | Yes, using status LED and software |
| U Aux | Yes, using status LED |
| Power output | |
| Internal I/O | 6.8 W for supplying external slaves (equal to 16 slaves each with 0.425 W) |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.5 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| EAC | Yes |
| KC | Yes |
| Interfaces | |
| Interface | |
| Type | SmartWire (LIN bus) |
| Variant | Connection made using 12-pin X20TB12 terminal block |
| Transfer rate | 19200 bit/s |
| SmartWire | |
| Data format | 1 start bit, 8 data bits, no parity bit, 1 stop bit |
| Max. distance | 4 m |
| Configuration button | |
| Internal | Integrated in the module on the bottom of the housing. |
| External | Connection via 12-pin terminal block N.O. contact, not electrically isolated (use potential-free contact) |
| SWIRE terminal 1 (24 VDC) | |
| Voltage drop for reverse polarity protection at 3 A | Max. 0.1 VDC |
| Voltage range | Voltage and supply |
| Current-carrying capacity | Max. 3 A |
| Short-circuit proof | No, only with external fuse |
| Monitoring | 20 VDC < 24 VDC Aux < 29.4 VDC (via firmware) |
| SWIRE terminal 2 | |
| Daisy chain signal | 5 VDC, CMOS level |
| SWIRE terminal 5 (bus level) | |
| Dominant | <2 VDC |
| Recessive | >14.85 VDC |
| SWIRE terminal 6 (17 VDC) | |
| Voltage range | Typ. 16.6 VDC (16.3 VDC to 16.8 VDC) |
| Summation current | Max. 400 mA for 16 SmartWire slaves |
| Short-circuit proof | Yes |
| Monitoring | 14.2 VDC < 17 VDC Aux < 17.9 VDC (via firmware) |
| U-Aux (24 VDC aux supply) | |
| Connection | Externally via 12-pin terminal block ¹⁾ |
| Input voltage | 24 VDC -15 % / +20 % |
| Fuse | Recommended line fuse: 3 A, slow-blow |
| Summation current | Max. 3 A for 16 SmartWire slaves |
| Reverse polarity protection | Yes |
| Electrical properties | |
| Electrical isolation | SmartWire isolated from bus SmartWire power supply (17 VDC) not isolated from I/O power supply |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |

Table 381: X20CS1011 - Technical data


| Model number | X20CS1011 |
|--|--|
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | 0 to 55°C |
| Vertical mounting orientation | 0 to 50°C |
| Derating | - |
| Storage | -25 to 70°C |
| Transport | -25 to 70°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order SmartWire attachment cable X20CA4S00.00xx separately Order 1x X20BM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm |

Table 381: X20CS1011 - Technical data

- 1) Using an external feed makes it possible to shut down via E-stop or switching relay

9.18.2.4 LED status indicators

For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|--|-------|-----------------------------|---------------------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | | | Single flash | Warning/Error on an I/O channel |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | S + R | Green | | The "S" and "R" LEDs indicate the status of the SmartWire interface. |
| A | Green | Off | U-Aux supply missing or too low | |
| | | On | U-Aux supply OK | |

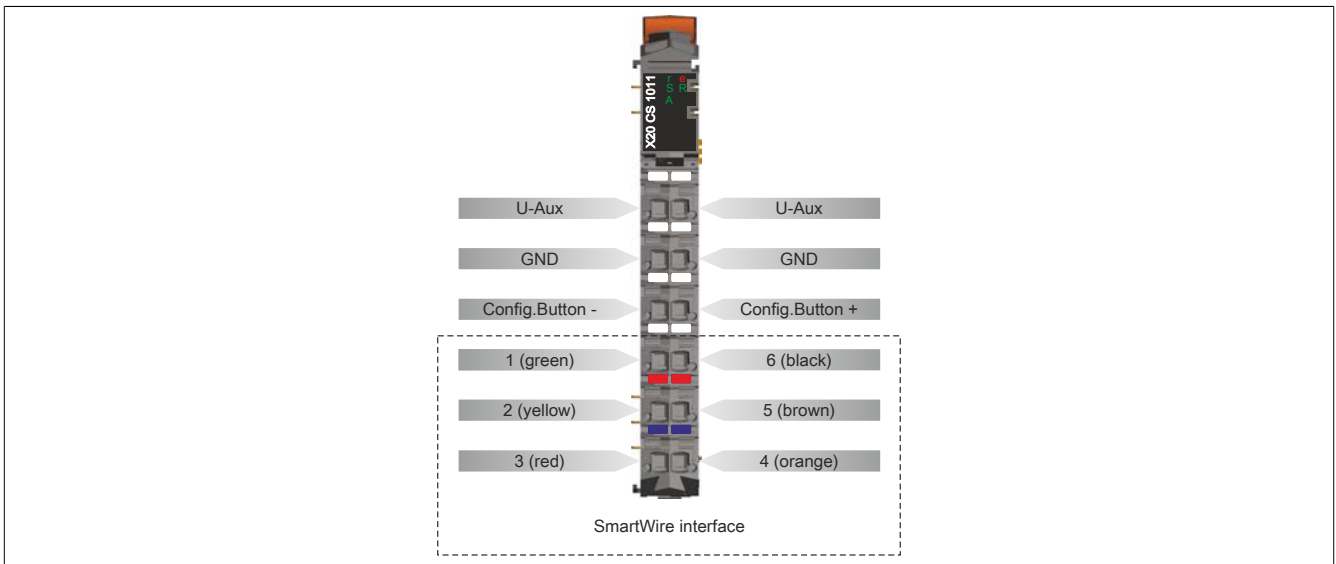
- 1) Depending on the configuration, a firmware update can take up to several minutes.

"S" and "R" LEDs

The status of the SmartWire interface is indicated by the "S" and "R" LEDs.

| S | R | Firmware status | Description |
|------------------|------------------|-----------------------|---|
| Off | Off | CHECK_INT_FRAM | Initialization |
| | | CHECK_LIN_SUPPLY | Wait until 17 VDC bus is OK |
| | | INT_ERROR_STATE | Internal error has occurred (remains) |
| Off | On | SET_TRANSCIEVER_MODE | Initialization of transceiver |
| | | RESET_UART | Initialization of UART + 10 ms delay |
| | | READ_REVISION_CNT | Initialization (revision counter from FLASH) |
| Blinking slowly | Blinking slowly | INIT_LIN_SCAN | Initialization for bus scan |
| | | RUN_LIN_SCAN | Perform bus scan |
| | | INIT_LIN_SETUP | Initialization for RUN_LIN_SETUP |
| | | RUN_LIN_SETUP | Perform bus setup |
| | | STORE_REVISION_CNT | Revision counter in FLASH |
| | | WAIT_FOR_PUSHBUTTON | Wait for configuration button after bus scan and difference with existing configuration |
| Blinking slowly | Blinking quickly | TIME_DELAY | 4 s optical confirmation signal after pressing the configuration button |
| On | Blinking slowly | DP_CFG_CHECK | Check of the configuration by the higher-level CPU (not currently used) |
| | | SET_SLAVES_TO_OP | Switch SmartWire stack to Operational |
| | | SET_SLAVES_TO_PREOP | Switch SmartWire stack to Preoperational |
| | | INIT_LIN_SCHED | Initialization for RUN_LIN_SCHED |
| On | On | RUN_LIN_SCHED (PREOP) | RUN SmartWire scheduler (in PREOP) |
| | | RUN_LIN_SCHED (OP) | RUN SmartWire scheduler (in OP) |
| Blinking slowly | On | IDLE_STATE | RUN SmartWire without scheduler (no slaves connected) |
| Blinking quickly | On | LIN_ERROR_STATE | ERROR LIN-BUS has occurred (remains) |

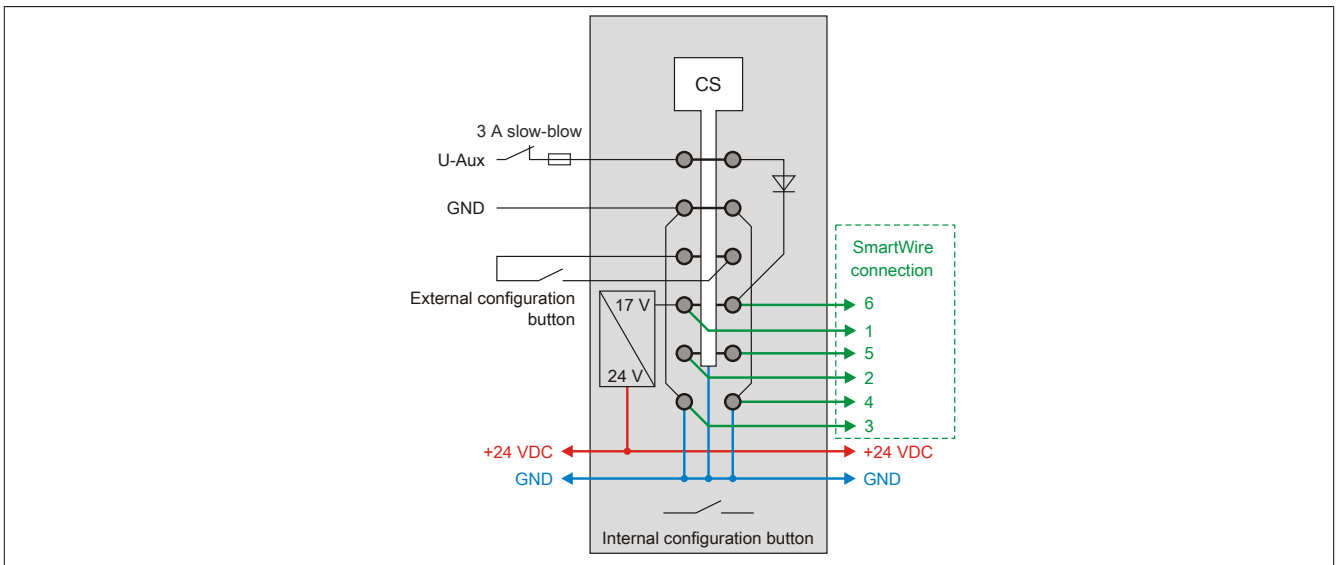
9.18.2.5 Pinout



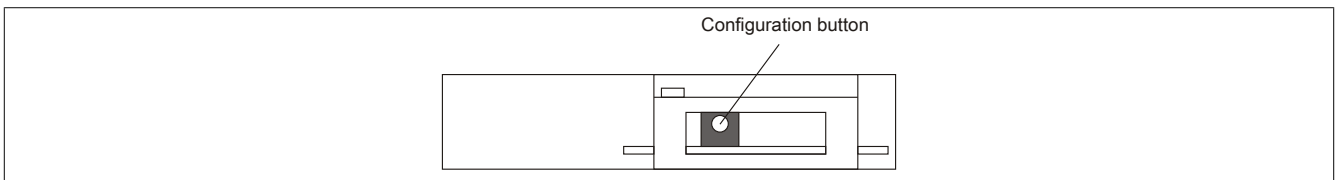
Information:

X20CA4S00.00xx SmartWire cables are delivered with the X20TB12 terminal block fully installed.

9.18.2.6 Connection example



9.18.2.7 Configuration button



A configuration button is integrated on the underside of the interface module housing. It can be used to completely reconfigure the entire system.

After adding or removing SmartWire sensors/actuators, pressing the configuration button rescans the SmartWire bus and saves the new configuration in the X20 SmartWire interface module.

In addition to the internal configuration button, it is also possible to connect an external configuration button to the terminal block.

9.18.2.8 Register description

9.18.2.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.18.2.8.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 5121 | FastOutput01_02 | USINT | | | • | |
| 5123 | FastOutput03_04 | USINT | | | • | |
| ... | ... | | | | | |
| 5133 | FastOutput13_14 | USINT | | | • | |
| 5135 | FastOutput15_16 | USINT | | | • | |
| 257 | SmartWireEnable | USINT | | | | • |
| 259 | Smart WireMode | USINT | | | | • |
| 8193 + (N-1) * 32 | VendorNCfg (Index N = 1 to 16) | USINT | | | | • |
| 8195 + (N-1) * 32 | DeviceNCfg (Index N = 1 to 16) | USINT | | | | • |
| Communication | | | | | | |
| 557 | MasterOperatingState | USINT | • | | | |
| 550 | MasterStatus | UINT | • | | | |
| 546 | SlaveStatus | UINT | • | | | |
| 4097 + (N-1) * 32 | InputN (Index N = 01 to 16) | USINT | • | | | |
| 513 + (N-1) * 2 | SlaveStatusN (Index N = 01 to 16) | USINT | | • | | |
| 8193 + (N-1) * 32 | VendorN (Index N = 1 to 16) | USINT | | • | | |
| 8195 + (N-1) * 32 | DeviceN (Index N = 1 to 16) | USINT | | • | | |

9.18.2.8.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 5121 | 0 | FastOutput01_02 | USINT | | | • | |
| 5123 | 1 | FastOutput03_04 | USINT | | | • | |
| ... | ... | ... | | | | | |
| 5133 | 6 | FastOutput13_14 | USINT | | | • | |
| 5135 | 7 | FastOutput15_16 | USINT | | | • | |
| 257 | - | SmartWireEnable | USINT | | | | • |
| 259 | - | Smart WireMode | USINT | | | | • |
| 8193 + (N-1) * 32 | - | VendorNCfg (Index N = 1 to 16) | USINT | | | | • |
| 8195 + (N-1) * 32 | - | DeviceNCfg (Index N = 1 to 16) | USINT | | | | • |
| Communication | | | | | | | |
| 77 | - | MasterOperatingState | USINT | | • | | |
| 70 | - | MasterStatus | UINT | | • | | |
| 66 | - | SlaveStatus | UINT | | • | | |
| 4097 + (N-1) * 32 | N - 1 | InputN (Index N = 01 to 16) | USINT | • | | | |
| 513 + (N-1) * 2 | - | SlaveStatusN (Index N = 01 to 16) | USINT | | • | | |
| 8193 + (N-1) * 32 | - | VendorN (Index N = 1 to 16) | USINT | | • | | |
| 8195 + (N-1) * 32 | - | DeviceN (Index N = 1 to 16) | USINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.18.2.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "[Using I/O modules on the bus controller](#)" on page 3789.

9.18.2.8.3.2 CAN I/O bus controller

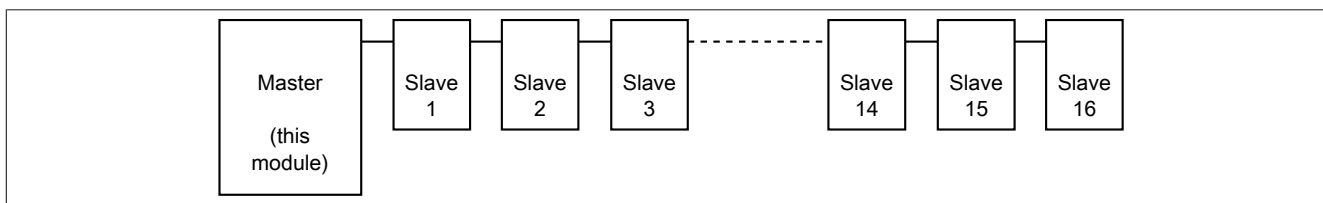
The module occupies 2 analog logical slots on CAN I/O.

9.18.2.8.4 Communication module Basic Master for SmartWire

SmartWire is essentially a master-slave system.

- All data traffic is initiated by the master, but the system can only contain one master.
- The SmartWire master can control up to 16 SmartWire slaves.
- The total scheduling time is 160 ms (i.e. after 160 ms, all 16 slaves have been queried one time).
- The maximum allowed bus extension is 2.6 m.
- Due to the automatic bus configuration, the numbering of the individual slaves is determined by the line structure of the bus.

This results in the following order:



Node address = Physical position in the bus line

9.18.2.8.5 Functions

9.18.2.8.5.1 Scan SmartWire

Automatically started and run after the system is turned on (default settings).

This procedure terminates if

- the set and actual configuration of the bus are identical: system changes to normal operation (i.e cyclic data exchange)
- or if there is a deviation between the set and actual configuration: error present, cyclic data transfer is not started

9.18.2.8.5.2 Setup SmartWire

Can be activated by pressing the configuration button or using a software command:

- if no configuration is saved
- if a SmartWire scan was just terminated due to error

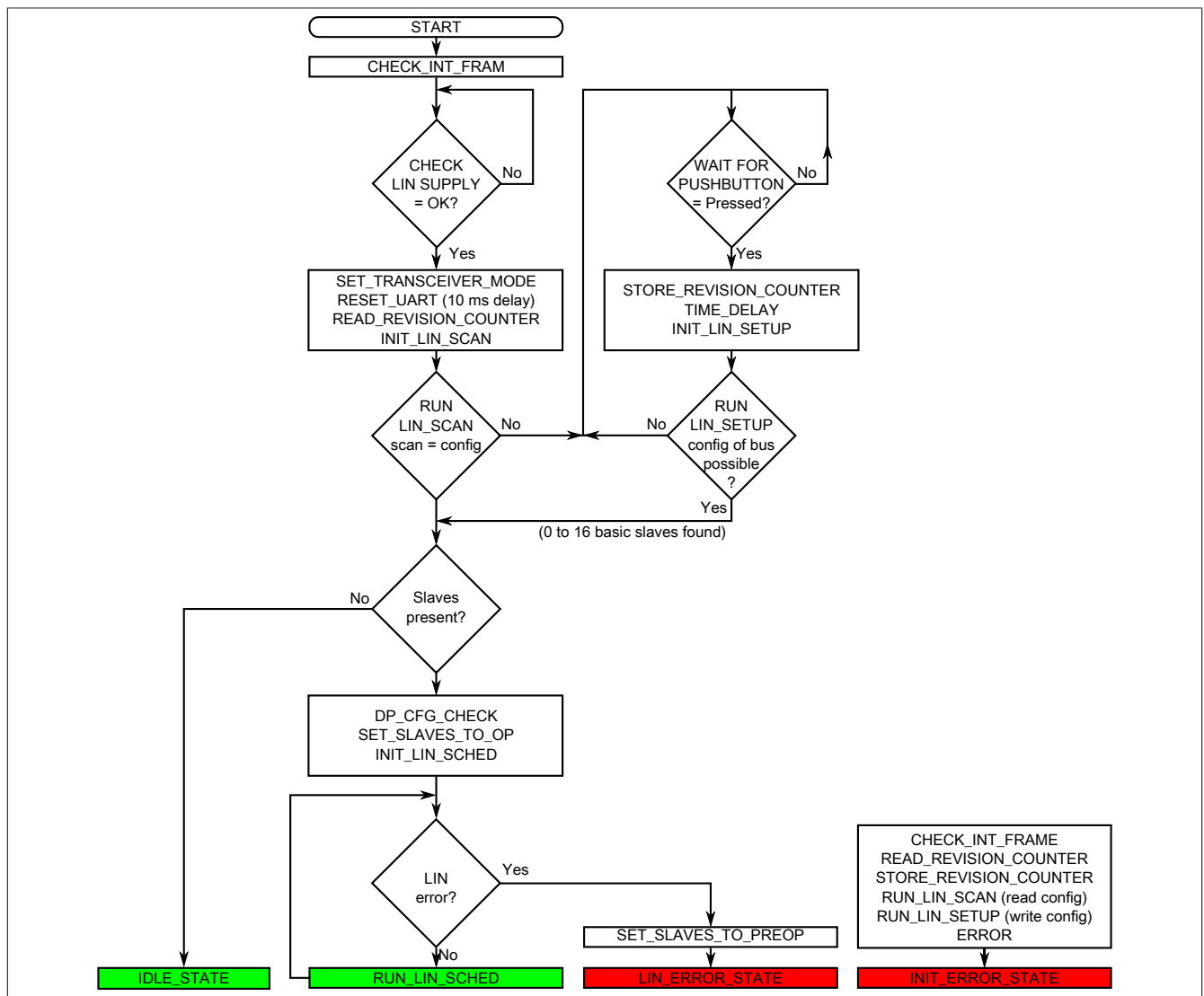
During setup, all connected stations are saved remanently in the master as new set configuration. Valid stations are uniquely identified by the two parameters "[Device ID](#)" on page 2113 and "[Vendor ID](#)" on page 2113.

9.18.2.8.6 Show operating state of the master

The current state of the master state machine is indicated in this register.

| Data type | Value | Code | Description |
|-----------|-------|----------------------|---|
| USINT | 1 | CHECK_INT_FRAM | Init State |
| | 2 | CHECK_LIN_SUPPLY | Waiting for 17 V voltage OK |
| | 3 | SET_TRANSCEIVER_MODE | Turn on transceiver |
| | 4 | RESET_UART UART | Reset |
| | 6 | INIT_LIN_SCAN | Init before bus scan |
| | 7 | RUN_LIN_SCAN | Bus scan is running |
| | 8 | WAIT_FOR_PUSHBUTTON | Scan != Configuration, waiting for Config button |
| | 9 | TIME_DELAY | Delay before bus setup |
| | 10 | INIT_LIN_SETUP | Init before bus setup |
| | 11 | RUN_LIN_SETUP | Bus setup is running (new configuration) |
| | 12 | DP_CFG_CHECK | PLC has set "Wait for configuration" |
| | 15 | SET_SLAVES_TO_OP | Sets slaves to OP mode (after successful scan or setup) |
| | 16 | SET_SLAVES_TO_PREOP | Sets slaves to PREOP mode (after errors have occurred, before LIN_ERROR or INT_ERROR) |
| | 19 | INIT_LIN_SCHED | Init bus scheduling |
| | 20 | RUN_LIN_SCHED | Bus scheduler is running |
| | 21 | LIN_ERROR_STATE | A fatal bus error has occurred (permanent) |
| | 22 | INT_ERROR_STATE | A fatal internal error has occurred (permanent) |
| | 23 | IDLE_STATE | Idle because there is no slave connected (permanent) |

9.18.2.8.6.1 Flow chart of SmartWire master operating status



The register receives the following value after successfully starting:

| Value | Code | Description |
|-------|---------------|--------------------------|
| 20 | RUN_LIN_SCHED | Bus scheduler is running |

9.18.2.8.7 Status of the master

Name:

MasterStatus

The current status information for the master is shown in this register.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|------------------------|-------|---|
| 0 | LIN_BUS_SETUP_COMPLETE | 0 | Saved configuration does not match the actual hardware on the bus |
| | | 1 | Setup finished: SCAN or SETUP after config button is valid |
| 1 | LIN_FATAL_ERROR | 0 | No error on the bus |
| | | 1 | SmartWire bus is defective: e.g. short circuit, no echo → more than 10 consecutive communication errors have occurred. |
| 2 | LIN_MASTER_PREOP | 0 | SmartWire stack not in PREOP mode |
| | | 1 | SmartWire stack in PREOP mode |
| 3 | LIN_MASTER_OP | 0 | SmartWire stack not in OP mode |
| | | 1 | SmartWire stack in OP mode |
| 4 | LIN_GLOBAL_CONTROL | 0 | No command sent |
| | | 1 | Set SmartWire stack to OP mode: Bit is written to the enable bit and can be read back |
| 5 | Reserved | 0 | |
| 6 | LIN_POWER_SUPPLY_STATE | 0 | Bus voltage supply is not OK |
| | | 1 | Bus voltage supply is OK |
| 7 | Reserved | 0 | |
| 8 | DP_CHECK_COMPLETED | 0 | Not a valid configuration |
| | | 1 | Configuration check completed (Not Used) (could optionally be written by the PLC, if the SCAN (configuration) is OK and was able to be read back from here) |
| 9 | Reserved | 0 | |
| 10 | DP_RECONFIGURATION | 0 | X2X Reconfiguration → X2X configuration button not pressed |
| | | 1 | X2X Reconfiguration → X2X configuration button can be read back |
| 11 - 15 | Reserved | 0 | |

The register receives the following value after successfully starting:

Equal to the decimal value: 345

| Bit | Description | Value | Information |
|-----|------------------------|-------|--|
| 0 | LIN_BUS_SETUP_COMPLETE | 1 | SmartWire setup complete: SCAN or SETUP after config button is valid |
| 3 | LIN_MASTER_OP | 1 | SmartWire stack in OP mode |
| 4 | LIN_GLOBAL_CONTROL | 1 | Set SmartWire stack to OP mode - Command set |
| 6 | LIN_POWER_SUPPLY_STATE | 1 | Bus voltage supply is OK |
| 7 | DP_CHECK_COMPLETED | 1 | Configuration is Ok |

9.18.2.8.8 Status of all slaves

Name:
SlaveStatus

The current state of the slave is indicated collectively in this register.

In the event of an error, the failed slaves are indicated in the respective bits, and in the status registers individually set up for the slaves (see "[SlaveStatus1 to SlaveStatus16](#)" on page 2113).

Data is exchanged cyclically as long as none of these bits are set. If an error does error, then I/O transfer is stopped. The bus can be started again after the error has been corrected or a setup has been performed again (see "[Basic application registers "SmartWireEnable" and "SmartWireMode"](#)" on page 2111).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------|-------|-------------|
| 0 | Slave 1 | 0 | Ok |
| | | 1 | Errors |
| ... | | ... | |
| 15 | Slave 16 | 0 | Ok |
| | | 1 | Errors |

9.18.2.8.9 Transfer control bits to slaves

Name:
FastOutput01_02 to FastOutput15_16

In these registers, the control bits are transferred to 2 consecutive slaves. Each slave receives 4 control bits, that must be selected from the 8 data bytes depending on the node address (1 to 16). These 4 control bits are assigned fixed values and utilization of the bits by the slave is optional.

All of the slaves evaluate this telegram. It must be sent cyclically by the master so that the slaves can ensure that the master is still functioning without any problems within the monitoring time (lifeguarding time = 400 ms).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------|-------|------------------------|
| 0 | Slave N | 0 | Digital output 1 reset |
| | | 1 | Digital output 1 set |
| ... | | .. | |
| 3 | Slave N | 0 | Digital output 4 reset |
| | | 1 | Digital output 4 set |
| 4 | Slave N + 1 | 0 | Digital output 1 reset |
| | | 1 | Digital output 1 set |
| ... | | .. | |
| 7 | Slave N + 1 | 0 | Digital output 4 reset |
| | | 1 | Digital output 4 set |

9.18.2.8.10 Read input data from slave

Name:

Input01 to Input16

Each slave sends its input data and/or its status to the master.

The data volume consumes 1 byte per slave. Each slave has one diagnostics bit, which it sends to the master with the cyclic data. This bit is a message bit if an application error occurs (on the module). It is always located in the highest value bit.

The master can constantly evaluate this bit. The diagnostic bit is set on the slave if the status of the slave is "Error". Slaves that do not have any input data will still send a byte that is used to make their status data available. This is required because the master also monitors the slaves for proper functionality through the receipt of this byte.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------------------------|--------|-----------------------|
| 0 | Input state - Digital input 1 | 0 or 1 | |
| ... | | ... | |
| 3 | Input state - Digital input 4 | 0 or 1 | |
| 4 - 6 | Reserved | 0 | |
| 7 | Error status | 0 | No error on the slave |
| | | 1 | Error on the slave |

9.18.2.8.11 Configure the function breakpoints on the master

Name:

SmartWireEnable

This register can be used to configure function breakpoints that may be implemented in master state machine.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 3 |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------|-------|---|
| 0 | Enable SmartWire stack | 0 | Disabled |
| | | 1 | Enabled (bus controller default setting) |
| 1 | Set SmartWire stack mode | 0 | Sets PREOP mode (scheduler is already running, output data will still be output with 0) |
| | | 1 | Sets to OP mode (bus controller default setting) |
| 2 | Reserved | 0 | |
| 3 | Software "Config button" | 0 | Not actuated (bus controller default setting) |
| | | 1 | Pressed (necessary so that slaves can also be reconfigured) |
| 4 - 7 | Reserved | 0 | |

9.18.2.8.12 Configure the operating mode of the master

Name:

SmartWireMode

This register can be used to configure the master operating mode.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 1 |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------|-------|--|
| 0 - 1 | Operating mode | 00 | CONFIG from RAM (controller) |
| | | 01 | Read CONFIG from flash memory (bus controller default setting) |
| | | 10 | Write CONFIG to flash |
| | | 11 | Reserved |
| 2 - 7 | Reserved | 0 | |

9.18.2.8.13 Basic application registers "SmartWireEnable" and "SmartWireMode"

By default, the SmartWire bus is started automatically and must at least be configured using an external method (e.g. external button or push-button).

If sensors / actuators are added to or removed from the SmartWire bus, then the configuration procedure must be restarted so that the SmartWire bus will be rescanned and the new configuration saved remanently in the master.

These registers can and must be used for special conditions and for acknowledging errors.

The commands with the library are sent asynchronously on the X2X link network. The following is therefore essential for error-free operation of the module.

- Command register "SmartWireMode" on page 2110 is written to first. Writing to register "SmartWireEnable" on page 2110 is permitted after the function block reports that it is finished.
- The function block status response is checked in the application.
- The specified response from the master status information must arrive in order for the master state machine to function properly

9.18.2.8.13.1 Starting the bus when Manual Start has been configured

Status information after startup:

| Value (decimal) | Register | Information |
|-----------------|----------------------|-------------|
| 1 | MasterOperatingState | Init State |
| 0 | MasterStatus | |
| 0 | SlaveStatus | |

If Manual start is selected for the bus in the configuration, then the AsIOAccWrite() function from the AsIOAcc library must be used to write to the two registers in the specified order.

| Value (decimal) | Register | Information |
|-----------------|-----------------|------------------------------------|
| 1 | SmartWireMode | Configuration from rem. memory |
| 3 | SmartWireEnable | Command for STACK ON / OPERATIONAL |

Status information after error-free startup of the bus:

| Value (decimal) | Register | Information |
|-----------------|----------------------|--|
| 20 | MasterOperatingState | "RUN without error if SlaveStatus = 0" |
| 345 | MasterStatus | "RUN without error if SlaveStatus = 0" |
| 0 | SlaveStatus | No slave errors |

9.18.2.8.13.2 Starting the bus after slave error

Status information after slave error

In this case, a change to MasterOperatingState and MasterStatus cannot be detected at first, although the respective error bits are set in the SlaveStatus. The slaves have failed, and data is no longer being exchanged.

| Value (decimal) | Register | Information |
|-----------------|----------------------|--|
| 20 | MasterOperatingState | |
| 345 | MasterStatus | |
| x | SlaveStatus | Bits for the faulty slaves have been set |

To set the master to a defined state, the bus must first be stopped with the following write commands.

| Value (decimal) | Register | Information |
|-----------------|-----------------|-------------|
| 0 | SmartWireMode | All off |
| 0 | SmartWireEnable | All off |

Wait until the commands have been completed successfully, which is indicated in the MasterStatus. Bit 4 is cleared: Response indicating that the bus is no longer operational.

| Value (decimal) | Register | Information |
|-----------------|----------------------|-------------|
| 20 | MasterOperatingState | |
| 329 | MasterStatus | |
| 0 | SlaveStatus | |

The bus can be restarted using the write commands after the errors have been corrected:

| Value (decimal) | Register | Information |
|-----------------|-----------------|------------------------------------|
| 1 | SmartWireMode | Configuration from rem. memory |
| 3 | SmartWireEnable | Command for STACK ON / OPERATIONAL |

Status information after error-free startup of the bus:

| Value (decimal) | Register | Information |
|-----------------|----------------------|--|
| 20 | MasterOperatingState | "RUN without error if SlaveStatus = 0" |
| 345 | MasterStatus | "RUN without error if SlaveStatus = 0" |
| 0 | SlaveStatus | No slave errors |

Different status information can result depending on the present error situation (see "[MasterOperatingState](#)" on [page 2107](#)).

Typical situation when there are hardware configuration differences:

| Value (decimal) | Register | Information |
|-----------------|----------------------|-------------|
| 0 | MasterOperatingState | |
| 80 | MasterStatus | |
| 0 | SlaveStatus | |

Information:

A stop command must be sent before a new start command can be applied!

9.18.2.8.14 Advanced applications

The following registers are used for advanced diagnostics, for reading back the current configuration and for creating a configuration from the application. The registers that have already been written and their respective contents are, of course, valid.

9.18.2.8.14.1 Status of the individual slaves

Name:

SlaveStatus1 to SlaveStatus16

These registers display the respective slave status.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|-----------------------------|
| 0 | | 0 | Slave integrated on the bus |
| | | 1 | Slave failure on the bus |
| 1 - 7 | Reserved | 0 | |

9.18.2.8.14.2 Read slave vendor ID

Name:

Vendor1 to Vendor16

These registers display the respective slave Vendor ID.

| Data type | Value | Information |
|-----------|-------|-----------------|
| USINT | x | Slave vendor ID |

9.18.2.8.14.3 Read slave device ID

Name:

Device1 to Device16

These registers display the respective slave device ID.

| Data type | Value | Information |
|-----------|-------|-----------------|
| USINT | x | Slave device ID |

9.18.2.8.14.4 Write slave vendor ID

Name:

Vendor1Cfg to Vendor16Cfg

The desired vendor ID for the slave can be written in these registers.

| Data type | Value | Information |
|-----------|-------|--|
| USINT | x | Vendor ID of the slave. Bus controller default setting: 1 |

9.18.2.8.14.5 Write slave device ID

Name:

Device1Cfg to Device16Cfg

The desired device ID for the slave can be written in these registers.

| Data type | Value | Information |
|-----------|-------|---|
| USINT | x | Device ID of the slave. Bus controller default setting: 33 |

Import the configuration without starting the bus

For safety reasons, it is possible to import the configuration for the connected bus without starting cyclic data transfer. This actual configuration can be compared with the set configuration stored in the application. Cyclic data transfer can be started if the configurations are the same. An error is reported if they are not the same.

Manual start is configured, status information after startup:

| Value (decimal) | Register | Information |
|-----------------|----------------------|-------------|
| 1 | MasterOperatingState | Init State |
| 0 | MasterStatus | |
| 0 | SlaveStatus | |

The function AsIOAccWrite() from the library AsIOAcc must be used to write the two registers in the specified order.

| Value (decimal) | Register | Information |
|-----------------|-----------------|---|
| 0 | SmartWireMode | RAM memory configuration |
| 9 | SmartWireEnable | Command for STACK ON / PREOPERATIONAL and CONFIG-BUTTON |

Status information after error-free import of the bus configuration:

| Value (decimal) | Register | Information |
|-----------------|----------------------|--|
| 20 | MasterOperatingState | "RUN without error if SlaveStatus = 0" |
| 1349 | MasterStatus | "PREOP and no errors" |
| 0 | SlaveStatus | No slave errors |

Once these commands have been completed, the connected slave modules are imported and stored in the remanent memory for subsequent startups.

The function AsIOAccRead() from the library AsIOAcc must now be used to read all corresponding registers "Vendor1 to Vendor16" on page 2113 and "Device1 to Device 16" on page 2113 . If the configuration matches, then the bus can now be started using the standard command:

| Value (decimal) | Register | Information |
|-----------------|-----------------|------------------------------------|
| 1 | SmartWireMode | Configuration from rem. memory |
| 3 | SmartWireEnable | Command for STACK ON / OPERATIONAL |

Status information after error-free startup of the bus:

| Value (decimal) | Register | Information |
|-----------------|----------------------|--|
| 20 | MasterOperatingState | "RUN without error if SlaveStatus = 0" |
| 345 | MasterStatus | "RUN without error if SlaveStatus = 0" |
| 0 | SlaveStatus | No slave errors |

Bus configuration settings

Manual start is configured, status information after startup:

| Value (decimal) | Register | Information |
|-----------------|--------------------------------------|-------------|
| 1 | MasterOperatingState | Init State |
| 0 | MasterStatus | |
| 0 | SlaveStatus | |

A running bus can, of course, also be stopped with the standard command and re-configured!

The function `AsIOAccWrite()` from the library `AsIOAcc` must now be used to write the respective data to all registers "[Vendor1Cfg to Vendor16Cfg](#)" on page 2113 and "[Device1Cfg to Device16Cfg](#)" on page 2113. All vendor and device registers that are not being used must be set to zero. This does not cause a change in the status registers.

To save the data in remanent memory, the function `AsIOAccWrite()` from the library `AsIOAcc` must be used to write to the two registers in the specified order.

| Value (decimal) | Register | Information |
|-----------------|---------------------------------|------------------------------------|
| 2 | SmartWireMode | WRITE rem. memory configuration |
| 1 | SmartWireEnable | Command for STACK ON / OPERATIONAL |

Status information after error-free configuration:

| Value (decimal) | Register | Information |
|-----------------|--------------------------------------|--|
| 20 | MasterOperatingState | "RUN without error if SlaveStatus = 0" |
| 325 | MasterStatus | "PREOP without errors" |
| 0 | SlaveStatus | No slave errors |

The bus can now be started using the standard command for the bus:

| Value (decimal) | Register | Information |
|-----------------|---------------------------------|------------------------------------|
| 1 | SmartWireMode | Configuration from rem. memory |
| 3 | SmartWireEnable | Command for STACK ON / OPERATIONAL |

Status information after error-free startup of the bus:

| Value (decimal) | Register | Information |
|-----------------|--------------------------------------|--|
| 20 | MasterOperatingState | "RUN without error if SlaveStatus = 0" |
| 345 | MasterStatus | "RUN without error if SlaveStatus = 0" |
| 0 | SlaveStatus | No slave errors |

9.18.2.8.15 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μ s |

9.18.3 X20CS1012

Data sheet version: 1.19

9.18.3.1 General information

The M-Bus master is designed as a single-width module and can be connected anywhere within the X20 I/O system. It can therefore be used decentrally for distributed topologies. The M-Bus master supports transfer rates of 300, 2400 and 9600 bit/s; up to 64 slaves supplied via M-Bus can be connected.

M-Bus (Meter-Bus) is a relatively simple fieldbus for recording consumption data, such as from electricity or heat meters. It is based on a reverse polarity protected two-wire line and works according to the master-slave principle.

- Power supply for up to 64 slaves on the M-Bus
- Decentralized use of the communication interface

9.18.3.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | X20 electronics module communication |  |
| X20CS1012 | X20 interface module, 1 M-Bus master interface, integrated slave supply | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 382: X20CS1012 - Order data

9.18.3.3 Technical data


| | |
|--|---|
| Model number | X20CS1012 |
| Short description | |
| Communication module | 1 M-Bus master for controlling up to 64 slaves |
| General information | |
| B&R ID code | 0xCABF |
| Status indicators | Data transfer, M-Bus supply, operating status, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Data transfer | Yes, using status LED |
| M-Bus power supply | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.2 W |
| Internal I/O | 0.35 W + (number of slaves * 0.08 W) |
| Module power dissipation | 0.55 W + (number of slaves * 0.006 W) |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| Isolation voltage between M-Bus and X2X Link | 500 VDC, 1 min |
| Interfaces | |
| Interface | |
| Type | M-Bus master |
| Variant | Connection made using 12-pin X20TB12 terminal block |
| Max. distance | See section "M-Bus" |
| Transfer rate | 300, 2400 or 9600 bit/s |
| Number of slaves | Max. 64 |
| Internal resistance of master | Max. 6 Ω |
| Bus voltage mark at 0 mA | I/O supply voltage (+ 11.5 to 13.5 V) |
| Bus voltage drop with space | 12 to 13.5 V |
| Overload shutdown | 250 mA ±10% |
| Bit threshold | 6 to 9 mA |
| Collision threshold | 24 to 36 mA |
| Received readjustment time | Max. 10 s ¹⁾ |
| Bus cable | Shielded or unshielded |
| Electrical properties | |
| Electrical isolation | M-Bus isolated from bus M-Bus not isolated from I/O power supply |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 383: X20CS1012 - Technical data

1) Dependent on the changes to the load on the M-Bus (e.g. switching slaves on and off)

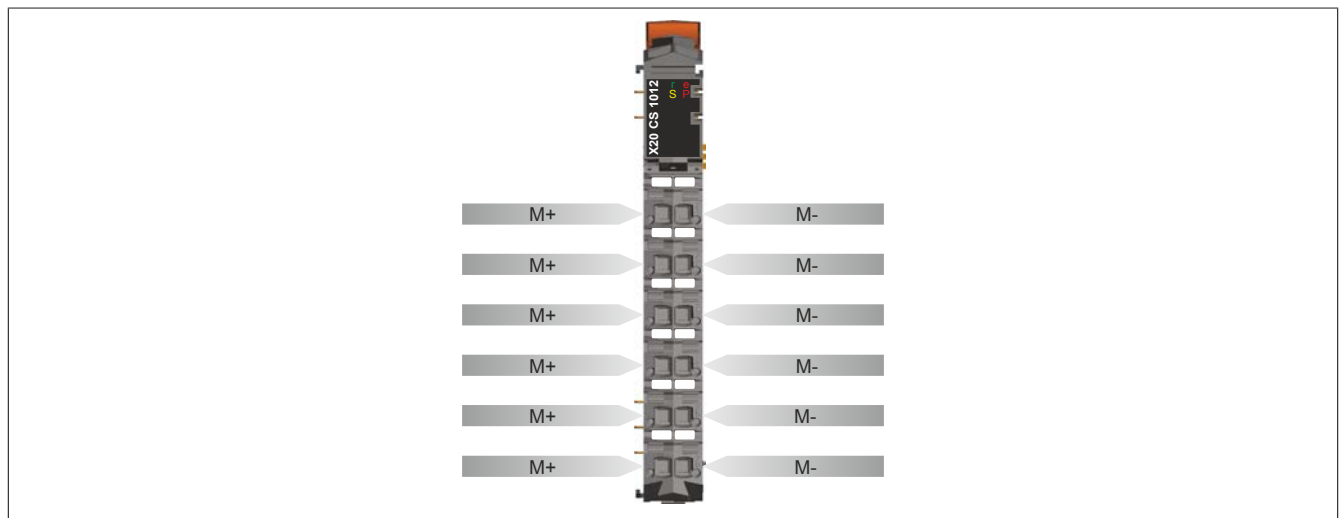
9.18.3.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

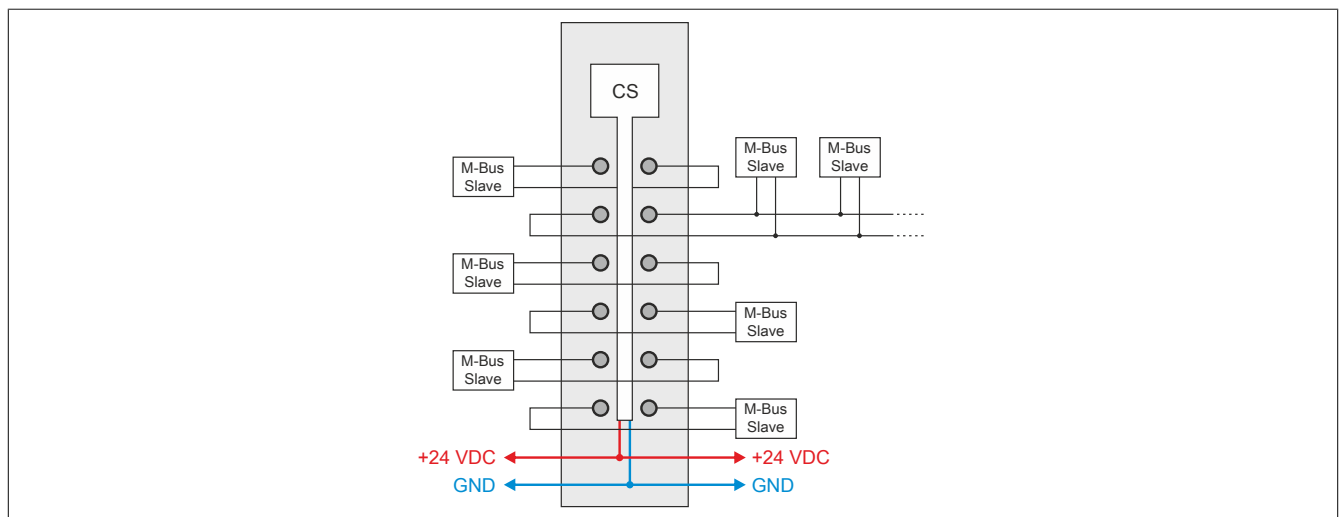
| Figure | LED | Color | Status | Description |
|---|-------|-----------------------------|--------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | UNLINK mode |
| | | | Double flash | Mode BOOT (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | e + r | Red on / Green single flash | | Invalid firmware |
| | S | Yellow | Off | No slaves sending data |
| | | | On | At least one slave is sending data via the M-Bus |
| | P | Red | Off | M-Bus supply ok |
| | | | On | Short-circuit or overload on M-Bus |

1) Depending on the configuration, a firmware update can take up to several minutes.

9.18.3.5 Pinout



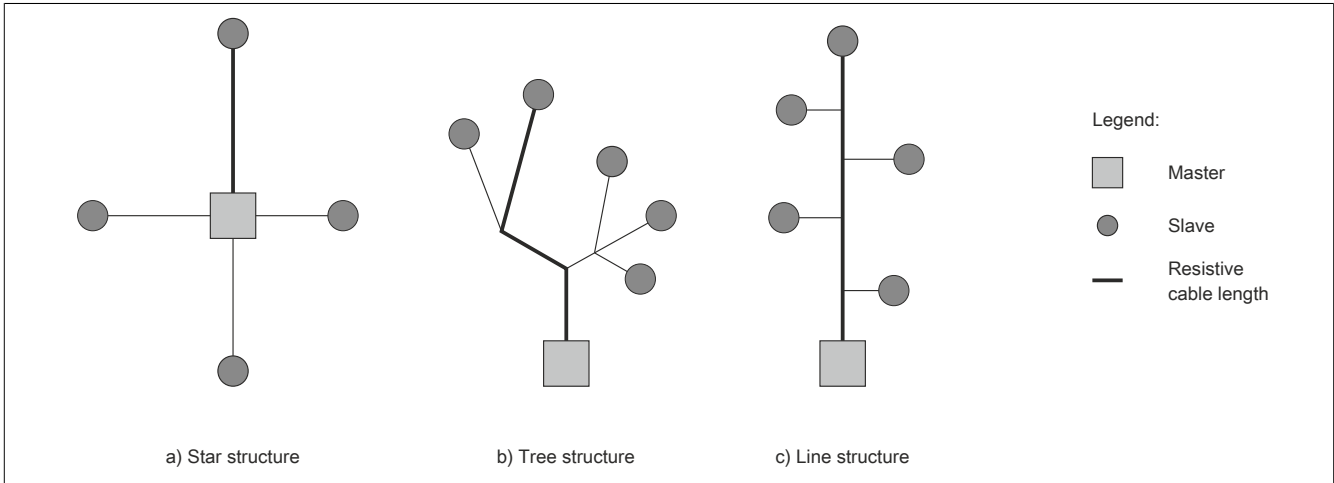
9.18.3.6 Connection example



9.18.3.7 M-Bus

9.18.3.7.1 Bus topology

The bus topology has a significant influence on the maximum load of an M-Bus network. In general a star structure is preferred over a tree structure and in turn a tree structure is preferred over a line structure. Furthermore, connecting the slaves to the bus the same way provides better values than connecting them all at the end of the branches after all other parameters have been determined.



9.18.3.7.2 Cable cross section

The cable being used has a specific capacity and resistance, which in turn has an effect on the operation of the bus. The resistive influence of the cable means a loss of voltage on the line, which is subsequently not available for supplying the bus. In order to guarantee sufficient power, the voltage on the slaves must never be less than 12 V neither when sending from the master to the slave, nor in the opposite direction. The deciding factor in this case is the longest branch of the network whose length is referred to as the resistive cable length.

The cable's capacity causes signal distortion during data transfer because the slew rates of the rising and falling edges are slowed down. For example, replacing a 3 km branch in a network with two 1.5 km branches will improve the signal. The total distance of the network is referred to as the capacitive cable length (the sum of all segment lengths).

Information:

The maximum permissible line resistance (for the longest loop) is 250 Ω .

The maximum permissible line capacitance for the entire bus is 500 nF.

9.18.3.7.3 Transmission current and bit threshold

The bit threshold on the master is typically 7.5 mA. Therefore, a slave transmission current of 15 mA results in the least amount of signal distortion while the highest amount occurs at 11 or 20 mA.

9.18.3.7.4 Transfer rate

A lower transfer rate decreases the influence of the signal distortion caused by cable capacity and bit threshold.

Information:

Starting with a total bus length >1 km, the slaves must be operated at a baud rate <9600 bit/s.

9.18.3.7.5 Calculating the resistive bus length

The resistive cable length must be calculated in order to ensure a sufficient power supply of 12 V on the M-Bus. What matters most here is the longest segment between the master and slave.

The resistive bus length is calculated using the following formula without taking an increased bus current caused by a defective receiver into account:

$$L_{\text{res}} = \frac{V_{\text{I/O}} - (n * 0.0015 + 0.02) * 6 - 12.6}{(n * 0.0015 + 0.02) * R_L} * 1000$$

- L_{res} ... Resistive bus length [m]
 n ... Number of slaves (all at end of line)
 R_L ... Line resistance (loop resistance [Ω /km])
 $V_{\text{I/O}}$... I/O supply voltage [V]

Examples for calculating the maximum resistive bus length:

| No. | Example | Maximum resistive bus length |
|-----|--|------------------------------|
| 1 | <ul style="list-style-type: none"> 64 slaves (all at end of line) 19.2 V I/O supply voltage 0.5 mm² wire cross-section | 675 m |
| 2 | <ul style="list-style-type: none"> 64 slaves (all at end of line) 28.8 V I/O supply voltage 1.5 mm² wire cross-section | 5340 m |

9.18.3.7.6 Accounting for the capacitive bus length

The total distance of the network is referred to as the capacitive bus length (the sum of all segment lengths). The capacitive bus length depends on two factors:

- Distributed capacitance of cable
- Transfer rate

Distributed capacitance of cable

A lower distributed capacitance on a cable means a higher capacitive bus length.

Transfer rate

A lower transfer rate on an M-Bus system means a higher capacitive bus length.

Example of a cable with a distributed capacitance of 50 nF/km:

| Transfer rate | Capacitive bus length |
|---------------|-----------------------|
| 9600 bit/s | 1 km |
| 2400 bit/s | 4 km |
| 300 bit/s | 10 km |

9.18.3.7.7 Bus installation

Cables with twisted pair wires and a cross-section of 0.5 mm² to 1.5 mm² are normally used for bus installation (according to standard: J-Y(ST)Y nx2x0.8). The shield on shielded cables only has to be grounded to the module on one side. On the slaves, the shielding must be high resistance for DC and low frequency signals.

9.18.3.7.8 Repeater

Repeaters can be used to further expand the M-Bus network.

9.18.3.8 Register description

9.18.3.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.18.3.8.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|------------------------------|--|-----------------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Module configuration | | | | | | |
| 774 | CfO_FunctionModel | UINT | | | | • |
| M-Bus - Configuration | | | | | | |
| Index * 16 + 767 | CfO_LengthData1 to CfO_LengthData8 | USINT | | | | • |
| Index * 16 + 775 | CfO_BaudData1 to CfO_BaudData8 | USINT | | | | • |
| Index * 16 + 761 | CfO_PAdrData1 to CfO_PAdrData8 | USINT | | | | • |
| Index * 16 + 765 | CfO_IndexData1 to CfO_IndexData8 | USINT | | | | • |
| Index * 16 + 773 | CfO_ReqTimeData1 to CfO_ReqTimeData8 | USINT | | | | • |
| Index * 16 + 770 | CfO_MBusModeData1 to CfO_MBusModeData8 | UINT | | | | • |
| Index * 16 + 763 | CfO_ToutOffData1 to CfO_ToutOffData8 | USINT | | | | • |
| Index * 8 + 1009 | CfO_ReplData1 to CfO_ReplData8 | (U)SINT | | | | • |
| Index * 8 + 1010 | CfO_ReplData1 to CfO_ReplData8 | (U)INT | | | | • |
| Index * 8 + 1012 | CfO_ReplData1 to CfO_ReplData8 | (U)DINT REAL | | | | • |
| M-Bus - Communication | | | | | | |
| 513 | MBusCommand | USINT | | | • | • |
| 263 | MBusOperation | USINT | • | | | |
| 257 | MBusState | USINT | • | | | |
| 259 | ValidDataByte | USINT | • | | | |
| | ValidData1 | Bit 0 | • | | | |
| | ... | ... | • | | | |
| | ValidData8 | Bit 7 | • | | | |
| 261 | InvalidDataByte | USINT | • | | | |
| | InvalidData1 | Bit 0 | • | | | |
| | ... | ... | • | | | |
| | InvalidData8 | Bit 7 | • | | | |
| Index * 8 + 265 | Data1 to Data8 | (U)SINT | • | | | |
| Index * 8 + 266 | Data1 to Data8 | (U)INT | • | | | |
| Index * 8 + 268 | Data1 to Data8 | (U)DINT REAL | • | | | |
| 337 | ChangedSNByte | USINT | • | | | |
| Index * 8 + 900 | SNData1 to SNData8 | UDINT | | • | | |
| FlatStream | | | | | | |
| 2051 | InputMTU | USINT | | | | • |
| 2049 | OutputMTU | USINT | | | | • |
| 2113 | InputSequence | USINT | • | | | |
| Index * 2 + 2113 | RxByte1 to RxByte15 | USINT | • | | | |
| 2177 | OutputSequence | USINT | | | • | |
| Index * 2 + 2177 | TxByte1 to TxByte15 | USINT | | | • | |
| 2053 | FlatstreamMode | USINT | | | | • |
| 2055 | Forward | USINT | | | | • |
| 2057 | ForwardDelay | UINT | | | | • |

9.18.3.8.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|------------------------------|----------------------|---|-----------------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Module configuration | | | | | | | |
| 774 | - | CfO_FunctionModel | UINT | | | | • |
| M-Bus - Configuration | | | | | | | |
| Index * 16 + 767 | - | CfO_LengthData1 to CfO_LengthData8 | USINT | | | | • |
| Index * 16 + 775 | - | CfO_BaudData1 to CfO_BaudData8 | USINT | | | | • |
| Index * 16 + 761 | - | CfO_PAdrData1 to CfO_PAdrData8 | USINT | | | | • |
| Index * 16 + 765 | - | CfO_IndexData1 to CfO_IndexData8 | USINT | | | | • |
| Index * 16 + 773 | - | CfO_ReqTimeData1 to CfO_ReqTimeData8 | USINT | | | | • |
| Index * 16 + 770 | - | CfO_MBusModeData1 to CfO_MBusMode-Data8 | UINT | | | | • |
| Index * 16 + 763 | - | CfO_ToutOffData1 to CfO_ToutOffData8 | USINT | | | | • |
| Index * 8 + 1009 | - | CfO_ReplData1 to CfO_ReplData8 | (U)SINT | | | | • |
| Index * 8 + 1010 | - | CfO_ReplData1 to CfO_ReplData8 | (U)INT | | | | • |
| Index * 8 + 1012 | - | CfO_ReplData1 to CfO_ReplData8 | (U)DINT REAL | | | | • |
| M-Bus - Communication | | | | | | | |
| 8 | 8 | MBusCommand | USINT | | | • | • |
| 11 | 11 | MBusOperation | USINT | • | | | |
| 8 | 8 | MBusState | USINT | • | | | |
| 9 | 9 | ValidDataByte | USINT | • | | | |
| 10 | 10 | InvalidDataByte | USINT | • | | | |
| Index * 4 + 5 | Index * 4 + 8 | Data1 to Data8 | (U)SINT | • | | | |
| Index * 4 + 6 | Index * 4 + 8 | Data1 to Data8 | (U)INT | • | | | |
| Index * 4 + 8 | Index * 4 + 8 | Data1 to Data8 | (U)DINT REAL | • | | | |
| 337 | - | ChangedSNByte | USINT | | • | | |
| Index * 8 + 900 | - | SNDData1 to SNDData8 | UDINT | | • | | |
| FlatStream | | | | | | | |
| 2051 | - | InputMTU | USINT | | | | • |
| 2049 | - | OutputMTU | USINT | | | | • |
| 0 | 0 | InputSequence | USINT | • | | | |
| Index * 1 + 0 | Index * 1 + 0 | RxByte1 to RxByte7 | USINT | • | | | |
| 0 | 0 | OutputSequence | USINT | | | • | |
| Index * 1 + 0 | Index * 1 + 0 | TxByte1 to TxByte7 | USINT | | | • | |
| 2053 | - | FlatstreamMode | USINT | | | | • |
| 2055 | - | Forward | USINT | | | | • |
| 2057 | - | ForwardDelay | UINT | | | | • |

1) The offset specifies the position of the register within the CAN object.

9.18.3.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "[Using I/O modules on the bus controller](#)" on page 3789.

9.18.3.8.3.2 CAN I/O bus controller

The module occupies 3 analog logical slots with CAN I/O.

9.18.3.8.4 General information

The M-Bus standard is a serial bus system that handles half-duplex or asynchronous communication. The high level of variability provided by this protocol enables a wide range of information to be handled via the same interface. In basic M-Bus networks, the master communicates with up to 250 slaves via the "primary address". In later stages of development, the secondary address (4 bytes) was then also specified. This made it possible to significantly increase the number of slaves in a network.

Important information about the module

- Generally: Primary address used (1 to 250)
- Secondary address only supported via FlatStream
- Bus can supply 64 slaves with power

9.18.3.8.5 Module configuration

The flexible design of the M-Bus protocol can quickly add up to a lot of configuration work. That's why B&R offers two different user interfaces for the module: "Standard" and "FlatStream". The user-friendly B&R Standard interface allows users to view up to eight values requested cyclically from the M-Bus network. In FlatStream mode, the module acts as a bridge between the PLC and the M-Bus slave, which makes all M-Bus functions available.

Information:

The B&R Standard interface is statically configured and based on cyclic registers. Because X2X Link can only transfer a certain number of values cyclically, the user must make his selection accordingly.

9.18.3.8.5.1 Settings for operation

Name:

CfO_FunctionModel

This register can be used to enable either the Standard or FlatStream interface, which makes the module much more efficient.

Bits 8 to 15 are only evaluated if bit 0 (B&R default interface) is enabled.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 1825 |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------|-------|---|
| 0 | B&R standard interface | 0 | Disabled |
| | | 1 | Enabled (bus controller default setting) |
| 1 | Flatstream | 0 | Disabled (bus controller default setting) |
| | | 1 | Enabled |
| 3 - 7 | Reserved | 0 | |
| 8 | Data1 | 0 | Disabled |
| | | 1 | Enabled (bus controller default setting) |
| ... | | ... | |
| 10 | Data 3 | 0 | Disabled |
| | | 1 | Enabled (bus controller default setting) |
| 11 | Data 4 | 0 | Disabled (bus controller default setting) |
| | | 1 | Enabled |
| ... | | ... | |
| 15 | Data8 | 0 | Disabled (bus controller default setting) |
| | | 1 | Enabled |

9.18.3.8.6 M-Bus - Configuration

Separate configuration registers are provided for each value to read. These must be configured correctly in order to call up a counter value from the M-Bus network. The user must know the following values from the slave:

- Transfer rate configured on the slave
- Primary address configured on the slave (value: 1 to 250, otherwise only point-to-point connection is possible)
- Data type / data length of value
- How the slave's memory is structured

Information:

The following section "M-Bus - Configuration" is based solely on the B&R standard interface.

9.18.3.8.6.1 Data length

Name:

CfO_LengthData1 to CfO_LengthData8

The Standard interface is able to request data from the M-Bus slave with different lengths. When using Automation Studio the value of the "Length" register is a result of the data type defined for the X2X Link. All common data types with up to 4 bytes in length are supported.

| Data type | Value | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 8 |

Bit structure:

| Bit | Name | Value | Information |
|-------|------------------|---------|--|
| 0 - 5 | Data length code | 00 0000 | USINT |
| | | 00 0001 | SINT |
| | | 00 0010 | UINT |
| | | 00 0100 | INT |
| | | 00 1000 | UDINT (bus controller default setting) |
| | | 01 0000 | DINT |
| | | 10 0000 | REAL |
| 6 - 7 | Reserved | 0 | |

9.18.3.8.6.2 Transfer rate

Name:

CfO_BaudData1 to CfO_BaudData8

This register can be used to define the transfer rate for retrieving the desired values.

| Data type | Value | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 4 |

Bit structure:

| Bit | Name | Value | Information |
|-------|------------------|-------|--|
| 0 - 3 | Baud rate (Code) | 0000 | Reserved! |
| | | 0001 | 300 bit/s |
| | | 0010 | 600 bit/s |
| | | 0011 | 1200 bit/s |
| | | 0100 | 2400 bits/s (bus controller default setting) |
| | | 0101 | 4800 bit/s |
| | | 0110 | 9600 bit/s |
| | | 0111 | 19200 bit/s |
| | | 1000 | 38400 bit/s |
| 4 - 7 | Reserved | 0 | |

9.18.3.8.6.3 Address

Name:

CfO_PAdrData1 to CfO_PAdrData8

This register can be used to define the address where the desired values will be requested from.

| Data type | Value | Information |
|-----------|----------|-------------------------------------|
| USINT | 1 to 250 | Bus controller default setting: 254 |

Special addresses:

| Value | Information |
|------------|--|
| 251 to 253 | Reserved (in accordance with M-Bus specification) |
| 254 | Broadcast address (response from all connected slaves - risk of collision) |

9.18.3.8.6.4 Index

Name:

CfO_IndexData1 to CfO_IndexData8

This register is used to specify the ordinal number of the value (independent of the medium). This value results from the order of values in the slave. The value is then transferred to the data register.

| Data type | Value | Information |
|-----------|----------|-----------------------------------|
| USINT | 1 to 255 | Bus controller default setting: 1 |

9.18.3.8.6.5 Specifies the refresh time

Name:

CfO_ReqTimeData1 to CfO_ReqTimeData8

The slave information can be queried manually or time-based. A time-controlled query must include the value for the refresh time. The associated unit is defined in register "M-Bus mode" on page 2125.

| Data type | Value | Information |
|-----------|----------|---|
| USINT | 1 to 255 | In [s, min]. Bus controller default setting: 0 |

9.18.3.8.6.6 M-Bus mode

Name:

CfO_MBusModeData1 to CfO_MBusModeData8

To speed up the module's boot procedure, various configuration details that define the module's behavior have been combined in this register.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 2 |

Bit structure:

| Bit | Description | Value | Information |
|---------|-----------------------------|-------|---|
| 0 - 2 | Byte offset | 0 - 7 | Data types. Bus controller default setting: 2 |
| 3 - 4 | Reserved | 0 | |
| 5 | InitFrame | 0 | No additional frame (bus controller default setting) |
| | | 1 | Transmit additional frame |
| 6 | ApplicationResetFrame | 0 | No additional frame (bus controller default setting) |
| | | 1 | Transmit additional frame |
| 7 | Replacement value strategy | 0 | Hold last valid value (bus controller default setting) |
| | | 1 | Replace with static value |
| 8 | Time-based reading | 0 | Disabled (bus controller default setting) |
| | | 1 | Enabled |
| 9 | Manually triggered reading | 0 | Disabled (bus controller default setting) |
| | | 1 | Reading via register " MBusCommand " on page 2127 |
| 10 | Unit of periodic reading | 0 | [s] - Seconds (bus controller default setting) |
| | | 1 | [min] - Minutes |
| 11 - 15 | Reserved | 0 | |

Byte offset

The M-Bus specification allows for many individual data types. In order to also read these counter values with up to 64 bits, a slave value may have to be read using 2 data registers. The byte offset can be defined to select a desired section of the information.

9.18.3.8.6.7 Timeout offset

Name:

CfO_ToutOffData1 to CfO_ToutOffData8

The timeout for the M-Bus communication generally depends on the currently defined transfer rate. The user can also define an offset value in addition to the calculated standard timeout.

Timeout = standard timeout + (timeout offset * 10 ms)

| Data type | Value | Information |
|-----------|----------|--|
| USINT | 0 to 255 | Resolution 10 ms. Bus controller default setting: 0 |

9.18.3.8.6.8 Static replacement value

Name:

CfO_ReplData1 to CfO_ReplData8

This register defines the static replacement value if replacement value strategy "Replace with static value" was enabled in register "[CfO_MBusModeData](#)" on [page 2125](#). The data register takes on this value if an invalid input value is detected.

| Data type | Value | Information |
|--------------------------------------|------------------------|-----------------------------------|
| (U)SINT (U)INT (U)DINT REAL | According to data type | Bus controller default setting: 0 |

9.18.3.8.7 M-Bus - Communication

Three important control and status bytes are provided in the B&R interface for communication with the M-Bus slaves. Register "MBusCommand" on page 2127 switches UART on/off, for example, in order to increase the system's energy efficiency.

Up to 8 cyclic input registers are registered depending on the configuration. Manually configured data must be requested via register "MBusCommand" on page 2127. Registers "ValidDataByte" on page 2128 and "InvalidDataByte" on page 2128 can be used to determine the quality of the value currently read.

Information:

The following section "M-Bus - Communication" is based solely on the B&R standard interface.

9.18.3.8.7.1 M-Bus commands

Name:

MBusCommand

This register can be used to apply different commands to the module. The module only responds to positive edges.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|--------------------------------------|-------|-----------------|
| 0 | Activate UART | 0 → 1 | Execute command |
| 1 | Read manually triggered values | 0 → 1 | Execute command |
| 2 | Acknowledge the "MBusState" register | 0 → 1 | Execute command |
| 3 - 6 | Reserved | 0 | |
| 7 | Deactivate UART | 0 → 1 | Execute command |

Bit 0 and 7

The level converter is switched on by default when the module boots. This bit can be used to switch it on or off from the application to save electricity, for example.

9.18.3.8.7.2 M-Bus operation

Name:

MBusOperation

This register shows the user which task the module is currently processing. The LSB is always set when the UART is active. Manual commands are indicated by an increase of one in this byte while being processed.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|--|-------|---------------------------------------|
| 0 | UART | 0 | Inactive |
| | | 1 | Active |
| 1 | Read values | 0 | - |
| | | 1 | Command being processed |
| 2 | Refresh/reset the "MBusState" register | 0 | - |
| | | 1 | Command being processed ¹⁾ |
| 3 - 6 | Reserved | 0 | |
| 7 | UART | 0 | Inactive |
| | | 1 | Active |

1) Bit 2 is only set for one X2X cycle. Requesting this bit is not recommended when operating the module behind a bus controller.

9.18.3.8.7.3 M-Bus state

Name:
MBusState

This register contains the current M-Bus network error state. All bits are managed in nonvolatile memory. This means they must be reset via register "MBusCommand" on page 2127.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|--|-------|---|
| 0 | Collision detection | 0 | Error-free addressing |
| | | 1 | Multiple addresses on the bus |
| 1 | Read error (at least once) | 0 | Configured information OK |
| | | 1 | Could not read information |
| 2 | Checksum | 0 | Received checksum OK |
| | | 1 | Error in input direction |
| 3 | M-Bus load | 0 | Power supply OK |
| | | 1 | Load too high on M-Bus network |
| 4 | Communication aborted due to overflow | 0 | Everything OK |
| | | 1 | The master is overloaded and cannot take on any additional requests. Corrective measure: Repeat the request. ¹⁾ |
| 5 | Communication aborted due to level converter | 0 | Everything OK |
| | | 1 | Level converter is OFF (aborted at runtime or not started). |
| 6 | Data exchange since startup | 0 | Valid data not yet received |
| | | 1 | Valid data at least once |
| 7 | UART off MBUS ENABLE | 0 | M-Bus driver, level converter inactive |
| | | 1 | Module ready for communication |

1) Communication is reestablished automatically as soon as the pending communication jobs have been processed.

9.18.3.8.7.4 Valid data

Name:
ValidDataByte

ValidData1 to ValidData8

This register indicates (by bit) which of the max. 8 read values are valid.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|------------|-------|-----------------|
| 0 | ValidData1 | 0 | Value 1 invalid |
| | | 1 | Value 1 valid |
| ... | ... | ... | ... |
| 7 | ValidData8 | 0 | Value 8 invalid |
| | | 1 | Value 8 valid |

9.18.3.8.7.5 Invalid data

Name:
InvalidDataByte

InvalidData1 to InvalidData8

The validity of the read values can be checked redundantly. This register indicates (by bit) which of the max. 8 read values are invalid.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|--------------|-------|-----------------|
| 0 | InvalidData1 | 0 | Value 1 valid |
| | | 1 | Value 1 invalid |
| ... | ... | ... | ... |
| 7 | InvalidData8 | 0 | Value 8 valid |
| | | 1 | Value 8 invalid |

9.18.3.8.7.6 Data

Name:

Data1 to Data8

Each cyclic data register contains the respective pre-configured value from the M-Bus network. The data type of the data register was designed to be variable and must be specified by the user during configuration.

Information:

Because X2X Link can only transfer a certain number of bytes cyclically, the user must make his selection accordingly.

| Data type | Value |
|--------------------------------------|------------------------|
| (U)SINT (U)INT (U)DINT REAL | According to data type |

9.18.3.8.7.7 Change the serial number of an M-bus slave

Name:

ChangedSNByte

This register indicates (by bit) whether one of the M-Bus slave serial numbers on the bus has changed. Only the serial numbers of the slaves accessed via the B&R interface are checked. The respective bit is toggled if a change is detected.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|--------------|--------|-------------------------------|
| 0 | SN (Slave 1) | 0 -> 1 | Slave1: Serial number changed |
| | | 1 -> 0 | |
| ... | ... | ... | ... |
| 7 | SN (Slave 8) | 0 -> 1 | Slave8: Serial number changed |
| | | 1 -> 0 | |

9.18.3.8.7.8 M-Bus slave serial numbers

Name:

SNDData1 to SNDData8

These registers contain the serial numbers of the M-Bus slaves that are queried via the B&R interface. They are implemented acyclically and can be read using library AsIOAcc.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.18.3.8.8 Flatstream communication

For a description of Flatstream communication, see ["Flatstream communication" on page 3802](#)

9.18.3.8.9 M-Bus with FlatStream

When using FlatStream communication, the module acts as a bridge between the X2X master and an intelligent field device connected to the module. FlatStream mode can be used for either point-to-point connections as well as for bus systems. Specific algorithms such as timeout and checksum monitoring are usually managed automatically. During normal operation, the user does not have direct access to these details.

Operation

The M-Bus specification recognizes four different frame types. From the application standpoint, only "long frames" are generated and transferred when using the M-Bus via FlatStreams. Due to the flexible design of the M-Bus protocol, the user must include the corresponding slave configuration with each request.

| FlatStream structure | | |
|-----------------------------------|-----------------------------|---|
| In-/OutputSequence (unchanged) | Control byte (unchanged) | Rx-/TxBytes M-Bus data (FlatStream) |

9.18.3.8.9.1 FlatStream in output direction

FlatStream query

This standard protocol specifies that a data query via FlatStream consists of a main part and two index records. An index record is made up of an introduction containing various information and followed by a parameter block.

Introduction

The primary role of the main part is to assign a synchronization number and register the protocol type.

Note 1

When registering an undefined protocol type, the module works with the standard protocol.

Note 2

Because there is currently only one protocol type defined, the corresponding configuration bytes should be set to 1. This will allow the protocol to be expanded later without becoming incompatible with existing projects.

| Bytes | Name | Value | Description |
|-------|--|---------|---|
| 1 | Frame number: For synchronization in the application | 0 - 255 | The frame number is repeated in the module's response. This allows the later response from the module to be distinctly attributed to the request. |
| 2 | Index Record Count "i" | 2! | Number of subsequent index records |
| 3 | Protocol type | 0 | Native M-Bus (level converter mode) - see "Native M-Bus" |
| | | 1 | Data query (raw data / parameters) |
| 4 | Reserved | 1! | |
| ... | Index record (configuration) | | |
| ... | Index record (data query) | | |

Native M-Bus

The "Native M-Bus" protocol type provides universal communication within the M-Bus network. It can be used to assemble and send M-Bus frames in the application.

A conventional data query is possible using a raw data or parameter query.

Index record 0

Configuration block

The interface parameters for defining the module's behavior in the M-Bus network must be chosen configuration part.

Information:

With the standard protocol, the index record must be resent with each request for configuration.

Introduction

| Bytes | Name | Value | Description |
|-------|----------------------------------|-------|---------------------------------------|
| 1 | Index record type | 0! | Module interface configuration |
| 2 | Counter (config parameter) | 5! | Number of subsequent M-Bus parameters |
| 3 | Length of parameter block - Low | 19! | Length of index record description |
| 4 | Length of parameter block - High | 0! | Length of index record description |

Parameter block

Configuration parameter 0 - Addressing type

| Bytes | Name | Value | Description |
|-------|------------------|-------|----------------------------------|
| 1 | Parameter number | 0! | |
| 2 | Length | 1! | |
| 3 | Addressing type | 1 | Addressing via primary address |
| | | 2 | Addressing via secondary address |

Configuration parameter 1 - Address

| Bytes | Name | Value | Description |
|-------|--------------------|---------|---------------------------|
| 4 | Parameter number | 1! | |
| 5 | Length | 4! | |
| 6 | Address - LowLow | 1 - 255 | Primary address |
| 7 | Address - LowHigh | 0 - 255 | 0!, if primary addressing |
| 8 | Address - HighLow | 0 - 255 | 0!, if primary addressing |
| 9 | Address - HighHigh | 0 - 255 | 0!, if primary addressing |

Configuration parameter 2 - Transfer rate

| Bytes | Name | Value | Description |
|-------|--------------------|---------|-----------------------------------|
| 10 | Parameter number | 2! | |
| 11 | Length | 2! | |
| 12 | Transfer rate Low | 0 - 255 | Verified transfer rates |
| 13 | Transfer rate High | 0 - 255 | 300 bit/s, 2400 bit/s, 9600 bit/s |

Configuration parameter 3 - Timeout offset

| Bytes | Name | Value | Description |
|-------|------------------|---------|---|
| 14 | Parameter number | 3! | |
| 15 | Length | 1! | |
| 16 | TimeoutOffset | 0 - 255 | Additional time for timeout monitoring on the M-Bus (Resolution: 10 ms) |

Configuration parameter 4 - Extra frames

| Bytes | Name | Value | Description |
|-------|------------------|-------------|-----------------------------------|
| 17 | Parameter number | 4! | |
| 18 | Length | 1! | |
| 19 | M-Bus options | Bit 0 ... 1 | Send Init frame |
| | | Bit 1 ... 1 | Send application reset |
| | | Bit 6 ... 1 | Set frame count bit ¹⁾ |
| | | Bit 7 ... 1 | Request media and version |

1) Some M-Bus slaves use this bit to switch to a another data set.

Index record 1

Data query block

The M-Bus parameters to be retrieved from the memory of the M-Bus slaves are requested in the request part. The user can request certain parameters from the slave or the entire slave memory.

Introduction

| Bytes | Name | Value | Description |
|-------|---|---------|---|
| 1 | Index record type | 1! | Data request for M-Bus slave |
| 2 | Counter (data parameter) = (d + 1) | 0 | <ul style="list-style-type: none"> Communication via native M-Bus Read out M-Bus raw data |
| | | 1 - 20 | Number of parameters to read out |
| 3 | Length of subsequent block - Low | 0 - 255 | <ul style="list-style-type: none"> Length of M-Bus frame to be sent Length of parameter block 0! with raw data query |
| 4 | Length of subsequent block - High | 0 - 255 | <ul style="list-style-type: none"> Length of M-Bus frame to be sent Length of parameter block 0! with raw data query |
| ... | Depending on request: <ul style="list-style-type: none"> Native M-Bus frame Parameter block | | <i>Not needed if raw data query = 0</i> |

M-Bus frame

M-Bus frame to be sent

| Bytes | Name | Value | Description |
|-------|----------|---------|----------------------------|
| 1 | TxByte 1 | 0 - 255 | Byte 1 in output direction |
| 2 | TxByte 2 | 0 - 255 | Byte 2 in output direction |
| n | TxByte n | 0 - 255 | Byte n in output direction |

Parameter block

Data parameter 0

| Bytes | Name | Value | Description |
|-------|------------------|--------|-------------------------------|
| 1 | Parameter number | 0! | |
| 2 | Data index | 1 - 48 | Data index in the M-Bus frame |

Data parameter 1

| Bytes | Name | Value | Description |
|-------|------------------|--------|-------------------------------|
| 2 | Parameter number | 1! | |
| 3 | Data index | 1 - 48 | Data index in the M-Bus frame |

Data parameter d

| Bytes | Name | Value | Description |
|-------|------------------|--------|-------------------------------|
| ... | Parameter number | d! | |
| ... | Data index | 1 - 48 | Data index in the M-Bus frame |

9.18.3.8.9.2 FlatStream in input direction

FlatStream response

The standard protocol has three different responses according to the request.

Error response

The error response occurs when the module receives an invalid or incomplete request.

| Byte | Name | Value | Description |
|------|--|---------|---|
| 1 | Frame number: For synchronization in the application | 0 - 255 | This frame number is repeated in the module's response. In this way, the response of the module can be clearly assigned to the request. |
| 2 | Error code - LowLow | 0 - 255 | See the error code table. |
| 3 | Error code - LowHigh | 0 - 255 | See the error code table. |
| 4 | Error code - HighLow | 0 - 255 | See the error code table. |
| 5 | Error code - HighHigh | 0 - 255 | See the error code table. |
| 6 | Additional information - LowLow | 0 - 255 | Optional |
| 7 | Additional information - LowHigh | 0 - 255 | Optional |
| 8 | Additional information - HighLow | 0 - 255 | Optional |
| 9 | Additional information - HighHigh | 0 - 255 | Optional |

Error codes

| Error code and name | Error description |
|---------------------|--|
| 0x11111111 | An M-Bus counter is not responding to a data request. This can have different causes: <ul style="list-style-type: none"> The counter is not connected. The counter is defective. A counter with the selected addressing parameters does not exist on the bus. |
| 0x22222222 | This error code is transmitted if addressing via the secondary address and the selected counter does not respond. |
| 0x33333333 | If an invalid transfer rate is sent along with the stream, it is not evaluated. No M-Bus frame is sent; the Flatstream interface responds directly with this error code. |
| 0x44444444 | If a collision occurs on the bus while querying the data, the data request is ended and this error code is returned. |
| 0x55555555 | Communication aborted due to overflow (see bit 4 in section "M-Bus state" on page 2128) |
| 0x66666666 | Before the data is evaluated by the M-Bus counter, the checksum of the M-Bus frame is checked. If this is not correct, the received data is not processed further; instead, the error code is transmitted to the CPU. |
| 0x77777777 | The stream (CPU → IOM) is not correct. It is possible that a parameter number is not correct. The stream is checked very carefully, so an incorrect stream is never used. |
| 0x88888888 | Overload during M-Bus communication |
| 0x99999999 | Communication aborted due to level converter (see bit 5 in section "M-Bus state" on page 2128) |
| 0xA8AAAAAA | Interpretation of slave data not possible. The M-Bus slave being used is not compatible with the parameter query. The M-Bus slave must be implemented using the native M-Bus protocol or a raw data query. |

Additional information

| Additional information | Error description |
|------------------------|---|
| 0x00000001 | Number of index records less than 2 |
| 0x00000002 | Invalid stream length |
| 0x00000004 | Invalid index numbers |
| 0x00000008 | Incorrect number of parameters per index record |
| 0x00000010 | Index length too small |
| 0x00000020 | Incorrect parameter number for index record 0 |
| 0x00000040 | Incorrect parameter length for index record 0 |
| 0x00000080 | Invalid addressing type |
| 0x00000100 | Invalid address |
| 0x00000200 | Invalid transfer rate |
| 0x00000400 | Invalid timeout offset |
| 0x00000800 | Invalid additional frame configuration |

Response - native M-Bus

This response corresponds with a successfully transferred M-Bus frame created within the application.

| Bytes | Name | Value | Description |
|-------|--|---------|---|
| 1 | Frame number: For synchronization in the application | 0 - 255 | The frame number is repeated in the module's response. This allows the response from the module to be distinctly attributed to the request. |
| 2 | Reserved | 0 | |
| ... | Response | | |

Response

| Bytes | Name | Value | Description |
|-------|----------|---------|---------------------------|
| 1 | RxByte 1 | 0 - 255 | Byte 1 in input direction |
| 2 | RxByte 2 | 0 - 255 | Byte 2 in input direction |
| n | RxByte n | 0 - 255 | Byte n in input direction |

Response - Raw data

The raw data response is sent if the M-Bus slave's entire memory is requested.

| Bytes | Name | Value | Description |
|-------|--|---------|---|
| 1 | Frame number: For synchronization in the application | 0 - 255 | The frame number is repeated in the module's response. This allows the response from the module to be distinctly attributed to the request. |
| 2 | M-Bus status | 0 - 255 | Status info from M-Bus header |
| 3 | Raw data frame | 0 - 255 | Includes all bytes sent by the M-Bus slave. |
| ... | | 0 - 255 | |

Response - Parameters

The parameter response is sent if one or more parameters from an M-Bus slave have been requested.

| Bytes | Name | Value | Description |
|-------|--|---------|---|
| 1 | Frame number: For synchronization in the application | 0 - 255 | The frame number is repeated in the module's response. This allows the response from the module to be distinctly attributed to the request. |
| 2 | M-Bus status | 0 - 255 | Status info from M-Bus header |
| 3 | Parameter count "p" | 0 - 255 | Number of parameters received |
| 4 | M-Bus address | 0 - 255 | Primary address |
| 5 | Serial number - LowLow | 0 - 255 | Secondary address |
| 6 | Serial number - LowHigh | 0 - 255 | Secondary address |
| 7 | Serial number - HighLow | 0 - 255 | Secondary address |
| 8 | Serial number - HighHigh | 0 - 255 | Secondary address |
| 9 | VendorID – Low \ Version | 0 - 255 | See "M-Bus option (IndexRecord 0)" on page 2131 |
| 10 | VendorID – High \ Medium | 0 - 255 | See "M-Bus option (IndexRecord 0)" on page 2131 |
| 11 | Data structure (M-Bus) | 1 | Fixed data structure |
| | | 2 | Variable data structure |
| ... | Received parameter 1 through p | | <i>Not needed if parameter count = 0</i> |

Received parameter

| Bytes | Name | Value | Description |
|-------|---------------|---------|------------------------------------|
| 1 | Medium | 0 - 255 | Medium of subsequent counter value |
| 2 | Index | 0 - 255 | Index of subsequent counter value |
| 3 | Data length | 1 - 8 | Length of the counter value |
| | | 255 | If the parameter number is invalid |
| 4 | DIF | 0 - 255 | 0!, if fixed data structure |
| 5 | VIF | 0 - 255 | 0!, if fixed data structure |
| 6 | Counter value | 0 - 255 | LowLowLowLowLowLowLowLow |
| ... | | ... | ... |
| 13 | | 0 - 255 | HighHighHighHighHighHighHighHigh |

9.18.3.8.10 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μ s |

9.18.3.8.11 Minimum I/O update time

The minimum I/O update time defines how far the bus cycle can be reduced while still allowing an I/O update to take place in each cycle.

| Minimum I/O update time |
|-------------------------|
| 1 s |

9.18.4 X20CS1013

Data sheet version: 1.25

9.18.4.1 General information

The module is a DALI control device with an integrated power supply. Up to 64 operating devices can be connected. DALI stands for Digital Addressable Lighting Interface and enables easy and safe control of light fixtures using a standardized digital operating device interface. The DALI bus conforms with EN 62386 series of standards and is now supported by many electronic ballast manufacturers.

- Integrated power supply
- Up to 64 operating devices (individual addresses)
- Up to 16 groups (group addresses)
- Up to 16 scenes (scene lighting values)

9.18.4.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | X20 electronics module communication |  |
| X20CS1013 | X20 interface module, 1 DALI master interface | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |

Table 384: X20CS1013 - Order data


9.18.4.3 Technical data

| | |
|--|---|
| Model number | X20CS1013 |
| Short description | |
| Communication module | DALI master |
| General information | |
| B&R ID code | 0xDE85 |
| Diagnostics | |
| Module status | Yes, using status LED and software |
| Bus status | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.2 W |
| Internal I/O | 0.4 W |
| Additional power dissipation caused by actuators (resistive) [W] | 4 W |
| Isolation voltages | |
| Channel - Bus | 510 VAC / 1 minute |
| Certifications | |
| CE | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| DALI bus | |
| Insulation system | Basic insulation |
| Open-circuit voltage | 16.5 V \pm 5% |
| Short-circuit proof | Yes (current limiting) |
| Signal voltage | |
| Low | -6.5 V to 6.5 V (typically 0 V) |
| High | 11.5 V to 20.5 V (typically 16 V) |
| Signal current | |
| Low | \leq 250 mA (internally limited) |
| High | \leq 130 mA at voltages \geq 11.5 V |
| Transfer rate | 1200 baud |
| Maximum number of slaves | 64 |
| Data signal slew rate (Manchester bi-phase) | |
| Falling edge | 10 μ s \leq t _{fall} \leq 100 μ s |
| Rising edge | 10 μ s \leq t _{rise} \leq 100 μ s |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB06 or X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 385: X20CS1013 - Technical data

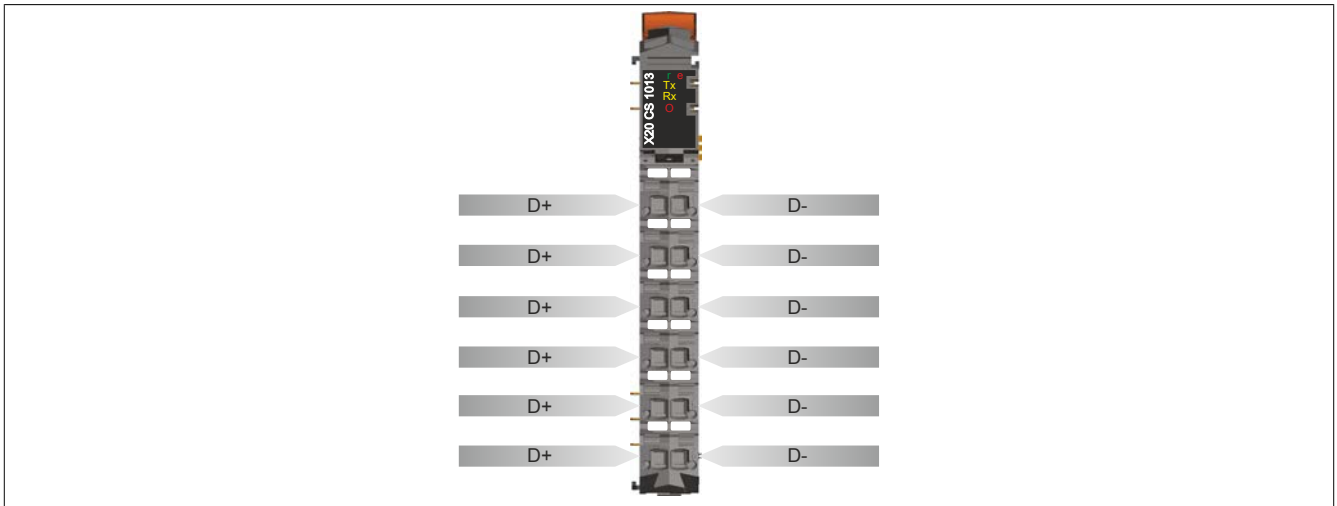
9.18.4.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-----|--------|---|--|
|  | r | Green | Off | No power to module |
| | | | On | RUN mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error status |
| | Tx | Yellow | | Control device (master) transmitting |
| | Rx | Yellow | | Operating device (slave) responding |
| O | Red | | Error status: Overload or short circuit | |

1) Depending on the configuration, a firmware update can take up to several minutes.

9.18.4.5 Pinout



9.18.4.6 Using an external power supply

Since the internal DALI power supply provides sufficient power for a configuration with up to 64 slaves, the module is not designed for an external power supply.

Warning!

Using an additional DALI power supply may result in damage to the module.

9.18.4.7 Register description

9.18.4.7.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.18.4.7.2 Function model 0 - default

| Register | Name | Data type | Read | | Write | |
|----------|-------------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 258 | Dali_State | UINT | • | | | |
| 263 | Dali_RequestCounter | USINT | • | | | |
| 261 | Dali_AnswerCounter | USINT | • | | | |
| 265 | Dali_Answer | USINT | • | | | |
| 257 | Dali_Enable | USINT | | | • | |
| 262 | Dali_Control | UINT | | | • | |
| 265 | Dali_Address | USINT | | | • | |
| 267 | Dali_Command | USINT | | | • | |

9.18.4.7.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|-------------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 258 | 0 | Dali_State | UINT | • | | | |
| 263 | 3 | Dali_RequestCounter | USINT | • | | | |
| 261 | 2 | Dali_AnswerCounter | USINT | • | | | |
| 265 | 4 | Dali_Answer | USINT | • | | | |
| 257 | 0 | Dali_Enable | USINT | | | • | |
| 262 | 2 | Dali_Control | UINT | | | • | |
| 265 | 4 | Dali_Address | USINT | | | • | |
| 267 | 5 | Dali_Command | USINT | | | • | |

1) The offset specifies the position of the register within the CAN object.

9.18.4.7.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "[Using I/O modules on the bus controller](#)" on page 3789.

9.18.4.7.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.18.4.7.4 General information

DALI stands for Digital Addressable Lighting Interface and is mainly used to control lighting systems. The communication standard is intended for building automation systems and described in the EN 62386 series of standards.

9.18.4.7.4.1 The DALI protocol

The DALI standard specifies bidirectional communication based on the "request and answer" principle. A DALI network may contain multiple masters. The serial asynchronous interface transmits voltage signals at a transfer rate of 1200 bits/s.

According to the DALI standard, up to 64 individual addresses can be assigned on the network. In addition, all of the slaves in the network can be addressed via broadcast and group addresses. 16 different group addresses can be assigned independently of the individual slave addresses. This makes it possible to send a command to multiple slaves at the same time.

9.18.4.7.5 DALI - Communication

The module provides the user with a channel for communicating with and controlling DALI slaves in a DALI network. The multi-master mode described in the DALI standard is accepted by the module but not actively supported.

9.18.4.7.5.1 Communication in the DALI network

The module supports all commands defined in the DALI standard.

Communication in the DALI network takes place using the 2 bytes of the following registers:

- "Address of the DALI slave" on page 2140
- "Direct or indirect command for receiver" on page 2140

Some commands are described in the DALI specification with the structure "YAAA AAAS XXXX XXXX". In order to translate this representation to the B&R interface, the two registers "DALI_Address" and "DALI_Command" must be viewed with "Byte" as the unit.

| Dali_Address | | | | | | | Dali_Command | | | | | | | | |
|--------------|---|---|---|---|---|---|--------------|---|---|---|---|---|---|---|---|
| MSB | 6 | 5 | 4 | 3 | 2 | 1 | LSB | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| Y | A | A | A | A | A | A | S | X | X | X | X | X | X | X | X |

Key

| | |
|---|--------------|
| Y | Address type |
| A | Address |
| S | Command type |
| X | Command |

Address of the DALI slave

Name:

Dali_Address

This register provides the module with the address of the DALI slave being addressed. It also defines the address type (single or group address) and command type (direct or indirect command).

| Data type | Value | Information |
|-----------|----------|--|
| USINT | 0 to 159 | Single or group address for direct or indirect command |
| | 254 | Broadcast address for direct DALI command |
| | 255 | Broadcast address for indirect DALI command |

Bit structure:

| Bit | Name | Value | Information |
|-------|--------------------------------|---------|-----------------------------------|
| 0 | Type of the subsequent command | 0 | Direct DALI command |
| | | 1 | Indirect DALI command |
| 1 - 6 | Address | 0 to 63 | Address of an individual slave |
| | | 0 to 15 | Address of a group of slaves |
| 7 | Type of the subsequent address | 0 | Addressing of an individual slave |
| | | 1 | Addressing of a group of slaves |

Direct or indirect command for receiver

Name:

Dali_Command

This register provides the module with the direct or indirect command for the receiver in the DALI network.

| Data type | Value | Information |
|-----------|----------|--------------------------------|
| USINT | 0 to 255 | DALI or slave-specific command |

9.18.4.7.5.2 Status in the DALI network

Name:

Dali_State

This register is used to indicate the current status of the DALI network.

| Data type | Value |
|-----------|--------------------|
| UINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|---------|--------------------------------------|-------|------------------------------------|
| 0 | Enables/Disables the level converter | 0 | Communication off |
| | | 1 | Communication on |
| 1 | Status of the last request | 0 | Valid request not yet sent |
| | | 1 | Transmit procedure successful |
| 2 | Status of the last response | 0 | No response since the last request |
| | | 1 | Receive procedure successful |
| 3 | Collision (multi-master) | 0 | No collision |
| | | 1 | Collision in the DALI network |
| 4 - 7 | Reserved | - | |
| 8 | Transmit error | 0 | No error |
| | | 1 | Transmit procedure failed |
| 9 | Receive error | 0 | No error |
| | | 1 | Invalid response received |
| 10 | TX busy | 0 | No transmission activity |
| | | 1 | Transmission taking place |
| 11 | RX busy | 0 | No receiving activity |
| | | 1 | Receiving taking place |
| 12 - 15 | Reserved | - | |

9.18.4.7.5.3 Transmission counter

Name:

Dali_RequestCounter

This register provides the user with information about how many DALI messages have already been sent by the module.

| Data type | Value |
|-----------|----------|
| USINT | 0 to 255 |

9.18.4.7.5.4 Response counter

Name:

Dali_AnswerCounter

This register provides the user with information about how many DALI messages have already been received by the module.

| Data type | Value |
|-----------|----------|
| USINT | 0 to 255 |

9.18.4.7.5.5 Response from DALI network

Name:

Dali_Answer

This register provides the user with access to the last valid response from the downstream DALI network.

| Data type | Value |
|-----------|----------|
| USINT | 0 to 255 |

9.18.4.7.5.6 Enabling the communication channel

Name:

Dali_Enable

This register is used to enable or disable the communication channel.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|--|-------|---|
| 0 | Turn communication on/off (via software) | 0 | Turn communication channel off |
| | | 1 | Turn communication channel on |
| 1 | Turn power saving mode on/off | 0 | Supply DALI network |
| | | 1 | Turn internal power supply for the module off |
| 2 - 7 | Reserved | - | |

Information:

for communication in the DALI network, the internal power supply in the module must be turned on.

9.18.4.7.5.7 Controlling the DALI module

Name:

Dali_Control

This register is used to control the module. The respective command is transported via X2X Link and then executed by the module. The register is edge-triggered (i.e. this type of command is only triggered if the state of the respective bit changes).

| Data type | Value |
|-----------|--------------------|
| UINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|--------|---|-------|---------------------------------------|
| 0 | Requests command (pos. edge) | 0 | No action |
| | | 1 | Transmits request in the DALI network |
| 1 | Reserved | - | |
| 2 | Acknowledges the status byte (pos. edge) | 0 | No action |
| | | 1 | Resets the status byte |
| 3 | Acknowledges the transmission counter (pos. edge) | 0 | No action |
| | | 1 | Resets the transmission counter |
| 4 | Acknowledges the response counter (pos. edge) | 0 | No action |
| | | 1 | Resets the response counter |
| 5 - 15 | Reserved | - | |

9.18.4.7.6 Excerpt from the DALI specification

9.18.4.7.6.1 General

The DALI standard involves 2 different command types. Direct commands control the brightness of the lights on the DALI slave being addressed. This type of communication runs only from the master to the slave.

Setting the LSB in the address register will use the included command for independent digital communication. The commands are also transferred from the master to the slave. Some requests require a response from the slave. In this case, communication from the slave to the master must also be possible.

9.18.4.7.6.2 Direct DALI commands (ARC)

These commands can be used to directly set the brightness of each DALI slave. The statements 1 to 254 correspond to a brightness of the connected DALI slave based on the following formula:

$$P = 10^{\frac{\text{Value} - 1}{253/3}} * \frac{P_{\max}}{1000}$$

Command 0 can also be transmitted to switch off a DALI slave. In this case, the brightness decreases slowly at first and then shuts off when a critical power level is crossed.

Command 255 serves as an internal mask value. It is not applied by the DALI slave, which means it has no effect on its behavior.

9.18.4.7.6.3 Indirect DALI commands for lamp wattage

Indirect commands make digital communication possible on the DALI network. In addition to the commands defined in the DALI standard, some manufacturers of DALI slaves also define their own commands.

Selected standardized DALI commands

Source: EN 62386-102:2009

| Code (dec.) | Function |
|---------------------------|--|
| Indirect control commands | |
| 0 | Switches off the light immediately <ul style="list-style-type: none"> – No smooth transition |
| 1 | 200 ms dimming up <ul style="list-style-type: none"> – Possible to configure the dimming speed separately – No further change once maximum is reached – Command ignored when light is off |
| 2 | 200 ms dimming down <ul style="list-style-type: none"> – Possible to configure the dimming speed separately – No further change once minimum is reached – Command does not turn light off |
| 3 | Increases the brightness by one step <ul style="list-style-type: none"> – No smooth transition – No further change once maximum is reached – Command ignored when light is off |
| 4 | Decreases the brightness by one step <ul style="list-style-type: none"> – No smooth transition – No further change once minimum is reached – Command does not turn light off |
| 5 | Maximum brightness <ul style="list-style-type: none"> – No smooth transition – Turns the light on |
| 6 | Minimum brightness <ul style="list-style-type: none"> – No smooth transition – Turns the light on |
| 7 | Decrease brightness by one step (including switching off) <ul style="list-style-type: none"> – No smooth transition – Command can turn light off |
| 8 | Increase brightness by one step (including switching on) <ul style="list-style-type: none"> – No smooth transition – Turns the light on |
| 9 | Commence DACP sequence <ul style="list-style-type: none"> – Starts direct power control – Dimming speed adjusted dynamically by the control device – DACP sequence required at the end |
| 10 - 15 | Reserved |
| 16 - 31 | Enables scene 0 to 15 <ul style="list-style-type: none"> – Power regulated to the level stored in the scene |

9.18.4.7.6.4 Indirect DALI commands for configuration

Indirect commands make digital communication possible on the DALI network. In addition to the commands defined in the DALI standard, some manufacturers of DALI slaves also define their own commands.

Information:

Some indirect DALI commands must be repeated within 100 ms. The module does not evaluate specified addresses and commands, which means this repetition must be ensured by the application.

Selected standardized DALI commands

Source: EN 62386-102:2009

| Code (dec.) | Function | Response | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|---|---|-----|-------|----------|---|---|----------------------|---|--------------------------|---|---|-----------------|---|---------------------|---|---|-----------|---|----------|---|---|--|---|--|---|---|---------------------------------|---|------------------------------------|---|---|-------------------------------|---|---------------------------|---|---|------------------------------|---|---------------------------------|---|---|---|---|---|
| Configuration commands ¹⁾ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 32 | Resets nonvolatile memory – DALI slave requires up to 300 ms for execution | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 33 | Reads out the current power level – Stores the current power value in the DTR – Command code 152 required | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 34 - 41 | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Save DTR value ¹⁾ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 42 | Save as maximum power value | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 43 | Save as minimum power value | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 44 | Save power value as value for event of error | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 45 | Save power value as switch-on value | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 46 | Save value as dimming time | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 47 | Save value as dimming speed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 48 - 63 | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Used for setting system parameters ¹⁾ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 64 - 79 | Save DTR value as selected scene 0 to 15 – Scene number = Command number - 64 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 80 - 95 | Removes DALI slave from scene 0 to 15 – Scene number = Command number - 80 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 96 - 111 | Adds DALI slave to group 0 to 15 – Group number = Command number - 96 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 112 - 127 | Removes DALI slave from group 0 to 15 – Group number = Command number - 112 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 128 | Save DTR value as short address | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 129 - 143 | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Request commands | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 144 | Checks the general status | <table border="1"> <thead> <tr> <th>Bit</th> <th>Value</th> <th>Function</th> </tr> </thead> <tbody> <tr> <td rowspan="2">0</td> <td>0</td> <td>DALI slave status OK</td> </tr> <tr> <td>1</td> <td>DALI slave status not OK</td> </tr> <tr> <td rowspan="2">1</td> <td>0</td> <td>Light status OK</td> </tr> <tr> <td>1</td> <td>Light status not OK</td> </tr> <tr> <td rowspan="2">2</td> <td>0</td> <td>Light off</td> </tr> <tr> <td>1</td> <td>Light on</td> </tr> <tr> <td rowspan="2">3</td> <td>0</td> <td>Last requested power level permissible</td> </tr> <tr> <td>1</td> <td>Last requested power level not permissible</td> </tr> <tr> <td rowspan="2">4</td> <td>0</td> <td>Last dimming procedure complete</td> </tr> <tr> <td>1</td> <td>Dimming procedure not yet complete</td> </tr> <tr> <td rowspan="2">5</td> <td>0</td> <td>DALI slave not in reset state</td> </tr> <tr> <td>1</td> <td>DALI slave in reset state</td> </tr> <tr> <td rowspan="2">6</td> <td>0</td> <td>DALI slave has short address</td> </tr> <tr> <td>1</td> <td>DALI slave has no short address</td> </tr> <tr> <td rowspan="2">7</td> <td>0</td> <td>Reset or control command not yet received by DALI slave</td> </tr> <tr> <td>1</td> <td>Reset or control command received by DALI slave</td> </tr> </tbody> </table> | Bit | Value | Function | 0 | 0 | DALI slave status OK | 1 | DALI slave status not OK | 1 | 0 | Light status OK | 1 | Light status not OK | 2 | 0 | Light off | 1 | Light on | 3 | 0 | Last requested power level permissible | 1 | Last requested power level not permissible | 4 | 0 | Last dimming procedure complete | 1 | Dimming procedure not yet complete | 5 | 0 | DALI slave not in reset state | 1 | DALI slave in reset state | 6 | 0 | DALI slave has short address | 1 | DALI slave has no short address | 7 | 0 | Reset or control command not yet received by DALI slave | 1 | Reset or control command received by DALI slave |
| Bit | Value | Function | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | 0 | DALI slave status OK | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1 | DALI slave status not OK | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 0 | Light status OK | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1 | Light status not OK | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | 0 | Light off | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1 | Light on | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | 0 | Last requested power level permissible | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1 | Last requested power level not permissible | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | 0 | Last dimming procedure complete | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1 | Dimming procedure not yet complete | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | 0 | DALI slave not in reset state | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1 | DALI slave in reset state | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | 0 | DALI slave has short address | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1 | DALI slave has no short address | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | 0 | Reset or control command not yet received by DALI slave | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1 | Reset or control command received by DALI slave | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 145 | Checks communication readiness | Yes/No | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 146 | Checks for light failure | Yes/No | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 147 | Checks whether light is currently on | Yes/No | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 148 | Checks whether the last requested power value was applied | Yes/No | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 149 | Checks whether the DALI slave is in reset state | Yes/No | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 150 | Checks whether the DALI slave has a short address | Yes/No | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 151 | Checks whether the DALI slave has a version number | The response depends on the DALI slave: <ul style="list-style-type: none"> • Yes/No (DALI slave has a version number or not) • Version number | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 152 | Checks the DTR value | DTR value | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 153 | Checks the device type | DALI-specific code for categorizing DALI slaves | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 154 | Checks the physical minimum level (greater than 0) | Value of physical minimum level | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 155 | Checks for power failure | Yes/No | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| Code (dec.) | Function | Response | | | | | | | | | | | | | | | | |
|-------------|---|--|-----|----------|----------|---------------|-------|----------------------|---|------------------|-----|--|--|---|---|-----------------------|---|-------------------|
| 156 - 159 | Reserved | | | | | | | | | | | | | | | | | |
| 160 | Checks the current power level | Current power level or 255 if the light is being warmed up | | | | | | | | | | | | | | | | |
| 161 | Checks the maximum value | Maximum value | | | | | | | | | | | | | | | | |
| 162 | Checks the minimum value | Minimum value | | | | | | | | | | | | | | | | |
| 163 | Checks the switch-on power level | Switch-on power level | | | | | | | | | | | | | | | | |
| 164 | Checks the power level in the event of error | Power level in the event of error | | | | | | | | | | | | | | | | |
| 165 | Checks the dimming time and dimming speed | <table border="1"> <thead> <tr> <th>Bit</th> <th>Function</th> </tr> </thead> <tbody> <tr> <td>0 - 3</td> <td>Dimming speed</td> </tr> <tr> <td>4 - 7</td> <td>Dimming time</td> </tr> </tbody> </table> | Bit | Function | 0 - 3 | Dimming speed | 4 - 7 | Dimming time | | | | | | | | | | |
| Bit | Function | | | | | | | | | | | | | | | | | |
| 0 - 3 | Dimming speed | | | | | | | | | | | | | | | | | |
| 4 - 7 | Dimming time | | | | | | | | | | | | | | | | | |
| 166 - 175 | Reserved | | | | | | | | | | | | | | | | | |
| 176 - 191 | Checks the light level for scene 0 to 15 | | | | | | | | | | | | | | | | | |
| 192 | Checks whether the DALI slave member is part of group 0 to 7 | <table border="1"> <thead> <tr> <th>Bit</th> <th>Value</th> <th>Function</th> </tr> </thead> <tbody> <tr> <td rowspan="2">0</td> <td>0</td> <td>Slave not in group 0</td> </tr> <tr> <td>1</td> <td>Slave in group 0</td> </tr> <tr> <td>...</td> <td></td> <td></td> </tr> <tr> <td rowspan="2">7</td> <td>0</td> <td>Slave not in group 7</td> </tr> <tr> <td>1</td> <td>Slave in group 7</td> </tr> </tbody> </table> | Bit | Value | Function | 0 | 0 | Slave not in group 0 | 1 | Slave in group 0 | ... | | | 7 | 0 | Slave not in group 7 | 1 | Slave in group 7 |
| Bit | Value | Function | | | | | | | | | | | | | | | | |
| 0 | 0 | Slave not in group 0 | | | | | | | | | | | | | | | | |
| | 1 | Slave in group 0 | | | | | | | | | | | | | | | | |
| ... | | | | | | | | | | | | | | | | | | |
| 7 | 0 | Slave not in group 7 | | | | | | | | | | | | | | | | |
| | 1 | Slave in group 7 | | | | | | | | | | | | | | | | |
| 193 | Checks whether the DALI slave member is part of group 8 to 15 | <table border="1"> <thead> <tr> <th>Bit</th> <th>Value</th> <th>Function</th> </tr> </thead> <tbody> <tr> <td rowspan="2">0</td> <td>0</td> <td>Slave not in group 8</td> </tr> <tr> <td>1</td> <td>Slave in group 8</td> </tr> <tr> <td>...</td> <td></td> <td></td> </tr> <tr> <td rowspan="2">7</td> <td>0</td> <td>Slave not in group 15</td> </tr> <tr> <td>1</td> <td>Slave in group 15</td> </tr> </tbody> </table> | Bit | Value | Function | 0 | 0 | Slave not in group 8 | 1 | Slave in group 8 | ... | | | 7 | 0 | Slave not in group 15 | 1 | Slave in group 15 |
| Bit | Value | Function | | | | | | | | | | | | | | | | |
| 0 | 0 | Slave not in group 8 | | | | | | | | | | | | | | | | |
| | 1 | Slave in group 8 | | | | | | | | | | | | | | | | |
| ... | | | | | | | | | | | | | | | | | | |
| 7 | 0 | Slave not in group 15 | | | | | | | | | | | | | | | | |
| | 1 | Slave in group 15 | | | | | | | | | | | | | | | | |
| 194 | Checks a 24-bit random address (H) | Random address (higher 8 bits) | | | | | | | | | | | | | | | | |
| 195 | Checks a 24-bit random address (M) | Random address (middle 8 bits) | | | | | | | | | | | | | | | | |
| 196 | Checks a 24-bit random address (L) | Random address (lower 8 bits) | | | | | | | | | | | | | | | | |
| 197 - 223 | Reserved | | | | | | | | | | | | | | | | | |
| 224 - 255 | Checks application-specific defined commands | | | | | | | | | | | | | | | | | |

- 1) Any command in the range 32 to 129 must be repeated within the next 100 ms. No other commands can be transmitted to the DALI slave being addressed during this time.

9.18.4.7.6.5 DALI special commands

In the DALI standard, special commands are described as a bit structure represented by the arrangement YAAAAAAS XXXXXXXX (see also "[Communication in the DALI network](#)" on page 2140). This section contains information about the most important special commands from the DALI specification.

Leave special modes

TERMINATE

YAAAAAAS XXXXXXXX 10100001 00000000
Switches all DALI slaves on the bus in normal mode

Write DTR

DATA TRANSFER REGISTER (DTR)

YAAAAAAS XXXXXXXX 10100011 xxxxxxxx
Writes the bit pattern xxxxxxxx to the Data Transfer Register (DTR)

Special addressing for address assignment

INITIALISE

YAAAAAAS XXXXXXXX 10100101 xxxxxxxx
Allows commands for special addressing within the next 15 minutes.

Information:

- The command must be sent twice within 100 ms.
- "TERMINATE" can be used to exit initialization early. Reinitializing (before the 15 minutes is completed) extends initialization by a further 15 minutes.

RANDOMISE

YAAAAAAS XXXXXXXX 10100111 00000000

Information:

The command must be sent twice within 100 ms.

**SEARCHADDRH
SEARCHADDRM
SEARCHADDRL**

YAAAAAAS XXXXXXXX 10110001 hhhhhhh
 10110011 mmmmmmm
 10110101 lllllll

"hhhhhhh", "mmmmmm" and "llllll" represent the currently "selected" 24-bit address in the DALI network.

COMPARE

YAAAAAAS XXXXXXXX 10101001 0000000

All slaves in the DALI network with a 24-bit address less than or equal to hhhhhhh mmmmmmm lllllll respond with YES. By repeatedly assigning new search addresses and using "COMPARE", it is possible to select the currently initialized slave with the smallest 24-bit address.

PROGRAM SHORT ADDRESS

YAAAAAAS XXXXXXXX 10110111 0aaaaaa1

The selected slave takes on the short address assigned to aaaaaa.

QUERY SHORT ADDRESS

YAAAAAAS XXXXXXXX = 10111011 0000000

The selected slave responds with its current short address. If no short address has been assigned, it responds with 255. This can be used to check the possible success of address assignment.

VERIFY SHORT ADDRESS

YAAAAAAS XXXXXXXX 10111001 0aaaaaa1

The selected slave responds with YES if the value specified on aaaaaa corresponds to its short address. This can be used to check the possible success of address assignment.

WITHDRAW

YAAAAAAS XXXXXXXX 10101011 0000000

The selected slave is excluded from the subsequent search with "COMPARE" statements but remains initialized and can be selected.

PHYSICAL SELECTION

YAAAAAAS XXXXXXXX = 10111011 0000000

The selected slave is excluded from the subsequent search with "COMPARE" statements, no longer initialized and can no longer be selected.

Additional special commands

Additional special commands can be found in the DALI standard.

9.18.4.7.7 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 µs |

9.18.4.7.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 30 ms |

9.18.5 X20(c)CS1020

Data sheet version: 3.38

9.18.5.1 General information

In addition to the standard I/O, complex devices often need to be connected. The X20CS communication modules are intended precisely for cases like this. As normal X20 electronics modules, they can be placed anywhere on the remote backplane.

- RS232 interface for serial, remote connection of complex devices to the X20 system

9.18.5.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.18.5.3 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | X20 electronics module communication |  |
| X20CS1020 | X20 interface module, 1 RS232 interface, max. 115.2 kbit/s | |
| X20cCS1020 | X20 interface module, coated, 1 RS232 interface, max. 115.2 kbit/s | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 386: X20CS1020, X20cCS1020 - Order data


9.18.5.4 Technical data

| Model number | X20CS1020 | X20cCS1020 |
|--|--|---|
| Short description | | |
| Communication module | 1x RS232 | |
| General information | | |
| B&R ID code | 0x1FCF | 0xE7F2 |
| Status indicators | Data transfer, operating status, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Data transfer | Yes, using status LED | |
| Power consumption | | |
| Bus | 0.01 W | |
| Internal I/O | 1.44 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| KC | Yes | - |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | - |
| Interfaces | | |
| Interface IF1 | | |
| Signal | RS232 | |
| Variant | Connection made using 12-pin X20TB12 terminal block | |
| Max. distance | 900 m | |
| Transfer rate | Max. 115.2 kbit/s | |
| FIFO buffer | 1 kB | |
| Handshake lines | RTS, CTS | |
| Controller | UART type 16C550 compatible | |
| Electrical properties | | |
| Electrical isolation | RS232 (IF1) isolated from bus RS232 (IF1) not isolated from I/O power supply | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating" | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB06 or X20T-B12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB06 or X20T-B12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 387: X20CS1020, X20cCS1020 - Technical data

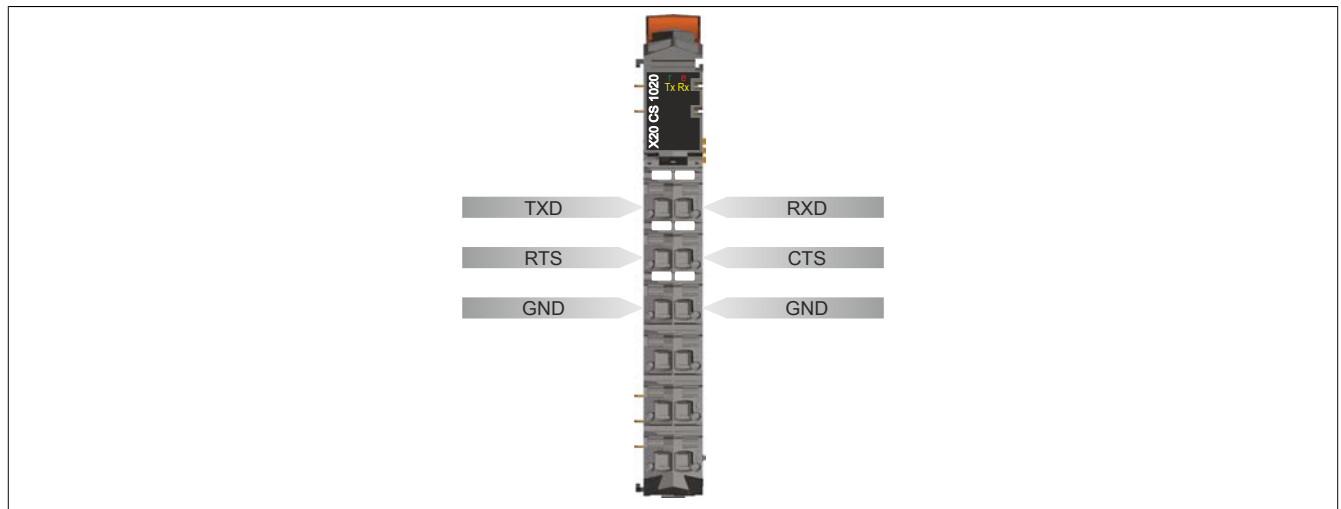
9.18.5.5 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|--------|-----------------------------|---|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Single flash | An I/O error has occurred, see " Error message status bits " on page 2160 |
| | | | On | Error or reset status |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | Tx | Yellow | On | The module transmits data via the RS232 interface. |
| Rx | Yellow | On | The module receives data via the RS232 interface. | |

1) Depending on the configuration, a firmware update can take up to several minutes.

9.18.5.6 Pinout

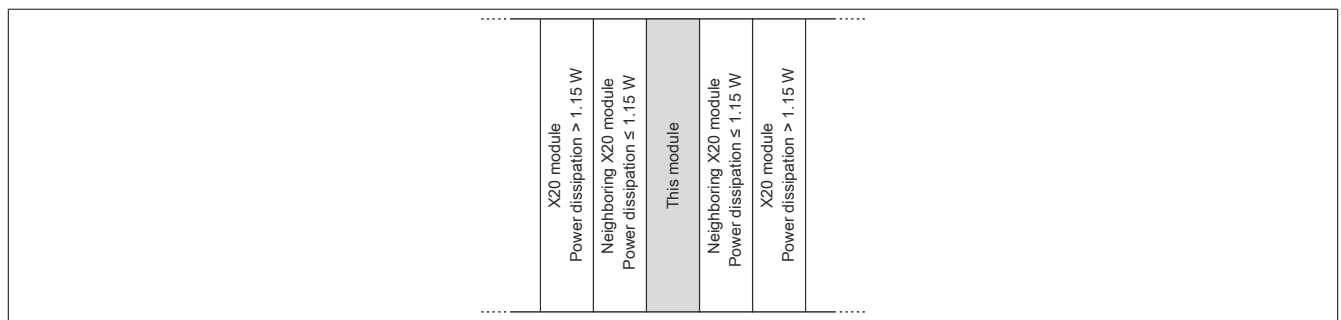


9.18.5.7 Derating

There is no derating when operated below 55°C.

During operation over 55°C, the power dissipation of the modules to the left and right of this module is not permitted to exceed 1.15 W!

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.



9.18.5.8 Register description

9.18.5.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.18.5.8.2 Function model 2 - Stream and Function model 254 - Cyclic stream

Function models "Stream" and "Cyclic stream" use a module-specific driver for the operating system. The interface can be controlled using library "DvFrame" and reconfigured at runtime.

Function model - Stream

In function model "Stream", the CPU communicates with the module acyclically. The interface is relatively convenient, but the timing is very imprecise.

Function model - Cyclic stream

Function model "Cyclic stream" was implemented later. From the application's point of view, there is no difference between function models "Stream" and "Cyclic stream". Internally, however, the cyclic I/O registers are used to ensure that communication follows deterministic timing.

Information:

- In order to use function models "Stream" and "Cyclic stream", you must be using B&R controllers of type "SG4".
- These function models can only be used in X2X Link and POWERLINK networks.

| Register | Name | Data type | Read | | Write | |
|--|-----------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module - Configuration | | | | | | |
| - | AsynSize | - | | | | |
| Status messages – Configuration | | | | | | |
| 50 | CfO_RxStateIgnoreMask | UINT | | | | • |
| 6273 | CfO_ErrorID0007 | USINT | | | | • |
| Status messages – Communication | | | | | | |
| 6145 | ErrorByte | USINT | • | | | |
| | StartBitError | Bit 0 | | | | |
| | StopBitError | Bit 1 | | | | |
| | ParityError | Bit 2 | | | | |
| | RXoverrun | Bit 3 | | | | |
| 6209 | ErrorQuitByte | USINT | | | • | |
| | QuitStartBitError | Bit 0 | | | | |
| | QuitStopBitError | Bit 1 | | | | |
| | QuitParityError | Bit 2 | | | | |
| | QuitRXoverrun | Bit 3 | | | | |

9.18.5.8.3 Function model 254 - Flatstream

Flatstream provides independent communication between an X2X Link master and the module. This interface was implemented as a separate function model for the module. Serial information is transferred via cyclic input and output registers. The sequence and control bytes are used to control the data stream (see "Flatstream communication" on page 3802).

When using function model Flatstream, the user can choose whether to use library "AsFltGen" in AS for implementation or to adapt Flatstream handling directly to the individual requirements of the application.

| Register | Name | Data type | Read | | Write | |
|---|-------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Serial interface - Configuration | | | | | | |
| 1 | phyMode | USINT | | | | • |
| 12 | phyBaud | UDINT | | | | • |
| 3 | phyData | USINT | | | | • |
| 5 | phyStop | USINT | | | | • |
| 7 | phyParity | USINT | | | | • |
| Handshake – Configuration | | | | | | |
| 66 | rxLock | UINT | | | | • |
| 70 | rxUnlock | UINT | | | | • |
| 34 | hssXOn | UINT | | | | • |
| 38 | hssXOff | UINT | | | | • |
| 42 | hssPeriod | UINT | | | | • |
| 19 | hshTxF | USINT | | | | • |
| 29 | hshRxF | USINT | | | | • |
| 27 | hshSet | USINT | | | | • |
| 25 | hshClr | USINT | | | | • |
| 17 | hshInv | USINT | | | | • |
| Frame – Configuration | | | | | | |
| 74 | rxCto | UINT | | | | • |
| 106 | txCto | UINT | | | | • |
| 78 | rxEomSize | UINT | | | | • |
| 110 | txEomSize | UINT | | | | • |
| Index * 4 + 82 | rxEomCharN (index N = 0 to 3) | UINT | | | | • |
| Index * 4 + 114 | txEomCharN (index N = 0 to 3) | UINT | | | | • |
| Status messages – Configuration | | | | | | |
| 50 | CfO_RxStateIgnoreMask | UINT | | | | • |
| 6273 | CfO_ErrorID0007 | USINT | | | | • |
| Status messages – Communication | | | | | | |
| 6145 | ErrorByte | USINT | • | | | |
| | StartBitError | Bit 0 | | | | |
| | StopBitError | Bit 1 | | | | |
| | ParityError | Bit 2 | | | | |
| | RXoverrun | Bit 3 | | | | |
| 6209 | ErrorQuitByte | USINT | | • | | |
| | QuitStartBitError | Bit 0 | | | | |
| | QuitStopBitError | Bit 1 | | | | |
| | QuitParityError | Bit 2 | | | | |
| | QuitRXoverrun | Bit 3 | | | | |
| Flatstream | | | | | | |
| 225 | OutputMTU | USINT | | | | • |
| 227 | InputMTU | USINT | | | | • |
| 229 | Mode | USINT | | | | • |
| 231 | Forward | USINT | | | | • |
| 238 | ForwardDelay | UINT | | | | • |
| 128 | InputSequence | USINT | • | | | |
| Index + 128 | RxByteN (index N = 1 to 27) | USINT | • | | | |
| 160 | OutputSequence | USINT | | | • | |
| Index + 160 | TxByteN (index N = 1 to 27) | USINT | | | • | |

9.18.5.8.4 Function model 254 - Bus controller

Function model "Bus controller" is a reduced form of function model "Flatstream". Instead of up to 27 Tx / Rx bytes, a maximum of 7 Tx / Rx bytes can be used.

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|---|----------------------|-----------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Serial interface - Configuration | | | | | | | |
| 257 | - | phyMode_CANIO | USINT | | | | • |
| 268 | - | phyBaud_CANIO | UDINT | | | | • |
| 259 | - | phyData_CANIO | USINT | | | | • |
| 261 | - | phyStop_CANIO | USINT | | | | • |
| 263 | - | phyParity_CANIO | USINT | | | | • |
| Handshake – Configuration | | | | | | | |
| 322 | - | rxILock_CANIO | UINT | | | | • |
| 326 | - | rxIUnlock_CANIO | UINT | | | | • |
| 290 | - | hssXOn_CANIO | UINT | | | | • |
| 294 | - | hssXOff_CANIO | UINT | | | | • |
| 298 | - | hssPeriod_CANIO | UINT | | | | • |
| 275 | - | hshTxF_CANIO | USINT | | | | • |
| 285 | - | hshRxF_CANIO | USINT | | | | • |
| 281 | - | hshClr_CANIO | USINT | | | | • |
| 283 | - | hshSet_CANIO | USINT | | | | • |
| 287 | - | hshFrm_CANIO | USINT | | | | • |
| 273 | - | hshInv_CANIO | USINT | | | | • |
| Frame – Configuration | | | | | | | |
| 330 | - | rxCto_CANIO | UINT | | | | • |
| 362 | - | txCto_CANIO | UINT | | | | • |
| 334 | - | rxEomSize_CANIO | UINT | | | | • |
| 366 | - | txEomSize_CANIO | UINT | | | | • |
| Index*4 + 338 | - | rxEomCharN (N = 0 to 3) | UINT | | | | • |
| Index*4 + 370 | - | txEomCharN (N = 0 to 3) | UINT | | | | • |
| Status messages – Configuration | | | | | | | |
| 306 | - | CfO_RxStatelgnoreMask_CANIO | UINT | | | | • |
| 6273 | - | CfO_ErrorID0007 | USINT | | | | • |
| Status messages – Communication | | | | | | | |
| 6145 | - | ErrorByte | USINT | | • | | |
| | | StartBitError | Bit 0 | | | | |
| | | StopBitError | Bit 1 | | | | |
| | | ParityError | Bit 2 | | | | |
| | | RXoverrun | Bit 3 | | | | |
| 6209 | - | ErrorQuitByte | USINT | | | | • |
| | | QuitStartBitError | Bit 0 | | | | |
| | | QuitStopBitError | Bit 1 | | | | |
| | | QuitParityError | Bit 2 | | | | |
| | | QuitRXoverrun | Bit 3 | | | | |
| Flatstream | | | | | | | |
| 225 | - | OutputMTU | USINT | | | | • |
| 227 | - | InputMTU | USINT | | | | • |
| 229 | - | Mode | USINT | | | | • |
| 231 | - | Forward | USINT | | | | • |
| 238 | - | ForwardDelay | UINT | | | | • |
| 128 | 0 | InputSequence | USINT | • | | | |
| Index + 128 | Index | RxByteN (index N = 1 to 7) | USINT | • | | | |
| 160 | 0 | OutputSequence | USINT | | | • | |
| Index + 160 | Index | TxByteN (index N = 1 to 7) | USINT | | | • | |

1) The offset specifies the position of the register within the CAN object.

9.18.5.8.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.18.5.8.4.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.18.5.8.5 Serial interface - Configuration

The user has to configure 5 registers to operate the serial interface.

9.18.5.8.5.1 Mode_IF

Name:

phyMode

phyMode_CANIO

This register is used to determine the current operating mode of the interface.

Enabling the interface is only permitted after complete configuration of the other registers. If parameters need to be changed, the interface must first be disabled.

| Data type | Value | Description |
|-----------|-------|---|
| USINT | 0 | RS232 interface disabled (bus controller default setting) |
| | 2 | RS232 interface enabled |

9.18.5.8.5.2 Baudrate_IF

Name:

phyBaud

phyBaud_CANIO

This register sets the baud rate of the interface in bit/s.

| Data type | Value | Function |
|-----------|--------|---|
| UDINT | 1200 | 1.2 kbaud |
| | 2400 | 2.4 kbaud |
| | 4800 | 4.8 kbaud |
| | 9600 | 9.6 kbaud |
| | 19200 | 19.2 kbaud |
| | 38400 | 38.4 kbaud |
| | 57600 | 57.6 kbaud (bus controller default setting) |
| | 115200 | 115.2 kbaud |

9.18.5.8.5.3 Databit_IF

Name:

phyData

phyData_CANIO

This register is used to specify the number of bits to be transferred for each character.

| Data type | Value | Description |
|-----------|-------|--|
| USINT | 7 | 7 data bits |
| | 8 | 8 data bits (bus controller default setting) |

9.18.5.8.5.4 Stopbit_IF

Name:

phyStop

phyStop_CANIO

This register is used to define the number of stop bits.

| Data type | Values | Explanation |
|-----------|--------|---|
| USINT | 2 | 1 stop bit (bus controller default setting) |
| | 4 | 2 stop bits |

9.18.5.8.5.5 Parity_IF

Name:

phyParity

phyParity_CANIO

This register is used to define the parity check type. Possible values are ASCII coded.

| Data type | Value | Description |
|-----------|-------|---|
| USINT | 48 | "0" - (low) bit is always 0 |
| | 49 | "1" - (high) bit is always 1 |
| | 69 | "E" - (even) even parity (bus controller default setting) |
| | 78 | "N" - (no) no bit |
| | 79 | "O" - (odd) odd parity |

9.18.5.8.6 Handshake - Configuration

In order to guarantee that serial communication runs smoothly, the size of the receive buffer in the module must be known. In addition, the user can configure a software or hardware handshake algorithm.

9.18.5.8.6.1 Locking the receive buffer

Name:
rxILock
rxILock_CANIO

This register is used to configure the upper threshold of the receive buffer.

The two registers "Lock" and "Unlock" can be used for "flow control" monitoring of the communication. If the amount of data from the module input exceeds the value of register "Lock", flow control switches to state "Passive". To return to state "Active" or "Ready", the amount of data in the receive buffer must fall below the default value of register "Unlock".

Information:

These registers simulate the behavior of a Schmitt trigger, so the value of register "Lock" must be greater than the value of register "Unlock".

| Data type | Value | Description |
|-----------|-----------|--|
| UINT | 0 to 4095 | Upper limit of receive buffer. Bus controller default setting: 1024 |

9.18.5.8.6.2 Unlocking the receive buffer

Name:
rxIUnlock
rxIUnlock_CANIO

This register is used to configure the lower threshold of the receive buffer.

The two registers "Lock" and "Unlock" can be used for "flow control" monitoring of the communication. If the amount of data from the module input exceeds the value of register "Lock", flow control switches to state "Passive". To return to state "Active" or "Ready", the amount of data in the receive buffer must fall below the default value of register "Unlock".

Information:

These registers simulate the behavior of a Schmitt trigger, so the value of register "Lock" must be greater than the value of register "Unlock".

| Data type | Value | Description |
|-----------|-----------|---|
| UINT | 0 to 4095 | Lower limit of receive buffer. Bus controller default setting: 512 |

9.18.5.8.6.3 RTS evaluation

Name:
hshRxF
hshRxF_CANIO

These registers can be used to configure how the hardware handshake line RTS is controlled depending on the fill level of the receive buffer.

The two registers "TxF" and "RxF" can be used to enable flow control for the input or output direction. Communication takes place here via a ring buffer.

Information:

Only one hsh register can be configured for controlling the RTS line.

| Data type | Value | Description |
|-----------|-------|---|
| USINT | 0 | RTS line freely available for other flow control methods (bus controller default setting) |
| | 16 | RTS line is controlled by the fill level of the receive buffer |

9.18.5.8.6.4 CTS evaluation

Name:

hshTxF

hshTxF_CANIO

This register is used to configure how the CTS hardware handshake line is evaluated. Make sure wiring to the peer station is correct when CTS query is enabled.

The two registers "TxF" and "RxF" can be used to enable flow control for the input or output direction. Communication takes place here via a ring buffer.

| Data type | Value | Description |
|-----------|-------|--|
| USINT | 0 | CTS line ignored, transmission can take place at any time (bus controller default setting) |
| | 1 | CTS line active and is being used for flow control, transmit enable from the peer station |

9.18.5.8.6.5 Turn on software handshake

Name:

hssXOn

hssXOn_CANIO

This register can be used to configure the XOn character. The value 17 is the default, but any other value can also be configured.

The two registers "Xon" and "Xoff" can be used to initiate a software handshake for flow control. A valid ASCII character must be configured in both registers for this.

| Data type | Value | Description |
|-----------|----------|--|
| UINT | 0 to 255 | XOn ASCII character |
| | 65535 | No software handshake (bus controller default setting) |

9.18.5.8.6.6 Turn off software handshake

Name:

hssXOff

hssXOff_CANIO

This register can be used to configure the XOff character. The value 19 is the default, but any other value can also be configured.

The two registers "Xon" and "Xoff" can be used to initiate a software handshake for flow control. A valid ASCII character must be configured in both registers for this.

| Data type | Value | Description |
|-----------|----------|--|
| UINT | 0 to 255 | XOff ASCII character |
| | 65535 | No software handshake (bus controller default setting) |

9.18.5.8.6.7 Handshake repetition

Name:

hssPeriod

hssPeriod_CANIO

When using a software handshake, some applications require periodic repetition of the current status. The repeat time can be defined in this register in ms for this purpose.

| Data type | Value | Description |
|-----------|--------------|---|
| UINT | 0 | Automatic status repeat disabled |
| | 500 to 10000 | Retry interval in ms. Bus controller default setting: 5000 |

9.18.5.8.6.8 Enable handshake manually

Name:
hshSet
hshSet_CANIO

The two registers "Set" and "Clr" can be used to manually manage the handshake via the application. These registers can be used to force the output level of the RTS hardware handshake line to remain active.

Information:

Only one hsh register can be configured for controlling the RTS line.

| Data type | Value | Description |
|-----------|-------|---|
| USINT | 0 | RTS line freely available for other flow control methods (bus controller default setting) |
| | 16 | RTS line enabled |

9.18.5.8.6.9 Disable handshake manually

Name:
hshClr
hshClr_CANIO

The two registers "Set" and "Clr" can be used to manually manage the handshake via the application. These registers can be used to force the output level of the RTS hardware handshake line to remain passive.

Information:

Only one hsh register can be configured for controlling the RTS line.

| Data type | Value | Description |
|-----------|-------|---|
| USINT | 0 | RTS line freely available for other flow control methods (bus controller default setting) |
| | 16 | RTS line disabled |

9.18.5.8.6.10 Frame detection

Name:
hshFrm
hshFrm_CANIO

This register generally enables hardware-based frame detection. The RTS line is enabled as long as data is being transmitted. This Tx framing mode can be used to control external interface converters.

Information:

Only one hsh register can be configured for controlling the RTS line.

| Data type | Values | Explanation |
|-----------|--------|---|
| USINT | 0 | RTS line freely available for other flow control methods (bus controller default setting) |
| | 16 | Tx framing enabled for RTS line |
| | 80 | Tx framing enabled for RTS line (without echo) |

9.18.5.8.6.11 Inverting RTS/CTS

Name:
hshInv
hshInv_CANIO

This register can be used to create a logical inverse of the RTS/CTS signals.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|--|
| 0 | CTS signal | 0 | Inversion off (bus controller default setting) |
| | | 1 | Inversion on |
| 1 - 3 | Reserved | 0 | |
| 4 | RTS signal | 0 | Inversion off (bus controller default setting) |
| | | 1 | Inversion on |
| 5 - 7 | Reserved | 0 | |

9.18.5.8.7 Frame - Configuration

Different message termination codes can be specified in order to correctly create transmitted Tx frames and correctly interpret received Rx frames.

9.18.5.8.7.1 Terminating when a receive timeout occurs

Name:
rxCto
rxCto_CANIO

This register is used to set the duration until a receive timeout is triggered.

The message is considered to be terminated when nothing is transferred for the specified duration.

The time is specified here in characters to ensure that it is independent of the transfer rate. The number of characters is then multiplied by the time needed to transfer a character.

| Data type | Value | Description |
|-----------|------------|---|
| UINT | 0 | Function disabled |
| | 1 to 65535 | Receive timeout in characters. Bus controller default setting: 4 |

9.18.5.8.7.2 Terminating when a transmit timeout occurs

Name:
txCto
txCto_CANIO

This register is used to set the duration until a transmit timeout is triggered.

The message is considered to be terminated when nothing is transferred for the specified duration.

The time is specified here in characters to ensure that it is independent of the transfer rate. The number of characters is then multiplied by the time needed to transfer a character.

| Data type | Value | Description |
|-----------|------------|--|
| UINT | 0 | Function disabled |
| | 1 to 65535 | Transmit timeout in characters. Bus controller default setting: 5 |

9.18.5.8.7.3 Maximum number of bytes received

Name:
rxEomSize
rxEomSize_CANIO

These registers configure the maximum number of bytes in the receive frame.

The message is considered to be ended as soon as a frame with the specified size in bytes is transferred. The longest possible frame length is the size of the 4096-byte receive buffer. Larger frames cause the Receive Overrun error.

| Data type | Value | Description |
|-----------|-----------|---|
| UINT | 0 | Function disabled |
| | 1 to 4096 | Configurable receive frame length in characters. Bus controller default setting: 256 |

9.18.5.8.7.4 Maximum number of bytes transmitted

Name:
txEomSize
txEomSize_CANIO

These registers configure the maximum number of bytes in the transmit frame.

The message is considered to be ended as soon as a frame with the specified size in bytes is transferred. The longest possible frame length is the size of the 4096-byte transmit buffer. The configured transmit timeout is maintained after the frame has been sent.

| Data type | Value | Description |
|-----------|-----------|---|
| UINT | 0 | Function disabled |
| | 1 to 4096 | Configurable transmit frame length in characters. Bus controller default setting: 4096 |

9.18.5.8.7.5 Define receive terminator

Name:

rxEomChar0 to rxEomChar3

rxEomChar0_CANIO to rxEomChar3_CANIO

It is possible to configure a receive terminator for all registers.

The message is considered to be terminated as soon as one of the defined characters is transferred.

| Data type | Value | Description |
|-----------|----------|--|
| UINT | 0 to 255 | Frame terminator (ASCII code) |
| | 65535 | Function disabled (bus controller default setting) |

9.18.5.8.7.6 Define transmit terminator

Name:

txEomChar0 to txEomChar3

txEomChar0_CANIO to txEomChar3_CANIO

It is possible to configure a transmit terminator for all registers.

The message is considered to be terminated as soon as one of the defined characters is transferred.

| Data type | Value | Description |
|-----------|----------|--|
| UINT | 0 to 255 | Frame terminator (ASCII code) |
| | 65535 | Function disabled (bus controller default setting) |

9.18.5.8.8 Status messages - Configuration

The status messages provide the user with information about the current situation in the downstream serial network.

9.18.5.8.8.1 Error detection setting

Name:

CfO_RxStatelgnoreMask

CfO_RxStatelgnoreMask_CANIO

This register has a direct effect on UART operation. Error detection in general can be disabled using the low byte. If error detection is not disabled, the high byte can be used to specify that a detected error should be interpreted as the end of the message.

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| UINT | See bit structure. | 0 |

Bit structure:

| Bit | Name | Value | Information |
|--------|--|-------|---|
| 0 - 3 | Reserved | 0 | |
| 4 | StartBitError | 0 | Detect invalid start bit (bus controller default setting) |
| | | 1 | Ignore |
| 5 | StopBitError | 0 | Detect invalid stop bit (bus controller default setting) |
| | | 1 | Ignore |
| 6 | ParityError | 0 | Detect invalid parity bit (bus controller default setting) |
| | | 1 | Ignore |
| 7 | RXoverrun | 0 | Detect overflow in receive direction (bus controller default setting) |
| | | 1 | Ignore |
| 8 - 11 | Reserved | 0 | |
| 12 | StartBitError corresponds to the end of the frame (if bit 4 = 0) | 0 | Indicate error in module only (bus controller default setting) |
| | | 1 | Also signal end of frame |
| 13 | StopBitError corresponds to the end of the frame (if bit 5 = 0) | 0 | Indicate error in module only (bus controller default setting) |
| | | 1 | Also signal end of frame |
| 14 | ParityError corresponds to the end of the frame (if bit 6 = 0) | 0 | Indicate error in module only (bus controller default setting) |
| | | 1 | Also signal end of frame |
| 15 | RXoverrun corresponds to the end of the frame (if bit 7 = 0) | 0 | Indicate error in module only (bus controller default setting) |
| | | 1 | Also signal end of frame |

9.18.5.8.8.2 Forward error to the application

Name:

CfO_ErrorID0007

This register sets which error messages are forwarded to the application.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Name | Value | Information |
|-------|---------------|-------|---|
| 0 | StartBitError | 0 | Ignore (bus controller default setting) |
| | | 1 | Indicating a faulty start bit |
| 1 | StopBitError | 0 | Ignore (bus controller default setting) |
| | | 1 | Indicating a faulty stop bit |
| 2 | ParityError | 0 | Ignore (bus controller default setting) |
| | | 1 | Indicating a faulty parity bit |
| 3 | RXoverrun | 0 | Ignore (bus controller default setting) |
| | | 1 | Indicating an overflow in the receive direction |
| 4 - 7 | Reserved | 0 | |

9.18.5.8.9 Status messages - Communication

After configuration is completed, up to four status messages can be evaluated in the application.

9.18.5.8.9.1 Error message status bits

Name:
StartBitError
StopBitError
ParityError
RXoverrun

This register transfers the individual bits that indicate an error. If a error occurs, the corresponding bit is set and maintained until it is acknowledged.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---------------|-------|--|
| 0 | StartBitError | 0 | No error |
| | | 1 | Start bit error occurred ¹⁾ |
| 1 | StopBitError | 0 | No error |
| | | 1 | Stop bit error occurred ¹⁾ |
| 2 | ParityError | 0 | No error |
| | | 1 | Parity bit error occurred ¹⁾ |
| 3 | RXoverrun | 0 | No error |
| | | 1 | Receive buffer overflow occurred ²⁾ |
| 4 - 7 | Reserved | 0 | |

- 1) This error can result from things such as mismatched interface configurations or problems with the wiring.
- 2) This data point reports a receive buffer overrun. The buffer capacity on the module is exhausted and all subsequent data arriving at the interface is lost. An overrun always means that the data received on the module is not read fast enough by the higher-level system. The solution here is to optimize the cycle times of all transfer routes and task classes involved and utilize the available handshake options.

9.18.5.8.9.2 Acknowledging the status bits

Name:
QuitStartBitError
QuitStopBitError
QuitParityError
QuitRXoverrun

This register is used to transfer the individual bits that acknowledge an indicated error state. After one of the bits has been set, it can be reset using the corresponding acknowledgment bit.

If the error is still actively pending, the error status bit is not deleted. The acknowledgment bit can only be reset if the error status bit is no longer set.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|-------------------|-------|---|
| 0 | QuitStartBitError | 0 | No acknowledgment |
| | | 1 | Acknowledge start bit error |
| 1 | QuitStopBitError | 0 | No acknowledgment |
| | | 1 | Acknowledge stop bit error |
| 2 | QuitParityError | 0 | No acknowledgment |
| | | 1 | Acknowledge parity bit error |
| 3 | QuitRXoverrun | 0 | No acknowledgment |
| | | 1 | Acknowledge receive buffer overflow error |
| 4 - 7 | Reserved | 0 | |

9.18.5.8.10 Flatstream communication

For a description of Flatstream communication, see ["Flatstream communication" on page 3802](#)

9.18.5.8.11 Serial with FlatStream

When using FlatStream communication, the module acts as a bridge between the X2X Link master and an intelligent field device connected to the module. FlatStream mode can be used for either point-to-point connections as well as for multidrop systems. Specific algorithms such as timeout and checksum monitoring are usually managed automatically. During normal operation, the user does not have access to these details.

In a serial network, the module is always the master (DTE). Various adjustments can be made to ensure that signals are transmitted without errors.

The user can, for example, define a handshake algorithm or set the baud rate in order to adapt the transmission quality to the requirements of the application.

Operation

When using FlatStream, the general structure of the FlatStream frame must be maintained.

| Input/Output sequence | Tx/Rx bytes | |
|-----------------------|--------------------------|--|
| (unchanged) | Control byte (unchanged) | Serial frame (without handshake or similar measures) |

9.18.5.8.12 Acyclic frame size

Name:

AsynSize

When the stream is used, data is exchanged internally between the module and CPU. For this purpose, a defined amount of acyclic bytes is reserved for this slot.

Increasing the acyclic frame size leads to increased data throughput on this slot.

Information:

This configuration involves a driver setting that cannot be changed during runtime!

| Data type | Value | Information |
|-----------|---------|---|
| - | 8 to 28 | Acyclic frame size in bytes. Default = 24 |

9.18.5.8.13 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μ s |

9.18.5.8.14 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 200 μ s |

9.18.6 X20(c)CS1030

Data sheet version: 3.27

9.18.6.1 General information

In addition to the standard I/O, complex devices often need to be connected. The X20CS communication modules are intended precisely for cases like this. As normal X20 electronics modules, they can be placed anywhere on the remote backplane.

- RS485/RS422 interface for serial, remote connection of complex devices to the X20 system
- Integrated terminating resistor

9.18.6.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.18.6.3 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | X20 electronics module communication |  |
| X20CS1030 | X20 interface module, 1 RS422/485 interface, max. 115.2 kbit/s | |
| X20cCS1030 | X20 interface module, coated, 1 RS422/485 interface, max. 115.2 kbit/s | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 388: X20CS1030, X20cCS1030 - Order data


9.18.6.4 Technical data

| Model number | X20CS1030 | X20cCS1030 |
|--|--|---|
| Short description | | |
| Communication module | 1x RS485/RS422 | |
| General information | | |
| B&R ID code | 0x1FD0 | 0xE500 |
| Status indicators | Data transfer, terminating resistor, operating status, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Data transfer | Yes, using status LED | |
| Terminating resistor | Yes, using status LED | |
| Power consumption | | |
| Bus | 0.01 W | |
| Internal I/O | 1.44 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| KC | Yes | - |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | - |
| Interfaces | | |
| Interface IF1 | | |
| Signal | RS485/RS422 | |
| Variant | Connection made using 12-pin X20TB12 terminal block | |
| Max. distance | 1200 m | |
| Transfer rate | Max. 115.2 kbit/s | |
| FIFO buffer | 1 kB | |
| Terminating resistor | Integrated in the module | |
| Controller | UART type 16C550 compatible | |
| Electrical properties | | |
| Electrical isolation | RS485/RS422 (IF1) isolated from bus and I/O power supply | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating" | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB06 or X20T-B12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB06 or X20T-B12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 389: X20CS1030, X20cCS1030 - Technical data

9.18.6.5 LED status indicators

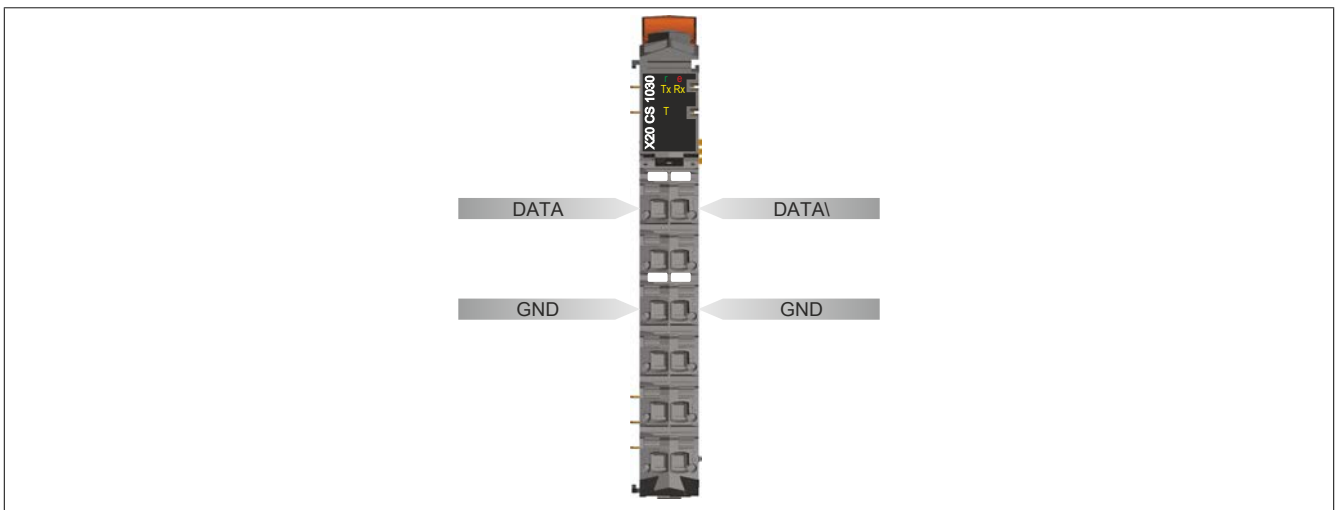
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|--------|-----------------------------|---|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | e | Red | On | RUN mode |
| | | | Off | No power to module or everything OK |
| | | | Single flash | An I/O error has occurred, see " Error message status bits " on page 2175 |
| | e + r | Red on / Green single flash | Error or reset status | Invalid firmware |
| | Tx | Yellow | On | The module transmits data via the RS485/RS422 interface |
| | Rx | Yellow | On | The module receives data via the RS485/RS422 interface |
| T | Yellow | On | Terminating resistor integrated in the module switched on | |

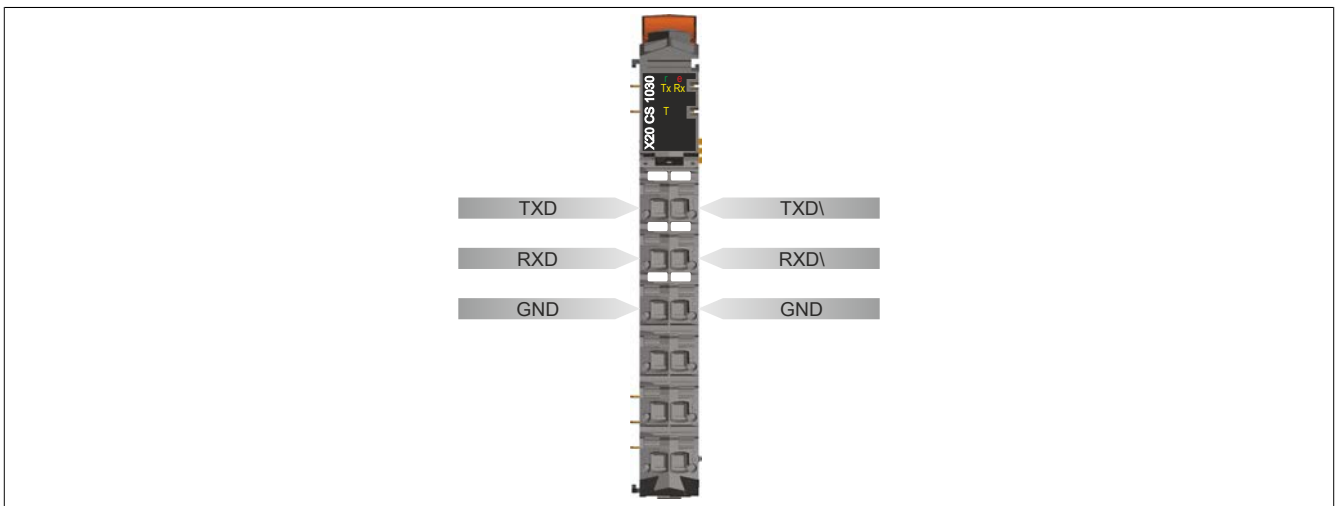
1) Depending on the configuration, a firmware update can take up to several minutes.

9.18.6.6 Pinout

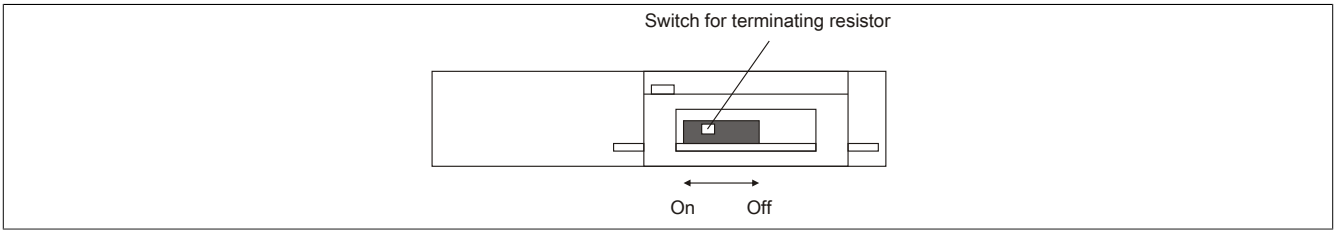
RS485 mode



RS422 mode



9.18.6.7 Terminating resistor



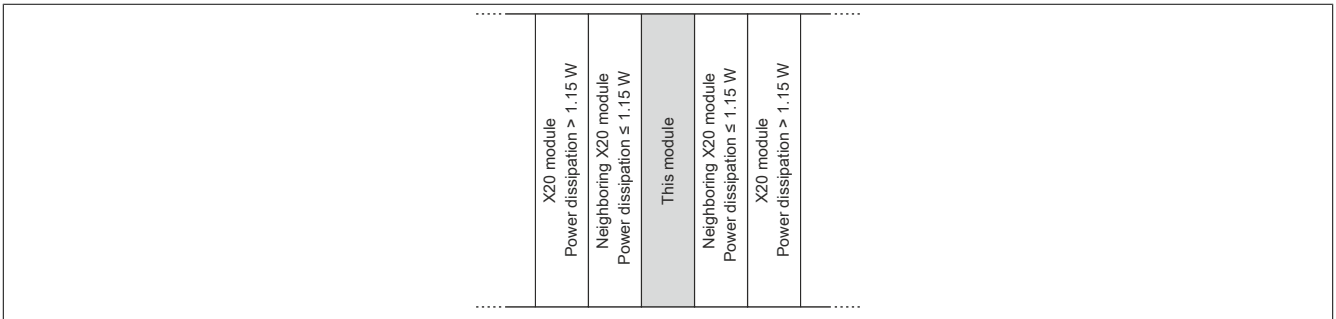
A terminating resistor is integrated in the communication module. It can be turned on and off with a switch on the bottom of the housing. An active terminating resistor is indicated by the "T" LED.

9.18.6.8 Derating

There is no derating when operated below 55°C.

During operation over 55°C, the power dissipation of the modules to the left and right of this module is not permitted to exceed 1.15 W!

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.



9.18.6.9 Register description

9.18.6.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.18.6.9.2 Function model 2 - Stream and Function model 254 - Cyclic stream

Function models "Stream" and "Cyclic stream" use a module-specific driver for the operating system. The interface can be controlled using library "DvFrame" and reconfigured at runtime.

Function model - Stream

In function model "Stream", the CPU communicates with the module acyclically. The interface is relatively convenient, but the timing is very imprecise.

Function model - Cyclic stream

Function model "Cyclic stream" was implemented later. From the application's point of view, there is no difference between function models "Stream" and "Cyclic stream". Internally, however, the cyclic I/O registers are used to ensure that communication follows deterministic timing.

Information:

- In order to use function models "Stream" and "Cyclic stream", you must be using B&R controllers of type "SG4".
- These function models can only be used in X2X Link and POWERLINK networks.

| Register | Name | Data type | Read | | Write | |
|--|-----------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module – Configuration | | | | | | |
| - | AsynSize | - | | | | |
| Status messages – Configuration | | | | | | |
| 50 | CfO_RxStateIgnoreMask | UINT | | | | • |
| 6273 | CfO_ErrorID0007 | USINT | | | | • |
| Status messages – Communication | | | | | | |
| 6145 | ErrorByte | USINT | • | | | |
| | StartBitError | Bit 0 | | | | |
| | StopBitError | Bit 1 | | | | |
| | ParityError | Bit 2 | | | | |
| | RXoverrun | Bit 3 | | | | |
| 6209 | ErrorQuitByte | USINT | | | • | |
| | QuitStartBitError | Bit 0 | | | | |
| | QuitStopBitError | Bit 1 | | | | |
| | QuitParityError | Bit 2 | | | | |
| | QuitRXoverrun | Bit 3 | | | | |

9.18.6.9.3 Function model 254 - Flatstream

Flatstream provides independent communication between an X2X Link master and the module. This interface was implemented as a separate function model for the module. Serial information is transferred via cyclic input and output registers. The sequence and control bytes are used to control the data stream (see "Flatstream communication" on page 3802).

When using function model Flatstream, the user can choose whether to use library "AsFltGen" in AS for implementation or to adapt Flatstream handling directly to the individual requirements of the application.

| Register | Name | Data type | Read | | Write | |
|---|-------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Serial interface - Configuration | | | | | | |
| 1 | phyMode | USINT | | | | • |
| 12 | phyBaud | UDINT | | | | • |
| 3 | phyData | USINT | | | | • |
| 5 | phyStop | USINT | | | | • |
| 7 | phyParity | USINT | | | | • |
| Handshake – Configuration | | | | | | |
| 66 | rxLock | UINT | | | | • |
| 70 | rxUnlock | UINT | | | | • |
| 34 | hssXOn | UINT | | | | • |
| 38 | hssXOff | UINT | | | | • |
| 42 | hssPeriod | UINT | | | | • |
| Frame – Configuration | | | | | | |
| 74 | rxCto | UINT | | | | • |
| 106 | txCto | UINT | | | | • |
| 78 | rxEomSize | UINT | | | | • |
| 110 | txEomSize | UINT | | | | • |
| Index * 4 + 82 | rxEomCharN (index N = 0 to 3) | UINT | | | | • |
| Index * 4 + 114 | txEomCharN (index N = 0 to 3) | UINT | | | | • |
| Status messages – Configuration | | | | | | |
| 50 | CfO_RxStateIgnoreMask | UINT | | | | • |
| 6273 | CfO_ErrorID0007 | USINT | | | | • |
| Status messages – Communication | | | | | | |
| 6145 | ErrorByte | USINT | • | | | |
| | StartBitError | Bit 0 | | | | |
| | StopBitError | Bit 1 | | | | |
| | ParityError | Bit 2 | | | | |
| | RXoverrun | Bit 3 | | | | |
| 6209 | ErrorQuitByte | USINT | | | • | |
| | QuitStartBitError | Bit 0 | | | | |
| | QuitStopBitError | Bit 1 | | | | |
| | QuitParityError | Bit 2 | | | | |
| | QuitRXoverrun | Bit 3 | | | | |
| Flatstream | | | | | | |
| 225 | OutputMTU | USINT | | | | • |
| 227 | InputMTU | USINT | | | | • |
| 229 | Mode | USINT | | | | • |
| 231 | Forward | USINT | | | | • |
| 238 | ForwardDelay | UINT | | | | • |
| 128 | InputSequence | USINT | • | | | |
| Index + 128 | RxByteN (index N = 1 to 27) | USINT | • | | | |
| 160 | OutputSequence | USINT | | | • | |
| Index + 160 | TxByteN (index N = 1 to 27) | USINT | | | • | |

9.18.6.9.4 Function model 254 - Bus controller

Function model "Bus controller" is a reduced form of function model "Flatstream". Instead of up to 27 Tx / Rx bytes, a maximum of 7 Tx / Rx bytes can be used.

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|---|----------------------|-----------------------------|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Serial interface - Configuration | | | | | | | |
| 257 | - | phyMode_CANIO | USINT | | | | • |
| 268 | - | phyBaud_CANIO | UDINT | | | | • |
| 259 | - | phyData_CANIO | USINT | | | | • |
| 261 | - | phyStop_CANIO | USINT | | | | • |
| 263 | - | phyParity_CANIO | USINT | | | | • |
| Handshake – Configuration | | | | | | | |
| 322 | - | rxILock_CANIO | UINT | | | | • |
| 326 | - | rxIUnlock_CANIO | UINT | | | | • |
| 290 | - | hssXOn_CANIO | UINT | | | | • |
| 294 | - | hssXOff_CANIO | UINT | | | | • |
| 298 | - | hssPeriod_CANIO | UINT | | | | • |
| Frame – Configuration | | | | | | | |
| 330 | - | rxCto_CANIO | UINT | | | | • |
| 362 | - | txCto_CANIO | UINT | | | | • |
| 334 | - | rxEomSize_CANIO | UINT | | | | • |
| 366 | - | txEomSize_CANIO | UINT | | | | • |
| Index*4 + 338 | - | rxEomCharN (N = 0 to 3) | UINT | | | | • |
| Index*4 + 370 | - | txEomCharN (N = 0 to 3) | UINT | | | | • |
| Status messages – Configuration | | | | | | | |
| 306 | - | CfO_RxStateIgnoreMask_CANIO | UINT | | | | • |
| 6273 | - | CfO_ErrorID0007 | USINT | | | | • |
| Status messages – Communication | | | | | | | |
| 6145 | - | ErrorByte | USINT | | • | | |
| | | StartBitError | Bit 0 | | | | |
| | | StopBitError | Bit 1 | | | | |
| | | ParityError | Bit 2 | | | | |
| | | RXoverrun | Bit 3 | | | | |
| 6209 | - | ErrorQuitByte | USINT | | | | • |
| | | QuitStartBitError | Bit 0 | | | | |
| | | QuitStopBitError | Bit 1 | | | | |
| | | QuitParityError | Bit 2 | | | | |
| | | QuitRXoverrun | Bit 3 | | | | |
| FlatStream | | | | | | | |
| 225 | - | OutputMTU | USINT | | | | • |
| 227 | - | InputMTU | USINT | | | | • |
| 229 | - | Mode | USINT | | | | • |
| 231 | - | Forward | USINT | | | | • |
| 238 | - | ForwardDelay | UINT | | | | • |
| 128 | 0 | InputSequence | USINT | • | | | |
| Index + 128 | Index | RxByteN (Index N = 1 to 7) | USINT | • | | | |
| 160 | 0 | OutputSequence | USINT | | | • | |
| Index + 160 | Index | TxByteN (Index N = 1 to 7) | USINT | | | • | |

1) The offset specifies the position of the register within the CAN object.

9.18.6.9.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.18.6.9.4.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.18.6.9.5 Serial interface - Configuration

The user has to configure 5 registers to operate the serial interface.

9.18.6.9.5.1 Mode_IF

Name:

phyMode

phyMode_CANIO

This register is used to determine the current operating mode of the interface.

Enabling the interface is only permitted after complete configuration of the other registers. If parameters need to be changed, the interface must first be disabled.

| Data type | Value | Description |
|-----------|-------|---|
| USINT | 0 | Interface disabled (bus controller default setting) |
| | 4 | RS422 interface enabled ¹⁾ |
| | 5 | RS422 interface enables as a bus ²⁾ |
| | 6 | RS485 interface enabled with echo |
| | 7 | RS485 interface enabled without echo |

1) Connection between 2 stations

2) Connections between multiple stations possible. Transmit lines connected as with RS485 TriState.

9.18.6.9.5.2 Baudrate_IF

Name:

phyBaud

phyBaud_CANIO

This register sets the baud rate of the interface in bit/s.

| Data type | Value | Function |
|-----------|--------|---|
| UDINT | 1200 | 1.2 kbaud |
| | 2400 | 2.4 kbaud |
| | 4800 | 4.8 kbaud |
| | 9600 | 9.6 kbaud |
| | 19200 | 19.2 kbaud |
| | 38400 | 38.4 kbaud |
| | 57600 | 57.6 kbaud (bus controller default setting) |
| | 115200 | 115.2 kbaud |

9.18.6.9.5.3 Databit_IF

Name:

phyData

phyData_CANIO

This register is used to specify the number of bits to be transferred for each character.

| Data type | Value | Description |
|-----------|-------|--|
| USINT | 7 | 7 data bits |
| | 8 | 8 data bits (bus controller default setting) |

9.18.6.9.5.4 Stopbit_IF

Name:

phyStop

phyStop_CANIO

This register is used to define the number of stop bits.

| Data type | Values | Explanation |
|-----------|--------|---|
| USINT | 2 | 1 stop bit (bus controller default setting) |
| | 4 | 2 stop bits |

9.18.6.9.5.5 Parity_IF

Name:

phyParity

phyParity_CANIO

This register is used to define the parity check type. Possible values are ASCII coded.

| Data type | Value | Description |
|-----------|-------|---|
| USINT | 48 | "0" - (low) bit is always 0 |
| | 49 | "1" - (high) bit is always 1 |
| | 69 | "E" - (even) even parity (bus controller default setting) |
| | 78 | "N" - (no) no bit |
| | 79 | "O" - (odd) odd parity |

9.18.6.9.6 Handshake - Configuration

In order to guarantee that serial communication runs smoothly, the size of the receive buffer in the module must be known. In addition, the user can configure a software or hardware handshake algorithm.

9.18.6.9.6.1 Locking the receive buffer

Name:

rxILock

rxILock_CANIO

This register is used to configure the upper threshold of the receive buffer.

The two registers "Lock" and "Unlock" can be used for "flow control" monitoring of the communication. If the amount of data from the module input exceeds the value of register "Lock", flow control switches to state "Passive". To return to state "Active" or "Ready", the amount of data in the receive buffer must fall below the default value of register "Unlock".

Information:

These registers simulate the behavior of a Schmitt trigger, so the value of register "Lock" must be greater than the value of register "Unlock".

| Data type | Value | Description |
|-----------|-----------|--|
| UINT | 0 to 4095 | Upper limit of receive buffer. Bus controller default setting: 1024 |

9.18.6.9.6.2 Unlocking the receive buffer

Name:

rxIUnlock

rxIUnlock_CANIO

This register is used to configure the lower threshold of the receive buffer.

The two registers "Lock" and "Unlock" can be used for "flow control" monitoring of the communication. If the amount of data from the module input exceeds the value of register "Lock", flow control switches to state "Passive". To return to state "Active" or "Ready", the amount of data in the receive buffer must fall below the default value of register "Unlock".

Information:

These registers simulate the behavior of a Schmitt trigger, so the value of register "Lock" must be greater than the value of register "Unlock".

| Data type | Value | Description |
|-----------|-----------|---|
| UINT | 0 to 4095 | Lower limit of receive buffer. Bus controller default setting: 512 |

9.18.6.9.6.3 Turn on software handshake

Name:

hssXOn

hssXOn_CANIO

This register can be used to configure the XOn character. The value 17 is the default, but any other value can also be configured.

The two registers "Xon" and "Xoff" can be used to initiate a software handshake for flow control. A valid ASCII character must be configured in both registers for this.

| Data type | Value | Description |
|-----------|----------|--|
| UINT | 0 to 255 | XOn ASCII character |
| | 65535 | No software handshake (bus controller default setting) |

9.18.6.9.6.4 Turn off software handshake

Name:

hssXOff

hssXOff_CANIO

This register can be used to configure the XOff character. The value 19 is the default, but any other value can also be configured.

The two registers "Xon" and "Xoff" can be used to initiate a software handshake for flow control. A valid ASCII character must be configured in both registers for this.

| Data type | Value | Description |
|-----------|----------|--|
| UINT | 0 to 255 | XOff ASCII character |
| | 65535 | No software handshake (bus controller default setting) |

9.18.6.9.6.5 Handshake repetition

Name:

hssPeriod

hssPeriod_CANIO

When using a software handshake, some applications require periodic repetition of the current status. The repeat time can be defined in this register in ms for this purpose.

| Data type | Value | Description |
|-----------|--------------|---|
| UINT | 0 | Automatic status repeat disabled |
| | 500 to 10000 | Retry interval in ms. Bus controller default setting: 5000 |

9.18.6.9.7 Frame - Configuration

Different message termination codes can be specified in order to correctly create transmitted Tx frames and correctly interpret received Rx frames.

9.18.6.9.7.1 Terminating when a receive timeout occurs

Name:
rxCto
rxCto_CANIO

This register is used to set the duration until a receive timeout is triggered.

The message is considered to be terminated when nothing is transferred for the specified duration.

The time is specified here in characters to ensure that it is independent of the transfer rate. The number of characters is then multiplied by the time needed to transfer a character.

| Data type | Value | Description |
|-----------|------------|---|
| UINT | 0 | Function disabled |
| | 1 to 65535 | Receive timeout in characters. Bus controller default setting: 4 |

9.18.6.9.7.2 Terminating when a transmit timeout occurs

Name:
txCto
txCto_CANIO

This register is used to set the duration until a transmit timeout is triggered.

The message is considered to be terminated when nothing is transferred for the specified duration.

The time is specified here in characters to ensure that it is independent of the transfer rate. The number of characters is then multiplied by the time needed to transfer a character.

| Data type | Value | Description |
|-----------|------------|--|
| UINT | 0 | Function disabled |
| | 1 to 65535 | Transmit timeout in characters. Bus controller default setting: 5 |

9.18.6.9.7.3 Maximum number of bytes received

Name:
rxEomSize
rxEomSize_CANIO

These registers configure the maximum number of bytes in the receive frame.

The message is considered to be ended as soon as a frame with the specified size in bytes is transferred. The longest possible frame length is the size of the 4096-byte receive buffer. Larger frames cause the Receive Overrun error.

| Data type | Value | Description |
|-----------|-----------|---|
| UINT | 0 | Function disabled |
| | 1 to 4096 | Configurable receive frame length in characters. Bus controller default setting: 256 |

9.18.6.9.7.4 Maximum number of bytes transmitted

Name:
txEomSize
txEomSize_CANIO

These registers configure the maximum number of bytes in the transmit frame.

The message is considered to be ended as soon as a frame with the specified size in bytes is transferred. The longest possible frame length is the size of the 4096-byte transmit buffer. The configured transmit timeout is maintained after the frame has been sent.

| Data type | Value | Description |
|-----------|-----------|---|
| UINT | 0 | Function disabled |
| | 1 to 4096 | Configurable transmit frame length in characters. Bus controller default setting: 4096 |

9.18.6.9.7.5 Define receive terminator

Name:

rxEomChar0 to rxEomChar3

rxEomChar0_CANIO to rxEomChar3_CANIO

It is possible to configure a receive terminator for all registers.

The message is considered to be terminated as soon as one of the defined characters is transferred.

| Data type | Value | Description |
|-----------|----------|--|
| UINT | 0 to 255 | Frame terminator (ASCII code) |
| | 65535 | Function disabled (bus controller default setting) |

9.18.6.9.7.6 Define transmit terminator

Name:

txEomChar0 to txEomChar3

txEomChar0_CANIO to txEomChar3_CANIO

It is possible to configure a transmit terminator for all registers.

The message is considered to be terminated as soon as one of the defined characters is transferred.

| Data type | Value | Description |
|-----------|----------|--|
| UINT | 0 to 255 | Frame terminator (ASCII code) |
| | 65535 | Function disabled (bus controller default setting) |

9.18.6.9.8 Status messages - Configuration

The status messages provide the user with information about the current situation in the downstream serial network.

9.18.6.9.8.1 Error detection setting

Name:

CfO_RxStatelgnoreMask

CfO_RxStatelgnoreMask_CANIO

This register has a direct effect on UART operation. Error detection in general can be disabled using the low byte. If error detection is not disabled, the high byte can be used to specify that a detected error should be interpreted as the end of the message.

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| UINT | See bit structure. | 0 |

Bit structure:

| Bit | Name | Value | Information |
|--------|--|-------|---|
| 0 - 3 | Reserved | 0 | |
| 4 | StartBitError | 0 | Detect invalid start bit (bus controller default setting) |
| | | 1 | Ignore |
| 5 | StopBitError | 0 | Detect invalid stop bit (bus controller default setting) |
| | | 1 | Ignore |
| 6 | ParityError | 0 | Detect invalid parity bit (bus controller default setting) |
| | | 1 | Ignore |
| 7 | RXoverrun | 0 | Detect overflow in receive direction (bus controller default setting) |
| | | 1 | Ignore |
| 8 - 11 | Reserved | 0 | |
| 12 | StartBitError corresponds to the end of the frame (if bit 4 = 0) | 0 | Indicate error in module only (bus controller default setting) |
| | | 1 | Also signal end of frame |
| 13 | StopBitError corresponds to the end of the frame (if bit 5 = 0) | 0 | Indicate error in module only (bus controller default setting) |
| | | 1 | Also signal end of frame |
| 14 | ParityError corresponds to the end of the frame (if bit 6 = 0) | 0 | Indicate error in module only (bus controller default setting) |
| | | 1 | Also signal end of frame |
| 15 | RXoverrun corresponds to the end of the frame (if bit 7 = 0) | 0 | Indicate error in module only (bus controller default setting) |
| | | 1 | Also signal end of frame |

9.18.6.9.8.2 Forward error to the application

Name:

CfO_ErrorID0007

This register sets which error messages are forwarded to the application.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Name | Value | Information |
|-------|---------------|-------|---|
| 0 | StartBitError | 0 | Ignore (bus controller default setting) |
| | | 1 | Indicating a faulty start bit |
| 1 | StopBitError | 0 | Ignore (bus controller default setting) |
| | | 1 | Indicating a faulty stop bit |
| 2 | ParityError | 0 | Ignore (bus controller default setting) |
| | | 1 | Indicating a faulty parity bit |
| 3 | RXoverrun | 0 | Ignore (bus controller default setting) |
| | | 1 | Indicating an overflow in the receive direction |
| 4 - 7 | Reserved | 0 | |

9.18.6.9.9 Status messages - Communication

After configuration is completed, up to four status messages can be evaluated in the application.

9.18.6.9.9.1 Error message status bits

Name:
StartBitError
StopBitError
ParityError
RXoverrun

This register transfers the individual bits that indicate an error. If a error occurs, the corresponding bit is set and maintained until it is acknowledged.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---------------|-------|--|
| 0 | StartBitError | 0 | No error |
| | | 1 | Start bit error occurred ¹⁾ |
| 1 | StopBitError | 0 | No error |
| | | 1 | Stop bit error occurred ¹⁾ |
| 2 | ParityError | 0 | No error |
| | | 1 | Parity bit error occurred ¹⁾ |
| 3 | RXoverrun | 0 | No error |
| | | 1 | Receive buffer overflow occurred ²⁾ |
| 4 - 7 | Reserved | 0 | |

- 1) This error can result from things such as mismatched interface configurations or problems with the wiring.
- 2) This data point reports a receive buffer overrun. The buffer capacity on the module is exhausted and all subsequent data arriving at the interface is lost. An overrun always means that the data received on the module is not read fast enough by the higher-level system. The solution here is to optimize the cycle times of all transfer routes and task classes involved and utilize the available handshake options.

9.18.6.9.9.2 Acknowledging the status bits

Name:
QuitStartBitError
QuitStopBitError
QuitParityError
QuitRXoverrun

This register is used to transfer the individual bits that acknowledge an indicated error state. After one of the bits has been set, it can be reset using the corresponding acknowledgment bit.

If the error is still actively pending, the error status bit is not deleted. The acknowledgment bit can only be reset if the error status bit is no longer set.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|-------------------|-------|---|
| 0 | QuitStartBitError | 0 | No acknowledgment |
| | | 1 | Acknowledge start bit error |
| 1 | QuitStopBitError | 0 | No acknowledgment |
| | | 1 | Acknowledge stop bit error |
| 2 | QuitParityError | 0 | No acknowledgment |
| | | 1 | Acknowledge parity bit error |
| 3 | QuitRXoverrun | 0 | No acknowledgment |
| | | 1 | Acknowledge receive buffer overflow error |
| 4 - 7 | Reserved | 0 | |

9.18.6.9.10 Flatstream communication

For a description of Flatstream communication, see ["Flatstream communication" on page 3802](#)

9.18.6.9.11 Serial with FlatStream

When using FlatStream communication, the module acts as a bridge between the X2X Link master and an intelligent field device connected to the module. FlatStream mode can be used for either point-to-point connections as well as for multidrop systems. Specific algorithms such as timeout and checksum monitoring are usually managed automatically. During normal operation, the user does not have access to these details.

In a serial network, the module is always the master (DTE). Various adjustments can be made to ensure that signals are transmitted without errors.

The user can, for example, define a handshake algorithm or set the baud rate in order to adapt the transmission quality to the requirements of the application.

Operation

When using FlatStream, the general structure of the FlatStream frame must be maintained.

| Input/Output sequence | Tx/Rx bytes | |
|-----------------------|--------------------------|--|
| (unchanged) | Control byte (unchanged) | Serial frame (without handshake or similar measures) |

9.18.6.9.12 Acyclic frame size

Name:

AsynSize

When the stream is used, data is exchanged internally between the module and CPU. For this purpose, a defined amount of acyclic bytes is reserved for this slot.

Increasing the acyclic frame size leads to increased data throughput on this slot.

Information:

This configuration involves a driver setting that cannot be changed during runtime!

| Data type | Value | Information |
|-----------|---------|---|
| - | 8 to 28 | Acyclic frame size in bytes. Default = 24 |

9.18.6.9.13 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μ s |

9.18.6.9.14 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 200 μ s |

9.18.7 X20CS1070

Data sheet version: 3.29

9.18.7.1 General information

In addition to the standard I/O, complex devices often need to be connected. The X20CS communication modules are intended precisely for cases like this. As normal X20 electronics modules, they can be placed anywhere on the remote backplane.

- CAN bus interface for serial, remote connection of complex devices to the X20 system
- Integrated terminating resistor

9.18.7.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | X20 electronics module communication |  |
| X20CS1070 | X20 interface module, 1 CAN bus interface, max. 1 Mbit/s, object buffers in both send and receive directions | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |

Table 390: X20CS1070 - Order data


9.18.7.3 Technical data

| | |
|--|--|
| Model number | X20CS1070 |
| Short description | |
| Communication module | 1x CAN bus |
| General information | |
| B&R ID code | 0x1FD1 |
| Status indicators | Data transfer, terminating resistor, operating status, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Data transfer | Yes, using status LED |
| Terminating resistor | Yes, using status LED |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.44 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| Interfaces | |
| Interface IF1 | |
| Signal | CAN bus |
| Variant | Connection made using 12-pin X20TB12 terminal block |
| Max. distance | 1000 m |
| Transfer rate | Max. 1 Mbit/s |
| Terminating resistor | Integrated in the module |
| Controller | SJA 1000 |
| Electrical properties | |
| Electrical isolation | CAN (IF1) isolated from bus and I/O power supply |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating" |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB06 or X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm |

Table 391: X20CS1070 - Technical data

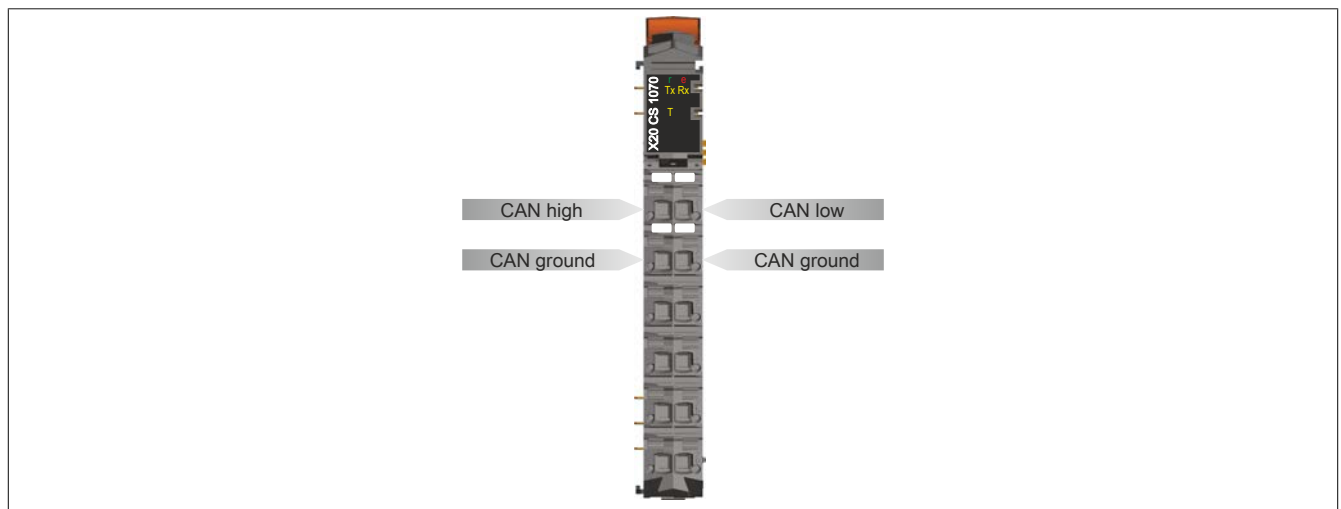
9.18.7.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

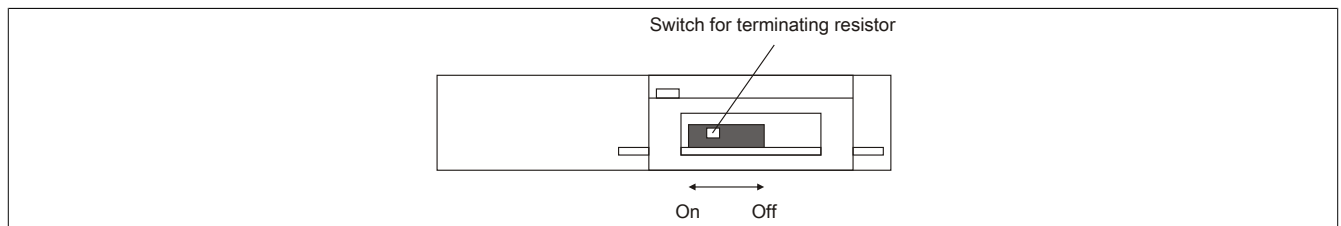
| Figure | LED | Color | Status | Description |
|---|-------|--------|-----------------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Single flash | I/O error occurred <ul style="list-style-type: none"> • CAN bus: Warning, passive or off • Buffer overflow |
| | | | On | Error or reset status |
| | e + r | | Red on / Green single flash | Invalid firmware |
| | Tx | | Yellow | On |
| Rx | | Yellow | On | The module is receiving data via the CAN bus interface |
| T | | Yellow | On | Terminating resistor integrated in the module switched on |

1) Depending on the configuration, a firmware update can take up to several minutes.

9.18.7.5 Pinout



9.18.7.6 Terminating resistor



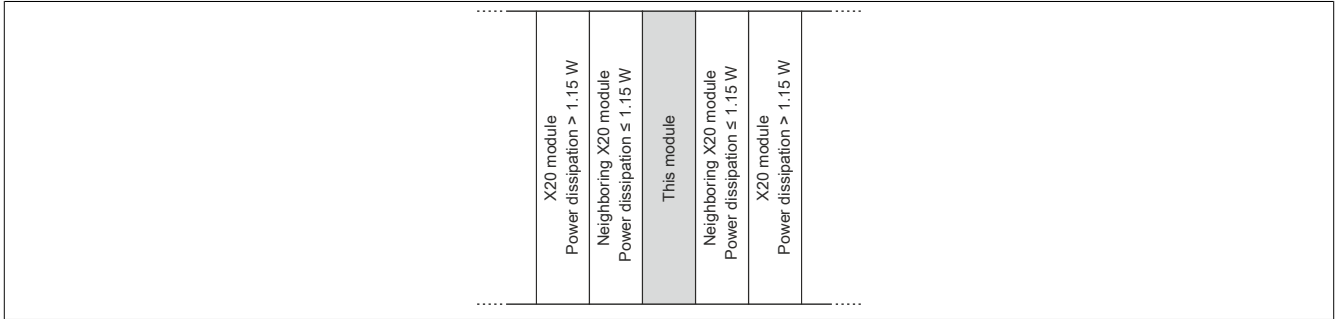
A terminating resistor is integrated in the communication module. It can be turned on and off with a switch on the bottom of the housing. An active terminating resistor is indicated by the "T" LED.

9.18.7.7 Derating

There is no derating when operated below 55°C.

During operation over 55°C, the power dissipation of the modules to the left and right of this module is not permitted to exceed 1.15 W!

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.



9.18.7.8 Register description

9.18.7.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.18.7.8.2 Function model 0 - Flat

In the "Flat" function model, CAN information is transferred via cyclic input and output registers. All data for a CAN object (8 CAN data bytes, identifier, status, etc.) is accessible as individual data points (see also ["CAN object" on page 2185](#)).

To transmit a CAN object, the CAN identifier, the CAN data (max. 8 bytes) and the number of bytes to be transmitted must be written to the cyclic I/O data points. "TXCount" is then increased to send the transmission. The data is applied to the module's internal buffer (max. 18 objects) and transmitted over the CAN network at the next opportunity.

The same algorithm is used for receiving information from the CAN network. The module saves the CAN messages in its internal buffer along with the respective identifiers. The CAN identifier, CAN data (max. 8 bytes) and number of bytes to be processed are then written to the cyclic I/O data points. "RXCount" tells the application which data must be applied from these input data points.

Information:

- Libraries "ArCAN" and "CAN_Lib" cannot be used.

| Register | Name | Data type | Read | | Write | |
|----------------------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Interface - Configuration | | | | | | |
| 257 | ConfigBaudrate | USINT | | | | • |
| 259 | ConfigSJW | USINT | | | | • |
| 261 | ConfigSPO | USINT | | | | • |
| 266 | ConfigTXtrigger | UINT | | | | • |
| 673 | Cfo_FIFOTXlimit | USINT | | | | • |
| 677 | Cfo_TXRXinfoFlags | USINT | | | | • |
| Interface - Communication | | | | | | |
| 641 | TXCount | USINT | | | • | |
| 513 | TXCountReadBack | USINT | • | | | |
| 545 | TXCountLatchReadBack | USINT | • | | | |
| 515 | RXCount | USINT | • | | | |
| 547 | RXCountLatch | USINT | • | | | |
| Transmit buffer | | | | | | |
| 645 | TXDataSize | USINT | | | • | |
| 652 | TXIdent | UDINT | | | • | |
| Index * 2 + 657 | TXDataByte0 to TXDataByte7 | USINT | | | • | |
| Index * 4 + 658 | TXDataWord0 to TXDataWord3 | UINT | | | • | |
| Index * 8 + 660 | TXDataLong0 to TXDataLong1 | UDINT | | | • | |
| Receive buffer 0 | | | | | | |
| 517 | RXDataSize0 | USINT | • | | | |
| 524 | RXIdent0 | UDINT | • | | | |
| Index * 2 + 529 | RXData0Byte0 to RXData0Byte7 | USINT | • | | | |
| Index * 4 + 530 | RXData0Word0 to RXData0Word3 | UINT | • | | | |
| Index * 8 + 532 | RXData0Long0 to RXData0Long1 | UDINT | • | | | |
| Receive buffer 1 | | | | | | |
| 549 | RXDataSize1 | USINT | • | | | |
| 556 | RXIdent1 | UDINT | • | | | |
| Index * 2 + 561 | RXData1Byte0 to RXData1Byte7 | USINT | • | | | |
| Index * 4 + 562 | RXData1Word0 to RXData1Word3 | UINT | • | | | |
| Index * 8 + 564 | RXData1Long0 to RXData1Long1 | UDINT | • | | | |

9.18.7.8.3 Function model 2 - Stream and Function model 254 - Cyclic stream

Function models "Stream" and "Cyclic stream" use a module-specific driver of the CPU's operating system. The interface can be controlled using libraries "ArCAN" and "CAN_Lib" and reconfigured at runtime.

Function model - Stream

In function model "Stream", the CPU communicates with the module acyclically. The interface is relatively convenient, but the timing is very imprecise.

Function model - Cyclic stream

Function model "Cyclic stream" was implemented later. From the application's point of view, there is no difference between function models "Stream" and "Cyclic stream". Internally, however, the cyclic I/O registers are used to ensure that communication follows deterministic timing.

Information:

- In order to use function models "Stream" and "Cyclic stream", you must be using B&R controllers of type "SG4".
- These function models can only be used in X2X Link and POWERLINK networks.

| Register | Name | Data type | Read | | Write | |
|----------------------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module - Configuration | | | | | | |
| - | AsynSize | - | | | | |
| Interface - Configuration | | | | | | |
| 6273 | CFO_ErrorID0007 | USINT | | | | • |
| Interface - Communication | | | | | | |
| 6145 | CAN error status | USINT | • | | | |
| | CANwarning | Bit 0 | | | | |
| | CANpassive | Bit 1 | | | | |
| | CANbusoff | Bit 2 | | | | |
| | CANRXoverrun | Bit 3 | | | | |
| 6209 | CAN error acknowledgment | USINT | | | • | |
| | QuitCANwarning | Bit 0 | | | | |
| | QuitCANpassive | Bit 1 | | | | |
| | QuitCANbusoff | Bit 2 | | | | |
| | QuitCANRXoverrun | Bit 3 | | | | |

9.18.7.8.4 Function model 254 - Flatstream

Flatstream provides independent communication between an X2X Link master and the module. This interface was implemented as a separate function model for the CAN module. CAN information (identifier, status, etc.) is transferred via cyclic input and output registers. The sequence and control bytes are used to control this data stream (see "Flatstream communication" on page 3802).

When using function model Flatstream, the user can choose whether to use library "AsFltGen" in AS for implementation or to adapt Flatstream handling directly to the individual requirements of the application.

Information:

- Libraries "ArCAN" and "CAN_Lib" cannot be used.
- Higher data rates can be achieved between X2X master and module compared to the "Flat" function model.

| Register | Name | Data type | Read | | Write | |
|-----------------------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Interface - Configuration | | | | | | |
| 257 | ConfigBaudrate | USINT | | | | • |
| 259 | ConfigSJW | USINT | | | | • |
| 261 | ConfigSPO | USINT | | | | • |
| 266 | ConfigTXtrigger | UINT | | | | • |
| 6273 | CfO_ErrorID0007 | USINT | | | | • |
| Interface - Communication | | | | | | |
| 6145 | CAN error status | USINT | • | | | |
| | CANwarning | Bit 0 | | | | |
| | CANpassive | Bit 1 | | | | |
| | CANbusoff | Bit 2 | | | | |
| 6209 | CANRXoverrun | Bit 3 | | | | |
| | CAN error acknowledgment | USINT | | | • | |
| | QuitCANwarning | Bit 0 | | | | |
| | QuitCANpassive | Bit 1 | | | | |
| | QuitCANbusoff | Bit 2 | | | | |
| | QuitCANRXoverrun | Bit 3 | | | | |
| Flatstream - Configuration | | | | | | |
| 193 | outputMTU | USINT | | | | • |
| 195 | inputMTU | USINT | | | | • |
| 197 | mode | USINT | | | | • |
| 199 | forward | USINT | | | | • |
| 206 | forwardDelay | UINT | | | | • |
| Flatstream - Communication | | | | | | |
| 0 | InputSequence | USINT | • | | | |
| Index * 1 + 0 | RxByte1 to RxByte27 | USINT | • | | | |
| 32 | OutputSequence | USINT | | | • | |
| Index * 1 + 32 | TxByte1 to TxByte27 | USINT | | | • | |

9.18.7.8.5 Function model 254 - Bus controller

Function model "Bus controller" is a reduced form of function model "Flatstream". Instead of up to 27 Tx/Rx bytes, a maximum of 7 Tx/Rx bytes can be used.

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|-----------------------------------|----------------------|--------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Interface - Configuration | | | | | | | |
| 257 | - | ConfigBaudrate | USINT | | | | • |
| 259 | - | ConfigSJW | USINT | | | | • |
| 261 | - | ConfigSPO | USINT | | | | • |
| 266 | - | ConfigTXtrigger | UINT | | | | • |
| 6273 | - | CfO_ErrorID0007 | USINT | | | | • |
| Interface - Communication | | | | | | | |
| 6145 | - | CAN error status | USINT | | • | | |
| | | CANwarning | Bit 0 | | | | |
| | | CANpassive | Bit 1 | | | | |
| | | CANbusoff | Bit 2 | | | | |
| | | CANRXoverrun | Bit 3 | | | | |
| 6209 | - | CAN error acknowledgment | USINT | | | | • |
| | | QuitCANwarning | Bit 0 | | | | |
| | | QuitCANpassive | Bit 1 | | | | |
| | | QuitCANbusoff | Bit 2 | | | | |
| | | QuitCANRXoverrun | Bit 3 | | | | |
| Flatstream - Configuration | | | | | | | |
| 193 | - | outputMTU | USINT | | | | • |
| 195 | - | inputMTU | USINT | | | | • |
| 197 | - | mode | USINT | | | | • |
| 199 | - | forward | USINT | | | | • |
| 206 | - | forwardDelay | UINT | | | | • |
| Flatstream - Communication | | | | | | | |
| 0 | 0 | InputSequence | USINT | • | | | |
| Index * 1 + 0 | Index * 1 + 0 | RxByte1 to RxByte7 | USINT | • | | | |
| 32 | 0 | OutputSequence | USINT | | | • | |
| Index * 1 + 32 | Index * 1 + 0 | TxByte1 to TxByte7 | USINT | | | • | |

1) The offset specifies the position of the register within the CAN object.

9.18.7.8.5.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.18.7.8.5.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.18.7.8.6 Using this module with SGC target systems

Information:

This module can only be used with SGC target systems if the function model is set to "Flatstream" or "Flat".

9.18.7.8.7 CAN object

A CAN object is always made up of a 4-byte identifier and a maximum of 8 subsequent data bytes. This also results in the relationship between CAN object length and the amount of CAN payload data. This is important because the number of CAN payload data bytes for communication via "FlatStream" always has to be determined using the frame length.

Composition of a CAN object / CAN frame

| Bytes | Function | Information |
|--------|------------------|-------------------------------|
| 1 | Code | ID bit 0 to 7 |
| 2 | | ID bit 8 to 15 |
| 3 | | ID bit 16 to 23 |
| 4 | | ID bit 24 to 31 |
| 5 - 12 | CAN payload data | 0 to 8 CAN payload data bytes |

Code

The 32 bits (4 bytes) of the CAN identifier are used as follows:

| Bit | Description | Value | Information |
|--------|---|-------|--|
| 0 | Frame format | 0 | Standard frame format (SFF) with an 11-bit identifier |
| | | 1 | Extended frame format (EFF) with an 29-bit identifier |
| 1 | Frame type | 0 | Data frame |
| | | 1 | Remote frame (RTR) |
| 2 | Reserved | - | |
| 3 - 31 | CAN identifier for telegram to be transmitted | x | Extended frame format (EFF) with 29 bits Standard frame format (SFF) with 11 bits ¹⁾ |

1) Only bits 21 to 31 are used; bits 3 to 20 = 0.

9.18.7.8.7.1 CAN module data stream

In function model 254, the data packets to be transferred in a data stream are referred to as frames.

Information:

For the CAN module, that means:

- A frame always contains one CAN object and therefore cannot be longer than 12 bytes.
- The CAN object is only transferred to the transmit buffer after the frame has been completed.
- The CAN payload data length has a fixed relationship with the frame length and the actual size of the CAN object. The following rules apply:
 - CAN payload data length = Frame length - 4
 - Frame length = CAN payload data length + 4

9.18.7.8.8 Interface - Configuration

9.18.7.8.8.1 Transfer rate

Name:

ConfigBaudrate

"Baud rate" in the Automation Studio I/O configuration.

Configuration of the CAN transfer rate for the interface.

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| USINT | See bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|---|
| 0 - 3 | Transfer rate | 0 | Interface disabled (bus controller default setting) |
| | | 1 | 10 kbit/s |
| | | 2 | 20 kbit/s |
| | | 3 | 50 kbit/s |
| | | 4 | 100 kbit/s |
| | | 5 | 125 kbit/s |
| | | 6 | 250 kbit/s |
| | | 7 | 500 kbit/s |
| | | 8 | 800 kbit/s |
| | | 9 | 1000 kbit/s |
| 4 - 7 | Reserved | - | |

9.18.7.8.8.2 Synchronization jump width

Name:

ConfigSJW

"Synchronization jump width" in the Automation Studio I/O configuration.

The synchronization jump width (SJW) is used to resynchronize the sample point within a CAN telegram.

See the CAN specification for more details on the SJW.

| Data type | Values | Explanation |
|-----------|--------|--|
| USINT | 0 to 4 | Synchronization jump width. Bus controller default setting: 3 |

9.18.7.8.8.3 Offset for the sampling instant

Name:

ConfigSPO

"Sample point offset" in the Automation Studio I/O configuration.

Offset for the sample instant of the individual bits on the CAN bus.

See the CAN specification for more details on the SPO.

| Data type | Values | Explanation |
|-----------|--------|---|
| USINT | 0 to 1 | Sample point offset. Bus controller default setting: 0 |

9.18.7.8.8.4 Start of transmission

Name:

ConfigTXtrigger

"TX objects / TX triggers" in the Automation Studio I/O configuration.

Defines the number of CAN objects that must be copied to the transmit buffer before the transmission is started.

| Data type | Values | Explanation |
|-----------|--------|---|
| UINT | 0 to 8 | Number of CAN objects in the transmit buffer before transmission is started. Bus controller default setting: 1 |

9.18.7.8.8.5 Configuration of error messages

Name:

Cfo_ErrorID0007

The error messages to be transferred must first be configured with this register. If the corresponding enable bit is not set, no error status will be sent to the higher-level system if the error occurs.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------|-------|---|
| 0 | CANwarning | 0 | Disabled (bus controller default setting) |
| | | 1 | Enabled |
| 1 | CANpassive | 0 | Disabled (bus controller default setting) |
| | | 1 | Enabled |
| 2 | CANbussoff | 0 | Disabled (bus controller default setting) |
| | | 1 | Enabled |
| 3 | CANRXoverrun | 0 | Disabled (bus controller default setting) |
| | | 1 | Enabled |
| 4 - 7 | Reserved | - | |

9.18.7.8.8.6 Size of the transmit buffer

Name:

Cfo_FIFOTXlimit

"TX FIFO size" in the Automation Studio I/O configuration.

Determines the size of the transmit buffer for the respective interface.

| Data type | Values | Explanation |
|-----------|---------|-----------------------------|
| USINT | 0 to 18 | Size of the transmit buffer |

9.18.7.8.8.7 Display of unprocessed elements remaining in the transmit/receive buffer

Name:

Cfo_TXRXinfoFlags

These registers can be used to configure for the interface that the number of unprocessed elements in the transmit or receive buffer is indicated in the upper 4 bits of registers "TXCountReadBack" and "RXCount".

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|--|
| 0 | TxFifoInfo "Mode of channel TXCountReadBack" in the Automation Studio I/O configuration | 0 | Registers "TXCountReadBack" on page 2189 and "TXCount-LatchReadBack" on page 2189 are used to read back "TXCount". |
| | | 1 | The lower 4 bits of registers "TXCountReadBack" on page 2189 and "TXCountLatchReadBack" on page 2189 are used to read back "TXCount". The upper 4 Bits are used to return the number of frames in the transmit buffer that have not been transmitted. |
| 1 | RxFifoInfo "Mode of channel RXCount" in the Automation Studio I/O configuration | 0 | Registers "RXCount" on page 2189 and "RXCountLatch" on page 2190 are used to indicate the number of telegrams that have been received. |
| | | 1 | The lower 4 bits of registers "RXCount" on page 2189 and "RX-CountLatch" on page 2190 are used to indicate the number of telegrams received. The upper 4 bits are used to indicate the number of received but not acknowledged telegrams in the receive buffer. |
| 2 - 7 | Reserved | - | |

9.18.7.8.9 Interface - Communication

9.18.7.8.9.1 CAN error status

Name:

CAN error status

The bits in this register indicate the error states defined in the CAN protocol. If an error occurs, the corresponding bit is set. For an error bit to be reset, the corresponding bit must be acknowledged (see "[CAN error acknowledgment](#)" on page 2188).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------|-------|---------------------------|
| 0 | CANwarning | 0 | No error |
| | | 1 | CANwarning error on IF1 |
| 1 | CANpassive | 0 | No error |
| | | 1 | CANpassive error on IF1 |
| 2 | CANbusoff | 0 | No error |
| | | 1 | CANbusoff error on IF1 |
| 3 | CANRXoverrun | 0 | No error |
| | | 1 | CANRXoverrun error on IF1 |
| 4 - 7 | Reserved | - | |

CANwarning

A faulty frame was detected on the CAN bus. This can include bit errors, bit stuffing errors, CRC errors, format errors in the telegram and acknowledgment errors, for example.

CANpassive

The internal transmit and/or receive error counter is greater than 127. CAN communication continues to run, but the interface can only issue a "passive error frame". Likewise, "error passive stations" have less ability to send new telegrams altogether.

CANbusoff

The internal transmit error counter is greater than 255. The bus is switched off, and CAN communication with the module no longer takes place.

CANRXoverrun

An overflow occurred in the module's receive buffer.

9.18.7.8.9.2 CAN error acknowledgment

Name:

CAN error acknowledgment

Setting the bits in this register acknowledges the error assigned to the bit and clears the corresponding bit in the "CAN error status" register. The application thus informs the module that it has recognized the error state.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------|-------|---------------------------------------|
| 0 | QuitCANwarning | 0 | No acknowledgment |
| | | 1 | Acknowledge CANwarning error on IF1 |
| 1 | QuitCANpassive | 0 | No acknowledgment |
| | | 1 | Acknowledge CANpassive error on IF1 |
| 2 | QuitCANbusoff | 0 | No acknowledgment |
| | | 1 | Acknowledge CANbusoff error on IF1 |
| 3 | QuitCANRXoverrun | 0 | No acknowledgment |
| | | 1 | Acknowledge CANRXoverrun error on IF1 |
| 4 - 7 | Reserved | - | |

9.18.7.8.9.3 New CAN telegram for transmit buffer

Name:

TXCount

By increasing this value, the application notifies the module that a new CAN telegram should be transferred into the transmit buffer.

| Data type | Value |
|-----------|----------|
| USINT | 0 to 255 |

9.18.7.8.9.4 Read "TXCount"

Name:

TXCountReadBack

The value of "TXCount" is copied from the module into this register. This makes it possible for the application task to verify that the CAN telegram data was transferred from the module correctly.

The meaning of the value depends on the "TxFifoInfo" bit. This is located in the register "Cfo_TXRXinfoFlags" on page 2187.

| Data type | Value | "TxFifoInfo" bit | Meaning |
|-----------|----------|------------------|----------------------|
| USINT | 0 to 255 | 0 | Read back "TX-Count" |
| | | 1 | See bit structure. |

Bit structure:

| Bit | Function | Value | Information |
|-------|--|---------|---|
| 0 - 3 | Read back "TX-Count" | 0 to 15 | Only the lower 4 bits |
| 4 - 7 | Number of frames in the transmit buffer that have not been transmitted | 0 to 15 | If this number exceeds the 15 (a maximum of 18 possible), the value 15 is returned. |

9.18.7.8.9.5 Read "TXCount" from the previous cycle

Name:

TXCountLatchReadBack

This register is used to copy the "TXCount" value from the previous cycle from the module. In the event of an X2X Link or POWERLINK transfer error, this makes it possible to determine if the error occurred on the way from the CPU to the module or on the way from the module to the CPU (see "Taking possible errors into consideration when transmitting" on page 2191).

The meaning of the value depends on the "TxFifoInfo" bit in the "Cfo_TXRXinfoFlags" on page 2187 register.

| Data type | Value | "TxFifoInfo" bit | Meaning |
|-----------|----------|------------------|--|
| USINT | 0 to 255 | 0 | TX-Count read back from the previous cycle |
| | | 1 | See bit structure. |

Bit structure:

| Bit | Function | Value | Information |
|-------|--|---------|-------------------------|
| 0 - 3 | TX-Count read back from the previous cycle | 0 to 15 | Only the lower 4 bits |
| 4 - 7 | Number of frames in the transmit buffer that have not been transmitted | 0 to 15 | From the previous cycle |

9.18.7.8.9.6 Counter for received CAN telegrams

Name:

RXCount

This counter is increased by 1 with each CAN telegram. The application task can thus detect when new data is received and get it from the corresponding "RXData" registers.

The meaning of the value depends on the "RxFifoInfo" on page 2187 bit in the "Cfo_TXRXinfoFlags" register.

| Data type | Value | "RxFifoInfo" bit | Meaning |
|-----------|----------|------------------|--------------------------------|
| USINT | 0 to 255 | 0 | Counter for received telegrams |
| | | 1 | See bit structure. |

Bit structure:

| Bit | Function | Value | Information |
|-------|--|---------|-----------------------|
| 0 - 3 | Counter for received telegrams | 0 to 15 | Only the lower 4 bits |
| 4 - 7 | Number of unacknowledged telegrams in the receive buffer | 0 to 15 | |

9.18.7.8.9.7 Read "RXCount" from the previous cycle

Name:

RXCountLatch

This register always contains the "RXCount" value from the previous cycle. It can be used to detect transfer errors from the module to the CPU (see ["Taking possible errors into consideration when transmitting" on page 2191](#)).

The meaning of the value depends on the RxFifoInfo bit in the ["Cfo_TXRXinfoFlags" on page 2187](#) register.

| Data type | Value | "RxFifoInfo" bit | Meaning |
|-----------|----------|------------------|--|
| USINT | 0 to 255 | 0 | Counter for received telegrams from the previous cycle |
| | | 1 | See bit structure. |

Bit structure:

| Bit | Function | Value | Information |
|-------|---|---------|-----------------------|
| 0 - 3 | Counter for received telegrams from the previous cycle | 0 to 15 | Only the lower 4 bits |
| 4 - 7 | Number of telegrams in the receive buffer from the previous cycle | 0 to 15 | |

9.18.7.8.10 Send buffer

9.18.7.8.10.1 Number of CAN payload data bytes

Name:

TXDataSize

Number of CAN payload data bytes to be transmitted. If a value less than 0 is specified here, this CAN telegram is marked as being invalid and is not transferred into the transmit buffer. This is useful in connection with transmit error detection between the module and the CPU (see ["Taking possible errors into consideration when transmitting" on page 2191](#)).

| Data type | Value | Meaning |
|-----------|-----------|---|
| USINT | -128 to 8 | Amount of CAN payload data to be transmitted. |

9.18.7.8.10.2 Identifier of the CAN telegram to be transmitted.

Name:

TXIdent

Identifier of the CAN telegram to be transmitted. The frame format and the identifier format are also defined in this register.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|---|-------|--|
| 0 | Frame format | 0 | Standard frame format (SFF) with an 11-bit identifier |
| | | 1 | Extended frame format (EFF) with an 29-bit identifier |
| 1 | Frame type | 0 | Data frame |
| | | 1 | Remote frame (RTR) |
| 2 | Reserved | - | |
| 3 - 31 | CAN identifier for telegram to be transmitted | x | Extended frame format (EFF) with 29 bits Standard frame format (SFF) with 11 bits ¹⁾ |

1) Only bits 21 to 31 are used; bits 3 to 20 = 0.

9.18.7.8.10.3 Configuration of the CAN payload data being sent

Name:

TXDataByte0 to TXDataByte7

TXDataWord0 to TXDataWord3

TXDataLong0 to TXDataLong1

CAN payload data in the transmit direction. The 8 payload data bytes for a telegram can be used as data points with 8 individual bytes, 4 words or 2 longs as needed.

| Data type | Value | Description |
|-----------|--------------------|---------------------------------------|
| USINT | 0 to 255 | CAN payload data transmitted as bytes |
| UINT | 0 to 65,535 | CAN payload data transmitted as words |
| UDINT | 0 to 4.294.967.295 | CAN payload data transmitted as longs |

9.18.7.8.10.4 Taking possible errors into consideration when transmitting

Data on the POWERLINK network or X2X Link can be lost due to transmission errors. One-time failures of cyclic data are tolerated by the I/O systems. This is possible since all I/O data is re-transferred in the subsequent cycle. A transfer error cannot be detected from the I/O variables; they remain frozen on the value from the last cycle.

These tolerated one-time I/O failures can lead to data loss or the delayed CAN telegram transmission. The counter feedback is derived on the module and used to detect these cases.

Register for counter feedback:

- ["TXCountReadBack" on page 2189](#)
- ["TXCountLatchReadBack" on page 2189](#)

9.18.7.8.11 Receive buffers 0 and 1

9.18.7.8.11.1 Number of valid CAN payload data bytes

Name:
RXDataSize0
RXDataSize1

Number of valid CAN payload data bytes.

This register also uses the value -1 (0xFF) to indicate a general error or gap in the input data stream. Details regarding the error that has occurred can be seen in the ["CAN error status" on page 2188](#) register.

| Data type | Value | Meaning |
|-----------|--------|-------------------------|
| USINT | 1 to 8 | Number CAN payload data |
| | -1 | Error |

9.18.7.8.11.2 Identifier of the received data

Name:
RXIdent0
RXIdent1

Identifiers assigned to the received data. The frame format and the identifier format can also be read from this register.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|---|-------|--|
| 0 | Frame format | 0 | Standard frame format (SFF) with an 11-bit identifier |
| | | 1 | Extended frame format (EFF) with an 29-bit identifier |
| 1 | Frame type | 0 | Data frame |
| | | 1 | Remote frame (RTR) |
| 2 | Reserved | - | |
| 3 - 31 | CAN identifier for telegram to be transmitted | x | Extended frame format (EFF) with 29 bits Standard frame format (SFF) with 11 bits ¹⁾ |

1) Only bits 21 to 31 are used; bits 3 to 20 = 0.

9.18.7.8.11.3 Configuration of the CAN payload data to be received

Name:
RXData0Byte0 to RXData0Byte7
RXData0Word0 to RXData0Word3
RXData0Long0 to RXData0Long1

RXData1Byte0 to RXData1Byte7
RXData1Word0 to RXData1Word3
RXData1Long0 to RXData1Long1

These registers hold the payload data of the CAN object to be transferred from the receive buffer to the CPU in the current cycle. If new data is received or if the receive buffer contains additional CAN objects, these registers are overwritten with the new data in the next cycle.

To avoid losing CAN objects, the application must respond immediately to a change in the "RXCount" and copies the data from these registers.

The maximum 8 bytes for a CAN telegram can be used as data points with 8 individual bytes, 4 words or 2 longs as needed.

| Data type | Value | Description |
|-----------|--------------------|------------------------------------|
| USINT | 0 to 255 | Received CAN payload data as bytes |
| UINT | 0 to 65,535 | Received CAN payload data as words |
| UDINT | 0 to 4.294.967.295 | Received CAN payload data as longs |

9.18.7.8.12 Flatstream communication

For a description of Flatstream communication, see ["Flatstream communication" on page 3802](#)

9.18.7.8.13 Acyclic frame size

Name:
AsynSize

When the stream is used, data is exchanged internally between the module and CPU. For this purpose, a defined amount of acyclic bytes is reserved for this slot.

Increasing the acyclic frame size leads to increased data throughput on this slot.

Information:

This configuration involves a driver setting that cannot be changed during runtime!

| Data type | Value | Information |
|-----------|---------|---|
| - | 8 to 28 | Acyclic frame size in bytes. Default = 24 |

9.18.7.8.14 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μ s |

9.18.7.8.15 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 200 μ s |

9.18.8 X20CS2770

Data sheet version: 3.28

9.18.8.1 General information

In addition to the standard I/O, complex devices often need to be connected. The X20 CS communication modules are intended precisely for cases like this. As normal X20 electronics modules, they can be placed anywhere on the remote backplane.

- 2 CAN bus interfaces for serial, remote connection of complex devices to the X20 system
- Integrated terminating resistors

9.18.8.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | X20 electronics module communication |  |
| X20CS2770 | X20 interface module, 2 CAN bus interfaces, max. 1 Mbit/s, object buffers in both send and receive directions | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 392: X20CS2770 - Order data


9.18.8.3 Technical data

| | |
|--|---|
| Model number | X20CS2770 |
| Short description | |
| Communication module | 2x CAN bus |
| General information | |
| B&R ID code | 0xA009 |
| Status indicators | Data transfer, terminating resistor, operating status, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Data transfer | Yes, using status LED |
| Terminating resistor | Yes, using status LED |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.5 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| Interfaces | |
| Interface IF1 | |
| Signal | CAN bus |
| Variant | Connection made using 12-pin X20TB12 terminal block |
| Max. distance | 1000 m |
| Transfer rate | Max. 1 Mbit/s |
| Terminating resistor | Integrated in the module |
| Controller | SJA 1000 |
| Interface IF2 | |
| Signal | CAN bus |
| Variant | Connection made using 12-pin X20TB12 terminal block |
| Max. distance | 1000 m |
| Transfer rate | Max. 1 Mbit/s |
| Terminating resistor | Integrated in the module |
| Controller | SJA 1000 |
| Electrical properties | |
| Electrical isolation | CAN (IF1, IF2) isolated from each other, from bus and I/O power supply |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating" |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 393: X20CS2770 - Technical data

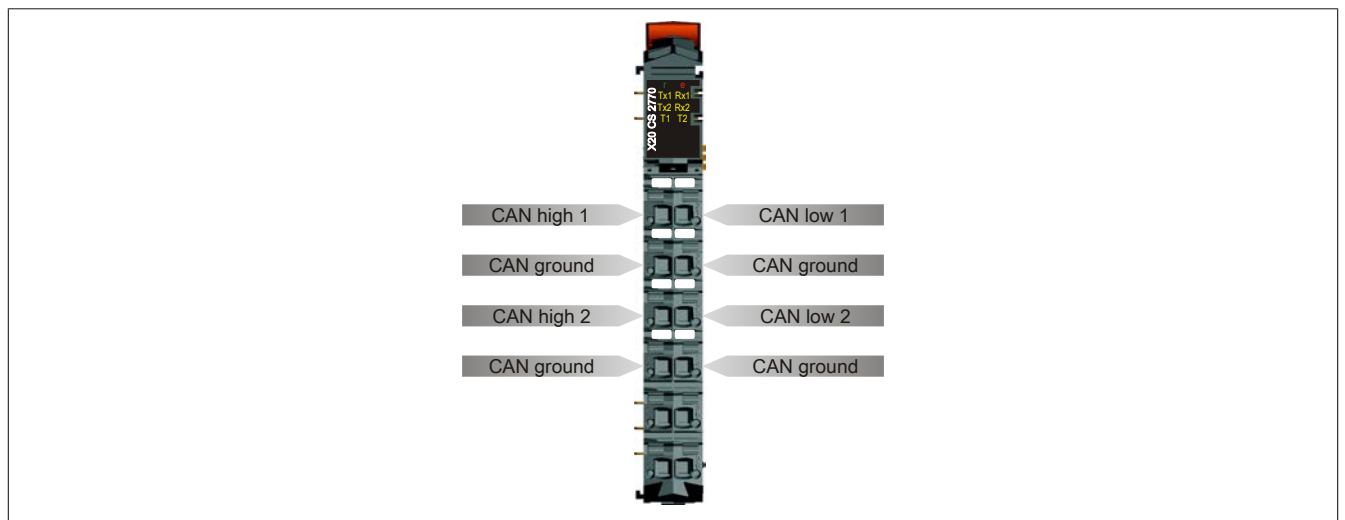
9.18.8.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

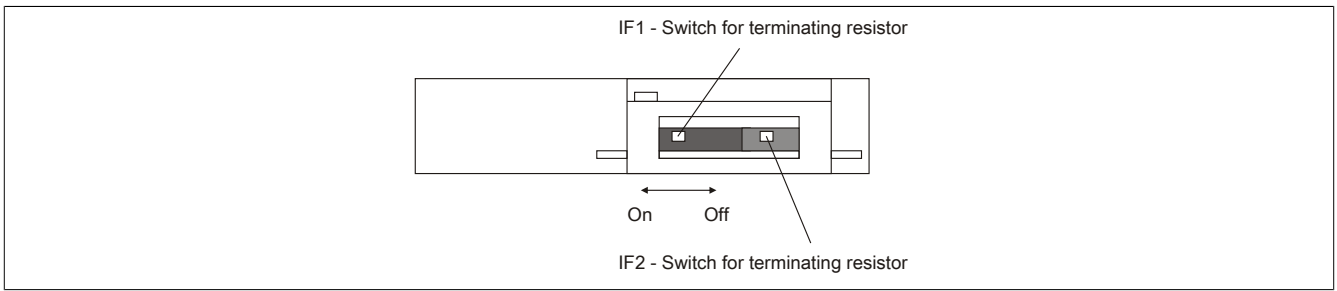
| Figure | LED | Color | Status | Description |
|---|--------|--------|--|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Single flash | I/O error occurred <ul style="list-style-type: none"> • CAN bus: Warning, passive or off • Buffer overflow |
| | | | On | Error or reset status |
| | e + r | | Red on / Green single flash | Invalid firmware |
| | Tx1/2 | Yellow | On | The module is sending data via the CAN bus interface IF1/IF2 |
| Rx1/2 | Yellow | On | The module is receiving data via the CAN bus interface IF1/IF2 | |
| T1/2 | Yellow | On | The integrated terminating resistor for the CAN bus interface IF1/IF2 is turned on | |

1) Depending on the configuration, a firmware update can take up to several minutes.

9.18.8.5 Pinout



9.18.8.6 Terminating resistors



Two terminating resistors are integrated in the communication module. The respective resistor can be turned on and off with a switch on the bottom of the housing. An active terminating resistor is indicated by the "T1" or "T2" LED.

9.18.8.7 Derating

There is no derating when operated below 55°C.

During operation over 55°C, the power dissipation of the modules to the left and right of this module is not permitted to exceed 1.15 W!

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.

| | | | | | | |
|-------|--|--|-------------|--|--|-------|
| | X20 module Power dissipation > 1.15 W | Neighboring X20 module Power dissipation ≤ 1.15 W | This module | Neighboring X20 module Power dissipation ≤ 1.15 W | X20 module Power dissipation > 1.15 W | |
|-------|--|--|-------------|--|--|-------|

9.18.8.8 Register description

9.18.8.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.18.8.8.2 Function model 0 - Flat

In the "Flat" function model, CAN information is transferred via cyclic input and output registers. All data for a CAN object (8 CAN data bytes, identifier, status, etc.) is accessible as individual data points (see also ["CAN object" on page 2202](#)).

To transmit a CAN object, the CAN identifier, the CAN data (max. 8 bytes) and the number of bytes to be transmitted must be written to the cyclic I/O data points. Then, "TX0[x]Count" is increased to send the transmission. The data is held in the module's internal buffer (max. 18 objects) and transmitted over the CAN network at the next available opportunity.

Receiving information from the CAN network uses the same algorithm. The module saves the CAN messages in its internal buffer along with the respective identifiers. Then the CAN identifier, the CAN data (max. 8 bytes) and the number of bytes to be processed are written to the cyclic I/O data points. RX0[x]Count tells the application how much new data must be taken from these input data points.

Information:

- Libraries "ArCAN" and "CAN_Lib" cannot be used.

| Register | Name | Data type | Read | | Write | |
|----------------------------------|--------------------------------|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Interface - Configuration | | | | | | |
| 257 | Config01Baudrate | USINT | | | | • |
| 259 | Config01SJW | USINT | | | | • |
| 261 | Config01SPO | USINT | | | | • |
| 266 | Config01TXtrigger | UINT | | | | • |
| 673 | Cfo_FIFOTXlimit01 | USINT | | | | • |
| 677 | Cfo_TXRXinfoFlags01 | USINT | | | | • |
| 769 | Config02Baudrate | USINT | | | | • |
| 771 | Config02SJW | USINT | | | | • |
| 773 | Config02SPO | USINT | | | | • |
| 778 | Config02TXtrigger | UINT | | | | • |
| 1185 | Cfo_FIFOTXlimit02 | USINT | | | | • |
| 1189 | Cfo_TXRXinfoFlags02 | USINT | | | | • |
| Interface - Communication | | | | | | |
| 641 | TX01Count | USINT | | | • | |
| 513 | TX01CountReadBack | USINT | • | | | |
| 515 | RX01Count | USINT | • | | | |
| 1153 | TX02Count | USINT | | | • | |
| 1025 | TX02CountReadBack | USINT | • | | | |
| 1027 | RX02Count | USINT | • | | | |
| Transmit buffer IF1 | | | | | | |
| 645 | TX01DataSize | USINT | | | • | |
| 652 | TX01Ident | UDINT | | | • | |
| Index * 2 + 657 | TX01DataByte0 to TX01DataByte7 | USINT | | | • | |
| Index * 4 + 658 | TX01DataWord0 to TX01DataWord3 | UINT | | | • | |
| Index * 8 + 660 | TX01DataLong0 to TX01DataLong1 | UDINT | | | • | |
| Receive buffer IF1 | | | | | | |
| 517 | RX01DataSize | USINT | • | | | |
| 524 | RX01Ident | UDINT | • | | | |
| Index * 2 + 529 | RX01DataByte0 to RX01DataByte7 | USINT | • | | | |
| Index * 4 + 530 | RX01DataWord0 to RX01DataWord3 | UINT | • | | | |
| Index * 8 + 532 | RX01DataLong0 to RX01DataLong1 | UDINT | • | | | |
| Transmit buffer IF2 | | | | | | |
| 1157 | TX02DataSize | USINT | | | • | |
| 1164 | TX02Ident | UDINT | | | • | |
| Index * 2 + 1170 | TX02DataByte0 to TX02DataByte7 | USINT | | | • | |
| Index * 4 + 658 | TX02DataWord0 to TX02DataWord3 | UINT | | | • | |
| Index * 8 + 1172 | TX02DataLong0 to TX02DataLong1 | UDINT | | | • | |
| Receive buffer IF2 | | | | | | |
| 1029 | RX02DataSize | USINT | • | | | |

| Register | Name | Data type | Read | | Write | |
|------------------|--------------------------------|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| 1036 | RX02Ident | UDINT | • | | | |
| Index * 2 + 1041 | RX02DataByte0 to RX02DataByte7 | USINT | • | | | |
| Index * 4 + 1042 | RX02DataWord0 to RX02DataWord3 | UINT | • | | | |
| Index * 8 + 1044 | RX02DataLong0 to RX02DataLong1 | UDINT | • | | | |

9.18.8.8.3 Function model 2 - Stream and Function model 254 - Cyclic stream

Function models "Stream" and "Cyclic stream" use a module-specific driver of the CPU's operating system. The interface can be controlled using libraries "ArCAN" and "CAN_Lib" and reconfigured at runtime.

Function model - Stream

In function model "Stream", the CPU communicates with the module acyclically. The interface is relatively convenient, but the timing is very imprecise.

Function model - Cyclic stream

Function model "Cyclic stream" was implemented later. From the application's point of view, there is no difference between function models "Stream" and "Cyclic stream". Internally, however, the cyclic I/O registers are used to ensure that communication follows deterministic timing.

Information:

- In order to use function models "Stream" and "Cyclic stream", you must be using B&R controllers of type "SG4".
- These function models can only be used in X2X Link and POWERLINK networks.

| Register | Name | Data type | Read | | Write | |
|----------------------------------|--------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module - Configuration | | | | | | |
| - | AsynSize | - | | | | |
| Interface - Configuration | | | | | | |
| 6273 | CfO_ErrorID0007 | USINT | | | | • |
| Interface - Communication | | | | | | |
| 6145 | CAN error status | USINT | • | | | |
| | CANIF1warning | Bit 0 | | | | |
| | CANIF1passive | Bit 1 | | | | |
| | CANIF1busoff | Bit 2 | | | | |
| | CANIF1RXoverrun | Bit 3 | | | | |
| | CANIF2warning | Bit 4 | | | | |
| | CANIF2passive | Bit 5 | | | | |
| | CANIF2busoff | Bit 6 | | | | |
| 6209 | CAN error acknowledgment | USINT | | | • | |
| | QuitCANIF1warning | Bit 0 | | | | |
| | QuitCANIF1passive | Bit 1 | | | | |
| | QuitCANIF1busoff | Bit 2 | | | | |
| | QuitCANIF1RXoverrun | Bit 3 | | | | |
| | QuitCANIF2warning | Bit 4 | | | | |
| | QuitCANIF2passive | Bit 5 | | | | |
| | QuitCANIF2busoff | Bit 6 | | | | |
| QuitCANIF2RXoverrun | Bit 7 | | | | | |

9.18.8.8.4 Function model 254 - Flatstream

Flatstream provides independent communication between an X2X Link master and the module. This interface was implemented as a separate function model for the CAN module. CAN information (identifier, status, etc.) is transferred via cyclic input and output registers. The sequence and control bytes are used to control this data stream (see "Flatstream communication" on page 3802).

When using function model Flatstream, the user can choose whether to use library "AsFltGen" in AS for implementation or to adapt Flatstream handling directly to the individual requirements of the application.

Information:

- Libraries "ArCAN" and "CAN_Lib" cannot be used.
- Higher data rates can be achieved between X2X master and module compared to the "Flat" function model.

| Register | Name | Data type | Read | | Write | |
|-----------------------------------|--------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Interface - Configuration | | | | | | |
| 257 | Config01Baudrate | USINT | | | | • |
| 259 | Config01SJW | USINT | | | | • |
| 261 | Config01SPO | USINT | | | | • |
| 266 | Config01TXtrigger | UINT | | | | • |
| 769 | Config02Baudrate | USINT | | | | • |
| 771 | Config02SJW | USINT | | | | • |
| 773 | Config02SPO | USINT | | | | • |
| 778 | Config02TXtrigger | UINT | | | | • |
| 6273 | CfO_ErrorID0007 | USINT | | | | • |
| Interface - Communication | | | | | | |
| 6145 | CAN error status | USINT | • | | | |
| | CANIF1warning | Bit 0 | | | | |
| | CANIF1passive | Bit 1 | | | | |
| | CANIF1busoff | Bit 2 | | | | |
| | CANIF1RXoverrun | Bit 3 | | | | |
| | CANIF2warning | Bit 4 | | | | |
| | CANIF2passive | Bit 5 | | | | |
| | CANIF2busoff | Bit 6 | | | | |
| 6209 | CAN error acknowledgment | USINT | | | • | |
| | QuitCANIF1warning | Bit 0 | | | | |
| | QuitCANIF1passive | Bit 1 | | | | |
| | QuitCANIF1busoff | Bit 2 | | | | |
| | QuitCANIF1RXoverrun | Bit 3 | | | | |
| | QuitCANIF2warning | Bit 4 | | | | |
| | QuitCANIF2passive | Bit 5 | | | | |
| | QuitCANIF2busoff | Bit 6 | | | | |
| QuitCANIF2RXoverrun | Bit 7 | | | | | |
| Flatstream - Configuration | | | | | | |
| 193 | output01MTU | USINT | | | | • |
| 195 | input01MTU | USINT | | | | • |
| 197 | mode01 | USINT | | | | • |
| 199 | forward01 | USINT | | | | • |
| 206 | forwardDelay01 | UINT | | | | • |
| 209 | output02MTU | USINT | | | | • |
| 211 | input02MTU | USINT | | | | • |
| 213 | mode02 | USINT | | | | • |
| 215 | forward02 | USINT | | | | • |
| 222 | forwardDelay02 | UINT | | | | • |
| Flatstream - Communication | | | | | | |
| 0 | Input01Sequence | USINT | • | | | |
| 64 | Input02Sequence | USINT | • | | | |
| Index * 1 + 0 | Rx01Byte1 to Rx01Byte27 | USINT | • | | | |
| Index * 1 + 64 | Rx02Byte1 to Rx02Byte27 | USINT | • | | | |
| 32 | Output01Sequence | USINT | | | • | |
| 96 | Output02Sequence | USINT | | | • | |
| Index * 1 + 32 | Tx01Byte1 to Tx01Byte27 | USINT | | | • | |
| Index * 1 + 96 | Tx02Byte1 to Tx02Byte27 | USINT | | | • | |

9.18.8.8.5 Function model 254 - Bus controller

The "Bus controller" function model is a reduced form of the "FlatStream" function model. Instead of up to 27 Tx / Rx bytes, a maximum of 7 Tx / Rx bytes can be used.

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|-----------------------------------|----------------------|--------------------------|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Interface - Configuration | | | | | | | |
| 257 | - | Config01Baudrate | USINT | | | | • |
| 259 | - | Config01SJW | USINT | | | | • |
| 261 | - | Config01SPO | USINT | | | | • |
| 266 | - | Config01TXtrigger | UINT | | | | • |
| 769 | - | Config02Baudrate | USINT | | | | • |
| 771 | - | Config02SJW | USINT | | | | • |
| 773 | - | Config02SPO | USINT | | | | • |
| 778 | - | Config02TXtrigger | UINT | | | | • |
| 6273 | - | CfO_ErrorID0007 | USINT | | | | • |
| Interface - Communication | | | | | | | |
| 6145 | - | CAN error status | USINT | | • | | |
| | | CANIF1warning | Bit 0 | | | | |
| | | CANIF1passive | Bit 1 | | | | |
| | | CANIF1busoff | Bit 2 | | | | |
| | | CANIF1RXoverrun | Bit 3 | | | | |
| | | CANIF2warning | Bit 4 | | | | |
| | | CANIF2passive | Bit 5 | | | | |
| | | CANIF2busoff | Bit 6 | | | | |
| 6209 | - | CAN error acknowledgment | USINT | | | | • |
| | | QuitCANIF1warning | Bit 0 | | | | |
| | | QuitCANIF1passive | Bit 1 | | | | |
| | | QuitCANIF1busoff | Bit 2 | | | | |
| | | QuitCANIF1RXoverrun | Bit 3 | | | | |
| | | QuitCANIF2warning | Bit 4 | | | | |
| | | QuitCANIF2passive | Bit 5 | | | | |
| | | QuitCANIF2busoff | Bit 6 | | | | |
| | | QuitCANIF2RXoverrun | Bit 7 | | | | |
| FlatStream - Configuration | | | | | | | |
| 193 | - | output01MTU | USINT | | | | • |
| 195 | - | input01MTU | USINT | | | | • |
| 197 | - | mode01 | USINT | | | | • |
| 199 | - | forward01 | USINT | | | | • |
| 206 | - | forwardDelay01 | UINT | | | | • |
| 209 | - | output02MTU | USINT | | | | • |
| 211 | - | input02MTU | USINT | | | | • |
| 213 | - | mode02 | USINT | | | | • |
| 215 | - | forward02 | USINT | | | | • |
| 222 | - | forwardDelay02 | UINT | | | | • |
| FlatStream - Communication | | | | | | | |
| 0 | 0 | Input01Sequence | USINT | • | | | |
| 64 | 8 | Input02Sequence | USINT | • | | | |
| Index * 1 + 0 | Index * 1 + 0 | Rx01Byte1 to Rx01Byte7 | USINT | • | | | |
| Index * 1 + 64 | Index * 1 + 8 | Rx02Byte1 to Rx02Byte7 | USINT | • | | | |
| 32 | 0 | Output01Sequence | USINT | | | • | |
| 96 | 8 | Output02Sequence | USINT | | | • | |
| Index * 1 + 32 | Index * 1 + 0 | Tx01Byte1 to Tx01Byte7 | USINT | | | • | |
| Index * 1 + 96 | Index * 1 + 8 | Tx02Byte1 to Tx02Byte7 | USINT | | | • | |

1) The offset specifies the position of the register within the CAN object.

9.18.8.8.5.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.18.8.8.5.2 CAN I/O bus controller

The module occupies 2 analog logical slots on CAN I/O.

9.18.8.8.6 Using this module with SGC target systems

Information:

This module can only be used with SGC target systems if the function model is set to "Flatstream" or "Flat".

9.18.8.8.7 CAN object

A CAN object is always made up of a 4-byte identifier and a maximum of 8 subsequent data bytes. This also results in the relationship between CAN object length and the amount of CAN payload data. This is important because the number of CAN payload data bytes for communication via "FlatStream" always has to be determined using the frame length.

Composition of a CAN object / CAN frame

| Bytes | Function | Information |
|--------|------------------|-------------------------------|
| 1 | Code | ID bit 0 to 7 |
| 2 | | ID bit 8 to 15 |
| 3 | | ID bit 16 to 23 |
| 4 | | ID bit 24 to 31 |
| 5 - 12 | CAN payload data | 0 to 8 CAN payload data bytes |

Code

The 32 bits (4 bytes) of the CAN identifier are used as follows:

| Bit | Description | Value | Information |
|--------|---|-------|--|
| 0 | Frame format | 0 | Standard frame format (SFF) with an 11-bit identifier |
| | | 1 | Extended frame format (EFF) with an 29-bit identifier |
| 1 | Frame type | 0 | Data frame |
| | | 1 | Remote frame (RTR) |
| 2 | Reserved | - | |
| 3 - 31 | CAN identifier for telegram to be transmitted | x | Extended frame format (EFF) with 29 bits Standard frame format (SFF) with 11 bits ¹⁾ |

1) Only bits 21 to 31 are used; bits 3 to 20 = 0.

9.18.8.8.7.1 CAN module data stream

In function model 254, the data packets to be transferred in a data stream are referred to as frames.

Information:

For the CAN module, that means:

- A frame always contains one CAN object and therefore cannot be longer than 12 bytes.
- The CAN object is only transferred to the transmit buffer after the frame has been completed.
- The CAN payload data length has a fixed relationship with the frame length and the actual size of the CAN object. The following rules apply:
 - CAN payload data length = Frame length - 4
 - Frame length = CAN payload data length + 4

9.18.8.8.8 Interface - Configuration

9.18.8.8.8.1 Transfer rate

Name:

Config01Baudrate to Config02Baudrate

"Baud rate" in the Automation Studio I/O configuration.

Configuration of the CAN transfer rate for the respective interface.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|---|
| 0 - 3 | Transfer rate | 0 | Interface disabled (bus controller default setting) |
| | | 1 | 10 kbit/s |
| | | 2 | 20 kbit/s |
| | | 3 | 50 kbit/s |
| | | 4 | 100 kbit/s |
| | | 5 | 125 kbit/s |
| | | 6 | 250 kbit/s |
| | | 7 | 500 kbit/s |
| | | 8 | 800 kbit/s |
| | | 9 | 1000 kbit/s |
| 4 - 7 | Reserved | - | |

9.18.8.8.8.2 Synchronization Jump Width

Name:

Config01SJW to Config02SJW

"Synchronization jump width" in the Automation Studio I/O configuration.

The synchronization jump width (SJW) is used to resynchronize the sample point within a CAN telegram.

A detailed description of the SJW can be found in the CAN specification.

| Data type | Value | Meaning |
|-----------|--------|--|
| USINT | 0 to 4 | Synchronization jump width. Bus controller default setting: 3 |

9.18.8.8.8.3 Offset for the sampling instant

Name:

Config01SPO to Config02SPO

"Sample point offset" in the Automation Studio I/O configuration.

Offset for the sample point of the individual bits on the CAN bus.

A detailed description of the SPO can be found in the CAN specification.

| Data type | Value | Meaning |
|-----------|--------|---|
| USINT | 0 to 1 | Sample point offset. Bus controller default setting: 0 |

9.18.8.8.8.4 Start of transmission

Name:

Config01TXtrigger to Config02TXtrigger

"TX objects / TX triggers" in the Automation Studio I/O configuration.

Defines the number of CAN objects that must be copied to the transmit buffer before the transmission is started.

| Data type | Value | Meaning |
|-----------|--------|---|
| UINT | 0 to 8 | Number of CAN objects in the transmit buffer before transmission is started. Bus controller default setting: 1 |

9.18.8.8.5 Configuration of error messages

Name:

Cfo_ErrorID0007

This register must be used first to configure the error messages that have to be transferred. If the corresponding enable bit is not set, no error status will be sent to the higher-level system when the error occurs.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------|-------|---|
| 0 | CANIF1warning | 0 | Disabled (bus controller default setting) |
| | | 1 | Enabled |
| 1 | CANIF1passive | 0 | Disabled (bus controller default setting) |
| | | 1 | Enabled |
| 2 | CANIF1bussoff | 0 | Disabled (bus controller default setting) |
| | | 1 | Enabled |
| 3 | CANIF1RXoverrun | 0 | Disabled (bus controller default setting) |
| | | 1 | Enabled |
| 4 | CANIF2warning | 0 | Disabled (bus controller default setting) |
| | | 1 | Enabled |
| 5 | CANIF2passive | 0 | Disabled (bus controller default setting) |
| | | 1 | Enabled |
| 6 | CANIF2bussoff | 0 | Disabled (bus controller default setting) |
| | | 1 | Enabled |
| 7 | CANIF2RXoverrun | 0 | Disabled (bus controller default setting) |
| | | 1 | Enabled |

9.18.8.8.6 Size of the transmit buffer

Name:

Cfo_FIFOTXlimit01 to Cfo_FIFOTXlimit02

"TX FIFO size" in the Automation Studio I/O configuration.

Determines the size of the transmit buffer for the respective interface.

| Data type | Value | Meaning |
|-----------|---------|-----------------------------|
| USINT | 0 to 18 | Size of the transmit buffer |

9.18.8.8.7 Display of unprocessed elements remaining in transmit/receive buffer

Name:

Cfo_TXRXinfoFlags01 to Cfo_TXRXinfoFlags02

This register can be used to specify that the number of unprocessed elements in the transmit and receive buffers is indicated in the upper 4 bits of the "TX0[x]CountReadBack" and "RX0[x]Count" registers for the respective interface.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|---|
| 0 | TxFifoInfo "Mode of channel TX0[x]CountReadBack" in the Automation Studio I/O configuration | 0 | The "TX0[x]Count" is read in the "TX0[x]CountReadBack" on page 2206 register. |
| | | 1 | The "TX0[x]Count" is read in the "TX0[x]CountReadBack" on page 2206 register. The upper 4 bits are used to return the number of frames in the transmit buffer that have not been transmitted. |
| 1 | RxFifoInfo "Mode of channel RX0[x]Count" in the Automation Studio I/O configuration | 0 | The number of received telegrams is shown in the "RX0[x]Count" on page 2207 register. |
| | | 1 | The number of received telegrams is shown in the lower 4 bits of the "RX0[x]Count" on page 2207 register. The upper 4 bits are used to indicate the number of received but not acknowledged telegrams in the receive buffer. |
| 2 - 7 | Reserved | - | |

9.18.8.8.9 Interface - Communication

9.18.8.8.9.1 CAN error status

Name:

CAN error status

The bits in this register indicate the error states defined in the CAN protocol. If an error occurs, the corresponding bit is set. For an error bit to be reset, the corresponding bit must be acknowledged (see "[CAN error acknowledgment](#)" on page 2206).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------|-------|--|
| 0 | CANIF1warning | 0 | No error |
| | | 1 | CANwarning Error occurred on IF1 |
| 1 | CANIF1passive | 0 | No error |
| | | 1 | CANpassive Error occurred on IF1 |
| 2 | CANIF1busoff | 0 | No error |
| | | 1 | CANbusoff Error occurred on IF1 |
| 3 | CANIF1RXoverrun | 0 | No error |
| | | 1 | CANRXoverrun Error occurred on IF1 |
| 4 | CANIF2warning | 0 | No error |
| | | 1 | CANwarning Error occurred on IF2 |
| 5 | CANIF2passive | 0 | No error |
| | | 1 | CANpassive Error occurred on IF2 |
| 6 | CANIF2busoff | 0 | No error |
| | | 1 | CANbusoff Error occurred on IF2 |
| 7 | CANIF2RXoverrun | 0 | No error |
| | | 1 | CANRXoverrun Error occurred on IF2 |

CANwarning

A faulty frame was detected on the CAN bus. This can include bit errors, bit stuffing errors, CRC errors, format errors in the telegram and acknowledgment errors, for example.

CANpassive

The internal transmit and/or receive error counter is greater than 127. CAN communication continues to run, but the interface can only issue a "passive error frame". Likewise, "error passive stations" have less ability to send new telegrams altogether.

CANbusoff

The internal transmit error counter is greater than 255. The bus is switched off, and CAN communication with the module no longer takes place.

CANRXoverrun

An overflow occurred in the module's receive buffer.

9.18.8.8.9.2 CAN error acknowledgment

Name:

CAN error acknowledgment

Setting the bits in this register acknowledges the error assigned to the bit and clears the corresponding bit in the "CAN error status" register. The application thus informs the module that it has recognized the error state.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|---------------------|-------|---------------------------------------|
| 0 | QuitCANIF1warning | 0 | No acknowledgment |
| | | 1 | Acknowledge CANwarning error on IF1 |
| 1 | QuitCANIF1passive | 0 | No acknowledgment |
| | | 1 | Acknowledge CANpassive error on IF1 |
| 2 | QuitCANIF1bussoff | 0 | No acknowledgment |
| | | 1 | Acknowledge CANbussoff error on IF1 |
| 3 | QuitCANIF1RXoverrun | 0 | No acknowledgment |
| | | 1 | Acknowledge CANRXoverrun error on IF1 |
| 4 | QuitCANIF2warning | 0 | No acknowledgment |
| | | 1 | Acknowledge CANwarning error on IF2 |
| 5 | QuitCANIF2passive | 0 | No acknowledgment |
| | | 1 | Acknowledge CANpassive error on IF2 |
| 6 | QuitCANIF2bussoff | 0 | No acknowledgment |
| | | 1 | Acknowledge CANbussoff error on IF2 |
| 7 | QuitCANIF2RXoverrun | 0 | No acknowledgment |
| | | 1 | Acknowledge CANRXoverrun error on IF2 |

9.18.8.8.9.3 New CAN telegram for transmit buffer

Name:

TX01Count to TX02Count

By increasing this value, the application notifies the module that a new CAN telegram should be transferred into the transmit buffer.

| Data type | Value |
|-----------|----------|
| USINT | 0 to 255 |

9.18.8.8.9.4 Read "TX0[x]Count"

Name:

TX01CountReadBack to TX02CountReadBack

The value of "TX0[x]Count" is copied from the module into this register. This makes it possible for the application task to verify that the CAN telegram data was transferred from the module correctly.

The meaning of the value depends on the "TxFifoInfo" bit. This is located in the register "[Cfo_TXRXinfoFlags0\[x\]](#)" on [page 2204](#).

| Data type | Value | "TxFifoInfo" bit | Meaning |
|-----------|----------|------------------|--------------------|
| USINT | 0 to 255 | 0 | Read "TX0[x]Count" |
| | | 1 | See bit structure. |

Bit structure:

| Bit | Function | Value | Information |
|-------|--|---------|---|
| 0 - 3 | Read "TX0[x]Count" | 0 to 15 | Only the lower 4 bits |
| 4 - 7 | Number of frames in the transmit buffer that have not been transmitted | 0 to 15 | If this number exceeds the 15 (a maximum of 18 possible), the value 15 is returned. |

9.18.8.8.9.5 Counter for received CAN telegrams

Name:

RX01Count to RX02Count

This counter is increased by 1 with each CAN telegram. The application task can thus detect when new data is received and get it from the corresponding "RX0[x]Data" registers.

The meaning of the value depends on the "Cfo_TXRXinfoFlags0[x]" on page 2204 bit in the "Cfo_TXRXinfoFlags" register.

| Data type | Value | "RxFifoInfo" bit | Meaning |
|-----------|----------|------------------|--------------------------------|
| USINT | 0 to 255 | 0 | Counter for received telegrams |
| | | 1 | See bit structure. |

Bit structure:

| Bit | Function | Value | Information |
|-------|--|---------|-----------------------|
| 0 - 3 | Counter for received telegrams | 0 to 15 | Only the lower 4 bits |
| 4 - 7 | Number of unacknowledged telegrams in the receive buffer | 0 to 15 | |

9.18.8.8.10 Transmit buffer for IF1 and IF2**9.18.8.8.10.1 Number of CAN payload data bytes**

Name:

TX01DataSize to TX02DataSize

Number of CAN payload data bytes to be transmitted. If a value less than 0 is specified here, this CAN telegram is marked as being invalid and is not transferred into the transmit buffer. This is useful in connection with transmit error detection between the module and the CPU (see ["Taking possible errors into consideration when transmitting" on page 2208](#)).

| Data type | Value | Meaning |
|-----------|-----------|--|
| USINT | -128 to 8 | Amount of CAN payload data to be transmitted |

9.18.8.8.10.2 Identifier of the CAN telegram to be transmitted.

Name:

TX01Ident to TX02Ident

Identifier of the CAN telegram to be transmitted. The frame format and the identifier format are also defined in this register.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|---|-------|--|
| 0 | Frame format | 0 | Standard frame format (SFF) with an 11-bit identifier |
| | | 1 | Extended frame format (EFF) with an 29-bit identifier |
| 1 | Frame type | 0 | Data frame |
| | | 1 | Remote frame (RTR) |
| 2 | Reserved | - | |
| 3 - 31 | CAN identifier for telegram to be transmitted | x | Extended frame format (EFF) with 29 bits Standard frame format (SFF) with 11 bits ¹⁾ |

1) Only bits 21 to 31 are used; bits 3 to 20 = 0.

9.18.8.8.10.3 Configuration of the CAN payload data being sent

Name:

TX0[x]DataByte0 to TX0[x]DataByte7

TX0[x]DataWord0 to TX0[x]DataWord3

TX0[x]DataLong0 to TX0[x]DataLong1

CAN payload data in the transmit direction. The 8 payload data bytes for a telegram can be used as data points with 8 individual bytes, 4 words or 2 longs as needed.

| Data type | Value | Description |
|-----------|--------------------|---------------------------------------|
| USINT | 0 to 255 | CAN payload data transmitted as bytes |
| UINT | 0 to 65,535 | CAN payload data transmitted as words |
| UDINT | 0 to 4.294.967.295 | CAN payload data transmitted as longs |

9.18.8.8.10.4 Taking possible errors into consideration when transmitting

Data on the POWERLINK network or X2X Link can be lost due to transmission errors. One-time failures of cyclic data are tolerated by the I/O systems. This is possible since all I/O data is re-transferred in the subsequent cycle. A transfer error cannot be detected from the I/O variables; they remain frozen on the value from the last cycle.

These tolerated one-time I/O failures can lead to data loss or the delayed CAN telegram transmission. The counter feedback is derived on the module and used to detect these cases.

Register for counter feedback: ["TX0\[x\]CountReadBack" on page 2206](#)

9.18.8.8.11 Receive buffer for IF1 and IF2

9.18.8.8.11.1 Number of valid CAN payload data bytes

Name:

RX01DataSize to RX02DataSize

Number of valid CAN payload data bytes.

This register also uses the value -1 (0xFF) to indicate a general error or gap in the input data stream. Details regarding the error that has occurred can be seen in the ["CAN error status" on page 2205](#) register.

| Data type | Value | Meaning |
|-----------|--------|-------------------------|
| USINT | 1 to 8 | Number CAN payload data |
| | -1 | Error |

9.18.8.8.11.2 Identifier of the received data

Name:

RX01Ident to RX02Ident

Identifiers assigned to the received data. The frame format and the identifier format can also be read from this register.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|---|-------|--|
| 0 | Frame format | 0 | Standard frame format (SFF) with an 11-bit identifier |
| | | 1 | Extended frame format (EFF) with an 29-bit identifier |
| 1 | Frame type | 0 | Data frame |
| | | 1 | Remote frame (RTR) |
| 2 | Reserved | - | |
| 3 - 31 | CAN identifier for telegram to be transmitted | x | Extended frame format (EFF) with 29 bits Standard frame format (SFF) with 11 bits ¹⁾ |

1) Only bits 21 to 31 are used; bits 3 to 20 = 0.

9.18.8.8.11.3 Configuration of the CAN payload data to be received

Name:

RX0[x]DataByte0 to RX0[x]DataByte7

RX0[x]DataWord0 to RX0[x]DataWord3

RX0[x]DataLong0 to RX0[x]DataLong1

These registers hold the payload data of the CAN object to be transferred from the receive buffer to the CPU in the current cycle. If new data is received or if the receive buffer contains additional CAN objects, these registers are overwritten with the new data in the next cycle.

To avoid losing CAN objects, the application must respond immediately to a change in the "RX0[x]Count" and copies the data from these registers.

The maximum 8 bytes for a CAN telegram can be used as data points with 8 individual bytes, 4 words or 2 longs as needed.

| Data type | Value | Description |
|-----------|--------------------|------------------------------------|
| USINT | 0 to 255 | Received CAN payload data as bytes |
| UINT | 0 to 65,535 | Received CAN payload data as words |
| UDINT | 0 to 4.294.967.295 | Received CAN payload data as longs |

9.18.8.8.12 Flatstream communication

For a description of Flatstream communication, see ["Flatstream communication" on page 3802](#)

9.18.8.8.13 Acyclic frame size

Name:
AsynSize

When the stream is used, data is exchanged internally between the module and CPU. For this purpose, a defined amount of acyclic bytes is reserved for this slot.

Increasing the acyclic frame size leads to increased data throughput on this slot.

Information:

This configuration involves a driver setting that cannot be changed during runtime!

| Data type | Value | Information |
|-----------|---------|---|
| - | 8 to 28 | Acyclic frame size in bytes. Default = 24 |

9.18.8.8.14 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 µs |

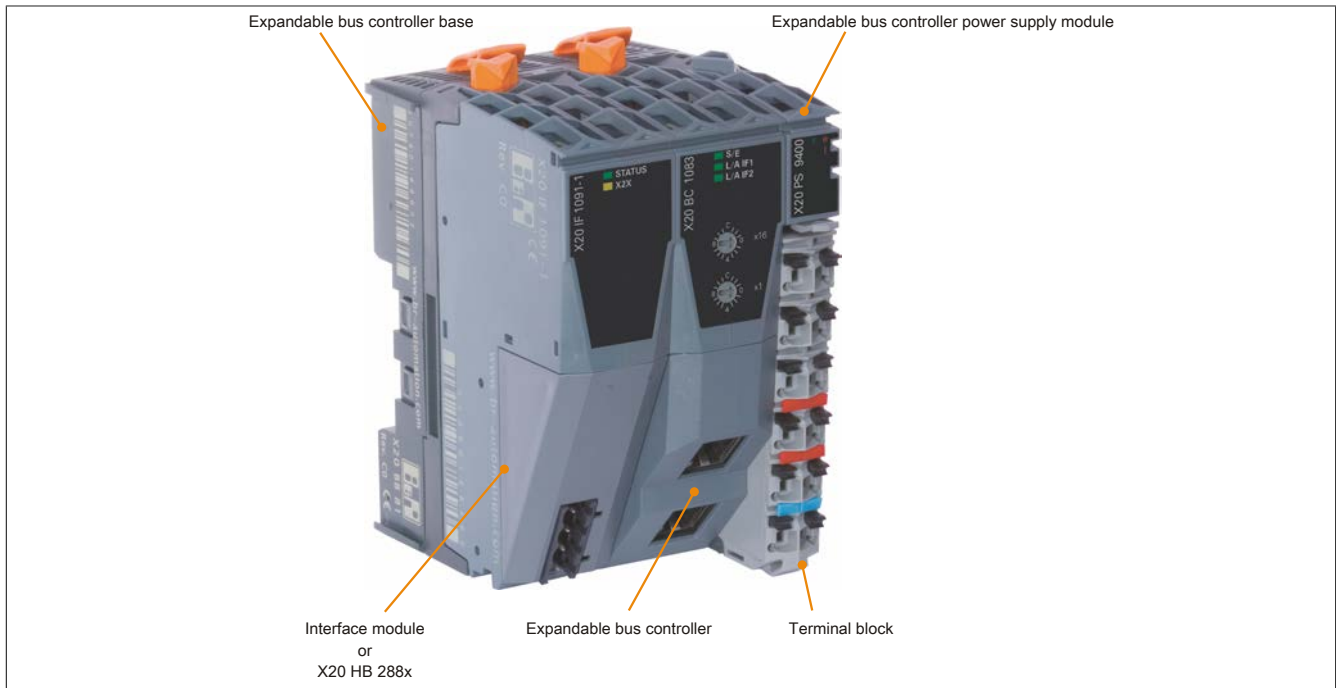
9.18.8.8.15 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 200 µs |

9.19 Expandable bus controllers

On expandable bus controllers, up to 2 interface or hub expansion modules can be connected depending on the bus module being used.



Compact design

The supply for the bus controller, X2X Link network and I/O modules is part of the bus controller. No additional power supply modules are required.

9.19.1 Summary

| Model number | Short description | Page |
|--------------|---|------|
| X20BC1083 | X20 bus controller, 1 POWERLINK interface, integrated 2-port hub, supports X20 interface module expansions, 2 RJ45, order bus base, power supply module and terminal block separately | 2213 |
| X20BC8083 | X20 bus controller, 1 POWERLINK interface, integrated 2-port hub, supports expansion with X20 hub modules, 2 RJ45, order bus base, power supply module and terminal block separately. | 2220 |
| X20BC8084 | X20 bus controller, 1 POWERLINK interface, 1x link selector for POWERLINK cable redundancy, supports expansion with enabled X20 hub modules, 2x RJ45, order bus base, power supply module and terminal block separately! | 2227 |
| X20cBC1083 | X20 bus controller, coated, 1 POWERLINK interface, integrated 2-port hub, supports X20 interface module expansions, 2 RJ45, order bus base, power supply module and terminal block separately | 2213 |
| X20cBC8083 | X20 bus controller, coated, 1 POWERLINK interface, integrated 2-port hub, supports X20 hub module expansions, 2 RJ45, order bus base, power supply module and terminal block separately | 2220 |
| X20cBC8084 | X20 bus controller, coated, 1 POWERLINK interface, 1x link selector for POWERLINK cable redundancy, supports expansion with active X20 hub modules, 2x RJ45, order bus base, power supply module and terminal block separately! | 2227 |

9.19.2 X20(c)BC1083

Data sheet version: 2.49

9.19.2.1 General information

The bus controller makes it possible to connect X2X Link I/O nodes to POWERLINK. It is also possible to operate the X2X Link cycle synchronously 1:1 or synchronous to POWERLINK using a prescaler.

POWERLINK is a standard protocol for Fast Ethernet with hard real-time characteristics. The POWERLINK Standardization Group (EPSG) ensures openness and continuous advancement. www.ethernet-powerlink.org

The bus modules expanded to the left allow connection of up to 2 interface modules in addition to the bus controller.

- POWERLINK
- I/O configuration and firmware update via the fieldbus
- Integrated hub for efficient cabling
- Up to 2 slots for interface modules

9.19.2.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.19.2.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C . During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.19.2.3 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Expandable bus controllers |  |
| X20BC1083 | X20 bus controller, 1 POWERLINK interface, integrated 2-port hub, supports X20 interface module expansions, 2 RJ45, order bus base, power supply module and terminal block separately | |
| X20cBC1083 | X20 bus controller, coated, 1 POWERLINK interface, integrated 2-port hub, supports X20 interface module expansions, 2 RJ45, order bus base, power supply module and terminal block separately | |
| | Required accessories | |
| | System modules for bus controllers | |
| X20PS9400 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply | |
| X20PS9402 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply, supply not electrically isolated | |
| X20cPS9400 | X20 power supply module, coated, for bus controller and internal I/O power supply, X2X Link power supply | |
| | System modules for expandable bus controllers | |
| X20BB81 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with one expansion slot for an X20 add-on module (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB82 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with 2 expansion slots for 2 X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cBB81 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with one expansion slot for an X20 add-on module (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cBB82 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with two expansion slots for two X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | Optional accessories | |
| | System modules for expandable bus controllers | |
| X20IF1091-1 | X20 interface module, for expandable bus controller, 1 X2X Link master interface, electrically isolated, order 1x TB704 terminal block separately | |
| | X20 interface module communication | |
| X20IF1041-1 | X20 interface module, for DTM configuration, 1 CANopen master interface, electrically isolated, order 1x TB2105 terminal block separately | |
| X20IF1043-1 | X20 interface module, for DTM configuration, 1 CANopen slave interface, electrically isolated, order 1x TB2105 terminal block separately | |
| X20IF1051-1 | X20 interface module, for DTM configuration, 1 DeviceNet scanner (master) interface, electrically isolated, order 1x terminal block TB2105 separately! | |
| X20IF1053-1 | X20 interface module, for DTM configuration, 1 DeviceNet adapter (slave) interface, electrically isolated, order 1x terminal block TB2105 separately! | |
| X20IF1061-1 | X20 interface module for DTM configuration, 1 PROFIBUS DP V0/V1 master interface, electrically isolated | |
| X20IF1063-1 | X20 interface module, for DTM configuration, 1 PROFIBUS DP V1 slave interface, electrically isolated | |
| X20IF1083-1 | X20 interface - POWERLINK controlled node (slave) | |
| X20IF10A1-1 | X20 interface module, for DTM configuration, 1 ASi master interface, electrically isolated, order 1x terminal block TB704 separately! | |
| X20IF10D1-1 | X20 interface module, for DTM configuration, 1 EtherNet/IP scanner (master) interface, electrically isolated | |
| X20IF10D3-1 | X20 interface module, for DTM configuration, 1 EtherNet/IP adapter (slave) interface, electrically isolated | |
| X20IF10E1-1 | X20 interface module, for DTM configuration, 1 PROFINET IO controller (master) interface, electrically isolated | |
| X20IF10E3-1 | X20 interface module, for DTM configuration, 1 PROFINET IO device (slave) interface module, electrically isolated | |
| X20IF10G3-1 | X20 interface module for DTM configuration, 1 EtherCAT slave interface, electrically isolated | |
| X20IF10H3-1 | X20 interface module for DTM configuration, 1 Sercos III slave interface, electrically isolated | |
| X20clF1041-1 | X20 interface module, coated, for DTM configuration, 1 CANopen master interface, electrically isolated, order 1x TB2105 terminal block separately | |

Table 394: X20BC1083, X20cBC1083 - Order data

| Model number | Short description | Figure |
|--------------|---|--------|
| X20clF1061-1 | X20 interface module coated, for DTM configuration, 1 PROFIBUS DP V0/V1 master interface, electrically isolated | |
| X20clF1063-1 | X20 interface module, coated, for DTM configuration, 1 PROFIBUS DP V1 slave interface, electrically isolated | |
| X20clF10D3-1 | X20 interface module, coated, for DTM configuration, 1 Ether-Net/IP adapter (slave) interface, electrically isolated | |
| X20clF10E3-1 | X20 interface module, coated, for DTM configuration, 1 PROFINET IO device (slave) interface module, electrically isolated | |

Table 394: X20BC1083, X20cBC1083 - Order data

9.19.2.4 Technical data

| Model number | X20BC1083 | X20cBC1083 |
|--|--|------------|
| Short description | | |
| Bus controller | POWERLINK (V1/V2) controlled node with up to 2 slots for interface modules | |
| General information | | |
| B&R ID code | 0x2268 | 0xE217 |
| Status indicators | Module status, bus function | |
| Diagnostics | | |
| Module status | Yes, using status LED and software | |
| Bus function | Yes, using status LED and software | |
| Power consumption | | |
| Bus | 2 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Interfaces | | |
| Fieldbus | POWERLINK (V1/V2) controlled node | |
| Type | Type 2 ¹⁾ | |
| Variant | 2x shielded RJ45 (hub) | |
| Cable length | Max. 100 m between 2 stations (segment length) | |
| Transfer rate | 100 Mbit/s | |
| Transfer | | |
| Physical layer | 100BASE-TX | |
| Half-duplex | Yes | |
| Full-duplex | No | |
| Autonegotiation | Yes | |
| Auto-MDI/MDIX | Yes | |
| Hub propagation delay | 0.96 to 1 µs | |
| Min. cycle time ²⁾ | | |
| Fieldbus | 200 µs | |
| X2X Link | 200 µs | |
| Synchronization between bus systems possible | Yes | |
| Cyclic data | | |
| Input data | Max. 1488 bytes | |
| Output data | Max. 1488 bytes | |
| Electrical properties | | |
| Electrical isolation | POWERLINK isolated from bus and I/O | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |

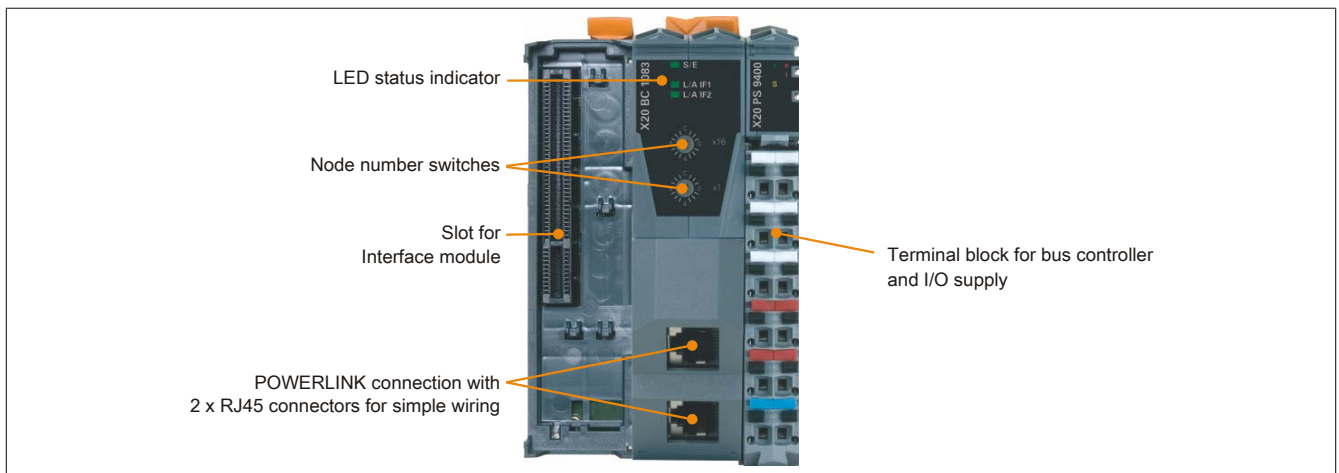
Table 395: X20BC1083, X20cBC1083 - Technical data

| Model number | X20BC1083 | X20cBC1083 |
|-----------------------------------|---|---|
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | | |
| Starting temperature | - | Yes, -40°C |
| Storage | | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20PS9400 or X20PS9402 power supply module separately Order 1x X20BB81 or X20BB82 bus base separately | Order 1x X20TB12 terminal block separately Order 1x X20cPS9400 power supply module separately Order 1x X20cBB81 or X20cBB82 bus base separately |
| Pitch ³⁾ | | |
| X20BB81 | 62.5 ^{+0.2} mm | |
| X20BB82 | 87.5 ^{+0.2} mm | |


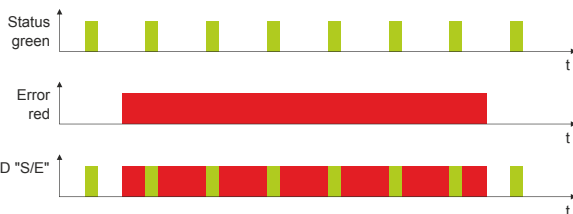
Table 395: X20BC1083, X20cBC1083 - Technical data

- 1) See Automation Help under "Communication / POWERLINK / General information / Hardware - CN" for more information.
- 2) The minimum cycle time defines how far the bus cycle can be reduced without communication errors occurring.
- 3) Spacing is based on the width of the X20BB81 or X20BB82 bus base. Up to 2 interfaces modules and 1 X20PS9400 or X20PS9402 supply module are also always required for the bus controller.

9.19.2.5 Operating and connection elements

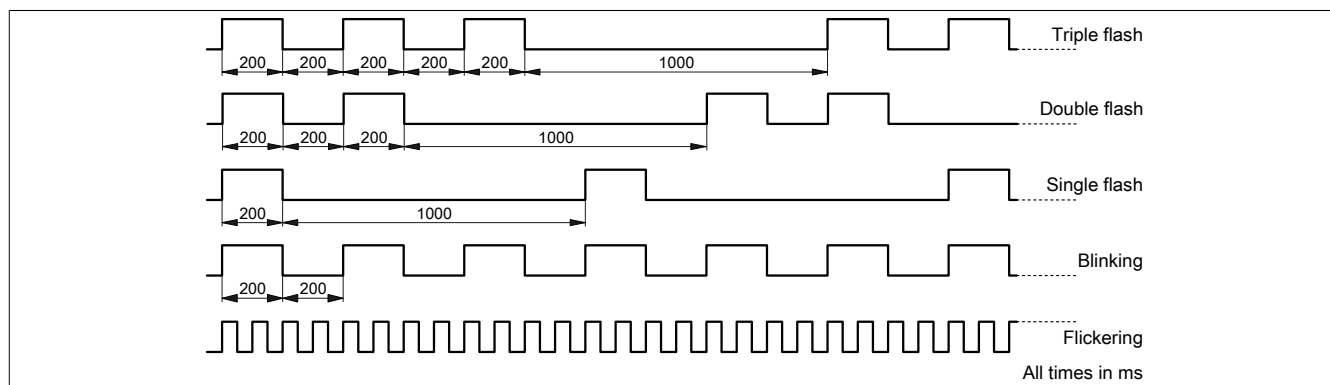


9.19.2.5.1 LED status indicators

| Figure | LED | Color | Status | Description | |
|---|-------------------|---------|--------------|--|---|
|  | S/E ¹⁾ | Green | Off | No power supply or mode NOT_ACTIVE. The controlled node (CN) is either not supplied with power, or it is in state NOT_ACTIVE. The CN waits in this state for about 5 seconds after a restart. Communication is not possible with the CN. If no POWERLINK communication is detected during these 5 seconds, the CN enters state BASIC_ETHERNET (flickering). If POWERLINK communication is detected before this time expires, however, the CN immediately enters state PRE_OPERATIONAL_1. | |
| | | | Flickering | Mode BASIC_ETHERNET. The CN has not detected any POWERLINK communication. In this state, it is possible to communicate directly with the CN (e.g. with UDP, IP, etc.) If communication POWERLINK is detected in this state, the CN switches to PRE_OPERATIONAL_1. | |
| | | | Single flash | Mode PRE_OPERATIONAL_1. When operating on a POWERLINK V1 manager, the CN switches directly to PRE_OPERATIONAL_2. When operated on a POWERLINK V2 manager, the CN waits until an SoC frame is received and then switches to the PRE_OPERATIONAL_2 state. | |
| | | | Double flash | Mode PRE_OPERATIONAL_2. The CN is normally configured by the manager in this state. It is then switched to state READY_TO_OPERATE by command (POWERLINK V2) or by setting the "data valid" flag in the output data (POWERLINK V1). | |
| | | | Triple flash | Mode READY_TO_OPERATE. In network POWERLINK V1, the CN switches automatically to OPERATIONAL as soon as input data is present. In a POWERLINK V2 network, the manager switches to the OPERATIONAL state by issuing a command. | |
| | | | On | Mode OPERATIONAL. The PDO mapping is active and cyclic data is evaluated. | |
| | | | Blinking | Mode STOPPED. Output data is not being output, and no input data is being provided. It is only possible to switch to or leave this state after the manager has given the appropriate command. | |
| | | | Red | On | The controlled node (CN) is in an error state (failed Ethernet frames, increased number of collisions on the network, etc.). If an error occurs in the following states, then the green LED blinks over the red LED: <ul style="list-style-type: none"> • PRE_OPERATIONAL_1 • PRE_OPERATIONAL_2 • READY_TO_OPERATE  <p>Note:</p> <ul style="list-style-type: none"> • Several red blinking signals are displayed immediately after the device is switched on. This is not an error, however. • The LED is lit red for CNs with configured physical node number 0 but that have not yet been assigned a node number via dynamic node allocation (DNA). |
| | | L/A IFx | Green | On | Link established to the remote station |
| | | | | | Blinking |

1) The Status/Error LED "S/E" is a green/red dual LED.

Status-LEDs - Blinkzeiten



9.19.2.5.2 POWERLINK node number

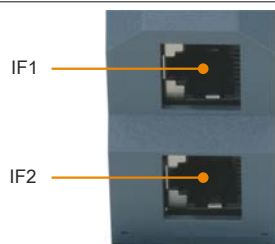


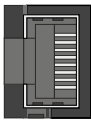
The node number for the POWERLINK node is set using the two number switches.

| Switch position | Description |
|-----------------|--|
| 0x00 | Only permitted when operating the POWERLINK node in DNA mode. |
| 0x01 - 0xEF | Node number of the POWERLINK node. Operation as a controlled node. |
| 0xF0 - 0xFF | Reserved, switch position not permitted. |

9.19.2.5.3 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see ["Cabling guidelines for X20 modules with an Ethernet cable" on page 58](#).



| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.19.2.5.4 Slot for interface modules

Depending on the bus base, up to two interface modules can be installed on the left side of the expandable bus controller:

| Bus base | Slots for interface modules |
|----------|-----------------------------|
| X20BB81 | 1 |
| X20BB82 | 2 |

Table 396: Slots for interface modules for various bus bases

9.19.2.6 Dynamic node allocation (DNA)

Most POWERLINK bus controllers have the ability to dynamically assign node numbers. This has the following advantages:

- No setting of the node number switch
- Easier installation
- Reduced error sources

For information regarding configuration as well as an example, see Automation Help → Communication → POWERLINK → General information → Dynamic node allocation (DNA)

Information:

Interface IF1 must always be used as the input from the preceding node.

9.19.2.7 Operating netX modules with bus controller X20BC1083

It is important to note the following in order to operate netX modules with the bus controller without problems:

- A minimum revision $\geq E0$ is required for the bus controller.
- netX modules can only be operated with the POWERLINK V2 setting. V1 is not permitted.
- With SDO access to POWERLINK object 0x1011/1 on the bus controller, the netX firmware and the configuration stored on the bus controller are not reset. They can only be overwritten by accessing them again. This affects objects 0x20C0 and 0x20C8, subindexes 92 to 95.

9.19.2.8 SG3

This module is not supported on SG3 target systems.

9.19.2.9 SG4

The module comes with preinstalled firmware. The firmware is also part of the Automation Runtime operating system for the PLC. With different versions, the Automation Runtime firmware is loaded onto the module.

The latest firmware is made available automatically when updating Automation Runtime.

9.19.3 X20(c)BC8083

Data sheet version: 2.39

9.19.3.1 General information

The bus controller makes it possible to connect X2X Link I/O nodes to POWERLINK. It is also possible to operate the X2X Link cycle synchronously 1:1 or synchronous to POWERLINK using a prescaler.

POWERLINK is a standard protocol for Fast Ethernet with hard real-time characteristics. The POWERLINK Standardization Group (EPG) ensures openness and continuous advancement. www.ethernet-powerlink.org

The bus modules expanded to the left allow connection of up to 2 hub expansion modules in addition to the bus controller. Each expansion module is equipped with 2 RJ45 connections. This means that a basic device provides up to 6 hub connections.

- POWERLINK
- I/O configuration and firmware update via the fieldbus
- Integrated hub for efficient cabling
- Up to 2 slots for hub expansion modules
- 2x/4x/6x Fast Ethernet hub

Notice!

Using the bus controller together with the X20HB1881 and X20HB2881 fiber optic cable connectors.

- **X20BC8083: Hardware revision G0 up to and including I0**
- **X20cBC8083: All hardware revisions up to and including I0**

In rare cases, a firmware update or reconnection of the bus controller may make it so the connection to the connected X20HB modules can no longer be established.

This problem can be corrected by restarting (removing power to) the bus controller or reconnecting (hot plugging) the X20HB modules.

Combining the bus controller with other X20HB modules does not cause any problems.

9.19.3.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.19.3.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.19.3.3 Order data


| Model number | Short description | Figure |
|--|--|---|
| Expandable bus controllers | |  |
| X20BC8083 | X20 bus controller, 1 POWERLINK interface, integrated 2-port hub, supports expansion with X20 hub modules, 2 RJ45, order bus base, power supply module and terminal block separately. | |
| X20cBC8083 | X20 bus controller, coated, 1 POWERLINK interface, integrated 2-port hub, supports X20 hub module expansions, 2 RJ45, order bus base, power supply module and terminal block separately | |
| Required accessories | | |
| System modules for bus controllers | | |
| X20BB80 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20PS9400 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply | |
| X20PS9402 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply, supply not electrically isolated | |
| X20cBB80 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cPS9400 | X20 power supply module, coated, for bus controller and internal I/O power supply, X2X Link power supply | |
| System modules for expandable bus controllers | | |
| X20BB81 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with one expansion slot for an X20 add-on module (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB82 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with 2 expansion slots for 2 X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cBB81 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with one expansion slot for an X20 add-on module (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cBB82 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with two expansion slots for two X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| Terminal blocks | | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| Optional accessories | | |
| System modules for the X20 hub system | | |
| X20HB1881 | X20 hub expansion module, integrated 1-port hub, for multimode fiber optic cable | |
| X20HB1882 | X20 hub expansion module, integrated 1-port hub, for monomode fiber optic cables | |
| X20HB2880 | X20 hub expansion module, integrated 2-port hub, 2x RJ45 | |
| X20HB2881 | X20 hub expansion module, integrated 2-port hub, for fiber optic cable | |
| X20cHB1881 | X20 hub expansion module, coated, integrated 1-port hub, for fiber optic cable | |
| X20cHB2880 | X20 hub expansion module, coated, integrated 2-port hub, 2x RJ45 | |
| X20cHB2881 | X20 hub expansion module, coated, integrated 2-port hub, for fiber optic cable | |

Table 397: X20BC8083, X20cBC8083 - Order data

9.19.3.4 Technical data

| Model number | X20BC8083 | X20cBC8083 |
|--|--|------------------------|
| Short description | | |
| Bus controller | POWERLINK (V1/V2) controlled node with up to 2 slots for hub expansion modules | |
| General information | | |
| B&R ID code | 0x2673 | 0xE218 |
| Status indicators | Module status, bus function | |
| Diagnostics | | |
| Module status | Yes, using status LED and software | |
| Bus function | Yes, using status LED and software | |
| Power consumption | | |
| Bus | 2 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Interfaces | | |
| Fieldbus | POWERLINK (V1/V2) controlled node | |
| Type | Type 2 ¹⁾ | |
| Variant | 2x shielded RJ45 (hub) | |
| Cable length | Max. 100 m between 2 stations (segment length) | |
| Transfer rate | 100 Mbit/s | |
| Transfer | | |
| Physical layer | 100BASE-TX | |
| Half-duplex | Yes | |
| Full-duplex | No | |
| Autonegotiation | Yes | |
| Auto-MDI/MDIX | Yes | |
| Hub propagation delay | 0.96 to 1 µs | |
| Min. cycle time ²⁾ | | |
| Fieldbus | 200 µs | |
| X2X Link | 200 µs | |
| Synchronization between bus systems possible | Yes | |
| Electrical properties | | |
| Electrical isolation | POWERLINK isolated from bus and I/O | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Starting temperature | - | Yes, -40°C |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |

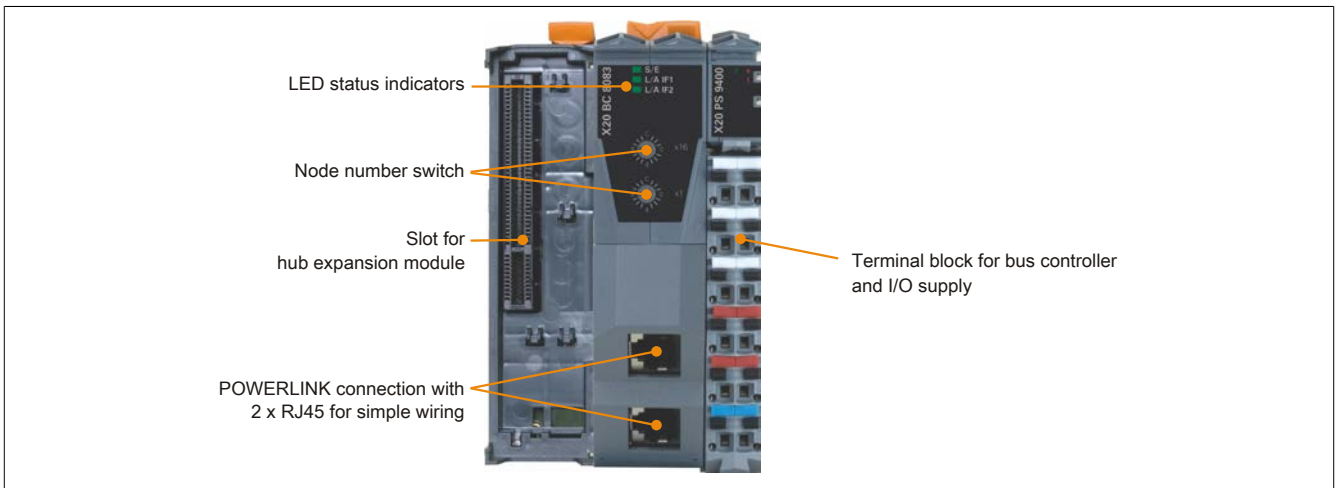
Table 398: X20BC8083, X20cBC8083 - Technical data

| Model number | X20BC8083 | X20cBC8083 |
|------------------------------|--|---|
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20PS9400 or X20PS9402 power supply module separately Order 1x X20BB8x bus base separately | Order 1x X20TB12 terminal block separately Order 1x X20cPS9400 power supply module separately Order 1x X20cBB8x bus base separately |
| Pitch ³⁾ | | |
| X20BB80 | | 37.5 ^{+0.2} mm |
| X20BB81 | | 62.5 ^{+0.2} mm |
| X20BB82 | | 87.5 ^{+0.2} mm |


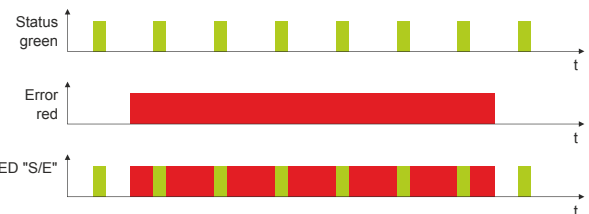
Table 398: X20BC8083, X20cBC8083 - Technical data

- 1) See Automation Help under "Communication / POWERLINK / General information / Hardware - CN" for more information.
- 2) The minimum cycle time defines how far the bus cycle can be reduced without communication errors occurring.
- 3) Spacing is based on the width of the X20BB80 bus base. Up to 2 X20HB2880 hub expansion modules and 1 X20PS9400 or X20PS9402 power supply module are also always required for the bus controller.

9.19.3.5 Operating and connection elements

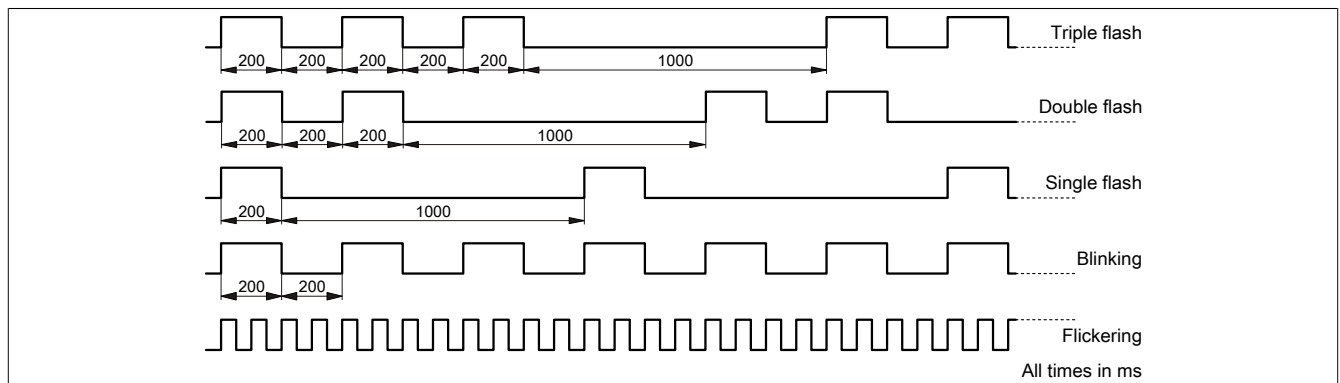


9.19.3.5.1 LED status indicators

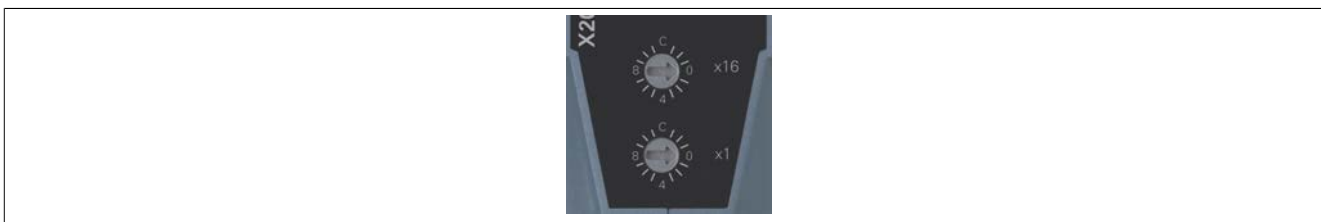
| Figure | LED | Color | Status | Description | |
|---|-------------------|---------|--------------|--|---|
|  | S/E ¹⁾ | Green | Off | No power supply or mode NOT_ACTIVE. The controlled node (CN) is either not supplied with power, or it is in state NOT_ACTIVE. The CN waits in this state for about 5 seconds after a restart. Communication is not possible with the CN. If no POWERLINK communication is detected during these 5 seconds, the CN enters state BASIC_ETHERNET (flickering). If POWERLINK communication is detected before this time expires, however, the CN immediately enters state PRE_OPERATIONAL_1. | |
| | | | Flickering | Mode BASIC_ETHERNET. The CN has not detected any POWERLINK communication. In this state, it is possible to communicate directly with the CN (e.g. with UDP, IP, etc.) If communication POWERLINK is detected in this state, the CN switches to PRE_OPERATIONAL_1. | |
| | | | Single flash | Mode PRE_OPERATIONAL_1. When operating on a POWERLINK V1 manager, the CN switches directly to PRE_OPERATIONAL_2. When operated on a POWERLINK V2 manager, the CN waits until an SoC frame is received and then switches to the PRE_OPERATIONAL_2 state. | |
| | | | Double flash | Mode PRE_OPERATIONAL_2. The CN is normally configured by the manager in this state. It is then switched to state READY_TO_OPERATE by command (POWERLINK V2) or by setting the "data valid" flag in the output data (POWERLINK V1). | |
| | | | Triple flash | Mode READY_TO_OPERATE. In network POWERLINK V1, the CN switches automatically to OPERATIONAL as soon as input data is present. In a POWERLINK V2 network, the manager switches to the OPERATIONAL state by issuing a command. | |
| | | | On | Mode OPERATIONAL. The PDO mapping is active and cyclic data is evaluated. | |
| | | | Blinking | Mode STOPPED. Output data is not being output, and no input data is being provided. It is only possible to switch to or leave this state after the manager has given the appropriate command. | |
| | | | Red | On | The controlled node (CN) is in an error state (failed Ethernet frames, increased number of collisions on the network, etc.). If an error occurs in the following states, then the green LED blinks over the red LED: <ul style="list-style-type: none"> • PRE_OPERATIONAL_1 • PRE_OPERATIONAL_2 • READY_TO_OPERATE  <p>Note:</p> <ul style="list-style-type: none"> • Several red blinking signals are displayed immediately after the device is switched on. This is not an error, however. • The LED is lit red for CNs with configured physical node number 0 but that have not yet been assigned a node number via dynamic node allocation (DNA). |
| | | L/A IFx | Green | On | Link established to the remote station |
| | | | | | Blinking |

1) The Status/Error LED "S/E" is a green/red dual LED.

LED status indicators - Blink times



9.19.3.5.2 POWERLINK node number

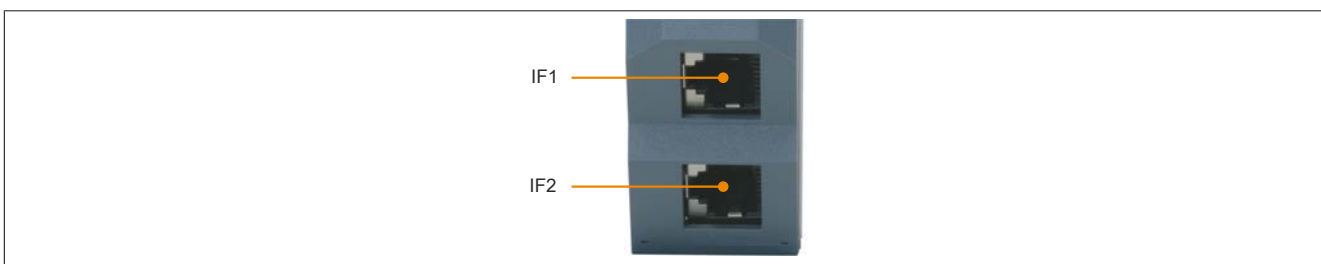


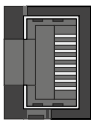
The node number for the POWERLINK node is set using the two number switches.

| Switch position | Description |
|-----------------|--|
| 0x00 | Only permitted when operating the POWERLINK node in DNA mode. |
| 0x01 - 0xEF | Node number of the POWERLINK node. Operation as a controlled node. |
| 0xF0 - 0xFF | Reserved, switch position not permitted. |

9.19.3.5.3 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see ["Cabling guidelines for X20 modules with an Ethernet cable"](#) on page 58.



| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.19.3.5.4 Slot for hub expansion modules

Depending on the bus base, up to 2 hub expansion modules can be installed on the left side of the bus controller:

| Bus base | Slots for hub expansion modules |
|----------|---------------------------------|
| X20BB81 | 1 |
| X20BB82 | 2 |

Hub expansion module X20HB2880 can be connected to the bus controller and is equipped with 2 RJ45 connections, which means that up to 6 hub ports are available.

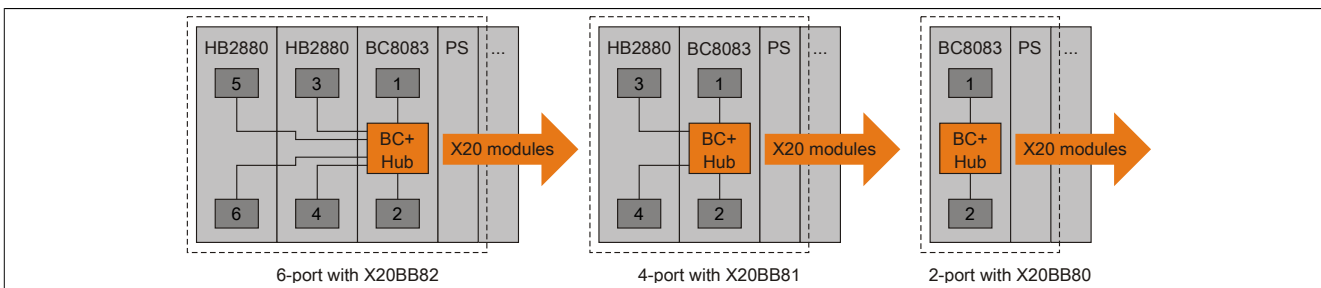


Figure 159: Numbering of hub ports

When using DNA, the desired hub port number must be specified under "Hub port on predecessor" in Automation Studio.

9.19.3.6 Dynamic node allocation (DNA)

Most POWERLINK bus controllers have the ability to dynamically assign node numbers. This has the following advantages:

- No setting of the node number switch
- Easier installation
- Reduced error sources

For information regarding configuration as well as an example, see Automation Help → Communication → POWERLINK → General information → Dynamic node allocation (DNA)

Information:

Interface IF1 must always be used as the input from the preceding node.

9.19.3.7 SG3

This module is not supported on SG3 target systems.

9.19.3.8 SG4

The module comes with preinstalled firmware. The firmware is also part of the Automation Runtime operating system for the PLC. With different versions, the Automation Runtime firmware is loaded onto the module.

The latest firmware is made available automatically when updating Automation Runtime.

9.19.4 X20(c)BC8084

Data sheet version: 2.39

9.19.4.1 General information

The bus controller makes it possible to connect X2X Link I/O nodes to POWERLINK. It is also possible to operate the X2X Link cycle synchronously 1:1 or synchronous to POWERLINK using a prescaler.

POWERLINK is a standard protocol for Fast Ethernet with hard real-time characteristics. The POWERLINK Standardization Group (EPSG) ensures openness and continuous advancement. www.ethernet-powerlink.org

Systems with redundant cabling can be implemented easily using POWERLINK. Unlike ring redundancy, cable redundancy does not require cable looping, which can sometimes be problematic. This allows the creation of all types of tree structures. When using a device with the link selector function, data is always transferred via the highest quality network lines. The link selector function is integrated in the bus controller.

- POWERLINK
- I/O configuration and firmware update via the fieldbus
- Integrated compact link selector function
- 2 active hub expansion modules can be connected to the bus controller
- Redundant supply possible

Notice!

Using the bus controller up to and including hardware revision G0 together with the X20HB1881 and X20HB2886 fiber optic cable connectors:

In rare cases, a firmware update or reconnection of the bus controller may make it so the connection to the connected X20HB modules can no longer be established.

This problem can be corrected by restarting (removing power to) the bus controller or reconnecting (hot plugging) the X20HB modules.

When using cable redundancy, the communication remains within the system if the redundant X20HB modules are reconnected individually and not at the same time!

Combining the bus controller with other X20HB modules does not cause any problems.

9.19.4.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.19.4.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C . During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.19.4.3 Order data

| Model number | Short description | Figure |
|--|---|---|
| Expandable bus controllers | |  |
| X20BC8084 | X20 bus controller, 1 POWERLINK interface, 1x link selector for POWERLINK cable redundancy, supports expansion with enabled X20 hub modules, 2x RJ45, order bus base, power supply module and terminal block separately! | |
| X20cBC8084 | X20 bus controller, coated, 1 POWERLINK interface, 1x link selector for POWERLINK cable redundancy, supports expansion with active X20 hub modules, 2x RJ45, order bus base, power supply module and terminal block separately! | |
| Required accessories | | |
| System modules for bus controllers | | |
| X20BB80 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20PS9400 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply | |
| X20PS9402 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply, supply not electrically isolated | |
| X20cBB80 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cPS9400 | X20 power supply module, coated, for bus controller and internal I/O power supply, X2X Link power supply | |
| System modules for expandable bus controllers | | |
| X20BB82 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with 2 expansion slots for 2 X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cBB82 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with two expansion slots for two X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| Terminal blocks | | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| Optional accessories | | |
| System modules for X20 redundancy system | | |
| X20HB2885 | X20 hub expansion module, integrated active 2-port hub, 2x RJ45 | |
| X20HB2886 | X20 hub expansion module, integrated active 2-port hub, 2 fiber optic interfaces | |
| X20cHB2885 | X20 hub expansion module, coated, integrated active 2-port hub, 2x RJ45 | |

Table 399: X20BC8084, X20cBC8084 - Order data

9.19.4.4 Technical data

| Model number | X20BC8084 | X20cBC8084 |
|--|--|------------------------|
| Short description | | |
| Bus controller | POWERLINK (V1/V2) controlled node with compact link selector | |
| General information | | |
| B&R ID code | 0x2674 | 0xDF10 |
| Status indicators | Module status, bus function | |
| Diagnostics | | |
| Module status | Yes, using LED status indicator and software | |
| Bus function | Yes, using LED status indicator and software | |
| Power consumption | | |
| Bus | 2 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Interfaces | | |
| Fieldbus | POWERLINK (V1/V2) controlled node | |
| Type | Type 2 ¹⁾ | |
| Variant | 2x shielded RJ45 | |
| Cable length | Max. 100 m between 2 stations (segment length) | |
| Transfer rate | 100 Mbit/s | |
| Transfer | | |
| Physical layer | 100BASE-TX | |
| Half-duplex | Yes | |
| Full-duplex | No | |
| Autonegotiation | Yes | |
| Auto-MDI/MDIX | Yes | |
| Hub propagation delay | 0.96 to 1 µs | |
| Min. cycle time ²⁾ | | |
| Fieldbus | 200 µs | |
| X2X Link | 200 µs | |
| Synchronization between bus systems possible | Yes | |
| Electrical properties | | |
| Electrical isolation | POWERLINK isolated from bus and I/O | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitation | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Starting temperature | - | Yes, -40°C |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |

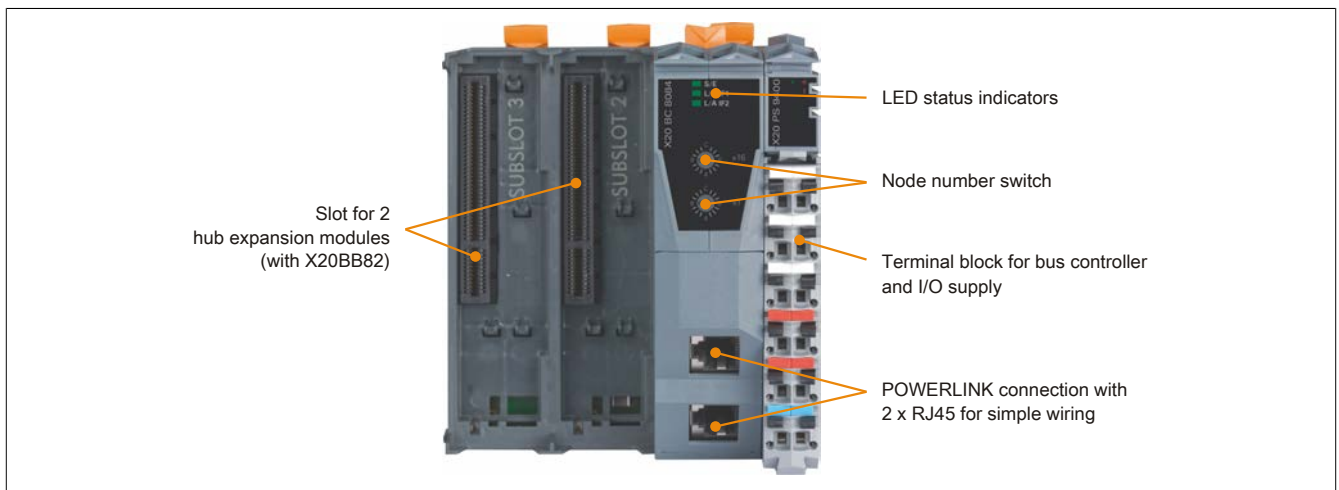
Table 400: X20BC8084, X20cBC8084 - Technical data

| Model number | X20BC8084 | X20cBC8084 |
|------------------------------|---|---|
| Mechanical properties | | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x power supply module X20PS9400 or X20PS9402 separately. Order 1x bus base X20B-B80 or X20BB82 separately. | Order 1x terminal block X20TB12 separately. Order 1x power supply module X20cPS9400 separately. Order 1x bus base X20cB-B80 or X20cBB82 separately. |
| Pitch ³⁾ | | |
| X20BB80 | | 37.5 ^{+0.2} mm |
| X20BB82 | | 87.5 ^{+0.2} mm |


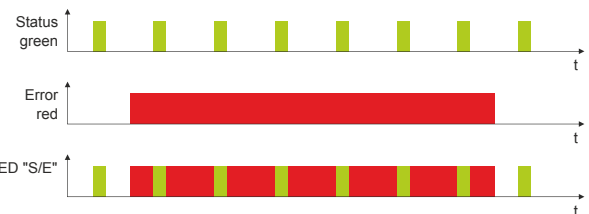
Table 400: X20BC8084, X20cBC8084 - Technical data

- 1) See Automation Help under "Communication / POWERLINK / General information / Hardware - CN" for more information.
- 2) The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring.
- 3) Spacing is based on the width of bus base X20BB80 or X20BB82. In addition, 1 power supply module X20PS9400 or X20PS9402 is always required for the bus controller. To save wiring for external hubs, the X20BC8084 can be expanded with 2 active hub modules, the X20HB2885 or X20HB2886.

9.19.4.5 Operating and connection elements

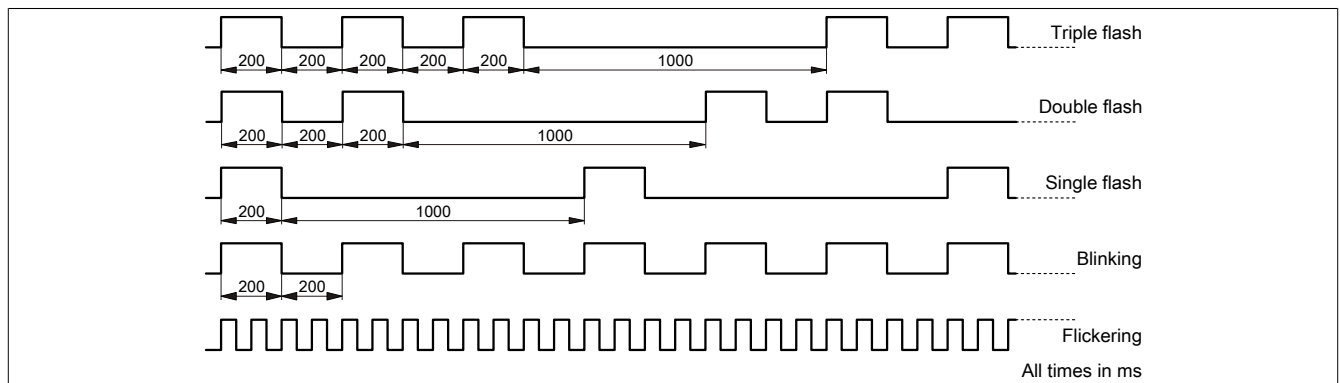


9.19.4.5.1 LED status indicators

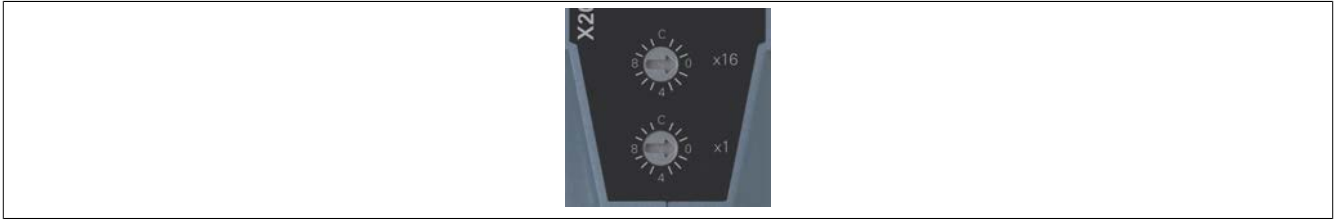
| Figure | LED | Color | Status | Description | |
|---|-------------------|---------|--------------|--|---|
|  | S/E ¹⁾ | Green | Off | No power supply or mode NOT_ACTIVE. The controlled node (CN) is either not supplied with power, or it is in state NOT_ACTIVE. The CN waits in this state for about 5 seconds after a restart. Communication is not possible with the CN. If no POWERLINK communication is detected during these 5 seconds, the CN enters state BASIC_ETHERNET (flickering). If POWERLINK communication is detected before this time expires, however, the CN immediately enters state PRE_OPERATIONAL_1. | |
| | | | Flickering | Mode BASIC_ETHERNET. The CN has not detected any POWERLINK communication. In this state, it is possible to communicate directly with the CN (e.g. with UDP, IP, etc.) If communication POWERLINK is detected in this state, the CN switches to PRE_OPERATIONAL_1. | |
| | | | Single flash | Mode PRE_OPERATIONAL_1. When operating on a POWERLINK V1 manager, the CN switches directly to PRE_OPERATIONAL_2. When operated on a POWERLINK V2 manager, the CN waits until an SoC frame is received and then switches to the PRE_OPERATIONAL_2 state. | |
| | | | Double flash | Mode PRE_OPERATIONAL_2. The CN is normally configured by the manager in this state. It is then switched to state READY_TO_OPERATE by command (POWERLINK V2) or by setting the "data valid" flag in the output data (POWERLINK V1). | |
| | | | Triple flash | Mode READY_TO_OPERATE. In network POWERLINK V1, the CN switches automatically to OPERATIONAL as soon as input data is present. In a POWERLINK V2 network, the manager switches to the OPERATIONAL state by issuing a command. | |
| | | | On | Mode OPERATIONAL. The PDO mapping is active and cyclic data is evaluated. | |
| | | | Blinking | Mode STOPPED. Output data is not being output, and no input data is being provided. It is only possible to switch to or leave this state after the manager has given the appropriate command. | |
| | | | Red | On | The controlled node (CN) is in an error state (failed Ethernet frames, increased number of collisions on the network, etc.). If an error occurs in the following states, then the green LED blinks over the red LED: <ul style="list-style-type: none"> • PRE_OPERATIONAL_1 • PRE_OPERATIONAL_2 • READY_TO_OPERATE  <p>Note:</p> <ul style="list-style-type: none"> • Several red blinking signals are displayed immediately after the device is switched on. This is not an error, however. • The LED is lit red for CNs with configured physical node number 0 but that have not yet been assigned a node number via dynamic node allocation (DNA). |
| | | L/A IFx | Green | On | Link established to the remote station |
| | | | | | Blinking |

1) The Status/Error LED "S/E" is a green/red dual LED.

LED status indicators - Blink times



9.19.4.5.2 POWERLINK node number

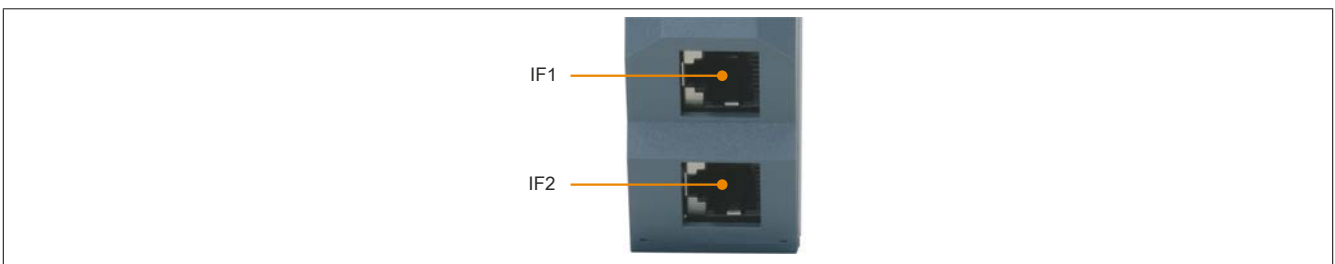


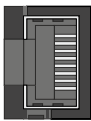
The node number for the POWERLINK node is set using the two number switches.

| Switch position | Description |
|-----------------|---|
| 0x00 | Reserved, switch position not permitted. |
| 0x01 - 0xEF | Node number of the POWERLINK node. Operation as a controlled node (CN). |
| 0xF0 - 0xFF | Reserved, switch position not permitted. |

9.19.4.5.3 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see "[Cabling guidelines for X20 modules with an Ethernet cable](#)" on page 58.



| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.19.4.6 SG3

This module is not supported on SG3 target systems.

9.19.4.7 SG4

The module comes with preinstalled firmware. The firmware is also part of the Automation Runtime operating system for the PLC. With different versions, the Automation Runtime firmware is loaded onto the module.

The latest firmware is made available automatically when updating Automation Runtime.

9.19.4.8 POWERLINK cable redundancy system

It is often indispensable to have redundant network cabling, especially in systems that handle technical processes. The potential for danger, especially to the lines that run through the system, is disproportionately high in relation to the need to keep communication active in all operating situations. This risk is effectively reduced with double cabling that is routed separately.

The POWERLINK cable redundancy system is based on the principle of doubling the transfer routing as well as providing continual and simultaneous monitoring. That means data is simultaneously fed into two cable lines using a corresponding mechanism. The same mechanisms are used to receive these telegrams from the redundant network.

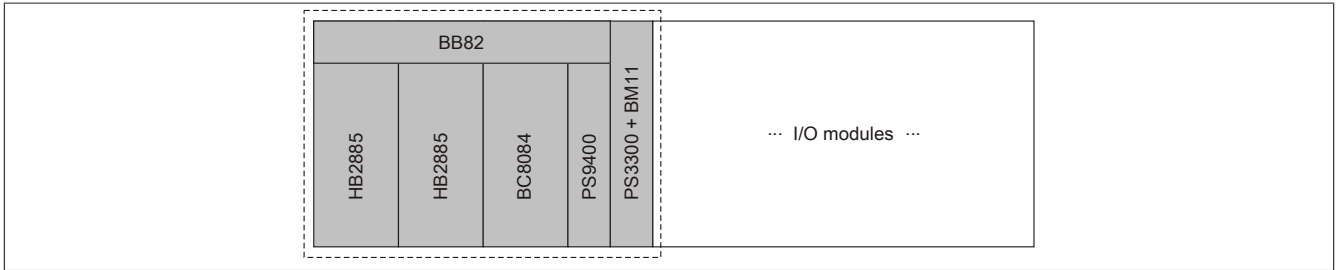
Information:

Details about the structure of a redundancy system can be found in the "Redundancy for control systems" user's manual. The user's manual is available in the Downloads section of the B&R website www.br-automation.com.

9.19.4.9 Redundant supply voltage

When operating the bus controller with two X20HB2885 hub modules, a redundant supply voltage for the system can be easily implemented using two X20 supply modules.

Hardware configuration for redundant supply voltage



Connection example for supply modules

X20PS9400

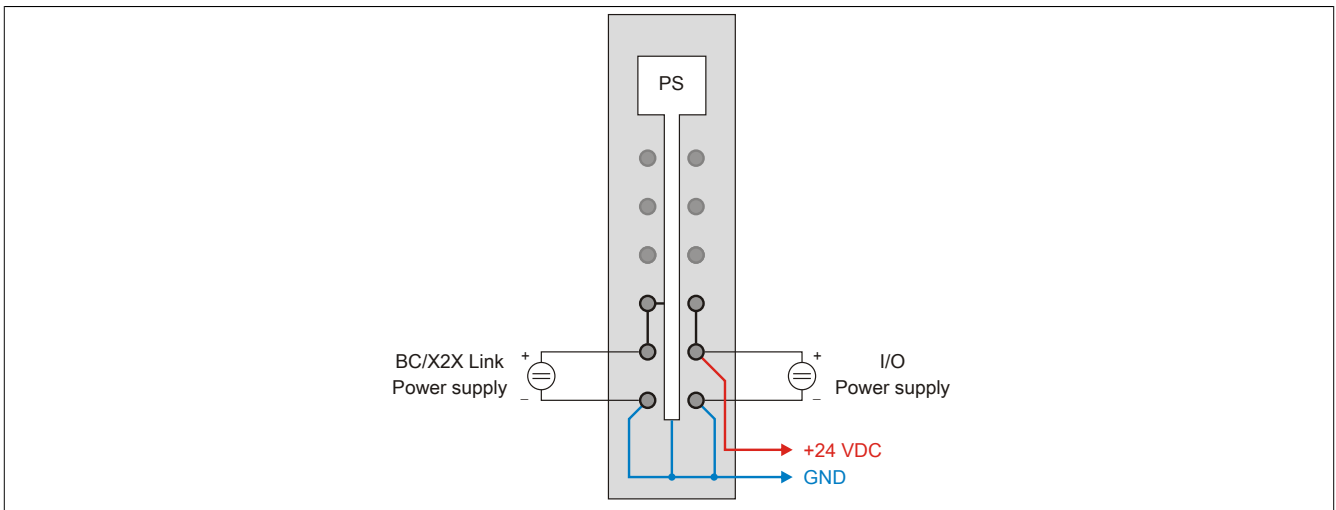


Figure 160: The X20PS9400 is connected as usual

X20PS3300

The supply module X20PS3300 is operated with a X20BM11 bus module. Only the BC/X2X Link supply is connected. A redundant I/O supply is not possible. By using the X20BM11 bus module, the I/O supply of the X20PS9400 supply module is connected to the I/O modules.

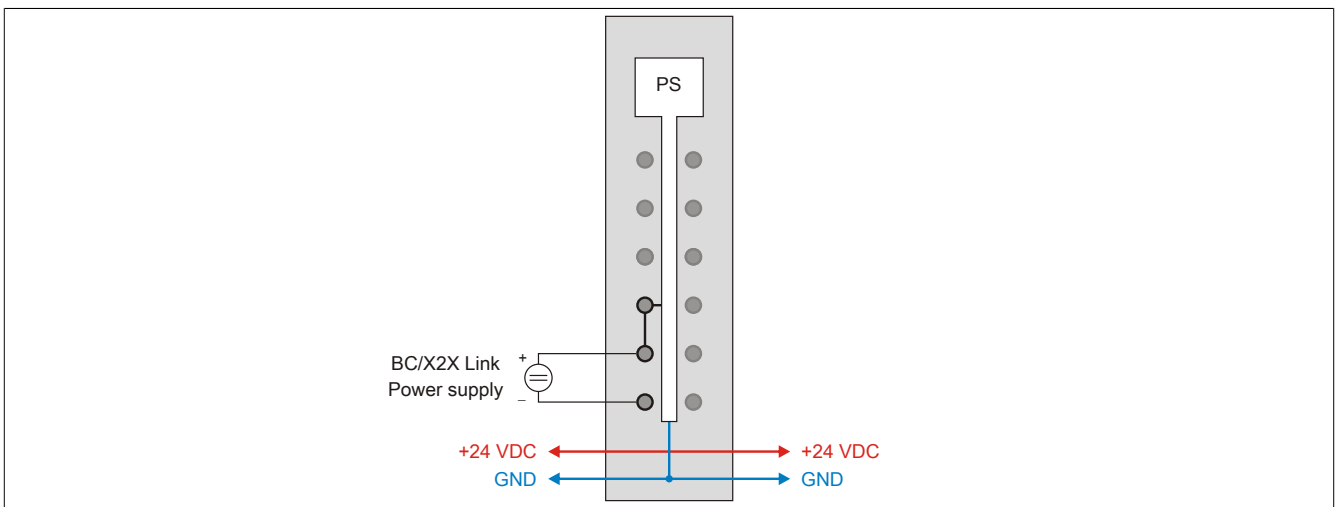


Figure 161: Only the BC/X2X Link supply is connected for the X20PS3300

9.20 Expandable bus controllers system modules

The expandable X20 bus controllers are made up of a bus controller fieldbus interface, a bus controller system module and an X20TB12 terminal block.

Expandable bus controller system modules include the base module and the supply module for providing power to the entire system.

9.20.1 Summary

| Model number | Short description | Page |
|--------------|--|------|
| X20BB81 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with one expansion slot for an X20 add-on module (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 2234 |
| X20BB82 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with 2 expansion slots for 2 X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 2237 |
| X20IF1091-1 | X20 interface module, for expandable bus controller, 1 X2X Link master interface, electrically isolated, order 1x TB704 terminal block separately | 2240 |
| X20cBB81 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with one expansion slot for an X20 add-on module (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 2234 |
| X20cBB82 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with two expansion slots for two X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 2237 |

9.20.2 X20(c)BB81

Data sheet version: 2.35

9.20.2.1 General information

The bus module has an expansion slot. The following modules are used on this module:

- Base module (BC, HB, etc.)
- Add-on module (IF, HB, etc.)
- Supply module

The left and right end plates are included in the delivery.

- Bus base with one expansion slot

Information:

The bus controller must be placed in the rightmost slot.

9.20.2.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.20.2.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.20.2.3 Order data

| Model number | Short description | Figure |
|--------------|---|--------|
| | System modules for expandable bus controllers | |
| X20BB81 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with one expansion slot for an X20 add-on module (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cBB81 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with one expansion slot for an X20 add-on module (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |

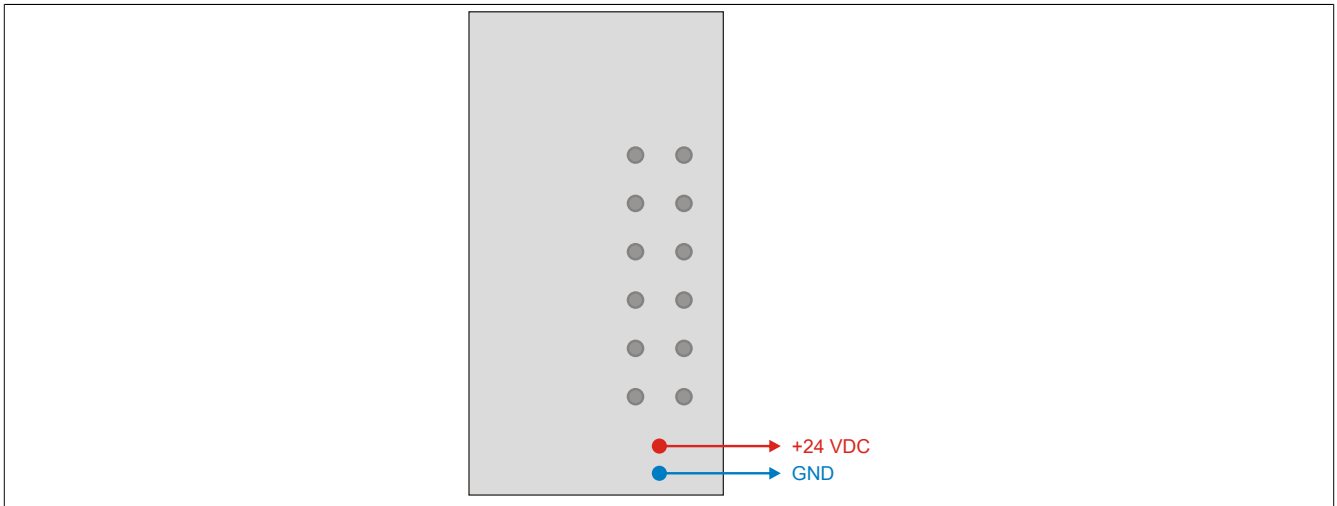
Table 401: X20BB81, X20cBB81 - Order data

9.20.2.4 Technical data

| Model number | X20BB81 | X20cBB81 |
|--|--|------------------------|
| Short description | | |
| Bus module | Bus base with one expansion slot | |
| General information | | |
| Power consumption | | |
| Bus | 0.50 W | |
| Internal I/O | - | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations | |
| DNV GL | Class 1, Division 2, Groups ABCD, T5 Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| EAC | Yes | |
| KC | Yes | - |
| I/O power supply | | |
| Nominal voltage | 24 VDC | |
| Permissible contact load | 10 A | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Left and right X20 locking plates included in delivery | |
| Pitch | 62.5 ^{+0.2} mm | |

Table 402: X20BB81, X20cBB81 - Technical data

9.20.2.5 Voltage routing



9.20.3 X20(c)BB82

Data sheet version: 2.35

9.20.3.1 General information

The bus module has 2 expansion slots. The following modules are used on this module:

- Base module (BC, HB, etc.)
- Two add-on modules (IF, HB, etc.)
- Supply module

The left and right end plates are included in the delivery.

- Bus base with 2 expansion slots

Information:

The bus controller must be placed in the rightmost slot.

9.20.3.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.20.3.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.20.3.3 Order data

| Model number | Short description | Figure |
|--------------|--|--------|
| | System modules for expandable bus controllers | |
| X20BB82 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with 2 expansion slots for 2 X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cBB82 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with two expansion slots for two X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |

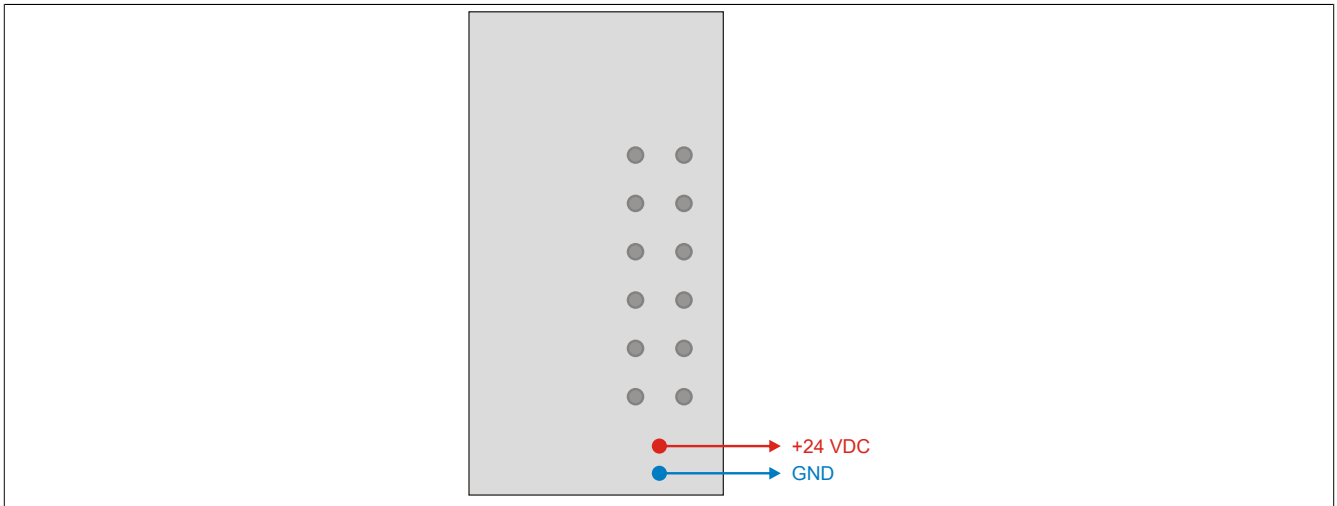
Table 403: X20BB82, X20cBB82 - Order data

9.20.3.4 Technical data

| Model number | X20BB82 | X20cBB82 |
|--|--|------------------------|
| Short description | | |
| Bus module | Bus base with 2 expansion slots | |
| General information | | |
| Power consumption | | |
| Bus | 0.70 W | |
| Internal I/O | - | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations | |
| DNV GL | Class 1, Division 2, Groups ABCD, T5 Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| I/O power supply | | |
| Nominal voltage | 24 VDC | |
| Permissible contact load | 10 A | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Left and right X20 locking plates included in delivery | |
| Pitch | 87.5 ^{+0.2} mm | |

Table 404: X20BB82, X20cBB82 - Technical data

9.20.3.5 Voltage routing



9.20.4 X20IF1091-1

Data sheet version: 2.23

9.20.4.1 General information

The interface module is operated in the X20BC1083 expandable bus controller. It is equipped with an X2X Link master interface.

- X2X Link connection

9.20.4.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | System modules for expandable bus controllers |  |
| X20IF1091-1 | X20 interface module, for expandable bus controller, 1 X2X Link master interface, electrically isolated, order 1x TB704 terminal block separately | |
| | Required accessories | |
| | Terminal blocks | |
| 0TB704.9 | Accessory terminal block, 4-pin, screw clamp terminal block 2.5 mm ² | |
| 0TB704.91 | Accessory terminal block, 4-pin, push-in terminal block 2.5 mm ² | |

Table 405: X20IF1091-1 - Order data

9.20.4.3 Technical data

| | |
|--|--|
| Model number | X20IF1091-1 |
| Short description | |
| Communication module | 1x X2X Link master |
| General information | |
| B&R ID code | 0x2525 |
| Status indicators | Module status, data transfer |
| Diagnostics | |
| Module status | Yes, using status LED |
| Data transfer | Yes, using status LED |
| Power consumption | 1.29 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations |
| ATEX | Class I, Division 2, Groups ABCD, T5 Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| Interfaces | |
| Interface IF1 | |
| Fieldbus | X2X Link master |
| Variant | 4-pin male multipoint connector |
| Number of stations | Max. 253 |
| Bus terminating resistor | Internal |
| Internal bus power supply | No |
| Network topology | Line |
| Distance between 2 stations | Max. 100 m |
| Electrical properties | |
| Electrical isolation | PLC isolated from X2X Link (IF1) |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x TB704 terminal block separately |
| Slot | In the X20BC1083-1 expandable bus controller |


Table 406: X20IF1091-1 - Technical data

9.20.4.4 Usage with POWERLINK bus controllers

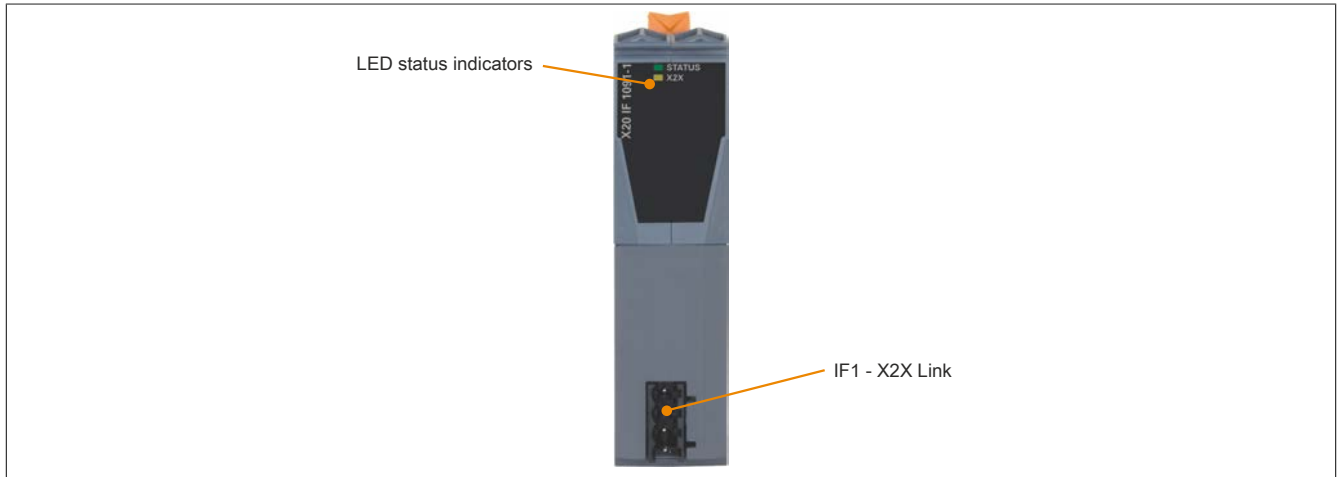
If this module is connected to the expandable POWERLINK bus controller, the amount of cyclic data is limited by the POWERLINK frame to 1488 bytes in each direction (input and output).

When using multiple IF10xx-1 interfaces or other X2X modules with a POWERLINK bus controller, the 1488 bytes are divided between all connected modules.


9.20.4.5 LED status indicators

| Figure | LED | Color | Status | Description |
|---|--------|--------|--------|--|
|  | STATUS | Green | On | Interface module active |
| | | Red | On | Bus controller booting |
| | X2X | Yellow | On | The module sends data via the X2X Link interface |

9.20.4.6 Operating and connection elements



9.20.4.7 X2X Link interface (IF1)

| Interface | Pinout | | |
|--|----------|------------------|--------|
| | Terminal | Function | |
|  4-pin male multipoint connector | 1 | X2X | |
| | 2 | X2X _L | |
| | 3 | X2X _I | |
| | 4 | SHLD | Shield |

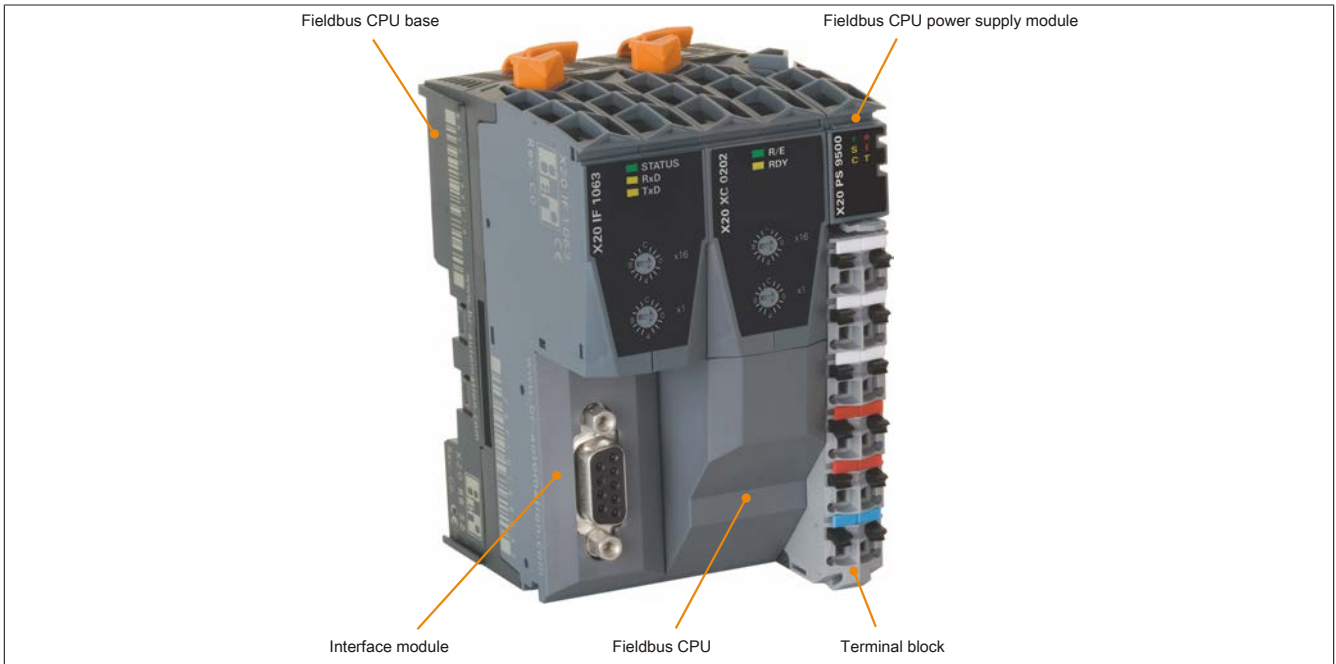
9.20.4.8 Firmware

The module comes with preinstalled firmware. The firmware is part of Automation Studio. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.21 Fieldbus CPUs

Fieldbus CPUs are a variant of the Compact CPUs. Their modular structure allows them to be quickly and easily assembled according to the individual requirements of the application. All CPUs are based on embedded micro-processors and available in 2 performance classes.



Available interfaces

Communication takes place over an Ethernet interface and RS232. An optional CAN interface is also available. If needed, up to 2 slots are also available for modular interface expansion.

Maintenance-free CPU

The CPUs were designed without fans or batteries in order to make them as easy as possible to service. This makes them completely maintenance-free.

Compact design

The supply for the CPU, X2X Link network and I/O modules is part of the CPU. No additional power supply modules are required.

9.21.1 Summary

| Model number | Short description | Page |
|--------------|--|------|
| X20XC0201 | X20 fieldbus CPU, μ P 16, 100 kB SRAM, 1 MB FlashPROM, support of RS232, CAN bus and interface module according to fieldbus CPU base, order power supply module, bus base and terminal block separately | 2245 |
| X20XC0202 | X20 fieldbus CPU, μ P 25, 750 kB SRAM, 3 MB FlashPROM, support of RS232, CAN bus and interface module according to fieldbus CPU base, order power supply module, bus base and terminal block separately | 2245 |
| X20XC0292 | X20 fieldbus CPU, μ P 25 750 kB SRAM, 3 MB FlashPROM, support of RS232, CAN bus and interface module, according to fieldbus CPU base, 1 Ethernet interface 100 Base-T, order bus base, power supply module and terminal block separately | 2245 |

9.21.2 X20XC02xx

Data sheet version: 2.23

9.21.2.1 General information

Fieldbus CPUs are variants of Compact CPUs. In addition to these features, fieldbus modules can be connected to the left side. These CPUs make applications possible in which data preprocessing must take place remotely on the I/O bus interface.

- Embedded μ P 16 / μ P 25 with additional I/O processor
- 100/750 kB User SRAM
- 1 MB / 3 MB User FlashPROM
- X20XC0292: Onboard Ethernet
- Up to 2 slots for fieldbus modules
- No battery
- Width
 - 1 fieldbus slot: 62.5 mm
 - 2 fieldbus slots: 87.5 mm

9.21.2.2 Order data

|  | |
|--|---|
| XC0201, XC0202 | XP0292 |
| Model number | Short description |
| Fieldbus CPUs | |
| X20XC0201 | X20 fieldbus CPU, μ P 16, 100 kB SRAM, 1 MB FlashPROM, support of RS232, CAN bus and interface module according to fieldbus CPU base, order power supply module, bus base and terminal block separately |
| X20XC0202 | X20 fieldbus CPU, μ P 25, 750 kB SRAM, 3 MB FlashPROM, support of RS232, CAN bus and interface module according to fieldbus CPU base, order power supply module, bus base and terminal block separately |
| X20XC0292 | X20 fieldbus CPU, μ P 25 750 kB SRAM, 3 MB FlashPROM, support of RS232, CAN bus and interface module, according to fieldbus CPU base, 1 Ethernet interface 100 Base-T, order bus base, power supply module and terminal block separately |
| Required accessories | |
| System modules for compact CPUs | |
| X20PS9500 | X20 power supply module for Compact and Fieldbus CPUs and internal I/O power supply, X2X Link power supply |
| X20PS9502 | X20 power supply module, for Compact and Fieldbus CPUs and internal I/O power supply, X2X Link power supply, supply not electrically isolated |
| System modules for fieldbus CPUs | |
| X20BB32 | X20 Fieldbus CPU base, for Fieldbus CPU and Compact CPU power supply module, base for integrated RS232 interface, slot for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included |
| X20BB37 | X20 Fieldbus CPU base, for Fieldbus CPU and Compact CPU power supply module, base for integrated RS232 and CAN bus interface, slot for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included |
| X20BB42 | X20 fieldbus CPU base, for fieldbus CPU and compact CPU power supply module, base for integrated RS232 interface, 2 slots for X20 interface modules, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included |
| X20BB47 | X20 fieldbus CPU base, for fieldbus CPU and compact CPU power supply module, base for integrated RS232 and CAN bus interface, 2 slots for X20 interface modules, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included |
| Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed |

Table 407: X20XC0201, X20XC0202, X20XC0292 - Order data

| Model number | Included in delivery |
|--------------|--------------------------|
| X20AC0SL1 | X20 locking plate, left |
| X20AC0SR1 | X20 locking plate, right |

9.21.2.3 Technical data

| Model number | X20XC0201 | X20XC0202 | X20XC0292 |
|--|--|--|------------------------|
| Short description | | | |
| Interfaces | - | | 1x Ethernet onboard |
| System module | CPU | | |
| General information | | | |
| B&R ID code | 0x2563 | 0x2564 | 0xA252 |
| Status indicators | CPU function | | CPU function, Ethernet |
| Diagnostics | | | |
| CPU function | Yes, using status LED | | |
| Ethernet | - | Yes, using status LED | |
| Overtemperature | - | Yes, using software | |
| Power consumption | 2 W | 2.2 W | 2.8 W |
| Temperature sensor | No | Yes | |
| ACOPOS support | Restricted (user PROM) via CAN bus | Yes, via CAN bus | |
| Visual Components support | Limited (User PROM) | Yes | |
| Additional power dissipation caused by actuators (resistive) [W] | - | | |
| Certifications | | | |
| CE | Yes | | |
| KC | Yes | | |
| EAC | Yes | | |
| UL | cULus E115267 Industrial control equipment | | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | | |
| KR | Yes | | |
| Controller | | | |
| Real-time clock ¹⁾ | Yes, 1 s resolution, -18 to 28 ppm accuracy at 25°C | | |
| Processor | | | |
| Type | Embedded µP 16 | Embedded µP 25 | |
| Integrated I/O processor | Processes I/O data points in the background | | |
| Backup battery | No | | |
| Shortest task class cycle time | 4 ms | 2 ms | |
| Typical instruction cycle time | 0.8 µs | 0.5 µs | |
| Permanent variables | | | |
| Self-discharge time | >10 years | | |
| Memory | 2.75 kB FRAM ²⁾ | | |
| Standard memory | | | |
| User PROM | 1 MB FlashPROM | 3 MB FlashPROM | |
| User RAM | 100 kB SRAM ³⁾ | 750 kB SRAM ³⁾ | |
| Slots for interface modules | | | |
| X20BB3x | 1 | | |
| X20BB4x | 2 | | |
| Interfaces | | | |
| Interface IF2 | | | |
| Signal | - | Ethernet | |
| Variant | - | 1x RJ45 shielded | |
| Line length | - | Max. 100 m between 2 stations (segment length) | |
| Transfer rate | - | 100 Mbit/s | |
| Transfer | | | |
| Physical layer | - | 100BASE-TX | |
| Half-duplex | - | Yes | |
| Full-duplex | - | No | |
| Autonegotiation | - | No | |
| Auto-MDI/MDIX | - | Yes | |
| On base module | | | |
| X20BB32 and X20BB42 ⁴⁾ | Fieldbus CPU base module with integrated RS232 interface | | |
| X20BB37 and X20BB47 ⁵⁾ | Fieldbus CPU base module with integrated RS232 and CAN interfaces | | |
| Operating conditions | | | |
| Mounting orientation | | | |
| Horizontal | Yes | | |
| Vertical | Yes | | |

Table 408: X20XC0201, X20XC0202, X20XC0292 - Technical data


| Model number | X20XC0201 | X20XC0202 | X20XC0292 |
|--|--|-----------|-----------|
| Installation elevation above sea level | | | |
| 0 to 2000 m | No limitations | | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | | |
| Degree of protection per EN 60529 | IP20 | | |
| Ambient conditions | | | |
| Temperature | | | |
| Operation | | | |
| Horizontal mounting orientation | -25 to 60°C | | |
| Vertical mounting orientation | -25 to 50°C | | |
| Derating | - | | |
| Storage | -40 to 85°C | | |
| Transport | -40 to 85°C | | |
| Relative humidity | | | |
| Operation | 5 to 95%, non-condensing | | |
| Storage | 5 to 95%, non-condensing | | |
| Transport | 5 to 95%, non-condensing | | |
| Mechanical properties | | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20PS9500 or X20PS9502 power supply module separately Order 1x X20BB3x/4x fieldbus CPU base separately | | |
| Spacing ⁶⁾ | | | |
| X20BB3x | 62.5 ^{+0.2} mm | | |
| X20BB4x | 87.5 ^{+0.2} mm | | |

Table 408: X20XC0201, X20XC0202, X20XC0292 - Technical data

- 1) The real-time clock is buffered for approx. 1000 hours by a gold foil capacitor. The gold foil capacitor is completely charged after 18 continuous hours of operation.
- 2) This FRAM stores its contents ferroelectrically. Therefore, no backup battery is needed.
- 3) Not buffered.
- 4) For technical data, see the data sheet for the X20PS9500 power supply module.
- 5) For technical data, see the data sheet for the X20PS9502 power supply module.
- 6) Spacing is based on the width of the X20BB3x/4x fieldbus CPU base. The CPU always requires up to two fieldbus modules and one supply module X20PS9500 or X20PS9502.


9.21.2.4 LED status indicators

X20XC020x

| Figure | LED | Color | Status | Description |
|---|-----|--------|--------|---------------------|
|  | R/E | Green | On | Application running |
| | | Red | On | SERVICE mode |
| | | | Off | ¹⁾ |
| | RDY | Yellow | On | SERVICE mode |
| | | | Off | ¹⁾ |
| | | | | |

- 1) BOOT mode: R/E and RDY LEDs are off and the power supply LED is blinking

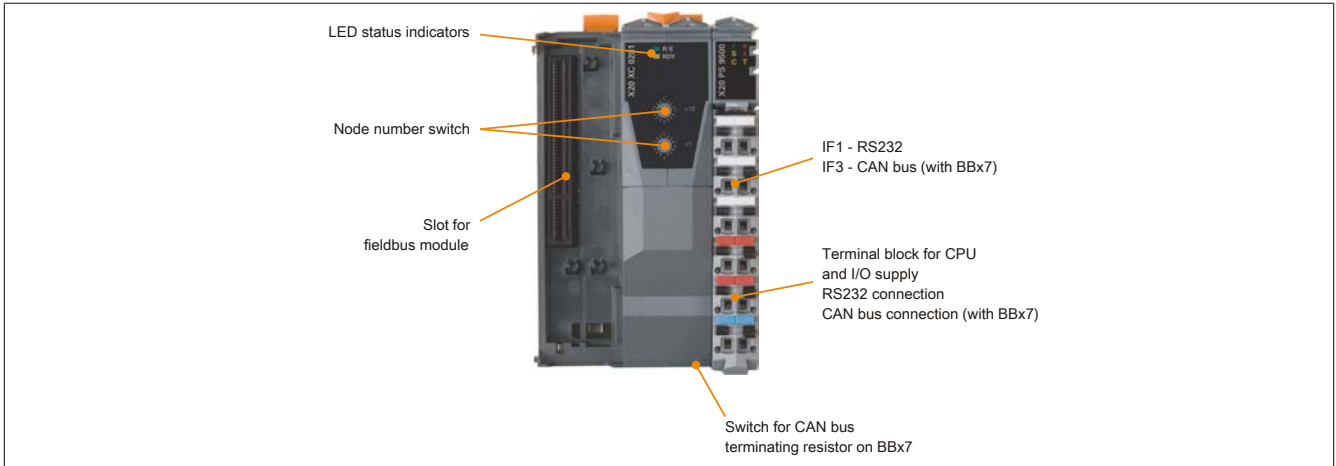
X20XC0292

| Figure | LED | Color | Status | Description |
|---|-----|--------|----------|--|
|  | R/E | Green | On | Application running |
| | | Red | On | SERVICE mode |
| | | | Off | ¹⁾ |
| | RDY | Yellow | On | SERVICE mode |
| | | | Off | ¹⁾ |
| | L/A | Green | On | A link to the peer station has been established. |
| | | | Blinking | A link to the peer station has been established. Indicates Ethernet activity is taking place on the bus. |

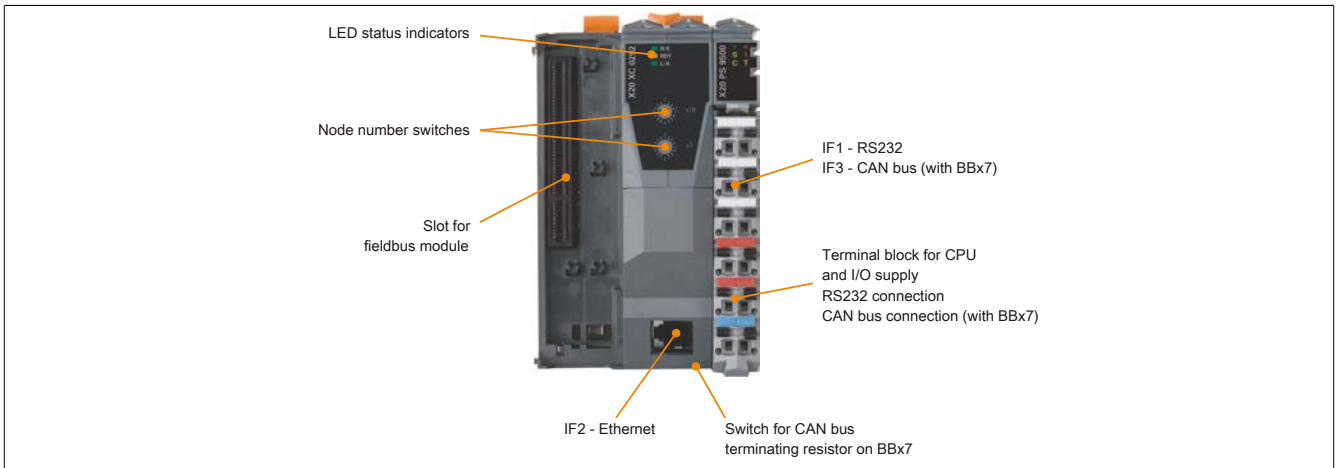
- 1) BOOT mode: R/E and RDY LEDs are off and the power supply LED is blinking

9.21.2.5 Operating and connection elements

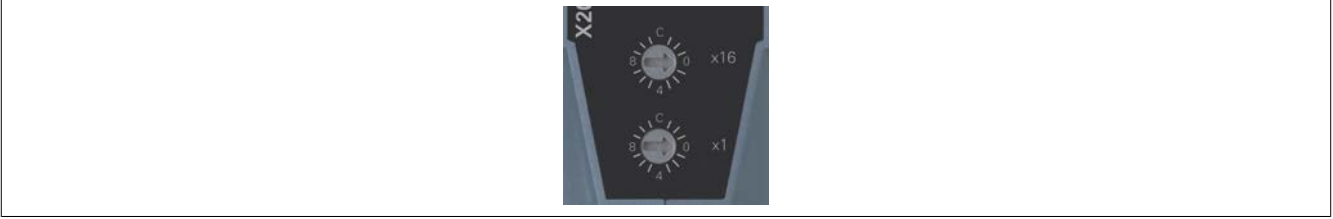
X20XC0201 and X20XC0202



X20XC0292



9.21.2.6 Node number switches



The node number is set using the two hex switches. The switch setting can be evaluated by the application program at any time. The operating system only evaluates the switch position when the device is switched on.

| Switch position | Operating mode | Description |
|-----------------|----------------|---|
| 0x00 | BOOT | In this switch position, the operating system can be installed via the RS232 interface configured as the online interface. User Flash is deleted only after the update begins. |
| 0x01 - 0xFE | RUN | RUN mode, the application is running. |
| 0xFF | Diagnostics | Boots the CPU in Diagnostics mode. Program sections in User RAM and User FlashPROM are not initialized. Following diagnostics mode, the CPU always boots with a cold restart . |

X20XP0201 and X20XP0202

When used with the X20BB37 or X20BB47 bus module, the CPUs have access to a CAN bus interface. The INA2000 station number for CAN is set using the node number switches.

X20XP0292

This CPU is equipped with an onboard Ethernet interface. When used with the X20BB37 or X20BB47 bus module, it also has access to a CAN bus interface.

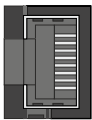
The number set using the two hex switches defines the INA2000 station number of both the CAN and the Ethernet interface.

9.21.2.7 Ethernet interface (IF2)



The X20XC0292 is equipped with an Ethernet interface. The connection is made using a 100 BASE-T twisted pair RJ45 socket.

Pinout

| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

For information about wiring X20 modules with an Ethernet interface, see "[Cabling guidelines for X20 modules with an Ethernet cable](#)" on page 58.

Information:

The Ethernet interface (IF2) is not suited for POWERLINK.

Starting with operating system version 1.07, CPUs have a default IP address.

IP address: 192.168.0.1
 Subnet mask: 255.255.0.0

9.21.2.8 Slot for fieldbus modules

Up to two fieldbus modules can be connected to the left side of the Fieldbus CPUs depending on the CPU base:

| CPU base | Slots for fieldbus modules |
|------------------|----------------------------|
| X20BB32, X20BB37 | 1 |
| X20BB42, X20BB47 | 2 |

Table 409: X20 Fieldbus CPUs - Slots for fieldbus modules depending on CPU base

The X20 system can be connected to various bus and network systems by selecting the appropriate fieldbus modules. The following fieldbus modules can be operated with the CPUs:

| Module | Description |
|-------------|--|
| X20IF1020 | X20 interface module, 1 RS232, max. 115.2 kbit/s, electrically isolated |
| X20IF1030 | X20 interface module, 1 RS485/RS422, max. 115.2 kbit/s, electrically isolated |
| X20IF1041-1 | X20 interface module for DTM configuration, 1 CANOpen master interface, electrically isolated |
| X20IF1043-1 | X20 interface module for DTM configuration, 1 CANOpen slave interface, electrically isolated |
| X20IF1051-1 | X20 interface module for DTM configuration, 1 DeviceNet scanner interface, electrically isolated |
| X20IF1053-1 | X20 interface module for DTM configuration, 1 DeviceNet slave (adapter) interface, electrically isolated |
| X20IF1061 | X20 interface module, 1 Profibus DP master interface, max.12 Mbit/s, max. 3.5 KB input data and max. 3.5 KB output data, electrically isolated |
| X20IF1061-1 | X20 interface module for DTM configuration, 1 PROFIBUS DP V1 master interface, electrically isolated |
| X20IF1063 | X20 interface module, 1 Profibus DP slave interface, max.12 Mbit/s, electrically isolated |
| X20IF1063-1 | X20 interface module for DTM configuration, 1 PROFIBUS DP V1 slave interface, electrically isolated |
| X20IF1074 | X20 interface module for SGC, 1 CAN interface, max. 1 Mbit/s, electrically isolated,... |
| X20IF10A1-1 | X20 interface module for DTM configuration, 1 ASI master interface, electrically isolated |
| X20IF10D1-1 | X20 interface module for DTM configuration, 1 EtherNet/IP scanner interface, electrically isolated |
| X20IF10D3-1 | X20 interface module for DTM configuration, 1 EtherNet/IP slave interface, electrically isolated |
| X20IF10E1-1 | X20 interface module for DTM configuration, 1 PROFINET RT controller (master), electrically isolated |
| X20IF10E3-1 | X20 interface module for DTM configuration, 1 PROFINET RT device (slave), electrically isolated |
| X20IF10G3-1 | X20 interface module for DTM configuration, 1 EtherCAT slave interface, electrically isolated |
| X20IF10H3-1 | X20 interface module for DTM configuration, 1 Sercos III slave interface, electrically isolated |

Table 410: X20 fieldbus CPUs - Possible fieldbus modules

9.21.2.9 Programming the system flash memory

General information

CPUs are delivered with a runtime system. When delivered, the node number switch is set to switch position 0x00 (bootstrap loader mode).

A suitable switch position must be set (0x01 to 0xFE) in order to boot the PLC in RUN mode. Updating the runtime system is only possible in RUN mode.

Runtime system update

The runtime system can be updated via the programming environment. When updating the runtime system via an online connection, the following procedure must be carried out:

1. An online runtime system update is only possible if the processor is in RUN mode. For this to be true, the node number must be set to a value in the range 0x01 to 0xFE.
2. Switch on the power.
3. The runtime system update is performed via the existing online connection. The online connection can be established via the onboard serial RS232 interface, for example. If a CPU has an Ethernet interface, then it too can be used to perform the update.
4. Start B&R Automation Studio.
5. Start the update procedure by selecting **Online** from the **Project** menu. Select **Transfer Automation Runtime** from the pop-up menu. Now follow the instructions given by B&R Automation Studio.
6. A window opens up for setting the runtime system version. The runtime system version is already pre-selected by the project settings made by the user. The drop-down menu can be used to select one of the runtime system versions stored in the project. Clicking on the **Browse** button allows a runtime system version to be loaded from the hard drive or CD.

Clicking on **Next** opens a pop-up window that allows the user to select whether modules with target memory SYSTEM ROM should be transferred during the subsequent runtime system update. If not, these modules can also be transferred later during an application download.

Clicking on **Next** opens a dialog box where the user can set the CAN transfer rate, CAN ID and CAN node number (the CAN node number set here is only relevant if an interface module does not have a CAN node number switch). The CAN node number must be between decimal 01 and 99. Assigning a unique node number is especially important with online communication over a CAN network (INA2000 protocol).

7. The update procedure is started by clicking on **Next**. Update progress is shown in a message box.

Information:

User flash memory is deleted.

8. When the update procedure is complete, the online connection is reestablished automatically.
9. The PLC is now ready for use.

Updating the runtime system is possible not only via an online connection, but also via a CAN network, serial network (INA2000 protocol) or Ethernet network, depending on the system configuration.

9.22 Fieldbus CPUs system modules

The X20 system Fieldbus CPUs consist of the Fieldbus CPU, Fieldbus CPU system modules and the X20TB12 terminal block.

Fieldbus CPU system modules include the base module and the supply modules for providing power to the entire system.

9.22.1 Summary

| Model number | Short description | Page |
|--------------|---|------|
| X20BB32 | X20 Fieldbus CPU base, for Fieldbus CPU and Compact CPU power supply module, base for integrated RS232 interface, slot for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 2253 |
| X20BB37 | X20 Fieldbus CPU base, for Fieldbus CPU and Compact CPU power supply module, base for integrated RS232 and CAN bus interface, slot for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included | 2255 |
| X20BB42 | X20 fieldbus CPU base, for fieldbus CPU and compact CPU power supply module, base for integrated RS232 interface, 2 slots for X20 interface modules, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 2258 |
| X20BB47 | X20 fieldbus CPU base, for fieldbus CPU and compact CPU power supply module, base for integrated RS232 and CAN bus interface, 2 slots for X20 interface modules, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | 2260 |
| X20IF1074 | X20 interface module, for SGC, 1 CAN bus interface, max. 1 Mbit/s, electrically isolated, order 1x TB2105 terminal block separately | 2263 |

9.22.2 X20BB32

Data sheet version: 2.25

9.22.2.1 General information

The bus module is the base for all X20 Fieldbus CPUs.

The left and right end plates are included in the delivery.

- Base for all X20 Fieldbus CPUs
- RS232 connection

Information:

The Fieldbus CPU must be placed in the rightmost slot.

9.22.2.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | System modules for fieldbus CPUs | |
| X20BB32 | X20 Fieldbus CPU base, for Fieldbus CPU and Compact CPU power supply module, base for integrated RS232 interface, slot for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included |  |

Table 411: X20BB32 - Order data

9.22.2.3 Technical data

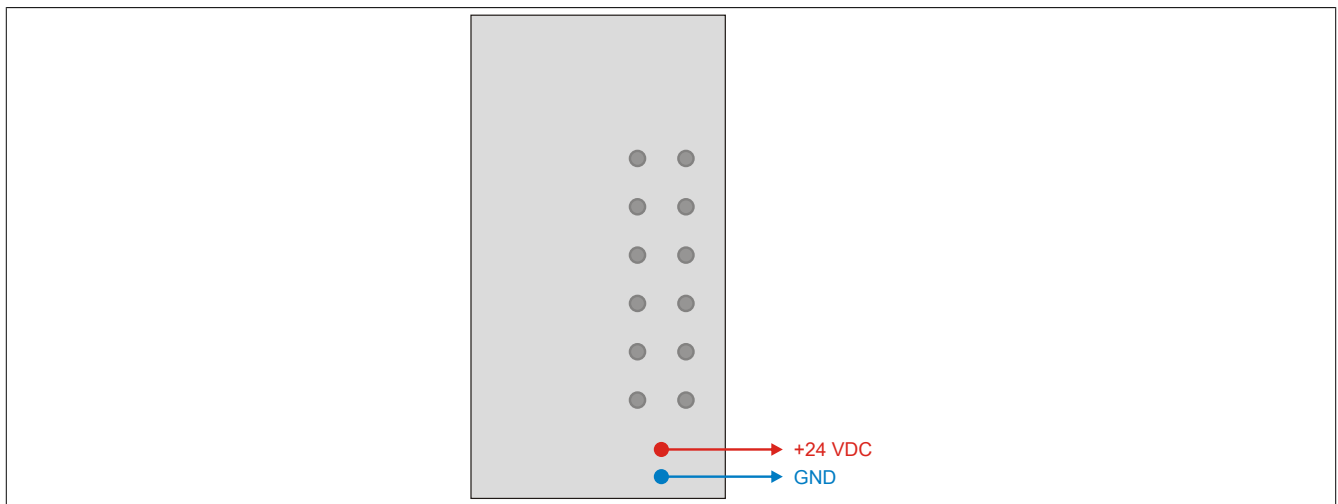
| Model number | X20BB32 |
|--|---|
| Short description | |
| Bus module | X20 Fieldbus CPU base, backplane for Fieldbus CPU, Fieldbus CPU power supply module and interface module |
| Interfaces | 1x RS232 connection |
| General information | |
| Power consumption | |
| Bus | 0.35 W |
| Internal I/O | - |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| I/O power supply | |
| Nominal voltage | 24 VDC |
| Permissible contact load | 10 A |
| Electrical properties | |
| Electrical isolation | Bus not isolated from RS232 |

Table 412: X20BB32 - Technical data

| | |
|--|--|
| Model number | X20BB32 |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Left and right X20 end cover plates included in delivery |
| Spacing | 62.5 ^{+0.2} mm |

Table 412: X20BB32 - Technical data

9.22.2.4 Voltage routing



9.22.3 X20BB37

Data sheet version: 2.25

9.22.3.1 General information

The bus module is the base for all X20 Fieldbus CPUs.

The left and right end plates are included in the delivery.

- Base for all X20 Fieldbus CPUs
- RS232 connection
- CAN bus connection
- Integrated terminating resistor for CAN bus

Information:

The bus controller must be placed in the rightmost slot.

9.22.3.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| X20BB37 | <p>System modules for fieldbus CPUs</p> <p>X20 Fieldbus CPU base, for Fieldbus CPU and Compact CPU power supply module, base for integrated RS232 and CAN bus interface, slot for X20 interface module, X20 connection, X20 end cover plates (left and right) X20AC0SL1/X20AC0SR1 included</p> |  |

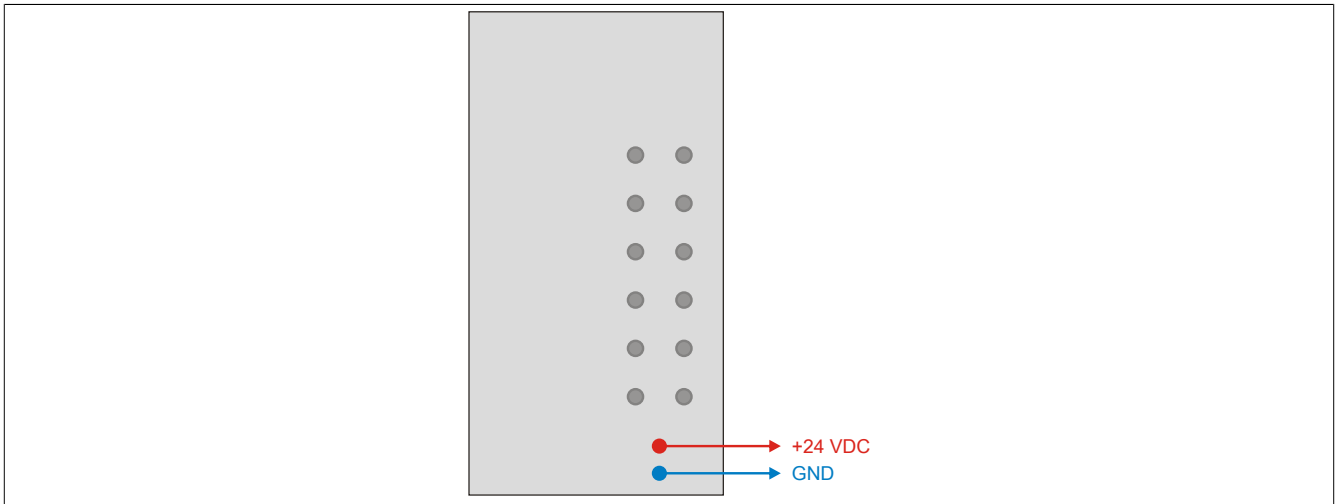
Table 413: X20BB37 - Order data

9.22.3.3 Technical data

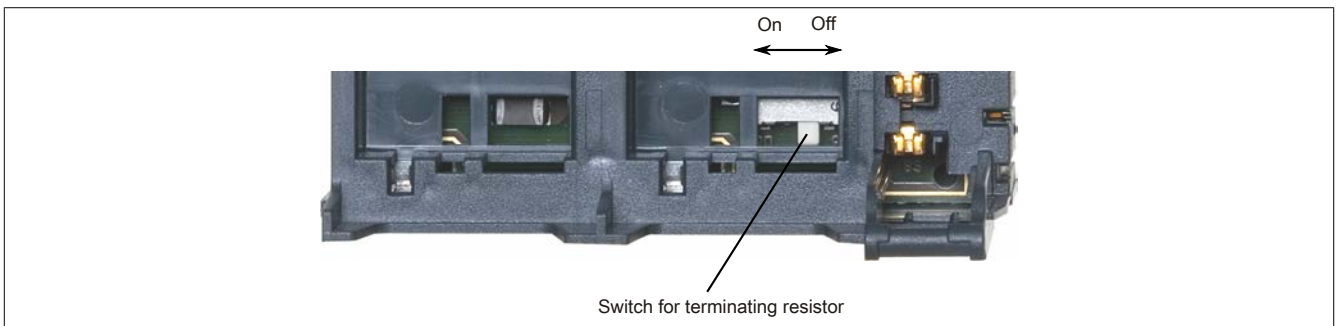
| Model number | X20BB37 |
|--|---|
| Short description | |
| Bus module | X20 Fieldbus CPU base, backplane for Fieldbus CPU, Fieldbus CPU power supply module and interface module |
| Interfaces | 1x RS232 connection, 1x CAN bus connection |
| General information | |
| Power consumption | |
| Bus | 0.56 W |
| Internal I/O | - |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| I/O power supply | |
| Nominal voltage | 24 VDC |
| Permissible contact load | 10 A |
| Electrical properties | |
| Electrical isolation | Bus, CAN bus and RS232 not isolated from each other |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Left and right X20 end cover plates included in delivery |
| Spacing | 62.5 ^{+0.2} mm |

Table 414: X20BB37 - Technical data

9.22.3.4 Voltage routing



9.22.3.5 Terminating resistor for CAN bus



The bus module has an integrated CAN bus terminating resistor. The terminating resistor is switched on or off using a switch. An enabled terminating resistor is indicated on the power supply module by LED "T".

9.22.4 X20BB42

Data sheet version: 2.23

9.22.4.1 General information

The bus module is a base for all X20 Fieldbus CPUs. It is equipped with 2 slots for interface modules.

The left and right end plates are included in the delivery.

- Base for all X20 Fieldbus CPUs
- 2 slots for interface modules
- RS232 connection

Information:

The bus controller must be placed in the rightmost slot.

9.22.4.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| X20BB42 | <p>System modules for fieldbus CPUs</p> <p>X20 fieldbus CPU base, for fieldbus CPU and compact CPU power supply module, base for integrated RS232 interface, 2 slots for X20 interface modules, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included</p> |  |

Table 415: X20BB42 - Order data

9.22.4.3 Technical data

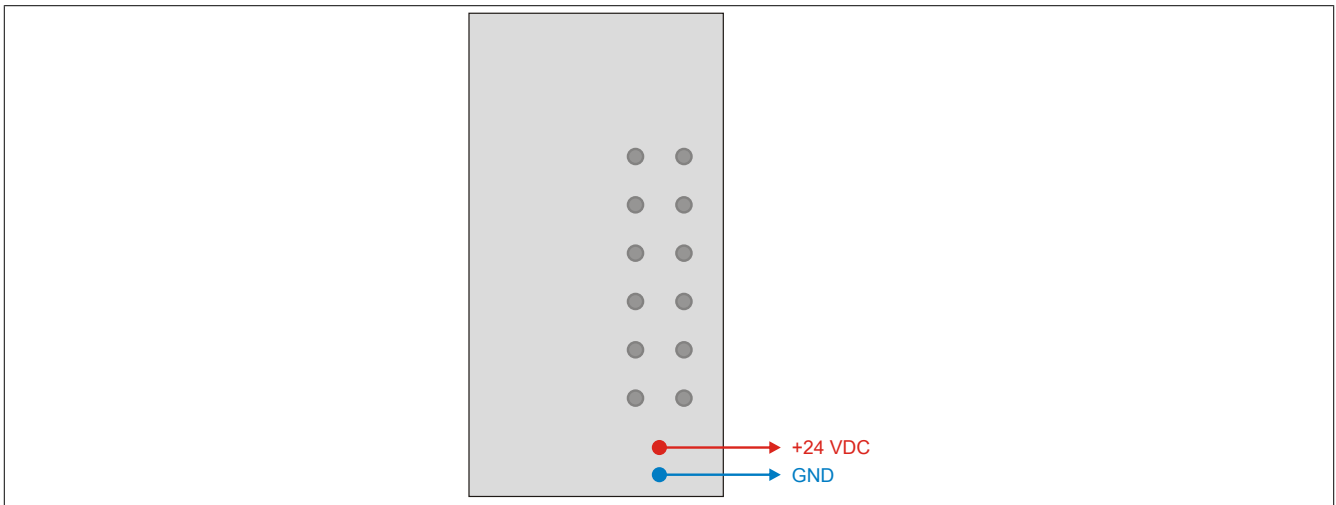
| Model number | X20BB42 |
|--|--|
| Short description | |
| Bus module | X20 fieldbus CPU base, backplane for fieldbus CPU, fieldbus CPU supply module and two interface modules |
| Interfaces | 1x RS232 connection |
| General information | |
| Power consumption | |
| Bus | 0.35 W |
| Internal I/O | - |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |

Table 416: X20BB42 - Technical data

| | |
|--|--|
| Model number | X20BB42 |
| I/O power supply | |
| Nominal voltage | 24 VDC |
| Permissible contact load | 10 A |
| Electrical properties | |
| Electrical isolation | Bus not isolated from RS232 |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Left and right X20 locking plates included in delivery |
| Spacing | 87.5 ^{+0.2} mm |

Table 416: X20BB42 - Technical data

9.22.4.4 Voltage routing



9.22.5 X20BB47

Data sheet version: 2.23

9.22.5.1 General information

The bus module is a base for all X20 Fieldbus CPUs. It is equipped with 2 slots for interface modules.

The left and right end plates are included in the delivery.

- Base for all X20 Fieldbus CPUs
- 2 slots for interface modules
- RS232 connection
- CAN bus connection
- Integrated terminating resistor for CAN bus

Information:

The bus controller must be placed in the rightmost slot.

9.22.5.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | System modules for fieldbus CPUs | |
| X20BB47 | X20 fieldbus CPU base, for fieldbus CPU and compact CPU power supply module, base for integrated RS232 and CAN bus interface, 2 slots for X20 interface modules, X20 connection, X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included |  |

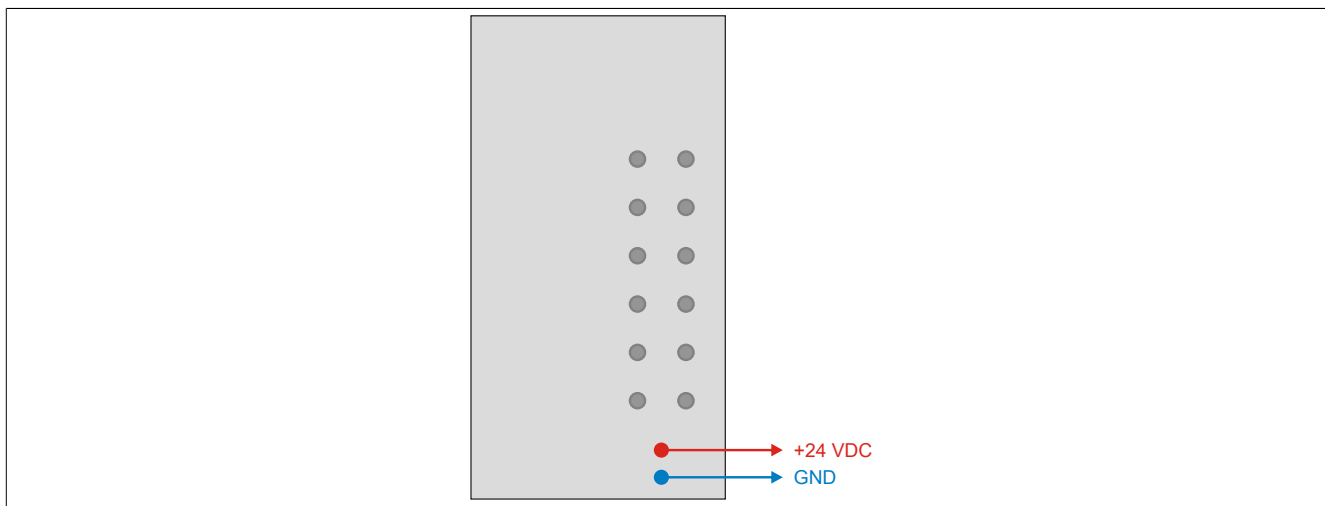
Table 417: X20BB47 - Order data

9.22.5.3 Technical data

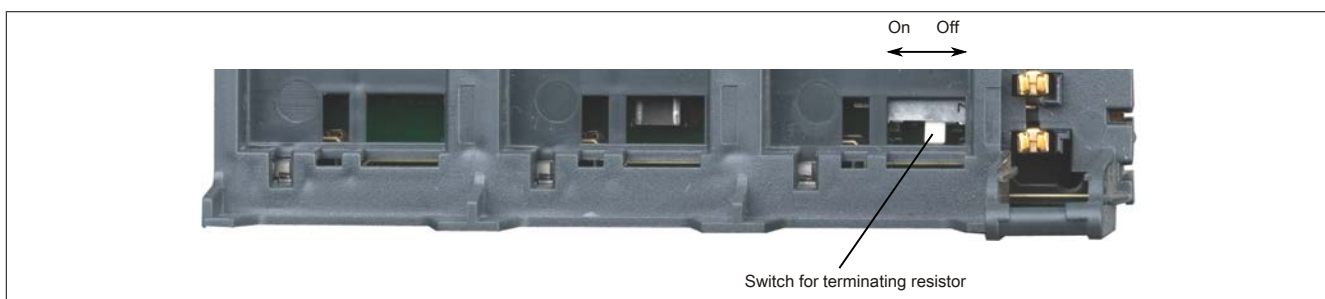
| Model number | X20BB47 |
|--|--|
| Short description | |
| Bus module | X20 Fieldbus CPU base, backplane for Fieldbus CPU, Fieldbus CPU power supply module and 2 interface modules |
| Interfaces | 1x RS232 connection, 1x CAN bus connection |
| General information | |
| Power consumption | |
| Bus | 0.56 W |
| Internal I/O | - |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| I/O power supply | |
| Nominal voltage | 24 VDC |
| Permissible contact load | 10 A |
| Electrical properties | |
| Electrical isolation | Bus, CAN bus and RS232 not isolated from each other |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Left and right X20 locking plates included in delivery |
| Spacing | 87.5 ^{+0.2} mm |

Table 418: X20BB47 - Technical data

9.22.5.4 Voltage routing



9.22.5.5 Terminating resistor for CAN bus



The bus module has an integrated CAN bus terminating resistor. The terminating resistor is switched on or off using a switch. An enabled terminating resistor is indicated on the power supply module by LED "T".

9.22.6 X20IF1074

Data sheet version: 2.23

9.22.6.1 General information

The module is an interface module for the X20 fieldbus CPU.

- CAN bus connection
- Integrated terminating resistor

Information:

This module does not support CAN RTR messages with extended CAN identifiers (29-bit) (memory/performance bottleneck).

9.22.6.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | System modules for fieldbus CPUs |  |
| X20IF1074 | X20 interface module, for SGC, 1 CAN bus interface, max. 1 Mbit/s, electrically isolated, order 1x TB2105 terminal block separately | |
| | Required accessories | |
| | Terminal blocks | |
| 0TB2105.9010 | Accessory terminal block, 5-pin, screw clamps 2.5 mm ² | |
| 0TB2105.9110 | Accessory terminal block, 5-pin, push-in terminal block 2.5 mm ² | |


Table 419: X20IF1074 - Order data

9.22.6.3 Technical data

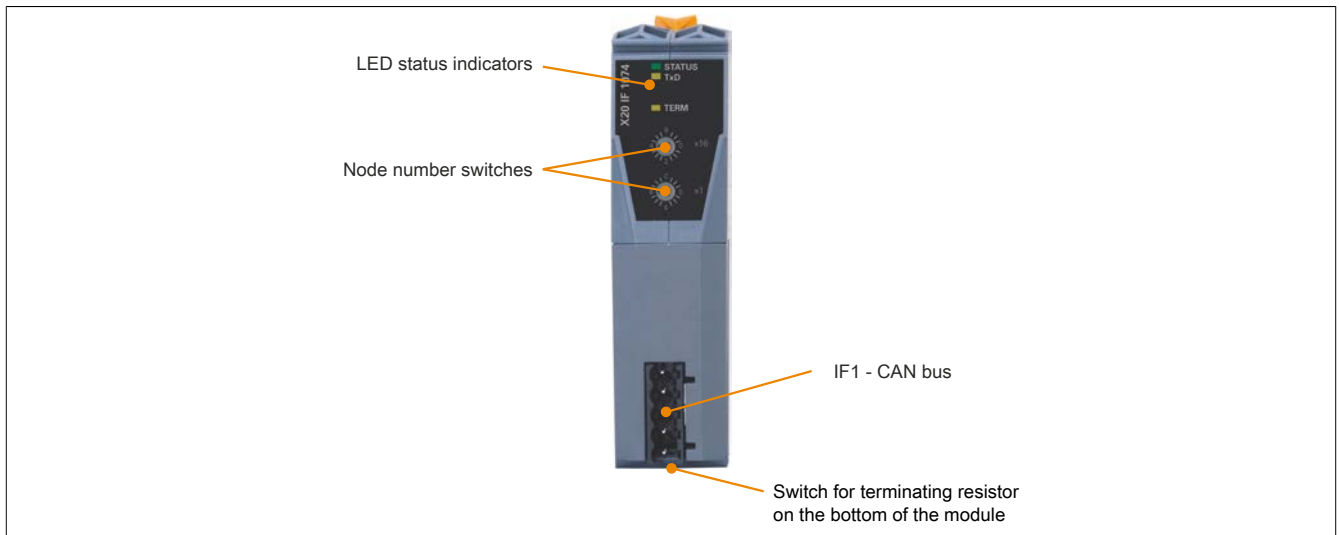
| | |
|--|--|
| Model number | X20IF1074 |
| Short description | |
| Communication module | 1x CAN bus |
| General information | |
| B&R ID code | 0xA399 |
| Status indicators | Module status, data transfer, terminating resistor |
| Diagnostics | |
| Module status | Yes, using status LED |
| Data transfer | Yes, using status LED |
| Terminating resistor | Yes, using status LED |
| Power consumption | 0.69 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Interfaces | |
| Interface IF1 | |
| Signal | CAN bus |
| Variant | 5-pin male multipoint connector |
| Max. distance | 1000 m |
| Transfer rate | Max. 1 Mbit/s |
| Terminating resistor | Integrated in the module |
| Controller | SJA 1000 |
| Electrical properties | |
| Electrical isolation | PLC isolated from CAN (IF1) |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x TB2105 terminal block separately |
| Slot | In X20 fieldbus CPU |

Table 420: X20IF1074 - Technical data

9.22.6.4 LED status indicators

| Figure | LED | Color | Status | Description |
|---|--------|--------|--------|--|
|  | STATUS | Green | On | Interface module active |
| | | Red | On | CPU starting up |
| | TxD | Yellow | On | The module is sending data via the CAN bus interface |
| | TERM | Yellow | On | Terminating resistor integrated in the module switched on. |

9.22.6.5 Operating and connection elements



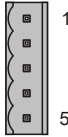
9.22.6.6 Node number switch



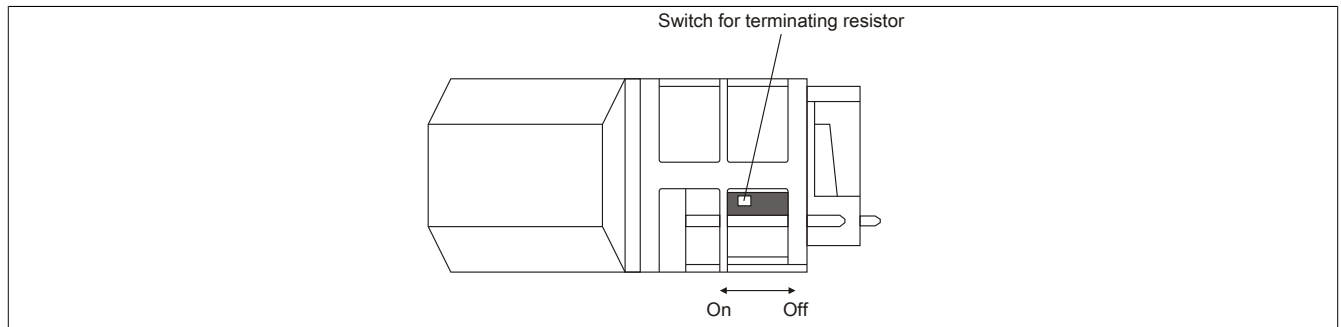
The node number for the interface is set with the two hex switches.

9.22.6.7 CAN bus interface

The interface is a 5-pin multipoint connector. Terminal block 0TB2105 must be ordered separately.

| Interface | | Pinout | |
|--|----------|------------------|------------|
|  5-pin male multipoint connector | Terminal | Function | |
| | 1 | CAN _⊥ | CAN ground |
| | 2 | CAN _L | CAN low |
| | 3 | SHLD | Shield |
| | 4 | CAN _H | CAN high |
| 5 | NC | | |

9.22.6.8 Terminating resistor



A terminating resistor is integrated in the interface module. It can be switched on or off with a switch on the bottom of the housing. A switched-on terminating resistor is indicated by LED "TERM".

9.22.6.9 Firmware

The module comes with preinstalled firmware. The firmware is part of Automation Studio. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.23 X20 interface module communication

The interface modules are added to the X20 CPU as an application-specific interface expansion.

9.23.1 Summary

| Model number | Short description | Page |
|--------------|---|------|
| X20IF1020 | X20 interface module, 1 RS232 interface, max. 115.2 kbit/s, electrically isolated | 2268 |
| X20IF1030 | X20 interface module, 1 RS422/485 interface, max. 115.2 kbit/s, electrically isolated | 2271 |
| X20IF1041-1 | X20 interface module, for DTM configuration, 1 CANopen master interface, electrically isolated, order 1x TB2105 terminal block separately | 2274 |
| X20IF1043-1 | X20 interface module, for DTM configuration, 1 CANopen slave interface, electrically isolated, order 1x TB2105 terminal block separately | 2288 |
| X20IF1051-1 | X20 interface module, for DTM configuration, 1 DeviceNet scanner (master) interface, electrically isolated, order 1x terminal block TB2105 separately! | 2302 |
| X20IF1053-1 | X20 interface module, for DTM configuration, 1 DeviceNet adapter (slave) interface, electrically isolated, order 1x terminal block TB2105 separately! | 2315 |
| X20IF1061-1 | X20 interface module for DTM configuration, 1 PROFIBUS DP V0/V1 master interface, electrically isolated | 2328 |
| X20IF1063 | X20 interface module, 1 PROFIBUS DP V0 slave interface, max. 12 Mbit/s, electrically isolated | 2339 |
| X20IF1063-1 | X20 interface module, for DTM configuration, 1 PROFIBUS DP V1 slave interface, electrically isolated | 2342 |
| X20IF1072 | X20 interface module, 1 CAN bus interface, max. 1 Mbit/s, electrically isolated, order 1x TB2105 terminal block separately | 2353 |
| X20IF1082 | X20 interface module, 1 POWERLINK interface, managing or controlled node, integrated 2-port hub, ring redundancy function | 2357 |
| X20IF1082-2 | X20 interface module, 1 POWERLINK interface, managing or controlled node, integrated 2-port hub, ring redundancy function PRC function | 2363 |
| X20IF1086-2 | X20 interface module, 1 POWERLINK interface, managing or controlled node, PRC function, 1 fiber optic connection | 2369 |
| X20IF1091 | X20 interface module, 1 X2X Link master interface, electrically isolated, order 1x TB704 terminal block separately | 2375 |
| X20IF10A1-1 | X20 interface module, for DTM configuration, 1 ASi master interface, electrically isolated, order 1x terminal block TB704 separately! | 2378 |
| X20IF10D1-1 | X20 interface module, for DTM configuration, 1 EtherNet/IP scanner (master) interface, electrically isolated | 2392 |
| X20IF10D3-1 | X20 interface module, for DTM configuration, 1 EtherNet/IP adapter (slave) interface, electrically isolated | 2402 |
| X20IF10E1-1 | X20 interface module, for DTM configuration, 1 PROFINET IO controller (master) interface, electrically isolated | 2413 |
| X20IF10E3-1 | X20 interface module, for DTM configuration, 1 PROFINET IO device (slave) interface module, electrically isolated | 2424 |
| X20IF10G3-1 | X20 interface module for DTM configuration, 1 EtherCAT slave interface, electrically isolated | 2434 |
| X20IF10X0 | X20 interface module, 1 redundancy link interface 1000BASE-SX, CPU-CPU data synchronization module for controller redundancy | 2447 |
| X20IF2181-2 | X20 interface module, 1x link selector for POWERLINK cable redundancy, POWERLINK functions: - Managing node - Controlled node for iCN operation - Redundant managing node for controller redundancy - Ring redundancy - 2x hub - Multi ASend - PRC function 2x RJ45 | 2452 |
| X20IF2772 | X20 interface module, 2 CAN bus interfaces, max. 1 Mbit/s, electrically isolated, order 2x TB2105 terminal block separately | 2458 |
| X20IF2792 | X20 interface module, 1 CAN bus interface, max. 1 Mbit/s, electrically isolated, 1 X2X Link master interface, electrically isolated, order 1x terminal block TB2105 and 1x terminal block TB704 separately! | 2462 |
| X20clF1030 | X20 interface module, coated, 1 RS422/485 interface, max. 115.2 kbit/s, electrically isolated | 2271 |
| X20clF1041-1 | X20 interface module, coated, for DTM configuration, 1 CANopen master interface, electrically isolated, order 1x TB2105 terminal block separately | 2274 |
| X20clF1061-1 | X20 interface module coated, for DTM configuration, 1 PROFIBUS DP V0/V1 master interface, electrically isolated | 2328 |
| X20clF1063-1 | X20 interface module, coated, for DTM configuration, 1 PROFIBUS DP V1 slave interface, electrically isolated | 2342 |
| X20clF1072 | X20 interface module, coated, 1 CAN bus interface, max. 1 Mbit/s, electrically isolated, order 1x TB2105 terminal block separately | 2353 |
| X20clF1082-2 | X20 interface module, coated, 1 POWERLINK interface, managing or controlled node, integrated 2-port hub, ring redundancy function PRC function | 2363 |
| X20clF10D1-1 | X20 interface module, coated, for DTM configuration, 1 EtherNet/IP scanner (master) interface, electrically isolated | 2392 |
| X20clF10D3-1 | X20 interface module, coated, for DTM configuration, 1 EtherNet/IP adapter (slave) interface, electrically isolated | 2402 |
| X20clF10E3-1 | X20 interface module, coated, for DTM configuration, 1 PROFINET IO device (slave) interface module, electrically isolated | 2424 |
| X20clF10X0 | X20 interface module, coated, 1 redundancy link interface 1000 Base-FX, CPU-CPU data synchronization for controller redundancy | 2447 |
| X20clF2181-2 | X20 interface module, coated, 1x link selector for POWERLINK cable redundancy, POWERLINK functions: - Managing node - Controlled node for iCN operation - Redundant managing node for controller redundancy - Ring redundancy - 2x hub - Multi ASend - PRC function 2x RJ45 | 2452 |

9.23.2 X20IF1020

Data sheet version: 2.23

9.23.2.1 General information

The interface module can be used to expand the X20 CPU for specific applications. It is equipped with an RS232 interface.

- The RS232 interface can be configured as an online interface

9.23.2.2 Order data


| Model number | Short description | Figure |
|---------------|---|---|
| | X20 interface module communication |  |
| X20IF1020 | X20 interface module, 1 RS232 interface, max. 115.2 kbit/s, electrically isolated | |
| | Optional accessories | |
| | Others | |
| 0G0001.00-090 | PC - PLC/PW cable, RS232, online cable | |


Table 421: X20IF1020 - Order data

9.23.2.3 Technical data

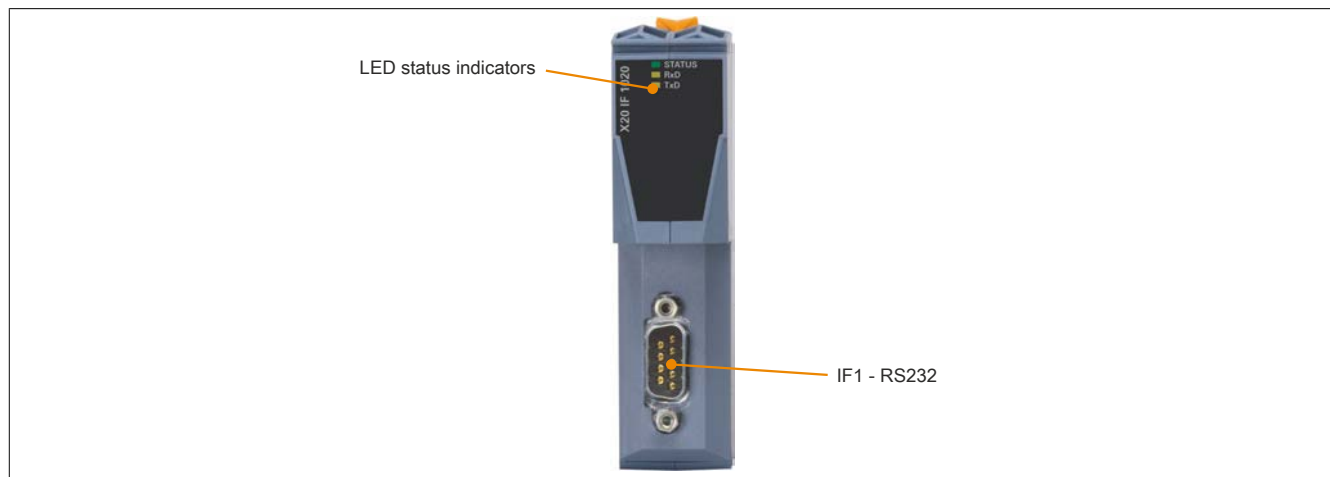
| | |
|--|--|
| Model number | X20IF1020 |
| Short description | |
| Communication module | 1x RS232 |
| General information | |
| B&R ID code | 0x1F27 |
| Status indicators | Module status, data transfer |
| Diagnostics | |
| Module status | Yes, using status LED |
| Data transfer | Yes, using status LED |
| Power consumption | 0.35 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations |
| ATEX | Class I, Division 2, Groups ABCD, T5 Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Interfaces | |
| Interface IF1 | |
| Signal | RS232 |
| Variant | 9-pin male DSUB connector |
| Max. distance | 900 m |
| Transfer rate | Max. 115.2 kbit/s |
| Network-capable | No |
| FIFO | 16 bytes in transmit and receive direction |
| Handshake lines | RTS, CTS |
| Controller | UART type 16C550 compatible |
| Data formats | |
| Data bits | 5 to 8 |
| Parity | Yes / No / Even / Odd |
| Stop bits | 1 or 2 |
| Electrical properties | |
| Electrical isolation | PLC isolated from RS232 (IF1) |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Slot | In X20 CPU |

Table 422: X20IF1020 - Technical data

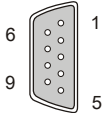
9.23.2.4 LED status indicators

| Figure | LED | Color | Status | Description |
|---|--------|--------|--------|--|
|  | STATUS | Green | On | Interface module active |
| | | Red | On | CPU starting up |
| | RxD | Yellow | On | The module receives data via the RS232 interface |
| | TxD | Yellow | On | The module sends data via the RS232 interface |

9.23.2.5 Operating and connection elements



9.23.2.6 RS232 interface (IF1)

| Interface | Pinout | | |
|--|--------|-------|-----------------|
| | Pin | RS232 | |
|  <p>9-pin male DSUB connector</p> | 1 | NC | |
| | 2 | RxD | Receive signal |
| | 3 | TxD | Transmit signal |
| | 4 | NC | |
| | 5 | GND | Ground |
| | 6 | NC | |
| | 7 | RTS | Request To Send |
| | 8 | CTS | Clear To Send |
| | 9 | NC | |

9.23.2.7 Firmware

The module comes with preinstalled firmware. The firmware is part of Automation Studio. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.23.3 X20(c)IF1030

Data sheet version: 2.34

9.23.3.1 General information

The interface module can be used to expand the X20 CPU for specific applications. It is equipped with an RS485/RS422 interface.

- RS485/RS422 connection

9.23.3.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.23.3.3 Order data

| Model number | Short description | Figure |
|---------------|---|--------|
| | X20 interface module communication | |
| X20IF1030 | X20 interface module, 1 RS422/485 interface, max. 115.2 kbit/s, electrically isolated | |
| X20cIF1030 | X20 interface module, coated, 1 RS422/485 interface, max. 115.2 kbit/s, electrically isolated | |
| | Optional accessories | |
| | Infrastructure components | |
| 0G1000.00-090 | Bus connector, RS485, for PROFIBUS networks | |


Table 423: X20IF1030, X20cIF1030 - Order data

9.23.3.4 Technical data

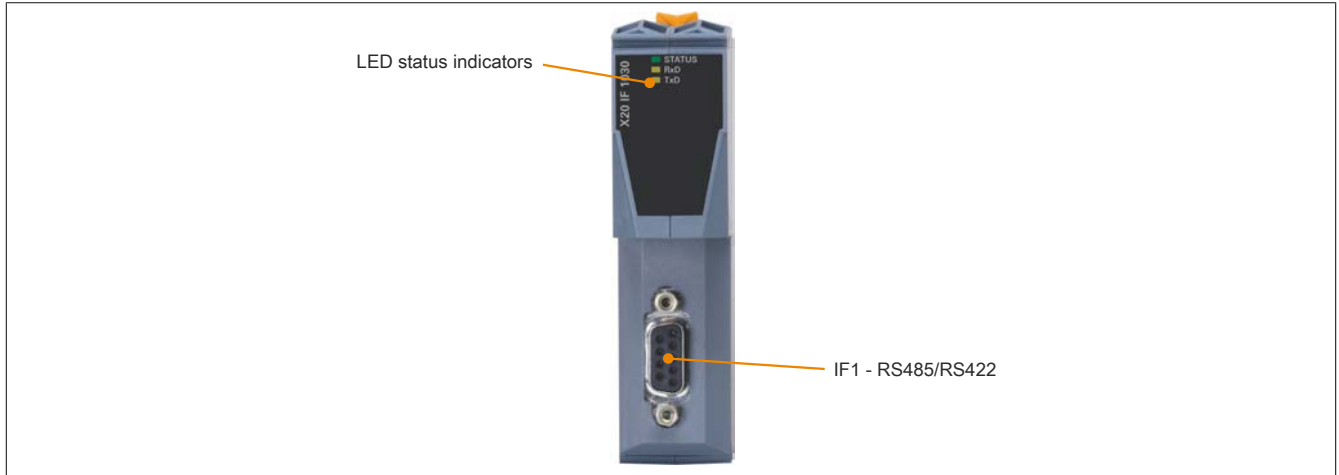
| Model number | X20IF1030 | X20cIF1030 |
|--|--|------------------------|
| Short description | | |
| Communication module | 1x RS485/RS422 | |
| General information | | |
| B&R ID code | 0x1F28 | 0xE233 |
| Status indicators | Module status, data transfer | |
| Diagnostics | | |
| Module status | Yes, using status LED | |
| Data transfer | Yes, using status LED | |
| Power consumption | 0.42 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| KC | Yes | - |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| Interfaces | | |
| Interface IF1 | | |
| Signal | RS485/RS422 | |
| Variant | 9-pin female DSUB connector | |
| Max. distance | 1200 m | |
| Transfer rate | Max. 115.2 kbit/s | |
| FIFO | 16 bytes in transmit and receive direction | |
| Terminating resistor | External T-connector (0G1000.00-090) | |
| Controller | UART type 16C550 compatible | |
| Electrical properties | | |
| Electrical isolation | PLC isolated from RS485/RS422 (IF1) | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | | |
| Storage | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Slot | In X20 CPU | In X20c CPU |

Table 424: X20IF1030, X20cIF1030 - Technical data

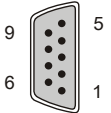
9.23.3.5 LED status indicators

| Figure | LED | Color | Status | Description |
|---|--------|--------|--------|--|
|  | STATUS | Green | On | Interface module active |
| | | Red | On | CPU starting up |
| | RxD | Yellow | On | The module is receiving data via the RS485/RS422 interface |
| | TxD | Yellow | On | The module is sending data via the RS485/RS422 interface |

9.23.3.6 Operating and connection elements



9.23.3.7 RS485/RS422 interface (IF1)

| Interface | Pinout | | |
|---|--------|--------------|-------------------|
| | Pin | RS485 | RS422 |
| User interface RS485/RS422  9-pin female DSUB connector | 1 | Reserved | Reserved |
| | 2 | Reserved | TxD ¹⁾ |
| | 3 | DATA | RxD |
| | 4 | Reserved | Reserved |
| | 5 | GND | GND |
| | 6 | +5 V / 50 mA | +5 V / 50 mA |
| | 7 | Reserved | TXD ¹⁾ |
| | 8 | DATA\ | RXD\ |
| | 9 | Reserved | Reserved |

1) RS422 send data is TRISTATE-capable.

9.23.3.8 Firmware

The module comes with preinstalled firmware. The firmware is part of Automation Studio. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.23.4 X20(c)IF1041-1

Data sheet version: 2.03

9.23.4.1 General information

The interface module is equipped with a CANopen interface. This allows third-party components to be integrated in the B&R system and makes it possible to quickly and easily transfer data in both directions.

The interface module can be operated in X20 CPUs or in the expandable POWERLINK bus controller X20BC1083.

- CANopen master
- Integrated terminating resistor

9.23.4.1.1 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.23.4.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | X20 interface module communication |  |
| X20IF1041-1 | X20 interface module, for DTM configuration, 1 CANopen master interface, electrically isolated, order 1x TB2105 terminal block separately | |
| X20cIF1041-1 | X20 interface module, coated, for DTM configuration, 1 CANopen master interface, electrically isolated, order 1x TB2105 terminal block separately | |
| | Required accessories | |
| | Terminal blocks | |
| 0TB2105.9010 | Accessory terminal block, 5-pin, screw clamps 2.5 mm ² | |
| 0TB2105.9110 | Accessory terminal block, 5-pin, push-in terminal block 2.5 mm ² | |

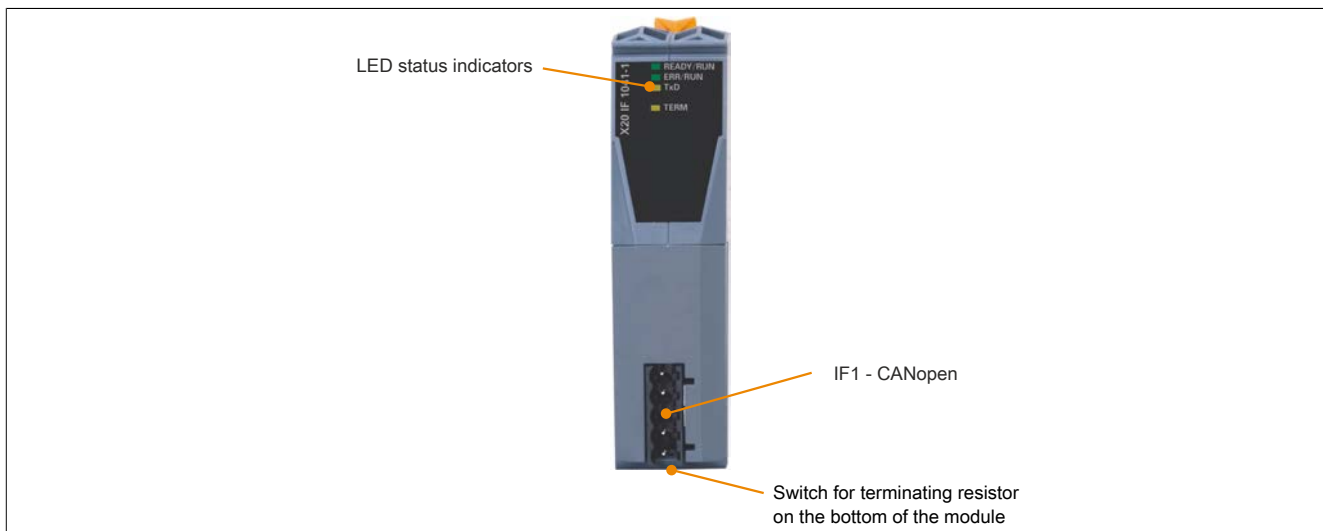
Table 425: X20IF1041-1, X20cIF1041-1 - Order data

9.23.4.3 Technical data

| Model number | X20IF1041-1 | X20cIF1041-1 |
|--|--|---|
| Short description | | |
| Communication module | CANopen master | |
| General information | | |
| B&R ID code | 0xA709 | 0xE505 |
| Status indicators | Module status, network status, data transfer, terminating resistor | |
| Diagnostics | | |
| Module status | Yes, using status LED and software | |
| Network status | Yes, using status LED and software | |
| Data transfer | Yes, using status LED | |
| Terminating resistor | Yes, using status LED | |
| Power consumption | 1.1 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations | |
| DNV GL | Class I, Division 2, Groups ABCD, T5 Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Interfaces | | |
| Interface IF1 | | |
| Fieldbus | CANopen master | |
| Variant | 5-pin male multipoint connector | |
| Max. distance | 1000 m | |
| Transfer rate | Max. 1 Mbit/s | |
| Terminating resistor | Integrated in the module | |
| Controller | netX100 | |
| Memory | 8 MB SDRAM | |
| Electrical properties | | |
| Electrical isolation | PLC isolated from CANopen (IF1) | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x TB2105 terminal block separately | |
| Slot | In the X20 CPU and in the X20BC1083 expandable bus controller | In the X20c CPU and in the X20cBC1083 expandable bus controller |

Table 426: X20IF1041-1, X20cIF1041-1 - Technical data

9.23.4.4 Operating and connection elements



9.23.4.4.1 LED status indicators

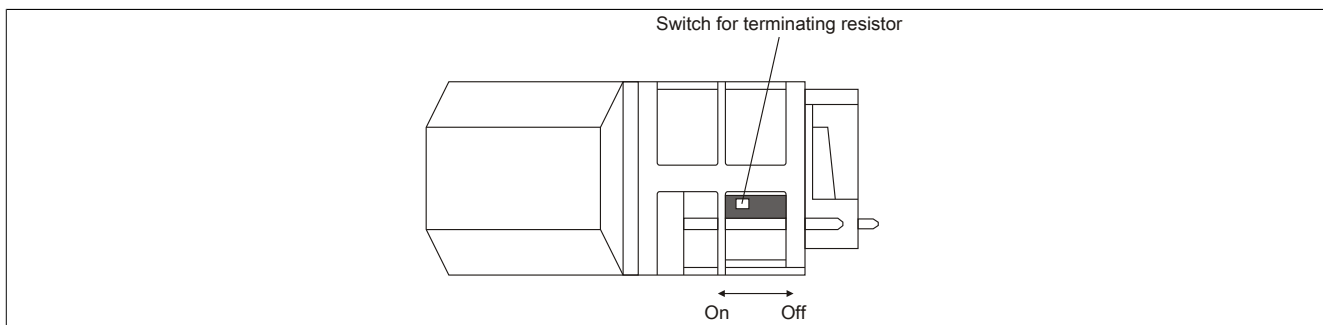
| Figure | LED | Color | Status | Description |
|--------|-----------|--|---|--|
| | READY/RUN | Green/red | Off | No power to module |
| | | Green | On | PCI bus communication in progress |
| | | Red | Blinking | Error when booting |
| | | On | On | Communication on the PCI bus has not yet been started |
| | ERR/RUN | Green/red | Off | Module executes a reset |
| | | Green on Red blinking with double pulse | On | CANopen communication disrupted. This may be due to one of the following reasons: <ul style="list-style-type: none"> The CAN bus cable is broken or the CAN bus controller is in "Bus off" mode The module is in PREOPERATIONAL mode At least one configured CANopen slave is not functioning |
| | | Green on Red blinking | On | Communication was stopped (the module is in STOPPED mode) |
| | | Green | Blinking | Communication is being started (module is being initialized) |
| | | On | On | Communication is ready |
| | TxD | Yellow | Flickering or on | Module sending data via the CANopen interface |
| TERM | Yellow | On | Terminating resistor integrated in the module switched on | |

9.23.4.4.2 CAN bus interface

The interface is a 5-pin multipoint connector. Terminal block 0TB2105 must be ordered separately.

| Interface | Pinout | | |
|--|----------|------------------|------------|
| | Terminal | Function | |
| <p>5-pin male multipoint connector</p> | 1 | CAN _⊥ | CAN ground |
| | 2 | CAN _L | CAN low |
| | 3 | SHLD | Shield |
| | 4 | CAN _H | CAN high |
| | 5 | NC | |

9.23.4.4.3 Terminating resistor



A terminating resistor is integrated in the interface module. It can be switched on or off with a switch on the bottom of the housing. A switched-on terminating resistor is indicated by LED "TERM".

9.23.4.5 Use in the expandable X20BC1083 POWERLINK bus controller

9.23.4.5.1 Cyclic data

If this module is connected to the expandable POWERLINK bus controller, the amount of cyclic data is limited by the POWERLINK frame to 1488 bytes in each direction (input and output).

When using multiple X20IF10xx-1 interfaces or other X2X modules with a POWERLINK bus controller, the 1488 bytes are divided between all connected modules.

9.23.4.5.2 Operating netX modules

It is important to note the following in order to operate netX modules with the bus controller without problems:

- A minimum revision $\geq E0$ is required for the bus controller.
- netX modules can only be operated with the POWERLINK V2 setting. V1 is not permitted.
- With SDO access to POWERLINK object 0x1011/1 on the bus controller, the netX firmware and the configuration stored on the bus controller are not reset. They can only be overwritten by accessing them again. This affects objects 0x20C0 and 0x20C8, subindexes 92 to 95.

9.23.4.6 netX error codes

netX modules return an error code when an error occurs. These error codes are fieldbus-specific. A complete list of all error codes in PDF format is available in Automation Help in section "Communication / Fieldbus systems / Support with FDT/DTM / Diagnostic functions / Diagnostics on the runtime system / Master diagnostics" under item "Communication_Error".

9.23.4.7 Firmware

The module comes with preinstalled firmware. The firmware is part of the Automation Studio project. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.23.4.8 The CANopen interface

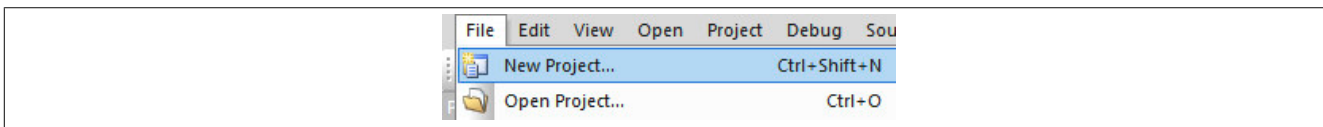
9.23.4.8.1 Settings in Automation Studio

The interface module can be operated in the slot of a CPU or in the slot of an expandable POWERLINK bus controller.

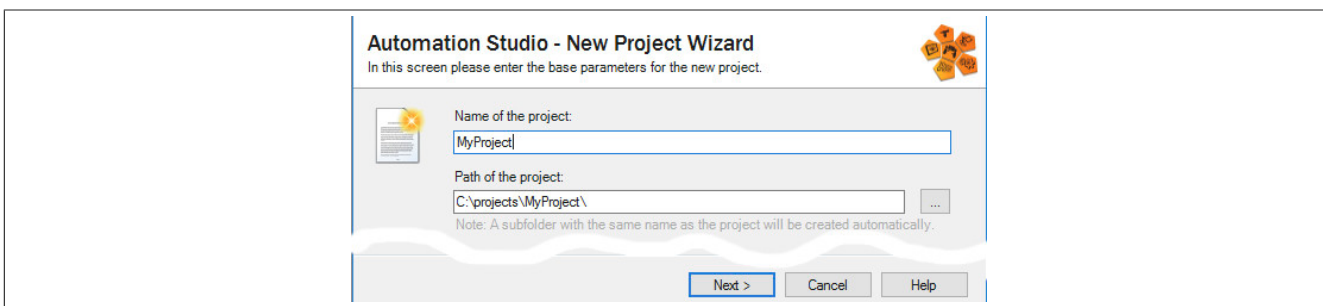
To do this, a new Automation Studio project is created and the suitable settings are made on the module.

9.23.4.8.1.1 Creating an Automation Studio project

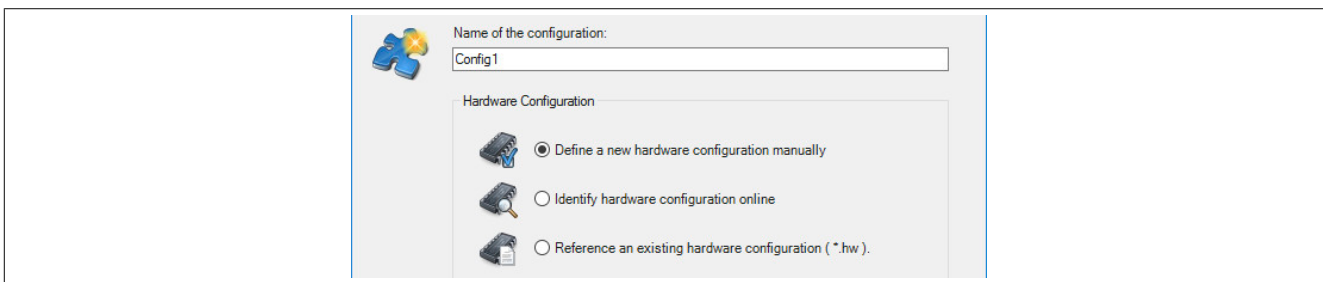
- Create a new Automation Studio project by selecting "New project".



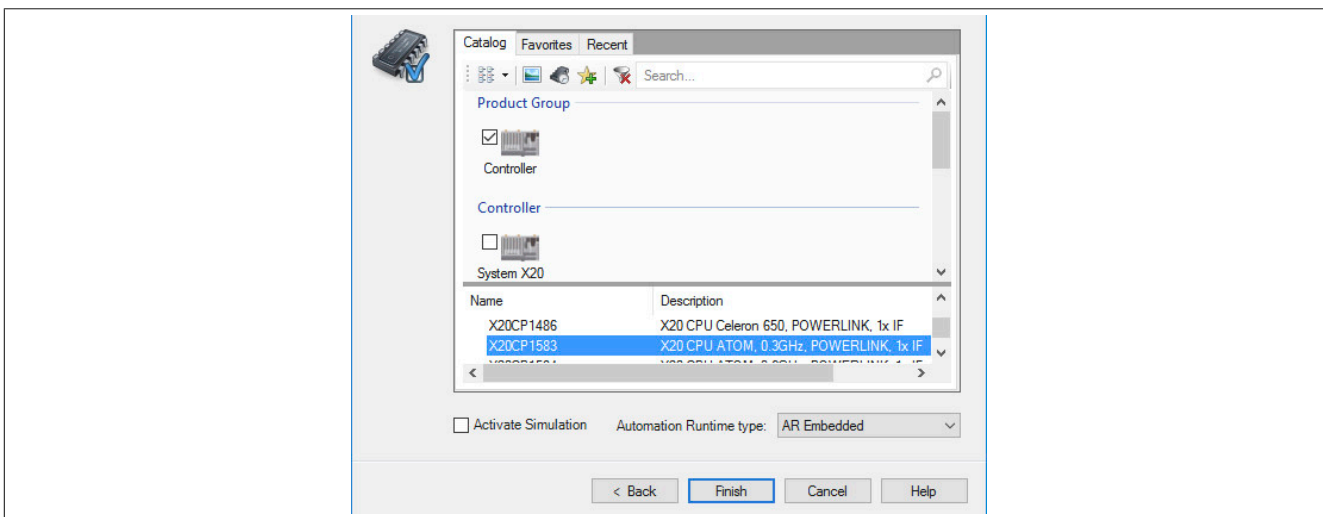
- Assign a project name and set up the project path.



- Assign the hardware configuration type and configuration name.

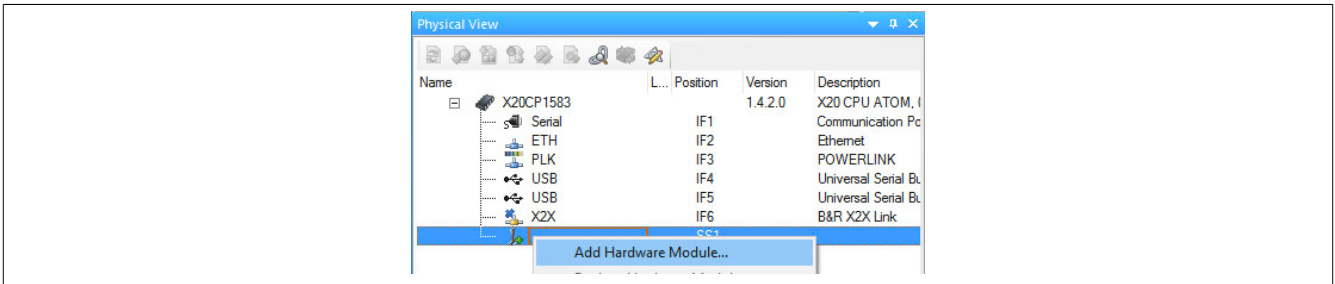


- Select the hardware in the next step if "Define a new hardware configuration manually" was selected. In order to simplify the search, different filters can be set in the Hardware Catalog. Lastly, highlight the required hardware and create the Automation Studio project by clicking on "Finish".

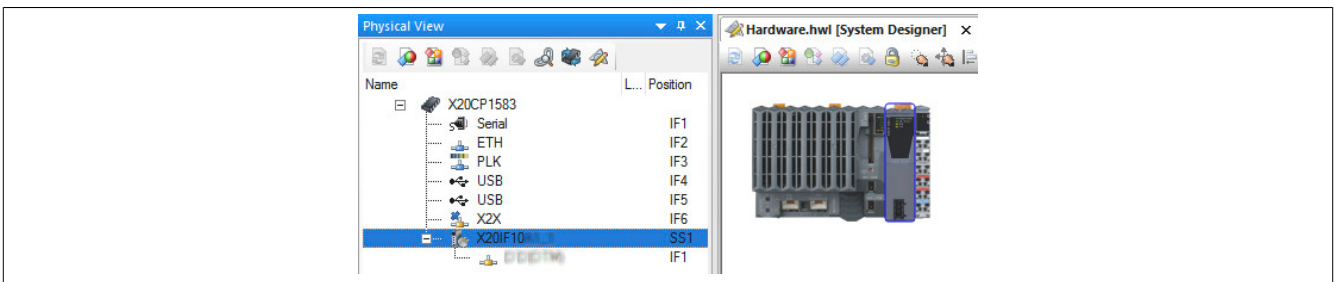


9.23.4.8.1.2 Adding and configuring the interface module

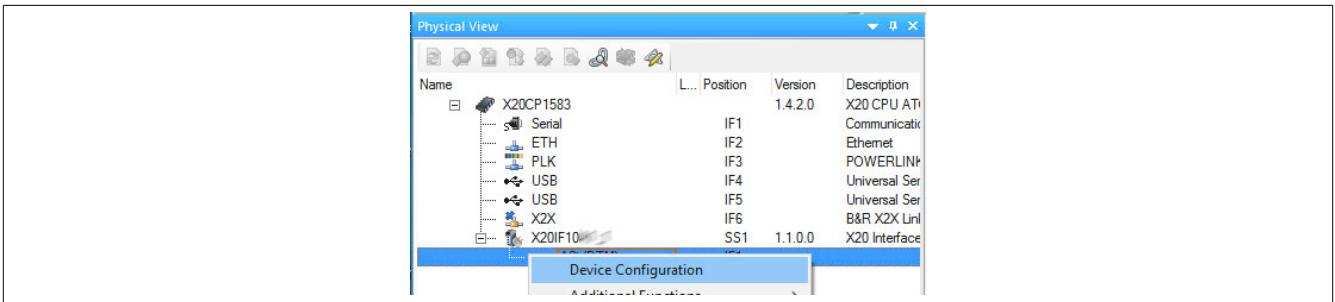
- In this example, the interface card is connected in the slot of a CPU. Right-clicking on the slot and selecting "Add hardware module" opens the Hardware Catalog.



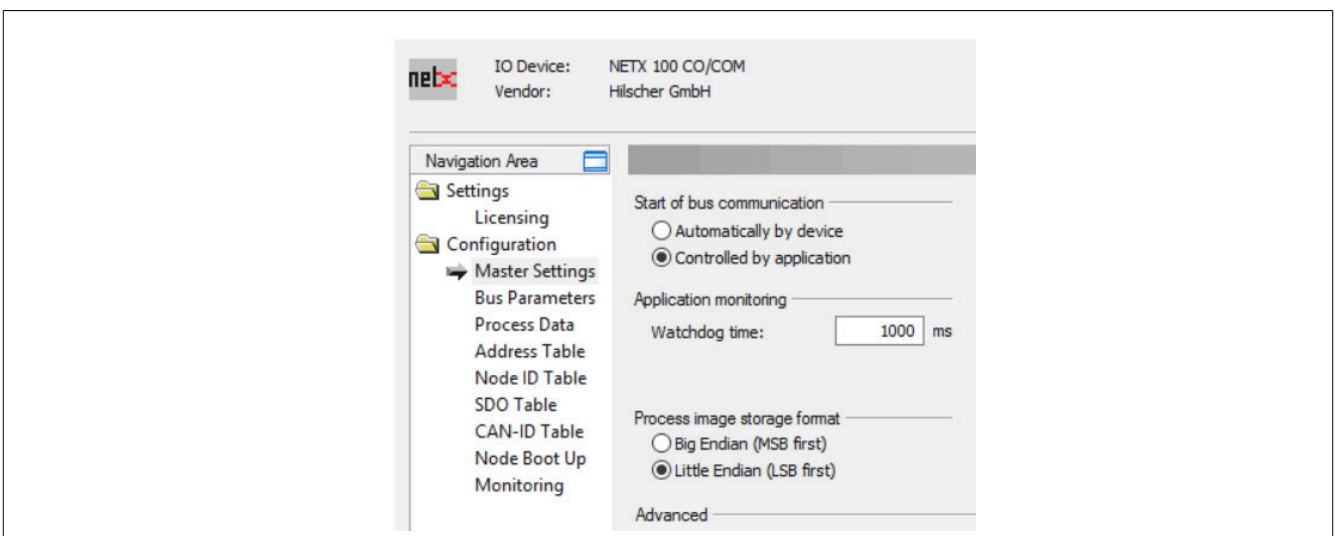
- The module is added to the project via drag-and-drop or by double-clicking on the interface card.



- Additional module settings can be made under "Device configuration". This configuration environment is opened by right-clicking on the IF interface and selecting "Device configuration".



- General settings are made in the device configuration.



Master settings

- Start of bus communication

It is possible to select how data exchange is started on the module.

| Parameter | Explanation |
|---------------------------|--|
| Automatically by device | Data exchange is started automatically after initializing this module. |
| Controlled by application | Data exchange is started by Automation Runtime. |

- Module alignment

The addressing mode is defined by the process image here. The addresses (offsets) of the process data are always interpreted as byte addresses.

| Addressing mode | Explanation |
|-------------------|---|
| Byte boundaries | The module address can start on any offset. |
| 2 byte boundaries | The module address can only start on even byte offsets. |

Information:

This configuration is automatically managed by Automation Runtime and is not permitted to be changed (default setting).

- Application monitoring

The module-internal watchdog time can be set here. If the watchdog has been enabled (watchdog time not equal to 0), the hardware watchdog must be reset after the set time at the latest.

| Parameter | Explanation | Values |
|---------------|-----------------------------|----------------|
| Watchdog time | Watchdog software disabled | 0 ms |
| | Permissible range of values | 20 to 65535 ms |
| | Default value: 1000 ms | |

Information:

The watchdog time is reset automatically by Automation Runtime.

- Process data handshake

This parameter configures the handshake for the data exchange between application and device. Only "Buffered, host-controlled" is supported here.

- Process image storage format

This is used to define how data is stored in the process image (I/O mapping). The storage format is only applied to data type "Word". This change has no effect on other data types.

| Storage format | Explanation |
|----------------|---|
| Big-endian | MSB/LSB = Higher/Lower byte (Motorola format) |
| Little-endian | MSB/LSB = Higher/Lower byte (Intel format) |

Information:

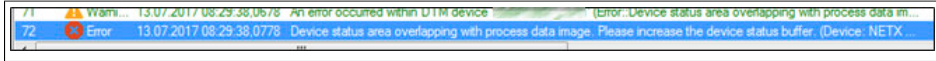
This configuration is automatically managed by Automation Runtime and is not permitted to be changed (default setting).

- Advanced

This parameter is not supported.

- Device status offset

Here, the status offset can be set to be calculated automatically or using a predefined value.

| Status offset | Explanation |
|-----------------------|---|
| Automatic calculation | The device status always directly follows the input bytes. If input data is added in the configuration, the start address of the device status is moved back in the dual-ported memory. |
| Static | <p>Here, the distance (free buffer) between the last input byte and the start of the device status can be set. This way, the start address of the device status never changes in the dual-ported memory. If additional input data is added, the distance (free buffer) is reduced. If the free buffer does not have enough space available for the data added to it, the start address of the device status in the dual-ported memory must be shifted.</p> <p>If the offset is too small, an error is output. To correct the error, the free buffer must be increased to a sufficient size.</p>  |

Information:

This configuration is automatically managed by Automation Runtime and is not permitted to be changed (default setting).

Bus parameters

- Device description

The symbolic name of the device can be changed here. However, this is only used by the configuration dialog boxes and not by Automation Studio.

- Node settings

The NodeID, baud rate and behavior at startup and in the event of error can be configured here.

| Parameter | Explanation | Values |
|----------------------------------|---|-----------------------|
| Node ID | The node ID is used in CANopen for addressing and each ID is only permitted to occur once in a network. | 1 to 127 |
| Baud rate | Configures the data transfer rate | 10 kbit/s to 1 Mbit/s |
| Stop in case of monitoring error | <p>How the master behaves in the event of a monitoring error is set here. In each case, the corresponding error code is output.</p> <ul style="list-style-type: none"> Enabled: The master switches to mode "Stop" and communication with all other slaves is aborted. Not enabled: The master remains in mode "Operational" and communication with the other slaves is maintained. | |
| Send "Global start node" | <p>If enabled, the master transmits a "Global start node" after the startup of all configured slaves. This synchronizes and starts all slaves.</p> <p>If a slave should not be started, both this parameter and "Send the start node command" must be disabled under "Node bootup" on page 2284. If only one of the two parameters is disabled, the slave is started.</p> | |

- SYNC master settings

The COB ID can be changed here. Each communication object in the network has a unique communication object identifier (COB ID).

In addition, the cyclic period of the SYNC message can be set or switched off (cycle period = 0).

| Sync object | Explanation | Values |
|--------------|---|--|
| COB ID | COB ID of the SYNC message Default value: 128 | 0 to 128 1664 to 1759 1761 to 1792 |
| Cycle period | Period of the SYNC message. The value 0 disables the transmission of messages. Default value: 100 | 0 to 65535 |

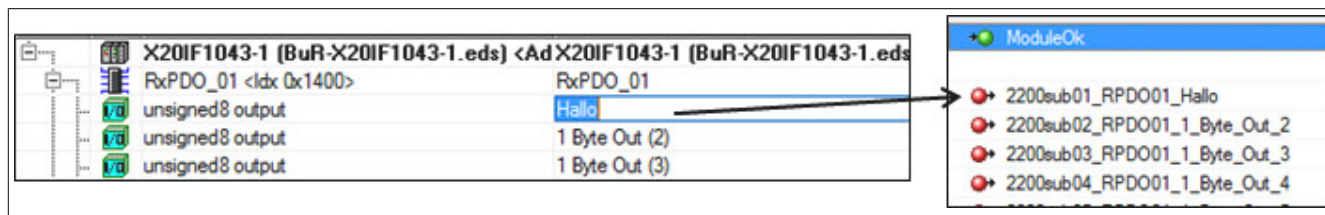
- 29-bit COB ID

This parameter is not supported.

Process data

This table lists the process data of the individual slaves.

| Parameter | Explanation |
|-----------|---|
| Type | Device designation specified by the hardware. Further description of modules configured on the device or the input or output signals. |
| Tag | The name of the input and output data can be changed in column "Day". |
| SCADA | This parameter is not supported. |



Address table

This table provides information about the addresses of the input and output data (in decimal or hexadecimal notation).

"Display mode" allows toggling between decimal and hexadecimal display.

| Column | Explanation |
|----------|---|
| Node ID | Node ID of the slave |
| Device | Device name of the slave |
| Name | Name of the slave |
| Obj.Idx | Object index |
| Obj.Name | Object name |
| COB ID | COB ID of the CAN message |
| Type | Data type for the input and output data |
| Length | Length of the input and output data |
| Address | Offset for the input and output data |

The address table can also be exported as a CSV file.

Node ID table

All slaves are listed in this table.

| Parameter | Explanation |
|-----------|--|
| Activate | This allows the slaves to be enabled or disabled. If a slave is disabled, the master reserves memory in the process data image for the slave, but no data is exchanged. If a slave is enabled, the process memory is reserved and data is exchanged. |
| Node ID | A node ID can be assigned to the slave here. |
| Device | Device name of the slave |
| Name | Name of the slave |
| Vendor | Device manufacturers |

SDO table

This table lists all objects that are transferred during the startup phase. The object information cannot be changed.

"Display mode" allows toggling between decimal and hexadecimal display.

| Column | Explanation |
|-----------|--------------------------|
| Node ID | Node ID of the slave |
| Device | Device name of the slave |
| Name | Name of the slave |
| Obj.Idx | Object index |
| Sub.Idx | Subindex |
| Parameter | Parameter name |
| Value | Value of the parameter |

CAN ID table

The CAN IDs used are listed in this table. If "Auto alloc = Enabled", the CAN IDs are assigned automatically. "Display mode" allows toggling between decimal and hexadecimal display.

| Column | Explanation | Values |
|--------------|---|---|
| Node ID | Station address of the device in the network | 1 to 127 |
| Device | Device name of the slave | |
| Name | Name of the slave | Any |
| Message type | Message type | <ul style="list-style-type: none"> • NODE GUARDING • EMCY • RXPDO[x] • TXPDO[x] • SYNC |
| CAN ID | COB ID | 0 to 2047 |
| Auto alloc | Enables/Disables automatic allocation To change a CAN ID, "Auto alloc" must be disabled. | |

| Message Type | CAN-ID | Auto Alloc |
|--------------|---|-------------------------------------|
| SYNC | 128 | <input type="checkbox"/> |
| EMCY | 130 | <input checked="" type="checkbox"/> |
| RxPDO_01 | 514 | <input checked="" type="checkbox"/> |
| RxPDO_02 | 770 | <input checked="" type="checkbox"/> |
| RxPDO_03 | 1026 | <input checked="" type="checkbox"/> |
| RxPDO_04 | 1282 | <input checked="" type="checkbox"/> |
| TxPDO_01 | <input style="border: 1px solid red;" type="text" value="386"/> | <input type="checkbox"/> |
| TxPDO_02 | 642 | <input checked="" type="checkbox"/> |
| TxPDO_03 | 898 | <input checked="" type="checkbox"/> |
| TxPDO_04 | 1154 | <input checked="" type="checkbox"/> |
| TxPDO_05 | 1791 | <input checked="" type="checkbox"/> |

Node bootup

The startup phase can be adjusted here. By disabling boot phases, these are not executed, e.g. to be able to transfer another configuration at a later time.

| Phase/Status | Parameter | Description |
|--|--|---|
| 1 - Node reset | Send the reset node command | If enabled, the master first transmits the CANopen-specific node reset command. |
| 2 - Check node, profile and type | Compare the configured profile and type object 1000H with real value | If enabled, the master compares the contents of object 0x1000 on the module with the set data. If the values do not match, the node is not accessed. The configuration is not transferred and a configuration error is reported. This option must be enabled if a node object is not defined in the EDS file. In this case, under "Profiles and type", the values for the profile and the device type of the node must be entered according to the specifications of the device manufacturer. "EDS default" resets the values for the profile and the device type of the node to the original values from the EDS file and disables the comparison. |
| 3 - Configuration, guarding protocol | Configure the guard time and lifetime factor | If enabled, the master writes the two objects 0x100C (guard time) and 0x100D (lifetime factor) into the corresponding node objects during startup. If not enabled, the last configured values are obtained from the slave. If the configuration on the slave has been deleted, these values are 0. |
| 4 - Configuration SYNC COB ID | Configure the COB ID for the synchronization message | If enabled, the master transfers the configuration of the SYNC COB ID set in Automation Studio under "SYNC master settings" on page 2281 to the slave (object 0x1005). However, if the set cycle period is 0, no SYNC messages are sent. If not enabled, the last configured value is obtained from the slave. If the configuration on the slave has been deleted, the default value is 0x80. |
| 5 - Configuration EMCY COB ID | Configure the COB ID for the emergency message | If enabled, the master transfers the fixed EMCY COB ID to the slave (object 0x1014). If not enabled, the last configured value is obtained from the slave. If the configuration on the slave has been deleted, the default value is 0x80 + NodeID. |
| 6 - Configuration, download of objects | Download the object configuration to the node | If enabled, the master transfers all relevant configuration objects to the node, e.g. information about the PDO mapping, the COB IDs of the transmit and receive PDOs and all configured objects from the node configuration. If not enabled, the slave receives no configuration from the master. Phases 3, 4 and 5 are also not executed. If the slave supports automatic configuration, only the first 4 PDOs are active. COB IDs are defined and obtained from the slave. |
| 7 - Start node | Send the start node command | If enabled, the master sends the CANopen-specific start node command at the end of the bootup procedure in order to achieve the operating state. |
| 8 - Initiate PDO data | Remote request all TxPDOs and send current RxPDOs once after bootup | If enabled, the master reads and writes the configured PDOs after startup. This transmits all current data from the process output data memory to the nodes in addition to reading all current data from the nodes and then storing it in the process input data area of the master. |

Information:

Parameters "Node boot up → Start node" and "Bus parameters → Send 'global start node'" must be considered together.

Example

If all boot phases have been disabled, but "Send 'Global start node'" is active, the slave is still started. In this case, communication is started without the configuration being applied.

Monitoring

Device monitoring can be configured here. The following types of monitoring are possible:

- The master monitors the individual nodes.
- A node monitors the master.
- One node monitors another node.

The node to be monitored can be selected in column "Active" of the table. For each node, the node guarding protocol or heartbeat protocol can be selected.

- Selected node

Contains all configured nodes.

- Node guarding protocol

The master transmits a cyclic poll request to the node to check whether the node still exists on the bus. The node transmits its current status back to the master as response. The node can use the poll request from the master in order to monitor the master.

| Parameter | Explanation |
|-----------------|---|
| Guarding time | Monitoring the slave from the point of view of the master If communication is running, the master queries the node at the set time interval to check whether the node is still present in the network. If the guarding time has the value 0, the monitoring is disabled on both the master and slave. |
| Lifetime factor | Using the slave to monitor the master. If the communication is running, the node monitors the master in the calculated time interval " <i>Guarding time * Lifetime factor</i> " to check whether the node is still present in the network. If the lifetime factor has the value 0, monitoring is disabled on the slave. |

Information:

In order to use the node guarding protocol, the node must support this protocol.

- Heartbeat protocol

A "heartbeat producer" transmits cyclic heartbeat requests. One or multiple "heartbeat consumers" can receive the request.

| Parameter | Explanation |
|---------------|--|
| Producer time | Time interval at which heartbeat requests are transmitted. |

Information:

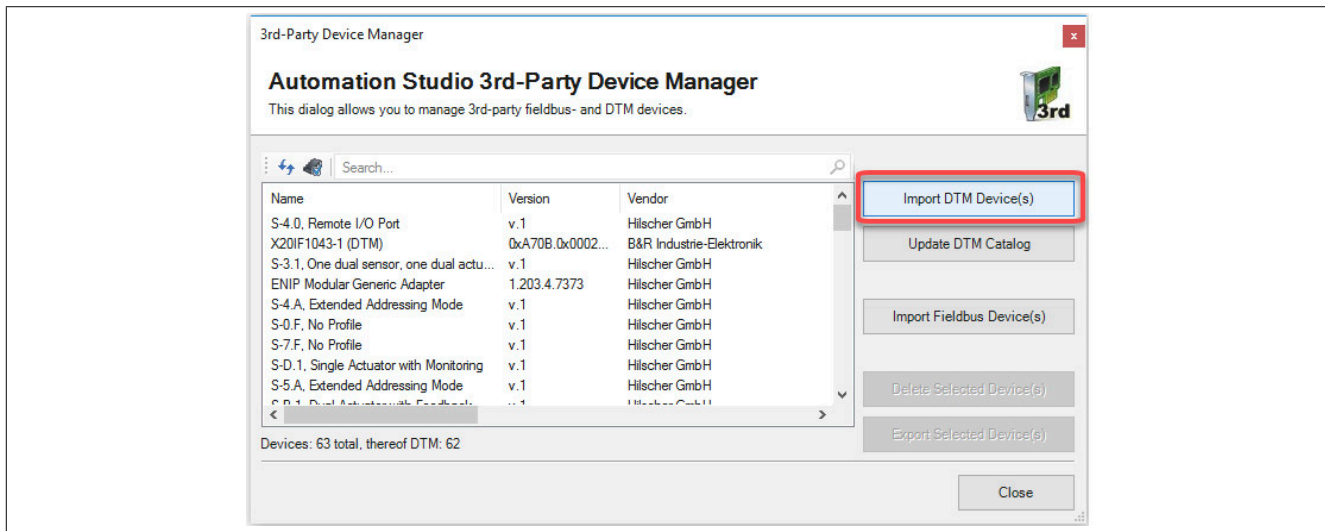
To use the heartbeat protocol, the node must support the heartbeat protocol.

9.23.4.8.2 Adding the EDS file in Automation Studio

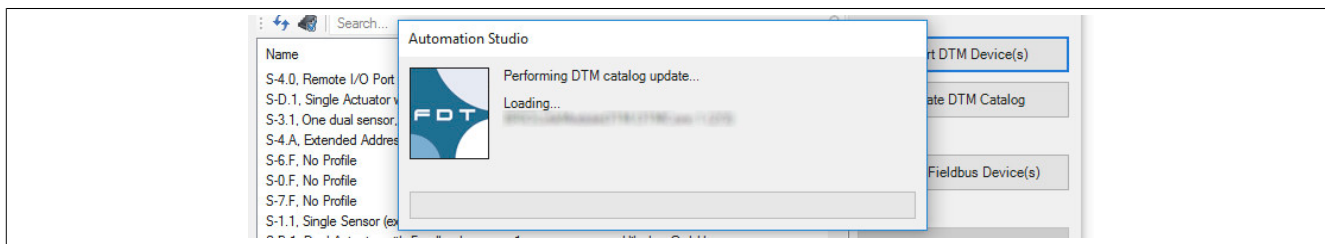
A device description file (EDS, DCF file) is required to inform the CANopen master which slaves were connected and how they were configured.

To add and use a device description file in Automation Studio, perform the following steps:

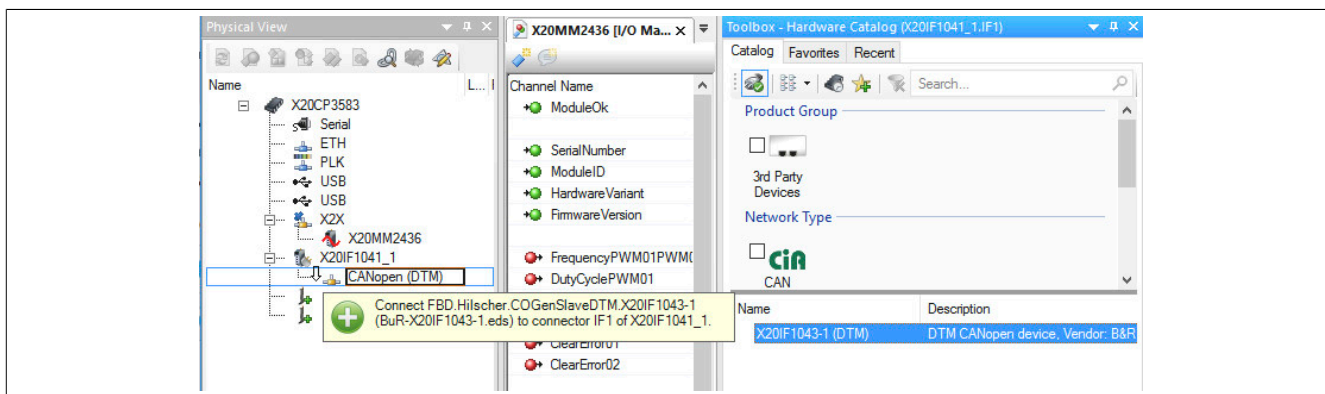
- The device description file (EDS, DCF) must be provided by the manufacturer of the CANopen slave.
- Open the dialog box in Automation Studio under "Tools - Manage 3rd-party devices" and select "Import DTM Device(s)".



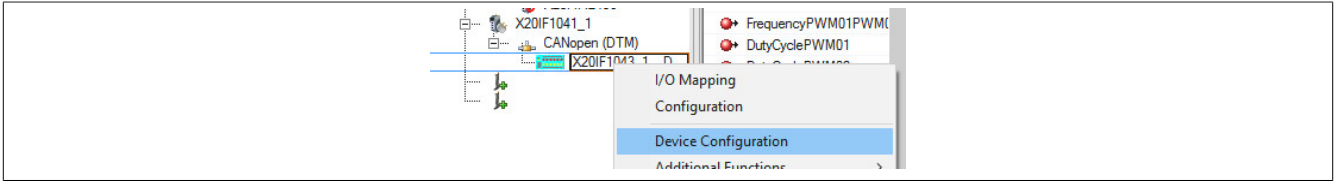
- Select the EDS file to be imported and confirm with OK. The EDS file is imported into Automation Studio.



- Click on "CANopen (DTM)" on the CANopen master X20IF1041-1, drag the EDS file from the Hardware Catalog and attach it to the CANopen master.



- Right-click on the device description file and select "Device configuration" to open the configuration environment for the EDS file.



9.23.5 X20IF1043-1

Data sheet version: 2.03

9.23.5.1 General information

The interface module is equipped with a CANopen (slave) interface. This allows the B&R system (I/O modules, POWERLINK, etc.) to be connected to systems from other manufacturers and makes it possible to quickly and easily transfer data in both directions.

The interface module can be operated in X20 CPUs or in the expandable POWERLINK bus controller X20BC1083.

- CANopen slave
- Integrated terminating resistor

9.23.5.2 Order data


| Model number | Short description | Figure |
|--------------|--|--|
| | X20 interface module communication |  |
| X20IF1043-1 | X20 interface module, for DTM configuration, 1 CANopen slave interface, electrically isolated, order 1x TB2105 terminal block separately | |
| | Required accessories | |
| | Terminal blocks | |
| 0TB2105.9010 | Accessory terminal block, 5-pin, screw clamps 2.5 mm ² | |
| 0TB2105.9110 | Accessory terminal block, 5-pin, push-in terminal block 2.5 mm ² | |

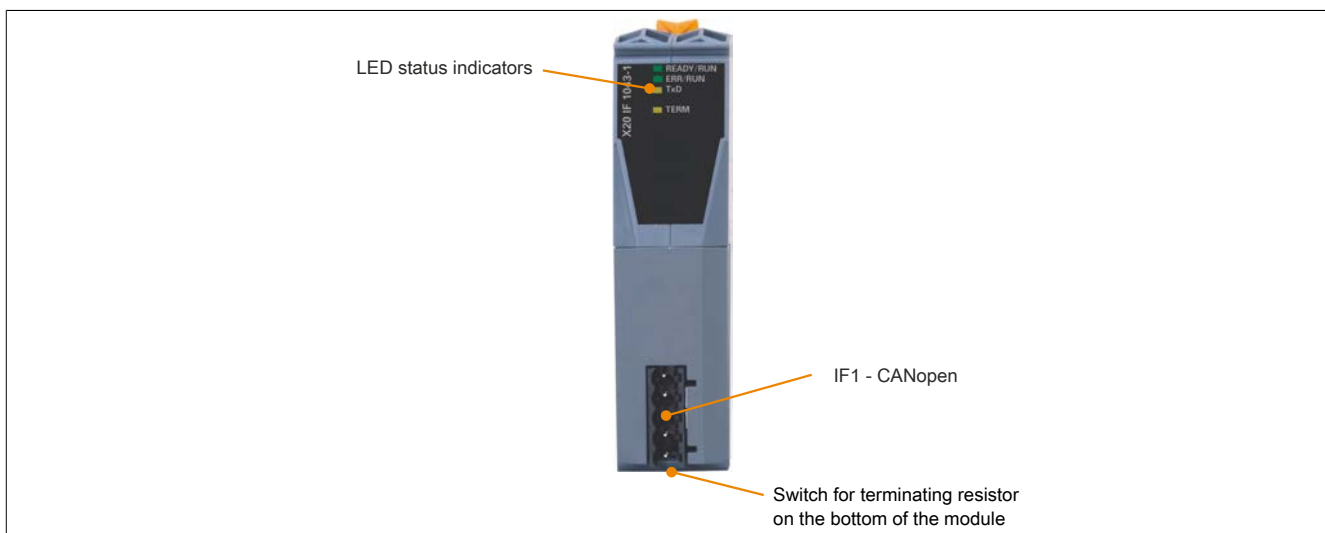
Table 427: X20IF1043-1 - Order data

9.23.5.3 Technical data

| | |
|--|--|
| Model number | X20IF1043-1 |
| Short description | |
| Communication module | CANopen slave |
| General information | |
| B&R ID code | 0xA70B |
| Status indicators | Module status, network status, data transfer, terminating resistor |
| Diagnostics | |
| Module status | Yes, using status LED and software |
| Network status | Yes, using status LED and software |
| Data transfer | Yes, using status LED |
| Terminating resistor | Yes, using status LED |
| Power consumption | 1.1 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| EAC | Yes |
| KC | Yes |
| Interfaces | |
| Interface IF1 | |
| Fieldbus | CANopen slave |
| Variant | 5-pin male multipoint connector |
| Max. distance | 1000 m |
| Transfer rate | Max. 1 Mbit/s |
| Terminating resistor | Integrated in the module |
| Controller | netX100 |
| Electrical properties | |
| Electrical isolation | PLC isolated from CANopen (IF1) |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x TB2105 terminal block separately |
| Slot | In the X20 CPU and in the X20BC1083 expandable bus controller |

Table 428: X20IF1043-1 - Technical data

9.23.5.4 Operating and connection elements



9.23.5.4.1 LED status indicators

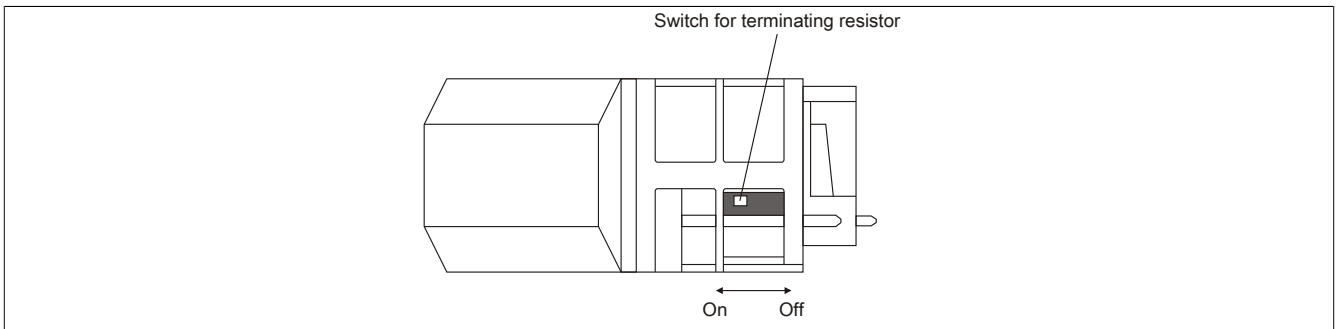
| Figure | LED | Color | Status | Description |
|--------|-----------|----------------------------------|---|---|
| | READY/RUN | Green/red | Off | No power to module |
| | | Green | On | PCI bus communication in progress |
| | | Red | Blinking | Error when booting |
| | | On | Communication on the PCI bus has not yet been started | |
| | ERR/RUN | Green/red | Off | Module executes a reset |
| | | Green blinking with double pulse | Red blinking with double pulse | CANopen communication disrupted. This may be due to one of the following reasons: <ul style="list-style-type: none"> The CAN bus cable is broken or the CAN bus controller is in "Bus off" mode The module is in PREOPERATIONAL mode CANopen communication was stopped (the module is in STOPPED mode) |
| | | Green blinking | Red blinking with double pulse | CANopen communication was stopped by the master |
| | | Green | Blinking | Communication is being started (module is being initialized) |
| | TxD | Yellow | Flickering or on | Module sending data via the CANopen interface |
| | TERM | Yellow | On | Terminating resistor integrated in the module switched on |

9.23.5.4.2 CAN bus interface

The interface is a 5-pin multipoint connector. Terminal block 0TB2105 must be ordered separately.

| Interface | Pinout | | |
|--|----------|------------------|------------|
| | Terminal | Function | |
| <p>5-pin male multipoint connector</p> | 1 | CAN _⊥ | CAN ground |
| | 2 | CAN _L | CAN low |
| | 3 | SHLD | Shield |
| | 4 | CAN _H | CAN high |
| | 5 | NC | |

9.23.5.4.3 Terminating resistor



A terminating resistor is integrated in the interface module. It can be switched on or off with a switch on the bottom of the housing. A switched-on terminating resistor is indicated by LED "TERM".

9.23.5.5 Use in the expandable X20BC1083 POWERLINK bus controller

9.23.5.5.1 Cyclic data

If this module is connected to the expandable POWERLINK bus controller, the amount of cyclic data is limited by the POWERLINK frame to 1488 bytes in each direction (input and output).

When using multiple X20IF10xx-1 interfaces or other X2X modules with a POWERLINK bus controller, the 1488 bytes are divided between all connected modules.

9.23.5.5.2 Operating netX modules

It is important to note the following in order to operate netX modules with the bus controller without problems:

- A minimum revision $\geq E0$ is required for the bus controller.
- netX modules can only be operated with the POWERLINK V2 setting. V1 is not permitted.
- With SDO access to POWERLINK object 0x1011/1 on the bus controller, the netX firmware and the configuration stored on the bus controller are not reset. They can only be overwritten by accessing them again. This affects objects 0x20C0 and 0x20C8, subindexes 92 to 95.

9.23.5.6 netX error codes

netX modules return an error code when an error occurs. These error codes are fieldbus-specific. A complete list of all error codes in PDF format is available in Automation Help in section "Communication / Fieldbus systems / Support with FDT/DTM / Diagnostic functions / Diagnostics on the runtime system / Master diagnostics" under item "Communication_Error".

9.23.5.7 Firmware

The module comes with preinstalled firmware. The firmware is part of the Automation Studio project. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.23.5.8 The CANopen interface

Information:

The settings on the slave must match the settings of the corresponding device description file; otherwise, no connection can be established.

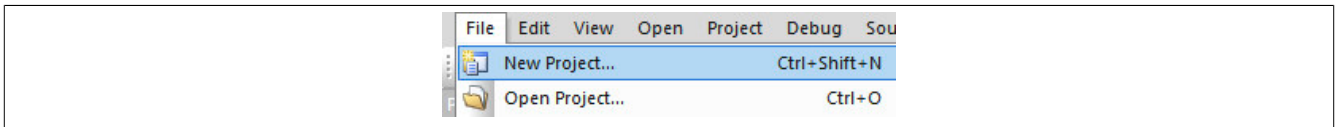
9.23.5.8.1 Settings in Automation Studio

The interface module can be operated in the slot of a CPU or in the slot of an expandable POWERLINK bus controller.

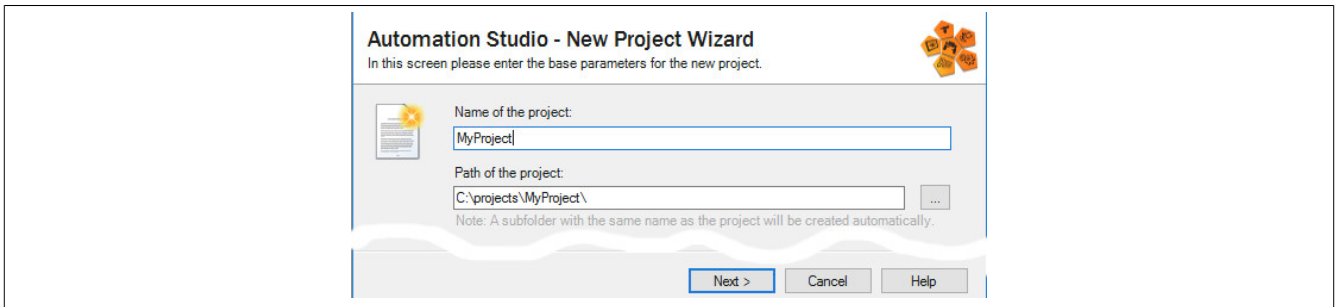
To do this, a new Automation Studio project is created and the suitable settings are made on the module.

9.23.5.8.1.1 Creating an Automation Studio project

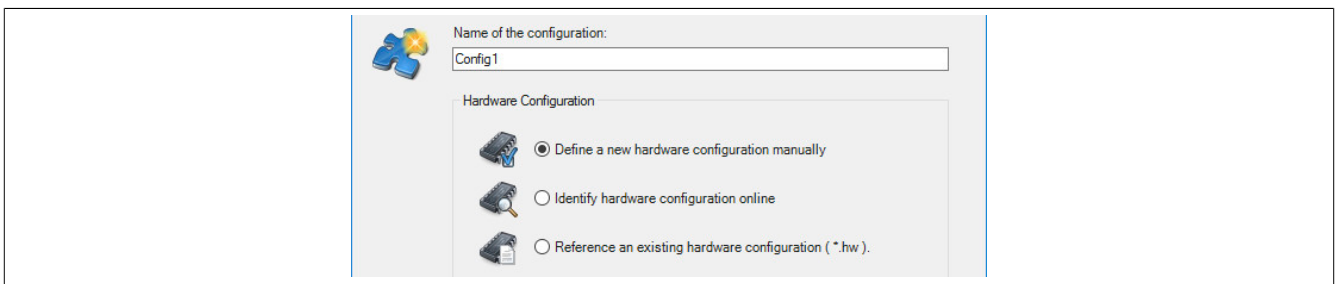
- Create a new Automation Studio project by selecting "New project".



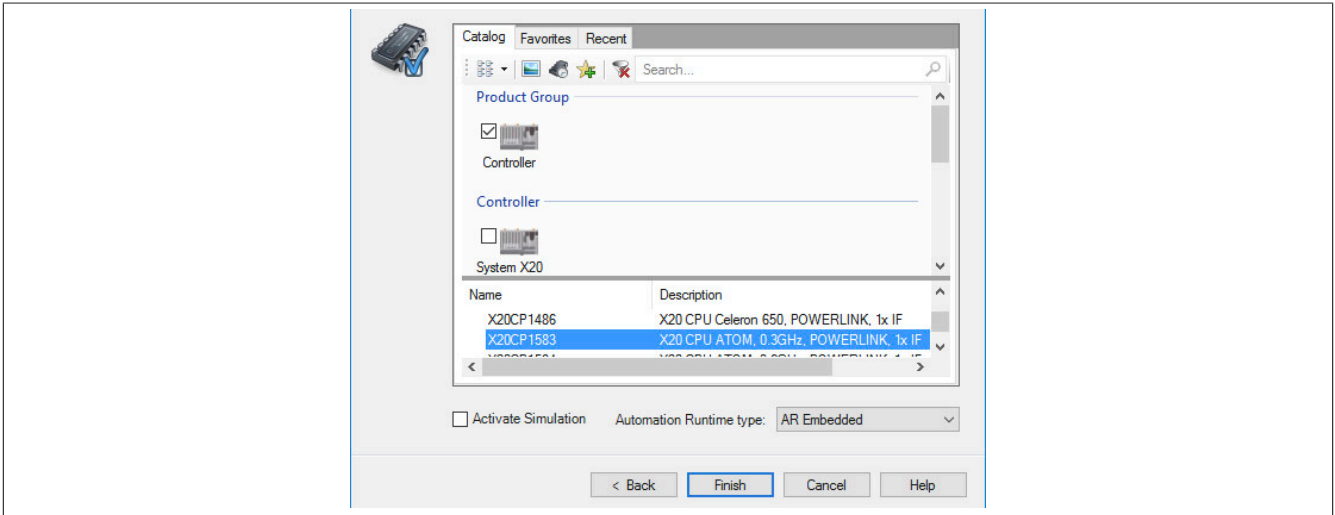
- Assign a project name and set up the project path.



- Assign the hardware configuration type and configuration name.

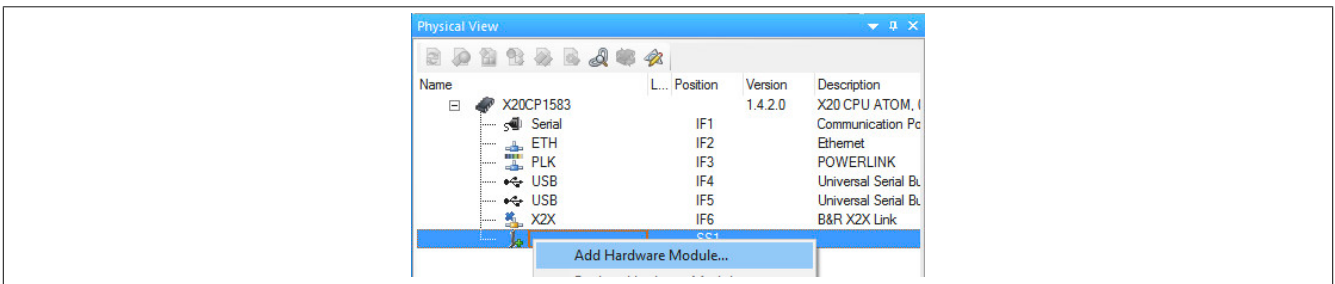


- Select the hardware in the next step if "Define a new hardware configuration manually" was selected. In order to simplify the search, different filters can be set in the Hardware Catalog. Lastly, highlight the required hardware and create the Automation Studio project by clicking on "Finish".

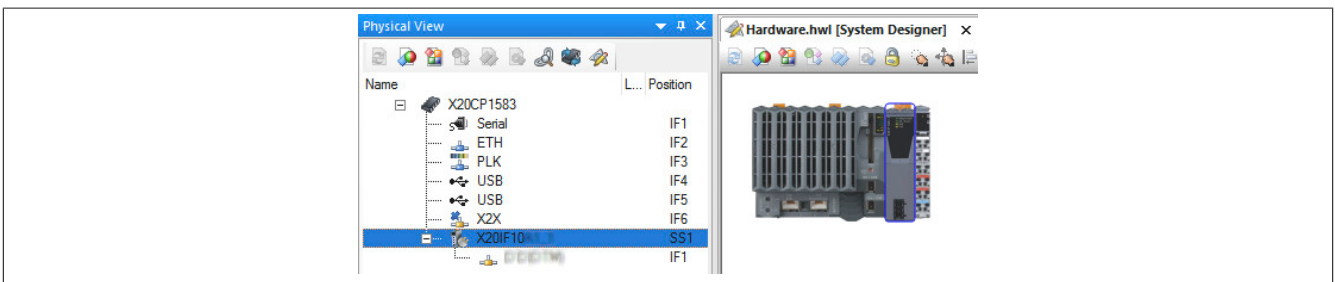


9.23.5.8.1.2 Adding and configuring the interface module

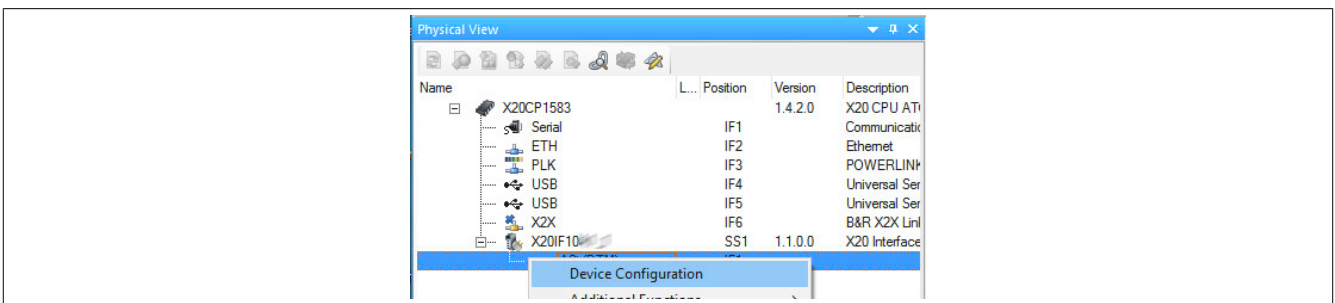
- In this example, the interface card is connected in the slot of a CPU. Right-clicking on the slot and selecting "Add hardware module" opens the Hardware Catalog.



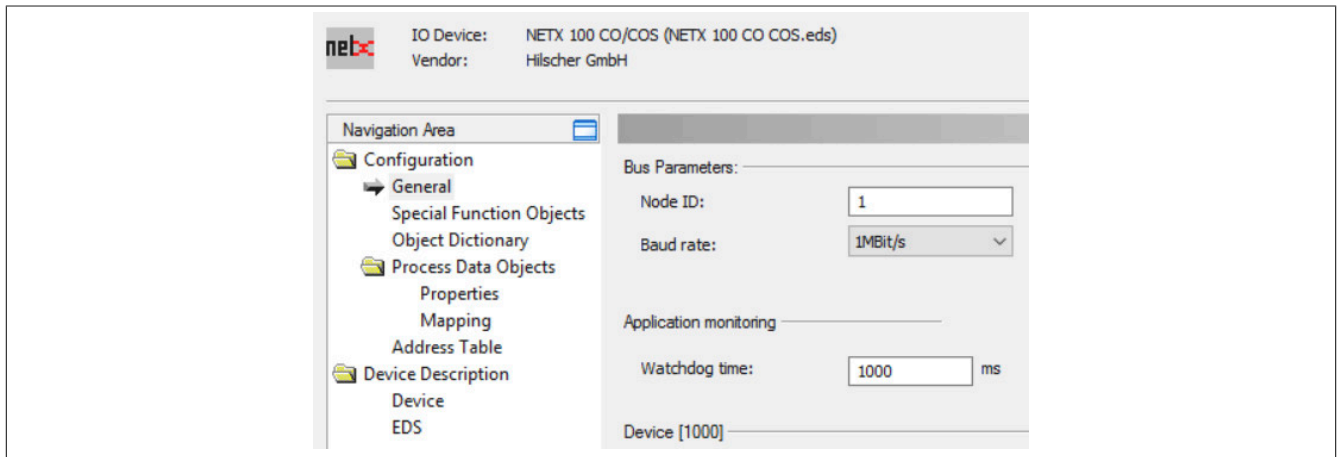
- The module is added to the project via drag-and-drop or by double-clicking on the interface card.



- Additional module settings can be made under "Device configuration". This configuration environment is opened by right-clicking on the IF interface and selecting "Device configuration".



- General settings are made in the device configuration.



General

- Bus parameters

The NodeID and baud rate can be configured here.

These values from the EDS description file on the master can only be read.

| Parameter | Explanation | Values |
|-----------------------|---|-----------------------|
| Node ID | The node ID is used in CANopen for addressing and each ID is only permitted to occur once in a network. The same node ID must be set in the EDS description file on the master and slave. | 1 to 127 |
| Baud rate | Sets the transfer rate | 10 kbit/s to 1 Mbit/s |
| Enable address switch | This parameter is not supported. | |

- Application monitoring

The module-internal watchdog time can be set here. If the watchdog has been enabled (watchdog time not equal to 0), the hardware watchdog must be reset after the set time at the latest.

| Parameter | Explanation | Values |
|---------------|-----------------------------|----------------|
| Watchdog time | Watchdog software disabled | 0 ms |
| | Permissible range of values | 20 to 65535 ms |
| | Default value: 1000 ms | |

Information:

The watchdog time is reset automatically by Automation Runtime.

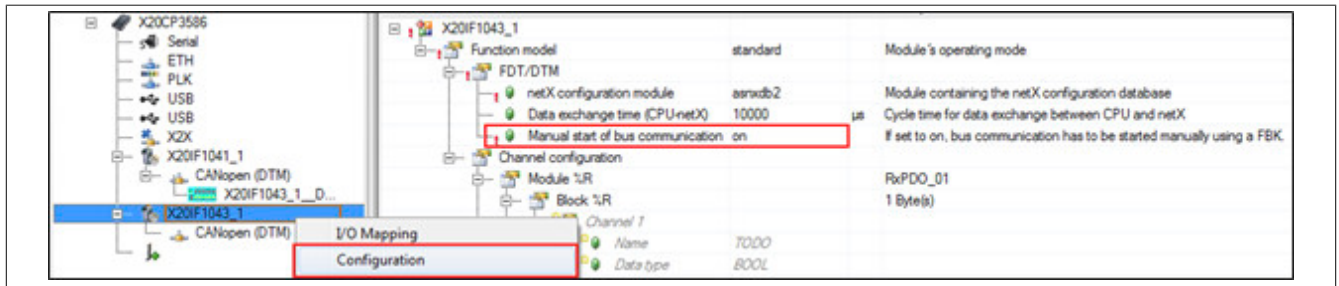
- Start of bus communication

It is possible to select how data exchange is started on the module.

| Parameter | Explanation |
|---------------------------|--|
| Automatically by device | Data exchange is started automatically after initializing this module. |
| Controlled by application | Data exchange is started by Automation Runtime. |

Information:

Parameter "Manual start of bus communication" can be enabled under the I/O configuration of the CANopen slave.



The following settings must be made in order to avoid automatic data exchange:

- In the IF module configuration, "Manual start of bus communication" must be set to "On".
- "Start of bus communication" must be set to "Controlled by application".

With this setting, communication can only be started via function block **AsNxCoS - nxcosStartBusComm()**.

- Device

This data is read from the EDS file (DTM) and not configurable.

- Vendor

This data is read from the EDS file (DTM) and not configurable.

Special function objects

The receipt of EMCY messages and transmission of SYNC messages can be set here. However, these settings can only be configured in the device description file on the master.

- Synchronization message

Whether the slave generates the SYNC messages can be set here.

Information:

On the slave, this setting causes an error message and is therefore not permitted to be used.

| Parameter | Explanation |
|-------------------------------|---|
| Device generates SYNC message | Enabling generation of the SYNC message |

No other parameters are supported.

- TimeStamp message

This parameter is not supported.

- Emergency message

Whether the master can receive EMCY messages can be set here.

| Parameter | Explanation |
|-------------|----------------------------------|
| EMCY exists | Master can receive EMCY messages |

No other parameters are supported.

Object dictionary

The object dictionary of the device is listed here. These are taken from the EDS file (DTM). PDO objects can be enabled or disabled in the object dictionary. This is done under "Process data objects - Properties" on page 2296.

The object dictionary can be filtered with "Area" and "Status"; using "Object", a single object can be searched.

| | | | | | | |
|-------|---------------|---------|-----|---------|--------|--|
| Area: | [1400 - 1FFF] | Status: | All | Object: | 0x1001 |  Go |
|-------|---------------|---------|-----|---------|--------|--|

Object dictionary

| Parameter | Explanation | Values |
|----------------|--|--|
| Configure | Overview of the configuration options. <ul style="list-style-type: none"> Key symbol: Entry cannot be configured in the object dictionary. Checkbox with check mark: Object can be configured. Checkbox without check mark: Object is locked for the configuration. | |
| Index.Subindex | Object address consisting of index and subindex | |
| Name | Symbolic name of the device | |
| Access | Access rights of the device | <ul style="list-style-type: none"> RO - Read only RW - Read and write WO - Write only CONST - Constant value |

When a specific object is selected in the object dictionary, the name, current value, default value, data type and minimum/maximum values of the object are listed. This listing can be in decimal and hexadecimal notation.

| | | |
|------------------|------------------------|-----------------------|
| Selected object: | 0181D.03 Inhibit Time | |
| Display mode: | Decimal | Data type: UNSIGNED16 |
| Current value: | Decimal Hexadecimal | Min: 0 |
| Default: | 0 | Max: 65535 |

Process data objects - Properties

Additional PDOs can be enabled here. Each additional PDO enabled is listed under "Process data objects → Mapping → PDO contents mapping for" and in the I/O mapping. The first 4 PDOs (0x1400 to 0x1404 for RxPDO and 0x1800 to 0x1804 for TxPDO) are enabled by default. To update the I/O mapping, additional PDOs must be enabled.

The PDO type can be used to toggle between transmit PDOs (TPDO) and receive PDOs (RPDO).

| Parameter | Explanation |
|-----------|---|
| Configure | Enables or disables a PDO for configuration and communication |
| Index | Object index of the PDO |
| PDO name | Name of the PDO |

If a PDO is selected in the table, the properties of the PDO are listed under the table.

- COB ID

The COB ID consists of the CAN identifier and additional parameters for the corresponding communication object.

| Parameter | Explanation | Values |
|---------------|--|-----------|
| CAN ID | CAN identifier of the object. | 1 to 2047 |
| PDO exists | This parameter is identical to enabling the PDOs in the table under "Configure". If this parameter was enabled, the affected PDO is present in the mapping. By default, only the first 4 PDOs are enabled. | |
| RTR permitted | If selected, the message trigger mode "Remotely requested" is permitted for this PDO. This means that when an RTR triggered by a PDO consumer is received, the transfer of an event-controlled PDO is triggered. Otherwise, message trigger mode "Remotely requested" is not permitted for this PDO. The value from the EDS file is applied as the default value. An RTR is not permitted to be used to query a transfer of emergency objects. | |
| 29-bit | This parameter is not supported. | |

- Transmission

The transfer type and rate are defined here.

| Parameter | Explanation | Values |
|-------------------|---|---|
| Transmission type | <p>For the transmit or receive PDOs, different transfer types are possible. A PDO can be configured for an event-driven, synchronous or asynchronous transfer. Transfer types can be synchronized, e.g. to the synchronization message SYNC, which is transmitted by the master in defined time intervals. Synchronous means that the transfer of the PDOs is related to the synchronization message. Asynchronous means that the transfer of the PDOs is not related to the SYNC synchronization message and can be executed at any time.</p> <p>Support for the different transfer types depends on the manufacturer and device. CANopen does not require support from individual or all transfer types. For information about whether a device supports the desired transfer type, check the device description of the device used.</p> | Synchronous acyclic (0) Synchronous cyclic (1 to 240) Event-controlled, manufacturer-specific (254) Event controlled, profile-specific (255) |
| Transmission rate | <p>For synchronous TPDOs, a number must be specified for transfer type "Synchronous cyclic (1 to 240)" to which the SYNC message of the data transfer refers.</p> <ul style="list-style-type: none"> A SYNC number of 1 indicates that the message is transferred with each SYNC synchronization message. A SYNC number of n indicates that the message is transferred with every nth SYNC synchronization message. <p>Asynchronous TPDOs are not transferred in any timing relationship with a SYNC synchronization message.</p> | 1 to 240 |
| Inhibit time | <p>It describes the minimum time period that must elapse between the sending of identical messages. This suppresses sending identical messages too frequently. This parameter is not supported.</p> | |
| Event timer | <p>Only for TPDOs transfer types 254 and 255. The expiration of the timer is used as an event to transmit the TPDO. Transmitting the TPDO and resetting the event timer can also be caused by an application event, however. This parameter is not supported.</p> | |

Process data objects - Mapping

The mapping can be configured here.

The PDO type can be used to toggle between transmit PDOs (TPDO) and receive PDOs (RPDO).

The table is divided into two parts. All usable objects are listed in the upper part. The lower part contains a list of the objects that have already been added to the mapping. It is added to the mapping by double-clicking on a PDO in the upper table.

| Parameter | Explanation |
|----------------|---|
| Index.Subindex | Index or subindex of the relevant object. |
| Parameter | Name of the object |
| Data type | Data type of the object |
| Length | Length of the PDO in bytes |
| Access | PDO access right |

The enabled PDOs can be toggled under "PDO contents mapping for". A maximum of 8 bytes, i.e. 64 bits, can be mapped in a PDO.

Information:

The number of mappable PDOs is limited. As soon as the limit has been reached, either an object must be removed or additional PDOs must be enabled under "[Process data objects - Properties](#)" on page 2296.

Address table

Contains a list of all PDOs that are categorized according to their inputs and outputs. The respective length of the inputs and outputs as well as the assigned address can be read in this table.

This table is not available in the EDS description file on the master.

"Display mode" allows toggling between decimal and hexadecimal display.

| Parameter | Explanation |
|----------------|--|
| PDO-Name | The RxPDO name or TxPDO name is displayed here. These are defined in the EDS file. |
| PDO-Idx | Object index of the process data object (PDO) |
| COB ID | COB ID of the CAN message |
| Obj.Idx Subidx | All objects are addressed in the object index and, if applicable, in the associated sub-indexes defined by the EDS file. |
| Obj.Name | Object name |
| Type | Type of input or output data |
| Length | Length of the input or output data of the PDO in bytes |
| Address | Offset address of the input or output data |

The address table can also be exported as a CSV file.

Device description

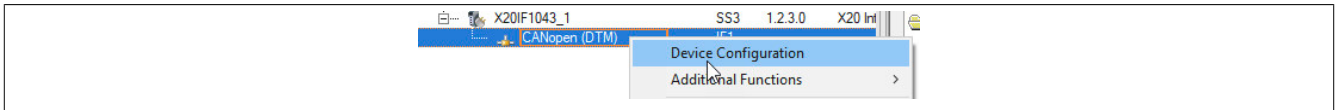
General device information and the entire EDS file can be read here.

9.23.5.8.2 EDS device description file

The module description is made available to the master in an EDS file. This file contains the description of the slave's complete range of functions. The EDS file can be downloaded from the B&R website (www.br-automation.com) in the Downloads section for the interface module and then imported into the respective master environment.

9.23.5.8.3 Configuration example

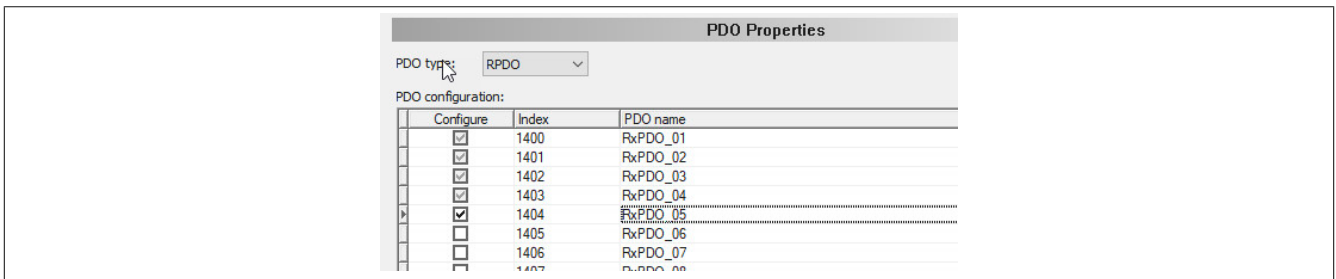
- In this example, the PDO mapping should be configured to 40 input bytes and 20 output bytes. "Device configuration" on the CANopen slave is opened for this.



- The number of RPDOs and TPDOs that must be applied is defined under "Process data objects → Properties". 8 bytes of data can be transferred per PDO. The minimum number of RPDOs and TPDOs is always 4, even if less data should be transferred.

RPDO

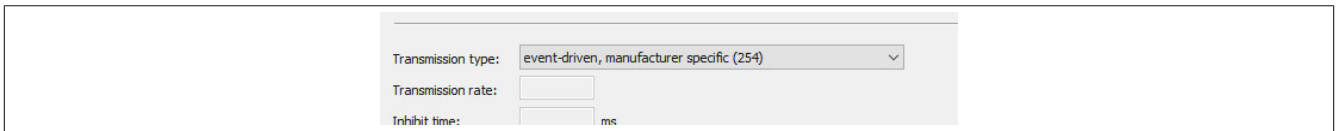
For 40 byte input data, 5 RPDOs are selected.



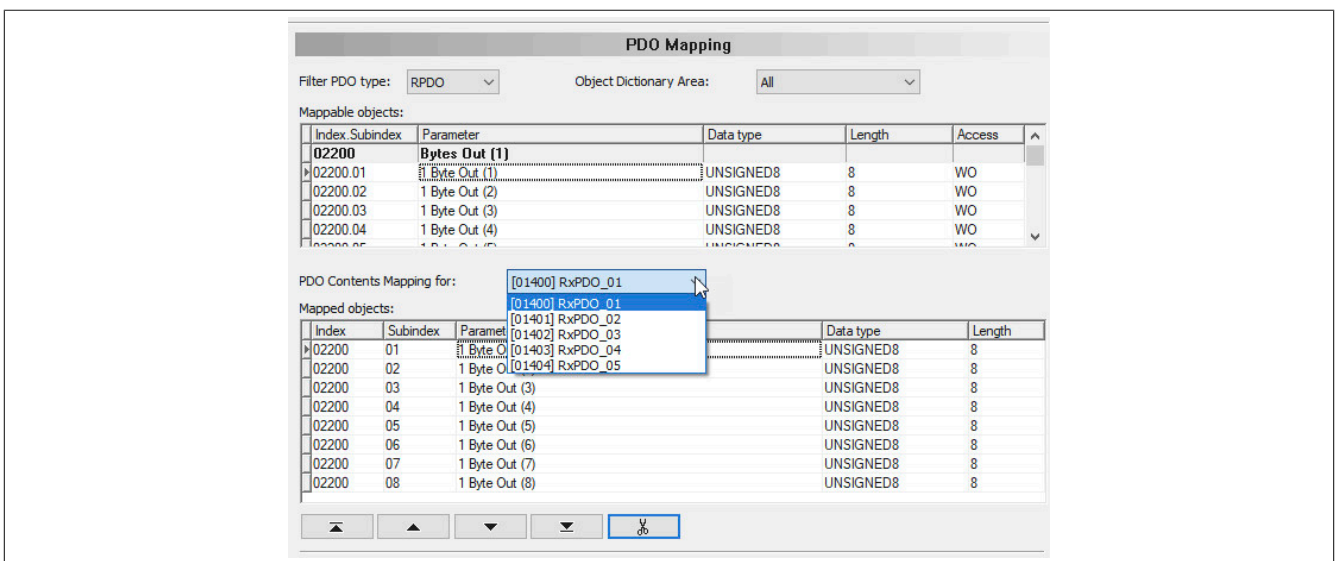
TPDO

To configure the TPDOs, "TPDO" is selected as the PDO type. Since only 20 bytes should be transferred, the default setting of 4 PDOs remains unchanged.

- The type of data transfer is defined (cyclic, acyclic, event-driven, etc.) under "Transmission type". For this example, the PDOs are transferred as "event-driven", i.e. only when data is changed.



- The PDOs are filled under "Process data objects → Mapping". The configured RPDOs are listed under "PDO contents mapping for"; in this example, they are listed as RPDO 1 to RPDO 5.

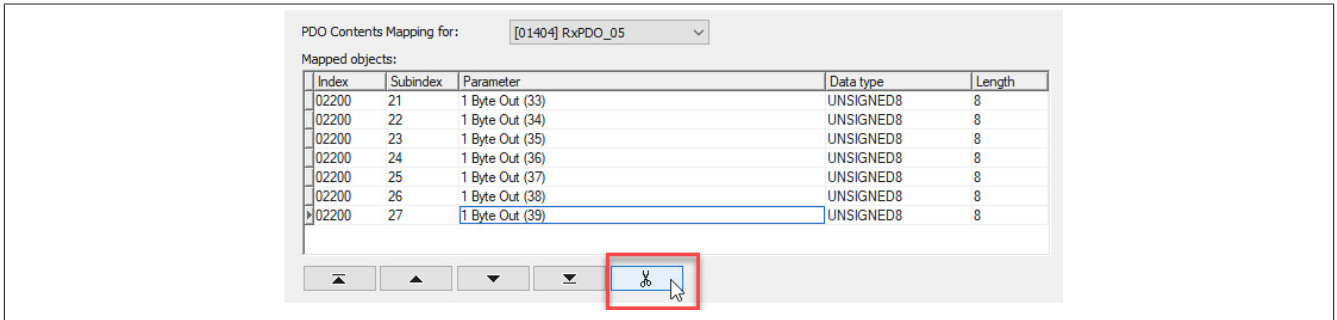


By default, the PDOs are filled with bytes. No change must therefore be made for the input bytes.

If a change is desired, RPDOs can be swapped out or data cut and pasted with "PDO contents mapping for".

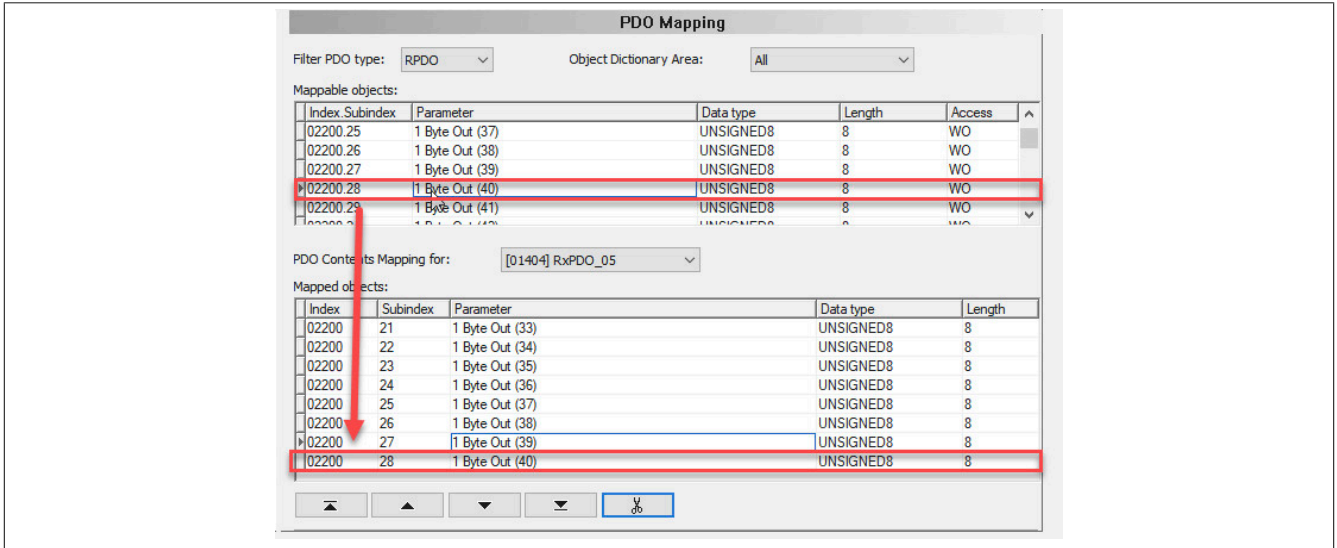
Cut

Select the desired object and cut it out with the scissors.



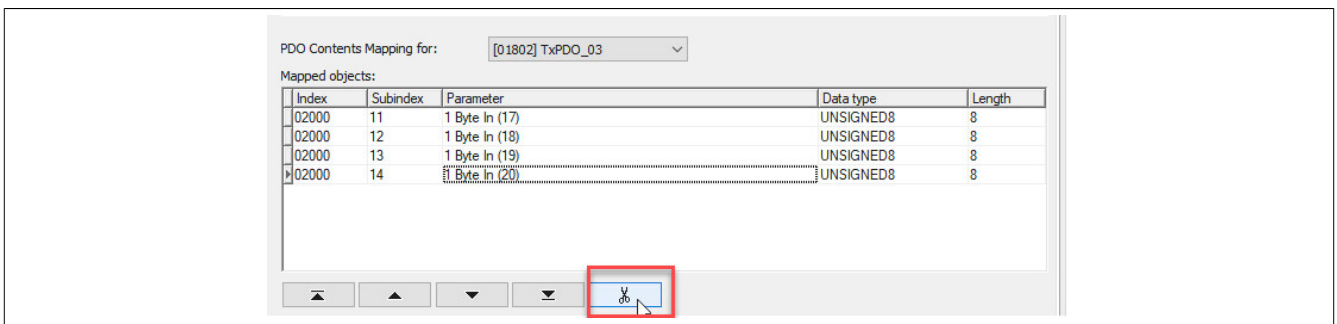
Paste

Double-clicking on an index in "Mappable objects" transfers the object to "Mapped objects".



- TPDOs are edited by changing to "TPDO" under "Filter PDO type". Bytes that are not required can be removed from the assignment. This is done by selecting the relevant TPDOs and cutting the superfluous objects using the scissors.

Because only 20 output bytes are needed in this example, no bytes are mapped in TPDO4 and only 4 bytes in TPDO3.



- Configuring the device description file

Identical settings must be made in the device description file. To do this, the device description file attached to the master must be set identically to the device configuration and I/O mapping of the CANopen slave.

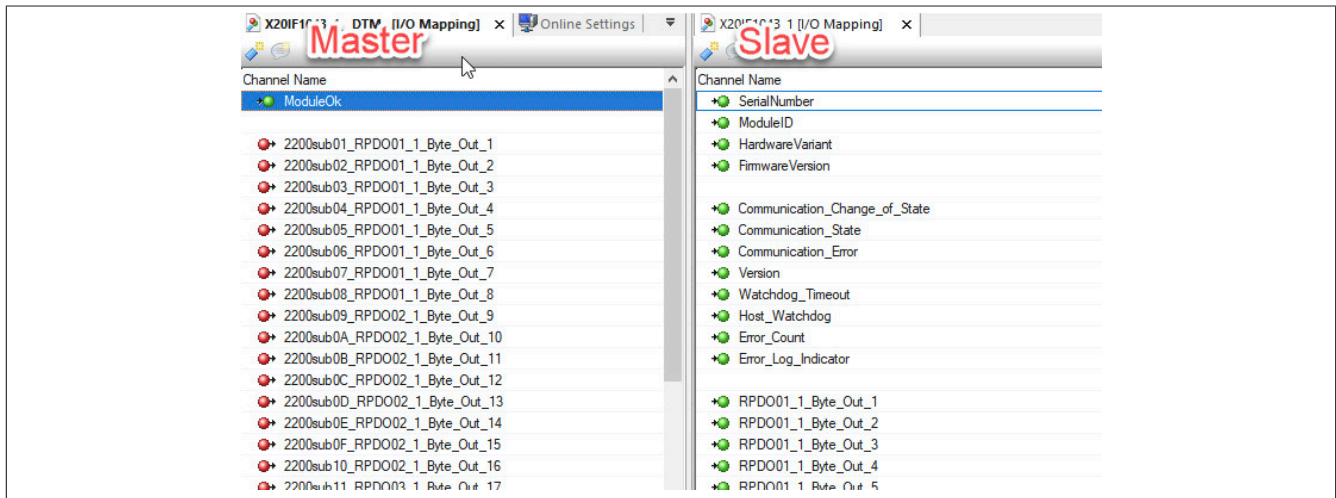
If the setting on the CANopen slave and the device description file attached to the master do not match, no connection is established.

Information:

The number of input and output bytes must be set identically on the master and slave. The direction of the data on the slave is applied in the direction opposite to the master since data exchange takes place in the opposite direction.

In the following example, this means:

- Device description file on the master: 40 bytes in the output direction and 20 bytes in the input direction.
- Slave: 40 bytes in the input direction and 20 bytes in the output direction.



9.23.6 X20IF1051-1

Data sheet version: 2.03

9.23.6.1 General information

The interface module is equipped with a DeviceNet scanner interface. This allows third-party components to be integrated in the B&R system and makes it possible to quickly and easily transfer data in both directions.

The interface module can be operated in X20 CPUs or in the expandable POWERLINK bus controller X20BC1083.

- DeviceNet scanner
- Integrated terminating resistor

9.23.6.2 Order data


| Model number | Short description | Figure |
|--------------|--|--|
| | X20 interface module communication |  |
| X20IF1051-1 | X20 interface module, for DTM configuration, 1 DeviceNet scanner (master) interface, electrically isolated, order 1x terminal block TB2105 separately! | |
| | Required accessories | |
| | Terminal blocks | |
| 0TB2105.9010 | Accessory terminal block, 5-pin, screw clamps 2.5 mm ² | |
| 0TB2105.9110 | Accessory terminal block, 5-pin, push-in terminal block 2.5 mm ² | |

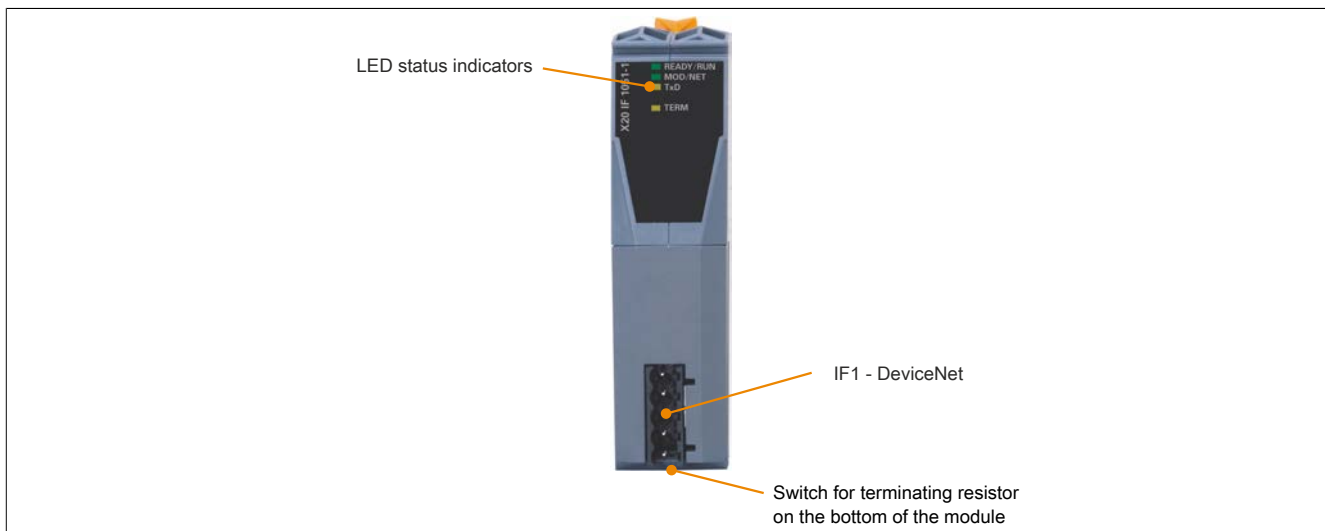
Table 429: X20IF1051-1 - Order data

9.23.6.3 Technical data

| | |
|--|--|
| Model number | X20IF1051-1 |
| Short description | |
| Communication module | DeviceNet scanner (master) |
| General information | |
| B&R ID code | 0xA70C |
| Status indicators | Module status, network status, data transfer, terminating resistor |
| Diagnostics | |
| Module status | Yes, using status LED and software |
| Network status | Yes, using status LED and software |
| Data transfer | Yes, using status LED |
| Terminating resistor | Yes, using status LED |
| Power consumption | 1.1 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| EAC | Yes |
| KC | Yes |
| Interfaces | |
| Interface IF1 | |
| Fieldbus | DeviceNet scanner (master) |
| Variant | 5-pin male multipoint connector |
| Max. distance | 500 m |
| Transfer rate | Max. 500 kbit/s |
| Terminating resistor | Integrated in module |
| Controller | netX100 |
| Memory | 8 MB SDRAM |
| Electrical properties | |
| Electrical isolation | PLC isolated from DeviceNet (IF1) |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block TB2105 separately |
| Slot | In the X20 CPU and expandable bus controller X20BC1083 |

Table 430: X20IF1051-1 - Technical data

9.23.6.4 Operating and connection elements



9.23.6.4.1 LED status indicators

| Figure | LED | Color | Status | Description |
|--------|-----------|-----------|------------------|---|
| | READY/RUN | Green/Red | Off | No power to module |
| | | Green | On | PCI bus communication in progress |
| | | Red | On | Communication on the PCI bus has not yet been started |
| | MOD/NET | Green/Red | Off | Module not supplied with power or not online |
| | | Green | Blinking | Module online but no I/O connection active |
| | | Green | On | Module online and I/O connection active ("operating") |
| | | Red | Blinking | The red LED blinks if at least one of the following errors has occurred: <ul style="list-style-type: none"> • Minor fault (recoverable fault) • Connection error • No DeviceNet supply voltage |
| | | On | | Critical fault or critical connection error (duplicate MAC ID, bus off or module defective) |
| | TxD | Yellow | Flickering or on | The module is transmitting data via the DeviceNet interface. |
| | TERM | Yellow | On | The terminating resistor integrated in the module is switched on. |

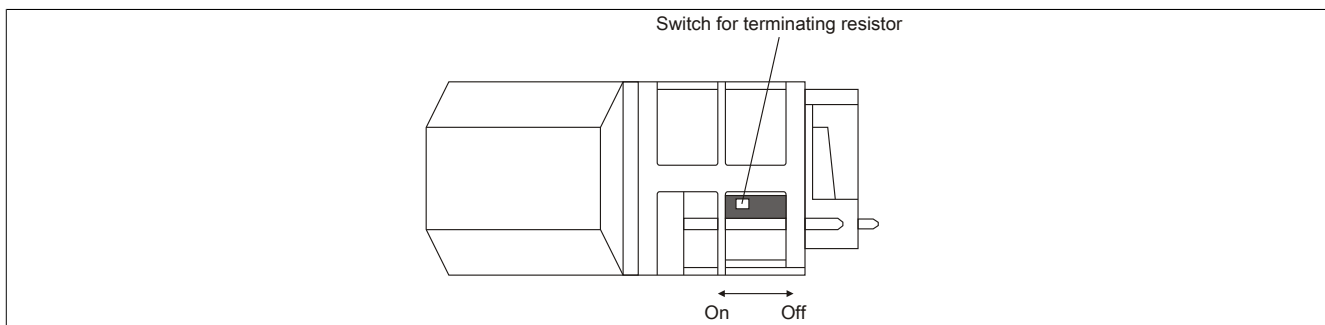
9.23.6.4.2 DeviceNet interface

The interface is a 5-pin multipoint connector. Terminal block 0TB2105 must be ordered separately.

| Interface | Pinout | | |
|--|----------|------------------------------|------------|
| <p>5-pin male multipoint connector</p> | Terminal | DeviceNet | |
| | 1 | CAN _⊥ (V-) | CAN ground |
| | 2 | CAN _L | CAN low |
| | 3 | SHLD | Shield |
| | 4 | CAN _H | CAN high |
| 5 | V+ | Supply voltage ¹⁾ | |

1) The 24 VDC in the DeviceNet network must be fed in externally in order to guarantee correct operation and data exchange. 24 VDC is not made available by the device.

9.23.6.4.3 Terminating resistor



A terminating resistor is integrated in the interface module. It can be switched on or off with a switch on the bottom of the housing. A switched-on terminating resistor is indicated by LED "TERM".

9.23.6.5 Use in the expandable X20BC1083 POWERLINK bus controller

9.23.6.5.1 Cyclic data

If this module is connected to the expandable POWERLINK bus controller, the amount of cyclic data is limited by the POWERLINK frame to 1488 bytes in each direction (input and output).

When using multiple X20IF10xx-1 interfaces or other X2X modules with a POWERLINK bus controller, the 1488 bytes are divided between all connected modules.

9.23.6.5.2 Operating netX modules

It is important to note the following in order to operate netX modules with the bus controller without problems:

- A minimum revision \geq E0 is required for the bus controller.
- netX modules can only be operated with the POWERLINK V2 setting. V1 is not permitted.
- With SDO access to POWERLINK object 0x1011/1 on the bus controller, the netX firmware and the configuration stored on the bus controller are not reset. They can only be overwritten by accessing them again. This affects objects 0x20C0 and 0x20C8, subindexes 92 to 95.

9.23.6.6 netX error codes

netX modules return an error code when an error occurs. These error codes are fieldbus-specific. A complete list of all error codes in PDF format is available in Automation Help in section "Communication / Fieldbus systems / Support with FDT/DTM / Diagnostic functions / Diagnostics on the runtime system / Master diagnostics" under item "Communication_Error".

9.23.6.7 Firmware

The module comes with preinstalled firmware. The firmware is part of the Automation Studio project. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.23.6.8 The DeviceNet interface

The interface module is equipped with a DeviceNet scanner interface. Up to 63 slaves can be operated on the master.

UCMM (Unconnected Message Manager) is supported.

Poll, change of state, cyclic, bit strobe and explicit peer-to-peer messaging are supported as connection types.

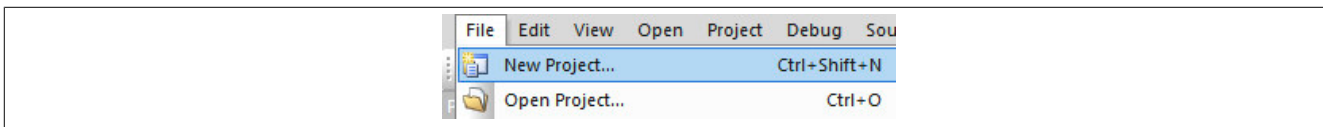
9.23.6.8.1 Settings in Automation Studio

The interface module can be operated in the slot of a CPU or in the slot of an expandable POWERLINK bus controller.

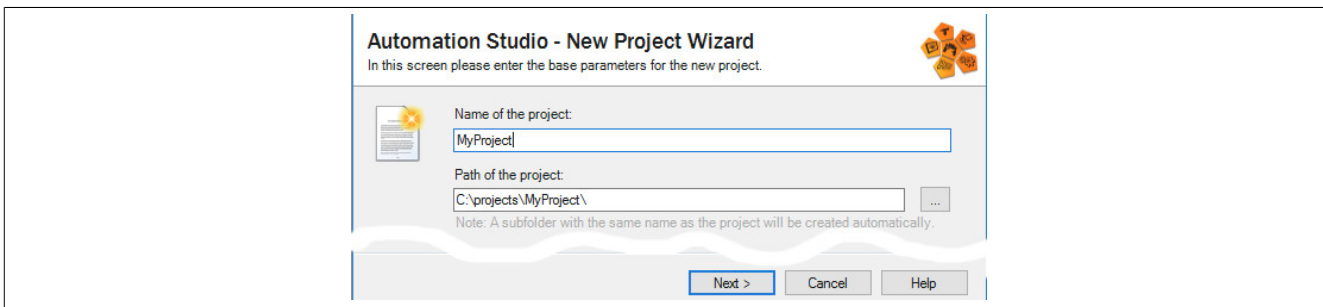
To do this, a new Automation Studio project is created and the suitable settings are made on the module.

9.23.6.8.1.1 Creating an Automation Studio project

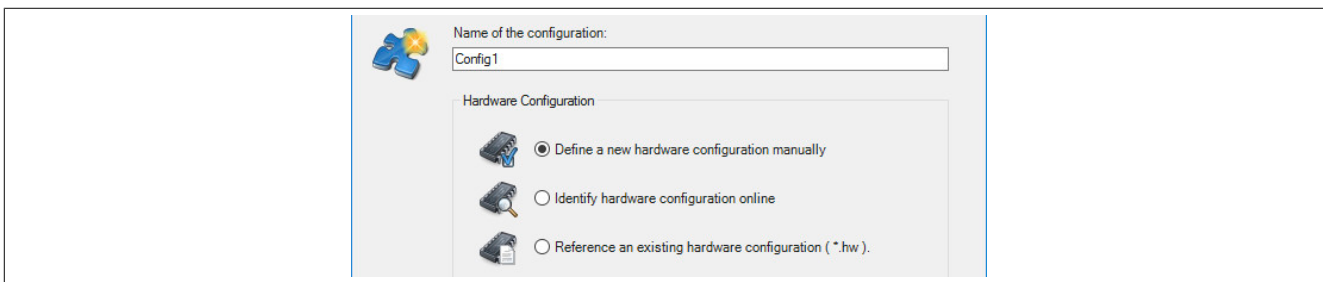
- Create a new Automation Studio project by selecting "New project".



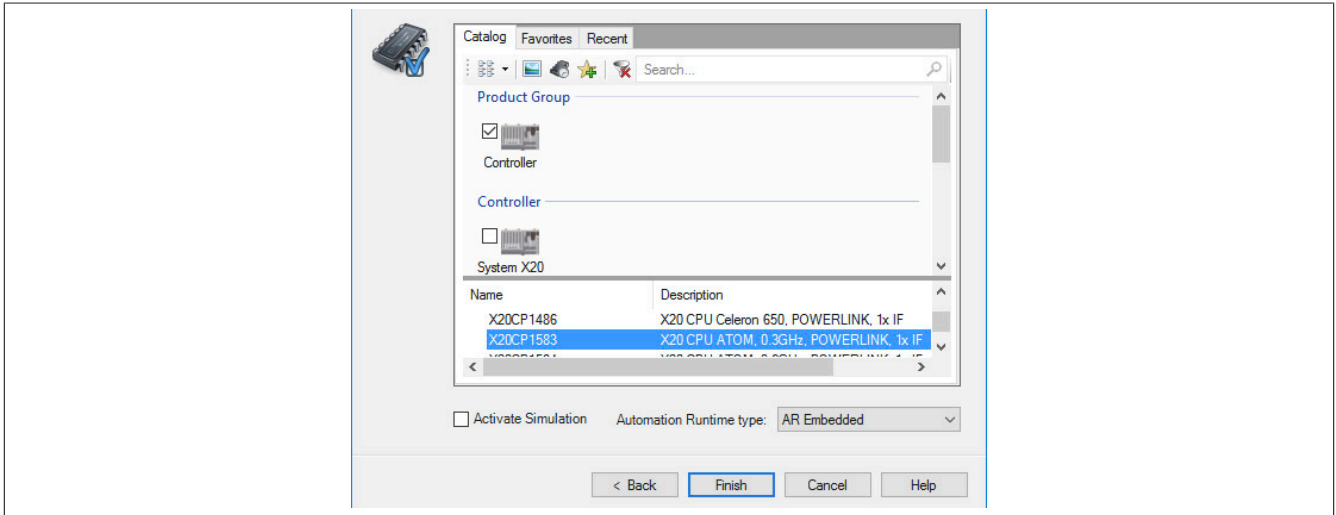
- Assign a project name and set up the project path.



- Assign the hardware configuration type and configuration name.

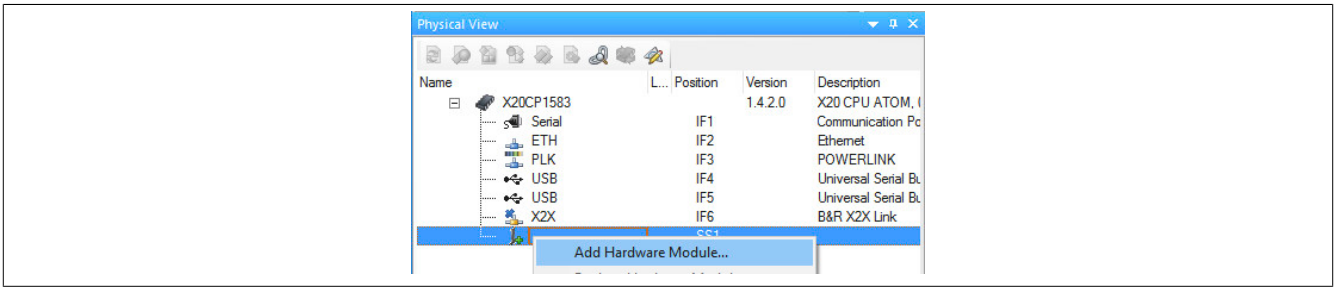


- Select the hardware in the next step if "Define a new hardware configuration manually" was selected. In order to simplify the search, different filters can be set in the Hardware Catalog. Lastly, highlight the required hardware and create the Automation Studio project by clicking on "Finish".

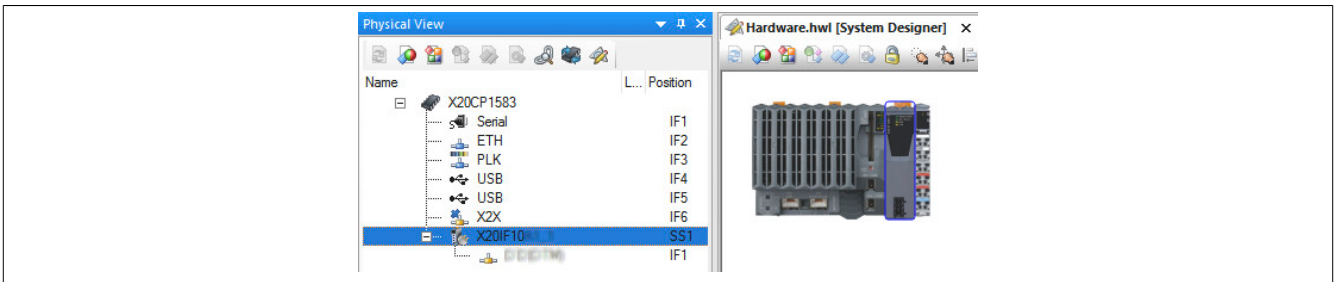


9.23.6.8.1.2 Adding and configuring the interface module

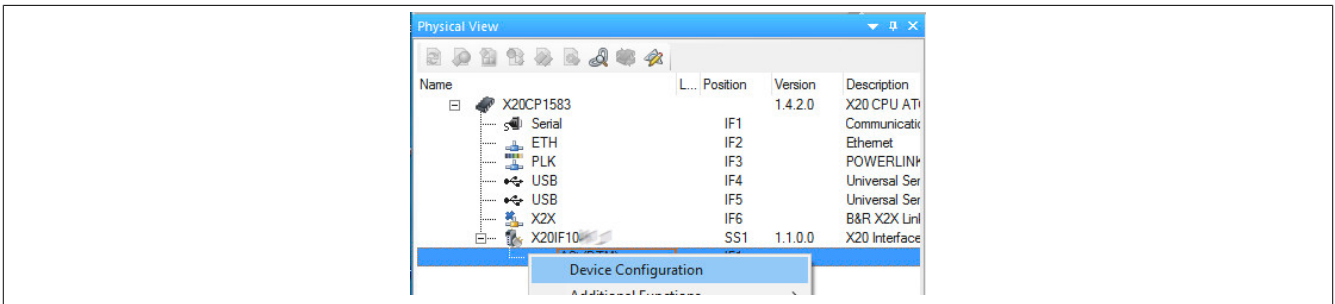
- In this example, the interface card is connected in the slot of a CPU. Right-clicking on the slot and selecting "Add hardware module" opens the Hardware Catalog.



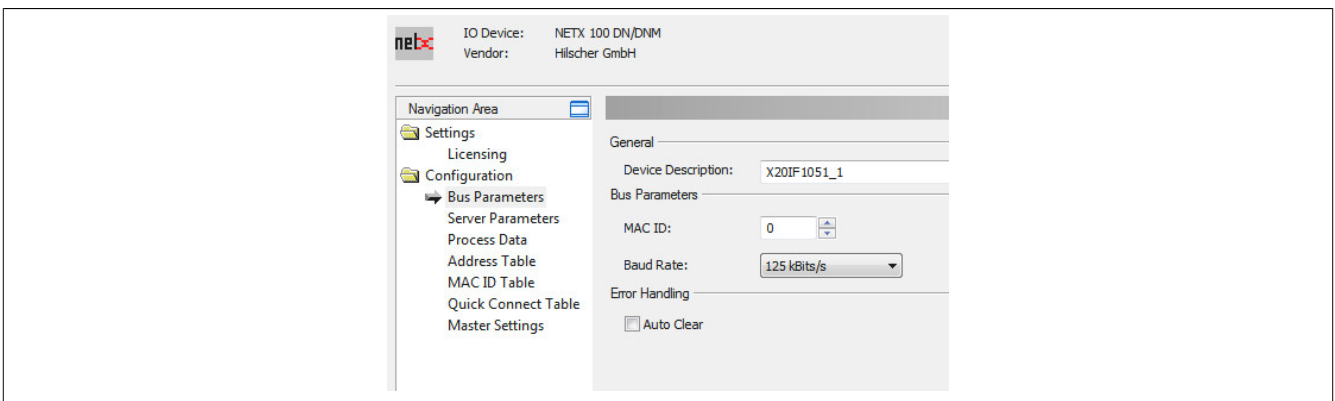
- The module is added to the project via drag-and-drop or by double-clicking on the interface card.



- Additional module settings can be made under "Device configuration". This configuration environment is opened by right-clicking on the IF interface and selecting "Device configuration".



- General settings are made in the device configuration.



Bus parameters

- General

The name of the device can be changed here. However, this is only used by the configuration dialog boxes and not by Automation Studio.

- Bus parameters

The MAC ID and baud rate can be set here.

- The MAC ID serves as the unique identification for a DeviceNet device in the network and is not permitted to be used twice. The range of values for available MAC IDs is between 0 and 63.
- The baud rate can be set between 125 and 500 kbit/s.

- Error handling

"Auto clear" ON is used for error handling.

| Parameter | Explanation |
|-----------|--|
| Enabled | The master changes to mode "Clear" first in the event of a communication error and then to mode "Stop". Communication to all slaves is stopped. The only way to exit mode "Stop" is by resetting the system. |
| Disabled | The master remains in mode "Operate" in the event of a communication error. The master is still connected to the other slaves and attempts to reestablish communication with the defective or missing slave. |

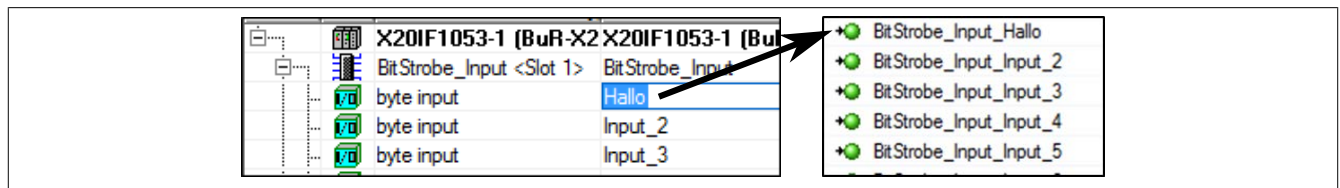
Server parameters

This parameter is not supported.

Process data

This table lists the process data of the individual slaves.

| Parameter | Explanation |
|-----------|---|
| Type | Device designation specified by the hardware. Further description of modules configured on the device or the input or output signals. |
| Tag | The name of the input and output data can be changed in column "Tag". |
| SCADA | This parameter is not supported. |



Address table

This table provides information about the addresses of the input and output data. If auto-addressing is disabled, addresses can be entered manually.

| Parameter | Explanation |
|-----------------|--|
| MAC ID | Network address of the device |
| Device | Device name of the slave |
| Name | Description of slave |
| Connection mode | Mode for the input and output data |
| Length | Length of the input and output data |
| Address | Address offset for the input and output data |

The input and output address table can also be exported as a CSV file.

Information:

Using the same address twice is not permitted. Addresses used twice are marked with a red exclamation point and an additional error message is displayed.

MAC ID table

All slaves are listed here. "Activate" is used to activate or deactivate the slaves.

| Parameter | Explanation |
|-----------|--|
| Activate | <ul style="list-style-type: none"> Enabled slaves: Process memory is reserved and data is exchanged. It is also possible to assign the slave a different MAC ID. Deactivated slaves: The master reserves memory in the process data image for the slave, but no data is exchanged. |
| MAC ID | Editable network address of the device. The new MAC ID must be unique; otherwise, an error message will appear. |
| Device | Device name of the slave |
| Name | Description of slave |
| Vendor | Slave manufacturer |

Quick connect table

This function allows for a quick startup of a device after it is replaced.

| Parameter | Explanation | Values |
|---------------|---|---------|
| Quick connect | Function "Quick connect" must be enabled separately for each slave. The following system requirements must be met in order to optimally use "Quick connect": <ul style="list-style-type: none"> The master must support "Quick connect". Additionally, the slave must support "UCMM" or "Predefined master/slave connection." | |
| MAC ID | Network address of the device. | 0 to 63 |
| Device | Device name of the slave and the EDS file | |
| Name | Name of the slave and the EDS file | |

Depending on the type of quick connect support, the following times may apply:

| Quick connect support | | Time to connect |
|-----------------------|-------|------------------|
| Master | Slave | |
| Yes | Yes | Under 200 ms |
| Yes | No | Approx. 2 s |
| No | Yes | Approx. 2 to 3 s |
| No | No | Approx. 2 to 5 s |

Master settings

- Start of bus communication

It is possible to select how data exchange is started on the module.

| Parameter | Explanation |
|---------------------------|--|
| Automatically by device | Data exchange is started automatically after initializing this module. |
| Controlled by application | Data exchange is started by Automation Runtime. |

- Module alignment

The addressing mode is defined by the process image here. The addresses (offsets) of the process data are always interpreted as byte addresses.

| Addressing mode | Explanation |
|-------------------|---|
| Byte boundaries | The module address can start on any offset. |
| 2 byte boundaries | The module address can only start on even byte offsets. |

Information:

This configuration is automatically managed by Automation Runtime and is not permitted to be changed (default setting).

- Application monitoring

The module-internal watchdog time can be set here. If the watchdog has been enabled (watchdog time not equal to 0), the hardware watchdog must be reset after the set time at the latest.

| Parameter | Explanation | Values |
|---------------|-----------------------------|----------------|
| Watchdog time | Watchdog software disabled | 0 ms |
| | Permissible range of values | 20 to 65535 ms |
| | Default value: 1000 ms | |

Information:

The watchdog time is reset automatically by Automation Runtime.

- Process data handshake

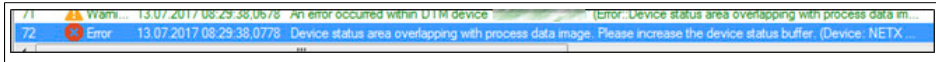
This parameter configures the handshake for the data exchange between application and device. Only "Buffered, host-controlled" is supported here.

- Advanced

This parameter is not supported.

- Device status offset

Here, the status offset can be set to be calculated automatically or using a predefined value.

| Status offset | Explanation |
|-----------------------|---|
| Automatic calculation | The device status always directly follows the input bytes. If input data is added in the configuration, the start address of the device status is moved back in the dual-ported memory. |
| Static | <p>Here, the distance (free buffer) between the last input byte and the start of the device status can be set. This way, the start address of the device status never changes in the dual-ported memory. If additional input data is added, the distance (free buffer) is reduced. If the free buffer does not have enough space available for the data added to it, the start address of the device status in the dual-ported memory must be shifted.</p> <p>If the offset is too small, an error is output. To correct the error, the free buffer must be increased to a sufficient size.</p>  |

Information:

This configuration is automatically managed by Automation Runtime and is not permitted to be changed (default setting).

9.23.6.8.1.3 I/O mapping

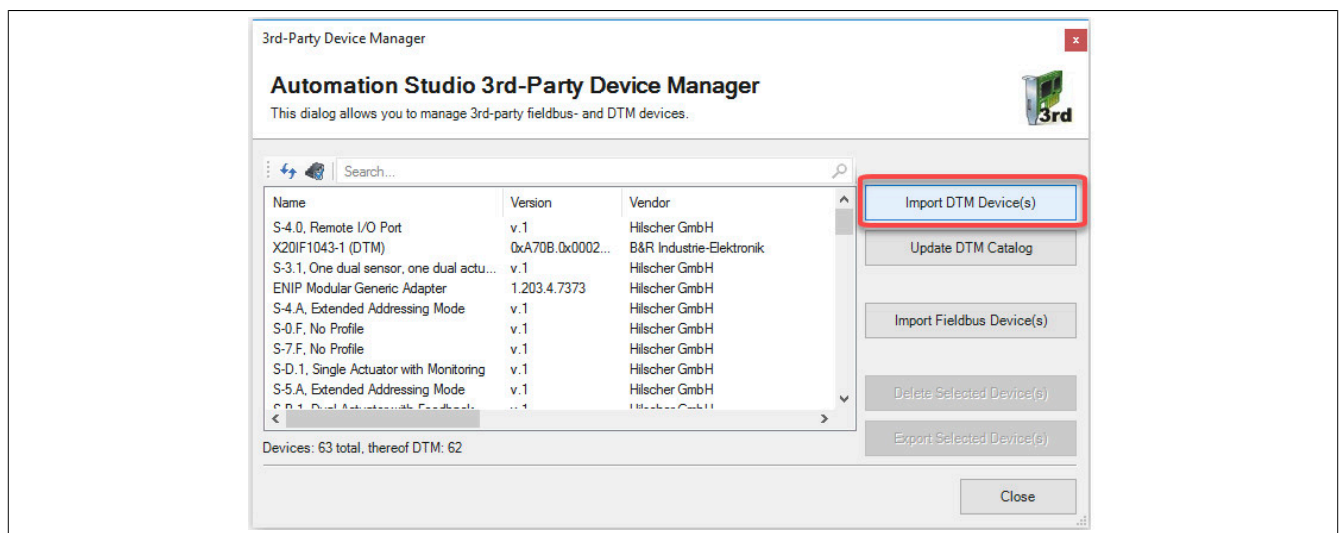
The I/O mapping resulting from the module configuration is opened by double-clicking on the DeviceNet master. General information such as the serial number and module ID are listed in the mapping along with DeviceNet-specific data points.

9.23.6.8.1.4 Adding the EDS file in Automation Studio

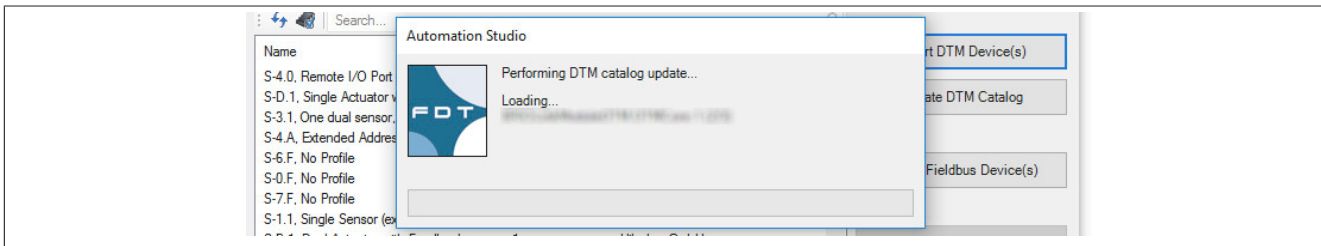
A device description file (EDS file) is required to inform the DeviceNet master which slaves were connected and how they were configured.

To add and use a device description file in Automation Studio, perform the following steps:

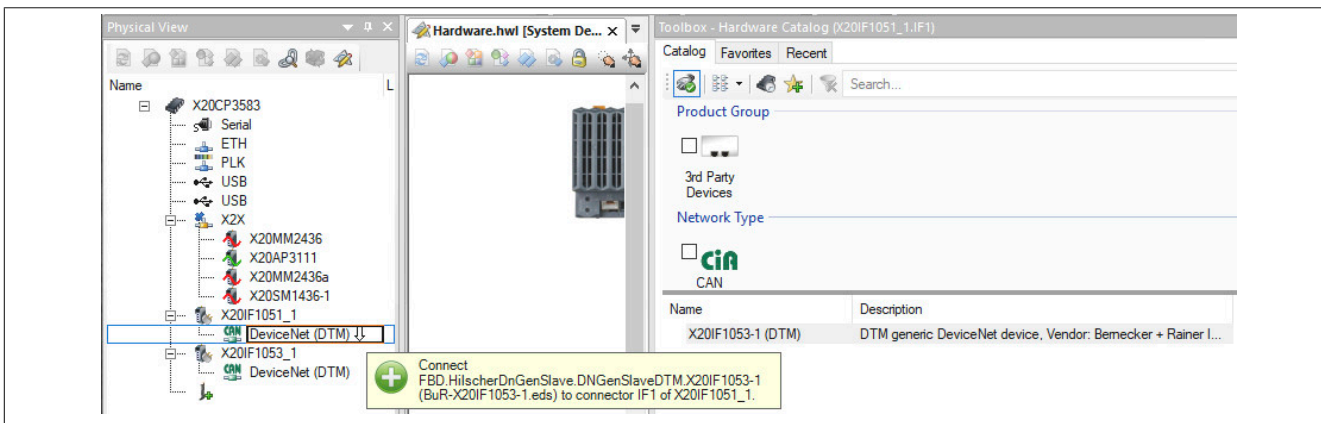
- If the DeviceNet slave from B&R is used, download the EDS file from the B&R website (www.br-automation.com) and unzip the ZIP file.
- Open the dialog box in Automation Studio under "Tools - Manage 3rd-party devices" and select "Import DTM device(s)".



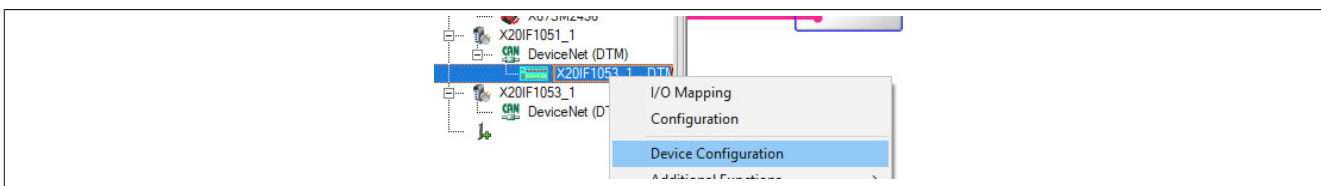
- Select the EDS file to be imported and confirm with OK. The EDS file is imported into Automation Studio.



- Click "DeviceNet(DTM)" on the DeviceNet master X20IF1051-1, drag the EDS file from the Hardware Catalog and attach it to the DeviceNet master.



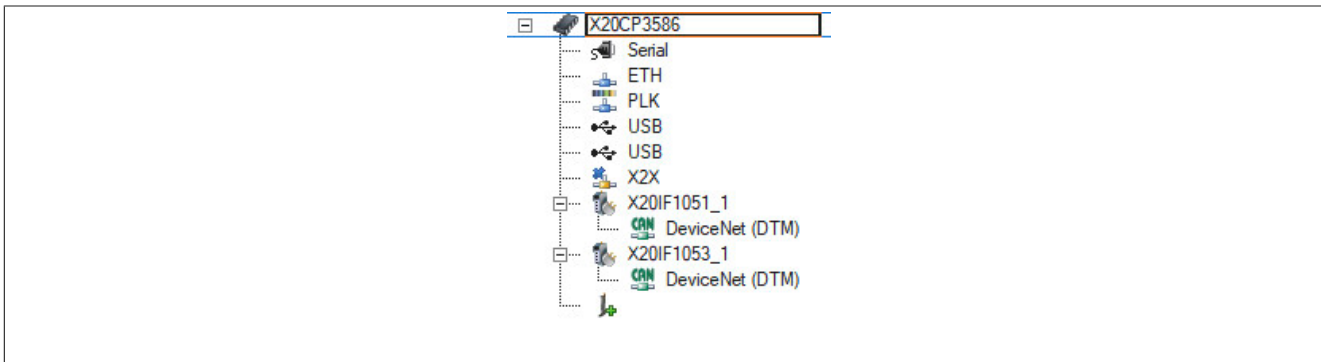
- Right-click on the device description file and select "Device configuration" to open the configuration environment for the EDS file.



9.23.6.8.2 Configuration example

In this example, a connection between a DeviceNet master and slave is established. Module X20IF1051-1 is used as the DeviceNet master; module X20IF1053-1 is used as the DeviceNet slave.

For this example, the DeviceNet master interface card is operated in the first slot of an X20CP3586 and the DeviceNet slave interface card in the second slot.



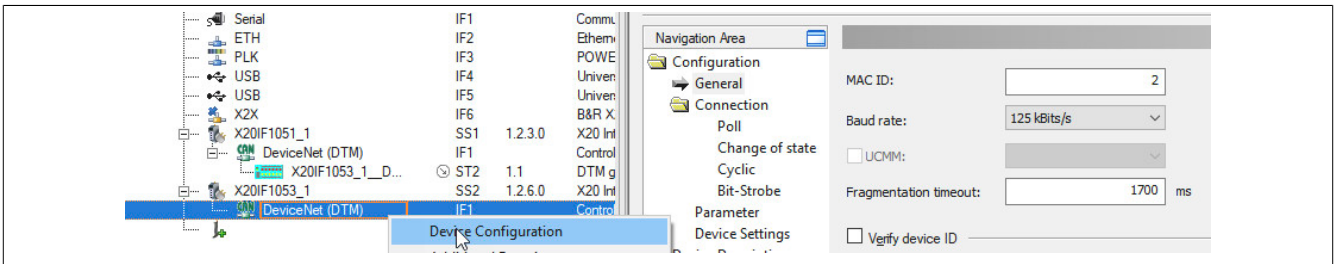
- To establish a connection between master and slave, the master must know the configuration data of the slave. To do this, the device description file of the X20IF1053-1 slave is imported into Automation Studio and attached to the master.

For details, see "Adding the EDS file in Automation Studio" on page 2311.

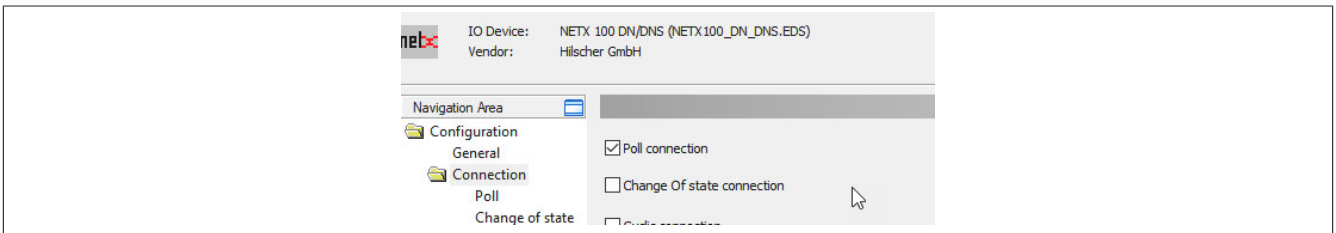
The settings on the DeviceNet slave and on the master (device description file) must match; otherwise, no connection is established.

Settings on the slave

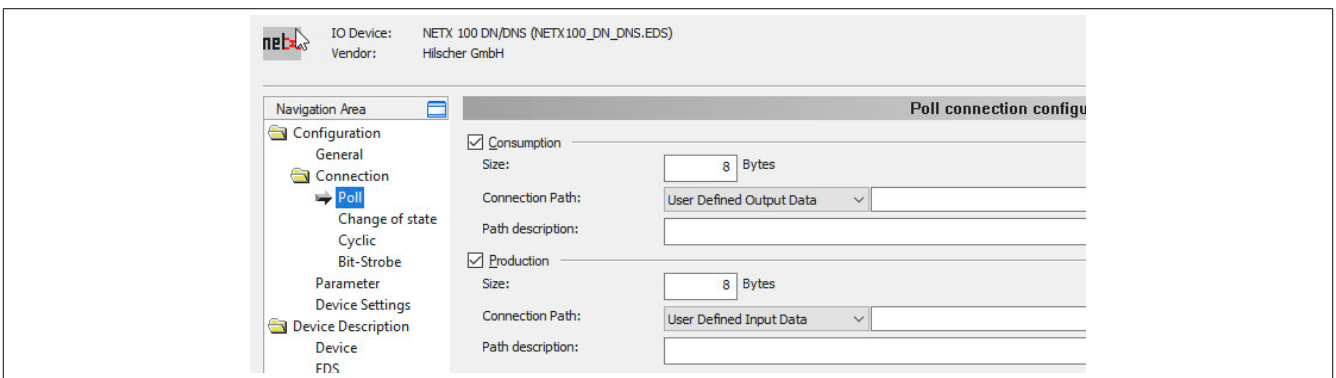
- In this example, the MAC ID "2" and a baud rate of 125 kbit/s were defined for the slave. These are set in "Device configuration" under "General" on the slave.



- Next, the connection type and I/O mapping are each defined with 8 bytes of input and output data. "Poll connection" is enabled in the "Connection" configuration.

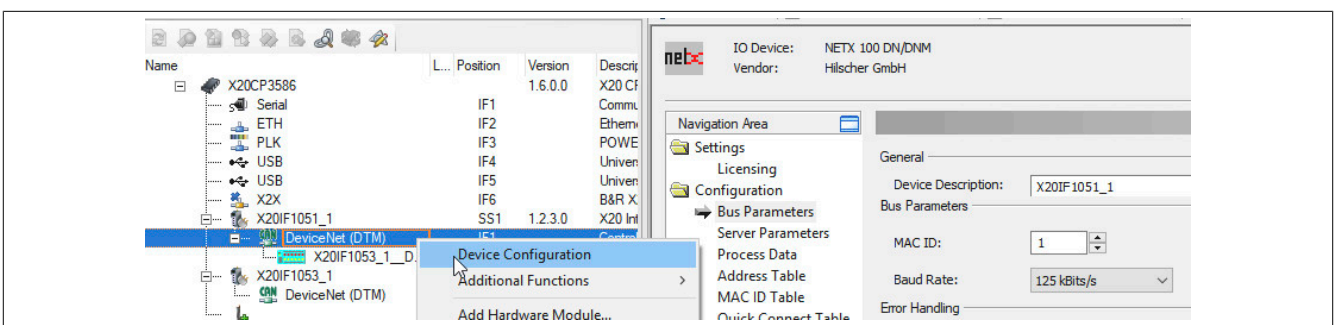


- Under "Poll connection configuration", 8 bytes each are entered for the input and output directions.

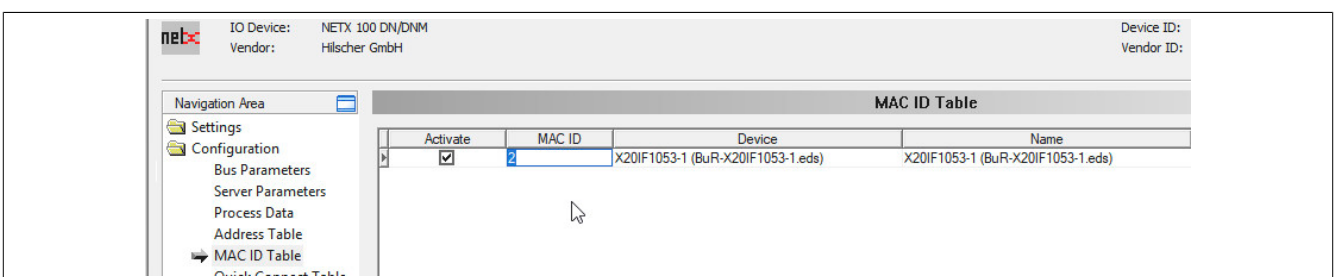


Settings on the master

- On the master, the MAC ID and the same baud rate as on the slave must be set. These are set in "Device configuration" under "Bus parameters".

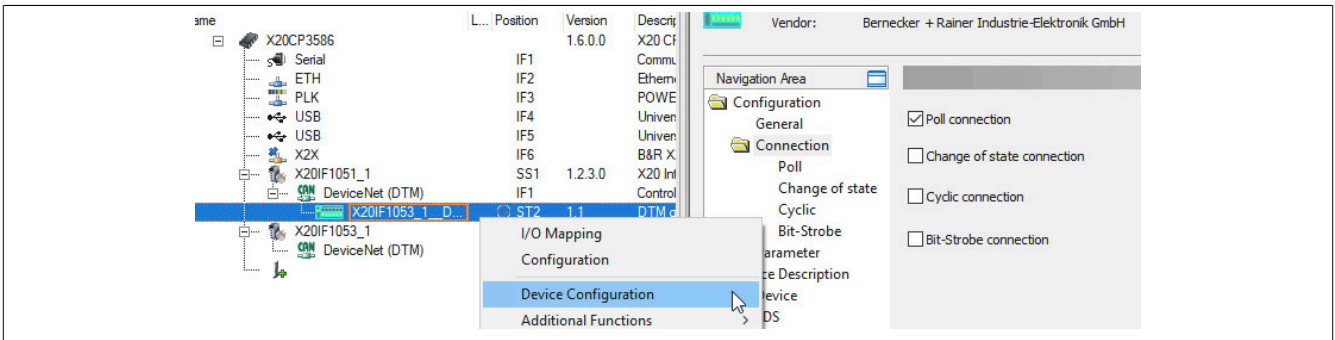


- Then the MAC ID of the slave is set under "MAC ID table".



Settings in the device description file

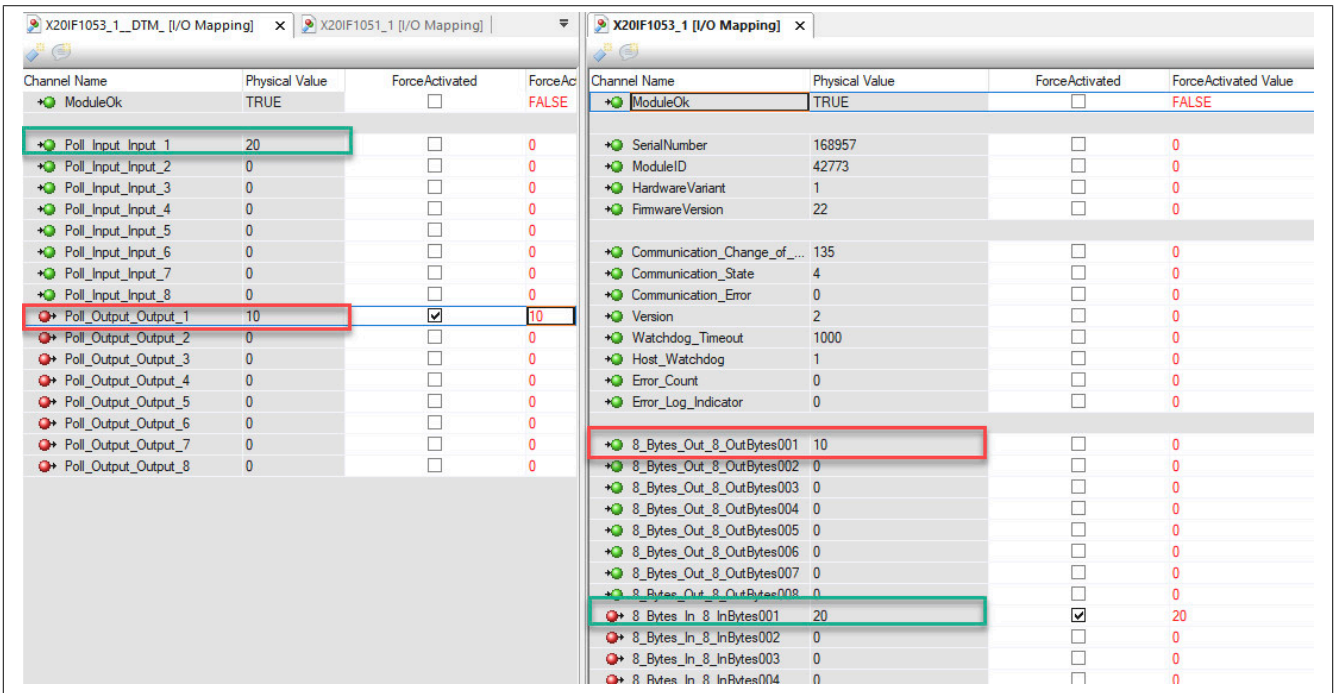
- The I/O mapping is set in the device description file under "Device configuration". The same settings are made here as on the DeviceNet slave.



By default, 8 bytes of input and output data are defined. If a different number of bytes should be set, the "Connection path" must be changed to "User defined consumption data".

- Confirm and save all settings with OK. The configuration is transferred to the CPU and, if correct, a connection between master and slave is automatically established.

The connection status can be checked with the ModulOK bit in the device description file. When ModulOK = True, data can be exchanged between master and slave.



9.23.7 X20IF1053-1

Data sheet version: 2.03

9.23.7.1 General information

The interface module is equipped with a DeviceNet interface. This allows the B&R system (I/O modules, POWERLINK, etc.) to be connected to systems from other manufacturers and makes it possible to quickly and easily transfer data in both directions.

The interface module can be operated in X20 CPUs or in the expandable POWERLINK bus controller X20BC1083.

- DeviceNet slave (adapter)
- Integrated terminating resistor

9.23.7.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | X20 interface module communication |  |
| X20IF1053-1 | X20 interface module, for DTM configuration, 1 DeviceNet adapter (slave) interface, electrically isolated, order 1x terminal block TB2105 separately! | |
| | Required accessories | |
| | Terminal blocks | |
| 0TB2105.9010 | Accessory terminal block, 5-pin, screw clamps 2.5 mm ² | |
| 0TB2105.9110 | Accessory terminal block, 5-pin, push-in terminal block 2.5 mm ² | |

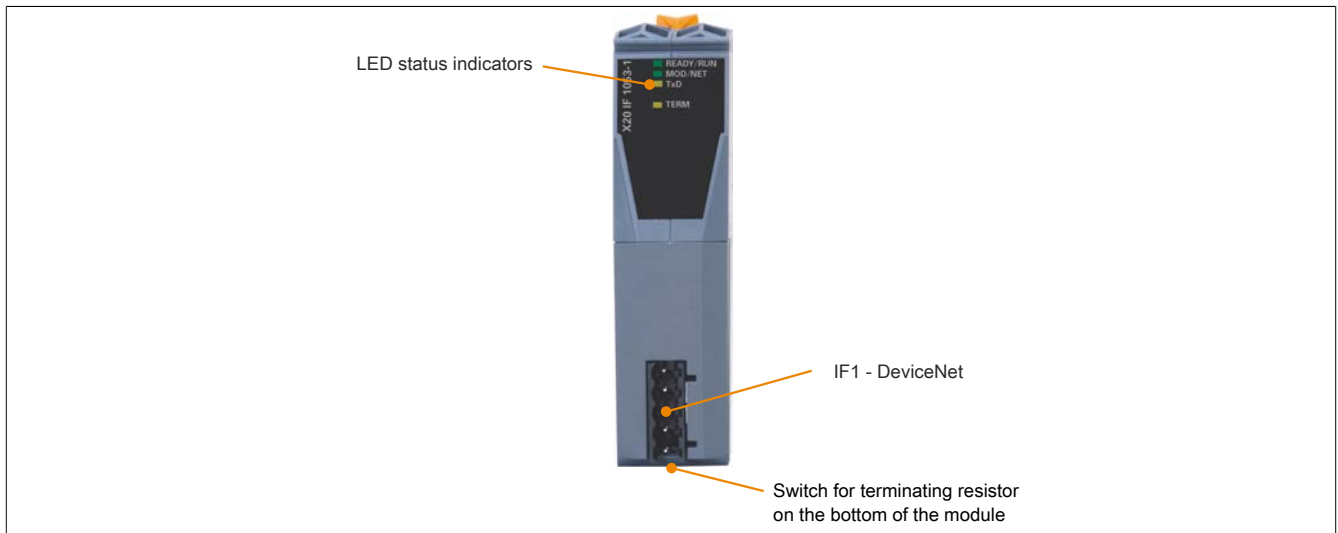
Table 431: X20IF1053-1 - Order data

9.23.7.3 Technical data

| | |
|--|--|
| Model number | X20IF1053-1 |
| Short description | |
| Communication module | DeviceNet adapter (slave) |
| General information | |
| B&R ID code | 0xA715 |
| Status indicators | Module status, network status, data transfer, terminating resistor |
| Diagnostics | |
| Module status | Yes, using status LED and software |
| Network status | Yes, using status LED and software |
| Data transfer | Yes, using status LED |
| Terminating resistor | Yes, using status LED |
| Power consumption | 1.1 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| EAC | Yes |
| KC | Yes |
| Interfaces | |
| Interface IF1 | |
| Fieldbus | DeviceNet adapter (slave) |
| Variant | 5-pin male multipoint connector |
| Max. distance | 500 m |
| Transfer rate | Max. 500 kbit/s |
| Terminating resistor | Integrated in module |
| Controller | netX100 |
| Electrical properties | |
| Electrical isolation | PLC isolated from DeviceNet (IF1) |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block TB2105 separately |
| Slot | In the X20 CPU and expandable bus controller X20BC1083 |

Table 432: X20IF1053-1 - Technical data

9.23.7.4 Operating and connection elements



9.23.7.4.1 LED status indicators

| Figure | LED | Color | Status | Description |
|--------|-----------|-----------|---|---|
| | READY/RUN | Green/Red | Off | No power to module |
| | | Green | On | PCI bus communication in progress |
| | | Red | On | Communication on the PCI bus has not yet been started |
| | MOD/NET | Green/Red | Off | Module not supplied with power or not online |
| | | Green | Blinking | Module online but no I/O connection active |
| | | | On | Module online and I/O connection active ("operating") |
| | | Red | Blinking | The red LED blinks if at least one of the following errors has occurred: <ul style="list-style-type: none"> • Minor fault (recoverable fault) • Connection error • No DeviceNet supply voltage |
| | | On | Critical fault or critical connection error (duplicate MAC ID, bus off or module defective) | |
| | TxD | Yellow | Flickering or on | The module is transmitting data via the DeviceNet interface. |
| | TERM | Yellow | On | The terminating resistor integrated in the module is switched on. |

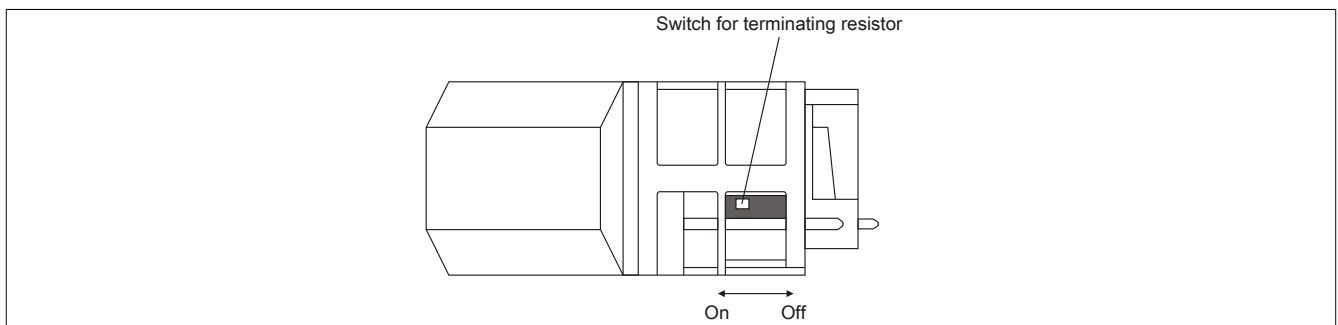
9.23.7.4.2 DeviceNet interface

The interface is a 5-pin multipoint connector. Terminal block 0TB2105 must be ordered separately.

| Interface | Pinout | | |
|--|----------|-----------------------|------------------------------|
| <p>5-pin male multipoint connector</p> | Terminal | DeviceNet | |
| | 1 | CAN _L (V-) | CAN ground |
| | 2 | CAN _L | CAN low |
| | 3 | SHLD | Shield |
| | 4 | CAN _H | CAN high |
| | 5 | V+ | Supply voltage ¹⁾ |

1) The 24 VDC in the DeviceNet network must be fed in externally in order to guarantee correct operation and data exchange. 24 VDC is not made available by the device.

9.23.7.4.3 Terminating resistor



A terminating resistor is integrated in the interface module. It can be switched on or off with a switch on the bottom of the housing. A switched-on terminating resistor is indicated by LED "TERM".

9.23.7.5 Use in the expandable X20BC1083 POWERLINK bus controller

9.23.7.5.1 Cyclic data

If this module is connected to the expandable POWERLINK bus controller, the amount of cyclic data is limited by the POWERLINK frame to 1488 bytes in each direction (input and output).

When using multiple X20IF10xx-1 interfaces or other X2X modules with a POWERLINK bus controller, the 1488 bytes are divided between all connected modules.

9.23.7.5.2 Operating netX modules

It is important to note the following in order to operate netX modules with the bus controller without problems:

- A minimum revision $\geq E0$ is required for the bus controller.
- netX modules can only be operated with the POWERLINK V2 setting. V1 is not permitted.
- With SDO access to POWERLINK object 0x1011/1 on the bus controller, the netX firmware and the configuration stored on the bus controller are not reset. They can only be overwritten by accessing them again. This affects objects 0x20C0 and 0x20C8, subindexes 92 to 95.

9.23.7.6 netX error codes

netX modules return an error code when an error occurs. These error codes are fieldbus-specific. A complete list of all error codes in PDF format is available in Automation Help in section "Communication / Fieldbus systems / Support with FDT/DTM / Diagnostic functions / Diagnostics on the runtime system / Master diagnostics" under item "Communication_Error".

9.23.7.7 Firmware

The module comes with preinstalled firmware. The firmware is part of the Automation Studio project. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.23.7.8 The DeviceNet interface

The interface module is equipped with a DeviceNet slave (adapter) interface. Explicit messaging is supported. Poll, change of state, cyclic and bit-strobe are supported as connection types.

Information:

Neither UCMM nor quick connect are supported.

Information:

The settings on the slave must match the settings of the corresponding device description file; otherwise, no connection can be established.

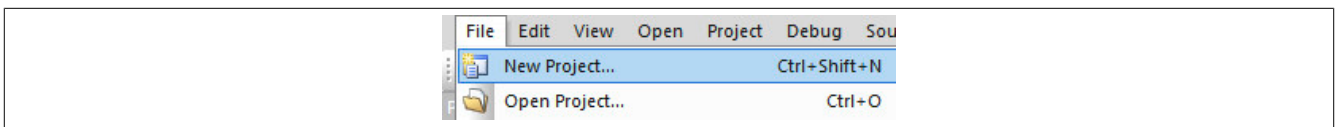
9.23.7.8.1 Settings in Automation Studio

The interface module can be operated in the slot of a CPU or in the slot of an expandable POWERLINK bus controller.

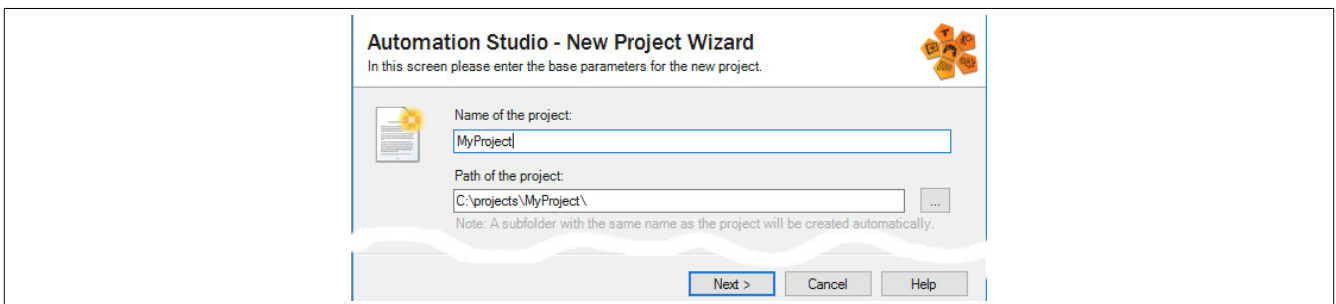
To do this, a new Automation Studio project is created and the suitable settings are made on the module.

9.23.7.8.1.1 Creating an Automation Studio project

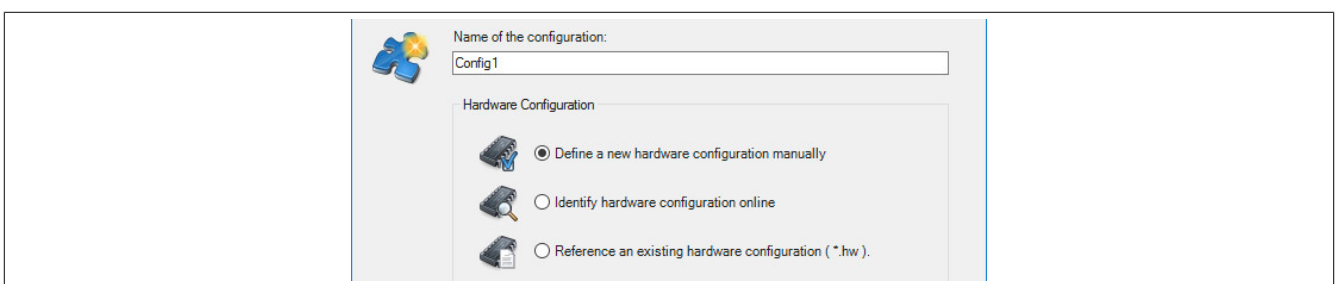
- Create a new Automation Studio project by selecting "New project".



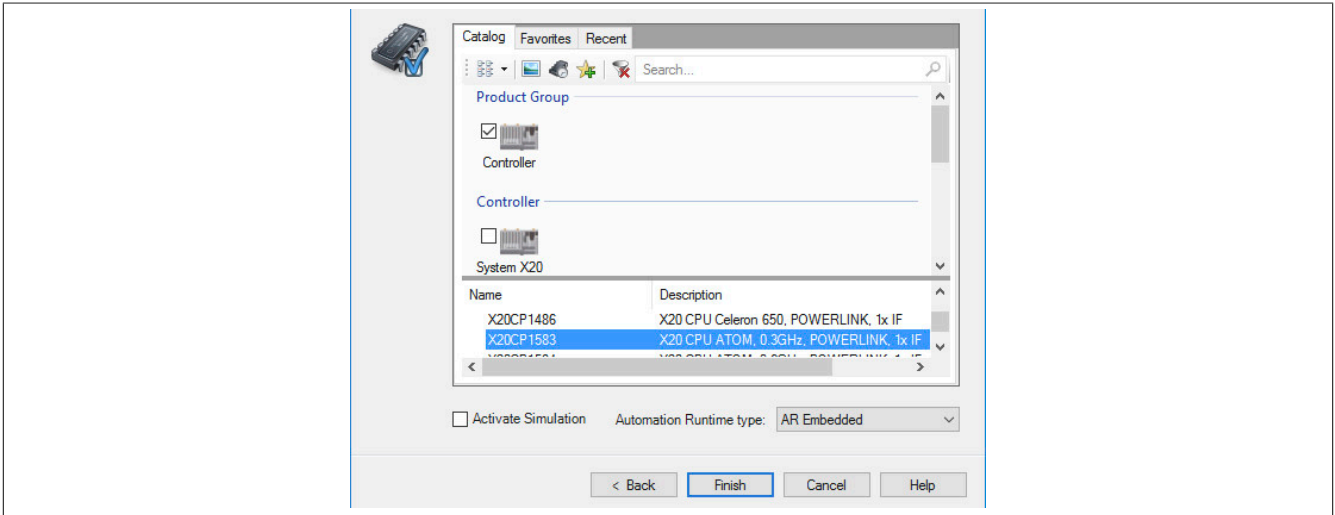
- Assign a project name and set up the project path.



- Assign the hardware configuration type and configuration name.

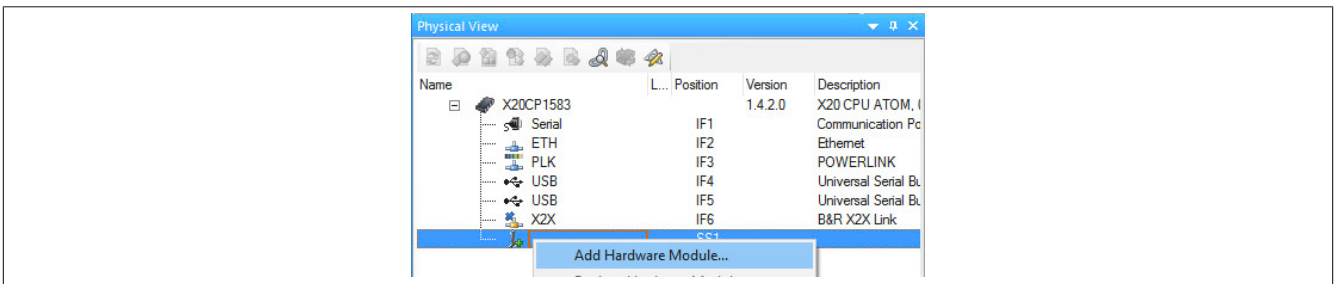


- Select the hardware in the next step if "Define a new hardware configuration manually" was selected. In order to simplify the search, different filters can be set in the Hardware Catalog. Lastly, highlight the required hardware and create the Automation Studio project by clicking on "Finish".

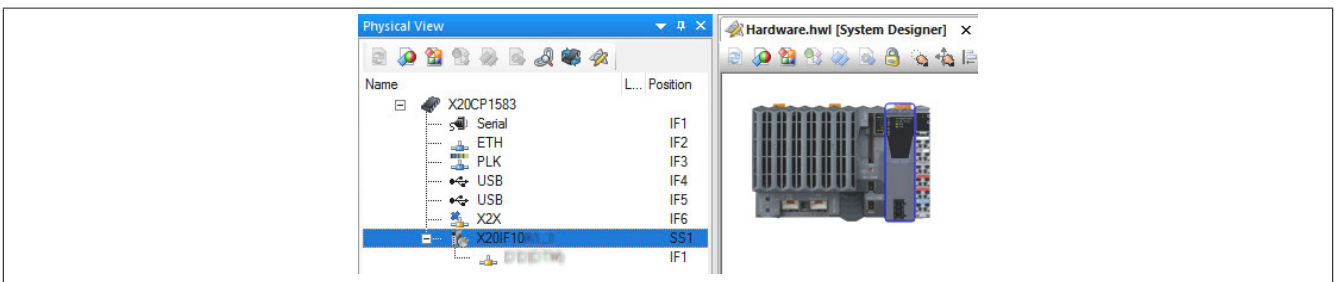


9.23.7.8.1.2 Adding and configuring the interface module

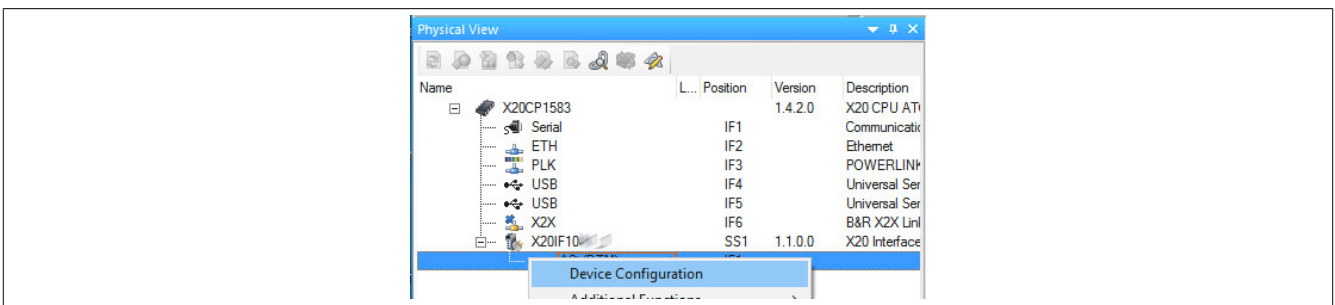
- In this example, the interface card is connected in the slot of a CPU. Right-clicking on the slot and selecting "Add hardware module" opens the Hardware Catalog.



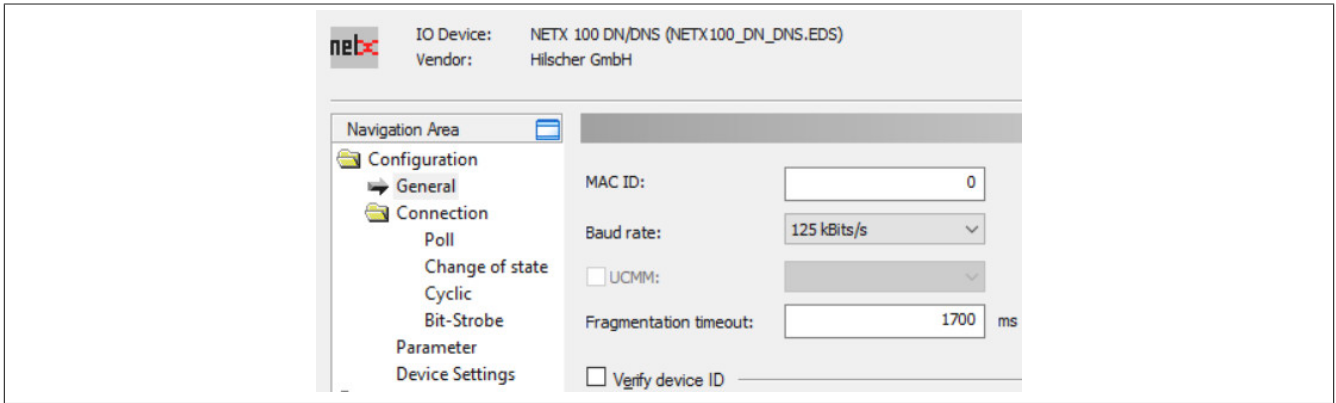
- The module is added to the project via drag-and-drop or by double-clicking on the interface card.



- Additional module settings can be made under "Device configuration". This configuration environment is opened by right-clicking on the IF interface and selecting "Device configuration".



- General settings are made in the device configuration.



Information:

The settings of the slave must match the settings of the corresponding EDS device description file; otherwise, no connection can be established.

General

General settings are configured here.

- MAC ID

This serves as the unique identification for a DeviceNet device in the network and is not permitted to be used twice. The range of values for available MAC IDs is between 0 and 63.

Information:

MAC ID addresses must be the same for both the master (device description file) and slave.

- Baud rate

This rate can be set between 125 and 500 kbit/s.

- Fragmentation timeout

This parameter defines how long the master waits until a slave answers a fragmented telegram.

- UCMM

This parameter is not supported.

- Verify device ID

This enables a comparison of the device description file with the existing hardware. The comparison only applies to the attributes selected in this area.

- Enable address switch

This parameter is not supported.

Connection

The connection type between master and slave can be selected here. The corresponding tab for additional configuration options can be activated by enabling a connection type.

All possible combinations are listed under "Valid combinations". If a combination is invalid, a corresponding error message will be sent.

Configure connection type

There is a tab marked with the respective name of the connection type (e.g. "Poll") that can be opened for additional settings. When selecting multiple connection types, Automation Studio generates a combination of the selected connection types. The inputs and outputs of ALL connection types are then combined in a single process image.

Information:

When combining connections, the number of inputs and outputs must be identical for all individual connection types.

A different number of inputs or outputs for the connection types results in an error message on the slave.

Example

| Connection | Inputs/Outputs | Resulting process image | Inputs/Outputs | Resulting process image |
|--------------------|-------------------------|-------------------------|-------------------------|------------------------------|
| Change of state: | 10 inputs and 8 outputs | 10 inputs and 8 outputs | 10 inputs and 8 outputs | Results in an error message. |
| Cyclic connection: | 10 inputs and 8 outputs | | 10 inputs and 7 outputs | |

Connecting the slave with the master

The used inputs and outputs must be defined on the slave as well as in the device description file for this. If multiple connection types are selected on the slave, the inputs and outputs of all used connection types are listed as one single process image (see above). In the device description file on the master, however, the inputs and outputs are listed separately in the I/O mapping for each connection type.

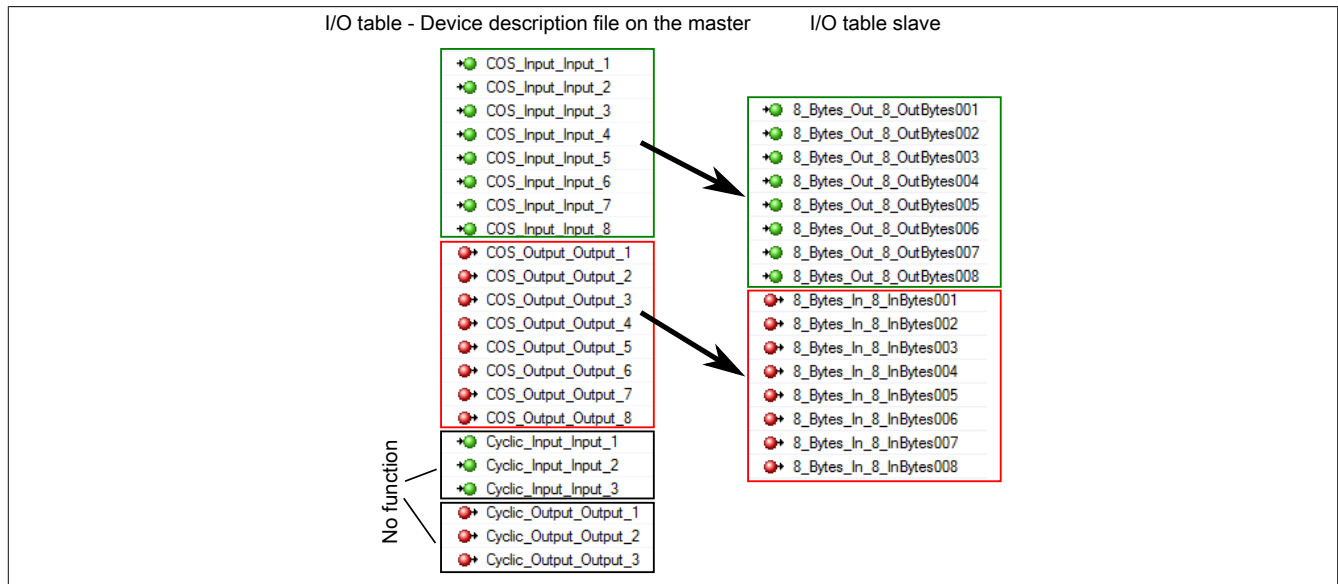
To ensure that the connection works properly, the following points must be observed:

- The number of defined inputs and outputs should be identical in the device description file and on the slave due to the fact that only the inputs and outputs defined on the slave are evaluated.
 - If there are more inputs or outputs in the device description file, these are ignored.
 - If there are less inputs or outputs in the device description file, the inputs or outputs on the slave remain without a function.
- Connection type "Bit strobe" only works via function block **AsNxDnM - AcyclicBitStrobing**. "Bit strobe" must also be enabled on the slaves.

Example

The change of state and cyclic connections are each set on the slave with 8 inputs and 8 outputs. In the device description file on the master, the change of state connection is specified with 8 inputs and 8 outputs. The cyclic is specified with 3 inputs and 3 outputs.

The image shows the generated and evaluated data points:



Information:

The number of connection types used is only determined by the slave. Therefore, only the inputs and outputs of one connection type should be defined in the device description file.

The following settings can be assigned for each connection type.

- Length of the input and output data

The maximum length is 255 bytes; for bit strobes, it is 8 bytes.

- Timing

| Parameter | Explanation |
|-------------------------|---|
| Production inhibit time | This parameter sets the time (in ms) within which identical telegrams are not permitted to be sent. This can be used to avoid sending identical telegrams too frequently and to reduce the bus load. A new telegram is only permitted to be sent after the delay time has expired. Examples Value 0: Telegrams can be sent without delay. Value 1000 in polling connection mode: A poll request telegram is sent every second (1000 ms). This parameter is not available for every connection type. |
| Expected packet rate | This parameter is always transmitted before an I/O transfer. If there is no response from the remote station within 4 times the time of the transmitted value, a timeout error occurs for the connection. |
| Watchdog timeout action | This parameter defines the behavior of the slave if the watchdog ("Expected packet rate") in the module has expired. <ul style="list-style-type: none"> Timeout: The connection goes into a timeout state and remains in this state until the connection is reset or deleted. Auto reset: The connection remains established and immediately resets the watchdog. Auto delete: The connection is deleted when a timeout occurs. |

Parameter

This parameter is not supported.

Device settings

- Start of bus communication

It is possible to select how data exchange is started on the module.

| Parameter | Explanation |
|---------------------------|--|
| Automatically by device | Data exchange is started automatically after initializing this module. |
| Controlled by application | Data exchange is started by Automation Runtime. |

Information:

Parameter "Manual start of bus communication" can be enabled under the I/O configuration of the DeviceNet slave.

The following settings must be made in order to avoid automatic data exchange:

- In the IF module configuration, "Manual start of bus communication" must be set to "On".
- "Start of bus communication" must be set to "Controlled by application".

With this setting, the communication can only be started via function block **AsNxDnS - nxdnsStartBusComm**.

- Application monitoring

The module-internal watchdog time can be set here. If the watchdog has been enabled (watchdog time not equal to 0), the hardware watchdog must be reset after the set time at the latest.

| Parameter | Explanation | Values |
|---------------|-----------------------------|----------------|
| Watchdog time | Watchdog software disabled | 0 ms |
| | Permissible range of values | 20 to 65535 ms |
| | Default value: 1000 ms | |

Information:

The watchdog time is reset automatically by Automation Runtime.

Device description

Device

This table displays the manufacturer information as defined in the EDS file.

EDS

The contents of the EDS file can be viewed and searched here.

9.23.7.8.1.3 I/O mapping

The I/O mapping resulting from the module configuration is opened by double-clicking on the DeviceNet slave.

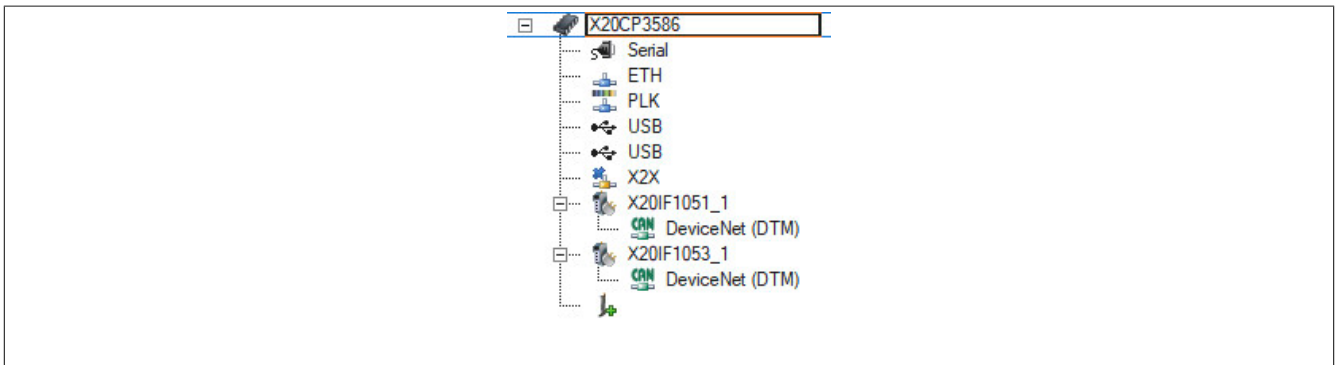
9.23.7.8.2 EDS device description file

The module description is made available to the master in an EDS file. This file contains the description of the slave's complete range of functions. The EDS file can be downloaded from the B&R website (www.br-automation.com) in the Downloads section for the interface module and then imported into the respective master environment.

9.23.7.8.3 Configuration example

In this example, a connection between a DeviceNet master and slave is established. Module X20IF1051-1 is used as the DeviceNet master; module X20IF1053-1 is used as the DeviceNet slave.

For this example, the DeviceNet master interface card is operated in the first slot of an X20CP3586 and the DeviceNet slave interface card in the second slot.



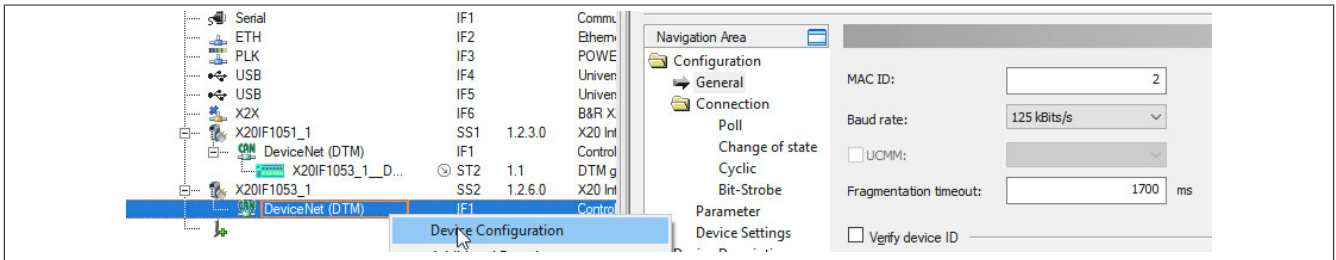
- To establish a connection between master and slave, the master must know the configuration data of the slave. To do this, the device description file of the X20IF1053-1 slave is imported into Automation Studio and attached to the master.

For details, see X20IF1051-1 "Adding the EDS file in Automation Studio" on page 2311.

The settings on the DeviceNet slave and on the master (device description file) must match; otherwise, no connection is established.

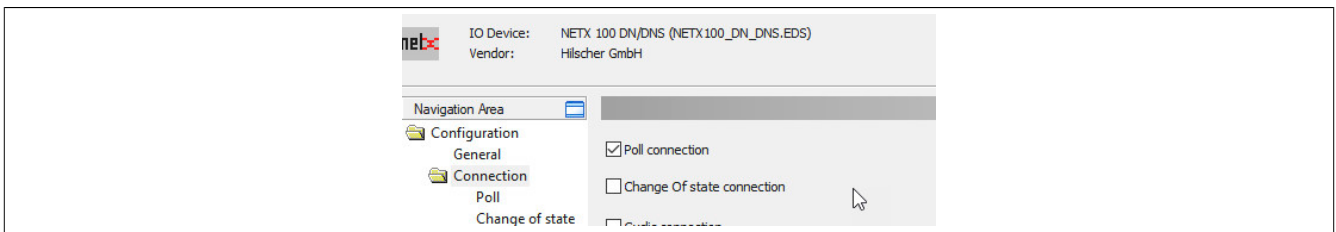
Settings on the slave

- In this example, the MAC ID "2" and a baud rate of 125 kbit/s were defined for the slave. These are set in "Device configuration" under "General" on the slave.

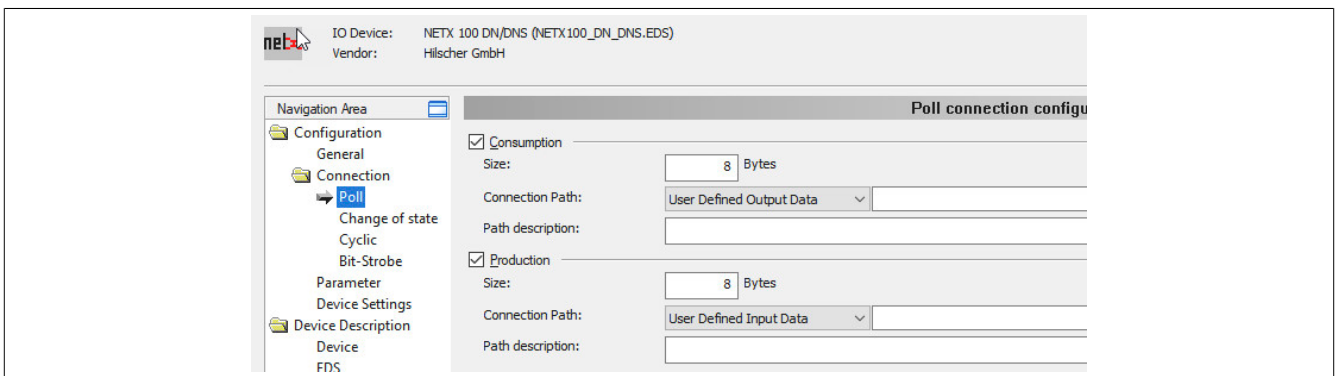


- Next, the connection type and I/O mapping are each defined with 8 bytes of input and output data.

"Poll connection" is enabled in the "Connection" configuration.

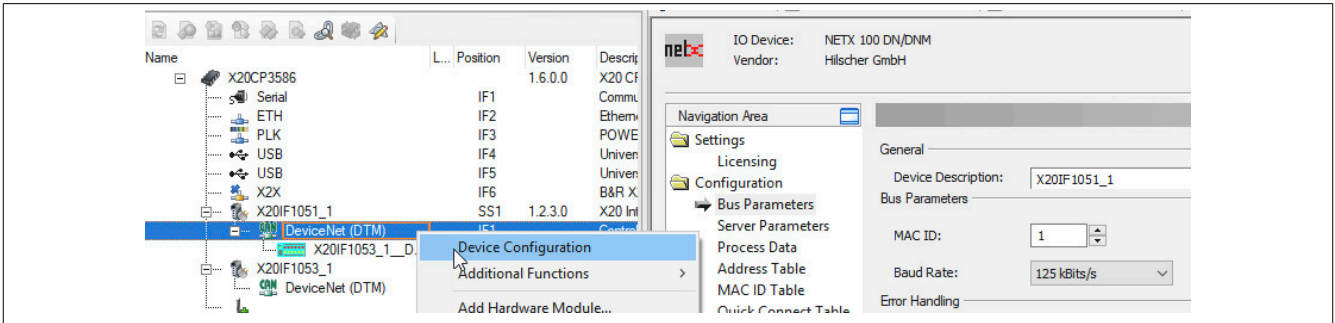


- Under "Poll connection configuration", 8 bytes each are entered for the input and output directions.

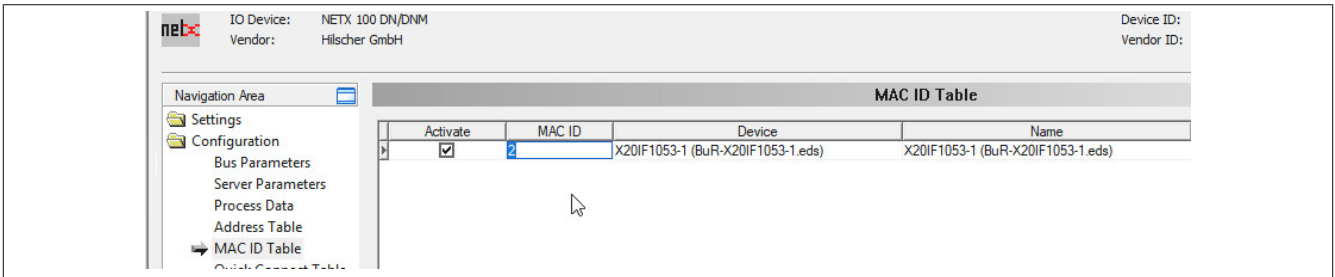


Settings on the master

- On the master, the MAC ID and the same baud rate as on the slave must be set. These are set in "Device configuration" under "Bus parameters".

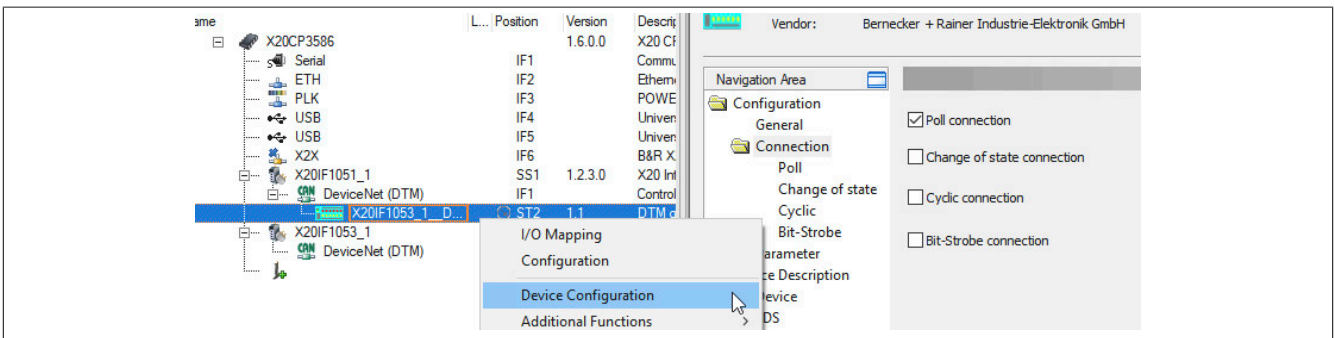


- Then the MAC ID of the slave is set under "MAC ID table".



Settings in the device description file

- The I/O mapping is set in the device description file under "Device configuration". The same settings are made here as on the DeviceNet slave.



By default, 8 bytes of input and output data are defined. If a different number of bytes should be set, the "Connection path" must be changed to "User defined consumption data".

- Confirm and save all settings with OK. The configuration is transferred to the CPU and, if correct, a connection between master and slave is automatically established.

The connection status can be checked with the ModulOK bit in the device description file. When ModulOK = True, data can be exchanged between master and slave.

| Channel Name | Physical Value | ForceActivated | ForceAc |
|----------------------|----------------|-------------------------------------|---------|
| ModuleOk | TRUE | <input type="checkbox"/> | FALSE |
| Poll_Input_Input_1 | 20 | <input type="checkbox"/> | 0 |
| Poll_Input_Input_2 | 0 | <input type="checkbox"/> | 0 |
| Poll_Input_Input_3 | 0 | <input type="checkbox"/> | 0 |
| Poll_Input_Input_4 | 0 | <input type="checkbox"/> | 0 |
| Poll_Input_Input_5 | 0 | <input type="checkbox"/> | 0 |
| Poll_Input_Input_6 | 0 | <input type="checkbox"/> | 0 |
| Poll_Input_Input_7 | 0 | <input type="checkbox"/> | 0 |
| Poll_Input_Input_8 | 0 | <input type="checkbox"/> | 0 |
| Poll_Output_Output_1 | 10 | <input checked="" type="checkbox"/> | 10 |
| Poll_Output_Output_2 | 0 | <input type="checkbox"/> | 0 |
| Poll_Output_Output_3 | 0 | <input type="checkbox"/> | 0 |
| Poll_Output_Output_4 | 0 | <input type="checkbox"/> | 0 |
| Poll_Output_Output_5 | 0 | <input type="checkbox"/> | 0 |
| Poll_Output_Output_6 | 0 | <input type="checkbox"/> | 0 |
| Poll_Output_Output_7 | 0 | <input type="checkbox"/> | 0 |
| Poll_Output_Output_8 | 0 | <input type="checkbox"/> | 0 |

| Channel Name | Physical Value | ForceActivated | ForceActivated Value |
|-----------------------------|----------------|-------------------------------------|----------------------|
| ModuleOk | TRUE | <input type="checkbox"/> | FALSE |
| SerialNumber | 168957 | <input type="checkbox"/> | 0 |
| ModuleID | 42773 | <input type="checkbox"/> | 0 |
| HardwareVariant | 1 | <input type="checkbox"/> | 0 |
| FirmwareVersion | 22 | <input type="checkbox"/> | 0 |
| Communication_Change_of_... | 135 | <input type="checkbox"/> | 0 |
| Communication_State | 4 | <input type="checkbox"/> | 0 |
| Communication_Error | 0 | <input type="checkbox"/> | 0 |
| Version | 2 | <input type="checkbox"/> | 0 |
| Watchdog_Timeout | 1000 | <input type="checkbox"/> | 0 |
| Host_Watchdog | 1 | <input type="checkbox"/> | 0 |
| Error_Count | 0 | <input type="checkbox"/> | 0 |
| Error_Log_Indicator | 0 | <input type="checkbox"/> | 0 |
| 8_Bytes_Out_8_OutBytes001 | 10 | <input type="checkbox"/> | 0 |
| 8_Bytes_Out_8_OutBytes002 | 0 | <input type="checkbox"/> | 0 |
| 8_Bytes_Out_8_OutBytes003 | 0 | <input type="checkbox"/> | 0 |
| 8_Bytes_Out_8_OutBytes004 | 0 | <input type="checkbox"/> | 0 |
| 8_Bytes_Out_8_OutBytes005 | 0 | <input type="checkbox"/> | 0 |
| 8_Bytes_Out_8_OutBytes006 | 0 | <input type="checkbox"/> | 0 |
| 8_Bytes_Out_8_OutBytes007 | 0 | <input type="checkbox"/> | 0 |
| 8_Bytes_Out_8_OutBytes008 | 0 | <input type="checkbox"/> | 0 |
| 8_Bytes_In_8_InBytes001 | 20 | <input checked="" type="checkbox"/> | 20 |
| 8_Bytes_In_8_InBytes002 | 0 | <input type="checkbox"/> | 0 |
| 8_Bytes_In_8_InBytes003 | 0 | <input type="checkbox"/> | 0 |
| 8_Bytes_In_8_InBytes004 | 0 | <input type="checkbox"/> | 0 |

9.23.8 X20(c)IF1061-1

Data sheet version: 2.06

9.23.8.1 General information

The interface module is equipped with a PROFIBUS DP V1 interface. This allows third-party components to be integrated in the B&R system and makes it possible to quickly and easily transfer data in both directions.

The interface module can be operated in X20 CPUs or in the expandable POWERLINK bus controller X20BC1083.

- PROFIBUS DP V1 master

9.23.8.1.1 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.23.8.1.1.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.23.8.2 Order data

| Model number | Short description | Figure |
|---------------|---|--------|
| | X20 interface module communication | |
| X20IF1061-1 | X20 interface module for DTM configuration, 1 PROFIBUS DP V0/V1 master interface, electrically isolated | |
| X20cIF1061-1 | X20 interface module coated, for DTM configuration, 1 PROFIBUS DP V0/V1 master interface, electrically isolated | |
| | Optional accessories | |
| | Infrastructure components | |
| 0G1000.00-090 | Bus connector, RS485, for PROFIBUS networks | |

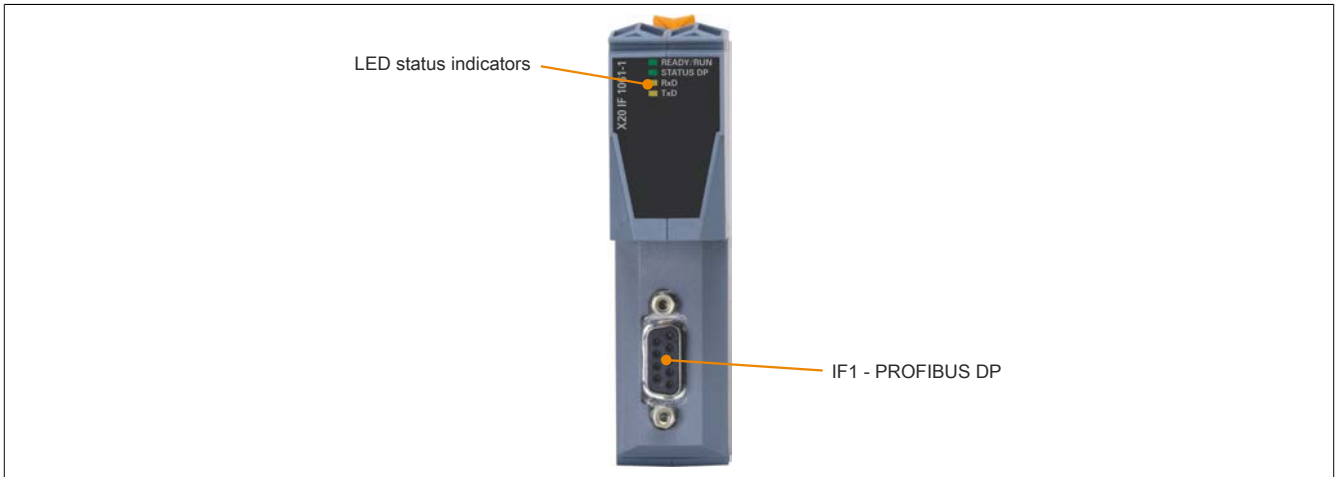
Table 433: X20IF1061-1, X20cIF1061-1 - Order data

9.23.8.3 Technical data


| Model number | X20IF1061-1 | X20cIF1061-1 |
|--|--|--|
| Short description | | |
| Communication module | 1x PROFIBUS DP V0/V1 master | |
| General information | | |
| B&R ID code | 0xA716 | 0xE234 |
| Status indicators | Module status, data transfer | |
| Diagnostics | | |
| Module status | Yes, using status LED and software | |
| Network status | Yes, using status LED and software | |
| Data transfer | Yes, using status LED | |
| Power consumption | 1.8 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Interfaces | | |
| Interface IF1 | | |
| Fieldbus | PROFIBUS DP V0/V1 master | |
| Variant | 9-pin female DSUB connector | |
| Max. distance | 1200 m | |
| Transfer rate | Max. 12 Mbit/s | |
| Controller | netX100 | |
| Memory | 8 MB SDRAM | |
| Cyclic data | | |
| Input data | Max. 3.5 kB | |
| Output data | Max. 3.5 kB | |
| Electrical properties | | |
| Electrical isolation | PLC isolated from PROFIBUS (IF1) | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Slot | In the X20 CPU and in the X20BC1083 expandable bus controller | In the X20c CPU and in the X20cBC1083 expandable bus controller |

Table 434: X20IF1061-1, X20cIF1061-1 - Technical data

9.23.8.4 Operating and connection elements

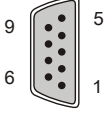


9.23.8.4.1 LED status indicators

| Figure | LED | Color | Status | Description |
|--|-----------|-----------------|---|---|
|  | READY/RUN | Green/Red | Off | No power to module |
| | | Green | On | PCI bus communication in progress |
| | | Red | Blinking | Boot error |
| | STATUS DP | Green | On | Communication on the PCI bus has not yet been started. |
| | | | Acyclic blinking | No configuration or stack error |
| | | Cyclic blinking | The bus is configured, but communication is not yet enabled by the application. | |
| | | On | Communication to all slaves established | |
| | Red | Cyclic blinking | Communication to at least one slave interrupted | |
| | | On | Communication to all slaves / one slave interrupted | |
| | RxD | Yellow | On | The module is receiving data from the PROFIBUS DP master interface. |
| TxD | Yellow | On | The module is transmitting data via the PROFIBUS DP master interface. | |

9.23.8.4.2 PROFIBUS DP interface

A shielded line must be used for the interface.

| Interface | Pinout | | |
|--|--------|-----------|--------------------|
| | Pin | RS485 | |
|  <p>9-pin female DSUB connector</p> | 1 | Reserved | |
| | 2 | Reserved | |
| | 3 | RxD/TxD-P | Data ¹⁾ |
| | 4 | CNTR-P | Transmit enable |
| | 5 | DGND | Power supply |
| | 6 | VP | Power supply |
| | 7 | Reserved | |
| | 8 | RxD/TxD-N | Data ²⁾ |
| | 9 | CNTR-N | Transmit enable\ |
| CNTR ... Direction switch for external repeaters | | | |

- 1) Cable color: Red
- 2) Cable color: Green

9.23.8.5 Use in the expandable X20BC1083 POWERLINK bus controller

9.23.8.5.1 Cyclic data

If this module is connected to the expandable POWERLINK bus controller, the amount of cyclic data is limited by the POWERLINK frame to 1488 bytes in each direction (input and output).

When using multiple X20IF10xx-1 interfaces or other X2X modules with a POWERLINK bus controller, the 1488 bytes are divided between all connected modules.

9.23.8.5.2 Operating netX modules

It is important to note the following in order to operate netX modules with the bus controller without problems:

- A minimum revision \geq E0 is required for the bus controller.
- netX modules can only be operated with the POWERLINK V2 setting. V1 is not permitted.
- With SDO access to POWERLINK object 0x1011/1 on the bus controller, the netX firmware and the configuration stored on the bus controller are not reset. They can only be overwritten by accessing them again. This affects objects 0x20C0 and 0x20C8, subindexes 92 to 95.

9.23.8.6 netX error codes

netX modules return an error code when an error occurs. These error codes are fieldbus-specific. A complete list of all error codes in PDF format is available in Automation Help in section "Communication / Fieldbus systems / Support with FDT/DTM / Diagnostic functions / Diagnostics on the runtime system / Master diagnostics" under item "Communication_Error".

9.23.8.7 Firmware

The module comes with preinstalled firmware. The firmware is part of the Automation Studio project. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.23.8.8 Minimum DTM version for coated modules

Information:

The minimum DTM version required for coated modules is 1.0370.140220.12186. This version is included starting with Automation Studio upgrade packs V4.0.18.x and V3.0.90.29.

9.23.8.9 PROFIBUS DP interface

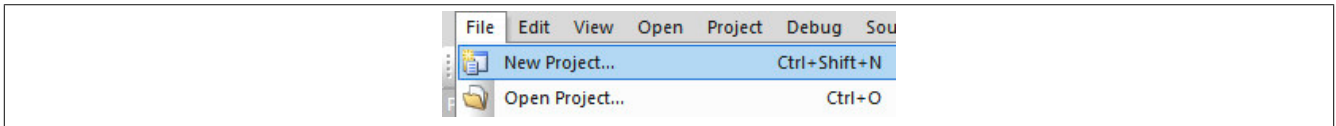
9.23.8.9.1 Settings in Automation Studio

The interface module can be operated in the slot of a CPU or in the slot of an expandable POWERLINK bus controller.

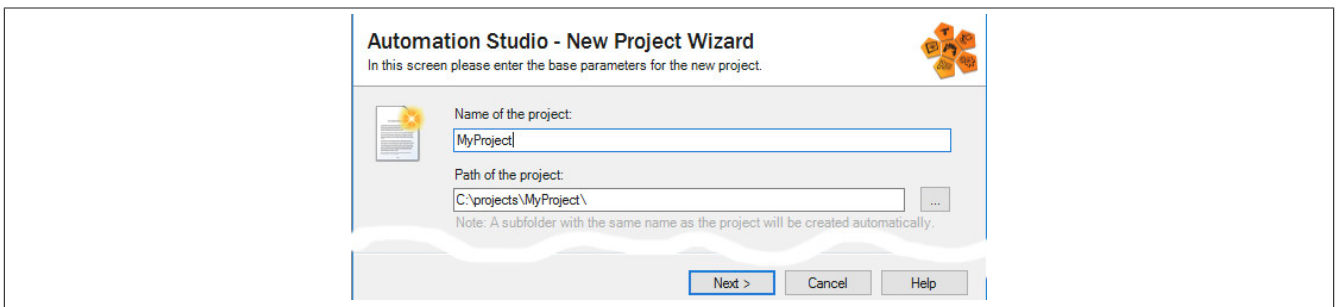
To do this, a new Automation Studio project is created and the suitable settings are made on the module.

9.23.8.9.1.1 Creating an Automation Studio project

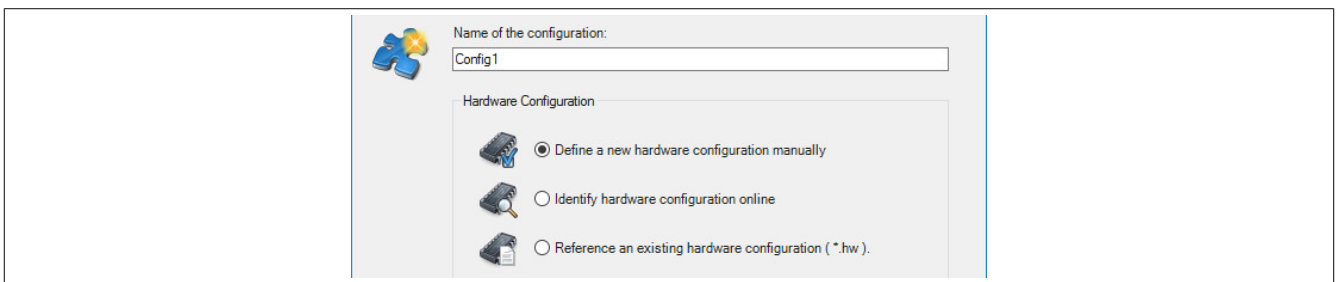
- Create a new Automation Studio project by selecting "New project".



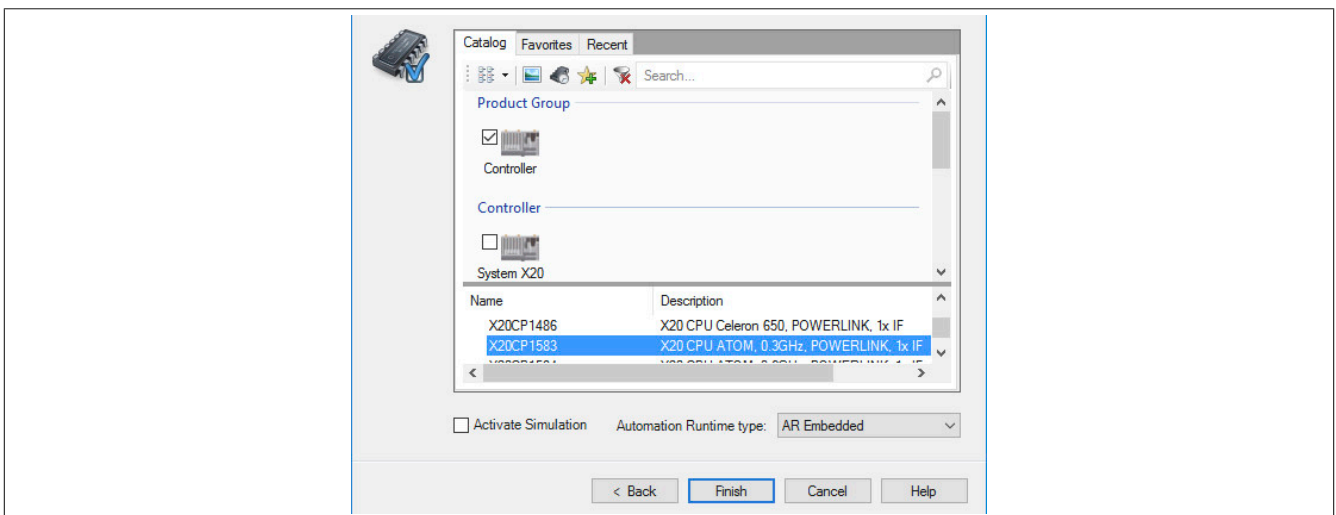
- Assign a project name and set up the project path.



- Assign the hardware configuration type and configuration name.

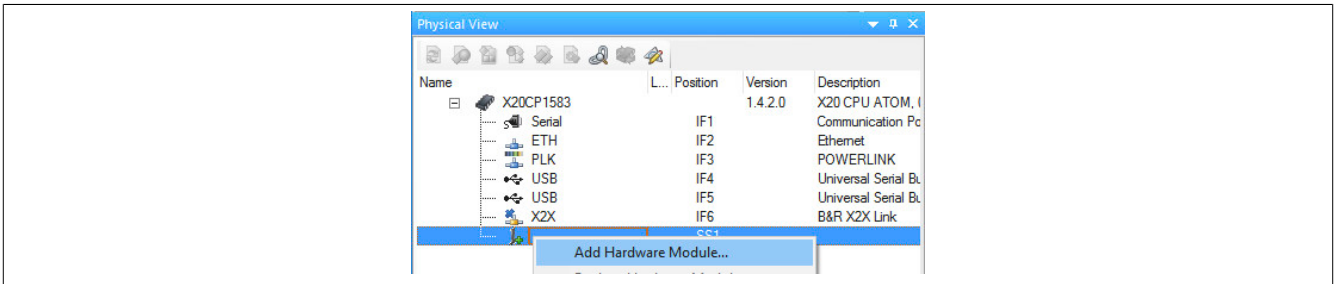


- Select the hardware in the next step if "Define a new hardware configuration manually" was selected. In order to simplify the search, different filters can be set in the Hardware Catalog. Lastly, highlight the required hardware and create the Automation Studio project by clicking on "Finish".

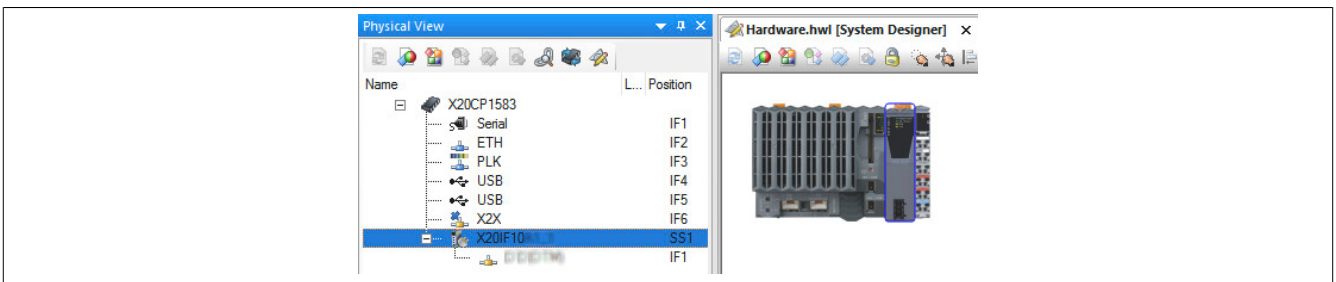


9.23.8.9.1.2 Adding and configuring the interface module

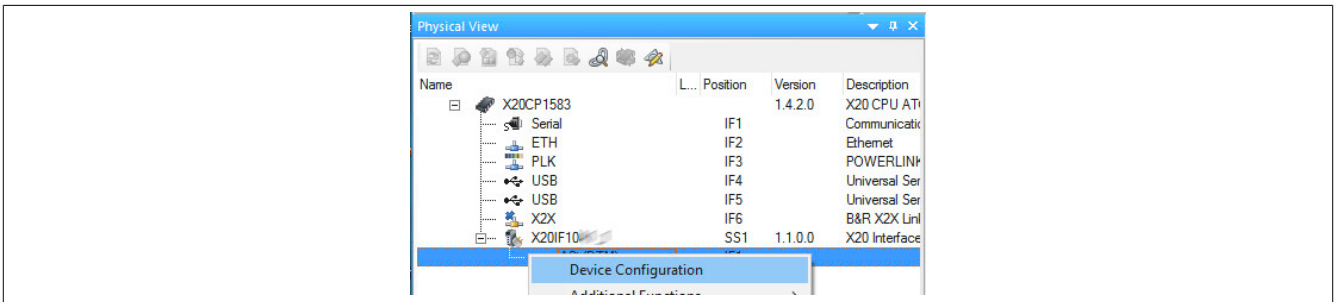
- In this example, the interface card is connected in the slot of a CPU. Right-clicking on the slot and selecting "Add hardware module" opens the Hardware Catalog.



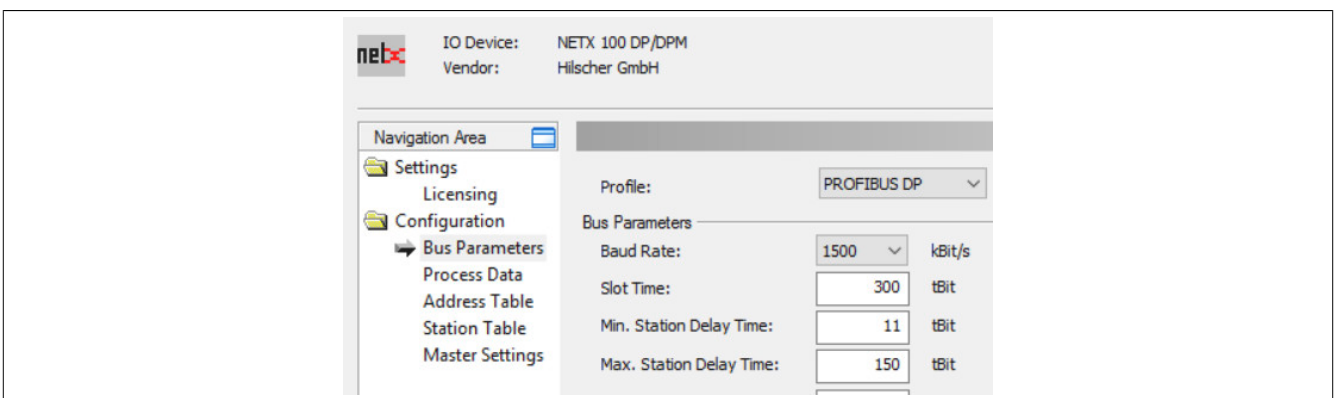
- The module is added to the project via drag-and-drop or by double-clicking on the interface card.



- Additional module settings can be made under "Device configuration". This configuration environment is opened by right-clicking on the IF interface and selecting "Device configuration".



- General settings are made in the device configuration.



Bus parameters

- Profile

The desired PROFIBUS profile is set here.

| Parameter | Explanation |
|-------------|--|
| PROFIBUS DP | Decentralized peripherals: Used to control sensors and actuators and to connect several controllers with each other. |
| PROFIBUS PA | Process automation: Runs protocol-based via PROFIBUS DP V1 class 2 services just like PROFIBUS DP. PROFIBUS PA runs on a different physical layer, however. |

Both profiles can be connected using a media converter.

- Bus parameters

Depending on the profile used, the bus parameters must be set. When switching the profile, the default settings of the respective profile are automatically added.

| Parameter | Explanation | Values |
|-------------------------------|---|-----------------|
| Baud rate | This parameter must be set the same for all devices. Changing the baud rate results in an automatic recalculation of dependent parameters, such as "Slot time". | |
| Slot time | This parameter is the monitoring time of the telegram transmitter and is used for the acknowledgment of the recipient. | 37 to 16383 |
| Min. station delay time | This parameter (min T_{SDR}) is the shortest time that must elapse between receiving the last bit of the telegram and transmitting the first bit of the following one. | 1 to 65535 |
| Max. station delay time | This parameter (max T_{SDR}) is the longest time span that must elapse between receiving the last bit of the telegram and transmitting the first bit of the following one. If an unanswered telegram (e.g. broadcast) is received, the transmitter must wait for this time to elapse before transmitting a new telegram. | 1 to 65535 |
| Quiet time | This parameter (T_{QUI}) defines the time delay that occurs with modulators and repeaters for the change from transmit to receive. | 0 to 127 |
| Setup time | This parameter (T_{SET}) is the response time of the transmitter. It determines the minimum time between receiving a confirmation and transmitting a new poll telegram. | 0 to 255 |
| Station address | This parameter defines the station address of the master. | 0 to 125 |
| Target rotation time | This parameter (T_{TR}) is the nominal token cycle time in milliseconds. The time the master has for transmitting the telegrams to the slaves depends on the difference between normal and actual token cycle time. The default value depends on the number of slaves and how they have been configured. | 1 to $2^{24}-1$ |
| GAP actualization factor | This parameter (G) determines after how many token cycles an added station is included in the token ring. After time " $G * T_{TR}$ " has elapsed, the station searches for other stations who want to be included in the logical ring. | 0 to 255 |
| Max. retry limit | This parameter determines the maximum number of retries to search for a station. | 1 to 15 |
| Highest station address (HSA) | This parameter is the highest bus address up to which the master searches to pass on the token to another master. <div style="border-left: 2px solid black; padding-left: 5px; margin-left: 20px;"> The address must always be higher than the station address of the master </div> | 1 to 126 |

Settings for correct communication:

$$T_{QUI} < \min T_{SDR}$$

$$T_{RDY} < \min T_{SDR}$$

$$T_{QUI} < T_{RDY}$$

t_{BIT} (Bit time) is composed as follows:

$$t_{BIT} = 1 / \text{Baud rate (in bit/s)}$$


$$\text{Bit time} = \text{Time[ms]} * \text{baud rate}$$

- Bus monitoring


| Parameter | Explanation | Values |
|---|--|------------------|
| Data control time | This parameter defines the time in which Data_Transfer_List is updated at least once. After this time has elapsed, the master automatically reports its operating state via command "Global_Control". | 10 to 655,350 |
| Min. slave interval | This parameter defines the minimum time period between 2 slave list cycles. The maximum value required by the active stations is specified here. | 100 to 6,553,500 |
| Override slave-specific watchdog control time | Each slave transmits a specific watchdog control time back to the master. This parameter makes it possible to overwrite individual slave-specific settings with the same value for all slaves configured on this master, for example, to set a consistent value for slower transfer rates for critical environments. | |
| Watchdog control time | The DP slaves use the watchdog control time setting to detect communication errors on the assigned master. If the slave detects an interruption in an already operational communication defined by a watchdog time, the slave performs an independent reset and sets the outputs to the safe state. | |

Information:

If the bus configurations are changed and this change affects the bus parameters, a symbol (yellow exclamation mark) is displayed next to the affected parameters.

| Bus Monitoring | | | |
|----------------------|---|----------------------------------|--|
| Data Control Time: |  | <input type="text" value="20"/> | ms <input checked="" type="checkbox"/> Override slave specific Watchdog Control Time |
| Min. Slave Interval: | | <input type="text" value="200"/> | µs |
| | | Watchdog Control Time: | <input type="text" value="20"/> ms |

The bus parameters can be recalculated by clicking on "Adjust".

| | | |
|---|---|---------------------------------------|
|  | Values marked with this symbol should be adjusted to changes in the topology. | <input type="button" value="Adjust"/> |
|---|---|---------------------------------------|

Error handling

"Auto clear" ON is used for error handling.

| Parameter | Explanation |
|-----------|---|
| Enabled | The master changes from mode Operate to mode Clear (standby mode) and ends communication with all slaves as soon as at least one slave does not respond within the data control time. |
| Disabled | The master remains in mode Operate and communication with all accessible slaves is maintained. |

- Calculated timing

Calculated timing is the time the transmitter remains idle after receiving the last bit of a telegram on the bus until the first bit of a new telegram is transmitted on the bus.

| Bus time | Explanation | Formula |
|----------|---|--|
| Tid1 | Tid1 starts after the initiator has received an acknowledgment, response or token telegram. | $T_{id1} = \max(T_{QUI} + 2 * T_{SET} + 2 + T_{SYN}, \min T_{SDR})$ $T_{SYN} (*)$ |
| Tid2 | Tid2 starts after the initiator has transmitted a telegram that is not confirmed. | $T_{id2} = \max(T_{QUI} + 2 * T_{SET} + 2 + T_{SYN}, \max T_{SDR})$ $T_{SYN} (*)$ |

Process data

This table lists the process data of the individual slaves.

| Parameter | Explanation |
|-----------|---|
| Type | Device designation specified by the hardware. Further description of modules configured on the device or the input or output signals. |
| Tag | Name of the input or output data. |
| SCADA | This parameter is not supported. |

Address table

This table lists all slaves categorized according to their input and output data. The respective length of the input and output data as well as the assigned address can be read.

"Display mode" allows toggling between decimal and hexadecimal display.

| Parameter | Explanation |
|-----------------|---|
| Station address | Station address of the assigned slave device |
| Device | Actual device name of the slave assigned from the GSD file. |
| Name | Name of the assigned slave device |
| Modules | Name of the module per the GSD file |
| Type | Type of input or output data |
| Length | Number of data types contained |
| Address | Offset address of the input or output data |

The address table can also be exported as a CSV file.

If auto-addressing is disabled, addresses can be entered manually.

Information:

If addresses are assigned twice, an error is output and the addresses affected are marked with a red exclamation mark.

Station table

All slaves are listed in this table.

| Parameter | Explanation |
|-----------------|--|
| Activate | This allows the slaves to be enabled or disabled. <ul style="list-style-type: none"> • Slave disabled: The master reserves memory in the process data image for the slave, but no data is exchanged. • Slave enabled: The master reserves memory in the process data image for the slave, and data is exchanged. |
| Station address | Station address of the assigned slave device. This address can be changed. |

Master settings

- Start of bus communication

It is possible to select how data exchange is started on the module.

| Parameter | Explanation |
|---------------------------|--|
| Automatically by device | Data exchange is started automatically after initializing this module. |
| Controlled by application | Data exchange is started by Automation Runtime. |

- Module alignment

The addressing mode is defined by the process image here. The addresses (offsets) of the process data are always interpreted as byte addresses.

| Addressing mode | Explanation |
|-------------------|---|
| Byte boundaries | The module address can start on any offset. |
| 2 byte boundaries | The module address can only start on even byte offsets. |

Information:

This configuration is automatically managed by Automation Runtime and is not permitted to be changed (default setting).

- Application monitoring

The module-internal watchdog time can be set here. If the watchdog has been enabled (watchdog time not equal to 0), the hardware watchdog must be reset after the set time at the latest.

| Parameter | Explanation | Values |
|---------------|-----------------------------|----------------|
| Watchdog time | Watchdog software disabled | 0 ms |
| | Permissible range of values | 20 to 65535 ms |
| | Default value: 1000 ms | |

Information:

The watchdog time is reset automatically by Automation Runtime.

- Process data handshake

This parameter configures the handshake for the data exchange between application and device. Only "Buffered, host-controlled" is supported here.

- Process image storage format

This is used to define how data is stored in the process image (I/O mapping). The storage format is only applied to data type "Word". This change has no effect on other data types.

| Storage format | Explanation |
|----------------|---|
| Big-endian | MSB/LSB = Higher/Lower byte (Motorola format) |
| Little-endian | MSB/LSB = Higher/Lower byte (Intel format) |

Input process image

Storage format - Little-endian (default setting)

| | | | | | | | | | |
|--------------------|---------|--------------------------|---------|-------|--------------------|---------|--------------------------|---------|-------|
| Module002_Output_1 | 16#00 | <input type="checkbox"/> | 16#00 | USINT | Module002_Output_1 | 16#00 | <input type="checkbox"/> | 16#00 | USINT |
| Module003_Input_2 | 16#3344 | <input type="checkbox"/> | 16#0000 | UINT | Module003_Input_2 | 16#4433 | <input type="checkbox"/> | 16#0000 | UINT |
| Module004_Output_2 | 16#0000 | <input type="checkbox"/> | 16#0000 | UINT | Module004_Output_2 | 16#0000 | <input type="checkbox"/> | 16#0000 | UINT |

Storage format - Big-endian

- Advanced

Information:

Function "Enable configuration download during network state operate" is not permitted to be enabled.

- Device status offset

Here, the status offset can be set to be calculated automatically or using a predefined value.

| Status offset | Explanation |
|-----------------------|--|
| Automatic calculation | The device status always directly follows the input bytes. If input data is added in the configuration, the start address of the device status is moved back in the dual-ported memory. |
| Static | <p>Here, the distance (free buffer) between the last input byte and the start of the device status can be set. This way, the start address of the device status never changes in the dual-ported memory. If additional input data is added, the distance (free buffer) is reduced. If the free buffer does not have enough space available for the data added to it, the start address of the device status in the dual-ported memory must be shifted.</p> <p>If the offset is too small, an error is output. To correct the error, the free buffer must be increased to a sufficient size.</p> |

Information:

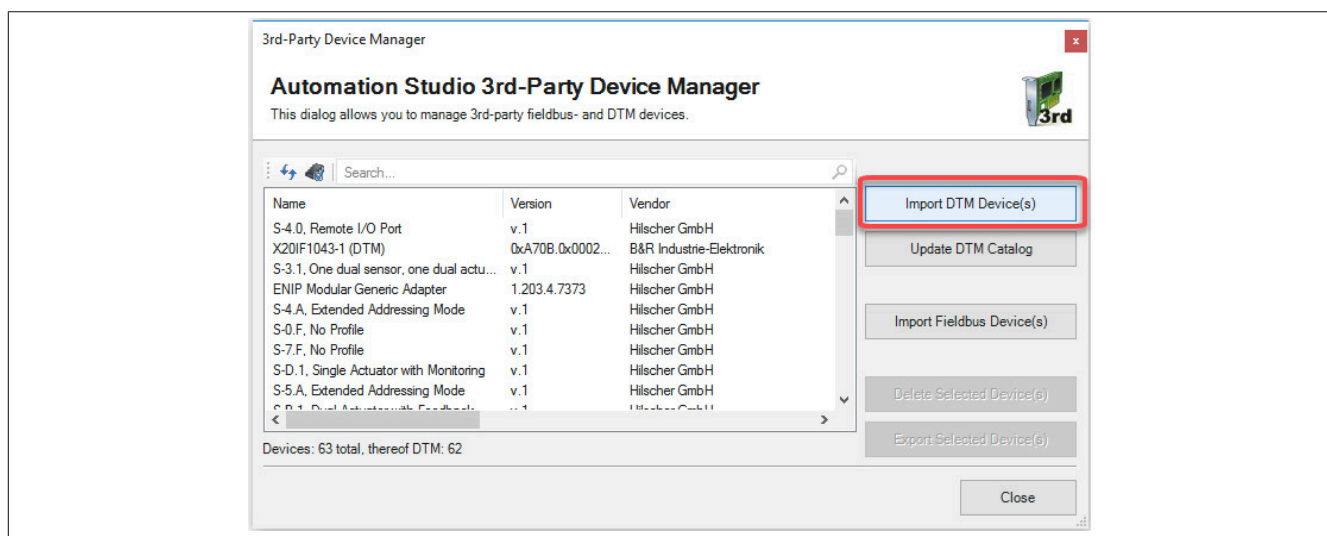
This configuration is automatically managed by Automation Runtime and is not permitted to be changed (default setting).

9.23.8.9.1.3 Adding the GSD file in Automation Studio

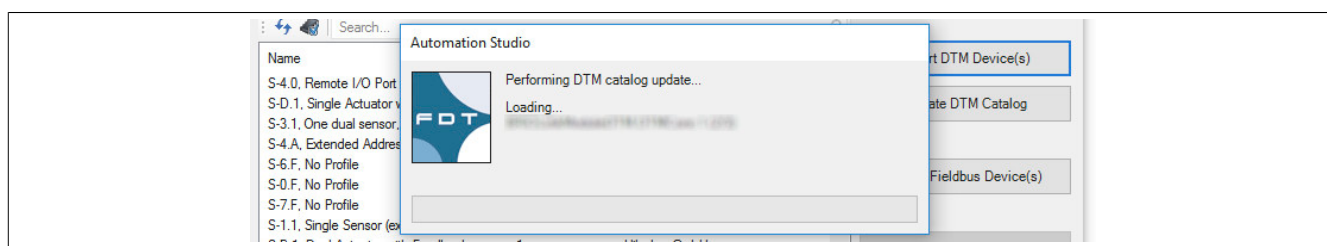
A device description file (GSD file) is required to inform the PROFIBUS DP master which slaves were connected and how they were configured.

To add and use a device description file in Automation Studio, perform the following steps:

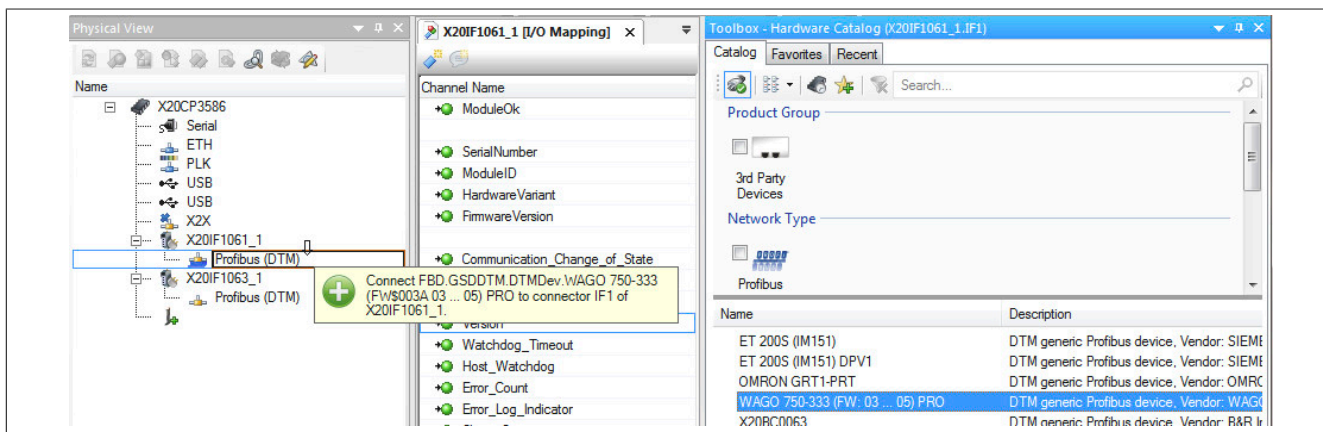
- If the PROFIBUS slave from B&R is used, download the GSD file from the B&R website (www.br-automation.com) and unzip the ZIP file.
- Open the dialog box in Automation Studio under "Tools - Manage 3rd-party devices" and select "Import DTM device(s)".



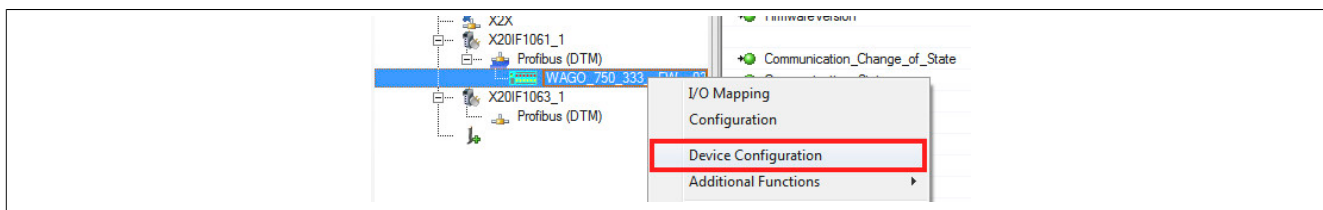
- Select the GSD file to be imported and confirm with OK. The GSD file is imported into Automation Studio.



- Click on "PROFIBUS (DTM)" on PROFIBUS DP master X20IF1061-1, drag the GSD file from the Hardware Catalog and attach it to the PROFIBUS DP master.



- Right-click on the IF interface and select "Device configuration" to open the configuration environment for the GSD file.



9.23.9 X20IF1063

Data sheet version: 2.23

9.23.9.1 General information

The interface module can be used to expand the X20 CPU for specific applications. It is equipped with a PROFIBUS DP V0 slave interface.

- PROFIBUS DP V0 slave connection

9.23.9.2 Order data


| Model number | Short description | Figure |
|---------------|---|---|
| | X20 interface module communication |  |
| X20IF1063 | X20 interface module, 1 PROFIBUS DP V0 slave interface, max. 12 Mbit/s, electrically isolated | |
| | Optional accessories | |
| | Infrastructure components | |
| 0G1000.00-090 | Bus connector, RS485, for PROFIBUS networks | |


Table 435: X20IF1063 - Order data

9.23.9.3 Technical data

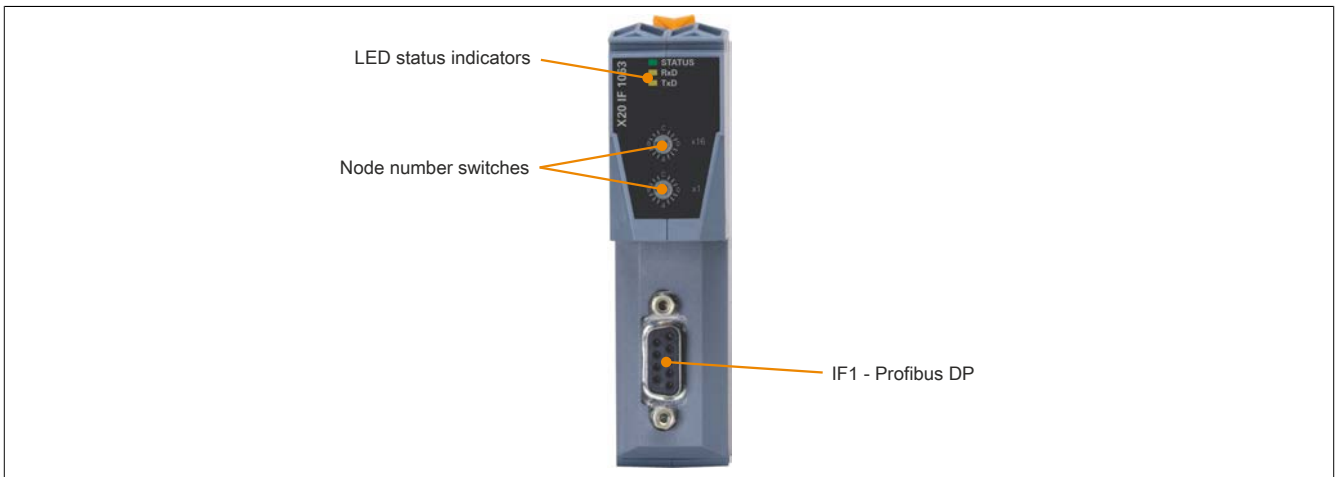
| | |
|--|--|
| Model number | X20IF1063 |
| Short description | |
| Communication module | 1x PROFIBUS DP V0 slave |
| General information | |
| B&R ID code | 0x1F23 |
| Status indicators | Module status, data transfer |
| Diagnostics | |
| Module status | Yes, using status LED |
| Data transfer | Yes, using status LED |
| Power consumption | 0.87 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations |
| ATEX | Class I, Division 2, Groups ABCD, T5 Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| Interfaces | |
| Interface IF1 | |
| Fieldbus | PROFIBUS DP V0 slave |
| Variant | 9-pin female DSUB connector |
| Max. distance | 1200 m |
| Transfer rate | Max. 12 Mbit/s |
| Terminating resistor | External T-connector (0G1000.00-090) |
| Controller | VPC3+C |
| Electrical properties | |
| Electrical isolation | PLC isolated from PROFIBUS (IF1) |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Slot | In X20 CPU |

Table 436: X20IF1063 - Technical data

9.23.9.4 LED status indicators

| Figure | LED | Color | Status | Description |
|---|--------|--------|--------|--|
|  | STATUS | Green | On | Interface module active |
| | | Red | On | CPU starting up |
| | RxD | Yellow | On | The module receives data via the PROFIBUS DP slave interface |
| | TxD | Yellow | On | The module sends data via the PROFIBUS DP slave interface |

9.23.9.5 Operating and connection elements



9.23.9.6 Node number switch



The node number for the interface is set with the two hex switches.

9.23.9.7 PROFIBUS DP interface

A shielded line must be used for the interface.

| Interface | Pinout | | |
|--|--------|-----------|--------------------|
| | Pin | RS485 | |
| <p>9-pin female DSUB connector</p> | 1 | Reserved | |
| | 2 | Reserved | |
| | 3 | RxD/TxD-P | Data ¹⁾ |
| | 4 | CNTR-P | Transmit enable |
| | 5 | DGND | Power supply |
| | 6 | VP | Power supply |
| | 7 | Reserved | |
| | 8 | RxD/TxD-N | Data ²⁾ |
| | 9 | CNTR-N | Transmit enable\ |
| CNTR ... Direction switch for external repeaters | | | |

- 1) Cable color: Red
2) Cable color: Green

9.23.9.8 Firmware

The module comes with preinstalled firmware. The firmware is part of Automation Studio. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.23.10 X20(c)IF1063-1

Data sheet version: 2.04

9.23.10.1 General information

The interface module is equipped with a PROFIBUS DP V1 interface. This allows the B&R system (I/O modules, POWERLINK, etc.) to be connected to systems from other manufacturers and makes it possible to quickly and easily transfer data in both directions.

The interface module can be operated in X20 CPUs or in the expandable POWERLINK bus controller X20BC1083.

- PROFIBUS DP V1 slave

9.23.10.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.23.10.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.23.10.3 Order data

| Model number | Short description | Figure |
|---------------|--|--------|
| | X20 interface module communication | |
| X20IF1063-1 | X20 interface module, for DTM configuration, 1 PROFIBUS DP V1 slave interface, electrically isolated | |
| X20clF1063-1 | X20 interface module, coated, for DTM configuration, 1 PROFIBUS DP V1 slave interface, electrically isolated | |
| | Optional accessories | |
| | Infrastructure components | |
| 0G1000.00-090 | Bus connector, RS485, for PROFIBUS networks | |

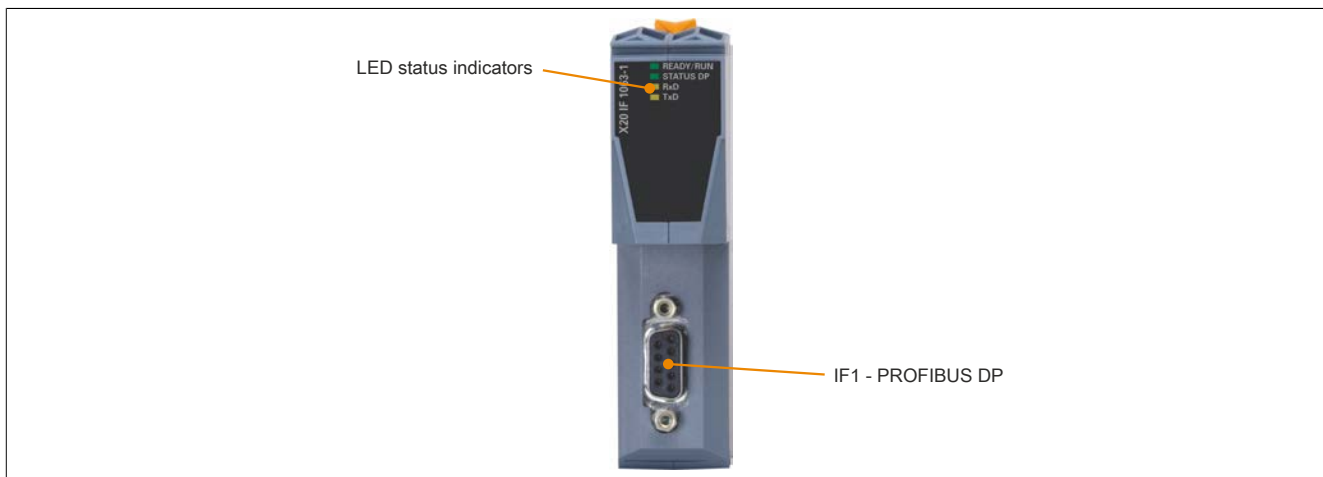
Table 437: X20IF1063-1, X20clF1063-1 - Order data

9.23.10.4 Technical data


| Model number | X20IF1063-1 | X20cIF1063-1 |
|--|--|---|
| Short description | | |
| Communication module | 1x PROFIBUS DP V0/V1 slave | |
| General information | | |
| B&R ID code | 0xA717 | 0xE235 |
| Status indicators | Module status, data transfer | |
| Diagnostics | | |
| Module status | Yes, using status LED and software | |
| Network status | Yes, using status LED and software | |
| Data transfer | Yes, using status LED | |
| Power consumption | 1.8 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Interfaces | | |
| Interface IF1 | | |
| Fieldbus | PROFIBUS DP V0/V1 slave | |
| Variant | 9-pin female DSUB connector | |
| Max. distance | 1200 m | |
| Transfer rate | Max. 12 Mbit/s | |
| Controller | netX100 | |
| Cyclic data | | |
| Input data | Max. 244 bytes | |
| Output data | Max. 244 bytes | |
| Electrical properties | | |
| Electrical isolation | PLC isolated from PROFIBUS (IF1) | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Slot | In the X20 CPU and in the X20BC1083 expandable bus controller | In the X20c CPU and in the X20cBC1083 expandable bus controller |

Table 438: X20IF1063-1, X20cIF1063-1 - Technical data

9.23.10.5 Operating and connection elements

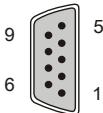


9.23.10.5.1 LED status indicators

| Figure | LED | Color | Status | Description | |
|--|-----------|-----------|----------|--|--|
|  | READY/RUN | Green/red | Off | No power to module | |
| | | Green | On | PCI bus communication in progress | |
| | | Red | Blinking | Boot error | |
| | STATUS DP | Green | On | Communication on the PCI bus has not yet been started | |
| | | Red | On | RUN, cyclic communication | |
| | | | | Faulty configuration (e.g. master configuration and interface card configuration do not match) | |
| | | | | Cyclic flash | STOP, no communication, connection error |
| | | | | Acyclic flash | Slave not configured |
| | RxD | Yellow | On | The module is receiving data via the PROFIBUS DP slave interface. | |
| | TxD | Yellow | On | The module is transmitting data via the PROFIBUS DP slave interface. | |

9.23.10.5.2 PROFIBUS DP interface

A shielded line must be used for the interface.

| Interface | Pinout | | |
|--|--------|-----------|--------------------|
| | Pin | RS485 | |
|  <p>9-pin female DSUB connector</p> | 1 | Reserved | |
| | 2 | Reserved | |
| | 3 | RxD/TxD-P | Data ¹⁾ |
| | 4 | CNTR-P | Transmit enable |
| | 5 | DGND | Power supply |
| | 6 | VP | Power supply |
| | 7 | Reserved | |
| | 8 | RxD/TxD-N | Data ²⁾ |
| | 9 | CNTR-N | Transmit enable\ |
| CNTR ... Direction switch for external repeaters | | | |

- 1) Cable color: Red
- 2) Cable color: Green

9.23.10.6 Use in the expandable X20BC1083 POWERLINK bus controller

9.23.10.6.1 Cyclic data

If this module is connected to the expandable POWERLINK bus controller, the amount of cyclic data is limited by the POWERLINK frame to 1488 bytes in each direction (input and output).

When using multiple X20IF10xx-1 interfaces or other X2X modules with a POWERLINK bus controller, the 1488 bytes are divided between all connected modules.

9.23.10.6.2 Operating netX modules

It is important to note the following in order to operate netX modules with the bus controller without problems:

- A minimum revision $\geq E0$ is required for the bus controller.
- netX modules can only be operated with the POWERLINK V2 setting. V1 is not permitted.
- With SDO access to POWERLINK object 0x1011/1 on the bus controller, the netX firmware and the configuration stored on the bus controller are not reset. They can only be overwritten by accessing them again. This affects objects 0x20C0 and 0x20C8, subindexes 92 to 95.

9.23.10.7 netX error codes

netX modules return an error code when an error occurs. These error codes are fieldbus-specific. A complete list of all error codes in PDF format is available in Automation Help in section "Communication / Fieldbus systems / Support with FDT/DTM / Diagnostic functions / Diagnostics on the runtime system / Master diagnostics" under item "Communication_Error".

9.23.10.8 Firmware

The module comes with preinstalled firmware. The firmware is part of the Automation Studio project. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.23.10.9 Minimum DTM version for coated modules

Information:

The minimum DTM version required for coated modules is 1.0370.140220.12186. This version is included starting with Automation Studio upgrade packs V4.0.18.x and V3.0.90.29.

9.23.10.10 The PROFIBUS interface

Two steps are generally necessary for connecting module X20IF1063-1 to an external master environment.

- 1) Add and configure the X20 interface module in B&R's Automation Studio.
- 2) Add the PROFIBUS slave GSD device description file in the external master environment, e.g. Siemens STEP 7 or Siemens TIA-Portal. The interface module must then be configured.

Information:

To ensure error-free PROFIBUS communication between master and slave, the settings for the interface module in Automation Studio must match the settings of the GSD device description file in the master environment.

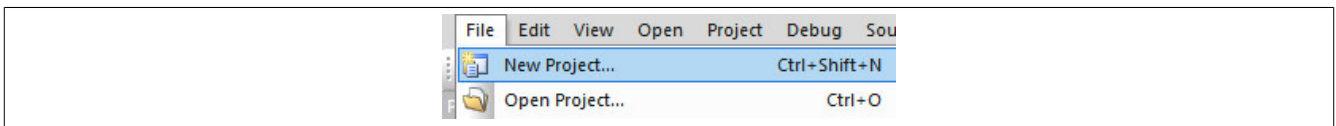
9.23.10.10.1 Settings in Automation Studio

The interface module can be operated in the slot of a CPU or in the slot of an expandable POWERLINK bus controller.

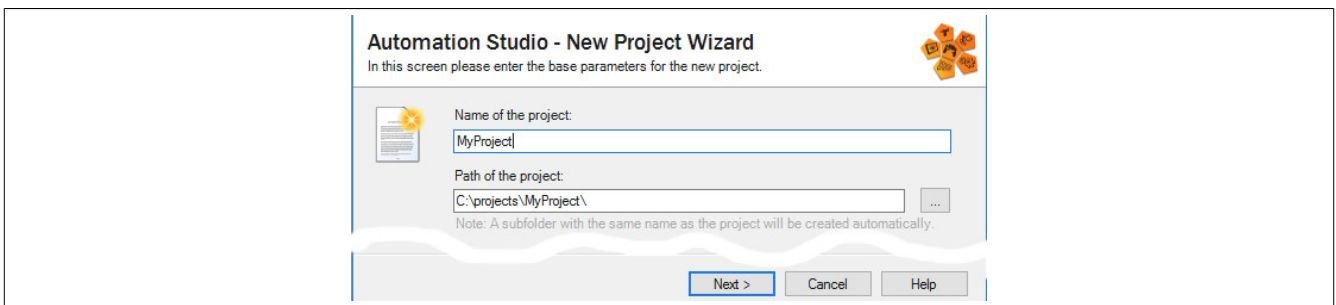
To do this, a new Automation Studio project is created and the suitable settings are made on the module.

9.23.10.10.1.1 Creating an Automation Studio project

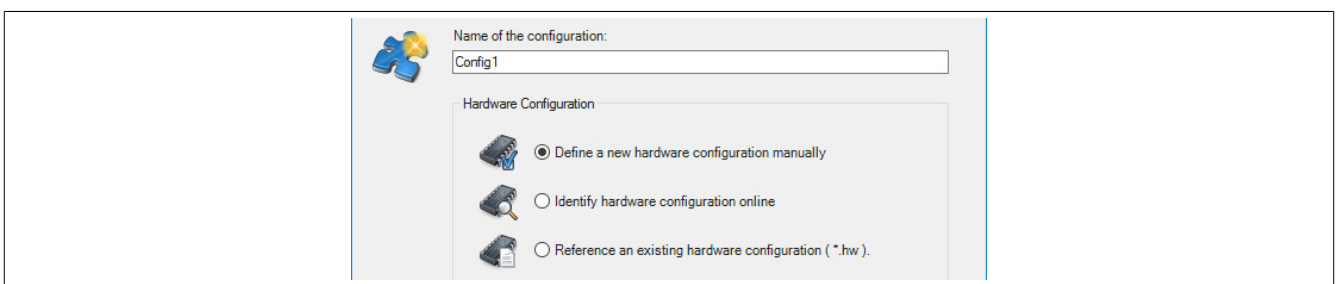
- Create a new Automation Studio project by selecting "New project".



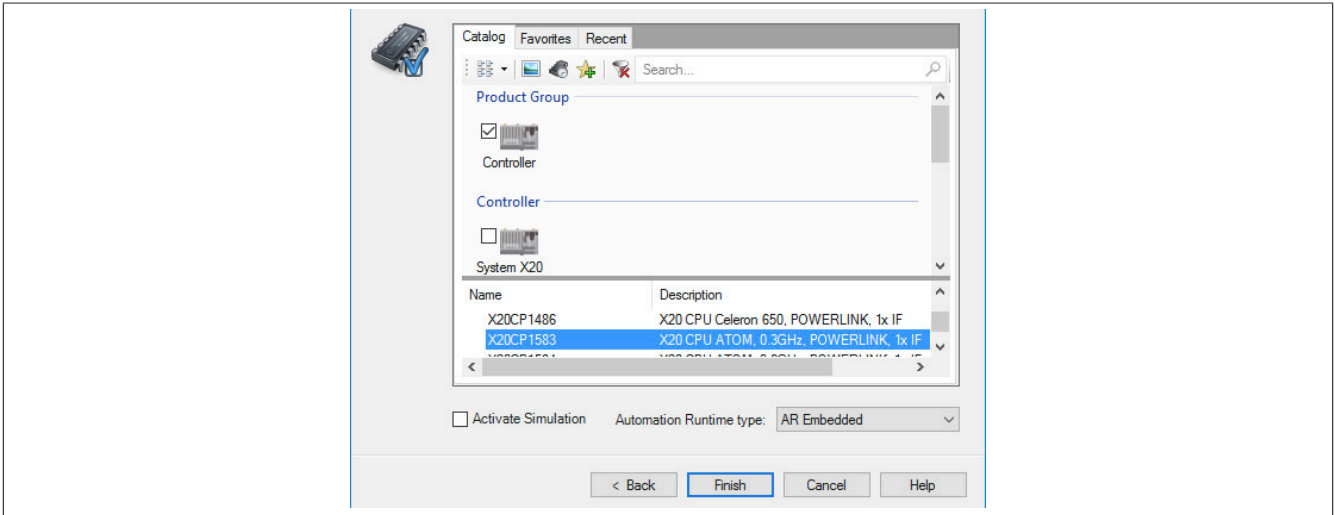
- Assign a project name and set up the project path.



- Assign the hardware configuration type and configuration name.

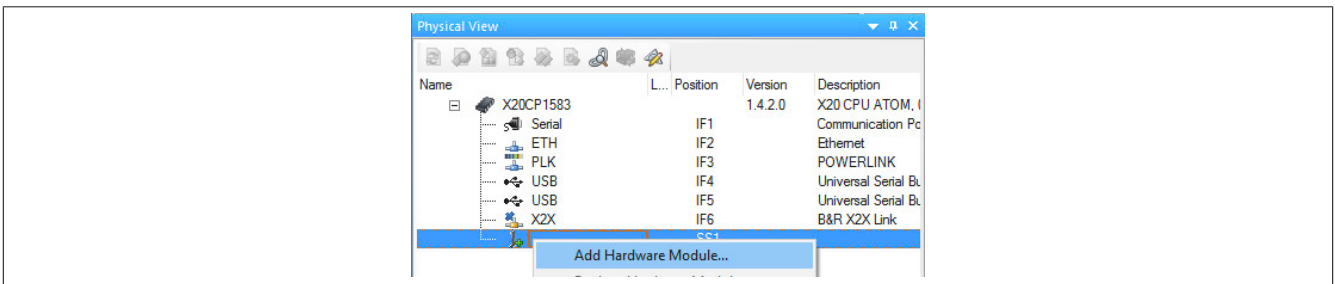


- Select the hardware in the next step if "Define a new hardware configuration manually" was selected. In order to simplify the search, different filters can be set in the Hardware Catalog. Lastly, highlight the required hardware and create the Automation Studio project by clicking on "Finish".

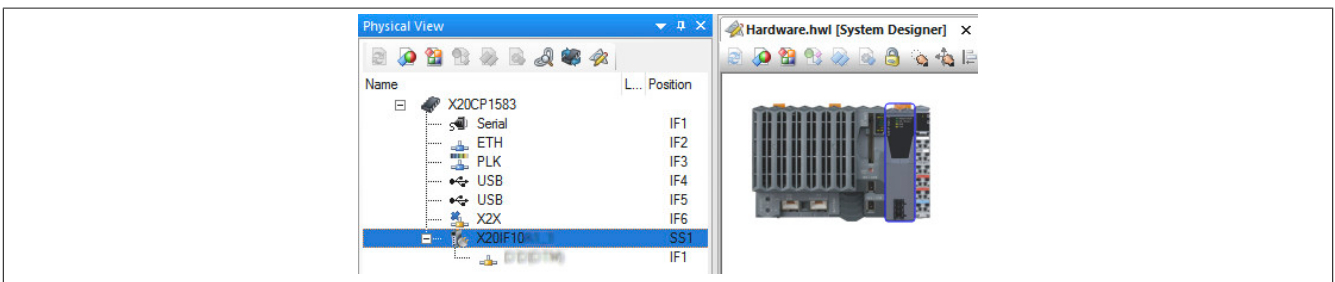


9.23.10.10.1.2 Adding and configuring the interface module

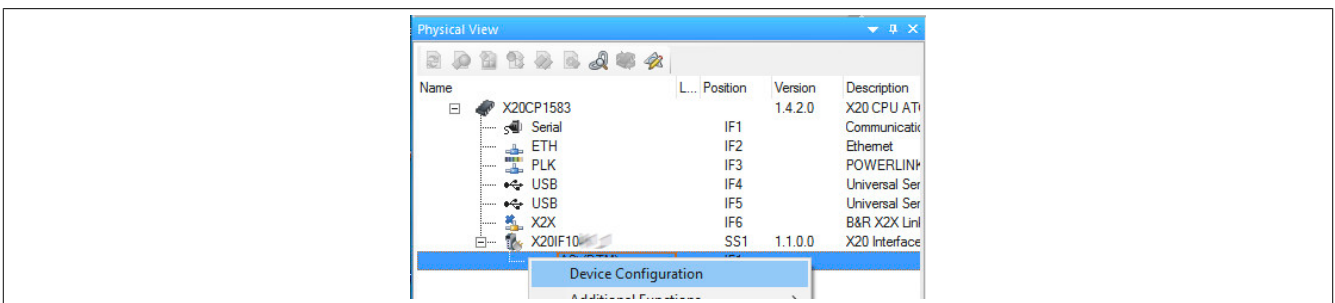
- In this example, the interface card is connected in the slot of a CPU. Right-clicking on the slot and selecting "Add hardware module" opens the Hardware Catalog.



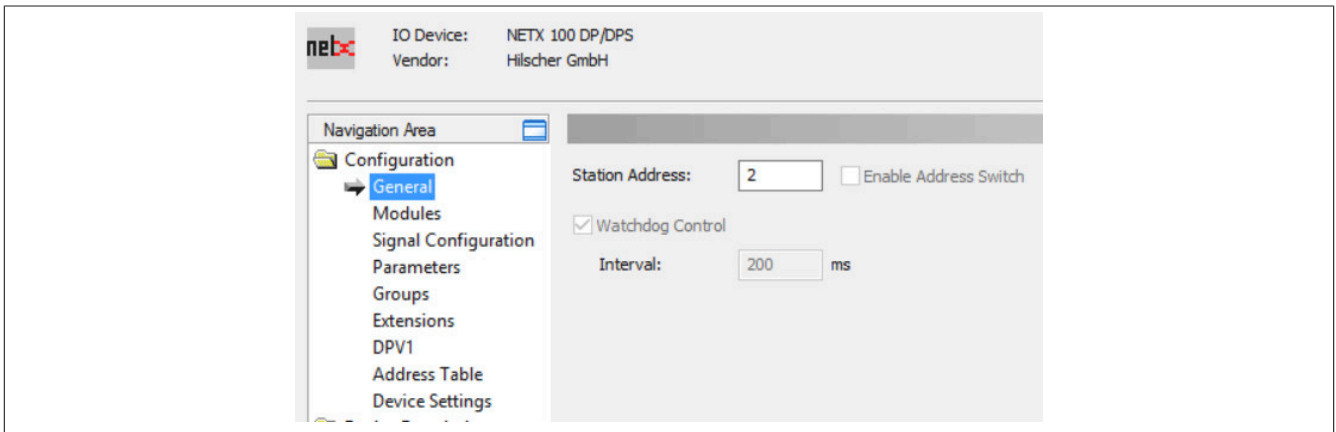
- The module is added to the project via drag-and-drop or by double-clicking on the interface card.



- Additional module settings can be made under "Device configuration". This configuration environment is opened by right-clicking on the IF interface and selecting "Device configuration".



- General settings are made in the device configuration.



General

Only the station addresses can be set here. No other setting options are supported for this module.

| Parameter | Explanation | Values |
|-------------------------------|--------------------------------------|----------|
| Station address | The desired station address. | 0 to 125 |
| Enable address switch | This parameter is not supported. | |
| Watchdog control and interval | These parameters are only displayed. | |

Modules

- Available modules

All available modules are listed in this table. Modules can be added to the configuration using buttons **Insert** and **Append**.

- **Insert:** Adds a new module before the selected module.
- **Append:** Adds a new module at the end of the configured modules list.

- Configured modules

The configured modules are listed in this table. If necessary, these can be removed with button **Remove**.

Signal configuration

The data structure of the individual modules can be defined here; the name and data type of the inputs and outputs can also be adjusted. Data types can also be combined.

| Parameter | Explanation |
|-------------|--|
| Slot | Position of the slot |
| Name | Name of the slot |
| Module type | Number of bytes and type of connection (input or output) |

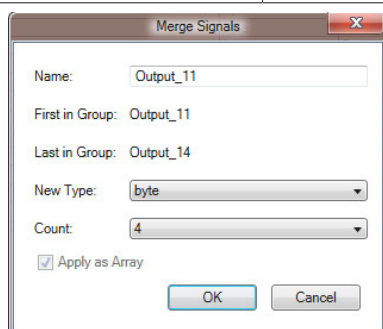
After selecting a slot, the type, data type and offset are displayed in another table below.

After right-clicking on the signal to be configured, the following options can be selected in the shortcut menu:

- **Edit signal**

This allows the currently selected signal to be edited.

| Parameter | Explanation |
|----------------|--|
| Name | The new name for the signal |
| New type | The new data type for the signal |
| Count | Number of individually listed data type elements for the signal. Only the data of the original type is re-structured; the quantity is not adjusted. - The maximum number corresponds to the quantity that the new data type requires to display the original type. - If fewer elements are selected, the last data type element is listed as an array of all remaining elements. |
| Apply as array | If selected, the new data type is displayed as an array. Otherwise, the data type elements set under "Count" are displayed. |



| Slot 5 12 Bytes Out | | |
|-----------------------|--------------|--------|
| Name | Type | Offset |
| Output_3 | byte | 3 |
| Output_4 | byte | 4 |
| Output_5 | byte | 5 |
| Output_6 | byte | 6 |
| Output_7 | byte | 7 |
| Output_8 | byte | 8 |
| Output_9 | byte | 9 |
| Output_10 | byte | 10 |
| Output_11 | 4 byte array | 11 |

- **Reset**

This can be used to undo the signal change or a merge previously completed with "Merge signal".

- **Merge signal**

This allows all signals between "First in group" and "Last in group" to be merged to form a new group. The same settings can be made for the new group as under "Edit signal".

The settings made are reflected in the process image (I/O mapping).

Configuring the signal

| Slot | Name | Type | Offset |
|--------|----------------------|-------|--------|
| Slot 1 | 8 Bytes In | | |
| | Temp_1 | byte | 0 |
| | Pressure_5 | byte | 1 |
| | Input_3_Byte_0_Bit_0 | bit | 2.0 |
| | Input_3_Byte_0_Bit_1 | bit | 2.1 |
| | Input_3_Byte_0_Bit_2 | bit | 2.2 |
| | Input_3_Byte_0_Bit_3 | bit | 2.3 |
| | Input_3_Byte_0_Bit_4 | bit | 2.4 |
| | Input_3_Byte_0_Bit_5 | bit | 2.5 |
| | Input_3_Byte_0_Bit_6 | bit | 2.6 |
| | Input_3_Byte_0_Bit_7 | bit | 2.7 |
| | Input_4 | byte | 3 |
| | Counter_Airflow_1 | dword | 4 |

Process image

| | | | | |
|--------------------------------|-------|--------------------------|-------|-------|
| Module001_Temp_1 | 0 | <input type="checkbox"/> | 0 | USINT |
| Module001_Pressure_5 | 0 | <input type="checkbox"/> | 0 | USINT |
| Module001_Input_3_Byte_0_Bit_0 | FALSE | <input type="checkbox"/> | FALSE | BOOL |
| Module001_Input_3_Byte_0_Bit_1 | FALSE | <input type="checkbox"/> | FALSE | BOOL |
| Module001_Input_3_Byte_0_Bit_2 | FALSE | <input type="checkbox"/> | FALSE | BOOL |
| Module001_Input_3_Byte_0_Bit_3 | FALSE | <input type="checkbox"/> | FALSE | BOOL |
| Module001_Input_3_Byte_0_Bit_4 | FALSE | <input type="checkbox"/> | FALSE | BOOL |
| Module001_Input_3_Byte_0_Bit_5 | FALSE | <input type="checkbox"/> | FALSE | BOOL |
| Module001_Input_3_Byte_0_Bit_6 | FALSE | <input type="checkbox"/> | FALSE | BOOL |
| Module001_Input_3_Byte_0_Bit_7 | FALSE | <input type="checkbox"/> | FALSE | BOOL |
| Module001_Input_4 | 0 | <input type="checkbox"/> | 0 | USINT |
| Module001_Counter_Airflow_1 | 0 | <input type="checkbox"/> | 0 | UDINT |

Parameters

These settings are not relevant because data types "Byte" and "Word" do not have parameter data.

Groups

These settings are configured in the GSD device description file on the PROFIBUS master. The master communicates the configuration to the slave via PROFIBUS.

The selected group memberships are transferred to the slave during startup. The group membership acts as a filter for global commands "Sync" and "Freeze". These are output as broadcast telegrams in order to synchronize the input and output data of the slaves. Only the slaves that have assigned to the group with the command respond to it.

| Parameter | Explanation |
|--------------------|------------------------------|
| Groups 1 through 8 | Selectable group memberships |

Extensions

These settings are configured in the GSD device description file on the PROFIBUS master. The master communicates the configuration to the slave via PROFIBUS.

- Auto clear

Function "Auto clear" is only used if "Auto clear on" has been enabled on the master.

| Parameter | Explanation |
|----------------------|---|
| Process "Auto clear" | In the event of a communication error, the master is put into standby mode and communication to the other slaves is aborted. |
| Ignore "Auto clear" | Communication errors to this slave are ignored. The master remains in mode "Operate" and communication to the other slaves is maintained. |

- Fail safe behavior

The "Fail safe" behavior shows the master whether the affected slave is working in mode "Fail safe".

| Parameter | Explanation |
|--|---|
| Slave receives zero data in Clear Mode | Mode "Fail safe" is enabled. In mode "Standby", the slave receives output data with a length of zero. |
| Slave receive no data in Clear Mode | Mode "Fail safe" is disabled. In mode "Standby", the slave does not receive output data. |

- Configuration data convention

Defines how configuration data is interpreted.

| Parameter | Explanation |
|-------------------|---|
| DPV1 compliant | Not supported by the module |
| EN50170 compliant | Configuration data interpreted per EN 50170 |

- Error on cyclic data exchange

Defines the behavior of the master in the event of error during cyclic data exchange.

| Parameter | Explanation |
|---|--|
| Continue if slave not responding. | The master remains in state DATA_EXCHANGE and retains the connection to the slave, even though the slave no longer responds and the master is not receiving any data from the slave. |
| Do not try to connect to slave on failure | The master does not remain in state DATA_EXCHANGE for the affected slave if the slave was detected as incorrect. |

- Diagnosis update delay

Some slaves require more time for the consistency check to process the SET_PRM configuration telegrams. In this case, the standard diagnostic cycle after the configuration phase is not sufficient for recognizing the arrangement of the slave for the DATA_EXCHANGE. "Diagnosis update delay" extends the number of diagnostic cycles after the configuration phase.

| Parameter | Explanation | Values |
|------------------------|--|----------|
| Diagnosis update delay | Specifies the delay time in cycles which the master waits before starting a new configuration phase. | 0 to 255 |

DPV1

These settings are configured in the GSD device description file on the PROFIBUS master. The master communicates the configuration to the slave via PROFIBUS.

Acyclic data exchange and alarm handling can be configured here.

| Parameter | Explanation | Values |
|--------------------------|---|----------|
| Enable DPV1 | Enables or disables the acyclic data exchange and alarm handling. | |
| Max. channel data length | Specifies the maximum length of the DPV1 alarm telegrams. The slave adapts its buffer size to the amount of data. | 4 to 244 |
| Max. alarm PDU length | Specifies the maximum number of active alarms | 4 to 64 |

- Alarm mode

This determines which alarms are transmitted by the slave.

| Parameter | Explanation |
|--|--|
| Alarm mode | Defines the maximum number of active alarms possible |
| Pull plug alarm Process alarm Diagnosis alarm Manufacturer specific alarm Status alarm Update alarm | Selection of alarms transmitted by the slave |

- Extra alarm SAP

This determines how the DPV1 master acknowledges an alarm from the DPV1 slave.

| Parameter | Explanation |
|------------------------------|--|
| Alarm acknowledge via SAP 51 | The PROFIBUS DPV1 master acknowledges alarms via SAP51 and uses SAP51 for DPV1 read/write. |
| Alarm acknowledge via SAP 50 | The PROFIBUS DPV1 master acknowledges alarms via SAP50. Nevertheless, the master still uses SAP51 for DPV1 read/write services. SAP50 is only used for acknowledging alarms and is not delayed by running DPV1 read-write services; this allows a higher performance to be achieved. |

Address table

This table provides information about the addresses of the input and output data (in decimal or hexadecimal notation).

"Display mode" allows toggling between decimal and hexadecimal display.

| Parameter | Explanation |
|-----------|--|
| Modules | Name of the module per the GSD file |
| Type | Type of input or output data |
| Length | Number of data types contained |
| Address | Offset address of the input or output data |

The address table can also be exported as a CSV file.

Device settings

- Start of bus communication

It is possible to select how data exchange is started on the module.

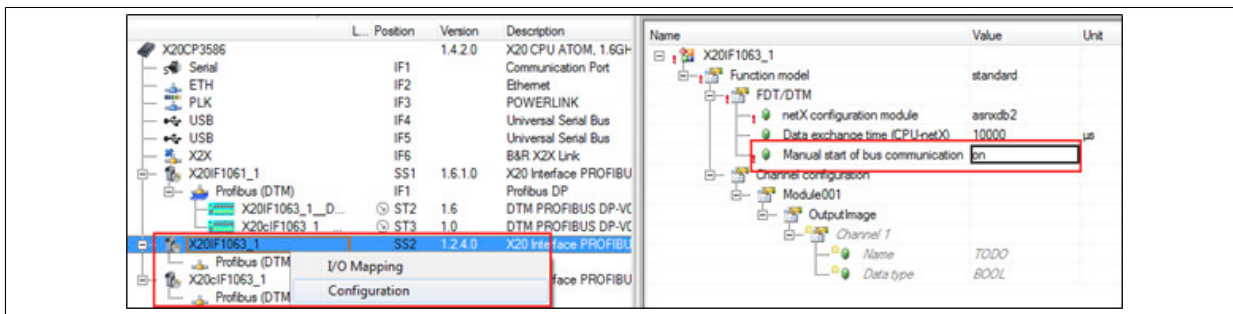
| Parameter | Explanation |
|---------------------------|--|
| Automatically by device | Data exchange is started automatically after initializing this module. |
| Controlled by application | Data exchange is started by Automation Runtime. |

Information:

Parameter "Manual start of bus communication" can be enabled under the I/O configuration of the PROFIBUS slave.

The following settings must be made in order to avoid automatic data exchange:

- In the IF module configuration, "Manual start of bus communication" must be set to "On".



- "Start of bus communication" must be set to "Controlled by application".

With this setting, the communication can only be started via function block **AsNxDpS - nx dpsStartBusComm()**.

- Process image storage format

This is used to define how data is stored in the process image (I/O mapping). The storage format is only applied to data type "Word". This change has no effect on other data types.

| Storage format | Explanation |
|----------------|---|
| Big-endian | MSB/LSB = Higher/Lower byte (Motorola format) |
| Little-endian | MSB/LSB = Higher/Lower byte (Intel format) |

Storage format - Little-endian (default setting)

| | | | | | | | | | |
|--------------------|---------|--------------------------|---------|-------|--------------------|---------|--------------------------|---------|-------|
| Module002_Output_1 | 16#00 | <input type="checkbox"/> | 16#00 | USINT | Module002_Output_1 | 16#00 | <input type="checkbox"/> | 16#00 | USINT |
| Module003_Input_2 | 16#3344 | <input type="checkbox"/> | 16#0000 | UINT | Module003_Input_2 | 16#4433 | <input type="checkbox"/> | 16#0000 | UINT |
| Module004_Output_2 | 16#0000 | <input type="checkbox"/> | 16#0000 | UINT | Module004_Output_2 | 16#0000 | <input type="checkbox"/> | 16#0000 | UINT |

Storage format - Big-endian

- Application monitoring

The module-internal watchdog time can be set here. If the watchdog has been enabled (watchdog time not equal to 0), the hardware watchdog must be reset after the set time at the latest.

| Parameter | Explanation | Values |
|---------------|-----------------------------|----------------|
| Watchdog time | Watchdog software disabled | 0 ms |
| | Permissible range of values | 20 to 65535 ms |
| | Default value: 1000 ms | |

Information:

The watchdog time is reset automatically by Automation Runtime.

- Configuration data flag

The configuration used is defined here.

| Parameter | Explanation |
|---------------------------|--|
| Fixed configuration | Uses the configuration created in the slave DTM |
| Configuration from master | Not supported, i.e. no connection is established |

Device description

General device information and the entire GSD file can be read here.

9.23.10.10.2 GSD device description file

The module description is made available to the master in an GSD file. This text file contains the description of the slave's complete range of functions. The GSD file can be downloaded from the B&R website (www.br-automation.com) in the Downloads section for the interface module and then imported into the respective master environment.

9.23.11 X20(c)IF1072

Data sheet version: 2.34

9.23.11.1 General information

The interface module can be used to expand the X20 CPU for specific applications. It is equipped with a CAN bus interface.

- CAN bus connection
- Integrated terminating resistor

Information:

This module does not support CAN RTR messages with extended CAN identifiers (29-bit) (memory/performance bottleneck).

9.23.11.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.23.11.3 Order data

| Model number | Short description | Figure |
|--------------|--|--------|
| | X20 interface module communication | |
| X20IF1072 | X20 interface module, 1 CAN bus interface, max. 1 Mbit/s, electrically isolated, order 1x TB2105 terminal block separately | |
| X20cIF1072 | X20 interface module, coated, 1 CAN bus interface, max. 1 Mbit/s, electrically isolated, order 1x TB2105 terminal block separately | |
| | Required accessories | |
| | Terminal blocks | |
| 0TB2105.9010 | Accessory terminal block, 5-pin, screw clamps 2.5 mm ² | |
| 0TB2105.9110 | Accessory terminal block, 5-pin, push-in terminal block 2.5 mm ² | |

Table 439: X20IF1072, X20cIF1072 - Order data


9.23.11.4 Technical data

| Model number | X20IF1072 | X20cIF1072 |
|--|--|------------------------|
| Short description | | |
| Communication module | 1x CAN bus | |
| General information | | |
| B&R ID code | 0x1F20 | 0xE506 |
| Status indicators | Module status, data transfer, terminating resistor | |
| Diagnostics | | |
| Module status | Yes, using status LED | |
| Data transfer | Yes, using status LED | |
| Terminating resistor | Yes, using status LED | |
| Power consumption | 0.79 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| KC | Yes | - |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | - |
| Interfaces | | |
| Interface IF1 | | |
| Signal | CAN bus ¹⁾ | |
| Variant | 5-pin male multipoint connector | |
| Max. distance | 1000 m | |
| Transfer rate | Max. 1 Mbit/s | |
| Terminating resistor | Integrated in the module | |
| Controller | SJA 1000 | |
| Electrical properties | | |
| Electrical isolation | PLC isolated from CAN (IF1) | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | | |
| Storage | - | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x TB2105 terminal block separately | |
| Slot | In X20 CPU | |

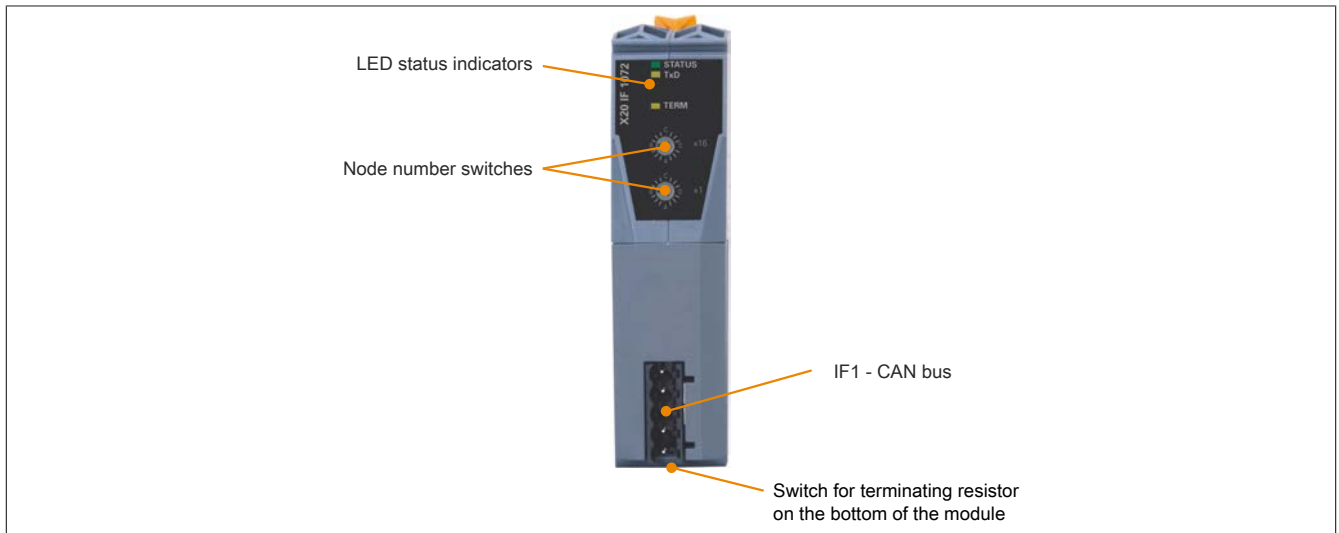
Table 440: X20IF1072, X20cIF1072 - Technical data

1) This CAN bus interface can be configured as a CANopen master in Automation Studio 3.0 and higher.

9.23.11.5 LED status indicators

| Figure | LED | Color | Status | Description |
|---|--------|--------|--------|---|
|  | STATUS | Green | On | Interface module active |
| | | Red | On | CPU starting up |
| | TxD | Yellow | On | The module is sending data via the CAN bus interface |
| | TERM | Yellow | On | Terminating resistor integrated in the module switched on |

9.23.11.6 Operating and connection elements



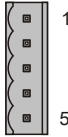
9.23.11.7 Node number switch



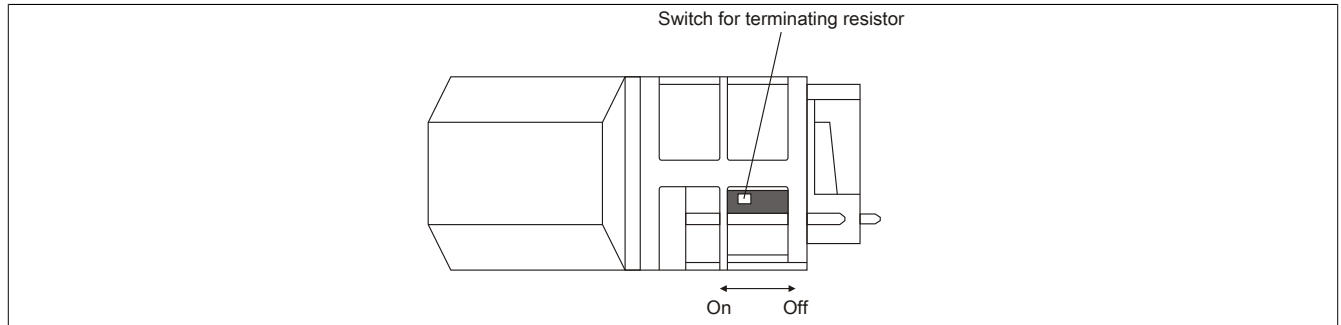
The node number for the interface is set with the two hex switches.

9.23.11.8 CAN bus interface

The interface is a 5-pin multipoint connector. Terminal block 0TB2105 must be ordered separately.

| Interface | | Pinout | |
|--|----------|------------------|------------|
|  5-pin male multipoint connector | Terminal | Function | |
| | 1 | CAN _⊥ | CAN ground |
| | 2 | CAN _L | CAN low |
| | 3 | SHLD | Shield |
| | 4 | CAN _H | CAN high |
| 5 | NC | | |

9.23.11.9 Terminating resistor



A terminating resistor is integrated in the interface module. It can be switched on or off with a switch on the bottom of the housing. A switched-on terminating resistor is indicated by LED "TERM".

9.23.11.10 Firmware

The module comes with preinstalled firmware. The firmware is part of Automation Studio. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.23.12 X20IF1082

Data sheet version: 2.25

9.23.12.1 General information

The interface module can be used to expand the X20 CPU for specific applications. It is equipped with an POWERLINK interface.

The interface has two RJ45 sockets. Both connections lead to an integrated hub. This makes it easy to create daisy-chain connections using POWERLINK.

- POWERLINK for real-time Ethernet communication
- Integrated hub for efficient cabling
- Configurable ring redundancy

9.23.12.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | X20 interface module communication | |
| X20IF1082 | X20 interface module, 1 POWERLINK interface, managing or controlled node, integrated 2-port hub, ring redundancy function |  |

Table 441: X20IF1082 - Order data

Optional accessories

| Model number | Short description |
|-----------------|--|
| X20CA0E61.xxxxx | POWERLINK/Ethernet connection cable, RJ45 to RJ45, 0.2 to 20 m |
| X20CA0E61.xxxx | POWERLINK/Ethernet connection cable, RJ45 to RJ45, 20 m and longer |


9.23.12.3 Technical data

| Model number | X20IF1082 |
|--|--|
| Short description | |
| Communication module | 1x POWERLINK (V1/V2) managing or controlled node |
| General information | |
| B&R ID code | 0x1F1F |
| Status indicators | Module status, bus function |
| Diagnosics | |
| Module status | Yes, using status LED and software |
| Bus function | Yes, using status LED and software |
| Power consumption | 2 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Interfaces | |
| Fieldbus | POWERLINK (V1/V2) managing or controlled node |
| Type | Type 3 ¹⁾ |
| Variant | 2x shielded RJ45 (hub) |
| Line length | Max. 100 m between 2 stations (segment length) |
| Transfer rate | 100 Mbit/s |
| Transfer | |
| Physical layer | 100BASE-TX |
| Half-duplex | Yes |
| Full-duplex | No |
| Autonegotiation | Yes |
| Auto-MDI/MDIX | Yes |
| Hub propagation delay | 0.96 to 1 µs |
| Controller | POWERLINK MAC |
| Electrical properties | |
| Electrical isolation | PLC isolated from POWERLINK (X1 and X2) |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Slot | In the X20 CPU |

Table 442: X20IF1082 - Technical data

1) See Automation Help under "Communication / POWERLINK / General information / Hardware - IF/LS" for more information.

9.23.12.4 LED status indicators

| Figure | LED | Color | Status | Description |
|---|---------|-----------|----------|--|
|  | S/E | Green/Red | | Status/Error LED. The LED indicators are described in section "LED "S/E" (LED "Status/Error")" on page 2359. |
| | L/A IFx | Green | On | A link to the remote station has been established. |
| | | | Blinking | A link to the remote station has been established. Indicates Ethernet activity is taking place on the bus |

9.23.12.4.1 LED "S/E" (LED "Status/Error")

This LED is a green/red dual LED and indicates the state of the POWERLINK interface. The LED states have a different meaning depending on the operating mode of the POWERLINK interface.

9.23.12.4.1.1 Ethernet mode

In this mode, the interface is operated as an Ethernet interface.

| LED "S/E" | | Description |
|-----------|-----|---|
| Green | Red | |
| On | Off | The interface is operated as an Ethernet interface. |

Table: LED "S/E": Interface in Ethernet mode

9.23.12.4.1.2 POWERLINK V1 mode

| LED "S/E" | | Current state of the POWERLINK node |
|----------------------|----------|--|
| Green | Red | |
| On | Off | The POWERLINK node is running with no errors. |
| Off | On | A system error occurred. The type of error can be read using the PLC logbook. An irreparable problem has occurred. The system can no longer properly carry out its tasks. This state can only be changed by resetting the module. |
| Blinking alternately | | The POWERLINK managing node has failed. This error code can only occur when operated as a controlled node. This means that the set node number lies within the range 0x01 - 0xFD. |
| Off | Blinking | System stop. The red blinking LED indicates an error code (see "System stop error codes" on page 2361). |
| Off | Off | The interface is either not active or one of the following states or errors is present: <ul style="list-style-type: none"> The device is switched off. The device is in the startup phase. The interface or device is not configured correctly in Automation Studio. The interface or device is defective. |

Table 443: LED "S/E": POWERLINK V1 mode

9.23.12.4.1.3 POWERLINK V2 mode

Error message

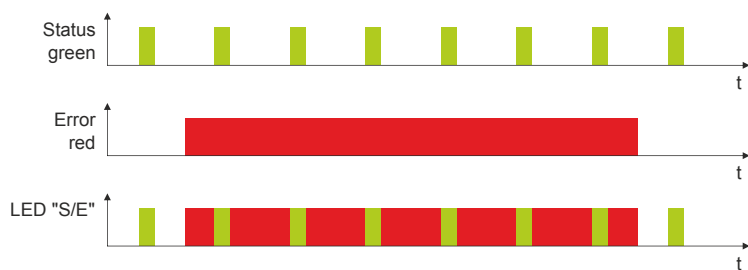
| LED "S/E" | | Description |
|-----------|-----|--|
| Green | Red | |
| Off | On | The interface is in error mode (failed Ethernet frames, increased number of collisions on the network, etc.). Note: Several red blinking signals are displayed immediately after the device is switched on. These are not errors, however. |
| Blinking | On | If an error occurs in the following modes, then the green LED blinks over the red LED: <ul style="list-style-type: none"> PRE_OPERATIONAL_1 PRE_OPERATIONAL_2 READY_TO_OPERATE  |

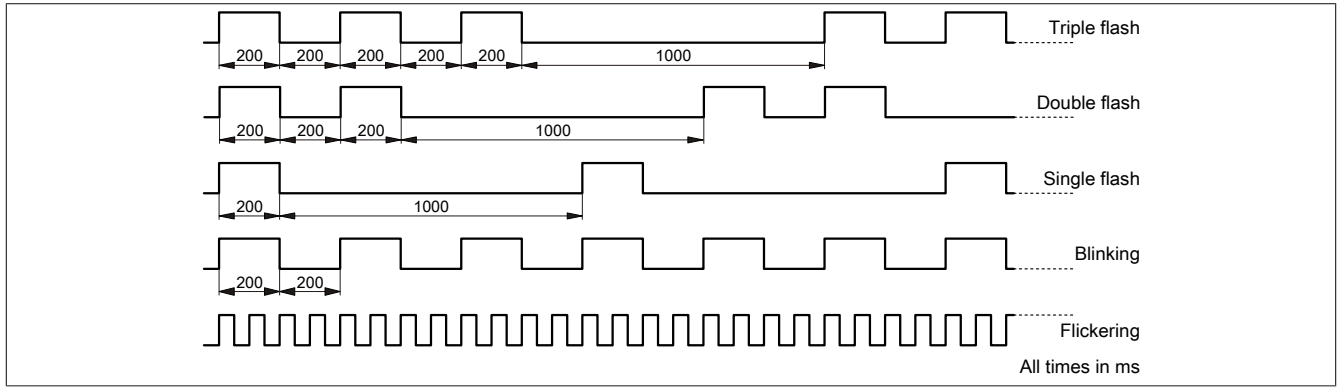
Table: LED "S/E" - Error message (interface in POWERLINK mode)

Interface status

| LED "S/E" | | Description |
|-----------------------------|-----|--|
| Green | Red | |
| Off | Off | <p>Mode: NOT_ACTIVE The interface is either in mode NOT_ACTIVE or one of the following modes or errors is present:</p> <ul style="list-style-type: none"> The device is switched off. The device is in the startup phase. The interface or device is not configured correctly in Automation Studio. The interface or device is defective. <p>Managing node (MN) The network is monitored for POWERLINK frames. If a frame is not received within the configured time window (timeout), the interface immediately enters mode PRE_OPERATIONAL_1. If POWERLINK communication is detected before the time has elapsed, however, the MN is not started.</p> <p>Controlled node (CN) The network is monitored for POWERLINK frames. If a frame is not received within the configured time window (timeout), the interface immediately enters mode BASIC_ETHERNET. If POWERLINK communication is detected before this time expires, however, the interface immediately enters mode PRE_OPERATIONAL_1.</p> |
| Flickering (approx. 10 Hz) | Off | <p>Mode: BASIC_ETHERNET The interface is in mode BASIC_ETHERNET. The interface is operated in <i>Ethernet mode</i>.</p> <p>Managing node (MN) This mode can only be exited by resetting the controller.</p> <p>Controlled node (CN) If POWERLINK communication is detected during this mode, the interface enters mode PRE_OPERATIONAL_1.</p> |
| Single flash (approx. 1 Hz) | Off | <p>Mode: PRE_OPERATIONAL_1 The interface is in mode PRE_OPERATIONAL_1.</p> <p>Managing node (MN) The MN is in "reduced cycle" operation. The CNs are configured in this mode. Cyclic communication is not yet taking place.</p> <p>Controlled node (CN) The CN can be configured by the MN in this mode. The CN waits until it receives an SoC frame and then switches to mode PRE_OPERATIONAL_2.</p> |
| | On | <p>Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed.</p> |
| Double flash (approx. 1 Hz) | Off | <p>Mode: PRE_OPERATIONAL_2 The interface is in mode PRE_OPERATIONAL_2.</p> <p>Managing node (MN) The MN starts cyclic communication (cyclic input data is not yet evaluated). The CNs are configured in this mode.</p> <p>Controlled node (CN) The CN can be configured by the MN in this mode. A command then switches the mode to READY_TO_OPERATE.</p> |
| | On | <p>Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed.</p> |
| Triple flash (approx. 1 Hz) | Off | <p>Mode: READY_TO_OPERATE The interface is in mode READY_TO_OPERATE.</p> <p>Managing node (MN) Cyclic and asynchronous communication. Received PDO data is ignored.</p> <p>Controlled node (CN) The configuration of the CN is completed. Normal cyclic and asynchronous communication. The transmitted PDO data corresponds to the PDO mapping. However, cyclic data is not yet evaluated.</p> |
| | On | <p>Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed.</p> |
| On | Off | <p>Mode: OPERATIONAL The interface is in mode OPERATIONAL. PDO mapping is active and cyclic data is evaluated.</p> |
| Blinking (approx. 2.5 Hz) | Off | <p>Mode: STOPPED The interface is in mode STOPPED.</p> <p>Managing node (MN) This mode does not occur for the MN.</p> <p>Controlled node (CN) Output data is not being output, and no input data is being provided. This mode can only be reached and exited by a corresponding command from the MN.</p> |

Table: LED "S/E" - Interface state (interface in POWERLINK mode)

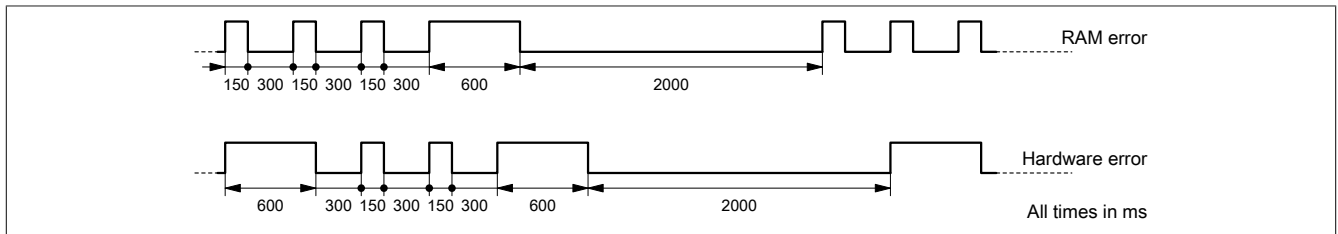
Blink times



9.23.12.4.1.4 System stop error codes

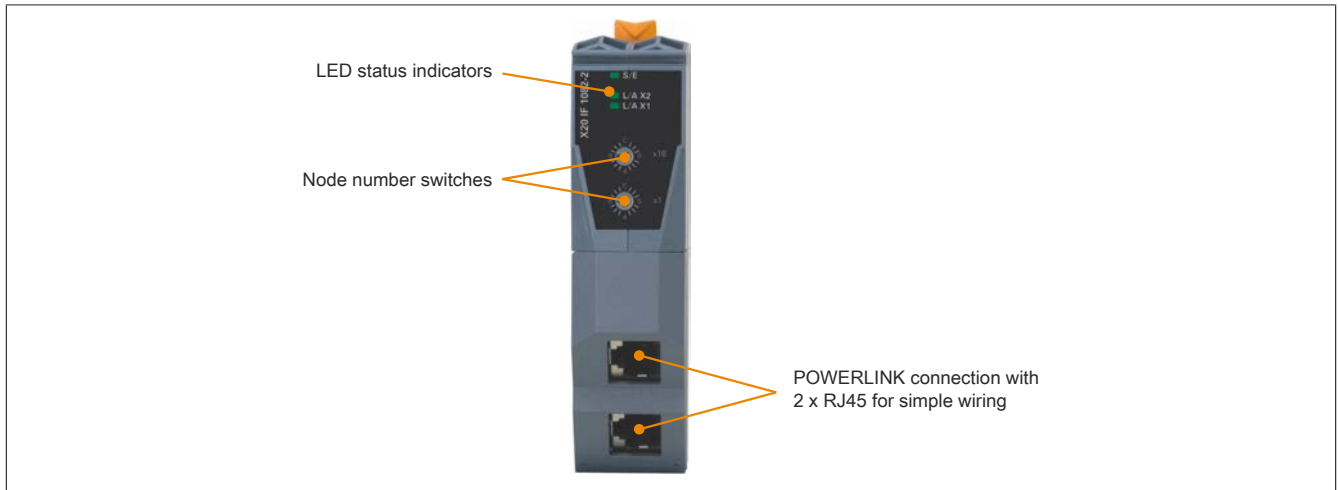
A system stop error can occur due to incorrect configuration or defective hardware.

The error code is indicated by LED "S/E" blinking red. The blinking signal of the error code consists of 4 switch-on phases with short (150 ms) or long (600 ms) duration. The error code is repeated every 2 seconds.



| Error | Error description |
|----------------|---|
| RAM error | The device is defective and must be replaced. |
| Hardware error | The device or a system component is defective and must be replaced. |

9.23.12.5 Operating and connection elements



9.23.12.6 POWERLINK node number



The node number for the POWERLINK station is set using the two number switches. The node number can also be directly configured using Automation Studio.

9.23.12.6.1 POWERLINK V1

| Switch position | Description |
|-----------------|--|
| 0x00 | Operation as managing node. |
| 0x01 - 0xFD | Node number of the POWERLINK node. Operation as controlled node. |
| 0xFE - 0xFF | Reserved, switch position not permitted |

9.23.12.6.2 POWERLINK V2

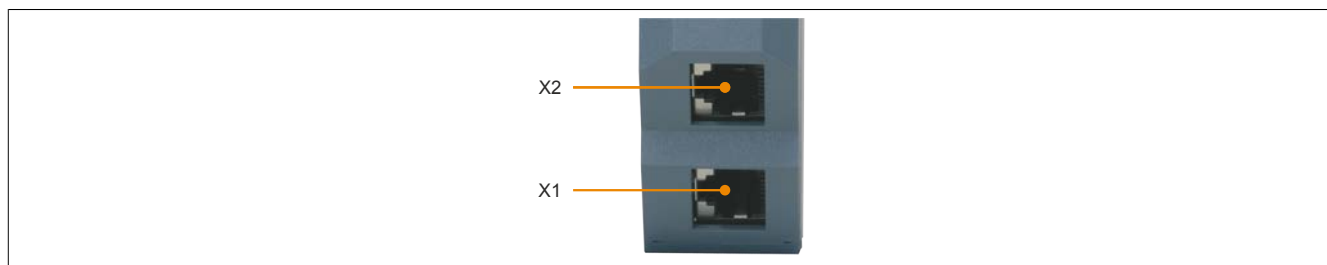
| Switch position | Description |
|-----------------|---|
| 0x00 | Reserved, switch position not permitted. |
| 0x01 - 0xEF | Node number of the POWERLINK node. Operation as a controlled node (CN). |
| 0xF0 | Operation as a managing node (MN). |
| 0xF1 - 0xFF | Reserved, switch position not permitted. |

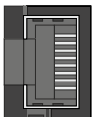
9.23.12.6.3 Ethernet mode

In this mode, the interface is operated as an Ethernet interface. The INA2000 station number is set using the B&R Automation Studio software.

9.23.12.7 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see ["Cabling guidelines for X20 modules with an Ethernet cable" on page 58](#).



| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.23.12.8 Firmware

The module comes with preinstalled firmware. The firmware is part of Automation Studio. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.23.13 X20(c)IF1082-2

Data sheet version: 1.25

9.23.13.1 General information

The interface module can be used to expand the X20 CPU for specific applications. It is equipped with an POWERLINK interface.

The interface has two RJ45 sockets. Both connections lead to an integrated hub. This makes it easy to create daisy-chain connections using POWERLINK.

- POWERLINK for real-time Ethernet communication
- Integrated hub for efficient cabling
- Configurable ring redundancy
- Poll response chaining
- Dynamic Node Allocation (DNA)

9.23.13.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.23.13.3 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | X20 interface module communication |  |
| X20IF1082-2 | X20 interface module, 1 POWERLINK interface, managing or controlled node, integrated 2-port hub, ring redundancy function PRC function | |
| X20clF1082-2 | X20 interface module, coated, 1 POWERLINK interface, managing or controlled node, integrated 2-port hub, ring redundancy function PRC function | |

Table 444: X20IF1082-2, X20clF1082-2 - Order data

Optional accessories

| Model number | Short description |
|-----------------|--|
| X20CA0E61.xxxxx | POWERLINK/Ethernet connection cable, RJ45 to RJ45, 0.2 to 20 m |
| X20CA0E61.xxxx | POWERLINK/Ethernet connection cable, RJ45 to RJ45, 20 m and longer |


9.23.13.4 Technical data

| Model number | X20IF1082-2 | X20cIF1082-2 |
|--|--|------------------------|
| Short description | | |
| Communication module | 1x POWERLINK (V1/V2) managing or controlled node | |
| General information | | |
| B&R ID code | 0xA7A3 | 0xE236 |
| Status indicators | Module status, bus function | |
| Diagnostics | | |
| Module status | Yes, using status LED and software | |
| Bus function | Yes, using status LED and software | |
| Power consumption | 2 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| KC | Yes | - |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| Interfaces | | |
| Fieldbus | POWERLINK (V1/V2) managing or controlled node | |
| Type | Type 4 ¹⁾ | |
| Variant | 2x shielded RJ45 (hub) | |
| Line length | Max. 100 m between 2 stations (segment length) | |
| Transfer rate | 100 Mbit/s | |
| Transfer | | |
| Physical layer | 100BASE-TX | |
| Half-duplex | Yes | |
| Full-duplex | No | |
| Autonegotiation | Yes | |
| Auto-MDI/MDIX | Yes | |
| Hub propagation delay | 0.96 to 1 µs | |
| Controller | POWERLINK MAC | |
| Electrical properties | | |
| Electrical isolation | PLC isolated from POWERLINK (X1 and X2) | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | | |
| Storage | - | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Slot | In the X20 CPU | In X20c CPU |

Table 445: X20IF1082-2, X20cIF1082-2 - Technical data

1) See Automation Help under "Communication / POWERLINK / General information / Hardware - IF/LS" for more information.

9.23.13.5 LED status indicators

| Figure | LED | Color | Status | Description |
|---|-----------|-----------|----------|--|
|  | S/E | Green/Red | | Status/Error LED. The LED indicators are described in section "LED "S/E" (LED "Status/Error")" on page 2365. |
| | L/A X1/X2 | Green | On | A link to the remote station has been established. |
| | | | Blinking | A link to the remote station has been established. Indicates Ethernet activity is taking place on the bus |

9.23.13.5.1 LED "S/E" (LED "Status/Error")

This LED is a green/red dual LED and indicates the state of the POWERLINK interface. The LED states have a different meaning depending on the operating mode of the POWERLINK interface.

9.23.13.5.1.1 Ethernet mode

In this mode, the interface is operated as an Ethernet interface.

| LED "S/E" | | Description |
|-----------|-----|---|
| Green | Red | |
| On | Off | The interface is operated as an Ethernet interface. |

Table: LED "S/E": Interface in Ethernet mode

9.23.13.5.1.2 POWERLINK V1 mode

| LED "S/E" | | Current state of the POWERLINK node |
|----------------------|----------|--|
| Green | Red | |
| On | Off | The POWERLINK node is running with no errors. |
| Off | On | A system error occurred. The type of error can be read using the PLC logbook. An irreparable problem has occurred. The system can no longer properly carry out its tasks. This state can only be changed by resetting the module. |
| Blinking alternately | | The POWERLINK managing node has failed. This error code can only occur when operated as a controlled node. This means that the set node number lies within the range 0x01 - 0xFD. |
| Off | Blinking | System stop. The red blinking LED indicates an error code (see "System stop error codes" on page 2367). |
| Off | Off | The interface is either not active or one of the following states or errors is present: <ul style="list-style-type: none"> • The device is switched off. • The device is in the startup phase. • The interface or device is not configured correctly in Automation Studio. • The interface or device is defective. |

Table 446: LED "S/E": POWERLINK V1 mode

9.23.13.5.1.3 POWERLINK V2 mode

Error message

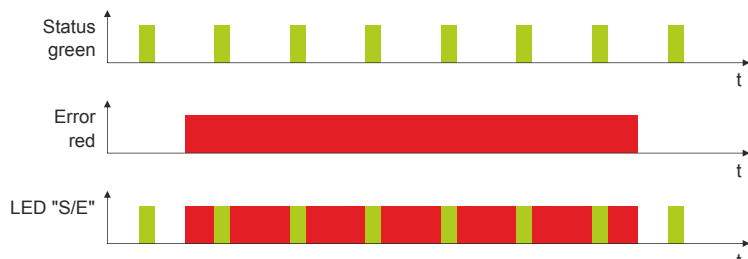
| LED "S/E" | | Description |
|-----------|-----|--|
| Green | Red | |
| Off | On | The interface is in error mode (failed Ethernet frames, increased number of collisions on the network, etc.). Note: Several red blinking signals are displayed immediately after the device is switched on. These are not errors, however. |
| Blinking | On | If an error occurs in the following modes, then the green LED blinks over the red LED: <ul style="list-style-type: none"> • PRE_OPERATIONAL_1 • PRE_OPERATIONAL_2 • READY_TO_OPERATE  |

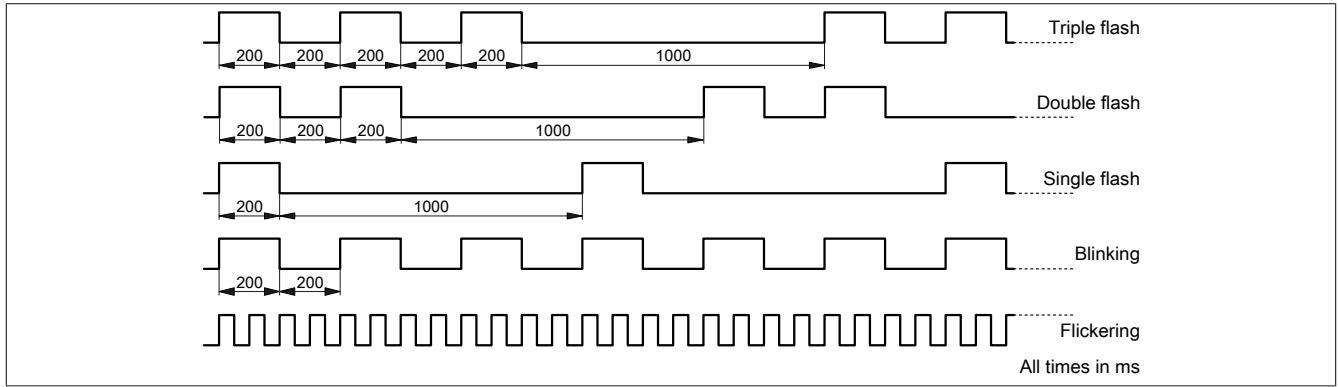
Table: LED "S/E" - Error message (interface in POWERLINK mode)

Interface status

| LED "S/E" | | Description |
|-----------------------------|-----|--|
| Green | Red | |
| Off | Off | <p>Mode: NOT_ACTIVE The interface is either in mode NOT_ACTIVE or one of the following modes or errors is present:</p> <ul style="list-style-type: none"> The device is switched off. The device is in the startup phase. The interface or device is not configured correctly in Automation Studio. The interface or device is defective. <p>Managing node (MN) The network is monitored for POWERLINK frames. If a frame is not received within the configured time window (timeout), the interface immediately enters mode PRE_OPERATIONAL_1. If POWERLINK communication is detected before the time has elapsed, however, the MN is not started.</p> <p>Controlled node (CN) The network is monitored for POWERLINK frames. If a frame is not received within the configured time window (timeout), the interface immediately enters mode BASIC_ETHERNET. If POWERLINK communication is detected before this time expires, however, the interface immediately enters mode PRE_OPERATIONAL_1.</p> |
| Flickering (approx. 10 Hz) | Off | <p>Mode: BASIC_ETHERNET The interface is in mode BASIC_ETHERNET. The interface is operated in <i>Ethernet mode</i>.</p> <p>Managing node (MN) This mode can only be exited by resetting the controller.</p> <p>Controlled node (CN) If POWERLINK communication is detected during this mode, the interface enters mode PRE_OPERATIONAL_1.</p> |
| Single flash (approx. 1 Hz) | Off | <p>Mode: PRE_OPERATIONAL_1 The interface is in mode PRE_OPERATIONAL_1.</p> <p>Managing node (MN) The MN is in "reduced cycle" operation. The CNs are configured in this mode. Cyclic communication is not yet taking place.</p> <p>Controlled node (CN) The CN can be configured by the MN in this mode. The CN waits until it receives an SoC frame and then switches to mode PRE_OPERATIONAL_2.</p> |
| | On | <p>Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed.</p> |
| Double flash (approx. 1 Hz) | Off | <p>Mode: PRE_OPERATIONAL_2 The interface is in mode PRE_OPERATIONAL_2.</p> <p>Managing node (MN) The MN starts cyclic communication (cyclic input data is not yet evaluated). The CNs are configured in this mode.</p> <p>Controlled node (CN) The CN can be configured by the MN in this mode. A command then switches the mode to READY_TO_OPERATE.</p> |
| | On | <p>Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed.</p> |
| Triple flash (approx. 1 Hz) | Off | <p>Mode: READY_TO_OPERATE The interface is in mode READY_TO_OPERATE.</p> <p>Managing node (MN) Cyclic and asynchronous communication. Received PDO data is ignored.</p> <p>Controlled node (CN) The configuration of the CN is completed. Normal cyclic and asynchronous communication. The transmitted PDO data corresponds to the PDO mapping. However, cyclic data is not yet evaluated.</p> |
| | On | <p>Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed.</p> |
| On | Off | <p>Mode: OPERATIONAL The interface is in mode OPERATIONAL. PDO mapping is active and cyclic data is evaluated.</p> |
| Blinking (approx. 2.5 Hz) | Off | <p>Mode: STOPPED The interface is in mode STOPPED.</p> <p>Managing node (MN) This mode does not occur for the MN.</p> <p>Controlled node (CN) Output data is not being output, and no input data is being provided. This mode can only be reached and exited by a corresponding command from the MN.</p> |

Table: LED "S/E" - Interface state (interface in POWERLINK mode)

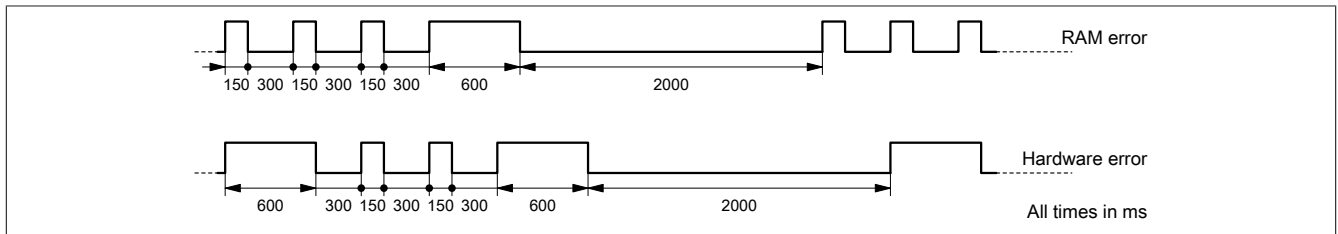
Blink times



9.23.13.5.1.4 System stop error codes

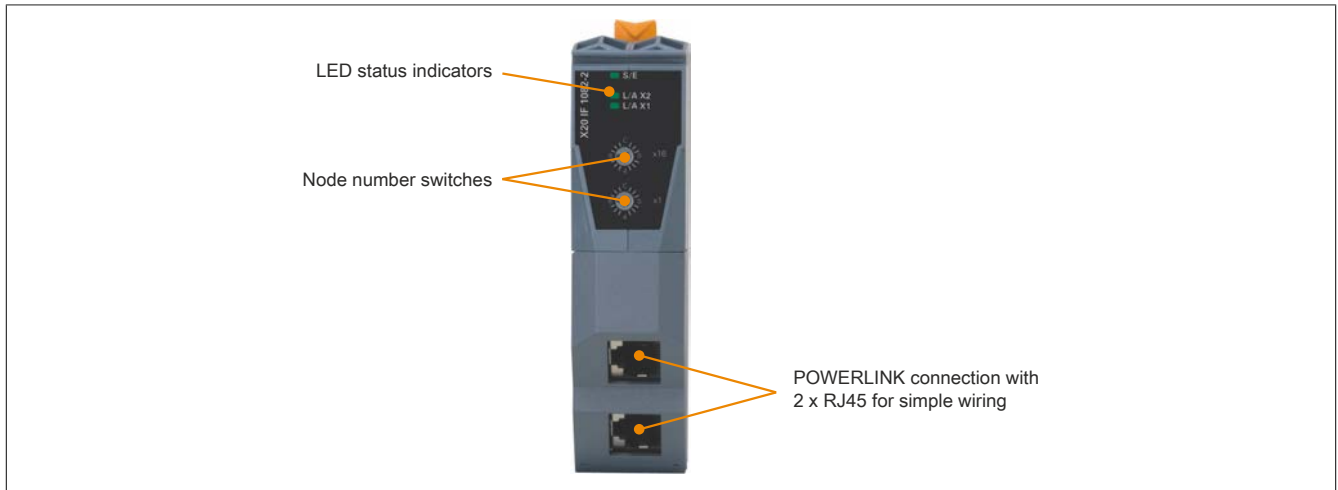
A system stop error can occur due to incorrect configuration or defective hardware.

The error code is indicated by LED "S/E" blinking red. The blinking signal of the error code consists of 4 switch-on phases with short (150 ms) or long (600 ms) duration. The error code is repeated every 2 seconds.



| Error | Error description |
|----------------|---|
| RAM error | The device is defective and must be replaced. |
| Hardware error | The device or a system component is defective and must be replaced. |

9.23.13.6 Operating and connection elements



9.23.13.7 POWERLINK node number



The node number for the POWERLINK station is set using the two number switches. The node number can also be directly configured using Automation Studio.

9.23.13.7.1 POWERLINK V1

| Switch position | Description |
|-----------------|--|
| 0x00 | Operation as managing node. |
| 0x01 - 0xFD | Node number of the POWERLINK node. Operation as controlled node. |
| 0xFE - 0xFF | Reserved, switch position not permitted |

9.23.13.7.2 POWERLINK V2

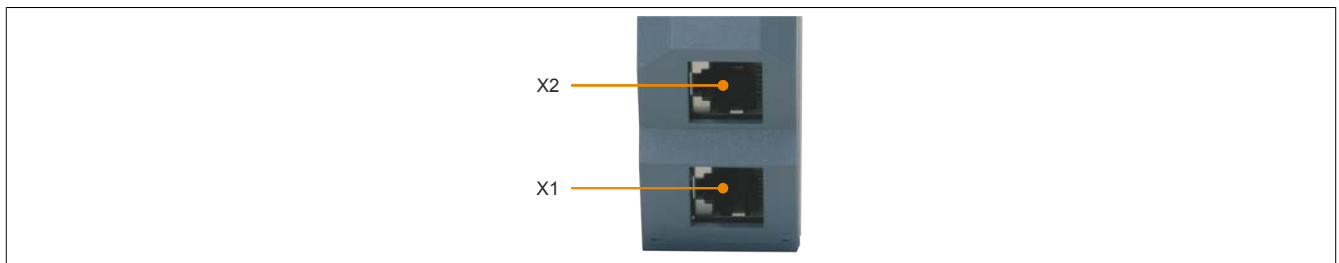
| Switch position | Description |
|-----------------|---|
| 0x00 | Reserved, switch position not permitted. |
| 0x01 - 0xEF | Node number of the POWERLINK node. Operation as a controlled node (CN). |
| 0xF0 | Operation as a managing node (MN). |
| 0xF1 - 0xFF | Reserved, switch position not permitted. |

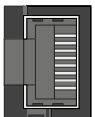
9.23.13.7.3 Ethernet mode

In this mode, the interface is operated as an Ethernet interface. The INA2000 station number is set using the B&R Automation Studio software.

9.23.13.8 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see ["Cabling guidelines for X20 modules with an Ethernet cable" on page 58](#).



| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.23.13.9 Firmware

The module comes with preinstalled firmware. The firmware is part of Automation Studio. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.23.14 X20IF1086-2

Data sheet version: 1.16

9.23.14.1 General information

The interface module can be used to expand the X20 CPU for specific applications. It is equipped with an POWERLINK interface.

This interface uses a 100 Base-FX port. The POWERLINK connection is made using 62.5/125 μm or 50/125 μm fiber optic multimode cable with a duplex LC connection. The module and network status is indicated using LEDs.

- POWERLINK for real-time Ethernet communication
- 100 Base-FX port
- Poll response chaining
- Dynamic Node Allocation (DNA)

9.23.14.2 Order data


| Model number | Short description | Figure |
|--------------|--|--|
| | X20 interface module communication | |
| X20IF1086-2 | X20 interface module, 1 POWERLINK interface, managing or controlled node, PRC function, 1 fiber optic connection |  |

Table 447: X20IF1086-2 - Order data

9.23.14.3 Technical data

| Model number | X20IF1086-2 |
|--|---|
| Short description | |
| Communication module | 1x POWERLINK (V1/V2) managing or controlled node |
| General information | |
| B&R ID code | 0xB455 |
| Status indicators | Module status, bus function |
| Diagnostics | |
| Module status | Yes, using LED status indicator and software |
| Bus function | Yes, using LED status indicator and software |
| Power consumption | 1.8 W (rev. <D0: 2 W) |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| EAC | Yes |
| KC | Yes |
| Interfaces | |
| Fieldbus | POWERLINK (V1/V2) managing or controlled node |
| Type | Type 4 ¹⁾ |
| Standard (compliance) | ANSI/IEEE 802.3 |
| Variant | 1x duplex LC |
| Transfer rate | 100 Mbit/s |

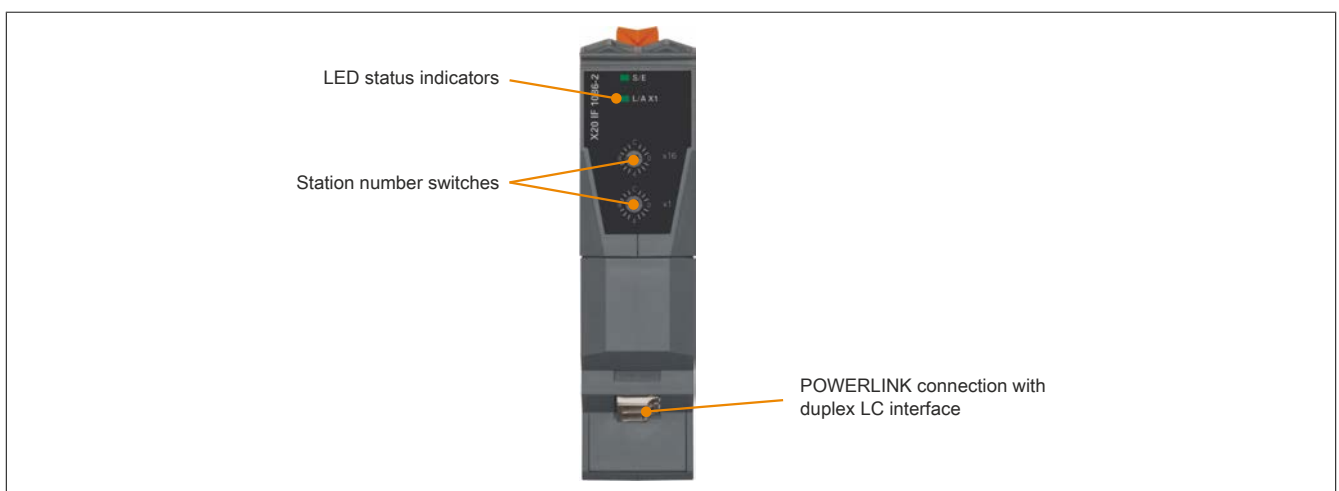
Table 448: X20IF1086-2 - Technical data

| Model number | X20IF1086-2 |
|---|---|
| Transfer | |
| Physical layer | 100BASE-FX |
| Half-duplex | Yes |
| Full-duplex | POWERLINK mode: No / Ethernet mode: Yes |
| Autonegotiation | No |
| Auto-MDI/MDIX | No |
| Controller | |
| | POWERLINK MAC |
| Wave length | |
| | Typ. 1300 nm Rx range: 1270 to 1380 nm Tx range: 1270 to 1380 nm |
| Cable fiber type | |
| | Multimode fiber with 62.5/125 µm or 50/125 µm core diameter LC connector on both sides |
| Optical power budget | |
| Glass fiber 62.5/125 µm, NA = 0.275 | 11 dB |
| Glass fiber 50/125 µm, NA = 0.200 | 7.5 dB |
| Cable length | |
| Ethernet TCP/IP | Max. 400 m between 2 stations (segment length) |
| POWERLINK | Max. 2 km between 2 stations (segment length) |
| Electrical properties | |
| Electrical isolation | PLC isolated from POWERLINK (X1) |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | |
| | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | |
| | - |
| Storage | |
| | -40 to 85°C |
| Transport | |
| | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Slot | In X20 CPU |


Table 448: X20IF1086-2 - Technical data

1) See Automation Help under "Communication / POWERLINK / General information / Hardware - IF/LS" for more information.

9.23.14.4 Operating and connection elements



9.23.14.4.1 LED status indicators

| Figure | LED | Color | Status | Description |
|---|--------|-----------|----------|--|
|  | S/E | Green/Red | | Status/Error LED. The LED indicators are described in section "LED "S/E" (LED "Status/Error")" on page 2371. |
| | L/A X1 | Green | On | A link to the remote station has been established. |
| | | | Blinking | A link to the remote station has been established. Indicates Ethernet activity is taking place on the bus |

9.23.14.4.2 LED "S/E" (LED "Status/Error")

This LED is a green/red dual LED and indicates the state of the POWERLINK interface. The LED states have a different meaning depending on the operating mode of the POWERLINK interface.

9.23.14.4.2.1 Ethernet mode

In this mode, the interface is operated as an Ethernet interface.

| LED "S/E" | | Description |
|-----------|-----|---|
| Green | Red | |
| On | Off | The interface is operated as an Ethernet interface. |

Table: LED "S/E": Interface in Ethernet mode

9.23.14.4.2.2 POWERLINK V1 mode

| LED "S/E" | | Current state of the POWERLINK node |
|----------------------|----------|--|
| Green | Red | |
| On | Off | The POWERLINK node is running with no errors. |
| Off | On | A system error occurred. The type of error can be read using the PLC logbook. An irreparable problem has occurred. The system can no longer properly carry out its tasks. This state can only be changed by resetting the module. |
| Blinking alternately | | The POWERLINK managing node has failed. This error code can only occur when operated as a controlled node. This means that the set node number lies within the range 0x01 - 0xFD. |
| Off | Blinking | System stop. The red blinking LED indicates an error code (see "System stop error codes" on page 2373). |
| Off | Off | The interface is either not active or one of the following states or errors is present: <ul style="list-style-type: none"> The device is switched off. The device is in the startup phase. The interface or device is not configured correctly in Automation Studio. The interface or device is defective. |

Table 449: LED "S/E": POWERLINK V1 mode

9.23.14.4.2.3 POWERLINK V2 mode

Error message

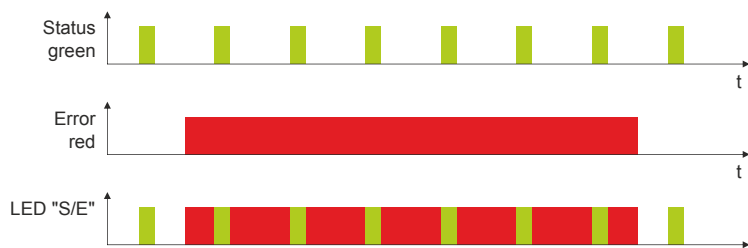
| LED "S/E" | | Description |
|-----------|-----|--|
| Green | Red | |
| Off | On | The interface is in error mode (failed Ethernet frames, increased number of collisions on the network, etc.). Note: Several red blinking signals are displayed immediately after the device is switched on. These are not errors, however. |
| Blinking | On | If an error occurs in the following modes, then the green LED blinks over the red LED: <ul style="list-style-type: none"> PRE_OPERATIONAL_1 PRE_OPERATIONAL_2 READY_TO_OPERATE  |

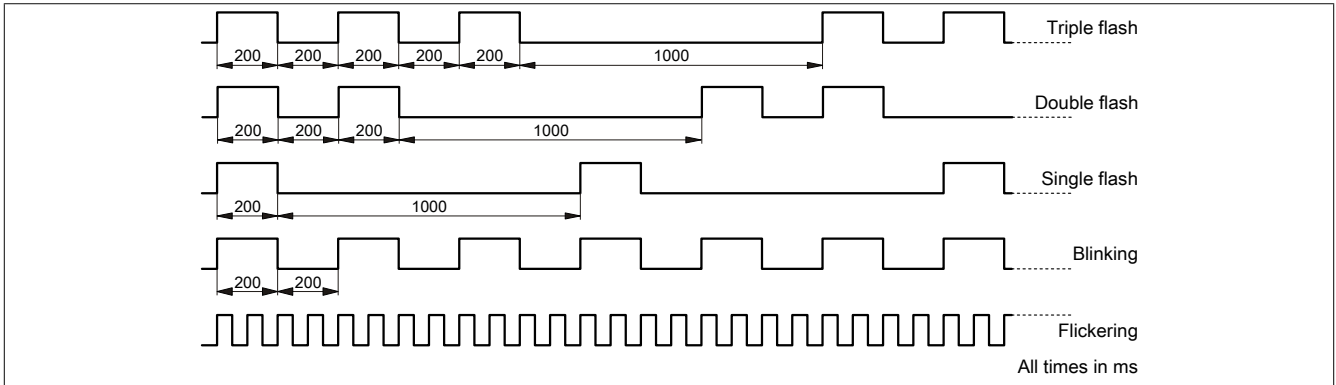
Table: LED "S/E" - Error message (interface in POWERLINK mode)

Interface status

| LED "S/E" | | Description |
|-----------------------------|-----|---|
| Green | Red | |
| Off | Off | <p>Mode: NOT_ACTIVE The interface is either in mode NOT_ACTIVE or one of the following modes or errors is present:</p> <ul style="list-style-type: none"> The device is switched off. The LED status indicator is disabled. The device is in the startup phase. The interface or device is not configured correctly in Automation Studio. The interface or device is defective. <p>Managing node (MN) The network is monitored for POWERLINK frames. If a frame is not received within the configured time window (timeout), the interface immediately enters mode PRE_OPERATIONAL_1. If POWERLINK communication is detected before the time has elapsed, however, the MN is not started.</p> <p>Controlled node (CN) The network is monitored for POWERLINK frames. If a frame is not received within the configured time window (timeout), the interface immediately enters mode BASIC_ETHERNET. If POWERLINK communication is detected before this time expires, however, the interface immediately enters mode PRE_OPERATIONAL_1.</p> |
| Flickering (approx. 10 Hz) | Off | <p>Mode: BASIC_ETHERNET The interface is in mode BASIC_ETHERNET. The interface is operated in Ethernet mode.</p> <p>Managing node (MN) This mode can only be exited by resetting the controller.</p> <p>Controlled node (CN) If POWERLINK communication is detected during this mode, the interface enters mode PRE_OPERATIONAL_1.</p> |
| Single flash (approx. 1 Hz) | Off | <p>Mode: PRE_OPERATIONAL_1 The interface is in mode PRE_OPERATIONAL_1.</p> <p>Managing node (MN) The MN is in "reduced cycle" operation. The CNs are configured in this mode. Cyclic communication is not yet taking place.</p> <p>Controlled node (CN) The CN can be configured by the MN in this mode. The CN waits until it receives an SoC frame and then switches to mode PRE_OPERATIONAL_2.</p> |
| | On | <p>Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed.</p> |
| Double flash (approx. 1 Hz) | Off | <p>Mode: PRE_OPERATIONAL_2 The interface is in mode PRE_OPERATIONAL_2.</p> <p>Managing node (MN) The MN starts cyclic communication (cyclic input data is not yet evaluated). The CNs are configured in this mode.</p> <p>Controlled node (CN) The CN can be configured by the MN in this mode. A command then switches the mode to READY_TO_OPERATE.</p> |
| | On | <p>Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed.</p> |
| Triple flash (approx. 1 Hz) | Off | <p>Mode: READY_TO_OPERATE The interface is in mode READY_TO_OPERATE.</p> <p>Managing node (MN) Cyclic and asynchronous communication. Received PDO data is ignored.</p> <p>Controlled node (CN) The configuration of the CN is completed. Normal cyclic and asynchronous communication. The transmitted PDO data corresponds to the PDO mapping. However, cyclic data is not yet evaluated.</p> |
| | On | <p>Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed.</p> |
| On | Off | <p>Mode: OPERATIONAL The interface is in mode OPERATIONAL. PDO mapping is active and cyclic data is evaluated.</p> |
| Blinking (approx. 2.5 Hz) | Off | <p>Mode: STOPPED The interface is in mode STOPPED.</p> <p>Managing node (MN) This mode does not occur for the MN.</p> <p>Controlled node (CN) Output data is not being output, and no input data is being provided. This mode can only be reached and exited by a corresponding command from the MN.</p> |

Table: LED "S/E" - Interface state (interface in POWERLINK mode)

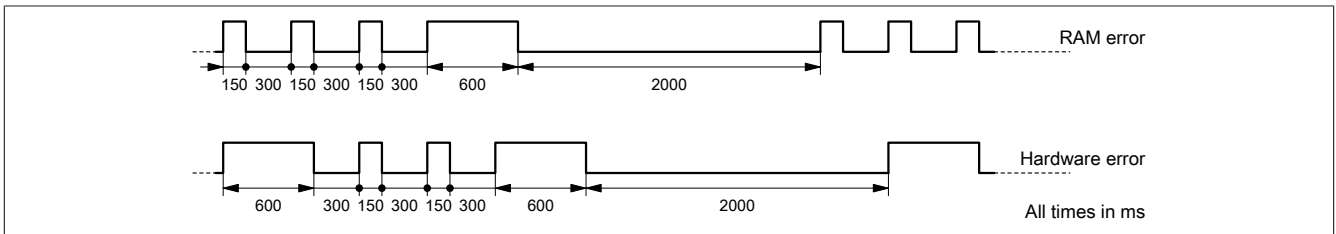
Blink times



9.23.14.4.2.4 System stop error codes

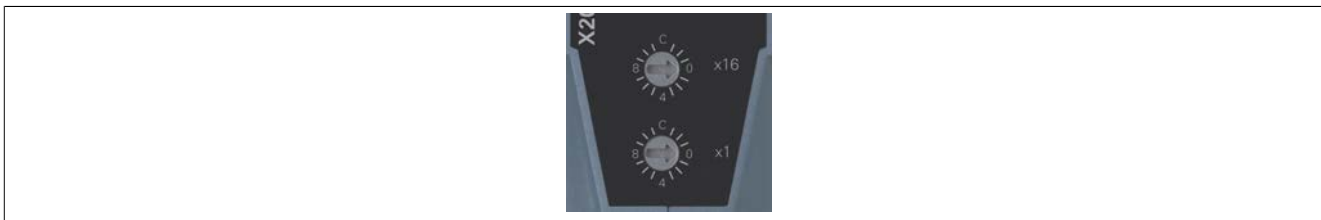
A system stop error can occur due to incorrect configuration or defective hardware.

The error code is indicated by LED "S/E" blinking red. The blinking signal of the error code consists of 4 switch-on phases with short (150 ms) or long (600 ms) duration. The error code is repeated every 2 seconds.



| Error | Error description |
|----------------|---|
| RAM error | The device is defective and must be replaced. |
| Hardware error | The device or a system component is defective and must be replaced. |

9.23.14.4.3 POWERLINK node number



The node number for the POWERLINK station is set using the two number switches. The node number can also be directly configured using Automation Studio.

9.23.14.4.3.1 POWERLINK V1

| Switch position | Description |
|-----------------|--|
| 0x00 | Operation as managing node. |
| 0x01 - 0xFD | Node number of the POWERLINK node. Operation as controlled node. |
| 0xFE - 0xFF | Reserved, switch position not permitted |

9.23.14.4.3.2 POWERLINK V2

| Switch position | Description |
|-----------------|---|
| 0x00 | Reserved, switch position not permitted. |
| 0x01 - 0xEF | Node number of the POWERLINK node. Operation as a controlled node (CN). |
| 0xF0 | Operation as a managing node (MN). |
| 0xF1 - 0xFF | Reserved, switch position not permitted. |

9.23.14.4.3.3 Ethernet mode

In this mode, the interface is operated as an Ethernet interface. The INA2000 station number is set using the B&R Automation Studio software.

9.23.14.4.4 Duplex LC port

| Figure | Description |
|--------|------------------------------------|
| | 100 Base FX port, Duplex LC socket |

9.23.14.4.4.1 Wiring guidelines for X20 modules with fiber optic cable

The following wiring guidelines must be observed:

- Cable fiber type: Multimode fiber with 62.5/125 μm or 50/125 μm core diameter
- On both sides: Duplex LC male connector
- Observe minimum cable flex radius (see data sheet for the cable)

9.23.14.5 Firmware

The module comes with preinstalled firmware. The firmware is part of the Automation Studio project. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.23.15 X20IF1091

Data sheet version: 2.23

9.23.15.1 General information

The interface module can be used to expand the X20 CPU for specific applications. It is equipped with an X2X Link master interface.

- X2X Link connection

9.23.15.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | X20 interface module communication |  |
| X20IF1091 | X20 interface module, 1 X2X Link master interface, electrically isolated, order 1x TB704 terminal block separately | |
| | Required accessories | |
| | Terminal blocks | |
| 0TB704.9 | Accessory terminal block, 4-pin, screw clamp terminal block 2.5 mm ² | |
| 0TB704.91 | Accessory terminal block, 4-pin, push-in terminal block 2.5 mm ² | |


Table 450: X20IF1091 - Order data

9.23.15.3 Technical data

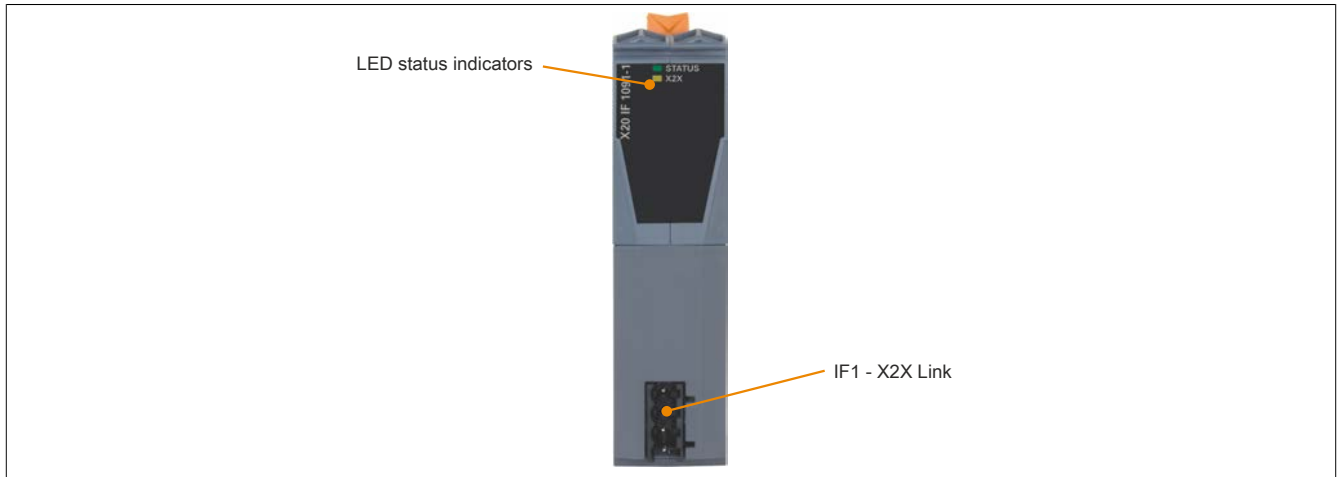
| | |
|--|--|
| Model number | X20IF1091 |
| Short description | |
| Communication module | 1x X2X Link master |
| General information | |
| B&R ID code | 0x1F24 |
| Status indicators | Module status, data transfer |
| Diagnostics | |
| Module status | Yes, using status LED |
| Data transfer | Yes, using status LED |
| Power consumption | 0.97 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations |
| ATEX | Class I, Division 2, Groups ABCD, T5 Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| Interfaces | |
| Interface IF1 | |
| Fieldbus | X2X Link master |
| Variant | 4-pin male multipoint connector |
| Number of stations | Max. 253 |
| Bus terminating resistor | Internal |
| Internal bus power supply | No |
| Network topology | Line |
| Distance between 2 stations | Max. 100 m |
| Electrical properties | |
| Electrical isolation | PLC isolated from X2X Link (IF1) |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x TB704 terminal block separately |
| Slot | In X20 CPU |

Table 451: X20IF1091 - Technical data


9.23.15.4 LED status indicators

| Figure | LED | Color | Status | Description |
|---|--------|--------|--------|--|
|  | STATUS | Green | On | Interface module active |
| | | Red | On | CPU starting up |
| | X2X | Yellow | On | Module sending data via the X2X Link interface |

9.23.15.5 Operating and connection elements



9.23.15.6 X2X Link interface (IF1)

| Interface | Pinout | | |
|--|----------|------------------|--------|
|  4-pin male multipoint connector | Terminal | Function | |
| | 1 | X2X | |
| | 2 | X2X _L | |
| | 3 | X2X _I | |
| | 4 | SHLD | Shield |

9.23.15.7 Firmware

The module comes with preinstalled firmware. The firmware is part of Automation Studio. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.23.16 X20IF10A1-1

Data sheet version: 2.13

9.23.16.1 General information

The interface module is equipped with an ASi master interface. This allows third-party components to be integrated in the B&R system and makes it possible to quickly and easily transfer data in both directions.

The interface module can be operated in X20 CPUs or in the expandable POWERLINK bus controller X20BC1083.

- ASi interface master
- Electrically isolated
- 4-pin bus connector

9.23.16.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | X20 interface module communication |  |
| X20IF10A1-1 | X20 interface module, for DTM configuration, 1 ASi master interface, electrically isolated, order 1x terminal block TB704 separately! | |
| | Required accessories | |
| | Terminal blocks | |
| 0TB704.9 | Accessory terminal block, 4-pin, screw clamp terminal block 2.5 mm ² | |
| 0TB704.91 | Accessory terminal block, 4-pin, push-in terminal block 2.5 mm ² | |

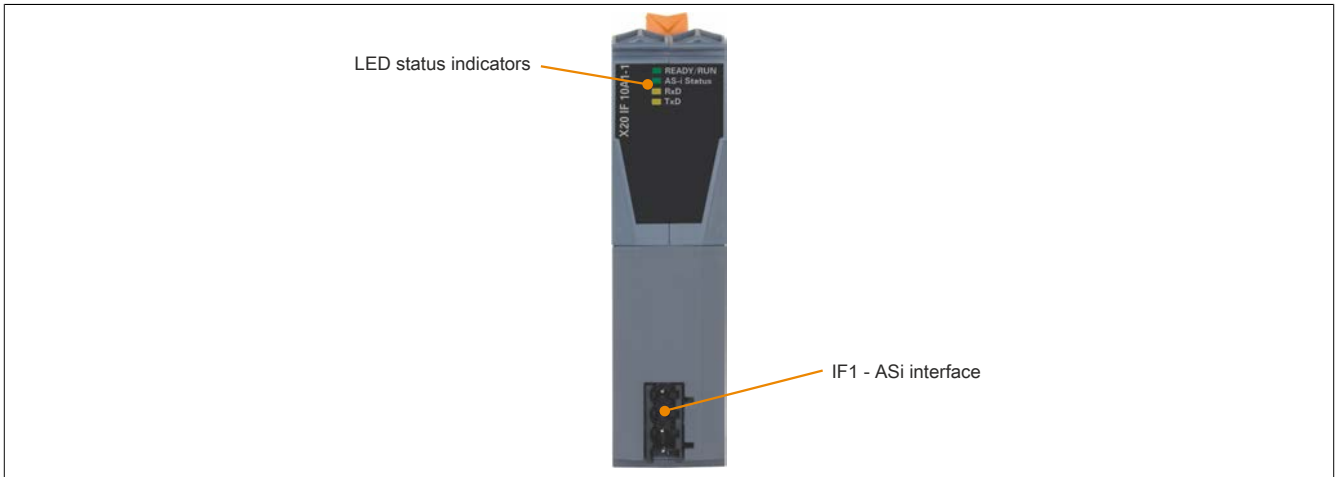
Table 452: X20IF10A1-1 - Order data

9.23.16.3 Technical data

| | |
|--|--|
| Model number | X20IF10A1-1 |
| Short description | |
| Communication module | ASi interface master |
| General information | |
| B&R ID code | 0xA718 |
| Status indicators | Module status, network status, data transfer |
| Diagnostics | |
| Module status | Yes, using LED status indicator and software |
| Network status | Yes, using LED status indicator and software |
| Data transfer | Yes, using LED status indicator |
| Fieldbus current consumption | Max. 27 mA |
| Power consumption | |
| Bus | 1.1 W |
| Fieldbus | 0.85 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| KR | Yes |
| EAC | Yes |
| KC | Yes |
| Interfaces | |
| Interface IF1 | |
| Fieldbus | ASi interface master |
| Type | ASi master profile M4 |
| Variant | 4-pin male multipoint connector |
| Power supply | ASi power supply |
| Voltage range | 24 to 32 V |
| Controller | netX100 |
| Max. number of slaves | 62 |
| Max. distance | |
| Standard | 100 m |
| With additional components | 500 m |
| Max. cycle time | 5 ms |
| Response time | Typ. 3 ms |
| Electrical properties | |
| Electrical isolation | PLC isolated from AS (IF1) |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x TB704 terminal block separately |
| Slot | In the X20 CPU and expandable bus controller X20BC1083 |

Table 453: X20IF10A1-1 - Technical data

9.23.16.4 Operating and connection elements



9.23.16.4.1 LED status indicators

| Figure | LED | Color | Status | Description |
|--------|------------|------------------|--|---|
| | READY/RUN | Green/red | Off | No power to module |
| | | Green | On | PCI bus communication in progress |
| | | Red | Blinking | Error when booting |
| | ASi status | Green/red | On | Communication on the PCI bus has not yet been started |
| | | | Blinking | Configuration mode is active |
| | | Green | Blinking quickly | Communication has stopped |
| | | | Blinking | Configuration error, data exchange is active |
| | | | On | Configuration error-free, data exchange is active |
| | | Red | Blinking | ASi interface power failure |
| | On | | Fatal system error or hardware error | |
| RxD | Yellow | Flickering or on | The module is receiving data via the ASi interface. | |
| TxD | Yellow | Flickering or on | The module is transmitting data via the ASi interface. | |

9.23.16.4.2 ASi interface (IF1)

| Interface | Pinout | |
|--|----------|-------------|
| | Terminal | Explanation |
| <p>4-pin male multipoint connector</p> | 1 | ASi+ |
| | 2 | ASi+ |
| | 3 | ASi- |
| | 4 | ASi- |

9.23.16.5 Use in the expandable X20BC1083 POWERLINK bus controller

9.23.16.5.1 Cyclic data

If this module is connected to the expandable POWERLINK bus controller, the amount of cyclic data is limited by the POWERLINK frame to 1488 bytes in each direction (input and output).

When using multiple X20IF10xx-1 interfaces or other X2X modules with a POWERLINK bus controller, the 1488 bytes are divided between all connected modules.

9.23.16.5.2 Operating netX modules

It is important to note the following in order to operate netX modules with the bus controller without problems:

- A minimum revision $\geq E0$ is required for the bus controller.
- netX modules can only be operated with the POWERLINK V2 setting. V1 is not permitted.
- With SDO access to POWERLINK object 0x1011/1 on the bus controller, the netX firmware and the configuration stored on the bus controller are not reset. They can only be overwritten by accessing them again. This affects objects 0x20C0 and 0x20C8, subindexes 92 to 95.

9.23.16.6 netX error codes

netX modules return an error code when an error occurs. These error codes are fieldbus-specific. A complete list of all error codes in PDF format is available in Automation Help in section "Communication / Fieldbus systems / Support with FDT/DTM / Diagnostic functions / Diagnostics on the runtime system / Master diagnostics" under item "Communication_Error".

9.23.16.7 Firmware

The module comes with preinstalled firmware. The firmware is part of the Automation Studio project. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.23.16.8 The ASi interface

ASi stands for "Actuator Sensor Interface" and is a bus system for the lowest field level of automation technology. Using ASi bus systems provides an easy and affordable way to connect, operate and service sensors and actuators.

ASi is particularly suitable for safety-related components such as safety monitors, emergency stop switches or door locks.

The bus system is composed of a 2-conductor cable that transfers both power and information at the same time. This eliminates the need for parallel wiring, where each individual sensor or actuator is connected to the controller's input or output module via a separate wire.

ASi is a single master system, meaning only one master can be operated in a network at a time. The communication between master and slave works via the cyclic polling method. The master sends a poll request to each slave, which is answered by the individual slaves with a poll response.

Either 31 or 62 slaves can be operated depending on the type of addressing.

- Standard addressing is suitable for 1 to 32 slaves.
- Extended addressing is suitable for up to 62 slaves. Here, the slaves are grouped as A and B slaves, i.e. 1A to 31A and 1B to 31B).

Information:

Only ASi slaves with the ID code A can be addressed in extended form. With an ID code other than A, only the standard addressing of up to 32 slaves can be used.

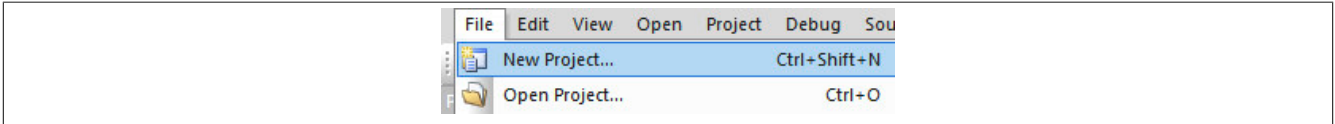
9.23.16.8.1 Settings in Automation Studio

The interface module can be operated in the slot of a CPU or in the slot of an expandable POWERLINK bus controller.

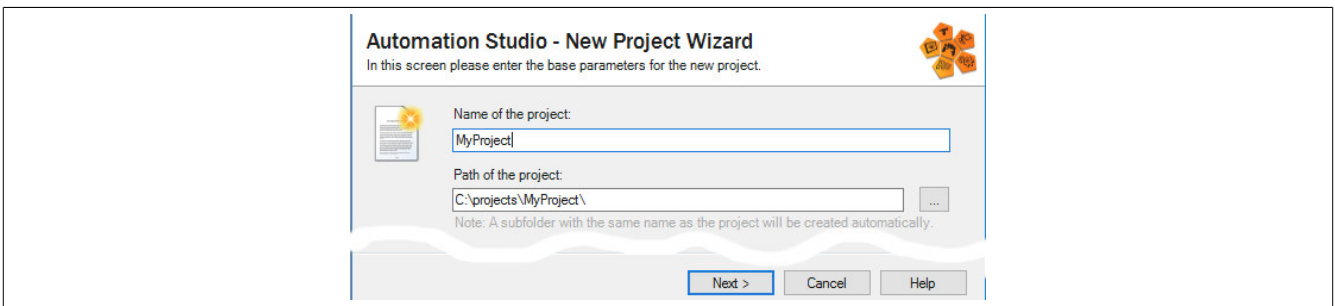
To do this, a new Automation Studio project is created and the suitable settings are made on the module.

9.23.16.8.1.1 Creating an Automation Studio project

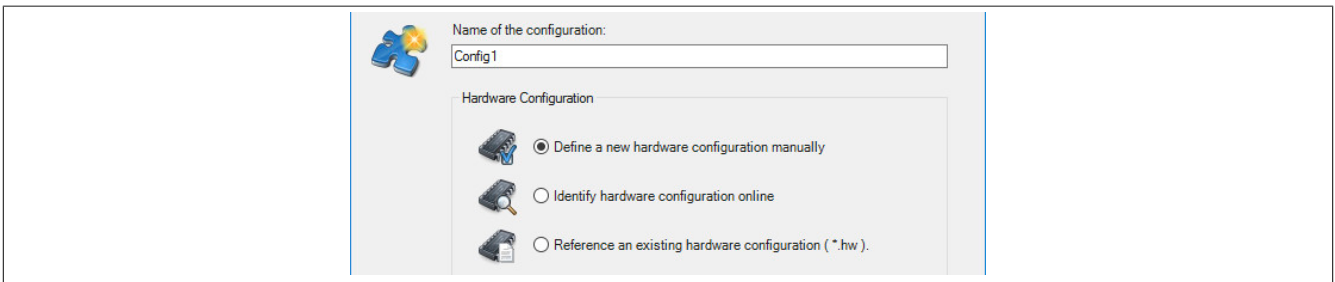
- Create a new Automation Studio project by selecting "New project".



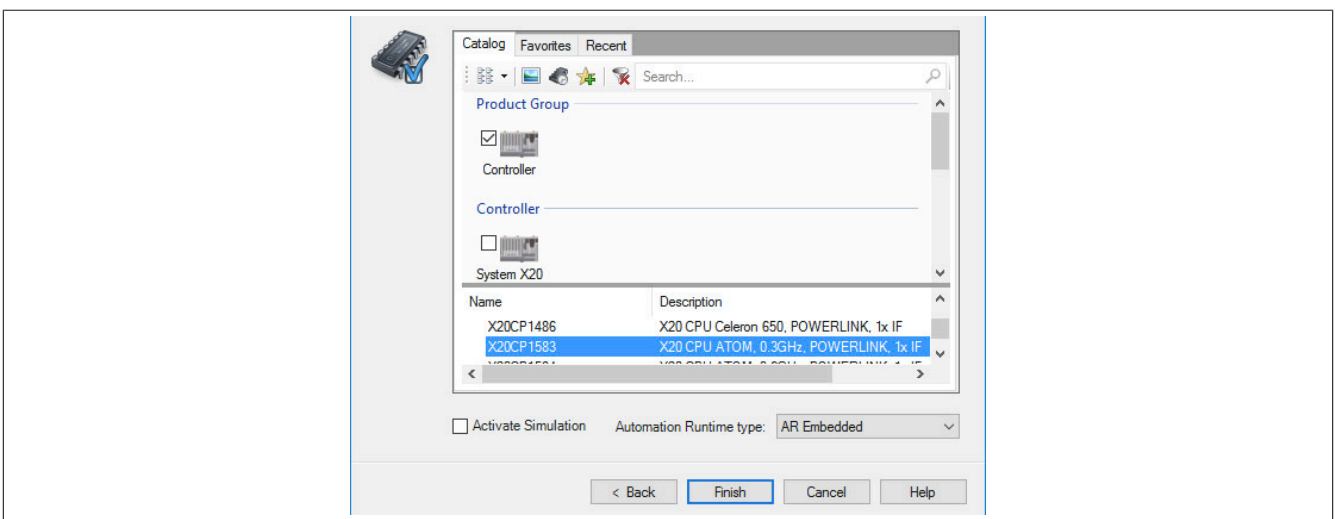
- Assign a project name and set up the project path.



- Assign the hardware configuration type and configuration name.

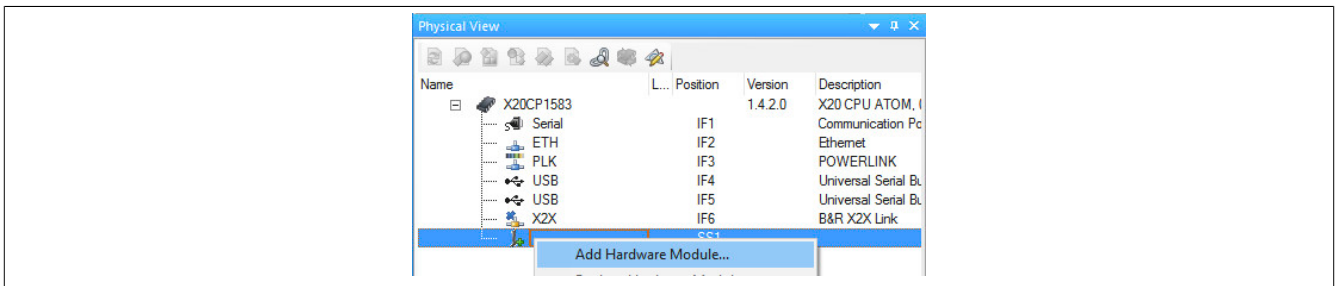


- Select the hardware in the next step if "Define a new hardware configuration manually" was selected. In order to simplify the search, different filters can be set in the Hardware Catalog. Lastly, highlight the required hardware and create the Automation Studio project by clicking on "Finish".

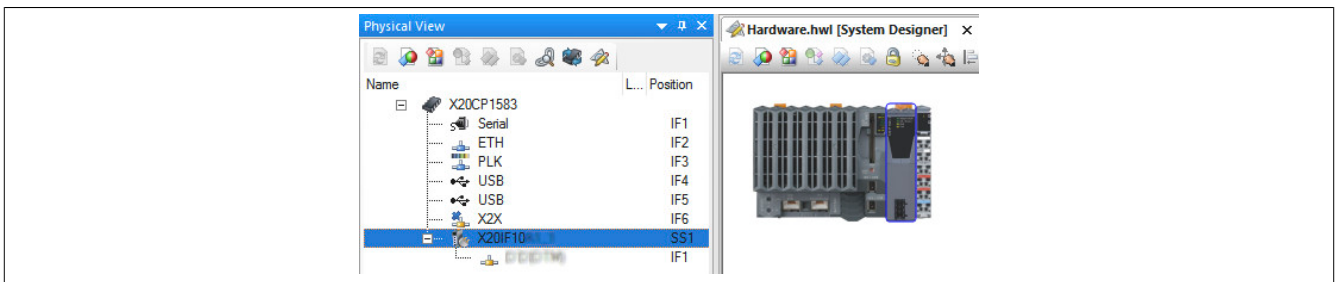


9.23.16.8.1.2 Adding an interface module

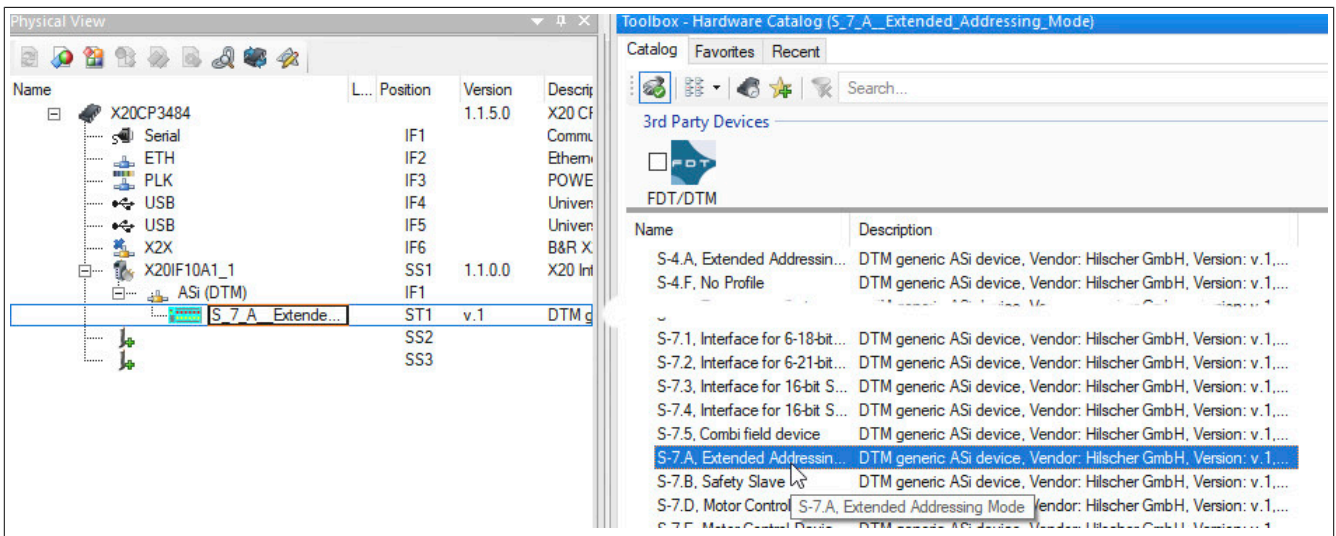
- In this example, the interface card is connected in the slot of a CPU. Right-clicking on the slot and selecting "Add hardware module" opens the Hardware Catalog.



- The module is added to the project via drag-and-drop or by double-clicking on the interface card.

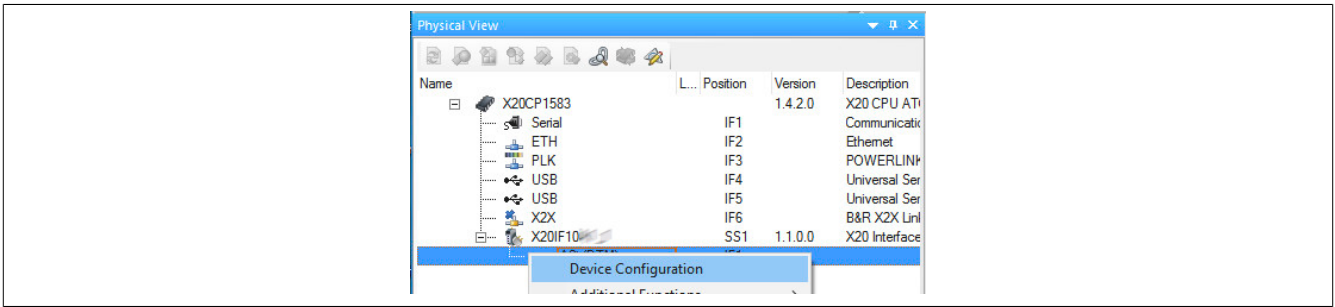


- ASi slaves from the Hardware Catalog containing the required ASi profile can now be connected to the ASi master via drag-and-drop.

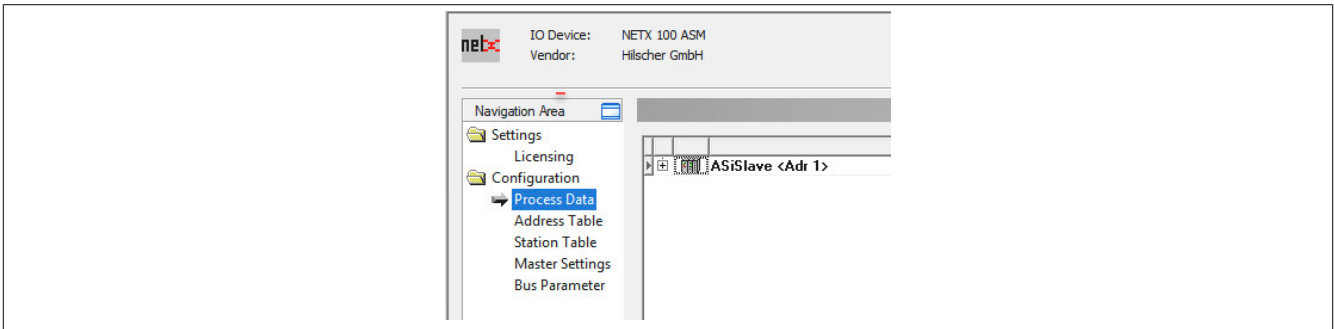


9.23.16.8.1.3 Configuring the ASi master

- Additional module settings can be made under "Device configuration". This configuration environment is opened by right-clicking on the IF interface and selecting "Device configuration".



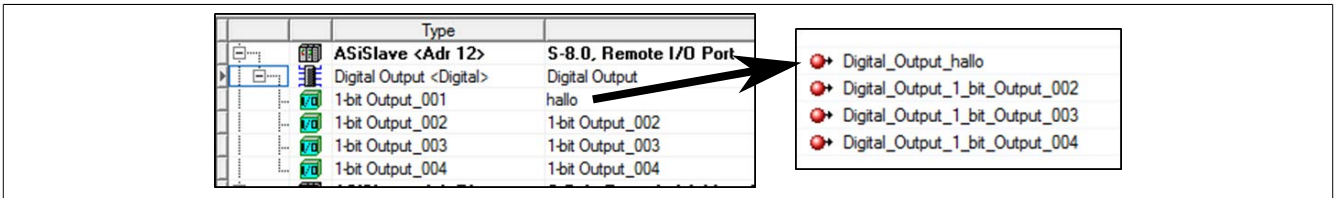
- General settings are made in the device configuration.



Process data

This table lists the process data of all attached slaves (device description files).

| Parameter | Explanation |
|-----------|---|
| Type | Device designation specified by the hardware. Further description of modules configured on the device or the input or output signals. |
| Tag | The name of the input and output data can be changed in column "Tag". |
| SCADA | This parameter is not supported. |



Address table

Contains a list of all slaves which are categorized according to their input and output data.

"Display mode" allows toggling between decimal and hexadecimal display.

| Parameter | Explanation |
|-----------------|---|
| Station address | Station address of the assigned slave device. |
| Device | Current device name of the assigned slave |
| Name | Device name of the assigned slave |
| Module | Name of the module |
| Type | Input or output type |
| Length | Number of bytes inserted (IB, QB, IW or QW). |
| Address | Input or output data offset address |

The address table can also be exported as a CSV file.

Station table

All ASi slaves are listed here.

| Parameter | Explanation |
|-----------------|---|
| Activate | This allows the slaves to be enabled or disabled. <ul style="list-style-type: none"> Enabled: Process memory is reserved and data is exchanged. Disabled: The master reserves memory in the process data image for the slave, but no data is exchanged. |
| Station address | Station address of the slave. Valid addresses: <ul style="list-style-type: none"> Standard address range: 1 to 31 Extended address range: 1A to 31A and 1B to 31B. In the application, this corresponds to the ranges 1 to 31 and 32 to 62. A/B slaves contain an "A" in their ID code. |
| Device | Name of the assigned slave |
| Name | Name of the assigned slave |
| Vendor | Vendor information |

Master settings

- Start of bus communication

It is possible to select how data exchange is started on the module.

| Parameter | Explanation |
|---------------------------|--|
| Automatically by device | Data exchange is started automatically after initializing this module. |
| Controlled by application | Data exchange is started by Automation Runtime. |

- Module alignment

The addressing mode is defined by the process image here. The addresses (offsets) of the process data are always interpreted as byte addresses.

| Addressing mode | Explanation |
|-------------------|---|
| Byte boundaries | The module address can start on any offset. |
| 2 byte boundaries | The module address can only start on even byte offsets. |

Information:

This configuration is automatically managed by Automation Runtime and is not permitted to be changed (default setting).

- Application monitoring

The module-internal watchdog time can be set here. If the watchdog has been enabled (watchdog time not equal to 0), the hardware watchdog must be reset after the set time at the latest.

| Parameter | Explanation | Values |
|---------------|-----------------------------|----------------|
| Watchdog time | Watchdog software disabled | 0 ms |
| | Permissible range of values | 20 to 65535 ms |
| | Default value: 1000 ms | |

Information:

The watchdog time is reset automatically by Automation Runtime.

- Process image storage format

This is used to define how data is stored in the process image (I/O mapping). The storage format is only applied to data type "Word". This change has no effect on other data types.

| Storage format | Explanation |
|----------------|---|
| Big-endian | MSB/LSB = Higher/Lower byte (Motorola format) |
| Little-endian | MSB/LSB = Higher/Lower byte (Intel format) |

Information:

This configuration is automatically managed by Automation Runtime and is not permitted to be changed (default setting).

- Process data handshake

This parameter configures the handshake for the data exchange between application and device. Only "Buffered, host-controlled" is supported here.

Bus parameters

— Behavior in case of defective slave device

The selection depends on the settings under "Behavior during startup sequence".

- **Don't take care about the status of any connected slave devices** - The slave status is disregarded but the communication remains intact.
- **Stop communication if a device is missing** - Communication is stopped if a slave is missing.
- **Stop communication if a device is reporting a periphery failure** - Communication is stopped if a slave reports a peripheral fault.
- **Stop communication if a device is missing or reporting a periphery failure** - Communication is stopped if a slave is missing or a peripheral fault is reported.

— Behavior during startup sequence

Determines the procedure of the master during startup in correlation with the connected slaves.

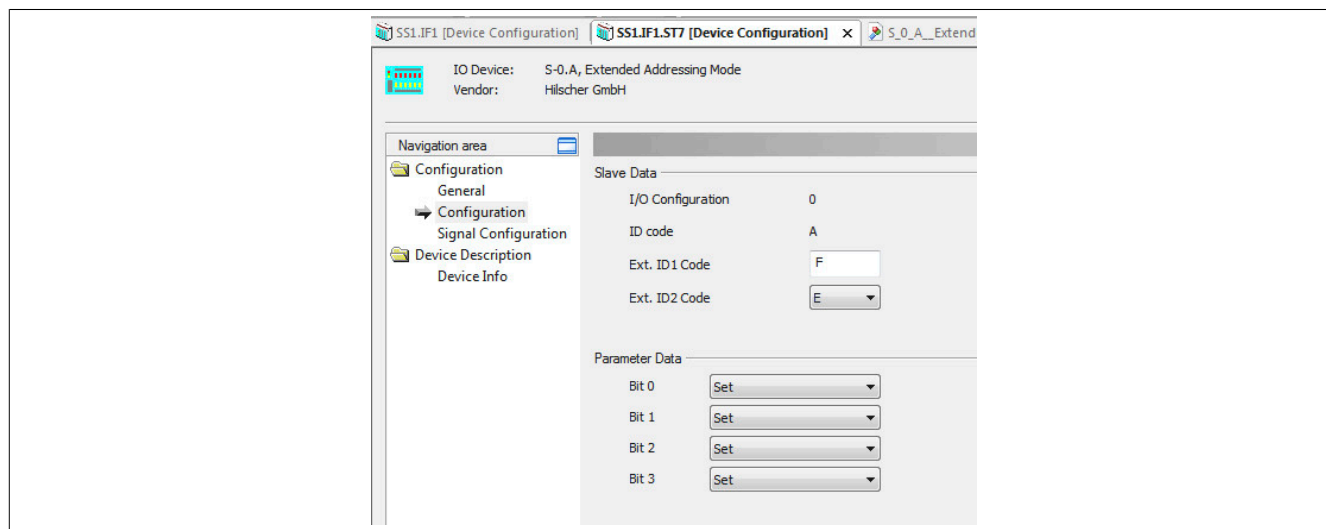
- **Protected mode** - If enabled, the master enters protected data exchange mode. If not enabled, the master enters configuration mode.
- **Auto address assignment** - If enabled, the master assigns a slave the address of a missing slave if it has an identical I/O, ID, ID1 and ID2 code and address 0.

— Overwrite configuration database

This parameter is not supported.

9.23.16.8.1.4 Configuring the ASi slave

- General settings can be made on the ASi slave using "Device configuration."



General

The description can be adjusted here. However, this is only used by the configuration dialog boxes and not by Automation Studio.

The slave address set on the master is also displayed. See "[Station table](#)" on page 2386 for setting the address.

Configuration

- Slave data

| Parameter | Explanation |
|-------------------|--|
| I/O configuration | I/O configuration used in the EDS file. This corresponds to the first position of the slave profile. |
| ID code | I/O code used in the EDS file. This corresponds to the second position of the slave profile. |
| Ext. ID1 code | Extended ID code, user-specific |
| Ext. ID2 code | Extended ID code, user-specific |

- Parameter data

| Parameter | Explanation | Values |
|----------------|---|--------------|
| Bit 0 to bit 3 | Parameter data to be set by the user. If these are contained in the EDS file, they are displayed here. | Set Reset |

Signal configuration

The name and data type of the I/O data point can be adjusted here.

The signal configuration can be set to the default values for the specified slave profile by clicking on "Default".

| Parameter | Explanation |
|-----------|--|
| Modules | Input or output modules of the signal configuration |
| Tag | Editable name of the individual input or output signals. The name can also be changed via the master (see " Process data " on page 2385) |
| Data type | Editable data type of the individual input or output signals. The data type can be selected from a list according to the AS slave profile defined in the EDS file. |
| Type | Type of input or output signal |

Device description

General device information can be read here.

9.23.16.8.2 EDS device description file

All possible ASi slave variants have already been imported into Automation Studio as device description files and can be taken from the Hardware Catalog.

Each ASi slave is assigned an ASi profile. The ASi profile is composed of 4 components:

- **I/O configuration**
Contains information about the configuration of individual ASi slave ports: output, input or bidirectional input/output.
- **ID code**
Contains the ID code of the slave.
- **Extended ID code 1**
Length: 4 bits
In extended address mode, the MSB indicates whether it is an A (MSB = 0) or B (MSB = 1) slave (starting with specification 3.0). In the Automation Studio Hardware Catalog, the extended address mode can be identified by an "A" in the slave address (e. g. "S-0. A"). The lower 3 bits contain additional slave-specific information.
- **Extended ID code 2**
Used for slave-specific settings. See description of the corresponding slave.

9.23.16.8.3 Slave addressing

There are 3 ways to assign an address to an ASi slave.

- With the programming device

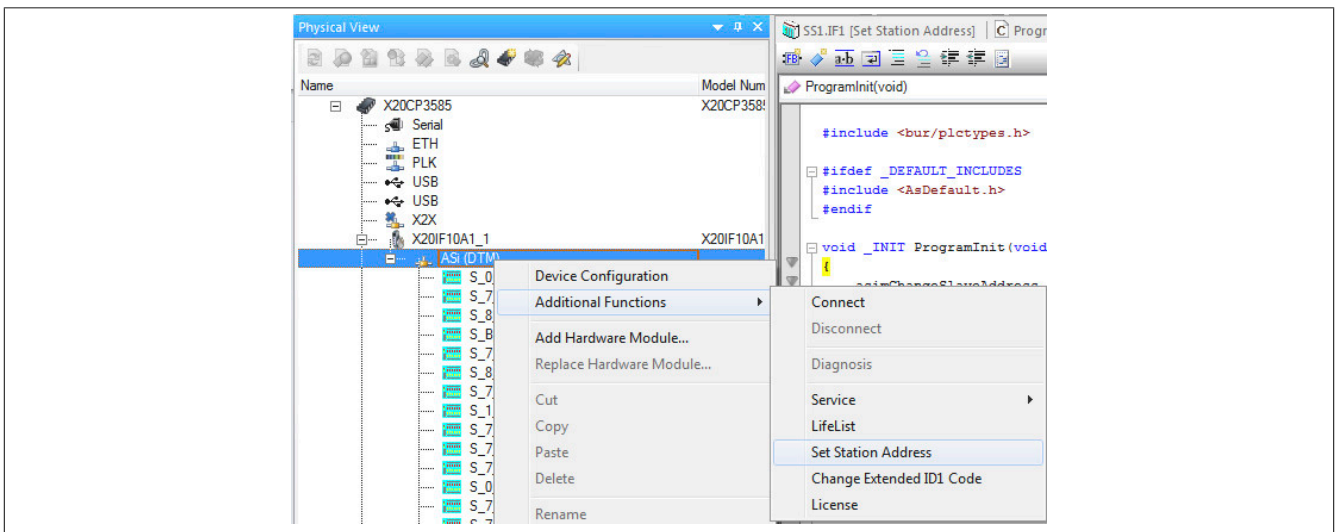
A programming interface is required for this, which does not exist for every slave. If a programming interface is installed in the ASi slave, the slave address can be adjusted via the programming device and the ASi profile can also be read.

- Assignment via function block

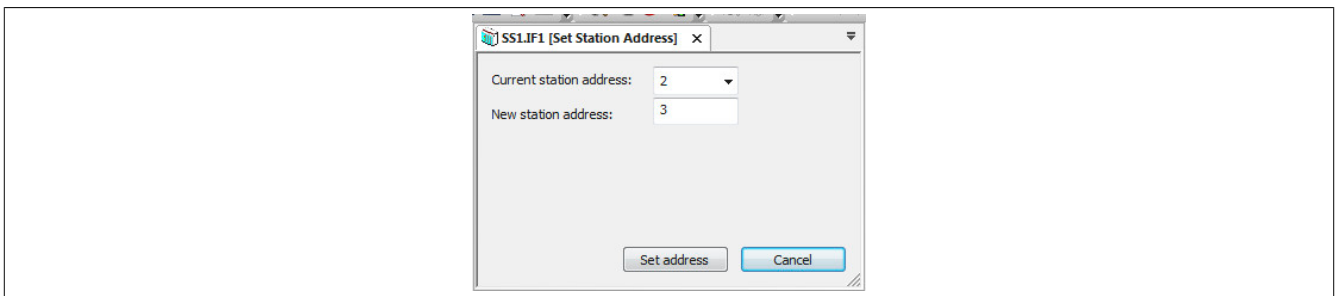
To do this, a program must be created and function block **AsNxAsiM - asimChangeSlaveAddress()** must be programmed. In order to change the slave address using this function block, the current address must be known. In most cases, address 0 (delivery state) is applied to a new ASi slave since no slave is permitted to have address 0.

- Direct mapping via the master

The current slave address is also required here. In the Physical View (Automation Studio), the slave address can be adjusted with a right-click on the ASi interface of the master → Additional functions → Set station address.



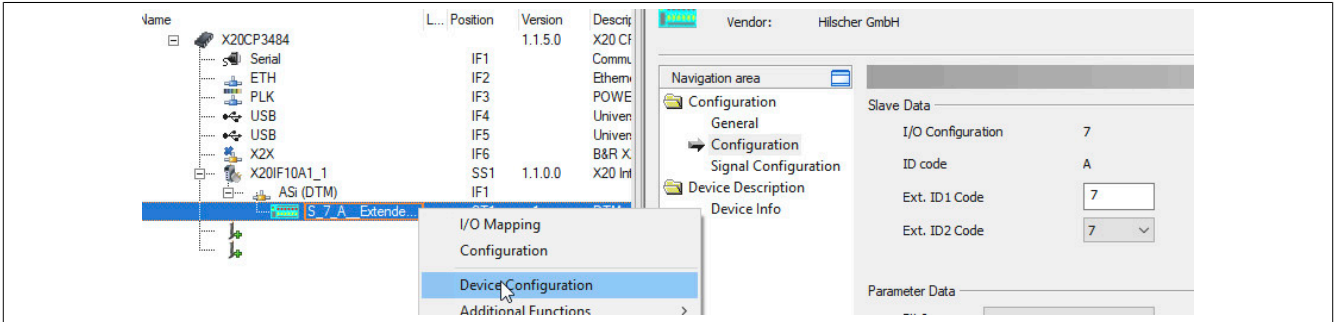
First, the slave to be addressed is selected and the desired new address is specified. A new address can be assigned using "Set address".



9.23.16.8.4 Configuration example

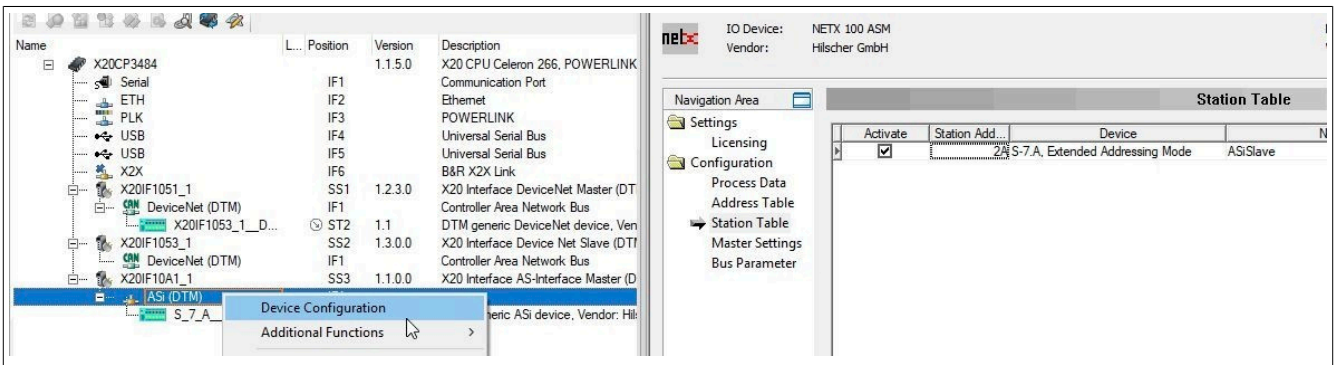
In this example, an ASi slave with the profile S-7.A is configured.

- The desired profile is first selected from the Hardware Catalog and added to the ASi master. See ["Adding an interface module" on page 2384](#).
- The ID code settings of the connected device are specified by the ASi slave manufacturer and must be set in the profile. The values under "Ext. ID1 code" and "Ext. ID2 code" are therefore entered via the device configuration of the device description file.



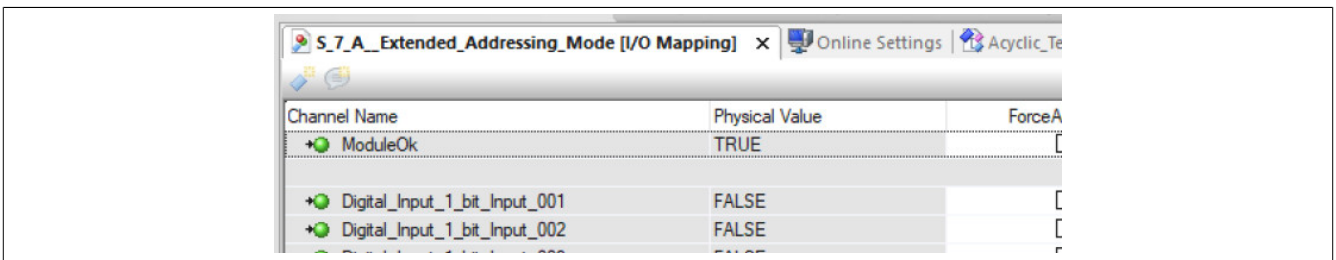
- The address of the ASi slave is then set in the device configuration on the master under "Station table".

Setting the address on the device itself is done differently depending on the ASi slave used, e.g. by a programming device, via a function block or via the master. See ["Slave addressing" on page 2389](#).



- Confirm and save all settings with OK. The configuration is transferred to the CPU and, if correct, a connection between master and slave is automatically established.

The connection status can be checked with the ModulOK bit in the I/O mapping of the device description file. When ModulOK = True, data can be exchanged between master and slave.



9.23.17 X20(c)IF10D1-1

Data sheet version: 3.04

9.23.17.1 General information

The interface module is equipped with an EtherNet/IP scanner interface. This allows third-party components to be integrated in the B&R system and makes it possible to quickly and easily transfer data in both directions.

The interface module can be operated in X20 CPUs or in the expandable POWERLINK bus controller X20BC1083.

The interface is equipped with 2 RJ45 connections. Both connections result in an integrated switch. This makes it easy to implement daisy chain cabling.

- EtherNet/IP scanner (master)
- Integrated switch for efficient wiring

9.23.17.1.1 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.23.17.1.1.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.23.17.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | X20 interface module communication | |
| X20IF10D1-1 | X20 interface module, for DTM configuration, 1 EtherNet/IP scanner (master) interface, electrically isolated |  |
| X20clF10D1-1 | X20 interface module, coated, for DTM configuration, 1 EtherNet/IP scanner (master) interface, electrically isolated | |

Table 454: X20IF10D1-1, X20clF10D1-1 - Order data

Optional accessories

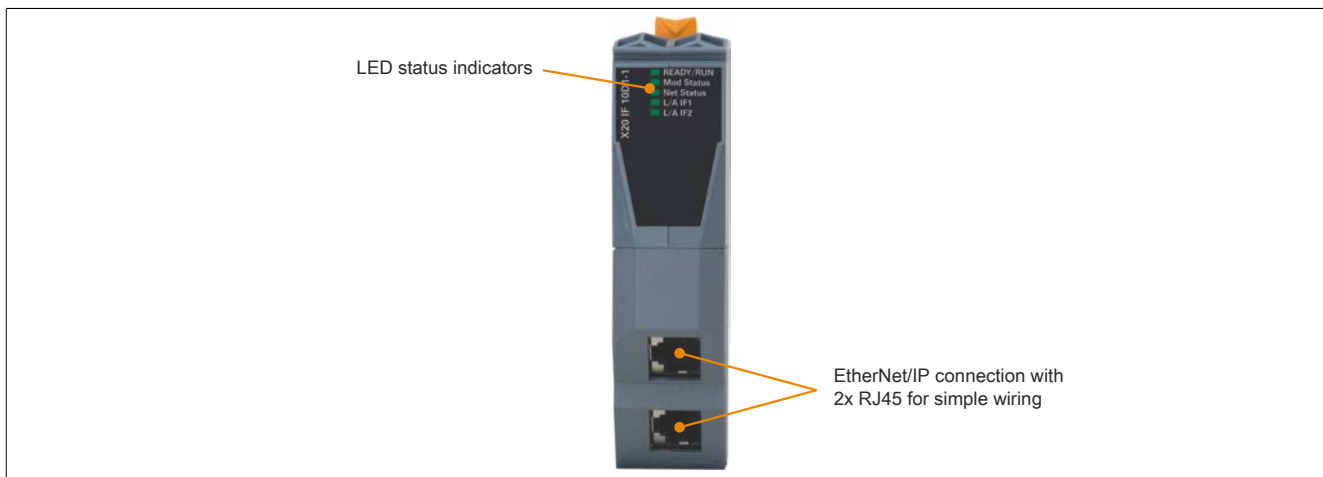
| Model number | Short description |
|----------------|--|
| X20CA0E61.xxxx | POWERLINK/Ethernet connection cable, RJ45 to RJ45, 0.2 to 20 m |
| X20CA0E61.xxxx | POWERLINK/Ethernet connection cable, RJ45 to RJ45, 20 m and longer |

9.23.17.3 Technical data

| Model number | X20IF10D1-1 | X20cIF10D1-1 |
|--|--|--|
| Short description | | |
| Communication module | EtherNet/IP scanner (master) | |
| General information | | |
| B&R ID code | 0xA71B | 0xE753 |
| Status indicators | Module status, network status, data transfer | |
| Diagnostics | | |
| Module status | Yes, using status LED and software | |
| Network status | Yes, using status LED and software | |
| Data transfer | Yes, using status LED | |
| Power consumption | 2 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Interfaces | | |
| Fieldbus | EtherNet/IP scanner (master) | |
| Variant | 2x shielded RJ45 (switch) | |
| Cable length | Max. 100 m between 2 stations (segment length) | |
| Transfer rate | 10/100 Mbit/s | |
| Transfer | | |
| Physical layer | 10BASE-T/100BASE-TX | |
| Half-duplex | Yes | |
| Full-duplex | Yes | |
| Autonegotiation | Yes | |
| Auto-MDI/MDIX | Yes | |
| Controller | netX100 | |
| Memory | 8 MB SDRAM | |
| Electrical properties | | |
| Electrical isolation | PLC isolated from EtherNet/IP (IF1 and IF2) | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Slot | In the X20 CPU and in the X20BC1083 expandable bus controller | In the X20 CPU and in the X20cBC1083 expandable bus controller |

Table 455: X20IF10D1-1, X20cIF10D1-1 - Technical data

9.23.17.4 Operating and connection elements



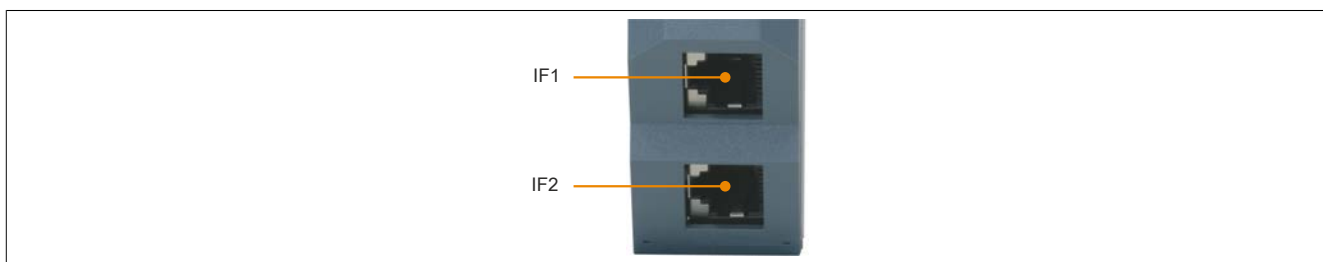
9.23.17.4.1 LED status indicators

| Figure | LED | Color | Status | Description |
|----------|--------------------------|------------|--|--|
| | READY/RUN | Green/Red | Off | No power to module |
| | | Green | On | PCI bus communication in progress |
| | | Red | Blinking | Boot error |
| | Mod status ¹⁾ | Green | Blinking | Communication on the PCI bus has not yet been started. |
| | | | On | The interface module has not yet been configured. |
| | | Red | Blinking | Scanner (master) is ready for operation. |
| | | | On | Correctable hardware errors |
| | Net status ¹⁾ | Green/Red | Blinking | Uncorrectable hardware errors |
| | | | On | Initialization/Self-test |
| | | Green | Off | No power to module |
| | | | Blinking | No active connections available |
| | | | On | A least one established active connection available |
| | L/A IF1/IF2 | Red | Blinking | A timeout occurred on at least one connection. |
| | | | On | An IP address has been used more than once. |
| | | Green/Red | Off | No IP address assigned or module not supplied |
| Blinking | | | Initialization/Self-test | |
| | Green | Off | No link to remote station | |
| | | Flickering | The link to the remote station is established. The LED blinks if Ethernet activity is taking place on the bus. | |
| | | On | The link to the remote station is established. | |

1) This LED is a green/red dual LED.

9.23.17.4.2 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see ["Cabling guidelines for X20 modules with an Ethernet cable"](#) on page 58.



| Interface | Pinout | | |
|----------------------|--------|-------------|----------------|
| | Pin | Ethernet | |
| <p>Shielded RJ45</p> | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.23.17.5 Use in the expandable X20BC1083 POWERLINK bus controller

9.23.17.5.1 Cyclic data

If this module is connected to the expandable POWERLINK bus controller, the amount of cyclic data is limited by the POWERLINK frame to 1488 bytes in each direction (input and output).

When using multiple X20IF10xx-1 interfaces or other X2X modules with a POWERLINK bus controller, the 1488 bytes are divided between all connected modules.

9.23.17.5.2 Operating netX modules

It is important to note the following in order to operate netX modules with the bus controller without problems:

- A minimum revision $\geq E0$ is required for the bus controller.
- netX modules can only be operated with the POWERLINK V2 setting. V1 is not permitted.
- With SDO access to POWERLINK object 0x1011/1 on the bus controller, the netX firmware and the configuration stored on the bus controller are not reset. They can only be overwritten by accessing them again. This affects objects 0x20C0 and 0x20C8, subindexes 92 to 95.

9.23.17.6 netX error codes

netX modules return an error code when an error occurs. These error codes are fieldbus-specific. A complete list of all error codes in PDF format is available in Automation Help in section "Communication / Fieldbus systems / Support with FDT/DTM / Diagnostic functions / Diagnostics on the runtime system / Master diagnostics" under item "Communication_Error".

9.23.17.7 Firmware

The module comes with preinstalled firmware. The firmware is part of the Automation Studio project. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.23.17.8 The EtherNet/IP interface

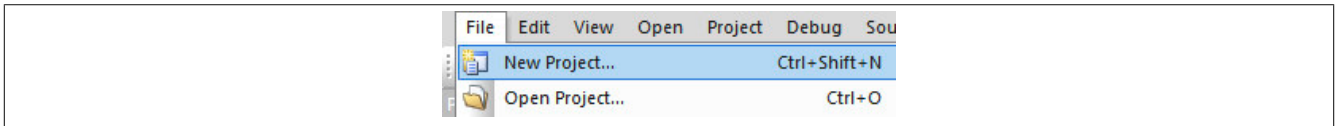
9.23.17.8.1 Settings in Automation Studio

The interface module can be operated in the slot of a CPU or in the slot of an expandable POWERLINK bus controller.

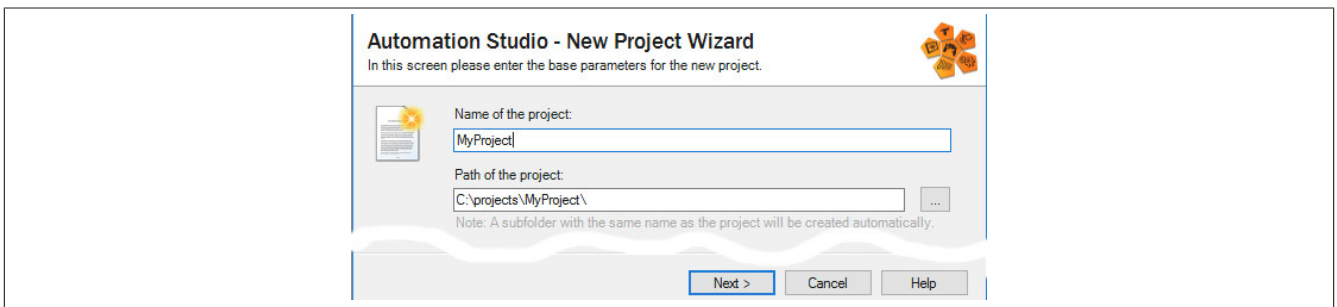
To do this, a new Automation Studio project is created and the suitable settings are made on the module.

9.23.17.8.1.1 Creating an Automation Studio project

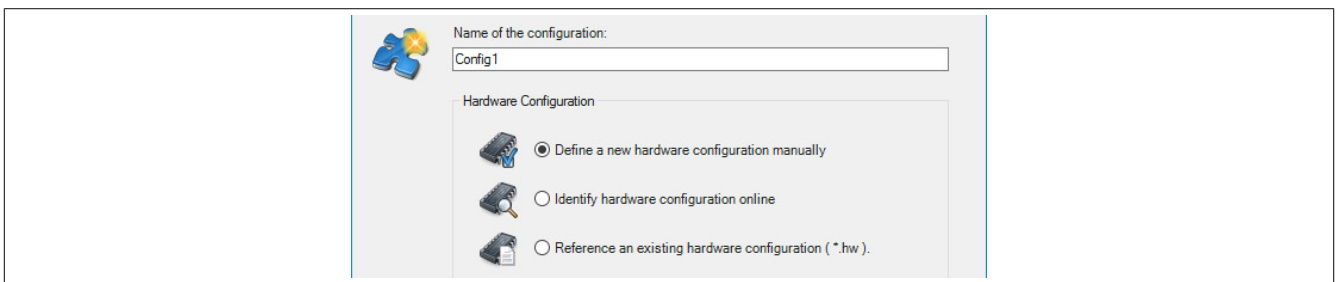
- Create a new Automation Studio project by selecting "New project".



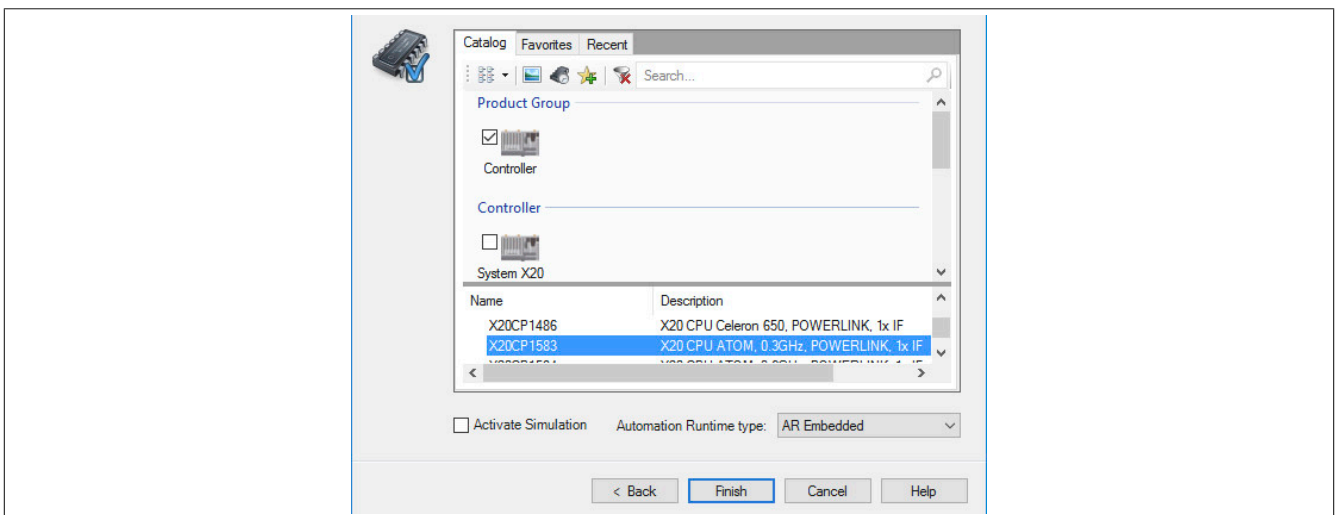
- Assign a project name and set up the project path.



- Assign the hardware configuration type and configuration name.

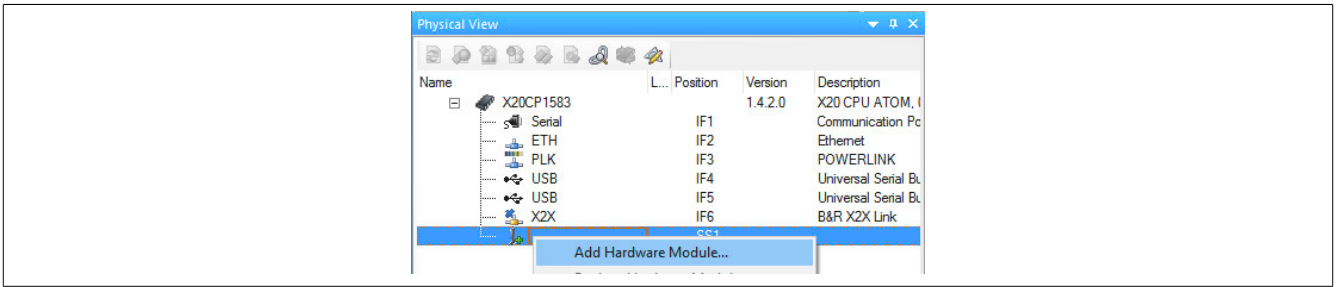


- Select the hardware in the next step if "Define a new hardware configuration manually" was selected. In order to simplify the search, different filters can be set in the Hardware Catalog. Lastly, highlight the required hardware and create the Automation Studio project by clicking on "Finish".

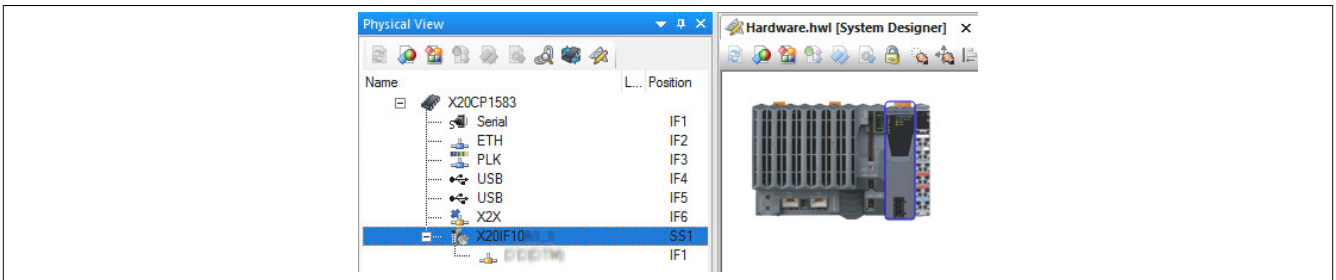


9.23.17.8.1.2 Adding and configuring the interface module

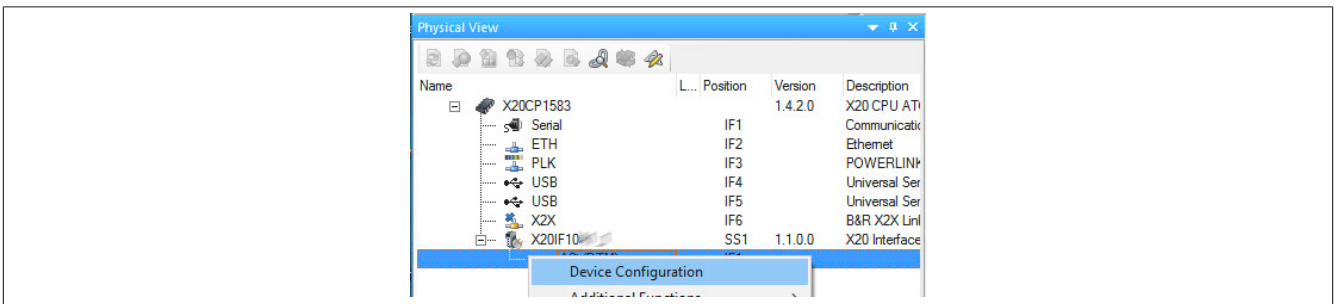
- In this example, the interface card is connected in the slot of a CPU. Right-clicking on the slot and selecting "Add hardware module" opens the Hardware Catalog.



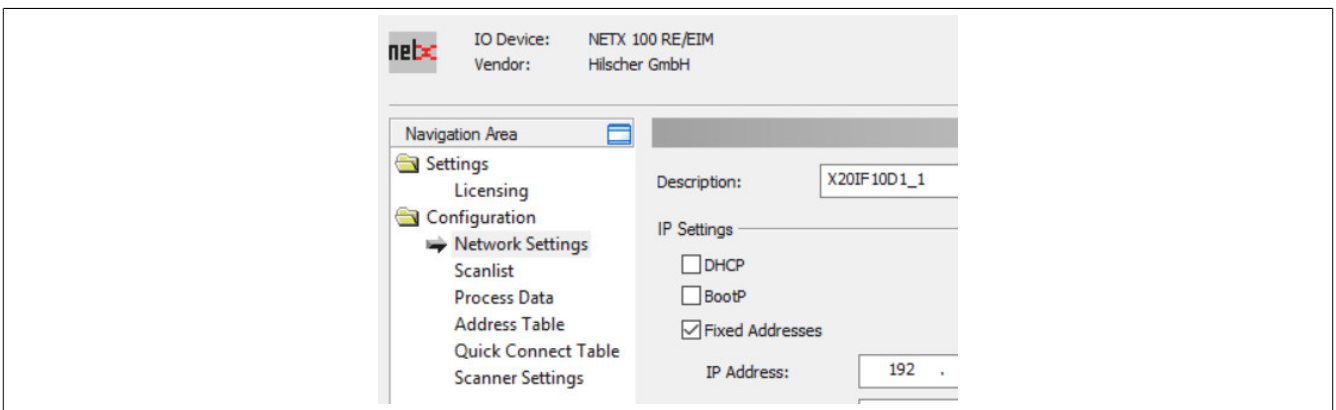
- The module is added to the project via drag-and-drop or by double-clicking on the interface card.



- Additional module settings can be made under "Device configuration". This configuration environment is opened by right-clicking on the IF interface and selecting "Device configuration".



- General settings are made in the device configuration.



Network settings

Contains the symbolic name of the module

| Parameter | Explanation |
|-------------|----------------------------|
| Description | Module name of the scanner |

- IP settings

The IP addresses and operation modes of the Ethernet interface are set here.

| Parameter | Explanation |
|-----------------|--|
| DHCP | IP address determined via DHCP protocol. |
| BootP | IP address determined via BootP protocol. |
| Fixed addresses | The IP address is static. The IP address is defined by the following 3 parameters. |
| IP address | IP address of the EtherNet/IP scanner station |
| Network mask | Network mask of the EtherNet/IP scanner station |
| Gateway address | Gateway address of the EtherNet/IP scanner station |

- Port 1

| Parameter | Explanation |
|----------------|--|
| Operating mode | Operating mode of the EtherNet/IP scanner (master) |
| MDI mode | Configure cable type <ul style="list-style-type: none"> • Auto MDI-X: Detect cable type automatically • MDI-X: Use crossover cable. • MDI: Use straight-through cable. |

- Port 2

Identical to port 1

Scan list

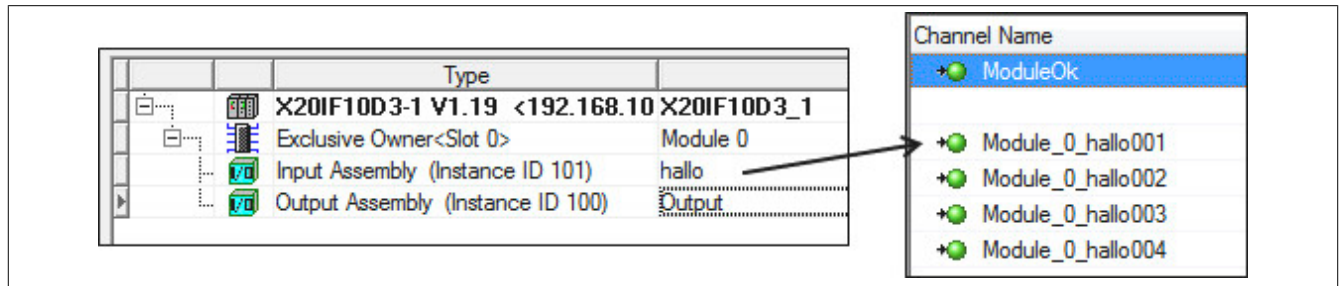
This table lists all attached EtherNet/IP adapters (slaves).

| Parameter | Explanation | Values | | | | | | | | | | | | | | | | | | | | |
|--------------------|---|---|-------|------------|---|-----|---|-----|---|------|---|----------------|---|------|---|-------|---|-------|---|-------|----------|----------|
| Activate | This is used to enable or disable the adapters. <ul style="list-style-type: none"> • Enabled: Process memory is reserved and data is exchanged. • Disabled: The master reserves memory in the process data image for the adapter, but no data is exchanged. | | | | | | | | | | | | | | | | | | | | | |
| Index | Continuous numbering of the EtherNet/IP devices in the scan list. | | | | | | | | | | | | | | | | | | | | | |
| IP address | Configurable IP address of the EtherNet/IP adapter station. | | | | | | | | | | | | | | | | | | | | | |
| Name | Editable station name. | | | | | | | | | | | | | | | | | | | | | |
| Description | Symbolic, non-editable station name | | | | | | | | | | | | | | | | | | | | | |
| RPI (ms) | Requested packet interval in milliseconds for a connection. For values in the microsecond range, the fixed point format can be used, e.g. 0.2 for 200 microseconds. | 0.001 to 4294967 (default: 100) | | | | | | | | | | | | | | | | | | | | |
| Timeout multiplier | Multiplication factor applied to the expected packet rate to obtain the connection timeout value. Whenever a timeout occurs during connection, modules should stop transmission over a connection, even if the pending closing signal has been transmitted. | <table border="1"> <thead> <tr> <th>Value</th> <th>Multiplier</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>x 4</td> </tr> <tr> <td>1</td> <td>x 8</td> </tr> <tr> <td>2</td> <td>x 16</td> </tr> <tr> <td>3</td> <td>x 32 (default)</td> </tr> <tr> <td>4</td> <td>x 64</td> </tr> <tr> <td>5</td> <td>x 128</td> </tr> <tr> <td>6</td> <td>x 256</td> </tr> <tr> <td>7</td> <td>x 512</td> </tr> <tr> <td>8 to 255</td> <td>Reserved</td> </tr> </tbody> </table> | Value | Multiplier | 0 | x 4 | 1 | x 8 | 2 | x 16 | 3 | x 32 (default) | 4 | x 64 | 5 | x 128 | 6 | x 256 | 7 | x 512 | 8 to 255 | Reserved |
| Value | Multiplier | | | | | | | | | | | | | | | | | | | | | |
| 0 | x 4 | | | | | | | | | | | | | | | | | | | | | |
| 1 | x 8 | | | | | | | | | | | | | | | | | | | | | |
| 2 | x 16 | | | | | | | | | | | | | | | | | | | | | |
| 3 | x 32 (default) | | | | | | | | | | | | | | | | | | | | | |
| 4 | x 64 | | | | | | | | | | | | | | | | | | | | | |
| 5 | x 128 | | | | | | | | | | | | | | | | | | | | | |
| 6 | x 256 | | | | | | | | | | | | | | | | | | | | | |
| 7 | x 512 | | | | | | | | | | | | | | | | | | | | | |
| 8 to 255 | Reserved | | | | | | | | | | | | | | | | | | | | | |

Process data

This table lists the process data of the individual Ethernet/IP adapters (slaves).

| Parameter | Explanation |
|-----------|---|
| Type | Device designation specified by the hardware. Further description of modules configured on the device or the input or output signals. |
| Day | The name of the input and output data can be changed in column "Day". |
| SCADA | This parameter is not supported. |



Address table

This table provides information about the addresses of the input and output data (in decimal or hexadecimal notation).

"Display mode" allows toggling between decimal and hexadecimal display.

| Parameter | Explanation |
|-----------------|-------------------------------------|
| Device | Device name of the adapter |
| Slot | Slot number for modular adapters |
| Connection name | Text-based name of the connection |
| Instance ID | Assembly instance ID |
| Length | Byte length of the instance |
| Address | Data offset address of the instance |

The address table can also be exported as a CSV file.

Quick connect table

This parameter is not supported.

Scanner settings

- Start of bus communication

It is possible to select how data exchange is started on the module.

| Parameter | Explanation |
|---------------------------|--|
| Automatically by device | Data exchange is started automatically after initializing this module. |
| Controlled by application | Data exchange is started by Automation Runtime. |

- Module alignment

The addressing mode is defined by the process image here. The addresses (offsets) of the process data are always interpreted as byte addresses.

| Addressing mode | Explanation |
|-------------------|---|
| Byte boundaries | The module address can start on any offset. |
| 2 byte boundaries | The module address can only start on even byte offsets. |

Information:

This configuration is automatically managed by Automation Runtime and is not permitted to be changed (default setting).

- Application monitoring

The module-internal watchdog time can be set here. If the watchdog has been enabled (watchdog time not equal to 0), the hardware watchdog must be reset after the set time at the latest.

| Parameter | Explanation | Values |
|---------------|---|----------------|
| Watchdog time | Watchdog software disabled | 0 ms |
| | Permissible range of values Default value: 1000 ms | 20 to 65535 ms |

Information:

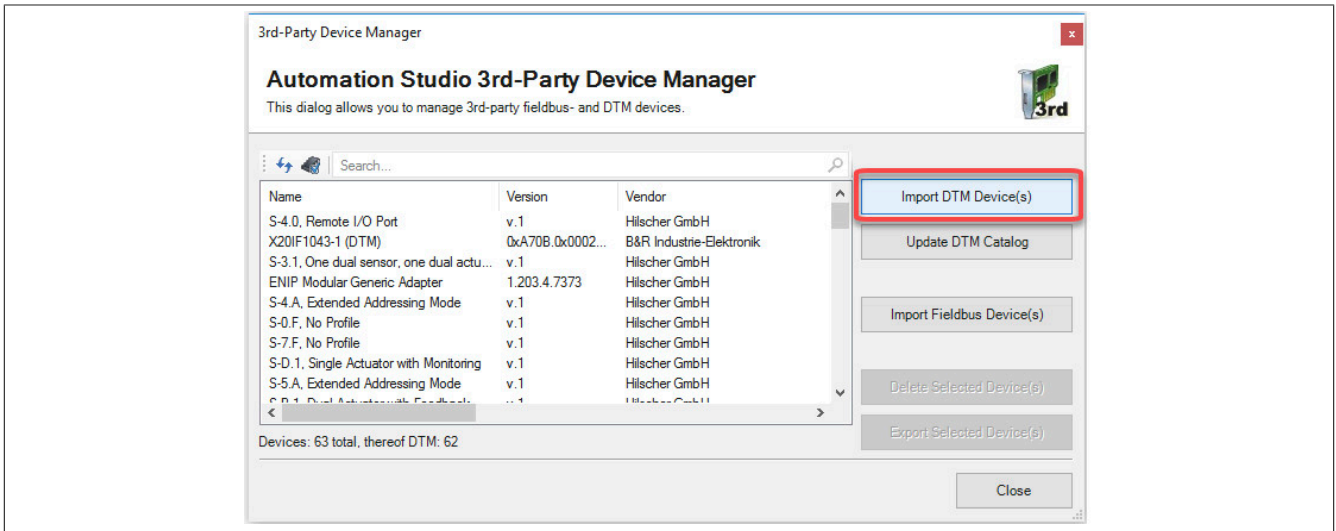
The watchdog time is reset automatically by Automation Runtime.

9.23.17.8.1.3 Adding the EDS file in Automation Studio

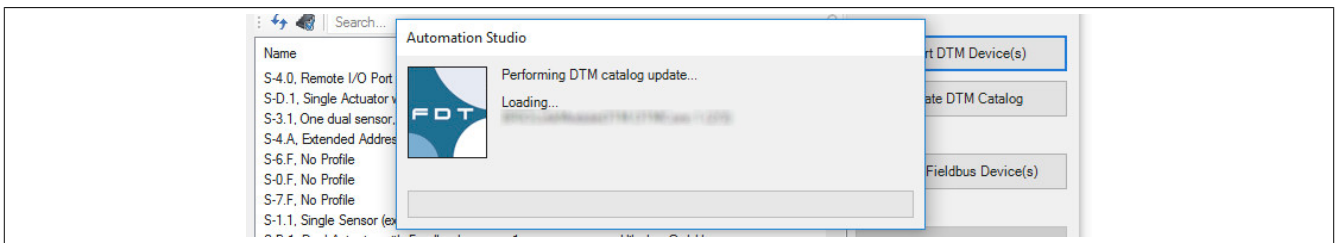
To tell the EtherNet/IP scanner (master) which adapters (slaves) were connected and how they were configured, a description file (EDS file) is required.

To add and use a device description file in Automation Studio, perform the following steps:

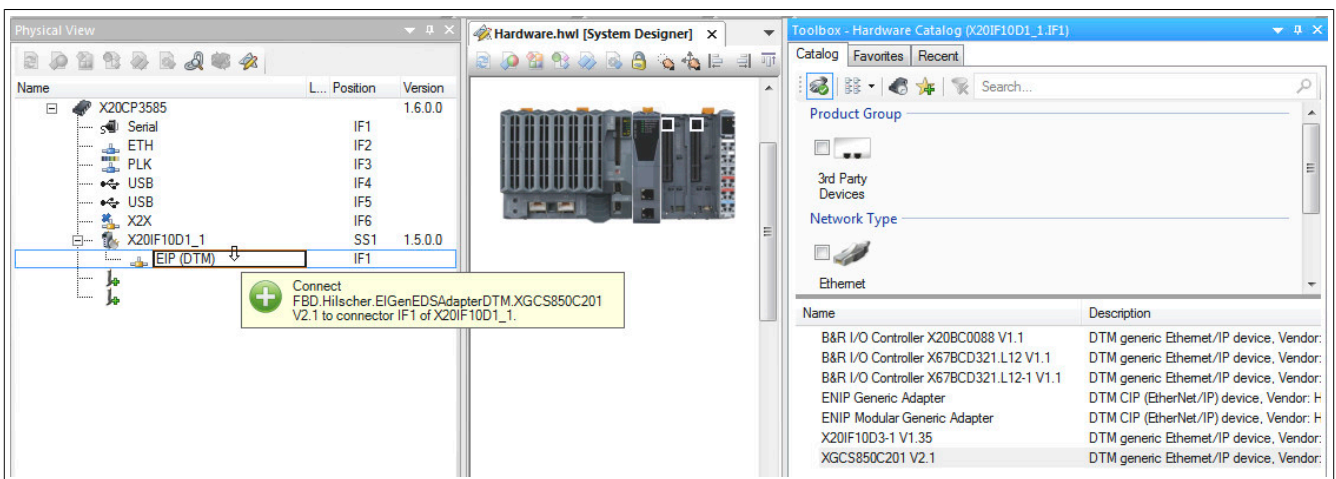
- If the B&R EtherNet/IP adapter (slave) is used, download the EDS file from the B&R website www.br-automation.com and unzip the ZIP file.
- Open the dialog box in Automation Studio under "Tools - Manage 3rd-party devices" and select "Import DTM device(s)".



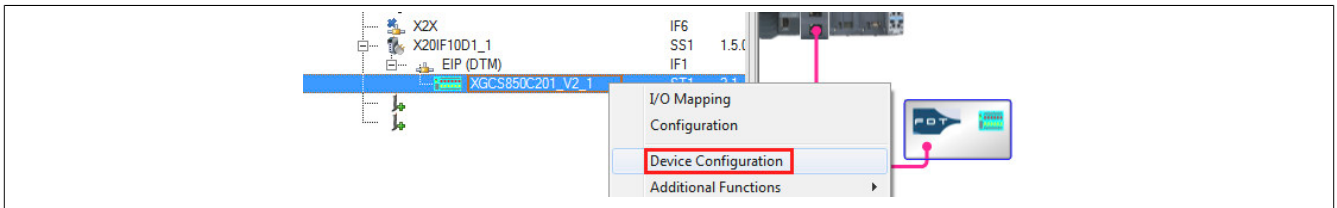
- Select the EDS file to be imported and confirm with OK. The EDS file is imported into Automation Studio.



- Click on "EIP(DTM)" on EtherNet/IP scanner (master) X20IF10D1-1, drag the EDS file from the Hardware Catalog and attach it to the EtherNet/IP scanner (master).



- Right-click on the IF interface and select "Device configuration" to open the configuration environment for the EDS file.



9.23.18 X20(c)IF10D3-1

Data sheet version: 2.04

9.23.18.1 General information

The interface module is equipped with an EtherNet/IP adapter interface. This allows the B&R system (I/O modules, POWERLINK, etc.) to be connected to systems from other manufacturers and makes it possible to quickly and easily transfer data in both directions.

The interface module can be operated in X20 CPUs or in the expandable POWERLINK bus controller X20BC1083.

The interface is equipped with 2 RJ45 connections. Both connections result in an integrated switch. This makes it easy to implement daisy chain cabling.

- EtherNet/IP adapter (slave)
- Integrated switch for efficient cabling

9.23.18.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.23.18.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.23.18.3 Order data

| Model number | Short description | Figure |
|--------------|---|--------|
| | X20 interface module communication | |
| X20IF10D3-1 | X20 interface module, for DTM configuration, 1 EtherNet/IP adapter (slave) interface, electrically isolated | |
| X20cIF10D3-1 | X20 interface module, coated, for DTM configuration, 1 EtherNet/IP adapter (slave) interface, electrically isolated | |

Table 456: X20IF10D3-1, X20cIF10D3-1 - Order data

Optional accessories

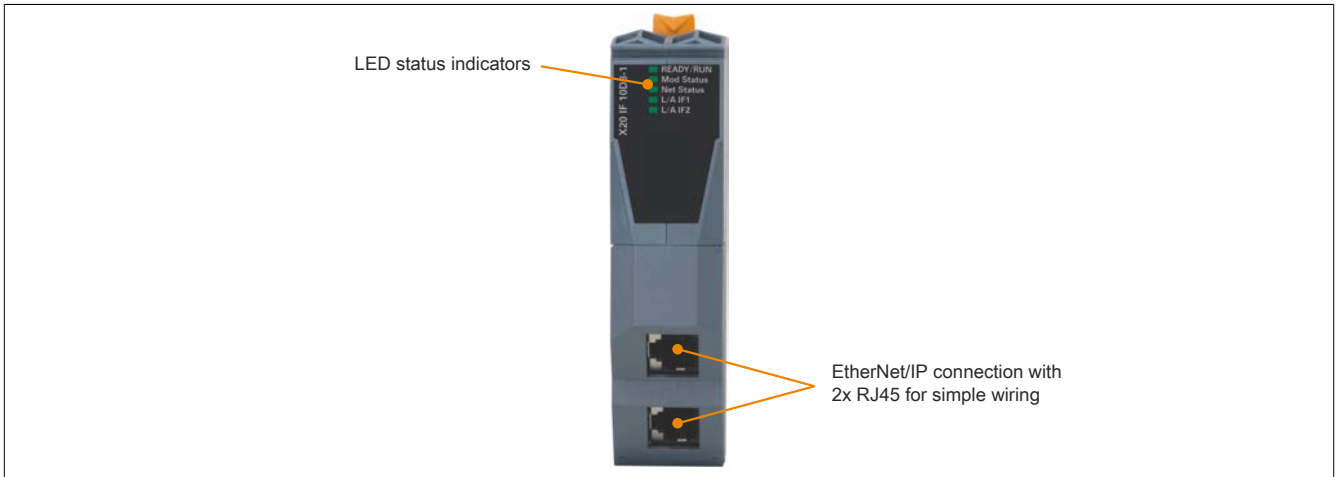
| Model number | Short description |
|-----------------|--|
| X20CA0E61.xxxxx | POWERLINK/Ethernet connection cable, RJ45 to RJ45, 0.2 to 20 m |
| X20CA0E61.xxx | POWERLINK/Ethernet connection cable, RJ45 to RJ45, 20 m and longer |

9.23.18.4 Technical data

| Model number | X20IF10D3-1 | X20cIF10D3-1 |
|--|--|--|
| Short description | | |
| Communication module | EtherNet/IP Adapter (slave) | |
| General information | | |
| B&R ID code | 0xA71C | 0xE237 |
| Status indicators | Module status, network status, data transfer | |
| Diagnostics | | |
| Module status | Yes, using status LED and software | |
| Network status | Yes, using status LED and software | |
| Data transfer | Yes, using status LED | |
| Power consumption | 2 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Interfaces | | |
| Fieldbus | EtherNet/IP Adapter (slave) | |
| Variant | 2x shielded RJ45 (switch) | |
| Cable length | Max. 100 m between 2 stations (segment length) | |
| Transfer rate | 10/100 Mbit/s | |
| Transfer | | |
| Physical layer | 10BASE-T/100BASE-TX | |
| Half-duplex | Yes | |
| Full-duplex | Yes | |
| Autonegotiation | Yes | |
| Auto-MDI/MDIX | Yes | |
| Controller | netX100 | |
| Electrical properties | | |
| Electrical isolation | PLC isolated from EtherNet/IP (IF1 and IF2) | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Slot | In the X20 CPU and in the X20BC1083 expandable bus controller | In the X20c CPU and in the X20cBC1083 expandable bus controller |

Table 457: X20IF10D3-1, X20cIF10D3-1 - Technical data

9.23.18.5 Operating and connection elements



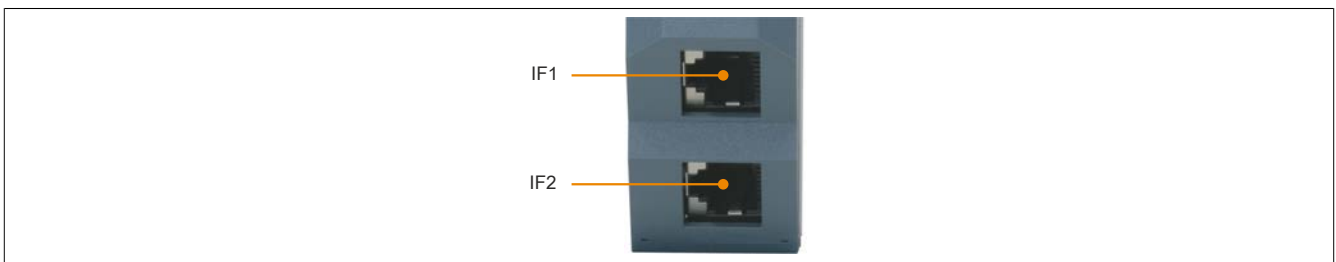
9.23.18.5.1 LED status indicators

| Figure | LED | Color | Status | Description |
|-------------|--------------------------|------------|--|---|
| | READY/RUN | Green/red | Off | No power to module |
| | | Green | On | PCI bus communication in progress |
| | | Red | Blinking | Boot error |
| | Mod status ¹⁾ | Green | Blinking | Communication on the PCI bus has not yet been started |
| | | | On | Interface module not yet configured |
| | | Red | Blinking | Adapter (Slave) is operational |
| | | | On | Recoverable hardware error |
| | Net status ¹⁾ | Green/red | Blinking | Irrecoverable hardware error |
| | | | On | Initialization / Self-test |
| | | Green | Off | No power to module |
| | | | Blinking | No active connection |
| | | | On | Indicates at least one active connection |
| | L/A IF1/IF2 | Red | Blinking | Timeout occurred on at least one connection |
| | | | On | An IP address has been used repeatedly |
| | | Green/red | Blinking | Initialization / Self-test |
| Off | | | No IP address assigned or module not supplied | |
| L/A IF1/IF2 | Green | Off | No link to remote station | |
| | | Flickering | A link to the remote station has been established. The LED blinks when Ethernet activity is taking place on the bus. | |
| | | On | A link to the remote station has been established. | |

1) This LED is a green/red dual LED.

9.23.18.5.2 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see "Cabling guidelines for X20 modules with an Ethernet cable" on page 58.



| Interface | Pinout | | |
|-------------------|--------|-------------|----------------|
| | Pin | Ethernet | |
| Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.23.18.6 Use in the expandable X20BC1083 POWERLINK bus controller

9.23.18.6.1 Cyclic data

If this module is connected to the expandable POWERLINK bus controller, the amount of cyclic data is limited by the POWERLINK frame to 1488 bytes in each direction (input and output).

When using multiple X20IF10xx-1 interfaces or other X2X modules with a POWERLINK bus controller, the 1488 bytes are divided between all connected modules.

9.23.18.6.2 Operating netX modules

It is important to note the following in order to operate netX modules with the bus controller without problems:

- A minimum revision $\geq E0$ is required for the bus controller.
- netX modules can only be operated with the POWERLINK V2 setting. V1 is not permitted.
- With SDO access to POWERLINK object 0x1011/1 on the bus controller, the netX firmware and the configuration stored on the bus controller are not reset. They can only be overwritten by accessing them again. This affects objects 0x20C0 and 0x20C8, subindexes 92 to 95.

9.23.18.7 netX error codes

netX modules return an error code when an error occurs. These error codes are fieldbus-specific. A complete list of all error codes in PDF format is available in Automation Help in section "Communication / Fieldbus systems / Support with FDT/DTM / Diagnostic functions / Diagnostics on the runtime system / Master diagnostics" under item "Communication_Error".

9.23.18.8 Firmware

The module comes with preinstalled firmware. The firmware is part of the Automation Studio project. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.23.18.9 Minimum DTM version for coated modules

Information:

The minimum DTM version required for coated modules is 1.0370.140220.12186. This version is included starting with Automation Studio upgrade packs V4.0.18.x and V3.0.90.29.

9.23.18.10 EtherNet/IP interface

Two steps are generally necessary for connecting module X20IF10D3-1 to an external master environment.

- 1) Add and configure the X20 interface module in B&R's Automation Studio.
- 2) Add the EtherNet/IP adapter (slave) EDS device description file in the external master environment, e.g. Rockwell RSLogix 5000. The interface module must then be configured.

Information:

To ensure error-free EtherNet/IP communication between master and slave, the settings for the interface module in Automation Studio must match the settings of the EDS device description file in the master environment.

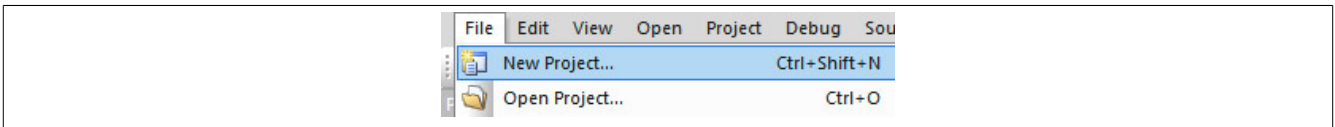
9.23.18.10.1 Settings in Automation Studio

The interface module can be operated in the slot of a CPU or in the slot of an expandable POWERLINK bus controller.

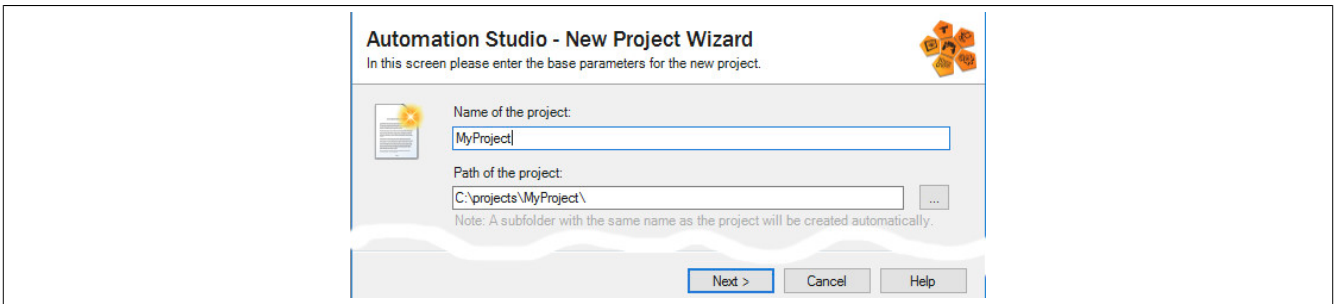
To do this, a new Automation Studio project is created and the suitable settings are made on the module.

9.23.18.10.1.1 Creating an Automation Studio project

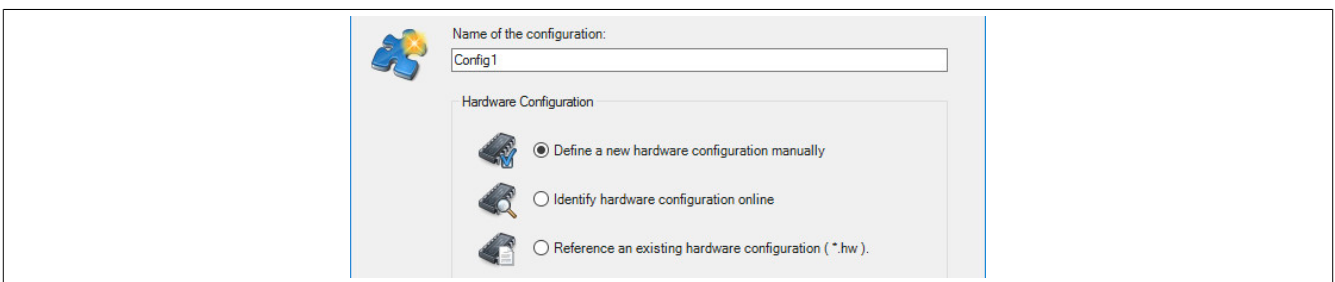
- Create a new Automation Studio project by selecting "New project".



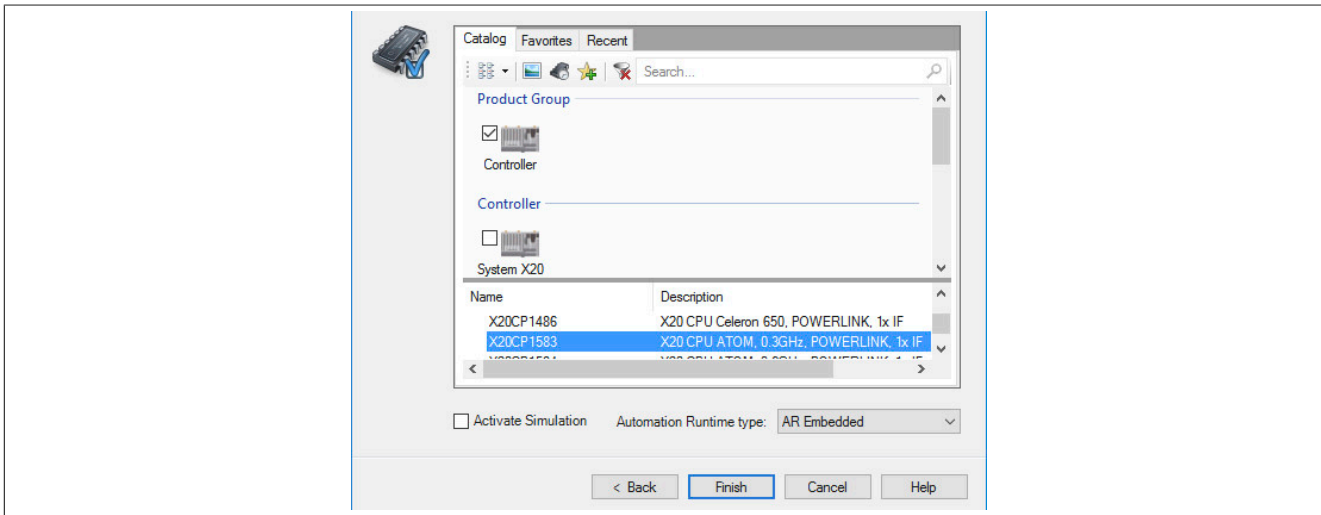
- Assign a project name and set up the project path.



- Assign the hardware configuration type and configuration name.

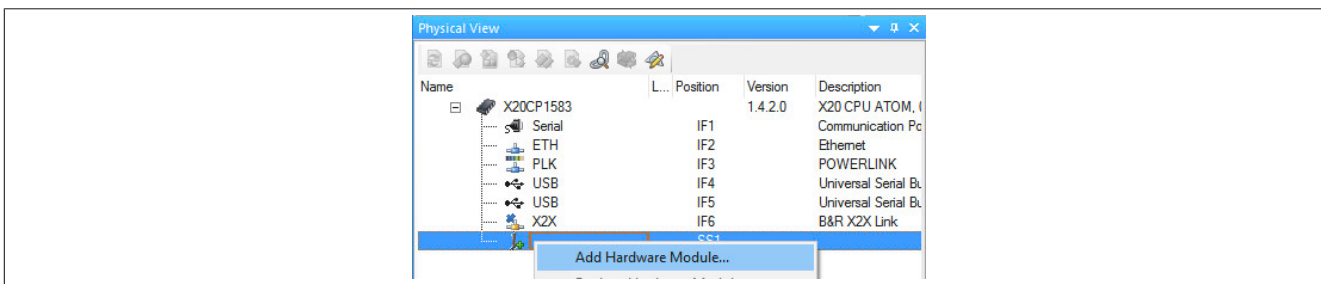


- Select the hardware in the next step if "Define a new hardware configuration manually" was selected. In order to simplify the search, different filters can be set in the Hardware Catalog. Lastly, highlight the required hardware and create the Automation Studio project by clicking on "Finish".

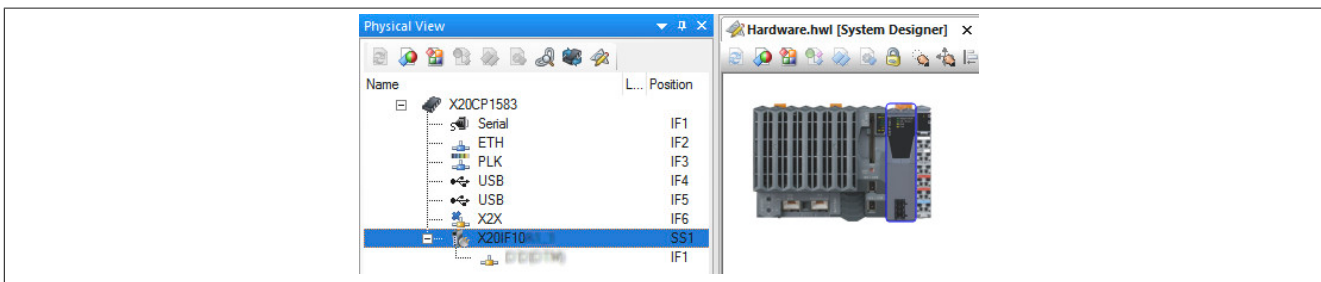


9.23.18.10.1.2 Adding and configuring the interface module

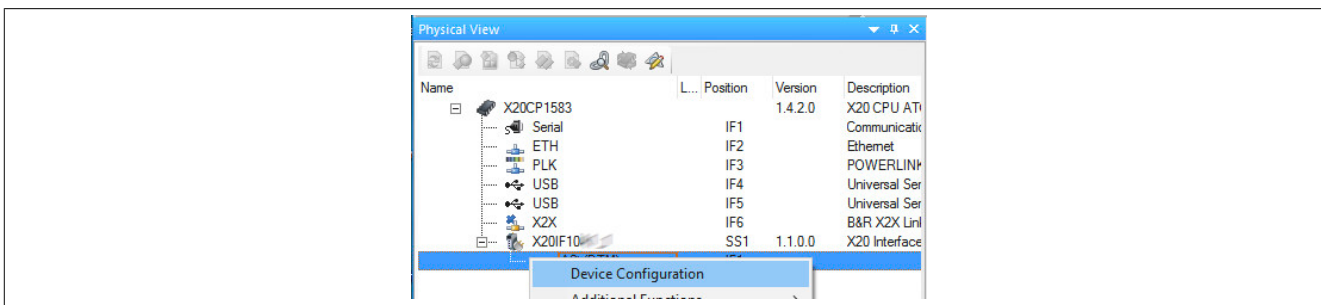
- In this example, the interface card is connected in the slot of a CPU. Right-clicking on the slot and selecting "Add hardware module" opens the Hardware Catalog.



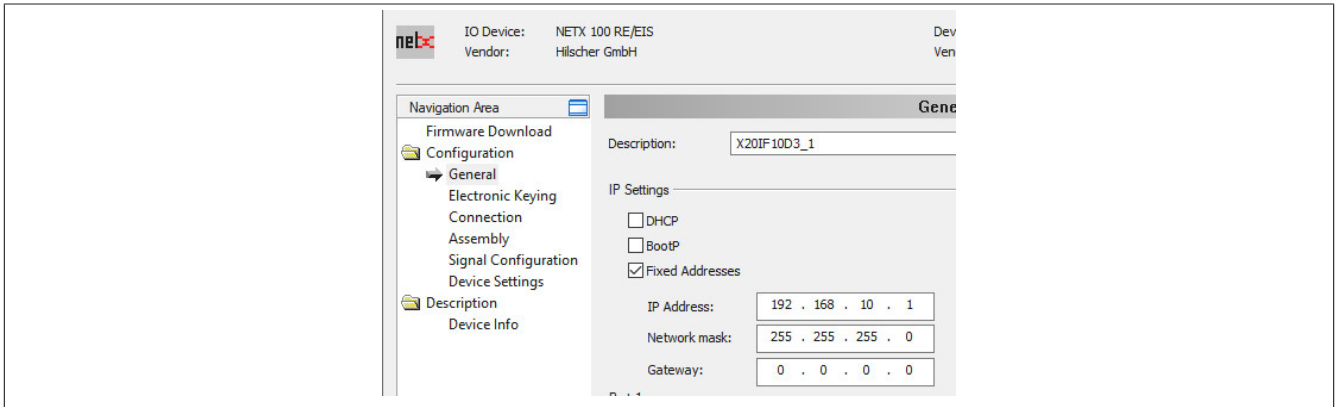
- The module is added to the project via drag-and-drop or by double-clicking on the interface card.



- Additional module settings can be made under "Device configuration". This configuration environment is opened by right-clicking on the IF interface and selecting "Device configuration".



- General settings are made in the device configuration.



General

The IP settings and operation modes of the ports are set here. Only one of the IP settings can be enabled on the adapter (slave).

Contains the symbolic name of the module.

| Parameter | Explanation |
|-------------|----------------------------|
| Description | Module name of the adapter |

- IP settings

The IP addresses and operation modes of the Ethernet interface are set here.

| Parameter | Explanation |
|-----------------|--|
| DHCP | IP address determined via DHCP protocol. |
| BootP | IP address determined via BootP protocol. |
| Fixed addresses | The IP address is static. The IP address is defined by the following 3 parameters. |
| IP address | IP address of the EtherNet/IP adapter |
| Network mask | Network mask of the EtherNet/IP adapter |
| Gateway address | Gateway address of the EtherNet/IP adapter |

- Port 1

| Parameter | Explanation |
|----------------|--|
| Operating mode | Operating mode of the EtherNet/IP adapter (slave) |
| MDI mode | Configure cable type <ul style="list-style-type: none"> • Auto MDI-X: Detect cable type automatically • MDI-X: Use crossover cable. • MDI: Use straight-through cable. |

- Port 2

Identical to port 1

Electronic keying

Here, it is possible to set which parameters on the device and in the master's device description file must match exactly.

A connection between the EtherNet/IP scanner and the adapter can only be established if the parameter settings for the interface module in Automation Studio defined by the keying method match those in the EDS device description file.

| Method | Explanation |
|---------------|--|
| Exact match | When validating an EtherNet/IP adapter connected to the network, all attributes of the electronic identity must correspond to the attributes for an expected device. |
| Custom keying | When validating an EtherNet/IP adapter connected to the network, all attributes must correspond to the configured keying. |
| No keying | The device identity is not validated. |

If "Custom keying" is selected, the following parameters can be checked.

| Parameter | Explanation |
|----------------------|--|
| Relaxed match | Devices can verify their electronic identity in a restricted form. |
| Match minor revision | Checks for compliance with the secondary revision |
| Match major revision | Checks for compliance with the main revision |
| Match product code | Checks for compliance with the product code |
| Match product type | Checks for compliance with the product type |
| Match vendor | Checks for compliance with the vendor ID |

Connection

- Connection name

The name of the connection can be assigned here.

| Parameter | Explanation |
|-----------------|------------------------|
| Connection name | Name of the connection |

- Originator to target

The transfer format from the scanner to the adapter can be assigned here.

| Parameter | Explanation |
|--------------------|---|
| RT transfer format | Transfer format <ul style="list-style-type: none"> • Connection is pure data and is modeless • 32-bit run/idle header |

- Target to originator

The transfer format from the adapter to the scanner can be assigned here.

| Parameter | Explanation |
|--------------------|---|
| RT transfer format | Transfer format <ul style="list-style-type: none"> • Connection is pure data and is modeless • 32-bit run/idle header |

Information:

The default settings for "RT transfer format" can differ depending on the Automation Studio version / DTM version used.

The device description file package available on the B&R website contains 2 different EDS device description files:

- RT_Transfer_format_OT_32bit_TO_32bit
- RT_Transfer_format_OT_32bit_TO_modeless

The settings must be adjusted depending on the EDS file used. Inconsistencies will occur in the I/O image if the settings for the interface module do not match the settings in the EDS device description file in Automation Studio.

Assembly

Here is a list of input and output connections. The data length and the instance ID can be adjusted. If the instance ID or the length of the data is changed, this setting must also be adjusted in the master environment. Otherwise, no connection can be established from the scanner to the adapter.

| Parameter | Explanation | Values |
|-----------------|---|------------|
| In/Out | Input/Output connections of the EtherNet/IP adapter | |
| Connection name | Name of the input or output connection of the EtherNet/IP adapter | |
| Instance ID | Instance ID of the connection (editable) | 1 to 65535 |
| Data length | Data length in bytes (editable) | 0 to 504 |
| Min. length | Minimum data length in bytes | 0 |
| Max. length | Maximum data length in bytes | |

Signal configuration

The data structure of the individual modules can be defined here; the name and data type of the inputs and outputs can also be adjusted. Data types can also be combined.

| Parameter | Explanation |
|-------------|-----------------------|
| Slot | Position of the slot |
| Name | Name of the slot |
| Module type | Data type of the slot |

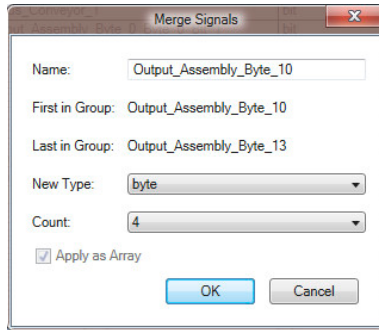
After selecting a slot, the type of the assembly (input or output), data type and offset are displayed in another table below.

After right-clicking on the signal to be configured, the following options can be selected in the shortcut menu:

- **Edit signal**

This allows the currently selected signal to be edited.

| Parameter | Explanation |
|----------------|--|
| Name | The new name for the signal |
| New type | The new data type for the signal |
| Count | Number of individually listed data type elements for the signal. Only the data of the original type is re-structured; the quantity is not adjusted. - The maximum number corresponds to the quantity that the new data type requires to display the original type. - If fewer elements are selected, the last data type element is listed as an array of all remaining elements. |
| Apply as array | If selected, the new data type is displayed as an array. Otherwise, the data type elements set under "Count" are displayed. |



| Slot | Name | Type | Offset |
|--------|-------------------------------------|--------------|--------|
| Slot 1 | Connection1 | | |
| | Status_Conveyor_1 | bit | 0.0 |
| | Output_Assembly_Byte_0_Byte_0_Bit_1 | bit | 0.1 |
| | Output_Assembly_Byte_0_Byte_0_Bit_2 | bit | 0.2 |
| | Output_Assembly_Byte_0_Byte_0_Bit_3 | bit | 0.3 |
| | Output_Assembly_Byte_0_Byte_0_Bit_4 | bit | 0.4 |
| | Output_Assembly_Byte_0_Byte_0_Bit_5 | bit | 0.5 |
| | Output_Assembly_Byte_0_Byte_0_Bit_6 | bit | 0.6 |
| | Output_Assembly_Byte_0_Byte_0_Bit_7 | bit | 0.7 |
| | Temp_1 | byte | 1 |
| | Position_5 | word | 2 |
| | Counter_10 | dword | 4 |
| | Output_Assembly_Byte_8 | byte | 8 |
| | Output_Assembly_Byte_9 | byte | 9 |
| | Output_Assembly_Byte_10 | 4 byte array | 10 |
| | Output_Assembly_Byte_13 | byte | 14 |
| | Output_Assembly_Byte_15 | byte | 15 |

- **Reset**

This can be used to undo the signal change or a merge previously completed with "Merge signal".

- **Merge signal**

This allows all signals between "First in group" and "Last in group" to be merged to form a new group. The same settings can be made for the new group as under "Edit signal".

The settings made are reflected in the process image (I/O mapping).

Configuring the signal

| Name | Type | Offset |
|-------------------------------------|-------|--------|
| Status_Conveyor_1 | bit | 0.0 |
| Output_Assembly_Byte_0_Byte_0_Bit_1 | bit | 0.1 |
| Output_Assembly_Byte_0_Byte_0_Bit_2 | bit | 0.2 |
| Output_Assembly_Byte_0_Byte_0_Bit_3 | bit | 0.3 |
| Output_Assembly_Byte_0_Byte_0_Bit_4 | bit | 0.4 |
| Output_Assembly_Byte_0_Byte_0_Bit_5 | bit | 0.5 |
| Output_Assembly_Byte_0_Byte_0_Bit_6 | bit | 0.6 |
| Output_Assembly_Byte_0_Byte_0_Bit_7 | bit | 0.7 |
| Temp_1 | byte | 1 |
| Position_5 | word | 2 |
| Counter_10 | dword | 4 |
| Output_Assembly_Byte_8 | byte | 8 |

Process image

| | | | | |
|---|---------|--------------------------|---------|-------|
| Connection1_Status_Conveyor_1 | TRUE | <input type="checkbox"/> | FALSE | BOOL |
| Connection1_Output_Assembly_Byte_0_Byte_0_Bit_1 | TRUE | <input type="checkbox"/> | FALSE | BOOL |
| Connection1_Output_Assembly_Byte_0_Byte_0_Bit_2 | TRUE | <input type="checkbox"/> | FALSE | BOOL |
| Connection1_Output_Assembly_Byte_0_Byte_0_Bit_3 | TRUE | <input type="checkbox"/> | FALSE | BOOL |
| Connection1_Output_Assembly_Byte_0_Byte_0_Bit_4 | TRUE | <input type="checkbox"/> | FALSE | BOOL |
| Connection1_Output_Assembly_Byte_0_Byte_0_Bit_5 | TRUE | <input type="checkbox"/> | FALSE | BOOL |
| Connection1_Output_Assembly_Byte_0_Byte_0_Bit_6 | TRUE | <input type="checkbox"/> | FALSE | BOOL |
| Connection1_Output_Assembly_Byte_0_Byte_0_Bit_7 | TRUE | <input type="checkbox"/> | FALSE | BOOL |
| Connection1_Temp_1 | 16#11 | <input type="checkbox"/> | 16#00 | USINT |
| Connection1_Position_5 | 16#3322 | <input type="checkbox"/> | 16#0000 | UINT |
| Connection1_Counter_10 | 16#7766 | <input type="checkbox"/> | 16#0000 | UDINT |
| Connection1_Output_Assembly_Byte_8 | 0 | <input type="checkbox"/> | 0 | USINT |

Device settings

- Start of bus communication

It is possible to select how data exchange is started on the module.

| Parameter | Explanation |
|---------------------------|--|
| Automatically by device | Data exchange is started automatically after initializing this module. |
| Controlled by application | Data exchange is started by Automation Runtime. |

- Application monitoring

The module-internal watchdog time can be set here. If the watchdog has been enabled (watchdog time not equal to 0), the hardware watchdog must be reset after the set time at the latest.

| Parameter | Explanation | Values |
|---------------|---|----------------|
| Watchdog time | Watchdog software disabled | 0 ms |
| | Permissible range of values Default value: 1000 ms | 20 to 65535 ms |

Information:

The watchdog time is reset automatically by Automation Runtime.

- Process image storage format

This parameter is not supported.

Description

General device information and the entire GSDML file can be read here.

9.23.18.10.2 EDS device description file

The module description is made available to the master in an EDS file. This file contains the description of the slave's complete range of functions. The EDS file can be downloaded from the B&R website (www.br-automation.com) in the Downloads section for the interface module and then imported into the respective master environment.

9.23.19 X20IF10E1-1

Data sheet version: 2.04

9.23.19.1 General information

The interface module is equipped with a PROFINET IO controller interface. This allows third-party components to be integrated in the B&R system and makes it possible to quickly and easily transfer data in both directions.

The interface module can be operated in X20 CPUs or in the expandable POWERLINK bus controller X20BC1083.

The interface is equipped with 2 RJ45 connections. Both connections result in an integrated switch. This makes it easy to implement daisy chain cabling.

- PROFINET IO controller
- Integrated switch for efficient cabling

9.23.19.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | X20 interface module communication | |
| X20IF10E1-1 | X20 interface module, for DTM configuration, 1 PROFINET IO controller (master) interface, electrically isolated |  |

Table 458: X20IF10E1-1 - Order data

Optional accessories

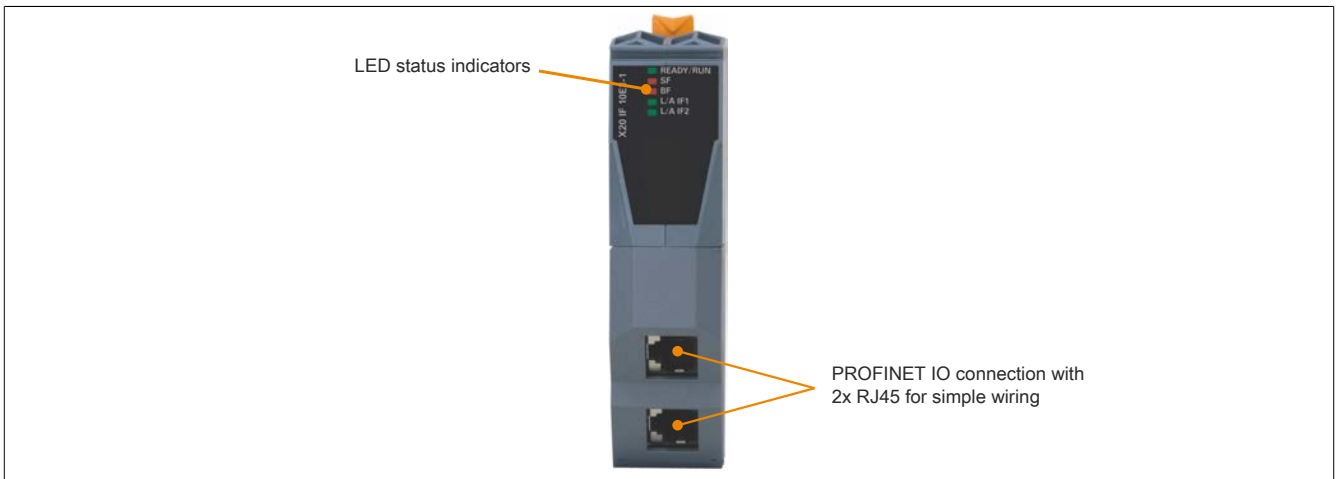
| Model number | Short description |
|-----------------|--|
| X20CA0E61.xxxxx | POWERLINK/Ethernet connection cable, RJ45 to RJ45, 0.2 to 20 m |
| X20CA0E61.xxxx | POWERLINK/Ethernet connection cable, RJ45 to RJ45, 20 m and longer |

9.23.19.3 Technical data

| Model number | X20IF10E1-1 |
|--|--|
| Short description | |
| Communication module | PROFINET IO controller (master) |
| General information | |
| B&R ID code | 0xA71D |
| Status indicators | Module status, network status, data transfer |
| Diagnostics | |
| Module status | Yes, using status LED and software |
| Network status | Yes, using status LED and software |
| Data transfer | Yes, using status LED |
| Power consumption | 2 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| KR | Yes |
| EAC | Yes |
| KC | Yes |
| Interfaces | |
| Fieldbus | PROFINET IO controller (master) |
| Variant | 2x shielded RJ45 (switch) |
| Cable length | Max. 100 m between 2 stations (segment length) |
| Transfer rate | 100 Mbit/s |
| Transfer | |
| Physical layer | 100BASE-TX |
| Half-duplex | Yes |
| Full-duplex | Yes |
| Autonegotiation | Yes |
| Auto-MDI/MDIX | Yes |
| Controller | netX100 |
| Memory | 8 MB SDRAM |
| Electrical properties | |
| Electrical isolation | PLC isolated from PROFINET IO (IF1 and IF2) |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Slot | In the X20 CPU and in the X20BC1083 expandable bus controller |

Table 459: X20IF10E1-1 - Technical data

9.23.19.4 Operating and connection elements

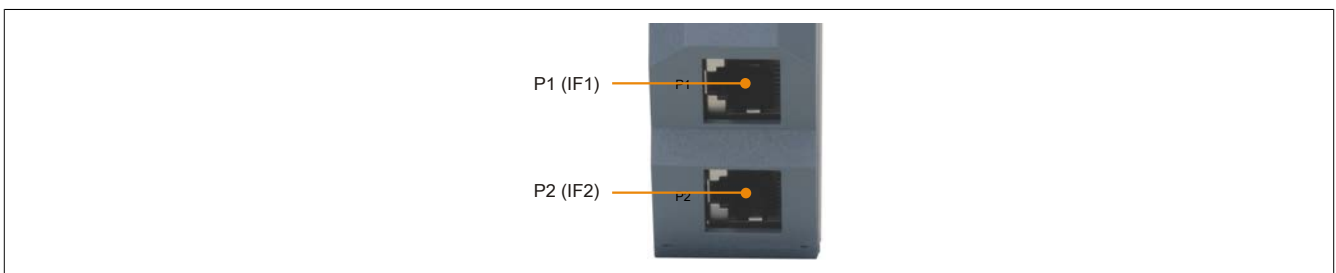


9.23.19.4.1 LED status indicators

| Figure | LED | Color | Status | Description | |
|--------|-------------|-----------|---|--|----------|
| | READY/RUN | Green/red | Off | No power to module | |
| | | Red | Blinking | Boot error | |
| | | On | Communication on the PCI bus has not yet been started | | |
| | SF | Green | On | PCI bus communication in progress | |
| | | | Red | Off | No error |
| | | | Blinking | Invalid configuration | |
| | BF | Red | On | System errors | |
| | | | Off | No error | |
| | | | Blinking | Configuration error: Not all configured I/O modules are connected | |
| | L/A IF1/IF2 | Green | On | No link to remote station | |
| | | | Off | No link to remote station | |
| | | | Flickering | A link to the remote station has been established. The LED blinks when Ethernet activity is taking place on the bus. | |
| | | | On | A link to the remote station has been established. | |

9.23.19.4.2 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see "[Cabling guidelines for X20 modules with an Ethernet cable](#)" on page 58.



| Interface | Pinout | | |
|----------------------|--------|-------------|----------------|
| | Pin | Ethernet | |
| <p>Shielded RJ45</p> | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.23.19.5 Use in the expandable X20BC1083 POWERLINK bus controller

9.23.19.5.1 Cyclic data

If this module is connected to the expandable POWERLINK bus controller, the amount of cyclic data is limited by the POWERLINK frame to 1488 bytes in each direction (input and output).

When using multiple X20IF10xx-1 interfaces or other X2X modules with a POWERLINK bus controller, the 1488 bytes are divided between all connected modules.

9.23.19.5.2 Operating netX modules

It is important to note the following in order to operate netX modules with the bus controller without problems:

- A minimum revision $\geq E0$ is required for the bus controller.
- netX modules can only be operated with the POWERLINK V2 setting. V1 is not permitted.
- With SDO access to POWERLINK object 0x1011/1 on the bus controller, the netX firmware and the configuration stored on the bus controller are not reset. They can only be overwritten by accessing them again. This affects objects 0x20C0 and 0x20C8, subindexes 92 to 95.

9.23.19.6 netX error codes

netX modules return an error code when an error occurs. These error codes are fieldbus-specific. A complete list of all error codes in PDF format is available in Automation Help in section "Communication / Fieldbus systems / Support with FDT/DTM / Diagnostic functions / Diagnostics on the runtime system / Master diagnostics" under item "Communication_Error".

9.23.19.7 Firmware

The module comes with preinstalled firmware. The firmware is part of the Automation Studio project. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.23.19.8 PROFINET IO interface

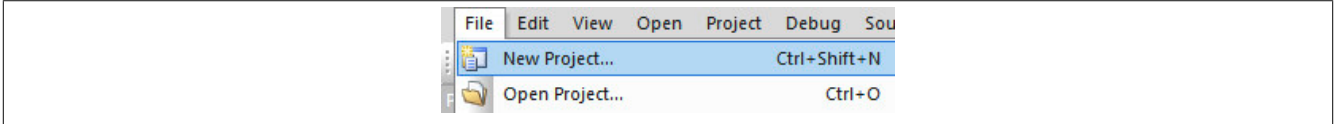
9.23.19.8.1 Settings in Automation Studio

The interface module can be operated in the slot of a CPU or in the slot of an expandable POWERLINK bus controller.

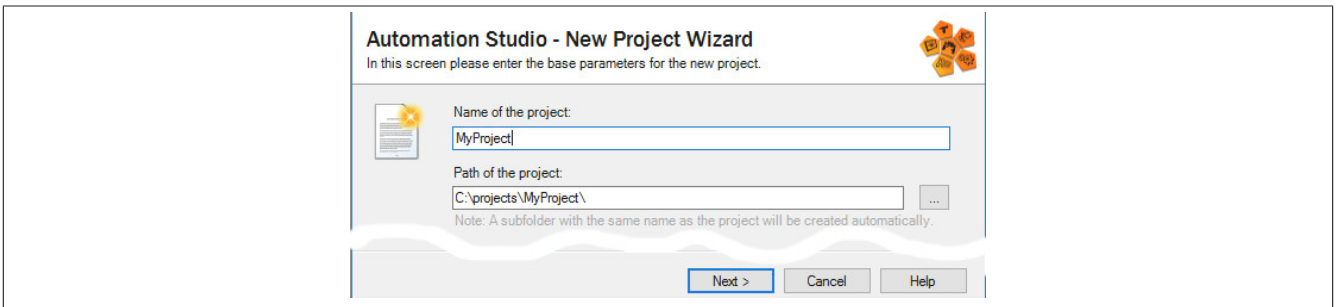
To do this, a new Automation Studio project is created and the suitable settings are made on the module.

9.23.19.8.1.1 Creating an Automation Studio project

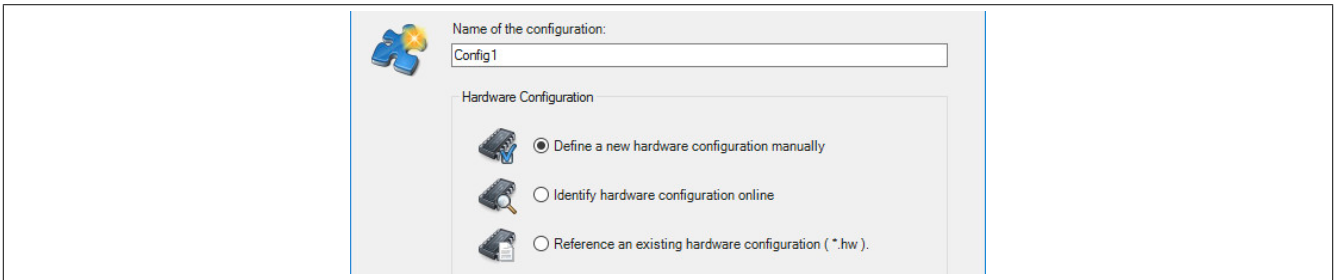
- Create a new Automation Studio project by selecting "New project".



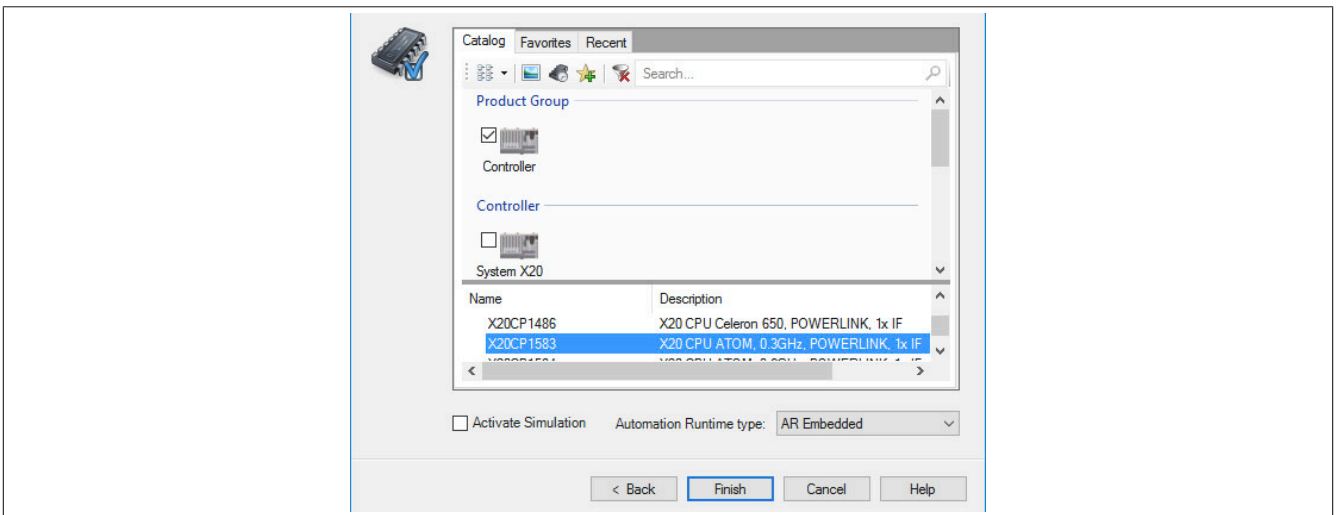
- Assign a project name and set up the project path.



- Assign the hardware configuration type and configuration name.

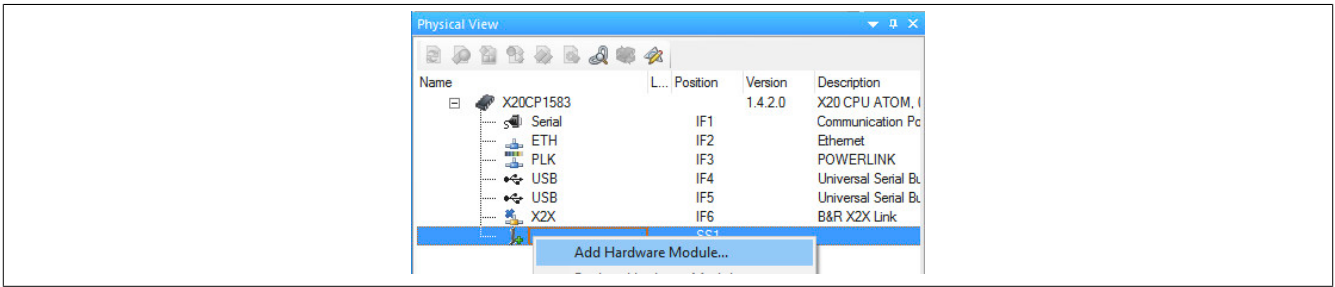


- Select the hardware in the next step if "Define a new hardware configuration manually" was selected. In order to simplify the search, different filters can be set in the Hardware Catalog. Lastly, highlight the required hardware and create the Automation Studio project by clicking on "Finish".

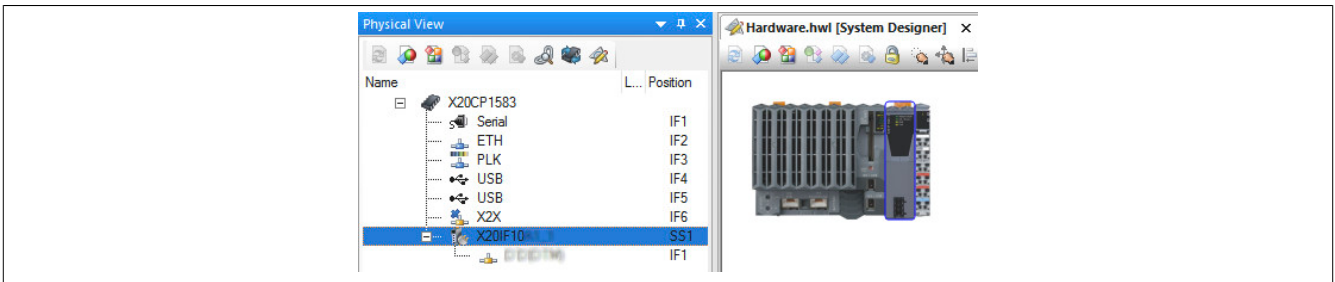


9.23.19.8.1.2 Adding and configuring the interface module

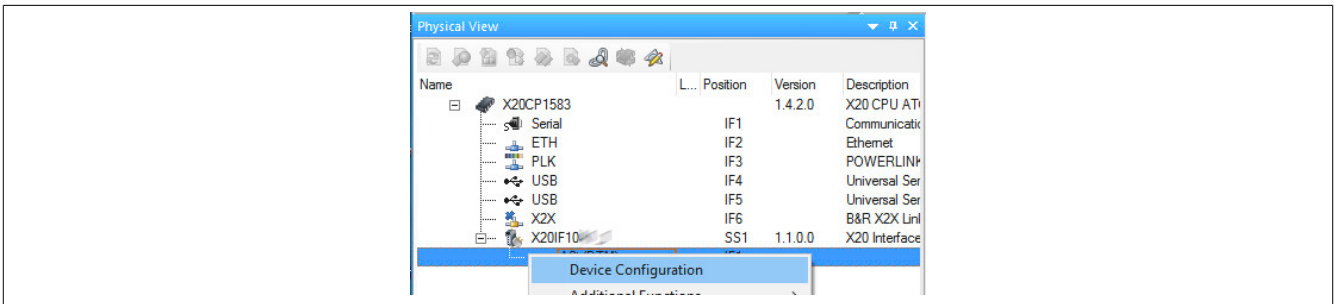
- In this example, the interface card is connected in the slot of a CPU. Right-clicking on the slot and selecting "Add hardware module" opens the Hardware Catalog.



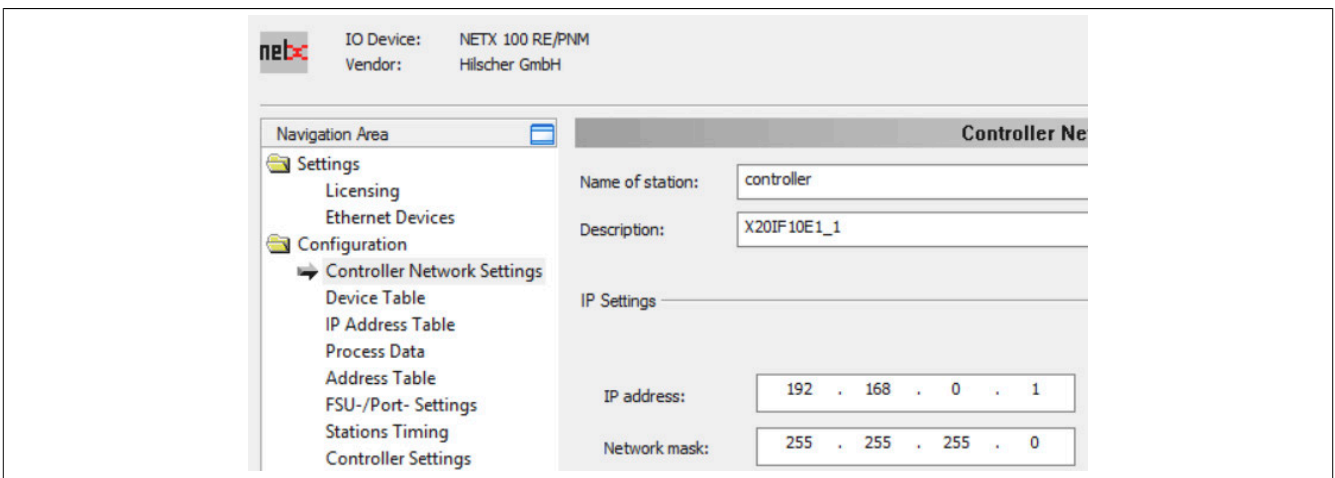
- The module is added to the project via drag-and-drop or by double-clicking on the interface card.



- Additional module settings can be made under "Device configuration". This configuration environment is opened by right-clicking on the IF interface and selecting "Device configuration".



- General settings are made in the device configuration.



Controller network settings

Contains the name and symbolic name of the PROFINET IO controller.

| Parameter | Explanation | Values |
|-----------------|---------------|---------------------|
| Name of station | Name | 1 to 240 characters |
| Description | Symbolic name | |

- IP settings

Contains the IP address of the PROFINET IO controller.

| Parameter | Explanation |
|-----------------|-----------------|
| IP address | IP address |
| Network mask | Subnet mask |
| Gateway address | Gateway address |

Device table

All PROFINET IO devices configured on the PROFINET IO controller are listed here.

| Parameter | Explanation | Values |
|-----------------|---|---------------------|
| Activate | This allows the slaves to be enabled or disabled. <ul style="list-style-type: none"> • Enabled: Process memory is reserved and data is exchanged. • Disabled: The master reserves memory in the process data image for the slave, but no data is exchanged. | |
| Index | Consecutive numbering of the PROFINET IO devices in the scan list. | |
| Name of station | Editable station name. | 1 to 240 characters |
| Device | Physical, non-editable station name | |
| Description | Symbolic, non-editable station name | |
| Vendor | Vendor information | |

IP address table

The IP addresses of the slaves are set here.

| Parameter | Explanation |
|-----------------|---|
| Name of station | Network name of the PROFINET station. The value is set in the DTM of the PROFINET IO controller. |
| IP address | IP address of the PROFINET station |
| Inherit | This permits the network mask and gateway address to be obtained from the master. <ul style="list-style-type: none"> • Selected: Network mask and gateway address are obtained from the master. • Not selected: The network mask and gateway address are configured manually. |
| Network mask | Subnet mask of the PROFINET station. |
| Gateway address | Gateway address of the PROFINET station |

Process data

This table lists the process data of the individual slaves.

| Parameter | Explanation |
|-----------|---|
| Type | Device designation specified by the hardware. Further description of modules configured on the device or the input or output signals. |
| Tag | Name of the input or output data. |
| SCADA | This parameter is not supported. |

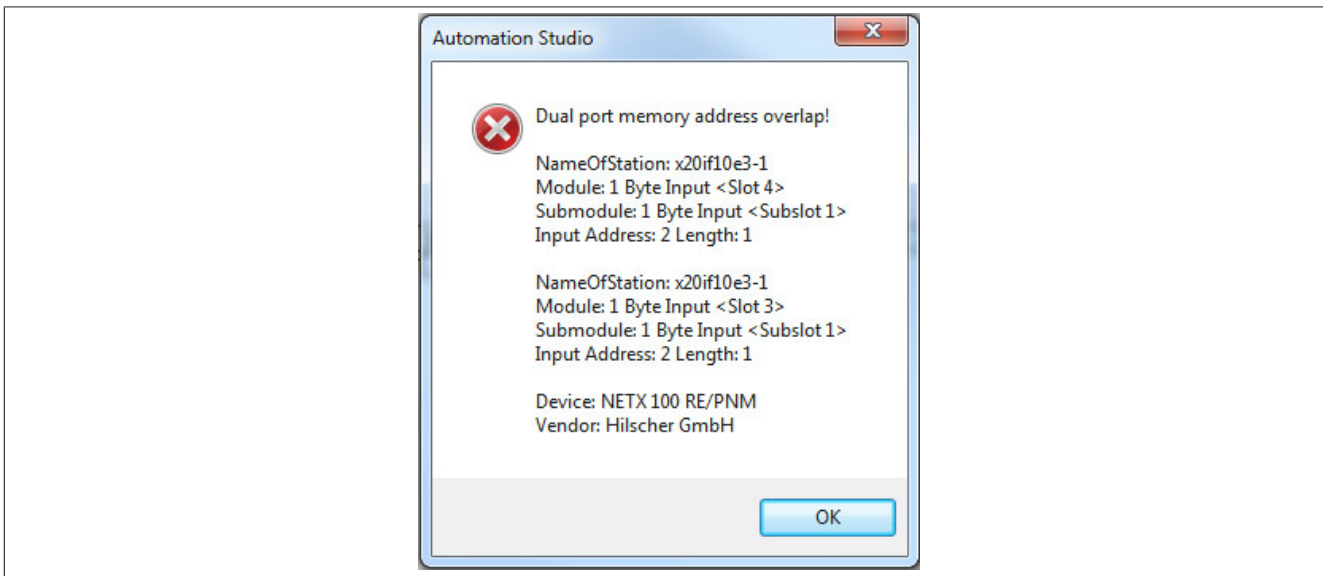
Address table

This table provides information about the addresses of the input and output data (in decimal or hexadecimal notation).

Auto addressing is used to select whether the addresses are assigned automatically or manually.

Information:

If addresses are assigned twice, an error is output and the addresses affected are marked with a red exclamation mark.



"Display mode" allows toggling between decimal and hexadecimal display.

| Parameter | Explanation |
|-----------------|--|
| Name of station | Network name of the PROFINET station. The value is set in the DTM of the PROFINET IO controller. |
| Modules | Module name |
| Submodule | Submodule name |
| Type | Data type |
| Length | Length of the module/submodule in bytes. |
| Address | Data offset address |

The address table can also be exported as a CSV file.

FSU / Port settings

The medium attachment unit (MAU) type can be set and fast startup (FSU) enabled here.

| Parameter | Explanation |
|-----------------|--|
| Name of station | Network name of the PROFINET station. The value is set in the DTM of the PROFINET IO controller. |
| MAU type | The MAU type must be set individually for each interface. <ul style="list-style-type: none"> • Auto: The connection between 2 adjacent devices is established automatically and takes about 2 to 3 seconds. • 100BASETXFD: The connection between adjacent devices is established with 100 Mbit / full-duplex. |
| FSU | Enables or disables FSU (fast startup). <p>If FSU is enabled, MAU type "100BASETXFD" should always be used, otherwise autonegotiation and auto-crossover (with MAU type = "AUTO") prevent a fast Ethernet connection.</p> |

Information:

The interfaces that are connected to each other must have the same MAU type; otherwise, no connection can be established. When FSU is enabled, the slave uses the fast start up connection to establish the cyclic data exchange.

Station timing

The timing of the individual PROFINET devices can be adjusted here.

| Parameter | Explanation |
|-----------------|---|
| Name of station | Device names of all PROFINET IO devices connected to the PROFINET IO controller. |
| Updating time | Configurable cycle time of the PROFINET IO device for exchanging cyclic data. |
| Watchdog time | Time after which the PROFINET IO device reports the absence of cyclic data and changes to the error state. The watchdog time must be a multiple of the update time. |

Information:

Different update and watchdog times can be set for each PROFINET IO device.

Controller settings

- Start of bus communication

It is possible to select how data exchange is started on the module.

| Parameter | Explanation |
|---------------------------|--|
| Automatically by device | Data exchange is started automatically after initializing this module. |
| Controlled by application | Data exchange is started by Automation Runtime. |

- Module alignment

The addressing mode is defined by the process image here. The addresses (offsets) of the process data are always interpreted as byte addresses.

| Addressing mode | Explanation |
|-------------------|---|
| Byte boundaries | The module address can start on any offset. |
| 2 byte boundaries | The module address can only start on even byte offsets. |

Information:

This configuration is automatically managed by Automation Runtime and is not permitted to be changed (default setting).

- Application monitoring

The module-internal watchdog time can be set here. If the watchdog has been enabled (watchdog time not equal to 0), the hardware watchdog must be reset after the set time at the latest.

| Parameter | Explanation | Values |
|---------------|---|----------------|
| Watchdog time | Watchdog software disabled | 0 ms |
| | Permissible range of values Default value: 1000 ms | 20 to 65535 ms |

Information:

The watchdog time is reset automatically by Automation Runtime.

Information:

This value refers exclusively to the software watchdog and not to the PROFINET watchdog time set in the station timing.

- Process image storage format

This is used to define how data is stored in the process image (I/O mapping). The storage format is only applied to data type "Word". This change has no effect on other data types.

| Storage format | Explanation |
|----------------|---|
| Big-endian | MSB/LSB = Higher/Lower byte (Motorola format) |
| Little-endian | MSB/LSB = Higher/Lower byte (Intel format) |

Input process image

Storage format - Little-endian (default setting)

| | | | | | | | | | |
|--------------------|---------|--------------------------|---------|-------|--------------------|---------|--------------------------|---------|-------|
| Module002_Output_1 | 16#00 | <input type="checkbox"/> | 16#00 | USINT | Module002_Output_1 | 16#00 | <input type="checkbox"/> | 16#00 | USINT |
| Module003_Input_2 | 16#3344 | <input type="checkbox"/> | 16#0000 | UINT | Module003_Input_2 | 16#4433 | <input type="checkbox"/> | 16#0000 | UINT |
| Module004_Output_2 | 16#0000 | <input type="checkbox"/> | 16#0000 | UINT | Module004_Output_2 | 16#0000 | <input type="checkbox"/> | 16#0000 | UINT |

Storage format - Big-endian

| | | | | | | | | | |
|--------------------|---------|--------------------------|---------|-------|--------------------|---------|--------------------------|---------|-------|
| Module002_Output_1 | 16#00 | <input type="checkbox"/> | 16#00 | USINT | Module002_Output_1 | 16#00 | <input type="checkbox"/> | 16#00 | USINT |
| Module003_Input_2 | 16#3344 | <input type="checkbox"/> | 16#0000 | UINT | Module003_Input_2 | 16#4433 | <input type="checkbox"/> | 16#0000 | UINT |
| Module004_Output_2 | 16#0000 | <input type="checkbox"/> | 16#0000 | UINT | Module004_Output_2 | 16#0000 | <input type="checkbox"/> | 16#0000 | UINT |

— Port settings

The settings must be made separately for each of the 2 interfaces.

| Setting | Explanation |
|-------------|--|
| Auto | The connection between 2 adjacent devices is established automatically and takes about 2 to 3 seconds. |
| 100BASETXFD | The connection between adjacent devices is established with 100 Mbit / full-duplex. |

Information:

The interfaces that are connected to each other must have the same settings; otherwise, no connection can be established.

— I/O state information

The IOPS interface can be configured here. If configured, the PROFINET input/output object provider state (IOPS) permits the PROFINET IO device application program to recognize whether the received data from the PROFINET device is valid or not and declares the output data as valid or invalid.

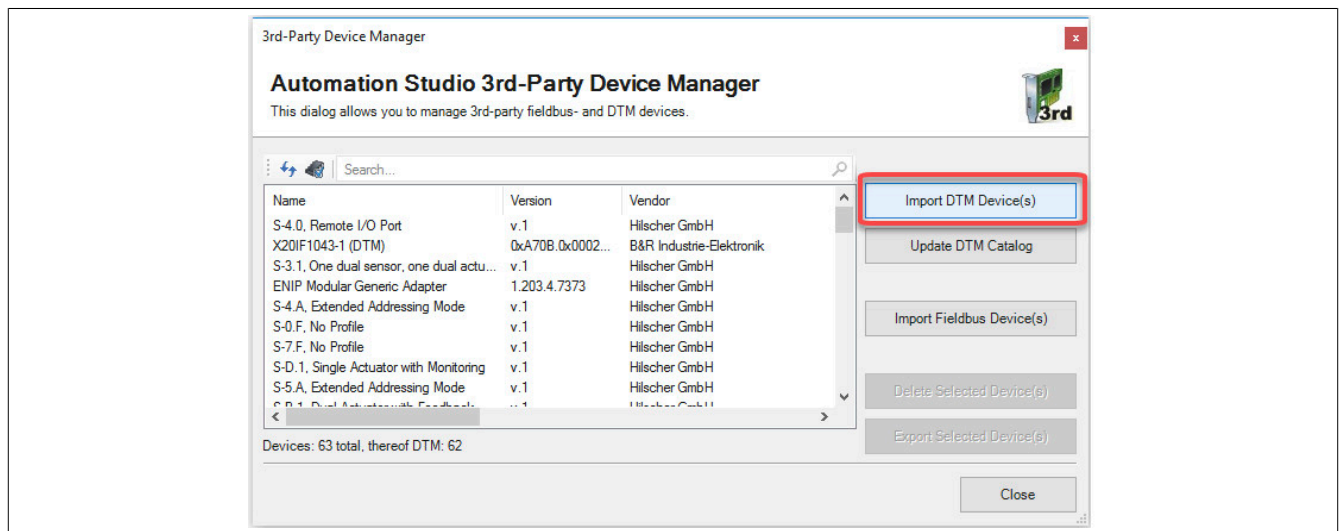
| Setting | Explanation |
|----------|--|
| Disabled | I/O state information disabled. |
| Bit | The IOPS is treated as a bit list in the DPM (Dual Port Memory) of the PROFINET IO device. For this purpose, 2 I/O data points (InIOPS and OutIOPS) are listed in the I/O assignment for the individual input and output data. <ul style="list-style-type: none"> Respective bit set to 1: Data is valid. Respective bit set to 0: Data is invalid. |
| Byte | The IOPS is treated as a byte array in the dual-ported memory (DPM) of the PROFINET IO device. For this purpose, 2 I/O data points (InIOPS and OutIOPS) are listed in the I/O assignment for the individual input and output data of the slave. <ul style="list-style-type: none"> Respective byte set to 0x80: Data is valid. Respective bit set to not equal to 0x80: Data is invalid. |

9.23.19.8.1.3 Adding the GSD file in Automation Studio

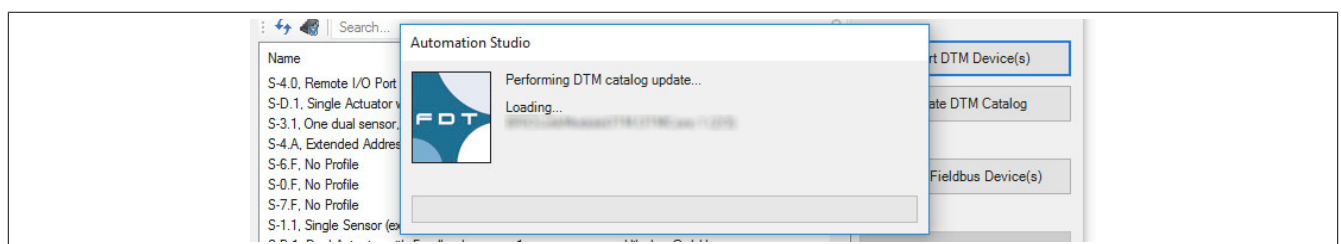
A device description file (GSDML file) is required to inform the PROFINET IO controller which slaves were connected and how they were configured.

To add and use a device description file in Automation Studio, perform the following steps:

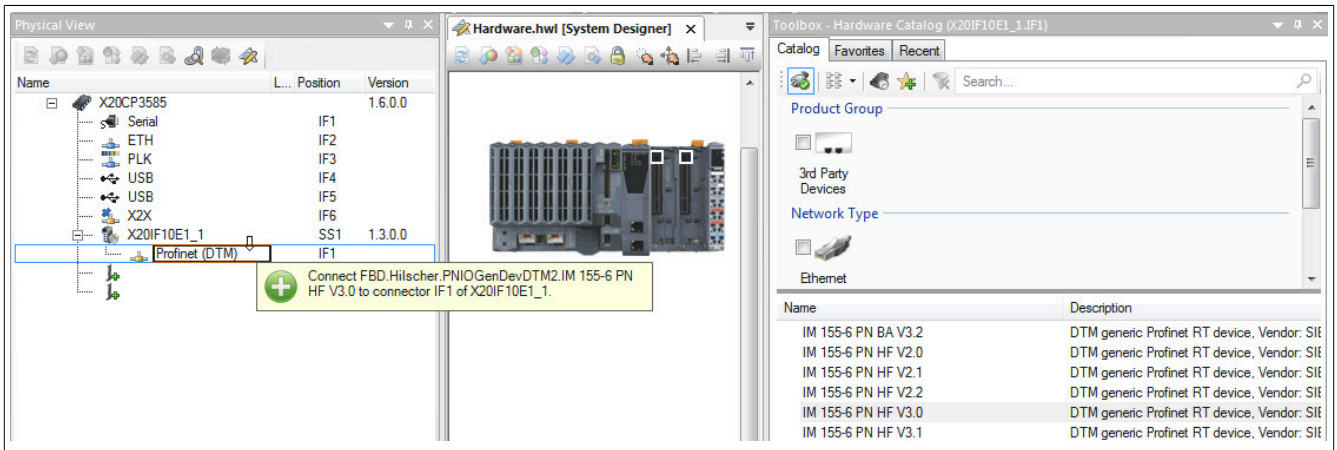
- If the PROFINET slave from B&R is used, download the GSDML file from the B&R website www.br-automation.com and unzip the ZIP file.
- Open the dialog box in Automation Studio under "Tools - Manage 3rd-party devices" and select "Import DTM device(s)".



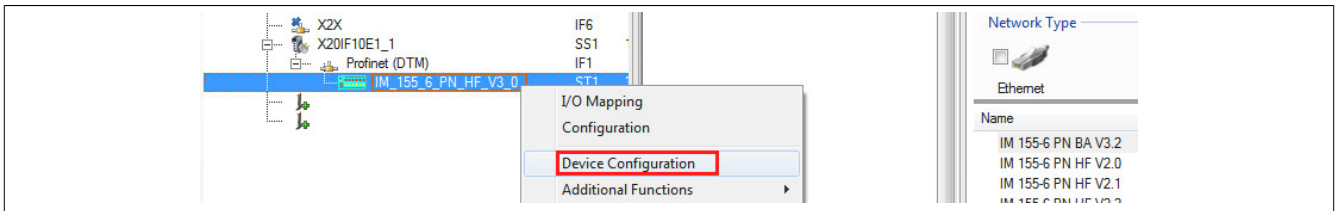
- Select the GSDML file to be imported and confirm with OK. The GSDML file is imported into Automation Studio.



- Click on "PROFINET (DTM)" on PROFINET IO controller X20IF10E1-1, drag the GSDML file from the Hardware Catalog and attach it to the PROFINET IO controller.



- Right-click on the IF interface and select "Device configuration" to open the configuration environment for the GSDML file.



9.23.20 X20(c)IF10E3-1

Data sheet version: 2.08

9.23.20.1 General information

The interface module is equipped with a PROFINET IO device interface. This allows the B&R system (I/O modules, POWERLINK, etc.) to be connected to systems from other manufacturers and makes it possible to quickly and easily transfer data in both directions.

The interface module can be operated in X20 CPUs or in the expandable POWERLINK bus controller X20BC1083.

The interface is equipped with 2 RJ45 connections. Both connections result in an integrated switch. This makes it easy to implement daisy chain cabling.

- PROFINET IO device
- Integrated switch for efficient cabling

9.23.20.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.23.20.3 Order data

| Model number | Short description | Figure |
|--------------|---|--------|
| | X20 interface module communication | |
| X20IF10E3-1 | X20 interface module, for DTM configuration, 1 PROFINET IO device (slave) interface module, electrically isolated | |
| X20clF10E3-1 | X20 interface module, coated, for DTM configuration, 1 PROFINET IO device (slave) interface module, electrically isolated | |

Table 460: X20IF10E3-1, X20clF10E3-1 - Order data

Optional accessories

| Model number | Short description |
|-----------------|--|
| X20CA0E61.xxxxx | POWERLINK/Ethernet connection cable, RJ45 to RJ45, 0.2 to 20 m |
| X20CA0E61.xxxx | POWERLINK/Ethernet connection cable, RJ45 to RJ45, 20 m and longer |

9.23.20.4 Technical data

| Model number | X20IF10E3-1 | X20cIF10E3-1 |
|--|--|---|
| Short description | | |
| Communication module | PROFINET IO device (slave) | |
| General information | | |
| B&R ID code | 0xA71E | 0xE238 |
| Status indicators | Module status, network status, data transfer | |
| Diagnostics | | |
| Module status | Yes, using status LED and software | |
| Network status | Yes, using status LED and software | |
| Data transfer | Yes, using status LED | |
| Power consumption | 2 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Interfaces | | |
| Fieldbus | PROFINET IO device (slave) | |
| PROFINET attributes | | |
| Conformance class | C | |
| Performance class | RT (switch supports IRT) | |
| Netload class | III | |
| Variant | 2x shielded RJ45 (switch) | |
| Cable length | Max. 100 m between 2 stations (segment length) | |
| Transfer rate | 100 Mbit/s | |
| Transfer | | |
| Physical layer | 100BASE-TX | |
| Half-duplex | Yes | |
| Full-duplex | Yes | |
| Autonegotiation | Yes | |
| Auto-MDI/MDIX | Yes | |
| Controller | netX100 | |
| Electrical properties | | |
| Electrical isolation | PLC isolated from PROFINET IO (IF1 and IF2) | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Slot | In the X20 CPU and in the X20BC1083 expandable bus controller | In the X20c CPU and in the X20cBC1083 expandable bus controller |

Table 461: X20IF10E3-1, X20cIF10E3-1 - Technical data

9.23.20.5 Operating and connection elements



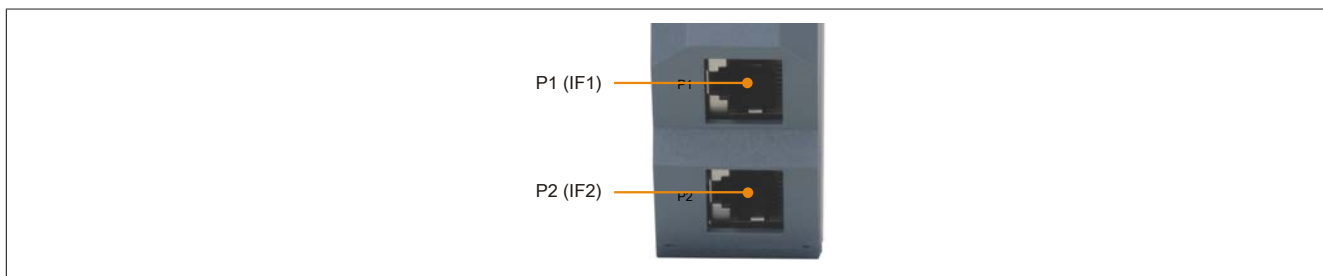
9.23.20.5.1 LED status indicators

| Figure | LED | Color | Status | Description | |
|--------|-------------|-----------|---|--|----------|
| | READY/RUN | Green/red | Off | No power to module | |
| | | Red | Blinking | Boot error | |
| | | On | Communication on the PCI bus has not yet been started | | |
| | SF | Green | On | PCI bus communication in progress | |
| | | | Red | Off | No error |
| | | | Cyc. Blinking ¹⁾ | DCP signal service triggered via bus | |
| | BF | Red | On | System errors | |
| | | | Off | No error | |
| | | | Blinking | No data exchange | |
| | L/A IF1/IF2 | Green | On | No configuration or physical connection error | |
| | | | Off | No link to remote station | |
| | | | Flickering | A link to the remote station has been established. The LED blinks when Ethernet activity is taking place on the bus. | |
| | | | On | A link to the remote station has been established. | |

1) Blinks cyclically at 2 Hz, duration 3 s.

9.23.20.5.2 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see "Cabling guidelines for X20 modules with an Ethernet cable" on page 58.



| Interface | Pinout | | |
|-------------------|--------|-------------|----------------|
| | Pin | Ethernet | |
| Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.23.20.6 Use in the expandable X20BC1083 POWERLINK bus controller

9.23.20.6.1 Cyclic data

If this module is connected to the expandable POWERLINK bus controller, the amount of cyclic data is limited by the POWERLINK frame to 1488 bytes in each direction (input and output).

When using multiple X20IF10xx-1 interfaces or other X2X modules with a POWERLINK bus controller, the 1488 bytes are divided between all connected modules.

9.23.20.6.2 Operating netX modules

It is important to note the following in order to operate netX modules with the bus controller without problems:

- A minimum revision \geq E0 is required for the bus controller.
- netX modules can only be operated with the POWERLINK V2 setting. V1 is not permitted.
- With SDO access to POWERLINK object 0x1011/1 on the bus controller, the netX firmware and the configuration stored on the bus controller are not reset. They can only be overwritten by accessing them again. This affects objects 0x20C0 and 0x20C8, subindexes 92 to 95.

9.23.20.7 netX error codes

netX modules return an error code when an error occurs. These error codes are fieldbus-specific. A complete list of all error codes in PDF format is available in Automation Help in section "Communication / Fieldbus systems / Support with FDT/DTM / Diagnostic functions / Diagnostics on the runtime system / Master diagnostics" under item "Communication_Error".

9.23.20.8 Firmware

The module comes with preinstalled firmware. The firmware is part of the Automation Studio project. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.23.20.9 Recognizing an invalid connection

All cyclic data is set to zero in the event of an invalid connection between the master and slave.

An invalid connection may be caused by the following:

- No connection between the master and the slave
- Interface card initialization is not yet complete.
- The master is in error mode.
- Data is marked as invalid (IOPS = Bad).

It cannot be determined whether the data is valid or invalid based on the transmitted data. In order to be able to reliably recognize an invalid connection, it is necessary to evaluate the master's IOPS data additionally in the application.

Forwarding IOPS data to the application can be enabled via the interface card's DTM ("I/O state information" in Automation Studio).

9.23.20.10 Minimum DTM version for coated modules

Information:

This module requires at least version 1.0.2.14 of DTM, which can be downloaded from the B&R website www.br-automation.com in category "Software/DTM" of the Downloads section.

9.23.20.11 PROFINET IO interface

2 steps are generally necessary for connecting module X20IF10E3-1 to an external master environment.

- 1) Add and configure the X20 interface module in B&R's Automation Studio.
- 2) Add the PROFINET device (slave) GSDML device description file in the external master environment, e.g. Siemens STEP 7 or Siemens TIA-Portal. The interface module must then be configured.

Information:

To ensure error-free PROFINET communication between controller (master) and device (slave), the settings for the interface module in Automation Studio must match the settings of the GSDML device description file in the master environment.

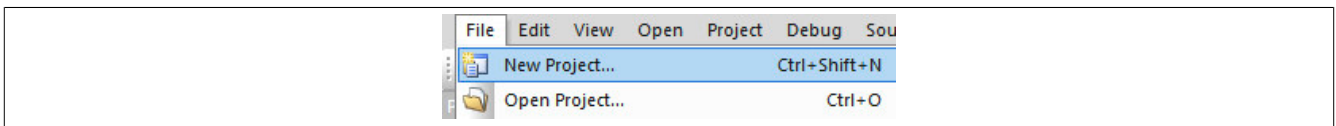
9.23.20.11.1 Settings in Automation Studio

The interface module can be operated in the slot of a CPU or in the slot of an expandable POWERLINK bus controller.

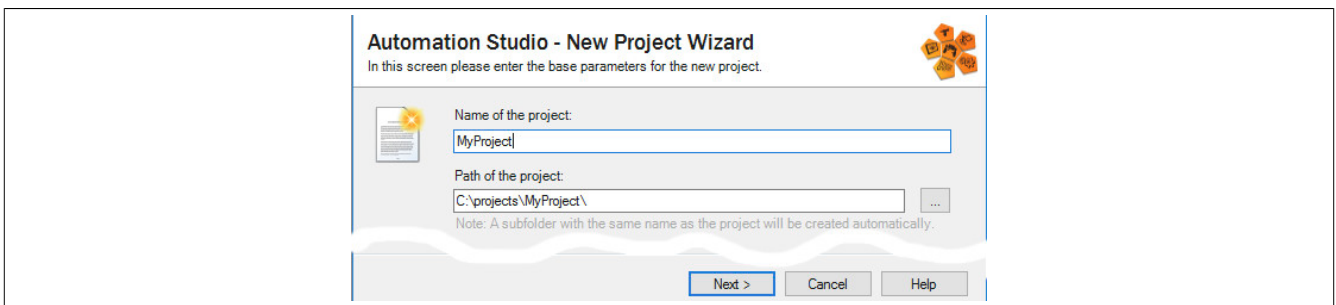
To do this, a new Automation Studio project is created and the suitable settings are made on the module.

9.23.20.11.1.1 Creating an Automation Studio project

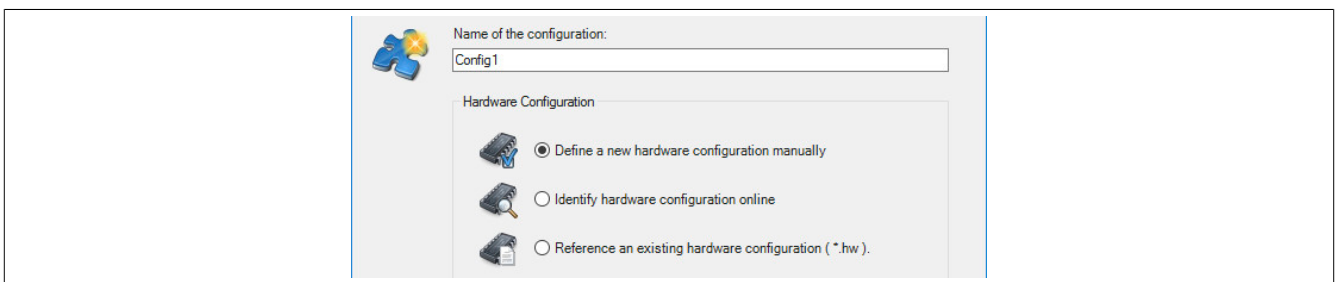
- Create a new Automation Studio project by selecting "New project".



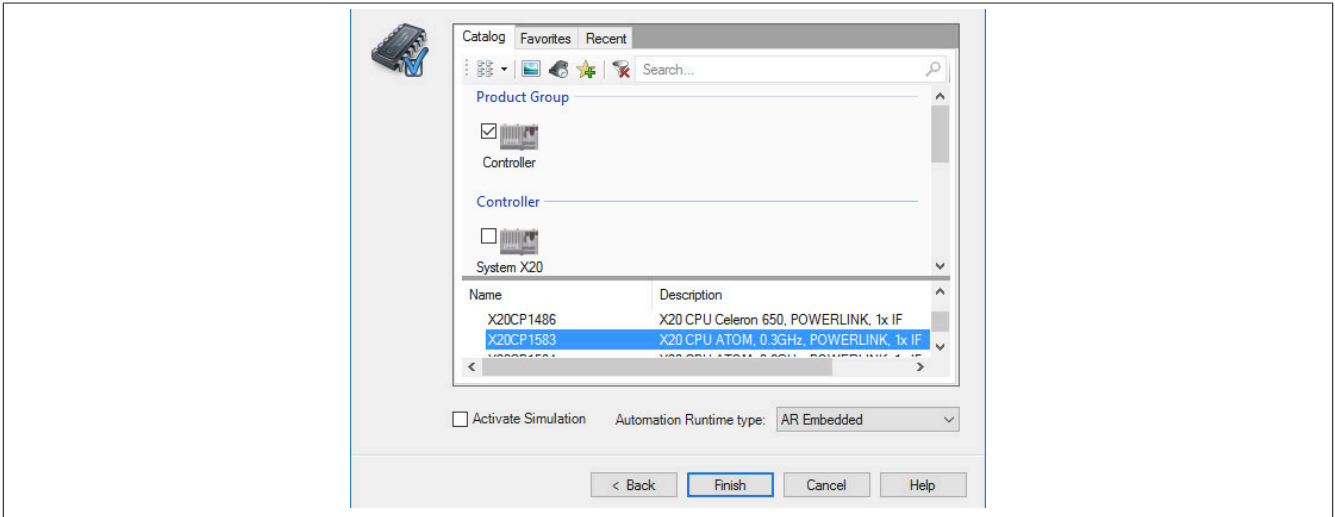
- Assign a project name and set up the project path.



- Assign the hardware configuration type and configuration name.

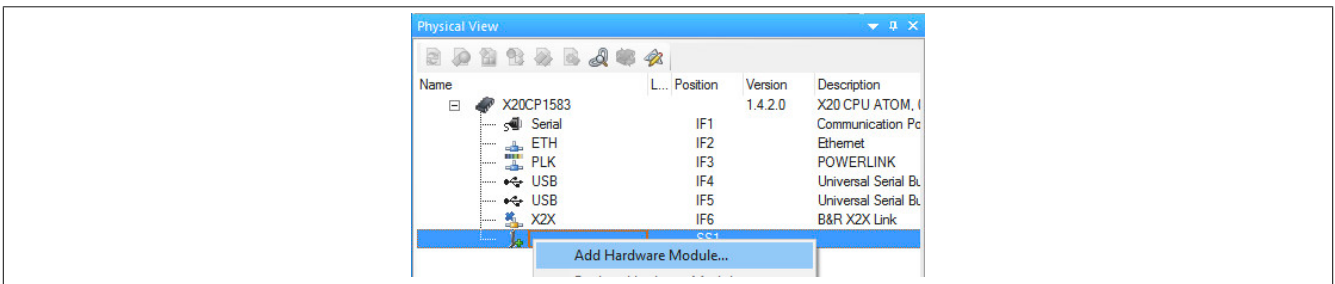


- Select the hardware in the next step if "Define a new hardware configuration manually" was selected. In order to simplify the search, different filters can be set in the Hardware Catalog. Lastly, highlight the required hardware and create the Automation Studio project by clicking on "Finish".

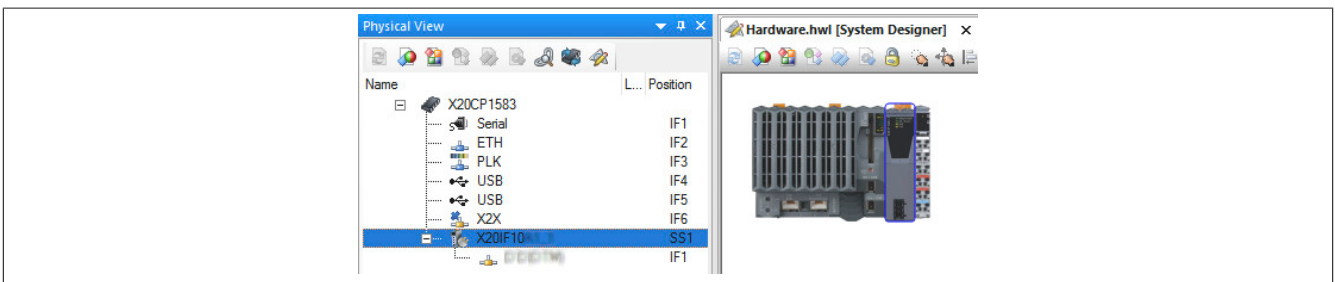


9.23.20.11.1.2 Adding and configuring the interface module

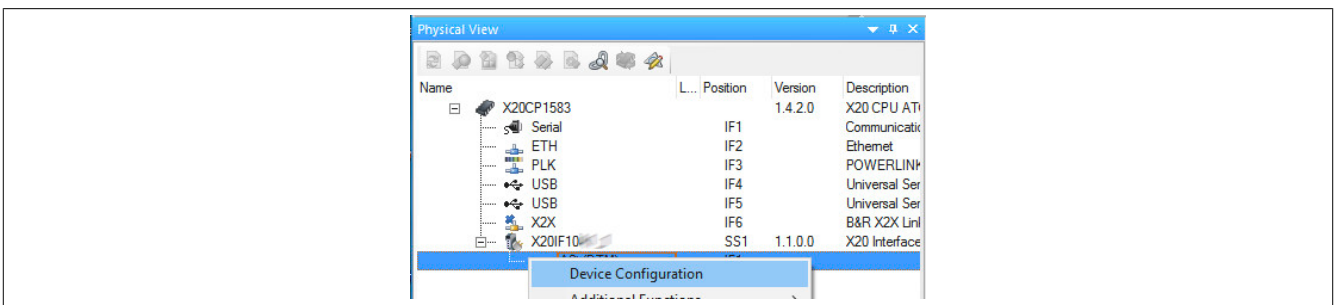
- In this example, the interface card is connected in the slot of a CPU. Right-clicking on the slot and selecting "Add hardware module" opens the Hardware Catalog.



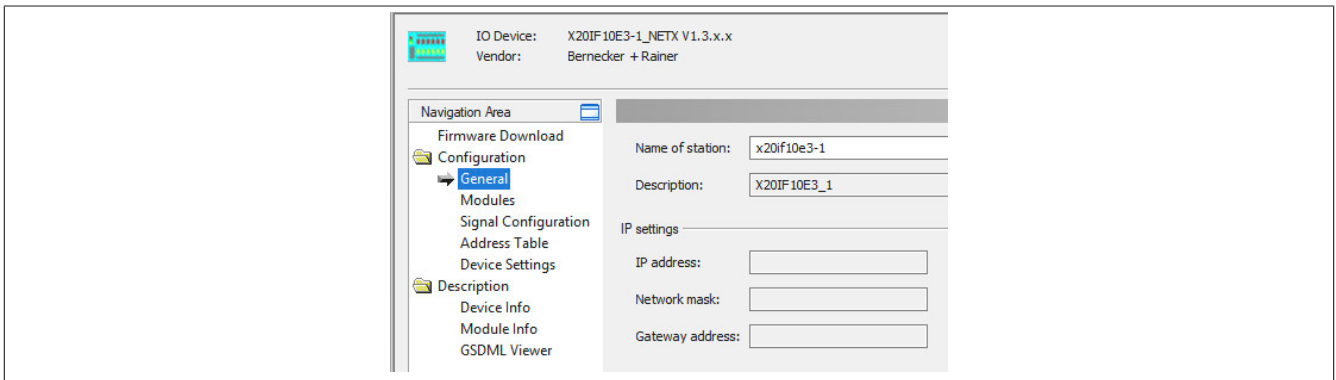
- The module is added to the project via drag-and-drop or by double-clicking on the interface card.



- Additional module settings can be made under "Device configuration". This configuration environment is opened by right-clicking on the IF interface and selecting "Device configuration".



- General settings are made in the device configuration.



General

The name of the station (slave) can be set here.

All other parameters are defined at the master. The PROFINET IO device (slave) is identified by the station name. As soon as there is a connection from the controller to the PROFINET IO device (slave), the other parameters (IP address, network mask, etc.) are transferred to the PROFINET IO device (slave).

Modules

Modules can be added to the PROFINET IO device (slave) here.

| Parameter | Explanation | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------|---|--|---|--|--|--|--------------|--|--|--------------|--|--|---------------|--|--|---------------|--|--|---------------|--|--|---------------|--|--|--------------------|--|--|---------------------|--|--|--------------------|--|--|---------------------|--|--|--------------------|
| | Selecting a submodule If a submodule is selected, more detailed information about the submodule is displayed in the lower table. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Slot | Shows the current slot number assigned to a module. The sequence of the modules can be changed by changing the slot number. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Subslot | Shows the current subslot number assigned to a module. The sequence of the modules can be changed by changing the subslot number. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ! | Slot symbol: Indicates the use of the (sub)modules. <ul style="list-style-type: none"> • No symbol: (Sub)slot number and name can be changed. • Pin symbol: No change possible | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Modules | The module type can be changed by selecting the desired type in the dropdown box. <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <table border="1"> <tr> <td>!</td> <td>✕</td> <td>X20IF10E3-1_NETX V1.3.x.x [X20IF10E3-1 V1.3.x.x]</td> </tr> <tr> <td></td> <td></td> <td>1 Byte Input</td> </tr> <tr> <td></td> <td></td> <td>1 Byte Input</td> </tr> <tr> <td></td> <td></td> <td>2 Bytes Input</td> </tr> <tr> <td></td> <td></td> <td>3 Bytes Input</td> </tr> <tr> <td></td> <td></td> <td>4 Bytes Input</td> </tr> <tr> <td></td> <td></td> <td>8 Bytes Input</td> </tr> <tr> <td></td> <td></td> <td>1 Unsigned16 Input</td> </tr> <tr> <td></td> <td></td> <td>1 Unsigned32 Output</td> </tr> <tr> <td></td> <td></td> <td>1 Unsigned32 Input</td> </tr> <tr> <td></td> <td></td> <td>1 Unsigned64 Output</td> </tr> <tr> <td></td> <td></td> <td>1 Unsigned64 Input</td> </tr> </table> </div> | ! | ✕ | X20IF10E3-1_NETX V1.3.x.x [X20IF10E3-1 V1.3.x.x] | | | 1 Byte Input | | | 1 Byte Input | | | 2 Bytes Input | | | 3 Bytes Input | | | 4 Bytes Input | | | 8 Bytes Input | | | 1 Unsigned16 Input | | | 1 Unsigned32 Output | | | 1 Unsigned32 Input | | | 1 Unsigned64 Output | | | 1 Unsigned64 Input |
| ! | ✕ | X20IF10E3-1_NETX V1.3.x.x [X20IF10E3-1 V1.3.x.x] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1 Byte Input | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1 Byte Input | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 2 Bytes Input | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 3 Bytes Input | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 4 Bytes Input | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 8 Bytes Input | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1 Unsigned16 Input | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1 Unsigned32 Output | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1 Unsigned32 Input | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1 Unsigned64 Output | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | 1 Unsigned64 Input | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

"Add module" adds the default module "1 byte input" to the slave. This module can be changed via the dropdown menu in column "Modules".

Use "Remove" to remove the modules again.

— Submodule details

"Dataset" can be used to toggle between I/O data and parameters.

"Display mode" allows toggling between decimal and hexadecimal display.

The modules are simple input and output modules. These have no adjustable parameters. I/O data cannot be changed in this table.

Signal configuration

The data structure of the individual modules can be defined here; the name and data type of the inputs and outputs can also be adjusted. Data types can also be combined.

| Parameter | Explanation |
|-------------|--|
| Slot | Position of the slot |
| Name | Name of the slot |
| Module type | Number of bytes and type of connection (input or output) |

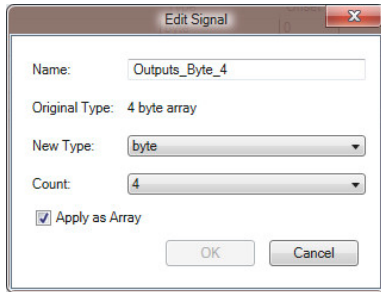
After selecting a slot, the type, data type and offset are displayed in another table below.

After right-clicking on the signal to be configured, the following options can be selected in the shortcut menu:

- **Edit signal**

This allows the currently selected signal to be edited.

| Parameter | Explanation |
|----------------|--|
| Name | The new name for the signal |
| New type | The new data type for the signal |
| Count | Number of individually listed data type elements for the signal. Only the data of the original type is re-structured; the quantity is not adjusted. - The maximum number corresponds to the quantity that the new data type requires to display the original type. - If fewer elements are selected, the last data type element is listed as an array of all remaining elements. |
| Apply as array | If selected, the new data type is displayed as an array. Otherwise, the data type elements set under "Count" are displayed. |



| Slot | Name |
|--------------------|---------------------------------|
| Slot 1 / Subslot 1 | 8 Bytes Input / 8 Bytes Input |
| Slot 2 / Subslot 1 | 8 Bytes Output / 8 Bytes Output |

| Name | Type | Offset |
|----------------|--------------|--------|
| Outputs_Byte_0 | byte | 0 |
| Outputs_Byte_1 | byte | 1 |
| Outputs_Byte_2 | byte | 2 |
| Outputs_Byte_3 | byte | 3 |
| Outputs_Byte_4 | 4 byte array | 4 |

- **Reset**

This can be used to undo the signal change or a merge previously completed with "Merge signal".

- **Merge signal**

This allows all signals to be merged into a new group. The same settings can be made for the new group as under "Edit signal".

The settings made are reflected in the process image (I/O mapping).

Configuring the signal

| Slot | Name |
|--------|------------|
| Slot 1 | 8 Bytes In |

| Name | Type | Offset |
|----------------------|-------|--------|
| Temp_1 | byte | 0 |
| Pressure_5 | byte | 1 |
| Input_3_Byte_0_Bit_0 | bit | 2.0 |
| Input_3_Byte_0_Bit_1 | bit | 2.1 |
| Input_3_Byte_0_Bit_2 | bit | 2.2 |
| Input_3_Byte_0_Bit_3 | bit | 2.3 |
| Input_3_Byte_0_Bit_4 | bit | 2.4 |
| Input_3_Byte_0_Bit_5 | bit | 2.5 |
| Input_3_Byte_0_Bit_6 | bit | 2.6 |
| Input_3_Byte_0_Bit_7 | bit | 2.7 |
| Input_4 | byte | 3 |
| Counter_Airflow_1 | dword | 4 |

Process image

| | | | | |
|--------------------------------|-------|--------------------------|-------|-------|
| Module001_Temp_1 | 0 | <input type="checkbox"/> | 0 | USINT |
| Module001_Pressure_5 | 0 | <input type="checkbox"/> | 0 | USINT |
| Module001_Input_3_Byte_0_Bit_0 | FALSE | <input type="checkbox"/> | FALSE | BOOL |
| Module001_Input_3_Byte_0_Bit_1 | FALSE | <input type="checkbox"/> | FALSE | BOOL |
| Module001_Input_3_Byte_0_Bit_2 | FALSE | <input type="checkbox"/> | FALSE | BOOL |
| Module001_Input_3_Byte_0_Bit_3 | FALSE | <input type="checkbox"/> | FALSE | BOOL |
| Module001_Input_3_Byte_0_Bit_4 | FALSE | <input type="checkbox"/> | FALSE | BOOL |
| Module001_Input_3_Byte_0_Bit_5 | FALSE | <input type="checkbox"/> | FALSE | BOOL |
| Module001_Input_3_Byte_0_Bit_6 | FALSE | <input type="checkbox"/> | FALSE | BOOL |
| Module001_Input_3_Byte_0_Bit_7 | FALSE | <input type="checkbox"/> | FALSE | BOOL |
| Module001_Input_4 | 0 | <input type="checkbox"/> | 0 | USINT |
| Module001_Counter_Airflow_1 | 0 | <input type="checkbox"/> | 0 | UDINT |

Address table

This table provides information about the addresses of the input and output data (in decimal or hexadecimal notation).

"Display mode" allows toggling between decimal and hexadecimal display.

| Parameter | Explanation |
|-----------|---|
| Modules | Name of the module |
| Submodule | Name of the submodule |
| Type | Data type |
| Length | Length of the module/submodule in bytes |
| Address | Offset address of the data |

The address table can also be exported as a CSV file.

Device settings

- Start of bus communication

It is possible to select how data exchange is started on the module.

| Parameter | Explanation |
|---------------------------|--|
| Automatically by device | Data exchange is started automatically after initializing this module. |
| Controlled by application | Data exchange is started by Automation Runtime. |

Information:

Parameter "Manual start of bus communication" can be enabled under the I/O configuration of the PROFINET IO device (slave).

| Name | Value | Unit | Description |
|-----------------------------------|----------|------|-------------------------------------|
| X20IF10E3_1 | | | |
| Function model | standard | | Module's operating mode |
| FDT/DTM | | | |
| netX configuration module | asrxd2 | | Module containing the netX configu |
| Data exchange time (CPU-netX) | 10000 | µs | Cycle time for data exchange betwe |
| Manual start of bus communication | on | | If set to on, bus communication has |
| Channel configuration | | | |
| Module001 | | | 1 Byte Input |
| Output Image | | | 1 Byte(s) |
| Channel 1 | | | |
| Name | TODO | | |
| Data type | BOOL | | |

The following settings must be made in order to avoid automatic data exchange:

- In the IF module configuration, "Manual start of bus communication" must be set to "On".
- "Start of bus communication" must be set to "Controlled by application".

With this setting, the communication can only be started via function block **AsNxPnS - nxpnsStartBusComm()**.

- Application monitoring

The module-internal watchdog time can be set here. If the watchdog has been enabled (watchdog time not equal to 0), the hardware watchdog must be reset after the set time at the latest.

| Parameter | Explanation | Values |
|---------------|-----------------------------|----------------|
| Watchdog time | Watchdog software disabled | 0 ms |
| | Permissible range of values | 20 to 65535 ms |
| | Default value: 1000 ms | |

Information:

The watchdog time is reset automatically by Automation Runtime.

Information:

This value refers exclusively to the software watchdog and not to the PROFINET watchdog time set in the PROFINET IO controller.

- Process image storage format

This is used to define how data is stored in the process image (I/O mapping). The storage format is only applied to data type "Word". This change has no effect on other data types.

| Storage format | Explanation |
|----------------|---|
| Big-endian | MSB/LSB = Higher/Lower byte (Motorola format) |
| Little-endian | MSB/LSB = Higher/Lower byte (Intel format) |

Storage format - Little-endian (default setting)

| | | | | |
|----------------------|---------|--------------------------|---------|-------|
| ➔ Module002_Output_1 | 16#00 | <input type="checkbox"/> | 16#00 | USINT |
| ➔ Module003_Input_2 | 16#3344 | <input type="checkbox"/> | 16#0000 | UINT |
| ➔ Module004_Output_2 | 16#0000 | <input type="checkbox"/> | 16#0000 | UINT |

Storage format - Big-endian

| | | | | |
|----------------------|---------|--------------------------|---------|-------|
| ➔ Module002_Output_1 | 16#00 | <input type="checkbox"/> | 16#00 | USINT |
| ➔ Module003_Input_2 | 16#4433 | <input type="checkbox"/> | 16#0000 | UINT |
| ➔ Module004_Output_2 | 16#0000 | <input type="checkbox"/> | 16#0000 | UINT |

— I/O state information

The IOPS interface can be configured here. If configured, the PROFINET input/output object provider state (IOPS) permits the PROFINET IO device application program to recognize whether the received data from the PROFINET device is valid or not and declares the output data as valid or invalid.

| Setting | Explanation |
|----------|--|
| Disabled | I/O state information disabled. |
| Bit | The IOPS is treated as a bit list in the DPM (Dual Port Memory) of the PROFINET IO device. For this purpose, 2 I/O data points (InIOPS and OutIOPS) are listed in the I/O assignment for the individual input and output data. <ul style="list-style-type: none"> Respective bit set to 1: Data is valid. Respective bit set to 0: Data is invalid. |
| Byte | The IOPS is treated as a byte array in the dual-ported memory (DPM) of the PROFINET IO device. For this purpose, 2 I/O data points (InIOPS and OutIOPS) are listed in the I/O assignment for the individual input and output data of the slave. <ul style="list-style-type: none"> Respective byte set to 0x80: Data is valid. Respective bit set to not equal to 0x80: Data is invalid. |

Description

General device information and the entire GSDML file can be read [here](#).

9.23.21 X20IF10G3-1

Data sheet version: 2.18

9.23.21.1 General information

The interface module is equipped with an EtherCAT interface. This allows the B&R system (I/O modules, POWERLINK, etc.) to be connected to systems from other manufacturers and makes it possible to quickly and easily transfer data in both directions.

The interface module can be operated in X20 CPUs or in the expandable POWERLINK bus controller X20BC1083.

The interface is equipped with 2 RJ45 connections. Both connections result in an integrated switch. This makes it easy to implement daisy chain cabling.

- EtherCAT slave
- Integrated switch for efficient cabling

9.23.21.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | X20 interface module communication | |
| X20IF10G3-1 | X20 interface module for DTM configuration, 1 EtherCAT slave interface, electrically isolated |  |

Table 462: X20IF10G3-1 - Order data

Optional accessories

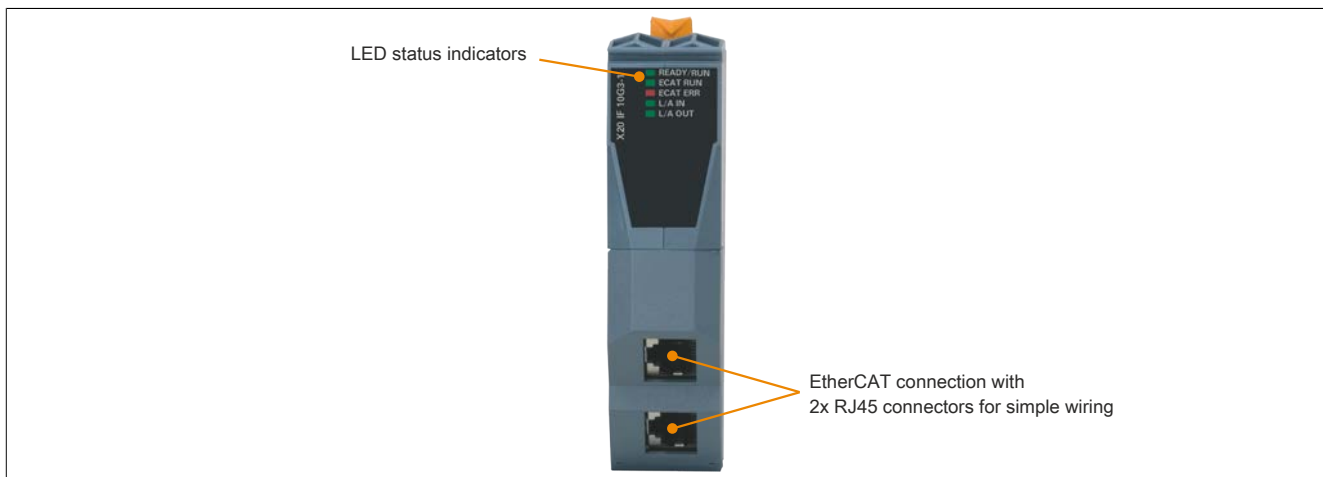
| Model number | Short description |
|-----------------|--|
| X20CA0E61.xxxxx | POWERLINK/Ethernet connection cable, RJ45 to RJ45, 0.2 to 20 m |
| X20CA0E61.xxxx | POWERLINK/Ethernet connection cable, RJ45 to RJ45, 20 m and longer |

9.23.21.3 Technical data

| | |
|--|--|
| Model number | X20IF10G3-1 |
| Short description | |
| Communication module | EtherCAT slave |
| General information | |
| B&R ID code | 0xA72C |
| Status indicators | Module status, network status, data transfer |
| Diagnostics | |
| Module status | Yes, using status LED and software |
| Network status | Yes, using status LED and software |
| Data transfer | Yes, using status LED |
| Power consumption | 2 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| KR | Yes |
| EAC | Yes |
| KC | Yes |
| Interfaces | |
| Fieldbus | EtherCAT (slave) |
| Variant | 2x shielded RJ45 |
| Cable length | Max. 100 m between 2 stations (segment length) |
| Transfer rate | 100 Mbit/s |
| Transfer | |
| Physical layer | 100BASE-TX |
| Half-duplex | No |
| Full-duplex | Yes |
| Autonegotiation | Yes |
| Auto-MDI/MDIX | Yes |
| Controller | netX100 |
| Electrical properties | |
| Electrical isolation | PLC isolated from EtherCAT (IF1 and IF2) |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Slot | In the X20 CPU and expandable bus controller X20BC1083 |

Table 463: X20IF10G3-1 - Technical data

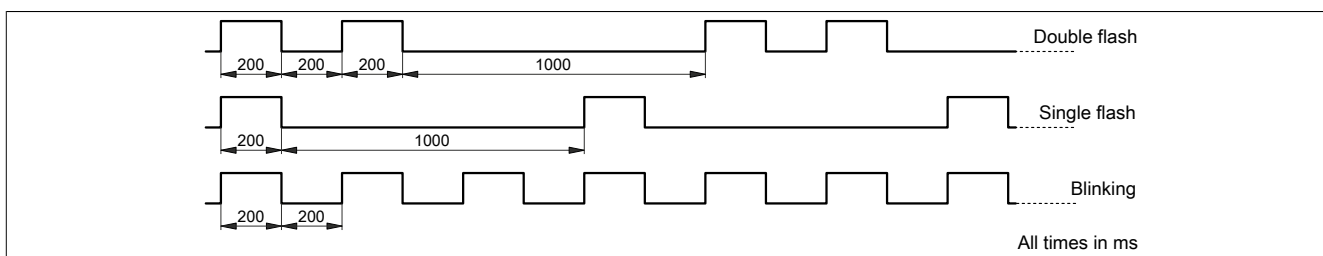
9.23.21.4 Operating and connection elements



9.23.21.4.1 LED status indicators

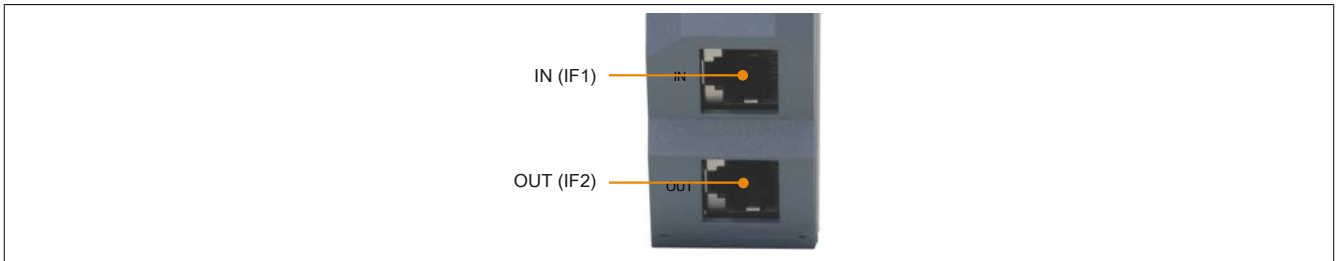
| Figure | LED | Color | Status | Description | |
|--------|-------------------|-----------|---|---|-----------------------------------|
| | READY/RUN | Green/Red | Off | No power to module | |
| | | Red | Blinking | Boot error | |
| | | On | Communication on the PCI bus has not yet been started | | |
| | ECAT RUN | Green | On | On | PCI bus communication in progress |
| | | | Off | Status INIT | |
| | | | Single flash | Status SAFE-OPERATIONAL | |
| | | | Blinking | Status PREOPERATIONAL | |
| | ECAT ERR | Red | On | Status OPERATIONAL | |
| | | | Off | No error | |
| | | | Single flash | Internal module error, EtherCAT status changed by module | |
| | | | Double flash | Watchdog timeout (process data watchdog or EtherCAT watchdog) | |
| | L/A IN L/A OUT | Green | Blinking | Invalid configuration data | |
| | | | On | Critical communication or application error | |
| | | | Off | No physical Ethernet connection (PORT CLOSED) | |
| | | | Blinking | The respective LED blinks when Ethernet activity is taking place (PORT OPEN) on the corresponding RJ45 interface (in, out). | |
| | | | On | Connection (link) established, but no communication taking place (PORT OPEN) | |

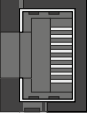
LED status indicators - Blink times



9.23.21.4.2 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see ["Cabling guidelines for X20 modules with an Ethernet cable"](#) on page 58.



| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  1 Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.23.21.5 Use in the expandable X20BC1083 POWERLINK bus controller

9.23.21.5.1 Cyclic data

If this module is connected to the expandable POWERLINK bus controller, the amount of cyclic data is limited by the POWERLINK frame to 1488 bytes in each direction (input and output).

When using multiple X20IF10xx-1 interfaces or other X2X modules with a POWERLINK bus controller, the 1488 bytes are divided between all connected modules.

9.23.21.5.2 Operating netX modules

It is important to note the following in order to operate netX modules with the bus controller without problems:

- A minimum revision $\geq E0$ is required for the bus controller.
- netX modules can only be operated with the POWERLINK V2 setting. V1 is not permitted.
- With SDO access to POWERLINK object 0x1011/1 on the bus controller, the netX firmware and the configuration stored on the bus controller are not reset. They can only be overwritten by accessing them again. This affects objects 0x20C0 and 0x20C8, subindexes 92 to 95.

9.23.21.6 netX error codes

netX modules return an error code when an error occurs. These error codes are fieldbus-specific. A complete list of all error codes in PDF format is available in Automation Help in section "Communication / Fieldbus systems / Support with FDT/DTM / Diagnostic functions / Diagnostics on the runtime system / Master diagnostics" under item "Communication_Error".

9.23.21.7 Firmware

The module comes with preinstalled firmware. The firmware is part of the Automation Studio project. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.23.21.8 Supported protocols and functions

Supported protocols:

- SDO client-server protocol (CoE object)
- CoE emergency message (CoE object)
- Ethernet over EtherCAT (EoE object)
- File access over EtherCAT (FoE object)
- Complete access (supported since firmware version 18)

Additional supported functions:

- 32-bit "distributed clocks" function

Unsupported functions:

- Reading and writing a logical memory area (LRW)

9.23.21.9 The EtherCAT interface

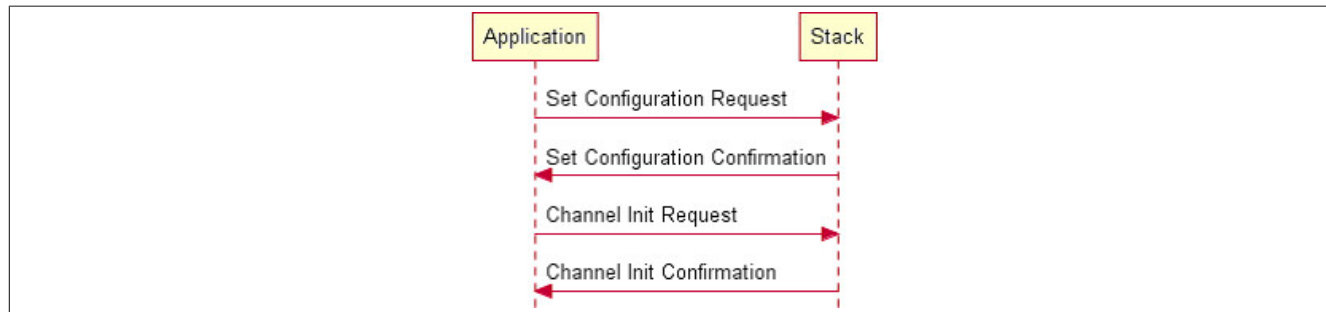
From an Ethernet standpoint, the EtherCAT bus is simply a single large Ethernet station. This "station" receives and transmits Ethernet telegrams. The station does not include an Ethernet controller with downstream microprocessor, however, but rather a large number of EtherCAT slaves. These slaves process the incoming telegrams during the cycle and extract the relevant payload data or add it and then forward the telegram to the next EtherCAT slave. The last EtherCAT slave then returns the now fully processed telegram so that it will be sent back to the master by the first slave as a kind of response telegram. This procedure utilizes the fact that Ethernet deals separately with transfers in separate directions (Tx and Rx lines) and operates in full-duplex mode.

The telegrams are processed in the cycle. While the telegrams are delayed by only a few bits before being forwarded, the slave detects and executes commands that were intended for it. Processing occurs in the hardware and is therefore separate from the slave response times. Each station has an addressable 64 kB memory area that can be written to, read from or simultaneously written to and read from. Multiple EtherCAT commands, which each address individual stations and/or memory areas, can be embedded in one Ethernet telegram.

9.23.21.9.1 Startup sequence

Switching on the power triggers the module initialization phase. These contain basic information such as vendor ID and product code. Then comes channel initialization. The new configurations and parameters are sent to the stack. The stack is then ready to start communicating with the EtherCAT master. The LED "READY/RUN" (see ["LED status indicators" on page 2436](#)) on the interface module indicates any problems during startup by blinking in a certain pattern.

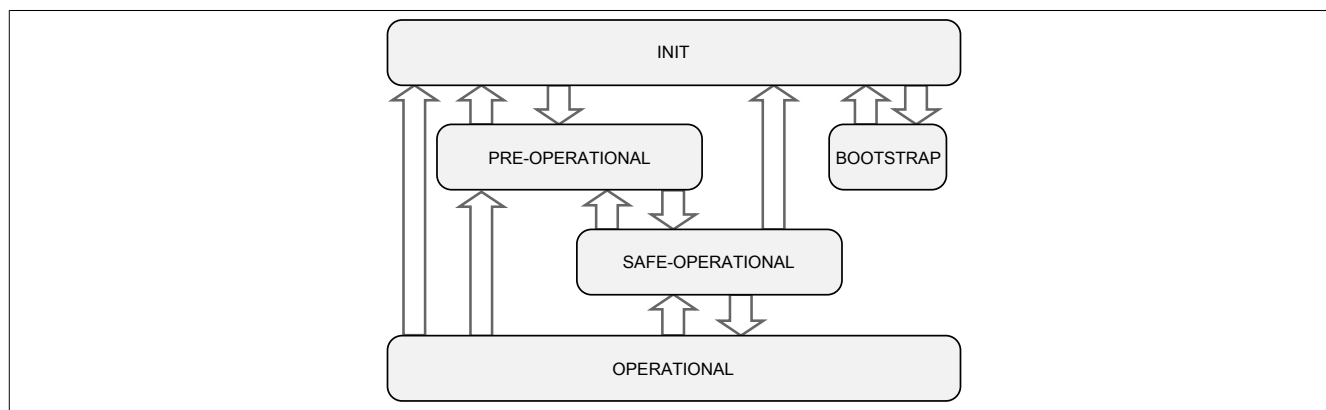
Startup sequence



Operating status

| Status | Description |
|------------------|---|
| INIT | The EtherCAT is being initialized. No process data is being exchanged yet. |
| PREOPERATIONAL | The master and slave are not yet operable but are exchanging parameter data acyclically via the mailbox. No process data is being exchanged yet. |
| SAFE-OPERATIONAL | The EtherCAT slave can process input data. Output data is in status "SAFE" |
| OPERATIONAL | The EtherCAT slave is operational. |
| BOOTSTRAP | Permitted according to EtherCAT specification but not necessary. |

The following diagram shows the possible status changes within the module.



9.23.21.9.2 Object dictionary

The object dictionary is subdivided into different, uniquely defined areas. Detailed information regarding the objects can be found in the EtherCAT specification.

| Index | Area | Description |
|------------------|----------------------|--|
| 0x0000 to 0x0FFF | Data type area | Definition and description of data types |
| 0x1000 to 0x1FFF | Communication area | Definition of generally valid variables (Communication objects for all devices are defined in the CANopen standard DS301) |
| 0x2000 to 0x5FFF | Vendor-specific area | Definition of vendor-specific variables |
| 0x6000 to 0x9FFF | Profile area | Definition of profile-related variables |
| 0xA000 to 0xFFFF | Reserved | Reserved |

9.23.21.9.3 AL status codes

The AL status code reflects the current slave error state. It is located in the ESC register and can be read by the master.

List of standard EtherCAT AL status codes

| Code | Description |
|------------------|---|
| 0x0000 | No error |
| 0x0001 | Unspecified error |
| 0x0011 | Invalid requested state change |
| 0x0012 | Unknown requested state |
| 0x0013 | Bootstrap not supported |
| 0x0014 | No valid firmware |
| 0x0015 | Invalid mailbox configuration (BOOTSTRAP) |
| 0x0016 | Invalid mailbox configuration (PREOP) |
| 0x0017 | Invalid sync manager configuration |
| 0x0018 | No valid inputs available |
| 0x0019 | No valid outputs available |
| 0x001A | Synchronization error |
| 0x001B | Sync manager watchdog |
| 0x001C | Invalid sync manager type |
| 0x001D | Invalid output configuration |
| 0x001E | Invalid input configuration |
| 0x001F | Invalid watchdog configuration |
| 0x0020 | Slave needs cold start |
| 0x0021 | Slave needs "INIT" |
| 0x0022 | Slave needs "PREOP" |
| 0x0023 | Slave needs "SAFEOP" |
| 0x002D | Invalid output "FMMU" configuration |
| 0x002E | Invalid input "FMMU" configuration |
| 0x0030 | Invalid DC "SYNCH" configuration |
| 0x0031 | Invalid DC latch configuration |
| 0x0032 | "PLL" error |
| 0x0033 | Invalid DC I/O error |
| 0x0034 | Invalid DC timeout error |
| 0x0042 | "MBX_EOE" |
| 0x0043 | "MBX_COE" |
| 0x0044 | "MBX_FOE" |
| 0x0045 | "MBX_SOE" |
| 0x004F | "MBX_VOE" |
| 0x0050 to 0x8000 | Reserved |
| 0x800 to 0xFFFF | Vendor-specific |

If the standard EtherCAT error code does not sufficiently describe the current error, then the status error code with an offset of "0x8000" (vendor-specific range) will be written to the "AL status code register".

Supported vendor-specific AL status codes

| Value | AL status code |
|--------|---|
| 0x8000 | ECAT_AL_STATUS_CODE_HOST_NOT_READY |
| 0x8001 | ECAT_AL_STATUS_CODE_IO_DATA_SIZE_NOT_CONFIGURED |
| 0x8002 | ECAT_AL_STATUS_CODE_DPM_HOST_WATCHDOG_TRIGGERED |
| 0x8003 | ECAT_AL_STATUS_CODE_DC_CFG_INVALID |
| 0x8004 | ECAT_AL_STATUS_CODE_FIRMWARE_IS_BOOTING |
| 0x8005 | ECAT_AL_STATUS_CODE_WARMSTART_REQUESTED |
| 0x8006 | ECAT_AL_STATUS_CODE_CHANNEL_INIT_REQUESTED |
| 0x8007 | ECAT_AL_STATUS_CODE_CONFIGURATION_CLEARED |

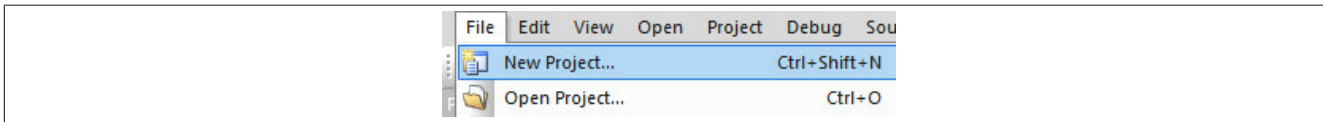
9.23.21.9.4 Settings in Automation Studio

The interface module can be operated in the slot of a CPU or in the slot of an expandable POWERLINK bus controller.

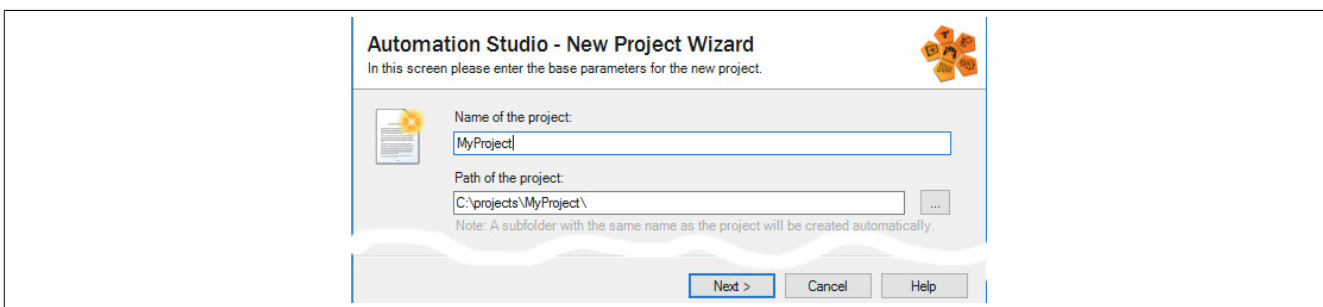
To do this, a new Automation Studio project is created and the suitable settings are made on the module.

9.23.21.9.4.1 Creating an Automation Studio project

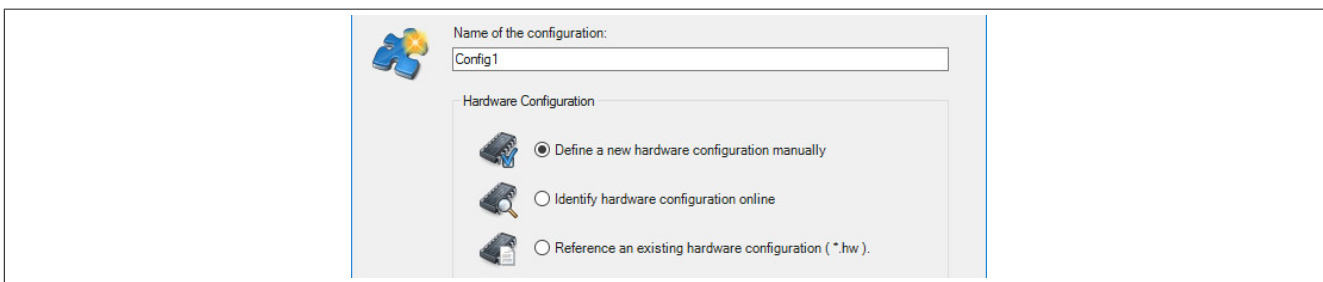
- Create a new Automation Studio project by selecting "New project".



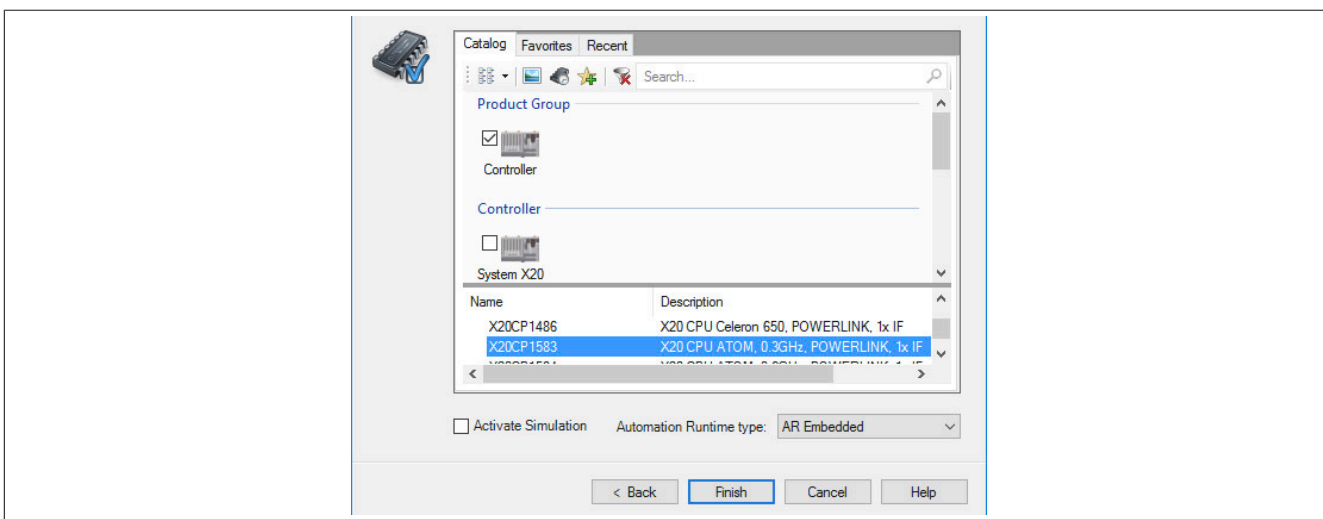
- Assign a project name and set up the project path.



- Assign the hardware configuration type and configuration name.

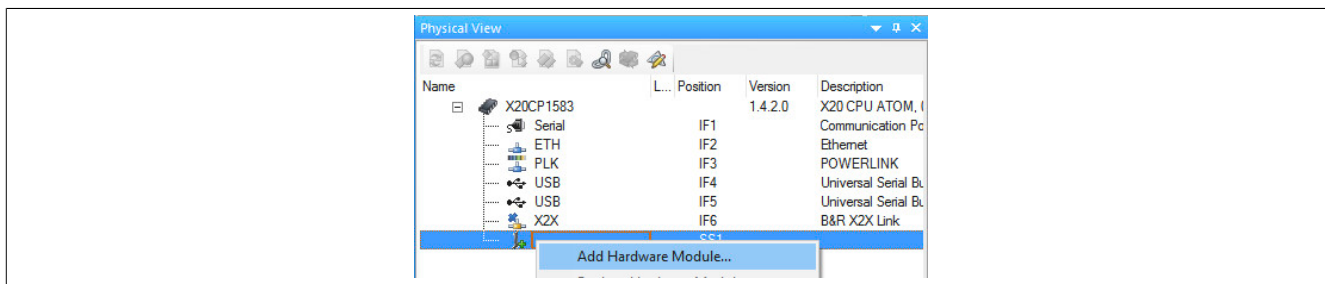


- Select the hardware in the next step if "Define a new hardware configuration manually" was selected. In order to simplify the search, different filters can be set in the Hardware Catalog. Lastly, highlight the required hardware and create the Automation Studio project by clicking on "Finish".

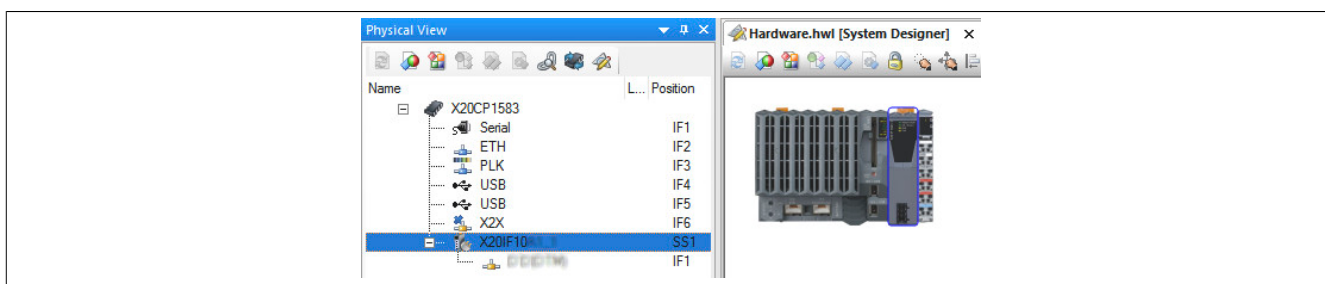


9.23.21.9.4.2 Adding and configuring the interface module

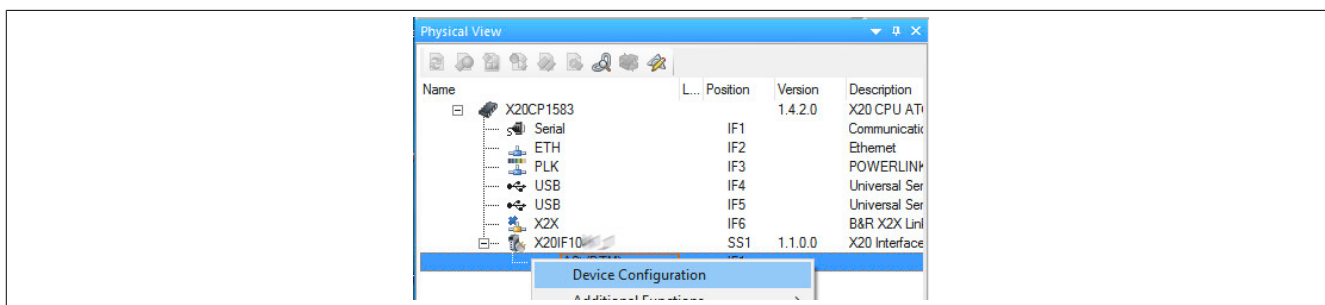
- In this example, the interface card is connected in the slot of a CPU. Right-clicking on the slot and selecting "Add hardware module" opens the Hardware Catalog.



- The module is added to the project via drag-and-drop or by double-clicking on the interface card.



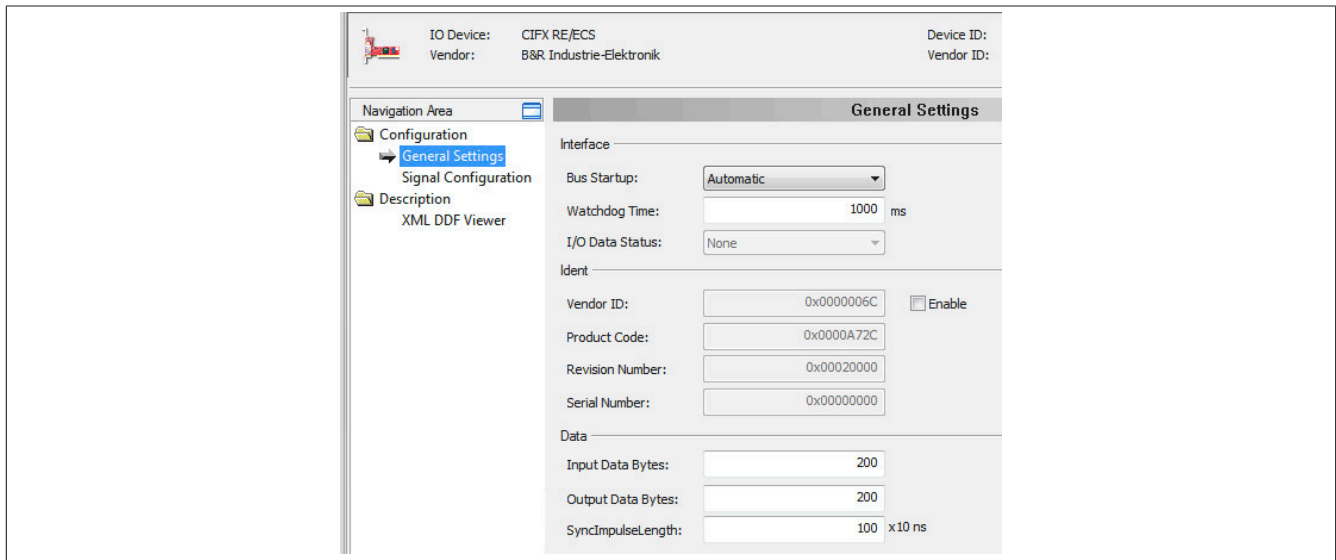
- Additional module settings can be made under "Device configuration". This configuration environment is opened by right-clicking on the IF interface and selecting "Device configuration".



Information:

The settings on the slave must match the settings of the corresponding device description file; otherwise, no connection can be established.

- General settings are made in the device configuration.



General settings

- Bus startup

It is possible to select how data exchange is started on the module.

| Parameter | Explanation |
|---------------------------|--|
| Automatically by device | Data exchange is started automatically after initializing this module. |
| Controlled by application | Data exchange is started by Automation Runtime. |

- Watchdog time

The watchdog is triggered as soon as it receives no feedback after the set "Watchdog time" has expired. In this case, [AL status code 0x8002](#) is output.

| Parameter | Explanation | Values |
|---------------|---|----------------|
| Watchdog time | Watchdog software disabled | 0 ms |
| | Permissible range of values Default value: 1000 ms | 20 to 65535 ms |

Information:

The watchdog time is reset automatically by Automation Runtime.

- Ident

Settings such as the vendor ID or product code can be read out or adjusted here.

| Parameter | Explanation | Default value | Subindex (in object 0x1018) |
|-----------------|--|--|-----------------------------|
| Vendor ID | Manufacturer identification of the EtherCAT device | 0x0000006C (B&R vendor ID) | 1 |
| Product code | Product code of the device | 0xA72C (product code of the X20IF10G3-1) | 2 |
| Revision number | Manufacturer revision number of the device | 0x20000 | 3 |
| Serial number | Serial number of the device | 0 | 4 |

To be able to change the identifier, checkbox "Enable" must be selected.

Information:

Care should be taken when changing the identifier parameters. Problems could arise when establishing a connection since the identifier data is compared in the process. The changed data must also be adjusted on the master side in order to avoid communication errors.

- Data

The length of the input and output data as well as the pulse length can be adjusted.

| Parameter | Explanation | Default value | Maximum value |
|---------------------|--|------------------------------|-------------------|
| Input data bytes | Number of input process data bytes | 200 bytes | 256 bytes |
| Output data bytes | Number of output process data bytes | 200 bytes | 256 bytes |
| Sync impulse length | Length of the synchronization pulse (optional) | 100 (corresponds to 1000 ns) | 65535 (655350 ns) |

Signal configuration

The current signal configuration of the PDOs is displayed here.

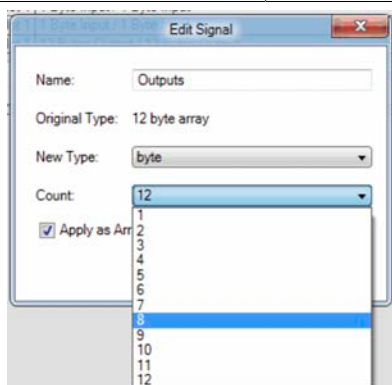
| Parameter | Explanation |
|-----------|----------------------|
| Name | Signal type |
| Type | Data type |
| Offset | Offset of the signal |

After right-clicking on the signal to be configured, the following options can be selected in the shortcut menu:

- **Edit signal**

This allows the currently selected signal to be edited.

| Parameter | Explanation |
|----------------|--|
| Name | The new name for the signal |
| New type | The new data type for the signal |
| Count | Number of individually listed data type elements for the signal. Only the data of the original type is re-structured; the quantity is not adjusted. - The maximum number corresponds to the quantity that the new data type requires to display the original type. - If fewer elements are selected, the last data type element is listed as an array of all remaining elements. |
| Apply as array | If selected, the new data type is displayed as an array. Otherwise, the data type elements set under "Count" are displayed. |



| Slot 4 / Subslot 1 12 Bytes Output / 12 Bytes Output | | |
|--|---------------|--------|
| Name | Type | Offset |
| Outputs | 12 byte array | 0 |
| Outputs_Byte_0 | byte | 0 |
| Outputs_Byte_1 | byte | 1 |
| Outputs_Byte_2 | byte | 2 |
| Outputs_Byte_3 | byte | 3 |
| Outputs_Byte_4 | byte | 4 |
| Outputs_Byte_5 | byte | 5 |
| Outputs_Byte_6 | byte | 6 |
| Outputs_Byte_7 | byte | 7 |
| Outputs_Byte_8 | 4 byte array | 8 |

- **Reset**

This can be used to undo the signal change or a merge previously completed with "Merge signal".

- **Merge signal**

This allows all signals between "First in group" and "Last in group" to be merged to form a new group. The same settings can be made for the new group as under "Edit signal".

XML DDF viewer

The contents of the DDF device description file can be viewed and searched here.

9.23.21.9.5 ESI device description file

The module description is made available to the master in an ESI file. This text file is a general description of the slave. The ESI file can be downloaded from the B&R website (www.br-automation.com) in the Downloads section for the interface module and then imported into the respective master environment.

The device description file defines all necessary sync managers and mailbox parameters.

Mailbox parameter "PdoUpload" is defined with "TRUE". This instructs the EtherCAT master to read all of the process data information via CoE (CANopen over EtherCAT) from the interface card and create a corresponding I/O mapping.

In 3rd-party environments, the interface card is displayed under the name "CIFX RE/ECS".



Sync master

The following entries in the ESI file define the outbox/inbox (required for asynchronous communication between the EtherCAT master and interface card) as well as the properties of the input/output process data (synchronous communication).

```

<!--SM0 MBX OUT-->
<Sm ControlByte="#x36" DefaultSize="128" Enable="1" MaxSize="128" MinSize="128"
  StartAddress="#x1000">MBoxOut</Sm>

<!--SM1 MBX INP-->
<Sm ControlByte="#x32" DefaultSize="128" Enable="1" MaxSize="128" MinSize="128"
  StartAddress="#x1080">MBoxIn</Sm>

<!--SM2 PD OUT-->
<Sm ControlByte="#x74" DefaultSize="200" Enable="1" MaxSize="256" MinSize="0"
  StartAddress="#x1100">Outputs</Sm>

<!--SM3 PD INP-->
<Sm ControlByte="#x30" DefaultSize="200" Enable="1" MaxSize="256" MinSize="0"
  StartAddress="#x1400">Inputs</Sm>

```

Mailbox setting

```

<Mailbox DataLinkLayer="1">
  <CoE CompleteAccess="1"
    PdoUpload="1"
    SdoInfo="1" />
</Mailbox>

```

EEPROM setting

```

<Eeprom>
  <ByteSize>65536</ByteSize>
  <ConfigData>060000CCE8030000</ConfigData>
  <BootStrap>0010800080108000</BootStrap>
</Eeprom>

```

9.23.22 X20(c)IF10X0

Data sheet version: 1.15

9.23.22.1 General information

Interface module for the operation of redundant CPUs.

- CPU-CPU data synchronization module for redundant CPU systems

9.23.22.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.23.22.3 Order data

| Model number | Short description | Figure |
|--------------|--|--------|
| | X20 interface module communication | |
| X20IF10X0 | X20 interface module, 1 redundancy link interface 1000BASE-SX, CPU-CPU data synchronization module for controller redundancy | |
| X20cIF10X0 | X20 interface module, coated, 1 redundancy link interface 1000 Base-FX, CPU-CPU data synchronization for controller redundancy | |


Table 464: X20IF10X0, X20cIF10X0 - Order data

9.23.22.4 Technical data

| Model number | X20IF10X0 | X20cIF10X0 |
|--|---|---------------------------------|
| Short description | | |
| Communication module | CPU redundancy link module | |
| General information | | |
| B&R ID code | 0xC3B4 | 0xE239 |
| Status indicators | Module status, bus function | |
| Diagnostics | | |
| Module status | Yes, using status LED and software | |
| Bus function | Yes, using status LED and software | |
| Data transfer | Yes, using status LED and software | |
| Power consumption | 1.93 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| KC | Yes | - |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | |
| Interfaces | | |
| Fieldbus | Redundancy link | |
| Standard (compliance) | IEEE Std 802.3, 2002 Edition, Clause 38 | |
| Variant | 1x duplex LC | |
| Transfer rate | 1 Gbit/s | |
| Transfer | | |
| Physical layer | 1000BASE-SX | |
| Wave length | 850 nm | |
| Cable fiber type | Multimode fiber with 62.5/125 µm or 50/125 µm core diameter LC connector on both sides | |
| Line length | | |
| MMF 50/125 µm | Min: 2 m, max: up to 500 m | |
| MMF 62.5/125 µm | Min: 2 m, max: up to 300 m | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating" | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 85%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 85%, non-condensing | |
| Transport | 5 to 85%, non-condensing | |
| Mechanical properties | | |
| Slot | Left IF slot on X20CP358x CPUs | Left IF slot on X20cCP358x CPUs |

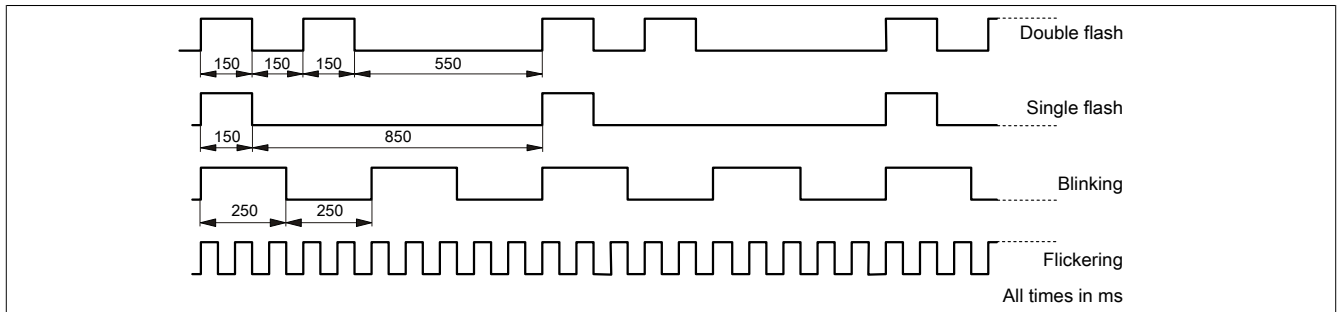
Table 465: X20IF10X0, X20cIF10X0 - Technical data

9.23.22.5 LED status indicators

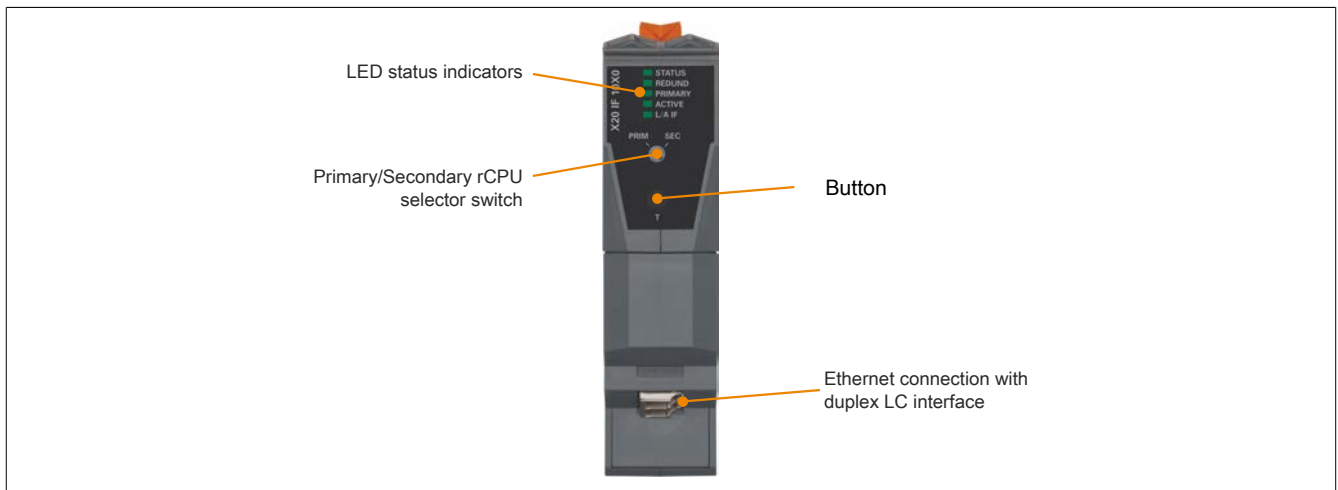
| Figure | LED | Color | Status | Description |
|---|-----------------------|------------|--|---------------------------------------|
|  | STATUS ¹⁾ | Green | On | Interface module active |
| | | Red | Blinking | CPU starting up |
| | REDUND ¹⁾ | Green | On | Bumpless switchover of CPU possible |
| | | | Blinking | Minor bump switchover of CPU possible |
| | | | Double flash | Major bump switchover of CPU possible |
| | | Flickering | Application synchronization in progress | |
| | Red | On | Switchover of CPU not possible. It is not differentiated whether it is not possible to switch over only for a short time or whether it is not possible to switch over permanently. | |
| | | Green | On | rCPU = Primary CPU |
| | PRIMARY ¹⁾ | Green | On | rCPU = Primary CPU |
| | | Off | Off | rCPU = Secondary CPU |
| | Red | On | Impermissible operation of the selector switch: One rCPU must be configured as primary, the other as secondary. Modifying the switch position during operation is not permitted. | |
| | | Green | On | rCPU actively controlling the process |
| | ACTIVE | Green | On | rCPU actively controlling the process |
| | | Off | Off | rCPU inactive |
| LA/IF ¹⁾ | Green | On | Connection established to redundancy partner | |
| | | Blinking | Redundancy link active. Data traffic is taking place for synchronization purposes. | |
| | Red | On | No connection to redundancy partner | |

1) This LED is a green/red dual LED.

LEDs - Blink times



9.23.22.6 Operating and connection elements



9.23.22.7 Switch positions



The CPU can be set to primary or secondary using the "PRIM/SEC" selection switch.

During configuration, make sure that one rCPU is set as primary and the other rCPU as secondary.

Information:

It is not permitted to change the switch position during operation.

The "T" button is used for redundancy switchovers and manually synchronizing the application.

9.23.22.8 Derating

The temperatures listed in the technical data are valid when the unit is operated in the left IF slot of the X20CP358x CPUs.

When operated in the IF slot of the X20CP158x CPUs, the maximum temperature values are reduced by 5°C

9.23.22.9 Firmware

The module comes with preinstalled firmware. The firmware is part of Automation Studio. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.23.23 X20(c)IF2181-2

Data sheet version: 1.15

9.23.23.1 General information

The interface module is used to expand the X20 CPU for specific applications. It is equipped with an POWERLINK interface.

POWERLINK is a standard protocol for Fast Ethernet equipped with hard real-time characteristics. The POWERLINK Standardization Group (EPSG, see www.ethernet-powerlink.org) ensures its openness and continual development.

Systems with redundant cabling can be implemented easily using POWERLINK. Unlike ring redundancy, cable redundancy does not require cable looping, which can sometimes be problematic. This allows the creation of all types of tree structures. When using a device with the link selector function, data is always transferred via the highest quality network lines. The link selector function is integrated in the X20IF2181-2 module.

- POWERLINK V2 for real-time Ethernet communication
- Integrated link selector function (preconfigured)
- Redundant Managing Node for controller redundancy
- Integrated hub for efficient cabling (configurable)
- Configurable ring redundancy
- Poll response chaining
- Dynamic Node Allocation (DNA)

9.23.23.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.23.23.3 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | X20 interface module communication |  |
| X20IF2181-2 | X20 interface module, 1x link selector for POWERLINK cable redundancy, POWERLINK functions: - Managing node - Controlled node for iCN operation - Redundant managing node for controller redundancy - Ring redundancy - 2x hub - Multi ASend - PRC function 2x RJ45 | |
| X20cIF2181-2 | X20 interface module, coated, 1x link selector for POWERLINK cable redundancy, POWERLINK functions: - Managing node - Controlled node for iCN operation - Redundant managing node for controller redundancy - Ring redundancy - 2x hub - Multi ASend - PRC function 2x RJ45 | |

Table 466: X20IF2181-2, X20cIF2181-2 - Order data

Optional accessories

| Model number | Short description |
|-----------------|--|
| X20CA0E61.xxxxx | POWERLINK/Ethernet connection cable, RJ45 to RJ45, 0.2 to 20 m |
| X20CA0E61.xxxx | POWERLINK/Ethernet connection cable, RJ45 to RJ45, 20 m and longer |

9.23.23.4 Technical data

| Model number | X20IF2181-2 | X20cIF2181-2 |
|--|--|--------------|
| Short description | 1x POWERLINK managing or controlled node | |
| Communication module | 1x POWERLINK managing or controlled node | |
| General information | | |
| B&R ID code | 0xC3B3 | 0xE23A |
| Status indicators | Module status, bus function | |
| Diagnostics | | |
| Module status | Yes, using status LED and software | |
| Bus function | Yes, using status LED and software | |
| POWERLINK cable redundancy system | Configurable | |
| Controller redundancy | Configurable | |
| Power consumption | 2 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| KC | Yes | - |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| Interfaces | | |
| Fieldbus | POWERLINK managing or controlled node | |
| Type | Type 5 ¹⁾ | |
| Variant | 2x shielded RJ45 | |
| Cable length | Max. 100 m between 2 stations (segment length) | |
| Transfer rate | 100 Mbit/s | |
| Transfer | | |
| Physical layer | 100BASE-TX | |
| Half-duplex | Yes | |
| Full-duplex | No | |
| Autonegotiation | Yes | |
| Auto-MDI/MDIX | Yes | |
| Hub propagation delay | 0.96 to 1 µs | |
| Controller | POWERLINK MAC | |

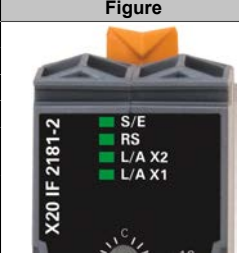
Table 467: X20IF2181-2, X20cIF2181-2 - Technical data

| Model number | X20IF2181-2 | X20cIF2181-2 |
|--|---|------------------------|
| Electrical properties | | |
| Electrical isolation | PLC isolated from POWERLINK (X1 and X2) | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Slot | In the X20 CPU | In X20c CPU |

Table 467: X20IF2181-2, X20cIF2181-2 - Technical data

1) See Automation Help under "Communication / POWERLINK / General information / Hardware - IF/LS" for more information.

9.23.23.5 LED status indicators

| Figure | LED | Color | Status | Description |
|--|-----------|-----------|----------|---|
|  | S/E | Green/Red | | Status/Error-LED. Die LED-Status sind im Abschnitt LED "S/E" beschrieben. |
| | RS | Green | On | Both cable connections are OK. |
| | | Red | On | At least one cable connection is faulty. |
| | L/A X1/X2 | Green | On | A link to the POWERLINK remote station has been established. |
| | | | Blinking | A link to the POWERLINK remote station has been established. Indicates Ethernet activity is taking place on the bus |

LED "S/E"

This LED is a green/red dual LED and indicates the state of the POWERLINK interface. The LED states have a different meaning depending on the operating mode of the POWERLINK interface.

Ethernet mode

In this mode, the interface is operated as an Ethernet interface.

| Farbe grün - Status | Beschreibung |
|---------------------|--|
| Ein | Die Schnittstelle wird als Ethernet-Schnittstelle betrieben. |

POWERLINK mode

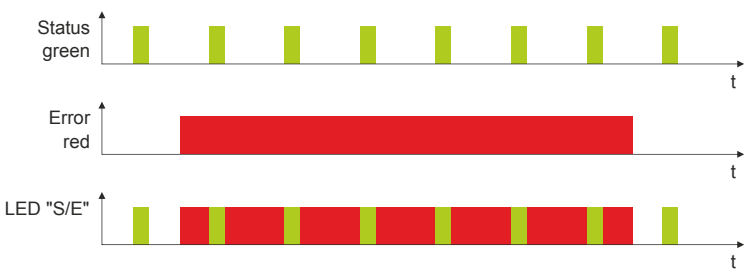
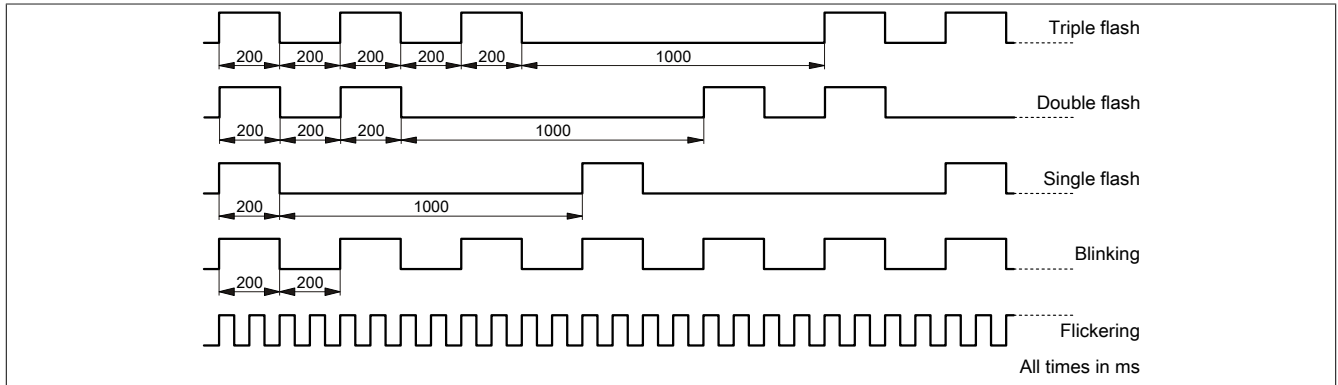
| Red - Error | Description |
|-------------|--|
| On | <p>The module is in an error mode (failed Ethernet frames, increased number of collisions on the network, etc.). If an error occurs in the following states, then the green LED blinks over the red LED:</p> <ul style="list-style-type: none"> PRE_OPERATIONAL_1 PRE_OPERATIONAL_2 READY_TO_OPERATE  <p>Note: The LED blinks red several times immediately after startup. This is not an error, however.</p> |

Table 468: Status/Error LED as Error LED

| Farbe grün - Status | Beschreibung |
|------------------------------------|---|
| Aus | <p>Modus Das Modul befindet sich im Modus NOT_ACTIVE oder es ist:</p> <ul style="list-style-type: none"> • ausgeschaltet • im Hochlauf • in Automation Studio nicht richtig konfiguriert • defekt <p>Managing Node (MN) Der Bus wird auf POWERLINK-Frames überwacht. Wird in dem eingestellten Zeitfenster (Timeout) kein entsprechender Frame empfangen, geht das Modul direkt in den Modus PRE_OPERATIONAL_1 über. Wenn jedoch vor Ablauf der Zeit eine POWERLINK-Kommunikation erkannt wird, wird der MN nicht gestartet.</p> <p>Controlled Node (CN) Der Bus wird auf POWERLINK-Frames überwacht. Wird in dem eingestellten Zeitfenster (Timeout) kein entsprechender Frame empfangen, geht das Modul direkt in den Modus BASIC_ETHERNET über. Wenn jedoch vor Ablauf der Zeit eine POWERLINK-Kommunikation erkannt wird, geht das Modul direkt in den Modus PRE_OPERATIONAL_1 über.</p> |
| Grün flackernd (ca. 10 Hz) | <p>Modus Das Modul befindet sich im Modus BASIC_ETHERNET. Die Schnittstelle wird als Ethernet-TCP/IP-Schnittstelle betrieben.</p> <p>Managing Node (MN) Dieser Zustand kann nur durch einen Reset des Moduls verlassen werden.</p> <p>Controlled Node (CN) Wird während dieses Zustandes eine POWERLINK-Kommunikation erkannt, geht das Modul in den Zustand PRE_OPERATIONAL_1 über.</p> |
| Single Flash (ca. 1 Hz) | <p>Modus Das Modul befindet sich im Modus PRE_OPERATIONAL_1.</p> <p>Managing Node (MN) Der MN startet den Betrieb des "reduced cycles". Es findet noch keine zyklische Kommunikation statt.</p> <p>Controlled Node (CN) In diesem Zustand kann das Modul vom MN konfiguriert werden. Der CN wartet auf den Empfang eines SoC Frames und wechselt dann in den Zustand PRE_OPERATIONAL_2. Wenn in diesem Zustand die rote LED leuchtet, heißt das, dass der MN ausgefallen ist.</p> |
| Single Flash (ca. 1 Hz) Invertiert | <p>Modus Das Modul befindet sich im Modus STANDBY.</p> <p>Dieser Zustand ist nur im Controller-Redundanz Mode möglich. Der POWERLINK Manager wird gerade als Standby Managing Node (SMN) betrieben.</p> |
| Double Flash (ca. 1 Hz) | <p>Modus Das Modul befindet sich im Modus PRE_OPERATIONAL_2.</p> <p>Managing Node (MN) Der MN beginnt mit der zyklischen Kommunikation (zyklische Eingangsdaten werden noch nicht ausgewertet). In diesem Zustand werden die CNs konfiguriert.</p> <p>Controlled Node (CN) In diesem Zustand kann das Modul vom MN konfiguriert werden. Danach wird per Kommando in den Zustand READY_TO_OPERATE weitergeschaltet. Wenn in diesem Modus die rote LED leuchtet, heißt das, dass der MN ausgefallen ist.</p> |
| Triple Flash (ca. 1 Hz) | <p>Modus Das Modul befindet sich im Zustand READY_TO_OPERATE.</p> <p>Managing Node (MN) Zyklische und asynchrone Kommunikation. Die empfangenen PDO-Daten werden ignoriert.</p> <p>Controlled Node (CN) Die Konfiguration des Moduls ist abgeschlossen. Normale zyklische und asynchrone Kommunikation. Die gesendeten PDO Daten entsprechen dem PDO-Mapping. Zyklische Daten werden jedoch noch nicht ausgewertet. Wenn in diesem Modus die rote LED leuchtet, heißt das, dass der MN ausgefallen ist.</p> |
| Ein | <p>Modus Das Modul befindet sich im Modus OPERATIONAL. PDO-Mapping ist aktiv und zyklische Daten werden ausgewertet.</p> |
| Blinkend (ca. 2,5 Hz) | <p>Modus Das Modul befindet sich im Modus STOPPED.</p> <p>Managing Node (MN) Dieser Zustand ist im MN nicht möglich.</p> <p>Controlled Node (CN) Ausgangsdaten werden nicht ausgegeben und es werden keine Eingangsdaten geliefert. Dieser Modus kann nur durch ein entsprechendes Kommando vom MN erreicht und wieder verlassen werden.</p> |

Table 469: Status/Error-LED als Status-LED - Betriebsmodus POWERLINK

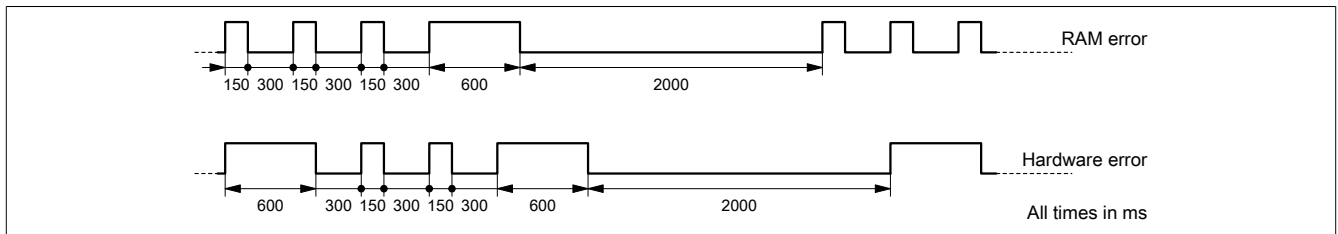
LED status indicators - Blinking patterns



9.23.23.5.1 System stop error codes

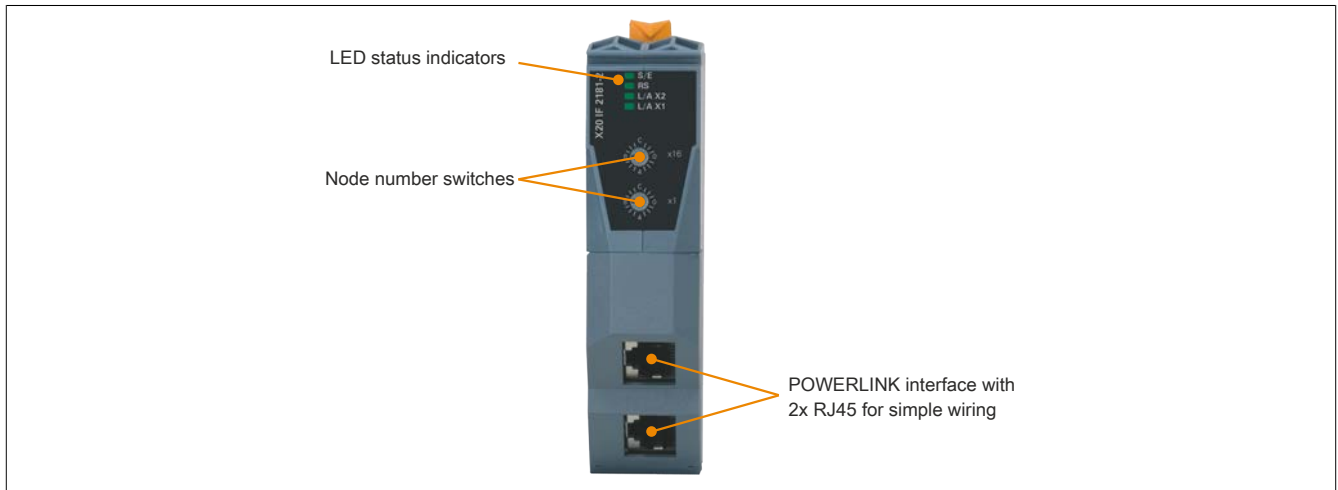
A system stop error can occur due to incorrect configuration or defective hardware.

The error code is indicated by LED "S/E" blinking red. The blinking signal of the error code consists of 4 switch-on phases with short (150 ms) or long (600 ms) duration. The error code is repeated every 2 seconds.



| Error | Error description |
|----------------|---|
| RAM error | The device is defective and must be replaced. |
| Hardware error | The device or a system component is defective and must be replaced. |

9.23.23.6 Operating and connection elements



9.23.23.7 POWERLINK node number



The node number for the POWERLINK station is set using the two number switches. The node number can also be directly configured using Automation Studio.

9.23.23.7.1 POWERLINK V2

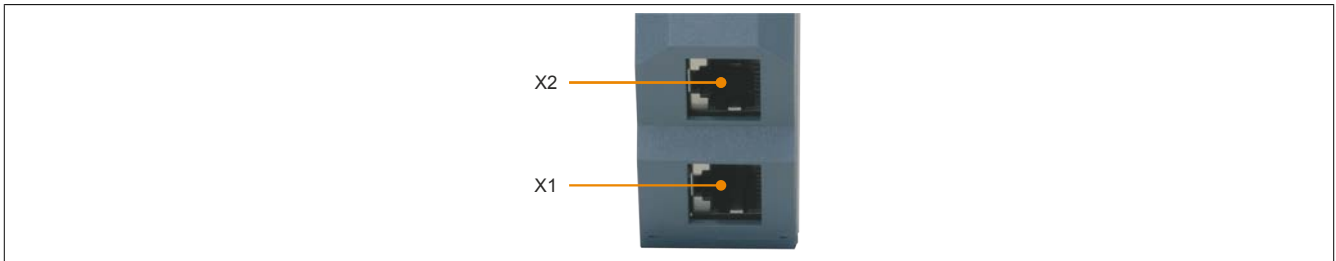
| Switch position | Description |
|-----------------|---|
| 0x00 | Reserved, switch position not permitted. |
| 0x01 - 0xEF | Node number of POWERLINK station. Operation as controlled node. |
| 0xF0 | Operation as managing node. |
| 0xF1 - 0xF7 | Reserved, switch position not permitted. |
| 0xF8 | Controller redundancy: Function as primary CPU |
| 0xF9 | Controller redundancy: Function as secondary CPU |
| 0xFA - 0xFF | Reserved, switch position not permitted. |

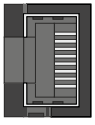
9.23.23.7.2 Ethernet mode

In this mode, the interface is operated as an Ethernet interface. The INA2000 station number is set using the B&R Automation Studio software.

9.23.23.8 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see "Cabling guidelines for X20 modules with an Ethernet cable" on page 58.



| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.23.23.9 Firmware

The module comes with preinstalled firmware. The firmware is part of Automation Studio. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.23.23.10 POWERLINK cable redundancy system

It is often indispensable to have redundant network cabling, especially in systems that handle technical processes. The potential for danger, especially to the lines that run through the system, is disproportionately high in relation to the need to keep communication active in all operating situations. This risk is effectively reduced with double cabling that is routed separately.

The POWERLINK cable redundancy system is based on the principle of doubling the transfer routing as well as providing continual and simultaneous monitoring. That means data is simultaneously fed into two cable lines using a corresponding mechanism. The same mechanisms are used to receive these telegrams from the redundant network.

Information:

Details about the structure of a redundancy system can be found in the "Redundancy for control systems" user's manual. The user's manual is available in the Downloads section of the B&R website www.br-automation.com.

9.23.24 X20IF2772

Data sheet version: 2.23

9.23.24.1 General information

The interface module can be used to expand the X20 CPU for specific applications. It is equipped with 2 CAN bus interfaces.

- Dual CAN bus connection
- Integrated terminating resistors

Information:

This module does not support CAN RTR messages with extended CAN identifiers (29-bit) (memory/performance bottleneck).

9.23.24.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | X20 interface module communication |  |
| X20IF2772 | X20 interface module, 2 CAN bus interfaces, max. 1 Mbit/s, electrically isolated, order 2x TB2105 terminal block separately | |
| | Required accessories | |
| | Terminal blocks | |
| 0TB2105.9010 | Accessory terminal block, 5-pin, screw clamps 2.5 mm ² | |
| 0TB2105.9110 | Accessory terminal block, 5-pin, push-in terminal block 2.5 mm ² | |

Table 470: X20IF2772 - Order data


9.23.24.3 Technical data

| | |
|--|--|
| Model number | X20IF2772 |
| Short description | |
| Communication module | 2x CAN bus |
| General information | |
| B&R ID code | 0x1F25 |
| Status indicators | Module status, data transfer, terminating resistor |
| Diagnostics | |
| Module status | Yes, using status LED |
| Data transfer | Yes, using status LED |
| Terminating resistor | Yes, using status LED |
| Power consumption | 1.2 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| Interfaces | |
| Interface IF1 | |
| Signal | CAN bus ¹⁾ |
| Variant | 5-pin male multipoint connector |
| Max. distance | 1000 m |
| Transfer rate | Max. 1 Mbit/s |
| Terminating resistor | Integrated in the module |
| Controller | SJA 1000 |
| Interface IF2 | |
| Signal | CAN bus ¹⁾ |
| Variant | 5-pin male multipoint connector |
| Max. distance | 1000 m |
| Transfer rate | Max. 1 Mbit/s |
| Terminating resistor | Integrated in the module |
| Controller | SJA 1000 |
| Electrical properties | |
| Electrical isolation | PLC isolated from CAN (IF1 and IF2) and interfaces from each other |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 2x TB2105 terminal blocks separately |
| Slot | In X20 CPU |

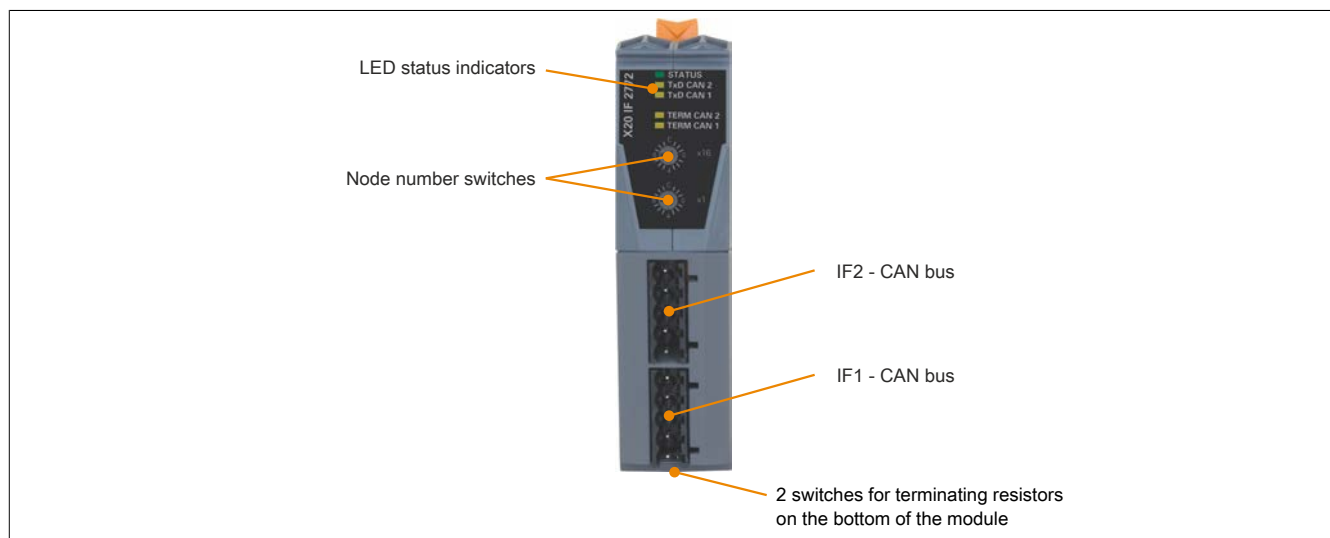
Table 471: X20IF2772 - Technical data

1) This CAN bus interface can be configured as a CANopen master in Automation Studio 3.0 and higher.

9.23.24.4 LED status indicators

| Figure | LED | Color | Status | Description |
|--|------------|--------|--------|--|
|  <p> X20 IF 2772 ■ STATUS ■ TxD CAN 2 ■ TxD CAN 1 ■ TERM CAN 2 ■ TERM CAN 1 </p> | STATUS | Green | On | Interface module active |
| | | Red | On | CPU starting up |
| | TxD CAN 1 | Yellow | On | The module is sending data via the CAN bus interface (IF1) |
| | TxD CAN 2 | Yellow | On | The module is sending data via the CAN bus interface (IF2) |
| | TERM CAN 1 | Yellow | On | The integrated terminating resistor for the CAN bus interface (IF1) is turned on |
| | TERM CAN 2 | Yellow | On | The integrated terminating resistor for the CAN bus interface (IF2) is turned on |

9.23.24.5 Operating and connection elements



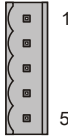
9.23.24.6 CAN bus node number



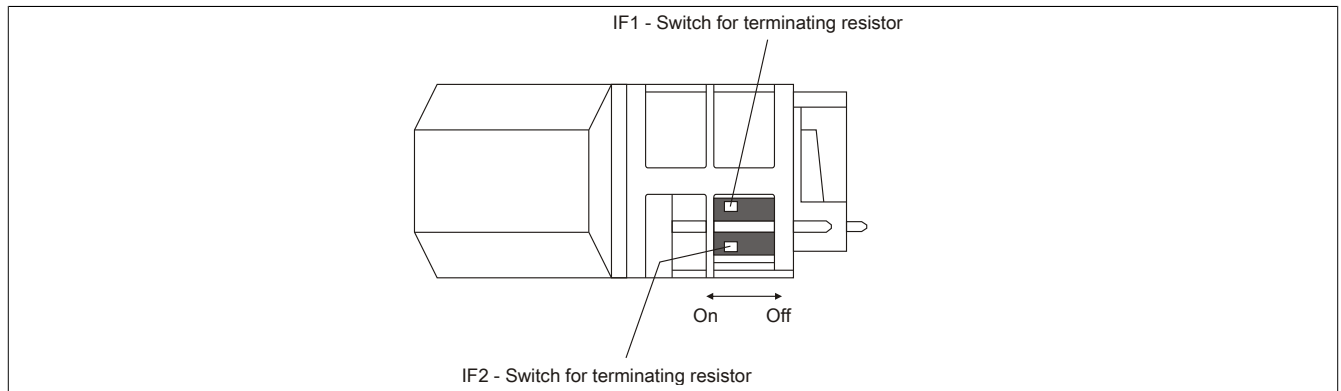
The node number for the CAN bus interfaces is set with the two hex switches.

9.23.24.7 Interfaces CAN bus 1 and CAN bus 2 (IF1 and IF2)

Both interfaces feature a 5-pin multipoint plug. The OTB2105 terminal block must be ordered separately.

| Interface | Pinout | | |
|--|----------|------------------|------------|
| | Terminal | Function | |
|  5-pin male multipoint connector | 1 | CAN _⊥ | CAN ground |
| | 2 | CAN _L | CAN low |
| | 3 | SHLD | Shield |
| | 4 | CAN _H | CAN high |
| | 5 | NC | |

9.23.24.8 Terminating resistor



Two terminating resistors are integrated in the interface module. The respective resistor can be turned on and off with a switch on the bottom of the housing. An active terminating resistor is indicated by the "TERM CAN 1" or "TERM CAN 2".

9.23.24.9 Firmware

The module comes with preinstalled firmware. The firmware is part of Automation Studio. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.23.25 X20IF2792

Data sheet version: 2.24

9.23.25.1 General information

The interface module can be used to expand the X20 CPU for specific applications. It is equipped with both an X2X Link interface and a CAN bus interface.

- X2X Link connection
- CAN bus connection
- Integrated terminating resistor

Information:

This module does not support CAN RTR messages with extended CAN identifiers (29-bit) (memory/performance bottleneck).

9.23.25.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | X20 interface module communication |  |
| X20IF2792 | X20 interface module, 1 CAN bus interface, max. 1 Mbit/s, electrically isolated, 1 X2X Link master interface, electrically isolated, order 1x terminal block TB2105 and 1x terminal block TB704 separately! | |
| | Required accessories | |
| | Terminal blocks | |
| 0TB2105.9010 | Accessory terminal block, 5-pin, screw clamps 2.5 mm ² | |
| 0TB2105.9110 | Accessory terminal block, 5-pin, push-in terminal block 2.5 mm ² | |
| 0TB704.9 | Accessory terminal block, 4-pin, screw clamp terminal block 2.5 mm ² | |
| 0TB704.91 | Accessory terminal block, 4-pin, push-in terminal block 2.5 mm ² | |

Table 472: X20IF2792 - Order data


9.23.25.3 Technical data

| | |
|--|---|
| Model number | X20IF2792 |
| Short description | |
| Communication module | 1x X2X Link master, 1x CAN bus |
| General information | |
| B&R ID code | 0x1F26 |
| Status indicators | Module status, data transfer, terminating resistor |
| Diagnostics | |
| Module status | Yes, using LED status indicator |
| Data transfer | Yes, using LED status indicator |
| Terminating resistor | Yes, using LED status indicator |
| Power consumption | 1.25 (Rev. <E0: 1.51 W) |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| Interfaces | |
| Interface IF1 | |
| Fieldbus | X2X Link master |
| Variant | 4-pin male multipoint connector |
| Number of stations | Max. 253 |
| Internal bus power supply | No |
| Network topology | Line |
| Distance between 2 stations | Max. 100 m |
| Bus terminating resistor | Internal |
| Interface IF2 | |
| Signal | CAN bus ¹⁾ |
| Variant | 5-pin male multipoint connector |
| Max. distance | 1000 m |
| Transfer rate | Max. 1 Mbit/s |
| Terminating resistor | Integrated in module |
| Controller | SJA 1000 |
| Electrical properties | |
| Electrical isolation | PLC isolated from X2X Link (IF1) and CAN (IF2) and interfaces isolated from each other |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block TB704 and 1x terminal block TB2105 separately. |
| Slot | In X20 CPU |

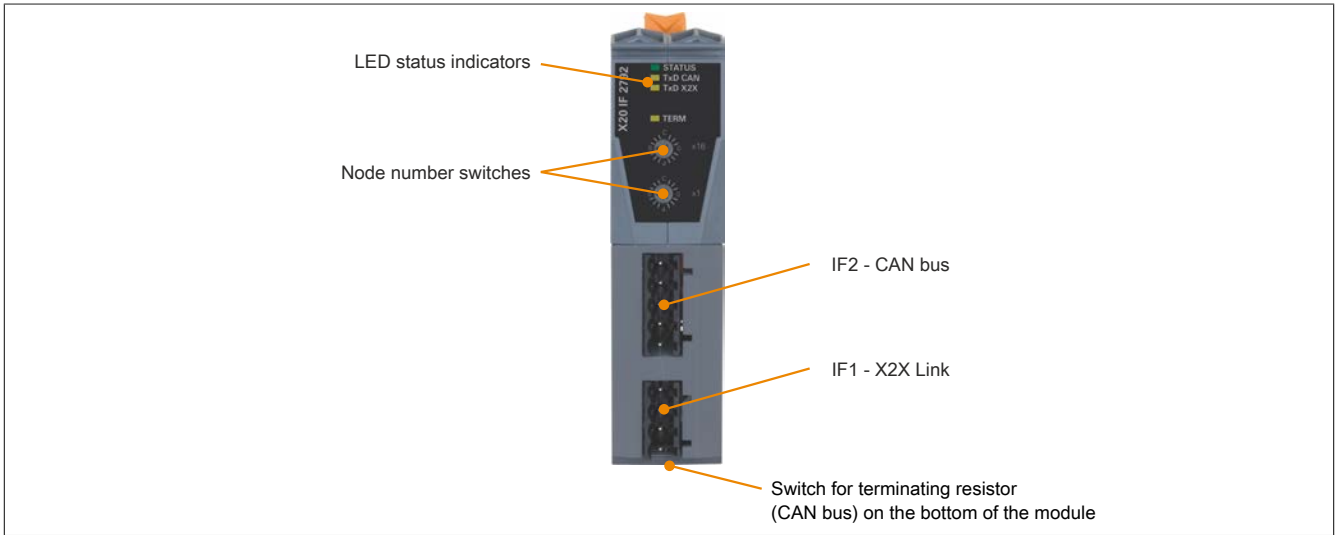
Table 473: X20IF2792 - Technical data

1) This CAN bus interface can be configured as a CANopen master in Automation Studio 3.0 and later.


9.23.25.4 LED status indicators

| Figure | LED | Color | Status | Description |
|---|---------|--------|--------|--|
|  | STATUS | Green | On | Interface module active |
| | | Red | On | CPU starting up |
| | TxD CAN | Yellow | On | The module is sending data via the CAN bus interface |
| | TxD X2X | Yellow | On | Module sending data via the X2X Link interface |
| | TERM | Yellow | On | The integrated terminating resistor for the CAN bus interface is turned on |

9.23.25.5 Operating and connection elements



9.23.25.6 X2X Link interface (IF1)

| Interface | Pinout | | |
|--|----------|------------------|--------|
| | Terminal | Function | |
|  4-pin male multipoint connector | 1 | X2X | |
| | 2 | X2X _L | |
| | 3 | X2X _I | |
| | 4 | SHLD | Shield |

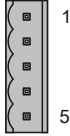
9.23.25.7 CAN bus node number



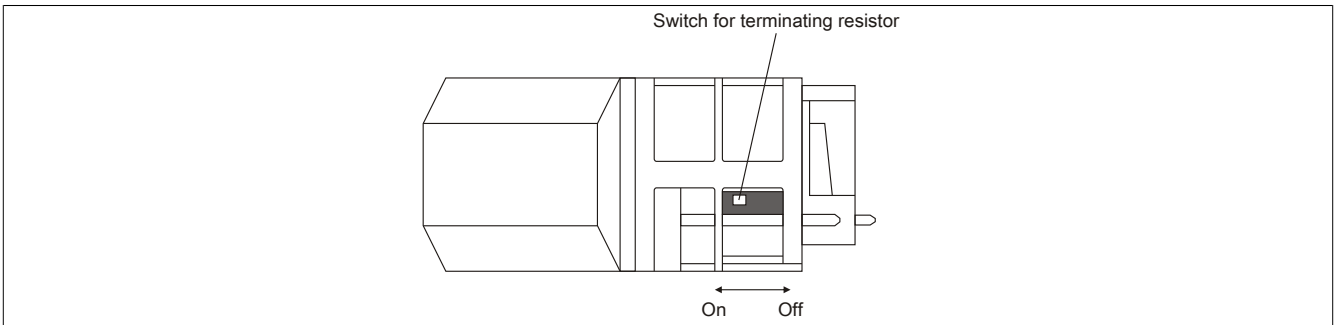
The node number for the CAN bus interface (IF2) is set with the two hex switches.

9.23.25.8 CAN bus interface

The interface is a 5-pin multipoint connector. Terminal block 0TB2105 must be ordered separately.

| Interface | | Pinout | | |
|--|---|----------|------------------|------------|
|  5-pin male multipoint connector | 1 | Terminal | Function | |
| | | 1 | CAN _L | CAN ground |
| | | 2 | CAN _L | CAN low |
| | | 3 | SHLD | Shield |
| | | 4 | CAN _H | CAN high |
| | | 5 | NC | |

9.23.25.9 Terminating resistor



The interface module has an integrated terminating resistor for the CAN bus interface. It can be turned on and off with a switch on the bottom of the housing. An active terminating resistor is indicated by the "TERM" LED.

9.23.25.10 Firmware

The module comes with preinstalled firmware. The firmware is part of Automation Studio. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

9.24 Hub system

The X20HB8880 hub is a device that can be used universally in standard Ethernet networks or POWERLINK networks. It is suitable for 100 Mbit/s (Fast Ethernet) networks. Due to its modular structure, the hub can be configured as 2/4/6x Fast Ethernet hub as needed.

The X20BC8083 bus controller makes it possible to connect X2X Link I/O nodes to POWERLINK. The bus modules expanded to the left allow connection of up to 2 hub expansion modules in addition to the bus controller. This means that a 2/4/6x Fast Ethernet hub is also available on the bus controller depending on the degree of expansion.

9.24.1 Summary

| Model number | Short description | Page |
|--------------|--|------|
| X20ET8819 | X20 Ethernet analysis tool, can be expanded with active hub modules, 2x RJ45 | 2468 |
| X20HB8815 | X20 POWERLINK - TCP/IP gateway, can be expanded with active hub modules, 2x RJ45 | 2480 |
| X20HB8880 | X20 base hub module, integrated 2-port hub, 2x RJ45 | 2490 |
| X20cHB8815 | X20 POWERLINK - TCP/IP gateway, coated, can be expanded with active hub modules, 2x RJ45 | 2480 |
| X20cHB8880 | X20 base hub module, coated, integrated 2-port hub, 2x RJ45 | 2490 |

9.24.2 X20ET8819

Data sheet version: 1.07

9.24.2.1 General information

Analyzing POWERLINK

POWERLINK has proven itself in the field for years and rarely has problems during commissioning and production. Nonetheless, it is still possible for communication disturbances to occur due to damaged or poor quality cables. If an error occurs, localizing and correcting it is usually very easy thanks to the heterogeneous structure of this flat network type (all data is always visible throughout the network). What's problematic are errors that occur sporadically. This is where tools such as Omnippeek or Wireshark come in.

These tools (or more likely the standard PC technology being used) reach their limits, however, when dealing with machines that have short network cycles. Either not all frames can be recorded, or some telegrams are lost altogether. In these cases, what's needed is a special hardware tool that can work very quickly, record and save every bit of traffic and then pass it on to a laptop.

Ethernet analysis tool X20ET8819

This module provides different operating modes. For example, it can work passively on the network, in which case the real-time behavior remains unchanged. The device listens in and selectively takes in data when certain defined trigger conditions are met. It can read all of the data, mark it with a timestamp, store it temporarily and ultimately pass it on to a PC. The data is then analyzed in the familiar PC environment.

- NetTime time stamp has a resolution of 20 ns
- Recording and analysis of CRC and frame errors
- Triggers can also be activated using external digital signals
- Analysis of both half-duplex and full-duplex networks
- Able to record two networks simultaneously

9.24.2.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | X20 hub system |  |
| X20ET8819 | X20 Ethernet analysis tool, can be expanded with active hub modules, 2x RJ45 | |
| | Required accessories | |
| | System modules for bus controllers | |
| X20BB80 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20PS9400 | X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply | |
| | System modules for expandable bus controllers | |
| X20BB81 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with one expansion slot for an X20 add-on module (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB82 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with 2 expansion slots for 2 X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | Optional accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Digital inputs | |
| X20DI9371 | X20 digital input module, 12 inputs, 24 VDC, sink, configurable input filter, 1-wire connections | |
| | Digital outputs | |
| X20DO9322 | X20 digital output module, 12 outputs, 24 VDC, 0.5 A, source, 1-wire connections | |
| | System modules for the X20 hub system | |
| X20HB2880 | X20 hub expansion module, integrated 2-port hub, 2x RJ45 | |
| X20HB2881 | X20 hub expansion module, integrated 2-port hub, for fiber optic cable | |

Table 474: X20ET8819 - Order data


9.24.2.3 Technical data

| | |
|--|--|
| Model number | X20ET8819 |
| Short description | |
| Ethernet analysis tool | Ethernet analysis tool with up to 2 slots for hub expansion modules |
| General information | |
| Status indicators | Module status, bus function |
| Diagnostics | |
| Module status | Yes, using status LED and software |
| Bus function | Yes, using status LED and software |
| Power consumption | 2 W |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 |
| HazLoc | Industrial control equipment cCSAus 244665 |
| ATEX | Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| Interfaces | |
| Type | Ethernet analysis tool |
| Variant | 2x shielded RJ45 |
| Line length | Max. 100 m between 2 stations (segment length) |
| Transfer rate | 100 Mbit/s |
| Transfer | |
| Physical layer | 100BASE-TX |
| Half-duplex | Yes |
| Full-duplex | Yes |
| Autonegotiation | Yes |
| Auto-MDI/MDIX | Yes |
| Electrical properties | |
| Electrical isolation | POWERLINK (IF1, IF2) isolated from power supply |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20PS9400 power supply module separately Order 1x X20BB8x bus base separately |
| Spacing ¹⁾ | |
| X20BB80 | 37.5 ^{+0.2} mm |
| X20BB81 | 62.5 ^{+0.2} mm |
| X20BB82 | 87.5 ^{+0.2} mm |

Table 475: X20ET8819 - Technical data

- 1) Spacing is based on the width of the X20BB80 bus base. Up to two X20HB2880 or X20HB2881 hub expansion modules and one X20PS9400 power supply module are also always required for the Ethernet analysis tool.

9.24.2.4 LED status indicators

| Figure | LED | Color | Status | Description |
|---|-------------------|-----------|----------|---|
|  | S/E ¹⁾ | Green/red | | Status/Error LED. The statuses of this LED are described in section "S/E LED" on page 2470. |
| | L/A IF1 | Green | On | A link to the remote station has been established. |
| | | | Blinking | A link to the remote station has been established. Indicates Ethernet activity is taking place on the bus |
| | L/A IF2 | Green | On | A link to the remote station has been established. |
| | | | Blinking | A link to the remote station has been established. Indicates Ethernet activity is taking place on the bus |

1) The Status/Error LED is a green/red dual LED.

9.24.2.5 S/E LED

The Status/Error LED is a green and red dual LED.

| Red - Error | Description |
|-------------|--|
| On | This error can occur only in Analysis mode. If packets are lost when in Analysis mode, the red Status LED lights up. Remedy: Use the "MODE" switch to reduce the number of bytes in the received packets (see "Analysis mode" on page 2476). As soon as no packets are lost for longer than 1 s, it switches back to green. |

Table 476: Status/error LED is red: LED indicates error

| Green - Status | Description |
|----------------------------------|--|
| Off | The Ethernet analysis tool is either booting or not receiving power. |
| Green flickering (approx. 10 Hz) | The analysis tool is in Service mode: Analysis tool disabled, go to website to update firmware (see "Firmware update" on page 2475) |
| Single flash (approx. 1 Hz) | The external trigger is active. No data is currently being recorded. No data has been recorded since turned on. |
| Double flash (approx. 1 Hz) | The external trigger is active. No data is currently being recorded. However, the analysis tool has recorded data at least once. This means that the trigger has been triggered at least once. |
| On | The analysis tool is active, and is recording all received packets. |

Table 477: Status/error LED is green: LED indicates operation

System failure error codes

Incorrect node number or defective hardware can cause a system failure error. The error code is indicated by the red error LED using four switch-on phases. The switch-on phases have a duration of either 150 ms or 600 ms. Error code output is repeated cyclically after 2 seconds.

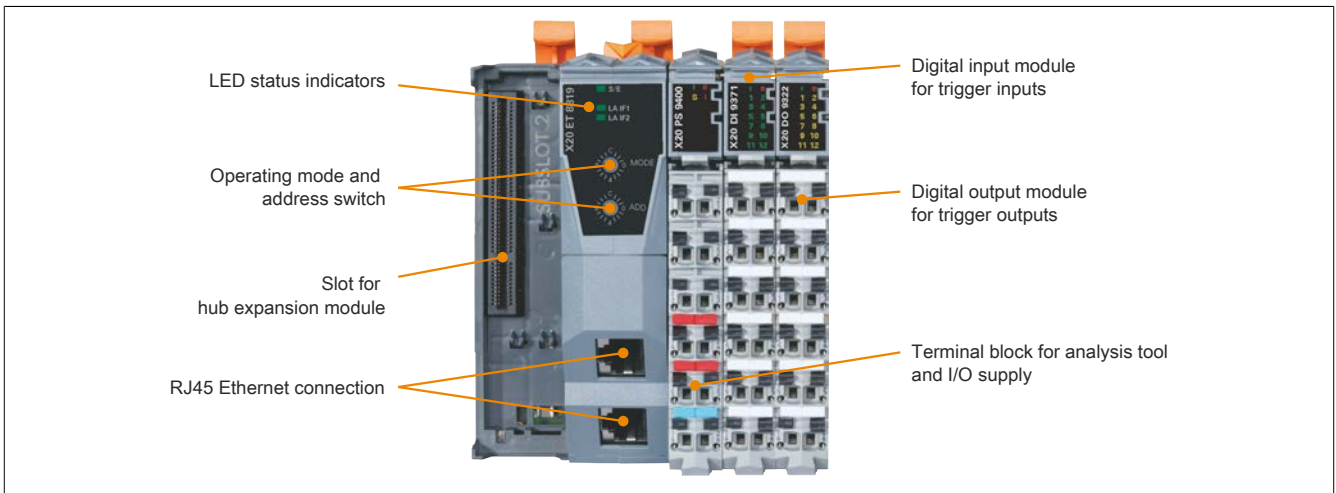
Key:

- ... 150 ms
- ... 600 ms
- Pause ... 2 sec. delay

| Error description | Error code indicated by red status LED | | | | | | | | | |
|---|--|---|---|---|-------|---|---|---|---|-------|
| RAM error: The module is defective and must be replaced. | • | • | • | – | Pause | • | • | • | – | Pause |
| Wrong node number | • | – | – | – | Pause | • | – | – | – | Pause |
| Hardware errors: The module or a system component is defective and must be replaced. | – | • | • | – | Pause | – | • | • | – | Pause |

Table 478: Status/Error LED as Error LED - System failure error codes

9.24.2.6 Operating and connection elements



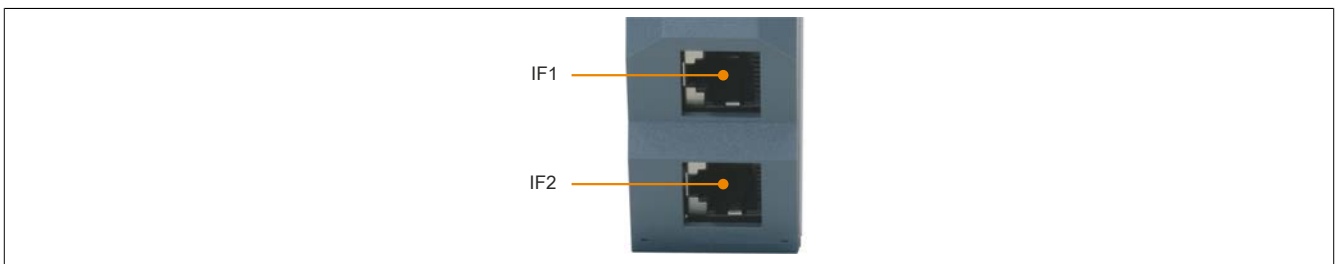
9.24.2.7 Operating mode and address switch

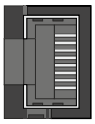


| switches | Description |
|----------|---|
| MODE | Specifies the mode in which the analysis tool is run (see "Analysis mode" on page 2476) |
| ADD | The following addresses are derived from the position of the ADD switch: <ul style="list-style-type: none"> • Own IP address (192.168.0.ADD) • Analysis mode: Destination MAC (01:00:5 e: 00:00: ADD) • Analysis mode: MulticastIP 239.0.0.ADD Note: Position 0 is not permitted |

9.24.2.8 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see "Cabling guidelines for X20 modules with an Ethernet cable" on page 58.



| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.24.2.9 Hardware configuration 1

If the Ethernet analysis tool is run without additional hub expansion modules, then recording is only possible on port T0. The analysis tool must be connected to an available hub port in the system.

Information:

An X20HB288x module is not permitted in this hardware configuration.

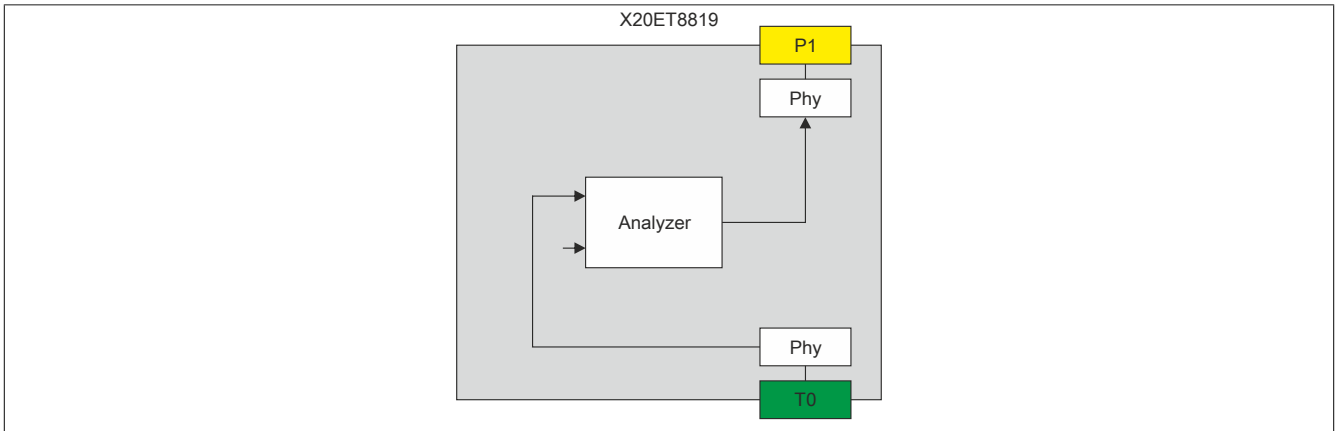


Figure 162: Diagram of hardware configuration 1

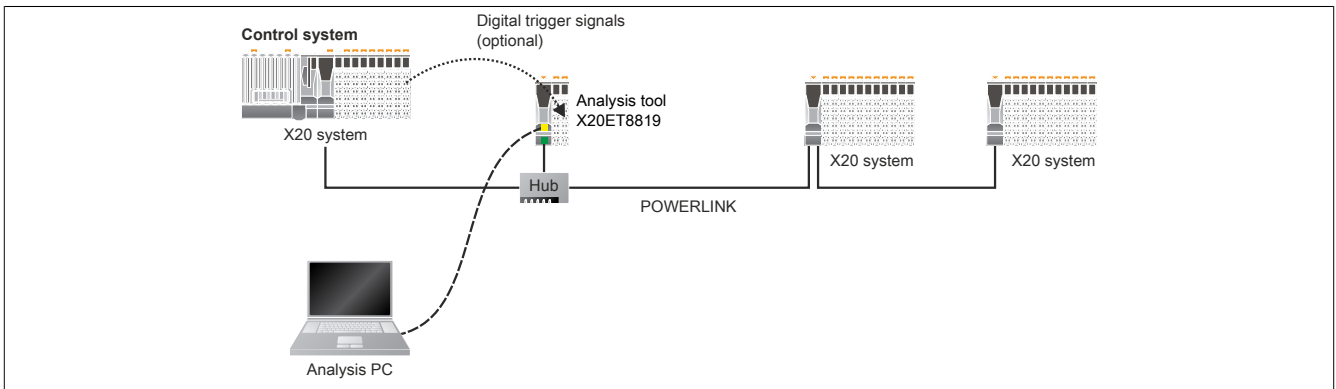


Figure 163: Example application of hardware configuration 1

9.24.2.10 Hardware configuration 2

Extending the Ethernet analysis tool with an X20HB2880 or X20HB2881 allows even full-duplex lines to be recorded as well. In this case ports T1 and T2 are analyzed.

Information:

Only the required X20HB288x module is permitted in this hardware configuration. A second X20HB288x module would produce different behavior (see Hardware configuration 3).

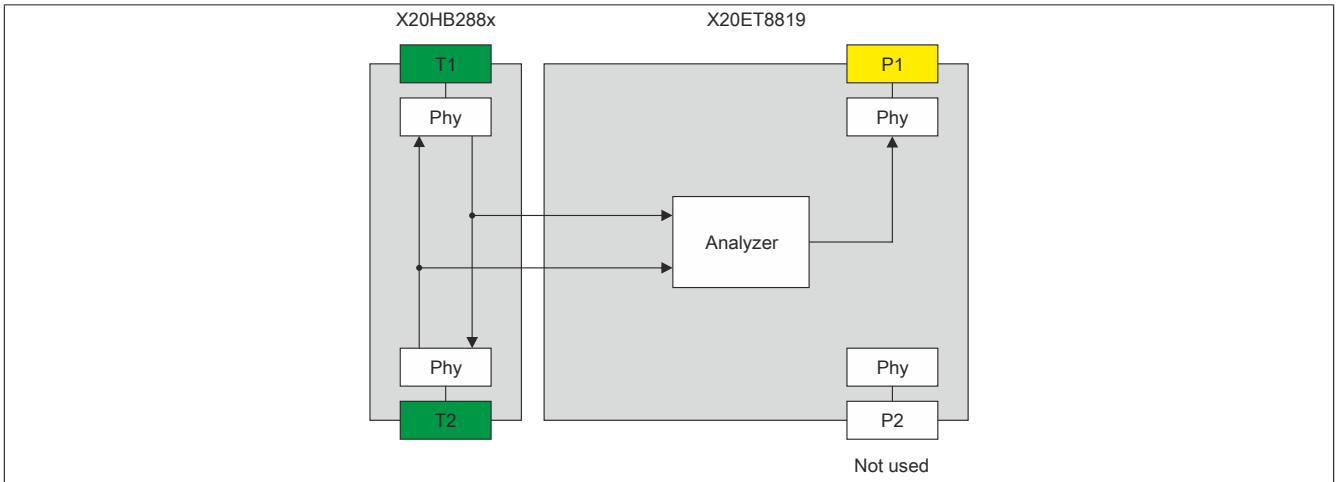


Figure 164: Diagram of hardware configuration 2

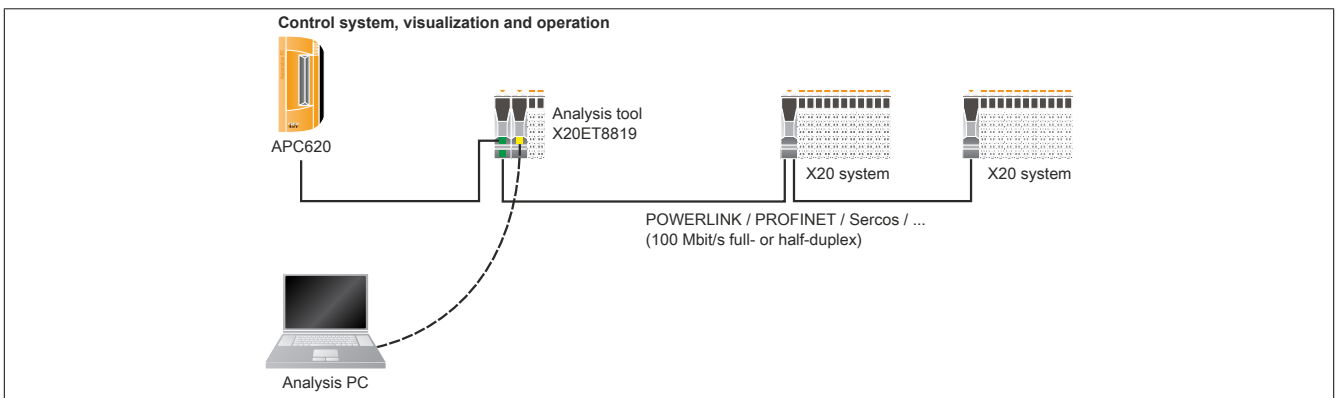


Figure 165: Example application of hardware configuration 2

9.24.2.11 Hardware configuration 3a

Simultaneous data recording at two locations in the network is possible by using two X20HB2880 or X20HB2881. **Only** data from T1 and T3 is analyzed.

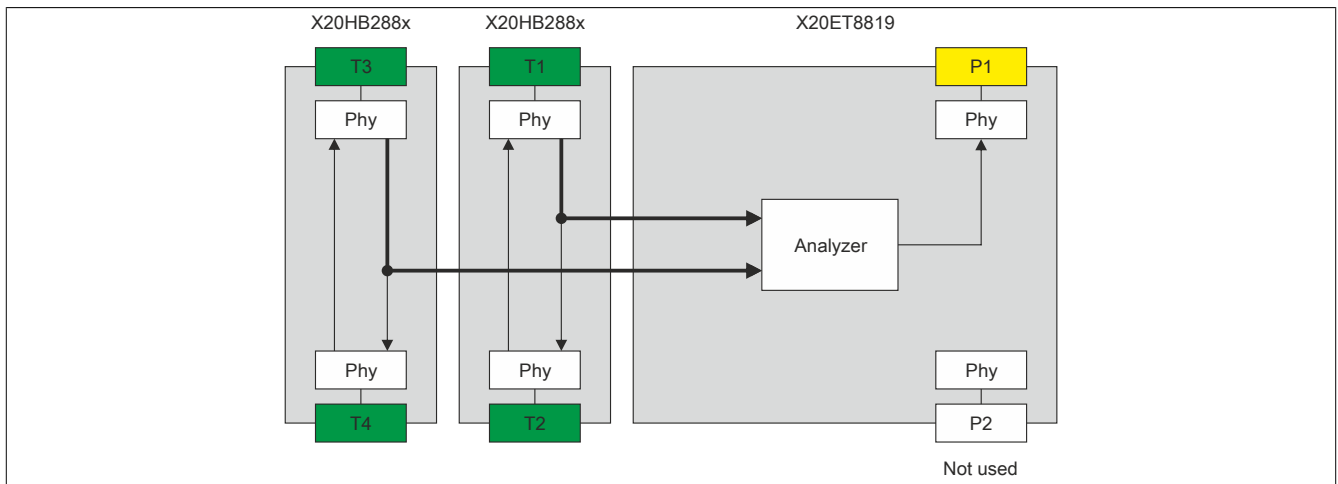


Figure 166: Diagram of hardware configuration 3a

Example application 1 shows data being recorded simultaneously from two hubs.

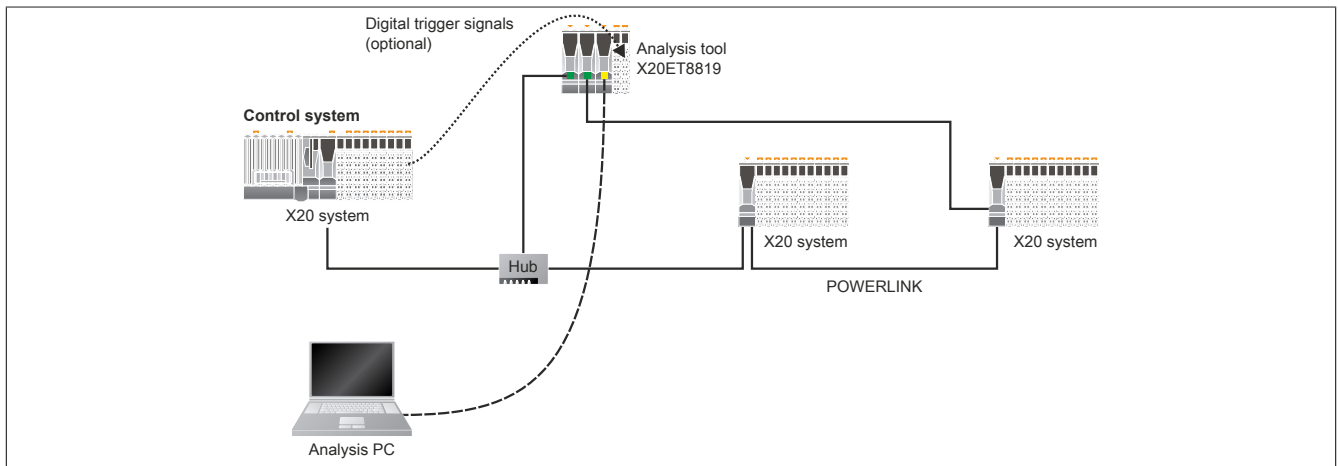


Figure 167: Example application 1 of hardware configuration 3, connection via hubs

The two hub expansion modules can also be inserted in series in the network. It should be noted that in this case data recording is only possible in one direction at a time.

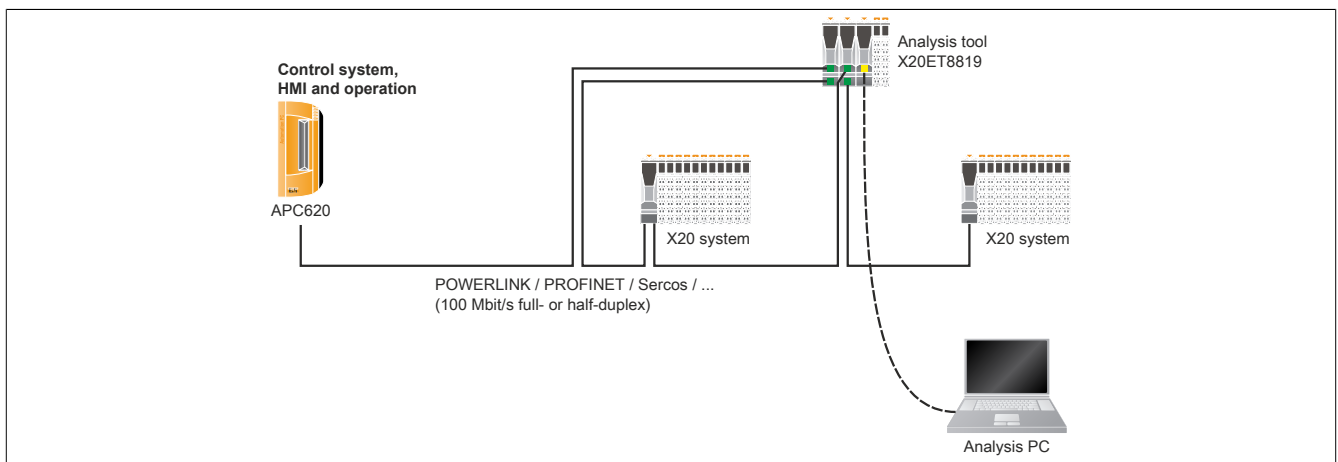


Figure 168: Example application 2 of hardware configuration 3, connection in line

9.24.2.12 Hardware configuration 3b

With firmware V 1.03 and higher, data traffic in half-duplex networks (e.g. POWERLINK) is recorded in both directions.

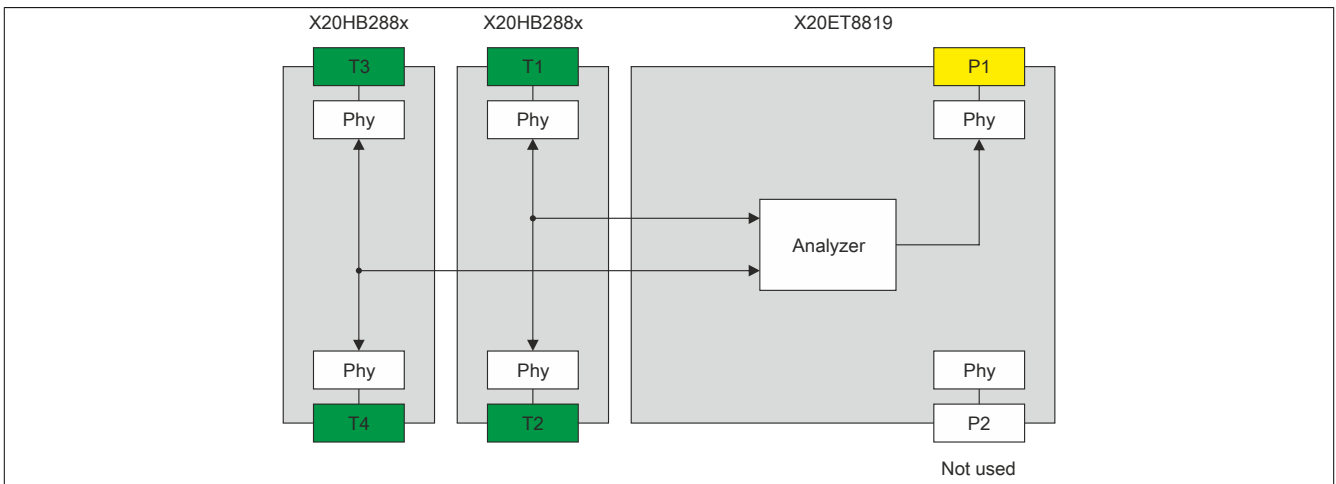


Figure 169: Diagram of hardware configuration 3b

9.24.2.13 Firmware update

To update the firmware, the webpage of the X20ET8819 module must be opened when in service mode. To do this, set the MODE switch to 0 and ADD to a value between 0x1 and 0xF. When the hardware is restarted now, the module will enter service mode. A connection can be established to the webpage using a web browser via the interface IF1 (P1) and the IP address 192.168.0.ADD. The update is started by selecting "Firmware Download".

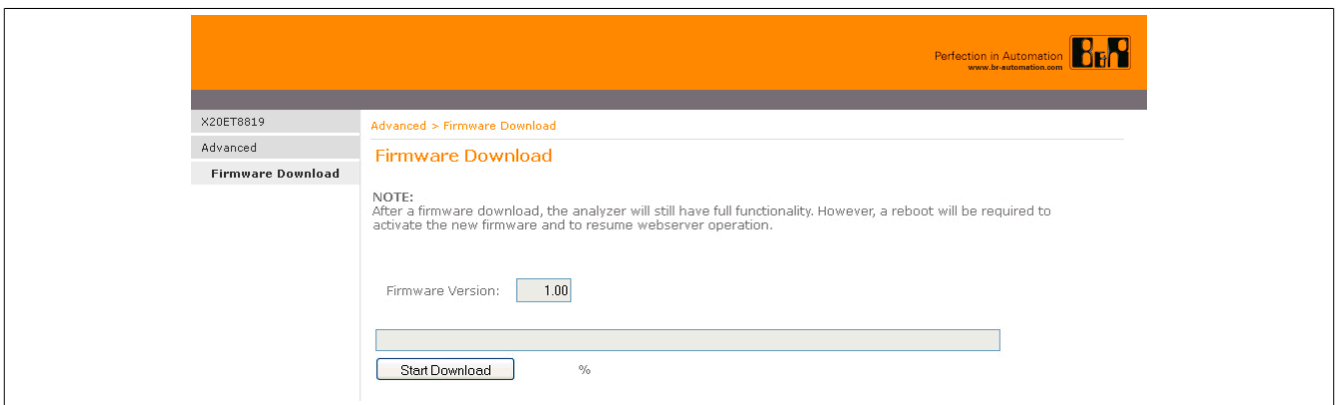


Figure 170: Start firmware update

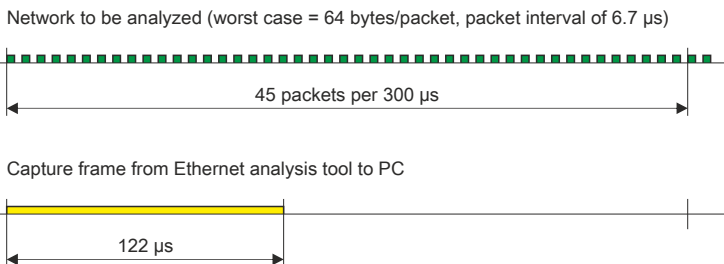
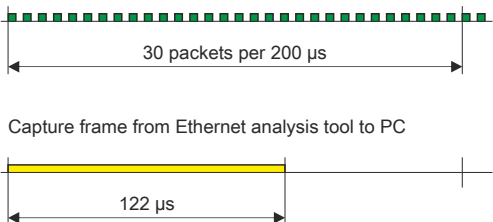
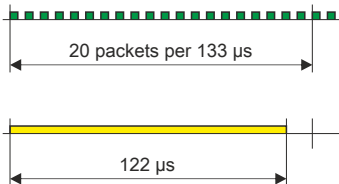
9.24.2.13.1 Firmware history

| Version | Comment |
|---------|---|
| 1.05 | Continuous product improvement for analysis mode A with frame lengths >1016 bytes. |
| 1.04 | <ul style="list-style-type: none"> New analysis mode: In this mode, every package is recorded in its original size. If two X20HB288x modules are used, data traffic on half-duplex networks can be recorded in both directions. |
| 1.02 | Support for trigger outputs: The X20DO9322 can now be used as the second I/O module. |
| 1.00 | First version |

9.24.2.14 Analysis mode

Each time an incoming packet is analyzed, (see hardware configurations 1 to 3), the analysis tool saves the reception timestamp, various flags and the first 'n' bytes of data from the received packet in capture frames. These frames are sent via IF 1 (P1).

The number of recorded data bytes, 'n', is set with the operating mode switch MODE. This defines the number of packets that are sent for each capture frame.

| MODE | n | p/s | Description |
|-------|------------|--------|---|
| 0 | - | - | Service mode |
| 1 | 24 | 148800 | <p>45 packets fit in a capture frame: $(1514-64) / (24+8) = 45$ packets</p>  |
| 2 | 40 | 148800 |  |
| 3 | 64 | 148800 | <p>This is the first setting at which complete packets fit in the capture frame (minimum packet with 60 byte payload). 20 packets can fit in one capture frame, however this setting could cause problems on the analysis PC because there is not much idle time between the capture frames.</p>  |
| 4 | 80 | 128000 | |
| 5 | 120 | 88000 | |
| 6 | 196 | 56000 | |
| 7 | 280 | 40000 | |
| 8 | 716 | 16000 | <p>2 packets fit in a capture frame: $(716+8)*2 + 64 = 1512$ bytes A setting 'n' > 716 has the disadvantage that a network with full capacity would not be able to be analyzed.</p> |
| 9 | 24 to 1440 | - | The analysis tool selects the largest possible value for 'n' itself due to the packet volume of the last capture frame that was sent. This means that each capture frame can be assigned a different 'n' value. 'n' is always a multiple of 4 and can assume values between 24 and 1440. |
| A | - | - | Up to a size of 1440 bytes every packet is recorded in its original size. |
| B - F | - | - | Reserved |

Note:

- A change in the position of the MODE switch from 1 to A will be applied online during operation.
- If the "S/E" LED is red, then the number of bytes to be recorded should be reduced.

9.24.2.15 Using trigger inputs

The Ethernet analysis tool launches the first connected I/O module in the standard function model. The X2X link is configured with a fixed cycle of 1 ms. If this configuration contains digital input data (digital input module X20DI9371), the first 4 digital inputs will be included in the packet header.

9.24.2.15.1 Background

When looking for very complicated errors, it is usually not possible to find a trigger condition on the network. It is often difficult to discern whether the cause of the problem is even associated with the Ethernet communication or somewhere else. The fact that such errors are extremely rare makes finding them that much harder.

A permanent record of network frames through the module X20ET8819 would exceed storage capabilities of the recording software due to the large amount of data. The trigger inputs on the X20ET8819 offer an additional way to circumvent this problem. Analysis of the network can be started or stopped when a specific event occurs.

In most cases, the problem can be indicated using a digital signal. The CPU can detect errors or irregularities (e.g. failure of a network slave), for example, and then set a digital output on the local I/O bus. If this signal is connected to a digital input on the Ethernet analysis tool, then the module is able to evaluate this information and trigger a response such as pausing an active recording.

9.24.2.15.2 Evaluation of the inputs on the analysis tool X20ET8819

Input 1 - 4

The first 4 inputs will be inserted only in the packet header by the X20ET8819. The recording software from B&R (OmniPeek full version and plugin) can determine how the signals are interpreted.

Input 5 - 7

If the recording software is unable to evaluate the first 4 inputs (Wireshark, OmniPeek, various other capture tools), then inputs 5 - 7 are used to control the Ethernet analysis tool X20ET8819 directly.

| Input | Name | Description |
|--------|----------------|--|
| 5 | ExternActivate | Recording will not start automatically if this input is set to HIGH when the analysis tool is turned on. The module waits for a positive edge on input 6. |
| 6 | ExternStart | Recording begins when a positive edge occurs on this input. The value in 'captureId', offset 49 in the capture frame header is incremented to indicate to the receiving tool that a new recording has been started. When recording using the recording software from B&R, this information can be used to switch to a new ring buffer and to store the last one. |
| 7 | ExternStop | Recording stops when a negative edge occurs on this input. |
| 8 - 12 | - | Reserved |

Table 479: Evaluation of inputs 5 - 7 on the analysis tool

Example 1

A drive is started one time each minute. After 10 to 30 hours, a problem arises on a network station shortly after starting the drive. To analyze the error, the Ethernet communication is recorded between when the start command is issued and when the error occurs.

Problems:

Due to the large amount of data it is not possible to record the entire 30 hours. Someone would have to stay on the analysis PC the whole time to stop recording when the error occurs.

Solution:

| Input | Description |
|--------------------------|---|
| ExternActivate | Input permanently wired to 24 VDC = Activates the external trigger function |
| ExternStart / ExternStop | Connect both inputs to the same digital output that the master uses to notify the X20ET8819 when to start and stop recording. The master can, for example, always set the output before the drive start command and reset it as soon as the startup has been completed. When the master detects an error, it only has stop setting the output. This would mean that after 30 hours the recording is certain to contain the time period in which the error occurred and as well as a few prior recordings of proper startups for comparison. |

Table 480: Function of the inputs in Example 1

Example 2

A system containing multiple X20 I/O systems on the POWERLINK network is experiencing sporadic failures. An I/O slave suddenly fails for no apparent reason after running properly for a long time. To analyze whether the failure is network related, the time before the failure must be recorded.

Problems:

The master has no indication as to when and why the problem occurs. That means there is no start condition for the recording. Someone would have to stay on the analysis PC the whole time to stop recording when the error occurs.

Solution:

| Input | Description |
|----------------|--|
| ExternActivate | Input permanently wired to 24 VDC = Activates the external trigger function |
| ExternStart | Input permanently wired to 24 VDC = Ensures that the recording starts immediately when the X20ET8819 is turned on |
| ExternStop | Connect input to a digital output on the affected I/O slave, which is permanently set to 1 by the program. As soon as the slave fails the first time and resets the digital outputs, recording is stopped by the negative edge on ExternStop and is not started again. |

Table 481: Function of the inputs in Example 2

9.24.2.16 Using trigger outputs

| Output | Name | Description |
|--------|------------|--|
| 1 | FrameError | As soon as a frame error (CRC, Oversize, Preamble, Noise or Alignment) occurs, this output is set for 10 ms. |
| 2 - 12 | - | Reserved |

Table 482: Using trigger outputs in the event of an error

9.24.2.17 B&R recording software

The recording plug-in (for WildPackets OmniPeek) to decode the capture frames is available for download in the Download section on the B&R homepage.

B&R provides the following free recording software for the module in the Downloads section of the B&R website:

- Ethernet Analyzer Plugin for Wildpackets OmniPeek
- B&R Network Analyzer (stand-alone solution)

9.24.3 X20(c)HB8815

Data sheet version: 1.44

9.24.3.1 General information

The POWERLINK TCP/IP gateway enables the exchange of all types of application data (HMI, diagnostics, parameter data, etc.) between a POWERLINK V2 network and a TCP/IP network. It functions like a layer 2 switch, with the exception that cyclic POWERLINK packets are not routed to the ETH port.

With respect to the functionality of layer 2 switches, it should be mentioned that the gateway uses the store-and-forward principle. Gateway functionality doesn't need to be configured separately.

When the gateway receives a frame, it saves the MAC address of the sender and the corresponding interface in the source address table (SAT). If the destination address is found in the SAT, the gateway routes the frame to the corresponding interface. Frames with a broadcast or multicast address are always routed to all interfaces.

When IP packets are received at the "ETH" port that are larger than the MTU configured for POWERLINK, they are fragmented, if permitted.

- "ETH" port: Interface for TCP/IP network
- "PLK" port: Interface for POWERLINK network

Information:

**I/O modules cannot be operated with the X20HB8815.
POWERLINK V1 is not supported.**

POWERLINK is a standard protocol for Fast Ethernet equipped with hard real-time characteristics. The POWERLINK Standardization Group (EPSG, see www.ethernet-powerlink.org) ensures its openness and continual development.

The bus modules expanded to the left allow connection of up to 2 hub expansion modules in addition to the gateway. This means that a basic device provides up to 2 POWERLINK ports.

- POWERLINK
- Up to 2 slots for hub expansion modules
- 3x / 5x POWERLINK hub

9.24.3.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.24.3.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.24.3.3 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | X20 hub system |  |
| X20HB8815 | X20 POWERLINK - TCP/IP gateway, can be expanded with active hub modules, 2x RJ45 | |
| X20cHB8815 | X20 POWERLINK - TCP/IP gateway, coated, can be expanded with active hub modules, 2x RJ45 | |
| | Required accessories | |
| | System modules for bus controllers | |
| X20BB80 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cBB80 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| | System modules for expandable bus controllers | |
| X20BB81 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with one expansion slot for an X20 add-on module (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB82 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with 2 expansion slots for 2 X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cBB81 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with one expansion slot for an X20 add-on module (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cBB82 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with two expansion slots for two X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| | System modules for the X20 hub system | |
| X20PS8002 | X20 power supply module for standalone hub and compact link selector | |
| X20cPS8002 | X20 power supply module, coated, for standalone hub and compact link selector | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | Optional accessories | |
| | System modules for the X20 hub system | |
| X20HB1881 | X20 hub expansion module, integrated 1-port hub, for multimode fiber optic cable | |
| X20HB1882 | X20 hub expansion module, integrated 1-port hub, for monomode fiber optic cables | |
| X20HB2880 | X20 hub expansion module, integrated 2-port hub, 2x RJ45 | |
| X20HB2881 | X20 hub expansion module, integrated 2-port hub, for fiber optic cable | |
| X20cHB1881 | X20 hub expansion module, coated, integrated 1-port hub, for fiber optic cable | |
| X20cHB2880 | X20 hub expansion module, coated, integrated 2-port hub, 2x RJ45 | |
| X20cHB2881 | X20 hub expansion module, coated, integrated 2-port hub, for fiber optic cable | |

Table 483: X20HB8815, X20cHB8815 - Order data

9.24.3.4 Technical data

| Model number | X20HB8815 | X20cHB8815 |
|----------------------------|--|------------|
| Short description | | |
| Gateway | POWERLINK controlled node with up to 2 slots for hub expansion modules | |
| General information | | |
| Status indicators | Module status, bus function | |
| Diagnostics | | |
| Module status | Yes, using status LED and software | |
| Bus function | Yes, using status LED and software | |
| Power consumption | 2 W | |

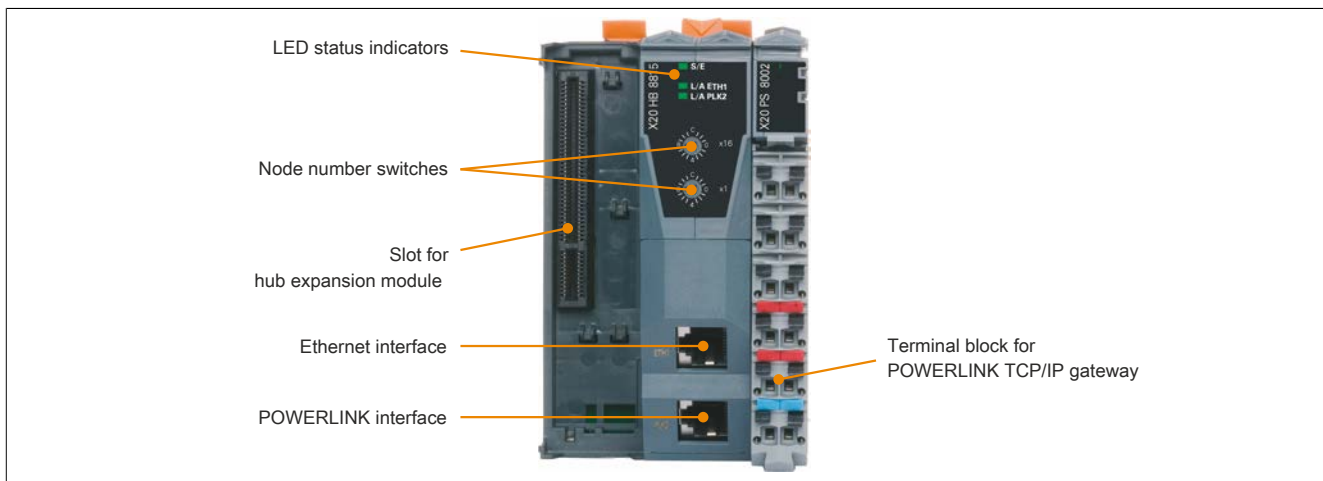
Table 484: X20HB8815, X20cHB8815 - Technical data

| Model number | X20HB8815 | X20cHB8815 |
|--|---|---|
| Certifications | | |
| CE | | Yes |
| ATEX | | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| UL | | cULus E115267 Industrial control equipment |
| HazLoc | | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| DNV GL | | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| KR | | Yes |
| EAC | | Yes |
| KC | Yes | - |
| Interfaces | | |
| Type | POWERLINK gateway | |
| Variant | 2x shielded RJ45 | |
| Cable length | Max. 100 m between 2 stations (segment length) | |
| Transfer rate | | |
| POWERLINK | 100 Mbit/s | |
| TCP/IP | 10/100 Mbit/s | |
| Transfer | | |
| POWERLINK | | |
| Physical layer | 100BASE-TX | |
| Half-duplex | Yes | |
| Full-duplex | No | |
| Autonegotiation | Yes | |
| Auto-MDI/MDIX | Yes | |
| TCP/IP | | |
| Physical layer | 10BASE-T/100BASE-TX | |
| Half-duplex | Yes | |
| Full-duplex | Yes | |
| Autonegotiation | Yes | |
| Auto-MDI/MDIX | Yes | |
| Hub propagation delay | 0.96 to 1 µs | |
| Electrical properties | | |
| Electrical isolation | Power supply isolated from Ethernet (ETH1) and POWERLINK (PLK2) | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Starting temperature | - | Yes, -40°C |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20PS8002 power supply module separately Order 1x X20BB8x bus base separately | Order 1x X20TB12 terminal block separately Order 1x X20cPS8002 power supply module separately Order 1x X20cBB8x bus base separately |
| Pitch ¹⁾ | | |
| X20BB80 | 37.5 ^{+0.2} mm | |
| X20BB81 | 62.5 ^{+0.2} mm | |
| X20BB82 | 87.5 ^{+0.2} mm | |


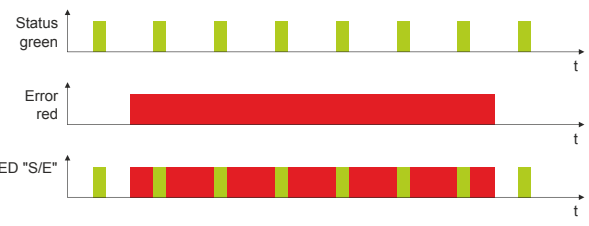
Table 484: X20HB8815, X20cHB8815 - Technical data

- 1) Spacing is based on the width of the X20BB80 bus base. Up to two X20HB2880 or X20HB2881 hub expansion modules and one X20PS8002 supply module are also always required for the gateway.

9.24.3.5 Operating and connection elements

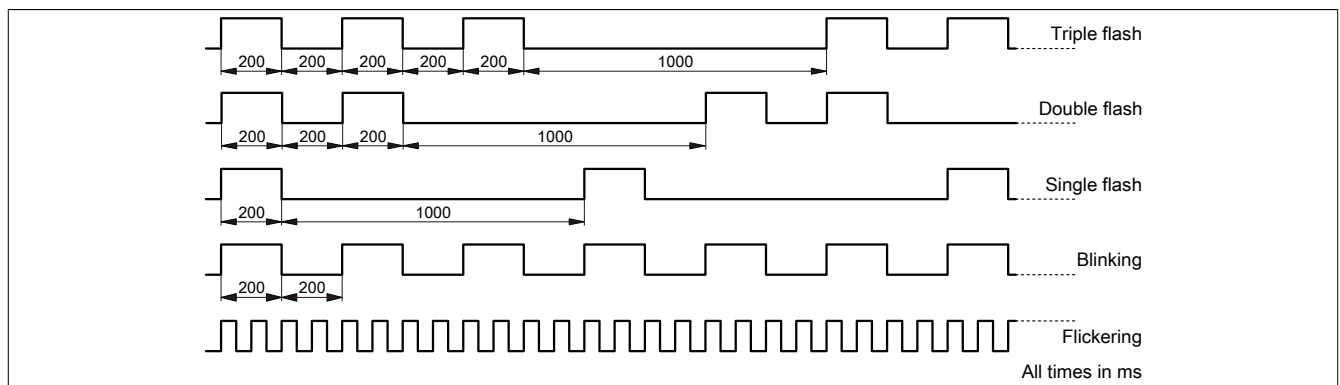


9.24.3.5.1 LED status indicators

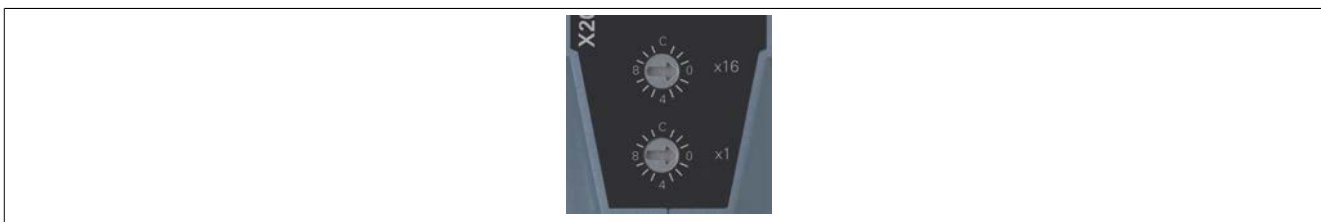
| Figure | LED | Color | Status | Description |
|---|-------------------|----------|--------------|---|
|  | S/E ¹⁾ | Green | Off | No power supply or mode NOT_ACTIVE. The controlled node (CN) is either not supplied with power, or it is in state NOT_ACTIVE. The CN waits in this state for about 5 seconds after a restart. Communication is not possible with the CN. If no POWERLINK communication is detected during these 5 seconds, the CN enters state BASIC_ETHERNET (flickering). If POWERLINK communication is detected before this time expires, however, the CN immediately enters state PRE_OPERATIONAL_1. |
| | | | Flickering | Mode BASIC_ETHERNET. The CN has not detected any POWERLINK communication. In this state, it is possible to communicate directly with the CN (e.g. with UDP, IP, etc.) If communication POWERLINK is detected in this state, the CN switches to PRE_OPERATIONAL_1. |
| | | | Single flash | PRE_OPERATIONAL_1 mode. The CN waits until it receives an SoC frame and then switches to the PRE_OPERATIONAL_2 state. |
| | | | Double flash | PRE_OPERATIONAL_2 mode. The CN is normally configured by the manager in this state. A command then switches the CN to the READY_TO_OPERATE state. |
| | | | Triple flash | READY_TO_OPERATE mode. The manager switches the CN via command to the OPERATIONAL state. |
| | | | On | Mode OPERATIONAL. The PDO mapping is active and cyclic data is evaluated. |
| | | | Blinking | Mode STOPPED. Output data is not being output, and no input data is being provided. It is only possible to switch to or leave this state after the manager has given the appropriate command. |
| | | | On | The controlled node (CN) is in an error state (failed Ethernet frames, increased number of collisions on the network, etc.). If an error occurs in the following states, then the green LED blinks over the red LED: |
| | | Red | On | <ul style="list-style-type: none"> PRE_OPERATIONAL_1 PRE_OPERATIONAL_2 READY_TO_OPERATE  <p>Note:</p> <ul style="list-style-type: none"> Several red blinking signals are displayed immediately after the device is switched on. This is not an error, however. The LED is lit red for CNs with configured physical node number 0 but that have not yet been assigned a node number via dynamic node allocation (DNA). |
| | | L/A ETH1 | Green | On |
| | | | Blinking | A link to the remote station has been established. Indicates Ethernet activity is taking place on the bus |
| | L/A PLK2 | Green | On | A link to the peer station has been established (POWERLINK network). |
| | | | Blinking | A link to the remote station has been established. Indicates Ethernet activity is taking place on the bus |

1) The Status/Error LED "S/E" is a green/red dual LED.

Status LED - Blinking patterns



9.24.3.5.2 POWERLINK node number switches

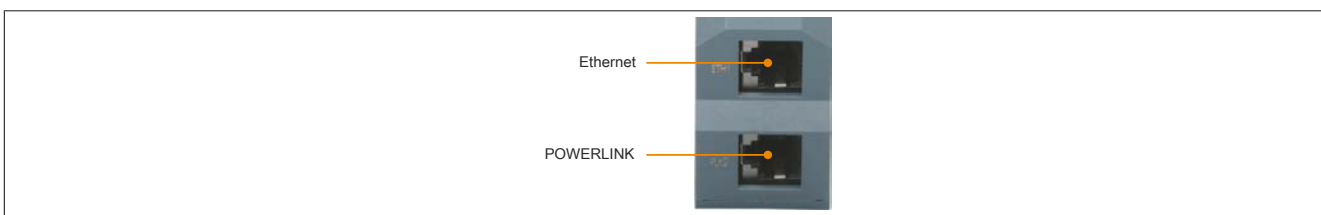


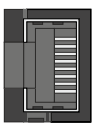
The node number for the POWERLINK node is set using the two number switches.

| Switch position | Description |
|-----------------|--|
| 0x00 | Only permitted when operating the POWERLINK node in DNA mode. |
| 0x01 - 0xEF | Node number of the POWERLINK node. Operation as a controlled node. |
| 0xF0 - 0xFF | Reserved, switch position not permitted. |

9.24.3.5.3 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see "[Cabling guidelines for X20 modules with an Ethernet cable](#)" on page 58.



| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

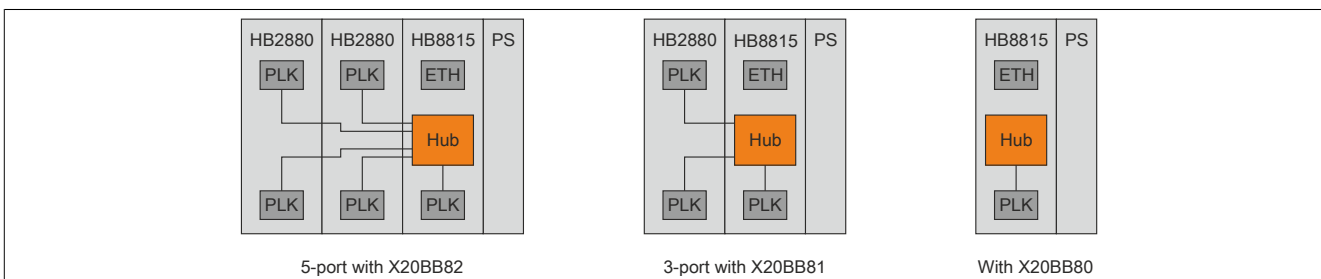
9.24.3.5.4 Slot for hub expansion modules

Depending on the bus base, up to 2 hub expansion modules can be installed on the left side of the module:

| Bus base | Slots for hub expansion modules |
|----------|---------------------------------|
| X20BB81 | 1 |
| X20BB82 | 2 |

Table 485: Slots for hub expansion modules for various bus bases

The hub expansion module for the gateway is a 2x hub, which allows the gateway to be expanded into a 5x POWERLINK hub.



9.24.3.6 Usage examples

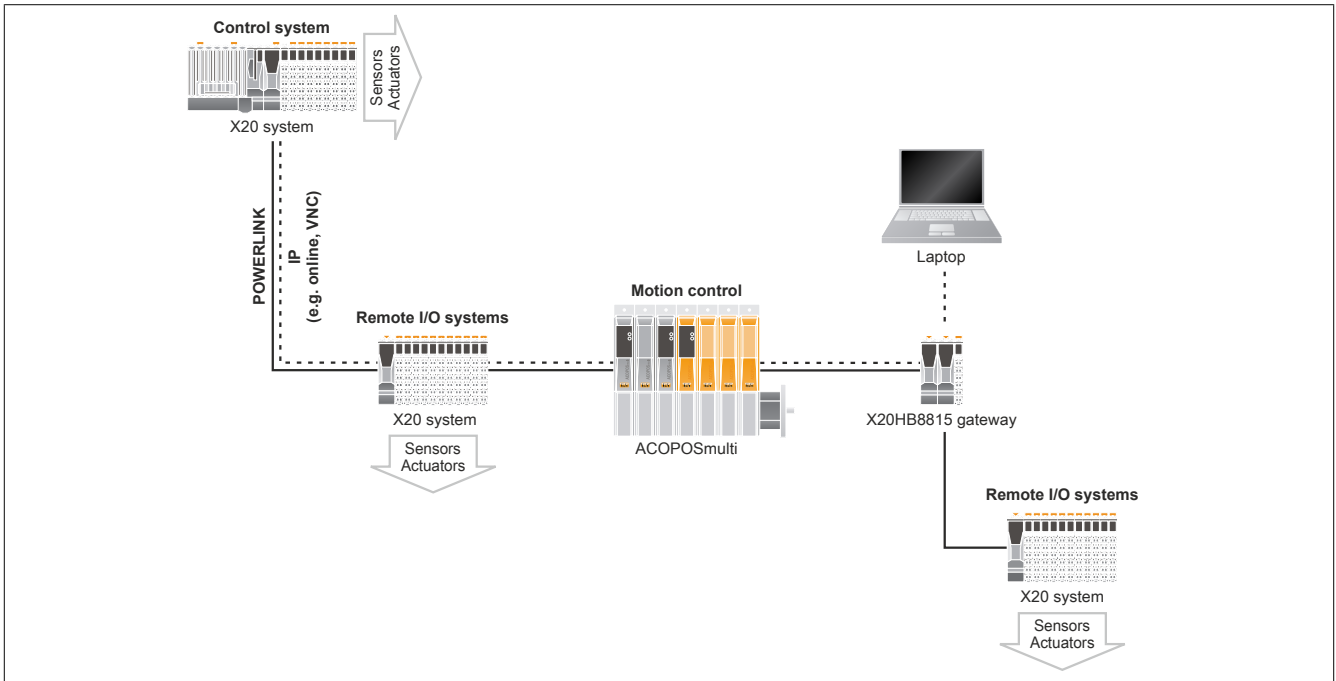
Information:

The X20HB8815 can also be operated as an async-only controlled node. Make sure that the node number is between 1 and 239 and that it is physically present and not yet being used in the POWERLINK network.

Information:

A direct connection via Ethernet (PC control system) is faster than a connection via the X20HB8815 since the available bandwidth must be shared with the POWERLINK protocol.

9.24.3.6.1 Example 1: Online connection with Automation Studio or SDM via POWERLINK



1. The following settings must be made on the POWERLINK manager interface.

- The desired IP address and subnet mask must be entered under the Ethernet parameters. This IP address is not permitted to overlap the POWERLINK default subnet address 192.168.100.x and the configured POWERLINK NAT subnet.
- INA communication must be enabled.

| | |
|--------------------------------|---------------------------|
| Ethernet parameters | |
| Activate Ethernet communic... | on |
| Device name | <InterfaceAddress>.ETH |
| Redundant parameter | Single CPU Project |
| Mode | enter IP address manually |
| Host name | |
| IP address | 10.0.8.10 |
| Subnet Mask | 255.255.255.0 |
| INA parameters | |
| Activate online communicati... | on |

If required, the web server and SDM must be enabled in Automation Studio.

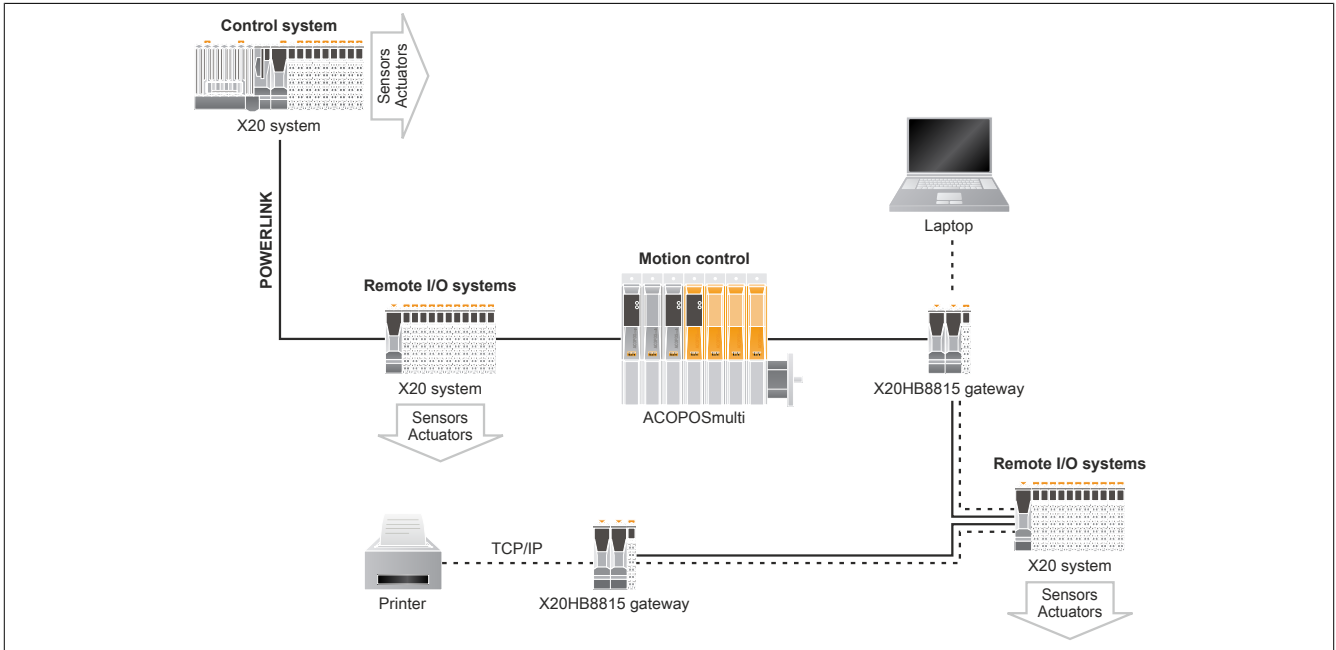
2. The following settings must be made on the PC:

- The IP address of the Ethernet interface must be located in the same subnet as the configured IP address (Ethernet parameters) of the POWERLINK interface. Otherwise, a route must be set manually.

Information:

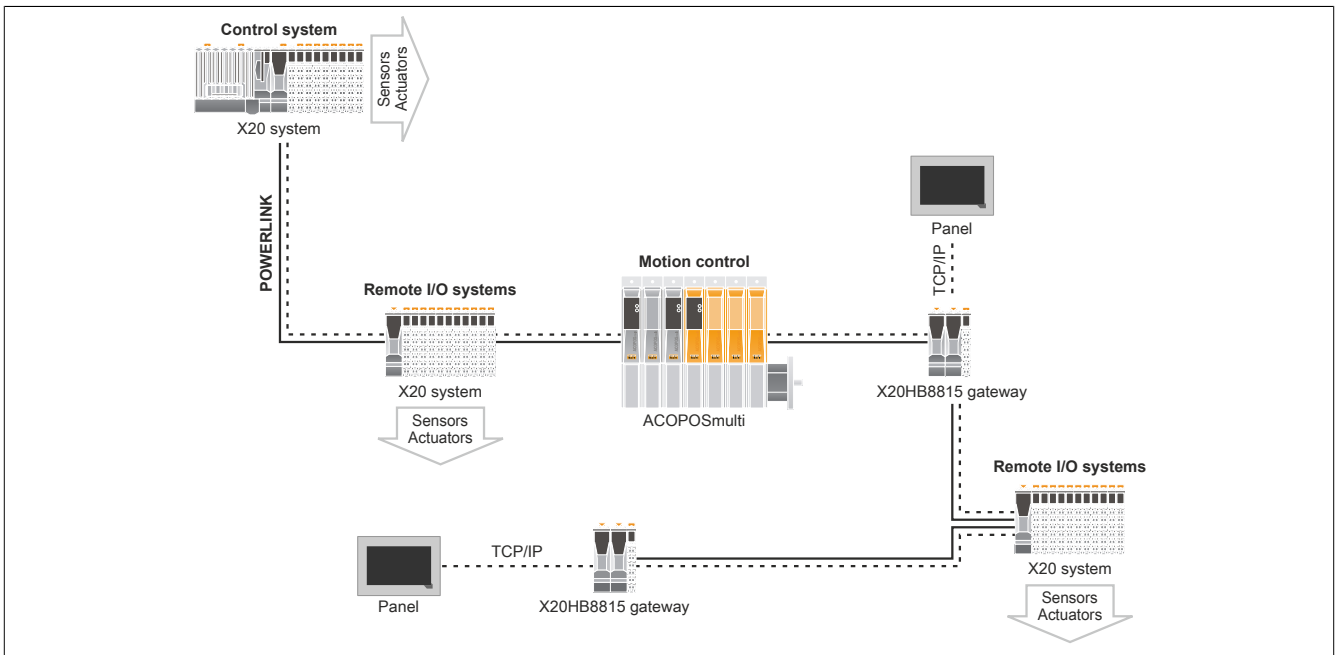
The search for destinations (SNMP) does not work via the X20HB8815.

9.24.3.6.2 Example 2: Using a POWERLINK network for TCP/IP services



With the 2 devices connected via the X20HB8815, it is important to make sure that they are in the same IP subnet and that corresponding routes are set.

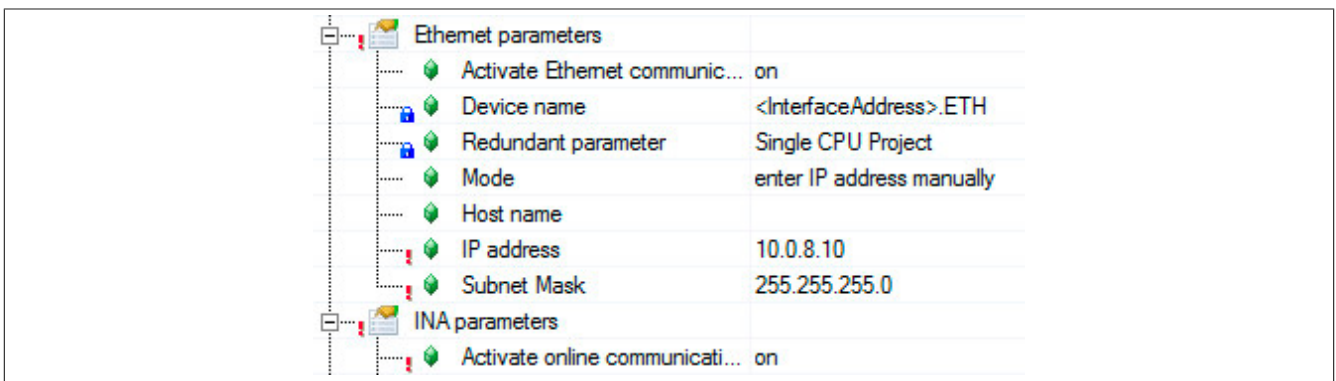
9.24.3.6.3 Example 3: Terminal panel via POWERLINK using X20HB8815



A terminal panel can be operated with POWERLINK using a X20HB8815 and VC3.95.6 or higher.

The following settings must be made on the POWERLINK manager interface.

- The desired IP address and subnet mask must be entered under the Ethernet parameters. This IP address is not permitted to overlap the POWERLINK default subnet address 192.168.100.x and the configured POWERLINK NAT subnet.
- INA communication must be enabled.



Information:

The terminal or T-Series panel must be attached to the ETH port in Automation Studio and have an IP configured that is located in the subnet of the POWERLINK Manager (under Ethernet parameters configured IP subnet).

T-Series Panel: Only works with this application over VNC. The configured IP address (Ethernet parameters) must be used as the terminal server IP address.

9.24.3.7 SG3

This module is not supported on SG3 target systems.

9.24.3.8 Firmware

The module comes with preinstalled firmware. The firmware is part of the Automation Studio project. The module is automatically brought up to this level.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

When using a 3rd-party device as a POWERLINK manager, the firmware update can be performed via the integrated Web server.

9.24.3.9 MTU size

Automatic MTU configuration is currently not supported. The MTU size is set to 300 (default value).

The MTU can be set manually under "Asynchronous Optimization" -> "Local ASnd MTU" in the I/O configuration of the module.

9.24.3.10 Asynchronous send priority

If needed, a higher asynchronous send priority can be assigned to the module. The setting for this is made in the I/O configuration of the module under "Asynchronous Optimization" -> "Asynchronous Send Priority".

Information:

If the priority is set too high, it is possible in some circumstances that other POWERLINK stations cannot send their asynchronous data on time.

9.24.4 X20(c)HB8880

Data sheet version: 2.41

9.24.4.1 General information

The X20 hub is a device that can be used universally in standard Ethernet networks or POWERLINK networks. It is suitable for 100 Mbit/s (Fast Ethernet) networks.

The bus modules expanded to the left allow connection of up to 2 hub expansion modules in addition to the hub base module. This means that a single base device provides up to 6 hub interfaces.

- 2x / 4x / 6x Fast Ethernet hub
- Modular construction
- Easily expandable

9.24.4.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.24.4.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.24.4.3 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | X20 hub system |  |
| X20HB8880 | X20 base hub module, integrated 2-port hub, 2x RJ45 | |
| X20cHB8880 | X20 base hub module, coated, integrated 2-port hub, 2x RJ45 | |
| | Required accessories | |
| | System modules for bus controllers | |
| X20BB80 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cBB80 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, X20 end plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| | System modules for expandable bus controllers | |
| X20BB81 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with one expansion slot for an X20 add-on module (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB82 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with 2 expansion slots for 2 X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cBB81 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with one expansion slot for an X20 add-on module (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cBB82 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with two expansion slots for two X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| | System modules for the X20 hub system | |
| X20PS8002 | X20 power supply module for standalone hub and compact link selector | |
| X20cPS8002 | X20 power supply module, coated, for standalone hub and compact link selector | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | Optional accessories | |
| | System modules for the X20 hub system | |
| X20HB1881 | X20 hub expansion module, integrated 1-port hub, for multimode fiber optic cable | |
| X20HB1882 | X20 hub expansion module, integrated 1-port hub, for monomode fiber optic cables | |
| X20HB2880 | X20 hub expansion module, integrated 2-port hub, 2x RJ45 | |
| X20HB2881 | X20 hub expansion module, integrated 2-port hub, for fiber optic cable | |
| X20cHB1881 | X20 hub expansion module, coated, integrated 1-port hub, for fiber optic cable | |
| X20cHB2880 | X20 hub expansion module, coated, integrated 2-port hub, 2x RJ45 | |
| X20cHB2881 | X20 hub expansion module, coated, integrated 2-port hub, for fiber optic cable | |

Table 486: X20HB8880, X20cHB8880 - Order data


9.24.4.4 Technical data

| Model number | X20HB8880 | X20cHB8880 |
|---|--|---|
| Short description | | |
| Hub | Modular X20 hub with up to 2 slots for hub expansion modules: | |
| General information | | |
| Status indicators | Module status, bus function | |
| Diagnostics | | |
| Module status | Yes, using status LED | |
| Bus function | Yes, using status LED | |
| Power consumption | 2 W | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Interfaces | | |
| Type | Hub base module | |
| Variant | 2x shielded RJ45 | |
| Cable length | Max. 100 m between 2 stations (segment length) | |
| Transfer rate | 100 Mbit/s | |
| Transfer | | |
| Physical layer | 100BASE-TX | |
| Half-duplex | Yes | |
| Full-duplex | No | |
| Autonegotiation | Yes | |
| Auto-MDI/MDIX | Yes | |
| Hub propagation delay | 0.96 to 1 µs | |
| Electrical properties | | |
| Electrical isolation | Power supply isolated from Ethernet (IF1 and IF2) | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20PS8002 power supply module separately Order 1x X20BB8x bus base separately | Order 1x X20TB12 terminal block separately Order 1x X20cPS8002 power supply module separately Order 1x X20cBB8x bus base separately |
| Pitch ¹⁾ | | |
| X20BB80 | 37.5 ^{+0.2} mm | |
| X20BB81 | 62.5 ^{+0.2} mm | 62.5 ^{+0.2} mm |
| X20BB82 | 87.5 ^{+0.2} mm | |

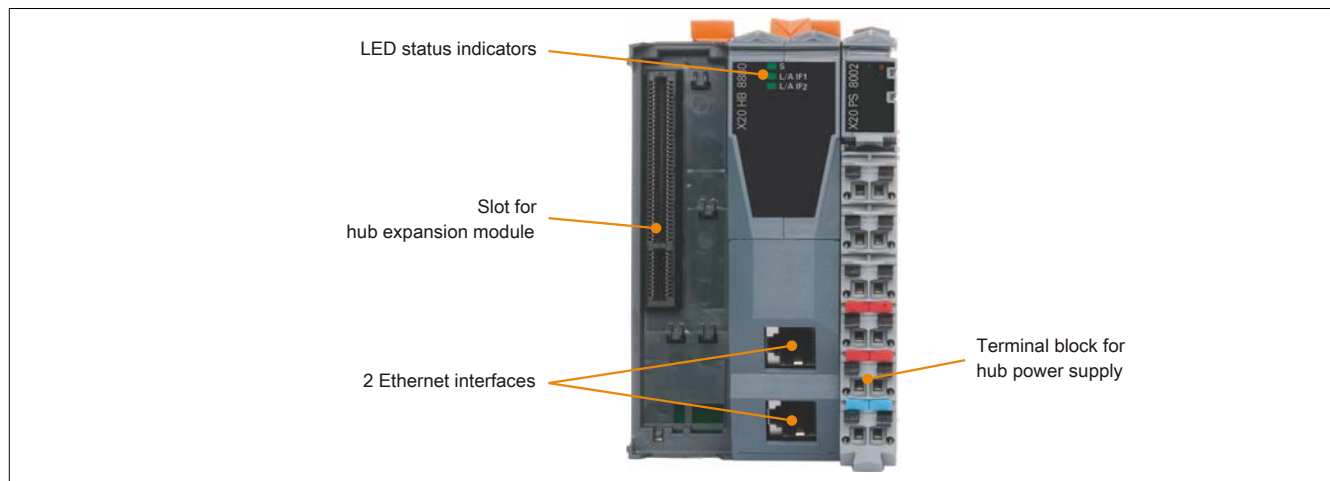
Table 487: X20HB8880, X20cHB8880 - Technical data

1) Spacing is based on the width of the X20BB80 bus base. Up to two X20HB2880 hub expansion modules and one X20PS8002 supply module are also always required for the hub.

9.24.4.5 LED status indicators

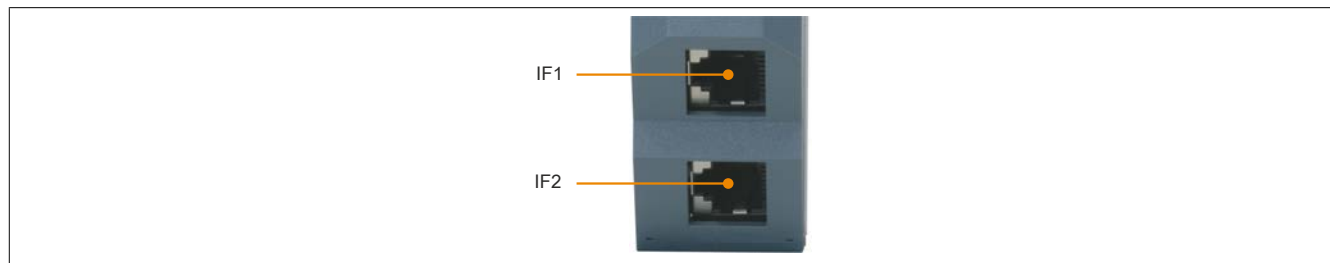
| Figure | LED | Color | Status | Description |
|---|---------|-------|----------|--|
|  | S | Green | On | Hub is active |
| | L/A IFx | Green | On | A link to the remote station has been established. |
| | | | Blinking | A link to the remote station has been established. Indicates Ethernet activity is taking place on the bus. |

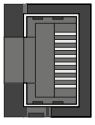
9.24.4.6 Operating and connection elements



9.24.4.7 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see "[Cabling guidelines for X20 modules with an Ethernet cable](#)" on page 58.



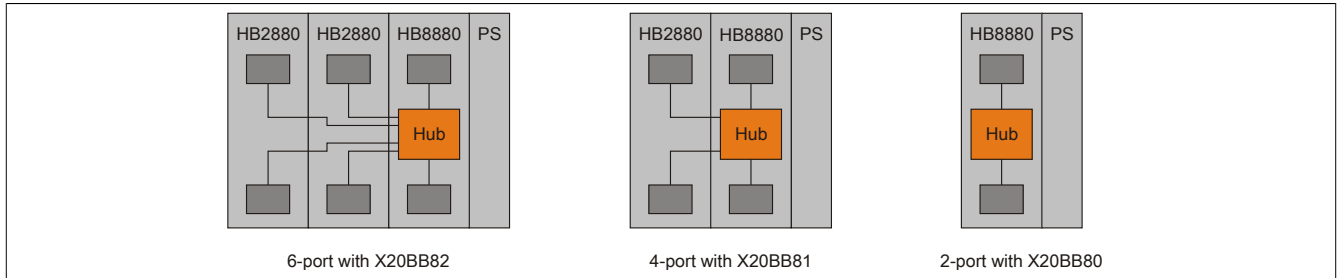
| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.24.4.8 Slot for hub expansion modules

Depending on the bus base, up to 2 hub expansion modules can be installed on the left side of the X20 hub:

| Bus base | Slots for hub expansion modules |
|----------|---------------------------------|
| X20BB81 | 1 |
| X20BB82 | 2 |

The hub expansion module is a 2x hub, which allows the hub base module to be expanded into a 6x hub.



9.24.4.9 Network size and collision detection

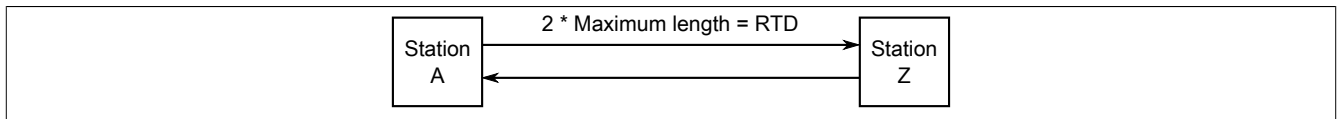
Information:

This section applies to the use of Ethernet networks, not POWERLINK networks.

According to Ethernet specification IEEE 802.3, the transmission duration of a frame of minimum length must always be greater than the round-trip delay time (RTD). RTD is the time needed by a data packet to travel from one end of the network to the other.

If this is not observed, collision detection can no longer be guaranteed.

Illustration of RTD



When using copper cables, the maximum distance is generally 100 m. Since there are often many different devices with different PHYs in a network, the propagation delay of the frames changes due to the different latency of each PHY. This also affects the network size, and collision detection can no longer be guaranteed at 100 m.

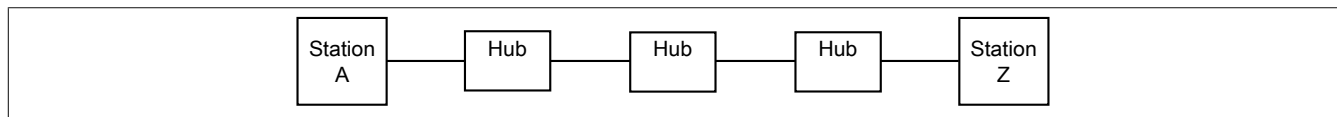
Example for calculating network size

The following parameters are specified for a network:

- Transfer rate: 100 Mbit/s
- Cable length: 100 m
- Number of hubs: 2
- Hub propagation delay of a frame: 1 μ s
- Minimum frame size in the Ethernet network: 72 bytes

Calculation procedure

| | |
|---|---|
| 1. How long does 1 byte take at 100 Mbit/s? – 100 Mbit/s / 8 = 12.5 MB/s | $\frac{12,500,000}{1} = \frac{1}{x}$ $x = \frac{1s}{12,500,000} = 80ns$ |
| 2. Propagation delay of minimum Ethernet frame – Minimum frame in Ethernet network: 72 bytes | $72 * 80ns = 5.76\mu s$ |
| 3. Propagation delay in cable and hub – 100 m cable = 0.5 μ s – 2 hubs = 2 x 1 μ s | $2\mu s + 0.5\mu s = 2.5\mu s$ |
| 4. Calculation of total propagation delay – Outbound/Inbound propagation delay | $2.5\mu s * 2 = 5\mu s$ |
| Result Collision detection is possible since the total time of 5 μ s is less than the minimum Ethernet propagation delay of 5.76 μ s. | |

Example for calculating the network reach with devices between 2 stations

Corresponding to the previous example, the following situation occurs in a network with 3 hubs and 100 m cables:

- The transmission duration of a frame of minimum length is 5.76 μ s.

Calculation procedure

| | |
|--|--------------------------------|
| 1. Propagation delay in cable and hub – 100 m cable = 0.5 μ s – 3 hubs = 3 x 1 μ s | $3\mu s + 0.5\mu s = 3.5\mu s$ |
| 2. Calculation of total propagation delay – Outbound/Inbound propagation delay | $3.5\mu s * 2 = 7\mu s$ |
| Result Collision detection is not possible since the total time of 7 μ s is greater than the minimum Ethernet propagation delay of 5.76 μ s. The ≈ 1.3 μ s missing for collision detection can only be recovered by removing a hub. | |

9.25 Motor controllers

The motor controllers offer extensive possibilities for controlling motors, valves or resistive loads and are particularly well suited for controlling brush DC motors. Each output is assigned a status LED.

9.25.1 Summary

| Model number | Short description | Page |
|--------------|---|------|
| X20MM2436 | X20 PWM motor module, 24 to 39 VDC $\pm 25\%$, 2 PWM motor bridges, 3 A continuous current, 3.5 A peak current, 4 digital inputs 24 VDC, sink, configurable as incremental encoder | 2496 |
| X20MM3332 | X20 digital motor module, 24 VDC, 3 digital outputs, full bridge (H bridge), 3 A continuous current, 5 A peak current | 2523 |
| X20MM4331 | X20 digital motor module, 24 VDC, 4 digital outputs, half bridge, 3 A continuous current, 5 A peak current | 2538 |
| X20MM4455 | X20 PWM motor module, 24 to 48 VDC $\pm 25\%$, 4 PWM motor bridges, 6 A continuous current, 10 A peak current, 4x 3 digital inputs 5 VDC single-ended, source, configurable as incremental encoder | 2551 |
| X20MM4456 | X20 PWM motor module, 24 to 48 VDC $\pm 25\%$, 4 PWM motor bridges, 6 A continuous current, 10 A peak current, 4x 4 digital inputs 24 VDC, sink, configurable as incremental encoder | 2577 |
| X20SM1426 | X20 stepper motor module, 1 motor connection, 1 A continuous current, 1.2 A peak current, 4 digital inputs 24 VDC, sink, configurable as incremental encoder, NetTime function | 2603 |
| X20SM1436 | X20 stepper motor module, module power supply 24 to 39 VDC $\pm 25\%$, 1 motor connection, 3 A continuous current, 3.5 A peak current, 4 digital inputs 24 VDC, sink, configurable as incremental encoder, NetTime function | 2652 |
| X20SM1436-1 | X20 stepper motor module, with current reduction function, module power supply 24 to 48 VDC $\pm 25\%$, 1 motor connection, 3 A continuous current, 3.5 A peak current, 4 digital inputs 24 VDC, sink, configurable as incremental encoder, NetTime function | 2700 |
| X20SM1446-1 | X20 stepper motor module, module power supply 24 to 48 VDC $\pm 25\%$, with current reduction function, 1 motor connection, 5 A continuous current, 10 A peak current, 4 digital inputs 24 VDC, sink, configurable as incremental encoder, NetTime function, double-width module | 2751 |
| X20cMM2436 | Coated X20 PWM motor module, 24 to 39 VDC $\pm 25\%$, 2 PWM motor bridges, 3 A continuous current, 3.5 A peak current, 4 digital inputs 24 VDC, sink, configurable as incremental encoder | 2496 |

9.25.2 X20(c)MM2436

Data sheet version: 2.30

9.25.2.1 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Motor controllers |  |
| X20MM2436 | X20 PWM motor module, 24 to 39 VDC \pm 25%, 2 PWM motor bridges, 3 A continuous current, 3.5 A peak current, 4 digital inputs 24 VDC, sink, configurable as incremental encoder | |
| X20cMM2436 | Coated X20 PWM motor module, 24 to 39 VDC \pm 25%, 2 PWM motor bridges, 3 A continuous current, 3.5 A peak current, 4 digital inputs 24 VDC, sink, configurable as incremental encoder | |
| | Required accessories | |
| | Bus modules | |
| X20BM31 | X20 bus module for double-width modules, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM31 | X20 bus module, coated, for double-width modules, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 488: X20MM2436, X20cMM2436 - Order data

9.25.2.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.25.2.2.1 Starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C . During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.25.2.3 Module description

The motor bridge module is used to control 2 DC motors with a nominal voltage of 24 to 39 VDC \pm 25% at a nominal current up to 3 A.

Functions:

- [Counters](#)
- [Standard PWM/current mode](#)
- [Frequency mode](#)
- [SuperVibe mode](#)
- [Valve control](#)
- [Automatic shutdown](#)

Digital counter inputs

The module is equipped with 4 digital inputs that can additionally be used as incremental counters. In addition to AB(R) and event counters, period duration and gate measurements are also possible.

Operating modes

The PWM outputs of the module can be controlled in 3 different operating modes. In addition to the standard PWM mode, a special current mode for controlling inductive loads and PWM control with reversed edges is available. This allows the module to be adapted to a wide range of applications.

Valve control

The module can be used to control valves. To prevent the valves from sticking, a dither can be configured exactly according to the specifications of the valve manufacturer.

Automatic shutdown

The voltage of the I/O power supply, the motor current and the module temperature are monitored. If a value overshoots the predefined limit value, the module is automatically switched off. As soon as the value is within the limit value again, the outputs of the module are automatically started up.

9.25.2.4 Technical data

| Model number | X20MM2436 | X20cMM2436 |
|--|--|------------|
| Short description | 2-channel PWM motor bridge, 2 AB incremental encoders | |
| General information | | |
| B&R ID code | 0x26B5 | 0xE752 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnosics | | |
| Module run/error | Yes, using status LED and software | |
| Output | Yes, using status LED and software | |
| I/O power supply | Yes, using software | |
| Power consumption | | |
| Bus | 0.01 W | |
| Internal I/O | - | |
| External I/O | | |
| 24 VDC | 2.45 W | |
| 48 VDC | 3.15 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | |
| UL | cULus E225616 Power conversion equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | - |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| KR | Yes | - |
| EAC | Yes | |
| KC | Yes | - |
| Digital inputs | | |
| Quantity | 4 | |
| Nominal voltage | 24 VDC | |
| Input voltage | 24 VDC (-15% / +20%) | |
| Input current at 24 VDC | Approx. 1.3 mA | |
| Input circuit | Sink | |
| Input filter | | |
| Hardware | <5 µs | |
| Software | - | |
| Connection type | 1-wire connections | |
| Input resistance | Typ. 18 kΩ | |
| Additional functions | 2x AB incremental encoder, 1x ABR counter, 2x event counter, 2x period duration/gate measurement | |
| Switching threshold | | |
| Low | <5 VDC | |
| High | >15 VDC | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| AB incremental encoder | | |
| Quantity | 2 | |
| Encoder inputs | 24 V, asymmetrical | |
| Counter size | 16-bit | |
| Input frequency | Max. 50 kHz | |
| Evaluation | 4x | |
| Signal form | Square wave pulse | |
| PWM output | | |
| Quantity | 2 | |
| Nominal voltage | 24 to 39 VDC ±25% | |
| Nominal current | 3 A | |
| Maximum current | 3.5 A (2 s) | |
| PWM frequency | Standard operating mode: 15 Hz to 50 kHz Frequency operating mode: 1 Hz to 6553.5 Hz SuperVibe operating mode: 1 Hz to 50 kHz | |
| Actuator power supply | | |
| Supply | External | |
| Fuse | Required line fuse: Max. 10 A, slow-blow | |
| Output protection | Thermal cutoff for overcurrent and short circuit | |
| Variant | H bridge | |
| Configurable dither | Amplitude, frequency | |


Table 489: X20MM2436, X20cMM2436 - Technical data

| Model number | X20MM2436 | X20cMM2436 |
|---|---|---|
| Period duration resolution (PWM/current operating mode) | 16-bit, min. 20 µs | |
| Frequency resolution | Frequency mode Scaling 0.1 Hz <3000 Hz: 0.1 Hz; 3000 to 6553.5 Hz: 0.1 to 0.4 Hz Scaling 0.01 Hz <300 Hz: 0.01 Hz; 300 to 6553.5 Hz: 0.01 to 0.04 Hz SuperVibe mode Scaling 1 Hz <10 kHz: 1 Hz; 10 to 50 kHz: 1 to 40 Hz Scaling 0.1 Hz <1000 Hz: 0.1 Hz; 1000 to 6553.5 Hz: 0.1 to 4 Hz | |
| Phase shift PWM1 to PWM2 | 180° - if possible (according to operating mode) | |
| DC bus capacitance | 100 µF | |
| PWM pulse width | 15-bit + sign ≥10 ns | |
| Frequency mode | 15-bit + sign ≥10 ns | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 50°C | |
| Vertical mounting orientation | Not permitted | |
| Derating | See section "Derating" | |
| Starting temperature | - | Yes, -40°C |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x terminal block X20TB12 separately Order 1x X20BM31 bus module separately | Order 1x terminal block X20TB12 separately Order 1x bus module X20cBM31 separately |
| Pitch | 25 ^{+0.2} mm | |

Table 489: X20MM2436, X20cMM2436 - Technical data

9.25.2.5 LED status indicators

For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|---|--------|-------|-----------------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | e + r | | Red on / Green single flash | Invalid firmware |
| | 1 - 4 | | Green | Input state of the corresponding digital input |
| | M1, M2 | | Orange | On |

1) Depending on the configuration, a firmware update can take up to several minutes.

9.25.2.6 Pinout

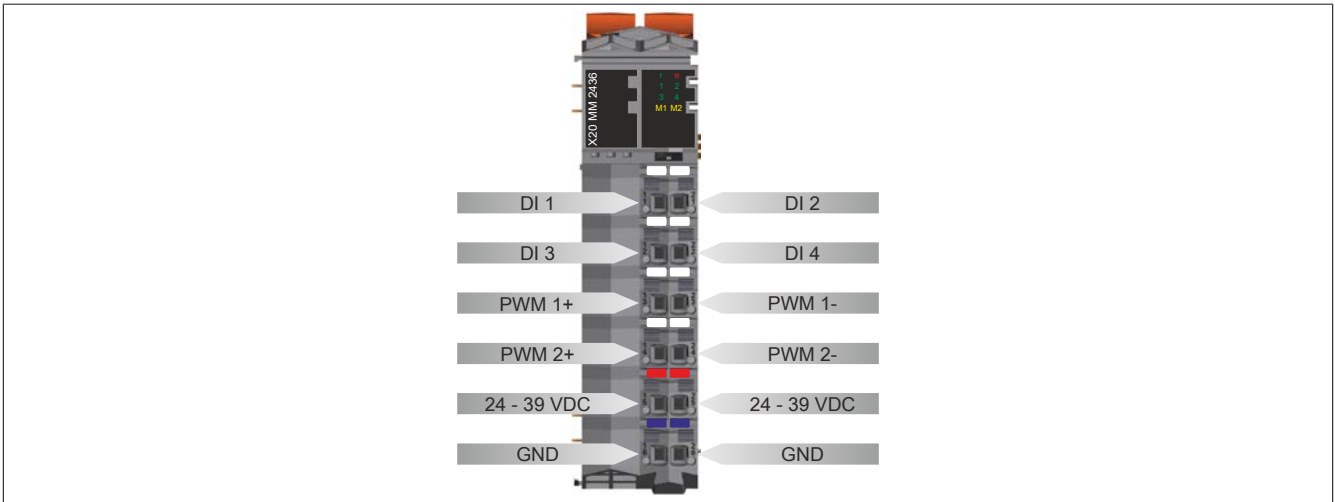
In accordance with the EN 60204-1 standard, a cable cross section of 0.75 mm² or larger must be used for the motor outputs in order to handle the maximum motor current of 3.5 A. To ensure full motor power, voltage drops that could result from the cable length and the electrical connections must also be taken into consideration when selecting the attachment cable.

Warning!

The terminal block is not permitted to be plugged in or unplugged during operation.

Information:

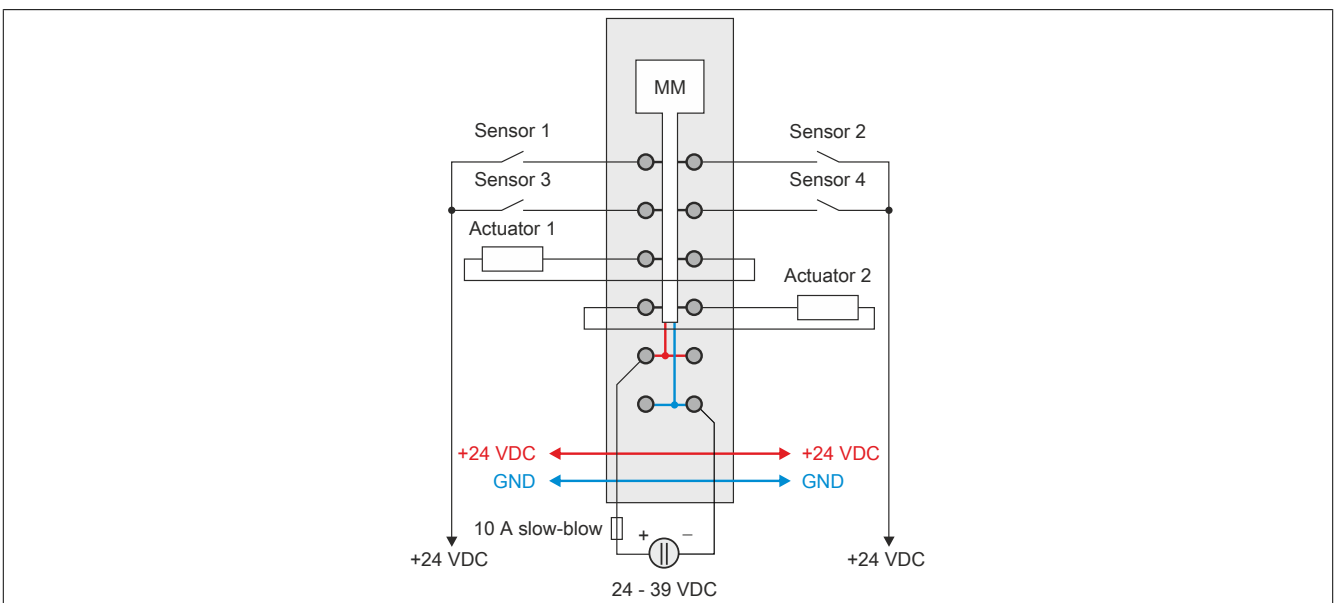
Shielded motor cables must be used in order to meet the limits according to the EN 55011 standard (emissions).



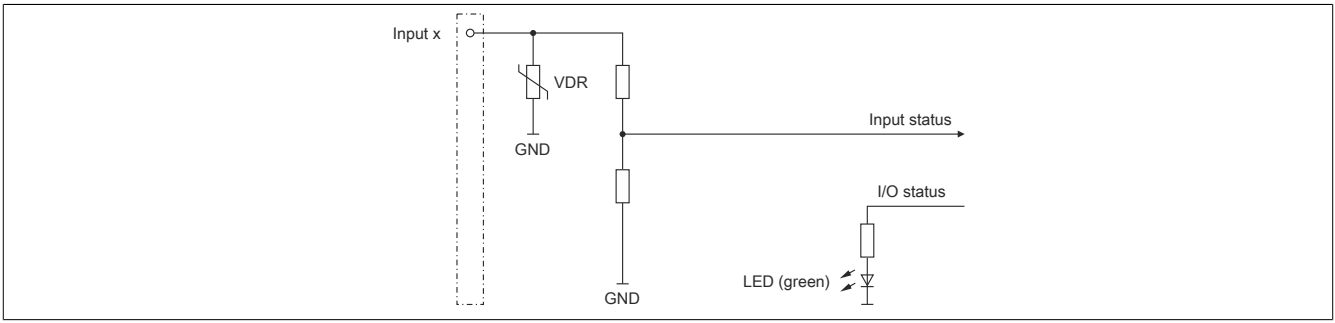
9.25.2.7 Connection example

Information:

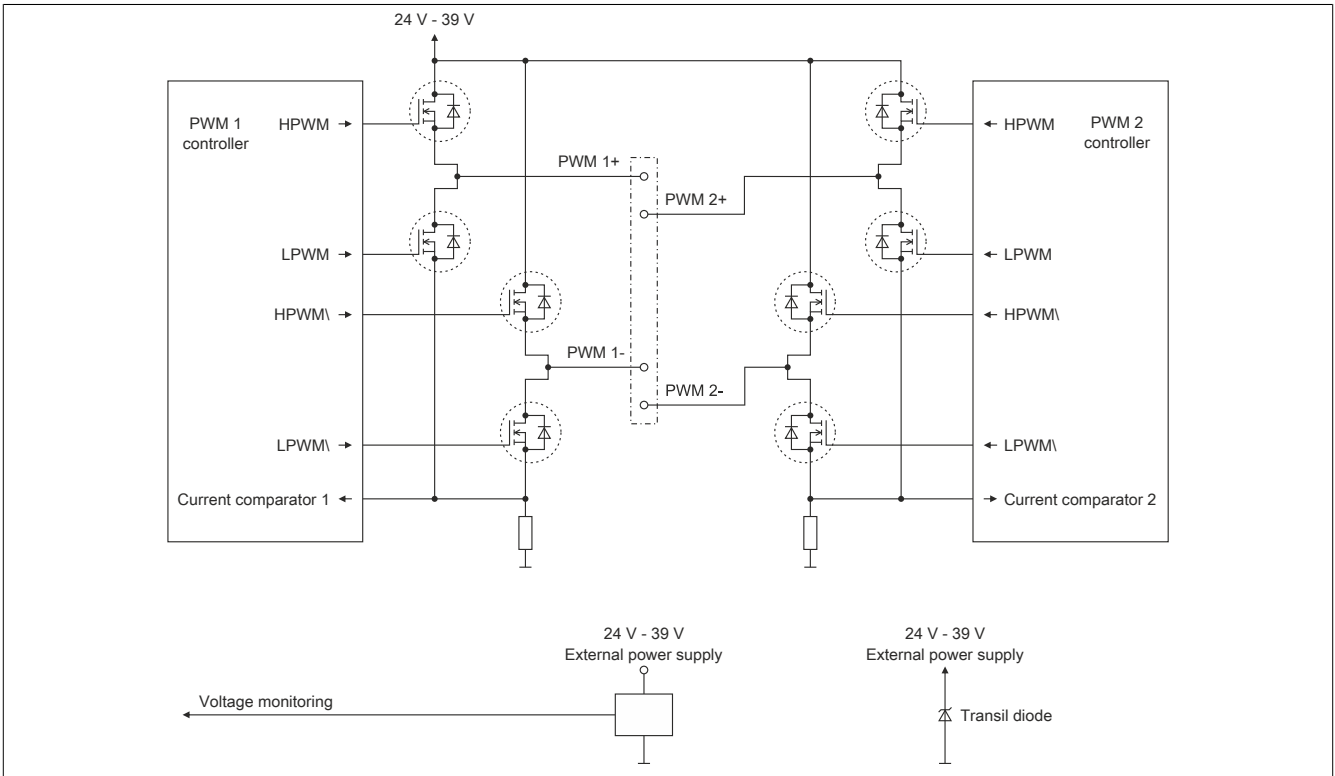
This module can only be operated if supplied with power via the terminal block.



9.25.2.8 Input circuit diagram



9.25.2.9 Output circuit diagram



9.25.2.10 Protection

The power supply line should be protected by a circuit breaker or a fuse. In general, dimensioning the supply line and overcurrent protection depends on the structure of the power supply (modules can be connected individually or in groups).

Information:

The effective current for the power supply depends on the load but is always less than the motor current. Make sure the maximum nominal current of 7 A is not exceeded on the power supply terminals of the power element.

When choosing a suitable fuse, the user must also account for characteristics such as aging effects, temperature derating, overcurrent capacity and the definition of the rated current, which can vary by manufacturer and type. In addition, the fuse that is selected must also be able to handle application-specific characteristics (e.g. overcurrent that occurs in acceleration cycles).

The cross section of the mains power input and the rated current of the used fuse are chosen according to the current-carrying capacity such that the permissible current-carrying capacity of the selected cable cross section (depending on wiring, see table) is greater than or equal to the current load in the mains power input. The rated current of the fuse protection must be less than or equal to the permissible current-carrying capacity of the selected cable cross section (depending on the how it is installed, see table):

$$I_{\text{Power system}} \leq I_{\text{Fuse}} \leq I_{\text{Line/cable}}$$

| Wire cross section [mm ²] | Current-carrying capacity of cable cross section I_z / rated current of fuse I_b [A] depending on the to type of wiring at an ambient air temperature of + 40°C per EN 60204-1 | | | |
|---------------------------------------|--|-----------|-----------|-----------|
| | B1 | B2 | C | E |
| 1.5 | 13.5 / 13 | 13.1 / 10 | 15.2 / 13 | 16.1 / 16 |
| 2.5 | 18.3 / 16 | 16.5 / 16 | 21 / 20 | 22 / 20 |

Table 490: Cable cross section of the mains power input depending on the type of wiring

The tripping current of the fuse is not permitted to exceed the rated current of the fuse I_b .

| Type of wiring | Description |
|----------------|--|
| B1 | Wires in conduit or cable duct |
| B2 | Cables in conduit or cable duct |
| C | Cables or wires on walls |
| E | Cables or wires on open-ended cable tray |

Table 491: Type of wiring used for the mains power input

9.25.2.11 Derating

To ensure proper operation, the following items must be taken into consideration:

- The sum of the square of both effective currents (I_N , peak value must not exceed 3 A) must not exceed $9 A^2$. The boost current of 3.5 A for 2 seconds is an exception.
- Modules next to the motor module can have a maximum power consumption of 1 W.
- The derating values listed below must be taken into consideration

Example calculations

In the following examples, the calculation of I_N^2 is used to check if the current operating state is permitted.

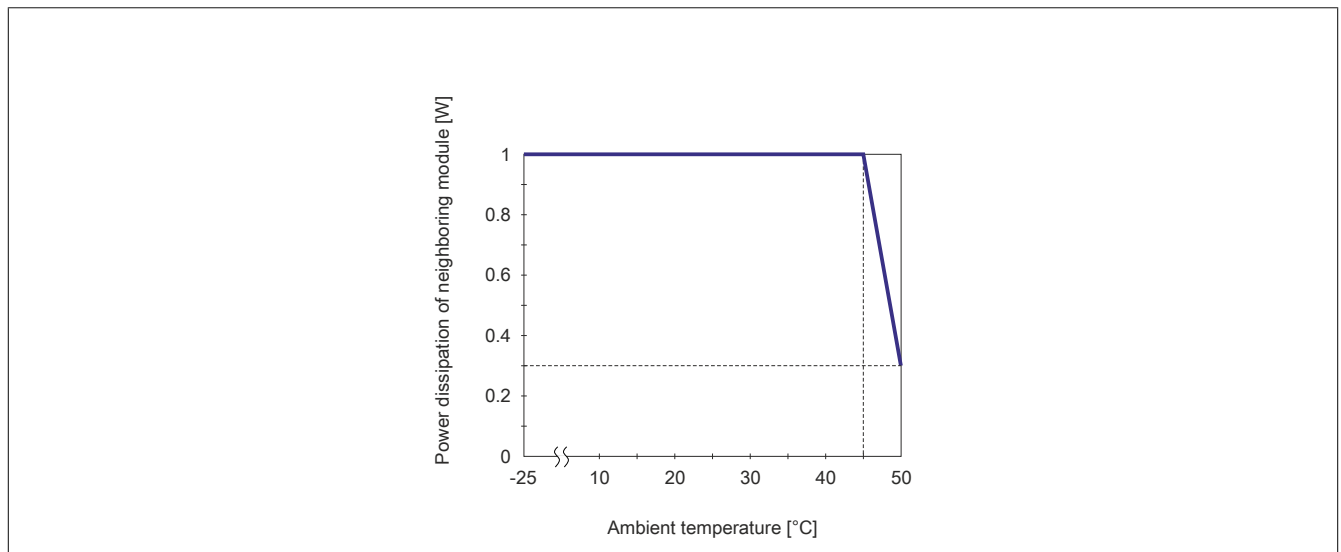
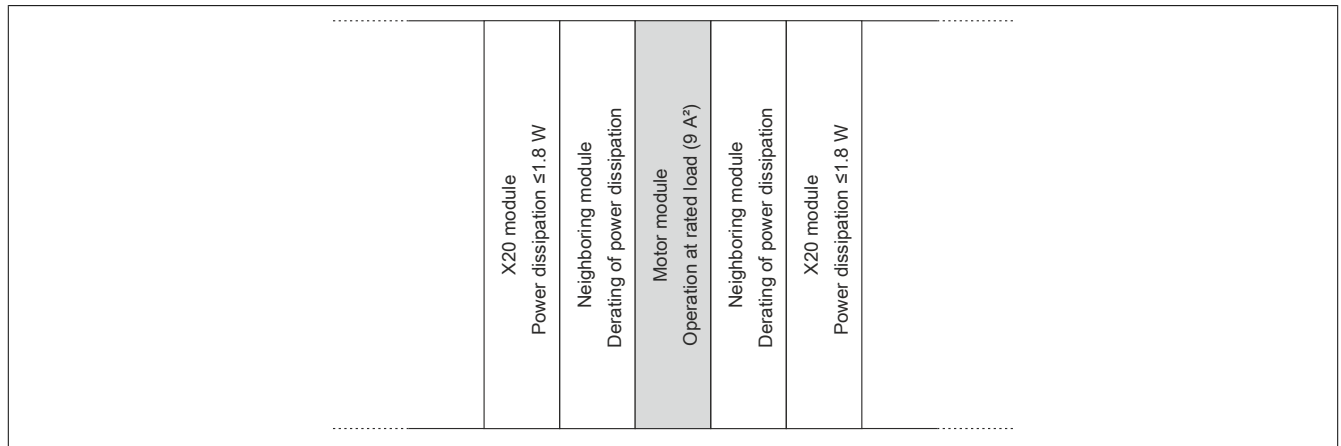
| Output current | | I_N^2 | Operating state permitted |
|----------------|-------|--|----------------------------|
| PWM 1 | PWM 2 | | |
| 3 A | 0 A | $I_N^2 = 3 A \cdot 3 A + 0 A \cdot 0 A = 9 A^2$ | Yes |
| 2.1 A | 2.1 A | $I_N^2 = 2.1 A \cdot 2.1 A + 2.1 A \cdot 2.1 A = 8.82 A^2$ | Yes |
| 2.8 A | 2 A | $I_N^2 = 2.8 A \cdot 2.8 A + 2 A \cdot 2 A = 11.84 A^2$ | for max. 2 s ¹⁾ |

1) The cooling time, which means operation $<9 A^2$, must be at least 5 times as long as the time of the overload.

Power loss derating for neighboring modules

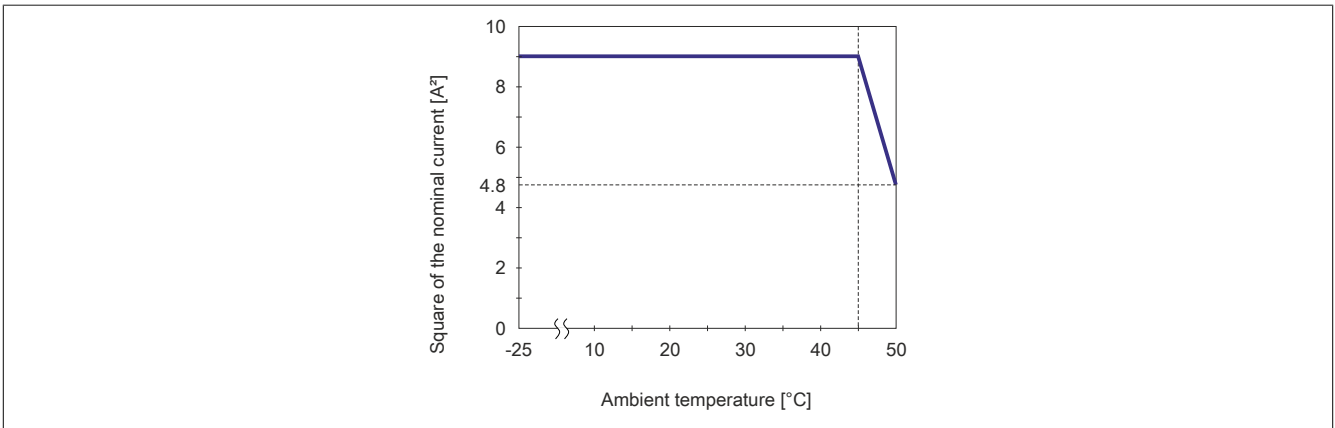
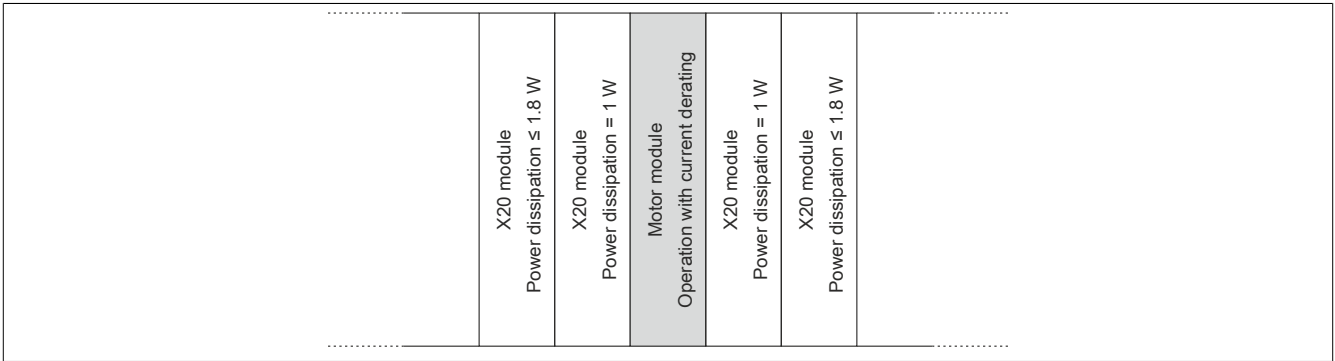
Modules directly next to the motor module can have a power loss of 1 W. If the motor module is operated with the rated load over the entire temperature range ($9 A^2$), a derating for power loss of the neighboring modules must be adhered to starting at $45^\circ C$.

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.



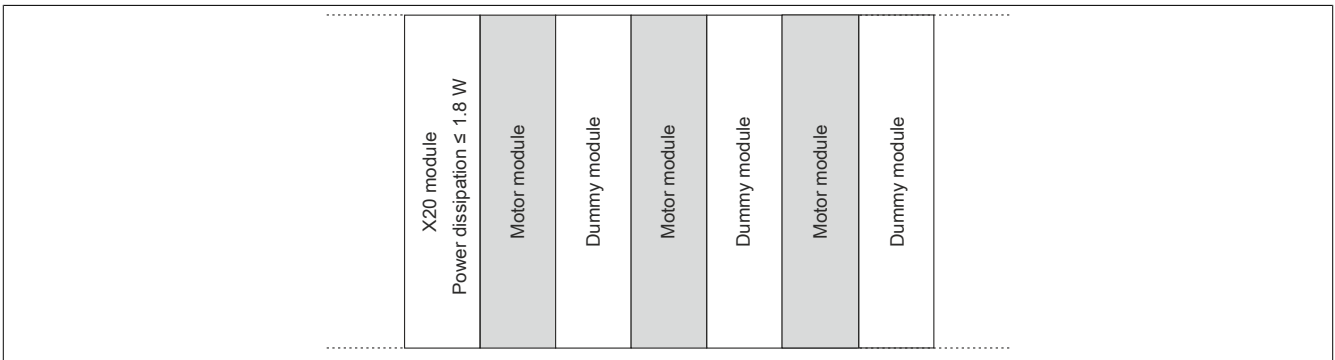
Current derating of the motor module

If the power loss of the neighboring modules to the motor module is 1 W, then the current of the motor module must be derated starting at 45°C.



Hardware configuration for multiple motor modules

If three or more motor modules are operated in a cluster, a dummy module must be inserted between the motor modules. There is no derating in this configuration.



9.25.2.12 Function description

9.25.2.12.1 Counters

The following counter types or measurements can be configured on the module:

- AB counters
- ABR counter (only counter 1)
- Event counters
- Period measurement
- Gate measurement

Counter function - Assignment of the digital inputs:

| Counter function | Counter number | A | B | R | Enable reference | Counter input | Period duration and gate signal | External measuring frequency |
|--------------------------------------|----------------|------|------|------|------------------|---------------|---------------------------------|------------------------------|
| Incremental counter | 1 | DI 1 | DI 2 | DI 3 | DI 4 | | | |
| | 2 | DI 3 | DI 4 | | | | | |
| Event counters | 1 | | | | | DI 1 | | |
| | 2 | | | | | DI 3 | | |
| Period duration and gate measurement | 1 | | | | | | DI 1 | DI 2 |
| | 2 | | | | | | DI 3 | DI 4 |

Information:

For the configuration, see ["Counter configuration 1" on page 2514](#) and ["Counter configuration 2" on page 2515](#).

9.25.2.12.2 Operating modes

The outputs of the module can be operated in different modes. The following table lists the differences between the different operating modes:

| Operating mode | Standard PWM/ current mode | Frequency mode 1 | Frequency mode 2 | SuperVibe mode |
|--------------------------------|--|---|--|---|
| Operating modes | PWM control Current control | Frequency mode | | SuperVibe control PWM control |
| Starting with firmware version | - | 7 | 7 | 8.02 |
| Frequency setting | 1x period duration in μs | 2x in 1/10 or 1/100 Hz | 1x in 1/10 or 1/100 Hz | 2x in 1/10 or 10 Hz |
| Duty cycle / Current setting | 2x -100 to 100% | 1x -100 to 100% | 2x -100 to 100% | 2x -100 to +100% |
| Dither | Yes | No | No | No |
| Decay mode setting | Yes | No | No | No |
| Channel reference | PWM start from channel 2 offset 180° compared to channel 1 | A fixed phase relationship between channel 1 and channel 2 is not possible. | PWM start from channel 2 offset 180° compared to channel 1 | A fixed phase relationship between channel 1 and channel 2 is not possible. |
| | 3.5 A per channel | 1 A per channel | 3.5 A per channel | Maximum 1 A per channel |

Information:

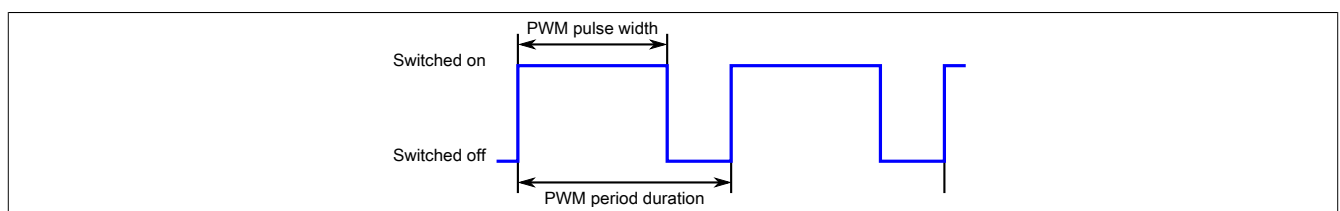
For the configuration, see ["Module configuration" on page 2515](#).

9.25.2.12.2.1 PWM control Standard PWM/current mode

PWM control

The following image illustrates how the current curves for the outputs are affected by registers [PWM period duration](#) and [PWM pulse width](#).

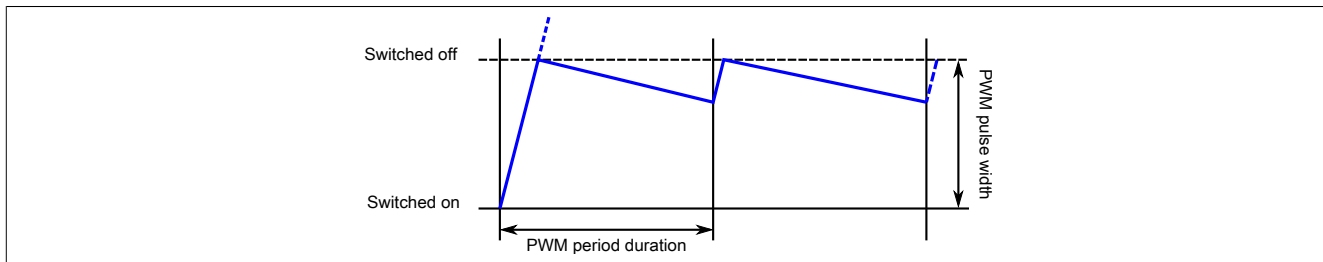
At the beginning of each period, the output is switched on for the percentage of time set in the PWM pulse width. The period duration is specified in μs .



Current control

The following image illustrates how the current curves for the outputs are affected by registers [PWM period duration](#) and [PWM pulse width](#).

At the beginning of each period, the current output is switched on. After reaching the value set in PWM pulse width, the output is switched off and the voltage drops according to the [decay configuration](#) until switched back on.



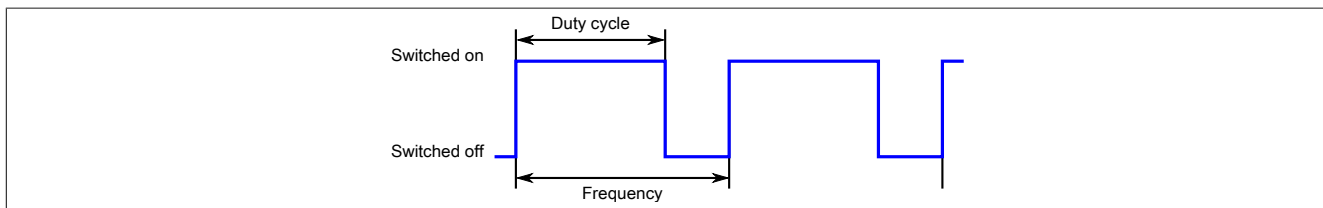
9.25.2.12.2.2 Frequency mode

The following image illustrates how the current curves for the outputs are affected by registers [Frequency](#) and [Duty cycle](#).

At the beginning of each period, the output is switched on for the percentage of time set in the duty cycle. The frequency is specified in Hz depending on register [FrequencyPrescale](#).

Depending on the operating mode, the following settings are possible:

- Frequency mode 1: Frequency is individually adjustable for PWM outputs; duty cycle is identical for PWM output 1 and 2.
- Frequency mode 2: Frequency is identical for PWM output 1 and 2; duty cycle can be set individually for PWM outputs.



9.25.2.12.2.3 SuperVibe mode

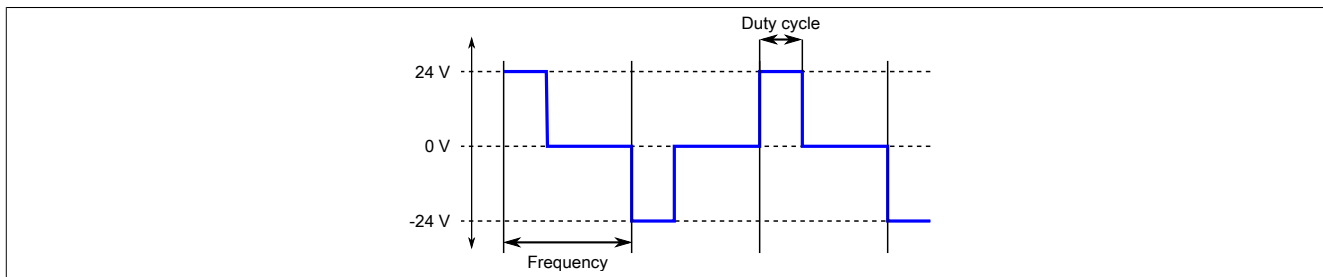
Information:

Only available with firmware version 8.02 or later.

SuperVibe control

SuperVibe (edge polarity reversal) is switched on.

Every second PWM edge is reversed. The following image illustrates how the current curves for the outputs are affected by registers [Frequency](#) and [Duty cycle](#).



PWM control

SuperVibe (edge polarity reversal) is switched off.

The PWM output is contained as described in [Frequency mode](#). [Frequency](#) and [Duty cycle](#) are configurable for each PWM output, however.

9.25.2.12.3 Valve control

When the position setpoint for valves remains constant for a long period of time, especially in fluids, there is a risk that a valve will stick. This is normally prevented using "dithering". When doing so, the value is permitted to slightly oscillate around the position setpoint.

In the module, this dithering is implemented in the form of a triangle wave.

- In PWM mode, the pulse width (duty cycle) of the PWM signal oscillates.
- In current mode, the current setpoint oscillates.

Concrete values for the dither amplitude and frequency to be set must be either taken from the valve data sheet or determined empirically.

By default, the dither is active for both outputs as soon as the dither amplitude and frequency are set to a value 0. If required, dither can be disabled individually and synchronously for each output (see "[Error acknowledgment, dither switch-off and FrequencyPrescale](#)" on page 2521).

Information:

For the configuration, see "[Dither amplitude](#)" on page 2518 and "[Dither frequency](#)" on page 2518.

9.25.2.12.3.1 Dither example

The values specified in the data sheet for a valve should be used to calculate [Dither amplitude](#) and [Dither frequency](#).

Data sheet for the valve

The data sheet for a valve manufacturer recommends the following dithering:

Dither height in percent (A_{Dither}): 20 to 35% (peak values) of the nominal valve current of 2 A

Dither frequency in Hertz (F_{Dither}): 40 to 70 Hz

Selected values

These values correspond to the average values on the valve data sheet.

$A_{\text{Dither}} = 27\%$ of the valve's nominal current (peak values)

$F_{\text{Dither}} = 56 \text{ Hz}$

Formulas

Dither amplitude = $(A_{\text{Dither}} / 2) * (\text{Nominal current}_{\text{valve}} / \text{Nominal current}_{\text{Module}}) * 10$

Info: $(A_{\text{Dither}} / 2)$ = Conversion of the peak values to amplitude, " * 10" = Scaling of the dither amplitude to 1/10%

Dither frequency = $F_{\text{Dither}} / 2 \text{ Hz}$

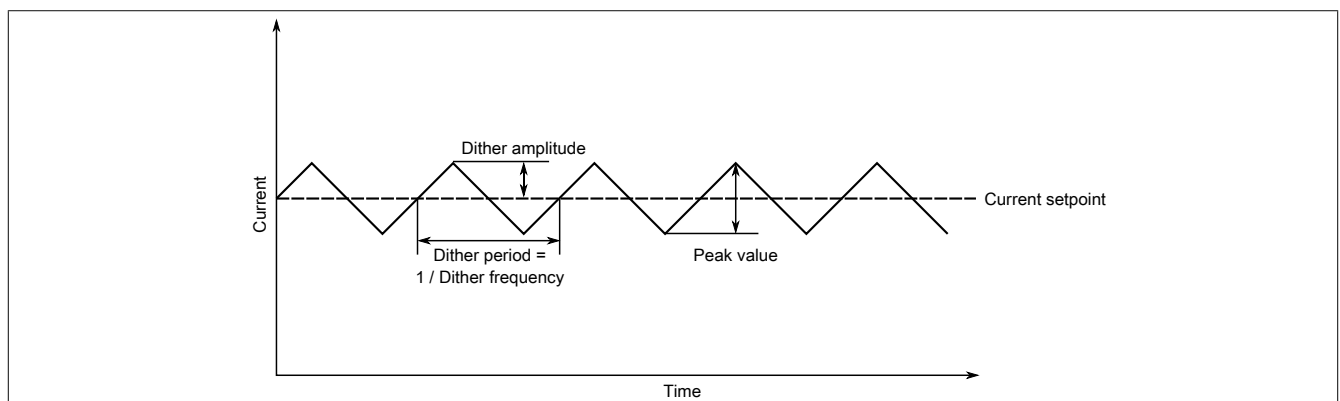
Info: Dither frequency is configured in 2 Hz steps.

Calculation

By using the selected values in the formulas.

Dither amplitude = $27\% / 2 * (2 \text{ A} / 3 \text{ A}) * 10 = 90$

Dither frequency = $56 \text{ Hz} / 2 \text{ Hz} = 28$



9.25.2.12.4 Automatic shutdown

To prevent damage to the module or motor, both the voltage and current of the module power supply and the module temperature are monitored.

9.25.2.12.4.1 Overvoltage cutoff

The module power supply voltage is continually monitored. The "error state" on page 2520 is reported back if a voltage is higher or lower than the limit values.

If the supply voltage in the module overshoots or undershoots the limit values (e.g. during regenerative operation), the motor output is cut off.

The outputs are enabled again as soon as the supply voltage is back in the valid range. In current mode (depending on the set target current and inductance of the load), switching on the outputs again can result in error "open-load" just like any other abrupt change in the current default value.

Limit values for the supply voltage

| | Drive cut off |
|-------------|---------------|
| Lower limit | <18 V |
| Upper limit | >50 V |

9.25.2.12.4.2 Shutdown in the event of overcurrent

The output current of the PWM outputs is monitored. An overcurrent error is reported in the following cases:

- The maximum output current of a PWM output is exceeded for at least 2 seconds.
 - Standard/PWM mode: ≥ 3.5 A
 - Frequency mode 1: > 1 A
 - SuperVibe mode: Value corresponding to register "MaxCurrentConfig" on page 2516
- The output current is ≥ 5 A for the PWM cycles set in register "ToleratedShortCycles" on page 2516.

In each case, the pins of the PWM output are short-circuited and the PWM output concerned is disabled. The user must acknowledge the error (see "Error acknowledgment, dither switch-off and FrequencyPrescale" on page 2521) before a disabled PWM output can be made operational again.

9.25.2.12.4.3 Shutdown in the event of overtemperature

If the module temperature reaches or overshoots the limit value of 85°C, the module performs the following actions:

- Sets error bit "Overtemperature" on page 2520
- Cuts off the outputs (short-circuited)

As soon as the temperature sinks below 83°C, the error bit is automatically cleared by the module and the outputs become operational again.

9.25.2.12.5 Decay operation

The decay configuration can be used to determine the method and dynamics of the current reduction of inductive loads or motors.

In default mode "Slow decay", the current is automatically reduced with resistance in the load. No energy is regenerated into the module.

Mode "Mixed decay" is for applications that require a dynamic and linear reduction of current. In this mode, energy is regenerated into the module during part of the PWM cycle (fast decay).

This function is available starting with firmware V3.

Information:

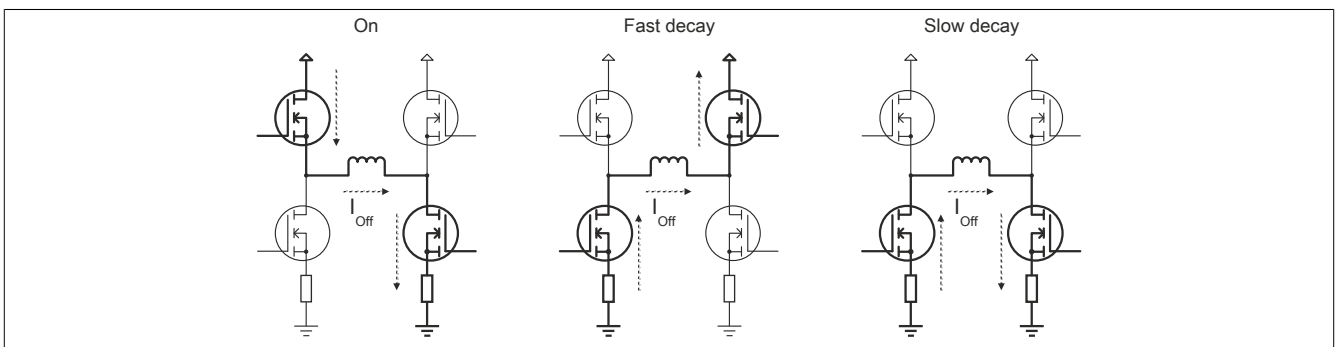
For the configuration, see ["Decay configuration"](#) on page 2516.

Mixed decay

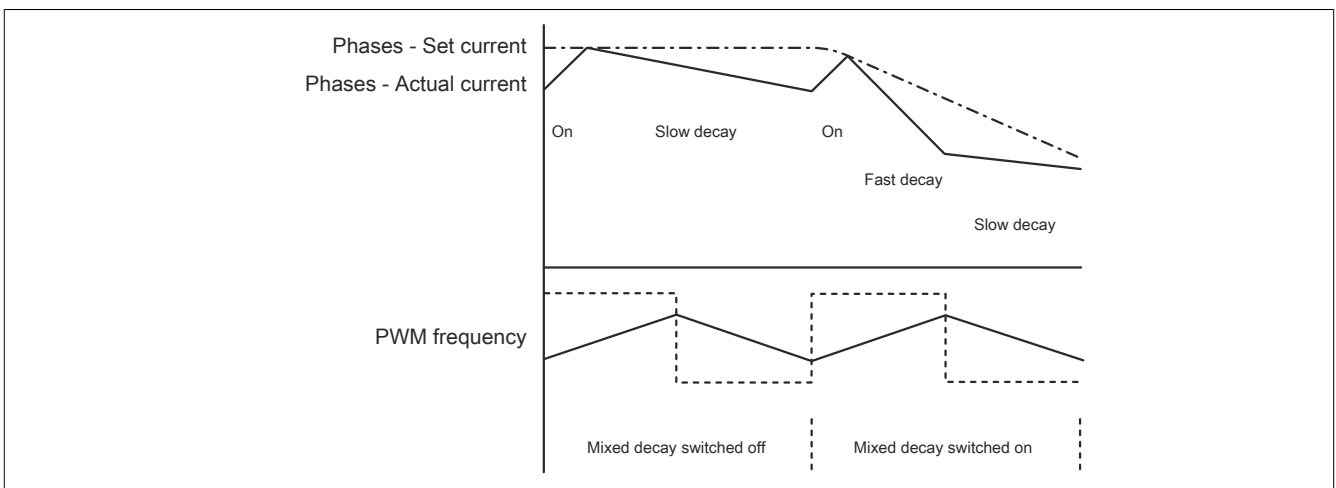
Mixed decay mode is a mix of "slow decay" and "fast decay".

A check is made at the beginning of each PWM cycle to determine if the actual current for the phases is below the current setpoint. If this is the case, PWM is enabled (On) until the set current is reached. The system switches to fast decay mode for the rest of the first half of the PWM cycle. If the current setpoint has already been exceeded at the beginning of the PWM cycle (generator operation), the system immediately switches to fast decay mode. The second half of the PWM cycle always takes place in slow decay mode.

This also permits generator operation as long as the valid range for the supply voltage has not been exceeded due to the regeneration into the DC circuit.



Mixed decay - Set / actual current, PWM frequency



Operating DC motors

In PWM mode, the motor current is limited to the maximum current (3.5 A), independent of the supply voltage.

However, the motor switches to generator operation when braking. Because of the counter EMF, which is dependent on the rotary speed, a current is generated in the module that is only limited by the internal resistance of the motor. This is not permitted to exceed 7 A (maximum 2 seconds).

The counter EMF closely corresponds to the voltage needed to achieve this speed. The maximum braking current can be calculated with the following formula.

$$I_{Brake} = U_e * \frac{PulseWidth}{100\%} * \frac{1}{R_{Motor}}$$

Example:

| | |
|------------------------------|----------------------|
| Module power supply | 38 V |
| Pulse width | 16364 (equal to 50%) |
| Internal resistance of motor | 3.5 Ω |

$$I_{Brake} = 38 \text{ V} * \frac{50}{100\%} * \frac{1}{3.5\Omega} = 5.4\text{A}$$

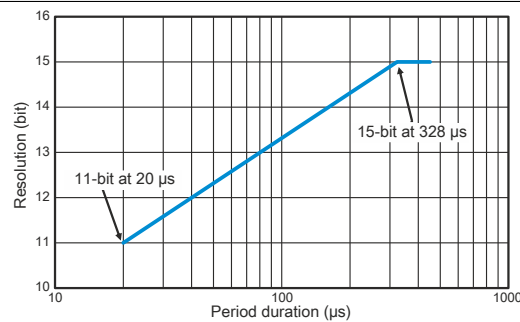
9.25.2.12.6 Bit resolutions of the PWM outputs

The bit resolution of the PWM outputs is 15 bits + sign. This resolution cannot be maintained in all cases, however.

Resolution in the standard PWM/current mode

Depending on the length of the period duration, the bit resolution is subject to derating due to the minimum time resolution of the PWM (10 ns).

The 15-bit resolution has a period duration of up to 328 μs. With the minimum PWM period duration of 20 μs, the PWM only has an 11-bit resolution.

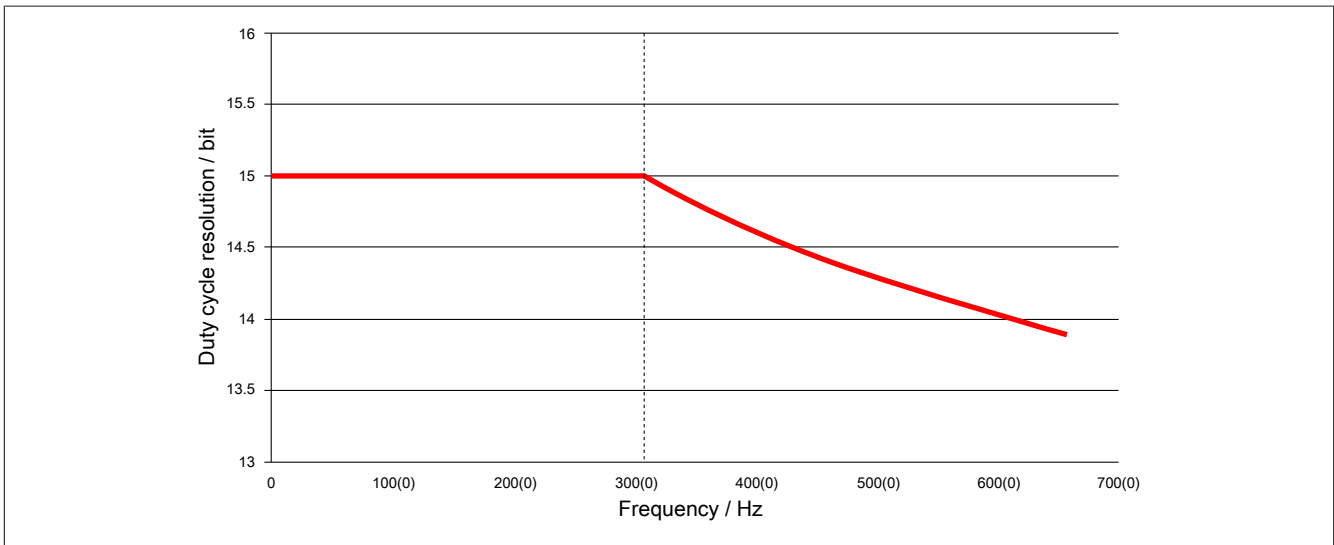


Resolution in frequency- and SuperVibe mode

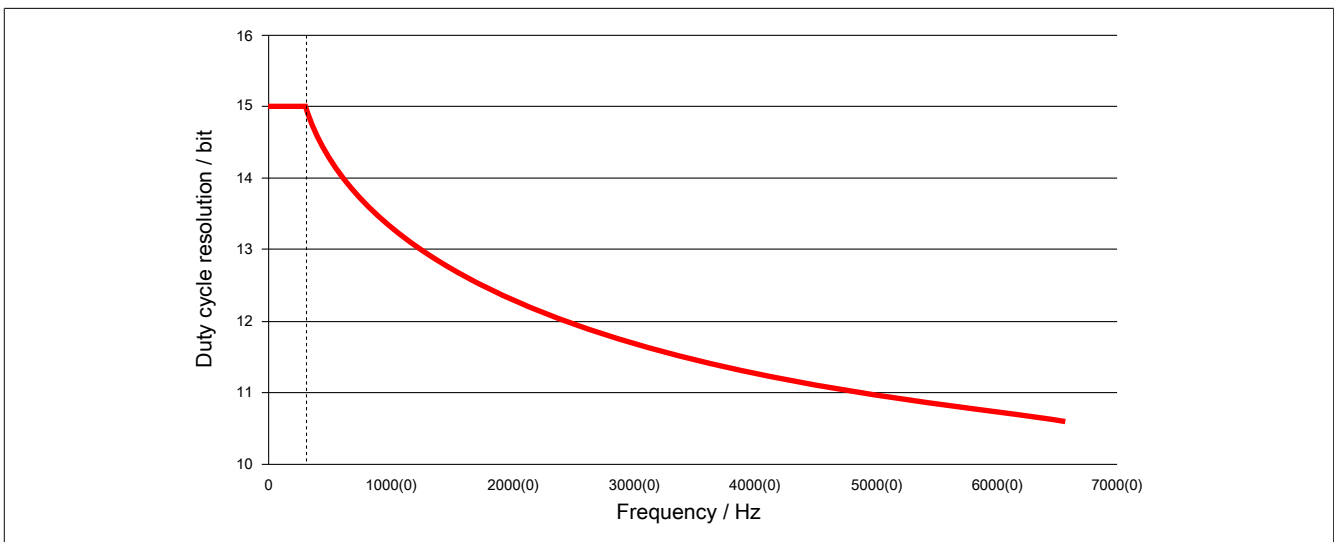
As with the standard PWM/current mode, the predefined duty cycle in the frequency and SuperVibe modes cannot be implemented over the entire frequency domain with the full 15-bit resolution; instead, it is subject to bit derating.

It is possible to achieve the full 15-bit resolution until about 305 or 3050 Hz (depending on the frequency range).

Resolution in frequency mode



Resolution in SuperVibe mode



9.25.2.13 Register description

9.25.2.13.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.25.2.13.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|---|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| Operating mode "Standard PWM/current mode" | | | | | | |
| 12 | PeriodDurationPWM01PWM02 | UINT | | | • | |
| 14 | PulseWidthCurrentPWM01 | INT | | | • | |
| 16 | PulseWidthCurrentPWM02 | INT | | | • | |
| 18 | ConfigOutput01 | USINT | | | | • |
| 20 | ConfigOutput02 | USINT | | | | • |
| 31 | DecayConfig ¹⁾ | USINT | | | | • |
| Operating mode "Frequency mode 1 and 2"²⁾ | | | | | | |
| 12 | FrequencyPWM01PWM02 | UINT | | | • | |
| | DutyCyclePWM01PWM02 | INT | | | | |
| 14 | DutyCyclePWM01 | INT | | | • | |
| | FrequencyPWM01 | UINT | | | | |
| 16 | DutyCyclePWM02 | INT | | | • | |
| | FrequencyPWM02 | UINT | | | | |
| Operating mode "SuperVibe"⁴⁾ | | | | | | |
| 12 | FrequencyPWM01 | UINT | | | • | |
| 14 | DutyCyclePWM01 | INT | | | • | |
| 16 | DutyCyclePWM02 | INT | | | • | |
| 22 | FrequencyPWM02 | UINT | | | • | |
| 42 | MaxCurrentConfig01 | UINT | | | | • |
| 44 | MaxCurrentConfig02 | UINT | | | | • |
| All operating modes | | | | | | |
| 30 | ConfigOutput03 | USINT | | | | • |
| 38 | CounterConfig01 ³⁾ | USINT | | | | • |
| 39 | CounterConfig02 ³⁾ | USINT | | | | • |
| 40 | ToleratedShortCycles ⁴⁾ | USINT | | | | • |
| Communication | | | | | | |
| All operating modes | | | | | | |
| 0 | Counter01 | INT | • | | | |
| 2 | Counter02 | INT | • | | | |
| 10 | Input status ³⁾ | USINT | • | | | |
| | StatusInput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | StatusInput04 | Bit 3 | | | | |
| | CounterOverflow01 | Bit 4 | | | | |
| | CounterOverflow02 | Bit 5 | | | | |
| | RefToggle01 | Bit 6 | | | | |
| 32 | Error status | USINT | • | | | |
| | UnderVoltageError | Bit 0 | | | | |
| | OverVoltageError | Bit 1 | | | | |
| | OvertemperaturError | Bit 2 | | | | |
| | OperatingError | Bit 3 | | | | |
| | CurrentError01 | Bit 4 | | | | |
| | OverCurrentError01 | Bit 5 | | | | |
| | CurrentError02 | Bit 6 | | | | |
| | OverCurrentError02 | Bit 7 | | | | |
| 34 | Error acknowledgment, dither switch-off ³⁾ and FrequencyPrescale ²⁾ | USINT | | | • | |
| | ClearError01 | Bit 0 | | | | |
| | ClearError02 | Bit 1 | | | | |
| | CounterOverflowDetectEnable01 | Bit 2 | | | | |
| | CounterOverflowDetectEnable02 | Bit 3 | | | | |
| | CounterReset01 | Bit 4 | | | | |

| Register | Name | Data type | Read | | Write | |
|---------------|---------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 36 | CounterReset02 | Bit 5 | | | | |
| | DitherDisable01 | Bit 6 | | | | |
| | FrequencyPrescale01 | Bit 7 | | | | |
| | DitherDisable02 | | | | | |
| | FrequencyPrescale02 | | | | | |
| Temperature01 | SINT | | • | | | |

- 1) Firmware version 3 or higher.
- 2) Firmware version 7.00 or higher.
- 3) Firmware version 4 or higher.
- 4) Firmware version 8.02 or later.

9.25.2.13.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|---|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| Operating mode "Standard PWM/current mode" | | | | | | | |
| 12 | 0 | PeriodDurationPWM01PWM02 | UINT | | | • | |
| 14 | 2 | PulseWidthCurrentPWM01 | INT | | | • | |
| 16 | 4 | PulseWidthCurrentPWM02 | INT | | | • | |
| 18 | - | ConfigOutput01 | USINT | | | | • |
| 20 | - | ConfigOutput02 | USINT | | | | • |
| 31 | - | DecayConfig ²⁾ | USINT | | | | • |
| Operating mode "Frequency mode 1 and 2"³⁾ | | | | | | | |
| 12 | 0 | FrequencyPWM01PWM02 | UINT | | | • | |
| | | DutyCyclePWM01PWM02 | INT | | | | |
| 14 | 2 | DutyCyclePWM01 | INT | | | • | |
| | | FrequencyPWM01 | UINT | | | | |
| 16 | 4 | DutyCyclePWM02 | INT | | | • | |
| | | FrequencyPWM02 | UINT | | | | |
| All operating modes | | | | | | | |
| 30 | - | ConfigOutput03 | USINT | | | | • |
| 38 | - | CounterConfig01 ⁴⁾ | USINT | | | | • |
| 39 | - | CounterConfig02 ⁴⁾ | USINT | | | | • |
| 49 | - | ToleratedShortCycles ⁵⁾ | USINT | | | | • |
| Communication | | | | | | | |
| All operating modes | | | | | | | |
| 0 | 0 | Counter01 | INT | • | | | |
| 2 | 2 | Counter02 | INT | • | | | |
| 10 | 4 | Input status ⁴⁾ | USINT | • | | | |
| | | StatusInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusInput04 | Bit 3 | | | | |
| | | CounterOverflow01 | Bit 4 | | | | |
| | | CounterOverflow02 | Bit 5 | | | | |
| | | RefToggle01 | Bit 6 | | | | |
| 32 | 6 | Error status | USINT | • | | | |
| | | UnderVoltageError | Bit 0 | | | | |
| | | OverVoltageError | Bit 1 | | | | |
| | | OvertemperatureError | Bit 2 | | | | |
| | | OperatingError | Bit 3 | | | | |
| | | CurrentError01 | Bit 4 | | | | |
| | | OverCurrentError01 | Bit 5 | | | | |
| | | CurrentError02 | Bit 6 | | | | |
| OverCurrentError02 | Bit 7 | | | | | | |
| 34 | 6 | Error acknowledgment, dither switch-off ⁴⁾ and FrequencyPrescale ³⁾ | USINT | | | • | |
| | | ClearError01 | Bit 0 | | | | |
| | | ClearError02 | Bit 1 | | | | |
| | | CounterOverflowDetectEnable01 | Bit 2 | | | | |
| | | CounterOverflowDetectEnable02 | Bit 3 | | | | |
| | | CounterReset01 | Bit 4 | | | | |
| | | CounterReset02 | Bit 5 | | | | |
| | | DitherDisable01 | Bit 6 | | | | |
| | | FrequencyPrescaled01 | Bit 7 | | | | |
| | | DitherDisable02 | | | | | |
| FrequencyPrescaled02 | | | | | | | |
| 36 | - | Temperature01 | SINT | | • | | |

- 1) The offset specifies the position of the register within the CAN object.
- 2) Firmware version 3 or higher.
- 3) Firmware version 7.00 or higher.
- 4) Firmware version 4 or higher.
- 5) Firmware version 8.02 or later.

9.25.2.13.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.25.2.13.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.25.2.13.4 Configuration

9.25.2.13.4.1 Counter configuration 1

Name:

CounterConfig01

This register can be used to configure counter 1.

This function is available beginning with firmware Version 4.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|------------|---|
| 0 - 2 | Sets the type of counter. | 000 | AB counter with 4x evaluation (A = DI 1, B = DI 2) (bus controller default setting) |
| | | 001 | Event counter (DI 1) |
| | | 010 | Period measurement (DI 1) |
| | | 011 | Gate measurement (DI 1) |
| | | 100 | ABR counter with 4x evaluation (A = DI 1, B = DI 2, R = DI 3, Reference enable = DI 4). Copies counter 1 to counter 2 on a reference pulse. Counter 2 is shown in the I/O map, even if it is disabled in counter configuration 2. |
| | | 101 to 111 | No counter. Counter is disabled and not shown in the I/O map. |
| 3 | Measurement starts | 0 | On rising edge of DI 1 Referencing on rising edge of DI 3 (only for ABR counters) (bus controller default setting) |
| | | 1 | At falling edge on DI 1 Referencing at falling edge on DI 3 (only for ABR counters) |
| 4 - 5 | Set the counter frequency for gate or period measurement | 00 | 4 MHz (bus controller default setting) |
| | | 01 | External via DI 2 |
| | | 10 | 31.25 kHz |
| | | 11 | Reserved |
| 6 - 7 | Set the reference input | 00 | Reference input always enabled (DI 3) (bus controller default setting) |
| | | 01 | Reserved |
| | | 10 | Enable for reference input (DI 3) if DI 4 = 0 |
| | | 11 | Enable for reference input (DI 3) if DI 4 = 1 |

9.25.2.13.4.2 Counter configuration 2

Name:

CounterConfig02

This register can be used to configure counter 2. Unlike counter 1, this counter cannot be configured as an ABR counter.

This function is available beginning with firmware Version 4.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|------------|---|
| 0 - 2 | Sets the type of counter. | 000 | AB counter with 4x evaluation (A = DI 3, B = DI 4) (bus controller default setting) |
| | | 001 | Event counter (DI 3) |
| | | 010 | Period measurement (DI 3) |
| | | 011 | Gate measurement (DI 3) |
| | | 100 to 111 | No counter. Counter is disabled and not shown in the I/O map. |
| 3 | Measurement starts | 0 | On rising edge of DI 3 (bus controller default setting) |
| | | 1 | At falling edge on DI 3 |
| 4 - 5 | Set the counter frequency for gate or period measurement | 00 | 4 MHz (bus controller default setting) |
| | | 01 | External via DI 4 |
| | | 10 | 31.25 kHz |
| | | 11 | Reserved |
| 6 - 7 | Reserved | - | |

9.25.2.13.4.3 Module configuration

Name:

ConfigOutput03

The output control for each motor can be configured separately in this register.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------------|-------|---|
| 0 | Output 1 | 0 | PWM control (bus controller default setting) |
| | | 1 | Current control or SuperVibe PWM (edge reversal) |
| 1 | Output 2 | 0 | PWM control (bus controller default setting) |
| | | 1 | Current control or SuperVibe PWM (edge reversal) |
| 2 - 3 | Operating mode ¹⁾ | 00 | Default PWM/current mode (bus controller default setting) |
| | | 01 | Frequency mode 1 (bit 0 to 1 ignored) |
| | | 10 | Frequency mode 2 (bit 0 to 1 ignored) |
| | | 11 | SuperVibe ²⁾ |
| 4 - 7 | Reserved | - | |

1) Firmware version 7.00 or later.

2) Firmware version 8.02 or later.

Information:

After switching on or resetting, only a one-time changeover from default mode "Standard PWM/current mode" to "Frequency mode 1" or "Frequency mode 2" is permitted. Later reconfigurations into another mode are ignored by the module's firmware.

9.25.2.13.4.4 Decay configuration

Name:

DecayConfig

The decay configuration determines the method and dynamics of current reduction for inductive loads or motors.

This function is available beginning with firmware version 3.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|----------|---|
| 0 - 1 | PWM 1 | 00 | Slow decay (bus controller default setting) |
| | | 01 | Mixed decay |
| | | 10 to 11 | Reserved |
| 2 - 3 | Reserved | 0 | |
| 4 - 5 | PWM 2 | 00 | Slow decay (bus controller default setting) |
| | | 01 | Mixed decay |
| | | 10 to 11 | Reserved |
| 6 - 7 | Reserved | 0 | |

9.25.2.13.4.5 Overload shutdown

Name:

ToleratedShortCycles

This register can be used to set how many periods in a row an overcurrent must be applied until it is detected as an error.

This function is available starting with firmware version 8.02.

| Data type | Values | Information |
|-----------|--------|-------------------|
| USINT | 2 to 5 | Number of periods |

9.25.2.13.4.6 Permissible maximum current

Name:

MaxCurrentConfig01 to MaxCurrentConfig02

In these registers, the maximum permissible current for PWM01 and PWM02 can be set individually in mode SuperVibe.

This function is available starting with firmware version 8.02.

| Data type | Values | Information |
|-----------|-------------|------------------------------|
| UINT | 100 to 1000 | Corresponds to 100 mA to 1 A |

9.25.2.13.4.7 PWM period duration

Name:

PeriodDurationPWM01PWM02

In this register, the period duration can be set from 20 μ s (50 kHz) to 65535 μ s (15 Hz). See also "[Operating modes](#)" on page 2505

| Data type | Value | Information |
|-----------|-------------|-----------------|
| UINT | 20 to 65535 | Time in μ s |

9.25.2.13.4.8 PWM pulse width

Name:

PulseWidthCurrentPWM01 to PulseWidthCurrentPWM02

The PWM pulse width (PWM mode) or current setting (in current mode) is entered in this register according to the setting in the module configuration register. (See also "[Operating modes](#)" on page 2505.) A negative value changes the output polarity.

Information:

In order to be software-compatible with module X67MM2436, the same scaling is used for this module. Current values larger than 3.5 A are limited to 3.5 A.

Derating must also be taken into account when using both channels (see "[Derating](#)" on page 2503).

PWM mode

| Data type | Value | Output + | Output - |
|-----------|--------|--------------------------------------|--------------------------------------|
| INT | 32767 | High | Low |
| | 16384 | PWM 50/50 | Low |
| | 0 | Low (bus controller default setting) | Low (bus controller default setting) |
| | -16384 | Low | PWM 50/50 |
| | -32767 | Low | High |

Current mode

| Data type | Value | Current mode | Note |
|-----------|------------------|--------------------------------------|--|
| INT | 22937 to 32767 | +3.5 A (max. 2 s) | Limited internally, check derating |
| | 22936 | 3.5 A (max. 2 s) | Derating must be taken into consideration. |
| | 19660 | +3 A | |
| | 0 | 0 A (bus controller default setting) | |
| | -19660 | -3 A | |
| | -22936 | -3.5 A (max. 2 s) | Derating must be taken into consideration. |
| | -22937 to -32767 | -3.5 A (max. 2 s) | Limited internally, check derating |

9.25.2.13.4.9 Frequency

Name:

FrequencyPWM01 to FrequencyPWM02 (frequency mode 1 and SuperVibe)

FrequencyPWM01PWM02 (frequency mode 2)

The frequency for PWM01 or PWM02 (depends on the mode) can be set individually or together in these registers. For more information, see the "[Error acknowledgment, dither switch-off and FrequencyPrescale](#)" on page 2521 registers.

Mode FrequencyPrescale

The unit is 1/10 or 1/100 Hz depending on how the "FrequencyPrescale" settings are configured.

| Data type | Value | Information |
|-----------|--------------|---|
| UINT | 0 | Disabled |
| | 1 to 99 | FrequencyPrescale 1/10: 10 Hz FrequencyPrescale 1/100: 1 Hz |
| | 100 to 65535 | FrequencyPrescale 1/10: 1/10 * Value = 10 to 6553.5 Hz FrequencyPrescale 1/100: 1/100 * Value = 1 to 655.35 Hz |

Mode SuperVibe

The unit is 1 Hz or 1/10 Hz depending on how the "FrequencyPrescale" settings are configured.

| Data type | Values | Information |
|-----------|----------------------------|---|
| UINT | 0 | Disabled |
| | 1 to 9 | FrequencyPrescale 1: 10 Hz FrequencyPrescale 1/10: 1 Hz |
| | 10 to 50000 10 to 65535 | FrequencyPrescale 1: 10 to 50000 Hz FrequencyPrescale 1/10: 1 to 6553.5 Hz |

9.25.2.13.4.10 Duty cycle

Name:

DutyCyclePWM01PWM02 (frequency mode 1)

DutyCyclePWM01 to DutyCyclePWM02 (frequency mode 2 and SuperVibe)

The duty cycle for the PWM outputs is set individually or separately depending on the frequency or SuperVibe mode.

For information about scaling, derating, etc. see the ["PWM pulse width" on page 2517](#) registers (PWM mode).

Notice!

A negative duty cycle can also be configured. In this case, the frequency is output to "PWM1/2" (identical to standard PWM/current mode) instead of the "PWM1/2+" output. It is especially important to take this into account with actuators that are only able to process positive input values.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

9.25.2.13.4.11 Dither amplitude

Name:

ConfigOutput01

This register can be used to configure the amplitude value or pulse width.

| Data type | Value | Information |
|-----------|----------|---|
| USINT | 0 to 255 | Current mode: 0 to 25.5% of the module's nominal current ¹⁾ PWM mode: 0 to 25.5% of the period duration. Bus controller default setting: 0 |

1) See the technical data for the module.

9.25.2.13.4.12 Dither frequency

Name:

ConfigOutput02

This register can be used to set the frequency in 2 Hz steps.

| Data type | Value | Information |
|-----------|----------|--|
| USINT | 0 to 255 | Corresponds to 0 to 510 Hz. Bus controller default setting: 0 |

9.25.2.13.5 Communication

9.25.2.13.5.1 Numerator

Name:

Counter01 to Counter02

This register indicates the status of counters 1 and 2. If counter 1 is configured as an ABR counter, then the register for counter 2 is assigned the current value of counter 1 when the reference pulse occurs.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

9.25.2.13.5.2 Input status

Name:

StatusInput01 to StatusInput04

CounterOverflow01 to CounterOverflow02

RefToggle01

The status of the inputs and counters is mapped in this register.

This function is available beginning with firmware Version 4.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------------|--------|---|
| 0 | StatusInput01 | 0 or 1 | Logical state of input 1 |
| ... | | ... | |
| 3 | StatusInput0 | 0 or 1 | Logical state of input 4 |
| 4 | CounterOverflow01 | 0 | Period duration or gate measurements of counter 1 are within the valid range (0x0 - 0xFFFF). The bit is only valid if overflow detection is enabled (bit 2 = 1 in the "Error acknowledgment, dither switch-off and FrequencyPrescale" on page 2521 register). |
| | | 1 | Overflow during period duration or gate measurement (reset with bit 2 = 0 in the "Error acknowledgment, dither switch-off and FrequencyPrescale" on page 2521 register). |
| 5 | CounterOverflow02 | 0 | Period duration or gate measurements of counter 2 are within the valid range (0x0 - 0xFFFF). The bit is only valid if overflow detection is enabled (bit 3 = 1 in the "Error acknowledgment, dither switch-off and FrequencyPrescale" on page 2521 register). |
| | | 1 | Overflow during period duration or gate measurement (reset with bit 3 = 0 in the "Error acknowledgment, dither switch-off and FrequencyPrescale" on page 2521 register). |
| 6 | RefToggle01 | x | Bit 6 changes value each time the counter state is latched from counter 1 to counter 2. After the module boots, bit 6 = 0. |
| 7 | Reserved | - | |

9.25.2.13.5.3 Temperature

Name:

Temperature01

The module temperature is displayed in this register.

| Data type | Value | Information |
|-----------|------------|--------------------------|
| SINT | -40 to 125 | Module temperature in °C |

9.25.2.13.5.4 Error status

Name:

UnderVoltageError

OverVoltageError

OvertemperatureError

OperatingError

CurrentError01 to CurrentError02

OverCurrentError01 to OverCurrentError02

If an error is detected, the corresponding error bit remains set in this register until the error is acknowledged (see ["Error acknowledgment, dither switch-off and FrequencyPrescale"](#) on page 2521).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|------------------------------|-------|---------------------------------|
| 0 | UnderVoltageError | 0 | No error |
| | | 1 | Module supply lower limit <18 V |
| 1 | OverVoltageError | 0 | No error |
| | | 1 | Module supply upper limit >50 V |
| 2 | OvertemperatureError | 0 | No error |
| | | 1 | Overtemperature |
| 3 | OperatingError ¹⁾ | 0 | No error |
| | | 1 | Faulty operation |
| 4 | CurrentError01 | 0 | No error |
| | | 1 | Open load error Output 1 |
| 5 | OverCurrentError01 | 0 | No error |
| | | 1 | Overcurrent error Output 1 |
| 6 | CurrentError02 | 0 | No error |
| | | 1 | Open load error Output 2 |
| 7 | OverCurrentError02 | 0 | No error |
| | | 1 | Overcurrent error Output 2 |

1) Firmware version 7.00 or higher.

Faulty operation

This warning indicates faulty operation of the module. The following table lists possible causes, the module's reaction and how to correct/acknowledge the error.

| Cause | Reaction | Correction/Acknowledgment |
|--|--|---|
| Default value for "PeriodDuration" on page 2516 or "Frequency" on page 2517 outside of specified range | Default value limited to the specified range | Automatic acknowledgment as soon as the default value is back within specifications |
| Later reconfiguration of the operating mode (see bits 2 to 3 of the "Module configuration" on page 2515 register) | The new configuration is ignored. The module continues to work in the original operating mode. | The original configuration is restored. |

Overcurrent error

An overcurrent error is reported when the current at the PWM output exceeds the set limit. For details, see ["Shutdown in the event of overcurrent"](#) on page 2508.

Open load error

An open load error is only registered in current control mode (see ["configuration register"](#) on page 2515) if the current setpoint is not reached. In some cases this can be caused by an open line, although usually the impedance of the load is too high.

9.25.2.13.5.5 Error acknowledgment, dither switch-off and FrequencyPrescale

Name:

ClearError01 to ClearError02

CounterOverflowDetectEnable01 to CounterOverflowDetectEnable02

CounterReset01 to CounterReset02

DitherDisable01 to DitherDisable02

FrequencyPrescale01 to FrequencyPrescale02

This register can be used to acknowledge errors; to enable/disable overflow detection, counters and dither; and to set a prescaler for the frequency domains.

This function is available beginning with firmware Version 4.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------------------------|-------|--|
| 0 | ClearError01 | 0 | No effect |
| | | 1 | Error acknowledgment on output 1 (overcurrent or open load) or acknowledgment from limit switch 1 |
| 1 | ClearError02 | 0 | No effect |
| | | 1 | Error acknowledgment on output 2 (overcurrent or open load) or acknowledgment from limit switch 2 |
| 2 | CounterOverflowDetectEnable01 | 0 | Overflow detection disabled. Bit 4 in the counter status register is reset (see "Input status" on page 2519) |
| | | 1 | Counter 1: Overflow detection enabled. |
| 3 | CounterOverflowDetectEnable02 | 0 | Overflow detection disabled. Bit 5 in the counter status register is reset (see "Input status" on page 2519) |
| | | 1 | Counter 2: Overflow detection enabled. |
| 4 | CounterReset01 | 0 | Counter 1 is enabled (default). |
| | | 1 | Counter 1 is set to 0 and disabled. If counter 1 is configured as an ABR counter (see "Counter configuration 1" on page 2514), then latch 2 is also set to 0. In this mode, the latched value from counter 1 is stored in counter 2. |
| 5 | CounterReset02 | 0 | Counter 2 is enabled (default). |
| | | 1 | Counter 2 is set to 0 and disabled (no effects if counter 1 is configured as an ABR counter) |
| 6 | DitherDisable01 | 0 | Dither for PWM output 1 is enabled (default). The dither frequency and dither amplitude must be >0 (see "Valve control" on page 2507). |
| | | 1 | Dither for PWM output 1 is disabled. |
| | FrequencyPrescale01 ¹⁾ | 0 | Unit in 1/10 or 1 Hz; depending on the operating mode |
| | | 1 | Unit in 1/100 or 1/10 Hz; depending on the operating mode |
| 7 | DitherDisable02 | 0 | Dither for PWM output 2 is enabled (default). The dither frequency and dither amplitude must be >0 (see "Valve control" on page 2507). |
| | | 1 | Dither for PWM output 2 is disabled. |
| | FrequencyPrescale02 ¹⁾ | 0 | Unit in 1/10 or 1 Hz; depending on the operating mode |
| | | 1 | Unit in 1/100 or 1/10 Hz; depending on the operating mode |

1) Firmware version 7.00 or higher.

FrequencyPrescale

Beginning with firmware version 7.00, bits 6 to 7 in the "Frequency mode 1 and 2" operating mode have a different meaning.

Instead of enabling/disabling dithering for channel 1 or 2, it toggles the prescaler for the frequency setting between:

- In the frequency mode
Unit in 1/10 Hz, frequency domain: 10 to 6553.5 Hz
Unit in 1/100 Hz, frequency domain: 1 to 655.35 Hz
- In the SuperVibe mode
Unit in 1 Hz, frequency domain: 10 to 50000 Hz
Unit in 1/10 Hz, frequency domain: 1 to 6553.5 Hz

In "Frequency mode 2" operating mode, only bit 6 (FrequencyPrescale01) is used since both channels are operated with the same frequency.

Information:

The frequency domain can be toggled at any time, but it also results in the frequency jumping by a factor of 10. If this frequency jump is not tolerated in the application, then the value set in the "Frequency" on page 2517 register must be adjusted accordingly.

9.25.2.13.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 250 μ s |

9.25.2.13.7 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 250 μ s |

9.25.3 X20MM3332

Data sheet version: 2.04

9.25.3.1 General information

The 3 outputs on the motor module are designed as full-bridge outputs. The continuous current per channel is 3 A at a peak current of up to 5 A. Integrated diagnostics offer the possibility to read back the output current for each channel using the application.

The module offers extensive possibilities for controlling motors, valves or resistive loads and is particularly well suited for controlling brush DC motors. Because the outputs are designed as full-bridge outputs, the motors can be moved in both directions.

- 3 full-bridge outputs (H-bridges)
- High component density
- 3 A continuous current
- 5 A peak current
- Readable current

9.25.3.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Motor controllers |  |
| X20MM3332 | X20 digital motor module, 24 VDC, 3 digital outputs, full bridge (H bridge), 3 A continuous current, 5 A peak current | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 492: X20MM3332 - Order data


9.25.3.3 Technical data

| | |
|--|---|
| Model number | X20MM3332 |
| Short description | |
| I/O module | 3 full-bridge outputs |
| General information | |
| B&R ID code | 0xA982 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Output | Yes, using status LED and software |
| I/O power supply | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 0.8 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| Motor bridge - Power unit | |
| Quantity | 3 |
| Variant | H bridge |
| Type | Full bridge High-side driver Low-side driver |
| Nominal voltage | 24 VDC |
| Switching voltage | 24 VDC (-15% / +20%) |
| Nominal current | 3 A |
| Maximum current | 5 A (250 ms) |
| Total nominal current | 10 A |
| Current value measurement | |
| Resolution | 100 mA |
| Data collection | In the driver |
| Output protection | Thermal cutoff for overcurrent and short circuit |
| Supply voltage | No reverse polarity protection |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Bus isolated from channel and external I/O power supply Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | 0 to 50°C |
| Vertical mounting orientation | Not permitted |
| Derating | See section "Derating" |
| Storage | -25 to 70°C |
| Transport | -25 to 70°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 493: X20MM3332 - Technical data

9.25.3.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

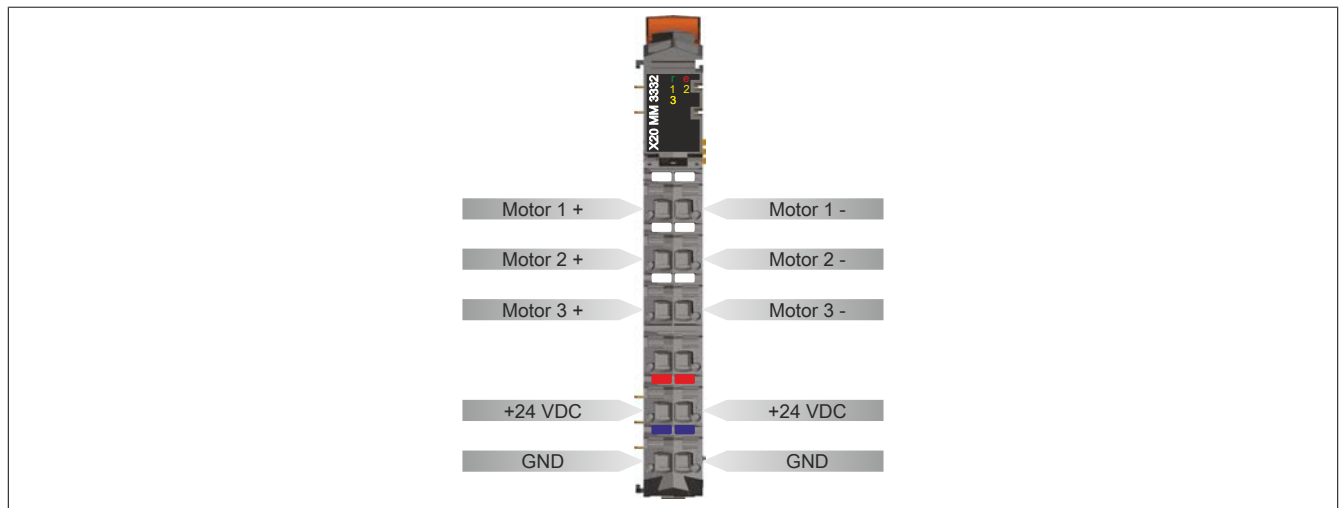
| Figure | LED | Color | Color | Description |
|---|-------|--------|-----------------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | e + r | | Red on / Green single flash | Invalid firmware |
| | 1 - 3 | Orange | On | The corresponding output is active |
| | | | Blinking | Error on the corresponding output |
| | | | Off | The corresponding output is switched off |

9.25.3.5 Pinout

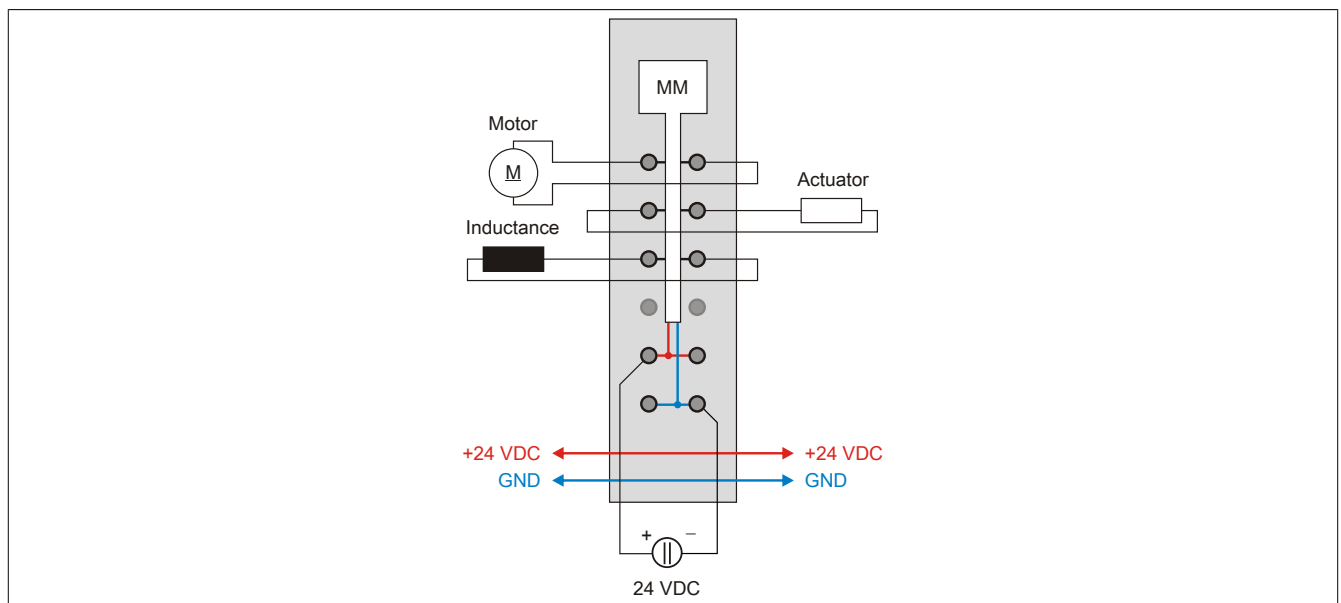
Lines with a cross section between a minimum of 0.75 mm² and a maximum of 2.5 mm² are recommended for the outputs.

Warning!

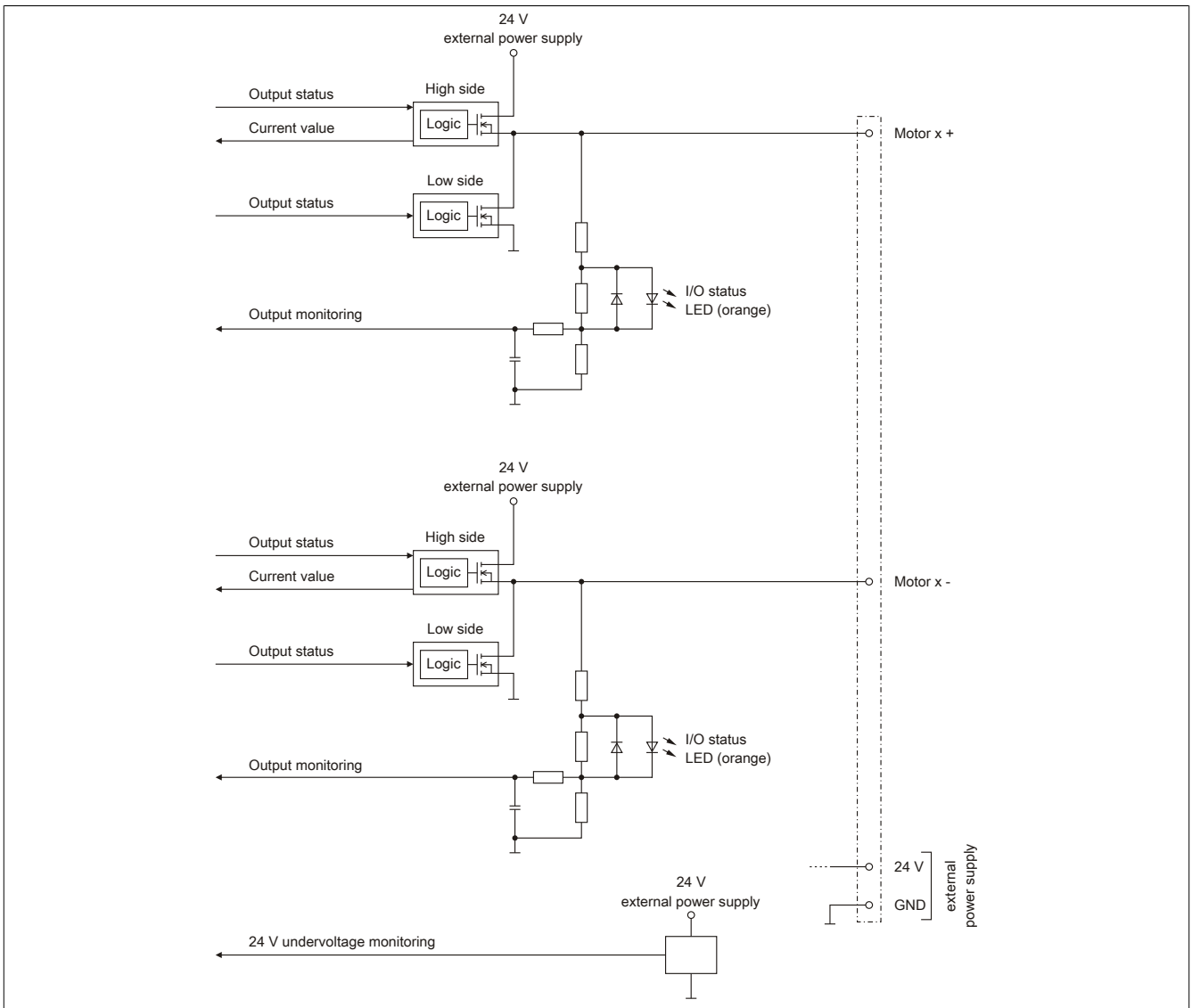
The terminal block is not permitted to be plugged in or unplugged during operation.



9.25.3.6 Connection example

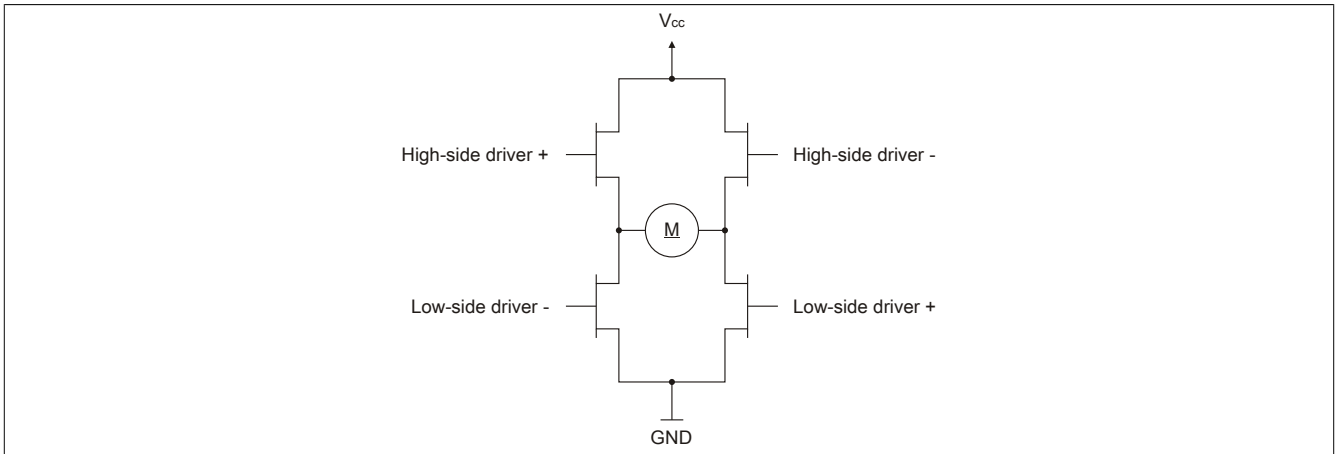


9.25.3.7 Output circuit diagram



9.25.3.8 Function description - Motor operation

Three DC motors can be operated with the module. Each output is designed as a full-bridge output, therefore the motors can be moved in both directions.



Description of the operating modes using the basic circuit diagram shown above:

| Operating mode | Description |
|------------------------|--|
| Rotational direction 1 | If the high-side driver + and the low-side driver + are active, the direction of rotation on the motor is from + to -. |
| Rotational direction 2 | If the high-side driver - and the low-side driver - are active, the direction of rotation on the motor is from - to +. |
| Brakes | If both low-side drivers are active, the motor is short-circuited. This functions as a motor brake. |

9.25.3.9 Protection

The power supply line should be protected by a circuit breaker or a fuse. In general, dimensioning the supply line and overcurrent protection depends on the structure of the power supply (modules can be connected individually or in groups).

Information:

The effective current for the power supply depends on the load, but is always less than the sum of the output currents. Make sure that the maximum nominal current of 31 A per pin is not exceeded on the power supply terminals of the power unit.

When choosing a suitable fuse, the user must also account for characteristics such as aging effects, temperature derating, overcurrent capacity and the definition of the rated current, which can vary by manufacturer and type. In addition, the fuse that is selected must also be able to handle application-specific characteristics (e.g. overcurrent that occurs in acceleration cycles).

The cross section of the power mains and the rated current of the overcurrent protection used are chosen according to the current load so that the maximum current load for the cable cross section selected (based on the type of layout, see table) is greater than or equal to the current load in the power mains. The rated current of the overcurrent protection must be less than or equal to the maximum current load for the cable cross section selected (based on the type of layout, see table):

$$I_{\text{Mains}} \leq I_{\text{Fuse}} \leq I_{\text{Line/cable}}$$

| Wire cross section [mm ²] | Current load of the cable cross section I_z / rated current of the over current protection I_b [A] according to type of installation in an ambient air temperature of 40°C in accordance to EN 60204-1 | | | |
|---------------------------------------|--|-----------|-----------|-----------|
| | B1 | B2 | C | E |
| 1.5 | 13.5 / 13 | 13.1 / 10 | 15.2 / 13 | 16.1 / 16 |
| 2.5 | 18.3 / 16 | 16.5 / 16 | 21 / 20 | 22 / 20 |
| 4 | 24 / 24 | 23 / 20 | 28 / 25 | 30 / 25 |
| 6 | 32 / 32 | 29 / 25 | 36 / 32 | 37 / 32 |

Table 494: Cable cross section of the mains supply line depending on the type of layout

The tripping current of the fuse cannot exceed the rated current of fuse I_b .

| Type of layout | Description |
|----------------|------------------------------------|
| B1 | Wires in conduit or cable duct |
| B2 | Cables in conduit or cable duct |
| C | Cables or wires on walls |
| E | Cables or wires on open cable tray |

Table 495: Type of layout for the mains supply line

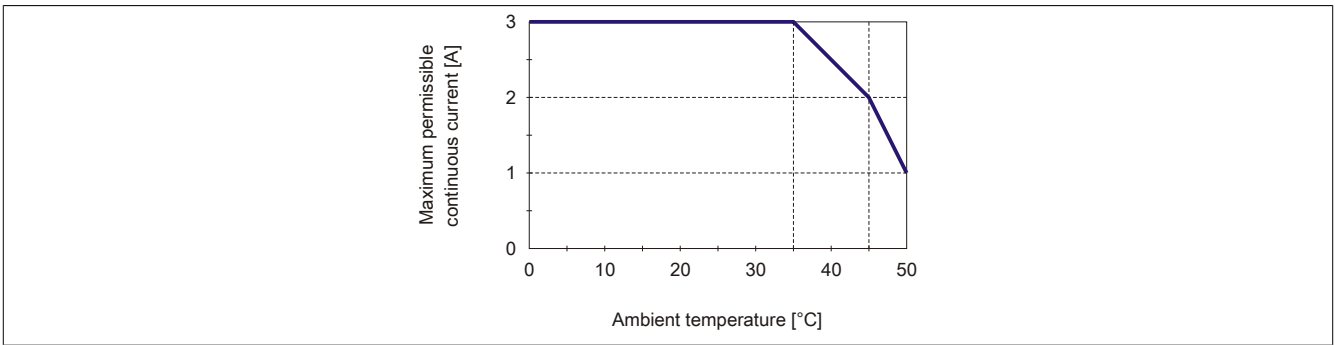
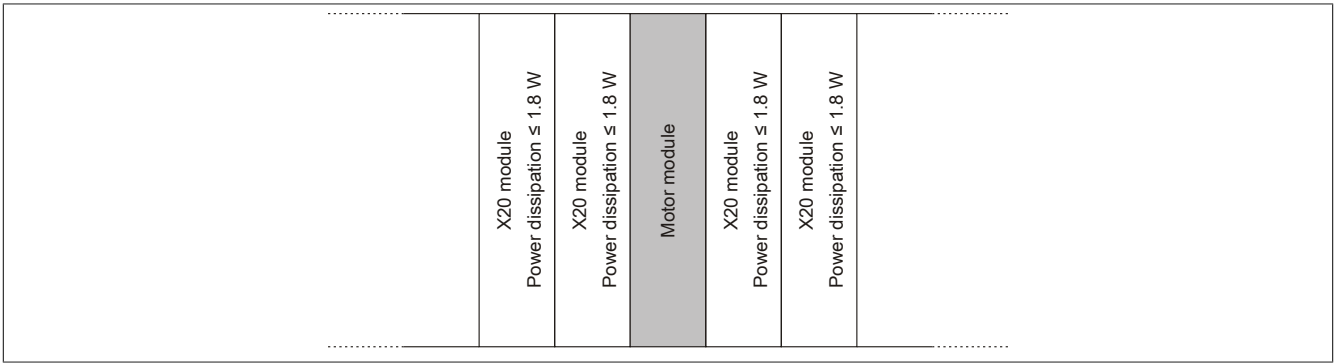
9.25.3.10 Derating

In order to be able to operate the motor module over the entire temperature range, only modules with a maximum power loss of 0.5 W can be installed next to the motor module or respective turn-off times must be implemented. If the neighboring modules have a higher power loss and all channels are operated continuously, the motor current must be derated.

When a motor is switched on, the current is increased for a short time. This behavior has no influence on the derating.

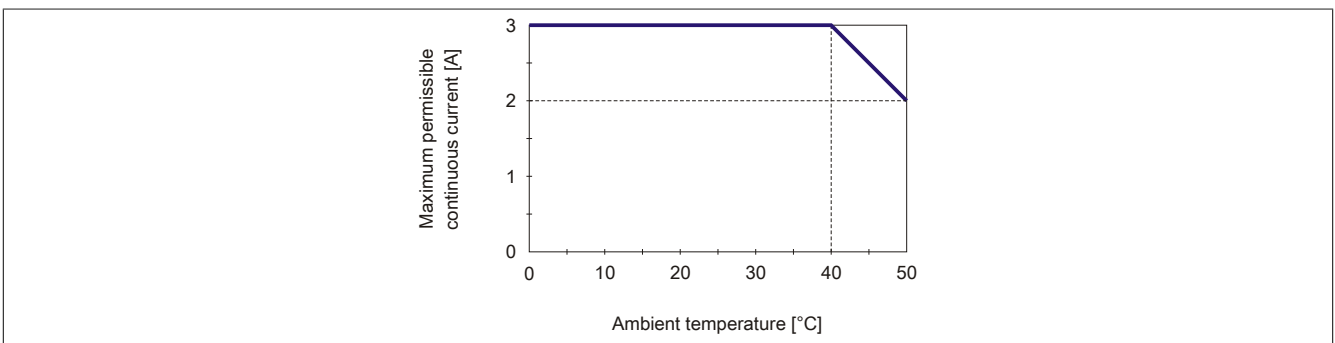
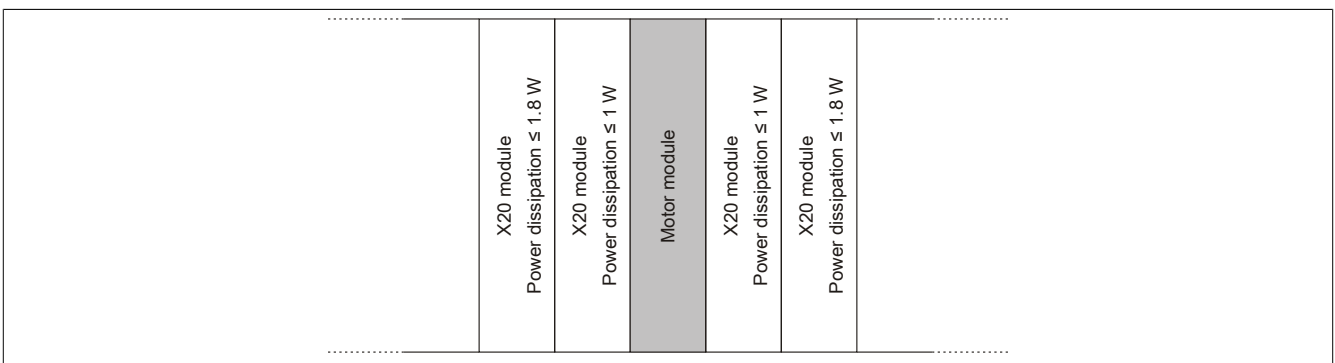
Current derating 1 of the motor module

Current derating for the motor module for neighboring modules with ≤ 1.8 W thermal power loss.



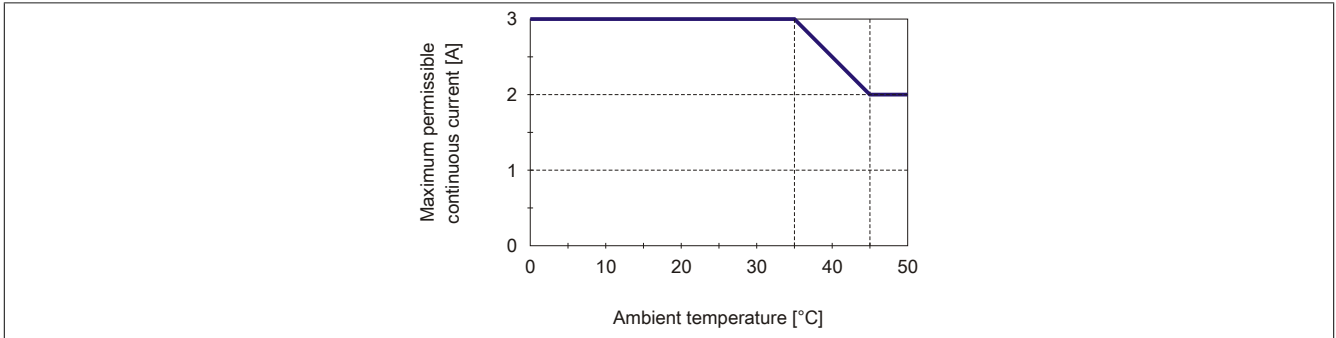
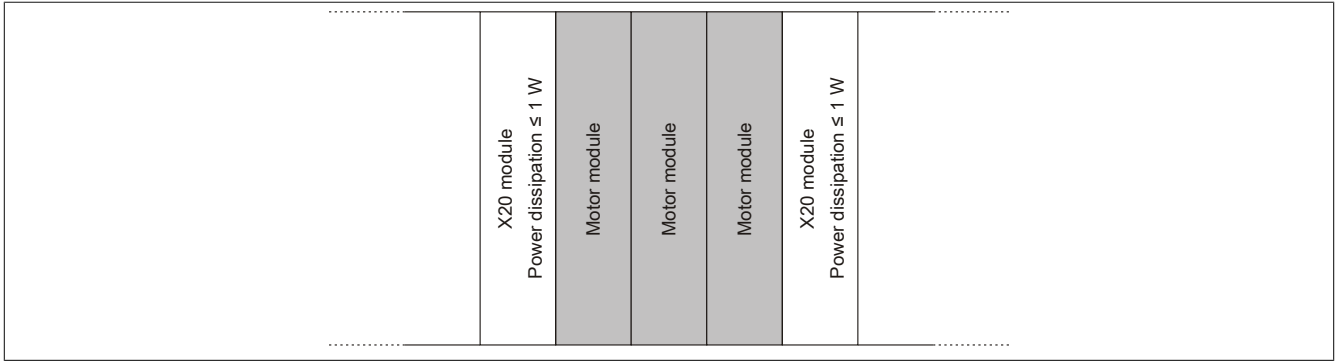
Current derating 2 of the motor module

Current derating for the motor module for neighboring modules with ≤ 1 W thermal power loss.



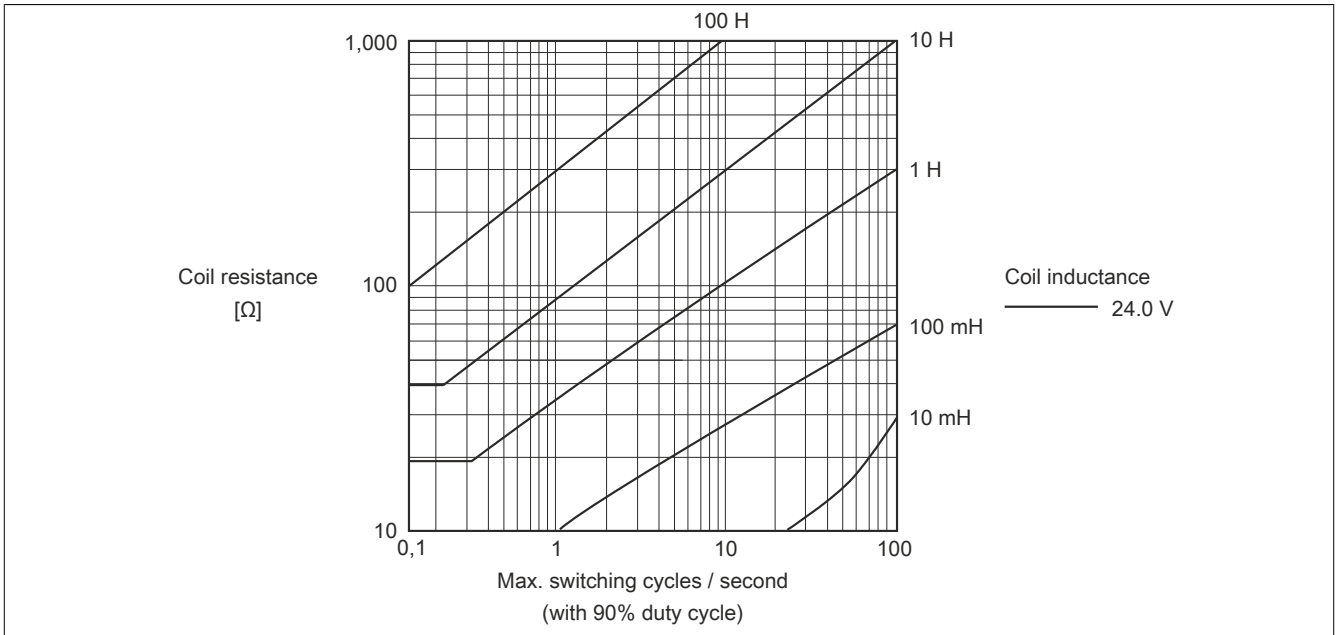
Current derating 3 of the motor module

Current derating with multiple motor modules next to each other.

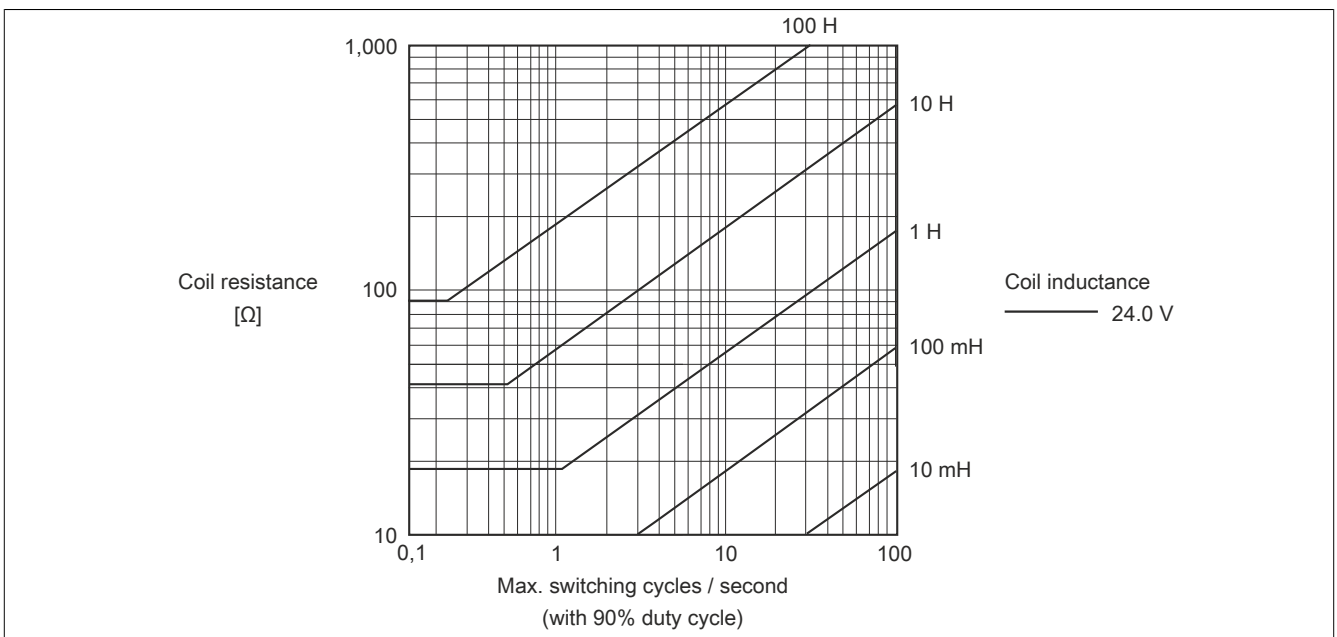


9.25.3.11 Switching inductive loads (e.g. valves)

With enabled short circuit channel - All outputs with same load



With disabled short circuit channel - All outputs with same load



9.25.3.12 Monitoring the module supply

The module supply is continually monitored. If the supply voltage drops below 18V, all channels are switched off and an error bit is set.

Information:

The undervoltage must be present for longer than 250 ms, before all channels are switched off. Power dips can occur when starting motors or capacitive loads!

9.25.3.13 Monitoring the module current

The module current is continually monitored. If an overcurrent occurs, the respective channel is switched off and an error bit is set.

Information:

The overcurrent must be present for longer than 250 ms, before the channel is switched off. High starting currents occur when starting motors or capacitive loads!

9.25.3.14 Channel monitoring

After each switching process, the status inputs are checked with a 2 ms delay to ensure they are correct. This is done so that faulty status signals are not generated when switching motors or capacitive loads.

If the status of the output does not correspond to the status that is expected (e.g. short circuit or motor spin-out), a warning bit is set.

Information:

When channel monitoring is triggered, a warning is given. The output remains switched even if there is a short circuit and is cycled to the output by the internal protective circuit.

If the motor is still spinning out, the voltage drops slowly. That means the warning bit "[StatusDigitalOutput](#)" on page 2537 can show a warning while the motor is spinning out.

If the motor is moved externally, voltage is induced into the module, which results in `StatusDigitalOutput` being set and the red LED being lit (warning).

9.25.3.15 Shutdown in the event of overtemperature (starting at 85°C)

If the module temperature reaches or overshoots the limit value of 85°C, the module performs the following actions:

- Sets the "overtemperature" error bit
- Cuts off the outputs (short-circuited)

As soon as the temperature is reduced below 85°C again, the error must be acknowledged with "OvertemperatureAcknowledge" so that the channels can be switched on again.

9.25.3.16 Register description

9.25.3.16.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.25.3.16.2 Function model 0 - Standard

In this function model, control of full bridges takes place using 3 bits per channel.

| Register | Name | Data type | Read | | Write | |
|----------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 0 | Motor configuration 1 - Default | USINT | | | • | |
| | StartChannel01 | Bit 0 | | | | |
| | ShortCircuitChannel01 | Bit 1 | | | | |
| | DirectionChannel01 | Bit 2 | | | | |
| | StartChannel02 | Bit 4 | | | | |
| | ShortCircuitChannel02 | Bit 5 | | | | |
| | DirectionChannel02 | Bit 6 | | | | |
| 1 | Motor configuration 2 - Default | USINT | | | • | |
| | StartChannel03 | Bit 0 | | | | |
| | ShortCircuitChannel03 | Bit 1 | | | | |
| | DirectionChannel03 | Bit 2 | | | | |
| 18 | Error acknowledged | USINT | | | • | |
| | OvercurrentAcknowledge01 | Bit 0 | | | | |
| | OvercurrentAcknowledge02 | Bit 1 | | | | |
| | OvercurrentAcknowledge03 | Bit 2 | | | | |
| | OvertemperatureAcknowledge | Bit 6 | | | | |
| | UndervoltageAcknowledge | Bit 7 | | | | |
| Communication | | | | | | |
| 4 | CurrentInput01 | USINT | • | | | |
| 6 | CurrentInput02 | USINT | • | | | |
| 8 | CurrentInput03 | USINT | • | | | |
| 20 | Module and channel status | USINT | • | | | |
| | OvercurrentError01 | Bit 0 | | | | |
| | OvercurrentError02 | Bit 1 | | | | |
| | OvercurrentError03 | Bit 2 | | | | |
| | StatusDigitalOutput01 | Bit 3 | | | | |
| | StatusDigitalOutput02 | Bit 4 | | | | |
| | StatusDigitalOutput03 | Bit 5 | | | | |
| | OvertemperatureError | Bit 6 | | | | |
| | UndervoltageError | Bit 7 | | | | |

9.25.3.16.3 Function model 1 - Byte control and Function model 254 - bus controller

Control of the half bridges takes place using one byte (two bits per channel). All other registers are the same as in [Function model 0 - Standard](#).

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 0 | 0 | Motor configuration - Byte control | USINT | | | • | |
| 18 | 4 | Error acknowledged | USINT | | | • | |
| | | OvercurrentAcknowledge01 | Bit 0 | | | | |
| | | OvercurrentAcknowledge02 | Bit 1 | | | | |
| | | OvercurrentAcknowledge03 | Bit 2 | | | | |
| | | OvertemperatureAcknowledge | Bit 6 | | | | |
| | | UndervoltageAcknowledge | Bit 7 | | | | |
| Communication | | | | | | | |
| 4 | 0 | CurrentInput01 | USINT | • | | | |
| 6 | 2 | CurrentInput02 | USINT | • | | | |
| 8 | 4 | CurrentInput03 | USINT | • | | | |
| 20 | 6 | Module and channel status | USINT | • | | | |
| | | OvercurrentError01 | Bit 0 | | | | |
| | | OvercurrentError02 | Bit 1 | | | | |
| | | OvercurrentError03 | Bit 2 | | | | |
| | | StatusDigitalOutput01 | Bit 3 | | | | |
| | | StatusDigitalOutput02 | Bit 4 | | | | |
| | | StatusDigitalOutput03 | Bit 5 | | | | |
| | | OvertemperatureError | Bit 6 | | | | |
| | | UndervoltageError | Bit 7 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.25.3.16.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.25.3.16.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.25.3.16.4 Configuration

9.25.3.16.4.1 Motor configuration 1 - Default

Name:

StartChannel01 to StartChannel02

ShortCircuitChannel01 to ShortCircuitChannel02

DirectionChannel01 to DirectionChannel02

This register contains the control bits for the first two channels.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | | | Description |
|-----|-----------------------|---|--|
| 0 | StartChannel01 | 0 | Switch off channel 1 |
| | | 1 | Channel 1 is started (bridge control) |
| 1 | ShortCircuitChannel01 | 0 | Do not short circuit channel 1. |
| | | 1 | Short circuit channel 1. |
| 2 | DirectionChannel01 | 0 | Rotational direction 1 |
| | | 1 | Rotational direction 2: The polarity of the connections for motor 1 are reversed internally. ¹⁾ |
| 3 | Reserved | - | Reserved |
| 4 | StartChannel02 | 0 | Switch off channel 2 |
| | | 1 | Channel 2 is started (bridge control) |
| 5 | ShortCircuitChannel02 | 0 | Do not short circuit channel 2. |
| | | 1 | Short circuit channel 2. |
| 6 | DirectionChannel02 | 0 | Rotational direction 1 |
| | | 1 | Rotational direction 2: The polarity of the connections for motor 2 are reversed internally. ¹⁾ |
| 7 | Reserved | - | |

1) The direction of rotation on the motor is changed by internally reversing the polarity of the connections.

Information:

StartChannel 1 to 2 and ShortCircuitChannel 1 to 2:

To avoid internal bridge shorts, the outputs are delayed by 200 µs when switching to another state or a short circuit.

Information:

When the direction of the motor is changed, the polarity is reversed. If the direction of rotation on the motor is changed during operation, the motor immediately brakes and turns in the other direction. This can result in very high current values. Therefore, we recommend short-circuiting the motor first (braking) and then changing to the other direction.

9.25.3.16.4.2 Motor configuration 2 - Default

Name:

StartChannel03

ShortCircuitChannel03

DirectionChannel03

This register contains the control bits for the third channel.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | | | Description |
|-------|-----------------------|---|--|
| 0 | StartChannel03 | 0 | Switch off channel 3 |
| | | 1 | Switch on channel 3 |
| 1 | ShortCircuitChannel03 | 0 | Do not short circuit channel 3. |
| | | 1 | Short circuit channel 3. |
| 2 | DirectionChannel03 | 0 | Rotational direction 1 |
| | | 1 | Rotational direction 2: The polarity of the connections for motor 3 are reversed internally. ¹⁾ |
| 3 - 7 | Reserved | - | |

1) The direction of rotation on the motor is changed by internally reversing the polarity of the connections.

Information:

StartChannel 3 and ShortCircuitChannel 3:

To avoid internal bridge shorts, the outputs are delayed by 200 µs when switching to another state or a short circuit.

Information:

When the direction of the motor is changed, the polarity is reversed. If the direction of rotation on the motor is changed during operation, the motor immediately brakes and turns in the other direction. This can result in very high current values. Therefore, we recommend short-circuiting the motor first (braking) and then changing to the other direction.

9.25.3.16.4.3 Motor configuration - Byte control

Name:

ControlByte01

This register is used to control all 3 channels. Two bits per channels are always grouped together. This register is only used in [Function model 1 - Byte control](#) and [Function model 254 - bus controller](#).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | | | Description |
|-------|-----------|-----|--|
| 0 - 1 | Channel 1 | 00 | No-load operation |
| | | 01 | Rotational direction 1 |
| | | 10 | Rotational direction 2: The polarity of the connections for motor 1 are reversed internally. ¹⁾ |
| | | 11 | Short circuit |
| ... | | ... | |
| 4 - 5 | Channel 3 | 00 | No-load operation |
| | | 01 | Rotational direction 1 |
| | | 10 | Rotational direction 2: The polarity of the connections for motor 3 are reversed internally. ¹⁾ |
| | | 11 | Short circuit |
| 6 - 7 | Reserved | - | |

1) The direction of rotation on the motor is changed by internally reversing the polarity of the connections.

Information:

When the direction of the motor is changed, the polarity is reversed. If the direction of rotation on the motor is changed during operation, the motor immediately brakes and turns in the other direction. This can result in very high current values. Therefore, we recommend short-circuiting the motor first (braking) and then changing to the other direction.

9.25.3.16.4.4 Error acknowledged

Name:

OvercurrentAcknowledge01 to OvercurrentAcknowledge03

OvertemperatureAcknowledge

UndervoltageAcknowledge

This register contains bits used to acknowledge an overcurrent error, an undervoltage error and an overtemperature error.

The errors are acknowledged with a rising edge. An existing error can only be acknowledged if the cause of the error has been corrected.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | | | Description |
|-------|----------------------------|---|---|
| 0 | OvercurrentAcknowledge01 | 1 | With a rising edge, the overcurrent error shown on channel 1 is acknowledged. |
| 1 | OvercurrentAcknowledge02 | 1 | With a rising edge, the overcurrent error shown on channel 2 is acknowledged. |
| 2 | OvercurrentAcknowledge03 | 1 | With a rising edge, the overcurrent error shown on channel 3 is acknowledged. |
| 3 - 5 | Reserved | - | |
| 6 | OvertemperatureAcknowledge | 1 | With a rising edge, the overtemperature error shown is acknowledged. |
| 7 | UndervoltageAcknowledge | 1 | With a rising edge, the undervoltage error shown is acknowledged. |

9.25.3.16.5 Communication**9.25.3.16.5.1 Voltage of the channels**

Name:

CurrentInput01 to CurrentInput03

Every 700 μ s, the current that flows through a channel is measured with a resolution of 8 bits. The value measured is stored in these registers.

| Data type | Value | Information |
|-----------|----------|-------------|
| USINT | 0 to 255 | 0 to 5 A |

9.25.3.16.5.2 Module and channel status

Name:

OvercurrentError01 to OvercurrentError03
 StatusDigitalOutput01 to StatusDigitalOutput03
 OvertemperatureError
 UndervoltageError

Some operating states are monitored by the module. They are:

- "Module supply" on page 2531
- "Module current" on page 2531
- "Status channels" on page 2531
- "Module temperature" on page 2531

The states are stored in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | | | Description |
|-----|-----------------------|---|--|
| 0 | OvercurrentError01 | 0 | No overcurrent on channel 1 |
| | | 1 | Overcurrent on channel 1 |
| 1 | OvercurrentError02 | 0 | No overcurrent on channel 2 |
| | | 1 | Overcurrent on channel 2 |
| 2 | OvercurrentError03 | 0 | No overcurrent on channel 3 |
| | | 1 | Overcurrent on channel 3 |
| 3 | StatusDigitalOutput01 | 0 | Channel 1 output status OK |
| | | 1 | Channel 1 output warning: Short-circuit or invalid output status |
| 4 | StatusDigitalOutput02 | 0 | Channel 2 output status OK |
| | | 1 | Channel 2 output warning: Short-circuit or invalid output status |
| 5 | StatusDigitalOutput03 | 0 | Channel 3 output status OK |
| | | 1 | Channel 3 output warning: Short-circuit or invalid output status |
| 6 | OvertemperatureError | 0 | Module temperature within permitted range |
| | | 1 | Module overtemperature error |
| 7 | UndervoltageError | 0 | Supply voltage within permitted range |
| | | 1 | Supply voltage has dropped below 18V |

9.25.3.16.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 400 μ s |

9.25.3.16.7 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 400 μ s |

9.25.4 X20MM4331

Data sheet version: 2.04

9.25.4.1 General information

The 4 outputs on the motor module are designed as half-bridge outputs. The continuous current per channel is 3 A at a peak current of up to 5 A. Integrated diagnostics offer the possibility to read back the output current for each channel using the application.

The module offers extensive possibilities for controlling motors, valves or resistive loads and is particularly well suited for controlling brush DC motors. The outputs can be switched on/off and short-circuited.

- 4 half-bridge outputs
- High component density
- 3 A continuous current
- 5 A peak current
- Readable current

9.25.4.2 Order data


| Model number | Short description | Figure |
|--------------|--|--|
| X20MM4331 | X20 digital motor module, 24 VDC, 4 digital outputs, half bridge, 3 A continuous current, 5 A peak current |  |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 496: X20MM4331 - Order data

9.25.4.3 Technical data

| Model number | X20MM4331 |
|--|---|
| Short description | |
| I/O module | 4 half-bridge outputs |
| General information | |
| B&R ID code | 0xA976 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Output | Yes, using status LED and software |
| I/O power supply | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 0.8 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |


Table 497: X20MM4331 - Technical data

| Model number | X20MM4331 |
|---|--|
| Motor bridge - Power unit | |
| Quantity | 4 |
| Type | Half bridge High-side driver Low-side driver |
| Nominal voltage | 24 VDC |
| Switching voltage | 24 VDC (-15% / +20%) |
| Nominal current | 3 A |
| Maximum current | 5 A (250 ms) |
| Total nominal current | 10 A |
| Current value measurement | |
| Resolution | 100 mA |
| Data collection | On the high-side branch |
| Output protection | Thermal cutoff for overcurrent and short circuit |
| Supply voltage | No reverse polarity protection |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Digital outputs | |
| Quantity | 4 |
| Nominal voltage | 24 VDC |
| Output protection | Thermal cutoff for overcurrent and short circuit |
| Type | Half bridge High-side driver (Source) Low-side driver (Sink) |
| Max. continuous current per output | 3 A |
| Max. module current | 10 A |
| Recording current value on high branch | |
| Resolution | 100 mA |
| Electrical properties | |
| Electrical isolation | Bus isolated from channel and external I/O power supply Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | 0 to 50°C |
| Vertical mounting orientation | Not permitted |
| Derating | See section "Derating" |
| Storage | -25 to 70°C |
| Transport | -25 to 70°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 497: X20MM4331 - Technical data

9.25.4.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

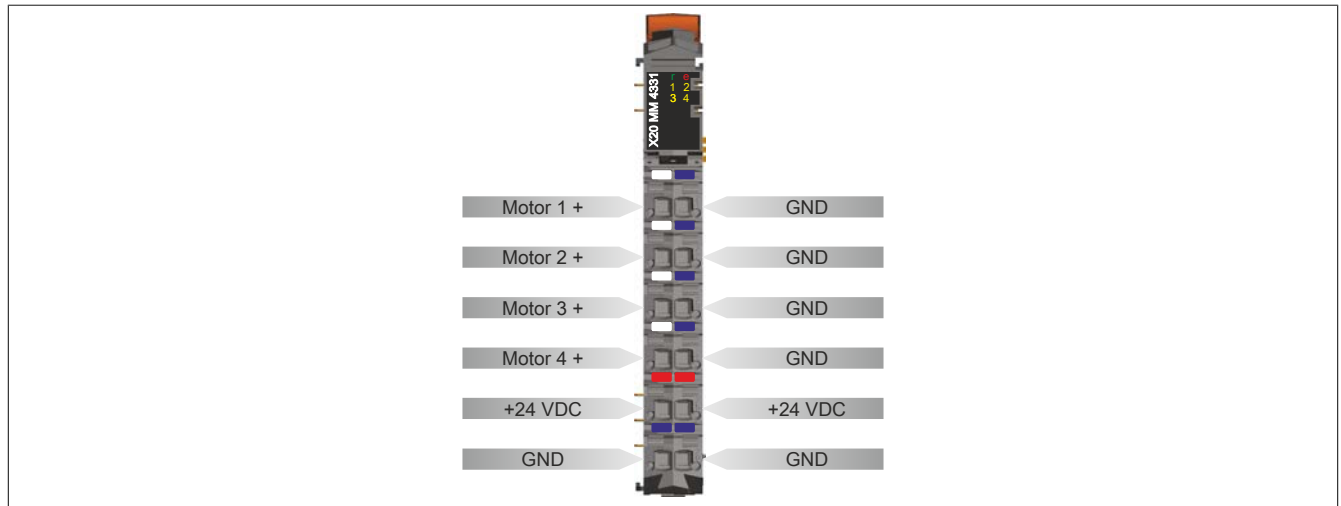
| Figure | LED | Color | Status | Description |
|---|-------|--------|-----------------------------|--|
|  | r | Green | Off | No power to module |
| | | | Off | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | e + r | | Red on / Green single flash | Invalid firmware |
| | 1 - 4 | Orange | On | The corresponding output is active |
| | | | Blinking | Error on the corresponding output |
| | | | Off | The corresponding output is switched off |

9.25.4.5 Pinout

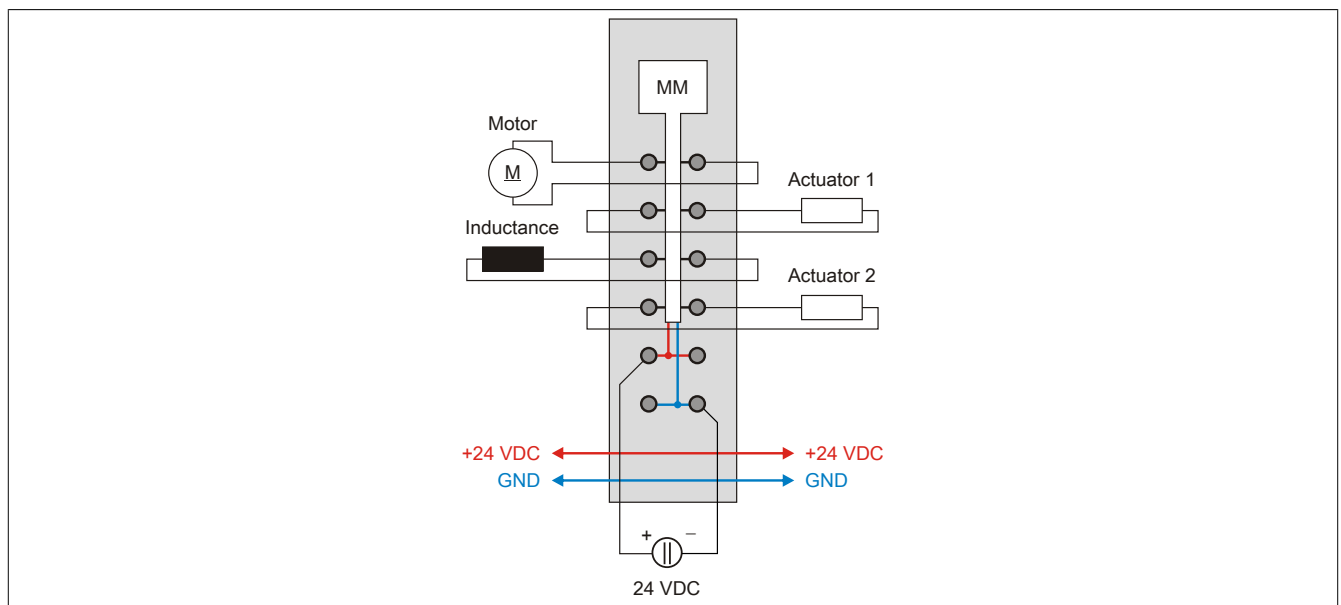
Lines with a cross section between a minimum of 0.75 mm² and a maximum of 2.5 mm² are recommended for the outputs.

Warning!

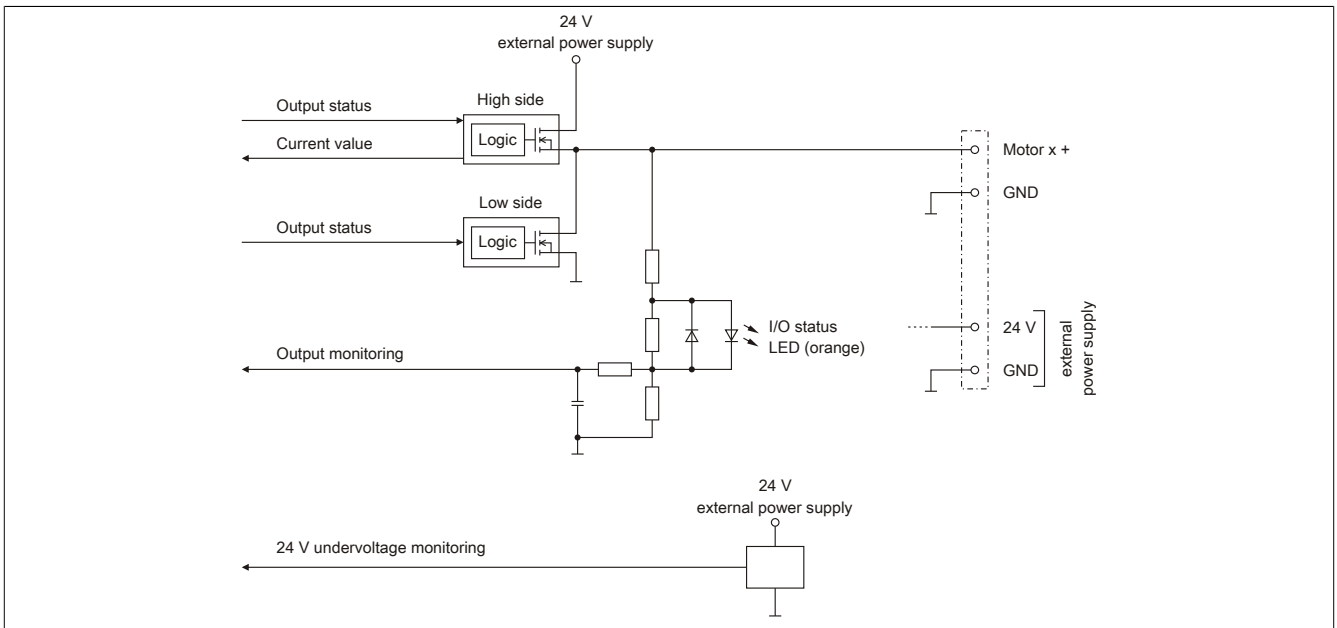
The terminal block is not permitted to be plugged in or unplugged during operation.



9.25.4.6 Connection example

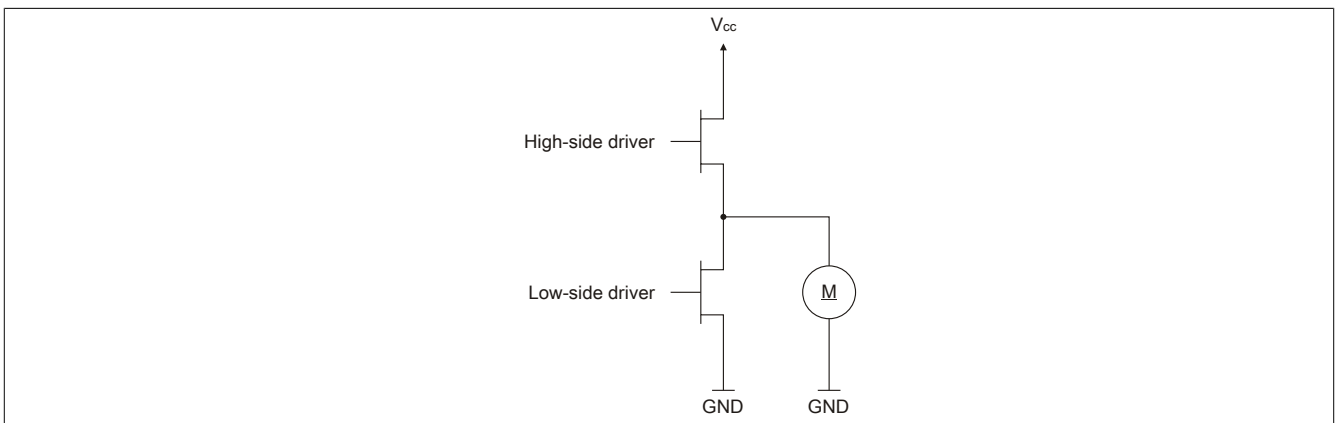


9.25.4.7 Output circuit diagram



9.25.4.8 Function description - Motor operation

Four DC motors can be operated with the module. Each output is designed as a half-bridge.



Description of the operating modes using the basic circuit diagram shown above:

| Operating mode | Description |
|------------------|--|
| Motor is running | If the high-side driver is active, the motor is switched on. |
| Brakes | If motor braking should take place, the high-side driver is first switched off and then the low-side driver is activated. In this way, the motor windings are short-circuited and the motor braking takes place. |

9.25.4.9 Protection

The power supply line should be protected by a circuit breaker or a fuse. In general, dimensioning the supply line and overcurrent protection depends on the structure of the power supply (modules can be connected individually or in groups).

Information:

The effective current for the power supply depends on the load, but is always less than the sum of the output currents. Make sure that the maximum nominal current of 31 A per pin is not exceeded on the power supply terminals of the power unit.

When choosing a suitable fuse, the user must also account for characteristics such as aging effects, temperature derating, overcurrent capacity and the definition of the rated current, which can vary by manufacturer and type. In addition, the fuse that is selected must also be able to handle application-specific characteristics (e.g. overcurrent that occurs in acceleration cycles).

The cross section of the power mains and the rated current of the overcurrent protection used are chosen according to the current load so that the maximum current load for the cable cross section selected (based on the type of layout, see table) is greater than or equal to the current load in the power mains. The rated current of the overcurrent protection must be less than or equal to the maximum current load for the cable cross section selected (based on the type of layout, see table):

$$I_{\text{Mains}} \leq I_{\text{Fuse}} \leq I_{\text{Line/cable}}$$

| Wire cross section [mm ²] | Current load of the cable cross section I_z / rated current of the over current protection I_b [A] according to type of installation in an ambient air temperature of 40°C in accordance to EN 60204-1 | | | |
|---------------------------------------|--|-----------|-----------|-----------|
| | B1 | B2 | C | E |
| 1.5 | 13.5 / 13 | 13.1 / 10 | 15.2 / 13 | 16.1 / 16 |
| 2.5 | 18.3 / 16 | 16.5 / 16 | 21 / 20 | 22 / 20 |
| 4 | 24 / 24 | 23 / 20 | 28 / 25 | 30 / 25 |
| 6 | 32 / 32 | 29 / 25 | 36 / 32 | 37 / 32 |

Table 498: Cable cross section of the mains supply line depending on the type of layout

The tripping current of the fuse cannot exceed the rated current of fuse I_b .

| Type of layout | Description |
|----------------|------------------------------------|
| B1 | Wires in conduit or cable duct |
| B2 | Cables in conduit or cable duct |
| C | Cables or wires on walls |
| E | Cables or wires on open cable tray |

Table 499: Type of layout for the mains supply line

9.25.4.10 Derating

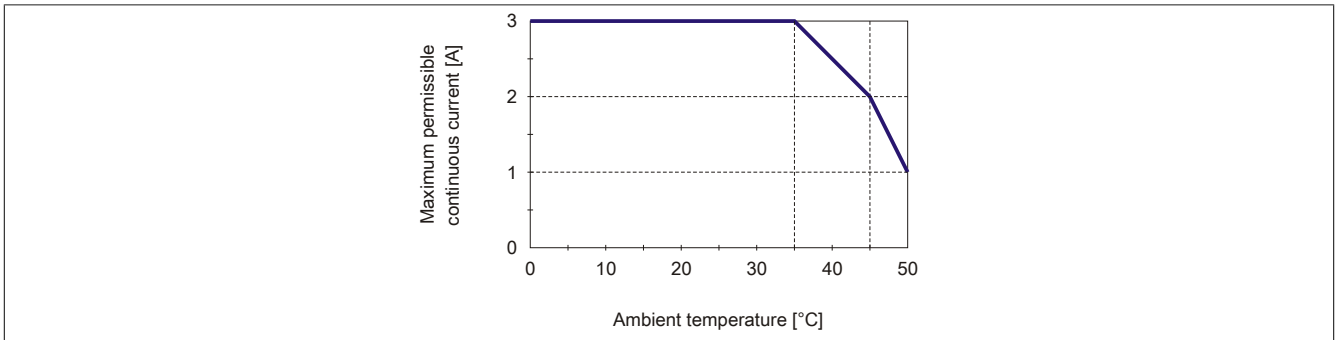
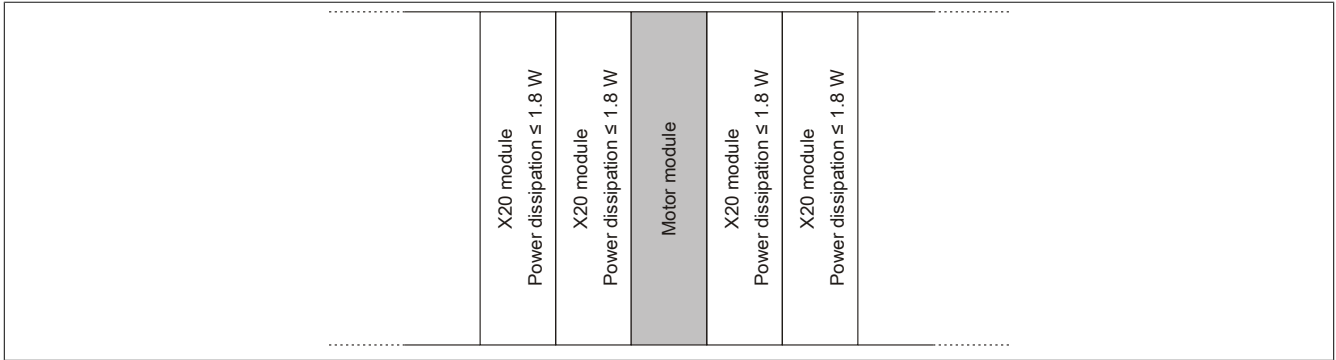
In order to be able to operate the motor module over the entire temperature range, only modules with a maximum power loss of 0.5 W can be installed next to the motor module or respective turn-off times must be implemented.

If the neighboring modules have a higher power loss and all channels are operated continuously, the motor current must be derated.

When a motor is switched on, the current is increased for a short time. This behavior has no influence on the derating.

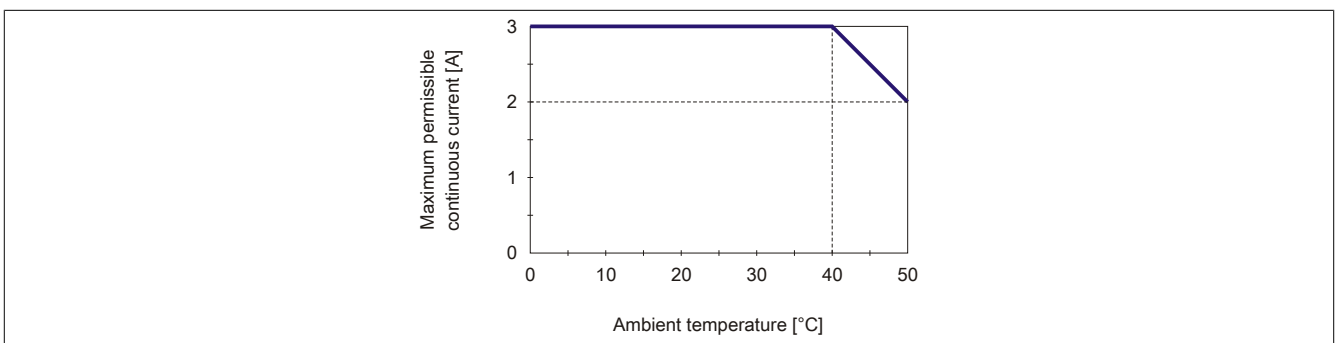
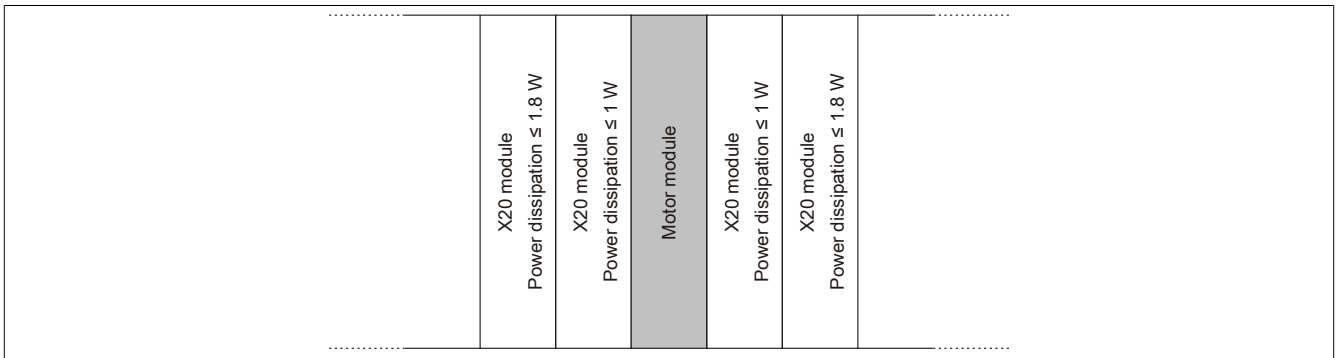
Current derating 1 of the motor module

Current derating for the motor module for neighboring modules with ≤ 1.8 W thermal power loss.



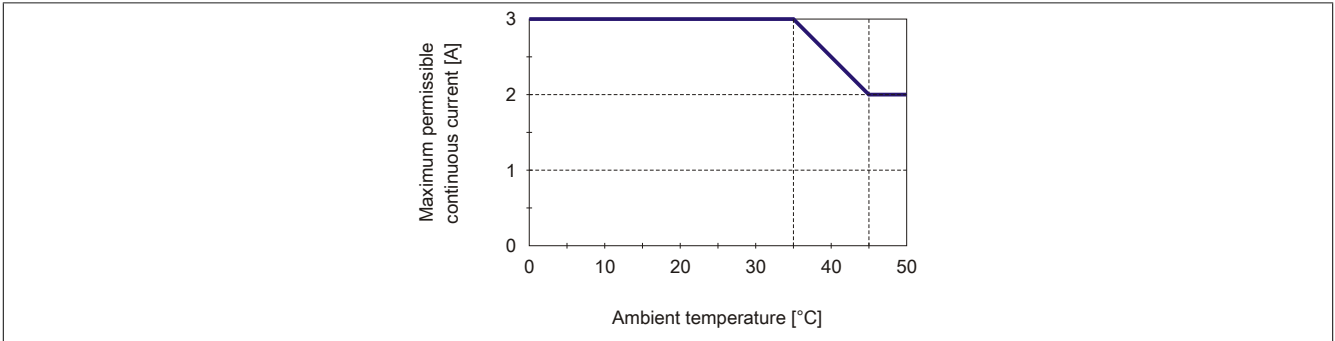
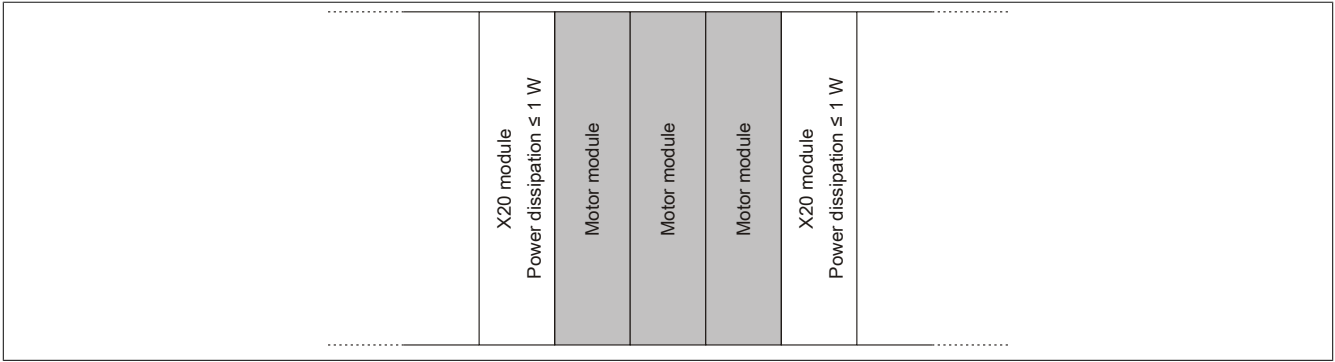
Current derating 2 of the motor module

Current derating for the motor module for neighboring modules with ≤ 1 W thermal power loss.



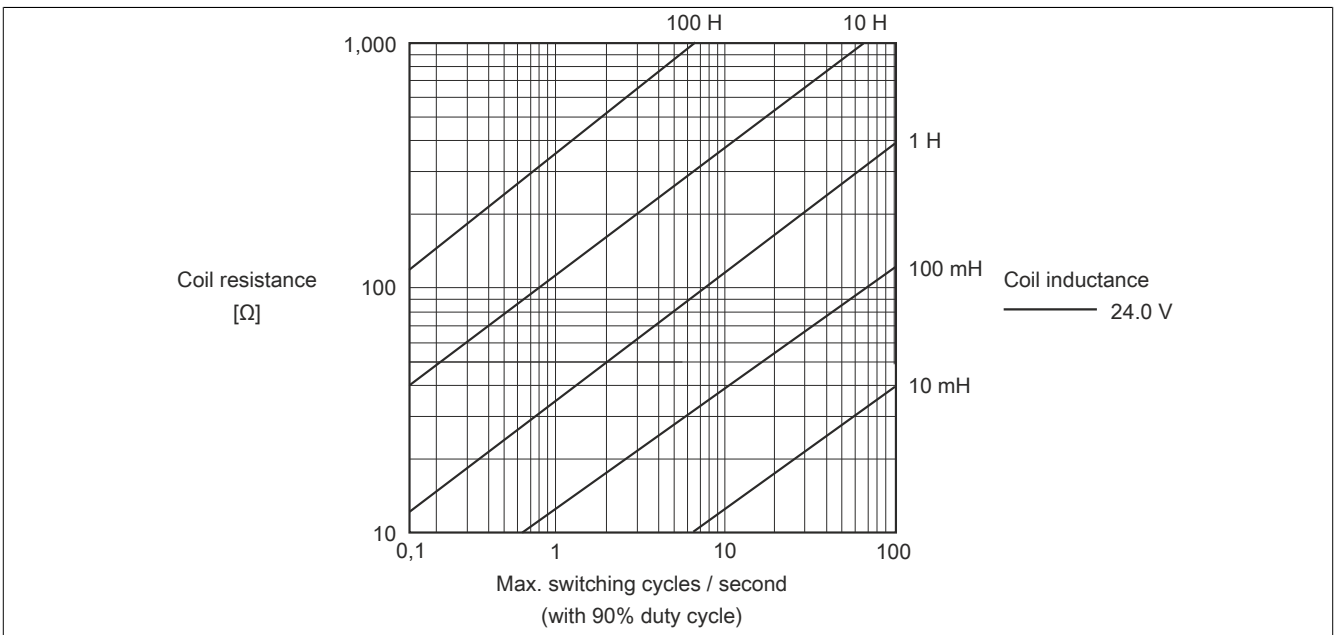
Current derating 3 of the motor module

Current derating with multiple motor modules next to each other.



9.25.4.11 Switching inductive loads (e.g. valves)

All outputs with the same load.



9.25.4.12 Monitoring the module supply

The module supply is continually monitored. If the supply voltage drops below 18V, all channels are switched off and an error bit is set.

Information:

The undervoltage must be present for longer than 250 ms, before all channels are switched off. Power dips can occur when starting motors or capacitive loads!

9.25.4.13 Monitoring the module current

The module current is continually monitored. If an overcurrent occurs, the respective channel is switched off and an error bit is set.

Information:

The overcurrent must be present for longer than 250 ms, before the channel is switched off. High starting currents occur when starting motors or capacitive loads!

9.25.4.14 Channel monitoring

After each switching process, the status inputs are checked with a 2 ms delay to ensure they are correct. This is done so that faulty status signals are not generated when switching motors or capacitive loads.

If the status of the output does not correspond to the status that is expected (e.g. short circuit or motor spin-out), a warning bit is set.

Information:

When channel monitoring is triggered, a warning is given. The output remains switched even if there is a short circuit and is cycled to the output by the internal protective circuit.

If the motor is still spinning out, the voltage drops slowly. That means the warning bit "[StatusDigitalOutput](#)" on page 2549 can show a warning while the motor is spinning out.

If the motor is moved externally, voltage is induced into the module, which results in `StatusDigitalOutput` being set and the red LED being lit (warning).

9.25.4.15 Shutdown in the event of overtemperature (starting at 85°C)

If the module temperature reaches or overshoots the limit value of 85°C, the module performs the following actions:

- Sets the "overtemperature" error bit
- Cuts off the outputs (short-circuited)

As soon as the temperature is reduced below 85°C again, the error must be acknowledged with "OvertemperatureAcknowledge" so that the channels can be switched on again.

9.25.4.16 Register description

9.25.4.16.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.25.4.16.2 Function model 0 - Standard

In this function model, control of full bridges takes place using 3 bits per channel.

| Register | Name | Data type | Read | | Write | |
|----------------------|-----------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 0 | Motor configuration - Default | USINT | | | • | |
| | StartChannel01 | Bit 0 | | | | |
| | ShortCircuitChannel01 | Bit 1 | | | | |
| | StartChannel02 | Bit 2 | | | | |
| | ShortCircuitChannel02 | Bit 3 | | | | |
| | StartChannel03 | Bit 4 | | | | |
| | ShortCircuitChannel03 | Bit 5 | | | | |
| | StartChannel04 | Bit 6 | | | | |
| 18 | Error acknowledged | USINT | | | • | |
| | OvercurrentAcknowledge01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | OvercurrentAcknowledge04 | Bit 3 | | | | |
| | OvertemperatureAcknowledge | Bit 5 | | | | |
| | UndervoltageAcknowledge | Bit 6 | | | | |
| Communication | | | | | | |
| 2 + N * 2 | CurrentInput0N (Index N = 1 to 4) | USINT | • | | | |
| 20 | Status of current and channels | USINT | • | | | |
| | OvercurrentError01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | OvercurrentError04 | Bit 3 | | | | |
| | StatusDigitalOutput01 | Bit 4 | | | | |
| | ... | ... | | | | |
| 21 | StatusDigitalOutput04 | Bit 7 | | | | |
| | Module status | USINT | • | | | |
| | OvertemperatureError | Bit 0 | | | | |
| | UndervoltageError | Bit 1 | | | | |

9.25.4.16.3 Function model 1 - Byte control and Function model 254 - bus controller

Control of the half bridges takes place using one byte (two bits per channel). All other registers are the same as in [Function model 0 - Standard](#).

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|------------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 0 | 0 | Motor configuration - Byte control | USINT | | | • | |
| 18 | 12 | Error acknowledged | USINT | | | • | |
| | | OvercurrentAcknowledge01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | OvercurrentAcknowledge04 | Bit 3 | | | | |
| | | OvertemperatureAcknowledge | Bit 5 | | | | |
| | | UndervoltageAcknowledge | Bit 6 | | | | |
| Communication | | | | | | | |
| $2 + N * 2$ | $2 + N * 2$ | CurrentInput0N (Index N = 1 to 4) | USINT | • | | | |
| 20 | 8 | Status of current and channels | USINT | • | | | |
| | | OvercurrentError01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | OvercurrentError04 | Bit 3 | | | | |
| | | StatusDigitalOutput01 | Bit 4 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput04 | Bit 7 | | | | |
| 21 | 10 | Module status | USINT | • | | | |
| | | OvertemperatureError | Bit 0 | | | | |
| | | UndervoltageError | Bit 1 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.25.4.16.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.25.4.16.3.2 CAN I/O bus controller

The module occupies 2 analog logical slots on CAN I/O.

9.25.4.16.4 Configuration

9.25.4.16.4.1 Motor configuration - Default

Name:

StartChannel01 to StartChannel04

ShortCircuitChannel01 to ShortCircuitChannel04

This register contains the control bits for all channels.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | | | Description |
|-----|-----------------------|---|---------------------------------------|
| 0 | StartChannel01 | 0 | Switch off channel 1 |
| | | 1 | Channel 1 is started (bridge control) |
| 1 | ShortCircuitChannel01 | 0 | Do not short circuit channel 1. |
| | | 1 | Short circuit channel 1. |
| 2 | StartChannel02 | 0 | Switch off channel 2 |
| | | 1 | Channel 2 is started (bridge control) |
| 3 | ShortCircuitChannel02 | 0 | Do not short circuit channel 2. |
| | | 1 | Short circuit channel 2. |
| 4 | StartChannel03 | 0 | Switch off channel 3 |
| | | 1 | Channel 3 is started (bridge control) |
| 5 | ShortCircuitChannel03 | 0 | Do not short circuit channel 3. |
| | | 1 | Short circuit channel 3. |
| 6 | StartChannel04 | 0 | Switch off channel 4 |
| | | 1 | Channel 4 is started (bridge control) |
| 7 | ShortCircuitChannel04 | 0 | Do not short circuit channel 4. |
| | | 1 | Short circuit channel 4. |

Information:

To avoid internal bridge shorts, the outputs are delayed by 200 µs when switching to another state or a short circuit.

9.25.4.16.4.2 Motor configuration - Byte control

Name:

ControlByte01

This register is used to control all four channels. Two bits per channels are always grouped together. This register is only used in [Function model 1 - Byte control](#) and [Function model 254 - bus controller](#).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | | | Description |
|-------|-----------|-----|---------------|
| 0 - 1 | Channel 1 | 00 | Off |
| | | 01 | On |
| | | 10 | Off |
| | | 11 | Short circuit |
| ... | | ... | |
| 6 - 7 | Channel 4 | 00 | Off |
| | | 01 | On |
| | | 10 | Off |
| | | 11 | Short circuit |

9.25.4.16.4.3 Error acknowledged

Name:

OvercurrentAcknowledge01 to OvercurrentAcknowledge04
OvertemperatureAcknowledge
UndervoltageAcknowledge

This register contains bits used to acknowledge an overcurrent error, an undervoltage error and an overtemperature error.

The errors are acknowledged with a rising edge. An existing error can only be acknowledged if the cause of the error has been corrected.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | | | Description |
|-------|----------------------------|-----|---|
| 0 | OvercurrentAcknowledge01 | 1 | With a rising edge, the overcurrent error shown on channel 1 is acknowledged. |
| ... | | ... | |
| 3 | OvercurrentAcknowledge04 | 1 | With a rising edge, the overcurrent error shown on channel 4 is acknowledged. |
| 4 - 5 | Reserved | - | |
| 6 | OvertemperatureAcknowledge | 1 | With a rising edge, the overtemperature error shown is acknowledged. |
| 7 | UndervoltageAcknowledge | 1 | With a rising edge, the undervoltage error shown is acknowledged. |

9.25.4.16.5 Communication

9.25.4.16.5.1 Voltage of the channels

Name:

CurrentInput01 to CurrentInput04

Every 500 μ s, the current that flows through a channel is measured with a resolution of 8 bits. The value measured is stored in these registers.

| Data type | Value | Information |
|-----------|----------|-------------|
| USINT | 0 to 255 | 0 to 5 A |

9.25.4.16.5.2 Status of current and channels

Name:

OvercurrentError01 to OvercurrentError04
StatusDigitalOutput01 to StatusDigitalOutput04

Some operating states are monitored by the module. They are:

- ["Module current" on page 2545](#)
- ["Status channels" on page 2545](#)

The states are stored in this register. For other operating modes, see ["Module status" on page 2550](#)

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | | | Description |
|-----|-----------------------|-----|--|
| 0 | OvercurrentError0 | 0 | No overcurrent on channel 1 |
| | | 1 | Overcurrent on channel 1 |
| ... | | ... | |
| 3 | OvercurrentError04 | 0 | No overcurrent on channel 4 |
| | | 1 | Overcurrent on channel 4 |
| 4 | StatusDigitalOutput01 | 0 | Channel 1 output status OK |
| | | 1 | Channel 1 output warning: Short-circuit or invalid output status |
| ... | | ... | |
| 7 | StatusDigitalOutput04 | 0 | Channel 4 output status OK |
| | | 1 | Channel 4 output warning: Short-circuit or invalid output status |

9.25.4.16.5.3 Module status

Name:

OvertemperatureError

UndervoltageError

Some operating states are monitored by the module. They are:

- ["Module supply" on page 2545](#)
- ["Module temperature" on page 2545](#)

The states are stored in this register. For other operating modes, see ["Status of current and channels" on page 2549](#)

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | | | Description |
|-------|----------------------|---|---|
| 0 | OvertemperatureError | 0 | Module temperature within permitted range |
| | | 1 | Module overtemperature error |
| 1 | UndervoltageError | 0 | Supply voltage within permitted range |
| | | 1 | Supply voltage has dropped below 18V |
| 2 - 7 | Reserved | - | |

9.25.4.16.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 400 μ s |

9.25.4.16.7 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 400 μ s |

9.25.5 X20MM4455

Data sheet version: 1.21

9.25.5.1 General information

The PWM motor bridge module is used to control 4 DC motors with a nominal voltage of 24 to 48 VDC $\pm 25\%$ at a nominal current up to 6 A. The module can be reconfigured and used in current controller mode for controlling inductive loads. The module is also equipped with 12 digital inputs, which can be used as incremental counters. The 4 motors are controlled with a full-bridge (H-bridge). This enables the motors to be moved in both directions.

- 4x outputs (H bridge) with PWM control and 24 to 48 VDC $\pm 25\%$ supply
- 6 A nominal current (10 A max. current)
- 15 Hz to 50 kHz frequency, 16-bit
- PWM resolution, 15-bit + sign, minimum 10 ns
- Configurable dither
- 12 inputs 5 V, configurable for AB and ABR incremental encoders
- 2x 5 V encoder supply with up to 200 mA
- Source connection of digital inputs for encoder's open collector outputs
- 1-wire connections

9.25.5.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Motor controllers |  |
| X20MM4455 | X20 PWM motor module, 24 to 48 VDC $\pm 25\%$, 4 PWM motor bridges, 6 A continuous current, 10 A peak current, 4x 3 digital inputs 5 VDC single-ended, source, configurable as incremental encoder | |
| | Required accessories | |
| | Terminal blocks | |
| 0TB3103-7020 | Accessory terminal block, 3-pin, screw clamps 6 mm ² | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 500: X20MM4455 - Order data

9.25.5.3 Technical data

| | |
|--|--|
| Model number | X20MM4455 |
| Short description | |
| I/O module | 4-channel PWM motor bridge, 4 ABR incremental encoders |
| General information | |
| B&R ID code | 0xE8A4 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Output | Yes, using status LED and software |
| Encoder power supply | Yes, using status LED and software |
| I/O power supply | Yes, using software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 2.4 W ¹⁾ |
| External I/O 50 kHz | |
| 24 VDC | 3.3 W / channel |
| 48 VDC | 4.7 W / channel |
| 60 VDC | 5.4 W / channel |
| External I/O 10 kHz | |
| 24 VDC | 2.1 W / channel |
| 48 VDC | 2.4 W / channel |
| 60 VDC | 2.6 W / channel |
| External I/O 5 kHz | |
| 24 VDC | 2 W / channel |
| 48 VDC | 2.1 W / channel |
| 60 VDC | 2.2 W / channel |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E225616 Power conversion equipment |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| Encoder power supply | |
| Quantity | 2 |
| Output voltage | 5 VDC ²⁾ |
| Output current | Max. 200 mA each |
| Short-circuit proof, overload protection | Yes |
| Digital inputs | |
| Quantity | 12 |
| Nominal voltage | 5 VDC, asymmetrical (single-ended) |
| Input circuit | Source |
| Input filter | |
| Hardware | <1 µs |
| Software | - |
| Connection type | 1-wire connections |
| Input resistance | Typ. 2.7 kΩ |
| Additional functions | 4x ABR incremental encoder |
| Switching threshold | |
| Low | <2 V |
| High | >3 V |
| Isolation voltage between channel and bus | 500 V _{eff} |
| ABR incremental encoder | |
| Quantity | 4 |
| Encoder inputs | 5 VDC, asymmetrical (single-ended) |
| Counter size | 16-bit |
| Input frequency | Max. 100 kHz |
| Evaluation | 4x |
| Signal form | Square wave pulse |
| PWM output | |
| Quantity | 4 |
| Nominal voltage | 24 to 48 VDC ±25% |
| Nominal current | 6 A |
| Maximum current | 10 A (2 s) |
| PWM frequency | 15 Hz to 50 kHz |
| Actuator power supply | |
| Supply | External |
| Fuse | Required line fuse: Max. 32 A slow-blow (see "Overcurrent protection") |
| Output protection | Thermal cutoff for overcurrent and short circuit |

Table 501: X20MM4455 - Technical data

| Model number | X20MM4455 | |
|---|---|--|
| Variant | H bridge | |
| Configurable dither | Amplitude, frequency | |
| Period duration resolution | 16-bit, min. 20 µs | |
| Phase shift PWM1, 2, 3, 4 | each 90° | |
| DC bus capacitance | 680 µF | |
| PWM pulse width | | |
| PWM mode | 15-bit + sign ≥10 ns | |
| Current mode | 15-bit + sign ≥10 ns | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | 0 to 50°C | |
| Vertical mounting orientation | Not permitted | |
| Derating | - | |
| Storage | -25 to 70°C | |
| Transport | -25 to 70°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 2x X20TB12 terminal block separately Order 1x OTB3103-7020 terminal block separately | |
| Spacing | 87.5 ^{+0.2} mm | |


Table 501: X20MM4455 - Technical data

- 1) Power consumption without encoder power supply
- 2) The 5 VDC is formed from the internal I/O power supply.

9.25.5.4 LED status indicators


For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

Status LED, left

| Figure | LED | Color | Status | Description |
|---|--------|-----------------------------|------------------------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1 - 6 | Green | | Input state of the corresponding digital input |
| | l | Red | Off | Encoder supply lies in the valid range |
| On | | | Encoder supply is overloaded | |
| M1 + M2 | Orange | On | The corresponding output is active | |

- 1) Depending on the configuration, a firmware update can take up to several minutes.

Status LED, right

| Figure | LED | Color | Status | Description |
|---|---------|--------|--------|--|
|  | 7 - 12 | Green | | Input state of the corresponding digital input |
| | l | Red | Off | Encoder supply lies in the valid range |
| | | | On | Encoder supply is overloaded |
| | M3 + M4 | Orange | On | The corresponding output is active |

9.25.5.5 Connection elements

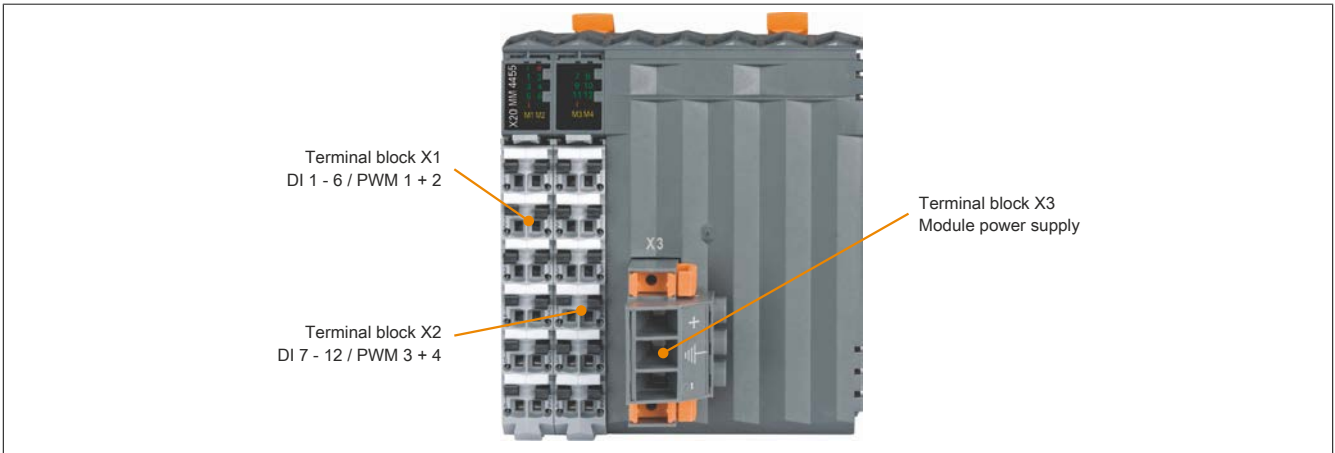
In accordance with the EN 60204-1 standard, a cable cross section of 1.5 mm² or larger must be used for the motor outputs in order to handle the maximum motor current of 10 A. To ensure full motor power, voltage drops that could result from the cable length and the electrical connections must also be taken into consideration when selecting the attachment cable.

Warning!

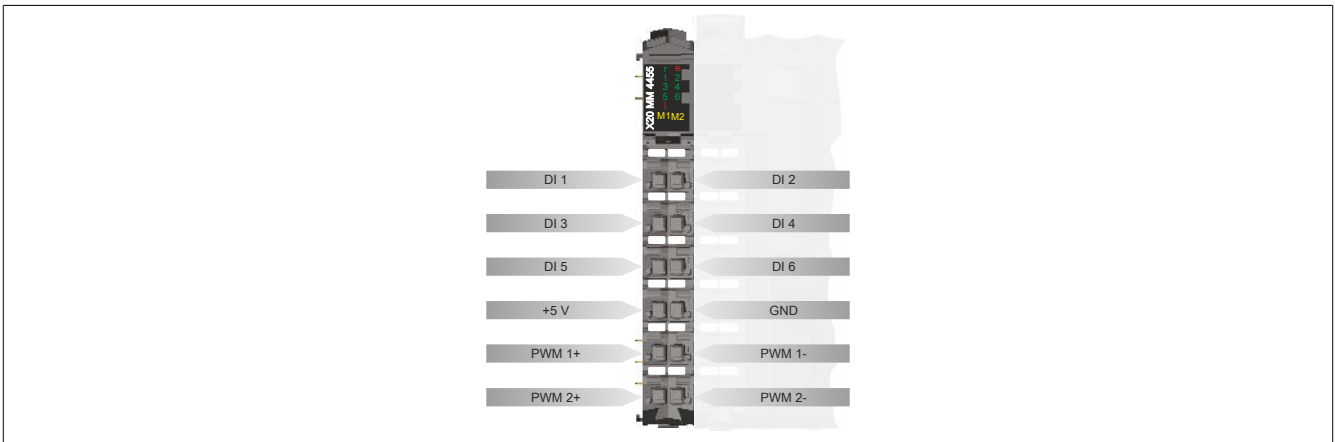
The terminal block is not permitted to be plugged in or unplugged during operation.

Information:

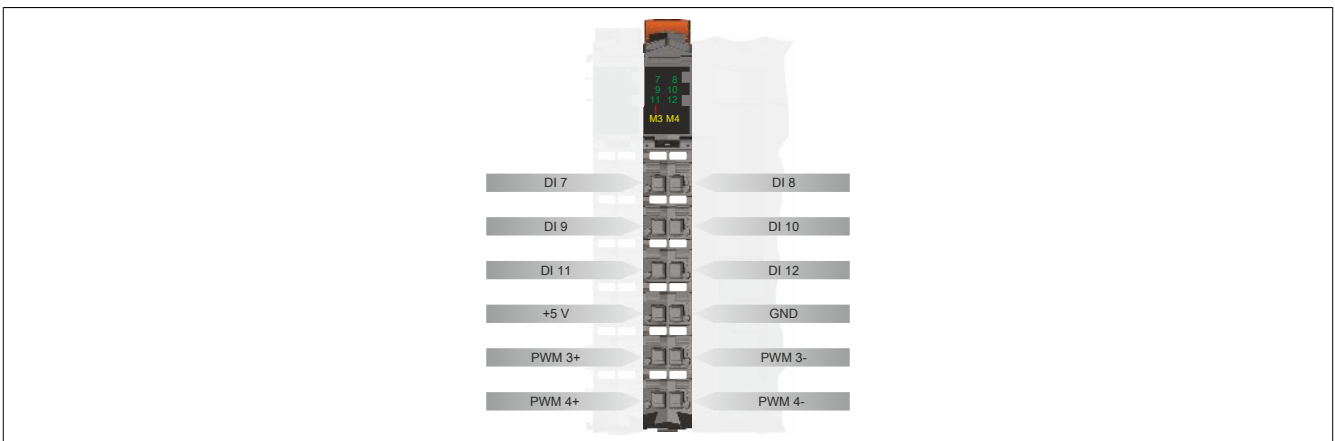
Shielded motor cables must be used in order to meet the limits according to the EN 55011 standard (emissions).



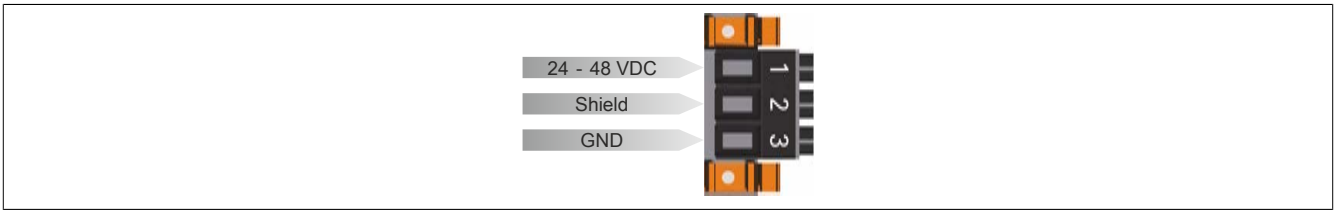
9.25.5.5.1 X1 terminal block - DI 1 to 6 / PWM 1 and 2



9.25.5.5.2 X2 terminal block - DI 7 to 12 / PWM 3 and 4



9.25.5.5.3 X3 terminal block - Module supply



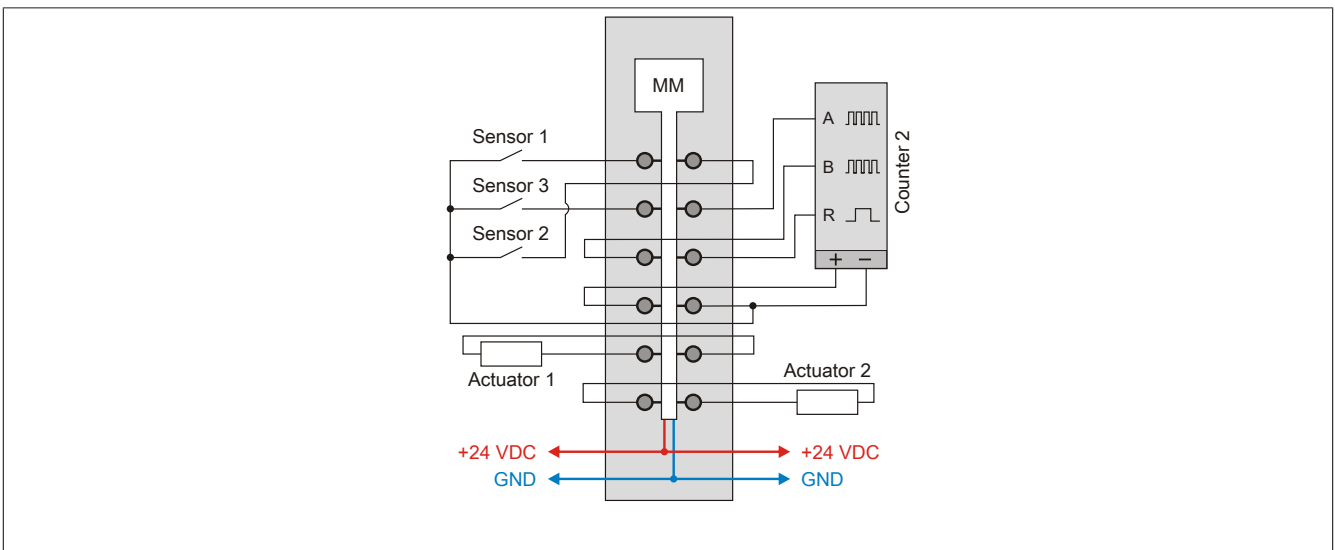
9.25.5.6 Connection examples

X1 and X2 terminal blocks

The following image shows a connection example for the X1 terminal block. The connection example also applies to the X2 terminal block.

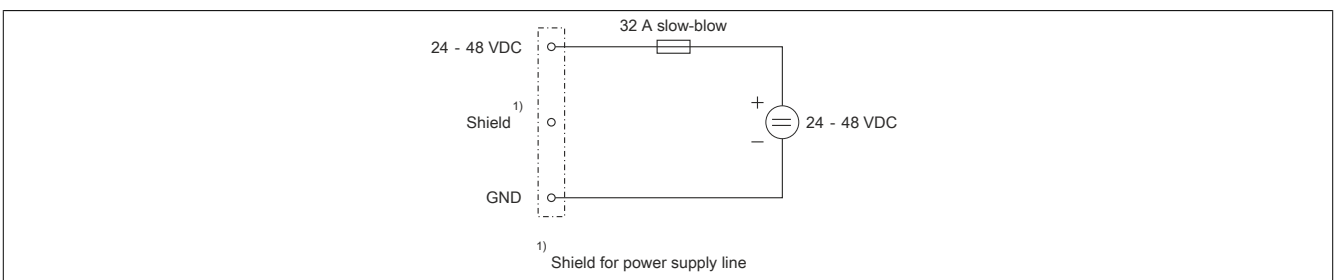
Information:

In order to ensure proper function in all cases, the GND connection on the respective terminal block (X1 or X2) must always be used as reference ground for ABR encoders and digital inputs!



X3 terminal block

For information on the fuse being used, see "Protection" on page 2558.



9.25.5.7 Possible uses for digital inputs

Digital input channels 1 to 12 can be used as follows:

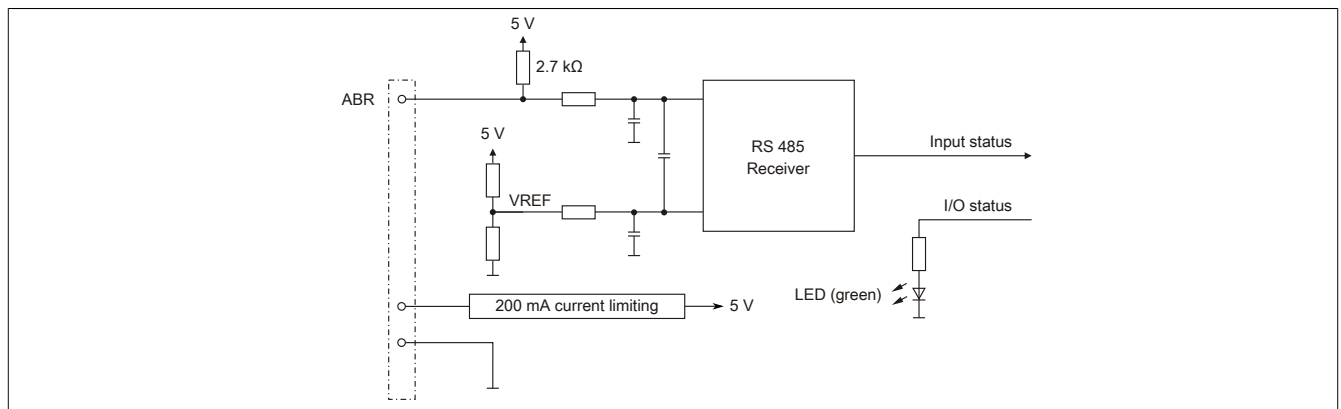
| Channel | Function | Special functions |
|---------|---------------|--|
| DI 1 | Digital input | A |
| DI 2 | Digital input | B |
| DI 3 | Digital input | Limit switch, trigger, reference pulse |
| DI 4 | Digital input | A |
| DI 5 | Digital input | B |
| DI 6 | Digital input | Limit switch, trigger, reference pulse |
| DI 7 | Digital input | A |
| DI 8 | Digital input | B |
| DI 9 | Digital input | Limit switch, trigger, reference pulse |
| DI 10 | Digital input | A |
| DI 11 | Digital input | B |
| DI 12 | Digital input | Limit switch, trigger, reference pulse |

The functions can also be mixed:

| Example 1 | |
|-----------|---------------|
| Channel | Function |
| DI 1 | Digital input |
| DI 2 | Digital input |
| DI 3 | Digital input |
| DI 4 | Digital input |
| DI 5 | Digital input |
| DI 6 | Digital input |
| DI 7 | A |
| DI 8 | B |
| DI 9 | R |
| DI 10 | A |
| DI 11 | B |
| DI 12 | R |

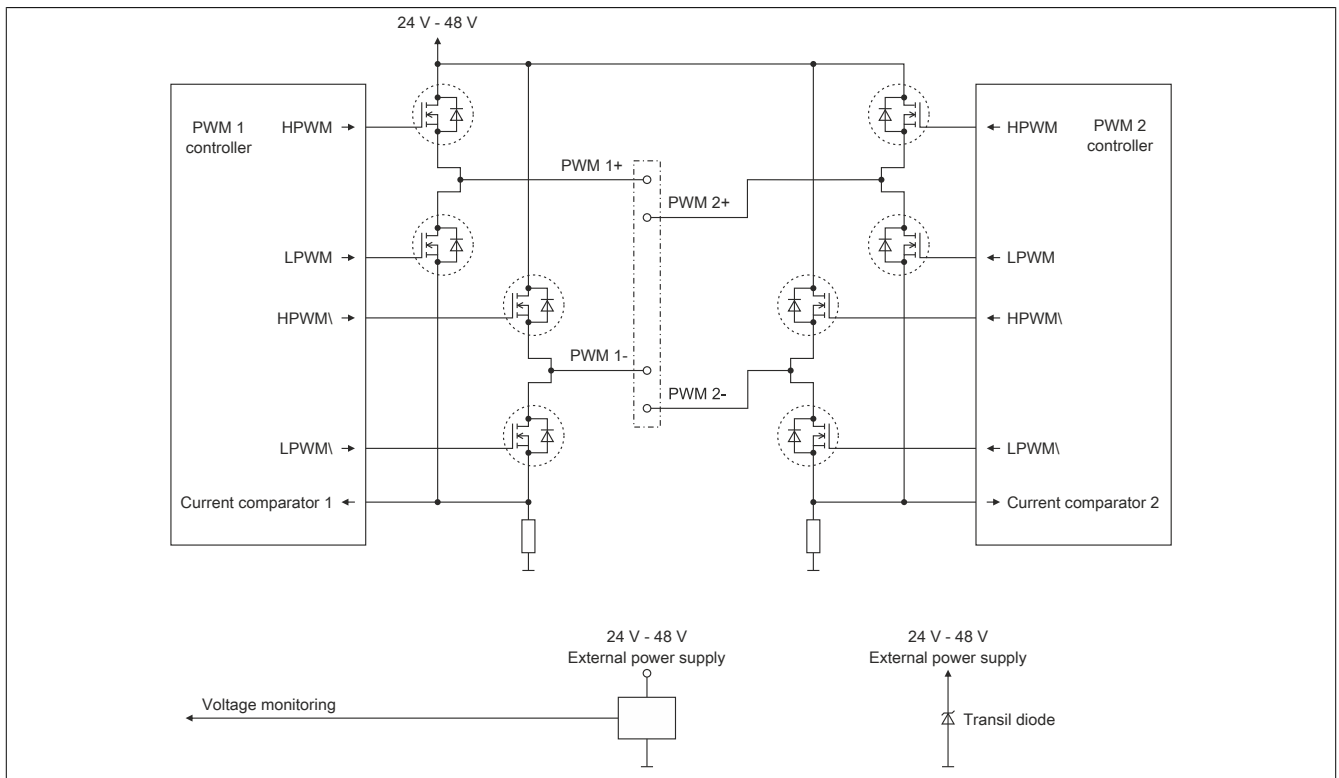
| Example 2 | |
|-----------|---------------|
| Channel | Function |
| DI 1 | A |
| DI 2 | B |
| DI 3 | R |
| DI 4 | Digital input |
| DI 5 | Digital input |
| DI 6 | Digital input |
| DI 7 | Digital input |
| DI 8 | Digital input |
| DI 9 | Digital input |
| DI 10 | A |
| DI 11 | B |
| DI 12 | R |

9.25.5.8 Input circuit diagram



9.25.5.9 Output circuit diagram

The following image shows the output circuit diagram for the outputs 1 and 2. The diagram also applies to the outputs 3 and 4.



9.25.5.10 Measurement of effective current

In current controller mode (see bit 12 in the ["configuration register" on page 2563](#)), there is an apparent deviation between the current setpoint and the measured effective current.

This is due to how the module operates. The PWM output remains "On" or in "Fast Decay" as long as needed to reach the current setpoint. Therefore, the current setpoint is the maximum or minimum current in a specified PWM cycle. This is why the effective current of this cycle (average current of this cycle) is lower (PWM = "On") or higher (PWM = "Fast Decay") than the current setpoint.

The size of the deviation depends on the load impedance.

9.25.5.11 Protection

The power supply line should be protected by a circuit breaker or a fuse. In general, dimensioning the supply line and overcurrent protection depends on the structure of the power supply (modules can be connected individually or in groups).

Information:

The effective current for the power supply depends on the load, but is always less than the sum of the output currents. Make sure that the maximum nominal current of 31 A per pin is not exceeded on the power supply terminals of the power unit.

When choosing a suitable fuse, the user must also account for characteristics such as aging effects, temperature derating, overcurrent capacity and the definition of the rated current, which can vary by manufacturer and type. In addition, the fuse that is selected must also be able to handle application-specific characteristics (e.g. overcurrent that occurs in acceleration cycles).

The cross section of the power mains and the rated current of the overcurrent protection used are chosen according to the current load so that the maximum current load for the cable cross section selected (based on the type of layout, see table) is greater than or equal to the current load in the power mains. The rated current of the overcurrent protection must be less than or equal to the maximum current load for the cable cross section selected (based on the type of layout, see table):

$$I_{\text{Mains}} \leq I_{\text{Fuse}} \leq I_{\text{Line/cable}}$$

| Wire cross section [mm ²] | Current load of the cable cross section I_z / rated current of the over current protection I_b [A] according to type of installation in an ambient air temperature of 40°C in accordance to EN 60204-1 | | | |
|---------------------------------------|--|-----------|-----------|-----------|
| | B1 | B2 | C | E |
| 1.5 | 13.5 / 13 | 13.1 / 10 | 15.2 / 13 | 16.1 / 16 |
| 2.5 | 18.3 / 16 | 16.5 / 16 | 21 / 20 | 22 / 20 |
| 4 | 24 / 24 | 23 / 20 | 28 / 25 | 30 / 25 |
| 6 | 32 / 32 | 29 / 25 | 36 / 32 | 37 / 32 |

Table 502: Cable cross section of the mains supply line depending on the type of layout

The tripping current of the fuse cannot exceed the rated current of fuse I_b .

| Type of layout | Description |
|----------------|------------------------------------|
| B1 | Wires in conduit or cable duct |
| B2 | Cables in conduit or cable duct |
| C | Cables or wires on walls |
| E | Cables or wires on open cable tray |

Table 503: Type of layout for the mains supply line

9.25.5.12 Monitoring the module supply

The module supply is continually monitored. If the following limits are exceeded in either direction, an error bit is set.

| | |
|----------------|-------|
| Upper limit: | >80 V |
| Warning stage: | >60 V |
| Lower limit: | <18 V |

9.25.5.13 Overvoltage cutoff

If the supply voltage on the module exceeds 80V (e.g. through feedback during generator operation), then all PWM outputs are disabled (PWM output pins are short-circuited). The outputs are reactivated as soon as the supply voltage is back in the valid range. Switching the outputs on again can cause an open load error in current mode (depending on the current setpoint and load inductance) as well as with any other abrupt change to the current setpoint value.

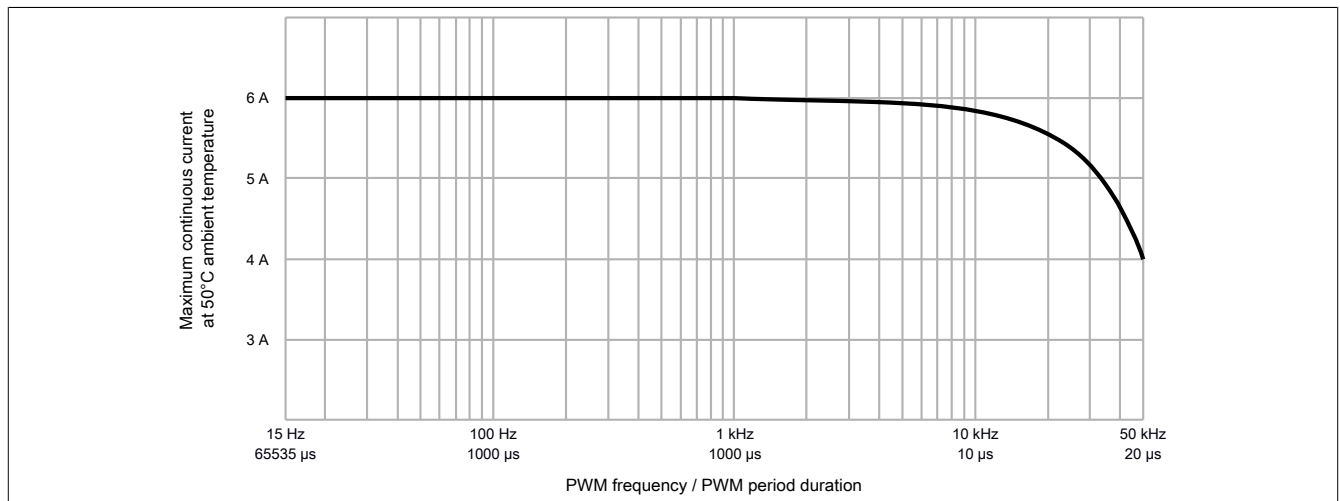
9.25.5.14 Overtemperature cutoff (at 85°C)

If the module temperature reaches or exceeds the limit value of 85°C, then the module executes the following actions:

- Setting the "overtemperature" error bit
- The PWM outputs are disabled (short-circuited)

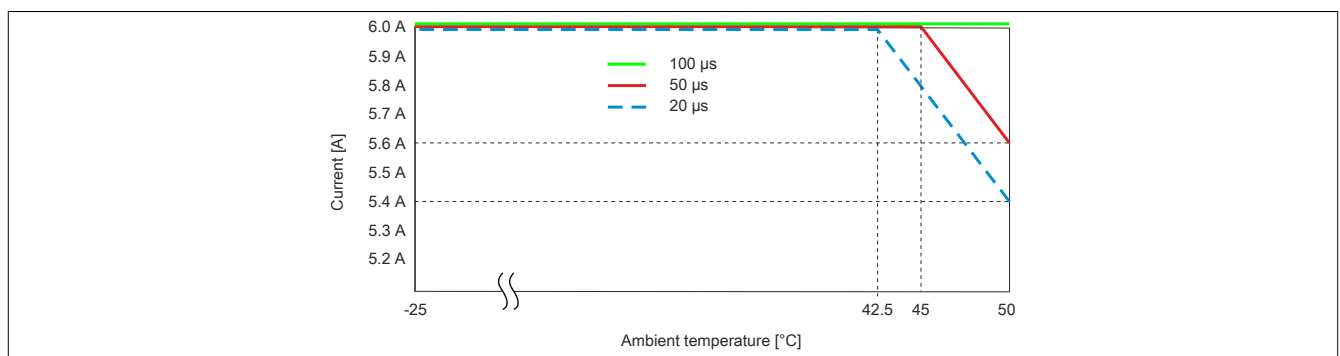
Once the module temperature sinks to 83°C, the error bit is automatically cleared by the module and the outputs become operational again.

At an ambient temperature of 50°C and natural convection, the following overtemperature cutoff limits result with a uniform load on all 4 channels:



9.25.5.15 Derating

The temperature of the module is affected by the PWM period duration. The following derating must therefore be taken into account with a PWM period duration under 100 μs.



9.25.5.16 Let-through current I2T

The module is designed for let-through current of 360 A²s for a period of 10 seconds. If more current is needed for a certain time, less current must be drawn during the remaining time in order to maintain the let-through current.

Calculating the remaining-time current

$$I_{\text{Boost}}^2 \cdot t_{\text{Boost}} + I_{\text{Remaining}}^2 \cdot (10 - t_{\text{Boost}}) \leq 360 \text{ A}^2 \text{ s}$$

$$I_{\text{Remaining}} = \sqrt{\frac{360 \text{ A}^2 \text{ s} - I_{\text{Boost}}^2 \cdot t_{\text{Boost}}}{10 \text{ s} - t_{\text{Boost}}}}$$

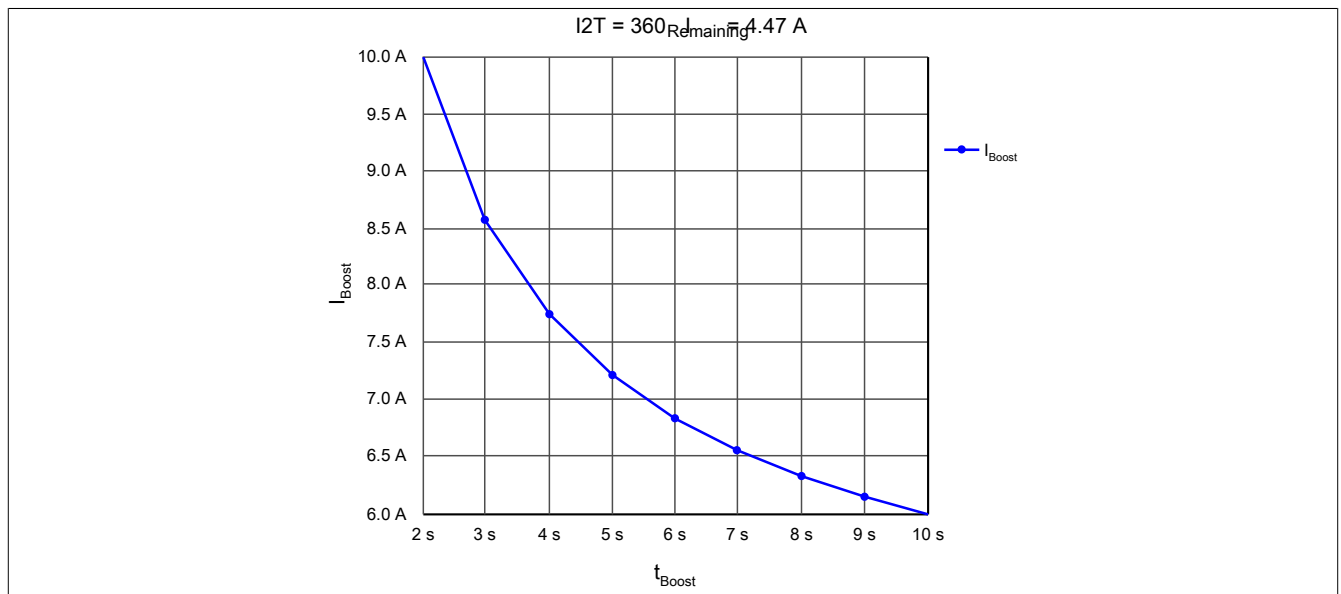
Example

A boost current of 8 A is needed for a duration of 3 seconds.

$$I_{\text{Remaining}} = \sqrt{\frac{360 \text{ A}^2 \text{ s} - 8 \text{ A}^2 \cdot 3 \text{ s}}{10 \text{ s} - 3 \text{ s}}} = 4.89 \text{ A}$$

| t_{Boost} s | I_{Boost} A | $t_{\text{Remaining}}$ s | $I_{\text{Remaining}}$ A | I2T A ² · s |
|-------------------------|-------------------------|-----------------------------|-----------------------------|---------------------------|
| 10 | 6.00 | 0 | 0 | 360.00 |
| 2 | 10.00 | 8 | 4.47 | 360.00 |
| 3 | 8.57 | 7 | 4.47 | 360.00 |
| 4 | 7.75 | 6 | 4.47 | 360.00 |
| 5 | 7.21 | 5 | 4.47 | 360.00 |
| 6 | 6.83 | 4 | 4.47 | 360.00 |
| 7 | 6.55 | 3 | 4.47 | 360.00 |
| 8 | 6.32 | 2 | 4.47 | 360.00 |
| 9 | 6.15 | 1 | 4.47 | 360.00 |

These values correspond to the following curve for let-through current I2T:



9.25.5.17 Register description

9.25.5.17.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.25.5.17.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 64 | ConfigOutput01 (dither amplitude) | USINT | | | | • |
| 65 | ConfigOutput02 (dither frequency) | USINT | | | | • |
| 72 + (N-1) * 8 | Configuration0N (index N = 1 to 4) (general configuration) | UINT | | | | • |
| 74 + (N-1) * 8 | HoldingCurrent0N (index N = 1 to 4) ¹⁾ | INT | | | | • |
| 76 + (N-1) * 8 | BoostCurrent0N (index N = 1 to 4) ¹⁾ | INT | | | | • |
| 78 + (N-1) * 8 | BoostTime0N (index N = 1 to 4) ¹⁾ | UINT | | | | • |
| 104 + (N-1) * 8 | SwitchingPeriod0N (index N = 1 to 4) ¹⁾ | UINT | | | | • |
| Communication | | | | | | |
| 0 + (N-1) * 8 | PulseWidthCurrentPWM0N (index N = 1 to 4) | INT | | | | • |
| 4 | PeriodDurationPWM | UINT | | | | • |
| 2 + (N-1) * 8 | Control | USINT | | | | • |
| | TriggerEdge0N | Bit 0 | | | | |
| | StartTrigger0N | Bit 1 | | | | |
| | StartLatch0N | Bit 2 | | | | |
| | DitherDisable0N | Bit 3 | | | | |
| | ClearError0N | Bit 4 | | | | |
| | ShowMeanCurrent0N | Bit 5 | | | | |
| | ResetCounter0N | Bit 6 | | | | |
| 0 + (N-1) * 8 | Counter0N (index N = 1 to 4) | INT | • | | | |
| 2 + (N-1) * 8 | CounterLatch0N (index N = 1 to 4) | INT | • | | | |
| 4 + (N-1) * 8 | usSinceTrigger0N (index N = 1 to 4) | UINT | • | | | |
| 6 + (N-1) * 8 | Status0N (index N = 1 to 4) | USINT | • | | | |
| | StatusInput(N-1)*4 + 1 | Bit 0 | | | | |
| | ... | ... | | | | |
| | StatusInput(N-1)*4 + 4 | Bit 3 | | | | |
| | EncoderPowerSupplyError01 / 02 | Bit 3 | | | | |
| | nLatchPending0N | Bit 4 | | | | |
| | LatchDone0N | Bit 5 | | | | |
| | EndswitchReached0N | Bit 6 | | | | |
| | PWMErr0N | Bit 7 | | | | |
| 7 | Global error | USINT | • | | | |
| | OverVoltageError | Bit 4 | | | | |
| | UnderVoltageError | Bit 5 | | | | |
| | VoltageWarning | Bit 6 | | | | |
| | OvertemperatureError | Bit 7 | | | | |
| 15 | Channel errors | USINT | • | | | |
| | CurrentError01 | Bit 0 | | | | |
| | OverCurrentError01 | Bit 1 | | | | |
| | CurrentError02 | Bit 2 | | | | |
| | OverCurrentError02 | Bit 3 | | | | |
| | CurrentError03 | Bit 4 | | | | |
| | OverCurrentError03 | Bit 5 | | | | |
| | CurrentError04 | Bit 6 | | | | |
| | OverCurrentError04 | Bit 7 | | | | |
| 128 | ModuleTemperature | SINT | | • | | |

1) Only available with firmware version 1.3.0.0 or later

9.25.5.17.3 Function model 254

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 64 | - | ConfigOutput01 (dither amplitude) | USINT | | | | • |
| 65 | - | ConfigOutput02 (dither frequency) | USINT | | | | • |
| 72 + (N-1) * 8 | - | Configuration0N (index N = 1 to 4) (general configuration) | UINT | | | | • |
| Communication | | | | | | | |
| 0 + (N-1) * 8 | 0 + (N-1) * 8 | PulseWidthCurrentPWM0N (index N = 1 to 4) | INT | | | • | |
| 4 | 4 | PeriodDurationPWM | UINT | | | • | |
| 2 + (N-1) * 8 | 2 + (N-1) * 8 | Control | USINT | | | • | |
| | | TriggerEdge0N | Bit 0 | | | | |
| | | StartTrigger0N | Bit 1 | | | | |
| | | StartLatch0N | Bit 2 | | | | |
| | | DitherDisable0N | Bit 3 | | | | |
| | | ClearError0N | Bit 4 | | | | |
| | | ShowMeanCurrent0N | Bit 5 | | | | |
| | | ResetCounter0N | Bit 6 | | | | |
| 0 + (N-1) * 8 | 0 + (N-1) * 8 | Counter0N (index N = 1 to 4) | INT | • | | | |
| 2 + (N-1) * 8 | 2 + (N-1) * 8 | CounterLatch0N (index N = 1 to 4) | INT | • | | | |
| 4 + (N-1) * 8 | 4 + (N-1) * 8 | usSinceTrigger0N (index N = 1 to 4) | UINT | • | | | |
| 6 + (N-1) * 8 | 6 + (N-1) * 8 | Status of the inputs | U(S)INT | • | | | |
| | | StatusInput(N-1)*4 + 1 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusInput(N-1)*4 + 4 | Bit 3 | | | | |
| | | EncoderPowerSupplyError01 / 02 | Bit 3 | | | | |
| | | nLatchPending0N | Bit 4 | | | | |
| | | LatchDone0N | Bit 5 | | | | |
| | | EndswitchReached0N | Bit 6 | | | | |
| | | PWMError0N | Bit 7 | | | | |
| | | CurrentError01 | Bit 8 | | | | |
| | | OverCurrentError01 | Bit 9 | | | | |
| | | CurrentError02 | Bit 10 | | | | |
| | | OverCurrentError02 | Bit 11 | | | | |
| | | CurrentError03 | Bit 12 | | | | |
| | | OverVoltageError | | | | | |
| | | OverCurrentError03 | Bit 13 | | | | |
| | | UnderVoltageError | | | | | |
| CurrentError04 | Bit 14 | | | | | | |
| VoltageWarning | | | | | | | |
| OverCurrentError04 | Bit 15 | | | | | | |
| OvertemperatureError | | | | | | | |
| 128 | - | ModuleTemperature | SINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.25.5.17.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "[Using I/O modules on the bus controller](#)" on page 3789.

9.25.5.17.3.2 CAN I/O bus controller

The module occupies 4 analog logical slots on CAN I/O.

9.25.5.17.4 Configuration

9.25.5.17.4.1 Configuration

Name:

Configuration01 to Configuration04

These registers can be used to configure the four DC motors.

The following placeholders are used in the configuration table:

| Register | Channel N | On |
|-----------------|-----------|------|
| Configuration01 | 1 | DI3 |
| Configuration02 | 2 | DI6 |
| Configuration03 | 3 | DI9 |
| Configuration04 | 4 | DI12 |

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|---------|--|-----------|---|
| 0 - 1 | Configuration of the latch function for ABR counter N. The reference enable input is ignored. Enabling the latch function is described in register "Control" on page 2564 (bit 2): | 00 | ABR counter N is latched unconditionally (default setting). The reference enable input is ignored (bus controller default setting). |
| | | 01 | ABR counter N is latched if a rising edge occurs on digital input On. |
| | | 10 | ABR counter N is latched if a falling edge occurs on digital input On. |
| | | 11 | The latch function is disabled. |
| 2 | Reserved | 0 | |
| 3 | Active level of the reference enable input for ABR counter N: | 0 | Active level = High (bus controller default setting) |
| | | 1 | Active level = Low |
| 4 | Reserved | 0 | |
| 5 - 7 | Definition of the limit switch N (see also "Limit switch function"): | 000 | Limit switch N is disabled (bus controller default setting) |
| | | 001 | Digital input On is used as the Enable input. ¹⁾ |
| | | 010 | Digital input In is used as the limit switch |
| | | 011 - 111 | Reserved |
| 8 | Active level for limit switch N: | 0 | Active level = High (bus controller default setting) |
| | | 1 | Active level = Low |
| 9 - 10 | Trigger input for trigger counter "usSinceTrigger" N: | 00 | The trigger counter is disabled (bus controller default setting). |
| | | 01 | Digital input In is used as the trigger input |
| | | 10 - 11 | Reserved |
| 11 | Display of current average for output N: | 0 | If the corresponding setting has been enabled, then the average current value is indicated in register "CounterLatch[x]" on page 2570 (see bit 5 in the "control register" on page 2564) (bus controller default setting) |
| | | 1 | If the corresponding setting has been enabled, then the average current value is indicated in register "usSinceTrigger[x]" on page 2570 (see bit 5 in "Control" on page 2564). |
| 12 + 15 | Output mode N: | 00 | PWM mode (bus controller default setting) |
| | | 01 | Current mode |
| | | 10 | Boost-and-hold current control ¹⁾ |
| | | 11 | Reserved |
| 13 - 14 | Decay configuration for PWM N (see also "Decay configuration" on page 2573) | 00 | Slow decay (bus controller default setting) |
| | | 01 | Mixed decay |
| | | 10 - 11 | Reserved |

1) Only available with firmware version 1.3.0.0 or later

Limit switch function

The limit switch function serves to quickly shut off the PWM outputs when a limit position is reached.

The limit switch is activated and the disable edge (rising or falling) on the limit switch input is selected using bits 6 to 8.

A PWM output is deactivated as soon as the configured disable edge is reached on the corresponding input of the limit switch. It remains deactivated until either the limit switch function is deactivated or the limit switch is acknowledged with bit 4 in the respective "control register" on page 2564.

Enable input

The limit switch input of the module can optionally be used as an enable input. Bits 5 to 7 must be configured accordingly for this. Data point [OutputEnable](#) and the digital input are logically linked by an AND operator.

When the enable input is enabled, the PWM output can be switched on and off via the digital input. Switching on and off is done with a jitter of 50 µs. Since it is possible to react only at the beginning of the PWM period, an additional jitter of the length of the [PWM period duration](#) must be taken into account.

9.25.5.17.4.2 Control

Name:

TriggerEdge01 to TriggerEdge04

StartTrigger01 to StartTrigger04

StartLatch01 to StartLatch04

DitherDisable01 to DitherDisable04

ClearError01 to ClearError04

ShowMeanCurrent01 to ShowMeanCurrent04

ResetCounter01 to ResetCounter04

OutputEnable01 to OutputEnable04

These registers can be used to configure the behavior of the trigger, the ABR counter and the dither.

[N] stands for the corresponding control number.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|--|-------|--|
| 0 | TriggerEdgeN Configuration of trigger edge for "usSinceTrigger": | 0 | Counting starts at rising edge |
| | | 1 | Counting starts at falling edge |
| 1 | StartTriggerN Enabling of "usSinceTrigger" due to a status change of bit 1 | x | Counting starts at the next trigger edge (see bit 0). For more information about trigger functionality, see " Trigger function procedure " on page 2564. |
| | | | |
| 2 | StartLatchN Latching or referencing ABR counters: | 0 | Disabled |
| | | 1 | Enabled |
| 3 | DitherDisable N | 0 | Dither for PWM output N is enabled (default setting). The dither frequency and dither amplitude must be greater than 0 (see " Dither " on page 2568). |
| | | 1 | Dither for PWM output N is disabled. |
| 4 | ClearErrorN Acknowledging error or limit switch: | 0 | No effect |
| | | 1 | Error acknowledgment on output N (overcurrent or open load) or acknowledgment of limit switch N |
| 5 | ShowMeanCurrentN Configuration of registers CounterLatch and usSinceTrigger | 0 | Register CounterLatch N contains the latched counter value. Register usSinceTriggerN contains the trigger counter. |
| | | 1 | Both registers contain the current PWM output current |
| 6 | ResetCounterN Reset ABR counter | 0 | Enable ABR counter |
| | | 1 | Reset ABR counter |
| 7 | OutputEnableN ¹⁾ | 0 | Switch off the PWM output |
| | | 1 | Switch on the PWM output |

1) Only for boost-and-hold current control

Trigger function procedure

The following points must be taken into consideration when configuring or activating the trigger function:

- Select the desired trigger edge using bit 0
- Enable the trigger function by changing the state of StartTrigger (bit 1). This edge clears the register [usSinceTrigger](#) (µs counter).
- When the trigger event occurs, the µs counter [usSinceTrigger](#) is started.
- The counter [usSinceTrigger](#) cannot overrun, i.e. the counter is stopped at $2^{16}-1$ and retains this value until the next time the trigger function is activated.
- The trigger function can be re-activated at any time by changing the state of StartTrigger (bit 1) regardless of if a trigger event has occurred or if "usSinceTrigger" has reached its maximum value.

Reset ABR counter

Bit 6 sets the following counters and status bits to 0:

- ABR counter
- Latch value of the ABR counter
- Latching started on the ABR counter (bit 4 of the "status register" on page 2571)
- ABR counter successfully latched (bit 5 of the "status register" on page 2571)

Please note that a started latch procedure is no longer active after the ABR counter has been reset. This means that latching must be restarted by a rising edge on bit 2.

OutputEnable

Bit 7 can start or stop the output profile in [Boost-and-hold current control](#). If a rising edge occurs on this data point, any pending [Overcurrent error](#) or [Open load error](#) of the associated PWM output are acknowledged and the output is switched on.

Starting or stopping occurs immediately after the transfer of the value on the X2X Link network with a jitter of 50 μ s. Note that during startup, an additional jitter of the length of the [PWM period duration](#) of the current controller is added.

Starting and stopping the output profile can also be controlled by the digital input. See ["Enable input" on page 2564](#).

9.25.5.17.4.3 Difference between operating modes

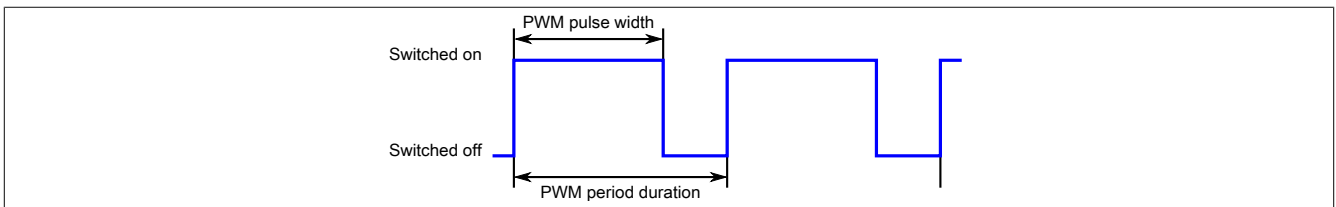
The module provides the following operating modes:

- [PWM mode](#)
- [Current mode](#)
- [Boost-and-hold current control](#)

The following images illustrate how the current curves for the outputs are affected by registers ["PWM period duration" on page 2566](#) and ["PWM pulse width" on page 2567](#).

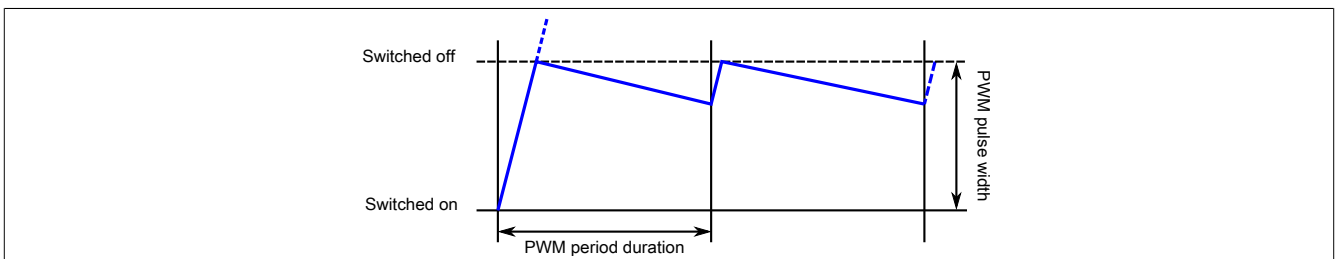
PWM mode

At the beginning of each period, the output is switched on for the percentage of time set in the PWM pulse width.



Current mode

At the beginning of each period, the current output is switched on. After reaching the value set in ["PulseWidthCurrentPWM" on page 2567](#), the output is switched off and the voltage drops according to the set [decay configuration](#) until it is next switched on.



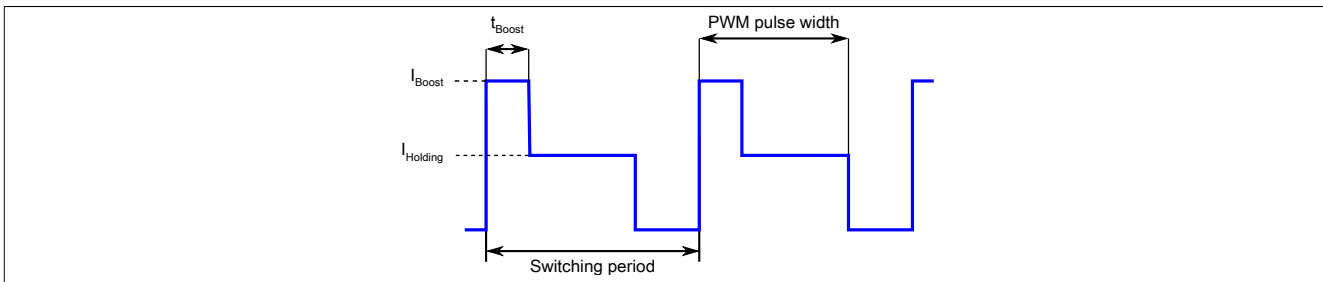
Boost-and-hold current control**Information:**

Only available with firmware version 1.3.0.0 or later.

In this operating mode, the current mode is combined with a higher-level PWM mode.

After the time (t_{Boost}) set in register "BoostTime" on page 2567, the inrush current (I_{Boost}) is changed to the holding current (I_{Holding}) specified in register "HoldingCurrent" on page 2568.

The period duration of the current profile is set in register "SwitchingPeriod" on page 2568 in 50- μs steps. In addition, the PWM period duration must be set in register PeriodDurationPWM. (Not shown, see Current mode.)

**Example: Controlling a digital valve**

The boost current (I_{Boost}) is used to quickly open a digital valve, for example. After the boost time (t_{Boost}), the current is reduced to the lower holding current (I_{Holding}) in order to save energy and not overload the PWM output. I_{Holding} is therefore set to a smaller value than I_{Boost} .

The pulse width can be used to set the opening time of the valve in relation to the period duration. After the period duration has expired, I_{Boost} is started again. If the valve should remain open continuously, the pulse width must be set to 100%. In this case, no boost current is output at the beginning of the next period.

I_{Boost} is only output if the valve has been switched off for at least 50 μs . If the pulse width is set smaller than t_{Boost} , the boost time is shortened accordingly.

9.25.5.17.4.4 PWM period duration

Name:

PeriodDurationPWM

This register can be used to set the period duration between 20 μs (50 kHz) and 65535 μs (15 Hz). See also "Difference between operating modes" on page 2565.

| Data type | Value | Information |
|-----------|-------------|-----------------------|
| UINT | 20 to 65535 | Time in μs |

9.25.5.17.4.5 PWM pulse width

Name:

PulseWidthCurrentPWM01 to PulseWidthCurrentPWM04

The PWM pulse width (PWM mode) or current setting (in current mode) is entered in this register according to the setting in the module configuration register. (see also ["Difference between operating modes"](#) on page 2565.) A negative value changes the output polarity.

PWM mode

| Data type | Value | Output + | Output - |
|-----------|--------|--------------------------------------|--------------------------------------|
| INT | 32767 | High | Low |
| | 16384 | PWM 50/50 | Low |
| | 0 | Low (bus controller default setting) | Low (bus controller default setting) |
| | -16384 | Low | PWM 50/50 |
| | -32767 | Low | High |

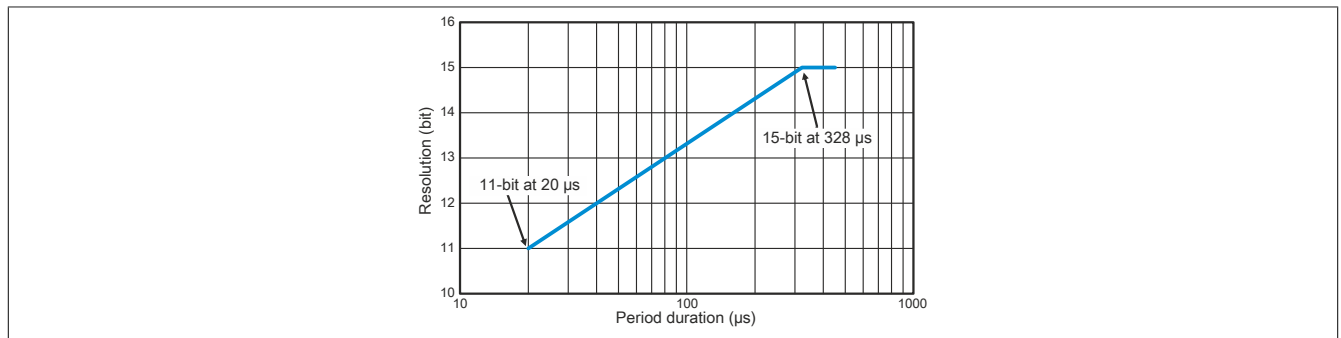
Current mode

| Data type | Value | Current mode |
|-----------|------------------|------------------------|
| INT | 19661 to 32767 | 6 to 10 A (max. 2 s) |
| | 19660 | 6 A |
| | 0 | 0 A |
| | -19660 | -6 A |
| | -19661 to -32767 | -6 to -10 A (max. 2 s) |

| Data type | Values | Information |
|-----------|-----------------|-------------------|
| INT | -32768 to 32767 | For -100% to 100% |

Resolution/Derating

As mentioned earlier in the technical data, the PWM resolution is 15-bit (+ sign). This value is derated for a period duration of less than 328 μs because of the minimal PWM timing resolution (10 ns) (see following diagram). With the minimum PWM period duration of 20 μs , the PWM has 11-bit resolution (+ sign):



9.25.5.17.4.6 Boost-and-hold registers

Boost current

Name:

BoostCurrent01 to BoostCurrent04

The boost current is set in mA in this register.

| Data type | Values | Information |
|-----------|------------|---------------|
| INT | 0 to 10000 | For 0 to 10 A |

Boost time

Name:

BoostTime01 to BoostTime04

The sampling time is set in μs in this register. The entered value is rounded up to the next largest 50- μs interval.

| Data type | Values | Information |
|-----------|------------|------------------|
| UINT | 0 to 65500 | In μs |

Holding current

Name:

HoldingCurrent01 to HoldingCurrent04

The holding current is set in mA in this register. After the boost time, the current for the remaining pulse width time is raised or lowered to this value.

| Data type | Values | Information |
|-----------|-----------|--------------|
| UINT | 0 to 6000 | For 0 to 6 A |

Period duration of the current profile

Name:

SwitchingPeriod01 to SwitchingPeriod04

This register is used to set the period duration of the current profile in μs for boost-and-hold mode. The entered value is rounded up to the next largest 50- μs interval.

| Data type | Values | Information |
|-----------|---------------|--------------------------------|
| UINT | 2000 to 65500 | Corresponds to 500 to 15.26 Hz |

Synchronous operation of channels

In order for 2 or more channels to run synchronously, their period durations of the output profile ([SwitchingPeriod](#)) must be set to the same value or to a multiple of the other channel. An exact phase position of 0 degrees can only be guaranteed if the channels are switched on simultaneously (in the same bus cycle) with [OutputEnable](#).

To operate the current profile synchronously to the X2X Link network, [SwitchingPeriod](#) should be set to a multiple of the bus cycle.

9.25.5.17.4.7 Dither

When the position setpoint for valves remains constant for a long period of time, especially in fluids, there is a risk that a valve will stick. This is normally prevented using "dithering". When doing so, the value is permitted to slightly oscillate around the position setpoint.

By default, the dither is active for both outputs as soon as the [dither amplitude](#) and [dither frequency](#) are set to a value >0 . If necessary, the dither can be disabled for each output individually or simultaneously (see bit 3 in register "[control register](#)" on [page 2564](#)).

No dither is used in boost-and-hold mode of the PWM output. Any set dither amplitude and dither frequency are ignored by the module.

Dither amplitude

Name:

ConfigOutput01

This register can be used to configure the amplitude value or pulse width.

| Data type | Value | Information |
|-----------|----------|---|
| USINT | 0 to 255 | Current mode: 0 to 25.5% of the module's nominal current ¹⁾ PWM mode: 0 to 25.5% of the period duration. Bus controller default setting: 0 |

1) See the technical data for the module.

Dither frequency

Name:

ConfigOutput02

This register can be used to set the frequency in 2 Hz steps.

| Data type | Value | Information |
|-----------|----------|--|
| USINT | 0 to 255 | Corresponds to 0 to 510 Hz. Bus controller default setting: 0 |

Dither example

The values specified in the data sheet for a valve should be used to calculate [Dither amplitude](#) and [Dither frequency](#).

Data sheet for the valve

The data sheet for a valve manufacturer recommends the following dithering:

Dither height in percent (A_{Dither}): 20 to 35% (peak values) of the nominal valve current of 2 A

Dither frequency in Hertz (F_{Dither}): 40 to 70 Hz

Selected values

These values correspond to the average values on the valve data sheet.

$A_{\text{Dither}} = 27\%$ of the valve's nominal current (peak values)

$F_{\text{Dither}} = 56 \text{ Hz}$

Formulas

[Dither amplitude](#) = $(A_{\text{Dither}} / 2) * (\text{Nominal current}_{\text{Valve}} / \text{Nominal current}_{\text{Module}}) * 10$

Info: $(A_{\text{Dither}} / 2)$ = Conversion of the peak values to amplitude, " * 10" = Scaling of the dither amplitude to 1/10%

[Dither frequency](#) = $F_{\text{Dither}} / 2 \text{ Hz}$

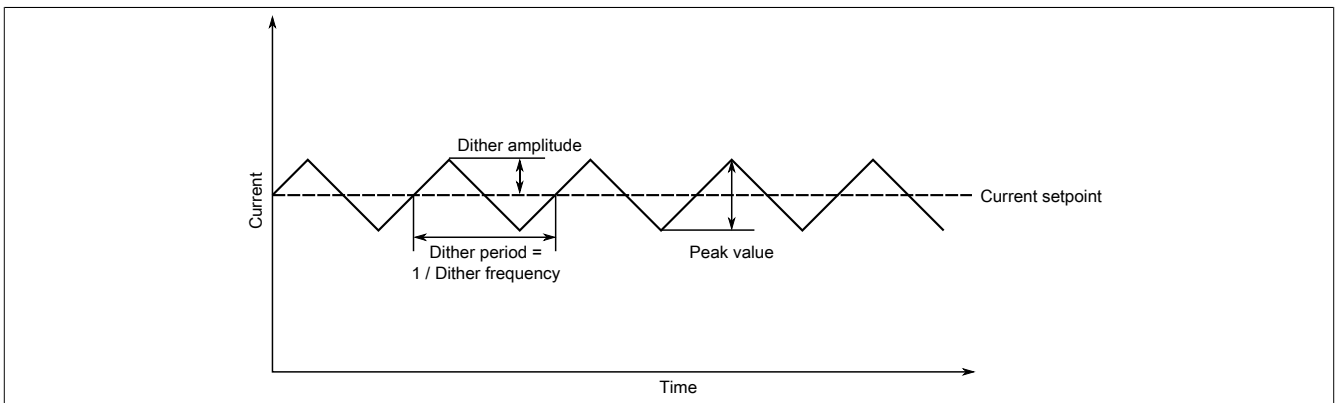
Info: Dither frequency is configured in 2 Hz steps.

Calculation

By using the selected values in the formulas.

[Dither amplitude](#) = $27\% / 2 * (2 \text{ A} / 6 \text{ A}) * 10 = 45$

[Dither frequency](#) = $56 \text{ Hz} / 2 \text{ Hz} = 28$



9.25.5.17.5 Communication

9.25.5.17.5.1 ABR counter

Name:

Counter01 to Counter04

These registers are 16-bit AB(R) counters.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

9.25.5.17.5.2 ABR counter latch

Name:

CounterLatch01 to CounterLatch04

When a latch event occurs, the current counter values are saved in these registers. For additional features, see bit 5 in the respective ["control register" on page 2564](#).

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

9.25.5.17.5.3 Microseconds since trigger

Name:

usSinceTrigger01 to usSinceTrigger04

This register shows either the time in μs since the last trigger event or the average current value.

- The usSinceTrigger counter cannot overrun, i.e. the counter is stopped at $2^{16}-1$ and retains this value until the next time the trigger function is activated.
- If the average current is displayed in this register (bit 11 in the respective ["configuration register" on page 2563](#)), then the data type of usSinceTrigger in Automation Studio must be unsigned integer (UINT). The average current value, on the other hand, is an Integer (INT). This means that negative currents are displayed between 32,769 and 65,535.

Counting mode

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

Measurement of average current value

| Data type | Value | Information |
|-----------|------------------|---------------------------------------|
| INT | 19,661 to 32,767 | 6 to 10 A |
| | 19,660 | 6 A |
| | 1 | 305 μA (= 10 A / 32,767) |
| | 0 | 0 A |
| | 65,535 | -305 μA (= -10 A / 32,767) |
| | 45,876 | -6 A |
| | 45,875 to 32,769 | -6 to -10 A |

9.25.5.17.5.4 Status of the inputs

Name:

StatusInput01 to StatusInput12

EncoderPowerSupplyError01 to EncoderPowerSupplyError02

nLatchPending01 to nLatchPending04

LatchDone01 to LatchDone04

EndswitchReached01 to EndswitchReached04

PWMError01 to PWMError0

These registers indicate the status of the inputs and outputs for each DC motor.

The following placeholders are used in the status table.

| Register | [x] | In1 | In2 | In3 | Enc |
|--------------------|-----|------|------|------|-----|
| Status of inputs 1 | 1 | DI1 | DI2 | DI3 | 01 |
| Status of inputs 2 | 2 | DI4 | DI5 | DI6 | - |
| Status of inputs 3 | 3 | DI7 | DI8 | DI9 | 02 |
| Status of inputs 4 | 4 | DI10 | DI11 | DI12 | - |

| Data type | Value |
|---------------------|--------------------|
| USINT ¹⁾ | See bit structure. |
| UINT ²⁾ | See bit structure. |

1) Function model 0 and function model 254 → registers "Status of inputs 3" and "Status of inputs 4"

2) Only function model 254 → registers "Status of inputs 1" and "Status of inputs 2"

Bit structure:

| Bit | Description | Value | Information |
|--------|------------------------------------|-------|---|
| 0 | StatusInput [In1] | x | Ein1 is used for the encoder signal A of ABR counter [x]. |
| 1 | StatusInput [In2] | x | Ein2 is used for the encoder signal B of ABR counter [x]. |
| 2 | StatusInput [In3] | 0 | Possible uses for the digital input <ul style="list-style-type: none"> • Trigger input [x] • Limit switch [x] • Referencing of the ABR counter [x] |
| 3 | EncoderPowerSupplyErrorInput [Enc] | 0 | Error free operation |
| | | 1 | Encoder power supply error |
| 4 | nLatchPending [x] | 00 | Latching started |
| | | 01 | ABR counter latch [x] ready. Latch not yet started. |
| 5 | LatchDone [x] | 0 | The status of this bit is changed each time ABR counter [x] is successfully latched |
| 6 | EndswitchReached [x] | 00 | No effect on PWM output [x] |
| | | 01 | Limit switch [x] reached. PWM output [x] disabled. |
| 7 | PWMError [x] | 0 | Error free operation |
| | | 1 | An error has occurred. The error can be determined by evaluating the two error registers "Global errors" on page 2573 and "Channel errors" on page 2572. |
| 8 - 15 | Only function model 254 | | |
| | Status of inputs 1 | x | With "Status of inputs 1", bits 12 to 15 contain error bits 4 to 7 from the register "Global error" on page 2573 |
| | Status of inputs 2 | x | With "Status of inputs 2", bits 8 to 15 contain error bits 0 to 7 from the register "Channel errors" on page 2572 |

9.25.5.17.5.5 Channel errors

Name:

CurrentError01 to CurrentError04

OverCurrentError01 to OverCurrentError04

If an error is detected, the corresponding error bit in this register remains set until the error is acknowledged using bit 4 in the respective "control register" on page 2564.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|--------------------|-------|--|
| 0 | CurrentError01 | 0 | No error |
| | | 1 | Open load error |
| 1 | OverCurrentError01 | 0 | No error |
| | | 1 | Overcurrent error, output deactivated. |
| 2 | CurrentError02 | 0 | No error |
| | | 1 | Open load error |
| 3 | OverCurrentError02 | 0 | No error |
| | | 1 | Overcurrent error, output deactivated. |
| 4 | CurrentError03 | 0 | No error |
| | | 1 | Open load error |
| 5 | OverCurrentError03 | 0 | No error |
| | | 1 | Overcurrent error, output deactivated. |
| 6 | CurrentError04 | 0 | No error |
| | | 1 | Open load error |
| 7 | OverCurrentError04 | 0 | No error |
| | | 1 | Overcurrent error, output deactivated. |

Overcurrent error

An overcurrent error is registered if one of the following conditions is met:

- ≥ 10 A flow from a PWM output for at least 2 seconds
- ≥ 16 A flow for 3 consecutive PWM cycles
- All PWM outputs together consume more than 32 A on the X3 connector

In all three cases, the affected PWM output is deactivated by the firmware (i.e. the pins on the PWM output are short-circuited). The user must acknowledge the error using bit 4 in the respective "control register" on page 2564 before a PWM output deactivated in this manner can be made operational again.

Open load error

An open load error is only registered in current control mode (see bit 12 in the respective "configuration register" on page 2563) if the current setpoint is not reached. In some cases this can be caused by an open line, although usually the impedance of the load is too high.

9.25.5.17.5.6 Global error

Name:

OverVoltageError

UnderVoltageError

VoltageWarning

OvertemperatureError

This register indicates overtemperature and errors in the module supply. The error bits are automatically acknowledged by the module as soon as the values are back within the permissible limits.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------------|-------|--|
| 0 - 3 | Reserved | 0 | |
| 4 | OverVoltageError | 0 | No error |
| | | 1 | Voltage >80 V. All outputs are deactivated. |
| 5 | UnderVoltageError | 0 | No error |
| | | 1 | Voltage <18 V |
| 6 | VoltageWarning | 0 | No error |
| | | 1 | Voltage >60 V |
| 7 | OvertemperatureError | 0 | No error |
| | | 1 | Module overtemperature; all outputs are deactivated. |

9.25.5.17.5.7 Temperature

Name:

ModuleTemperature

The module temperature is displayed in this register.

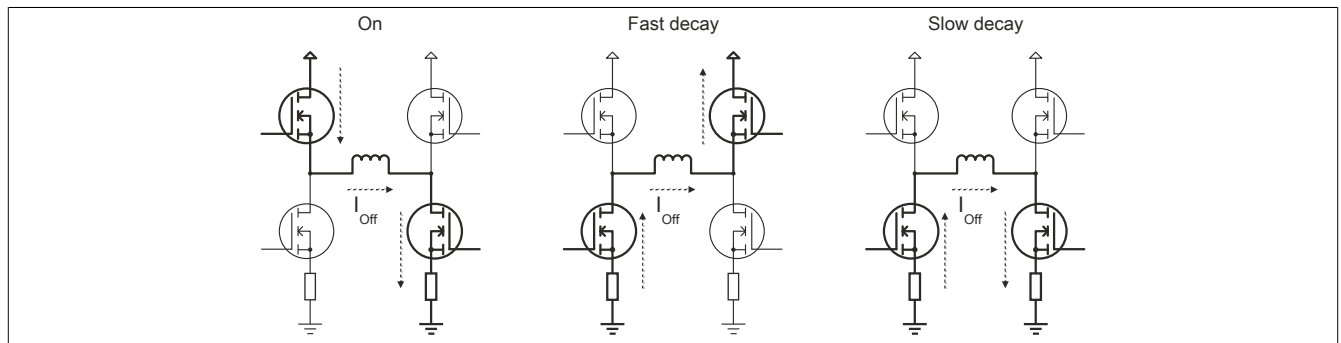
| Data type | Value | Information |
|-----------|------------|--------------------------|
| SINT | -40 to 125 | Module temperature in °C |

9.25.5.17.6 Decay configuration

The decay configuration determines the method and dynamics of current reduction for inductive loads or motors.

"Slow decay" is configured by default. In this mode, the current is automatically reduced relatively slowly with resistance in the load. No energy is regenerated into the module.

"Mixed decay" mode is recommended for applications that require a dynamic and linear reduction of current. In this mode, energy is regenerated into the module during part of the PWM cycle (fast decay).



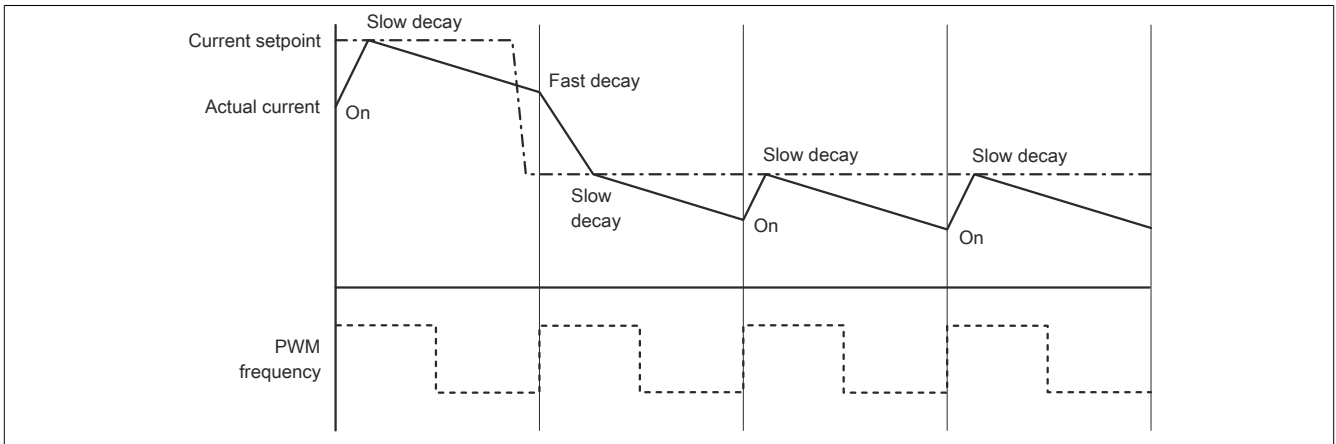
9.25.5.17.6.1 Current control

As its name suggests, mixed decay mode is a mix of "slow decay" and "fast decay". This occurs as follows:

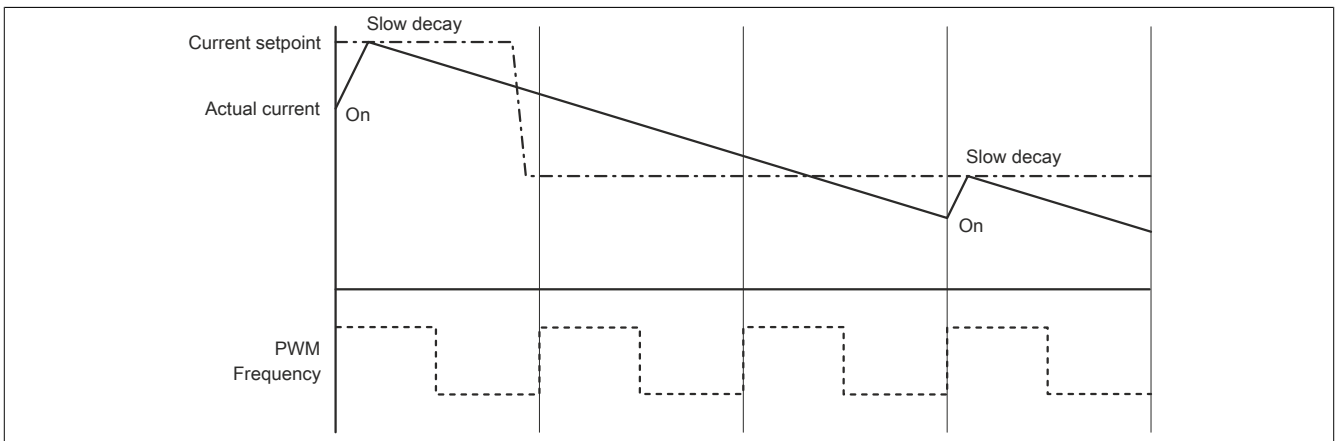
A check is made at the beginning of each PWM cycle to determine if the actual current for the phases is below the set current. If this is the case, PWM is enabled (On) until the current setpoint is reached. If the current setpoint has already been exceeded at the beginning of the PWM cycle (generator operation), the system immediately switches to fast decay mode until the current setpoint is exceeded. The rest of the PWM cycle always takes place in slow decay mode.

This also permits generator operation as long as the valid range for the supply voltage has not been exceeded due to the regeneration into the DC circuit.

Current control in Mixed Decay mode



Current control in Slow Decay mode

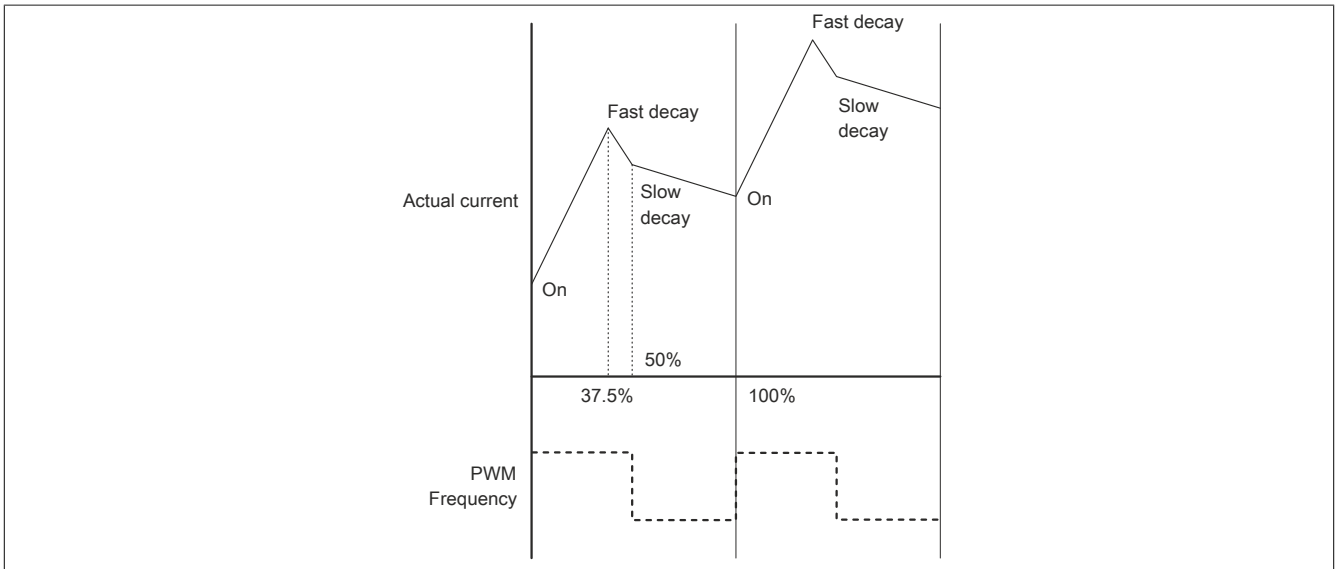


9.25.5.17.6.2 PWM control

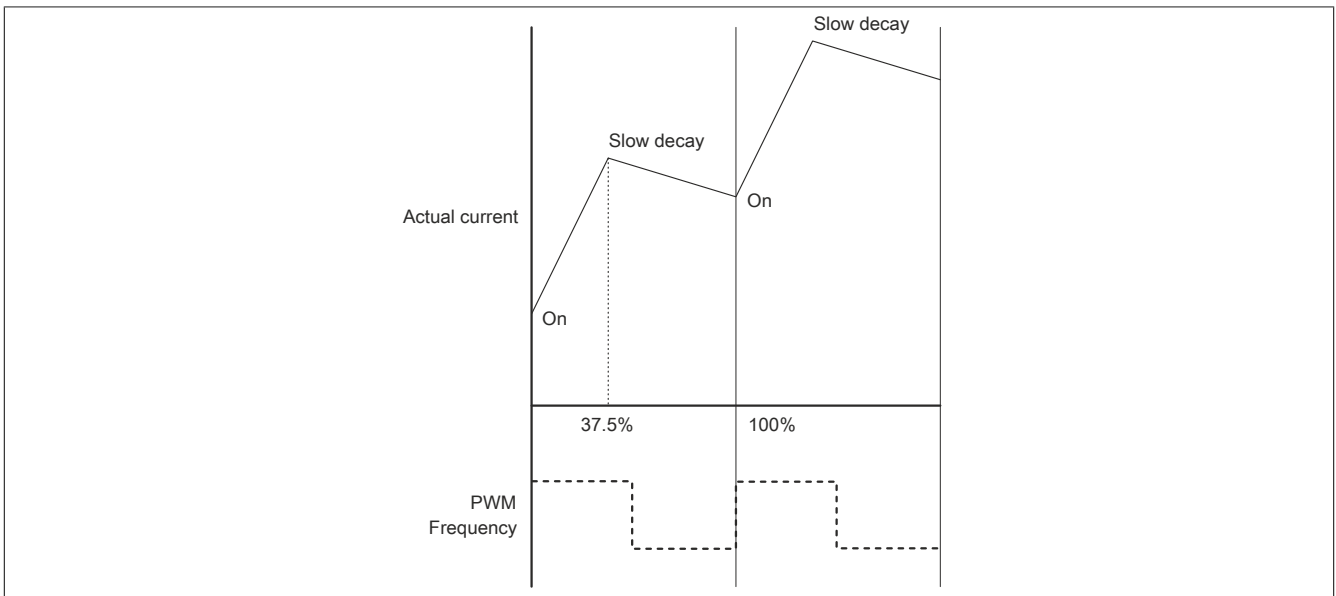
When Mixed Decay mode is enabled, the outputs are driven in Fast Decay mode up until 50% of the period and in Slow Decay mode for the remainder of the switch-off phase.

When Slow Decay mode is used, it is immediately enabled during the switch-off phase.

PWM control in Mixed Decay mode (pulse duty factor = 37.5%)



PWM control in Slow Decay mode (pulse duty factor = 37.5%)



Operating DC motors

In PWM mode, the motor current is limited to the maximum current (10 A), independent of the supply voltage.

However, the motor switches to generator operation when braking. Because of the counter EMF, which is dependent on the rotary speed, a current is generated in the module that is only limited by the internal resistance of the motor. This is not permitted to exceed 15 A (maximum 2 seconds).

The counter EMF closely corresponds to the voltage needed to achieve this speed. Therefore, the maximum brake current is very easy to calculate with the following formula.

$$I_{Brake} = U_e * \frac{PulseWidth}{100\%} * \frac{1}{R_{Motor}}$$

Example:

| | |
|------------------------------|----------------------|
| Module supply | 42 V |
| Pulse width | 16364 (equal to 50%) |
| Internal resistance of motor | 3.5 Ω |

$$I_{Brake} = 38 \text{ V} * \frac{50}{100\%} * \frac{1}{3.5\Omega} = 5.4A$$

9.25.5.17.7 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| |
|---------------------------|
| Minimum cycle time |
| 400 μs |

9.25.5.17.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| |
|--------------------------------|
| Minimum I/O update time |
| 400 μs |

9.25.6 X20MM4456

Data sheet version: 2.21

9.25.6.1 General information

The PWM motor bridge module is used to control 4 DC motors with a nominal voltage of 24 to 48 VDC $\pm 25\%$ at a nominal current up to 6 A. The module can be reconfigured and used in current controller mode for controlling inductive loads. The module is also equipped with 16 digital inputs, which can be used as incremental counters. The 4 motors are controlled with a full-bridge (H-bridge). This enables the motors to be moved in both directions.

- 4x outputs (H bridge) with PWM control and 24 to 48 VDC $\pm 25\%$ supply
- 6 A nominal current (10 A max current)
- 15 Hz to 50 kHz frequency, 16-bit
- PWM resolution, 15-bit, + sign, minimum 10 ns
- Configurable dither
- 4x 4 inputs 24V, can be configured as ABR
- Sink connection
- 1-wire connections

9.25.6.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Motor controllers |  |
| X20MM4456 | X20 PWM motor module, 24 to 48 VDC $\pm 25\%$, 4 PWM motor bridges, 6 A continuous current, 10 A peak current, 4x 4 digital inputs 24 VDC, sink, configurable as incremental encoder | |
| | Required accessories | |
| | Terminal blocks | |
| 0TB3103-7020 | Accessory terminal block, 3-pin, screw clamps 6 mm ² | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 504: X20MM4456 - Order data

9.25.6.3 Technical data

| | |
|--|---|
| Model number | X20MM4456 |
| Short description | |
| I/O module | 4-channel PWM motor bridge, 4 AB incremental encoders |
| General information | |
| B&R ID code | 0xA177 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Output | Yes, using status LED and software |
| I/O power supply | Yes, using software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 2.4 W |
| External I/O 50 kHz | |
| 24 VDC | 3.3 W / channel |
| 48 VDC | 4.7 W / channel |
| 60 VDC | 5.4 W / channel |
| External I/O 10 kHz | |
| 24 VDC | 2.1 W / channel |
| 48 VDC | 2.4 W / channel |
| 60 VDC | 2.6 W / channel |
| External I/O 5 kHz | |
| 24 VDC | 2 W / channel |
| 48 VDC | 2.1 W / channel |
| 60 VDC | 2.2 W / channel |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E225616 Power conversion equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| Digital inputs | |
| Quantity | 16 |
| Nominal voltage | 24 VDC |
| Input voltage | 24 VDC (-15% / +20%) |
| Input current at 24 VDC | Approx. 4 mA |
| Input characteristics per EN 61131-2 | Type 1 |
| Input filter | |
| Hardware | <5 µs |
| Software | - |
| Connection type | 1-wire connections |
| Input circuit | Sink |
| Additional functions | 4x ABR incremental encoder |
| Input resistance | Typ. 6 kΩ |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| ABR incremental encoder | |
| Quantity | 4 |
| Encoder inputs | 24 V, asymmetrical |
| Counter size | 16-bit |
| Input frequency | Max. 50 kHz |
| Evaluation | 4x |
| Signal form | Square wave pulse |
| PWM output | |
| Quantity | 4 |
| Nominal voltage | 24 to 48 VDC ±25% |
| Nominal current | 6 A |
| Maximum current | 10 A (2 s) |
| PWM frequency | 15 Hz to 50 kHz |

Table 505: X20MM4456 - Technical data


| Model number | X20MM4456 | |
|---|---|--|
| Actuator power supply | | |
| Supply | External | |
| Fuse | Required line fuse: Max. 32 A slow-blow (see "Overcurrent protection") | |
| Output protection | Thermal cutoff for overcurrent and short circuit | |
| Variant | H bridge | |
| Configurable dither | Amplitude, frequency | |
| Period duration resolution | 16-bit, min. 20 µs | |
| Phase shift PWM1, 2, 3, 4 | each 90° | |
| DC bus capacitance | 680 µF | |
| PWM pulse width | | |
| PWM mode | 15-bit + sign ≥10 ns | |
| Current mode | 15-bit + sign ≥10 ns | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | 0 to 50°C | |
| Vertical mounting orientation | Not permitted | |
| Derating | - | |
| Storage | -25 to 70°C | |
| Transport | -25 to 70°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 2x X20TB12 terminal block separately Order 1x 0TB3103-7020 terminal block separately | |
| Pitch | 87.5 ^{+0.2} mm | |

Table 505: X20MM4456 - Technical data

9.25.6.4 LED status indicators


For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

Status LED, left

| Figure | LED | Color | Status | Description |
|---|---------|-----------------------------|--------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | e | Red | On | RUN mode |
| | | | Off | No power to module or everything OK |
| | e + r | Red on / Green single flash | On | Error or reset status |
| | | | Off | Invalid firmware |
| | 1 - 8 | Green | | Input state of the corresponding digital input |
| | M1 + M2 | Orange | On | The corresponding output is active |

1) Depending on the configuration, a firmware update can take up to several minutes.

Status LED, right

| Figure | LED | Color | Status | Description |
|---|---------|--------|--------|--|
|  | 9 - 16 | Green | | Input state of the corresponding digital input |
| | M3 + M4 | Orange | On | The corresponding output is active |
| | | | | |

9.25.6.5 Connection elements

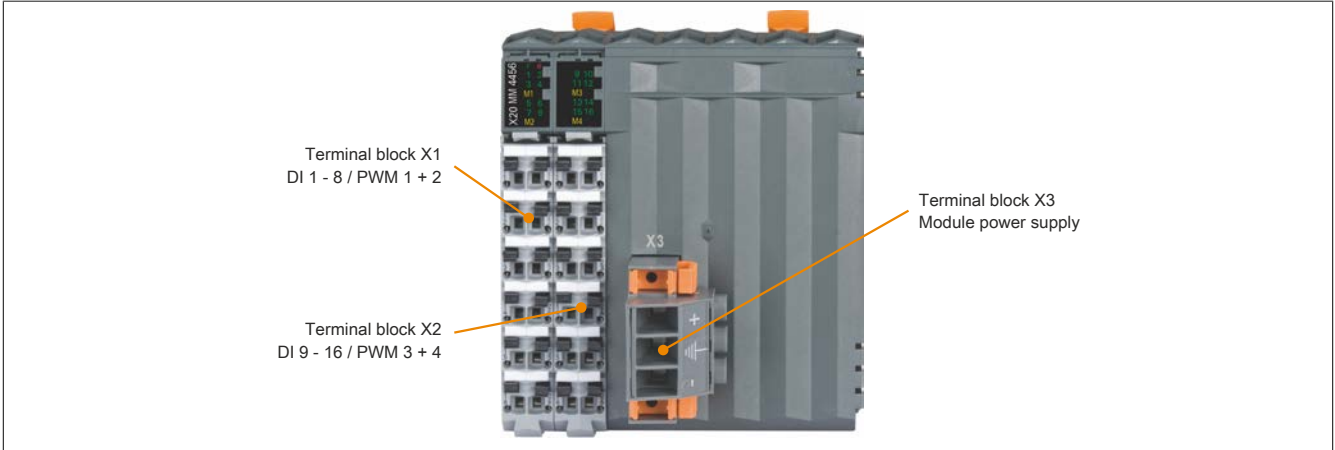
In accordance with the EN 60204-1 standard, a cable cross section of 1.5 mm² or larger must be used for the motor outputs in order to handle the maximum motor current of 10 A. To ensure full motor power, voltage drops that could result from the cable length and the electrical connections must also be taken into consideration when selecting the attachment cable.

Warning!

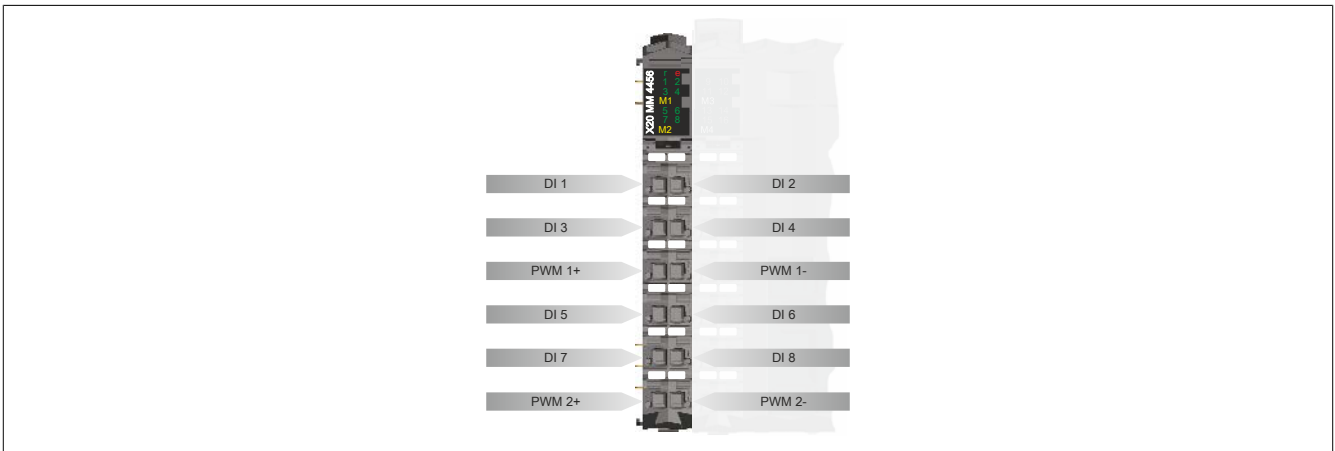
The terminal block is not permitted to be plugged in or unplugged during operation.

Information:

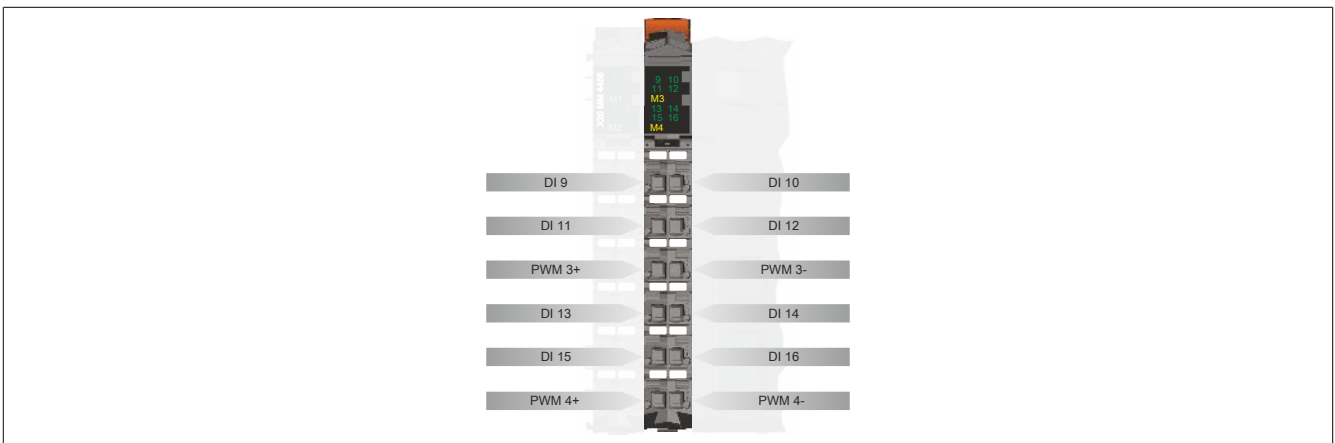
Shielded motor cables must be used in order to meet the limits according to the EN 55011 standard (emissions).



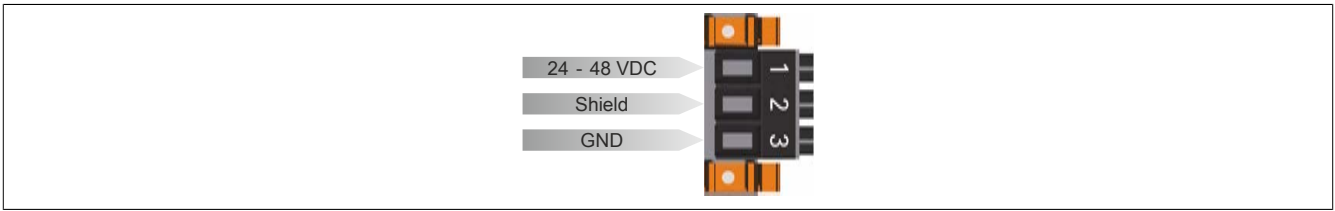
9.25.6.5.1 Terminal block X1 - DI 1 - 8 / PWM 1 + 2



9.25.6.5.2 Terminal block X2 - DI 9 - 16 / PWM 3 + 4



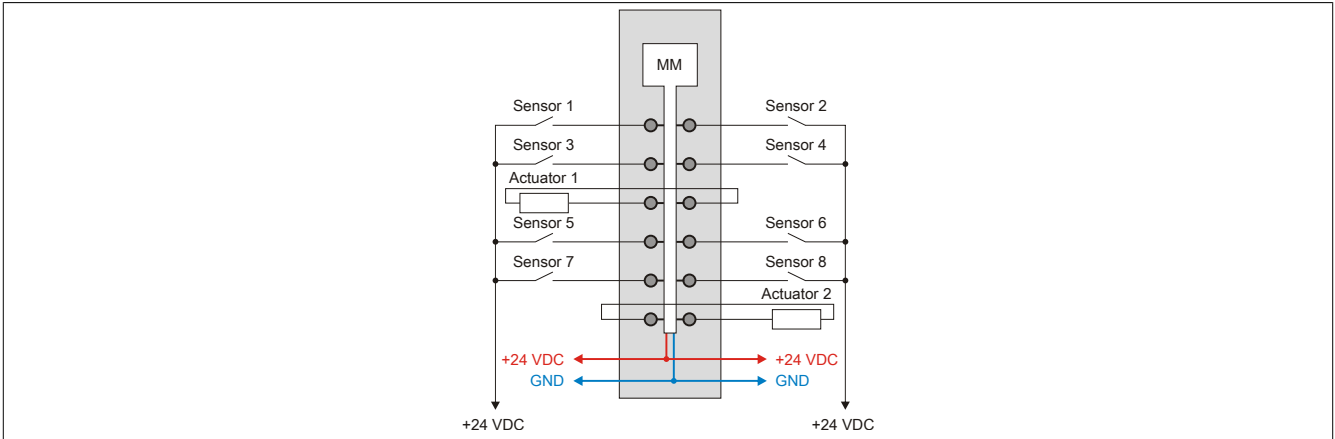
9.25.6.5.3 X3 terminal block - Module supply



9.25.6.6 Connection examples

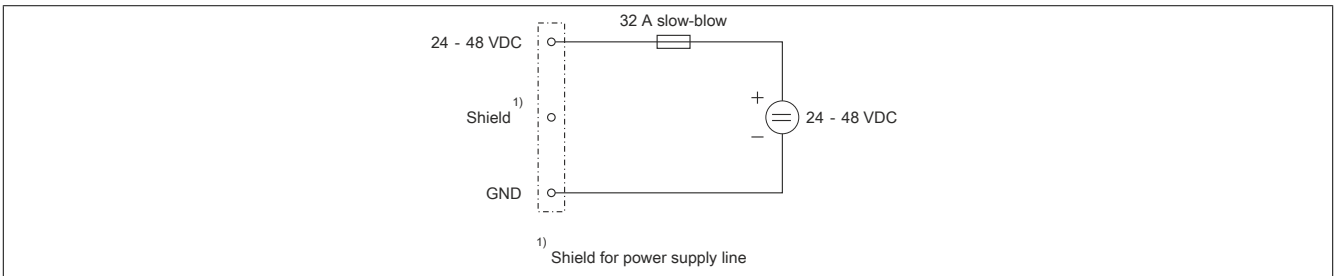
X1 and X2 terminal blocks

The following image shows a connection example for the X1 terminal block. The connection example also applies to the X2 terminal block.



X3 terminal block

For information on the fuse used, see "Protection" on page 2583.



9.25.6.7 Possible uses for digital inputs

Digital input channels 1 to 16 can be used as follows:

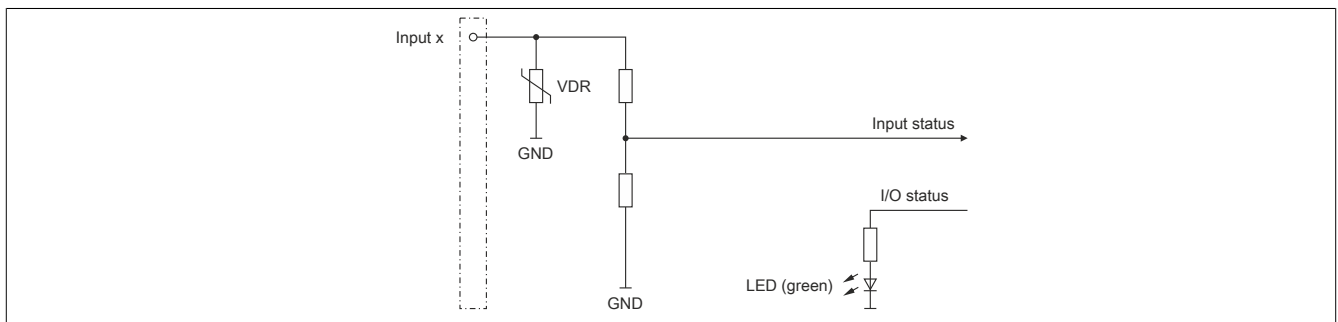
| Channel | Function | Special functions |
|---------|---------------|---|
| DI 1 | Digital input | A |
| DI 2 | Digital input | B |
| DI 3 | Digital input | Limit switch, trigger, reference pulse |
| DI 4 | Digital input | Limit switch, trigger, reference enable |
| DI 5 | Digital input | A |
| DI 6 | Digital input | B |
| DI 7 | Digital input | Limit switch, trigger, reference pulse |
| DI 8 | Digital input | Limit switch, trigger, reference enable |
| DI 9 | Digital input | A |
| DI 10 | Digital input | B |
| DI 11 | Digital input | Limit switch, trigger, reference pulse |
| DI 12 | Digital input | Limit switch, trigger, reference enable |
| DI 13 | Digital input | A |
| DI 14 | Digital input | B |
| DI 15 | Digital input | Limit switch, trigger, reference pulse |
| DI 16 | Digital input | Limit switch, trigger, reference enable |

The functions can also be mixed:

| Example 1 | |
|-----------|---------------|
| Channel | Function |
| DI 1 | Digital input |
| DI 2 | Digital input |
| DI 3 | Digital input |
| DI 4 | Digital input |
| DI 5 | Digital input |
| DI 6 | Digital input |
| DI 7 | Digital input |
| DI 8 | Digital input |
| DI 9 | A |
| DI 10 | B |
| DI 11 | R |
| DI 12 | |
| DI 13 | A |
| DI 14 | B |
| DI 15 | R |
| DI 16 | |

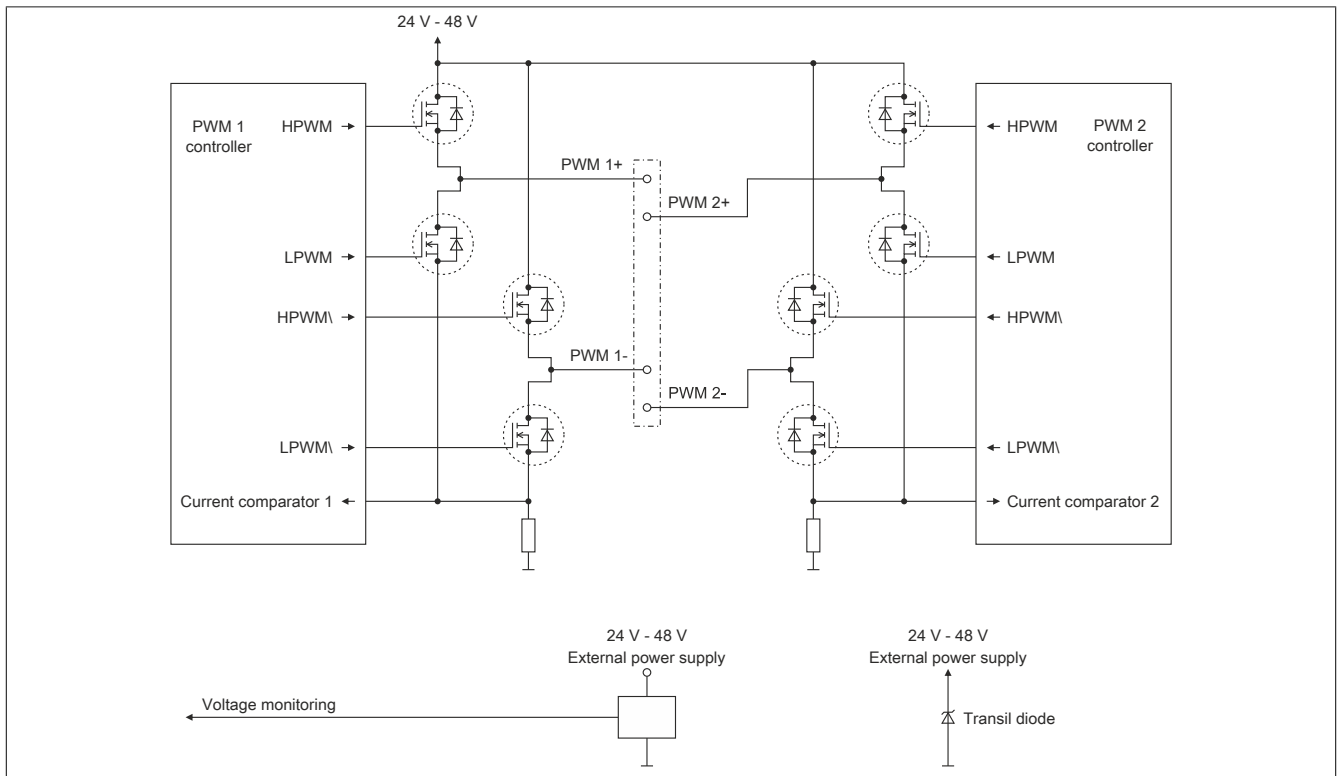
| Example 2 | |
|-----------|---------------|
| Channel | Function |
| DI 1 | A |
| DI 2 | B |
| DI 3 | R |
| DI 4 | |
| DI 5 | Digital input |
| DI 6 | Digital input |
| DI 7 | Digital input |
| DI 8 | Digital input |
| DI 8 | Digital input |
| DI 10 | Digital input |
| DI 11 | Digital input |
| DI 12 | Digital input |
| DI 13 | A |
| DI 14 | B |
| DI 15 | R |
| DI 16 | |

9.25.6.8 Input circuit diagram



9.25.6.9 Output circuit diagram

The following image shows the output circuit diagram for the outputs 1 and 2. The diagram also applies to the outputs 3 and 4.



9.25.6.10 Protection

The power supply line should be protected by a circuit breaker or a fuse. In general, dimensioning the supply line and overcurrent protection depends on the structure of the power supply (modules can be connected individually or in groups).

Information:

The effective current for the power supply depends on the load, but is always less than the sum of the output currents. Make sure that the maximum nominal current of 31 A per pin is not exceeded on the power supply terminals of the power unit.

When choosing a suitable fuse, the user must also account for characteristics such as aging effects, temperature derating, overcurrent capacity and the definition of the rated current, which can vary by manufacturer and type. In addition, the fuse that is selected must also be able to handle application-specific characteristics (e.g. overcurrent that occurs in acceleration cycles).

The cross section of the power mains and the rated current of the overcurrent protection used are chosen according to the current load so that the maximum current load for the cable cross section selected (based on the type of layout, see table) is greater than or equal to the current load in the power mains. The rated current of the overcurrent protection must be less than or equal to the maximum current load for the cable cross section selected (based on the type of layout, see table):

$$I_{\text{Mains}} \leq I_{\text{Fuse}} \leq I_{\text{Line/cable}}$$

| Wire cross section [mm ²] | Current load of the cable cross section I_z / rated current of the over current protection I_b [A] according to type of installation in an ambient air temperature of 40°C in accordance to EN 60204-1 | | | |
|---------------------------------------|--|-----------|-----------|-----------|
| | B1 | B2 | C | E |
| 1.5 | 13.5 / 13 | 13.1 / 10 | 15.2 / 13 | 16.1 / 16 |
| 2.5 | 18.3 / 16 | 16.5 / 16 | 21 / 20 | 22 / 20 |
| 4 | 24 / 24 | 23 / 20 | 28 / 25 | 30 / 25 |
| 6 | 32 / 32 | 29 / 25 | 36 / 32 | 37 / 32 |

Table 506: Cable cross section of the mains supply line depending on the type of layout

The tripping current of the fuse cannot exceed the rated current of fuse I_b .

| Type of layout | Description |
|----------------|------------------------------------|
| B1 | Wires in conduit or cable duct |
| B2 | Cables in conduit or cable duct |
| C | Cables or wires on walls |
| E | Cables or wires on open cable tray |

Table 507: Type of layout for the mains supply line

9.25.6.11 Monitoring the module supply

The module supply is continually monitored. If the following limits are exceeded in either direction, an error bit is set.

| | |
|----------------|-------|
| Upper limit: | >80 V |
| Warning stage: | >60 V |
| Lower limit: | <18 V |

9.25.6.12 Overvoltage cutoff

If the supply voltage on the module exceeds 80V (e.g. through feedback during generator operation), then all PWM outputs are disabled (PWM output pins are short-circuited). The outputs are reactivated as soon as the supply voltage is back in the valid range. Switching the outputs on again can cause an open load error in current mode (depending on the current setpoint and load inductance) as well as with any other abrupt change to the current setpoint value.

9.25.6.13 Overtemperature cutoff (at 85°C)

If the module temperature reaches or exceeds the limit value of 85°C, then the module executes the following actions:

- Setting the "overtemperature" error bit
- The PWM outputs are disabled (short-circuited)

Once the module temperature sinks to 83°C, the error bit is automatically cleared by the module and the outputs become operational again.

9.25.6.14 Measurement of effective current

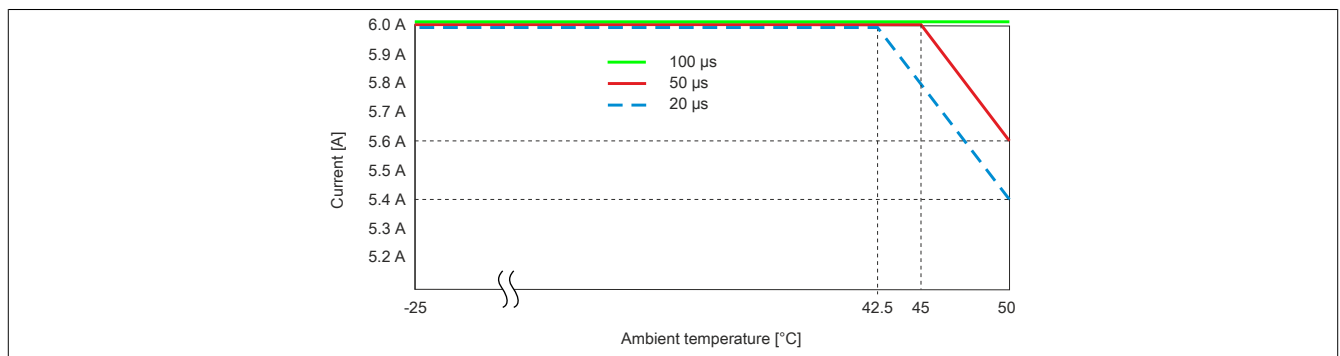
In current controller mode (see bit 12 in the "configuration register" on page 2588), there is an apparent deviation between the current setpoint and the measured effective current.

This is due to how the module operates. The PWM output remains "On" or in "Fast Decay" as long as needed to reach the current setpoint. Therefore, the current setpoint is the maximum or minimum current in a specified PWM cycle. This is why the effective current of this cycle (average current of this cycle) is lower (PWM = "On") or higher (PWM = "Fast Decay") than the current setpoint.

The size of the deviation depends on the load impedance.

9.25.6.15 Derating

The temperature of the module is affected by the PWM period duration. The following derating must therefore be taken into account with a PWM period duration under 100 μ s.



9.25.6.16 Let-through current I2T

The module is designed for let-through current of 360 A²s for a period of 10 seconds. If more current is needed for a certain time, less current must be drawn during the remaining time in order to maintain the let-through current.

Calculating the remaining-time current

$$I_{\text{Boost}}^2 \cdot t_{\text{Boost}} + I_{\text{Remaining}}^2 \cdot (10 - t_{\text{Boost}}) \leq 360 \text{ A}^2 \text{ s}$$

$$I_{\text{Remaining}} = \sqrt{\frac{360 \text{ A}^2 \text{ s} - I_{\text{Boost}}^2 \cdot t_{\text{Boost}}}{10 \text{ s} - t_{\text{Boost}}}}$$

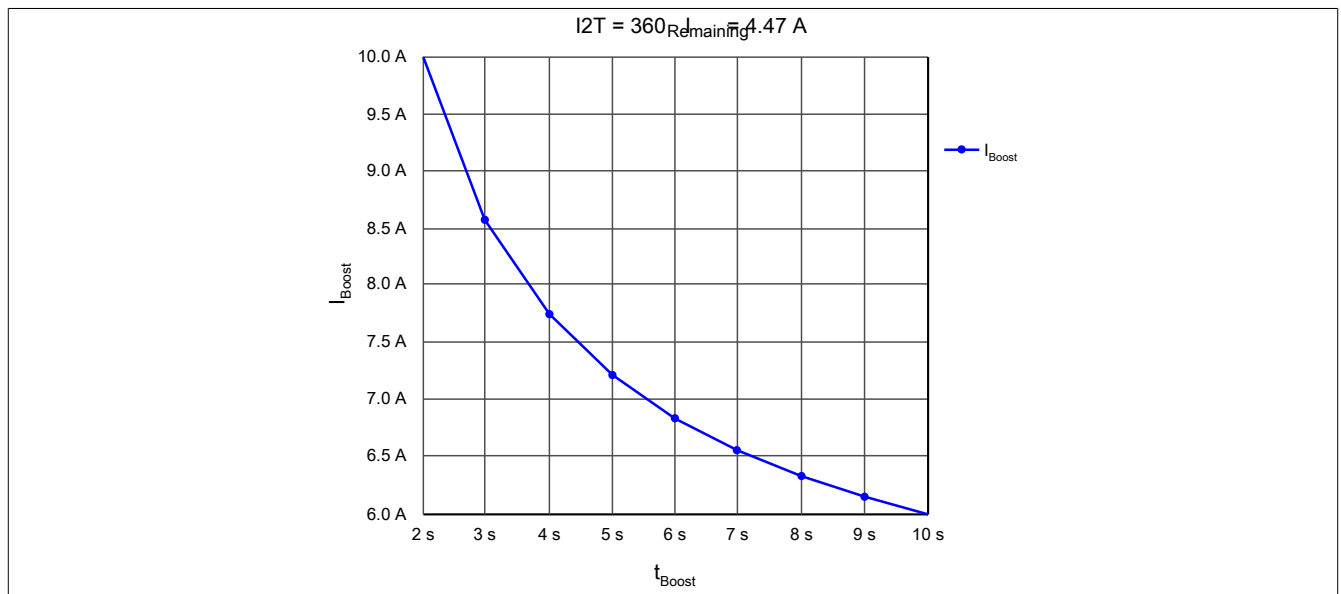
Example

A boost current of 8 A is needed for a duration of 3 seconds.

$$I_{\text{Remaining}} = \sqrt{\frac{360 \text{ A}^2 \text{ s} - 8 \text{ A}^2 \cdot 3 \text{ s}}{10 \text{ s} - 3 \text{ s}}} = 4.89 \text{ A}$$

| t_{Boost} s | I_{Boost} A | $t_{\text{Remaining}}$ s | $I_{\text{Remaining}}$ A | I2T A ² · s |
|-------------------------|-------------------------|-----------------------------|-----------------------------|---------------------------|
| 10 | 6.00 | 0 | 0 | 360.00 |
| 2 | 10.00 | 8 | 4.47 | 360.00 |
| 3 | 8.57 | 7 | 4.47 | 360.00 |
| 4 | 7.75 | 6 | 4.47 | 360.00 |
| 5 | 7.21 | 5 | 4.47 | 360.00 |
| 6 | 6.83 | 4 | 4.47 | 360.00 |
| 7 | 6.55 | 3 | 4.47 | 360.00 |
| 8 | 6.32 | 2 | 4.47 | 360.00 |
| 9 | 6.15 | 1 | 4.47 | 360.00 |

These values correspond to the following curve for let-through current I2T:



9.25.6.17 Register description

9.25.6.17.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.25.6.17.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|--|--------------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 64 | ConfigOutput01 | USINT | | | | • |
| 65 | ConfigOutput02 | USINT | | | | • |
| 72 + (N-1) * 8 | Configuration0N (index N = 1 to 4) | UINT | | | | • |
| 74 + (N-1) * 8 | HoldingCurrent0N (index N = 1 to 4) ¹⁾ | INT | | | | • |
| 76 + (N-1) * 8 | BoostCurrent0N (index N = 1 to 4) ¹⁾ | INT | | | | • |
| 78 + (N-1) * 8 | BoostTime0N (index N = 1 to 4) ¹⁾ | UINT | | | | • |
| 104 + (N-1) * 2 | SwitchingPeriod0N (index N = 1 to 4) ¹⁾ | UINT | | | | • |
| Communication | | | | | | |
| 0 + (N-1) * 8 | PulseWidthCurrentPWM0N (index N = 1 to 4) | INT | | | • | |
| 0 + (N-1) * 8 | Counter0N (index N = 1 to 4) | INT | • | | | |
| 2 + (N-1) * 8 | CounterLatch0N (index N = 1 to 4) | INT | • | | | |
| 2 + (N-1) * 8 | Control | USINT | | | • | |
| | TriggerEdge0N | Bit 0 | | | | |
| | StartTrigger0N | Bit 1 | | | | |
| | StartLatch0N | Bit 2 | | | | |
| | DitherDisable0N | Bit 3 | | | | |
| | ClearError0N | Bit 4 | | | | |
| | ShowMeanCurrent0N | Bit 5 | | | | |
| | ResetCounter0N | Bit 6 | | | | |
| | OutputEnable0N | Bit 7 | | | | |
| 4 | PeriodDurationPWM | UINT | | | • | |
| 4 + (N-1) * 8 | usSinceTrigger0N (index N = 1 to 4) | UINT | • | | | |
| 6 + (N-1) * 8 | Status0N (index N = 1 to 4) | USINT | • | | | |
| | StatusInput(N-1)*4 + 1 | Bit 0 | | | | |
| | ... | ... | | | | |
| | StatusInput(N-1)*4 + 4 | Bit 3 | | | | |
| | nLatchPending0N | Bit 4 | | | | |
| | LatchDone0N | Bit 5 | | | | |
| | EndswitchReached0N | Bit 6 | | | | |
| | PWMErr0N | Bit 7 | | | | |
| | 7 | Global error | USINT | • | | |
| | OverVoltageError | Bit 4 | | | | |
| | UnderVoltageError | Bit 5 | | | | |
| | VoltageWarning | Bit 6 | | | | |
| | OvertemperatureError | Bit 7 | | | | |
| 15 | Channel errors | USINT | • | | | |
| | CurrentError01 | Bit 0 | | | | |
| | OverCurrentError01 | Bit 1 | | | | |
| | CurrentError02 | Bit 2 | | | | |
| | OverCurrentError02 | Bit 3 | | | | |
| | CurrentError03 | Bit 4 | | | | |
| | OverCurrentError03 | Bit 5 | | | | |
| | CurrentError04 | Bit 6 | | | | |
| | OverCurrentError04 | Bit 7 | | | | |
| 128 | ModuleTemperature | SINT | | • | | |

1) Only available with firmware version 102 or later

9.25.6.17.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 64 | - | ConfigOutput01 | USINT | | | | • |
| 65 | - | ConfigOutput02 | USINT | | | | • |
| 72 + (N-1) * 8 | - | Configuration0N (index N = 1 to 4) | UINT | | | | • |
| 74 + (N-1) * 8 | - | HoldingCurrent0N (index N = 1 to 4) | INT | | | | • |
| 76 + (N-1) * 8 | - | BoostCurrent0N (index N = 1 to 4) | INT | | | | • |
| 78 + (N-1) * 8 | - | BoostTime0N (index N = 1 to 4) | UINT | | | | • |
| 104 + (N-1) * 2 | - | SwitchingPeriod0N (index N = 1 to 4) | UINT | | | | • |
| Communication | | | | | | | |
| 0 + (N-1) * 8 | 0 + (N-1) * 8 | PulseWidthCurrentPWM0N (index N = 1 to 4) | INT | | | • | |
| 0 + (N-1) * 8 | 0 + (N-1) * 8 | Counter0N (index N = 1 to 4) | INT | • | | | |
| 2 + (N-1) * 8 | 2 + (N-1) * 8 | CounterLatch0N (index N = 1 to 4) | INT | • | | | |
| 2 + (N-1) * 8 | 2 + (N-1) * 8 | Control | USINT | | | • | |
| | | TriggerEdge0N | Bit 0 | | | | |
| | | StartTrigger0N | Bit 1 | | | | |
| | | StartLatch0N | Bit 2 | | | | |
| | | DitherDisable0N | Bit 3 | | | | |
| | | ClearError0N | Bit 4 | | | | |
| | | ShowMeanCurrent0N | Bit 5 | | | | |
| | | ResetCounter0N | Bit 6 | | | | |
| | | OutputEnable0N | Bit 7 | | | | |
| 4 | 4 | PeriodDurationPWM | UINT | | | • | |
| 4 + (N-1) * 8 | 4 + (N-1) * 8 | usSinceTrigger0N (index N = 1 to 4) | UINT | • | | | |
| 6 (N-1) * 8 | 6 (N-1) * 8 | Status of the inputs | U(S)INT | • | | | |
| | | StatusInput(N-1) * 4 + 1 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusInput(N-1) * 4 + 4 | Bit 3 | | | | |
| | | nLatchPending0N | Bit 4 | | | | |
| | | LatchDone0N | Bit 5 | | | | |
| | | EndswitchReached0N | Bit 6 | | | | |
| | | PWMErr0N | Bit 7 | | | | |
| | | CurrentError01 | Bit 8 | | | | |
| | | OverCurrentError01 | Bit 9 | | | | |
| | | CurrentError02 | Bit 10 | | | | |
| | | OverCurrentError02 | Bit 11 | | | | |
| | | CurrentError03 | Bit 12 | | | | |
| | | OverVoltageError | | | | | |
| | | OverCurrentError03 | Bit 13 | | | | |
| | | UnderVoltageError | | | | | |
| CurrentError04 | Bit 14 | | | | | | |
| VoltageWarning | | | | | | | |
| OverCurrentError04 | Bit 15 | | | | | | |
| OvertemperatureError | | | | | | | |
| 128 | - | ModuleTemperature | SINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.25.6.17.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.25.6.17.3.2 CAN I/O bus controller

The module occupies 4 analog logical slots on CAN I/O.

9.25.6.17.4 Configuration

9.25.6.17.4.1 Configuration

Name:

Configuration01 to Configuration04

These registers can be used to configure the four DC motors.

The following placeholders are used in the configuration table:

| Register | Channel N | In1 | In2 |
|-----------------|-----------|------|------|
| Configuration01 | 1 | DI3 | DI4 |
| Configuration02 | 2 | DI7 | DI8 |
| Configuration03 | 3 | DI11 | DI12 |
| Configuration04 | 4 | DI15 | DI16 |

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|---------|--|---------|---|
| 0 - 1 | Configuration of the latch function for ABR counter N. Enabling the latch function is described in the control register (bit 2): | 00 | ABR counter N is latched unconditionally (default setting). The reference enable input is ignored. (Bus controller default setting) |
| | | 01 | ABR counter N is latched if a rising edge occurs on digital input In1 and reference enable input In2 is "1". The reference enable input must be enabled to do this (see bit 2). |
| | | 10 | ABR counter N is latched if a falling edge occurs on digital input In1 and reference enable input In2 is "1". The reference enable input must be enabled to do this (see bit 2). |
| | | 11 | The latch function is disabled. |
| 2 | Reference enable input: | 0 | No reference enable input (bus controller default setting) |
| | | 1 | Digital input In2 is used as a reference enable input |
| 3 | Active level of the reference enable input for ABR counter N: | 0 | Active level = High (bus controller default setting) |
| | | 1 | Active level = Low |
| 4 | Reserved | 0 | |
| 5 - 7 | Definition of limit switch N (see also "Limit switch function" on page 2588): | 000 | Limit switch N is disabled (bus controller default setting) |
| | | 001 | Digital input In1 is used as the Enable input . ¹⁾ |
| | | 010 | Digital input In1 is used as the limit switch |
| | | 011 | Reserved |
| | | 100 | Digital input In2 is used as the limit switch |
| | | 101 | Reserved |
| | | 110 | Digital inputs In1 and In2 are used as left and right limit switches |
| | | 111 | Reserved |
| 8 | Active level for limit switch N: | 0 | Active level = High (bus controller default setting) |
| | | 1 | Active level = Low |
| 9 - 10 | Trigger input for trigger counter "usSinceTrigger" N: | 00 | The trigger counter is disabled (bus controller default setting). |
| | | 01 | Digital input In1 is used as trigger input |
| | | 10 | Digital input In2 is used as trigger input |
| | | 11 | Reserved |
| 11 | Display of current average for output N: | 0 | If the corresponding setting has been enabled, then the average current value is indicated in register "CounterLatch[x]" on page 2596 (see bit 5 in the "control register" on page 2589) (bus controller default setting) |
| | | 1 | If the corresponding setting has been activated, then the average current value is shown in the "usSinceTrigger[x]" on page 2596 register (see bit 5 in the "control register" on page 2589). |
| 12 + 15 | Output mode N: | 00 | PWM mode (bus controller default setting) |
| | | 01 | Current mode |
| | | 10 | Boost-and-hold current control ¹⁾ |
| | | 11 | Reserved |
| 13 - 14 | Decay configuration for PWM N (see also "Decay configuration" on page 2599): | 00 | Slow decay (bus controller default setting) |
| | | 01 | Mixed decay |
| | | 10 - 11 | Reserved |

1) Only available with firmware version 102 or later

Limit switch function

The limit switch function serves to quickly shut off the PWM outputs when a limit position is reached.

The limit switch is activated and the disable edge (rising or falling) on the limit switch input is selected using bits 6 to 8.

A PWM output is deactivated as soon as the configured disable edge is reached on the corresponding input of the limit switch. This deactivation occurs independently of the current direction of movement. It remains deactivated until either the limit switch function is deactivated or the limit switch is acknowledged with bit 4 in the respective "control register" on page 2589.

Enable input

The limit switch input of the module can optionally be used as an enable input. Bits 5 to 7 must be configured accordingly for this. Data point [OutputEnable](#) and the digital input are logically linked by an AND operator.

When the enable input is enabled, the PWM output can be switched on and off via the digital input. Switching on and off is done with a jitter of 50 µs. Since it is possible to react only at the beginning of the PWM period, an additional jitter of the length of the [PWM period duration](#) must be taken into account.

9.25.6.17.4.2 Control

Name:

TriggerEdge01 to TriggerEdge04
 StartTrigger01 to StartTrigger04
 StartLatch01 to StartLatch04
 DitherDisable01 to DitherDisable04
 ClearError01 to ClearError04
 ShowMeanCurrent01 to ShowMeanCurrent04
 ResetCounter01 to ResetCounter04
 OutputEnable01 to OutputEnable04

These registers can be used to configure the behavior of the trigger, the ABR counter and the dither.

[N] stands for the index number of the register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|--|-------|--|
| 0 | TriggerEdgeN Configuration of trigger edge for "usSinceTrigger": | 0 | Counting starts at rising edge |
| | | 1 | Counting starts at falling edge |
| 1 | StartTriggerN Enabling of "usSinceTrigger" due to a status change of bit 1 | x | Counting starts at the next trigger edge (see bit 0). For more information about trigger functionality, see " Trigger function procedure " on page 2589. |
| | | | |
| 2 | StartLatchN Latching or referencing ABR counters: | 0 | Disabled |
| | | 1 | Enabled |
| 3 | DitherDisable N | 0 | Dither for PWM output N is switched on. The dither frequency and dither amplitude must be greater than 0 (see " Dither " on page 2593). |
| | | 1 | Dither for PWM output N is switched off. |
| 4 | ClearErrorN Acknowledging error or limit switch: | 0 | No effect |
| | | 1 | Error acknowledgment on output N (overcurrent or open load) or acknowledgment of limit switch N |
| 5 | ShowMeanCurrentN Konfiguration der Register "CounterLatch" on page 2596 und "usSinceTrigger" on page 2596 | 0 | Register CounterLatchN contains the latched counter value. Register usSinceTriggerN contains the trigger counter. |
| | | 1 | Both registers contain the current PWM output current |
| 6 | ResetCounterN Reset ABR counter | 0 | Enable ABR counter |
| | | 1 | Reset ABR counter |
| 7 | OutputEnableN ¹⁾ | 0 | Switch off the PWM output |
| | | 1 | Switch on the PWM output |

1) Only for boost-and-hold current control.

Trigger function procedure

The following points must be taken into consideration when configuring or activating the trigger function:

- Select the desired trigger edge using bit 0
- Enable the trigger function by changing the state of StartTrigger (bit 1). This edge clears the register [usSinceTrigger](#) (µs counter).
- When the trigger event occurs, the µs counter "usSinceTrigger" is started
- The "usSinceTrigger" counter cannot overrun, i.e. the counter is stopped at $2^{16}-1$ and retains this value until the next time the trigger function is activated
- The trigger function can be re-activated at any time by changing the state of StartTrigger (bit 1) regardless of if a trigger event has occurred or if "usSinceTrigger" has reached its maximum value.

Reset ABR counter

Bit 6 sets the following counters and status bits to 0:

- ABR counter
- Latch value of the ABR counter
- Latching started on the ABR counter (bit 4 of the "status register" on page 2597)
- ABR counter successfully latched (bit 5 of the "status register" on page 2597)

Please note that a started latch procedure is no longer active after the ABR counter has been reset. This means that latching must be restarted by a rising edge on bit 2.

OutputEnable

Bit 7 can start or stop the output profile in [Boost-and-Hold Betrieb](#). If a rising edge occurs on this data point, any pending [Overcurrent error](#) or [Open load error](#) of the associated PWM output are acknowledged and the output is switched on.

Starting or stopping occurs immediately after the transfer of the value on the X2X Link network with a jitter of 50 µs. Note that during startup, an additional jitter of the length of the [PWM period duration](#) of the current controller is added.

Starting and stopping the output profile can also be controlled by the digital input. See ["Enable input" on page 2589](#).

9.25.6.17.4.3 Difference between operating modes

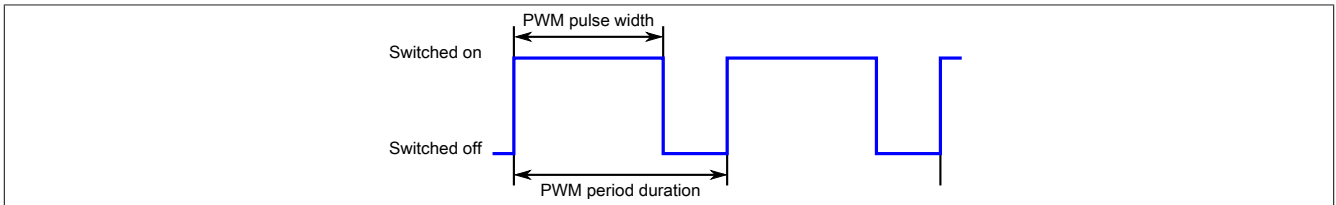
The module provides the following operating modes:

- PWM mode
- Current mode
- Boost-and-hold current control

The following images illustrate how the current curves for the outputs are affected by registers "PWM period duration" on page 2595 and "PWM pulse width" on page 2595.

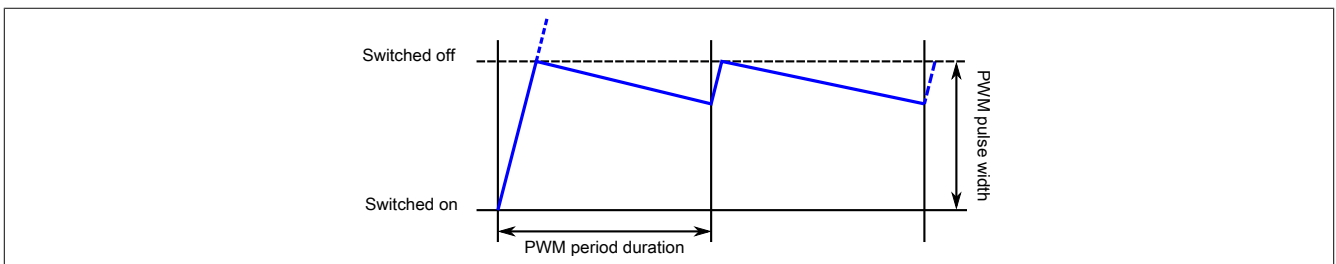
PWM mode

At the beginning of each period, the output is switched on for the percentage of time set in the PWM pulse width.



Current mode

At the beginning of each period, the current output is switched on. After reaching the value set in "PulseWidthCurrentPWM" on page 2595, the output is switched off and the voltage drops according to the set decay configuration until it is next switched on.



Boost-and-hold current control

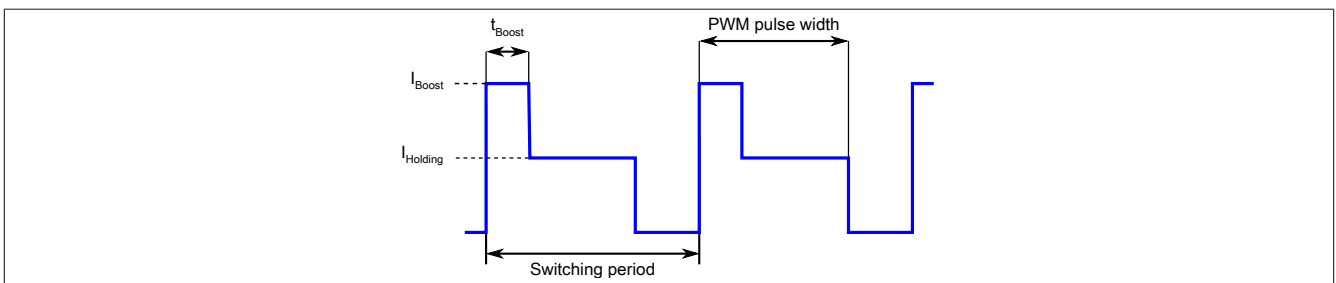
Information:

Only available with firmware version 102 or later.

In this operating mode, the current mode is combined with a higher-level PWM mode.

After the time (t_{Boost}) set in register "BoostTime" on page 2592, the inrush current (I_{Boost}) is changed to the holding current ($I_{Holding}$) specified in register "HoldingCurrent" on page 2592.

The period duration of the current profile is set in register "SwitchingPeriod" on page 2592 in 50- μ s steps. In addition, the PWM period duration must be set in register PeriodDurationPWM. (Not shown, see Current mode.)



Example: Controlling a digital valve

The boost current (I_{Boost}) is used to quickly open a digital valve, for example. After the boost time (t_{Boost}), the current is reduced to the lower holding current (I_{Holding}) in order to save energy and not overload the PWM output. I_{Holding} is therefore set to a smaller value than I_{Boost} .

The pulse width can be used to set the opening time of the valve in relation to the period duration. After the period duration has expired, I_{Boost} is started again. If the valve should remain open continuously, the pulse width must be set to 100%. In this case, no boost current is output at the beginning of the next period.

I_{Boost} is only output if the valve has been switched off for at least 50 μs . If the pulse width is set smaller than t_{Boost} , the boost time is shortened accordingly.

9.25.6.17.4.4 Boost-and-hold registers**Boost current**

Name:

BoostCurrent01 to BoostCurrent04

The boost current is set in mA in this register.

| Data type | Values | Information |
|-----------|------------|---------------|
| INT | 0 to 10000 | For 0 to 10 A |

Boost time

Name:

BoostTime01 to BoostTime04

The sampling time is set in μs in this register. The entered value is rounded up to the next largest 50- μs interval.

| Data type | Values | Information |
|-----------|------------|------------------|
| UINT | 0 to 65500 | In μs |

Holding current

Name:

HoldingCurrent01 to HoldingCurrent04

The holding current is set in mA in this register. After the boost time, the current for the remaining pulse width time is raised or lowered to this value.

| Data type | Values | Information |
|-----------|-----------|--------------|
| INT | 0 to 6000 | For 0 to 6 A |

Period duration of the current profile

Name:

SwitchingPeriod01 to SwitchingPeriod04

This register is used to set the period duration of the current profile in μs for boost-and-hold mode. The entered value is rounded up to the next largest 50- μs interval.

| Data type | Values | Information |
|-----------|---------------|--------------------------------|
| UINT | 2000 to 65500 | Corresponds to 500 to 15.26 Hz |

Synchronous operation of channels

In order for 2 or more channels to run synchronously, their period durations of the output profile ([SwitchingPeriod](#)) must be set to the same value or to a multiple of the other channel. An exact phase position of 0 degrees can only be guaranteed if the channels are switched on simultaneously (in the same bus cycle) with [OutputEnable](#).

To operate the current profile synchronously to the X2X Link network, [SwitchingPeriod](#) should be set to a multiple of the bus cycle.

9.25.6.17.4.5 Dither

When the position setpoint for valves remains constant for a long period of time, especially in fluids, there is a risk that a valve will stick. This is normally prevented using "dithering". When doing so, the value is permitted to slightly oscillate around the position setpoint.

By default, the dither is active for both outputs as soon as the **dither amplitude** and **dither frequency** are set to a value >0. If necessary, the dither can be disabled for each output individually or simultaneously (see bit 3 in register "control register" on page 2589).

No dither is used in boost-and-hold mode of the PWM output. Any set dither amplitude and dither frequency are ignored by the module.

Dither amplitude

Name:

ConfigOutput01

This register can be used to configure the amplitude value or pulse width.

| Data type | Value | Information |
|-----------|----------|---|
| USINT | 0 to 255 | Current mode: 0 to 25.5% of the module's nominal current ¹⁾ PWM mode: 0 to 25.5% of the period duration. Bus controller default setting: 0 |

1) See the technical data for the module.

Dither frequency

Name:

ConfigOutput02

This register can be used to set the frequency in 2 Hz steps.

| Data type | Value | Information |
|-----------|----------|--|
| USINT | 0 to 255 | Corresponds to 0 to 510 Hz. Bus controller default setting: 0 |

Dither example

The values specified in the data sheet for a valve should be used to calculate [Dither amplitude](#) and [Dither frequency](#).

Data sheet for the valve

The data sheet for a valve manufacturer recommends the following dithering:

Dither height in percent (A_{Dither}): 20 to 35% (peak values) of the nominal valve current of 2 A

Dither frequency in Hertz (F_{Dither}): 40 to 70 Hz

Selected values

These values correspond to the average values on the valve data sheet.

$A_{\text{Dither}} = 27\%$ of the valve's nominal current (peak values)

$F_{\text{Dither}} = 56 \text{ Hz}$

Formulas

[Dither amplitude](#) = $(A_{\text{Dither}} / 2) * (\text{Nominal current}_{\text{Valve}} / \text{Nominal current}_{\text{Module}}) * 10$

Info: $(A_{\text{Dither}} / 2)$ = Conversion of the peak values to amplitude, " * 10" = Scaling of the dither amplitude to 1/10%

[Dither frequency](#) = $F_{\text{Dither}} / 2 \text{ Hz}$

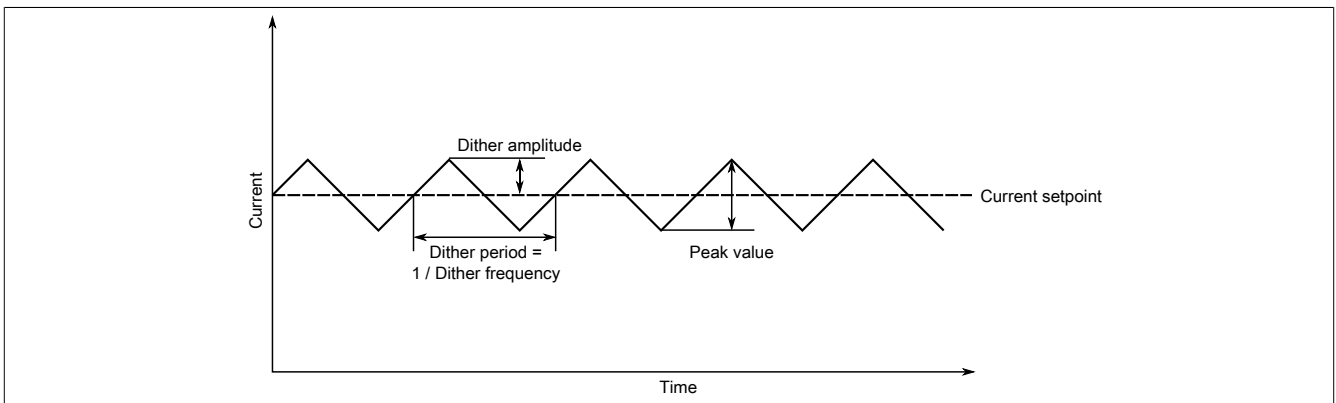
Info: Dither frequency is configured in 2 Hz steps.

Calculation

By using the selected values in the formulas.

[Dither amplitude](#) = $27\% / 2 * (2 \text{ A} / 6 \text{ A}) * 10 = 45$

[Dither frequency](#) = $56 \text{ Hz} / 2 \text{ Hz} = 28$



9.25.6.17.5 Communication

9.25.6.17.5.1 PWM pulse width

Name:

PulseWidthCurrentPWM01 to PulseWidthCurrentPWM04

The PWM pulse width (PWM mode) or current setting (in current mode) is entered in this register according to the setting in the module configuration register. (see also ["Difference between operating modes" on page 2591.](#)) A negative value changes the output polarity.

PWM mode

| Data type | Value | Output + | Output - |
|-----------|--------|--------------------------------------|--------------------------------------|
| INT | 32767 | High | Low |
| | 16384 | PWM 50/50 | Low |
| | 0 | Low (bus controller default setting) | Low (bus controller default setting) |
| | -16384 | Low | PWM 50/50 |
| | -32767 | Low | High |

Current mode

| Data type | Value | Current mode |
|-----------|------------------|------------------------|
| INT | 19661 to 32767 | 6 to 10 A (max. 2 s) |
| | 19660 | 6 A |
| | 0 | 0 A |
| | -19660 | -6 A |
| | -19661 to -32767 | -6 to -10 A (max. 2 s) |

Boost-and-hold current control

In this operating mode, this register is used to control the pulse width of the output signal in a way similar to PWM mode. In contrast, the pulse width of the current profile is specified. See ["Current mode" on page 2591.](#)

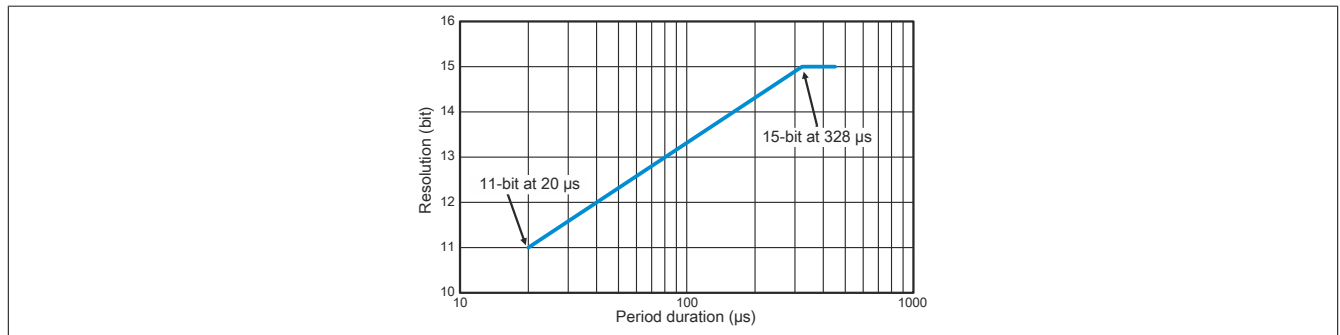
In this operating mode, the pulse width can be set with a resolution of 50 μ s. The pulse width of the current is specified as a percentage of the period duration of output signal [SwitchingPeriod](#). If the value of this register is modified during a period, the pulse width is immediately adjusted.

Negative values correspond to an output with negative current direction.

| Data type | Values | Information |
|-----------|-----------------|-------------------|
| INT | -32768 to 32767 | For -100% to 100% |

Resolution/Derating

As mentioned earlier in the technical data, the PWM resolution is 15-bit (+ sign). This value is derated for a period duration of less than 328 μ s because of the minimal PWM timing resolution (10 ns) (see following diagram). With the minimum PWM period duration of 20 μ s, the PWM has 11-bit resolution (+ sign):



9.25.6.17.5.2 PWM period duration

Name:

PeriodDurationPWM

This register can be used to set the period duration between 20 μ s (50 kHz) and 65535 μ s (15 Hz). See also ["Difference between operating modes" on page 2591.](#)

| Data type | Value | Information |
|-----------|-------------|-----------------|
| UINT | 20 to 65535 | Time in μ s |

9.25.6.17.5.3 ABR counter

Name:

Counter01 to Counter04

These registers are 16-bit AB(R) counters.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

9.25.6.17.5.4 ABR counter latch

Name:

CounterLatch01 to CounterLatch04

When a latch event occurs, the current counter values are saved in these registers. For additional features, see bit 5 in the respective "control register" on page 2589.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

9.25.6.17.5.5 Microseconds since trigger

Name:

usSinceTrigger01 to usSinceTrigger04

This register shows either the time in μs since the last trigger event or the average current value.

- The usSinceTrigger counter cannot overrun, i.e. the counter is stopped at $2^{16}-1$ and retains this value until the next time the trigger function is activated.
- If the average current is displayed in this register (bit 11 in the respective "configuration register" on page 2588), then the data type of usSinceTrigger in Automation Studio must be unsigned integer (UINT). The average current value, on the other hand, is an Integer (INT). This means that negative currents are displayed between 32,769 and 65,535.

Counting mode

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

Measurement of average current value

| Data type | Value | Information |
|-----------|------------------|---------------------------------------|
| INT | 19,661 to 32,767 | 6 to 10 A |
| | 19,660 | 6 A |
| | 1 | 305 μA (= 10 A / 32,767) |
| | 0 | 0 A |
| | 65,535 | -305 μA (= -10 A / 32,767) |
| | 45,876 | -6 A |
| | 45,875 to 32,769 | -6 to -10 A |

9.25.6.17.5.6 Status of the inputs

Name:

StatusInput01 to StatusInput16

nLatchPending01 to nLatchPending04

LatchDone01 to LatchDone04

EndswitchReached01 to EndswitchReached04

PWMError01 to PWMError0

These registers contain the status of the inputs and outputs for each DC motor.

The following placeholders are used in the status table.

| Register | Channel [N] | In1 | In2 | In3 | In4 |
|--------------------|-------------|------|------|------|------|
| Status of inputs 1 | 1 | DI1 | DI2 | DI3 | DI4 |
| Status of inputs 2 | 2 | DI5 | DI6 | DI7 | DI8 |
| Status of inputs 3 | 3 | DI9 | DI10 | DI11 | DI12 |
| Status of inputs 4 | 4 | DI13 | DI14 | DI15 | DI16 |

| Data type | Values |
|---------------------|------------------------|
| USINT ¹⁾ | See the bit structure. |
| UINT ²⁾ | See the bit structure. |

1) Function model 0 and function model 254 → Registers "Status of inputs 3" and "Status of inputs 4"

2) Only function model 254 → Registers "Status of inputs 1" and "Status of inputs 2"

Bit structure:

| Bit | Description | Value | Information |
|--------|--------------------------------|-------|---|
| 0 | StatusInput [In1] | x | In1 is used with ABR counter N for encoder signal A. |
| 1 | StatusInput [In2] | x | In2 is used with ABR counter N for encoder signal B. |
| 2 | StatusInput [In3] | 0 | Possible uses of the digital input <ul style="list-style-type: none"> • Trigger input N • Reference pulse for ABR counter N • Limit switch N (left) |
| 3 | StatusInput [In4] | 0 | Possible uses of the digital input <ul style="list-style-type: none"> • Reference enable N • Trigger input N • Limit switch N (right) |
| 4 | nLatchPending [x] | 00 | Latching is started. |
| | | 01 | ABR counter latch N is ready. Latch not yet started. |
| 5 | LatchDone [x] | 0 | After each successful latch of ABR counter N, the status of this bit is changed. |
| 6 | EndswitchReached [x] | 00 | No effect on PWM output N |
| | | 01 | Limit switch N is reached. PWM output N is switched off. |
| 7 | PWMError [x] | 0 | No channel error |
| | | 1 | Channel error occurred. PWMError [x] is a summary of the two error bits CurrentError0x and OverCurrentError0x in register "Channel errors" on page 2598. PWMError [x] is not affected by the error flags contained in the "global errors" on page 2599 register. In order to intercept error states that can affect the PWM outputs, the global errors register must also be monitored. |
| 8 - 15 | Function model 254 only | | |
| | Status of inputs 1 | x | With "Status of inputs 1", bits 12 to 15 contain error bits 4 to 7 of register "Global error" on page 2599. |
| | Status of inputs 2 | x | With "Status of inputs 2", bits 8 to 15 contain error bits 0 to 7 of register "Channel errors" on page 2598. |

9.25.6.17.5.7 Channel errors

Name:

CurrentError01 to CurrentError04

OverCurrentError01 to OverCurrentError04

If an error is detected, the corresponding error bit in this register remains set until the error is acknowledged using bit 4 in the respective "control register" on page 2589.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|--------------------|-------|--|
| 0 | CurrentError01 | 0 | No error |
| | | 1 | Open load error |
| 1 | OverCurrentError01 | 0 | No error |
| | | 1 | Overcurrent error, output deactivated. |
| 2 | CurrentError02 | 0 | No error |
| | | 1 | Open load error |
| 3 | OverCurrentError02 | 0 | No error |
| | | 1 | Overcurrent error, output deactivated. |
| 4 | CurrentError03 | 0 | No error |
| | | 1 | Open load error |
| 5 | OverCurrentError03 | 0 | No error |
| | | 1 | Overcurrent error, output deactivated. |
| 6 | CurrentError04 | 0 | No error |
| | | 1 | Open load error |
| 7 | OverCurrentError04 | 0 | No error |
| | | 1 | Overcurrent error, output deactivated. |

Overcurrent error

An overcurrent error is registered if one of the following conditions is met:

- ≥ 10 A flow from a PWM output for at least 2 seconds
- ≥ 16 A flow for 3 consecutive PWM cycles
- All PWM outputs together consume more than 32 A on the X3 connector

In all three cases, the affected PWM output is deactivated by the firmware (i.e. the pins on the PWM output are short-circuited). The user must acknowledge the error using bit 4 in the respective "control register" on page 2589 before a PWM output deactivated in this manner can be made operational again.

Open load error

An open load error is only registered in current control mode (see bit 12 in the respective "configuration register" on page 2588) if the current setpoint is not reached. In some cases this can be caused by an open line, although usually the impedance of the load is too high.

9.25.6.17.5.8 Global error

Name:

OverVoltageError

UnderVoltageError

VoltageWarning

OvertemperatureError

This register indicates overtemperature and errors in the module supply. The error bits are automatically acknowledged by the module as soon as the values are back within the permissible limits.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------------|-------|--|
| 0 - 3 | Reserved | 0 | |
| 4 | OverVoltageError | 0 | No error |
| | | 1 | Voltage >80 V. All outputs are deactivated. |
| 5 | UnderVoltageError | 0 | No error |
| | | 1 | Voltage <18 V |
| 6 | VoltageWarning | 0 | No error |
| | | 1 | Voltage >60 V |
| 7 | OvertemperatureError | 0 | No error |
| | | 1 | Module overtemperature; all outputs are deactivated. |

9.25.6.17.5.9 Temperature

Name:

ModuleTemperature

The module temperature is displayed in this register.

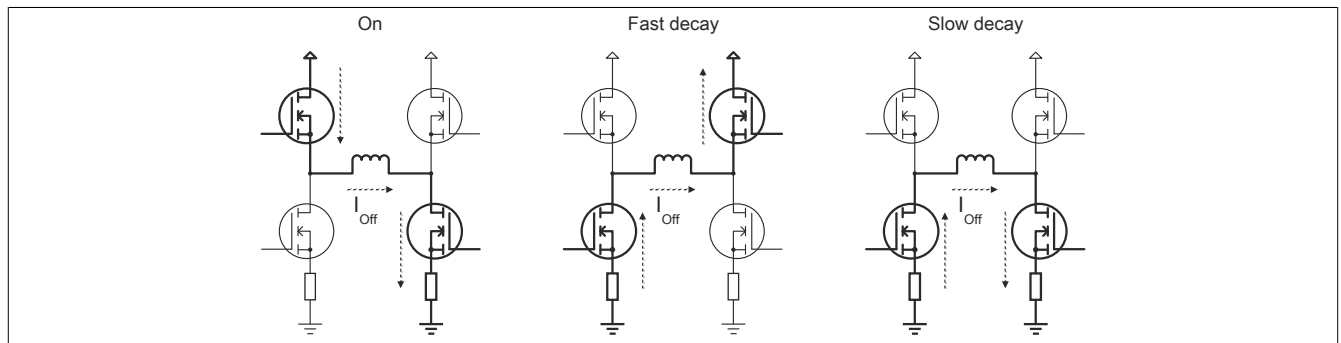
| Data type | Value | Information |
|-----------|------------|--------------------------|
| SINT | -40 to 125 | Module temperature in °C |

9.25.6.17.6 Decay configuration

The decay configuration determines the method and dynamics of current reduction for inductive loads or motors.

"Slow decay" is configured by default. In this mode, the current is automatically reduced relatively slowly with resistance in the load. No energy is regenerated into the module.

"Mixed decay" mode is recommended for applications that require a dynamic and linear reduction of current. In this mode, energy is regenerated into the module during part of the PWM cycle (fast decay).



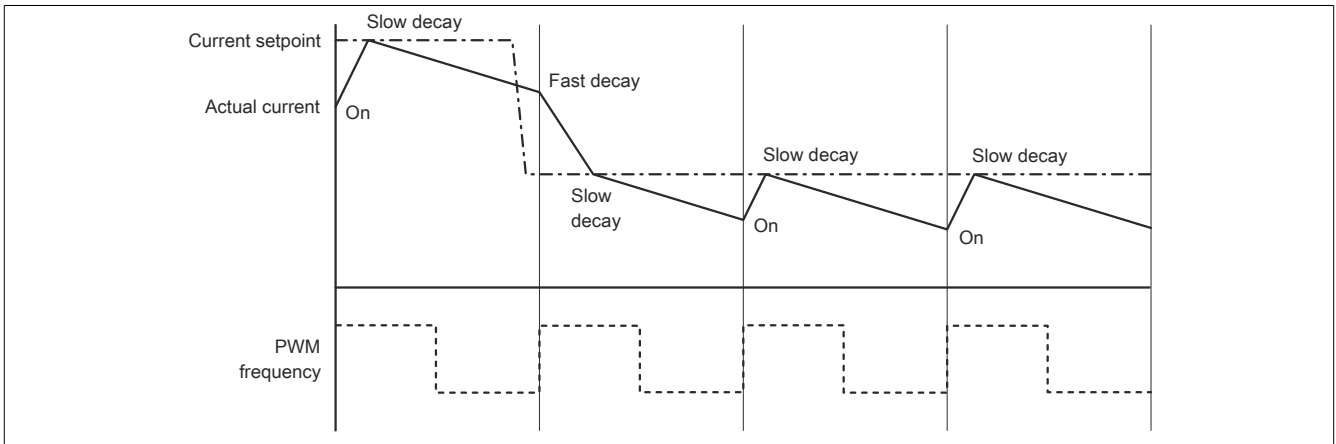
9.25.6.17.6.1 Current control

As its name suggests, mixed decay mode is a mix of "slow decay" and "fast decay". This occurs as follows:

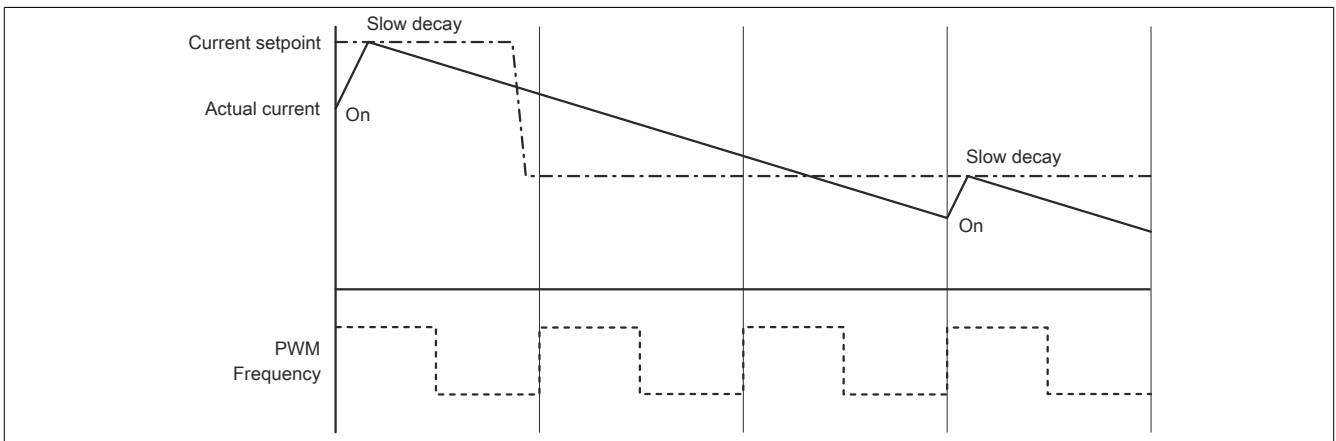
A check is made at the beginning of each PWM cycle to determine if the actual current for the phases is below the set current. If this is the case, PWM is enabled (On) until the current setpoint is reached. If the current setpoint has already been exceeded at the beginning of the PWM cycle (generator operation), the system immediately switches to fast decay mode until the current setpoint is exceeded. The rest of the PWM cycle always takes place in slow decay mode.

This also permits generator operation as long as the valid range for the supply voltage has not been exceeded due to the regeneration into the DC circuit.

Current control in Mixed Decay mode



Current control in Slow Decay mode

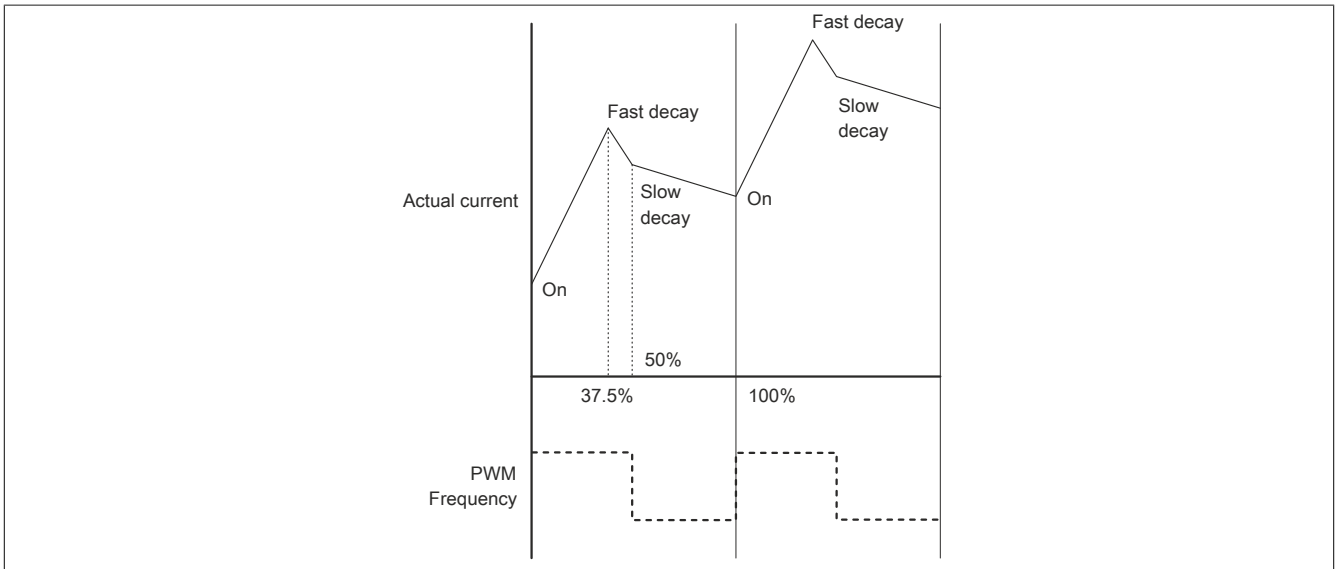


9.25.6.17.6.2 PWM control

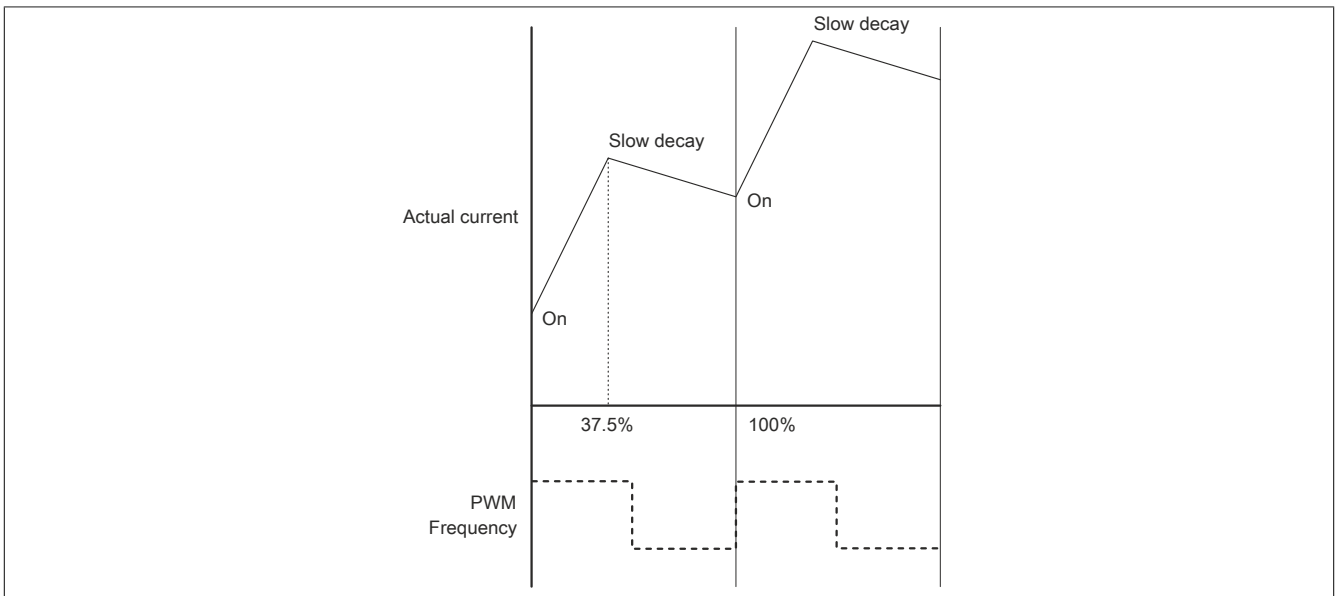
When Mixed Decay mode is enabled, the outputs are driven in Fast Decay mode up until 50% of the period and in Slow Decay mode for the remainder of the switch-off phase.

When Slow Decay mode is used, it is immediately enabled during the switch-off phase.

PWM control in Mixed Decay mode (pulse duty factor = 37.5%)



PWM control in Slow Decay mode (pulse duty factor = 37.5%)



Operating DC motors

In PWM mode, the motor current is limited to the maximum current (10 A), independent of the supply voltage.

However, the motor switches to generator operation when braking. Because of the counter EMF, which is dependent on the rotary speed, a current is generated in the module that is only limited by the internal resistance of the motor. This is not permitted to exceed 15 A (maximum 2 seconds).

The counter EMF closely corresponds to the voltage needed to achieve this speed. Therefore, the maximum brake current is very easy to calculate with the following formula.

$$I_{\text{Brake}} = U_e * \frac{\text{Pulse width}}{100\%} * \frac{1}{R_{\text{Motor}}}$$

Example:

| | |
|------------------------------|----------------------|
| Module supply | 42 V |
| Pulse width | 16364 (equal to 50%) |
| Internal resistance of motor | 3.5 Ω |

$$I_{\text{Brake}} = 38\text{V} * \frac{50}{100\%} * \frac{1}{3.5\Omega} = 5.4\text{A}$$

9.25.6.17.7 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| |
|---------------------------|
| Minimum cycle time |
| 400 μs |

9.25.6.17.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| |
|--------------------------------|
| Minimum I/O update time |
| 400 μs |

9.25.7 X20SM1426

Data sheet version: 1.51

9.25.7.1 General information

The stepper motor module is used to control stepper motors with a rated voltage of 24 VDC at a motor current up to 1 A (1.2 A peak). Additionally, this module has four digital inputs that can be used as limit switches or as encoder inputs.

Due to the individual adjustment of the coil currents, the motor is only operated with the current it actually needs. This simplifies the selection of the available motors and prevents unnecessary heating. Because this affects energy consumption and thermal load, the effects are positive on the service life of the complete system. Complete flexibility is achieved through the use of independently adjustable holding, maximum and nominal current values. The current for microsteps is automatically adjusted to the configured current values.

The automatic motor identification system is an enormous help during standstills. The stepper motor modules can identify the connected motors using their coil characteristics and generate feedback in the form of an analog value. This makes it possible to detect not only wiring errors, but also incorrect motor types being used mistakenly. A stall detection mechanism is integrated to analyze the motor load. Detection of the stall is defined via a configurable threshold. This allows an overload or motor standstill to be detected precisely in many different types of applications.

- 1 stepper motor, 24 VDC, 1 A (1.2 A peak)
- Resolution of current values at 1%
- Maximum, rated and holding current configured independent of each other
- 38.5 kHz PWM frequency
- Integrated motor detection
- 256 micro-steps
- Stall detection
- Complete integration in Automation Studio and CNC applications
- 4 inputs, 24 VDC, can be configured as ABR
- Ramp function model based on the CANopen communication profile DS402
- NetTime timestamp: Position change, trigger time

NetTime timestamp of the position and trigger time

It is not just the position value that is important for highly dynamic positioning tasks, but also the exact time the position is measured. The module is equipped with a NetTime function for this that supplies a timestamp for the recorded position and trigger time with microsecond accuracy.

The timestamp function is based on synchronized timers. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

9.25.7.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Motor controllers |  |
| X20SM1426 | X20 stepper motor module, 1 motor connection, 1 A continuous current, 1.2 A peak current, 4 digital inputs 24 VDC, sink, configurable as incremental encoder, NetTime function | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 508: X20SM1426 - Order data

9.25.7.3 Technical data

| | |
|--|---|
| Model number | X20SM1426 |
| Short description | |
| I/O module | 1 full bridge for controlling stepper motors |
| General information | |
| B&R ID code | 0x2681 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Output | Yes, using status LED and software |
| I/O power supply | Yes, using software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.8 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E225616 Power conversion equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| Motor bridge - Power unit | |
| Quantity | 1 |
| Type | 2-phase bipolar stepper motor (full bridge) |
| Nominal voltage | 24 VDC -15% / +20% |
| Nominal current | 1 A |
| Maximum current | 1,2 A for 2 s (after a recovery time of at least 10 s at maximal 1 A) |
| Controller frequency | 38.4 kHz |
| DC bus capacitance | 57 µF |
| Step resolution | Max. 256 microsteps per step |
| Digital inputs | |
| Quantity | 4 |
| Nominal voltage | 24 VDC -15% / +20% |
| Input filter | |
| Hardware | <5 µs |
| Software | - |
| Connection type | 1-wire connections |
| Input circuit | Sink |
| Additional functions | 1x ABR incremental encoder |
| Input resistance | Typ. 18.2 kΩ |
| ABR incremental encoder | |
| Quantity | 1 |
| Encoder inputs | 24 V, asymmetrical |
| Counter size | 16-bit |
| Input frequency | Max. 50 kHz |
| Evaluation | 4x |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from I/O power supply |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | 0 to 50°C |
| Vertical mounting orientation | Not allowed |
| Derating | - |
| Storage | -25 to 70°C |
| Transport | -25 to 70°C |


Table 509: X20SM1426 - Technical data

| Model number | X20SM1426 |
|-----------------------|--|
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm |

Table 509: X20SM1426 - Technical data

9.25.7.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|-------|-----------------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset state |
| | e + r | | Red on / Green single flash | Invalid firmware |
| | 1 - 4 | | Green | Input state of the corresponding digital input |
| | M | | Orange | On |

1) Depending on the configuration, a firmware update can take up to several minutes.

9.25.7.5 Pinout

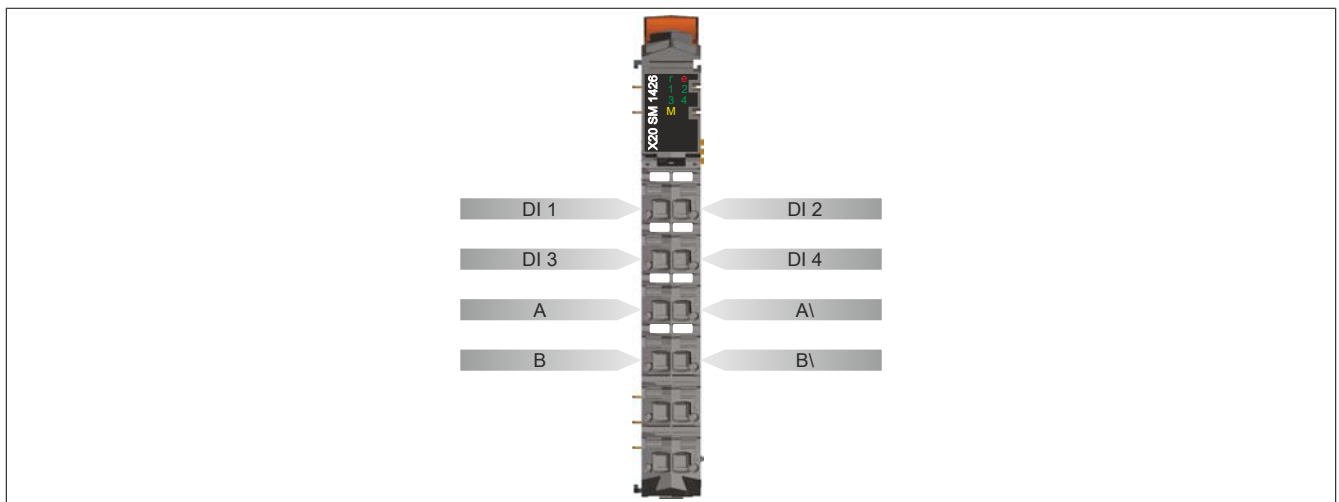
In accordance with the EN 60204-1 standard, a cable cross section of 0.75 mm² or larger must be used for the motor outputs in order to handle the maximum motor current of 1.2 A. To ensure full motor power, voltage drops that could result from the cable length and the electrical connections must also be taken into consideration when selecting the attachment cable.

Warning!

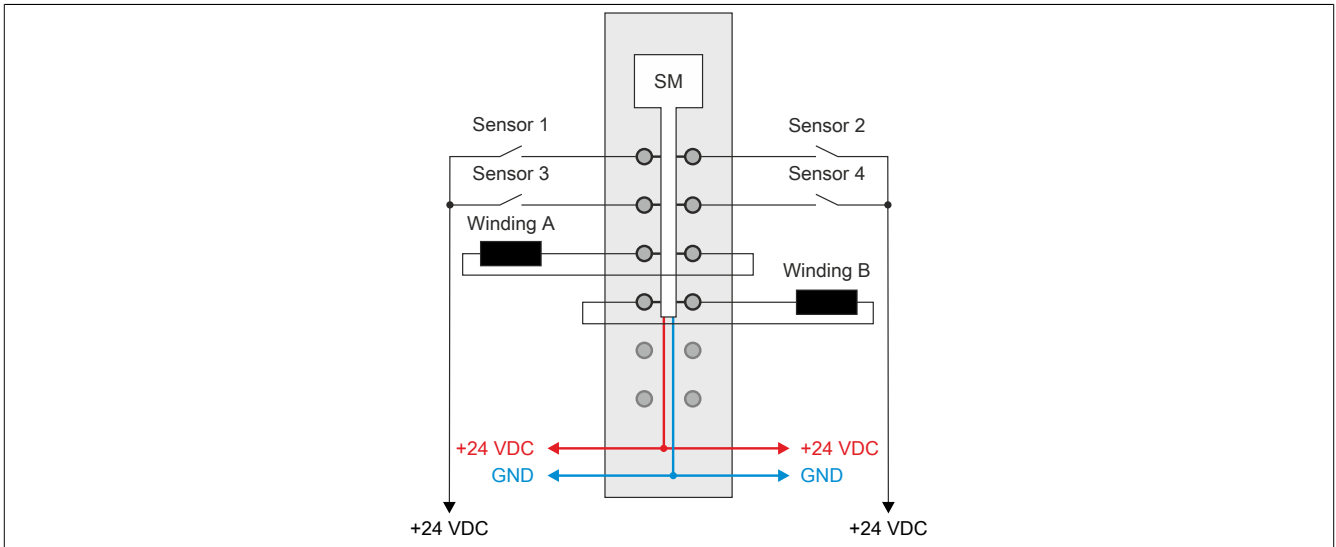
The terminal block is not permitted to be plugged in or unplugged during operation.

Information:

Shielded motor cables must be used in order to meet the limits according to the EN 55011 standard (emissions).



9.25.7.6 Connection example



9.25.7.7 Connection options for digital inputs

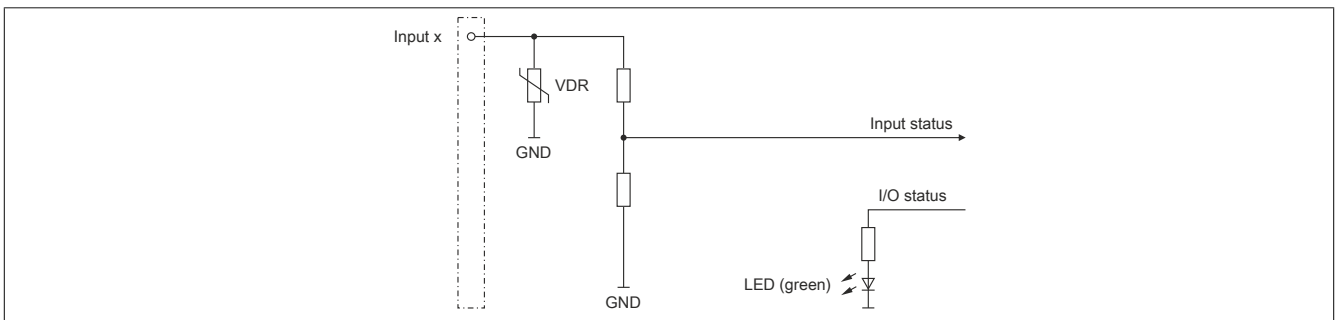
Function model "Standard"

| Channel | Function | | |
|---------|---------------|--|---------------|
| DI 1 | Digital input | | A |
| DI 2 | Digital input | | B |
| DI 3 | Digital input | | R |
| DI 4 | Digital input | | Trigger input |

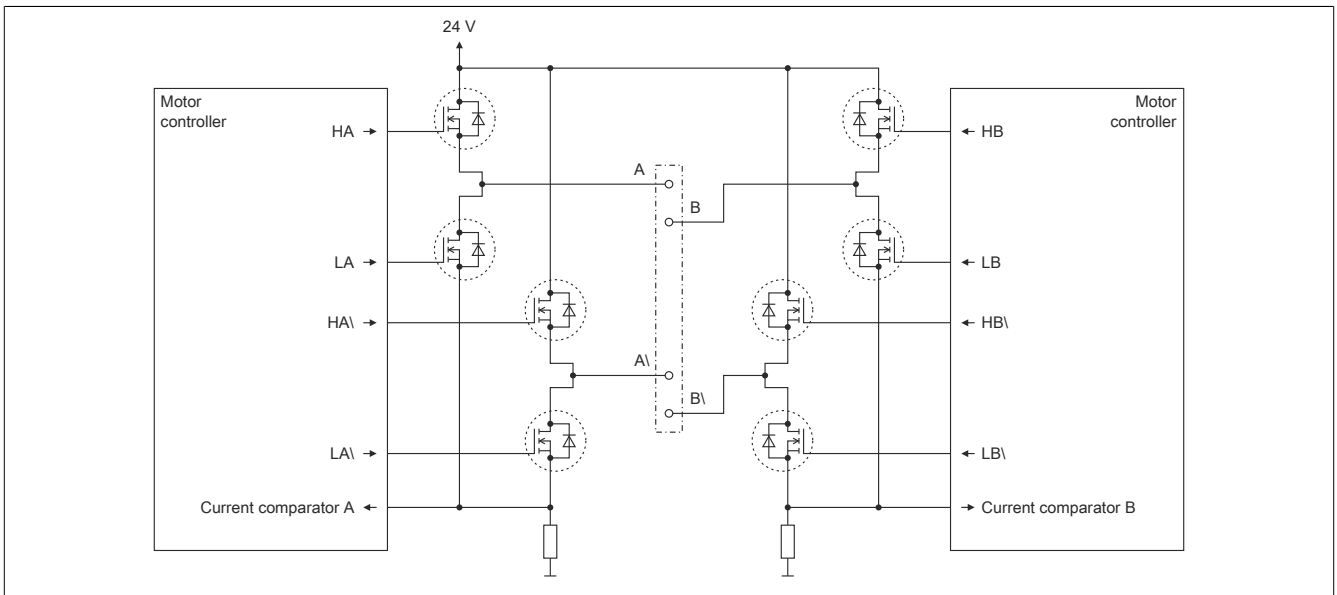
Function model "Ramp"

| Channel | Function | | |
|---------|---------------|---------------|-----------------------|
| DI 1 | Digital input | A | A |
| DI 2 | Digital input | B | B |
| DI 3 | Digital input | R | Negative limit switch |
| DI 4 | Digital input | Digital input | Positive limit switch |

9.25.7.8 Input circuit diagram



9.25.7.9 Output circuit diagram



9.25.7.10 Overvoltage cutoff

The module supply voltage is continually monitored. Its status can be read. The error "Module power supply error" occurs when the voltage is above or below the limits.

If the supply voltage on the module rises or falls outside the limit values (e.g. due to regeneration), then the motor output is switched off. The outputs are reactivated as soon as the supply voltage is back in the valid range and the error bit is reset.

Supply voltage limit values

| | Drive is switched off | Drive is switched back on |
|-------------|-----------------------|---------------------------|
| Lower limit | <17.5 V | >19.5 V |
| Upper limit | >30 V | <29.0 V |

9.25.7.11 Shutdown in the event of overtemperature (starting at 85°C)

If the module temperature reaches or overshoots the limit value of 85°C, the module performs the following actions:

- Sets the "overtemperature" error bit
- Cuts off the outputs (short-circuited)

As soon as the temperature is reduced below 85°C again, the error must be acknowledged with "OvertemperatureAcknowledge" so that the channels can be switched on again.

9.25.7.12 Derating

Only modules with a maximum power dissipation of 1 W are permitted to be operated next to the SM module. To ensure proper operation, observe the derating values listed below.

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.

Power dissipation derating for neighboring modules

Modules directly next to the SM module can have a power loss of 1 W. If the SM module is operated at the rated load over the entire temperature range (1 A rated current), the power loss of neighboring modules must be derated starting at 45°C.

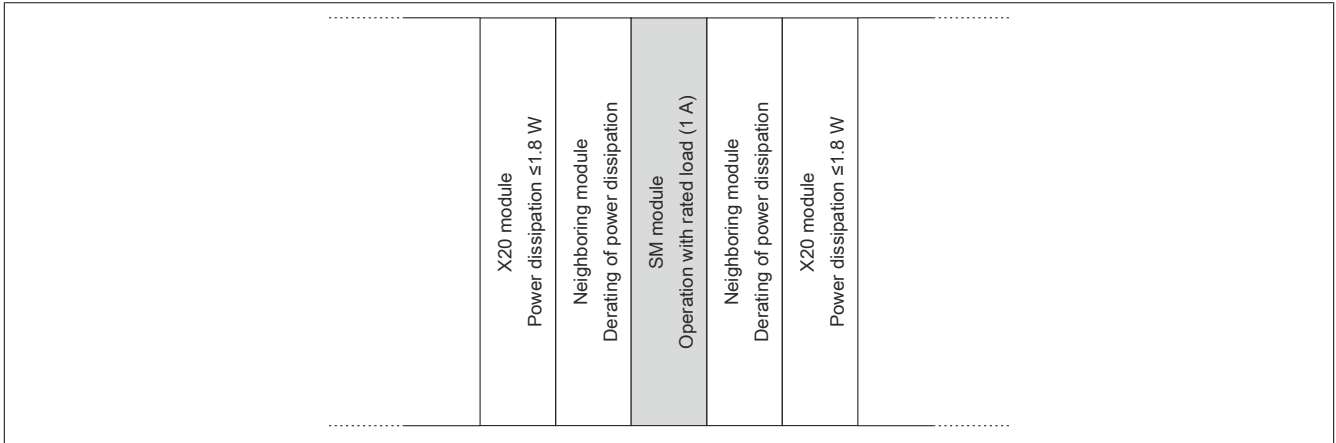


Figure 171: Operating the SM module over the entire temperature range at 1.0 A rated current

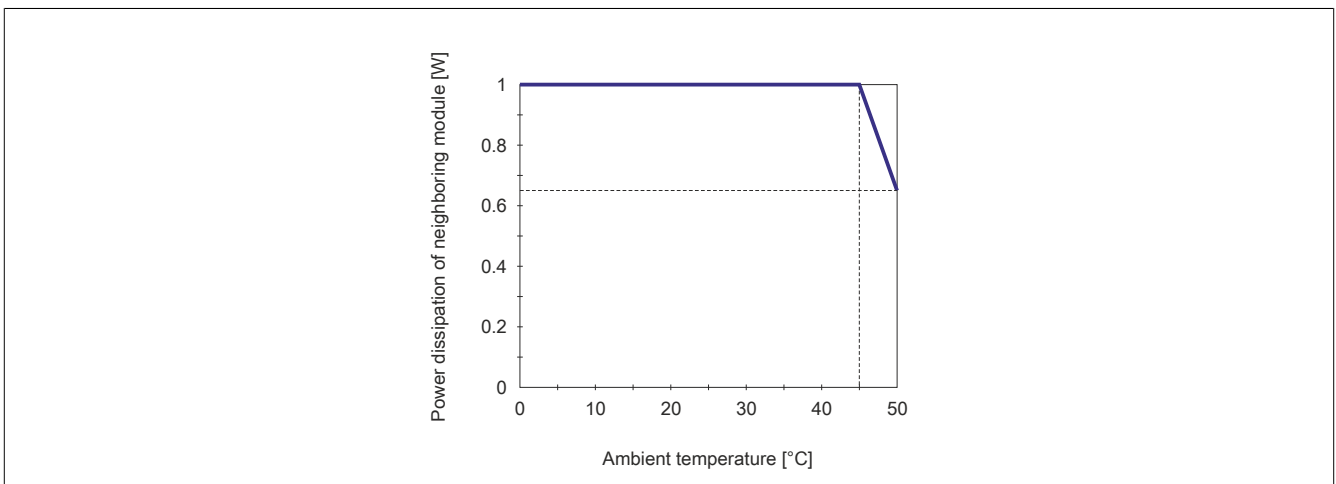


Figure 172: Power loss derating for directly neighboring modules

Current derating of the SM module

If the power loss of the neighboring modules to the SM module is 1 W, then the current of the SM module must be derated starting at 45°C.

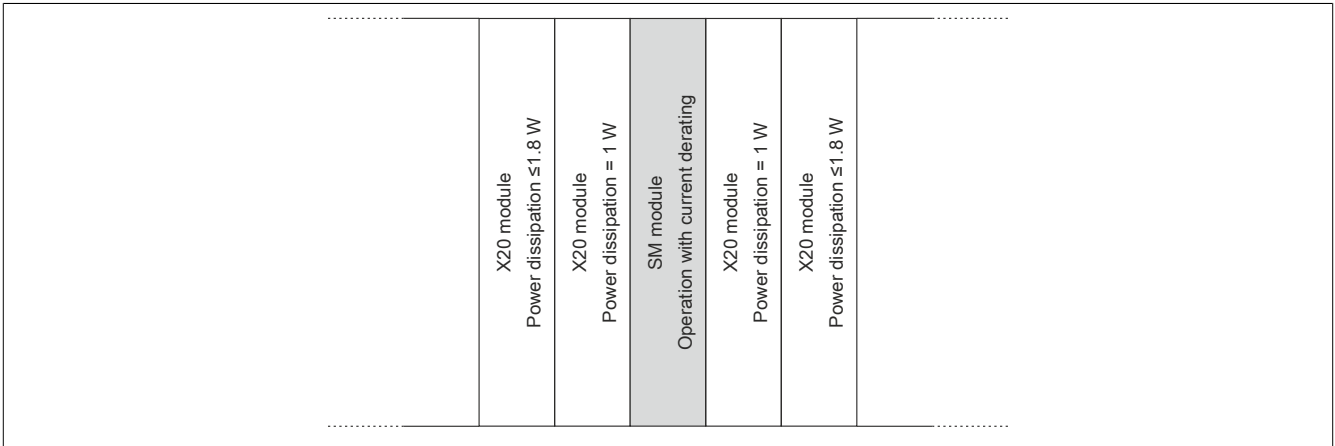


Figure 173: Neighboring modules to the SM module have a power loss of 1.0 W

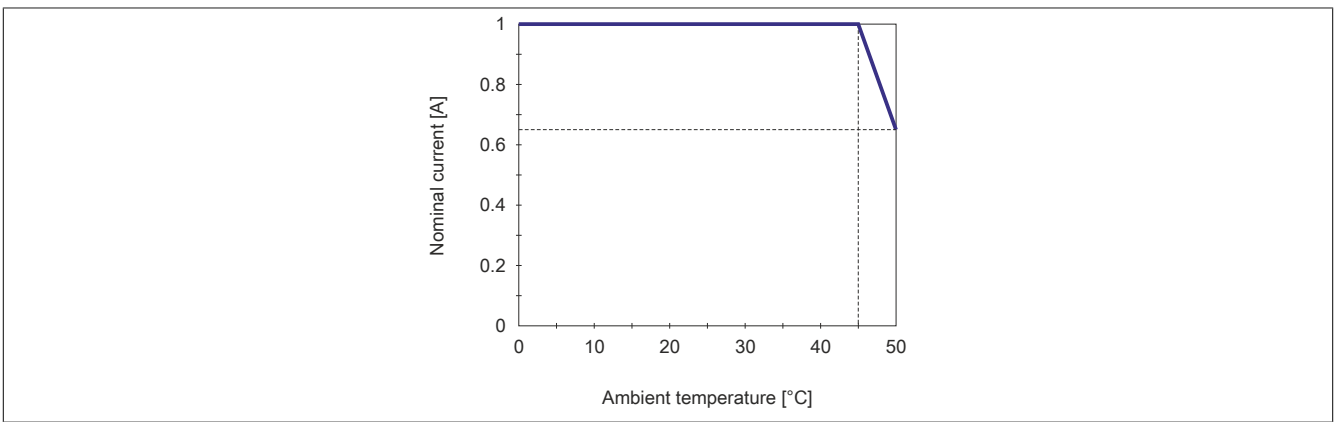


Figure 174: Current derating

Current derating for multiple SM modules

If three or more SM modules are operated in a cluster, the current of the SM modules must be derated as follows starting at 40°C.

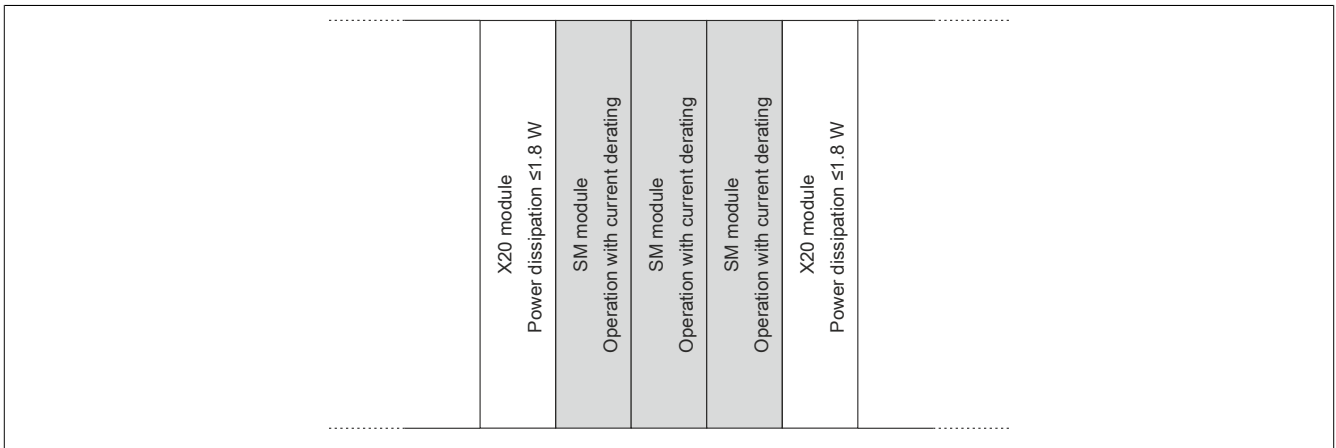


Figure 175: Operating three or more SM modules in a cluster

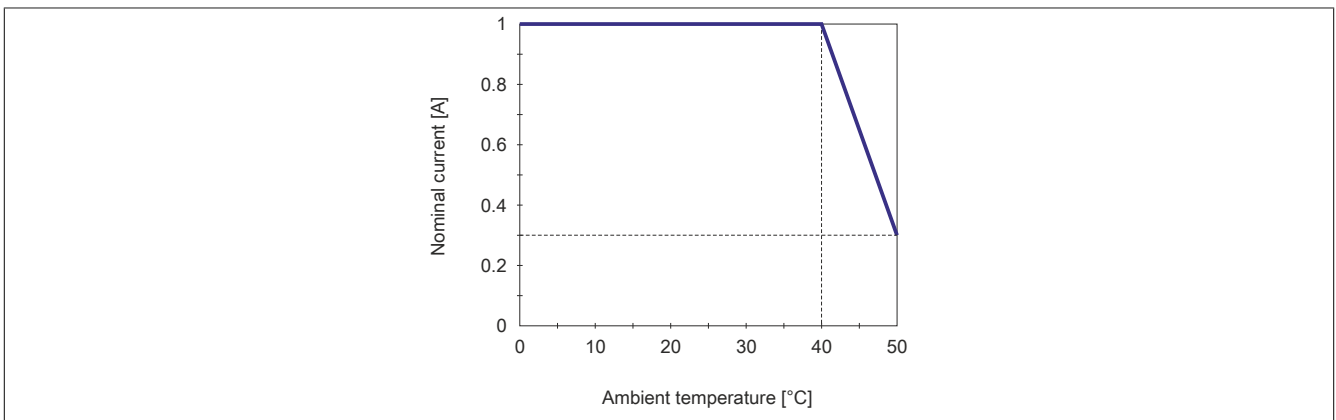


Figure 176: Current derating

9.25.7.13 Register description

9.25.7.13.1 mapp Motion system requirements

This module can be operated with mapp Motion function blocks. The following minimum versions are required for this:

- Upgrade version 2.2.0.0
- Automation Studio 4.7.2
- Automation Runtime 4.72

9.25.7.13.2 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.25.7.13.3 Function model 0 - Standard without SDC

| Register | Name | Data type | Read | | Write | |
|--------------------------------|--|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration | | | | | | |
| 44 | ConfigOutput01 (Stall threshold) | UINT | | | | • |
| 46 | ConfigOutput02 (Module configuration 1) | UINT | | | | • |
| 33 | ConfigOutput03 (Holding current) | USINT | | | | • |
| 34 | ConfigOutput04 (Nominal current) | USINT | | | | • |
| 35 | ConfigOutput05 (Maximum current) | USINT | | | | • |
| 32 | ConfigOutput09 (Counter configuration) | USINT | | | | • |
| 52 | ConfigOutput16 (Mixed decay threshold) | UINT | | | | • |
| 81 | MotorIdentTrigger | USINT | | | | • |
| 84 | FullStepThreshold01 | UINT | | | | • |
| 92 | StallDetectMinSpeed01 | UINT | | | | • |
| Reads the configuration | | | | | | |
| 33 | ConfigOutput03Read (Holding current) | USINT | | • | | |
| 34 | ConfigOutput04Read (Nominal current) | USINT | | • | | |
| 35 | ConfigOutput05Read (Maximum current) | USINT | | • | | |
| Communication | | | | | | |
| 6 | PositionSync | UINT | | • | | |
| 64 | PositionLatchedASync | INT | | • | | |
| 12 | Motoridentification01 | UINT | | • | | |
| Index* 2 + 16 | MotorStepN (Index N = 0 to 3) | UINT | | | • | |
| 0 | PositionAsync | INT | • | | | |
| 86 | PositionSync02 | INT | • | | | |
| 4 | Input counter state | USINT | • | | | |
| | ModulePowerSupplyError | Bit 0 | | | | |
| | StatusInput01 | Bit 2 | | | | |
| | StatusInput02 | Bit 3 | | | | |
| | StatusInput03 | Bit 4 | | | | |
| 10 | Error status | USINT | • | | | |
| | StallError | Bit 0 | | | | |
| | OvertemperatureError | Bit 1 | | | | |
| | CurrentError | Bit 2 | | | | |
| 60 | OvercurrentError | Bit 3 | | | | |
| | PositionLatchedSync | INT | • | | | |
| 68 | usSinceTrigger | UINT | • | | | |
| 54 | Module configuration 2 | USINT | | | • | |
| | StartLatch | Bit 0 | | | | |
| | TriggerEdgePos | Bit 1 | | | | |
| | TriggerEdgeNeg | Bit 2 | | | | |
| | TriggerEdge | Bit 3 | | | | |
| | StartTrigger | Bit 4 | | | | |
| 72 | ClearError | Bit 5 | | | | |
| | Stepper latch trigger status | USINT | • | | | |

| Register | Name | Data type | Read | | Write | |
|----------|--------------|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| 74 | LatchInput | Bit 0 | | | | |
| | LatchDone | Bit 1 | | | | |
| | TriggerInput | Bit 4 | | | | |
| | MotorLoad | USINT | • | | | |

9.25.7.13.4 Function model 0 - Standard with SDC

| Register | Name | Data type | Read | | Write | |
|--------------------------------|--|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration | | | | | | |
| 44 | ConfigOutput01 (Stall threshold) | UINT | | | | • |
| - | ConfigOutput02 (Module configuration 1) | UINT | | | | • |
| 33 | ConfigOutput03 (Holding current) | USINT | | | | • |
| 34 | ConfigOutput04 (Nominal current) | USINT | | | | • |
| 35 | ConfigOutput05 (Maximum current) | USINT | | | | • |
| 32 | ConfigOutput09 (Counter configuration) | USINT | | | | • |
| 52 | ConfigOutput16 (Mixed decay threshold) | UINT | | | | • |
| 81 | MotorIdentTrigger | USINT | | | | • |
| 84 | FullStepThreshold01 | UINT | | | | • |
| 92 | StallDetectMinSpeed01 | UINT | | | | • |
| 102 | SDCConfig01 | USINT | | | | • |
| 103 | MotorSettlingTime01 | USINT | | | | • |
| 107 | DelayedCurrentSwitchOff01 | USINT | | | | • |
| Reads the configuration | | | | | | |
| 33 | ConfigOutput03Read (Holding current) | USINT | | • | | |
| 34 | ConfigOutput04Read (Nominal current) | USINT | | • | | |
| 35 | ConfigOutput05Read (Maximum current) | USINT | | • | | |
| Communication | | | | | | |
| 6 | PositionAsync | UINT | | • | | |
| 12 | Motoridentification01 | UINT | | • | | |
| 112 | SetTime01 | INT | | | • | |
| 100 | Motor current | USINT | | | • | |
| | DriveEnable01 | Bit 0 | | | | |
| | BoostCurrent01 | Bit 1 | | | | |
| | StandstillCurrent01 | Bit 2 | | | | |
| 74 | MotorLoad | USINT | • | | | |
| 73 | LifeCnt | SINT | • | | | |
| 0 | PositionSync | INT | • | | | |
| 4 | Input counter value | USINT | • | | | |
| | ModulePowerSupplyError | Bit 0 | | | | |
| | StatusInput01 | Bit 2 | | | | |
| | StatusInput02 | Bit 3 | | | | |
| | StatusInput03 | Bit 4 | | | | |
| | StatusInput04 | Bit 5 | | | | |
| 10 | Error status | USINT | • | | | |
| | StallError01 | Bit 0 | | | | |
| | OvertemperatureError01 | Bit 1 | | | | |
| | CurrentError01 | Bit 2 | | | | |
| | OvercurrentError01 | Bit 3 | | | | |
| | DrvOk01 | Bit 4 | | | | |
| 54 | Error acknowledgment | USINT | | • | | |
| | ClearError01 | Bit 5 | | | | |
| 16 | Motor1Step0 | INT | | • | | |
| 200 | RefPulsePos01 | INT | • | | | |
| 204 | RefPulsePos01 | INT | • | | | |
| 212 | RefPulseCnt01 | SNT | • | | | |
| 214 | RefPulseCnt01 | SNT | • | | | |
| 220 | ActTime01 | INT | • | | | |
| 208 | TriggerTime01 | INT | • | | | |
| 216 | TriggerCnt01 | SINT | • | | | |

9.25.7.13.5 Function model 254 - Bus controller and function model 3 - Ramp

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------|----------------------|--|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration | | | | | | | |
| 48 | - | ConfigOutput03a (Holding current) | USINT | | | | • |
| 49 | - | ConfigOutput04a (Nominal current) | USINT | | | | • |
| 50 | - | ConfigOutput05a (Maximum current) | USINT | | | | • |
| 72 | - | FullStepThreshold01 | UINT | | | | • |
| 52 | - | MaxSpeed01pos | UINT | | | | • |
| 54 | - | MaxAcc01 | UINT | | | | • |
| 56 | - | MaxDec01 | UINT | | | | • |
| 58 | - | RevLoop01 | INT | | | | • |
| 60 | - | FixedPos01a | DINT | | | | • |
| 64 | - | FixedPos01b | DINT | | | | • |
| 68 | - | RefSpeed01 | UINT | | | | • |
| 74 | - | StallRecognitionDelay01 | USINT | | | | • |
| 75 | - | JoltTime01 | USINT | | | | • |
| 78 | - | StallDetectMinSpeed01 | UINT | | | | • |
| 70 | - | RefConfig01 | SINT | | | | • |
| 51 | - | StallDetectConfig01 | USINT | | | | • |
| 306 | - | GeneralConfig01 | USINT | | | | • |
| 308 | - | LimitSwitchConfig01 | USINT | | | | • |
| 344 | - | PositionLimitMin01 | DINT | | | | • |
| 348 | - | PositionLimitMax01 | DINT | | | | • |
| Reads the configuration | | | | | | | |
| 48 | - | ConfigOutput03aRead (Holding current) | USINT | | • | | |
| 49 | - | ConfigOutput04aRead (Nominal current) | USINT | | • | | |
| 50 | - | ConfigOutput05aRead (Maximum current) | USINT | | • | | |
| Communication | | | | | | | |
| 0 | 0 | AbsPos01 | DINT | | | • | |
| 4 | 4 | MpGenControl01 | UINT | | | • | |
| 6 | 6 | MpGenMode01 | SINT | | | • | |
| 0 | 0 | AbsPos01ActVal | DINT | • | | | |
| 4 | 4 | MpGenStatus01 | UINT | • | | | |
| 6 | 6 | InputStatus | USINT | • | | | |
| 84 | - | Motoridentification01 | UINT | | • | | |
| 86 | - | RefPos01CyclicCounter | DINT | | • | | |
| 94 | - | RefPos01AcyclicCounter | DINT | | • | | |
| 90 | - | AbsPos1ActValAcyclic | DINT | | • | | |
| 80 | - | ControlReadback01 | UINT | | • | | |
| 82 | - | ModeReadback01 | SINT | | • | | |
| 98 | - | ErrorCode01 | UINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.25.7.13.5.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "Using I/O modules on the bus controller" on page 3789.

9.25.7.13.5.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.25.7.13.6 Register description: Function model "Standard", general registers

9.25.7.13.6.1 Configuration registers

Stall threshold

Name:

ConfigOutput01

The SM module features integrated sensorless load measurement for the motor axis. This is especially useful for detecting a "stall condition" (e.g. if the motor moves to the end point during a homing procedure). It cannot be used for torque monitoring during dynamic movements.

With the "stall threshold" register, a threshold can be defined according to the motor load, and the module detects a stall condition started at this threshold (see "[Error status](#)" on page 2622).

This threshold value must be determined on a case-by-case basis, since the results of load measurement are influenced by a variety of factors.

- Motor speed: A higher speed results in higher measurement values
- Speeds that cause motor resonances (which interfere with load measurement) are to be avoided
- Motor accelerations that create a dynamic load (and also affect the measurement) should also be avoided
- It is especially important to be aware that mixed decay mode must be optimized for reliable stall detection (see "[Mixed decay threshold](#)" on page 2616)

The higher the load measurement value, the lower the load. This means that a stall condition is detected if the load measurement value drops below the trigger threshold for stall detection.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|---------------------------------------|--------|--|
| 0 - 2 | Trigger threshold for stall detection | 0 | Stall detection is disabled |
| | | 1 | Minimum sensitivity for stall detection |
| | | 2 to 6 | Setting the sensitivity of stall detection |
| | | 7 | Maximum sensitivity for stall detection |
| 3 - 15 | Reserved | 0 | |

Mixed decay threshold

Name:

ConfigOutput16

The mixed decay threshold is configured in this register. This value must be adjusted according to the motor being used, current and voltage when using [stall detection](#). Otherwise, the default value 15 will be used.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|-----------------------|---------|-----------------------------------|
| 0 - 3 | Mixed Decay Threshold | 0 | Mixed decay disabled |
| | | 1 to 14 | Setting for mixed decay threshold |
| | | 15 | Mixed decay always enabled |
| 4 - 15 | Reserved | - | |

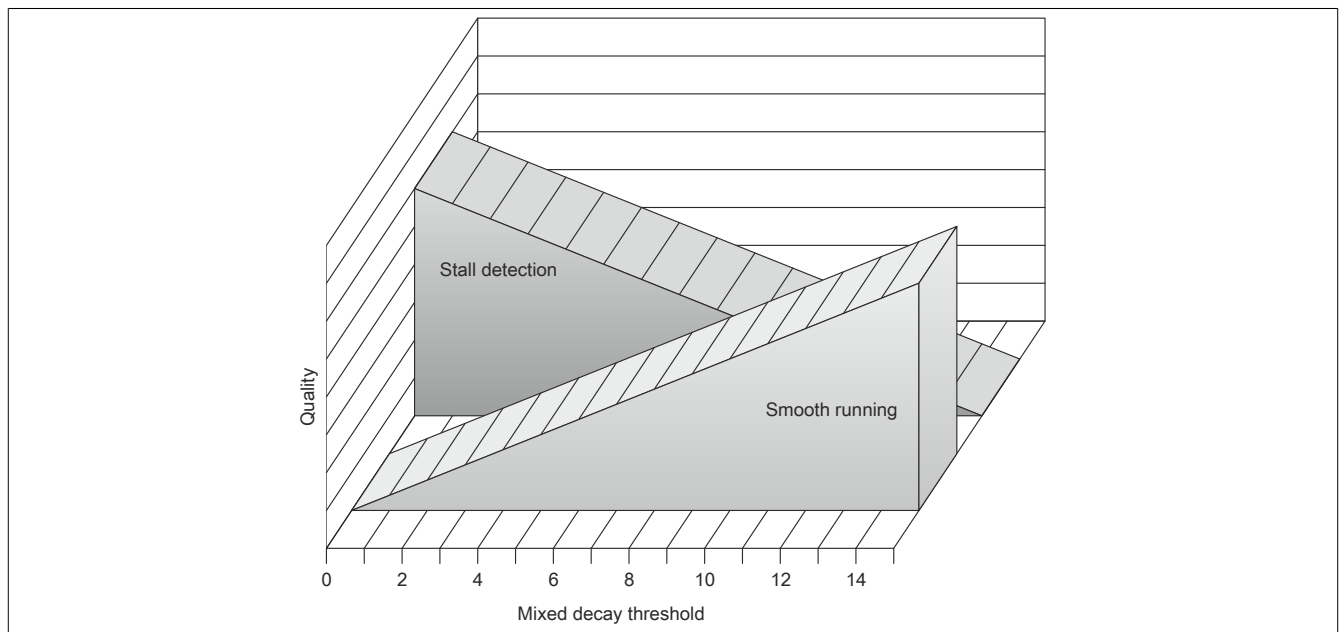
Mixed decay modules provide a greatly optimized sinusoidal current profile in the individual phases of the stepper motor, especially for fast current changes and low current values.

Mixed decay interferes with reliable stall detection, however. For this reason, mixed decay mode can be disabled during stall detection (motor load measurement) using the mixed decay threshold. The smaller the configured mixed decay threshold, the larger the range in which mixed decay is disabled while motor load measurement takes place.

Mixed decay mode is always enabled if the mixed decay threshold is set to 15.

Relationship between stall detection and mixed decay

Depending on the application and the motor used, satisfactorily smooth operation can be achieved while using stall detection by setting the mixed decay threshold to a value between 1 and 14. This is a compromise between smooth operation and stall detection quality and must be fine tuned during commissioning.



Minimum speed for stall detection

Name:

StallDetectMinSpeed01

If the motor speed exceeds the value set in this register, then stall detection is enabled and the configured [mixed decay threshold](#) is used. The value 15 is always used for the mixed decay threshold below this threshold value, and no stall error is reported. This means that mixed decay mode is always enabled at low speeds where stall detection principally does not work.

| Data type | Value | Information |
|-----------|------------|------------------------------------|
| UINT | 0 to 65535 | Minimum speed in steps per second. |

Full step threshold

Name:

FullStepThreshold01

This register configures a rotational speed. When this defined speed has been reached, the drive will automatically change from microsteps to full step mode. This makes it possible to optimize the torque at higher speeds, while microstep mode ensures optimal radial runout at lower speeds.

It does not make sense to change to full step mode at a standstill because fine positioning would then no longer be possible. This is why value "0" does not make sense in the full step threshold register and is interpreted as disabling full step mode (i.e. the motor will always be operated in microstep mode).

| Data type | Values | Information |
|-----------|-------------|-------------------------|
| UINT | 0 | Full step mode disabled |
| | 1 to 65,535 | Steps/second |

Example

Microstep mode should change to full step mode at 500 steps/second. On a motor with 200 steps per revolution, this would be equal to a speed of:

$$T^{-1} = \frac{500 \text{ steps/second}}{200 \text{ steps/revolution}} = 2.5 \frac{\text{revolutions}}{\text{second}} = 150 \text{ min}^{-1}$$

Holding current, rated current and maximum current

Name:

ConfigOutput03 (holding current)

ConfigOutput04 (rated current)

ConfigOutput05 (maximum current)

The holding current, nominal current and maximum current registers are used to configure the desired motor current.

Reasonable values are:

- Holding current < Nominal current < Maximum current

The motor's nominal current is entered in the nominal current register according to the motor's data sheet.

| Register | Description |
|-----------------|---|
| Nominal current | Current during normal operation |
| Maximum current | Should be selected if a higher motor torque is required briefly during acceleration phases. |
| Holding current | The holding current should be used in situations when less torque is required (e.g. at a standstill). This reduces the amount of heat generated by the motor. |

Switching between preset current values (holding current, rated current, maximum current):

| Function model | Switching between preset current values at runtime |
|---------------------------------------|--|
| Default | Using bits 14 and 15 in the registers "Motor StepX" on page 2624 |
| Standard with enabled SDC information | Using the register "Motor current" on page 2629 |

| Data type | Value | Unit |
|-----------|----------|--|
| USINT | 0 to 117 | Percent of the module's rated current <ul style="list-style-type: none"> • 100% corresponds to the rated current of the motor bridge power unit listed in the technical data • 117% corresponds to the maximum current of the motor bridge power unit listed in the technical data |

Counter configuration

Name:

ConfigOutput09

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------------|-------|--|
| 0 | ABR latch function | 0 | Negative edge: Disable ABR latch function. |
| | | 1 | Positive edge: Enable latch ABR latch function. After a latch event has occurred, the latch function can be started again with a new rising edge. |
| 1 - 2 | Definition of the latch mode | 00 | Latch ABR counter state unconditionally |
| | | 01 | Latch ABR counter state at a positive edge on the R input |
| | | 10 | Latch ABR counter state at a negative edge on the R input |
| | | 11 | Reserved |
| 3 | | 0 | <ul style="list-style-type: none"> • Position sync: Internal position counter • Position async: ABR counter state • Position latched sync: Internal position counter • Position latched async: ABR counter state |
| | | 1 | <ul style="list-style-type: none"> • Position sync: ABR counter state • Position async: Internal position counter • Position latched sync: ABR counter state • Position latched async: Internal position counter |
| 4 - 7 | Reserved | | |

1) These registers are not available in the standard function model with SDC information enabled.

Motor ID trigger

Name:

MotorIdentTrigger

With this register, a measurement of the motor ID can be initiated acyclically (see "[Motor identification](#)" on page 2621). The application must ensure that the conditions for measurement are met (see table "Notes" in register "[Motor identification](#)" on page 2621).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|---|
| 0 | | 0 | No effect |
| | | 1 | Positive edge triggers motor identifier measurement |
| 1 - 7 | Reserved | 0 | |

9.25.7.13.6.2 Registers for reading back the configuration

Reading back the holding current, nominal current and maximum current

ConfigOutput03Read (holding current)

ConfigOutput04Read (nominal current)

ConfigOutput05Read (maximum current)

These registers are used to read the respective current values in percent.

| Register | Description |
|-----------------|--|
| Nominal current | Current during operation at constant speed |
| Maximum current | Current during acceleration phases |
| Holding current | Current when motor is at standstill |

| Data type | Values | Unit |
|-----------|----------|---|
| USINT | 0 to 255 | Percentage of module's nominal current (100% corresponds to the nominal current of the motor bridge power unit in the technical data) |

9.25.7.13.6.3 Communication registers

Measuring motor load

Name:
MotorLoad

This register contains the current measured load value for stall detection. Can be used to tune stall detection.

| Data type | Values |
|-----------|--------|
| USINT | 0 to 7 |

Module configuration 1

Name:
ConfigOutput02

The number of transfer values and the resolution of microsteps for the drive can be configured in this register.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|---|-------|---|
| 0 | The setting for these two bits determines the meaning of bits 2 and 3 in the "Input counter state" on page 2623 register. | x | |
| 1 - 2 | Reserved | 0 | |
| 3 - 4 | Number of transfer values per X2X cycle (See "Motor StepX" on page 2624.) | 00 | 1 x $\Delta s / \Delta t$ (transfer values: MotorStep0) |
| | | 01 | 2 x $\Delta s / \Delta t$ (transfer values: MotorStep0 - MotorStep1) |
| | | 10 | 4 x $\Delta s / \Delta t$ (transfer values: MotorStep0 - MotorStep3) |
| | | 11 | Reserved |
| 5 - 6 | Resolution of microsteps for the following registers: <ul style="list-style-type: none"> • "Motor StepX" on page 2624 • "Position sync/async" on page 2620 | 00 | Resolution: 5 bits (bit 0 - 4) microsteps; 8 bits (bit 5 - 13) full steps |
| | | 01 | Resolution: 6 bits (bit 0 - 5) microsteps; 7 bits (bit 6 - 13) full steps |
| | | 10 | Resolution: 7 bits (bit 0 - 6) microsteps; 6 bits (bit 7 - 13) full steps |
| | | 11 | Resolution: 8 bits (bit 0 - 7) microsteps; 5 bits (bit 8 - 13) full steps |
| 7 - 15 | Reserved | 0 | |

Position sync/async

Name:

PositionSync

Positionasync

Depending on the [Counter configuration](#), these registers can be used to read either the internal position counter or the counter state of the ABR input.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

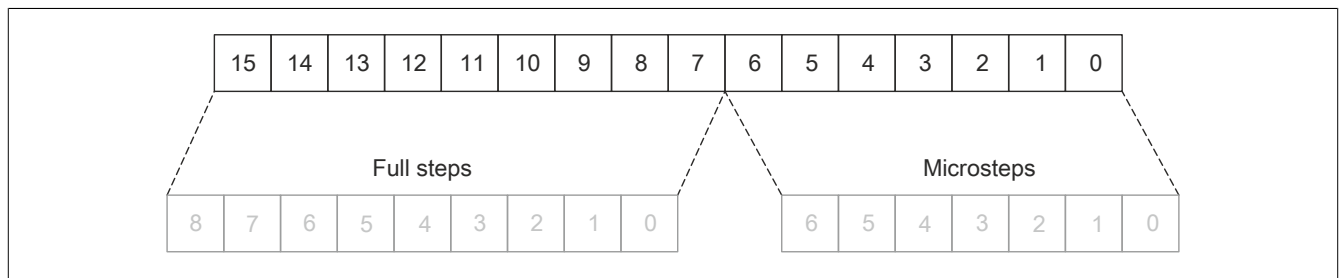
| Register | Counter configuration | |
|----------------|---------------------------|---------------------------|
| | Bit 3 ... 0 | Bit 3 ... 1 |
| Position sync | Internal position counter | ABR counter |
| Position async | ABR counter | Internal position counter |

Internal position counter

The internal position counter is the position calculated by the SM module (set position). This is a cyclic 16-bit counter.

The lowest 5 to 8 bits represent microsteps, while the highest 8 to 11 bits represent full steps (depending on bits 5 and 6 of the register "[Module configuration 1](#)" on page 2619). In the standard function model with SDC, this value is set to "8-bit microsteps" and can not be changed.

Example of the internal position counter format (7-bit micro steps, i.e. set bit 5 and 6 of the module configuration to binary 10):



ABR counter

This counter is a cyclic 16-bit counter. The relationship between this counter and the internal position counter depends on the resolution of the ABR encoder and the microsteps defined for the internal position counter.

Motor identification

Name:

Motoridentification01

This register is used to identify the connected motor type for service purposes and to differentiate between motors in the application. After successful measurement, this register contains the time [µs] required to apply a current increase of $\Delta I = 1 \text{ A}$ to a motor winding.

This depends on:

- Operating voltage
- Inductance and resistance of the motor winding

| Notes | |
|-------|---|
| 1) | To achieve reproducible results, the measurement must be made under the following defined conditions: |
| a) | Motor is at standstill. |
| b) | The motor must be in a half-step position (phase A fully powered, phase B not powered). This means the internal position counter on the SM module must have a value that fulfills the following conditions: <ul style="list-style-type: none"> • Full steps are divisible by 4. • Microsteps = 0 |
| 2) | Condition 1b) is fulfilled after a the SM module is reset or switched on. Immediately afterwards, when the holding current is applied to the motor for the first time (at standstill), the duration for applying the current is measured. This is therefore a suitable time to read the motor identification register in the application. |
| 3) | The current range from approximately 1/3 of the nominal current up to the nominal current is used as operating range for determining the motor identifier. |

| Data type | Motor ID values | Explanation |
|-----------|-----------------|--|
| UINT | 0 | No motor identifier available (after switching on for as long as the measurement conditions are not met) |
| | 1 to 32767 | Valid range of values for the motor ID register (in µs) |
| | 65504 to 65519 | Ground fault: Measurement of motor identification not possible |
| | 65528 | Motor ID trigger not possible <ul style="list-style-type: none"> • Motor not supplied with current • Motor in movement • Nominal current set to 0 A • Ground fault present |
| | 65529 | Invalid value: Underflow |
| | 65530 | Overtemperature: Measurement not possible |
| | 65532 | Open circuit: Measurement not possible |
| | 65533 | Incorrect motor position: Measurement not possible |
| | 65534 | Invalid value: Overflow |
| | 65535 | Measurement in progress |

Ground fault detection

When the motor is powered on, a ground fault check is performed before motor identification. Error numbers have been added in the motor identification register for the event of a ground fault error (values 65504 to 65519 in the table above).

Error status

Name: The names of the bits are different depending on whether [SDC information](#) is enabled or disabled.

| Without SDC | With SDC |
|-------------------|---------------------|
| StallError | StallError01 |
| Overtemperature | Overtemperature01 |
| ErrorCurrentError | ErrorCurrentError01 |
| OvercurrentError | OvercurrentError01 |
| - | DrvOK01 |

The current error status of the drive is indicated in this register. Each bit indicates a certain error or status. If an error is registered in bits 0 to 3, then the corresponding bit remains set until the error has been acknowledged (see ["Module configuration 2"](#) on page 2626 and ["Error acknowledgment"](#) on page 2630).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|---|-------|---|
| 0 | StallError(01) | 0 | No stall |
| | | 1 | Stall |
| 1 | Overtemperature error OvertemperatureError(01) | 0 | No overtemperature |
| | | 1 | Overtemperature |
| 2 | Current error CurrentError(01) | 0 | No current error |
| | | 1 | Current error |
| 3 | Overcurrent error OvercurrentError(01) | 0 | No overcurrent |
| | | 1 | Overcurrent |
| 4 | Status of the drive DrvOk0 ¹⁾ | 0 | An error was triggered for the motor axis |
| | | 1 | The drive is running error-free |
| 5 - 15 | Reserved | 0 | |

1) Only when SDC information is enabled

Overtemperature error

The "Overtemperature" error bit can be set for the following reasons:

- A specific temperature was exceeded near the channel due to overload
- Module temperature exceeds 85°C

Current error

This error bit occurs whenever the required current cannot be supplied to the motor windings. This can be (but is not necessarily) caused by an open line. At higher speeds (depending on the motor), this error can also occur without an open line. In this case it is simply no longer possible to supply the desired current to the motor windings. Because of the Back-EMF on the motor, this bit is set at slightly lower speeds if the motor is operated with no load compared with full or partial loads.

Overcurrent error

Overcurrent occurs if the motor current measured in the motor windings is twice as high as it should be (e.g. short circuit).

Status of the drive

The status of the drive is only shown when SDC information is enabled. The drive bit is 1 when the following conditions are met:

- Motor turned on (see ["Motor current"](#) on page 2629)
- Ground fault detection is completed and OK
- MotorID measurement is completed
- Motor is supplied with current
- Motor settling time has passed
- Supply voltage is in the valid range
- No overtemperature fault
- Preset position value is valid (see ["SDC life sign monitoring"](#) on page 2628)

9.25.7.13.7 Register description: Function model "Standard" without SDC information**9.25.7.13.7.1 Communication registers****Input counter state**

Name:

ModulePowerSupplyError

StatusInput01 to StatusInput04

This register is used to indicate the status of the digital inputs and counters.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------|---|---|
| 0 | ModulePowerSupplyError | 0 | OK |
| | | 1 | Module supply error |
| 1 | Reserved | 0 | |
| 2 | StatusInput01 | When bit 0 in Module configuration 1 = 0 | |
| | | 0 or 1 | Input state - Digital input 1 |
| | | When bit 0 in Module configuration 1 = 1 | |
| | | x | Ref toggle bit for counter 1: The state of this bit is changed after the homing procedure is complete. |
| 3 | StatusInput02 | When bit 0 in Module configuration 1 = 0 | |
| | | 0 or 1 | Input state - Digital input 2 |
| | | When bit 0 in Module configuration 1 = 1 | |
| | | 0 | Homing of ABR counter active |
| | | 1 | Homing of ABR counter complete |
| 4 | StatusInput03 | 0 or 1 | Input state - Digital input 3 |
| 5 | StatusInput04 | 0 or 1 | Input state - Digital input 4 |
| 6 - 7 | Reserved | 0 | |

Motor StepX

Name:

MotorStep0 to MotorStep3

These registers specify the number and direction of steps that must be moved by the module during the next X2X cycle and also select the motor current (see also "[Holding current, rated current and maximum current](#)" on page 2617).

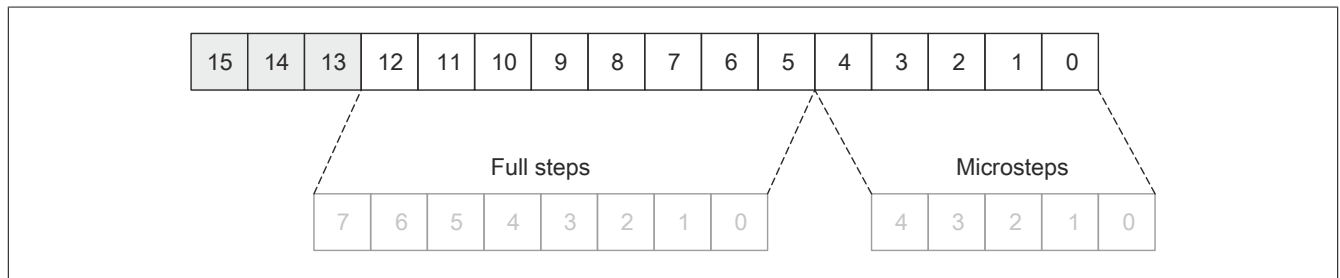
| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|---|-------|-------------------|
| 0 - 12 | Number of steps for the module to move during the next X2X cycle. | x | |
| 13 | Direction of movement | 0 | Positive |
| | | 1 | Negative |
| 14 - 15 | Selection of motor current | 00 | Motor not powered |
| | | 01 | Holding current |
| | | 10 | Nominal current |
| | | 11 | Maximum current |

Depending on the necessary resolution and maximum configurable speed, module configuration 1 can be used to set which bit position is used as the 1st position for full steps (see bits 5 and 6 of "[Module configuration 1](#)" on page 2619).

Example for 5-bit microsteps (set bits 5 and 6 of the module configuration to binary 00):



The number of transfer values per X2X cycle is specified by bits 3 and 4 in the module configuration 1 (see "[Module configuration 1](#)" on page 2619). If only one transfer value (bits 3 and 4 = 00) is specified, then the motor is advanced by MotorStep0 until the next X2X cycle. If 2 or 4 transfer values are specified, then the X2X cycle is divided accordingly.

Example: X2X cycle = 1 ms (1000 μ s)

| Time | Number of transfer values (see " Module configuration 1 " on page 2619) | | |
|--------------------|---|---------------------|---------------------|
| | 1 (bits 3 - 4 = 00) | 2 (bits 3 - 4 = 01) | 4 (bits 3 - 4 = 10) |
| 0 - 250 μ s | MotorStep0 | MotorStep0 | MotorStep0 |
| 250 - 500 μ s | | | MotorStep1 |
| 500 - 750 μ s | | MotorStep1 | MotorStep2 |
| 750 - 1000 μ s | | | MotorStep3 |

Position latched sync/async

Name:

PositionLatchedSync

PositionLatchedASync

The position counter (internal position counter or ABR counter) is applied at the latch event (see "Module configuration 2" on page 2626). Bits 3 and 7 of the "Counter configuration" on page 2618 register are used to determine which counter state (internal position counter or ABR encoder) should be saved in the registers "Position latched sync" and "Position latched async".

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

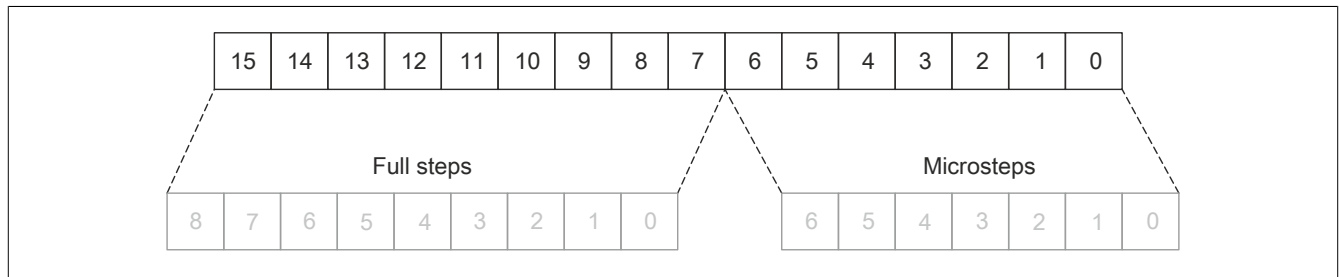
| Register | Counter configuration | |
|----------------|---------------------------|---------------------------|
| | Bit 3 ... 0 | Bit 3 ... 1 |
| Position sync | Internal position counter | ABR counter |
| Position async | ABR counter | Internal position counter |

Internal position counter

The internal position counter is the position calculated by the SM module (set position). This is a cyclic 16-bit counter.

The lowest 5 to 8 bits represent microsteps, while the highest 8 to 11 bits represent full steps (depending on bits 5 and 6 of the register "Module configuration 1" on page 2619).

Example of the internal position counter format (7-bit micro steps, i.e. set bit 5 and 6 of the module configuration to binary 10):



ABR counter

This counter is a cyclic 16-bit counter. The relationship between this counter and the internal position counter depends on the resolution of the ABR encoder and the microsteps defined for the internal position counter.

usSinceTrigger

Name:

usSinceTrigger

This register indicates the time (in μs) that has passed since the trigger event occurred (see "Module configuration 2" on page 2626).

Information:

The absolute accuracy of the trigger can be delayed up to 5 μs due to the input filter of the digital inputs.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

Stepper latch trigger status

Name:
 LatchInput
 LatchDone
 TriggerInput

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------|-------|---|
| 0 | Latch input: | x | Digital input for the latch event (level) |
| 1 | LatchDone | x | Changes its state each time the counter state is successfully latched (reset value = 0) |
| 2 - 3 | Reserved | - | |
| 4 | TriggerInput | x | Trigger input (level) |
| 5 - 7 | Reserved | 0 | |

9.25.7.13.7.2 Configuration registers

Module configuration 2

Name:
 StartLatch
 TriggerEdgePos
 TriggerEdgeNeg
 StartTrigger
 TriggerEdge
 ClearError

The trigger functions for the stepper motor can be configured with this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|---|
| 0 | Latch function for stepper motor Latch byte | 0 | The latch function for stepper motor position is deactivated at the negative edge of this bit |
| | | 1 | The latch function for stepper motor position is deactivated at the positive edge of this bit |
| 1 - 2 | Latch mode for stepper motor TriggerEdgePos (Bit 1) TriggerEdgeNeg (Bit 2) | 00 | Latch position of stepper motor, unconditional |
| | | 01 | Latch position of stepper motor at positive edge on input DI 3 |
| | | 10 | Latch position of stepper motor at negative edge on input DI 3 |
| | | 11 | Reserved |
| 3 | TriggerEdge | 0 | Trigger edge (input DI 4) = positive |
| | | 1 | Trigger edge (input DI 4) = negative |
| 4 | Enable trigger (when changes occur) StartTrigger | x | |
| 5 | ClearError | 0 | No effect |
| | | 1 | Error acknowledgment for the motor (for more info, see "Error status" on page 2622) |
| 6 - 7 | Reserved | - | |

Trigger function procedure:

- Select the desired trigger edge using bit 3
- Enable the trigger function by changing the state of bit 4. When this bit changes, `usSinceTrigger` (μ s counter) is cleared.
- When the trigger event occurs, `usSinceTrigger` (μ s counter) is started.
- The `usSinceTrigger` counter cannot overrun, i.e. it is stopped at 2^{16} and retains this value until the next time the trigger function is activated.

The trigger function can be re-activated at any time by changing the state of bit 4, regardless of whether a trigger event has occurred or if `usSinceTrigger` has reached the maximum value.

Position sync 2

Name:

PositionSync02

Depending on [Counter configuration](#) (bit 3), this register contains the state of either the position counter or the ABR counter. It's an exact complement to the "Position sync" on [page 2620](#) register.

If the position sync register contains the position counter, then the PositionSync02 register contains the ABR counter state and vice versa.

By default, the register cannot be seen in the I/O map; instead, it has to first be activated in the I/O configuration.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

9.25.7.13.8 Register description: Function model "Standard" with SDC information

9.25.7.13.8.1 Configuration registers

SDC configuration

Name:

SDCConfig01

This register can be used to enable/disable additional SDC information.

The additional cyclic registers are hidden or shown depending on whether SDC information is disabled or enabled. It is comparable to the two variants of the standard function model [with](#) and [without SDC information](#).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|----------------------|
| 0 | Trigger edge | 0 | Rising trigger edge |
| | | 1 | Falling trigger edge |
| 1 - 5 | Reserved | 0 | |
| 6 | SDC life sign monitoring | 0 | Disabled |
| | | 1 | Enabled |
| 7 | SDC information ¹⁾ | 0 | Disabled |
| | | 1 | Enabled |

1) When the "SDC information" bit is enabled, the "EncOK01" bit is shown in the Automation Studio I/O mapping. This bit is linked to the ModulOK bit and always indicates its value.

Advice:

Neither SDC information nor SDC life sign monitoring is permitted to be changed at runtime.

Module configuration 1 with SDC

The "[Module configuration 1](#)" on [page 2619](#) register is ignored in the standard function model with SDC information enabled. The module behaves as if the module configuration were described as follows:

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|--|-------|---|
| 0 | Meaning of bits 2 and 3 in the register " Input counter value " on page 2629 | | |
| 1 - 2 | Reserved | 0 | |
| 3 - 4 | Number of transfer values per X2X cycle | 00 | 1x $\Delta s / \Delta t$ (transfer values: Motor settings Motor1Step0) |
| 5 - 6 | Resolution of microsteps | 11 | 8-bit microsteps |
| 7 - 15 | Reserved | 0 | |

Motor settling time

Name:

MotorSettlingTime01

This register determines the motor setting time. This is the minimum time from the time the motor is energized until the drive bit (DrvOK) is set (see "[Error status](#)" on page 2622). The setting is made in steps of 10 ms.

| Data type | Values | Information |
|-----------|----------|---------------------------------|
| USINT | 1 to 255 | 10 ms to 2.55 s, default: 10 ms |

Turn-off delay

Name:

DelayedCurrentSwitchOff01

If the [SDC life sign monitoring](#) is triggered (i.e. the [NetTime timestamp](#) is in the past) the motor is decelerated at nominal current with speed setpoint = 0.

Then the motor is switched off after the delay configured with this register.

| Data type | Value | Information |
|-----------|----------|---|
| USINT | 0 to 255 | 0 to 25.5 ms in steps of 100 ms (default: 100 ms) |

9.25.7.13.8.2 Communication registers**SDC life sign monitoring**

Name:

SetTime01

The module uses SDC life sign monitoring to check whether valid values have been received for the speed setpoint. SDC life sign monitoring is activated in the "[SDC configuration](#)" on page 2627 register by setting bit 6 (SDCSetTime = on).

If the specified [NetTime timestamp](#) is in the past, then an error is triggered for the motor axis (only when the motor is switched on). The module performs the following steps:

- 1) The CPU is informed of the error using the Drive bit (DrvOk) = 0
- 2) Braking at configured rated current with speed setpoint = 0
- 3) Wait for configured turn-off delay to expire
- 4) Power off motor

When the timestamp is back in the valid range, the motor can be powered on again by a rising edge on the DriveEnable bit (see "[Motor current](#)" on page 2629).

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

Motor current

Name:

DriveEnable01

BoostCurrent01

StandstillCurrent01

Bits 0 to 2 of this register control the motor's current feed.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------------|-------|-----------------|
| 0 | DriveEnable01 | x | Motor powered |
| 1 | BoostCurrent01 | x | Maximum current |
| 2 | StandstillCurrent01 | x | Holding current |
| 3 - 7 | Reserved | 0 | |

The possible status of bits 0 to 2

| StandstillCurrent01 | BoostCurrent01 | DriveEnable01 | Description |
|---------------------|----------------|---------------|-----------------------------------|
| x | x | 0 | Motor not supplied with current |
| 0 | 0 | 1 | Rated current supplied to motor |
| 0 | 1 | 1 | Maximum current supplied to motor |
| 1 | 0 | 1 | Holding current supplied to motor |
| 1 | 1 | 1 | Holding current supplied to motor |

Lifecycle counter

Name:

LifeCnt

This register is incremented by one with each X2X Link cycle.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

Input counter value

Name:

ModulePowerSupplyError

StatusInput01 to StatusInput04

This register contains the state of the digital inputs and counter.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------|--------|-------------------------------|
| 0 | ModulePowerSupplyError | 0 | OK |
| | | 1 | Error in module power supply |
| 1 | Reserved | 0 | |
| 2 | StatusInput01 | 0 or 1 | Input state - Digital input 1 |
| ... | | ... | |
| 5 | StatusInput04 | 0 or 1 | Input state - Digital input 4 |
| 6 - 7 | Reserved | 0 | |

Error acknowledgment

Name:
ClearError01

This register can be used to acknowledge errors that have occurred on the motor.

For more info, see ["Error status" on page 2622](#).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------|-------|--------------------------------|
| 0 - 4 | Reserved | 0 | |
| 5 | ClearError01 | 0 | No effect |
| | | 1 | Error acknowledgment for motor |
| 6 - 7 | Reserved | 0 | |

Motor1Step0

Name:
Motor1Step0

This registers is used to specify the number and direction of steps that should be carried out by the module during the next X2X cycle.

The value is specified with a resolution of 1/256 of a full step (corresponds to 8-bit microsteps).

The direction of movement is derived from the value's sign:

| Data type | Values | Information |
|-----------|--------|--|
| INT | >0 | Movement in the positive direction in 1/256 full steps |
| | <0 | Movement in the negative direction in 1/256 full steps |

Unlike function model "Standard" without enabled SDC information, the motor current is selected using a separate register (see register ["Motor current" on page 2629](#)).

Home position

Name:
RefPulsePos01

These 2 registers have the following contents:

| Register | Description |
|--|--|
| Home position of the internal position counter | This register contains the home position of the internal position counter. |
| Home position for the ABR counter | This register contains the home position of the ABR counter. |

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

Setting "Position sync" in the Automation Studio I/O configuration can be used to select which of the 2 registers is addressed by variable RefPulsePos01.

| Variables in Automation Studio | I/O configuration, counter 01, option "Position sync" | |
|---|---|---|
| | Stepper counter 01 is indicated on ActPos01 . | ABR counter 01 is indicated on ActPos01 . |
| RefPulsePos01 | Home position of the internal position counter | Home position of the ABR counter |
| Option "Position sync" for counter 1 also sets bit 3 in register "Counter configuration" on page 2618 : | | |
| Bit 3 (counter 1) | 0 | 1 |

Reference pulse counter

Name:

RefPulseCnt01

These 2 registers have the following contents:

| Register | Description |
|---|---|
| Reference pulse counter for the internal position counter | The reference pulses of the internal position counter are counted in this register. |
| Reference pulse counter for the ABR counter | The reference pulses of the ABR counter are counted in this register. |

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

Setting "Position sync" in the Automation Studio I/O configuration can be used to select which of 2 registers is addressed by variable RefPulsePos01.

| Variables in Automation Studio | I/O configuration, counter 01, option "Position sync" | |
|--|---|---|
| | Stepper counter 01 is indicated on ActPos01 . | ABR counter 01 is indicated on ActPos01 . |
| RefPulseCnt01 | Reference pulse counter for the internal position counter | Reference pulse counter of the ABR counter |
| Option "Position sync" for counter 1 also sets bit 3 in register "Counter configuration" on page 2618: | | |
| Bit 3 (counter 1) | 0 | 1 |

NetTime of the position value

Name:

ActTime01

This register contains the NetTime of the most recent valid position value.

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

Trigger counter

Name:

TriggerCnt01

This register contains a cyclic counter that is incremented with each trigger event.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

Trigger timestamp

Name:

TriggerTime01

This register contains the NetTime instant of the most recent trigger event. The trigger edge must be configured in register ["SDC configuration" on page 2627](#).

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

Information:

The absolute accuracy of the trigger can be delayed up to 5 μ s due to the input filter of the digital inputs.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

9.25.7.13.9 Register description: Function model 254 - "Bus controller" and function model 3 - "Ramp"**9.25.7.13.9.1 Configuration registers****Holding current, rated current and maximum current**

Name:

ConfigOutput03a (holding current)

ConfigOutput04a (rated current)

ConfigOutput05a (maximum current)

The holding current, nominal current and maximum current registers are used to configure the desired motor current.

Reasonable values are:

- Holding current < Nominal current < Maximum current

The motor's nominal current is entered in the nominal current register according to the motor's data sheet.

| Register | Description |
|-----------------|--|
| Nominal current | Current during operation at constant speed |
| Maximum current | Current during acceleration phases. In the mode "Homing during stall", the rated current is always used instead of the maximum current, even in acceleration phases. |
| Holding current | Current when motor is at standstill |

When the current changes to a weaker value (e.g. when transitioning from the acceleration phase to the constant speed mode), the stronger current is maintained for an additional 100 ms. This is done according to the following priority regardless of the actual defined values: maximum current before nominal current before holding current.

| Data type | Value | Unit |
|-----------|----------|--|
| USINT | 0 to 117 | Percent of the module's rated current <ul style="list-style-type: none"> • 100% corresponds to the rated current of the motor bridge power unit listed in the technical data • 117% corresponds to the maximum current of the motor bridge power unit listed in the technical data Bus controller default setting: 0 |

Full step threshold

Name:

FullStepThreshold01

This register defines the threshold speed, above which the motor is operated in full step mode, and below which it is operated in microstep mode.

| Data type | Value | Information |
|-----------|------------|---|
| UINT | 1 to 65534 | Speed in microsteps / cycle. Bus controller default setting: 0 |
| | 65535 | Motor is always operated in microstep mode |

Maximum speed

Name:

MaxSpeed01pos

This register defines the maximum speed for the absolute positioning modes (1, -123, -124, -125, -126).

Information:

The setting does not apply to the speed and homing modes (2, -127, -128).

| Data type | Value | Information |
|-----------|-------------|---|
| UINT | 0 to 65,535 | Speed in microsteps / cycle. Bus controller default setting: 0 |

Maximum acceleration

Name:

MaxAcc01

This register defines the maximum acceleration (also applies for homing modes).

| Data type | Value | Information |
|-----------|-------------|--|
| UINT | 0 to 65,535 | Acceleration in microsteps / cycle ² . Bus controller default setting: 0 |

Maximum deceleration

Name:
MaxDec01

This register defines the maximum deceleration (also applies for homing modes).

| Data type | Value | Information |
|-----------|-------------|--|
| UINT | 0 to 65,535 | Deceleration in microsteps / cycle ² . Bus controller default setting: 0 |

Reversing loop

Name:
RevLoop01

This parameter is only used in mode 1, -123, -124, -125, -126 (absolute positioning modes).

If the value for the reversing loop is not equal to 0, the target position is approached directly when coming from one direction; when coming from the other direction, the target position is initially overshoot by the configured number of steps before finally moving to the target position. This ensures that the target position is always approached from the same direction (to avoid mechanical backlash).

The sign of the defined value determines the direction in which the reversing loop runs.

| Sign | Effective direction |
|----------|--|
| Positive | Reversing loop in positive direction of movement |
| Negative | Reversing loop in negative direction of movement |

| Data type | Values | Information |
|-----------|-----------------|-----------------------------------|
| INT | -32768 to 32767 | Bus controller default setting: 0 |

Fixed position A

Name:
FixedPos01a

This register defines the position to move to in modes -124 (if the digital input is set to 1) and -125.

| Data type | Values | Information |
|-----------|------------------------------------|-----------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: 0 |

Fixed position B

Name:
FixedPos01b

This register defines the position to move to in modes -124 (if the digital input is set to 0) and -126.

| Data type | Values | Information |
|-----------|------------------------------------|-----------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: 0 |

Homing speed

Name:
RefSpeed01

This register sets the speed for homing modes -127 and -128.

| Data type | Value | Information |
|-----------|-------------|---|
| UINT | 0 to 65,535 | Speed in microsteps / cycle. Bus controller default setting: 0 |

Stall recognition delay

Name:

StallRecognitionDelay01

The value in this register is only relevant for "Homing during stall".

A stall is only detected after the time specified here has expired and after the homing procedure has started.

For example, a setting of 4 (and a cycle time of 25 ms) means that a stall will not be detected until 100 ms after the motor starts moving (start of the homing procedure).

Set to 0 to eliminate delay.

| Data type | Value | Information |
|-----------|----------|---|
| USINT | 0 to 255 | in cycles, see "General configuration" on page 2636. Bus controller default setting: 0 |

Minimum speed for stall detection

Name:

StallDetectMinSpeed01

If the motor speed exceeds the value set in this register, then stall detection is enabled and the configured **mixed decay threshold** is used. The value 15 is always used for the mixed decay threshold below this threshold value, and no stall error is reported. This means that mixed decay mode is always enabled at low speeds where stall detection principally does not work.

| Data type | Value | Information |
|-----------|------------|---|
| UINT | 0 to 65535 | Minimum speed in microsteps per cycle. Bus controller default setting: 0 |

Jolt time

Name:

JoltTime01

If a value other than 0 is assigned to this register, then jolt limitation is performed. This is done by averaging the values for the steps to be carried out (speed setpoint) in each cycle using FIFO memory. The jolt time corresponds to the number of FIFO elements (0 to 80). If a value greater than 80 is entered, then it will be limited internally to 80.

Changes made while a motor is running will be applied as soon as ...

- the motor has reached the position setpoint (positioning modes only)
- the motor has stopped (all modes)

| Data type | Value | Information |
|-----------|-----------------------|---|
| USINT | 0 | No jolt time limitation. Bus controller default setting: 0 |
| | 1 to 80 ¹⁾ | Number of FIFO elements |

1) Starting with upgrade 1.4.1.0 (firmware version 14); For older versions: 16

Homing configuration

Name:

RefConfig01

The homing mode can be set with this register.

| Data type | Values | Information |
|-----------|------------|--|
| SINT | -120 | Set home position |
| | -121 | Homing on positive edge of input DI 4 |
| | -122 | Homing on falling edge of input DI 4 |
| | -125 | Homing on positive edge of input DI 3 (R pulse). Bus controller default setting |
| | -126 | Homing on negative edge of input DI 3 (R pulse) |
| | -127 | Homing during stall detection |
| | -128 | Immediate homing |
| | All others | No effect |

Stall detection configuration / Mixed decay

Name:

StallDetectConfig01

The mixed decay threshold and stall detection sensitivity can be configured in this register.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------|---------|---|
| 0 - 3 | Mixed decay threshold | 0 | Mixed decay disabled (bus controller default setting) |
| | | 1 to 14 | Setting for mixed decay threshold |
| | | 15 | Mixed decay always enabled |
| 4 - 6 | Stall threshold | 0 | Stall detection is disabled (bus controller default setting) |
| | | 1 to 6 | Steps involved in setting stall detection sensitivity |
| | | 7 | Maximum sensitivity for stall detection |
| 7 | Motor load | 0 | Motor load value not shown (bus controller default setting) |
| | | 1 | Show value in register "Status word" on page 2644 ¹⁾ |

1) If this bit is 1, then the motor load value is indicated in bits 13 to 15 of the status word register (otherwise these bits are 0). This value can help when testing stall detection and *Home during stall mode*.

Stall threshold

The SM module features integrated sensorless load measurement for the motor axis. This is especially useful for detecting a "stall condition" (e.g. if the motor moves to the end point during a homing procedure). It cannot be used for torque monitoring during dynamic movements.

The "stall threshold" (bits 4 to 6 of this register) can be used to define a threshold value for each axis individually according to the motor load, beyond which the motor will detect a stall condition.

This threshold value must be determined on a case-by-case basis, since the results of load measurement are influenced by a variety of factors.

- Motor speed: A higher speed results in higher measurement values
- Speeds that cause motor resonances (which interfere with load measurement) are to be avoided
- Motor accelerations that create a dynamic load (and also affect the measurement) should also be avoided
- It is especially important to be aware that mixed decay mode must be optimized for reliable stall detection.

The higher the load measurement value, the lower the load. This means that a stall condition is detected if the load measurement value drops below the trigger threshold for stall detection.

Mixed decay threshold

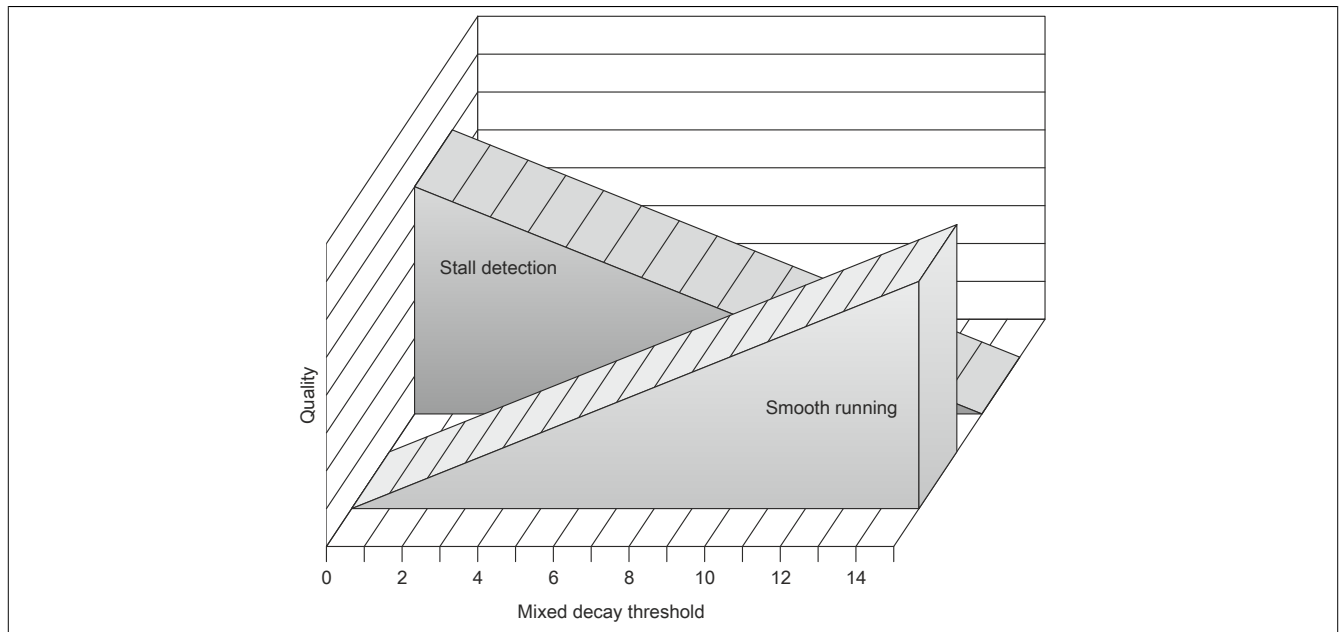
Mixed decay modules provide a greatly optimized sinusoidal current profile in the individual phases of the stepper motor, especially for fast current changes and low current values.

Mixed decay interferes with reliable stall detection, however. For this reason, mixed decay mode can be disabled during stall detection (motor load measurement) using the mixed decay threshold. The smaller the configured mixed decay threshold, the larger the range in which mixed decay is disabled while motor load measurement takes place.

Mixed decay mode is always enabled if the mixed decay threshold is set to 15.

Relationship between stall detection and mixed decay

Depending on the application and the motor used, satisfactorily smooth operation can be achieved while using stall detection by setting the mixed decay threshold to a value between 1 and 14. This is a compromise between smooth operation and stall detection quality and must be fine tuned during commissioning.



General configuration

Name:

GeneralConfig01

Bit 0 of this register can be used to switch the positioning mode. This register can also be used to configure the cycle time of the motion profile generator.

- 0: "Mode 1: Position mode" without extended control word
- 1: "Mode 1: Position mode with extended control word"

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|--|
| 0 | Position mode | 0 | Without extended control word (bus controller default setting) |
| | | 1 | With extended control word |
| 1 - 2 | Cycle time of the motion profile generator ¹⁾ | 00 | 25 ms (bus controller default setting) |
| | | 01 | 10 ms |
| | | 10 | 5 ms |
| | | 11 | Reserved |
| 3 - 7 | Reserved | 0 | |

1) This parameter is supported starting with upgrade 1.4.1.0 (firmware version 14).

The cycle time for the motion profile generator is configured with this cycle. This cycle time affects the unit for specifying the speed and acceleration:

- Unit for speed: Microsteps/Cycle
- Unit for acceleration: Microsteps/Cycle²

Limit switch configuration

Name:

LimitSwitchConfig01

This register configures the behavior of the limit switches.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------|-------|---|
| 0 - 1 | Negative limit switch | 00 | Switched off (bus controller default setting) |
| | | 01 | Active if low |
| | | 10 | Reserved |
| | | 11 | Active if high |
| 2 - 3 | Positive limit switch | 00 | Switched off (bus controller default setting) |
| | | 01 | Active if low |
| | | 10 | Reserved |
| | | 11 | Active if high |
| 4 - 6 | Reserved | 0 | |
| 7 | Direction monitoring | 0 | Off (bus controller default setting) |
| | | 1 | On |

Negative/Positive limit switch:

When one of the limit switches is reached, a warning is triggered and the speed is decelerated to 0. There is no state change of "Device control state machine". This keeps current flowing to the motor.

The error that occurred can be read from the error code register. Normal operation can be resumed by acknowledging the warning. This will not restrict motor movement to a specific direction and the limit switch will not be triggered until the next active edge.

Overshooting the limit switch while braking

The limit switches are not linked with the corresponding direction of movement. If the limit switch is exceeded, another error will be triggered when reversing after acknowledging the initial error.

Direction monitoring

If this function is enabled, then the two limit switches will be linked with the respective direction of movement. This means that the negative limit switch is only triggered in the negative and the positive limit switch only in the positive direction of movement (specified direction).

This prevents specifying a movement in the wrong direction when direction monitoring is enabled and limit switches are active.

Warning!

If the motor is wired incorrectly with this configuration (wrong direction of movement), then the limit switch will not be triggered and the actual correct direction of movement will be denied. This will also be the case when the limit switch connections are reversed.

Software limit

Name:

PositionLimitMin01

PositionLimitMax01

This register configures software limits. The function is active if at least one of the two registers is unequal to zero. These limits are effective in all positioning modes. Position overrun is not possible when this function is enabled. Movement is always contained within the two limits.

If a position is specified that violates the minimum/maximum software limit, the "Internal limit active" bit will be set in the "Status word" on page 2644 register. The motor movement will be stopped until a position is specified within the limits.

The "Internal limit active" bit will also be set in the "Status word" register if there is a configuration error (minimum > maximum).

| Data type | Values | Information |
|-----------|------------------------------------|-----------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: 0 |

Information:

The software limits will only be monitored in connection with the following CANopen bus controllers:

- X20BC0043-10
- X20BC0143-10
- X67BC4321-10
- X67BC4321.L08-10
- X67BC4321.L12-10

9.25.7.13.9.2 Reading back the configuration

Reading back the holding current, nominal current and maximum current

ConfigOutput03aRead (holding current)

ConfigOutput04aRead (nominal current)

ConfigOutput05aRead (maximum current)

These registers are used to read the respective current values in percent.

| Register | Description |
|-----------------|--|
| Nominal current | Current during operation at constant speed |
| Maximum current | Current during acceleration phases |
| Holding current | Current when motor is at standstill |

| Data type | Values | Unit |
|-----------|----------|---|
| USINT | 0 to 255 | Percentage of module's nominal current (100% corresponds to the nominal current of the motor bridge power unit in the technical data) |

9.25.7.13.9.3 Communication registers

Set position/speed

Name:

AbsPos01

This register is used to set position or speed, depending on the operating mode.

- Position mode (see "Mode" on page 2639): Cyclic setting of the position setpoint in microsteps. In this mode, one micro-step is always 1/256 full-step.
- Speed mode (see "Mode" on page 2639): In this mode, this register is considered a signed speed setpoint.

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

Control word

Name:

MpGenControl01

This register can be used to issue commands based on the module's state (see ["Ramp function model operation on page 2648"](#)).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|------------------------|-------|--|
| 0 | Switch on | x | |
| 1 | Enable voltage | x | |
| 2 | Quick stop | x | |
| 3 | Enable operation | x | |
| 4 - 6 | Mode-specific | x | |
| 7 | Fault reset | x | |
| 8 | Stop ¹⁾ | x | |
| 9 - 10 | Reserved | 0 | |
| 11 | Motor ID trigger | 0 | No effect |
| | | 1 | Rising edge: Motor ID trigger ²⁾ |
| 12 | Warning reset | 0 | No effect |
| | | 1 | Rising edge: Reset warnings |
| 13 | Undercurrent detection | 0 | Disable current error detection (default) |
| | | 1 | Enable current error detection |
| 14 | ABR counter sync/async | 0 | Default: <ul style="list-style-type: none"> Internal position counter, cyclic ABR counter, acyclic |
| | | 1 | <ul style="list-style-type: none"> Internal position counter, acyclic ABR counter, cyclic |
| 15 | Stall detection | 0 | Disable stall detection (default) |
| | | 1 | Enable stall detection |

1) The "Halt" bit is only evaluated when the extended control word is enabled (see ["General configuration" on page 2636](#)).

2) This bit can be used to trigger a measurement of the motor ID. Keep in mind that the application must ensure that the conditions for measurement are fulfilled (see table in the ["Motor identification" on page 2645](#) register).

Mode

Name:

MpGenMode01

| Data type | Value | Information |
|-----------|-------|--|
| SINT | 0 | No mode selected |
| | 1 | Depending on bit 0 in the "General configuration" on page 2636 register, the position mode will behave as follows: <ul style="list-style-type: none"> Position mode without extended control word: Move to target position as soon as the target position changes Position mode with extended control word: Move to position setpoint as described in "Mode 1 - Position mode with extended control word" on page 2640 |
| | 2 | Speed mode: Constant speed |
| | -120 | Set reference position |
| | -121 | Remaining distance mode |
| | -122 | Set actual position |
| | -123 | Move to target position when external input set |
| | -124 | Two-position module |
| | -125 | Move to fixed position A (position set acyclically) |
| | -126 | Move to fixed position B (position set acyclically) |
| | -127 | Positive homing (see also "Homing configuration" on page 2634) |
| | -128 | Negative homing (see also "Homing configuration" on page 2634) |

Information:

For all modes: The "Target reached" bit is set in the ["Status word" on page 2644](#) register when the current action is finished (i.e. when the position or speed is reached, depending on the mode).

A new position or speed can be specified even before the current action is finished.

Mode 1 - Position mode

The position setpoint is specified in the "Set position/speed" on page 2638 register. The motor is then moved to this new position. This is done with a ramp function that accounts for the defined maximum speed and acceleration values.

The position setpoint can also be changed during an active positioning procedure.

The position setpoint is specified in microsteps (1/256 of a full step).

If bit 0 in the "General configuration" on page 2636 register is 0 (no extended control word), then the position setpoint will be applied as soon as it is different from the current position. Then the new position is used for the movement.

However, if bit 0 in the "General configuration" on page 2636 register is set to 1 (extended control word), then the position setpoint will be applied as described under "Mode 1 - Position mode with extended control word" on page 2640.

Mode 1 - Position mode with extended control word

The position mode with extended control word behaves like the previously described Position mode 1 (without extended control word) except that the new position setpoint ("Position/speed" on page 2638 register) is applied according to the extended control word.

Extended control word

This register can be used to issue commands based on the module's state (see "Ramp function model operation" on page 2648).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|---|-------|---|
| 0 - 3 | Corresponds to the default Control word | x | |
| 4 | New setpoint | 0 | Do not apply position setpoint |
| | | 1 | Apply position setpoint |
| 5 | Change set immediately | 0 | Complete current positioning movement and then start next positioning movement |
| | | 1 | Interrupt current positioning movement and then start next positioning movement |
| 6 | abs / rel | 0 | Position setpoint is an absolute value |
| | | 1 | Position setpoint is a relative value |
| 7 | Corresponds to the default Control word | x | |
| 8 | stop ¹⁾ | 0 | Execute positioning |
| | | 1 | Stop axis with deceleration |
| 9 - 15 | Corresponds to the default Control word | x | |

1) This bit applies to all modes.

Extended status word

The bits in the status word reflect the status of the state machine (for a detailed description, see "Status word" on page 2649 and "State machine" on page 2650).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|---|-------|---|
| 0 - 9 | Corresponds to the default Status word | x | |
| 10 | Target reached, depending on bit 8 (Halt) in the register "Control word" on page 2639 | | If Halt = 0 |
| | | 0 | Position setpoint not reached |
| | | 1 | Position setpoint reached |
| | | | If Halt = 1 |
| | | 0 | Axis decelerating |
| 11 | Corresponds to the default Status word | 0 | Axis speed = 0 |
| | | 1 | |
| 12 | Setpoint acknowledge | 0 | Ramp generator did not apply the position value |
| | | 1 | Ramp generator applied the position value |
| 13 - 15 | Corresponds to the default Status word | x | |

Position setting

The target position can be defined in 2 different ways:

| Type of setpoint definition | Description |
|-----------------------------|--|
| Single setpoint | After the target position is reached, Bit <i>Target reached</i> in register "Status word" on page 2644 is set. A new target position (setpoint) is then defined. The drive stops at each target position before starting the movement to the next target position. |
| Set of setpoints | After the target position has been reached, the movement to the next target position is started immediately without stopping the drive. It is therefore possible to initiate a new positioning by specifying another target position during active positioning. |

Table 510: Types of position setpoint definition

The two options "Single setpoint" and "Set of setpoints" are controlled by the timing of bits *New setpoint* and *Change set immediately* in the "extended control word" on page 2640 and *Setpoint acknowledge* in the "extended status word" on page 2640 register.

These bits can be used to create a Request-Response mechanism. This makes it possible to specify a target position while a previous position specification is still being processed.

Specifying the target position

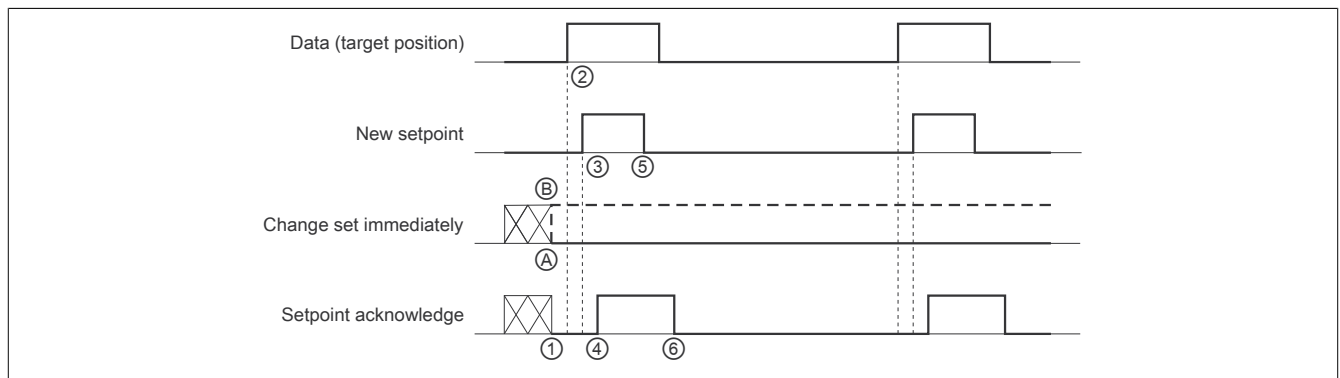


Figure 177: Principle for applying the setpoint

Transferring a new setpoint:

- 1) If bit *Setpoint acknowledge* in register "Extended status word" on page 2640 is 0, the module will accept a new target position.
- 2) The new target position is specified in register "Set position/speed" on page 2638.
- 3) A rising edge on bit *New setpoint* in the "extended control word" on page 2640 indicates that the new target position in register "Set position/speed" on page 2638 is valid and can be used for the next positioning movement.
- 4) After the module has received and saved the new target position, bit *Setpoint acknowledge* is set to 1 in register *Status word*.
- 5) Now the controller can reset the *New setpoint* bit to 0.
- 6) Then the module resets bit *Setpoint acknowledge* to 0 to signal when a new target position is accepted.

Position specification "Single setpoint"

If bit *Change set immediately* is set to 0 (Ⓐ in figure "Principle for applying the setpoint"), then the module is operating with position specification *Single setpoint*. This mechanism results in a speed of 0 when the motor reaches target position x_1 at time t_1 . After the controller has been notified that the setpoint has been reached, the next target position x_2 will be processed at time t_2 and reached at t_3 .

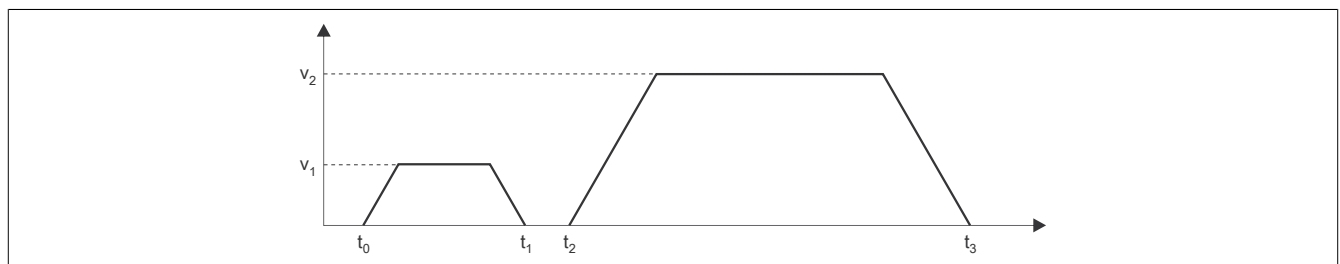


Figure 178: Ramp in *Single setpoint*

Position specification "Set of setpoints"

If bit *Change set immediately* is set to 1 (Ⓢ in figure "Principle for applying the setpoint"), then the module is operating with position specification *Set of setpoints*. This means that the module receives the first target position at t_0 . A second target position is received at time t_1 . The drive immediately adapts the current movement to the new target position.

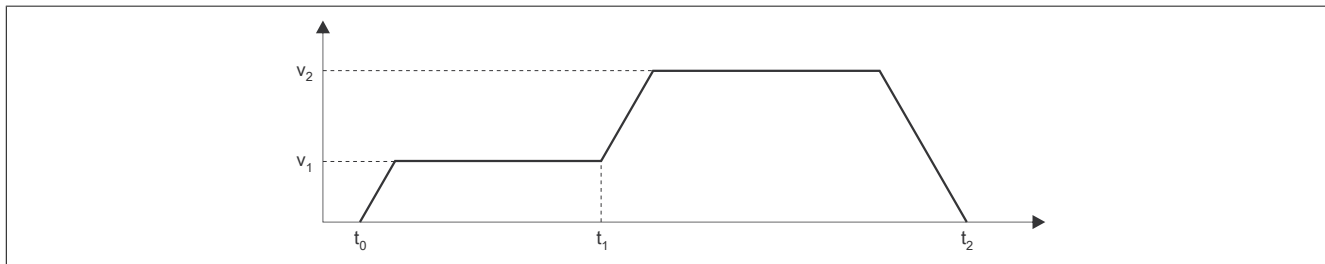


Figure 179: Ramp in *Set of setpoints*

Relative position setting

When the *abs / rel* bit in the "Extended control word" on page 2640 register is set, then the position setpoint is interpreted as a relative value. At each *New setpoint* trigger, the position setpoint will be increased by this value (or decreased if the value is negative).

If the mode changes between the position settings, relative movement will then proceed starting at the last specified position. The position setpoint mode is initialized with 0 when the module is started.

Mode 2: Speed mode - Constant speed (pos./neg.)

The value in the "Position/Speed" on page 2638 register is now interpreted as the speed setpoint (microsteps/cycle).

Observing the maximum permissible acceleration, the motor moves with a ramp to the desired speed setpoint and maintains this speed until a new speed setpoint is specified.

Values are allowed within the range -65535 to 65535. When a value is entered outside of this range, it is readjusted to these limits.

Mode -120: Set home position

This mode is supported starting with upgrade 1.4.1.0 (firmware version 14).

The current value for the actual position is modified so that the position specified by the "Position/Speed" on page 2638 register is the home position. If you subsequently move to this position, the motor is at the home position.

The home position in the "Home position" on page 2646 register is also set to this value.

Before this mode is called, the motor must be at a standstill and the home position must have been determined using "Positive / negative homing" mode. In order to set the position, the *State machine* must be in state "Operation enable".

Mode -121: Remaining distance mode (like Modus 1)

The number of steps defined in the "Fixed position A" on page 2633 register are added to the current position and the resulting position is approached at a rising/falling edge on digital input 3.

Advice:

Steps are not added to the position setpoint, but rather to the current position at the moment the trigger occurs.

Negative values are also allowed for the offset defined in Fixed position A.

New position setpoints are no longer accepted in the "Position/speed" on page 2638 register after the trigger event. There must first be a switch made to mode 0 and then back to mode -121.

The "Target reached" bit in the "Status word" on page 2644 register is not set to 1 until the end position (after the trigger event) has been reached.

The "homing configuration" on page 2634 determines whether a rising or falling edge of the digital input is used as a trigger.

The Reversing loop is not enabled in this mode (i.e. any configured values not equal to 0 are ignored).

Mode -122: Set the actual position

The position setpoint set in the "Position/speed" on page 2638 register is accepted as the current actual position in the internal position counter when the state machine is in the "Operation Enable" state.

Before this mode is started, the motor must be at a standstill and physically located at the point for which the position being set should be applied.

Mode -123: Move to the position setpoint when the external input is set

The set position defined in the "Position/speed" on page 2638 is moved to when a rising edge occurs on the corresponding digital input.

A new position setpoint is not accepted until another rising edge occurs on the corresponding digital input. This can also occur during the active positioning procedure and will be applied immediately.

Mode -124: Two-position mode

Positions Fixed position A and Fixed position B are defined in the acyclic registers.

Value 1 on digital input 3 moves to fixed position A. Value 0 moves to fixed position B. It is also possible to switch between the two during an active positioning movement.

Mode -125/-126: Move to fixed position X

The purpose of these modes is to enable a virtual switch from speed mode to position mode, which otherwise is not possible because of the shared use of the register for position and speed setpoints.

- Mode -125: "Fixed position A" on page 2633
- Mode -126: "Fixed position B" on page 2633

Mode -127/-128: Homing (positive/negative)

Mode -127 and -128 are used to select which direction to move in.

The motor must be at a standstill before switching from another mode to one of the homing modes.

If the homing condition occurs, then the motor stops and the values of the position counter and ABR counter valid at the moment when the homing condition occurs are written to the "Homed zero position" on page 2646 register.

You must specify in the Homing configuration whether homing should occur at low/high level on the digital input, during stall or unconditionally.

Homing via digital input

Case 1: Active homing level not yet reached → Motor not yet at end position:

Movement continues at homing speed in the homing direction until the active level for "homing-stop" is on the digital input.

Case 2: Active homing level already reached → Motor at end position:

Movement continues at the homing speed, counter to the homing direction, until the active level for "homing-stop" is no longer on the digital input. Movement continues at homing speed in the homing direction until the active level for "homing-stop" is on the digital input again.

Homing during stall

Movement continues in the homing direction until a stall is detected. When a stall is detected, the value of the position counter is entered in the "[Homed zero position](#)" on [page 2646](#) register within one millisecond. The motor is then stopped abruptly (not using the deceleration ramp). However, it can take up to 25 ms to stop the motor because the ramp generator runs with a configurable internal cycle of up to 25 ms.

In this mode, the rated current is always used instead of the maximum current, even in acceleration phases.

To test the response behavior of this homing mode, the motor load value used for identifying a stall can be made visible in the status word (see "[Stall detection configuration / Mixed decay](#)" on [page 2635](#)).

Homing unconditional (immediate)

Immediate homing: The current values of the position counter and ABR counter are immediately entered in the "[Homed zero position](#)" on [page 2646](#) register (no motor movement).

Current position (cyclic)

Name:

AbsPos01ActVal

This cyclic register contains the current position.

Default: Value of the internal position counter, can be changed to ABR counter

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

Status word

Name:

MpGenStatus01

The bits in this register reflect the state of the state machine. For a more detailed description, see "[Status word](#)" on [page 2649](#) and "[State machine](#)" on [page 2650](#).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|-----------------------------|-------|---|
| 0 | Ready to switch on | x | |
| 1 | Switched on | x | |
| 2 | Operation enabled | x | |
| 3 | Fault (error bit) | x | |
| 4 | Voltage enabled | x | |
| 5 | Quick stop | x | |
| 6 | Switch on disabled | x | |
| 7 | Warning | x | |
| 8 | Reserved | 0 | |
| 9 | Remote | 1 | Always 1 because there is no local mode for the SM module |
| 10 | Target reached | x | |
| 11 | Internal limit active | 0 | No limit violation |
| | | 1 | Internal limit is active (upper/lower software limit violated) |
| 12 | Mode-specific | x | |
| 13 - 15 | Reserved / Motor load value | 0 | Always 0 when bit 7 in the " Stall detection configuration / Mixed decay " on page 2635 register is set to 0. |
| | | x | Returned motor load value |

Input status

Name:

InputStatus

This register indicates the logical states of digital inputs.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------|--------|-------------------------------|
| 0 | Digital input 1 | 0 or 1 | Input state - Digital input 1 |
| ... | | ... | |
| 3 | Digital input 4 | 0 or 1 | Input state - Digital input 4 |
| 4 - 7 | Reserved | 0 | |

Motor identification

Name:

Motoridentification01

This register is used to identify the connected motor type for service purposes and to differentiate between motors in the application. After successful measurement, this register contains the time [µs] required to apply a current increase of $\Delta I = 1$ A to a motor winding.

This depends on:

- Operating voltage
- Inductance and resistance of the motor winding

| Notes | |
|-------|---|
| 1) | To achieve reproducible results, the measurement must be made under the following defined conditions: |
| a) | Motor is at standstill. |
| b) | The motor must be in a half-step position (phase A fully powered, phase B not powered). This means the internal position counter on the SM module must have a value that fulfills the following conditions: <ul style="list-style-type: none"> • Full steps are divisible by 4. • Microsteps = 0 |
| 2) | Condition 1b) is fulfilled after a the SM module is reset or switched on. Immediately afterwards, when the holding current is applied to the motor for the first time (at standstill), the duration for applying the current is measured. This is therefore a suitable time to read the motor identification register in the application. |
| 3) | The current range from approximately 1/3 of the nominal current up to the nominal current is used as operating range for determining the motor identifier. |

| Data type | Motor ID values | Explanation |
|-----------|-----------------|--|
| UINT | 0 | No motor identifier available (after switching on for as long as the measurement conditions are not met) |
| | 1 to 32767 | Valid range of values for the motor ID register (in µs) |
| | 65504 to 65519 | Ground fault: Measurement of motor identification not possible |
| | 65528 | Motor ID trigger not possible <ul style="list-style-type: none"> • Motor not supplied with current • Motor in movement • Nominal current set to 0 A • Ground fault present |
| | 65529 | Invalid value: Underflow |
| | 65530 | Overtemperature: Measurement not possible |
| | 65532 | Open circuit: Measurement not possible |
| | 65533 | Incorrect motor position: Measurement not possible |
| | 65534 | Invalid value: Overflow |
| | 65535 | Measurement in progress |

Ground fault detection

When the motor is powered on, a ground fault check is performed before motor identification. Error numbers have been added in the motor identification register for the event of a ground fault error (values 65504 to 65519 in the table above).

Homed zero position

Name:

RefPos01CyclicCounter

RefPos01AcyclicCounter

After a homing procedure, the homing point for the cyclic or acyclic position counter can be read back with these registers (either the internal position counter or ABR counter depending on bit 14 of register "Control word" on [page 2639](#)).

The following two registers are provided for the motor:

- Homed zero position for cyclic counter
- Homed zero position for acyclic counter

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

Current position (acyclic)

Name:

AbsPos1ActValAcyclic

This acyclic register contains the current position.

Default: Value of the ABR counter, can be changed to internal position counter

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

Reading back the control word

Name:

ControlReadback01

With this register, the contents of register "Control word" on [page 2639](#) can be read back.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

Read back mode

Name:

ModeReadback01

This register can be used to read the content of the "Mode" on [page 2639](#) register.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

Error code

Name:

ErrorCode01

The cause of an error or warning can be read in this register.

| Data type | Error code | Error type | Priority | Description |
|-----------|------------|------------|----------|-----------------------------|
| UINT | 0x0000 | - | - | No error |
| | 0x3000 | Error | hoch | Voltage |
| | 0x4200 | Error | : | Overtemperature |
| | 0xFF20 | Warning | : | Negative limit switch |
| | 0xFF21 | Warning | : | Positive limit switch |
| | 0x2300 | Warning | : | Overcurrent |
| | 0xFF00 | Warning | : | Current error ¹⁾ |
| | 0xFF01 | Warning | Low | Stall ²⁾ |

1) A current error is only detected if bit 13 = 1 in the [control word](#) (current error detection enabled).

2) Stall is only detected if bit 15 = 1 in the [control word](#) (stall detection enabled).

Information regarding the handling of errors and warnings:

- Bit 3 (Fault) and bit 7 (Warning) in the [status word](#) can be used to query whether an error or a warning was reported in the Error code register.
- Bit 7 (Fault Reset) and bit 12 (Warning Reset) in the [control word](#) are used to acknowledge pending errors and warnings.
- If two or more errors/warnings are pending, the one with the highest priority (the order in the table above) will be displayed in the Error code register.

9.25.7.13.9.4 Ramp function model operation

Control for this model has been based on the CANopen communication profile DS402.

Commands for controlling the modules are written to the "Control word" on page 2648. The current module state is returned to the "Status word" on page 2649 register. The function mode (absolute position, constant speed, homing, etc.) is set in the "Mode" on page 2639 register.

Control word

Control word bits and their state for the commands of the state machine:

| Command | Reserved | Encoder position sync/async | Current error detection | Warning reset | Motor ID trigger | Reserved | Reserved | Stop 2) | Fault reset | Mode-specific | Mode-specific | Mode-specific | Enable operation | Quick stop | Enable voltage | Switch on |
|-------------------|----------|-----------------------------|-------------------------|---------------|------------------|----------|----------|---------|-------------|---------------|---------------|---------------|------------------|------------|----------------|-----------|
| Bit ¹⁾ | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Shutdown | x | x | x | x | x | 0 | 0 | x | 0 | x | x | x | x | 1 | 1 | 0 |
| Switch on | x | x | x | x | x | 0 | 0 | x | 0 | x | x | x | 0 | 1 | 1 | 1 |
| Disable voltage | x | x | x | x | x | 0 | 0 | x | 0 | x | x | x | x | x | 0 | x |
| Quick stop | x | x | x | x | x | 0 | 0 | x | 0 | x | x | x | x | 0 | 1 | x |
| Disable operation | x | x | x | x | x | 0 | 0 | x | 0 | x | x | x | 0 | 1 | 1 | 1 |
| Enable operation | x | x | x | x | x | 0 | 0 | x | 0 | x | x | x | 1 | 1 | 1 | 1 |
| Fault reset | x | x | x | x | x | 0 | 0 | x | ↑ | x | x | x | x | x | x | x |

1) x ... Any; ↑ ... Rising edge

2) Bit 8 (stop) is only evaluated if the extended control word is enabled in register "General configuration" on page 2636.

| | |
|---|--|
| Bits 0, 1, 2, 3 and 7 (light gray in the previous table) | These bits control the state of the State machine according to the commands in the table above. |
| Stop | 0 ... Perform motor movement 1 ... Stop axis with deceleration This bit is only evaluated when the extended control word is activated in the "General configuration" on page 2636 register. |
| Motor ID trigger | A rising edge enables the motor ID measurement. |
| Warning reset | A rising edge resets warnings (no effect on errors, which are reset using "Fault Reset"; the state machine is not affected by this bit) |
| Fault reset | A rising edge resets errors and warnings (see "State machine" on page 2650) |
| Current error detection | 0 ... Current error detection disabled 1 ... Current error detection enabled |
| ABR counter sync/async | 0 ... Value of the ABR counter on the "Current position (acyclic)" on page 2646 register. Internal position counter of the ramp generator on the "Current position (cyclic)" register. 1 ... Value of the ABR counter on the "Current position (cyclic)" on page 2644 register. Internal position counter of the ramp generator on the "Current position (acyclic)" register. |
| Stall detection | 0 ... Stall detection disabled 1 ... Stall detection enabled |

Status word

The individual bits of this register and its states depend on the current state of the state machine:

| Status | Reserved / MotorLoadBit 2 ¹⁾ | Reserved / MotorLoadBit 1 ¹⁾ | Reserved / MotorLoadBit 0 ¹⁾ | Reserved | Int. limit active | Target reached | Remote | Reserved | Warning | Switch on disabled | Quick stop | Voltage enabled | Fault | Operation enabled | Switched on | Ready to switch on |
|------------------------|---|---|---|----------|-------------------|----------------|--------|----------|---------|--------------------|------------|-----------------|-------|-------------------|-------------|--------------------|
| Bit | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Not ready to switch on | x | x | x | x | x | x | 1 | 0 | x | 0 | x | 0 | 0 | 0 | 0 | 0 |
| Switch on disabled | x | x | x | x | x | x | 1 | 0 | x | 1 | x | 0 | 0 | 0 | 0 | 0 |
| Ready to switch on | x | x | x | x | x | x | 1 | 0 | x | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Switched on | x | x | x | x | x | x | 1 | 0 | x | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| Operation enable | x | x | x | x | x | x | 1 | 0 | x | 0 | 1 | 1 | 0 | 1 | 1 | 1 |
| Quick stop active | x | x | x | x | x | x | 1 | 0 | x | 0 | 0 | 1 | 0 | 1 | 1 | 1 |
| Fault reaction active | x | x | x | x | x | x | 1 | 0 | x | 0 | x | 0 | 1 | 1 | 1 | 1 |
| Fault | x | x | x | x | x | x | 1 | 0 | x | 0 | x | 0 | 1 | 0 | 0 | 0 |

- 1) If bit 7 is set to 1 in the "Mixed Decay / Stall Detection" on page 2635 register, then the motor load value is returned in bits 13-15 of the status word. Otherwise these bits are always 0.

Information about the status word:

| | | |
|--|--|--|
| Bits 0,1,2,3,5 and 6 (light gray in the previous table) | These bits are set according to the current state of the State machine . | |
| Voltage enabled | Becomes 1 as soon as the motor is powered | |
| Warning | Becomes 1 if a warning is detected ("Overcurrent", "Undercurrent"). The type of warning is indicated in the " Error code " on page 2647 register. The highest priority error / warning is shown in each case, with the priority corresponding to the order in the respective table. Warnings can be reset with a rising edge on the "Warning reset" bit in the control word. | |
| Remote | Always 1 since there is no local mode on the SM module | |
| Target reached ¹⁾ , depending on bit 8 (Halt) in the register "Control word" on page 2648 | <p>If Halt = 0</p> <p>In modes 1, -123, -124, -125 and -126 (absolute positioning): 0...Positioning begins 1...Target has been reached</p> <p>In mode 2 (constant speed): 0...Motor accelerates/brakes 1...Speed setpoint reached</p> <p>In modes -127 and -128 (homing): 0...Homing started 1...Homing ended</p> <p>In mode -122 (set actual position): The bit briefly becomes 0 and immediately becomes 1 again as soon as the position is set.</p> | <p>If Halt = 1</p> <p>In all modes: 0...Axis decelerating 1...Axis speed = 0</p> |
| Internal limit active | 0 ... No limit violation 1 ... Internal limit is active (upper/lower software limit violated) | |

Table 511: Information about the status word

- 1) If Halt has not been activated in the "General configuration" on page 2636 register, then "Target Reached" behaves the same as when Halt = 0.

State machine

The motor is controlled according to the state machine illustrated below. After the module is started, the state machine automatically changes to state *"Not ready to switch on"*. The application then operates the state machine by writing commands to the [Control word](#).

The state machine successively reaches states *"Ready to switch on"*, *"Switched on"* and *"Operation enable"* by writing the consecutive commands *"Shutdown"*, *"Switch on"* and *"Enable operation"*.

Information:

Motor movements are performed according to the setting in register **"Mode"** on page 2639 only in state *"Operation enable"*.

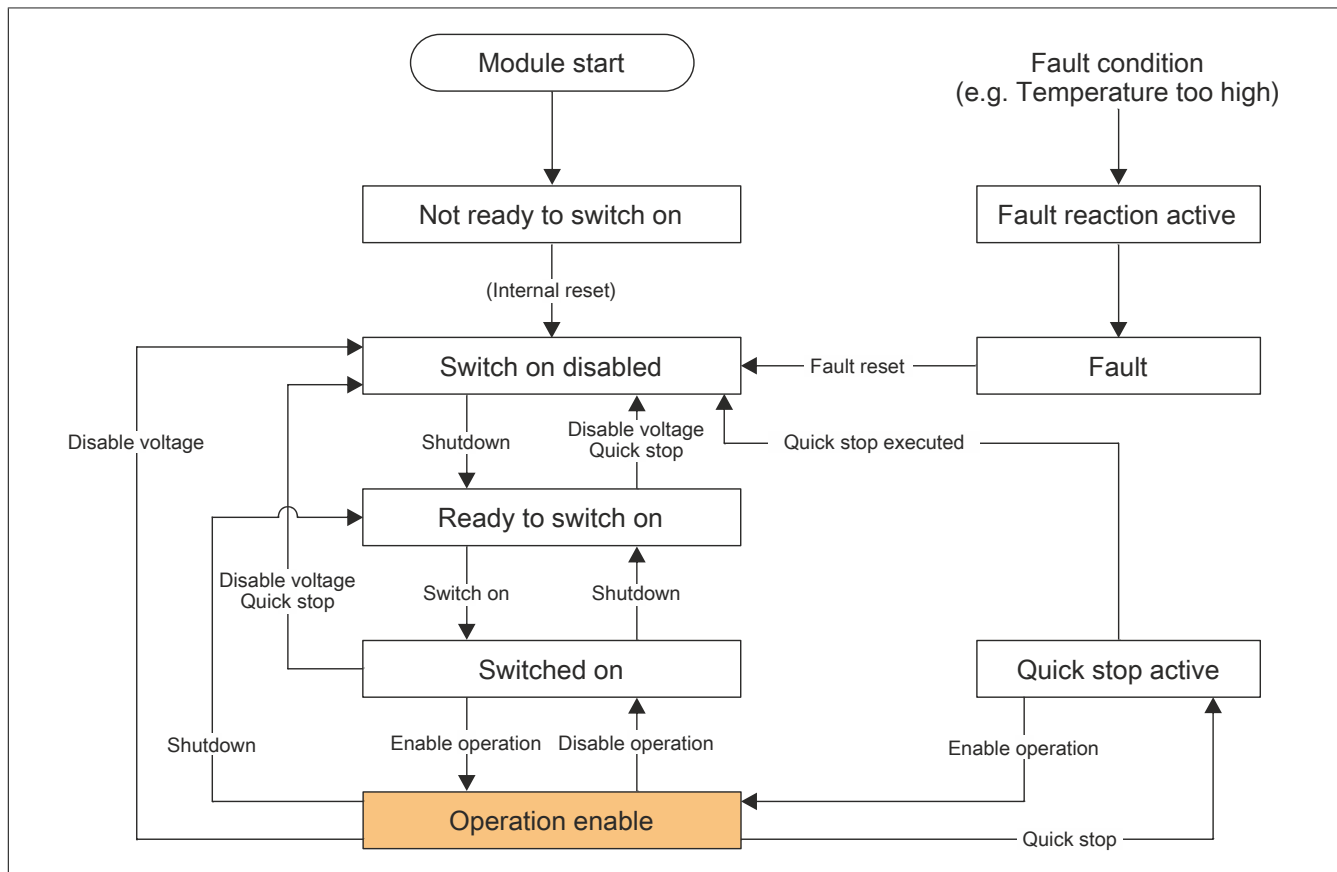


Figure 180: State machine - Flow chart

| State change | Description |
|--|---|
| Not ready to switch on → Switch on disabled | This state change occurs automatically after starting the module and internal initialization has taken place. |
| Switch on disabled → Ready to switch on | This state change is initiated by command <i>Shutdown</i> . No others actions are performed. |
| Ready to switch on → Switch on disabled | This state change is brought on by the command <i>Disable voltage</i> or <i>Quick stop</i> . No others actions are performed. |
| Switched on → Switch on disabled | This state change is brought on by the command <i>Disable voltage</i> or <i>Quick stop</i> . The motor voltage is switched off immediately. |
| Ready to switch on → Switched on | This state change is brought on by the <i>Switch on</i> command. The motor voltage is switched on. When this state change occurs for the first time since the module is started, the motor ID measurement is performed before the <i>Switched on</i> state is achieved. This can take approximately 1 second. |
| Switched on → Ready to switch on | This state change is initiated by command <i>Shutdown</i> . The motor voltage is switched off immediately. |
| Switched on → Operation enable | This state change is brought on by the <i>Enable operation</i> command. Motor movements are now performed depending on the defined mode. |
| Operation enable → Switched on | This state change is brought on by the <i>Disable operation</i> command. If in motion, the motor is decelerated with the configured braking deceleration. Motor voltage remains on in state <i>Switched on</i> . |
| Operation enable → Ready to switch on | This state change is initiated by command <i>Shutdown</i> . The motor voltage is switched off immediately. |

Table 512: State machine - State change

| State change | Description |
|--|--|
| Operation enable → Switch on disabled | This state change is brought on by the <i>Disable voltage</i> command. Motor voltage switched off. It is strongly recommended to only make this state change on a stopped motor since regeneration on a motor running at no load can cause an overvoltage error on the DC bus (0x3210). |
| Operation enable → Quick stop active | This state change is brought on by the <i>Quick stop</i> command. If in motion, the motor is decelerated with the configured braking deceleration. During the deceleration, the state machine remains in state <i>Quick stop active</i> . If the motor comes to standstill, the switch to state <i>Switch on disabled</i> takes place automatically. While the state machine is in state <i>Quick stop active</i> , command <i>Enable operation</i> can be used to switch it back to state <i>Operation enable</i> . |
| → Fault reaction active | This state change is brought on when an error occurs and cannot be triggered by a command from the user. It can be triggered by error types classified as an "Error" (see "Error code" on page 2647). (The other error types classified as "Warning" only cause the "Warning" bit to be set in the status word and do not cause a state change of the state machine.) The motor voltage is cut off and the state machine immediately changes to state <i>Fault</i> . The type of error is listed in the Error code register (see the table under "Error code" on page 2647). The highest priority error is shown. The priority corresponds to the order in the error code table. |
| Fault → Switch on disabled | This state change is brought on by the <i>Fault reset</i> command. However, the state only changes if no more errors are present when the command is written. All errors and warnings are reset. The error code register contains 0 or the warning code if a warning is still present. |

Table 512: State machine - State change

9.25.7.13.10 NetTime Technology

For a description of NetTime Technology, see "NetTime Technology" on page 3035.

9.25.7.13.11 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|---------------------------|--------|
| Function model "Standard" | 250 µs |
| Function model "Ramp" | 250 µs |

9.25.7.13.12 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|---------------------------|--------|
| Function model "Standard" | 250 µs |
| Function model "Ramp" | |
| Inputs | 250 µs |
| Outputs ¹⁾ | 25 ms |

1) Depends on the configuration of the "movement profile generator" on page 2636.

9.25.8 X20SM1436

Data sheet version: 1.51

9.25.8.1 General information

The stepper motor module is used to control stepper motors with a nominal voltage of 24 to 39 VDC ($\pm 25\%$) at a motor current up to 3 A (3.5 A peak). In addition, this module has 4 digital inputs that can be used as limit switches or encoder inputs.

Due to the individual adjustment of the coil currents, the motor is only operated with the current it actually needs. This simplifies the selection of the available motors and prevents unnecessary heating. Because this affects energy consumption and thermal load, the effects are positive on the service life of the complete system. Complete flexibility is achieved through the use of independently adjustable holding, maximum and nominal current values. The current for microsteps is automatically adjusted to the configured current values.

The automatic motor identification system is an enormous help during standstills. The stepper motor modules can identify the connected motors using their coil characteristics and generate feedback in the form of an analog value. This makes it possible to detect not only wiring errors, but also incorrect motor types being used mistakenly. A stall detection mechanism is integrated to analyze the motor load. Detection of the stall is defined via a configurable threshold. This allows an overload or motor standstill to be detected precisely in many different types of applications.

- 1 stepper motor, 24 to 39 VDC $\pm 25\%$, 3 A (3.5 A peak)
- Resolution of current values at 1%
- Boost, nominal and holding current separately configurable
- 38.5 kHz PWM frequency
- Integrated motor detection
- 256 microsteps
- Stall detection
- Complete integration in Automation Studio and CNC applications
- 4 inputs, 24 VDC, configurable for ABR incremental encoders
- Function model "Ramp" based on CANopen communication profile DS402
- NetTime timestamp: Position change, trigger time

NetTime timestamp of the position and trigger time

It is not just the position value that is important for highly dynamic positioning tasks, but also the exact time the position is measured. The module is equipped with a NetTime function for this that supplies a timestamp for the recorded position and trigger time with microsecond accuracy.

The timestamp function is based on synchronized timers. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

9.25.8.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Motor controllers |  |
| X20SM1436 | X20 stepper motor module, module power supply 24 to 39 VDC $\pm 25\%$, 1 motor connection, 3 A continuous current, 3.5 A peak current, 4 digital inputs 24 VDC, sink, configurable as incremental encoder, NetTime function | |
| | Required accessories | |
| | Bus modules | |
| X20BM31 | X20 bus module for double-width modules, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 513: X20SM1436 - Order data

9.25.8.3 Technical data

| | |
|--|---|
| Model number | X20SM1436 |
| Short description | |
| I/O module | 1 full bridge for controlling stepper motors |
| General information | |
| B&R ID code | 0x2682 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Output | Yes, using status LED and software |
| I/O power supply | Yes, using software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | - |
| External I/O | |
| 24 VDC | 2.45 W |
| 48 VDC | 3.15 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E225616 Power conversion equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| Motor bridge - Power unit | |
| Quantity | 1 |
| Type | 2-phase bipolar stepper motor (full bridge) |
| Nominal voltage | 24 to 39 VDC $\pm 25\%$ |
| Nominal current | 3 A |
| Maximum current | 3,5 A for 2 s (after a recovery time of at least 10 s at maximal 3 A) |
| Controller frequency | 38.4 kHz |
| DC bus capacitance | 100 μ F |
| Step resolution | Max. 256 microsteps per step |
| Module power supply | |
| Supply | External |
| Fuse | Required line fuse: Max. 10 A, slow-blow |
| Output protection | No reverse polarity protection for supply voltage |
| Digital inputs | |
| Quantity | 4 |
| Nominal voltage | 24 VDC |
| Input filter | |
| Hardware | <5 μ s |
| Software | - |
| Connection type | 1-wire connections |
| Input circuit | Sink |
| Additional functions | 1x ABR incremental encoder |
| Input resistance | Typ. 18.2 k Ω |
| ABR incremental encoder | |
| Quantity | 1 |
| Encoder inputs | 24 V, asymmetrical |
| Counter size | 16-bit |
| Input frequency | Max. 50 kHz |
| Evaluation | 4x |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from I/O power supply |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |


Table 514: X20SM1436 - Technical data

| Model number | X20SM1436 |
|---------------------------------|--|
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | 0 to 50°C |
| Vertical mounting orientation | Not allowed |
| Derating | See section "Derating". |
| Storage | -25 to 70°C |
| Transport | -25 to 70°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM31 bus module separately |
| Pitch | 25 ^{+0.2} mm |

Table 514: X20SM1436 - Technical data

9.25.8.4 LED status indicators

For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|--|-------|-----------------------------|------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset state |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1 - 4 | Green | | Input state of the corresponding digital input |
| | M | Orange | On | Motor is active |

1) Depending on the configuration, a firmware update can take up to several minutes.

9.25.8.5 Pinout

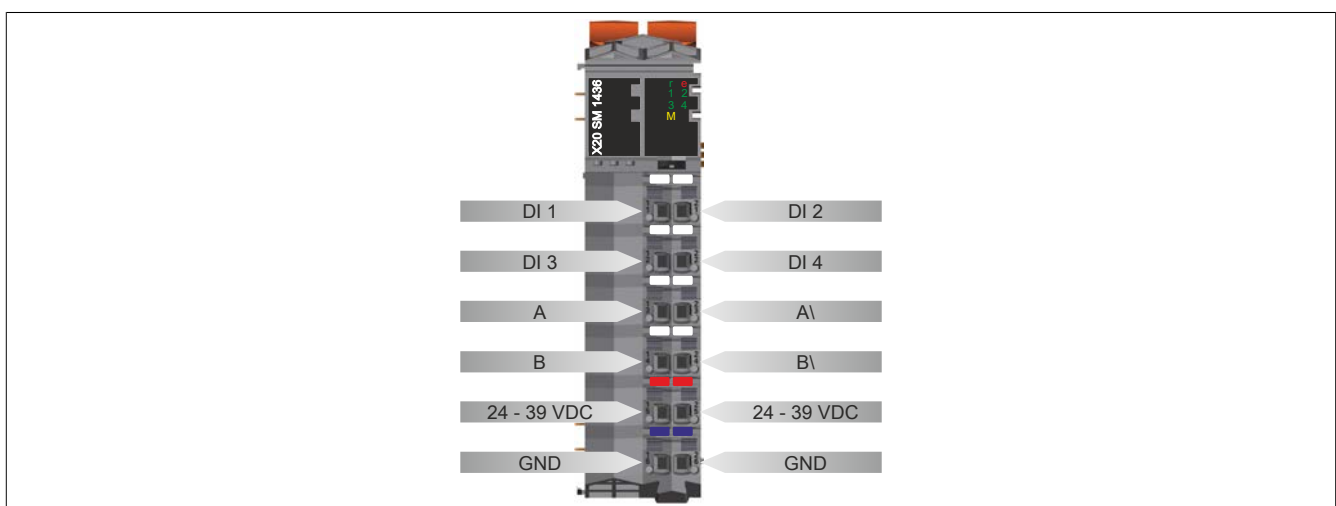
In accordance with the EN 60204-1 standard, a cable cross section of 0.75 mm² or larger must be used for the motor outputs in order to handle the maximum motor current of 3.5 A. To ensure full motor power, voltage drops that could result from the cable length and the electrical connections must also be taken into consideration when selecting the attachment cable.

Warning!

The terminal block is not permitted to be connected or disconnected during operation.

Information:

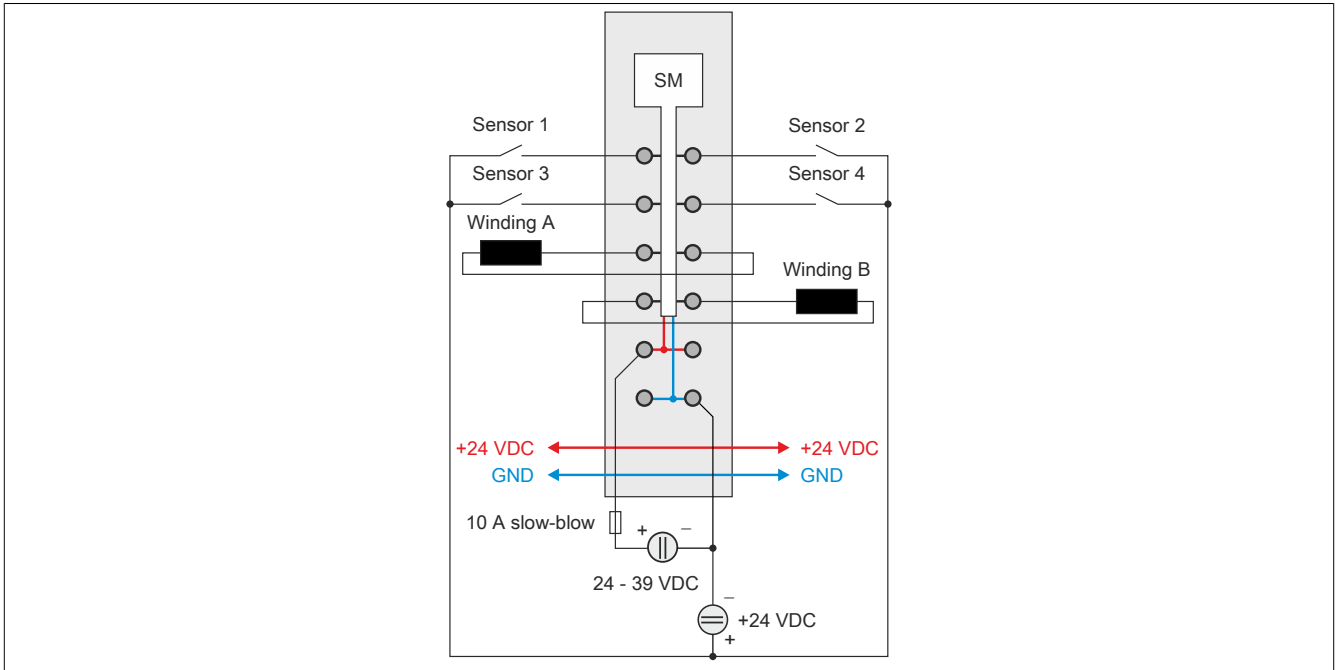
Shielded motor cables must be used in order to meet the limit values per standard EN 55011 (emissions).



9.25.8.6 Connection example

Information:

This module can only be operated if supplied with power via the terminal block.



9.25.8.7 Connection options for digital inputs

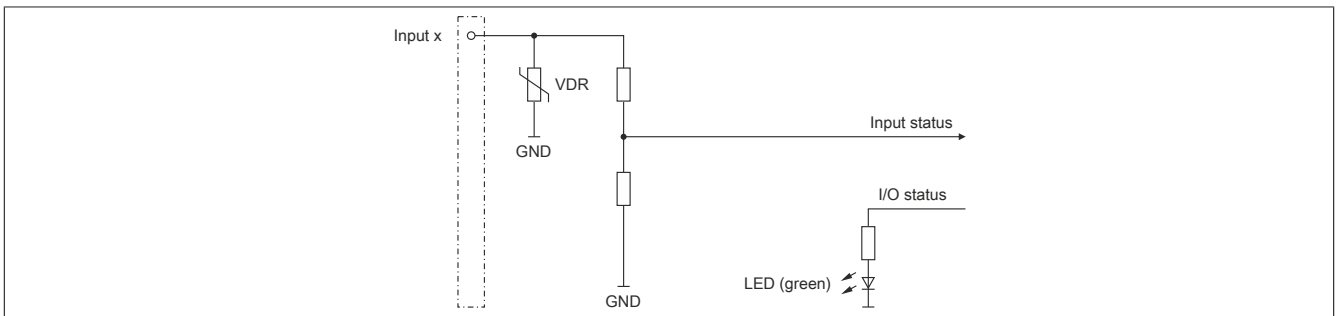
Function model "Standard"

| Channel | Function |
|---------|-----------------|
| DI 1 | Digital input A |
| DI 2 | Digital input B |
| DI 3 | Digital input R |
| DI 4 | Trigger input |

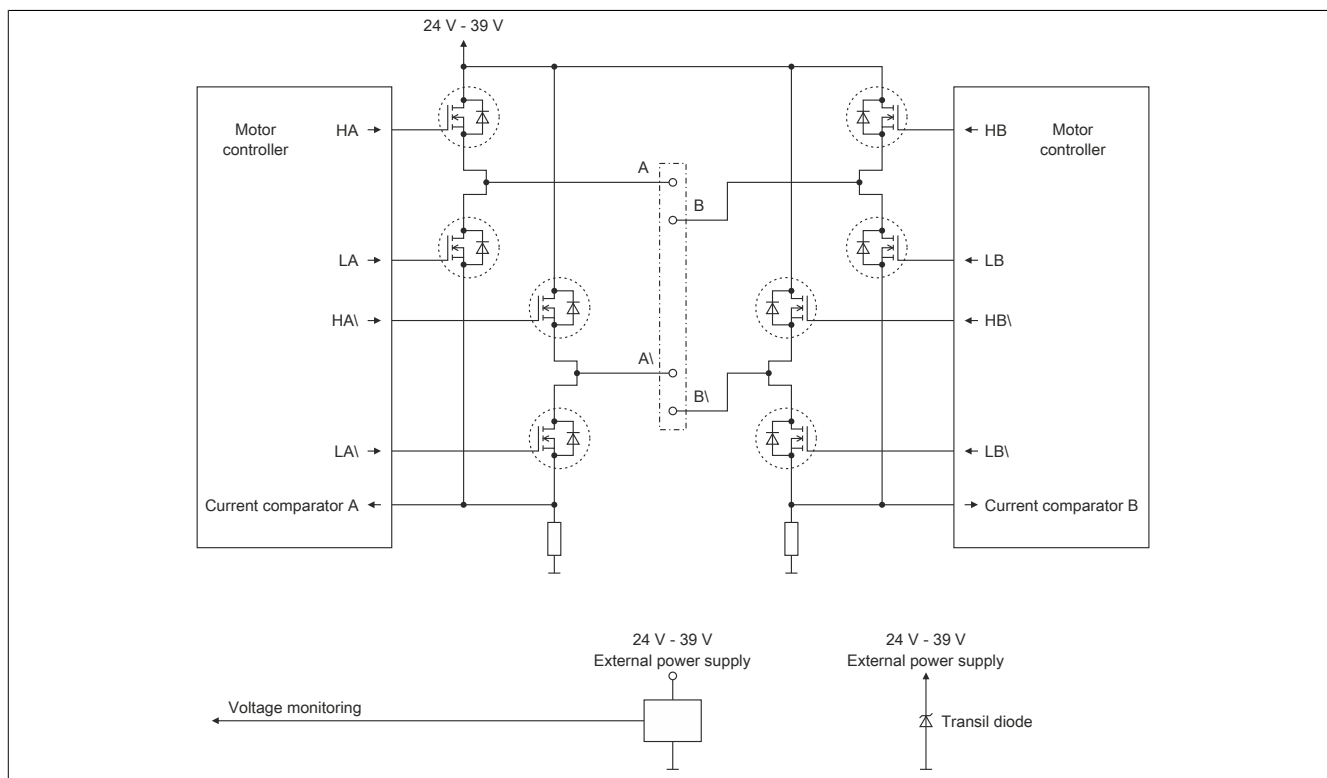
Function model "Ramp"

| Channel | Function |
|---------|-------------------------------------|
| DI 1 | Digital input A |
| DI 2 | Digital input B |
| DI 3 | Digital input R |
| DI 4 | Digital input Negative limit switch |

9.25.8.8 Input circuit diagram



9.25.8.9 Output circuit diagram



9.25.8.10 Overvoltage motor cutoff

The module supply voltage is continually monitored. Its status can be read. The error "Module power supply error" occurs when the voltage is above or below the limits.

If the supply voltage on the module rises or falls outside the limit values (e.g. due to regeneration), then the motor output is switched off.

The outputs are reactivated as soon as the supply voltage is back in the valid range and the error bit is reset.

Supply voltage limit values

| | Drive is switched off | Drive is switched back on |
|-------------|-----------------------|---------------------------|
| Lower limit | <18 V | >19.5 V |
| Upper limit | >50 V | <49 V |

9.25.8.10.1 Energy regeneration of the voltage

If voltage is regenerated during generator operation of the motor, the built-in Transil diode may be overloaded and the module could be irreparably damaged as a result. The following recovery values are therefore not permitted to be exceeded:

- 6 W at more than 53 V

Notice!

Overshoot of the limit values must not be avoided by means of suitable technical measures or by disconnecting cables during maintenance work.

9.25.8.11 Shutdown in the event of overtemperature (starting at 85°C)

If the module temperature reaches or overshoots the limit value of 85°C, the module performs the following actions:

- Sets the "overtemperature" error bit
- Cuts off the outputs (short-circuited)

As soon as the temperature is reduced below 85°C again, the error must be acknowledged with "OvertemperatureAcknowledge" so that the channels can be switched on again.

9.25.8.12 Power supply dimensioning

The motor's current consumption depends on the defined motor currents, the available power and the actual motor being used.

| Example | |
|-------------------------------------|-------------------|
| Motor model number | 80MPD5.300S000-01 |
| Defined current in the motor module | 3 A |
| Motor module supply voltage | 48 VDC |
| Motor load | 1 Nm |

Table 515: Power supply dimensioning example - Basic data

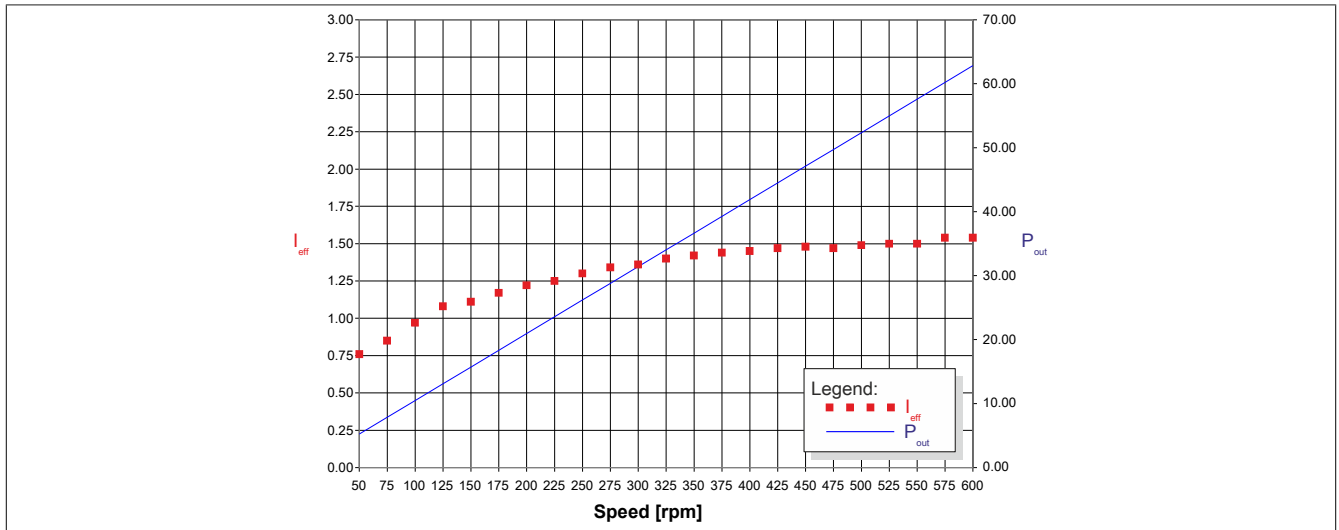


Figure 181: Power supply dimensioning example - Power/Speed relationship

The example is based on a constant load throughout the entire speed range.

An increase in the motor load causes an increase in the effective current of the I/O power supply.

9.25.8.13 Fuse protection

The power supply line should be protected by a circuit breaker or a fuse. In general, dimensioning the supply line and overcurrent protection depends on the structure of the power supply (modules can be connected individually or in groups).

Information:

The effective current for the power supply depends on the load but is always less than the motor current. Make sure the maximum nominal current of 10 A is not exceeded on the power supply terminals of the power unit.

When choosing a suitable fuse, the user must also account for characteristics such as aging effects, temperature derating, overcurrent capacity and the definition of the rated current, which can vary by manufacturer and type. In addition, the fuse that is selected must also be able to handle application-specific characteristics (e.g. overcurrent that occurs in acceleration cycles).

The cross section of the mains power input and the rated current of the used fuse are chosen according to the current-carrying capacity such that the permissible current-carrying capacity of the selected cable cross section (depending on wiring, see table) is greater than or equal to the current load in the mains power input. The rated current of the fuse protection must be less than or equal to the permissible current-carrying capacity of the selected cable cross section (depending on the how it is installed, see table):

$$I_{\text{Power system}} \leq I_{\text{Fuse}} \leq I_{\text{Line/cable}}$$

| Wire cross section [mm ²] | Current-carrying capacity of cable cross section I_z / rated current of fuse I_b [A] depending on the to type of wiring at an ambient air temperature of + 40°C per EN 60204-1 | | | |
|---------------------------------------|--|-----------|-----------|-----------|
| | B1 | B2 | C | E |
| 1.5 | 13.5 / 13 | 13.1 / 10 | 15.2 / 13 | 16.1 / 16 |
| 2.5 | 18.3 / 16 | 16.5 / 16 | 21 / 20 | 22 / 20 |

Table 516: Cable cross section of the mains power input depending on the type of wiring

The tripping current of the fuse is not permitted to exceed the rated current of the fuse I_b .

| Type of wiring | Description |
|----------------|--|
| B1 | Wires in conduit or cable duct |
| B2 | Cables in conduit or cable duct |
| C | Cables or wires on walls |
| E | Cables or wires on open-ended cable tray |

Table 517: Type of wiring used for the mains power input

9.25.8.14 Derating

Only modules with a maximum power dissipation of 1 W are permitted to be operated next to the SM module. To ensure proper operation, observe the derating values listed below.

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.

Power dissipation derating for neighboring modules

Modules directly next to the SM module can have a power loss of 1 W. If the SM module is operated at the rated load over the entire temperature range (3 A rated current), the power loss of neighboring modules must be derated starting at 45°C.

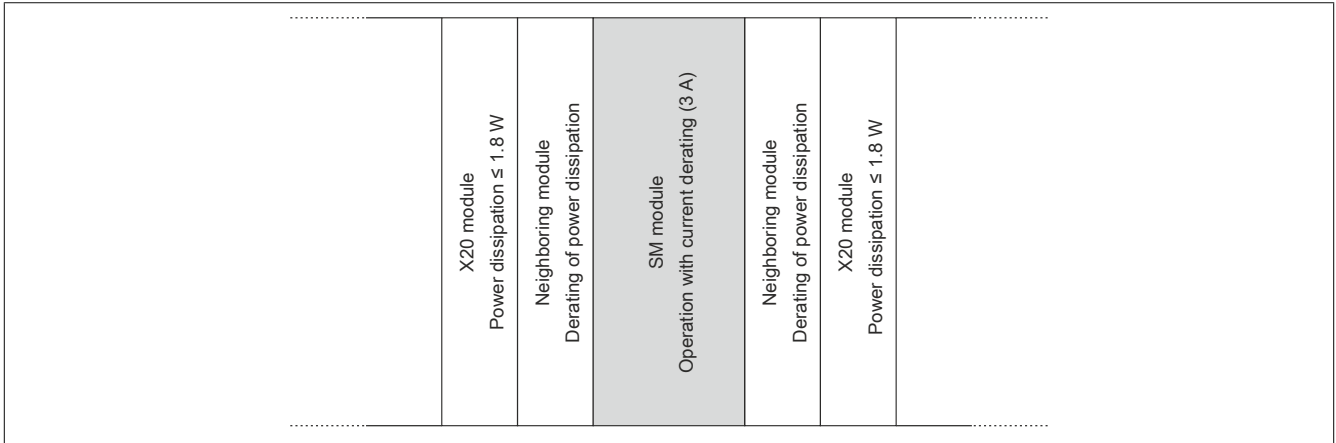
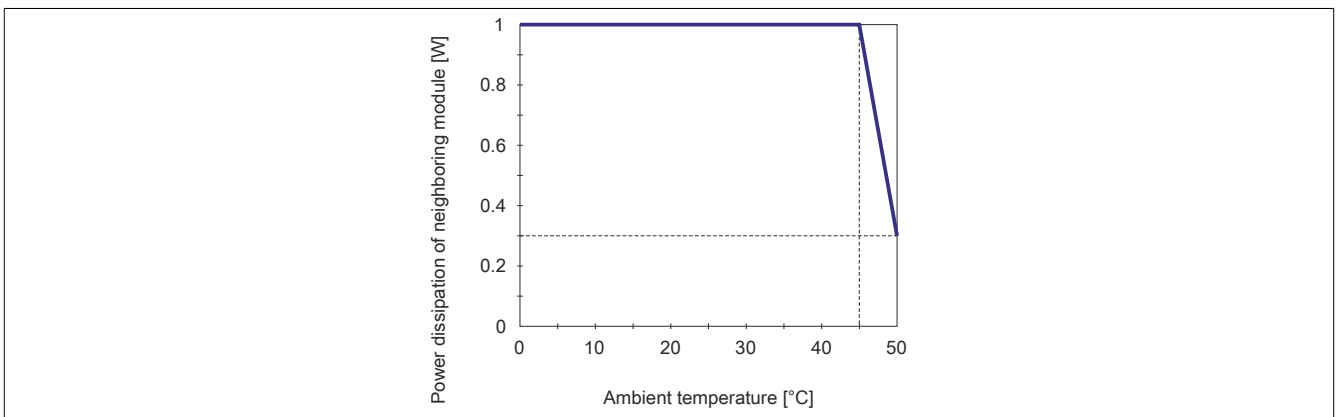
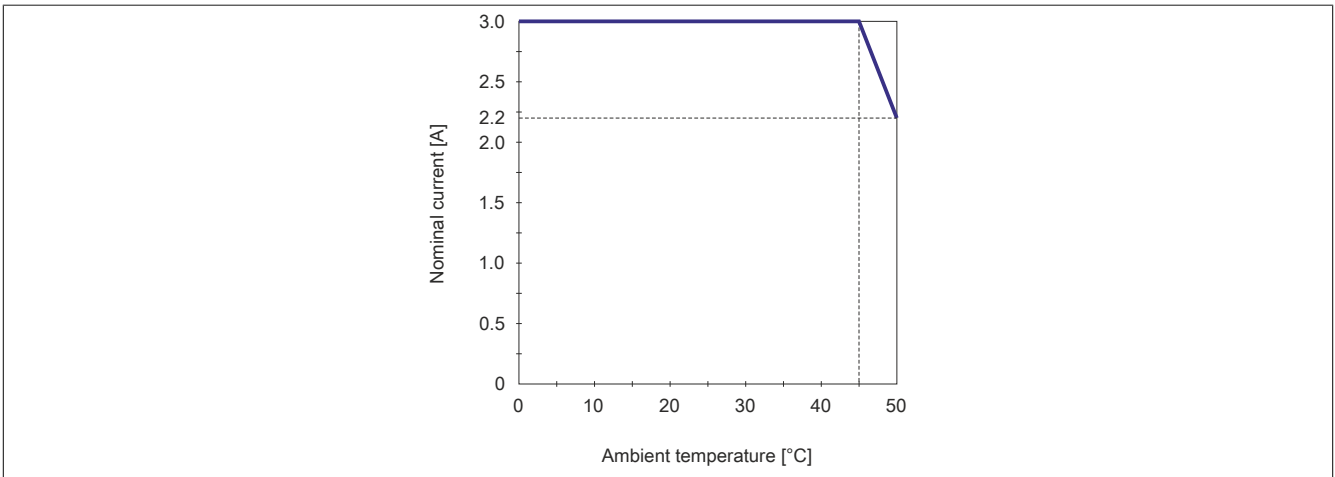
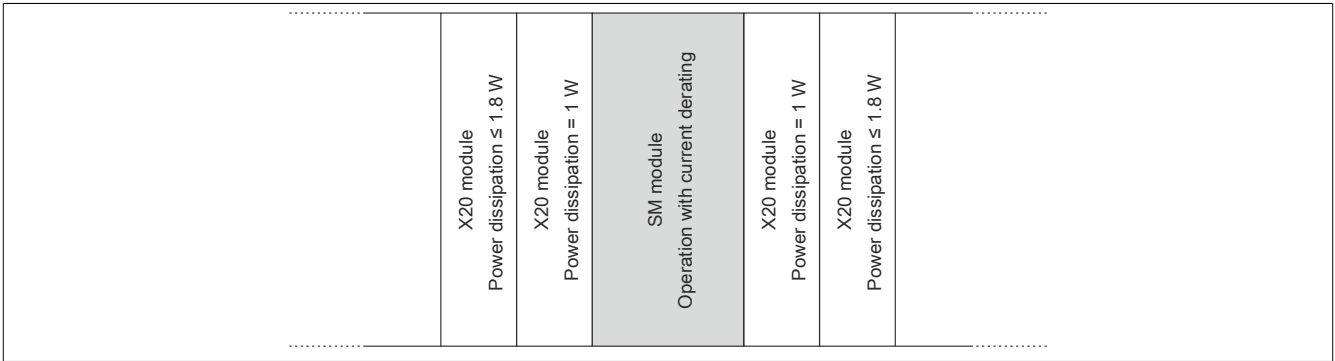


Figure 182: Operating the SM module over the entire temperature range at 3.0 A rated current



Current derating of the SM module

If the power loss of the neighboring modules to the SM module is 1 W, then the current of the SM module must be derated starting at 45°C.



Hardware configuration for multiple SM modules

If three or more SM modules are operated in a cluster, a dummy module must be inserted between the SM modules. There is no derating in this configuration.

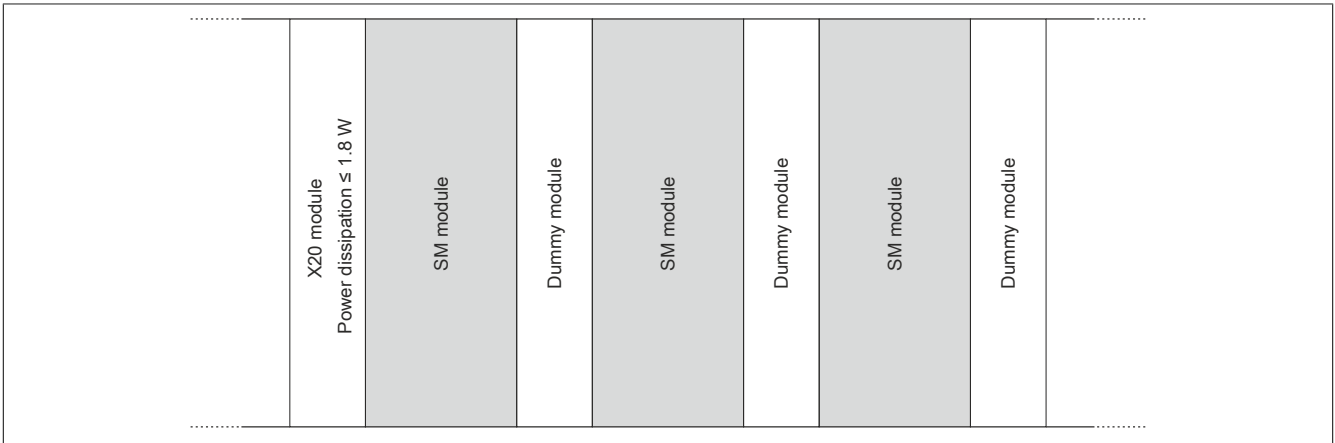


Figure 183: Operating three or more SM modules in a cluster

9.25.8.15 Register description

9.25.8.15.1 mapp Motion system requirements

This module can be operated with mapp Motion function blocks. The following minimum versions are required for this:

- Upgrade version 2.2.0.0
- Automation Studio 4.7.2
- Automation Runtime 4.72

9.25.8.15.2 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.25.8.15.3 Function model 0 - Standard without SDC

| Register | Name | Data type | Read | | Write | |
|--------------------------------|--|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration | | | | | | |
| 44 | ConfigOutput01 (Stall threshold) | UINT | | | | • |
| 46 | ConfigOutput02 (Module configuration 1) | UINT | | | | • |
| 33 | ConfigOutput03 (Holding current) | USINT | | | | • |
| 34 | ConfigOutput04 (Nominal current) | USINT | | | | • |
| 35 | ConfigOutput05 (Maximum current) | USINT | | | | • |
| 32 | ConfigOutput09 (Counter configuration) | USINT | | | | • |
| 52 | ConfigOutput16 (Mixed decay threshold) | UINT | | | | • |
| 81 | MotorIdentTrigger | USINT | | | | • |
| 84 | FullStepThreshold01 | UINT | | | | • |
| 92 | StallDetectMinSpeed01 | UINT | | | | • |
| Reads the configuration | | | | | | |
| 33 | ConfigOutput03Read (Holding current) | USINT | | • | | |
| 34 | ConfigOutput04Read (Nominal current) | USINT | | • | | |
| 35 | ConfigOutput05Read (Maximum current) | USINT | | • | | |
| Communication | | | | | | |
| 6 | PositionAsync | UINT | | • | | |
| 64 | PositionLatchedASync | INT | | • | | |
| 12 | Motoridentification01 | UINT | | • | | |
| Index* 2 + 16 | MotorStepN (Index N = 0 to 3) | UINT | | | • | |
| 0 | PositionSync | INT | • | | | |
| 86 | PositionSync02 | INT | • | | | |
| 4 | Input counter value | USINT | • | | | |
| | ModulePowerSupplyError | Bit 0 | | | | |
| | StatusInput01 | Bit 2 | | | | |
| | StatusInput02 | Bit 3 | | | | |
| | StatusInput03 | Bit 4 | | | | |
| 10 | StatusInput04 | Bit 5 | | | | |
| | Error status | USINT | • | | | |
| | StallError | Bit 0 | | | | |
| | OvertemperatureError | Bit 1 | | | | |
| 60 | CurrentError | Bit 2 | | | | |
| | OvercurrentError | Bit 3 | | | | |
| 60 | PositionLatchedSync | INT | • | | | |
| 68 | usSinceTrigger | UINT | • | | | |
| 54 | Module configuration 2 | USINT | | | • | |
| | StartLatch | Bit 0 | | | | |
| | TriggerEdgePos | Bit 1 | | | | |
| | TriggerEdgeNeg | Bit 2 | | | | |
| | TriggerEdge | Bit 3 | | | | |
| | StartTrigger | Bit 4 | | | | |
| 72 | ClearError | Bit 5 | | | | |
| | Stepper latch trigger status | USINT | • | | | |

| Register | Name | Data type | Read | | Write | |
|----------|--------------|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| 74 | LatchInput | Bit 0 | • | | | |
| | LatchDone | Bit 1 | | | | |
| | TriggerInput | Bit 4 | | | | |
| | MotorLoad | USINT | | | | |

9.25.8.15.4 Function model 0 - Standard with SDC

| Register | Name | Data type | Read | | Write | |
|--------------------------------|--|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration | | | | | | |
| 44 | ConfigOutput01 (Stall threshold) | UINT | | | | • |
| - | ConfigOutput02 (Module configuration 1) | UINT | | | | • |
| 33 | ConfigOutput03 (Holding current) | USINT | | | | • |
| 34 | ConfigOutput04 (Nominal current) | USINT | | | | • |
| 35 | ConfigOutput05 (Maximum current) | USINT | | | | • |
| 32 | ConfigOutput09 (Counter configuration) | USINT | | | | • |
| 52 | ConfigOutput16 (Mixed decay threshold) | UINT | | | | • |
| 81 | MotorIdentTrigger | USINT | | | | • |
| 84 | FullStepThreshold01 | UINT | | | | • |
| 92 | StallDetectMinSpeed01 | UINT | | | | • |
| 102 | SDCConfig01 | USINT | | | | • |
| 103 | MotorSettlingTime01 | USINT | | | | • |
| 107 | DelayedCurrentSwitchOff01 | USINT | | | | • |
| Reads the configuration | | | | | | |
| 33 | ConfigOutput03Read (Holding current) | USINT | | • | | |
| 34 | ConfigOutput04Read (Nominal current) | USINT | | • | | |
| 35 | ConfigOutput05Read (Maximum current) | USINT | | • | | |
| Communication | | | | | | |
| 6 | PositionAsync | UINT | | • | | |
| 12 | Motoridentification01 | UINT | | • | | |
| 112 | SetTime01 | INT | | | • | |
| 100 | Motor current | USINT | | | • | |
| | DriveEnable01 | Bit 0 | | | | |
| | BoostCurrent01 | Bit 1 | | | | |
| | StandstillCurrent01 | Bit 2 | | | | |
| 74 | MotorLoad | USINT | • | | | |
| 73 | LifeCnt | SINT | • | | | |
| 0 | PositionSync | INT | • | | | |
| 4 | Input counter value | USINT | • | | | |
| | ModulePowerSupplyError | Bit 0 | | | | |
| | StatusInput01 | Bit 2 | | | | |
| | StatusInput02 | Bit 3 | | | | |
| | StatusInput03 | Bit 4 | | | | |
| | StatusInput04 | Bit 5 | | | | |
| 10 | Error status | USINT | • | | | |
| | StallError01 | Bit 0 | | | | |
| | OvertemperatureError01 | Bit 1 | | | | |
| | CurrentError01 | Bit 2 | | | | |
| | OvercurrentError01 | Bit 3 | | | | |
| | DrvOk01 | Bit 4 | | | | |
| 54 | Error acknowledgment | USINT | | • | | |
| | ClearError01 | Bit 5 | | | | |
| 16 | Motor1Step0 | INT | | • | | |
| 200 | RefPulsePos01 | INT | • | | | |
| 204 | RefPulsePos01 | INT | • | | | |
| 212 | RefPulseCnt01 | SNT | • | | | |
| 214 | RefPulseCnt01 | SNT | • | | | |
| 220 | ActTime01 | INT | • | | | |
| 208 | TriggerTime01 | INT | • | | | |
| 216 | TriggerCnt01 | SINT | • | | | |

9.25.8.15.5 Function model 254 - Bus controller and function model 3 - Ramp

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--------------------------------|----------------------|--|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration | | | | | | | |
| 48 | - | ConfigOutput03a (Holding current) | USINT | | | | • |
| 49 | - | ConfigOutput04a (Nominal current) | USINT | | | | • |
| 50 | - | ConfigOutput05a (Maximum current) | USINT | | | | • |
| 72 | - | FullStepThreshold01 | UINT | | | | • |
| 52 | - | MaxSpeed01pos | UINT | | | | • |
| 54 | - | MaxAcc01 | UINT | | | | • |
| 56 | - | MaxDec01 | UINT | | | | • |
| 58 | - | RevLoop01 | INT | | | | • |
| 60 | - | FixedPos01a | DINT | | | | • |
| 64 | - | FixedPos01b | DINT | | | | • |
| 68 | - | RefSpeed01 | UINT | | | | • |
| 74 | - | StallRecognitionDelay01 | USINT | | | | • |
| 75 | - | JoltTime01 | USINT | | | | • |
| 78 | - | StallDetectMinSpeed01 | UINT | | | | • |
| 70 | - | RefConfig01 | SINT | | | | • |
| 51 | - | StallDetectConfig01 | USINT | | | | • |
| 306 | - | GeneralConfig01 | USINT | | | | • |
| 308 | - | LimitSwitchConfig01 | USINT | | | | • |
| 344 | - | PositionLimitMin01 | DINT | | | | • |
| 348 | - | PositionLimitMax01 | DINT | | | | • |
| Reads the configuration | | | | | | | |
| 48 | - | ConfigOutput03aRead (Holding current) | USINT | | • | | |
| 49 | - | ConfigOutput04aRead (Nominal current) | USINT | | • | | |
| 50 | - | ConfigOutput05aRead (Maximum current) | USINT | | • | | |
| Communication | | | | | | | |
| 0 | 0 | AbsPos01 | DINT | | | • | |
| 4 | 4 | MpGenControl01 | UINT | | | • | |
| 6 | 6 | MpGenMode01 | SINT | | | • | |
| 0 | 0 | AbsPos01ActVal | DINT | • | | | |
| 4 | 4 | MpGenStatus01 | UINT | • | | | |
| 6 | 6 | InputStatus | USINT | • | | | |
| 84 | - | Motoridentification01 | UINT | | • | | |
| 86 | - | RefPos01CyclicCounter | DINT | | • | | |
| 94 | - | RefPos01AcyclicCounter | DINT | | • | | |
| 90 | - | AbsPos1ActValAcyclic | DINT | | • | | |
| 80 | - | ControlReadback01 | UINT | | • | | |
| 82 | - | ModeReadback01 | SINT | | • | | |
| 98 | - | ErrorCode01 | UINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.25.8.15.5.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "Using I/O modules on the bus controller" on page 3789.

9.25.8.15.5.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.25.8.15.6 Register description: Function model "Standard", general registers**9.25.8.15.6.1 Configuration registers****Stall threshold**

Name:

ConfigOutput01

The SM module features integrated sensorless load measurement for the motor axis. This is especially useful for detecting a "stall condition" (e.g. if the motor moves to the end point during a homing procedure). It cannot be used for torque monitoring during dynamic movements.

With the "stall threshold" register, a threshold can be defined according to the motor load, and the module detects a stall condition started at this threshold (see "[Error status](#)" on page 2671).

This threshold value must be determined on a case-by-case basis, since the results of load measurement are influenced by a variety of factors.

- Motor speed: A higher speed results in higher measurement values
- Speeds that cause motor resonances (which interfere with load measurement) are to be avoided
- Motor accelerations that create a dynamic load (and also affect the measurement) should also be avoided
- It is especially important to be aware that mixed decay mode must be optimized for reliable stall detection (see "[Mixed decay threshold](#)" on page 2665)

The higher the load measurement value, the lower the load. This means that a stall condition is detected if the load measurement value drops below the trigger threshold for stall detection.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|---------------------------------------|--------|--|
| 0 - 2 | Trigger threshold for stall detection | 0 | Stall detection is disabled |
| | | 1 | Minimum sensitivity for stall detection |
| | | 2 to 6 | Setting the sensitivity of stall detection |
| | | 7 | Maximum sensitivity for stall detection |
| 3 - 15 | Reserved | 0 | |

Mixed decay threshold

Name:

ConfigOutput16

The mixed decay threshold is configured in this register. This value must be adjusted according to the motor being used, current and voltage when using [stall detection](#). Otherwise, the default value 15 will be used.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|-----------------------|---------|-----------------------------------|
| 0 - 3 | Mixed Decay Threshold | 0 | Mixed decay disabled |
| | | 1 to 14 | Setting for mixed decay threshold |
| | | 15 | Mixed decay always enabled |
| 4 - 15 | Reserved | - | |

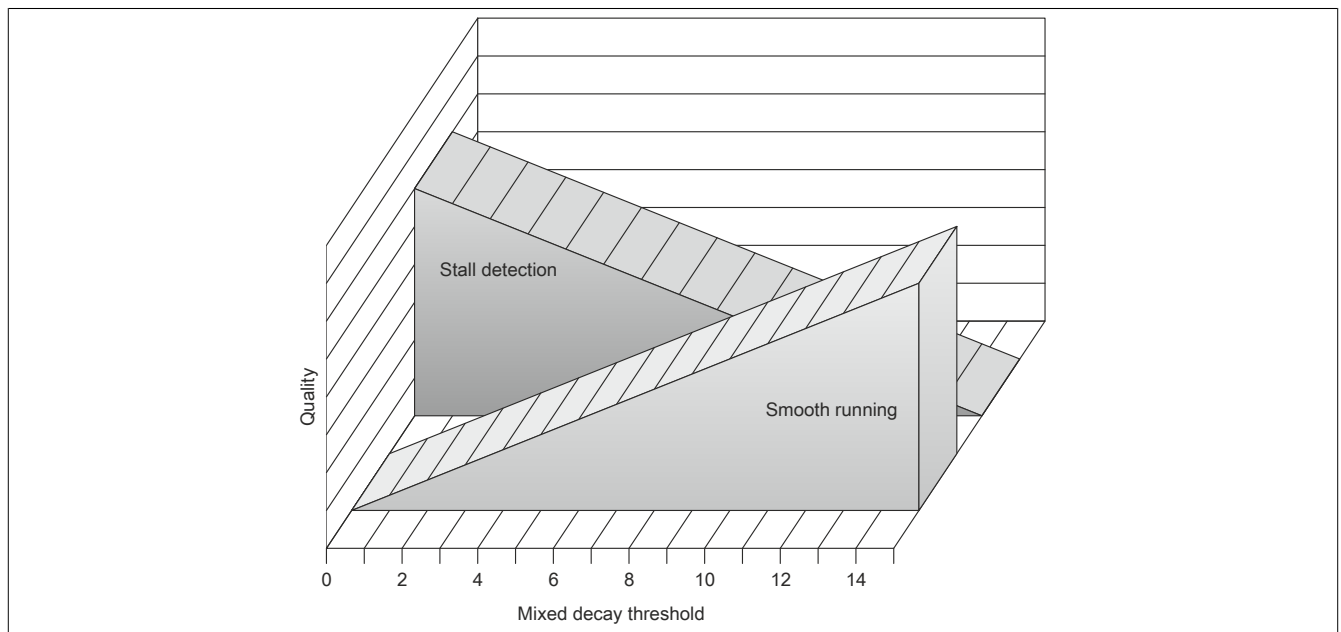
Mixed decay modules provide a greatly optimized sinusoidal current profile in the individual phases of the stepper motor, especially for fast current changes and low current values.

Mixed decay interferes with reliable stall detection, however. For this reason, mixed decay mode can be disabled during stall detection (motor load measurement) using the mixed decay threshold. The smaller the configured mixed decay threshold, the larger the range in which mixed decay is disabled while motor load measurement takes place.

Mixed decay mode is always enabled if the mixed decay threshold is set to 15.

Relationship between stall detection and mixed decay

Depending on the application and the motor used, satisfactorily smooth operation can be achieved while using stall detection by setting the mixed decay threshold to a value between 1 and 14. This is a compromise between smooth operation and stall detection quality and must be fine tuned during commissioning.



Minimum speed for stall detection

Name:

StallDetectMinSpeed01

If the motor speed exceeds the value set in this register, then stall detection is enabled and the configured [mixed decay threshold](#) is used. The value 15 is always used for the mixed decay threshold below this threshold value, and no stall error is reported. This means that mixed decay mode is always enabled at low speeds where stall detection principally does not work.

| Data type | Values | Information |
|-----------|-------------|------------------------------------|
| UINT | 0 to 65,535 | Minimum speed in steps per second. |

Full step threshold

Name:

FullStepThreshold01

This register configures a rotational speed. When this defined speed has been reached, the drive will automatically change from microsteps to full step mode. This makes it possible to optimize the torque at higher speeds, while microstep mode ensures optimal radial runout at lower speeds.

It does not make sense to change to full step mode at a standstill because fine positioning would then no longer be possible. This is why value "0" does not make sense in the full step threshold register and is interpreted as disabling full step mode (i.e. the motor will always be operated in microstep mode).

| Data type | Values | Information |
|-----------|-------------|-------------------------|
| UINT | 0 | Full step mode disabled |
| | 1 to 65,535 | Steps/second |

Example

Microstep mode should change to full step mode at 500 steps/second. On a motor with 200 steps per revolution, this would be equal to a speed of:

$$T^{-1} = \frac{500 \text{ steps/second}}{200 \text{ steps/revolution}} = 2.5 \frac{\text{revolutions}}{\text{second}} = 150 \text{ min}^{-1}$$

Holding current, nominal current and maximum current

Name:

ConfigOutput03 (holding current)

ConfigOutput04 (nominal current)

ConfigOutput05 (maximum current)

The holding current, nominal current and maximum current registers are used to configure the desired motor current.

Reasonable values are:

- Holding current < Nominal current < Maximum current

Information:

The maximum current must always be configured higher than the nominal current.

The motor's nominal current is entered in the nominal current register according to the motor's data sheet.

| Register | Description |
|-----------------|---|
| Nominal current | Current during normal operation |
| Maximum current | Should be selected if a higher motor torque is required briefly during acceleration phases. |
| Holding current | The holding current should be used in situations when less torque is required (e.g. at a standstill). This reduces the amount of heat generated by the motor. |

Switching between preset current values (holding current, rated current, maximum current):

| Function model | Switching between preset current values at runtime |
|---------------------------------------|--|
| Standard | Using bits 14 and 15 in registers "Motor StepX" on page 2672 |
| Standard with enabled SDC information | Using register "Motor current" on page 2677 |

| Data type | Values | Unit |
|-----------|----------|---|
| USINT | 0 to 120 | Percent of the module's rated current <ul style="list-style-type: none"> • 100% corresponds to the rated current of the motor bridge power unit listed in the technical data • 120% corresponds to the maximum current of the motor bridge power unit listed in the technical data. |

Counter configuration

Name:

ConfigOutput09

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------------|-------|--|
| 0 | ABR latch function | 0 | Negative edge: Disable ABR latch function |
| | | 1 | Positive edge: Enable ABR latch function. After a latch event has occurred, the latch function can be started again on a new rising edge. |
| 1 - 2 | Definition of the latch mode | 00 | ABR latch counter state unconditionally |
| | | 01 | ABR latch counter state on a positive edge of input R |
| | | 10 | ABR latch counter state on a negative edge of input R |
| | | 11 | Reserved |
| 3 | | 0 | <ul style="list-style-type: none"> • Position sync: Internal position counter • Position async: ABR counter state • Position latched sync: Internal position counter • Position latched async: ABR counter state |
| | | 1 | <ul style="list-style-type: none"> • Position sync: ABR counter state • Position async: Internal position counter • Position latched sync: ABR counter state • Position latched async: Internal position counter |
| 4 - 7 | Reserved | | |

1) These registers are not available in function model "Standard" with SDC information enabled.

Motor ID trigger

Name:

MotorIdentTrigger

With this register, a measurement of the motor ID can be initiated acyclically (see ["Motor identification" on page 2670](#)). The application must ensure that the conditions for measurement are met (see table "Notes" in register ["Motor identification" on page 2670](#)).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|---|
| 0 | | 0 | No effect |
| | | 1 | Positive edge triggers motor identifier measurement |
| 1 - 7 | Reserved | 0 | |

9.25.8.15.6.2 Registers for reading back the configuration

Reading back the holding current, nominal current and maximum current

ConfigOutput03Read (holding current)

ConfigOutput04Read (nominal current)

ConfigOutput05Read (maximum current)

These registers are used to read the respective current values in percent.

| Register | Description |
|-----------------|--|
| Nominal current | Current during operation at constant speed |
| Maximum current | Current during acceleration phases |
| Holding current | Current when motor is at standstill |

| Data type | Values | Unit |
|-----------|----------|---|
| USINT | 0 to 255 | Percentage of module's nominal current (100% corresponds to the nominal current of the motor bridge power unit in the technical data) |

9.25.8.15.6.3 Communication registers**Measuring motor load**

Name:
MotorLoad

Dieses Register enthält den aktuellen Lastmesswert der Stall Detection. Kann zum Abstimmen der Stall Detection verwendet werden.

| Data type | Values |
|-----------|---------|
| USINT | 0 bis 7 |

Module configuration 1

Name:
ConfigOutput02

The number of transfer values and the resolution of microsteps for the drive can be configured in this register.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|--|-------|---|
| 0 | The setting for these two bits determines the meaning of bits 2 and 3 in register "Input counter value" on page 2674. | x | |
| 1 - 2 | Reserved | 0 | |
| 3 - 4 | Number of transfer values per X2X Link cycle (see "Motor StepX" on page 2672) | 00 | 1 x $\Delta s / \Delta t$ (transfer values: MotorStep0) |
| | | 01 | 2 x $\Delta s / \Delta t$ (transfer values: MotorStep0 - MotorStep1) |
| | | 10 | 4 x $\Delta s / \Delta t$ (transfer values: MotorStep0 - MotorStep3) |
| | | 11 | Reserved |
| 5 - 6 | Resolution of microsteps for the following registers: <ul style="list-style-type: none"> "Motor StepX" on page 2672 "Position sync/async" on page 2669 | 00 | Resolution: 5 bits (bits 0 - 4) microsteps; 8 bits (bits 5 - 13) full steps |
| | | 01 | Resolution: 6 bits (bits 0 - 5) microsteps; 7 bits (bits 6 - 13) full steps |
| | | 10 | Resolution: 7 bits (bits 0 - 6) microsteps; 6 bits (bits 7 - 13) full steps |
| | | 11 | Resolution: 8 bits (bits 0 - 7) microsteps; 5 bits (bits 8 - 13) full steps |
| 7 - 15 | Reserved | 0 | |

Position sync/async

Name:

PositionSync

Positionasync

Depending on the [Counter configuration](#), these registers can be used to read either the internal position counter or the counter value on the ABR input.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

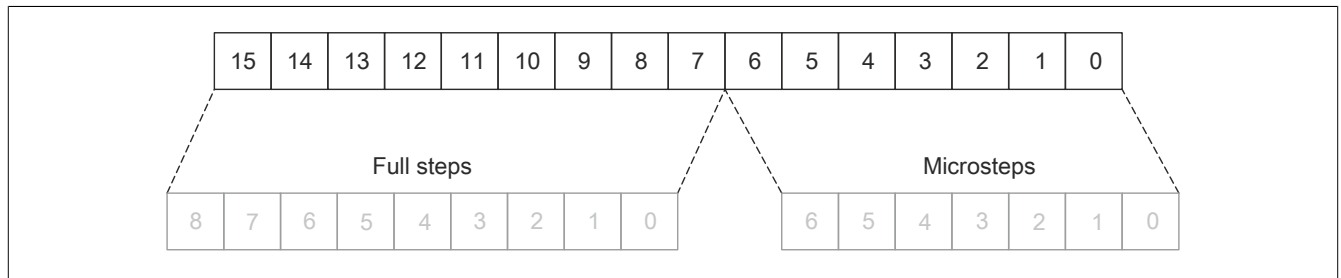
| Register | Counter configuration | |
|----------------|---------------------------|---------------------------|
| | Bit 3 = 0 | Bit 3 = 1 |
| Position sync | Internal position counter | ABR counter |
| Position async | ABR counter | Internal position counter |

Internal position counter

The internal position counter is the position calculated by the SM module (position setpoint). This is a cyclic 16-bit counter.

The lowest 5 to 8 bits represent microsteps, while the highest 8 to 11 bits represent full steps (depending on bits 5 and 6 of the ["Module configuration 1" on page 2668](#)). In function model "Standard" with SDC, this value is defined as **"8-bit microstep"** and cannot be changed.

Example of the internal position counter format (7-bit microsteps, i.e. set bit 5 and 6 of the module configuration to binary 10):



ABR counter

This counter is a cyclic 16-bit counter. The relationship between this counter and the internal position counter depends on the resolution of the ABR encoder and the microsteps defined for the internal position counter.

Motor identification

Name:

Motoridentification01

This register is used to identify the connected motor type for service purposes and to differentiate between motors in the application. After successful measurement, this register contains the time [µs] required to apply a current increase of $\Delta I = 1 \text{ A}$ to a motor winding.

This depends on:

- Operating voltage
- Inductance and resistance of the motor winding

| Notes | |
|-------|---|
| 1) | To achieve reproducible results, the measurement must be made under the following defined conditions: |
| a) | Motor is at standstill. |
| b) | The motor must be in a half-step position (phase A fully powered, phase B not powered). This means the internal position counter on the SM module must have a value that fulfills the following conditions: <ul style="list-style-type: none"> • Full steps are divisible by 4. • Microsteps = 0 |
| 2) | Condition 1b) is fulfilled after a the SM module is reset or switched on. Immediately afterwards, when the holding current is applied to the motor for the first time (at standstill), the duration for applying the current is measured. This is therefore a suitable time to read the motor identification register in the application. |
| 3) | The current range from approximately 1/3 of the nominal current up to the nominal current is used as operating range for determining the motor identifier. |

| Data type | Motor ID values | Explanation |
|-----------|-----------------|--|
| UINT | 0 | No motor identifier available (after switching on for as long as the measurement conditions are not met) |
| | 1 to 32767 | Valid range of values for the motor ID register (in µs) |
| | 65504 to 65519 | Ground fault: Measurement of motor identification not possible |
| | 65528 | Motor ID trigger not possible <ul style="list-style-type: none"> • Motor not supplied with current • Motor in movement • Nominal current set to 0 A • Ground fault present |
| | 65529 | Invalid value: Underflow |
| | 65530 | Overtemperature: Measurement not possible |
| | 65532 | Open circuit: Measurement not possible |
| | 65533 | Incorrect motor position: Measurement not possible |
| | 65534 | Invalid value: Overflow |
| | 65535 | Measurement in progress |

Ground fault detection

When the motor is powered on, a ground fault check is performed before motor identification. Error numbers have been added in the motor identification register for the event of a ground fault error (values 65504 to 65519 in the table above).

Error status

Name: The names of the bits are different depending on whether [SDC information](#) is enabled or disabled.

| Without SDC | With SDC |
|--------------------------------|---------------------|
| StallError | StallError01 |
| Overtemperature | Overtemperature01 |
| ErrorCurrentError | ErrorCurrentError01 |
| OvercurrentError | OvercurrentError01 |
| - | DrvOK01 |
| OpenCircuit01 to OpenCircuit04 | |

The current error status of the drive is indicated in this register. Each bit indicates a certain error or status. If an error is registered in bits 0 to 3, then the corresponding bit remains set until the error has been acknowledged (see ["Module configuration 2" on page 2675](#) and ["Error acknowledgment" on page 2678](#)).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|---|-------|---|
| 0 | StallError(01) | 0 | No stall |
| | | 1 | Stall |
| 1 | Overtemperature error OvertemperatureError(01) | 0 | No overtemperature |
| | | 1 | Overtemperature |
| 2 | Current error CurrentError(01) | 0 | No current error |
| | | 1 | Current error |
| 3 | Overcurrent error OvercurrentError(01) | 0 | No overcurrent |
| | | 1 | Overcurrent |
| 4 | Status of the drive DrvOk0 ¹⁾ | 0 | An error was triggered for the motor axis |
| | | 1 | The drive is running error-free |
| 5 - 15 | Reserved | 0 | |

1) Only when SDC information is enabled

Overtemperature error

The "Overtemperature" error bit can be set for the following reasons:

- A specific temperature was exceeded near the channel due to overload
- The module temperature rises above the 85°C.

Current error

This error bit occurs whenever the required current cannot be supplied to the motor windings. This can be (but is not necessarily) caused by an open circuit. At higher speeds (depending on the motor), this error can also occur without an open circuit. In this case it is simply no longer possible to supply the desired current to the motor windings. Because of the Back-EMF on the motor, this bit is set at slightly lower speeds if the motor is operated with no load compared with full or partial loads.

Overcurrent error

Overcurrent occurs if the motor current measured in the motor windings is twice as high as it should be (e.g. short circuit).

Status of the drive

The status of the drive is only shown when SDC information is enabled. The drive bit is 1 when the following conditions are met:

- Motor turned on (see ["Motor current" on page 2677](#))
- Ground fault detection is completed and OK
- MotorID measurement is completed
- Motor is supplied with current
- Motor settling time has passed
- Supply voltage is in the valid range
- No overtemperature fault
- Preset position value is valid (see ["SDC life sign monitoring" on page 2677](#))

9.25.8.15.7 Register description: Function model "Standard" without SDC information

9.25.8.15.7.1 Communication registers

Motor StepX

Name:

MotorStep0 to MotorStep3

These registers specify the number and direction of steps that must be moved by the module during the next X2X cycle and also select the motor current (see also "[Holding current, nominal current and maximum current](#)" on page 2666).

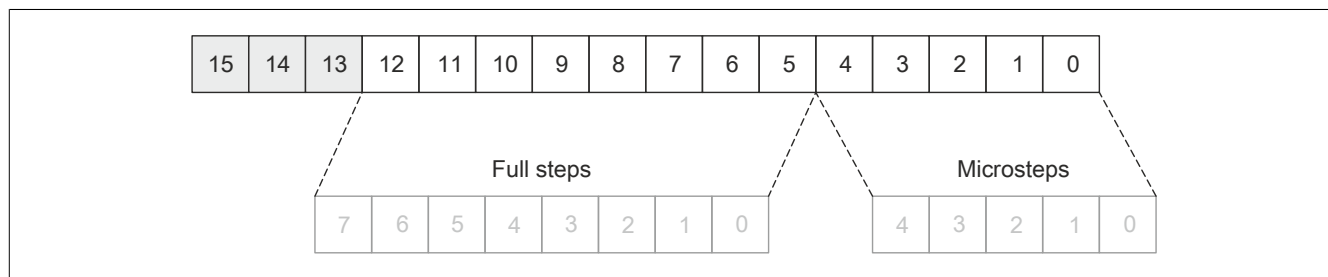
| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|--|-------|-------------------|
| 0 - 12 | Number of steps for the module to move during the next X2X cycle | x | |
| 13 | Direction of movement | 0 | Positive |
| | | 1 | Negative |
| 14 - 15 | Selection of motor current | 00 | Motor not powered |
| | | 01 | Holding current |
| | | 10 | Nominal current |
| | | 11 | Maximum current |

Depending on the necessary resolution and maximum configurable speed, module configuration 1 can be used to specify which bit position is used as the 1s position for full steps (see bits 5 and 6 of "[Module configuration 1](#)" on page 2668).

Example for 5-bit microsteps (set bits 5 and 6 of the module configuration to binary 00):



The number of transfer values per X2X cycle is specified by bits 3 and 4 in the module configuration 1 (see "[Module configuration 1](#)" on page 2668). If only one transfer value (bits 3 and 4 = 00) is specified, then the motor is advanced by MotorStep0 until the next X2X cycle. If 2 or 4 transfer values are specified, then the X2X cycle is divided accordingly.

Example: X2X cycle = 1 ms (1000 μ s)

| Time | Number of transfer values (see " Module configuration 1 " on page 2668) | | |
|---------------------|---|---------------------|---------------------|
| | 1 (bits 3 - 4 = 00) | 2 (bits 3 - 4 = 01) | 4 (bits 3 - 4 = 10) |
| 0 - 250 μ s) | MotorStep0 | MotorStep0 | MotorStep0 |
| 250 - 500 μ s) | | | MotorStep1 |
| 500 - 750 μ s) | MotorStep1 | MotorStep1 | MotorStep2 |
| 750 - 1000 μ s) | | | MotorStep3 |

Position latched sync-async

Name:

PositionLatchedSync

PositionLatchedASync

The position counter (internal position counter or ABR counter) is applied at the latch event (see "Module configuration 2" on page 2675). Bits 3 and 7 of register "Counter configuration" on page 2667 are used to determine which counter state (internal position counter or ABR encoder) should be saved in registers "Position latched sync" and "Position latched async".

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

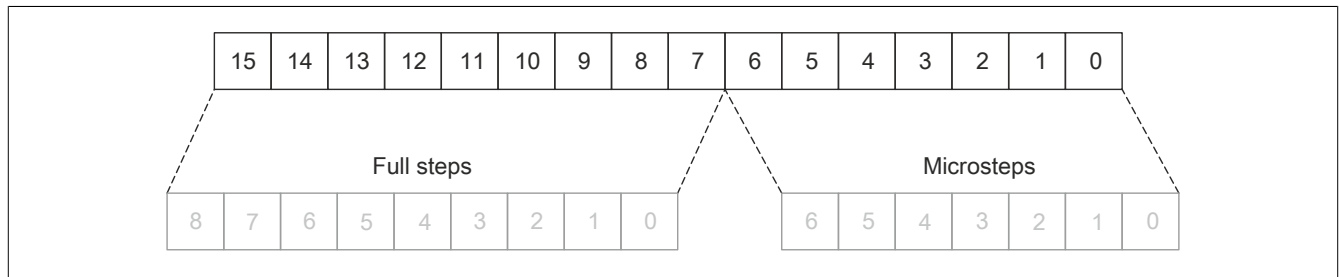
| Register | Counter configuration | |
|----------------|---------------------------|---------------------------|
| | Bit 3 = 0 | Bit 3 = 1 |
| Position sync | Internal position counter | ABR counter |
| Position async | ABR counter | Internal position counter |

Internal position counter

The internal position counter is the position calculated by the module (position setpoint). This is a cyclic 16-bit counter.

The lowest 5 to 8 bits represent microsteps, while the highest 8 to 11 bits represent full steps (depending on bits 5 and 6 of the "Module configuration 1" on page 2668).

Example of the internal position counter format (7-bit microsteps, i.e. set bit 5 and 6 of the module configuration to binary 10):



ABR counter

This counter is a cyclic 16-bit counter. The relationship between this counter and the internal position counter depends on the resolution of the ABR encoder and the microsteps defined for the internal position counter.

usSinceTrigger

Name:

usSinceTrigger

This register indicates the time in μs that has passed since the trigger event occurred (see "Module configuration 2" on page 2675).

Information:

The absolute accuracy of the trigger can be delayed up to 5 μs due to the input filter of the digital inputs.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

Stepper latch trigger status

Name:

LatchInput

LatchDone

TriggerInput

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------|-------|---|
| 0 | Latch input: | x | Digital input for the latch event (level) |
| 1 | LatchDone | x | Changes its state each time the counter state is successfully latched (reset value = 0) |
| 2 - 3 | Reserved | - | |
| 4 | TriggerInput | x | Trigger input (level) |
| 5 - 7 | Reserved | 0 | |

9.25.8.15.7.2 Input counter value

Name:

ModulePowerSupplyError

StatusInput01 to StatusInput04

This register indicates the state of the digital inputs and counters.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------|---|--|
| 0 | ModulePowerSupplyError | 0 | OK |
| | | 1 | Module power supply error |
| 1 | Reserved | 0 | |
| 2 | StatusInput01 | If bit 0 in Module configuration 1 = 0 | |
| | | 0 or 1 | Input state - Digital input 1 |
| | | If bit 0 in Module configuration 1 = 1 | |
| | | x | Ref toggle bit for counter 1: The state of this bit is changed after homing is completed. |
| 3 | StatusInput02 | If bit 0 in Module configuration 1 = 0 | |
| | | 0 or 1 | Input state - Digital input 2 |
| | | If bit 0 in Module configuration 1 = 1 | |
| | | 0 | The homing procedure for the ABR counter is active. |
| | | 1 | The homing procedure of the ABR counter is completed. |
| 4 | StatusInput03 | 0 or 1 | Input state - Digital input 3 |
| 5 | StatusInput04 | 0 or 1 | Input state - Digital input 4 |
| 6 - 7 | Reserved | 0 | |

9.25.8.15.7.3 Configuration registers

Module configuration 2

Name:
 StartLatch
 TriggerEdgePos
 TriggerEdgeNeg
 StartTrigger
 TriggerEdge
 ClearError

The trigger functions for the stepper motor can be configured with this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|---|
| 0 | Latch function for stepper motor 2 Latch byte | 0 | The latch function for stepper motor position is disabled on the negative edge of this bit. |
| | | 1 | The latch function for stepper motor position is disabled on the positive edge of this bit. |
| 1 - 2 | Latch mode for stepper motor TriggerEdgePos (bit 1) TriggerEdgeNeg (bit 2) | 00 | Latch position of stepper motor unconditional |
| | | 01 | Latch position of stepper motor on positive edge of input DI 3 |
| | | 10 | Latch position of stepper motor on negative edge of input DI 3 |
| | | 11 | Reserved |
| 3 | TriggerEdge | 0 | Trigger edge (input DI 4) = Positive |
| | | 1 | Trigger edge (input DI 4) = Negative |
| 4 | Enable trigger (on change) StartTrigger | x | |
| 5 | ClearError | 0 | No effect |
| | | 1 | Error acknowledgment for motor (for more information, see "Error status" on page 2671) |
| 6 - 7 | Reserved | - | |

Trigger function procedure:

- Selection of the desired trigger edge using bit 3
- Enabling of the trigger function by changing the state of bit 4. Changing this bit deletes `usSinceTrigger` (μ s counter).
- When the trigger event occurs, μ s counter `usSinceTrigger` is started.
- Counter `usSinceTrigger` cannot overflow, i.e. the counter is stopped at $2^{16} - 1$ and retains this value until the next time the trigger function is enabled.

The trigger function can be re-enabled at any time by changing the state of bit 4, regardless of whether a trigger event has occurred or if `usSinceTrigger` has reached the maximum value.

Position sync 2

Name:
 PositionSync02

This register contains the state of either the position counter or the ABR counter depending on [Counter configuration](#) (bit 3). It behaves exactly complementary to register "Position sync" on page 2669.

If "Position sync" contains the position counter, then register "PositionSync02" contains the ABR counter state, and vice versa.

By default, the register is not visible in the I/O map; it must first be enabled in the I/O configuration.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

9.25.8.15.8 Register description: Function model "Standard" with SDC information

9.25.8.15.8.1 Configuration registers

SDC configuration

Name:
SDCConfig01

This register can be used to enable/disable additional SDC information.

The additional cyclic registers are hidden or shown depending on whether SDC information is disabled or enabled. Compare the two variants of function model "Standard" [with](#) and [without enabled SDC information](#).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|----------------------|
| 0 | Trigger edge | 0 | Rising trigger edge |
| | | 1 | Falling trigger edge |
| 1 - 5 | Reserved | 0 | |
| 6 | SDC life sign monitoring | 0 | Disabled |
| | | 1 | Enabled |
| 7 | SDC information ¹⁾ | 0 | Disabled |
| | | 1 | Enabled |

- 1) When the "SDC information" bit is enabled, the "EncOK01" bit is shown in the Automation Studio I/O mapping. This bit is linked to the ModulOK bit and always indicates its value.

Information:

Neither SDC information nor SDC life sign monitoring is permitted to be changed at runtime.

Module configuration 1 with SDC

Register "[Module configuration 1](#)" on [page 2668](#) is ignored in function model "Standard" with SDC information enabled. The module behaves as follows, i.e. whether the module configuration was written in this way:

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|--|-------|---|
| 0 | Meaning of bits 2 and 3 in register " Input counter value " on page 2678 | | |
| 1 - 2 | Reserved | 0 | |
| 3 - 4 | Number of transfer values per X2X cycle | 00 | 1x Δs / Δt (transfer values: motor settings Motor1Step0) |
| 5 - 6 | Resolution of microsteps | 11 | 8-bit microsteps |
| 7 - 15 | Reserved | 0 | |

Motor settling time

Name:
MotorSettlingTime01

This register determines the motor setting time. The motor settling time determines the minimum time between when the motor is powered on to when the DrvOk bit is set (see "[Error status](#)" on [page 2671](#)). The setting is made in steps of 10 ms.

| Data type | Values | Information |
|-----------|----------|---------------------------------|
| USINT | 1 to 255 | 10 ms to 2.55 s, default: 10 ms |

Switch-off delay

Name:
DelayedCurrentSwitchOff01

If the [SDC life sign monitoring](#) is triggered (i.e. the [NetTime timestamp](#) is in the past) the motor is decelerated at nominal current with speed setpoint = 0.

Then the motor is switched off after the delay configured with this register.

| Data type | Values | Information |
|-----------|----------|--|
| USINT | 0 to 255 | 0 to 25.5 s in steps of 100 ms (default: 100 ms) |

9.25.8.15.8.2 Communication registers

SDC life sign monitoring

Name:

SetTime01

The module uses SDC life sign monitoring to check whether valid values have been received for the speed setpoint.

SDC life sign monitoring is enabled in register "SDC configuration" on page 2676 by setting bit 6 (SDCSetTime = On).

If the specified [NetTime timestamp](#) is in the past, then an error is triggered for the motor axis (only when the motor is switched on). The module performs the following steps:

- 1) The CPU is informed of the error using the Drive bit (DrvOk) = 0
- 2) Braking at configured nominal current with speed setpoint = 0
- 3) Wait for configured turn-off delay to expire
- 4) Power off motor

When the timestamp is back within the valid range, the motor can be operated again by a rising edge on bit "DriveEnable" (see "[Motor current](#)" on page 2677) .

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

Motor current

Name:

DriveEnable01

BoostCurrent01

StandstillCurrent01

Bits 0 to 2 of this register control the motor's current feed.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------------|-------|-----------------|
| 0 | DriveEnable01 | x | Motor powered |
| 1 | BoostCurrent01 | x | Maximum current |
| 2 | StandstillCurrent01 | x | Holding current |
| 3 - 7 | Reserved | 0 | |

The possible status of bits 0 to 2

| StandstillCurrent01 | BoostCurrent01 | DriveEnable01 | Description |
|---------------------|----------------|---------------|-----------------------------------|
| x | x | 0 | Motor not supplied with current |
| 0 | 0 | 1 | Rated current supplied to motor |
| 0 | 1 | 1 | Maximum current supplied to motor |
| 1 | 0 | 1 | Holding current supplied to motor |
| 1 | 1 | 1 | Holding current supplied to motor |

Lifecycle counter

Name:

LifeCnt

This register is incremented by one with each X2X Link cycle.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

Input counter value

Name:

ModulePowerSupplyError

StatusInput01 to StatusInput04

This register indicates the state of the digital inputs and counters.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------|---|--|
| 0 | ModulePowerSupplyError | 0 | OK |
| | | 1 | Module power supply error |
| 1 | Reserved | 0 | |
| 2 | StatusInput01 | If bit 0 in Module configuration 1 = 0 | |
| | | 0 or 1 | Input state - Digital input 1 |
| | | If bit 0 in Module configuration 1 = 1 | |
| | | x | Ref toggle bit for counter 1: The state of this bit is changed after homing is completed. |
| 3 | StatusInput02 | If bit 0 in Module configuration 1 = 0 | |
| | | 0 or 1 | Input state - Digital input 2 |
| | | If bit 0 in Module configuration 1 = 1 | |
| | | 0 | The homing procedure for the ABR counter is active. |
| | | 1 | The homing procedure of the ABR counter is completed. |
| 4 | StatusInput03 | 0 or 1 | Input state - Digital input 3 |
| 5 | StatusInput04 | 0 or 1 | Input state - Digital input 4 |
| 6 - 7 | Reserved | 0 | |

Error acknowledgment

Name:

ClearError01

This register can be used to acknowledge errors that have occurred on the motor.

For more info, see ["Error status" on page 2671](#).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------|-------|--------------------------------|
| 0 - 4 | Reserved | 0 | |
| 5 | ClearError01 | 0 | No effect |
| | | 1 | Error acknowledgment for motor |
| 6 - 7 | Reserved | 0 | |

Motor1Step0

Name:

Motor1Step0

This registers is used to specify the number and direction of steps that should be carried out by the module during the next X2X cycle.

The value is specified with a resolution of 1/256 of a full step (corresponds to 8-bit microsteps).

The direction of movement is derived from the value's sign:

| Data type | Values | Information |
|-----------|--------|--|
| INT | >0 | Movement in the positive direction in 1/256 full steps |
| | <0 | Movement in the negative direction in 1/256 full steps |

Unlike function model "Standard" without enabled SDC information, the motor current is selected using a separate register (see register ["Motor current" on page 2677](#)).

Home position

Name:

RefPulsePos01

These 2 registers have the following contents:

| Register | Description |
|--|--|
| Home position of the internal position counter | This register contains the home position of the internal position counter. |
| Home position for the ABR counter | This register contains the home position of the ABR counter. |

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

Setting "Position sync" in the Automation Studio I/O configuration can be used to select which of the 2 registers is addressed by variable RefPulsePos01.

| Variables in Automation Studio | I/O configuration, counter 01, option "Position sync" | |
|--|---|---|
| | Stepper counter 01 is indicated on ActPos01 . | ABR counter 01 is indicated on ActPos01 . |
| RefPulsePos01 | Home position of the internal position counter | Home position of the ABR counter |
| Option "Position sync" for counter 1 also sets bit 3 in register " Counter configuration " on page 2667: | | |
| Bit 3 (counter 1) | 0 | 1 |

Reference pulse counter

Name:

RefPulseCnt01

These 2 registers have the following contents:

| Register | Description |
|---|---|
| Reference pulse counter for the internal position counter | The reference pulses of the internal position counter are counted in this register. |
| Reference pulse counter for the ABR counter | The reference pulses of the ABR counter are counted in this register. |

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

Setting "Position sync" in the Automation Studio I/O configuration can be used to select which of 2 registers is addressed by variable RefPulsePos01.

| Variables in Automation Studio | I/O configuration, counter 01, option "Position sync" | |
|--|---|---|
| | Stepper counter 01 is indicated on ActPos01 . | ABR counter 01 is indicated on ActPos01 . |
| RefPulseCnt01 | Reference pulse counter for the internal position counter | Reference pulse counter of the ABR counter |
| Option "Position sync" for counter 1 also sets bit 3 in register " Counter configuration " on page 2667: | | |
| Bit 3 (counter 1) | 0 | 1 |

NetTime of the position value

Name:

ActTime01

This register contains the NetTime of the most recent valid position value.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

Trigger counter

Name:

TriggerCnt01

This register contains a cyclic counter that is incremented with each trigger event.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

Trigger timestamp

Name:

TriggerTime01

This register contains the NetTime instant of the most recent trigger event. The trigger edge must be configured in register "[SDC configuration](#)" on page 2676.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

Information:

The absolute accuracy of the trigger can be delayed up to 5 µs due to the input filter of the digital inputs.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

9.25.8.15.9 Register description: Function model 254 - "Bus controller" and function model 3 - "Ramp"

9.25.8.15.9.1 Configuration registers

Holding current, nominal current and maximum current

Name:

ConfigOutput03a (holding current)

ConfigOutput04a (nominal current)

ConfigOutput05a (maximum current)

The holding current, nominal current and maximum current registers are used to configure the desired motor current.

Reasonable values are:

- Holding current < Nominal current < Maximum current

The motor's nominal current is entered in the nominal current register according to the motor's data sheet.

| Register | Description |
|-----------------|---|
| Nominal current | Current during operation at constant speed |
| Maximum current | Current during acceleration phases. In the mode " Referencing during stall ", the rated current is always used instead of the maximum current, even in acceleration phases. |
| Holding current | Current when motor is at standstill |

When the current changes to a weaker value (e.g. when transitioning from the acceleration phase to the constant speed mode), the stronger current is maintained for an additional 100 ms. The following priority applies regardless of the values actually set: maximum current before nominal current before holding current.

| Data type | Values | Unit |
|-----------|----------|---|
| USINT | 0 to 120 | Percent of the module's rated current <ul style="list-style-type: none"> • 100% corresponds to the rated current of the motor bridge power unit listed in the technical data • 120% corresponds to the maximum current of the motor bridge power unit listed in the technical data. Bus controller default setting: 0 |

Full step threshold

Name:

FullStepThreshold01

Starting with the speed specified in this register, the motor is operated in full step mode; it is operated in microstep mode below it.

| Data type | Values | Information |
|-----------|------------|---|
| UINT | 1 to 65534 | Speed in microsteps/cycle. Bus controller default setting: 0 |
| | 65535 | Motor is always operated in microstep mode |

Maximum speed

Name:
MaxSpeed01pos

This register defines the maximum speed for the absolute positioning modes (1, -123, -124, -125, -126).

Information:

The setting does not apply to the speed and homing modes (2, -127, -128).

| Data type | Values | Information |
|-----------|-------------|---|
| UINT | 0 to 65,535 | Speed in microsteps/cycle. Bus controller default setting: 0 |

Maximum acceleration

Name:
MaxAcc01

This register defines the maximum acceleration. (also applies for homing modes).

| Data type | Values | Information |
|-----------|-------------|--|
| UINT | 0 to 65,535 | Acceleration in microsteps/cycle ² . Bus controller default setting: 0 |

Maximum deceleration

Name:
MaxDec01

This register defines the maximum deceleration. (also applies for homing modes).

| Data type | Values | Information |
|-----------|-------------|--|
| UINT | 0 to 65,535 | Brake deceleration in microsteps/cycle ² . Bus controller default setting: 0 |

Reversing loop

Name:
RevLoop01

This parameter is only used in modes 1, -123, -124, -125, -126 (absolute positioning modes).

If the value for the reversing loop is not equal to 0, the target position is approached directly when coming from one direction; when coming from the other direction, the target position is initially overshoot by the configured number of steps before finally moving to the target position. This ensures that the target position is always approached from the same direction (to avoid mechanical backlash).

The sign of the defined value determines the direction in which the reversing loop runs.

| Sign | Effective direction |
|----------|--|
| Positive | Reversing loop in positive direction of movement |
| Negative | Reversing loop in negative direction of movement |

| Data type | Values | Information |
|-----------|-----------------|-----------------------------------|
| INT | -32768 to 32767 | Bus controller default setting: 0 |

Fixed position A

Name:
FixedPos01a

This register defines the position to move to in modes -124 (if the digital input is set to 1) and -125.

| Data type | Values | Information |
|-----------|------------------------------------|-----------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: 0 |

Fixed position B

Name:
FixedPos01b

This register defines the position to move to in modes [-124](#) (if the digital input is set to 0) and [-126](#).

| Data type | Values | Information |
|-----------|------------------------------------|-----------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: 0 |

Homing speed

Name:
RefSpeed01

This register sets the speed for homing modes [-127](#) and [-128](#).

| Data type | Values | Information |
|-----------|-------------|---|
| UINT | 0 to 65,535 | Speed in microsteps/cycle. Bus controller default setting: 0 |

Stall recognition delay

Name:
StallRecognitionDelay01

The value in this register is only relevant for [Referencing during stall](#).

A stall is only detected after the time specified here has expired and after the homing procedure has started.

For example, a setting of 4 (and a cycle time of 25 ms) means that a stall will not be detected until 100 ms after the motor starts moving (start of the homing procedure).

Set to 0 to eliminate delay.

| Data type | Values | Information |
|-----------|----------|---|
| USINT | 0 to 255 | In cycles, see " General configuration " on page 2684. Bus controller default setting: 0 |

Minimum speed for stall detection

Name:
StallDetectMinSpeed01

If the motor speed exceeds the value set in this register, then stall detection is enabled and the configured [mixed decay threshold](#) is used. The value 15 is always used for the mixed decay threshold below this threshold value, and no stall error is reported. This means that mixed decay mode is always enabled at low speeds where stall detection principally does not work.

| Data type | Values | Information |
|-----------|-------------|---|
| UINT | 0 to 65,535 | Minimum speed in microsteps per cycle. Bus controller default setting: 0 |

Jerk time

Name:
JoltTime01

If a value other than 0 is assigned to this register, then jerk limitation is performed. This is done by averaging the values for the steps to be carried out (speed setpoint) in each cycle using a FIFO buffer. The jerk time corresponds to the number of FIFO elements (0 to 80). If a value greater than 80 is entered, then it will be limited internally to 80.

Changes made while a motor is running will be applied as soon as ...

- The motor has reached the set position (positioning mode only).
- The motor has stopped (all modes).

| Data type | Values | Information |
|-----------|-----------------------|---|
| USINT | 0 | No jerk limitation time. Bus controller default setting: 0 |
| | 1 to 80 ¹⁾ | Number of FIFO elements |

1) Starting with upgrade 1.3.1.0 (firmware version 16), for older versions: 16

Homing configuration

Name:
RefConfig01

The homing mode can be set with this register.

| Data type | Values | Information |
|-----------|------------|--|
| USINT | -120 | Set home position |
| | -121 | Homing on positive edge of input DI 4 |
| | -122 | Homing on falling edge of input DI 4 |
| | -125 | Homing on positive edge of input DI 3 (R pulse). Bus controller default setting |
| | -126 | Homing on negative edge of input DI 3 (R pulse) |
| | -127 | Homing during stall detection |
| | -128 | Immediate homing |
| | All others | No effect |

Stall detection configuration / Mixed decay

Name:
StallDetectConfig01

The mixed decay threshold and stall detection sensitivity can be configured in this register.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------|---------|---|
| 0 - 3 | Mixed decay threshold | 0 | Mixed decay disabled (bus controller default setting) |
| | | 1 to 14 | Setting for mixed decay threshold |
| | | 15 | Mixed decay always enabled |
| 4 - 6 | Stall threshold | 0 | Stall detection is disabled (bus controller default setting) |
| | | 1 to 6 | Steps involved in setting stall detection sensitivity |
| | | 7 | Maximum sensitivity for stall detection |
| 7 | Motor load | 0 | Motor load value not shown (bus controller default setting) |
| | | 1 | Show value in register "Status word" on page 2692 ¹⁾ |

1) If this bit is 1, then the motor load value is shown in bits 13 to 15 of the status word register (otherwise these bits are 0). This value can help when testing the stall detection and the [Home during stall](#) mode.

Stall threshold

The SM module features integrated sensorless load measurement for the motor axis. This is especially useful for detecting a "stall condition" (e.g. if the motor moves to the end point during a homing procedure). It cannot be used for torque monitoring during dynamic movements.

The "stall threshold" (bits 4 to 6 of this register) can be used to define a threshold value for each axis individually according to the motor load, beyond which the motor will detect a stall condition.

This threshold value must be determined on a case-by-case basis, since the results of load measurement are influenced by a variety of factors.

- Motor speed: A higher speed results in higher measurement values
- Speeds that cause motor resonances (which interfere with load measurement) are to be avoided
- Motor accelerations that create a dynamic load (and also affect the measurement) should also be avoided
- It is especially important to be aware that mixed decay mode must be optimized for reliable stall detection.

The higher the load measurement value, the lower the load. This means that a stall condition is detected if the load measurement value drops below the trigger threshold for stall detection.

Mixed decay threshold

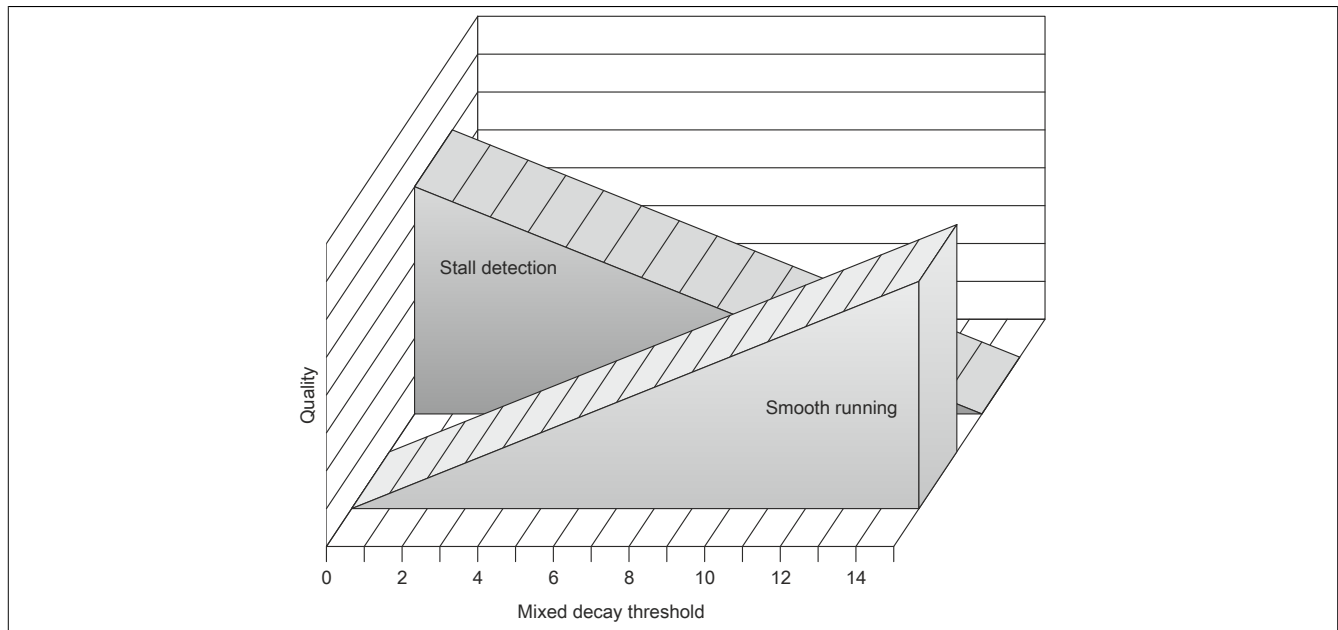
Mixed decay modules provide a greatly optimized sinusoidal current profile in the individual phases of the stepper motor, especially for fast current changes and low current values.

Mixed decay interferes with reliable stall detection, however. For this reason, mixed decay mode can be disabled during stall detection (motor load measurement) using the mixed decay threshold. The smaller the configured mixed decay threshold, the larger the range in which mixed decay is disabled while motor load measurement takes place.

Mixed decay mode is always enabled if the mixed decay threshold is set to 15.

Relationship between stall detection and mixed decay

Depending on the application and the motor used, satisfactorily smooth operation can be achieved while using stall detection by setting the mixed decay threshold to a value between 1 and 14. This is a compromise between smooth operation and stall detection quality and must be fine tuned during commissioning.



General configuration

Name:

GeneralConfig01

Bit 0 of this register can be used to switch the positioning mode. This register can also be used to configure the cycle time of the motion profile generator.

- 0: "Mode 1: Position mode" without extended control word
- 1: "Mode 1: Position mode with extended control word"

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|--|
| 0 | Position mode | 0 | Without extended control word (bus controller default setting) |
| | | 1 | With extended control word |
| 1 - 2 | Cycle time of the motion profile generator ¹⁾ | 00 | 25 ms (bus controller default setting) |
| | | 01 | 10 ms |
| | | 10 | 5 ms |
| | | 11 | Reserved |
| 3 - 7 | Reserved | 0 | |

1) This parameter is supported starting with upgrade 1.3.1.0 (firmware version 16).

The cycle time for the motion profile generator is configured with this cycle. This cycle time affects the unit for specifying the speed and acceleration:

- Unit for speed: Microsteps/Cycle
- Unit for acceleration: Microsteps/Cycle²

Limit switch configuration

Name:

LimitSwitchConfig01

This register configures the behavior of the limit switches.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------|-------|---|
| 0 - 1 | Negative limit switch | 00 | Switched off (bus controller default setting) |
| | | 01 | Active if low |
| | | 10 | Reserved |
| | | 11 | Active if high |
| 2 - 3 | Positive limit switch | 00 | Switched off (bus controller default setting) |
| | | 01 | Active if low |
| | | 10 | Reserved |
| | | 11 | Active if high |
| 4 - 6 | Reserved | 0 | |
| 7 | Direction monitoring | 0 | Off (bus controller default setting) |
| | | 1 | On |

Negative/Positive limit switch:

When one of the limit switches is reached, a warning is triggered and the speed is decelerated to 0. There is no state change of "Device control state machine". This keeps current flowing to the motor.

The error that occurred can be read from the error code register. Normal operation can be resumed by acknowledging the warning. This will not restrict motor movement to a specific direction and the limit switch will not be triggered until the next active edge.

Overshooting the limit switch while braking

The limit switches are not linked with the corresponding direction of movement. If the limit switch is exceeded, another error will be triggered when reversing after acknowledging the initial error.

Direction monitoring

If this function is enabled, then the two limit switches will be linked with the respective direction of movement. This means that the negative limit switch is only triggered in the negative and the positive limit switch only in the positive direction of movement (specified direction).

This prevents specifying a movement in the wrong direction when direction monitoring is enabled and limit switches are active.

Warning!

If the motor is wired incorrectly with this configuration (wrong direction of movement), then the limit switch will not be triggered and the actual correct direction of movement will be denied. This will also be the case when the limit switch connections are reversed.

Software limit

Name:

PositionLimitMin01

PositionLimitMax01

This register configures software limits. The function is enabled if at least one of the two registers is not equal to zero.

These limits are effective in all positioning modes. Position overflow is not possible when this function is enabled. Movement is always contained within the two limits.

If a position is specified that violates the minimum/maximum software limit, the "Internal limit active" bit will be set in the "Status word" on page 2692 register. The motor movement will be stopped until a position is specified within the limits.

Bit "Internal limit active" will also be set in register "Status word" if incorrectly configured (minimum > maximum).

| Data type | Values | Information |
|-----------|------------------------------------|-----------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: 0 |

Information:

The software limits will only be monitored when using the following CANopen bus controllers:

- X20BC0043-10
- X20BC0143-10
- X67BC4321-10
- X67BC4321.L08-10
- X67BC4321.L12-10

9.25.8.15.9.2 Reading back the configuration

Reading back the holding current, nominal current and maximum current

ConfigOutput03aRead (holding current)

ConfigOutput04aRead (nominal current)

ConfigOutput05aRead (maximum current)

These registers are used to read the respective current values in percent.

| Register | Description |
|-----------------|--|
| Nominal current | Current during operation at constant speed |
| Maximum current | Current during acceleration phases |
| Holding current | Current when motor is at standstill |

| Data type | Values | Unit |
|-----------|----------|---|
| USINT | 0 to 255 | Percentage of module's nominal current (100% corresponds to the nominal current of the motor bridge power unit in the technical data) |

9.25.8.15.9.3 Communication registers

Set position/speed

Name:

AbsPos01

This register is used to set position or speed, depending on the operating mode.

- Position mode (see "Mode" on page 2687): Cyclic setting of the position setpoint in microsteps. In this mode, one micro-step is always 1/256 full-step.
- Speed mode (see "Mode" on page 2687): In this mode, this register is considered a signed speed setpoint.

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

Control word

Name:

MpGenControl01

This register can be used to issue commands based on the module's state (see ["Operating function model "Ramp" on page 2695](#)).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|------------------------|-------|--|
| 0 | Switch on | x | |
| 1 | Enable voltage | x | |
| 2 | Quick stop | x | |
| 3 | Enable operation | x | |
| 4 - 6 | Mode-specific | x | |
| 7 | Fault reset | x | |
| 8 | Stop ¹⁾ | x | |
| 9 - 10 | Reserved | 0 | |
| 11 | Motor ID trigger | 0 | No effect |
| | | 1 | Rising edge: Motor ID trigger ²⁾ |
| 12 | Warning reset | 0 | No effect |
| | | 1 | Rising edge: Reset warnings |
| 13 | Undercurrent detection | 0 | Disable current error detection (default) |
| | | 1 | Enable current error detection |
| 14 | ABR counter sync/async | 0 | Default: <ul style="list-style-type: none"> Internal position counter, cyclic ABR counter, acyclic |
| | | 1 | <ul style="list-style-type: none"> Internal position counter, acyclic ABR counter, cyclic |
| 15 | Stall detection | 0 | Disable stall detection (default) |
| | | 1 | Enable stall detection |

1) The "Stop" bit is only evaluated when the extended control word is enabled (see ["General configuration" on page 2684](#)).

2) This bit can be used to trigger a measurement of the motor ID. Keep in mind that the application must ensure that the conditions for measurement are fulfilled (see table in the ["Motor identification" on page 2693](#) register).

Mode

Name:

MpGenMode01

| Data type | Values | Information |
|-----------|--------|---|
| SINT | 0 | No mode selected |
| | 1 | Depending on bit 0 in the "General configuration" on page 2684 register, the position mode will behave as follows: <ul style="list-style-type: none"> Position mode without extended control word: Move to target position as soon as the target position is changed Position mode with extended control word: Move to the target position as described in "Mode 1 - Position mode with extended control word" on page 2688 |
| | 2 | Speed mode: Constant speed |
| | -120 | Set home position |
| | -121 | Remaining distance mode |
| | -122 | Set actual position |
| | -123 | Move to target position when external input set |
| | -124 | Two-position module |
| | -125 | Move to fixed position A (position set acyclically) |
| | -126 | Move to fixed position B (position set acyclically) |
| | -127 | Positive homing (see also "Homing configuration" on page 2683) |
| | -128 | Negative homing (see also "Homing configuration" on page 2683) |

Information:

For all modes: The "Target reached" bit is set in the ["Status word" on page 2692](#) register when the current action is finished (i.e. when the position or speed is reached, depending on the mode).

A new position or speed can be specified even before the current action is finished.

Mode 1 - Position mode

The position setpoint is specified in the "Set position/speed" on page 2686 register. The motor is then moved to this new position. This is done with a ramp function that accounts for the defined maximum speed and acceleration values.

The position setpoint can also be changed during an active positioning procedure.

The position setpoint is specified in microsteps (1/256 of a full step).

If bit 0 in the "General configuration" on page 2684 register is 0 (no extended control word), then the position setpoint will be applied as soon as it is different from the current position. Then the new position is used for the movement.

However, if bit 0 in the "General configuration" on page 2684 register is set to 1 (extended control word), then the position setpoint will be applied as described under "Mode 1 - Position mode with extended control word" on page 2688.

Mode 1 - Position mode with extended control word

Position mode with extended control word behaves like Position mode 1 as described previously (without the extended control word), but the new position setpoint ("Position/Speed" on page 2686 register) is applied according to the extended control word.

Extended control word

Commands can be issued using this register depending on the state of the module (see "Operating function model "Ramp"" on page 2695).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|---|-------|---|
| 0 - 3 | Corresponds to the default Control word | x | |
| 4 | New setpoint | 0 | Do not apply target position. |
| | | 1 | Apply target position. |
| 5 | Change set immediately | 0 | Complete current positioning movement and then start next positioning movement |
| | | 1 | Interrupt current positioning movement and then start next positioning movement |
| 6 | abs / rel | 0 | Target position is an absolute value. |
| | | 1 | Target position is a relative value. |
| 7 | Corresponds to the default Control word | x | |
| 8 | Stop ¹⁾ | 0 | Execute positioning |
| | | 1 | Stop axis with deceleration |
| 9 - 15 | Corresponds to the default Control word | x | |

1) This bit applies to all modes.

Extended status word

The bits in the status word reflect the status of the state machine (for a detailed description, see "Status word" on page 2696 and "State machine" on page 2697).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|--|-------|---|
| 0 - 9 | Corresponds to the default Status word | x | |
| 10 | Target reached, depending on bit 8 (Stop) in the Control word register | | If Stop = 0 |
| | | 0 | Target position not reached. |
| | | 1 | Target position reached |
| | | | If Stop = 1 |
| | | 0 | Axis decelerating |
| 11 | Corresponds to the default Status word | x | |
| | | | |
| 12 | Setpoint acknowledge | 0 | Ramp generator did not apply the position value |
| | | 1 | Ramp generator applied the position value |
| 13 - 15 | Corresponds to the default Status word | x | |

Position setting

The target position can be defined in 2 different ways:

| Type of setpoint definition | Description |
|-----------------------------|---|
| Single setpoint | After the target position is reached, Bit <i>Target reached</i> in register "Status word" on page 2692 is set. Then a new target position is defined. The drive stops at each target position before starting the movement to the next target position. |
| Set of setpoints | After the target position has been reached, the movement to the next target position is started immediately without stopping the drive. It is therefore possible to initiate a new positioning by specifying another target position during active positioning. |

The two modes "Single setpoint" and "Set of setpoints" are controlled by the timing of bits *New setpoint* and *Change set immediately* in the "extended control word" on page 2688 and *Setpoint acknowledge* in register "Extended control word" on page 2688.

These bits can be used to create a Request-Response mechanism. This makes it possible to specify a target position while a previous position specification is still being processed.

Specifying the target position

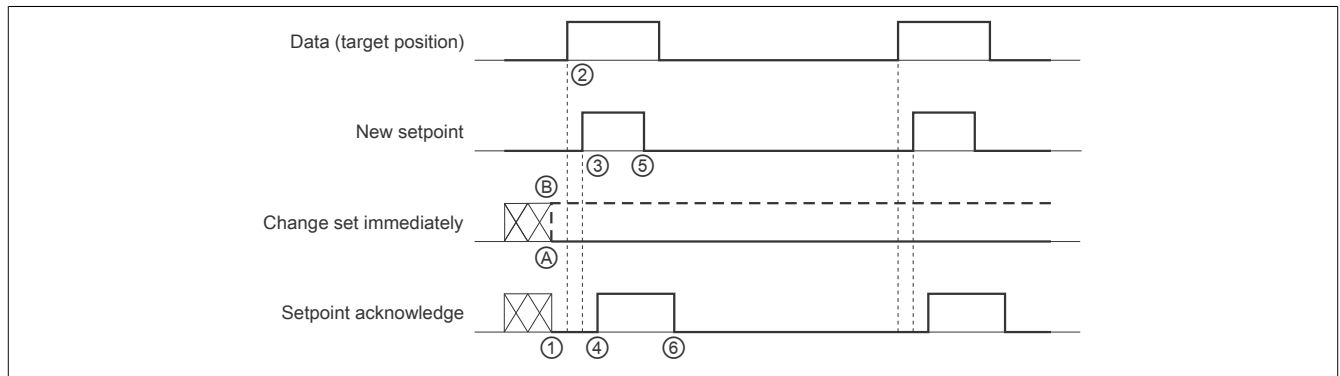


Figure 184: Principle for applying the setpoint

Transferring a new setpoint:

- 1) If bit *Setpoint acknowledge* in register "Extended status word" on page 2688 is 0, the module will accept a new target position.
- 2) The new target position is specified in register "Set position/speed" on page 2686.
- 3) A rising edge on bit *New setpoint* in the "extended control word" on page 2688 indicates that the new target position in register "Set position/speed" on page 2686 is valid and can be used for the next positioning movement.
- 4) After the module has received and saved the new target position, bit *Setpoint acknowledge* is set to 1 in register *Status word*.
- 5) Now the controller can reset the *New setpoint* bit to 0.
- 6) Then the module resets bit *Setpoint acknowledge* to 0 to signal when a new target position is accepted.

Position specification "Single setpoint"

When the *Change set immediately* bit is set to 0 (A in figure "Principle for applying the setpoint"), then the module is operating in *Single setpoint* mode. This mechanism results in a speed of 0 when the motor reaches target position x_1 at time t_1 . After the controller has been notified that the setpoint has been reached, the next target position x_2 will be processed at time t_2 and reached at t_3 .

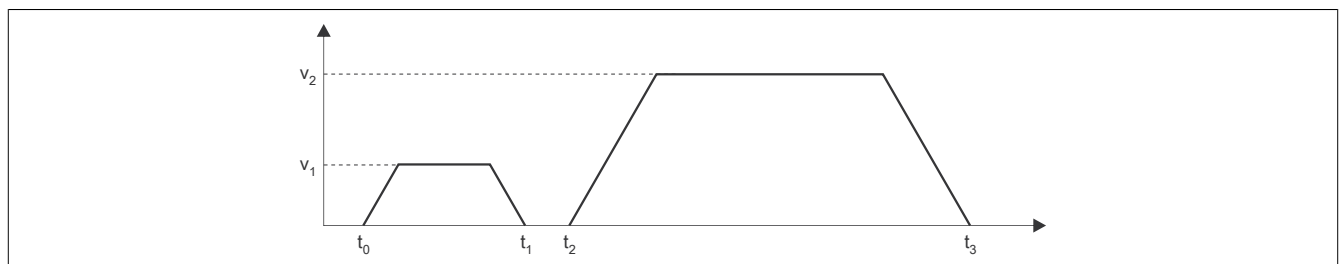


Figure 185: Ramp in *Single setpoint*

"Set of setpoints" preset position value

When the *Change set immediately* bit is set to 1 (Ⓢ in figure "Principle for applying the setpoint"), then the module is operating in *Single setpoint* mode. This means that the module receives the first target position at t_0 . A second target position is received at time t_1 . The drive immediately adapts the current movement to the new target position.

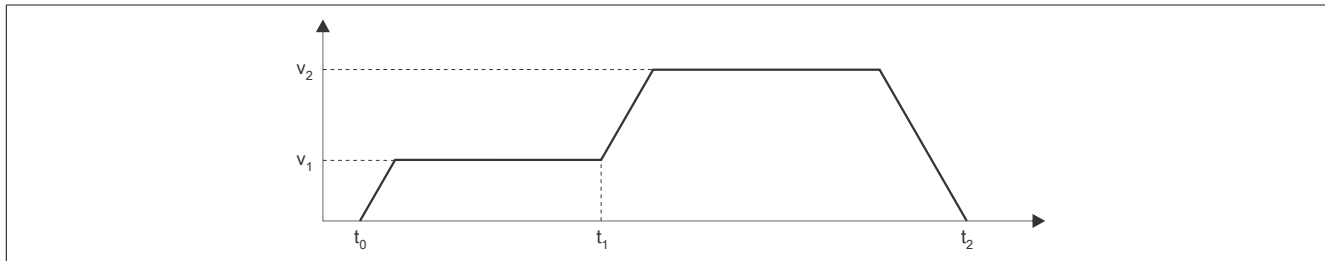


Figure 186: Ramp in *Set of setpoints*

Relative position setting

If bit *abs / rel* in register *Extended control word* is set, then the target position is interpreted as a relative value. At each *New setpoint* trigger, the target position will be increased by this value (or decreased if the value is negative).

If the mode changes between the position settings, relative movement will then proceed starting at the last specified position. The position setpoint mode is initialized with 0 when the module is started.

Mode 2: Speed mode - Constant speed (pos./neg.)

The value in register "*Position/Speed*" on page 2686 is now interpreted as the speed setpoint (microsteps/ cycle).

Observing the maximum permissible acceleration, the motor moves with a ramp to the desired speed setpoint and maintains this speed until a new speed setpoint is specified.

Values are allowed within the range -65535 to 65535. When a value is entered outside of this range, it is readjusted to these limits.

Mode -120: Set home position

This mode is supported starting with upgrade 1.3.1.0 (firmware version 16).

The current actual position is changed so that the position specified in register "*Position/Speed*" on page 2686 is the home position. If you then move to this position, the motor is at the home position.

The home position in register "*Home position*" on page 2693 is also set to this value.

Before this mode is called, the motor must be at a standstill and the home position must have been determined using "*Positive / negative homing*" mode. In order to set the position, the *State machine* must be in state "Operation enable".

Mode -121: Remaining distance mode (like mode 1)

The number of steps defined in register "*Fixed position A*" on page 2681 are added to the current position and the resulting position is approached at a rising/falling edge on digital input 3.

Advice:

Steps are not added to the target position, but rather to the current position at the moment the trigger occurs.

Negative values are also allowed for the offset defined in *Fixed position A*.

New target positions are no longer accepted in register "*Position/Speed*" on page 2686 after the trigger event. There must first be a switch made to *mode 0* and then back to mode -121.

Bit "Target reached" in register "*Status word*" on page 2692 is not set to 1 until the end position (after the trigger event) has been reached.

The "*homing configuration*" on page 2683 determines whether a rising or falling edge of the digital input is used as a trigger.

The *Reversing loop* is not enabled in this mode (i.e. any configured values not equal to 0 are ignored).

Mode -122: Set actual position

The target position set in register "[Position/Speed](#)" on page 2686 is applied as the current actual position in the internal position counter if the state machine is in state "Operation enable".

Before this mode is started, the motor must be at a standstill and physically located at the point for which the position being set should be applied.

Mode -123: Move to the target position when the external input is set

The position setpoint set in register "[Position/Speed](#)" on page 2686 is moved on a rising edge of digital input 3.

A new position setpoint is not applied until another rising edge occurs on the corresponding digital input. This can also occur during the active positioning procedure and will be applied immediately.

Mode -124: Two-position mode

Positions [Fixed position A](#) and [Fixed position B](#) are defined in the acyclic registers.

Value 1 on digital input 3 moves to fixed position A. Value 0 moves to fixed position B. It is also possible to switch between the two during an active positioning movement.

Mode -125/-126: Move to fixed position X

The purpose of these modes is to enable a virtual switch from speed mode to position mode, which otherwise is not possible because of the shared use of the register for position and speed setpoints.

- Mode -125: "[Fixed position A](#)" on page 2681
- Mode -126: "[Fixed position B](#)" on page 2682

Mode -127/-128: Positive/Negative homing

Mode -127 and -128 are used to select which direction to move.

The motor must be at a standstill before switching from another mode to one of the homing modes.

If the referencing condition occurs, then the motor stops and the values of the position counter and ABR counter valid at the moment when the referencing condition occurs are written to the "[Referenced zero position](#)" on page 2693 register.

In the [referencing configuration](#) you must specify whether referencing should occur at low/high level on the digital input, during stall or unconditionally.

Homing via digital input

Case 1: Active referencing level not yet reached → Motor not yet at end position:

Movement continues at the referencing speed in the referencing direction until the active level for "Stop referencing" is on the input.

Case 2: Active referencing level already reached → Motor at end position:

Movement continues at the referencing speed against the referencing direction until the active level for "Stop referencing" is no longer at the digital input. Movement continues at homing speed in the homing direction until the active level for "homing-stop" is on the digital input again.

Referencing during stall

Movement continues in the referencing direction until a stall is detected. When a stall is detected, the value of the position counter is entered in the "[Referenced zero position](#)" on page 2693 register within one millisecond. The motor is then stopped abruptly (not using the deceleration ramp). However, it can take up to 25 ms to stop the motor because the ramp generator runs with a configurable internal cycle of up to 25 ms.

In this mode, the nominal current is always used instead of the maximum current, even in acceleration phases.

To test the responsiveness of this homing mode, the motor load value used for identifying a stall can be made visible in the status word (see "[Stall detection configuration / Mixed decay](#)" on page 2683).

Unconditional referencing (immediate)

Immediate referencing: The current values of the position counter and of the ABR counter are immediately entered in register "[Homed zero position](#)" on page 2693, no motor movement.)

Current position (cyclic)

Name:

AbsPos01ActVal

This cyclic register contains the current position.

Default: Value of the internal position counter, can be changed to ABR counter

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

Status word

Name:

MpGenStatus01

The bits in this register reflect the state of the state machine. For a more detailed description, see ["Status word" on page 2696](#) and ["State machine" on page 2697](#).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|-----------------------------|-------|---|
| 0 | Ready to switch on | x | |
| 1 | Switched on | x | |
| 2 | Operation enabled | x | |
| 3 | Fault (error bit) | x | |
| 4 | Voltage enabled | x | |
| 5 | Quick stop | x | |
| 6 | Switch on disabled | x | |
| 7 | Warning | x | |
| 8 | Reserved | 0 | |
| 9 | Remote | 1 | Always 1 since there is no local mode for the SM module |
| 10 | Target reached | x | |
| 11 | Internal limit active | 0 | No limit violation |
| | | 1 | Internal limit is active (upper or lower software limit violated) |
| 12 | Mode-specific | x | |
| 13 - 15 | Reserved / Motor load value | 0 | Always 0 if bit 7 in register "Stall detection configuration / Mixed decay" on page 2683 is set to 0. |
| | | x | Returned motor load value |

Input status

Name:

InputStatus

This register indicates the logical states of digital inputs.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------|--------|-------------------------------|
| 0 | Digital input 1 | 0 or 1 | Input state - Digital input 1 |
| ... | | ... | |
| 3 | Digital input 4 | 0 or 1 | Input state - Digital input 4 |
| 4 - 7 | Reserved | 0 | |

Motor identification

Name:

Motoridentification01

This register is used to identify the connected motor type for service purposes and to differentiate between motors in the application. After successful measurement, this register contains the time [µs] required to apply a current increase of $\Delta I = 1 \text{ A}$ to a motor winding.

This depends on:

- Operating voltage
- Inductance and resistance of the motor winding

| Notes | |
|-------|---|
| 1) | To achieve reproducible results, the measurement must be made under the following defined conditions: |
| a) | Motor is at standstill. |
| b) | The motor must be in a half-step position (phase A fully powered, phase B not powered). This means the internal position counter on the SM module must have a value that fulfills the following conditions: <ul style="list-style-type: none"> • Full steps are divisible by 4. • Microsteps = 0 |
| 2) | Condition 1b) is fulfilled after a the SM module is reset or switched on. Immediately afterwards, when the holding current is applied to the motor for the first time (at standstill), the duration for applying the current is measured. This is therefore a suitable time to read the motor identification register in the application. |
| 3) | The current range from approximately 1/3 of the nominal current up to the nominal current is used as operating range for determining the motor identifier. |

| Data type | Motor ID values | Explanation |
|-----------|-----------------|--|
| UINT | 0 | No motor identifier available (after switching on for as long as the measurement conditions are not met) |
| | 1 to 32767 | Valid range of values for the motor ID register (in µs) |
| | 65504 to 65519 | Ground fault: Measurement of motor identification not possible |
| | 65528 | Motor ID trigger not possible <ul style="list-style-type: none"> • Motor not supplied with current • Motor in movement • Nominal current set to 0 A • Ground fault present |
| | 65529 | Invalid value: Underflow |
| | 65530 | Overtemperature: Measurement not possible |
| | 65532 | Open circuit: Measurement not possible |
| | 65533 | Incorrect motor position: Measurement not possible |
| | 65534 | Invalid value: Overflow |
| | 65535 | Measurement in progress |

Ground fault detection

When the motor is powered on, a ground fault check is performed before motor identification. Error numbers have been added in the motor identification register for the event of a ground fault error (values 65504 to 65519 in the table above).

Homed zero position

Name:

RefPos01CyclicCounter

RefPos01AcyclicCounter

After a homing procedure, the homing point for the cyclic or acyclic position counter can be read back with these registers (either the internal position counter or ABR counter depending on bit 14 of register "Control word" on [page 2687](#)).

The following two registers are provided for the motor:

- Homed zero position for cyclic counter
- Homed zero position for acyclic counter

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

Current position (acyclic)

Name:

AbsPos1ActValAcyclic

This acyclic register contains the current position.

Default: Value of the ABR counter, can be changed to internal position counter

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

Read back control word

Name:

ControlReadback01

This register can be used to read the contents of register "Control word" on page 2687.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

Read back mode

Name:

ModeReadback01

This register can be used to read the contents of register "Mode" on page 2687.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

Error code

Name:

ErrorCode01

The cause of an error or warning can be read in this register.

| Data type | Error code | Error type | Priority | Description |
|-----------|------------|------------|----------|-----------------------------|
| UINT | 0x0000 | - | - | No error |
| | 0x3000 | Error | High | Voltage |
| | 0x4200 | Error | : | Overtemperature |
| | 0xFF20 | Warning | : | Negative limit switch |
| | 0xFF21 | Warning | : | Positive limit switch |
| | 0x2300 | Warning | : | Overcurrent |
| | 0xFF00 | Warning | : | Current error ¹⁾ |
| | 0xFF01 | Warning | low | Stall ²⁾ |

1) A current error is only detected if bit 13 = 1 in the [control word](#) (current error detection enabled).2) Stall is only detected if bit 15 = 1 in the [control word](#) (stall detection enabled).

Information regarding the handling of errors and warnings:

- Bit 3 (fault) and bit 8 (warning) in the [status word](#) can be used to query whether an error or a warning was reported in the error code register.
- Bit 7 (Fault Reset) and bit 8 (Warning Reset) in the [control word](#) are used to acknowledge pending errors and warnings.
- If two or more errors/warnings are pending, the one with the highest priority (the order in the table above) will be displayed in the error code register.

9.25.8.15.9.4 Operating function model "Ramp"

Control for this model has been based on the CANopen communication profile DS402.

Commands for controlling the modules are written to the "Control word" on page 2695. The current module state is returned in register "Status word" on page 2696. The function mode (absolute position, constant speed, homing, etc.) is set in register "Mode" on page 2687.

Control word

Control word bits and their state for the commands of the state machine:

| Command | Reserved | Encoder position sync/async | Current error detection | Warning reset | Motor ID trigger | Reserved | Reserved | Stop 2) | Fault reset | Mode-specific | Mode-specific | Mode-specific | Enable operation | Quick stop | Enable voltage | Switch on |
|-------------------|----------|-----------------------------|-------------------------|---------------|------------------|----------|----------|---------|-------------|---------------|---------------|---------------|------------------|------------|----------------|-----------|
| Bit ¹⁾ | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Shutdown | x | x | x | x | x | 0 | 0 | x | 0 | x | x | x | x | 1 | 1 | 0 |
| Switch on | x | x | x | x | x | 0 | 0 | x | 0 | x | x | x | 0 | 1 | 1 | 1 |
| Disable voltage | x | x | x | x | x | 0 | 0 | x | 0 | x | x | x | x | x | 0 | x |
| Quick stop | x | x | x | x | x | 0 | 0 | x | 0 | x | x | x | x | 0 | 1 | x |
| Disable operation | x | x | x | x | x | 0 | 0 | x | 0 | x | x | x | x | 0 | 1 | 1 |
| Enable operation | x | x | x | x | x | 0 | 0 | x | 0 | x | x | x | 1 | 1 | 1 | 1 |
| Fault reset | x | x | x | x | x | 0 | 0 | x | ↑ | x | x | x | x | x | x | x |

1) x ... Any, ↑ ... Rising edge

2) Bit 8 (stop) is only evaluated if the extended control word is enabled in register "General configuration" on page 2684.

| | |
|---|--|
| Bits 0, 1, 2, 3 and 7 (light gray in the previous table) | These bits control the state of the State machine according to the commands in the table above. |
| Stop | 0 ... Perform motor movement 1 ... Stop axis with deceleration This bit is only evaluated when the extended control word is enabled in register "General configuration" on page 2684. |
| Motor ID trigger | A rising edge enables the motor ID measurement. |
| Warning reset | A rising edge resets warnings (no effect on errors, which are reset using "Fault reset"; the state machine is not affected by this bit). |
| Fault reset | A rising edge resets errors and warnings (see "State machine" on page 2697) |
| Current error detection | 0 ... Current error detection disabled 1 ... Current error detection enabled |
| ABR counter sync/async | 0 ... Value of the ABR counter on register "Current position (acyclic)" on page 2694. Internal position counter of the ramp generator on register "Current position (cyclic)". 1 ... Value of the ABR counter on register "Current position (cyclic)" on page 2692. Internal position counter of the ramp generator on register "Current position (acyclic)". |
| Stall detection | 0 ... Stall detection disabled 1 ... Stall detection enabled |
| CurrentControlEnable | 0 ... Load-dependent current control disabled 1 ... Load-dependent current control enabled |

Status word

The individual bits of this register and its states depend on the current state of the state machine:

| Status | Reserved / MotorLoadBit 2 ¹⁾ | Reserved / MotorLoadBit 1 ¹⁾ | Reserved / MotorLoadBit 0 ¹⁾ | Reserved | Int. limit active | Target reached | Remote | Reserved | Warning | Switch on disabled | Quick stop | Voltage enabled | Fault | Operation enabled | Switched on | Ready to switch on |
|------------------------|---|---|---|----------|-------------------|----------------|--------|----------|---------|--------------------|------------|-----------------|-------|-------------------|-------------|--------------------|
| Bit | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Not ready to switch on | x | x | x | x | x | x | 1 | 0 | x | 0 | x | 0 | 0 | 0 | 0 | 0 |
| Switch-on disabled | x | x | x | x | x | x | 1 | 0 | x | 1 | x | 0 | 0 | 0 | 0 | 0 |
| Ready to switch on | x | x | x | x | x | x | 1 | 0 | x | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Switched on | x | x | x | x | x | x | 1 | 0 | x | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| Operation enable | x | x | x | x | x | x | 1 | 0 | x | 0 | 1 | 1 | 0 | 1 | 1 | 1 |
| Quick stop active | x | x | x | x | x | x | 1 | 0 | x | 0 | 0 | 1 | 0 | 1 | 1 | 1 |
| Fault reaction active | x | x | x | x | x | x | 1 | 0 | x | 0 | x | 0 | 1 | 1 | 1 | 1 |
| Fault | x | x | x | x | x | x | 1 | 0 | x | 0 | x | 0 | 1 | 0 | 0 | 0 |

- 1) If bit 7 is set to 1 in register "Mixed Decay / Stall Detection" on page 2683, then the motor load value is returned in bits 13-15 of the status word. Otherwise, these bits are always 0.

Information about the status word:

| | | |
|---|--|--|
| Bits 0, 1, 2, 3, 5 and 6 (light gray in the previous table) | These bits are set according to the current state of the State machine . | |
| Voltage enabled | Becomes 1 as soon as the motor is powered | |
| Warning | Becomes 1 if a warning is detected ("Overcurrent", "Undercurrent"). The type of warning is indicated in register "Error code" on page 2694. The highest priority error / warning is shown in each case, with the priority corresponding to the order in the respective table. Warnings can be reset with a rising edge on the "Warning reset" bit in the control word. | |
| Remote | Always 1 since there is no local mode on the SM module | |
| Target reached ¹⁾ , depending on bit 8 (Stop) in register Control word | <p>If Stop = 0</p> <p>In modes 1, -123, -124, -125 and -126 (absolute positioning): 0...Positioning begins 1...Target has been reached</p> <p>In mode 2 (constant speed): 0...Motor accelerates/brakes 1...Speed setpoint reached</p> <p>In modes -127 and -128 (homing): 0...Homing started 1...Homing ended</p> <p>In mode -122 (set actual position): The bit briefly becomes 0 and immediately becomes 1 again as soon as the position is set.</p> | <p>If Stop = 1</p> <p>In all modes: 0...Axis decelerating 1...Axis speed = 0</p> |
| Internal limit active | 0 ... No limit violation 1 ... Internal limit is active (upper/lower software limit violated) | |

- 1) If "Stop" has not been enabled in register "General configuration" on page 2684, then "Target reached" behaves the same as if Stop = 0.

State machine

The motor is controlled according to the state machine illustrated below. After the module is started, the state machine automatically changes to state "Not ready to switch on". The application then operates the state machine by writing commands to the [Control word](#).

The state machine successively reaches the states "Ready to switch on", "Switched on" and "Operation enable" by writing the consecutive commands "Shutdown", "Switch on" and "Enable operation".

Information:

Only in state "Operation enable" are motor movements executed according to the setting in register "Mode" on page 2687.

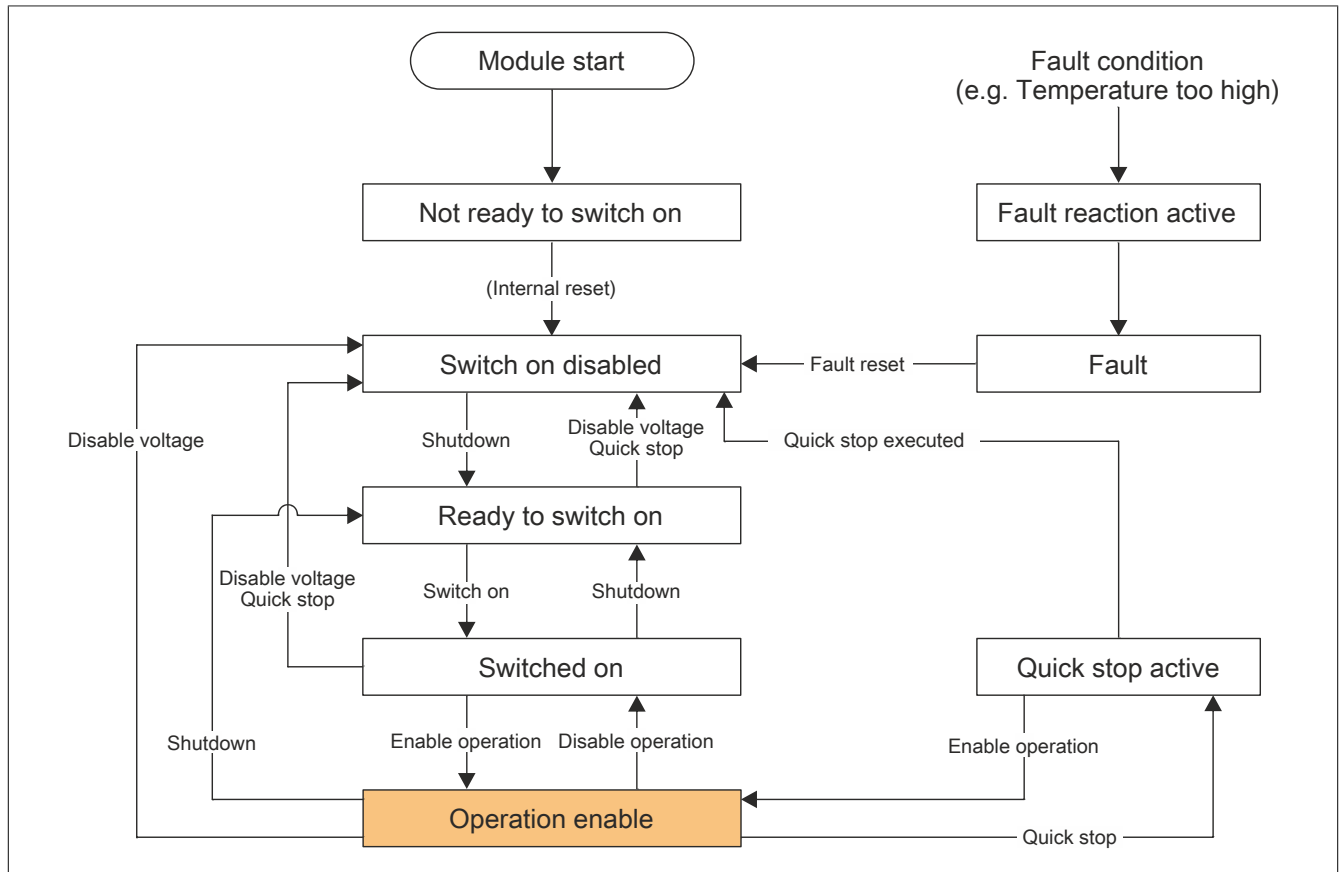


Figure 187: State machine - Flow chart

| State change | Description |
|--|--|
| Not ready to switch on → Switch on disabled | This state change occurs automatically after starting the module and internal initialization has taken place. |
| Switch-on disabled → Ready to switch on | This state change is initiated by command <i>Shutdown</i> . No others actions are performed. |
| Ready to switch on → Switch-on disabled | This state change is brought on by the command <i>Disable voltage</i> or <i>Quick stop</i> . No others actions are performed. |
| Switched on → Switch-on disabled | This state change is brought on by the command <i>Disable voltage</i> or <i>Quick stop</i> . The motor voltage is cut off immediately. |
| Ready to switch on → Switched on | This state change is brought on by the <i>Switch on</i> command. The motor voltage is switched on. When this state change occurs for the first time since the module is started, the motor ID measurement is performed before state <i>Switched on</i> is achieved. This can take approximately 1 second. |
| Switched on → Ready to switch on | This state change is initiated by command <i>Shutdown</i> . The motor voltage is cut off immediately. |
| Switched on → Operation enable | This state change is brought on by the <i>Enable operation</i> command. Motor movements are now performed depending on the set mode. |
| Operation enable → Switched on | This state change is brought on by the <i>Disable operation</i> command. If in motion, the motor is decelerated with the configured braking deceleration. The motor voltage remains switched on in state <i>Switched on</i> . |
| Operation enable → Ready to switch on | This state change is initiated by command <i>Shutdown</i> . The motor voltage is cut off immediately. |
| Operation enable → Switch on disabled | This state change is brought on by the <i>Disable voltage</i> command. Motor voltage switched off. It is strongly recommended to only make this state change on a stopped motor since regeneration on a motor running at no load can cause an overvoltage error on the DC bus (0x3210). |
| Operation enable → Quick stop active | This state change is brought on by the <i>Quick stop</i> command. If in motion, the motor is decelerated with the configured braking deceleration. During the deceleration, the state machine remains in state <i>Quick stop active</i> . If the motor comes to standstill, the switch to state <i>Switch on disabled</i> takes place automatically. While the state machine is in state <i>Quick stop active</i> , command <i>Enable operation</i> can be used to switch it back to state <i>Operation enable</i> . |
| → Fault reaction active | This state change is brought on when an error occurs and cannot be triggered by a command from the user. It can be triggered by error types classified as an "Error" (see "Error code" on page 2694). (The other error types classified as "Warning" only cause the "Warning" bit to be set in the status word and do not cause a state change of the state machine.) The motor voltage is cut off and the state machine immediately changes to state <i>Fault</i> . The error code register contains the error type (see table in "Error code" on page 2694). The highest priority error is shown. The priority corresponds to the order in the error code table. |
| Fault → Switch-on disabled | This state change is brought on by the <i>Fault reset</i> command. However, the state only changes if no more errors are present when the command is written. All errors and warnings are reset. The error code register contains 0 or the warning code if a warning is still present. |

Table 518: State machine - State change

9.25.8.15.10 NetTime Technology

For a description of NetTime Technology, see ["NetTime Technology" on page 3035](#).

9.25.8.15.11 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|---------------------------|--------|
| Function model "Standard" | 250 µs |
| Function model "Ramp" | 250 µs |

9.25.8.15.12 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|---------------------------|--------|
| Function model "Standard" | 250 µs |
| Function model "Ramp" | |
| Inputs | 250 µs |
| Outputs ¹⁾ | 25 ms |

1) Depends on the configuration of the ["movement profile generator" on page 2684](#).

9.25.9 X20SM1436-1

Data sheet version: 1.17

9.25.9.1 General information

The stepper motor module is used to control stepper motors with a nominal voltage of 24 to 48 VDC ($\pm 25\%$) at a motor current up to 2.5 A (3.5 A peak). In addition, this module has 4 digital inputs that can be used as limit switches or encoder inputs.

Due to the individual adjustment of the coil currents, the motor is only operated with the current it actually needs. This simplifies the selection of the available motors and prevents unnecessary heating. Because this affects energy consumption and thermal load, the effects are positive on the service life of the complete system. Complete flexibility is achieved through the use of independently adjustable holding, maximum and nominal current values. The current for microsteps is automatically adjusted to the configured current values.

In addition, the module contains a sensorless, load-dependent current control. Depending on the operating situation and load, the module regulates the current downwards. Energy savings up to 75% are possible in this way.

The automatic motor identification system is an enormous help during standstills. The stepper motor modules can identify the connected motors using their coil characteristics and generate feedback in the form of an analog value. This makes it possible to detect not only wiring errors, but also incorrect motor types being used mistakenly. A stall detection mechanism is integrated to analyze the motor load. Detection of the stall is defined via a configurable threshold. This allows an overload or motor standstill to be detected precisely in many different types of applications.

- 1 stepper motor, 24 to 48 VDC $\pm 25\%$, 2.5 A (3.5 A peak)
- Resolution of current values at 1%
- Boost, nominal and holding current separately configurable
- Sensorless, load-dependent current control
- Integrated motor detection
- 256 microsteps per step
- Stall detection
- Complete integration in Automation Studio and CNC applications
- 4 inputs, 24 VDC, adjustable for ABR incremental encoders
- Open circuit detection for push-pull encoders
- Input ramp limit at max. 10 A
- Function model "Ramp" based on CANopen communication profile DS402

NetTime timestamp of the position and trigger time

It is not just the position value that is important for highly dynamic positioning tasks, but also the exact time the position is measured. The module is equipped with a NetTime function for this that supplies a timestamp for the recorded position and trigger time with microsecond accuracy.

The timestamp function is based on synchronized timers. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

9.25.9.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Motor controllers |  |
| X20SM1436-1 | X20 stepper motor module, with current reduction function, module power supply 24 to 48 VDC $\pm 25\%$, 1 motor connection, 3 A continuous current, 3.5 A peak current, 4 digital inputs 24 VDC, sink, configurable as incremental encoder, NetTime function | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 519: X20SM1436-1 - Order data

9.25.9.3 Technical data

| Model number | X20SM1436-1 |
|--|--|
| Short description | |
| I/O module | 1 full bridge for controlling stepper motors |
| General information | |
| B&R ID code | 0xF1B0 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| Output | Yes, using LED status indicator and software |
| I/O power supply | Yes, using software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | - |
| External I/O | |
| 24 VDC | 2.2 W |
| 48 VDC | 3 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Input current limiting | Max. 10 A |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| Motor bridge - Power unit | |
| Quantity | 1 |
| Type | 2-phase bipolar stepper motor (full bridge) |
| Nominal voltage | 24 to 48 VDC $\pm 25\%$ |
| Nominal current | 2.5 A |
| Maximum current | 3.5 A for 1 s ¹⁾ |
| DC bus capacitance | 100 μ F |
| Step resolution | Max. 256 microsteps per step |
| Module power supply | |
| Supply | External |
| Fuse | Required line fuse: Max. 10 A, slow-blow |
| Output protection | Reverse polarity protection on supply voltage |
| Digital inputs | |
| Quantity | 4 |
| Nominal voltage | 24 VDC |
| Input circuit | Sink |
| Input filter | |
| Hardware | <5 μ s |
| Software | - |
| Connection type | 1-wire connections |
| Input resistance | Typ. 10 k Ω |
| Additional functions | 1x ABR incremental encoder, open-circuit detection |
| ABR incremental encoder | |
| Quantity | 1 |
| Encoder inputs | 24 V, asymmetrical |
| Counter size | 16-bit |

Table 520: X20SM1436-1 - Technical data


| | |
|--|--|
| Model number | X20SM1436-1 |
| Input frequency | Max. 50 kHz |
| Evaluation | 4x |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from I/O power supply |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 50°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating". |
| Storage | -25 to 70°C |
| Transport | -25 to 70°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x bus module X20BM11 separately. |
| Pitch | 12.5 ^{+0.2} mm |

Table 520: X20SM1436-1 - Technical data

1) See section "Let-through energy I2T".

9.25.9.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|--------|-------|--------------------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | Mode RESET |
| | | | Double flash | Mode BOOT (during firmware update) ¹⁾ |
| | | | Blinking | Mode PREOPERATIONAL |
| | | | On | Mode RUN |
| | e | Red | Off | Module not supplied with power or everything OK |
| | | | On | Error or reset state |
| | e + r | Green | Solid red / Single green flash | Invalid firmware |
| | | | On/Off | Input state of the corresponding digital input |
| | 1 - 4 | Green | Blinking | Open circuit or not connected |
| On | | | The motor is active. | |
| M | Orange | On | The motor is active. | |

1) Depending on the configuration, a firmware update can take up to several minutes.

9.25.9.5 Pinout

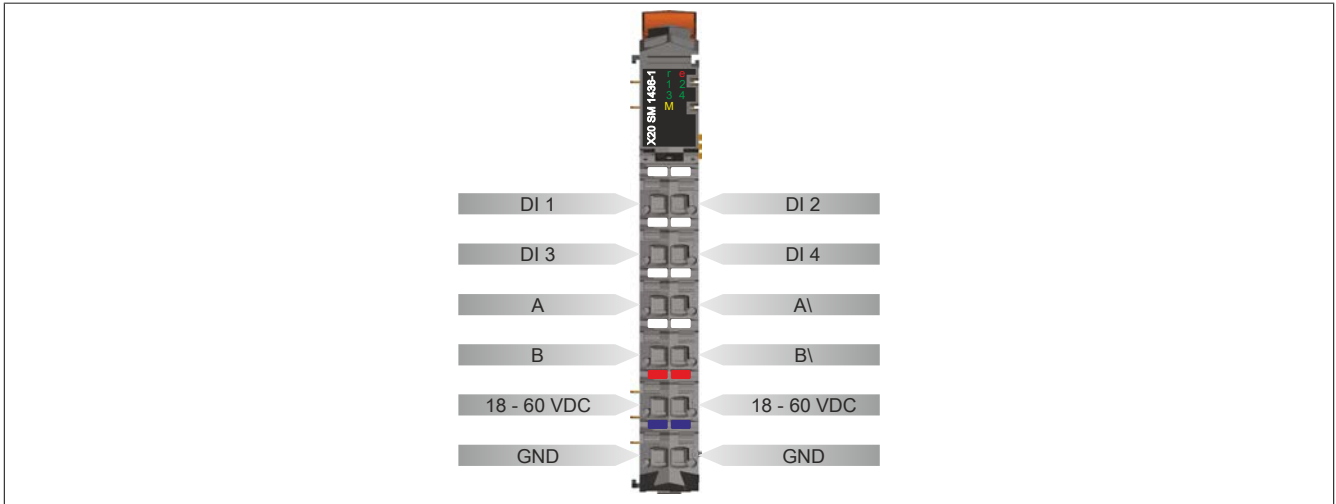
Per standard EN 60204-1, a cable cross section of 0.75 mm² or larger must be used for the motor outputs for the maximum motor current of 3.5 A. To guarantee full motor power, voltage drops that could result from the cable length and the electrical connections must also be taken into account when selecting the attachment cable.

Warning!

The terminal block is not permitted to be connected or disconnected during operation.

Information:

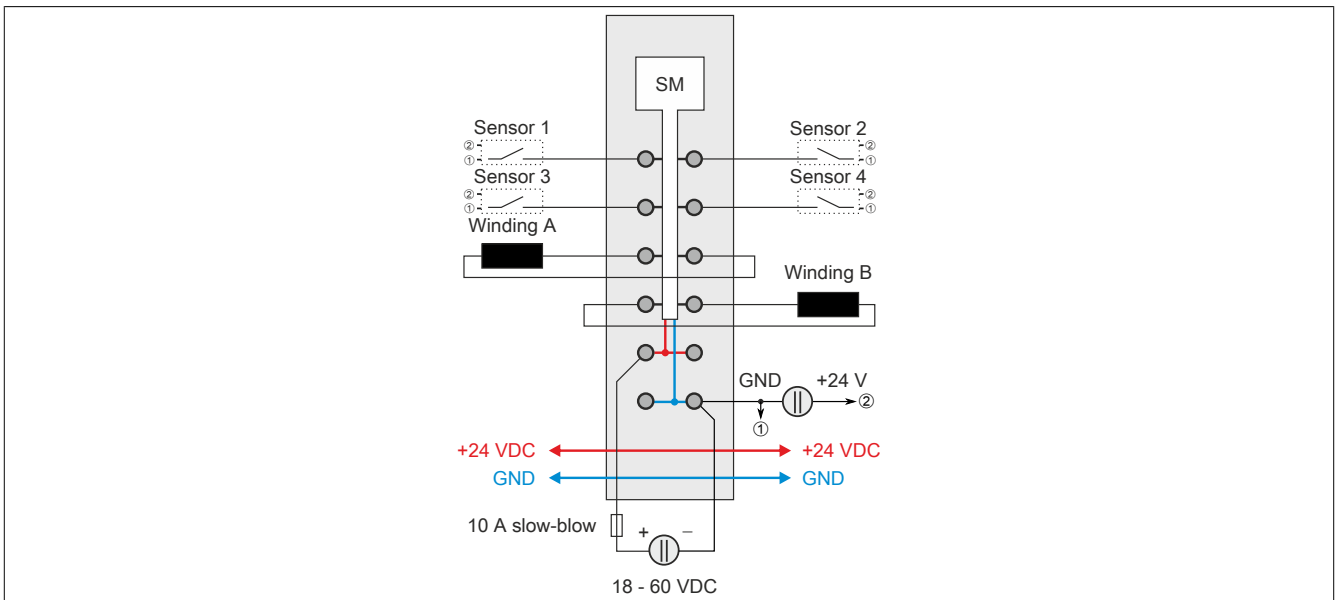
Shielded motor cables must be used in order to meet the limit values per standard EN 55011 (emissions).



9.25.9.6 Connection example

Information:

This module can only be operated if supplied with power via the terminal block.



For the wiring of sensors 1 to 4 see "Push-pull input circuits" on page 2703

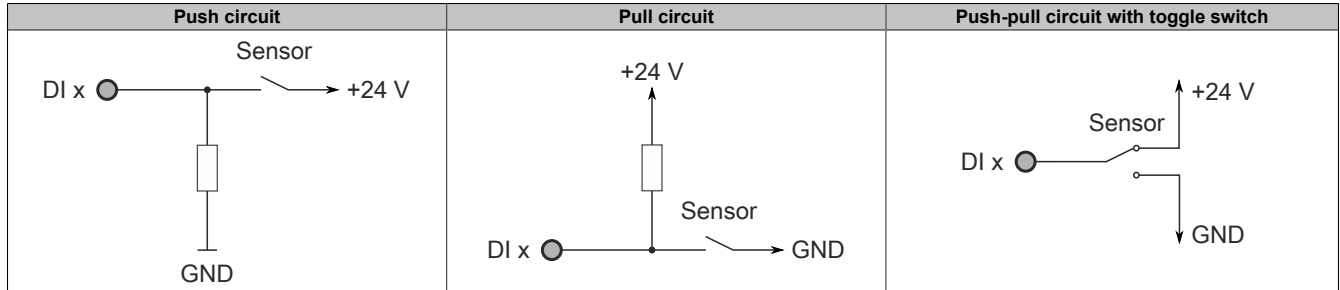
9.25.9.6.1 Push-pull input circuits

The digital inputs of the module are equipped with open-circuit detection and therefore designed for push-pull circuits.

Information:

If no push-pull circuit is used, an open sensor contact is interpreted by the module as an open circuit.

Circuit variants



The size of the resistor depends on the sensor used and must therefore be calculated in each individual case.

9.25.9.7 Connection options for digital inputs

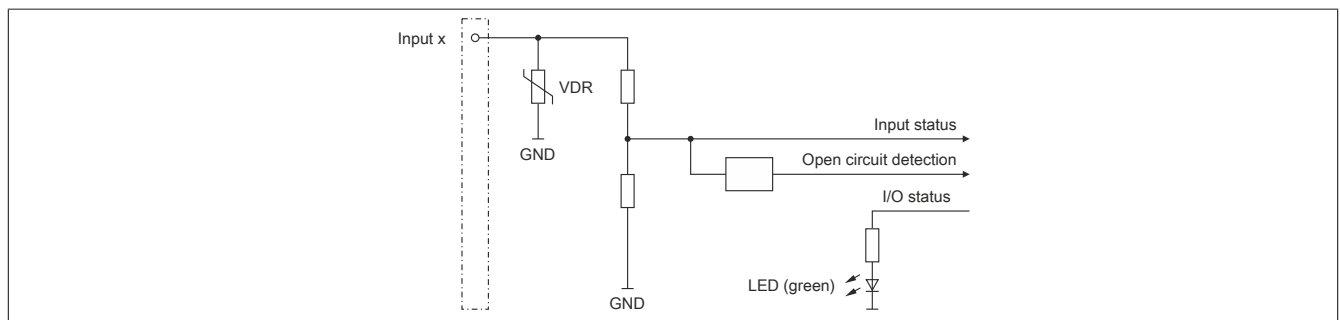
Function model "Standard"

| Channel | Function | |
|---------|---------------|---------------|
| DI 1 | Digital input | A |
| DI 2 | Digital input | B |
| DI 3 | Digital input | R |
| DI 4 | Digital input | Trigger input |

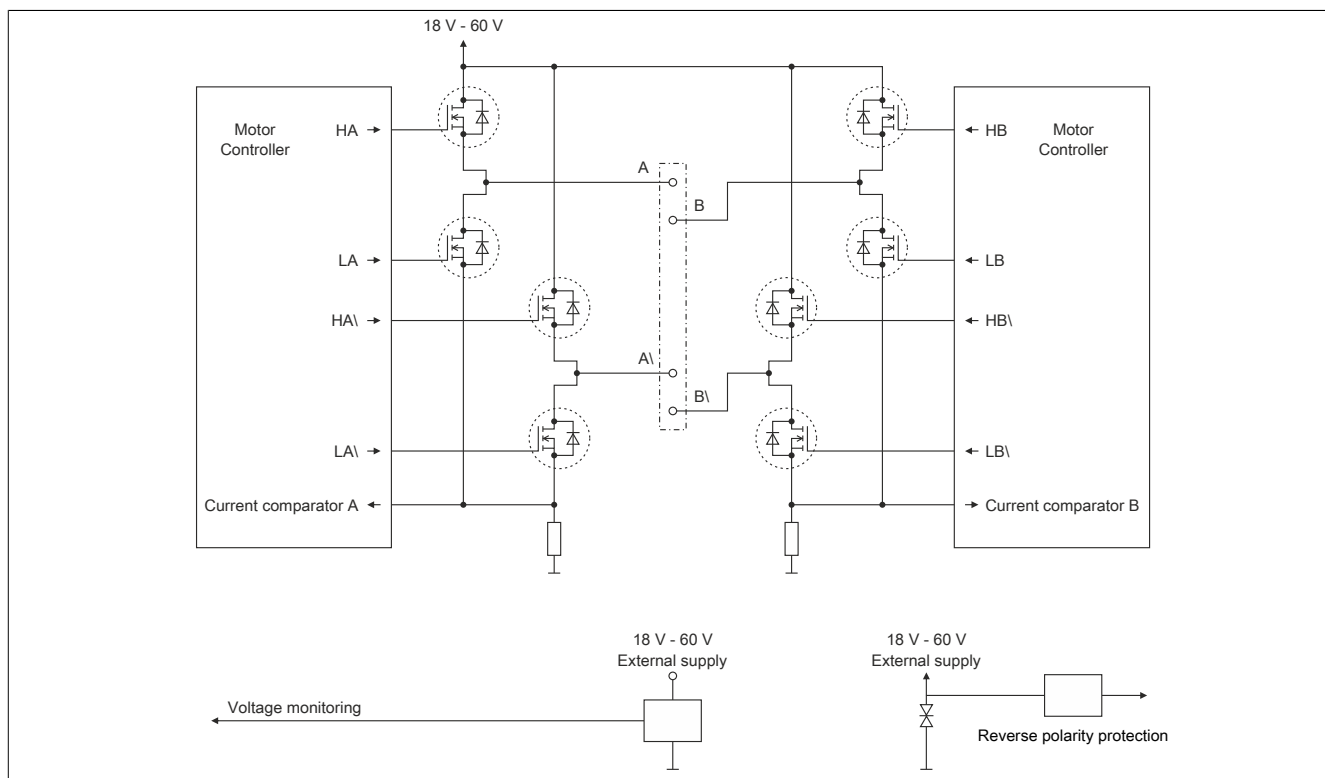
Function model "Ramp"

| Channel | Function | | |
|---------|---------------|---------------|-----------------------|
| DI 1 | Digital input | A | A |
| DI 2 | Digital input | B | B |
| DI 3 | Digital input | R | Negative limit switch |
| DI 4 | Digital input | Digital input | Positive limit switch |

9.25.9.8 Input circuit diagram



9.25.9.9 Output circuit diagram



9.25.9.10 Motor cutoff in the event of overvoltage

The module power supply voltage is continually monitored. Its status can be read. Error "[Module power supply error](#)" is reported if the voltage is greater than or less than the limit values.

If the supply voltage in the module overshoots or undershoots the limit values (e.g. during regenerative operation), the motor output is cut off!

If the supply voltage is within the permissible range again, the error must first be [acknowledged](#). The output stage can then be switched on again.

Limit values for the supply voltage

| | Drive cut off | Drive switched back on |
|-------------|---------------|------------------------|
| Lower limit | <17.4 V | >17.8 V |
| Upper limit | >60.3 V | <58.6 V |

9.25.9.11 Shutdown in the event of overtemperature (starting at 110°C)

If the module temperature reaches or overshoots the limit value of 110°C, the module performs the following actions:

- Sets the "overtemperature" error bit
- Cuts off the outputs (short-circuited)

As soon as the temperature is reduced below 110°C again, the error must be acknowledged with "OvertemperatureAcknowledge" so that the channels can be switched on again.

9.25.9.12 Power supply dimensioning

The motor's current consumption depends on the defined motor currents, the available power and the actual motor being used.

| Example | |
|--|-------------------|
| Model number of the motor | 80MPD5.300S000-01 |
| Configured current in the motor module | 3 A |
| Supply voltage of the motor module | 48 VDC |
| Motor load | 1 Nm |

Table 521: Power supply dimensioning example - Basic data

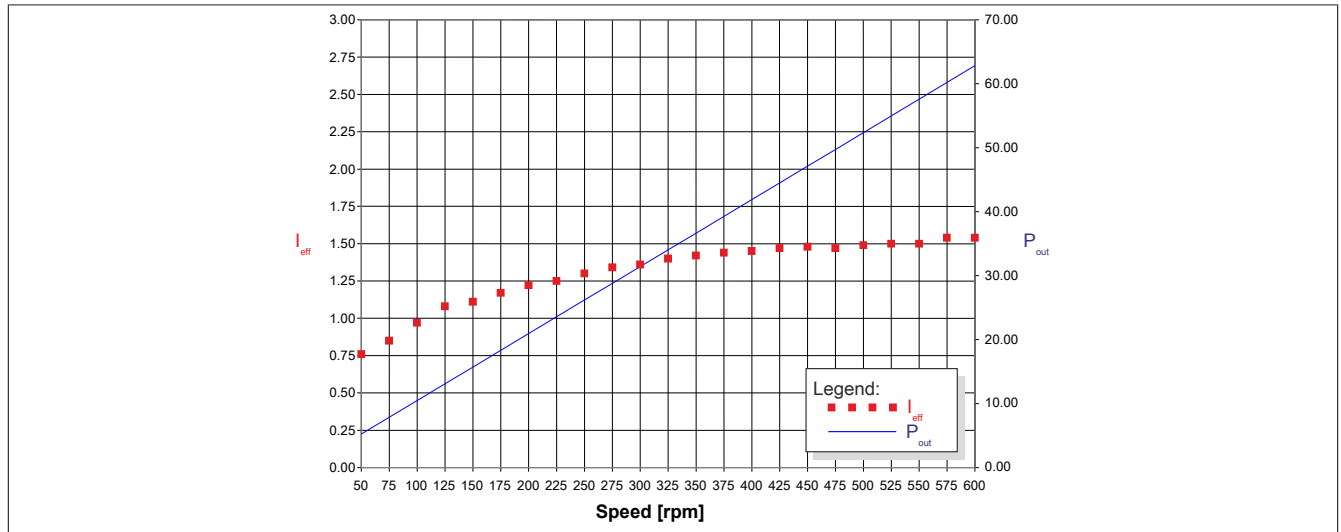


Figure 188: Power supply dimensioning example - Power/Speed relationship

The example is based on a constant load throughout the entire speed range.

An increase in the motor load causes an increase in the effective current of the I/O power supply.

9.25.9.13 Fuse protection

The power supply line should be protected by a circuit breaker or a fuse. In general, dimensioning the supply line and overcurrent protection depends on the structure of the power supply (modules can be connected individually or in groups).

Information:

The effective current for the power supply depends on the load but is always less than the motor current. Make sure the maximum nominal current of 10 A is not exceeded on the power supply terminals of the power unit.

When choosing a suitable fuse, the user must also account for characteristics such as aging effects, temperature derating, overcurrent capacity and the definition of the rated current, which can vary by manufacturer and type. In addition, the fuse that is selected must also be able to handle application-specific characteristics (e.g. overcurrent that occurs in acceleration cycles).

The cross section of the mains power input and the rated current of the used fuse are chosen according to the current-carrying capacity such that the permissible current-carrying capacity of the selected cable cross section (depending on wiring, see table) is greater than or equal to the current load in the mains power input. The rated current of the fuse protection must be less than or equal to the permissible current-carrying capacity of the selected cable cross section (depending on the how it is installed, see table):

$$\begin{array}{ccccc} I_{\text{Power system}} & \leq & I_b & \leq & I_z \\ \text{Power system} & \leq & \text{Fuse} & \leq & \text{Line/cable} \end{array}$$

| Wire cross section [mm ²] | Current-carrying capacity of cable cross section I_z / rated current of fuse I_b [A] depending on the to type of wiring at an ambient air temperature of + 40°C per EN 60204-1 | | | |
|---------------------------------------|--|-----------|-----------|-----------|
| | B1 | B2 | C | E |
| 1.5 | 13.5 / 13 | 13.1 / 10 | 15.2 / 13 | 16.1 / 16 |
| 2.5 | 18.3 / 16 | 16.5 / 16 | 21 / 20 | 22 / 20 |

Table 522: Cable cross section of the mains power input depending on the type of wiring

The tripping current of the fuse is not permitted to exceed the rated current of the fuse I_b .

| Type of wiring | Description |
|----------------|--|
| B1 | Wires in conduit or cable duct |
| B2 | Cables in conduit or cable duct |
| C | Cables or wires on walls |
| E | Cables or wires on open-ended cable tray |

Table 523: Type of wiring used for the mains power input

9.25.9.14 Let-through energy I²T

The module is designed for a continuous current of 2.5 A. A higher current can be temporarily drawn, however. The following points must be observed:

- The module is designed for a let-through energy of 194 A²s for a period of 30 seconds.

Information:

Exceeding the maximum let-through energy can result in damage to the module.

- If maximum current I_{boost} is drawn for maximum time t_{boost} , the continuous current of 2.5 A can be drawn for the remaining time of 30 seconds.
- If maximum current I_{boost} is drawn for more than maximum time t_{boost} , the current is not permitted to exceed the calculated residual current for the remaining time of 30 seconds (see example below).
- At the end of a 30 second period with increased current consumption, 2.5 A continuous current or a higher current can be drawn again.

Calculating the residual current

$$I_{\text{boost}}^2 \cdot t_{\text{boost}} + I_{\text{residual}}^2 \cdot (30 - t_{\text{boost}}) \leq 194 \text{ A}^2 \text{ s}$$

$$I_{\text{residual}} = \sqrt{\frac{194 \text{ A}^2 \text{ s} - I_{\text{boost}}^2 \cdot t_{\text{boost}}}{30 \text{ s} - t_{\text{boost}}}}$$

Example

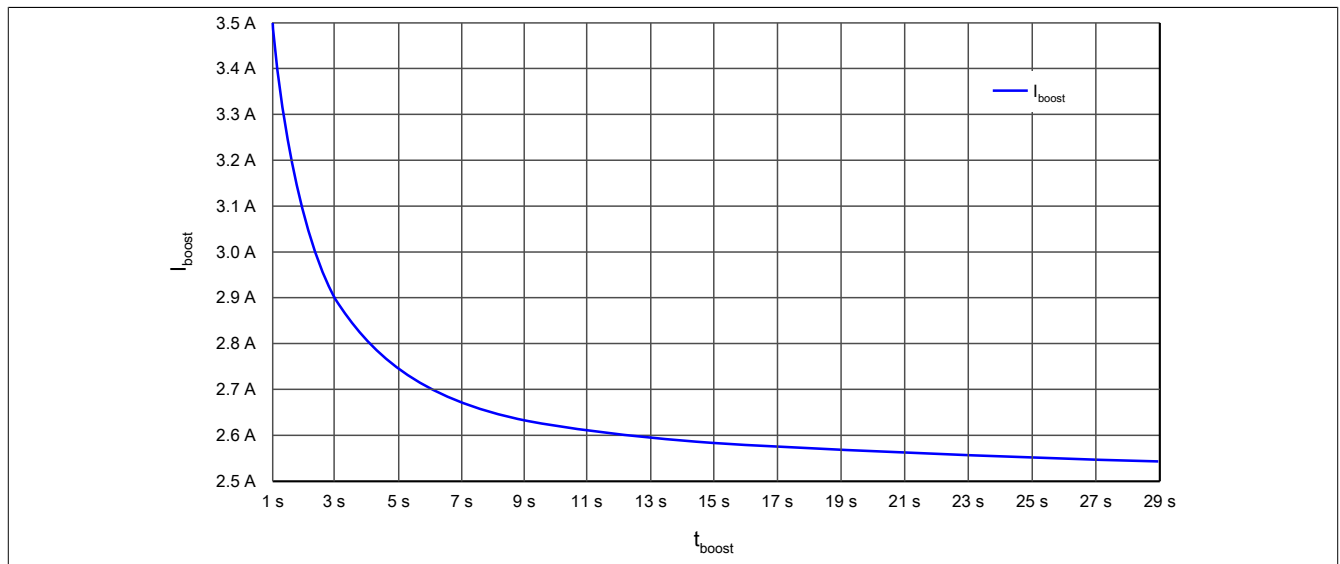
A boost current of 3.2 A is needed for a duration of 3 seconds. According to the formula, the residual current of 2.45 A is not permitted to be exceeded for the remaining 27 seconds.

$$I_{\text{residual}} = \sqrt{\frac{194 \text{ A}^2 \text{ s} - 3.2 \text{ A}^2 \cdot 3 \text{ s}}{30 \text{ s} - 3 \text{ s}}} = 2.45 \text{ A}$$

I_{boost} values if $I_{2T} = 194 \text{ A}^2 \text{ s}$ and $I_{\text{residual}} = 2.5 \text{ A}$

| t_{boost} s | I_{boost} A | t_{residual} s | t_{boost} s | I_{boost} A | t_{residual} s |
|-------------------------|-------------------------|----------------------------|-------------------------|-------------------------|----------------------------|
| 1 | 3.50 | 29 | 16 | 2.58 | 14 |
| 2 | 3.08 | 28 | 17 | 2.58 | 13 |
| 3 | 2.90 | 27 | 18 | 2.57 | 12 |
| 4 | 2.81 | 26 | 19 | 2.57 | 11 |
| 5 | 2.75 | 25 | 20 | 2.56 | 10 |
| 6 | 2.71 | 24 | 21 | 2.56 | 9 |
| 7 | 2.68 | 23 | 22 | 2.56 | 8 |
| 8 | 2.66 | 22 | 23 | 2.56 | 7 |
| 9 | 2.64 | 21 | 24 | 2.55 | 6 |
| 10 | 2.63 | 20 | 25 | 2.55 | 5 |
| 11 | 2.62 | 19 | 26 | 2.55 | 4 |
| 12 | 2.61 | 18 | 27 | 2.55 | 3 |
| 13 | 2.60 | 17 | 28 | 2.55 | 2 |
| 14 | 2.59 | 16 | 29 | 2.54 | 1 |
| 15 | 2.59 | 15 | 30 | 2.54 | 0 |

These values correspond to the following curve for let-through current I_{2T} :



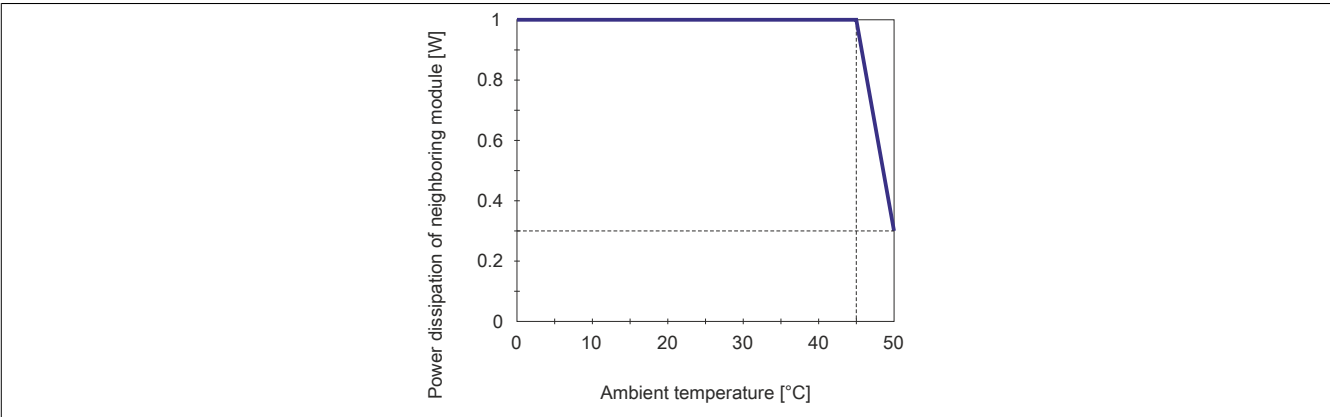
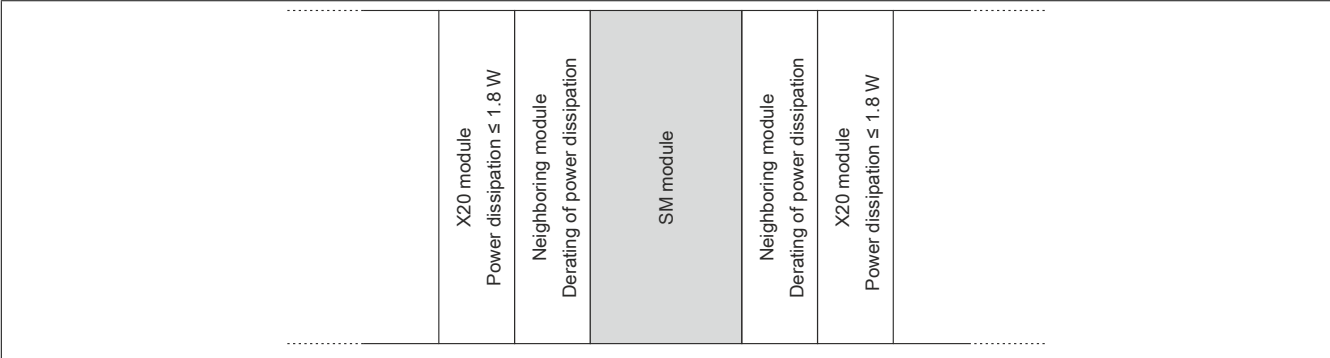
9.25.9.15 Derating

Only modules with a maximum power dissipation of 1 W are permitted to be operated next to the SM module. To ensure proper operation, observe the derating values listed below:

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.

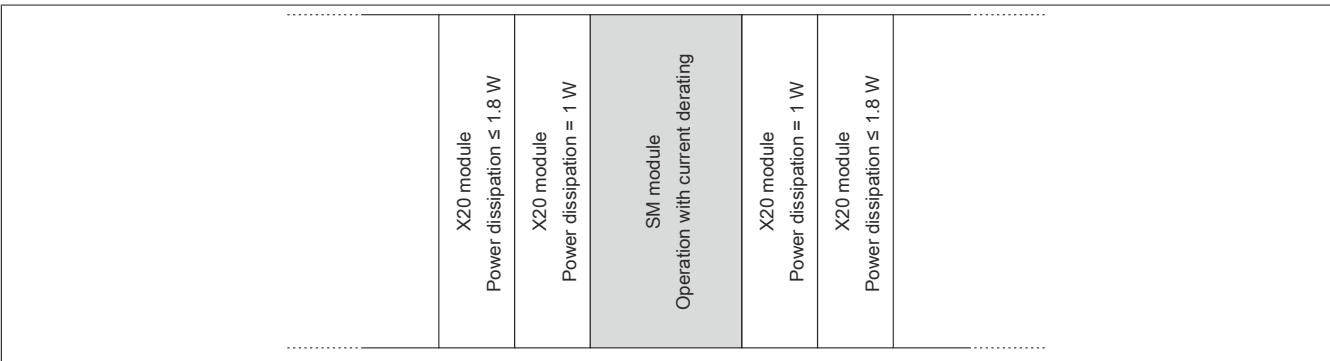
Power dissipation derating for neighboring modules

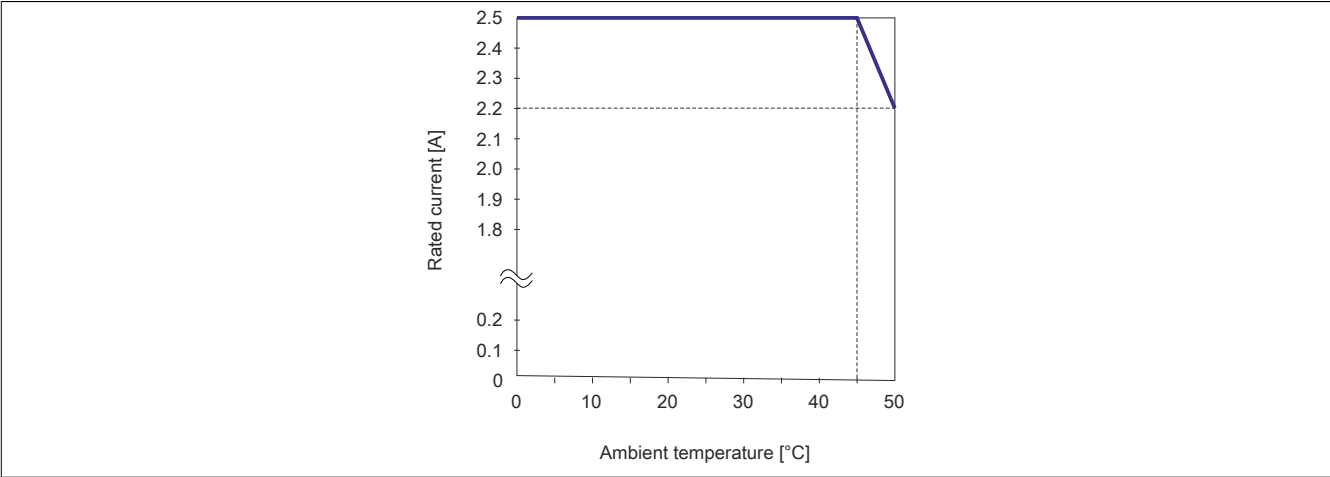
The power dissipation of immediate neighboring modules of the SM module is permitted to be 1 W. If the SM module is operated at the rated load over the entire temperature range (2.5 A nominal current), the power dissipation of neighboring modules must be derated starting at 45°C.



Current derating of the SM module

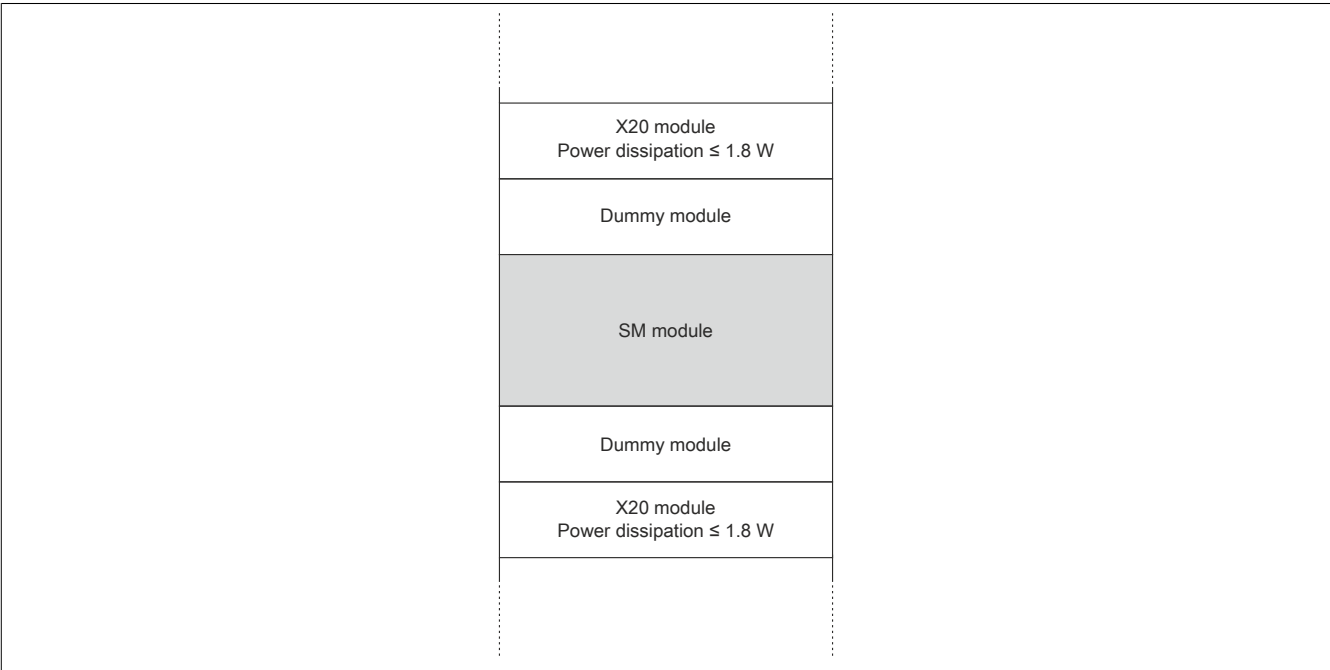
If the power dissipation of the neighboring modules to the SM module is 1 W, then the current of the SM module must be derated starting at 45°C.





Derating for vertical mounting orientation

When operating the module in a vertical mounting orientation, dummy modules must be connected as neighboring modules. There is no derating in this configuration.



9.25.9.16 Register description

9.25.9.16.1 mapp Motion system requirements

This module can be operated with mapp Motion function blocks. The following minimum versions are required for this:

- Upgrade version 2.2.0.0
- Automation Studio 4.7.2
- Automation Runtime 4.72

9.25.9.16.2 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.25.9.16.3 Function model 0 - "Standard" without SDC

| Register | Name | Data type | Read | | Write | |
|---------------------------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 46 | ConfigOutput02 (module configuration 1) | UINT | | | | • |
| 33 | ConfigOutput03 (holding current) | USINT | | | | • |
| 34 | ConfigOutput04 (nominal current) | USINT | | | | • |
| 35 | ConfigOutput05 (maximum current) | USINT | | | | • |
| 32 | ConfigOutput09 (counter configuration) | USINT | | | | • |
| 81 | MotorIdentTrigger | USINT | | | | • |
| 84 | FullStepThreshold01 | UINT | | | | • |
| 92 | StallDetectMinSpeed01 | UINT | | | | • |
| 120 | SGT_Speed01a | UINT | | | | • |
| 122 | SGT_Speed01b | UINT | | | | • |
| 124 | SGT_Value01a | INT | | | | • |
| 126 | SGT_Value01b | INT | | | | • |
| 130 | CfO_SmartEnable01 | UINT | | | | • |
| Reading back the configuration | | | | | | |
| 33 | ConfigOutput03Read (holding current) | USINT | | • | | |
| 34 | ConfigOutput04Read (nominal current) | USINT | | • | | |
| 35 | ConfigOutput05Read (maximum current) | USINT | | • | | |
| Communication | | | | | | |
| 6 | Positionasync | UINT | | • | | |
| 64 | PositionLatchedASync | INT | | • | | |
| 12 | Motoridentification01 | UINT | | • | | |
| Index* 2 + 16 | MotorStepN (index N = 0 to 3) | UINT | | | • | |
| 0 | PositionSync | INT | • | | | |
| 86 | PositionSync02 | INT | • | | | |
| 4 | Input counter value | USINT | • | | | |
| | ModulePowerSupplyError | Bit 0 | | | | |
| | StatusInput01 | Bit 2 | | | | |
| | StatusInput02 | Bit 3 | | | | |
| | StatusInput03 | Bit 4 | | | | |
| | StatusInput04 | Bit 5 | | | | |
| 10 | Error status | USINT | • | | | |
| | StallError | Bit 0 | | | | |
| | OvertemperatureError | Bit 1 | | | | |
| | CurrentError | Bit 2 | | | | |
| | OvercurrentError | Bit 3 | | | | |
| | OpenCircuit01 | Bit 12 | | | | |
| | ... | ... | | | | |
| OpenCircuit04 | Bit 15 | | | | | |
| 60 | PositionLatchedSync | INT | • | | | |
| 68 | usSinceTrigger | UINT | • | | | |
| 54 | Module configuration 2 | USINT | | | • | |
| | StartLatch | Bit 0 | | | | |
| | TriggerEdgePos | Bit 1 | | | | |
| | TriggerEdgeNeg | Bit 2 | | | | |
| | TriggerEdge | Bit 3 | | | | |
| | StartTrigger | Bit 4 | | | | |
| | ClearError | Bit 5 | | | | |
| | CurrentControlEnable | Bit 7 | | | | |
| | ... | ... | | | | |
| 72 | Stepper latch trigger status | USINT | • | | | |

| Register | Name | Data type | Read | | Write | |
|----------|--------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| | LatchInput | Bit 0 | | | | |
| | LatchDone | Bit 1 | | | | |
| | TriggerInput | Bit 4 | | | | |
| 74 | MotorLoad | UINT | • | | | |

9.25.9.16.4 Function model 0 - "Standard" with SDC

| Register | Name | Data type | Read | | Write | |
|---------------------------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| - | ConfigOutput02 (module configuration 1) | UINT | | | | • |
| 33 | ConfigOutput03 (holding current) | USINT | | | | • |
| 34 | ConfigOutput04 (nominal current) | USINT | | | | • |
| 35 | ConfigOutput05 (maximum current) | USINT | | | | • |
| 32 | ConfigOutput09 (counter configuration) | USINT | | | | • |
| 81 | MotorIdentTrigger | USINT | | | | • |
| 84 | FullStepThreshold01 | UINT | | | | • |
| 92 | StallDetectMinSpeed01 | UINT | | | | • |
| 102 | SDCConfig01 | USINT | | | | • |
| 103 | MotorSettingTime01 | USINT | | | | • |
| 107 | DelayedCurrentSwitchOff01 | USINT | | | | • |
| 120 | SGT_Speed01a | UINT | | | | • |
| 122 | SGT_Speed01b | UINT | | | | • |
| 124 | SGT_Value01a | INT | | | | • |
| 126 | SGT_Value01b | INT | | | | • |
| 130 | CF0_SmartEnable01 | UINT | | | | • |
| Reading back the configuration | | | | | | |
| 33 | ConfigOutput03Read (holding current) | USINT | | • | | |
| 34 | ConfigOutput04Read (nominal current) | USINT | | • | | |
| 35 | ConfigOutput05Read (maximum current) | USINT | | • | | |
| Communication | | | | | | |
| 6 | Positionasync | UINT | | • | | |
| 12 | Motoridentification01 | UINT | | • | | |
| 64 | PositionLatchedAsync | INT | | • | | |
| 112 | SetTime01 | INT | | | • | |
| 100 | Motor current | USINT | | | • | |
| | DriveEnable01 | Bit 0 | | | | |
| | BoostCurrent01 | Bit 1 | | | | |
| | StandstillCurrent01 | Bit 2 | | | | |
| | CurrentControlEnable01 | Bit 7 | | | | |
| 74 | MotorLoad | UINT | • | | | |
| 73 | LifeCnt | SINT | • | | | |
| 0 | ActPos01 | INT | • | | | |
| 4 | Input counter value | USINT | • | | | |
| | ModulePowerSupplyError | Bit 0 | | | | |
| | StatusInput01 | Bit 2 | | | | |
| | StatusInput02 | Bit 3 | | | | |
| | StatusInput03 | Bit 4 | | | | |
| | StatusInput04 | Bit 5 | | | | |
| 10 | Error status | USINT | • | | | |
| | StallError01 | Bit 0 | | | | |
| | OvertemperatureError01 | Bit 1 | | | | |
| | CurrentError01 | Bit 2 | | | | |
| | OvercurrentError01 | Bit 3 | | | | |
| | DrvOk01 | Bit 4 | | | | |
| | OpenCircuit01 | Bit 12 | | | | |
| | ... | ... | | | | |
| | OpenCircuit04 | Bit 15 | | | | |
| 54 | Error acknowledgment | USINT | | • | | |
| | ClearError01 | Bit 5 | | | | |
| 16 | Motor1Step0 | INT | | • | | |
| 200 | RefPulsePos01 | INT | • | | | |
| 204 | RefPulsePos01 | INT | • | | | |
| 212 | RefPulseCnt01 | SNT | • | | | |
| 214 | RefPulseCnt01 | SNT | • | | | |
| 220 | ActTime01 | INT | • | | | |
| 208 | TriggerTime01 | INT | • | | | |
| 216 | TriggerCnt01 | SINT | • | | | |

9.25.9.16.5 Function model 254 - "Bus controller" and function model 3 - "Ramp"

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|---------------------------------------|----------------------|---------------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 48 | - | ConfigOutput03a (holding current) | USINT | | | | • |
| 49 | - | ConfigOutput04a (nominal current) | USINT | | | | • |
| 50 | - | ConfigOutput05a (maximum current) | USINT | | | | • |
| 72 | - | FullStepThreshold01 | UINT | | | | • |
| 52 | - | MaxSpeed01pos | UINT | | | | • |
| 54 | - | MaxAcc01 | UINT | | | | • |
| 56 | - | MaxDec01 | UINT | | | | • |
| 58 | - | RevLoop01 | INT | | | | • |
| 60 | - | FixedPos01a | DINT | | | | • |
| 64 | - | FixedPos01b | DINT | | | | • |
| 68 | - | RefSpeed01 | UINT | | | | • |
| 74 | - | StallRecognitionDelay01 | USINT | | | | • |
| 75 | - | JoltTime01 | USINT | | | | • |
| 78 | - | StallDetectMinSpeed01 | UINT | | | | • |
| 70 | - | RefConfig01 | SINT | | | | • |
| 120 | - | SGT_Speed01a | UINT | | | | • |
| 122 | - | SGT_Speed01b | UINT | | | | • |
| 124 | - | SGT_Value01a | INT | | | | • |
| 126 | - | SGT_Value01b | INT | | | | • |
| 130 | - | CfO_SmartEnable01 | UINT | | | | • |
| 306 | - | GeneralConfig01 | USINT | | | | • |
| 308 | - | LimitSwitchConfig01 | USINT | | | | • |
| 344 | - | PositionLimitMin01 | DINT | | | | • |
| 348 | - | PositionLimitMax01 | DINT | | | | • |
| Reading back the configuration | | | | | | | |
| 48 | - | ConfigOutput03aRead (holding current) | USINT | | • | | |
| 49 | - | ConfigOutput04aRead (nominal current) | USINT | | • | | |
| 50 | - | ConfigOutput05aRead (maximum current) | USINT | | • | | |
| Communication | | | | | | | |
| 0 | 0 | AbsPos01 | DINT | | | • | |
| 4 | 4 | MpGenControl01 | UINT | | | • | |
| 6 | 6 | MpGenMode01 | SINT | | | • | |
| 0 | 0 | AbsPos01ActVal | DINT | • | | | |
| 4 | 4 | MpGenStatus01 | UINT | • | | | |
| 6 | 6 | InputStatus | USINT | • | | | |
| 8 | 8 | MotorLoad | UINT | • | | | |
| 84 | - | Motoridentification01 | UINT | | • | | |
| 86 | - | RefPos01CyclicCounter | DINT | | • | | |
| 94 | - | RefPos01AcyclicCounter | DINT | | • | | |
| 90 | - | AbsPos1ActValAcyclic | DINT | | • | | |
| 80 | - | ControlReadback01 | UINT | | • | | |
| 82 | - | ModeReadback01 | SINT | | • | | |
| 98 | - | ErrorCode01 | UINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.25.9.16.5.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "Using I/O modules on the bus controller" on page 3789.

9.25.9.16.5.2 CAN I/O bus controller

The module occupies 2 analog logical slots on CAN I/O.

9.25.9.16.6 Register description: General registers

9.25.9.16.6.1 General configuration registers

Determining the SGT parameters

Due to the dependence of the [MotorLoad value](#) on motor-specific properties and application-specific load and speed requirements, the operating conditions should be matched to the actual application.

To reliably detect a standstill of the motor, the stall threshold must be determined. The stall threshold should be a value within the operating limits and slightly higher than the minimum value before an actual motor standstill occurs.

- Parameter [SGT_Value01x](#) is used to compensate for an offset that results from the back EMF of the motor. For this purpose, the maximum load that the motor can run without blocking must be determined. Ideally, the MotorLoad load value should drop to 0 before a step loss due to overload causes the motor to stop. If the value of [SGT_Value01x](#) is set so that a value of 0 is displayed at maximum motor load, then the stall is precisely detected and the [stall error bit](#) is set correctly. For some motors, however, stall detection is very difficult to use or cannot be used at all. With these motors, no settings can be determined where the motor stops without slipping, e.g. due to electrical parameters or too little magnetic field feedback from the motor.
- [SGT_Speed01x](#) sets the threshold value at which speed the determined [SGT_Speed01x](#) becomes active. These are:

| | |
|---------------------|--|
| SGT_Value01a | From 0 to SGT_Speed01a |
| SGT_Value01b | From SGT_Speed01b to maximum |

Since the [MotorLoad value](#) drops to 0 during acceleration from standstill, this would be incorrectly detected as a stall and the motor would stop again immediately. Register [StallDetectMinSpeed01](#) can therefore be used to set a minimum speed at which stall detection is enabled.

Information:

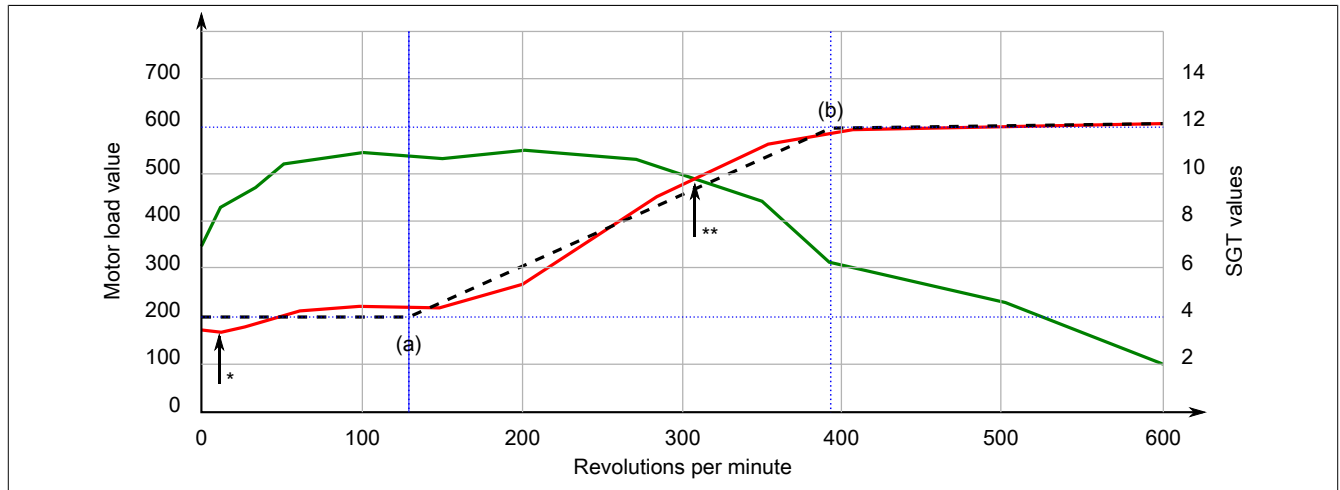
- **At very low motor speeds (<1 revolution/second), stall detection cannot be carried out reliably due to low back EMF values.**
- **At very high motor speeds, at which the sinusoidal motor current can no longer be impressed into the motor coil, poor responsiveness can also occur.**

Determining the motor load characteristic curve

To be able to set the points (SGT_Value01a and SGT_Value01b) for the offset of the MotorLoad value, creating a motor load characteristic curve is helpful.

This graph shows an example of 200 steps per revolution:

| | SGT_Value | SGT_Speed |
|-----------|-----------|--|
| Value (a) | 4 | 129 revolutions/minute = 430 steps/second |
| Value (b) | 12 | 392 revolutions/minute = 1307 steps/second |



Legend

- Green line Motor load characteristic curve without load
- Red line Offset-corrected motor load characteristic curve
- Black line Interpolated motor load characteristic curve
- * Minimum speed for stall detection (>10 rpm)
- ** Back EMF reaches supply voltage

Since the back EMF increases with increasing speed (MotorLoad value decreases to 0) and counteracts, there is a maximum speed for stall detection.

SGT speed

Name:

SGT_Speed01a to SGT_Speed01b

The associated speed value for the respective SGT_Value can be set in these registers.

| Data type | Values | Information |
|-----------|-------------|--|
| UINT | 0 to 65,535 | In microsteps / X2X cycle (function model "Standard") In microsteps/cycle (function models "Bus controller" and "Ramp") |

SGT correction values

Name:

SGT_Value01a to SGT_Value01b

These registers optimize the motor load measurement.

The SGT value (Stallguard threshold) optimizes the motor load measurement. A negative value increases the sensitivity of the measurement; a positive value decreases it.

The correction value used depends on the value of SGT_Speed. The following applies:

- SGT_Value01 is used if the motor speed ≤ SGTSpeed01.
- SGT_Value02 is used if the motor speed ≥ SGTSpeed02.
- If the motor speed lies between the values, the SGT_Value is interpolated linearly.

The initial value for the optimization is 0. Values below -10 or over +10 should not be used.

| Data type | Values |
|-----------|-----------|
| INT | -64 to 63 |

Load-dependent current control

Load-dependent current control uses the **MotorLoad** value to reduce the current for the motor when the motor is only slightly loaded. In addition to saving energy, this also reduces the noise level of the motor. In addition, the motor is not heated as much. If a heavier load is again placed on the motor, the motor current is increased and thus more torque can be applied.

To set the load-dependent current control, 2 parameters must be set with "**MotorLoad_UpperLimit**" on page 2716 and "**MotorLoad_LowerLimit**" on page 2716 so that they can be increased or decreased as needed.

Stall detection for constant speed

If stall detection is only needed for a constant speed, the module can be configured as follows:

- 1) Set the initial values.
 - Disable current control. (**CurrentControlEnabel01** = 0)
 - Disable stall detection. (**StallDetectMinSpeed01** = 65535)
 - Set register **SGT_Speed01x** to 0.
 - Set register **SGT_Value01x** to 0.
- 2) Operate the motor at the speed needed for the application without load and observe the **MotorLoad** value.
- 3) Adjust the value.
 - a) Slowly increase the load on the motor. If the motor stops before the **MotorLoad** value indicates 0, reduce **SGT_Value01x** by 1.

Information:

Registers **SGT_Value01a and **SGT_Value01b** must always be set to the same value!**

- b) If the **MotorLoad** value is 0 before the motor stops, increase **SGT_Value01x** by 1. The optimal setting is achieved when the **MotorLoad** value remains above 0 at the maximum load necessary. If the value becomes 0, the maximum load on the motor is exceeded. In this case, bit 0 "StallError" is set in register **Error status**.
- 4) In register **StallDetectMinSpeed01**, set the speed value from which stall detection is enabled.

Stall detection for variable speeds

If stall detection is needed for a range of speeds ([SGT_Speed01a](#) and [SGT_Speed01b](#)), the module can be configured as follows:

- 1) Set the initial values.
 - Disable current control. ([CurrentControlEnabel01](#) = 0)
 - Disable stall detection. ([StallDetectMinSpeed01](#) = 65535)
 - Set register [SGT_Speed01x](#) to 0.
 - Set register [SGT_Value01x](#) to 0.
- 2) Operate the motor at the start of the speed range ([SGT_Speed01a](#)) without load and observe the [MotorLoad value](#).
- 3) Adjust the value.
 - a) Slowly increase the load on the motor. If the motor stops before the [MotorLoad value](#) indicates 0, reduce [SGT_Value01x](#) by 1.
 - b) If the [MotorLoad](#) value is 0 before the motor stops, increase [SGT_Value01x](#) by 1. The optimal setting is achieved when the [MotorLoad](#) value remains above 0 at the maximum load necessary. If the value becomes 0, the maximum load on the motor is exceeded. In this case, bit 0 "StallError" is set in register [Error status](#).
- 4) Operate the motor at the end of the speed range ([SGT_Speed01b](#)) without load and observe the [MotorLoad value](#).
- 5) Adjust the value, see 3.
- 6) Set the determined range values.

The [SGT_Value0x](#) values between the range start and range end are interpolated linearly.

 - Set [SGT_Value01a](#) and [SGT_Speed01a](#) for the range start with the determined values.
 - Set [SGT_Value01b](#) and [SGT_Speed01b](#) for the range end with the determined values.
- 7) In register [StallDetectMinSpeed01](#) , set the speed value from which stall detection is enabled.

Configuring current control

Name:

CfO_SmartEnable01

The values for load-dependent current control can be set in this register. For reduced motor loads, the power supply can be reduced to a minimum of 25% nominal current in order to save electricity.

For increased motor loads, the module automatically adjusts the power supply according to the set values.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|---------|---|---------|--|
| 0 - 3 | MotorLoad_LowerLimit | 0 | Current control disabled (bus controller default setting) |
| | | 1 to 15 | |
| 4 | Reserved | - | |
| 5 - 6 | Current increase¹⁾ | 0 | 1 measured values (bus controller default setting) |
| | | 1 | 2 measured values |
| | | 2 | 4 measured values |
| | | 3 | 8 measured value |
| 7 | Reserved | - | |
| 8 - 11 | MotorLoad_UpperLimit | 0 to 15 | |
| 12 | Reserved | - | |
| 13 - 14 | Current decrease¹⁾ | 0 | 32 measured values (bus controller default setting) |
| | | 1 | 8 measured values |
| | | 2 | 2 measured values |
| | | 3 | 1 measured value |
| 15 | Current reduction | 0 | Reduction to 50% of the nominal current (bus controller default setting) |
| | | 1 | Reduction to 25% of the nominal current |

1) The measured values are recorded with each full step of the motor.

MotorLoad_LowerLimit

Increase of the current up to a maximum of 100% of the nominal current set in register "ConfigOutput04" on page 2718 if `MotorLoad` < (`MotorLoad_LowerLimit` * 32). If `MotorLoad_LowerLimit` = 0, load-dependent current control is disabled.

Current increase

Specifies the number `MotorLoad` measured values that are less than or equal to the limit value (`MotorLoad_LowerLimit` * 32) in order to increase current.

MotorLoad_UpperLimit

Reduction of the current if `MotorLoad` > (`MotorLoad_LowerLimit` + `MotorLoad_UpperLimit` + 1) * 32.

Current decrease

Number of `MotorLoad` measured values that are greater than or equal to the limit value (`MotorLoad_LowerLimit` + `MotorLoad_UpperLimit` + 1) * 32 in order to decrease the current.

Current reduction

Maximum reduction of the current to 25% or 50% of the nominal current.

9.25.9.16.7 Register description: Function model "Standard", general registers**9.25.9.16.7.1 Configuration registers****Minimum speed for stall detection**

Name:

StallDetectMinSpeed01

If the motor speed exceeds the value set in this register, then stall detection is enabled. This means that stall detection principally does not work at low speeds.

| Data type | Values | Information |
|-----------|-------------|------------------------------------|
| UINT | 0 to 65,535 | Minimum speed in steps per second. |

Full step threshold

Name:

FullStepThreshold01

This register configures a rotational speed. When this defined speed has been reached, the drive will automatically change from microsteps to full step mode. This makes it possible to optimize the torque at higher speeds, while microstep mode ensures optimal radial runout at lower speeds.

It does not make sense to change to full step mode at a standstill because fine positioning would then no longer be possible. This is why value "0" does not make sense in the full step threshold register and is interpreted as disabling full step mode (i.e. the motor will always be operated in microstep mode).

| Data type | Values | Information |
|-----------|-------------|-------------------------|
| UINT | 0 | Full step mode disabled |
| | 1 to 65,535 | Steps/second |

Example

Microstep mode should change to full step mode at 500 steps/second. On a motor with 200 steps per revolution, this would be equal to a speed of:

$$T^{-1} = \frac{500 \text{ steps/second}}{200 \text{ steps/revolution}} = 2.5 \frac{\text{revolutions}}{\text{second}} = 150 \text{ min}^{-1}$$

Holding current, nominal current and maximum current

Name:

ConfigOutput03 (holding current)

ConfigOutput04 (nominal current)

ConfigOutput05 (maximum current)

The holding current, nominal current and maximum current registers are used to configure the desired motor current.

Reasonable values are:

- Holding current < Nominal current < Maximum current

Information:

The maximum current must always be configured higher than the nominal current.

The motor's nominal current is entered in the nominal current register according to the motor's data sheet.

| Register | Description |
|-----------------|---|
| Nominal current | Current during normal operation |
| Maximum current | Should be selected if a higher motor torque is required briefly during acceleration phases. |
| Holding current | The holding current should be used in situations when less torque is required (e.g. at a standstill). This reduces the amount of heat generated by the motor. |

Switching between preset current values (holding current, rated current, maximum current):

| Function model | Switching between preset current values at runtime |
|---------------------------------------|--|
| Standard | Using bits 14 and 15 in registers "Motor StepX" on page 2723 |
| Standard with enabled SDC information | Using register "Motor current" on page 2728 |

| Data type | Values | Unit |
|-----------|----------|---|
| USINT | 0 to 200 | Percent of the module's rated current <ul style="list-style-type: none"> • 100% corresponds to the rated current of the motor bridge power unit listed in the technical data • 200% corresponds to the maximum current of the motor bridge power unit listed in the technical data. |

Counter configuration

Name:

ConfigOutput09

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------------|-------|--|
| 0 | ABR latch function | 0 | Negative edge: Disable ABR latch function |
| | | 1 | Positive edge: Enable ABR latch function. After a latch event has occurred, the latch function can be started again on a new rising edge. |
| 1 - 2 | Definition of the latch mode | 00 | ABR latch counter state unconditionally |
| | | 01 | ABR latch counter state on a positive edge of input R |
| | | 10 | ABR latch counter state on a negative edge of input R |
| | | 11 | Reserved |
| 3 | | 0 | <ul style="list-style-type: none"> • Position sync: Internal position counter • Position async: ABR counter state • Position latched sync: Internal position counter • Position latched async: ABR counter state |
| | | 1 | <ul style="list-style-type: none"> • Position sync: ABR counter state • Position async: Internal position counter • Position latched sync: ABR counter state • Position latched async: Internal position counter |
| 4 - 7 | Reserved | | |

1) These registers are not available in function model "Standard" with SDC information enabled.

Motor ID trigger

Name:

MotorIdentTrigger

With this register, a measurement of the motor ID can be initiated acyclically (see "[Motor identification](#)" on page 2721). The application must ensure that the conditions for measurement are met (see table "Notes" in register "[Motor identification](#)" on page 2721).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|---|
| 0 | | 0 | No effect |
| | | 1 | Positive edge triggers motor identifier measurement |
| 1 - 7 | Reserved | 0 | |

9.25.9.16.7.2 Registers for reading back the configuration

Reading back the holding current, nominal current and maximum current

ConfigOutput03Read (holding current)

ConfigOutput04Read (nominal current)

ConfigOutput05Read (maximum current)

These registers are used to read the respective current values in percent.

| Register | Description |
|-----------------|--|
| Nominal current | Current during operation at constant speed |
| Maximum current | Current during acceleration phases |
| Holding current | Current when motor is at standstill |

| Data type | Values | Unit |
|-----------|----------|---|
| USINT | 0 to 255 | Percentage of module's nominal current (100% corresponds to the nominal current of the motor bridge power unit in the technical data) |

9.25.9.16.7.3 Communication registers

Measuring motor load

Name:

MotorLoad

This register contains the current measured load value for stall detection. A high value indicates a small load on the motor; the lower the value, the higher the motor load. The SGT values (see "[SGT speed](#)" on page 2714 and "[SGT correction values](#)" on page 2714) should be set so that the motor load returns value 0 at maximum load (shortly before stall).

This register can be shown and hidden via the module configuration.

| Data type | Values |
|-----------|-----------|
| UINT | 0 to 1023 |

Module configuration 1

Name:

ConfigOutput02

The number of transfer values and the resolution of microsteps for the drive can be configured in this register.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|--|-------|---|
| 0 | The setting for these two bits determines the meaning of bits 2 and 3 in register "Input counter value" on page 2725. | x | |
| 1 - 2 | Reserved | 0 | |
| 3 - 4 | Number of transfer values per X2X Link cycle (see "Motor StepX" on page 2723) | 00 | $1 \times \Delta s / \Delta t$ (transfer values: MotorStep0) |
| | | 01 | $2 \times \Delta s / \Delta t$ (transfer values: MotorStep0 - MotorStep1) |
| | | 10 | $4 \times \Delta s / \Delta t$ (transfer values: MotorStep0 - MotorStep3) |
| | | 11 | Reserved |
| 5 - 6 | Resolution of microsteps for the following registers: <ul style="list-style-type: none"> "Motor StepX" on page 2723 "Position sync/async" on page 2720 | 00 | Resolution: 5 bits (bits 0 - 4) microsteps; 8 bits (bits 5 - 13) full steps |
| | | 01 | Resolution: 6 bits (bits 0 - 5) microsteps; 7 bits (bits 6 - 13) full steps |
| | | 10 | Resolution: 7 bits (bits 0 - 6) microsteps; 6 bits (bits 7 - 13) full steps |
| | | 11 | Resolution: 8 bits (bits 0 - 7) microsteps; 5 bits (bits 8 - 13) full steps |
| 7 - 15 | Reserved | 0 | |

Position sync/async

Name:

PositionSync (function model 1 - "Standard" with SDC)

ActPos01 (function model 0 - "Standard" without SDC)

Positionasync

Depending on the [Counter configuration](#), these registers can be used to read either the internal position counter or the counter value on the ABR input.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

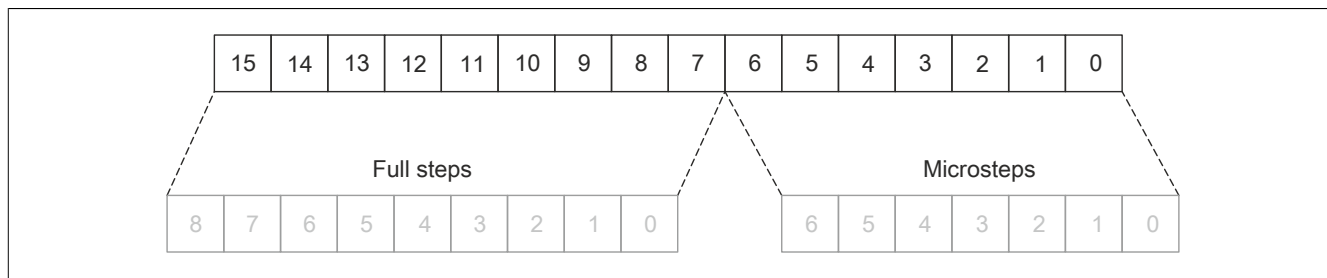
| Register | Counter configuration | |
|--------------------------|---------------------------|---------------------------|
| | Bit 3 = 0 | Bit 3 = 1 |
| Position sync (ActPos01) | Internal position counter | ABR counter |
| Position async | ABR counter | Internal position counter |

Internal position counter

The internal position counter is the position calculated by the SM module (position setpoint). This is a cyclic 16-bit counter.

The lowest 5 to 8 bits represent microsteps, while the highest 8 to 11 bits represent full steps (depending on bits 5 and 6 of the "Module configuration 1" on page 2720). In function model "Standard" with SDC, this value is defined as "8-bit microstep" and cannot be changed.

Example of the internal position counter format (7-bit microsteps, i.e. set bit 5 and 6 of the module configuration to binary 10):



ABR counter

This counter is a cyclic 16-bit counter. The relationship between this counter and the internal position counter depends on the resolution of the ABR encoder and the microsteps defined for the internal position counter.

Motor identification

Name:

Motoridentification01

This register is used to identify the connected motor type for service purposes and to differentiate between motors in the application. After successful measurement, this register contains the time [µs] required to apply a current increase of $\Delta I = 1 \text{ A}$ to a motor winding.

This depends on:

- Operating voltage
- Inductance and resistance of the motor winding

| Notes | | |
|-----------|---|--|
| 1) | To achieve reproducible results, the measurement must be made under the following defined conditions: | |
| a) | Motor is at standstill. | |
| b) | The motor must be in a half-step position (phase A fully powered, phase B not powered). This means the internal position counter on the SM module must have a value that fulfills the following conditions: <ul style="list-style-type: none"> • Full steps are divisible by 4. • Microsteps = 0 | |
| 2) | Condition 1b) is fulfilled after a the SM module is reset or switched on. Immediately afterwards, when the holding current is applied to the motor for the first time (at standstill), the duration for applying the current is measured. This is therefore a suitable time to read the motor identification register in the application. | |
| 3) | The current range from approximately 1/3 of the nominal current up to the nominal current is used as operating range for determining the motor identifier. | |
| Data type | Motor ID values | Explanation |
| UINT | 0 | No motor identifier available (after switching on for as long as the measurement conditions are not met) |
| | 1 to 32767 | Valid range of values for the motor ID register (in µs) |
| | 65534 | Invalid value: Overflow |

Error status

Name: The names of the bits are different depending on whether [SDC information](#) is enabled or disabled.

Without SDC

StallError

Overtemperature

ErrorCurrentError

OvercurrentError

-

With SDC

StallError01

Overtemperature01

ErrorCurrentError01

OvercurrentError01

DrvOK01

OpenCircuit01 to OpenCircuit04

The current error status of the drive is indicated in this register. Each bit indicates a certain error or status. If an error is registered in bits 0 to 3, then the corresponding bit remains set until the error has been acknowledged (see "[Module configuration 2](#)" on page 2726 and "[Error acknowledgment](#)" on page 2729).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|---|-------|---|
| 0 | StallError(01) | 0 | No stall |
| | | 1 | Stall |
| 1 | Overtemperature error OvertemperatureError(01) | 0 | No overtemperature |
| | | 1 | Overtemperature |
| 2 | Current error CurrentError(01) | 0 | No current error |
| | | 1 | Current error |
| 3 | Overcurrent error OvercurrentError(01) | 0 | No overcurrent |
| | | 1 | Overcurrent |
| 4 | Status of the drive DrvOk0 ¹⁾ | 0 | An error was triggered for the motor axis |
| | | 1 | The drive is running error-free |
| 5 - 11 | Reserved | 0 | |
| 12 | Open circuit OpenCircuit01 | 0 | No open circuit |
| | | 1 | Open circuit detected |
| ... | | ... | |
| 15 | Open circuit OpenCircuit04 | 0 | No open circuit |
| | | 1 | Open circuit detected |

1) Only when SDC information is enabled

Overtemperature error

The "Overtemperature" error bit can be set for the following reasons:

- A specific temperature was exceeded near the channel due to overload
- The module temperature rises above the limit (see ["Shutdown in the event of overtemperature \(starting at 110°C\)" on page 2704](#)).

Current error

This error bit occurs whenever the required current cannot be supplied to the motor windings. This can be (but is not necessarily) caused by an open circuit. At higher speeds (depending on the motor), this error can also occur without an open circuit. In this case it is simply no longer possible to supply the desired current to the motor windings. Because of the Back-EMF on the motor, this bit is set at slightly lower speeds if the motor is operated with no load compared with full or partial loads.

Overcurrent error

Overcurrent occurs if there is not enough voltage for the motor winding (e.g. short circuit).

Status of the drive

The status of the drive is only shown when SDC information is enabled. The drive bit is 1 when the following conditions are met:

- Motor turned on (see ["Motor current" on page 2728](#))
- MotorID measurement is completed
- Motor is supplied with current
- Motor settling time has passed
- Supply voltage is in the valid range
- No overtemperature fault
- Preset position value is valid (see ["SDC life sign monitoring" on page 2728](#))

Open circuit

The module is equipped with open circuit detection for the digital inputs. If the digital input is not connected to ground or to 24 V, an open circuit is detected.

9.25.9.16.8 Register description: Function model "Standard" without SDC information

9.25.9.16.8.1 Communication registers

Motor StepX

Name:

MotorStep0 to MotorStep3

These registers specify the number and direction of steps that must be moved by the module during the next X2X cycle and also select the motor current (see also "[Holding current, nominal current and maximum current](#)" on page 2718).

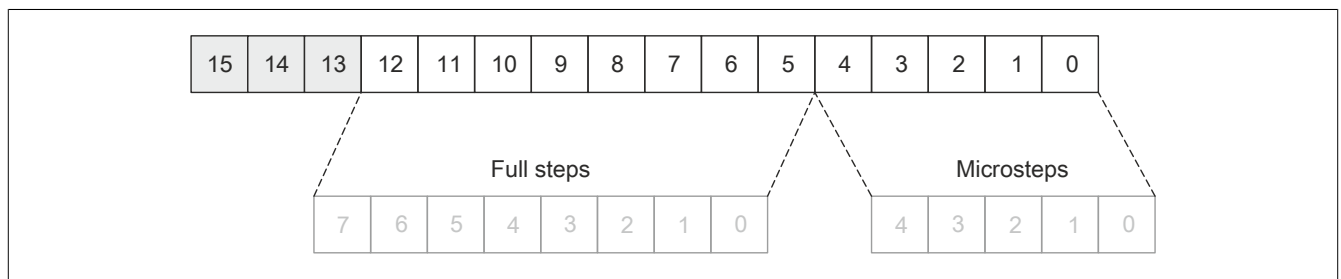
| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|--|-------|-------------------|
| 0 - 12 | Number of steps for the module to move during the next X2X cycle | x | |
| 13 | Direction of movement | 0 | Positive |
| | | 1 | Negative |
| 14 - 15 | Selection of motor current | 00 | Motor not powered |
| | | 01 | Holding current |
| | | 10 | Nominal current |
| | | 11 | Maximum current |

Depending on the necessary resolution and maximum configurable speed, module configuration 1 can be used to specify which bit position is used as the 1s position for full steps (see bits 5 and 6 of "[Module configuration 1](#)" on page 2720).

Example for 5-bit microsteps (set bits 5 and 6 of the module configuration to binary 00):



The number of transfer values per X2X cycle is specified by bits 3 and 4 in the module configuration 1 (see "[Module configuration 1](#)" on page 2720). If only one transfer value (bits 3 and 4 = 00) is specified, then the motor is advanced by MotorStep0 until the next X2X cycle. If 2 or 4 transfer values are specified, they are added and executed in the next X2X cycle.

Position latched sync-async

Name:

PositionLatchedSync

PositionLatchedASync

The position counter (internal position counter or ABR counter) is applied at the latch event (see "Module configuration 2" on page 2726). Bits 3 and 7 of register "Counter configuration" on page 2718 are used to determine which counter state (internal position counter or ABR encoder) should be saved in registers "Position latched sync" and "Position latched async".

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

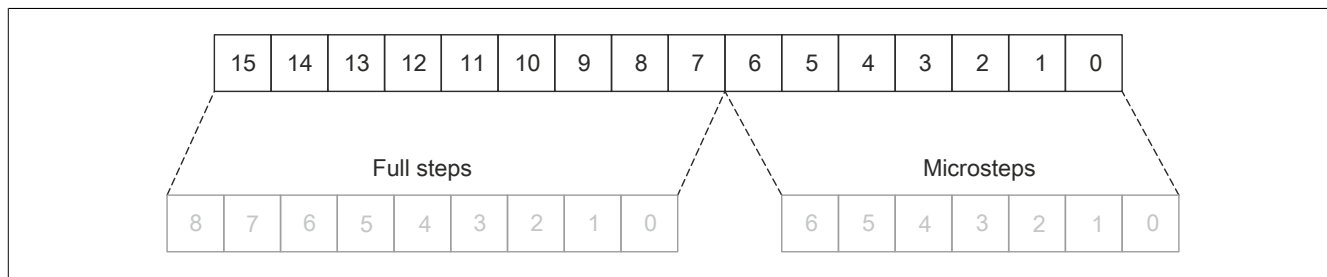
| Register | Counter configuration | |
|----------------|---------------------------|---------------------------|
| | Bit 3 = 0 | Bit 3 = 1 |
| Position sync | Internal position counter | ABR counter |
| Position async | ABR counter | Internal position counter |

Internal position counter

The internal position counter is the position calculated by the module (position setpoint). This is a cyclic 16-bit counter.

The lowest 5 to 8 bits represent microsteps, while the highest 8 to 11 bits represent full steps (depending on bits 5 and 6 of the "Module configuration 1" on page 2720).

Example of the internal position counter format (7-bit microsteps, i.e. set bit 5 and 6 of the module configuration to binary 10):



ABR counter

This counter is a cyclic 16-bit counter. The relationship between this counter and the internal position counter depends on the resolution of the ABR encoder and the microsteps defined for the internal position counter.

usSinceTrigger

Name:

usSinceTrigger

This register indicates the time in μs that has passed since the trigger event occurred (see "Module configuration 2" on page 2726).

Information:

The absolute accuracy of the trigger can be delayed up to 5 μs due to the input filter of the digital inputs.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

Stepper latch trigger status

Name:

LatchInput

LatchDone

TriggerInput

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------|-------|---|
| 0 | Latch input: | x | Digital input for the latch event (level) |
| 1 | LatchDone | x | Changes its state each time the counter state is successfully latched (reset value = 0) |
| 2 - 3 | Reserved | - | |
| 4 | TriggerInput | x | Trigger input (level) |
| 5 - 7 | Reserved | 0 | |

9.25.9.16.8.2 Input counter value

Name:

ModulePowerSupplyError

StatusInput01 to StatusInput04

This register indicates the state of the digital inputs and counters.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------|---|--|
| 0 | ModulePowerSupplyError | 0 | OK |
| | | 1 | Module power supply error |
| 1 | Reserved | 0 | |
| 2 | StatusInput01 | If bit 0 in Module configuration 1 = 0 | |
| | | 0 or 1 | Input state - Digital input 1 |
| | | If bit 0 in Module configuration 1 = 1 | |
| | | x | Ref toggle bit for counter 1: The state of this bit is changed after homing is completed. |
| 3 | StatusInput02 | If bit 0 in Module configuration 1 = 0 | |
| | | 0 or 1 | Input state - Digital input 2 |
| | | If bit 0 in Module configuration 1 = 1 | |
| | | 0 | The homing procedure for the ABR counter is active. |
| | | 1 | The homing procedure of the ABR counter is completed. |
| 4 | StatusInput03 | 0 or 1 | Input state - Digital input 3 |
| 5 | StatusInput04 | 0 or 1 | Input state - Digital input 4 |
| 6 - 7 | Reserved | 0 | |

9.25.9.16.8.3 Configuration registers

Module configuration 2

Name:

StartLatch

TriggerEdgePos

TriggerEdgeNeg

StartTrigger

TriggerEdge

ClearError

CurrentControlEnable

The trigger functions for the stepper motor can be configured with this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|---|
| 0 | Latch function for stepper motor 2 Latch byte | 0 | The latch function for stepper motor position is disabled on the negative edge of this bit. |
| | | 1 | The latch function for stepper motor position is disabled on the positive edge of this bit. |
| 1 - 2 | Latch mode for stepper motor TriggerEdgePos (bit 1) TriggerEdgeNeg (bit 2) | 00 | Latch position of stepper motor unconditional |
| | | 01 | Latch position of stepper motor on positive edge of input DI 3 |
| | | 10 | Latch position of stepper motor on negative edge of input DI 3 |
| | | 11 | Reserved |
| 3 | TriggerEdge | 0 | Trigger edge (input DI 4) = Positive |
| | | 1 | Trigger edge (input DI 4) = Negative |
| 4 | Enable trigger (on change) StartTrigger | x | |
| 5 | ClearError | 0 | No effect |
| | | 1 | Error acknowledgment for motor (for more information, see "Error status" on page 2721) |
| 6 | Reserved | - | |
| 7 | CurrentControlEnable | 0 | Enable load-dependent current control |
| | | 1 | Disable load-dependent current control |

Trigger function procedure:

- Selection of the desired trigger edge using bit 3
- Enabling of the trigger function by changing the state of bit 4. Changing this bit deletes `usSinceTrigger` (μ s counter).
- When the trigger event occurs, μ s counter `usSinceTrigger` is started.
- Counter `usSinceTrigger` cannot overflow, i.e. the counter is stopped at $2^{16} - 1$ and retains this value until the next time the trigger function is enabled.

The trigger function can be re-enabled at any time by changing the state of bit 4, regardless of whether a trigger event has occurred or if `usSinceTrigger` has reached the maximum value.

Position sync 2

Name:

PositionSync02

This register contains the state of either the position counter or the ABR counter depending on [Counter configuration](#) (bit 3). It behaves exactly complementary to register "Position sync" on page 2720.

If "Position sync" contains the position counter, then register "PositionSync02" contains the ABR counter state, and vice versa.

By default, the register is not visible in the I/O map; it must first be enabled in the I/O configuration.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

9.25.9.16.9 Register description: Function model "Standard" with SDC information

9.25.9.16.9.1 Configuration registers

SDC configuration

Name:
SDCConfig01

This register can be used to enable/disable additional SDC information.

The additional cyclic registers are hidden or shown depending on whether SDC information is disabled or enabled. Compare the two variants of function model "Standard" [with](#) and [without enabled SDC information](#).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------------------------|-------|----------------------|
| 0 | Trigger edge | 0 | Rising trigger edge |
| | | 1 | Falling trigger edge |
| 1 - 5 | Reserved | 0 | |
| 6 | SDC life sign monitoring | 0 | Disabled |
| | | 1 | Enabled |
| 7 | SDC information ¹⁾ | 0 | Disabled |
| | | 1 | Enabled |

- 1) When the "SDC information" bit is enabled, the "EncOK01" bit is shown in the Automation Studio I/O mapping. This bit is linked to the ModulOK bit and always indicates its value.

Information:

Neither SDC information nor SDC life sign monitoring is permitted to be changed at runtime.

Module configuration 1 with SDC

Register "[Module configuration 1](#)" on page 2720 is ignored in function model "Standard" with SDC information enabled. The module behaves as follows, i.e. whether the module configuration was written in this way:

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|--|-------|---|
| 0 | Meaning of bits 2 and 3 in register " Input counter value " on page 2729 | | |
| 1 - 2 | Reserved | 0 | |
| 3 - 4 | Number of transfer values per X2X cycle | 00 | 1x Δs / Δt (transfer values: motor settings Motor1Step0) |
| 5 - 6 | Resolution of microsteps | 11 | 8-bit microsteps |
| 7 - 15 | Reserved | 0 | |

Motor settling time

Name:
MotorSettlingTime01

This register determines the motor setting time. The motor settling time determines the minimum time between when the motor is powered on to when the DrvOk bit is set (see "[Error status](#)" on page 2721). The setting is made in steps of 10 ms.

| Data type | Values | Information |
|-----------|----------|---------------------------------|
| USINT | 1 to 255 | 10 ms to 2.55 s, default: 10 ms |

Switch-off delay

Name:
DelayedCurrentSwitchOff01

If the [SDC life sign monitoring](#) is triggered (i.e. the [NetTime timestamp](#) is in the past) the motor is decelerated at nominal current with speed setpoint = 0.

Then the motor is switched off after the delay configured with this register.

| Data type | Values | Information |
|-----------|----------|--|
| USINT | 0 to 255 | 0 to 25.5 s in steps of 100 ms (default: 100 ms) |

9.25.9.16.9.2 Communication registers**SDC life sign monitoring**

Name:

SetTime01

The module uses SDC life sign monitoring to check whether valid values have been received for the speed setpoint.

SDC life sign monitoring is enabled in register "SDC configuration" on page 2727 by setting bit 6 (SDCSetTime = On).

If the specified [NetTime timestamp](#) is in the past, then an error is triggered for the motor axis (only when the motor is switched on). The module performs the following steps:

- 1) The CPU is informed of the error using the Drive bit (DrvOk) = 0
- 2) Braking at configured nominal current with speed setpoint = 0
- 3) Wait for configured turn-off delay to expire
- 4) Power off motor

When the timestamp is back within the valid range, the motor can be operated again by a rising edge on bit "DriveEnable" (see "[Motor current](#)" on page 2728) .

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

Motor current

Name:

DriveEnable01

BoostCurrent01

StandstillCurrent01

CurrentControlEnable01

Bits 0 to 2 of this register control the motor's current feed.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------|-------|---|
| 0 | DriveEnable01 | x | Motor powered |
| 1 | BoostCurrent01 | x | Maximum current |
| 2 | StandstillCurrent01 | x | Holding current |
| 3 - 6 | Reserved | 0 | |
| 7 | CurrentControlEnable01 | 0 | Load-dependent current control disabled |
| | | 1 | Load-dependent current control enabled |

The possible status of bits 0 to 2

| StandstillCurrent01 | BoostCurrent01 | DriveEnable01 | Description |
|---------------------|----------------|---------------|-----------------------------------|
| x | x | 0 | Motor not supplied with current |
| 0 | 0 | 1 | Rated current supplied to motor |
| 0 | 1 | 1 | Maximum current supplied to motor |
| 1 | 0 | 1 | Holding current supplied to motor |
| 1 | 1 | 1 | Holding current supplied to motor |

Lifecycle counter

Name:

LifeCnt

This register is incremented by one with each X2X Link cycle.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

Input counter value

Name:

ModulePowerSupplyError

StatusInput01 to StatusInput04

This register indicates the state of the digital inputs and counters.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------|---|--|
| 0 | ModulePowerSupplyError | 0 | OK |
| | | 1 | Module power supply error |
| 1 | Reserved | 0 | |
| 2 | StatusInput01 | If bit 0 in Module configuration 1 = 0 | |
| | | 0 or 1 | Input state - Digital input 1 |
| | | If bit 0 in Module configuration 1 = 1 | |
| | | x | Ref toggle bit for counter 1: The state of this bit is changed after homing is completed. |
| 3 | StatusInput02 | If bit 0 in Module configuration 1 = 0 | |
| | | 0 or 1 | Input state - Digital input 2 |
| | | If bit 0 in Module configuration 1 = 1 | |
| | | 0 | The homing procedure for the ABR counter is active. |
| | | 1 | The homing procedure of the ABR counter is completed. |
| 4 | StatusInput03 | 0 or 1 | Input state - Digital input 3 |
| 5 | StatusInput04 | 0 or 1 | Input state - Digital input 4 |
| 6 - 7 | Reserved | 0 | |

Error acknowledgment

Name:

ClearError01

This register can be used to acknowledge errors that have occurred on the motor.

For more info, see ["Error status" on page 2721](#).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------|-------|--------------------------------|
| 0 - 4 | Reserved | 0 | |
| 5 | ClearError01 | 0 | No effect |
| | | 1 | Error acknowledgment for motor |
| 6 - 7 | Reserved | 0 | |

Motor1Step0

Name:

Motor1Step0

This registers is used to specify the number and direction of steps that should be carried out by the module during the next X2X cycle.

The value is specified with a resolution of 1/256 of a full step (corresponds to 8-bit microsteps).

The direction of movement is derived from the value's sign:

| Data type | Values | Information |
|-----------|--------|--|
| INT | >0 | Movement in the positive direction in 1/256 full steps |
| | <0 | Movement in the negative direction in 1/256 full steps |

Unlike function model "Standard" without enabled SDC information, the motor current is selected using a separate register (see register ["Motor current" on page 2728](#)).

Home position

Name:

RefPulsePos01

These 2 registers have the following contents:

| Register | Description |
|--|--|
| Home position of the internal position counter | This register contains the home position of the internal position counter. |
| Home position for the ABR counter | This register contains the home position of the ABR counter. |

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

Setting "Position sync" in the Automation Studio I/O configuration can be used to select which of the 2 registers is addressed by variable RefPulsePos01.

| Variables in Automation Studio | I/O configuration, counter 01, option "Position sync" | |
|--|---|---|
| | Stepper counter 01 is indicated on ActPos01 . | ABR counter 01 is indicated on ActPos01 . |
| RefPulsePos01 | Home position of the internal position counter | Home position of the ABR counter |
| Option "Position sync" for counter 1 also sets bit 3 in register " Counter configuration " on page 2718: | | |
| Bit 3 (counter 1) | 0 | 1 |

Reference pulse counter

Name:

RefPulseCnt01

These 2 registers have the following contents:

| Register | Description |
|---|---|
| Reference pulse counter for the internal position counter | The reference pulses of the internal position counter are counted in this register. |
| Reference pulse counter for the ABR counter | The reference pulses of the ABR counter are counted in this register. |

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

Setting "Position sync" in the Automation Studio I/O configuration can be used to select which of 2 registers is addressed by variable RefPulsePos01.

| Variables in Automation Studio | I/O configuration, counter 01, option "Position sync" | |
|--|---|---|
| | Stepper counter 01 is indicated on ActPos01 . | ABR counter 01 is indicated on ActPos01 . |
| RefPulseCnt01 | Reference pulse counter for the internal position counter | Reference pulse counter of the ABR counter |
| Option "Position sync" for counter 1 also sets bit 3 in register " Counter configuration " on page 2718: | | |
| Bit 3 (counter 1) | 0 | 1 |

NetTime of the position value

Name:

ActTime01

This register contains the NetTime of the most recent valid position value.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

Trigger counter

Name:

TriggerCnt01

This register contains a cyclic counter that is incremented with each trigger event.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

Trigger timestamp

Name:

TriggerTime01

This register contains the NetTime instant of the most recent trigger event. The trigger edge must be configured in register "[SDC configuration](#)" on [page 2727](#).

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on [page 3035](#).

Information:

The absolute accuracy of the trigger can be delayed up to 5 µs due to the input filter of the digital inputs.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

9.25.9.16.10 Register description: Function model 254 - "Bus controller" and function model 3 - "Ramp"

9.25.9.16.10.1 Configuration registers

Holding current, nominal current and maximum current

Name:

ConfigOutput03a (holding current)

ConfigOutput04a (nominal current)

ConfigOutput05a (maximum current)

The holding current, nominal current and maximum current registers are used to configure the desired motor current.

Reasonable values are:

- Holding current < Nominal current < Maximum current

The motor's nominal current is entered in the nominal current register according to the motor's data sheet.

| Register | Description |
|-----------------|---|
| Nominal current | Current during operation at constant speed |
| Maximum current | Current during acceleration phases. In the mode " Referencing during stall ", the rated current is always used instead of the maximum current, even in acceleration phases. |
| Holding current | Current when motor is at standstill |

When the current changes to a weaker value (e.g. when transitioning from the acceleration phase to the constant speed mode), the stronger current is maintained for an additional 100 ms. The following priority applies regardless of the values actually set: maximum current before nominal current before holding current.

| Data type | Values | Unit |
|-----------|----------|---|
| USINT | 0 to 200 | Percent of the module's rated current <ul style="list-style-type: none"> • 100% corresponds to the rated current of the motor bridge power unit listed in the technical data • 200% corresponds to the maximum current of the motor bridge power unit listed in the technical data. Bus controller default setting: 0 |

Full step threshold

Name:

FullStepThreshold01

Starting with the speed specified in this register, the motor is operated in full step mode; it is operated in microstep mode below it.

| Data type | Values | Information |
|-----------|------------|---|
| UINT | 1 to 65534 | Speed in microsteps/cycle. Bus controller default setting: 0 |
| | 65535 | Motor is always operated in microstep mode |

Maximum speed

Name:

MaxSpeed01pos

This register defines the maximum speed for the absolute positioning modes (1, -123, -124, -125, -126).

Information:

The setting does not apply to the speed and homing modes (2, -127, -128).

| Data type | Values | Information |
|-----------|-------------|---|
| UINT | 0 to 65,535 | Speed in microsteps/cycle. Bus controller default setting: 0 |

Maximum acceleration

Name:

MaxAcc01

This register defines the maximum acceleration. (also applies for homing modes).

| Data type | Values | Information |
|-----------|-------------|--|
| UINT | 0 to 65,535 | Acceleration in microsteps/cycle ² . Bus controller default setting: 0 |

Maximum deceleration

Name:

MaxDec01

This register defines the maximum deceleration. (also applies for homing modes).

| Data type | Values | Information |
|-----------|-------------|--|
| UINT | 0 to 65,535 | Brake deceleration in microsteps/cycle ² . Bus controller default setting: 0 |

Reversing loop

Name:

RevLoop01

This parameter is only used in modes 1, -123, -124, -125, -126 (absolute positioning modes).

If the value for the reversing loop is not equal to 0, the target position is approached directly when coming from one direction; when coming from the other direction, the target position is initially overshoot by the configured number of steps before finally moving to the target position. This ensures that the target position is always approached from the same direction (to avoid mechanical backlash).

The sign of the defined value determines the direction in which the reversing loop runs.

| Sign | Effective direction |
|----------|--|
| Positive | Reversing loop in positive direction of movement |
| Negative | Reversing loop in negative direction of movement |

| Data type | Values | Information |
|-----------|-----------------|-----------------------------------|
| INT | -32768 to 32767 | Bus controller default setting: 0 |

Fixed position A

Name:

FixedPos01a

This register defines the position to move to in modes -124 (if the digital input is set to 1) and -125.

| Data type | Values | Information |
|-----------|------------------------------------|-----------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: 0 |

Fixed position B

Name:
FixedPos01b

This register defines the position to move to in modes [-124](#) (if the digital input is set to 0) and [-126](#).

| Data type | Values | Information |
|-----------|------------------------------------|-----------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: 0 |

Homing speed

Name:
RefSpeed01

This register sets the speed for homing modes [-127](#) and [-128](#).

| Data type | Values | Information |
|-----------|-------------|---|
| UINT | 0 to 65,535 | Speed in microsteps/cycle. Bus controller default setting: 0 |

Stall recognition delay

Name:
StallRecognitionDelay01

The value in this register is only relevant for [Referencing during stall](#).

A stall is only detected after the time specified here has expired and after the homing procedure has started.

For example, a setting of 4 (and a cycle time of 25 ms) means that a stall will not be detected until 100 ms after the motor starts moving (start of the homing procedure).

Set to 0 to eliminate delay.

| Data type | Values | Information |
|-----------|----------|---|
| USINT | 0 to 255 | In cycles, see " General configuration " on page 2734. Bus controller default setting: 0 |

Minimum speed for stall detection

Name:
StallDetectMinSpeed01

If the motor speed exceeds the value set in this register, then stall detection is enabled. No error is reported below this threshold value.

| Data type | Values | Information |
|-----------|-------------|---|
| UINT | 0 to 65,535 | Minimum speed in microsteps per cycle. Bus controller default setting: 0 |

Jerk time

Name:
JoltTime01

If a value other than 0 is assigned to this register, then jerk limitation is performed. This is done by averaging the values for the steps to be carried out (speed setpoint) in each cycle using a FIFO buffer. The jerk time corresponds to the number of FIFO elements (0 to 80). If a value greater than 80 is entered, then it will be limited internally to 80.

Changes made while a motor is running will be applied as soon as ...

- The motor has reached the set position (positioning mode only).
- The motor has stopped (all modes).

| Data type | Values | Information |
|-----------|---------|---|
| USINT | 0 | No jerk limitation time. Bus controller default setting: 0 |
| | 1 to 80 | Number of FIFO elements |

Homing configuration

Name:
RefConfig01

The homing mode can be set with this register.

| Data type | Values | Information |
|-----------|------------|--|
| SINT | -120 | Set home position |
| | -121 | Homing on positive edge of input DI 4 |
| | -122 | Homing on falling edge of input DI 4 |
| | -125 | Homing on positive edge of input DI 3 (R pulse). Bus controller default setting |
| | -126 | Homing on negative edge of input DI 3 (R pulse) |
| | -127 | Homing during stall detection |
| | -128 | Immediate homing |
| | All others | No effect |

General configuration

Name:
GeneralConfig01

Bit 0 of this register can be used to switch the positioning mode. This register can also be used to configure the cycle time of the motion profile generator.

- 0: "Mode 1: Position mode" without extended control word
- 1: "Mode 1: Position mode with extended control word"

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|--|
| 0 | Position mode | 0 | Without extended control word (bus controller default setting) |
| | | 1 | With extended control word |
| 1 - 2 | Cycle time of the motion profile generator ¹⁾ | 00 | 25 ms (bus controller default setting) |
| | | 01 | 10 ms |
| | | 10 | 5 ms |
| | | 11 | Reserved |
| 3 - 7 | Reserved | 0 | |

1) The cycle time for the motion profile generator is configured with this cycle. This cycle time affects the unit for specifying the speed and acceleration:

- Unit for speed: Microsteps/Cycle
- Unit for acceleration: Microsteps/Cycle²

Limit switch configuration

Name:

LimitSwitchConfig01

This register configures the behavior of the limit switches.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------|-------|---|
| 0 - 1 | Negative limit switch | 00 | Switched off (bus controller default setting) |
| | | 01 | Active if low |
| | | 10 | Reserved |
| | | 11 | Active if high |
| 2 - 3 | Positive limit switch | 00 | Switched off (bus controller default setting) |
| | | 01 | Active if low |
| | | 10 | Reserved |
| | | 11 | Active if high |
| 4 - 6 | Reserved | 0 | |
| 7 | Direction monitoring | 0 | Off (bus controller default setting) |
| | | 1 | On |

Negative/Positive limit switch:

When one of the limit switches is reached, a warning is triggered and the speed is decelerated to 0. There is no state change of "Device control state machine". This keeps current flowing to the motor.

The error that occurred can be read from the error code register. Normal operation can be resumed by acknowledging the warning. This will not restrict motor movement to a specific direction and the limit switch will not be triggered until the next active edge.

Overshooting the limit switch while braking

The limit switches are not linked with the corresponding direction of movement. If the limit switch is exceeded, another error will be triggered when reversing after acknowledging the initial error.

Direction monitoring

If this function is enabled, then the two limit switches will be linked with the respective direction of movement. This means that the negative limit switch is only triggered in the negative and the positive limit switch only in the positive direction of movement (specified direction).

This prevents specifying a movement in the wrong direction when direction monitoring is enabled and limit switches are active.

Warning!

If the motor is wired incorrectly with this configuration (wrong direction of movement), then the limit switch will not be triggered and the actual correct direction of movement will be denied. This will also be the case when the limit switch connections are reversed.

Software limit

Name:

PositionLimitMin01

PositionLimitMax01

This register configures software limits. The function is enabled if at least one of the two registers is not equal to zero.

These limits are effective in all positioning modes. Position overflow is not possible when this function is enabled. Movement is always contained within the two limits.

If a position is specified that violates the minimum/maximum software limit, the "Internal limit active" bit will be set in the "Status word" on page 2743 register. The motor movement will be stopped until a position is specified within the limits.

Bit "Internal limit active" will also be set in register "Status word" if incorrectly configured (minimum > maximum).

| Data type | Values | Information |
|-----------|------------------------------------|-----------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: 0 |

Information:

The software limits will only be monitored when using the following CANopen bus controllers:

- X20BC0043-10
- X20BC0143-10
- X67BC4321-10
- X67BC4321.L08-10
- X67BC4321.L12-10

9.25.9.16.10.2 Reading back the configuration

Reading back the holding current, nominal current and maximum current

ConfigOutput03aRead (holding current)

ConfigOutput04aRead (nominal current)

ConfigOutput05aRead (maximum current)

These registers are used to read the respective current values in percent.

| Register | Description |
|-----------------|--|
| Nominal current | Current during operation at constant speed |
| Maximum current | Current during acceleration phases |
| Holding current | Current when motor is at standstill |

| Data type | Values | Unit |
|-----------|----------|---|
| USINT | 0 to 255 | Percentage of module's nominal current (100% corresponds to the nominal current of the motor bridge power unit in the technical data) |

9.25.9.16.10.3 Communication registers

Measuring motor load

Name:

MotorLoad

This register contains the current measured load value for stall detection. A high value indicates a small load on the motor; the lower the value, the higher the motor load. The SGT values (see "SGT speed" on page 2714 and "SGT correction values" on page 2714) should be set so that the motor load returns value 0 at maximum load (shortly before stall).

This register can be shown and hidden via the module configuration.

| Data type | Values |
|-----------|-----------|
| UINT | 0 to 1023 |

Set position/speed

Name:
AbsPos01

This register is used to set position or speed, depending on the operating mode.

- Position mode (see "Mode" on page 2738): Cyclic setting of the position setpoint in microsteps. In this mode, one micro-step is always 1/256 full-step.
- Speed mode (see "Mode" on page 2738): In this mode, this register is considered a signed speed setpoint.

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

Control word

Name:
MpGenControl01

This register can be used to issue commands based on the module's state (see "Operating function model "Ramp"" on page 2746).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------|-------|--|
| 0 | Switch on | x | |
| 1 | Enable voltage | x | |
| 2 | Quick stop | x | |
| 3 | Enable operation | x | |
| 4 - 6 | Mode-specific | x | |
| 7 | Fault reset | x | |
| 8 | Stop ¹⁾ | x | |
| 9 | CurrentControlEnable | 0 | Disable load-dependent current control |
| | | 1 | Enable load-dependent current control |
| 10 | Reserved | 0 | |
| 11 | Motor ID trigger | 0 | No effect |
| | | 1 | Rising edge: Motor ID trigger ²⁾ |
| 12 | Warning reset | 0 | No effect |
| | | 1 | Rising edge: Reset warnings |
| 13 | Undercurrent detection | 0 | Disable current error detection (default) |
| | | 1 | Enable current error detection |
| 14 | ABR counter sync/async | 0 | Default: <ul style="list-style-type: none"> • Internal position counter, cyclic • ABR counter, acyclic |
| | | 1 | <ul style="list-style-type: none"> • Internal position counter, acyclic • ABR counter, cyclic |
| 15 | Stall detection | 0 | Disable stall detection (default) |
| | | 1 | Enable stall detection |

1) The "Stop" bit is only evaluated when the extended control word is enabled (see "General configuration" on page 2734).

2) This bit can be used to trigger a measurement of the motor ID. Keep in mind that the application must ensure that the conditions for measurement are fulfilled (see table in the "Motor identification" on page 2744 register).

Mode

Name:

MpGenMode01

| Data type | Values | Information |
|-----------|--------|---|
| SINT | 0 | No mode selected |
| | 1 | Depending on bit 0 in the "General configuration" on page 2734 register, the position mode will behave as follows: <ul style="list-style-type: none"> Position mode without extended control word: Move to target position as soon as the target position is changed Position mode with extended control word: Move to the target position as described in "Mode 1 - Position mode with extended control word" on page 2738 |
| | 2 | Speed mode: Constant speed |
| | -120 | Set home position |
| | -121 | Remaining distance mode |
| | -122 | Set actual position |
| | -123 | Move to target position when external input set |
| | -124 | Two-position module |
| | -125 | Move to fixed position A (position set acyclically) |
| | -126 | Move to fixed position B (position set acyclically) |
| | -127 | Positive homing (see also "Homing configuration" on page 2734) |
| | -128 | Negative homing (see also "Homing configuration" on page 2734) |

Information:

For all modes: The "Target reached" bit is set in the "Status word" on page 2743 register when the current action is finished (i.e. when the position or speed is reached, depending on the mode).

A new position or speed can be specified even before the current action is finished.

Mode 1 - Position mode

The position setpoint is specified in the "Set position/speed" on page 2737 register. The motor is then moved to this new position. This is done with a ramp function that accounts for the defined maximum speed and acceleration values.

The position setpoint can also be changed during an active positioning procedure.

The position setpoint is specified in microsteps (1/256 of a full step).

If bit 0 in the "General configuration" on page 2734 register is 0 (no extended control word), then the position setpoint will be applied as soon as it is different from the current position. Then the new position is used for the movement.

However, if bit 0 in the "General configuration" on page 2734 register is set to 1 (extended control word), then the position setpoint will be applied as described under "Mode 1 - Position mode with extended control word" on page 2738.

Mode 1 - Position mode with extended control word

Position mode with extended control word behaves like [Position mode 1](#) as described previously (without the extended control word), but the new position setpoint ("Position/Speed" on page 2737 register) is applied according to the [extended control word](#).

Extended control word

Commands can be issued using this register depending on the state of the module (see "Operating function model "Ramp"" on page 2746).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|---|-------|---|
| 0 - 3 | Corresponds to the default Control word | x | |
| 4 | New setpoint | 0 | Do not apply target position. |
| | | 1 | Apply target position. |
| 5 | Change set immediately | 0 | Complete current positioning movement and then start next positioning movement |
| | | 1 | Interrupt current positioning movement and then start next positioning movement |
| 6 | abs / rel | 0 | Target position is an absolute value. |
| | | 1 | Target position is a relative value. |
| 7 | Corresponds to the default Control word | x | |
| 8 | Stop ¹⁾ | 0 | Execute positioning |
| | | 1 | Stop axis with deceleration |
| 9 - 15 | Corresponds to the default Control word | x | |

1) This bit applies to all modes.

Extended status word

The bits in the status word reflect the status of the state machine (for a detailed description, see "Status word" on page 2747 and "State machine" on page 2748).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|--|-------|---|
| 0 - 9 | Corresponds to the default Status word | x | |
| 10 | Target reached, depending on bit 8 (Stop) in the Control word register | 0 | If Stop = 0 |
| | | | Target position not reached. |
| | | 1 | Target position reached |
| | | | If Stop = 1 |
| | | 0 | Axis decelerating |
| | | 1 | Axis speed = 0 |
| 11 | Corresponds to the default Status word | x | |
| 12 | Setpoint acknowledge | 0 | Ramp generator did not apply the position value |
| | | 1 | Ramp generator applied the position value |
| 13 - 15 | Corresponds to the default Status word | x | |

Position setting

The target position can be defined in 2 different ways:

| Type of setpoint definition | Description |
|-----------------------------|---|
| Single setpoint | After the target position is reached, Bit <i>Target reached</i> in register " Status word " on page 2743 is set. Then a new target position is defined. The drive stops at each target position before starting the movement to the next target position. |
| Set of setpoints | After the target position has been reached, the movement to the next target position is started immediately without stopping the drive. It is therefore possible to initiate a new positioning by specifying another target position during active positioning. |

The two modes "Single setpoint" and "Set of setpoints" are controlled by the timing of bits *New setpoint* and *Change set immediately* in the "[extended control word](#)" on page 2739 and *Setpoint acknowledge* in register "[Extended control word](#)" on page 2739.

These bits can be used to create a Request-Response mechanism. This makes it possible to specify a target position while a previous position specification is still being processed.

Specifying the target position

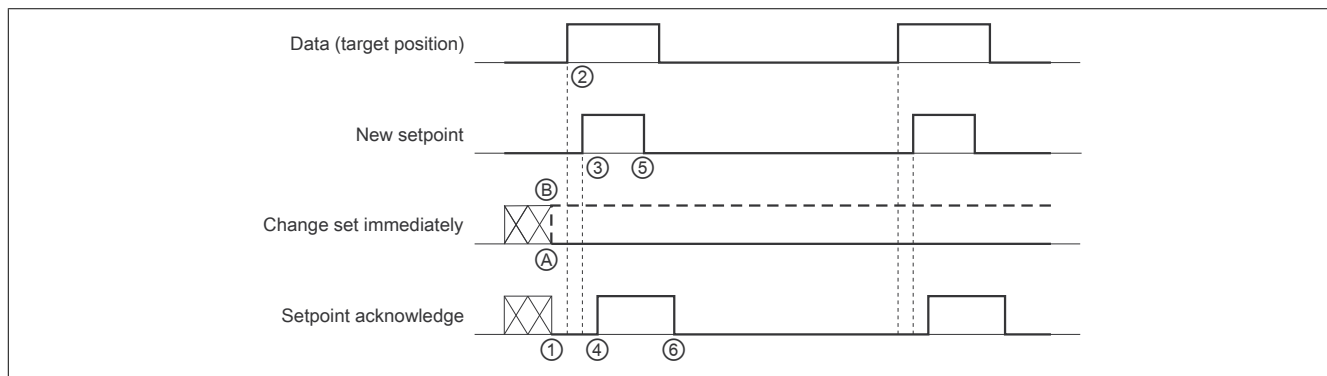


Figure 189: Principle for applying the setpoint

Transferring a new setpoint:

- 1) If bit *Setpoint acknowledge* in register "Extended status word" on page 2739 is 0, the module will accept a new target position.
- 2) The new target position is specified in register "Set position/speed" on page 2737.
- 3) A rising edge on bit *New setpoint* in the "extended control word" on page 2739 indicates that the new target position in register "Set position/speed" on page 2737 is valid and can be used for the next positioning movement.
- 4) After the module has received and saved the new target position, bit *Setpoint acknowledge* is set to 1 in register *Status word*.
- 5) Now the controller can reset the *New setpoint* bit to 0.
- 6) Then the module resets bit *Setpoint acknowledge* to 0 to signal when a new target position is accepted.

Position specification "Single setpoint"

When the *Change set immediately* bit is set to 0 (A in figure "Principle for applying the setpoint"), then the module is operating in *Single setpoint* mode. This mechanism results in a speed of 0 when the motor reaches target position x_1 at time t_1 . After the controller has been notified that the setpoint has been reached, the next target position x_2 will be processed at time t_2 and reached at t_3 .

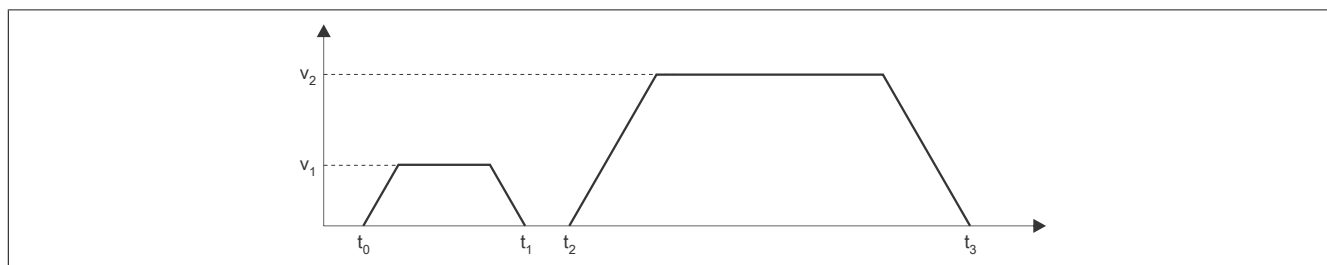


Figure 190: Ramp in *Single setpoint*

"Set of setpoints" preset position value

When the *Change set immediately* bit is set to 1 (B in figure "Principle for applying the setpoint"), then the module is operating in *Single setpoint* mode. This means that the module receives the first target position at t_0 . A second target position is received at time t_1 . The drive immediately adapts the current movement to the new target position.

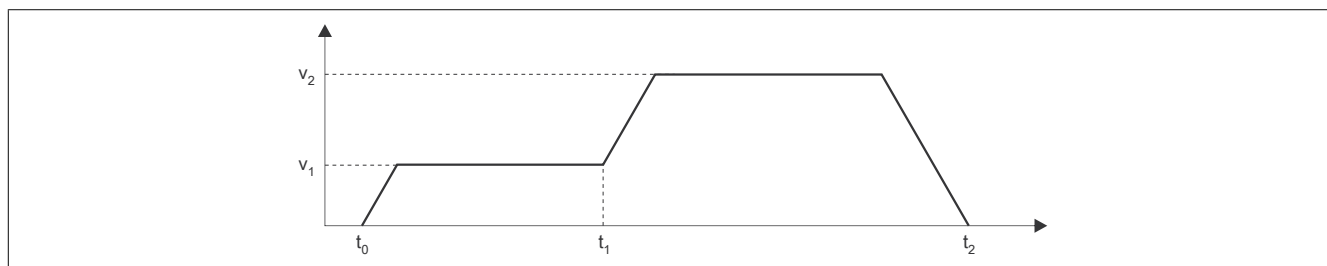


Figure 191: Ramp in *Set of setpoints*

Relative position setting

If bit *abs / rel* bit in register [Extended control word](#) is set, then the target position is interpreted as a relative value. At each *New setpoint* trigger, the target position will be increased by this value (or decreased if the value is negative).

If the mode changes between the position settings, relative movement will then proceed starting at the last specified position. The position setpoint mode is initialized with 0 when the module is started.

Mode 2: Speed mode - Constant speed (pos./neg.)

The value in register ["Position/Speed" on page 2737](#) is now interpreted as the speed setpoint (microsteps/ *cycle*).

Observing the maximum permissible acceleration, the motor moves with a ramp to the desired speed setpoint and maintains this speed until a new speed setpoint is specified.

Values are allowed within the range -65535 to 65535. When a value is entered outside of this range, it is readjusted to these limits.

Mode -120: Set home position

The current actual position is changed so that the position specified in register ["Position/Speed" on page 2737](#) is the home position. If you then move to this position, the motor is at the home position.

The home position in register ["Home position" on page 2744](#) is also set to this value.

Before this mode is called, the motor must be at a standstill and the home position must have been determined using ["Positive / negative homing"](#) mode. In order to set the position, the [State machine](#) must be in state "Operation enable".

Mode -121: Remaining distance mode (like mode 1)

The number of steps defined in register ["Fixed position A" on page 2732](#) are added to the current position and the resulting position is approached at a rising/falling edge on digital input 3.

Advice:

Steps are not added to the target position, but rather to the current position at the moment the trigger occurs.

Negative values are also allowed for the offset defined in [Fixed position A](#).

New target positions are no longer accepted in register ["Position/Speed" on page 2737](#) after the trigger event. There must first be a switch made to [mode 0](#) and then back to mode -121.

Bit "Target reached" in register ["Status word" on page 2743](#) is not set to 1 until the end position (after the trigger event) has been reached.

The ["homing configuration" on page 2734](#) determines whether a rising or falling edge of the digital input is used as a trigger.

The [Reversing loop](#) is not enabled in this mode (i.e. any configured values not equal to 0 are ignored).

Mode -122: Set actual position

The target position set in register ["Position/Speed" on page 2737](#) is applied as the current actual position in the internal position counter if the state machine is in state "Operation enable".

Before this mode is started, the motor must be at a standstill and physically located at the point for which the position being set should be applied.

Mode -123: Move to the target position when the external input is set

The position setpoint set in register ["Position/Speed" on page 2737](#) is moved on a rising edge of digital input 3.

A new position setpoint is not applied until another rising edge occurs on the corresponding digital input. This can also occur during the active positioning procedure and will be applied immediately.

Mode -124: Two-position mode

Positions [Fixed position A](#) and [Fixed position B](#) are defined in the acyclic registers.

Value 1 on digital input 3 moves to fixed position A. Value 0 moves to fixed position B. It is also possible to switch between the two during an active positioning movement.

Mode -125/-126: Move to fixed position X

The purpose of these modes is to enable a virtual switch from speed mode to position mode, which otherwise is not possible because of the shared use of the register for position and speed setpoints.

- Mode -125: "Fixed position A" on page 2732
- Mode -126: "Fixed position B" on page 2733

Mode -127/-128: Positive/Negative homing

Mode -127 and -128 are used to select which direction to move.

The motor must be at a standstill before switching from another mode to one of the homing modes.

If the referencing condition occurs, then the motor stops and the values of the position counter and ABR counter valid at the moment when the referencing condition occurs are written to the "Referenced zero position" on page 2744 register.

In the [referencing configuration](#) you must specify whether referencing should occur at low/high level on the digital input, during stall or unconditionally.

Homing via digital input

Case 1: Active referencing level not yet reached → Motor not yet at end position:

Movement continues at the referencing speed in the referencing direction until the active level for "Stop referencing" is on the input.

Case 2: Active referencing level already reached → Motor at end position:

Movement continues at the referencing speed against the referencing direction until the active level for "Stop referencing" is no longer at the digital input. Movement continues at homing speed in the homing direction until the active level for "homing-stop" is on the digital input again.

Referencing during stall

Movement continues in the referencing direction until a stall is detected. When a stall is detected, the value of the position counter is entered in the "Referenced zero position" on page 2744 register within one millisecond. The motor is then stopped abruptly (not using the deceleration ramp). However, it can take up to 25 ms to stop the motor because the ramp generator runs with a configurable internal cycle of up to 25 ms.

In this mode, the nominal current is always used instead of the maximum current, even in acceleration phases.

To test the responsiveness of this homing mode, the motor load value used for identifying a stall can be made visible in the status word.

Unconditional referencing (immediate)

Immediate referencing: The current values of the position counter and of the ABR counter are immediately entered in register "Homed zero position" on page 2744, no motor movement.)

Current position (cyclic)

Name:

AbsPos01ActVal

This cyclic register contains the current position.

Default: Value of the internal position counter, can be changed to ABR counter

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

Status word

Name:

MpGenStatus01

The bits in this register reflect the state of the state machine. For a more detailed description, see "[Status word](#)" on page 2747 and "[State machine](#)" on page 2748.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|-----------------------|-------|---|
| 0 | Ready to switch on | x | |
| 1 | Switched on | x | |
| 2 | Operation enabled | x | |
| 3 | Fault (error bit) | x | |
| 4 | Voltage enabled | x | |
| 5 | Quick stop | x | |
| 6 | Switch on disabled | x | |
| 7 | Warning | x | |
| 8 | Reserved | 0 | |
| 9 | Remote | 1 | Always 1 since there is no local mode for the SM module |
| 10 | Target reached | x | |
| 11 | Internal limit active | 0 | No limit violation |
| | | 1 | Internal limit is active (upper or lower software limit violated) |
| 12 | Mode-specific | x | |
| 13 - 15 | Reserved | 0 | Always 0 |

Input status

Name:

InputStatus

This register indicates the logical states of digital inputs.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------|--------|---------------------------------|
| 0 | Digital input 1 | 0 or 1 | Input state - Digital input 1 |
| ... | | ... | |
| 3 | Digital input 4 | 0 or 1 | Input state - Digital input 4 |
| 4 | Open circuit 1 | 0 | No error |
| | | 1 | Open circuit on digital input 1 |
| ... | | ... | |
| 7 | Open circuit 4 | 0 | No error |
| | | 1 | Open circuit on digital input 4 |

Motor identification

Name:

Motoridentification01

This register is used to identify the connected motor type for service purposes and to differentiate between motors in the application. After successful measurement, this register contains the time [µs] required to apply a current increase of $\Delta I = 1 \text{ A}$ to a motor winding.

This depends on:

- Operating voltage
- Inductance and resistance of the motor winding

| Notes | |
|-------|---|
| 1) | To achieve reproducible results, the measurement must be made under the following defined conditions: |
| a) | Motor is at standstill. |
| b) | The motor must be in a half-step position (phase A fully powered, phase B not powered). This means the internal position counter on the SM module must have a value that fulfills the following conditions: <ul style="list-style-type: none"> • Full steps are divisible by 4. • Microsteps = 0 |
| 2) | Condition 1b) is fulfilled after a the SM module is reset or switched on. Immediately afterwards, when the holding current is applied to the motor for the first time (at standstill), the duration for applying the current is measured. This is therefore a suitable time to read the motor identification register in the application. |
| 3) | The current range from approximately 1/3 of the nominal current up to the nominal current is used as operating range for determining the motor identifier. |

| Data type | Motor ID values | Explanation |
|-----------|-----------------|--|
| UINT | 0 | No motor identifier available (after switching on for as long as the measurement conditions are not met) |
| | 1 to 32767 | Valid range of values for the motor ID register (in µs) |
| | 65534 | Invalid value: Overflow |

Homed zero position

Name:

RefPos01CyclicCounter

RefPos01AcyclicCounter

After a homing procedure, the homing point for the cyclic or acyclic position counter can be read back with these registers (either the internal position counter or ABR counter depending on bit 14 of register "[Control word](#)" on [page 2737](#)).

The following two registers are provided for the motor:

- Homed zero position for cyclic counter
- Homed zero position for acyclic counter

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

Current position (acyclic)

Name:

AbsPos1ActValAcyclic

This acyclic register contains the current position.

Default: Value of the ABR counter, can be changed to internal position counter

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

Read back control word

Name:

ControlReadback01

This register can be used to read the contents of register "[Control word](#)" on [page 2737](#).

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

Read back mode

Name:

ModeReadback01

This register can be used to read the contents of register "Mode" on page 2738.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

Error code

Name:

ErrorCode01

The cause of an error or warning can be read in this register.

| Data type | Error code | Error type | Priority | Description |
|-----------|------------|------------|----------|-----------------------------|
| UINT | 0x0000 | - | - | No error |
| | 0x3000 | Error | High | Voltage |
| | 0x4200 | Error | : | Overtemperature |
| | 0xFF20 | Warning | : | Negative limit switch |
| | 0xFF21 | Warning | : | Positive limit switch |
| | 0x2300 | Warning | : | Overcurrent |
| | 0xFF00 | Warning | : | Current error ¹⁾ |
| | 0xFF01 | Warning | : | Stall ²⁾ |
| | 0xFF11 | Warning | Low | Open circuit |

1) A current error is only detected if bit 13 = 1 in the [control word](#) (current error detection enabled).

2) Stall is only detected if bit 15 = 1 in the [control word](#) (stall detection enabled).

Information regarding the handling of errors and warnings:

- Bit 3 (fault) and bit 8 (warning) in the [status word](#) can be used to query whether an error or a warning was reported in the error code register.
- Bit 7 (Fault Reset) and bit 8 (Warning Reset) in the [control word](#) are used to acknowledge pending errors and warnings.
- If two or more errors/warnings are pending, the one with the highest priority (the order in the table above) will be displayed in the error code register.

9.25.9.16.10.4 Operating function model "Ramp"

Control for this model has been based on the CANopen communication profile DS402.

Commands for controlling the modules are written to the "Control word" on page 2746. The current module state is returned in register "Status word" on page 2747. The function mode (absolute position, constant speed, homing, etc.) is set in register "Mode" on page 2738.

Control word

Control word bits and their state for the commands of the state machine:

| Command | Stall detection | Encoder position sync/async | Current error detection | Warning reset | Motor ID trigger | Reserved | CurrentControlEnable | Stop 2) | Fault reset | Mode-specific | Mode-specific | Mode-specific | Enable operation | Quick stop | Enable voltage | Switch on |
|-------------------|-----------------|-----------------------------|-------------------------|---------------|------------------|----------|----------------------|---------|-------------|---------------|---------------|---------------|------------------|------------|----------------|-----------|
| Bit ¹⁾ | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Shutdown | x | x | x | x | x | 0 | 0 | x | 0 | x | x | x | x | 1 | 1 | 0 |
| Switch on | x | x | x | x | x | 0 | 0 | x | 0 | x | x | x | 0 | 1 | 1 | 1 |
| Disable voltage | x | x | x | x | x | 0 | 0 | x | 0 | x | x | x | x | x | 0 | x |
| Quick stop | x | x | x | x | x | 0 | 0 | x | 0 | x | x | x | x | 0 | 1 | x |
| Disable operation | x | x | x | x | x | 0 | 0 | x | 0 | x | x | x | x | 0 | 1 | 1 |
| Enable operation | x | x | x | x | x | 0 | 0 | x | 0 | x | x | x | 1 | 1 | 1 | 1 |
| Fault reset | x | x | x | x | x | 0 | 0 | x | ↑ | x | x | x | x | x | x | x |

1) x ... Any, ↑ ... Rising edge

2) Bit 8 (stop) is only evaluated if the extended control word is enabled in register "General configuration" on page 2734.

| | |
|---|--|
| Bits 0, 1, 2, 3 and 7 (light gray in the previous table) | These bits control the state of the State machine according to the commands in the table above. |
| Stop | 0 ... Perform motor movement 1 ... Stop axis with deceleration This bit is only evaluated when the extended control word is enabled in register "General configuration" on page 2734. |
| Motor ID trigger | A rising edge enables the motor ID measurement. |
| Warning reset | A rising edge resets warnings (no effect on errors, which are reset using "Fault reset"; the state machine is not affected by this bit). |
| Fault reset | A rising edge resets errors and warnings (see "State machine" on page 2748) |
| Current error detection | 0 ... Current error detection disabled 1 ... Current error detection enabled |
| ABR counter sync/async | 0 ... Value of the ABR counter on register "Current position (acyclic)" on page 2744. Internal position counter of the ramp generator on register "Current position (cyclic)". 1 ... Value of the ABR counter on register "Current position (cyclic)" on page 2742. Internal position counter of the ramp generator on register "Current position (acyclic)". |
| Stall detection | 0 ... Stall detection disabled 1 ... Stall detection enabled |
| CurrentControlEnable | 0 ... Load-dependent current control disabled 1 ... Load-dependent current control enabled |

Status word

The individual bits of this register and its states depend on the current state of the state machine:

| Status | Reserved | Reserved | Reserved | Reserved | Int. limit active | Target reached | Remote | Reserved | Warning | Switch on disabled | Quick stop | Voltage enabled | Fault | Operation enabled | Switched on | Ready to switch on |
|------------------------|----------|----------|----------|----------|-------------------|----------------|--------|----------|---------|--------------------|------------|-----------------|-------|-------------------|-------------|--------------------|
| Bit | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Not ready to switch on | x | x | x | x | x | x | 1 | 0 | x | 0 | x | 0 | 0 | 0 | 0 | 0 |
| Switch-on disabled | x | x | x | x | x | x | 1 | 0 | x | 1 | x | 0 | 0 | 0 | 0 | 0 |
| Ready to switch on | x | x | x | x | x | x | 1 | 0 | x | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Switched on | x | x | x | x | x | x | 1 | 0 | x | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| Operation enable | x | x | x | x | x | x | 1 | 0 | x | 0 | 1 | 1 | 0 | 1 | 1 | 1 |
| Quick stop active | x | x | x | x | x | x | 1 | 0 | x | 0 | 0 | 1 | 0 | 1 | 1 | 1 |
| Fault reaction active | x | x | x | x | x | x | 1 | 0 | x | 0 | x | 0 | 1 | 1 | 1 | 1 |
| Fault | x | x | x | x | x | x | 1 | 0 | x | 0 | x | 0 | 1 | 0 | 0 | 0 |

Information about the status word:

| | | |
|---|--|--|
| Bits 0, 1, 2, 3, 5 and 6 (light gray in the previous table) | These bits are set according to the current state of the State machine . | |
| Voltage enabled | Becomes 1 as soon as the motor is powered | |
| Warning | Becomes 1 if a warning is detected ("Overcurrent", "Undercurrent"). The type of warning is indicated in register " Error code " on page 2745. The highest priority error / warning is shown in each case, with the priority corresponding to the order in the respective table. Warnings can be reset with a rising edge on the "Warning reset" bit in the control word. | |
| Remote | Always 1 since there is no local mode on the SM module | |
| Target reached ¹⁾ , depending on bit 8 (Stop) in register Control word | <p>If Stop = 0</p> <p>In modes 1, -123, -124, -125 and -126 (absolute positioning): 0...Positioning begins 1...Target has been reached</p> <p>In mode 2 (constant speed): 0...Motor accelerates/brakes 1...Speed setpoint reached</p> <p>In modes -127 and -128 (homing): 0...Homing started 1...Homing ended</p> <p>In mode -122 (set actual position): The bit briefly becomes 0 and immediately becomes 1 again as soon as the position is set.</p> | <p>If Stop = 1</p> <p>In all modes: 0...Axis decelerating 1...Axis speed = 0</p> |
| Internal limit active | 0 ... No limit violation 1 ... Internal limit is active (upper/lower software limit violated) | |

1) If "Stop" has not been enabled in register "[General configuration](#)" on page 2734, then "Target reached" behaves the same as if Stop = 0.

State machine

The motor is controlled according to the state machine illustrated below. After the module is started, the state machine automatically changes to state "Not ready to switch on". The application then operates the state machine by writing commands to the [Control word](#).

The state machine successively reaches the states "Ready to switch on", "Switched on" and "Operation enable" by writing the consecutive commands "Shutdown", "Switch on" and "Enable operation".

Information:

Only in state "Operation enable" are motor movements executed according to the setting in register "Mode" on page 2738.

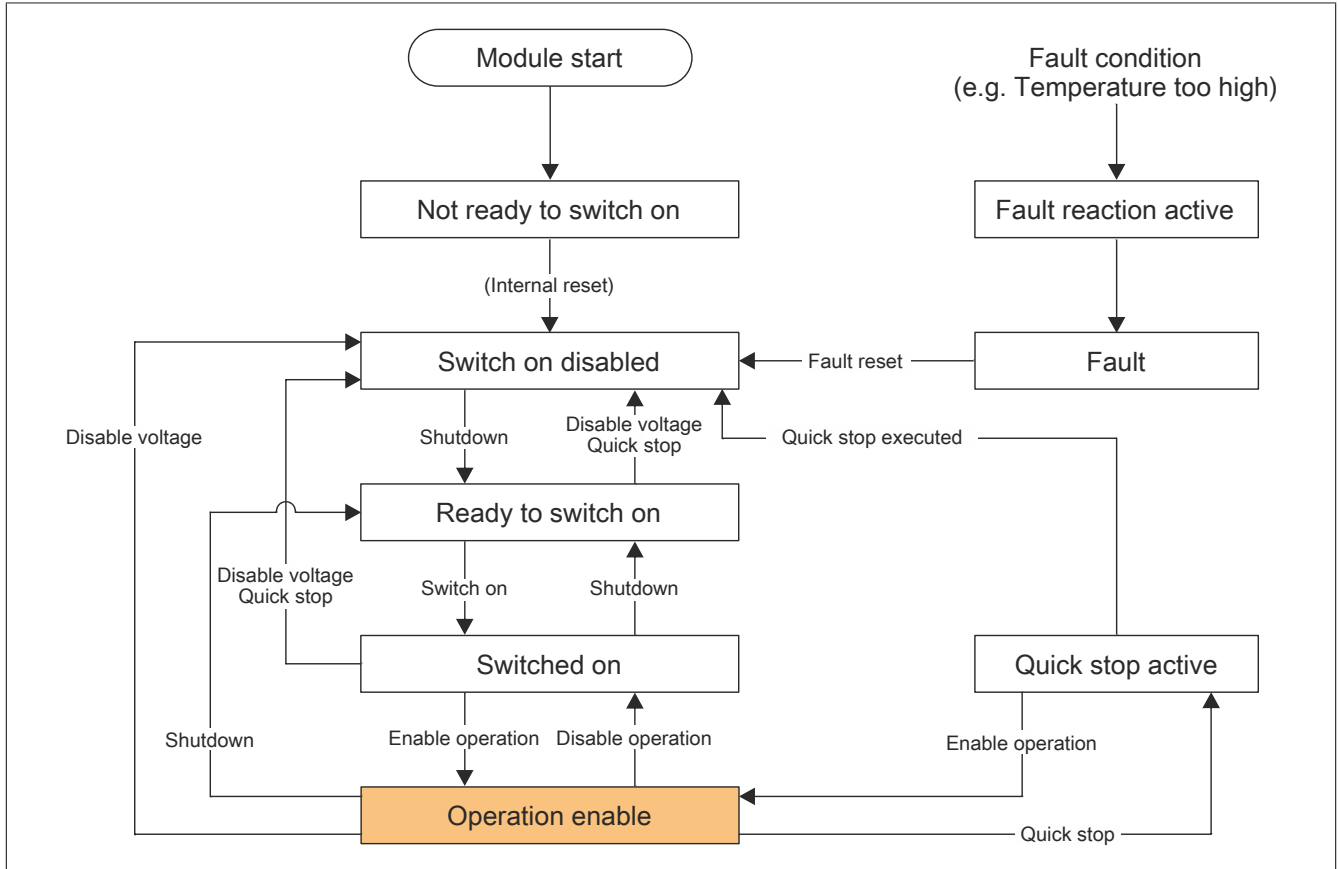


Figure 192: State machine - Flow chart

| State change | Description |
|--|--|
| Not ready to switch on → Switch on disabled | This state change occurs automatically after starting the module and internal initialization has taken place. |
| Switch-on disabled → Ready to switch on | This state change is initiated by command <i>Shutdown</i> . No others actions are performed. |
| Ready to switch on → Switch-on disabled | This state change is brought on by the command <i>Disable voltage</i> or <i>Quick stop</i> . No others actions are performed. |
| Switched on → Switch-on disabled | This state change is brought on by the command <i>Disable voltage</i> or <i>Quick stop</i> . The motor voltage is cut off immediately. |
| Ready to switch on → Switched on | This state change is brought on by the <i>Switch on</i> command. The motor voltage is switched on. When this state change occurs for the first time since the module is started, the motor ID measurement is performed before state <i>Switched on</i> is achieved. This can take approximately 1 second. |
| Switched on → Ready to switch on | This state change is initiated by command <i>Shutdown</i> . The motor voltage is cut off immediately. |
| Switched on → Operation enable | This state change is brought on by the <i>Enable operation</i> command. Motor movements are now performed depending on the set mode. |
| Operation enable → Switched on | This state change is brought on by the <i>Disable operation</i> command. If in motion, the motor is decelerated with the configured braking deceleration. The motor voltage remains switched on in state <i>Switched on</i> . |
| Operation enable → Ready to switch on | This state change is initiated by command <i>Shutdown</i> . The motor voltage is cut off immediately. |
| Operation enable → Switch on disabled | This state change is brought on by the <i>Disable voltage</i> command. Motor voltage switched off. It is strongly recommended to only make this state change on a stopped motor since regeneration on a motor running at no load can cause an overvoltage error on the DC bus (0x3210). |
| Operation enable → Quick stop active | This state change is brought on by the <i>Quick stop</i> command. If in motion, the motor is decelerated with the configured braking deceleration. During the deceleration, the state machine remains in state <i>Quick stop active</i> . If the motor comes to standstill, the switch to state <i>Switch on disabled</i> takes place automatically. While the state machine is in state <i>Quick stop active</i> , command <i>Enable operation</i> can be used to switch it back to state <i>Operation enable</i> . |
| → Fault reaction active | This state change is brought on when an error occurs and cannot be triggered by a command from the user. It can be triggered by error types classified as an "Error" (see "Error code" on page 2745). (The other error types classified as "Warning" only cause the "Warning" bit to be set in the status word and do not cause a state change of the state machine.) The motor voltage is cut off and the state machine immediately changes to state <i>Fault</i> . The error code register contains the error type (see table in "Error code" on page 2745). The highest priority error is shown. The priority corresponds to the order in the error code table. |
| Fault → Switch-on disabled | This state change is brought on by the <i>Fault reset</i> command. However, the state only changes if no more errors are present when the command is written. All errors and warnings are reset. The error code register contains 0 or the warning code if a warning is still present. |

Table 524: State machine - State change

9.25.9.16.11 NetTime Technology

For a description of NetTime Technology, see ["NetTime Technology" on page 3035](#).

9.25.9.16.12 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|---------------------------|--------|
| Function model "Standard" | 400 µs |
| Function model "Ramp" | 400 µs |

9.25.9.16.13 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|---------------------------|--------|
| Function model "Standard" | 400 µs |
| Function model "Ramp" | |
| Inputs | 400 µs |
| Outputs ¹⁾ | 25 ms |

1) Depends on the configuration of the ["movement profile generator" on page 2734](#).

9.25.10 X20SM1446-1

Data sheet version: 1.26

9.25.10.1 General information

The stepper motor module is used to control stepper motors with a nominal voltage of 24 to 48 VDC ($\pm 25\%$) at a motor current up to 5 A (10 A peak). In addition, this module has 4 digital inputs that can be used as limit switches or encoder inputs.

Due to the individual adjustment of the coil currents, the motor is only operated with the current it actually needs. This simplifies the selection of the available motors and prevents unnecessary heating. Because this affects energy consumption and thermal load, the effects are positive on the service life of the complete system. Complete flexibility is achieved through the use of independently adjustable holding, maximum and nominal current values. The current for microsteps is automatically adjusted to the configured current values.

In addition, the module contains a sensorless, load-dependent current control. Depending on the operating situation and load, the module controls the current downwards. Energy savings up to 75% are possible in this way.

The automatic motor identification system is an enormous help during standstills. The stepper motor modules can identify the connected motors using their coil characteristics and generate feedback in the form of an analog value. This makes it possible to detect not only wiring errors, but also incorrect motor types being used mistakenly. A stall detection mechanism is integrated to analyze the motor load. Detection of the stall is defined via a configurable threshold. This allows an overload or motor standstill to be detected precisely in many different types of applications.

- 1 stepper motor, 24 to 48 VDC $\pm 25\%$, 5 A (10 A peak)
- Resolution of current values at 1%
- Boost, nominal and holding current separately configurable
- Sensorless, load-dependent current control
- Integrated motor detection
- 256 microsteps per step
- Stall detection
- Complete integration in Automation Studio and CNC applications
- 4 inputs, 24 VDC, adjustable for ABR incremental encoders
- Open circuit detection for push-pull encoders
- Input ramp limit at max. 12.5 A
- Function model "Ramp" based on CANopen communication profile DS402

NetTime timestamp of the position and trigger time

It is not just the position value that is important for highly dynamic positioning tasks, but also the exact time the position is measured. The module is equipped with a NetTime function for this that supplies a timestamp for the recorded position and trigger time with microsecond accuracy.

The timestamp function is based on synchronized timers. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

9.25.10.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Motor controllers |  |
| X20SM1446-1 | X20 stepper motor module, module power supply 24 to 48 VDC $\pm 25\%$, with current reduction function, 1 motor connection, 5 A continuous current, 10 A peak current, 4 digital inputs 24 VDC, sink, configurable as incremental encoder, NetTime function, double-width module | |
| | Required accessories | |
| | Bus modules | |
| X20BM31 | X20 bus module for double-width modules, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 525: X20SM1446-1 - Order data

9.25.10.3 Technical data

| Model number | X20SM1446-1 |
|--|--|
| Short description | |
| I/O module | 1 full bridge for controlling stepper motors |
| General information | |
| B&R ID code | 0xF3B0 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| Output | Yes, using LED status indicator and software |
| I/O power supply | Yes, using software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | - |
| External I/O | |
| 24 VDC | 2.4 W |
| 48 VDC | 3.5 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Input current limiting | Max. 12.5 A |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| Motor bridge - Power unit | |
| Quantity | 1 |
| Type | 2-phase bipolar stepper motor (full bridge) |
| Nominal voltage | 24 to 48 VDC $\pm 25\%$ |
| Nominal current | 5 A |
| Maximum current | 10 A for 1 s ¹⁾ |
| DC bus capacitance | 100 μ F |
| Step resolution | Max. 256 microsteps per step |
| Module power supply | |
| Supply | External |
| Fuse | Required line fuse: Max. 10 A, slow-blow |
| Output protection | Reverse polarity protection on supply voltage |
| Digital inputs | |
| Quantity | 4 |
| Nominal voltage | 24 VDC |
| Input circuit | Sink |
| Input filter | |
| Hardware | <5 μ s |
| Software | - |
| Connection type | 1-wire connections |
| Input resistance | Typ. 10 k Ω |
| Additional functions | 1x ABR incremental encoder. Open-circuit detection |
| ABR incremental encoder | |
| Quantity | 1 |
| Encoder inputs | 24 V, asymmetrical |
| Counter size | 16-bit |

Table 526: X20SM1446-1 - Technical data


| Model number | X20SM1446-1 |
|--|---|
| Input frequency | Max. 50 kHz |
| Evaluation | 4x |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from I/O power supply |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 50°C |
| Vertical mounting orientation | -25 to 40°C |
| Derating | See section "Derating". |
| Storage | -25 to 70°C |
| Transport | -25 to 70°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x bus module X20BM31 separately |
| Pitch | 25 ^{+0.2} mm |

Table 526: X20SM1446-1 - Technical data

1) See section "Let-through energy I2T".

9.25.10.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|--------|--------------------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | Mode RESET |
| | | | Double flash | Mode BOOT (during firmware update) ¹⁾ |
| | | | Blinking | Mode PREOPERATIONAL |
| | | | On | Mode RUN |
| | e | Red | Off | Module not supplied with power or everything OK |
| | | | On | Error or reset status |
| | e + r | | Solid red / Single green flash | Invalid firmware |
| | 1 - 4 | Green | On/Off | Input state of the corresponding digital input |
| | | | Blinking | Open circuit or not connected |
| M | | Orange | On | The motor is active. |

1) Depending on the configuration, a firmware update can take up to several minutes.

9.25.10.5 Pinout

Per standard EN 60204-1, a cable cross section of 0.75 mm² or larger must be used for the motor outputs in order to handle the maximum motor current of 5 A. To ensure full motor power, voltage drops that could result from the cable length and the electrical connections must also be taken into consideration when selecting the attachment cable.

Warning!

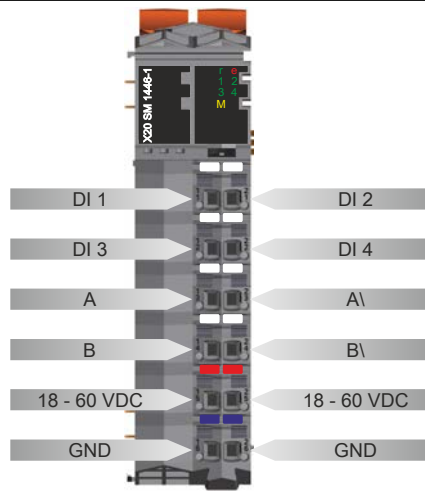
The terminal block is not permitted to be plugged in or unplugged during operation.

Information:

Shielded motor cables must be used in order to meet the limits per standard EN 55011 (emissions).

Information:

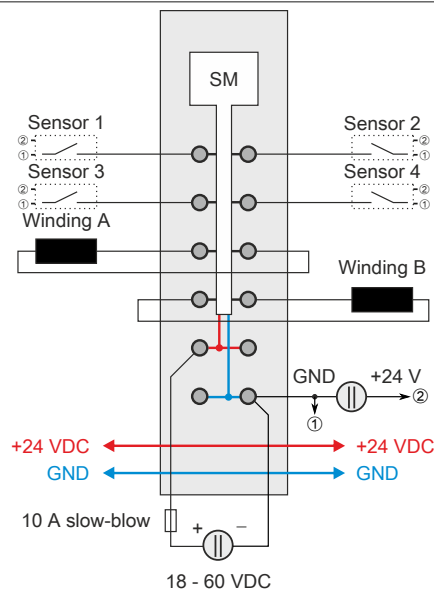
If a boot current of 10 A is required, the motor cables are not permitted to be longer than 2 meters.



9.25.10.6 Connection example

Information:

This module can only be operated if supplied with power via the terminal block.



For the wiring of sensors 1 to 4 see ["Push-pull input circuits" on page 2754](#)

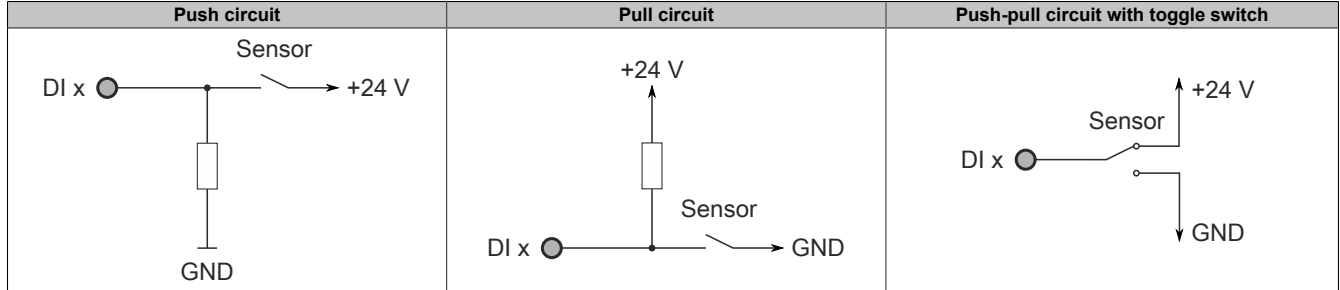
9.25.10.6.1 Push-pull input circuits

The digital inputs of the module are equipped with open-circuit detection and therefore designed for push-pull circuits.

Information:

If no push-pull circuit is used, an open sensor contact is interpreted by the module as an open circuit.

Circuit variants



The size of the resistor depends on the sensor used and must therefore be calculated in each individual case.

9.25.10.7 Connection options for digital inputs

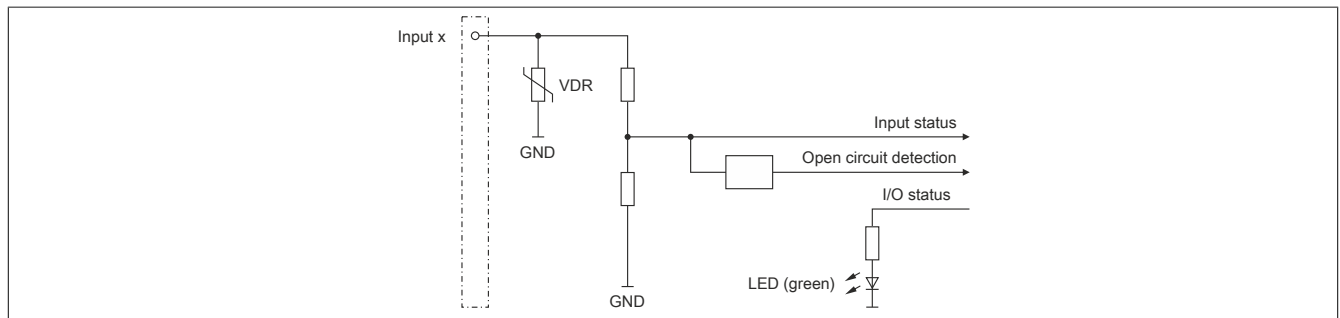
Function model "Standard"

| Channel | Function | |
|---------|---------------|---------------|
| DI 1 | Digital input | A |
| DI 2 | Digital input | B |
| DI 3 | Digital input | R |
| DI 4 | Digital input | Trigger input |

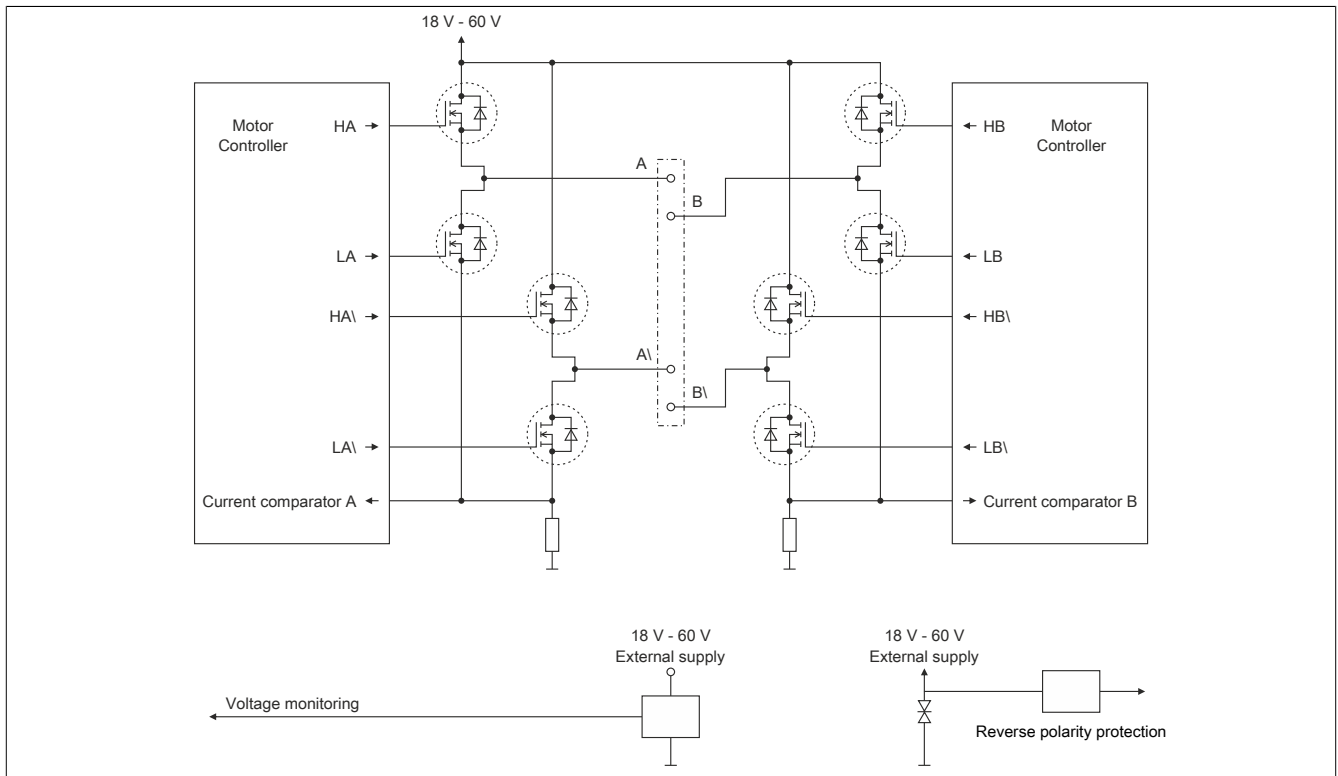
Function model "Ramp"

| Channel | Function | | |
|---------|---------------|---------------|-----------------------|
| DI 1 | Digital input | A | A |
| DI 2 | Digital input | B | B |
| DI 3 | Digital input | R | Negative limit switch |
| DI 4 | Digital input | Digital input | Positive limit switch |

9.25.10.8 Input circuit diagram



9.25.10.9 Output circuit diagram



9.25.10.10 Motor cutoff in the event of overvoltage

The module power supply voltage is continually monitored. Its status can be read. Error "[Module power supply error](#)" is reported if the voltage is greater than or less than the limit values.

If the supply voltage in the module overshoots or undershoots the limit values (e.g. during regenerative operation), the motor output is cut off!

If the supply voltage is within the permissible range again, the error must first be [acknowledged](#). The output stage can then be switched on again.

Limit values for the supply voltage

| | Drive cut off | Drive switched back on |
|-------------|---------------|------------------------|
| Lower limit | <17.4 V | >17.8 V |
| Upper limit | >60.3 V | <58.6 V |

9.25.10.11 Shutdown in the event of overtemperature (starting at 116°C)

If the module temperature reaches or overshoots the limit value of 116°C, the module performs the following actions:

- Sets the "overtemperature" error bit
- Cuts off the outputs (short-circuited)

As soon as the temperature is reduced below 116°C again, the error must be acknowledged with "OvertemperatureAcknowledge" so that the channels can be switched on again.

9.25.10.12 Power supply dimensioning

The motor's current consumption depends on the defined motor currents, the available power and the actual motor being used.

| Example | |
|--|-------------------|
| Model number of the motor | 80MPD5.300S000-01 |
| Configured current in the motor module | 3 A |
| Supply voltage of the motor module | 48 VDC |
| Motor load | 1 Nm |

Table 527: Power supply dimensioning example - Basic data

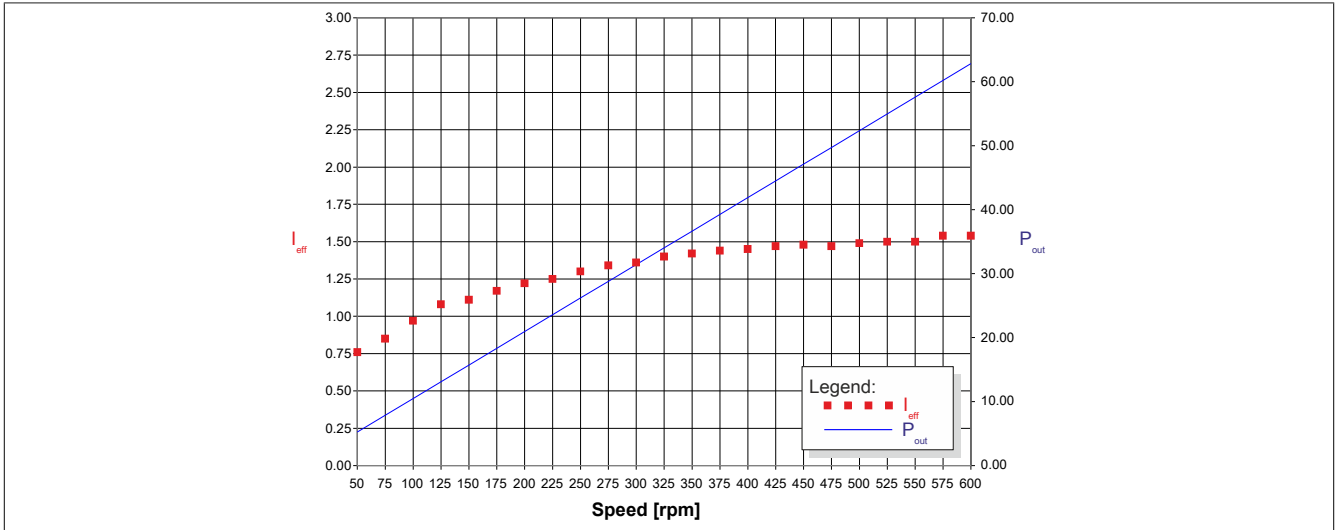


Figure 193: Power supply dimensioning example - Power/Speed relationship

The example is based on a constant load throughout the entire speed range.

An increase in the motor load causes an increase in the effective current of the I/O power supply.

9.25.10.13 Fuse protection

The power supply line should be protected by a circuit breaker or a fuse. In general, dimensioning the supply line and overcurrent protection depends on the structure of the power supply (modules can be connected individually or in groups).

Information:

The effective current for the power supply depends on the load but is always less than the motor current. Make sure the maximum nominal current of 10 A is not exceeded on the power supply terminals of the power unit.

When choosing a suitable fuse, the user must also account for characteristics such as aging effects, temperature derating, overcurrent capacity and the definition of the rated current, which can vary by manufacturer and type. In addition, the fuse that is selected must also be able to handle application-specific characteristics (e.g. overcurrent that occurs in acceleration cycles).

The cross section of the mains power input and the rated current of the used fuse are chosen according to the current-carrying capacity such that the permissible current-carrying capacity of the selected cable cross section (depending on wiring, see table) is greater than or equal to the current load in the mains power input. The rated current of the fuse protection must be less than or equal to the permissible current-carrying capacity of the selected cable cross section (depending on the how it is installed, see table):

$$I_{\text{Power system}} \leq I_{\text{Fuse}} \leq I_{\text{Line/cable}}$$

| Wire cross section [mm ²] | Current-carrying capacity of cable cross section I_z / rated current of fuse I_b [A] depending on the to type of wiring at an ambient air temperature of + 40°C per EN 60204-1 | | | |
|---------------------------------------|--|-----------|-----------|-----------|
| | B1 | B2 | C | E |
| 1.5 | 13.5 / 13 | 13.1 / 10 | 15.2 / 13 | 16.1 / 16 |
| 2.5 | 18.3 / 16 | 16.5 / 16 | 21 / 20 | 22 / 20 |

Table 528: Cable cross section of the mains power input depending on the type of wiring

The tripping current of the fuse is not permitted to exceed the rated current of the fuse I_b .

| Type of wiring | Description |
|----------------|--|
| B1 | Wires in conduit or cable duct |
| B2 | Cables in conduit or cable duct |
| C | Cables or wires on walls |
| E | Cables or wires on open-ended cable tray |

Table 529: Type of wiring used for the mains power input

9.25.10.14 Let-through energy I²T

The module is designed for a continuous current of 5 A. A higher current can be temporarily drawn, however. The following points must be observed:

- The module is designed for a let-through energy of 825 A²s for a period of 30 seconds.

Information:

Exceeding the maximum let-through energy can result in damage to the module.

- If maximum current I_{boost} is drawn for maximum time t_{boost} , the continuous current of 5 A can be drawn for the remaining time of 30 seconds.
- If maximum current I_{boost} is drawn for more than maximum time t_{boost} , the current is not permitted to exceed the calculated residual current for the remaining time of 30 seconds (see example below).
- At the end of a 30 second period with increased current consumption, 5 A continuous current or a higher current can be drawn again.

Calculating the residual current

$$I_{\text{boost}}^2 \cdot t_{\text{boost}} + I_{\text{residual}}^2 \cdot (30 - t_{\text{boost}}) \leq 825 \text{ A}^2 \text{ s}$$

$$I_{\text{residual}} = \sqrt{\frac{825 \text{ A}^2 \text{ s} - I_{\text{boost}}^2 \cdot t_{\text{boost}}}{30 \text{ s} - t_{\text{boost}}}}$$

Example

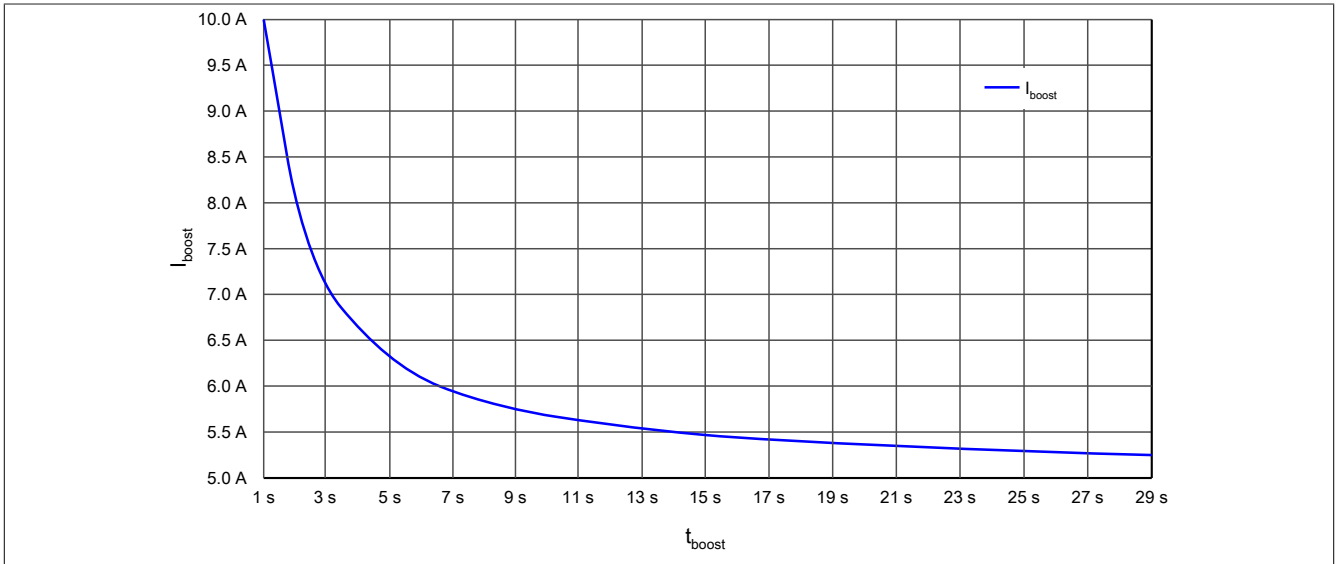
A boost current of 8 A is needed for a duration of 3 seconds. According to the formula, the residual current of 4.84 A is not permitted to be exceeded for the remaining 27 seconds.

$$I_{\text{residual}} = \sqrt{\frac{825 \text{ A}^2 \text{ s} - 8 \text{ A}^2 \cdot 3 \text{ s}}{30 \text{ s} - 3 \text{ s}}} = 4.84 \text{ A}$$

I_{boost} values if I²T = 825 A²s and $I_{\text{residual}} = 5 \text{ A}$

| t_{boost} s | I_{boost} A | t_{residual} s | t_{boost} s | I_{boost} A | t_{residual} s |
|-------------------------|-------------------------|----------------------------|-------------------------|-------------------------|----------------------------|
| 1 | 10.00 | 29 | 16 | 5.45 | 14 |
| 2 | 7.91 | 28 | 17 | 5.42 | 13 |
| 3 | 7.07 | 27 | 18 | 5.40 | 12 |
| 4 | 6.61 | 26 | 19 | 5.38 | 11 |
| 5 | 6.32 | 25 | 20 | 5.36 | 10 |
| 6 | 6.12 | 25 | 21 | 5.35 | 9 |
| 7 | 5.98 | 23 | 22 | 5.33 | 8 |
| 9 | 5.77 | 21 | 23 | 5.32 | 7 |
| 10 | 5.70 | 20 | 24 | 5.30 | 6 |
| 11 | 5.64 | 19 | 25 | 5.29 | 5 |
| 12 | 5.59 | 18 | 26 | 5.28 | 4 |
| 13 | 5.55 | 17 | 27 | 5.27 | 3 |
| 14 | 5.51 | 16 | 28 | 5.26 | 2 |
| 15 | 5.48 | 15 | 29 | 5.25 | 1 |
| | | | 30 | 5.24 | 0 |

These values correspond to the following curve for let-through current I_{2T}:



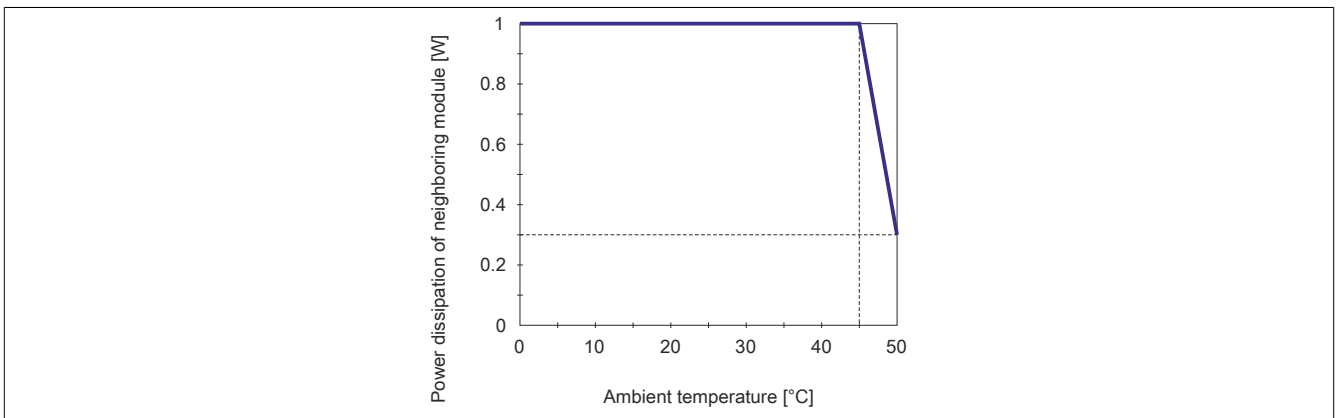
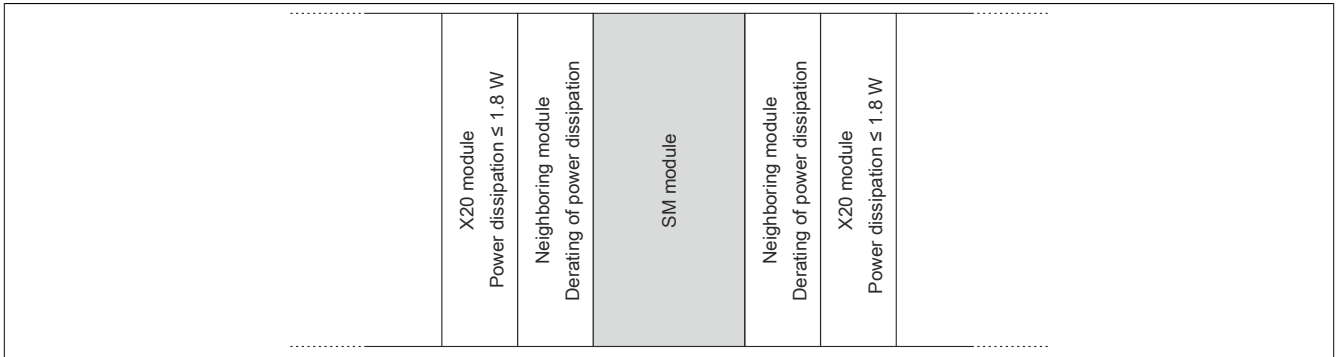
9.25.10.15 Derating

Only modules with a maximum power dissipation of 1 W are permitted to be operated next to the SM module. To ensure proper operation, observe the derating values listed below:

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.

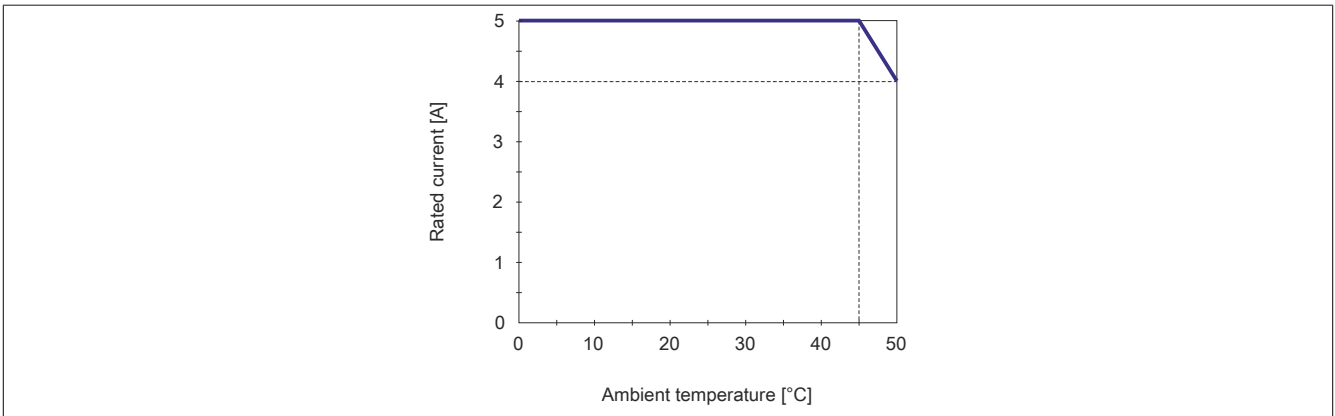
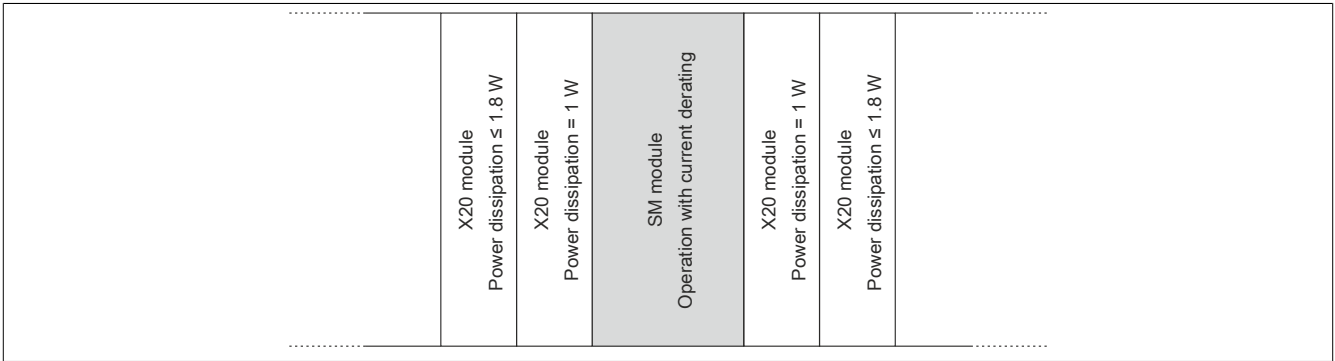
Power dissipation derating for neighboring modules

The power dissipation of immediate neighboring modules of the SM module is permitted to be 1 W. If the SM module is operated at the rated load over the entire temperature range (5 A nominal current), the power dissipation of neighboring modules must be derated starting at 45°C.



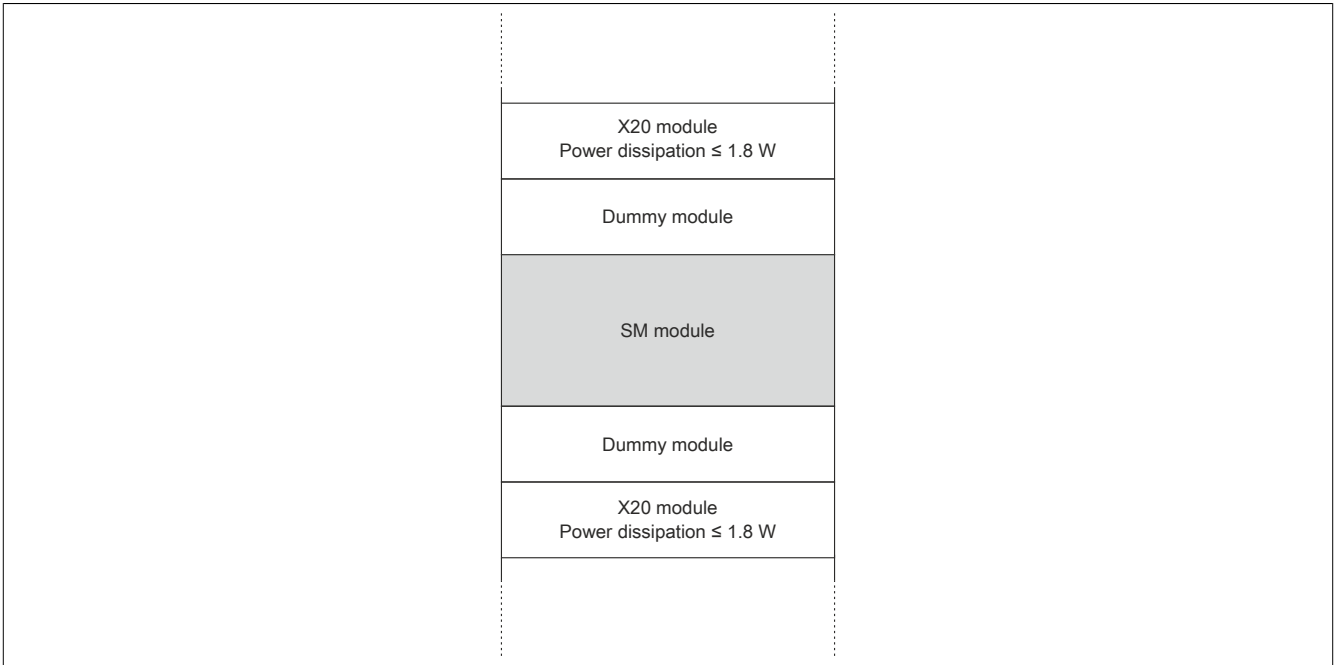
Current derating of the SM module

If the power dissipation of the neighboring modules to the SM module is 1 W, then the current of the SM module must be derated starting at 45°C.



Derating for vertical mounting orientation

When operating the module in a vertical mounting orientation, dummy modules must be connected as neighboring modules. There is no derating in this configuration.



9.25.10.16 Register description

9.25.10.16.1 mapp Motion system requirements

This module can be operated with mapp Motion function blocks. The following minimum versions are required for this:

- Upgrade version 2.2.0.0
- Automation Studio 4.7.2
- Automation Runtime 4.72

9.25.10.16.2 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.25.10.16.3 Function model 0 - "Standard" without SDC

| Register | Name | Data type | Read | | Write | |
|---------------------------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 46 | ConfigOutput02 (module configuration 1) | UINT | | | | • |
| 33 | ConfigOutput03 (holding current) | USINT | | | | • |
| 34 | ConfigOutput04 (nominal current) | USINT | | | | • |
| 35 | ConfigOutput05 (maximum current) | USINT | | | | • |
| 32 | ConfigOutput09 (counter configuration) | USINT | | | | • |
| 81 | MotorIdentTrigger | USINT | | | | • |
| 84 | FullStepThreshold01 | UINT | | | | • |
| 92 | StallDetectMinSpeed01 | UINT | | | | • |
| 120 | SGT_Speed01a | UINT | | | | • |
| 122 | SGT_Speed01b | UINT | | | | • |
| 124 | SGT_Value01a | INT | | | | • |
| 126 | SGT_Value01b | INT | | | | • |
| 130 | CfO_SmartEnable01 | UINT | | | | • |
| Reading back the configuration | | | | | | |
| 33 | ConfigOutput03Read (holding current) | USINT | | • | | |
| 34 | ConfigOutput04Read (nominal current) | USINT | | • | | |
| 35 | ConfigOutput05Read (maximum current) | USINT | | • | | |
| Communication | | | | | | |
| 6 | Positionasync | UINT | | • | | |
| 64 | PositionLatchedASync | INT | | • | | |
| 12 | Motoridentification01 | UINT | | • | | |
| Index* 2 + 16 | MotorStepN (index N = 0 to 3) | UINT | | | • | |
| 0 | PositionSync | INT | • | | | |
| 86 | PositionSync02 | INT | • | | | |
| 4 | Input counter value | USINT | • | | | |
| | ModulePowerSupplyError | Bit 0 | | | | |
| | StatusInput01 | Bit 2 | | | | |
| | StatusInput02 | Bit 3 | | | | |
| | StatusInput03 | Bit 4 | | | | |
| | StatusInput04 | Bit 5 | | | | |
| 10 | Error status | USINT | • | | | |
| | StallError | Bit 0 | | | | |
| | OvertemperatureError | Bit 1 | | | | |
| | CurrentError | Bit 2 | | | | |
| | OvercurrentError | Bit 3 | | | | |
| | OpenCircuit01 | Bit 12 | | | | |
| | ... | ... | | | | |
| OpenCircuit04 | Bit 15 | | | | | |
| 60 | PositionLatchedSync | INT | • | | | |
| 68 | usSinceTrigger | UINT | • | | | |
| 54 | Module configuration 2 | USINT | | | • | |
| | StartLatch | Bit 0 | | | | |
| | TriggerEdgePos | Bit 1 | | | | |
| | TriggerEdgeNeg | Bit 2 | | | | |
| | TriggerEdge | Bit 3 | | | | |
| | StartTrigger | Bit 4 | | | | |
| | ClearError | Bit 5 | | | | |
| | CurrentControlEnable | Bit 7 | | | | |
| | ... | ... | | | | |
| 72 | Stepper latch trigger status | USINT | • | | | |

| Register | Name | Data type | Read | | Write | |
|----------|--------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| | LatchInput | Bit 0 | | | | |
| | LatchDone | Bit 1 | | | | |
| | TriggerInput | Bit 4 | | | | |
| 74 | MotorLoad | UINT | • | | | |

9.25.10.16.4 Function model 0 - "Standard" with SDC

| Register | Name | Data type | Read | | Write | |
|---------------------------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| - | ConfigOutput02 (module configuration 1) | UINT | | | | • |
| 33 | ConfigOutput03 (holding current) | USINT | | | | • |
| 34 | ConfigOutput04 (nominal current) | USINT | | | | • |
| 35 | ConfigOutput05 (maximum current) | USINT | | | | • |
| 32 | ConfigOutput09 (counter configuration) | USINT | | | | • |
| 81 | MotorIdentTrigger | USINT | | | | • |
| 84 | FullStepThreshold01 | UINT | | | | • |
| 92 | StallDetectMinSpeed01 | UINT | | | | • |
| 102 | SDCConfig01 | USINT | | | | • |
| 103 | MotorSettingTime01 | USINT | | | | • |
| 107 | DelayedCurrentSwitchOff01 | USINT | | | | • |
| 120 | SGT_Speed01a | UINT | | | | • |
| 122 | SGT_Speed01b | UINT | | | | • |
| 124 | SGT_Value01a | INT | | | | • |
| 126 | SGT_Value01b | INT | | | | • |
| 130 | CF0_SmartEnable01 | UINT | | | | • |
| Reading back the configuration | | | | | | |
| 33 | ConfigOutput03Read (holding current) | USINT | | • | | |
| 34 | ConfigOutput04Read (nominal current) | USINT | | • | | |
| 35 | ConfigOutput05Read (maximum current) | USINT | | • | | |
| Communication | | | | | | |
| 6 | Positionasync | UINT | | • | | |
| 12 | Motoridentification01 | UINT | | • | | |
| 64 | PositionLatchedAsync | INT | | • | | |
| 112 | SetTime01 | INT | | | • | |
| 100 | Motor current | USINT | | | • | |
| | DriveEnable01 | Bit 0 | | | | |
| | BoostCurrent01 | Bit 1 | | | | |
| | StandstillCurrent01 | Bit 2 | | | | |
| | CurrentControlEnable01 | Bit 7 | | | | |
| 74 | MotorLoad | UINT | • | | | |
| 73 | LifeCnt | SINT | • | | | |
| 0 | ActPos01 | INT | • | | | |
| 4 | Input counter value | USINT | • | | | |
| | ModulePowerSupplyError | Bit 0 | | | | |
| | StatusInput01 | Bit 2 | | | | |
| | StatusInput02 | Bit 3 | | | | |
| | StatusInput03 | Bit 4 | | | | |
| | StatusInput04 | Bit 5 | | | | |
| 10 | Error status | USINT | • | | | |
| | StallError01 | Bit 0 | | | | |
| | OvertemperatureError01 | Bit 1 | | | | |
| | CurrentError01 | Bit 2 | | | | |
| | OvercurrentError01 | Bit 3 | | | | |
| | DrvOk01 | Bit 4 | | | | |
| | OpenCircuit01 | Bit 12 | | | | |
| | ... | ... | | | | |
| | OpenCircuit04 | Bit 15 | | | | |
| 54 | Error acknowledgment | USINT | | • | | |
| | ClearError01 | Bit 5 | | | | |
| 16 | Motor1Step0 | INT | | • | | |
| 200 | RefPulsePos01 | INT | • | | | |
| 204 | RefPulsePos01 | INT | • | | | |
| 212 | RefPulseCnt01 | SNT | • | | | |
| 214 | RefPulseCnt01 | SNT | • | | | |
| 220 | ActTime01 | INT | • | | | |
| 208 | TriggerTime01 | INT | • | | | |
| 216 | TriggerCnt01 | SINT | • | | | |

9.25.10.16.5 Function model 254 - "Bus controller" and function model 3 - "Ramp"

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|---------------------------------------|----------------------|---------------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 48 | - | ConfigOutput03a (holding current) | USINT | | | | • |
| 49 | - | ConfigOutput04a (nominal current) | USINT | | | | • |
| 50 | - | ConfigOutput05a (maximum current) | USINT | | | | • |
| 72 | - | FullStepThreshold01 | UINT | | | | • |
| 52 | - | MaxSpeed01pos | UINT | | | | • |
| 54 | - | MaxAcc01 | UINT | | | | • |
| 56 | - | MaxDec01 | UINT | | | | • |
| 58 | - | RevLoop01 | INT | | | | • |
| 60 | - | FixedPos01a | DINT | | | | • |
| 64 | - | FixedPos01b | DINT | | | | • |
| 68 | - | RefSpeed01 | UINT | | | | • |
| 74 | - | StallRecognitionDelay01 | USINT | | | | • |
| 75 | - | JoltTime01 | USINT | | | | • |
| 78 | - | StallDetectMinSpeed01 | UINT | | | | • |
| 70 | - | RefConfig01 | SINT | | | | • |
| 120 | - | SGT_Speed01a | UINT | | | | • |
| 122 | - | SGT_Speed01b | UINT | | | | • |
| 124 | - | SGT_Value01a | INT | | | | • |
| 126 | - | SGT_Value01b | INT | | | | • |
| 130 | - | CfO_SmartEnable01 | UINT | | | | • |
| 306 | - | GeneralConfig01 | USINT | | | | • |
| 308 | - | LimitSwitchConfig01 | USINT | | | | • |
| 344 | - | PositionLimitMin01 | DINT | | | | • |
| 348 | - | PositionLimitMax01 | DINT | | | | • |
| Reading back the configuration | | | | | | | |
| 48 | - | ConfigOutput03aRead (holding current) | USINT | | • | | |
| 49 | - | ConfigOutput04aRead (nominal current) | USINT | | • | | |
| 50 | - | ConfigOutput05aRead (maximum current) | USINT | | • | | |
| Communication | | | | | | | |
| 0 | 0 | AbsPos01 | DINT | | | • | |
| 4 | 4 | MpGenControl01 | UINT | | | • | |
| 6 | 6 | MpGenMode01 | SINT | | | • | |
| 0 | 0 | AbsPos01ActVal | DINT | • | | | |
| 4 | 4 | MpGenStatus01 | UINT | • | | | |
| 6 | 6 | InputStatus | USINT | • | | | |
| 8 | 8 | MotorLoad | UINT | • | | | |
| 84 | - | Motoridentification01 | UINT | | • | | |
| 86 | - | RefPos01CyclicCounter | DINT | | • | | |
| 94 | - | RefPos01AcyclicCounter | DINT | | • | | |
| 90 | - | AbsPos1ActValAcyclic | DINT | | • | | |
| 80 | - | ControlReadback01 | UINT | | • | | |
| 82 | - | ModeReadback01 | SINT | | • | | |
| 98 | - | ErrorCode01 | UINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.25.10.16.5.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "Using I/O modules on the bus controller" on page 3789.

9.25.10.16.5.2 CAN I/O bus controller

The module occupies 2 analog logical slots on CAN I/O.

9.25.10.16.6 Register description: General registers

9.25.10.16.6.1 General configuration registers

Determining the SGT parameters

Due to the dependence of the [MotorLoad value](#) on motor-specific properties and application-specific load and speed requirements, the operating conditions should be matched to the actual application.

To reliably detect a standstill of the motor, the stall threshold must be determined. The stall threshold should be a value within the operating limits and slightly higher than the minimum value before an actual motor standstill occurs.

- Parameter [SGT_Value01x](#) is used to compensate for an offset that results from the back EMF of the motor. For this purpose, the maximum load that the motor can run without blocking must be determined. Ideally, the MotorLoad load value should drop to 0 before a step loss due to overload causes the motor to stop. If the value of [SGT_Value01x](#) is set so that a value of 0 is displayed at maximum motor load, then the stall is precisely detected and the [stall error bit](#) is set correctly. For some motors, however, stall detection is very difficult to use or cannot be used at all. With these motors, no settings can be determined where the motor stops without slipping, e.g. due to electrical parameters or too little magnetic field feedback from the motor.
- [SGT_Speed01x](#) sets the threshold value at which speed the determined [SGT_Speed01x](#) becomes active. These are:

| | |
|---------------------|--|
| SGT_Value01a | From 0 to SGT_Speed01a |
| SGT_Value01b | From SGT_Speed01b to maximum |

Since the [MotorLoad value](#) drops to 0 during acceleration from standstill, this would be incorrectly detected as a stall and the motor would stop again immediately. Register [StallDetectMinSpeed01](#) can therefore be used to set a minimum speed at which stall detection is enabled.

Information:

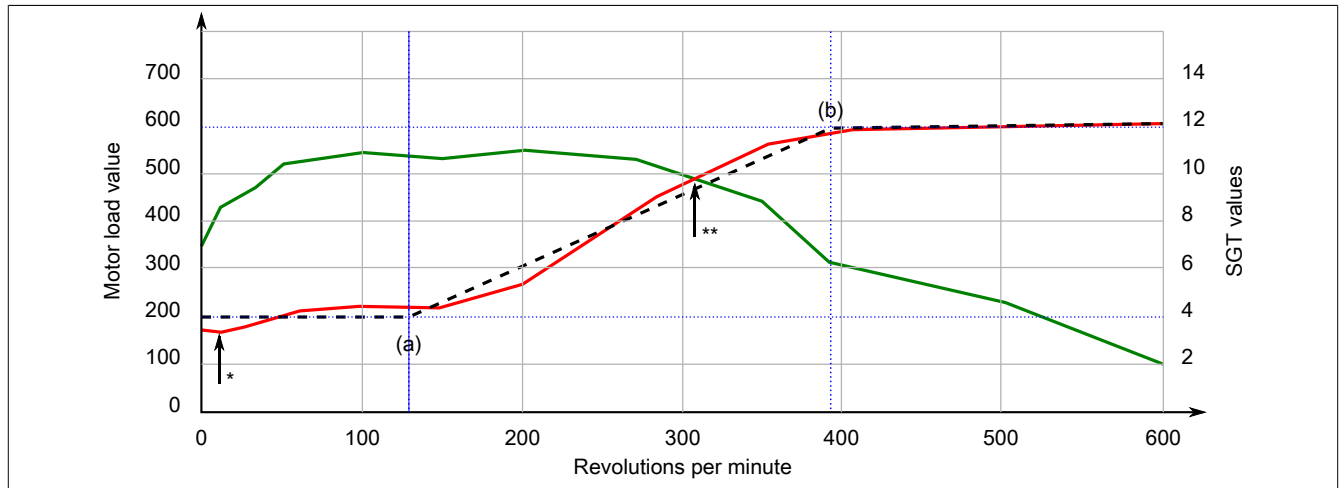
- **At very low motor speeds (<1 revolution/second), stall detection cannot be carried out reliably due to low back EMF values.**
- **At very high motor speeds, at which the sinusoidal motor current can no longer be impressed into the motor coil, poor responsiveness can also occur.**

Determining the motor load characteristic curve

To be able to set the points (SGT_Value01a and SGT_Value01b) for the offset of the MotorLoad value, creating a motor load characteristic curve is helpful.

This graph shows an example of 200 steps per revolution:

| | SGT_Value | SGT_Speed |
|-----------|-----------|--|
| Value (a) | 4 | 129 revolutions/minute = 430 steps/second |
| Value (b) | 12 | 392 revolutions/minute = 1307 steps/second |



Legend

| | |
|------------|--|
| Green line | Motor load characteristic curve without load |
| Red line | Offset-corrected motor load characteristic curve |
| Black line | Interpolated motor load characteristic curve |
| * | Minimum speed for stall detection (>10 rpm) |
| ** | Back EMF reaches supply voltage |

Since the back EMF increases with increasing speed (MotorLoad value decreases to 0) and counteracts, there is a maximum speed for stall detection.

SGT speed

Name:

SGT_Speed01a to SGT_Speed01b

The associated speed value for the respective SGT_Value can be set in these registers.

| Data type | Values | Information |
|-----------|-------------|--|
| UINT | 0 to 65,535 | In microsteps / X2X cycle (function model "Standard") In microsteps/cycle (function models "Bus controller" and "Ramp") |

SGT correction values

Name:

SGT_Value01a to SGT_Value01b

These registers optimize the motor load measurement.

The SGT value (Stallguard threshold) optimizes the motor load measurement. A negative value increases the sensitivity of the measurement; a positive value decreases it.

The correction value used depends on the value of SGT_Speed. The following applies:

- SGT_Value01 is used if the motor speed \leq SGTSpeed01.
- SGT_Value02 is used if the motor speed \geq SGTSpeed02.
- If the motor speed lies between the values, the SGT_Value is interpolated linearly.

The initial value for the optimization is 0. Values below -10 or over +10 should not be used.

| Data type | Values |
|-----------|-----------|
| INT | -64 to 63 |

Load-dependent current control

Load-dependent current control uses the **MotorLoad** value to reduce the current for the motor when the motor is only slightly loaded. In addition to saving energy, this also reduces the noise level of the motor. In addition, the motor is not heated as much. If a heavier load is again placed on the motor, the motor current is increased and thus more torque can be applied.

To set the load-dependent current control, 2 parameters must be set with "**MotorLoad_UpperLimit**" on page 2767 and "**MotorLoad_LowerLimit**" on page 2767 so that they can be increased or decreased as needed.

Stall detection for constant speed

If stall detection is only needed for a constant speed, the module can be configured as follows:

- 1) Set the initial values.
 - Disable current control. (**CurrentControlEnabel01** = 0)
 - Disable stall detection. (**StallDetectMinSpeed01** = 65535)
 - Set register **SGT_Speed01x** to 0.
 - Set register **SGT_Value01x** to 0.
- 2) Operate the motor at the speed needed for the application without load and observe the **MotorLoad** value.
- 3) Adjust the value.
 - a) Slowly increase the load on the motor. If the motor stops before the **MotorLoad** value indicates 0, reduce **SGT_Value01x** by 1.

Information:

Registers **SGT_Value01a and **SGT_Value01b** must always be set to the same value!**

- b) If the **MotorLoad** value is 0 before the motor stops, increase **SGT_Value01x** by 1. The optimal setting is achieved when the **MotorLoad** value remains above 0 at the maximum load necessary. If the value becomes 0, the maximum load on the motor is exceeded. In this case, bit 0 "StallError" is set in register **Error status**.
- 4) In register **StallDetectMinSpeed01**, set the speed value from which stall detection is enabled.

Stall detection for variable speeds

If stall detection is needed for a range of speeds (SGT_Speed01a and SGT_Speed01b), the module can be configured as follows:

- 1) Set the initial values.
 - Disable current control. (CurrentControlEnabel01 = 0)
 - Disable stall detection. (StallDetectMinSpeed01 = 65535)
 - Set register SGT_Speed01x to 0.
 - Set register SGT_Value01x to 0.
- 2) Operate the motor at the start of the speed range (SGT_Speed01a) without load and observe the MotorLoad value.
- 3) Adjust the value.
 - a) Slowly increase the load on the motor. If the motor stops before the MotorLoad value indicates 0, reduce SGT_Value01x by 1.
 - b) If the MotorLoad value is 0 before the motor stops, increase SGT_Value01x by 1. The optimal setting is achieved when the MotorLoad value remains above 0 at the maximum load necessary. If the value becomes 0, the maximum load on the motor is exceeded. In this case, bit 0 "StallError" is set in register Error status.
- 4) Operate the motor at the end of the speed range (SGT_Speed01b) without load and observe the MotorLoad value.
- 5) Adjust the value, see 3.
- 6) Set the determined range values.

The SGT_Value0x values between the range start and range end are interpolated linearly.

 - Set SGT_Value01a and SGT_Speed01a for the range start with the determined values.
 - Set SGT_Value01b and SGT_Speed01b for the range end with the determined values.
- 7) In register StallDetectMinSpeed01, set the speed value from which stall detection is enabled.

Configuring current control

Name:

CfO_SmartEnable01

The values for load-dependent current control can be set in this register. For reduced motor loads, the power supply can be reduced to a minimum of 25% nominal current in order to save electricity.

For increased motor loads, the module automatically adjusts the power supply according to the set values.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|---------|--------------------------------|---------|--|
| 0 - 3 | MotorLoad_LowerLimit | 0 | Current control disabled (bus controller default setting) |
| | | 1 to 15 | |
| 4 | Reserved | - | |
| 5 - 6 | Current increase ¹⁾ | 0 | 1 measured values (bus controller default setting) |
| | | 1 | 2 measured values |
| | | 2 | 4 measured values |
| | | 3 | 8 measured value |
| 7 | Reserved | - | |
| 8 - 11 | MotorLoad_UpperLimit | 0 to 15 | |
| 12 | Reserved | - | |
| 13 - 14 | Current decrease ¹⁾ | 0 | 32 measured values (bus controller default setting) |
| | | 1 | 8 measured values |
| | | 2 | 2 measured values |
| | | 3 | 1 measured value |
| 15 | Current reduction | 0 | Reduction to 50% of the nominal current (bus controller default setting) |
| | | 1 | Reduction to 25% of the nominal current |

1) The measured values are recorded with each full step of the motor.

MotorLoad_LowerLimit

Increase of the current up to a maximum of 100% of the nominal current set in register "ConfigOutput04" on page 2769 if `MotorLoad` < (`MotorLoad_LowerLimit` * 32). If `MotorLoad_LowerLimit` = 0, load-dependent current control is disabled.

Current increase

Specifies the number `MotorLoad` measured values that are less than or equal to the limit value (`MotorLoad_LowerLimit` * 32) in order to increase current.

MotorLoad_UpperLimit

Reduction of the current if `MotorLoad` > (`MotorLoad_LowerLimit` + `MotorLoad_UpperLimit` + 1) * 32.

Current decrease

Number of `MotorLoad` measured values that are greater than or equal to the limit value (`MotorLoad_LowerLimit` + `MotorLoad_UpperLimit` + 1) * 32 in order to decrease the current.

Current reduction

Maximum reduction of the current to 25% or 50% of the nominal current.

9.25.10.16.7 Register description: Function model "Standard", general registers**9.25.10.16.7.1 Configuration registers****Minimum speed for stall detection**

Name:

StallDetectMinSpeed01

If the motor speed exceeds the value set in this register, then stall detection is enabled. This means that stall detection principally does not work at low speeds.

| Data type | Values | Information |
|-----------|-------------|------------------------------------|
| UINT | 0 to 65,535 | Minimum speed in steps per second. |

Full step threshold

Name:

FullStepThreshold01

This register configures a rotational speed. When this defined speed has been reached, the drive will automatically change from microsteps to full step mode. This makes it possible to optimize the torque at higher speeds, while microstep mode ensures optimal radial runout at lower speeds.

It does not make sense to change to full step mode at a standstill because fine positioning would then no longer be possible. This is why value "0" does not make sense in the full step threshold register and is interpreted as disabling full step mode (i.e. the motor will always be operated in microstep mode).

| Data type | Values | Information |
|-----------|-------------|-------------------------|
| UINT | 0 | Full step mode disabled |
| | 1 to 65,535 | Steps/second |

Example

Microstep mode should change to full step mode at 500 steps/second. On a motor with 200 steps per revolution, this would be equal to a speed of:

$$T^{-1} = \frac{500 \text{ steps/second}}{200 \text{ steps/revolution}} = 2.5 \frac{\text{revolutions}}{\text{second}} = 150 \text{ min}^{-1}$$

Holding current, nominal current and maximum current

Name:

ConfigOutput03 (holding current)

ConfigOutput04 (nominal current)

ConfigOutput05 (maximum current)

The holding current, nominal current and maximum current registers are used to configure the desired motor current.

Reasonable values are:

- Holding current < Nominal current < Maximum current

Information:

The maximum current must always be configured higher than the nominal current.

The motor's nominal current is entered in the nominal current register according to the motor's data sheet.

| Register | Description |
|-----------------|---|
| Nominal current | Current during normal operation |
| Maximum current | Should be selected if a higher motor torque is required briefly during acceleration phases. |
| Holding current | The holding current should be used in situations when less torque is required (e.g. at a standstill). This reduces the amount of heat generated by the motor. |

Switching between preset current values (holding current, rated current, maximum current):

| Function model | Switching between preset current values at runtime |
|---------------------------------------|--|
| Standard | Using bits 14 and 15 in registers "Motor StepX" on page 2774 |
| Standard with enabled SDC information | Using register "Motor current" on page 2779 |

| Data type | Values | Unit |
|-----------|----------|---|
| USINT | 0 to 200 | Percent of the module's rated current <ul style="list-style-type: none"> • 100% corresponds to the rated current of the motor bridge power unit listed in the technical data • 200% corresponds to the maximum current of the motor bridge power unit listed in the technical data. |

Counter configuration

Name:

ConfigOutput09

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------------|-------|--|
| 0 | ABR latch function | 0 | Negative edge: Disable ABR latch function |
| | | 1 | Positive edge: Enable ABR latch function. After a latch event has occurred, the latch function can be started again on a new rising edge. |
| 1 - 2 | Definition of the latch mode | 00 | ABR latch counter state unconditionally |
| | | 01 | ABR latch counter state on a positive edge of input R |
| | | 10 | ABR latch counter state on a negative edge of input R |
| | | 11 | Reserved |
| 3 | | 0 | <ul style="list-style-type: none"> • Position sync: Internal position counter • Position async: ABR counter state • Position latched sync: Internal position counter • Position latched async: ABR counter state |
| | | 1 | <ul style="list-style-type: none"> • Position sync: ABR counter state • Position async: Internal position counter • Position latched sync: ABR counter state • Position latched async: Internal position counter |
| 4 - 7 | Reserved | | |

1) These registers are not available in function model "Standard" with SDC information enabled.

Motor ID trigger

Name:

MotorIdentTrigger

With this register, a measurement of the motor ID can be initiated acyclically (see "[Motor identification](#)" on page 2772). The application must ensure that the conditions for measurement are met (see table "Notes" in register "[Motor identification](#)" on page 2772).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|---|
| 0 | | 0 | No effect |
| | | 1 | Positive edge triggers motor identifier measurement |
| 1 - 7 | Reserved | 0 | |

9.25.10.16.7.2 Registers for reading back the configuration

Reading back the holding current, nominal current and maximum current

ConfigOutput03Read (holding current)

ConfigOutput04Read (nominal current)

ConfigOutput05Read (maximum current)

These registers are used to read the respective current values in percent.

| Register | Description |
|-----------------|--|
| Nominal current | Current during operation at constant speed |
| Maximum current | Current during acceleration phases |
| Holding current | Current when motor is at standstill |

| Data type | Values | Unit |
|-----------|----------|---|
| USINT | 0 to 255 | Percentage of module's nominal current (100% corresponds to the nominal current of the motor bridge power unit in the technical data) |

9.25.10.16.7.3 Communication registers

Measuring motor load

Name:

MotorLoad

This register contains the current measured load value for stall detection. A high value indicates a small load on the motor; the lower the value, the higher the motor load. The SGT values (see "[SGT speed](#)" on page 2765 and "[SGT correction values](#)" on page 2765) should be set so that the motor load returns value 0 at maximum load (shortly before stall).

This register can be shown and hidden via the module configuration.

| Data type | Values |
|-----------|-----------|
| UINT | 0 to 1023 |

Module configuration 1

Name:

ConfigOutput02

The number of transfer values and the resolution of microsteps for the drive can be configured in this register.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|--|-------|---|
| 0 | The setting for these two bits determines the meaning of bits 2 and 3 in register "Input counter value" on page 2776. | x | |
| 1 - 2 | Reserved | 0 | |
| 3 - 4 | Number of transfer values per X2X Link cycle (see "Motor StepX" on page 2774) | 00 | 1 x $\Delta s / \Delta t$ (transfer values: MotorStep0) |
| | | 01 | 2 x $\Delta s / \Delta t$ (transfer values: MotorStep0 - MotorStep1) |
| | | 10 | 4 x $\Delta s / \Delta t$ (transfer values: MotorStep0 - MotorStep3) |
| | | 11 | Reserved |
| 5 - 6 | Resolution of microsteps for the following registers: <ul style="list-style-type: none"> "Motor StepX" on page 2774 "Position sync/async" on page 2771 | 00 | Resolution: 5 bits (bits 0 - 4) microsteps; 8 bits (bits 5 - 13) full steps |
| | | 01 | Resolution: 6 bits (bits 0 - 5) microsteps; 7 bits (bits 6 - 13) full steps |
| | | 10 | Resolution: 7 bits (bits 0 - 6) microsteps; 6 bits (bits 7 - 13) full steps |
| | | 11 | Resolution: 8 bits (bits 0 - 7) microsteps; 5 bits (bits 8 - 13) full steps |
| 7 - 15 | Reserved | 0 | |

Position sync/async

Name:

PositionSync (function model 1 - "Standard" with SDC)

ActPos01 (function model 0 - "Standard" without SDC)

Positionasync

Depending on the [Counter configuration](#), these registers can be used to read either the internal position counter or the counter value on the ABR input.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

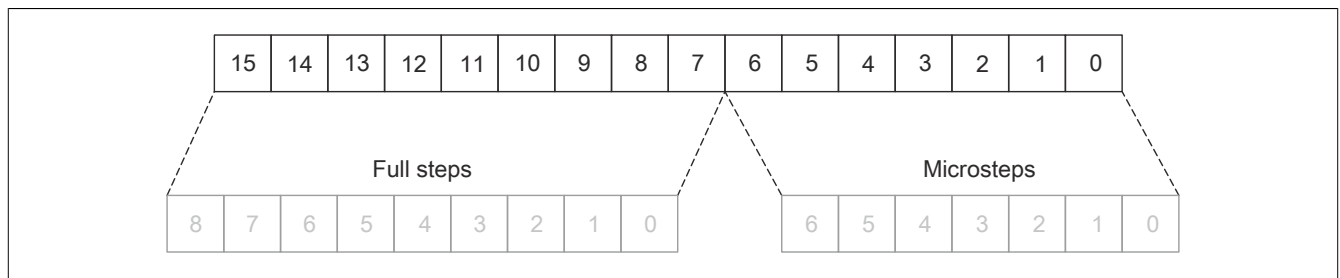
| Register | Counter configuration | |
|--------------------------|---------------------------|---------------------------|
| | Bit 3 = 0 | Bit 3 = 1 |
| Position sync (ActPos01) | Internal position counter | ABR counter |
| Position async | ABR counter | Internal position counter |

Internal position counter

The internal position counter is the position calculated by the SM module (position setpoint). This is a cyclic 16-bit counter.

The lowest 5 to 8 bits represent microsteps, while the highest 8 to 11 bits represent full steps (depending on bits 5 and 6 of the "Module configuration 1" on page 2771). In function model "Standard" with SDC, this value is defined as "8-bit microstep" and cannot be changed.

Example of the internal position counter format (7-bit microsteps, i.e. set bit 5 and 6 of the module configuration to binary 10):



ABR counter

This counter is a cyclic 16-bit counter. The relationship between this counter and the internal position counter depends on the resolution of the ABR encoder and the microsteps defined for the internal position counter.

Motor identification

Name:

Motoridentification01

This register is used to identify the connected motor type for service purposes and to differentiate between motors in the application. After successful measurement, this register contains the time [µs] required to apply a current increase of $\Delta I = 1 \text{ A}$ to a motor winding.

This depends on:

- Operating voltage
- Inductance and resistance of the motor winding

| Notes | | |
|-----------|---|--|
| 1) | To achieve reproducible results, the measurement must be made under the following defined conditions: | |
| | a) | Motor is at standstill. |
| | b) | The motor must be in a half-step position (phase A fully powered, phase B not powered). This means the internal position counter on the SM module must have a value that fulfills the following conditions: <ul style="list-style-type: none"> • Full steps are divisible by 4. • Microsteps = 0 |
| 2) | Condition 1b) is fulfilled after a the SM module is reset or switched on. Immediately afterwards, when the holding current is applied to the motor for the first time (at standstill), the duration for applying the current is measured. This is therefore a suitable time to read the motor identification register in the application. | |
| 3) | The current range from approximately 1/3 of the nominal current up to the nominal current is used as operating range for determining the motor identifier. | |
| Data type | Motor ID values | Explanation |
| UINT | 0 | No motor identifier available (after switching on for as long as the measurement conditions are not met) |
| | 1 to 32767 | Valid range of values for the motor ID register (in µs) |
| | 65534 | Invalid value: Overflow |

Error status

Name: The names of the bits are different depending on whether [SDC information](#) is enabled or disabled.

Without SDC

StallError

Overtemperature

ErrorCurrentError

OvercurrentError

-

With SDC

StallError01

Overtemperature01

ErrorCurrentError01

OvercurrentError01

DrvOK01

OpenCircuit01 to OpenCircuit04

The current error status of the drive is indicated in this register. Each bit indicates a certain error or status. If an error is registered in bits 0 to 3, then the corresponding bit remains set until the error has been acknowledged (see "[Module configuration 2](#)" on page 2777 and "[Error acknowledgment](#)" on page 2780).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|---|-------|---|
| 0 | StallError(01) | 0 | No stall |
| | | 1 | Stall |
| 1 | Overtemperature error OvertemperatureError(01) | 0 | No overtemperature |
| | | 1 | Overtemperature |
| 2 | Current error CurrentError(01) | 0 | No current error |
| | | 1 | Current error |
| 3 | Overcurrent error OvercurrentError(01) | 0 | No overcurrent |
| | | 1 | Overcurrent |
| 4 | Status of the drive DrvOk0 ¹⁾ | 0 | An error was triggered for the motor axis |
| | | 1 | The drive is running error-free |
| 5 - 11 | Reserved | 0 | |
| 12 | Open circuit OpenCircuit01 | 0 | No open circuit |
| | | 1 | Open circuit detected |
| ... | | ... | |
| 15 | Open circuit OpenCircuit04 | 0 | No open circuit |
| | | 1 | Open circuit detected |

1) Only when SDC information is enabled

Overtemperature error

The "Overtemperature" error bit can be set for the following reasons:

- A specific temperature was exceeded near the channel due to overload
- The module temperature rises above the limit (see ["Shutdown in the event of overtemperature \(starting at 116°C\)" on page 2755](#)).

Current error

This error bit occurs whenever the required current cannot be supplied to the motor windings. This can be (but is not necessarily) caused by an open circuit. At higher speeds (depending on the motor), this error can also occur without an open circuit. In this case it is simply no longer possible to supply the desired current to the motor windings. Because of the Back-EMF on the motor, this bit is set at slightly lower speeds if the motor is operated with no load compared with full or partial loads.

Overcurrent error

Overcurrent occurs if there is not enough voltage for the motor winding (e.g. short circuit).

Status of the drive

The status of the drive is only shown when SDC information is enabled. The drive bit is 1 when the following conditions are met:

- Motor turned on (see ["Motor current" on page 2779](#))
- MotorID measurement is completed
- Motor is supplied with current
- Motor settling time has passed
- Supply voltage is in the valid range
- No overtemperature fault
- Preset position value is valid (see ["SDC life sign monitoring" on page 2779](#))

Open circuit

The module is equipped with open circuit detection for the digital inputs. If the digital input is not connected to ground or to 24 V, an open circuit is detected.

9.25.10.16.8 Register description: Function model "Standard" without SDC information

9.25.10.16.8.1 Communication registers

Motor StepX

Name:

MotorStep0 to MotorStep3

These registers specify the number and direction of steps that must be moved by the module during the next X2X cycle and also select the motor current (see also "[Holding current, nominal current and maximum current](#)" on page 2769).

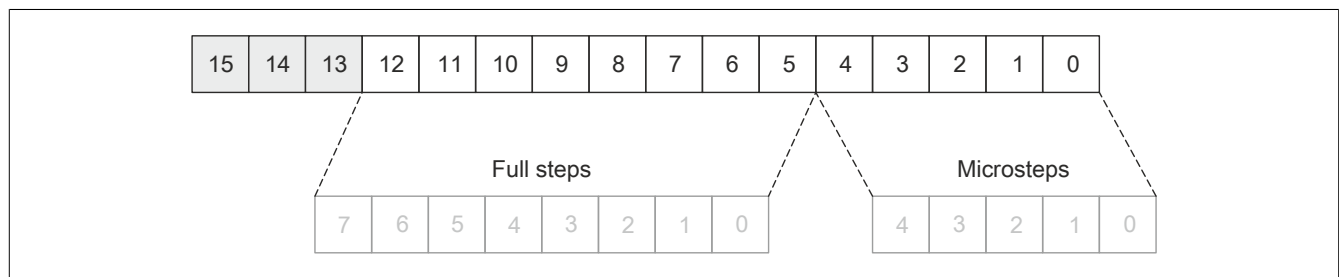
| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|--|-------|-------------------|
| 0 - 12 | Number of steps for the module to move during the next X2X cycle | x | |
| 13 | Direction of movement | 0 | Positive |
| | | 1 | Negative |
| 14 - 15 | Selection of motor current | 00 | Motor not powered |
| | | 01 | Holding current |
| | | 10 | Nominal current |
| | | 11 | Maximum current |

Depending on the necessary resolution and maximum configurable speed, module configuration 1 can be used to specify which bit position is used as the 1s position for full steps (see bits 5 and 6 of "[Module configuration 1](#)" on page 2771).

Example for 5-bit microsteps (set bits 5 and 6 of the module configuration to binary 00):



The number of transfer values per X2X cycle is specified by bits 3 and 4 in the module configuration 1 (see "[Module configuration 1](#)" on page 2771). If only one transfer value (bits 3 and 4 = 00) is specified, then the motor is advanced by MotorStep0 until the next X2X cycle. If 2 or 4 transfer values are specified, they are added and executed in the next X2X cycle.

Position latched sync-async

Name:

PositionLatchedSync

PositionLatchedASync

The position counter (internal position counter or ABR counter) is applied at the latch event (see "Module configuration 2" on page 2777). Bits 3 and 7 of register "Counter configuration" on page 2769 are used to determine which counter state (internal position counter or ABR encoder) should be saved in registers "Position latched sync" and "Position latched async".

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

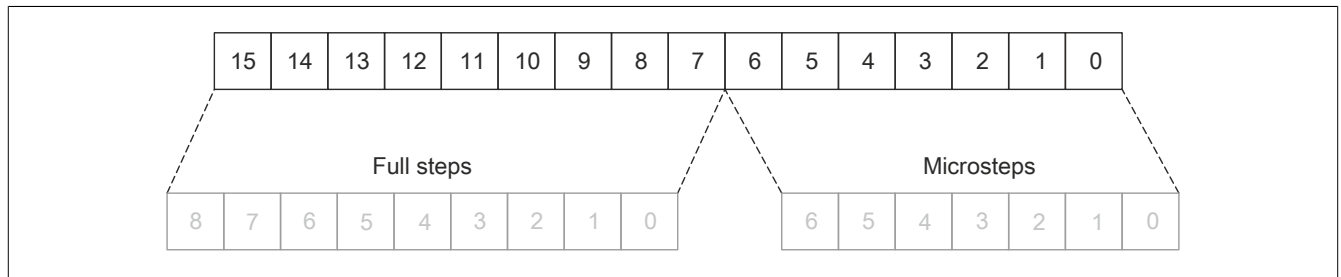
| Register | Counter configuration | |
|----------------|---------------------------|---------------------------|
| | Bit 3 = 0 | Bit 3 = 1 |
| Position sync | Internal position counter | ABR counter |
| Position async | ABR counter | Internal position counter |

Internal position counter

The internal position counter is the position calculated by the module (position setpoint). This is a cyclic 16-bit counter.

The lowest 5 to 8 bits represent microsteps, while the highest 8 to 11 bits represent full steps (depending on bits 5 and 6 of the "Module configuration 1" on page 2771).

Example of the internal position counter format (7-bit microsteps, i.e. set bit 5 and 6 of the module configuration to binary 10):



ABR counter

This counter is a cyclic 16-bit counter. The relationship between this counter and the internal position counter depends on the resolution of the ABR encoder and the microsteps defined for the internal position counter.

usSinceTrigger

Name:

usSinceTrigger

This register indicates the time in μs that has passed since the trigger event occurred (see "Module configuration 2" on page 2777).

Information:

The absolute accuracy of the trigger can be delayed up to 5 μs due to the input filter of the digital inputs.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

Stepper latch trigger status

Name:
 LatchInput
 LatchDone
 TriggerInput

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------|-------|---|
| 0 | Latch input: | x | Digital input for the latch event (level) |
| 1 | LatchDone | x | Changes its state each time the counter state is successfully latched (reset value = 0) |
| 2 - 3 | Reserved | - | |
| 4 | TriggerInput | x | Trigger input (level) |
| 5 - 7 | Reserved | 0 | |

9.25.10.16.8.2 Input counter value

Name:
 ModulePowerSupplyError
 StatusInput01 to StatusInput04

This register indicates the state of the digital inputs and counters.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------|---|--|
| 0 | ModulePowerSupplyError | 0 | OK |
| | | 1 | Module power supply error |
| 1 | Reserved | 0 | |
| 2 | StatusInput01 | If bit 0 in Module configuration 1 = 0 | |
| | | 0 or 1 | Input state - Digital input 1 |
| | | If bit 0 in Module configuration 1 = 1 | |
| | | x | Ref toggle bit for counter 1: The state of this bit is changed after homing is completed. |
| 3 | StatusInput02 | If bit 0 in Module configuration 1 = 0 | |
| | | 0 or 1 | Input state - Digital input 2 |
| | | If bit 0 in Module configuration 1 = 1 | |
| | | 0 | The homing procedure for the ABR counter is active. |
| | | 1 | The homing procedure of the ABR counter is completed. |
| 4 | StatusInput03 | 0 or 1 | Input state - Digital input 3 |
| 5 | StatusInput04 | 0 or 1 | Input state - Digital input 4 |
| 6 - 7 | Reserved | 0 | |

9.25.10.16.8.3 Configuration registers

Module configuration 2

Name:

StartLatch

TriggerEdgePos

TriggerEdgeNeg

StartTrigger

TriggerEdge

ClearError

CurrentControlEnable

The trigger functions for the stepper motor can be configured with this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|---|
| 0 | Latch function for stepper motor 2 Latch byte | 0 | The latch function for stepper motor position is disabled on the negative edge of this bit. |
| | | 1 | The latch function for stepper motor position is disabled on the positive edge of this bit. |
| 1 - 2 | Latch mode for stepper motor TriggerEdgePos (bit 1) TriggerEdgeNeg (bit 2) | 00 | Latch position of stepper motor unconditional |
| | | 01 | Latch position of stepper motor on positive edge of input DI 3 |
| | | 10 | Latch position of stepper motor on negative edge of input DI 3 |
| | | 11 | Reserved |
| 3 | TriggerEdge | 0 | Trigger edge (input DI 4) = Positive |
| | | 1 | Trigger edge (input DI 4) = Negative |
| 4 | Enable trigger (on change) StartTrigger | x | |
| 5 | ClearError | 0 | No effect |
| | | 1 | Error acknowledgment for motor (for more information, see "Error status" on page 2772) |
| 6 | Reserved | - | |
| 7 | CurrentControlEnable | 0 | Enable load-dependent current control |
| | | 1 | Disable load-dependent current control |

Trigger function procedure:

- Selection of the desired trigger edge using bit 3
- Enabling of the trigger function by changing the state of bit 4. Changing this bit deletes `usSinceTrigger` (μ s counter).
- When the trigger event occurs, μ s counter `usSinceTrigger` is started.
- Counter `usSinceTrigger` cannot overflow, i.e. the counter is stopped at $2^{16} - 1$ and retains this value until the next time the trigger function is enabled.

The trigger function can be re-enabled at any time by changing the state of bit 4, regardless of whether a trigger event has occurred or if `usSinceTrigger` has reached the maximum value.

Position sync 2

Name:

PositionSync02

This register contains the state of either the position counter or the ABR counter depending on [Counter configuration](#) (bit 3). It behaves exactly complementary to register "[Position sync](#)" on page 2771.

If "Position sync" contains the position counter, then register "PositionSync02" contains the ABR counter state, and vice versa.

By default, the register is not visible in the I/O map; it must first be enabled in the I/O configuration.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

9.25.10.16.9 Register description: Function model "Standard" with SDC information

9.25.10.16.9.1 Configuration registers

SDC configuration

Name:
SDCConfig01

This register can be used to enable/disable additional SDC information.

The additional cyclic registers are hidden or shown depending on whether SDC information is disabled or enabled. Compare the two variants of function model "Standard" [with](#) and [without enabled SDC information](#).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------------------------|-------|----------------------|
| 0 | Trigger edge | 0 | Rising trigger edge |
| | | 1 | Falling trigger edge |
| 1 - 5 | Reserved | 0 | |
| 6 | SDC life sign monitoring | 0 | Disabled |
| | | 1 | Enabled |
| 7 | SDC information ¹⁾ | 0 | Disabled |
| | | 1 | Enabled |

- 1) When the "SDC information" bit is enabled, the "EncOK01" bit is shown in the Automation Studio I/O mapping. This bit is linked to the ModulOK bit and always indicates its value.

Information:

Neither SDC information nor SDC life sign monitoring is permitted to be changed at runtime.

Module configuration 1 with SDC

Register "Module configuration 1" on page 2771 is ignored in function model "Standard" with SDC information enabled. The module behaves as follows, i.e. whether the module configuration was written in this way:

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|--|-------|---|
| 0 | Meaning of bits 2 and 3 in register "Input counter value" on page 2780 | | |
| 1 - 2 | Reserved | 0 | |
| 3 - 4 | Number of transfer values per X2X cycle | 00 | 1x Δs / Δt (transfer values: motor settings Motor1Step0) |
| 5 - 6 | Resolution of microsteps | 11 | 8-bit microsteps |
| 7 - 15 | Reserved | 0 | |

Motor settling time

Name:
MotorSettlingTime01

This register determines the motor setting time. The motor settling time determines the minimum time between when the motor is powered on to when the DrvOk bit is set (see "Error status" on page 2772). The setting is made in steps of 10 ms.

| Data type | Values | Information |
|-----------|----------|---------------------------------|
| USINT | 1 to 255 | 10 ms to 2.55 s, default: 10 ms |

Switch-off delay

Name:
DelayedCurrentSwitchOff01

If the [SDC life sign monitoring](#) is triggered (i.e. the [NetTime timestamp](#) is in the past) the motor is decelerated at nominal current with speed setpoint = 0.

Then the motor is switched off after the delay configured with this register.

| Data type | Values | Information |
|-----------|----------|--|
| USINT | 0 to 255 | 0 to 25.5 s in steps of 100 ms (default: 100 ms) |

9.25.10.16.9.2 Communication registers

SDC life sign monitoring

Name:

SetTime01

The module uses SDC life sign monitoring to check whether valid values have been received for the speed setpoint.

SDC life sign monitoring is enabled in register "SDC configuration" on page 2778 by setting bit 6 (SDCSetTime = On).

If the specified [NetTime timestamp](#) is in the past, then an error is triggered for the motor axis (only when the motor is switched on). The module performs the following steps:

- 1) The CPU is informed of the error using the Drive bit (DrvOk) = 0
- 2) Braking at configured nominal current with speed setpoint = 0
- 3) Wait for configured turn-off delay to expire
- 4) Power off motor

When the timestamp is back within the valid range, the motor can be operated again by a rising edge on bit "DriveEnable" (see "[Motor current](#)" on page 2779) .

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

Motor current

Name:

DriveEnable01

BoostCurrent01

StandstillCurrent01

CurrentControlEnable01

Bits 0 to 2 of this register control the motor's current feed.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------|-------|---|
| 0 | DriveEnable01 | x | Motor powered |
| 1 | BoostCurrent01 | x | Maximum current |
| 2 | StandstillCurrent01 | x | Holding current |
| 3 - 6 | Reserved | 0 | |
| 7 | CurrentControlEnable01 | 0 | Load-dependent current control disabled |
| | | 1 | Load-dependent current control enabled |

The possible status of bits 0 to 2

| StandstillCurrent01 | BoostCurrent01 | DriveEnable01 | Description |
|---------------------|----------------|---------------|-----------------------------------|
| x | x | 0 | Motor not supplied with current |
| 0 | 0 | 1 | Rated current supplied to motor |
| 0 | 1 | 1 | Maximum current supplied to motor |
| 1 | 0 | 1 | Holding current supplied to motor |
| 1 | 1 | 1 | Holding current supplied to motor |

Lifecycle counter

Name:

LifeCnt

This register is incremented by one with each X2X Link cycle.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

Input counter value

Name:

ModulePowerSupplyError

StatusInput01 to StatusInput04

This register indicates the state of the digital inputs and counters.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------|---|--|
| 0 | ModulePowerSupplyError | 0 | OK |
| | | 1 | Module power supply error |
| 1 | Reserved | 0 | |
| 2 | StatusInput01 | If bit 0 in Module configuration 1 = 0 | |
| | | 0 or 1 | Input state - Digital input 1 |
| | | If bit 0 in Module configuration 1 = 1 | |
| | | x | Ref toggle bit for counter 1: The state of this bit is changed after homing is completed. |
| 3 | StatusInput02 | If bit 0 in Module configuration 1 = 0 | |
| | | 0 or 1 | Input state - Digital input 2 |
| | | If bit 0 in Module configuration 1 = 1 | |
| | | 0 | The homing procedure for the ABR counter is active. |
| | | 1 | The homing procedure of the ABR counter is completed. |
| 4 | StatusInput03 | 0 or 1 | Input state - Digital input 3 |
| 5 | StatusInput04 | 0 or 1 | Input state - Digital input 4 |
| 6 - 7 | Reserved | 0 | |

Error acknowledgment

Name:

ClearError01

This register can be used to acknowledge errors that have occurred on the motor.

For more info, see ["Error status" on page 2772](#).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------|-------|--------------------------------|
| 0 - 4 | Reserved | 0 | |
| 5 | ClearError01 | 0 | No effect |
| | | 1 | Error acknowledgment for motor |
| 6 - 7 | Reserved | 0 | |

Motor1Step0

Name:

Motor1Step0

This registers is used to specify the number and direction of steps that should be carried out by the module during the next X2X cycle.

The value is specified with a resolution of 1/256 of a full step (corresponds to 8-bit microsteps).

The direction of movement is derived from the value's sign:

| Data type | Values | Information |
|-----------|--------|--|
| INT | >0 | Movement in the positive direction in 1/256 full steps |
| | <0 | Movement in the negative direction in 1/256 full steps |

Unlike function model "Standard" without enabled SDC information, the motor current is selected using a separate register (see register ["Motor current" on page 2779](#)).

Home position

Name:

RefPulsePos01

These 2 registers have the following contents:

| Register | Description |
|--|--|
| Home position of the internal position counter | This register contains the home position of the internal position counter. |
| Home position for the ABR counter | This register contains the home position of the ABR counter. |

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

Setting "Position sync" in the Automation Studio I/O configuration can be used to select which of the 2 registers is addressed by variable RefPulsePos01.

| Variables in Automation Studio | I/O configuration, counter 01, option "Position sync" | |
|--|---|---|
| | Stepper counter 01 is indicated on ActPos01 . | ABR counter 01 is indicated on ActPos01 . |
| RefPulsePos01 | Home position of the internal position counter | Home position of the ABR counter |
| Option "Position sync" for counter 1 also sets bit 3 in register " Counter configuration " on page 2769: | | |
| Bit 3 (counter 1) | 0 | 1 |

Reference pulse counter

Name:

RefPulseCnt01

These 2 registers have the following contents:

| Register | Description |
|---|---|
| Reference pulse counter for the internal position counter | The reference pulses of the internal position counter are counted in this register. |
| Reference pulse counter for the ABR counter | The reference pulses of the ABR counter are counted in this register. |

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

Setting "Position sync" in the Automation Studio I/O configuration can be used to select which of 2 registers is addressed by variable RefPulsePos01.

| Variables in Automation Studio | I/O configuration, counter 01, option "Position sync" | |
|--|---|---|
| | Stepper counter 01 is indicated on ActPos01 . | ABR counter 01 is indicated on ActPos01 . |
| RefPulseCnt01 | Reference pulse counter for the internal position counter | Reference pulse counter of the ABR counter |
| Option "Position sync" for counter 1 also sets bit 3 in register " Counter configuration " on page 2769: | | |
| Bit 3 (counter 1) | 0 | 1 |

NetTime of the position value

Name:

ActTime01

This register contains the NetTime of the most recent valid position value.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

Trigger counter

Name:

TriggerCnt01

This register contains a cyclic counter that is incremented with each trigger event.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

Trigger timestamp

Name:

TriggerTime01

This register contains the NetTime instant of the most recent trigger event. The trigger edge must be configured in register "[SDC configuration](#)" on [page 2778](#).

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on [page 3035](#).

Information:

The absolute accuracy of the trigger can be delayed up to 5 µs due to the input filter of the digital inputs.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

9.25.10.16.10 Register description: Function model 254 - "Bus controller" and function model 3 - "Ramp"

9.25.10.16.10.1 Configuration registers

Holding current, nominal current and maximum current

Name:

ConfigOutput03a (holding current)

ConfigOutput04a (nominal current)

ConfigOutput05a (maximum current)

The holding current, nominal current and maximum current registers are used to configure the desired motor current.

Reasonable values are:

- Holding current < Nominal current < Maximum current

The motor's nominal current is entered in the nominal current register according to the motor's data sheet.

| Register | Description |
|-----------------|---|
| Nominal current | Current during operation at constant speed |
| Maximum current | Current during acceleration phases. In the mode " Referencing during stall ", the rated current is always used instead of the maximum current, even in acceleration phases. |
| Holding current | Current when motor is at standstill |

When the current changes to a weaker value (e.g. when transitioning from the acceleration phase to the constant speed mode), the stronger current is maintained for an additional 100 ms. The following priority applies regardless of the values actually set: maximum current before nominal current before holding current.

| Data type | Values | Unit |
|-----------|----------|---|
| USINT | 0 to 200 | Percent of the module's rated current <ul style="list-style-type: none"> • 100% corresponds to the rated current of the motor bridge power unit listed in the technical data • 200% corresponds to the maximum current of the motor bridge power unit listed in the technical data. Bus controller default setting: 0 |

Full step threshold

Name:

FullStepThreshold01

Starting with the speed specified in this register, the motor is operated in full step mode; it is operated in microstep mode below it.

| Data type | Values | Information |
|-----------|------------|---|
| UINT | 1 to 65534 | Speed in microsteps/cycle. Bus controller default setting: 0 |
| | 65535 | Motor is always operated in microstep mode |

Maximum speed

Name:

MaxSpeed01pos

This register defines the maximum speed for the absolute positioning modes (1, -123, -124, -125, -126).

Information:

The setting does not apply to the speed and homing modes (2, -127, -128).

| Data type | Values | Information |
|-----------|-------------|---|
| UINT | 0 to 65,535 | Speed in microsteps/cycle. Bus controller default setting: 0 |

Maximum acceleration

Name:

MaxAcc01

This register defines the maximum acceleration. (also applies for homing modes).

| Data type | Values | Information |
|-----------|-------------|--|
| UINT | 0 to 65,535 | Acceleration in microsteps/cycle ² . Bus controller default setting: 0 |

Maximum deceleration

Name:

MaxDec01

This register defines the maximum deceleration. (also applies for homing modes).

| Data type | Values | Information |
|-----------|-------------|--|
| UINT | 0 to 65,535 | Brake deceleration in microsteps/cycle ² . Bus controller default setting: 0 |

Reversing loop

Name:

RevLoop01

This parameter is only used in modes 1, -123, -124, -125, -126 (absolute positioning modes).

If the value for the reversing loop is not equal to 0, the target position is approached directly when coming from one direction; when coming from the other direction, the target position is initially overshoot by the configured number of steps before finally moving to the target position. This ensures that the target position is always approached from the same direction (to avoid mechanical backlash).

The sign of the defined value determines the direction in which the reversing loop runs.

| Sign | Effective direction |
|----------|--|
| Positive | Reversing loop in positive direction of movement |
| Negative | Reversing loop in negative direction of movement |

| Data type | Values | Information |
|-----------|-----------------|-----------------------------------|
| INT | -32768 to 32767 | Bus controller default setting: 0 |

Fixed position A

Name:

FixedPos01a

This register defines the position to move to in modes -124 (if the digital input is set to 1) and -125.

| Data type | Values | Information |
|-----------|------------------------------------|-----------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: 0 |

Fixed position B

Name:
FixedPos01b

This register defines the position to move to in modes [-124](#) (if the digital input is set to 0) and [-126](#).

| Data type | Values | Information |
|-----------|------------------------------------|-----------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: 0 |

Homing speed

Name:
RefSpeed01

This register sets the speed for homing modes [-127](#) and [-128](#).

| Data type | Values | Information |
|-----------|-------------|---|
| UINT | 0 to 65,535 | Speed in microsteps/cycle. Bus controller default setting: 0 |

Stall recognition delay

Name:
StallRecognitionDelay01

The value in this register is only relevant for [Referencing during stall](#).

A stall is only detected after the time specified here has expired and after the homing procedure has started.

For example, a setting of 4 (and a cycle time of 25 ms) means that a stall will not be detected until 100 ms after the motor starts moving (start of the homing procedure).

Set to 0 to eliminate delay.

| Data type | Values | Information |
|-----------|----------|---|
| USINT | 0 to 255 | In cycles, see " General configuration " on page 2785. Bus controller default setting: 0 |

Minimum speed for stall detection

Name:
StallDetectMinSpeed01

If the motor speed exceeds the value set in this register, then stall detection is enabled. No error is reported below this threshold value.

| Data type | Values | Information |
|-----------|-------------|---|
| UINT | 0 to 65,535 | Minimum speed in microsteps per cycle. Bus controller default setting: 0 |

Jerk time

Name:
JoltTime01

If a value other than 0 is assigned to this register, then jerk limitation is performed. This is done by averaging the values for the steps to be carried out (speed setpoint) in each cycle using a FIFO buffer. The jerk time corresponds to the number of FIFO elements (0 to 80). If a value greater than 80 is entered, then it will be limited internally to 80.

Changes made while a motor is running will be applied as soon as ...

- The motor has reached the set position (positioning mode only).
- The motor has stopped (all modes).

| Data type | Values | Information |
|-----------|---------|---|
| USINT | 0 | No jerk limitation time. Bus controller default setting: 0 |
| | 1 to 80 | Number of FIFO elements |

Homing configuration

Name:
RefConfig01

The homing mode can be set with this register.

| Data type | Values | Information |
|-----------|------------|--|
| SINT | -120 | Set home position |
| | -121 | Homing on positive edge of input DI 4 |
| | -122 | Homing on falling edge of input DI 4 |
| | -125 | Homing on positive edge of input DI 3 (R pulse). Bus controller default setting |
| | -126 | Homing on negative edge of input DI 3 (R pulse) |
| | -127 | Homing during stall detection |
| | -128 | Immediate homing |
| | All others | No effect |

General configuration

Name:
GeneralConfig01

Bit 0 of this register can be used to switch the positioning mode. This register can also be used to configure the cycle time of the motion profile generator.

- 0: "Mode 1: Position mode" without extended control word
- 1: "Mode 1: Position mode with extended control word"

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|--|
| 0 | Position mode | 0 | Without extended control word (bus controller default setting) |
| | | 1 | With extended control word |
| 1 - 2 | Cycle time of the motion profile generator ¹⁾ | 00 | 25 ms (bus controller default setting) |
| | | 01 | 10 ms |
| | | 10 | 5 ms |
| | | 11 | Reserved |
| 3 - 7 | Reserved | 0 | |

1) The cycle time for the motion profile generator is configured with this cycle. This cycle time affects the unit for specifying the speed and acceleration:

- Unit for speed: Microsteps/Cycle
- Unit for acceleration: Microsteps/Cycle²

Limit switch configuration

Name:

LimitSwitchConfig01

This register configures the behavior of the limit switches.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------|-------|---|
| 0 - 1 | Negative limit switch | 00 | Switched off (bus controller default setting) |
| | | 01 | Active if low |
| | | 10 | Reserved |
| | | 11 | Active if high |
| 2 - 3 | Positive limit switch | 00 | Switched off (bus controller default setting) |
| | | 01 | Active if low |
| | | 10 | Reserved |
| | | 11 | Active if high |
| 4 - 6 | Reserved | 0 | |
| 7 | Direction monitoring | 0 | Off (bus controller default setting) |
| | | 1 | On |

Negative/Positive limit switch:

When one of the limit switches is reached, a warning is triggered and the speed is decelerated to 0. There is no state change of "Device control state machine". This keeps current flowing to the motor.

The error that occurred can be read from the error code register. Normal operation can be resumed by acknowledging the warning. This will not restrict motor movement to a specific direction and the limit switch will not be triggered until the next active edge.

Overshooting the limit switch while braking

The limit switches are not linked with the corresponding direction of movement. If the limit switch is exceeded, another error will be triggered when reversing after acknowledging the initial error.

Direction monitoring

If this function is enabled, then the two limit switches will be linked with the respective direction of movement. This means that the negative limit switch is only triggered in the negative and the positive limit switch only in the positive direction of movement (specified direction).

This prevents specifying a movement in the wrong direction when direction monitoring is enabled and limit switches are active.

Warning!

If the motor is wired incorrectly with this configuration (wrong direction of movement), then the limit switch will not be triggered and the actual correct direction of movement will be denied. This will also be the case when the limit switch connections are reversed.

Software limit

Name:

PositionLimitMin01

PositionLimitMax01

This register configures software limits. The function is enabled if at least one of the two registers is not equal to zero.

These limits are effective in all positioning modes. Position overflow is not possible when this function is enabled. Movement is always contained within the two limits.

If a position is specified that violates the minimum/maximum software limit, the "Internal limit active" bit will be set in the "Status word" on page 2794 register. The motor movement will be stopped until a position is specified within the limits.

Bit "Internal limit active" will also be set in register "Status word" if incorrectly configured (minimum > maximum).

| Data type | Values | Information |
|-----------|------------------------------------|-----------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: 0 |

Information:

The software limits will only be monitored when using the following CANopen bus controllers:

- X20BC0043-10
- X20BC0143-10
- X67BC4321-10
- X67BC4321.L08-10
- X67BC4321.L12-10

9.25.10.16.10.2 Reading back the configuration

Reading back the holding current, nominal current and maximum current

ConfigOutput03aRead (holding current)

ConfigOutput04aRead (nominal current)

ConfigOutput05aRead (maximum current)

These registers are used to read the respective current values in percent.

| Register | Description |
|-----------------|--|
| Nominal current | Current during operation at constant speed |
| Maximum current | Current during acceleration phases |
| Holding current | Current when motor is at standstill |

| Data type | Values | Unit |
|-----------|----------|---|
| USINT | 0 to 255 | Percentage of module's nominal current (100% corresponds to the nominal current of the motor bridge power unit in the technical data) |

9.25.10.16.10.3 Communication registers

Measuring motor load

Name:

MotorLoad

This register contains the current measured load value for stall detection. A high value indicates a small load on the motor; the lower the value, the higher the motor load. The SGT values (see "SGT speed" on page 2765 and "SGT correction values" on page 2765) should be set so that the motor load returns value 0 at maximum load (shortly before stall).

This register can be shown and hidden via the module configuration.

| Data type | Values |
|-----------|-----------|
| UINT | 0 to 1023 |

Set position/speed

Name:
AbsPos01

This register is used to set position or speed, depending on the operating mode.

- Position mode (see ["Mode" on page 2789](#)): Cyclic setting of the position setpoint in microsteps. In this mode, one micro-step is always 1/256 full-step.
- Speed mode (see ["Mode" on page 2789](#)): In this mode, this register is considered a signed speed setpoint.

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

Control word

Name:
MpGenControl01

This register can be used to issue commands based on the module's state (see ["Operating function model "Ramp" on page 2797](#)).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------|-------|--|
| 0 | Switch on | x | |
| 1 | Enable voltage | x | |
| 2 | Quick stop | x | |
| 3 | Enable operation | x | |
| 4 - 6 | Mode-specific | x | |
| 7 | Fault reset | x | |
| 8 | Stop ¹⁾ | x | |
| 9 | CurrentControlEnable | 0 | Disable load-dependent current control |
| | | 1 | Enable load-dependent current control |
| 10 | Reserved | 0 | |
| 11 | Motor ID trigger | 0 | No effect |
| | | 1 | Rising edge: Motor ID trigger ²⁾ |
| 12 | Warning reset | 0 | No effect |
| | | 1 | Rising edge: Reset warnings |
| 13 | Undercurrent detection | 0 | Disable current error detection (default) |
| | | 1 | Enable current error detection |
| 14 | ABR counter sync/async | 0 | Default: <ul style="list-style-type: none"> • Internal position counter, cyclic • ABR counter, acyclic |
| | | 1 | <ul style="list-style-type: none"> • Internal position counter, acyclic • ABR counter, cyclic |
| 15 | Stall detection | 0 | Disable stall detection (default) |
| | | 1 | Enable stall detection |

1) The "Stop" bit is only evaluated when the extended control word is enabled (see ["General configuration" on page 2785](#)).

2) This bit can be used to trigger a measurement of the motor ID. Keep in mind that the application must ensure that the conditions for measurement are fulfilled (see table in the ["Motor identification" on page 2795](#) register).

Mode

Name:

MpGenMode01

| Data type | Values | Information |
|-----------|--------|---|
| SINT | 0 | No mode selected |
| | 1 | Depending on bit 0 in the "General configuration" on page 2785 register, the position mode will behave as follows: <ul style="list-style-type: none"> Position mode without extended control word: Move to target position as soon as the target position is changed Position mode with extended control word: Move to the target position as described in "Mode 1 - Position mode with extended control word" on page 2789 |
| | 2 | Speed mode: Constant speed |
| | -120 | Set home position |
| | -121 | Remaining distance mode |
| | -122 | Set actual position |
| | -123 | Move to target position when external input set |
| | -124 | Two-position module |
| | -125 | Move to fixed position A (position set acyclically) |
| | -126 | Move to fixed position B (position set acyclically) |
| | -127 | Positive homing (see also "Homing configuration" on page 2785) |
| | -128 | Negative homing (see also "Homing configuration" on page 2785) |

Information:

For all modes: The "Target reached" bit is set in the "Status word" on page 2794 register when the current action is finished (i.e. when the position or speed is reached, depending on the mode).

A new position or speed can be specified even before the current action is finished.

Mode 1 - Position mode

The position setpoint is specified in the "Set position/speed" on page 2788 register. The motor is then moved to this new position. This is done with a ramp function that accounts for the defined maximum speed and acceleration values.

The position setpoint can also be changed during an active positioning procedure.

The position setpoint is specified in microsteps (1/256 of a full step).

If bit 0 in the "General configuration" on page 2785 register is 0 (no extended control word), then the position setpoint will be applied as soon as it is different from the current position. Then the new position is used for the movement.

However, if bit 0 in the "General configuration" on page 2785 register is set to 1 (extended control word), then the position setpoint will be applied as described under "Mode 1 - Position mode with extended control word" on page 2789.

Mode 1 - Position mode with extended control word

Position mode with extended control word behaves like [Position mode 1](#) as described previously (without the extended control word), but the new position setpoint ("Position/Speed" on page 2788 register) is applied according to the [extended control word](#).

Extended control word

Commands can be issued using this register depending on the state of the module (see "Operating function model "Ramp"" on page 2797).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|---|-------|---|
| 0 - 3 | Corresponds to the default Control word | x | |
| 4 | New setpoint | 0 | Do not apply target position. |
| | | 1 | Apply target position. |
| 5 | Change set immediately | 0 | Complete current positioning movement and then start next positioning movement |
| | | 1 | Interrupt current positioning movement and then start next positioning movement |
| 6 | abs / rel | 0 | Target position is an absolute value. |
| | | 1 | Target position is a relative value. |
| 7 | Corresponds to the default Control word | x | |
| 8 | Stop ¹⁾ | 0 | Execute positioning |
| | | 1 | Stop axis with deceleration |
| 9 - 15 | Corresponds to the default Control word | x | |

1) This bit applies to all modes.

Extended status word

The bits in the status word reflect the status of the state machine (for a detailed description, see "Status word" on page 2798 and "State machine" on page 2799).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|--|-------|---|
| 0 - 9 | Corresponds to the default Status word | x | |
| 10 | Target reached, depending on bit 8 (Stop) in the Control word register | 0 | If Stop = 0 |
| | | | Target position not reached. |
| | | 1 | Target position reached |
| | | | If Stop = 1 |
| | | 0 | Axis decelerating |
| | | | 1 |
| 11 | Corresponds to the default Status word | x | |
| 12 | Setpoint acknowledge | 0 | Ramp generator did not apply the position value |
| | | 1 | Ramp generator applied the position value |
| 13 - 15 | Corresponds to the default Status word | x | |

Position setting

The target position can be defined in 2 different ways:

| Type of setpoint definition | Description |
|-----------------------------|---|
| Single setpoint | After the target position is reached, Bit <i>Target reached</i> in register "Status word" on page 2794 is set. Then a new target position is defined. The drive stops at each target position before starting the movement to the next target position. |
| Set of setpoints | After the target position has been reached, the movement to the next target position is started immediately without stopping the drive. It is therefore possible to initiate a new positioning by specifying another target position during active positioning. |

The two modes "Single setpoint" and "Set of setpoints" are controlled by the timing of bits *New setpoint* and *Change set immediately* in the "extended control word" on page 2790 and *Setpoint acknowledge* in register "Extended control word" on page 2790.

These bits can be used to create a Request-Response mechanism. This makes it possible to specify a target position while a previous position specification is still being processed.

Specifying the target position

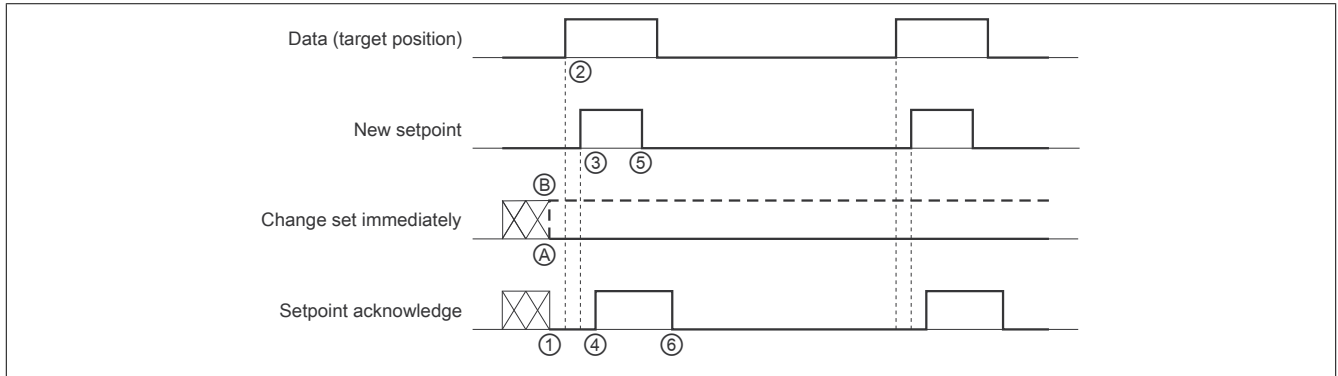


Figure 194: Principle for applying the setpoint

Transferring a new setpoint:

- 1) If bit *Setpoint acknowledge* in register "Extended status word" on page 2790 is 0, the module will accept a new target position.
- 2) The new target position is specified in register "Set position/speed" on page 2788.
- 3) A rising edge on bit *New setpoint* in the "extended control word" on page 2790 indicates that the new target position in register "Set position/speed" on page 2788 is valid and can be used for the next positioning movement.
- 4) After the module has received and saved the new target position, bit *Setpoint acknowledge* is set to 1 in register *Status word*.
- 5) Now the controller can reset the *New setpoint* bit to 0.
- 6) Then the module resets bit *Setpoint acknowledge* to 0 to signal when a new target position is accepted.

Position specification "Single setpoint"

When the *Change set immediately* bit is set to 0 (A in figure "Principle for applying the setpoint"), then the module is operating in *Single setpoint* mode. This mechanism results in a speed of 0 when the motor reaches target position x_1 at time t_1 . After the controller has been notified that the setpoint has been reached, the next target position x_2 will be processed at time t_2 and reached at t_3 .

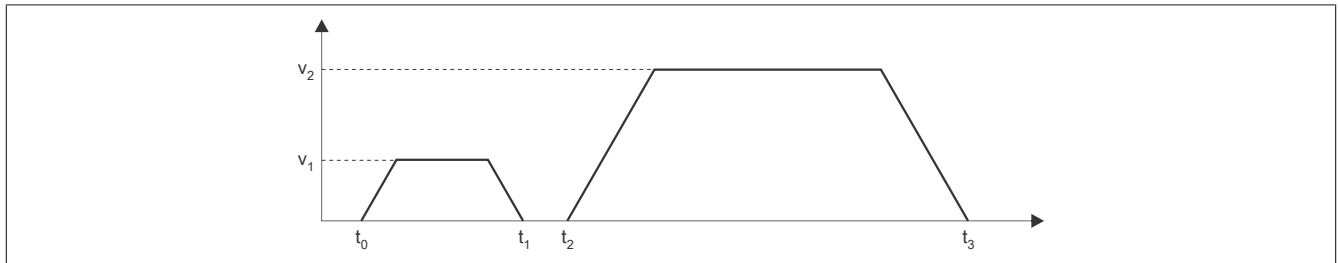


Figure 195: Ramp in *Single setpoint*

"Set of setpoints" preset position value

When the *Change set immediately* bit is set to 1 (B in figure "Principle for applying the setpoint"), then the module is operating in *Single setpoint* mode. This means that the module receives the first target position at t_0 . A second target position is received at time t_1 . The drive immediately adapts the current movement to the new target position.

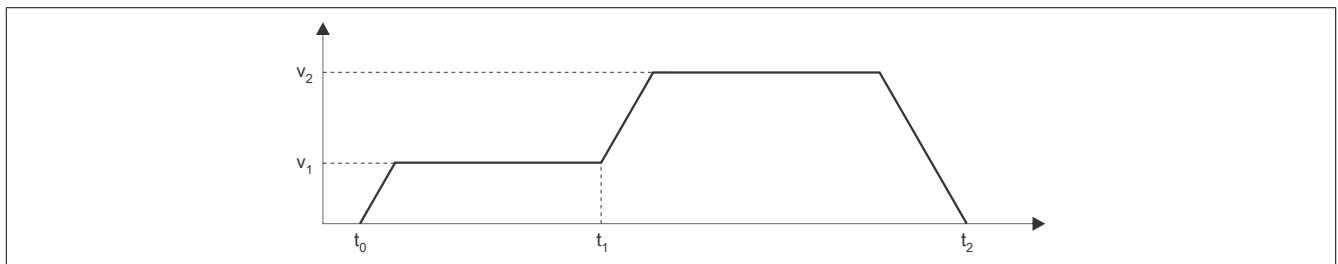


Figure 196: Ramp in *Set of setpoints*

Relative position setting

If bit *abs / rel* bit in register [Extended control word](#) is set, then the target position is interpreted as a relative value. At each *New setpoint* trigger, the target position will be increased by this value (or decreased if the value is negative).

If the mode changes between the position settings, relative movement will then proceed starting at the last specified position. The position setpoint mode is initialized with 0 when the module is started.

Mode 2: Speed mode - Constant speed (pos./neg.)

The value in register ["Position/Speed"](#) on page 2788 is now interpreted as the speed setpoint (microsteps/ cycle).

Observing the maximum permissible acceleration, the motor moves with a ramp to the desired speed setpoint and maintains this speed until a new speed setpoint is specified.

Values are allowed within the range -65535 to 65535. When a value is entered outside of this range, it is readjusted to these limits.

Mode -120: Set home position

The current actual position is changed so that the position specified in register ["Position/Speed"](#) on page 2788 is the home position. If you then move to this position, the motor is at the home position.

The home position in register ["Home position"](#) on page 2795 is also set to this value.

Before this mode is called, the motor must be at a standstill and the home position must have been determined using ["Positive / negative homing"](#) mode. In order to set the position, the [State machine](#) must be in state "Operation enable".

Mode -121: Remaining distance mode (like mode 1)

The number of steps defined in register ["Fixed position A"](#) on page 2783 are added to the current position and the resulting position is approached at a rising/falling edge on digital input 3.

Advice:

Steps are not added to the target position, but rather to the current position at the moment the trigger occurs.

Negative values are also allowed for the offset defined in [Fixed position A](#).

New target positions are no longer accepted in register ["Position/Speed"](#) on page 2788 after the trigger event. There must first be a switch made to [mode 0](#) and then back to mode -121.

Bit "Target reached" in register ["Status word"](#) on page 2794 is not set to 1 until the end position (after the trigger event) has been reached.

The ["homing configuration"](#) on page 2785 determines whether a rising or falling edge of the digital input is used as a trigger.

The [Reversing loop](#) is not enabled in this mode (i.e. any configured values not equal to 0 are ignored).

Mode -122: Set actual position

The target position set in register ["Position/Speed"](#) on page 2788 is applied as the current actual position in the internal position counter if the state machine is in state "Operation enable".

Before this mode is started, the motor must be at a standstill and physically located at the point for which the position being set should be applied.

Mode -123: Move to the target position when the external input is set

The position setpoint set in register ["Position/Speed"](#) on page 2788 is moved on a rising edge of digital input 3.

A new position setpoint is not applied until another rising edge occurs on the corresponding digital input. This can also occur during the active positioning procedure and will be applied immediately.

Mode -124: Two-position mode

Positions [Fixed position A](#) and [Fixed position B](#) are defined in the acyclic registers.

Value 1 on digital input 3 moves to fixed position A. Value 0 moves to fixed position B. It is also possible to switch between the two during an active positioning movement.

Mode -125/-126: Move to fixed position X

The purpose of these modes is to enable a virtual switch from speed mode to position mode, which otherwise is not possible because of the shared use of the register for position and speed setpoints.

- Mode -125: "Fixed position A" on page 2783
- Mode -126: "Fixed position B" on page 2784

Mode -127/-128: Positive/Negative homing

Mode -127 and -128 are used to select which direction to move.

The motor must be at a standstill before switching from another mode to one of the homing modes.

If the referencing condition occurs, then the motor stops and the values of the position counter and ABR counter valid at the moment when the referencing condition occurs are written to the "Referenced zero position" on page 2795 register.

In the [referencing configuration](#) you must specify whether referencing should occur at low/high level on the digital input, during stall or unconditionally.

Homing via digital input

Case 1: Active referencing level not yet reached → Motor not yet at end position:

Movement continues at the referencing speed in the referencing direction until the active level for "Stop referencing" is on the input.

Case 2: Active referencing level already reached → Motor at end position:

Movement continues at the referencing speed against the referencing direction until the active level for "Stop referencing" is no longer at the digital input. Movement continues at homing speed in the homing direction until the active level for "homing-stop" is on the digital input again.

Referencing during stall

Movement continues in the referencing direction until a stall is detected. When a stall is detected, the value of the position counter is entered in the "Referenced zero position" on page 2795 register within one millisecond. The motor is then stopped abruptly (not using the deceleration ramp). However, it can take up to 25 ms to stop the motor because the ramp generator runs with a configurable internal cycle of up to 25 ms.

In this mode, the nominal current is always used instead of the maximum current, even in acceleration phases.

To test the responsiveness of this homing mode, the motor load value used for identifying a stall can be made visible in the status word.

Unconditional referencing (immediate)

Immediate referencing: The current values of the position counter and of the ABR counter are immediately entered in register "Homed zero position" on page 2795, no motor movement.)

Current position (cyclic)

Name:

AbsPos01ActVal

This cyclic register contains the current position.

Default: Value of the internal position counter, can be changed to ABR counter

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

Status word

Name:

MpGenStatus01

The bits in this register reflect the state of the state machine. For a more detailed description, see "[Status word](#)" on page 2798 and "[State machine](#)" on page 2799.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|-----------------------|-------|---|
| 0 | Ready to switch on | x | |
| 1 | Switched on | x | |
| 2 | Operation enabled | x | |
| 3 | Fault (error bit) | x | |
| 4 | Voltage enabled | x | |
| 5 | Quick stop | x | |
| 6 | Switch on disabled | x | |
| 7 | Warning | x | |
| 8 | Reserved | 0 | |
| 9 | Remote | 1 | Always 1 since there is no local mode for the SM module |
| 10 | Target reached | x | |
| 11 | Internal limit active | 0 | No limit violation |
| | | 1 | Internal limit is active (upper or lower software limit violated) |
| 12 | Mode-specific | x | |
| 13 - 15 | Reserved | 0 | Always 0 |

Input status

Name:

InputStatus

This register indicates the logical states of digital inputs.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------|--------|---------------------------------|
| 0 | Digital input 1 | 0 or 1 | Input state - Digital input 1 |
| ... | | ... | |
| 3 | Digital input 4 | 0 or 1 | Input state - Digital input 4 |
| 4 | Open circuit 1 | 0 | No error |
| | | 1 | Open circuit on digital input 1 |
| ... | | ... | |
| 7 | Open circuit 4 | 0 | No error |
| | | 1 | Open circuit on digital input 4 |

Motor identification

Name:

Motoridentification01

This register is used to identify the connected motor type for service purposes and to differentiate between motors in the application. After successful measurement, this register contains the time [µs] required to apply a current increase of $\Delta I = 1 \text{ A}$ to a motor winding.

This depends on:

- Operating voltage
- Inductance and resistance of the motor winding

| Notes | |
|-------|---|
| 1) | To achieve reproducible results, the measurement must be made under the following defined conditions: |
| a) | Motor is at standstill. |
| b) | The motor must be in a half-step position (phase A fully powered, phase B not powered). This means the internal position counter on the SM module must have a value that fulfills the following conditions: <ul style="list-style-type: none"> • Full steps are divisible by 4. • Microsteps = 0 |
| 2) | Condition 1b) is fulfilled after a the SM module is reset or switched on. Immediately afterwards, when the holding current is applied to the motor for the first time (at standstill), the duration for applying the current is measured. This is therefore a suitable time to read the motor identification register in the application. |
| 3) | The current range from approximately 1/3 of the nominal current up to the nominal current is used as operating range for determining the motor identifier. |

| Data type | Motor ID values | Explanation |
|-----------|-----------------|--|
| UINT | 0 | No motor identifier available (after switching on for as long as the measurement conditions are not met) |
| | 1 to 32767 | Valid range of values for the motor ID register (in µs) |
| | 65534 | Invalid value: Overflow |

Homed zero position

Name:

RefPos01CyclicCounter

RefPos01AcyclicCounter

After a homing procedure, the homing point for the cyclic or acyclic position counter can be read back with these registers (either the internal position counter or ABR counter depending on bit 14 of register "[Control word](#)" on [page 2788](#)).

The following two registers are provided for the motor:

- Homed zero position for cyclic counter
- Homed zero position for acyclic counter

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

Current position (acyclic)

Name:

AbsPos1ActValAcyclic

This acyclic register contains the current position.

Default: Value of the ABR counter, can be changed to internal position counter

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

Read back control word

Name:

ControlReadback01

This register can be used to read the contents of register "[Control word](#)" on [page 2788](#).

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

Read back mode

Name:

ModeReadback01

This register can be used to read the contents of register "Mode" on page 2789.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

Error code

Name:

ErrorCode01

The cause of an error or warning can be read in this register.

| Data type | Error code | Error type | Priority | Description |
|-----------|------------|------------|----------|-----------------------------|
| UINT | 0x0000 | - | - | No error |
| | 0x3000 | Error | High | Voltage |
| | 0x4200 | Error | | Overtemperature |
| | 0xFF20 | Warning | : | Negative limit switch |
| | 0xFF21 | Warning | : | Positive limit switch |
| | 0x2300 | Warning | : | Overcurrent |
| | 0xFF00 | Warning | : | Current error ¹⁾ |
| | 0xFF01 | Warning | : | Stall ²⁾ |
| | 0xFF11 | Warning | Low | Open circuit |

1) A current error is only detected if bit 13 = 1 in the **control word** (current error detection enabled).

2) Stall is only detected if bit 15 = 1 in the **control word** (stall detection enabled).

Information regarding the handling of errors and warnings:

- Bit 3 (fault) and bit 8 (warning) in the **status word** can be used to query whether an error or a warning was reported in the error code register.
- Bit 7 (Fault Reset) and bit 8 (Warning Reset) in the **control word** are used to acknowledge pending errors and warnings.
- If two or more errors/warnings are pending, the one with the highest priority (the order in the table above) will be displayed in the error code register.

9.25.10.16.10.4 Operating function model "Ramp"

Control for this model has been based on the CANopen communication profile DS402.

Commands for controlling the modules are written to the "Control word" on page 2797. The current module state is returned in register "Status word" on page 2798. The function mode (absolute position, constant speed, homing, etc.) is set in register "Mode" on page 2789.

Control word

Control word bits and their state for the commands of the state machine:

| Command | Stall detection | Encoder position sync/async | Current error detection | Warning reset | Motor ID trigger | Reserved | CurrentControlEnable | Stop 2) | Fault reset | Mode-specific | Mode-specific | Mode-specific | Enable operation | Quick stop | Enable voltage | Switch on |
|-------------------|-----------------|-----------------------------|-------------------------|---------------|------------------|----------|----------------------|---------|-------------|---------------|---------------|---------------|------------------|------------|----------------|-----------|
| Bit ¹⁾ | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Shutdown | x | x | x | x | x | 0 | 0 | x | 0 | x | x | x | x | 1 | 1 | 0 |
| Switch on | x | x | x | x | x | 0 | 0 | x | 0 | x | x | x | 0 | 1 | 1 | 1 |
| Disable voltage | x | x | x | x | x | 0 | 0 | x | 0 | x | x | x | x | x | 0 | x |
| Quick stop | x | x | x | x | x | 0 | 0 | x | 0 | x | x | x | x | 0 | 1 | x |
| Disable operation | x | x | x | x | x | 0 | 0 | x | 0 | x | x | x | x | 0 | 1 | 1 |
| Enable operation | x | x | x | x | x | 0 | 0 | x | 0 | x | x | x | 1 | 1 | 1 | 1 |
| Fault reset | x | x | x | x | x | 0 | 0 | x | ↑ | x | x | x | x | x | x | x |

1) x ... Any, ↑ ... Rising edge

2) Bit 8 (stop) is only evaluated if the extended control word is enabled in register "General configuration" on page 2785.

| | |
|---|--|
| Bits 0, 1, 2, 3 and 7 (light gray in the previous table) | These bits control the state of the State machine according to the commands in the table above. |
| Stop | 0 ... Perform motor movement 1 ... Stop axis with deceleration This bit is only evaluated when the extended control word is enabled in register "General configuration" on page 2785. |
| Motor ID trigger | A rising edge enables the motor ID measurement. |
| Warning reset | A rising edge resets warnings (no effect on errors, which are reset using "Fault reset"; the state machine is not affected by this bit). |
| Fault reset | A rising edge resets errors and warnings (see "State machine" on page 2799) |
| Current error detection | 0 ... Current error detection disabled 1 ... Current error detection enabled |
| ABR counter sync/async | 0 ... Value of the ABR counter on register "Current position (acyclic)" on page 2795. Internal position counter of the ramp generator on register "Current position (cyclic)". 1 ... Value of the ABR counter on register "Current position (cyclic)" on page 2793. Internal position counter of the ramp generator on register "Current position (acyclic)". |
| Stall detection | 0 ... Stall detection disabled 1 ... Stall detection enabled |
| CurrentControlEnable | 0 ... Load-dependent current control disabled 1 ... Load-dependent current control enabled |

Status word

The individual bits of this register and its states depend on the current state of the state machine:

| Status | Reserved | Reserved | Reserved | Reserved | Int. limit active | Target reached | Remote | Reserved | Warning | Switch on disabled | Quick stop | Voltage enabled | Fault | Operation enabled | Switched on | Ready to switch on |
|------------------------|----------|----------|----------|----------|-------------------|----------------|--------|----------|---------|--------------------|------------|-----------------|-------|-------------------|-------------|--------------------|
| Bit | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Not ready to switch on | x | x | x | x | x | x | 1 | 0 | x | 0 | x | 0 | 0 | 0 | 0 | 0 |
| Switch-on disabled | x | x | x | x | x | x | 1 | 0 | x | 1 | x | 0 | 0 | 0 | 0 | 0 |
| Ready to switch on | x | x | x | x | x | x | 1 | 0 | x | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Switched on | x | x | x | x | x | x | 1 | 0 | x | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| Operation enable | x | x | x | x | x | x | 1 | 0 | x | 0 | 1 | 1 | 0 | 1 | 1 | 1 |
| Quick stop active | x | x | x | x | x | x | 1 | 0 | x | 0 | 0 | 1 | 0 | 1 | 1 | 1 |
| Fault reaction active | x | x | x | x | x | x | 1 | 0 | x | 0 | x | 0 | 1 | 1 | 1 | 1 |
| Fault | x | x | x | x | x | x | 1 | 0 | x | 0 | x | 0 | 1 | 0 | 0 | 0 |

Information about the status word:

| | | |
|---|--|--|
| Bits 0, 1, 2, 3, 5 and 6 (light gray in the previous table) | These bits are set according to the current state of the State machine . | |
| Voltage enabled | Becomes 1 as soon as the motor is powered | |
| Warning | Becomes 1 if a warning is detected ("Overcurrent", "Undercurrent"). The type of warning is indicated in register " Error code " on page 2796. The highest priority error / warning is shown in each case, with the priority corresponding to the order in the respective table. Warnings can be reset with a rising edge on the "Warning reset" bit in the control word. | |
| Remote | Always 1 since there is no local mode on the SM module | |
| Target reached ¹⁾ , depending on bit 8 (Stop) in register Control word | <p>If Stop = 0</p> <p>In modes 1, -123, -124, -125 and -126 (absolute positioning): 0...Positioning begins 1...Target has been reached</p> <p>In mode 2 (constant speed): 0...Motor accelerates/brakes 1...Speed setpoint reached</p> <p>In modes -127 and -128 (homing): 0...Homing started 1...Homing ended</p> <p>In mode -122 (set actual position): The bit briefly becomes 0 and immediately becomes 1 again as soon as the position is set.</p> | <p>If Stop = 1</p> <p>In all modes: 0...Axis decelerating 1...Axis speed = 0</p> |
| Internal limit active | 0 ... No limit violation 1 ... Internal limit is active (upper/lower software limit violated) | |

1) If "Stop" has not been enabled in register "[General configuration](#)" on page 2785, then "Target reached" behaves the same as if Stop = 0.

State machine

The motor is controlled according to the state machine illustrated below. After the module is started, the state machine automatically changes to state "Not ready to switch on". The application then operates the state machine by writing commands to the [Control word](#).

The state machine successively reaches the states "Ready to switch on", "Switched on" and "Operation enable" by writing the consecutive commands "Shutdown", "Switch on" and "Enable operation".

Information:

Only in state "Operation enable" are motor movements executed according to the setting in register "Mode" on page 2789.

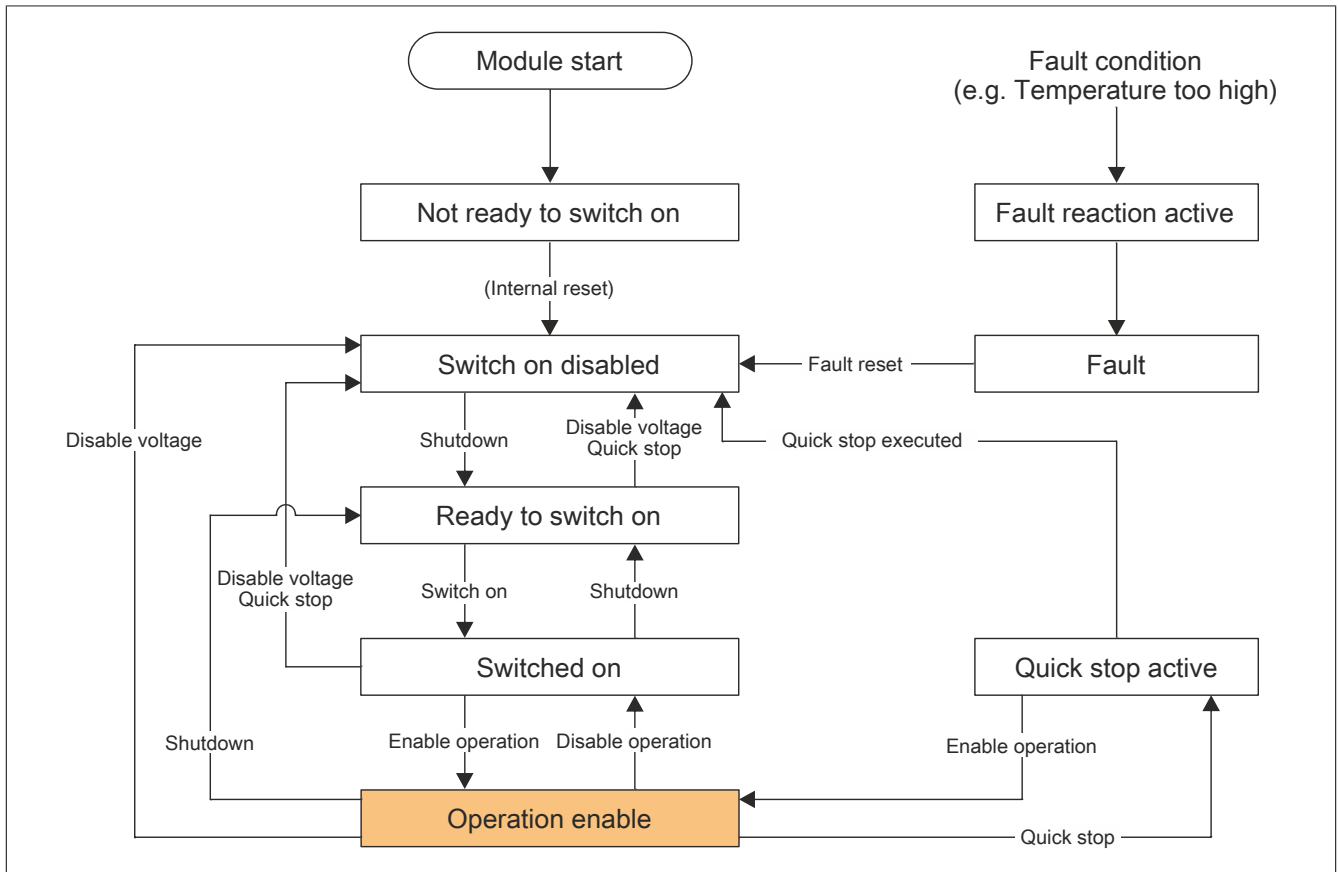


Figure 197: State machine - Flow chart

| State change | Description |
|--|--|
| Not ready to switch on → Switch on disabled | This state change occurs automatically after starting the module and internal initialization has taken place. |
| Switch-on disabled → Ready to switch on | This state change is initiated by command <i>Shutdown</i> . No others actions are performed. |
| Ready to switch on → Switch-on disabled | This state change is brought on by the command <i>Disable voltage</i> or <i>Quick stop</i> . No others actions are performed. |
| Switched on → Switch-on disabled | This state change is brought on by the command <i>Disable voltage</i> or <i>Quick stop</i> . The motor voltage is cut off immediately. |
| Ready to switch on → Switched on | This state change is brought on by the <i>Switch on</i> command. The motor voltage is switched on. When this state change occurs for the first time since the module is started, the motor ID measurement is performed before state <i>Switched on</i> is achieved. This can take approximately 1 second. |
| Switched on → Ready to switch on | This state change is initiated by command <i>Shutdown</i> . The motor voltage is cut off immediately. |
| Switched on → Operation enable | This state change is brought on by the <i>Enable operation</i> command. Motor movements are now performed depending on the set mode. |
| Operation enable → Switched on | This state change is brought on by the <i>Disable operation</i> command. If in motion, the motor is decelerated with the configured braking deceleration. The motor voltage remains switched on in state <i>Switched on</i> . |
| Operation enable → Ready to switch on | This state change is initiated by command <i>Shutdown</i> . The motor voltage is cut off immediately. |
| Operation enable → Switch on disabled | This state change is brought on by the <i>Disable voltage</i> command. Motor voltage switched off. It is strongly recommended to only make this state change on a stopped motor since regeneration on a motor running at no load can cause an overvoltage error on the DC bus (0x3210). |
| Operation enable → Quick stop active | This state change is brought on by the <i>Quick stop</i> command. If in motion, the motor is decelerated with the configured braking deceleration. During the deceleration, the state machine remains in state <i>Quick stop active</i> . If the motor comes to standstill, the switch to state <i>Switch on disabled</i> takes place automatically. While the state machine is in state <i>Quick stop active</i> , command <i>Enable operation</i> can be used to switch it back to state <i>Operation enable</i> . |
| → Fault reaction active | This state change is brought on when an error occurs and cannot be triggered by a command from the user. It can be triggered by error types classified as an "Error" (see "Error code" on page 2796). (The other error types classified as "Warning" only cause the "Warning" bit to be set in the status word and do not cause a state change of the state machine.) The motor voltage is cut off and the state machine immediately changes to state <i>Fault</i> . The error code register contains the error type (see table in "Error code" on page 2796). The highest priority error is shown. The priority corresponds to the order in the error code table. |
| Fault → Switch-on disabled | This state change is brought on by the <i>Fault reset</i> command. However, the state only changes if no more errors are present when the command is written. All errors and warnings are reset. The error code register contains 0 or the warning code if a warning is still present. |

Table 530: State machine - State change

9.25.10.16.11 NetTime Technology

For a description of NetTime Technology, see ["NetTime Technology" on page 3035](#).

9.25.10.16.12 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|---------------------------|--------|
| Function model "Standard" | 400 µs |
| Function model "Ramp" | 400 µs |

9.25.10.16.13 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|---------------------------|--------|
| Function model "Standard" | 400 µs |
| Function model "Ramp" | |
| Inputs | 400 µs |
| Outputs ¹⁾ | 25 ms |

1) Depends on the configuration of the ["movement profile generator" on page 2785](#).

9.26 Other functions

The following modules are included in this module group:

- Multi-measurement transformers / synchronization modules
- Universal mixed modules and combination modules
- Diode array modules
- PWM modules
- IO-Link master modules
- Potential distribution modules
- Supply modules for potentiometers
- Condition monitoring modules
- Specialty modules

9.26.1 Summary

| Model number | Short description | Page |
|---------------|---|------|
| 0ACS100A.00-1 | Accelerometer, nominal sensitivity 100 mV/g, top exit | 3166 |
| 0ACS100A.90-1 | Accelerometer, nominal sensitivity 100 mV/g, side exit | 3169 |
| X20CM0985 | X20 digital and analog mixed module, multi-measurement transducer/ synchronization module, 5 digital outputs, 24 VDC, 0.5 A source, 1 relay, 1 A, changeover contact, 8 analog inputs, ± 480 V / 120 V, 16-bit converter resolution, 3 analog inputs 5 A / 1 A AC, 16-bit converter resolution, order terminal blocks 0TB3102-7011, 0TB3104-7011, 0TB3102-7012, 0TB3104-7012 and 2x TB12 separately. | 2803 |
| X20CM0985-02 | X20 digital and analog mixed module, multi-measurement transducer / synchronization module, 5 digital outputs, 24 VDC, 0.5 A, source, 1 relay, 1 A, 8 analog inputs, ± 480 V / 120 V, 16-bit converter resolution, 3 analog inputs, 5 A / 1 A AC, 16-bit converter resolution, additional software functionalities, adapted to VDE guidelines (2018), order terminal blocks 0TB3102-7011, 0TB3104-7011, 0TB3102-7012, 0TB3104-7012 and 2x X20TB12 separately! | 2846 |
| X20CM0985-1 | X20 digital and analog mixed module, multi-measurement transducer / synchronization module, 5 digital outputs, 24 VDC, 0.5 A, source, 1 relay, 1 A, 8 analog inputs, ± 480 V / 120 V, 16-bit converter resolution, 3 analog inputs, 5 A / 1 A AC, 16-bit converter resolution, additional software functionalities, order terminal blocks 0TB3102-7011, 0TB3104-7011, 0TB3102-7012, 0TB3104-7012 and 2x X20TB12 separately! | 2921 |
| X20CM4323 | X20 PWM module, 4 digital outputs for switching electromechanical loads, 24 VDC, oversampling output functions, time-triggered output functions, NetTime function | 2992 |
| X20CM4800X | X20 analog input module, vibration measurement, 4 IEPE analog inputs, 50 kHz sampling frequency, 24-bit converter resolution | 3021 |
| X20CM4810 | X20 analog input module, for vibration measurement and analysis of condition monitoring tasks, 4 IEPE analog inputs, 51.5625 kHz sampling frequency, 24-bit converter resolution | 3039 |
| X20CM6209 | X20 diode array module, 1 A, 40 V reverse voltage, no module status data | 3174 |
| X20CM8281 | X20 universal mixed module, 4 digital inputs, 24 VDC, sink, 1-wire connections, 2 digital outputs, 0.5 A, source, 1-wire connections, 1 analog input, ± 10 V or 0 to 20 mA / 4 to 20 mA, 12-bit converter resolution, 1 analog output, ± 10 V / 0 to 20 mA, 12-bit converter resolution, 2 counters as event counters or gate measurement | 3178 |
| X20CM8323 | X20 PWM module, 8 digital outputs for switching electromechanical loads, 0.6 A continuous current, 2 A peak current, current monitoring, switching time detection | 3197 |
| X20CMR010 | X20 cabinet monitoring module, integrated temperature and humidity sensor, production data acquisition, 512 kB flash memory for user data | 3216 |
| X20CMR100 | X20 cabinet monitoring module, integrated temperature and humidity sensor, production data acquisition, integrated Technology Guard | 3230 |
| X20CMR111 | X20 cabinet monitoring module, integrated temperature sensor, moisture sensor and accelerometer, production data acquisition, 2 inputs for external PT1000, 2 digital inputs 24 V, 1 digital output 24 V, 0.5 A, 512 kB flash memory for user data, integrated Technology Guard | 3242 |
| X20DS4387 | X20 digital signal module, 4x IO-Link master, 4 digital channels configurable as inputs or outputs, 3-wire connections | 3269 |
| X20DS438A | X20 digital signal module, 4x IO-Link master V1.1, 4 digital channels configurable as inputs or outputs, 3-wire connections, NetTime function | 3287 |
| X20PD0011 | X20 potential distributor module, 12x GND, integrated microfuse | 3327 |
| X20PD0012 | X20 potential distributor module, 12x 24 VDC, integrated microfuse | 3332 |
| X20PD0016 | X20 potential distributor module, 5x GND, 5x 24 VDC, each with 1x floating feed, integrated microfuse | 3337 |
| X20PD2113 | X20 potential distributor module, 6x GND, 6x 24 VDC, with feed option, integrated microfuse | 3343 |
| X20PS4951 | X20 power supply module, for potentiometers, 4x ± 10 V for potentiometer supply | 3349 |
| X20cCM0985-1 | X20 digital and analog mixed module, coated, multi-measurement transducer / synchronization module, 5 digital outputs, 24 VDC, 0.5 A, source, 1 relay, 1 A, 8 analog inputs, ± 480 V / 120 V, 16-bit converter resolution, 3 analog inputs, 5 A / 1 A AC, 16-bit converter resolution, additional software functionalities, order terminal blocks 0TB3102-7011, 0TB3104-7011, 0TB3102-7012, 0TB3104-7012 and 2x X20TB12 separately! | 2921 |
| X20cCM4810 | X20 analog input module, coated, for vibration measurement and analysis of condition monitoring tasks, 4 IEPE analog inputs, 51.5625 kHz sampling frequency, 24-bit converter resolution | 3039 |
| X20cDS438A | X20 digital signal module, coated, 4x IO-Link master V1.1, 4 digital channels configurable as inputs or outputs, 3-wire connections, NetTime function | 3287 |
| X20cPD2113 | X20 potential distributor, coated, 6x GND, 6x 24 VDC, with supply option, integrated microfuse | 3343 |

9.26.2 X20CM0985

Data sheet version: 1.30

9.26.2.1 General information

The module has a compact size and combines a power measurement module that has special features with a synchronization unit that is able to meet all demands.

The measurement unit's 3 current inputs are suitable for both X: 1 A and X: 5 A current transformers. Overcurrent resistance and the high resolution of the measurement unit round off its features. For the voltage inputs, the value range can be configured between 480 VAC and 120 VAC.

The area of use includes 4-wire AC networks with a phase voltage up to 480 VAC and 3-wire systems, whereas L2 can be grounded (V-connection). The module can also handle Aron measuring circuits.

The resulting measured values include the pure phase current; line-to-line voltage or phase voltage; the effective, reactive and apparent power parts; the mains frequency; the power factor and much more. In addition, peak values and energy meters are stored on the module in nonvolatile memory. Depending on the configuration, it is also possible to use a digital output as a pulse encoder for an external energy meter.

The synchronization unit doesn't just take the phasing and phase voltage into consideration; integrated intelligence also monitors the rate of change and other parameters, allowing them to influence when the synchronization output is switched. It is also possible to monitor a generator using a large number of additional conditions. A total of 4 voltage inputs provide substantial overall flexibility.

Monitoring functions expand the features of the module. Rating-dependent overcurrent monitoring is included, which utilizes the thermal capacity of the motor/generator to allow short overloads while still providing full protection. The dependent, delayed imbalanced load monitoring used to protect three-phase generator and three-phase networks from imbalanced load can be adapted to the characteristics of different generator types using parameters while taking their special thermal time constants into account.

- Energy measurement for 120 to 480 VAC
- Simultaneous measurement of 2 AC mains networks plus 2 additional voltages
- For multifunctional measurement tasks
- Intelligent mains synchronization unit

Information:

Please refer to section "[Safety guidelines](#)" on page 2806 before operating the module.

9.26.2.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Other functions |  |
| X20CM0985 | X20 digital and analog mixed module, multi-measurement transducer/ synchronization module, 5 digital outputs, 24 VDC, 0.5 A source, 1 relay, 1 A, changeover contact, 8 analog inputs, ± 480 V / 120 V, 16-bit converter resolution, 3 analog inputs 5 A / 1 A AC, 16-bit converter resolution, order terminal blocks 0TB3102-7011, 0TB3104-7011, 0TB3102-7012, 0TB3104-7012 and 2x TB12 separately. | |
| | Required accessories | |
| | Terminal blocks | |
| 0TB3102-7011 | Accessory terminal block, 2-pin, A keyed, screw clamp terminal block 6 mm ² | |
| 0TB3102-7012 | Accessory terminal block, 2-pin, B keyed, screw clamp terminal block 6 mm ² | |
| 0TB3104-7011 | Accessory terminal block, 4-pin, A keyed, screw clamp terminal block 6 mm ² | |
| 0TB3104-7012 | Accessory terminal block, 4-pin, B keyed, screw clamp terminal block 6 mm ² | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 531: X20CM0985 - Order data

9.26.2.3 Technical data

| Model number | X20CM0985 |
|---|---|
| Short description | |
| I/O module | X20 energy measurement and synchronization module |
| General information | |
| B&R ID code | 0x2433 |
| Status indicators | Channel status, operating status, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Analog inputs | Yes, using status LED (measurement range of analog inputs) |
| Digital outputs | Yes, using status LED and software |
| Overvoltage category | II ¹⁾ |
| Power consumption | |
| Bus | 1.4 W |
| Internal I/O | 4 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| KC | Yes |
| Digital outputs | |
| Quantity | 5 |
| Variant | FET positive switching |
| Nominal voltage | 24 VDC |
| Switching voltage | 24 VDC -15% / +20% |
| Nominal output current | 0.1 A |
| Total nominal current | 0.5 A |
| Connection type | 1-wire connections |
| Output circuit | Source |
| Output protection | Thermal cutoff for overcurrent and short circuit |
| Diagnostic status | Output monitoring with 10 ms delay |
| Leakage current when the power is switched off | 5 μ A |
| Residual voltage | <0.3 V at 0.1 A rated current |
| Peak short-circuit current | <2 A |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms, depends on the module temperature |
| Switching delay | |
| 0 \rightarrow 1 | <300 μ s |
| 1 \rightarrow 0 | <300 μ s |
| Switching frequency | |
| Resistive load | Max. 100 Hz |

Table 532: X20CM0985 - Technical data

| Model number | X20CM0985 |
|--|---|
| Isolation voltage between channel and bus | 500 V _{eff} |
| Relay outputs | |
| Quantity | 1 |
| Variant | Relay / Changeover contact |
| Nominal voltage | 30 VDC / 240 VAC |
| Rated frequency | DC / 45 to 63 Hz |
| Switching capacity | |
| Min. | 10 mA / 5 VDC |
| Max. | 30 W / 240 VAC |
| Nominal output current | 1 A at 30 VDC / 1 A at 240 VAC |
| Actuator power supply | External |
| Switching voltage | Max. 60 VDC / 250 VAC |
| Switching delay | |
| 0 → 1 | ≤10 ms |
| 1 → 0 | ≤10 ms |
| Service life ²⁾ | |
| Mechanical | Min. 10 x 10 ⁶ ops. |
| Electrical | Min. 60 x 10 ³ ops. (NC) at 1 A Min. 30 x 10 ³ ops. (NO) at 1 A |
| Contact resistance | Max. 100 mΩ |
| Protective circuit | |
| Internal | None |
| External | None |
| DC | Inverse diode, RC combination or VDR |
| AC | RC combination or VDR |
| Isolation voltage | |
| Channel - Channel | 1000 VAC / 1 min |
| Channel - Bus | 4000 VAC / 1 min |
| Analog input voltage | |
| Channels | 8 |
| Input | 120 VAC / 480 VAC |
| Input type | Single-ended |
| Digital converter resolution | ±15-bit |
| Conversion time | |
| 50 Hz | 20 ms |
| 60 Hz | 16.67 ms |
| Permissible input signal | Max. 132 VAC / 528 VAC |
| Output format ³⁾ | |
| ±120 VAC | 1 LSB = 0x0001 = 5.707 mV |
| ±480 VAC | 1 LSB = 0x0001 = 22.787 mV |
| Output of digital value during overload | |
| Overshoot | 0x7FFF |
| Undershoot | 0x8001 |
| Conversion method | SAR |
| Input filter | |
| Cutoff frequency | 10 kHz |
| Slope | 60 dB |
| Maximum gain drift ⁴⁾ | 0.02% per °C |
| Maximum offset drift ⁵⁾ | 0.003% per °C |
| Crosstalk between channels | -70 dB |
| Nonlinearity ⁵⁾ | ≤0.5% at 45 to 65 Hz |
| Protection against electrical shock | Protective impedance in accordance with EN 61131-2 |
| Test voltage between channel and bus (type test) | 3700 V _{eff} |
| Output format | INT |
| Input impedance in signal range | Approx. 3 MΩ |
| Max. error at 25°C | |
| Gain | 0.09% ⁴⁾ |
| Offset | 0.03% ⁵⁾ |
| Input protection | Overvoltage protection |
| Analog input current | |
| Channels | 3 |
| Input | 1 A / 5 A AC |
| Input type | Isolated current transformer according to the compensation principle with a magnetic sensor, for connecting an external transformer |
| Digital converter resolution | ±15-bit |
| Conversion time | |
| 50 Hz | 20 ms |
| 60 Hz | 16.67 ms |
| Permissible input signal | Max. 1.5 A / 7.7 A |
| Output format ³⁾ | |
| ±1 A | 1 LSB = 0x0001 = 189.903 μA |
| ±5 A | 1 LSB = 0x0001 = 949.513 μA |

Table 532: X20CM0985 - Technical data

| Model number | X20CM0985 |
|---|--|
| Output of digital value during overload | |
| Overshoot | 0x7FFF |
| Undershoot | 0x8001 |
| Conversion method | SAR |
| Input filter | |
| Cutoff frequency | 10 kHz |
| Slope | 60 dB |
| Maximum gain drift ⁴⁾ | 0.07% per °C |
| Maximum offset drift ⁶⁾ | 0.003% per °C |
| Crosstalk between channels | -70 dB |
| Nonlinearity ⁵⁾ | ≤0.5% at 45 to 65 Hz |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Output format | INT |
| Max. error at 25°C | |
| Gain | 0.2% ⁴⁾ |
| Offset | 0.05% ⁶⁾ |
| Thermal overcurrent | 15 x I _{Nom} for 0.2 s ⁷⁾ |
| Monitored overcurrent | 4 x I _{Nom} ⁷⁾ |
| Input impedance ⁸⁾ | |
| Measurement range 1 A | Max. 30 mΩ |
| Measurement range 5 A | Max. 10 mΩ |
| Electrical properties | |
| Electrical isolation | Bus isolated from I/O power supply and digital inputs and outputs Digital inputs and outputs isolated from each other |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | 0 to 60°C |
| Vertical mounting orientation | 0 to 50°C |
| Derating | See section "Derating". |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 2x X20TB12 terminal block separately Order 2x TB3102 and 2x TB3104 screw clamps separately |
| Pitch | 87.5 ^{+0.2} mm |

Table 532: X20CM0985 - Technical data

- 1) EN 61131-2
- 2) See section "Electrical service life"
- 3) INT, range of values: 0x8001 to 0x7FFF
- 4) Based on the current measured value.
- 5) Based on the measurement range 240 VAC / 960 VAC.
- 6) Based on the measurement range 2 A / 10 A.
- 7) Based on the measurement range 1 A / 5 A.
- 8) Including current transformer, circuit path and X20TB12 terminal block (5 mΩ)

9.26.2.4 Safety guidelines

General information

Programmable logic controllers, operating/monitoring devices (e.g. industrial PCs, Power Panels, Mobile Panels, etc.) as well as uninterruptible power supplies have all been designed, developed and manufactured by B&R for conventional use or for use with increased safety requirements (safety technology) in industry. They were not designed, developed and manufactured for any use involving serious risks or hazards that could lead to death, injury, serious physical damage or loss of any kind without the implementation of exceptionally stringent safety precautions. In particular, such risks and hazards include the use of these devices to monitor nuclear reactions in nuclear power plants, their use in flight control or flight safety systems as well as in the control of mass transportation systems, medical life support systems or weapons systems.

When using programmable logic controllers or operating/monitoring devices as control systems together with a Soft PLC (e.g. B&R Automation Runtime or comparable product) or Slot PLC (e.g. B&R LS251 comparable product), safety precautions relevant to industrial control systems (e.g. the provision of safety devices such as emergency stop circuits, etc.) must be observed in accordance with applicable national and international regulations. The same applies for all other devices connected to the system, e.g. drives.

All tasks such as the installation, commissioning and servicing of devices are only permitted to be carried out by qualified personnel. Qualified personnel are those familiar with the transport, mounting, installation, commissioning and operation of devices who also have the appropriate qualifications (e.g. IEC 60364-1). National accident prevention regulations must be observed.

The safety notices, connection descriptions (type plate and documentation) and limit values listed in the technical data are to be read carefully before installation and commissioning and must be observed.

Intended use

Danger!

Electronic devices are never completely failsafe. If the multi-measurement and synchronization unit fails, the user is responsible for making sure that the motor or generator is brought to a secure state.

Some errors are detected and prevented in the synchronization unit by the system's internal software monitoring. However, when the device is in operation it is always possible for errors, defective components, software errors or configuration mistakes to occur at any time. B&R emphasizes that the multi-measurement and synchronization unit possesses neither a failsafe function nor a redundancy system. For this reason, independent higher-level safety precautions need to be put in place to ensure that personnel and machines are protected.

Grounding the Mounting Rail

For grounding purposes, a good conductive connection between the mounting rail and the metal back wall is required. The mounting rail is to be connected conductively to the back wall. This is achieved by inserting a contact washer with the fastening screw.


Information:

The control cabinet back wall must be connected with GND

9.26.2.5 LED status indicators


For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

LED status indicators - Right

| Figure | LED | Color | Status | Description |
|---|-------|-----------------------------|------------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1 - 6 | Orange | | Output status of the corresponding digital output |

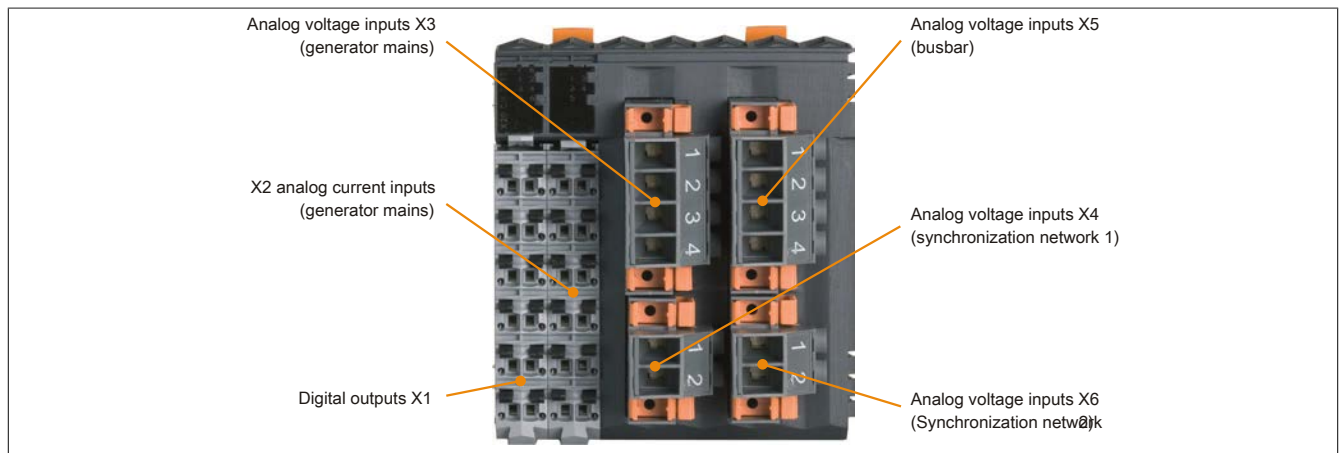
1) Depending on the configuration, a firmware update can take up to several minutes.

Status-LEDs right

| Figure | LED ¹⁾ | Terminal | Color | Status | Description |
|---|-------------------|----------|-------|--------|----------------------------|
|  | 1 | X3 | Green | On | Measurement range: 120 VAC |
| | | | Red | On | Measurement range: 480 VAC |
| | 2 | X4 | Green | On | Measurement range: 120 VAC |
| | | | Red | On | Measurement range: 480 VAC |
| | 3 | X5 | Green | On | Measurement range: 120 VAC |
| | | | Red | On | Measurement range: 480 VAC |
| | 4 | X6 | Green | On | Measurement range: 120 VAC |
| | | | Red | On | Measurement range: 480 VAC |
| | 5 | X2 | Green | On | Measurement range: 1 A |
| | | | Red | On | Measurement range: 5 A |

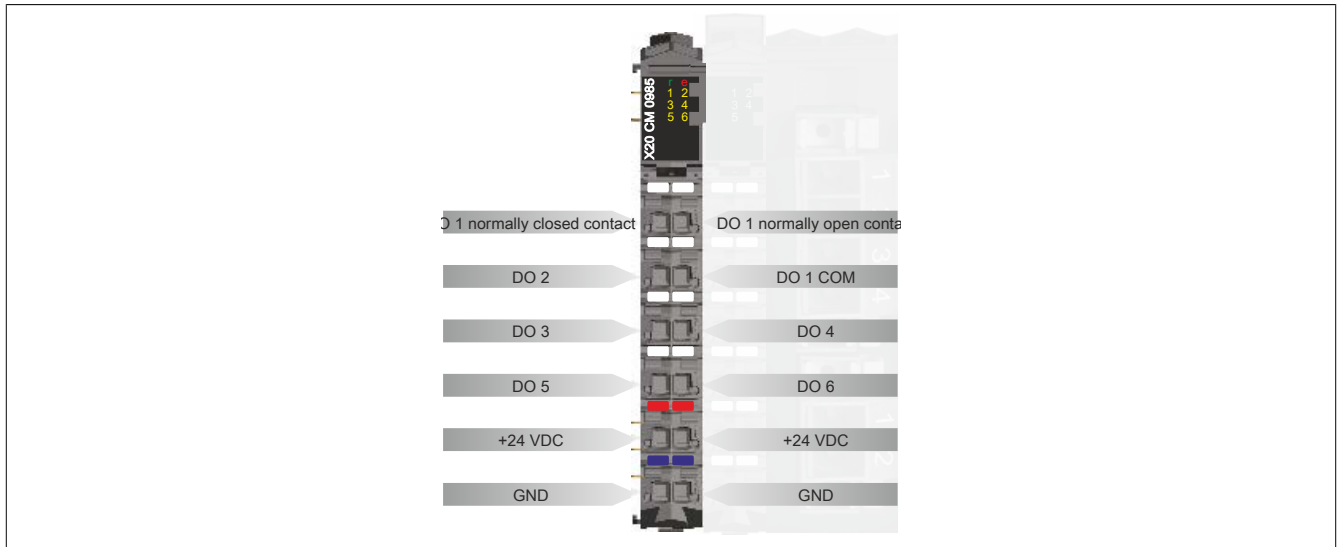
1) LEDs 1 - 5 are green/red dual LEDs.

9.26.2.6 Connection elements



9.26.2.7 Digital outputs X1

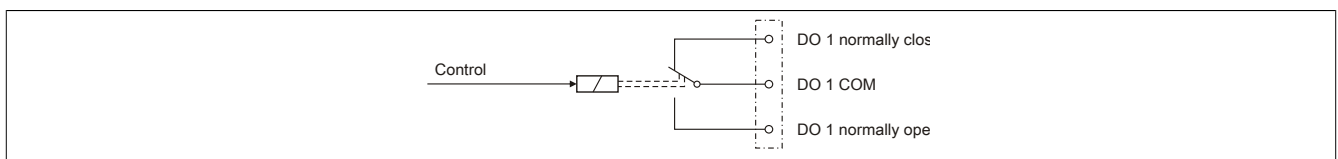
The X1 and X2 terminals can each be keyed differently to prevent them from being inadvertently plugged into the module incorrectly.



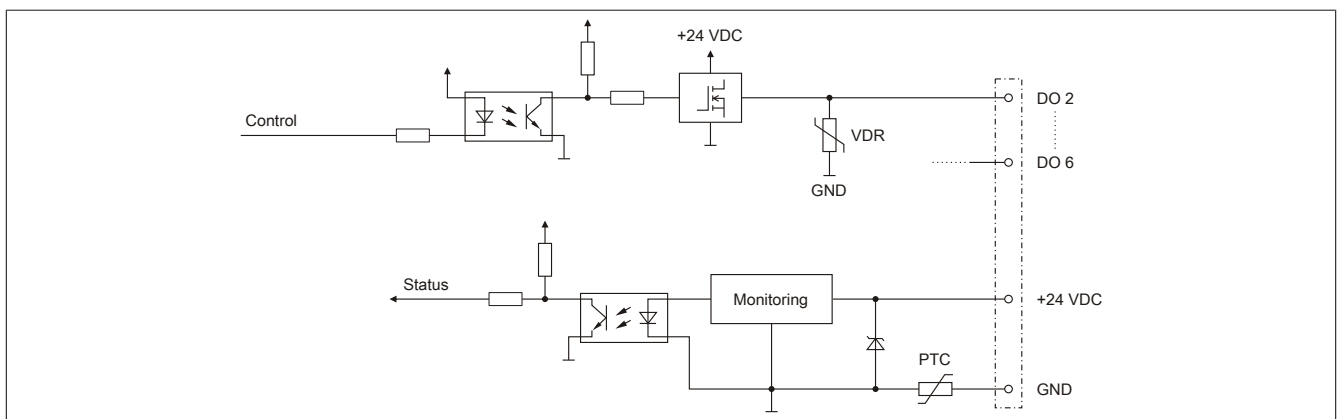
Function description of the digital outputs

| Digital output | Description |
|----------------|--|
| DO1 | This digital output is designed as a changeover contact switch. The monitoring relay allows selective monitoring of: <ul style="list-style-type: none"> • Overvoltage and undervoltage • Overfrequency and underfrequency • Voltage asymmetry • Current asymmetry • Calculated neutral conductor current (maximum) • Short circuit current • Rating-dependent overcurrent • Limit value of the capacitive reactive power (exciter failure) |
| DO2 | DO2 serves as a meter output. The generated pulses can be recorded by an external energy meter (kWh). |
| DO3 | This output is set when there is no voltage on the bus bar (below the lower limit of the defined parameter). 3-phase monitoring takes place for the bus bar voltage. |
| DO4 | DO4 serves as a synchronization pulse. The power switch is activated by setting this output. The output is deactivated after the configured time has elapsed (exception: "Synchro check" operating mode). |
| DO5 and DO6 | These outputs are freely available to the user. |

DO1 - Output circuit diagram



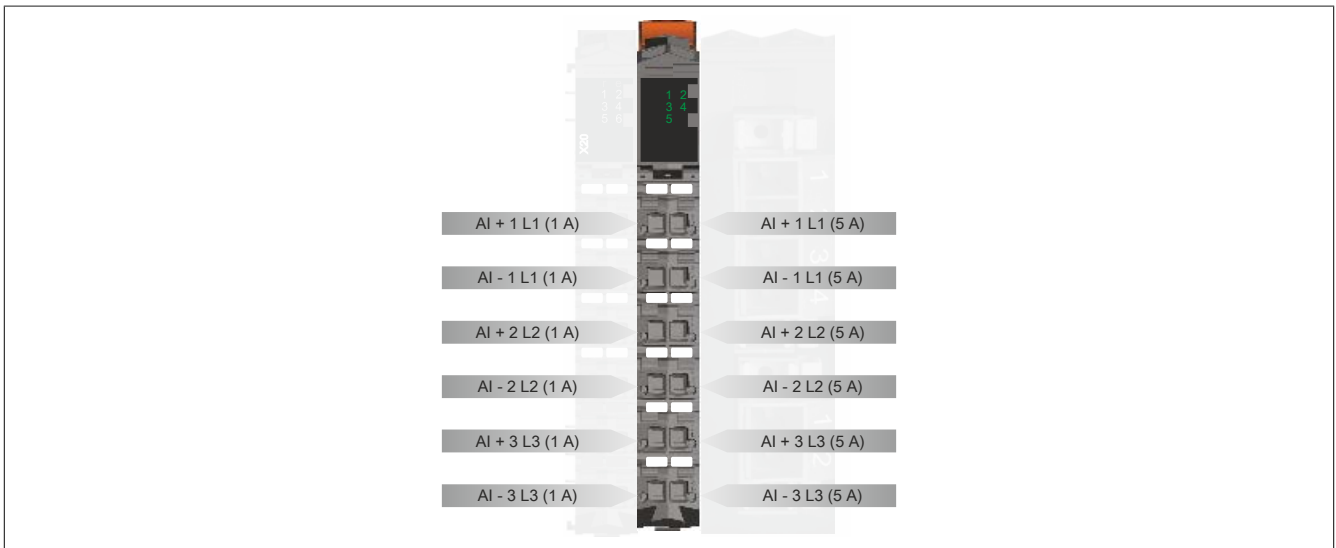
DO2 - DO 6 - Output circuit diagram



9.26.2.8 X2 analog current inputs

The X2 terminal measures the three phase currents of the generator mains using an externally connected current transformer. The measurement range of the current inputs can be configured as 1 A or 5 A.

Terminals X1 and X2 can be keyed differently to prevent unintentional incorrect connection on the module.

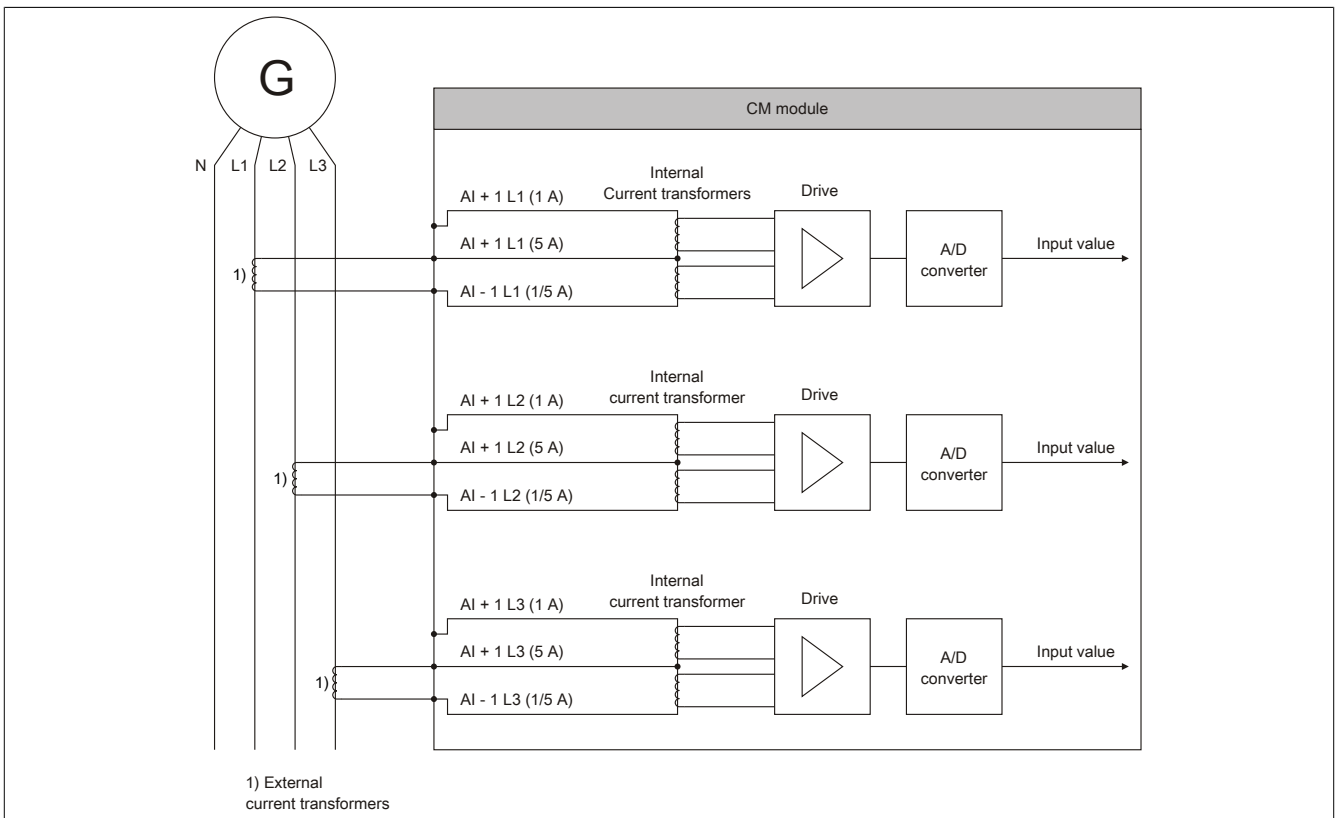


Danger!

Risk of electric shock!

The terminal block must only be allowed to conduct voltage when it is inserted. It must not under any circumstances be removed or inserted when voltage is applied or have voltage applied to it when it is removed.

Input circuit diagram - Analog current inputs

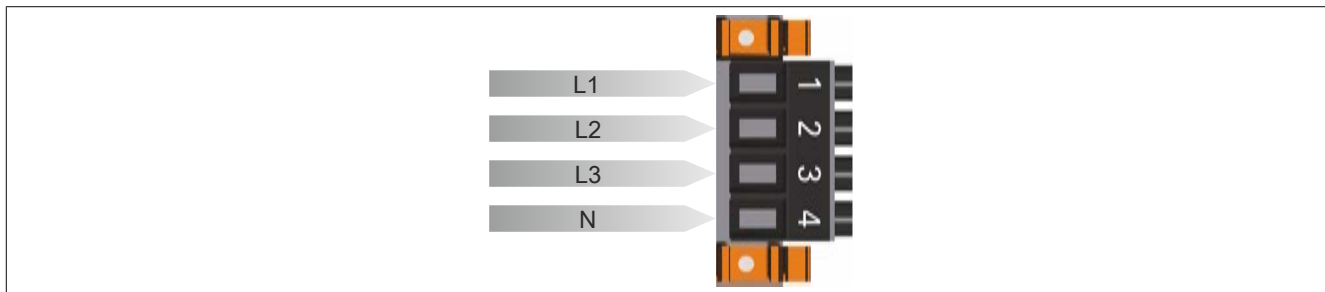


9.26.2.9 X3 and X5 analog voltage inputs

The X3 and X5 terminals are used to measure and monitor the line-to-line and phase voltages of the generator mains and bus bar.

- Terminal X3: Generator mains
- Terminal X5: Bus bar

Terminals X3 and X5 are keyed differently to prevent unintentional incorrect connection on the module. Section ["Releasing the locking clip for terminals X3 - X6" on page 2816](#) describes how to release the terminal locking clip.

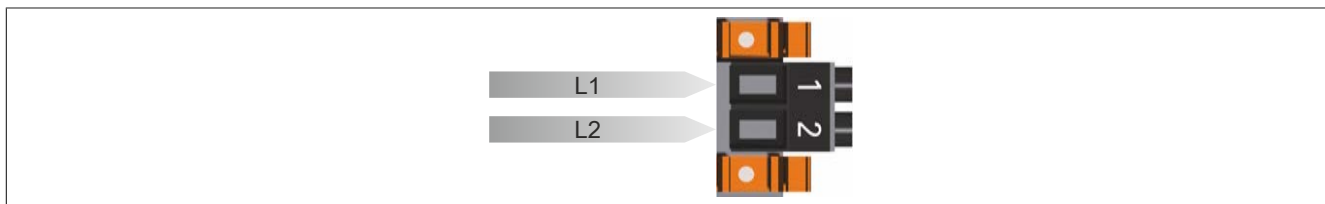


9.26.2.10 X4 and X6 analog voltage inputs

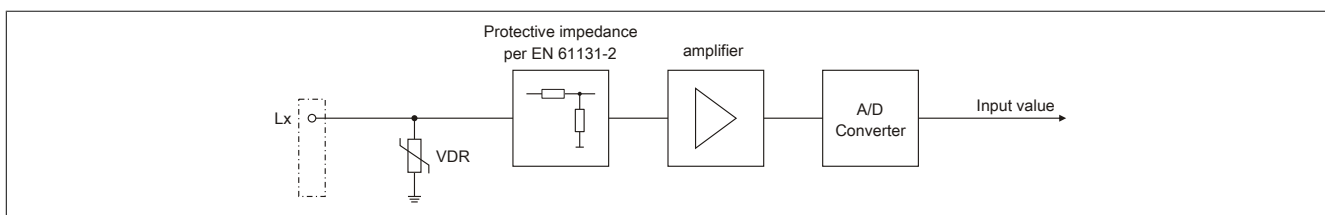
The voltage inputs on the X4 and X6 terminals are used to determine the line-to-line voltages for synchronization between two different mains networks.

- Terminal X4: Synchronization mains network 1
- Terminal X6: Synchronization mains network 2

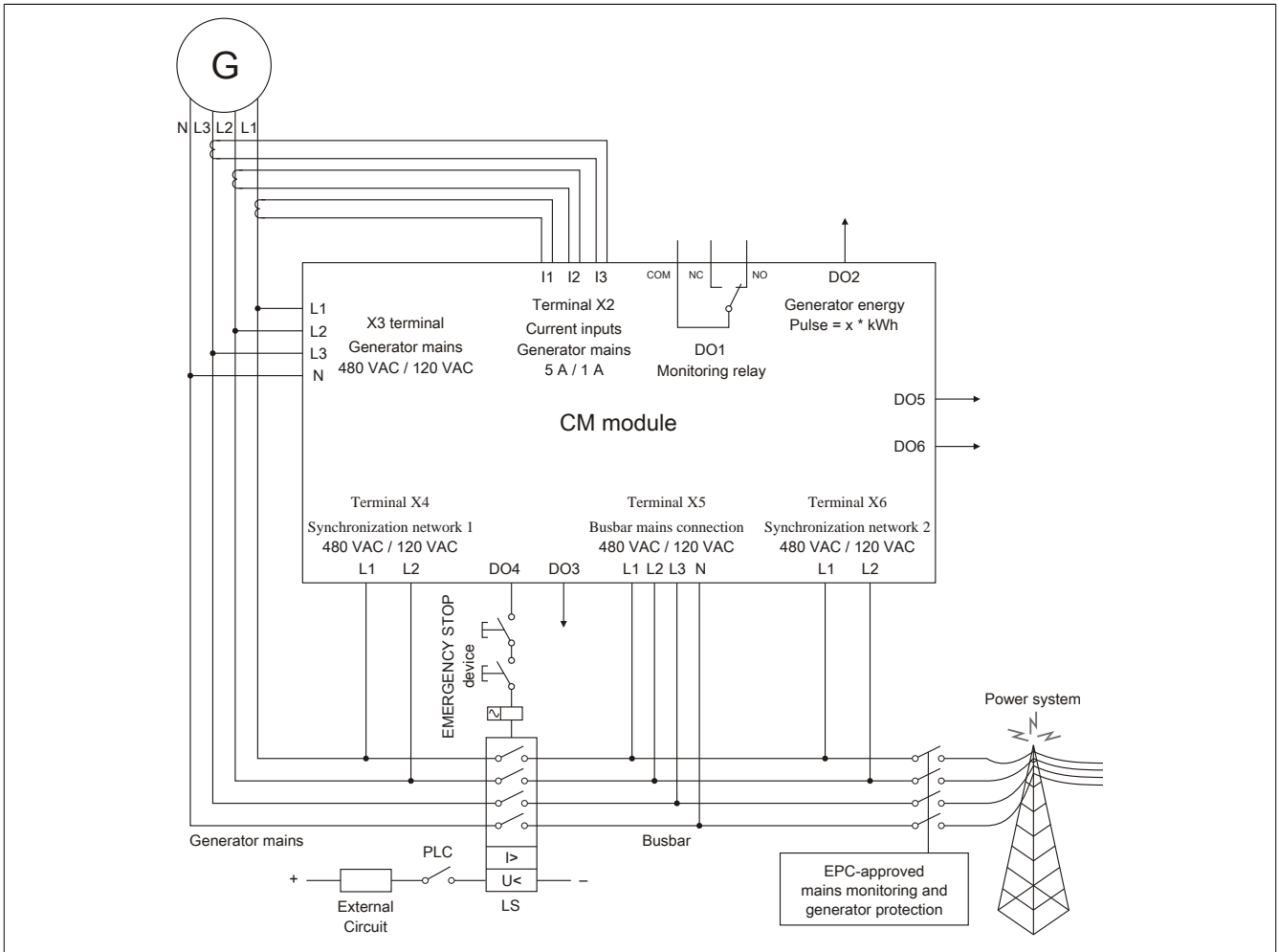
The X4 and X6 terminals are each keyed differently to prevent them from being inadvertently plugged into the module incorrectly. Section ["Releasing the locking clip for terminals X3 - X6" on page 2816](#) describes how to release the terminal locking clip.



Input circuit diagram, analog voltage inputs



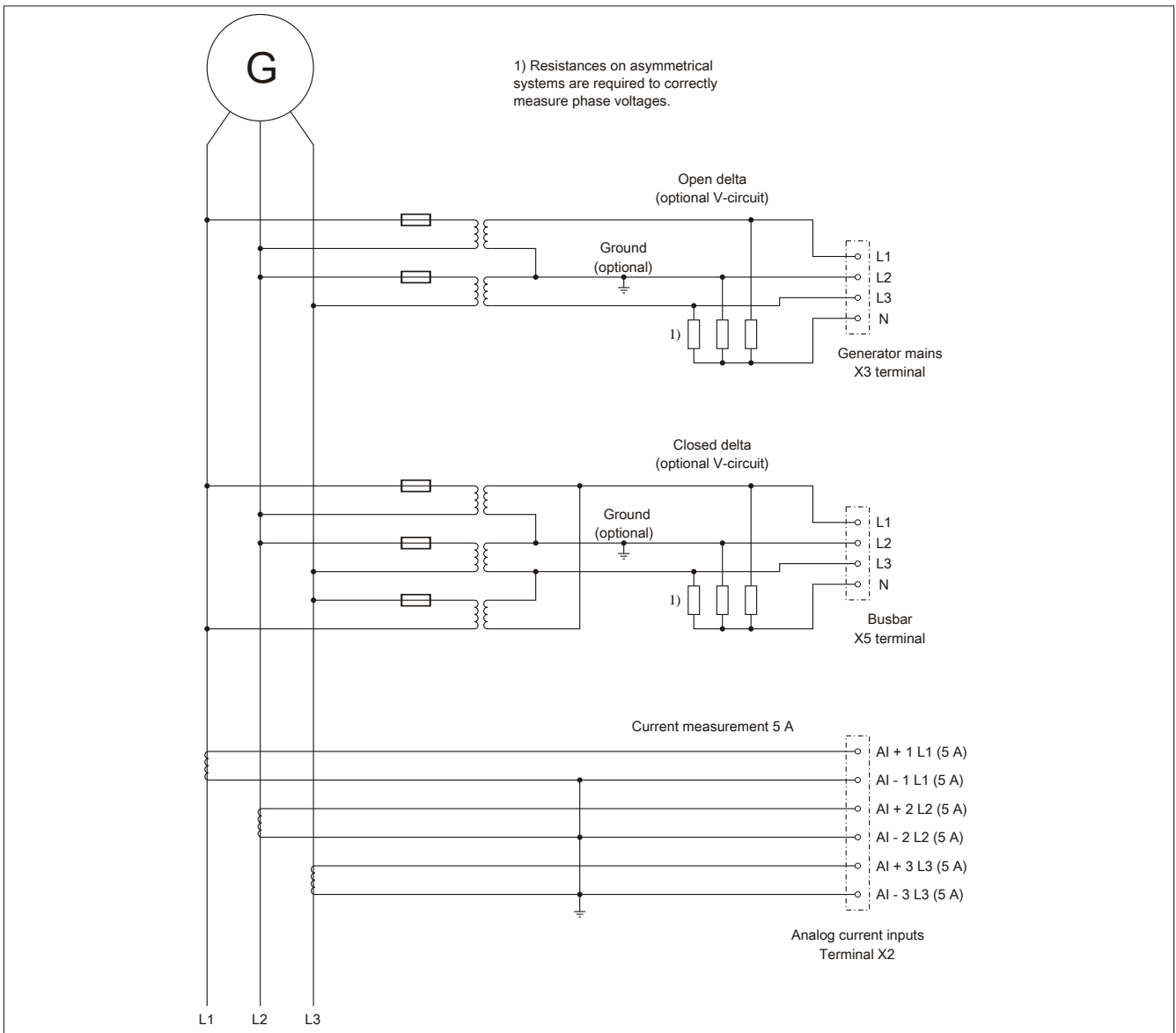
9.26.2.11 Circuit diagram



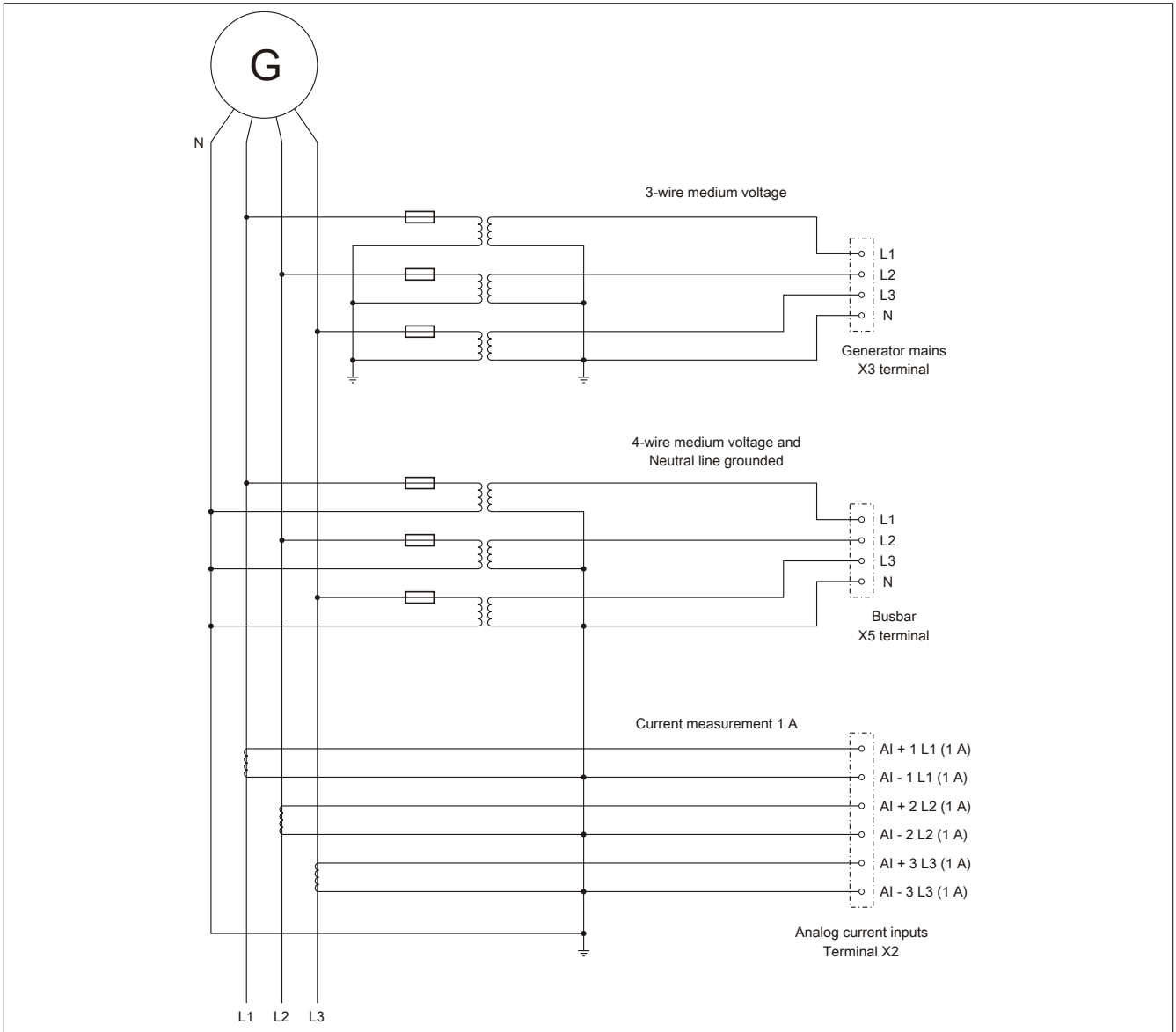
9.26.2.12 Typical connection examples for voltage/current measurement

For power measurement, the X3 terminal must always be used in connection with the X2 terminal! For single-phase measurement, always ensure that current input 1 is used for power measurement if voltage input 1 is being used. Otherwise, accurate power measurement is not possible for this phase!

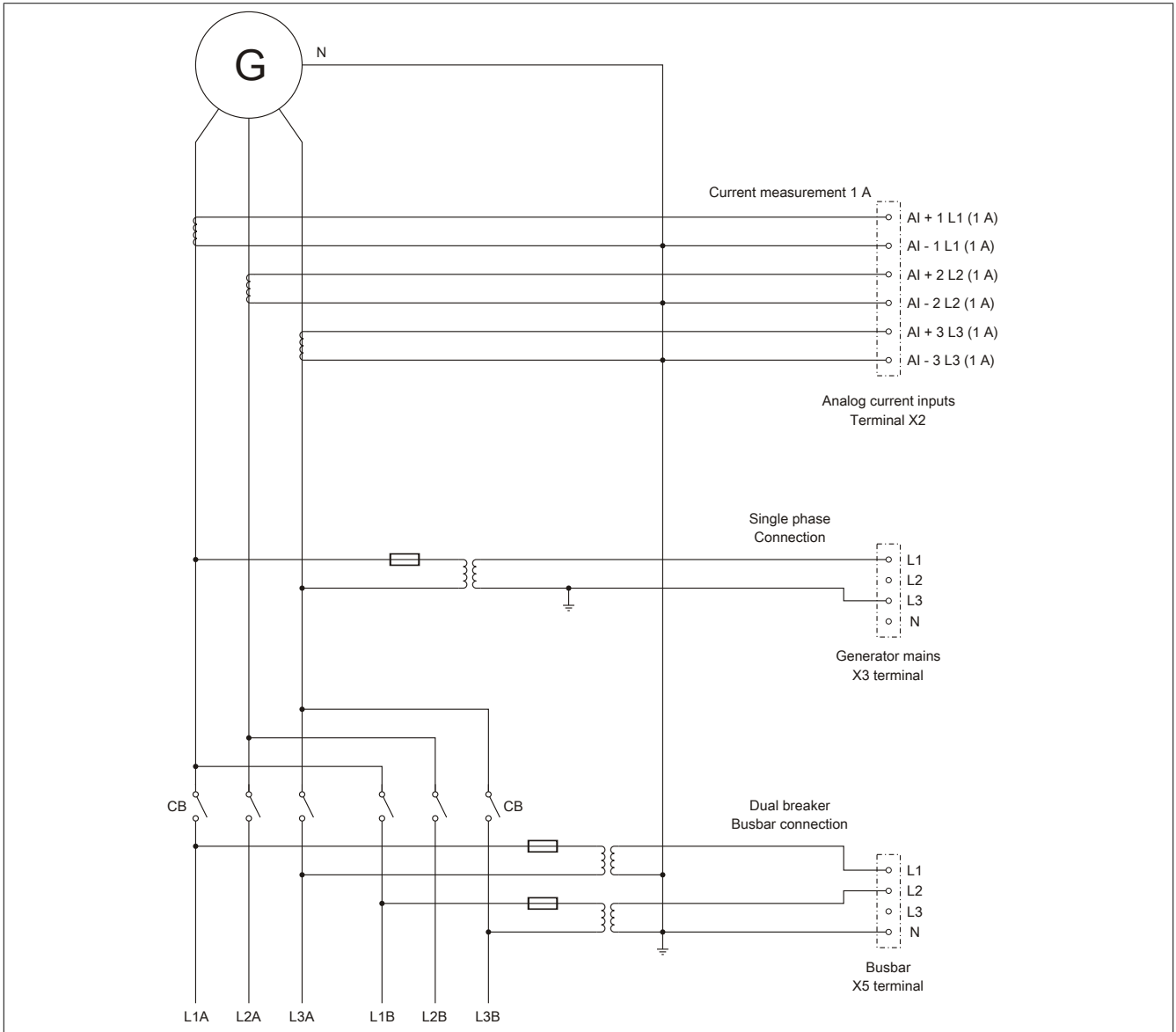
Connection example 1



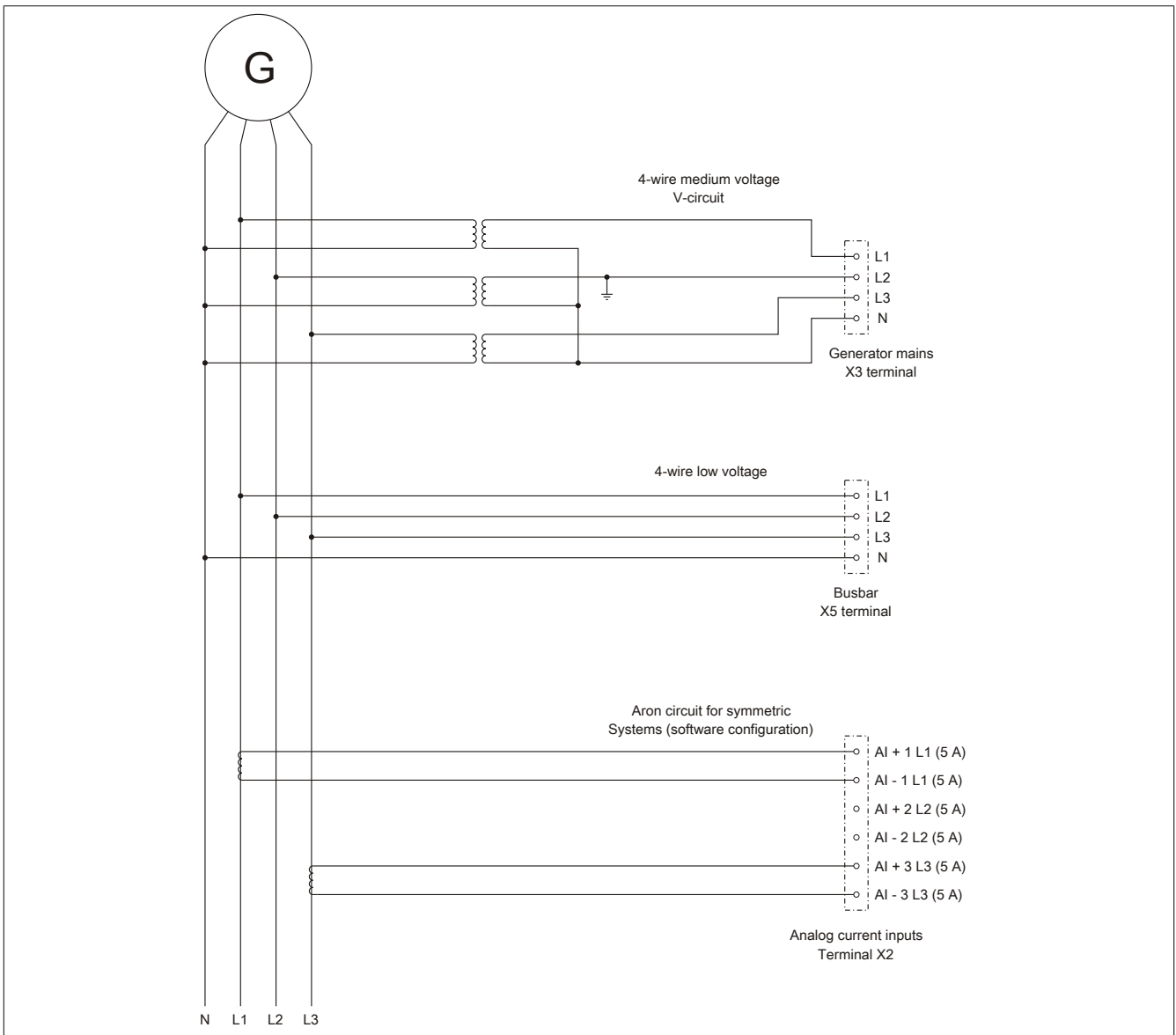
Connection example 2



Connection example 3

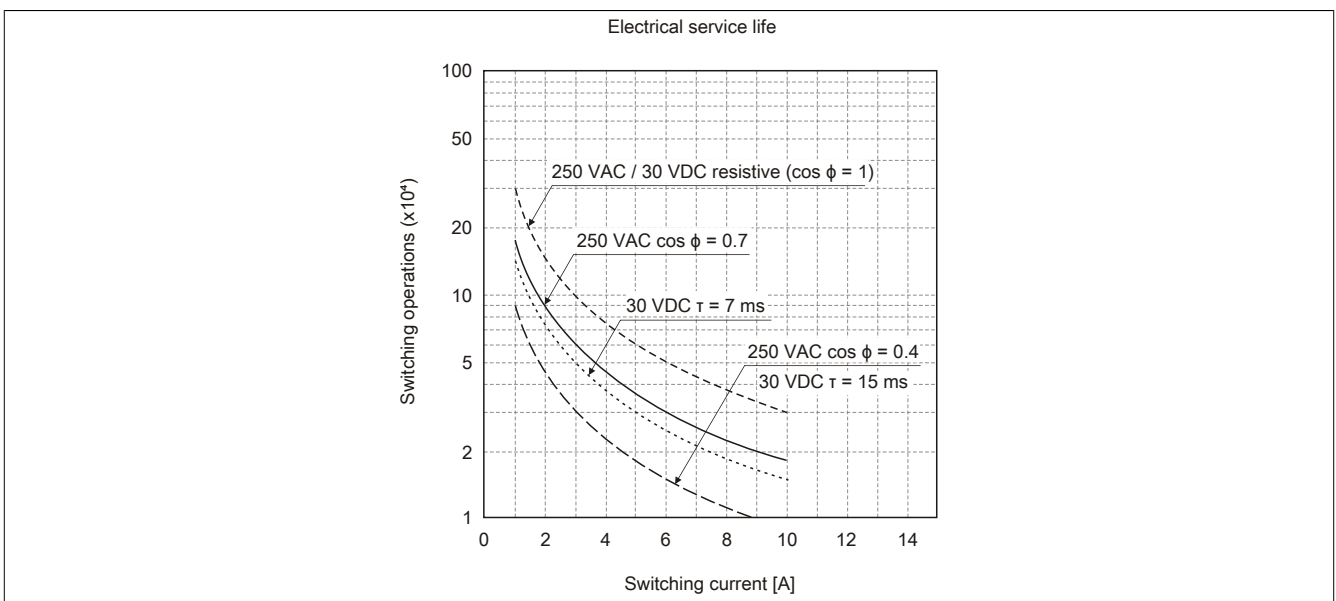


Connection example 4



9.26.2.13 Electrical service life

The electrical service life for the DO1 relay output can be seen in the following diagram.



9.26.2.14 Releasing the locking clip for terminals X3 - X6

Terminals X3 - X6 are equipped with a terminal locking clip. This clip attaches the terminal block securely to the electronic module. This prevents the terminal from accidentally being disconnected.

To release the locking clip, press inwards on the corrugated part of the lever with your fingertip (1) and then slide outwards (2). No additional tools are required for removing the terminal.

Terminals X5 and X6 must be removed first before terminals X3 and X4 can be removed.



9.26.2.15 Synchronization functions

The following three synchronization functions are available on the module:

- ["Synchronization with slip" on page 2816](#)
- ["Synchro check" on page 2817](#)
- ["Switching to voltage-free "dead bus"" on page 2817](#)

Synchronization with slip

The following is valid for synchronization mains 1 and synchronization mains 2:

- $50\% < U < 125\%$ of the nominal voltage U_N
- $80\% < f < 110\%$ of the nominal frequency f_N

The generator voltage is adjusted to the synchronization voltage with regard to amplitude and frequency. Taking into account the configured phase angle ($\Delta\alpha$), a defined transformer vector group and the switching response time, the switch-on command is calculated and transmitted in advance so that the main contacts of the power switch are closed at the point of synchronicity.

Synchronization occurs under the following conditions:

- The "Synchronization selection" command is set using a software application
- The device is ready.
- The configured limit for voltage difference is not exceeded (ΔU_{\max}).
- The configured limits for frequency difference are not exceeded (Δf_{\max} and Δf_{\min}).
- The configured limit for the phase angle (including vector group transformer $\Delta\alpha$) is not exceeded (j_{\max}).

The actual synchronization is "authorized" if the condition for the phase angle is met the first time and the phase window is exited once. It should be noted that the conditions for voltage and frequency difference do not yet have to be fulfilled this first time.

This means that if the phase difference happens to lie within the phase window when the request is made, it is not necessary to re-enter the window for this "authorization" to take place. In order to abort synchronization when in an "authorized" state, the "Synchronization with slip" command must be reset.

After the synchronization command has been authorized, the synchronization window of all the aforementioned synchronization conditions must be entered again from any phase angle in order to obtain a synchronization impulse in accordance with the switch lead time.

At very low frequencies or equivalent frequencies and in adherence to the conditions described above, synchronization will also take place when entering the synchronization window a second time. The synchronization impulse is only issued at a phase angle = 0° , however.

At low differential frequencies, the switch is not immediately engaged when the phase window is reached. This only occurs when synchronization is possible at the point of synchronicity.

DO4 changes its state from Low to High when all conditions are met. It changes back from High to Low after the configured pulse duration has elapsed.

Synchro check

In this operating mode, the device can be used to check the synchronization. The DO4 output remains set as long as the following conditions are met:

- The "Enable Synchro Check" command is set using software.
- The device is ready.
- The configured limit for voltage difference is not exceeded (ΔU_{\max}).
- The configured limits for frequency difference are not exceeded (Δf_{\max} and Δf_{\min}).
- The defined limit for the phase angle is not exceeded (ϕ_{\max}).

DO4 stays at High as long as all conditions are met.

Switching to voltage-free "dead bus"

The switch-on command for the power switch is output without synchronization if the following conditions have been met:

- The "Enable Dead Bus" command is set using software.
- The device is ready.
- The bus bar does not have voltage applied: $U_B < U_{B\min}$ as a percentage of U_{NomBus}

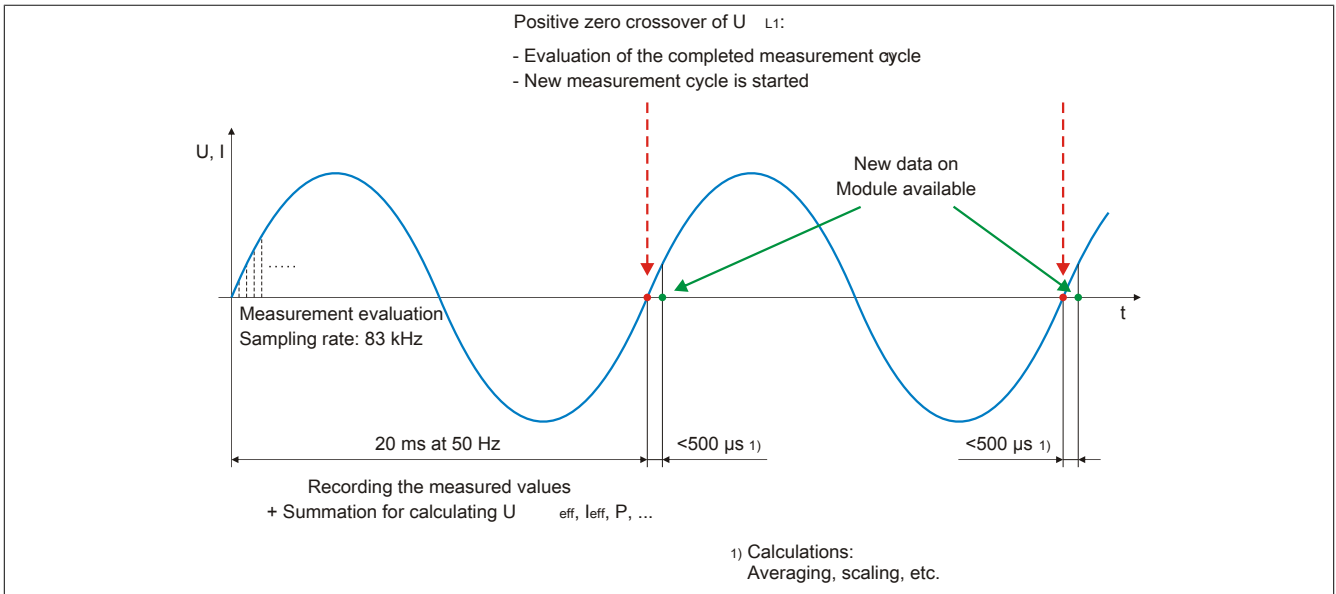
| | |
|-------------------------|-------------------------|
| U_B ... | Bus bar phase voltage |
| $U_{B\min}$... | Minimum bus bar voltage |
| U_{NomBus} ... | Bus bar nominal voltage |

- The generator voltage and frequency can be any valid value.

DO4 changes its state from Low to High when all conditions are met. It changes back from High to Low after the configured pulse duration has elapsed.

9.26.2.16 Measurement functions

Timing diagram



Measured parameters for generator mains (X3)

- Phase currents
- Current average
- Dynamic current average
- Neutral current
- Line-to-line voltages
- Phase voltages
- Voltage average
- Total apparent power
- Total reactive power
- Total active power
- Active power factor
- Frequency

Measured parameters between synchronization mains networks

- Differential angle
- Differential voltage

Rating-dependent overcurrent

Rating-dependent overcurrent monitoring is in accordance with the specifications of IEC 255-8 "Electrical relay; Relay for protecting against thermal overload (overload relay)" and IEC 255-17 "Electrical relay; Relay for protecting against the thermal overload of motors (overload relay for motors)".

Dependent delayed imbalanced load monitoring

Dependent delayed imbalanced load monitoring protects against imbalanced loads in three-phase generators and three-phase mains. Parameters can be changed to make it possible to match the trigger characteristics to different generator types while taking their special thermal time constants into consideration.

An imbalanced load can be caused by uneven current distribution in the mains due to imbalanced load, asymmetrical short circuits, line interruptions or switching operations. Imbalanced loads result in reverse system currents in the stator, which causes harmonics with an uneven ordinal number in the stator winding and harmonics with an even ordinal number in the rotor winding. The rotor is at particular risk here because the harmonic waves place an additional load on the rotor winding and induce eddy currents in the rotor's solid iron, which may melt the metal or destroy the metallic structure.

An imbalanced load can be permissible within certain limits, however, when accounting for the thermal load limit of the generator. To avoid premature failure of the generator when an imbalanced load occurs, the characteristics that trigger imbalanced load protection should be adapted to the thermal characteristics of the generator. Imbalanced load protection can also be triggered by external errors in the mains caused by asymmetric short circuits.

Short circuit current monitoring

If overcurrent or a short circuit occurs and the limit value is exceeded, the error message "Overcurrent / Short circuit" is signaled after the configured time delay has passed.

Voltage asymmetry monitoring

The trigger value, which is adjustable by percentage, is always based on the respective average voltage of the linked generator voltages. This value defines the maximum permitted deviation of one of the three differential voltages between the three monitored, interlinked phase voltages.

If this value is exceeded in either direction, the error notification "Asymmetrical voltage" is indicated after the configured time delay has passed.

Bus bar voltage measurement and zero voltage monitoring

3-phase monitoring takes place for the bus bar voltage. The measured values are represented as phase-to-phase and phase-to-neutral values. The DO3 output is set when there is no voltage (below the lower dead bus limit) on the bus bar (X5 terminal).

This monitoring can be used to determine which synchronization function should be used.

| Synchronization function | Bus bar voltage measurement |
|---------------------------|---|
| Dead bus | No voltage is being supplied to the bus bar or the value is below the lower limit parameter. Output DO3 is set. |
| Synchronization with slip | The voltage measured on the bus bar is above the defined parameter value. Output DO3 is not set. |

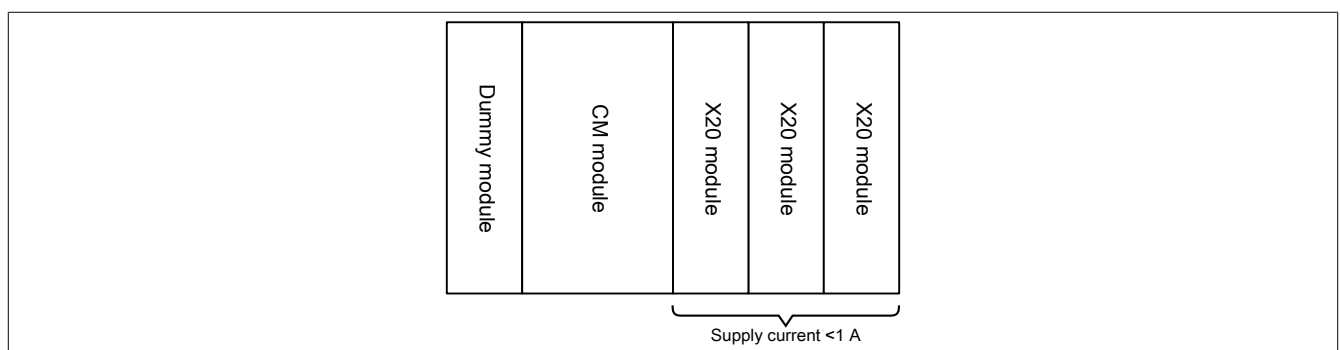
Exciter failure

The reactive power monitoring can be used to protect a generator against operating in the impermissible range. The capacitive reactive power monitor offers protection against under-excitation (exciter failure). If the lower limit is exceeded (in the negative direction), the error message "Exciter failure" is signaled after the configured time delay has passed.

9.26.2.17 Derating

Derating does not need to be taken into account for operation below 55°C.

For operation above 55°C, a dummy module must be connected to the left of the module. A maximum supply current of 1 A is permitted to pass through the module to the modules connected to the right.



9.26.2.18 Register description

9.26.2.18.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.26.2.18.2 Function model 0 - default

| Register | Name | Data type | Read | | Write | |
|---|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Generator mains - Configuration | | | | | | |
| 2582 | ConfigOutput02 Nominal voltage of generator mains (U_{NomGen}) | UINT | | | | • |
| 2590 | ConfigOutput04 Nominal current of generator mains (I_{Nom}) | UINT | | | | • |
| 2598 | ConfigOutput06 Multiplier for generator mains | UINT | | | | • |
| 2610 | ConfigOutput09 Multiplier for current transformer | UINT | | | | • |
| 2658 | ConfigOutput16 Overvoltage limit of generator mains (U_{max}) | UINT | | | | • |
| 2561 | ConfigOutput20 Nominal voltage range of generator mains | USINT | | | | • |
| 2569 | ConfigOutput24 Nominal current range of the generator mains | USINT | | | | • |
| 2571 | ConfigOutput25 Aron circuit | USINT | | | | • |
| 2662 | ConfigOutput27 Undervoltage limit of generator mains (U_{min}) | UINT | | | | • |
| 2782 | ConfigOutput41 Low-pass filter for total power ratings | UINT | | | | • |
| Generator monitoring functions - Configuration | | | | | | |
| 2614 | ConfigOutput10 Nominal frequency (f_{Nom}) | UINT | | | | • |
| 2710 | ConfigOutput26 Response time for generator overvoltage (U_{max}) | UINT | | | | • |
| 2718 | ConfigOutput28 Response time for generator undervoltage (U_{min}) | UINT | | | | • |
| 2666 | ConfigOutput29 Generator over-frequency (f_{max}) | UINT | | | | • |
| 2726 | ConfigOutput30 Response time for generator over-frequency (f_{max}) | UINT | | | | • |
| 2670 | ConfigOutput31 Generator under-frequency (f_{min}) | UINT | | | | • |
| 2734 | ConfigOutput32 Response time for generator under-frequency (f_{min}) | UINT | | | | • |
| 2674 | ConfigOutput33 Generator voltage asymmetry (U_{as}) | UINT | | | | • |
| 2742 | ConfigOutput34 Response time for generator voltage asymmetry (U_{as}) | UINT | | | | • |
| 2774 | ConfigOutput35 Load time constant for current asymmetry | UINT | | | | • |
| 2678 | ConfigOutput36 Maximum limit of neutral conductor current | UINT | | | | • |
| 2750 | ConfigOutput37 Response time for neutral conductor current monitor | UINT | | | | • |
| 2682 | ConfigOutput38 Short circuit current | UINT | | | | • |
| 2758 | ConfigOutput39 Response time for short circuit current | UINT | | | | • |
| 2686 | ConfigOutput42 Rating-dependent overcurrent | UINT | | | | • |
| 2690 | ConfigOutput43 Integration coefficient for rating-dependent overcurrent (iths) | UINT | | | | • |
| 2694 | ConfigOutput44 Capacitive reactive power | INT | | | | • |
| 2766 | ConfigOutput45 Response time for reactive power monitoring | UINT | | | | • |
| 2698 | ConfigOutput57 DO1 function | UINT | | | | • |
| Busbar - Configuration | | | | | | |
| 2586 | ConfigOutput03 Busbar nominal voltage (U_{NomBus}) | UINT | | | | • |
| 2594 | ConfigOutput05 Multiplier for busbar | UINT | | | | • |

| Register | Name | Data type | Read | | Write | |
|---|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2563 | ConfigOutput21 Nominal voltage range of busbar | USINT | | | | • |
| 2650 | ConfigOutput40 Minimum busbar voltage (U_{Bmin}) | UINT | | | | • |
| Synchronization - Configuration | | | | | | |
| 518 | ConfigOutput Synchronization mode | USINT | | | • | |
| 2578 | ConfigOutput01 Nominal voltage of synchronization mains (U_{NomSyn}) | UINT | | | | • |
| 2602 | ConfigOutput07 Multiplier for synchronization mains | UINT | | | | • |
| 2606 | ConfigOutput08 Multiplier for synchronization mains | UINT | | | | • |
| 2626 | ConfigOutput11 Max. differential frequency (df_{max}) | UINT | | | | • |
| 2630 | ConfigOutput12 Min. differential frequency (df_{min}) | INT | | | | • |
| 2634 | ConfigOutput13 Max. differential voltage (dU_{max}) | UINT | | | | • |
| 2638 | ConfigOutput14 Max. permitted differential angle (ϕ_{Max}) | UINT | | | | • |
| 2618 | ConfigOutput15 Phase rotation of sync mains 1 ($d\alpha$) | UINT | | | | • |
| 2565 | ConfigOutput22 Nominal voltage range of synchronization mains | USINT | | | | • |
| 2567 | ConfigOutput23 Nominal voltage range of synchronization mains | USINT | | | | • |
| 2794 | ConfigOutput47 Pulse duration of the turn-on delay | UINT | | | | • |
| 2798 | ConfigOutput48 Switching response time of the power switch | UINT | | | | • |
| 2654 | ConfigOutput56 Synchronization configuration | UINT | | | | • |
| 2622 | ConfigOutput58 Dead bus voltage | UINT | | | | • |
| Maximum value buffer and power meter - Configuration | | | | | | |
| 2790 | ConfigOutput46 Pulse value of energy meter output | UINT | | | | • |
| 2950 | ConfigOutput49 Maximum phase current I1 | INT | | • | | |
| 2054 | ConfigOutput50 Maximum phase current I2 | INT | | • | | |
| 2058 | ConfigOutput51 Maximum phase current I3 | INT | | • | | |
| 2062 | ConfigOutput52 Maximum total active power | INT | | • | | |
| 2066 | ConfigOutput53 Maximum neutral conductor current | INT | | • | | |
| 2076 | ConfigOutput54 Active energy counter | DINT | | • | | |
| 2084 | ConfigOutput55 Reactive energy counter | DINT | | • | | |
| 2834 | ConfigOutput60 Reset maximum phase current I1 | INT | | | | • |
| 2838 | ConfigOutput61 Reset maximum phase current I2 | INT | | | | • |
| 2842 | ConfigOutput62 Reset maximum phase current I3 | INT | | | | • |
| 2846 | ConfigOutput63 Resets maximum total active power | INT | | | | • |
| 2850 | ConfigOutput64 Resets maximum neutral conductor current | INT | | | | • |
| 2860 | ConfigOutput66 Reset active energy meter | DINT | | | | • |
| 2868 | ConfigOutput67 Write to reactive energy meter | DINT | | | | • |
| General registers - Communication | | | | | | |
| 514 | DigitalOutput Digital outputs 05 to 06 | USINT | | | • | |
| | DigitalOutput05 | Bit 0 | | | | |
| | DigitalOutput06 | Bit 1 | | | | |
| 126 | Status of digital outputs | UINT | • | | | |
| | StatusDigitalOutput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | StatusDigitalOutput06 | Bit 5 | | | | |
| | StatusInput17 | Bit 6 | | | | |
| | StatusInput16 | Bit 7 | | | | |

| Register | Name | Data type | Read | | Write | |
|---|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 122 | Error registers | UINT | • | | | |
| | Error registers | | | | | |
| | StatusInput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | StatusInput15 | Bit 14 | | | | |
| Generator mains measured values - Communication | | | | | | |
| 2 | AnalogInput01 Phase current I1 | INT | • | | | |
| 6 | AnalogInput02 Phase current I2 | INT | • | | | |
| 10 | AnalogInput03 Phase current I3 | INT | • | | | |
| 14 | AnalogInput04 Current average I1, I2, I3 | INT | • | | | |
| 18 | AnalogInput05 Neutral conductor current In | INT | • | | | |
| 22 | AnalogInput06 Current average, dynamic (Im_dyn) | UINT | • | | | |
| 26 | AnalogInput07 Line-to-line voltage UG12 | INT | • | | | |
| 30 | AnalogInput08 Line-to-line voltage UG23 | INT | • | | | |
| 34 | AnalogInput09 Line-to-line voltage UG31 | INT | • | | | |
| 38 | AnalogInput10 Phase voltage UG1 | INT | • | | | |
| 42 | AnalogInput11 Phase voltage UG2 | INT | • | | | |
| 46 | AnalogInput12 Phase voltage UG3 | INT | • | | | |
| 74 | AnalogInput19 Total active power filtered P/P_H1 | INT | • | | | |
| 78 | AnalogInput20 Total reactive power filtered Q/Q_H1 | INT | • | | | |
| 82 | AnalogInput21 Total apparent power filtered Q/S_H1 | INT | • | | | |
| 86 | AnalogInput22 Voltage average UG12, UG23, UG31 | INT | • | | | |
| 90 | AnalogInput23 Power factor of generator/cos ϕ | INT | • | | | |
| 94 | AnalogInput24 Frequency of the generator mains | UINT | • | | | |
| Measured values for busbar - Communication | | | | | | |
| 50 | AnalogInput13 Line-to-line voltage of busbar UB12 | INT | • | | | |
| 54 | AnalogInput14 Line-to-line voltage of busbar UB23 | INT | • | | | |
| 58 | AnalogInput15 Line-to-line voltage of busbar UB31 | INT | • | | | |
| 62 | AnalogInput16 Phase voltage of busbar UB1 | INT | • | | | |
| 66 | AnalogInput17 Phase voltage of busbar UB2 | INT | • | | | |
| 70 | AnalogInput18 Phase voltage of busbar UB3 | INT | • | | | |
| Measured values of synchronization mains - Communication | | | | | | |
| 98 | AnalogInput25 Line-to-line voltage of sync mains 1 US1 | INT | • | | | |
| 102 | AnalogInput26 Line-to-line voltage of sync mains 2 US2 | INT | • | | | |
| 106 | AnalogInput27 Frequency of sync mains 1 | UINT | • | | | |
| 110 | AnalogInput28 Frequency of sync mains 2 | UINT | • | | | |
| 114 | AnalogInput29 Differential angle between sync mains | INT | • | | | |
| 118 | AnalogInput30 Differential voltage between sync mains | INT | • | | | |

9.26.2.18.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|---|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Generator mains - Configuration | | | | | | | |
| 2582 | - | ConfigOutput02 Nominal voltage of generator mains | UINT | | | | • |
| 2590 | - | ConfigOutput04 Nominal current of generator mains | UINT | | | | • |
| 2598 | - | ConfigOutput06 Multiplier for generator mains | UINT | | | | • |
| 2610 | - | ConfigOutput09 Multiplier for current transformer | UINT | | | | • |
| 2658 | - | ConfigOutput16 Overvoltage limit of generator mains | UINT | | | | • |
| 2561 | - | ConfigOutput20 Nominal voltage range of generator mains | USINT | | | | • |
| 2569 | - | ConfigOutput24 Nominal current range of the generator mains | USINT | | | | • |
| 2571 | - | ConfigOutput25 Aron circuit | USINT | | | | • |
| 2662 | - | ConfigOutput27 Undervoltage limit of generator mains | UINT | | | | • |
| 2782 | - | ConfigOutput41 Low-pass filter for total power ratings | UINT | | | | • |
| Generator monitoring functions - Configuration | | | | | | | |
| 2614 | - | ConfigOutput10 Rated frequency | UINT | | | | • |
| 2710 | - | ConfigOutput26 Response time for generator overvoltage | UINT | | | | • |
| 2718 | - | ConfigOutput28 Response time for generator undervoltage | UINT | | | | • |
| 2666 | - | ConfigOutput29 Generator overfrequency | UINT | | | | • |
| 2726 | - | ConfigOutput30 Response time for generator overfrequency | UINT | | | | • |
| 2670 | - | ConfigOutput31 Generator underfrequency | UINT | | | | • |
| 2734 | - | ConfigOutput32 Response time for generator underfrequency | UINT | | | | • |
| 2674 | - | ConfigOutput33 Generator voltage asymmetry | UINT | | | | • |
| 2742 | - | ConfigOutput34 Response time for generator asymmetry | UINT | | | | • |
| 2774 | - | ConfigOutput35 Load time constant for current asymmetry | UINT | | | | • |
| 2678 | - | ConfigOutput36 Maximum limit of neutral conductor current | UINT | | | | • |
| 2750 | - | ConfigOutput37 Response time for neutral conductor current monitor | UINT | | | | • |
| 2682 | - | ConfigOutput38 Short circuit current | UINT | | | | • |
| 2758 | - | ConfigOutput39 Response time for short circuit current | UINT | | | | • |
| 2686 | - | ConfigOutput42 Rating-dependent overcurrent | UINT | | | | • |
| 2690 | - | ConfigOutput43 Integration coefficient Overcurrent | UINT | | | | • |
| 2694 | - | ConfigOutput44 Capacitive reactive power | INT | | | | • |
| 2766 | - | ConfigOutput45 Response time for reactive power monitoring | UINT | | | | • |
| 2698 | - | ConfigOutput57 DO1 function | UINT | | | | • |
| Busbar - Configuration | | | | | | | |
| 2586 | - | ConfigOutput03 Nominal voltage of busbar | UINT | | | | • |
| 2594 | - | ConfigOutput05 Multiplier for busbar | UINT | | | | • |
| 2563 | - | ConfigOutput21 Nominal voltage range of busbar | USINT | | | | • |
| 2650 | - | ConfigOutput40 Minimum busbar voltage | UINT | | | | • |
| Synchronization - Configuration | | | | | | | |
| 518 | 2 | ConfigOutput Synchronization mode | USINT | | | • | |
| 2578 | - | ConfigOutput01 Nominal voltage range of sync mains 1 | UINT | | | | • |
| 2602 | - | ConfigOutput07 Multiplier for sync mains 2 | UINT | | | | • |

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|---|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2606 | - | ConfigOutput08 Multiplier for sync mains | UINT | | | | • |
| 2626 | - | ConfigOutput11 Maximum permitted difference frequency | UINT | | | | • |
| 2630 | - | ConfigOutput12 Minimum permitted difference frequency | INT | | | | • |
| 2634 | - | ConfigOutput13 Maximum permitted differential voltage | UINT | | | | • |
| 2638 | - | ConfigOutput14 Maximum permitted differential angle | UINT | | | | • |
| 2618 | - | ConfigOutput15 Phase rotation of sync mains 1 | UINT | | | | • |
| 2565 | - | ConfigOutput22 Nominal voltage of sync mains 1 | USINT | | | | • |
| 2567 | - | ConfigOutput23 Nominal voltage of sync mains 2 | USINT | | | | • |
| 2794 | - | ConfigOutput47 Pulse duration of the turn-on delay | UINT | | | | • |
| 2798 | - | ConfigOutput48 Switching response time of the power switch | UINT | | | | • |
| 2654 | - | ConfigOutput56 Synchronization configuration | UINT | | | | • |
| 2622 | - | ConfigOutput58 Dead bus voltage | UINT | | | | • |
| Maximum value buffer and power meter - Configuration | | | | | | | |
| 2790 | - | ConfigOutput46 Pulse value of energy meter output | UINT | | | | • |
| 2950 | - | ConfigOutput49 Maximum phase current I1 | INT | | • | | |
| 2054 | - | ConfigOutput50 Maximum phase current I2 | INT | | • | | |
| 2058 | - | ConfigOutput51 Maximum phase current I3 | INT | | • | | |
| 2062 | - | ConfigOutput52 Maximum total active power | INT | | • | | |
| 2066 | - | ConfigOutput53 Maximum neutral conductor current | INT | | • | | |
| 2076 | - | ConfigOutput54 Active energy counter | DINT | | • | | |
| 2084 | - | ConfigOutput55 Reactive energy counter | DINT | | • | | |
| 2834 | - | ConfigOutput60 Reset maximum phase current I1 | INT | | | | • |
| 2838 | - | ConfigOutput61 Reset maximum phase current I2 | INT | | | | • |
| 2842 | - | ConfigOutput62 Reset maximum phase current I3 | INT | | | | • |
| 2846 | - | ConfigOutput63 Resets maximum total active power | INT | | | | • |
| 2850 | - | ConfigOutput64 Resets maximum neutral conductor current | INT | | | | • |
| 2860 | - | ConfigOutput66 Reset active energy meter | DINT | | | | • |
| 2868 | - | ConfigOutput67 Write to reactive energy meter | DINT | | | | • |
| General registers - Communication | | | | | | | |
| 514 | 0 | DigitalOutput | USINT | | | | • |
| | | Digital outputs 05 to 06 | | | | | |
| | | DigitalOutput05 | Bit 0 | | | | |
| | | DigitalOutput06 | Bit 1 | | | | |
| 126 | 62 | Status of digital outputs | UINT | • | | | |
| | | StatusDigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusDigitalOutput06 | Bit 5 | | | | |
| | | StatusInput17 | Bit 6 | | | | |
| | | StatusInput16 | Bit 7 | | | | |
| 122 | 60 | Error registers | UINT | • | | | |
| | | Error registers | | | | | |
| | | StatusInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | StatusInput15 | Bit 14 | | | | |
| Generator mains measured values - Communication | | | | | | | |
| 2 | 16 | AnalogInput01 Phase current I1 | INT | • | | | |
| 6 | 18 | AnalogInput02 Phase current I2 | INT | • | | | |

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|---|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 10 | 20 | AnalogInput03 Phase current I3 | INT | • | | | |
| 14 | 46 | AnalogInput04 Current average I1, I2, I3 | INT | • | | | |
| 18 | 22 | AnalogInput05 Neutral conductor current In | INT | • | | | |
| 22 | 38 | AnalogInput06 Current average, dynamic | UINT | • | | | |
| 26 | 0 | AnalogInput07 Line-to-line voltage UG12 | INT | • | | | |
| 30 | 2 | AnalogInput08 Line-to-line voltage UG23 | INT | • | | | |
| 34 | 4 | AnalogInput09 Line-to-line voltage UG31 | INT | • | | | |
| 38 | 8 | AnalogInput10 Phase voltage UG1 | INT | • | | | |
| 42 | 10 | AnalogInput11 Phase voltage UG2 | INT | • | | | |
| 46 | 12 | AnalogInput12 Phase voltage UG3 | INT | • | | | |
| 74 | 40 | AnalogInput19 Total active power filtered P/P_H1 | INT | • | | | |
| 78 | 42 | AnalogInput20 Total reactive power filtered Q/Q_H1 | INT | • | | | |
| 82 | 44 | AnalogInput21 Total apparent power filtered Q/S_H1 | INT | • | | | |
| 86 | 14 | AnalogInput22 Voltage average UG12, UG23, UG31 | INT | • | | | |
| 90 | 30 | AnalogInput23 Power factor of generator/cos ϕ | INT | • | | | |
| 94 | 6 | AnalogInput24 Frequency of the generator mains | UINT | • | | | |
| Measured values for busbar - Communication | | | | | | | |
| 50 | 32 | AnalogInput13 Line-to-line voltage of busbar UB12 | INT | • | | | |
| 54 | 34 | AnalogInput14 Line-to-line voltage of busbar UB23 | INT | • | | | |
| 58 | 36 | AnalogInput15 Line-to-line voltage of busbar UB31 | INT | • | | | |
| 62 | 24 | AnalogInput16 Phase voltage of busbar UB1 | INT | • | | | |
| 66 | 26 | AnalogInput17 Phase voltage of busbar UB2 | INT | • | | | |
| 70 | 28 | AnalogInput18 Phase voltage of busbar UB3 | INT | • | | | |
| Measured values of synchronization mains - Communication | | | | | | | |
| 98 | 48 | AnalogInput25 Line-to-line voltage of sync mains 1 US1 | INT | • | | | |
| 102 | 50 | AnalogInput26 Line-to-line voltage of sync mains 2 US2 | INT | • | | | |
| 106 | 52 | AnalogInput27 Frequency of sync mains 1 | UINT | • | | | |
| 110 | 54 | AnalogInput28 Frequency of sync mains 2 | UINT | • | | | |
| 114 | 56 | AnalogInput29 Differential angle between sync mains | INT | • | | | |
| 118 | 58 | AnalogInput30 Differential voltage between sync mains | INT | • | | | |

1) The offset specifies the position of the register within the CAN object.

9.26.2.18.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.26.2.18.3.2 CAN I/O bus controller

The module occupies 8 analog logical slots on CAN I/O.

9.26.2.18.4 Configuration registers**9.26.2.18.4.1 Generator mains****Nominal voltage of generator mains (U_{NomGen})**

Name:

ConfigOutput02

This is needed for converting the percentages based on this nominal value into physical units.

| Data type | Value | Information | Resolution |
|-----------|-------------|--|------------|
| UINT | 70 to 65000 | Corresponds to 70 to 65000 V. Bus controller default setting: 0 | 1 V |

Nominal current of generator mains (I_{Nom})

Name:

ConfigOutput04

This is needed for converting the percentages based on this nominal value into physical units.

| Data type | Value | Information | Resolution |
|-----------|------------|---|------------|
| UINT | 0 to 65000 | Corresponds to 0 to 65000 A. Bus controller default setting: 0 | 1 A |

Multiplier for generator mains

Name:

ConfigOutput06

This is used for converting the measured value into a physical value. The multiplier is applied to the respective input value.

The value 100 corresponds to a multiplication factor of 1 (measured value not changed).

| Data type | Value | Information | Resolution |
|-----------|------------|---|------------|
| UINT | 1 to 65535 | Corresponds to 0.01 to 655.35. Bus controller default setting: 0 | 0.01 |

Multiplier for current transformer

Name:

ConfigOutput09

This is used for converting the measured value into a physical value. The multiplier is applied to the respective input value.

| Data type | Value | Information | Resolution |
|-----------|------------|---|------------|
| UINT | 1 to 65535 | Corresponds to 1 to 65535. Bus controller default setting: 0 | 1 |

Overvoltage limit of generator mains (U_{max})

Name:

ConfigOutput16

If the value of one of the linked generator voltages exceeds the value set here, then the "Overvoltage" error message (register "Error registers" on page 2840) is indicated after the delay time has passed and, if configured, the DO1 monitoring relay is switched.

| Data type | Value | Information | Resolution |
|-----------|-----------|---|------------|
| UINT | 0 to 2000 | Corresponds to 0 to 200% of U_{NomGen} . Bus controller default setting: 0 | 0.1% |

Nominal voltage range of generator mains

Name:

ConfigOutput20

Can be toggled between 100 and 400 V.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 1 |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|--|
| 0 | Voltage | 0 | 100 V |
| | | 1 | 400 V (bus controller default setting) |
| 1 - 7 | Reserved | - | |

Nominal current range of the generator mains

Name:

ConfigOutput24

Can be toggled between 1 and 5 A.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 1 |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|--------------------------------------|
| 0 | Current range | 0 | 1 A |
| | | 1 | 5 A (bus controller default setting) |
| 1 - 7 | Reserved | - | |

Aron circuit

Name:

ConfigOutput25

Switch to power measurement principle of Aron circuit.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------|-------|--|
| 0 | Aron circuit | 0 | Disabled: Three-phase power system with neutral conductor (bus controller default setting) |
| | | 1 | Enabled: Three-phase supply without neutral line |
| 1 - 7 | Reserved | - | |

Undervoltage limit of generator mains (U_{min})

Name:

ConfigOutput27

If the value of one of the linked generator voltages falls below the value set here, then the "Undervoltage" error message (register "[Error register](#)" on page 2840) is indicated after the delay time has passed and, if configured, the DO1 monitoring relay is switched.

| Data type | Value | Information | Resolution |
|-----------|-----------|---|------------|
| UINT | 0 to 2000 | Corresponds to 0 to 200% of U_{NomGen} . Bus controller default setting: 0 | 0.1% |

Low-pass filter for total power ratings

Name:

ConfigOutput41

Parameter for the response time of the low-pass filter of the total power values P, Q and S. The maximum total power values are recorded independently of this without being filtered.

This parameter is used as a delay element so that current or voltage fluctuations have less effect on how the calculated power values are represented. The damping behavior of the low-pass filter acts in accordance with the configurable time constant of a decaying e-function.

| Data type | Value | Information | Resolution |
|-----------|----------|--|------------|
| UINT | 0 to 300 | Corresponds to 0 to 300 ms. Bus controller default setting: 0 | 1 ms |

9.26.2.18.4.2 Generator monitoring**Nominal frequency (f_{Nom})**

Name:

ConfigOutput10

This is needed for converting the percentages based on this nominal value into physical units.

| Data type | Value | Information | Resolution |
|-----------|------------|--|------------|
| UINT | 480 to 620 | Corresponds to 48 to 62 Hz. Bus controller default setting: 0 | 0.1 Hz |

Response time for generator overvoltage (U_{max})

Name:

ConfigOutput26

The error is only triggered if the response value is exceeded in the positive direction without interruption for as long as is specified in this register.

| Data type | Value | Information | Resolution |
|-----------|----------|--|------------|
| UINT | 5 to 100 | Corresponds to 0.5 to 10 s; Bus controller default setting: 0 | 0.1 s |

Response time for generator undervoltage (U_{min})

Name:

ConfigOutput28

The error is only triggered if the response value is exceeded in the negative direction without interruption for as long as is specified in this register.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|--|------------|
| UINT | 5 to 100 | Corresponds to 0.5 to 10 s; Bus controller default setting: 0 | 0.1 s |

Generator over-frequency (f_{max})

Name:

ConfigOutput29

If the value of the generator frequency exceeds the percentage of the nominal frequency set here, then the error message "Overfrequency" is indicated (register "[Error register](#)" on page 2840) and, if configured, the DO1 monitoring relay is switched.

| Data type | Value | Information | Resolution |
|-----------|-----------|---|------------|
| UINT | 0 to 2000 | For 0 to 200% of f_{Nom} . Bus controller default setting: 0 | 0.1% |

Response time for generator over-frequency (f_{max})

Name:

ConfigOutput30

The error is only triggered if the response value is exceeded in the positive direction without interruption for as long as is specified in this register.

| Data type | Value | Information | Resolution |
|-----------|----------|--|------------|
| UINT | 5 to 100 | For 0.5 for 10 s. Bus controller default setting: 0 | 0.1 s |

Generator under-frequency (f_{min})

Name:

ConfigOutput31

If the value of the generator frequency falls below the percentage of the nominal frequency set here, then the error message "Underfrequency" is indicated (register "Error register" on page 2840) and, if configured, the DO1 monitoring relay is switched.

| Data type | Value | Information | Resolution |
|-----------|-----------|---|------------|
| UINT | 0 to 2000 | For 0 to 200% of f_{Nom} . Bus controller default setting: 0 | 0.1% |

Response time for generator under-frequency (f_{min})

Name:

ConfigOutput32

The error is only triggered if the response value is exceeded in the negative direction without interruption for as long as is specified in this register.

| Data type | Value | Information | Resolution |
|-----------|----------|---|------------|
| UINT | 5 to 100 | For 0.5 to 10 s. Bus controller default setting: 0 | 0.1 s |

Generator voltage asymmetry (U_{as})

Name:

ConfigOutput33

The trigger value, which is adjustable by percentage, is always based on the respective average voltage of the linked generator voltages. If the value of the voltage difference exceeds or falls below the value set here, then the "Voltage asymmetry" error message is indicated (register "Error register" on page 2840) after the delay time has passed and, if configured, the DO1 monitoring relay is switched.

| Data type | Value | Information | Resolution |
|-----------|----------|---|------------|
| UINT | 0 to 300 | For 0 to 30% of $U_{3average}$. Bus controller default setting: 0 | 0.1% |

Response time for generator voltage asymmetry (U_{as})

Name:

ConfigOutput34

This error is triggered only if the response value is exceeded without interruption (in either the positive or negative direction) for as long as is specified in this register.

| Data type | Value | Information | Resolution |
|-----------|----------|---|------------|
| UINT | 5 to 100 | For 0.5 to 10 s. Bus controller default setting: 0 | 0.1 s |

Load time constant for current asymmetry

Name:

ConfigOutput35

The dependent delayed unbalanced load monitoring function continually monitors the AC currents coming from the main current converters and continually calculates the present unbalanced load current. This is compared with the threshold value, which is calculated using the load time constants. If this threshold value is exceeded, the error message "Current asymmetry" is indicated (register "Error register" on page 2840) and, if configured, the DO1 monitoring relay is switched.

| Data type | Value | Information | Resolution |
|-----------|------------|---|------------|
| UINT | 1 to 65535 | For 0.1 to 6553.5 s. Bus controller default setting: 0 | 0.1 s |

Dependent delayed unbalanced load monitoring

Unbalanced load monitoring protects against unbalanced load in three-phase generators and three-phase mains. Parameters can be changed to make it possible to match the trigger characteristics to different generator types while taking their special thermal time constants into consideration.

An unbalanced load can be caused by uneven current distribution in the mains due to unbalanced load, asymmetrical short circuits, line interruptions or switching operations. Unbalanced loads result in reverse system currents in the stator, which causes harmonics with an uneven ordinal number in the stator winding and harmonics with an even ordinal number in the rotor winding. The rotor is at particular risk here because the harmonic waves place an additional load on the rotor winding and induce eddy currents in the rotor's solid iron, which may melt the metal or destroy the metallic structure.

An unbalanced load can be permissible within certain limits, however, when accounting for the thermal load limit of the generator. To avoid premature failure of the generator when an unbalanced load occurs, the characteristics that trigger unbalanced load protection should be adapted to the thermal characteristics of the generator. Unbalanced load protection can also be triggered by external errors in the mains caused by asymmetric short circuits.

When unbalanced load protection is tripped can be calculated using the following formula:

| Operating mode | Formula |
|----------------------|--|
| Short-term operation | $t = \frac{K1}{\frac{I_2}{I_{Nom}} - 0.08^2}$ |
| Continuous operation | $\frac{I_2}{I_{Nom}} \leq 0.08 \rightarrow t = \infty$ |
| Key | |
| t | Calculated tripping time |
| K1 | Valid load time constant for the generator [s] |
| I ₂ | Calculated inverse current / unbalanced load current [A] |
| I _{Nom} | Nominal current for the generator [A] |

To calculate the tripping time instant, the scan duration of the measurement system (i.e. 20 ms for 50 Hz voltage) is divided by the calculated trigger time, and the results are continually added up. With short-term operation, the value of the summands increases; with continuous operation, it decreases. If the summand reaches the value 1 (100%), then the max. permitted value has been reached. The summand is limited between 0 and 1.

Information:

The boundary between continuous operation and short-term operation is always 0.08 for calculations.

When the generator is at a standstill, the summand is neither reset nor is its value reduced.

Maximum limit of neutral conductor current

Name:

ConfigOutput36

Configurable limit for the neutral conductor current. If the value is exceeded, then the error message "Maximum neutral conductor current" is indicated (register "Error register" on page 2840) after the delay time has passed and, if configured, the DO1 monitoring relay is switched.

| Data type | Value | Information | Resolution |
|-----------|-----------|--|------------|
| UINT | 0 to 1000 | For 0 to 100% of I _{Nom} . Bus controller default setting: 0 | 0.1% |

Response time for neutral conductor current monitor

Name:

ConfigOutput37

The error is only triggered if the response value is exceeded in the positive direction without interruption for as long as is specified in this register.

| Data type | Value | Information | Resolution |
|-----------|----------|---|------------|
| UINT | 5 to 100 | For 0.5 to 10 s. Bus controller default setting: 0 | 0.1 s |

Short circuit current

Name:

ConfigOutput38

If the value of the generator current exceeds the percentage based on the converter's nominal current set here, then the error message "Short circuit current" is indicated (register "[Error register](#)" on page 2840) and, if configured, the DO1 monitoring relay is switched.

| Data type | Value | Information | Resolution |
|-----------|--------------|---|------------|
| UINT | 1000 to 5000 | For 100 to 500% of I_{Nom} . Bus controller default setting: 0 | 0.1% |

Response time for short circuit current

Name:

ConfigOutput39

The error is only triggered if the response value is exceeded in the positive direction without interruption for as long as is specified in this register.

| Data type | Value | Information | Resolution |
|-----------|---------|---|------------|
| UINT | 4 to 30 | For 0.04 to 0.3 s. Bus controller default setting: 0 | 0.01 s |

Rating-dependent overcurrent

Name:

ConfigOutput42

The response value percentage is based on the nominal current of the generator. If the response value is exceeded, then the error message "Rating-dependent overcurrent" is indicated (register "[Error register](#)" on page 2840) and, if configured, the DO1 monitoring relay is switched.

| Data type | Value | Information | Resolution |
|-----------|--------------|---|------------|
| UINT | 1000 to 2000 | For 100 to 200% of I_{Nom} . Bus controller default setting: 0 | 0.1% |

Rating-dependent overcurrent monitoring

A generator that is operated at its nominal current I_{Nom} normally reaches about half of its maximum thermal load. Operating it above the rated current I_{Nom} result in additional warming, which is permitted until the maximum temperature is reached. The highest permissible continuous temperature is determined by the class of the insulation material used in the generator.

Based on the settings and the current measurement, the device forms an internal model based on an I^2t characteristic curve of the generator temperature. This allows the heat capacity of the generator to be completely utilized for short overloads while at the same time providing full protection. The configurable parameters for determining the machine model include the nominal current I_{Nom} of the generator and the time multiplier.

Integration coefficient for rating-dependent overcurrent (iths)

Name:

ConfigOutput43

To calculate the tripping time instant, the sampling duration of the measurement system is divided by the calculated trigger time (t). The results are continually added up. If the summand reaches the value 1 (100%), then the max. permitted value has been reached. The summand is limited between 0 and 1.

| Data type | Value | Information | Resolution |
|-----------|---------|--|------------|
| UINT | 1 to 20 | For 0.1 to 2. Bus controller default setting: 1 | 0.1 |

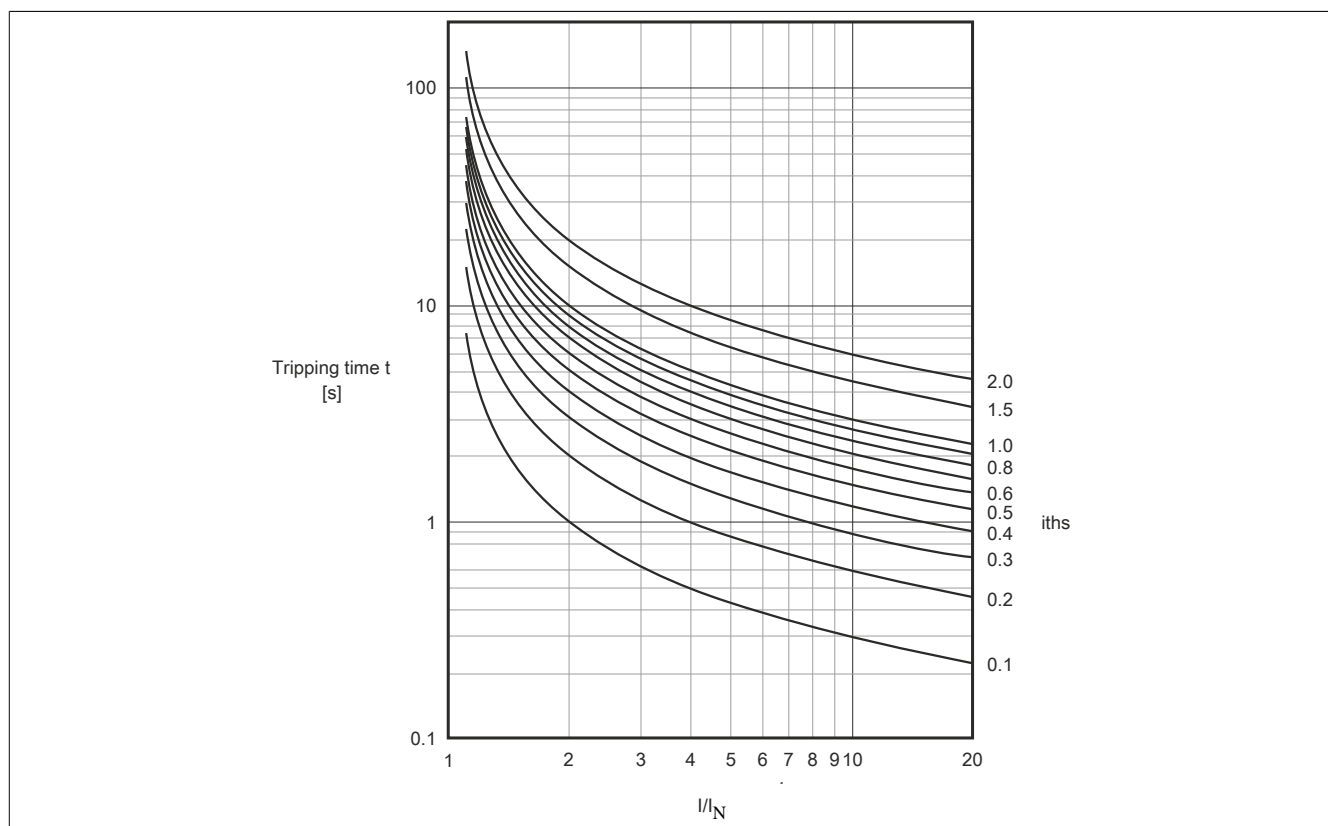
For a constant overcurrent, the trigger characteristic curve can be calculated based on the following formula:

$$t = \frac{0.14}{\left(\frac{I}{I_N}\right)^{0.02} - 1} * iths$$

Key:

| | |
|-------|--|
| t | Tripping time [s] |
| I | The highest value of the 3 phase currents [A] |
| I_N | Rating-dependent overcurrent [A] (0.5 to 2 * I_{Nom}) |
| iths | Integration coefficient (0.1 to 2) |

The monitor function can be reset by restarting the module or by falling below the overcurrent value so that the results of the continuous addition decrease according to the formula.

Trigger characteristic curve in accordance with IEC 255-4 (normal, inverse)

The monitor function can be reset by restarting the module or by falling below the overcurrent value so that the results of the continuous addition decrease according to the formula.

Capacitive reactive power

Name:

ConfigOutput44

The capacitive reactive power for the generator is monitored to determine if it falls below the defined response value. In this way, monitoring the capacitive reactive power can be used to detect exciter failure. If the response value is fallen below, then the error message "Capacitive reactive power" is indicated (register "Error register" on page 2840) after the delay time has passed and, if configured, the DO1 monitoring relay is switched.

| Data type | Value | Information | Resolution |
|-----------|-----------------|--|------------|
| INT | -32768 to 32767 | For -32768 to 32767 kvar. Bus controller default setting: 0 | 1 kvar |

Response time for reactive power monitoring

Name:

ConfigOutput45

The error is only triggered if the response value is exceeded in the positive direction without interruption for as long as is specified in this register.

| Data type | Value | Information | Resolution |
|-----------|----------|---|------------|
| UINT | 5 to 100 | For 0.5 to 10 s. Bus controller default setting: 0 | 0.1 s |

DO1 function

Name:

ConfigOutput57

This digital output can be set after the defined response time has elapsed depending on the assignment of the generator mains' monitoring variables (X3).

The monitoring variables can be assigned to this input either individually or with additional monitoring variables using an OR connective. This makes it possible to set the relay when there are multiple monitoring variables.

The following monitoring functions can be assigned to the monitoring relay using this register:

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|---------|---|-------|---|
| 0 | Overvoltage (of a phase) | 0 | Do not assign function (bus controller default setting) |
| | | 1 | Assign function |
| 1 | Undervoltage (or a phase) | 0 | Do not assign function (bus controller default setting) |
| | | 1 | Assign function |
| 2 | Overfrequency | 0 | Do not assign function (bus controller default setting) |
| | | 1 | Assign function |
| 3 | Underfrequency | 0 | Do not assign function (bus controller default setting) |
| | | 1 | Assign function |
| 4 | Voltage asymmetry | 0 | Do not assign function (bus controller default setting) |
| | | 1 | Assign function |
| 5 | Current asymmetry (unbalanced load) | 0 | Do not assign function (bus controller default setting) |
| | | 1 | Assign function |
| 6 | Neutral conductor current, maximum | 0 | Do not assign function (bus controller default setting) |
| | | 1 | Assign function |
| 7 | Short circuit current | 0 | Do not assign function (bus controller default setting) |
| | | 1 | Assign function |
| 8 | Rating-dependent overcurrent | 0 | Do not assign function (bus controller default setting) |
| | | 1 | Assign function |
| 9 | Capacitive reactive power (exciter failure) | 0 | Do not assign function (bus controller default setting) |
| | | 1 | Assign function |
| 10 | Ready | 0 | Do not assign function (bus controller default setting) |
| | | 1 | Assign function |
| 11 - 15 | Reserved | 0 | |

Information:

The minimum pulse duration when addressing a monitoring function on the error bit via X2X as well as on the relay is 500 ms.

9.26.2.18.4.3 Busbar**Busbar nominal voltage (U_{NomBus})**

Name:

ConfigOutput03

This is needed for converting the percentages based on this nominal value into physical units.

| Data type | Value | Information | Resolution |
|-----------|-------------|---|------------|
| UINT | 70 to 65000 | For 70 to 65000 V. Bus controller default setting: 0 | 1 V |

Multiplier for busbar

Name:

ConfigOutput05

This is used for converting the measured value into a physical value. The multiplier is applied to the respective input value.

100 thus means a multiplier factor of 1 (measured value not changed).

| Data type | Value | Information | Resolution |
|-----------|------------|--|------------|
| UINT | 1 to 65535 | For 0.01 to 655.35. Bus controller default setting: 0 | 0.01 |

Nominal voltage range of busbar

Name:

ConfigOutput21

Can be toggled between 100 and 400 V.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 1 |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|--|
| 0 | Voltage | 0 | 100 V |
| | | 1 | 400 V (bus controller default setting) |
| 1 - 7 | Reserved | - | |

Minimum busbar voltage (U_{Bmin})

Name:

ConfigOutput40

Name:

ConfigOutput40

ConfigOutput40Read

Configurable threshold for zero voltage monitoring of the busbar based on its nominal voltage. DO3 is set if the value falls below the configured threshold.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|--|------------|
| UINT | 0 to 1000 | For 0 to 100% of U_{NomBus} . Bus controller default setting: 0 | 0.1% |

9.26.2.18.4.4 Synchronization

Synchronization mode

Name:

ConfigOutput

ConfigOutput17 to ConfigOutput19

If multiple mode bits are set at the same time, then no mode will be selected (type BOOL).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------|-------|----------------------|
| 0 | ConfigOutput17 | 0 | Sync mode ≠ Slip |
| | | 1 | Sync mode = Slip |
| 1 | ConfigOutput18 | 0 | Sync mode ≠ Check |
| | | 1 | Sync mode = Check |
| 2 | ConfigOutput19 | 0 | Sync mode ≠ Dead bus |
| | | 1 | Sync Mode = Dead bus |
| 3 - 7 | Reserved | - | |

Nominal voltage of synchronization mains (U_{NomSyn})

Name:

ConfigOutput01

This is needed for converting the percentages based on this nominal value into physical units.

| Data type | Value | Information | Resolution |
|-----------|-------------|---|------------|
| UINT | 70 to 65000 | For 70 to 65000 V. Bus controller default setting: 0 | 1 V |

Multiplier for synchronization mains

Name:

ConfigOutput07 (mains 1)

ConfigOutput08 (mains 2)

This is used for converting the measured value into a physical value. The multiplier is applied to the respective input value.

100 means a multiplier factor of 1 (measured value not changed).

| Data type | Value | Information | Resolution |
|-----------|------------|--|------------|
| UINT | 1 to 65535 | For 0.01 to 655.35. Bus controller default setting: 0 | 0.01 |

Max. differential frequency (df_{max})

Name:

ConfigOutput11

A switch-on command on DO4 is only output if this configured differential frequency is not exceeded. This value specifies the upper frequency (positive value corresponds to positive slip → generator frequency is greater than the busbar frequency when synchronizing).

| Data type | Value | Information | Resolution |
|-----------|---------|---|------------|
| UINT | 2 to 49 | For 0.02 to 0.49 Hz. Bus controller default setting: 0 | 0.01 Hz |

Min. differential frequency (df_{min})

Name:

ConfigOutput12

A switch-on command on DO4 is only output if this configured differential frequency is not exceeded in the negative direction. This value specifies the lower frequency (negative value corresponds to negative slip → generator frequency is less than the busbar frequency when synchronizing).

| Data type | Value | Information | Resolution |
|-----------|----------|---|------------|
| INT | -49 to 0 | For -0.49 to 0 Hz. Bus controller default setting: 0 | 0.01 Hz |

Max. differential voltage (dU_{max})

Name:

ConfigOutput13

A switch-on command on DO4 is only output if this configured differential voltage percentage based on the synchronization mains' nominal voltage is not exceeded.

| Data type | Value | Information | Resolution |
|-----------|----------|---|------------|
| UINT | 1 to 300 | For 0.1 to 30% of U_{NomSyn} . Bus controller default setting: 0 | 0.1% |

Max. permitted differential angle (ϕ_{Max})

Name:

ConfigOutput14

A switch-on command on DO4 is only output if the configured differential angle between the two synchronization mains is not exceeded.

| Data type | Value | Information | Resolution |
|-----------|----------|--|------------|
| UINT | 1 to 600 | For 0.1 to 60°. Bus controller default setting: 0 | 0.1° |

Phase rotation of sync mains 1 ($d\alpha$)

Name:

ConfigOutput15

This parameter is used for correcting any phase shifting from upstream transformer vector groups before reaching the mains being synchronized.

This parameter specifies how many degrees the synchronization mains lags behind the mains being synchronized.

| Data type | Value | Information | Resolution |
|-----------|-----------|---|------------|
| UINT | 0 to 3600 | For 0 to 360°. Bus controller default setting: 0 | 0.1° |

Nominal voltage range of synchronization mains

Name:

ConfigOutput22 (mains 1)

ConfigOutput23 (mains 2)

Can be toggled between 100 and 400 V.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 1 |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|--|
| 0 | Voltage | 0 | 100 V |
| | | 1 | 400 V (bus controller default setting) |
| 1 - 7 | Reserved | - | |

Pulse duration of the turn-on delay

Name:

ConfigOutput47

The duration of the switch-on pulse can be adjusted for the following switching units. The time set here is valid for the switch-on pulse for DO4.

| Data type | Value | Information | Resolution |
|-----------|-----------|---|------------|
| UINT | 40 to 500 | For 0.04 to 0.5 s. Bus controller default setting: 0 | 0.001 s |

Switching response time of the power switch

Name:

ConfigOutput48

The actuation time of the generator power switch corresponds to the lead time of the switch-on command. The switch-on command is executed before the point of synchronization according to the amount of time defined here.

| Data type | Value | Information | Resolution |
|-----------|-----------|---|------------|
| UINT | 40 to 300 | For 0.04 to 0.3 s. Bus controller default setting: 0 | 0.001 s |

Synchronization configuration

Name:

ConfigOutput56

Parameter for configuring which mains or voltages should be synchronized with each other.

This configuration makes it possible to synchronize the AC mains on terminal X4 either with terminal X3, X5 or X6. In each case, synchronization mains 1 (X4) is the network to which synchronization takes place.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|--------|-----------------|-------|---|
| 0 - 1 | Synchronization | 00 | X4 - X6: Synchronization network 1 - Synchronization network 2 (bus controller default setting) |
| | | 01 | X4 - X5: Synchronization mains 1 - Busbar |
| | | 10 | X4 - X3: Synchronization mains 1 - Generator |
| | | 11 | Reserved |
| 2 - 15 | Reserved | - | |

Dead bus voltage

Name:

ConfigOutput58

Configurable threshold for dead bus synchronization based on the nominal voltage of the busbar.

| Data type | Value | Information | Resolution |
|-----------|-----------|--|------------|
| UINT | 0 to 1000 | For 0 to 100% of U_{NomBus} . Bus controller default setting: 0 | 0.1% |

9.26.2.18.4.5 Maximum value buffer and power meter**Pulse value of energy meter output**

Name:

ConfigOutput46

Output DO2 outputs pulses that occur at a frequency proportional to the measured energy. The frequency of the pulses can be specified. The length of the pulse is 400 ms. The frequency at which the pulses occur should be set so that the duration between two pulses does not exceed 400 ms at the highest possible power. The pulse output's internal meter starts at 0 kWh after a restart. This register has no effect on the "[ConfigOutput54](#)" on page 2838 and "[ConfigOutput55](#)" on page 2838 registers.

| Data type | Value | Information | Resolution |
|-----------|------------|--|-------------|
| UINT | 0 to 65535 | For 0 to 65535 kWh/pulse. Bus controller default setting: 0 | 1 kWh/pulse |

Maximum value buffer and meter buffer

These registers are used for nonvolatile storage of the maximum value and meter level values. After restarting, the stored maximum values and meter states are loaded back into their registers and the module's internal work meter is reset. It is possible to reset or write to the stored maximum values and meter states using an acyclic register.

The maximum values are recorded by the effective measured values before reaching the configurable filter. The maximum values can be read or written to as acyclic registers.

Maximum phase current

Name:

Reading: ConfigOutput49 (generator I1)

Reading: ConfigOutput50 (generator I2)

Reading: ConfigOutput51 (generator I3)

Reset: ConfigOutput60 (generator I1)

Reset: ConfigOutput61 (generator I2)

Reset: ConfigOutput62 (generator I3)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 A |

Maximum total active power

Name:

Reading: ConfigOutput52

Reset: ConfigOutput63

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 kW |

Maximum neutral conductor current

Name:

Reading: ConfigOutput53

Reset: ConfigOutput64

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 A |

Active energy counter

Name:

Reading: ConfigOutput54

Writing: ConfigOutput66

| Data type | Value | Information | Resolution |
|-----------|------------------------------------|-------------|------------|
| DINT | -2,147,483,648 to 2,147,483,647 | - | 100 kWh |

Reactive energy counter

Name:

Reading: ConfigOutput55

Writing: ConfigOutput67

| Data type | Value | Information | Resolution |
|-----------|------------------------------------|-------------|------------|
| DINT | -2,147,483,648 to 2,147,483,647 | - | 100 kvarh |

9.26.2.18.5 Communication registers

9.26.2.18.5.1 General registers

Digital outputs

Name:

DigitalOutput

DigitalOutput05

DigitalOutput06

(data point applied as BOOL)

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------|-------|----------------|
| 0 | DigitalOutput05 | 0 | Reset output 5 |
| | | 1 | Set output 5 |
| 1 | DigitalOutput06 | 0 | Reset output 6 |
| | | 1 | Set output 6 |

Status of digital outputs

Name:

StatusDigitalOutput01 to StatusDigitalOutput06

StatusInput16 to StatusInput17

(data point applied as BOOL)

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------|-------|--|
| 0 | StatusDigitalOutput01 | 0 | Current state of output 1 = LOW |
| | | 1 | Current state of output 1 = HIGH |
| 1 - 7 | Reserved | - | |
| 8 | StatusDigitalOutput02 | 0 | Current state of output 2 = LOW |
| | | 1 | Current state of output 2 = HIGH |
| ... | | ... | |
| 12 | StatusDigitalOutput06 | 0 | Current state of output 6 = LOW |
| | | 1 | Current state of output 6 = HIGH |
| 13 | Reserved | - | |
| 14 | StatusInput17 | 0 | Status DO OK |
| | | 1 | Status DO overload |
| 15 | StatusInput16 | 0 | Status 24 V output supply OK |
| | | 1 | Status 24 V output supply undervoltage |

Error registers

Name:

StatusInput18

StatusInput01 to StatusInput15

This register contains status inputs (type BOOL).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|---------------|-------|--|
| 0 | StatusInput01 | 0 | Overvoltage (one phase), OK |
| | | 1 | Overvoltage (one phase), present |
| 1 | StatusInput02 | 0 | Undervoltage (one phase), OK |
| | | 1 | Undervoltage (one phase), present |
| 2 | StatusInput03 | 0 | Over-frequency, OK |
| | | 1 | Over-frequency, present |
| 3 | StatusInput04 | 0 | Under-frequency, OK |
| | | 1 | Under-frequency, present |
| 4 | StatusInput05 | 0 | Voltage asymmetry, OK |
| | | 1 | Voltage asymmetry, present |
| 5 | StatusInput06 | 0 | Current asymmetry, OK |
| | | 1 | Current asymmetry, present |
| 6 | StatusInput07 | 0 | Maximum neutral conductor current, OK |
| | | 1 | Maximum neutral conductor current exceeded |
| 7 | StatusInput08 | 0 | Short circuit-current, OK |
| | | 1 | Short circuit-current, present |
| 8 | StatusInput09 | 0 | Rating-dependent overcurrent OK |
| | | 1 | Rating-dependent overcurrent occurring |
| 9 | StatusInput10 | 0 | Capacitive reactive power (exciter failure), OK |
| | | 1 | Capacitive reactive power (exciter failure), present |
| 10 | StatusInput11 | 0 | Ready, OK |
| | | 1 | Not ready |
| 11 | StatusInput12 | 0 | Generator mains phase 1 OK |
| | | 1 | Failure of generator mains phase 1 |
| 12 | StatusInput13 | 0 | Busbar phase 1 OK |
| | | 1 | Busbar phase 1 failure |
| 13 | StatusInput14 | 0 | Phase 1 sync mains 1 OK |
| | | 1 | Phase 1 sync mains 1 failure |
| 15 | StatusInput15 | 0 | Phase 1 sync mains 2 OK |
| | | 1 | Phase 1 sync mains 2 failure |
| 15 | Reserved | - | |

StatusInput11

The error message "Not ready" is triggered if the X20 I/O supply drops below 18 VDC.

StatusInput

(StatusInput12 to StatusInput 14)

Phase failure is detected if phase 1 of the respective terminal fails.

If this error occurs, it will mean losses in measurement precision.

9.26.2.18.5.2 Generator mains measured values

Phase currents of the generator

Name:

AnalogInput01 (I1)

AnalogInput02 (I2)

AnalogInput03 (I3)

Phase currents of the generator

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 A |

Current average of generator I1, I2, I3

Name:

AnalogInput04

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 A |

Neutral conductor current of generator I_n

Name:

AnalogInput05

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 A |

Dynamic current average of generator (I_{m_dyn})

Name:

AnalogInput06

Describes the change to the current average.

The dynamic average is the amount of change (I_{m_diff}) of the current average (sampling time: 10 ms).

This value decays in an e-function.

$$I_{m_diff} > I_{m_dyn} \rightarrow I_{m_dyn} = I_{m_diff}$$

$$I_{m_diff} \leq I_{m_dyn} \rightarrow I_{m_dyn} = I_{m_dyn} * 0.98$$

| Data type | Value | Information | Resolution |
|-----------|-------------|-------------|------------|
| UINT | 0 to 65,535 | - | 1 A |

Line-to-line voltages of the generator

Name:

AnalogInput07 (UG12)

AnalogInput08 (UG23)

AnalogInput09 (UG31)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

Phase voltages of the generator

Name:

AnalogInput10 (UG 1)

AnalogInput11 (UG 2)

AnalogInput12 (UG 3)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

Generator power: Total active power P

Name:

AnalogInput19

Filtered generator power values:

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 kW |

Generator power: Total reactive power Q

Name:

AnalogInput20

Filtered generator power values:

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 kvar |

Generator power: Total apparent power S

Name:

AnalogInput21

Filtered generator power values:

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 kVA |

Voltage average of the generator

Name:

AnalogInput22

Voltage average of the generator UG12, UG23, UG31 (U~3 average)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

Power factor of generator/cos ϕ

Name:

AnalogInput23

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 0.001 |

Frequency of the generator mains

Name:

AnalogInput24

| Data type | Value | Information | Resolution |
|-----------|-------------|-------------|------------|
| UINT | 0 to 65,535 | - | 0.01 Hz |

9.26.2.18.5.3 Busbar measured values**Line-to-line voltages of the busbar**

Name:

AnalogInput13 (UB12)

AnalogInput14 (UB23)

AnalogInput15 (UB31)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

Phase voltages of the busbar

Name:

AnalogInput16 (UB1)

AnalogInput17 (UB2)

AnalogInput18 (UB3)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

9.26.2.18.5.4 Synchronization mains measured values**Line-to-line voltages**

Name:

AnalogInput25 (sync mains 1 US1)

AnalogInput26 (sync mains 2 US2)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

Frequencies

Name:

AnalogInput27 (sync mains 1)

AnalogInput28 (sync mains 2)

| Data type | Value | Information | Resolution |
|-----------|-------------|-------------|------------|
| UINT | 0 to 65,535 | - | 0.01 Hz |

Differential angle between synchronization mains

Name:

AnalogInput29

Angular difference between the mains being synchronized

Specifies how many degrees the sync mains are ahead of the mains being synchronized.

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 0.1° |

Differential voltage between synchronization mains

Name:

AnalogInput30

Voltage difference between the mains being synchronized

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

9.26.2.18.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| ≥ 250 μs |

9.26.2.18.7 Minimum I/O update time

The minimum I/O update time for the analog inputs depends on the respective period duration of the measurement signal frequency.

| Minimum I/O update time | |
|-------------------------|-------|
| At 50 Hz | 20 ms |

9.26.3 X20CM0985-02

Data sheet version: 1.02

9.26.3.1 General information

The module combines a power measurement module with special features in a compact footprint together with a synchronizing unit that meets all requirements.

The measurement unit is suitable for both X: 1 A and X: 5 A current transformers. Overcurrent resistance and the high resolution of the unit of measurement round off its features. For the voltage inputs, the value range can also be configured between 480 VAC and 120 VAC without any loss in converter resolution.

The area of application includes 4-wire AC power systems with a line-to-line voltage up to 480 VAC and 3-wire systems, where L2 can be grounded (V circuit). In addition, the module masters the measuring principle of the Aron circuit.

The resulting measured values range from the pure phase current and line-to-line or phase voltage to active, reactive and apparent power components, mains frequency, power factor and much more. In addition, peak values and energy meters are stored on the module in nonvolatile memory. Depending on the configuration, it is also possible to use a digital output as a pulse encoder for an external energy meter.

The synchronization unit does not just take the phasing and phase voltage into consideration; integrated intelligence also monitors the rate of change and other parameters, allowing them to influence when the synchronization output is switched. It is also possible to monitor a generator using a large number of additional conditions. A total of 4 voltage inputs provide substantial overall flexibility.

Monitoring functions expand the features of the module. Rating-dependent overcurrent monitoring is included, which utilizes the thermal capacity of the motor/generator to allow short overloads while still providing full protection. The dependent, delayed imbalanced load monitoring used to protect three-phase generator and three-phase networks from imbalanced load can be adapted to the characteristics of different generator types using parameters while taking their special thermal time constants into account.

- Energy measurement for 120 to 480 VAC
- Simultaneous measurement of 2 AC power systems plus 2 additional voltages
- For multifunction measurement tasks
- Intelligent power system synchronization unit
- Current values of generator voltage and current
- Monitor functions per current power system guidelines

9.26.3.2 Order data


| Model number | Short description | Figure |
|----------------------|---|---|
| Other functions | | |
| X20CM0985-02 | X20 digital and analog mixed module, multi-measurement transducer / synchronization module, 5 digital outputs, 24 VDC, 0.5 A, source, 1 relay, 1 A, 8 analog inputs, ± 480 V / 120 V, 16-bit converter resolution, 3 analog inputs, 5 A / 1 A AC, 16-bit converter resolution, additional software functionalities, adapted to VDE guidelines (2018), order terminal blocks 0TB3102-7011, 0TB3104-7011, 0TB3102-7012, 0TB3104-7012 and 2x X20TB12 separately! |  |
| Required accessories | | |
| Terminal blocks | | |
| 0TB3102-7011 | Accessory terminal block, 2-pin, A keyed, screw clamp terminal block 6 mm ² | |
| 0TB3102-7012 | Accessory terminal block, 2-pin, B keyed, screw clamp terminal block 6 mm ² | |
| 0TB3104-7011 | Accessory terminal block, 4-pin, A keyed, screw clamp terminal block 6 mm ² | |
| 0TB3104-7012 | Accessory terminal block, 4-pin, B keyed, screw clamp terminal block 6 mm ² | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 533: X20CM0985-02 - Order data

9.26.3.3 Technical data

| Model number | X20CM0985-02 |
|---|---|
| Short description | X20 energy measurement and synchronization module |
| I/O module | |
| General information | |
| B&R ID code | 0xF425 |
| Status indicators | Channel status, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Analog inputs | Yes, using status LED (measurement range of analog inputs) |
| Digital outputs | Yes, using status LED and software |
| Overvoltage category | II ¹⁾ |
| Measurable frequency | |
| Measurement range | 15.2 Hz to 2x nominal frequency ²⁾ |
| Accuracy | Typ. 10 mHz at 400 V / 50 Hz and sinusoidal signals |
| Power consumption | |
| Bus | 1.05 W |
| Internal I/O | 4 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| UL | cULus E115267 Industrial control equipment |
| Digital outputs | |
| Quantity | 5 |
| Variant | FET positive switching |
| Nominal voltage | 24 VDC |
| Switching voltage | 24 VDC -15% / +20% |
| Nominal output current | 0.1 A |
| Total nominal current | 0.5 A |
| Connection type | 1-wire connections |
| Output circuit | Source |
| Output protection | Thermal shutdown in the event of overcurrent or short circuit |
| Diagnostic status | Output monitoring with 10 ms delay |
| Leakage current when the power is switched off | 5 μ A |
| Residual voltage | <0.3 V at 0.1 A nominal current |
| Peak short-circuit current | <2 A |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms, depends on the module temperature |
| Switching delay | |
| 0 \rightarrow 1 | <300 μ s |
| 1 \rightarrow 0 | <300 μ s |
| Switching frequency | |
| Resistive load | Max. 100 Hz |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Relay outputs | |
| Quantity | 1 |

Table 534: X20CM0985-02 - Technical data

| Model number | X20CM0985-02 |
|--|---|
| Variant | Relay / Changeover contact |
| Nominal voltage | 30 VDC / 240 VAC |
| Rated frequency | DC / 45 to 63 Hz |
| Switching capacity | |
| Min. | 10 mA / 5 VDC |
| Max. | 30 W / 240 VAC |
| Nominal output current | 1 A at 30 VDC / 1 A at 240 VAC |
| Actuator power supply | External |
| Switching voltage | Max. 60 VDC / 250 VAC |
| Switching delay | |
| 0 → 1 | ≤10 ms |
| 1 → 0 | ≤10 ms |
| Service life ³⁾ | |
| Mechanical | Min. 10 x 10 ⁶ ops. |
| Electrical | Min. 60 x 10 ³ ops. (NC) at 1 A Min. 30 x 10 ³ ops. (NO) at 1 A |
| Contact resistance | Max. 100 mΩ |
| Protective circuit | |
| Internal | None |
| External | None |
| DC | Inverse diode, RC combination or VDR |
| AC | RC combination or VDR |
| Isolation voltage | |
| Channel - Channel | 1000 VAC / 1 min |
| Channel - Bus | 4000 VAC / 1 min |
| Analog input voltage | |
| Channels | 8 |
| Input | 120 VAC / 480 VAC |
| Input type | Single-ended |
| Digital converter resolution | ±15-bit |
| Conversion time | |
| 50 Hz | 10 ms |
| 60 Hz | 8.33 ms |
| Instantaneous values | Corresponds to the X2X cycle time |
| Permissible input signal | Max. 132 VAC / 528 VAC |
| Output format ⁴⁾ | |
| ±120 VAC | 1 LSB = 0x0001 = 5.707 mV |
| ±480 VAC | 1 LSB = 0x0001 = 22.787 mV |
| Output of digital value during overload | |
| Overshoot | 0x7FFF |
| Undershoot | 0x8001 |
| Conversion method | SAR |
| Input filter | |
| Cutoff frequency | 10 kHz |
| Slope | 60 dB |
| Maximum gain drift ⁵⁾ | 0.02% per °C |
| Maximum offset drift ⁶⁾ | 0.003% per °C |
| Crosstalk between channels | -70 dB |
| Nonlinearity ⁶⁾ | ≤0.5% at 45 to 65 Hz |
| Protection against electrical shock | Protective impedance per EN 61131-2 |
| Test voltage between channel and bus (type test) | 3700 V _{eff} |
| Output format | INT |
| Input impedance in signal range | Approx. 3 MΩ |
| Max. error at 25°C | |
| Gain | 0.09% ⁵⁾ |
| Offset | 0.03% ⁶⁾ |
| Input protection | Overvoltage protection |
| Analog input current | |
| Channels | 3 |
| Input | 1 A / 5 A AC |
| Input type | Isolated current transformer according to the compensation principle with a magnetic sensor, for connecting an external transformer |
| Digital converter resolution | ±15-bit |
| Conversion time | |
| 50 Hz | 10 ms |
| 60 Hz | 8.33 ms |
| Instantaneous values | Corresponds to the X2X cycle time |
| Permissible input signal | Max. 1.5 A / 7.7 A |
| Output format ⁴⁾ | |
| ±1 A | 1 LSB = 0x0001 = 189.903 μA |
| ±5 A | 1 LSB = 0x0001 = 949.513 μA |

Table 534: X20CM0985-02 - Technical data

| Model number | X20CM0985-02 |
|---|--|
| Output of digital value during overload | |
| Overshoot | 0x7FFF |
| Undershoot | 0x8001 |
| Conversion method | SAR |
| Input filter | |
| Cutoff frequency | 10 kHz |
| Slope | 60 dB |
| Maximum gain drift ⁵⁾ | 0.07% per °C |
| Maximum offset drift | Measurement range 2 A: 0.0064% per °C, measurement range 10 A: 0.00384% per °C |
| Crosstalk between channels | -70 dB |
| Nonlinearity ⁷⁾ | ≤0.5% at 45 to 65 Hz |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Output format | INT |
| Max. error at 25°C | |
| Gain | 0.2% ⁵⁾ |
| Offset | 0.05% ⁷⁾ |
| Thermal overcurrent ⁸⁾ | 15 x I _{Nom} for 0.2 s ⁹⁾ |
| Monitored overcurrent | 4 x I _{Nom} ⁹⁾ |
| Input impedance ¹⁰⁾ | |
| Measurement range 1 A | Max. 30 mΩ |
| Measurement range 5 A | Max. 10 mΩ |
| Electrical properties | |
| Electrical isolation | Bus isolated from I/O power supply and digital inputs and outputs Digital inputs and outputs isolated from each other |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating". |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 2x terminal block X20TB12 separately. Order 2x screw clamp terminal block TB3102 and 2x screw clamp terminal block TB3104 separately. |
| Pitch | 87.5 ^{+0.2} mm |

Table 534: X20CM0985-02 - Technical data

- 1) EN 61131-2
- 2) Rated frequency: 48 to 62 Hz. Synchronization is only possible at the nominal frequency.
- 3) See section "Electrical service life".
- 4) INT, range of values: 0x8001 to 0x7FFF
- 5) Based on the current measured value
- 6) Based on the measurement range 240 VAC / 960 VAC
- 7) Based on the measurement range 2 A / 10 A
- 8) This can result in the measurement hysteresis being offset in relation to the overcurrent.
- 9) Based on the measurement range 1 A / 5 A
- 10) Including current transformer, circuit path and X20TB12 terminal block (5 mΩ)

9.26.3.4 Safety guidelines

General information

Programmable logic controllers, operating/monitoring devices (e.g. industrial PCs, Power Panels, Mobile Panels, etc.) as well as uninterruptible power supplies have all been designed, developed and manufactured by B&R for conventional use or for use with increased safety requirements (safety technology) in industry. They were not designed, developed and manufactured for any use involving serious risks or hazards that could lead to death, injury, serious physical damage or loss of any kind without the implementation of exceptionally stringent safety precautions. In particular, such risks and hazards include the use of these devices to monitor nuclear reactions in nuclear power plants, their use in flight control or flight safety systems as well as in the control of mass transportation systems, medical life support systems or weapons systems.

When using programmable logic controllers or operating/monitoring devices as control systems together with a Soft PLC (e.g. B&R Automation Runtime or comparable product) or Slot PLC (e.g. B&R LS251 comparable product), safety precautions relevant to industrial control systems (e.g. the provision of safety devices such as emergency stop circuits, etc.) must be observed in accordance with applicable national and international regulations. The same applies for all other devices connected to the system, e.g. drives.

All tasks such as the installation, commissioning and servicing of devices are only permitted to be carried out by qualified personnel. Qualified personnel are those familiar with the transport, mounting, installation, commissioning and operation of devices who also have the appropriate qualifications (e.g. IEC 60364-1). National accident prevention regulations must be observed.

The safety notices, connection descriptions (type plate and documentation) and limit values listed in the technical data are to be read carefully before installation and commissioning and must be observed.

Intended use

Danger!

Electronic devices are never completely failsafe. If the multi-measurement and synchronization unit fails, the user is responsible for making sure that the motor or generator is brought to a secure state.

Some errors are detected and prevented in the synchronization unit by the system's internal software monitoring. However, when the device is in operation it is always possible for errors, defective components, software errors or configuration mistakes to occur at any time. B&R emphasizes that the multi-measurement and synchronization unit possesses neither a failsafe function nor a redundancy system. For this reason, independent higher-level safety precautions need to be put in place to ensure that personnel and machines are protected.

Grounding the Mounting Rail

For grounding purposes, a good conductive connection between the mounting rail and the metal back wall is required. The mounting rail is to be connected conductively to the back wall. This is achieved by inserting a contact washer with the fastening screw.


Information:

The control cabinet back wall must be connected with GND

9.26.3.5 LED status indicators


For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

LED status indicators - Left

| Figure | LED | Color | Status | Description |
|---|-------|--------------------------------|----------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | Mode RESET |
| | | | Double flash | Mode BOOT (during firmware update) ¹⁾ |
| | | | Blinking | Mode PREOPERATIONAL |
| | | | On | Mode RUN |
| | e | Red | Off | Module not supplied with power or everything OK |
| | On | | Error or reset state | |
| | e + r | Solid red / Single green flash | Invalid firmware | |
| | 1 - 6 | Orange | | Output state of the corresponding digital output |

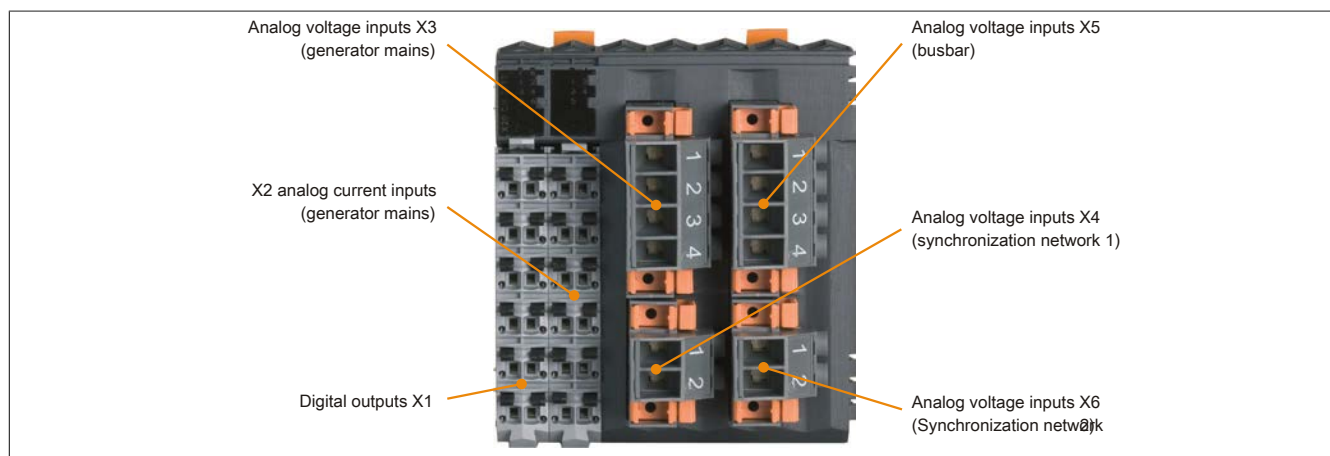
1) Depending on the configuration, a firmware update can take up to several minutes.

LED status indicators - Right

| Figure | LED ¹⁾ | Terminal | Color | Status | Description |
|---|-------------------|----------|-------|--------|----------------------------|
|  | 1 | X3 | Green | On | Measurement range: 120 VAC |
| | | | Red | On | Measurement range: 480 VAC |
| | 2 | X4 | Green | On | Measurement range: 120 VAC |
| | | | Red | On | Measurement range: 480 VAC |
| | 3 | X5 | Green | On | Measurement range: 120 VAC |
| | | | Red | On | Measurement range: 480 VAC |
| | 4 | X6 | Green | On | Measurement range: 120 VAC |
| | | | Red | On | Measurement range: 480 VAC |
| | 5 | X2 | Green | On | Measurement range: 1 A |
| | | | Red | On | Measurement range: 5 A |

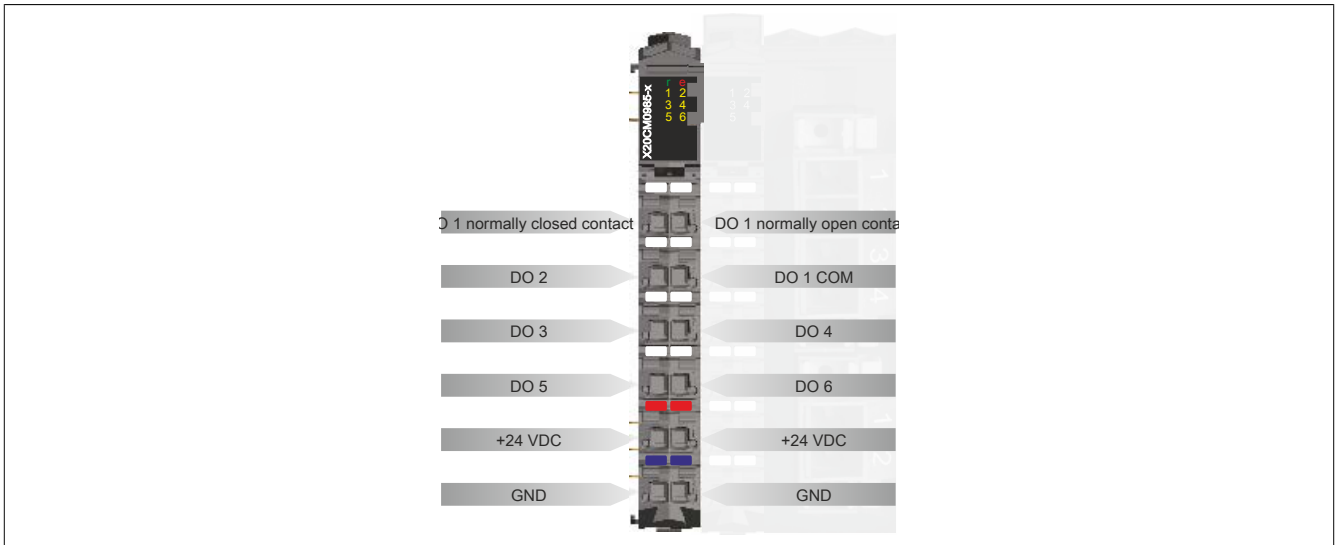
1) LEDs 1 - 5 are green/red dual LEDs.

9.26.3.6 Connection elements



9.26.3.7 Digital outputs X1

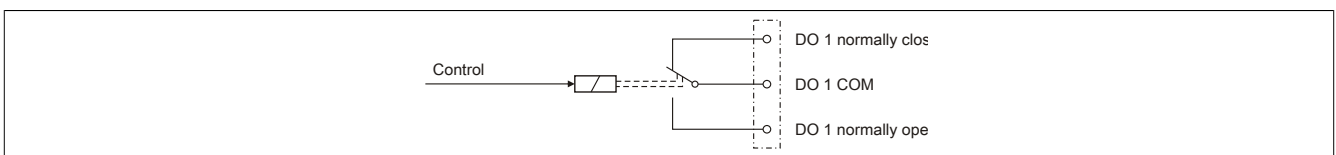
Terminals X1 and X2 can be keyed differently to prevent unintentional incorrect connection on the module.

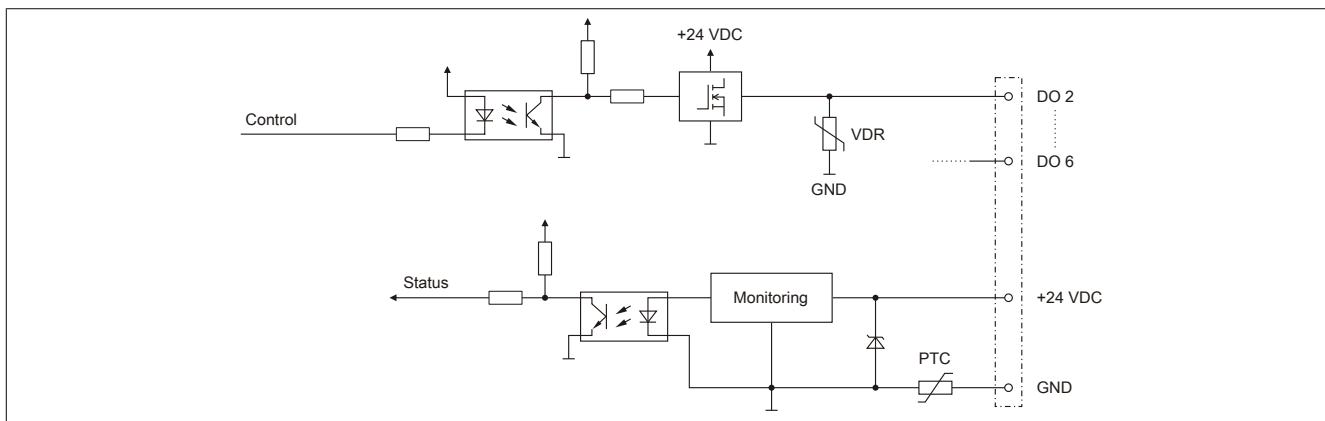


Function description of the digital outputs

| Digital output | Description |
|----------------|--|
| DO1 | <p>This output is designed as a changeover contact switch and serves either as a digital output or monitoring relay (see register "ConfigOutput24" on page 2876) for monitoring the following measured values of the generator mains:</p> <ul style="list-style-type: none"> • Overvoltage and undervoltage • Overfrequency and underfrequency • Voltage asymmetry • Current asymmetry • Calculated neutral conductor current (maximum) • Short circuit current • Rating-dependent overcurrent • Limit value of the capacitive reactive power (exciter failure) • Generator overload • Generator feedback • Inductive reactive power reference (Q-U protection) |
| DO2 | DO2 serves as a meter output. The generated pulses can be recorded by an external energy meter (kWh). |
| DO3 | This output is set when there is no voltage on the bus bar (below the lower limit of the defined parameter). 3-phase monitoring takes place for the bus bar voltage. |
| DO4 | DO4 serves as a synchronization pulse. The power switch is activated by setting this output. The output is deactivated after the configured time has elapsed (exception:Synchro check operating mode). |
| DO5 | <p>This output can be configured either as a digital output or monitoring output (see register "ConfigOutput24" on page 2876). The monitoring function is only available with the "3-phase mains" configuration. When configured as monitoring output, the user can choose between monitoring the following mains measurement values:</p> <ul style="list-style-type: none"> • Overvoltage and undervoltage • Overfrequency and underfrequency • Voltage asymmetry • Phase shift • Frequency change <p>The monitoring status can be output either normally or inverted. This can be defined using the "DigitalOutput" on page 2910 register. This setting is then disabled when shutting off, resetting, restarting, etc.</p> |
| DO6 | <p>Can be configured as a digital output or synchronization output (see register "ConfigOutput24" on page 2876).</p> <p>When configured as a synchronization output: DO6 serves as the synchronization pulse. The power switch is activated by setting this output. The output is deactivated after the configured time has elapsed (exception:Synchro check operating mode).</p> |

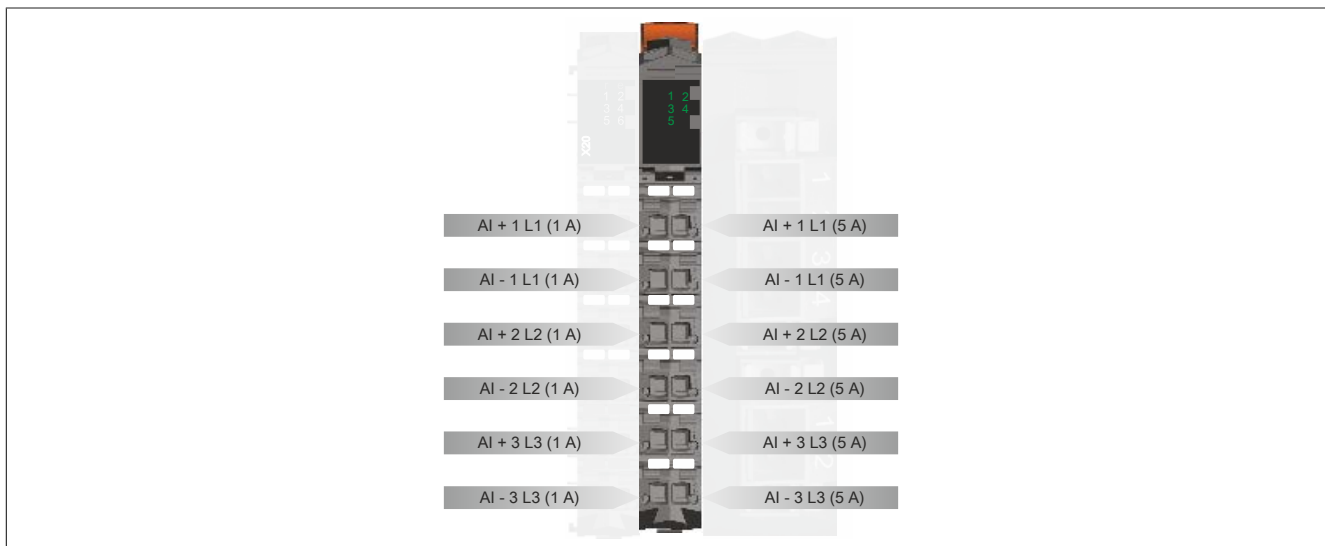
DO1 - Output circuit diagram



DO2 - DO 6 - Output circuit diagram**9.26.3.8 X2 analog current inputs**

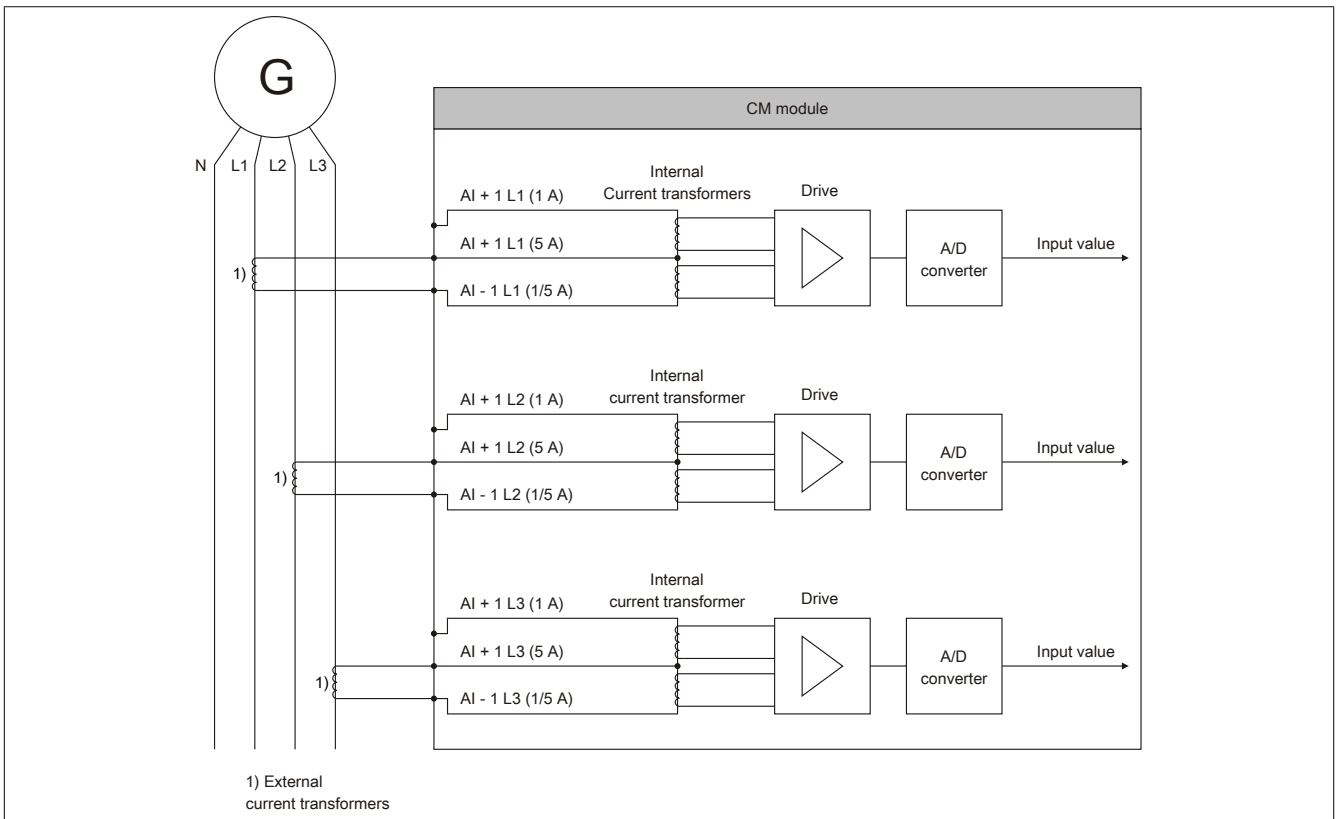
The X2 terminal measures the three phase currents of the generator mains using an externally connected current transformer. The measurement range of the current inputs can be configured as 1 A or 5 A.

Terminals X1 and X2 can be keyed differently to prevent unintentional incorrect connection on the module.

**Danger!****Risk of electric shock!**

The terminal block must only be allowed to conduct voltage when it is inserted. It must not under any circumstances be removed or inserted when voltage is applied or have voltage applied to it when it is removed.

Input circuit diagram - Analog current inputs

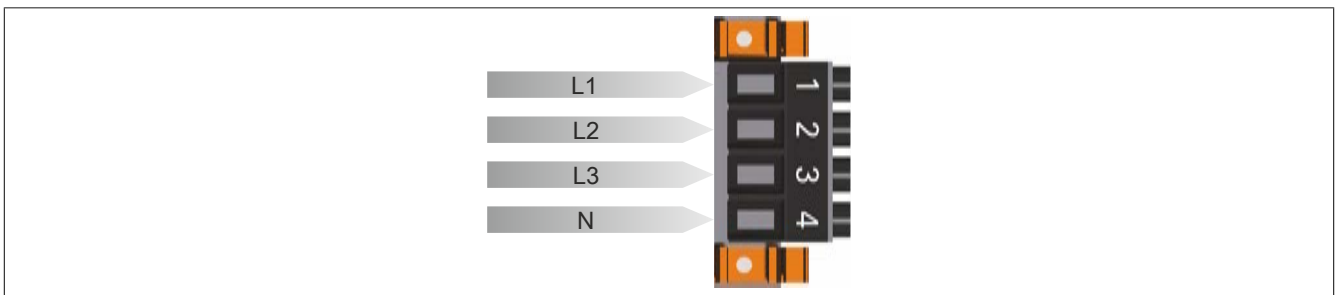


9.26.3.9 X3 and X5 analog voltage inputs

The X3 and X5 terminals are used to measure and monitor the line-to-line and phase voltages of the generator mains and bus bar.

- Terminal X3: Generator mains
- Terminal X5: Bus bar

Terminals X3 and X5 are keyed differently to prevent unintentional incorrect connection on the module. Section ["Releasing the locking clip for terminals X3 - X6" on page 2861](#) describes how to release the terminal locking clip.



9.26.3.10 X4 and X6 analog voltage inputs

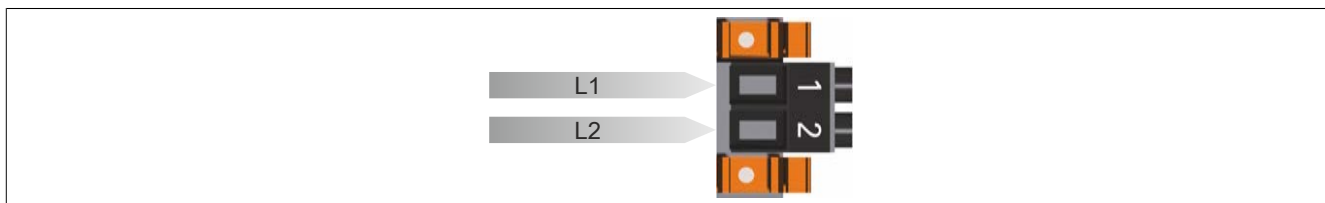
Terminals X4 and X6 are keyed differently to prevent unintentional incorrect connection on the module. Section "Releasing the locking clip for terminals X3 - X6" on page 2861 describes how to release the terminal locking clip.

The two terminals are connected differently depending on the selected configuration (see register "ConfigOutput68" on page 2875).

Configuration as Sync-mains 1 / Sync-mains 2

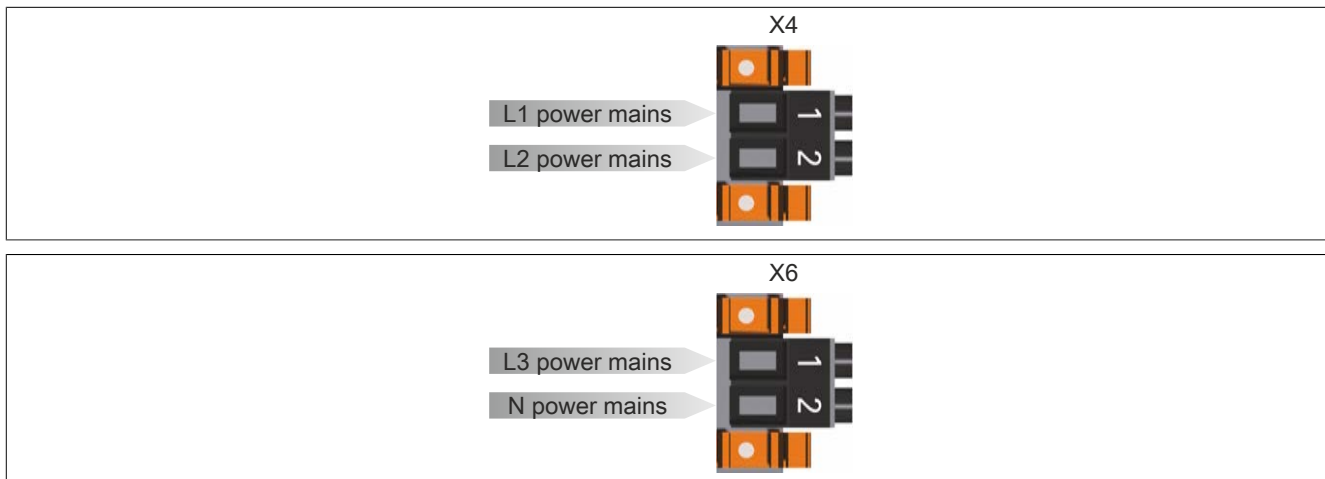
The voltage inputs on the X4 and X6 terminals are used to determine the line-to-line voltages for synchronization between two different mains networks.

- Terminal X4: Synchronization mains network 1
- Terminal X6: Synchronization mains network 2

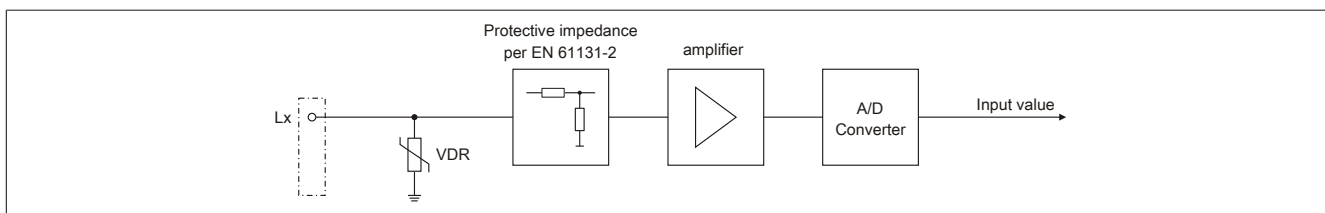


Configuration as 3-phase mains

The terminals X4 and X6 can be combined to form a 3-phase mains. The X4 and X6 terminals are used to measure and monitor the line-to-line voltages and phase voltages of the power mains.

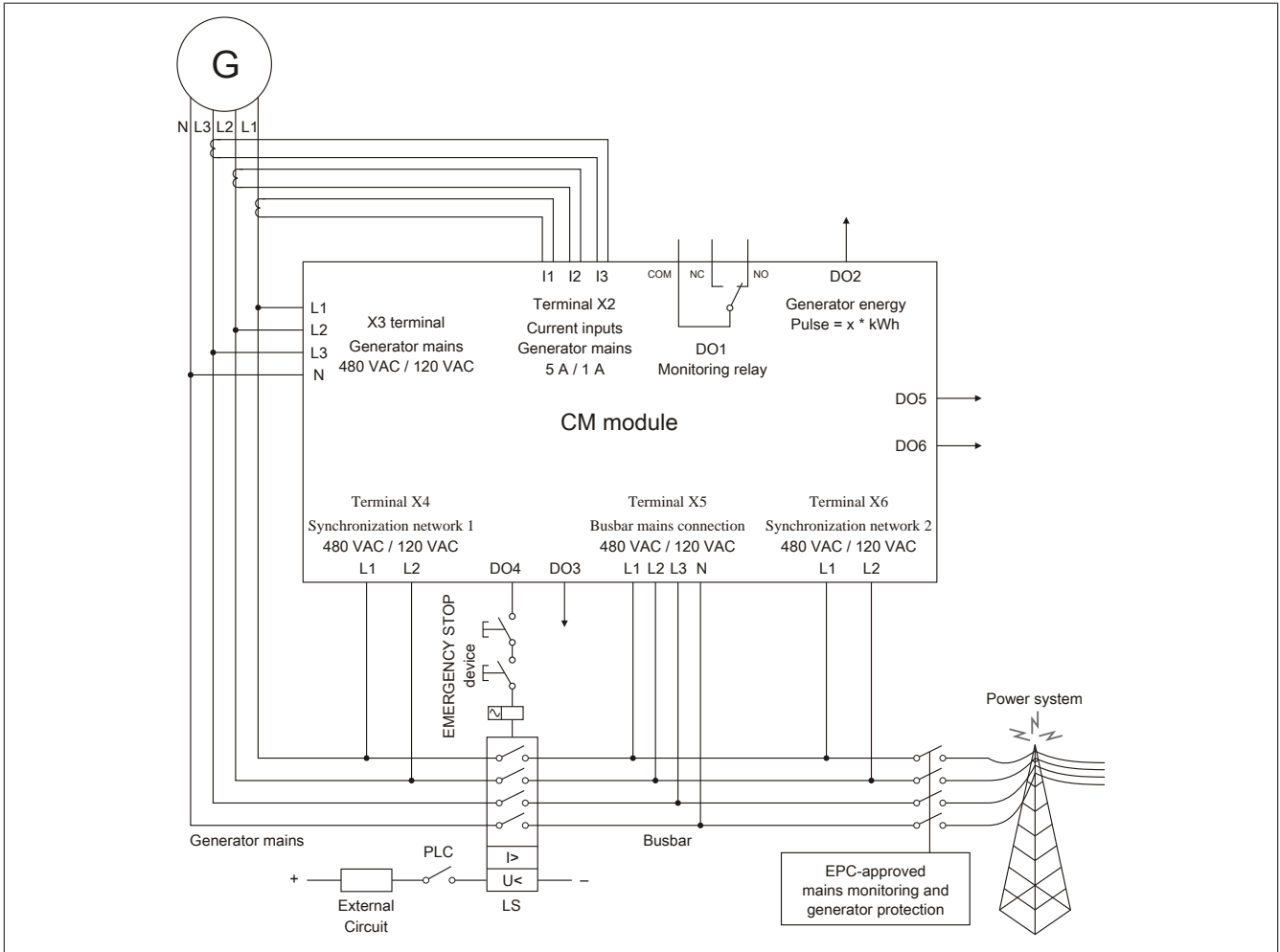


Input circuit diagram, analog voltage inputs

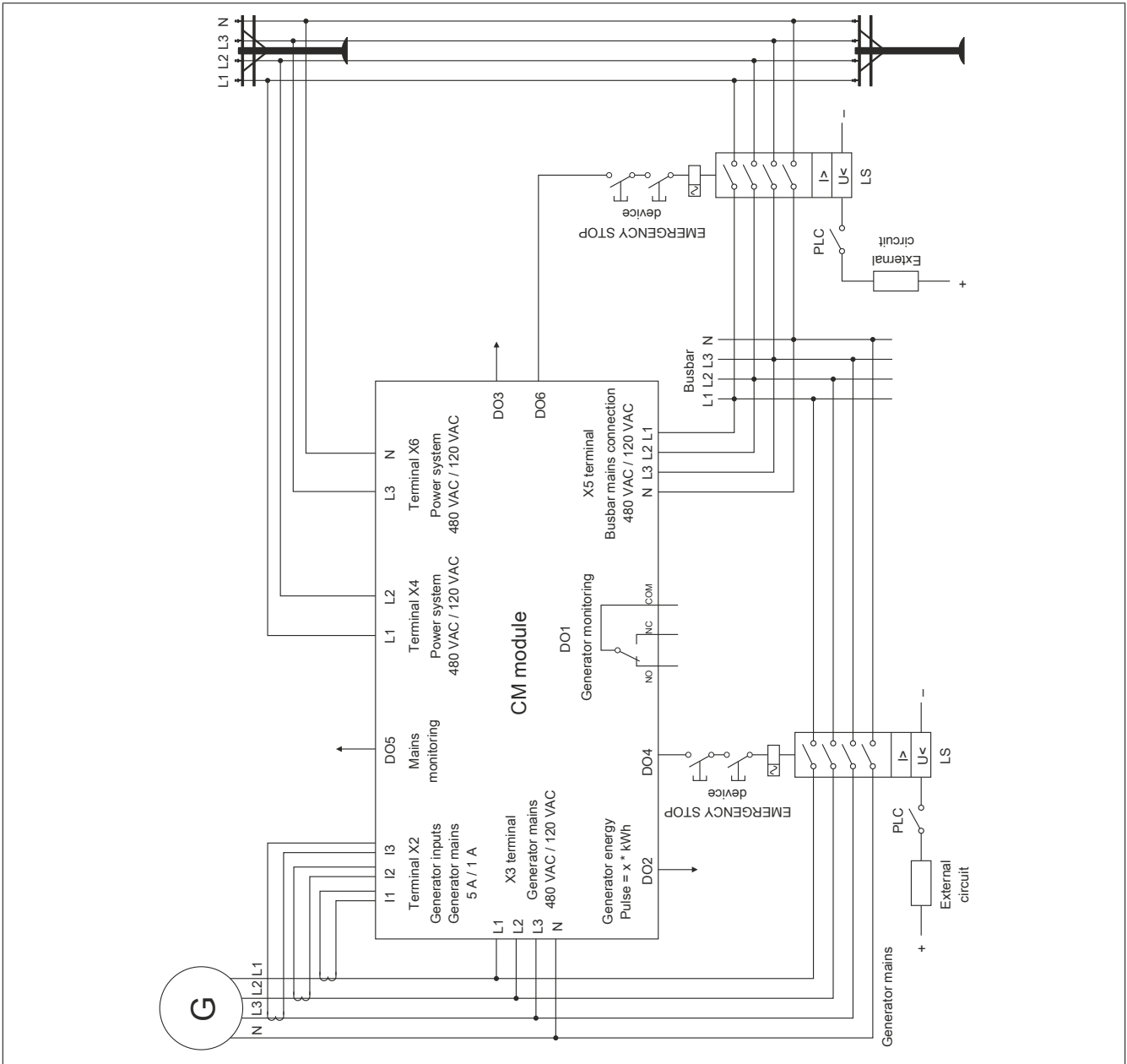


9.26.3.11 Circuit diagram

Example of mains configuration "Sync-mains 1 / Sync-mains 2"



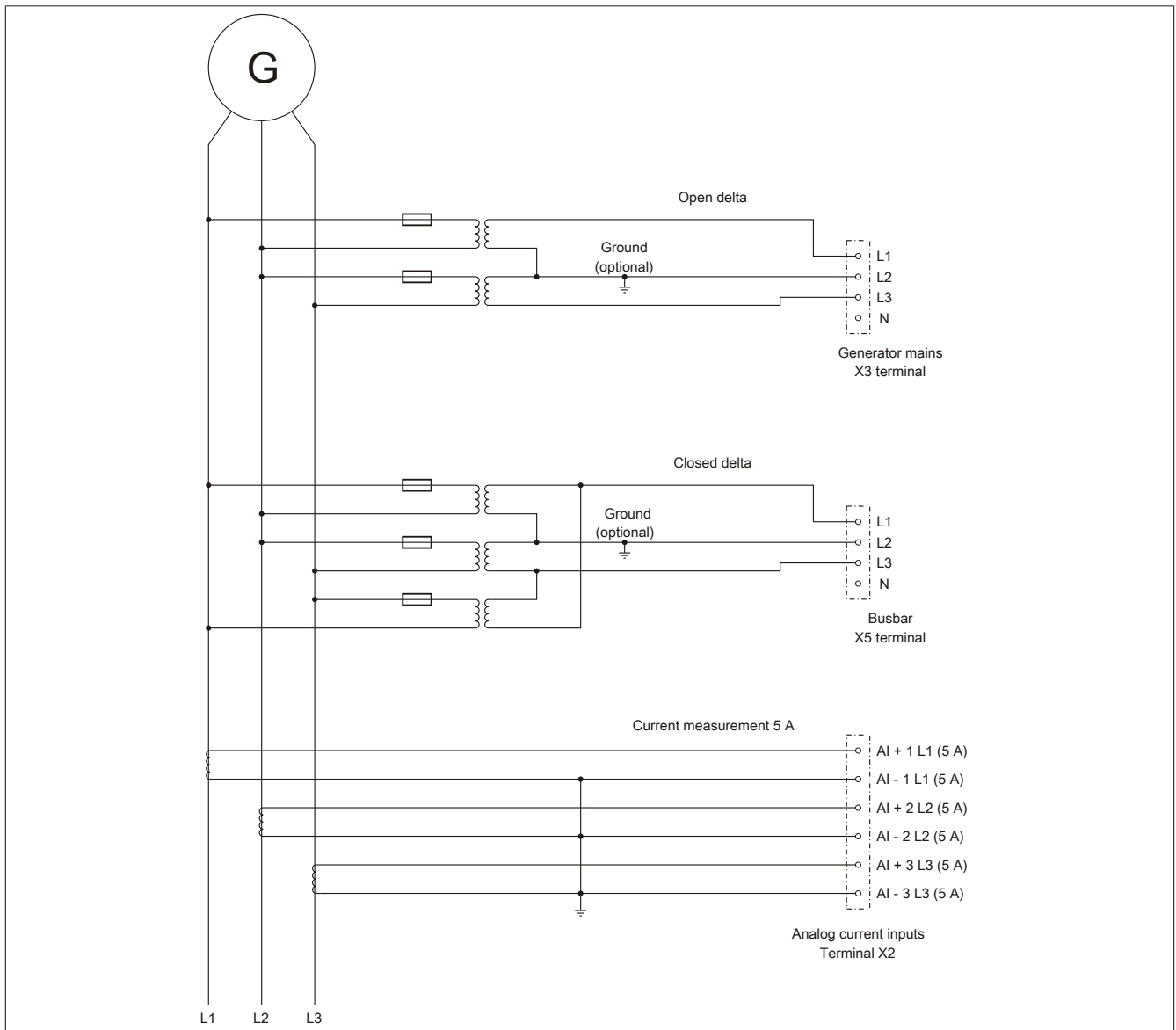
Example of mains configuration "3-phase mains"



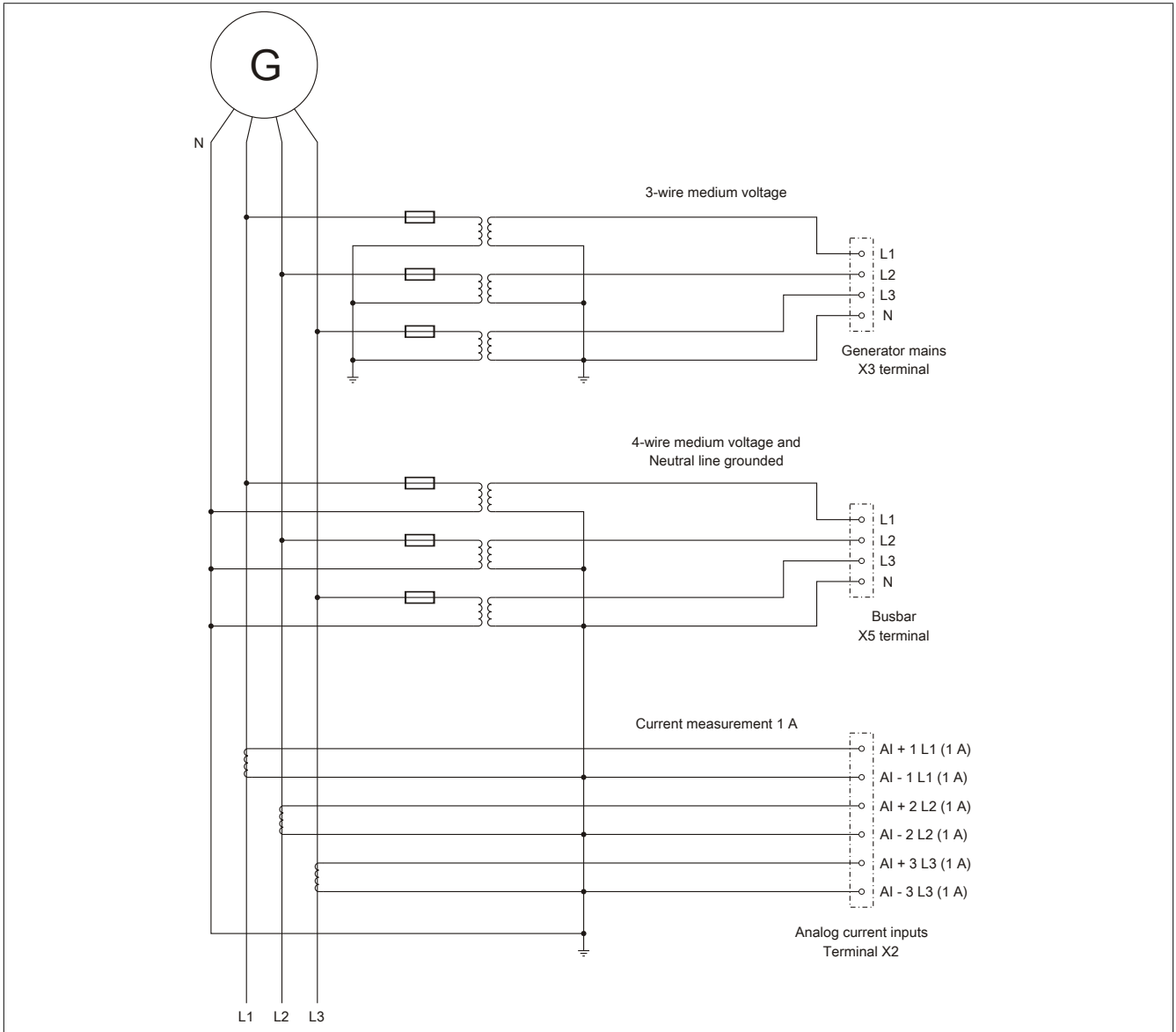
9.26.3.12 Typical connection examples for voltage/current measurement

For power measurement, the X3 terminal must always be used in connection with the X2 terminal! For single-phase measurement, always ensure that current input 1 is used for power measurement if voltage input 1 is being used. Otherwise, accurate power measurement is not possible for this phase!

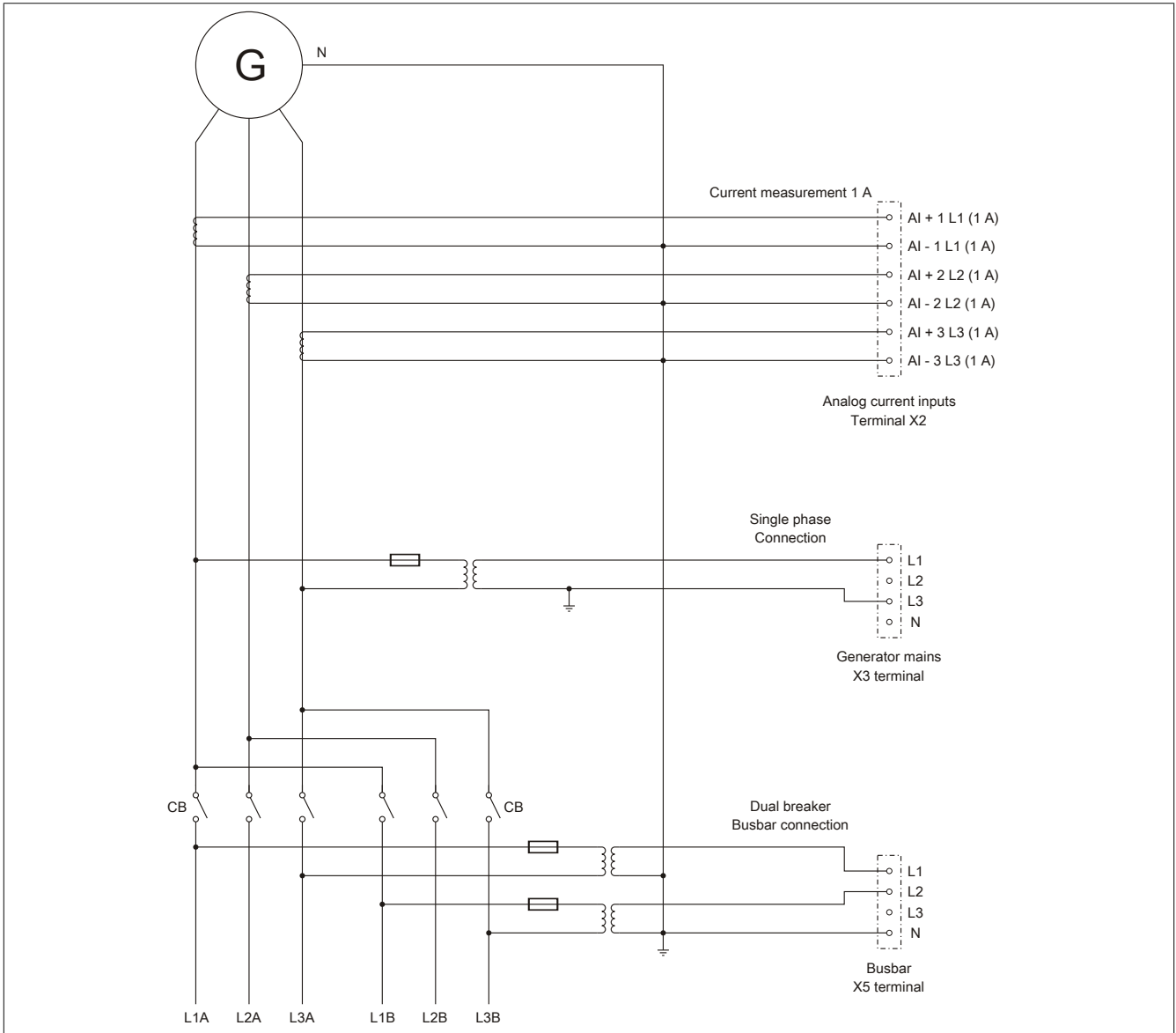
Connection example 1



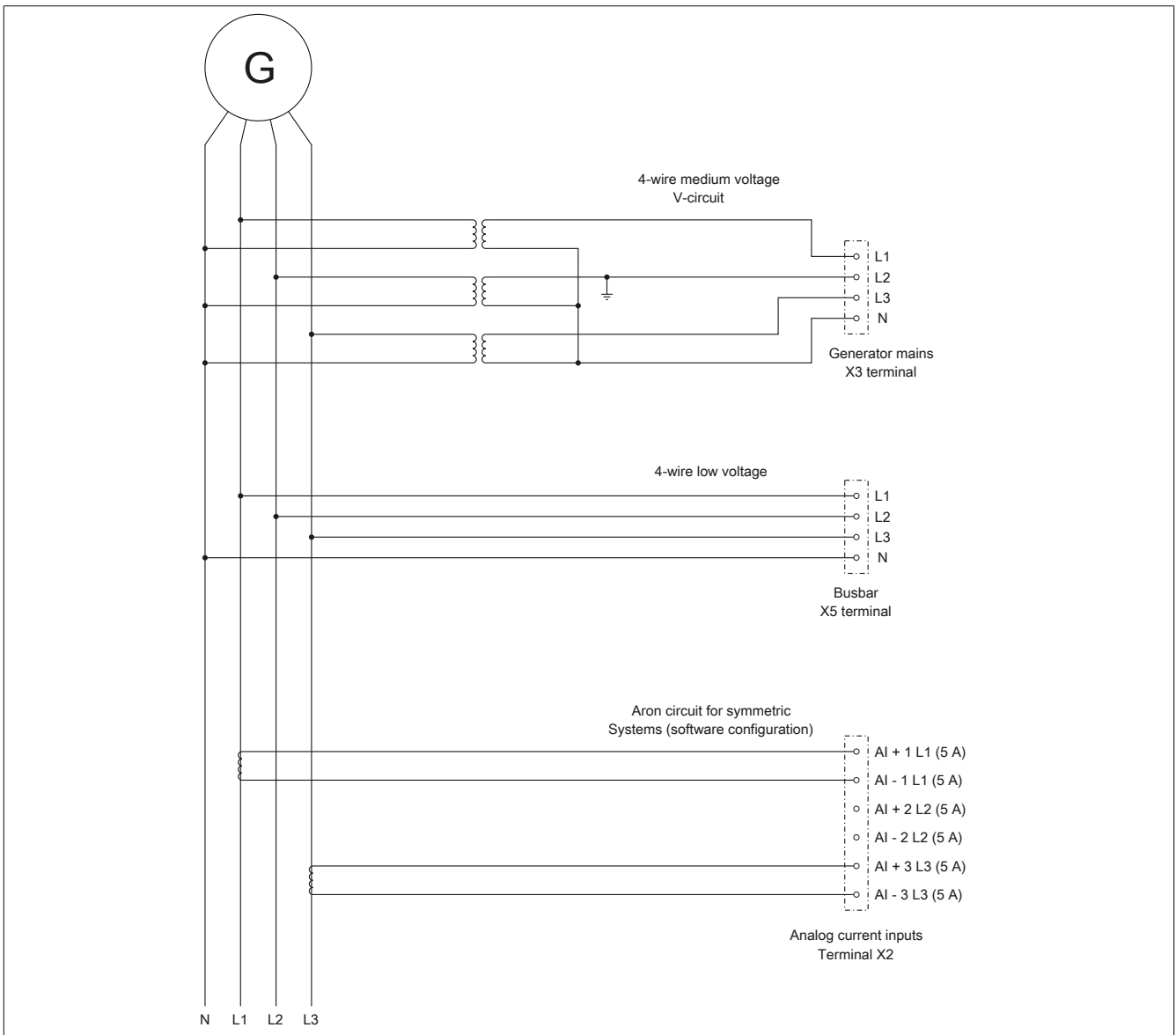
Connection example 2



Connection example 3

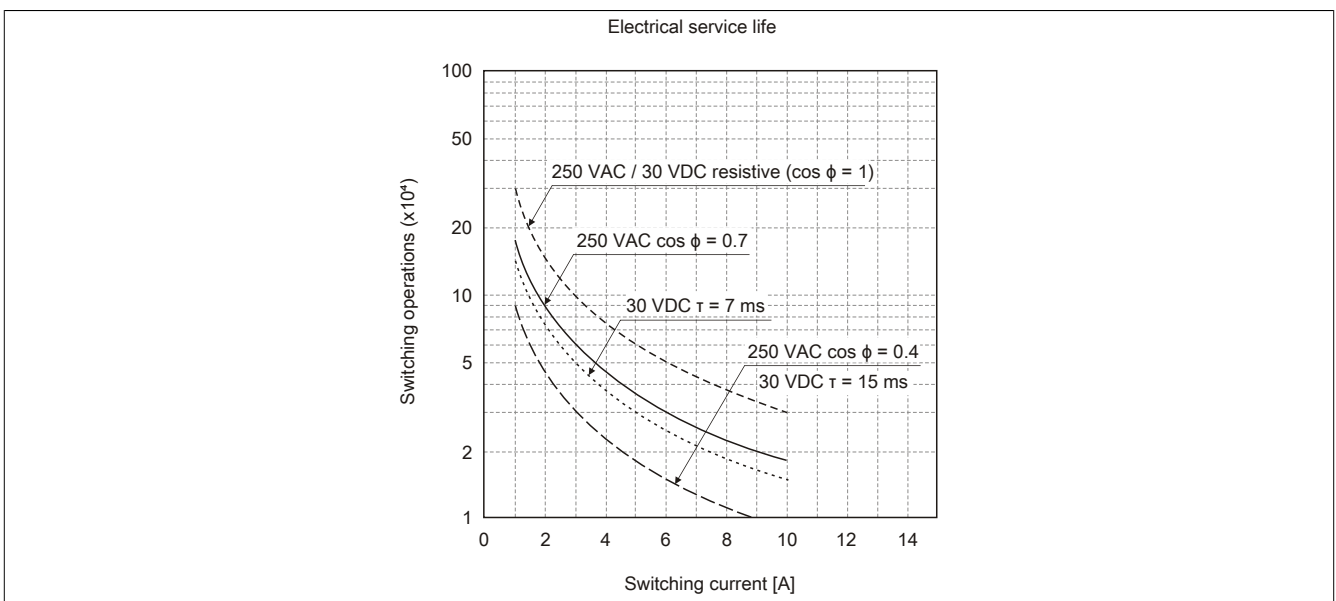


Connection example 4



9.26.3.13 Electrical service life

The electrical service life for the DO1 relay output can be seen in the following diagram.



9.26.3.14 Releasing the locking clip for terminals X3 - X6

Terminals X3 - X6 are equipped with a terminal locking clip. This clip attaches the terminal block securely to the electronic module. This prevents the terminal from accidentally being disconnected.

To release the locking clip, press inwards on the corrugated part of the lever with your fingertip (1) and then slide outwards (2). No additional tools are required for removing the terminal.

Terminals X5 and X6 must be removed first before terminals X3 and X4 can be removed.



9.26.3.15 Synchronization functions

The following three synchronization functions are available on the module:

- "Synchronization with slip" on page 2862
- "Synchro check" on page 2862
- "Switching to voltage-free "dead bus"" on page 2863

Synchronization with slip

The following is valid for synchronization mains 1 and synchronization mains 2:

- $50\% < U < 125\%$ of the nominal voltage U_N
- $80\% < f < 110\%$ of the nominal frequency f_N

The generator voltage is adjusted to the synchronization voltage with regard to amplitude and frequency. Taking into account the configured phase angle ($\Delta\alpha$), a defined transformer vector group and the switching response time, the switch-on command is calculated and transmitted in advance so that the main contacts of the power switch are closed at the point of synchronicity.

Synchronization occurs under the following conditions:

- Synchronization mode "Slip" is set using software.
- The device is ready.
- The phase sequences of the mains networks being synchronized are OK (phase sequence detection).
- The configured limit for voltage difference is not exceeded (ΔU_{\max}).
- The configured limits for frequency difference are not exceeded (Δf_{\max} and Δf_{\min}).
- The configured limit for the phase angle (including vector group transformer $\Delta\alpha$) is not exceeded (j_{\max}).

When the synchronization mode is set to "Slip", synchronization is not activated until the value of the differential angle between the two synchronized mains networks is $>5^\circ$ for at least 100 ms.

In other words, if the phase difference happens to be within $\pm 5^\circ$ at the time of the synchronization request, the synchronization won't be activated unless/until the phase difference is larger for 100 ms.

Resetting the mode "Synchronization with slip" cancels the synchronization.

In order to receive a synchronization pulse, the synchronization window must be entered from any phase direction after the synchronization command has been authorized and all of the synchronization conditions specified above are observed.

The switch is not engaged immediately after reaching the phase window. The switch is only engaged if synchronization is possible at the synchronization point while observing the switch lead time.

With very low frequency differences or equivalent frequencies and in adherence to the conditions described above, synchronization will also take place at a phase angle = 0° .

The synchronization output changes its state from Low to High when all conditions are met. It changes back from High to Low after the configured pulse duration has elapsed.

Synchro check

In this operating mode, the device can be used to check the synchronization. The DO4 output remains set as long as the following conditions are met:

- The "-Check" command is set using software.
- The device is ready.
- The phase sequences of the mains networks being synchronized are OK (phase sequence detection).
- The configured limit for voltage difference is not exceeded (ΔU_{\max}).
- The configured limits for frequency difference are not exceeded (Δf_{\max} and Δf_{\min}).
- The defined limit for the phase angle is not exceeded (ϕ_{\max}).

DO4 stays at High as long as all conditions are met.

Switching to voltage-free "dead bus"

The switch-on command for the power switch is output without synchronization if the following conditions have been met:

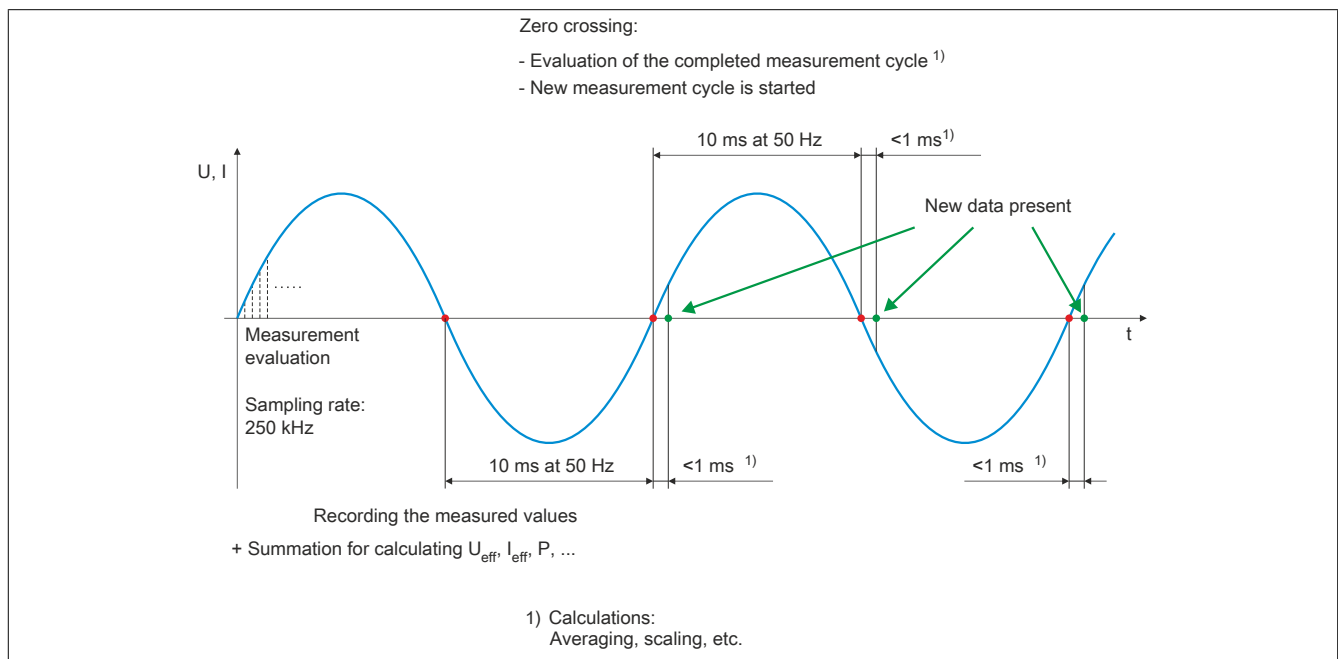
- The "Dead Bus" command is set using software.
- The device is ready.
- The bus bar does not have voltage applied: $U_B < U_{BminSync}$ as a percentage of U_{NomBus}

| | |
|--------------------|-------------------------|
| U_B ... | Bus bar phase voltage |
| $U_{BminSync}$... | Dead bus voltage |
| U_{NomBus} ... | Bus bar nominal voltage |

DO4 changes its state from Low to High when all conditions are met. It changes back from High to Low after the configured pulse duration has elapsed.

9.26.3.16 Measurement functions

Timing diagram



Measured parameters for generator mains (X3)

- Phase currents
- Current average
- Dynamic current average
- Neutral current
- Line-to-line voltages
- Phase voltages
- Voltage average
- Total apparent power
- Total reactive power
- Total active power
- Active power factor
- Frequency
- Instantaneous values of the phase voltages
- Instantaneous values of the phase currents

Measured parameters between synchronization mains networks

- Differential angle
- Differential voltage

Rating-dependent overcurrent

Rating-dependent overcurrent monitoring is in accordance with the specifications of IEC 255-8 "Electrical relay; Relay for protecting against thermal overload (overload relay)" and IEC 255-17 "Electrical relay; Relay for protecting against the thermal overload of motors (overload relay for motors).

Dependent delayed imbalanced load monitoring

Dependent delayed imbalanced load monitoring protects against imbalanced loads in three-phase generators and three-phase mains. Parameters can be changed to make it possible to match the trigger characteristics to different generator types while taking their special thermal time constants into consideration.

An imbalanced load can be caused by uneven current distribution in the mains due to imbalanced load, asymmetrical short circuits, line interruptions or switching operations. Imbalanced loads result in reverse system currents in the stator, which causes harmonics with an uneven ordinal number in the stator winding and harmonics with an even ordinal number in the rotor winding. The rotor is at particular risk here because the harmonic waves place an additional load on the rotor winding and induce eddy currents in the rotor's solid iron, which may melt the metal or destroy the metallic structure.

An imbalanced load can be permissible within certain limits, however, when accounting for the thermal load limit of the generator. To avoid premature failure of the generator when an imbalanced load occurs, the characteristics that trigger imbalanced load protection should be adapted to the thermal characteristics of the generator. Imbalanced load protection can also be triggered by external errors in the mains caused by asymmetric short circuits.

Short circuit current monitoring

If overcurrent or a short circuit occurs and the limit value is exceeded, the error message "Short circuit current" is signaled after the configured time delay has passed.

Voltage asymmetry monitoring

This trigger value, specified as a percentage, is based on the nominal voltage of the generator. If the difference between the three line-to-line voltages of the generator mains exceeds the set limit value, then the error message "Voltage asymmetry" is signaled after the response time has passed. For this to happen, only one of these voltages has to exceed the respective limit value (in either the positive or negative direction).

Bus bar voltage measurement and zero voltage monitoring

3-phase monitoring takes place for the bus bar voltage. The measured values are represented as phase-to-phase and phase-to-neutral values. The DO3 output is set when there is no voltage (below the lower limit of the defined limit bus bar voltage minimum U_{Bmin}) on the bus bar (X5 terminal).

This monitoring can be used to determine which synchronization function should be used.

| Synchronization function | Bus bar voltage measurement |
|---------------------------|---|
| Dead bus | No voltage is being supplied to the bus bar or the value is below the lower limit parameter. Output DO3 is set. |
| Synchronization with slip | The voltage measured on the bus bar is above the defined parameter value. Output DO3 is not set. |

Exciter failure

The reactive power monitoring can be used to protect a generator against operating in the impermissible range. The capacitive reactive power monitor offers protection against under-excitation (exciter failure). If the lower limit is exceeded (in the negative direction), the error message "Capacitive reactive power" is signaled after the configured time delay has passed.

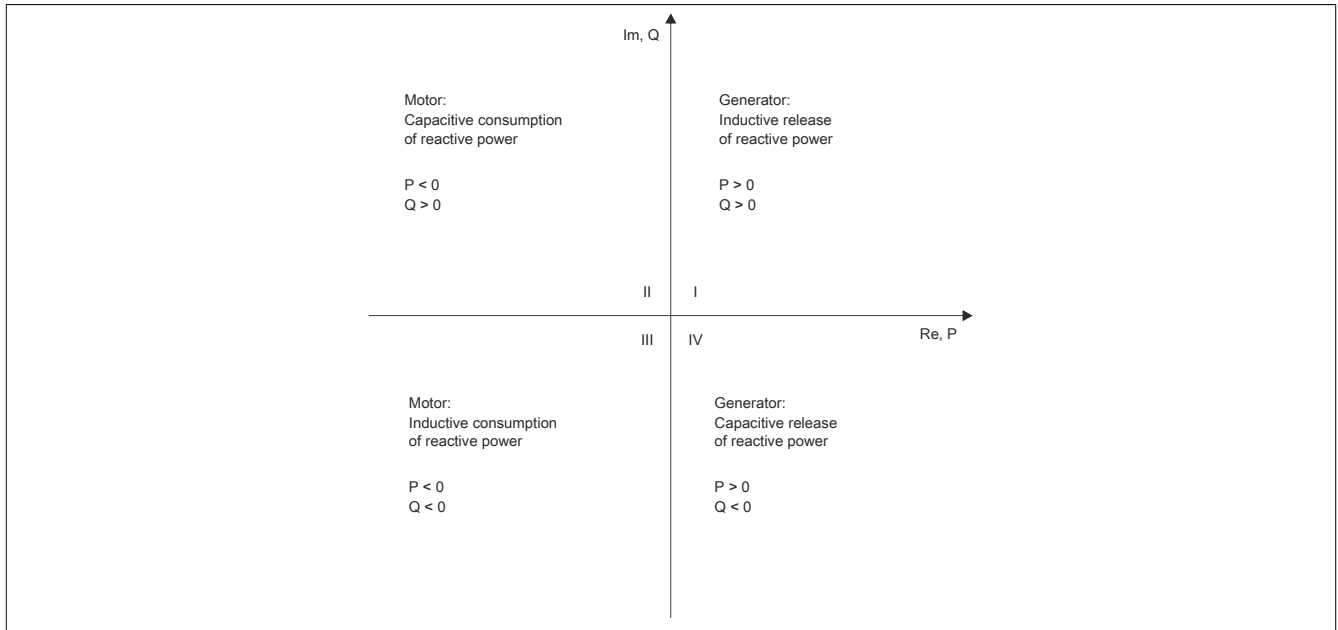
Phase sequence detection

Phase sequence detection is used to detect incorrectly wired voltage and current inputs or if the generator is rotating in the wrong direction (for information about configuration, see register "[ConfigOutput24](#)" on page 2876).

Phase sequence L1, L2 and L3 is monitored for this. If not correct, then an error message is output (see register "[StatusDigitalOutput](#)" on page 2910) and synchronization cannot take place.

9.26.3.17 Generator operating modes

The operating modes possible for the generator are illustrated in this 4 quadrant diagram.

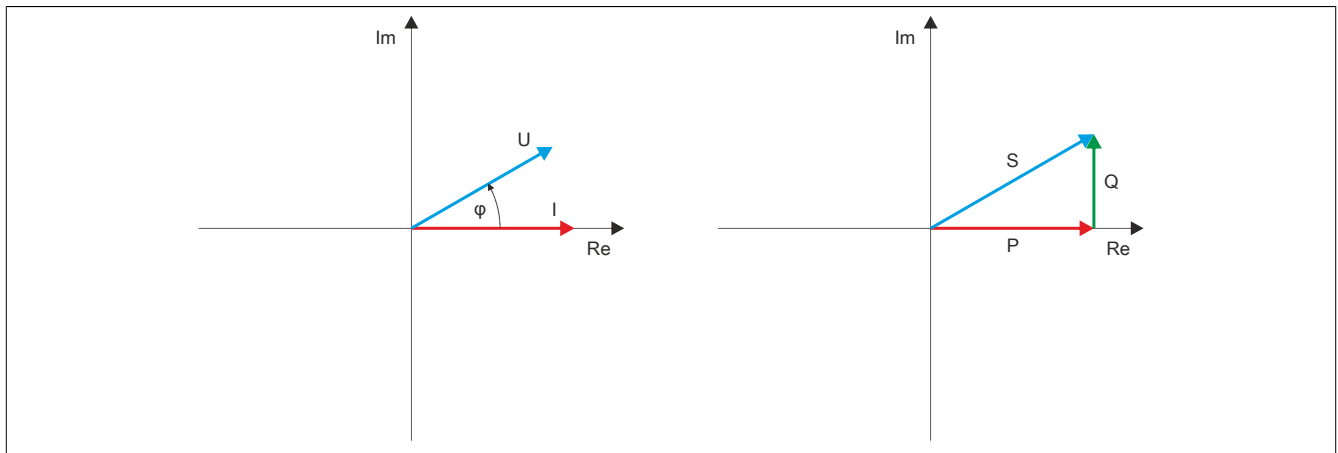


Quadrant I

Generator operation, inductive release of reactive power:

- The active power P and the reactive power Q are greater than 0.
- The phase angle ϕ is between 0 and 90° . This means that U keeps ahead of I .

Example: $\phi = 30^\circ$

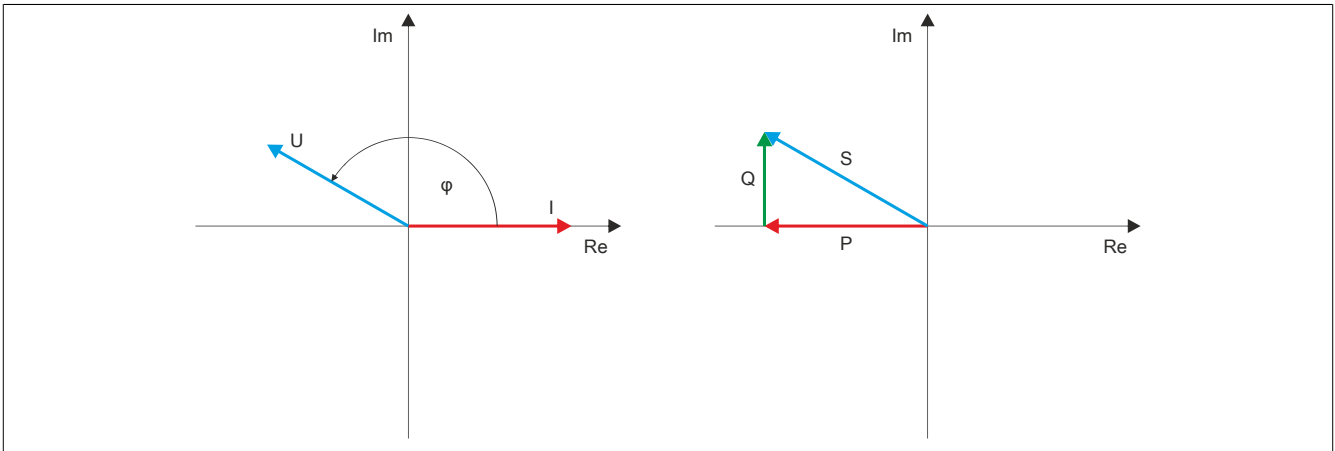


Quadrant II

Motor operation, capacitive reactive power consumption:

- The active power P is less than 0 while the reactive power Q is greater than 0.
- The phase angle ϕ is between 90 and 180° . This means that U keeps ahead of I .

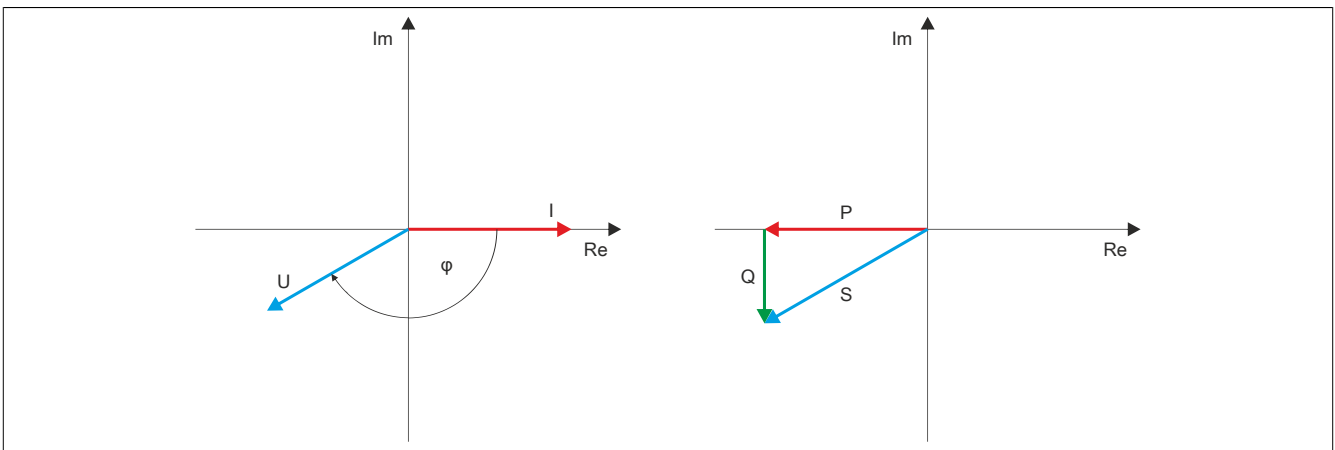
Example: $\phi = 150^\circ$

**Quadrant III**

Motor operation, inductive reactive power consumption:

- The active power P and the reactive power Q are less than 0.
- The phase angle ϕ is between -90 and -180° . This means that U lags behind I .

Example: $\phi = -150^\circ$

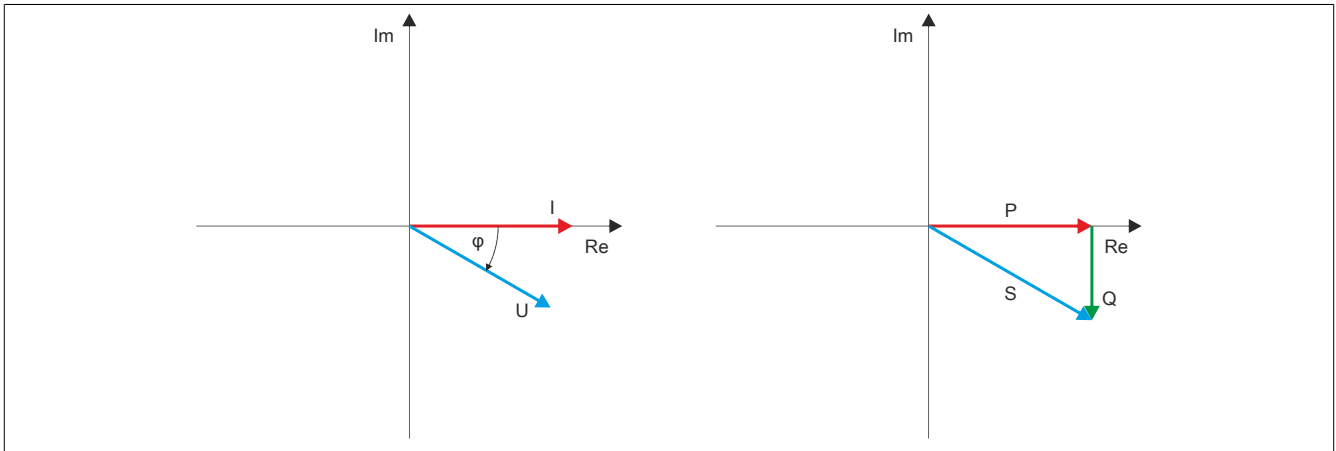


Quadrant IV

Generator operation, capacitive release of reactive power:

- The active power P is greater than 0 while the reactive power Q is less than 0.
- The phase angle ϕ is between 0 and -90° . This means that U lags behind I.

Example: $\phi = -30^\circ$



Power factor of the generator

The power factor is a product of the ratio between the active power P and apparent power S. With sinusoidal values, this corresponds to the cosine of the phase shift angle ϕ .

$$|\text{Power factor}| = \left| \frac{P}{S} \right|$$

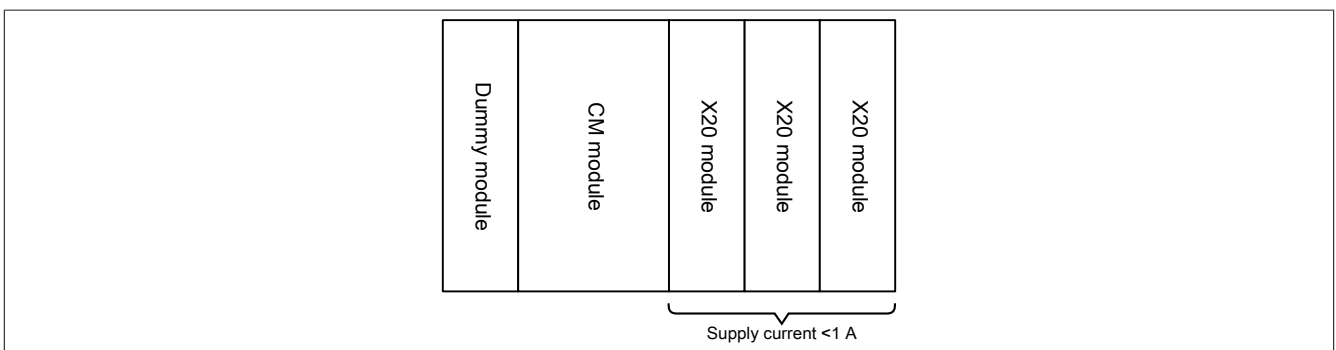
The module derives the sign used for the power factor from the signs used with the P and Q values. In this way, it depends on the generator's operating mode:

| Sign | Description |
|----------|--|
| Positive | <ul style="list-style-type: none"> • Quadrant I or III, P and Q positive or P and Q negative • Inductive release of reactive power or inductive reactive power consumption |
| Negative | <ul style="list-style-type: none"> • Quadrant II or IV, P negative and Q positive or P positive and Q negative • Capacitive release of reactive power or capacitive reactive power consumption |

9.26.3.18 Derating

Derating does not need to be taken into account for operation below 55°C .

For operation above 55°C , a dummy module must be connected to the left of the module. A maximum supply current of 1 A is permitted to pass through the module to the modules connected to the right.



9.26.3.19 Register description

9.26.3.19.1 System requirements

The following minimum versions are recommended to generally be able to use all functions:

- Automation Studio 4.2.5
- Automation Runtime G4.26

9.26.3.19.2 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.26.3.19.3 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|---|--|-----------|--------|-------------------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| General registers - Configuration | | | | | | |
| 2762 | ConfigOutput68 (Read) Mains settings | UINT | | (●) ¹⁾ | | • |
| 2561 | ConfigOutput20 (Read) Nominal voltage range, nominal current range and Aron circuit | USINT | | (●) ¹⁾ | | • |
| 2614 | ConfigOutput10 (Read) Nominal frequency (f_{Nom}) | UINT | | (●) ¹⁾ | | • |
| 2569 | ConfigOutput24 (Read) General configuration register | USINT | | (●) ¹⁾ | | • |
| 2567 | ConfigOutput23 (Read) Trigger bits | USINT | | (●) ¹⁾ | | • |
| Generator mains - Configuration | | | | | | |
| 2582 | ConfigOutput02 (Read) Nominal voltage of the generator mains (U_{NomGen}) | UINT | | (●) ¹⁾ | | • |
| 2598 | ConfigOutput06 (Read) Multiplier for generator mains | UINT | | (●) ¹⁾ | | • |
| 2590 | ConfigOutput04 (Read) Nominal current of generator mains (I_{Nom}) | UINT | | (●) ¹⁾ | | • |
| 2610 | ConfigOutput09 (Read) Multiplier for current transformer | UINT | | (●) ¹⁾ | | • |
| 2563 | ConfigOutput21 (Read) Turns generator mains functions on/off | UINT | | (●) ¹⁾ | | • |
| 2746 | ConfigOutput41 (Read) Low-pass filter for total power ratings | UINT | | (●) ¹⁾ | | • |
| 2966 | ConfigOutput125(Read) Filter cycles for real-time values | UINT | | (●) ¹⁾ | | • |
| Generator monitoring functions - Configuration | | | | | | |
| 2658 | ConfigOutput16 (Read) Overvoltage limit of the generator mains (U_{maxGen}) | UINT | | (●) ¹⁾ | | • |
| 2938 | ConfigOutput118 (Read) Overvoltage limit 2 of the generator mains (U_{maxGen}) | UINT | | (●) ¹⁾ | | • |
| 2706 | ConfigOutput26 (Read) Response time for generator overvoltage (U_{maxGen}) | UINT | | (●) ¹⁾ | | • |
| 2942 | ConfigOutput119(Read) Response time 2 for generator overvoltage (U_{maxGen}) | UINT | | (●) ¹⁾ | | • |
| 2662 | ConfigOutput27 (Read) Undervoltage limit of generator mains (U_{minGen}) | UINT | | (●) ¹⁾ | | • |
| 2702 | ConfigOutput59 (Read) Undervoltage limit of generator mains 2 ($U_{min2Gen}$) | UINT | | (●) ¹⁾ | | • |
| 2710 | ConfigOutput28 (Read) Response time for generator undervoltage (U_{minGen}) | UINT | | (●) ¹⁾ | | • |
| 2734 | ConfigOutput65 (Read) Response time for generator undervoltage 2 ($U_{min2Gen}$) | UINT | | (●) ¹⁾ | | • |
| 2666 | ConfigOutput29 (Read) Generator overfrequency (f_{maxGen}) | UINT | | (●) ¹⁾ | | • |
| 2954 | ConfigOutput122 (Read) Generator overfrequency 2 (f_{maxGen}) | UINT | | (●) ¹⁾ | | • |
| 2714 | ConfigOutput30 (Read) Response time for generator overfrequency (f_{maxGen}) | UINT | | (●) ¹⁾ | | • |
| 2958 | ConfigOutput123 (Read) Response time 2 for generator overfrequency (f_{maxGen}) | UINT | | (●) ¹⁾ | | • |
| 2670 | ConfigOutput31 (Read) Generator underfrequency (f_{minGen}) | UINT | | (●) ¹⁾ | | • |
| 2946 | ConfigOutput120 (Read) Generator underfrequency 2 (f_{minGen}) | UINT | | (●) ¹⁾ | | • |
| 2718 | ConfigOutput32 (Read) Response time for generator underfrequency (f_{minGen}) | UINT | | (●) ¹⁾ | | • |

| Register | Name | Data type | Read | | Write | |
|--|---|-----------|--------|-------------------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2950 | ConfigOutput121 (Read) Response time 2 for generator underfrequency ($f_{\min\text{Gen}}$) | UINT | | (●) ¹⁾ | | • |
| 2674 | ConfigOutput33 (Read) Generator voltage asymmetry (U_{asGen}) | UINT | | (●) ¹⁾ | | • |
| 2722 | ConfigOutput34 (Read) Response time for the generator voltage asymmetry (U_{asGen}) | UINT | | (●) ¹⁾ | | • |
| 2742 | ConfigOutput35 (Read) Load time constant for current asymmetry | UINT | | (●) ¹⁾ | | • |
| 2902 | ConfigOutput109 (Read) Unbalanced load constant | UINT | | (●) ¹⁾ | | • |
| 2962 | ConfigOutput124 (Read) Nominal current on generator mains for unbalanced load protection | UINT | | (●) ¹⁾ | | • |
| 2678 | ConfigOutput36 (Read) Maximum limit of neutral conductor current | UINT | | (●) ¹⁾ | | • |
| 2726 | ConfigOutput37 (Read) Response time for neutral conductor current monitoring | UINT | | (●) ¹⁾ | | • |
| 2682 | ConfigOutput38 (Read) Short circuit current | UINT | | (●) ¹⁾ | | • |
| 2730 | ConfigOutput39 (Read) Response time for short circuit current | UINT | | (●) ¹⁾ | | • |
| 2686 | ConfigOutput42 (Read) Rating-dependent overcurrent | UINT | | (●) ¹⁾ | | • |
| 2690 | ConfigOutput43 (Read) Integration coefficient for rating-dependent overcurrent (iths) | UINT | | (●) ¹⁾ | | • |
| 2694 | ConfigOutput44 (Read) Capacitive reactive power | UINT | | (●) ¹⁾ | | • |
| 2738 | ConfigOutput45 (Read) Response time for reactive power monitoring | UINT | | (●) ¹⁾ | | • |
| 2830 | ConfigOutput89 (Read) Generator overload | UINT | | (●) ¹⁾ | | • |
| 2834 | ConfigOutput90 (Read) Response time for generator overload | UINT | | (●) ¹⁾ | | • |
| 2838 | ConfigOutput91 (Read) Generator feedback | UINT | | (●) ¹⁾ | | • |
| 2842 | ConfigOutput92 (Read) Response time for generator feedback | UINT | | (●) ¹⁾ | | • |
| 2970 | ConfigOutput126(Read) Q-U protection | UINT | | (●) ¹⁾ | | • |
| 2974 | ConfigOutput127(Read) Response time for Q-U protection | UINT | | (●) ¹⁾ | | • |
| DO1 function | | | | | | |
| 2698 | ConfigOutput57 (Read) Monitoring functions - 1 | UINT | | (●) ¹⁾ | | • |
| 2854 | ConfigOutput97 (Read) Monitoring functions - 2 | UINT | | (●) ¹⁾ | | • |
| Synchronization mains (for mains configuration "Sync mains 1 / Sync mains 2") - Configuration | | | | | | |
| 2578 | ConfigOutput01 (Read) Nominal voltage of synchronization mains (U_{NomSyn}) | UINT | | (●) ¹⁾ | | • |
| 2602 | ConfigOutput07 (Read) Multiplier for synchronization mains 1 | UINT | | (●) ¹⁾ | | • |
| 2606 | ConfigOutput08 (Read) Multiplier for synchronization mains 2 | UINT | | (●) ¹⁾ | | • |
| Mains (for mains configuration "3-phase mains") - Configuration | | | | | | |
| 2578 | ConfigOutput01 (Read) Nominal voltage of mains (U_{NomMains}) | UINT | | (●) ¹⁾ | | • |
| 2602 | ConfigOutput07 (Read) Multiplier for mains | UINT | | (●) ¹⁾ | | • |
| 2565 | ConfigOutput22 (Read) Enable/disable mains functions | UINT | | (●) ¹⁾ | | • |
| Mains monitoring functions (for mains configuration "3-phase mains") - Configuration | | | | | | |
| Mains voltage monitoring | | | | | | |
| 2766 | ConfigOutput73 (Read) Overvoltage limit of the mains (U_{maxMains}) | UINT | | (●) ¹⁾ | | • |
| 2978 | ConfigOutput128(Read) Overvoltage limit value dropout threshold | UINT | | (●) ¹⁾ | | • |
| 2802 | ConfigOutput82 (Read) Response time for mains voltage (U_{MaxMains}) | UINT | | (●) ¹⁾ | | • |
| 2858 | ConfigOutput98 (Read) Overvoltage limit 2 of the mains (U_{maxMains}) | UINT | | (●) ¹⁾ | | • |
| 2986 | ConfigOutput130(Read) Overvoltage limit value 2 dropout threshold | UINT | | (●) ¹⁾ | | • |
| 2862 | ConfigOutput99 (Read) Response time 2 for mains overvoltage (U_{maxMains}) | UINT | | (●) ¹⁾ | | • |
| 2774 | ConfigOutput75 (Read) Mains overfrequency (f_{maxMains}) | UINT | | (●) ¹⁾ | | • |
| 2994 | ConfigOutput132(Read) Overfrequency limit value dropout threshold | UINT | | (●) ¹⁾ | | • |

| Register | Name | Data type | Read | | Write | |
|--|---|-----------|--------|-------------------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2810 | ConfigOutput84 (Read) Response time for mains overfrequency ($f_{\max\text{Mains}}$) | UINT | | (●) ¹⁾ | | • |
| 2874 | ConfigOutput102 (Read) Mains overfrequency 2 ($f_{\max\text{Mains}}$) | UINT | | (●) ¹⁾ | | • |
| 3002 | ConfigOutput134Read Overfrequency limit value 2 dropout threshold | UINT | | (●) ¹⁾ | | • |
| 2878 | ConfigOutput103 (Read) Response time 2 for mains overfrequency ($f_{\max\text{Mains}}$) | UINT | | (●) ¹⁾ | | • |
| 2778 | ConfigOutput76 (Read) Mains underfrequency ($f_{\min\text{Mains}}$) | UINT | | (●) ¹⁾ | | • |
| 2998 | ConfigOutput133Read Underfrequency limit value dropout threshold | UINT | | (●) ¹⁾ | | • |
| 2814 | ConfigOutput85 (Read) Response time for mains underfrequency ($f_{\min\text{Mains}}$) | UINT | | (●) ¹⁾ | | • |
| 2882 | ConfigOutput104 (Read) Mains underfrequency 2 ($f_{\min\text{Mains}}$) | UINT | | (●) ¹⁾ | | • |
| 3006 | ConfigOutput135Read Underfrequency limit value 2 dropout threshold | UINT | | (●) ¹⁾ | | • |
| 2886 | ConfigOutput105 (Read) Response time 2 for mains underfrequency ($f_{\min\text{Mains}}$) | UINT | | (●) ¹⁾ | | • |
| 2782 | ConfigOutput77 (Read) Mains voltage asymmetry (U_{asMains}) | UINT | | (●) ¹⁾ | | • |
| 2818 | ConfigOutput86 (Read) Response time for the mains voltage asymmetry (U_{asMains}) | UINT | | (●) ¹⁾ | | • |
| Undervoltage monitoring in 2-point mode | | | | | | |
| 2770 | ConfigOutput74 (Read) Undervoltage limit of the mains ($U_{\min\text{Mains}}$) | UINT | | (●) ¹⁾ | | • |
| 2982 | ConfigOutput129(Read) Undervoltage limit value dropout threshold | UINT | | (●) ¹⁾ | | • |
| 2806 | ConfigOutput83 (Read) Response time for mains undervoltage ($U_{\min\text{Mains}}$) | UINT | | (●) ¹⁾ | | • |
| 2866 | ConfigOutput100 (Read) Undervoltage limit 2 of the mains ($U_{\min\text{Mains}}$) | UINT | | (●) ¹⁾ | | • |
| 2990 | ConfigOutput131(Read) Undervoltage limit value 2 dropout threshold | UINT | | (●) ¹⁾ | | • |
| 2870 | ConfigOutput101 (Read) Response time 2 for mains undervoltage ($U_{\min\text{Mains}}$) | UINT | | (●) ¹⁾ | | • |
| Undervoltage monitoring in 6-point mode | | | | | | |
| 2770 | ConfigOutput74 (Read) Undervoltage limit ($U_{\min\text{Mains}}$) (1st mains) | UINT | | (●) ¹⁾ | | • |
| 2866 | ConfigOutput100 (Read) Undervoltage limit ($U_{\min\text{Mains}}$) (2nd mains) | UINT | | (●) ¹⁾ | | • |
| 2906 | ConfigOutput110 (Read) Undervoltage limit ($U_{\min\text{Mains}}$) (3rd mains) | UINT | | (●) ¹⁾ | | • |
| 2914 | ConfigOutput112 (Read) Undervoltage limit ($U_{\min\text{Mains}}$) (4th mains) | UINT | | (●) ¹⁾ | | • |
| 2922 | ConfigOutput114 (Read) Undervoltage limit ($U_{\min\text{Mains}}$) (5th mains) | UINT | | (●) ¹⁾ | | • |
| 2930 | ConfigOutput116 (Read) Undervoltage limit ($U_{\min\text{Mains}}$) (6th mains) | UINT | | (●) ¹⁾ | | • |
| 2806 | ConfigOutput83 (Read) Response time for mains undervoltage ($U_{\min\text{Mains}}$) (1st mains) | UINT | | (●) ¹⁾ | | • |
| 2870 | ConfigOutput101 (Read) Response time for mains undervoltage ($U_{\min\text{Mains}}$) (2nd mains) | UINT | | (●) ¹⁾ | | • |
| 2910 | ConfigOutput111 (Read) Response time for mains undervoltage ($U_{\min\text{Mains}}$) (3rd mains) | UINT | | (●) ¹⁾ | | • |
| 2918 | ConfigOutput113 (Read) Response time for mains undervoltage ($U_{\min\text{Mains}}$) (4th mains) | UINT | | (●) ¹⁾ | | • |
| 2926 | ConfigOutput115 (Read) Response time for mains undervoltage ($U_{\min\text{Mains}}$) (5th mains) | UINT | | (●) ¹⁾ | | • |
| 2934 | ConfigOutput117 (Read) Response time for mains undervoltage ($U_{\min\text{Mains}}$) (6th mains) | UINT | | (●) ¹⁾ | | • |
| Microgrid monitoring | | | | | | |
| 2890 | ConfigOutput106 (Read) Overvoltage limit of the microgrid ($U_{\max\text{Mains}}$) | UINT | | (●) ¹⁾ | | • |
| 2894 | ConfigOutput107 (Read) Undervoltage limit of the microgrid ($U_{\min\text{Mains}}$) | UINT | | (●) ¹⁾ | | • |
| 2898 | ConfigOutput108 (Read) Response time for microgrid limit | UINT | | (●) ¹⁾ | | • |
| Phase shift monitoring | | | | | | |
| 2786 | ConfigOutput78 (Read) Maximum phase difference for a single phase | UINT | | (●) ¹⁾ | | • |
| 2790 | ConfigOutput79 (Read) Maximum phase difference for three phases | UINT | | (●) ¹⁾ | | • |
| 2826 | ConfigOutput88 (Read) Minimum voltage for phase shift monitoring | UINT | | (●) ¹⁾ | | • |
| Mains frequency chance | | | | | | |

| Register | Name | Data type | Read | | Write | |
|---|--|-----------|--------|-------------------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2794 | ConfigOutput80 (Read) Response value for mains frequency change (df/dt) | UINT | | (●) ¹⁾ | | ● |
| 2822 | ConfigOutput87 (Read) Number of periods for mains frequency change (df/dt) | UINT | | (●) ¹⁾ | | ● |
| DO5 function | | | | | | |
| 2798 | ConfigOutput81 (Read) DO5 function | UINT | | (●) ¹⁾ | | ● |
| Busbar - Configuration | | | | | | |
| 2586 | ConfigOutput03 (Read) Busbar nominal voltage (U_{NomBus}) | UINT | | (●) ¹⁾ | | ● |
| 2594 | ConfigOutput05 (Read) Multiplier for busbar | UINT | | (●) ¹⁾ | | ● |
| 2650 | ConfigOutput40 (Read) Minimum busbar voltage (U_{Bmin}) | UINT | | (●) ¹⁾ | | ● |
| Synchronization - Configuration | | | | | | |
| 3 | ConfigOutputPacked01 Synchronization mode | USINT | | | ● | |
| 2654 | ConfigOutput56 (Read) Synchronization configuration | UINT | | (●) ¹⁾ | | ● |
| 2654 | ConfigOutput11 (Read) Max. permissible difference frequency (df_{max}) | UINT | | (●) ¹⁾ | | ● |
| 2630 | ConfigOutput12 (Read) Min. permissible difference frequency (df_{min}) | UINT | | (●) ¹⁾ | | ● |
| 2634 | ConfigOutput13 (Read) Max. permissible differential voltage (dU_{max}) | UINT | | (●) ¹⁾ | | ● |
| 2638 | ConfigOutput14 (Read) Max. permissible differential angle (ϕ_{max}) | UINT | | (●) ¹⁾ | | ● |
| 2618 | ConfigOutput15 (Read) Phase shift of sync mains 1 ($d\alpha$) | UINT | | (●) ¹⁾ | | ● |
| 2754 | ConfigOutput47 (Read) Pulse duration of switch-on relay on DO4 | UINT | | (●) ¹⁾ | | ● |
| 2758 | ConfigOutput48 (Read) Switching response time of power switch on DO4 | UINT | | (●) ¹⁾ | | ● |
| 2642 | ConfigOutput95 (Read) Pulse duration of switch-on relay on DO6 | UINT | | (●) ¹⁾ | | ● |
| 2646 | ConfigOutput96 (Read) Switching response time of power switch on DO6 | UINT | | (●) ¹⁾ | | ● |
| 2622 | ConfigOutput58 (Read) Dead bus voltage ($U_{BminSync}$) | UINT | | (●) ¹⁾ | | ● |
| 2846 | ConfigOutput93 (Read) 2-phase synchronization for commissioning tests | UINT | | (●) ¹⁾ | | ● |
| Maximum value buffer and power meter - Configuration | | | | | | |
| 2750 | ConfigOutput46 (Read) Pulse value of energy meter output | UINT | | (●) ¹⁾ | | ● |
| 2850 | ConfigOutput94 (Read) Count value for active energy meter and reactive energy meter | UINT | | (●) ¹⁾ | | ● |
| 3074 | ConfigOutput49 Maximum phase current of generator I1 | INT | | ● | | |
| | ConfigOutput60 Reset maximum phase current I1 | INT | | | | ● |
| 3078 | ConfigOutput50 Maximum phase current I2 | INT | | ● | | |
| | ConfigOutput61 Reset maximum phase current I2 | INT | | | | ● |
| 3082 | ConfigOutput51 Maximum phase current I3 | INT | | ● | | |
| | ConfigOutput62 Reset maximum phase current I3 | INT | | | | ● |
| 3086 | ConfigOutput52 Maximum total active power | INT | | ● | | |
| | ConfigOutput63 Resets maximum total active power | INT | | | | ● |
| 3090 | ConfigOutput53 Maximum neutral conductor current | INT | | ● | | |
| | ConfigOutput64 Resets maximum neutral conductor current | INT | | | | ● |
| 3108 | ConfigOutput54 Active energy meter for supply | DINT | | ● | | |
| | ConfigOutput66 Write to active energy meter for supply | DINT | | | | ● |
| 3124 | ConfigOutput55 Reactive energy meter for supply | DINT | | ● | | |
| | ConfigOutput67 Write to reactive energy meter for supply | DINT | | | | ● |
| 3116 | ConfigOutput71 Active energy meter for reference | DINT | | ● | | |
| | ConfigOutput69 Write to active energy meter for reference | DINT | | | | ● |

| Register | Name | Data type | Read | | Write | |
|--|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 3132 | ConfigOutput72 Reactive energy meter for reference | DINT | | • | | |
| | ConfigOutput70 Write to reactive energy meter for reference | DINT | | | | • |
| General registers - Communication | | | | | | |
| 1 | DigitalOutputPacked01 Digital outputs 01, 05 - 06 and various control bits | USINT | | | • | |
| | DigitalOutput05 | Bit 0 | | | | |
| | DigitalOutput06 | Bit 1 | | | | |
| | ResetGeneratorErrors | Bit 2 | | | | |
| | ResetMainsErrors | Bit 3 | | | | |
| | InvertDO5 | Bit 4 | | | | |
| | DigitalOutput01 | Bit 5 | | | | |
| 165 | StatusDigitalOutputPacked01 Status of digital outputs | USINT | • | | | |
| | StatusDigitalOutput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | StatusDigitalOutput06 | Bit 5 | | | | |
| | StatusInput17 | Bit 6 | | | | |
| 162 | StatusInputPacked01 Generator mains error registers | UINT | • | | | |
| | StatusInput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | StatusInput11 | Bit 10 | | | | |
| | StatusInput31 | Bit 11 | | | | |
| | StatusInput32 | Bit 12 | | | | |
| 167 | StatusInputPacked02 Power mains error registers | USINT | • | | | |
| | StatusInput24 | Bit 0 | | | | |
| | ... | ... | | | | |
| | StatusInput30 | Bit 6 | | | | |
| 186 | StatusInputPacked03 General error registers | UINT | • | | | |
| | StatusInput12 | Bit 0 | | | | |
| | ... | ... | | | | |
| | StatusInput15 | Bit 3 | | | | |
| | StatusInput19 | Bit 4 | | | | |
| 190 | StatusInputPacked04 Power mains error registers (continued) | UINT | • | | | |
| | StatusInput34 | Bit 0 | | | | |
| | ... | ... | | | | |
| 194 | StatusInputPacked05 Generator mains error registers (continued) | UINT | • | | | |
| | StatusInput38 | Bit 0 | | | | |
| ... | ... | | | | | |
| | StatusInput41 | Bit 3 | | | | |
| Generator mains measured values - Communication | | | | | | |
| 30 | AnalogInput01 Phase current I1 | INT | • | | | |
| 34 | AnalogInput02 Phase current I2 | INT | • | | | |
| 38 | AnalogInput03 Phase current I3 | INT | • | | | |
| 42 | AnalogInput04 Current average I1, I2, I3 | INT | • | | | |
| 46 | AnalogInput05 Neutral conductor current In | INT | • | | | |
| 170 | AnalogInput06 Current average, dynamic (Im_dyn) | UINT | • | | | |
| 2 | AnalogInput07 Line-to-line voltage UG12 | INT | • | | | |
| 6 | AnalogInput08 Line-to-line voltage UG23 | INT | • | | | |
| 10 | AnalogInput09 Line-to-line voltage UG31 | INT | • | | | |
| 18 | AnalogInput10 Phase voltage UG1 | INT | • | | | |
| 22 | AnalogInput11 Phase voltage UG2 | INT | • | | | |
| 26 | AnalogInput12 Phase voltage UG3 | INT | • | | | |

| Register | Name | Data type | Read | | Write | |
|--|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 14 | AnalogInput22 Voltage average UG12, UG23, UG31 | INT | • | | | |
| 174 | AnalogInput19 Total active power filtered P/P_H1 | INT | • | | | |
| 178 | AnalogInput20 Total reactive power filtered Q/Q_H1 | INT | • | | | |
| 182 | AnalogInput21 Total apparent power filtered Q/S_H1 | INT | • | | | |
| 54 | AnalogInput23 Power factor of generator/cos ϕ | INT | • | | | |
| 50 | AnalogInput24 Frequency of the generator mains | UINT | • | | | |
| 202 | AnalogInput45 Instantaneous value of phase voltage UG1 | UINT | • | | | |
| 206 | AnalogInput46 Instantaneous value of phase voltage UG2 | UINT | • | | | |
| 210 | AnalogInput47 Instantaneous value of phase voltage UG3 | UINT | • | | | |
| 214 | AnalogInput48 Instantaneous value of phase current I1 | UINT | • | | | |
| 218 | AnalogInput49 Instantaneous value of phase current I2 | UINT | • | | | |
| 222 | AnalogInput50 Instantaneous value of phase current I3 | UINT | • | | | |
| 197 | LifeCnt Counter for real-time values | SINT | • | | | |
| Timestamp for generator voltages and currents | | | | | | |
| 772 | AnalogInput38 Timestamp of pos. zero crossing of phase voltage UG1 | DINT | • | | | |
| 780 | AnalogInput39 Timestamp of pos. zero crossing of phase voltage UG2 | DINT | • | | | |
| 788 | AnalogInput40 Timestamp of pos. zero crossing of phase voltage UG3 | DINT | • | | | |
| 796 | AnalogInput41 Timestamp of pos. zero crossing of phase current I1 | DINT | • | | | |
| 804 | AnalogInput42 Timestamp of pos. zero crossing of phase current I2 | DINT | • | | | |
| 812 | AnalogInput43 Timestamp of pos. zero crossing of phase current I3 | DINT | • | | | |
| Generator monitoring functions - Communication | | | | | | |
| 3330 | AnalogInput36 Read unbalanced load meter | UINT | | • | | |
| 3334 | AnalogInput37 Read unbalanced load current I2 | INT | | • | | |
| Measured values for busbar - Communication | | | | | | |
| 82 | AnalogInput13 Line-to-line voltage of busbar UB12 | INT | • | | | |
| 86 | AnalogInput14 Line-to-line voltage of busbar UB23 | INT | • | | | |
| 90 | AnalogInput15 Line-to-line voltage of busbar UB31 | INT | • | | | |
| 94 | AnalogInput16 Phase voltage of bus bar UB1 | INT | • | | | |
| 98 | AnalogInput17 Phase voltage of bus bar UB2 | INT | • | | | |
| 102 | AnalogInput18 Phase voltage of bus bar UB3 | INT | • | | | |
| 106 | AnalogInput35 Frequency of busbar | UINT | • | | | |
| Measured values for synchronization mains (for "Sync mains 1 / Sync mains 2" mains configuration) - Communication | | | | | | |
| 114 | AnalogInput25 Line-to-line voltage of sync mains 1 US1 | INT | • | | | |
| 134 | AnalogInput26 Line-to-line voltage of sync mains 2 US2 | INT | • | | | |
| 138 | AnalogInput27 Frequency of sync mains 1 | UINT | • | | | |
| 142 | AnalogInput28 Frequency of sync mains 2 | UINT | • | | | |
| Power mains measured values (for "3-phase mains" configuration) - Communication | | | | | | |
| 114 | AnalogInput25 Line-to-line voltage of power mains UN12 | INT | • | | | |
| 118 | AnalogInput31 Line-to-line voltage of power mains UN23 | INT | • | | | |
| 122 | AnalogInput32 Line-to-line voltage of power mains UN31 | INT | • | | | |
| 126 | AnalogInput33 Phase voltage of power mains UN1 | INT | • | | | |
| 130 | AnalogInput34 Phase voltage of power mains UN2 | INT | • | | | |

| Register | Name | Data type | Read | | Write | |
|--|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 134 | AnalogInput26 Phase voltage of power mains UN3 | INT | • | | | |
| 138 | AnalogInput27 Frequency of power mains | UINT | • | | | |
| Synchronization - Communication | | | | | | |
| 146 | AnalogInput29 Differential angle between sync mains | INT | • | | | |
| 150 | AnalogInput30 Differential voltage between sync mains | INT | • | | | |

1) This configuration register has a dual design. The register with "Read" in the name allows the configured value to be read back.

9.26.3.19.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.26.3.19.4 Configuration registers

9.26.3.19.4.1 General registers

Mains settings

Name:

ConfigOutput68

ConfigOutput68Read

This register is used to configure the module on the connected mains.

The value of this register can be read back.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|-------------------------------|----------|---|
| 0 - 1 | Generator mains configuration | 00 | 3-phase network with neutral conductor |
| | | 01 | 3-phase mains without neutral conductor |
| | | 10 to 11 | Reserved |
| 2 - 3 | Busbar configuration | 00 | 3-phase network with neutral conductor |
| | | 01 | 3-phase mains without neutral conductor |
| | | 10 to 11 | Reserved |
| 4 - 5 | Mains configuration | 00 | 3-phase network with neutral conductor |
| | | 01 | 3-phase mains without neutral conductor |
| | | 10 | Sync network 1 / Sync network 2 |
| | | 11 | Reserved |
| 6 - 7 | Reserved | 0 | |
| 8 - 9 | Generator mains ground | 00 | No phases grounded |
| | | 01 | L1 grounded |
| | | 10 | L2 grounded |
| | | 11 | L3 grounded |
| 10 - 11 | Busbar ground | 00 | No phases grounded |
| | | 01 | L1 grounded |
| | | 10 | L2 grounded |
| | | 11 | L3 grounded |
| 12 - 13 | Sync Mains 1 ground | 00 | No phases grounded |
| | | 01 | L1 grounded |
| | | 10 | L2 grounded |
| | | 11 | L3 grounded |
| 14 - 15 | Sync Mains 2 ground | 00 | No phases grounded |
| | | 01 | L1 grounded |
| | | 10 | L2 grounded |
| | | 11 | L3 grounded |

Mains without neutral conductor

If configured as "3-phase mains without neutral conductor", the potential of the neutral conductor is calculated from the 3 phases ("virtual neutral point").

The phase voltages are then measured in relation to this "virtual neutral point".

Mains with ground

If one of the phases of a mains system is grounded, then it must be configured as such. Otherwise, it is possible that the module will report a phase failure that blocks the mains synchronization function.

Monitoring functions disabled:

- Phase failure monitoring is not carried out for the phase configured as "grounded".
- Phase sequence monitoring is not performed on 2-phase mains that are grounded.

Mains configuration

The mains can be used as two 2-phase synchronization mains or combined into a 3-phase mains.

If the mains configuration is set to "3-phase mains" then the monitoring functions will be enabled for these combined mains.

Nominal voltage range, nominal current range and Aron circuit

Name:

ConfigOutput20

ConfigOutput20Read

The value of this register can be read back.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---|-------|---|
| 0 | Nominal voltage range of generator mains | 0 | Voltage 100 V |
| | | 1 | Voltage 400 V |
| 1 | Nominal voltage range of busbar | 0 | Voltage 100 V |
| | | 1 | Voltage 400 V |
| 2 | Nominal voltage range of Sync Mains 1 | 0 | Voltage 100 V |
| | | 1 | Voltage 400 V |
| 3 | Nominal voltage range of Sync Mains 2 | 0 | Voltage 100 V |
| | | 1 | Voltage 400 V |
| 4 | Nominal current range of the generator mains | 0 | Current range 1 A |
| | | 1 | Current range 5 A |
| 5 | Switch to power measurement principle of Aron circuit | 0 | Aron circuit disabled: Three-phase supply with neutral line |
| | | 1 | Aron circuit enabled: Three-phase supply without neutral line |
| 6 - 7 | Reserved | 0 | |

Nominal frequency (f_{Nom})

Name:

ConfigOutput10

ConfigOutput10Read

This is needed for converting the percentages based on this nominal value into physical units.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|--------------|-----------------------------|------------|
| UINT | 4800 to 6200 | corresponds to 48 to 62 Hz. | 0.01 Hz |

General configuration register

Name:

ConfigOutput24

ConfigOutput24Read

The value of this register can be read back.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|----------|---|
| 0 - 1 | DO5 function | 00 | DO5 is freely available to the user |
| | | 01 | Monitoring output of the mains |
| | | 10 | DO5 is freely available to the user or can be used as a mains monitoring output (the two signals are linked with an OR) |
| | | 11 | Reserved |
| 2 - 3 | DO6 function | 00 | DO6 is freely available to the user |
| | | 01 | Synchronization output (control of power switch) |
| | | 10 to 11 | Reserved |
| 4 | Definition of rotational direction monitoring of all mains | 0 | Right rotating field |
| | | 1 | Left rotating field |
| 5 - 6 | DO1 function | 00 | Monitoring output of the generator |
| | | 01 | DO1 is freely available to the user. |
| | | 10 | DO1 is freely available to the user or can be used as a monitoring output of the generator (both signals are linked logically by an OR operator). |
| | | 11 | Reserved |
| 7 | Reserved | 0 | |

Trigger bits

Name:

ConfigOutput23

ConfigOutput23Read

The value of this register can be read back.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------------|-------|--|
| 0 | Reset unbalanced load meter | 0 | Unbalanced load meter not set to 0 |
| | | 1 | On rising edge: Unbalanced load meter set to 0 |
| 1 - 7 | Reserved | 0 | |

9.26.3.19.4.2 Generator mains**Nominal voltage of generator mains (U_{NomGen})**

Name:

ConfigOutput02

ConfigOutput02Read

This is needed for converting the percentages based on this nominal value into physical units.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-------------|------------------------------|------------|
| UINT | 70 to 65000 | Corresponds to 70 to 65000 V | 1 V |

Multiplier for generator mains

Name:

ConfigOutput06

ConfigOutput06Read

This is used for converting the measured value into a physical value. The multiplier is applied to the respective input value.

The value 100 corresponds to a multiplication factor of 1 (measured value not changed).

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|-------------------------------|------------|
| UINT | 1 to 65535 | Corresponds to 0.01 to 655.35 | 0.01 |

Nominal current of generator mains (I_{Nom})

Name:

ConfigOutput04

ConfigOutput04Read

This is needed for converting the percentages based on this nominal value into physical units.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|-----------------------------|------------|
| UINT | 0 to 65000 | Corresponds to 0 to 65000 A | 1 A |

Multiplier for current transformer

Name:

ConfigOutput09

ConfigOutput09Read

This is used for converting the measured value into a physical value. The multiplier is applied to the respective input value.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|---------------------------|------------|
| UINT | 1 to 65535 | Corresponds to 1 to 65535 | 1 |

Turns generator mains functions on/off

Name:

ConfigOutput21

ConfigOutput21Read

The value of this register can be read back.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|---|
| 0 | Error acknowledgment mode | 0 | Error bits are reset by the module |
| | | 1 | Error bits are reset by the user |
| 2 - 3 | Check all overvoltages and undervoltages ¹⁾ | 00 | 3 phase voltages |
| | | 01 | 3 line-to-line voltages |
| | | 10 | 3 line-to-line and 3 phase voltages |
| | | 11 | Reserved |
| 4 - 5 | Reserved | 0 | |
| 6 | Power measurement mode | 0 | Total output - Including the harmonic component |
| | | 1 | Fundamental power - 1st harmonic only |
| 7 | Reserved | 0 | |

1) For information about configuring limit values, see "Generator monitoring" on page 2879.

Power measurement mode

In real transmission networks, neither the voltages nor the currents are strictly sinusoidal. This means: The fundamental frequencies are generally subject to strong harmonics.

By default, the module always accounts for the contributions of the fundamental frequency as well as the harmonics. In addition to the voltage and current measured values, this also affects the power measurements.

When controlling with reactive power in applications, the part of the reactive power coming from the harmonic frequencies (distortion reactive power) can have negative effects. Only the displacement reactive power should be controlled (i.e. the reactive power component of the fundamental frequency). In particular, this can make a control to displacement reactive power = 0 ($\cos \varphi = 1$) impossible.

This is why the module offers the possibility of accounting for only the fundamental frequency (1st harmonic) for power measurement, when necessary. This primarily serves to filter out the distortion reactive power. However, all other measured values associated with the power measurement as well as the corresponding generator protection functions are affected when re-configuring the power measurement to the fundamental frequency.

The voltage and current measured values from the generator mains are **not** affected. Just as before (as with the other voltage supply systems), they also always include the contribution of harmonics regardless of the mode being used for power measurement.

| Measured value / Functionality | Corresponding data point | Corresponding output | Remarks/Details |
|--|--------------------------------|----------------------|--|
| Active power | AnalogInput19 | | $P \rightarrow P_H1$ |
| Reactive power | AnalogInput20 | | $Q \rightarrow Q_H1$ |
| Apparent power | AnalogInput21 | | $S \rightarrow S_H1$ |
| Power factor | AnalogInput23 | | Power factor $\rightarrow \cos \varphi$ $ \cos \varphi = \cos(\arctan(Q_H1/P_H1))$ The signs for $\cos \varphi$ are described in section "Generator operating modes" on page 2865. "I" and "U" must be replaced by the respective 1st harmonics "I_H1" and "U_H1". |
| Maximum total active power | ConfigOutput52 | | Changing the parameter "Power measurement mode" during runtime has no immediate effect on any of these registers or the internal energy meters (e.g. meter reset). It only determines the summands or comparison value that is effective immediately (total output / fundamental frequency power). |
| Active energy meter for supply | ConfigOutput54 | | |
| Reactive energy meter for supply | ConfigOutput55 | | |
| Active energy meter for reference | ConfigOutput71 | | |
| Reactive energy meter for reference | ConfigOutput72 | | |
| Energy meter output | | DO 2 | |
| Generator monitoring function: Capacitive reactive power | StatusInput10 | DO 1 | |
| Generator monitoring function: Generator overload | StatusInput31 | DO 1 | |
| Generator monitoring function: Generator feedback | StatusInput32 | DO 1 | |

Low-pass filter for total power ratings

Name:

ConfigOutput41
ConfigOutput41Read

Parameter for delay time of the low-pass filter of the total power values P, Q and S or P_H1, Q_H1 and S_H1 (see "[Power measurement mode](#)" on page 2878). The maximum total power values are recorded independently of this without being filtered.

This parameter is used as a delay element so that current or voltage fluctuations have less effect on how the calculated power values are represented. The damping behavior of the low-pass filter acts in accordance with the configurable time constant of a decaying e-function.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|----------------------------|------------|
| UINT | 0 to 300 | Corresponds to 0 to 300 ms | 1 ms |

Filter cycles for real-time values

Name:

ConfigOutput125
ConfigOutput125Read

This register influences the pre-filtering of the instantaneous values for generator voltage and current in the module. When using task classes that are a multiple of the X2X cycle, the cutoff frequency of the pre-filter must be adjusted to avoid aliasing the instantaneous values.

This is done by specifying the task cycle time as a multiple of the X2X cycle time. If the calculated total value (i.e. Pre-filter time * X2X cycle time) exceeds 64.77 ms, it is limited to this.

The value of this register can be read back.

| Data type | Values | Information | Resolution |
|-----------|-----------|-------------------------------------|------------|
| UINT | 1 to 2000 | Corresponds to 1 to 2000 X2X cycles | 1 cycle |

9.26.3.19.4.3 Generator monitoring**Overvoltage limit of generator mains (U_{max})**

Name:

ConfigOutput16 (1st value)
ConfigOutput118 (2nd value)
ConfigOutput16Read (1st value)
ConfigOutput118Read (2nd value)

If the value of one of the generator voltages configured in the "[ConfigOutput21](#)" on page 2878 register exceeds the value set here, then the "Overvoltage" error message (register "[StatusInputPacked01](#)" on page 2911) or "Overvoltage2" (register "[StatusInputPacked05](#)" on page 2914) is indicated after the delay time has expired and, if configured, the DO1 monitoring relay is switched.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|---|------------|
| UINT | 0 to 2000 | Corresponds to 0 to 200% of U _{NomGen} | 0.1% |

Response time for generator overvoltage (U_{max})

Name:

ConfigOutput26 (1st time)
ConfigOutput119 (2nd time)
ConfigOutput26Read (1st time)
ConfigOutput119Read (2nd time)

The error is only triggered if the response value is exceeded in the positive direction without interruption for as long as is specified in this register. A response time of up to 80 s can be configured for a monitor.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------------------|--|------------|
| UINT | 5 to 100 5 to 800 | Corresponds to 0.5 to 10 s Corresponds to 0.5 to 80 s | 0.1 s |

Undervoltage limit of generator mains (U_{min})

Name:

ConfigOutput27 (1st value)

ConfigOutput59 (2nd value)

ConfigOutput27Read (1st value)

ConfigOutput59Read (2nd value)

If the value of one of the generator voltages configured in the "ConfigOutput21" on page 2878 register falls below the value set here, then the "Undervoltage" or "Undervoltage2" error message (register "StatusInputPacked01" on page 2911) is indicated after the delay time has passed and, if configured, the DO1 monitoring relay is switched.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|--|------------|
| UINT | 0 to 2000 | Corresponds to 0 to 200% of U_{NomGen} | 0.1% |

Response time for generator undervoltage (U_{min})

Name:

ConfigOutput28 (1st time)

ConfigOutput65 (2nd time)

ConfigOutput28Read (1st time)

ConfigOutput65Read (2nd time)

The error is only triggered if the response value is exceeded in the negative direction without interruption for as long as is specified in this register. A response time of up to 80 s can be configured for a monitor.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------------------|--|------------|
| UINT | 5 to 100 5 to 800 | Corresponds to 0.5 to 10 s Corresponds to 0.5 to 80 s | 0.1 s |

Generator over-frequency (f_{max})

Name:

ConfigOutput29 (1st frequency)

ConfigOutput122 (2nd frequency)

ConfigOutput29Read (1st frequency)

ConfigOutput122Read (2nd frequency)

If the value of the generator frequency exceeds the percent value set here in relation to the nominal frequency, then the error message "Overfrequency" (register "StatusInputPacked01" on page 2911) or "Overfrequency 2" (register "StatusPacked05" on page 2914) is indicated after the delay time has passed and, if configured, the DO1 monitoring relay is switched.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|----------------------------|------------|
| UINT | 0 to 2000 | For 0 to 200% of f_{Nom} | 0.1% |

Response time for generator over-frequency (f_{max})

Name:

ConfigOutput30 (1st time)

ConfigOutput123 (2nd time)

ConfigOutput30Read (1st time)

ConfigOutput123Read (2nd time)

The error is only triggered if the response value is exceeded in the positive direction without interruption for as long as is specified in this register.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|------------------|------------|
| UINT | 5 to 100 | For 0.5 for 10 s | 0.1 s |

Generator under-frequency (f_{min})

Name:

ConfigOutput31 (1st frequency)
 ConfigOutput120 (2nd frequency)
 ConfigOutput31Read (1st frequency)
 ConfigOutput120Read (2nd frequency)

If the value of the generator frequency falls below the percent value set here in relation to the nominal frequency, then the error message "Underfrequency" (register "StatusInputPacked01" on page 2911) or "Underfrequency 2" (register "StatusInputPacked05" on page 2914) is indicated after the delay time has passed and, if configured, the DO1 monitoring relay is switched.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|----------------------------|------------|
| UINT | 0 to 2000 | For 0 to 200% of f_{Nom} | 0.1% |

Response time for generator under-frequency (f_{min})

Name:

ConfigOutput32 (1st time)
 ConfigOutput121 (2nd time)
 ConfigOutput32Read (1st time)
 ConfigOutput121Read (2nd time)

The error is only triggered if the response value is exceeded in the negative direction without interruption for as long as is specified in this register.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|-----------------|------------|
| UINT | 5 to 100 | For 0.5 to 10 s | 0.1 s |

Generator voltage asymmetry (U_{as})

Name:

ConfigOutput33
 ConfigOutput33Read

This trigger value, specified as a percentage, is based on the nominal voltage of the generator. If the difference between the three line-to-line voltages of the generator mains exceeds the configured limit value, then the error message "Voltage asymmetry" is indicated (register "StatusInputPacked01" on page 2911) after the delay time has passed and, if configured, the DO1 monitoring relay is switched.

For this to happen, only one of these voltages has to exceed the respective limit value (in either the positive or negative direction).

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|------------------------------|------------|
| UINT | 0 to 300 | For 0 to 30% of U_{NomGen} | 0.1% |

Response time for generator voltage asymmetry (U_{as})

Name:

ConfigOutput34
 ConfigOutput34Read

This error is triggered only if the response value is exceeded without interruption (in either the positive or negative direction) for as long as is specified in this register.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|-----------------|------------|
| UINT | 5 to 100 | For 0.5 to 10 s | 0.1 s |

Load time constant for current asymmetry (K1)

Name:

ConfigOutput35

ConfigOutput35Read

The dependent delayed unbalanced load monitoring function (see "[Dependent delayed unbalanced load monitoring](#)" on page 2882) continually monitors the AC currents coming from the main current converters and continually calculates the present unbalanced load current. This is compared with the threshold value, which is calculated using the load time constants. If this threshold value is exceeded, the error message "Current asymmetry" is indicated (register "[StatusInputPacked01](#)" on page 2911) and, if configured, the DO1 monitoring relay is switched.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|---------------------|------------|
| UINT | 1 to 65535 | For 0.1 to 6553.5 s | 0.1 s |

Unbalanced load constant (K2)

Name:

ConfigOutput109

ConfigOutput109Read

The boundary between continuous operation and short-term operation is defined by the unbalanced load constant K2 (see "[Dependent delayed unbalanced load monitoring](#)" on page 2882).

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|---------|------------------|------------|
| UINT | 8 to 15 | For 0.08 to 0.15 | 0.01 |

Dependent delayed unbalanced load monitoring

Unbalanced load monitoring protects against unbalanced load in three-phase generators and three-phase mains. Parameters can be changed to make it possible to match the trigger characteristics to different generator types while taking their special thermal time constants into consideration.

An unbalanced load can be caused by uneven current distribution in the mains due to unbalanced load, asymmetrical short circuits, line interruptions or switching operations. Unbalanced loads result in reverse system currents in the stator, which causes harmonics with an uneven ordinal number in the stator winding and harmonics with an even ordinal number in the rotor winding. The rotor is at particular risk here because the harmonic waves place an additional load on the rotor winding and induce eddy currents in the rotor's solid iron, which may melt the metal or destroy the metallic structure.

An unbalanced load can be permissible within certain limits, however, when accounting for the thermal load limit of the generator. To avoid premature failure of the generator when an unbalanced load occurs, the characteristics that trigger unbalanced load protection should be adapted to the thermal characteristics of the generator. Unbalanced load protection can also be triggered by external errors in the mains caused by asymmetric short circuits.

When unbalanced load protection is tripped can be calculated using the following formula:

| Operating mode | Formula |
|----------------------|--|
| Short-term operation | $t = \frac{K1}{\left(\frac{I_2}{I_{Nom}}\right)^2 - K2^2}$ |
| Continuous operation | $\frac{I_2}{I_{Nom}} \leq K2 \rightarrow t = \infty$ |
| Key | |
| t | Calculated tripping time |
| K1 | Valid load time constant for the generator [s] |
| K2 | Unbalanced load constant |
| I ₂ | Calculated inverse current / unbalanced load current [A] |
| I _{Nom} | Nominal current for the generator [A] |

To calculate the tripping time instant, the scan duration of the measurement system (i.e. 20 ms for 50 Hz voltage) is divided by the calculated trigger time, and the results are continually added up. With short-term operation, the value of the summands increases; with continuous operation, it decreases. If the summand reaches the value 1 (100%), then the max. permitted value has been reached. The summand is limited between 0 and 1.

The boundary between continuous operation and short-term operation is defined by the unbalanced load constant K2.

Information:

When the generator is at a standstill, the summand is neither reset nor is its value reduced.

Nominal current on generator mains for unbalanced load protection

Name:

ConfigOutput124

ConfigOutput124Read

The nominal current for unbalanced load protection can be set separately. If the value is set to 0, the normal nominal current is used for calculations.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|------------------|------------|
| UINT | 0 to 65000 | For 0 to 65000 A | 1 A |

Maximum limit of neutral conductor current

Name:

ConfigOutput36

ConfigOutput36Read

Configurable limit for the neutral conductor current. If the value is exceeded, then the error message "Maximum neutral conductor current" is indicated (register "[StatusInputPacked01](#)" on [page 2911](#)) after the delay time has passed and, if configured, the DO1 monitoring relay is switched.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|-----------------------------------|------------|
| UINT | 0 to 1000 | For 0 to 100% of I _{Nom} | 0.1% |

Response time for neutral conductor current monitor

Name:

ConfigOutput37

ConfigOutput37Read

The error is only triggered if the response value is exceeded in the positive direction without interruption for as long as is specified in this register.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|-----------------|------------|
| UINT | 5 to 100 | For 0.5 to 10 s | 0.1 s |

Short circuit current

Name:

ConfigOutput38

ConfigOutput38Read

If the value of the generator current exceeds the percentage based on the converter's nominal current set here, then the error message "Short circuit current" is indicated (register "[StatusInputPacked01](#)" on page 2911) and, if configured, the DO1 monitoring relay is switched.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|--------------|------------------------------|------------|
| UINT | 1000 to 5000 | For 100 to 500% of I_{Nom} | 0.1% |

Response time for short circuit current

Name:

ConfigOutput39

ConfigOutput39Read

The error is only triggered if the response value is exceeded in the positive direction without interruption for as long as is specified in this register.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|-----------------|------------|
| UINT | 4 to 500 | For 0.04 to 5 s | 0.01 s |

Rating-dependent overcurrent

Name:

ConfigOutput42

ConfigOutput42Read

The response value percentage is based on the nominal current of the generator. If the response value is exceeded, then the error message "Rating-dependent overcurrent" is indicated (register "[StatusInputPacked01](#)" on page 2911) and, if configured, the DO1 monitoring relay is switched.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|--------------|------------------------------|------------|
| UINT | 1000 to 2000 | For 100 to 200% of I_{Nom} | 0.1% |

Rating-dependent overcurrent monitoring

A generator that is operated at its nominal current I_{Nom} normally reaches about half of its maximum thermal load. Operating it above the rated current I_{Nom} result in additional warming, which is permitted until the maximum temperature is reached. The highest permissible continuous temperature is determined by the class of the insulation material used in the generator.

Based on the settings and the current measurement, the device forms an internal model based on an I^2t characteristic curve of the generator temperature. This allows the heat capacity of the generator to be completely utilized for short overloads while at the same time providing full protection. The configurable parameters for determining the machine model include the nominal current I_{Nom} of the generator and the time multiplier.

Integration coefficient for rating-dependent overcurrent (iths)

Name:

ConfigOutput43

ConfigOutput43Read

To calculate the tripping time instant, the sampling duration of the measurement system is divided by the calculated trigger time (t). The results are continually added up. If the summand reaches the value 1 (100%), then the max. permitted value has been reached. The summand is limited between 0 and 1.

The value of this register can be read back.

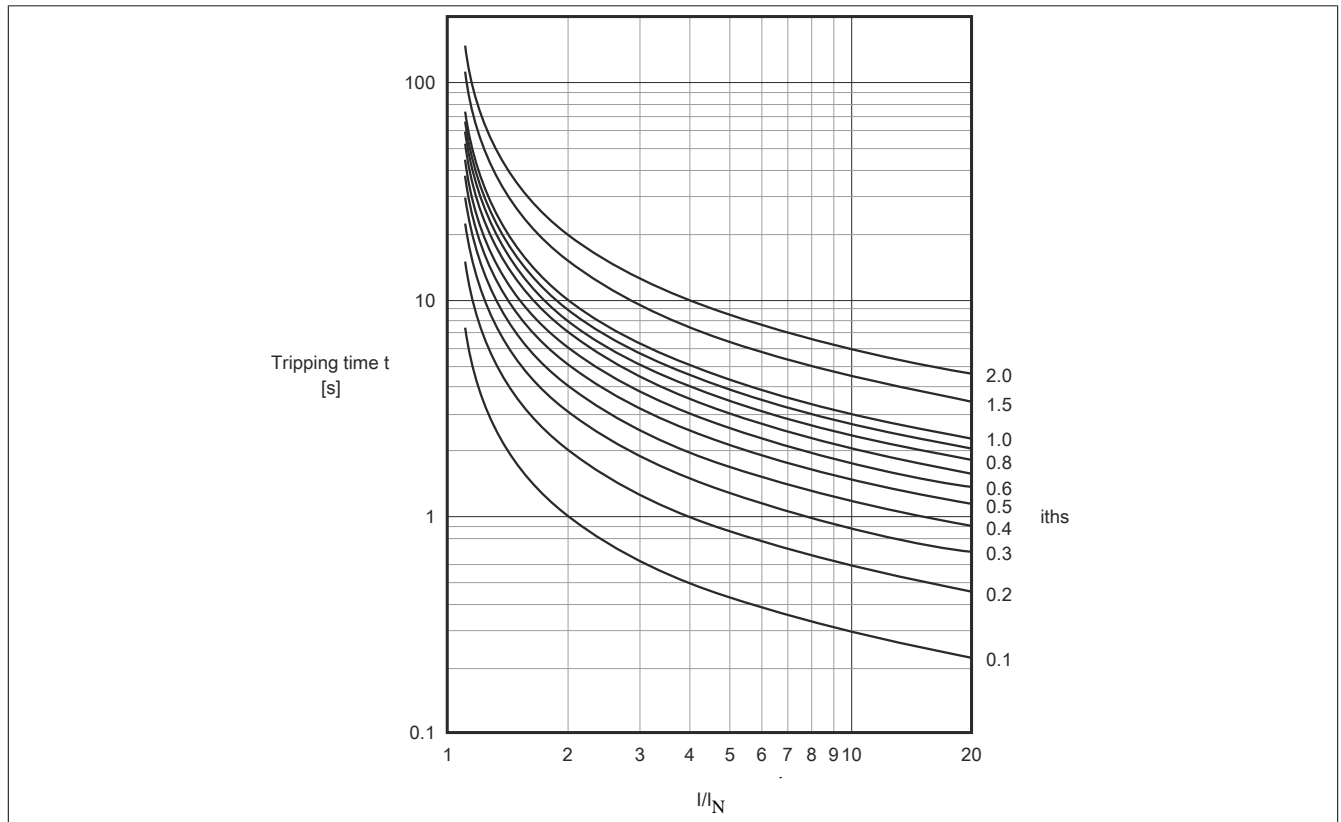
| Data type | Value | Information | Resolution |
|-----------|---------|--------------|------------|
| UINT | 1 to 20 | For 0.1 to 2 | 0.1 |

For a constant overcurrent, the trigger characteristic curve can be calculated based on the following formula:

$$t = \frac{0.14}{\left(\frac{I}{I_N}\right)^{0.02} - 1} * iths$$

Key:

| | |
|-------|---|
| t | Tripping time [s] |
| I | The highest value of the 3 phase currents [A] |
| I_N | Rating-dependent overcurrent [A] |
| iths | Integration coefficient |

Trigger characteristic curve in accordance with IEC 255-4 (normal, inverse)

The monitor function can be reset by restarting the module or by falling below the overcurrent value so that the results of the continuous addition decrease according to the formula.

Capacitive reactive power

Name:

ConfigOutput44

ConfigOutput44Read

The capacitive reactive power for the generator is monitored to determine if it falls below the defined response value. In this way, monitoring the capacitive reactive power can be used to detect exciter failure. If the response value is fallen below, then the error message "Capacitive reactive power" is indicated (register "[StatusInputPacked01](#)" on [page 2911](#)) after the delay time has passed and, if configured, the DO1 monitoring relay is switched.

Depending on how the "Power measurement mode" parameter is set in the "[ConfigOutput21](#)" on [page 2878](#) register, either the total reactive power or the fundamental frequency reactive power (displacement reactive power) is compared with the response value.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------------|--------------------------|------------|
| INT | -32768 to 32767 | For -32768 to 32767 kvar | 1 kvar |

Response time for reactive power monitoring

Name:

ConfigOutput45

ConfigOutput45Read

The error is only triggered if the response value is exceeded in the positive direction without interruption for as long as is specified in this register.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|-----------------|------------|
| UINT | 5 to 100 | For 0.5 to 10 s | 0.1 s |

Generator overload

Name:

ConfigOutput89

ConfigOutput89Read

If the value of the active power of the generator exceeds the percentage of the generator's nominal power set here, then the error message "Generator overload" is indicated (register "[StatusInputPacked01](#)" on [page 2911](#)) after the delay time has passed and, if configured, the DO1 monitoring relay is switched.

Depending on how the "Power measurement mode" parameter is set in the "[ConfigOutput21](#)" on [page 2878](#) register, either the total active power or the fundamental frequency active power is compared with the response value.

The nominal power is calculated as follows:

$$P_{\text{NomGen}} = U_{\text{NomGen}} * I_{\text{NomGen}} * \sqrt{3}$$

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|--------------------------------------|------------|
| UINT | 0 to 2000 | For 0 to 200% of P_{NomGen} | 0.1% |

Response time for generator overload

Name:

ConfigOutput90

ConfigOutput90Read

The error is only triggered if the response value is exceeded in the positive direction without interruption for as long as is specified in this register.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|-----------------|------------|
| UINT | 5 to 100 | For 0.5 to 10 s | 0.1 s |

Generator feedback

Name:

ConfigOutput91

ConfigOutput91Read

If the value of the negative active power of the generator falls below the percentage of the generator's nominal power set here, then the error message "Generator feedback" is indicated (register "[StatusInputPacked01](#)" on page [2911](#)) after the delay time has passed and, if configured, the DO1 monitoring relay is switched.

Depending on how the "Power measurement mode" parameter is set in the "[ConfigOutput21](#)" on page [2878](#) register, either the total active power or the fundamental frequency active power is compared with the response value.

The nominal power is calculated as follows:

$$P_{\text{NomGen}} = U_{\text{NomGen}} \cdot I_{\text{NomGen}} \cdot \sqrt{3}$$

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|----------------------------------|------------|
| UINT | 0 to 2000 | 0 to 200% of P_{NomGen} | 0.1% |

Response time for generator feedback

Name:

ConfigOutput92

ConfigOutput92Read

The error is only triggered if the response value is exceeded in the negative direction without interruption for as long as is specified in this register.

The values of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|-----------------|------------|
| UINT | 5 to 100 | For 0.5 to 10 s | 0.1 s |

DO1 function

This digital output can be set after the defined response time has elapsed depending on the assignment of the generator mains' monitoring variables (X3). Assignments are made using the "ConfigOutput57" on page 2888 and "ConfigOutput97" on page 2889 registers.

The monitoring variables can be assigned to this input either individually or with additional monitoring variables using an OR connective. This makes it possible to set the relay when there are multiple monitoring variables.

Assigning monitoring functions - 1

Name:

ConfigOutput57

ConfigOutput57Read

The following monitoring functions can be assigned to the monitoring relay using this register:

The value of this register can be read back.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|---|-------|------------------------|
| 0 | Overvoltage (of a phase) | 0 | Do not assign function |
| | | 1 | Assign function |
| 1 | Undervoltage (or a phase) | 0 | Do not assign function |
| | | 1 | Assign function |
| 2 | Overfrequency | 0 | Do not assign function |
| | | 1 | Assign function |
| 3 | Underfrequency | 0 | Do not assign function |
| | | 1 | Assign function |
| 4 | Voltage asymmetry | 0 | Do not assign function |
| | | 1 | Assign function |
| 5 | Current asymmetry (unbalanced load) | 0 | Do not assign function |
| | | 1 | Assign function |
| 6 | Neutral conductor current, maximum | 0 | Do not assign function |
| | | 1 | Assign function |
| 7 | Short circuit current | 0 | Do not assign function |
| | | 1 | Assign function |
| 8 | Rating-dependent overcurrent | 0 | Do not assign function |
| | | 1 | Assign function |
| 9 | Capacitive reactive power (exciter failure) | 0 | Do not assign function |
| | | 1 | Assign function |
| 10 | Ready | 0 | Do not assign function |
| | | 1 | Assign function |
| 11 | Generator overload | 0 | Do not assign function |
| | | 1 | Assign function |
| 12 | Generator feedback | 0 | Do not assign function |
| | | 1 | Assign function |
| 13 - 14 | Reserved | 0 | |
| 15 | Undervoltage 2 (one phase) | 0 | Do not assign function |
| | | 1 | Assign function |

Information:

The minimum pulse duration when addressing a monitoring function on the error bit via X2X as well as on the relay is 500 ms.

Assigning monitoring functions - 2

Name:

ConfigOutput97

The following additional monitoring functions can be assigned to the monitoring relay using this register:

The value of this register can be read back.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|---------------------------|-------|------------------------|
| 0 | Overvoltage 2 (one phase) | 0 | Do not assign function |
| | | 1 | Assign function |
| 1 | Underfrequency 2 | 0 | Do not assign function |
| | | 1 | Assign function |
| 2 | Overfrequency 2 | 0 | Do not assign function |
| | | 1 | Assign function |
| 3 | Q-U protection | 0 | Do not assign function |
| | | 1 | Assign function |
| 4 - 15 | Reserved | 0 | |

Information:

The minimum pulse duration when addressing a monitoring function on the error bit via X2X as well as on the relay is 500 ms.

Q-U protection

Name:

ConfigOutput126

ConfigOutput126Read

If all generator voltages configured in register "[ConfigOutput21](#)" on page 2878 undershoot the value set here and inductive reactive power is simultaneously absorbed (active power $P < 0$ and reactive power $Q < 0$), if configured, error message "Q-U protection" is indicated in register "[StatusInputPacked05](#)" on page 2914 and monitoring relay DO1 is switched after the [time delay](#) has expired.

The values of these registers can be read back.

| Data type | Values | Information | Resolution |
|-----------|-----------|---|------------|
| UINT | 0 to 2000 | Corresponds to 0 to 200% of the nominal voltage | 0.1% |

Response time for Q-U protection

Name:

ConfigOutput127

ConfigOutput127Read

Response time for triggering Q-U protection. For more information, see "[Q-U protection](#)" on page 2889.

The value of this register can be read back.

| Data type | Values | Information | Resolution |
|-----------|----------|----------------------------|------------|
| UINT | 1 to 100 | Corresponds to 0.1 to 10 s | 0.1 s |

9.26.3.19.4.4 Synchronization mains

(for mains configuration "Sync mains 1 / Sync mains 2")

Nominal voltage of synchronization mains (U_{NomSyn})

Name:

ConfigOutput01

ConfigOutput01Read

This is needed for converting the percentages based on this nominal value into physical units.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-------------|-------------------|------------|
| UINT | 70 to 65000 | For 70 to 65000 V | 1 V |

Multiplier for synchronization mains

Name:

ConfigOutput07 (mains 1)

ConfigOutput08 (mains 2)

ConfigOutput07Read (mains 1)

ConfigOutput08Read (mains 2)

This is used for converting the measured value into a physical value. The multiplier is applied to the respective input value.

100 means a multiplier factor of 1 (measured value not changed).

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|--------------------|------------|
| UINT | 1 to 65535 | For 0.01 to 655.35 | 0.01 |

9.26.3.19.4.5 Mains

Mains (for mains configuration "3-phase mains")

Nominal voltage of mains (U_{NomMains})

Name:

ConfigOutput01

ConfigOutput01Read

This is needed for converting the percentages based on this nominal value into physical units.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-------------|-------------------|------------|
| UINT | 70 to 65000 | For 70 to 65000 V | 1 V |

Multiplier for mains

Name:

ConfigOutput07

ConfigOutput07Read

This is used for converting the measured value into a physical value. The multiplier is applied to the respective input value.

100 means a multiplier factor of 1 (measured value not changed).

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|--------------------|------------|
| UINT | 1 to 65535 | For 0.01 to 655.35 | 0.01 |

Enable/disable mains functions

Name:

ConfigOutput22

ConfigOutput22Read

The value of this register can be read back.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|--|
| 0 | Error acknowledgment mode | 0 | Mains error bits are reset by the module |
| | | 1 | Mains error bits are reset by the user |
| 1 | Phase shift measurement | 0 | Three-phase only |
| | | 1 | Single- or three-phase |
| 2 - 3 | Check all overvoltages and undervoltages ¹⁾ | 00 | 3 phase voltages |
| | | 01 | 3 line-to-line voltages |
| | | 10 | 3 line-to-line and 3 phase voltages |
| | | 11 | Reserved |
| 4 | Configuration of undervoltage monitoring | 0 | 2-point mode |
| | | 1 | 6-point mode |
| 5 - 7 | Reserved | 0 | |

1) For information about configuring limit values, see "Mains voltage monitoring" on page 2892.

9.26.3.19.4.6 Mains monitoring functions

(for "3-phase mains" configuration)

The following mains monitoring functions are available if the network configuration is set to a 3-phase mains (see register "Mains settings" on page 2875).

Mains voltage monitoring

Overvoltage limit of the mains ($U_{\max\text{Mains}}$)

Name:

ConfigOutput73 (1st value)

ConfigOutput98 (2nd value)

ConfigOutput73Read (1st value)

ConfigOutput98Read (2nd value)

If the value of one of the mains voltages configured in the "ConfigOutput22" on page 2891 register exceeds the value set here, then the "Overvoltage" error message (register "StatusInputPacked02" on page 2912) or "Overvoltage 2" (register "StatusInputPacked04" on page 2913) is indicated after the delay time has expired and, if configured, the DO5 monitoring relay is switched.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|--|------------|
| UINT | 0 to 2000 | For 0 to 200% of U_{NomMains} | 0.1% |

Mains overvoltage dropout threshold

Name:

ConfigOutput128 (1st value)

ConfigOutput130 (2nd value)

ConfigOutput128Read (1st value)

ConfigOutput130Read (2nd value)

If the dropout threshold is undershot within the response time after the overvoltage limit value has been overshoot by a mains voltage, the monitor is not triggered and the response time starts again from the beginning when the overvoltage limit value is overshoot again. If values are selected for the dropout threshold that are greater than or equal to the overvoltage limit value, then the dropout threshold is disabled.

The values of these registers can be read back.

| Data type | Values | Information | Resolution |
|-----------|-----------|---|------------|
| UINT | 0 to 2000 | Corresponds to 0 to 200% of the nominal voltage | 0.1% |

Response time for mains overvoltage (U_{MaxMains})

Name:

ConfigOutput82 (1st time)

ConfigOutput99 (2nd time)

ConfigOutput82Read (1st time)

ConfigOutput99Read (2nd time)

The error is only triggered if the response value is exceeded in the positive direction without interruption for as long as is specified in this register.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|-------------------|------------|
| UINT | 5 to 60000 | For 0.005 to 60 s | 0.001 s |

Mains over-frequency ($f_{\max\text{Mains}}$)

Name:

ConfigOutput75 (1st frequency)

ConfigOutput102 (2nd frequency)

ConfigOutput75Read (1st frequency)

ConfigOutput102Read (2nd frequency)

If the value of the mains frequency exceeds the percent value set here in relation to the nominal frequency, then the error message "Overfrequency" (register "StatusInputPacked02" on page 2912) or "Overfrequency 2" (register "StatusInputPacked04" on page 2913) is indicated after the delay time has passed and, if configured, the DO5 monitoring relay is switched.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|-----------------------------------|------------|
| UINT | 0 to 2000 | For 0 to 200% of f_{Nom} | 0.1% |

Overfrequency dropout threshold

Name:

ConfigOutput132 (1st value)

ConfigOutput134 (2nd value)

ConfigOutput132Read (1st value)

ConfigOutput134Read (2nd value)

If the dropout threshold is undershot within the response time after the overfrequency limit value has been overshoot by a mains voltage, the monitor is not triggered and the response time starts again from the beginning when the overfrequency limit value is overshoot again. If values are selected for the dropout threshold that are greater than or equal to the overfrequency limit value, then the dropout threshold is disabled.

The values of these registers can be read back.

| Data type | Values | Information | Resolution |
|-----------|-----------|---|------------|
| UINT | 0 to 2000 | Corresponds to 0 to 200% of the rated frequency | 0.1% |

Response time for mains over-frequency ($f_{\max\text{Mains}}$)

Name:

ConfigOutput84 (1st time)

ConfigOutput103 (2nd time)

ConfigOutput84Read (1st time)

ConfigOutput103Read (2nd time)

The error is only triggered if the response value is exceeded in the positive direction without interruption for as long as is specified in this register.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|-------------------|------------|
| UINT | 5 to 60000 | For 0.005 to 60 s | 0.001 s |

Mains under-frequency ($f_{\min\text{Mains}}$)

Name:

ConfigOutput76 (1st frequency)

ConfigOutput104 (2nd frequency)

ConfigOutput76Read (1st frequency)

ConfigOutput104Read (2nd frequency)

If the value of the mains frequency falls below the percent value set here in relation to the nominal frequency, then the error message "Underfrequency" (register "StatusInputPacked02" on page 2912) or "Underfrequency 2" (register "StatusInputPacked04" on page 2913) is indicated after the delay time has passed and, if configured, the DO5 monitoring relay is switched.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|-----------------------------------|------------|
| UINT | 0 to 2000 | For 0 to 200% of f_{Nom} | 0.1% |

Underfrequency dropout threshold

Name:

ConfigOutput133 (1st value)

ConfigOutput135 (2nd value)

ConfigOutput133Read (1st value)

ConfigOutput135Read (2nd value)

If the dropout threshold is overshot within the response time after the underfrequency limit value has been undershot by a mains voltage, the monitor is not triggered and the response time starts again from the beginning when the underfrequency limit value is undershot again. If values are selected for the dropout threshold that are less than or equal to the underfrequency limit value, then the dropout threshold is disabled.

The values of these registers can be read back.

| Data type | Values | Information | Resolution |
|-----------|-----------|---|------------|
| UINT | 0 to 2000 | Corresponds to 0 to 200% of the rated frequency | 0.1% |

Response time for mains under-frequency ($f_{\min\text{Mains}}$)

Name:

ConfigOutput85 (1st time)

ConfigOutput105 (2nd time)

ConfigOutput85Read (1st time)

ConfigOutput105Read (2nd time)

The error is only triggered if the response value is exceeded in the negative direction without interruption for as long as is specified in this register.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|-------------------|------------|
| UINT | 5 to 60000 | For 0.005 to 60 s | 0.001 s |

Mains voltage asymmetry (U_{asMains})

Name:

ConfigOutput77

ConfigOutput77Read

This trigger value, specified as a percentage, is based on the nominal voltage of the mains. If the difference between the 3 line-to-line voltages of the mains exceeds the configured limit value, then the error message "Voltage asymmetry" is indicated (register "[StatusInputPacked02](#)" on page 2912) after the delay time has passed and, if configured, the DO5 monitoring relay is switched.

For this to happen, only one of these voltages has to exceed the respective limit value (in either the positive or negative direction).

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|---------------------------------------|------------|
| UINT | 0 to 300 | For 0 to 30% of U_{NomMains} | 0.1% |

Response time for the mains voltage asymmetry (U_{asMains})

Name:

ConfigOutput86

ConfigOutput86Read

This error is triggered only if the response value is exceeded without interruption (in either the positive or negative direction) for as long as is specified in this register.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|--------------------|------------|
| UINT | 5 to 100 | For 0.005 to 0.1 s | 0.001 s |

Undervoltage monitoring in 2-point mode

2 independent limit values and response times can be defined for undervoltage monitoring.

Undervoltage limit of the mains ($U_{\min\text{Mains}}$)

Name:

ConfigOutput74

ConfigOutput74Read

If the value of one of the mains voltages configured in the "ConfigOutput22" on page 2891 register falls below the value set here, then the "Undervoltage" error message (register "StatusInputPacked02" on page 2912) is indicated after the delay time has passed and, if configured, the DO5 monitoring relay is switched.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|--|------------|
| UINT | 0 to 2000 | For 0 to 200% of U_{NomMains} | 0.1% |

Mains undervoltage dropout threshold

Name:

ConfigOutput129 (1st value)

ConfigOutput131 (2nd value)

ConfigOutput129Read (1st value)

ConfigOutput131Read (2nd value)

If the dropout threshold is overshoot within the response time after the undervoltage limit value has been undershot by a mains voltage, the monitor is not triggered and the response time starts again from the beginning when the undervoltage limit value is undershot again. If values are selected for the dropout threshold that are less than or equal to the undervoltage limit value, then the dropout threshold is disabled.

The values of these registers can be read back.

| Data type | Values | Information | Resolution |
|-----------|-----------|---|------------|
| UINT | 0 to 2000 | Corresponds to 0 to 200% of the nominal voltage | 0.1% |

Response time for mains undervoltage ($U_{\min\text{Mains}}$)

Name:

ConfigOutput83 (1st time)

ConfigOutput101 (2nd time)

ConfigOutput83Read (1st time)

ConfigOutput101Read (2nd time)

The error is only triggered if the response value is exceeded in the negative direction without interruption for as long as is specified in this register.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|-------------------|------------|
| UINT | 5 to 60000 | For 0.005 to 60 s | 0.001 s |

Undervoltage limit 2 of the mains ($U_{\min\text{Mains}}$)

Name:

ConfigOutput100

ConfigOutput100Read

If the value of one of the linked mains voltages falls below the value set here, then the "Undervoltage" error message (register "StatusInputPacked02" on page 2912) is indicated after the delay time has passed and, if configured, the DO5 monitoring relay is switched.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|------------------------------------|------------|
| UINT | 0 to 2000 | 0 to 200% of U_{NomMains} | 0.1% |

Undervoltage monitoring in 6-point mode

Up to 6 limit values and response times can be set for undervoltage monitoring. If not all 6 points are required, then unused limit values and response times should be set to 0.

Note that for each point, the specified limit value and response time must be greater than or equal to the preceding point ($P1 \leq P2 \leq P3$, etc.).

The defined points are used to create a limit value curve. If the voltage drops below the curve and a response time has expired, the error message "Undervoltage" is signaled ("[StatusInputPacked02](#)" on [page 2912](#) register). If configured, the D05 monitoring relay is also switched.

A faulty undervoltage monitoring configuration also triggers the "Undervoltage" error message, and monitor relay DO5 is switched if configured to do so (e.g. $P1 > P2$ and $P2$ not equal to (0% / 0 ms)).

The types of voltages to be monitored are specified in the mains configuration ("[ConfigOutput22](#)" on [page 2891](#) register):

- Line-to-line voltages
- Phase voltages
- Line-to-line and phase voltages

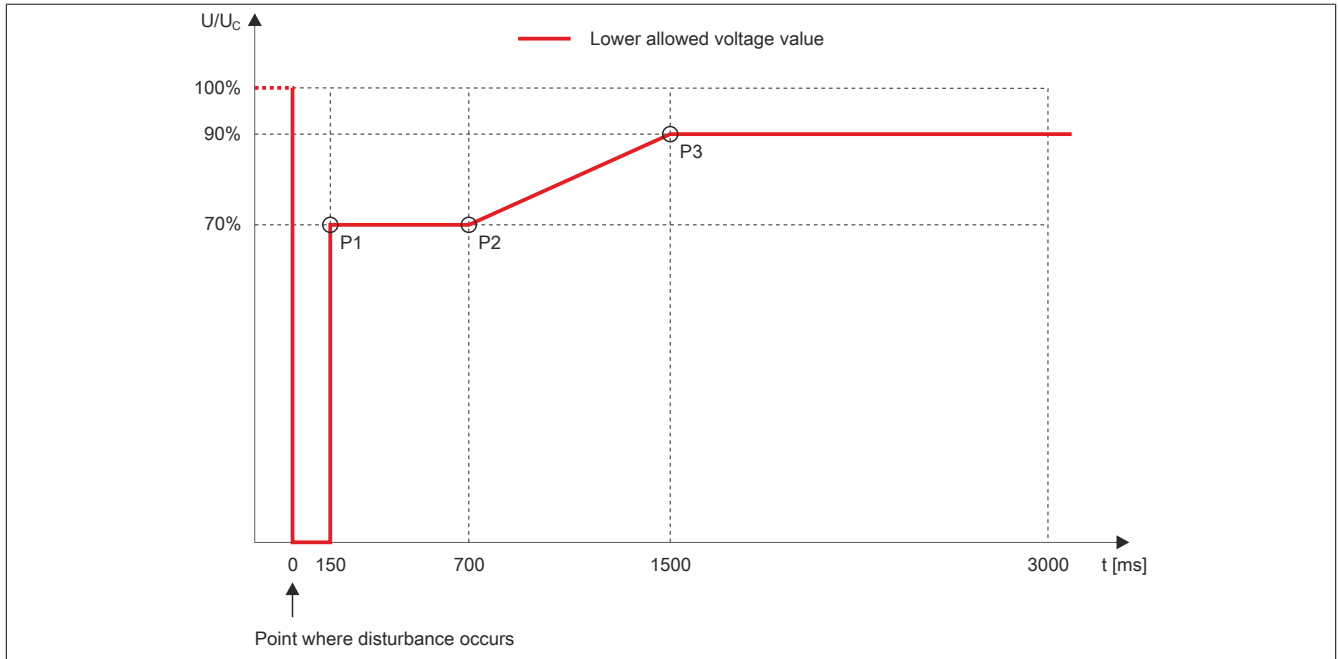
As soon as one of the monitored voltages drops below the limit curve, the corresponding time counter begins counting. The time counter is reset when all voltages are once again equal to or higher than the defined value.

The "Undervoltage" error message is generated when one of the time counters crosses over the limit curve.

Example 1 with 3 points:

In this example, 3 limit values are defined, along with the corresponding response times:

- P1 (70% / 150 ms)
- P2 (70% / 700 ms)
- P3 (90% / 1500 ms)
- P4 (0% / 0 ms)
- P5 (0% / 0 ms)
- P6 (0% / 0 ms)

**Notes regarding limit curve**

- The red line marks the lowest permitted value for monitored voltages.
- If 2 consecutive points have the same limit value, then the response time of the first point is applied. In the example above, this situation is shown with points 1 and 2.
- Between points 2 and 3 the curve has a positive linear slope. If one of the monitored voltages drops in this area, the module calculates the appropriate response time.

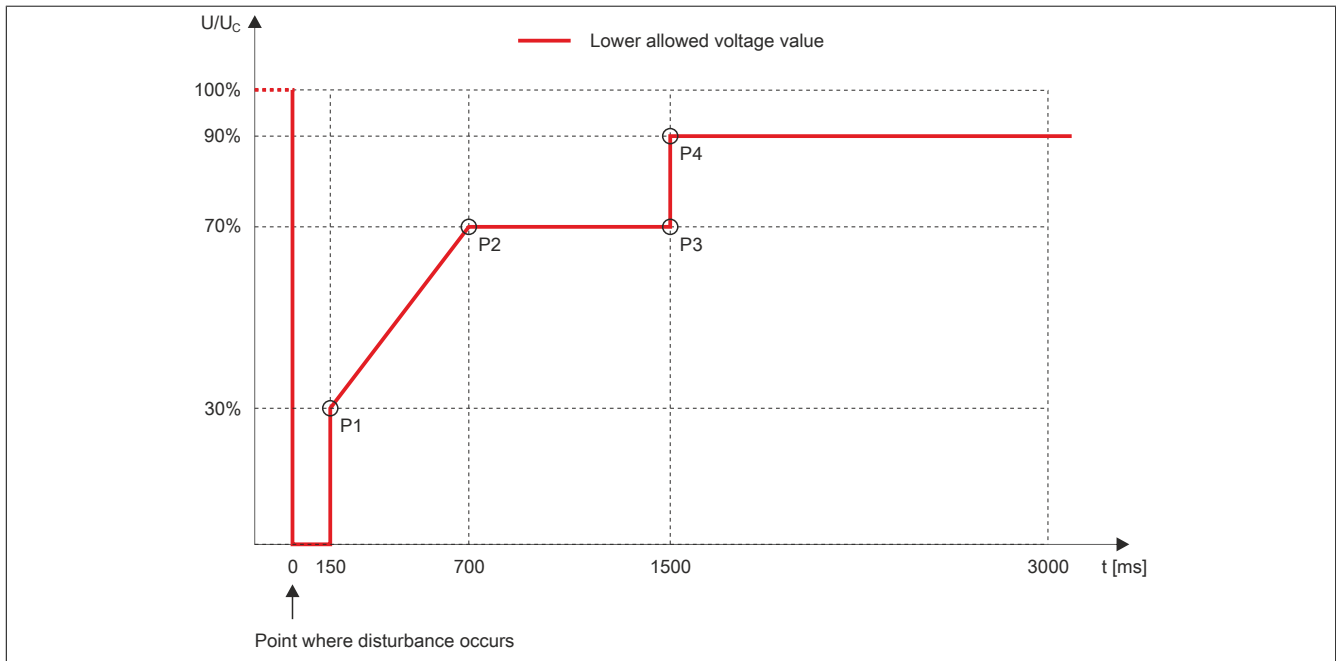
Determining the response time

- 1) Find voltage value on Y axis
- 2) Locate intersection on curve
- 3) Read the response time on the X axis

Example 2 with 4 points:

In this example, 4 limit values are defined, along with the corresponding response times:

- P1 (30% / 150 ms)
- P2 (70% / 700 ms)
- P3 (70% / 1500 ms)
- P4 (90% / 1500 ms)
- P5 (0% / 0 ms)
- P6 (0% / 0 ms)

**Notes regarding limit curve**

- The red line marks the lowest permitted value for monitored voltages.
- Between points 1 and 2 the curve has a positive linear slope. If one of the monitored voltages drops in this area, the module calculates the appropriate response time.
- If 2 consecutive points have the same limit value, then the response time of the first point is applied. In the example, this situation is shown with points 2 and 3.
- Points 1 and 2 are connected directly by a line with a positive slope. To avoid a direct connection between points 2 and 4, one would have to define another point between them with the same limit as point 2 and the same response time as point 4. In this case, that is point 3.

Determining the response time

- 1) Find voltage value on Y axis
- 2) Locate intersection on curve
- 3) Read the response time on the X axis

Undervoltage limit of the microgrid (U_{MinMains})

Name:

ConfigOutput74 (1st mains)
 ConfigOutput100 (2nd mains)
 ConfigOutput110 (3rd mains)
 ConfigOutput112 (4th mains)
 ConfigOutput114 (5th mains)
 ConfigOutput116 (6th mains)
 ConfigOutput74Read (1st mains)
 ConfigOutput100Read (2nd mains)
 ConfigOutput110Read (3rd mains)
 ConfigOutput112Read (4th mains)
 ConfigOutput114Read (5th mains)
 ConfigOutput115Read (6th mains)

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|------------------------------------|------------|
| UINT | 0 to 2000 | 0 to 200% of U_{NomMains} | 0.1% |

Response time for mains undervoltage (U_{minMains})

Name:

ConfigOutput83 (1st mains)
 ConfigOutput101 (2nd mains)
 ConfigOutput111 (3rd mains)
 ConfigOutput113 (4th mains)
 ConfigOutput115 (5th mains)
 ConfigOutput117 (6th mains)
 ConfigOutput83Read (1st mains)
 ConfigOutput101Read (2nd mains)
 ConfigOutput111Read (3rd mains)
 ConfigOutput113Read (4th mains)
 ConfigOutput115Read (5th mains)
 ConfigOutput117Read (6th mains)

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|-------------------|------------|
| UINT | 5 to 60000 | For 0.005 to 60 s | 0.001 s |

Microgrid monitoring

A microgrid is a small mains power grid that only supplies a limited area and generally is not connected to other mains grids, which means it can function autonomously. This is in contrast to a synchronous grid, in which multiple smaller mains grids are connected together and synchronized.

With microgrid monitoring, the mains is monitored for over/undervoltage. After a defined response time elapses, a corresponding error message is generated. Microgrid monitoring always checks the line-to-line voltages independently of the configuration in the "ConfigOutput22" on page 2891 register.

Overvoltage limit of the mains ($U_{\max\text{Mains}}$)

Name:

ConfigOutput106

ConfigOutput106Read

If the value of one of the linked mains voltages exceeds the value set here, then the "Microgrid monitoring" error message (register "StatusInputPacked04" on page 2913) is indicated after the delay time has passed and, if configured, the DO5 monitoring relay is switched.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|------------------------------------|------------|
| UINT | 0 to 2000 | 0 to 200% of U_{NomMains} | 0.1% |

Undervoltage limit of the mains ($U_{\min\text{Mains}}$)

Name:

ConfigOutput107

ConfigOutput107Read

If the value of one of the linked mains voltages falls below the value set here, then the "Microgrid monitoring" error message (register "StatusInputPacked04" on page 2913) is indicated after the delay time has passed and, if configured, the DO5 monitoring relay is switched.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|--|------------|
| UINT | 0 to 2000 | For 0 to 200% of U_{NomMains} | 0.1% |

Response time for microgrid limit

Name:

ConfigOutput108

ConfigOutput108Read

An error is triggered only if the response value is exceeded without interruption (in either the positive or negative direction) for as long as is specified in this register.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|--------------------|------------|
| UINT | 5 to 200 | For 0.005 to 0.2 s | 0.001 s |

Phase shift monitoring

A phase shift is an abrupt change to the voltage curve that can be caused by a significant change to the load.

In this case, the device recognizes a single change to the period duration. This changed period duration is compared with the calculated average value from past measurements. Monitoring takes place for three phases and if desired also for a single phase. The phase shift monitoring function is only active if the mains voltage is higher than the set percentage value based on the nominal voltage for the converter.

If the response value is exceeded, the error message "Phase shift" is indicated (register "StatusInputPacked02" on page 2912) and, if configured, the DO5 monitoring relay is switched.

Phase shift monitoring response time

A phase shift is indicated on output DO5 within 2 ms after detection of the phase shift (i.e. after zero crossing of the extended/shortened period), as long as this is configured accordingly.

Phase shift detection

Phase shift detection is configured in the "ConfigOutput22" on page 2891 register.

| Type of monitoring | Description |
|--|--|
| Only three-phase monitoring | Triggering takes place if the limit value for three-phase monitoring was exceeded on all 3 phases within 2 periods. |
| Single-phase or three-phase monitoring | Triggering takes place: <ul style="list-style-type: none"> • If the limit value for single-phase monitoring is exceeded on at least one of the 3 phases • If the limit value for three-phase monitoring was exceeded on all 3 phases within 2 periods. |

Phase shift monitoring detects an abrupt change to the period duration of the mains voltage.

The period duration of the current period is compared with the average value for the period duration over the past 4 periods. If the difference exceeds the set limit value, then triggering takes place immediately.

Limit value

Setting of the limit value takes place in 0.1° steps. The internal limit value in μs is calculated as follows:

$$t_{\text{hres}}[\mu\text{s}] = t_{\text{hres}}[0.1^\circ] * \text{Period duration} / 3600$$

When do this, the period duration for the set nominal frequency is used.

Example

Calculation of $t_{\text{hres}}[\mu\text{s}]$ at 50 Hz (period duration = 20000 μs) and limit value of 7°:

$$t_{\text{hres}}[\mu\text{s}] = 70 * 20000 \mu\text{s} / 3600 = 388.88 \mu\text{s} \text{ (rounded to } 389 \mu\text{s)}$$

If the period duration thus changes abruptly by more than +389 μs , triggering takes place.

Maximum phase difference for a single phase

Name:

ConfigOutput78

ConfigOutput78Read

Triggering occurs if the electrical angle of the voltage curve shifts by more than the set angle on at least one phase.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|--------------|------------|
| UINT | 0 to 990 | For 0 to 99° | 0.1° |

Maximum phase difference for three phases

Name:

ConfigOutput79

ConfigOutput79Read

Triggering occurs if the electrical angle of the voltage curve shifts by more than the set angle on all 3 phases.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|--------------|------------|
| UINT | 0 to 990 | For 0 to 99° | 0.1° |

Minimum voltage for phase shift monitoring

Name:

ConfigOutput88

ConfigOutput88Read

A minimum voltage can be set. Phase shift monitoring is only active if the voltage on all 3 phases exceeds this value. The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|---------------------------------|------------|
| UINT | 0 to 2000 | For 0 to 200% of $U_{NomMains}$ | 0.1% |

Mains frequency change**Response value for mains frequency change (df/dt)**

Name:

ConfigOutput80

ConfigOutput80Read

For df/dt monitoring, the frequency change in each period is compared to the previous period.

If this value exceeds the configured limit value in each of the periods for the specified number of periods and the sign for the frequency change is always the same, the error message "Df/dt (mains frequency change)" is indicated (register "[StatusInputPacked02](#)" on page 2912) and, if configured, the DO5 monitoring relay is switched.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|-------------------|------------|
| UINT | 0 to 1000 | For 0 to 100 Hz/s | 0.1 Hz/s |

Number of periods for mains frequency change (df/dt)

Name:

ConfigOutput87

ConfigOutput87Read

This register is used to define the number of periods for monitoring the mains frequency change. For activation, the response value must be continually exceeded at least for as many periods as specified in this register. The display of the error message on output DO5 takes place max. 2 ms after internal detection.

The value of this register can be read back.

Example

The maximum tripping time at 4 periods and 50 Hz mains frequency is calculated as follows:

Max. tripping time = $4 \times 20 \text{ ms} + 2 \text{ ms} = 82 \text{ ms}$

The change in period duration caused by the frequency gradients must also be accounted for.

| Data type | Value | Information | Resolution |
|-----------|----------|-------------|------------|
| UINT | 1 to 250 | - | - |

DO5 function**DO5 function**

Name:

ConfigOutput81

ConfigOutput81Read

This digital output can be set after the defined response time has elapsed depending on the assignment of the mains' monitoring variables.

The monitoring variables can be assigned to this input either individually or with additional monitoring variables using an OR operator. This makes it possible to set the output when there are multiple monitoring variables.

The following table is an overview of the monitoring functions that can be assigned to the monitoring output.

The value of this register can be read back.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Error notification |
|---------|-----------------------------|-------|------------------------|
| 0 | Overvoltage (of a phase) | 0 | Do not assign function |
| | | 1 | Assign function |
| 1 | Undervoltage (of a phase) | 0 | Do not assign function |
| | | 1 | Assign function |
| 2 | Overfrequency | 0 | Do not assign function |
| | | 1 | Assign function |
| 3 | Underfrequency | 0 | Do not assign function |
| | | 1 | Assign function |
| 4 | Voltage asymmetry | 0 | Do not assign function |
| | | 1 | Assign function |
| 5 | Phase shift - 1-/3-phase | 0 | Do not assign function |
| | | 1 | Assign function |
| 6 | Df/dt exceeded | 0 | Do not assign function |
| | | 1 | Assign function |
| 7 | Undervoltage 2 (of a phase) | 0 | Do not assign function |
| | | 1 | Assign function |
| 8 | Overvoltage 2 (of a phase) | 0 | Do not assign function |
| | | 1 | Assign function |
| 9 | Underfrequency 2 | 0 | Do not assign function |
| | | 1 | Assign function |
| 10 | Overfrequency 2 | 0 | Do not assign function |
| | | 1 | Assign function |
| 11 | Microgrid monitoring | 0 | Do not assign function |
| | | 1 | Assign function |
| 12 - 15 | Reserved | - | |

Information:

The minimum pulse duration when a monitoring function responds to both the fault bit via X2X as well as on the output is 500 ms.

9.26.3.19.4.7 Busbar**Busbar nominal voltage (U_{NomBus})**

Name:

ConfigOutput03

ConfigOutput03Read

This is needed for converting the percentages based on this nominal value into physical units.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-------------|-------------------|------------|
| UINT | 70 to 65000 | For 70 to 65000 V | 1 V |

Multiplier for busbar

Name:

ConfigOutput05

ConfigOutput05Read

This is used for converting the measured value into a physical value. The multiplier is applied to the respective input value.

100 thus means a multiplier factor of 1 (measured value not changed).

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|--------------------|------------|
| UINT | 1 to 65535 | For 0.01 to 655.35 | 0.01 |

Minimum busbar voltage (U_{Bmin})

Name:

ConfigOutput40

ConfigOutput40Read

Configurable threshold for zero voltage monitoring of the busbar based on its nominal voltage. DO3 is set if the value falls below the configured threshold.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|-------------------------------|------------|
| UINT | 0 to 1000 | For 0 to 100% of U_{NomBus} | 0.1% |

9.26.3.19.4.8 Synchronization**Synchronization mode**

Name:

ConfigOutputPacked01

ConfigOutput17 to ConfigOutput19

If multiple mode bits are set at the same time, then no mode will be selected (type BOOL).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------|-------|----------------------|
| 0 | ConfigOutput17 | 0 | Sync mode ≠ Slip |
| | | 1 | Sync mode = Slip |
| 1 | ConfigOutput18 | 0 | Sync mode ≠ Check |
| | | 1 | Sync mode = Check |
| 2 | ConfigOutput19 | 0 | Sync mode ≠ Dead bus |
| | | 1 | Sync Mode = Dead bus |
| 3 - 7 | Reserved | - | |

Synchronization configuration

Name:

ConfigOutput56

ConfigOutput56Read

This register contains parameters for configuring which mains or voltages should be synchronized with each other.

The value of this register can be read back.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|--|-------|---|
| 0 - 1 | Synchronization configuration (synchronization mains - mains being synchronized) | 00 | X4 - X6: Synchronization mains 1 - Synchronization mains 2 The configuration X4 - X6 is only possible if "Sync mains 1 / Sync mains 2" is configured in the "ConfigOutput68" on page 2875 register. |
| | | 01 | X4 - X5: Synchronization mains 1 - Busbar |
| | | 10 | X4 - X3: Synchronization mains 1 - Generator |
| | | 11 | X5 - X3: Busbar - Generator |
| 2 - 7 | Reserved | 0 | |
| 8 | Synchronization output | 0 | Digital output 4 |
| | | 1 | Digital output 6 - Output must be configured as a synchronization output (see register "ConfigOutput24" on page 2876) |
| 9 - 15 | Reserved | 0 | |

Max. differential frequency (df_{max})

Name:

ConfigOutput11

ConfigOutput11Read

A switch-on command on DO4 is only output if this configured differential frequency is not exceeded. This value specifies the upper frequency (positive value corresponds to positive slip → generator frequency is greater than the busbar frequency when synchronizing).

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|---------|---------------------|------------|
| UINT | 2 to 49 | For 0.02 to 0.49 Hz | 0.01 Hz |

Min. differential frequency (df_{min})

Name:

ConfigOutput12

ConfigOutput12Read

A switch-on command on DO4 is only output if this configured differential frequency is not exceeded in the negative direction. This value specifies the lower frequency (negative value corresponds to negative slip → generator frequency is less than the busbar frequency when synchronizing).

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|-------------------|------------|
| INT | -49 to 0 | For -0.49 to 0 Hz | 0.01 Hz |

Max. differential voltage (dU_{max})

Name:

ConfigOutput13

ConfigOutput13Read

A switch-on command on DO4 is only output if this configured differential voltage percentage based on the synchronization mains' nominal voltage is not exceeded.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|--------------------------------|------------|
| UINT | 1 to 300 | For 0.1 to 30% of U_{NomSyn} | 0.1% |

Max. permitted differential angle (ϕ_{Max})

Name:

ConfigOutput14

ConfigOutput14Read

A switch-on command on DO4 is only output if the configured differential angle between the two synchronization mains is not exceeded.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|----------------|------------|
| UINT | 1 to 600 | For 0.1 to 60° | 0.1° |

Phase rotation of sync mains 1 ($d\alpha$)

Name:

ConfigOutput15

ConfigOutput15Read

This parameter is used for correcting any phase shifting from upstream transformer vector groups before reaching the mains being synchronized.

This parameter specifies how many degrees the synchronization mains lags behind the mains being synchronized.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|---------------|------------|
| UINT | 0 to 3600 | For 0 to 360° | 0.1° |

Pulse duration of the switch-on relay

Name:

ConfigOutput47 (DO4)

ConfigOutput95 (DO6)

ConfigOutput47Read (DO4)

ConfigOutput95Read (DO6)

The duration of the switch-on pulse can be adjusted for the following switching units.

The value of this register can be read back.

| Data type | Values | Information | Resolution |
|-----------|------------|-----------------|------------|
| UINT | 40 to 1000 | For 0.04 to 1 s | 0.001 s |

Switching response time of the power switch

Name:

ConfigOutput48 (DO4)

ConfigOutput96 (DO6)

ConfigOutput48Read (DO4)

ConfigOutput96Read (DO6)

The actuation time of the generator power switch corresponds to the lead time of the switch-on command. The switch-on command is executed before the point of synchronization according to the amount of time defined here.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|-------------------|------------|
| UINT | 40 to 300 | For 0.04 to 0.3 s | 0.001 s |

Dead bus voltage ($U_{BminSync}$)

Name:

ConfigOutput58

ConfigOutput58Read

Configurable threshold for dead bus synchronization based on the nominal voltage of the busbar.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|-------------------------------|------------|
| UINT | 0 to 1000 | For 0 to 100% of U_{NomBus} | 0.1% |

2-phase synchronization for commissioning tests

Name:

ConfigOutput93

ConfigOutput93Read

2-phase synchronization for commissioning tests.

The value of this register can be read back.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------|-------|---|
| 0 | Synchronization | 0 | 3-phase synchronization (normal operation) |
| | | 1 | 2-phase synchronization with L1 and L2 (commissioning tests with 2-phase simulation design) |
| 1 - 7 | Reserved | 0 | |

Information:

It is only possible to set 2-phase synchronization for commissioning tests with a 2-phase simulation design.

If only 2 phases are connected, then the respective mains must be configured with neutral conductors since a network with a "virtual neutral point" is not possible with 2 phases (see register "[ConfigOutput68](#)" on page 2875).

9.26.3.19.4.9 Maximum value buffer and power meter**Pulse value of energy meter output**

Name:

ConfigOutput46

ConfigOutput46Read

Output DO2 outputs pulses that occur at a frequency proportional to the measured energy. The frequency of the pulses can be specified. The length of the pulse is 400 ms. The frequency at which the pulses occur should be set so that the duration between two pulses does not exceed 400 ms at the highest possible power. The pulse output's internal meter starts at 0 kWh after a restart. This register has no effect on the "ConfigOutput54" on page 2909 and "ConfigOutput55" on page 2909 registers.

When set to 0, meter output is disabled.

Depending on how the "Power measurement mode" parameter is set in the "ConfigOutput21" on page 2878 register, either the total active power or the active power of the fundamental wave is added together. Changing the parameter "Power measurement mode" during runtime does not cause the internal energy meter to restart.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|--------------------------|-------------|
| UINT | 0 to 65535 | For 0 to 65535 kWh/pulse | 1 kWh/pulse |

Count value for active energy meter and reactive energy meter

Name:

ConfigOutput94

ConfigOutput94Read

This parameter is used to configure the resolution of active and reactive energy counters.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-------------|-------------|------------|
| UINT | 0 to 65,535 | - | 1 kWh |

Maximum value buffer and meter buffer

These registers are used for nonvolatile storage of the maximum value and meter level values. After restarting, the stored maximum values and meter states are loaded back into their registers and the module's internal work meter is reset. It is possible to reset or write to the stored maximum values and meter states using an acyclic register.

The maximum values are recorded by the effective measured values before reaching the configurable filter. The maximum values can be read or written to as acyclic registers.

Maximum phase current

Name:

Reading: ConfigOutput49 (generator I1)

Reading: ConfigOutput50 (generator I2)

Reading: ConfigOutput51 (generator I3)

Writing: ConfigOutput60 (generator I1)

Writing: ConfigOutput61 (generator I2)

Writing: ConfigOutput62 (generator I3)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 A |

Maximum total active power (supplied power)

Name:

Reading: ConfigOutput52

Writing: ConfigOutput63

Depending on the status of the "Power measurement mode" parameter in the "ConfigOutput21" on page 2878 register, either the total power or the fundamental power is added together or compared.

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 kW |

Maximum neutral conductor current

Name:

Reading: ConfigOutput53

Writing: ConfigOutput64

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 A |

Active energy counter

Name:

Reading: ConfigOutput54 (delivered (producing))

Reading: ConfigOutput71 (drawn (consuming))

Writing: ConfigOutput66 (delivered (producing))

Writing: ConfigOutput69 (drawn (consuming))

Depending on the status of the "Power measurement mode" parameter in the "ConfigOutput21" on page 2878 register, either the total power or the fundamental power is added together or compared.

The resolution can be configured (see register "ConfigOutput94" on page 2908).

| Data type | Value | Information | Resolution |
|-----------|------------------------------------|-------------|------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | - | Default: 100 kWh |

Reactive energy counter

Name:

Reading: ConfigOutput55 (reactive energy meter delivered (producing))

Reading: ConfigOutput72 (reactive energy meter drawn (consuming))

Writing: ConfigOutput67 (reactive energy meter delivered (producing))

Writing: ConfigOutput70 (reactive energy meter drawn (consuming))

Depending on the status of the "Power measurement mode" parameter in the "ConfigOutput21" on page 2878 register, either the total power or the fundamental power is added together or compared.

The resolution can be configured (see register "ConfigOutput94" on page 2908).

| Data type | Value | Information | Resolution |
|-----------|------------------------------------|-------------|--------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | - | Default: 100 kvarh |

9.26.3.19.5 Communication registers

9.26.3.19.5.1 General registers

DigitalOutputPacked01

Name:

DigitalOutputPacked01

DigitalOutput05

DigitalOutput06

ResetGeneratorErrors

ResetMainsErrors

InvertDO5

DigitalOutput01

The module's default configuration is that the generator and mains error bits are reset by the module. If this should be done by the user, then the module needs to be configured accordingly using the following registers.

- Generator error: "[ConfigOutput21](#)" on page 2878
- Network error: "[ConfigOutput22](#)" on page 2891

(data point applied as BOOL)

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------------|-------|--|
| 0 | DigitalOutput05 | 0 | Reset output 5 |
| | | 1 | Set output 5 |
| 1 | DigitalOutput06 | 0 | Reset output 6 |
| | | 1 | Set output 6 |
| 2 | ResetGeneratorErrors | 0 | Does not reset generator error bits |
| | | 1 | Resets generator error bits |
| 3 | ResetMainsErrors | 0 | Do not reset mains error bits |
| | | 1 | Reset mains error bits |
| 4 | InvertDO5 | 0 | Do not invert Output 5 |
| | | 1 | Invert output 5 of the mains monitoring function |
| 5 | DigitalOutput01 | 0 | Reset output 1 |
| | | 1 | Set output 1 |
| 6 - 7 | Reserved | 0 | |

StatusDigitalOutputPacked01

Name:

StatusDigitalOutputPacked01

StatusDigitalOutput01 to StatusDigitalOutput06

StatusInput16 to StatusInput17

(data point applied as BOOL)

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------------|-------|--|
| 0 | StatusDigitalOutput01 | 0 | Current state of output 1 = LOW |
| | | 1 | Current state of output 1 = HIGH |
| ... | | ... | |
| 5 | StatusDigitalOutput06 | 0 | Current state of output 6 = LOW |
| | | 1 | Current state of output 6 = HIGH |
| 6 | StatusInput17 | 0 | Status DO OK |
| | | 1 | Status DO overload |
| 7 | StatusInput16 | 0 | Status 24 V output supply OK |
| | | 1 | Status 24 V output supply undervoltage |

StatusInputPacked01

Name:

StatusInputPacked01

StatusInput01 to StatusInput11

StatusInput31 to StatusInput32

StatusInput18

This register is the error register for the generator mains (error bits are of type BOOL). With regard to bits 9, 11 and 12, please also observe the description of the "Power measurement mode" parameter in the register "[ConfigOutput21](#)" on page 2878.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|---------------|-------|--|
| 0 | StatusInput01 | 0 | Overvoltage (one phase), OK |
| | | 1 | Overvoltage (one phase), present |
| 1 | StatusInput02 | 0 | Undervoltage (one phase), OK |
| | | 1 | Undervoltage (one phase), present |
| 2 | StatusInput03 | 0 | Over-frequency, OK |
| | | 1 | Over-frequency, present |
| 3 | StatusInput04 | 0 | Under-frequency, OK |
| | | 1 | Under-frequency, present |
| 4 | StatusInput05 | 0 | Voltage asymmetry, OK |
| | | 1 | Voltage asymmetry, present |
| 5 | StatusInput06 | 0 | Current asymmetry, OK |
| | | 1 | Current asymmetry, present |
| 6 | StatusInput07 | 0 | Maximum neutral conductor current, OK |
| | | 1 | Maximum neutral conductor current exceeded |
| 7 | StatusInput08 | 0 | Short circuit-current, OK |
| | | 1 | Short circuit-current, present |
| 8 | StatusInput09 | 0 | Rating-dependent overcurrent OK |
| | | 1 | Rating-dependent overcurrent occurring |
| 9 | StatusInput10 | 0 | Capacitive reactive power (exciter failure), OK |
| | | 1 | Capacitive reactive power (exciter failure), present |
| 10 | StatusInput11 | 0 | Ready, OK |
| | | 1 | Not ready |
| 11 | StatusInput31 | 0 | No generator overload |
| | | 1 | Generator overload |
| 12 | StatusInput32 | 0 | No generator feedback |
| | | 1 | Generator feedback |
| 13 - 14 | Reserved | - | |
| 15 | StatusInput18 | 0 | Undervoltage 2 (of a phase) OK |
| | | 1 | Undervoltage 2 (of a phase) occurring |

StatusInput11

The error message "Not ready" is triggered if the X20 I/O supply drops below 18 VDC.

StatusInputPacked02

Name:

StatusInputPacked02

StatusInput24 to StatusInput30

StatusInput33

This register is the error register for the mains (error bits are of type BOOL).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|---------------|-------|---------------------------------------|
| 0 | StatusInput24 | 0 | Overvoltage (one phase), OK |
| | | 1 | Overvoltage (one phase), present |
| 1 | StatusInput25 | 0 | Undervoltage (one phase), OK |
| | | 1 | Undervoltage (one phase), present |
| 2 | StatusInput26 | 0 | Over-frequency, OK |
| | | 1 | Over-frequency, present |
| 3 | StatusInput27 | 0 | Under-frequency, OK |
| | | 1 | Under-frequency, present |
| 4 | StatusInput28 | 0 | Voltage asymmetry, OK |
| | | 1 | Voltage asymmetry, present |
| 5 | StatusInput29 | 0 | Phase shift monitoring OK |
| | | 1 | Phase shift error (1/3 of a phase) |
| 6 | StatusInput30 | 0 | Df/dt OK |
| | | 1 | Df/dt error |
| 7 | StatusInput33 | 0 | Undervoltage 2 (of a phase) OK |
| | | 1 | Undervoltage 2 (of a phase) occurring |

StatusInput33

The data point is only valid if 2-point mode is configured (see register "[ConfigOutput22](#)" on page 2891). This bit only appears in the I/O mapping in Automation Studio if the corresponding status information is enabled in the I/O configuration ("Mains configuration / Additional status information" menu option).

StatusInputPacked03

Name:

StatusInputPacked03

StatusInput12 to StatusInput15

StatusInput19 to StatusInput23

This register is the error register for general error messages (error bits are of type BOOL).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|---------------|-------|--|
| 0 | StatusInput12 | 0 | All phases of the generator mains OK |
| | | 1 | Failure of at least one phase of the generator mains |
| 1 | StatusInput13 | 0 | All phases of the busbar OK |
| | | 1 | Failure of at least one phase of the busbar |
| 2 | StatusInput14 | 0 | All phases of Sync Mains 1 OK |
| | | 1 | Failure of at least one phase of Sync Mains 1 |
| 3 | StatusInput15 | 0 | All phases of Sync Mains 2 OK |
| | | 1 | Failure of at least one phase of Sync Mains 2 |
| 4 | StatusInput19 | 0 | Phase sequence of generator voltage OK |
| | | 1 | Phase sequence of generator voltage incorrect |
| 5 | StatusInput20 | 0 | Phase sequence of generator current OK |
| | | 1 | Phase sequence of generator current incorrect |
| 6 | StatusInput21 | 0 | Phase sequence of busbar OK |
| | | 1 | Phase sequence of busbar incorrect |
| 7 | StatusInput22 | 0 | Phase sequence of Sync Mains 1 OK |
| | | 1 | Phase sequence of Sync Mains 1 incorrect |
| 8 | StatusInput23 | 0 | Phase sequence of Sync Mains 2 OK |
| | | 1 | Phase sequence of Sync Mains 2 incorrect |
| 9 - 15 | Reserved | - | |

StatusInput12 to StatusInput15: Phase failure is detected if at least one of the phases of the respective terminal fails.

StatusInput19 to StatusInput23 are status bits for detecting a change of rotation.

StatusInputPacked04

Name:

StatusInputPacked04

StatusInput34 to StatusInput37

This register is the error register for the mains (error bits are of type BOOL). These bits only appear in the I/O mapping in Automation Studio if the corresponding status information is enabled in the I/O configuration ("Mains configuration / Additional status information" menu option).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|---------------|-------|--------------------------------------|
| 0 | StatusInput34 | 0 | Overvoltage 2 (of a phase) OK |
| | | 1 | Overvoltage 2 (of a phase) occurring |
| 1 | StatusInput35 | 0 | Underfrequency 2 OK |
| | | 1 | Underfrequency 2 occurring |
| 2 | StatusInput36 | 0 | Overfrequency 2 OK |
| | | 1 | Overfrequency 2 occurring |
| 3 | StatusInput37 | 0 | Microgrid monitoring OK |
| | | 1 | Microgrid monitoring tripped |
| 4 - 15 | Reserved | - | |

StatusInputPacked05

Name:

StatusInputPacked05

StatusInput38 to StatusInput40

This register is the error register for the generator mains (error bits are of type BOOL). These bits only appear in the I/O mapping in Automation Studio if the corresponding status information is enabled in the I/O configuration ("Generator mains / Additional status information" menu option).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|---------------|-------|--------------------------------------|
| 0 | StatusInput38 | 0 | Overvoltage 2 (of a phase) OK |
| | | 1 | Overvoltage 2 (of a phase) occurring |
| 1 | StatusInput39 | 0 | Underfrequency 2 OK |
| | | 1 | Underfrequency 2 occurring |
| 2 | StatusInput40 | 0 | Overfrequency 2 OK |
| | | 1 | Overfrequency 2 occurring |
| 3 | StatusInput41 | 0 | Q-U protection OK |
| | | 1 | Q-U protection active |
| 4 - 15 | Reserved | - | |

9.26.3.19.5.2 Generator mains measured values**Phase currents of the generator**

Name:

AnalogInput01 (I1)

AnalogInput02 (I2)

AnalogInput03 (I3)

Phase currents of the generator

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 A |

Neutral conductor current of generator I_n

Name:

AnalogInput05

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 A |

Current average of generator I1, I2, I3

Name:

AnalogInput04

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 A |

Dynamic current average of generator (I_{m_dyn})

Name:

AnalogInput06

Describes the change to the current average.

The dynamic average is the amount of change (I_{m_diff}) of the current average (sampling time: 10 ms).

This value decays in an e-function.

$$I_{m_diff} > I_{m_dyn} \rightarrow I_{m_dyn} = I_{m_diff}$$

$$I_{m_diff} \leq I_{m_dyn} \rightarrow I_{m_dyn} = I_{m_dyn} * 0.98$$

| Data type | Value | Information | Resolution |
|-----------|-------------|-------------|------------|
| UINT | 0 to 65,535 | - | 1 A |

Line-to-line voltages of the generator

Name:

AnalogInput07 (UG12)

AnalogInput08 (UG23)

AnalogInput09 (UG31)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

Phase voltages of the generator

Name:

AnalogInput10 (UG 1)

AnalogInput11 (UG 2)

AnalogInput12 (UG 3)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

Voltage average of the generator

Name:

AnalogInput22

Voltage average of the generator UG12, UG23, UG31 (U~3 average)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

Filtered generator power values:

Name:

AnalogInput19

AnalogInput20

AnalogInput21

Filtered generator power values:

- Total output (sum of all harmonic frequencies)
- Fundamental frequency power (_H1)

Configuration is explained in the "[ConfigOutput21](#)" on [page 2878](#) register.

| Data type | Value | Information | Resolution |
|-----------|-----------------|-----------------------------|------------|
| INT | -32768 to 32767 | Total active power P/P_H1 | 1 kW |
| | -32768 to 32767 | Total reactive power Q/Q_H1 | 1 kvar |
| | -32768 to 32767 | Total apparent power S/S_H1 | 1 kVA |

Power factor of generator/cos ϕ

Name:

AnalogInput23

The factor is described in "[Power factor of the generator](#)" on [page 2865](#) and register "[ConfigOutput21](#)" on [page 2878](#).

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 0.001 |

Frequency of the generator mains

Name:

AnalogInput24

| Data type | Value | Information | Resolution |
|-----------|-------------|-------------|------------|
| UINT | 0 to 65,535 | - | 0.01 Hz |

Timestamp for generator voltages and currents

These timestamps mark the last positive zero crossing of the generator voltages (L1-N, L2-N, L3-N) and generator currents (I1, I2, I3). They can be used to calculate all the necessary phase ratios.

Calculation of the phase ratios and error handling for the calculations are to be implemented by the user (e.g. period duration monitoring or verification that the voltages are high enough, etc.).

These timestamps only appear in the I/O mapping in Automation Studio if they are enabled in the I/O configuration ("Enable timestamps for generator voltage and current" menu option).

Timestamp of pos. zero crossing of phase voltage

Name:

AnalogInput38 (UG1)

AnalogInput39 (UG2)

AnalogInput40 (UG3)

Time stamp of pos. zero crossing of phase voltage of the respective generator

| Data type | Value | Information | Resolution |
|-----------|------------------------------------|-------------|------------|
| DINT | -2,147,483,648 to 2,147,483,647 | - | 1/4096 µs |

Timestamp of pos. zero crossing of phase current

Name:

AnalogInput41 (I1)

AnalogInput42 (I2)

AnalogInput43 (I3)

Time stamp of pos. zero crossing of phase current of the respective generator

| Data type | Value | Information | Resolution |
|-----------|------------------------------------|-------------|------------|
| DINT | -2,147,483,648 to 2,147,483,647 | - | 1/4096 µs |

Instantaneous values of the phase currents generator

Name:

AnalogInput48 (I1)

AnalogInput49 (I2)

AnalogInput50 (I3)

The instantaneous measured values of the respective phase currents are applied here. To calculate the actual physical quantities, the transferred values must be multiplied by the multiplier for the current transformer ("[ConfigOutput09Read](#)" on page 2877). To avoid aliasing through transfer in the X2X cycle, the values are pre-filtered on the module.

| Data type | Values | Information | Resolution |
|-----------|-----------------|---|------------|
| UINT | -32768 to 32767 | Corresponds to the direct measured values of the phase currents | - |

Instantaneous values of the phase voltages generator

Name:

AnalogInput45 (UG1)

AnalogInput46 (UG2)

AnalogInput47 (UG3)

The instantaneous measured values of the respective phase voltages are applied here. To calculate the actual physical quantities, the transferred values must be multiplied by the multiplier for the generator mains ("[ConfigOutput06Read](#)" on page 2877). To avoid aliasing through transfer in the X2X cycle, the values are pre-filtered on the module.

| Data type | Values | Information | Resolution |
|-----------|-----------------|---|------------|
| UINT | -32768 to 32767 | Corresponds to the direct measured values of the phase voltages | - |

Counter for real-time values

Name:
LifeCnt

The counter is incremented with each X2X cycle (new instantaneous values are available 1x per X2X cycle). This makes it possible in the application to detect whether values were skipped or the same value was read twice.

In principle, tasks in which the instantaneous values are processed should have a cycle time equal to the X2X cycle time. If the task cycle time is a multiple of the X2X cycle time, this must be taken into account when configuring register "ConfigOutput125" on page 2879.

| Data type | Values | Information | Resolution |
|-----------|-------------|---|------------|
| SINT | -128 to 127 | Counter incremented if new instantaneous values available | - |

9.26.3.19.5.3 Busbar measured values**Line-to-line voltages of the busbar**

Name:
AnalogInput13 (UB12)
AnalogInput14 (UB23)
AnalogInput15 (UB31)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

Phase voltages of the busbar

Name:
AnalogInput16 (UB1)
AnalogInput17 (UB2)
AnalogInput18 (UB3)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

Frequency of busbar

Name:
AnalogInput35

| Data type | Value | Information | Resolution |
|-----------|-------------|-------------|------------|
| UINT | 0 to 65,535 | - | 0.01 Hz |

9.26.3.19.5.4 Measured value of synchronization mains

(for mains configuration "Sync mains 1 / Sync mains 2")

Line-to-line voltages

Name:

AnalogInput25 (sync mains 1 US1)

AnalogInput26 (sync mains 2 US2)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

Frequencies

Name:

AnalogInput27 (sync mains 1)

AnalogInput28 (sync mains 2)

| Data type | Value | Information | Resolution |
|-----------|-------------|-------------|------------|
| UINT | 0 to 65,535 | - | 0.01 Hz |

9.26.3.19.5.5 Measured value of mains

(for "3-phase mains" configuration)

Line-to-line voltages of mains

Name:

AnalogInput25 (UN12)

AnalogInput31 (UN23)

AnalogInput32 (UN31)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

Phase voltages of the generator

Name:

AnalogInput33 (UN1)

AnalogInput34 (UN2)

AnalogInput26 (UN3)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

Frequency of power mains

Name:

AnalogInput27

| Data type | Value | Information | Resolution |
|-----------|-------------|-------------|------------|
| UINT | 0 to 65,535 | - | 0.01 Hz |

9.26.3.19.5.6 Generator monitoring**Read unbalanced load meter**

Name:

AnalogInput36

This register can be used to track the current state of the unbalanced load meter (see "[Dependent delayed unbalanced load monitoring](#)" on page 2882). The unbalanced load meter can be reset with an acyclic trigger bit (see register "[ConfigOutput23](#)" on page 2877).

| Data type | Value | Information | Resolution |
|-----------|------------|---------------|------------|
| UINT | 0 to 65535 | For 0 to 100% | |

Reads the unbalanced load current (I₂)

Name:

AnalogInput37

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 A |

9.26.3.19.5.7 Synchronization**Differential angle between synchronization mains**

Name:

AnalogInput29

Angular difference between the mains being synchronized

Specifies how many degrees the sync mains are ahead of the mains being synchronized.

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 0.1° |

Differential voltage between synchronization mains

Name:

AnalogInput30

Voltage difference between the mains being synchronized

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

9.26.3.19.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 250 μ s |

9.26.3.19.7 Minimum I/O update time

The minimum I/O update time for the analog inputs depends on the respective period duration of the measurement signal frequency.

| Minimum I/O update time |
|-------------------------|
| At 50 Hz 10 ms |

9.26.4 X20(c)CM0985-1

Data sheet version: 1.42

9.26.4.1 General information

The module has a compact size and combines a power measurement module that has special features with a synchronization unit that is able to meet all demands.

The measurement unit's 3 current inputs are suitable for both X: 1 A and X: 5 A current transformers. Overcurrent resistance and the high resolution of the measurement unit round off its features. For the voltage inputs, the value range can be configured between 480 VAC and 120 VAC.

The area of use includes 4-wire AC networks with a phase voltage up to 480 VAC and 3-wire systems, whereas L2 can be grounded (V-connection). The module can also handle Aron measuring circuits.

The resulting measured values include the pure phase current; line-to-line voltage or phase voltage; the effective, reactive and apparent power parts; the mains frequency; the power factor and much more. In addition, peak values and energy meters are stored on the module in nonvolatile memory. Depending on the configuration, it is also possible to use a digital output as a pulse encoder for an external energy meter.

The synchronization unit doesn't just take the phasing and phase voltage into consideration; integrated intelligence also monitors the rate of change and other parameters, allowing them to influence when the synchronization output is switched. It is also possible to monitor a generator using a large number of additional conditions. A total of 4 voltage inputs provide substantial overall flexibility.

Monitoring functions expand the features of the module. Rating-dependent overcurrent monitoring is included, which utilizes the thermal capacity of the motor/generator to allow short overloads while still providing full protection. The dependent, delayed imbalanced load monitoring used to protect three-phase generator and three-phase networks from imbalanced load can be adapted to the characteristics of different generator types using parameters while taking their special thermal time constants into account.

- Energy measurement for 120 to 480 VAC
- Simultaneous measurement of 2 AC mains networks plus 2 additional voltages
- For multifunctional measurement tasks
- Intelligent mains synchronization unit

Information:

Please refer to section "[Safety guidelines](#)" on page 2925 before operating the module.

9.26.4.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.26.4.3 Order data

| Model number | Short description | Figure |
|--------------|---|--------|
| | Other functions | |
| X20CM0985-1 | X20 digital and analog mixed module, multi-measurement transducer / synchronization module, 5 digital outputs, 24 VDC, 0.5 A, source, 1 relay, 1 A, 8 analog inputs, ± 480 V / 120 V, 16-bit converter resolution, 3 analog inputs, 5 A / 1 A AC, 16-bit converter resolution, additional software functionalities, order terminal blocks 0TB3102-7011, 0TB3104-7011, 0TB3102-7012, 0TB3104-7012 and 2x X20TB12 separately! | |
| | Analog inputs | |
| X20cCM0985-1 | X20 digital and analog mixed module, coated, multi-measurement transducer / synchronization module, 5 digital outputs, 24 VDC, 0.5 A, source, 1 relay, 1 A, 8 analog inputs, ± 480 V / 120 V, 16-bit converter resolution, 3 analog inputs, 5 A / 1 A AC, 16-bit converter resolution, additional software functionalities, order terminal blocks 0TB3102-7011, 0TB3104-7011, 0TB3102-7012, 0TB3104-7012 and 2x X20TB12 separately! | |
| | Required accessories | |
| | Terminal blocks | |
| 0TB3102-7011 | Accessory terminal block, 2-pin, A keyed, screw clamp terminal block 6 mm ² | |
| 0TB3102-7012 | Accessory terminal block, 2-pin, B keyed, screw clamp terminal block 6 mm ² | |
| 0TB3104-7011 | Accessory terminal block, 4-pin, A keyed, screw clamp terminal block 6 mm ² | |
| 0TB3104-7012 | Accessory terminal block, 4-pin, B keyed, screw clamp terminal block 6 mm ² | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 535: X20CM0985-1, X20cCM0985-1 - Order data

9.26.4.4 Technical data

| Model number | X20CM0985-1 | X20cCM0985-1 |
|---|--|--------------|
| Short description | X20 energy measurement and synchronization module | |
| General information | | |
| B&R ID code | 0xB768 | 0xE4FF |
| Status indicators | Channel status, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using LED status indicator and software | |
| Analog inputs | Yes, using LED status indicator (measurement range of analog inputs) | |
| Digital outputs | Yes, using LED status indicator and software | |
| Overvoltage category | II ¹⁾ | |
| Measurable frequency | | |
| Measurement range | 15.2 Hz to 2x nominal frequency ²⁾ | |
| Accuracy | <10 mHz at 400 V ±5% or 100 V ±5% ³⁾ | |
| Power consumption | | |
| Bus | 1.05 W | |
| Internal I/O | 4 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| KC | Yes | - |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| KR | Yes | |
| Digital outputs | | |
| Quantity | 5 | |
| Variant | FET positive switching | |
| Nominal voltage | 24 VDC | |
| Switching voltage | 24 VDC -15% / +20% | |
| Nominal output current | 0.1 A | |
| Total nominal current | 0.5 A | |
| Connection type | 1-wire connections | |
| Output circuit | Source | |
| Output protection | Thermal shutdown in the event of overcurrent or short circuit | |
| Diagnostic status | Output monitoring with 10 ms delay | |
| Leakage current when switched off | 5 µA | |
| Residual voltage | <0.3 V at 0.1 A nominal current | |
| Peak short-circuit current | <2 A | |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms, depends on the module temperature | |
| Switching delay | | |
| 0 → 1 | <300 µs | |
| 1 → 0 | <300 µs | |
| Switching frequency | | |
| Resistive load | Max. 100 Hz | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Relay outputs | | |
| Quantity | 1 | |
| Variant | Relay / Changeover contact | |
| Nominal voltage | 30 VDC / 240 VAC | |
| Rated frequency | DC / 45 to 63 Hz | |
| Switching capacity | | |
| Min. | 10 mA / 5 VDC | |
| Max. | 30 W / 240 VAC | |
| Nominal output current | 1 A at 30 VDC / 1 A at 240 VAC | |
| Actuator power supply | External | |
| Switching voltage | Max. 60 VDC / 250 VAC | |
| Switching delay | | |
| 0 → 1 | ≤10 ms | |
| 1 → 0 | ≤10 ms | |

Table 536: X20CM0985-1, X20cCM0985-1 - Technical data

| Model number | X20CM0985-1 | X20cCM0985-1 |
|--|-------------|---|
| Service life ⁴⁾ | | |
| Mechanical | | Min. 10 x 10 ⁶ ops. |
| Electrical | | Min. 60 x 10 ³ ops. (NC) at 1 A Min. 30 x 10 ³ ops. (NO) at 1 A |
| Contact resistance | | Max. 100 mΩ |
| Protective circuit | | |
| Internal | | None |
| External | | None |
| DC | | Inverse diode, RC combination or VDR |
| AC | | RC combination or VDR |
| Isolation voltage | | |
| Channel - Channel | | 1000 VAC / 1 min |
| Channel - Bus | | 4000 VAC / 1 min |
| Analog input voltage | | |
| Channels | | 8 |
| Input | | 120 VAC / 480 VAC |
| Input type | | Single-ended |
| Digital converter resolution | | ±15-bit |
| Conversion time | | |
| 50 Hz | | 10 ms |
| 60 Hz | | 8.33 ms |
| Permissible input signal | | Max. 132 VAC / 528 VAC |
| Output format ⁵⁾ | | |
| ±120 VAC | | 1 LSB = 0x0001 = 5.707 mV |
| ±480 VAC | | 1 LSB = 0x0001 = 22.787 mV |
| Output of digital value during overload | | |
| Overshoot | | 0x7FFF |
| Undershoot | | 0x8001 |
| Conversion method | | SAR |
| Input filter | | |
| Cutoff frequency | | 10 kHz |
| Slope | | 60 dB |
| Maximum gain drift ⁶⁾ | | 0.02% per °C |
| Maximum offset drift ⁷⁾ | | 0.003% per °C |
| Crosstalk between channels | | -70 dB |
| Nonlinearity ⁷⁾ | | ≤0.5% at 45 to 65 Hz |
| Protection against electrical shock | | Protective impedance per EN 61131-2 |
| Test voltage between channel and bus (type test) | | 3700 V _{eff} |
| Output format | | INT |
| Input impedance in signal range | | Approx. 3 MΩ |
| Max. error at 25°C | | |
| Gain | | 0.09% ⁶⁾ |
| Offset | | 0.03% ⁷⁾ |
| Input protection | | Overvoltage protection |
| Analog input current | | |
| Channels | | 3 |
| Input | | 1 A / 5 A AC |
| Input type | | Isolated current transformer according to the compensation principle with a magnetic sensor, for connecting an external transformer |
| Digital converter resolution | | ±15-bit |
| Conversion time | | |
| 50 Hz | | 10 ms |
| 60 Hz | | 8.33 ms |
| Permissible input signal | | Max. 1.5 A / 7.7 A |
| Output format ⁵⁾ | | |
| ±1 A | | 1 LSB = 0x0001 = 189.903 μA |
| ±5 A | | 1 LSB = 0x0001 = 949.513 μA |
| Output of digital value during overload | | |
| Overshoot | | 0x7FFF |
| Undershoot | | 0x8001 |
| Conversion method | | SAR |
| Input filter | | |
| Cutoff frequency | | 10 kHz |
| Slope | | 60 dB |
| Maximum gain drift ⁶⁾ | | 0.07% per °C |
| Maximum offset drift | | Measurement range 2 A: 0.0064% per °C, measurement range 10 A: 0.00384% per °C |
| Crosstalk between channels | | -70 dB |
| Nonlinearity ⁸⁾ | | ≤0.5% at 45 to 65 Hz |
| Isolation voltage between channel and bus | | 500 V _{eff} |
| Output format | | INT |
| Max. error at 25°C | | |
| Gain | | 0.2% ⁶⁾ |
| Offset | | 0.05% ⁸⁾ |

Table 536: X20CM0985-1, X20cCM0985-1 - Technical data

| Model number | X20CM0985-1 | X20cCM0985-1 |
|--|--|------------------------|
| Thermal overcurrent ⁹⁾ | 15 x I _{Nom} for 0.2 s ¹⁰⁾ | |
| Monitored overcurrent | 4 x I _{Nom} ¹⁰⁾ | |
| Input impedance ¹¹⁾ | | |
| Measurement range 1 A | Max. 30 mΩ | |
| Measurement range 5 A | Max. 10 mΩ | |
| Electrical properties | | |
| Electrical isolation | Bus isolated from I/O power supply and digital inputs and outputs Digital inputs and outputs isolated from each other | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitation | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating". | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 2x terminal block X20TB12 separately. Order 2x screw clamp terminal block TB3102 and 2x screw clamp terminal block TB3104 separately. | |
| Spacing | 87.5 ^{+0.2} mm | |

Table 536: X20CM0985-1, X20cCM0985-1 - Technical data

- 1) EN 61131-2
- 2) Rated frequency: 48 to 62 Hz. Synchronization is only possible at the nominal frequency.
- 3) - In the frequency range from 49 to 51 Hz provided that the line-to-line voltages (L1 - L2, L2 - L3, L3 - L1) have a strictly monotone zero crossing.
- The measurement precision of the frequency measurement results from:
 - a. Internal measurement precision of the frequency measurement <5 mHz.
 - b. Resolution of the frequency value 10 mHz
 - c. Rounding
- 4) See section "Electrical service life".
- 5) INT, range of values: 0x8001 to 0x7FFF
- 6) Based on the current measured value
- 7) Based on the measurement range 240 VAC / 960 VAC
- 8) Based on the measurement range 2 A / 10 A
- 9) This can result in the measurement hysteresis being offset in relation to the overcurrent.
- 10) Based on the measurement range 1 A / 5 A
- 11) Including current transformer, circuit path and X20TB12 terminal block (5 mΩ)

9.26.4.5 Safety guidelines

General information

Programmable logic controllers, operating/monitoring devices (e.g. industrial PCs, Power Panels, Mobile Panels, etc.) as well as uninterruptible power supplies have all been designed, developed and manufactured by B&R for conventional use or for use with increased safety requirements (safety technology) in industry. They were not designed, developed and manufactured for any use involving serious risks or hazards that could lead to death, injury, serious physical damage or loss of any kind without the implementation of exceptionally stringent safety precautions. In particular, such risks and hazards include the use of these devices to monitor nuclear reactions in nuclear power plants, their use in flight control or flight safety systems as well as in the control of mass transportation systems, medical life support systems or weapons systems.

When using programmable logic controllers or operating/monitoring devices as control systems together with a Soft PLC (e.g. B&R Automation Runtime or comparable product) or Slot PLC (e.g. B&R LS251 comparable product), safety precautions relevant to industrial control systems (e.g. the provision of safety devices such as emergency stop circuits, etc.) must be observed in accordance with applicable national and international regulations. The same applies for all other devices connected to the system, e.g. drives.

All tasks such as the installation, commissioning and servicing of devices are only permitted to be carried out by qualified personnel. Qualified personnel are those familiar with the transport, mounting, installation, commissioning and operation of devices who also have the appropriate qualifications (e.g. IEC 60364-1). National accident prevention regulations must be observed.

The safety notices, connection descriptions (type plate and documentation) and limit values listed in the technical data are to be read carefully before installation and commissioning and must be observed.

Intended use

Danger!

Electronic devices are never completely failsafe. If the multi-measurement and synchronization unit fails, the user is responsible for making sure that the motor or generator is brought to a secure state.

Some errors are detected and prevented in the synchronization unit by the system's internal software monitoring. However, when the device is in operation it is always possible for errors, defective components, software errors or configuration mistakes to occur at any time. B&R emphasizes that the multi-measurement and synchronization unit possesses neither a failsafe function nor a redundancy system. For this reason, independent higher-level safety precautions need to be put in place to ensure that personnel and machines are protected.

Grounding the Mounting Rail

For grounding purposes, a good conductive connection between the mounting rail and the metal back wall is required. The mounting rail is to be connected conductively to the back wall. This is achieved by inserting a contact washer with the fastening screw.

Information:

The control cabinet back wall must be connected with GND

9.26.4.6 LED status indicators

For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

LED status indicators - Right

| Figure | LED | Color | Status | Description |
|--------|-------|-----------------------------|------------------|---|
| | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1 - 6 | Orange | | Output status of the corresponding digital output |

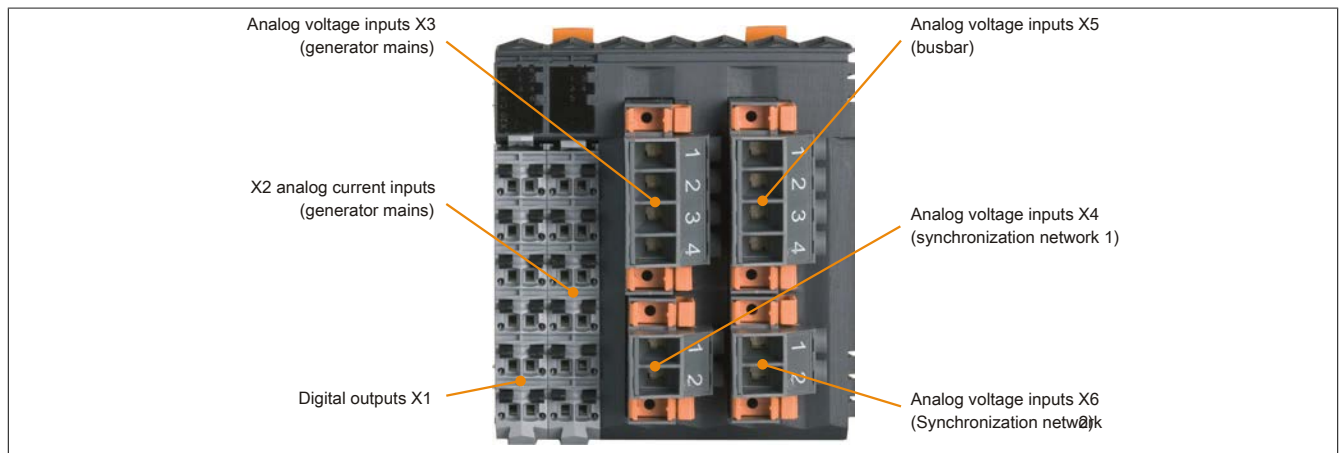
1) Depending on the configuration, a firmware update can take up to several minutes.

Status-LEDs right

| Figure | LED ¹⁾ | Terminal | Color | Status | Description |
|--------|-------------------|----------|-------|--------|----------------------------|
| | 1 | X3 | Green | On | Measurement range: 120 VAC |
| | | | Red | On | Measurement range: 480 VAC |
| | 2 | X4 | Green | On | Measurement range: 120 VAC |
| | | | Red | On | Measurement range: 480 VAC |
| | 3 | X5 | Green | On | Measurement range: 120 VAC |
| | | | Red | On | Measurement range: 480 VAC |
| | 4 | X6 | Green | On | Measurement range: 120 VAC |
| | | | Red | On | Measurement range: 480 VAC |
| | 5 | X2 | Green | On | Measurement range: 1 A |
| | | | Red | On | Measurement range: 5 A |

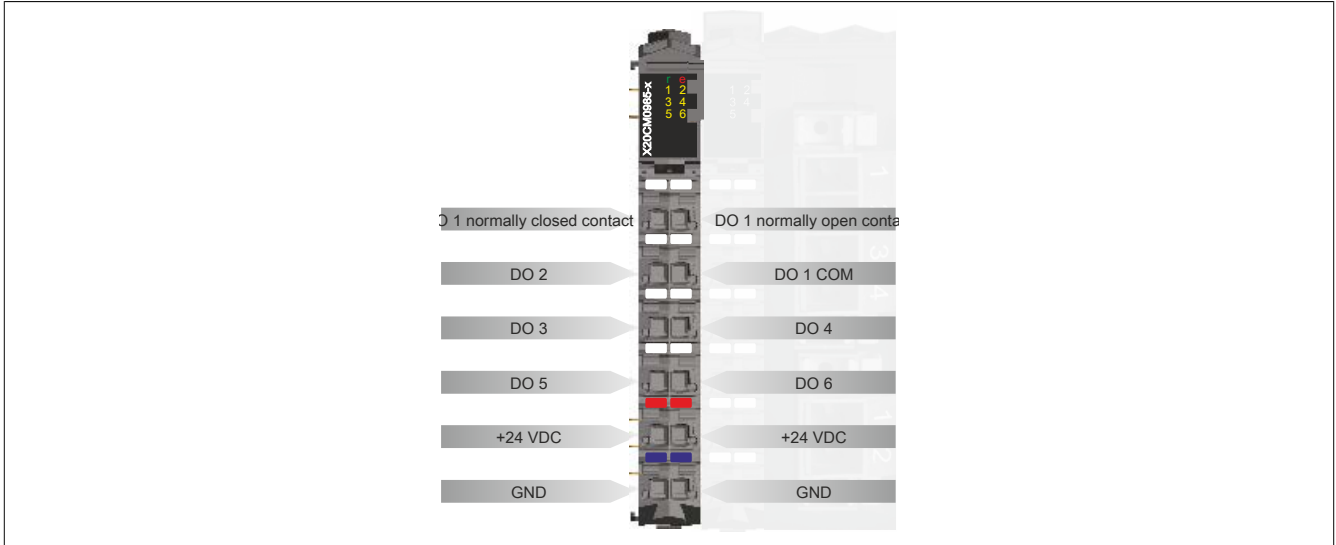
1) LEDs 1 - 5 are green/red dual LEDs.

9.26.4.7 Connection elements



9.26.4.8 Digital outputs X1

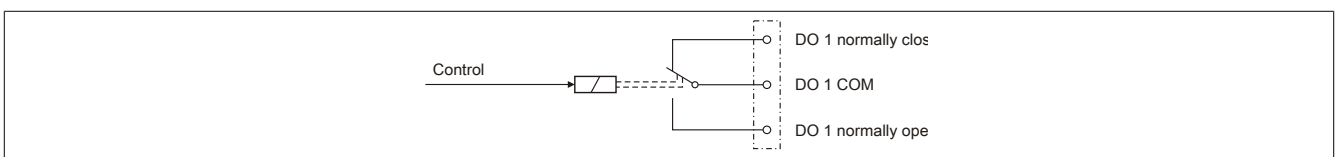
Terminals X1 and X2 can be keyed differently to prevent unintentional incorrect connection on the module.



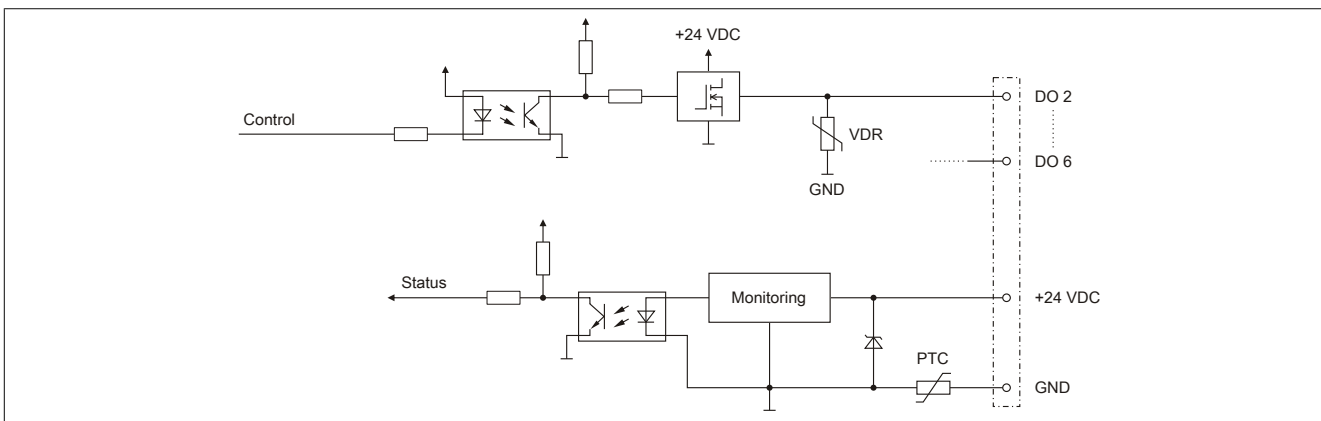
Function description of the digital outputs

| Digital output | Description |
|----------------|--|
| DO1 | <p>This digital output is designed as a changeover contact switch. The monitoring relay is used for optional monitoring of the following measured values of the generator mains:</p> <ul style="list-style-type: none"> • Overvoltage and undervoltage • Overfrequency and underfrequency • Voltage asymmetry • Current asymmetry • Calculated neutral conductor current (maximum) • Short circuit current • Rating-dependent overcurrent • Limit value of the capacitive reactive power (exciter failure) • Generator overload • Generator feedback |
| DO2 | DO2 serves as a meter output. The generated pulses can be recorded by an external energy meter (kWh). |
| DO3 | This output is set when there is no voltage on the bus bar (below the lower limit of the defined parameter). 3-phase monitoring takes place for the bus bar voltage. |
| DO4 | DO4 serves as a synchronization pulse. The power switch is activated by setting this output. The output is deactivated after the configured time has elapsed (exception:Synchro check operating mode). |
| DO5 | <p>This output can be configured either as a digital output or monitoring output (see register "ConfigOutput24" on page 2951). The monitoring function is only available with the "3-phase mains" configuration. When configured as monitoring output, the user can choose between monitoring the following mains measurement values:</p> <ul style="list-style-type: none"> • Overvoltage and undervoltage • Overfrequency and underfrequency • Voltage asymmetry • Phase shift • Frequency change <p>The monitoring status can be output either normally or inverted. This can be defined using the "DigitalOutput" on page 2983 register. This setting is then disabled when shutting off, resetting, restarting, etc.</p> |
| DO6 | <p>Can be configured as a digital output or synchronization output (see register "ConfigOutput24" on page 2951).</p> <p>When configured as a synchronization output: DO6 serves as the synchronization pulse. The power switch is activated by setting this output. The output is deactivated after the configured time has elapsed (exception:Synchro check operating mode).</p> |

DO1 - Output circuit diagram



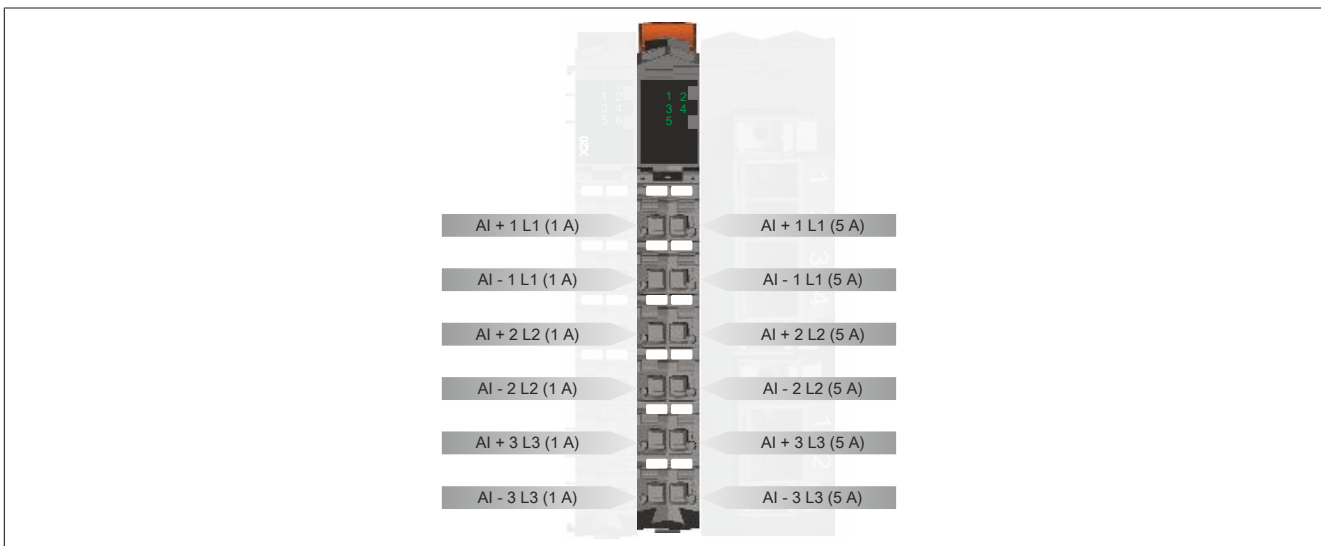
DO2 - DO 6 - Output circuit diagram



9.26.4.9 X2 analog current inputs

The X2 terminal measures the three phase currents of the generator mains using an externally connected current transformer. The measurement range of the current inputs can be configured as 1 A or 5 A.

Terminals X1 and X2 can be keyed differently to prevent unintentional incorrect connection on the module.

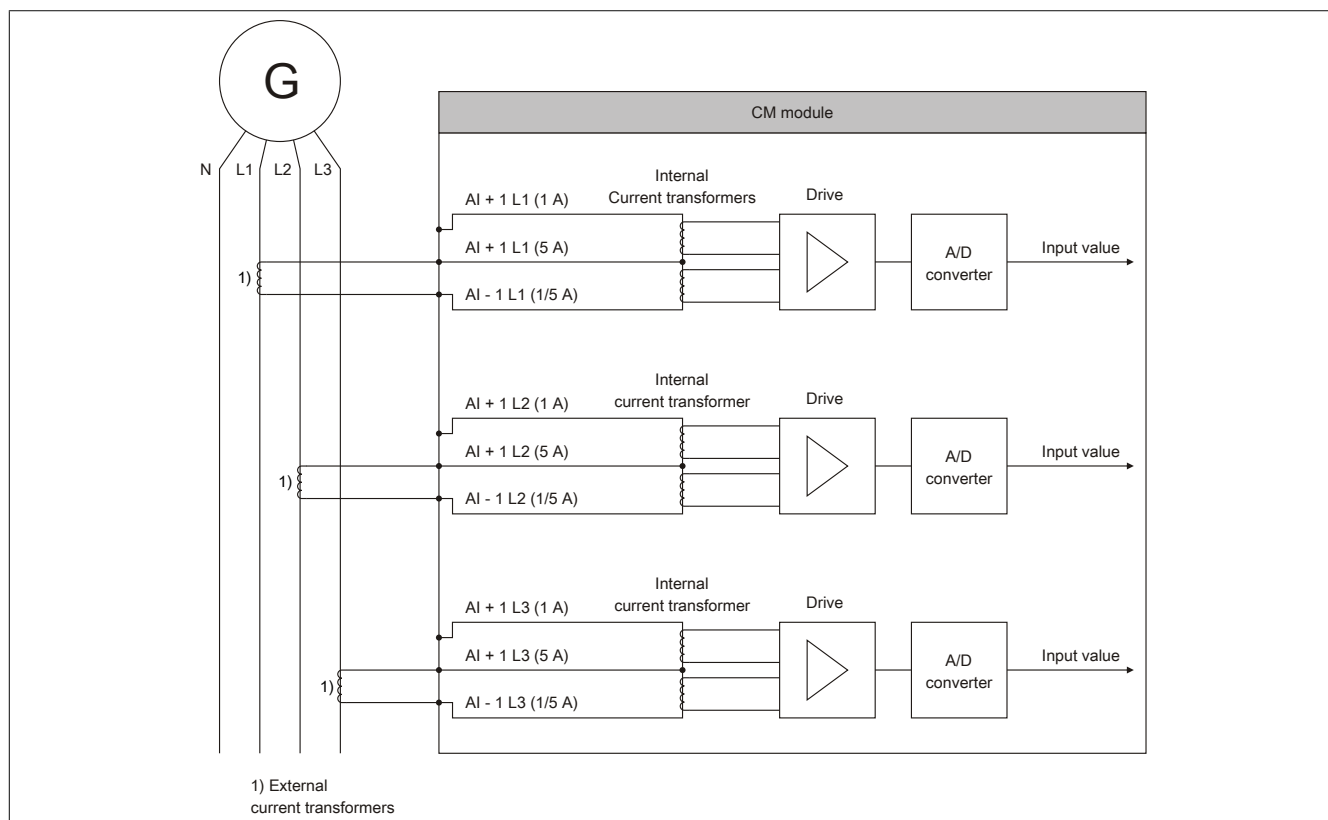


Danger!

Risk of electric shock!

The terminal block must only be allowed to conduct voltage when it is inserted. It must not under any circumstances be removed or inserted when voltage is applied or have voltage applied to it when it is removed.

Input circuit diagram - Analog current inputs

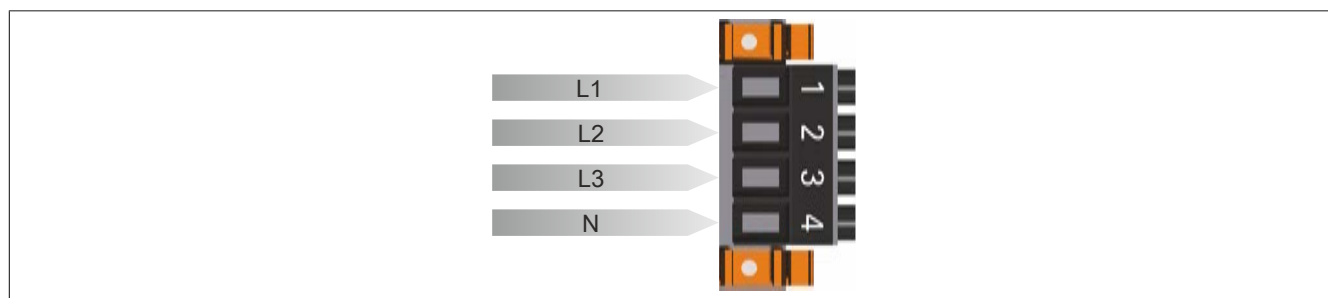


9.26.4.10 X3 and X5 analog voltage inputs

The X3 and X5 terminals are used to measure and monitor the line-to-line and phase voltages of the generator mains and bus bar.

- Terminal X3: Generator mains
- Terminal X5: Bus bar

Terminals X3 and X5 are keyed differently to prevent unintentional incorrect connection on the module. Section ["Releasing the locking clip for terminals X3 - X6" on page 2937](#) describes how to release the terminal locking clip.



9.26.4.11 X4 and X6 analog voltage inputs

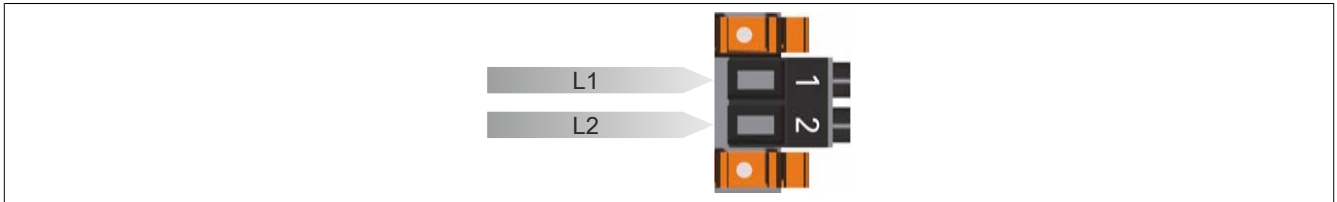
Terminals X4 and X6 are keyed differently to prevent unintentional incorrect connection on the module. Section "Releasing the locking clip for terminals X3 - X6" on page 2937 describes how to release the terminal locking clip.

The two terminals are connected differently depending on the selected configuration (see register "ConfigOutput68" on page 2950).

Configuration as Sync-mains 1 / Sync-mains 2

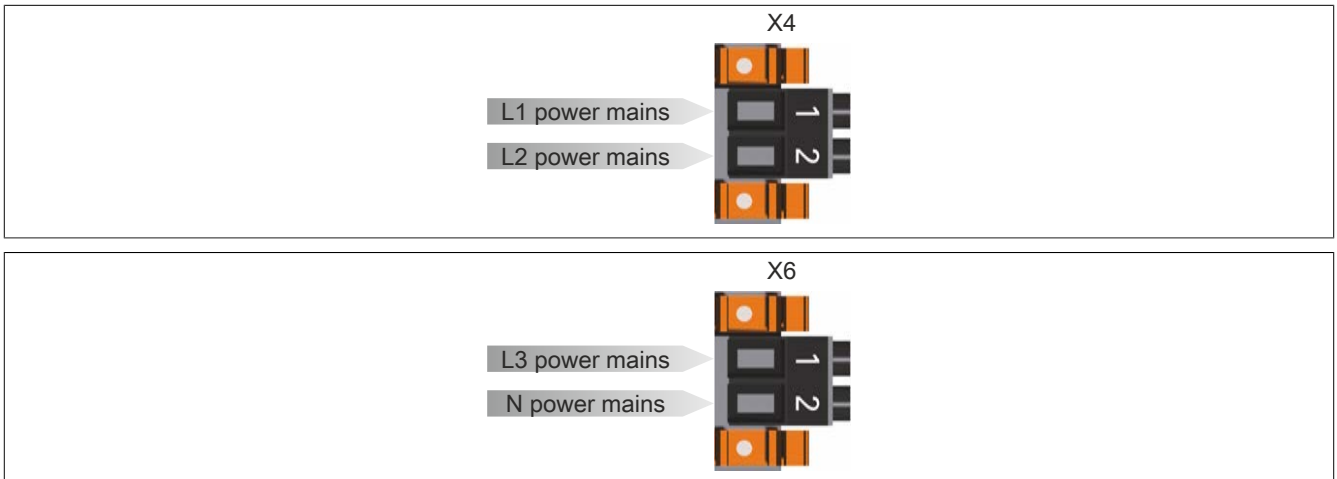
The voltage inputs on the X4 and X6 terminals are used to determine the line-to-line voltages for synchronization between two different mains networks.

- Terminal X4: Synchronization mains network 1
- Terminal X6: Synchronization mains network 2

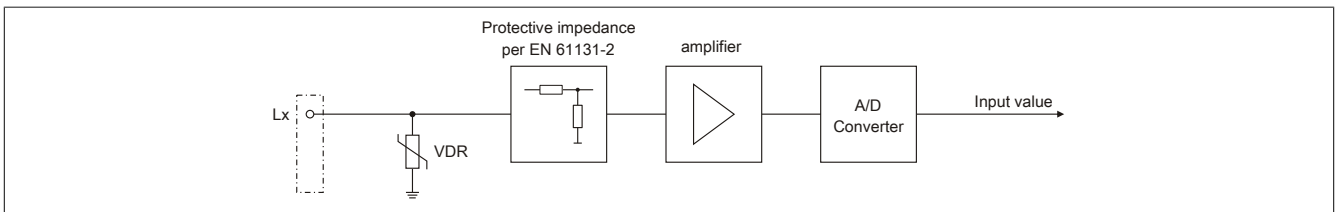


Configuration as 3-phase mains

The terminals X4 and X6 can be combined to form a 3-phase mains. The X4 and X6 terminals are used to measure and monitor the line-to-line voltages and phase voltages of the power mains.

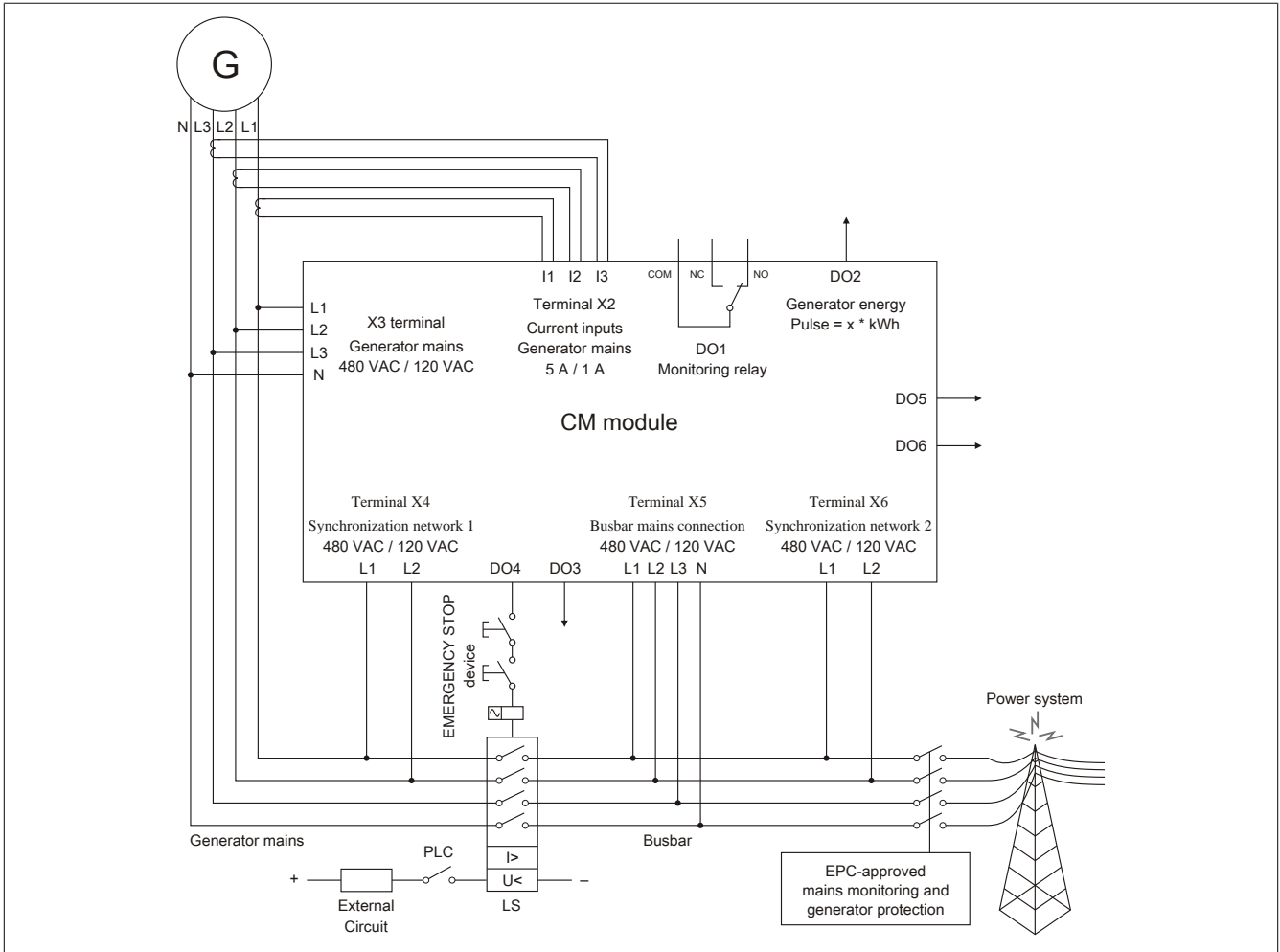


Input circuit diagram, analog voltage inputs

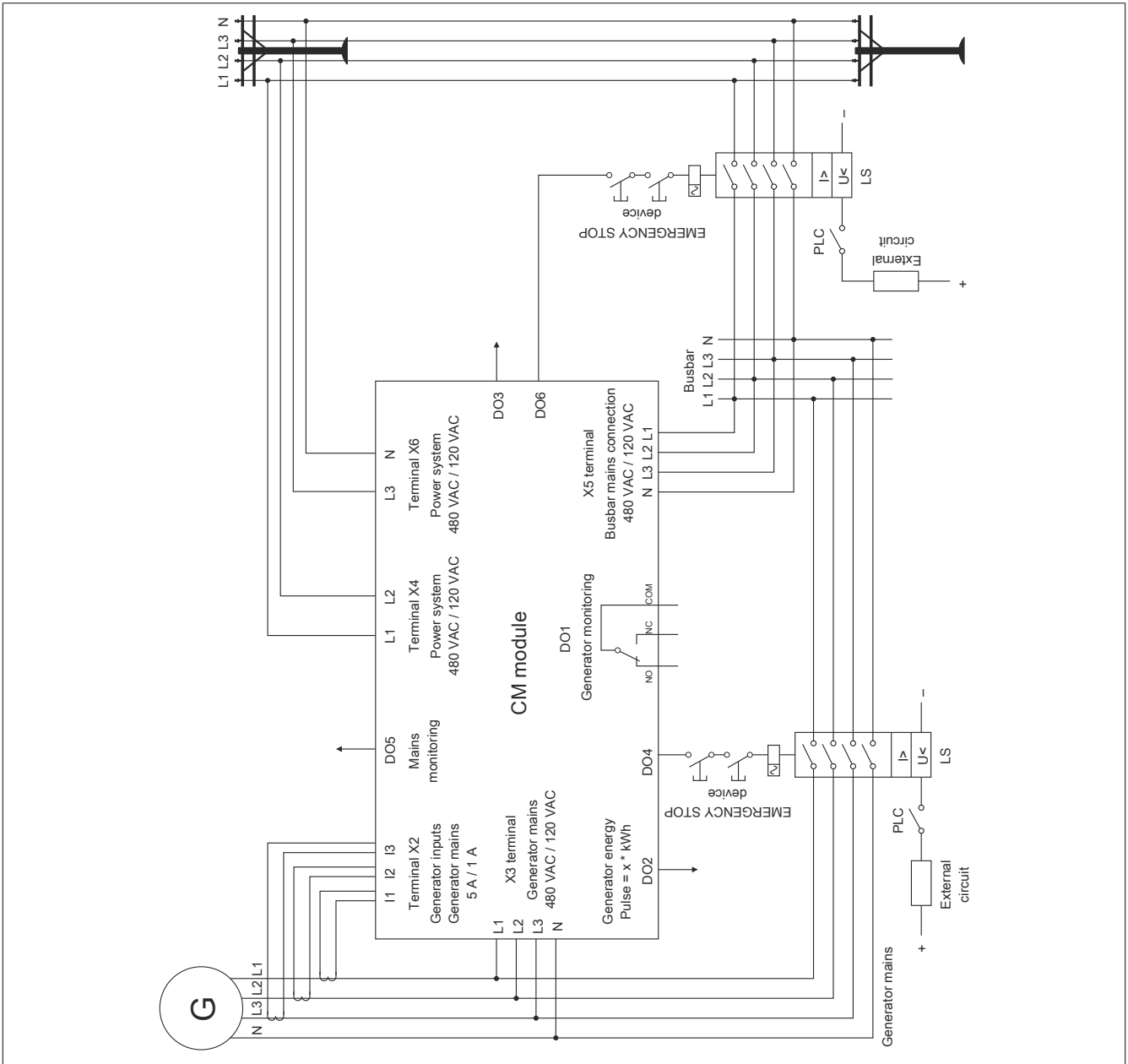


9.26.4.12 Circuit diagram

Example of mains configuration "Sync-mains 1 / Sync-mains 2"



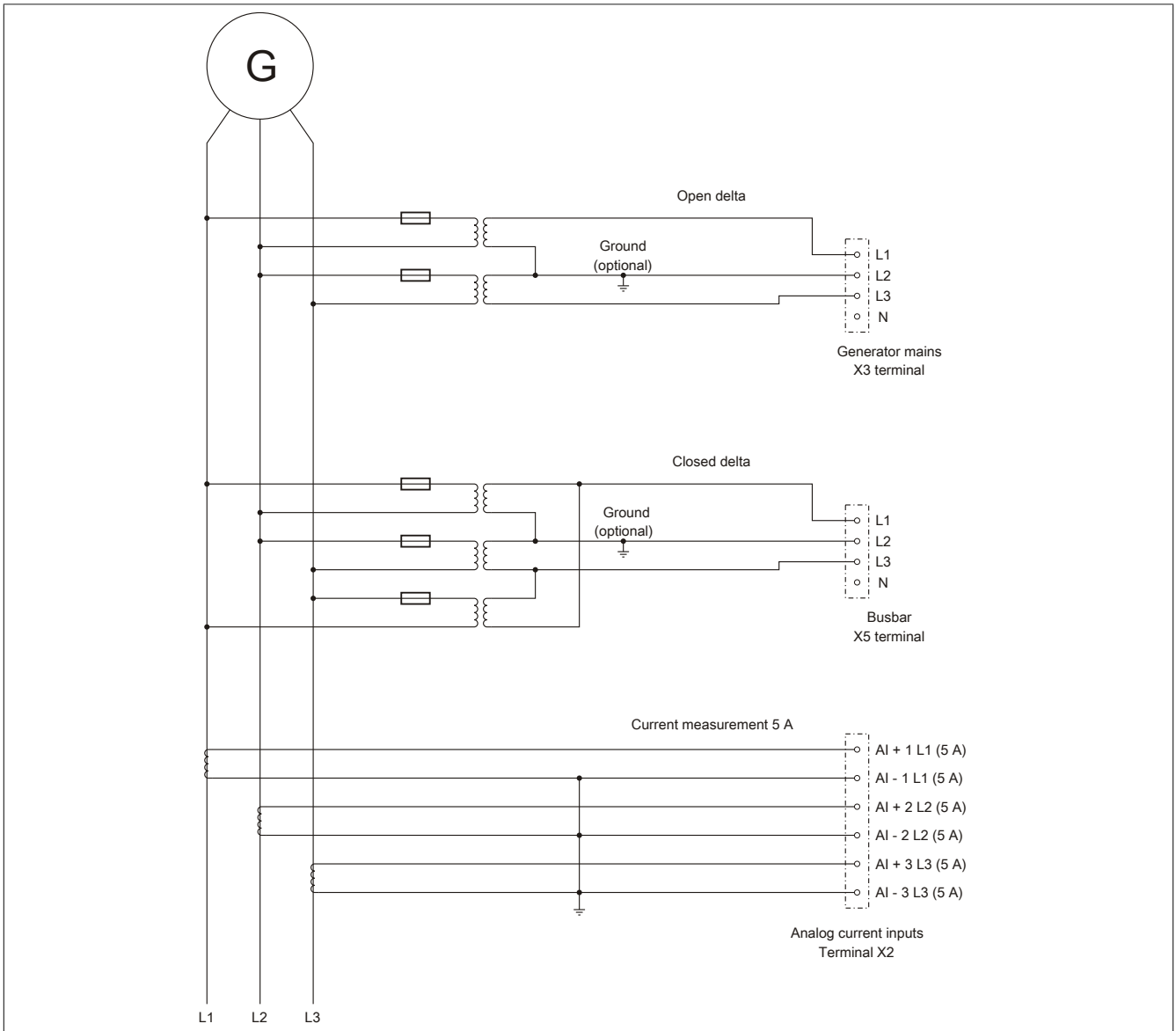
Example of mains configuration "3-phase mains"



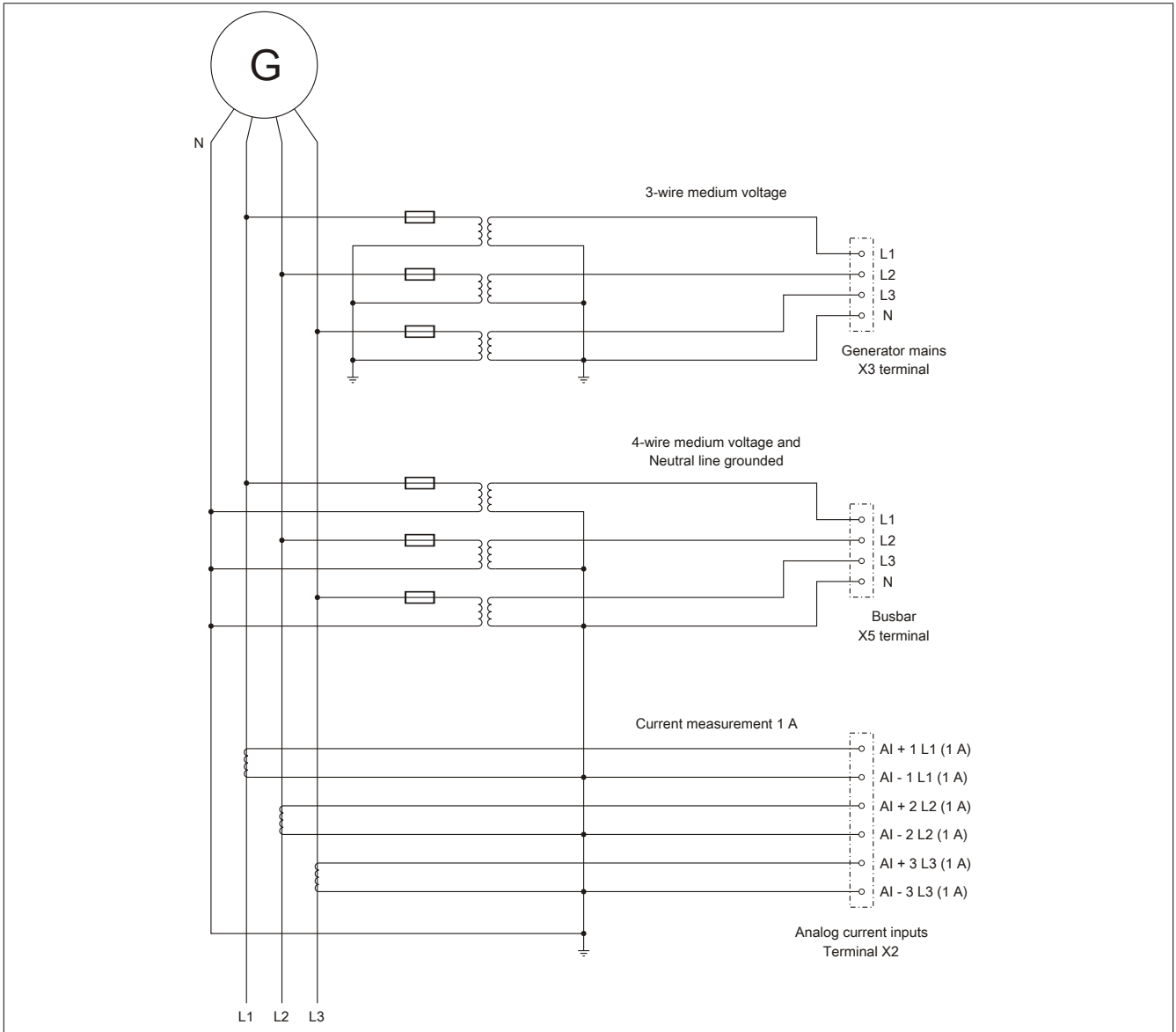
9.26.4.13 Typical connection examples for voltage/current measurement

For power measurement, the X3 terminal must always be used in connection with the X2 terminal! For single-phase measurement, always ensure that current input 1 is used for power measurement if voltage input 1 is being used. Otherwise, accurate power measurement is not possible for this phase!

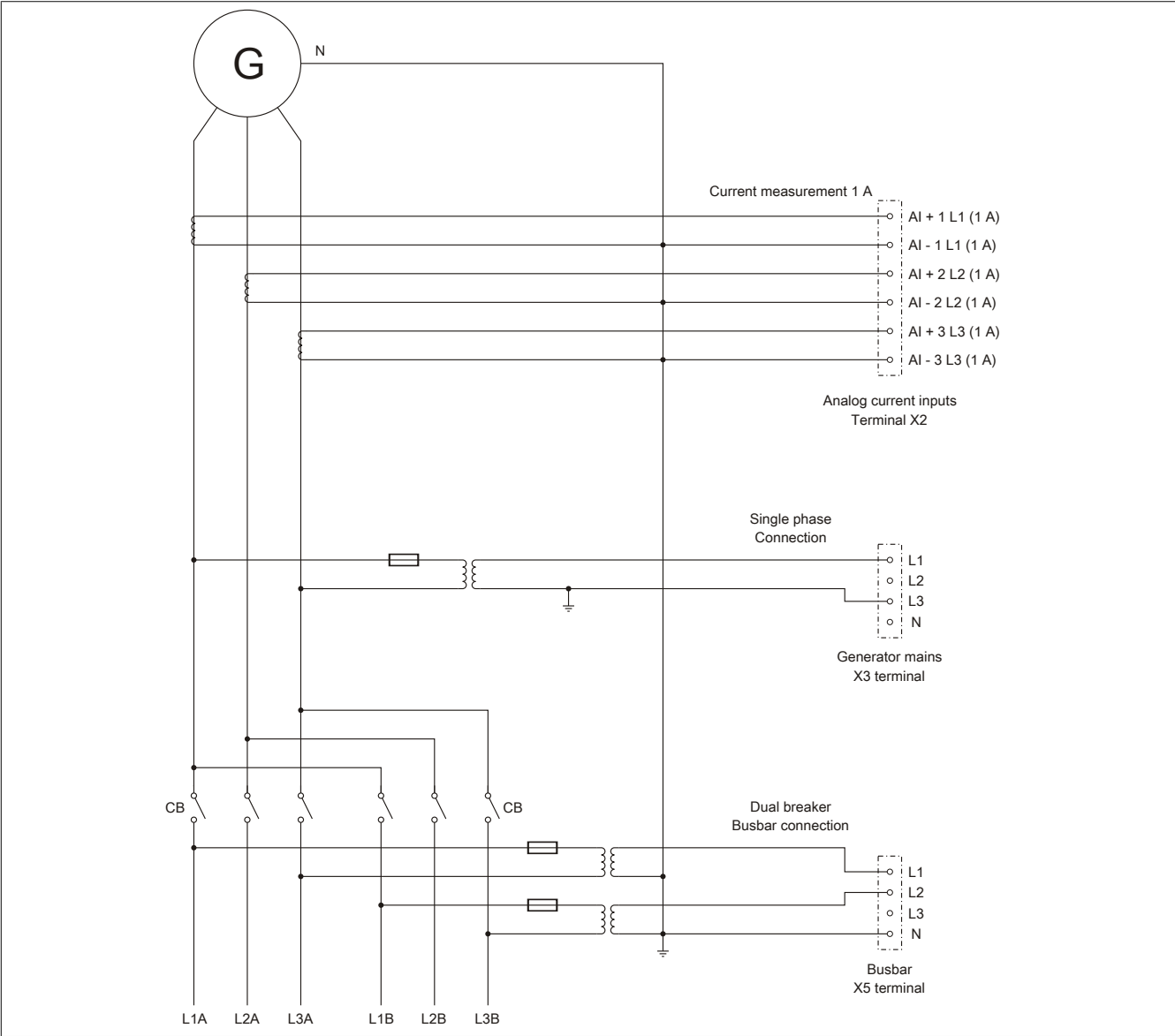
Connection example 1



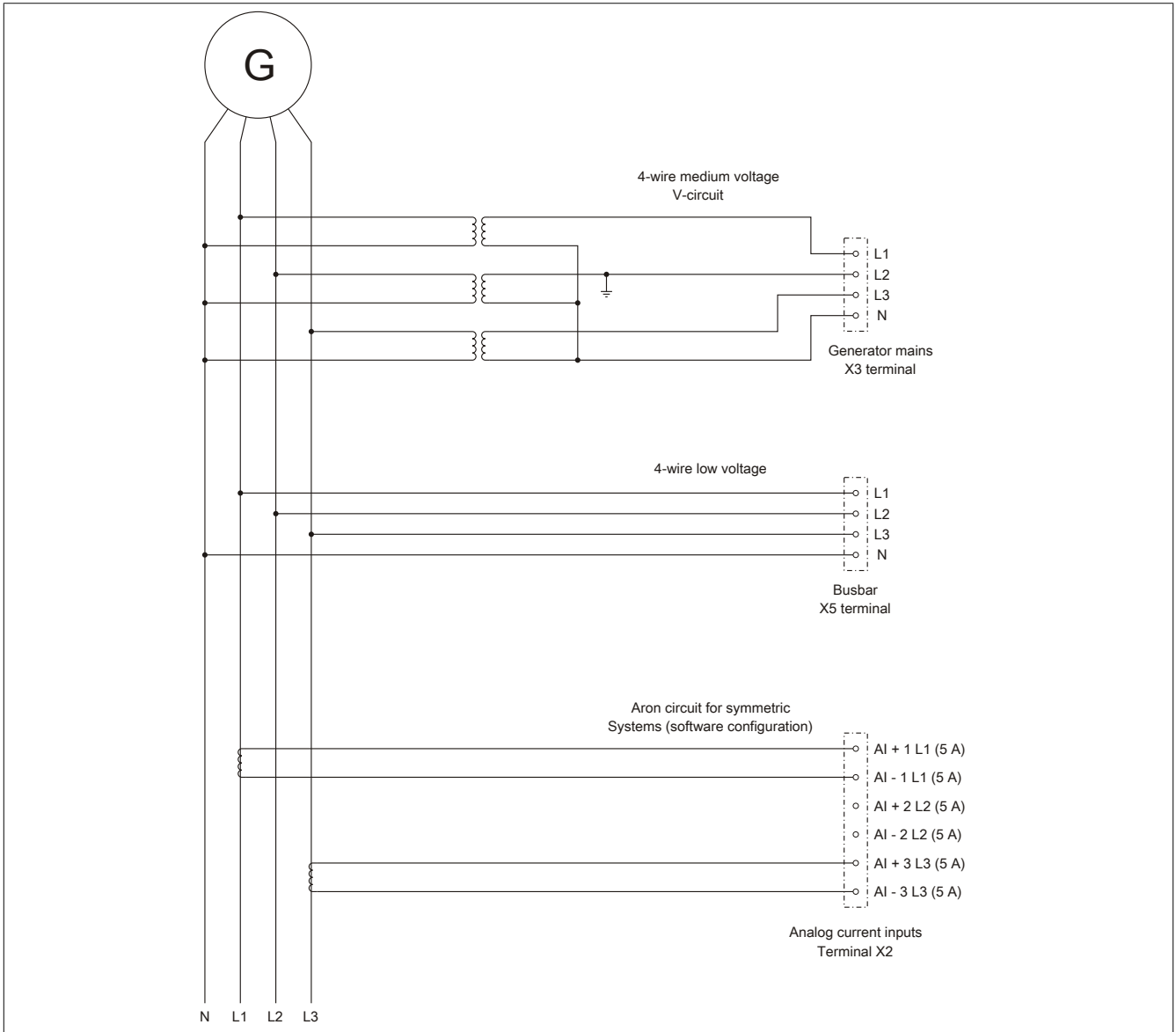
Connection example 2



Connection example 3

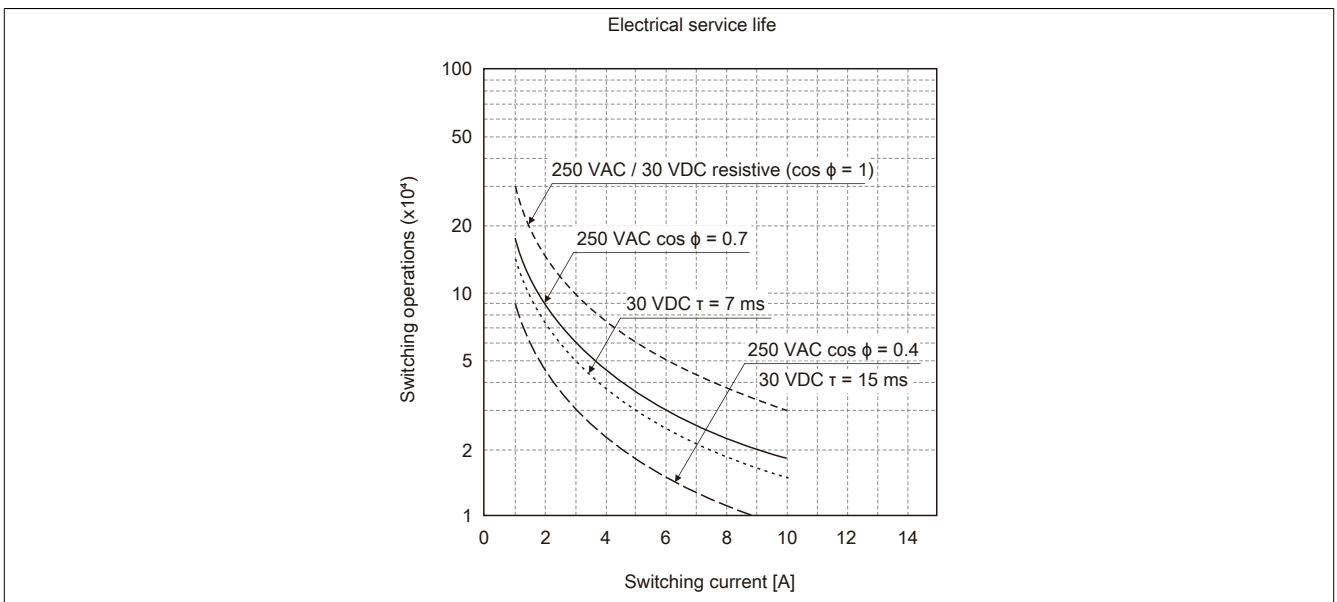


Connection example 4



9.26.4.14 Electrical service life

The electrical service life for the DO1 relay output can be seen in the following diagram.



9.26.4.15 Releasing the locking clip for terminals X3 - X6

Terminals X3 - X6 are equipped with a terminal locking clip. This clip attaches the terminal block securely to the electronic module. This prevents the terminal from accidentally being disconnected.

To release the locking clip, press inwards on the corrugated part of the lever with your fingertip (1) and then slide outwards (2). No additional tools are required for removing the terminal.

Terminals X5 and X6 must be removed first before terminals X3 and X4 can be removed.



9.26.4.16 Synchronization functions

The following three synchronization functions are available on the module:

- "Synchronization with slip" on page 2938
- "Synchro check" on page 2938
- "Switching to voltage-free "dead bus"" on page 2939

Synchronization with slip

The following is valid for synchronization mains 1 and synchronization mains 2:

- $50\% < U < 125\%$ of the nominal voltage U_N
- $80\% < f < 110\%$ of the nominal frequency f_N

The generator voltage is adjusted to the synchronization voltage with regard to amplitude and frequency. Taking into account the configured phase angle ($\Delta\alpha$), a defined transformer vector group and the switching response time, the switch-on command is calculated and transmitted in advance so that the main contacts of the power switch are closed at the point of synchronicity.

Synchronization occurs under the following conditions:

- Synchronization mode "Slip" is set using software.
- The device is ready.
- The phase sequences of the mains networks being synchronized are OK (phase sequence detection).
- The configured limit for voltage difference is not exceeded (ΔU_{\max}).
- The configured limits for frequency difference are not exceeded (Δf_{\max} and Δf_{\min}).
- The configured limit for the phase angle (including vector group transformer $\Delta\alpha$) is not exceeded (j_{\max}).

When the synchronization mode is set to "Slip", synchronization is not activated until the value of the differential angle between the two synchronized mains networks is $>5^\circ$ for at least 100 ms.

In other words, if the phase difference happens to be within $\pm 5^\circ$ at the time of the synchronization request, the synchronization won't be activated unless/until the phase difference is larger for 100 ms.

Resetting the mode "Synchronization with slip" cancels the synchronization.

In order to receive a synchronization pulse, the synchronization window must be entered from any phase direction after the synchronization command has been authorized and all of the synchronization conditions specified above are observed.

The switch is not engaged immediately after reaching the phase window. The switch is only engaged if synchronization is possible at the synchronization point while observing the switch lead time.

With very low frequency differences or equivalent frequencies and in adherence to the conditions described above, synchronization will also take place at a phase angle = 0° .

The synchronization output changes its state from Low to High when all conditions are met. It changes back from High to Low after the configured pulse duration has elapsed.

Synchro check

In this operating mode, the device can be used to check the synchronization. The DO4 output remains set as long as the following conditions are met:

- The "-Check" command is set using software.
- The device is ready.
- The phase sequences of the mains networks being synchronized are OK (phase sequence detection).
- The configured limit for voltage difference is not exceeded (ΔU_{\max}).
- The configured limits for frequency difference are not exceeded (Δf_{\max} and Δf_{\min}).
- The defined limit for the phase angle is not exceeded (ϕ_{\max}).

DO4 stays at High as long as all conditions are met.

Switching to voltage-free "dead bus"

The switch-on command for the power switch is output without synchronization if the following conditions have been met:

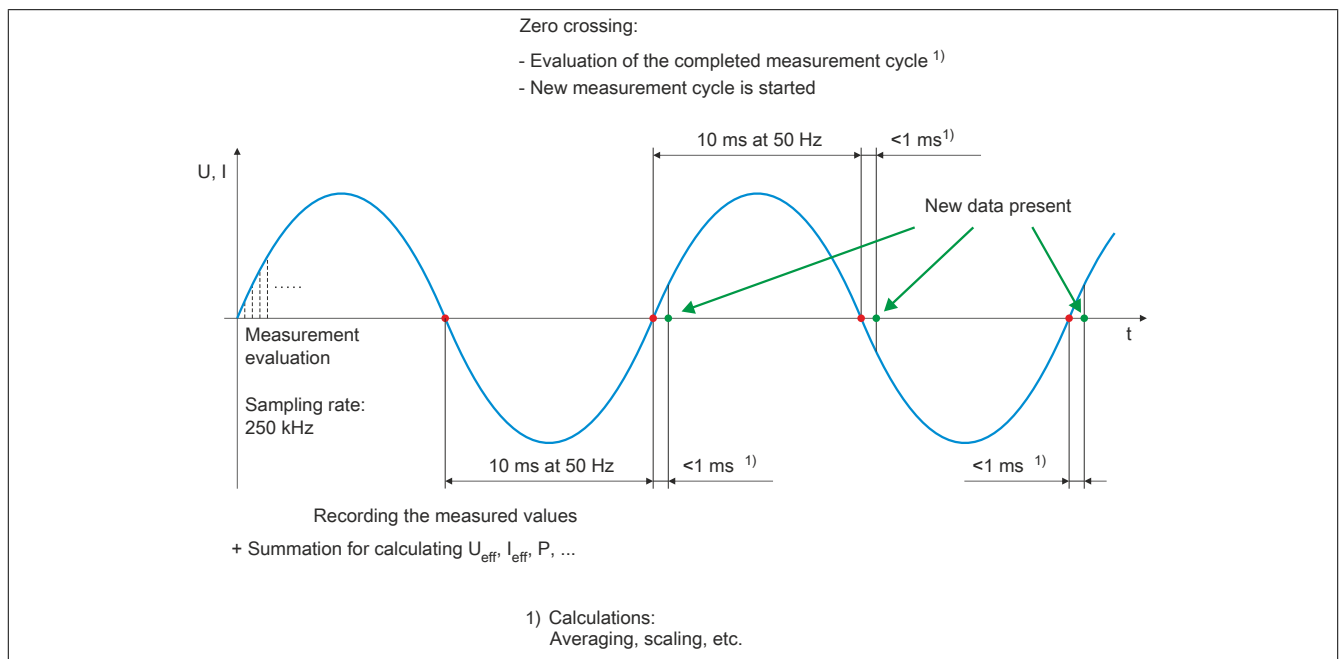
- The "Dead Bus" command is set using software.
- The device is ready.
- The bus bar does not have voltage applied: $U_B < U_{BminSync}$ as a percentage of U_{NomBus}

| | |
|--------------------|-------------------------|
| U_B ... | Bus bar phase voltage |
| $U_{BminSync}$... | Dead bus voltage |
| U_{NomBus} ... | Bus bar nominal voltage |

DO4 changes its state from Low to High when all conditions are met. It changes back from High to Low after the configured pulse duration has elapsed.

9.26.4.17 Measurement functions

Timing diagram



Measured parameters for generator mains (X3)

- Phase currents
- Current average
- Dynamic current average
- Neutral current
- Line-to-line voltages
- Phase voltages
- Voltage average
- Total apparent power
- Total reactive power
- Total active power
- Active power factor
- Frequency

Measured parameters between synchronization mains networks

- Differential angle
- Differential voltage

Rating-dependent overcurrent

Rating-dependent overcurrent monitoring is in accordance with the specifications of IEC 255-8 "Electrical relay; Relay for protecting against thermal overload (overload relay)" and IEC 255-17 "Electrical relay; Relay for protecting against the thermal overload of motors (overload relay for motors).

Dependent delayed imbalanced load monitoring

Dependent delayed imbalanced load monitoring protects against imbalanced loads in three-phase generators and three-phase mains. Parameters can be changed to make it possible to match the trigger characteristics to different generator types while taking their special thermal time constants into consideration.

An imbalanced load can be caused by uneven current distribution in the mains due to imbalanced load, asymmetrical short circuits, line interruptions or switching operations. Imbalanced loads result in reverse system currents in the stator, which causes harmonics with an uneven ordinal number in the stator winding and harmonics with an even ordinal number in the rotor winding. The rotor is at particular risk here because the harmonic waves place an additional load on the rotor winding and induce eddy currents in the rotor's solid iron, which may melt the metal or destroy the metallic structure.

An imbalanced load can be permissible within certain limits, however, when accounting for the thermal load limit of the generator. To avoid premature failure of the generator when an imbalanced load occurs, the characteristics that trigger imbalanced load protection should be adapted to the thermal characteristics of the generator. Imbalanced load protection can also be triggered by external errors in the mains caused by asymmetric short circuits.

Short circuit current monitoring

If overcurrent or a short circuit occurs and the limit value is exceeded, the error message "Short circuit current" is signaled after the configured time delay has passed.

Voltage asymmetry monitoring

This trigger value, specified as a percentage, is based on the nominal voltage of the generator. If the difference between the three line-to-line voltages of the generator mains exceeds the set limit value, then the error message "Voltage asymmetry" is signaled after the response time has passed. For this to happen, only one of these voltages has to exceed the respective limit value (in either the positive or negative direction).

Bus bar voltage measurement and zero voltage monitoring

3-phase monitoring takes place for the bus bar voltage. The measured values are represented as phase-to-phase and phase-to-neutral values. The DO3 output is set when there is no voltage (below the lower limit of the defined limit bus bar voltage minimum U_{Bmin}) on the bus bar (X5 terminal).

This monitoring can be used to determine which synchronization function should be used.

| Synchronization function | Bus bar voltage measurement |
|---------------------------|---|
| Dead bus | No voltage is being supplied to the bus bar or the value is below the lower limit parameter. Output DO3 is set. |
| Synchronization with slip | The voltage measured on the bus bar is above the defined parameter value. Output DO3 is not set. |

Exciter failure

The reactive power monitoring can be used to protect a generator against operating in the impermissible range. The capacitive reactive power monitor offers protection against under-excitation (exciter failure). If the lower limit is exceeded (in the negative direction), the error message "Capacitive reactive power" is signaled after the configured time delay has passed.

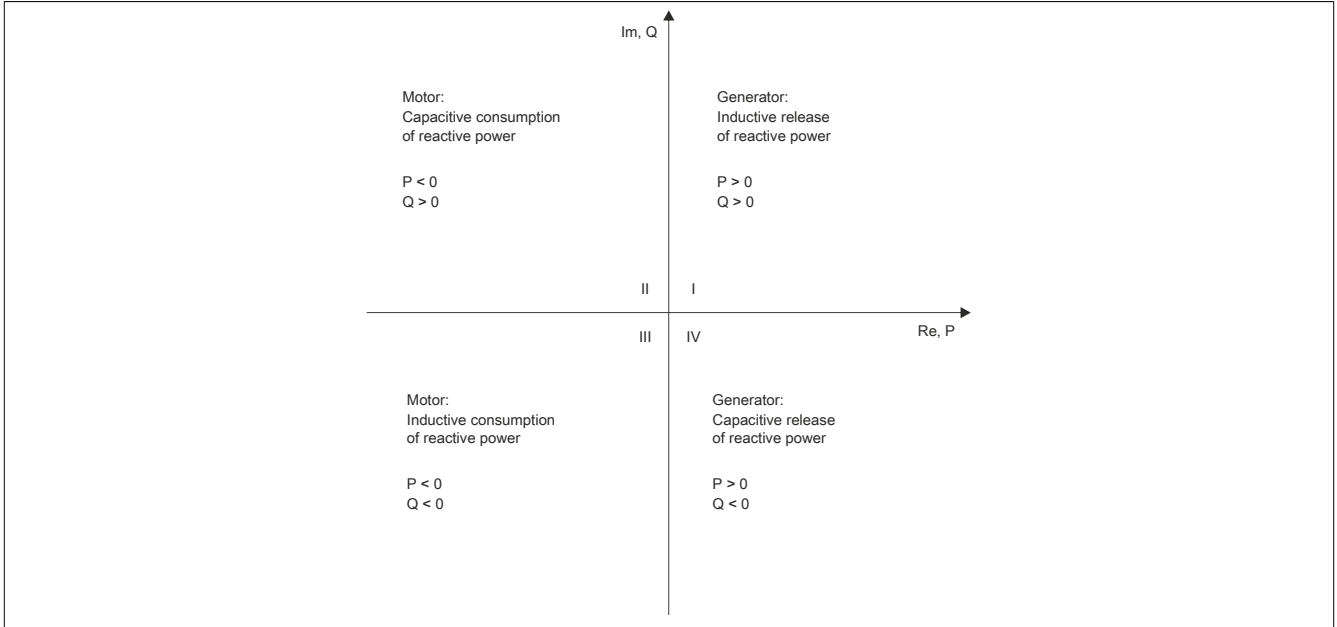
Phase sequence detection

Phase sequence detection is used to detect incorrectly wired voltage and current inputs or if the generator is rotating in the wrong direction (for information about configuration, see register "[ConfigOutput24](#)" on page 2951).

Phase sequence L1, L2 and L3 is monitored for this. If not correct, then an error message is output (see register "[StatusDigitalOutput](#)" on page 2983) and synchronization cannot take place.

9.26.4.18 Generator operating modes

The operating modes possible for the generator are illustrated in this 4 quadrant diagram.

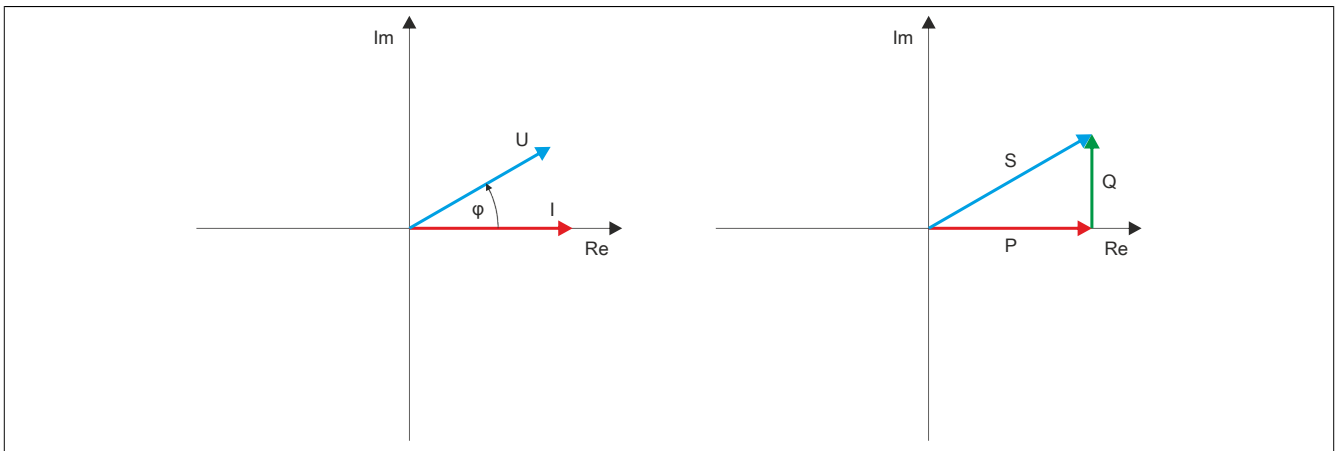


Quadrant I

Generator operation, inductive release of reactive power:

- The active power P and the reactive power Q are greater than 0.
- The phase angle ϕ is between 0 and 90° . This means that U keeps ahead of I .

Example: $\phi = 30^\circ$

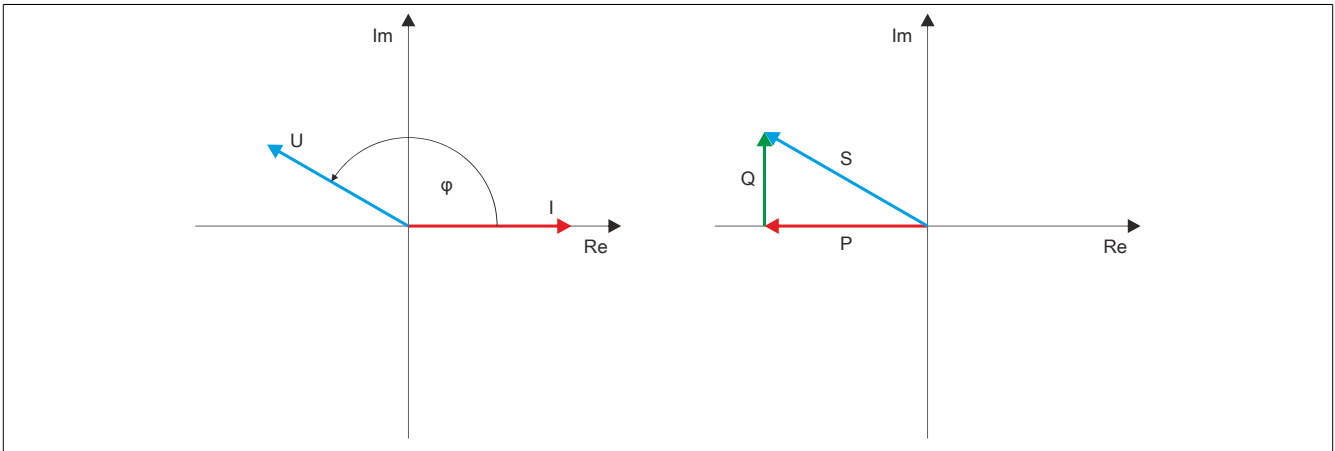


Quadrant II

Motor operation, capacitive reactive power consumption:

- The active power P is less than 0 while the reactive power Q is greater than 0.
- The phase angle ϕ is between 90 and 180° . This means that U keeps ahead of I .

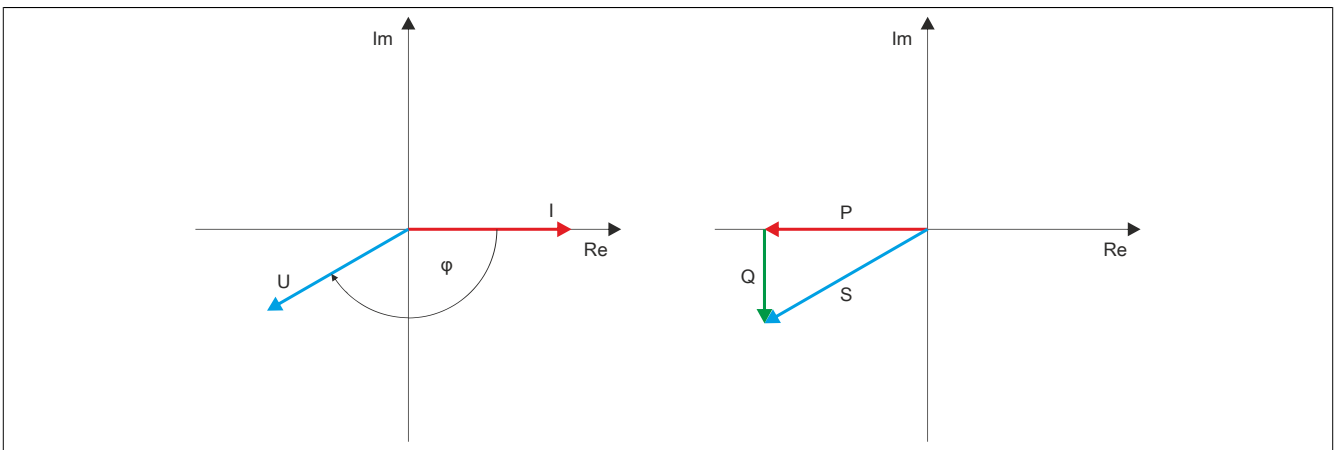
Example: $\phi = 150^\circ$

**Quadrant III**

Motor operation, inductive reactive power consumption:

- The active power P and the reactive power Q are less than 0.
- The phase angle ϕ is between -90 and -180° . This means that U lags behind I .

Example: $\phi = -150^\circ$

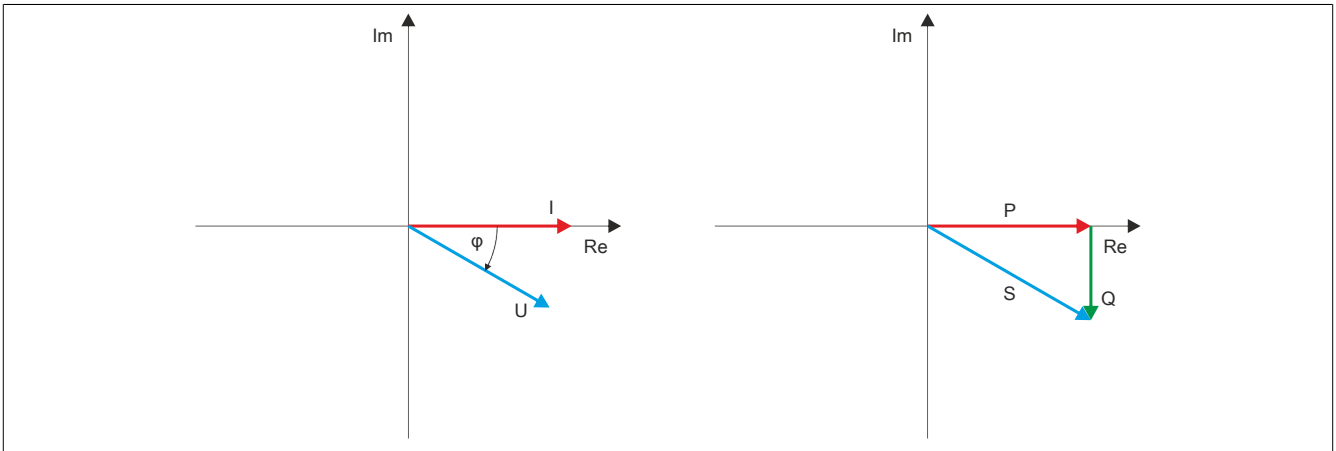


Quadrant IV

Generator operation, capacitive release of reactive power:

- The active power P is greater than 0 while the reactive power Q is less than 0.
- The phase angle ϕ is between 0 and -90° . This means that U lags behind I.

Example: $\phi = -30^\circ$



Power factor of the generator

The power factor is a product of the ratio between the active power P and apparent power S. With sinusoidal values, this corresponds to the cosine of the phase shift angle ϕ .

$$|\text{Power factor}| = \left| \frac{P}{S} \right|$$

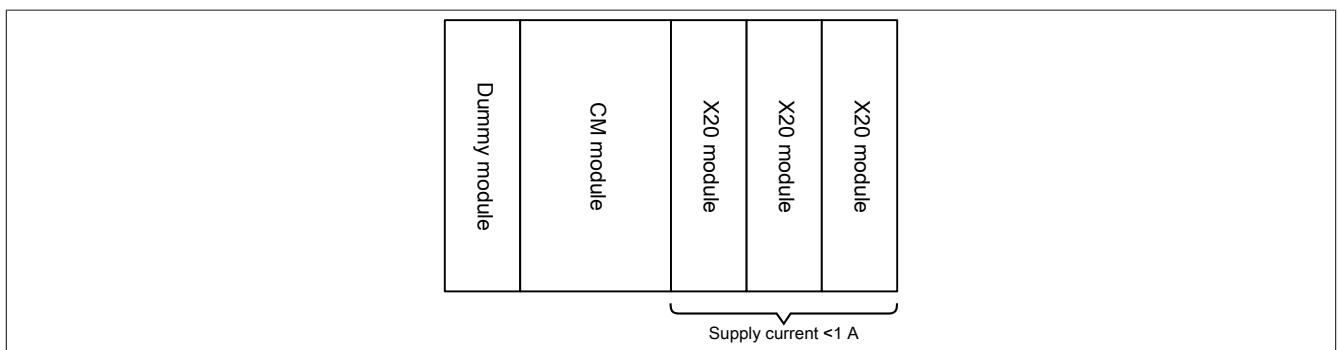
The module derives the sign used for the power factor from the signs used with the P and Q values. In this way, it depends on the generator's operating mode:

| Sign | Description |
|----------|--|
| Positive | <ul style="list-style-type: none"> • Quadrant I or III, P and Q positive or P and Q negative • Inductive release of reactive power or inductive reactive power consumption |
| Negative | <ul style="list-style-type: none"> • Quadrant II or IV, P negative and Q positive or P positive and Q negative • Capacitive release of reactive power or capacitive reactive power consumption |

9.26.4.19 Derating

Derating does not need to be taken into account for operation below 55°C .

For operation above 55°C , a dummy module must be connected to the left of the module. A maximum supply current of 1 A is permitted to pass through the module to the modules connected to the right.



9.26.4.20 Register description

9.26.4.20.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.26.4.20.2 Function model 0 - default

| Register | Name | Data type | Read | | Write | |
|---|--|-----------|--------|-------------------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| General registers - Configuration | | | | | | |
| 2762 | ConfigOutput68 (Read) Mains settings | UINT | | (●) ¹⁾ | | • |
| 2561 | ConfigOutput20 (Read) Nominal voltage range, nominal current range and Aron circuit | USINT | | (●) ¹⁾ | | • |
| 2614 | ConfigOutput10 (Read) Nominal frequency (f_{Nom}) | UINT | | (●) ¹⁾ | | • |
| 2569 | ConfigOutput24 (Read) General configuration register | USINT | | (●) ¹⁾ | | • |
| 2567 | ConfigOutput23 (Read) Trigger bits | USINT | | (●) ¹⁾ | | • |
| Generator mains - Configuration | | | | | | |
| 2582 | ConfigOutput02 (Read) Nominal voltage of generator mains (U_{NomGen}) | UINT | | (●) ¹⁾ | | • |
| 2598 | ConfigOutput06 (Read) Multiplier for generator mains | UINT | | (●) ¹⁾ | | • |
| 2590 | ConfigOutput04 (Read) Nominal current of generator mains (I_{Nom}) | UINT | | (●) ¹⁾ | | • |
| 2610 | ConfigOutput09 (Read) Multiplier for current transformer | UINT | | (●) ¹⁾ | | • |
| 2563 | ConfigOutput21 (Read) Turns generator mains functions on/off | UINT | | (●) ¹⁾ | | • |
| 2746 | ConfigOutput41 (Read) Low-pass filter for total power ratings | UINT | | (●) ¹⁾ | | • |
| Generator monitoring functions - Configuration | | | | | | |
| 2658 | ConfigOutput16 (Read) Overvoltage limit of the generator mains (U_{maxGen}) | UINT | | (●) ¹⁾ | | • |
| 2938 | ConfigOutput118 (Read) Overvoltage limit 2 of the generator mains (U_{maxGen}) | UINT | | (●) ¹⁾ | | • |
| 2706 | ConfigOutput26 (Read) Response time for generator overvoltage (U_{maxGen}) | UINT | | (●) ¹⁾ | | • |
| 2942 | ConfigOutput119 (Read) Response time 2 for generator overvoltage (U_{maxGen}) | UINT | | (●) ¹⁾ | | • |
| 2662 | ConfigOutput27 (Read) Undervoltage limit of generator mains (U_{minGen}) | UINT | | (●) ¹⁾ | | • |
| 2702 | ConfigOutput59 (Read) Undervoltage limit of generator mains 2 ($U_{min2Gen}$) | UINT | | (●) ¹⁾ | | • |
| 2710 | ConfigOutput28 (Read) Response time for generator undervoltage (U_{minGen}) | UINT | | (●) ¹⁾ | | • |
| 2734 | ConfigOutput65 (Read) Response time for generator undervoltage 2 ($U_{min2Gen}$) | UINT | | (●) ¹⁾ | | • |
| 2666 | ConfigOutput29 (Read) Generator over-frequency (f_{maxGen}) | UINT | | (●) ¹⁾ | | • |
| 2954 | ConfigOutput122 (Read) Generator over-frequency 2 (f_{maxGen}) | UINT | | (●) ¹⁾ | | • |
| 2714 | ConfigOutput30 (Read) Response time for generator over-frequency (f_{maxGen}) | UINT | | (●) ¹⁾ | | • |
| 2958 | ConfigOutput123 (Read) Response time 2 for generator over-frequency (f_{maxGen}) | UINT | | (●) ¹⁾ | | • |
| 2670 | ConfigOutput31 (Read) Generator under-frequency (f_{minGen}) | UINT | | (●) ¹⁾ | | • |
| 2946 | ConfigOutput120 (Read) Generator under-frequency 2 (f_{minGen}) | UINT | | (●) ¹⁾ | | • |
| 2718 | ConfigOutput32 (Read) Response time for generator under-frequency (f_{minGen}) | UINT | | (●) ¹⁾ | | • |
| 2950 | ConfigOutput121 (Read) Response time 2 for generator under-frequency (f_{minGen}) | UINT | | (●) ¹⁾ | | • |
| 2674 | ConfigOutput33 (Read) Generator voltage asymmetry (U_{asGen}) | UINT | | (●) ¹⁾ | | • |
| 2722 | ConfigOutput34 (Read) Response time for the generator voltage asymmetry (U_{asGen}) | UINT | | (●) ¹⁾ | | • |
| 2742 | ConfigOutput35 (Read) Load time constant for current asymmetry | UINT | | (●) ¹⁾ | | • |
| 2902 | ConfigOutput109 (Read) Unbalanced load constant | UINT | | (●) ¹⁾ | | • |

| Register | Name | Data type | Read | | Write | |
|--|---|-----------|--------|-------------------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2962 | ConfigOutput124 (Read) Nominal current on generator mains for unbalanced load protection | UINT | | (●) ¹⁾ | | ● |
| 2678 | ConfigOutput36 (Read) Maximum limit of neutral conductor current | UINT | | (●) ¹⁾ | | ● |
| 2726 | ConfigOutput37 (Read) Response time for neutral conductor current monitoring | UINT | | (●) ¹⁾ | | ● |
| 2682 | ConfigOutput38 (Read) Short circuit current | UINT | | (●) ¹⁾ | | ● |
| 2730 | ConfigOutput39 (Read) Response time for short circuit current | UINT | | (●) ¹⁾ | | ● |
| 2686 | ConfigOutput42 (Read) Rating-dependent overcurrent | UINT | | (●) ¹⁾ | | ● |
| 2690 | ConfigOutput43 (Read) Integration coefficient for rating-dependent overcurrent (iths) | UINT | | (●) ¹⁾ | | ● |
| 2694 | ConfigOutput44 (Read) Capacitive reactive power | UINT | | (●) ¹⁾ | | ● |
| 2738 | ConfigOutput45 (Read) Response time for reactive power monitoring | UINT | | (●) ¹⁾ | | ● |
| 2830 | ConfigOutput89 (Read) Generator overload | UINT | | (●) ¹⁾ | | ● |
| 2834 | ConfigOutput90 (Read) Response time for generator overload | UINT | | (●) ¹⁾ | | ● |
| 2838 | ConfigOutput91 (Read) Generator feedback | UINT | | (●) ¹⁾ | | ● |
| 2842 | ConfigOutput92 (Read) Response time for generator feedback | UINT | | (●) ¹⁾ | | ● |
| DO1 function | | | | | | |
| 2698 | ConfigOutput57 (Read) Monitoring functions - 1 | UINT | | (●) ¹⁾ | | ● |
| 2854 | ConfigOutput97 (Read) Monitoring functions - 2 | UINT | | (●) ¹⁾ | | ● |
| Synchronization mains (for mains configuration "Sync mains 1 / Sync mains 2") - Configuration | | | | | | |
| 2578 | ConfigOutput01 (Read) Nominal voltage of synchronization mains (U_{NomSyn}) | UINT | | (●) ¹⁾ | | ● |
| 2602 | ConfigOutput07 (Read) Multiplier for synchronization mains 1 | UINT | | (●) ¹⁾ | | ● |
| 2606 | ConfigOutput08 (Read) Multiplier for synchronization mains 2 | UINT | | (●) ¹⁾ | | ● |
| Mains (for mains configuration "3-phase mains") - Configuration | | | | | | |
| 2578 | ConfigOutput01 (Read) Nominal voltage of mains ($U_{NomMains}$) | UINT | | (●) ¹⁾ | | ● |
| 2602 | ConfigOutput07 (Read) Multiplier for mains | UINT | | (●) ¹⁾ | | ● |
| 2565 | ConfigOutput22 (Read) Enable/disable mains functions | UINT | | (●) ¹⁾ | | ● |
| Mains monitoring functions (for mains configuration "3-phase mains") - Configuration | | | | | | |
| Mains voltage monitoring | | | | | | |
| 2766 | ConfigOutput73 (Read) Overvoltage limit of the mains ($U_{maxMains}$) | UINT | | (●) ¹⁾ | | ● |
| 2858 | ConfigOutput98 (Read) Overvoltage limit 2 of the mains ($U_{maxMains}$) | UINT | | (●) ¹⁾ | | ● |
| 2802 | ConfigOutput82 (Read) Response time for mains overvoltage ($U_{maxMains}$) | UINT | | (●) ¹⁾ | | ● |
| 2862 | ConfigOutput99 (Read) Response time 2 for mains overvoltage ($U_{maxMains}$) | UINT | | (●) ¹⁾ | | ● |
| 2774 | ConfigOutput75 (Read) Mains over-frequency ($f_{maxMains}$) | UINT | | (●) ¹⁾ | | ● |
| 2874 | ConfigOutput102 (Read) Mains over-frequency 2 ($f_{maxMains}$) | UINT | | (●) ¹⁾ | | ● |
| 2810 | ConfigOutput84 (Read) Response time for mains over-frequency ($f_{maxMains}$) | UINT | | (●) ¹⁾ | | ● |
| 2878 | ConfigOutput103 (Read) Response time 2 for mains over-frequency ($f_{maxMains}$) | UINT | | (●) ¹⁾ | | ● |
| 2778 | ConfigOutput76 (Read) Mains under-frequency ($f_{minMains}$) | UINT | | (●) ¹⁾ | | ● |
| 2882 | ConfigOutput104 (Read) Mains under-frequency 2 ($f_{minMains}$) | UINT | | (●) ¹⁾ | | ● |
| 2814 | ConfigOutput85 (Read) Response time for mains under-frequency ($f_{minMains}$) | UINT | | (●) ¹⁾ | | ● |
| 2886 | ConfigOutput105 (Read) Response time 2 for mains under-frequency ($f_{minMains}$) | UINT | | (●) ¹⁾ | | ● |
| 2782 | ConfigOutput77 (Read) Mains voltage asymmetry ($U_{asMains}$) | UINT | | (●) ¹⁾ | | ● |
| 2818 | ConfigOutput86 (Read) Response time for the mains voltage asymmetry ($U_{asMains}$) | UINT | | (●) ¹⁾ | | ● |
| Undervoltage monitoring in 2-point mode | | | | | | |

| Register | Name | Data type | Read | | Write | |
|--|---|-----------|--------|-------------------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2770 | ConfigOutput74 (Read) Undervoltage limit of the mains ($U_{\min\text{Mains}}$) | | | (●) ¹⁾ | | • |
| 2866 | ConfigOutput100 (Read) Undervoltage limit 2 of the mains ($U_{\min\text{Mains}}$) | | | (●) ¹⁾ | | • |
| 2806 | ConfigOutput83 (Read) Response time for mains undervoltage ($U_{\min\text{Mains}}$) | | | (●) ¹⁾ | | • |
| 2870 | ConfigOutput101 (Read) Response time 2 for mains undervoltage ($U_{\min\text{Mains}}$) | | | (●) ¹⁾ | | • |
| Undervoltage monitoring in 6-point mode | | | | | | |
| 2770 | ConfigOutput74 (Read) Undervoltage limit ($U_{\min\text{Mains}}$) (1st mains) | | | (●) ¹⁾ | | • |
| 2866 | ConfigOutput100 (Read) Undervoltage limit ($U_{\min\text{Mains}}$) (2nd mains) | | | (●) ¹⁾ | | • |
| 2906 | ConfigOutput110 (Read) Undervoltage limit ($U_{\min\text{Mains}}$) (3rd mains) | | | (●) ¹⁾ | | • |
| 2914 | ConfigOutput112 (Read) Undervoltage limit ($U_{\min\text{Mains}}$) (4th mains) | | | (●) ¹⁾ | | • |
| 2922 | ConfigOutput114 (Read) Undervoltage limit ($U_{\min\text{Mains}}$) (5th mains) | | | (●) ¹⁾ | | • |
| 2930 | ConfigOutput116 (Read) Undervoltage limit ($U_{\min\text{Mains}}$) (6th mains) | | | (●) ¹⁾ | | • |
| 2806 | ConfigOutput83 (Read) Response time for mains undervoltage ($U_{\min\text{Mains}}$) (1st mains) | | | (●) ¹⁾ | | • |
| 2870 | ConfigOutput101 (Read) Response time for mains undervoltage ($U_{\min\text{Mains}}$) (2nd mains) | | | (●) ¹⁾ | | • |
| 2910 | ConfigOutput111 (Read) Response time for mains undervoltage ($U_{\min\text{Mains}}$) (3rd mains) | | | (●) ¹⁾ | | • |
| 2918 | ConfigOutput113 (Read) Response time for mains undervoltage ($U_{\min\text{Mains}}$) (4th mains) | | | (●) ¹⁾ | | • |
| 2926 | ConfigOutput115 (Read) Response time for mains undervoltage ($U_{\min\text{Mains}}$) (5th mains) | | | (●) ¹⁾ | | • |
| 2934 | ConfigOutput117 (Read) Response time for mains undervoltage ($U_{\min\text{Mains}}$) (6th mains) | | | (●) ¹⁾ | | • |
| Microgrid monitoring | | | | | | |
| 2890 | ConfigOutput106 (Read) Overvoltage limit of the microgrid ($U_{\max\text{Mains}}$) | UINT | | (●) ¹⁾ | | • |
| 2894 | ConfigOutput107 (Read) Undervoltage limit of the microgrid ($U_{\min\text{Mains}}$) | UINT | | (●) ¹⁾ | | • |
| 2898 | ConfigOutput108 (Read) Response time for microgrid limit | UINT | | (●) ¹⁾ | | • |
| Phase shift monitoring | | | | | | |
| 2786 | ConfigOutput78 (Read) Maximum phase difference for a single phase | UINT | | (●) ¹⁾ | | • |
| 2790 | ConfigOutput79 (Read) Maximum phase difference for three phases | UINT | | (●) ¹⁾ | | • |
| 2826 | ConfigOutput88 (Read) Minimum voltage for phase shift monitoring | UINT | | (●) ¹⁾ | | • |
| Mains frequency change | | | | | | |
| 2794 | ConfigOutput80 (Read) Response value for mains frequency change (df/dt) | UINT | | (●) ¹⁾ | | • |
| 2822 | ConfigOutput87 (Read) Number of periods for mains frequency change (df/dt) | UINT | | (●) ¹⁾ | | • |
| DO5 function | | | | | | |
| 2798 | ConfigOutput81 (Read) DO5 function | UINT | | (●) ¹⁾ | | • |
| Busbar - Configuration | | | | | | |
| 2586 | ConfigOutput03 (Read) Busbar nominal voltage (U_{NomBus}) | UINT | | (●) ¹⁾ | | • |
| 2594 | ConfigOutput05 (Read) Multiplier for busbar | UINT | | (●) ¹⁾ | | • |
| 2650 | ConfigOutput40 (Read) Minimum busbar voltage (U_{Bmin}) | UINT | | (●) ¹⁾ | | • |
| Synchronization - Configuration | | | | | | |
| 3 | ConfigOutputPacked01 Synchronization mode | USINT | | | | • |
| 2654 | ConfigOutput56 (Read) Synchronization configuration | UINT | | (●) ¹⁾ | | • |
| 2654 | ConfigOutput11 (Read) Max. permissible difference frequency (df_{\max}) | UINT | | (●) ¹⁾ | | • |
| 2630 | ConfigOutput12 (Read) Min. permissible difference frequency (df_{\min}) | UINT | | (●) ¹⁾ | | • |
| 2634 | ConfigOutput13 (Read) Max. permissible differential voltage (dU_{\max}) | UINT | | (●) ¹⁾ | | • |
| 2638 | ConfigOutput14 (Read) Max. permissible differential angle (ϕ_{\max}) | UINT | | (●) ¹⁾ | | • |
| 2618 | ConfigOutput15 (Read) Phase shift of sync mains 1 ($d\alpha$) | UINT | | (●) ¹⁾ | | • |

| Register | Name | Data type | Read | | Write | |
|---|--|-----------|--------|-------------------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 2754 | ConfigOutput47 (Read) Pulse duration of switch-on relay on DO4 | UINT | | (●) ¹⁾ | | ● |
| 2758 | ConfigOutput48 (Read) Switching response time of power switch on DO4 | UINT | | (●) ¹⁾ | | ● |
| 2642 | ConfigOutput95 (Read) Pulse duration of switch-on relay on DO6 | UINT | | (●) ¹⁾ | | ● |
| 2646 | ConfigOutput96 (Read) Switching response time of power switch on DO6 | UINT | | (●) ¹⁾ | | ● |
| 2622 | ConfigOutput58 (Read) Dead bus voltage ($U_{BminSync}$) | UINT | | (●) ¹⁾ | | ● |
| 2846 | ConfigOutput93 (Read) 2-phase synchronization for commissioning tests | UINT | | (●) ¹⁾ | | ● |
| Maximum value buffer and power meter - Configuration | | | | | | |
| 2750 | ConfigOutput46 (Read) Pulse value of energy meter output | UINT | | (●) ¹⁾ | | ● |
| 2850 | ConfigOutput94 (Read) Count value for active energy meter and reactive energy meter | UINT | | (●) ¹⁾ | | ● |
| 3074 | ConfigOutput49 Maximum phase current of generator I1 | INT | | ● | | |
| | ConfigOutput60 Reset maximum phase current I1 | INT | | | | ● |
| 3078 | ConfigOutput50 Maximum phase current I2 | INT | | ● | | |
| | ConfigOutput61 Reset maximum phase current I2 | INT | | | | ● |
| 3082 | ConfigOutput51 Maximum phase current I3 | INT | | ● | | |
| | ConfigOutput62 Reset maximum phase current I3 | INT | | | | ● |
| 3086 | ConfigOutput52 Maximum total active power | INT | | ● | | |
| | ConfigOutput63 Resets maximum total active power | INT | | | | ● |
| 3090 | ConfigOutput53 Maximum neutral conductor current | INT | | ● | | |
| | ConfigOutput64 Resets maximum neutral conductor current | INT | | | | ● |
| 3108 | ConfigOutput54 Active energy meter for supply | DINT | | ● | | |
| | ConfigOutput66 Write to active energy meter for supply | DINT | | | | ● |
| 3124 | ConfigOutput55 Reactive energy meter for supply | DINT | | ● | | |
| | ConfigOutput67 Write to reactive energy meter for supply | DINT | | | | ● |
| 3116 | ConfigOutput71 Active energy meter for reference | DINT | | ● | | |
| | ConfigOutput69 Write to active energy meter for reference | DINT | | | | ● |
| 3132 | ConfigOutput72 Reactive energy meter for reference | DINT | | ● | | |
| | ConfigOutput70 Write to reactive energy meter for reference | DINT | | | | ● |
| General registers - Communication | | | | | | |
| 1 | DigitalOutputPacked01 Digital outputs 05 - 06 and various control bits | USINT | | | | ● |
| | DigitalOutput05 | Bit 0 | | | | |
| | DigitalOutput06 | Bit 1 | | | | |
| | ResetGeneratorErrors | Bit 2 | | | | |
| | ResetMainsErrors | Bit 3 | | | | |
| 165 | InvertDO5 | Bit 4 | | | | |
| | StatusDigitalOutputPacked01 Status of digital outputs | USINT | ● | | | |
| | StatusDigitalOutput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | StatusDigitalOutput06 | Bit 5 | | | | |
| 162 | StatusInput17 | Bit 6 | | | | |
| | StatusInput16 | Bit 7 | | | | |
| | StatusInputPacked01 Generator mains error registers | UINT | ● | | | |
| | StatusInput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | StatusInput11 | Bit 10 | | | | |
| 167 | StatusInput31 | Bit 11 | | | | |
| | StatusInput32 | Bit 12 | | | | |
| | StatusInput18 | Bit 15 | | | | |
| 167 | StatusInputPacked02 Power mains error registers | USINT | ● | | | |

| Register | Name | Data type | Read | | Write | |
|--|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| | StatusInput24 | Bit 0 | | | | |
| | ... | ... | | | | |
| | StatusInput30 | Bit 6 | | | | |
| | StatusInput33 | Bit 7 | | | | |
| 186 | StatusInputPacked03 General error registers | UINT | • | | | |
| | StatusInput12 | Bit 0 | | | | |
| | ... | ... | | | | |
| | StatusInput15 | Bit 3 | | | | |
| | StatusInput19 | Bit 4 | | | | |
| | ... | ... | | | | |
| | StatusInput23 | Bit 7 | | | | |
| 190 | StatusInputPacked04 Power mains error registers (continued) | UINT | • | | | |
| | StatusInput34 | Bit 0 | | | | |
| | ... | ... | | | | |
| | StatusInput37 | Bit 4 | | | | |
| 194 | StatusInputPacked05 Generator mains error registers (continued) | UINT | • | | | |
| | StatusInput38 | Bit 0 | | | | |
| | ... | ... | | | | |
| | StatusInput40 | Bit 2 | | | | |
| Generator mains measured values - Communication | | | | | | |
| 30 | AnalogInput01 Phase current I1 | INT | • | | | |
| 34 | AnalogInput02 Phase current I2 | INT | • | | | |
| 38 | AnalogInput03 Phase current I3 | INT | • | | | |
| 42 | AnalogInput04 Current average I1, I2, I3 | INT | • | | | |
| 46 | AnalogInput05 Neutral conductor current In | INT | • | | | |
| 170 | AnalogInput06 Current average, dynamic (Im_dyn) | UINT | • | | | |
| 2 | AnalogInput07 Line-to-line voltage UG12 | INT | • | | | |
| 6 | AnalogInput08 Line-to-line voltage UG23 | INT | • | | | |
| 10 | AnalogInput09 Line-to-line voltage UG31 | INT | • | | | |
| 18 | AnalogInput10 Phase voltage UG1 | INT | • | | | |
| 22 | AnalogInput11 Phase voltage UG2 | INT | • | | | |
| 26 | AnalogInput12 Phase voltage UG3 | INT | • | | | |
| 14 | AnalogInput22 Voltage average UG12, UG23, UG31 | INT | • | | | |
| 174 | AnalogInput19 Total active power filtered P/P_H1 | INT | • | | | |
| 178 | AnalogInput20 Total reactive power filtered Q/Q_H1 | INT | • | | | |
| 182 | AnalogInput21 Total apparent power filtered Q/S_H1 | INT | • | | | |
| 54 | AnalogInput23 Power factor of generator/cos ϕ | INT | • | | | |
| 50 | AnalogInput24 Frequency of the generator mains | UINT | • | | | |
| Timestamp for generator voltages and currents | | | | | | |
| 772 | AnalogInput38 Timestamp of pos. zero crossing of phase voltage UG1 | DINT | • | | | |
| 780 | AnalogInput39 Timestamp of pos. zero crossing of phase voltage UG2 | DINT | • | | | |
| 788 | AnalogInput40 Timestamp of pos. zero crossing of phase voltage UG3 | DINT | • | | | |
| 796 | AnalogInput41 Timestamp of pos. zero crossing of phase current I1 | DINT | • | | | |
| 804 | AnalogInput42 Timestamp of pos. zero crossing of phase current I2 | DINT | • | | | |
| 812 | AnalogInput43 Timestamp of pos. zero crossing of phase current I3 | DINT | • | | | |
| Generator monitoring functions - Communication | | | | | | |
| 3330 | AnalogInput36 Read unbalanced load meter | UINT | | • | | |
| 3334 | AnalogInput37 Read unbalanced load current I2 | INT | | • | | |
| Measured values for busbar - Communication | | | | | | |

| Register | Name | Data type | Read | | Write | |
|--|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 82 | AnalogInput13 Line-to-line voltage of busbar UB12 | INT | • | | | |
| 86 | AnalogInput14 Line-to-line voltage of busbar UB23 | INT | • | | | |
| 90 | AnalogInput15 Line-to-line voltage of busbar UB31 | INT | • | | | |
| 94 | AnalogInput16 Phase voltage of busbar UB1 | INT | • | | | |
| 98 | AnalogInput17 Phase voltage of busbar UB2 | INT | • | | | |
| 102 | AnalogInput18 Phase voltage of busbar UB3 | INT | • | | | |
| 106 | AnalogInput35 Frequency of busbar | UINT | • | | | |
| Measured values for synchronization mains (for "Sync mains 1 / Sync mains 2" mains configuration) - Communication | | | | | | |
| 114 | AnalogInput25 Line-to-line voltage of sync mains 1 US1 | INT | • | | | |
| 134 | AnalogInput26 Line-to-line voltage of sync mains 2 US2 | INT | • | | | |
| 138 | AnalogInput27 Frequency of sync mains 1 | UINT | • | | | |
| 142 | AnalogInput28 Frequency of sync mains 2 | UINT | • | | | |
| Power mains measured values (for "3-phase mains" configuration) | | | | | | |
| 114 | AnalogInput25 Line-to-line voltage of power mains UN12 | INT | • | | | |
| 118 | AnalogInput31 Line-to-line voltage of power mains UN23 | INT | • | | | |
| 122 | AnalogInput32 Line-to-line voltage of power mains UN31 | INT | • | | | |
| 126 | AnalogInput33 Phase voltage of power mains UN1 | INT | • | | | |
| 130 | AnalogInput34 Phase voltage of power mains UN2 | INT | • | | | |
| 134 | AnalogInput26 Phase voltage of power mains UN3 | INT | • | | | |
| 138 | AnalogInput27 Frequency of power mains | UINT | • | | | |
| Synchronization - Communication | | | | | | |
| 146 | AnalogInput29 Differential angle between sync mains | INT | • | | | |
| 150 | AnalogInput30 Differential voltage between sync mains | INT | • | | | |

1) This configuration register has a dual design. The register with "Read" in the name allows the configured value to be read back.

9.26.4.20.2.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.26.4.20.3 Configuration registers

9.26.4.20.3.1 General registers

Mains settings

Name:

ConfigOutput68

ConfigOutput68Read

This register is used to configure the module on the connected mains.

The value of this register can be read back.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|-------------------------------|----------|---|
| 0 - 1 | Generator mains configuration | 00 | 3-phase network with neutral conductor |
| | | 01 | 3-phase mains without neutral conductor |
| | | 10 to 11 | Reserved |
| 2 - 3 | Busbar configuration | 00 | 3-phase network with neutral conductor |
| | | 01 | 3-phase mains without neutral conductor |
| | | 10 to 11 | Reserved |
| 4 - 5 | Mains configuration | 00 | 3-phase network with neutral conductor |
| | | 01 | 3-phase mains without neutral conductor |
| | | 10 | Sync network 1 / Sync network 2 |
| | | 11 | Reserved |
| 6 - 7 | Reserved | 0 | |
| 8 - 9 | Generator mains ground | 00 | No phases grounded |
| | | 01 | L1 grounded |
| | | 10 | L2 grounded |
| | | 11 | L3 grounded |
| 10 - 11 | Busbar ground | 00 | No phases grounded |
| | | 01 | L1 grounded |
| | | 10 | L2 grounded |
| | | 11 | L3 grounded |
| 12 - 13 | Sync Mains 1 ground | 00 | No phases grounded |
| | | 01 | L1 grounded |
| | | 10 | L2 grounded |
| | | 11 | L3 grounded |
| 14 - 15 | Sync Mains 2 ground | 00 | No phases grounded |
| | | 01 | L1 grounded |
| | | 10 | L2 grounded |
| | | 11 | L3 grounded |

Mains without neutral conductor

If configured as "3-phase mains without neutral conductor", the potential of the neutral conductor is calculated from the 3 phases ("virtual neutral point").

The phase voltages are then measured in relation to this "virtual neutral point".

Mains with ground

If one of the phases of a mains system is grounded, then it must be configured as such. Otherwise, it is possible that the module will report a phase failure that blocks the mains synchronization function.

Monitoring functions disabled:

- Phase failure monitoring is not carried out for the phase configured as "grounded".
- Phase sequence monitoring is not performed on 2-phase mains that are grounded.

Mains configuration

The mains can be used as two 2-phase synchronization mains or combined into a 3-phase mains.

If the mains configuration is set to "3-phase mains" then the monitoring functions will be enabled for these combined mains.

Nominal voltage range, nominal current range and Aron circuit

Name:

ConfigOutput20

ConfigOutput20Read

The value of this register can be read back.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---|-------|---|
| 0 | Nominal voltage range of generator mains | 0 | Voltage 100 V |
| | | 1 | Voltage 400 V |
| 1 | Nominal voltage range of busbar | 0 | Voltage 100 V |
| | | 1 | Voltage 400 V |
| 2 | Nominal voltage range of Sync Mains 1 | 0 | Voltage 100 V |
| | | 1 | Voltage 400 V |
| 3 | Nominal voltage range of Sync Mains 2 | 0 | Voltage 100 V |
| | | 1 | Voltage 400 V |
| 4 | Nominal current range of the generator mains | 0 | Current range 1 A |
| | | 1 | Current range 5 A |
| 5 | Switch to power measurement principle of Aron circuit | 0 | Aron circuit disabled: Three-phase supply with neutral line |
| | | 1 | Aron circuit enabled: Three-phase supply without neutral line |
| 6 - 7 | Reserved | 0 | |

Nominal frequency (f_{Nom})

Name:

ConfigOutput10

ConfigOutput10Read

This is needed for converting the percentages based on this nominal value into physical units.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|--------------|-----------------------------|------------|
| UINT | 4800 to 6200 | corresponds to 48 to 62 Hz. | 0.01 Hz |

General configuration register

Name:

ConfigOutput24

ConfigOutput24Read

The value of this register can be read back.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|----------|---|
| 0 - 1 | DO5 function | 00 | DO5 is freely available to the user |
| | | 01 | Monitoring output of the mains |
| | | 10 | DO5 is freely available to the user or can be used as a mains monitoring output (the two signals are linked with an OR) |
| | | 11 | Reserved |
| 2 - 3 | DO6 function | 00 | DO6 is freely available to the user |
| | | 01 | Synchronization output (control of power switch) |
| | | 10 to 11 | Reserved |
| 4 | Definition of rotational direction monitoring of all mains | 0 | Right rotating field |
| | | 1 | Left rotating field |
| 5 - 7 | Reserved | 0 | |

Trigger bits

Name:

ConfigOutput23

ConfigOutput23Read

The value of this register can be read back.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------------|-------|--|
| 0 | Reset unbalanced load meter | 0 | Unbalanced load meter not set to 0 |
| | | 1 | On rising edge: Unbalanced load meter set to 0 |
| 1 - 7 | Reserved | 0 | |

9.26.4.20.3.2 Generator mains**Nominal voltage of generator mains (U_{NomGen})**

Name:

ConfigOutput02

ConfigOutput02Read

This is needed for converting the percentages based on this nominal value into physical units.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-------------|------------------------------|------------|
| UINT | 70 to 65000 | Corresponds to 70 to 65000 V | 1 V |

Multiplier for generator mains

Name:

ConfigOutput06

ConfigOutput06Read

This is used for converting the measured value into a physical value. The multiplier is applied to the respective input value.

The value 100 corresponds to a multiplication factor of 1 (measured value not changed).

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|-------------------------------|------------|
| UINT | 1 to 65535 | Corresponds to 0.01 to 655.35 | 0.01 |

Nominal current of generator mains (I_{Nom})

Name:

ConfigOutput04

ConfigOutput04Read

This is needed for converting the percentages based on this nominal value into physical units.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|-----------------------------|------------|
| UINT | 0 to 65000 | Corresponds to 0 to 65000 A | 1 A |

Multiplier for current transformer

Name:

ConfigOutput09

ConfigOutput09Read

This is used for converting the measured value into a physical value. The multiplier is applied to the respective input value.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|---------------------------|------------|
| UINT | 1 to 65535 | Corresponds to 1 to 65535 | 1 |

Turns generator mains functions on/off

Name:

ConfigOutput21

ConfigOutput21Read

The value of this register can be read back.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|---|
| 0 | Error acknowledgment mode | 0 | Error bits are reset by the module |
| | | 1 | Error bits are reset by the user |
| 2 - 3 | Check all overvoltages and undervoltages ¹⁾ | 00 | 3 phase voltages |
| | | 01 | 3 line-to-line voltages |
| | | 10 | 3 line-to-line and 3 phase voltages |
| | | 11 | Reserved |
| 4 - 5 | Reserved | 0 | |
| 6 | Power measurement mode ²⁾ | 0 | Total output - Including the harmonic component |
| | | 1 | Fundamental power - 1st harmonic only |
| 7 | Reserved | 0 | |

1) This parameter is supported starting with upgrade 1.6.0.0 (firmware version 102). For information about configuring limit values, see "[Generator monitoring](#)" on page 2954.

2) This parameter is supported starting with upgrade 1.5.0.0 (firmware version 101).

Power measurement mode

In real transmission networks, neither the voltages nor the currents are strictly sinusoidal. This means: The fundamental frequencies are generally subject to strong harmonics.

By default, the module always accounts for the contributions of the fundamental frequency as well as the harmonics. In addition to the voltage and current measured values, this also affects the power measurements.

When controlling with reactive power in applications, the part of the reactive power coming from the harmonic frequencies (distortion reactive power) can have negative effects. Only the displacement reactive power should be controlled (i.e. the reactive power component of the fundamental frequency). In particular, this can make a control to displacement reactive power = 0 ($\cos \varphi = 1$) impossible.

This is why the module offers the possibility of accounting for only the fundamental frequency (1st harmonic) for power measurement, when necessary. This primarily serves to filter out the distortion reactive power. However, all other measured values associated with the power measurement as well as the corresponding generator protection functions are affected when re-configuring the power measurement to the fundamental frequency.

The voltage and current measured values from the generator mains are **not** affected. Just as before (as with the other voltage supply systems), they also always include the contribution of harmonics regardless of the mode being used for power measurement.

| Measured value / Functionality | Corresponding data point | Corresponding output | Remarks/Details |
|--|--------------------------------|----------------------|--|
| Active power | AnalogInput19 | | P → P_H1 |
| Reactive power | AnalogInput20 | | Q → Q_H1 |
| Apparent power | AnalogInput21 | | S → S_H1 |
| Power factor | AnalogInput23 | | Power factor → $\cos \varphi$ $ \cos \varphi = \cos(\arctan(Q_H1/P_H1))$ The signs for $\cos \varphi$ are described in section " Generator operating modes " on page 2941. "I" and "U" must be replaced by the respective 1st harmonics "I_H1" and "U_H1". |
| Maximum total active power | ConfigOutput52 | | Changing the parameter "Power measurement mode" during runtime has no immediate effect on any of these registers or the internal energy meters (e.g. meter reset). It only determines the summands or comparison value that is effective immediately (total output / fundamental frequency power). |
| Active energy meter for supply | ConfigOutput54 | | |
| Reactive energy meter for supply | ConfigOutput55 | | |
| Active energy meter for reference | ConfigOutput71 | | |
| Reactive energy meter for reference | ConfigOutput72 | | |
| Energy meter output | | DO 2 | |
| Generator monitoring function: Capacitive reactive power | StatusInput10 | DO 1 | |
| Generator monitoring function: Generator overload | StatusInput31 | DO 1 | |
| Generator monitoring function: Generator feedback | StatusInput32 | DO 1 | |

Low-pass filter for total power ratings

Name:

ConfigOutput41

ConfigOutput41Read

Parameter for delay time of the low-pass filter of the total power values P, Q and S or P_H1, Q_H1 and S_H1 (see "Power measurement mode" on page 2953). The maximum total power values are recorded independently of this without being filtered.

This parameter is used as a delay element so that current or voltage fluctuations have less effect on how the calculated power values are represented. The damping behavior of the low-pass filter acts in accordance with the configurable time constant of a decaying e-function.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|----------------------------|------------|
| UINT | 0 to 300 | Corresponds to 0 to 300 ms | 1 ms |

9.26.4.20.3.3 Generator monitoring**Overvoltage limit of generator mains (U_{max})**

Name:

ConfigOutput16 (1st value)

ConfigOutput118 (2nd value)

ConfigOutput16Read (1st value)

ConfigOutput118Read (2nd value)

If the value of one of the generator voltages configured in the "ConfigOutput21" on page 2953 register exceeds the value set here, then the "Overvoltage" error message (register "StatusInputPacked01" on page 2984) or "Overvoltage2" (register "StatusInputPacked05" on page 2987) is indicated after the delay time has expired and, if configured, the DO1 monitoring relay is switched.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|--|------------|
| UINT | 0 to 2000 | Corresponds to 0 to 200% of U_{NomGen} | 0.1% |

Response time for generator overvoltage (U_{max})

Name:

ConfigOutput26 (1st time)

ConfigOutput119 (2nd time)

ConfigOutput26Read (1st time)

ConfigOutput119Read (2nd time)

The error is only triggered if the response value is exceeded in the positive direction without interruption for as long as is specified in this register.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|----------------------------|------------|
| UINT | 5 to 100 | Corresponds to 0.5 to 10 s | 0.1 s |

Undervoltage limit of generator mains (U_{min})

Name:

ConfigOutput27 (1st value)

ConfigOutput59 (2nd value)

ConfigOutput27Read (1st value)

ConfigOutput59Read (2nd value)

If the value of one of the generator voltages configured in the "ConfigOutput21" on page 2953 register falls below the value set here, then the "Undervoltage" or "Undervoltage2" error message (register "StatusInputPacked01" on page 2984) is indicated after the delay time has passed and, if configured, the DO1 monitoring relay is switched.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|--|------------|
| UINT | 0 to 2000 | Corresponds to 0 to 200% of U_{NomGen} | 0.1% |

Response time for generator undervoltage (U_{min})

Name:

ConfigOutput28 (1st time)

ConfigOutput65 (2nd time)

ConfigOutput28Read (1st time)

ConfigOutput65Read (2nd time)

The error is only triggered if the response value is exceeded in the negative direction without interruption for as long as is specified in this register.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|----------------------------|------------|
| UINT | 5 to 100 | Corresponds to 0.5 to 10 s | 0.1 s |

Generator over-frequency (f_{max})

Name:

ConfigOutput29 (1st frequency)

ConfigOutput122 (2nd frequency)

ConfigOutput29Read (1st frequency)

ConfigOutput122Read (2nd frequency)

If the value of the generator frequency exceeds the percent value set here in relation to the nominal frequency, then the error message "Overfrequency" (register "[StatusInputPacked01](#)" on page 2984) or "Overfrequency 2" (register "[StatusPacked05](#)" on page 2987) is indicated after the delay time has passed and, if configured, the DO1 monitoring relay is switched.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|----------------------------|------------|
| UINT | 0 to 2000 | For 0 to 200% of f_{Nom} | 0.1% |

Response time for generator over-frequency (f_{max})

Name:

ConfigOutput30 (1st time)

ConfigOutput123 (2nd time)

ConfigOutput30Read (1st time)

ConfigOutput123Read (2nd time)

The error is only triggered if the response value is exceeded in the positive direction without interruption for as long as is specified in this register.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|------------------|------------|
| UINT | 5 to 100 | For 0.5 for 10 s | 0.1 s |

Generator under-frequency (f_{min})

Name:

ConfigOutput31 (1st frequency)

ConfigOutput120 (2nd frequency)

ConfigOutput31Read (1st frequency)

ConfigOutput120Read (2nd frequency)

If the value of the generator frequency falls below the percent value set here in relation to the nominal frequency, then the error message "Underfrequency" (register "[StatusInputPacked01](#)" on page 2984) or "Underfrequency 2" (register "[StatusInputPacked05](#)" on page 2987) is indicated after the delay time has passed and, if configured, the DO1 monitoring relay is switched.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|----------------------------|------------|
| UINT | 0 to 2000 | For 0 to 200% of f_{Nom} | 0.1% |

Response time for generator under-frequency (f_{\min})

Name:

ConfigOutput32 (1st time)

ConfigOutput121 (2nd time)

ConfigOutput32Read (1st time)

ConfigOutput121Read (2nd time)

The error is only triggered if the response value is exceeded in the negative direction without interruption for as long as is specified in this register.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|-----------------|------------|
| UINT | 5 to 100 | For 0.5 to 10 s | 0.1 s |

Generator voltage asymmetry (U_{as})

Name:

ConfigOutput33

ConfigOutput33Read

This trigger value, specified as a percentage, is based on the nominal voltage of the generator. If the difference between the three line-to-line voltages of the generator mains exceeds the configured limit value, then the error message "Voltage asymmetry" is indicated (register "[StatusInputPacked01](#)" on page 2984) after the delay time has passed and, if configured, the DO1 monitoring relay is switched.

For this to happen, only one of these voltages has to exceed the respective limit value (in either the positive or negative direction).

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|------------------------------|------------|
| UINT | 0 to 300 | For 0 to 30% of U_{NomGen} | 0.1% |

Response time for generator voltage asymmetry (U_{as})

Name:

ConfigOutput34

ConfigOutput34Read

This error is triggered only if the response value is exceeded without interruption (in either the positive or negative direction) for as long as is specified in this register.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|-----------------|------------|
| UINT | 5 to 100 | For 0.5 to 10 s | 0.1 s |

Load time constant for current asymmetry ($K1$)

Name:

ConfigOutput35

ConfigOutput35Read

The dependent delayed unbalanced load monitoring function (see "[Dependent delayed unbalanced load monitoring](#)" on page 2957) continually monitors the AC currents coming from the main current converters and continually calculates the present unbalanced load current. This is compared with the threshold value, which is calculated using the load time constants. If this threshold value is exceeded, the error message "Current asymmetry" is indicated (register "[StatusInputPacked01](#)" on page 2984) and, if configured, the DO1 monitoring relay is switched.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|---------------------|------------|
| UINT | 1 to 65535 | For 0.1 to 6553.5 s | 0.1 s |

Unbalanced load constant (K2)

Name:

ConfigOutput109

ConfigOutput109Read

The boundary between continuous operation and short-term operation is defined by the unbalanced load constant K2 (see "[Dependent delayed unbalanced load monitoring](#)" on page 2957).

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|---------|------------------|------------|
| UINT | 8 to 15 | For 0.08 to 0.15 | 0.01 |

Dependent delayed unbalanced load monitoring

Unbalanced load monitoring protects against unbalanced load in three-phase generators and three-phase mains. Parameters can be changed to make it possible to match the trigger characteristics to different generator types while taking their special thermal time constants into consideration.

An unbalanced load can be caused by uneven current distribution in the mains due to unbalanced load, asymmetrical short circuits, line interruptions or switching operations. Unbalanced loads result in reverse system currents in the stator, which causes harmonics with an uneven ordinal number in the stator winding and harmonics with an even ordinal number in the rotor winding. The rotor is at particular risk here because the harmonic waves place an additional load on the rotor winding and induce eddy currents in the rotor's solid iron, which may melt the metal or destroy the metallic structure.

An unbalanced load can be permissible within certain limits, however, when accounting for the thermal load limit of the generator. To avoid premature failure of the generator when an unbalanced load occurs, the characteristics that trigger unbalanced load protection should be adapted to the thermal characteristics of the generator. Unbalanced load protection can also be triggered by external errors in the mains caused by asymmetric short circuits.

When unbalanced load protection is tripped can be calculated using the following formula:

| Operating mode | Formula |
|--|--|
| Short-term operation | $t = \frac{K1}{\left(\frac{I_2}{I_{Nom}}\right)^2 - K2^2}$ |
| Continuous operation | $\frac{I_2}{I_{Nom}} \leq K2 \rightarrow t = \infty$ |
| Key t Calculated tripping time K1 Valid load time constant for the generator [s] K2 Unbalanced load constant I ₂ Calculated inverse current / unbalanced load current [A] I _{Nom} Nominal current for the generator [A] | |

To calculate the tripping time instant, the scan duration of the measurement system (i.e. 20 ms for 50 Hz voltage) is divided by the calculated trigger time, and the results are continually added up. With short-term operation, the value of the summands increases; with continuous operation, it decreases. If the summand reaches the value 1 (100%), then the max. permitted value has been reached. The summand is limited between 0 and 1.

The boundary between continuous operation and short-term operation is defined by the unbalanced load constant K2.

Information:

When the generator is at a standstill, the summand is neither reset nor is its value reduced.

Nominal current on generator mains for unbalanced load protection

Name:

ConfigOutput124

ConfigOutput124Read

The nominal current for unbalanced load protection can be set separately. If the value is set to 0, the normal nominal current is used for calculations.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|------------------|------------|
| UINT | 0 to 65000 | For 0 to 65000 A | 1 A |

Maximum limit of neutral conductor current

Name:

ConfigOutput36

ConfigOutput36Read

Configurable limit for the neutral conductor current. If the value is exceeded, then the error message "Maximum neutral conductor current" is indicated (register "[StatusInputPacked01](#)" on page 2984) after the delay time has passed and, if configured, the DO1 monitoring relay is switched.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|----------------------------|------------|
| UINT | 0 to 1000 | For 0 to 100% of I_{Nom} | 0.1% |

Response time for neutral conductor current monitor

Name:

ConfigOutput37

ConfigOutput37Read

The error is only triggered if the response value is exceeded in the positive direction without interruption for as long as is specified in this register.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|-----------------|------------|
| UINT | 5 to 100 | For 0.5 to 10 s | 0.1 s |

Short circuit current

Name:

ConfigOutput38

ConfigOutput38Read

If the value of the generator current exceeds the percentage based on the converter's nominal current set here, then the error message "Short circuit current" is indicated (register "[StatusInputPacked01](#)" on page 2984) and, if configured, the DO1 monitoring relay is switched.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|--------------|------------------------------|------------|
| UINT | 1000 to 5000 | For 100 to 500% of I_{Nom} | 0.1% |

Response time for short circuit current

Name:

ConfigOutput39

ConfigOutput39Read

The error is only triggered if the response value is exceeded in the positive direction without interruption for as long as is specified in this register.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|-----------------|------------|
| UINT | 4 to 500 | For 0.04 to 5 s | 0.01 s |

Rating-dependent overcurrent

Name:

ConfigOutput42

ConfigOutput42Read

The response value percentage is based on the nominal current of the generator. If the response value is exceeded, then the error message "Rating-dependent overcurrent" is indicated (register "[StatusInputPacked01](#)" on page 2984) and, if configured, the DO1 monitoring relay is switched.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|--------------|------------------------------|------------|
| UINT | 1000 to 2000 | For 100 to 200% of I_{Nom} | 0.1% |

Rating-dependent overcurrent monitoring

A generator that is operated at its nominal current I_{Nom} normally reaches about half of its maximum thermal load. Operating it above the rated current I_{Nom} result in additional warming, which is permitted until the maximum temperature is reached. The highest permissible continuous temperature is determined by the class of the insulation material used in the generator.

Based on the settings and the current measurement, the device forms an internal model based on an I^2t characteristic curve of the generator temperature. This allows the heat capacity of the generator to be completely utilized for short overloads while at the same time providing full protection. The configurable parameters for determining the machine model include the nominal current I_{Nom} of the generator and the time multiplier.

Integration coefficient for rating-dependent overcurrent (iths)

Name:

ConfigOutput43

ConfigOutput43Read

To calculate the tripping time instant, the sampling duration of the measurement system is divided by the calculated trigger time (t). The results are continually added up. If the summand reaches the value 1 (100%), then the max. permitted value has been reached. The summand is limited between 0 and 1.

The value of this register can be read back.

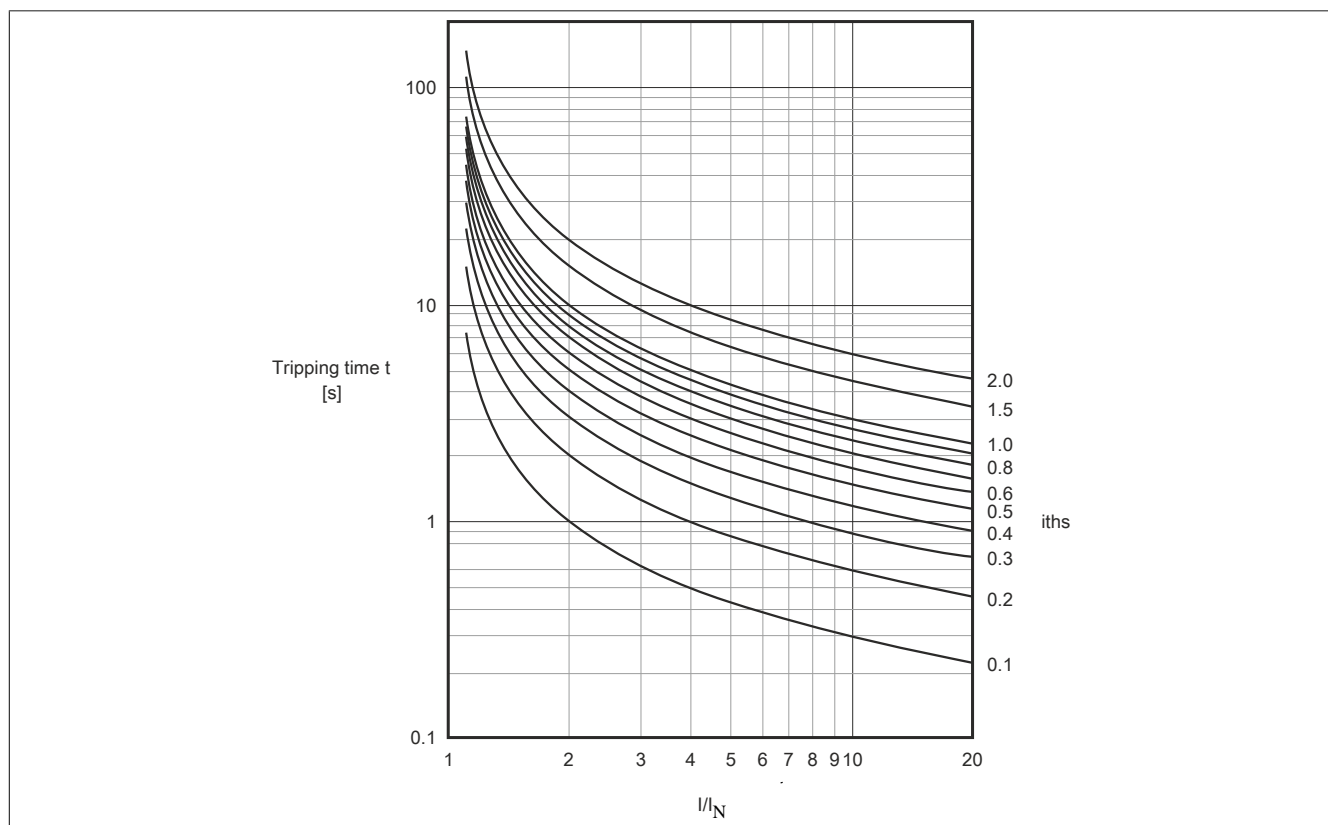
| Data type | Value | Information | Resolution |
|-----------|---------|--------------|------------|
| UINT | 1 to 20 | For 0.1 to 2 | 0.1 |

For a constant overcurrent, the trigger characteristic curve can be calculated based on the following formula:

$$t = \frac{0.14}{\left(\frac{I}{I_N}\right)^{0.02} - 1} * iths$$

Key:

| | |
|-------|---|
| t | Tripping time [s] |
| I | The highest value of the 3 phase currents [A] |
| I_N | Rating-dependent overcurrent [A] |
| iths | Integration coefficient |

Trigger characteristic curve in accordance with IEC 255-4 (normal, inverse)

The monitor function can be reset by restarting the module or by falling below the overcurrent value so that the results of the continuous addition decrease according to the formula.

Capacitive reactive power

Name:

ConfigOutput44

ConfigOutput44Read

The capacitive reactive power for the generator is monitored to determine if it falls below the defined response value. In this way, monitoring the capacitive reactive power can be used to detect exciter failure. If the response value is fallen below, then the error message "Capacitive reactive power" is indicated (register "[StatusInputPacked01](#)" on [page 2984](#)) after the delay time has passed and, if configured, the DO1 monitoring relay is switched.

Depending on how the "Power measurement mode" parameter is set in the "[ConfigOutput21](#)" on [page 2953](#) register, either the total reactive power or the fundamental frequency reactive power (displacement reactive power) is compared with the response value.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------------|--------------------------|------------|
| INT | -32768 to 32767 | For -32768 to 32767 kvar | 1 kvar |

Response time for reactive power monitoring

Name:

ConfigOutput45

ConfigOutput45Read

The error is only triggered if the response value is exceeded in the positive direction without interruption for as long as is specified in this register.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|-----------------|------------|
| UINT | 5 to 100 | For 0.5 to 10 s | 0.1 s |

Generator overload

Name:

ConfigOutput89

ConfigOutput89Read

If the value of the active power of the generator exceeds the percentage of the generator's nominal power set here, then the error message "Generator overload" is indicated (register "[StatusInputPacked01](#)" on [page 2984](#)) after the delay time has passed and, if configured, the DO1 monitoring relay is switched.

Depending on how the "Power measurement mode" parameter is set in the "[ConfigOutput21](#)" on [page 2953](#) register, either the total active power or the fundamental frequency active power is compared with the response value.

The nominal power is calculated as follows:

$$P_{\text{NomGen}} = U_{\text{NomGen}} * I_{\text{NomGen}} * \sqrt{3}$$

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|--------------------------------------|------------|
| UINT | 0 to 2000 | For 0 to 200% of P_{NomGen} | 0.1% |

Response time for generator overload

Name:

ConfigOutput90

ConfigOutput90Read

The error is only triggered if the response value is exceeded in the positive direction without interruption for as long as is specified in this register.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|-----------------|------------|
| UINT | 5 to 100 | For 0.5 to 10 s | 0.1 s |

Generator feedback

Name:

ConfigOutput91

ConfigOutput91Read

If the value of the negative active power of the generator falls below the percentage of the generator's nominal power set here, then the error message "Generator feedback" is indicated (register "[StatusInputPacked01](#)" on page 2984) after the delay time has passed and, if configured, the DO1 monitoring relay is switched.

Depending on how the "Power measurement mode" parameter is set in the "[ConfigOutput21](#)" on page 2953 register, either the total active power or the fundamental frequency active power is compared with the response value.

The nominal power is calculated as follows:

$$P_{\text{NomGen}} = U_{\text{NomGen}} * I_{\text{NomGen}} * \sqrt{3}$$

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|----------------------------------|------------|
| UINT | 0 to 2000 | 0 to 200% of P_{NomGen} | 0.1% |

Response time for generator feedback

Name:

ConfigOutput92

ConfigOutput92Read

The error is only triggered if the response value is exceeded in the negative direction without interruption for as long as is specified in this register.

The values of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|-----------------|------------|
| UINT | 5 to 100 | For 0.5 to 10 s | 0.1 s |

DO1 function

This digital output can be set after the defined response time has elapsed depending on the assignment of the generator mains' monitoring variables (X3). Assignments are made using the "ConfigOutput57" on page 2963 and "ConfigOutput97" on page 2964 registers.

The monitoring variables can be assigned to this input either individually or with additional monitoring variables using an OR connective. This makes it possible to set the relay when there are multiple monitoring variables.

Assigning monitoring functions - 1

Name:

ConfigOutput57

ConfigOutput57Read

The following monitoring functions can be assigned to the monitoring relay using this register:

The value of this register can be read back.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|---|-------|------------------------|
| 0 | Overvoltage (of a phase) | 0 | Do not assign function |
| | | 1 | Assign function |
| 1 | Undervoltage (or a phase) | 0 | Do not assign function |
| | | 1 | Assign function |
| 2 | Overfrequency | 0 | Do not assign function |
| | | 1 | Assign function |
| 3 | Underfrequency | 0 | Do not assign function |
| | | 1 | Assign function |
| 4 | Voltage asymmetry | 0 | Do not assign function |
| | | 1 | Assign function |
| 5 | Current asymmetry (unbalanced load) | 0 | Do not assign function |
| | | 1 | Assign function |
| 6 | Neutral conductor current, maximum | 0 | Do not assign function |
| | | 1 | Assign function |
| 7 | Short circuit current | 0 | Do not assign function |
| | | 1 | Assign function |
| 8 | Rating-dependent overcurrent | 0 | Do not assign function |
| | | 1 | Assign function |
| 9 | Capacitive reactive power (exciter failure) | 0 | Do not assign function |
| | | 1 | Assign function |
| 10 | Ready | 0 | Do not assign function |
| | | 1 | Assign function |
| 11 | Generator overload | 0 | Do not assign function |
| | | 1 | Assign function |
| 12 | Generator feedback | 0 | Do not assign function |
| | | 1 | Assign function |
| 13 - 14 | Reserved | 0 | |
| 15 | Undervoltage 2 (one phase) | 0 | Do not assign function |
| | | 1 | Assign function |

Information:

The minimum pulse duration when addressing a monitoring function on the error bit via X2X as well as on the relay is 500 ms.

Assigning monitoring functions - 2

Name:

ConfigOutput97

The following additional monitoring functions can be assigned to the monitoring relay using this register:

The value of this register can be read back.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|---------------------------|-------|------------------------|
| 0 | Overvoltage 2 (one phase) | 0 | Do not assign function |
| | | 1 | Assign function |
| 1 | Underfrequency 2 | 0 | Do not assign function |
| | | 1 | Assign function |
| 2 | Overfrequency 2 | 0 | Do not assign function |
| | | 1 | Assign function |
| 3 - 15 | Reserved | 0 | |

Information:

The minimum pulse duration when addressing a monitoring function on the error bit via X2X as well as on the relay is 500 ms.

9.26.4.20.3.4 Synchronization mains

(for mains configuration "Sync mains 1 / Sync mains 2")

Nominal voltage of synchronization mains (U_{NomSyn})

Name:

ConfigOutput01

ConfigOutput01Read

This is needed for converting the percentages based on this nominal value into physical units.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-------------|-------------------|------------|
| UINT | 70 to 65000 | For 70 to 65000 V | 1 V |

Multiplier for synchronization mains

Name:

ConfigOutput07 (mains 1)

ConfigOutput08 (mains 2)

ConfigOutput07Read (mains 1)

ConfigOutput08Read (mains 2)

This is used for converting the measured value into a physical value. The multiplier is applied to the respective input value.

100 means a multiplier factor of 1 (measured value not changed).

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|--------------------|------------|
| UINT | 1 to 65535 | For 0.01 to 655.35 | 0.01 |

9.26.4.20.3.5 Mains

Mains (for mains configuration "3-phase mains")

Nominal voltage of mains (U_{NomMains})

Name:

ConfigOutput01

ConfigOutput01Read

This is needed for converting the percentages based on this nominal value into physical units.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-------------|-------------------|------------|
| UINT | 70 to 65000 | For 70 to 65000 V | 1 V |

Multiplier for mains

Name:

ConfigOutput07

ConfigOutput07Read

This is used for converting the measured value into a physical value. The multiplier is applied to the respective input value.

100 means a multiplier factor of 1 (measured value not changed).

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|--------------------|------------|
| UINT | 1 to 65535 | For 0.01 to 655.35 | 0.01 |

Enable/disable mains functions

Name:

ConfigOutput22

ConfigOutput22Read

The value of this register can be read back.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|--|
| 0 | Error acknowledgment mode | 0 | Mains error bits are reset by the module |
| | | 1 | Mains error bits are reset by the user |
| 1 | Phase shift measurement | 0 | Three-phase only |
| | | 1 | Single- or three-phase |
| 2 - 3 | Check all overvoltages and undervoltages ¹⁾ | 00 | 3 phase voltages |
| | | 01 | 3 line-to-line voltages |
| | | 10 | 3 line-to-line and 3 phase voltages |
| | | 11 | Reserved |
| 4 | Configuration of undervoltage monitoring | 0 | 2-point mode |
| | | 1 | 6-point mode |
| 5 - 7 | Reserved | 0 | |

- 1) This parameter is supported starting with upgrade 1.6.0.0 (firmware version 102). For information about configuring limit values, see "Mains voltage monitoring" on page 2966.

9.26.4.20.3.6 Mains monitoring functions

(for "3-phase mains" configuration)

The following mains monitoring functions are available if the network configuration is set to a 3-phase mains (see register "Mains settings" on page 2950).

Mains voltage monitoring**Overvoltage limit of the mains ($U_{\max\text{Mains}}$)**

Name:

ConfigOutput73 (1st value)

ConfigOutput98 (2nd value)

ConfigOutput73Read (1st value)

ConfigOutput98Read (2nd value)

If the value of one of the mains voltages configured in the "ConfigOutput22" on page 2965 register exceeds the value set here, then the "Overvoltage" error message (register "StatusInputPacked02" on page 2985) or "Overvoltage 2" (register "StatusInputPacked04" on page 2986) is indicated after the delay time has expired and, if configured, the DO5 monitoring relay is switched.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|--|------------|
| UINT | 0 to 2000 | For 0 to 200% of U_{NomMains} | 0.1% |

Response time for mains overvoltage (U_{MaxMains})

Name:

ConfigOutput82 (1st time)

ConfigOutput99 (2nd time)

ConfigOutput82Read (1st time)

ConfigOutput99Read (2nd time)

The error is only triggered if the response value is exceeded in the positive direction without interruption for as long as is specified in this register.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|-------------------|------------|
| UINT | 5 to 60000 | For 0.005 to 60 s | 0.001 s |

Mains over-frequency ($f_{\max\text{Mains}}$)

Name:

ConfigOutput75 (1st frequency)

ConfigOutput102 (2nd frequency)

ConfigOutput75Read (1st frequency)

ConfigOutput102Read (2nd frequency)

If the value of the mains frequency exceeds the percent value set here in relation to the nominal frequency, then the error message "Overfrequency" (register "StatusInputPacked02" on page 2985) or "Overfrequency 2" (register "StatusInputPacked04" on page 2986) is indicated after the delay time has passed and, if configured, the DO5 monitoring relay is switched.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|-----------------------------------|------------|
| UINT | 0 to 2000 | For 0 to 200% of f_{Nom} | 0.1% |

Response time for mains over-frequency ($f_{\max\text{Mains}}$)

Name:

ConfigOutput84 (1st time)
 ConfigOutput103 (2nd time)
 ConfigOutput84Read (1st time)
 ConfigOutput103Read (2nd time)

The error is only triggered if the response value is exceeded in the positive direction without interruption for as long as is specified in this register.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|-------------------|------------|
| UINT | 5 to 60000 | For 0.005 to 60 s | 0.001 s |

Mains under-frequency ($f_{\min\text{Mains}}$)

Name:

ConfigOutput76 (1st frequency)
 ConfigOutput104 (2nd frequency)
 ConfigOutput76Read (1st frequency)
 ConfigOutput104Read (2nd frequency)

If the value of the mains frequency falls below the percent value set here in relation to the nominal frequency, then the error message "Underfrequency" (register "[StatusInputPacked02](#)" on page 2985) or "Underfrequency 2" (register "[StatusInputPacked04](#)" on page 2986) is indicated after the delay time has passed and, if configured, the DO5 monitoring relay is switched.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|-----------------------------------|------------|
| UINT | 0 to 2000 | For 0 to 200% of f_{Nom} | 0.1% |

Response time for mains under-frequency ($f_{\min\text{Mains}}$)

Name:

ConfigOutput85 (1st time)
 ConfigOutput105 (2nd time)
 ConfigOutput85Read (1st time)
 ConfigOutput105Read (2nd time)

The error is only triggered if the response value is exceeded in the negative direction without interruption for as long as is specified in this register.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|-------------------|------------|
| UINT | 5 to 60000 | For 0.005 to 60 s | 0.001 s |

Mains voltage asymmetry (U_{asMains})

Name:

ConfigOutput77
 ConfigOutput77Read

This trigger value, specified as a percentage, is based on the nominal voltage of the mains. If the difference between the 3 line-to-line voltages of the mains exceeds the configured limit value, then the error message "Voltage asymmetry" is indicated (register "[StatusInputPacked02](#)" on page 2985) after the delay time has passed and, if configured, the DO5 monitoring relay is switched.

For this to happen, only one of these voltages has to exceed the respective limit value (in either the positive or negative direction).

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|---------------------------------------|------------|
| UINT | 0 to 300 | For 0 to 30% of U_{NomMains} | 0.1% |

Response time for the mains voltage asymmetry ($U_{asMains}$)

Name:

ConfigOutput86

ConfigOutput86Read

This error is triggered only if the response value is exceeded without interruption (in either the positive or negative direction) for as long as is specified in this register.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|--------------------|------------|
| UINT | 5 to 100 | For 0.005 to 0.1 s | 0.001 s |

Undervoltage monitoring in 2-point mode

2 independent limit values and response times can be defined for undervoltage monitoring.

Undervoltage limit of the mains ($U_{minMains}$)

Name:

ConfigOutput74

ConfigOutput74Read

If the value of one of the mains voltages configured in the "ConfigOutput22" on page 2965 register falls below the value set here, then the "Undervoltage" error message (register "StatusInputPacked02" on page 2985) is indicated after the delay time has passed and, if configured, the DO5 monitoring relay is switched.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|---------------------------------|------------|
| UINT | 0 to 2000 | For 0 to 200% of $U_{NomMains}$ | 0.1% |

Undervoltage limit 2 of the mains ($U_{minMains}$)

Name:

ConfigOutput100

ConfigOutput100Read

If the value of one of the linked mains voltages falls below the value set here, then the "Undervoltage" error message (register "StatusInputPacked02" on page 2985) is indicated after the delay time has passed and, if configured, the DO5 monitoring relay is switched.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|-----------------------------|------------|
| UINT | 0 to 2000 | 0 to 200% of $U_{NomMains}$ | 0.1% |

Response time for mains undervoltage ($U_{minMains}$)

Name:

ConfigOutput83 (1st time)

ConfigOutput101 (2nd time)

ConfigOutput83Read (1st time)

ConfigOutput101Read (2nd time)

The error is only triggered if the response value is exceeded in the negative direction without interruption for as long as is specified in this register.

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|-------------------|------------|
| UINT | 5 to 60000 | For 0.005 to 60 s | 0.001 s |

Undervoltage monitoring in 6-point mode

Up to 6 limit values and response times can be set for undervoltage monitoring. If not all 6 points are required, then unused limit values and response times should be set to 0.

Note that for each point, the specified limit value and response time must be greater than or equal to the preceding point ($P1 \leq P2 \leq P3$, etc.).

The defined points are used to create a limit value curve. If the voltage drops below the curve and a response time has expired, the error message "Undervoltage" is signaled ("[StatusInputPacked02](#)" on [page 2985](#) register). If configured, the D05 monitoring relay is also switched.

A faulty undervoltage monitoring configuration also triggers the "Undervoltage" error message, and monitor relay DO5 is switched if configured to do so (e.g. $P1 > P2$ and $P2$ not equal to (0% / 0 ms)).

The types of voltages to be monitored are specified in the mains configuration ("[ConfigOutput22](#)" on [page 2965](#) register):

- Line-to-line voltages
- Phase voltages
- Line-to-line and phase voltages

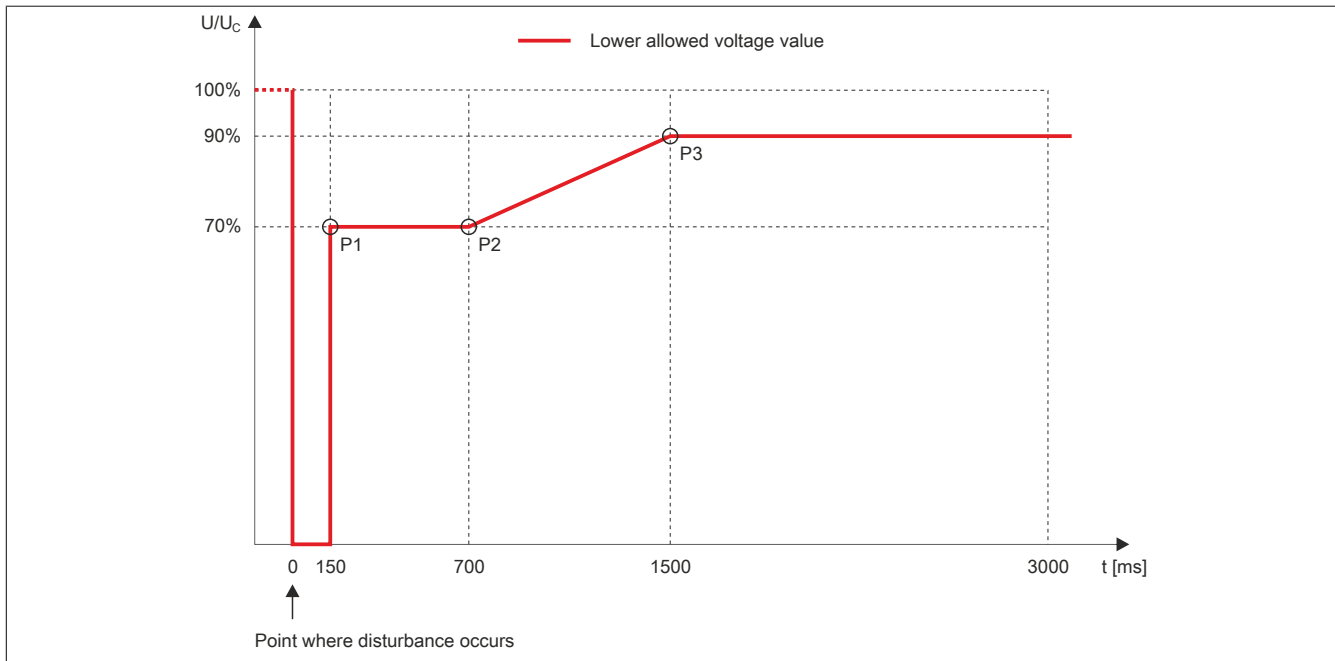
As soon as one of the monitored voltages drops below the limit curve, the corresponding time counter begins counting. The time counter is reset when all voltages are once again equal to or higher than the defined value.

The "Undervoltage" error message is generated when one of the time counters crosses over the limit curve.

Example 1 with 3 points:

In this example, 3 limit values are defined, along with the corresponding response times:

- P1 (70% / 150 ms)
- P2 (70% / 700 ms)
- P3 (90% / 1500 ms)
- P4 (0% / 0 ms)
- P5 (0% / 0 ms)
- P6 (0% / 0 ms)

**Notes regarding limit curve**

- The red line marks the lowest permitted value for monitored voltages.
- If 2 consecutive points have the same limit value, then the response time of the first point is applied. In the example above, this situation is shown with points 1 and 2.
- Between points 2 and 3 the curve has a positive linear slope. If one of the monitored voltages drops in this area, the module calculates the appropriate response time.

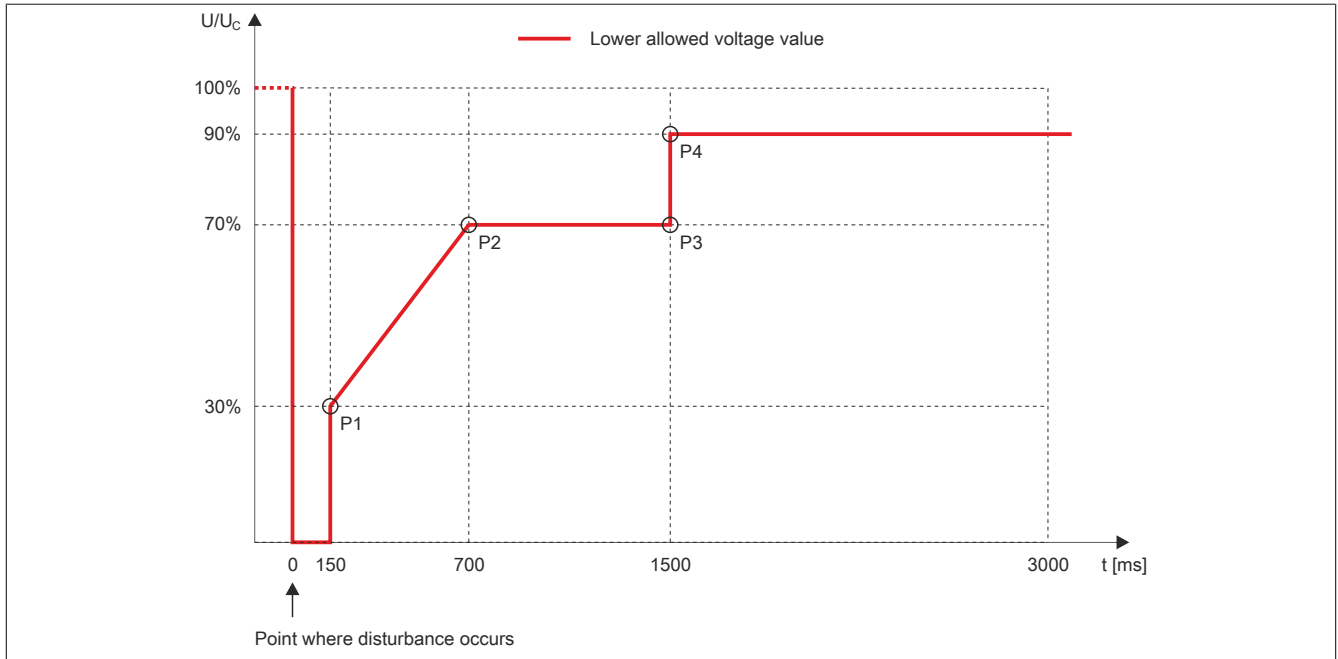
Determining the response time

- 1) Find voltage value on Y axis
- 2) Locate intersection on curve
- 3) Read the response time on the X axis

Example 2 with 4 points:

In this example, 4 limit values are defined, along with the corresponding response times:

- P1 (30% / 150 ms)
- P2 (70% / 700 ms)
- P3 (70% / 1500 ms)
- P4 (90% / 1500 ms)
- P5 (0% / 0 ms)
- P6 (0% / 0 ms)

**Notes regarding limit curve**

- The red line marks the lowest permitted value for monitored voltages.
- Between points 1 and 2 the curve has a positive linear slope. If one of the monitored voltages drops in this area, the module calculates the appropriate response time.
- If 2 consecutive points have the same limit value, then the response time of the first point is applied. In the example, this situation is shown with points 2 and 3.
- Points 1 and 2 are connected directly by a line with a positive slope. To avoid a direct connection between points 2 and 4, one would have to define another point between them with the same limit as point 2 and the same response time as point 4. In this case, that is point 3.

Determining the response time

- 1) Find voltage value on Y axis
- 2) Locate intersection on curve
- 3) Read the response time on the X axis

Undervoltage limit of the microgrid (U_{MinMains})

Name:

ConfigOutput74 (1st mains)
 ConfigOutput100 (2nd mains)
 ConfigOutput110 (3rd mains)
 ConfigOutput112 (4th mains)
 ConfigOutput114 (5th mains)
 ConfigOutput116 (6th mains)
 ConfigOutput74Read (1st mains)
 ConfigOutput100Read (2nd mains)
 ConfigOutput110Read (3rd mains)
 ConfigOutput112Read (4th mains)
 ConfigOutput114Read (5th mains)
 ConfigOutput115Read (6th mains)

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|------------------------------------|------------|
| UINT | 0 to 2000 | 0 to 200% of U_{NomMains} | 0.1% |

Response time for mains undervoltage (U_{minMains})

Name:

ConfigOutput83 (1st mains)
 ConfigOutput101 (2nd mains)
 ConfigOutput111 (3rd mains)
 ConfigOutput113 (4th mains)
 ConfigOutput115 (5th mains)
 ConfigOutput117 (6th mains)
 ConfigOutput83Read (1st mains)
 ConfigOutput101Read (2nd mains)
 ConfigOutput111Read (3rd mains)
 ConfigOutput113Read (4th mains)
 ConfigOutput115Read (5th mains)
 ConfigOutput117Read (6th mains)

The values of these registers can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|-------------------|------------|
| UINT | 5 to 60000 | For 0.005 to 60 s | 0.001 s |

Microgrid monitoring

A microgrid is a small mains power grid that only supplies a limited area and generally is not connected to other mains grids, which means it can function autonomously. This is in contrast to a synchronous grid, in which multiple smaller mains grids are connected together and synchronized.

With microgrid monitoring, the mains is monitored for over/undervoltage. After a defined response time elapses, a corresponding error message is generated. Microgrid monitoring always checks the line-to-line voltages independently of the configuration in the "ConfigOutput22" on page 2965 register.

Overvoltage limit of the mains ($U_{\max\text{Mains}}$)

Name:

ConfigOutput106

ConfigOutput106Read

If the value of one of the linked mains voltages exceeds the value set here, then the "Microgrid monitoring" error message (register "StatusInputPacked04" on page 2986) is indicated after the delay time has passed and, if configured, the DO5 monitoring relay is switched.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|------------------------------------|------------|
| UINT | 0 to 2000 | 0 to 200% of U_{NomMains} | 0.1% |

Undervoltage limit of the mains ($U_{\min\text{Mains}}$)

Name:

ConfigOutput107

ConfigOutput107Read

If the value of one of the linked mains voltages falls below the value set here, then the "Microgrid monitoring" error message (register "StatusInputPacked04" on page 2986) is indicated after the delay time has passed and, if configured, the DO5 monitoring relay is switched.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|--|------------|
| UINT | 0 to 2000 | For 0 to 200% of U_{NomMains} | 0.1% |

Response time for microgrid limit

Name:

ConfigOutput108

ConfigOutput108Read

An error is triggered only if the response value is exceeded without interruption (in either the positive or negative direction) for as long as is specified in this register.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|--------------------|------------|
| UINT | 5 to 200 | For 0.005 to 0.2 s | 0.001 s |

Phase shift monitoring

A phase shift is an abrupt change to the voltage curve that can be caused by a significant change to the load.

In this case, the device recognizes a single change to the period duration. This changed period duration is compared with the calculated average value from past measurements. Monitoring takes place for three phases and if desired also for a single phase. The phase shift monitoring function is only active if the mains voltage is higher than the set percentage value based on the nominal voltage for the converter.

If the response value is exceeded, the error message "Phase shift" is indicated (register "StatusInputPacked02" on page 2985) and, if configured, the DO5 monitoring relay is switched.

Phase shift monitoring response time

A phase shift is indicated on output DO5 within 2 ms after detection of the phase shift (i.e. after zero crossing of the extended/shortened period), as long as this is configured accordingly.

Phase shift detection

Phase shift detection is configured in the "ConfigOutput22" on page 2965 register.

| Type of monitoring | Description |
|--|--|
| Only three-phase monitoring | Triggering takes place if the limit value for three-phase monitoring was exceeded on all 3 phases within 2 periods. |
| Single-phase or three-phase monitoring | Triggering takes place: <ul style="list-style-type: none"> • If the limit value for single-phase monitoring is exceeded on at least one of the 3 phases • If the limit value for three-phase monitoring was exceeded on all 3 phases within 2 periods. |

Phase shift monitoring detects an abrupt change to the period duration of the mains voltage.

The period duration of the current period is compared with the average value for the period duration over the past 4 periods. If the difference exceeds the set limit value, then triggering takes place immediately.

Limit value

Setting of the limit value takes place in 0.1° steps. The internal limit value in μs is calculated as follows:

$$t_{\text{hres}}[\mu\text{s}] = t_{\text{hres}}[0.1^\circ] \cdot \text{Period duration} / 3600$$

When do this, the period duration for the set nominal frequency is used.

Example

Calculation of $t_{\text{hres}}[\mu\text{s}]$ at 50 Hz (period duration = 20000 μs) and limit value of 7°:

$$t_{\text{hres}}[\mu\text{s}] = 70 \cdot 20000 \mu\text{s} / 3600 = 388.88 \mu\text{s} \text{ (rounded to } 389 \mu\text{s)}$$

If the period duration thus changes abruptly by more than +389 μs , triggering takes place.

Maximum phase difference for a single phase

Name:

ConfigOutput78

ConfigOutput78Read

Triggering occurs if the electrical angle of the voltage curve shifts by more than the set angle on at least one phase.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|--------------|------------|
| UINT | 0 to 990 | For 0 to 99° | 0.1° |

Maximum phase difference for three phases

Name:

ConfigOutput79

ConfigOutput79Read

Triggering occurs if the electrical angle of the voltage curve shifts by more than the set angle on all 3 phases.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|--------------|------------|
| UINT | 0 to 990 | For 0 to 99° | 0.1° |

Minimum voltage for phase shift monitoring

Name:

ConfigOutput88

ConfigOutput88Read

A minimum voltage can be set. Phase shift monitoring is only active if the voltage on all 3 phases exceeds this value.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|---------------------------------|------------|
| UINT | 0 to 2000 | For 0 to 200% of $U_{NomMains}$ | 0.1% |

Mains frequency change

Response value for mains frequency change (df/dt)

Name:

ConfigOutput80

ConfigOutput80Read

For df/dt monitoring, the frequency change in each period is compared to the previous period.

If this value exceeds the configured limit value in each of the periods for the specified number of periods and the sign for the frequency change is always the same, the error message "Df/dt (mains frequency change)" is indicated (register "[StatusInputPacked02](#)" on page 2985) and, if configured, the DO5 monitoring relay is switched.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|-------------------|------------|
| UINT | 0 to 1000 | For 0 to 100 Hz/s | 0.1 Hz/s |

Number of periods for mains frequency change (df/dt)

Name:

ConfigOutput87

ConfigOutput87Read

This register is used to define the number of periods for monitoring the mains frequency change. For activation, the response value must be continually exceeded at least for as many periods as specified in this register. The display of the error message on output DO5 takes place max. 2 ms after internal detection.

The value of this register can be read back.

Example

The maximum tripping time at 4 periods and 50 Hz mains frequency is calculated as follows:

Max. tripping time = $4 \times 20 \text{ ms} + 2 \text{ ms} = 82 \text{ ms}$

The change in period duration caused by the frequency gradients must also be accounted for.

| Data type | Value | Information | Resolution |
|-----------|----------|-------------|------------|
| UINT | 1 to 250 | - | - |

DO5 function**DO5 function**

Name:

ConfigOutput81

ConfigOutput81Read

This digital output can be set after the defined response time has elapsed depending on the assignment of the mains' monitoring variables.

The monitoring variables can be assigned to this input either individually or with additional monitoring variables using an OR operator. This makes it possible to set the output when there are multiple monitoring variables.

The following table is an overview of the monitoring functions that can be assigned to the monitoring output.

The value of this register can be read back.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Error notification |
|---------|-----------------------------|-------|------------------------|
| 0 | Overvoltage (of a phase) | 0 | Do not assign function |
| | | 1 | Assign function |
| 1 | Undervoltage (of a phase) | 0 | Do not assign function |
| | | 1 | Assign function |
| 2 | Overfrequency | 0 | Do not assign function |
| | | 1 | Assign function |
| 3 | Underfrequency | 0 | Do not assign function |
| | | 1 | Assign function |
| 4 | Voltage asymmetry | 0 | Do not assign function |
| | | 1 | Assign function |
| 5 | Phase shift - 1-/3-phase | 0 | Do not assign function |
| | | 1 | Assign function |
| 6 | Df/dt exceeded | 0 | Do not assign function |
| | | 1 | Assign function |
| 7 | Undervoltage 2 (of a phase) | 0 | Do not assign function |
| | | 1 | Assign function |
| 8 | Overvoltage 2 (of a phase) | 0 | Do not assign function |
| | | 1 | Assign function |
| 9 | Underfrequency 2 | 0 | Do not assign function |
| | | 1 | Assign function |
| 10 | Overfrequency 2 | 0 | Do not assign function |
| | | 1 | Assign function |
| 11 | Microgrid monitoring | 0 | Do not assign function |
| | | 1 | Assign function |
| 12 - 15 | Reserved | - | |

Information:

The minimum pulse duration when a monitoring function responds to both the fault bit via X2X as well as on the output is 500 ms.

9.26.4.20.3.7 Busbar

Busbar nominal voltage (U_{NomBus})

Name:

ConfigOutput03

ConfigOutput03Read

This is needed for converting the percentages based on this nominal value into physical units.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-------------|-------------------|------------|
| UINT | 70 to 65000 | For 70 to 65000 V | 1 V |

Multiplier for busbar

Name:

ConfigOutput05

ConfigOutput05Read

This is used for converting the measured value into a physical value. The multiplier is applied to the respective input value.

100 thus means a multiplier factor of 1 (measured value not changed).

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|--------------------|------------|
| UINT | 1 to 65535 | For 0.01 to 655.35 | 0.01 |

Minimum busbar voltage (U_{Bmin})

Name:

ConfigOutput40

ConfigOutput40Read

Configurable threshold for zero voltage monitoring of the busbar based on its nominal voltage. DO3 is set if the value falls below the configured threshold.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|--------------------------------------|------------|
| UINT | 0 to 1000 | For 0 to 100% of U_{NomBus} | 0.1% |

9.26.4.20.3.8 Synchronization

Synchronization mode

Name:

ConfigOutputPacked01

ConfigOutput17 to ConfigOutput19

If multiple mode bits are set at the same time, then no mode will be selected (type BOOL).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------|-------|----------------------|
| 0 | ConfigOutput17 | 0 | Sync mode ≠ Slip |
| | | 1 | Sync mode = Slip |
| 1 | ConfigOutput18 | 0 | Sync mode ≠ Check |
| | | 1 | Sync mode = Check |
| 2 | ConfigOutput19 | 0 | Sync mode ≠ Dead bus |
| | | 1 | Sync Mode = Dead bus |
| 3 - 7 | Reserved | - | |

Synchronization configuration

Name:

ConfigOutput56

ConfigOutput56Read

This register contains parameters for configuring which mains or voltages should be synchronized with each other.

The value of this register can be read back.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|--|-------|---|
| 0 - 1 | Synchronization configuration (synchronization mains - mains being synchronized) | 00 | X4 - X6: Synchronization mains 1 - Synchronization mains 2 The configuration X4 - X6 is only possible if "Sync mains 1 / Sync mains 2" is configured in the "ConfigOutput68" on page 2950 register. |
| | | 01 | X4 - X5: Synchronization mains 1 - Busbar |
| | | 10 | X4 - X3: Synchronization mains 1 - Generator |
| | | 11 | X5 - X3: Busbar - Generator |
| 2 - 7 | Reserved | 0 | |
| 8 | Synchronization output | 0 | Digital output 4 |
| | | 1 | Digital output 6 - Output must be configured as a synchronization output (see register "ConfigOutput24" on page 2951) |
| 9 - 15 | Reserved | 0 | |

Max. differential frequency (df_{max})

Name:

ConfigOutput11

ConfigOutput11Read

A switch-on command on DO4 is only output if this configured differential frequency is not exceeded. This value specifies the upper frequency (positive value corresponds to positive slip → generator frequency is greater than the busbar frequency when synchronizing).

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|---------|---------------------|------------|
| UINT | 2 to 49 | For 0.02 to 0.49 Hz | 0.01 Hz |

Min. differential frequency (df_{min})

Name:

ConfigOutput12

ConfigOutput12Read

A switch-on command on DO4 is only output if this configured differential frequency is not exceeded in the negative direction. This value specifies the lower frequency (negative value corresponds to negative slip → generator frequency is less than the busbar frequency when synchronizing).

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|-------------------|------------|
| INT | -49 to 0 | For -0.49 to 0 Hz | 0.01 Hz |

Max. differential voltage (dU_{max})

Name:

ConfigOutput13

ConfigOutput13Read

A switch-on command on DO4 is only output if this configured differential voltage percentage based on the synchronization mains' nominal voltage is not exceeded.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|--------------------------------|------------|
| UINT | 1 to 300 | For 0.1 to 30% of U_{NomSyn} | 0.1% |

Max. permitted differential angle (ϕ_{Max})

Name:

ConfigOutput14

ConfigOutput14Read

A switch-on command on DO4 is only output if the configured differential angle between the two synchronization mains is not exceeded.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|----------|----------------|------------|
| UINT | 1 to 600 | For 0.1 to 60° | 0.1° |

Phase rotation of sync mains 1 (α)

Name:

ConfigOutput15

ConfigOutput15Read

This parameter is used for correcting any phase shifting from upstream transformer vector groups before reaching the mains being synchronized.

This parameter specifies how many degrees the synchronization mains lags behind the mains being synchronized.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|---------------|------------|
| UINT | 0 to 3600 | For 0 to 360° | 0.1° |

Pulse duration of the switch-on relay

Name:

ConfigOutput47 (DO4)

ConfigOutput95 (DO6)

ConfigOutput47Read (DO4)

ConfigOutput95Read (DO6)

The duration of the switch-on pulse can be adjusted for the following switching units.

The value of this register can be read back.

| Data type | Values | Information | Resolution |
|-----------|------------|-----------------|------------|
| UINT | 40 to 1000 | For 0.04 to 1 s | 0.001 s |

Switching response time of the power switch

Name:

ConfigOutput48 (DO4)

ConfigOutput96 (DO6)

ConfigOutput48Read (DO4)

ConfigOutput96Read (DO6)

The actuation time of the generator power switch corresponds to the lead time of the switch-on command. The switch-on command is executed before the point of synchronization according to the amount of time defined here.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|-------------------|------------|
| UINT | 40 to 300 | For 0.04 to 0.3 s | 0.001 s |

Dead bus voltage ($U_{BminSync}$)

Name:

ConfigOutput58

ConfigOutput58Read

Configurable threshold for dead bus synchronization based on the nominal voltage of the busbar.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-----------|-------------------------------|------------|
| UINT | 0 to 1000 | For 0 to 100% of U_{NomBus} | 0.1% |

2-phase synchronization for commissioning tests

Name:

ConfigOutput93

ConfigOutput93Read

2-phase synchronization for commissioning tests.

The value of this register can be read back.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------|-------|---|
| 0 | Synchronization | 0 | 3-phase synchronization (normal operation) |
| | | 1 | 2-phase synchronization with L1 and L2 (commissioning tests with 2-phase simulation design) |
| 1 - 7 | Reserved | 0 | |

Information:

It is only possible to set 2-phase synchronization for commissioning tests with a 2-phase simulation design.

If only 2 phases are connected, then the respective mains must be configured with neutral conductors since a network with a "virtual neutral point" is not possible with 2 phases (see register "[ConfigOutput68](#)" on page 2950).

9.26.4.20.3.9 Maximum value buffer and power meter

Pulse value of energy meter output

Name:

ConfigOutput46

ConfigOutput46Read

Output DO2 outputs pulses that occur at a frequency proportional to the measured energy. The frequency of the pulses can be specified. The length of the pulse is 400 ms. The frequency at which the pulses occur should be set so that the duration between two pulses does not exceed 400 ms at the highest possible power. The pulse output's internal meter starts at 0 kWh after a restart. This register has no effect on the "ConfigOutput54" on page 2982 and "ConfigOutput55" on page 2982 registers.

When set to 0, meter output is disabled.

Depending on how the "Power measurement mode" parameter is set in the "ConfigOutput21" on page 2953 register, either the total active power or the active power of the fundamental wave is added together. Changing the parameter "Power measurement mode" during runtime does not cause the internal energy meter to restart.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|------------|--------------------------|-------------|
| UINT | 0 to 65535 | For 0 to 65535 kWh/pulse | 1 kWh/pulse |

Count value for active energy meter and reactive energy meter

Name:

ConfigOutput94

ConfigOutput94Read

This parameter is used to configure the resolution of active and reactive energy counters.

The value of this register can be read back.

| Data type | Value | Information | Resolution |
|-----------|-------------|-------------|------------|
| UINT | 0 to 65,535 | - | 1 kWh |

Maximum value buffer and meter buffer

These registers are used for nonvolatile storage of the maximum value and meter level values. After restarting, the stored maximum values and meter states are loaded back into their registers and the module's internal work meter is reset. It is possible to reset or write to the stored maximum values and meter states using an acyclic register.

The maximum values are recorded by the effective measured values before reaching the configurable filter. The maximum values can be read or written to as acyclic registers.

Maximum phase current

Name:

Reading: ConfigOutput49 (generator I1)

Reading: ConfigOutput50 (generator I2)

Reading: ConfigOutput51 (generator I3)

Writing: ConfigOutput60 (generator I1)

Writing: ConfigOutput61 (generator I2)

Writing: ConfigOutput62 (generator I3)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 A |

Maximum total active power (supplied power)

Name:

Reading: ConfigOutput52

Writing: ConfigOutput63

Depending on the status of the "Power measurement mode" parameter in the "ConfigOutput21" on page 2953 register, either the total power or the fundamental power is added together or compared.

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 kW |

Maximum neutral conductor current

Name:

Reading: ConfigOutput53

Writing: ConfigOutput64

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 A |

Active energy counter

Name:

Reading: ConfigOutput54 (delivered (producing))

Reading: ConfigOutput71 (drawn (consuming))

Writing: ConfigOutput66 (delivered (producing))

Writing: ConfigOutput69 (drawn (consuming))

Depending on the status of the "Power measurement mode" parameter in the "ConfigOutput21" on page 2953 register, either the total power or the fundamental power is added together or compared.

The resolution can be configured (see register "ConfigOutput94" on page 2981).

| Data type | Value | Information | Resolution |
|-----------|------------------------------------|-------------|------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | - | Default: 100 kWh |

Reactive energy counter

Name:

Reading: ConfigOutput55 (reactive energy meter delivered (producing))

Reading: ConfigOutput72 (reactive energy meter drawn (consuming))

Writing: ConfigOutput67 (reactive energy meter delivered (producing))

Writing: ConfigOutput70 (reactive energy meter drawn (consuming))

Depending on the status of the "Power measurement mode" parameter in the "ConfigOutput21" on page 2953 register, either the total power or the fundamental power is added together or compared.

The resolution can be configured (see register "ConfigOutput94" on page 2981).

| Data type | Value | Information | Resolution |
|-----------|------------------------------------|-------------|--------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | - | Default: 100 kvarh |

9.26.4.20.4 Communication registers

9.26.4.20.4.1 General registers

DigitalOutputPacked01

Name:

DigitalOutputPacked01

DigitalOutput05

DigitalOutput06

ResetGeneratorErrors

ResetMainsErrors

InvertDO5

The module's default configuration is that the generator and mains error bits are reset by the module. If this should be done by the user, then the module needs to be configured accordingly using the following registers.

- Generator error: "[ConfigOutput21](#)" on page 2953
- Network error: "[ConfigOutput22](#)" on page 2965

(data point applied as BOOL)

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------------|-------|--|
| 0 | DigitalOutput05 | 0 | Reset output 5 |
| | | 1 | Set output 5 |
| 1 | DigitalOutput06 | 0 | Reset output 6 |
| | | 1 | Set output 6 |
| 2 | ResetGeneratorErrors | 0 | Does not reset generator error bits |
| | | 1 | Resets generator error bits |
| 3 | ResetMainsErrors | 0 | Do not reset mains error bits |
| | | 1 | Reset mains error bits |
| 4 | InvertDO5 | 0 | Do not invert Output 5 |
| | | 1 | Invert output 5 of the mains monitoring function |
| 5 - 7 | Reserved | 0 | |

StatusDigitalOutputPacked01

Name:

StatusDigitalOutputPacked01

StatusDigitalOutput01 to StatusDigitalOutput06

StatusInput16 to StatusInput17

(data point applied as BOOL)

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------------|-------|--|
| 0 | StatusDigitalOutput01 | 0 | Current state of output 1 = LOW |
| | | 1 | Current state of output 1 = HIGH |
| ... | | ... | |
| 5 | StatusDigitalOutput06 | 0 | Current state of output 6 = LOW |
| | | 1 | Current state of output 6 = HIGH |
| 6 | StatusInput17 | 0 | Status DO OK |
| | | 1 | Status DO overload |
| 7 | StatusInput16 | 0 | Status 24 V output supply OK |
| | | 1 | Status 24 V output supply undervoltage |

StatusInputPacked01

Name:

StatusInputPacked01

StatusInput01 to StatusInput11

StatusInput31 to StatusInput32

StatusInput18

This register is the error register for the generator mains (error bits are of type BOOL). With regard to bits 9, 11 and 12, please also observe the description of the "Power measurement mode" parameter in the register "[ConfigOutput21](#)" on page 2953.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|---------------|-------|--|
| 0 | StatusInput01 | 0 | Overvoltage (one phase), OK |
| | | 1 | Overvoltage (one phase), present |
| 1 | StatusInput02 | 0 | Undervoltage (one phase), OK |
| | | 1 | Undervoltage (one phase), present |
| 2 | StatusInput03 | 0 | Over-frequency, OK |
| | | 1 | Over-frequency, present |
| 3 | StatusInput04 | 0 | Under-frequency, OK |
| | | 1 | Under-frequency, present |
| 4 | StatusInput05 | 0 | Voltage asymmetry, OK |
| | | 1 | Voltage asymmetry, present |
| 5 | StatusInput06 | 0 | Current asymmetry, OK |
| | | 1 | Current asymmetry, present |
| 6 | StatusInput07 | 0 | Maximum neutral conductor current, OK |
| | | 1 | Maximum neutral conductor current exceeded |
| 7 | StatusInput08 | 0 | Short circuit-current, OK |
| | | 1 | Short circuit-current, present |
| 8 | StatusInput09 | 0 | Rating-dependent overcurrent OK |
| | | 1 | Rating-dependent overcurrent occurring |
| 9 | StatusInput10 | 0 | Capacitive reactive power (exciter failure), OK |
| | | 1 | Capacitive reactive power (exciter failure), present |
| 10 | StatusInput11 | 0 | Ready, OK |
| | | 1 | Not ready |
| 11 | StatusInput31 | 0 | No generator overload |
| | | 1 | Generator overload |
| 12 | StatusInput32 | 0 | No generator feedback |
| | | 1 | Generator feedback |
| 13 - 14 | Reserved | - | |
| 15 | StatusInput18 | 0 | Undervoltage 2 (of a phase) OK |
| | | 1 | Undervoltage 2 (of a phase) occurring |

StatusInput11

The error message "Not ready" is triggered if the X20 I/O supply drops below 18 VDC.

StatusInputPacked02

Name:

StatusInputPacked02

StatusInput24 to StatusInput30

StatusInput33

This register is the error register for the mains (error bits are of type BOOL).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|---------------|-------|---------------------------------------|
| 0 | StatusInput24 | 0 | Overvoltage (one phase), OK |
| | | 1 | Overvoltage (one phase), present |
| 1 | StatusInput25 | 0 | Undervoltage (one phase), OK |
| | | 1 | Undervoltage (one phase), present |
| 2 | StatusInput26 | 0 | Over-frequency, OK |
| | | 1 | Over-frequency, present |
| 3 | StatusInput27 | 0 | Under-frequency, OK |
| | | 1 | Under-frequency, present |
| 4 | StatusInput28 | 0 | Voltage asymmetry, OK |
| | | 1 | Voltage asymmetry, present |
| 5 | StatusInput29 | 0 | Phase shift monitoring OK |
| | | 1 | Phase shift error (1/3 of a phase) |
| 6 | StatusInput30 | 0 | Df/dt OK |
| | | 1 | Df/dt error |
| 7 | StatusInput33 | 0 | Undervoltage 2 (of a phase) OK |
| | | 1 | Undervoltage 2 (of a phase) occurring |

StatusInput33

The data point is only valid if 2-point mode is configured (see register "[ConfigOutput22](#)" on page 2965). This bit only appears in the I/O mapping in Automation Studio if the corresponding status information is enabled in the I/O configuration ("Mains configuration / Additional status information" menu option).

StatusInputPacked03

Name:

StatusInputPacked03

StatusInput12 to StatusInput15

StatusInput19 to StatusInput23

This register is the error register for general error messages (error bits are of type BOOL).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|---------------|-------|--|
| 0 | StatusInput12 | 0 | All phases of the generator mains OK |
| | | 1 | Failure of at least one phase of the generator mains |
| 1 | StatusInput13 | 0 | All phases of the busbar OK |
| | | 1 | Failure of at least one phase of the busbar |
| 2 | StatusInput14 | 0 | All phases of Sync Mains 1 OK |
| | | 1 | Failure of at least one phase of Sync Mains 1 |
| 3 | StatusInput15 | 0 | All phases of Sync Mains 2 OK |
| | | 1 | Failure of at least one phase of Sync Mains 2 |
| 4 | StatusInput19 | 0 | Phase sequence of generator voltage OK |
| | | 1 | Phase sequence of generator voltage incorrect |
| 5 | StatusInput20 | 0 | Phase sequence of generator current OK |
| | | 1 | Phase sequence of generator current incorrect |
| 6 | StatusInput21 | 0 | Phase sequence of busbar OK |
| | | 1 | Phase sequence of busbar incorrect |
| 7 | StatusInput22 | 0 | Phase sequence of Sync Mains 1 OK |
| | | 1 | Phase sequence of Sync Mains 1 incorrect |
| 8 | StatusInput23 | 0 | Phase sequence of Sync Mains 2 OK |
| | | 1 | Phase sequence of Sync Mains 2 incorrect |
| 9 - 15 | Reserved | - | |

StatusInput12 to StatusInput15: Phase failure is detected if at least one of the phases of the respective terminal fails.

StatusInput19 to StatusInput23 are status bits for detecting a change of rotation.

StatusInputPacked04

Name:

StatusInputPacked04

StatusInput34 to StatusInput37

This register is the error register for the mains (error bits are of type BOOL). These bits only appear in the I/O mapping in Automation Studio if the corresponding status information is enabled in the I/O configuration ("Mains configuration / Additional status information" menu option).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|---------------|-------|--------------------------------------|
| 0 | StatusInput34 | 0 | Overvoltage 2 (of a phase) OK |
| | | 1 | Overvoltage 2 (of a phase) occurring |
| 1 | StatusInput35 | 0 | Underfrequency 2 OK |
| | | 1 | Underfrequency 2 occurring |
| 2 | StatusInput36 | 0 | Overfrequency 2 OK |
| | | 1 | Overfrequency 2 occurring |
| 3 | StatusInput37 | 0 | Microgrid monitoring OK |
| | | 1 | Microgrid monitoring tripped |
| 4 - 15 | Reserved | - | |

StatusInputPacked05

Name:

StatusInputPacked05

StatusInput38 to StatusInput40

This register is the error register for the generator mains (error bits are of type BOOL). These bits only appear in the I/O mapping in Automation Studio if the corresponding status information is enabled in the I/O configuration ("Generator mains / Additional status information" menu option).

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|---------------|-------|--------------------------------------|
| 0 | StatusInput38 | 0 | Overvoltage 2 (of a phase) OK |
| | | 1 | Overvoltage 2 (of a phase) occurring |
| 1 | StatusInput39 | 0 | Underfrequency 2 OK |
| | | 1 | Underfrequency 2 occurring |
| 2 | StatusInput40 | 0 | Overfrequency 2 OK |
| | | 1 | Overfrequency 2 occurring |
| 3 - 15 | Reserved | - | |

9.26.4.20.4.2 Generator mains measured values**Phase currents of the generator**

Name:

AnalogInput01 (I1)

AnalogInput02 (I2)

AnalogInput03 (I3)

Phase currents of the generator

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 A |

Neutral conductor current of generator I_n

Name:

AnalogInput05

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 A |

Current average of generator I1, I2, I3

Name:

AnalogInput04

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 A |

Dynamic current average of generator (I_{m_dyn})

Name:

AnalogInput06

Describes the change to the current average.

The dynamic average is the amount of change (I_{m_diff}) of the current average (sampling time: 10 ms).

This value decays in an e-function.

$$I_{m_diff} > I_{m_dyn} \rightarrow I_{m_dyn} = I_{m_diff}$$

$$I_{m_diff} \leq I_{m_dyn} \rightarrow I_{m_dyn} = I_{m_dyn} * 0.98$$

| Data type | Value | Information | Resolution |
|-----------|-------------|-------------|------------|
| UINT | 0 to 65,535 | - | 1 A |

Line-to-line voltages of the generator

Name:

AnalogInput07 (UG12)

AnalogInput08 (UG23)

AnalogInput09 (UG31)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

Phase voltages of the generator

Name:

AnalogInput10 (UG 1)

AnalogInput11 (UG 2)

AnalogInput12 (UG 3)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

Voltage average of the generator

Name:

AnalogInput22

Voltage average of the generator UG12, UG23, UG31 (U~3 average)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

Filtered generator power values:

Name:

AnalogInput19

AnalogInput20

AnalogInput21

Filtered generator power values:

- Total output (sum of all harmonic frequencies)
- Fundamental frequency power (_H1)

Configuration is explained in the "[ConfigOutput21](#)" on page 2953 register.

| Data type | Value | Information | Resolution |
|-----------|-----------------|-----------------------------|------------|
| INT | -32768 to 32767 | Total active power P/P_H1 | 1 kW |
| | -32768 to 32767 | Total reactive power Q/Q_H1 | 1 kvar |
| | -32768 to 32767 | Total apparent power S/S_H1 | 1 kVA |

Power factor of generator/cos ϕ

Name:

AnalogInput23

The factor is described in "[Power factor of the generator](#)" on page 2941 and register "[ConfigOutput21](#)" on page 2953.

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 0.001 |

Frequency of the generator mains

Name:

AnalogInput24

| Data type | Value | Information | Resolution |
|-----------|-------------|-------------|------------|
| UINT | 0 to 65,535 | - | 0.01 Hz |

Timestamp for generator voltages and currents

These timestamps mark the last positive zero crossing of the generator voltages (L1-N, L2-N, L3-N) and generator currents (I1, I2, I3). They can be used to calculate all the necessary phase ratios.

Calculation of the phase ratios and error handling for the calculations are to be implemented by the user (e.g. period duration monitoring or verification that the voltages are high enough, etc.).

These timestamps only appear in the I/O mapping in Automation Studio if they are enabled in the I/O configuration ("Enable timestamps for generator voltage and current" menu option).

Timestamp of pos. zero crossing of phase voltage

Name:

AnalogInput38 (UG1)

AnalogInput39 (UG2)

AnalogInput40 (UG3)

Time stamp of pos. zero crossing of phase voltage of the respective generator

| Data type | Value | Information | Resolution |
|-----------|------------------------------------|-------------|------------|
| DINT | -2,147,483,648 to 2,147,483,647 | - | 1/4096 µs |

Timestamp of pos. zero crossing of phase current

Name:

AnalogInput41 (I1)

AnalogInput42 (I2)

AnalogInput43 (I3)

Time stamp of pos. zero crossing of phase current of the respective generator

| Data type | Value | Information | Resolution |
|-----------|------------------------------------|-------------|------------|
| DINT | -2,147,483,648 to 2,147,483,647 | - | 1/4096 µs |

9.26.4.20.4.3 Busbar measured values**Line-to-line voltages of the busbar**

Name:

AnalogInput13 (UB12)

AnalogInput14 (UB23)

AnalogInput15 (UB31)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

Phase voltages of the busbar

Name:

AnalogInput16 (UB1)

AnalogInput17 (UB2)

AnalogInput18 (UB3)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

Frequency of busbar

Name:

AnalogInput35

| Data type | Value | Information | Resolution |
|-----------|-------------|-------------|------------|
| UINT | 0 to 65,535 | - | 0.01 Hz |

9.26.4.20.4.4 Measured value of synchronization mains

(for mains configuration "Sync mains 1 / Sync mains 2")

Line-to-line voltages

Name:

AnalogInput25 (sync mains 1 US1)

AnalogInput26 (sync mains 2 US2)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

Frequencies

Name:

AnalogInput27 (sync mains 1)

AnalogInput28 (sync mains 2)

| Data type | Value | Information | Resolution |
|-----------|-------------|-------------|------------|
| UINT | 0 to 65,535 | - | 0.01 Hz |

9.26.4.20.4.5 Measured value of mains

(for "3-phase mains" configuration)

Line-to-line voltages of mains

Name:

AnalogInput25 (UN12)

AnalogInput31 (UN23)

AnalogInput32 (UN31)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

Phase voltages of the generator

Name:

AnalogInput33 (UN1)

AnalogInput34 (UN2)

AnalogInput26 (UN3)

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

Frequency of power mains

Name:

AnalogInput27

| Data type | Value | Information | Resolution |
|-----------|-------------|-------------|------------|
| UINT | 0 to 65,535 | - | 0.01 Hz |

9.26.4.20.4.6 Generator monitoring**Read unbalanced load meter**

Name:

AnalogInput36

This register can be used to track the current state of the unbalanced load meter (see "[Dependent delayed unbalanced load monitoring](#)" on page 2957). The unbalanced load meter can be reset with an acyclic trigger bit (see register "[ConfigOutput23](#)" on page 2952).

| Data type | Value | Information | Resolution |
|-----------|------------|---------------|------------|
| UINT | 0 to 65535 | For 0 to 100% | |

Reads the unbalanced load current (I₂)

Name:

AnalogInput37

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 A |

9.26.4.20.4.7 Synchronization**Differential angle between synchronization mains**

Name:

AnalogInput29

Angular difference between the mains being synchronized

Specifies how many degrees the sync mains are ahead of the mains being synchronized.

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 0.1° |

Differential voltage between synchronization mains

Name:

AnalogInput30

Voltage difference between the mains being synchronized

| Data type | Value | Information | Resolution |
|-----------|-----------------|-------------|------------|
| INT | -32768 to 32767 | - | 1 V |

9.26.4.20.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 250 μ s |

9.26.4.20.6 Minimum I/O update time

The minimum I/O update time for the analog inputs depends on the respective period duration of the measurement signal frequency.

| Minimum I/O update time |
|-------------------------|
| At 50 Hz 10 ms |

9.26.5 X20CM4323

Data sheet version: 1.10

9.26.5.1 General information

The module has digital outputs for connecting electromechanical loads (e.g. valves and relays) and additional functions such as edge generation.

With a resolution down to 125 ns, the module makes it possible to set switching operations at exactly specified moments.

The following operating modes can optionally be supplemented with PWM functionality:

- Direct I/O
- Oversampled I/O
- Edge generator
- Edge generator in toggle operation for output patterns such as digital cam switches (e.g. digital cam switch of function block "ASMcDcsTimedDigitalCamSwitch")

Additional functions:

- PWM modulation of outputs for setting the overexcitation and holding current.
- Configuration of each channel by specifying PWM period duration
- Control value for overexcitation current, holding current and overexcitation time
- Possibility of disabling high-speed cutoff

Features:

- 4 digital outputs
- Control of PWM output signals based exactly on NetTime
- 4x oversampling output functions
- Integrated output protection
- 24 VDC and GND for actuator power supply

9.26.5.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Other functions |  |
| X20CM4323 | X20 PWM module, 4 digital outputs for switching electro-mechanical loads, 24 VDC, oversampling output functions, time-triggered output functions, NetTime function | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 537: X20CM4323 - Order data


9.26.5.3 Technical data

| | |
|--|--|
| Model number | X20CM4323 |
| Short description | |
| I/O module | 4 digital outputs for switching electromechanical loads, pulse width modulation |
| General information | |
| B&R ID code | 0xEC21 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Outputs | Yes, using status LED and software (output error status) |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.4 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| Digital outputs | |
| Nominal voltage | 24 VDC |
| Nominal output current | 0.75 A |
| Total nominal current | 3 A |
| Connection type | 1-wire connections |
| Output circuit | Sink |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs, integrated protection for switching inductances |
| Pulse width modulation | |
| Period duration | 1 ms (1 kHz) or 20 µs (50 kHz) |
| Pulse duration | 0 to 100% |
| Resolution for pulse duration | 1% |
| Inrush current | 1.5 A for max. 25 ms |
| Braking voltage when switching off inductive loads | 27 VDC |
| Reverse polarity protection | No (must be protected externally) |
| Output voltage | |
| Minimum | 18 VDC |
| Nominal | 24 VDC |
| Maximum | 48 VDC |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel and I/O power supply |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | 0 to 50°C |
| Vertical mounting orientation | 0 to 40°C |
| Derating | - |
| Storage | -25 to 70°C |
| Transport | -25 to 70°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately Order 1x bus module X20BM11 separately |
| Pitch | 12.5 ^{+0.2} mm |

Table 538: X20CM4323 - Technical data

9.26.5.4 LED status indicators

For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

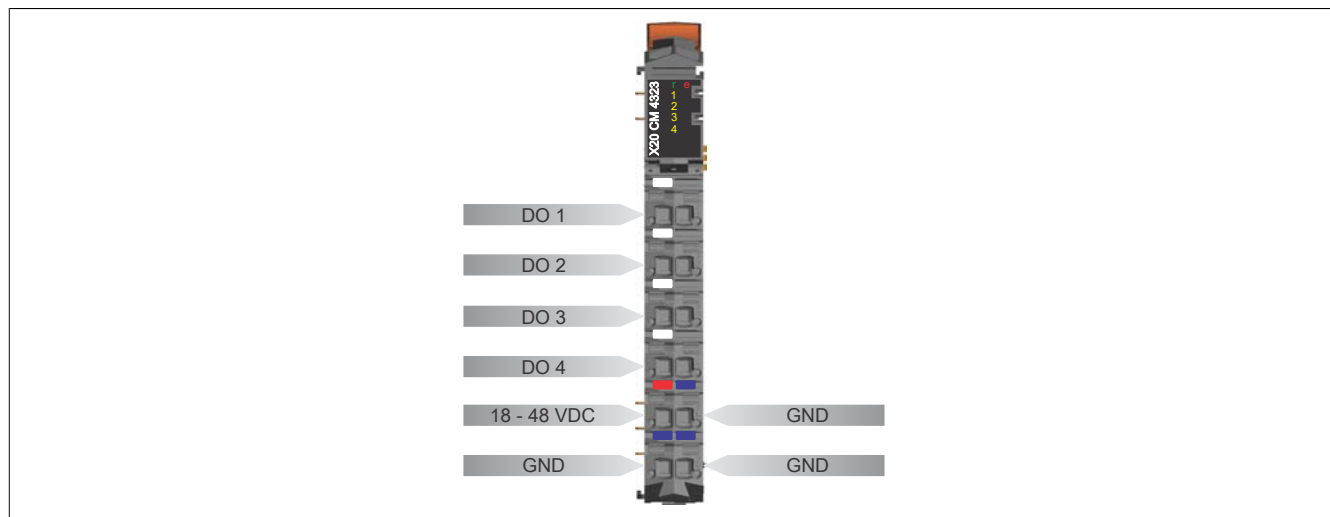
| Figure | LED | Color | Status | Description |
|---|-------|--------------------------------|--------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. |
| | e + r | Solid red / Single green flash | | Invalid firmware |
| | 1 - 4 | Orange | On/Off | Status of the digital outputs |
| | | | Blinking | Short circuit / overcurrent cutoff |

Information:

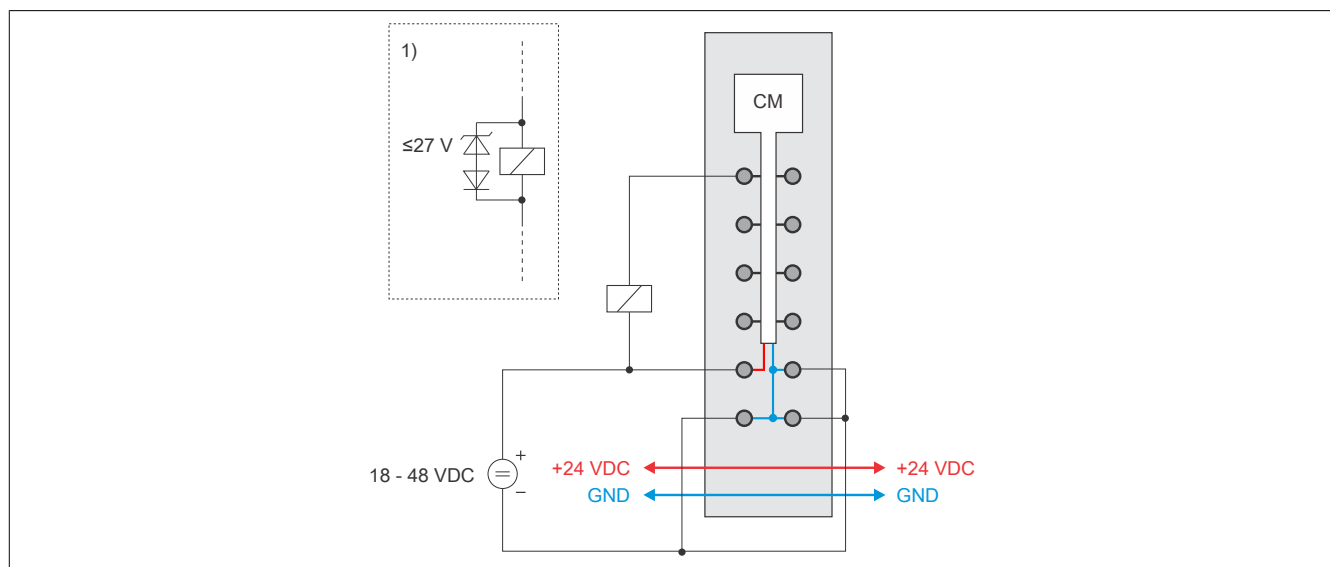
The output is not automatically activated after an overcurrent cutoff. It must be switched on again.

1) Depending on the configuration, a firmware update can take up to several minutes.

9.26.5.5 Pinout

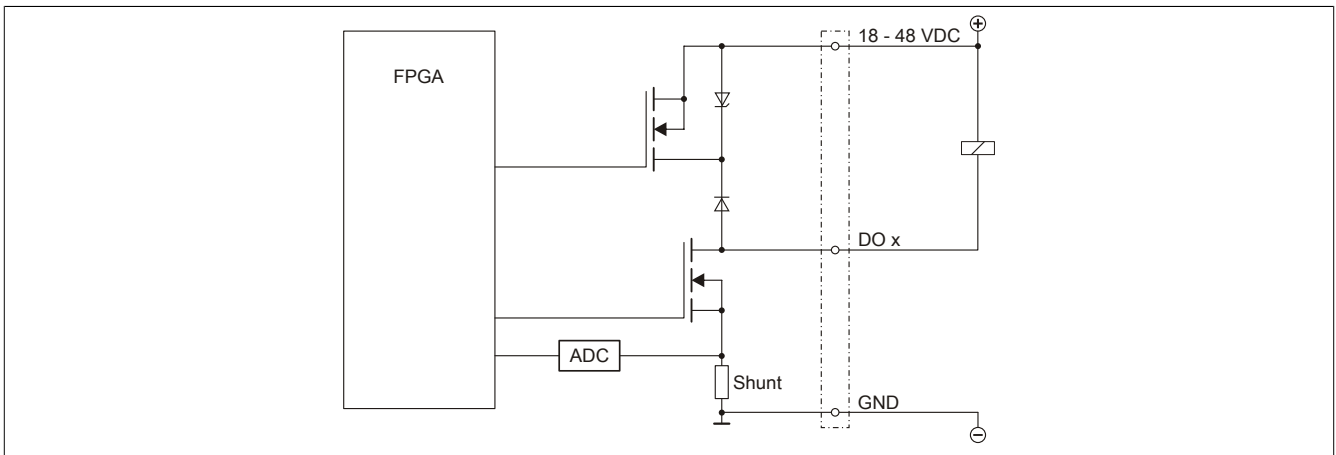


9.26.5.6 Connection example

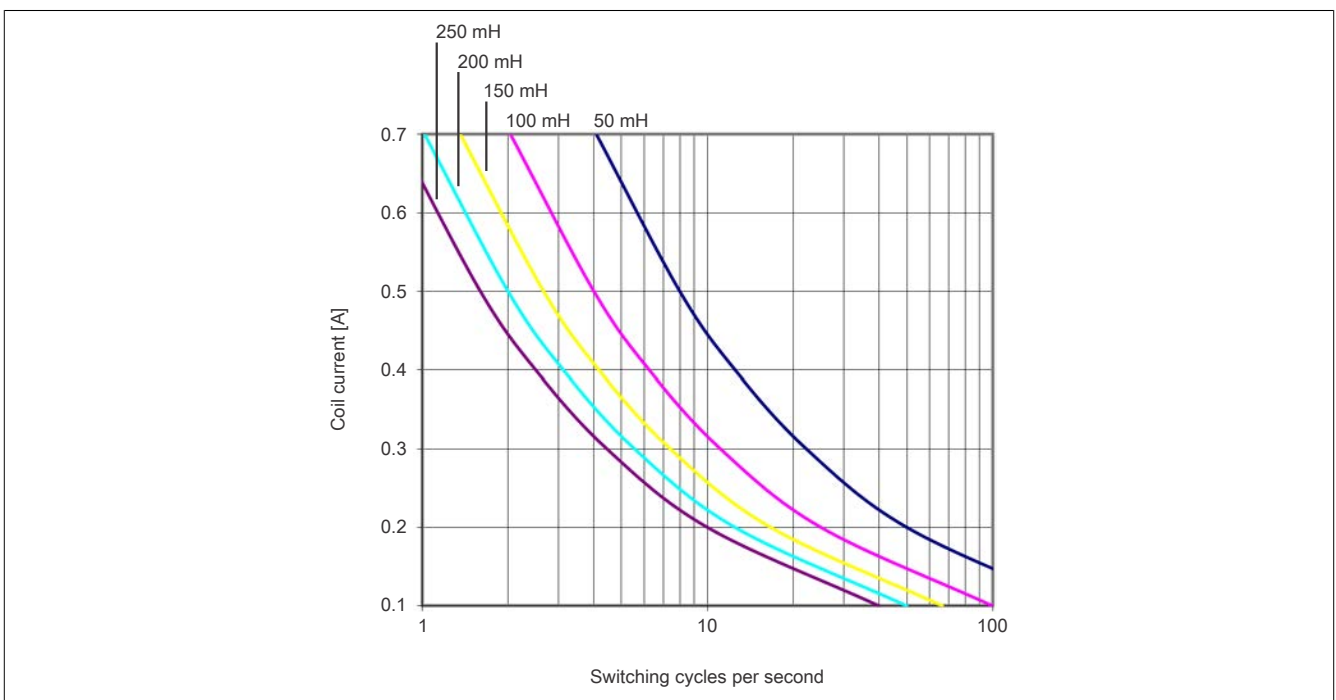


1) If larger inductances or more current are used; the "transil-diode combination" must be placed externally on the relay/valve.

9.26.5.7 Output circuit diagram



9.26.5.8 Switching inductive loads



In principle, the inductance that is connected is limited by the maximum power dissipation of the module.

If larger inductances or more current are used, the "transil-diode combination" must be placed externally on the relay/valve (see ["Connection example" on page 2994](#)).

Information:

The inductance of a relay/valve depends greatly on the core material being used. Therefore, an inductance must be used that corresponds to the diagram at 1Hz. This information can be found in the data sheet of the connected inductance (relay/valve).

9.26.5.9 Register description

9.26.5.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.26.5.9.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|--|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration - General | | | | | | |
| 513 | CfO_SlframeGenID | USINT | | | | • |
| Configuration - System timer | | | | | | |
| 642 | CfO_SystemCycleTime | UINT | | | | • |
| 646 | CfO_SystemCycleOffset | INT | | | | • |
| 650 | CfO_SystemCyclePrescaler | UINT | | | | • |
| Configuration - Direct I/O | | | | | | |
| 899 | CfO_DirectIOClearMask0_3 | USINT | | | | • |
| 903 | CfO_DirectIOSetMask0_3 | USINT | | | | • |
| 905 | CfO_OutputUpdateCycle | USINT | | | | • |
| Configuration - Oversampled I/O | | | | | | |
| 1025 | CfO_OversampleMode | USINT | | | | • |
| 1027 | CfO_OversampleSampleCycleID | USINT | | | | • |
| 1029 | CfO_OversampleRelativeCycleID | USINT | | | | • |
| 1031 | CfO_OversampleConsumeCycleID | USINT | | | | • |
| 1033 | CfO_OversampleOutputBits | USINT | | | | • |
| 1037 | CfO_OversampleOutputWindow | USINT | | | | • |
| 1049 + (N*2) | CfO_OversampleConfigOutputN (index N = 0 to 3) | USINT | | | | • |
| Configuration - PWM | | | | | | |
| 1282 + (N-1) * 32 | CfO_PWM0N_Periode (index N = 1 to 4) | UINT | | | | • |
| 1286 + (N-1) * 32 | CfO_PWM0N_Duty1 (index N = 1 to 4) | UINT | | | | • |
| 1290 + (N-1) * 32 | CfO_PWM0N_Duty2 (index N = 1 to 4) | UINT | | | | • |
| 1294 + (N-1) * 32 | CfO_PWM0N_Duty1Time (index N = 1 to 4) | UINT | | | | • |
| 1298 + (N-1) * 32 | CfO_PWM0N_Duty1TimeBase (index N = 1 to 4) | UINT | | | | • |
| 1302 + (N-1) * 32 | CfO_PWM0N_FastSwitchOff (index N = 1 to 4) | UINT | | | | • |
| 1409 | CfO_PWM_UpdateCycle | USINT | | | | • |
| Configuration - Edge generator | | | | | | |
| 2945 | CfO_EdgeGenPollCycleEventID | USINT | | | | • |
| 2947 | CfO_EdgeGenConsumeCycleEventID | USINT | | | | • |
| 3585 + (N-1) * 64 | CfO_EdgeGenUnit0NMode (index N = 1 to 4) | USINT | | | | • |
| 3589 + (N-1) * 64 | CfO_EdgeGenUnit0NTimestampFifoLim (index N = 1 to 4) | USINT | | | | • |
| 3591 + (N-1) * 64 | CfO_EdgeGenUnit0NTimestampRegCount (index N = 1 to 4) | USINT | | | | • |
| 3596 + (N-1) * 64 | CfO_EdgeGenUnit0NPickupDiff (index N = 1 to 4) | UDINT | | | | • |
| 3602 + (N-1) * 64 | CfO_EdgeGenUnit0NConfigEdge0 (index N = 1 to 4) | UINT | | | | • |
| 3606 + (N-1) * 64 | CfO_EdgeGenUnit0NConfigEdge1 (index N = 1 to 4) | UINT | | | | • |
| 3610 + (N-1) * 64 | CfO_EdgeGenUnit0NConfigEdge2 (index N = 1 to 4) | UINT | | | | • |
| 3614 + (N-1) * 64 | CfO_EdgeGenUnit0NConfigEdge3 (index N = 1 to 4) | UINT | | | | • |
| Communication - General | | | | | | |
| 546 | ProtocolError (16-bit) | UINT | • | | | |
| 547 | ProtocolError (8-bit) | USINT | • | | | |
| 550 | ProtocolSequenceViolation (16-bit) | UINT | • | | | |
| 551 | ProtocolSequenceViolation (8-bit) | USINT | • | | | |
| Communication - Error register | | | | | | |
| 257 | Error status - Output data | USINT | • | | | |
| | OutputControlError | Bit 4 | | | | |
| | OutputCopyError | Bit 5 | | | | |

| Register | Name | Data type | Read | | Write | |
|---|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 259 | Error messages - Edge generator | USINT | • | | | |
| | EdgeGen01Error | Bit 0 | | | | |
| | EdgeGen01Warning | Bit 1 | | | | |
| | EdgeGen02Error | Bit 2 | | | | |
| | EdgeGen02Warning | Bit 3 | | | | |
| | EdgeGen03Error | Bit 4 | | | | |
| | EdgeGen03Warning | Bit 5 | | | | |
| | EdgeGen04Error | Bit 6 | | | | |
| EdgeGen04Warning | Bit 7 | | | | | |
| 321 | Acknowledge error messages - Output data | USINT | | | • | |
| | QuitOutputControlError | Bit 4 | | | | |
| | QuitOutputCopyError | Bit 5 | | | | |
| 323 | Acknowledge error messages - Edge generator | USINT | | | • | |
| | QuitEdgeGen01Error | Bit 0 | | | | |
| | QuitEdgeGen01Warning | Bit 1 | | | | |
| | QuitEdgeGen02Error | Bit 2 | | | | |
| | QuitEdgeGen02Warning | Bit 3 | | | | |
| | QuitEdgeGen03Error | Bit 4 | | | | |
| | QuitEdgeGen03Warning | Bit 5 | | | | |
| | QuitEdgeGen04Error | Bit 6 | | | | |
| QuitEdgeGen04Warning | Bit 7 | | | | | |
| 1443 | Error status - Overcurrent of a PWM output | USINT | • | | | |
| | DigitalOutput01Err | BOOL | | | | |
| | DigitalOutput02Err | BOOL | | | | |
| | DigitalOutput03Err | BOOL | | | | |
| | DigitalOutput04Err | BOOL | | | | |
| 1463 | Acknowledge error messages - Overcurrent of a PWM output | USINT | | | • | |
| | DigitalOutput01ErrQuit | BOOL | | | | |
| | DigitalOutput02ErrQuit | BOOL | | | | |
| | DigitalOutput03ErrQuit | BOOL | | | | |
| | DigitalOutput04ErrQuit | BOOL | | | | |
| Communication - System timer | | | | | | |
| 683 | SDCLifeCount | SINT | • | | | |
| Communication - Direct I/O | | | | | | |
| 915 | Direct operation of the output channel - Output status | USINT | | | • | |
| | DigitalOutput01 | Bit 0 | | | | |
| | DigitalOutput02 | Bit 1 | | | | |
| | DigitalOutput03 | Bit 2 | | | | |
| | DigitalOutput04 | Bit 3 | | | | |
| 1459 | Direct operation of the output channel - Enabling the PWM function | USINT | | | • | |
| | DigitalOutput01Enable | Bit 0 | | | | |
| | DigitalOutput02Enable | Bit 1 | | | | |
| | DigitalOutput03Enable | Bit 2 | | | | |
| | DigitalOutput04Enable | Bit 3 | | | | |
| Communication - Oversampled I/O (output) | | | | | | |
| 1079 | OversampleInputCycle | USINT | • | | | |
| 1059 | Oversampling configuration | USINT | | | • | |
| | OversampleEnable | Bit 1 | | | | |
| | OversampleOutputValidate | Bit 2 | | | | |
| 1063 | OversampleOutputCycle | USINT | | | • | |
| | OversampleSampleOffset | USINT | | | | |
| 1088 + N | OversampleOutput0NSample1_8 (index N = 1 to 4) | USINT | | | • | |
| 1092 + N | OversampleOutput0NSample9_16 (index N = 1 to 4) | USINT | | | • | |
| 1096 + N | OversampleOutput0NSample17_24 (index N = 1 to 4) | USINT | | | • | |
| 1100 + N | OversampleOutput0NSample25_32 (index N = 1 to 4) | USINT | | | • | |
| 1104 + N | OversampleOutput0NSample33_40 (index N = 1 to 4) | USINT | | | • | |
| 1108 + N | OversampleOutput0NSample41_48 (index N = 1 to 4) | USINT | | | • | |
| 1112 + N | OversampleOutput0NSample49_56 (index N = 1 to 4) | USINT | | | • | |
| 1116 + N | OversampleOutput0NSample57_64 (index N = 1 to 4) | USINT | | | • | |
| Communication - Edge generator | | | | | | |
| 6145 + (N-1) * 256 | Enabling units | USINT | | | • | |
| | EdgeGen0NEnable | Bit 0 | | | | |
| | EdgeGen0NEnableReadback (index N = 1 to 4) | | | | | |
| 6147 + (N-1) * 256 | EdgeGen0NSequence | USINT | • | | • | |
| | EdgeGen0NSequenceReadback | USINT | | | | |
| 6180 + (N-1) * 256 | EdgeGen0NOffset1 (index N = 1 to 4) (32-bit) | UDINT | | | • | |
| | CfO_EdgeGen0NOffset_32bit1 (index N = 1 to 4) | | | | | |
| 6182 + (N-1) * 256 | EdgeGen0NOffset1 (index N = 1 to 4) (16-bit) | UINT | | | • | |
| 6188 + (N-1) * 256 | EdgeGen0NOffset2 (index N = 1 to 4) (32-bit) | UDINT | | | • | |
| | CfO_EdgeGen0NOffset_32bit2 (index N = 1 to 4) | | | | | |
| 6190 + (N-1) * 256 | EdgeGen0NOffset2 (index N = 1 to 4) (16-bit) | UINT | | | • | • |

| Register | Name | Data type | Read | | Write | |
|-----------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 6196 + (N-1) * 256 | EdgeGen0NOffset3 (index N = 1 to 4) (32-bit) CfO_EdgeGen0NOffset_32bit3 (index N = 1 to 4) | UDINT | | | • | • |
| 6198 + (N-1) * 256 | EdgeGen0NOffset3 (index N = 1 to 4) (16-bit) | UINT | | | • | |
| 6204 + (N-1) * 256 | EdgeGen0NOffset4 (index N = 1 to 4) (32-bit) CfO_EdgeGen0NOffset_32bit4 (index N = 1 to 4) | UDINT | | | • | • |
| 6206 + (N-1) * 256 | EdgeGen0NOffset4 (index N = 1 to 4) (16-bit) | UINT | | | • | |
| 6212 + (N-1) * 256 | EdgeGen0NTimestamp1 (index N = 1 to 4) (32-bit) | UDINT | | | • | |
| 6214 + (N-1) * 256 | EdgeGen0NTimestamp1 (index N = 1 to 4) (16-bit) | UINT | | | • | |
| 6220 + (N-1) * 256 | EdgeGen0NTimestamp2 (index N = 1 to 4) (32-bit) | UDINT | | | • | |
| 6222 + (N-1) * 256 | EdgeGen0NTimestamp2 (index N = 1 to 4) (16-bit) | UINT | | | • | |
| 6228 + (N-1) * 256 | EdgeGen0NTimestamp3 (index N = 1 to 4) (32-bit) | UDINT | | | • | |
| 6230 + (N-1) * 256 | EdgeGen0NTimestamp3 (index N = 1 to 4) (16-bit) | UINT | | | • | |
| 6236 + (N-1) * 256 | EdgeGen0NTimestamp4 (index N = 1 to 4) (32-bit) | UDINT | | | • | |
| 6238 + (N-1) * 256 | EdgeGen0NTimestamp4 (index N = 1 to 4) (16-bit) | UINT | | | • | |

9.26.5.9.3 General

9.26.5.9.3.1 Use with Automation Studio

The module is only supported by SG4 target systems via X2X and POWERLINK!

X2X Link supports the following synchronous cyclic data per module:

- 31 bytes input data consisting of 30 input bytes and X2X status byte
- 30 bytes output data

To optimize use and prevent needless data transfer, data points can be adjusted as needed in Automation Studio. Unnecessary data points can be disabled, and the bit width of the data points can be defined.

9.26.5.9.3.2 Timestamp function

The timestamp function is based on synchronized timers. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

Conversely, the CPU can predefine output events, apply a timestamp and transfer them to the module. The module then executes the predefined action at the precise moment defined by the CPU.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

The resolution of the timestamp is up to 1/8 μ s in both directions.

Synchronization jitter

Because the CPU – which specifies the X2X NetTime – and the module have different clocks, the module's internal X2X NetTime must be synchronized with the CPU's NetTime. Due to this synchronization, the module's internal X2X NetTime is corrected by a maximum of 1/8 μ s per system cycle if necessary. This synchronization jitter becomes noticeable when using the NetTime with 1/8 μ s resolution (max. \pm 1/8 μ s).

If a 100% exact 1/8 μ s resolution without jitter is required, then "Local time 1/8 μ s" must be used (see register "[CfO_EdgeGenUnitMode](#)" on page 3016).

9.26.5.9.4 General registers

9.26.5.9.4.1 Defining the moment for generating synchronous input data

Name:

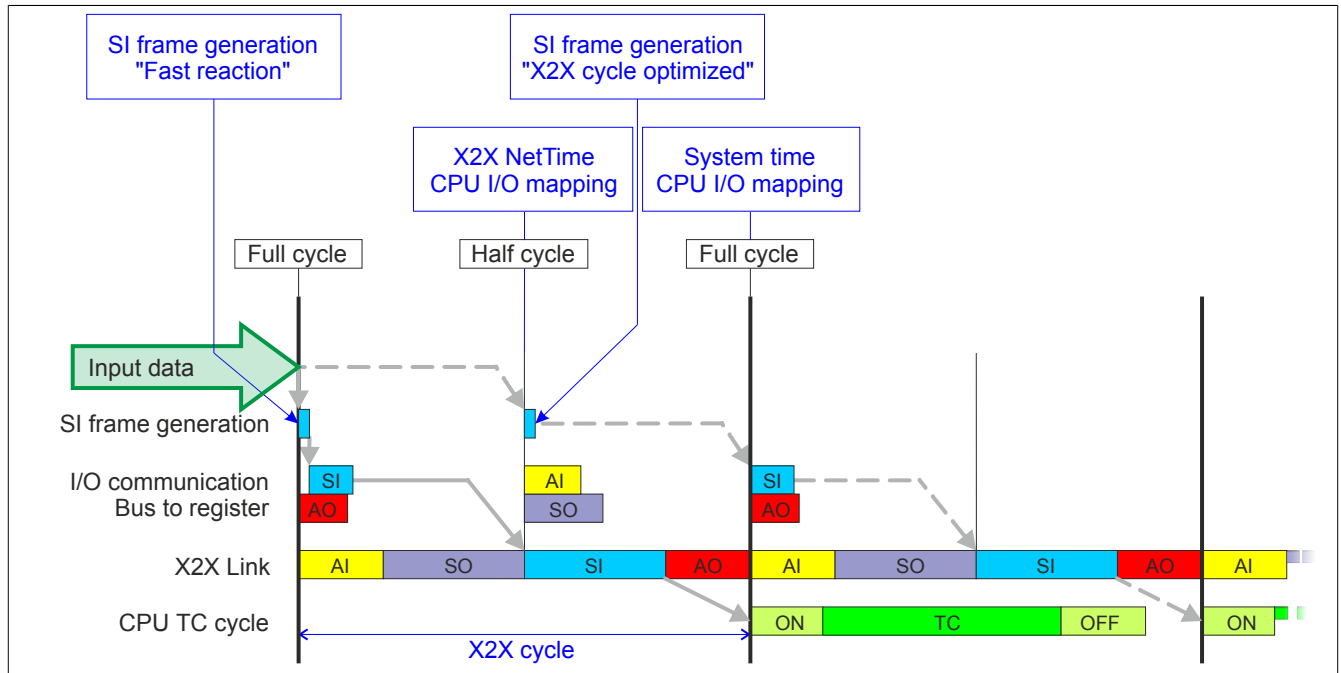
CfO_SlframeGenID

"SI frame generation" in the Automation Studio I/O configuration.

When the synchronous input data is generated for transfer is defined in this register. This has a decisive effect on the timing of the input data.

Setting "Fast reaction" causes the input data to be available one X2X cycle sooner in the CPU. However, this setting also has a negative effect on the minimum X2X cycle time.

| Data type | Values | Information |
|-----------|--------|---------------------|
| USINT | 9 | X2X cycle optimized |
| | 14 | Fast reaction |



9.26.5.9.4.2 Number of X2X protocol errors

Name:

ProtocolError

This register contains an error counter that specifies the number of X2X protocol errors. In the I/O configuration, parameter "Network information" can be used to help configure a data point for this register with a bit width of 8 or 16 bits in the I/O mapping.

| Data type | Values | Information |
|-----------|------------|------------------------|
| USINT | 0 to 255 | Error counter (8-bit) |
| UINT | 0 to 65535 | Error counter (16-bit) |

9.26.5.9.4.3 Number of X2X sequence violations

Name:

ProtocolSequenceViolation

This register contains an error counter that specifies the number of X2X sequence violations. In the I/O configuration, parameter "Network information" can be used to help configure a data point with a bit width of 8 or 16 bits in the I/O mapping.

| Data type | Values | Information |
|-----------|------------|------------------------|
| USINT | 0 to 255 | Error counter (8-bit) |
| UINT | 0 to 65535 | Error counter (16-bit) |

9.26.5.9.4.4 System clock counter for checking the validity of the data frame

Name:

SDCLifeCount

Counter that is incremented with each system timer cycle. "SDC information" in the Automation Studio I/O configuration can be used to enable this register in the I/O mapping as data point "SDCLifeCount".

The 8-bit counter register is needed for the SDC software package. It is incremented with the system clock to allow the SDC to check the validity of the data frame.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

9.26.5.9.5 Error handling

If one of the functions detects an error, then an error bit is set in one of the error state registers. The application is now able to react accordingly and acknowledge the errors by setting a respective bit in the "Acknowledge error message" registers. This causes the bit to be reset in the error state register. If the source of the error persists, then the error bit is set again as soon as the error is detected again (i.e. cannot be reset).

After the error source has been corrected and the error acknowledged, the module must be re-enabled by disabling and re-enabling the enable registers in order to resume processing. The following registers are affected:

- Oversampling configuration: Register "[OversampleEnable](#)" on page 3010
- Edge generation - Enabling units: Register "[EdgeGenEnable](#)" on page 3018
- Enabling the PWM function: Register "[DigitalOutputEnable](#)" on page 3005

If an error occurs (not a warning), this is indicated by the red "e" LED on the module (double flash). This signal is automatically acknowledged as soon as the source of the error has been corrected.

9.26.5.9.5.1 Error status - Output data

Name:

OutputControlError

OutputCopyError

This register indicates data output errors.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------|-------|--|
| 0 - 3 | Reserved | - | |
| 4 | OutputControlError | 0 | No error |
| | | 1 | The module did not receive new data in time while in the mode "Output control mode = single", meaning that a bit that has already been output would have been output again by the output control buffer. |
| 5 | OutputCopyError | 0 | No error |
| | | 1 | Oversampling output data could not be copied to the output control buffer (attempted to write to an address outside the oversampling output window , for example). |
| 6 - 7 | Reserved | - | |

9.26.5.9.5.2 Error messages - Edge generator

Name:

EdgeGen01Error to EdgeGen04Error

EdgeGen01Warning to EdgeGen04Warning

This register indicates edge detection errors.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|------------------|-------|------------------------------|
| 0 | EdgeGen01Error | 0 | No error |
| | | 1 | Unit 1 error ¹⁾ |
| 1 | EdgeGen01Warning | 0 | No error |
| | | 1 | Unit 1 warning ²⁾ |
| 2 | EdgeGen02Error | 0 | No error |
| | | 1 | Unit 2 error ¹⁾ |
| 3 | EdgeGen02Warning | 0 | No error |
| | | 1 | Unit 2 warning ²⁾ |
| 4 | EdgeGen03Error | 0 | No error |
| | | 1 | Unit 3 error ¹⁾ |
| 5 | EdgeGen03Warning | 0 | No error |
| | | 1 | Unit 3 warning ²⁾ |
| 6 | EdgeGen04Error | 0 | No error |
| | | 1 | Unit 4 error ¹⁾ |
| 7 | EdgeGen04Warning | 0 | No error |
| | | 1 | Unit 4 warning ²⁾ |

1) Possible errors

- Due to "EdgeGenPollCycle", one or more timestamps from the edge generator of a unit were not able to be processed in time, and it was not possible to catch back up (see register "CfO_EdgeGenUnitPickupDiff" on page 3017).
- A branched ring-shaped chain of edges in a unit is attempting to set the timestamp for an edge even though the FIFO buffer of the configured physical channel is already full (see register "CfO_EdgeGenUnitConfigEdge" on page 3018 → - Ring-shaped chain of edges).

- 2) Due to "EdgeGenPollCycle", one or more timestamps from the edge generator of a unit were not able to be processed in time, and it was possible to catch back up (see register "CfO_EdgeGenUnitPickupDiff" on page 3017).

9.26.5.9.5.3 Error status - Overcurrent of a PWM output

Name:

DigitalOutput01Err to DigitalOutput04Err

A set bit reports an overcurrent error from the PWM hardware and disables the output until acknowledged by the user.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------|-------|-------------|
| 0 | DigitalOutput01Err | 0 | No change |
| | | 1 | Overcurrent |
| 1 | DigitalOutput02Err | 0 | No change |
| | | 1 | Overcurrent |
| 2 | DigitalOutput03Err | 0 | No change |
| | | 1 | Overcurrent |
| 3 | DigitalOutput04Err | 0 | No change |
| | | 1 | Overcurrent |
| 4 - 7 | Reserved | - | |

9.26.5.9.5.4 Acknowledge error messages - Output data

Name:

QuitOutputControlError

QuitOutputCopyError

Error messages from the "[Error status - Output data](#)" on page 3000 register can be acknowledged by setting the corresponding bits in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------|-------|-------------------|
| 0 - 3 | Reserved | - | |
| 4 | QuitOutputControlError | 0 | No change |
| | | 1 | Acknowledge error |
| 5 | QuitOutputCopyError | 0 | No change |
| | | 1 | Acknowledge error |
| 6 - 7 | Reserved | - | |

9.26.5.9.5.5 Acknowledge error messages - Edge generator

Name:

QuitEdgeGen01Error to QuitEdgeGen04Error

QuitEdgeGen01Warning to QuitEdgeGen04Warning

The error message from register "[Error messages - Edge generator](#)" on page 3001 can be acknowledged in this register by setting the respective bit.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|----------------------|-------|---------------------|
| 0 | QuitEdgeGen01Error | 0 | No change |
| | | 1 | Acknowledge error |
| 1 | QuitEdgeGen01Warning | 0 | No change |
| | | 1 | Acknowledge warning |
| 2 | QuitEdgeGen02Error | 0 | No change |
| | | 1 | Acknowledge error |
| 3 | QuitEdgeGen02Warning | 0 | No change |
| | | 1 | Acknowledge warning |
| 4 | QuitEdgeGen03Error | 0 | No change |
| | | 1 | Acknowledge error |
| 5 | QuitEdgeGen03Warning | 0 | No change |
| | | 1 | Acknowledge warning |
| 6 | QuitEdgeGen04Error | 0 | No change |
| | | 1 | Acknowledge error |
| 7 | QuitEdgeGen04Warning | 0 | No change |
| | | 1 | Acknowledge warning |

9.26.5.9.5.6 Acknowledge error messages - Overcurrent of a PWM output

Name:

DigitalOutput01ErrQuit to DigitalOutput04ErrQuit

Error messages from the "[Error status - Overcurrent of a PWM output](#)" on page 3001 register can be acknowledged by setting the corresponding bits in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------|-------|----------------------|
| 0 | DigitalOutput01ErrQuit | 0 | No change |
| | | 1 | Acknowledging errors |
| 1 | DigitalOutput02ErrQuit | 0 | No change |
| | | 1 | Acknowledging errors |
| 2 | DigitalOutput03ErrQuit | 0 | No change |
| | | 1 | Acknowledging errors |
| 3 | DigitalOutput04ErrQuit | 0 | No change |
| | | 1 | Acknowledging errors |
| 4 - 7 | Reserved | - | |

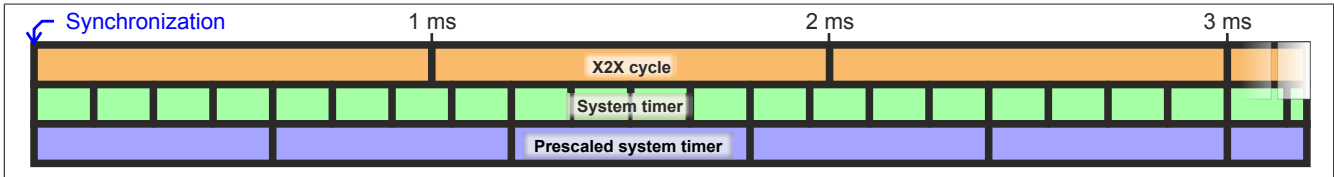
9.26.5.9.6 System timer

The module's individual functions all depend on a system timer. This internal "system cycle time" can be defined from 25 to 255 μ s. The functions can also be run with the help of a configurable "prescaled system timer" to minimize the load on the module, thereby making it possible to use the shortest possible X2X cycle time.

The cycle of the "prescaled system timer" (and system timer) is referenced with the X2X Link as soon as the module has been started up and the X2X Link has been initialized. Since the system timer and the module's internal `NetTime` use the same clock, the two run synchronously from that point on. An X2X cycle time that is not a multiple of the system cycle time results in an offset, which can be calculated, however.

The following values apply to the following example:

| | |
|------------------------|-------------|
| X2X cycle | 1 ms |
| System timer | 150 μ s |
| Prescaled system timer | 4 |



9.26.5.9.6.1 Setting the cycle time of the system timer

Name:

`CfO_SystemCycleTime`

"Cycle time" in the Automation Studio I/O configuration.

The cycle time of the system timer can be set in steps of 1/8 μ s in this register. The value entered in the Automation Studio I/O configuration is automatically multiplied by 8.

Information:

A setting <50 μ s has a negative effect on the minimum X2X cycle time!

| Data type | Values | Information |
|-----------|-------------|---|
| UINT | 200 to 2047 | System timer cycle time in steps of 1/8 μ s (25 to 255.875 μ s) |

9.26.5.9.6.2 Offsetting the synchronization moment of the system cycle

Name:

`CfO_SystemCycleOffset`

"Cycle offset" in the Automation Studio I/O configuration.

The synchronization moment for the system cycle can be offset in steps of 1/8 μ s in this register. The value entered in the Automation Studio I/O configuration is automatically multiplied by 8.

| Data type | Values | Information |
|-----------|-----------------|--|
| INT | -32768 to 32767 | Cycle offset in steps of 1/8 μ s (-4096 to 4095.875 μ s) |

9.26.5.9.6.3 Configuration of the cycle prescaler

Name:

`CfO_SystemCyclePrescaler`

"Cycle prescaler" in the Automation Studio I/O configuration.

The prescaler for setting the `prescaled system timer` can be configured in this register. The cycle time of the specified system timer is a product of the system timer multiple set in this register.

The "prescaled system timer" can be used as an alternative time source for the individual functions. This is useful if a function requires a very short system cycle. To reduce the load on the module in such a situation, other functions can be processed in a slow cycle.

| Data type | Values | Information |
|-----------|----------|------------------------------|
| UINT | 2 to 128 | Multiple of the system timer |

9.26.5.9.7 Direct I/O

Direct I/O makes it possible to use the physical I/Os like normal I/Os. Additionally, the application can only set or reset I/Os (e.g. an output channel is set by the edge generator and manually reset by the application).

9.26.5.9.7.1 Direct operation of the output channel - Reset

Name:

CfO_DirectIOClearMask0_3

"Direct operation of output channel 01" to "Direct operation of output channel 04" in the Automation Studio I/O configuration.

If the bit for the respective channel is set in this register, then the output is reset as soon as its direct I/O output channel is reset (register "[DigitalOutput0x](#)" on page 3005 in the Automation Studio I/O mapping).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------|-------|---------------|
| 0 | Output channel 1 | 0 | No change |
| | | 1 | Reset channel |
| 1 | Output channel 2 | 0 | No change |
| | | 1 | Reset channel |
| 2 | Output channel 3 | 0 | No change |
| | | 1 | Reset channel |
| 3 | Output channel 4 | 0 | No change |
| | | 1 | Reset channel |
| 4 - 7 | Reserved | - | |

9.26.5.9.7.2 Direct operation of the output channel - Set

Name:

CfO_DirectIOSetMask0_3

"Direct operation of output channel 01" to "Direct operation of output channel 04" in the Automation Studio I/O configuration.

If the bit for the respective channel is set in this register, then the output is set as soon as its direct I/O output channel is set (register "[DigitalOutput0x](#)" on page 3005 in the Automation Studio I/O mapping).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------|-------|-------------|
| 0 | Output channel 1 | 0 | No change |
| | | 1 | Set channel |
| 1 | Output channel 2 | 0 | No change |
| | | 1 | Set channel |
| 2 | Output channel 3 | 0 | No change |
| | | 1 | Set channel |
| 3 | Output channel 4 | 0 | No change |
| | | 1 | Set channel |
| 4 - 7 | Reserved | - | |

9.26.5.9.7.3 Direct operation of the output channel - Moment of data output

Name:

CfO_OutputUpdateCycle

The moment when data is output is set with this register.

| Data type | Values | Information |
|-----------|--------|-----------------------------------|
| USINT | 10 | X2X cycle optimized (jitter-free) |
| | 15 | Fast reaction (with jitter) |

9.26.5.9.7.4 Direct operation of the output channel - Output status

Name:

DigitalOutput01 to DigitalOutput04

This register contains the bits for controlling the direct I/O output channels. Depending on the configuration of registers "CfO_DirectIOClearMask0_3" on page 3004 and "CfO_DirectIOSetMask0_3" on page 3004, the digital outputs are set to the status of the respective bit in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------|--------|----------------------------|
| 0 | DigitalOutput01 | 0 or 1 | Output status of channel 1 |
| 1 | DigitalOutput02 | 0 or 1 | Output status of channel 2 |
| 2 | DigitalOutput03 | 0 or 1 | Output status of channel 3 |
| 3 | DigitalOutput04 | 0 or 1 | Output status of channel 4 |
| 4 - 7 | Reserved | - | |

9.26.5.9.7.5 Direct operation of the output channel - Enabling the PWM function

Name:

DigitalOutput01Enable to DigitalOutput04Enable

A set bit enables the PWM function.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------|-------|--------------|
| 0 | Output channel 1 | 0 | PWM disabled |
| | | 1 | PWM enabled |
| 1 | Output channel 2 | 0 | PWM disabled |
| | | 1 | PWM enabled |
| 2 | Output channel 3 | 0 | PWM disabled |
| | | 1 | PWM enabled |
| 3 | Output channel 4 | 0 | PWM disabled |
| | | 1 | PWM enabled |
| 4 - 7 | Reserved | - | |

9.26.5.9.8 Oversampled I/O

"Oversampled I/O" based on output control buffers. Output control occurs in one sample cycle (one sample cycle corresponds to one bit in the buffer).

In "Output control mode = single" every output buffer entry is marked as invalid once it has been executed. This ensures that the outputs are not supplied with invalid data. In this mode, the application needs to ensure that the module is always supplied with valid data.

When using "Output control mode = continuous" the contents of the buffer are output again if the module is not supplied with new oversample output data.

9.26.5.9.8.1 Addressing the output control buffer

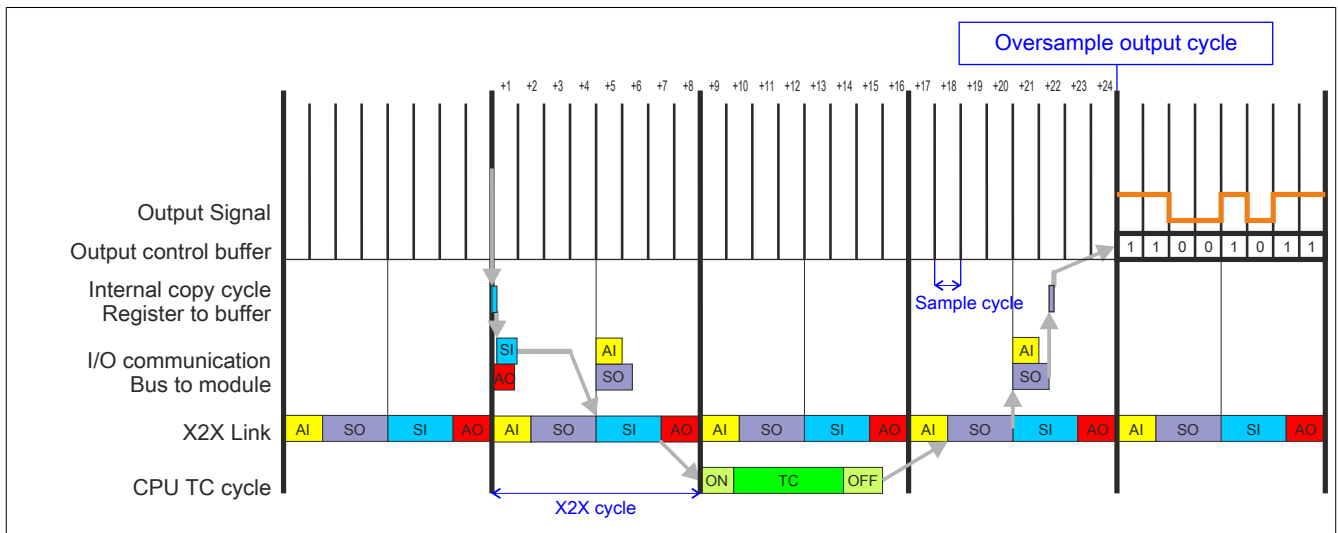
The module has one cyclic 256-bit output control buffer for each oversample channel. One bit is output from these buffers to the configured physical output channels in each "sample cycle". When new data is transferred to one of these buffers, the application must define where in the respective buffer the data should be written to. There are 2 possibilities available for this (absolute or relative "Output mode" in the Automation Studio I/O configuration).

9.26.5.9.8.2 Absolute addressing of the output control buffer

With absolute addressing, in each cycle where "OversampleOutputValidate = True", in addition to the oversample output sample data (in the "OversampleOutput0NSample" on page 3011 registers) an address must also be transferred in the "OversampleOutputCycle" on page 3011 register. This address determines where in the output control buffer the new data should be copied to. In order to calculate this address, the contents of register "OversampleInputCycle" on page 3011, which contains the address of the most recently output data, and the transfer time to the module must be taken into consideration. To help avoid incorrect addressing of the output control buffer, the buffer section that is capable of being written to can be limited using register "OversampleOutputWindow" on page 3010. This window will always be shifted relative to the current sample address. An "OutputCopyError" will be triggered if an attempt is made to write to an address that is outside of this window.

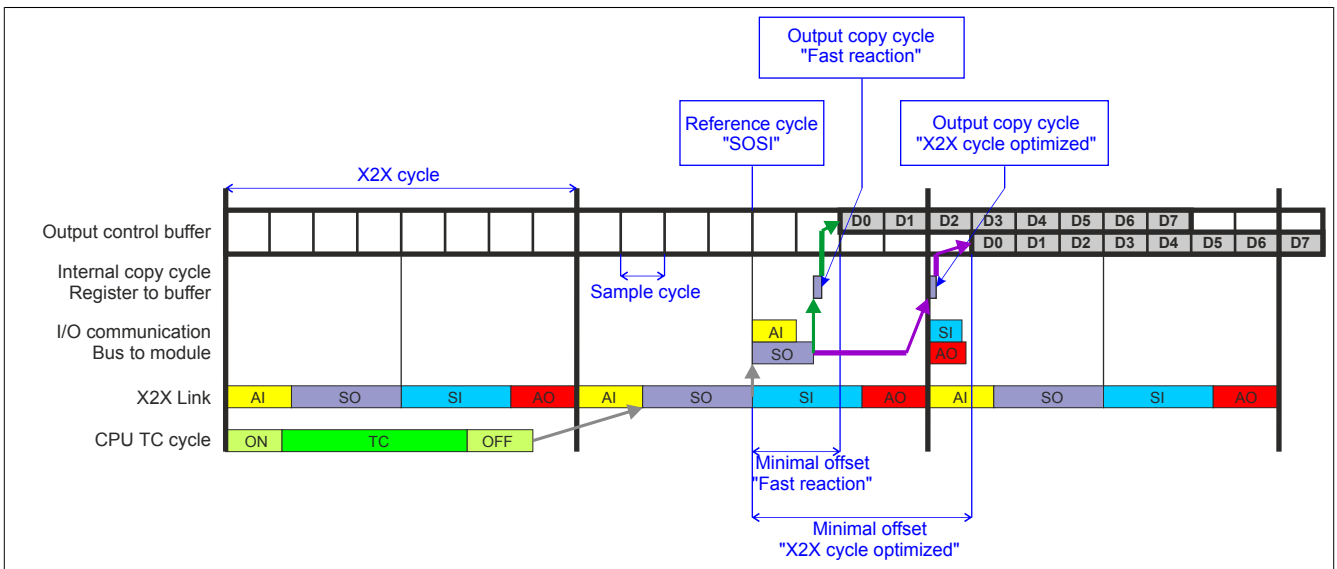
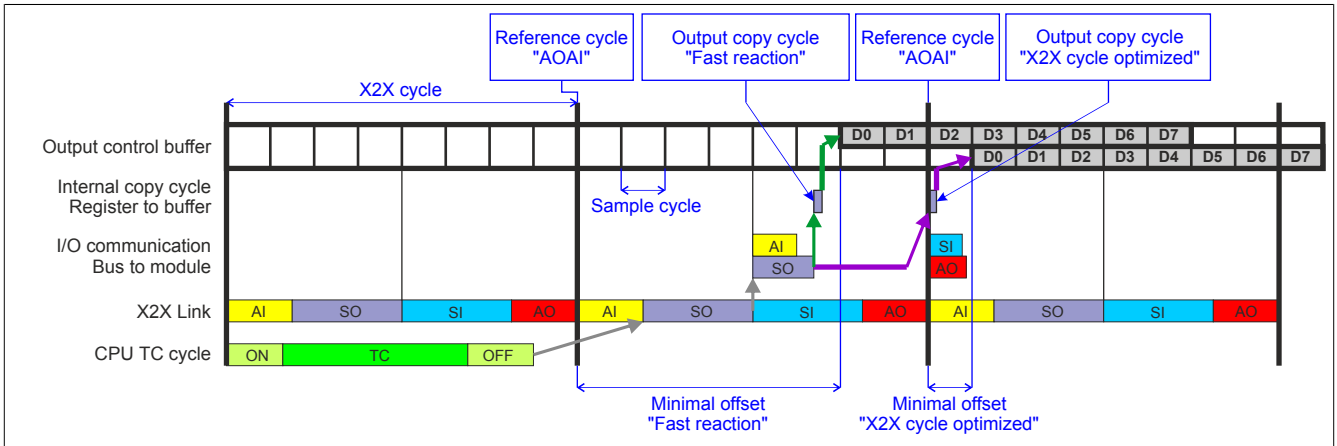
Example

Timing of an oversample output cycle in absolute output mode ("SI frame generation = Fast reaction", "Output copy cycle = Fast reaction", 8 samples per X2X cycle):



9.26.5.9.8.3 Relative addressing of the output control buffer

When "OversampleOutputValidate = True", then the oversample output sample data is automatically copied to an address relative to the last referenced address at the defined **output copy cycle** time. The "OversampleSampleOffset" on page 3011 register serves as the offset. The new data cannot start being output immediately at the **output copy cycle** time because it takes time to copy the data from the registers to the buffer. This means that an offset of 0 is not allowed. The relative output control buffer address + offset must point to an address within the "oversample output window". The **oversample output window** is always offset relative to the current sample address. An **OutputCopyError** is triggered if an attempt is made to write to an address that is outside of this window.



9.26.5.9.8.4 Configuration of the output control buffer

Name:

CfO_OversampleMode

"Output mode" in the Automation Studio I/O configuration

"Output control mode" in the Automation Studio I/O configuration

The output control buffer can be configured globally for all channels in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------------------|-------|---|
| 0 | Addressing the output control buffer | 0 | Absolute addressing of the output control buffer |
| | | 1 | Relative addressing of the output control buffer |
| 1 | Cyclic output control | 0 | Single - Output control buffer entry is marked invalid after execution. |
| | | 1 | Continuous - Output control buffer entry is not changed. |
| 2 - 7 | Reserved | - | |

Cyclic output control

If cyclic output control is enabled, then all data in the output control buffer is marked invalid as soon as it is output ("Output control mode = single"). An [OutputControlError](#) is generated if the module does not receive data in time, thereby causing a situation in which a bit that has already been output would be output in the buffer again. In such a situation, the output assumes the "Output default state" configured in the "[CfO_OversampleConfigOutput](#)" on [page 3010](#) register.

If cyclic output control is disabled, then the data is output again if the output control buffer overflows ("Output control mode = continuous").

Information:

All 256 bits of the output control buffer are always output.

9.26.5.9.8.5 Configuration of the source for the sample cycle

Name:

CfO_OversampleSampleCycleID

"Sample cycle" in the Automation Studio I/O configuration.

The source of the sample cycle can be configured in this register. During each sample cycle, a bit is output from the output control buffers of the oversample I/O channels to the configured physical output.

| Data type | Value | Information |
|-----------|-------|--|
| USINT | 2 | System timer The value configured in the " CfO_SystemCycleTime " on page 3003 register is used as the sample cycle. |
| | 3 | Prescaled system timer The "prescaled system timer" is used as sample cycle. |
| | 10 | AOAI The sample cycle is clocked with the AOAI interrupt of the X2X cycle. |
| | 14 | SOSI The sample cycle is clocked with the SOSI interrupt of the X2X cycle. |

9.26.5.9.8.6 Configuration of the source for the user interface reference cycle

Name:

CfO_OversampleRelativeCycleID

"Reference cycle" in the Automation Studio I/O configuration.

The source of the user interface reference cycle can be configured in this register.

- With relative addressing of the output control buffer, the new sample data is copied to an address relative to the output control buffer address current to the "reference cycle".
- The reference cycle is also used to reference the sample cycle, and with it also the output data production (e.g. to the X2X cycle).

| Data type | Value | Information |
|-----------|-------|---|
| USINT | 2 | System timer The value configured in the "CfO_SystemCycleTime" on page 3003 register is used as the reference cycle. |
| | 3 | Prescaled system timer The prescaled system timer is used as sample cycle. |
| | 10 | AOAI The sample cycle is referenced with the AOAI interrupt of the X2X cycle. |
| | 14 | SOSI The sample cycle is referenced with the SOSI interrupt of the X2X cycle. |

9.26.5.9.8.7 Defining the moment for copying the data to the output control buffer

Name:

CfO_OversampleConsumeCycleID

"Output copy cycle" in the Automation Studio I/O configuration.

At the time of the output copy cycle, data is copied from the "[OversampleOutput0NSample](#)" on page 3011 registers into the output control buffer.

When "Output copy cycle = Fast reaction", it is not possible to determine when the data is copied to the output control buffer in either of the two addressing modes. The copy cycles will experience a certain degree of jitter depending on the module load. However, this only affects the moment of the internal copy procedures and therefore the moment of the earliest possible output sample. This will not affect the quality of the output signal. However, "Output copy cycle = Fast reaction" also has a negative effect on the minimum X2X cycle time.

When using the setting "Output copy cycle = X2X cycle optimized", be aware that the sample data cannot start being output immediately at the "Output copy cycle" time due to the internal copy cycle to the output control buffers.

| Data type | Values | Information |
|-----------|--------|---|
| USINT | 10 | X2X cycle optimized The output data is copied to the output control buffer with the AOAI interrupt of the X2X cycle. |
| | 15 | Fast reaction The output data is copied to the output control buffer immediately after being received. |

9.26.5.9.8.8 Number of output bits to be transferred

Name:

CfO_OversampleOutputBits

"User interface size" in the Automation Studio I/O configuration.

Specifies how many bits are transferred from the "[OversampleOutput0NSample](#)" on page 3011 registers to the output control buffers at the [output copy cycle](#) moment.

| Data type | Values | Information |
|-----------|---------|-------------|
| USINT | 1 to 64 | Output bits |

9.26.5.9.8.9 Write area in the output control buffer

Name:

CfO_OversampleOutputWindow

"Output control mode" in the Automation Studio I/O configuration.

Determines the area in the output control buffer in which data can be written. The window is always offset relative to the current sample position. (a value of 128, for example, means that the 128 bits following the current sample cycle can be written to). An [OutputCopyError](#) is triggered if an attempt is made to write output sample data to a location outside of this window.

In Automation Studio, with the setting "Output control mode = Single", this register is set to 128 bits and with the setting "Output control mode = Continuous" it is set to 255 bits.

| Data type | Value | Information |
|-----------|----------|---------------|
| USINT | 0 to 255 | Output window |

9.26.5.9.8.10 Configuration of the outputs of the oversampling channels

Name:

CfO_OversampleConfigOutput

"Oversample I/O 01 → Output" to "Oversample I/O 04 → Output" in the Automation Studio I/O configuration

"Oversample I/O 01 → Output control" to "Oversample I/O 04 → Output control" in the Automation Studio I/O configuration

"Oversample I/O 01 → Output default state" to "Oversample I/O 04 → Output default state" in the Automation Studio I/O configuration

This register helps configure the outputs of the individual oversample channels.

The "Output default state" bits determine which level the respective output assumes before oversampling is started. Furthermore, the output is set to the defined "Output default state" in the event of an error.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------------------------------|-------|--|
| 0 - 1 | Number of the physical output channel | 0 | Output channel 1 |
| | | 1 | Output channel 2 |
| | | 2 | Output channel 3 |
| | | 3 | Output channel 4 |
| 2 - 3 | Reserved | - | |
| 4 - 5 | Output operation | 1 | Output can be reset by the oversample channel. |
| | | 2 | Output can be set by the oversample channel. |
| | | 3 | Output can be set and cleared by the oversample channel. |
| 6 - 7 | Default value output | 0 | Last value |
| | | 1 | Output cleared by default |
| | | 2 | Output set by default |

9.26.5.9.8.11 Oversampling configuration

Name:

OversampleEnable

OversampleOutputValidate

The oversampling and copy process for the output buffer can be configured in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------|-------|--|
| 0 | OversampleEnable | 0 | Disables oversampling (with the next reference cycle) |
| | | 1 | Enables oversampling (with the next reference cycle) |
| 1 | OversampleOutputValidate | 0 | Disable the copy procedure to the output control buffer. |
| | | 1 | Enables the copy procedure to the output control buffer. <ul style="list-style-type: none"> Used to synchronize the oversampling procedure at startup. This makes it possible to prevent new data from being transferred to the "OversampleOutput0NSample" on page 3011 registers in each X2X cycle. |
| 2 - 7 | Reserved | - | |

9.26.5.9.8.12 Address of the new output sampling data in the output control buffer

Name:

OversampleOutputCycle

When absolute addressing of the output control buffer is being used, this register specifies the address from which the new output sample data should be copied to the output control buffer.

| Data type | Values | Information |
|-----------|----------|--------------------------------------|
| USINT | 0 to 255 | Address of the output control buffer |

9.26.5.9.8.13 Offset of new output sample data

Name:

OversampleSampleOffset

When relative addressing of the output control buffer is being used, this register serves as the offset for the new output sample data. Sample address at the time of the [reference cycle](#) + Offset = address to which the new output sample data is copied in the output control buffer).

| Data type | Value | Information |
|-----------|----------|------------------------------|
| USINT | 0 to 255 | Offset of output sample data |

9.26.5.9.8.14 Oversample output sample data

Name:

OversampleOutput01Sample1_8 to OversampleOutput04Sample1_8
 OversampleOutput01Sample9_16 to OversampleOutput04Sample9_16
 OversampleOutput01Sample17_24 to OversampleOutput04Sample17_24
 OversampleOutput01Sample25_32 to OversampleOutput04Sample25_32
 OversampleOutput01Sample33_40 to OversampleOutput04Sample33_40
 OversampleOutput01Sample41_48 to OversampleOutput04Sample41_48
 OversampleOutput01Sample49_56 to OversampleOutput04Sample49_56
 OversampleOutput01Sample57_64 to OversampleOutput04Sample57_64

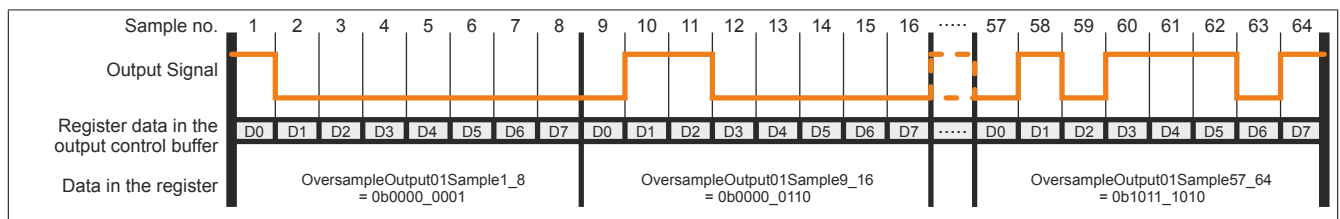
Contains the oversample output sample data. Up to 64 samples (8 bytes) for each oversample I/O channel can be synchronously transferred with a X2X cycle. This data is copied to the specified address (absolute or relative) in the output control buffer at the set [output copy cycle](#). 1 bit of this data is then output during each "sample cycle" to the physical output that is assigned to the oversample I/O channel.

Bit 0 of "OversampleOutputSample8_1" is copied to the output control buffer first, meaning that it is the first bit that is output. "OversampleOutputSample64_57" bit 7 is the last bit to be output.

| Data type | Values | Information |
|-----------|----------|--------------------|
| USINT | 0 to 255 | Output sample data |

Example

Assignment of "OversampleOutputSample" register data to output signal



9.26.5.9.8.15 Input status buffer address of the input sample data

Name:

OversampleInputCycle

The value in this register can be used to reference absolute addressing of the output control buffer.

| Data type | Value | Information |
|-----------|----------|-----------------------------|
| USINT | 0 to 255 | Input status buffer address |

9.26.5.9.9 PWM

9.26.5.9.9.1 Period duration

Name:

CfO_PWM01_Periode to CfO_PWM04_Periode

This register can be used to set the period duration between 20 and 1000 μ s.

| Data type | Value | Information |
|-----------|------------|--|
| UINT | 20 to 1000 | The period duration is specified in μ s. |

9.26.5.9.9.2 Excitation current

Name:

CfO_PWM01_Duty1 to CfO_PWM04_Duty1

This value is enabled from the time the output is switched on until the configured excitation time expires.

| Data type | Value | Information |
|-----------|-------|-----------------------|
| UINT | 0 | Output statically off |
| | 1000 | Output statically on |

9.26.5.9.9.3 Holding current

Name:

CfO_PWM01_Duty2 to CfO_PWM04_Duty2

This value is enabled if the output is switched on and the configured excitation time is expired.

| Data type | Value | Information |
|-----------|-------|-----------------------|
| UINT | 0 | Output statically off |
| | 1000 | Output statically on |

9.26.5.9.9.4 Excitation time

Name:

CfO_PWM01_Duty1Time to CfO_PWM04_Duty1Time

The excitation time is configured in steps in this register according to the [Excitation time base](#). The excitation time starts running as soon as the output is switched on. When the output is switched off, the excitation time is reset and the physical output disabled.

| Data type | Value | Information |
|-----------|------------|---|
| UINT | 0 to 65000 | Definition of the excitation time in steps according to the time base |

9.26.5.9.9.5 Excitation time base

Name:

CfO_PWM01_Duty1TimeBase to CfO_PWM04_Duty1TimeBase

The time base for the [Excitation time](#) is set in this register.

| Data type | Value | Information |
|-----------|-----------|--|
| UINT | 0 to 1000 | The time base for the excitation time is specified in μ s. |

9.26.5.9.9.6 High-speed cutoff

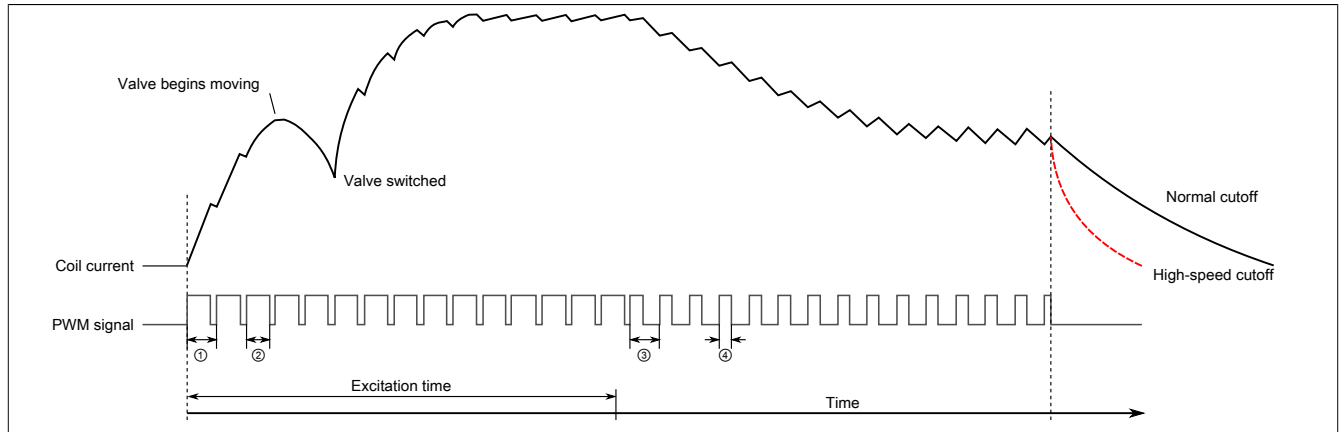
Name:

CfO_PWM01_FastSwitchOff to CfO_PWM04_FastSwitchOff

Setting this register enables/disables the high-speed cutoff after switching off the output.

| Data type | Value | Information |
|-----------|-------|----------------------------|
| UINT | 0 | High-speed cutoff disabled |
| | 1 | High-speed cutoff enabled |

Difference between normal and high-speed cutoff



- ①, ③ PWM period duration
- ② PWM excitation current value
- ④ PWM holding current value

9.26.5.9.9.7 PWM update timestamp

Name:

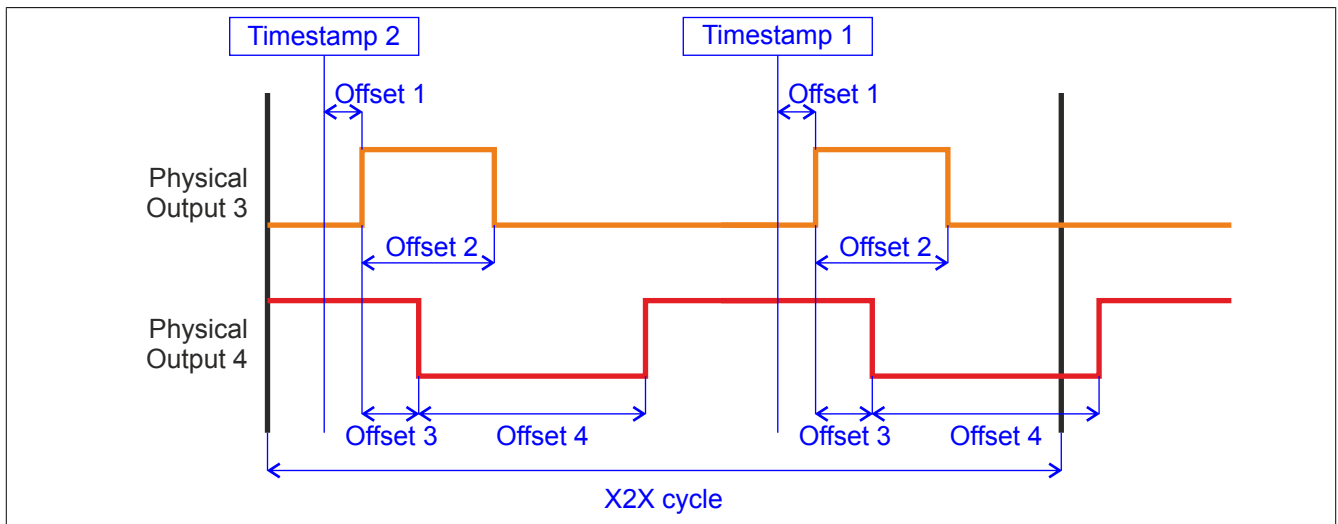
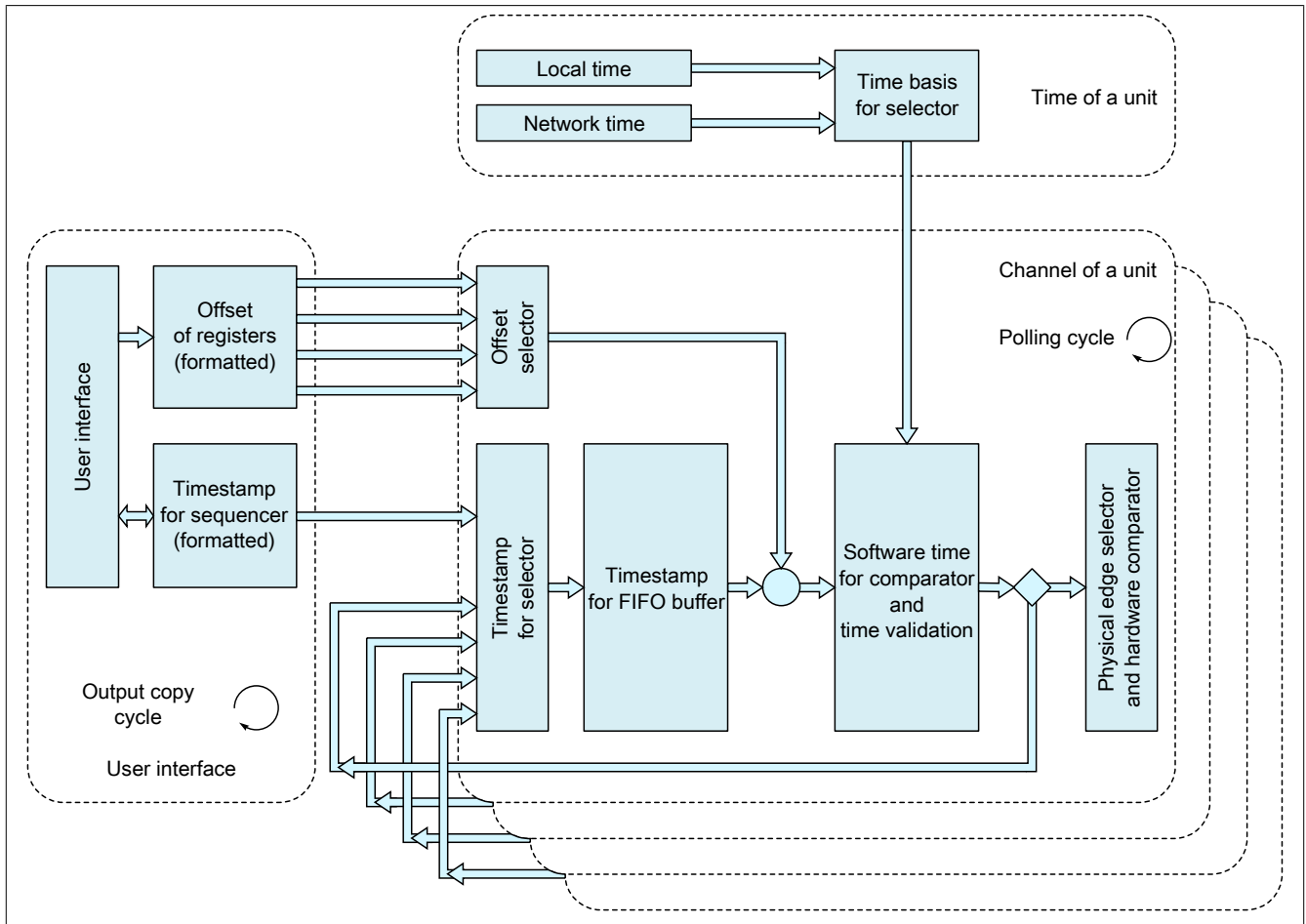
CfO_PWM_UpdateCycle

This register sets the time of data output.

| Data type | Value | Information |
|-----------|-------|---------------------------------|
| USINT | 10 | X2X cycle optimized (no jitter) |
| | 15 | Fast reaction (with jitter) |

9.26.5.9.10 Edge generator

The edge generator is based on 4 units. The units are able to generate edges independently of the X2X cycle. For each unit, up to 4 timestamps can be set per X2X cycle. The individual edges can then be referenced to this timestamp or to other edges using an offset.



9.26.5.9.10.1 Mode "DigitalCamSwitch"

"Unit 0x" in the Automation Studio I/O configuration.

Mode "DigitalCamSwitch" can additionally be selected for each unit when configuring the edge generator in Automation Studio.

In this mode, all configuration and operation takes place exclusively using the function blocks in motion library "ASMCDcs". For more information, see the corresponding ASMCDcs function block descriptions.

9.26.5.9.10.2 Preparing data for edge generation by hardware comparators

Name:

CfO_EdgeGenPollCycleEventID

"Generation cycle" in the Automation Studio I/O configuration.

To ensure edge output with μs precision, edge generation is based on internal hardware components. One such comparator is available for one rising and one falling edge respectively for each physical output channel. The data for the comparators is prepared in "EdgeGenPollCycle". Therefore, a maximum of one rising and one falling edge can be generated for each physical output channel per "EdgeGenPollCycle". If [timestamps](#) are set that cannot be processed in time due to this limitation, then an [EdgeGenWarning](#) is generated. Processing of such timestamps is made up for as quickly as possible, as long as they are within [EdgeGenUnitPickupDiff](#).

A shorter "Generation cycle" means that an enabled edge generator function has a less negative effect on the minimum X2X cycle time.

| Data type | Value | Information |
|-----------|-------|------------------------|
| USINT | 2 | System timer |
| | 3 | Prescaled system timer |

9.26.5.9.10.3 Moment when output data is applied for edge generation

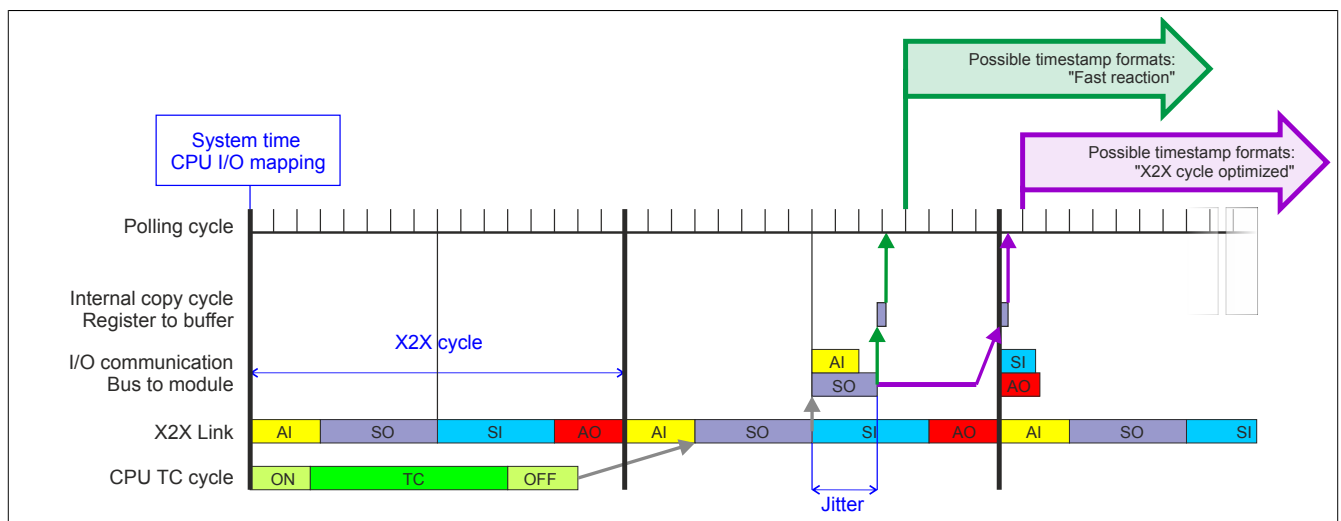
Name:

CfO_EdgeGenConsumeCycleEventID

This register determines when the output data for edge generation is applied within the X2X cycle.

| Data type | Value | Information |
|-----------|-------|--|
| USINT | 10 | "X2X cycle optimized" The data is force-applied between the periods ASYNC IN (AI) and ASYNC OUT (AO). |
| | 15 | "Fast reaction (with jitter)" The data is applied immediately after SYNC OUT (SO) processing. |

Setting "Fast reaction" results in jitter because the copy cycle of the SYNC OUT data can take different amounts of time. However, this only affects the moment at which the internal copy cycle takes place and therefore possibly also the earliest possible timestamp. [Timestamps](#) that are set outside of this jitter range are not affected by this.



9.26.5.9.10.4 Configuration of units

Name:

CfO_EdgeGenUnit01Mode to CfO_EdgeGenUnit04Mode

"Time base" in the Automation Studio I/O configuration

"Timestamp format" in the Automation Studio I/O configuration.

"Offset format" in the Automation Studio I/O configuration.

"Unit 01" to "Unit 04" in the Automation Studio I/O configuration

These registers contain the configuration bits for the respective units.

If "timestamp resolution = 1/8 μ s" is used, be aware that the timestamp data must also have a resolution of 1/8 μ s. Because the CPU system time and the X2X NetTime only have μ s resolution, the system time or the NetTime must be offset by 3 bits to the left or multiplied by 8 in the application. This value can then be used as reference for timestamps with a resolution of 1/8 μ s. It is also possible to use 1/8 μ s timestamps from input edges as a reference.

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

When using the NetTime with 1/8 μ s resolution, the synchronization jitter affects the output results (see ["Synchronization jitter" on page 2998](#)).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|-------|-------------|
| 0 | Resolution of the timestamp | 0 | 1 μ s |
| | | 1 | 1/8 μ s |
| 1 | Number of bits in the timestamp register | 0 | 16-bit |
| | | 1 | 32-bit |
| 2 | Offset resolution | 0 | 1 μ s |
| | | 1 | 1/8 μ s |
| 3 | Number of bits in the offset register | 0 | 16-bit |
| | | 1 | 32-bit |
| 4 | Time base | 0 | NetTime |
| 5 - 6 | Reserved | - | |
| 7 | Enable/disable units | 0 | Disabled |
| | | 1 | Enabled |

9.26.5.9.10.5 Number of timestamps for FIFO

Name:

CfO_EdgeGenUnit01TimestampFifoLim to CfO_EdgeGenUnit04TimestampFifoLim

These registers define how many timestamps can be transferred to the FIFO buffer of a unit. The FIFO buffer serves as a memory buffer for timestamps in the future. Timestamps must be entered in the FIFO buffer in the same order in which they should be output. This means it is not possible to set a timestamp in the future followed by an earlier timestamp. The ["EdgeGenSequenceReadback" on page 3019](#) register can be used to indicate if the defined limit has been reached.

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

| Data type | Value | Information |
|-----------|---------|-------------|
| USINT | 1 to 12 | FIFO limit |

9.26.5.9.10.6 Number of timestamps per X2X cycle

Name:

CfO_EdgeGenUnit01TimestampRegCount to CfO_EdgeGenUnit04TimestampRegCount

"Timestamp elements" in the Automation Studio I/O configuration.

This register determines how many timestamps can be transferred per X2X cycle.

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

| Data type | Value | Information |
|-----------|--------|------------------------------------|
| USINT | 1 to 4 | Number of timestamps per X2X cycle |

9.26.5.9.10.7 Pickup difference to be regained for timestamps

Name:

CfO_EdgeGenUnit01PickupDiff to CfO_EdgeGenUnit04PickupDiff

These registers determine how far in the past timestamps can be so that they can still be picked up. Timestamps in the past are processed as quickly as possible as long as they fall within the pickup difference specified in this register. [EdgeGenWarning](#) is triggered if a timestamp was not able to be processed in time and its difference had to be regained. If a timestamp could not be picked up because it was outside the pickup difference window, then both "EdgeGenWarning" and "EdgeGenError" are reported.

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

In Automation Studio, if "Timestamp format = 16-bit" this register is initialized with 65535 (0xFFFF), and if "Timestamp format = 32-bit" it is initialized with 134,217,728 (0x8000000).

| Data type | Value | Information |
|-----------|------------------|--|
| UDINT | 0 to 65535 | Difference to be regained in μ s when "Offset format = 16-bit" |
| | 0 to 134,217,728 | Difference to be regained in μ s when "Offset format = 32-bit" |

9.26.5.9.10.8 Configuration of edge properties for each unit

Name:

CfO_EdgeGenUnit01ConfigEdge0 to CfO_EdgeGenUnit04ConfigEdge0

CfO_EdgeGenUnit01ConfigEdge1 to CfO_EdgeGenUnit04ConfigEdge1

CfO_EdgeGenUnit01ConfigEdge2 to CfO_EdgeGenUnit04ConfigEdge2

CfO_EdgeGenUnit01ConfigEdge3 to CfO_EdgeGenUnit04ConfigEdge3

"Unit 01 → Edge" to "Unit 04 → Edge" in the Automation Studio I/O configuration.

"Unit 01 → Operating mode" to "Unit 04 → Operating mode" in the Automation Studio I/O configuration.

"Unit 01 → Offset" to "Unit 04 → Offset" in the Automation Studio I/O configuration.

"Unit 01 → Unit 01" to "Unit 04 → Unit 01" in the Automation Studio I/O configuration.

The property of each of the 4 edges of a unit can be configured in these registers.

Ring-shaped chain of edges

If the individual edges are chained together in a ring (e.g. edge 2 is relative to edge 1 and edge 1 is relative to edge 2), then a head must be defined for the ring using bit 11 "Ring-shaped chain" so that this type of cycle can start without a timestamp. In Automation Studio, bit 11 "Ring-shaped chain" is set for edge 1 for all units by default. If this type of ring is branched (e.g. a third edge is relative to an edge within the ring), then it is important to make sure that the internal FIFO buffer, which is available to every physical I/O edge, does not overflow. This happens if more than 12 edges are generated by the ring but should not be output until much later. If this situation occurs – a ring generates edges even though the FIFO buffer is full, then [EdgeGenError](#) is triggered.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|--------------------------|--------|--|
| 0 - 4 | Physical edge | 0 | Rising edge on channel 1 |
| | | 1 | Rising edge on channel 2 |
| | | 2 | Rising edge on channel 3 |
| | | 3 | Rising edge on channel 4 |
| | | 16 | Falling edge on channel 1 |
| | | 17 | Falling edge on channel 2 |
| | | 18 | Falling edge on channel 3 |
| | | 19 | Falling edge on channel 4 |
| 5 - 7 | Reserved | - | |
| 8 - 10 | Timestamp of FIFO source | 0 | User interface, absolute |
| | | 1 to 3 | Reserved |
| | | 4 | Edge 1, relative |
| | | 5 | Edge 2, relative |
| | | 6 | Edge 3, relative |
| | | 7 | Edge 4, relative |
| | | 11 | Ring-shaped chain Default in Automation Studio for "Edge 01 = 1", "Edge 02 = 0", "Edge 03 = 0", "Edge 04 = 0" |
| | | 1 | Enabled |
| 12 - 13 | Offset register numbers | 0 | Offset register 0 |
| | | 1 | Offset register 1 |
| | | 2 | Offset register 2 |
| | | 3 | Offset register 3 |
| 14 | Reserved | - | |
| 15 | Switching edge on/off | 0 | Disabled |
| | | 1 | Enabled |

9.26.5.9.10.9 Enabling units

Name:

EdgeGen01Enable to EdgeGen04Enable

EdgeGen01EnableReadback to EdgeGen04EnableReadback

"Unit 01" to "Unit 04" in the Automation Studio I/O configuration

The different units of the edge generator can be enabled/disabled using this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------------------|-------|-------------|
| 0 | EdgeGen01Enable | 0 | Disabled |
| | EdgeGen01EnableReadback | 1 | Enabled |
| 1 - 7 | Reserved | - | |

9.26.5.9.10.10 Sequence number for generating switching edges

Name:

EdgeGen01Sequence to EdgeGen04Sequence

If new timestamp data is to be applied to the module, then the sequence number must be increased by the number of timestamp elements that must be applied. If multiple elements are transferred within one X2X cycle, then you must make sure that the individual **timestamps** are placed in the FIFO buffer in the same order in which they occur chronologically. Data from **EdgeGenTimestamp** arrives in the FIFO buffer first; data from "EdgeGenTimestamp1" arrives last.

| Data type | Value | Information |
|-----------|-------------|--|
| SINT | -128 to 127 | Sequence number for generating switching edges |

9.26.5.9.10.11 Last sequence number applied by the module for edge generation.

Name:

EdgeGen01SequenceReadback to EdgeGen04SequenceReadback

The sequence number is read back in this register. Like register "**EdgeGenSequence**" on page 3019, this register is incremented if the specified **timestamps** can also be recorded by the module. If the module is not able to record any new timestamps (e.g. because **EdgeGenUnitTimestampFifoLim** has been reached), then this register indicates the number of the last sequence recorded by the module.

| Data type | Value | Information |
|-----------|-------------|--|
| SINT | -128 to 127 | Last sequence number accepted by the module for edge generation. |

9.26.5.9.10.12 Offset formats

Automation Studio provides 3 different parameters for setting offsets.

- **Offset format:** This parameter allows you to select the file type (16- or 32-bit) for cyclic transfer and only affects "**EdgeGenOffset**" on page 3019 registers.
Acyclic transfer of offset values with register "**CfO_EdgeGenOffset_32bit**" on page 3020 is not affected by this parameter and always remains 32 bits wide.
- **Offset 01 to Offset 04:** This parameter has 2 possible settings:
 - Initial configuration: The offset value is only written once during configuration.
 - Cyclic data: A data point is created in the Automation Studio I/O mapping and the offset value is written cyclically.
- **Offset 01 value to Offset 04 value:** The actual offset value.

Offset per unit - Transferred once during configuration

Name:

EdgeGen01Offset1 to EdgeGen04Offset1

...

EdgeGen01Offset4 to EdgeGen04Offset4

"Offset 01 value" to "Offset 04 value" in the Automation Studio I/O configuration

The 4 offsets of an edge generator unit are written in this register. Depending on the configuration in register "**Edge generator unit mode**" on page 3016, the offset values are handled in μs or $1/8 \mu\text{s}$ steps.

For information regarding how to use the register and set the offset formats in Automation Studio, see "**Offset formats**" on page 3019.

| Data type | Value | Information |
|-----------|--------------------|--|
| UINT | 0 to 65,535 | 16-bit offset |
| UDINT | 0 to 134,217,728 | Offset when "Offset format = 32-bit" and "Time base" = 1 μs |
| | 0 to 1,073,741,824 | Offset when "Offset format = 32-bit" and "Time base" = 1/8 μs |

Offset per unit - Acyclic transfer

Name:

CfO_EdgeGen01Offset_32bit1 to CfO_EdgeGen04Offset_32bit1

...

CfO_EdgeGen01Offset_32bit4 to CfO_EdgeGen04Offset_32bit4

The 4 offsets of an edge generator unit can be written acyclically using these registers. Depending on the configuration in register "Edge generator unit mode" on page 3016, the offset values are handled in μs or $1/8 \mu\text{s}$ steps.

For information regarding how to use the register and set the offset formats in Automation Studio, see "Offset formats" on page 3019.

| Data type | Value | Information |
|-----------|--------------------|--|
| UDINT | 0 to 134,217,728 | Offset when "Offset format = 32-bit" and "Time base" = $1 \mu\text{s}$ |
| | 0 to 1,073,741,824 | Offset when "Offset format = 32-bit" and "Time base" = $1/8 \mu\text{s}$ |

9.26.5.9.10.13 Timestamp registers

Name:

EdgeGen01Timestamp1 to EdgeGen04Timestamp1

...

EdgeGen01Timestamp4 to EdgeGen04Timestamp4

Registers for the timestamps to which edges pending generation are referenced. Up to 4 timestamp elements can be transferred per X2X cycle. Between 1 and 4 of these timestamp elements are placed in the FIFO, depending on how much the sequence number is increased by. If an attempt is made to set timestamps to a time that has already passed, then [EdgeGenWarning](#) is generated (see register "CfO_EdgeGenUnitPickupDiff" on page 3017).

For more information about NetTime and timestamps, see "NetTime Technology" on page 3035.

| Data type | Value |
|-----------|---------------------------------|
| INT | -32768 to 32767 |
| DINT | -2,147,483,648 to 2,147,483,647 |

9.26.5.9.11 NetTime Technology

For a description of NetTime Technology, see "NetTime Technology" on page 3035.

9.26.5.9.12 Minimum X2X cycle time

The minimum X2X cycle time is strongly dependent on the configured functions and the resulting load on the module. Setting "Fast reaction" and a very short system cycle ($<50 \mu\text{s}$) generally have a negative effect on the minimum X2X cycle time. This can result in error behavior with short X2X cycle times.

9.26.6 X20CM4800X

Data sheet version: 1.02

9.26.6.1 Order data


| Model number | Short description | Figure |
|---------------|---|---|
| | Other functions |  |
| X20CM4800X | X20 analog input module, vibration measurement, 4 IEPE analog inputs, 50 kHz sampling frequency, 24-bit converter resolution | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | Optional accessories | |
| | Sensor cable | |
| 0ACC0020.01-1 | Cable for accelerometer, length 2 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| 0ACC0050.01-1 | Cable for accelerometer, length 5 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| 0ACC0100.01-1 | Cable for accelerometer, length 10 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| 0ACC0150.01-1 | Cable for accelerometer, length 15 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| 0ACC0200.01-1 | Cable for accelerometer, length 20 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| 0ACC0500.01-1 | Cable for accelerometer, length 50 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| 0ACC1000.01-1 | Cable for accelerometer, length 100 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| | Sensors | |
| 0ACS100A.00-1 | Accelerometer, nominal sensitivity 100 mV/g, top exit | |
| 0ACS100A.90-1 | Accelerometer, nominal sensitivity 100 mV/g, side exit | |

Table 539: X20CM4800X - Order data

9.26.6.2 Module description

The module is intended for vibration measurement on machines and systems as well as for further evaluation of the data on the controller. The module has 4 input channels, whereby the selected sampling rate per input can be set between 200 Hz and 50 kHz.

Functions:

- [Configuration of inputs](#)
- [Vibration measurement](#)
- [NetTime timestamp](#)

If a measurement is started, the vibrations are measured with the set sampling and transferred with a configurable data resolution of 16, 24 or 32 bits.

A NetTime timestamp is generated when the measurement is started. This allows each recorded measured value to be assigned to a unique time. If the measurement is stopped, an additional NetTime timestamp is generated.


9.26.6.3 Technical data

| | |
|---|---|
| Model number | X20CM4800X |
| Short description | |
| I/O module | X20 4-channel analog input module for vibration measurement of condition monitoring tasks |
| General information | |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Nominal voltage | 24 VDC ±20% |
| B&R ID code | 0xF1C5 |
| Status indicators | Run, error, vibration inputs 1 to 4 |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.5 W |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| Analog inputs | |
| Quantity | 4 |
| Input type | IEPE sensor: Acceleration |
| Digital converter resolution | 24-bit |
| Open-circuit detection | |
| Per channel | Less than 8 V or greater than 14 V for more than 4 s |
| Permissible input signal | ±10 VAC |
| Conversion procedure | Sigma-delta |
| Type | Vibration input |
| Sampling frequency | Configurable from 200 Hz to 50 kHz |
| Input high pass cutoff frequency | 34 mHz |
| Input low pass cutoff frequency | 23 kHz |
| Sensor power supply | IEPE, 5 mA constant current source (4.9 - 5.5 mA), can be switched off for each channel |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 50°C |
| Vertical mounting orientation | -25 to 45°C |
| Derating | See section "Derating". |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x bus module X20BM11 separately. |
| Pitch | 12.5 ^{+0.2} mm |

Table 540: X20CM4800X - Technical data

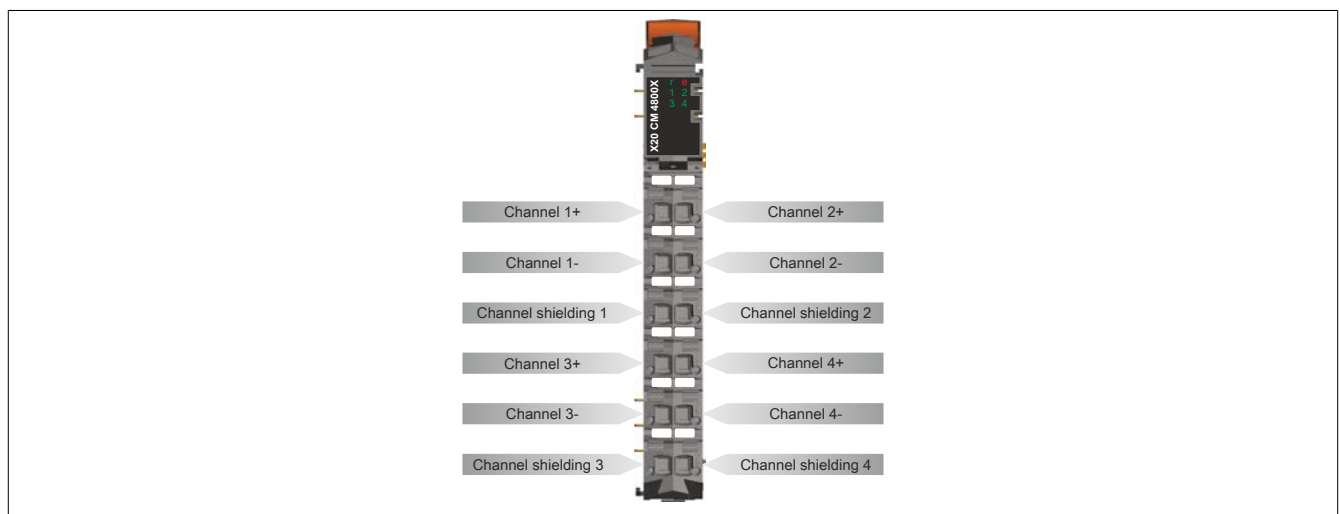
9.26.6.4 LED status indicators

For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|-------|----------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | Mode RESET |
| | | | Double flash | Mode BOOT (during firmware update) ¹⁾ |
| | | | Blinking | Mode PREOPERATIONAL |
| | | | On | Mode RUN |
| | e | Red | Off | Module not supplied with power or everything OK |
| | | | On | Warning, error or reset state |
| | | | Single flash | Open circuit on the active channel |
| | | | Double flash | Buffer overflow |
| | | | On | Invalid firmware |
| | e + r | Red | On | Invalid firmware |
| | | Green | Single flash | |
| | 1 - 4 | Green | Off | Channel inactive |
| On | | | Channel active | |

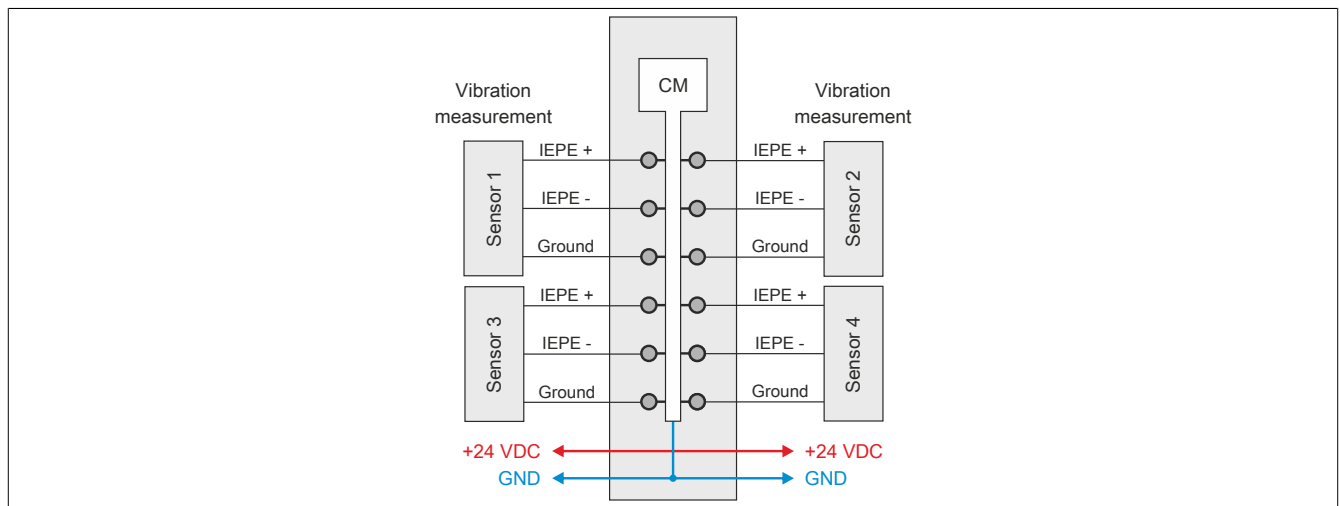
1) Depending on the configuration, a firmware update can take up to several minutes.

9.26.6.5 Pinout

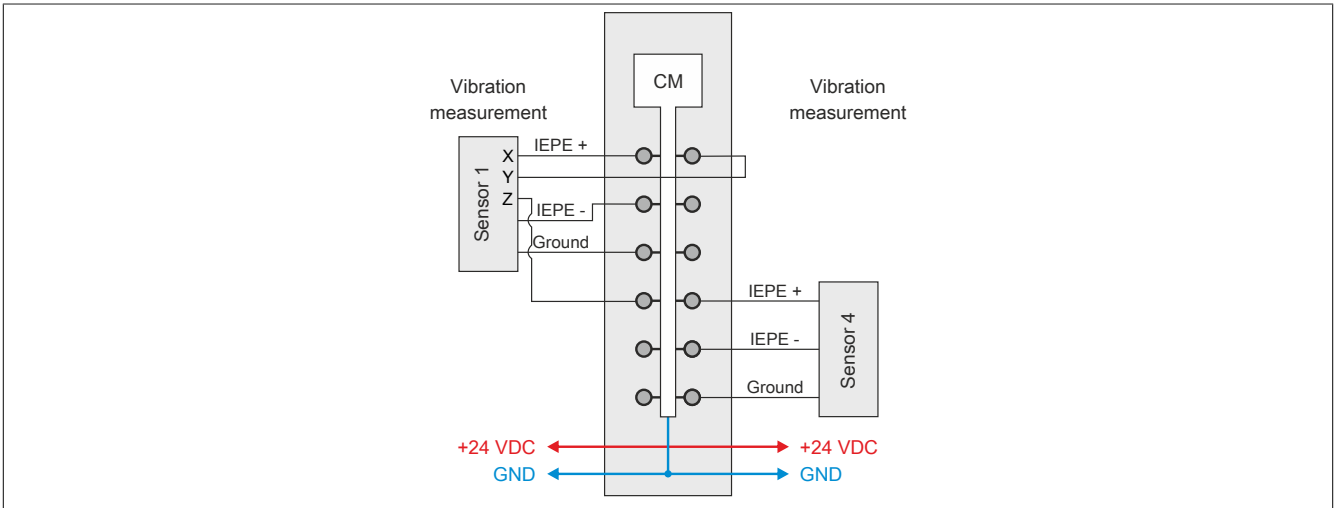


9.26.6.6 Connection example

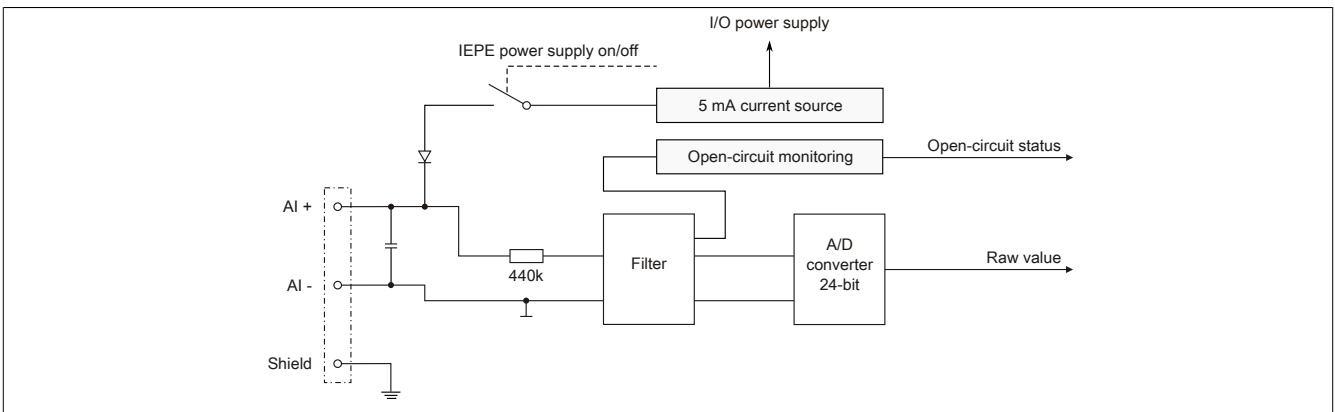
Connecting 1-axis sensors



Connecting 1-axis and 3-axis sensors

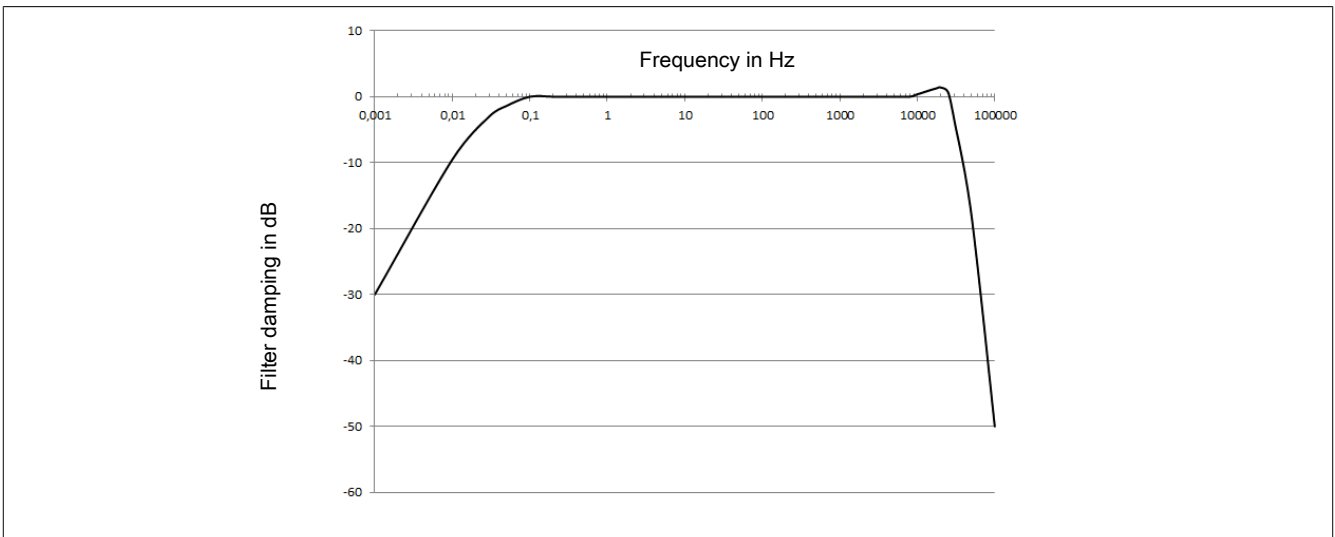


9.26.6.7 Input circuit diagram



9.26.6.8 Gain curve

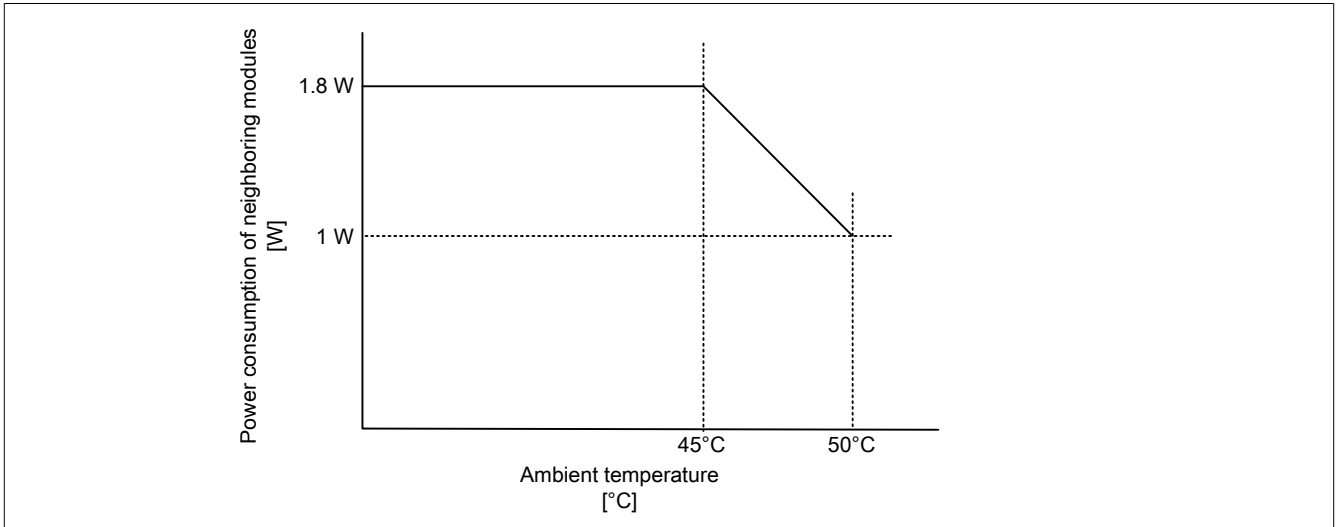
The following diagram shows a typical gain curve for the module.



9.26.6.9 Derating

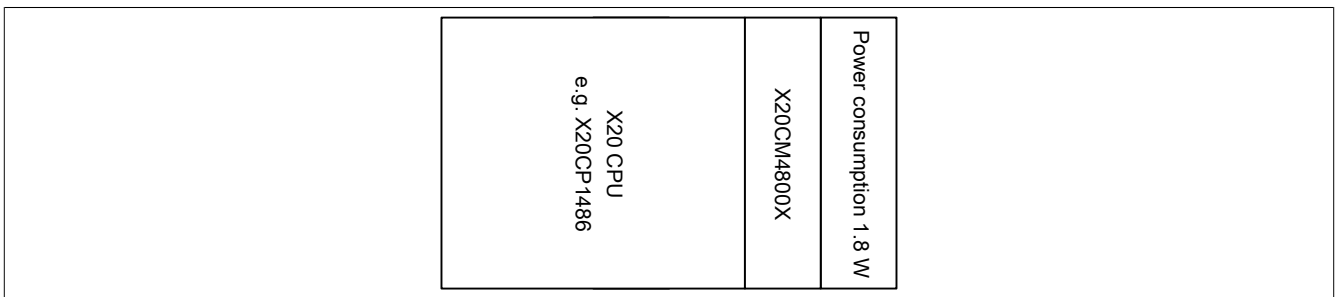
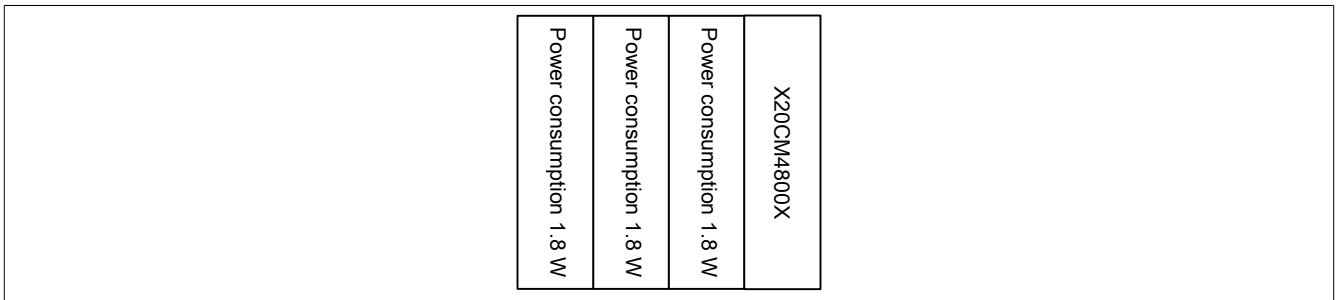
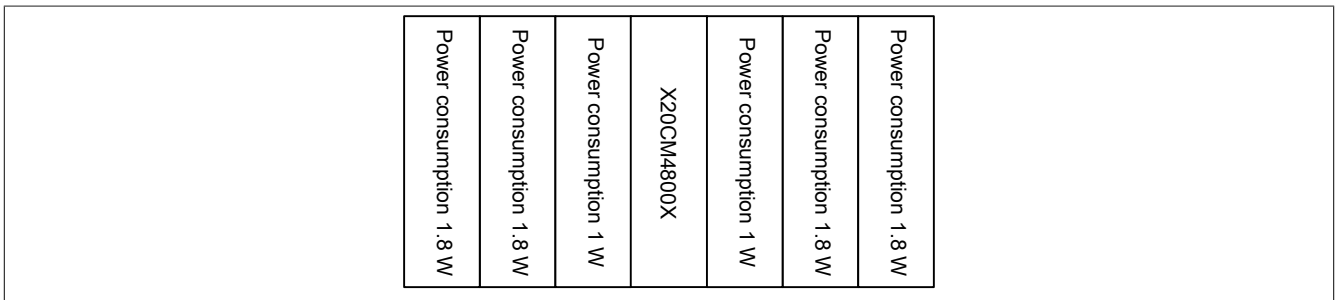
Horizontal mounting orientation

For ambient temperatures greater than 45°C, power derating must be observed for the X20CM4800X:

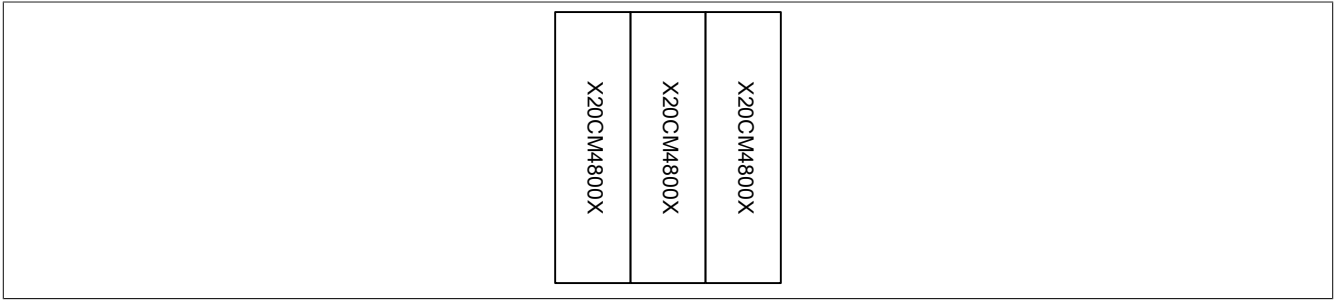


If the X20CM4800X is to be operated at an ambient temperature of up to 50°C, the neighboring modules are not permitted to consume more than 1 W of power.

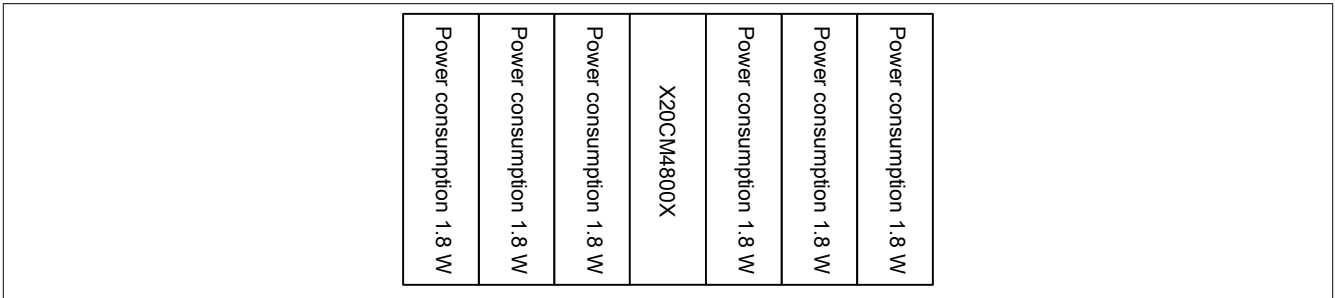
Example of an ambient temperature of up to 50°C



Multiple X20CM4800X modules can be used side by side.

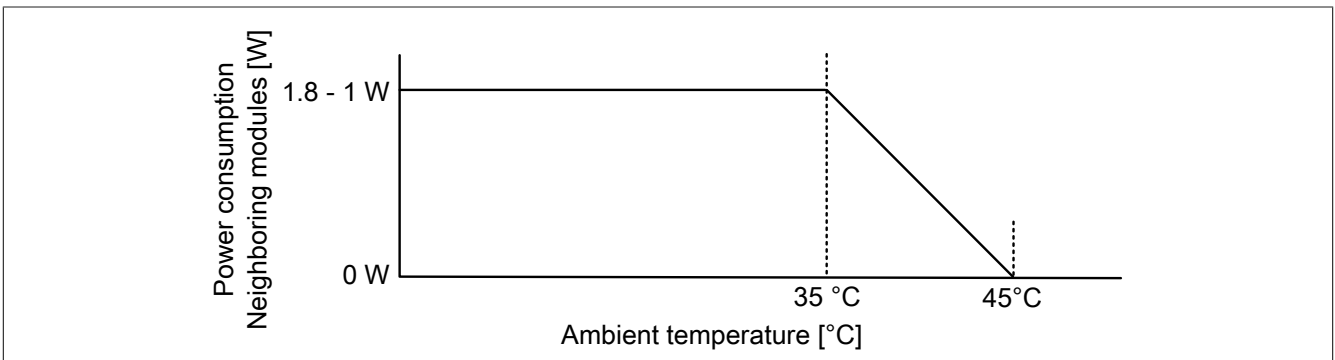


Example of an ambient temperature of up to 45°C



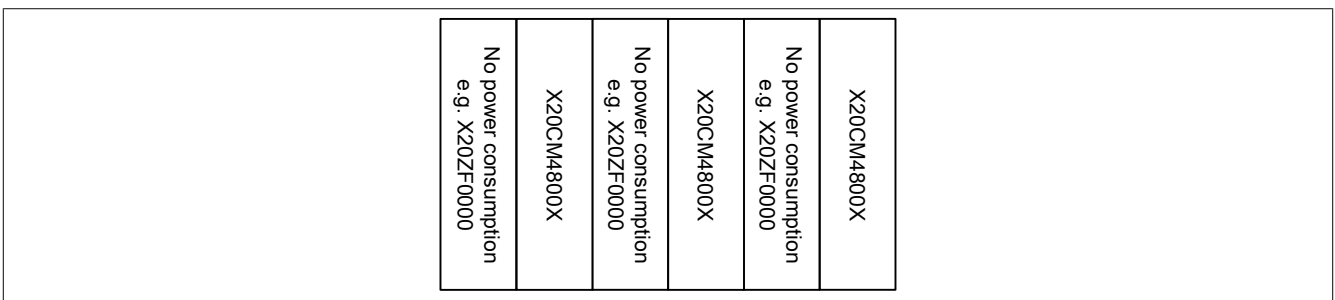
Vertical mounting orientation

For ambient temperatures greater than 35°C, power derating must be observed for the X20CM4800X:



If the X20CM4800X is to be operated at an ambient temperature of up to 45°C, the neighboring modules are not permitted to consume any power.

Example of an ambient temperature of up to 45°C



Example of an ambient temperature of up to 35°C

| |
|-------------------------|
| Power consumption 1.8 W |
| Power consumption 1.8 W |
| Power consumption 1.8 W |
| X20CM4800X |
| Power consumption 1.8 W |
| Power consumption 1.8 W |
| Power consumption 1.8 W |

| |
|-------------------------|
| X20CM4800X |
| Power consumption 1.8 W |
| Power consumption 1.8 W |
| Power consumption 1.8 W |

| |
|---------------------------|
| Power consumption 1.8 W |
| X20CM4800X |
| X20 CPU e.g. X20CP1486 |

Multiple X20CM4800X modules can be operated side by side up to an ambient temperature of 30°C.

| |
|------------|
| X20CM4800X |
| X20CM4800X |
| X20CM4800X |

9.26.6.10 Function description

9.26.6.10.1 Configuration of inputs

There is only a limited number of bytes available for transferring raw data to the X2X Link network that are distributed among all active channels. In order to make more bytes available on the channels used, unused channels can be switched off.

In addition, the IEPE sensor power supply can be enabled separately for each channel. If a sensor is connected to multiple channels, the power supply must be enabled for one channel only.

Information:

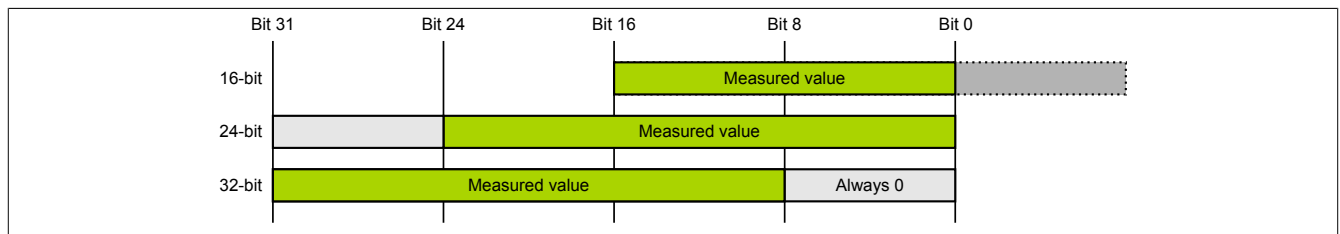
Registers are described in section "[Channel configuration](#)" on page 3032.

9.26.6.10.1.1 Data resolution

The data is scaled by the module according to the set data resolution:

| Mode | Data format | Maximum value +10 V | Minimum value -10 V | Scaling |
|--------|-------------|---------------------------|---------------------------|---|
| 16-bit | INT | 32767 (0x7FFF) | -32767 (0x8000) | Shifted 8 bits to the right |
| 24-bit | DINT | 8388607 (0x7FFFFFF) | -8388608 (0x8000000) | Internal converter resolution of the module ¹⁾ |
| 32-bit | DINT | 2147483392 (0x7FFFFFFF00) | -2147483648 (0x800000000) | Shifted 8 bits to the left. Bits 0 to 7 are always 0. |

1) The 3 bytes must be transferred from the application in a DINT. For negative values, bits 25 to 31 must be set to 1.



9.26.6.10.2 Vibration measurement

Up to 4 vibration sensors can be connected to the module. The raw data of the sensors is recorded with the set sampling rate and resolution.

However, processing and evaluation of the transferred data must be carried out in the application. For a description of how to convert raw data into a vibration value, see "[Converting raw data to \[mg\]](#)" on page 3029.

Information:

There is no preprocessing of the data within the module.

9.26.6.10.2.1 Converting raw data to [mg]

The following formulas can be used to convert the raw value into a vibration value [mg]:

$$\text{Sensor resolution} = 0.0001 \cdot \frac{\text{V}}{\text{mg}}$$

$$\text{Vibration value [mg]} = \text{Raw value} \cdot \left(\frac{\text{MaximumResolution}_{10\text{V_AnalogIn}}}{\text{MaximumValue}_{10\text{V_DigitalIn}}} \right) \cdot \frac{1}{\text{Sensor resolution}}$$

Information:

The maximum resolution always depends on the sensor used. The module operates in the range of ± 10 V. For a 100 mV/g sensor, this corresponds to a maximum value of ± 100 g. With a 50 mV/g sensor, the maximum value is ± 200 g.

Example

A 100 mV/g sensor is used; the module provides the value 4608 as a raw value and the data resolution is configured to 24 bits. This results in the following values for the calculation:

- Raw value = 4608
- MaximumValue_10V_AnalogIn = 10 V (module value, cannot be changed)
- MaximumValue_10V_DigitalIn with 24 bits = 8388607 (see "Data resolution" on page 3028)
- Sensor resolution = 100 mV/g = 0.1 V/g = 0.0001 V/mg

$$\text{Vibration value [mg]} = 4608 \cdot \left(\frac{10 \text{ V}}{8388607} \right) \cdot \frac{1}{0.0001 \text{ V/mg}} = 54.93 \text{ mg}$$

9.26.6.10.2.2 Flatstream

The data interface for the raw data is based on Flatstream communication. Operation takes place using library "AsFitGen".

Information:

Each channel has its own Flatstream.

For information about library "AsFitGen", see Automation Help.

The required bytes for transmitting the raw data at the Flatstream depend on the set sampling rate, the set data resolution and the bus cycle time used.

Information:

If the raw data is not transferred to the controller fast enough, it is buffered in the module per channel. As soon as the buffer is full, error message **BufferOverflow** occurs.

Calculation example for required number of bytes

The following settings are made for a measurement evaluation:

- Bus cycle time: 2 ms
- Sampling rate: 2 kHz (one value every 500 μ s)
- Data resolution: 16 bits (2 bytes)

In the bus cycle time of 2 ms, this results in 4 values of 2 bytes each – a total of 8 bytes. The Flatstream data interface must be configured in accordance with this calculation.

If the bus cycle time is reduced from 2 ms to 1 ms, the number of bytes required for the raw data is reduced by half, i.e. 4 bytes. This means that other channels have more bytes available.

Setting the MTU size

The MTU size to be set for the Flatstream is equal to the calculated data bytes + 1 control byte. Therefore, the input MTU size must be configured to at least $8 + 1 = 9$ bytes, or in the second case, to $4 + 1 = 5$ bytes.

Since this is only the ideal value, reserve bytes must still be planned to compensate for any timing tolerances or communication errors. Otherwise, it could happen that not all data can be transferred in time, causing a buffer overflow at some point.

9.26.6.10.3 NetTime

If a measurement is started for a channel, a timestamp is automatically determined for the first raw value. The configured sampling rate can then be used to establish a unique time reference for each raw value.

In addition, a timestamp is automatically determined again even after the measurement has been completed.

Information:

The timestamps for the other raw values must be determined by the application. The module only provides the start or end timestamp.

Information:

Registers are described in section ["NetTime" on page 3034](#).

9.26.6.11 Register description

9.26.6.11.1 Function model 1 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 770 | CfO_ChannelConfig01 CfO_ChannelConfig01_rb | UINT | | • | | • |
| 774 | CfO_ChannelConfig02 CfO_ChannelConfig02_rb | UINT | | • | | • |
| 778 | CfO_ChannelConfig03 CfO_ChannelConfig03_rb | UINT | | • | | • |
| 782 | CfO_ChannelConfig04 CfO_ChannelConfig04_rb | UINT | | • | | • |
| Communication | | | | | | |
| 1 | Starting/stopping measurements and buffer overflow | USINT | | | • | |
| | Measurement01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | Measurement04 | Bit 3 | | | | |
| | BufferOverflowAck01 | Bit 4 | | | | |
| | ... | ... | | | | |
| 2 | BufferOverflowAck04 | Bit 7 | | | | |
| | Status of the module | UINT | • | | | |
| | MeasurementState01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | MeasurementState04 | Bit 3 | | | | |
| | BufferOverflow01 | Bit 4 | | | | |
| | ... | ... | | | | |
| | BufferOverflow04 | Bit 7 | | | | |
| NetTime | | | | | | |
| 788 | Nettime_StartMeasCh01 | DINT | | • | | |
| 796 | Nettime_StartMeasCh02 | DINT | | • | | |
| 804 | Nettime_StartMeasCh03 | DINT | | • | | |
| 812 | Nettime_StartMeasCh04 | DINT | | • | | |
| 820 | Nettime_StopMeasCh01 | DINT | | • | | |
| 828 | Nettime_StopMeasCh02 | DINT | | • | | |
| 836 | Nettime_StopMeasCh03 | DINT | | • | | |
| 844 | Nettime_StopMeasCh04 | DINT | | • | | |
| Flatstream | | | | | | |
| Channel 1 | | | | | | |
| 1281 | Ch1_CfO_OutputMTU | USINT | | | | • |
| 1283 | Ch1_CfO_InputMTU | USINT | | | | • |
| 1285 | Ch1_CfO_FlatstreamMode | USINT | | | | • |
| 1287 | Ch1_CfO_Forward | USINT | | | | • |
| 1290 | Ch1_CfO_ForwardDelay | UINT | | | | • |
| 1536 | Ch1_CfO_InputSequence | USINT | • | | | |
| 1536 + Index | Ch1_CfO_RxByteN (index N = 1 to 25) | USINT | • | | | |
| 1536 | Ch1_CfO_OutputSequence | USINT | | | • | |
| 1536 + Index | Ch1_CfO_TxByteN (index N = 1 to 3) | USINT | | | • | |
| Channel 2 | | | | | | |
| 1297 | Ch2_CfO_OutputMTU | USINT | | | | • |
| 1299 | Ch2_CfO_InputMTU | USINT | | | | • |
| 1301 | Ch2_CfO_FlatstreamMode | USINT | | | | • |
| 1303 | Ch2_CfO_Forward | USINT | | | | • |
| 1306 | Ch2_CfO_ForwardDelay | UINT | | | | • |
| 1792 | Ch2_CfO_InputSequence | USINT | • | | | |
| 1792 + Index | Ch2_CfO_RxByteN (index N = 1 to 25) | USINT | • | | | |
| 1792 | Ch2_CfO_OutputSequence | USINT | | | • | |
| 1792 + Index | Ch2_CfO_TxByteN (index N = 1 to 3) | USINT | | | • | |
| Channel 3 | | | | | | |
| 1313 | Ch3_CfO_OutputMTU | USINT | | | | • |
| 1315 | Ch3_CfO_InputMTU | USINT | | | | • |
| 1317 | Ch3_CfO_FlatstreamMode | USINT | | | | • |
| 1319 | Ch3_CfO_Forward | USINT | | | | • |
| 1322 | Ch3_CfO_ForwardDelay | UINT | | | | • |
| 2048 | Ch3_CfO_InputSequence | USINT | • | | | |
| 2048 + Index | Ch3_CfO_RxByteN (index N = 1 to 25) | USINT | • | | | |
| 2048 | Ch3_CfO_OutputSequence | USINT | | | • | |
| 2048 + Index | Ch3_CfO_TxByteN (index N = 1 to 3) | USINT | | | • | |

| Register | Name | Data type | Read | | Write | |
|------------------|-------------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Channel 4 | | | | | | |
| 1329 | Ch4_CfO_OutputMTU | USINT | | | | • |
| 1331 | Ch4_CfO_InputMTU | USINT | | | | • |
| 1333 | Ch4_CfO_FlatstreamMode | USINT | | | | • |
| 1335 | Ch4_CfO_Forward | USINT | | | | • |
| 1338 | Ch4_CfO_ForwardDelay | UINT | | | | • |
| 2304 | Ch4_CfO_InputSequence | USINT | • | | | |
| 2304 + Index | Ch4_CfO_RxByteN (index N = 1 to 25) | USINT | • | | | |
| 2304 | Ch4_CfO_OutputSequence | USINT | | | • | |
| 2304 + Index | Ch4_CfO_TxByteN (index N = 1 to 3) | USINT | | | • | |

9.26.6.11.2 Configuration

9.26.6.11.2.1 Channel configuration

Name:

CfO_ChannelConfig01 to CfO_ChannelConfig04

CfO_ChannelConfig01_rb CfO_ChannelConfig04_rb

These registers can be used to configure the respective channels.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|-------------------------------|-------|------------------------------|
| 0 | Enables/Disables channel | 0 | Channel disabled |
| | | 1 | Channel enabled |
| 1 | Sensor power supply | 0 | Sensor power supply disabled |
| | | 1 | Sensor power supply enabled |
| 2 - 3 | Data resolution ¹⁾ | 0 | 32-bit |
| | | 1 | 24-bit |
| | | 2 | 16-bit |
| 4 - 7 | Sampling rate ²⁾ | 0 | 50000 Hz |
| | | 1 | 25000 Hz |
| | | 2 | 10000 Hz |
| | | 3 | 5000 Hz |
| | | 4 | 2500 Hz |
| | | 5 | 2000 Hz |
| | | 6 | 1000 Hz |
| | | 7 | 500 Hz |
| 8 - 15 | Reserved | 8 | 200 Hz |
| | | 0 | |

1) The maximum or minimum value of the respective resolution corresponds to ± 10 VAC.

2) The sampling rate of an analog signal with respect to 1 second. Specified in [Hz].

Examples:

- Sampling an analog signal once per second corresponds to a sampling rate of 1 Hz.
- Sampling an analog signal once per millisecond corresponds to a sampling rate of 1 kHz.

9.26.6.11.3 Communication

9.26.6.11.3.1 Starting/stopping measurements and buffer overflow

Name:

Measurement01 to Measurement04

BufferOverflowAck01 to BufferOverflowAck04

In this register, the measurements can be started or stopped. In addition, a potential buffer overflow can be acknowledged.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|---------------------|-------|--|
| 0 | Measurement01 | 0 | Stop measurement of channel 1 |
| | | 1 | Start measurement of channel 1 |
| ... | | ... | |
| 3 | Measurement04 | 0 | Stop measurement of channel 4 |
| | | 1 | Start measurement of channel 4 |
| 4 | BufferOverflowAck01 | 0 | Do not acknowledge channel 1 buffer overflow |
| | | 1 | Acknowledge channel 1 buffer overflow |
| ... | | ... | |
| 7 | BufferOverflowAck04 | 0 | Do not acknowledge channel 4 buffer overflow |
| | | 1 | Acknowledge channel 4 buffer overflow |

9.26.6.11.3.2 Status of the module

Name:

MeasurementState01 to MeasurementState04

BufferOverflow01 to BufferOverflow04

BrokenWire01 to BrokenWire04

This register specifies the module status.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|--------------------|-------|----------------------------------|
| 0 | MeasurementState01 | 0 | Measurement of channel 1 stopped |
| | | 1 | Measurement of channel 1 running |
| ... | | ... | |
| 3 | MeasurementState04 | 0 | Measurement of channel 4 stopped |
| | | 1 | Measurement of channel 4 running |
| 4 | BufferOverflow01 | 0 | No buffer overflow on channel 1 |
| | | 1 | Buffer overflow on channel 1 |
| ... | | ... | |
| 7 | BufferOverflow04 | 0 | No buffer overflow on channel 4 |
| | | 1 | Buffer overflow on channel 4 |
| 8 | BrokenWire01 | 0 | No error on channel 1 |
| | | 1 | Open circuit - Channel 1 |
| ... | | ... | |
| 11 | BrokenWire04 | 0 | No error on channel 4 |
| | | 1 | Open circuit - Channel 4 |
| 12 - 15 | Reserved | - | |

BufferOverflow

Each channel is equipped with an internal buffer of 50 kB. Depending on the set sampling rate, data resolution and MTU size, a buffer overflow occurs at the earliest after approx. 250 ms if the data is not transferred via Flatstream. The overflow must be acknowledged by the application using register [BufferOverflowAck0x](#).

9.26.6.11.4 NetTime**9.26.6.11.4.1 Time of first valid scan**

Name:

Nettime_StartMeasCh01 to Nettime_StartMeasCh04

The register writes the timestamp of the first valid sample after the measurements are started.

| Data type | Values | Information |
|-----------|------------------------------------|----------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | Timestamp in μ s |

9.26.6.11.4.2 Time of last valid scan

Name:

Nettime_StopMeasCh01 to Nettime_StopMeasCh04

The register writes the timestamp of the last valid sample. The timestamp of the last valid sample of a measurement is available after measurement has ended.

| Data type | Values | Information |
|-----------|------------------------------------|----------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | Timestamp in μ s |

9.26.6.11.4.3 NetTime Technology

NetTime refers to the ability to precisely synchronize and transfer system times between individual components of the controller or network (CPU, I/O modules, X2X Link, POWERLINK, etc.).

This allows the moment that events occur to be determined system-wide with microsecond precision. Upcoming events can also be executed precisely at a specified moment.



Time information

Various time information is available in the controller or on the network:

- System time (on the PLC, Automation PC, etc.)
- X2X Link time (for each X2X Link network)
- POWERLINK time (for each POWERLINK network)
- Time data points of I/O modules

The NetTime is based on 32-bit counters, which are increased with microsecond resolution. The sign of the time information changes after 35 min, 47 s, 483 ms and 648 μ s; an overflow occurs after 71 min, 34 s, 967 ms and 296 μ s.

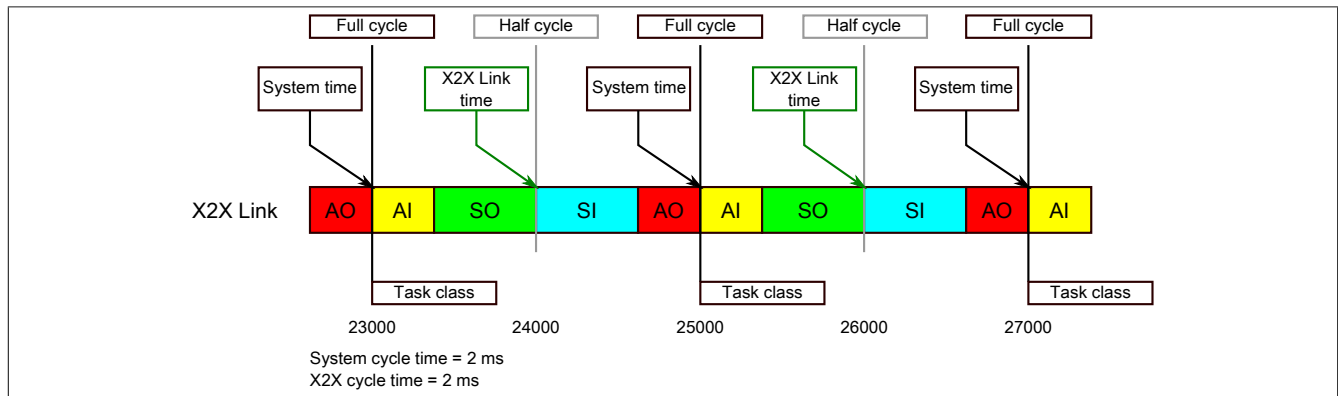
The initialization of the times is based on the system time during the startup of the X2X Link, the I/O modules or the POWERLINK interface.

Current time information in the application can also be determined via library AsIOTime.

PLC/Controller data points

The NetTime I/O data points of the PLC or the controller are latched to each system clock and made available.

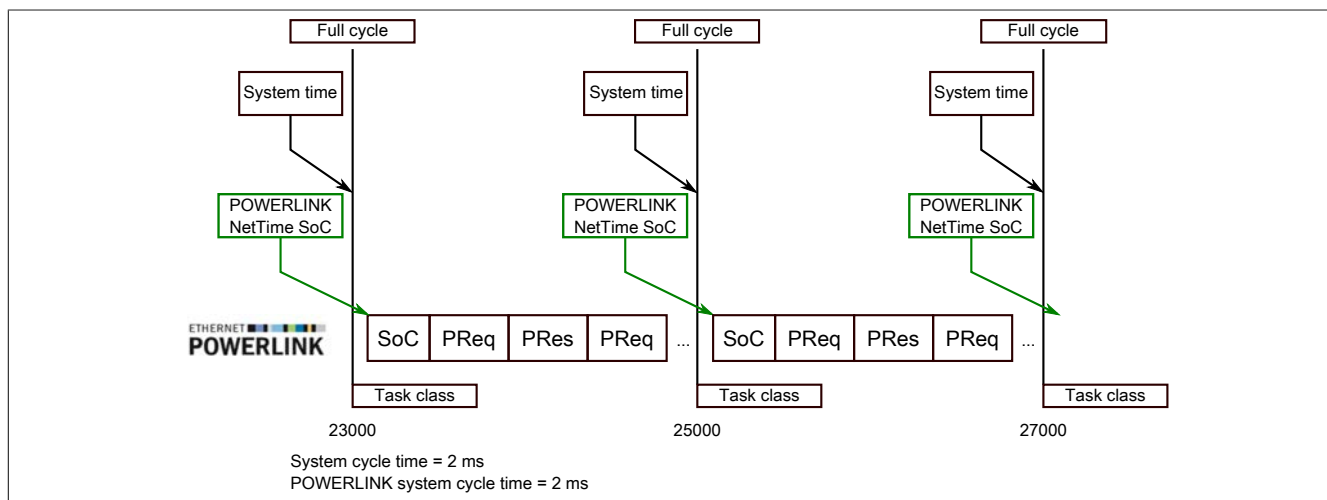
X2X Link reference moment



The reference moment on the X2X Link network is always calculated at the half cycle of the X2X Link cycle. This results in a difference between the system time and the X2X Link reference moment when the reference time is read out.

In the example above, this results in a difference of 1 ms, i.e. if the system time and X2X Link reference moment are compared at time 25000 in the task, then the system time returns the value 25000 and the X2X Link reference moment returns the value 24000.

POWERLINK reference moment

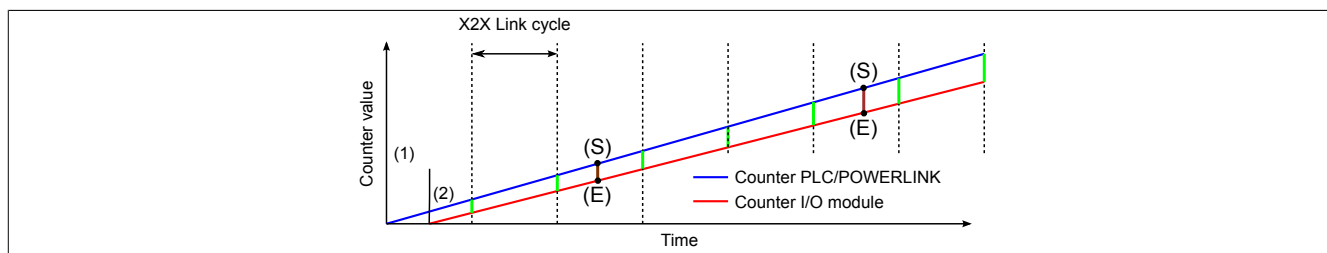


The reference moment on the POWERLINK network is always calculated at the start of cycle (SoC) of the POWERLINK network. The SoC starts 20 μ s after the system tick. This results in the following difference between the system time and the POWERLINK reference time:

POWERLINK reference time = System time - POWERLINK cycle time + 20 μ s.

In the example above, this means a difference of 1980 μ s, i.e. if the system time and POWERLINK reference moment are compared at time 25000 in the task, then the system time returns the value 25000 and the POWERLINK reference moment returns the value 23020.

Synchronization of system time/POWERLINK time and I/O module



At startup, the internal counters for the PLC/POWERLINK (1) and the I/O module (2) start at different times and increase the values with microsecond resolution.

At the beginning of each X2X Link cycle, the PLC or the POWERLINK network sends time information to the I/O module. The I/O module compares this time information with the module's internal time and forms a difference (green line) between the two times and stores it.

When a NetTime event (E) occurs, the internal module time is read out and corrected with the stored difference value (brown line). This means that the exact system moment (S) of an event can always be determined, even if the counters are not absolutely synchronous.

Note

The deviation from the clock signal is strongly exaggerated in the picture as a red line.

Timestamp functions

NetTime-capable modules provide various timestamp functions depending on the scope of functions. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

For details, see the respective module documentation.

Time-based inputs

NetTime Technology can be used to determine the exact moment of a rising edge at an input. The rising and falling edges can also be detected and the duration between 2 events can be determined.

Information:

The determined moment always lies in the past.

Time-based outputs

NetTime Technology can be used to specify the exact moment of a rising edge on an output. The rising and falling edges can also be specified and a pulse pattern generated from them.

Information:

The specified time must always be in the future, and the set X2X Link cycle time must be taken into account for the definition of the moment.

Time-based measurements

NetTime Technology can be used to determine the exact moment of a measurement that has taken place. Both the starting and end moment of the measurement can be transmitted.

9.26.6.11.5 Flatstream communication

For a description of Flatstream communication, see ["Flatstream communication" on page 3802](#)

9.26.6.11.6 Required cycle time

The cycle time depends on the sampling rate, data resolution and MTU size. It must be selected such that no buffer overflow occurs when the measured values are transmitted via the Flatstream.

9.26.7 X20(c)CM4810

Data sheet version: 2.20

9.26.7.1 General information

This compact module provides a system for measuring and analyzing vibrations for use in applications such as condition monitoring for machinery and equipment.

The measurement unit consists of 4 vibration inputs with 24-bit converter resolution and a sampling frequency of 51.562 kHz. Each of the inputs has a separately activated constant current source to supply IEPE sensors.

Signal conditioning algorithms integrated in the module include configurable high and low-pass filters, an envelope curve generator and a Fourier transform, among many others.

Various parameters and configurable frequency bands are available to ensure seamless signal evaluation. The module performs calculations internally to minimize the load on the bus and CPU.

Whether used for traditional condition monitoring or as a means of process optimization, the maximum evaluable frequency of 10 kHz and maximum frequency resolution of under 63 mHz make it suitable for almost any application. If desired, it can also be used as a standard input module.

The ability to upload all values in the time and frequency domain also allow measurements to be evaluated externally or archived.

Information:

The X20CM4810 module is supported starting with Automation Studio 3.0.90.x and Automation Runtime versions ≥ J3.09, J4.01 and O4.02.

- 4-channel vibration measurement and analysis module
- 24-bit resolution at 51.562 kHz
- IEPE supply
- Internal calculation of an extensive range of condition parameters
- Data buffer upload

9.26.7.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.26.7.3 Order data


| Model number | Short description | Figure |
|---------------|--|---|
| | Other functions |  |
| X20CM4810 | X20 analog input module, for vibration measurement and analysis of condition monitoring tasks, 4 IEPE analog inputs, 51.5625 kHz sampling frequency, 24-bit converter resolution | |
| X20cCM4810 | X20 analog input module, coated, for vibration measurement and analysis of condition monitoring tasks, 4 IEPE analog inputs, 51.5625 kHz sampling frequency, 24-bit converter resolution | |
| | Required accessories | |
| | Bus modules | |
| X20BM31 | X20 bus module for double-width modules, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM31 | X20 bus module, coated, for double-width modules, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | Optional accessories | |
| | Sensor cable | |
| 0ACC0020.01-1 | Cable for accelerometer, length 2 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| 0ACC0050.01-1 | Cable for accelerometer, length 5 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| 0ACC0100.01-1 | Cable for accelerometer, length 10 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| 0ACC0150.01-1 | Cable for accelerometer, length 15 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| 0ACC0200.01-1 | Cable for accelerometer, length 20 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| 0ACC0500.01-1 | Cable for accelerometer, length 50 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| 0ACC1000.01-1 | Cable for accelerometer, length 100 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| | Sensors | |
| 0ACS100A.00-1 | Accelerometer, nominal sensitivity 100 mV/g, top exit | |
| 0ACS100A.90-1 | Accelerometer, nominal sensitivity 100 mV/g, side exit | |

Table 541: X20CM4810, X20cCM4810 - Order data

9.26.7.4 Technical data

| Model number | X20CM4810 | X20cCM4810 |
|---|---|------------|
| Short description | X20 4-channel analog input module for vibration measurement and analysis of condition monitoring tasks | |
| I/O module | X20 4-channel analog input module for vibration measurement and analysis of condition monitoring tasks | |
| General information | | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Nominal voltage | 24 VDC ±20% | |
| B&R ID code | 0xC8F9 | 0xE7F0 |
| Status indicators | Run, error, vibration inputs 1 to 4 | |
| Diagnosics | | |
| Module run/error | Yes, using LED status indicator and software | |
| Power consumption | | |
| Bus | 0.01 W | |
| Internal I/O | 2.5 W | |
| Certifications | | |
| CE | Yes | |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| Analog inputs | | |
| Quantity | 4 | |
| Input type | IEPE sensor: Acceleration | |

Table 542: X20CM4810, X20cCM4810 - Technical data


| Model number | X20CM4810 | X20cCM4810 |
|---|---|---|
| Digital converter resolution | 24-bit | |
| Open-circuit detection | Yes | |
| Per channel | Yes | |
| At minimum supply voltage ¹⁾ | Starting at 17 V (or greater) for more than 1 ms | |
| At nominal supply voltage ²⁾ | Starting at 21.3 V (or greater) for more than 1 ms | |
| At maximum supply voltage ³⁾ | Starting at 25.5 V (or greater) for more than 1 ms | |
| Permissible input signal | ±10 VAC | |
| Conversion procedure | Sigma-delta | |
| Type | Vibration input | |
| Sampling frequency | 51.5625 kHz | |
| Input high pass cutoff frequency | 34 mHz | |
| Input low pass cutoff frequency | 19.75 kHz | |
| Downsampling | 200 Hz, 500 Hz, 1 kHz, 2 kHz, 5 kHz, 10 kHz (configurable) | |
| Frequency resolution of spectra | 0.0629 Hz, 0.1574 Hz, 0.3147 Hz, 0.6294 Hz, 1.5736 Hz, 3.1471 Hz | |
| Sensor power supply | IEPE, 5 mA constant current source (4.9 - 5.5 mA), can be switched off for each channel | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitation | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 50°C | |
| Vertical mounting orientation | -25 to 45°C | |
| Derating | See section "Derating". | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x bus module X20BM31 separately. | Order 1x terminal block X20TB12 separately. Order 1x bus module X20cBM31 separately. |
| Pitch | 25 ^{+0.2} mm | |

Table 542: X20CM4810, X20cCM4810 - Technical data

- 1) Input voltage: 19.2 V
2) Input voltage: 24 V
3) Input voltage: 28.8 V

9.26.7.5 LED status indicators

For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|-------|-------------------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Warning, error or reset status |
| | e + r | | Red on and green single flash | Invalid firmware |
| | 1 - 4 | Green | On | Status of the respective acceleration sensor (no open circuit) |

- 1) Depending on the configuration, a [firmware update](#) can take up to several minutes.

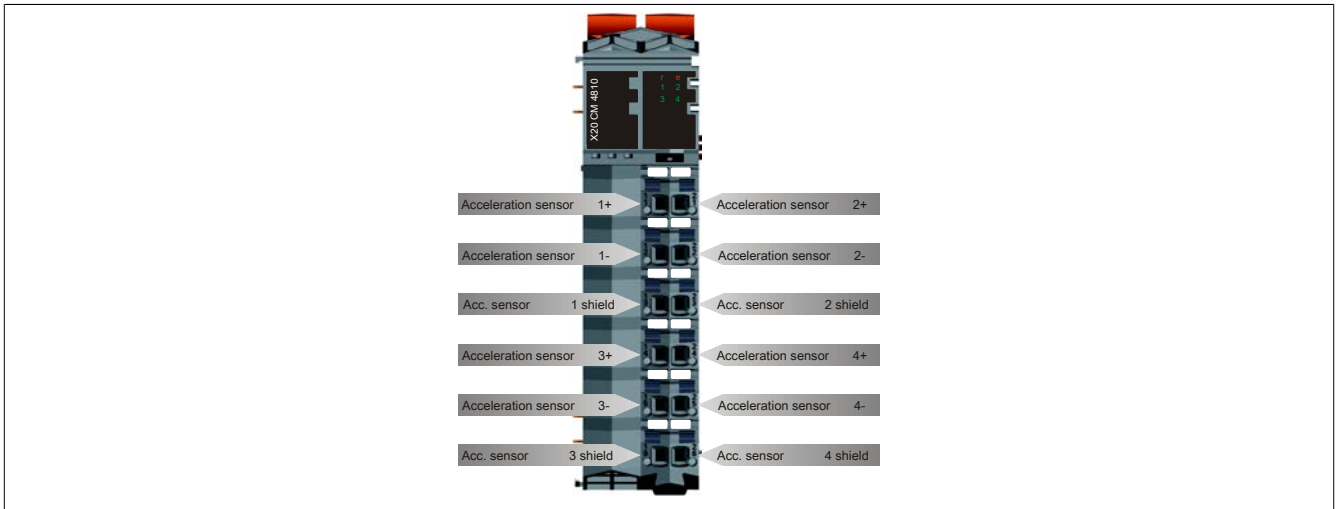
9.26.7.6 Firmware update time

Due to the large size of the firmware, the firmware update takes some time.

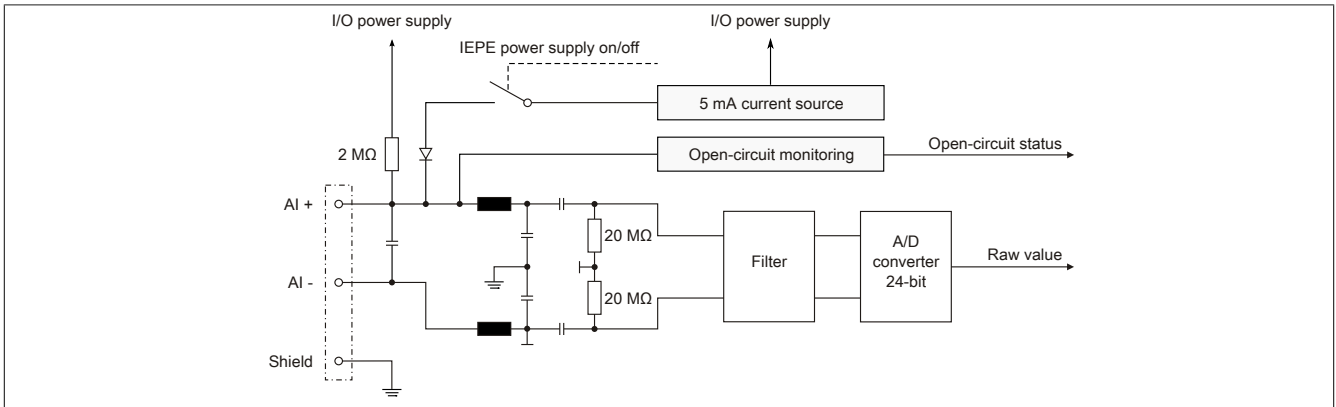
The following firmware update times can be expected depending on the configured bus cycle time:

| Bus cycle time | Update time |
|----------------|----------------|
| 400 µs | Approx. 3 min |
| 2 ms | Approx. 15 min |

9.26.7.7 Pinout



9.26.7.8 Input circuit diagram



9.26.7.9 Shielding

There are 2 ways to shield the cable for the acceleration sensors:

- Shielding possibilities on the terminal block. (Contact "Acc. sensor 1 - 4 shield")
- X20 shielding on the bus module. (See the "Shielding" section in the X20 system user's manual)

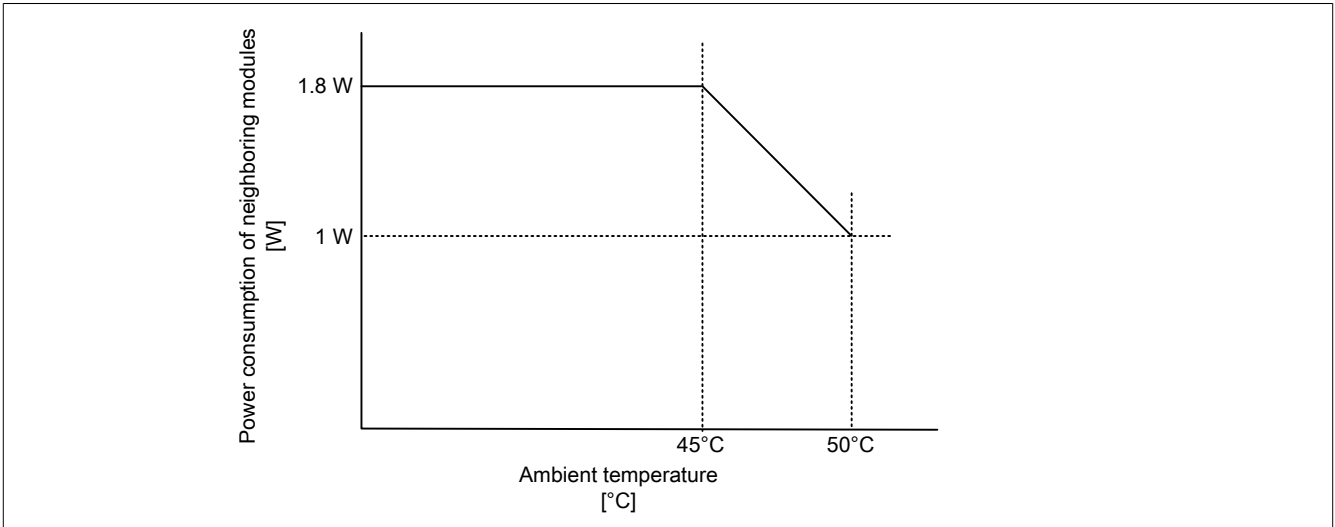
Shielding via the terminal block is perfectly sufficient for environments with no special EMC requirements.

However, if the module is used in an environment with special EMC requirements and high frequency disturbances, both options should be used together.

9.26.7.10 Derating

Horizontal installation

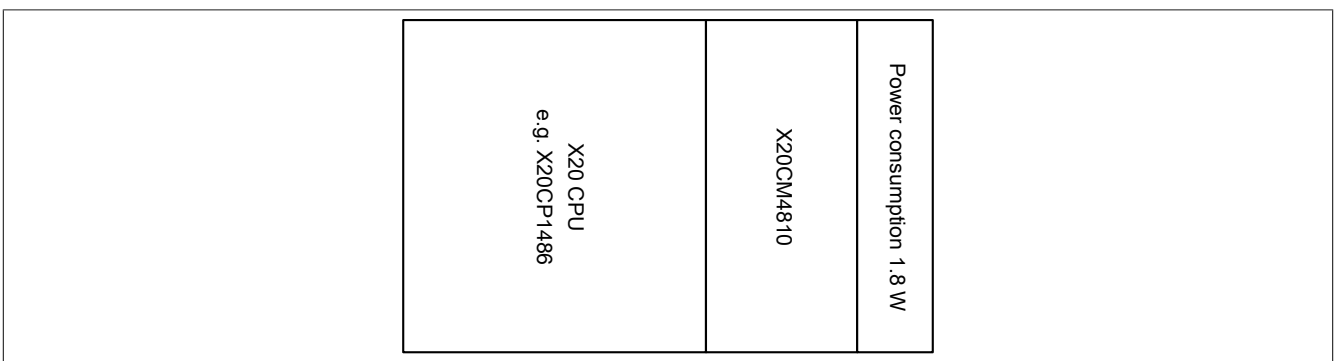
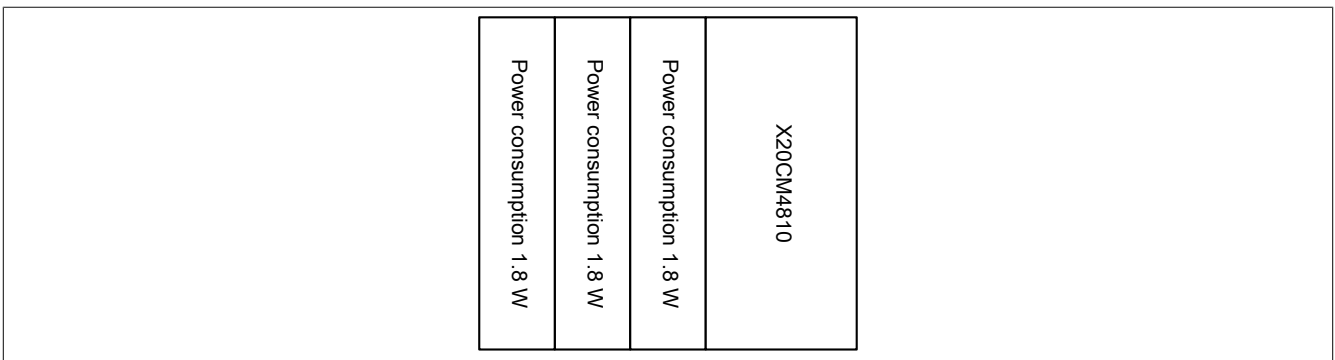
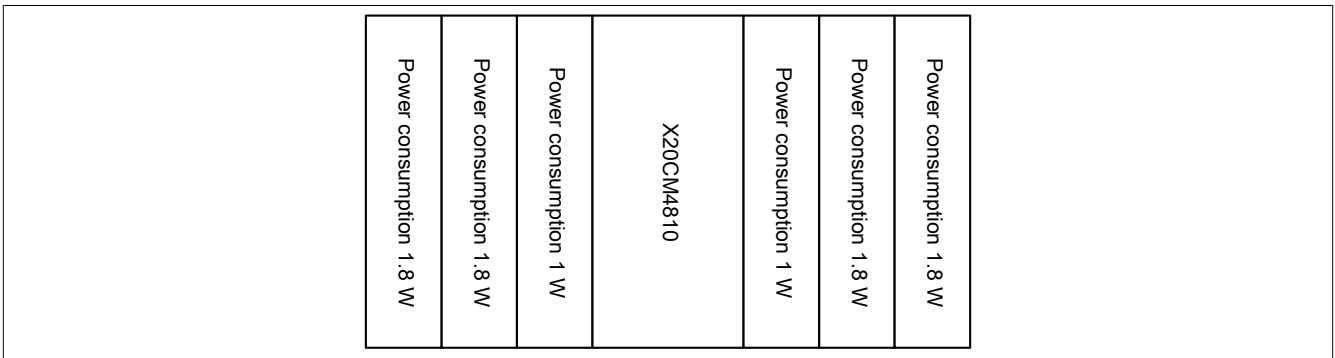
At ambient temperatures higher than 45°C, the X20CM4810 requires power derating:



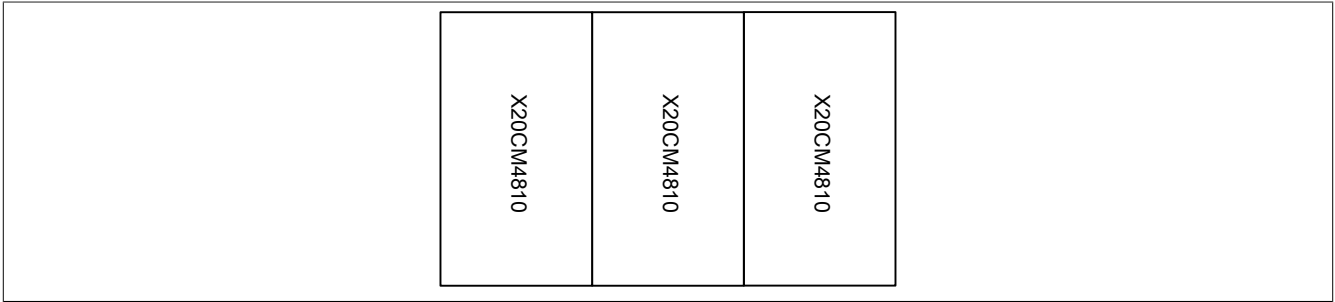
If the X20CM4810 is to be operated with ambient temperatures up to 50°C, then the neighboring modules must not consume more than 1 W.

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.

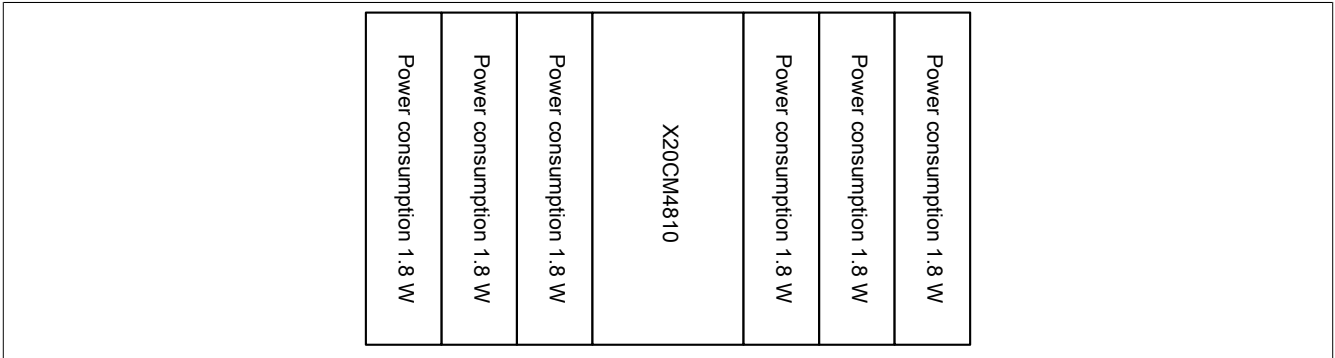
Example: ambient temperature up to 50°C



X20 double-width modules are an exception. It is also possible, for example, to place multiple X20CM4810 modules next to one another.

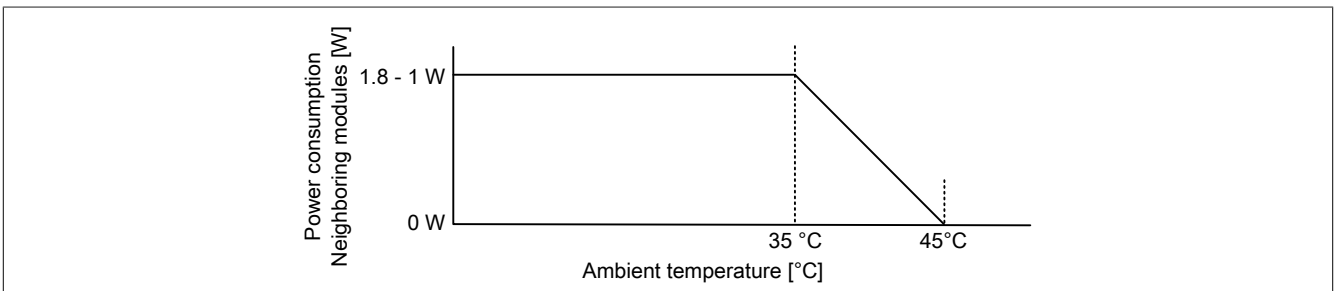


Example: ambient temperature up to 45°C



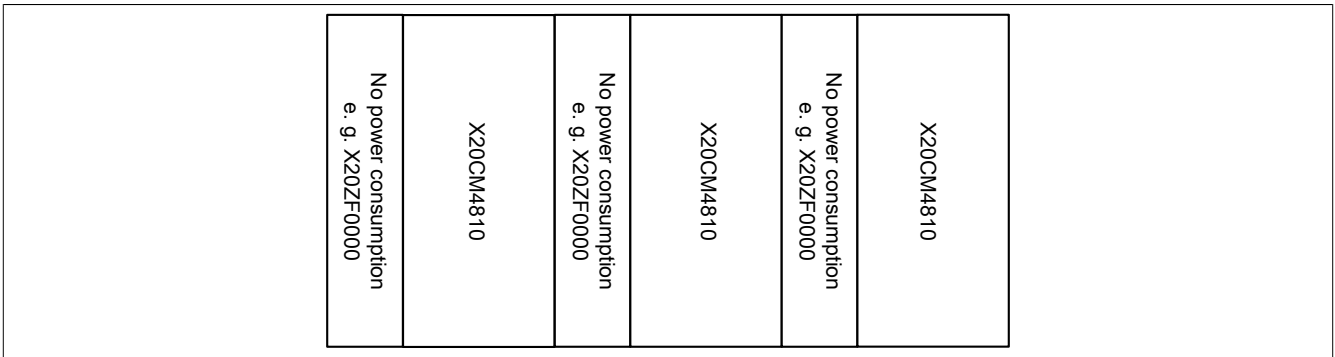
Vertical installation

At ambient temperatures higher than 35 °C, the X20CM4810 requires power derating:

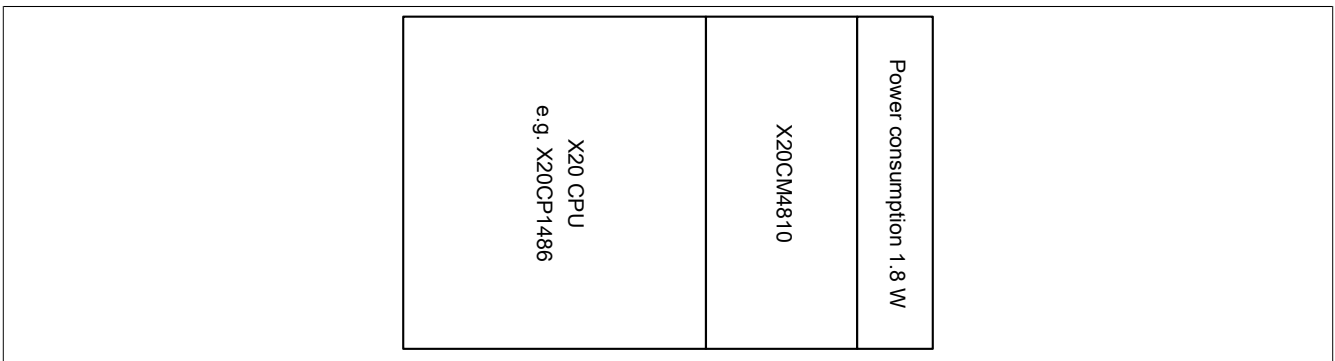
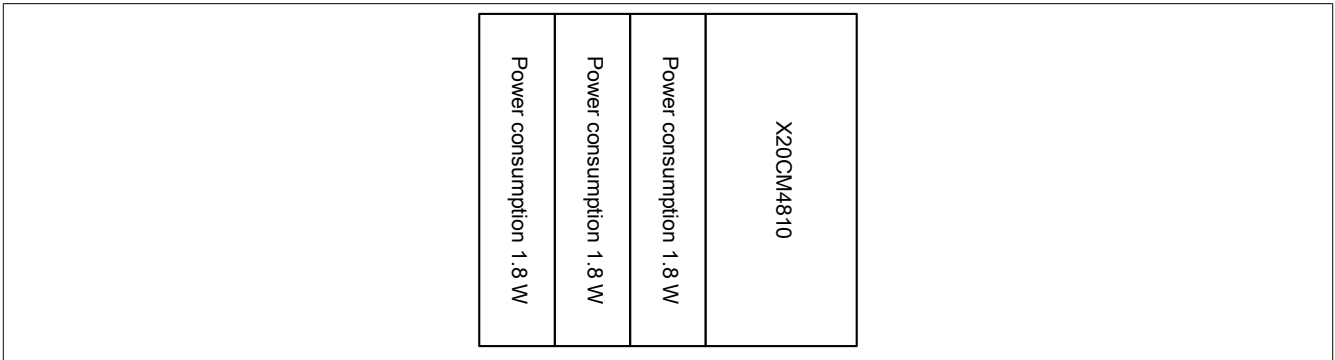
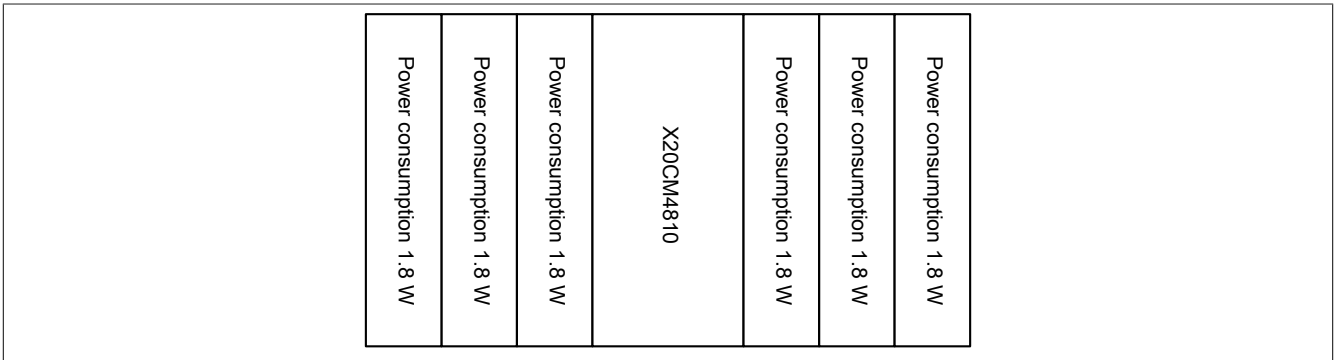


If the X20CM4810 is to be operated with ambient temperatures up to 45°C, then the neighboring modules must not consume power.

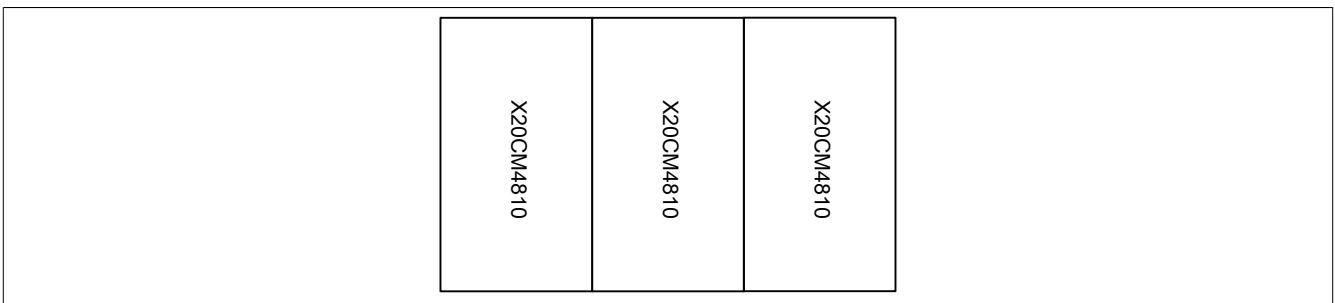
Example: ambient temperature up to 45°C



Example: ambient temperature up to 35°C

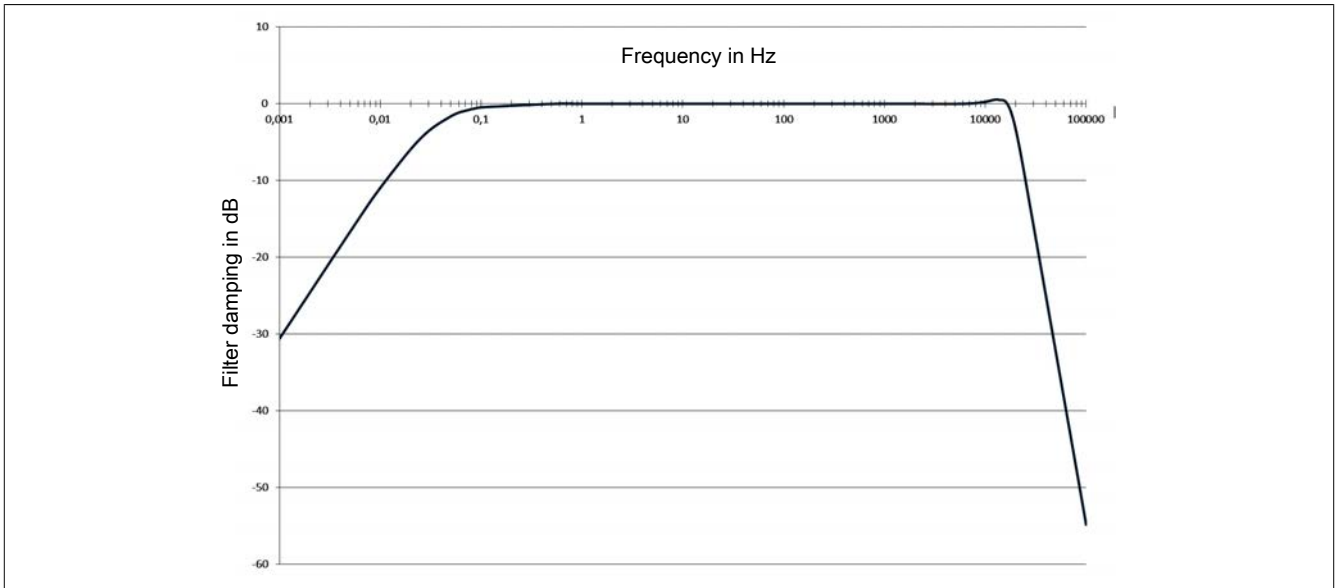


X20 double-width modules are an exception. For example, multiple neighboring X20CM4810 modules can be operated up to an ambient temperature of 30°C.



9.26.7.11 Gain curve

The following diagram shows a typical gain curve for the module.



9.26.7.12 Settling time

The input high-pass cutoff frequency of the AC voltage input (limit frequency of 34 MHz) means that a certain amount of settling time is required after changing the DC offset of the pending signal.

- Settling time of approximately 30 seconds at 100 mV/g sensor sensitivity and a 24 V supply voltage with an accuracy of 0.4 g
- Settling time of approximately 60 seconds at 100 mV/g sensor sensitivity and a 24 V supply voltage with an accuracy of 0.001 g
- The respective settling time must be allowed to pass in order to achieve accurate measurement results when an open line occurs. Because of this, all characteristic values and analog input values are set to 0 by the module during the first 30 seconds after a restart or wire breakage.

9.26.7.13 Sensor sensitivity

The module always assumes a 100 mV/g acceleration sensor on the input. When using [Function model 0 - Standard](#), it is possible to configure a different sensor sensitivity using the "[SensitivitySensor](#)" on [page 3069](#) register.

If a different function model is used, for example an SGC controller or bus controller, any conversion to a different sensitivity must be performed manually.

Example

Factor = 100 / (sensor sensitivity in mV/g)

All values must be multiplied by the calculated factor. This also applies to the analog characteristic values if the characteristic value calculation is enabled as well as for uploaded time signals and amplitude spectra. Exempt from this are all characteristic values without any units, such as "[KurtosisRaw](#)" on [page 3077](#), "[CrestFactorRaw](#)" on [page 3075](#) and "[SkewnessRaw](#)" on [page 3078](#).

9.26.7.14 Using a B&R Compact CPU or fieldbus CPU

Due to the size of the firmware for the module, only CPUs with sufficient ROM (> 1MB) are supported. (X20CP0292 or X20XC0292)

9.26.7.15 Register description

9.26.7.15.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.26.7.15.2 Function model 0 - Standard

This is the default function model for the module. The calculated module characteristic values are streamed from the module via Flatstream every 300 ms and prepared for the user by Automation Runtime. If the streamed data is not collected by the next transfer, the characteristic values of the next measurement are lost. For this reason, the maximum cycle time must be observed for an error-free evaluation.

Analog inputs are provided as cyclic data points.

To help the user, all of the module's characteristic values – such as Flatstream handling for characteristic values, unit scaling and so on – are prepared in this function model using Automation Runtime and then made available to the user. See ["Automation Runtime support" on page 3066](#).

With this function model, it is also possible to upload data from the module via another Flatstream data buffer. Library **AsIOVib** is available for uploading the buffers from the module. For a description of the library, see ["Automation Help - Programming - Libraries - Direct I/O access - AsIOVib"](#).

In this function model, the module can only be configured using the I/O configuration. No registers are permitted to be reconfigured acyclically.

| Register | Name | Data type | Read | | Write | |
|---|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module - Configuration | | | | | | |
| - | Cycle time | - | | | | |
| General registers | | | | | | |
| 2 + N*2 | ActSpeed0N (index N = 1 to 4) | UINT | | | • | |
| 1310 | AutogainDelay01 | UINT | | | | • |
| 526 | AutogainDelay01Read | UINT | | • | | |
| 0 | Control01 | UINT | | | • | |
| 514 | SensorConfig01 | UINT | | | | • |
| | SensorConfig01Read | | | • | | |
| 0 | Status01 | UINT | • | | | |
| Analog input functions | | | | | | |
| 2 * N | AnalogInput0N (index N = 1 to 4) | INT | • | | | |
| 1330 | AnalogInputConfig01 | UINT | | | | • |
| 570 | AnalogInputConfig01Read | UINT | | • | | |
| 2 | AnalogInputControlByte01 | UINT | | | • | |
| 22 + N* 4 | AnalogInputSamples0N (index N = 1 to 4) | UINT | | | • | |
| 1298 | AnalogInputScale01 | UINT | | | | • |
| 546 | AnalogInputScale01Read | UINT | | • | | |
| 1310 + N*4 | SamplesAnalogInput0N (index N = 1 to 4) | UINT | | | | • |
| 526 + N* 4 | SamplesAnalogInput0NRead (index N = 1 to 4) | UINT | | • | | |
| Additional registers and characteristic values generated by Automation Runtime | | | | | | |
| - | CrestFactorHighFrequency0N (index N = 1 to 4) | REAL | • | | | |
| - | DataConsistentWithLockedBuffers0N (index N = 1 to 4) | BOOL | • | | | |
| - | DataToggleBit01 | BOOL | • | | | |
| - | OverflowAnalogInput0N (index N = 1 to 4) | BOOL | • | | | |
| - | OverflowCharacteristicValues0N (index N = 1 to 4) | UINT | • | | | |
| - | OverflowFrequencyBands01 | UDINT | • | | | |
| - | PeakHighFrequencyRef0N (index N = 1 to 4) | REAL | | | • | |
| - | PeakHighFrequencyRefCalculated0N (index N = 1 to 4) | REAL | • | | | |
| - | PeakRawRef0N (index N = 1 to 4) | REAL | | | • | |
| - | PeakRawRefCalculated0N (index N = 1 to 4) | REAL | • | | | |
| - | RmsHighFrequencyRef0N (index N = 1 to 4) | REAL | | | • | |
| - | RmsHighFrequencyRefCalculated0N (index N = 1 to 4) | REAL | • | | | |
| - | RmsRawRef0N (index N = 1 to 4) | REAL | | | • | |
| - | RmsRawRefCalculated0N (index N = 1 to 4) | REAL | • | | | |
| - | SensitivitySensor0N (index N = 1 to 4) | REAL | | | • | |
| - | Vdi3832KtHighFrequency0N (index N = 1 to 4) | REAL | • | | | |
| - | Vdi3832KtRaw0N (index N = 1 to 4) | REAL | • | | | |
| Characteristic values (transferred in Flatstream) | | | | | | |
| - | CrestFactorRaw0N (index N = 1 to 4) | REAL | • | | | |
| - | Iso10816_0N (index N = 1 to 4) | REAL | • | | | |
| - | KurtosisRaw0N (index N = 1 to 4) | REAL | • | | | |
| - | PeakHighFrequency0N (index N = 1 to 4) | REAL | • | | | |

| Register | Name | Data type | Read | | Write | |
|--|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| - | PeakRaw0N (index N = 1 to 4) | REAL | • | | | |
| - | RmsAccEnvelope0N (index N = 1 to 4) | REAL | • | | | |
| - | RmsAccRaw0N (index N = 1 to 4) | REAL | • | | | |
| - | RmsHighFrequency0N (index N = 1 to 4) | REAL | • | | | |
| - | RmsRaw0N (index N = 1 to 4) | REAL | • | | | |
| - | RmsVelEnvelope0N (index N = 1 to 4) | REAL | • | | | |
| - | RmsVelRaw0N (index N = 1 to 4) | REAL | • | | | |
| - | SkewnessRaw0N (index N = 1 to 4) | REAL | • | | | |
| Minimum and maximum characteristic values | | | | | | |
| 2690 | MinMaxCounter01 | UINT | | • | | |
| 3588 + N*8 | CrestFactorRawMax0N (index N = 1 to 4) | UDINT | | • | | |
| 2948 + N*8 | CrestFactorRawMin0N (index N = 1 to 4) | UDINT | | • | | |
| 3332 + N*8 | Iso10816Max0N (index N = 1 to 4) | UDINT | | • | | |
| 2692 + N*8 | Iso10816Min0N (index N = 1 to 4) | UDINT | | • | | |
| 3556 + N*8 | KurtosisRawMax0N (index N = 1 to 4) | DINT | | • | | |
| 2916 + N*8 | KurtosisRawMin0N (index N = 1 to 4) | DINT | | • | | |
| 3492 + N*8 | PeakHighFrequencyMax0N (index N = 1 to 4) | UDINT | | • | | |
| 2852 + N*8 | PeakHighFrequencyMin0N (index N = 1 to 4) | UDINT | | • | | |
| 3684 + N*8 | PeakRawMax0N (index N = 1 to 4) | UDINT | | • | | |
| 3044 + N*8 | PeakRawMin0N (index N = 1 to 4) | UDINT | | • | | |
| 3428 + N*8 | RmsAccEnvelopeMax0N (index N = 1 to 4) | UDINT | | • | | |
| 2788 + N*8 | RmsAccEnvelopeMin0N (index N = 1 to 4) | UDINT | | • | | |
| 3364 + N*8 | RmsAccRawMax0N (index N = 1 to 4) | UDINT | | • | | |
| 2724 + N*8 | RmsAccRawMin0N (index N = 1 to 4) | UDINT | | • | | |
| 3524 + N*8 | RmsHighFrequencyMax0N (index N = 1 to 4) | UDINT | | • | | |
| 2884 + N*8 | RmsHighFrequencyMin0N (index N = 1 to 4) | UDINT | | • | | |
| 3652 + N*8 | RmsRawMax0N (index N = 1 to 4) | UDINT | | • | | |
| 3012 + N*8 | RmsRawMin0N (index N = 1 to 4) | UDINT | | • | | |
| 3460 + N*8 | RmsVelEnvelopeMax0N (index N = 1 to 4) | UDINT | | • | | |
| 2820 + N*8 | RmsVelEnvelopeMin0N (index N = 1 to 4) | UDINT | | • | | |
| 3396 + N*8 | RmsVelRawMax0N (index N = 1 to 4) | UDINT | | • | | |
| 2756 + N*8 | RmsVelRawMin0N (index N = 1 to 4) | UDINT | | • | | |
| 3620 + N*8 | SkewnessRawMax0N (index N = 1 to 4) | DINT | | • | | |
| 2980 + N*8 | SkewnessRawMin0N (index N = 1 to 4) | DINT | | • | | |
| Frequency configuration | | | | | | |
| 1302 | HighFrequencyConfig01 | UINT | | | | • |
| 550 | HighFrequencyConfig01Read | UINT | | • | | |
| 1306 | MaxFrequencyEnvelope01 | UINT | | | | • |
| 558 | MaxFrequencyEnvelope01Read | UINT | | • | | |
| 526 | MaxFrequencyRaw01 | UINT | | | | • |
| 554 | MaxFrequencyRaw01Read | UINT | | • | | |
| 522 | MinFrequencyEnvelope01 | UINT | | | | • |
| 566 | MinFrequencyEnvelope01Read | UINT | | • | | |
| 518 | MinFrequencyRaw01 | UINT | | | | • |
| 562 | MinFrequencyRaw01Read | UINT | | • | | |
| Frequency bands | | | | | | |
| 3716 + N*8 | FrequencyBandMaxN (index N = 01 to 32) | UDINT | | • | | |
| 3076 + N*8 | FrequencyBandMinN (index N = 01 to 32) | UDINT | | • | | |
| 506 + N*24 | FrequencyBandNConfig (index N = 01 to 32) | UINT | | | | • |
| 1194 + N*24 | FrequencyBandNConfigRead (index N = 01 to 32) | UINT | | • | | |
| 514 + N*24 | FrequencyBandNDmgFreq60rpm (index N = 01 to 32) | UINT | | | | • |
| 1202 + N*24 | FrequencyBandNDmgFreq60rpmRead (index N = 01 to 32) | UINT | | • | | |
| 522 + N*24 | FrequencyBandNLowerFrequency (index N = 01 to 32) | UINT | | | | • |
| 1210 + N*24 | FrequencyBandNLowerFrequencyRead (index N = 01 to 32) | UINT | | • | | |
| 518 + N*24 | FrequencyBandNTolerance (index N = 01 to 32) | UINT | | | | • |
| 1206 + N*24 | FrequencyBandNToleranceRead (index N = 01 to 32) | UINT | | • | | |
| 526 + N*24 | FrequencyBandNUpperFrequency (index N = 01 to 32) | UINT | | | | • |
| 1214 + N*24 | FrequencyBandNUpperFrequencyRead (index N = 01 to 32) | UINT | | • | | |
| Flatstream | | | | | | |
| 2311 | BufferForward01 | USINT | | | | • |
| 2318 | BufferForwardDelay01 | UINT | | | | • |
| 2368 | BufferInputSequence01 | USINT | • | | | |
| 2400 | BufferOutputSequence01 | USINT | | | • | |
| 2368 + N | BufferRxByte0N (index N = 1 to 5) | USINT | • | | | |
| 2400 + N | BufferTxByte0N (index N = 1 to 4) | USINT | | | • | |
| 263 | ParameterForward01 | USINT | | | | • |

9.26.7.15.3 Function model 1 - Fast master

The characteristic values calculated by the module are streamed to the master every 300 ms via Flatstream. If the streamed data is not collected by the next transfer, the characteristic values of the next measurement are lost. For this reason, the maximum cycle time must be observed for an error-free evaluation.

With this function model, it is also possible to use an additional Flatstream to read data buffers from the module.

Analog inputs are provided as cyclic data points.

This function model can only be used on Ethernet-based masters and SGC or fieldbus CPUs. However, it must be ensured that Flatstream handling is implemented on the master and that the module changes the data in the Flatstream in every X2X cycle.

| Register | Name | Data type | Read | | Write | |
|--|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module - Configuration | | | | | | |
| - | Cycle time | - | | | | |
| General registers | | | | | | |
| 2 + N*2 | ActSpeed0N (Index N = 1 to 4) | UINT | | | • | |
| 1310 | AutogainDelay01 | UINT | | | | • |
| 526 | AutogainDelay01Read | UINT | | • | | |
| 0 | Control01 | UINT | | | • | |
| 514 | SensorConfig01 | UINT | | | | • |
| | SensorConfig01Read | | | • | | |
| 0 | Status01 | UINT | • | | | |
| Analog input functions | | | | | | |
| 2 * N | AnalogInput0N (Index N = 1 to 4) | INT | • | | | |
| 1330 | AnalogInputConfig01 | UINT | | | | • |
| 570 | AnalogInputConfig01Read | UINT | | • | | |
| 2 | AnalogInputControlByte01 | UINT | | | • | |
| 22 + N*4 | AnalogInputSamples0N (Index N = 1 to 4) | UINT | | | • | |
| 1298 | AnalogInputScale01 | UINT | | | | • |
| 546 | AnalogInputScale01Read | UINT | | • | | |
| 1310 + N*4 | SamplesAnalogInput0N (Index N = 1 to 4) | UINT | | | | • |
| 526 + N*4 | SamplesAnalogInput0NRead (Index N = 1 to 4) | UINT | | • | | |
| Transferring characteristic values via Flatstream | | | | | | |
| - | CrestFactorRaw0N (Index N = 1 to 4) | REAL | • | | | |
| - | Iso10816_0N (Index N = 1 to 4) | REAL | • | | | |
| - | KurtosisRaw0N (Index N = 1 to 4) | REAL | • | | | |
| - | PeakHighFrequency0N (Index N = 1 to 4) | REAL | • | | | |
| - | PeakRaw0N (Index N = 1 to 4) | REAL | • | | | |
| - | RmsAccEnvelope0N (Index N = 1 to 4) | REAL | • | | | |
| - | RmsAccRaw0N (Index N = 1 to 4) | REAL | • | | | |
| - | RmsHighFrequency0N (Index N = 1 to 4) | REAL | • | | | |
| - | RmsRaw0N (Index N = 1 to 4) | REAL | • | | | |
| - | RmsVelEnvelope0N (Index N = 1 to 4) | REAL | • | | | |
| - | RmsVelRaw0N (Index N = 1 to 4) | REAL | • | | | |
| - | SkewnessRaw0N (Index N = 1 to 4) | REAL | • | | | |
| Minimum and maximum characteristic values | | | | | | |
| 2690 | MinMaxCounter01 | UINT | | • | | |
| 3588 + N*8 | CrestFactorRawMax0N (Index N = 1 to 4) | UDINT | | • | | |
| 2948 + N*8 | CrestFactorRawMin0N (Index N = 1 to 4) | UDINT | | • | | |
| 3332 + N*8 | Iso10816Max0N (Index N = 1 to 4) | UDINT | | • | | |
| 2692 + N*8 | Iso10816Min0N (Index N = 1 to 4) | UDINT | | • | | |
| 3556 + N*8 | KurtosisRawMax0N (Index N = 1 to 4) | DINT | | • | | |
| 2916 + N*8 | KurtosisRawMin0N (Index N = 1 to 4) | DINT | | • | | |
| 3492 + N*8 | PeakHighFrequencyMax0N (Index N = 1 to 4) | UDINT | | • | | |
| 2852 + N*8 | PeakHighFrequencyMin0N (Index N = 1 to 4) | UDINT | | • | | |
| 3684 + N*8 | PeakRawMax0N (Index N = 1 to 4) | UDINT | | • | | |
| 3044 + N*8 | PeakRawMin0N (Index N = 1 to 4) | UDINT | | • | | |
| 3428 + N*8 | RmsAccEnvelopeMax0N (Index N = 1 to 4) | UDINT | | • | | |
| 2788 + N*8 | RmsAccEnvelopeMin0N (Index N = 1 to 4) | UDINT | | • | | |
| 3364 + N*8 | RmsAccRawMax0N (Index N = 1 to 4) | UDINT | | • | | |
| 2724 + N*8 | RmsAccRawMin0N (Index N = 1 to 4) | UDINT | | • | | |
| 3524 + N*8 | RmsHighFrequencyMax0N (Index N = 1 to 4) | UDINT | | • | | |
| 2884 + N*8 | RmsHighFrequencyMin0N (Index N = 1 to 4) | UDINT | | • | | |
| 3652 + N*8 | RmsRawMax0N (Index N = 1 to 4) | UDINT | | • | | |
| 3012 + N*8 | RmsRawMin0N (Index N = 1 to 4) | UDINT | | • | | |
| 3460 + N*8 | RmsVelEnvelopeMax0N (Index N = 1 to 4) | UDINT | | • | | |
| 2820 + N*8 | RmsVelEnvelopeMin0N (Index N = 1 to 4) | UDINT | | • | | |
| 3396 + N*8 | RmsVelRawMax0N (Index N = 1 to 4) | UDINT | | • | | |
| 2756 + N*8 | RmsVelRawMin0N (Index N = 1 to 4) | UDINT | | • | | |
| 3620 + N*8 | SkewnessRawMax0N (Index N = 1 to 4) | DINT | | • | | |
| 2980 + N*8 | SkewnessRawMin0N (Index N = 1 to 4) | DINT | | • | | |

| Register | Name | Data type | Read | | Write | |
|--------------------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Frequency configuration | | | | | | |
| 1302 | HighFrequencyConfig01 | UINT | | | | • |
| 550 | HighFrequencyConfig01Read | UINT | | • | | |
| 1306 | MaxFrequencyEnvelope01 | UINT | | | | • |
| 558 | MaxFrequencyEnvelope01Read | UINT | | • | | |
| 526 | MaxFrequencyRaw01 | UINT | | | | • |
| 554 | MaxFrequencyRaw01Read | UINT | | • | | |
| 522 | MinFrequencyEnvelope01 | UINT | | | | • |
| 566 | MinFrequencyEnvelope01Read | UINT | | • | | |
| 518 | MinFrequencyRaw01 | UINT | | | | • |
| 562 | MinFrequencyRaw01Read | UINT | | • | | |
| Frequency bands | | | | | | |
| 3716 + N*8 | FrequencyBandMaxN (Index N = 01 to 32) | UDINT | | • | | |
| 3076 + N*8 | FrequencyBandMinN (Index N = 01 to 32) | UDINT | | • | | |
| 506 + N*24 | FrequencyBandNConfig (Index N = 01 to 32) | UINT | | | | • |
| 1194 + N*24 | FrequencyBandNConfigRead (Index N = 01 to 32) | UINT | | • | | |
| 514 + N*24 | FrequencyBandNDmgFreq60rpm (Index N = 01 to 32) | UINT | | | | • |
| 1202 + N*24 | FrequencyBandNDmgFreq60rpmRead (Index N = 01 to 32) | UINT | | • | | |
| 522 + N*24 | FrequencyBandNLowerFrequency (Index N = 01 to 32) | UINT | | | | • |
| 1210 + N*24 | FrequencyBandNLowerFrequencyRead (Index N = 01 to 32) | UINT | | • | | |
| 518 + N*24 | FrequencyBandNTolerance (Index N = 01 to 32) | UINT | | | | • |
| 1206 + N*24 | FrequencyBandNToleranceRead (Index N= 01 to 32) | UINT | | • | | |
| 526 + N*24 | FrequencyBandNUpperFrequency (Index N = 01 to 32) | UINT | | | | • |
| 1214 + N*24 | FrequencyBandNUpperFrequencyRead (Index N = 01 to 32) | UINT | | • | | |
| Flatstream | | | | | | |
| 2311 | BufferForward01 | USINT | | | | • |
| 2318 | BufferForwardDelay01 | UINT | | | | • |
| 2368 | BufferInputSequence01 | USINT | • | | | |
| 2400 | BufferOutputSequence01 | USINT | | | • | |
| 2368 + N | BufferRxByte0N (Index N = 1 to 5) | USINT | • | | | |
| 2400 + N | BufferTxByte0N (Index N = 1 to 4) | USINT | | | • | |
| 263 | ParameterForward01 | USINT | | | | • |
| 270 | ParameterForwardDelay01 | INT | | | | • |
| 320 | ParameterInputSequence01 | USINT | • | | | |
| 352 | ParameterOutputSequence01 | USINT | | | • | |
| 320 + N | ParameterRxByteN (Index N = 1 to 13) | USINT | • | | | |

9.26.7.15.4 Function model 2 - Slow master

This function model was developed specifically for operating the module with "slow masters" and for conserving resources on the PLC.

With this function model, it is not possible to upload data buffers from the module.

Analog inputs are provided as cyclic data points. Scaling of the characteristic values must be performed manually.

Characteristic values are calculated by the module every 300 ms and can only be read via acyclic access. In order to keep all characteristic values consistent with one another, they can be locked as they are read. This function model does not allow for seamless measurements. The Min/Max functionality can be used for seamless measurements, however. See ["Characteristic values \(minimum and maximum\)" on page 3079](#)

This function model is recommended for all slow buses and masters. It is important to note that acyclic register access must be implemented on the master if a B&R master is not being used.

| Register | Name | Data type | Read | | Write | |
|--|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| General registers | | | | | | |
| 2 + N*2 | ActSpeed0N (Index N = 1 to 4) | UINT | | | • | |
| 1310 | AutogainDelay01 | UINT | | | | • |
| 526 | AutogainDelay01Read | UINT | | • | | |
| 0 | Control01 | UINT | | | • | |
| 514 | SensorConfig01 | UINT | | | | • |
| | SensorConfig01Read | | | • | | |
| 0 | Status01 | UINT | • | | | |
| Analog input functions | | | | | | |
| 2 * N | AnalogInput0N (Index N = 1 to 4) | INT | • | | | |
| 1330 | AnalogInputConfig01 | UINT | | | | • |
| 570 | AnalogInputConfig01Read | UINT | | • | | |
| 2 | AnalogInputControlByte01 | UINT | | | • | |
| 22 + N*4 | AnalogInputSamples0N (Index N = 1 to 4) | UINT | | | • | |
| 1298 | AnalogInputScale01 | UINT | | | | • |
| 546 | AnalogInputScale01Read | UINT | | • | | |
| 1310 + N*4 | SamplesAnalogInput0N (Index N = 1 to 4) | UINT | | | | • |
| 526 + N*4 | SamplesAnalogInput0NRead (Index N = 1 to 4) | UINT | | • | | |
| Characteristic values | | | | | | |
| 828 + N*8 | CrestFactorRaw0N (Index N = 1 to 4) | UDINT | | • | | |
| 572 + N*8 | Iso10816_0N (Index N = 1 to 4) | UDINT | | • | | |
| 796 + N*8 | KurtosisRaw0N (Index N = 1 to 4) | DINT | | • | | |
| 732 + N*8 | PeakHighFrequency0N (Index N = 1 to 4) | UDINT | | • | | |
| 924 + N*8 | PeakRaw0N (Index N = 1 to 4) | UDINT | | • | | |
| 668 + N*8 | RmsAccEnvelope0N (Index N = 1 to 4) | UDINT | | • | | |
| 604 + N*8 | RmsAccRaw0N (Index N = 1 to 4) | UDINT | | • | | |
| 764 + N*8 | RmsHighFrequency0N (Index N = 1 to 4) | UDINT | | • | | |
| 982 + N*8 | RmsRaw0N (Index N = 1 to 4) | UDINT | | • | | |
| 700 + N*8 | RmsVelEnvelope0N (Index N = 1 to 4) | UDINT | | • | | |
| 636 + N*8 | RmsVelRaw0N (Index N = 1 to 4) | UDINT | | • | | |
| 860 + N*8 | SkewnessRaw0N (Index N = 1 to 4) | DINT | | • | | |
| Minimum and maximum characteristic values | | | | | | |
| 2690 | MinMaxCounter01 | UINT | | • | | |
| 3588 + N*8 | CrestFactorRawMax0N (Index N = 1 to 4) | UDINT | | • | | |
| 2948 + N*8 | CrestFactorRawMin0N (Index N = 1 to 4) | UDINT | | • | | |
| 3332 + N*8 | Iso10816Max0N (Index N = 1 to 4) | UDINT | | • | | |
| 2692 + N*8 | Iso10816Min0N (Index N = 1 to 4) | UDINT | | • | | |
| 3556 + N*8 | KurtosisRawMax0N (Index N = 1 to 4) | DINT | | • | | |
| 2916 + N*8 | KurtosisRawMin0N (Index N = 1 to 4) | DINT | | • | | |
| 3492 + N*8 | PeakHighFrequencyMax0N (Index N = 1 to 4) | UDINT | | • | | |
| 2852 + N*8 | PeakHighFrequencyMin0N (Index N = 1 to 4) | UDINT | | • | | |
| 3684 + N*8 | PeakRawMax0N (Index N = 1 to 4) | UDINT | | • | | |
| 3044 + N*8 | PeakRawMin0N (Index N = 1 to 4) | UDINT | | • | | |
| 3428 + N*8 | RmsAccEnvelopeMax0N (Index N = 1 to 4) | UDINT | | • | | |
| 2788 + N*8 | RmsAccEnvelopeMin0N (Index N = 1 to 4) | UDINT | | • | | |
| 3364 + N*8 | RmsAccRawMax0N (Index N = 1 to 4) | UDINT | | • | | |
| 2724 + N*8 | RmsAccRawMin0N (Index N = 1 to 4) | UDINT | | • | | |
| 3524 + N*8 | RmsHighFrequencyMax0N (Index N = 1 to 4) | UDINT | | • | | |
| 2884 + N*8 | RmsHighFrequencyMin0N (Index N = 1 to 4) | UDINT | | • | | |
| 3652 + N*8 | RmsRawMax0N (Index N = 1 to 4) | UDINT | | • | | |
| 3012 + N*8 | RmsRawMin0N (Index N = 1 to 4) | UDINT | | • | | |
| 3460 + N*8 | RmsVelEnvelopeMax0N (Index N = 1 to 4) | UDINT | | • | | |
| 2820 + N*8 | RmsVelEnvelopeMin0N (Index N = 1 to 4) | UDINT | | • | | |
| 3396 + N*8 | RmsVelRawMax0N (Index N = 1 to 4) | UDINT | | • | | |
| 2756 + N*8 | RmsVelRawMin0N (Index N = 1 to 4) | UDINT | | • | | |
| 3620 + N*8 | SkewnessRawMax0N (Index N = 1 to 4) | DINT | | • | | |
| 2980 + N*8 | SkewnessRawMin0N (Index N = 1 to 4) | DINT | | • | | |

| Register | Name | Data type | Read | | Write | |
|--------------------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Frequency configuration | | | | | | |
| 1302 | HighFrequencyConfig01 | UINT | | | | • |
| 550 | HighFrequencyConfig01Read | UINT | | • | | |
| 1306 | MaxFrequencyEnvelope01 | UINT | | | | • |
| 558 | MaxFrequencyEnvelope01Read | UINT | | • | | |
| 526 | MaxFrequencyRaw01 | UINT | | | | • |
| 554 | MaxFrequencyRaw01Read | UINT | | • | | |
| 522 | MinFrequencyEnvelope01 | UINT | | | | • |
| 566 | MinFrequencyEnvelope01Read | UINT | | • | | |
| 518 | MinFrequencyRaw01 | UINT | | | | • |
| 562 | MinFrequencyRaw01Read | UINT | | • | | |
| Frequency bands | | | | | | |
| 3716 + N*8 | FrequencyBandMaxN (Index N = 01 to 32) | UDINT | | • | | |
| 3076 + N*8 | FrequencyBandMinN (Index N = 01 to 32) | UDINT | | • | | |
| 956 + N*8 | FrequencyBandN (Index N = 01 to 32) | UDINT | | • | | |
| 506 + N*24 | FrequencyBandNConfig (Index N = 01 to 32) | UINT | | | | • |
| 1194 + N*24 | FrequencyBandNConfigRead (Index N = 01 to 32) | UINT | | • | | |
| 514 + N*24 | FrequencyBandNDmgFreq60rpm (Index N = 01 to 32) | UINT | | | | • |
| 1202 + N*24 | FrequencyBandNDmgFreq60rpmRead (Index N = 01 to 32) | UINT | | • | | |
| 522 + N*24 | FrequencyBandNLowerFrequency (Index N = 01 to 32) | UINT | | | | • |
| 1210 + N*24 | FrequencyBandNLowerFrequencyRead (Index N = 01 to 32) | UINT | | • | | |
| 518 + N*24 | FrequencyBandNTolerance (Index N = 01 to 32) | UINT | | | | • |
| 1206 + N*24 | FrequencyBandNToleranceRead (Index N = 01 to 32) | UINT | | • | | |
| 526 + N*24 | FrequencyBand0NUpperFrequency (Index N = 01 to 32) | UINT | | | | • |
| 1214 + N*24 | FrequencyBand0NUpperFrequencyRead (Index N = 01 to 32) | UINT | | • | | |

9.26.7.15.5 Function model 254 - Bus controller

This function model can only be used with a CANIO bus controller. It includes the same functionality as [Function model 2 - Slow master](#).

Differences:

- The order of cyclic registers is somewhat different on the bus.
- Since the AnalogInputToggleBit01-04 data points cannot be consistently transferred to the "AnalogInput" on page 3061 data points, they are not available in this function model. The user must watch for changes in the value of the data points "AnalogInput" in order to determine whether a new value is available.

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| General registers | | | | | | | |
| 2 + N*2 | 2 + N*4 | ActSpeed0N (Index N = 1 to 4) | UINT | | | • | |
| 1310 | | AutogainDelay01 | UINT | | | | • |
| 526 | | AutogainDelay01Read | UINT | | • | | |
| 0 | 2 | Control01 | UINT | | | • | |
| 514 | | SensorConfig01 | UINT | | | | • |
| | | SensorConfig01Read | | | • | | |
| 0 | 2 | Status01 | UINT | • | | | |
| Analog input functions | | | | | | | |
| 2 * N | 2 * N*4 | AnalogInput0N (Index N = 1 to 4) | INT | • | | | |
| 1330 | | AnalogInputConfig01 | UINT | | | | • |
| 570 | | AnalogInputConfig01Read | UINT | | • | | |
| 2 | 22 | AnalogInputControlByte01 | UINT | | | • | |
| 1298 | | AnalogInputScale01 | UINT | | | | • |
| 546 | | AnalogInputScale01Read | UINT | | • | | |
| 1310 + N*4 | | SamplesAnalogInput0N (Index N = 1 to 4) | UINT | | | | • |
| 526 + N*4 | | SamplesAnalogInput0NRead (Index N = 1 to 4) | UINT | | • | | |
| Characteristic values | | | | | | | |
| 828 + N*8 | | CrestFactorRaw0N (Index N = 1 to 4) | UDINT | | | • | |
| 572 + N*8 | | Iso10816_0N (Index N = 1 to 4) | UDINT | | | • | |
| 796 + N*8 | | KurtosisRaw0N (Index N = 1 to 4) | DINT | | | • | |
| 732 + N*8 | | PeakHighFrequency0N (Index N = 1 to 4) | UDINT | | | • | |
| 924 + N*8 | | PeakRaw0N (Index N = 1 to 4) | UDINT | | | • | |
| 668 + N*8 | | RmsAccEnvelope0N (Index N = 1 to 4) | UDINT | | | • | |
| 604 + N*8 | | RmsAccRaw0N (Index N = 1 to 4) | UDINT | | | • | |
| 764 + N*8 | | RmsHighFrequency0N (Index N = 1 to 4) | UDINT | | | • | |
| 982 + N*8 | | RmsRaw0N (Index N = 1 to 4) | UDINT | | | • | |
| 700 + N*8 | | RmsVelEnvelope0N (Index N = 1 to 4) | UDINT | | | • | |
| 636 + N*8 | | RmsVelRaw0N (Index N = 1 to 4) | UDINT | | | • | |
| 860 + N*8 | | SkewnessRaw0N (Index N = 1 to 4) | DINT | | | • | |
| Minimum and maximum characteristic values | | | | | | | |
| 2690 | | MinMaxCounter01 | UINT | | | • | |
| 3588 + N*8 | | CrestFactorRawMax0N (Index N = 1 to 4) | UDINT | | | • | |
| 2948 + N*8 | | CrestFactorRawMin0N (Index N = 1 to 4) | UDINT | | | • | |
| 3332 + N*8 | | Iso10816Max0N (Index N = 1 to 4) | UDINT | | | • | |
| 2692 + N*8 | | Iso10816Min0N (Index N = 1 to 4) | UDINT | | | • | |
| 3556 + N*8 | | KurtosisRawMax0N (Index N = 1 to 4) | DINT | | | • | |
| 2916 + N*8 | | KurtosisRawMin0N (Index N = 1 to 4) | DINT | | | • | |
| 3492 + N*8 | | PeakHighFrequencyMax0N (Index N = 1 to 4) | UDINT | | | • | |
| 2852 + N*8 | | PeakHighFrequencyMin0N (Index N = 1 to 4) | UDINT | | | • | |
| 3684 + N*8 | | PeakRawMax0N (Index N = 1 to 4) | UDINT | | | • | |
| 3044 + N*8 | | PeakRawMin0N (Index N = 1 to 4) | UDINT | | | • | |
| 3428 + N*8 | | RmsAccEnvelopeMax0N (Index N = 1 to 4) | UDINT | | | • | |
| 2788 + N*8 | | RmsAccEnvelopeMin0N (Index N = 1 to 4) | UDINT | | | • | |
| 3364 + N*8 | | RmsAccRawMax0N (Index N = 1 to 4) | UDINT | | | • | |
| 2724 + N*8 | | RmsAccRawMin0N (Index N = 1 to 4) | UDINT | | | • | |
| 3524 + N*8 | | RmsHighFrequencyMax0N (Index N = 1 to 4) | UDINT | | | • | |
| 2884 + N*8 | | RmsHighFrequencyMin0N (Index N = 1 to 4) | UDINT | | | • | |
| 3652 + N*8 | | RmsRawMax0N (Index N = 1 to 4) | UDINT | | | • | |
| 3012 + N*8 | | RmsRawMin0N (Index N = 1 to 4) | UDINT | | | • | |
| 3460 + N*8 | | RmsVelEnvelopeMax0N (Index N = 1 to 4) | UDINT | | | • | |
| 2820 + N*8 | | RmsVelEnvelopeMin0N (Index N = 1 to 4) | UDINT | | | • | |
| 3396 + N*8 | | RmsVelRawMax0N (Index N = 1 to 4) | UDINT | | | • | |
| 2756 + N*8 | | RmsVelRawMin0N (Index N = 1 to 4) | UDINT | | | • | |
| 3620 + N*8 | | SkewnessRawMax0N (Index N = 1 to 4) | DINT | | | • | |
| 2980 + N*8 | | SkewnessRawMin0N (Index N = 1 to 4) | DINT | | | • | |
| Frequency configuration | | | | | | | |
| 1302 | | HighFrequencyConfig01 | UINT | | | | • |
| 550 | | HighFrequencyConfig01Read | UINT | | • | | |
| 1306 | | MaxFrequencyEnvelope01 | UINT | | | | • |
| 558 | | MaxFrequencyEnvelope01Read | UINT | | • | | |

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|------------------------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 526 | | MaxFrequencyRaw01 | UINT | | | | • |
| 554 | | MaxFrequencyRaw01Read | UINT | | • | | |
| 522 | | MinFrequencyEnvelope01 | UINT | | | | • |
| 566 | | MinFrequencyEnvelope01Read | UINT | | • | | |
| 518 | | MinFrequencyRaw01 | UINT | | | | • |
| 562 | | MinFrequencyRaw01Read | UINT | | • | | |
| Frequency bands | | | | | | | |
| 3716 + N*8 | | FrequencyBandMaxN (Index N = 01 to 32) | UDINT | | • | | |
| 3076 + N*8 | | FrequencyBandMinN (Index N = 01 to 32) | UDINT | | • | | |
| 956 + N*8 | | FrequencyBandN (Index N = 01 to 32) | UDINT | | • | | |
| 506 + N*24 | | FrequencyBandNConfig (Index N = 01 to 32) | UINT | | | | • |
| 1194 + N*24 | | FrequencyBandNConfigRead (Index N = 01 to 32) | UINT | | • | | |
| 514 + N*24 | | FrequencyBandNDmgFreq60rpm (Index N = 01 to 32) | UINT | | | | • |
| 1202 + N*24 | | FrequencyBandNDmgFreq60rpmRead (Index N = 01 to 32) | UINT | | • | | |
| 522 + N*24 | | FrequencyBandNLowerFrequency (Index N = 01 to 32) | UINT | | | | • |
| 1210 + N*24 | | FrequencyBandNLowerFrequencyRead (Index N = 01 to 32) | UINT | | • | | |
| 518 + N*24 | | FrequencyBandNTolerance (Index N = 01 to 32) | UINT | | | | • |
| 1206 + N*24 | | FrequencyBandNToleranceRead (Index N = 01 to 32) | UINT | | • | | |
| 526 + N*24 | | FrequencyBandNUpperFrequency (Index N = 01 to 32) | UINT | | | | • |
| 1214 + N*24 | | FrequencyBandNUpperFrequencyRead (Index N = 01 to 32) | UINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.26.7.15.5.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.26.7.15.5.2 CAN I/O bus controller

The module occupies 2 analog logical slots on CAN I/O.

9.26.7.15.6 General information

9.26.7.15.6.1 Signal generation

The following signals and characteristic values are calculated from the acceleration sensor's input signal:

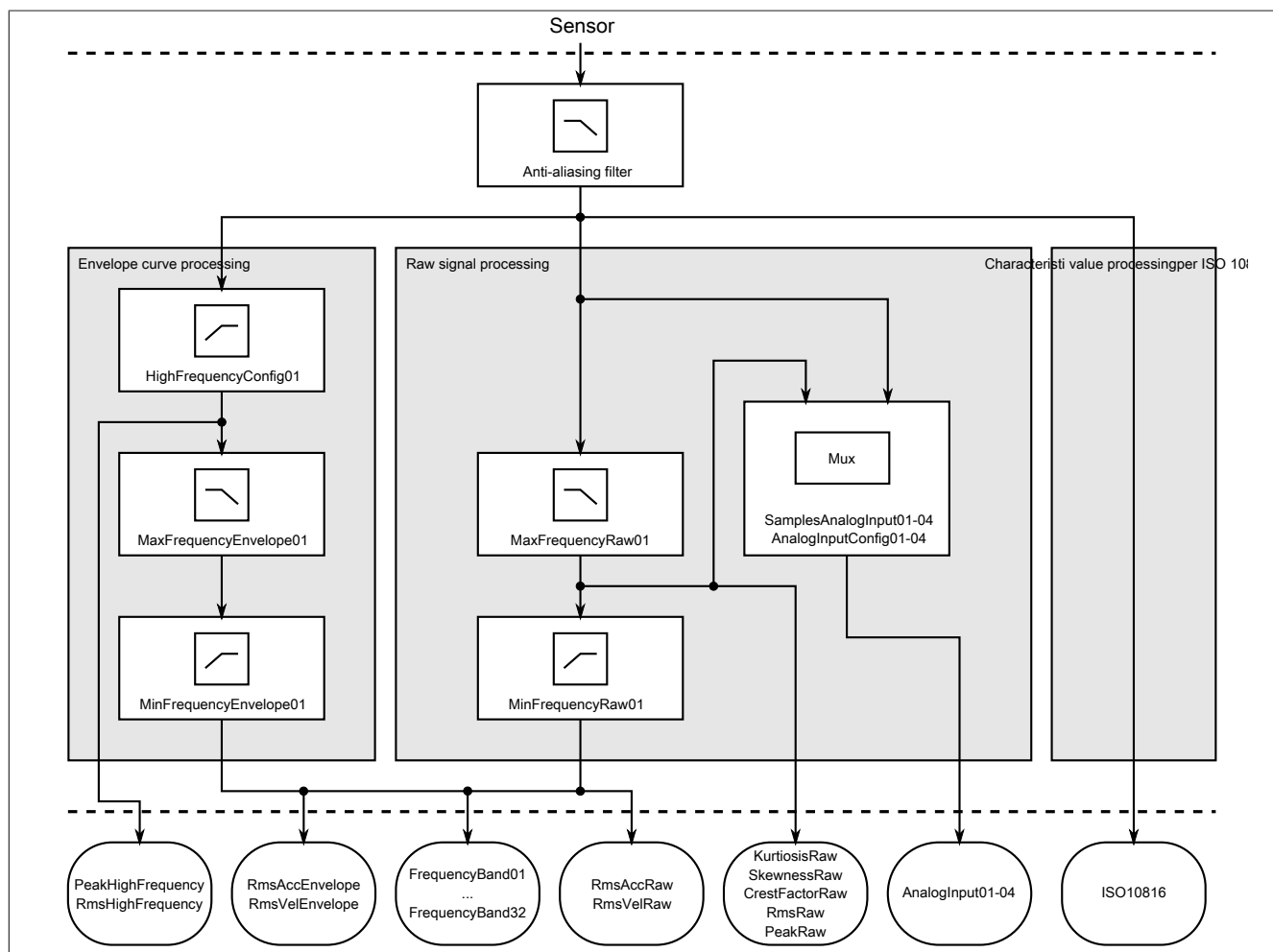


Figure 198: Signal generation in the module

9.26.7.15.6.2 Filter configuration

The module has a number of configurable filters.

There is a configurable high-pass filter for the whole module that can be configured using register "[HighFrequencyConfig](#)" on page 3085. Possible settings are 500 Hz, 1 kHz and 2 kHz. This high-pass affects all high-frequency and envelope characteristic values of all module channels.

In addition, there are 2 adjustable low pass filters per channel.

- Filtering of the raw signal. This filter is configured using register "[MaxFrequencyRaw](#)" on page 3086. Possible settings are 200 Hz, 500 Hz, 1 kHz, 2 kHz, 5 kHz and 10 kHz.
- Filtering of the envelope signal. This filter is configured using register "[MaxFrequencyEnvelope](#)" on page 3085. Possible settings are 200 Hz, 500 Hz, 1 kHz and 2 kHz.

These low-pass filters affect all calculated characteristic values of the respective signal, i.e. the raw or envelope signal. They can be used to increase the frequency resolution of the FFT. For the characteristic value calculation in the analog input, however, it can be selected whether the characteristic values are to be calculated from the direct input signal or the low-pass filtered raw signal.

9.26.7.15.6.3 Frequency bands

It is possible to individually configure up to 32 frequency bands where the RMS value (RMS) or the noise of a quadrant is calculated.

| Parameter | Settings | | |
|-------------------------------------|---|---|------------|
| Enable | Off RMS Noise | | |
| Channel | 1 2 3 4 | | |
| Source | Raw acceleration signal Raw velocity signal Enveloped acceleration signal Enveloped velocity signal | | |
| Calculation of harmonics (RMS only) | Yes No | | |
| Rotation-dependent (RMS only) | On | Selects the data point for velocity (" ActSpeed " on page 3056) | [1/100 Hz] |
| | | Standardized damage frequency at 60 rpm | [1/100] |
| | Off | ± Width of the frequency band (tolerance band) | [1/100 Hz] |
| | | Lower frequency | [1/4 Hz] |
| | Upper frequency | [1/4 Hz] | |
| Quadrant (noise only) | 1st quadrant 2nd quadrant 3rd quadrant 4th quadrant | | |

9.26.7.15.6.4 Calculating the velocity signal automatically

The module can calculate the velocity signal from the signal provided by the acceleration sensor. This calculation is disabled by default since it can reduce the accuracy of the acceleration signal.

Reason

When converting from acceleration to velocity, low frequency portions become very large. As a result, the [autogain](#) is decreased by a few levels, which then further degrades accuracy.

If this calculation is not enabled, 0 is output for all characteristic values calculated from the velocity spectrum. Characteristic value "[Iso10816](#)" on page 3072 is not affected by this.

9.26.7.15.6.5 Autogain, AutogainDelay and overflow

The module automatically adjusts the measurement signal dynamically (autogain) to ensure that it is measured with the highest possible accuracy. This adjustment is made in multiple steps. Each step amplifies the input signal more than the last. If the signal was very small for a long time and an impact suddenly occurs, an overflow may occur with some calculated characteristic values. This is indicated by the overflow bit for the respective channel (Overflow01-04 in the "[Status](#)" on page 3059 register) being set and the affected module characteristic values being set to their maximum.

With [Function model 0 - Standard](#), there are also the "[OverflowCharacteristicValues](#)" on page 3067 and "[OverflowFrequencyBands](#)" on page 3068 registers. These are automatically generated by Automation Runtime and directly indicate the overflow status of the individual characteristic values and frequency bands.

If an overflow occurs or if an internal threshold is exceeded, the autogain for the next measurement is reduced by one level. If no overflow occurs for a certain number of measurements (adjustable using the "[AutogainDelay](#)" on page 3056 register), or the signal stays below the internal threshold, the autogain is increased by one level again.

If overflows are occurring frequently, increasing AutogainDelay may help.

9.26.7.15.6.6 Term definition: Sampling rate and sampling frequency

The terms sampling rate and sampling frequency are used in this document. The following is a definition of these terms:

| Term | Definition |
|--------------------|---|
| Sampling rate | Number of times an analog signal is sampled per unit of time. The unit of time is generally 1 second. Example: 100 samples per second |
| Sampling frequency | Sampling of an analog signal with respect to 1 second. Specified in Hertz [Hz]. Examples: <ul style="list-style-type: none"> • Sampling an analog signal once per second corresponds to a sampling frequency of 1 Hz. • Sampling an analog signal once per millisecond corresponds to a sampling frequency of 1 kHz. |

9.26.7.15.7 General registers

9.26.7.15.7.1 ActSpeed

Name:

ActSpeed01 to ActSpeed04

Registers for the current speed for calculating frequency bands 01 to 32 if they have been configured as speed-dependent.

The current speed must be specified in 1/100 Hz. In [Function model 0 - Standard](#), Automation Runtime handles this.

If the 4 different speed data points are not sufficient, e.g. for several different gear ratios, the speed ratio can also be included when calculating the standardized damage frequency for the frequency band ("[FrequencyBandDmgFreq60rpm](#)" on page 3095 register).

Characteristic value in [Function model 0 - Standard](#)

| Format | Values | Unit |
|--------|---------------------------|---------|
| REAL | 0 to 655.35 ¹⁾ | in 1 Hz |

1) The driver reduces larger values to 655.35.

Characteristic value in all other function models

| Format | Values | Unit |
|--------|-------------|-------------|
| UINT | 0 to 65,535 | in 1/100 Hz |

9.26.7.15.7.2 AutogainDelay

Name:

AutogainDelay01

This register can be used to configure the autogain delay for all 4 channels.

To ensure that even smaller signals can be calculated precisely, the autogain can be increased in steps. This happens if there has been no overflow in the number of measurement cycles configured in this register and all conditions for the next step were always met. If an overflow does occur, then autogain is reduced immediately by one step.

The unit for delaying autogain is specified in measurement cycles (300 ms).

| Data type | Values | Information |
|-----------|-------------|---|
| UINT | 1 to 65,535 | Number of measurement cycles. Bus controller default setting: 50 |

9.26.7.15.7.3 AutogainDelayRead

Name:

AutogainDelay01Read

Register for reading the current "[AutogainDelay](#)" on page 3056 configuration.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.26.7.15.7.4 Control

Name:

Control01

General control register for the module.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|--|-------|---|
| 0 | RequestBufferLock01 or RequestDataLock01 | 0 | Data should not be locked. |
| | | 1 | Data should be locked. |
| 1 | MinMaxUpdate01 | x | The acyclic minimum and maximum values are refreshed at each edge |
| 2 - 15 | Reserved | 0 | |

RequestBufferLock01 or RequestDataLock01

"Function model 0 - Standard" and "1 - Fast master"

RequestBufferLock01 can be used to lock all buffers and parameters on the module. When the bit is set to 1, all buffers (raw data and FFT) are locked starting at the beginning of the next measurement. Before a buffer can be uploaded, all the data it contains must be locked.

The characteristic values associated with the locked buffers are transferred in the Flatstream characteristic values as soon as BufferLockValid01 = 1.

Information:

Since the measurement is universal, the parameters associated with the buffers are only transferred once.

"Function model 2 - Slow master" and "254 - Bus controller"

RequestDataLock01 can be used to lock all parameters on the module. When the bit is set to 1, then a consistent version of all measured values is retained until the next measurement. Once all data on the module has been locked, all the calculated characteristic values can be read acyclically from the module.

Data on the module is only locked once bit BufferLockValid01 or DataLockValid01 in register "Status01" on page 3059 is set.

Once the data has been uploaded, the RequestBufferLock01 or RequestDataLock01 bit can be reset to 0. Once BufferLockValid01 or DataLockValid01 in register "Status01" on page 3059 are back to 0, the data on the module is no longer locked.

A new freezing is only permitted by the module if the buffers of the channel with the largest buffer length are filled again. The buffer length depends on the settings of registers "MaxFrequencyRaw" on page 3086 and "MaxFrequencyEnvelope" on page 3085.

MinMaxUpdate01

An edge on MinMaxUpdate01 updates all acyclic minimum and maximum values. A new cycle then starts internally to generate the minimum and maximum values that are again copied to the acyclic registers on the next edge. Once an edge has been reached, the current minimum and maximum values can be read acyclically in the next X2X cycle. Register "MinMaxCounter" on page 3081 specifies how many measurement cycles were analyzed with minimum and maximum mapping. The minimum/maximum values themselves are only valid if the counter has a value other than 0.

9.26.7.15.7.5 SensorConfig

Name:

SensorConfig01

This register can be used to enable or disable the IEPE sensor supply for individual channels.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|---------|--------------------------------------|-------|---|
| 0 | Channel 1: IEPE supply | 0 | Off (bus controller default setting) |
| | | 1 | On |
| ... | | ... | |
| 3 | Channel 4: IEPE supply | 0 | Off (bus controller default setting) |
| | | 1 | On |
| 4 - 7 | Reserved | 0 | |
| 8 | Channel 1: EnableVelocityCalculation | 0 | No calculation (bus controller default setting) |
| | | 1 | Calculation enabled |
| ... | | ... | |
| 11 | Channel 4: EnableVelocityCalculation | 0 | No calculation (bus controller default setting) |
| | | 1 | Calculation enabled |
| 12 - 13 | Reserved | 0 | |
| 14 | Buffer length | 0 | 8192 measured values (bus controller default setting) |
| | | 1 | 65535 measured values |
| 15 | Selects the function model | 0 | Function model 2 - Slow master and Function model 254 - Bus controller (bus controller default setting) |
| | | 1 | Function model 1 - Fast master |

EnableVelocityCalculation

This bit can be used to enable the calculation of all characteristic values calculated on the velocity spectrum.

If this calculation is not enabled, 0 is output for all characteristic values calculated on the velocity spectrum.

To maximize the precision of the characteristic values based on the acceleration spectrum, it is recommended to only enable this bit if the velocity signals are absolutely required.

9.26.7.15.7.6 SensorConfigRead

Name:

SensorConfig01Read

Register for reading the current "[SensorConfig](#)" on [page 3058](#) configuration.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.26.7.15.7.7 Status

Name:

Status01

General status register for the module.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|--|-------|---|
| 0 | Channel 1: BrokenWire01 | 0 | No error |
| | | 1 | Open circuit |
| ... | | ... | |
| 3 | Channel 4: BrokenWire04 | 0 | No error |
| | | 1 | Open circuit |
| 4 | BufferLockValid01 or DataLockValid01 ¹⁾ | 0 | Data not locked |
| | | 1 | Data locked, consistent and valid |
| 5 | Channel 1: Overflow01 | 0 | No error |
| | | 1 | Overflow of one or more characteristic values |
| ... | | ... | |
| 8 | Channel 4: Overflow04 | 0 | No error |
| | | 1 | Overflow of one or more characteristic values |
| 9 | Channel 1: AnalogInputToggleBit01 ²⁾ | 0 | Does not toggle |
| | | 1 | Toggles |
| ... | | ... | |
| 12 | Channel 4: AnalogInputToggleBit04 ²⁾ | 0 | Does not toggle |
| | | 1 | Toggles |
| 13 - 15 | Reserved | - | |

1) Confirmation of RequestBufferLock01 or RequestDataLock01 in register "Control" on page 3057

2) Toggles with each new calculation and each new input value in register "AnalogInput0x" on page 3061

9.26.7.15.8 Analog input functions

Each of the module's 4 accelerometer inputs can also be used directly as an analog input with various special functions (see register ["AnalogInput" on page 3061](#)).

The resolution of the analog inputs can be set using the configuration (["AnalogInputScale" on page 3064](#)). The lower the maximum value, the higher the resolution of the register and vice versa. When the maximum value is exceeded, the register is limited to the respective maximum (positive or negative).

A toggle bit ([AnalogInputToggleBit01-04](#)) signals when a new value has been transferred.

The following functions are available:

- Normal analog input function
- Characteristic value calculation in continuous mode with enable (continuous mode)
- Characteristic value calculation in trigger mode (single shot)

9.26.7.15.8.1 Measured values

The last 8 measured values before the X2X cycle are always averaged and transferred on the bus. Here, the direct input signal (raw signal max. 10 kHz) with a sampling frequency of 25.781 kHz is always used and is not mean-adjusted. The value is scaled according to the configuration. (see ["AnalogInputScale" on page 3064](#) register)

9.26.7.15.8.2 Characteristic value calculation in AnalogInput

The following characteristic values can be indicated directly in register ["AnalogInput" on page 3061](#). In this case, it is necessary to check the configured scale.

- Mean
- Peak value (absolute)
- RMS value
- Crest factor

There are 2 signals available to calculate the configured characteristic values:

- Input signal filtered to 10 kHz with a sampling frequency of 25.781 kHz and not mean-adjusted.
- Raw signal filtered to the maximum frequency with a sampling frequency that is dependent on the ["MaxFrequencyRaw" on page 3086](#) configuration and with mean adjustment using the last 8192 samples.

Register ["SamplesAnalogInput" on page 3065](#) can be used to set how many sampled values should be used to calculate the respective parameter. The time between 2 samples depends on the maximum frequency.

2 modes are available:

- ["Continuous mode with enable \(continuous mode\)" on page 3060](#)
- ["Trigger mode \(single shot\)" on page 3061](#)

Continuous mode with enable (continuous mode)

This mode offers the following advantages:

- When the parameters are configured correctly, nothing can be overlooked.
- Using "enable", measurement in the module can be started after an event or events can be hidden.
- The toggle bit toggles with every new value.

The following must be taken into consideration for the configuration:

- In order to guarantee seamless measurement, the sample time (number of samples * sample rate) must be longer than the X2X Link cycle (see register ["SamplesAnalogInput" on page 3065](#)).
- If a shorter sample time than the X2X Link cycle is configured, the last complete measurement is always transferred.

Information:

Values are lost in this mode. The measured values cannot be transferred to the bus because multiple values are calculated in each X2X Link cycle.

Trigger mode (single shot)

This mode offers the following advantages:

- Only one measurement is taken at a time.
- The trigger is edge-sensitive, so it can be retriggered in each X2X Link cycle.
- The toggle bit toggles with every new value.

The following must be taken into consideration for the configuration:

- A new trigger will be ignored during an ongoing measurement. The runtime on the bus can cause retriggering before the toggle bit has changed.
- If a shorter sample time than the X2X Link cycle time is configured, the last complete measurement is always transferred.
- In trigger mode, values are lost because the measured values are recorded acyclically to the X2X Link and cannot be synchronized continually.
- The trigger results in temporary synchronization with X2X Link.

9.26.7.15.8.3 AnalogInput

Name:

AnalogInput01 to AnalogInput04

Depending on the configuration, these registers contain

- The actual input value of the associated input averaged over the last 8 samples
- Or the characteristic value to be calculated using the configured number of samples

The value in the register is scaled according to the configuration of register "[AnalogInputScale](#)" on page 3064.

If scaling the value takes it outside of the permissible range of values for INT, then it will be limited to the minimum or maximum INT value. The overflow bit for the corresponding channel is not set in this case.

Information:

In Function model 0 - Standard, Automation Runtime automatically scales the analog input to mg or non-dimensional values (crest factor) while taking SensitivitySensor and AnalogInputScale into account. If the value of AnalogInput without sensor scaling exceeds the value range of AnalogInputScale related to 100 mV/g, the corresponding AnalogInputOverflow bit is set.

| Data type | Values |
|-----------|-----------------|
| INT | -32768 to 32767 |

9.26.7.15.8.4 AnalogInputConfig

Name:

AnalogInputConfig01

Register for configuring the characteristic value calculation in "AnalogInput" on page 3061. This is only needed if "SamplesAnalogInput" on page 3065 of the respective channel is greater than 0.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Description |
|-------|---|-------|---|
| 0 - 1 | Value to be calculated in AnalogInput01 | 0 | Mean value (bus controller default setting) |
| | | 1 | Peak value |
| | | 2 | RMS value |
| | | 3 | Crest factor |
| 2 - 3 | Value to be calculated in AnalogInput02 | x | For possible values, see bits 0-1. |
| 4 - 5 | Value to be calculated in AnalogInput03 | x | For possible values, see bits 0-1. |
| 6 - 7 | Value to be calculated in AnalogInput04 | x | For possible values, see bits 0-1. |
| 8 | Trigger mode of AnalogInput01 | 0 | Continuous with enable (bus controller default setting) |
| | | 1 | Once with trigger |
| ... | | ... | |
| 11 | Trigger mode of AnalogInput04 | 0 | Continuous with enable (bus controller default setting) |
| | | 1 | Once with trigger |
| 12 | Signal source for characteristic value calculation AnalogInput01 | 0 | Raw signal filtered to the configured maximum frequency (see "MaxFrequencyRaw" on page 3086) with mean value adjustment. ¹⁾ (Bus controller default setting) |
| | | 1 | Raw signal filtered to 10 kHz without mean adjustment |
| ... | | ... | |
| 15 | Signal source for characteristic value calculation of AnalogInput04 | 0 | Raw signal filtered to the configured maximum frequency (see "MaxFrequencyRaw" on page 3086) with mean value adjustment. ¹⁾ (Bus controller default setting) |
| | | 1 | Raw signal filtered to 10 kHz without mean adjustment |

1) The average of the last 8192 samples is used for mean adjustment.

9.26.7.15.8.5 AnalogInputConfigRead

Name:

AnalogInputConfig01Read

Register for reading the current AnalogInput01 configuration.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.26.7.15.8.6 AnalogInputControlByte

Name:

AnalogInputControlByte01

The control register for "AnalogInput" on page 3061 is only functional if the respective "SamplesAnalogInput" on page 3065 configuration register is greater than 0.

The configuration in "AnalogInputConfig" on page 3062 for the respective channel determines whether the respective bit is an enable or trigger bit.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|----------------------|-------|---|
| 0 | AnalogInputControl01 | x | See Function of the bit |
| ... | | ... | |
| 3 | AnalogInputControl04 | x | See Function of the bit |
| 4 - 15 | Reserved | 0 | |

Function of the bit

Function in continuous mode:

Bit to start the continuous characteristic value calculation of "AnalogInput".

0 = Calculation disabled

1 = Continuous calculation of characteristic values

Function in single-shot mode:

Bit to start a new characteristic value calculation of "AnalogInput".

0, 1 Every edge starts a new characteristic value calculation provided the previous one is already completed.

Characteristic value calculation

The characteristic value configured in "AnalogInputConfig" on page 3062 for the respective channel is calculated. The number of samples configured in "SamplesAnalogInput" on page 3065 is used. The calculated value is displayed in "AnalogInput" on page 3061 with the scaling of the respective channel configured in "AnalogInputScale" on page 3064. The value of AnalogInputToggleBit01-04 changes each time a new calculation takes place.

9.26.7.15.8.7 AnalogInputSamples

Name:

AnalogInputSamples01 to AnalogInputSamples04

If bit 15 of the respective "SamplesAnalogInput" on page 3065 register is 1, then this register cyclically defines the number of samples used to calculate characteristic values.

Information:

If the register is changed while a measurement is running, then the current measurement is discarded (AnalogInputToggleBit0X does not change). This is especially important to remember when using continuous mode with enable.

| Data type | Values | Information |
|-----------|-----------|--|
| UINT | 0 | Invalid |
| | 1 to 8191 | Characteristic value calculation active for the respective channel in the corresponding analog input |
| | >8191 | Invalid |

The time between 2 samples depends on register "MaxFrequencyRaw" on page 3086:

| Maximum frequency | Sampling time (time between 2 samples) |
|-------------------|--|
| 10000 Hz | 38.79 μ s |
| 5000 Hz | 77.58 μ s |
| 2000 Hz | 193.94 μ s |
| 1000 Hz | 387.88 μ s |
| 500 Hz | 775.76 μ s |
| 200 Hz | 1939.39 μ s |

9.26.7.15.8.8 AnalogInputScale

Name:

AnalogInputScale01

This register can be used to specify the scale of the 4 analog inputs ("[AnalogInput](#)" on page 3061). If the actual value is greater than the value configured in this register, the respective register for the analog input ("[AnalogInput](#)" on page 3061) is limited to the positive maximum (32767).

For example, if ± 128 is configured for AnalogInput04, then the 16 bits represent a value range of ± 128 g or without units if the crest factor has been calculated.

Information:

The configured scaling value is always based on a 100 mV/g sensor. Any sensor that has a different sensor sensitivity must be reflected in the configuration.

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| UINT | See bit structure. | 0x8888 |

Bit structure:

| Bit | Description | Value | Information |
|---------|---------------------------|-------|--|
| 0 - 3 | Scaling for AnalogInput01 | 0 | Invalid |
| | | 1 | ± 1 |
| | | 2 | ± 2 |
| | | 3 | ± 4 |
| | | 4 | ± 8 |
| | | 5 | ± 16 |
| | | 6 | ± 32 |
| | | 7 | ± 64 |
| | | 8 | ± 128 (bus controller default setting) |
| 9 to 15 | Invalid | | |
| 4 - 7 | Scaling for AnalogInput02 | x | For possible values, see AnalogInput01. |
| 8 - 11 | Scaling for AnalogInput03 | x | For possible values, see AnalogInput01. |
| 12 - 15 | Scaling for AnalogInput04 | x | For possible values, see AnalogInput01. |

9.26.7.15.8.9 AnalogInputScaleRead

Name:

AnalogInputScale01Read

This register can be used to read the scale of the analog inputs ("[AnalogInput](#)" on page 3061).

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.26.7.15.8.10 SamplesAnalogInput

Name:

SamplesAnalogInput01 to SamplesAnalogInput04

If the corresponding SamplesAnalogInput register is equal to 0, then the "AnalogInput" on page 3061 registers will provide the current input value for the analog input.

If the SamplesAnalogInput register is greater than 0, the characteristic value configured in register "AnalogInput-Config" on page 3062 for the respective channel is calculated. For this, the number of samples configured in this register will be used and displayed in the corresponding AnalogInput with the configured scaling.

If bit 15 of this register equals 1, then the characteristic value configured in "AnalogInputConfig01" for the respective channel is calculated. However, the number of samples specified cyclically in register "AnalogInputSamples" on page 3063 is used and displayed in the associated analog input with the configured scaling.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure

| Bit | Explanation | Values | Information |
|--------|-------------|-----------|---|
| 0 - 14 | | 0 | No characteristic value calculation of the respective channel in the associated analog input (bus controller default setting) |
| | | 1 to 8191 | Characteristic value calculation active for the respective channel in the corresponding analog input |
| | | >8191 | Invalid |
| 15 | | 0 | Cyclic specification of samplings via register "AnalogInputSamples" on page 3063 (bus controller default setting) |
| | | 1 | Sampling defined cyclically according to configuration of this register |

The time between 2 samples depends on register "MaxFrequencyRaw" on page 3086:

| Maximum frequency | Sampling time (time between 2 samples) |
|-------------------|--|
| 10000 Hz | 38.79 μ s |
| 5000 Hz | 77.58 μ s |
| 2000 Hz | 193.94 μ s |
| 1000 Hz | 387.88 μ s |
| 500 Hz | 775.76 μ s |
| 200 Hz | 1939.39 μ s |

9.26.7.15.8.11 SamplesAnalogInputRead

Name:

SamplesAnalogInput01Read to SamplesAnalogInput04Read

Register for reading the current "SamplesAnalogInput" on page 3065 configuration.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.26.7.15.9 Automation Runtime support

In [Function model 0 - Standard](#), Automation Runtime also prepares some of the characteristic values calculated by the module for the user.

Information:

To ensure error-free evaluation, it is important to observe the maximum cycle time. The module streams the characteristic values it calculates every 300 ms via Flatstream. If the streamed data is not collected by the next transfer, the measured characteristic values are lost.

Other features provided by Automation Runtime support:

- **"ActSpeed"**: The module always expects a value in 0.01 Hz resolution on these data points. Automation Runtime support allows the user to specify can state the current speed directly in Hz in the "standard" function model.
- **"AnalogInput"**: The analog input is automatically scaled to the sensor resolution and with the defined AnalogInputScale. It is then made available to the user in mg. This scaling does not apply to the **"Crest factor"** on page 3075 since it is a non-dimensional value.
- **Characteristic values and frequency bands**: All characteristic values and frequency bands calculated by the module are flat and can be connected directly in the I/O mapping. They are already scaled to the correct sensor resolution and will be displayed in mg or mm/s or as non-dimensional values (kurtosis, crest factor, skewness and Vdi3832) depending on the characteristic value.
- **Additional characteristic values**: In addition to the characteristic values calculated by the module, the following characteristic values are also provided automatically via Automation Runtime:
 - **Vdi3832KtRaw01-04** Requires PeakRawRef and RmsRawRef as reference values and outputs the reference values used in the calculation to PeakRawRefCalculated and RmsRawRefCalculated.
 - **CrestFactorHighFrequency01-04** Ratio of the absolute maximum to the RMS value (**"Crest factor"** on page 3075) of the high-pass filtered input signal. (**"PeakHighFrequency"** on page 3071 and **"RmsHighFrequency"** on page 3073)
 - **Vdi3832KtHighFrequency01-04** Requires PeakHighFrequencyRef and RmsHighFrequencyRef as reference values and outputs the reference values used in the calculated to PeakHighFrequencyRefCalculated and RmsHighFrequencyRefCalculated.

9.26.7.15.9.1 DataConsistentWithLockedBuffers

Name:

DataConsistentWithLockedBuffers01

If the data buffers on the module are locked to prevent uploading, this bit is used to indicate the time at which all characteristic values and frequency bands are consistent with the locked buffers on the module.

This register is only available in [Function model 0 - Standard](#) in the Automation Studio I/O mapping.

| Data type | Values |
|-----------|--------|
| BOOL | 0 or 1 |

9.26.7.15.9.2 DataToggleBit

Name:

DataToggleBit01

This bit changes its value whenever new characteristic values are loaded from the module and updated (approximately every 300 ms).

This register is only available in [Function model 0 - Standard](#) in the Automation Studio I/O mapping.

| Data type | Values |
|-----------|--------|
| BOOL | 0 or 1 |

9.26.7.15.9.3 OverflowAnalogInput

Name:

OverflowAnalogInput01 to OverflowAnalogInput04

Indicates whether a signal is pending on the input that is greater than the configured "AnalogInputScale" on page 3064.

Information:

This is always based on a 100 mV/g sensor.

This register is only available in [Function model 0 - Standard](#) in the Automation Studio I/O mapping.

| Data type | Values |
|-----------|--------|
| BOOL | 0 or 1 |

9.26.7.15.9.4 OverflowCharacteristicValues

Name:

OverflowCharacteristicValues01 to OverflowCharacteristicValues04

This register contains an overflow indicator bit for each characteristic value of the respective channel.

This register is only available in [Function model 0 - Standard](#) in the Automation Studio I/O mapping.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|--------------------------|-------|-------------|
| 0 | PeakHighFrequency | 0 | No error |
| | | 1 | Overflow |
| 1 | RmsHighFrequency | 0 | No error |
| | | 1 | Overflow |
| 2 | CrestFactorHighFrequency | 0 | No error |
| | | 1 | Overflow |
| 3 | Vdi3832KtHighFrequency | 0 | No error |
| | | 1 | Overflow |
| 4 | RmsAccEnvelope | 0 | No error |
| | | 1 | Overflow |
| 5 | RmsVelEnvelope | 0 | No error |
| | | 1 | Overflow |
| 6 | RmsAccRaw | 0 | No error |
| | | 1 | Overflow |
| 7 | RmsVelRaw | 0 | No error |
| | | 1 | Overflow |
| 8 | PeakRaw | 0 | No error |
| | | 1 | Overflow |
| 9 | CrestFactorRaw | 0 | No error |
| | | 1 | Overflow |
| 10 | SkewnessRaw | 0 | No error |
| | | 1 | Overflow |
| 11 | KurtosisRaw | 0 | No error |
| | | 1 | Overflow |
| 12 | Vdi3832KtRaw | 0 | No error |
| | | 1 | Overflow |
| 13 | Iso10816 | 0 | No error |
| | | 1 | Overflow |
| 14 | RmsRaw | 0 | No error |
| | | 1 | Overflow |
| 15 | Reserved | 0 | |

9.26.7.15.9.5 OverflowFrequencyBands

Name:

OverflowFrequencyBands01

This register contains an overflow indicator bit for each frequency band.

This register is only available in [Function model 0 - Standard](#) in the Automation Studio I/O mapping.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------|-------|-------------|
| 0 | FrequencyBand01 | 0 | No error |
| | | 1 | Overflow |
| ... | ... | ... | ... |
| 31 | FrequencyBand32 | 0 | No error |
| | | 1 | Overflow |

9.26.7.15.9.6 PeakHighFrequencyRef

Name:

PeakHighFrequencyRef01 to PeakHighFrequencyRef04

Reference value (correct state) specified from the application for the peak value of the high-pass filtered input signal used to calculate the Vdi3832 K(t) of the high-pass filtered input signal.

This register is only available in [Function model 0 - Standard](#) in the Automation Studio I/O mapping.

| Data type | Information |
|-----------|---|
| REAL | Range of values depends on sensor sensitivity |

9.26.7.15.9.7 PeakHighFrequencyRefCalculated

Name:

PeakHighFrequencyRefCalculated01 to PeakHighFrequencyRefCalculated04

Reference value (correct state) used by the module for the absolute maximum of the high-pass filtered input signal used to last calculate the Vdi3832 K(t) of the peak value.

This register is only available in [Function model 0 - Standard](#) in the Automation Studio I/O mapping.

| Data type | Information |
|-----------|---|
| REAL | Range of values depends on sensor sensitivity |

9.26.7.15.9.8 PeakRawRef

Name:

PeakRawRef01 to PeakRawRef04

Reference value (correct state) specified by the application for the absolute maximum of the raw signal used to calculate Vdi3832 K(t) of the raw signal.

This register is only available in [Function model 0 - Standard](#) in the Automation Studio I/O mapping.

| Data type | Information |
|-----------|---|
| REAL | Range of values depends on sensor sensitivity |

9.26.7.15.9.9 PeakRawRefCalculated

Name:

PeakRawRefCalculated01 to PeakRawRefCalculated04

Reference value (correct state) used by the module for the absolute maximum of the raw signal used to last calculate the Vdi3832 K(t) of the raw signal.

This register is only available in [Function model 0 - Standard](#) in the Automation Studio I/O mapping.

| Data type | Information |
|-----------|---|
| REAL | Range of values depends on sensor sensitivity |

9.26.7.15.9.10 RmsHighFrequencyRef

Name:

RmsHighFrequencyRef01 to RmsHighFrequencyRef04

Reference value (correct state) specified from the application for the RMS value of the high-pass filtered input signal used to calculate the Vdi3832 K(t) of the high-pass filtered input signal.

This register is only available in [Function model 0 - Standard](#) in the Automation Studio I/O mapping.

| Data type | Information |
|-----------|---|
| REAL | Range of values depends on sensor sensitivity |

9.26.7.15.9.11 RmsHighFrequencyRefCalculated

Name:

RmsHighFrequencyRefCalculated01 to RmsHighFrequencyRefCalculated04

Reference value (correct state) used by the module for the RMS value of the high-pass filtered input signal used to last calculate the Vdi3832 K(t) of the high-pass filtered input signal.

This register is only available in [Function model 0 - Standard](#) in the Automation Studio I/O mapping.

| Data type | Information |
|-----------|---|
| REAL | Range of values depends on sensor sensitivity |

9.26.7.15.9.12 RmsRawRef

Name:

RmsRawRef01 to RmsRawRef04

Reference value (correct state) specified by the application for the RMS value of the raw signal used to calculate Vdi3832 K(t) of the raw signal.

This register is only available in [Function model 0 - Standard](#) in the Automation Studio I/O mapping.

| Data type | Information |
|-----------|---|
| REAL | Range of values depends on sensor sensitivity |

9.26.7.15.9.13 RmsRawRefCalculated

Name:

RmsRawRefCalculated01 to RmsRawRefCalculated04

Reference value (correct state) used by the module for the RMS value of the raw signal used to last calculate the Vdi3832 K(t) of the raw signal.

This register is only available in [Function model 0 - Standard](#) in the Automation Studio I/O mapping.

| Data type | Information |
|-----------|---|
| REAL | Range of values depends on sensor sensitivity |

9.26.7.15.9.14 SensitivitySensor

Name:

SensitivitySensor01 to SensitivitySensor04

The module always calculates the characteristic values based on a 100 mV/g sensor on the input. If using a different sensor, the sensor sensitivity can be specified in mV/g for each channel on these registers. All cyclic characteristic values are then automatically scaled to the correct sensor resolution by Automation Runtime. If this parameter is changed, then the next measurement indicated by "[DataToggleBit](#)" on [page 3066](#) is invalid.

This register is only available in [Function model 0 - Standard](#) in the Automation Studio I/O mapping.

| Data type | Information |
|-----------|---|
| REAL | Range of values depends on sensor sensitivity |

9.26.7.15.10 Characteristic values

The following applies to all characteristic value module registers:

- These registers are only available in [Function model 2 - Slow master](#) and [Function model 254 - Bus controller](#).
- All calculated characteristic values can be locked using RequestDataLock01, which allows all registers to be read in a consistent manner.

The following characteristic values can be read from the X20CM4810 module for each channel:

| Characteristic values | Description |
|---|---|
| PeakHighFrequency | Absolute maximum of the high-pass filtered input signal. |
| CrestFactorHighFrequency¹⁾ | Ratio of the absolute maximum to the RMS value of the high-pass filtered input signal |
| Vdi3832KtHighFrequency¹⁾ | Ratio between the reference values and the currently measured values of the high-pass filtered input signal in accordance with the VDI 3832 guideline |
| PeakRaw | Peak value (absolute) of the input signal up to the configured maximum frequency |
| CrestFactorRaw | Ratio of the absolute maximum to the RMS value of the input signal up to the configured maximum frequency |
| SkewnessRaw | Skewness (third statistical moment) of the input signal up to the configured maximum frequency |
| KurtosisRaw | Kurtosis (fourth statistical moment) of the input signal up to the configured maximum frequency |
| Vdi3832KtRaw¹⁾ | Ratio between the reference values and the currently measured values of the input signal in accordance with the VDI 3832 guideline |
| RmsHighFrequency | RMS value of the high-pass filtered input signal |
| RmsRaw | RMS value of the input signal up to the configured maximum frequency |
| RmsAccRaw | RMS value of the input signal's acceleration from the configured minimum frequency up to the configured maximum frequency |
| RmsVelRaw | RMS value of the input signal's speed from the configured minimum frequency up to the configured maximum frequency ²⁾ |
| Iso10816 | RMS value of the velocity in the frequency domain 10 Hz to 1 kHz in accordance with ISO 10816 |
| RmsAccEnvelope | RMS value of the acceleration of the input signal's envelope from the configured minimum frequency up to the configured maximum frequency |
| RmsVelEnvelope | RMS value of the speed of the input signal's envelope from the configured minimum frequency up to the configured maximum frequency ²⁾ |

1) Only in [Function model 0 - Standard](#)

2) Only calculated if the EnableVelocityCalculation bit (configured in the "[SensorConfig](#)" on [page 3058](#) register) of the respective channel is set; otherwise, 0 is output.

9.26.7.15.10.1 Sum of maximum value

The maximum value is often also referred to as the peak value.

The peak value of a mechanical oscillation signal indicate the maximum sum of individual impacts that come from the ambient noise. Different types of damage give rise to strong impacts, which show up in the peak value.

PeakHighFrequency

Name:

PeakHighFrequency01 to PeakHighFrequency04

Registers for reading the absolute maximum of the high-pass filtered input signal of the respective channel.

PeakHighFrequency is formed from the high-pass filtered input signal of the oscillation acceleration in the frequency domain between the value set in register "[HighFrequencyConfig](#)" on page 3085 and 10 kHz.

Characteristic value in [Function model 0 - Standard](#)

| Format | Unit | Value on overflow |
|--------|------|-------------------|
| REAL | mg | 256000.0 |

Characteristic value in all other function models

| Format | Resolution and unit | Value on overflow |
|--------|---------------------|-------------------|
| UDINT | 1/65536 g | 16777215 |

PeakRaw

Name:

PeakRaw01 to PeakRaw04

Registers for reading the absolute maximum of the raw signal of the respective channel.

PeakRaw is formed from the raw signal of the oscillation acceleration up to the maximum frequency configured in register "[MaxFrequencyRaw](#)" on page 3086.

Characteristic value in [Function model 0 - Standard](#)

| Format | Unit | Value on overflow |
|--------|------|-------------------|
| REAL | mg | 256000.0 |

Characteristic value in all other function models

| Format | Resolution and unit | Value on overflow |
|--------|---------------------|-------------------|
| UDINT | 1/65536 g | 16777215 |

9.26.7.15.10.2 RMS value

The RMS value is also known as the quadratic mean, or the root-mean-square. Along with the amplitude, it also takes the energy content of the oscillation into consideration and is the mathematical background for many characteristic values of assessment.

If the RMS is calculated to be above the oscillation velocity, this can be referred to as oscillation speed. In the RMS value, everything contributing to the oscillation is added up. The high oscillation amplitudes of an imbalance are the same as the low oscillation level of bearing damage that is just beginning to occur.

If the RMS value is measured broadly, changes in individual elements contributing to the oscillation can be masked by the averaging. The ability to detect damage early, e.g. due to defects in roller bearings, is limited.

Iso10816

Name:

Iso10816_01 to Iso10816_04

Registers for reading the RMS value (per ISO 10816) of the respective channel.

Iso10816 is formed from the raw signal of the oscillation velocity in a frequency range from 10 Hz to 1 kHz.

This broad characteristic value is often used in the assessment of the machine condition since assessment limits are specified for this characteristic value in the standard. These depend on the type of machine and type of installation (rigid or elastic). The characteristic value limits for a pre-warning or a warning are given according to their defined classification.

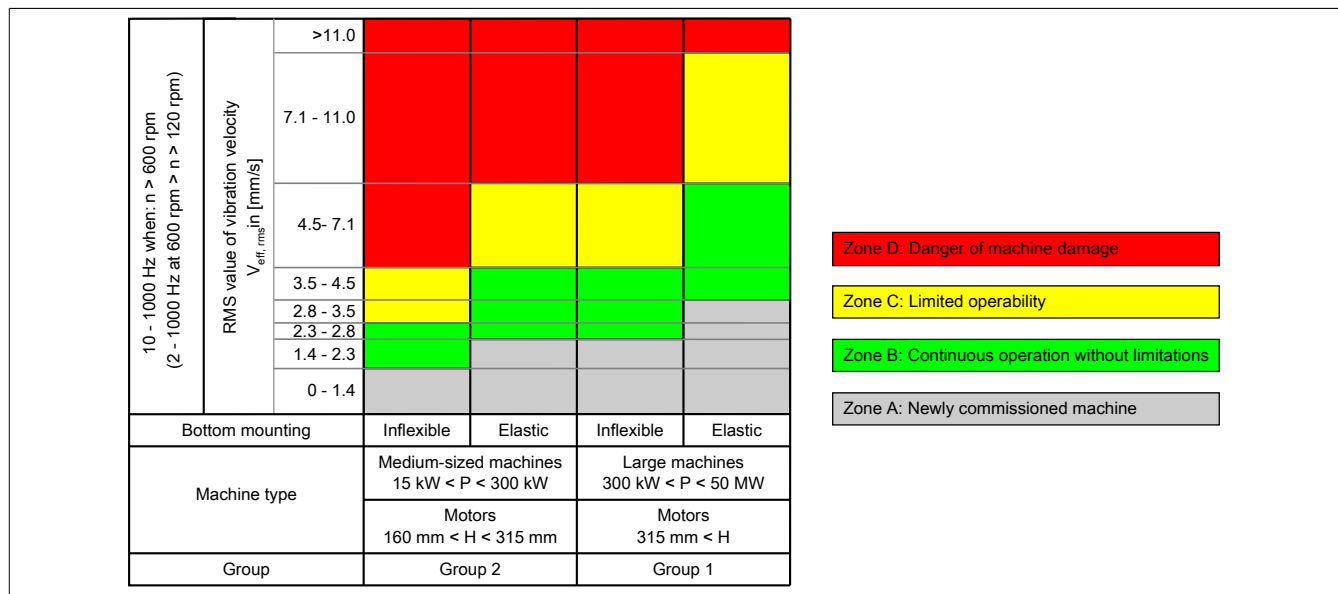


Figure 199: ISO assessment scheme

If the machine condition is in order, this characteristic value is low. If damage occurs, then this value increases severely. If the RMS is assessed in the range of the oscillation velocity, lower frequency portions such as drive speed (and associated imbalance and/or misalignment) that are emphasized more and reflected more heavily in the characteristic value.

Characteristic value in [Function model 0 - Standard](#)

| Format | Unit | Value on overflow |
|--------|------|-------------------|
| REAL | mm/s | 16777.21 |

Characteristic value in all other function models

| Format | Resolution and unit | Value on overflow |
|--------|---------------------|-------------------|
| UDINT | 0.001 mm/s | 16777215 |

RmsAccEnvelope

Name:

RmsAccEnvelope01 to RmsAccEnvelope04

Registers for reading the RMS value of the envelope signal of the respective channel.

RmsAccEnvelope is formed from the envelope signal of the oscillation acceleration from the configured minimum frequency ("[MinFrequencyEnvelope](#)" on page 3087) to the configured maximum frequency ("[MaxFrequencyEnvelope](#)" on page 3085).

Characteristic value in [Function model 0 - Standard](#)

| Format | Unit | Value on overflow |
|--------|------|-------------------|
| REAL | mg | 1.677722E+7 |

Characteristic value in all other function models

| Format | Resolution and unit | Value on overflow |
|--------|---------------------|-------------------|
| UDINT | 0.001 g | 16777215 |

RmsAccRaw

Name:

RmsAccRaw01 to RmsAccRaw04

Registers for reading the acceleration RMS value of the respective channel.

RmsAccRaw is formed from the raw signal of the oscillation acceleration from the configured minimum frequency ("[MinFrequencyRaw](#)" on page 3088) to the configured maximum frequency ("[MaxFrequencyRaw](#)" on page 3086).

Characteristic value in [Function model 0 - Standard](#)

| Format | Unit | Value on overflow |
|--------|------|-------------------|
| REAL | mg | 1.677722E+7 |

Characteristic value in all other function models

| Format | Resolution and unit | Value on overflow |
|--------|---------------------|-------------------|
| UDINT | 0.001 g | 16777215 |

RmsHighFrequency

Name:

RmsHighFrequency01 to RmsHighFrequency04

Registers for reading the high-pass RMS value of the respective channel.

RmsHighFrequency is formed from the high-pass filtered input signal of the oscillation acceleration in the frequency domain between the value set in register "[HighFrequencyConfig](#)" on page 3085 and 10 kHz.

Characteristic value in [Function model 0 - Standard](#)

| Format | Unit | Unit on overflow |
|--------|------|------------------|
| REAL | mg | 256000.0 |

Characteristic value in all other function models

| Format | Resolution and unit | Value on overflow |
|--------|---------------------|-------------------|
| UDINT | 1/65536 g | 16777215 |

RmsRaw

Name:

RmsRaw01 to RmsRaw04

Registers for reading the raw signal RMS value of the respective channel.

RmsRaw is formed from the raw signal of the oscillation acceleration up to the maximum frequency configured in register "[MaxFrequencyRaw](#)" on page 3086.Characteristic value in [Function model 0 - Standard](#)

| Format | Unit | Value on overflow |
|--------|------|-------------------|
| REAL | mg | 256000.0 |

Characteristic value in all other function models

| Format | Resolution and unit | Value on overflow |
|--------|---------------------|-------------------|
| UDINT | 1/65536 g | 16777215 |

RmsVelEnvelope

Name:

RmsVelEnvelope01 to RmsVelEnvelope04

Registers for reading the RMS value of the envelope velocity of the respective channel.

RmsVelEnvelope is formed from the envelope signal of the oscillation acceleration from the configured minimum frequency ("[MinFrequencyEnvelope](#)" on page 3087) to the configured maximum frequency ("[MaxFrequencyEnvelope](#)" on page 3085).This characteristic value is only calculated if the EnableVelocityCalculation bit (configuration in register "[Sensor-Config](#)" on page 3058) is set for the respective channel; otherwise, 0 is output.Characteristic value in [Function model 0 - Standard](#)

| Format | Unit | Value on overflow |
|--------|------|-------------------|
| REAL | mm/s | 16777.21 |

Characteristic value in all other function models

| Format | Resolution and unit | Value on overflow |
|--------|---------------------|-------------------|
| UDINT | 0.001 mm/s | 16777215 |

RmsVelRaw

Name:

RmsVelRaw01 to RmsVelRaw04

Registers for reading the velocity RMS value of the respective channel.

RmsVelRaw is formed from the raw signal of the oscillation velocity from the configured minimum frequency ("[MinFrequencyRaw](#)" on page 3088) to the configured maximum frequency ("[MaxFrequencyRaw](#)" on page 3086).This characteristic value is only calculated if the EnableVelocityCalculation bit (configuration in register "[Sensor-Config](#)" on page 3058) is set for the respective channel; otherwise, 0 is output.Characteristic value in [Function model 0 - Standard](#)

| Format | Unit | Value on overflow |
|--------|------|-------------------|
| REAL | mm/s | 16777.21 |

Characteristic value in all other function models

| Format | Resolution and unit | Value on overflow |
|--------|---------------------|-------------------|
| UDINT | 0.001 mm/s | 16777215 |

9.26.7.15.10.3 Crest factor

The crest factor is defined as the quotient derived from the peak value and the RMS value. In a sinusoidal oscillation, this factor amounts to $\sqrt{2}$. This value is also known in electrical engineering as the crest factor.

In a bearing that is operating normally, the crest factor is also approximately the value $\sqrt{2}$. If the condition of the bearing deteriorates, individual impacts affect the peak value and consequently raise the crest factor. If pronounced defects are then compounded by overall wear, the RMS value is increased further. In the worst case, the crest factor can remain unchanged or even sink again, even despite increasing damage.

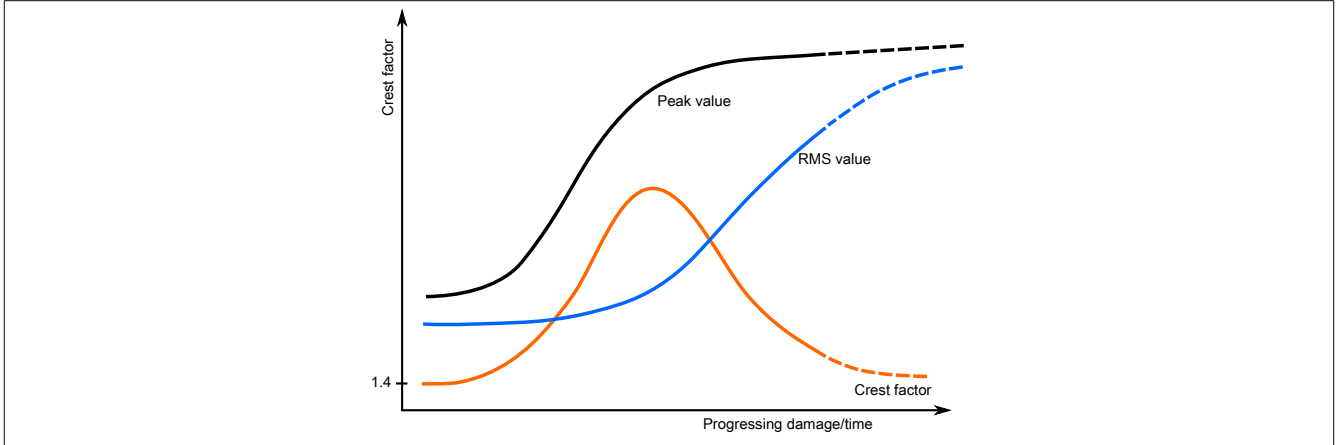


Figure 200: Relationship between the RMS value and peak value

Information:

When a recording of the crest factor is made, the peak and RMS values should also be recorded.

CrestFactorHighFrequency

Name:

CrestFactorHighFrequency01 to CrestFactorHighFrequency04

Registers for reading the raw value ratio of the absolute maximum ("[PeakHighFrequency](#)" on page 3071) to the RMS value ("[RmsHighFrequency](#)" on page 3073) of the respective channel.

CrestFactorHighFrequency is formed from the high-pass filtered input signal of the oscillation acceleration in the frequency domain between the value set in register "[HighFrequencyConfig](#)" on page 3085 and 10 kHz.

This register is only available in [Function model 0 - Standard](#) in the Automation Studio I/O mapping.

| Format | Unit |
|--------|------|
| REAL | 1 |

CrestFactorRaw

Name:

CrestFactorRaw01 to CrestFactorRaw04

Registers for reading the raw value ratio of the absolute maximum to the RMS value of the respective channel.

CrestFactorRaw is formed from the raw signal of the oscillation acceleration up to the maximum frequency configured in register "[MaxFrequencyRaw](#)" on page 3086.

Since this register value is divided by the RMS value in the module ("[RmsRaw](#)" on page 3074), there may be an overflow if the RMS value is very small. To prevent this, the module has an internal lower limit of 1 mg for the RMS value.

Characteristic value in [Function model 0 - Standard](#)

| Format | Unit |
|--------|------|
| REAL | 1 |

Characteristic value in all other function models

| Format | Resolution and unit | Value on overflow |
|--------|---------------------|-------------------|
| UDINT | 0.001 | 16777215 |

9.26.7.15.10.4 K(t) value

The K(t) is described in the VDI 3832 guideline and is calculated from the RMS value and the absolute maximum of a broadband time signal of the oscillation acceleration. For the time signal, the entire available frequency spectrum is used for calculation.

This ratio correlates to the reference values. The reference values should be measured by the operator shortly after the running-in time. These values can be classified as "Plant in order" and are therefore the initial values.

The K(t) value decreases with progressive wear. This allows it to be classified into 3 groups:

- Undamaged
- Early damage
- Pronounced damage

The advantage of the K(t) value is that does not change much, even when damage is severe.

$$K(t) = \frac{a_{\text{RMS}}(0) \cdot a_p(0)}{a_{\text{RMS}}(t) \cdot a_p(t)}$$

The following applies:

| Formula symbols | Explanation | Characteristic value in the module |
|---------------------|--------------------------------------|------------------------------------|
| $a_{\text{rms}}(0)$ | RMS value of the reference value | RmsHighFrequencyRef RmsRawRef |
| $a_p(0)$ | Maximum value of the reference value | PeakHighFrequencyRef PeakRawRef |
| $a_{\text{rms}}(t)$ | Current RMS value | RmsHighFrequency RmsRaw |
| $a_p(t)$ | Current absolute maximum | PeakHighFrequency ReakRaw |

Example

Possible progression of the (K/t) characteristic value

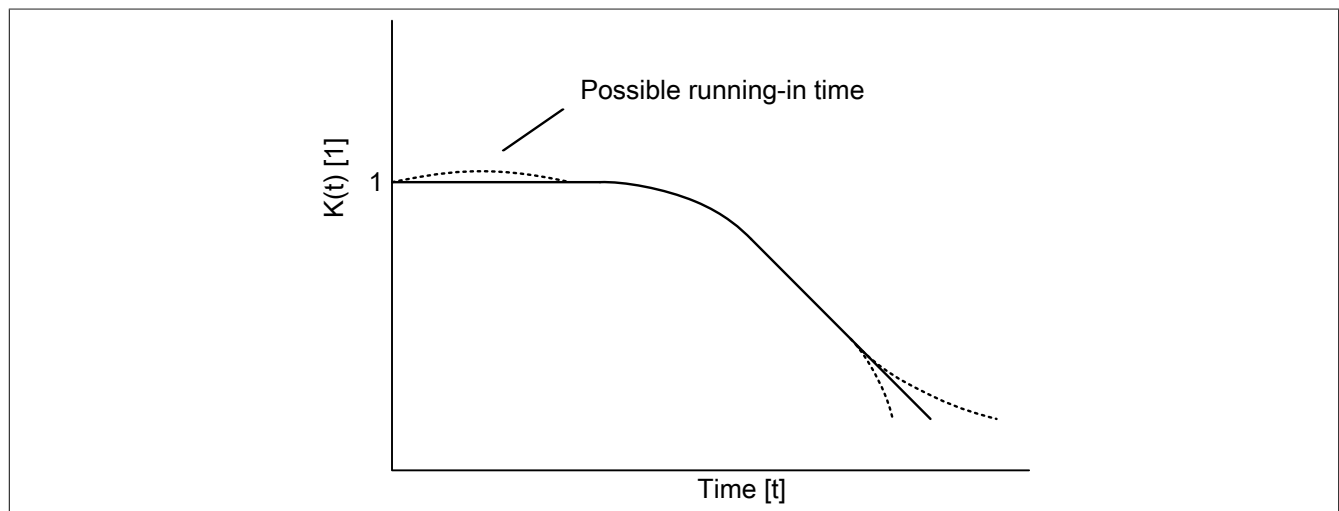


Figure 201: K(t) value progression

Vdi3832KtHighFrequency

Name:

Vdi3832KtHighFrequency01 to Vdi3832KtHighFrequency04

Registers for reading the high-pass K(t) value (per VDI 3832 guideline) of the respective channel.

Vdi3832KtHighFrequency is formed from the peak value ("[PeakHighFrequency](#)" on page 3071) and RMS value ("[RmsHighFrequency](#)" on page 3073) of the high-pass filtered input signal and the vibration acceleration in the frequency range between the value set in register "[HighFrequencyConfig](#)" on page 3085 and 10 kHz.

This register is only available in [Function model 0 - Standard](#) in the Automation Studio I/O mapping.

| Format | Unit |
|--------|------|
| REAL | 1 |

Vdi3832KtRaw

Name:

Vdi3832KtRaw01 to Vdi3832KtRaw04

Registers for reading the raw K(t) value (per VDI 3832 guideline) of the respective channel.

Vdi3832KtRaw is formed from the raw signal of the oscillation acceleration up to the maximum frequency configured in register "[MaxFrequencyRaw](#)" on page 3086.

This register is only available in [Function model 0 - Standard](#) in the Automation Studio I/O mapping.

| Format | Unit |
|--------|------|
| REAL | 1 |

9.26.7.15.10.5 Kurtosis

Kurtosis is an effective characteristic value for assessing the number of peaks in a signal. Kurtosis (peakedness, fourth statistical moment) is defined as the ratio of two statistical characteristic values/processes.

Kurtosis is a type of weighted [Crest factor](#). The signal peaks are valued higher than the "signal noise" (also called the carpet value) due to the fourth power of the integral. Not only is the RMS value also used, but the entire signal progression as well. This increases the informational value of this characteristic value.

Information:

The kurtosis factor is standardized at 0 in the module.

A kurtosis factor of less than 2 is typical of a machine in good condition.

KurtosisRaw

Name:

KurtosisRaw01 to KurtosisRaw04

Registers to read the kurtosis factor of the respective channel.

KurtosisRaw is formed from the raw signal of the oscillation acceleration up to the maximum frequency configured in register "[MaxFrequencyRaw](#)" on page 3086.

Since this register value is divided by the RMS value in the module ("[RmsRaw](#)" on page 3074), there may be an overflow if the RMS value is very small. To prevent this, the module has an internal lower limit of 1 mg for the RMS value.

Characteristic value in [Function model 0 - Standard](#)

| Format | Unit |
|--------|------|
| REAL | 1 |

Characteristic value in all other function models

| Format | Resolution and unit | Value on overflow |
|--------|---------------------|-------------------|
| DINT | 0.001 | 8388607 |

9.26.7.15.10.6 Skewness factor

The skewness factor (skewness, third statistical moment) specifies the degree of a signal's asymmetry in reference to its standard distribution. The lower the skewness, the more evenly distributed the signal. A signal with a high skewness factor has many large amplitudes in the assessment range.

A symmetrically distributed signal has a skewness factor of 0. Depending on the direction of the slant, the skewness can be positive or negative. A considerable slant means approximately a skewness factor of ± 1 .

A large kurtosis factor combined with a large skewness factor indicates electrostatic discharge.

SkewnessRaw

Name:

SkewnessRaw01 to SkewnessRaw04

Registers to read the skewness factor of the respective channel.

SkewnessRaw is formed from the raw signal of the oscillation acceleration up to the maximum frequency configured in register "[MaxFrequencyRaw](#)" on page 3086.

Since this register value is divided by the RMS value in the module ("[RmsRaw](#)" on page 3074), there may be an overflow if the RMS value is very small. To prevent this, the module has an internal lower limit of 1 mg for the RMS value.

Characteristic value in [Function model 0 - Standard](#)

| Format | Unit |
|--------|------|
| REAL | 1 |

Characteristic value in all other function models

| Format | Resolution and unit | Value on overflow |
|--------|---------------------|-------------------|
| DINT | 0.001 | 8388607 |

9.26.7.15.10.7 FrequencyBand

Name:

FrequencyBand01 to FrequencyBand32

Registers for reading the respective frequency band.

If the frequency band is configured to a velocity signal, this value is only calculated if bit EnableVelocityCalculation (configuration in register "[SensorConfig](#)" on page 3058) of the corresponding channel is set; otherwise, 0 is output.

For more information, see "[Frequency bands](#)" on page 3055.

| Format | Resolution and unit | Value on overflow |
|-----------------|---|-------------------|
| 24-bit unsigned | 0.001 g or 0.001 mm/s Depends on the configuration | 16777215 |
| 24-bit unsigned | 1/65536 g or 1/65536 mm/s Depends on the configuration | 16777215 |

Parameter after preparation by Automation Runtime in [Function model 0 - Standard](#)

| Format | Unit |
|--------|---|
| REAL | mg or mm/s depending on the configuration |

9.26.7.15.11 Characteristic values (minimum and maximum)

The module's characteristic values are recalculated every 300 ms. To prevent values from being lost, it is necessary to collect this data quickly enough. If this is not possible, the characteristic values on the module can be locked using data point RequestDataLock01 and then read acyclically in [Function model 2 - Slow master](#) and [Function model 254 - Bus controller](#). However, measurements are lost.

To prevent measurements from being lost, a special function has been implemented in the module that records the minimum and maximum values of all characteristic values calculated in the module. With each edge of bit MinMayUpdate01 in register "Control" on [page 3057](#), a new measurement can be started whereby the minimum and maximum values are reinitialized. Simultaneously, the current data is copied to the acyclic registers.

The number of collected measurements can then be read using acyclic register "MinMaxCounter" on [page 3081](#). The respective values are read using the acyclic minimum and maximum registers.

Example

For Iso10816, these are the Iso10816Min01-04 and Iso10816Max01-04 registers.

Information:

- If data is locked with RequestDataLock01, no further measured values are collected. This only affects [Function model 2 - Slow master](#) and [Function model 254 - Bus controller](#) since the characteristic values are not locked in the standard function model.
- If a characteristic value overflow or open circuit occurs, no new values are collected.
- The minimum and maximum registers are each initialized using the maximum and minimum of the respective data type. If there is no valid value on the characteristic value for the overall measurement, then the initial value is retained (e.g. on overflow, open circuit or locked data).
- If the data on the module is frozen (DataLockValid01 = 1), no new values are included in the minimum formation, but the measurement cycles are still counted.

The registers are only updated on an edge of "MinMaxUpdate01" on [page 3057](#) and only valid if "MinMaxCounter" on [page 3081](#) is not equal to 0. Register "MinMaxCounter" on [page 3081](#) specifies the number of collected measurement cycles for the minimum and maximum.

9.26.7.15.11.1 CrestFactorRawMax

Name:

CrestFactorRawMax01 to CrestFactorRawMax04

Maximum value of the "CrestFactorRaw" on page 3075 characteristic value of the respective channel in 1/1000.

Since this register value is divided by the RMS value in the module ("RmsRaw" on page 3074), there may be an overflow if the RMS value is very small. To prevent this, the module has an internal lower limit of 1 mg for the RMS value.

See also "Characteristic values (minimum and maximum)" on page 3079 for additional information.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.7.15.11.2 CrestFactorRawMin

Name:

CrestFactorRawMin01 to CrestFactorRawMin04

Minimum value of the "CrestFactorRaw" on page 3075 characteristic value of the respective channel in 1/1000.

Since this register value is divided by the RMS value in the module ("RmsRaw" on page 3074), there may be an overflow if the RMS value is very small. To prevent this, the module has an internal lower limit of 1 mg for the RMS value.

See also "Characteristic values (minimum and maximum)" on page 3079 for additional information.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.7.15.11.3 Iso10816Max

Name:

Iso10816Max01 to Iso10816Max04

Maximum value of the "Iso10816" on page 3072 characteristic value of the respective channel in 1/1000 mm/s.

See also "Characteristic values (minimum and maximum)" on page 3079 for additional information.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.7.15.11.4 Iso10816Min

Name:

Iso10816Min01 to Iso10816Min04

Minimum value of the "Iso10816" on page 3072 characteristic value of the respective channel in 1/1000 mm/s.

See also "Characteristic values (minimum and maximum)" on page 3079 for additional information.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.7.15.11.5 KurtosisRawMax

Name:

KurtosisRawMax01 to KurtosisRawMax04

Maximum value of the "KurtosisRaw" on page 3077 characteristic value of the respective channel in 1/1000.

Since this register value is divided by the RMS value in the module ("RmsRaw" on page 3074), there may be an overflow if the RMS value is very small. To prevent this, the module has an internal lower limit of 1 mg for the RMS value.

See also "Characteristic values (minimum and maximum)" on page 3079 for additional information.

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

9.26.7.15.11.6 KurtosisRawMin

Name:

KurtosisRawMin01 to KurtosisRawMin04

Minimum value of the "[KurtosisRaw](#)" on page 3077 characteristic value of the respective channel in 1/1000.

Since this register value is divided by the RMS value in the module ("[RmsRaw](#)" on page 3074), there may be an overflow if the RMS value is very small. To prevent this, the module has an internal lower limit of 1 mg for the RMS value.

See also "[Characteristic values \(minimum and maximum\)](#)" on page 3079 for additional information.

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

9.26.7.15.11.7 MinMaxCounter

Name:

MinMaxCounter01

This register specifies how many measurements were collected the last time the minimum and maximum were determined. It is only updated when an edge occurs for MinMaxUpdate01. If the MinMaxUpdate01 bit is not toggled after 65535 measurements, then the counter is limited to 65535. However, the minimum and maximum formation continues. All acyclic minimum and maximum values are only valid if "[MinMaxCounter](#)" on page 3081 is not equal to 0.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.26.7.15.11.8 PeakHighFrequencyMax

Name:

PeakHighFrequencyMax01 to PeakHighFrequencyMax04

Maximum value of the "[PeakHighFrequency](#)" on page 3071 characteristic value of the respective channel in 1/65536 g.

See also "[Characteristic values \(minimum and maximum\)](#)" on page 3079 for additional information.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.7.15.11.9 PeakHighFrequencyMin

Name:

PeakHighFrequencyMin01 to PeakHighFrequencyMin04

Minimum value of the "[PeakHighFrequency](#)" on page 3071 characteristic value of the respective channel in 1/65536 g.

See also "[Characteristic values \(minimum and maximum\)](#)" on page 3079 for additional information.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.7.15.11.10 PeakRawMax

Name:

PeakRawMax01 to PeakRawMax04

Maximum value of the "[PeakRaw](#)" on page 3071 characteristic value of the respective channel in 1/65536 g.

See also "[Characteristic values \(minimum and maximum\)](#)" on page 3079 for additional information.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.7.15.11.11 PeakRawMin

Name:

PeakRawMin01 to PeakRawMin04

Minimum value of the "PeakRaw" on page 3071 characteristic value of the respective channel in 1/65536 g.

See also "Characteristic values (minimum and maximum)" on page 3079 for additional information.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.7.15.11.12 RmsAccEnvelopeMax

Name:

RmsAccEnvelopeMax01 to RmsAccEnvelopeMax04

Maximum value of the "RmsAccEnvelope" on page 3073 characteristic value of the respective channel in 1/1000 g.

See also "Characteristic values (minimum and maximum)" on page 3079 for additional information.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.7.15.11.13 RmsAccEnvelopeMin

Name:

RmsAccEnvelopeMin01 to RmsAccEnvelopeMin04

Minimum value of the "RmsAccEnvelope" on page 3073 characteristic value of the respective channel in 1/1000 g.

See also "Characteristic values (minimum and maximum)" on page 3079 for additional information.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.7.15.11.14 RmsAccRawMax

Name:

RmsAccRawMax01 to RmsAccRawMax04

Maximum value of the "RmsAccRaw" on page 3073 characteristic value of the respective channel in 1/1000 g.

See also "Characteristic values (minimum and maximum)" on page 3079 for additional information.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.7.15.11.15 RmsAccRawMin

Name:

RmsAccRawMin01 to RmsAccRawMin04

Minimum value of the "RmsAccRaw" on page 3073 characteristic value of the respective channel in 1/1000 g.

See also "Characteristic values (minimum and maximum)" on page 3079 for additional information.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.7.15.11.16 RmsHighFrequencyMax

Name:

RmsHighFrequencyMax01 to RmsHighFrequencyMax04

Maximum value of the "RmsHighFrequency" on page 3073 characteristic value of the respective channel in 1/65536 g.

See also "Characteristic values (minimum and maximum)" on page 3079 for additional information.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.7.15.11.17 RmsHighFrequencyMin

Name:

RmsHighFrequencyMin01 to RmsHighFrequencyMin04

Minimum value of the "PeakHighFrequency" on page 3071 characteristic value of the respective channel in 1/65536 g.

See also "Characteristic values (minimum and maximum)" on page 3079 for additional information.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.7.15.11.18 RmsRawMax

Name:

RmsRawMax01 to RmsRawMax04

Maximum value of the "RmsRaw" on page 3074 characteristic value of the respective channel in 1/65536 g.

See also "Characteristic values (minimum and maximum)" on page 3079 for additional information.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.7.15.11.19 RmsRawMin

Name:

RmsRawMin01 to RmsRawMin04

Minimum value of the "RmsRaw" on page 3074 characteristic value of the respective channel in 1/65536 g.

See also "Characteristic values (minimum and maximum)" on page 3079 for additional information.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.7.15.11.20 RmsVelEnvelopeMax

Name:

RmsVelEnvelopeMax01 to RmsVelEnvelopeMax04

Maximum value of the "RmsVelEnvelope" on page 3074 characteristic value of the respective channel in 1/1000 mm/s.

See also "Characteristic values (minimum and maximum)" on page 3079 for additional information.

This value is only calculated if the EnableVelocityCalculation bit (configuration in register "SensorConfig" on page 3058) is set for the respective channel; otherwise, 0 is output.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.7.15.11.21 RmsVelEnvelopeMin

Name:

RmsVelEnvelopeMin01 to RmsVelEnvelopeMin04

Minimum value of the "RmsVelEnvelope" on page 3074 characteristic value of the respective channel in 1/1000 mm/s.

See also "Characteristic values (minimum and maximum)" on page 3079 for additional information.

This value is only calculated if the EnableVelocityCalculation bit (configuration in register "SensorConfig" on page 3058) is set for the respective channel; otherwise, 0 is output.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.7.15.11.22 RmsVelRawMin

Name:

RmsVelRawMin01 to RmsVelRawMin04

Minimum value of the "RmsVelRaw" on page 3074 characteristic value of the respective channel in 1/1000 mm/s.

See also "Characteristic values (minimum and maximum)" on page 3079 for additional information.

This value is only calculated if the EnableVelocityCalculation bit (configuration in register "SensorConfig" on page 3058) is set for the respective channel; otherwise, 0 is output.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.7.15.11.23 RmsVelRawMax

Name:

RmsVelRawMax01 to RmsVelRawMax04

Maximum value of the "RmsVelRaw" on page 3074 characteristic value of the respective channel in 1/1000 mm/s.

See also "Characteristic values (minimum and maximum)" on page 3079 for additional information.

This value is only calculated if the EnableVelocityCalculation bit (configuration in register "SensorConfig" on page 3058) is set for the respective channel; otherwise, 0 is output.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.7.15.11.24 SkewnessRawMax

Name:

SkewnessRawMax01 to SkewnessRawMax04

Maximum value of the "SkewnessRaw" on page 3078 characteristic value of the respective channel in 1/1000.

Since this register value is divided by the RMS value in the module ("RmsRaw" on page 3074), there may be an overflow if the RMS value is very small. To prevent this, the module has an internal lower limit of 1 mg for the RMS value.

See also "Characteristic values (minimum and maximum)" on page 3079 for additional information.

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

9.26.7.15.11.25 SkewnessRawMin

Name:

SkewnessRawMin01 to SkewnessRawMin04

Minimum value of the "SkewnessRaw" on page 3078 characteristic value of the respective channel in 1/1000.

Since this register value is divided by the RMS value in the module ("RmsRaw" on page 3074), there may be an overflow if the RMS value is very small. To prevent this, the module has an internal lower limit of 1 mg for the RMS value.

See also "Characteristic values (minimum and maximum)" on page 3079 for additional information.

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

9.26.7.15.12 Frequency band configuration registers

9.26.7.15.12.1 HighFrequencyConfig

Name:

HighFrequencyConfig01

Register for defining the envelope signal high-pass and characteristic values "[PeakHighFrequency](#)" on page 3071 and "[RmsHighFrequency](#)" on page 3073. This setting applies to the entire module.

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| UINT | See bit structure. | 1 |

Bit structure:

| Bit | Description | Values | Information |
|--------|---|---------|--|
| 0 - 3 | High-pass configuration for the entire module | 0 | 2000 Hz |
| | | 1 | 1000 Hz (bus controller default setting) |
| | | 2 | 500 Hz |
| | | 3 to 15 | Invalid |
| 4 - 15 | Reserved | - | |

9.26.7.15.12.2 HighFrequencyConfigRead

Name:

HighFrequencyConfig01Read

Register for reading the envelope signal high-pass and characteristic values "[PeakHighFrequency](#)" on page 3071 and "[RmsHighFrequency](#)" on page 3073.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.26.7.15.12.3 MaxFrequencyEnvelope

Name:

MaxFrequencyEnvelope01

Registers for setting the maximum frequency of the channel. Reducing the maximum frequency allows the frequency resolution in the spectrum to be increased.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|---------|---------------------------------|---------|--|
| 0 - 3 | Maximum frequency for channel 1 | 0 | 2000 Hz (bus controller default setting) |
| | | 1 | 1000 Hz |
| | | 2 | 500 Hz |
| | | 3 | 200 Hz |
| | | 4 to 15 | Invalid |
| 4 - 7 | Maximum frequency for channel 2 | x | For possible values, see channel 1. |
| 8 - 11 | Maximum frequency for channel 3 | x | For possible values, see channel 1. |
| 12 - 15 | Maximum frequency for channel 4 | x | For possible values, see channel 1. |

Overview of the maximum frequency of the envelope signal

| Maximum frequency | Sampling frequency | Duration of measurement | Frequency resolution in the frequency spectrum |
|-------------------|--------------------|-------------------------|--|
| 2000 Hz | 5156 Hz | 1.5888 s | 0.6294 Hz |
| 1000 Hz | 2578 Hz | 3.1775 s | 0.3147 Hz |
| 500 Hz | 1289 Hz | 6.3550 s | 0.1574 Hz |
| 200 Hz | 516 Hz | 15.8875 s | 0.0629 Hz |

Important information for configuring the maximum frequency

- The frequency range must be larger than the damage frequency but should otherwise be kept as small as possible in order to achieve a good resolution.
- When using broadband values (e.g. [PeakRaw](#)), only the largest peak value is returned during a measurement. Using a longer measurement time at a lower frequency can lead to the measured value being overlooked in some applications.
- The maximum frequency influences the size of the sampling rate and can be configured using register "[AnalogInput](#)" on page 3065.

9.26.7.15.12.4 MaxFrequencyEnvelopeRead

Name:

MaxFrequencyEnvelope01Read

This register is used to read the configured maximum frequency for the individual channels' envelope signal.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.26.7.15.12.5 MaxFrequencyRaw

Name:

MaxFrequencyRaw01

Registers for setting the maximum frequency of the channel. Reducing the maximum frequency allows the frequency resolution in the spectrum to be increased.

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| UINT | See bit structure. | 8738 |

Bit structure:

| Bit | Description | Value | Information |
|---------|---------------------------------|---------|--|
| 0 - 3 | Maximum frequency for channel 1 | 0 | 10000 Hz |
| | | 1 | 5000 Hz |
| | | 2 | 2000 Hz (bus controller default setting) |
| | | 3 | 1000 Hz |
| | | 4 | 500 Hz |
| | | 5 | 200 Hz |
| 6 to 15 | | Invalid | |
| 4 - 7 | Maximum frequency for channel 2 | x | For possible values, see channel 1. |
| 8 - 11 | Maximum frequency for channel 3 | x | For possible values, see channel 1. |
| 12 - 15 | Maximum frequency for channel 4 | x | For possible values, see channel 1. |

Overview of the maximum frequency of the raw signal

| Maximum frequency | Sampling frequency | Duration of measurement | Frequency resolution in the frequency spectrum |
|-------------------|--------------------|-------------------------|--|
| 10000 Hz | 25781 Hz | 0.3178 s | 3.1471 Hz |
| 5000 Hz | 12891 Hz | 0.6355 s | 1.5736 Hz |
| 2000 Hz | 5156 Hz | 1.5888 s | 0.6294 Hz |
| 1000 Hz | 2578 Hz | 3.1775 s | 0.3147 Hz |
| 500 Hz | 1289 Hz | 6.3550 s | 0.1574 Hz |
| 200 Hz | 516 Hz | 15.8875 s | 0.0629 Hz |

Important information for configuring the maximum frequency

- The frequency range must be larger than the damage frequency but should otherwise be kept as small as possible in order to achieve a good resolution.
- When using broadband values (e.g. PeakRaw), only the largest peak value is returned during a measurement. Using a longer measurement time at a lower frequency can lead to the measured value being overlooked in some applications.
- The maximum frequency influences the size of the sampling rate and can be configured using register "[AnalogInput](#)" on page 3065.

9.26.7.15.12.6 MaxFrequencyRawRead

Name:

MaxFrequencyRaw01Read

This register is used to read the configured maximum frequency for the raw signal of individual channels.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.26.7.15.12.7 MinFrequencyEnvelope

Name:

MinFrequencyEnvelope01

This register is used to configure the lowest frequency of the envelope signal to be evaluated for the individual channels.

This configuration only needs to be set for channels whose EnableVelocityCalculation bit has been set (configured in the "SensorConfig" on page 3058 register).

Bit EnableVelocityCalculation = 0

The following minimum values based on the maximum frequency ("MaxFrequencyEnvelope" on page 3085) are used: This table shows the minimum MinFrequencyEnvelope based on MaxFrequencyEnvelope:

| Maximum frequency | Frequency resolution in the frequency spectrum | Minimum frequency |
|-------------------|--|-------------------|
| 2000 Hz | 0.6294 Hz | 1.888 Hz |
| 1000 Hz | 0.3147 Hz | 0.944 Hz |
| 500 Hz | 0.1574 Hz | 0.472 Hz |
| 200 Hz | 0.0629 Hz | 0.188 Hz |

Bit EnableVelocityCalculation = 1

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|---------|--------------------------------|---------|--|
| 0 - 3 | Lowest frequency for channel 1 | 0 | 10 Hz (bus controller default setting) |
| | | 1 | 5 Hz |
| | | 2 | 2 Hz |
| | | 3 | 1 Hz |
| | | 4 | 0.5 Hz |
| | | 5 to 15 | Invalid |
| 4 - 7 | Lowest frequency for channel 2 | x | For possible values, see channel 1. |
| 8 - 11 | Lowest frequency for channel 3 | x | For possible values, see channel 1. |
| 12 - 15 | Lowest frequency for channel 4 | x | For possible values, see channel 1. |

Information:

If a channel's frequency is set lower than the minimum frequency, then the channel will be limited to this lower frequency.

9.26.7.15.12.8 MinFrequencyEnvelopeRead

Name:

MinFrequencyEnvelope01Read

This register is used to read the lowest frequency of the envelope signal to be evaluated for the individual channels.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|--------------------------------|---------|-------------------------------------|
| 0 - 3 | Lowest frequency for channel 1 | 0 | 10 Hz |
| | | 1 | 5 Hz |
| | | 2 | 2 Hz |
| | | 3 | 1 Hz |
| | | 4 | 0.5 Hz |
| | | 5 to 14 | Invalid |
| | | 15 | Limited to lowest frequency |
| 4 - 7 | Lowest frequency for channel 2 | x | For possible values, see channel 1. |
| 8 - 11 | Lowest frequency for channel 3 | x | For possible values, see channel 1. |
| 12 - 15 | Lowest frequency for channel 4 | x | For possible values, see channel 1. |

9.26.7.15.12.9 MinFrequencyRaw

Name:

MinFrequencyRaw01

This register is used to configure the lowest frequency of the raw signal to be evaluated for the individual channels.

This configuration only needs to be set for channels whose EnableVelocityCalculation bit has been set (configured in the "SensorConfig" on page 3058 register).

Bit EnableVelocityCalculation = 0

The following minimum values based on the maximum frequency ("MaxFrequencyRaw" on page 3086) are used: This table shows the minimum MinFrequencyRaw based on MaxFrequencyRaw:

| Maximum frequency | Frequency resolution in the frequency spectrum | Minimum frequency |
|-------------------|--|-------------------|
| 10000 Hz | 3.1471 Hz | 9.441 Hz |
| 5000 Hz | 1.5736 Hz | 4.720 Hz |
| 2000 Hz | 0.6294 Hz | 1.888 Hz |
| 1000 Hz | 0.3147 Hz | 0.944 Hz |
| 500 Hz | 0.1574 Hz | 0.472 Hz |
| 200 Hz | 0.0629 Hz | 0.188 Hz |

Bit EnableVelocityCalculation = 1

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|---------|--------------------------------|---------|--|
| 0 - 3 | Lowest frequency for channel 1 | 0 | 10 Hz (bus controller default setting) |
| | | 1 | 5 Hz |
| | | 2 | 2 Hz |
| | | 3 | 1 Hz |
| | | 4 | 0.5 Hz |
| | | 5 to 15 | Invalid |
| 4 - 7 | Lowest frequency for channel 2 | x | For possible values, see channel 1. |
| 8 - 11 | Lowest frequency for channel 3 | x | For possible values, see channel 1. |
| 12 - 15 | Lowest frequency for channel 4 | x | For possible values, see channel 1. |

Information:

If a channel's frequency is set lower than the minimum frequency, then the channel will be limited to this lower frequency.

9.26.7.15.12.10 MinFrequencyRawRead

Name: MinFrequencyRaw01Read

This register is used to configure the lowest frequency of the raw signal to be evaluated for the individual channels.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|--------------------------------|---------|-------------------------------------|
| 0 - 3 | Lowest frequency for channel 1 | 0 | 10 Hz |
| | | 1 | 5 Hz |
| | | 2 | 2 Hz |
| | | 3 | 1 Hz |
| | | 4 | 0.5 Hz |
| | | 5 to 14 | Invalid |
| | | 15 | Limited to lowest frequency |
| 4 - 7 | Lowest frequency for channel 2 | x | For possible values, see channel 1. |
| 8 - 11 | Lowest frequency for channel 3 | x | For possible values, see channel 1. |
| 12 - 15 | Lowest frequency for channel 4 | x | For possible values, see channel 1. |

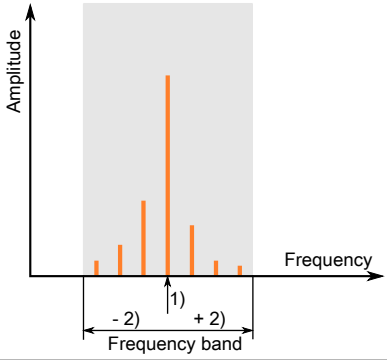
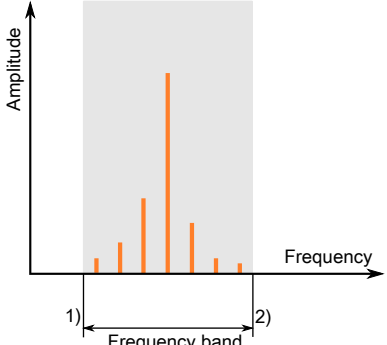
9.26.7.15.13 Frequency bands

For the early detection of damage and problems, it is often useful to monitor individual frequency bands. A selective RMS value can be used as the characteristic value for these frequency bands.

Possibilities:

- "Broadband RMS value" on page 3091
- "Speed-dependent RMS value" on page 3092
- "Noise" on page 3092

Up to 32 different frequency bands can be defined. It is important to note that the format varies slightly depending on the configuration.

| Speed-dependent RMS value | |
|--|--|
|  | <p>Frequency broadband is formed from the speed frequency \pm the frequency interval.</p> <ol style="list-style-type: none"> 1) Speed frequency: $\text{FrequencyBand} \times \text{DmgFreq60Rpm} * \text{ActSpeed}$ 2) Frequency interval: $\text{FrequencyBandTolerance}$ |
| Speed-independent RMS value | |
|  | <p>Frequency bandwidth is formed of the lower and upper frequency band limits.</p> <ol style="list-style-type: none"> 1) Lower frequency band limit: $\text{FrequencyBandLowerFrequency}$ 2) Upper frequency band limit: $\text{FrequencyBandUpperFrequency}$ |

Restricting the frequency range allows certain errors to be identified easily.

One example of this is imbalance. This is clearly shown by an increase in the frequency line for speed. Forming a selective characteristic value for the speed frequency can thus improve classification.

Selective characteristic values can also be formed for RMS values formed from the envelope.

Damage to the outer ring is shown more clearly in the increase of the frequency known as the bearing damage frequency. Damage to the outer ring is shown in the increase of the component of the outer ring damage frequency. This bearing damage frequency is generally available from the bearing manufacturer.

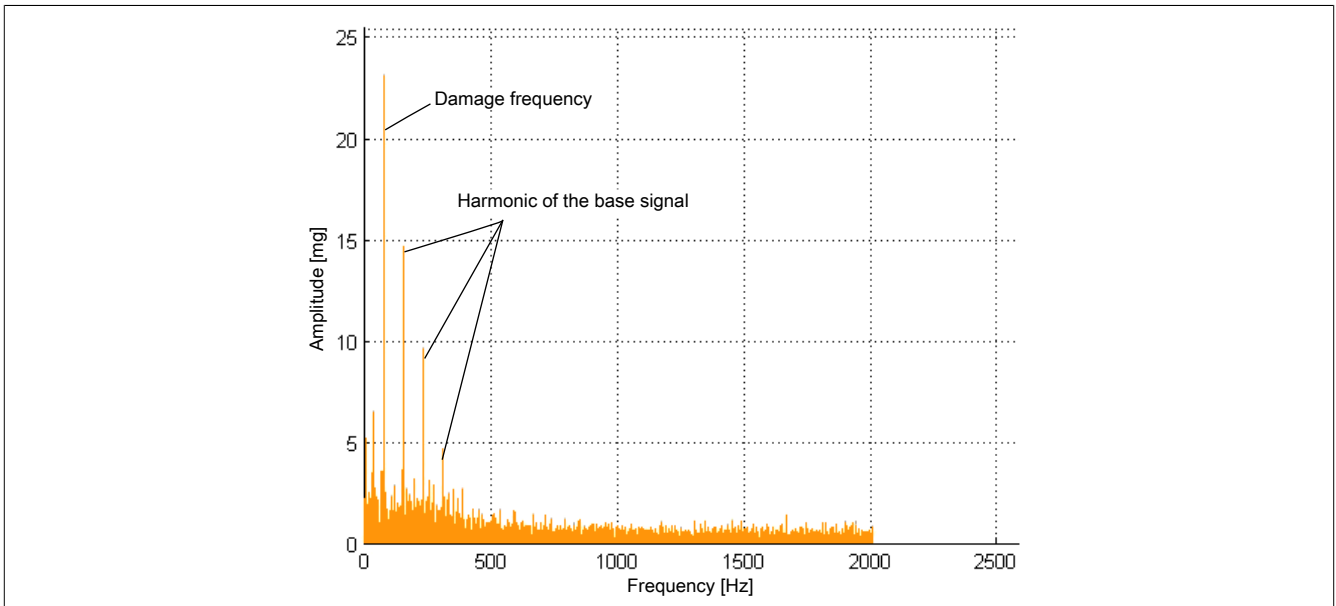


Figure 202: Selective characteristic value for outer ring damage

By configuring a characteristic value with a frequency range around the damage frequency, rolling bearing damage to the outer ring can be detected at an early stage.

If frequencies are entered that are outside the minimum and maximum signal frequency for the selected channel, then only the domains between the minimum and maximum frequency will be analyzed.

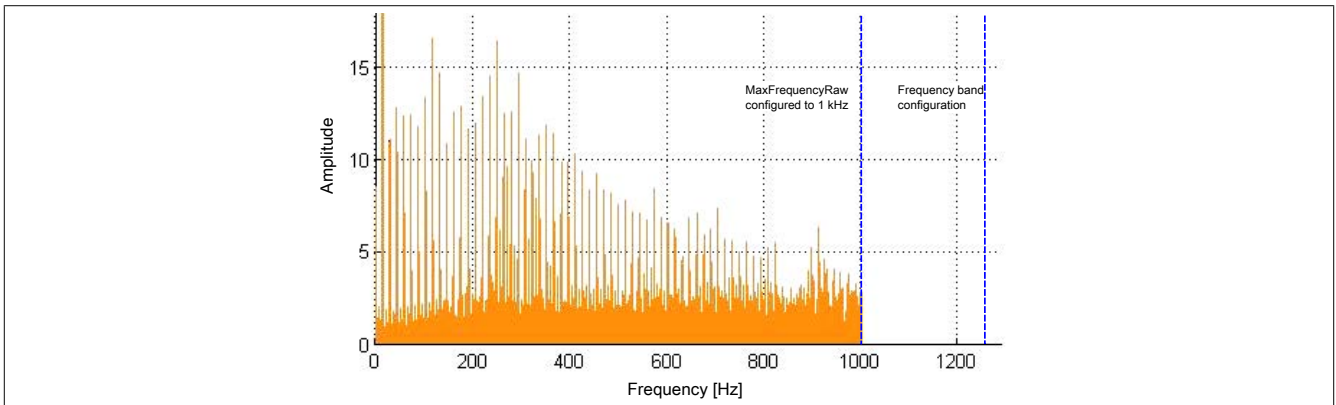


Figure 203: Restricting the frequency band evaluation

The two neighboring lines (samples) in the spectrum that are already outside the set window (one above and one below the window) will be partially included in the calculation depending on their distance from the window.

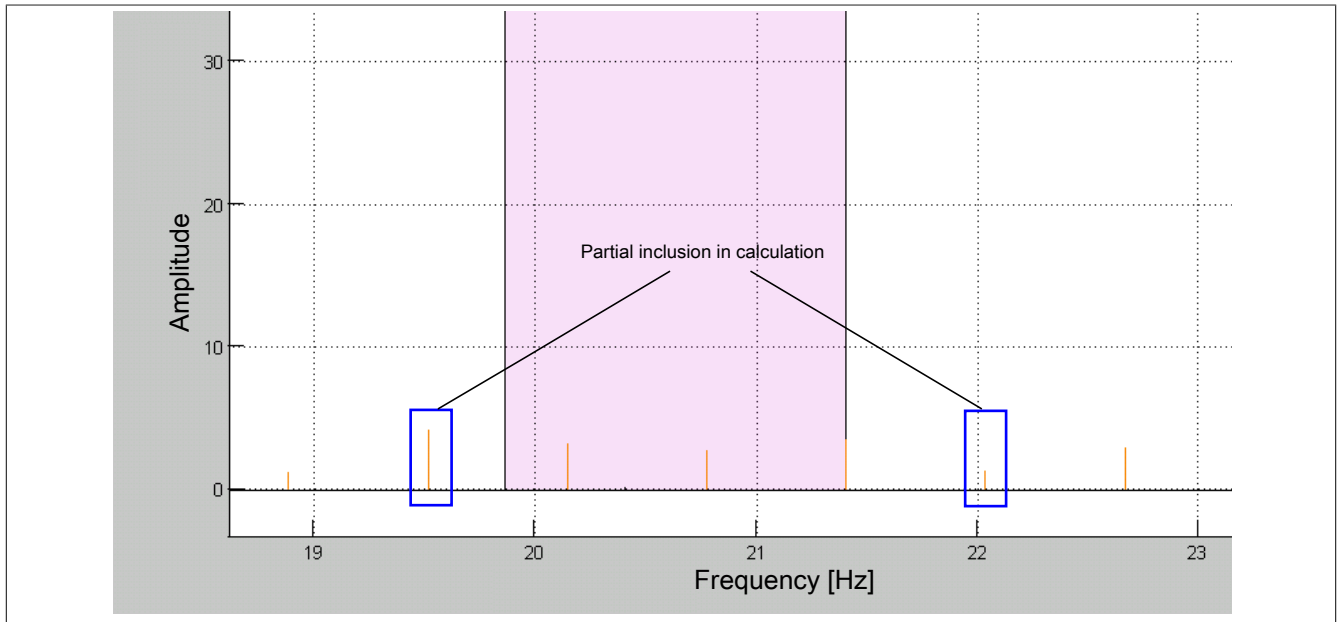


Figure 204: Partial inclusion of marginal lines in the calculation

9.26.7.15.13.1 Broadband RMS value

In this configuration, the RMS value of the configured signal and channel in the frequency band is calculated. The value is calculated from the configured minimum frequency ("[FrequencyBandXXLowerFrequency](#)" on page 3095) to the configured maximum frequency ("[FrequencyBandXXUpperFrequency](#)" on page 3096). The minimum and maximum frequency can be entered here in increments of 0.25 Hz.

Any channel for any frequency band can be selected. The following signals can be selected for each channel:

- Raw acceleration signal
- Raw velocity signal. Equal to 0 if the speed calculation is disabled.
- Enveloped acceleration signal
- Enveloped velocity signal. Equal to 0 if the speed calculation is disabled.

The harmonic frequencies (integer multiples) of the window can also be included in the calculation. Here, the width of the window is simply retained and the mean frequency of the window is multiplied (by 1, 2, 3, etc.) until the maximum frequency of the configured signal and channel is reached.

9.26.7.15.13.2 Speed-dependent RMS value

In this configuration, the RMS value is calculated in a movable window. There are 4 speed inputs available for this (see "ActSpeed" on page 3056 register). One of the 4 speeds can be selected for each of the 32 frequency bands. In addition, the standardized damage frequency at 60 rpm ("FrequencyBandXXDmgFreq60rpm" on page 3095) and a tolerance ("FrequencyBandXXTolerance" on page 3095) must be configured. These can be configured separately for each frequency band.

The window in which the RMS value is calculated is determined as follows:

Minimum frequency = (speed * standardized damage frequency at 60 rpm) - tolerance

Maximum frequency = (speed * standardized damage frequency at 60 rpm) + tolerance

The standardized damage frequency and tolerance can be entered here in increments of 0.01 Hz.

The following signals can be selected for each channel:

- Raw acceleration signal
- Raw velocity signal. Equal to 0 if the speed calculation is disabled.
- Enveloped acceleration signal
- Enveloped velocity signal. Equal to 0 if the speed calculation is disabled.

The harmonic frequencies (integer multiples) of the window can also be included in the calculation. Here, the width of the window is simply retained and the mean frequency of the window is multiplied (by *1, *2, *3, etc.) until the maximum frequency of the set signal and channel is reached.

Information:

If a fixed frequency band is needed in which the minimum frequency ("FrequencyBandXXLowerFrequency" on page 3095) and maximum frequency ("FrequencyBandXXUpperFrequency" on page 3096) must be set with a higher precision than 0.25 Hz, then a speed-dependent frequency band with a fixed speed can be used.

9.26.7.15.13.3 Noise

In this configuration, the noise from a quadrant of the respective signal on the selected channel that is within the frequency band is calculated.

To do this, the configured maximum frequency (registers "MaxFrequencyEnvelope" on page 3085 and "MaxFrequencyRaw" on page 3086) of the signal on the selected channel is divided by 4. This results in 4 quadrants. The configuration can then be used to select one of the 4 quadrants in which the noise should be determined.

The following signals can be selected for each channel:

- Raw acceleration signal
- Raw velocity signal. Equal to 0 if the speed calculation is disabled.
- Enveloped acceleration signal
- Enveloped velocity signal. Equal to 0 if the speed calculation is disabled.

This configuration allows slippage to be effectively measured, for example. The higher the friction, the more noise that is created.

9.26.7.15.13.4 Configuration

Each of the 32 frequency bands can be configured to one of the following characteristic values.

| Characteristic value | Description |
|-------------------------------|--|
| FrequencyBandRmsAccEnvelope | The RMS value formed from the envelope signal of the oscillation acceleration in a freely selectable frequency range. |
| FrequencyBandRmsVelEnvelope | The RMS value formed from the envelope signal of the oscillation acceleration in a freely selectable frequency range. This frequency band is only calculated if the EnableVelocityCalculation bit (configuration in register "SensorConfig" on page 3058) is set for the respective channel; otherwise, 0 is output. |
| FrequencyBandRmsAccRaw | The RMS value formed from the raw signal of the oscillation acceleration in a freely selectable frequency range. |
| FrequencyBandRmsVelRaw | The RMS value formed from the raw signal of the oscillation velocity in a freely selectable frequency range. |
| FrequencyBandNoiseAccEnvelope | The noise value formed from the raw signal of the oscillation acceleration in a freely selectable frequency range. |
| FrequencyBandNoiseVelEnvelope | The noise value formed from the raw signal of the oscillation acceleration in a freely selectable frequency range. This frequency band is only calculated if the EnableVelocityCalculation bit (configuration in register "SensorConfig" on page 3058) is set for the respective channel; otherwise, 0 is output. |
| FrequencyBandNoiseAccRaw | The noise value formed from the raw signal of the oscillation acceleration in a freely selectable frequency range. |
| FrequencyBandNoiseVelRaw | The noise value formed from the raw signal of the oscillation acceleration in a freely selectable frequency range. This frequency band is only calculated if the EnableVelocityCalculation bit (configuration in register "SensorConfig" on page 3058) is set for the respective channel; otherwise, 0 is output. |

Calculating the total width of the frequency band

The measured damage frequency may vary slightly from the expected frequency. It must therefore be ensured that the frequency band is wide enough to monitor the harmful frequency to compensate for this deviation.

The maximum permissible deviation has been defined as 1/2% of the maximum drive frequency. Since the deviation could occur in either the positive or negative direction, it must be counted twice. This results in the following formula:

$$\text{Total range of frequency band} = 2 * 1/2\% * \text{max. drive frequency [Hz]}$$

Depending on the MaxFrequency selected, a least 3 lines should be configured within each frequency band.

The first lines to the left and right of the configured frequency band are included proportionally based on their distance from the frequency band (see figure in "Frequency bands" on page 3089).

Example

At a maximum drive frequency of 50 Hz, a frequency band should be set at 10 Hz.

10 Hz \pm (0.005 * 50 Hz) = At least 9.75 Hz lower and 10.25 Hz upper frequency band limits

9.26.7.15.13.5 FrequencyBandMax

Name:

FrequencyBandMax01 to FrequencyBandMax32

Maximum value of the respective frequency band in 1/1000 mm/s or g depending on the configuration. See also "Characteristic values (minimum and maximum)" on page 3079 and "Frequency bands" on page 3055 for additional information.

If the frequency band is configured to a velocity signal, this value is only calculated if bit EnableVelocityCalculation (configuration in register "SensorConfig" on page 3058) of the corresponding channel is set; otherwise, 0 is output.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.7.15.13.6 FrequencyBandMin

Name:

FrequencyBandMin01 to FrequencyBandMin32

Minimum value of the respective frequency band in 1/1000 mm/s or g depending on the configuration. See also "Characteristic values (minimum and maximum)" on page 3079 and "Frequency bands" on page 3055 for additional information.

If the frequency band is configured to a velocity signal, this value is only calculated if bit EnableVelocityCalculation (configuration in register "SensorConfig" on page 3058) of the corresponding channel is set; otherwise, 0 is output.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.7.15.13.7 FrequencyBandConfig

Name:

FrequencyBand01Config to FrequencyBand32Config

General configuration of individual frequency bands.

Each frequency band can be calculated on any channel with any of the 4 speed data points ("ActSpeed" on page 3056).

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|---------|---|---------|---|
| 0 - 3 | Input channel for calculating the frequency band | 0 | Channel 1 (bus controller default setting) |
| | | 1 | Channel 2 |
| | | 2 | Channel 3 |
| | | 3 | Channel 4 |
| | | 4 to 15 | Invalid |
| 4 - 5 | Signal for calculating the frequency band | 0 | Raw signal speed ¹⁾ (bus controller default setting) |
| | | 1 | Enveloped velocity signal ¹⁾ |
| | | 2 | Raw acceleration signal |
| | | 3 | Enveloped acceleration signal |
| 6 | Speed-dependant calculation of the frequency band of the configured ActSpeed data point | 0 | Off Uses "FrequencyBandLowerFrequency" on page 3095 and "FrequencyBandUpperFrequency" on page 3096 for the calculation (bus controller default setting) |
| | | 1 | On "FrequencyBandDmgFreq60rpm" on page 3095 and "FrequencyBandTolerance" on page 3095 are used for the calculation. |
| 7 | Harmonic frequencies also calculated | 0 | Off (bus controller default setting) |
| | | 1 | On All harmonic frequencies up to the maximum frequency are always calculated. The harmonic frequencies can also include frequency portions that are the result of damage at other positions. This can lead to a misinterpretation of the measurement. |
| 8 - 11 | ActSpeed data point used for the calculation if the frequency band is speed-dependent | 0 | ActSpeed01 (bus controller default setting) |
| | | 1 | ActSpeed02 |
| | | 2 | ActSpeed03 |
| | | 3 | ActSpeed04 |
| | | 4 to 15 | Invalid |
| 12 | Enables noise calculation instead of RMS | 0 | Off (bus controller default setting) |
| | | 1 | On The speed-dependant and harmonic settings are ignored. |
| 13 - 14 | Selects the quadrant to calculate the noise | 0 | 1st quadrant from MinFrequency to 1/4 MaxFrequency ²⁾ (bus controller default setting) |
| | | 1 | 2nd quadrant from 1/4 MaxFrequency to 1/2 MaxFrequency ²⁾ |
| | | 2 | 3rd quadrant from 1/2 MaxFrequency to 3/4 MaxFrequency ²⁾ |
| | | 3 | 4th quadrant from 3/4 MaxFrequency to MaxFrequency ²⁾ |
| 15 | Reserved | 0 | |

1) This is only calculated if the EnableVelocityCalculation bit (configuration in register "SensorConfig" on page 3058) is set for the respective channel; otherwise, 0 is output.

2) Refers to the respective signal (raw signal or envelope signal) on the channel

9.26.7.15.13.8 FrequencyBandConfigRead

Name:

FrequencyBand01ConfigRead to FrequencyBand32ConfigRead

Registers for reading the configuration of individual frequency bands.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.26.7.15.13.9 FrequencyBandDmgFreq60rpm

Name:

FrequencyBand01DmgFreq60rpm to FrequencyBand32DmgFreq60rpm

Standardized damage frequency at 60 rpm if the frequency band is configured as speed-dependent.

This is multiplied with the configured velocity data point in the module to calculate the frequency band.

The standardized damage frequency must be specified in 1/100.

| Data type | Values | Information |
|-----------|-------------|-----------------------------------|
| UINT | 1 to 65,535 | Bus controller default setting: 0 |

9.26.7.15.13.10 FrequencyBandDmgFreq60rpmRead

Name:

FrequencyBand01DmgFreq60rpmRead to FrequencyBand32DmgFreq60rpmRead

Register to read the standardized damage frequency at 60 rpm for the individual frequency bands.

The standardized damage frequency is specified in 1/100.

| Data type | Values |
|-----------|-------------|
| UINT | 1 to 65,535 |

9.26.7.15.13.11 FrequencyBandTolerance

Name:

FrequencyBand01Tolerance to FrequencyBand32Tolerance

If the frequency band is configured as speed-dependent, then this data point can be used to specify the frequency band's width.

The [FrequencyBandTolerance](#) is subtracted once from the damage frequency calculated from [ActSpeed](#) and [FrequencyBandDmgFreq60rpm](#) to get the frequency band's lower frequency and added once to get its higher frequency.

The tolerance must be specified in 1/100 Hz.

| Data type | Values | Information |
|-----------|-------------|-----------------------------------|
| UINT | 1 to 65,535 | Bus controller default setting: 0 |

9.26.7.15.13.12 FrequencyBandToleranceRead

Name:

FrequencyBand01ToleranceRead to FrequencyBand32ToleranceRead

Registers for reading the tolerance of individual frequency bands.

The tolerance is specified in 1/100 Hz.

| Data type | Values |
|-----------|-------------|
| UINT | 1 to 65,535 |

9.26.7.15.13.13 FrequencyBandLowerFrequency

Name:

FrequencyBand01LowerFrequency to FrequencyBand32LowerFrequency

Minimum frequency for calculating the frequency band if it is not speed-dependent.

The minimum frequency must be specified in 1/4 Hz.

| Data type | Values | Information |
|-----------|-------------|-----------------------------------|
| UINT | 1 to 40,000 | Bus controller default setting: 0 |

9.26.7.15.13.14 FrequencyBandLowerFrequencyRead

Name:

FrequencyBand01LowerFrequencyRead to FrequencyBand32LowerFrequencyRead

Registers for reading the minimum frequency of individual frequency bands.

The minimum frequency is specified in 1/4 Hz.

| Data type | Values |
|-----------|-------------|
| UINT | 1 to 40,000 |

9.26.7.15.13.15 FrequencyBandUpperFrequency

Name:

FrequencyBand01UpperFrequency to FrequencyBand32UpperFrequency

Maximum frequency for calculating the frequency band if it is not speed-dependent.

The maximum frequency must be specified in 1/4 Hz.

| Data type | Values | Information |
|-----------|-------------|-----------------------------------|
| UINT | 1 to 40,000 | Bus controller default setting: 0 |

9.26.7.15.13.16 FrequencyBandUpperFrequencyRead

Name:

FrequencyBand01UpperFrequencyRead to FrequencyBand32UpperFrequencyRead

Registers for reading the maximum frequency of individual frequency bands.

The maximum frequency is specified in 1/4 Hz.

| Data type | Values |
|-----------|-------------|
| UINT | 1 to 40,000 |

9.26.7.15.14 Flatstream

9.26.7.15.14.1 Transferring characteristic values via Flatstream

In function model "Standard", Automation Runtime takes over Flatstream communication for transferring characteristic values. The user is automatically provided with all characteristic values, already properly scaled. As a result, the registers for the characteristic value Flatstream are not shown in the I/O mapping in [Function model 0 - Standard](#).

When using Flatstream in [Function model 0 - Standard](#) and [Function model 1 - Fast master](#), the following should be noted:

- The maximum bus cycle time should not exceed 10 ms.
- The task cycle should either be the same speed and synchronous to the module's bus or faster.

Bus cycle time

Since the characteristic values are transferred over the Flatstream, a maximum bus cycle time of 10 ms should not be exceeded. Otherwise, the data calculated by the module every 300 ms cannot be fully transferred on the bus. If the current transfer is not completed when new characteristic values become available, then they will be discarded. A cycle time of ≤ 10 ms is therefore required in order to ensure seamless measurements.

Task cycle time

It is important to note that the module normally changes the values in the Flatstream in every X2X Link cycle. To optimize performance and avoid missing any values in the task, it is important to select a task cycle that is either the same speed and synchronous to the module's bus or faster. This also applies to fieldbus connections between the CPU and bus controller. If this is not possible for some reason, it is also possible to change the ForwardDelay of the Flatstream (see ["The Forward function on the X20CM4810" on page 3099](#)).

Registers for the characteristic value Flatstream

The following registers are needed to transfer characteristic values:

["ParameterInputSequence01" on page 3808](#)

["ParameterRxByte01-13" on page 3806](#)

["ParameterOutputSequence01" on page 3807](#)

This results in an [InputMTU](#) of 13 and an [OutputMTU](#) of 0 bytes for the characteristic value Flatstream.

Structure of the characteristic value Flatstream

Each characteristic value transferred from the module via Flatstream has a length of 3 bytes with the high byte first. For the exact format, see ["Characteristic values" on page 3070](#). The stream has a total length of 240 bytes. First, all characteristic values from channel 1 are transferred, then those from channels 2, 3 and 4. The 32 frequency bands then follow next.

The RmsVelRaw and RmsVelEnvelope characteristic values and FrequencyBandxx are only transferred if they are set to a velocity signal and the EnableVelocityCalculation bit for the respective channel is set. Otherwise, 0 is output. EnableVelocityCalculation is configured in the ["SensorConfig" on page 3058](#) register.

| Byte offset in the stream | | | | Characteristic value |
|---------------------------|-----------|-----------|-----------|-----------------------------------|
| Channel 1 | Channel 2 | Channel 3 | Channel 4 | |
| Channel parameters | | | | |
| 0 | 36 | 72 | 108 | RmsAccRaw |
| 3 | 39 | 75 | 111 | RmsVelRaw |
| 6 | 42 | 78 | 114 | RmsAccEnvelope |
| 9 | 45 | 81 | 117 | RmsVelEnvelope |
| 12 | 48 | 84 | 120 | PeakHighFrequency |
| 15 | 51 | 87 | 123 | RmsHighFrequency |
| 18 | 54 | 90 | 126 | Iso10816 |
| 21 | 57 | 93 | 129 | CrestFactorRaw |
| 24 | 60 | 96 | 132 | KurtosisRaw |
| 27 | 63 | 99 | 135 | PeakRaw |
| 30 | 66 | 102 | 138 | SkewnessRaw |
| 33 | 69 | 105 | 141 | RmsRaw |
| Frequency band 1 - 32 | | | | |
| 144 | | | | FrequencyBand01 |
| : | | | | : |
| 237 | | | | FrequencyBand32 |

9.26.7.15.14.2 Uploading buffers via Flatstream

For information about Flatstream, see ["Flatstream communication"](#) on page 3802.

Uploading buffers via Flatstream is available on the module in [Function model 0 - Standard](#) and [Function model 1 - Fast master](#).

Library **AsIOVib** is available for uploading the buffers from the module. For a description of the library, see ["Automation Help - Programming - Libraries - Direct I/O access - AsIOVib"](#).

The raw data buffers (raw signal and FFT) from the module are transferred on request (buffer Flatstream in the Tx direction) from the module via the buffer Flatstream (Rx direction) but only if the buffers were previously frozen on the module with settings `RequestBufferLock01 = 1` and `BufferLockValid01 = 1`. It is important to note that the module refreshes the data points of the buffer Flatstream every X2X Link cycle. Once the transmission is complete, the buffer from the stream needs to be "reassembled" on the PLC.

Registers for the buffer Flatstream

The following registers are needed to upload buffers:

["BufferInputSequence01"](#) on page 3808

["BufferRxByte01-05"](#) on page 3806

["BufferOutputSequence01"](#) on page 3807

["BufferTxByte01-04"](#) on page 3806

This results in an `InputMTU` of 5 and an `OutputMTU` of 4 bytes for the buffer Flatstream.

Buffer upload procedure

Before a buffer can be uploaded from the module, the buffers on the module must first be locked by setting `RequestBufferLock01 = 1`. The upload can only begin once the buffers have been locked by setting `BufferLockValid01 = 1`.

If a velocity buffer is uploaded, it only contains values if bit `EnableVelocityCalculation` of the corresponding channel is set; otherwise, 0 is output. Bit `EnableVelocityCalculation` can be configured in register ["SensorConfig"](#) on page 3058.

A buffer first needs to be requested from the module via the buffer Flatstream (Tx direction). Meaning:

- `BufferTxByte01`: Value 0x83 (frame end and 3 bytes are valid)
- `BufferTxByte02`: The requested buffer from the module
- `BufferTxByte03`: High byte of the number of the values to be read (per 4-byte value)
- `BufferTxByte04`: Low byte of the number of the values to be read (per 4-byte value)

The sequence is subsequently increased by 1. As soon as the sequence has been confirmed by the module, it is important to set the number of valid bytes in `BufferTxByte` to 0; otherwise, the module interprets this as a new request. The module can temporarily store up to 2 consecutive requests.

As soon as the module receives the request, it begins streaming the requested number of values from the specified buffer via the buffer Flatstream (Rx direction). Values are always transferred in 16.16 fixed data point format (1/65536) with the high byte first. A scaling factor is transferred first. All other values are then multiplied by this factor. With time signal buffers, the first value according to the scaling factor is always the oldest. With FFT buffers, the first value according to the scaling factor is always 0 Hz. FFT buffers are only valid from the configured `MinFrequency` to the configured `MaxFrequency` of the respective signal (raw or envelope) and the respective channel.

For the time and frequency intervals of individual values, see register ["MinFrequencyRaw"](#) on page 3088 or ["MinFrequencyEnvelope"](#) on page 3087.

`RequestBufferLock01` must be set to 1 throughout the entire uploading process. Once the requested buffers have been uploaded from the module, the lock can be reset. In the module, the buffers are then once again filled with new values. After some time has passed, they can be locked and uploaded again (see register ["Control"](#) on page 3057).

| Buffer number (dec.) | | | | Buffer | Maximum number of values (1 values = 4 bytes) |
|----------------------|--------------|--------------|--------------|--|--|
| Channel 1 | Channel 2 | Channel 3 | Channel 4 | | |
| 9 | 11 | 13 | 15 | Raw signal (filter value: "MaxFrequencyRaw" on page 3086) | 8193 or 65535 ¹⁾ |
| 25 | 27 | 29 | 31 | Envelope signal (filter value: "MinFrequencyEnvelope" on page 3087) | 8193 or 65535 ¹⁾ |
| 66 | 70 | 74 | 78 | FFT amplitude spectrum raw velocity signal (filter value: "MaxFrequencyRaw" on page 3086) | 4097 ¹⁾ |
| 67 | 71 | 75 | 79 | FFT amplitude spectrum raw acceleration signal (filter value: "MaxFrequencyRaw" on page 3086) | 4097 ¹⁾ |
| 82 | 86 | 90 | 94 | FFT amplitude spectrum envelope signal velocity (filter value: "MinFrequencyEnvelope" on page 3087) | 4097 ¹⁾ |
| 83 | 87 | 91 | 95 | FFT amplitude spectrum envelope signal acceleration (filter value: "MinFrequencyEnvelope" on page 3087) | 4097 ¹⁾ |

1) The first value in the buffer is the scaling factor.

In special applications it may be necessary to upload larger buffers.

In register "[SensorConfig](#)" on page 3058, a buffer length of 8193 or 65535 values can be configured using bit 14. This makes it possible to read the raw signal and envelope signal (buffer number 9, 11, 13, 15, 25, 27, 29 and 31) using 65535 values, including the scaling factor, from the module. However, the FFT buffers still contain 4097 values including scaling factor and refer to the last 8193 values of the 65535 values of the raw or envelope signal.

After locking the buffer for the upload (RequestBufferLock01) until the next locking, it is necessary to wait until the longest buffer is filled again. If the buffer tries to lock again before this time elapses, it is prevented by the module until after the buffer is filled.

9.26.7.15.14.3 The Forward function on the X20CM4810

The ForwardDelay for the buffer Flatstream can be configured acyclically in [Function model 0 - Standard](#) and [Function model 1 - Fast master](#) in the I/O configuration of the module (BufferForwardDelay01). When using the "Fast master" function model, the ForwardDelay can also be configured acyclically for the parameter Flatstream in the I/O configuration (ParameterForwardDelay01).

Forwarding for the parameter and buffer Flatstreams can be adjusted acyclically (see registers "[ParameterForward01](#)" on page 3826 and "[BufferForward01](#)" on page 3826). However, it should only be adjusted after the forward delay for the respective Flatstream has already been set.

When using an SG4 CPU, the ForwardDelay cannot be configured manually for the parameter Flatstream. Starting with J3.09 and J4.01 of Automation Runtime, it is automatically configured and in earlier versions, it is ForwardDelay 0.

9.26.7.15.14.4 Flatstream communication

For a description of Flatstream communication, see "[Flatstream communication](#)" on page 3802

9.26.7.15.15 Using the module with on the fieldbus

9.26.7.15.15.1 Bus controller with FieldbusDESIGNER support

Only [Function model 1 - Fast master](#) and [Function model 2 - Slow master](#) are available for this.

The module is configured using FieldbusDESIGNER in Automation Studio. Implementation must be handled on the master.

9.26.7.15.15.2 Bus controller without FieldbusDESIGNER support

Only [Function model 2 - Slow master](#) is available for this. Configuration and implementation must be handled on the master.

9.26.7.15.15.3 B&R SG4 CPU with an interface module

This combination offers the following advantages:

- Modular condition monitoring solution possible
- All characteristic values prepared by Automation Runtime (no extra work required for implementation)
- Communication with the master via the interface card

9.26.7.15.15.4 CANIO bus controller

Only [Function model 254 - Bus controller](#) is available for this. Configuration and implementation must be handled on the master.

9.26.7.15.16 Assignment of the task class

Name:

Cycle time

By assigning the cycle time to a task class, the data exchange between the CPU and module can be prioritized and adapted to the requirements of the application. Faster task classes result in increased data throughput, but this increases the system load.

Information:

Using a task class that is too slow can result in new data from the module not being available within a measurement cycle.

The task class must be less than or equal to to the [maximum cycle time](#).

Information:

This configuration involves a driver setting that cannot be changed during runtime!

| Data type | Values | Information |
|-----------|--------|-----------------|
| - | 1 to 8 | Task class used |

9.26.7.15.17 Maximum cycle time

The maximum cycle time defines how far the cycle time of the X2X Link can be increased without causing a communication error or impaired functionality.

| Maximum cycle time | |
|---|-------|
| Function model 0 - Standard Function model 1 - Fast master | 10 ms |
| Function model 2 - Slow master Function model 254 - Bus controller | - |

9.26.7.15.18 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|---------------------|--------|
| All function models | 400 µs |

9.26.7.16 Condition monitoring / Oscillation analyses

9.26.7.16.1 Basic information

System availability is one of the most important criteria in machine operation. For this reason, increasing and ensuring this availability over the long term is a primary objective of the system operator.

Unplanned stoppages and the resulting loss of production can lead to substantial costs. The implementation of condition monitoring has proven to be a very good method for supporting anticipatory maintenance.

9.26.7.16.1.1 What is condition monitoring?

Condition monitoring involves recording the status of the machines at regular intervals by measuring important values in order to recognize impending problems in the system. The goal is to recognize imminent damage early enough so that a faulty machine part can be repaired or replaced before it leads to consequential damage or a partial or complete breakdown of the system.

The specific purpose of condition monitoring is to collect and process sensor data (e.g. oscillations, temperatures, lubricant conditions, pressures, flows) that can be used to assess the overall condition of the system.

Deviations from normal process or system conditions are caused by defects, which can occur for a variety of reasons. If corresponding countermeasures are not taken, this can quickly lead to a malfunction and breakdown of the system. Monitoring the sources of defects through the analysis of machine parameters can make it possible to recognize malfunctions as early as possible in order to take preventive action. Possible responses can include, for example, an error message or warning to the operator or an automated action for fault clearance and prevention of damage all the way up to automatic shutdown.

The integration and systematic implementation of condition monitoring provides many advantages:

- System components are only repaired or replaced when actually necessary. Potential defects are recognized early on in operation.
- Reliability can be significantly increased by integrating condition monitoring into the process.

Bathtub / Deterioration curve

The operating performance of every mechanical component changes over the course of operation, with each component becoming defective at some point. It is crucial to recognize such a change before the component can no longer fulfill its function. This behavior can be illustrated very well by the so-called "bathtub curve". This indicates the probable failure rate over time.

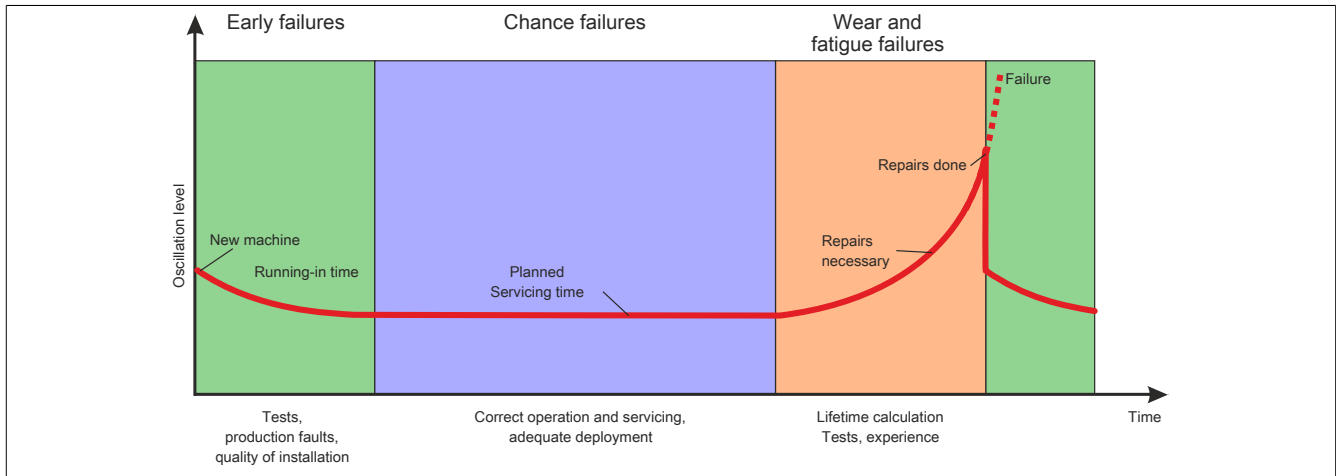


Figure 205: Bathtub curve illustrating the 3 typical phases

Each component is subject to the regularities of this curve, with a typical trend emerging as a result.

- **Area 1 (early failures)** is characterized by a decreasing failure rate. Early failures are caused almost exclusively by errors in assembly or construction. However, special care and quality during production and commissioning significantly reduces the failure rate at the beginning. This area also explains the increased failure performance after an intervention in a system that functions well.
- During continuous operation in **Area 2 (chance failures)**, the failure rate is almost consistent. These chance failures are fundamentally difficult to ascertain and, most importantly, not easily influenced. Operating and maintenance errors contribute towards an increase in the failure rate in this region.
- The failure rate increases dramatically in **Area 3 (wear and failure due to fatigue)**. Wear and fatigue failures are primarily characterized by damage that progresses slowly over time.

The trend provides valuable information about the failure probability of the parameters measured by condition monitoring. This usually behaves like the bathtub curve, i.e. an increase in the characteristic value signifies a change in the system. The characteristic values can be synchronized with the operating parameters through the integration of automation technology. Assessing curve performance and incorporating operating parameters makes it possible to identify the best time to perform service work depending on condition.

In addition, oscillations are often representative of the condition of a machine or component. They are a good indication of wear or damage. One example of this is roller bearings. Surface damage (pitting) leads to increased oscillations in the bearing housing. These can be measured and evaluated. An increase in oscillations during operation indicates damage and/or increased wear. By constantly observing this condition, deviations from normal operation can be recognized immediately.

Damage development and the damage chain

Explaining damage development with a roller bearing example

The majority of bearing damage develops slowly and usually without being noticed. In many cases, it is only once the damage is more advanced that irregular running and unusual operating noises indicate bearing damage. This points to material fatigue, e.g. chipping or altered radial clearance through wear.

If the damage is so advanced that it can be detected without measuring equipment, spontaneous failures such as blockages and breakage of the bearing housing components often occur.

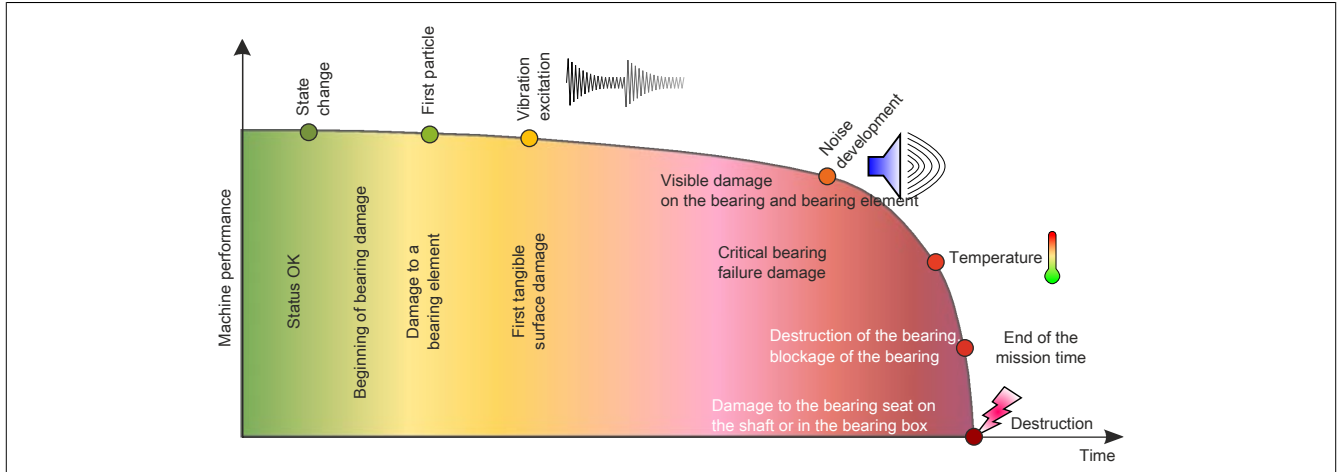


Figure 206: Illustration of the damage chain and the development of damage over time

The damage chain illustrated in the image above presents condition monitoring as an important tool in the condition-based operation and maintenance of a system.

It is possible to draw conclusions about the condition of the machine or its components from the parameters recorded by the sensors. Deterioration of the condition of components or system parts becomes apparent through the detection and observation of their condition, the consideration of the trend and, if necessary, through the detailed analysis of the measurement data obtained. Based on this, targeted measures can be put in place for maintenance.

Condition monitoring is a suitable option under the following conditions:

- Measurable parameters that correlate with a failure need to be identified and selected.
- The failure cannot be prevented by redesign or altered usage.
- Events lead to failures that occur randomly.
- Sufficient warning time must be given in advance before a function fails.

The consideration of condition monitoring resources is not permitted to be limited to the consideration of the recording of operating conditions alone but should be integrated into this as part of a general asset management strategy. In order to manage this, all types of condition monitoring and industrial diagnostics should be combined into an overall strategy.

For a failure-oriented operational mode ("reactive maintenance"), components are only replaced if they can no longer fulfill their function. For planned operation ("preventive maintenance"), components are replaced at a certain point in time – regardless of their current condition.

For condition-based maintenance, the area where maintenance is planned can be significantly isolated while reducing the risk of failure at the same time.

| | Advantages | Disadvantages |
|-----------------------------|---|---|
| Reactive maintenance | <ul style="list-style-type: none"> - Utilization of the wear reserve - No costs during the period of use | <ul style="list-style-type: none"> - Unexpected failure - Consequential damage - High downtime costs - Low operational safety |
| Preventive maintenance | <ul style="list-style-type: none"> - Can be planned well | <ul style="list-style-type: none"> - No utilization of the wear reserve - Increased risk of failure after maintenance - Repair costs |
| Condition-based maintenance | <ul style="list-style-type: none"> - Early recognition of problems - Downtime can be planned - Utilization of the wear reserve - High operational safety - Avoidance of consequential damage | <ul style="list-style-type: none"> - Dealing with the issue - Investment costs - Additional costs for equipment to measure condition |

9.26.7.16.1.2 Conventional condition monitoring

- There exists a lot of measurement and process data that is not used for condition monitoring (CM). Links and correlations with process parameters and further CM parameters can often be made possible only with considerable expenditure.
- CM systems are implemented as "isolated applications". In such cases condition monitoring is performed by standalone sensor and measurement systems with standalone hardware and software
- The range of different systems can lead to significant problems in the on-site operation of the system. Different software solutions make it more difficult since there is separate hardware and a separate user interface for each CM method and each CM tool.
- In many cases, necessary expert knowledge specific to a system is not available. The complexity of some configuration tools exceeds the user's existing expertise.

Using the X20CM4810 together with B&R standard modules has the following advantages:

- Easy exchange of process data and condition monitoring data
- Easy integration of parameters in the overall process
- Modular construction

9.26.7.16.1.3 Overview of condition monitoring methods

| Method | Brief description of operation | Available signals/interfaces |
|--|--|--|
| Determination of the condition of coolants and lubricants, visual assessment, filtering, ferrography, magnetic detection, spectroscopy, radioactive trace analysis | Quantitative examination of wear products (filtering, magnetic catches, ferrography, spectral oil analysis, particle counting) that are obtained from the lubricant oil or coolant fluid Regular taking of samples according to a defined time schedule or according to operating hours Quantitative comparison of the samples | Using suitable measurement systems, these condition monitoring methods can be processed in the B&R system using analog/digital inputs or bus controller modules. |
| Thermal diagnostics Temperature sensors, thermometry, infrared measurement technology | Recording of temperatures through sensors with different physical modes of action Recording of temperature distribution through detection of infrared radiation | |
| Acoustic emission analysis Airborne sound measurement, pulse analysis, pulse density fluctuation analysis, sound pressure measurement, sound emission location | Airborne sound measurement from infrasound to ultrasound using a microphone Multidimensional microphone structure for emission source location Recognition of microdamage (cracks), etc. through the measurement of acoustic emissions of transient waves with high frequencies | |
| Vibration measurement Structure-borne sound measurement, FFT analyses, order analyses, modal analyses | Vibroacoustic diagnostics Measurement of the structure-borne sound at bearing positions or structures with accelerometers, analysis and evaluation | |
| Electrical parameters, motor current analysis, Isolation resistance measurement | Compilation of electro-technical parameters and analysis with regard to condition monitoring | |

9.26.7.16.2 Oscillation measurement technology

9.26.7.16.2.1 Sensor technology

Oscillation sensors convert the mechanical oscillations of the machines being monitored into electrical signals.

For the most part, structure-borne sound, i.e. the sound that spreads through a solid object, is measured.

The acceleration measured within the scope of the condition monitoring is typically measured with piezoelectric sensors. The oscillation sensors being used utilize the piezoelectric properties of quartz or certain ceramics. The actual measured value is a force that is proportional to the acceleration.

The piezoelectric effect involves a charge separation when a force acts on the piezoelectric material. This is in proportion to the force and is consequently proportional to the acceleration. Piezoelectric quartz or piezoelectric ceramic is used as the piezoelectric material. The output signal is an electrical charge that is specified in pC (picocoulombs). A charging amplifier is necessary in order to convert the charge into a voltage signal.

The Integrated Electronics Piezo Electric (IEPE) technology used in B&R sensors strengthens the signal directly in the sensor and emits it as a low-resistance voltage signal. Sensor sensitivity is specified in mV/g.

1 g = 9.81 m/s² (gravitational acceleration)

Information:

Piezoelectric sensors cannot measure static magnitudes.

Basic design

In a compression sensor, the piezoelectric crystal is held between a seismic mass and the base of the sensor. Through the acceleration that occurs, the force acting upon the crystal increases or decreases. The larger the seismic mass, the larger the output signal.

Sensors of this design can be built with a very high stiffness and thus have a correspondingly high resonance frequency.

Influencing variables on the sensor

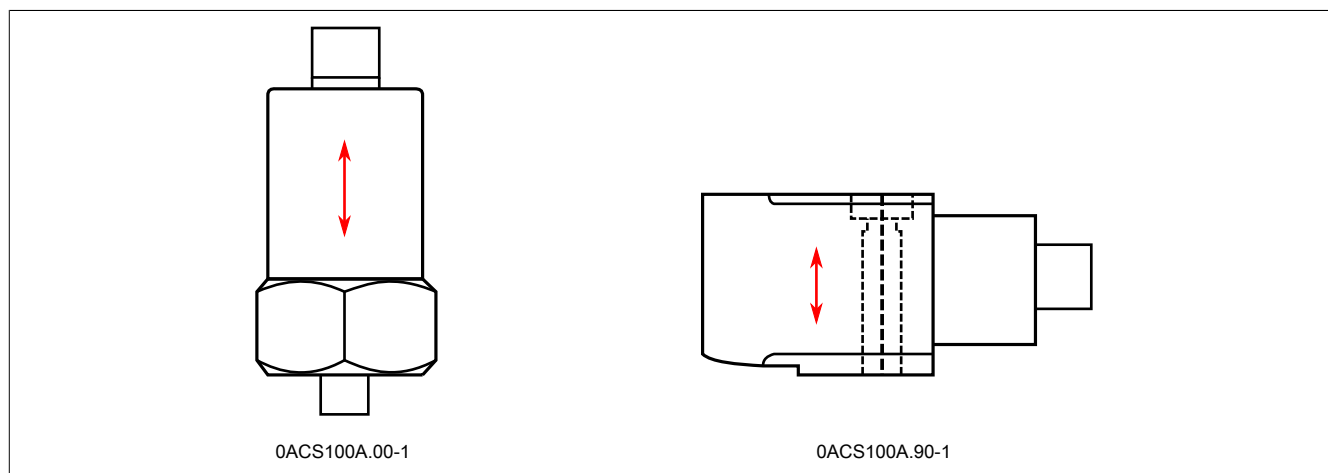
Mounting direction - Preferred direction

Oscillation sensors can be fitted at any location. The installation position usually results from the measuring task itself. Nevertheless, vibration sensors have a preferred measuring direction. This is normally marked on the sensor housing.

Oscillations perpendicular to the installation position also act upon the sensor. These can be compensated as much as possible through appropriate constructive measures and suitable selection of the piezoelectric crystal.

Installation position

B&R vibration sensor 0ACS100A.00-1 is designed for measurements in the longitudinal axis; sensor 0ACS100A.90-1 is designed for measurements in the transverse axis.



Cross-sensitivity

Oscillations in all directions act upon the sensor. The sensor preferentially transmits vibrations in its main direction, i.e. in the direction indicated on the sensor. Vibrations deviating from this main direction, however, are also registered by the sensor and transmitted differently in the overall signal depending on the design.

Cables

When transferring a signal over a connector, errors such as noise, ground loops and contortions may occur. This influence is particularly important in the transfer of charges since system noise is a function of the cable's capacity. When using IEPE technology, the sensor produces a high voltage signal with a low source impedance due to its internal electronics.

As a result, this technology is well suited for signal transmission over long lines.

The power supply unit provides constant current to supply the IEPE electronics in the sensor. The maximum frequency that can be transferred via the test lead without considerable loss depends on the length of the cable, the cable capacity and the ratio between the output amplitude and the constant current.

Information:

Maximum cable length when using B&R cable 0ACCxx0.01-1: 100 m

Temperature influence

All piezoelectric materials also have a distinct pyroelectric effect. This describes the change in the electric polarization of ferroelectric materials as a result of a change in temperature. This effect is undesirable since it often leads to charge separations in the oscillation measurement. These arise from the change in temperature and not through the mechanical vibrations occurring in the measured object.

However, this effect can be limited due to the design. The interferences are grouped together in the interference transfer factor for temperature changes.

Temperature drift

The values specified in the sensor's technical data have been determined as a step response to a change in temperature for the lower electrical limit frequency $f_u = 1$ Hz.

Changes in temperature, in particular, cause interference in the low frequency domain below $f = 10$ Hz since this is generally a low frequency event.

Interference

In the vicinity of electromechanical machines such as motors and generators, electromagnetic alternating fields and the associated induction and magnetostriction cause a reaction on the sensor. Due to the shielding concept used and the use of IEPE technology, however, this retroactive effect is very low.

This effect is specified in the interference transfer factor. It is determined by a magnetic flow density of 0.01 T and a frequency of 50 Hz.

Information:

B&R sensors have an isolated base. When using sensors from other manufacturers, it is important to pay attention to isolation/screening in order to minimize interference. This allows interference frequencies with single and double mains frequency.

Linearity

The piezoelectric sensor is linear over long distances of the frequency response.

Frequency response

The frequency response of the sensor is determined by its mechanical construction. The seismic mass and the rigidity of the inner structure is crucial here, as is its construction.

The sensitivity is linear in other areas of the frequency response. The frequency response only increases significantly when near the resonant frequency. Since misinterpretations can occur in proximity to the resonant frequency, the resonant frequency must be correspondingly high.

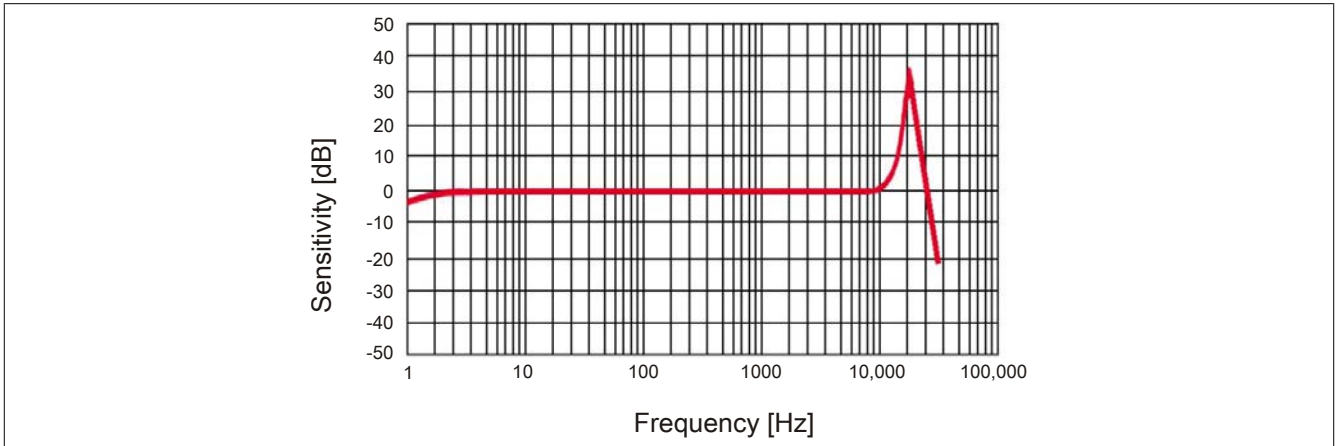


Figure 207: Frequency response of B&R sensors 0ACS100A.00-1 and 0ACS100A.90-1

Installing sensors

Sensors can be connected to object to be measured using various methods. How the sensors are installed on the measurement object is crucial for the quality of the overall measurement.

In order to transfer all frequency portions to be measured to the sensor accordingly, very good coupling of the sensor to the mechanical component is necessary.

Machine parts may be subject to temperature-related expansion and deformation, with the result that the sensor no longer has its whole measurement surface available. This affects the quality of the measurement.



Figure 208: Temperature deformation of a machine part (excessive deformation shown)

Information:

For optimal measurement, the mounting surface of the sensor must be flat and the sensor must be fully supported.

In order to increase the quality of the measurement accordingly, a fixed connection to the measurement object is necessary. Cover plates and plastic parts are therefore not suitable for securing sensors.

The following methods are available for installing sensors:

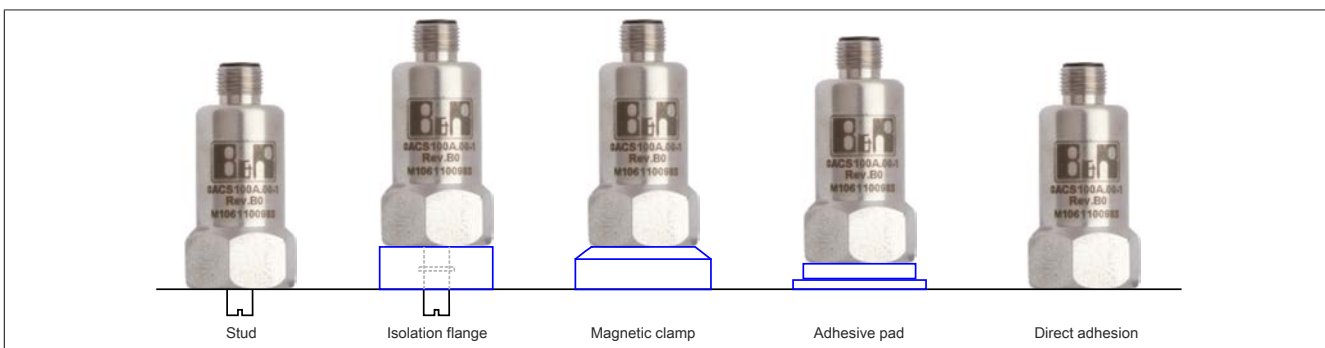


Figure 209: Overview of installation methods

Of all of the mounting methods, fastening by means of a screw is preferable due to the low attenuation between the sensor and the measurement surface.

Typical sensor installation is performed by screwing the sensor to the measurement object with what is called a stud (supplied with the sensor). Studs are specially-made setscrews made from special materials that facilitate the optimal transfer of vibrations.

If the mounting location is well prepared and the sensor is screwed on correctly, frequencies of up to approximately 10 kHz can be transferred without significant loss.

Information:

To ensure measurements of sufficient quality, B&R recommends mounting the sensor with a screw.

Ground loops can occur when the module and sensor are mounted far apart. If necessary, isolated mounting must be performed using an isolated adhesive mounting plate.

The resonant frequency is reduced by additional elements such as an isolation flange, collar screw, magnetic clamp and probe tip positioned between the coupling surfaces. The coupling becomes softer using these elements. These differences can be clearly seen in the frequency response diagram

Different frequency responses of the relative voltage transfer factor are illustrated in the image below.

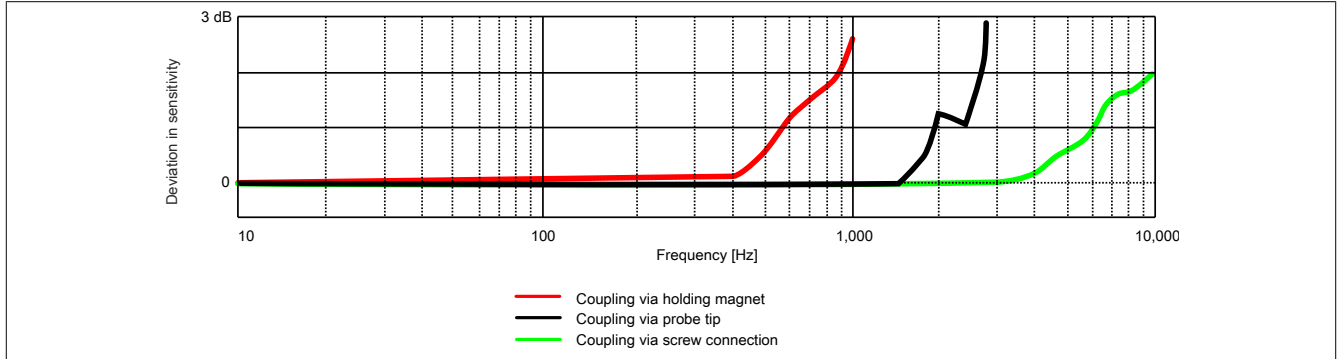
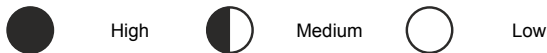


Figure 210: Attenuation of the different types of sensor mounting

The choice of mounting is influenced by the resonance frequency and temperature. The following table shows how strongly these influences impact on the different mounting methods.

| | Resonant frequency | Temperature |
|----------------------------|--------------------|-------------|
| Stud | ● | ● |
| Instant adhesive | ● | ● |
| Beeswax | ◐ | ○ |
| Double-sided adhesive tape | ○ | ◐ |
| Magnetic clamp | ◐ | ● |
| Probe tip | ○ | ○ |

Effects on the installation methods:



Installation procedure

Depending on the conditions of the location, sensors can be screwed directly onto the surface of the object to be measured.

STEP 1: As smooth and flat a surface as possible is needed to mount the sensors. The required size depends on the sensor; see the data sheet.

For a vertical installation position:

See ["Dimensions" on page 3167](#).

For a horizontal installation position:

See ["Dimensions" on page 3170](#).

STEP 2: An M8 blind hole is needed to attach the B&R sensors.

STEP 3: To further improve the transfer performance, a thin layer of silicon grease can be applied between the object surface and the sensor mounting surface. This is not necessary in most cases and is only useful when measuring particularly high-frequency vibrations.

STEP 4: The sensor should be tightened by approx. 8 Nm when using the M8x1 screw thread. If necessary, the sensor can additionally be secured with adhesive.

Sensor positioning

In order to optimally measure and detect the sound propagation of damage, the position of the sensor must be carefully selected. Although it is often not possible to mount a sensor at the absolute best position, this is not always necessary. Since sound waves propagate throughout the entire structure, the damage frequencies can be measured at various locations with varying intensity or amplitude (green arrow). If a flexible connection is used, a valid measurement is no longer possible (red arrow).

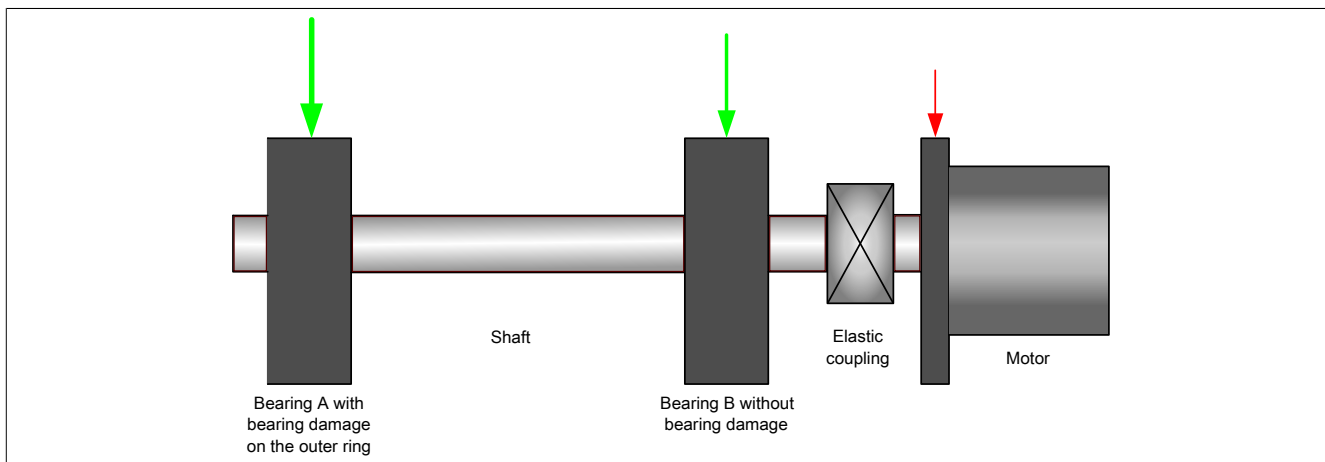


Figure 211: Suitable and unsuitable sensor attachments

9.26.7.16.2.2 Oscillations - Overview of measuring structure-borne sound

Oscillations

Oscillations are forms of movement that occur very frequently in nature. Harmonic oscillation is the third basic type of form of movement alongside uniform movement and uniform accelerating movement. An oscillation or vibration is a cyclic, i.e. repetitive simultaneous movement of a structure in its rest or equilibrium position.

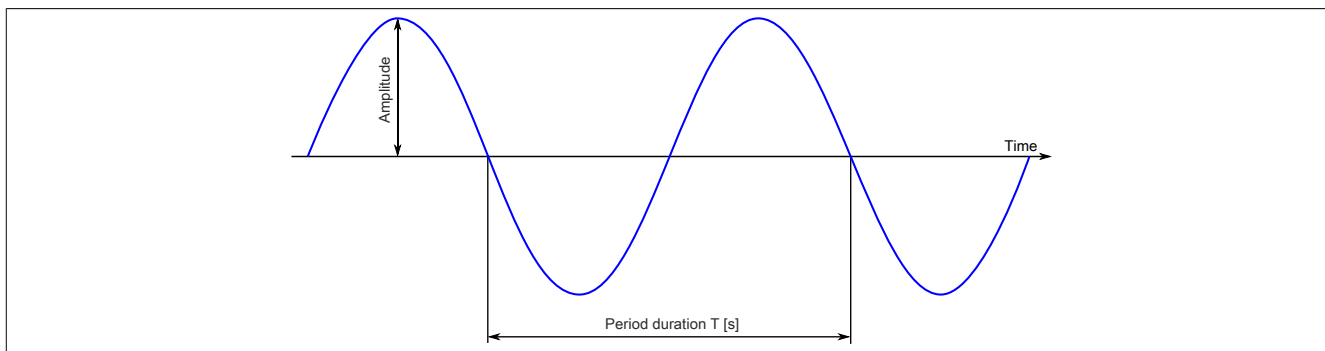


Figure 212: Illustration of a basic oscillation

If a fixed medium is stimulated by an impact, structure-borne sound spreads throughout it. This consists of additional frequencies which are determined by the shape of the structure and the material it is made from (e.g. gong or concrete block).

A portion of the structure-borne sound energy is converted into airborne sound through the surrounding atmosphere.

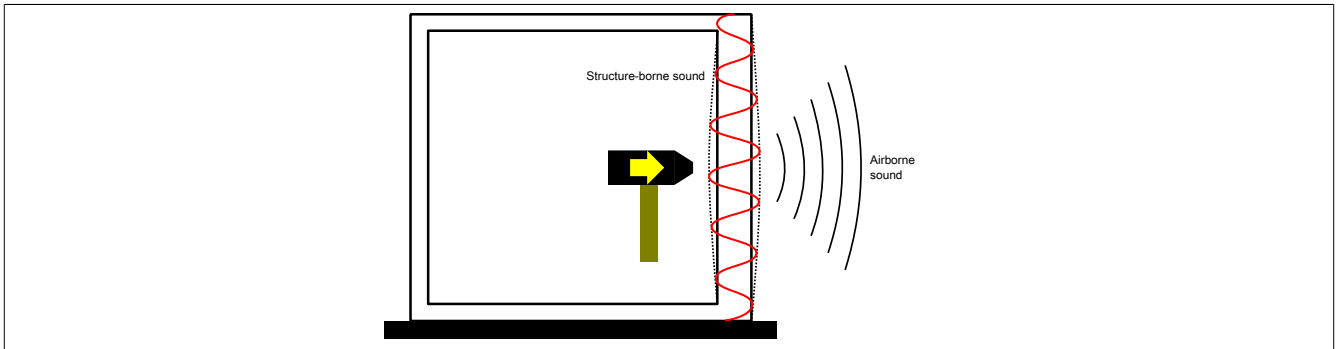


Figure 213: Propagation of structure-borne sound

The measurement and subsequent analysis of the mechanical oscillations on stationary and rotating parts of machines, support structures and pipelines has become accepted as technically possible with practically applicable monitoring procedures.

The absolute bearing oscillation is measured on the housing of the machine and involves the movements of the housing in relation to a fixed reference point in the room.

Mechanical oscillations are a good parameter for detecting initial defects and damage and can be used for machine diagnostics.

There are numerous overlapping causes for oscillations. The size (amplitude) of the oscillation depends on several factors such as attenuation through joints or grease, the rigidity of the component, the housing and foundations and much more.

Damage is always a consequence of stress. If cyclic stress occur, it can be identified by its excitation frequency and intensity.

Resonant frequency

Every machine has what are known as resonant frequencies. These must be observed during operation since with these frequencies the amplitude of the oscillation increases dramatically, putting strain on the mechanical components. If harmonic oscillations occur for a long time in proximity to the resonant frequency, this can lead to a so-called "resonance catastrophe", which causes the destruction of the affected part.

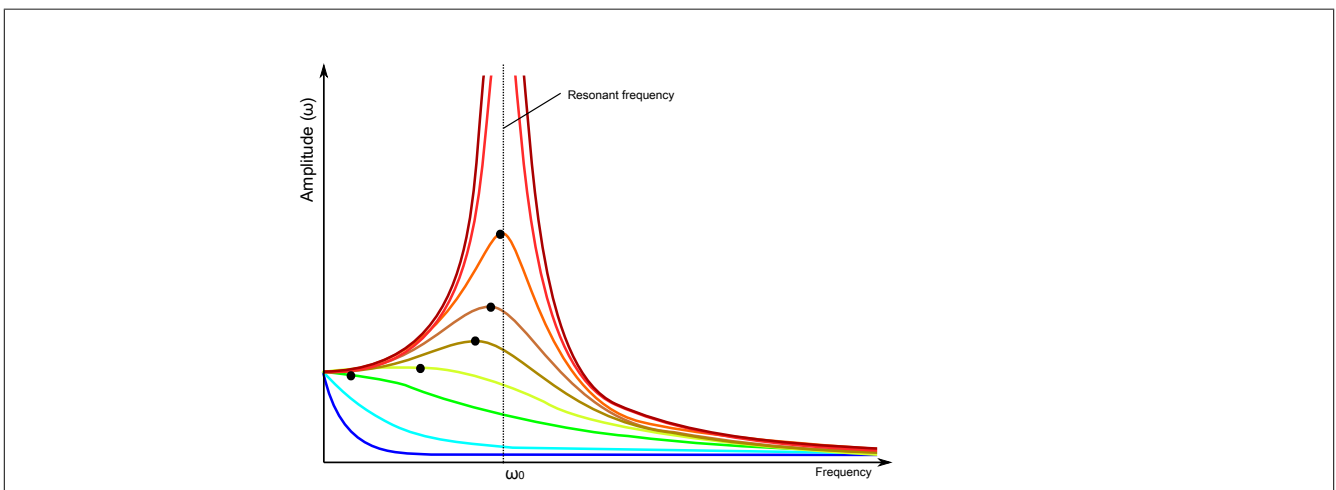


Figure 214: Increase of the amplitude in proximity to the resonant frequency

Causes of oscillations:**Imbalance**

Per DIN ISO¹⁾, an imbalance is present in a rotating system if forces or oscillation movements are transferred to the bearing as a consequence of imbalanced centrifuges.

Imbalances on a rotating structure not only cause forces on the bearing and foundations, but also oscillations in the machine. These oscillations have a harmonic nature, with the excitation frequency corresponding to the rotary frequency of the imbalanced rotor.

Alignment errors

The main function of coupling is to connect 2 shafts in order to achieve a statically determinate complete system. In addition to transferring torque, couplings also offset misalignment (radial, axial, angular) to a certain extent. However, if the misalignment exceeds the compensation capability of the coupling, additional loads such as increased bearing forces, forced shaft deformation and axial forces occur for the machine elements involved.

Oscillations have a harmonic nature and are bound to the rotary frequency of the misaligned shafts and the multiples of this frequency. Misalignment can be measured using the rotary frequency of the misaligned part or its harmonic oscillations.

Impacts

Foreign objects as well as loose or colliding parts can cause shocks between rotating and stationary parts. These shocks repeat periodically once or several times each time the shaft revolves.

The frequency of these shock repetitions corresponds to the rotary frequency of the shaft or its harmonic frequency.

Roller bearing damage

Most bearing damage results from changes on the surface (pitting). By rolling over the damaged area on the inner ring, outer ring, cage or rolling element, pulse-shaped shocks occur that make the bearing structure and its components vibrate.

Each of these shocks appears in the oscillation signal through the typical course of a shock sequence. Characteristic values can be obtained from these measurements that give an indication of the condition of the bearing.

The excitation frequency on the inner ring, outer ring, cage and roller bearing damage is specified by the bearing manufacturer.

Magnetic induction

A rotating magnetic field causes counterforces in the stator of the machine. This electric magnetic stimulation often causes oscillations on the electric motors that are hard to detect.

Inverters also often lead to an inference of oscillations, the cause of which is of an electrical magnetic nature.

Effects

Machines and systems with moving parts cause mechanical oscillations. The effects on the immediate location and surrounding area include tremors and structure-borne sound, often creating a disturbing noise development.

Increased vibrations can lead to malfunctions in the machine, particularly in measurement and control devices. If this causes the measuring equipment to resonate as well, incorrect measurements will result and manufacturing quality will suffer.

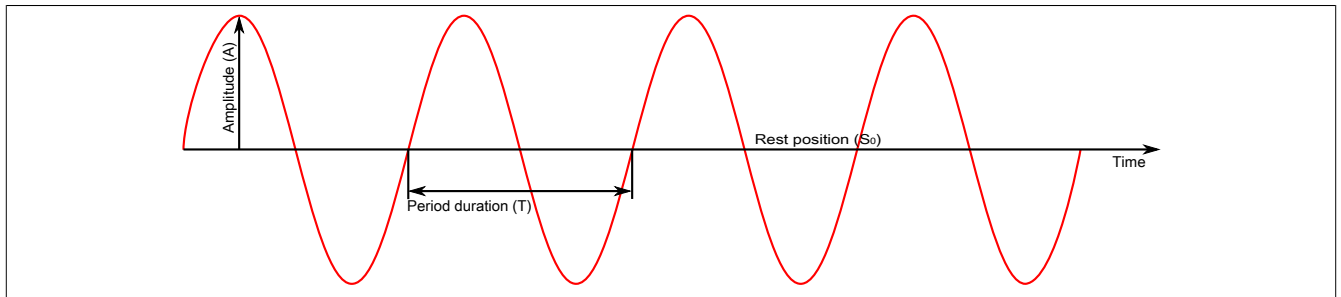
In addition, stress will develop on the components of the machine. Unwanted vibrations lead to increased wear with partly plastic distortion of components and increased crack formation all the way up to failure.

Noticeable oscillations are felt through the equilibrium organ and sense of touch. Long-term exposure can impair working performance and well-being, even leading to health damage.

¹⁾ 1925 DIN ISO 1925: Issue: 1996-11 Mechanical oscillations - Balancing technology - Terms (ISO 1925:1990 + AMD 1:1995)

Oscillation parameters

| Parameter | Explanation | Symbol | Formula |
|------------------|---|----------|--------------------------------|
| Rest position | The structure's undisplaced position | s_0 | |
| Amplitude | The greatest displacement from the rest position | A | |
| Period duration | Minimal time span for a complete oscillation after which a structure has reached its initial position and initial speed again | T | |
| Frequency | Number of oscillations per unit of time | f | $f = 1 / T$ |
| Angular velocity | Change of angle in the radian measure over time | ω | $\omega = 2 \cdot \pi \cdot f$ |



Large mechanical oscillations

The amplitude of an oscillation can be defined by its path (s), velocity (v) and acceleration (a) values.

These 3 values have a consistent relationship with one another and can be converted from one to the other using simple calculations.

The B&R sensors measure oscillation acceleration. The unit is m/s^2 . The acceleration is also often specified with the unit g ($1 g = 9.81 m/s^2$) for the acceleration due to gravity.

For some diagnoses, however, the oscillation velocity or oscillation path is more meaningful. The acceleration can then be passed converted to the oscillation velocity through integration. The path can be calculated from the acceleration by using integration twice.

Mathematical relationship

Displacement

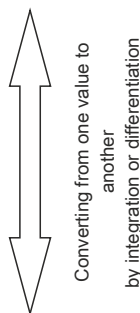
$$s = \hat{s} \cdot \sin(\omega t + \varphi)$$

Oscillation velocity

$$v = \frac{ds}{dt} = \hat{s} \cdot \omega \cdot \cos(\omega t + \varphi)$$

Oscillation acceleration

$$a = \frac{d^2s}{dt^2} = \frac{dv}{dt} = -\hat{s} \cdot \omega^2 \cdot \sin(\omega t + \varphi)$$



Information:

Displacement is not calculated by the module.

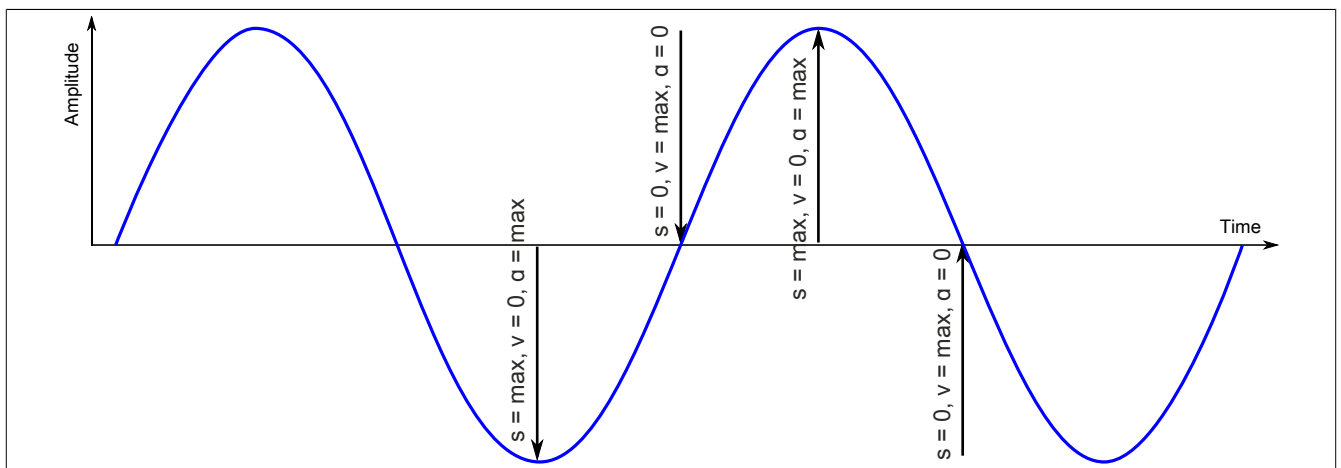


Figure 215: The s-v-a relationship

A harmonic oscillation can be clearly described by its amplitude, frequency and phase angle.

- The amplitude in the path, velocity or acceleration indicates the instantaneous value.
- The frequency describes how often an oscillation changes within one second. In oscillation diagnostics, this plays an important role since many frequencies can be assigned to one cause.
- The phase angle refers to the starting point of the oscillation. This is usually not that important since in most cases several oscillations are present.

Fast Fourier transforms (FFT)

Oscillation signals generally consist of a number of oscillations that occur simultaneously and overlap. Individual frequencies are not directly evident from a timing diagram.

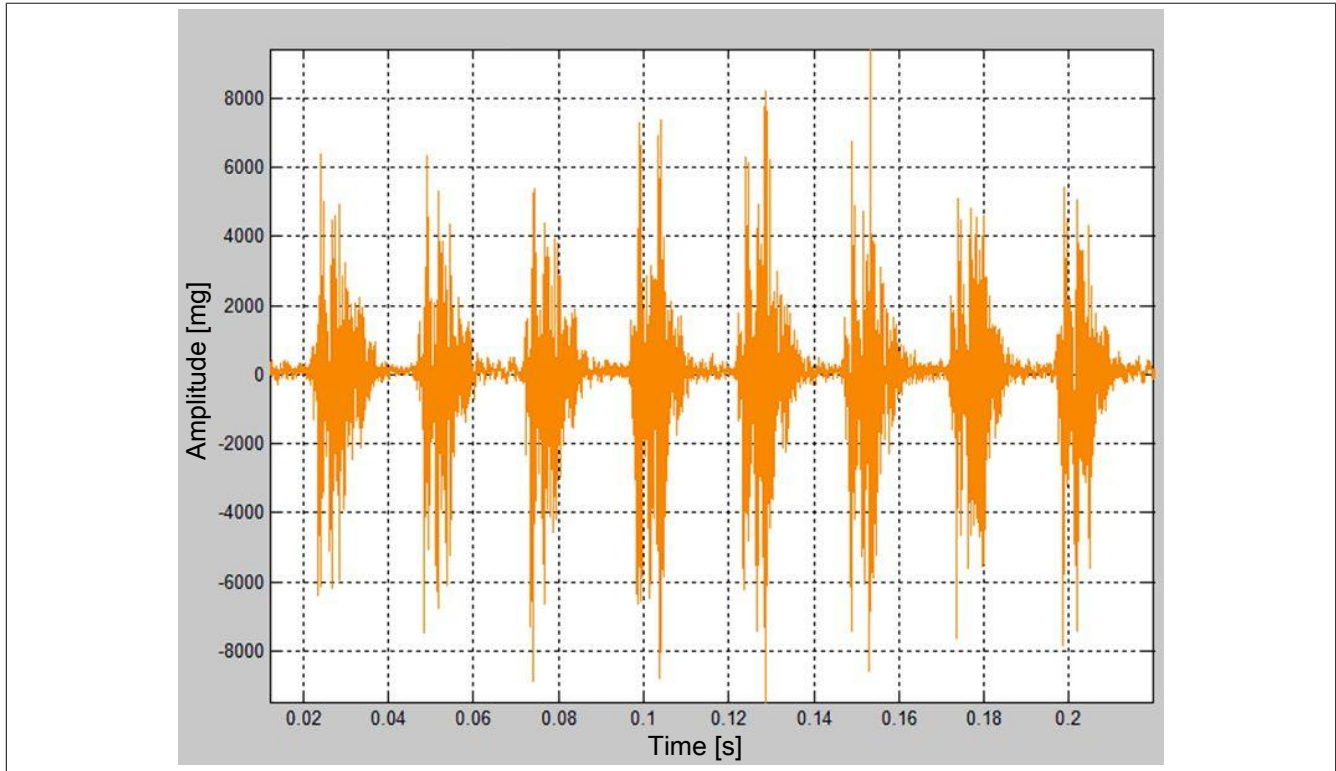


Figure 216: Timing diagram of an oscillation

Calculating a line spectrum is suitable for analyzing a mixture of oscillations of different frequencies where each participating oscillation and their frequencies and amplitudes are represented by a single line.

Within the scope of condition monitoring, spectra are a valuable aid in finding the cause of a failure. Many frequencies can be traced back to individual components so that damaged components can be identified.

Adding sinusoidal oscillations to generate a signal

The following figures show how a square wave signal is created by overlapping sinusoidal oscillations.

Sinusoidal oscillation with 1 Hz and an amplitude of 1.

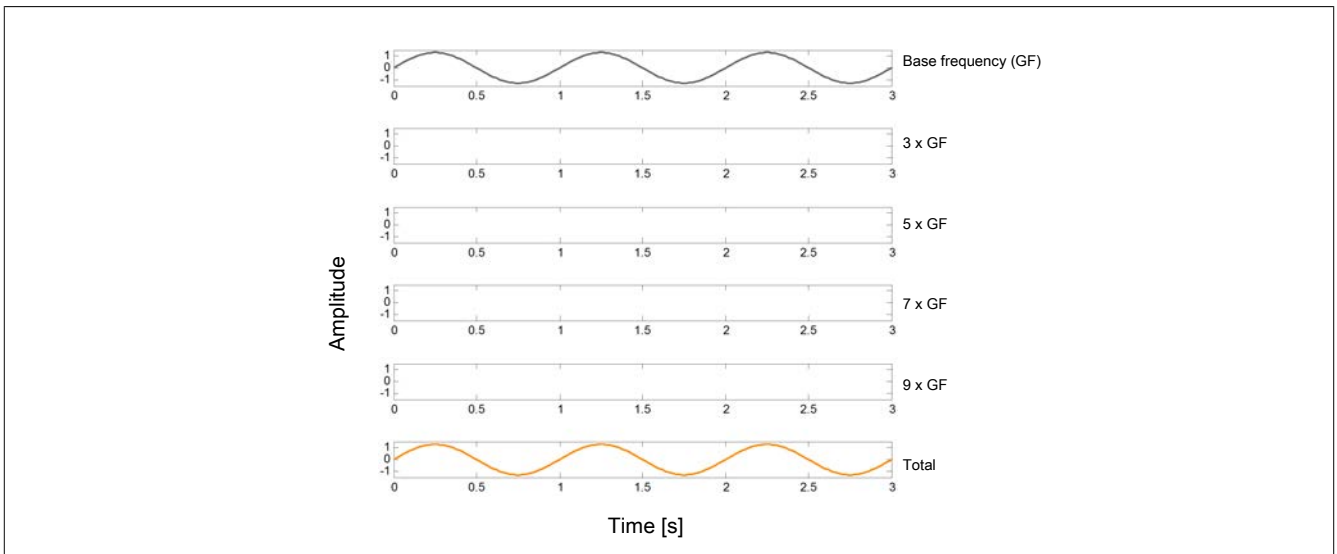


Figure 217: Pure sinusoidal oscillation

Sinusoidal oscillation with 1 Hz and an amplitude of 1 and sinusoidal oscillation with 3x the base frequency, i.e. 3 Hz and a lower amplitude.

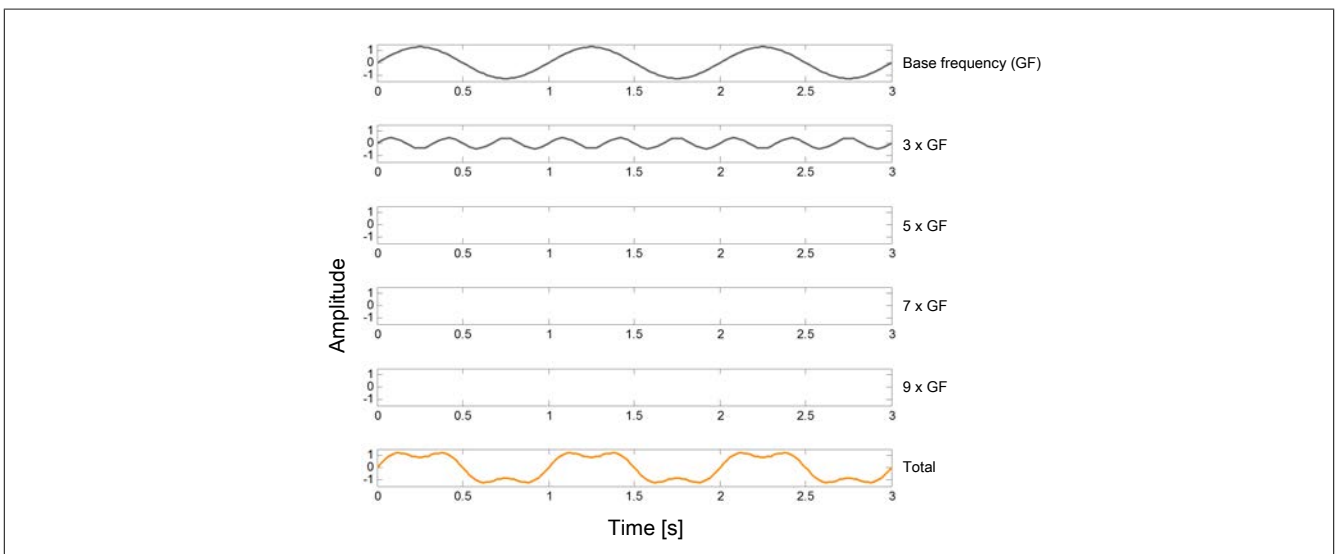


Figure 218: Sinusoidal oscillation with one harmonic

Sinusoidal oscillation with 1 Hz and an amplitude of 1 and sinusoidal oscillations with 3x, 5x, 7x and 9x the base frequency and a lower amplitude.

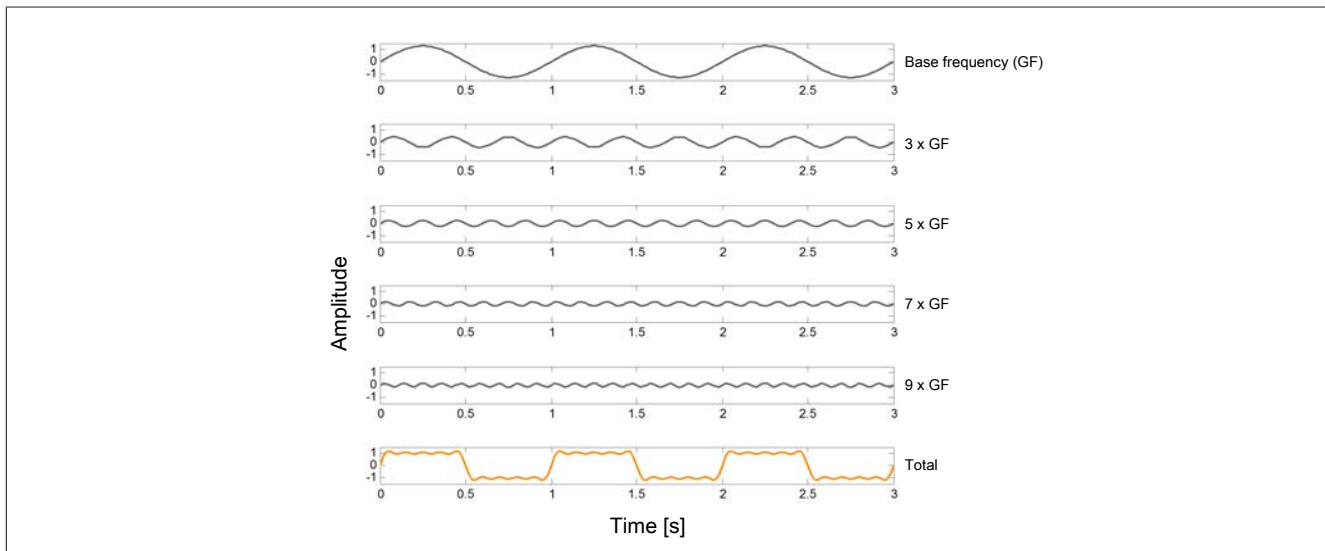


Figure 219: Sinusoidal oscillation with several harmonics

General description

The Fourier transform is the basic principle of frequency analysis. It assumes that each harmonic oscillation can be broken down into any number of sinusoidal and cosinusoidal waves, the sum of which reproduces the original oscillation. Linked individual waves are "broken down" again accordingly.

Probably the most well-known concept in connection with signal processing and frequency analysis is the fast Fourier transform, or FFT.

In order to be able to evaluate single partial oscillations into amplitude and frequency, the digitized time signal is converted into a frequency spectrum. In addition, a small extract is taken from the signal; this is known as the time window. Using the FFT algorithm, the frequency spectrum is calculated from this so that each involved oscillation and its associated frequencies and amplitudes is shown as a single line in the line spectrum.

Example

For a single sine signal with a constant frequency, a single line is shown in the frequency spectrum.

Information about using FFT

Window functions

Depending on the signal structure and boundary conditions, discontinuities may occur at the time window limits of the extract taken. These reflect partial oscillations that do not exist at all in reality.

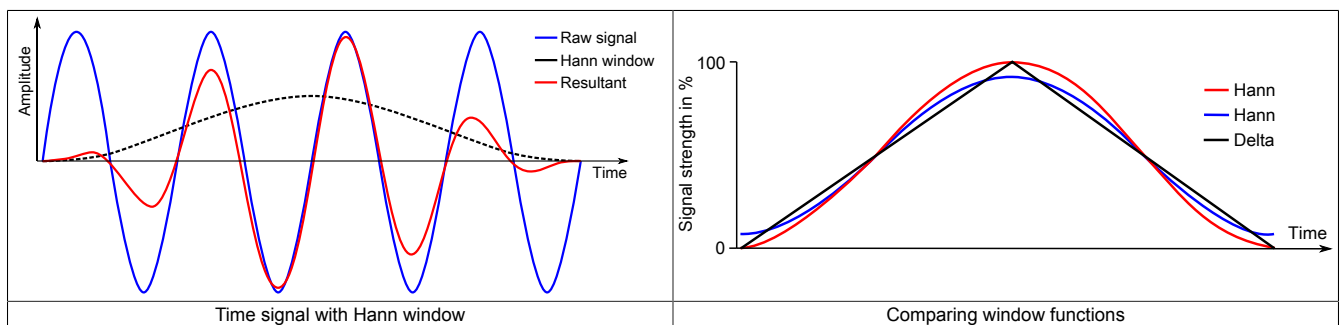
These discontinuities arise if the period of the sampling does not correspond to an integral multiple of the period of the time signal. This occurs with practically every measured signal since this is composed of a number of signals with different period durations.

Window functions are used to suppress these discontinuities. This is done by multiplying the input signal with the window function and supplying the Fourier transform with the resulting signal.

Common window functions are:

- Triangular window
- Hann window
- Hamming window

All of these functions share the fact that they approach zero at the edges, so the periodic continuation now no longer has any jump discontinuities.



Information:

The Hann window is used in the X20CM4810 module.

Sampling

Scanning or sampling refers to the recording of an analog value at certain intervals.

At defined times, the precise voltage level of the signal is recorded and stored. The distance Δt (Delta t) between the recording points is called the sampling interval.

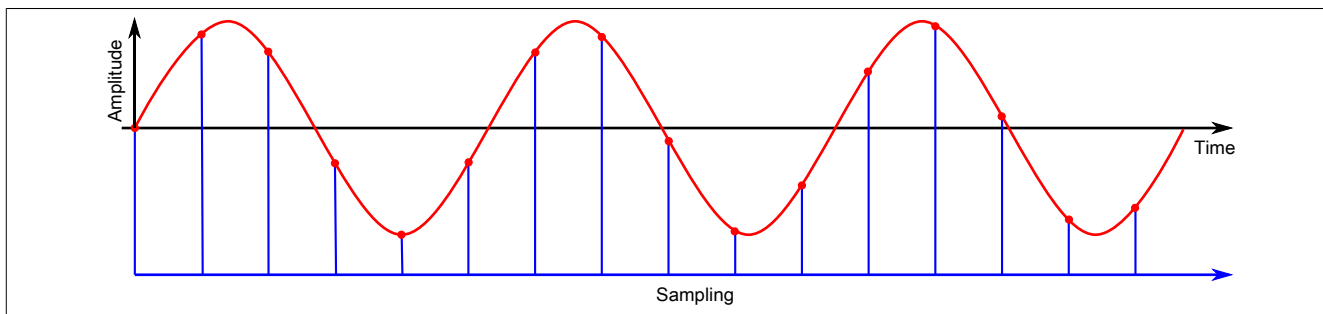


Figure 220: Sampling of a curve

If the actual sampling rate is many times higher than the theoretically required sampling frequency, it is called "oversampling". The reduction of the sampling rate to the required rate is called "downsampling".

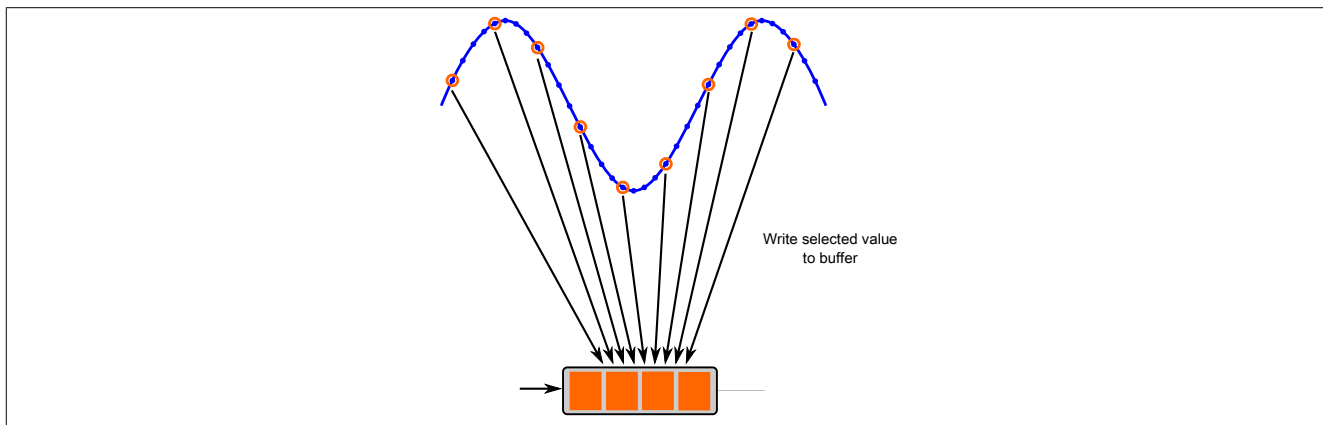
If the Fourier transform is used in accordance with the sampling theorem on a purely sinusoidal signal whose frequency corresponds exactly with a node in the frequency spectrum (whole number multiple of the frequency resolution), then this signal appears as a single line in the spectrum. If the frequency of the sinusoidal oscillation does not fall on a node in the frequency spectrum, then it will appear as 2 neighboring lines whose vertical relationship to each other is indirectly proportional to the frequency deviation of the respective node.

In practice, a pure sinusoidal signal will rarely occur. Rather, a signal will consist of a multitude of sinusoidal oscillations of different frequencies. As a result, the resulting frequency spectrum also consists of a large number of lines.

Depending on the resolution selected, the lines manifest themselves in different ways on the spectrum.

Buffer storage

The values that have been sampled are stored for 300 ms in the module's internal buffer and must be transferred during this time. (See ["Transferring characteristic values via Flatstream" on page 3097.](#))



The size of the buffer is constant and can store 8192 measured values. This results in the following relationship between the sampling rate and the duration of measurement.

Measurement duration = Buffer size / Samples per second

Since the number of values stored depends on the configured sampling rate and not the hardware-based sampling rate, not all values that are measured are stored. At a measurement duration of 318 ms, every second value is stored; at a duration of 15.9 ms, every hundredth value is stored.

The number of stored values can be set indirectly through registers ["MaxFrequencyEnvelope" on page 3085](#) and ["MaxFrequencyRaw" on page 3086](#)

Aliasing effect

The input signal is sampled at regular intervals. If the sampling rate used is too low, the input signal will be sampled incorrectly and a flawed image of the oscillation will occur. This undesirable phenomenon is called the aliasing effect.

To avoid such false results, the requirements of the theorem known as Nyquist's sampling theorem must be fulfilled in the sampling. This sampling theorem describes the necessary frequency ratio between the sampling and the signal and states that the sampling rate must be more than double the maximum frequency of the measured signal.

Example of incorrect sampling

Sine wave with 4 kHz sampled at 6 kHz. The red wave shows the sine wave measuring 2 kHz, which is a result of the sampling being too low.

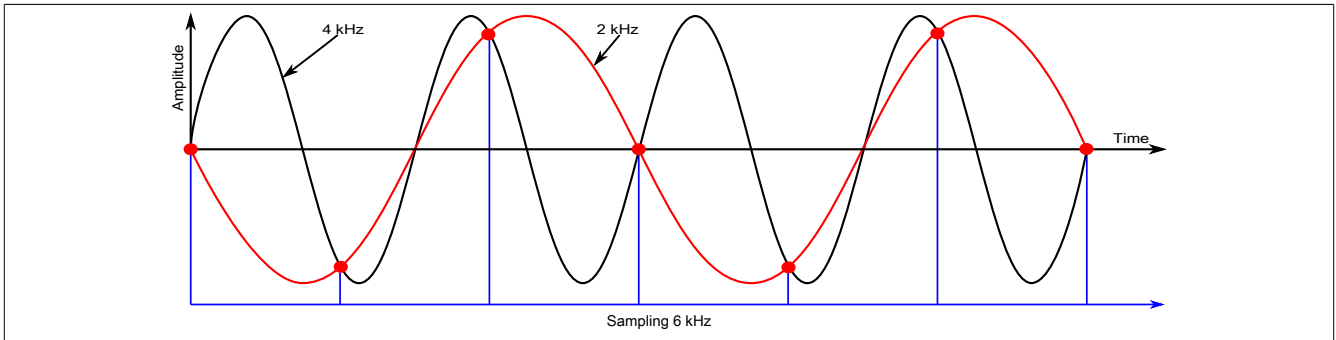


Figure 221: Incorrect sampling with 6 kHz and 4 kHz

Information:

The module ensures that Nyquist's sampling theorem is always fulfilled.

With a wanted signal of 10 kHz, a reduced sampling frequency of 25.7812 kHz is used!

Resolution

The time-continuous input signal is converted into a series of discrete digital output values. The A/D converter resolution determines the maximum possible number of digital values. Since this is always a discrete number, digitization always results in a deviation from the actual input signal, which is known as quantization error.

The sampling rate determines the interval between 2 conversions and must be selected to suit the type of processing planned for the signal. For many signal processing tasks, it is fundamentally important to adhere to the sampling theorem. The module performs appropriate filtering and decimation steps to ensure that the sampling theorem is adhered to at all times, regardless of the configured sampling rate.

In the time domain, a higher sampling rate allows for a more detailed description of the signal but also consumes a larger amount of memory. In the frequency domain, a higher sampling rate increases the maximum frequency that can be evaluated. Since a defined number of values is used for the FFT, however, the resolution decreases and thus the possibility of distinguishing frequency ranges close to each other.

Information:

On the X20CM4810, a MaxFrequency of 200 Hz results in a distance of 0.0629 Hz between 2 lines.

Time signal

The resolution can be identified in the time signal from the distance between 2 adjacent measurement points.

Example

MaxFrequencyRaw is 2 kHz in this example.

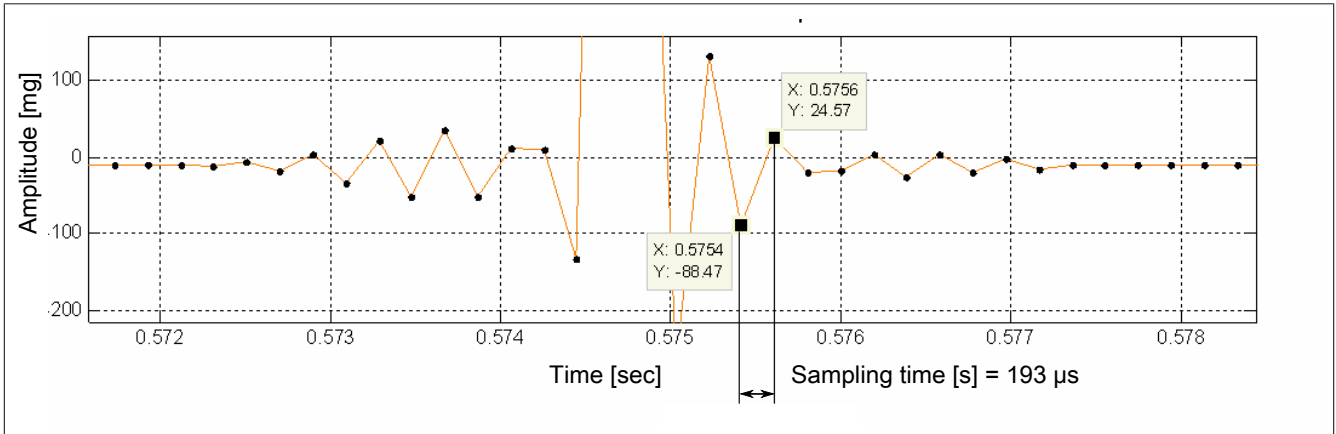


Figure 222: Time signal with corresponding resolution

Frequency spectrum

The resolution in the frequency spectrum indicates the distance between the individual frequency lines (spectral lines) that can still be evaluated.

Example

Frequency spectrum at a MaxFrequency of 2 kHz.

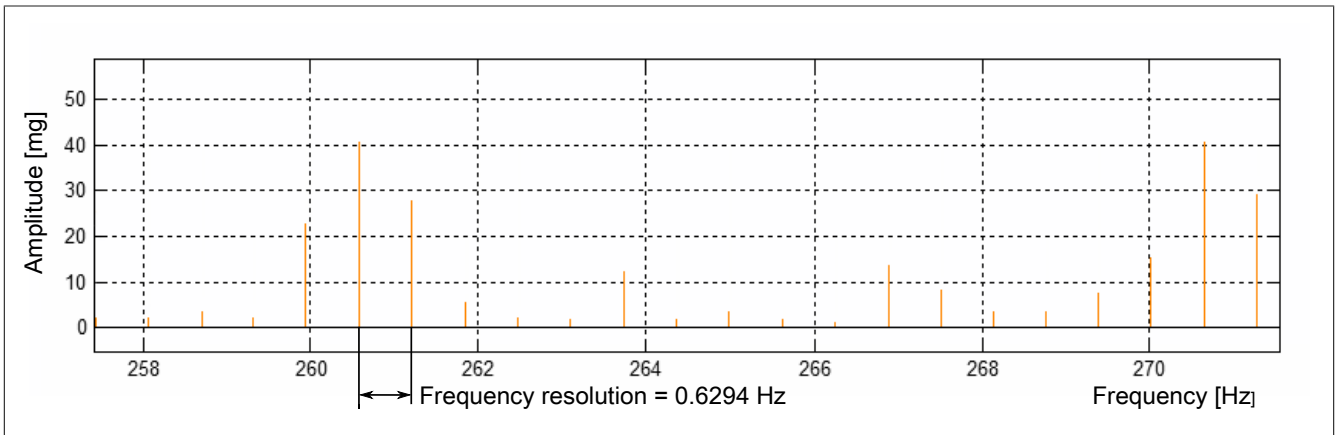


Figure 223: Frequency spectrum

Quantization

To process analog signals digitally, an analog-to-digital converter (AD converter) is required. However, only voltages in steps can be measured by an A/D converter. This is known as quantum voltage. The range to be measured is thus quantized.

In an AD converter, the digital resolution depicts the number of levels there are in the quantization. This determines the accuracy and sensitivity with which a previously analog level value is depicted. The more available levels there are, the more precise the discrete signal received and the higher the sensitivity of the measurement.

The resolution indicates how many varying digital values an analog signal can be converted into. The resolution is expressed in bits.

| | |
|-------------------|-------------------------|
| 8-bit resolution | 256 level values |
| 16-bit resolution | 65,536 level values |
| 24-bit resolution | 16,777,216 level values |

Example

A 24-bit resolution, a sensor measurement range of ± 10 V and a sensor sensitivity of 100 mV/g result in:

$$20 \text{ V} / 2^{24} = 1.192 \text{ } \mu\text{V} \rightarrow \text{Corresponds to } 11.92 \text{ } \mu\text{g}$$

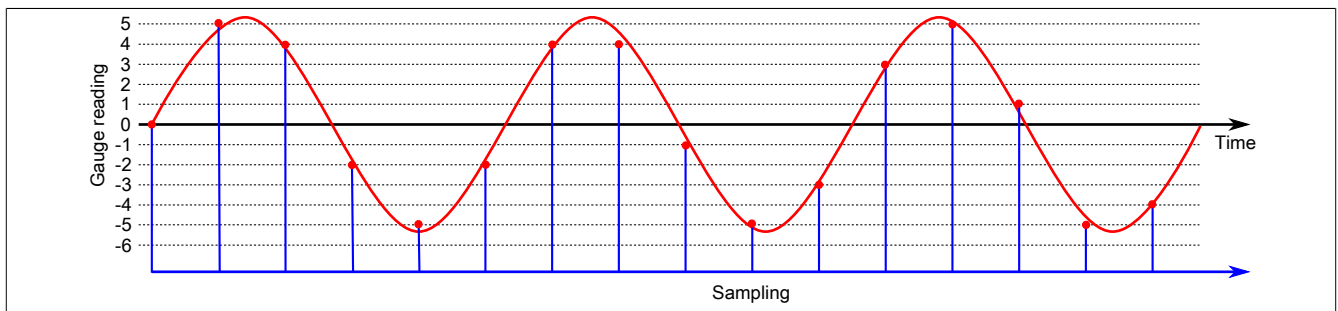


Figure 224: Quantization error at low resolution

Information:

The module has 24-bit resolution.

Duration of measurement

The duration of measurement depends on the configured maximum frequency. Depending on whether the envelope or raw values are to be measured, the following registers are used for configuration:

- "MaxFrequencyEnvelope" on page 3085 for envelope measurement
- "MaxFrequencyRaw" on page 3086 for raw value measurement

| Maximum frequency | Sampling frequency | Duration of measurement |
|-------------------|--------------------|-------------------------|
| 10000 Hz | 25781 Hz | 0.3178 s |
| 5000 Hz | 12891 Hz | 0.6355 s |
| 2000 Hz | 5156 Hz | 1.5888 s |
| 1000 Hz | 2578 Hz | 3.1775 s |
| 500 Hz | 1289 Hz | 6.3550 s |
| 200 Hz | 516 Hz | 15.8875 s |

Envelope

When you look at the various causes of oscillations, it becomes clear that they primarily come from 2 sources:

1. Imbalance and misalignment

Imbalance and problems with alignment lead to predominantly harmonic, sinusoidal oscillations.

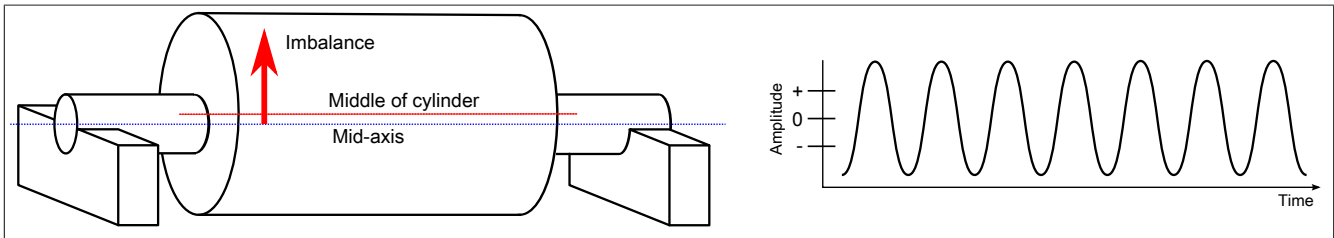


Figure 225: Imbalance - Harmonic oscillation

2. Impacts

Many types of machine damage can result in oscillations that cause the structure of the machine or adjacent machine parts to vibrate at their natural frequency. Impact-related causes of this are a result of corrosion, a rotor brushing up against the machine housing or roller bearing/gearing damage to the gears.

In the case of roller bearing damage, impact occurs when either the rolling elements roll over damage on the inner or outer track or when one of the rolling elements themselves is damaged.

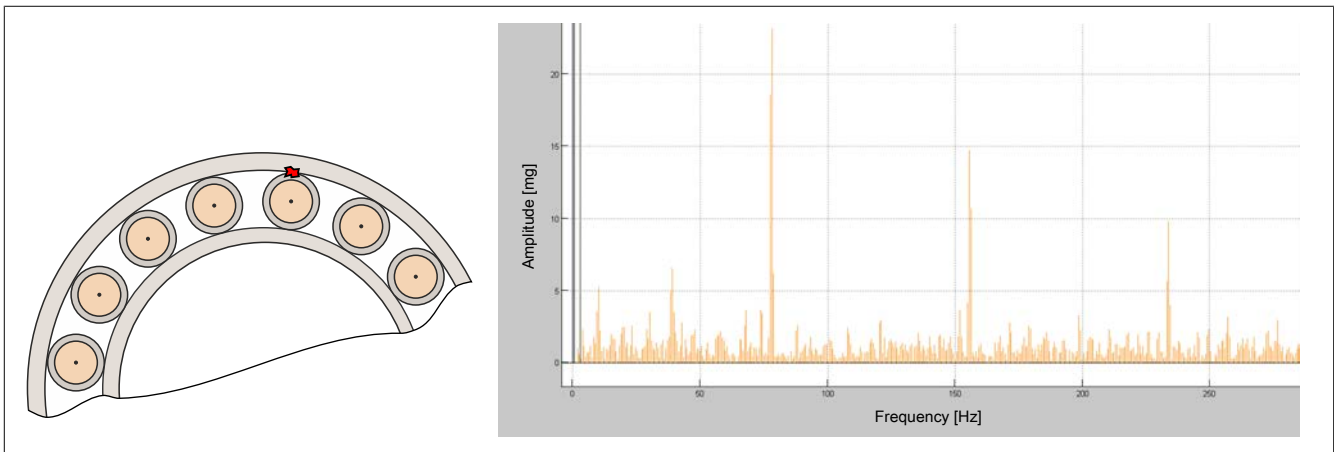


Figure 226: Bearing damage - FFT of envelope signal

This kind of impact can be compared to a clapper hitting a bell. If the bell is struck 2x per second, it vibrates at its natural frequency and not 2 Hz. The natural frequency is determined by the constructive design and material properties. As with any sound boxes, mounting also factors into this.

If the damage is to the roller bearing track, every shock pulse will lead to a corresponding reaction in the vibrating system. It is only practical to measure the sum of all pulses, i.e. the total signal.

In the case of damage to roller bearings, the bearing rings are the first to start vibrating.

Analyzing oscillations

Oscillations are transmitted in the machine as waves and can be measured on the machine's surface. A prerequisite, of course, is that a path is available for the sound transport, i.e. there are no sound-absorbing border crossings such as air, rubber, etc. between the roller bearing and sensor.

This signal can be measured on the surfaces of the machine by means of an accelerometer. The signal is made up of a variety of oscillations and impacts that overlap each other. When considering the time signal in this way, it is easy to see that allocating individual frequencies is difficult, if not impossible.

Using a Fast Fourier transform, this time signal can be converted to give the natural frequency of the system. These are in the high-frequency range. The rotor frequency and its harmonic frequency are clearly identifiable as the dominant frequency portion.

The rollover frequencies of the roller bearings are between 15 and 70 Hz at a speed of approximately 600 rpm, depending on the bearing.

In particular, shock pulses of a lower intensity, as they are when damage first begins, can barely be noticed or assessed. It is only when there is advanced damage to bearings that signal peaks can be clearly observed.

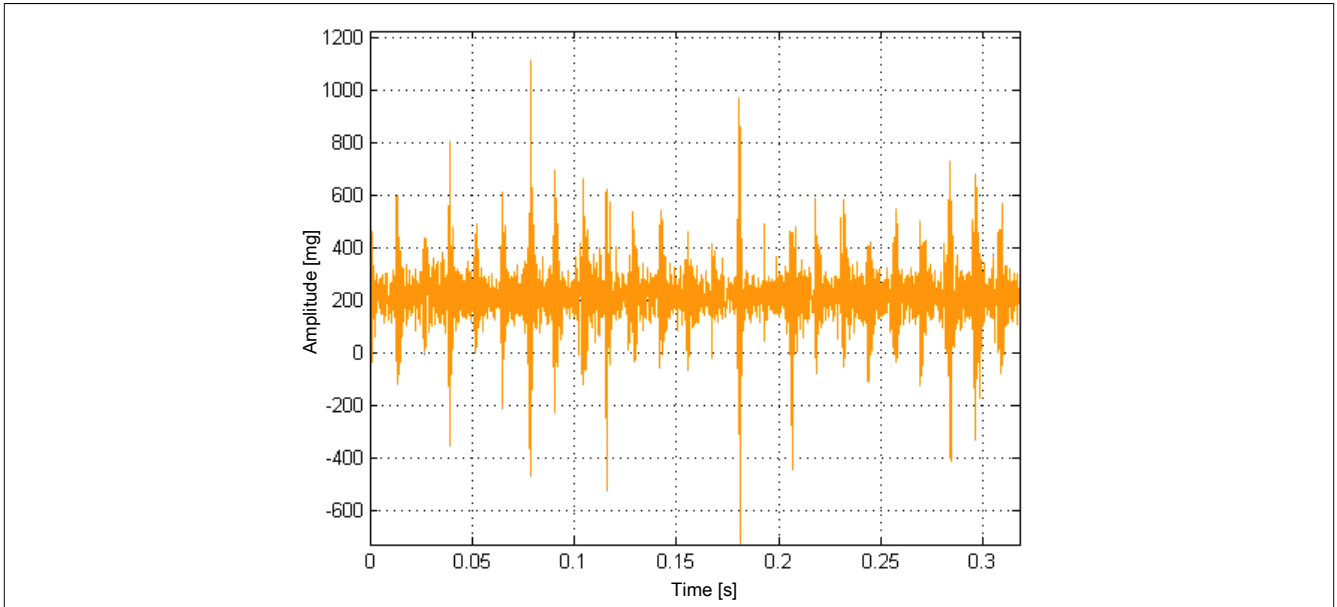


Figure 227: Advanced bearing damage at 600 rpm

To make the actual result, or shock sequence, clearly visible, it is obviously not enough to simply provide the amplitude spectrum. It is much more important that the process of convolution that took place when the signal occurred be appropriately reversed so as to separate the excitation function from the natural frequency. This is what envelope analysis provides.

An amplitude-modulated signal is made up of a high-frequency carrier signal and a low-frequency wanted signal. The amplitude of the carrier signal changes depending on the wanted signal. In the receiver, the wanted signal is extracted from the carrier signal by the formation of the envelope curve (demodulation).

In the case of machine resonances caused by periodic impacts, the machine resonances can be viewed as the carrier signal and the low-pass-filtered shock pulses can be viewed as the low-frequency modulation signal. Demodulation results in the shock pulses being extracted from the resonance frequencies.

Envelope analysis

Normally in an envelope analysis, the frequency spectrum of the envelope signal is evaluated. Suppressing the steady component gives a frequency spectrum that exhibits only one increased amplitude at the frequency of the low-frequency sinusoidal oscillation.

The envelope signal of the periodically peaked excited machine resonance shows mostly increased amplitudes in the shock pulse repetition rate and its multiples.

The envelope analysis is thus a method for differentiating between harmonic causes (imbalance, orientation) and impact-related causes (roller bearing damage, gearing damage, etc.).

Conversely, it must be stated that harmonic causes in an envelope spectrum cannot be determined accordingly.

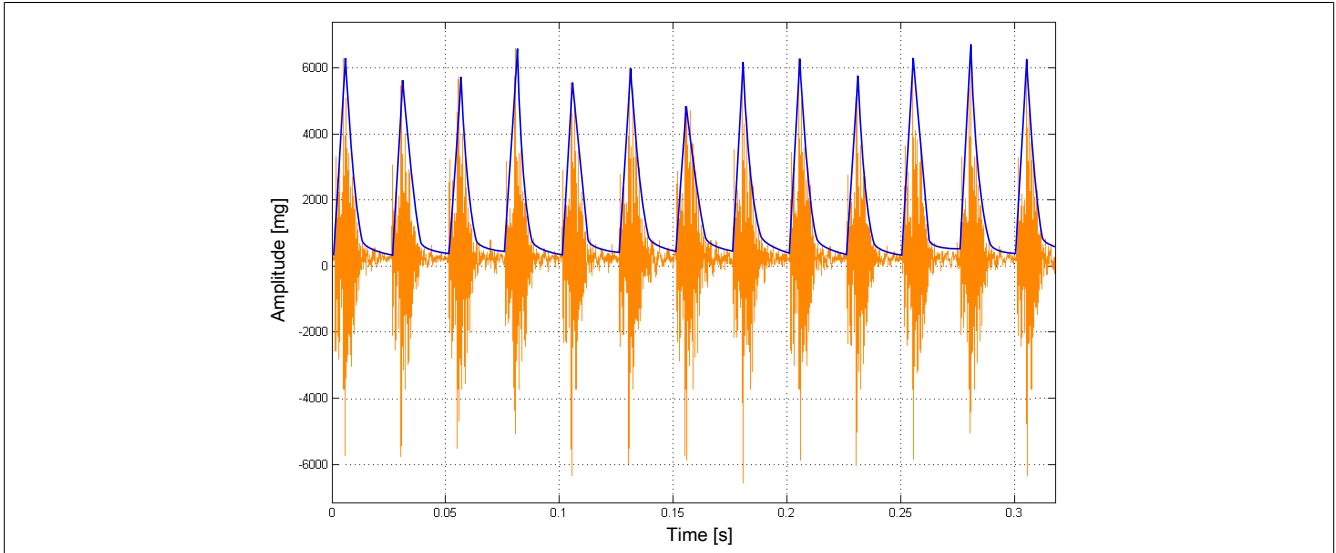


Figure 228: Time signal with envelope

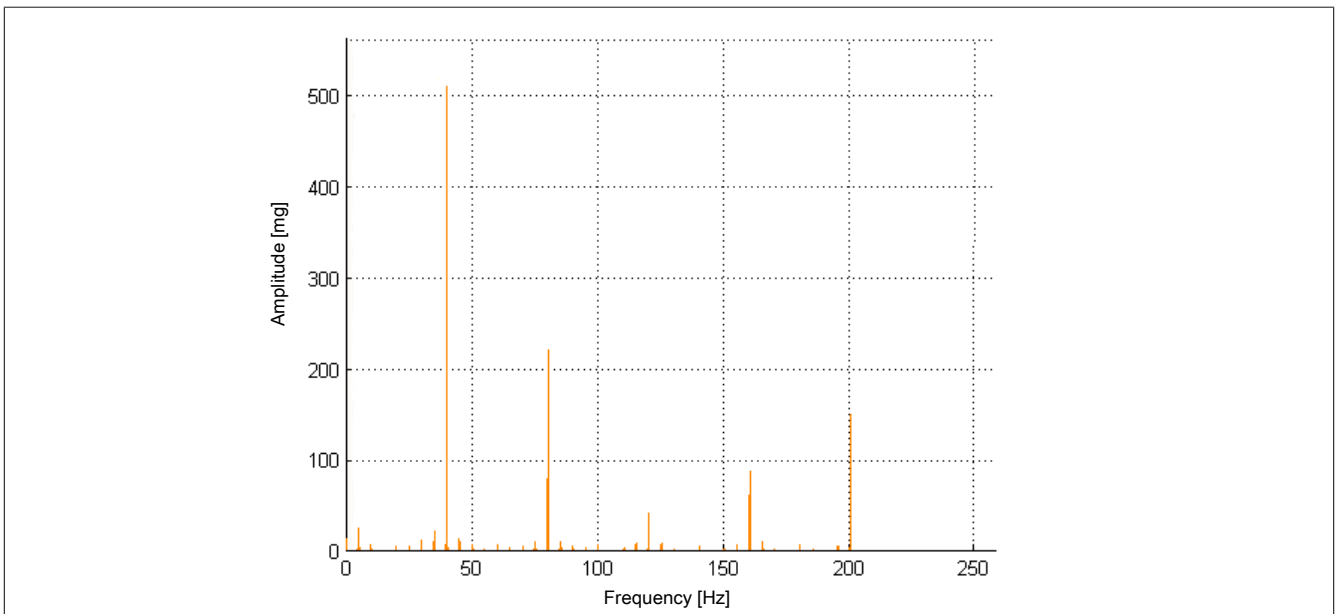


Figure 229: Resulting frequency spectrum of the envelope

Displacement, velocity and acceleration

Sensors can record oscillation acceleration, oscillation velocity or oscillation displacement. Regardless of the physical value that the sensor records, the oscillation can be represented as a combination of acceleration, velocity or displacement since:

$$s = \int v dt = \iint a dt^2, \text{ or } a = \frac{dv}{dt} = \frac{d^2s}{dt^2}$$

Legend:

- s - Oscillation path
- v - Oscillation velocity
- a - Oscillation acceleration
- t - Time

Since oscillation velocity is calculated through integration from the oscillation acceleration and oscillation displacement is calculated through integration from the oscillation velocity, it is possible to convert the sensor value whenever necessary.

Acceleration is proportional to the force. In contrast, the velocity is an indication of the energy.

What is significant from a practical standpoint is that, when one physical value is converted to another, the frequency is included. For a sinusoidal oscillation, the following applies:

$$s = \frac{a}{(2 \cdot \pi \cdot f)^2} \quad v = \frac{a}{2 \cdot \pi \cdot f}$$

The frequency is in the denominator. As a result, high-frequency signal portions are underestimated when using oscillation velocity in comparison with oscillation acceleration. This effect is squared with the application of oscillation displacement.

9.26.7.16.2.3 Determining limits and alarm limits

A general statement about the health of a machine can be made by comparing the measured characteristic values with limit values defined by standards (e.g. ISO 10816) or by the manufacturer of the machine.

Characteristic values are calculated from the measured signals, which are representative of the status of the system at the given measurement point.

Norms can be used in part to determine alarm limits. In addition, limits can be set based on the machine's history and the experience of the operator.

Comparison with references and norms

For certain machines and systems, limits are fixed by norms. With the exception of ISO 10816, these give little information for assessing the actual status of the machine.

Manufacturer's limits

A few machine manufacturers give limits for permissible oscillations and other relevant factors for assessing the status of the machine. These are based partly on calculations as well as the manufacturer's own knowledge and experience.

Whenever possible, these are the limits that should be used for assessing condition.

Operator's limits - Experience-based values

Operators can also draw on their own experience when assessing the status of the machine. Long-term observation of the characteristic values and the machine's history can provide relevant values based on experience.

The limits ascertained from this can vary significantly from limits set by norms and those prescribed by the manufacturer of the machines. This assessment is only possible when operators have considerable experience with oscillations in the machine and are in a position to differentiate between positive and negative characteristics.

When determining limit values, it is important to note that vibration measurements are influenced by factors such as:

- The location of the damage
- The location of the sensor
- The speed of the moving parts of the machine
- The load on the machine parts

Assessing the trend

In many cases, not enough is known about the actual behavior of a machine during operation, in particular when there is damage.

To make a reliable statement about its condition, the chronological sequence of the characteristic values (characteristic value trend) must also be used when making the assessment.

In the progression of the trend, the "Normal condition" is the starting point. The reference level (normal level) is the level of the characteristic value as set in the normal condition.

Changes in the trend are observed with the normal condition as the starting point. When there is damage, the relevant characteristic values in each case generally increase, although a decrease can also be an indication of a problem in the system.

In order to assess trends accurately, it is essential that the characteristic values of the oscillations are always recorded under the same operating conditions and always classified in the same way. In particular, the speed and load ratio have a strong effect on the characteristic values. Increases in trends under differing operating conditions cannot necessarily be a sign of a change in the actual condition. In many cases, trend observation can assist in monitoring the condition of the machine and bearings.

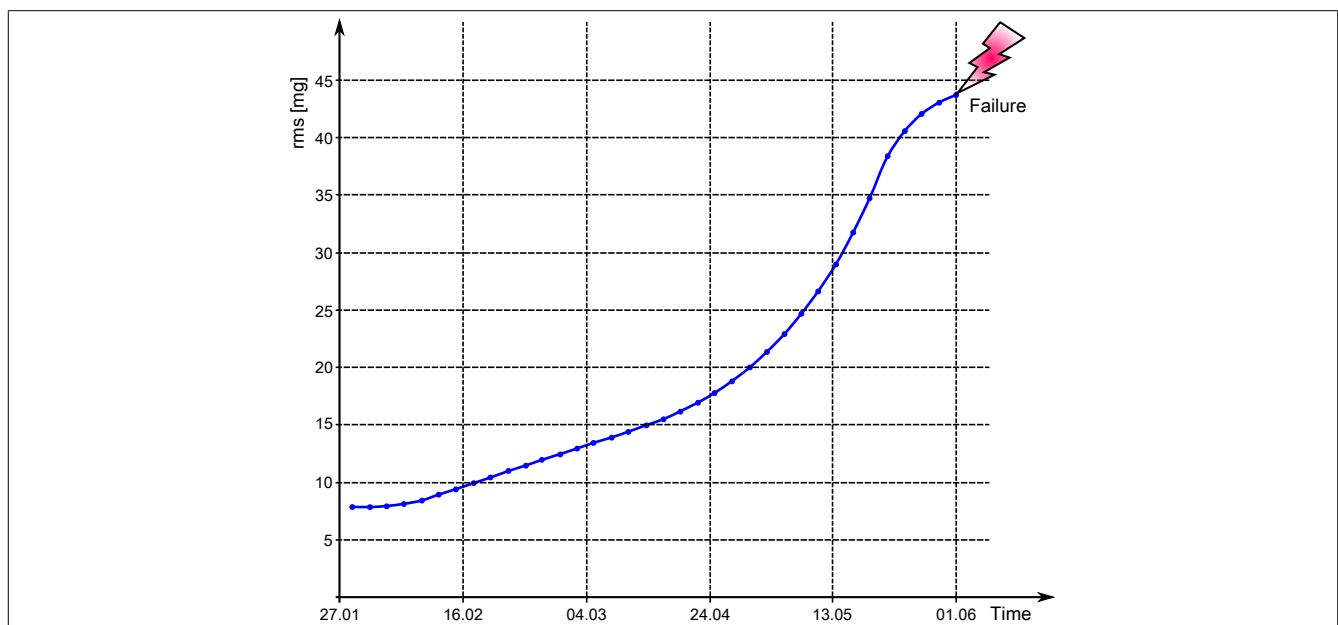


Figure 230: Typical trend progression

The first and second derivatives of the damage progression trend line can provide good information about how badly a component is damaged.

Example

This example will use the first and second derivative to determine the best time for repairs. The maximum service life will be taken into account when selecting a time to perform a replacement. The possibility of lowered production quality is not taken into consideration.

Various times for performing a replacement can be selected by referring to the trend progression.

- k1 = First increase. Very conservative, service life is wasted.
- k2 = Second increase. Good compromise between conservative and optimal.
- k3 = Drop in second derivative. Optimal utilization of service life.

Information:

This example of derivative usage is not permitted to be used as a rule in your own applications.

First derivative

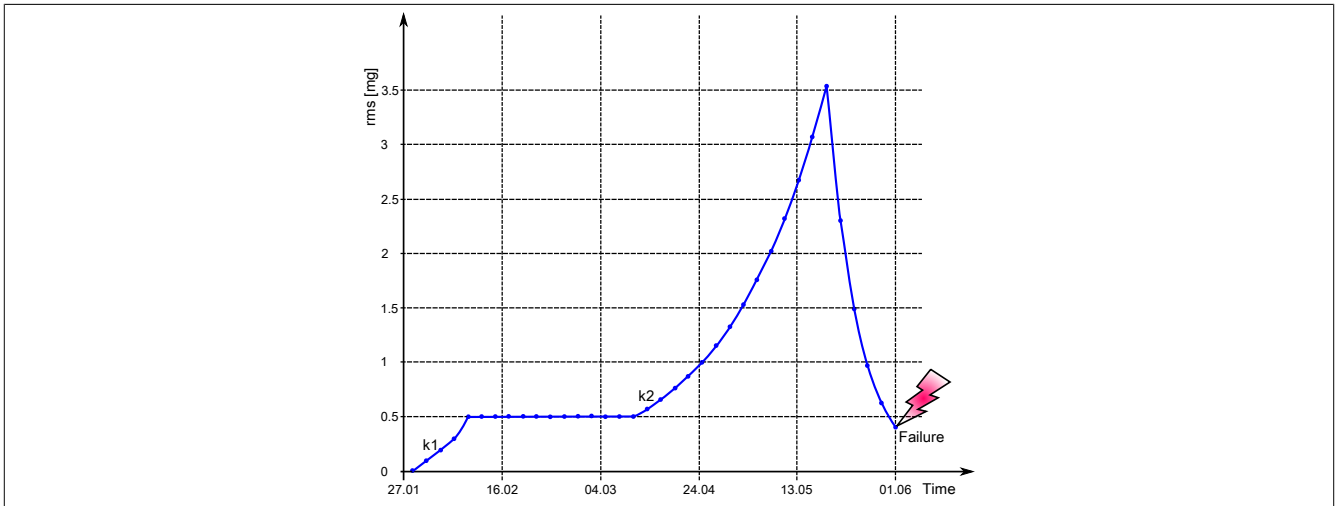


Figure 231: First derivative of the trend progression

Second derivative

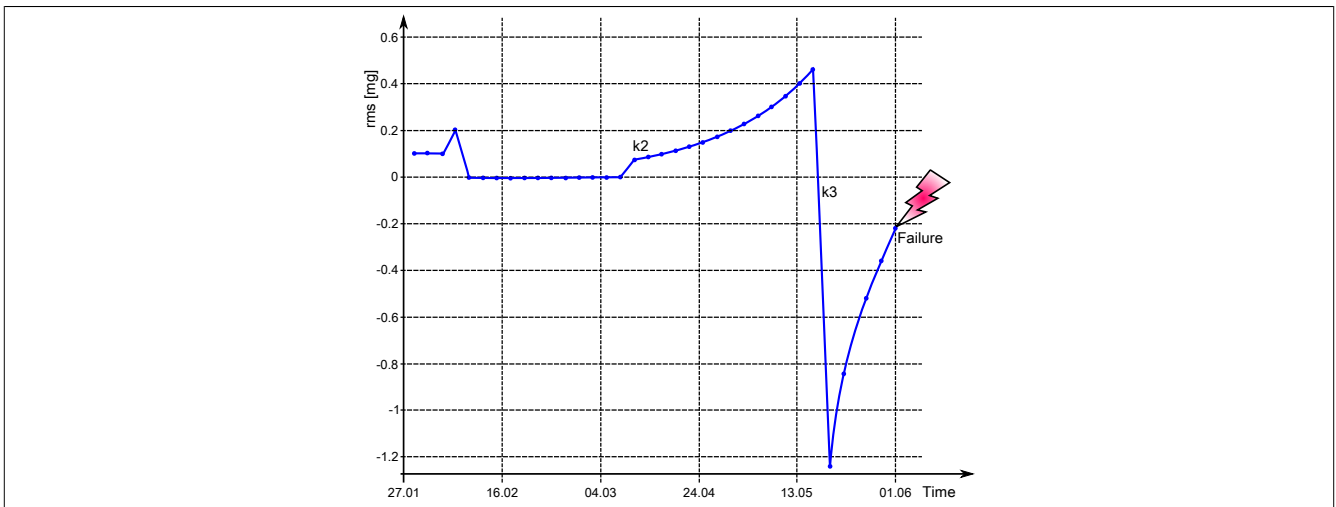


Figure 232: Second derivative of the trend progression

Dynamic speed change

With the resulting FFT calculation in the module, it is assumed that the frequency spectrum and the resulting lines do not shift during the time it takes to calculate a data buffer. For shafts, this is only the case when they are running at a constant speed.

In the case of dynamic speed, narrow-band frequencies cannot be used to monitor or analyze damaged frequencies since these do not give valid results.

The following example shows the effect of variations in shaft speed on the resulting frequency spectrum during FFT calculation.

Example

The speed of a shaft changes from 100 Hz to 200 Hz.

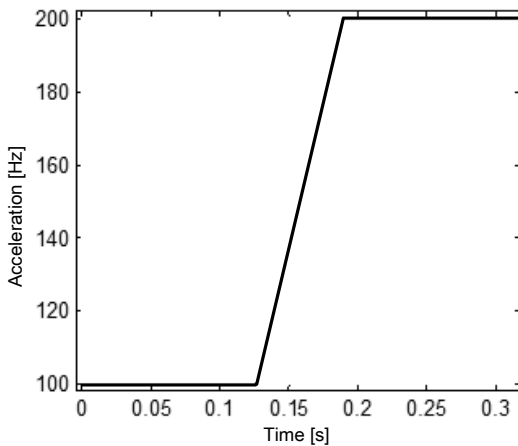


Figure 233: Speed profile

Changing the speed of a shaft
(Within one buffer measurement length.
Damage is simulated with the speed frequency.)

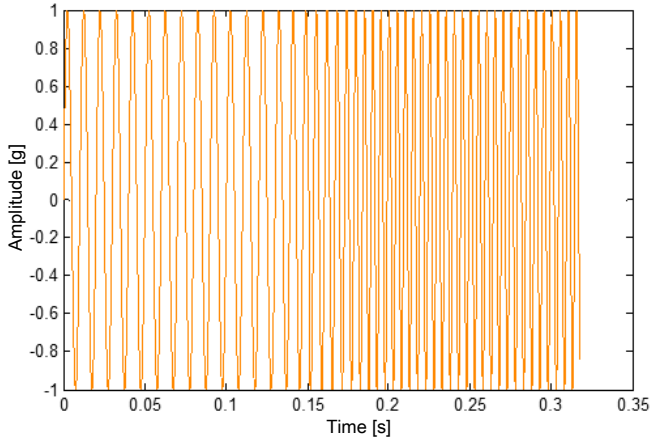
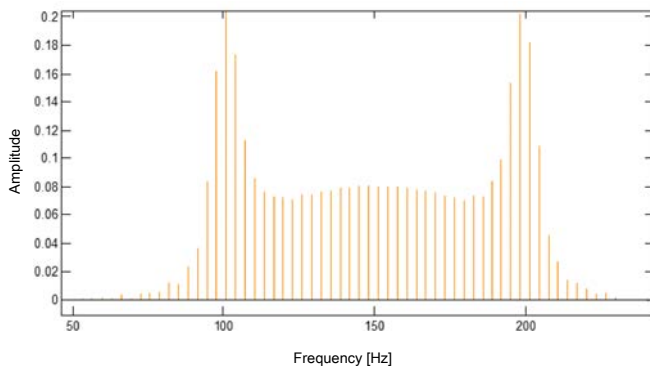


Figure 234: Time signal

Change in the time signal



Resulting spectrum
calculated from the time signal

Figure 235: Invalid result in the frequency spectrum

Possible approaches to measuring in a dynamic system

- **Best solution:** Adopting separate measurements for trend analysis where the speed can be kept constant for the duration of measuring.
- If a measurement cannot be taken at constant speed, an assessment of the machine condition can be made using the characteristic values or a broadband frequency (in this example, this would be 80 to 220 Hz).

9.26.7.16.3 Practical applications of damage recognition

It is possible to gain good insight into the condition of a machine or system by measuring the parameters associated with errors. This parameter data is used by different algorithms in the module to calculate the characteristic values. This method of forming characteristic values occurs continually and automatically. It requires little technical knowledge and is easy to use and implement. It is an easy way to check a machine for damage and error states.

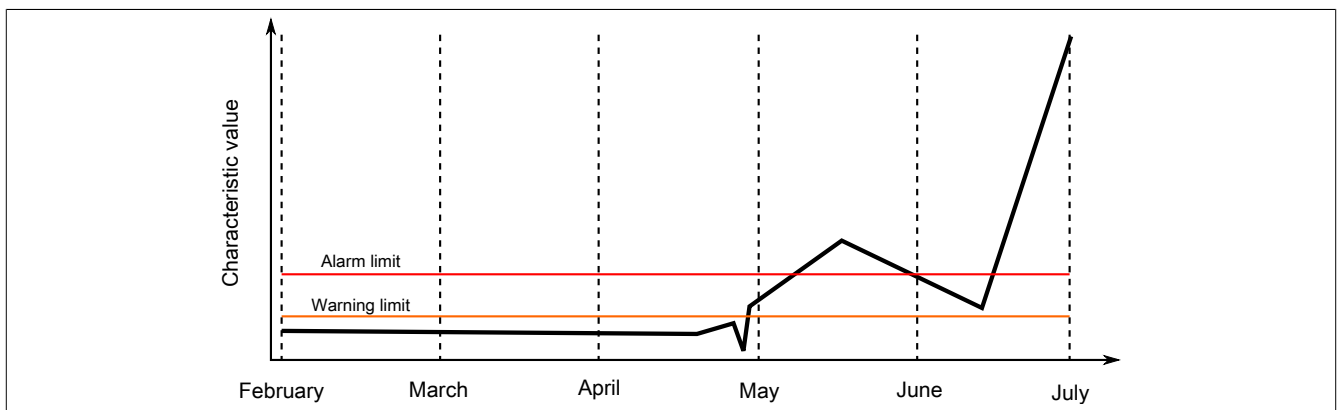
Selecting suitable characteristic values and assessing them over a longer time frame is the basis for effective and successful monitoring of a machine, a process known as "trending". It enables multiple aggregates to be monitored with a relatively low need for technical measuring and a low demand on staff.

Simply setting basic limits as a warning is not enough. Instead, logical correlations with other parameters such as load or speed, or even the shape of the trend curve, are also required.

Characteristic values are thus gathered in the trend curve and compared with norms or values taken from available experience over a long period of time. This trend progression can be used to make a good assessment of the machine's condition. The way these factors change over time indicates whether the condition is worsening, i.e. if damage is beginning to occur.

Recording the measured values in a diagram over a longer period of time shows the status of the characteristic values at the defined warning and alarm thresholds. If these thresholds are exceeded oscillation diagnostics gives the cause of the error so that appropriate maintenance measures can be taken.

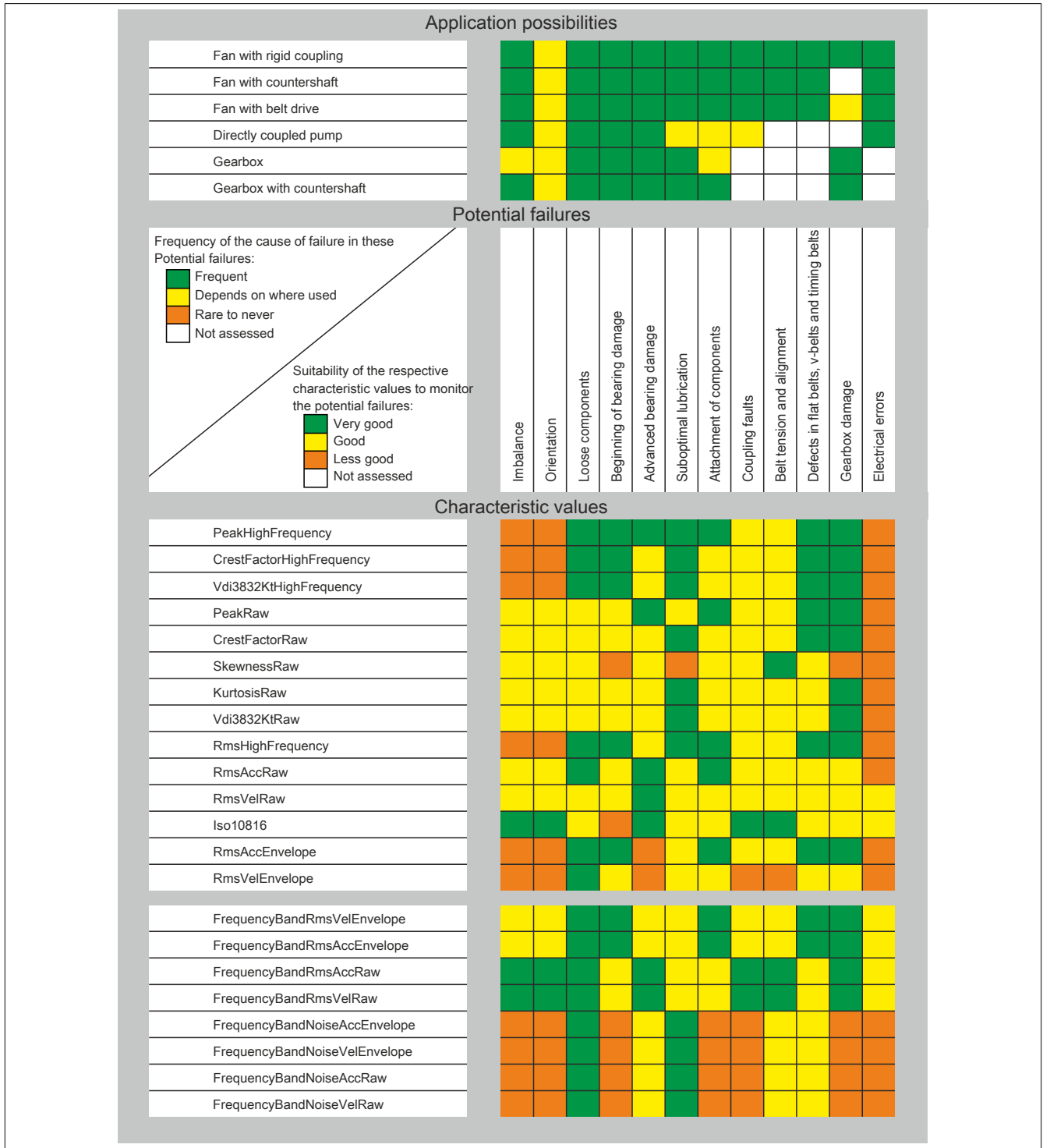
Example: Trend curve for a characteristic value



9.26.7.16.3.1 Characteristic values

The following matrix shows the relationship between potential failures and the suitability of the characteristic values provided in the module for error analysis. The potential failures refer to the individual application possibilities.

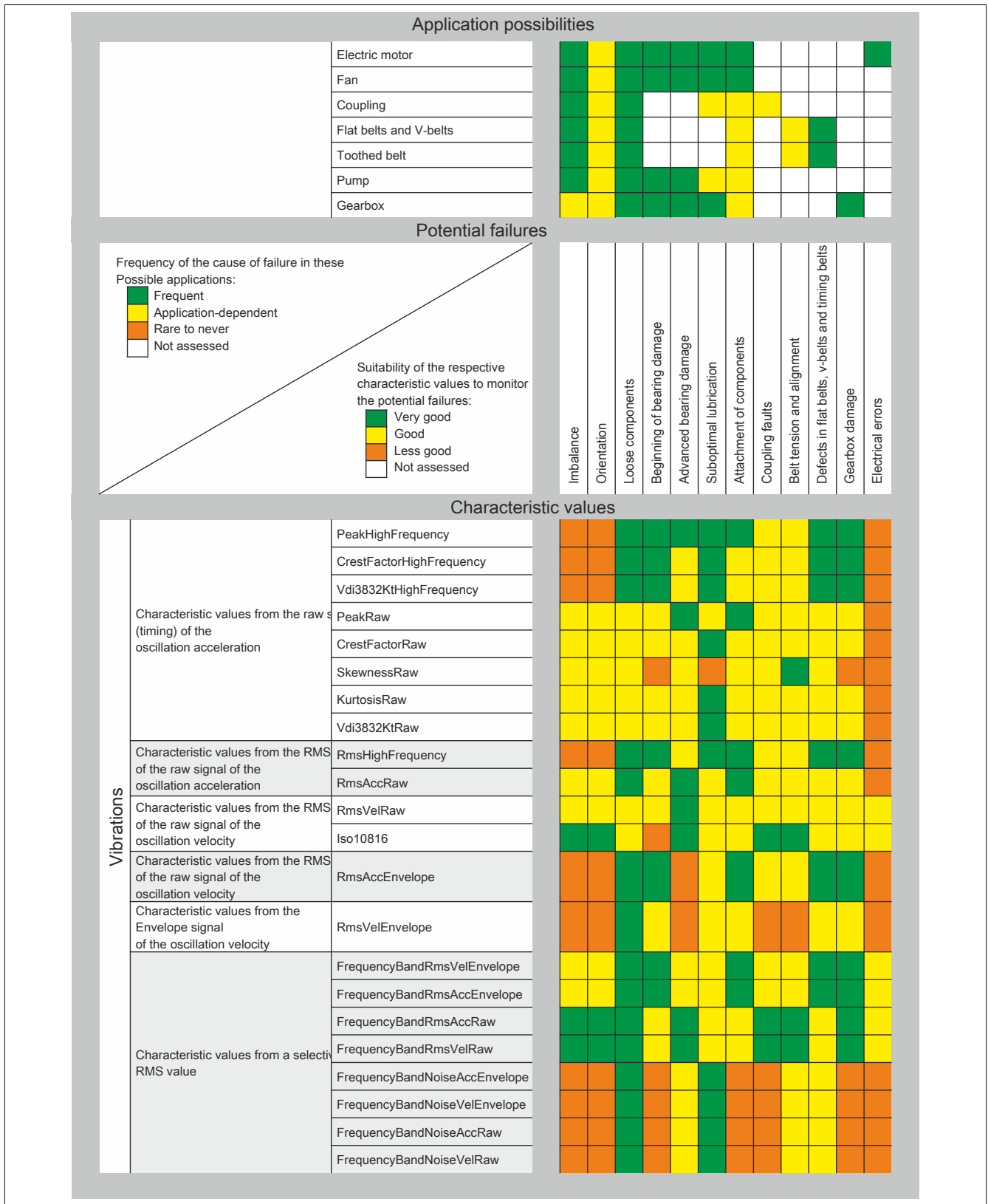
This assessment is based on an estimation of typical applications.



For the meaning of individual characteristic values, see "Characteristic values" on page 3070 and "Configuration" on page 3093.

9.26.7.16.3.2 Potential failures

The effect of damage on the oscillation behavior depends on the type and extent of the damage. For this reason, it must be assessed on a case-by-case basis.



For the meaning of individual characteristic values, see "Characteristic values" on page 3070 and "Configuration" on page 3093.

Imbalance

The term imbalance refers to rotating bodies with a mass that is not rotationally symmetrical. In other words, the center of mass is not on the axis of rotation

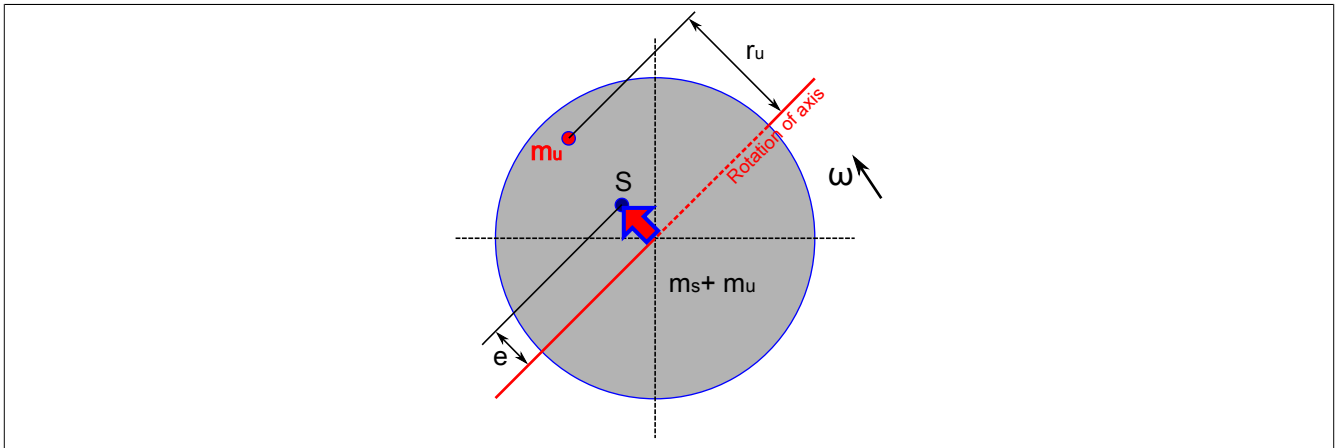


Figure 236: Representative sketch of an imbalance

Imbalance leads to vibrations and increased wear, particularly at high speeds, which is why counterweights are applied to compensate for this as counterbalance. In practice, it is very rarely possible to fully compensate for this, meaning every rotating body has some residual imbalance.

The centrifugal force caused by imbalance is dependent on the square speed and thus has a more significant effect at higher speeds (higher speed frequency). On a spectrum, therefore, the frequency line denoting speed is significantly higher.

| Failure mode | Frequency in raw signal spectrum | Frequency in envelope spectrum | Comment |
|--------------|----------------------------------|--------------------------------|--|
| Imbalance | $1 \times f_n$ | - | Only severe imbalance causes peaks in the speed that show up in the envelope spectrum. |

f_n ... Nominal speed

Information:

The module can only measure the intensity of the imbalance, not its position on the shaft. For this reason, it cannot be used for balancing.

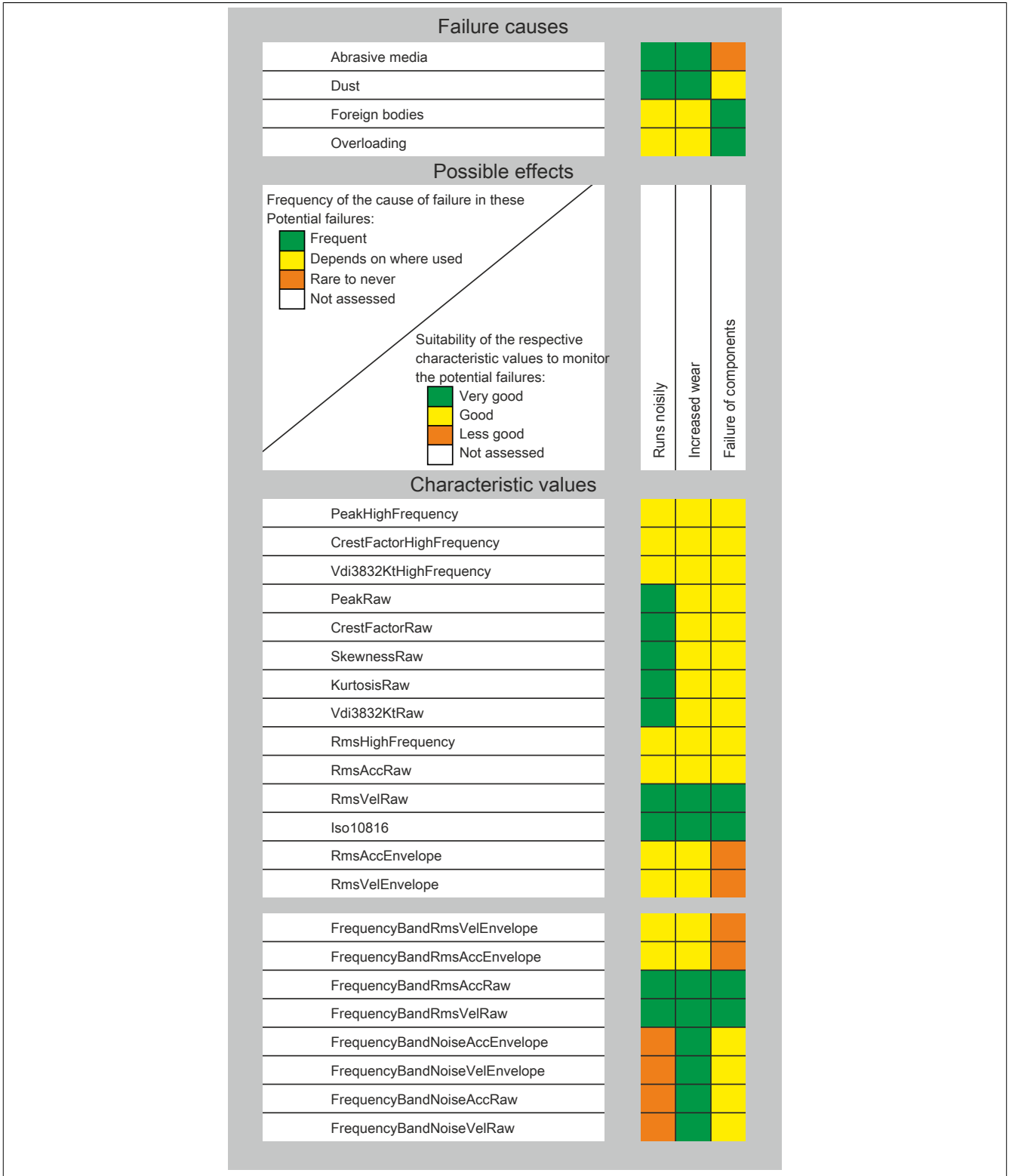


Figure 237: Failure causes and effects of imbalance

For the meaning of individual characteristic values, see "Characteristic values" on page 3070 and "Configuration" on page 3093.

Misalignment

During operation, a number of different factors can cause machine parts to fail to align or stop aligning with each other.

Shafts should rotate around a linear axis at the coupling positions, so that the restoring forces at the coupling position and the loading forces in the bearings are kept as low as possible. Misalignment causes increased vibrations and wear.

Misalignment usually consists of a parallel and an angular misalignment. In the event of a severe parallel misalignment, strongly increased values can be observed in the area of double speed.

| Failure mode | Frequency in raw signal spectrum | Frequency in envelope spectrum | Comment |
|--------------------------|--|--------------------------------|---|
| Misalignment in coupling | 1 x fn, 2 x fn (sometimes 3 x fn, 4 x fn) | - | With parallel misalignment, usually only "1 x fn" occurs. |

fn ... Nominal speed

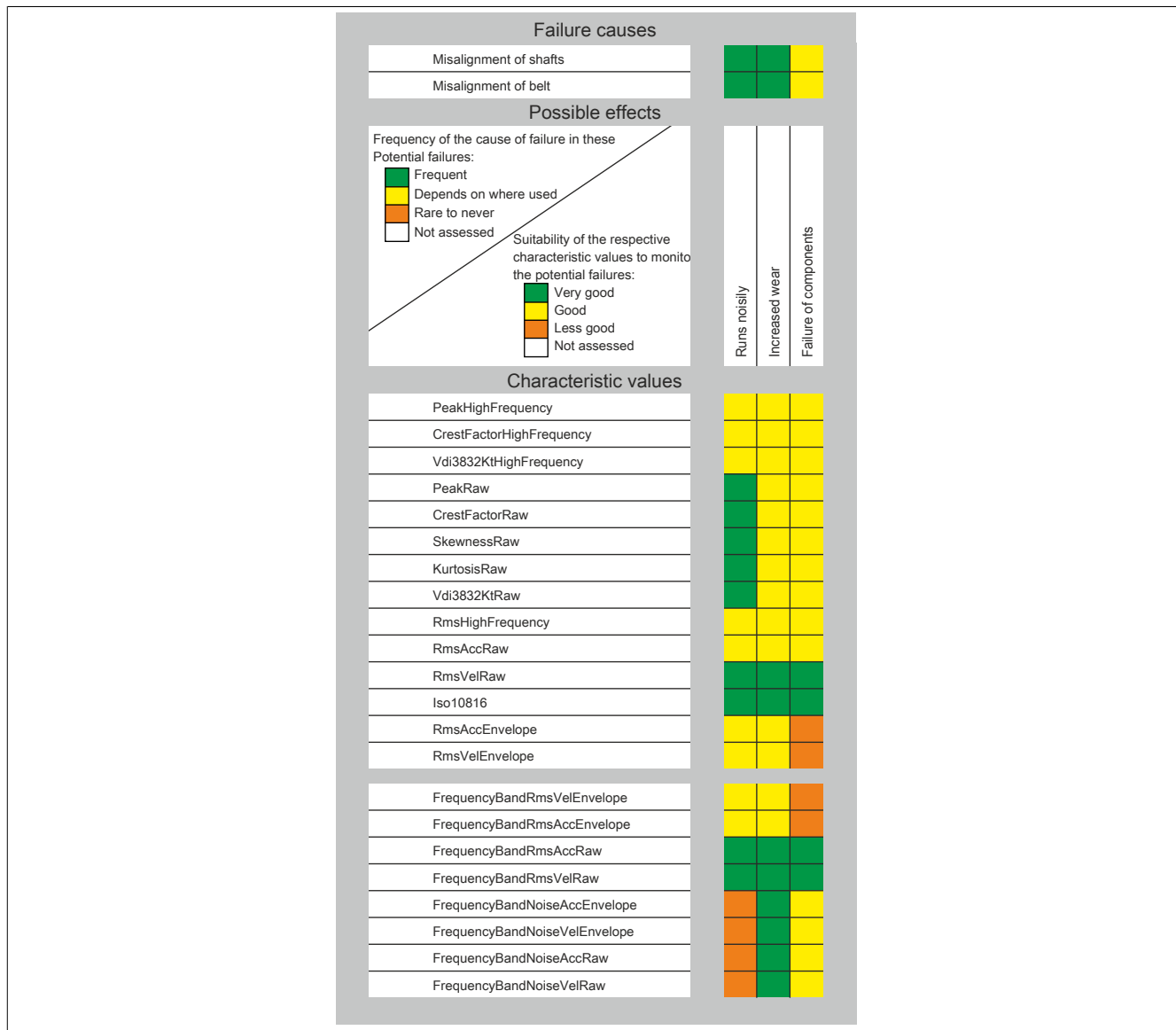


Figure 238: Failure causes and effects of an alignment failure

For the meaning of individual characteristic values, see "Characteristic values" on page 3070 and "Configuration" on page 3093.

Belt damage

Belts often cause various problems during operation. A belt can be damaged if the tension is too low or too high or if the belt is incorrectly aligned. If the damaged belt part rolls over the pulley, this causes impacts that can be measured.

Flat belts and V-belts

With flat belts and V-belts, torque is transferred between the belt and the pulley through the contact surface. Belt drives are not very sensitive with regard to alignment but nevertheless lead to vibration development and above all to increased wear and energy consumption if the deviation is too high.

| Failure mode | Frequency in raw signal spectrum | Frequency in envelope spectrum | Comment |
|----------------|----------------------------------|--------------------------------|---|
| Defective belt | 1 x fr, 2 x fr, 3 x fr ... | 1 x fn1, 1 x fn2, 1 x fr | Belt frequencies usually occur in both spectra. |

fr ... Belt speed

fn1 ... Nominal speed of shaft 1

fn2 ... Nominal speed of shaft 2

Poorly aligned or incorrectly tensioned belts can also cause severe stress on the bearing points. The increased vibration also causes heavier wear on belts and pulleys.

The vibrations are clearly identifiable at the bearing points of the individual shafts.

| Failure mode | Frequency in raw signal spectrum | Frequency in envelope spectrum | Comment |
|----------------------|----------------------------------|--------------------------------|---|
| Misalignment of belt | 1 x fn, 2 x fn 1 x fr | 1 x fn | If the belts strike against the pulley laterally, impacts can also occur with speed and belt frequency. |

fn ... Nominal speed

fr ... Belt speed

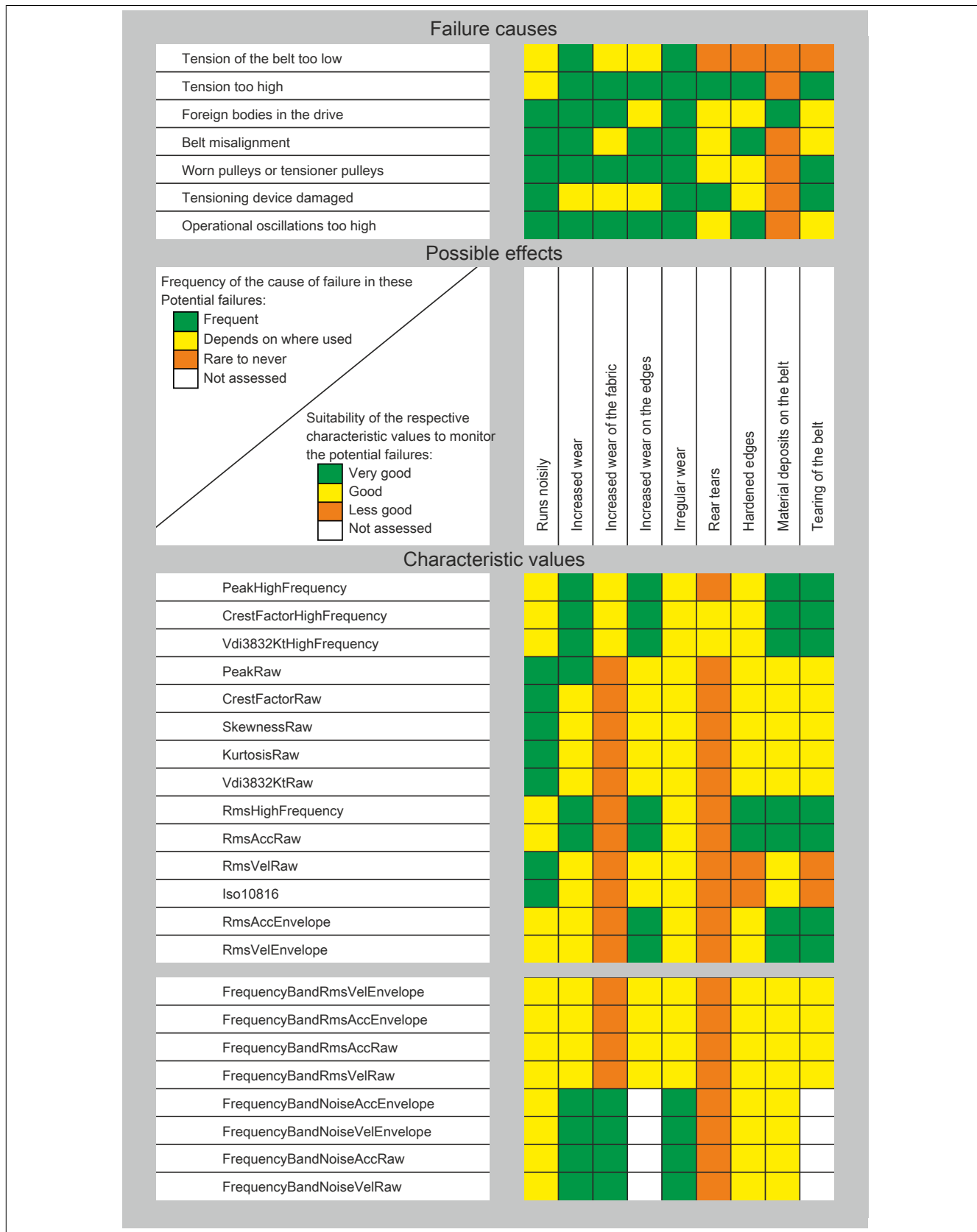


Figure 239: Failure causes and effects of belt damage in flat belts and V-belts

For the meaning of individual characteristic values, see "Characteristic values" on page 3070 and "Configuration" on page 3093.

Toothed belt

With toothed belts, torque is transferred via the meshing of the teeth. In addition to the already known failure causes, there are also the failures caused by the toothing.

| Failure mode | Frequency in raw signal spectrum | Frequency in envelope spectrum | Comment |
|---------------------|----------------------------------|--------------------------------|---|
| Toothed belt damage | 1 x fr | 1 x fr, 1 x fzn | The tooth meshing frequencies in combination with the respective speed are clearly visible. |

fr ... Belt speed
fzn ... Meshing frequency

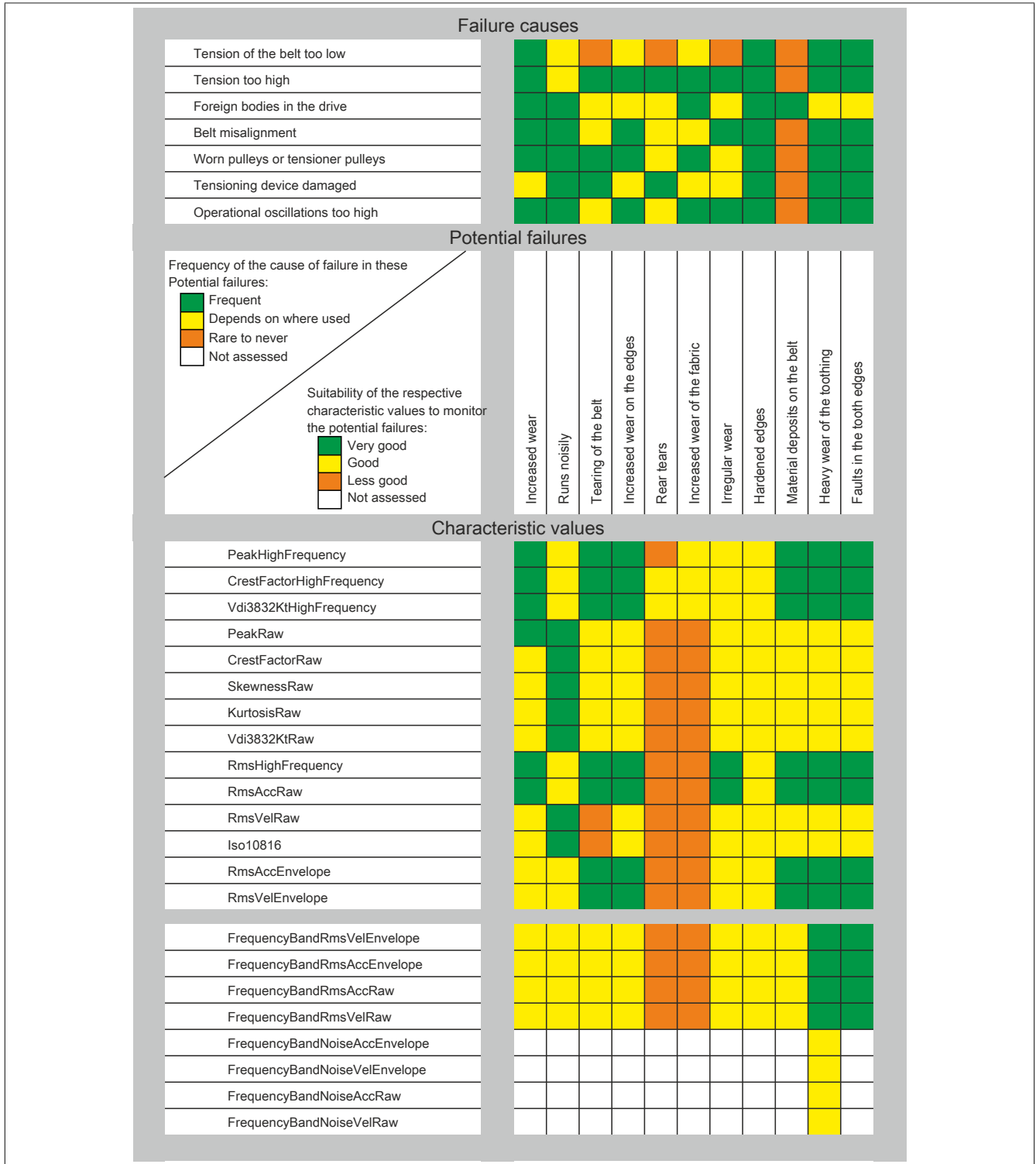


Figure 240: Frequency of failure indicators on toothed belts

For the meaning of individual characteristic values, see "Characteristic values" on page 3070 and "Configuration" on page 3093.

Loose or striking parts

If individual parts in the machine are loose, they can cause unwanted oscillations. When individual parts strike housings or attachment parts, these appear very similar. As a result, the two causes of damage cannot be analyzed separately.

In addition, components strike their counterparts on each revolution. This in turn causes the attachment parts to vibrate at their natural frequency. Envelope analysis can be used to separate the causes of impact.

| Failure mode | Frequency in raw signal spectrum | Frequency in envelope spectrum | Comment |
|--|----------------------------------|--------------------------------|---|
| Loose parts, parts striking each other | (1 x fn) | 1 x fn | There is usually one strike per revolution. If an envelope occurs for the load, a double frequency can be determined. |

fn ... Nominal speed

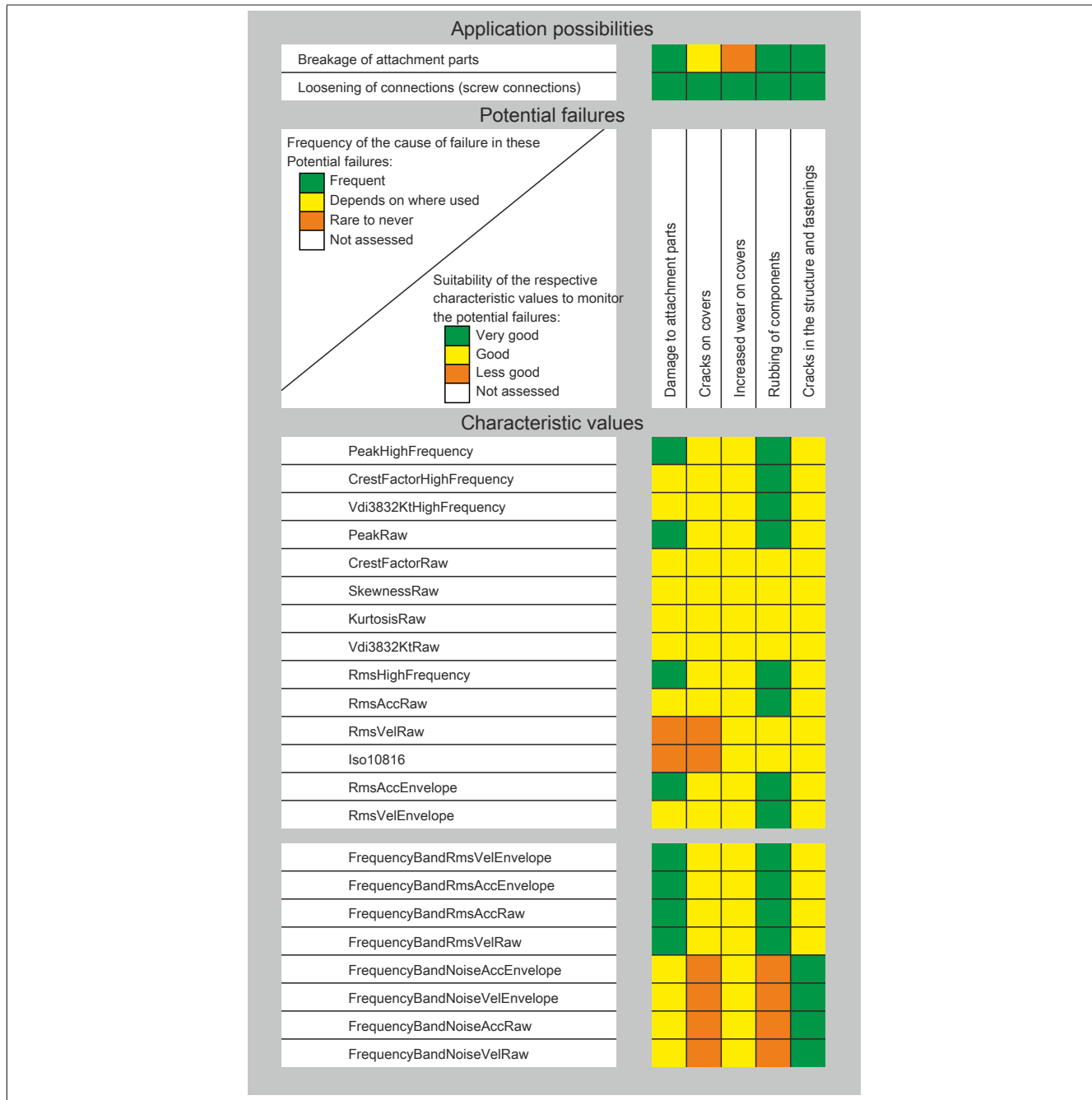


Figure 241: Failure causes and effects of belt damage

For the meaning of individual characteristic values, see "Characteristic values" on page 3070 and "Configuration" on page 3093.

Slide bearing damage

In a structure-borne sound measurement, the typical damage frequencies for a slide bearing do not manifest themselves until a very late stage. For this reason, this method is less suitable for early detection.

Roller bearing damage

Many types of bearing damage are caused by imprecisions in the bearing surface such as material damage or micro-cracks. These pittings (i.e. material damage or micro-cracks) are rolled over by the roller elements cause impacts on the roller bearing and its attachment parts.

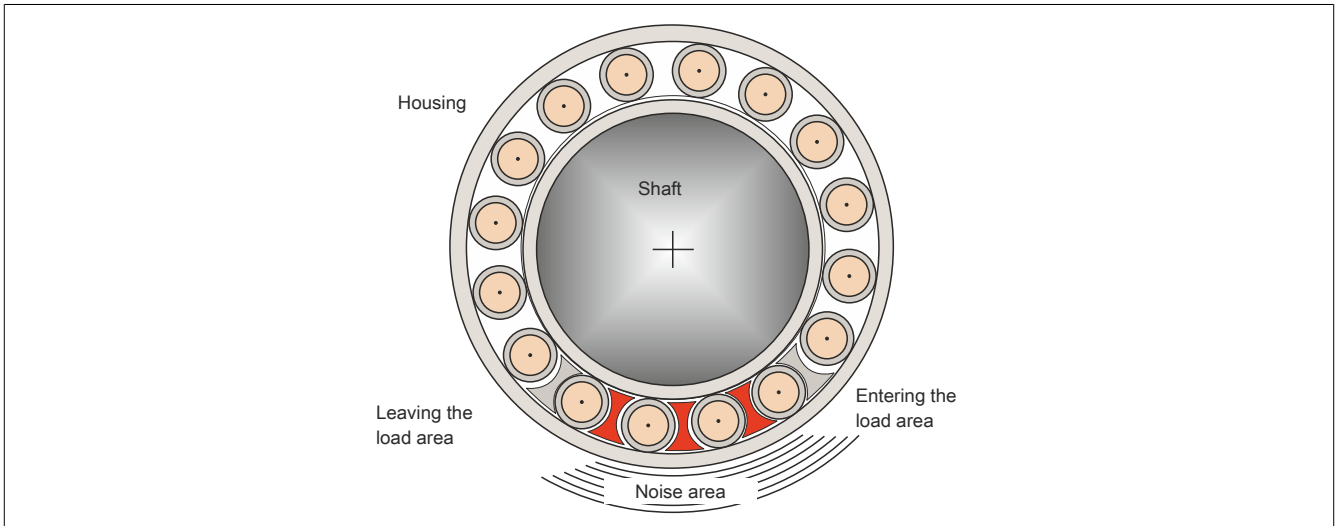


Figure 242: Roll-over processes in the bearing

The mechanism is very similar to the striking of a bell: The clapper strikes the body of the bell, and the bell starts vibrating at its natural frequency.

In the case of the bearing, each time the roller moves over the damaged area it is like the striking of the clapper, and the roller parts and attachment parts start to vibrate.

These very small oscillations can be measured as a modulation or superposition of the excitation frequency on the surface of the bearing.

Appropriate analysis methods such as formation of the envelope can separate the superposition to make the roll-over frequencies of the bearing clearly discernible.

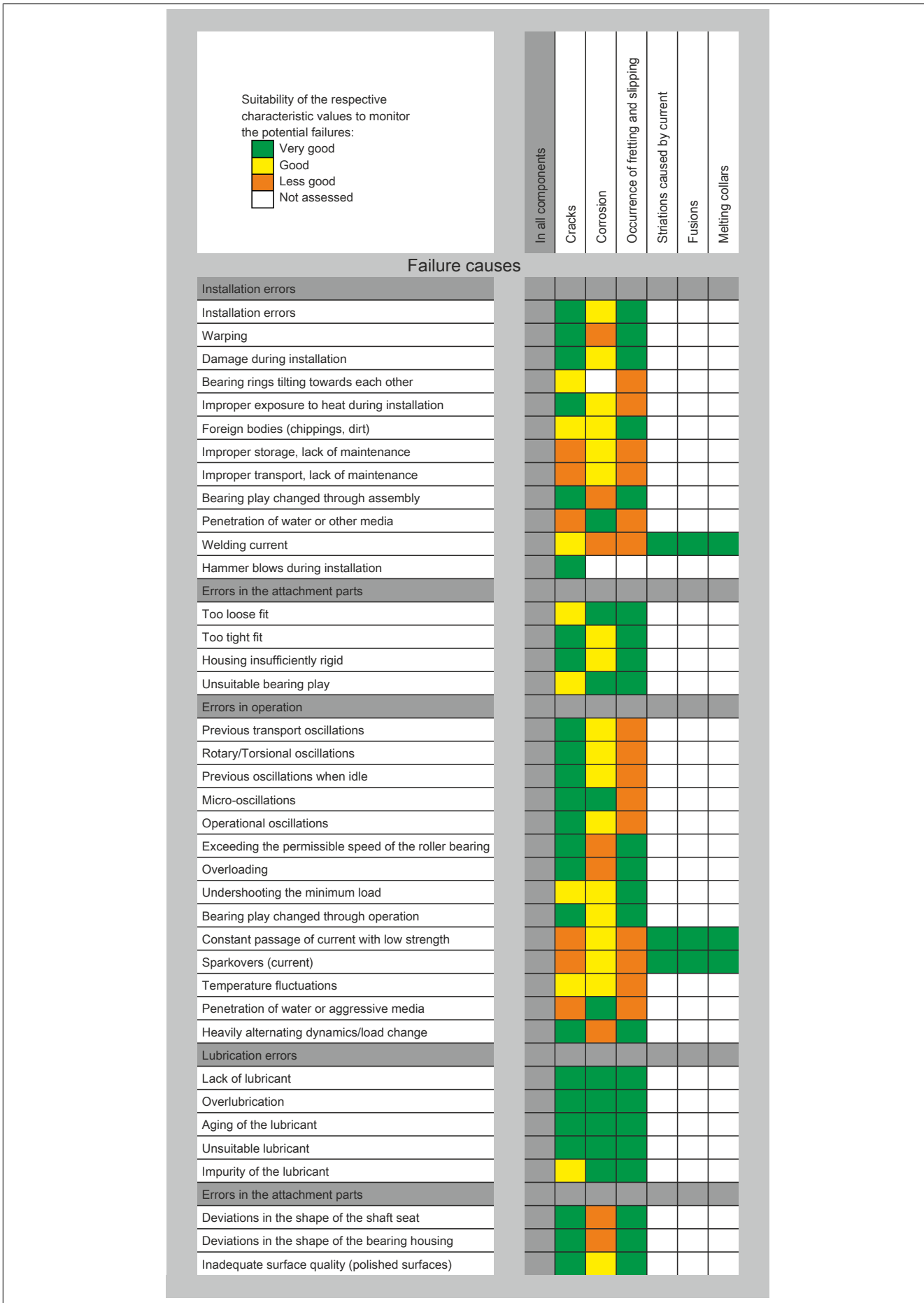


Figure 243: Frequency of failure indicators on roller bearings

For the meaning of individual characteristic values, see "Characteristic values" on page 3070 and "Configuration" on page 3093.

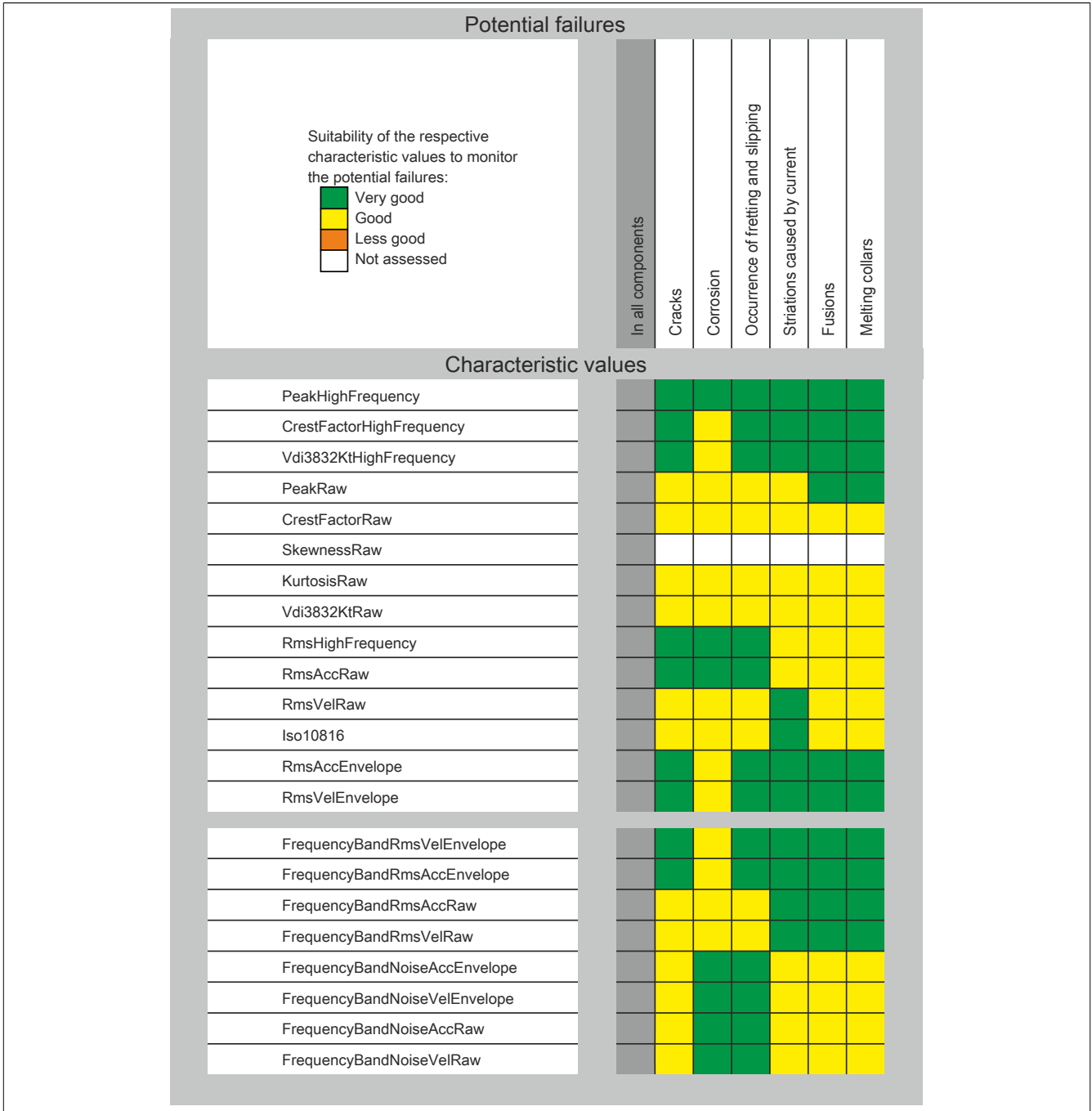


Figure 244: Frequency of failure indicators on roller bearings

For the meaning of individual characteristic values, see "Characteristic values" on page 3070 and "Configuration" on page 3093.

Typical outer and inner ring damage

Outer ring damage

In most cases the outer ring remains stationary while the inner ring turns. This gives a clearly defined fixed load zone. Most damage occurs in this load zone. If pitting or other surface damage forms, vibrations occur when the roller element moves over it that can be measured on the housing components.

| Failure mode | Frequency in raw signal spectrum | Frequency in envelope spectrum | Comment |
|-------------------|----------------------------------|--------------------------------|--|
| Outer ring damage | (1 x fa) | 1 x fa, 2 x fa, 3 x fa ... | With advanced damage, the outer ring frequencies can also be seen in the raw signal spectrum |

fa ... Frequency of the outer ring damage

Inner ring damage

Any inner ring damage that occurs travels with the rotating shaft. Due to the different rotary speeds of the revolving roller elements and the inner ring, pronounced modulations occur. As a result, inner ring damage frequencies are usually shown with sidebands in the spectrum.

| Failure mode | Frequency in raw signal spectrum | Frequency in envelope spectrum | Comment |
|-------------------|----------------------------------|--------------------------------|--|
| Inner ring damage | (1 x fi) | i x fi ± i x fn | Inner ring damage generally appears based on modulation with pronounced sidebands for the speed. |

fi ... Frequency of the inner ring damage

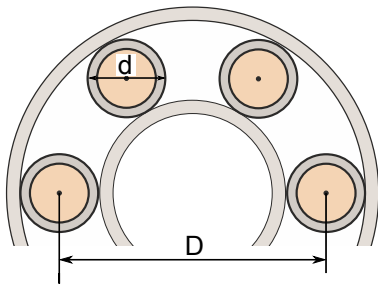
fn ... Nominal speed

Calculating damage frequencies

Details of bearing damage frequencies are normally provided by the manufacturer and can be taken from the data sheets for the bearings.

However, they can also be calculated easily. The following values are necessary for this.

| | |
|-----------|-----------------------------|
| N | Speed in rpm |
| n_b | Number of roller elements |
| d | Diameter of roller elements |
| β_c | Pressure angle |
| D | Roller ring diameter |



Formula for calculating the inner ring damage frequency

$$f_i = \frac{n_b \cdot N}{2 \cdot 60} \cdot \left[1 + \frac{d}{D} \cdot \cos \beta_c \right]$$

Figure 245: Calculation of the inner ring damage frequency

fi ... Inner ring damage frequency

Formula for calculating the outer ring damage frequency

$$f_a = \frac{n_b \cdot N}{2 \cdot 60} \cdot \left[1 - \frac{d}{D} \cdot \cos \beta_c \right]$$

Figure 246: Calculation of the outer ring damage frequency

fa ... Outer ring damage frequency

Formula for calculating the roller element damage frequency

Damage impacting the individual pitch line:

$$f_{ew} = \frac{1}{2} \cdot \frac{D \cdot N}{d \cdot 60} \cdot \left[1 - \left(\frac{d}{D} \cdot \cos \beta_c \right)^2 \right]$$

Figure 247: Calculating the damage frequency on one roller element

few ... Damage frequency of the individual roller element

Damage impacting both pitch lines:

$$f_w = \frac{D \cdot N}{d \cdot 60} \cdot \left[1 - \left(\frac{d}{D} \cdot \cos \beta_c \right)^2 \right]$$

Figure 248: Calculating the damage frequency on both roller elements

fw ... Damage frequency of both roller elements

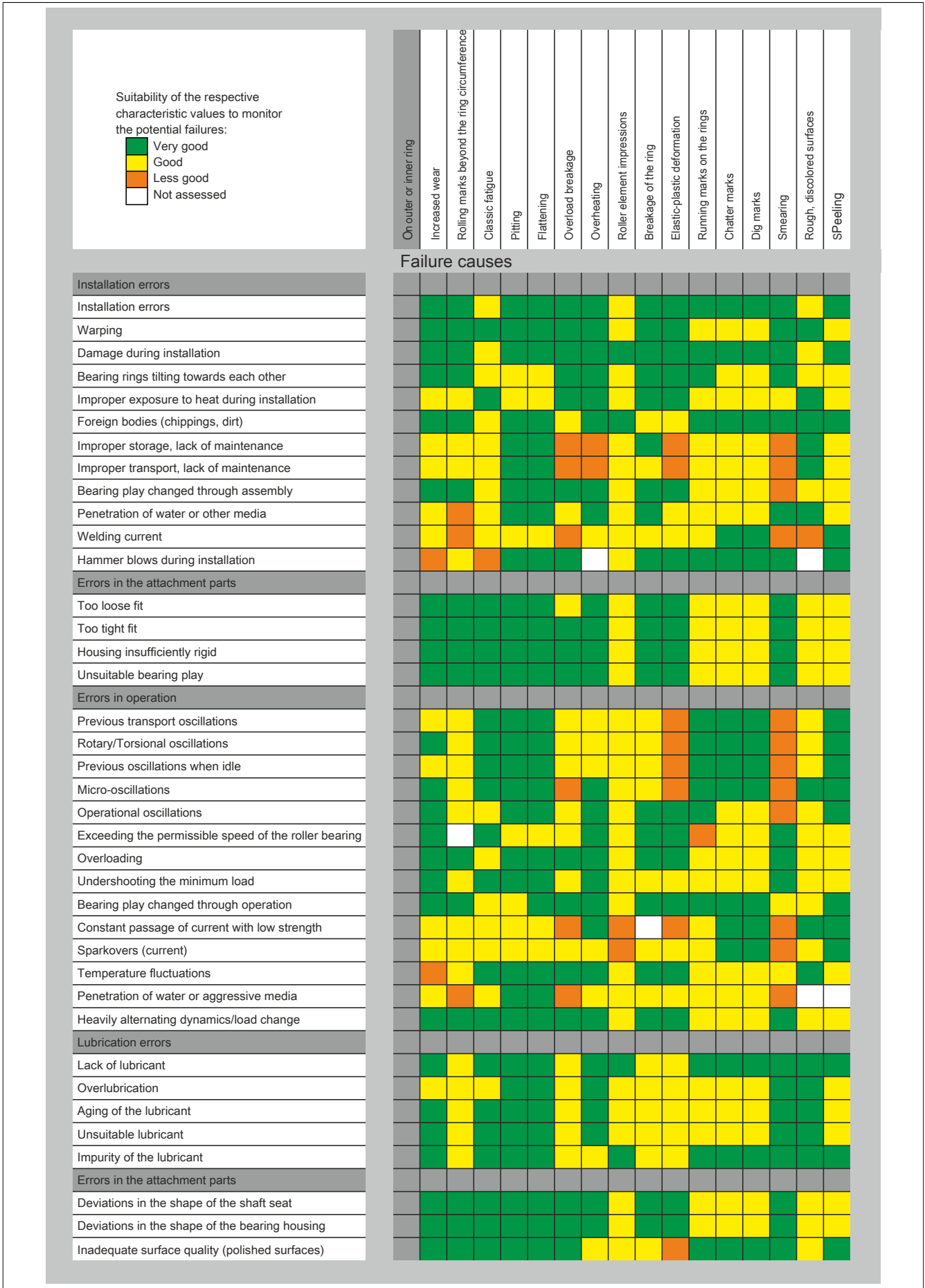


Figure 249: Frequency of failure indicators on roller bearings

For the meaning of individual characteristic values, see "Characteristic values" on page 3070 and "Configuration" on page 3093.

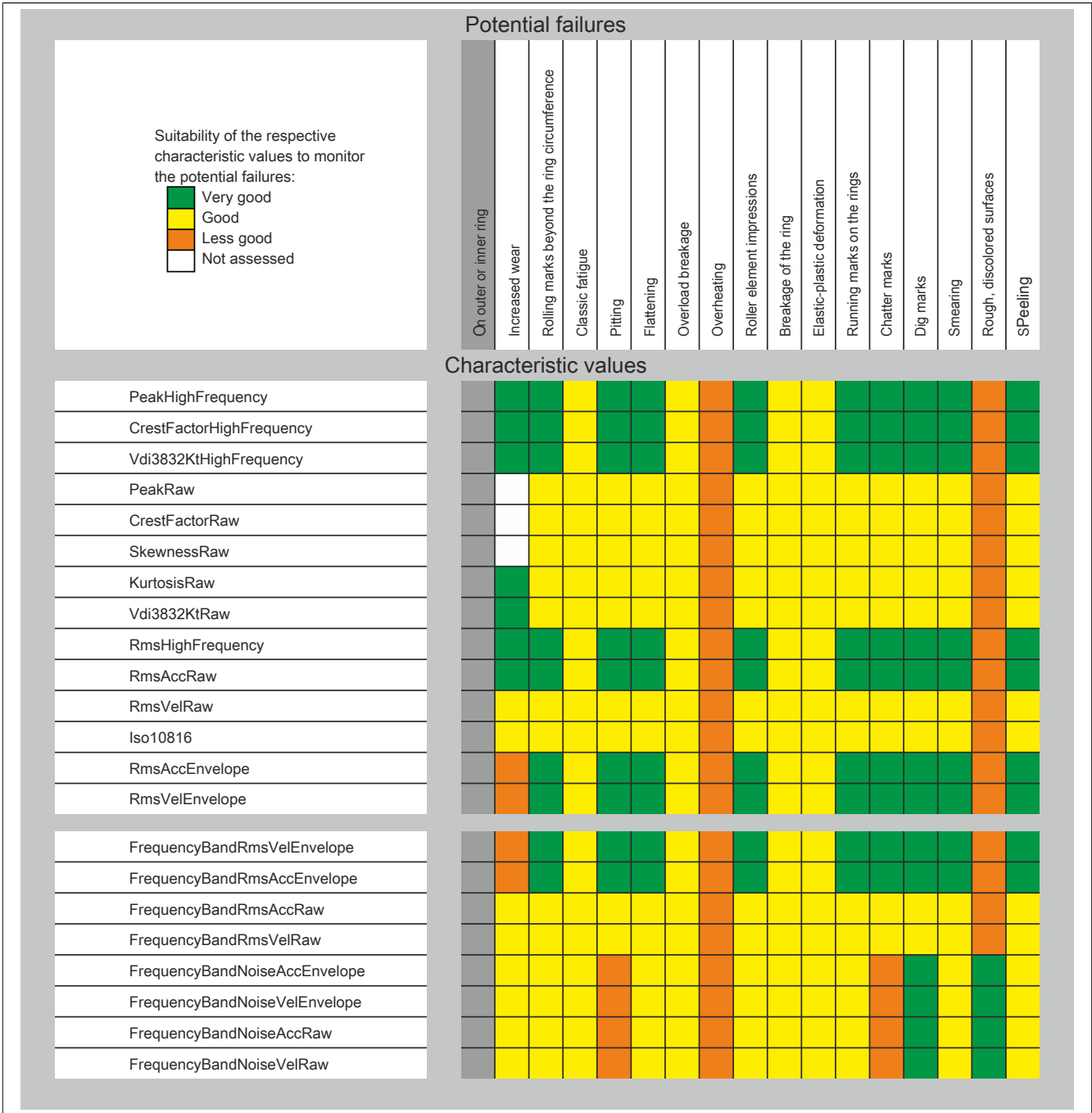


Figure 250: Frequency of failure indicators on roller bearings

For the meaning of individual characteristic values, see "Characteristic values" on page 3070 and "Configuration" on page 3093.

Typical cage and roller element damage

Cage damage

Cage frequencies often occur in electric motors, especially where bearings with increased bearing play are used. If this is not used, oscillation of the cage often occurs. This is then reflected in increased operating noise.

Roller element damage

Damage to rolling elements without damage to the outer or inner ring occurs extremely rarely; the individual features are therefore only given as examples.

If the roller element is damaged, an impact occurs either on the inner ring, outer ring or both. This makes it possible to detect damage to rolling elements caused by the rollover frequency or twice the frequency. For this reason, the harmonic should be included in the characteristic value calculation where possible to detect roller element damage.

For the damage symptoms, see "Typical outer and inner ring damage" on page 3142.

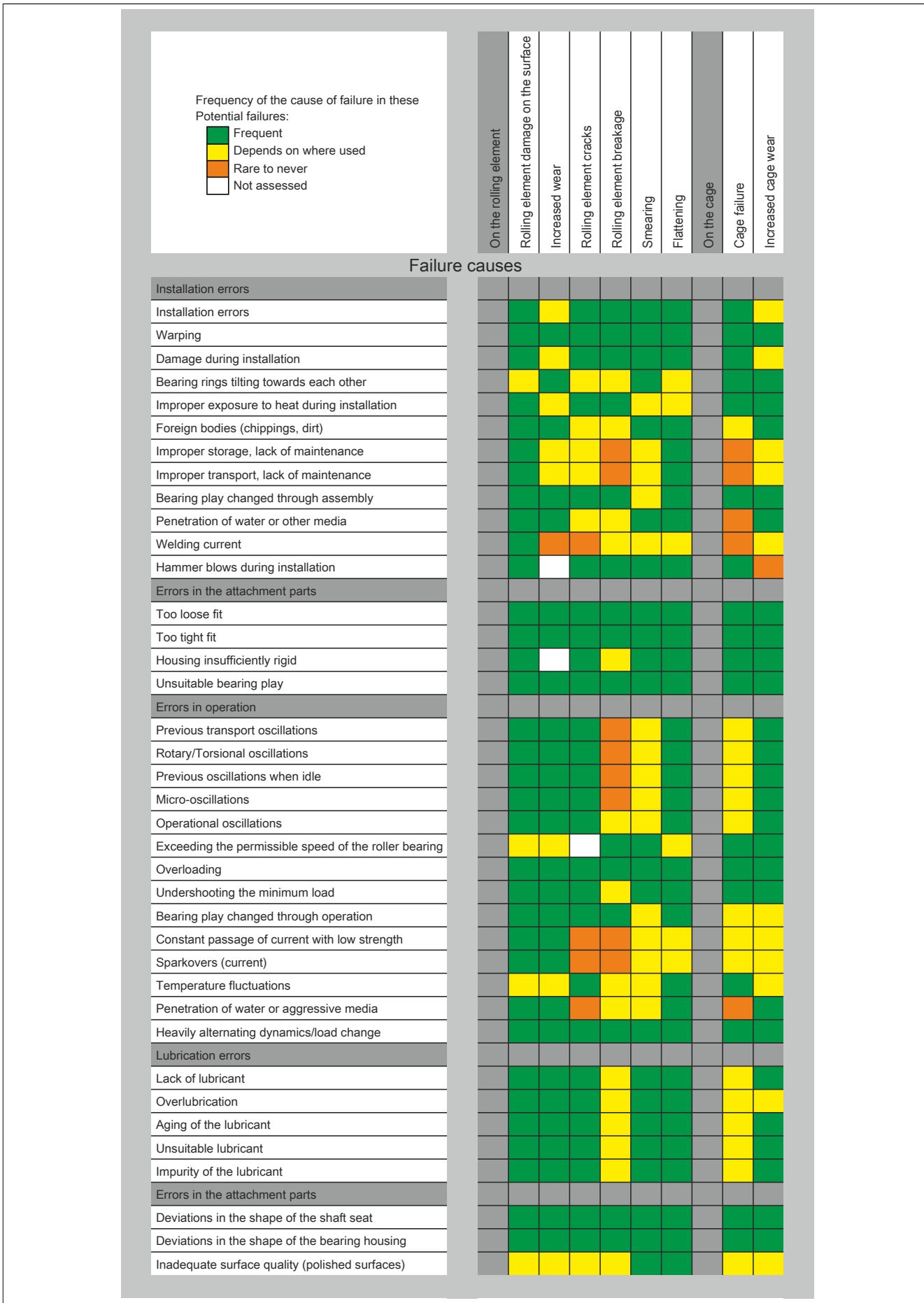


Figure 251: Frequency of failure indicators on roller bearings

For the meaning of individual characteristic values, see "Characteristic values" on page 3070 and "Configuration" on page 3093.

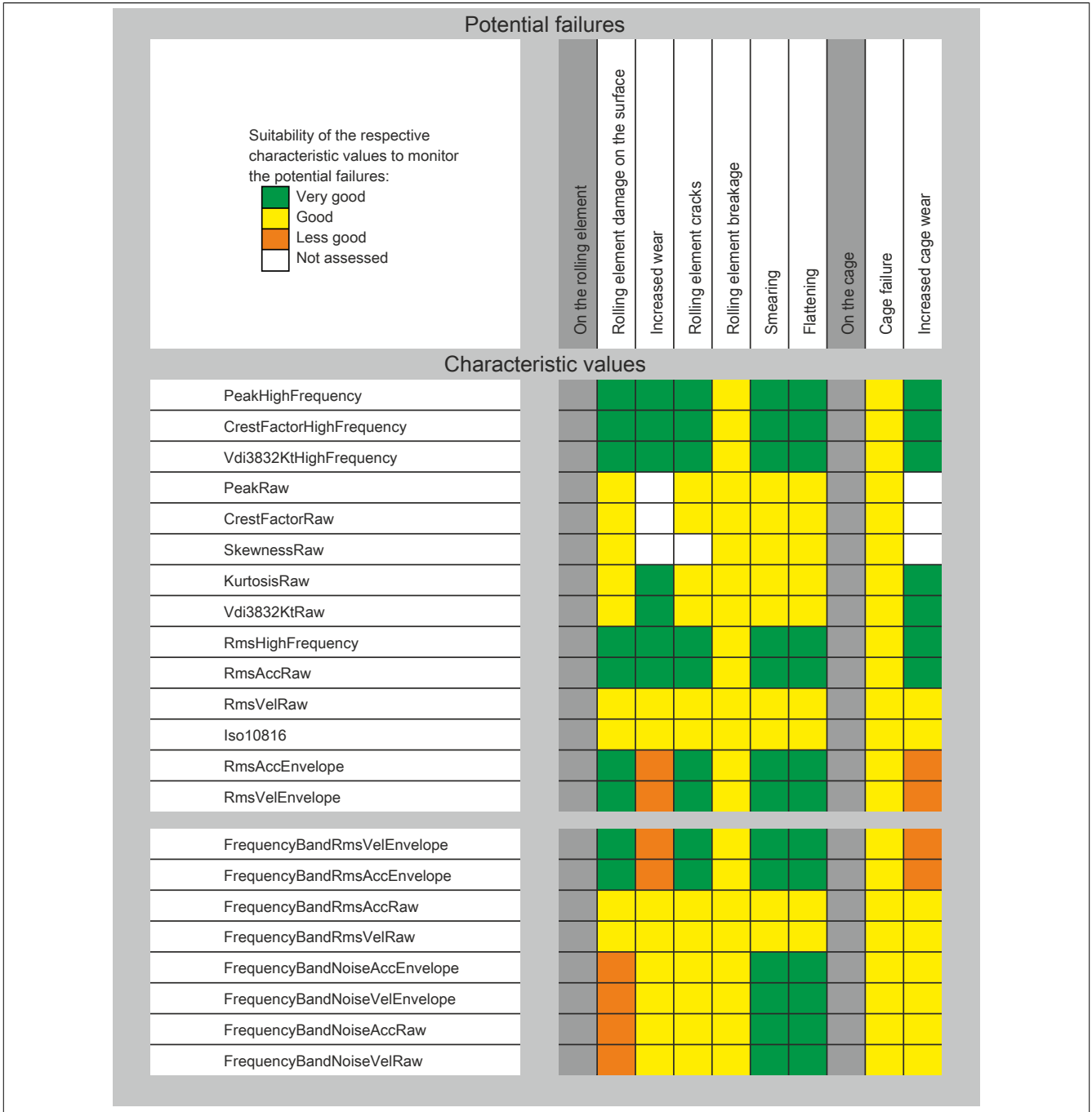


Figure 252: Frequency of failure indicators on roller bearings

For the meaning of individual characteristic values, see "Characteristic values" on page 3070 and "Configuration" on page 3093.

Gear damage

DIN 3979 provides a description of gear errors and defects. The most common errors in individual gearboxes are described below.

The complexity of the machine dynamics must be taken into consideration in individual applications.

Gear ratio

The speed ratio must always be converted according to the gear ratio. The frequencies on the gearwheels are always based on the speed of the respective axis.

Manufacturing defects

Oscillations due to manufacturing always occur in a gearbox. Typical manufacturing defects are pitch errors, profile deviations, concentricity and spacing errors.

Depending on the gearwheel pairing, these individual defects can intensify or become less intense depending on how the defects affect each other. The interplay of the individual defects is also responsible for the overall oscillation behavior.

Pitch error is a frequently occurring defect and is used as an example here. Depending on whether the pitch error is positive or negative, it is intensified or compensated by an existing load. The effects on the oscillation behavior depend very much on the rigidity of the gearwheel. If there is a pitch error, a shock occurs that can be measured effectively.

In addition to pitch errors, all form and dimensional gear errors lead to oscillations.

| Failure mode | Frequency in raw signal spectrum | Frequency in envelope spectrum | Comment |
|---------------------|----------------------------------|--------------------------------|---|
| Meshing frequencies | $1 \times fz$ | $1 \times fz$ | Gear frequencies depend on the respective geometric ratios of the wheels but can be precisely calculated in any case. |

fz ... Meshing frequency

Defects caused by wear

If form and dimensional deviations occur during operation, observing the trend can lead to an appropriate level of confidence when performing diagnostics.

| Failure mode | Frequency in raw signal spectrum | Frequency in envelope spectrum | Comment |
|---------------|----------------------------------|--------------------------------|---|
| Deterioration | $1 \times fz$ | $1 \times fz \pm i \times fn$ | Geometric errors increasingly appear additionally with sidebands for the tooth meshing frequency. |

fz ... Meshing frequency

fn ... Nominal speed

Wobbling

If the toothed belt axis and the rotation axis are not parallel, the phenomenon called wobbling occurs. This causes 2 flank errors per revolution. Depending on the position, there is one transmission on the inner edge and one on the outer edge of the toothed wheel.

The doubled speed frequency is clearly evident in the frequency spectrum.

| Failure mode | Frequency in raw signal spectrum | Frequency in envelope spectrum | Comment |
|--------------|----------------------------------|--------------------------------|--|
| Wobbling | $1 \times fn, 2 \times fn$ | $1 \times fz, 2 \times fz$ | Wobbling movements manifest as doubled speed frequency and are usually accompanied by sidebands. |

fn ... Nominal speed

fz ... Meshing frequency

Cyclic running errors and axial distance errors

In DIN 3960, axial distance errors are defined as a deviation between the target/actual value.

An error that changes the distance between two axes changes the way the gears mesh and has a negative effect on the overlap ratio.

Even small pitch errors lead to increased noise in the gearbox.

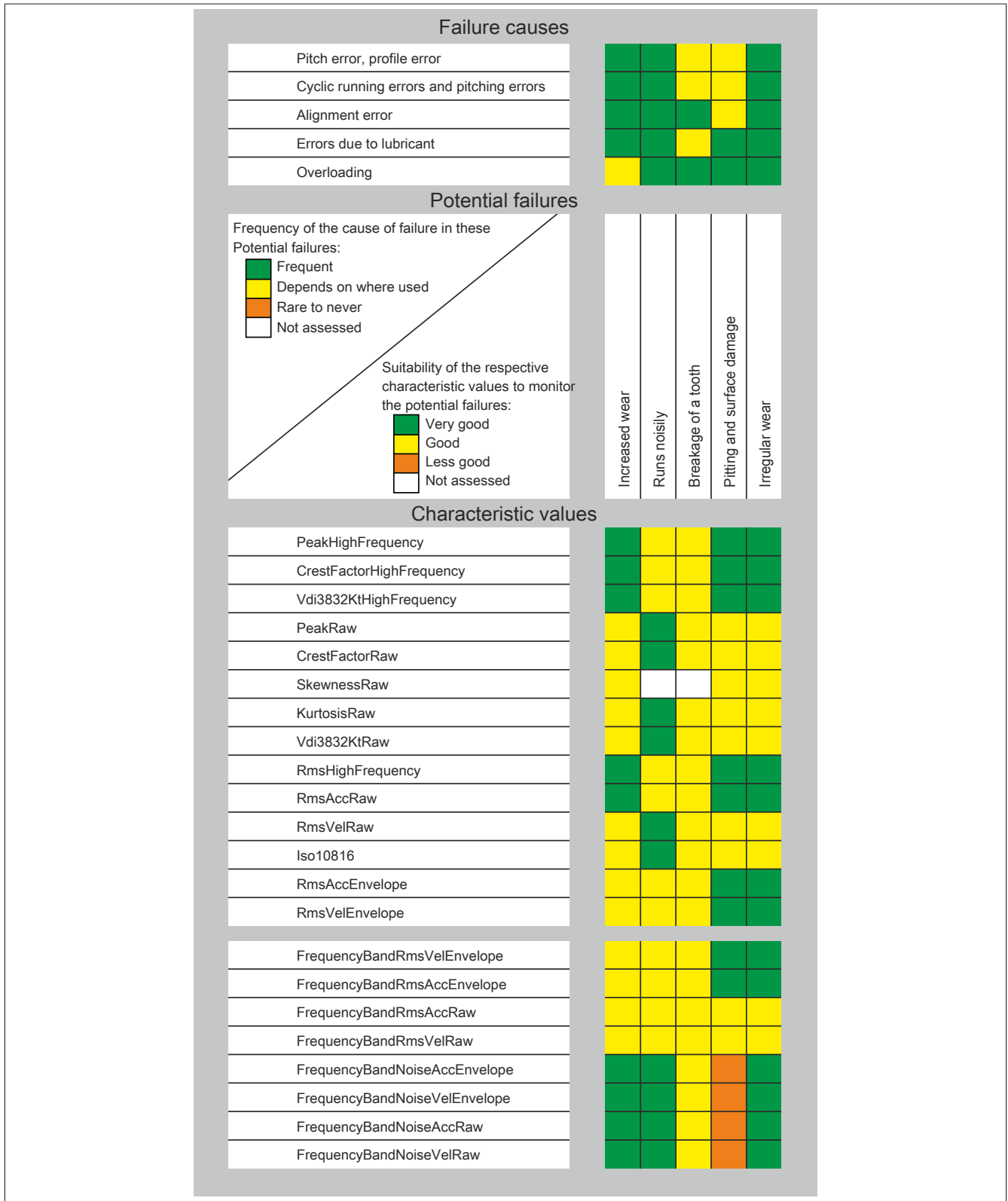


Figure 253: Frequency of failure indicators for gearbox damage

For the meaning of individual characteristic values, see "Characteristic values" on page 3070 and "Configuration" on page 3093.

Electrical errors

Occasionally, bridges in the rotor bars or short circuit rings occur. They occur as a result of overloading as well as aging and the ongoing oscillation load. This leads to a very uneven distribution of the induction current in the rotor.

| Failure causes | | | | |
|------------------------|--------|-------|--------|--------|
| Overloading | Green | Green | Green | Yellow |
| Aging | Green | Green | Green | Yellow |
| Dust entry | White | Green | Yellow | White |
| Foreign bodies | Yellow | Green | Yellow | White |
| Short circuits in coil | Yellow | Green | Yellow | Green |

| Potential failures | | | | |
|--|-------|-------|-------|-------|
| Frequency of the cause of failure in these Potential failures: Green: Frequent Yellow: Depends on where used Orange: Rare to never White: Not assessed | | | | |
| Suitability of the respective characteristic values to monitor the potential failures: Green: Very good Yellow: Good Orange: Less good White: Not assessed | | | | |
| Loose rods, rod breakage | Green | Green | Green | Green |
| Increased running noise | Green | Green | Green | Green |
| Break in short circuit ring | Green | Green | Green | Green |
| Magnetic imbalance | Green | Green | Green | Green |

| Characteristic values | | | | |
|-------------------------------|--------|--------|--------|--------|
| PeakHighFrequency | Green | Yellow | Yellow | Yellow |
| CrestFactorHighFrequency | Green | Yellow | Yellow | Yellow |
| Vdi3832KtHighFrequency | Green | Yellow | Yellow | Yellow |
| PeakRaw | Yellow | Yellow | Yellow | Green |
| CrestFactorRaw | Yellow | Yellow | Yellow | Green |
| SkewnessRaw | White | White | White | Green |
| KurtosisRaw | Yellow | Yellow | Yellow | Green |
| Vdi3832KtRaw | Yellow | Yellow | Yellow | Green |
| RmsHighFrequency | Green | Green | Yellow | Yellow |
| RmsAccRaw | Green | Green | Yellow | Yellow |
| RmsVelRaw | Yellow | Green | Yellow | Green |
| Iso10816 | Yellow | Green | Yellow | Green |
| RmsAccEnvelope | Green | Yellow | Yellow | Yellow |
| RmsVelEnvelope | Green | Yellow | Yellow | Yellow |
| FrequencyBandRmsVelEnvelope | Green | Yellow | Yellow | Yellow |
| FrequencyBandRmsAccEnvelope | Green | Yellow | Yellow | Yellow |
| FrequencyBandRmsAccRaw | Green | Yellow | Yellow | Green |
| FrequencyBandRmsVelRaw | Green | Yellow | Yellow | Green |
| FrequencyBandNoiseAccEnvelope | White | White | White | White |
| FrequencyBandNoiseVelEnvelope | White | White | White | White |
| FrequencyBandNoiseAccRaw | White | White | White | White |
| FrequencyBandNoiseVelRaw | White | White | White | White |

For the meaning of individual characteristic values, see "Characteristic values" on page 3070 and "Configuration" on page 3093.

9.26.7.16.3.3 Typical applications of damage recognition

The examples listed in the following are typical use cases and should provide assistance during integration. However, detailed planning of the applications must be carried out individually for each application.

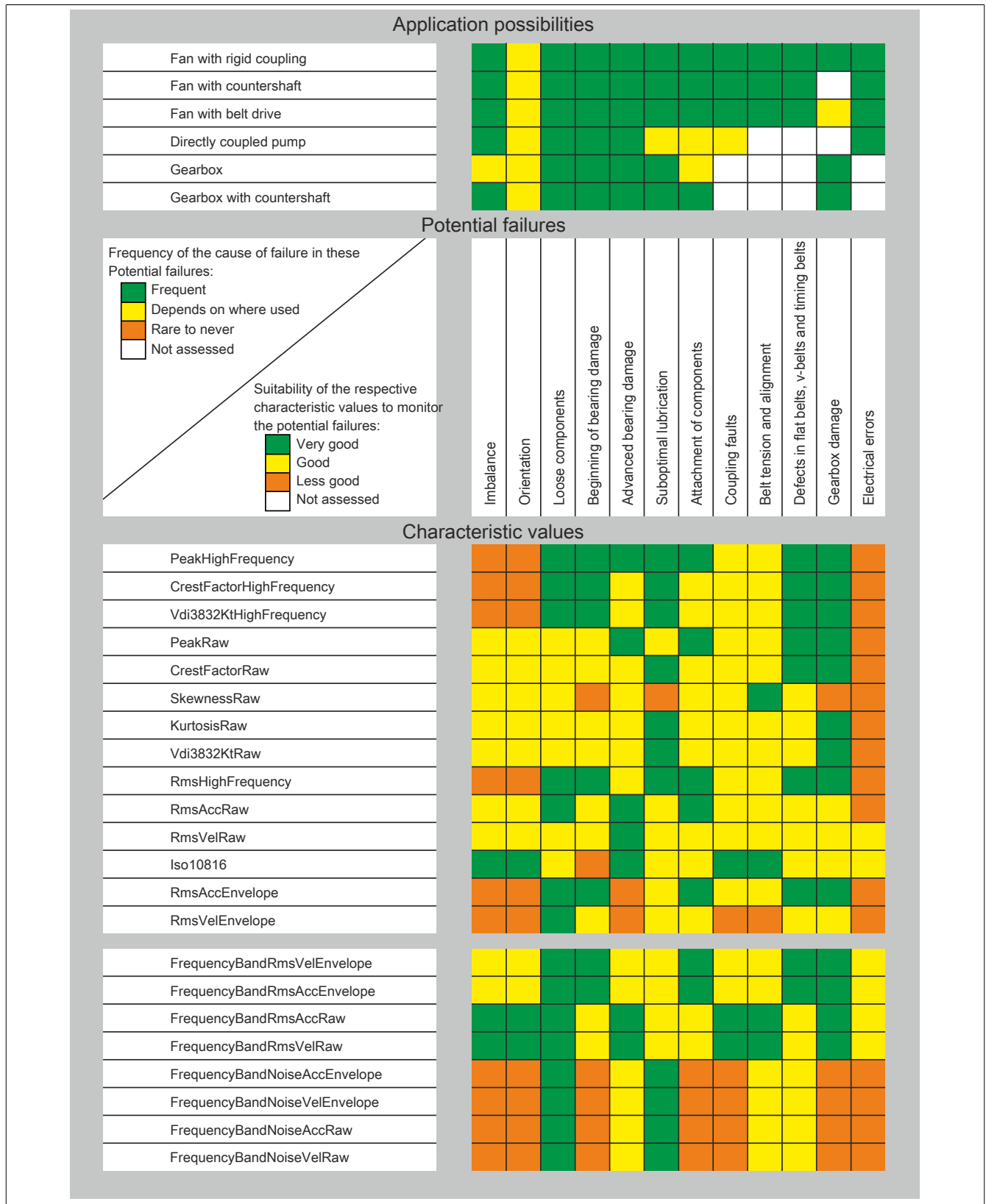


Figure 254: Typical applications of damage recognition

For the meaning of individual characteristic values, see "Characteristic values" on page 3070 and "Configuration" on page 3093.

Fan with rigid coupling

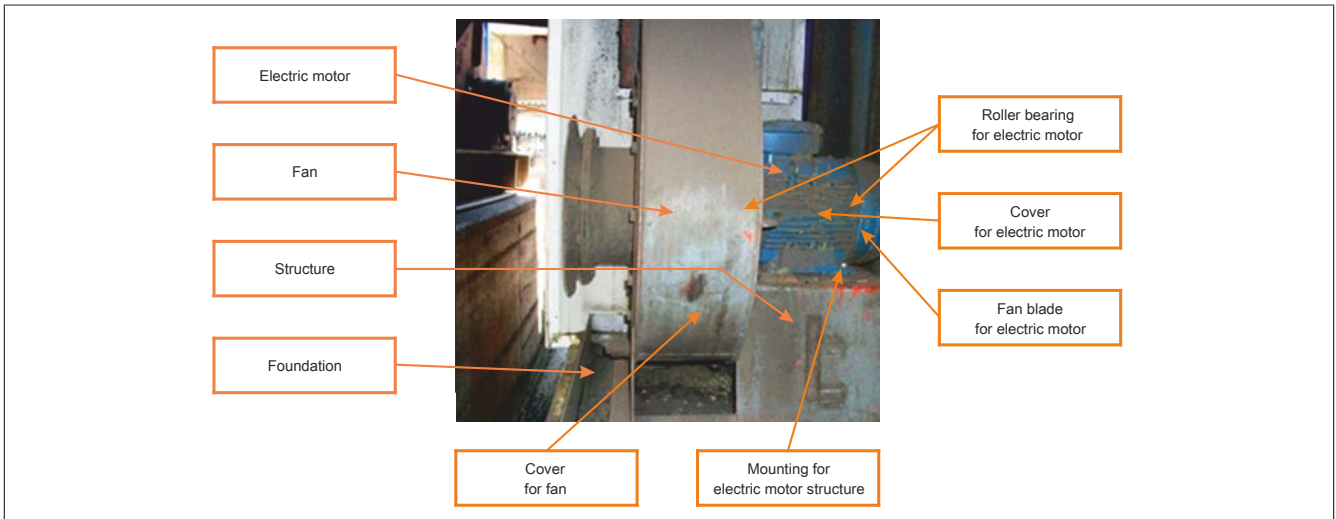


Figure 255: Drive unit with fan

Condition monitoring solution

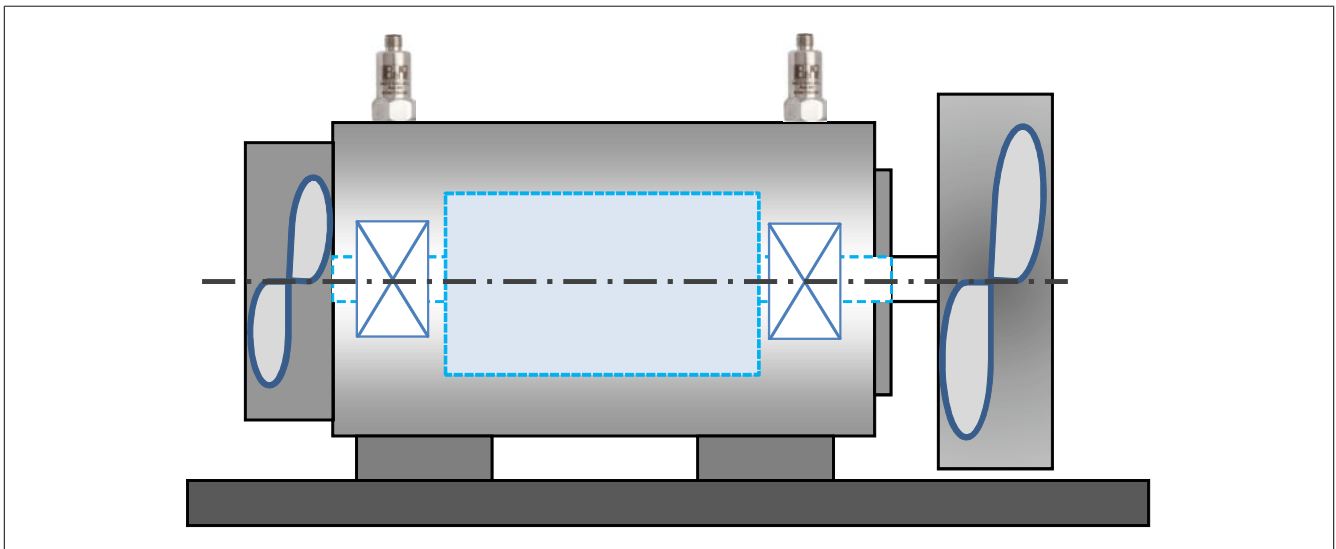
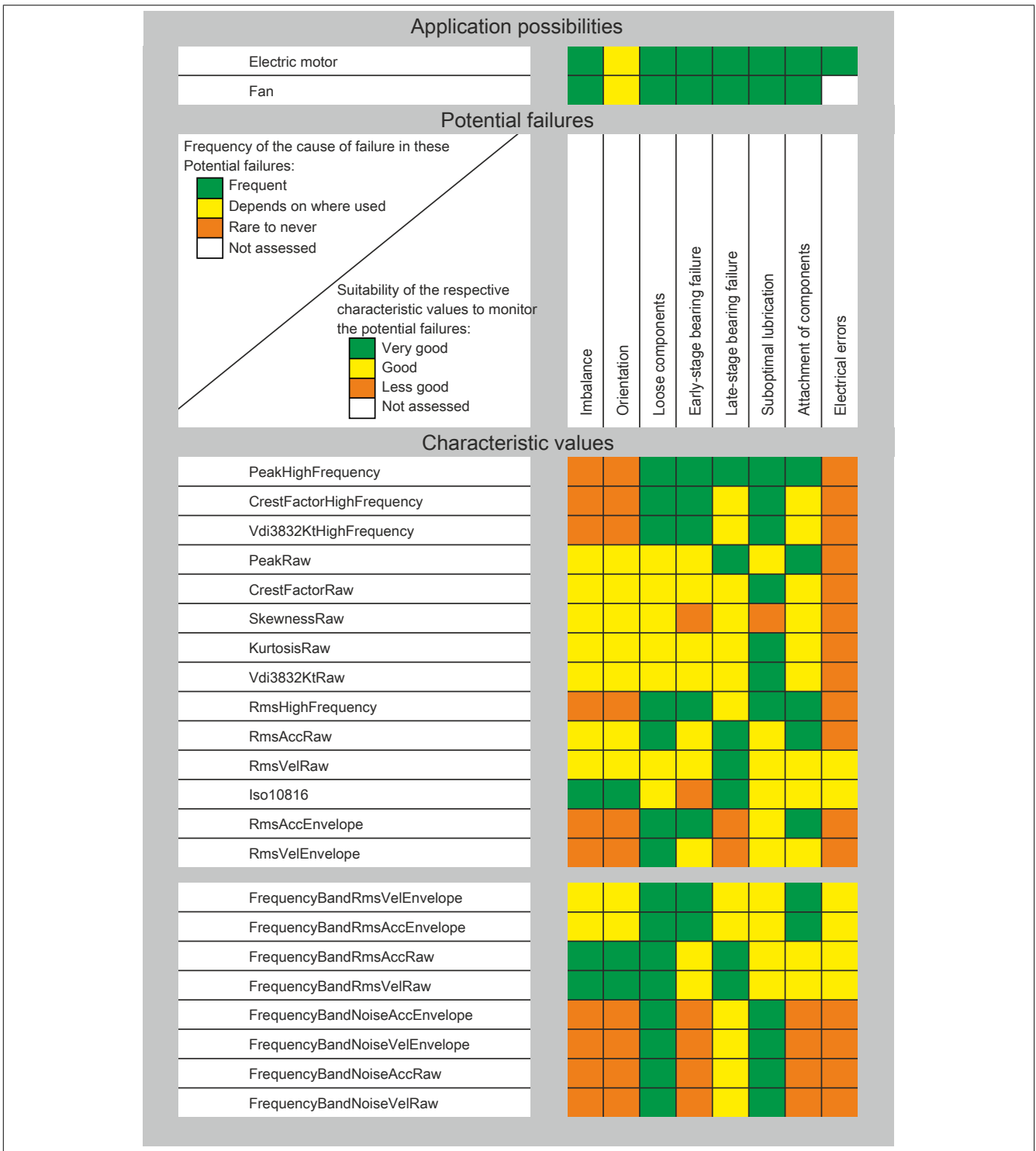


Figure 256: System diagram - Drive unit with fan

Sensor usage:

| | |
|---------------------|--|
| Number of sensors | Usually 2 sensors. One sensor is sufficient for smaller drive units. |
| Sensor installation | Preferably vertical. Horizontal installation is also possible, if necessary. |

Fan with rigid coupling - Common problems:



For the meaning of individual characteristic values, see "Characteristic values" on page 3070 and "Configuration" on page 3093.

Fan with countershaft

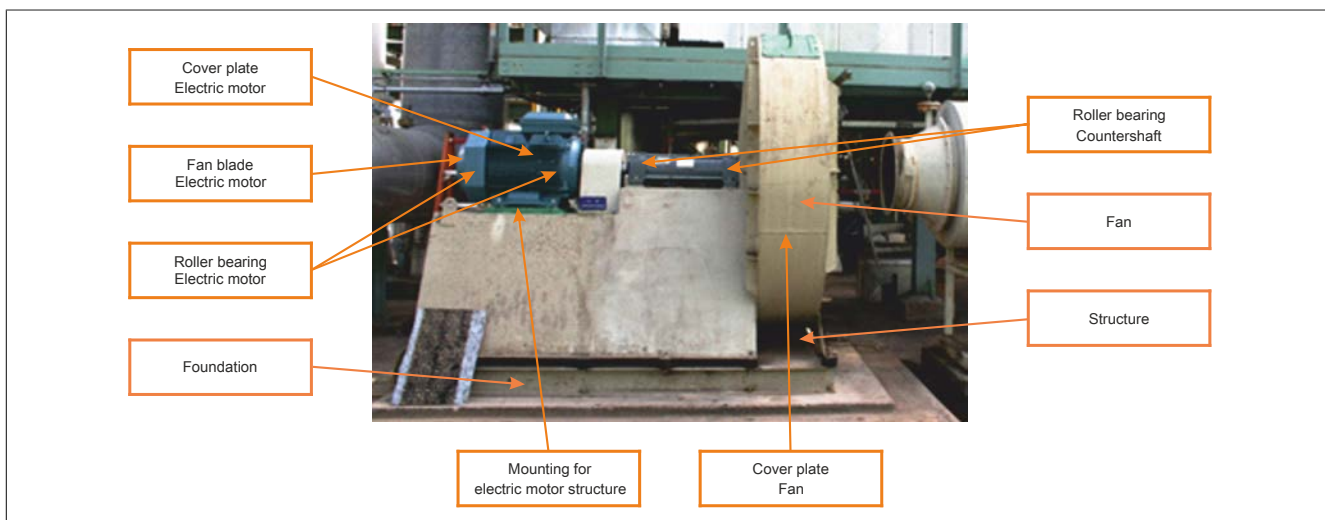


Figure 257: Drive unit with fan

Condition monitoring solution

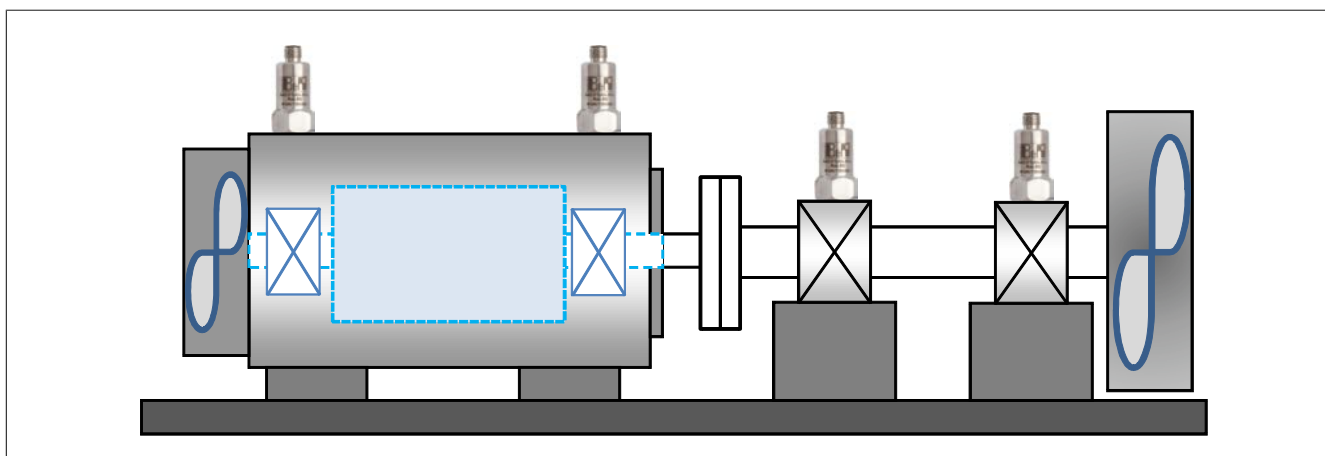


Figure 258: System diagram - Drive unit with countershaft and fan

Sensor usage:

| | |
|---------------------|--|
| Number of sensors | Usually 4 sensors. One sensor is sufficient for smaller drive units. |
| Sensor installation | Preferably vertical. Horizontal installation is also possible, if necessary. |

Fan with countershaft - Common problems:

| Application possibilities | | | | | | | | | |
|---------------------------|--|--|--|--|--|--|--|--|--|
| Electric motor | | | | | | | | | |
| Fan | | | | | | | | | |
| Coupling | | | | | | | | | |

| Potential failures | | | | | | | | | | | |
|--|--|-----------|-------------|------------------|-----------------------------|----------------------------|------------------------|--------------------------|-----------------|-------------------|--|
| Frequency of the cause of failure in these Potential failures: Frequent Depends on where used Rare to never Not assessed | Suitability of the respective characteristic values to monitor the potential failures: Very good Good Less good Not assessed | Imbalance | Orientation | Loose components | Early-stage bearing failure | Late-stage bearing failure | Suboptimal lubrication | Attachment of components | Coupling faults | Electrical errors | |
| | | | | | | | | | | | |
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| Characteristic values | | | | | | | | | |
|-------------------------------|--|--|--|--|--|--|--|--|--|
| PeakHighFrequency | | | | | | | | | |
| CrestFactorHighFrequency | | | | | | | | | |
| Vdi3832KtHighFrequency | | | | | | | | | |
| PeakRaw | | | | | | | | | |
| CrestFactorRaw | | | | | | | | | |
| SkewnessRaw | | | | | | | | | |
| KurtosisRaw | | | | | | | | | |
| Vdi3832KtRaw | | | | | | | | | |
| RmsHighFrequency | | | | | | | | | |
| RmsAccRaw | | | | | | | | | |
| RmsVelRaw | | | | | | | | | |
| Iso10816 | | | | | | | | | |
| RmsAccEnvelope | | | | | | | | | |
| RmsVelEnvelope | | | | | | | | | |
| FrequencyBandRmsVelEnvelope | | | | | | | | | |
| FrequencyBandRmsAccEnvelope | | | | | | | | | |
| FrequencyBandRmsAccRaw | | | | | | | | | |
| FrequencyBandRmsVelRaw | | | | | | | | | |
| FrequencyBandNoiseAccEnvelope | | | | | | | | | |
| FrequencyBandNoiseVelEnvelope | | | | | | | | | |
| FrequencyBandNoiseAccRaw | | | | | | | | | |
| FrequencyBandNoiseVelRaw | | | | | | | | | |

For the meaning of individual characteristic values, see "Characteristic values" on page 3070 and "Configuration" on page 3093.

Fan with belt drive

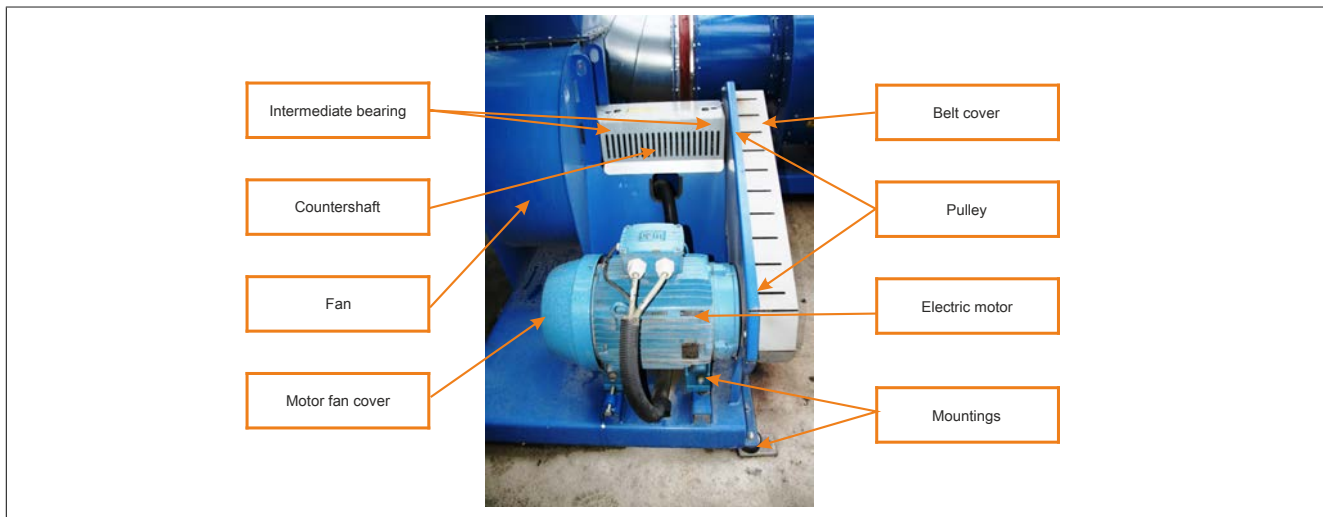


Figure 259: Structure of a fan with belt drive

Condition monitoring solutions

Assembly A

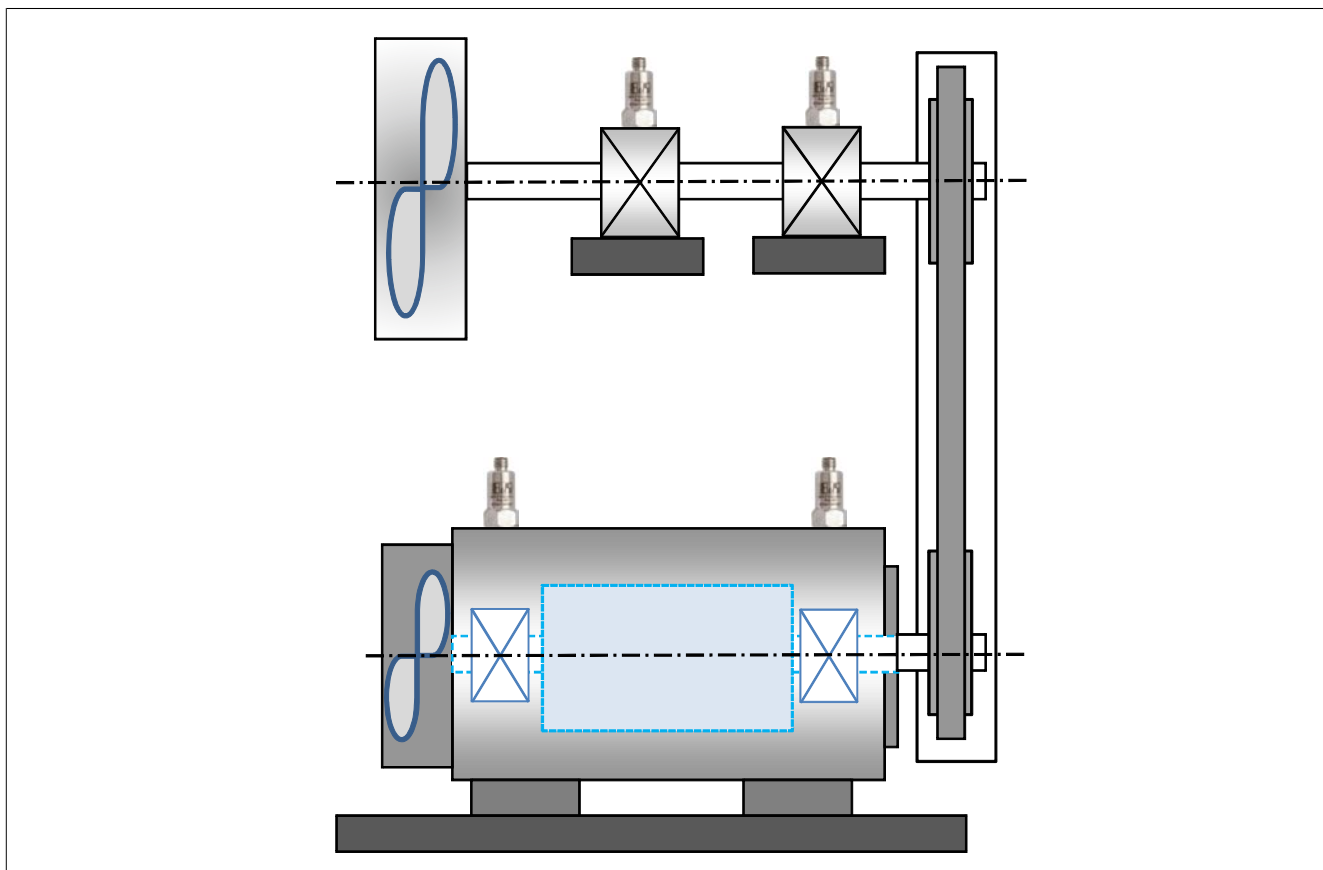


Figure 260: System diagram - Structure of a fan with belt drive

Assembly B

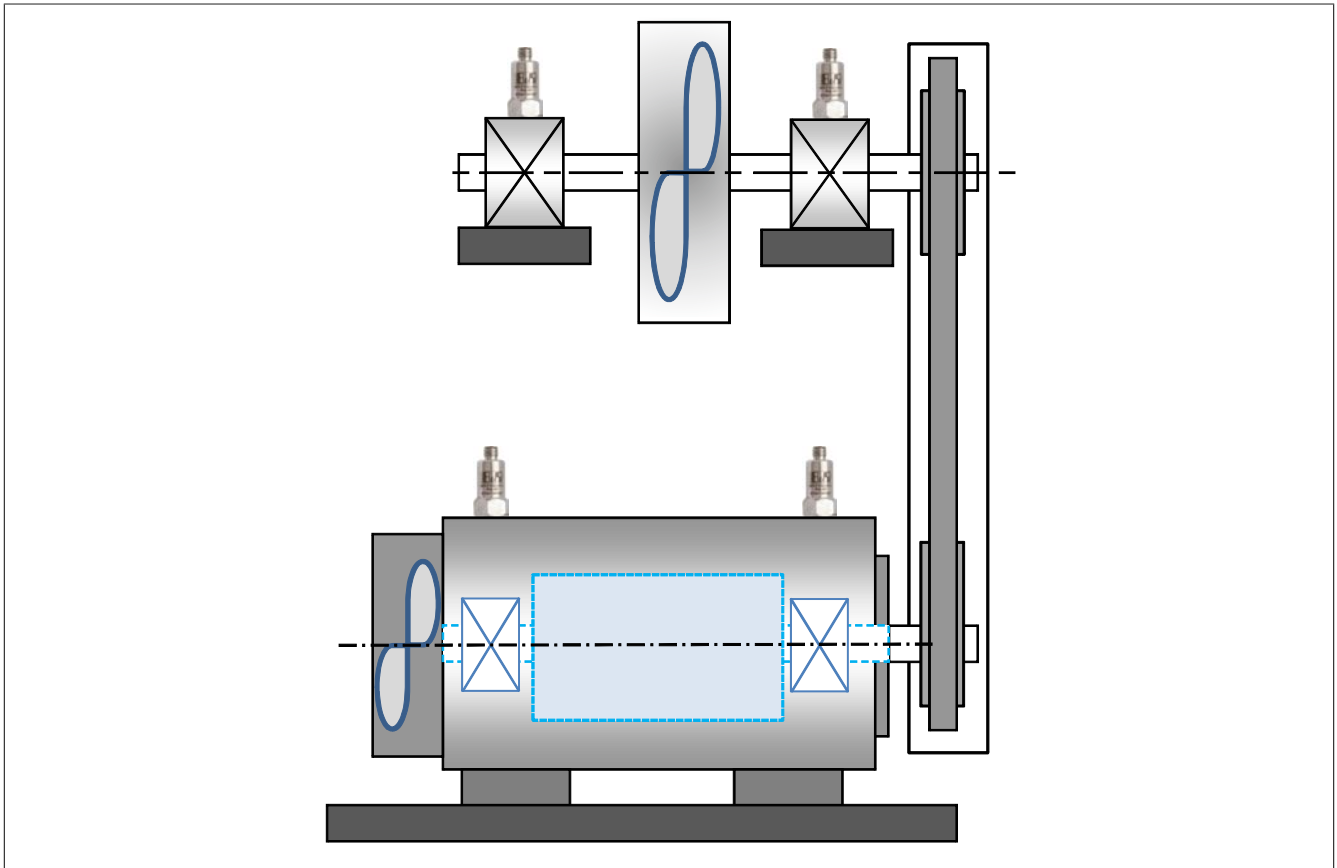


Figure 261: System diagram - Structure of a fan with belt drive - Alternative bearing

Sensor usage:

| | |
|---------------------|--|
| Number of sensors | Usually 4 sensors. One sensor is sufficient for smaller drive units. |
| Sensor installation | Preferably vertical. Horizontal installation is also possible, if necessary. Belt misalignment is particularly apparent in the axial direction. |

Fan with belt drive - Common problems:

| Application possibilities | | | | | | | | | |
|---------------------------|-------|--------|-------|-------|-------|-------|--------|--------|-------|
| Electric motor | Green | Yellow | Green | Green | Green | Green | Green | Green | Green |
| Fan | Green | Yellow | Green | Green | Green | Green | Green | Green | Green |
| Flat belts and V-belts | Green | Yellow | Green | White | White | White | Yellow | Yellow | White |
| Toothed belt | Green | Yellow | Green | White | White | White | White | White | White |

| Potential failures | | | | | | | | | | |
|--|--------------------------|-------------|------------------|-----------------------------|----------------------------|------------------------|--------------------------|----------------------------|-------------------|--------|
| Frequency of the cause of failure in these Potential failures: Green: Frequent Yellow: Depends on where used Orange: Rare to never White: Not assessed Suitability of the respective characteristic values to monitor the potential failures: Green: Very good Yellow: Good Orange: Less good White: Not assessed | Imbalance | Orientation | Loose components | Early-stage bearing failure | Late-stage bearing failure | Suboptimal lubrication | Attachment of components | Belt tension and alignment | Electrical errors | |
| | PeakHighFrequency | Orange | Orange | Green | Green | Green | Green | Yellow | Orange | |
| | CrestFactorHighFrequency | Orange | Orange | Green | Green | Yellow | Green | Yellow | Orange | |
| | Vdi3832KtHighFrequency | Orange | Orange | Green | Green | Yellow | Green | Yellow | Orange | |
| | PeakRaw | Yellow | Yellow | Yellow | Green | Yellow | Green | Yellow | Orange | |
| | CrestFactorRaw | Yellow | Yellow | Yellow | Yellow | Yellow | Green | Yellow | Orange | |
| | SkewnessRaw | Yellow | Yellow | Yellow | Orange | Yellow | Orange | Yellow | Green | Orange |
| | KurtosisRaw | Yellow | Yellow | Yellow | Yellow | Yellow | Green | Yellow | Yellow | Orange |
| | Vdi3832KtRaw | Yellow | Yellow | Yellow | Yellow | Yellow | Green | Yellow | Yellow | Orange |
| | RmsHighFrequency | Orange | Orange | Green | Green | Yellow | Green | Green | Yellow | Orange |
| RmsAccRaw | Yellow | Yellow | Green | Yellow | Green | Yellow | Green | Yellow | Orange | |
| RmsVelRaw | Yellow | Yellow | Yellow | Yellow | Green | Yellow | Yellow | Yellow | Orange | |
| Iso10816 | Green | Green | Yellow | Orange | Green | Yellow | Yellow | Green | Yellow | |
| RmsAccEnvelope | Orange | Orange | Green | Green | Orange | Yellow | Green | Yellow | Orange | |
| RmsVelEnvelope | Orange | Orange | Green | Yellow | Orange | Yellow | Yellow | Orange | Orange | |
| FrequencyBandRmsVelEnvelope | Yellow | Yellow | Green | Green | Yellow | Yellow | Green | Yellow | Yellow | |
| FrequencyBandRmsAccEnvelope | Yellow | Yellow | Green | Green | Yellow | Yellow | Green | Yellow | Yellow | |
| FrequencyBandRmsAccRaw | Green | Green | Green | Yellow | Green | Yellow | Green | Yellow | Orange | |
| FrequencyBandRmsVelRaw | Green | Green | Green | Green | Yellow | Yellow | Green | Yellow | Orange | |
| FrequencyBandNoiseAccEnvelope | Orange | Orange | Green | Orange | Yellow | Green | Orange | Yellow | Orange | |
| FrequencyBandNoiseVelEnvelope | Orange | Orange | Green | Orange | Yellow | Green | Orange | Yellow | Orange | |
| FrequencyBandNoiseAccRaw | Orange | Orange | Green | Orange | Yellow | Green | Orange | Yellow | Orange | |
| FrequencyBandNoiseVelRaw | Orange | Orange | Green | Orange | Yellow | Green | Orange | Yellow | Orange | |

For the meaning of individual characteristic values, see "Characteristic values" on page 3070 and "Configuration" on page 3093.

Directly coupled pump



Figure 262: Structure of a pump drive

Condition monitoring solution

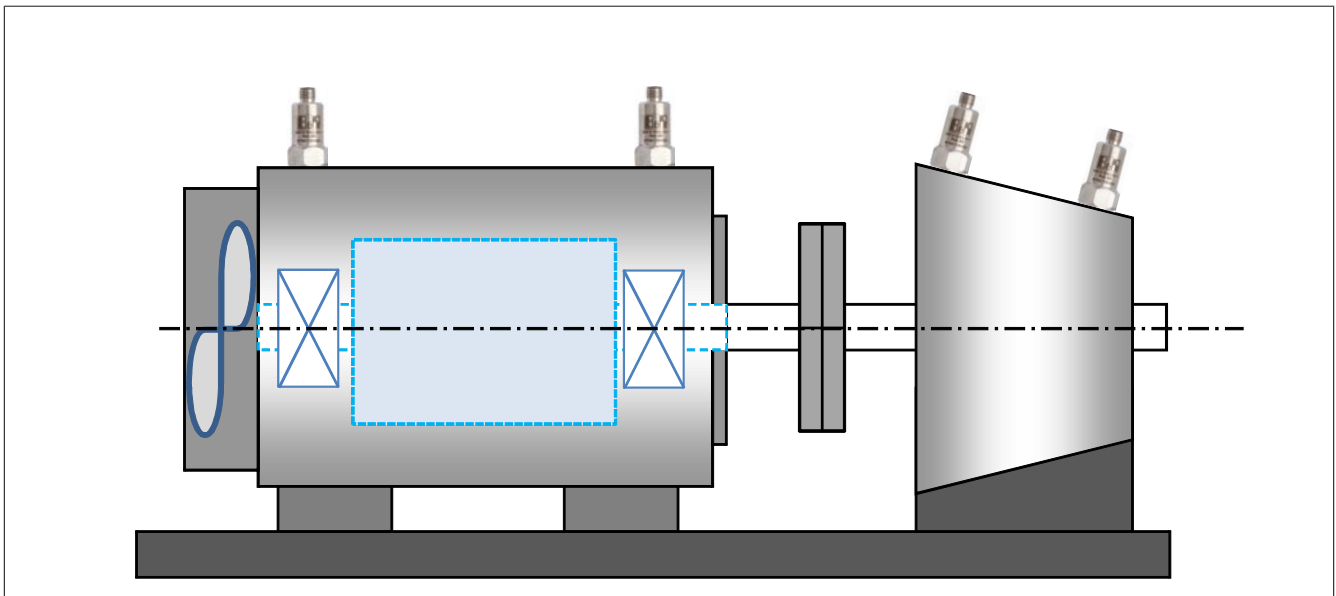
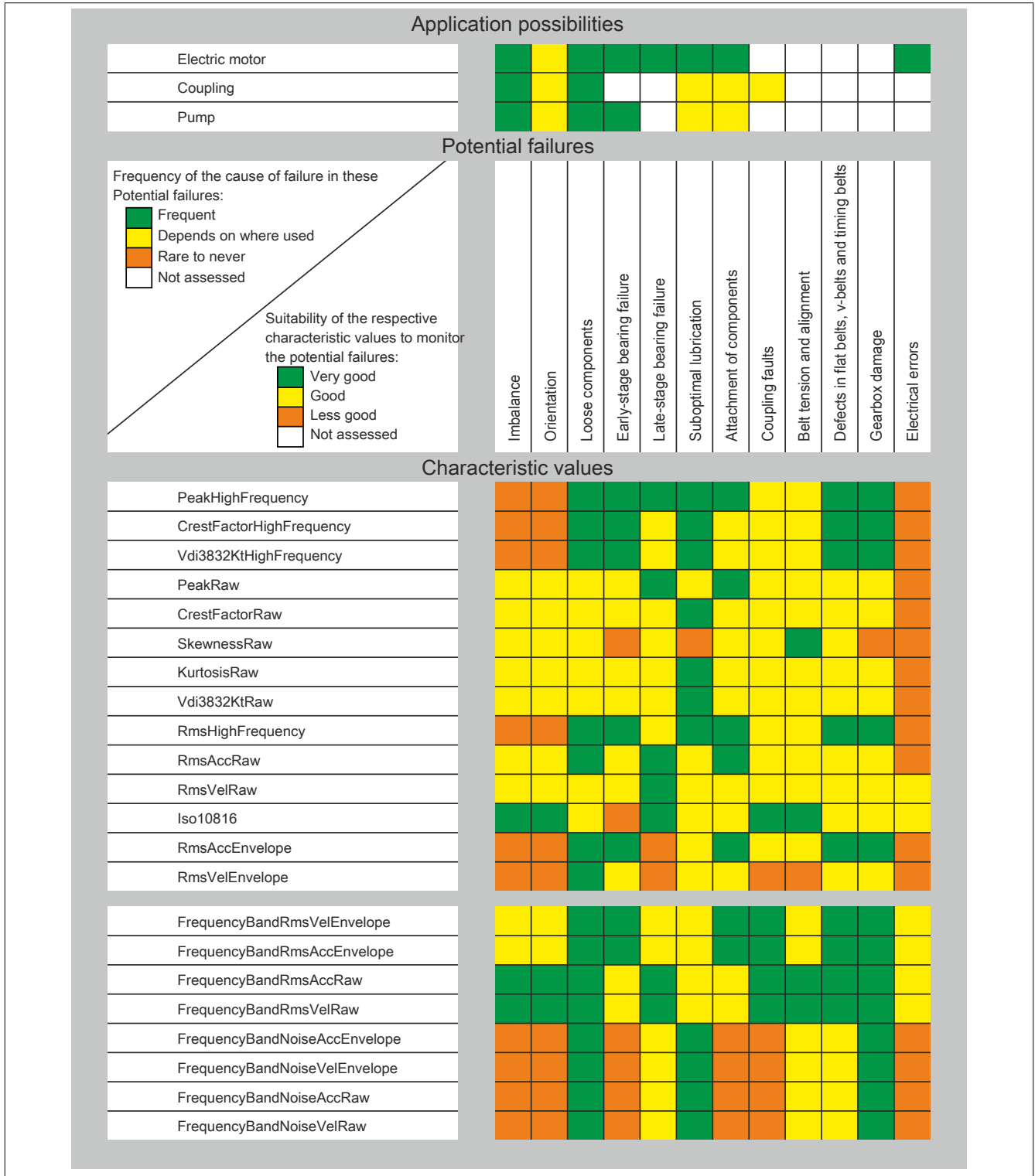


Figure 263: System diagram - Structure of a pump drive

Sensor usage:

| | |
|---------------------|--|
| Number of sensors | Usually 4 sensors. 2 sensors are sufficient for smaller drive units. |
| Sensor installation | Preferably vertical. Horizontal installation is also possible, if necessary. |

Directly coupled pump - Common problems:



For the meaning of individual characteristic values, see "Characteristic values" on page 3070 and "Configuration" on page 3093.

Gearbox

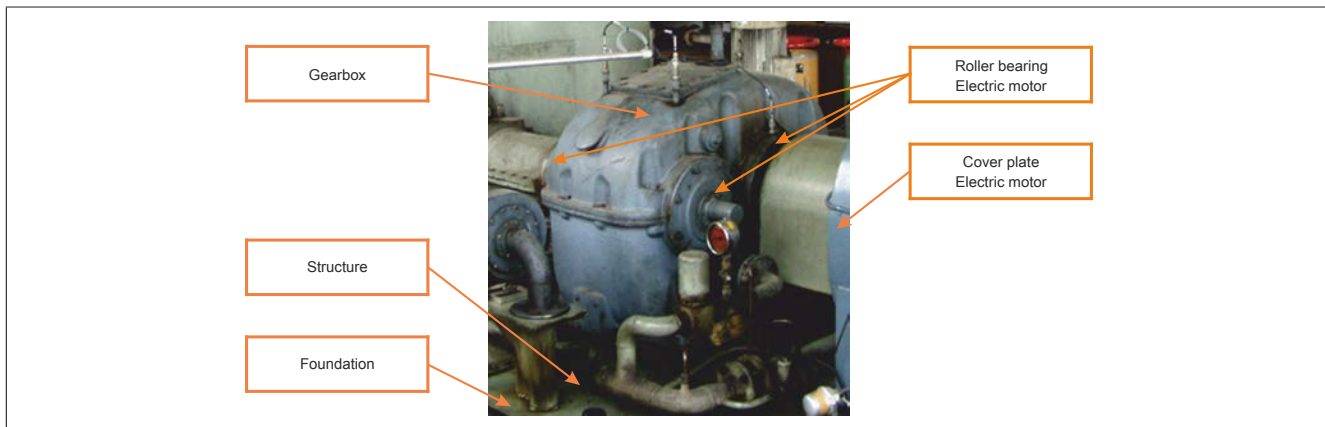


Figure 264: Structure of a gearbox

Condition monitoring solution

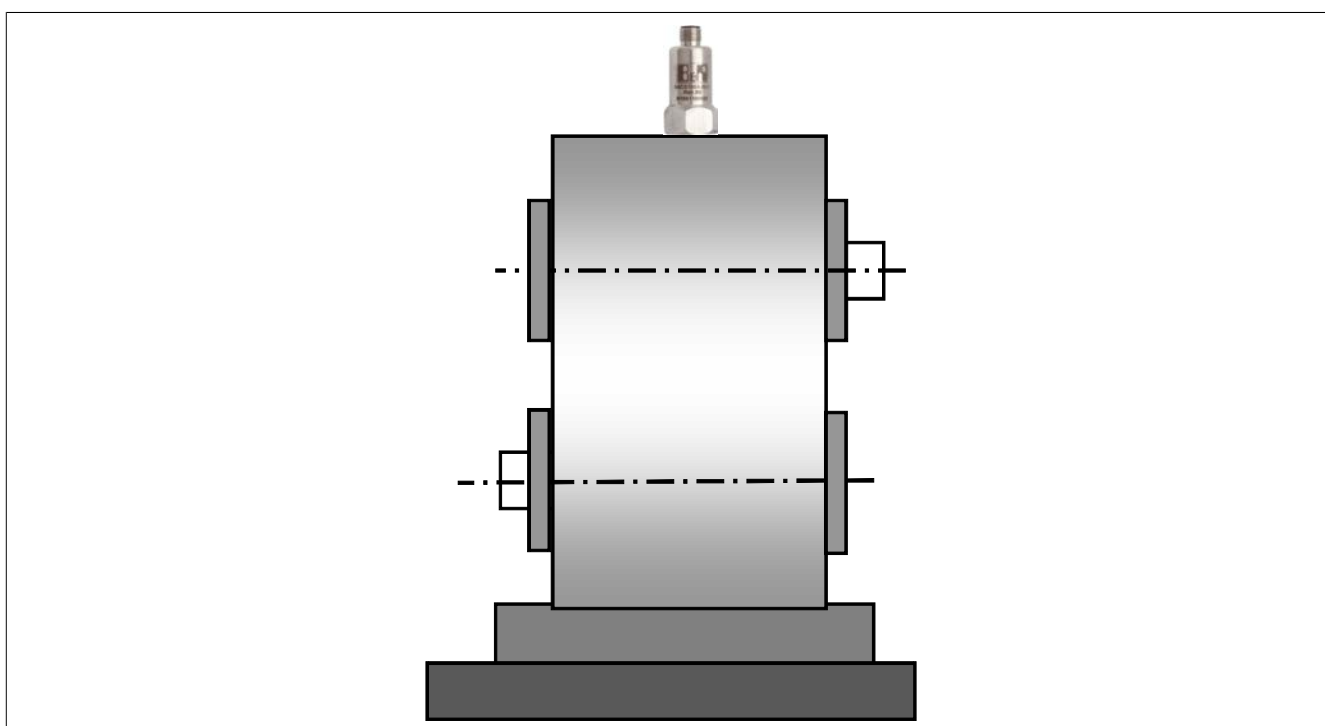


Figure 265: System diagram - Structure of a gearbox

Sensor usage:

| | |
|---------------------|--|
| Number of sensors | The number of sensors depends on the type and size of the gearbox. |
| Sensor installation | Preferably vertical. Horizontal installation is also possible, if necessary. The mounting direction depends greatly on the loading direction of the gearbox. |

Gearbox - Common problems:

| Application possibilities | | | | | | | | | | | | |
|--|--|-------------|------------------|-----------------------------|----------------------------|------------------------|--------------------------|-----------------|----------------------------|---|----------------|-------------------|
| Gearbox | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | |
| Potential failures | | | | | | | | | | | | |
| Frequency of the cause of failure in these Potential failures: ■ Frequent ■ Depends on where used ■ Rare to never ■ Not assessed | | | | | | | | | | | | |
| | Suitability of the respective characteristic values to monitor the potential failures: ■ Very good ■ Good ■ Less good ■ Not assessed | | | | | | | | | | | |
| | Imbalance | Orientation | Loose components | Early-stage bearing failure | Late-stage bearing failure | Suboptimal lubrication | Attachment of components | Coupling faults | Belt tension and alignment | Defects in flat belts, v-belts and timing belts | Gearbox damage | Electrical errors |
| Characteristic values | | | | | | | | | | | | |
| PeakHighFrequency | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| CrestFactorHighFrequency | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Vdi3832KtHighFrequency | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| PeakRaw | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| CrestFactorRaw | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| SkewnessRaw | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| KurtosisRaw | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Vdi3832KtRaw | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| RmsHighFrequency | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| RmsAccRaw | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| RmsVelRaw | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Iso10816 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| RmsAccEnvelope | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| RmsVelEnvelope | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| FrequencyBandRmsVelEnvelope | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| FrequencyBandRmsAccEnvelope | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| FrequencyBandRmsAccRaw | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| FrequencyBandRmsVelRaw | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| FrequencyBandNoiseAccEnvelope | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| FrequencyBandNoiseVelEnvelope | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| FrequencyBandNoiseAccRaw | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| FrequencyBandNoiseVelRaw | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |

For the meaning of individual characteristic values, see "Characteristic values" on page 3070 and "Configuration" on page 3093.

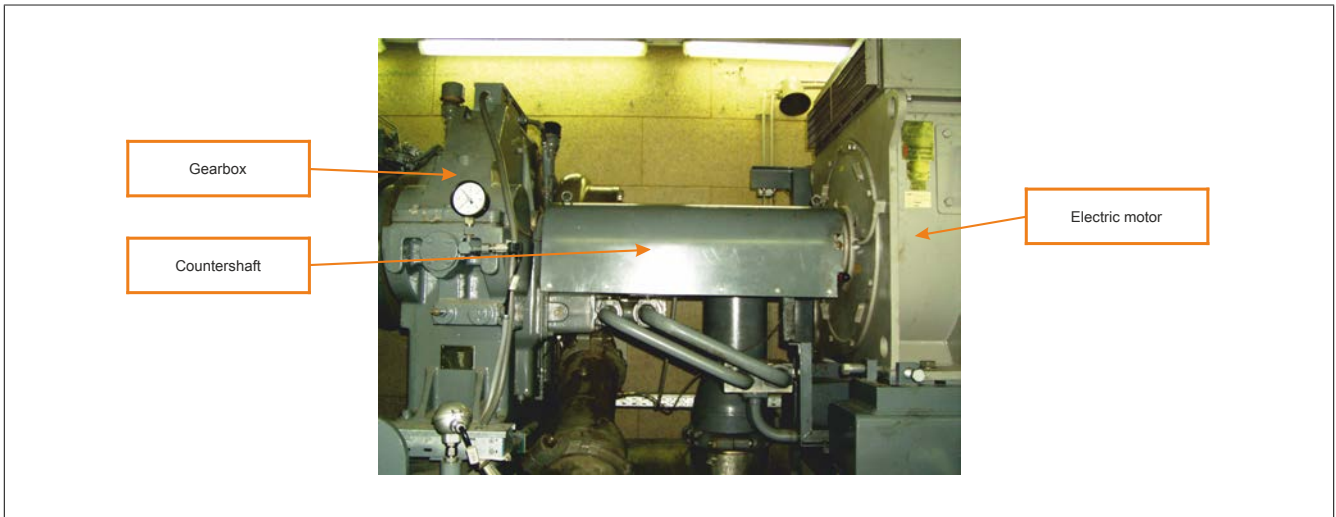
Gearbox with countershaft

Figure 266: Structure of a gearbox with countershaft

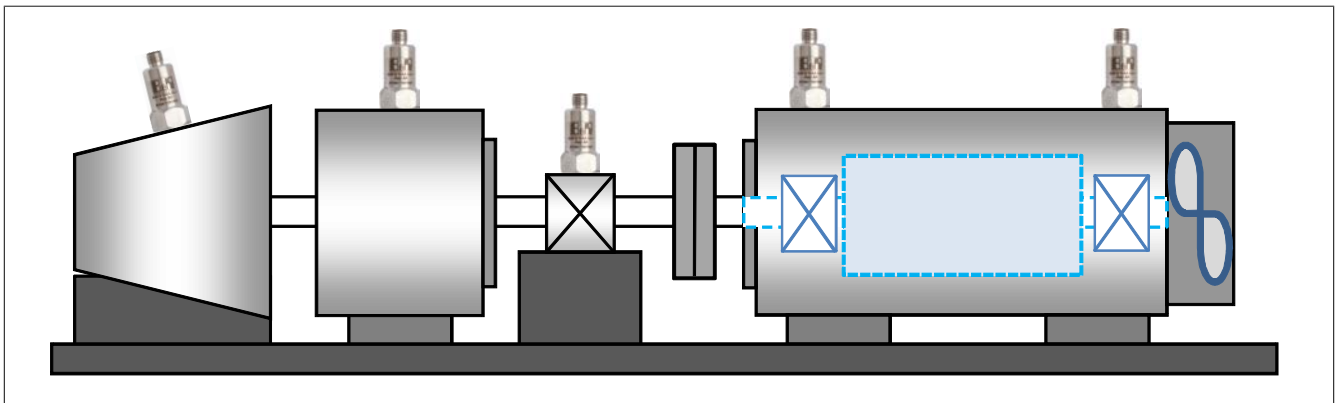
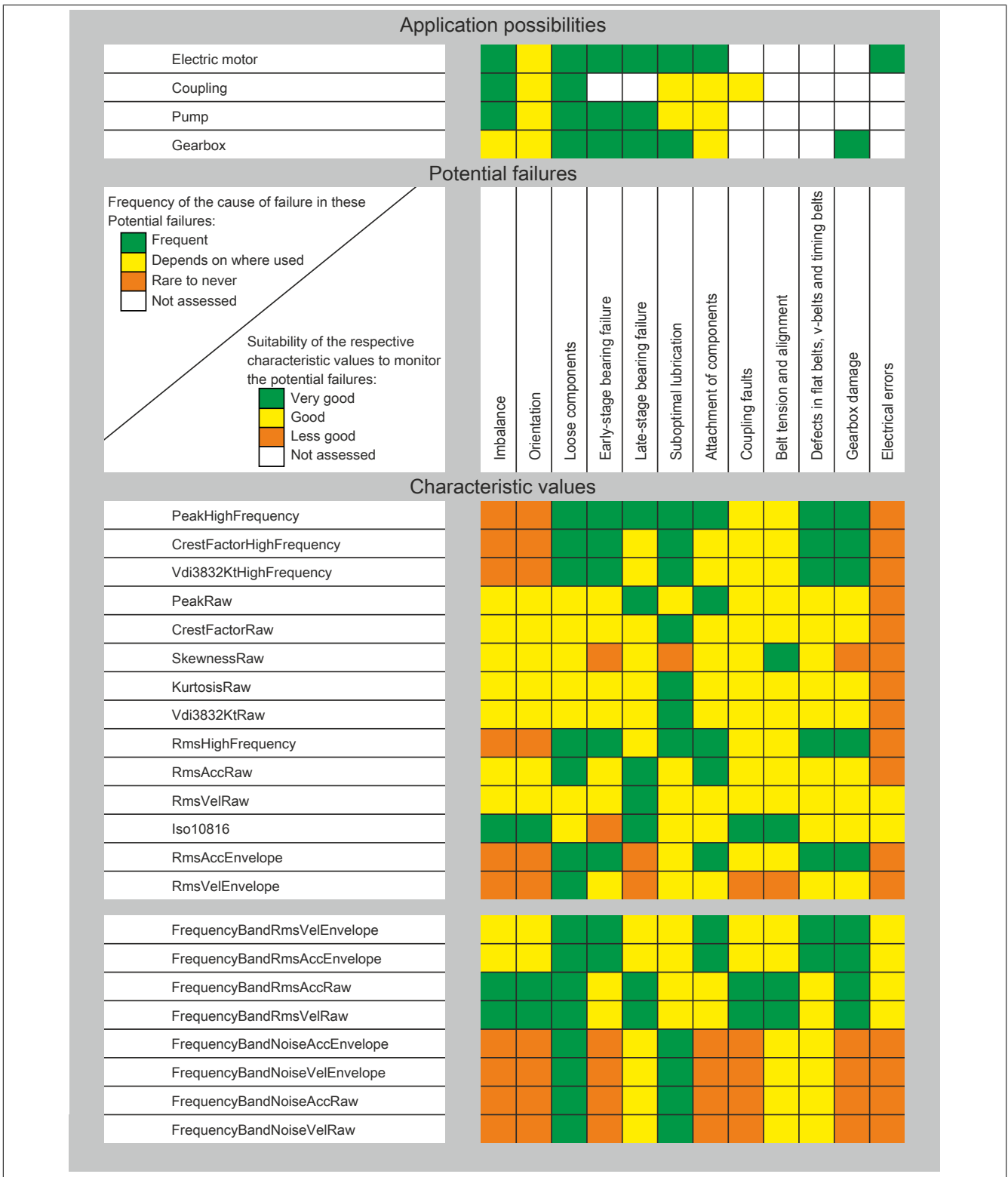
Condition monitoring solution

Figure 267: System diagram - Gearbox with countershaft

Sensor usage:

| | |
|---------------------|---|
| Number of sensors | Usually 5 sensors. 2 sensors are sufficient for smaller and inflexibly coupled drive units. |
| Sensor installation | Preferably vertical. Horizontal installation is also possible, if necessary. |

Gearbox with countershaft - Common problems:



For the meaning of individual characteristic values, see "Characteristic values" on page 3070 and "Configuration" on page 3093.

9.26.7.16.4 Further reading

Due to its extensive nature, the subject of oscillation analysis can only be outlined in this user's manual.

The following book is well suited to beginners and recommended for those wishing to research this subject in greater detail.

Zustandsüberwachung von Maschinen [Condition Monitoring of Machines]

Publisher: Expert-Verlag GmbH
Author: Dr. Josef Kolerus and Prof. Dr. Johann Wassermann
Edition: 5th, newly revised 2011 edition
Language: German
Pages: 408
ISBN-13: 978-3-8169-3080-8

9.26.7.17 Accessories

9.26.7.17.1 Sensors

9.26.7.17.1.1 0ACS100A.00-1

Order data


| Model number | Short description | Figure |
|---------------|---|---|
| | Sensors |  |
| 0ACS100A.00-1 | Accelerometer, nominal sensitivity 100 mV/g, top exit | |
| | Required accessories | |
| | Sensor cable | |
| 0ACC0020.01-1 | Cable for accelerometer, length 2 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| 0ACC0050.01-1 | Cable for accelerometer, length 5 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| 0ACC0100.01-1 | Cable for accelerometer, length 10 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| 0ACC0150.01-1 | Cable for accelerometer, length 15 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| 0ACC0200.01-1 | Cable for accelerometer, length 20 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| 0ACC0500.01-1 | Cable for accelerometer, length 50 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| 0ACC1000.01-1 | Cable for accelerometer, length 100 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |

Table 543: 0ACS100A.00-1 - Order data

Technical data

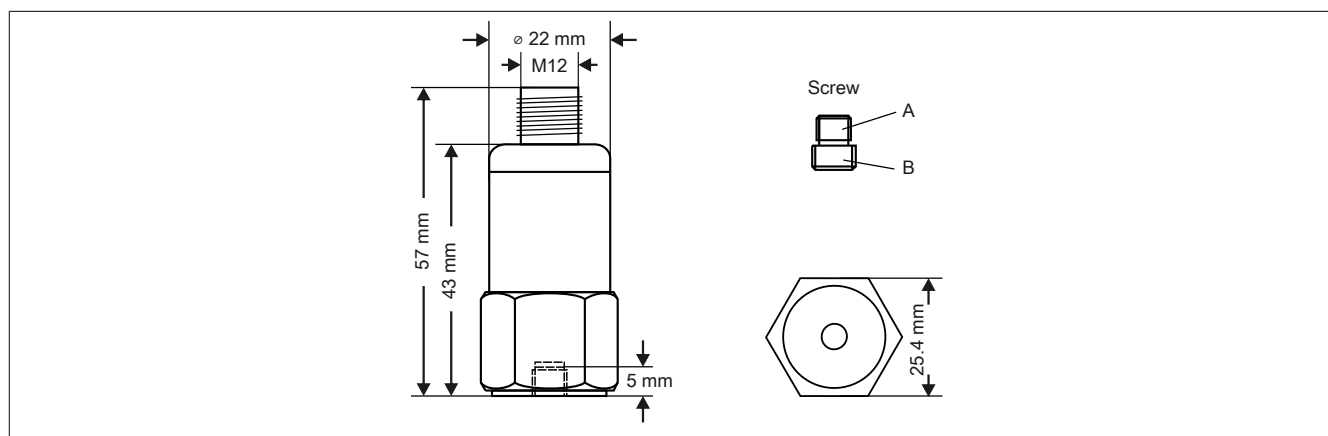
| | |
|-----------------------------------|---|
| Model number | 0ACS100A.00-1 |
| Sensor properties | |
| Natural resonance (installed) | 22 kHz (rated) |
| Sensitivity | 100 mV/g $\pm 10\%$ nominal 80 Hz at 22°C |
| Frequency response | 2 Hz to 10 kHz $\pm 5\%$ 0.8 Hz to 15 kHz ± 3 dB |
| Isolation | Isolated base |
| Measurement range | ± 50 g |
| Cross-sensitivity | <5% |
| Electrical properties | |
| Electrical disturbances | Max. 0.1 mg |
| Broadband resolution | 0.2 mg (200 μ g) over 1 Hz to 15 kHz |
| Spectral noise | 10 Hz to 10 μ g/Hz 100 Hz to 4 μ g/Hz 1 kHz to 3 μ g/Hz |
| Current range | 0.5 to 8 mA |
| Bias voltage | 10 to 12 VDC |
| Settling time | 2 s |
| Output impedance | Max. 200 Ω |
| Housing isolation | >10 ⁸ Ω at 500 V |
| Operating conditions | |
| Degree of protection per EN 60529 | IP67 |
| Ambient conditions | |
| Temperature | |
| Operation | -55 to 140°C |
| Max. shock resistance | 5000 g |
| Emitted interferences | EN 61000-6-4:2001 |
| Immunity to interference | EN 61000-6-2:1999 |
| Mechanical properties | |
| Housing | |
| Material | Stainless steel |
| Installation | M8 x 1.25 x 6 mm bolt, pre-assembled on the sensor |
| Weight | 110 g |
| Measurement element | PZT piezoelectric crystal (lead zirconate titanate) |
| Measurement execution | Compressed |
| Tightening torque | 8 Nm |
| Connectors | M12 |

Table 544: 0ACS100A.00-1 - Technical data

For applicable certifications for the sensor, see the manufacturer's website.

 **Certificates**

<http://www.hansfordsensors.com/resources/certificates/>

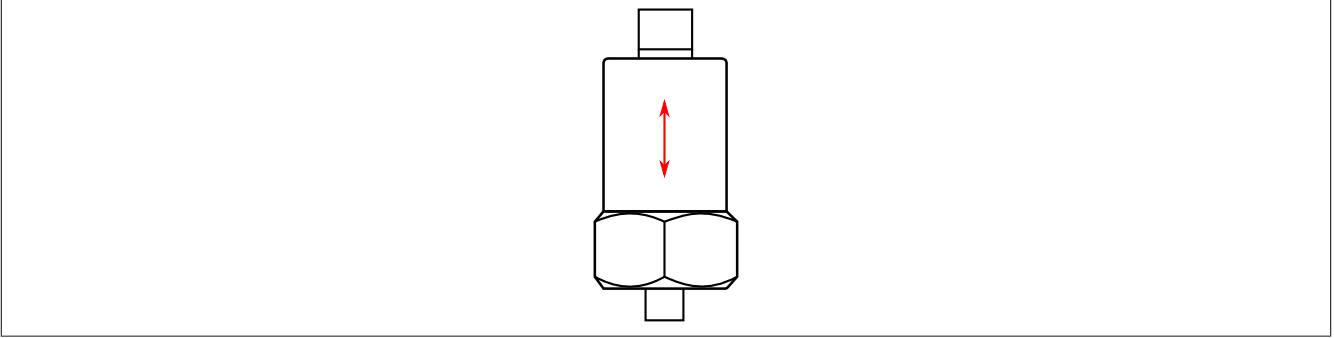
Dimensions

The screw is already installed when delivered.

- A 1/4" - 28 UNF (maximum thread length: 5 mm)
- B M8 x 6 x 1.25

Installation direction

B&R vibration sensor 0ACS100A.00-1 is designed for measurements in the longitudinal axis.



9.26.7.17.1.2 0ACS100A.90-1

Order data


| Model number | Short description | Figure |
|---------------|---|---|
| | Sensors |  |
| 0ACS100A.90-1 | Accelerometer, nominal sensitivity 100 mV/g, side exit | |
| | Required accessories | |
| | Sensor cable | |
| 0ACC0020.01-1 | Cable for accelerometer, length 2 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| 0ACC0050.01-1 | Cable for accelerometer, length 5 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| 0ACC0100.01-1 | Cable for accelerometer, length 10 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| 0ACC0150.01-1 | Cable for accelerometer, length 15 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| 0ACC0200.01-1 | Cable for accelerometer, length 20 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| 0ACC0500.01-1 | Cable for accelerometer, length 50 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |
| 0ACC1000.01-1 | Cable for accelerometer, length 100 m, 2x 0.34 mm ² , female M12 connector on the sensor side, can be used in cable drag chains, UL listed | |

Table 545: 0ACS100A.90-1 - Order data

Technical data

| Model number | 0ACS100A.90-1 |
|-----------------------------------|---|
| Sensor properties | |
| Natural resonance (installed) | 22 kHz (rated) |
| Sensitivity | 100 mV/g \pm 10% nominal 80 Hz at 22°C |
| Frequency response | 2 Hz to 10 kHz \pm 5% 0.8 Hz to 15 kHz \pm 3 dB |
| Isolation | Isolated base |
| Measurement range | \pm 50 g |
| Cross-sensitivity | <5% |
| Electrical properties | |
| Electrical disturbances | Max. 0.1 mg |
| Broadband resolution | 0.2 mg (200 μ g) over 1 Hz to 15 kHz |
| Spectral noise | 10 Hz to 10 μ g/Hz 100 Hz to 4 μ g/Hz 1 kHz to 3 μ g/Hz |
| Current range | 0.5 to 8 mA |
| Bias voltage | 10 to 12 VDC |
| Settling time | 2 s |
| Output impedance | Max. 200 Ω |
| Housing isolation | >10 ⁸ Ω at 500 V |
| Operating conditions | |
| Degree of protection per EN 60529 | IP67 |
| Ambient conditions | |
| Temperature | |
| Operation | -55 to 140°C |
| Max. shock resistance | 5000 g |
| Emitted interferences | EN 61000-6-4:2001 |
| Immunity to interference | EN 61000-6-2:1999 |
| Mechanical properties | |
| Housing | |
| Material | Stainless steel |
| Installation | M8 x 1.25 x 33 mm screw, included in delivery |
| Weight | 170 g |
| Measurement element | PZT piezoelectric crystal (lead zirconate titanate) |
| Measurement execution | Compressed |
| Tightening torque | 8 Nm |
| Connectors | M12 |

Table 546: 0ACS100A.90-1 - Technical data

For applicable certifications for the sensor, see the manufacturer's website.



Certificates

<http://www.hansfordsensors.com/resources/certificates/>

Dimensions

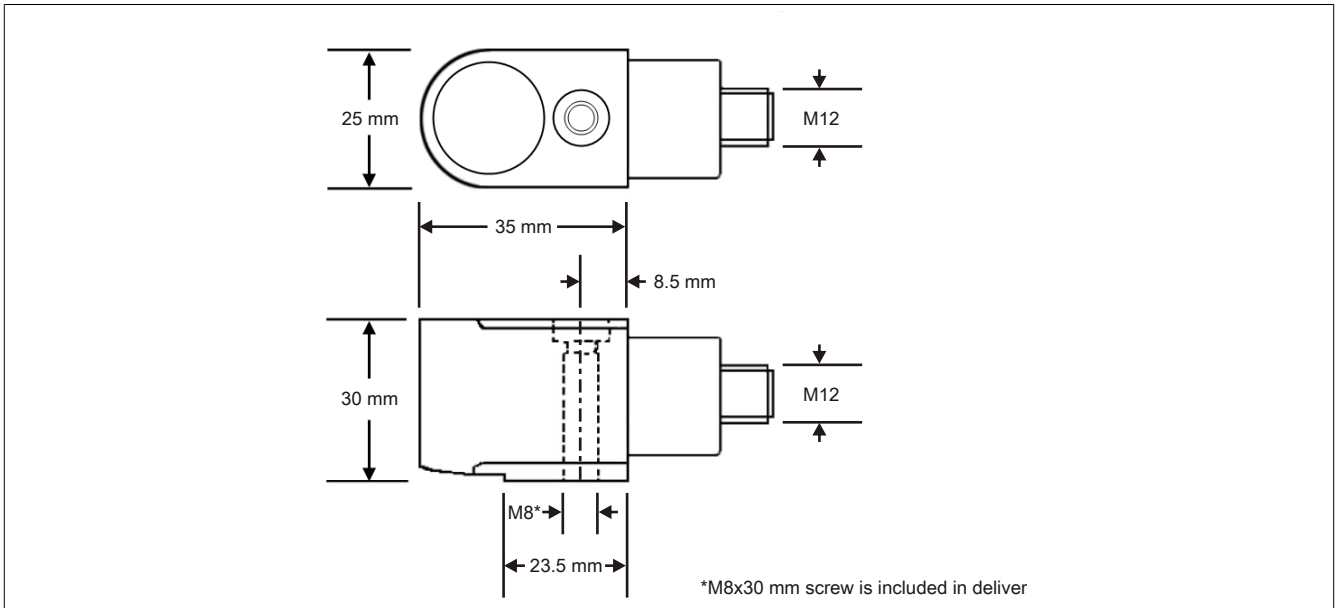
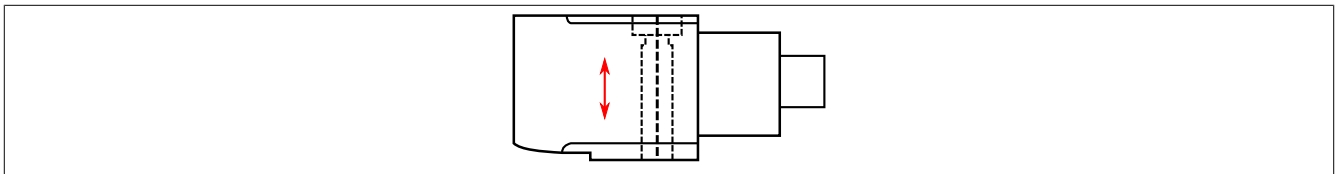


Figure 268: 0ACS100A.90-1 - Dimensions

Installation direction

B&R vibration sensor 0ACS100A.90-1 is designed for measurements in the transverse axis.



9.26.7.17.1.3 General information

Pinout

| Pin | Description |
|-----|--------------------|
| 1 | Not assigned |
| 2 | 18 to 30 V (brown) |
| 3 | Not assigned |
| 4 | 0 V (blue) |

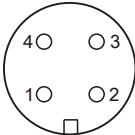


Table 547: 0ACS100A.x0-1 - Pinout

Frequency response

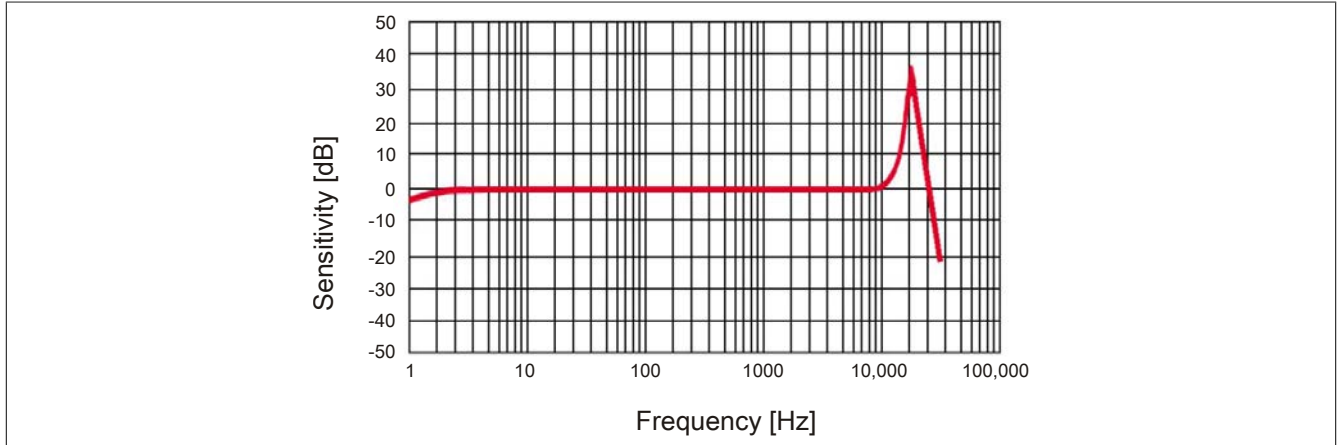


Figure 269: 0ACS100A.x0-1 - Frequency response

9.26.7.17.2 Sensor cables

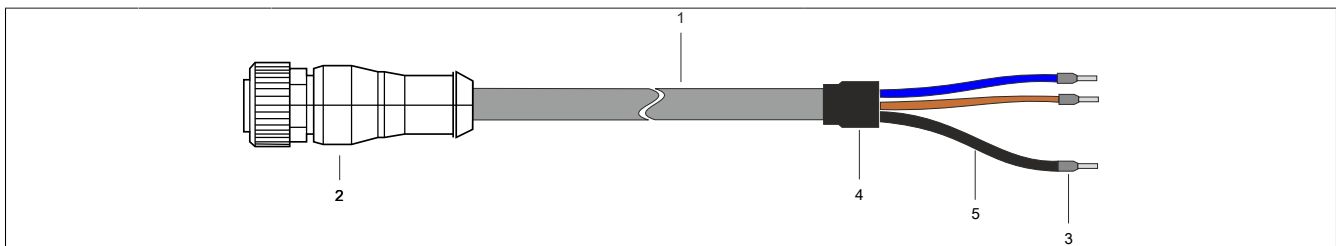
9.26.7.17.2.1 Order data

| Model number | Length | Short description |
|---------------|--------|--|
| 0ACC0020.01-1 | 2 m | Cable for accelerometer, 2x 0.34 mm ² , 1x 0.25 mm ² , M12 female connector on sensor side, 1x 25 mm ² shield connection, can be used in cable drag chains, UL/CSA listed |
| 0ACC0050.01-1 | 5 m | |
| 0ACC0100.01-1 | 10 m | |
| 0ACC0150.01-1 | 15 m | |
| 0ACC0200.01-1 | 20 m | |
| 0ACC0500.01-1 | 50 m | |
| 0ACC1000.01-1 | 100 m | |

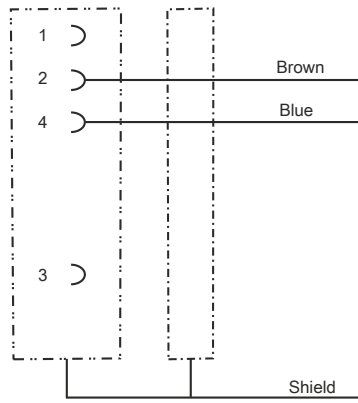
9.26.7.17.2.2 Technical data

| Name | 0ACC0xx0.01-1 |
|--|--|
| General information | |
| Number of pins | 3 |
| Cable length | x |
| Characteristic values of the wire | |
| Cable type | PUR halogen-free black shielded |
| AWG signal lead | 22 |
| Conductor design signal lead | 42x 0.10 mm |
| Wire diameter incl. insulation | 1.27 mm ±0.02 mm |
| Wall thickness insulation | ≥0.21 mm (wire insulation) Approx. 1.1 mm (outer jacket) |
| External diameter of cable | 5.9 mm ±0.15 mm |
| Insulation resistance | ≥100 GΩ*km (at 20°C) |
| Conductor resistance | Max. 58 Ω/km (at 20°C) |
| Shielding | Braided copper wires |
| Cable weight | 44 kg/km |
| Smallest bend radius, fixed | 29.5 mm |
| Smallest bend radius, movable | 59 mm |
| Number of flex cycles | 4000000 |
| Bend radius | 59 mm |
| Travel path | 10 m |
| Movement speed | 3 m/s |
| Acceleration | 10 m/s ² |
| Ambient temperature (during operation) | -40°C ... 80°C (cable, inflexible installation) -25°C ... 80°C (cable, flexible installation) |
| Degree of protection per EN 60529 | IP67 |

9.26.7.17.2.3 Sensor cables with female M12 connector



| Pos. | Pieces | Description | Note |
|------|--------|--|---|
| 1 | 1 | Sensor cable | 2x 0.34 mm ² (1501702 3x 0.34) |
| 2 | 1 | Female M12 connector (axial) | Female M12 connector (M12x1 A-keyed) |
| 3 | 2 | Wire end sleeve (2x sensor cables) | 3203066 AI 0.34-8 TQ |
| 4 | 1 | Heat shrink tubing | |
| 5 | 1 | Shield connection | 1x 0.25 mm ² black |
| 6 | 1 | Wire end sleeve (1x shield connection) | 3200632 AI 0.25-12 BU |

9.26.7.17.2.4 Cable diagram

9.26.8 X20CM6209

Data sheet version: 2.24

9.26.8.1 General information

This module is a diode array module with six diodes. The diodes can be used as freewheeling diodes or decoupling diodes.

The diode array module has no connection to X2X Link. It behaves like a dummy module.

- 6 potential-free diodes
- 24 VDC
- 1 A current load for each diode

9.26.8.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Other functions |  |
| X20CM6209 | X20 diode array module, 1 A, 40 V reverse voltage, no module status data | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

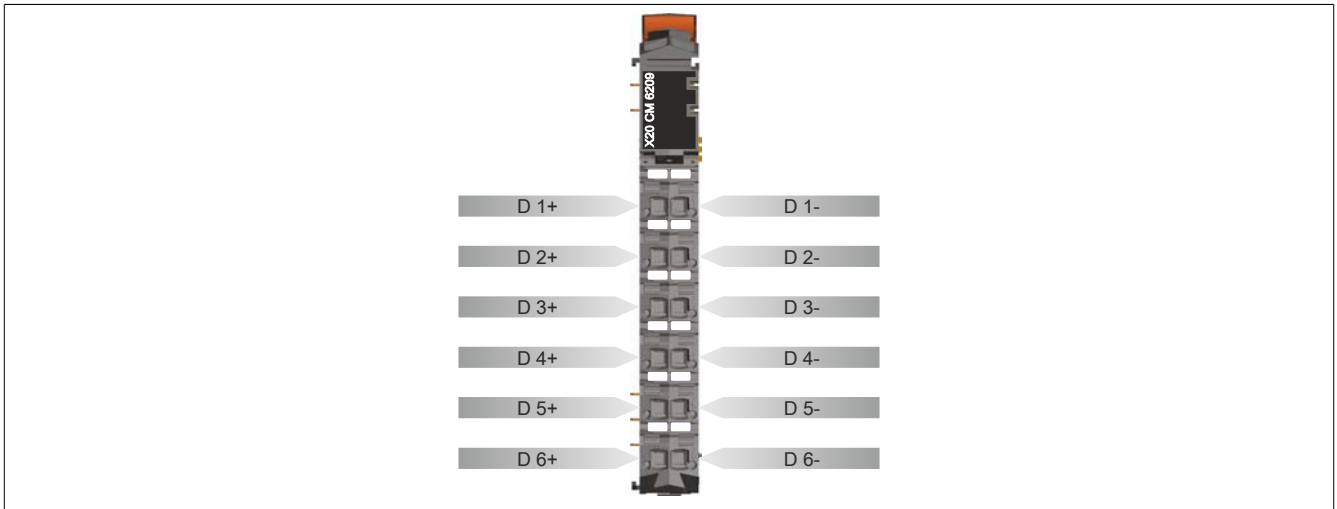
Table 548: X20CM6209 - Order data

9.26.8.3 Technical data

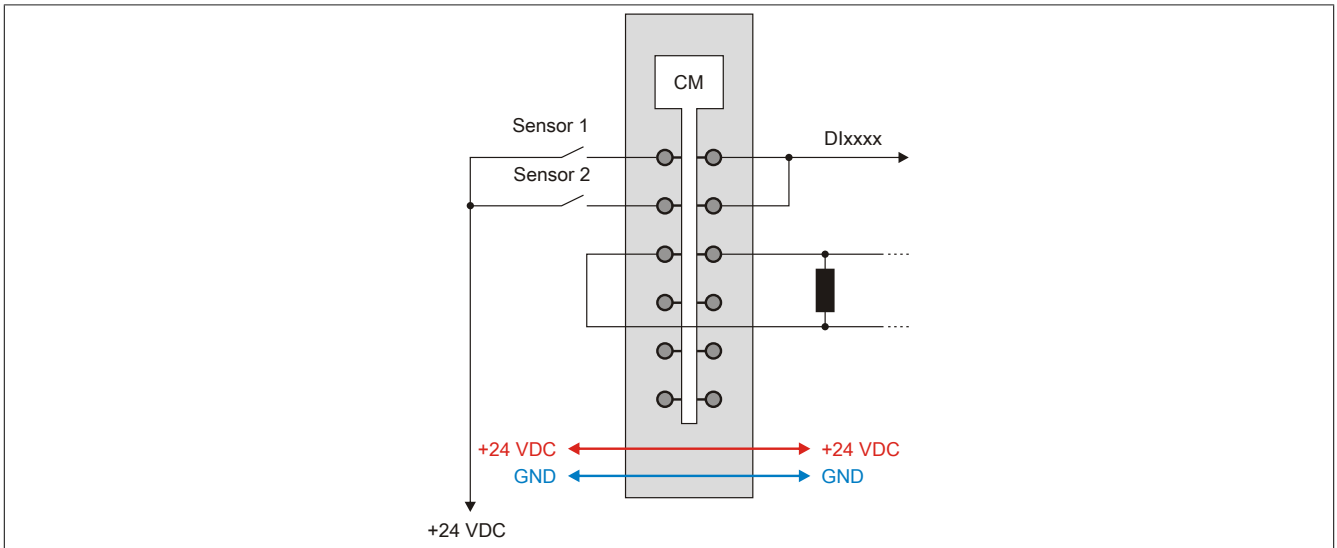
| | |
|--|---|
| Model number | X20CM6209 |
| Short description | |
| I/O module | 6 diodes, 24 VDC |
| General information | |
| B&R ID code | 0xA7A1 |
| Power consumption | |
| Bus | - |
| Internal I/O | - |
| External I/O | 2.5 W |
| Certifications | |
| CE | Yes |
| KC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| Diode array | |
| Nominal voltage | 24 VDC |
| Nominal input current | 1 A |
| Input voltage | 24 VDC -15 % / +20 % |
| Summation current | 6 A, see section "Derating" |
| Short-circuit proof | No |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | 0 to 55°C |
| Vertical mounting orientation | 0 to 50°C |
| Derating | See section "Derating" |
| Storage | -25 to 70°C |
| Transport | -25 to 70°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately, Order 1x X20BM11 bus module or 1x X20BM01 supply bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 549: X20CM6209 - Technical data

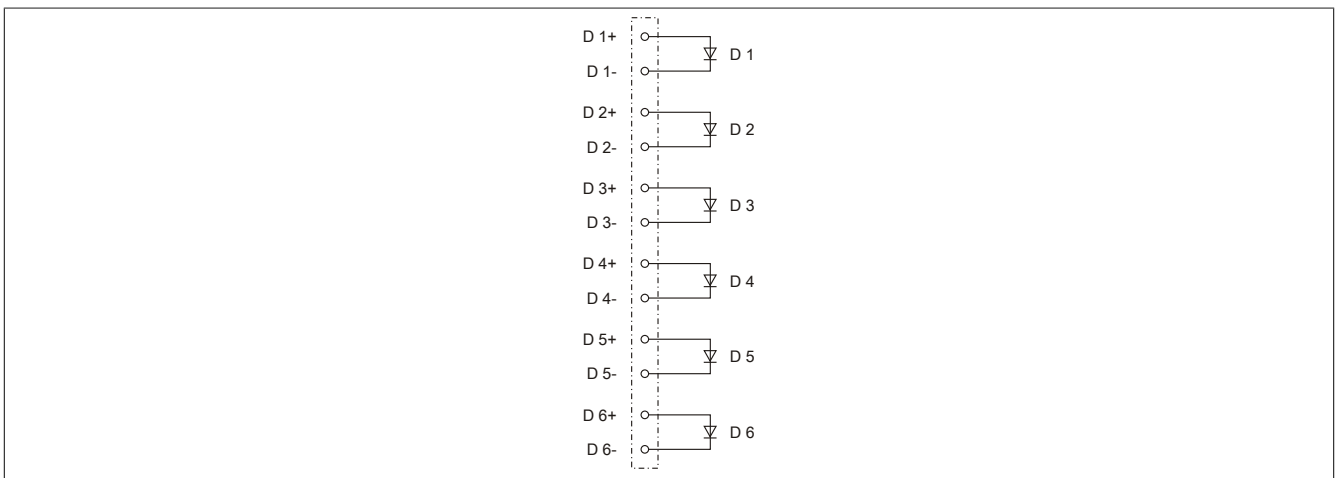
9.26.8.4 Pinout



9.26.8.5 Connection example

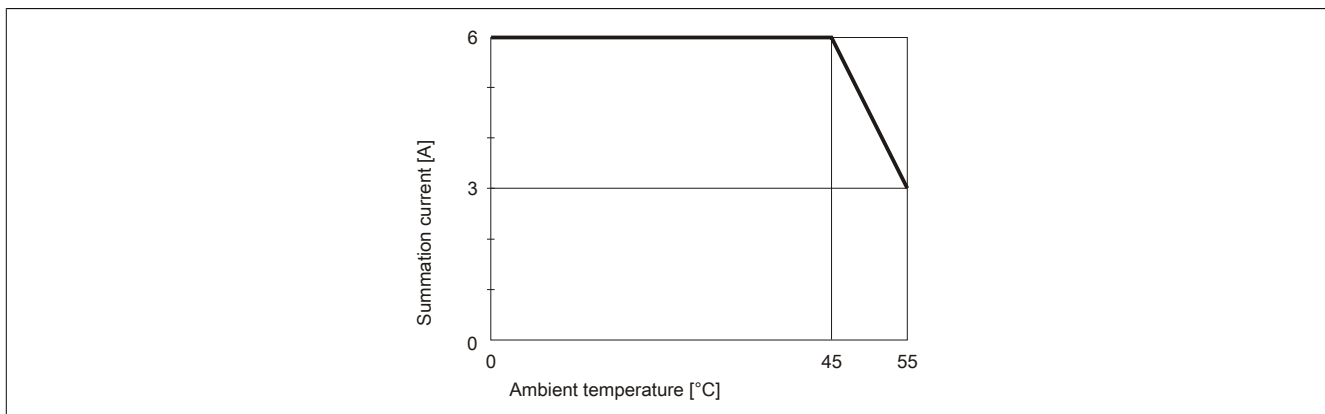


9.26.8.6 Input circuit diagram



9.26.8.7 Derating

The following diagram illustrates the permitted summation current depending on the ambient temperature.



9.26.9 X20CM8281

Data sheet version: 3.15

9.26.9.1 General information

The module is a universal mixed module. On this module, digital I/O and analog I/O are combined. A current or voltage signal can be used for the analog I/O as desired. Counter functions on two of the digital inputs expand the range of use.

- Digital and analog channels
- Selectable current and voltage for AI and AO
- Counter functions

9.26.9.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Other functions |  |
| X20CM8281 | X20 universal mixed module, 4 digital inputs, 24 VDC, sink, 1-wire connections, 2 digital outputs, 0.5 A, source, 1-wire connections, 1 analog input, ± 10 V or 0 to 20 mA / 4 to 20 mA, 12-bit converter resolution, 1 analog output, ± 10 V / 0 to 20 mA, 12-bit converter resolution, 2 counters as event counters or gate measurement | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 550: X20CM8281 - Order data

9.26.9.3 Technical data

| Model number | X20CM8281 |
|--|--|
| Short description | |
| I/O module | 4 digital inputs, 2 digital outputs, 1 analog input, 1 analog output, special functions |
| General information | |
| B&R ID code | 0x24C3 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Analog inputs | Yes, using status LED and software |
| Digital outputs | Yes, using status LED and software (output error status) |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.75 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Digital inputs | |
| Quantity | 4 |
| Nominal voltage | 24 VDC |
| Input characteristics per EN 61131-2 | Type 1 |
| Input voltage | 24 VDC -15 % / +20 % |
| Input current at 24 VDC | Typ. 3.3 mA |
| Input circuit | Sink |
| Input filter | |
| Hardware | ≤2 μs |
| Software | Default 1 ms, configurable between 0 and 25 ms in 0.2 ms intervals |
| Connection type | 1-wire connections |
| Input resistance | Typ. 7.18 kΩ |
| Additional functions | 20 kHz event counting, gate measurement |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Event counters | |
| Quantity | 2 |
| Signal form | Square wave pulse |
| Evaluation | Each falling edge, cyclic counter |
| Input frequency | Max. 20 kHz |
| Counter 1 | Input 1 |
| Counter 2 | Input 3 |
| Counter frequency | Max. 20 kHz |
| Counter size | 16-bit |
| Gate measurement | |
| Quantity | 1 |
| Signal form | Square wave pulse |
| Evaluation | Rising edge - falling edge |
| Counter frequency | |
| Internal | 48 MHz, 24 MHz, 12 MHz, 6 MHz, 3 MHz, 1.5 MHz, 750 kHz, 375 kHz, 187.5 kHz |
| Counter size | 16-bit |
| Length of pause between pulses | ≥100 μs |
| Pulse length | ≥20 μs |
| Supported inputs | Input 4 |
| Analog inputs | |
| Quantity | 1 |
| Input | ±10 V or 0 to 20 mA / 4 to 20 mA, via different terminal connections |

Table 551: X20CM8281 - Technical data

| Model number | X20CM8281 |
|---|--|
| Input type | Single ended |
| Digital converter resolution | |
| Voltage | ±12-bit |
| Current | 12-bit |
| Conversion time | 400 µs, conversion runs asynchronously to the X2X Link cycle |
| Output format | INT |
| Output format | |
| Voltage | INT 0x8001 - 0x7FFF / 1 LSB = 0x0008 = 2.441 mV |
| Current | INT 0x0000 - 0x7FFF / 1 LSB = 0x0008 = 4.883 µA |
| Input impedance in signal range | |
| Voltage | >1 MΩ |
| Current | - |
| Load | |
| Voltage | - |
| Current | <300 Ω |
| Input protection | Protection against wiring with supply voltage |
| Permissible input signal | |
| Voltage | Max. ±15 V |
| Current | Max. ±50 mA |
| Output of digital value during overload | |
| Undershoot | |
| Voltage | 0x8001 |
| Current | 0x0000 |
| Overshoot | |
| Voltage | 0x7FFF |
| Current | 0x7FFF |
| Conversion procedure | Successive approximation |
| Input filter | 2nd-order low pass / cutoff frequency 1 kHz |
| Max. error at 25°C | |
| Voltage | |
| Gain | 0.08% ¹⁾ |
| Offset | 0.02% ²⁾ |
| Current | |
| Gain | 0 to 20 mA = 0.08 % / 4 to 20 mA = 0.1 % ¹⁾ |
| Offset | 0 to 20 mA = 0.03 % / 4 to 20 mA = 0.16 % ³⁾ |
| Max. gain drift | |
| Voltage | 0.01 %/°C ¹⁾ |
| Current | 0 to 20 mA = 0.009 %/°C 4 to 20 mA = 0.0113 %/°C ¹⁾ |
| Max. offset drift | |
| Voltage | 0.002 %/°C ²⁾ |
| Current | 0 to 20 mA = 0.004 %/°C 4 to 20 mA = 0.005 %/°C ³⁾ |
| Nonlinearity | |
| Voltage | <0.02% ²⁾ |
| Current | <0.02% ³⁾ |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Digital outputs | |
| Quantity | 2 |
| Variant | FET positive switching |
| Nominal voltage | 24 VDC |
| Switching voltage | 24 VDC -15 % / +20 % |
| Nominal output current | 0.5 A |
| Total nominal current | 1 A |
| Connection type | 1-wire connections |
| Output circuit | Source |
| Output protection | Thermal cutoff for overcurrent and short circuit, integrated protection for switching inductances, reverse polarity protection |
| Diagnostic status | Output monitoring with 10 ms delay |
| Leakage current when switched off | 5 µA |
| R _{DS(on)} | 105 mΩ |
| Peak short-circuit current | <14 A |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms (depends on the module temperature) |
| Switching delay | |
| 0 → 1 | <250 µs |
| 1 → 0 | <270 µs |
| Switching frequency | |
| Resistive load | Max. 100 Hz |
| Inductive load | See section "Switching inductive loads" |
| Braking voltage when switching off inductive loads | Typ. 50 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |

Table 551: X20CM8281 - Technical data


| Model number | X20CM8281 |
|--|--|
| Analog outputs | |
| Quantity | 1 |
| Output | ±10 V or 0 to 20 mA, via different terminal connections |
| Digital converter resolution | 12-bit |
| Conversion time | 300 µs, conversion runs asynchronously to the X2X Link cycle |
| Settling time for output changes over entire range | 1 ms |
| Switch on/off behavior | Internal enable relay for booting and errors |
| Max. error at 25°C | |
| Voltage | |
| Gain | 0.04% ⁴⁾ |
| Offset | 0.0225% ⁵⁾ |
| Current | |
| Gain | 0.05% ⁴⁾ |
| Offset | 0.125% ⁵⁾ |
| Output protection | Short circuit protection |
| Output format | |
| Voltage | INT 0x8001 - 0x7FFF / 1 LSB = 0x0010 = 4.882 mV |
| Current | INT 0x0000 - 0x7FFF / 1 LSB = 0x0010 = 9.766 µA |
| Load per channel | |
| Voltage | Max. ±10 mA, load ≥ 1 kΩ |
| Current | Max. load is 400 Ω |
| Max. gain drift | |
| Voltage | 0.012 %/°C ⁴⁾ |
| Current | 0.014 %/°C ⁴⁾ |
| Max. offset drift | |
| Voltage | 0.0075 %/°C ⁵⁾ |
| Current | 0.03 %/°C ⁵⁾ |
| Error caused by load change | |
| Voltage | Max. 0.02%, from 10 MΩ → 1 kΩ, resistive |
| Current | Max. 0.5%, from 1 Ω → 400 Ω, resistive |
| Nonlinearity | <0.1% ⁶⁾ |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating" |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 551: X20CM8281 - Technical data

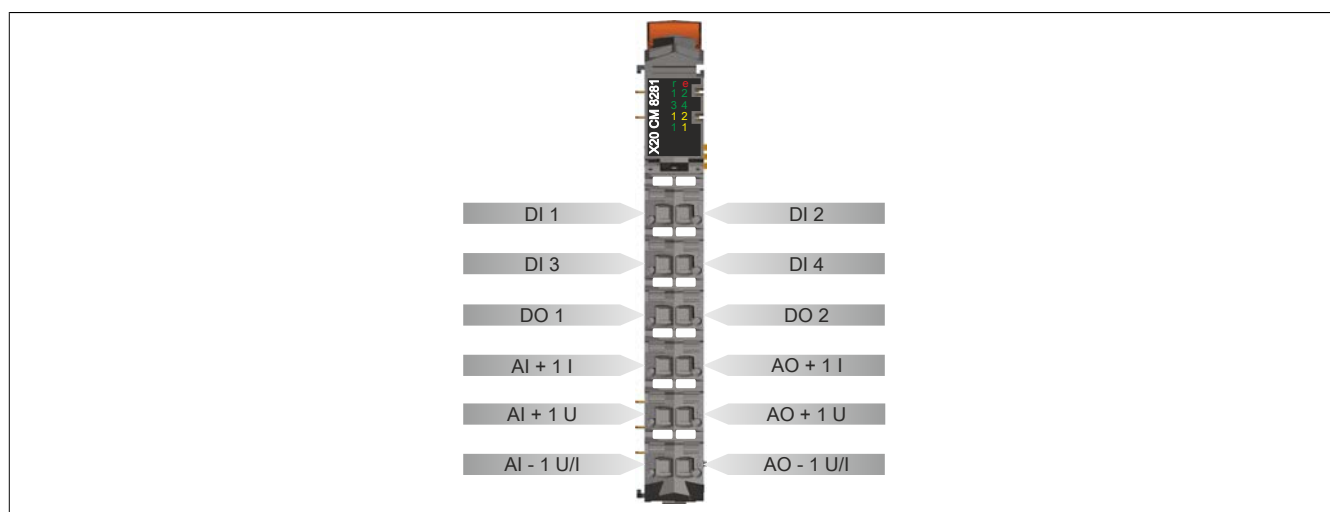
- 1) Based on the current measured value.
- 2) Based on the 20 V measurement range.
- 3) Based on the 20 mA measurement range.
- 4) Based on the current output value.
- 5) Based on the entire output range.
- 6) Based on the output range.

9.26.9.4 LED status indicators

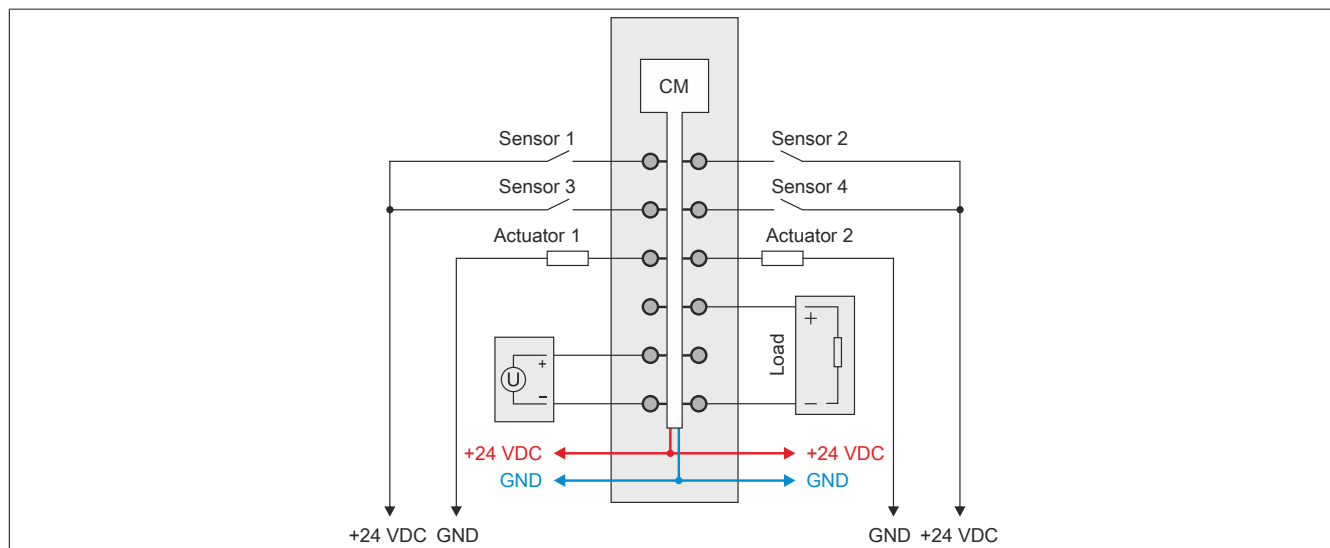
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|-----------------------------|--------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. |
| | e + r | Red on / Green single flash | | Invalid firmware |
| | 1 - 4 | Green | | Input state of the corresponding digital input |
| | 1 - 2 | Orange | | Output status of the corresponding digital output |
| | 1 | Green | Off | Open line or sensor is disconnected |
| | | | Blinking | Input signal overflow or underflow |
| | | | On | Analog/digital converter running, value OK |
| | 1 | Orange | Off | Value = 0 |
| | | | On | Value ≠ 0 |

9.26.9.5 Pinout

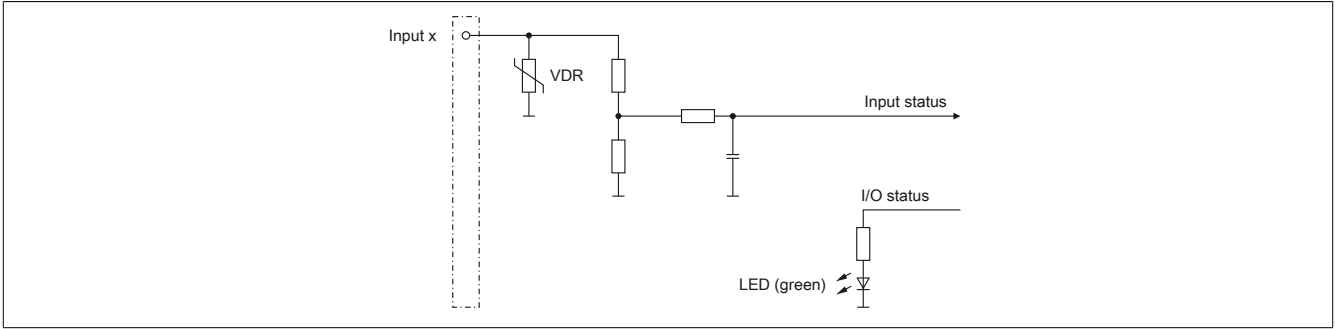


9.26.9.6 Connection example

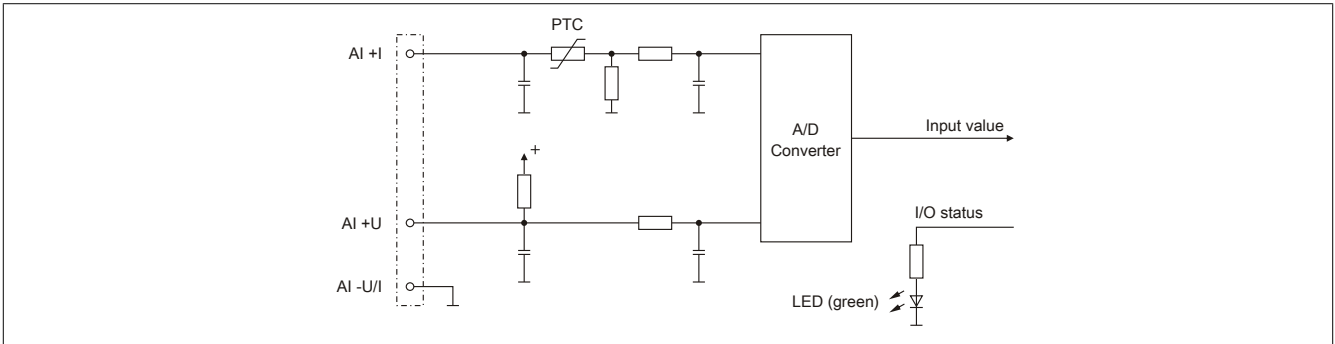


9.26.9.7 Input circuit diagram

Digital inputs

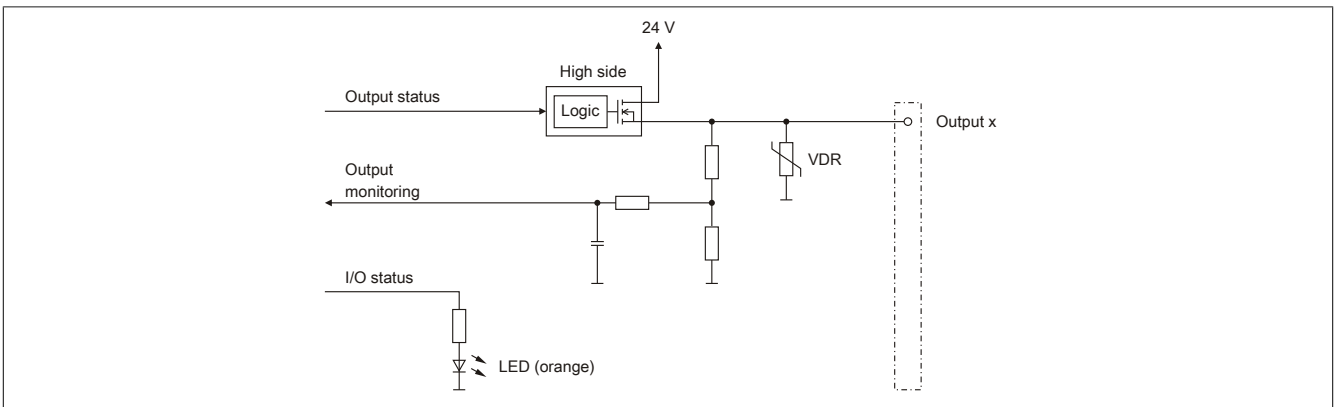


Analog inputs

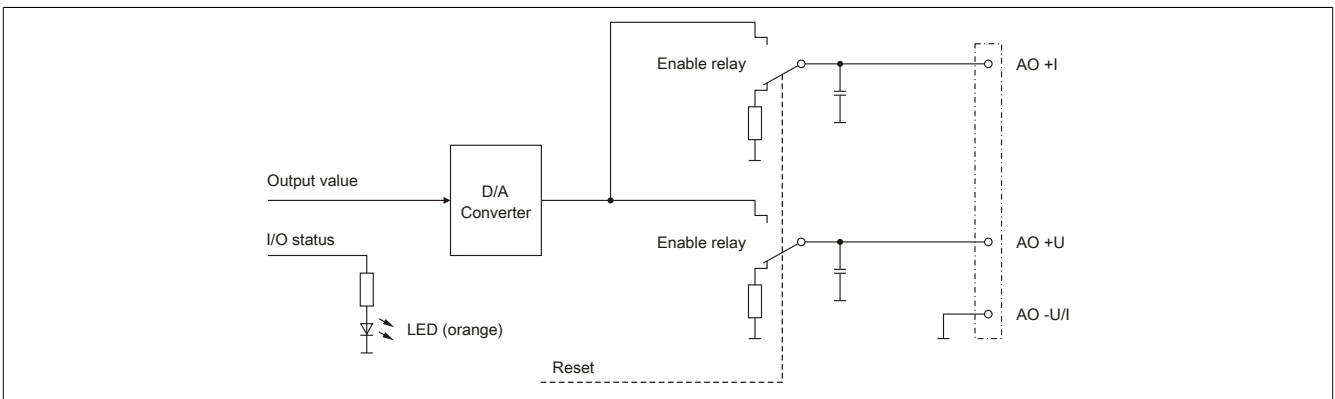


9.26.9.8 Output circuit diagram

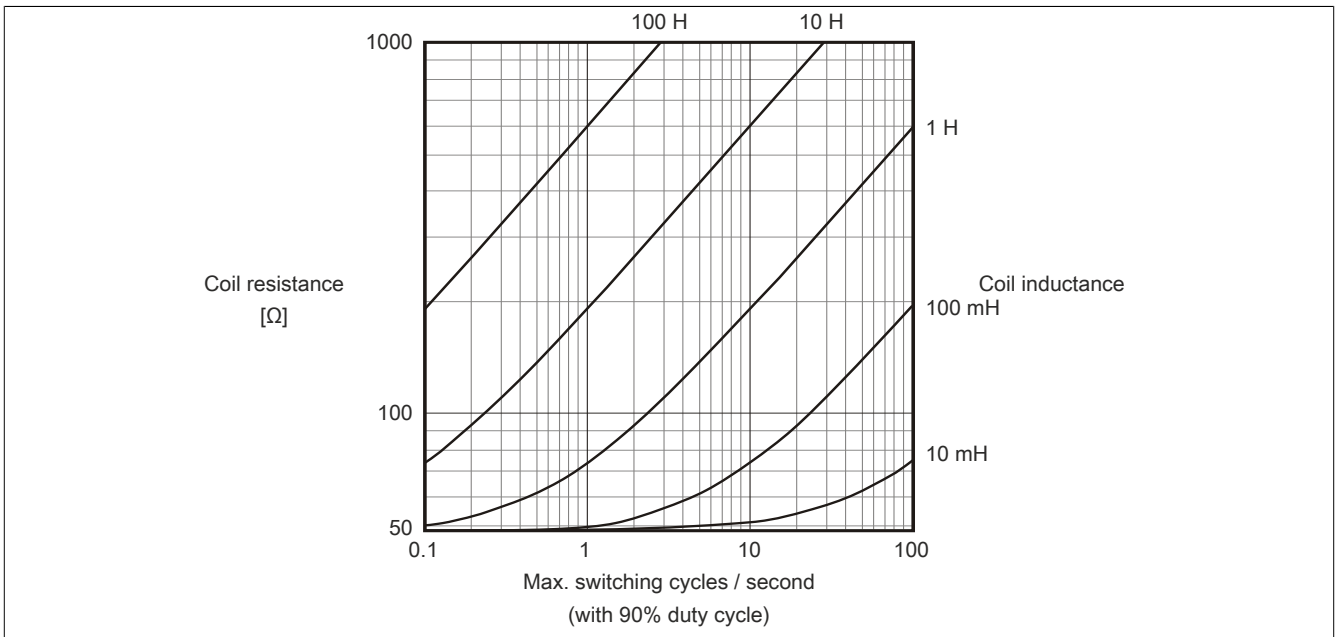
Digital outputs



Analog outputs



9.26.9.9 Switching inductive loads

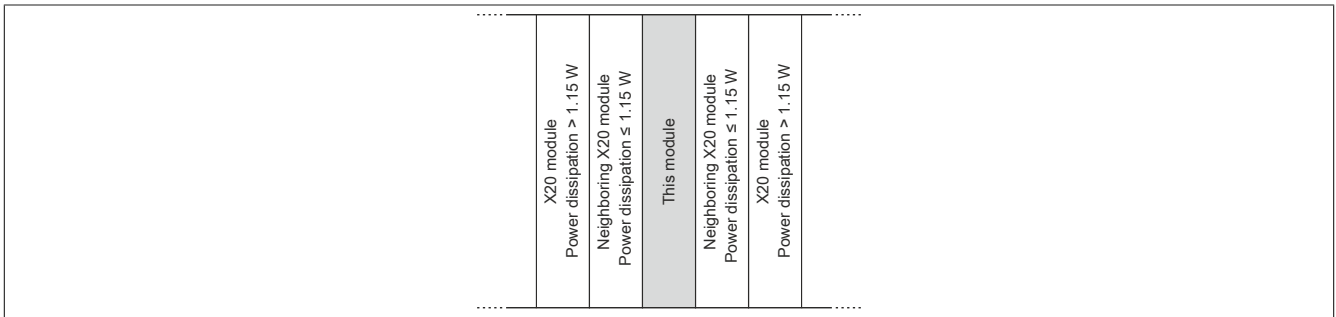


9.26.9.10 Derating

There is no derating when operated below 55°C.

During operation over 55°C, the power dissipation of the modules to the left and right of this module is not permitted to exceed 1.15 W!

For an example of calculating the power dissipation of I/O modules, see section "[Power dissipation calculation of I/O modules](#)" on page 101.



9.26.9.11 Register description

9.26.9.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.26.9.11.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|------------------------|--|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration | | | | | | |
| 12 | ConfigOutput01 (digital input filter) | USINT | | | | • |
| 14 | ConfigOutput02 (counter configuration) | USINT | | | | • |
| 22 | ConfigOutput03 (analog input filter) | USINT | | | | • |
| 24 | ConfigOutput04 (configure analog input/output) | USINT | | | | • |
| 26 | ConfigOutput05 (lower limit value) | INT | | | | • |
| 28 | ConfigOutput06 (upper limit value) | INT | | | | • |
| Communication | | | | | | |
| Digital inputs | | | | | | |
| 0 | Digital inputs | USINT | • | | | |
| | DigitalInput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalInput04 | Bit 3 | | | | |
| 4 | Counter01 | UINT | • | | | |
| 6 | Counter02 | UINT | • | | | |
| 14 | Reset counter | USINT | | | • | |
| | ResetCounter01 | Bit 4 | | | | |
| | ResetCounter02 | Bit 5 | | | | |
| 16 | Input state of digital latch inputs 1 - 4 | DINT | • | | | |
| | DigitalInput01Latch | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalInput04Latch | Bit 3 | | | | |
| 18 | Acknowledge digital inputs | USINT | | | • | |
| | DigitalInput01LatchQuit | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalInput04LatchQuit | Bit 3 | | | | |
| Digital outputs | | | | | | |
| 0 | Status of the digital outputs | USINT | • | | | |
| | StatusDigitalOutput01 | Bit 4 | | | | |
| | StatusDigitalOutput02 | Bit 5 | | | | |
| 2 | Switching state of digital outputs 1 to 2 | USINT | | | • | |
| | DigitalOutput01 | Bit 0 | | | | |
| | DigitalOutput02 | Bit 1 | | | | |
| Analog input | | | | | | |
| 8 | AnalogInput01 | INT | • | | | |
| 31 | StatusInput01 | USINT | • | | | |
| Analog output | | | | | | |
| 10 | AnalogOutput01 | INT | | | • | |

9.26.9.11.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|------------------------|----------------------|--|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration | | | | | | | |
| 12 | - | ConfigOutput01 (digital input filter) | USINT | | | | • |
| 14 | - | ConfigOutput02(counter configuration) | USINT | | | | • |
| 22 | - | ConfigOutput03 (analog input filter) | USINT | | | | • |
| 24 | - | ConfigOutput04 (configure analog input/output) | USINT | | | | • |
| 26 | - | ConfigOutput05 (lower limit value) | INT | | | | • |
| 28 | - | ConfigOutput06 (upper limit value) | INT | | | | • |
| Communication | | | | | | | |
| Digital inputs | | | | | | | |
| 0 | 0 | Digital inputs | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput04 | Bit 3 | | | | |
| 4 | 2 | Counter01 | UINT | • | | | |
| 6 | 4 | Counter02 | UINT | • | | | |
| 14 | - | Reset counter | USINT | | | | • |
| | | ResetCounter01 | Bit 4 | | | | |
| | | ResetCounter02 | Bit 5 | | | | |
| 16 | - | Input state of digital latch inputs 1 - 4 | DINT | | • | | |
| | | DigitalInput01Latch | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput04Latch | Bit 3 | | | | |
| 18 | - | Acknowledge digital inputs | USINT | | | | • |
| | | DigitalInput01LatchQuit | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput04LatchQuit | Bit 3 | | | | |
| Digital outputs | | | | | | | |
| 0 | 0 | Status of the digital outputs | USINT | • | | | |
| | | StatusDigitalOutput01 | Bit 4 | | | | |
| | | StatusDigitalOutput02 | Bit 5 | | | | |
| 2 | 0 | Switching state of digital outputs 1 to 2 | USINT | | | • | |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | DigitalOutput02 | Bit 1 | | | | |
| Analog input | | | | | | | |
| 8 | 6 | AnalogInput01 | INT | • | | | |
| 31 | - | StatusInput01 | USINT | | • | | |
| Analog output | | | | | | | |
| 10 | 2 | AnalogOutput01 | INT | | | • | |

1) The offset specifies the position of the register within the CAN object.

9.26.9.11.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.26.9.11.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.26.9.11.4 Digital inputs

Unfiltered

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

Filtered

The filtered status is collected with a fixed offset to the network cycle and transferred in the same cycle. Filtering takes place asynchronously to the network in multiples of 200 μ s with a network-related jitter of up to 50 μ s.

9.26.9.11.4.1 Digital inputs and status of the digital outputs

Name:

DigitalInput01 to DigitalInput04

StatusDigitalOutput01 to StatusDigitalOutput02

This register is used to indicate the input state of the digital inputs and the status of the digital outputs.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|-----------------------|--------|---|
| 0 | DigitalInput01 | 0 or 1 | Input state - Digital input 1 |
| ... | | ... | |
| 3 | DigitalInput04 | 0 or 1 | Input state - Digital input 1 |
| 4 | StatusDigitalOutput01 | 0 | Digital output channel 1: No error |
| | | 1 | Digital output channel 1: Short circuit or overload |
| 5 | StatusDigitalOutput02 | 0 | Digital output channel 2: No error |
| | | 1 | Digital output channel 2: Short circuit or overload |
| 6 - 7 | Reserved | - | |

9.26.9.11.4.2 Digital input filter

Name:

ConfigOutput01

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 μ s. It makes sense to enter values in steps of 2, however, since the input signals are sampled every 200 μ s.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No software filter (bus controller default setting) |
| | 2 | 0.2 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

9.26.9.11.4.3 Event or gate counter

Event counter operation

The rising (positive) edges are registered on the counter input.

The counter status is collected with a fixed offset to the network cycle and transferred in the same cycle.

Gate measurement

The time of rising to falling edges for the gate input is registered using an internal frequency. The result is checked for overflow (0xFFFF) and corrected with the adjustable prescaler.

The recovery time between measurements must be >100 μ s.

The measurement result is transferred with the falling edge to the result memory.

Event or gate counter

Name:

Counter01 to Counter02

Counter01 is intended for event counter operation.

Event counter operation or gate measurement can be selected for Counter02:

| Data type | Value |
|-----------|---------------|
| UINT | Counter value |

Counter configuration

Name:

ConfigOutput02

This register can be used to configure and reset the individual counters.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Name | Value | Information |
|-------|---|-------|--|
| 0 - 3 | Counter02 (counter frequency, only with gate measurement) | 0 | 48 MHz (bus controller default setting) |
| | | 1 | 3 MHz |
| | | 2 | 187.5 kHz |
| | | 3 | 24 MHz |
| | | 4 | 12 MHz |
| | | 5 | 6 MHz |
| | | 6 | 1.5 MHz |
| | | 7 | 750 kHz |
| | | 8 | 375 kHz |
| 4 | ResetCounter01 | 0 | No influence on the counter |
| | | 1 | Clear counter (at positive edge) |
| 5 | ResetCounter02 | 0 | No influence on the counter |
| | | 1 | Clear counter (at positive edge) |
| 6 - 7 | Counter02 (operating mode) | 0 | Event counter measurement (bus controller default setting) |
| | | 1 | Gate measurement |

This register also includes configuration data in addition to the cyclic data. If the register is used cyclically and in the init script, then the preset configuration only remains available when operated directly on the CPU. On the bus controller, the configuration is always overwritten with 0.

However, starting with upgrade version 1.0.2.1, the cyclic bit can be hidden in order to prevent the configuration from being overwritten.

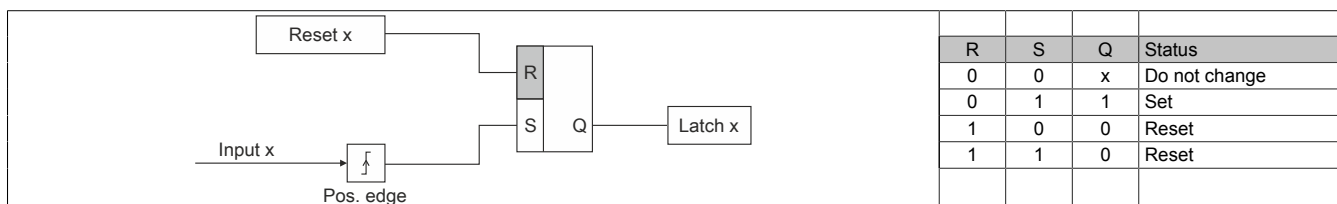
Information:

If the counter should be cleared, this must be done using a non-cyclic write command. When doing so, the configuration bit must be transferred together with the reset counter bit!

9.26.9.11.4.4 Rising edge input latch

Using this function, the rising edges of the input signal can be latched with a resolution of 200 μ s. With the "Acknowledge - input latch" function, the input latch is either reset or prevented from latching.

It works in the same way as a dominant reset RS flip-flop.



Input state of digital latch inputs 1 - 4

Name:

DigitalInputLatch01 to DigitalInputLatch04

This register is used to indicate input state of digital inputs 1 to 4 after expiration of the input filter time.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---------------------|--------|---|
| 0 | DigitalInputLatch01 | 0 or 1 | Input state of digital input 1 after expiration of the delay time |
| ... | | ... | |
| 3 | DigitalInputLatch04 | 0 or 1 | Input state of digital input 4 after expiration of the delay time |
| 4 - 7 | Reserved | - | |

Acknowledge digital inputs

Name:

DigitalInput01LatchQuitt to DigitalInput04LatchQuitt

This register is used to reset the input latches channel by channel.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|--------------------------|-------|----------------------------------|
| 0 | DigitalInput01LatchQuitt | 0 | No influence on the latch status |
| | | 1 | Resets the latch status |
| ... | | ... | |
| 3 | DigitalInput04LatchQuitt | 0 | No influence on the latch status |
| | | 1 | Resets the latch status |
| 4 - 7 | Reserved | - | |

9.26.9.11.5 Digital outputsThe output state is transferred to the output channels with a fixed offset (<60 μ s) based on the network cycle (SyncOut).**9.26.9.11.5.1 Switching state of digital outputs 1 to 2**

Name:

DigitalOutput01 to DigitalOutput02

This register is used to store the switching state of digital outputs 1 to 2.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 01 reset |
| | | 1 | Digital output 01 set |
| 1 | DigitalOutput02 | 0 | Digital output 02 reset |
| | | 1 | Digital output 02 set |

9.26.9.11.5.2 Digital inputs and status of the digital outputs

Name:

DigitalInput01 to DigitalInput04

StatusDigitalOutput01 to StatusDigitalOutput02

This register is used to indicate the input state of the digital inputs and the status of the digital outputs.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|-----------------------|--------|---|
| 0 | DigitalInput01 | 0 or 1 | Input state - Digital input 1 |
| ... | | ... | |
| 3 | DigitalInput04 | 0 or 1 | Input state - Digital input 1 |
| 4 | StatusDigitalOutput01 | 0 | Digital output channel 1: No error |
| | | 1 | Digital output channel 1: Short circuit or overload |
| 5 | StatusDigitalOutput02 | 0 | Digital output channel 2: No error |
| | | 1 | Digital output channel 2: Short circuit or overload |
| 6 - 7 | Reserved | - | |

9.26.9.11.6 Analog inputs

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

9.26.9.11.6.1 Analog input register

Name:

AnalogInput01

This register is used to indicate the analog input value depending on the configured operating mode.

| Data type | Value | Input signal: |
|-----------|-----------------|------------------------------|
| INT | -32768 to 32767 | Voltage signal -10 to 10 VDC |
| | 0 to 32767 | Current signal 0 to 20 mA |
| | 0 to 32767 | Current signal 4 mA to 20 mA |

9.26.9.11.6.2 Input filter

This module is equipped with a configurable input filter. The minimum cycle time must be $>400\ \mu\text{s}$. Filtering is disabled for shorter cycle times.

If the input filter is active, then the channels are scanned in 1 ms cycles. Conversion is performed acyclically to the X2X cycle.

Information:

The filter sampling time is fixed at 1 ms and is acyclic to the X2X cycle.

Input ramp limiting

Input ramp limiting can only be performed in conjunction with filtering. Input ramp limiting is performed before filtering.

The difference of the input value change is checked for exceeding the specified limit. In the event of overshoot, the tracked input value is equal to the old value \pm the limit value.

Configurable limit values:

| Value | Limit value |
|-------|---|
| 0 | The input value is used without limitation. |
| 1 | 0x3FFF = 16383 |
| 2 | 0x1FFF = 8191 |
| 3 | 0x0FFF = 4095 |
| 4 | 0x07FF = 2047 |
| 5 | 0x03FF = 1023 |
| 6 | 0x01FF = 511 |
| 7 | 0x00FF = 255 |

Input ramp limiting is well suited for suppressing disturbances (spikes). The following examples show the functionality of input ramp limiting based on an input step and a disturbance.

Example 1

The input value jumps from 8000 to 17000. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = 0x07FF = 2047

Filter level = 2

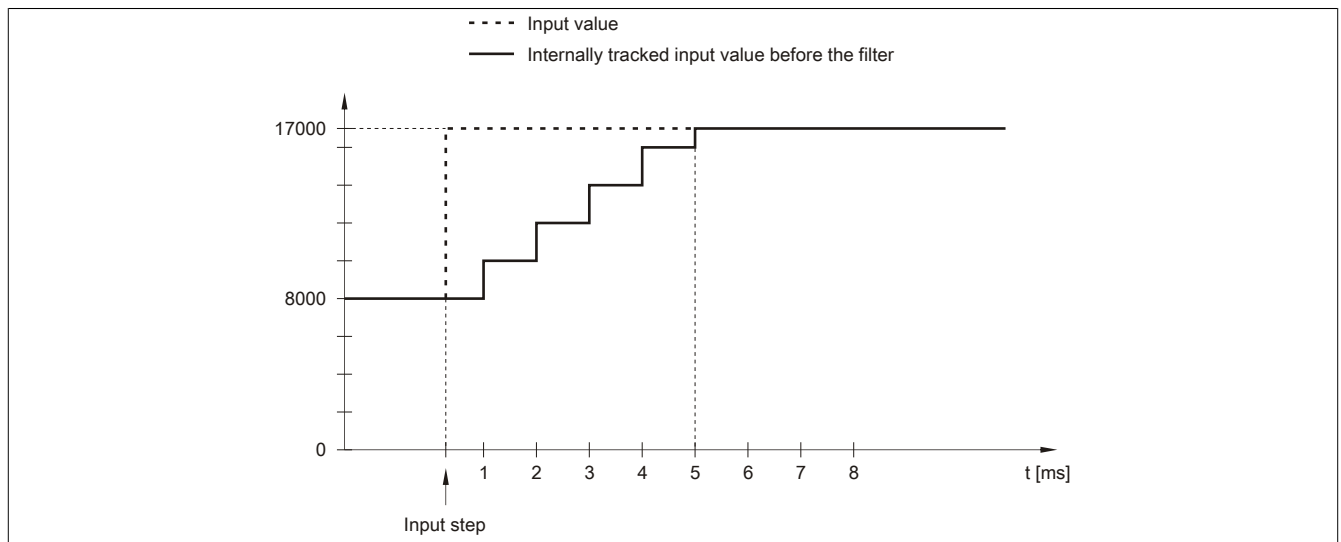


Figure 270: Tracked input value for input step

Example 2

A disturbance interferes with the input value. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = 0x07FF = 2047

Filter level = 2

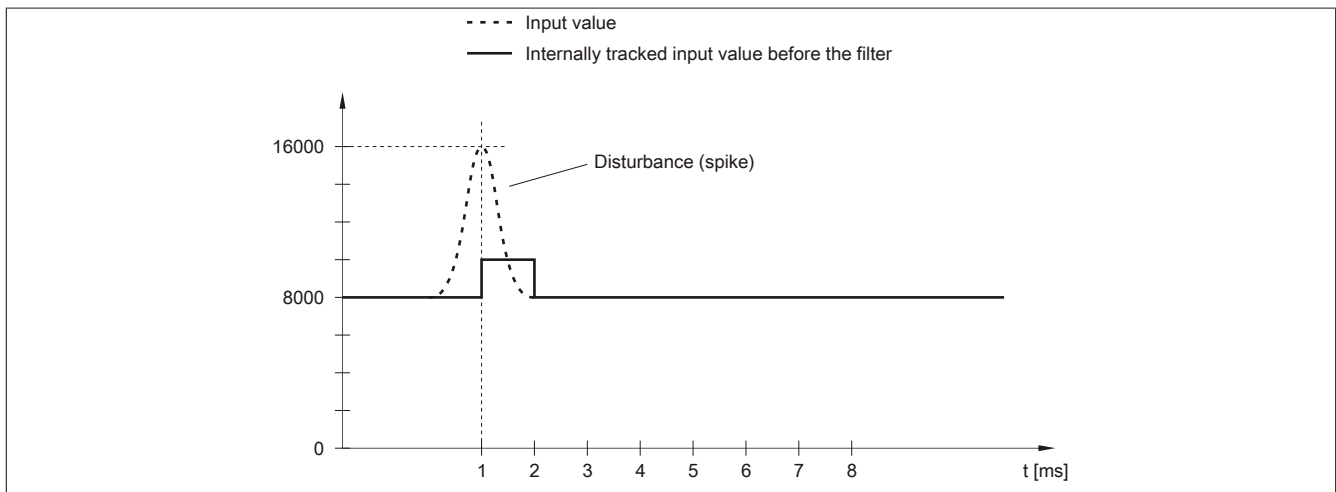


Figure 271: Tracked input value for disturbance

Filter level

A filter can be defined to prevent large input steps. This filter is used to bring the input value closer to the actual analog value over a period of several milliseconds.

Filtering takes place after any input ramp limiting has been carried out.

Formula for calculating the input value:

$$\text{Value}_{\text{New}} = \text{Value}_{\text{Old}} - \frac{\text{Value}_{\text{Old}}}{\text{Filter level}} + \frac{\text{Input value}}{\text{Filter level}}$$

Adjustable filter levels:

| Value | Filter level |
|-------|---------------------|
| 0 | Filter switched off |
| 1 | Filter level 2 |
| 2 | Filter level 4 |
| 3 | Filter level 8 |
| 4 | Filter level 16 |
| 5 | Filter level 32 |
| 6 | Filter level 64 |
| 7 | Filter level 128 |

The following examples show the functionality of the filter based on an input step and a disturbance.

Example 1

The input value jumps from 8000 to 16000. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

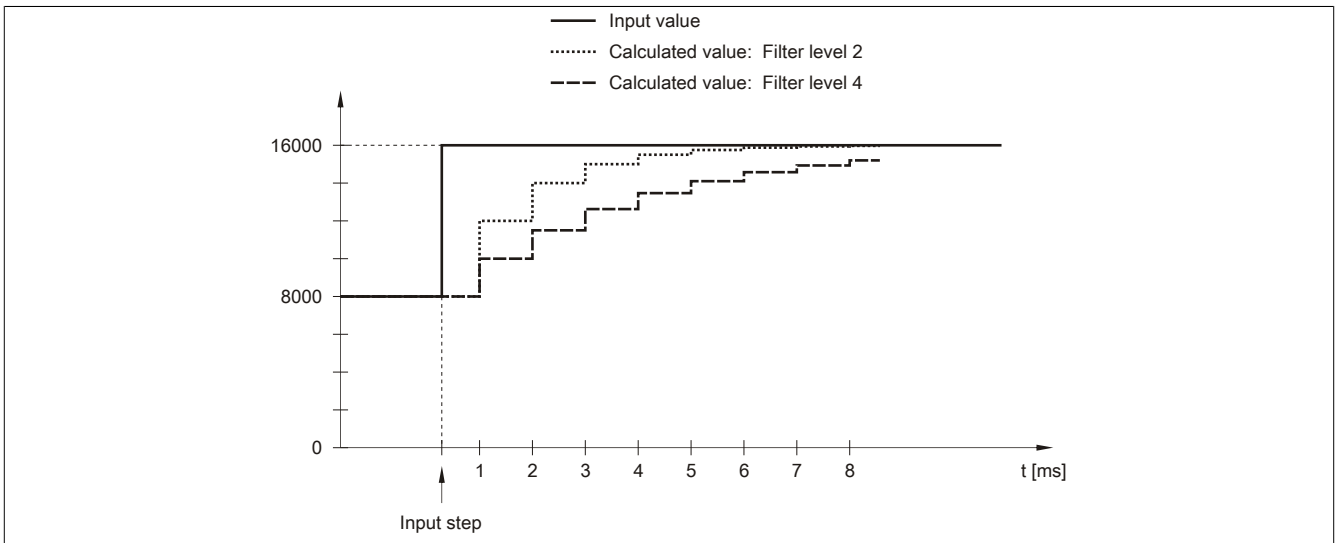


Figure 272: Calculated value during input step

Example 2

A disturbance interferes with the input value. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

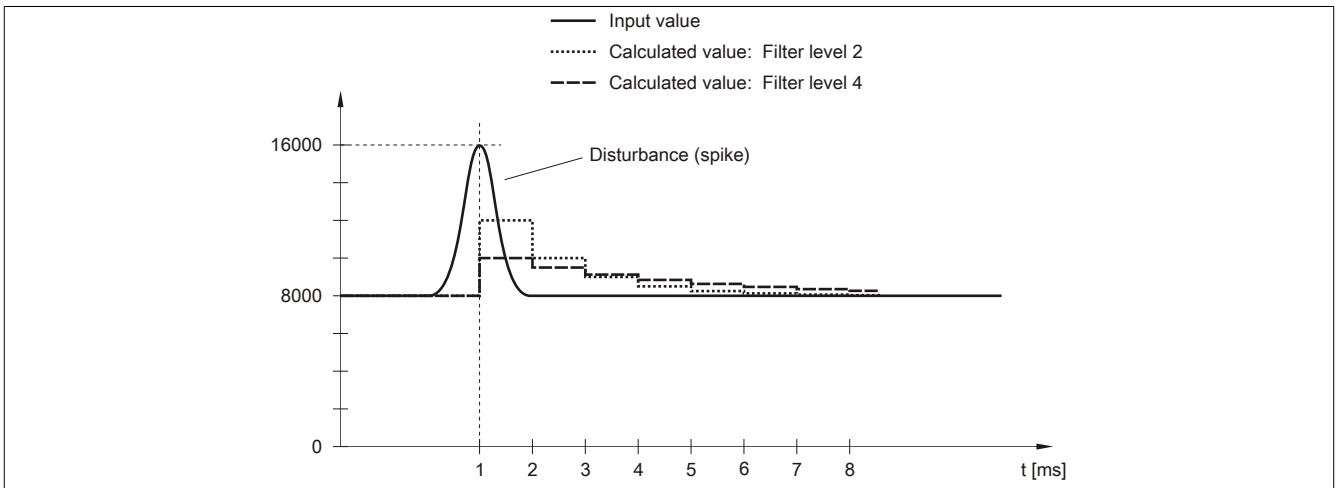


Figure 273: Calculated value during disturbance

9.26.9.11.6.3 Configuring the input filter

Name:

ConfigOutput03

This register is used to define the filter level and input ramp limitation of the input filter.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------------|-------|--|
| 0 - 2 | Defines the filter level | 000 | Filter disabled (bus controller default setting) |
| | | 001 | Filter level 2 |
| | | 010 | Filter level 4 |
| | | 011 | Filter level 8 |
| | | 100 | Filter level 16 |
| | | 101 | Filter level 32 |
| | | 110 | Filter level 64 |
| | | 111 | Filter level 128 |
| 3 | Reserved | 0 | |
| 4 - 6 | Defines input ramp limiting | 000 | The input value is applied without limitation (bus controller default setting) |
| | | 001 | Limit value = 0x3FFF (16383) |
| | | 010 | Limit value = 0x1FFF (8191) |
| | | 011 | Limit value = 0x0FFF (4095) |
| | | 100 | Limit value = 0x07FF (2047) |
| | | 101 | Limit value = 0x03FF (1023) |
| | | 110 | Limit value = 0x01FF (511) |
| | | 111 | Limit value = 0x00FF (255) |
| 7 | Reserved | 0 | |

9.26.9.11.6.4 Lower limit for the analog value

Name:

ConfigOutput05

This register can be used to configure the lower limit for analog values. If the analog value goes below the limit value, it is frozen at this value and the corresponding error status bit is set.

| Data type | Values | Information |
|-----------|-----------------|--|
| INT | -32768 to 32767 | Bus controller default setting: -32768 |

Information:

- The default value of -32768 corresponds to the minimum default value of -10 VDC.
- For current measurements, this value should be set to 0.
- When configured as 4 to 20 mA, this value can be set to -8192 (corresponds to 0 mA) in order to display values <4 mA.

9.26.9.11.6.5 Upper limit for the analog value

Name:

ConfigOutput06

This register can be used to configure the upper limit for analog values. If the analog value goes above the limit value, it is frozen at this value and the corresponding error status bit is set.

| Data type | Values | Information |
|-----------|-----------------|---------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 32767 |

Information:

- The default value of 32767 corresponds to the maximum default value of 20 mA or +10 VDC.

9.26.9.11.6.6 Status of the analog input

Name:
StatusInput01

This register is used to monitor the analog input on the module. A change in the monitoring status generates an error message.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|----------------------------|
| 0 - 1 | Channel 1 | 00 | No error |
| | | 01 | Lower limit value exceeded |
| | | 10 | Upper limit value exceeded |
| | | 11 | Open line ¹⁾ |
| 2 - 7 | Reserved | 0 | |

1) Open-circuit detection does not occur during current signal measurement.

9.26.9.11.7 Analog output

The channel can be configured for either current or voltage signals. The type of signal is also determined by the terminals used.

9.26.9.11.7.1 Analog output register

Name:
AnalogOutput01

This register is used to output the analog output value appears depending on the operating mode that is set.

| Data type | Value | Information |
|-----------|-----------------|------------------------------|
| INT | -32768 to 32767 | Voltage signal -10 to 10 VDC |
| | 0 to 32767 | Current signal 0 to 20 mA |

9.26.9.11.8 Configuration of the analog inputs and outputs

Name:
ConfigOutput04

This register can be used to define the type and range of signal measurement.

Each channel is capable of handling either current or voltage signals. The type of signal is determined by the terminal connections used. Since current and voltage require different adjustment values, it is also necessary to configure the desired type of output signal.

Input signal:

- ± 10 V voltage signal
- 0 to 20 mA current signal
- 4 to 20 mA current signal

Output signal:

- ± 10 V voltage signal
- 0 to 20 mA current signal

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|--|
| 0 - 1 | Analog input | 00 | Voltage signal -10 VDC to +10 VDC (bus controller default setting) |
| | | 01 | Current signal 0 mA to 20 mA |
| | | 11 | Current signal 4 mA to 20 mA |
| 2 - 3 | Reserved | 0 | |
| 4 | Analog output | 0 | Voltage signal -10 VDC to +10 VDC (bus controller default setting) |
| | | 1 | Current signal 0 mA to 20 mA |
| 5 - 7 | Reserved | 0 | |

9.26.9.11.9 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|--------|
| Without filtering | 100 µs |
| With filtering | 150 µs |

9.26.9.11.10 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|---------------------------|---------|
| Digital without filtering | 150 µs |
| Digital with filtering | 200 µs |
| Analog without filtering | 400 µs |
| Analog with filtering | 1000 µs |

9.26.10 X20CM8323

Data sheet version: 3.15

9.26.10.1 General information

The module has digital outputs for switching electromechanical loads (e.g. valves, relays) and additional functions.

- 8 digital outputs
- Current trace
- Switching time detection
- Pulse width modulation

9.26.10.2 Order data


| Model number | Short description | Figure |
|--------------|--|--|
| | Other functions |  |
| X20CM8323 | X20 PWM module, 8 digital outputs for switching electro-mechanical loads, 0.6 A continuous current, 2 A peak current, current monitoring, switching time detection | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 552: X20CM8323 - Order data

9.26.10.3 Technical data

| Model number | X20CM8323 |
|--|---|
| Short description | |
| I/O module | 8 digital outputs for switching electromechanical loads, current monitoring, switching time detection, pulse width modulation |
| General information | |
| B&R ID code | 0x1D43 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Outputs | Yes, using status LED and software (output error status) |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1 W (Rev. ≥ G0), 1.5 W (Rev. < G0) |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| Digital outputs | |
| Nominal voltage | 24 VDC |
| Nominal output current | 0.6 A |
| Total nominal current | 4.8 A |
| Connection type | 1-wire connections |
| Output circuit | Sink |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs, integrated protection for switching inductances |
| Pulse width modulation | |
| Period duration | 1 ms (1 kHz) or 20 μs (50 kHz) |
| Pulse duration | 0 to 100 % |
| Resolution for pulse duration | 1% |
| Inrush current | Max. 2 A for max. 25.5 ms |
| Braking voltage when switching off inductive loads | 39 VDC |
| Reverse polarity protection | No (must be protected externally) |
| Output voltage | |
| Minimum | 18 VDC |
| Nominal | 24 VDC |
| Maximum | 42 VDC |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel and I/O power supply |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | 0 to 60°C (Rev. ≥ G0); 0 to 55°C (Rev. < G0) ¹⁾ |
| Vertical mounting orientation | 0 to 50°C ²⁾ |
| Derating | - |
| Storage | -25 to 70°C |
| Transport | -25 to 70°C |

Table 553: X20CM8323 - Technical data

| Model number | X20CM8323 |
|-----------------------|--|
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 553: X20CM8323 - Technical data

- 1) Rev. G0 and higher: Up to a maximum of 6 channels only are permitted to be switched on simultaneously over 55°C.
- 2) Rev. G0 and higher: Up to a maximum of 6 channels only are permitted to be switched on simultaneously over 45°C.

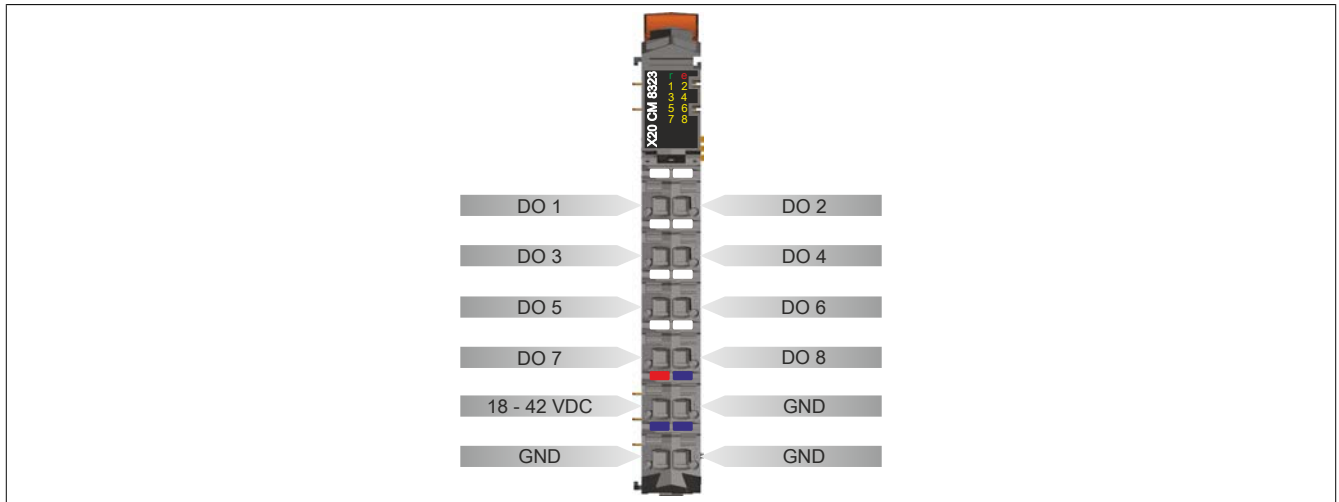
9.26.10.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

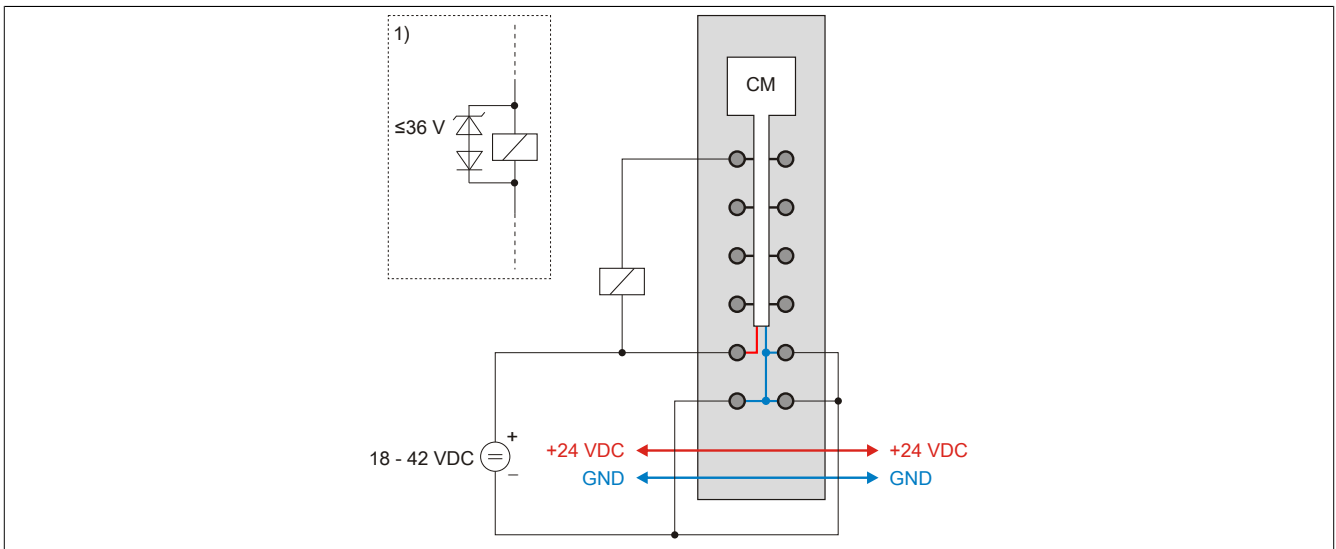
| Figure | LED | Color | Status | Description |
|--------|-------|--------|-----------------------------|--|
| | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring for digital outputs has been triggered. |
| | e + r | | Red on / Green single flash | Invalid firmware |
| | 1 - 8 | Orange | On/Off | Status of the digital outputs |
| | | | Blinking | Short-circuit / overcurrent cutoff |
| | | | | <p>Information:</p> <p>The output is not automatically activated after an overcurrent cutoff. It must be switched on again.</p> |

- 1) Depending on the configuration, a firmware update can take up to several minutes.

9.26.10.5 Pinout

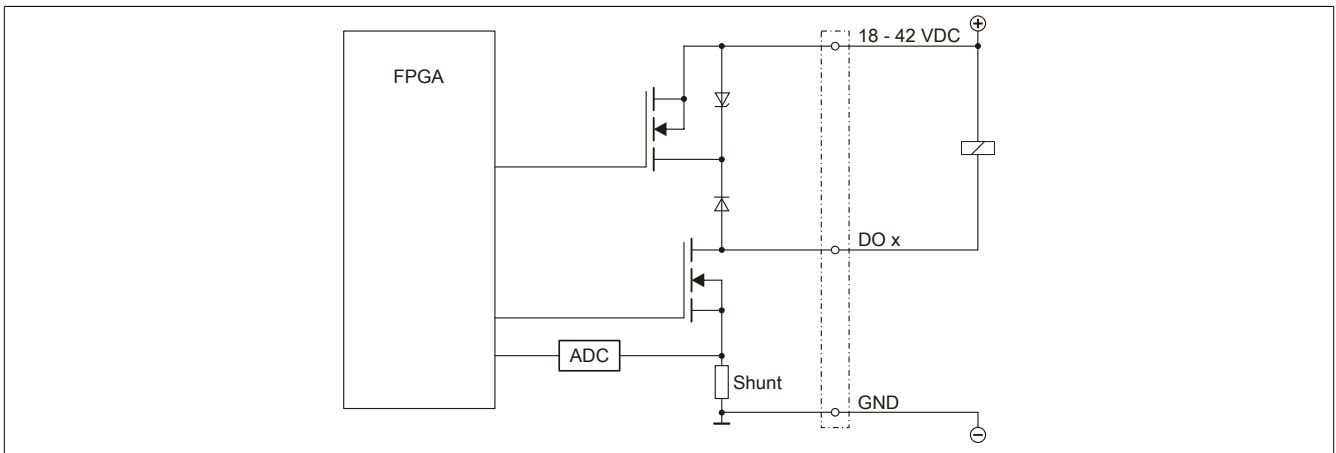


9.26.10.6 Connection example



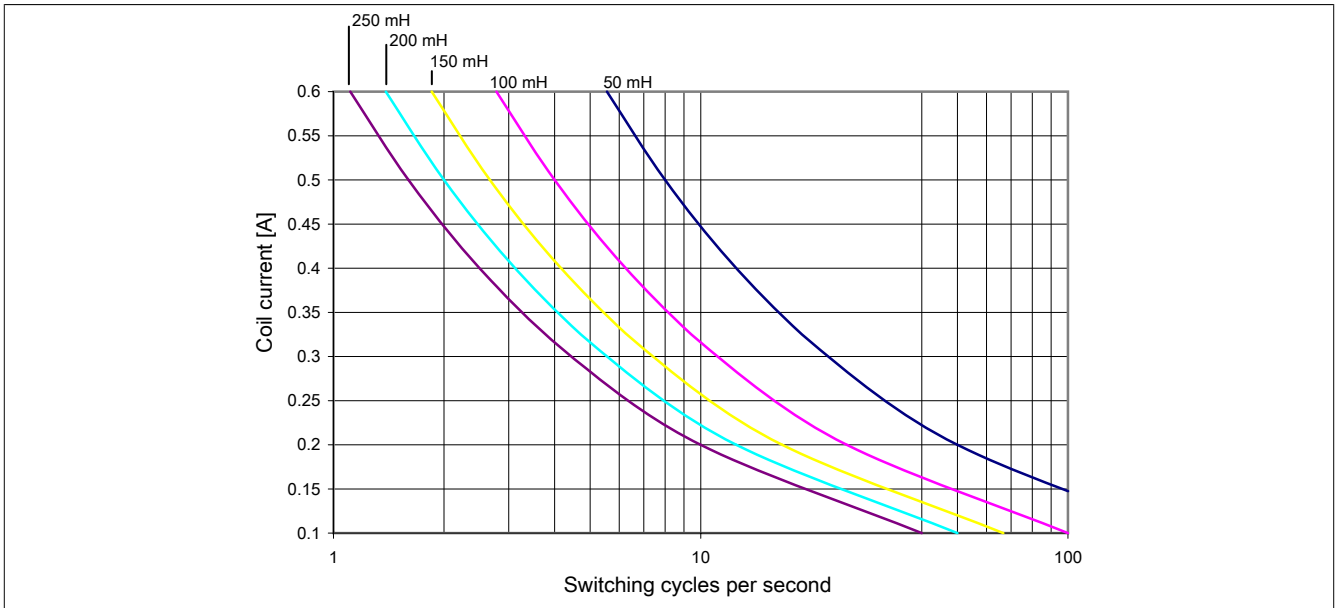
1) If larger inductances or more current are used; the "transil-diode combination" must be placed externally on the relay/valve.

9.26.10.7 Output circuit diagram

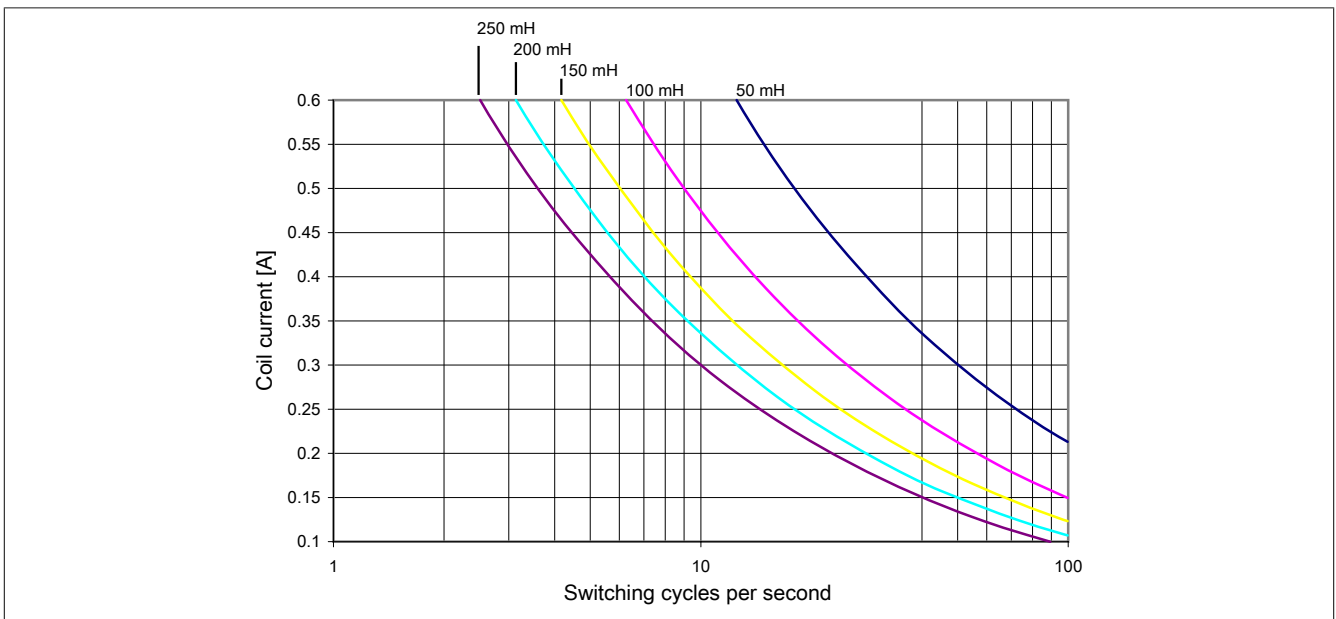


9.26.10.8 Switching inductive loads

Prior to revision G0



From revision G0



In principle, the inductance that is connected is limited by the maximum power dissipation of the module.

If larger inductances or more current are used, the the "transil-diode combination" must be placed externally on the relay/valve (see ["Connection example" on page 3200](#)).

Information:

The inductance of a relay/valve depends greatly on the core material being used. Therefore, an inductance must be used that corresponds to the diagram at 1Hz. This information can be found in the data sheet of the connected inductance (relay/valve).

9.26.10.9 Register description

9.26.10.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.26.10.9.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|--|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration | | | | | | |
| 12 | ConfigOutput02 (Excitation time) | USINT | | | | • |
| 13 | ConfigOutput03 (PWM duty cycle) | USINT | | | | • |
| 14 | ConfigOutput04 (Module configuration) | USINT | | | | • |
| Index + 10 | ConfigOutputN (Index N = 05 to 20) (Current and time differential) | USINT | | | | • |
| 38 | ConfigOutput21 (Disables high-speed cutoff) | USINT | | | | • |
| Communication | | | | | | |
| 9 | Digital outputs | USINT | | | • | |
| | DigitalOutput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalOutput08 | Bit 7 | | | | |
| 9 | StatusInput01 | USINT | • | | | |
| 10 | StatusInput02 | USINT | | • | | |
| 0 | AnalogInput01 | USINT | • | | | |
| Index - 1 | AnalogInput0N (Index N = 2 to 9) | USINT | • | | | |
| 10 | StatusOutput01 | UINT | | | • | |
| Index + 47 | Current0N (Index N = 1 to 8) | USINT | • | | | |
| 56 | StatusCurrent | USINT | • | | | |
| | StatusCurrent01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | StatusCurrent08 | Bit 7 | | | | |

9.26.10.9.3 Function model 1

| Register | Name | Data type | Read | | Write | |
|----------------------|--|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration | | | | | | |
| 12 | ConfigOutput02 (Excitation time) | USINT | | | | • |
| 13 | ConfigOutput03 (PWM duty cycle) | USINT | | | | • |
| 14 | ConfigOutput04 (Module configuration) | USINT | | | | • |
| Index + 10 | ConfigOutputN (Index N = 05 to 20) (Current and time differential) | USINT | | | | • |
| 38 | ConfigOutput21 (Disables high-speed cutoff) | USINT | | | | • |
| Communication | | | | | | |
| 9 | DigitalOutput | USINT | | | • | |
| 9 | StatusInput01 | USINT | • | | | |
| 10 | StatusInput02 | USINT | | • | | |
| 0 | AnalogInput01 | USINT | • | | | |
| Index - 1 | AnalogInput0N (Index N = 2 to 9) | USINT | • | | | |
| 10 | StatusOutput01 | UINT | | | • | |
| Index + 47 | Current0N (Index N = 1 to 8) | USINT | • | | | |

9.26.10.9.4 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| Configuration | | | | | | | |
| 12 | - | ConfigOutput02 (Excitation time) | USINT | | | | • |
| 13 | - | ConfigOutput03 (PWM duty cycle) | USINT | | | | • |
| 14 | - | ConfigOutput04 (Module configuration) | USINT | | | | • |
| Index + 10 | - | ConfigOutputN (Index N = 05 to 20) (Current and time differential) | USINT | | | | • |
| 38 | - | ConfigOutput21 (Disables high-speed cutoff) | USINT | | | | • |
| 48 | - | TimeBase | UINT | | | | • |
| Communication | | | | | | | |
| 9 | 0 | Digital outputs | USINT | | | | • |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput08 | Bit 7 | | | | |
| 9 | 6 | StatusInput01 | USINT | • | | | |
| 10 | - | StatusInput02 | USINT | | • | | |
| Index + 1 | Index + 1 | AnalogInput0N (Index N = 1 to 4) | USINT | • | | | |
| 10 | 2 | StatusOutput01 | UINT | | | • | |
| 0 | 4 | AddressSet | UINT | | | • | |
| | 4 | LineID_Set | USINT | | | | |
| | 5 | BlockID_Set | USINT | | | | |
| 0 | 0 | IndexAct | UINT | • | | | |
| | 0 | LineID_Act | USINT | | | | |
| | 1 | BlockID_Act | USINT | | | | |

1) The offset specifies the position of the register within the CAN object.

9.26.10.9.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.26.10.9.4.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.26.10.9.5 Configuration registers

9.26.10.9.5.1 Excitation time

Name:

ConfigOutput02

The excitation time is configured in this register.

The output is switched fully on for the time set in this register after the module is switched on. After the excitation time expires, the module goes into PWM mode.

| Data type | Value | Information |
|-----------|----------|---|
| USINT | 0 to 255 | In steps of 100 µs or 1000 µs. Bus controller default setting: 0 |

9.26.10.9.5.2 PWM duty cycle

Name:

ConfigOutput03

In this register, a configuration is made for the percentage of the PWM cycle (in 1% steps) that the PWM output is logical 1, i.e. ON.

| Data type | Value | Information |
|-----------|---------|---|
| USINT | 0 | PWM output always off |
| | 1 to 99 | Switch-on time in 1% steps. Bus controller default setting: 50 |
| | 100 | PWM output always on |

9.26.10.9.5.3 Module configuration

Name:

ConfigOutput04

This register is used to configure the module's general parameters.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------|-------|---|
| 0 | PWM frequency | 0 | 1 kHz (bus controller default setting) |
| | | 1 | 50 kHz |
| 1 | Reserved | | |
| 2 | Excitation time base | 0 | 100 μ s (bus controller default setting) |
| | | 1 | 1000 μ s |
| 3 | Reserved | | |
| 4 | Switching point search | 0 | Low-point method (bus controller default setting) |
| | | 1 | Curvature method |
| 5 - 7 | Reserved | | |

9.26.10.9.5.4 Current and time differential

Name:

ConfigOutput05 to ConfigOutput20

The switching point search is configured with the parameters dl and dt in these non-cyclic registers.

- dl - Current differential in LSB
- dt - Time differential in 100 μ s steps

For a sample configuration, see ["Configuring dl and dt" on page 3212](#)

| Data type | Values | Information |
|-----------|----------|-----------------------------------|
| USINT | 0 to 255 | Bus controller default setting: 0 |

| Registers | Description | |
|----------------|-------------|-----------|
| ConfigOutput05 | dl | Channel 1 |
| ConfigOutput06 | dt | |
| ... | | ... |
| ConfigOutput19 | dl | Channel 8 |
| ConfigOutput20 | dt | |

9.26.10.9.5.5 Disabling the high-speed cutoff

Name:

ConfigOutput21

The high-speed cutoff can be enabled or disabled for individual channels in this register.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-----|-------------------|-------|--|
| 0 | High-speed cutoff | 0 | Enabled for channel 1 (bus controller default setting) |
| | | 1 | Disabled for channel 1 |
| ... | | ... | |
| 7 | High-speed cutoff | 0 | Enabled for channel 8 (bus controller default setting) |
| | | 1 | Disabled for channel 8 |

9.26.10.9.5.6 Configuration of the time base

Name:

TimeBase

This register can be used to configure the interval between current measurement points.

The interval between measurement points is normally one quarter of the defined X2X Link cycle. When using a CAN controller this value is not available. The time base for the 1/4 measurement cycle must therefore be set separately in [Function model 254 - Bus controller](#).

| Data type | Value | Information |
|-----------|--------------|--|
| UINT | 400 to 10000 | Measurement point interval in μ s for 1/4 measurement cycle. Bus controller default setting: X2X cycle time |

9.26.10.9.6 Communication registers

9.26.10.9.6.1 Uploading the current curves (function models 0 and 1)

A current curve with 200 values is recorded for each channel. The interval between measurement points is equal to a quarter of the defined X2X Link cycle.

The following registers are used to read the current curve recorded by the module:

- "AnalogInput01" on page 3205
- "AnalogInput02 to Analog09" on page 3205

Set the channel number and line index

Name:

AnalogInput01

If this register contains a valid value (i.e. index is in the valid range) then registers "AnalogInput02 to AnalogInput09" on page 3205 provide a block of 8 current values for Channel X.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------|---------|-------------|
| 0 - 2 | Channel number | 0 | Channel 1 |
| | | ... | |
| | | 7 | Channel 8 |
| 3 - 7 | Index | 0 to 24 | Line index |

The index specifies which part of the current curve is represented by the block of 8 values:

| Value X of the current curve | Index | Register |
|------------------------------|-------|---------------|
| 1 | 0 | AnalogInput02 |
| 2 | | AnalogInput03 |
| ... | | ... |
| 8 | | AnalogInput09 |
| 9 | 1 | AnalogInput02 |
| ... | | ... |
| 193 | | AnalogInput02 |
| ... | | ... |
| 200 | 24 | AnalogInput09 |

Table 554: Relationship between index, channel and AnalogInput02 - AnalogInput09

Examples

The 200th value of the curve contains the switching point of the connected valve/relay found by the module.

- Value 200 = 78: The 78th measurement point corresponds to the switching point of the valve/relay.
- Value 200 = 255: No switching point was found.

Analog input values

Name:

AnalogInput02 to AnalogInput09

A current curve with 200 values is recorded for each channel. These registers provide a block of 8 current values from Channel X.

The following register is required for configuration:

- The "AnalogInput01" on page 3205 register defines the channel used and the block index.
- The interval between measurement points is equal to a quarter of the defined X2X Link cycle.

| Data type | Values |
|-----------|----------|
| USINT | 0 to 255 |

Programming example in ANSI C for uploading the curves:

```

#include <bur/plctypes.h>
#define ILEN 200

typedef struct {
    USINT          data[ILEN];
} curve_typ;
typedef struct {
    BOOL          ok;
    UDINT        serial;
    UINT         id, hw, fwver;
    BOOL         out[8];
    UINT         delay;
    USINT        i_addr;
    USINT        i_ch1_in, i_ch2_in, i_ch3_in, i_ch4_in;
    USINT        i_ch5_in, i_ch6_in, i_ch7_in, i_ch8_in;
    curve_typ    curves[8];
    USINT        switched;
} cm8323_typ;
_LOCAL cm8323_typ cm;
_LOCAL USINT ventilNummer, adrPtr;

void _INIT up() {}

void _CYCLIC cycle() {
    ventilNummer = cm.i_addr & 0x07;
    adrPtr = cm.i_addr >> 3;

    if(cm.i_addr != 200 && ventilNummer <= 7) {
        cm.curves[ventilNummer].data[adrPtr * 8 + 0] = cm.i_ch1_in;
        cm.curves[ventilNummer].data[adrPtr * 8 + 1] = cm.i_ch2_in;
        cm.curves[ventilNummer].data[adrPtr * 8 + 2] = cm.i_ch3_in;
        cm.curves[ventilNummer].data[adrPtr * 8 + 3] = cm.i_ch4_in;
        cm.curves[ventilNummer].data[adrPtr * 8 + 4] = cm.i_ch5_in;
        cm.curves[ventilNummer].data[adrPtr * 8 + 5] = cm.i_ch6_in;
        cm.curves[ventilNummer].data[adrPtr * 8 + 6] = cm.i_ch7_in;
        cm.curves[ventilNummer].data[adrPtr * 8 + 7] = cm.i_ch8_in;
    }
}

```

I/O mapping of following data points for curve evaluation:

| Data point | Variable |
|---------------|-------------|
| AnalogInput01 | cm.i_addr |
| AnalogInput02 | cm.i_ch1_in |
| AnalogInput03 | cm.i_ch2_in |
| AnalogInput04 | cm.i_ch3_in |
| AnalogInput05 | cm.i_ch4_in |
| AnalogInput06 | cm.i_ch5_in |
| AnalogInput07 | cm.i_ch6_in |
| AnalogInput08 | cm.i_ch7_in |
| AnalogInput09 | cm.i_ch8_in |

9.26.10.9.6.2 Uploading the current curves with CAN I/O

A current curve with 200 values is recorded for each channel. The interval between measurement points is equal to the value set in the "TimeBase" on page 3204 register.

The following registers are needed in order to read the current curve recorded by the module in the [Function model 254 - Bus controller](#):

- "BlockID_Set" on page 3207
- "BlockID_Act" on page 3207
- "LineID_Set" on page 3207
- "LineID_Act" on page 3208
- "AnalogInput01 to AnalogInput04" on page 3208

Summary of set registers

Name:

AddressSet

This register is a summary of the "LineID_Set" on page 3207 and "BlockID_Set" on page 3207 registers.

| Data type | Bit | Information |
|-----------|--------|-------------|
| UINT | 0 - 7 | LineID_Set |
| | 8 - 15 | BlockID_Set |

Summary of read registers

Name:

IndexAct

This register is a summary of the "LineID_Act" on page 3208 and "BlockID_Act" on page 3207.

| Data type | Bit | Information |
|-----------|--------|-------------|
| UINT | 0 - 7 | LineID_Act |
| | 8 - 15 | BlockID_Act |

Sets the channel number

Name:

BlockID_Set

The channel for the data stream can be selected in this register. The value of this register can be read using "BlockID_Act" on page 3207.

| Data type | Value | Information |
|-----------|-------|-------------|
| USINT | 0 | Channel 1 |
| | ... | ... |
| | 7 | Channel 8 |

Reads the channel number

Name:

BlockID_Act

Reads the "BlockID_Set" on page 3207 register. This register allows you to determine which channel is providing the current values in registers "AnalogInput01 to AnalogInput04" on page 3208. If the selected channel or line does not exist, then this register returns the value 255.

| Data type | Value | Information |
|-----------|--------|--------------------------------------|
| USINT | 0 to 7 | Channel or line currently being used |
| | 255 | Invalid selection |

Setting the line index

Name:

LineID_Set

The line index for the data stream can be selected in this register. The value of this register can be read using "LineID_Act" on page 3208.

| Data type | Value | Information |
|-----------|---------|---------------------------|
| USINT | 0 to 49 | Line index currently used |

Reading the line index

Name:

LineID_Act

Reads the "LineID_Set" on page 3207 register. This register allows you to determine which line is providing the current values in registers "AnalogInput01 to AnalogInput04" on page 3208. If the selected channel or line does not exist, then this register returns the value 255.

If the channel number and index are in the valid range, then registers "AnalogInput01 to AnalogInput04" on page 3208 provide a block of 4 current values for Channel X.

The index specifies which part of the current curve is represented by the block of 4 values:

| Data type | Value | Information | Register |
|-----------|------------------------------|-------------|-------------------|
| USINT | Value X of the current curve | Index | |
| | 1 | 0 | AnalogInput01 |
| | ... | | ... |
| | 4 | | AnalogInput04 |
| | 5 | 1 | AnalogInput01 |
| | ... | | ... |
| | 197 | | AnalogInput01 |
| | ... | 49 | ... |
| | 200 | | AnalogInput04 |
| | 255 | | Invalid selection |

Analog input values - CAN I/O

Name:

AnalogInput01 to AnalogInput04

A current curve with 200 values is recorded for each channel. These registers provide a block of 4 current values from Channel X.

The following registers are required for configuration:

- The "BlockID_Set" on page 3207 register defines the channel used.
- The "LineID_Set" on page 3207 register defines the block index within the channel.
- The interval between measurement points is equal to the value set in the "TimeBase" on page 3204 register.

| Data type | Values |
|-----------|----------|
| USINT | 0 to 255 |

9.26.10.9.6.3 Digital outputs

Name:

DigitalOutput

DigitalOutput01 to DigitalOutput08

Registers "DigitalOutput01" to "DigitalOutput08" set the output value of Channels 1 to 8.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------|--------|-----------------------------------|
| 0 | DigitalOutput01 | 0 or 1 | Output value of digital output 01 |
| ... | | ... | |
| 7 | DigitalOutput08 | 0 or 1 | Output value of digital output 08 |

9.26.10.9.6.4 Status of the outputs

Name:
StatusInput01

This register indicates whether a switching point has been found for a channel.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|-----------------|-------|--|
| 0 | Switching point | 0 | Channel 1 was not switched or no switching point was found |
| | | 1 | Switching point found for Channel 1 |
| ... | | ... | |
| 7 | Switching point | 0 | Channel 8 was not switched or no switching point was found |
| | | 1 | Switching point found for Channel 8 |

9.26.10.9.6.5 Module status

Name:
StatusInput02

The current module status is indicated in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------|-------|------------------------------|
| 0 - 2 | Reserved | 0 | |
| 3 | Overload cutoff | 0 | No overcurrent |
| | | 1 | Overcurrent cutoff activated |
| 4 - 7 | Reserved | 0 | |

9.26.10.9.6.6 Switching delay of channels

Name:
StatusOutput01

2 bits of this register are used to set the switching delay for each channel. Values of the switching delay are specified in quarter-steps of the X2X Link cycle.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|------------------------------|-------|-------------------------------------|
| 0 - 1 | Switching delay of channel 1 | 00 | No delay |
| | | 01 | 1/4 of the X2X Link cycle |
| | | 10 | 2/4 of the X2X Link cycle |
| | | 11 | 3/4 of the X2X Link cycle |
| 2 - 3 | Switching delay of channel 2 | x | For possible values, see channel 1. |
| ... | | ... | |
| 14 - 15 | Switching delay of channel 8 | x | For possible values, see channel 1. |

9.26.10.9.6.7 Reads actual values of the current

Name:

Current01 to Current08

These registers are used to read the actual value of the current from channels 1 to 8. These values have no units and are used only as characteristic values. A more precise, compensated current measurement is not possible using this module.

Relationship between register name and channel number:

| Register name | Channel number |
|---------------|--|
| Current01 | Actual value of the current of Channel 1 |
| ... | ... |
| Current08 | Actual value of the current of Channel 8 |

If an output is switched off, the corresponding register returns the value 0. After the output is switched on, valid current measurements are not available on the module until after two X2X Link cycles. The measurements in the registers are delayed by two cycles to account for this.

When the output is switched on, the corresponding bit in the "[StatusCurrent](#)" on page 3210 register can be used to check whether the register contains valid measurements. The first measured value is provided with the rising edge of this bit.

| Data type | Value | Information |
|-----------|----------|------------------------|
| USINT | 0 | Output is switched off |
| | 1 to 255 | Current value |

9.26.10.9.6.8 Checking for measured values

Name:

StatusCurrent

StatusCurrent01 to StatusCurrent08

This register can be used to check whether valid measured values are present in registers "[Current01 to Current08](#)" on page 3210.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

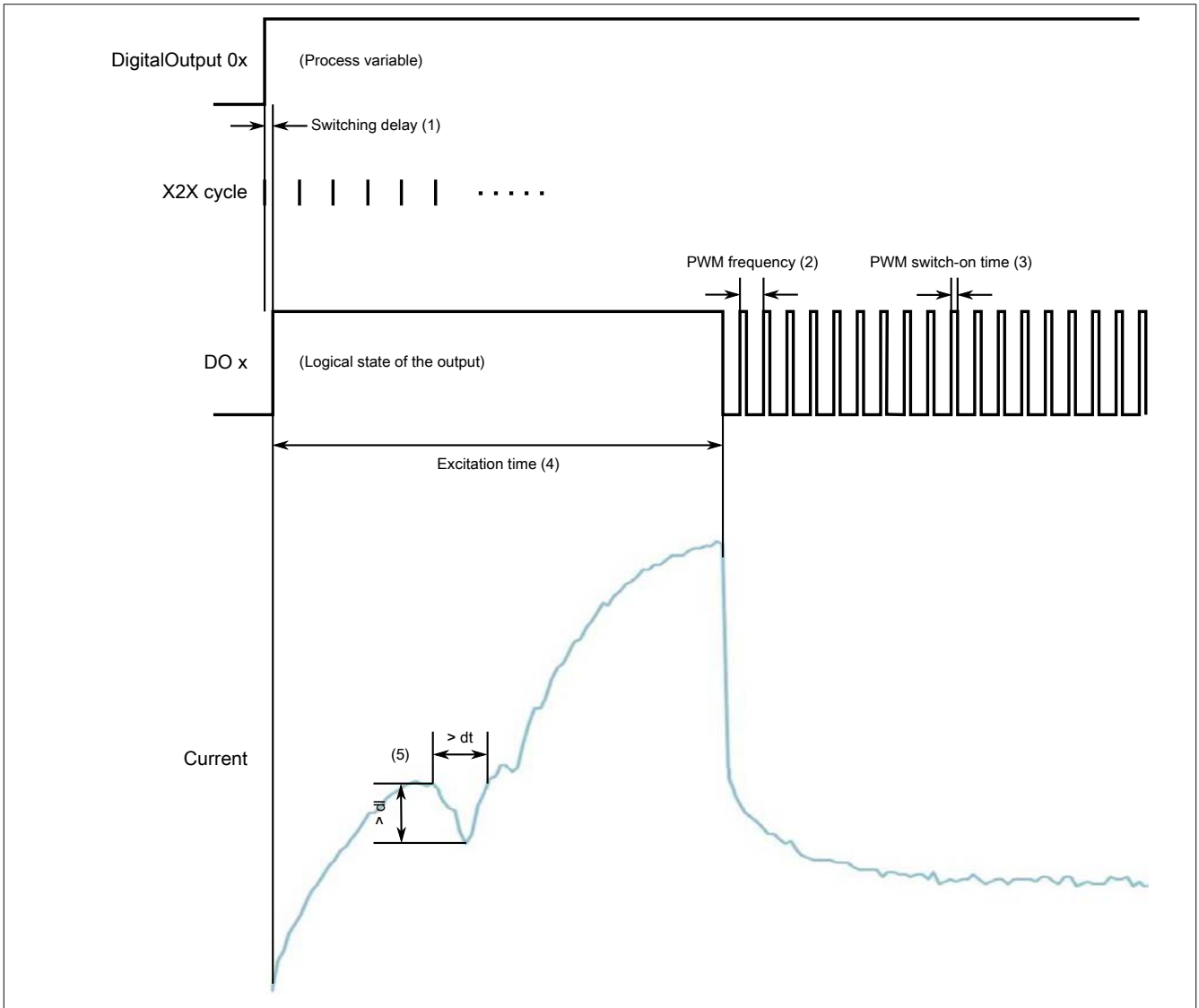
| Bit | Description | Value | Information |
|-----|-----------------|-------|---|
| 0 | StatusCurrent01 | 0 | Output switched off |
| | | 1 | The current value of channel 01 is valid. |
| ... | | ... | |
| 7 | StatusCurrent08 | 0 | Output switched off |
| | | 1 | The current value of channel 08 is valid. |

9.26.10.9.7 Functionality of the digital outputs

The following image shows the configuration and functionality of a digital output.

Configuration registers

- 1) Switching delay: See register "StatusOutput01" on page 3209
- 2) PWM frequency: See bit 0 of register "ConfigOutput04" on page 3204
- 3) PWM duty cycle: See register "ConfigOutput03" on page 3203
- 4) Excitation time = ConfigOutput02 * Excitation time base (bit 2 of "ConfigOutput04" on page 3204)
- 5) di / dt : See registers "ConfigOutput05 to 20" on page 3204



9.26.10.9.8 Configuring dl and dt

9.26.10.9.8.1 Procedure - Searching for switching points

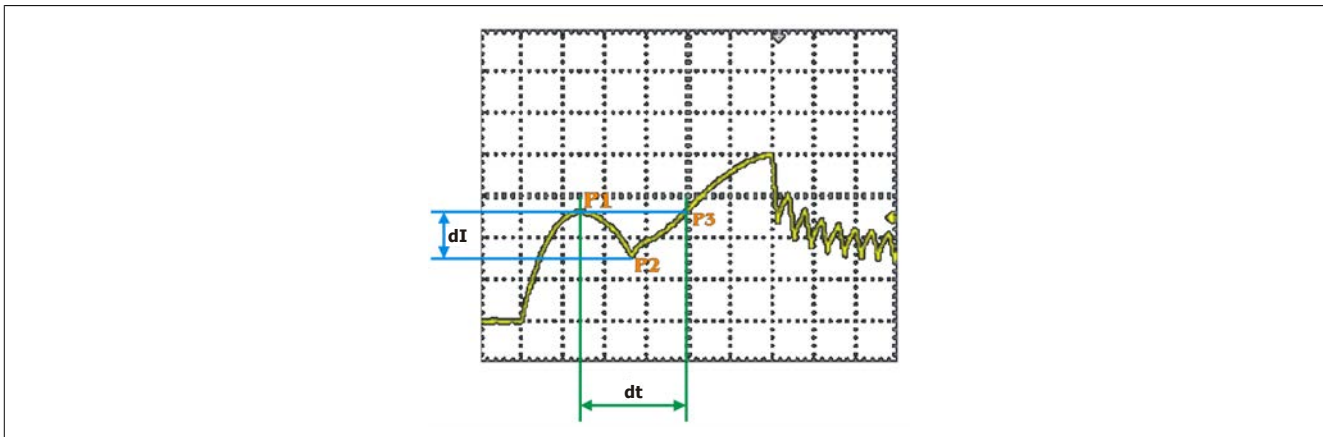


Figure 274: Searching for switching points

The current in the inductance gradually rises when the valve is switched on. The valve starts to move mechanically at a certain point. This process becomes noticeable due to a current dip that occurs as a result of the braking voltage (anti-EMF) (point P1).

When this mechanical process is complete, the current returns to its original curve and continues to rise (point P2).

Point P3 and point P1 have the same current value, but different times.

A valid low-point, which simultaneously corresponds to the switching point, must meet the following criteria:

- Point 2 must be lower than P1 by dI
- The time between P1 and P3 must be longer than dt

9.26.10.9.8.2 Configuration example for dl and dt with trace data from Automation Studio

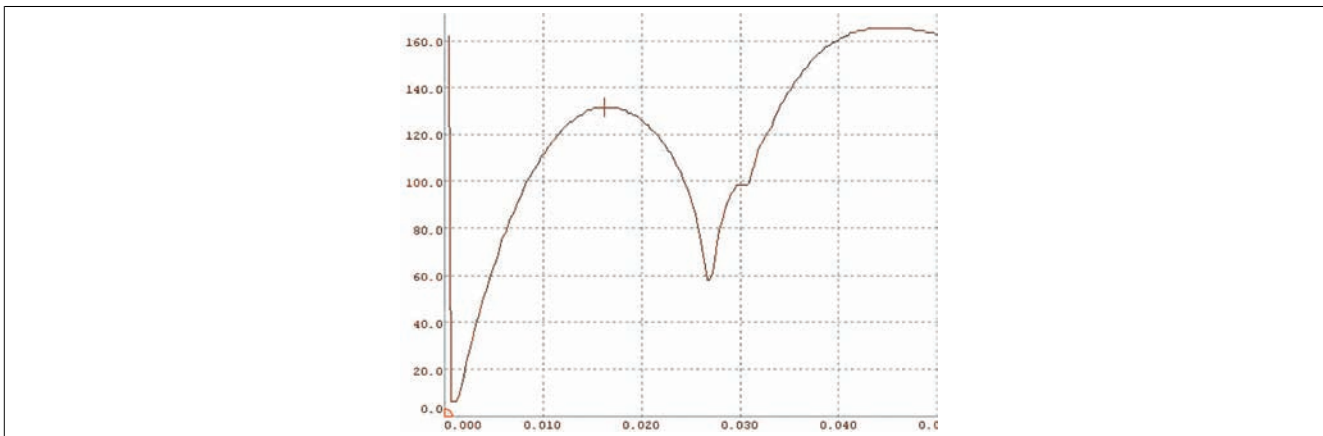


Figure 275: Search for the switching point with trace data from Automation Studio

The difference between the "current high-point" ($P1 = 131$) and the subsequent low-point ($P2 = 58$) is calculated ($P1 - P2 = 73$). The module compares this difference to the configured parameter dI .

If the difference measured by the module is larger than the configured dI value, then the first condition for a switching point search is met:

- In the module, the parameter dI should therefore be set to at least 72.

The next criteria is the time between P1 and P3. This must be larger than the value set for the parameter dt .

According to the trace data, this is 4.43 ms:

- In the module, the parameter dt should therefore be set to 43 ($4430 \mu s / 100 \mu s$).

With that, the second condition is met and a valid switching point can be detected.

It is recommended to avoid setting values all the way to the limits, since valves and relays change mechanically over time, which can lead to faulty readings (unless you wish to detect every minor deviation from the reference curve).

9.26.10.9.8.3 Modified switching point search (curvature method)

The method described (searching for and detecting switching points by locating low-points in the current trace) may not provide the desired level of reliability for certain types of valves and under certain conditions (e.g. pneumatic pressure).

For this reason, an alternative method of switchover detection is provided. This method is based on an evaluation of the curvature of the current curve. In the module configuration, the user can select which method to use for switchover detection (see "[Module configuration](#)" on page 3204).

The modified switching point search calculates the first derivative (slope) and then the second derivative (curvature) for every point in the current curve. At the switching point this second derivative has a local maximum, which is found by the module. More specifically, in order to improve the signal/noise ratio, a summation window is moved over the second derivative and the maximum of this summation is searched for.

This is not only valid when the current trace itself has a more or less low minimum in the switching point, but also in cases where the current increase only levels-out in the area of the switching point, but never becomes negative. Therefore, it can be said that the curvature method should generally be more sensitive.

Like the switching point search with the low-point method, valid switching points are configured using the parameters dl and dt. The meaning of these parameters is different here, however.

- dl - minimum curvature sum
- dt - width of the summation window in 1/4 X2X Link cycles

Meaningful values for this parameter can no longer be obtained simply by reading / measuring the current trace. That is why the module provides, in addition to the switching point (200th value of the current curve), also the following measurement and calculation values that can be used for the configuration:

| Value X of the current curve | Description |
|------------------------------|---|
| 1 | 1. Value of the current curve |
| : | : |
| 197 | Peak position of the first valid or highest invalid curvature peak |
| 198 | Height of the peak sum of the first valid or highest invalid peak |
| 199 | Width of the first valid or highest invalid peak (Important: not standardized to 100 μ s) |
| 200 | 255 at invalid peak, otherwise peak position in the current trace |

When a valid maximum curvature has been found (Value 198 \geq dl) then Values 197 to 199 represent the position (= Value 200), height and width of the first maximum that meets the criteria. Any higher and/or wider maximum that occurs later will not be found!

If no maximum curvature reaches the necessary height, then Values 197 through 200 represent the highest invalid maximum.

Determining the parameters dl and dt

| | |
|------------------------|--|
| dl \ll Value 198 | Set dl much lower than 198 |
| dt \approx Value 199 | dt should be set approximately the same as Value 199 Note: Maximum value for dt = 16 |

A certain amount of jitter in Value 198 must be assumed due to the high sensitivity of the modified switching point search. It is therefore recommended to monitor Value 198 over several switching cycles before setting dl with a safety clearance from the lowest monitored value.

As you can see in the examples below, the switching point peak is a number of times higher than any other peak in the summation curves.

The switching point peak is also still the first peak that occurs in the positive range. Therefore, it should not be a problem to set dl far enough from the minimum of the Value198 and far above the highest peak that arises from the noise (or valve chatter).

Example 1:

Configuration example of the modified switching point detection for a valve with a distinctive switching point.

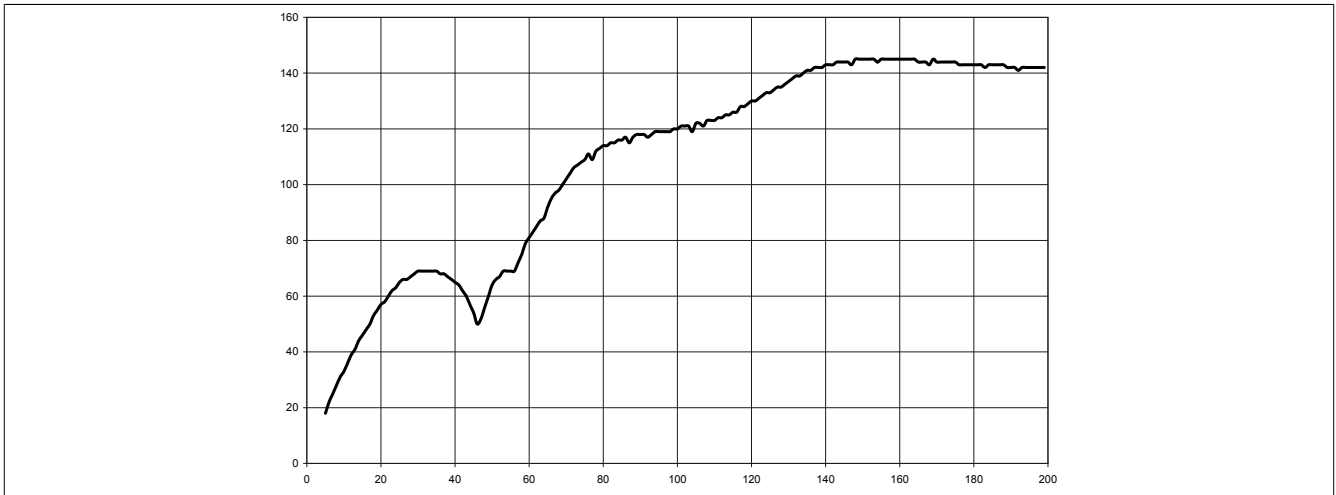


Figure 276: Example 1 - Valve current

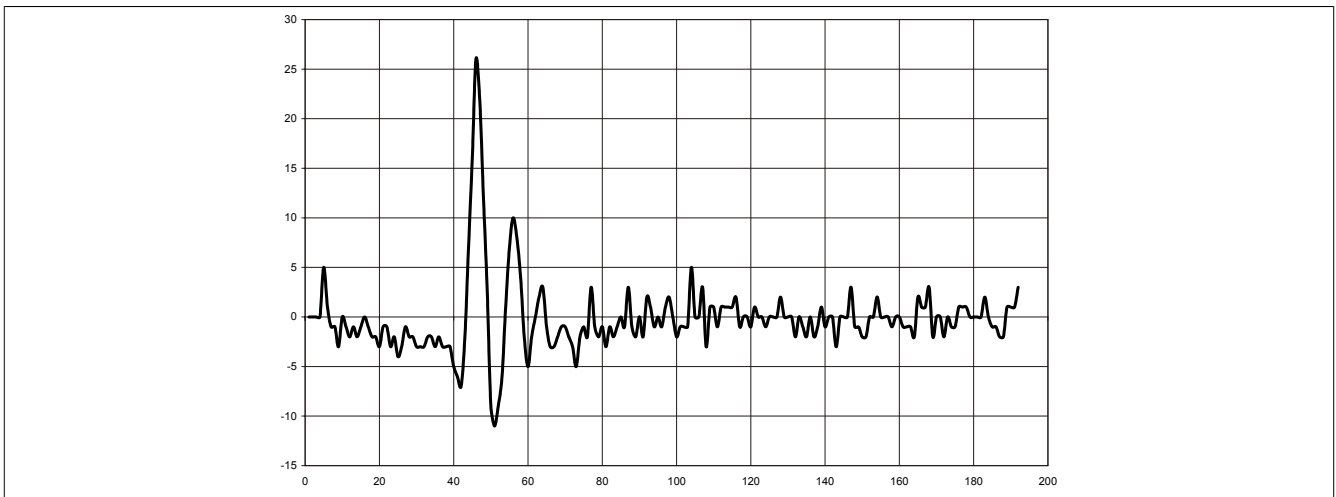


Figure 277: Example 1 - Calculated curvature (2nd derivative) of the current curve

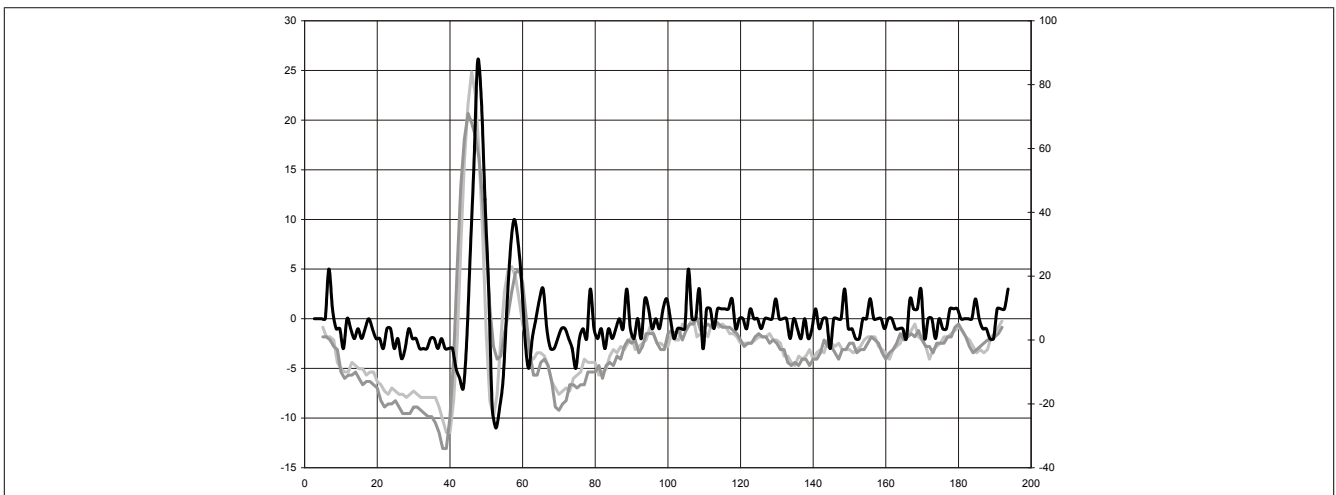


Figure 278: Example 1 - Calculated curvature (2nd derivative) of the current curve including overlapping sum with 3 different window widths

Example 2:

Configuration example of the modified switching point detection for a valve with a faintly distinctive switching point.

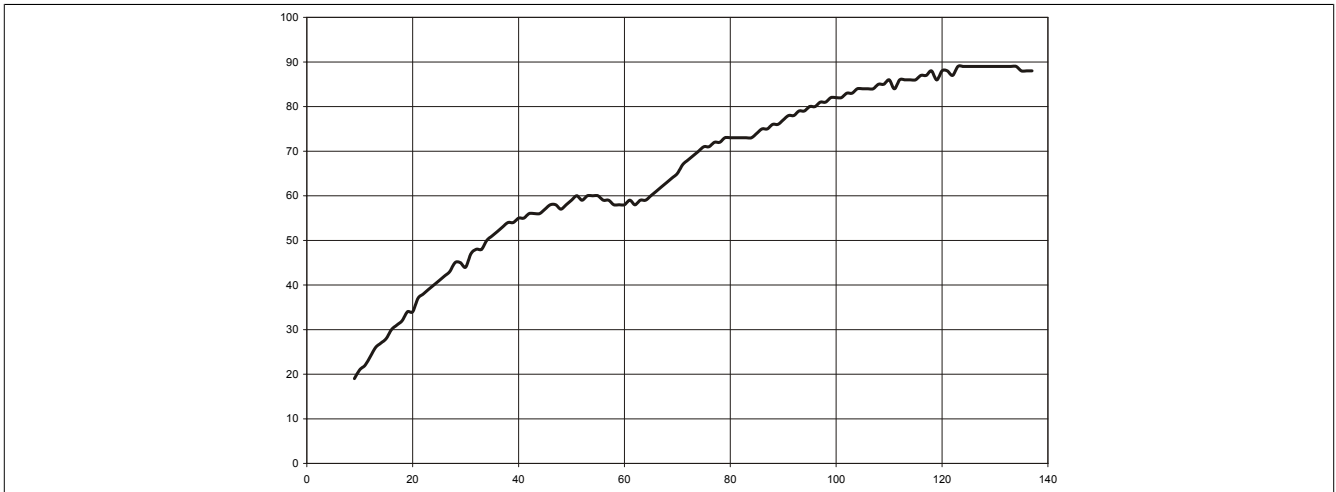


Figure 279: Example 2 - Valve current

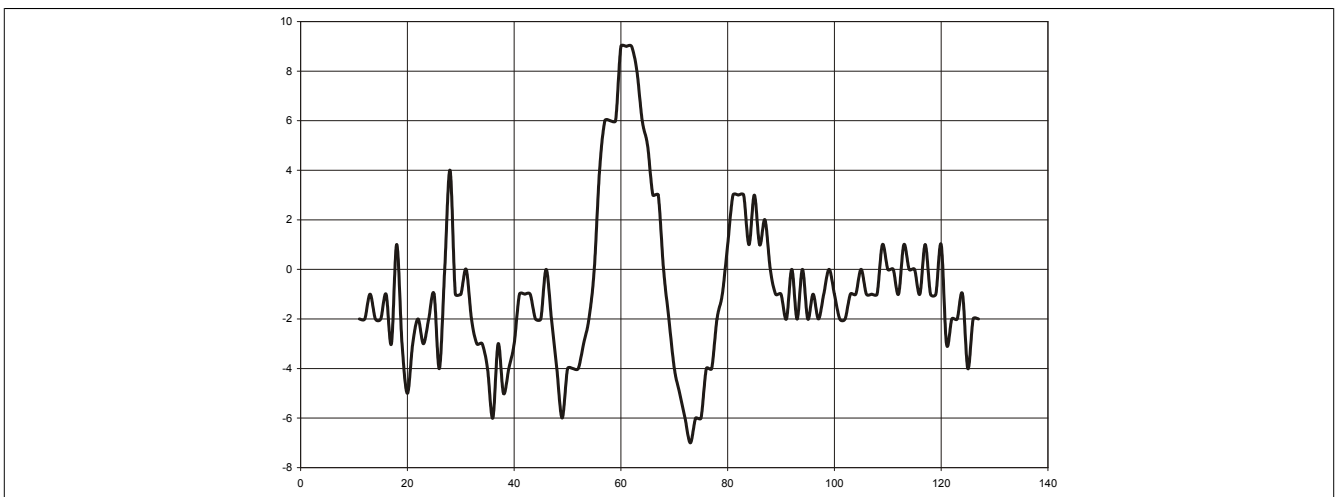


Figure 280: Example 2 - Calculated curvature (2nd derivative) of the current curve

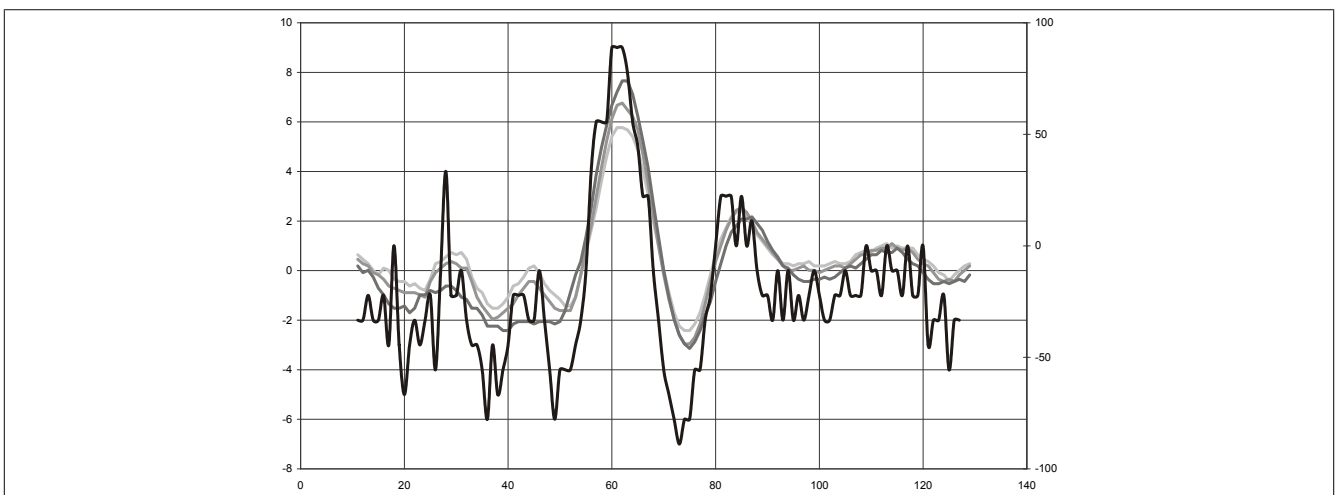


Figure 281: Example 2 - Calculated curvature (2nd derivative) of the current curve including overlapping sum with 3 different window widths

9.26.11 X20CMR010

Data sheet version: 1.04

9.26.11.1 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Other functions |  |
| X20CMR010 | X20 cabinet monitoring module, integrated temperature and humidity sensor, production data acquisition, 512 kB flash memory for user data | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 555: X20CMR010 - Order data

9.26.11.2 Module description

The module is designed for measuring ambient conditions in the control cabinet as well as recording operating hours and power-on cycles. In addition, the module offers the option of storing user data directly on the module and supports blackout mode.

Functions:

- "Measuring and evaluating ambient conditions"
- "Recording operating data"
- "Internal module memory for user data"
- "Blackout mode"

Measuring and evaluating ambient conditions

The ambient conditions are continuously evaluated by the module. The duration in which individual parameters are within certain ranges is stored internally. This makes it possible, for example, to determine how long the system remained in a certain temperature range. The histograms recorded by the module can be read out by the user.

Internal module memory for user data

With 512 kB nonvolatile user memory (flash), data from the application can be saved directly on the module and also read back from the module. The data is therefore retained after the module or CPU is restarted and remains with the module in the event that the module is connected to another machine or system, for example. Data retention is maintenance-free – without batteries.

Information:

It is important to note that the internal module memory is not available in function model "Bus controller"!

Blackout mode

The integrated blackout mode ensures that module functionality is maintained even in the event of network failure.


9.26.11.3 Technical data

| Model number | X20CMR010 |
|--|--|
| Short description | |
| I/O module | Measurement of ambient conditions: Internal module temperature, relative humidity, operating hours, power-on cycles |
| General information | |
| B&R ID code | 0xF1AC |
| Status indicators | Memory access, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Blackout mode | |
| Scope | Module |
| Function | Module function |
| Standalone mode | No |
| Power consumption | |
| Bus | 0.4 W |
| Internal I/O | - |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Application memory | |
| Type | 512 kB flash memory |
| Sectors | 8 sectors, 64 kB each |
| Data retention | 20 years at 55°C |
| Guaranteed erase/write cycles | 100,000 per sector |
| Error-correcting code (ECC) | No |
| Write protection | No |
| Certifications | |
| CE | Yes |
| Temperature and humidity sensor | |
| Sensor position | Module-internal |
| Sampling rate | 1 s |
| Temperature measurement | |
| Measurement range | -25 to 125°C |
| Resolution | 0.1°C/LSB |
| Max. error | ±0.3°C |
| Humidity measurement | |
| Measurement range | 5 to 95% |
| Resolution | 1%/LSB |
| Max. error | ±2% at 10 to 80% relative humidity ±3% at <10 and >80% relative humidity |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x bus module X20BM11 separately |
| Pitch | 12.5 ^{+0.2} mm |

Table 556: X20CMR010 - Technical data

9.26.11.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|--------------------------------|--|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | Mode RESET |
| | | | Double flash | Blackout mode active |
| | | | Blinking | Mode PREOPERATIONAL |
| | | | On | Mode RUN |
| | e | Red | Off | Module not supplied with power or everything OK |
| | e + r | Solid red / Single green flash | Invalid firmware | |
| | R | Green | Off | No data is being read from internal memory. |
| | | | On | The user is reading data from internal memory. |
| | W | Yellow | Off | No data is being written to internal memory. |
| On | | | The user is writing data to internal memory. | |

9.26.11.5 Pinout



9.26.11.6 Function description

9.26.11.6.1 Measuring and evaluating ambient conditions

The module is equipped with internal sensors to collect the following conditions:

- Relative humidity [%]
- Ambient temperature [°C]

Information:

The sampling rate is 1 s.

Since the sensor for relative humidity and ambient temperature is located directly in the module, the measured values depend on the intrinsic heating of the module and the heat radiated by neighboring modules.

The effect of this warming on the measured values can be circumvented by using an external temperature sensor on another module. The value measured with the external temperature sensor is used as a reference. With this value, the relative humidity at the position of the external temperature sensor is calculated using the Magnus formula.

$$\text{saturated water vapor pressure [Pa]} = 611.2 \cdot e^{\frac{17.62 \cdot \text{temperature}}{243.12 + \text{temperature}}}$$

$$\text{absolute humidity [g/m}^3\text{]} = \frac{\text{saturated water vapor pressure}}{461.52 \cdot (273.15 + \text{temperature})} \cdot 1000$$

$$\text{humidity [g/m}^3\text{]} = \text{absolute humidity} \cdot \text{relative humidity}$$

$$\text{relative humidity [\%]} = \frac{\text{humidity}}{\text{absolute humidity}} \cdot 100$$

Example

The following example calculates the relative humidity at the position of the external temperature sensor using the Magnus formula.

- Relative humidity in module: 20%
- Ambient temperature in module: 40°C
- External temperature sensor: 35°C

Module

$$\text{saturated water vapor pressure}_{\text{module}} = 611.2 \cdot e^{\frac{17.62 \cdot 40}{243.12 + 40}} = 7367.5 \text{ Pa}$$

$$\text{absolute humidity}_{\text{module}} = \frac{7367.5}{461.52 \cdot (273.15 + 40)} \cdot 1000 = 50.98 \text{ g/m}^3$$

$$\text{humidity}_{\text{module}} = 50.98 \cdot 0.2 = 10.2 \text{ g/m}^3$$

External temperature sensor

$$\text{saturated water vapor pressure}_{\text{ExtSensor}} = 611.2 \cdot e^{\frac{17.62 \cdot 35}{243.12 + 35}} = 5612.8 \text{ Pa}$$

$$\text{absolute humidity}_{\text{ExtSensor}} = \frac{5612.8}{461.52 \cdot (273.15 + 35)} \cdot 1000 = 39.47 \text{ g/m}^3$$

$$\text{relative humidity}_{\text{ExtSensor}} = \frac{10.2}{39.47} \cdot 100 = 25.84\%$$

In this example, a deviation of the relative humidity of approx. 6% results between the measured value in the module and the calculated value at the position of the external temperature sensor.

9.26.11.6.1.1 Additional information

The ambient conditions are recorded and evaluated in the module. The following values can be read:

- Smallest value occurred
- Largest value occurred

Information:

The values are saved to module-internal FRAM.

If needed, the values can be reset.

The registers are described in section "[Additional information](#)" on page 3227.

9.26.11.6.1.2 Histogram for relative humidity

A histogram for relative humidity is recorded in the module. The measuring range for the relative humidity is divided into 10 areas:

| Area | Relative humidity | Register |
|------|-------------------|---------------------------------------|
| 1 | 0 to <10% | RelHumHist01Entry RelHumHist01Time |
| 2 | 10 to <20% | RelHumHist02Entry RelHumHist02Time |
| 3 | 20 to <30% | RelHumHist03Entry RelHumHist03Time |
| 4 | 30 to <40% | RelHumHist04Entry RelHumHist04Time |
| 5 | 40 to <50% | RelHumHist05Entry RelHumHist05Time |
| 6 | 50 to <60% | RelHumHist06Entry RelHumHist06Time |
| 7 | 60 to <70% | RelHumHist07Entry RelHumHist07Time |
| 8 | 70 to <80% | RelHumHist08Entry RelHumHist08Time |
| 9 | 80 to <90% | RelHumHist09Entry RelHumHist09Time |
| 10 | 90 to 100% | RelHumHist10Entry RelHumHist10Time |

As soon as the relative humidity reaches one of the predefined areas, a delay time of 3 s begins. Once the delay time has expired, the entry counter is increased by 1 and the dwell time begins. The delay time prevents the counter from constantly being incremented in the crossover area.

Information:

The values are saved to module-internal FRAM.

If needed, the registers can be reset.

The registers are described in section "[Relative humidity](#)" on page 3228.

9.26.11.6.1.3 Histogram for ambient temperature

A histogram for ambient temperature is recorded in the module. The measuring range for the ambient temperature is divided into 12 areas:

| Area | Ambient temperature | Register |
|------|---------------------|-----------------------------------|
| 1 | <-20°C | TempHist01Entry TempHist01Time |
| 2 | -20 to <-10°C | TempHist02Entry TempHist02Time |
| 3 | -10 to <0°C | TempHist03Entry TempHist03Time |
| 4 | 0 to <10°C | TempHist04Entry TempHist04Time |
| 5 | 10 to <20°C | TempHist05Entry TempHist05Time |
| 6 | 20 to <30°C | TempHist06Entry TempHist06Time |
| 7 | 30 to <40°C | TempHist07Entry TempHist07Time |
| 8 | 40 to <50°C | TempHist08Entry TempHist08Time |
| 9 | 50 to <60°C | TempHist09Entry TempHist09Time |
| 10 | 60 to <70°C | TempHist10Entry TempHist10Time |
| 11 | 70 to <80°C | TempHist11Entry TempHist11Time |
| 12 | ≥80°C | TempHist12Entry TempHist12Time |

As soon as the ambient temperature reaches one of the predefined areas, a delay time of 3 s begins. Once the delay time has expired, the entry counter is increased by 1 and the dwell time begins. The delay time prevents the counter from constantly being incremented in the crossover area.

Information:

The values are saved to module-internal FRAM.

If needed, the registers can be reset.

The registers are described in section "[Ambient temperature](#)" on page 3228.

9.26.11.6.2 Recording operating data

The following operating data is collected by the module:

- Operating time with active connection to network master
- Operating time without active connection to network master (blackout mode)
- Total operating time
- Number of power-on cycles

Information:

The values are saved to module-internal FRAM.

If needed, the operating data can be reset.

The registers are described in section "[Operating data](#)" on page 3227.

9.26.11.6.3 Internal module memory for user data

9.26.11.6.3.1 General information

The module is equipped with 512 kB nonvolatile internal flash memory that can be used by the application. Data can be saved directly to the module and then read back. This makes it possible to store recipe data or production information about the machine on the module, for example.

9.26.11.6.3.2 Operation

The module's memory interface is based on Flatstream communication. Operation takes place using library "AsFltGen".

Information:

For more information about library "AsFltGen", see Automation Help.

Information:

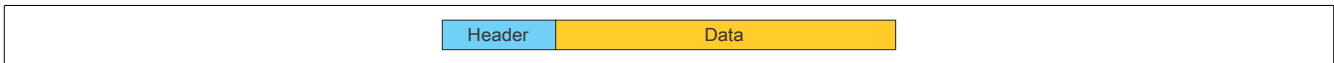
The following points must be observed:

- Up to 256 bytes can be read or written per read or write command. These 256 bytes represent a page. If more than 256 bytes must be read or written, then a consecutive sequence of commands and memory management must be implemented in the application.
- The erase command is based on sectors. One sector is 64 kB. This corresponds to 256 pages. The entire sector containing the specified address is erased. The flash memory is divided into a total of 8 sectors (8 x 64 kB = 512 kB).
- In order to overwrite data, the corresponding sector must first be erased. Only then can the new data be saved.
- Memory can be arranged as needed. A separate sector should be used for data that is overwritten regularly.

9.26.11.6.3.3 Commands

Protocol

A header precedes each command. The data follows the header and depends on the command.


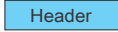


Header



Each request or response begins with a 16-byte header. The following elements must be defined in the header:

| Element | Data type | Activity | Description |
|--------------------|-----------|-------------|---|
| Code | USINT | Requirement | Defines the command: "r" ... Read data (ASCII code 0x72) "w" ... Write data (ASCII code 0x77) "e" ... Erase data (ASCII code 0x65) |
| | | Response | The command code contained in the request is sent back. |
| Consecutive number | USINT | Requirement | Unrestricted use. The consecutive number is important, for example, if more than 256 bytes must be read or written. In this case, the user must implement a sequential series of commands and memory management in the application. |
| | | Response | The number contained in the request is sent back. |
| Status | UINT | Requirement | Not used: The byte is not evaluated. |
| | | Response | Status response: 0x0000 ... Command executed successfully 0x8001 ... Invalid: General fault 0x8002 ... Invalid address 0x8003 ... Invalid size 0x8004 ... Flash memory busy 0x8006 ... Flash memory timeout |
| Address | UDINT | Requirement | Starting address from which data should be read or written. |
| | | Response | The starting address contained in the request is sent back. |
| Data size | UDINT | Requirement | Size of the data to be read or written. |
| | | Response | The data size contained in the request is sent back. |
| Reserve | UDINT | Reserved | |


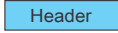
Write data

| Action | Description |
|-------------|---|
| Requirement | In order to save data to the module, the header must be prepared for communication. The data is appended directly to the header. The header and data must be specified to function block "fitWrite" as a transmit buffer.  |
| Response | The module's response – the returned header – is stored in the receive buffer using function block "fitRead" and can be evaluated by the application.  |

Read data

| Action | Description |
|-------------|--|
| Requirement | In order to read data from the module, the header must be prepared for communication. The header must be specified to function block "fitWrite" as a transmit buffer.  |
| Response | The module's response – the returned header and data – is stored in the receive buffer using function block "fitRead" and can be evaluated by the application.  |

Erasing a sector

| Action | Description |
|-------------|---|
| Requirement | In order to erase an area of the module's flash memory, the header must be prepared for communication. The entire 64 kB sector containing the specified address is erased. The header must be specified to function block "fitWrite" as a transmit buffer.  |
| Response | The module's response – the returned header – is stored in the receive buffer using function block "fitRead" and can be evaluated by the application.  |

9.26.11.6.4 Blackout mode

For a description of blackout mode, see "[Blackout mode](#)" on page 3794.

9.26.11.7 Register description

9.26.11.7.1 Using this module with SGC target systems

Information:

It is not possible to use the module with SGC target systems.

9.26.11.7.2 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.26.11.7.3 Function model 0 - Standard

| Register | Description | Data type | Read | | Write | |
|---|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module - Control | | | | | | |
| 134 | Reset additional information and data point histograms | UINT | | | • | |
| | ClrStatistics_OperatingData | Bit 0 | | | | |
| | ClrStatistics_RelHumidity | Bit 1 | | | | |
| | ClrStatistics_Temperature | Bit 2 | | | | |
| Measured values | | | | | | |
| 2 | RelHumidity | INT | • | | | |
| 6 | Temperature | INT | • | | | |
| Additional information | | | | | | |
| 4100 | OnTimeConnected | UDINT | • | | | |
| 4108 | OnTimeDisconnected | UDINT | • | | | |
| 4116 | OnTimeCombined | UDINT | • | | | |
| 4124 | PowerCycles | UDINT | • | | | |
| 4134 | RelHumidityMin | INT | • | | | |
| 4138 | RelHumidityMax | INT | • | | | |
| 4150 | TemperatureMin | INT | • | | | |
| 4154 | TemperatureMax | INT | • | | | |
| Data point histogram | | | | | | |
| 4244 + N*16 | RelHumHist0NEntry (index N = 1 to 10) | UDINT | • | | | |
| 4252 + N*16 | RelHumHist0NTime (index N = 1 to 10) | UDINT | • | | | |
| 4404 + N*16 | TempHist0NEntry (index N = 1 to 12) | UDINT | • | | | |
| 4412 + N*16 | TempHist0NTime (index N = 1 to 12) | UDINT | • | | | |
| Flatstream - Configuration (access to internal flash memory) | | | | | | |
| 513 | OutputMTU | USINT | | | | • |
| 515 | InputMTU | USINT | | | | • |
| 517 | FlatstreamMode | USINT | | | | • |
| 519 | Forward | USINT | | | | • |
| 522 | ForwardDelay | UINT | | | | • |
| Flatstream - Communication (access to internal flash memory) | | | | | | |
| 577 | InputSequence | USINT | • | | | |
| 577 + N*2 | RxByteN (index N = 1 to 27) | USINT | • | | | |
| 641 | OutputSequence | USINT | | | • | |
| 641 + N*2 | TxByteN (index N = 1 to 15) | USINT | | | • | |

9.26.11.7.4 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Description | Data type | Read | | Write | |
|-------------------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module - Control | | | | | | | |
| 134 | - | Reset additional information and data point histograms | UINT | | | | • |
| | | ClrStatistics_OperatingData | Bit 0 | | | | |
| | | ClrStatistics_RelHumidity | Bit 1 | | | | |
| | | ClrStatistics_Temperature | Bit 2 | | | | |
| Measured values | | | | | | | |
| 2 | 0 | RelHumidity | INT | • | | | |
| 6 | 2 | Temperature | INT | • | | | |
| Additional information | | | | | | | |
| 4100 | - | OnTimeConnected | UDINT | | • | | |
| 4108 | - | OnTimeDisconnected | UDINT | | • | | |
| 4116 | - | OnTimeCombined | UDINT | | • | | |
| 4124 | - | PowerCycles | UDINT | | • | | |
| 4134 | - | RelHumidityMin | INT | | • | | |
| 4138 | - | RelHumidityMax | INT | | • | | |
| 4150 | - | TemperatureMin | INT | | • | | |
| 4154 | - | TemperatureMax | INT | | • | | |
| Data point histogram | | | | | | | |
| 4244 + N*16 | - | RelHumHist0NEntry (index N = 1 to 10) | UDINT | | • | | |
| 4252 + N*16 | - | RelHumHist0NTime (index N = 1 to 10) | UDINT | | • | | |
| 4404 + N*16 | - | TempHist0NEntry (index N = 1 to 12) | UDINT | | • | | |
| 4412 + N*16 | - | TempHist0NTime (index N = 1 to 12) | UDINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.26.11.7.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.26.11.7.4.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.26.11.7.5 Controller

9.26.11.7.5.1 Reset additional information and data point histograms

Name:

ClrStatistics_OperatingData

ClrStatistics_RelHumidity

ClrStatistics_Temperature

Setting the respective bit in the register resets operating data, information and histograms. Procedure:

- Set the bit for resetting the desired data
- The bit must remain set until the registers have been reset
- As soon as the user has determined that the data has been reset, then the bit for resetting the data can be deleted
- If the bit for resetting the data is not deleted, the data will be permanently set to 0

Information:

It can take up to 1 s until the delete operation for the data is executed.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|--|-------|--------------|
| 0 | ClrStatistics_OperatingData Reset operating data | 0 | Do not reset |
| | | 1 | Reset |
| 1 | ClrStatistics_RelHumidity Resets information and histograms for relative humidity | 0 | Do not reset |
| | | 1 | Reset |
| 2 | ClrStatistics_Temperature Resets information and histograms for ambient temperature | 0 | Do not reset |
| | | 1 | Reset |
| 3 - 15 | Reserved | 0 | |

9.26.11.7.6 Measured values

9.26.11.7.6.1 Relative humidity

Name:

RelHumidity

An internal sensor measures the relative humidity in the area.

| Data type | Values | Information |
|-----------|----------|--------------------------------------|
| INT | 0 to 100 | Relative humidity [%], resolution 1% |

9.26.11.7.6.2 Ambient temperature

Name:

Temperature

An internal sensor measures the ambient temperature.

| Data type | Values | Information |
|-----------|--------------|--|
| INT | -250 to 1250 | Ambient temperature [°C], resolution 0.1°C |

9.26.11.7.7 Additional information

Information:

The following points must be observed:

- Data recorded on the module is saved in intervals of 10 s.
- When resetting the values, it can take up to 1 s until the delete operation is executed (see register "ClrStatistics" on page 3226).

9.26.11.7.7.1 Operating data

Name:

OnTimeConnected
OnTimeDisconnected
OnTimeCombined
PowerCycles

The respective operating data is output in these registers. If needed, the values can be reset using register "ClrStatistics" on page 3226.

| Register | Data type | Values | Information |
|--------------------|-----------|--------------------|---|
| OnTimeConnected | UDINT | 0 to 4,294,967,295 | Operating time during which the module was actively connected to the network master [s], resolution 1 s |
| OnTimeDisconnected | UDINT | 0 to 4,294,967,295 | Operating time during which the module was not actively connected to the network master [s] (blackout mode), resolution 1 s |
| OnTimeCombined | UDINT | 0 to 4,294,967,295 | Total operating time of the module [s], resolution 1 s |
| PowerCycles | UDINT | 0 to 4,294,967,295 | Number of power-on cycles |

9.26.11.7.7.2 Relative humidity

Name:

RelHumidityMin
RelHumidityMax

Information about the relative humidity is output in these registers. The sampling interval is 1 s. If needed, the values can be reset using register "ClrStatistics" on page 3226.

| Register | Data type | Values | Information |
|----------------|-----------|----------|---|
| RelHumidityMin | INT | 0 to 100 | Smallest value that occurred [%], resolution 1% |
| RelHumidityMax | INT | 0 to 100 | Largest value that occurred [%], resolution 1% |

9.26.11.7.7.3 Ambient temperature

Name:

TemperatureMin
TemperatureMax

Information about the ambient temperature is output in these registers. The sampling interval is 1 s. If needed, the values can be reset using register "ClrStatistics" on page 3226.

| Register | Data type | Values | Information |
|----------------|-----------|--------------|--|
| TemperatureMin | INT | -250 to 1250 | Lowest value that occurred [°C], resolution 0.1°C |
| TemperatureMax | INT | -250 to 1250 | Highest value that occurred [°C], resolution 0.1°C |

9.26.11.7.8 Data point histogram

9.26.11.7.8.1 Relative humidity

Name:

RelHumHist01Entry to RelHumHist10Entry

RelHumHist01Time to RelHumHist10Time

The relative humidity histogram data recorded on the module is displayed on these registers. If needed, the values can be reset using register "[ClrStatistics](#)" on page 3226.

| Register | Data type | Values | Information |
|--|-----------|--------------------|--|
| RelHumHist01Entry to RelHumHist10Entry | UDINT | 0 to 4,294,967,295 | Entry counter for the corresponding area |
| RelHumHist01Time to RelHumHist10Time | UDINT | 0 to 4,294,967,295 | Dwell time in corresponding area [s], resolution 1 s |

9.26.11.7.8.2 Ambient temperature

Name:

TempHist01Entry to TempHist12Entry

TempHist01Time to TempHist12Time

The ambient temperature histogram data recorded on the module is displayed on these registers. If needed, the values can be reset using register "[ClrStatistics](#)" on page 3226.

| Register | Data type | Values | Information |
|------------------------------------|-----------|--------------------|--|
| TempHist01Entry to TempHist12Entry | UDINT | 0 to 4,294,967,295 | Entry counter for the corresponding area |
| TempHist01Time to TempHist12Time | UDINT | 0 to 4,294,967,295 | Dwell time in corresponding area [s], resolution 1 s |

9.26.11.7.9 Flatstream communication

For a description of Flatstream communication, see "[Flatstream communication](#)" on page 3802

9.26.11.7.10 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|--|
| 200 μ s | |

9.26.11.7.11 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------------------|--------|
| Temperature and relative humidity | 1 s |
| User flash Flatstream communication | <10 ms |

9.26.12 X20CMR100

Data sheet version: 1.05

9.26.12.1 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Other functions |  |
| X20CMR100 | X20 cabinet monitoring module, integrated temperature and humidity sensor, production data acquisition, integrated Technology Guard | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 557: X20CMR100 - Order data

9.26.12.2 Module description

The module is designed for measuring ambient conditions in the control cabinet as well as recording operating hours and power-on cycles. In addition, the module is equipped with a Technology Guard and supports blackout mode.

Functions:

- "Measuring and evaluating ambient conditions"
- "Recording operating data"
- "Technology Guarding"
- "Blackout mode"

Measuring and evaluating ambient conditions

The ambient conditions are continuously evaluated by the module. The duration in which individual parameters are within certain ranges is stored internally. This makes it possible, for example, to determine how long the system remained in a certain temperature range. The histograms recorded by the module can be read out by the user.

Technology Guarding

With the integrated Technology Guard, it is possible to implement license protection directly via the module instead of the USB dongle. The same functions can be used as with the USB dongle.

Information:

- **Automation Runtime C4.44 or later is required to use the functions of the Technology Guard.**
- **It is important to note that the Technology Guard is not available in function model "Bus controller"!**
- **This module is not suitable for controller redundancy applications.**

Blackout mode

The integrated blackout mode ensures that module functionality is maintained even in the event of network failure.


9.26.12.3 Technical data

| Model number | X20CMR100 |
|--|--|
| Short description | |
| I/O module | Measurement of ambient conditions: Internal module temperature, relative humidity, operating hours, power-on cycles |
| General information | |
| B&R ID code | 0xF1AD |
| Status indicators | Memory access, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Blackout mode | |
| Scope | Module |
| Function | Module function |
| Standalone mode | No |
| Power consumption | |
| Bus | 0.4 W |
| Internal I/O | - |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Technology Guard | |
| Data retention | 10 years at room temperature |
| Guaranteed erase/write cycles | Up to 10 million |
| Application memory | 241 bytes customized data |
| Keying | 128-bit AES, SHA-256, 2048-bit RSA, 224-bit ECC |
| Certifications | |
| CE | Yes |
| UL | cULus E115267 Industrial control equipment |
| Temperature and humidity sensor | |
| Sensor position | Module-internal |
| Sampling rate | 1 s |
| Temperature measurement | |
| Measurement range | -25 to 125°C |
| Resolution | 0.1°C/LSB |
| Max. error | ±0.3°C |
| Humidity measurement | |
| Measurement range | 5 to 95% |
| Resolution | 1%/LSB |
| Max. error | ±2% at 10 to 80% relative humidity ±3% at <10 and >80% relative humidity |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x bus module X20BM11 separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 558: X20CMR100 - Technical data

9.26.12.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|--------------------------------|------------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | Mode RESET |
| | | | Double flash | Blackout mode active |
| | | | Blinking | Mode PREOPERATIONAL |
| | | | On | Mode RUN |
| | e | Red | Off | Module not supplied with power or everything OK |
| | e + r | Solid red / Single green flash | Invalid firmware | |
| | TG | Yellow | Off | Technology Guard is not accessed |
| | | | On | The module accesses the Technology Guard |

9.26.12.5 Pinout



9.26.12.6 Function description

9.26.12.6.1 Measuring and evaluating ambient conditions

The module is equipped with internal sensors to collect the following conditions:

- Relative humidity [%]
- Ambient temperature [°C]

Information:

The sampling rate is 1 s.

Since the sensor for relative humidity and ambient temperature is located directly in the module, the measured values depend on the intrinsic heating of the module and the heat radiated by neighboring modules.

The effect of this warming on the measured values can be circumvented by using an external temperature sensor on another module. The value measured with the external temperature sensor is used as a reference. With this value, the relative humidity at the position of the external temperature sensor is calculated using the Magnus formula.

$$\text{saturated water vapor pressure [Pa]} = 611.2 \cdot e^{\frac{17.62 \cdot \text{temperature}}{243.12 + \text{temperature}}}$$

$$\text{absolute humidity [g/m}^3\text{]} = \frac{\text{saturated water vapor pressure}}{461.52 \cdot (273.15 + \text{temperature})} \cdot 1000$$

$$\text{humidity [g/m}^3\text{]} = \text{absolute humidity} \cdot \text{relative humidity}$$

$$\text{relative humidity [\%]} = \frac{\text{humidity}}{\text{absolute humidity}} \cdot 100$$

Example

The following example calculates the relative humidity at the position of the external temperature sensor using the Magnus formula.

- Relative humidity in module: 20%
- Ambient temperature in module: 40°C
- External temperature sensor: 35°C

Module

$$\text{saturated water vapor pressure}_{\text{module}} = 611.2 \cdot e^{\frac{17.62 \cdot 40}{243.12 + 40}} = 7367.5 \text{ Pa}$$

$$\text{absolute humidity}_{\text{module}} = \frac{7367.5}{461.52 \cdot (273.15 + 40)} \cdot 1000 = 50.98 \text{ g/m}^3$$

$$\text{humidity}_{\text{module}} = 50.98 \cdot 0.2 = 10.2 \text{ g/m}^3$$

External temperature sensor

$$\text{saturated water vapor pressure}_{\text{ExtSensor}} = 611.2 \cdot e^{\frac{17.62 \cdot 35}{243.12 + 35}} = 5612.8 \text{ Pa}$$

$$\text{absolute humidity}_{\text{ExtSensor}} = \frac{5612.8}{461.52 \cdot (273.15 + 35)} \cdot 1000 = 39.47 \text{ g/m}^3$$

$$\text{relative humidity}_{\text{ExtSensor}} = \frac{10.2}{39.47} \cdot 100 = 25.84\%$$

In this example, a deviation of the relative humidity of approx. 6% results between the measured value in the module and the calculated value at the position of the external temperature sensor.

9.26.12.6.1.1 Additional information

The ambient conditions are recorded and evaluated in the module. The following values can be read:

- Smallest value occurred
- Largest value occurred

Information:

The values are saved to module-internal FRAM.

If needed, the values can be reset.

The registers are described in section "[Additional information](#)" on page 3240.

9.26.12.6.1.2 Histogram for relative humidity

A histogram for relative humidity is recorded in the module. The measuring range for the relative humidity is divided into 10 areas:

| Area | Relative humidity | Register |
|------|-------------------|---------------------------------------|
| 1 | 0 to <10% | RelHumHist01Entry RelHumHist01Time |
| 2 | 10 to <20% | RelHumHist02Entry RelHumHist02Time |
| 3 | 20 to <30% | RelHumHist03Entry RelHumHist03Time |
| 4 | 30 to <40% | RelHumHist04Entry RelHumHist04Time |
| 5 | 40 to <50% | RelHumHist05Entry RelHumHist05Time |
| 6 | 50 to <60% | RelHumHist06Entry RelHumHist06Time |
| 7 | 60 to <70% | RelHumHist07Entry RelHumHist07Time |
| 8 | 70 to <80% | RelHumHist08Entry RelHumHist08Time |
| 9 | 80 to <90% | RelHumHist09Entry RelHumHist09Time |
| 10 | 90 to 100% | RelHumHist10Entry RelHumHist10Time |

As soon as the relative humidity reaches one of the predefined areas, a delay time of 3 s begins. Once the delay time has expired, the entry counter is increased by 1 and the dwell time begins. The delay time prevents the counter from constantly being incremented in the crossover area.

Information:

The values are saved to module-internal FRAM.

If needed, the registers can be reset.

The registers are described in section "[Relative humidity](#)" on page 3241.

9.26.12.6.1.3 Histogram for ambient temperature

A histogram for ambient temperature is recorded in the module. The measuring range for the ambient temperature is divided into 12 areas:

| Area | Ambient temperature | Register |
|------|---------------------|-----------------------------------|
| 1 | <-20°C | TempHist01Entry TempHist01Time |
| 2 | -20 to <-10°C | TempHist02Entry TempHist02Time |
| 3 | -10 to <0°C | TempHist03Entry TempHist03Time |
| 4 | 0 to <10°C | TempHist04Entry TempHist04Time |
| 5 | 10 to <20°C | TempHist05Entry TempHist05Time |
| 6 | 20 to <30°C | TempHist06Entry TempHist06Time |
| 7 | 30 to <40°C | TempHist07Entry TempHist07Time |
| 8 | 40 to <50°C | TempHist08Entry TempHist08Time |
| 9 | 50 to <60°C | TempHist09Entry TempHist09Time |
| 10 | 60 to <70°C | TempHist10Entry TempHist10Time |
| 11 | 70 to <80°C | TempHist11Entry TempHist11Time |
| 12 | ≥80°C | TempHist12Entry TempHist12Time |

As soon as the ambient temperature reaches one of the predefined areas, a delay time of 3 s begins. Once the delay time has expired, the entry counter is increased by 1 and the dwell time begins. The delay time prevents the counter from constantly being incremented in the crossover area.

Information:

The values are saved to module-internal FRAM.

If needed, the registers can be reset.

The registers are described in section "[Ambient temperature](#)" on page 3241.

9.26.12.6.2 Recording operating data

The following operating data is collected by the module:

- Operating time with active connection to network master
- Operating time without active connection to network master (blackout mode)
- Total operating time
- Number of power-on cycles

Information:

The values are saved to module-internal FRAM.

If needed, the operating data can be reset.

The registers are described in section "[Operating data](#)" on page 3240.

9.26.12.6.3 Technology Guarding

This module is equipped with a Technology Guard. The Technology Guard integrated in the module results in the following advantages:

- USB interface not required for the Technology Guard
- Module can be used when no additional USB interfaces are available
- Module can be used when USB interfaces are prohibited for security reasons

Technology Guarding for the module is based on the same mechanism as the USB dongle connected to the CPU. The licenses themselves are verified in Automation Runtime on the target system. Automation Runtime will signal a license violation if the system has licensing requirements that are not covered by the licenses on the Technology Guard.

The Technology Guard provides the following possibilities:

- 2 tamper-resistant operating hours counters
- Possible to store multiple B&R licenses
- Customized license storage possible
- Customized data storage possible

Information:

The extended user-specific operation of the Technology Guard is handled via library "AsGuard". For more information about library "AsGuard", see Automation Help.

Information:

Automation Runtime C4.44 or later is required to use the functions of the Technology Guard.

9.26.12.6.4 Blackout mode

For a description of blackout mode, see "[Blackout mode](#)" on page 3794.

9.26.12.7 Register description

9.26.12.7.1 Using this module with SGC target systems

Information:

It is not possible to use the module with SGC target systems.

9.26.12.7.2 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.26.12.7.3 Function model 0 - Standard

| Register | Description | Data type | Read | | Write | |
|-------------------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module - Control | | | | | | |
| 134 | Reset additional information and data point histograms | UINT | | | • | |
| | ClrStatistics_OperatingData | Bit 0 | | | | |
| | ClrStatistics_RelHumidity | Bit 1 | | | | |
| | ClrStatistics_Temperature | Bit 2 | | | | |
| Measured values | | | | | | |
| 2 | RelHumidity | INT | • | | | |
| 6 | Temperature | INT | • | | | |
| Additional information | | | | | | |
| 4100 | OnTimeConnected | UDINT | • | | | |
| 4108 | OnTimeDisconnected | UDINT | • | | | |
| 4116 | OnTimeCombined | UDINT | • | | | |
| 4124 | PowerCycles | UDINT | • | | | |
| 4134 | RelHumidityMin | INT | • | | | |
| 4138 | RelHumidityMax | INT | • | | | |
| 4150 | TemperatureMin | INT | • | | | |
| 4154 | TemperatureMax | INT | • | | | |
| Data point histogram | | | | | | |
| 4244 + N*16 | RelHumHist0NEntry (index N = 1 to 10) | UDINT | • | | | |
| 4252 + N*16 | RelHumHist0NTime (index N = 1 to 10) | UDINT | • | | | |
| 4404 + N*16 | TempHist0NEntry (index N = 1 to 12) | UDINT | • | | | |
| 4412 + N*16 | TempHist0NTime (index N = 1 to 12) | UDINT | • | | | |

9.26.12.7.4 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Description | Data type | Read | | Write | |
|-------------------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module - Control | | | | | | | |
| 134 | - | Reset additional information and data point histograms | UINT | | | | • |
| | | ClrStatistics_OperatingData | Bit 0 | | | | |
| | | ClrStatistics_RelHumidity | Bit 1 | | | | |
| | | ClrStatistics_Temperature | Bit 2 | | | | |
| Measured values | | | | | | | |
| 2 | 0 | RelHumidity | INT | • | | | |
| 6 | 2 | Temperature | INT | • | | | |
| Additional information | | | | | | | |
| 4100 | - | OnTimeConnected | UDINT | | • | | |
| 4108 | - | OnTimeDisconnected | UDINT | | • | | |
| 4116 | - | OnTimeCombined | UDINT | | • | | |
| 4124 | - | PowerCycles | UDINT | | • | | |
| 4134 | - | RelHumidityMin | INT | | • | | |
| 4138 | - | RelHumidityMax | INT | | • | | |
| 4150 | - | TemperatureMin | INT | | • | | |
| 4154 | - | TemperatureMax | INT | | • | | |
| Data point histogram | | | | | | | |
| 4244 + N*16 | - | RelHumHist0NEntry (index N = 1 to 10) | UDINT | | • | | |
| 4252 + N*16 | - | RelHumHist0NTime (index N = 1 to 10) | UDINT | | • | | |
| 4404 + N*16 | - | TempHist0NEntry (index N = 1 to 12) | UDINT | | • | | |
| 4412 + N*16 | - | TempHist0NTime (index N = 1 to 12) | UDINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.26.12.7.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.26.12.7.4.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.26.12.7.5 Controller

9.26.12.7.5.1 Reset additional information and data point histograms

Name:

ClrStatistics_OperatingData

ClrStatistics_RelHumidity

ClrStatistics_Temperature

Setting the respective bit in the register resets operating data, information and histograms. Procedure:

- Set the bit for resetting the desired data
- The bit must remain set until the registers have been reset
- As soon as the user has determined that the data has been reset, then the bit for resetting the data can be deleted
- If the bit for resetting the data is not deleted, the data will be permanently set to 0

Information:

It can take up to 1 s until the delete operation for the data is executed.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|--|-------|--------------|
| 0 | ClrStatistics_OperatingData Resets operating data | 0 | Do not reset |
| | | 1 | Reset |
| 1 | ClrStatistics_RelHumidity Resets information and histograms for relative humidity | 0 | Do not reset |
| | | 1 | Reset |
| 2 | ClrStatistics_Temperature Resets information and histograms for ambient temperature | 0 | Do not reset |
| | | 1 | Reset |
| 3 - 15 | Reserved | 0 | |

9.26.12.7.6 Measured values

9.26.12.7.6.1 Relative humidity

Name:

RelHumidity

An internal sensor measures the relative humidity in the area.

| Data type | Values | Information |
|-----------|----------|--------------------------------------|
| INT | 0 to 100 | Relative humidity [%], resolution 1% |

9.26.12.7.6.2 Ambient temperature

Name:

Temperature

An internal sensor measures the ambient temperature.

| Data type | Values | Information |
|-----------|--------------|--|
| INT | -250 to 1250 | Ambient temperature [°C], resolution 0.1°C |

9.26.12.7.7 Additional information

Information:

The following points must be observed:

- Data recorded on the module is saved in intervals of 10 s.
- When resetting the values, it can take up to 1 s until the delete operation is executed (see register "ClrStatistics" on page 3239).

9.26.12.7.7.1 Operating data

Name:

OnTimeConnected
OnTimeDisconnected
OnTimeCombined
PowerCycles

The respective operating data is output in these registers. If needed, the values can be reset using register "ClrStatistics" on page 3239.

| Register | Data type | Values | Information |
|--------------------|-----------|--------------------|---|
| OnTimeConnected | UDINT | 0 to 4,294,967,295 | Operating time during which the module was actively connected to the network master [s], resolution 1 s |
| OnTimeDisconnected | UDINT | 0 to 4,294,967,295 | Operating time during which the module was not actively connected to the network master [s] (blackout mode), resolution 1 s |
| OnTimeCombined | UDINT | 0 to 4,294,967,295 | Total operating time of the module [s], resolution 1 s |
| PowerCycles | UDINT | 0 to 4,294,967,295 | Number of power-on cycles |

9.26.12.7.7.2 Relative humidity

Name:

RelHumidityMin
RelHumidityMax

Information about the relative humidity is output in these registers. The sampling interval is 1 s. If needed, the values can be reset using register "ClrStatistics" on page 3239.

| Register | Data type | Values | Information |
|----------------|-----------|----------|---|
| RelHumidityMin | INT | 0 to 100 | Smallest value that occurred [%], resolution 1% |
| RelHumidityMax | INT | 0 to 100 | Largest value that occurred [%], resolution 1% |

9.26.12.7.7.3 Ambient temperature

Name:

TemperatureMin
TemperatureMax

Information about the ambient temperature is output in these registers. The sampling interval is 1 s. If needed, the values can be reset using register "ClrStatistics" on page 3239.

| Register | Data type | Values | Information |
|----------------|-----------|--------------|--|
| TemperatureMin | INT | -250 to 1250 | Lowest value that occurred [°C], resolution 0.1°C |
| TemperatureMax | INT | -250 to 1250 | Highest value that occurred [°C], resolution 0.1°C |

9.26.12.7.8 Data point histogram

9.26.12.7.8.1 Relative humidity

Name:

RelHumHist01Entry to RelHumHist10Entry

RelHumHist01Time to RelHumHist10Time

The relative humidity histogram data recorded on the module is displayed on these registers. If needed, the values can be reset using register "[ClrStatistics](#)" on page 3239.

| Register | Data type | Values | Information |
|--|-----------|--------------------|--|
| RelHumHist01Entry to RelHumHist10Entry | UDINT | 0 to 4,294,967,295 | Entry counter for the corresponding area |
| RelHumHist01Time to RelHumHist10Time | UDINT | 0 to 4,294,967,295 | Dwell time in corresponding area [s], resolution 1 s |

9.26.12.7.8.2 Ambient temperature

Name:

TempHist01Entry to TempHist12Entry

TempHist01Time to TempHist12Time

The ambient temperature histogram data recorded on the module is displayed on these registers. If needed, the values can be reset using register "[ClrStatistics](#)" on page 3239.

| Register | Data type | Values | Information |
|------------------------------------|-----------|--------------------|--|
| TempHist01Entry to TempHist12Entry | UDINT | 0 to 4,294,967,295 | Entry counter for the corresponding area |
| TempHist01Time to TempHist12Time | UDINT | 0 to 4,294,967,295 | Dwell time in corresponding area [s], resolution 1 s |

9.26.12.7.9 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μ s |

9.26.12.7.10 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------------------|--------|
| Temperature and relative humidity | 1 s |
| User flash Flatstream communication | <10 ms |

9.26.13 X20CMR111

Data sheet version: 1.06

9.26.13.1 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Other functions |  |
| X20CMR111 | X20 cabinet monitoring module, integrated temperature sensor, moisture sensor and accelerometer, production data acquisition, 2 inputs for external PT1000, 2 digital inputs 24 V, 1 digital output 24 V, 0.5 A, 512 kB flash memory for user data, integrated Technology Guard | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 559: X20CMR111 - Order data

9.26.13.2 Module description

The module is designed for measuring ambient conditions in the control cabinet as well as recording operating hours and power-on cycles. In addition, the module offers the option of storing user data directly on the module, is equipped with a Technology Guard as well as inputs/outputs and supports blackout mode.

Functions:

- [Measuring and evaluating ambient conditions](#)
- [Recording operating data](#)
- [Internal module memory for user data](#)
- [Technology Guarding](#)
- [Configuration of inputs](#)
- [Blackout mode](#)

Measuring and evaluating ambient conditions

The ambient conditions are continuously evaluated by the module. The duration in which individual parameters are within certain ranges is stored internally. This makes it possible, for example, to determine how long the system remained in a certain temperature range. The histograms recorded by the module can be read out by the user.

Internal module memory for user data

With 512 kB nonvolatile user memory (flash), data from the application can be saved directly on the module and also read back from the module. The data is therefore retained after the module or CPU is restarted and remains with the module in the event that the module is connected to another machine or system, for example. Data retention is maintenance-free – without batteries.

Information:

It is important to note that the internal module memory is not available in function model "Bus controller"!

Technology Guarding

With the integrated Technology Guard, it is possible to implement license protection directly via the module instead of the USB dongle. The same functions can be used as with the USB dongle.

Information:

- **Automation Runtime C4.44 or later is required to use the functions of the Technology Guard.**
- **It is important to note that the Technology Guard is not available in function model "Bus controller"!**
- **This module is not suitable for controller redundancy applications.**

Inputs/Outputs

The module is equipped with 2 inputs for PT1000 temperature sensors, 2 digital inputs (24 VDC) and 1 digital output (24 VDC).

Blackout mode

The integrated blackout mode ensures that module functionality is maintained even in the event of network failure.

9.26.13.3 Technical data

| Model number | X20CMR111 |
|--|--|
| Short description | |
| I/O module | Measurement of ambient conditions: Temperature in the module, relative humidity, vibration, shock, position, operating hours, power-on cycles 2 digital inputs, 1 digital output, 2 PT1000 temperature inputs, Technology Guarding |
| General information | |
| B&R ID code | 0xF1AE |
| Status indicators | I/O function by channel, overload, memory access, Technology Guarding, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Output | Yes, using status LED and software (output error status) |
| Blackout mode | |
| Scope | Module |
| Function | Module function |
| Standalone mode | No |
| Power consumption | |
| Bus | 0.4 W |
| Internal I/O | 0.1 W |
| Additional power dissipation caused by actuators (resistive) [W] | +0.075 |
| Application memory | |
| Type | 512 kB flash memory |
| Sectors | 8 sectors, 64 kB each |
| Data retention | 20 years at 55°C |
| Guaranteed erase/write cycles | 100,000 per sector |
| Error-correcting code (ECC) | No |
| Write protection | No |
| Technology Guard | |
| Data retention | 10 years at room temperature |
| Guaranteed erase/write cycles | Up to 10 million |
| Application memory | 241 bytes customized data |
| Keying | 128-bit AES, SHA-256, 2048-bit RSA, 224-bit ECC |
| Certifications | |
| CE | Yes |
| UL | cULus E115267 Industrial control equipment |
| Digital inputs | |
| Quantity | 2 |
| Nominal voltage | 24 VDC |
| Input voltage | 24 VDC -15% / +20% |
| Input current at 24 VDC | Typ. 3.75 mA |
| Input circuit | Sink |
| Input filter | |
| Hardware | ≤100 µs |
| Software | Default 1 ms, configurable between 0 and 25 ms in 0.2 ms intervals |
| Connection type | 1-wire connections |
| Input resistance | Typ. 6.4 kΩ |

Table 560: X20CMR111 - Technical data

| Model number | X20CMR111 |
|--|---|
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Resistance measurement temperature inputs | |
| Quantity | 2 |
| Input | Resistance measurement for 2-wire connections |
| Digital converter resolution | 12-bit |
| Filter time | Configurable |
| Conversion time | 1 ms for all inputs |
| Output format | INT |
| Sensor | |
| PT1000 | -40 to 125°C |
| Input filter | Averaging with clipping function |
| Linearization method | Internal |
| Permissible input signal | Short-term ±15 V |
| Max. gain drift | 0.0003 %/°C |
| Max. offset drift | 0.06 %/°C |
| Nonlinearity | <0.010% |
| Temperature sensor resolution | |
| PT1000 | 1 LSB = 0.1°C |
| Temperature measurement monitoring | |
| Range undershoot | 0x8001 |
| Range overshoot | 0x7FFF |
| Open circuit | 0x7FFF |
| General fault | 0x8000 |
| Open inputs | 0x7FFF |
| Temperature and humidity sensor | |
| Sensor position | Module-internal |
| Sampling rate | 1 s |
| Temperature measurement | |
| Measurement range | -25 to 125°C |
| Resolution | 0.1°C/LSB |
| Max. error | ±0.3°C |
| Humidity measurement | |
| Measurement range | 5 to 95% |
| Resolution | 1%/LSB |
| Max. error | ±2% at 10 to 80% relative humidity ±3% at <10 and >80% relative humidity |
| Acceleration and angle sensor | |
| Sensor position | Module-internal |
| Sampling rate | Typ. 10 ms |
| Acceleration measurement | |
| Measurement range | ±16 g |
| Resolution | 0.488 mg/LSB |
| Linearity over temperature | ±1% at -40 to 85°C |
| Offset calibration error | ±40 mg |
| Angular velocity measurement | |
| Measurement range | ±2000 dps ¹⁾ |
| Resolution | ±70 mdps per LSB |
| Linearity over temperature | ±1.5% at -40 to 85°C |
| Offset calibration error | ±10 dps |
| Digital outputs | |
| Quantity | 1 |
| Variant | FET positive switching |
| Nominal voltage | 24 VDC |
| Switching voltage | 24 VDC -15% / +20% |
| Nominal output current | 0.5 A |
| Connection type | 1- or 2-wire connections |
| Output circuit | Source |
| Diagnostic status | Output monitoring with 10 ms delay |
| Leakage current when switched off | 120 µA |
| R _{DS(on)} | 300 mΩ |
| Switching delay | |
| 0 → 1 | <300 µs |
| 1 → 0 | <300 µs |
| Switching frequency | |
| Resistive load | Max. 100 Hz |
| Inductive load | Max. 0.5 J with single pulse |
| Isolation voltage between channel and bus | 500 V _{eff} |

Table 560: X20CMR111 - Technical data


| Model number | X20CMR111 | |
|--|--|--|
| Protective measures | | |
| Short-circuit proof | Yes | |
| Overload-proof | Temporary overload | |
| Electrical properties | | |
| Electrical isolation | Analog channel not isolated from bus Digital channel isolated from bus Digital channel not isolated from digital channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitation | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x bus module X20BM11 separately | |
| Spacing | 12.5 ^{+0.2} mm | |

Table 560: X20CMR111 - Technical data

1) dps: Degrees per second (°/s)

9.26.13.4 LED status indicators

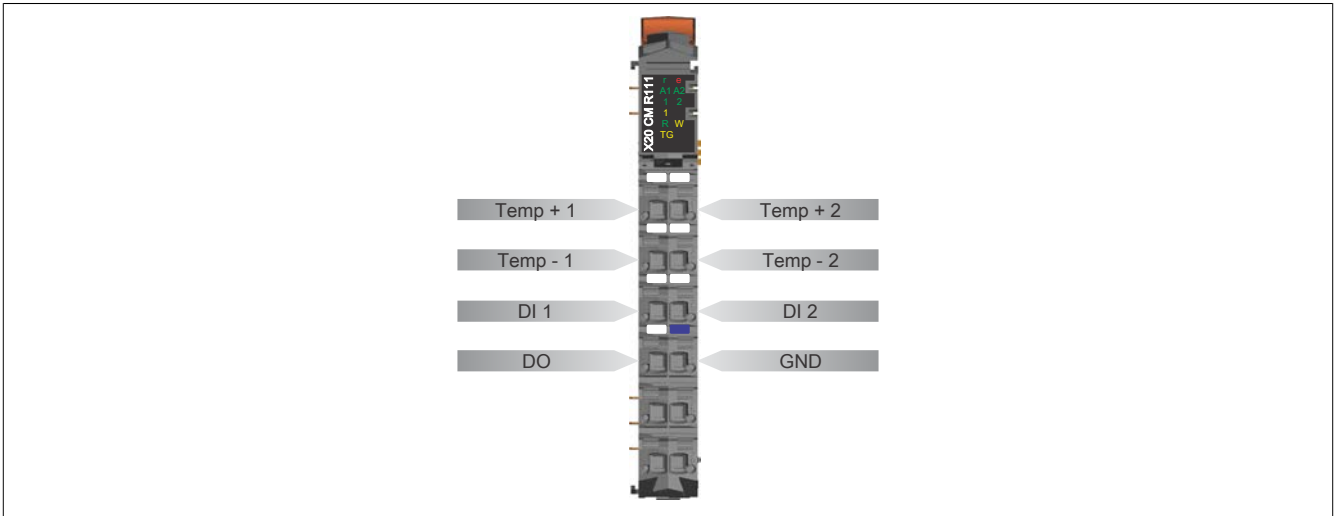
For a description of the various operating modes, see ["Diagnostic LEDs" on page 3787](#).

| Figure | LED | Color | Status | Description |
|---|---------|--------------------------------|--|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | Mode RESET |
| | | | Double flash | Blackout mode active |
| | | | Blinking | Mode PREOPERATIONAL |
| | e | Red | On | Mode RUN |
| | | | Off | Module not supplied with power or everything OK |
| | e + r | Solid red / Single green flash | Invalid firmware | |
| | A1 - A2 | Green | Off | Channel is switched off |
| | | | Blinking | Open circuit, overflow or underflow of the input signal |
| | | | On | Analog/Digital converter running, value OK |
| | 1 - 2 | Green | | Input state of the corresponding digital input |
| | 1 | Yellow | | Output state of the corresponding digital output |
| | R | Green | Off | No data is being read from internal memory. |
| | | | On | The module is reading data from internal memory. |
| | W | Yellow | Off | No data is being written to internal memory. |
| | | | On | The module is writing data to internal memory. |
| Tg | Yellow | Off | Technology Guard is not accessed | |
| | | On | The module accesses the Technology Guard | |

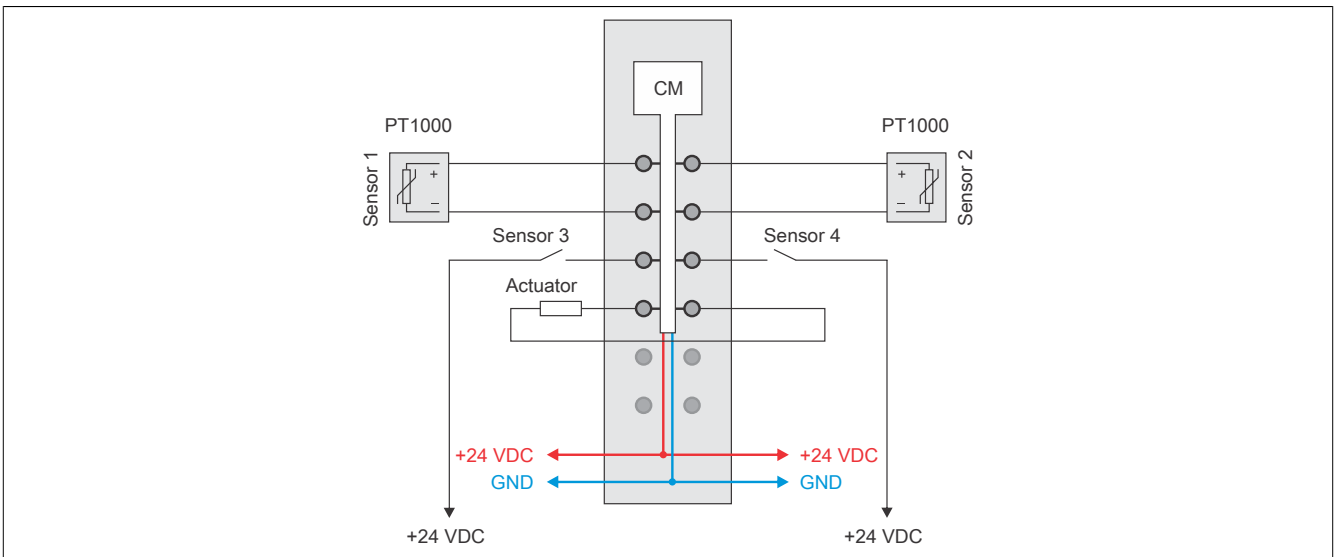
9.26.13.5 Pinout

Information:

The maximum cable length for the external temperature sensor is 20 m.

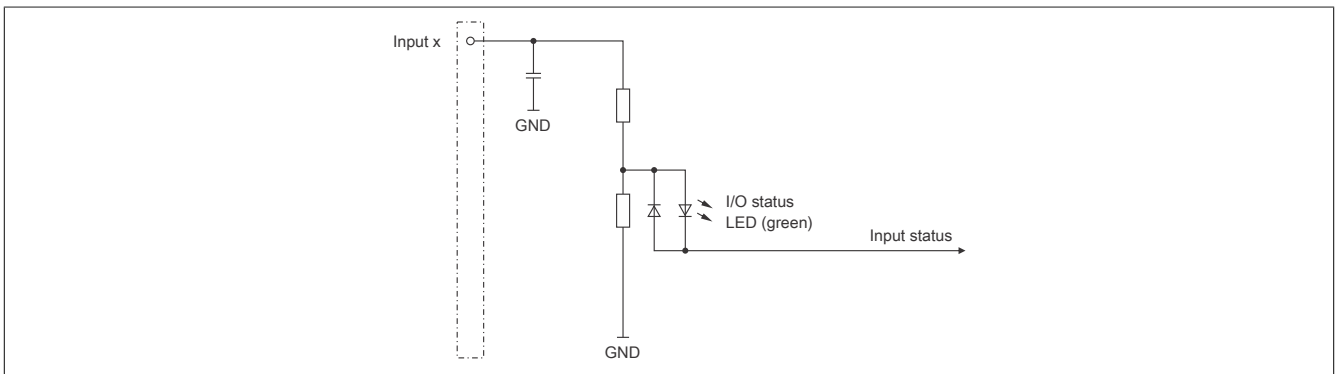


9.26.13.6 Connection example

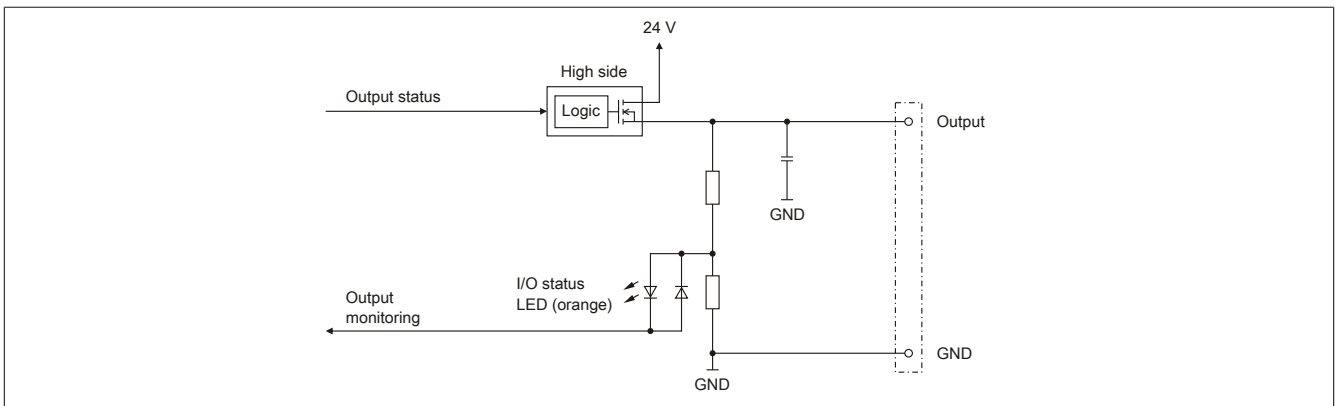


9.26.13.7 Input/Output circuit diagram

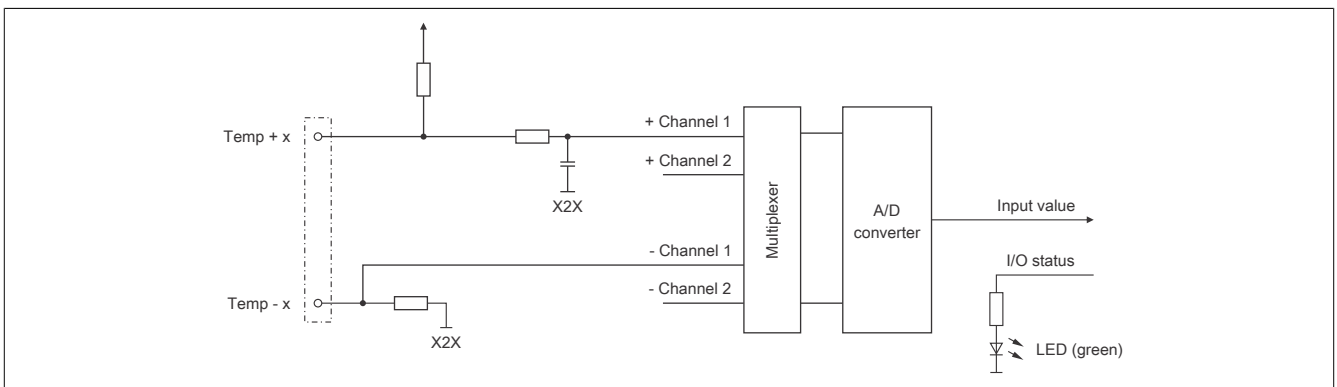
9.26.13.7.1 Digital inputs



9.26.13.7.2 Digital output



9.26.13.7.3 PT1000 temperature inputs



9.26.13.8 Function description

9.26.13.8.1 Measuring and evaluating ambient conditions

The module is equipped with internal sensors to collect the following conditions:

| Condition | Unit | Sampling rate |
|---------------------|-------|---------------|
| Relative humidity | [%] | 1 s |
| Ambient temperature | [°C] | 1 s |
| Acceleration | [g] | Typ. 10 ms |
| Rotation | [dps] | Typ. 10 ms |

9.26.13.8.1.1 Relative humidity and ambient temperature

Since the sensor for relative humidity and ambient temperature is located directly in the module, the measured values depend on the intrinsic heating of the module and the heat radiated by neighboring modules.

The effect of this warming on the measured values can be circumvented by connecting an external temperature sensor on one of the temperature sensors on the module. The value measured with the external temperature sensor is used as a reference. With this value, the relative humidity at the position of the external temperature sensor is calculated using the Magnus formula.

$$\text{saturated water vapor pressure [Pa]} = 611.2 \cdot e^{\frac{17.62 \cdot \text{temperature}}{243.12 + \text{temperature}}}$$

$$\text{absolute humidity [g/m}^3\text{]} = \frac{\text{saturated water vapor pressure}}{461.52 \cdot (273.15 + \text{temperature})} \cdot 1000$$

$$\text{humidity [g/m}^3\text{]} = \text{absolute humidity} \cdot \text{relative humidity}$$

$$\text{relative humidity [\%]} = \frac{\text{humidity}}{\text{absolute humidity}} \cdot 100$$

Example

The following example calculates the relative humidity at the position of the external temperature sensor using the Magnus formula.

- Relative humidity in module: 20%
- Ambient temperature in module: 40°C
- External temperature sensor: 35°C

Module

$$\text{saturated water vapor pressure}_{\text{module}} = 611.2 \cdot e^{\frac{17.62 \cdot 40}{243.12 + 40}} = 7367.5 \text{ Pa}$$

$$\text{absolute humidity}_{\text{module}} = \frac{7367.5}{461.52 \cdot (273.15 + 40)} \cdot 1000 = 50.98 \text{ g/m}^3$$

$$\text{humidity}_{\text{module}} = 50.98 \cdot 0.2 = 10.2 \text{ g/m}^3$$

External temperature sensor

$$\text{saturated water vapor pressure}_{\text{ExtSensor}} = 611.2 \cdot e^{\frac{17.62 \cdot 35}{243.12 + 35}} = 5612.8 \text{ Pa}$$

$$\text{absolute humidity}_{\text{ExtSensor}} = \frac{5612.8}{461.52 \cdot (273.15 + 35)} \cdot 1000 = 39.47 \text{ g/m}^3$$

$$\text{relative humidity}_{\text{ExtSensor}} = \frac{10.2}{39.47} \cdot 100 = 25.84\%$$

In this example, a deviation of the relative humidity of approx. 6% results between the measured value in the module and the calculated value at the position of the external temperature sensor.

9.26.13.8.1.2 Acceleration and rotation

Acceleration and rotation measured by the internal sensor are returned as raw values. The conversion is to be carried out in the application.

| Measured size | Conversion |
|---------------|--|
| Acceleration | 16 g = 32767 -16 g = -32768 |
| Rotation | 2000 dps = 32767 -2000 dps = -32768 |

9.26.13.8.1.3 Additional information

The ambient conditions are recorded and evaluated in the module. The following values can be read:

- Smallest value occurred
- Largest value occurred

Information:

The values are saved to module-internal FRAM.

If needed, the values can be reset.

The registers are described in section ["Additional information" on page 3263](#).

9.26.13.8.1.4 Histogram for relative humidity

A histogram for relative humidity is recorded in the module. The measuring range for the relative humidity is divided into 10 areas:

| Area | Relative humidity | Register |
|------|-------------------|---------------------------------------|
| 1 | 0 to <10% | RelHumHist01Entry RelHumHist01Time |
| 2 | 10 to <20% | RelHumHist02Entry RelHumHist02Time |
| 3 | 20 to <30% | RelHumHist03Entry RelHumHist03Time |
| 4 | 30 to <40% | RelHumHist04Entry RelHumHist04Time |
| 5 | 40 to <50% | RelHumHist05Entry RelHumHist05Time |
| 6 | 50 to <60% | RelHumHist06Entry RelHumHist06Time |
| 7 | 60 to <70% | RelHumHist07Entry RelHumHist07Time |
| 8 | 70 to <80% | RelHumHist08Entry RelHumHist08Time |
| 9 | 80 to <90% | RelHumHist09Entry RelHumHist09Time |
| 10 | 90 to 100% | RelHumHist10Entry RelHumHist10Time |

As soon as the relative humidity reaches one of the predefined areas, a delay time of 3 s begins. Once the delay time has expired, the entry counter is increased by 1 and the dwell time begins. The delay time prevents the counter from constantly being incremented in the crossover area.

Information:

The values are saved to module-internal FRAM.

If needed, the registers can be reset.

The registers are described in section ["Relative humidity" on page 3265](#).

9.26.13.8.1.5 Histogram for ambient temperature

A histogram for ambient temperature is recorded in the module. The measuring range for the ambient temperature is divided into 12 areas:

| Area | Ambient temperature | Register |
|------|---------------------|-----------------------------------|
| 1 | <-20°C | TempHist01Entry TempHist01Time |
| 2 | -20 to <-10°C | TempHist02Entry TempHist02Time |
| 3 | -10 to <0°C | TempHist03Entry TempHist03Time |
| 4 | 0 to <10°C | TempHist04Entry TempHist04Time |
| 5 | 10 to <20°C | TempHist05Entry TempHist05Time |
| 6 | 20 to <30°C | TempHist06Entry TempHist06Time |
| 7 | 30 to <40°C | TempHist07Entry TempHist07Time |
| 8 | 40 to <50°C | TempHist08Entry TempHist08Time |
| 9 | 50 to <60°C | TempHist09Entry TempHist09Time |
| 10 | 60 to <70°C | TempHist10Entry TempHist10Time |
| 11 | 70 to <80°C | TempHist11Entry TempHist11Time |
| 12 | ≥80°C | TempHist12Entry TempHist12Time |

As soon as the ambient temperature reaches one of the predefined areas, a delay time of 3 s begins. Once the delay time has expired, the entry counter is increased by 1 and the dwell time begins. The delay time prevents the counter from constantly being incremented in the crossover area.

Information:

The values are saved to module-internal FRAM.

If needed, the registers can be reset.

The registers are described in section "[Ambient temperature](#)" on page 3265.

9.26.13.8.1.6 Histogram for acceleration

A histogram for acceleration is recorded in the module. The measurement range for the acceleration is divided into 8 areas:

| Area | Acceleration | Register |
|------|---------------|-------------------------------------|
| 1 | -16 to <-12 g | AccHist0N01Entry AccHist0N01Time |
| 2 | -12 to <-8 g | AccHist0N02Entry AccHist0N02Time |
| 3 | -8 to <-4 g | AccHist0N03Entry AccHist0N03Time |
| 4 | -4 to <0 g | AccHist0N04Entry AccHist0N04Time |
| 5 | 0 to <4 g | AccHist0N05Entry AccHist0N05Time |
| 6 | 4 to <8 g | AccHist0N06Entry AccHist0N06Time |
| 7 | 8 to <12 g | AccHist0N07Entry AccHist0N07Time |
| 8 | 12 to 16 g | AccHist0N08Entry AccHist0N08Time |

Legend: N = 1 to 3

As soon as the acceleration reaches one of the predefined areas, a delay time of 3 s begins. Once the delay time has expired, the entry counter is increased by 1 and the dwell time begins. The delay time prevents the counter from constantly being incremented in the crossover area.

Information:

The values are saved to module-internal FRAM.

If needed, the registers can be reset.

The registers are described in section "[Acceleration](#)" on page 3265.

9.26.13.8.1.7 Histogram for rotation

A histogram for rotation is recorded in the module. The measurement range for the rotation is divided into 8 areas:

| Area | Rotation | Register |
|------|---------------------|---|
| 1 | -2000 to <-1500 dps | RotationHist0N01Entry RotationHist0N01Time |
| 2 | -1500 to <-1000 dps | RotationHist0N02Entry RotationHist0N02Time |
| 3 | -1000 to <-500 dps | RotationHist0N03Entry RotationHist0N03Time |
| 4 | -500 to <0 dps | RotationHist0N04Entry RotationHist0N04Time |
| 5 | 0 to <500 dps | RotationHist0N05Entry RotationHist0N05Time |
| 6 | 500 to <1000 dps | RotationHist0N06Entry RotationHist0N06Time |
| 7 | 1000 to <1500 dps | RotationHist0N07Entry RotationHist0N07Time |
| 8 | 1500 to 2000 dps | RotationHist0N08Entry RotationHist0N08Time |

Legend: N = 1 to 3

As soon as the rotation reaches one of the predefined areas, a delay time of 3 s begins. Once the delay time has expired, the entry counter is increased by 1 and the dwell time begins. The delay time prevents the counter from constantly being incremented in the crossover area.

Information:

The values are saved to module-internal FRAM.

If needed, the registers can be reset.

The registers are described in section ["Rotation" on page 3265](#).

9.26.13.8.2 Recording operating data

The following operating data is collected by the module:

- Operating time with active connection to network master
- Operating time without active connection to network master (blackout mode)
- Total operating time
- Number of power-on cycles

Information:

The values are saved to module-internal FRAM.

If needed, the operating data can be reset.

The registers are described in section ["Operating data" on page 3263](#).

9.26.13.8.3 Internal module memory for user data

9.26.13.8.3.1 General information

The module is equipped with 512 kB nonvolatile internal flash memory that can be used by the application. Data can be saved directly to the module and then read back. This makes it possible to store recipe data or production information about the machine on the module, for example.

9.26.13.8.3.2 Operation

The module's memory interface is based on Flatstream communication. Operation takes place using library "AsFitGen".

Information:

For more information about library "AsFitGen", see [Automation Help](#).

Information:

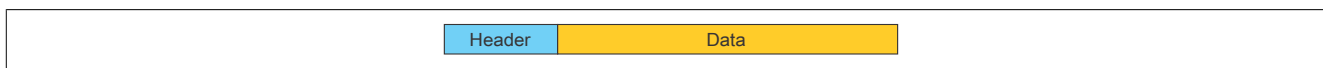
The following points must be observed:

- Up to 256 bytes can be read or written per read or write command. These 256 bytes represent a page. If more than 256 bytes must be read or written, then a consecutive sequence of commands and memory management must be implemented in the application.
- The erase command is based on sectors. One sector is 64 kB. This corresponds to 256 pages. The entire sector containing the specified address is erased. The flash memory is divided into a total of 8 sectors (8 x 64 kB = 512 kB).
- In order to overwrite data, the corresponding sector must first be erased. Only then can the new data be saved.
- Memory can be arranged as needed. A separate sector should be used for data that is overwritten regularly.

9.26.13.8.3.3 Commands

Protocol

A header precedes each command. The data follows the header and depends on the command.



Header



Each request or response begins with a 16-byte header. The following elements must be defined in the header:

| Element | Data type | Activity | Description |
|--------------------|-----------|-------------|---|
| Code | USINT | Requirement | Defines the command: "r" ... Read data (ASCII code 0x72) "w" ... Write data (ASCII code 0x77) "e" ... Erase data (ASCII code 0x65) |
| | | Response | The command code contained in the request is sent back. |
| Consecutive number | USINT | Requirement | Unrestricted use. The consecutive number is important, for example, if more than 256 bytes must be read or written. In this case, the user must implement a sequential series of commands and memory management in the application. |
| | | Response | The number contained in the request is sent back. |
| Status | UINT | Requirement | Not used: The byte is not evaluated. |
| | | Response | Status response: 0x0000 ... Command executed successfully 0x8001 ... Invalid: General fault 0x8002 ... Invalid address 0x8003 ... Invalid size 0x8004 ... Flash memory busy 0x8006 ... Flash memory timeout |
| Address | UDINT | Requirement | Starting address from which data should be read or written. |
| | | Response | The starting address contained in the request is sent back. |
| Data size | UDINT | Requirement | Size of the data to be read or written. |
| | | Response | The data size contained in the request is sent back. |
| Reserve | UDINT | Reserved | |


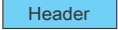
Write data

| Action | Description |
|-------------|--|
| Requirement | In order to save data to the module, the header must be prepared for communication. The data is appended directly to the header. The header and data must be specified to function block "fitWrite" as a transmit buffer. <div style="text-align: center; margin-top: 10px;"> </div> |
| Response | The module's response – the returned header – is stored in the receive buffer using function block "fitRead" and can be evaluated by the application. <div style="text-align: center; margin-top: 10px;"> </div> |

Read data

| Action | Description |
|-------------|---|
| Requirement | In order to read data from the module, the header must be prepared for communication. The header must be specified to function block "ftWrite" as a transmit buffer.  |
| Response | The module's response – the returned header and data – is stored in the receive buffer using function block "ftRead" and can be evaluated by the application.  |

Erasing a sector

| Action | Description |
|-------------|--|
| Requirement | In order to erase an area of the module's flash memory, the header must be prepared for communication. The entire 64 kB sector containing the specified address is erased. The header must be specified to function block "ftWrite" as a transmit buffer.  |
| Response | The module's response – the returned header – is stored in the receive buffer using function block "ftRead" and can be evaluated by the application.  |

9.26.13.8.4 Technology Guarding

This module is equipped with a Technology Guard. The Technology Guard integrated in the module results in the following advantages:

- USB interface not required for the Technology Guard
- Module can be used when no additional USB interfaces are available
- Module can be used when USB interfaces are prohibited for security reasons

Technology Guarding for the module is based on the same mechanism as the USB dongle connected to the CPU. The licenses themselves are verified in Automation Runtime on the target system. Automation Runtime will signal a license violation if the system has licensing requirements that are not covered by the licenses on the Technology Guard.

The Technology Guard provides the following possibilities:

- 2 tamper-resistant operating hours counters
- Possible to store multiple B&R licenses
- Customized license storage possible
- Customized data storage possible

Information:

The extended user-specific operation of the Technology Guard is handled via library "AsGuard". For more information about library "AsGuard", see Automation Help.

Information:

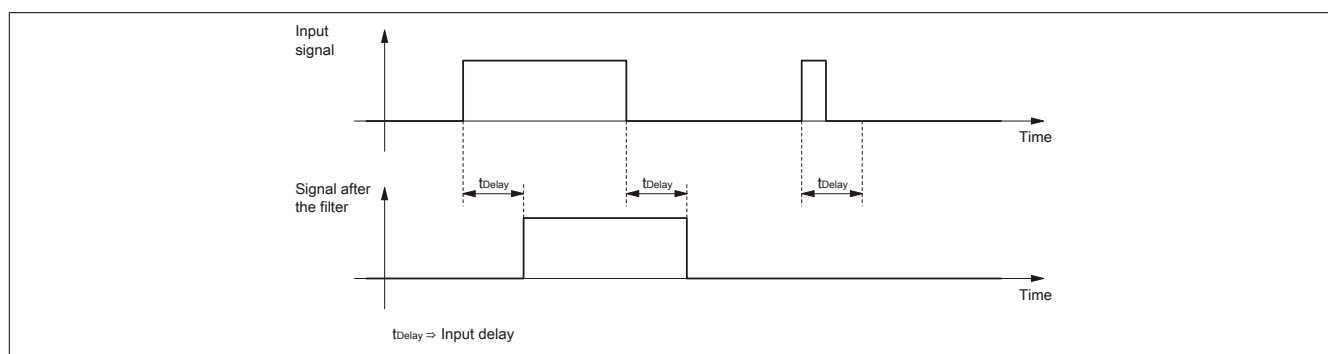
Automation Runtime C4.44 or later is required to use the functions of the Technology Guard.

9.26.13.8.5 Digital inputs

This module is equipped with 2 digital inputs. This makes it possible to use a door contact to determine whether the control cabinet door is open or closed, for example.

9.26.13.8.5.1 Input filter

An input filter is available for each input. Disturbance pulses which are shorter than the input delay are suppressed by the input filter.



The input delay can be set in steps of 100 μs . It makes sense to enter values in steps of 2, however, since the input signals are sampled every 200 μs .

| Values | Filter |
|--------|--|
| 0 | No software filter |
| 2 | 0.2 ms |
| ... | ... |
| 250 | 25 ms - Higher values are limited to this value. |

Information:

The register is described in section "Digital input filter" on page 3258.

9.26.13.8.5.2 Record input state

Unfiltered

The input state is collected with a fixed offset to the network cycle and transferred in the same cycle.

Filtered

The filtered status is collected with a fixed offset to the network cycle and transferred in the same cycle. Filtering takes place asynchronously to the network in multiples of 200 µs with a network-related jitter of up to 50 µs.

9.26.13.8.6 Analog inputs

Using 2 PT1000 temperature inputs, the control cabinet temperature can be determined at critical locations.

9.26.13.8.6.1 Filter level

The filter level determines the number of measurements for averaging. The external temperature sensors are measured every 1 ms. This means that by default, a new value (100 x 1 ms = 100 ms) with 100 measurements is available for averaging every 100 ms.

Information:

The register is described in section "[Filter level and input ramp limiting](#)" on page 3259.

9.26.13.8.6.2 Input ramp limiting

Input ramp limiting can only be performed in conjunction with filtering. Input ramp limiting is performed before filtering.

The difference of the input value change is checked for exceeding the specified limit. In the event of overshoot, the tracked input value is equal to the old value ± the limit value. The input value is monitored with the scanning grid every 1 ms.

Input ramp limiting is well suited for suppressing disturbances (spikes).

Information:

The register is described in section "[Filter level and input ramp limiting](#)" on page 3259.

9.26.13.8.6.3 Limiting the analog value

When an error state occurs, the analog value is set by default to the values listed below.

| Error state | Digital value on error |
|------------------------------|-------------------------------|
| Open circuit | 32767 (0x7FFF) |
| Upper limit value overshoot | 32767 (0x7FFF) |
| Lower limit value undershoot | -32767 (0x8001) |
| Invalid value | -32768 (0x8000) ¹⁾ |

1) After switching off the channel during operation or when the channel is disabled

9.26.13.8.6.4 Output value

In order for the user to always be supplied with a defined output value, the following must be taken into consideration:

- Up to the first conversion, 0x8000 is output.
- If the input is not switched on, 0x8000 is output.

9.26.13.8.7 Blackout mode

For a description of blackout mode, see "[Blackout mode](#)" on page 3794.

9.26.13.9 Register description

9.26.13.9.1 Using this module with SGC target systems

Information:

It is not possible to use the module with SGC target systems.

9.26.13.9.2 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.26.13.9.3 Function model 0 - Standard

| Register | Description | Data type | Read | | Write | |
|-------------------------------|---|----------------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module - Configuration | | | | | | |
| 794 | CfO_DiFilter | UINT | | | | • |
| 798 | CfO_AnFilter | UINT | | | | • |
| 802 | CfO_AnEnable | UINT | | | | • |
| Module - Control | | | | | | |
| 129 | Switching state of the digital output DigitalOutput01 | USINT Bit 0 | | | • | |
| 134 | Reset additional information and data point histograms ClrStatistics_OperatingData | UINT Bit 0 | | | • | |
| | ClrStatistics_RelHumidity | Bit 1 | | | | |
| | ClrStatistics_Temperature | Bit 2 | | | | |
| | ClrStatistics_Acceleration01 | Bit 8 | | | | |
| | ClrStatistics_Acceleration02 | Bit 9 | | | | |
| | ClrStatistics_Acceleration03 | Bit 10 | | | | |
| | ClrStatistics_Rotation01 | Bit 11 | | | | |
| | ClrStatistics_Rotation02 | Bit 12 | | | | |
| | ClrStatistics_Rotation03 | Bit 13 | | | | |
| Module communication | | | | | | |
| 41 | Status of digital inputs, digital output and I/O power supply DigitalInput01 | USINT Bit 0 | • | | | |
| | DigitalInput02 | Bit 1 | | | | |
| | StateDigitalOutput01 | Bit 4 | | | | |
| | PowerSupply | Bit 7 | | | | |
| 46 | ModuleState01 | UINT | • | | | |
| Measured values | | | | | | |
| 2 | RelHumidity | INT | • | | | |
| 6 | Temperature | INT | • | | | |
| 10 | Acceleration01 | INT | • | | | |
| 14 | Acceleration02 | INT | • | | | |
| 18 | Acceleration03 | INT | • | | | |
| 22 | Rotation01 | INT | • | | | |
| 26 | Rotation02 | INT | • | | | |
| 30 | Rotation03 | INT | • | | | |
| 34 | TempExt01 | INT | • | | | |
| 38 | TempExt02 | INT | • | | | |
| Additional information | | | | | | |
| 4100 | OnTimeConnected | UDINT | • | | | |
| 4108 | OnTimeDisconnected | UDINT | • | | | |
| 4116 | OnTimeCombined | UDINT | • | | | |
| 4124 | PowerCycles | UDINT | • | | | |
| 4134 | RelHumidityMin | INT | • | | | |
| 4138 | RelHumidityMax | INT | • | | | |
| 4150 | TemperatureMin | INT | • | | | |
| 4154 | TemperatureMax | INT | • | | | |
| 4166 + N*16 | Acceleration0NMin (index N = 1 to 3) | INT | • | | | |
| 4170 + N*16 | Acceleration0NMax (index N = 1 to 3) | INT | • | | | |
| 4198 + N*16 | Rotation0NMin (index N = 1 to 3) | INT | • | | | |
| 4202 + N*16 | Rotation0NMax (index N = 1 to 3) | INT | • | | | |
| Data point histogram | | | | | | |
| 4244 + N*16 | RelHumHist0NEntry (index N = 1 to 10) | UDINT | • | | | |
| 4252 + N*16 | RelHumHist0NTime (index N = 1 to 10) | UDINT | • | | | |
| 4404 + N*16 | TempHist0NEntry (index N = 1 to 12) | UDINT | • | | | |
| 4412 + N*16 | TempHist0NTime (index N = 1 to 12) | UDINT | • | | | |
| 4596 + N*16 | AccHist010NEntry (index N = 1 to 8) | UDINT | • | | | |
| 4604 + N*16 | AccHist010NTime (index N = 1 to 8) | UDINT | • | | | |

| Register | Description | Data type | Read | | Write | |
|---|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 4724 + N*16 | AccHist020NEntry (index N = 1 to 8) | UDINT | • | | | |
| 4732 + N*16 | AccHist020NTime (index N = 1 to 8) | UDINT | • | | | |
| 4852 + N*16 | AccHist030NEntry (index N = 1 to 8) | UDINT | • | | | |
| 4860 + N*16 | AccHist030NTime (index N = 1 to 8) | UDINT | • | | | |
| 4980 + N*16 | RotationHist010NEntry (index N = 1 to 8) | UDINT | • | | | |
| 4988 + N*16 | RotationHist010NTime (index N = 1 to 8) | UDINT | • | | | |
| 5108 + N*16 | RotationHist020NEntry (index N = 1 to 8) | UDINT | • | | | |
| 5116 + N*16 | RotationHist020NTime (index N = 1 to 8) | UDINT | • | | | |
| 5236 + N*16 | RotationHist030NEntry (index N = 1 to 8) | UDINT | • | | | |
| 5244 + N*16 | RotationHist030NTime (index N = 1 to 8) | UDINT | • | | | |
| Flatstream - Configuration (access to internal flash memory) | | | | | | |
| 513 | OutputMTU | USINT | | | | • |
| 515 | InputMTU | USINT | | | | • |
| 517 | FlatstreamMode | USINT | | | | • |
| 519 | Forward | USINT | | | | • |
| 522 | ForwardDelay | UINT | | | | • |
| Flatstream - Communication (access to internal flash memory) | | | | | | |
| 577 | InputSequence | USINT | • | | | |
| 577 + N*2 | RxByteN (index N = 1 to 27) | USINT | • | | | |
| 641 | OutputSequence | USINT | | | • | |
| 641 + N*2 | TxByteN (index N = 1 to 15) | USINT | | | • | |

9.26.13.9.4 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Description | Data type | Read | | Write | |
|-------------------------------|----------------------|---|---|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module - Configuration | | | | | | | |
| 794 | - | CfO_DiFilter | UINT | | | | • |
| 798 | - | CfO_AnFilter | UINT | | | | • |
| 802 | - | CfO_AnEnable | UINT | | | | • |
| Module - Control | | | | | | | |
| 129 | 2 | Switching state of the digital output DigitalOutput01 | USINT Bit 0 | | | • | |
| 134 | - | Reset additional information and data point histograms ClrStatistics_OperatingData ClrStatistics_RelHumidity ClrStatistics_Temperature ClrStatistics_Acceleration01 ClrStatistics_Acceleration02 ClrStatistics_Acceleration03 ClrStatistics_Rotation01 ClrStatistics_Rotation02 ClrStatistics_Rotation03 | UINT Bit 0 Bit 1 Bit 2 Bit 8 Bit 9 Bit 10 Bit 11 Bit 12 Bit 13 | | | | • |
| Module communication | | | | | | | |
| 41 | 20 | Status of digital inputs, digital output and I/O power supply DigitalInput01 DigitalInput02 StateDigitalOutput01 PowerSupply | USINT Bit 0 Bit 1 Bit 4 Bit 7 | • | | | |
| 46 | 22 | ModuleState01 | UINT | • | | | |
| Measured values | | | | | | | |
| 2 | 0 | RelHumidity | INT | • | | | |
| 6 | 2 | Temperature | INT | • | | | |
| 10 | 4 | Acceleration01 | INT | • | | | |
| 14 | 6 | Acceleration02 | INT | • | | | |
| 18 | 8 | Acceleration03 | INT | • | | | |
| 22 | 10 | Rotation01 | INT | • | | | |
| 26 | 12 | Rotation02 | INT | • | | | |
| 30 | 14 | Rotation03 | INT | • | | | |
| 34 | 16 | TempExt01 | INT | • | | | |
| 38 | 18 | TempExt02 | INT | • | | | |
| Additional information | | | | | | | |
| 4100 | - | OnTimeConnected | UDINT | | • | | |
| 4108 | - | OnTimeDisconnected | UDINT | | • | | |
| 4116 | - | OnTimeCombined | UDINT | | • | | |
| 4124 | - | PowerCycles | UDINT | | • | | |
| 4134 | - | RelHumidityMin | INT | | • | | |
| 4138 | - | RelHumidityMax | INT | | • | | |
| 4150 | - | TemperatureMin | INT | | • | | |
| 4154 | - | TemperatureMax | INT | | • | | |
| 4166 + N*16 | - | Acceleration0NMin (index N = 1 to 3) | INT | | • | | |

| Register | Offset ¹⁾ | Description | Data type | Read | | Write | |
|-----------------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 4170 + N*16 | - | Acceleration0NMax (index N = 1 to 3) | INT | | • | | |
| 4198 + N*16 | - | Rotation0NMin (index N = 1 to 3) | INT | | • | | |
| 4202 + N*16 | - | Rotation0NMax (index N = 1 to 3) | INT | | • | | |
| Data point histogram | | | | | | | |
| 4244 + N*16 | - | RelHumHist0NEntry (index N = 1 to 10) | UDINT | | • | | |
| 4252 + N*16 | - | RelHumHist0NTime (index N = 1 to 10) | UDINT | | • | | |
| 4404 + N*16 | - | TempHist0NEntry (index N = 1 to 12) | UDINT | | • | | |
| 4412 + N*16 | - | TempHist0NTime (index N = 1 to 12) | UDINT | | • | | |
| 4596 + N*16 | - | AccHist010NEntry (index N = 1 to 8) | UDINT | | • | | |
| 4604 + N*16 | - | AccHist010NTime (index N = 1 to 8) | UDINT | | • | | |
| 4724 + N*16 | - | AccHist020NEntry (index N = 1 to 8) | UDINT | | • | | |
| 4732 + N*16 | - | AccHist020NTime (index N = 1 to 8) | UDINT | | • | | |
| 4852 + N*16 | - | AccHist030NEntry (index N = 1 to 8) | UDINT | | • | | |
| 4860 + N*16 | - | AccHist030NTime (index N = 1 to 8) | UDINT | | • | | |
| 4980 + N*16 | - | RotationHist010NEntry (index N = 1 to 8) | UDINT | | • | | |
| 4988 + N*16 | - | RotationHist010NTime (index N = 1 to 8) | UDINT | | • | | |
| 5108 + N*16 | - | RotationHist020NEntry (index N = 1 to 8) | UDINT | | • | | |
| 5116 + N*16 | - | RotationHist020NTime (index N = 1 to 8) | UDINT | | • | | |
| 5236 + N*16 | - | RotationHist030NEntry (index N = 1 to 8) | UDINT | | • | | |
| 5244 + N*16 | - | RotationHist030NTime (index N = 1 to 8) | UDINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.26.13.9.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.26.13.9.4.2 CAN I/O bus controller

The module occupies 4 analog logical slots on CAN I/O.

9.26.13.9.5 Configuration

9.26.13.9.5.1 Digital input filter

Name:

CfO_DiFilter

The filter value for all digital inputs can be configured in this register.

| Data type | Values | Filter |
|-----------|--------|---|
| USINT | 0 | No software filter (bus controller default setting) |
| | 2 | 0.2 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value. |

9.26.13.9.5.2 Filter level and input ramp limiting

Name:

CfO_AnFilter

The filter level and input ramp limiting of the input filter of the analog inputs are set in this register.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|---------------------|-------|--|
| 0 - 7 | Filter level | 0 | Filter switched off |
| | | 1 | 1 measurement |
| | | 2 | 2 measurements |
| | | 3 | 3 measurements |
| | | : | : |
| | | 100 | 100 measurements: Default |
| | | : | : |
| | | 255 | 255 measurements |
| 8 - 10 | Input ramp limiting | 000 | The input value is applied without limiting. |
| | | 001 | Limit value = 0x3FFF (16383) |
| | | 010 | Limit value = 0x1FFF (8191) |
| | | 011 | Limit value = 0x0FFF (4095) |
| | | 100 | Limit value = 0x07FF (2047) |
| | | 101 | Limit value = 0x03FF (1023) |
| | | 110 | Limit value = 0x01FF (511) |
| | | 111 | Limit value = 0x00FF (255): Default |
| 11 - 15 | Reserved | 0 | |

9.26.13.9.5.3 Enable analog input

Name:

CfO_AnEnable

These registers enable the analog inputs

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|--------|-------------|-------|-------------|
| 0 | Channel 1 | 0 | Not enabled |
| | | 1 | Enabled |
| 1 - 7 | Reserved | 0 | |
| 8 | Channel 2 | 0 | Not enabled |
| | | 1 | Enabled |
| 9 - 15 | Reserved | 0 | |

9.26.13.9.6 Controller

9.26.13.9.6.1 Switching state of the digital output

Name:

DigitalOutput01

This register controls the digital output.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------|-------|--------------|
| 0 | DigitalOutput01 | 0 | Reset output |
| | | 1 | Set output |
| 1 - 7 | Reserved | 0 | |

9.26.13.9.6.2 Reset additional information and data point histograms

Name:

ClrStatistics_OperatingData

ClrStatistics_RelHumidity

ClrStatistics_Temperature

ClrStatistics_Acceleration01 to ClrStatistics_Acceleration03

ClrStatistics_Rotation01 to ClrStatistics_Rotation03

Setting the respective bit in the register resets operating data, information and histograms. Procedure:

- Set the bit for resetting the desired data
- The bit must remain set until the registers have been reset
- As soon as the user has determined that the data has been reset, then the bit for resetting the data can be deleted
- If the bit for resetting the data is not deleted, the data will be permanently set to 0

Information:

It can take up to 1 s until the delete operation for the data is executed.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|--|-------|--------------|
| 0 | ClrStatistics_OperatingData Resets operating data | 0 | Do not reset |
| | | 1 | Reset |
| 1 | ClrStatistics_RelHumidity Resets information and histograms for relative humidity | 0 | Do not reset |
| | | 1 | Reset |
| 2 | ClrStatistics_Temperature Resets information and histograms for ambient temperature | 0 | Do not reset |
| | | 1 | Reset |
| 3 - 7 | Reserved | 0 | |
| 8 | ClrStatistics_Acceleration01 Resets information and histograms for Acceleration01 | 0 | Do not reset |
| | | 1 | Reset |
| 9 | ClrStatistics_Acceleration02 Resets information and histograms for Acceleration02 | 0 | Do not reset |
| | | 1 | Reset |
| 10 | ClrStatistics_Acceleration03 Resets information and histograms for Acceleration03 | 0 | Do not reset |
| | | 1 | Reset |
| 11 | ClrStatistics_Rotation01 Resets information and histograms for Rotation01 | 0 | Do not reset |
| | | 1 | Reset |
| 12 | ClrStatistics_Rotation02 Resets information and histograms for Rotation02 | 0 | Do not reset |
| | | 1 | Reset |
| 13 | ClrStatistics_Rotation03 Resets information and histograms for Rotation03 | 0 | Do not reset |
| | | 1 | Reset |
| 14 - 15 | Reserved | 0 | |

9.26.13.9.7 Communication**9.26.13.9.7.1 Status of digital inputs, digital output and I/O power supply**

Name:

DigitalInput01

DigitalInput02

StateDigitalOutput01

PowerSupply

This register is used to indicate the status of the digital inputs, the digital output and the I/O power supply voltage.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--|--------|--|
| 0 | DigitalInput01 | 0 or 1 | Input state - Digital input 1 |
| 1 | DigitalInput02 | 0 or 1 | Input state - Digital input 2 |
| 2 - 3 | Reserved | - | |
| 4 | StateDigitalOutput01 | 0 or 1 | Output state digital output 1 |
| 5 - 6 | Reserved | - | |
| 7 | PowerSupply State of I/O power supply voltage | 0 | I/O power supply in the permissible range: 24 VDC -15% / +20% |
| | | 1 | I/O power supply outside the permissible range |

9.26.13.9.7.2 Module status

Name:

ModuleState01

Status register for monitoring analog inputs.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|------------------|
| 0 - 1 | Channel 1 | 00 | No error |
| | | 01 | Range undershoot |
| | | 10 | Range overshoot |
| | | 11 | Open circuit |
| 2 - 3 | Channel 2 | 00 | No error |
| | | 01 | Range undershoot |
| | | 10 | Range overshoot |
| | | 11 | Open circuit |
| 4 - 7 | Reserved | - | |

9.26.13.9.8 Measured values**9.26.13.9.8.1 Relative humidity**

Name:
RelHumidity

An internal sensor measures the relative humidity in the area.

| Data type | Values | Information |
|-----------|----------|--------------------------------------|
| INT | 0 to 100 | Relative humidity [%], resolution 1% |

9.26.13.9.8.2 Ambient temperature

Name:
Temperature

An internal sensor measures the ambient temperature.

| Data type | Values | Information |
|-----------|--------------|--|
| INT | -250 to 1250 | Ambient temperature [°C], resolution 0.1°C |

9.26.13.9.8.3 Acceleration

Name:
Acceleration01 to Acceleration03

An internal sensor measures the acceleration.

| Data type | Values | Information |
|-----------|-----------------|---|
| INT | -32768 to 32767 | Acceleration as raw value. The conversion is to be carried out in the application: <ul style="list-style-type: none"> • 16 g = 32767 • -16 g = -32768 |

9.26.13.9.8.4 Rotation

Name:
Rotation01 to Rotation03

An internal sensor measures the rotation.

| Data type | Values | Information |
|-----------|-----------------|---|
| INT | -32768 to 32767 | Rotation as raw value. The conversion is to be carried out in the application: <ul style="list-style-type: none"> • 2000 dps = 32767 • -2000 dps = -32768 |

9.26.13.9.8.5 Analog inputs

Name:
TempExt01 to TempExt02

This register contains the analog input values. The input filter and input ramp limiting are set with register "[CfO_An-Filter](#)" on page 3259.

| Data type | Digital value | Input signal |
|-----------|---------------------------------|--|
| INT | -400 to 1250 (resolution 0.1°C) | Sensor type PT1000, Temperature measurement -40.0 to 125.0°C |

9.26.13.9.9 Additional information

Information:

The following points must be observed:

- Data recorded on the module is saved in intervals of 10 s.
- When resetting the values, it can take up to 1 s until the delete operation is executed (see register "ClrStatistics" on page 3260).

9.26.13.9.9.1 Operating data

Name:

OnTimeConnected
OnTimeDisconnected
OnTimeCombined
PowerCycles

The respective operating data is output in these registers. If needed, the values can be reset using register "ClrStatistics" on page 3260.

| Register | Data type | Values | Information |
|--------------------|-----------|--------------------|---|
| OnTimeConnected | UDINT | 0 to 4,294,967,295 | Operating time during which the module was actively connected to the network master [s], resolution 1 s |
| OnTimeDisconnected | UDINT | 0 to 4,294,967,295 | Operating time during which the module was not actively connected to the network master [s] (blackout mode), resolution 1 s |
| OnTimeCombined | UDINT | 0 to 4,294,967,295 | Total operating time of the module [s], resolution 1 s |
| PowerCycles | UDINT | 0 to 4,294,967,295 | Number of power-on cycles |

9.26.13.9.9.2 Relative humidity

Name:

RelHumidityMin
RelHumidityMax

Information about the relative humidity is output in these registers. The sampling interval is 1 s. If needed, the values can be reset using register "ClrStatistics" on page 3260.

| Register | Data type | Values | Information |
|----------------|-----------|----------|---|
| RelHumidityMin | INT | 0 to 100 | Smallest value that occurred [%], resolution 1% |
| RelHumidityMax | INT | 0 to 100 | Largest value that occurred [%], resolution 1% |

9.26.13.9.9.3 Ambient temperature

Name:

TemperatureMin
TemperatureMax

Information about the ambient temperature is output in these registers. The sampling interval is 1 s. If needed, the values can be reset using register "ClrStatistics" on page 3260.

| Register | Data type | Values | Information |
|----------------|-----------|--------------|--|
| TemperatureMin | INT | -250 to 1250 | Lowest value that occurred [°C], resolution 0.1°C |
| TemperatureMax | INT | -250 to 1250 | Highest value that occurred [°C], resolution 0.1°C |

9.26.13.9.9.4 Acceleration

Name:

Acceleration01Min to Acceleration03Min
Acceleration01Max to Acceleration03Max

Information about acceleration is output in these registers. The sampling interval is typ. 10 ms. If needed, the values can be reset using register "ClrStatistics" on page 3260.

The acceleration is provided as a raw value. The conversion is to be carried out in the application.

| Register | Data type | Values | Information |
|--|-----------|-----------------|-------------------------|
| Acceleration01Min to Acceleration03Min | INT | -32768 to 32767 | Smallest value occurred |
| Acceleration01Max to Acceleration03Max | INT | -32768 to 32767 | Largest value occurred |

9.26.13.9.9.5 Rotation

Name:

Rotation01Min to Rotation03Min

Rotation01Max to Rotation03Max

Information about rotation is output in these registers. The sampling interval is typ. 10 ms. If needed, the values can be reset using register "[ClrStatistics](#)" on page 3260.

The rotation is provided as a raw value. The conversion is to be carried out in the application.

| Register | Data type | Values | Information |
|-----------------------------------|-----------|-----------------|-------------------------|
| Rotation01Min to Rotation03Min | INT | -32768 to 32767 | Smallest value occurred |
| Rotation01Max to Rotation03Max | INT | -32768 to 32767 | Largest value occurred |

9.26.13.9.10 Data point histogram

9.26.13.9.10.1 Relative humidity

Name:

RelHumHist01Entry to RelHumHist10Entry

RelHumHist01Time to RelHumHist10Time

The relative humidity histogram data recorded on the module is displayed on these registers. If needed, the values can be reset using register "[ClrStatistics](#)" on page 3260.

| Register | Data type | Values | Information |
|--|-----------|--------------------|--|
| RelHumHist01Entry to RelHumHist10Entry | UDINT | 0 to 4,294,967,295 | Entry counter for the corresponding area |
| RelHumHist01Time to RelHumHist10Time | UDINT | 0 to 4,294,967,295 | Dwell time in corresponding area [s], resolution 1 s |

9.26.13.9.10.2 Ambient temperature

Name:

TempHist01Entry to TempHist12Entry

TempHist01Time to TempHist12Time

The ambient temperature histogram data recorded on the module is displayed on these registers. If needed, the values can be reset using register "[ClrStatistics](#)" on page 3260.

| Register | Data type | Values | Information |
|------------------------------------|-----------|--------------------|--|
| TempHist01Entry to TempHist12Entry | UDINT | 0 to 4,294,967,295 | Entry counter for the corresponding area |
| TempHist01Time to TempHist12Time | UDINT | 0 to 4,294,967,295 | Dwell time in corresponding area [s], resolution 1 s |

9.26.13.9.10.3 Acceleration

Name:

AccHist0101Entry to AccHist0108Entry

AccHist0101Time to AccHist0108Time

AccHist0201Entry to AccHist0208Entry

AccHist0201Time to AccHist0208Time

AccHist0301Entry to AccHist0308Entry

AccHist0301Time to AccHist0308Time

The acceleration histogram data recorded on the module is displayed on these registers. If needed, the values can be reset using register "[ClrStatistics](#)" on page 3260.

| Register | Data type | Values | Information |
|--------------------------------------|-----------|--------------------|--|
| AccHist0N01Entry to AccHist0N08Entry | UDINT | 0 to 4,294,967,295 | Entry counter for the corresponding area |
| AccHist0N01Time to AccHist0N08Time | UDINT | 0 to 4,294,967,295 | Dwell time in corresponding area [s], resolution 1 s |

Legend: N = 1 to 3

9.26.13.9.10.4 Rotation

Name:

RotationHist0101Entry to RotationHist0108Entry

RotationHist0101Time to RotationHist0108Time

RotationHist0201Entry to RotationHist0208Entry

RotationHist0201Time to RotationHist0208Time

RotationHist0301Entry to RotationHist0308Entry

RotationHist0301Time to RotationHist0308Time

The rotation histogram data recorded on the module is displayed on these registers. If needed, the values can be reset using register "[ClrStatistics](#)" on page 3260.

| Register | Data type | Values | Information |
|--|-----------|--------------------|--|
| RotationHist0N01Entry to RotationHist0N08Entry | UDINT | 0 to 4,294,967,295 | Entry counter for the corresponding area |
| RotationHist0N01Time to RotationHist0N08Time | UDINT | 0 to 4,294,967,295 | Dwell time in corresponding area [s], resolution 1 s |

Legend: N = 1 to 3

9.26.13.9.11 Flatstream communication

For a description of Flatstream communication, see ["Flatstream communication" on page 3802](#)

9.26.13.9.12 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|-------------|
| | 200 μ s |

9.26.13.9.13 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------------------|---|
| Temperature and relative humidity | 1 s |
| Acceleration and rotation | Typ. 10 ms |
| Digital inputs | 100 μ s without filtering 200 μ s with filtering |
| Digital output | Equal to the minimum cycle time |
| Analog inputs | 1 ms |
| State of I/O power supply voltage | <10 ms |
| User flash Flatstream communication | <10 ms |

9.26.14 X20DS4387

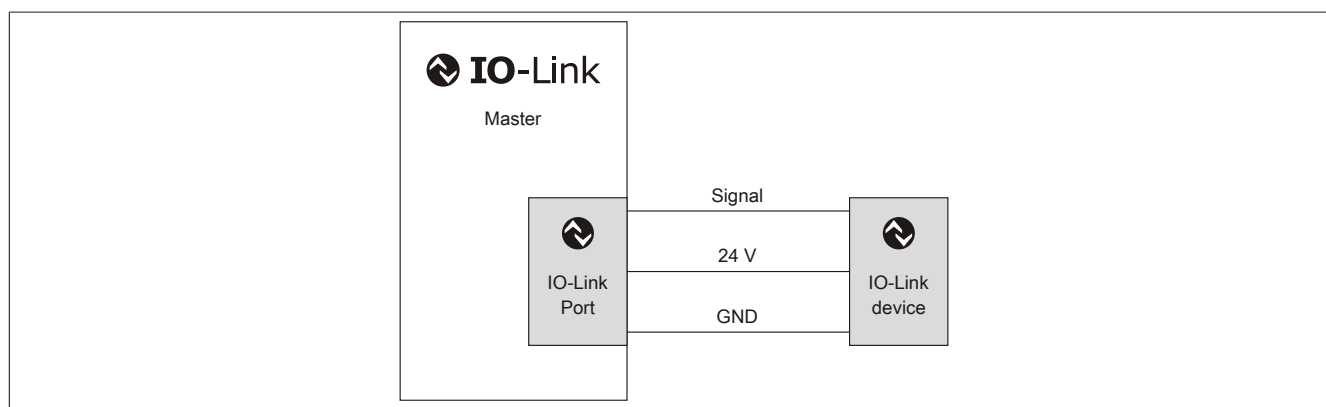
Data sheet version: 3.04

9.26.14.1 General information

IO-Link is a standardized communication system for connecting intelligent sensors and actuators in an automation system. The standardization includes electrical connection data as well as a digital communication protocol, which is used by the sensors and actuators in the automation system for data exchange.

An IO-Link system consists of an IO-Link master and one or more IO-Link devices, i.e. sensors and actuators. The IO-Link master makes the interface available for higher level control and controls communication with the connected IO-Link devices.

An IO-Link device is an intelligent sensor or actuator. With regard to IO-Link, "intelligent" means that a device possesses a series number or parameter data (sensitivity, switching delays or characteristic curves), which can be written to or read via the IO-Link protocol.



Process optimization

The use of intelligent sensors and actuators contributes to process optimization. Process optimization means that downtimes should be kept as short as possible. These consist mainly of standstills due to errors and setup times.

Integrated communication down to the IO-Link devices offers many advantages in error diagnostics. Errors are detected much faster than before. If a sensor or actuator must be replaced, lengthy configuration work is no longer necessary after the change thanks to a potentiometer, or a configuration tool and laptop. After changing the sensor/actuator, the parameters are automatically transferred to the sensor.

This parameter download is not only beneficial when errors occur. It can also be used for changing parameters when a load change is performed. This shortens setup times, making product changes and small batches more economical.

Integration of IO-Link in X20 System

IO-Link is integrated in the X20 system using this digital module. All 4 channels are IO-Link interfaces, but can also be used as standard inputs or outputs. The specified 3-wire connections can be ideally implemented thanks to the X20 connector system with 12 terminal points per module. All specified transfer rates are also supported.

POWERLINK integration

IO-Link doesn't stop at the I/O module. It must be integrated in the higher-level bus system to fully utilize the benefits. When using POWERLINK, access is made possible via device description files in XML format.

- 4 IO-Link interfaces per module
- Each interface can be configured as a standard input or output
- Seamless integration in POWERLINK
- Supports all transfer rates

9.26.14.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Other functions |  |
| X20DS4387 | X20 digital signal module, 4x IO-Link master, 4 digital channels configurable as inputs or outputs, 3-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 561: X20DS4387 - Order data

9.26.14.3 Technical data

| Model number | X20DS4387 |
|--|---|
| Short description | |
| I/O module | IO-Link master with 4 IO-Link interfaces |
| General information | |
| B&R ID code | 0xA38E |
| Status indicators | IO-Link, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| IO-Link operating state | Yes, using status LED and software |
| C/Q status | Yes, using status LED and software |
| Cable specification | |
| Cable type | 3-pin standard sensor cable |
| Cable length | Max. 20 m |
| Line capacitance | Max. 3 nF |
| Loop resistance | Max. 6 Ω |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.6 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| Sensor/Actuator power supply | |
| Voltage | I/O supply minus voltage drop for short circuit protection |
| Voltage drop for short-circuit protection at 0.3 A | Max. 1 VDC |
| Power consumption | Max. 9 W per interface |
| Short-circuit proof | Yes |
| IO-Link in master mode | |
| Transfer rates | |
| COM1 | 4.8 kbaud |
| COM2 | 38.4 kbaud |
| COM3 | 230.4 kbaud |
| Limit values for COM3 | |
| Max. connection capacity | 47 nF (cable + device) |
| Max. load | 100 Ω / 0.3 A |
| Data format | 1 start bit, 8 data bits, 1 parity bit (even), 1 stop bit |
| Bus level | 24 VDC (active), 0 VDC (resting voltage) |
| IO-Link device power supply | 24 VDC / max. 0.3 A per interface (protected) |


Table 562: X20DS4387 - Technical data

| Model number | X20DS4387 |
|---|--|
| IO-Link in master mode or in SIO mode "digital output" | |
| Variant | Bipolar, positive and negative switching |
| Diagnostics | Output monitoring with 100 ns delay and internal semiconductor protection with 100 µs delay |
| Peak short-circuit current | <1.5 A |
| Residual voltage | <1.5 VDC at nominal current 0.2 A |
| Switching voltage | I/O supply minus voltage drop for short circuit protection and semiconductor switch |
| Voltage drop on semiconductor switch | Max. 1.5 VDC at 0.2 A |
| Switching frequency | Typ. 25 kHz 300 kHz in IO-Link master mode |
| Switching delay | |
| 0 → 1 | <10 µs |
| 1 → 0 | <10 µs |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 10 ms (depends on the module temperature) |
| Braking voltage when switching off inductive loads | Typ. 52 VDC |
| Isolation voltage between IO-Link and bus | 500 V _{eff} |
| IO-Link in SIO mode "digital output" | |
| Nominal voltage | 24 VDC |
| Nominal output current | 0.2 A |
| Total nominal current | 0.4 A |
| Output circuit | Sink or source |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs, integrated protection for switching inductances |
| Actuator power supply | 24 VDC / max. 0.3 A per interface (protected) |
| IO-Link in SIO mode "digital input" | |
| Nominal voltage | 24 VDC |
| Input filter | |
| Hardware | 100 ns |
| Software | - |
| Input circuit | Sink |
| Sensor power supply | 24 VDC / max. 0.3 A per interface (protected) |
| Input voltage | 24 VDC -15% / +20% |
| Input current at 24 VDC | Typ. 5 mA |
| Input resistance | Typ. 4.8 kΩ |
| Switching threshold | |
| Low | <8 VDC |
| High | >13 VDC |
| Isolation voltage between IO-Link and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Bus isolated from IO-Link IO-Link not isolated from IO-Link |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | 0 to 55°C |
| Vertical mounting orientation | 0 to 45°C |
| Derating | - |
| Storage | -25 to 70°C |
| Transport | -25 to 70°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB12 separately Order 1x bus module X20BM11 separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 562: X20DS4387 - Technical data

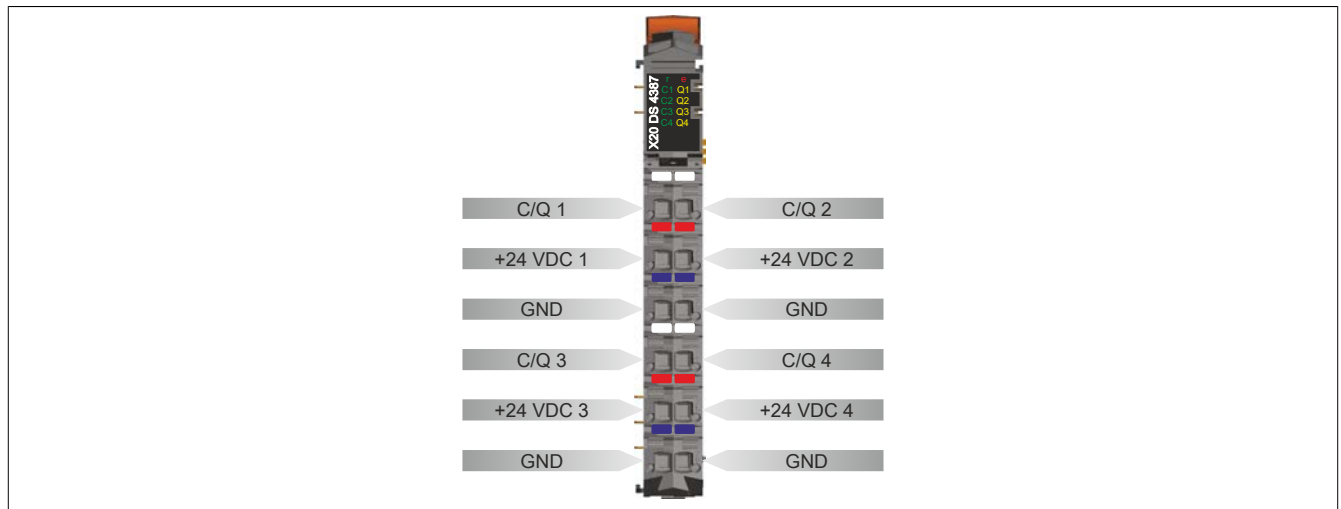
9.26.14.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

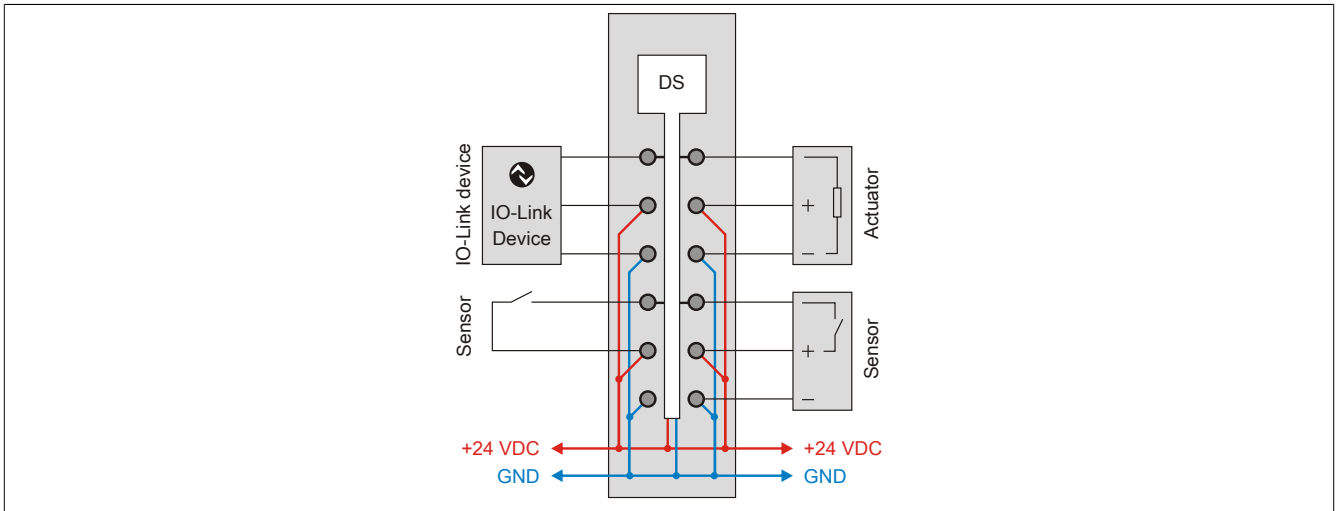
| Figure | LED | Color | Status | Description |
|---|---------|-----------|--------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Single flash | Warning / error for an IO-Link interface |
| | C1 - C4 | Green/Red | Off | Interface in SIO mode |
| | | | Green | Interface in IO-Link mode |
| | | | Red | Output overloaded (short circuit, temperature) |
| | Q1 - Q4 | Orange | | Input/output status of the corresponding IO-Link interface |

1) Depending on the configuration, a firmware update can take up to several minutes.

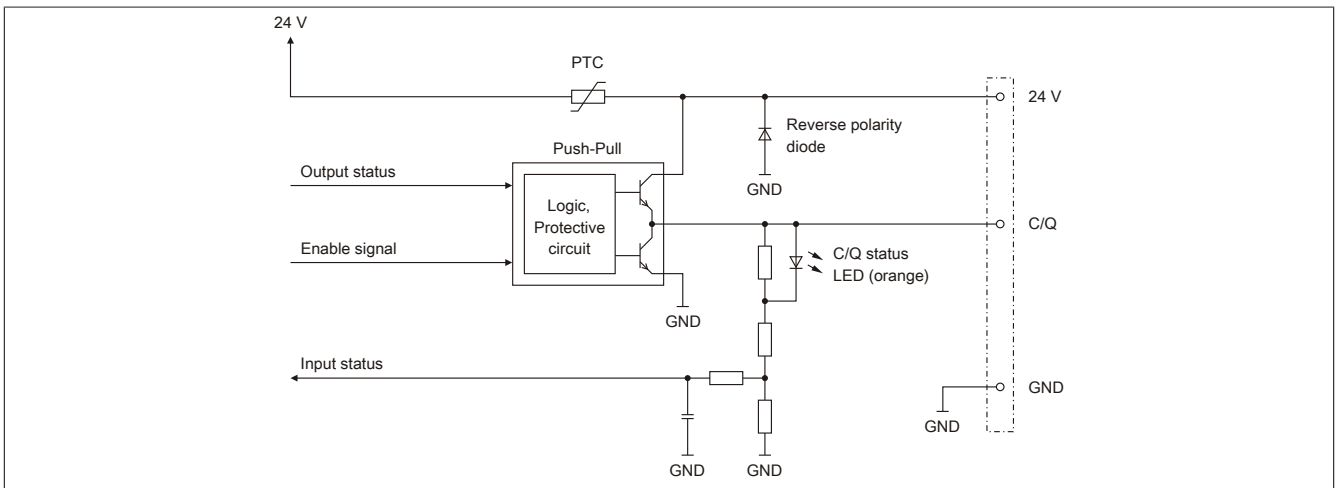
9.26.14.5 Pinout



9.26.14.6 Connection example



9.26.14.7 Output circuit diagram



9.26.14.8 Register description

9.26.14.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.26.14.8.2 Function model 0 - default

| Register | Name | Data type | Read | | Write | |
|------------------------------|--|-----------|-----------------|---------|-----------------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Interface operation | | | | | | |
| 321 + (N-1) * 256 | Control0N (index N = 1 to 4) | USINT | | | | • |
| 323 + (N-1) * 256 | StatusEvents0N (index N = 1 to 4) | U(S)INT | • | | | |
| 328 + (N-1) * 256 | CycleLength0N (index N = 1 to 4) | UINT | • | | | |
| 342 + (N-1) * 256 | DeviceId0N (index N = 1 to 4) | UDINT | • | | | |
| 336 + (N-1) * 256 | FunctionId0N (index N = 1 to 4) | UINT | • | | | |
| 332 + (N-1) * 256 | VendorId0N (index N = 1 to 4) | UINT | • | | | |
| 255 + N | DataIn01_N (index N = 01 to 27) | USINT | • | | | |
| 511 + N | DataIn02_N (index N = 01 to 27) | USINT | • | | | |
| 767 + N | DataIn03_N (index N = 01 to 27) | USINT | • | | | |
| 1023 + N | DataIn04_N (index N = 01 to 27) | USINT | • | | | |
| 255 + N | DataOut01_N (index N = 01 to 30) | USINT | | | • | |
| 511 + N | DataOut02_N (index N = 01 to 30) | USINT | | | • | |
| 767 + N | DataOut03_N (index N = 01 to 30) | USINT | | | • | |
| 1023 + N | DataOut04_N (index N = 01 to 30) | USINT | | | • | |
| SIO mode | | | | | | |
| 356 + (N-1) * 256 | ChInputFilter0N (index N = 1 to 4) | USINT | | | | • |
| 256 + (N-1) * 256 | Digital inputs | USINT | • | | | |
| | DigitalInput0N (index N = 1 to 4) | Bit 0 | | | | |
| 256 + (N-1) * 256 | Digital outputs | USINT | | | • | |
| | DigitalOutput0N (index N = 1 to 4) | Bit 0 | | | | |
| Boot configuration | | | | | | |
| 14852 + N*8 | ODW_Data_N (index N = 0 to 127) | UDINT | | | | • |
| 14848 + N*8 | ODW_Target_N (index N = 0 to 127) | UDINT | | | | • |
| Runtime configuration | | | | | | |
| 7680 | ParameterCtrlIn | UINT | • | | | |
| 7680 | ParameterCtrlOut | UINT | | | • | |
| 7684 | ParameterCmdIn | UDINT | | • | | |
| 7684 | ParameterCmdOut | UDINT | | | • | |
| 7688 + N*4 | ParameterDataIn_N (index N = 0 to 57) | UDINT | • ¹⁾ | • | | |
| 7688 + N*4 | ParameterDataOut_N (index N = 0 to 57) | UDINT | | | • ¹⁾ | • |
| Errors and warnings | | | | | | |
| 325 + (N-1) * 256 | ErrorsWarnings0N (index N = 1 to 4) | USINT | • | | | |
| IO-Link events | | | | | | |
| 7937 | EventPortSeq | USINT | • | | | |
| 7939 | EventQualifier | USINT | • | | | |
| 7942 | EventCode | UINT | • | | | |
| 7952 | EventQuit | USINT | | | • | |

1) Only parameters with index = 0

9.26.14.8.3 Function model 256 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|------------------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Interface operation | | | | | | | |
| 321 + (N-1) * 256 | - | Control0N (index N = 1 to 4) | USINT | | | | • |
| 323 + (N-1) * 256 | 4 + (N-1) * 8 | StatusEvents0N (index N = 1 to 4) | USINT | • | | | |
| 328 + (N-1) * 256 | - | CycleLength0N (index N = 1 to 4) | UINT | | • | | |
| 342 + (N-1) * 256 | - | DeviceId0N (index N = 1 to 4) | UDINT | | • | | |
| 336 + (N-1) * 256 | - | FunctionId0N (index N = 1 to 4) | UINT | | • | | |
| 332 + (N-1) * 256 | - | VendorId0N (index N = 1 to 4) | UINT | | • | | |
| 255 + N | N - 1 | DataIn01_N (Index 0N = 1 to 4) | USINT | • | | | |
| 511 + N | 7 + N | DataIn02_N (Index 0N = 1 to 4) | USINT | • | | | |
| 767 + N | 15 + N | DataIn03_N (Index 0N = 1 to 4) | USINT | • | | | |
| 1023 + N | 23 + N | DataIn04_N (Index 0N = 1 to 4) | USINT | • | | | |
| 255 + N | N - 1 | DataOut01_0N (index N = 1 to 4) | USINT | | | • | |
| 511 + N | 3 + N | DataOut02_0N (index N = 1 to 4) | USINT | | | • | |
| 767 + N | 7 + N | DataOut03_0N (index N = 1 to 4) | USINT | | | • | |
| 1023 + N | 11 + N | DataOut04_0N (index N = 1 to 4) | USINT | | | • | |
| SIO mode | | | | | | | |
| 356 + (N-1) * 256 | - | ChInputFilter0N (index N = 1 to 4) | USINT | | | | • |
| 256 + (N-1) * 256 | (N-1) * 8 | Digital inputs | USINT | • | | | |
| | | DigitalInput0N (index N = 1 to 4) | Bit 0 | | | | |
| 256 + (N-1) * 256 | (N-1) * 4 | Digital outputs | USINT | | | • | |
| | | DigitalOutput0N (index N = 1 to 4) | Bit 0 | | | | |
| Boot configuration | | | | | | | |
| 14852 + N*8 | - | ODW_Data_N (index N = 0 to 127) | UDINT | | | | • |
| 14848 + N*8 | - | ODW_Target_N (index N = 0 to 127) | UDINT | | | | • |
| Runtime configuration | | | | | | | |
| 7680 | - | ParameterCtrlIn | UINT | | • | | |
| 7680 | - | ParameterCtrlOut | UINT | | | | • |
| 7684 | - | ParameterCmdIn | UDINT | | • | | |
| 7684 | - | ParameterCmdOut | UDINT | | | | • |
| 7688 + N*4 | - | ParameterDataIn_N (index N = 0 to 57) | UDINT | | • | | |
| 7688 + N*4 | - | ParameterDataOut_N (index N = 0 to 57) | UDINT | | | | • |
| Errors and warnings | | | | | | | |
| 325 + (N-1) * 256 | 5 + (N-1) * 8 | ErrorsWarnings0N (index N = 1 to 4) | USINT | • | | | |
| IO-Link events | | | | | | | |
| 7937 | - | EventPortSeq | USINT | | • | | |
| 7939 | - | EventQualifier | USINT | | • | | |
| 7942 | - | EventCode | UINT | | • | | |
| 7952 | - | EventQuit | USINT | | | | • |

1) The offset specifies the position of the register within the CAN object.

9.26.14.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "Using I/O modules on the bus controller" on page 3789.

9.26.14.8.3.2 CAN I/O bus controller

The module occupies 2 analog logical slots on CAN I/O.

9.26.14.8.4 Limitations

The I/O module offers extensive function and configuration options. Many of these options require cycle data. The amount of cycle data required depends on the following parameters:

- Number of interfaces in use
- Use of events
- Runtime configuration in the cycle data

Take note that the amount of cycle data available for each I/O module used in the system is limited:

| | |
|-------------------------|----------|
| Sum of the input data: | 29 bytes |
| Sum of the output data: | 30 bytes |

Runtime configuration and events

Each I/O module requires the following amounts of cycle data for runtime configuration and events, if enabled:

| Activated function | Input | Output |
|---|-------|--------|
| Runtime configuration in the cycle data | 6 | 10 |
| Events | 4 | 1 |

Interface data

The following amounts of cyclic data are required for each interface being used:

| Functionality | Operating state | | | | | | | |
|--------------------|-----------------------|-----------------------|----------|--------|-----------|--------|----------|--------|
| | OPERATE | | DIGINPUT | | DIGOUTPUT | | INACTIVE | |
| | Input | Output | Input | Output | Input | Output | Input | Output |
| Payload | 0 to 27 ¹⁾ | 0 to 30 ¹⁾ | 1 | - | - | 1 | - | - |
| Status information | 2 | - | 2 | - | 2 | - | - | - |

1) User configurable

9.26.14.8.5 Interface operation

9.26.14.8.5.1 Communication mode

Name:

Control01 to Control04

Writing to this register defines the desired state of the IO-Link device. This register can be used to define if the IO-Link device should be operated in "normal" communication mode (OPERATE), as a digital input (DIGINPUT) or as a digital output (DIGOUTPUT).

Switching to SIO mode can make sense for IO-Link devices that only transfer digital information anyway (e.g. light curtains) but after the basic configuration should be faster than is possible in "normal" communication mode. A parameter configuration for the object directory can also be made in SIO mode.

To deactivate an interface, INACTIV should be used.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 10 |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------|-------|--|
| 0 - 3 | Communication mode | 0 | INACTIV |
| | | 1 | DIGINPUT |
| | | 2 | DIGOUTPUT |
| | | 10 | OPERATE (bus controller default setting) |
| 4 - 7 | Reserved | - | |

9.26.14.8.5.2 Operating state

Name:

StatusEvents01 to StatusEvents04

This register contains the actual status of communication between the module and IO-Link device. Additionally, the number of events read by the IO-Link device are also counted in this register.

| Data type | Values |
|---------------------|------------------------|
| USINT ¹⁾ | See the bit structure. |
| UINT | |

1) In the bus controller or standard function model, of communication mode = INACTIV

Bit structure:

| Bit | Description | Value | Information |
|-------------|--|-------|-----------------|
| 0 - 3 | State of the IO-Link device | x | See table below |
| 4 - 7 or 15 | Event counter from the respective IO-Link device | x | |

State of the IO-Link device

| Value | Abbreviation | Description |
|-------|----------------|---|
| 0 | INACTIVE | Interface is inactive: No communication and signal output or input. This state is not changed automatically. |
| 1 | DIGINPUT | SIO input mode: The interface behaves like a digital input. |
| 2 | DIGOUTPUT | SIO output mode: The interface behaves like a digital output. |
| 4 | ESTABLISHCOMM | Establishing connection to IO-Link device. This state remains as long as a device is not found. |
| 5 | INITMASTER | Consecutive states experienced during startup and configuration of an IO-Link device. |
| 6 | INITDEVICE | |
| 7 | INITOPERATE | |
| 8 | PREOPERATE | |
| 9 | READYTOOPERATE | Waiting for valid data from the IO-Link device. This state can follow the OPERATE state if the device reports during operation that it cannot send any more valid data. |
| 10 | OPERATE | Communication with the IO-Link device via serial protocol. Valid data is exchanged. |
| 11 | COMSTOP | The IO-Link interface is reinitialized. The ESTABLISHCOMM state follows this state. |
| 12 | FALLBACK | For switching to SIO mode |
| 13 | STARTUP | IO-Link device restart |
| 14 | SIO | Switching to SIO mode |

States with a gray background are applied continuously, all others are intermediate states. An exception is state ESTABLISHCOMM (4): This state is permanently assumed if no device is connected.

Dynamic values from the IO-Link device make up the input data for an IO-Link interface if one of the states DIGINPUT, DIGOUTPUT or OPERATE has been reached. These states can also be exited when errors occur. The device is restarted if a fatal error occurs, which means the state reverts back to ESTABLISHCOMM. Another possibility is that there is no new data being read from the device in the OPERATE state. In this case, the state changes to READYTOOPERATE and waits for new data.

During the first startup, the module sends the value 0 for the inputs of an IO-Link interface. If the states DIGINPUT, DIGOUTPUT or OPERATE are exited, then the inputs are frozen at the most recently read value until valid data is able to be read from the device again.

9.26.14.8.5.3 Length of the I/O cycle

Name:

CycleLength01 to CycleLength04

The value in this register specifies how many X2X cycles are required on the respective interface for a the IO-Link process data to be completely updated.

The module automatically selects the best possible IO-Link cycle time per interface for the connected IO-Link device. This is always a multiple of the X2X cycle time. The cycle times of the 4 IO-Link interfaces are independent of one another.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.26.14.8.5.4 Reading

Name:

DeviceID01 to DeviceID04

This register contains the IO-Link device ID assigned by the manufacturer. The device ID can be read for every IO-Link interface.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.14.8.5.5 Function ID

Name:

FunctionID01 to FunctionID04

This register contains the IO-Link function ID assigned by the manufacturer. The function ID can be read for every IO-Link interface.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.26.14.8.5.6 IO-Link vendor ID

Name:

VendorID01 to VendorID04

This register contains the IO-Link vendor ID. The ID can be read for every IO-Link interface.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.26.14.8.5.7 Cyclic input data

Name:

DataIn01_01 to DataIn01_27 (bus controller function model: up to xx01_04)

...

DataIn04_01 to DataIn04_27 (bus controller function model: up to xx04_04)

This register contains the cyclic input data for the respective interface.

| Data type | Values |
|-----------|----------|
| USINT | 0 to 255 |

9.26.14.8.5.8 Cyclic output data

Name:

DataOut01_01 to DataOut01_30 (bus controller function model: up to xx01_04)

...

DataOut04_01 to DataOut04_30 (bus controller function model: up to xx04_04)

This register contains the cyclic output data for the respective interface.

| Data type | Values |
|-----------|----------|
| USINT | 0 to 255 |

9.26.14.8.6 SIO mode

The IO-Link interface can be used like a digital input or output in SIO mode. To activate the SIO mode, the operating state must be set in the "Control0x" on page 3275 register to DIGINPUT or DIGOUTPUT. Runtime configuration is not possible during operation in SIO mode, however the boot configuration can be used.

9.26.14.8.6.1 Digital input filter

Name:

ChInputFilter01 to ChInputFilter04

When operated as a digital input, a filter time can be configured in this register. Valid values for the filter time are 0 and 2 to 250. Value 0 disables the filter. Other values specify the filter time as a multiple of 0.1 ms.

| Data type | Values | Filter |
|-----------|--------|--|
| USINT | 0 | No software filter |
| | 2 | 0.2 ms |
| | ... | ... |
| | 10 | 1 ms (bus controller default setting) |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value. |

9.26.14.8.6.2 Digital inputs

Name:

DigitalInput01 to DigitalInput04

These registers display the input states of the digital inputs individually for each channel.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

| Bit | Name | Value | Information |
|-------|----------------|--------|-------------------------------|
| 0 | DigitalInput0x | 0 or 1 | Input state - Digital input x |
| 1 - 7 | Reserved | - | |

9.26.14.8.6.3 Digital outputs

Name:

DigitalOutput01 to DigitalOutput04

These registers display the output states of the digital outputs individually for each channel.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

| Bit | Name | Value | Information |
|-------|-----------------|-------|------------------------|
| 0 | DigitalOutput0x | 0 | Digital output x reset |
| | | 1 | Digital output x set |
| 1 - 7 | Reserved | - | |

9.26.14.8.7 Parameter

IO-Link devices can provide user parameters. There are two ways to access these parameters:

- "Boot configuration" on page 3279
- "Runtime configuration" on page 3279

9.26.14.8.7.1 Boot configuration

The values specified by the user are transferred during the boot procedure (or when the IO-Link device is connected).

Up to 32 parameter values can be specified for each IO-Link interface. 1, 2, and 4 byte parameters are supported.

The boot configuration can be used in the operating states OPERATE, DIGINPUT and DIGOUTPUT.

The following specifications are necessary for parameters that should be set during the boot procedure:

| Name | Range of values | Description |
|----------|--------------------|---|
| Index | 0 to 65535 | Parameter index according to device manufacturer's specifications |
| Subindex | 0 to 255 | Parameter sub index according to device manufacturer's specifications |
| Length | 1, 2, 4 | Length of data in bytes |
| Data | 0 to 4,294,967,295 | Data to be written. Only low-order bytes are used for 1 or 2 byte parameters. |

9.26.14.8.7.2 Runtime configuration

The runtime configuration can also be made after the IO-Link device has booted up. Parameters can be read or written.

The runtime configuration can take place in the cyclic data or through acyclic communication (function blocks AsIOAccRd and AsIOAccWr).

Runtime configuration is available for interfaces in the OPERATE state.

The following specifications are necessary for accessing parameters:

| Name | Range of values | Description |
|-----------------|-----------------|--|
| Interface | 0, 1, 2, 3 | Addressed interface of the module |
| Sequence number | 0 to 15 | A change to this value indicates a new task. The sequence number is set identically to the value of the request in the response message. |
| Index | 0 to 65535 | Parameter index according to device manufacturer's specifications. |
| Subindex | 0 to 255 | Parameter sub index according to device manufacturer's specifications. |
| Length | 0 to 228 (229) | Length of data in bytes. Up to 228 bytes are supported for write access and 229 bytes for read access. The length does not have to be specified when requesting a read access (the device reports the length of the read data). |
| Data | | IO-Link supports up to 228 (229) bytes of data each time a parameter is accessed. The length is limited to 1, 2 or 4 bytes in the cyclic data with boot configuration and runtime configuration. The full data range can be used with acyclic runtime configuration (AsIOAcc Library). |
| Read/write | 0, 1 | For the request to the IO-Link device. 0 → read 1 → write |
| Errors | 0, 1 | Defined in the response from the IO-Link device. 0 → No error occurred 1 → Error When an error occurs, the first two bytes of data are contained in the error code (the reported length is 2). |
| Sequence number | 0 to 15 | |

Access to an IO-Link device's parameters occurs via a request and subsequent response from the device.

A new request is detected due to a changed sequence number. Therefore, the sequence number must be the last data item that is written.

The response contains the sequence number of the request.

The length is not relevant for a read request. It is automatically determined by the IO-Link device and reported in the response message.

If an error occurs (e.g. due to accessing an index or sub index that does not exist), this is signaled by a set error bit in the response. The error response always has a length of 2. These 2 bytes contain the manufacturer-specific error code.

9.26.14.8.8 Object directory access

Writing to the corresponding registers "[ParameterCmdOut](#)" on page 3282 and "[ParameterCtrlOut](#)" on page 3281 defines and sends an order for reading or writing an IO-Link object.

Procedure for sending an order

- Define register "[ParameterCmdOut](#)" on page 3282 by entering the length, index and subindex
- During write access, write the required parameter data that is to be stored in the object directory to registers "[ParameterDataOut_XX](#)" on page 3282.
- Define register "[ParameterCtrlOut](#)" on page 3281 by entering the interface number, read/write ID and the incremental sequence number. Additionally, an error bit can be configured during read access.

The module detects when the sequence number changes and accepts the order. Communication with the IO-Link device takes place.

When evaluating read/write access, the following is available from the register "[ParameterCtrlIn](#)" on page 3281:

- Access sequence number
- Access interface number
- Type of access
- Payload length for read access to values smaller than 15 bytes
- Read access error bit

When evaluating read/write access, the following is available from the register "[ParameterCmdIn](#)" on page 3281:

- Payload length for read access
- Access index and subindex

When evaluating read access, the following is available from the register "[ParameterDataIn_XX](#)" on page 3282:

- Values read/written

During write access, the sequence number in register "[ParameterCtrlIn](#)" on page 3281 is only set to the written value when processing the order has been completed and the parameter data has been read from the object directory for the IO-Link device and entered in the registers "[ParameterDataIn_XX](#)" on page 3282.

A response provided by increasing the sequence number must be guaranteed (a timeout may be necessary for this purpose). That means, if the written sequence number from register "[ParameterCtrlOut](#)" on page 3281 is accepted by register "[ParameterCtrlIn](#)" on page 3281, then the application can safely assume that access has taken place.

Limit values for write/read access

- Index: 0 to 65535
- Subindex: 0 to 255
- Data length: 1 to 228 bytes for write access
- Data length: 1 to 229 bytes for read access

The resulting changes are written once to the IO-Link device without being temporarily saved on the module. That means, after disconnecting the IO-Link device, the values from the ODW registers are written back to the IO-Link device (see register "[ODW_Data_XX](#)" on page 3282).

9.26.14.8.8.1 Response to read/write access

Name:

ParameterCtrlIn

This register contains the response for dynamic read/write access of the object directory.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|-------------------------------------|--------------|-----------------|
| 0 - 3 | Sequence number | x | |
| 4 - 7 | Interface number | 00 | Interface 1 |
| | | 01 | Interface 2 |
| | | 10 | Interface 3 |
| | | 11 | Interface 4 |
| 8 - 11 | Payload data length | 0000 to 1111 | Number of bytes |
| 12 - 13 | Reserved | - | |
| 14 | Read / write | 0 | Read access |
| | | 1 | Write access |
| 15 | Errors | 0 | No error |
| | | 1 | Errors |

Payload data length

The payload data length of the parameter access is copied by the module from the register "[ParameterCmdIn](#)" on [page 3281](#) (bit 24 to 27). Because this is a 4-bit value, the specification of the payload length is possible for a value with a maximum of 15 bytes. In the event that parameter sets larger than 15 bytes are accessed, the information about the number of bytes read during the parameter access must be taken from "[ParameterCmdIn](#)".

9.26.14.8.8.2 Configuration of dynamic read/write access

Name:

ParameterCtrlOut

This register is used to configure dynamic read/write access of the object directory.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|--------|--|-------|--|
| 0 - 3 | Sequence number | x | |
| 4 - 7 | Interface number | 00 | Interface 1 (bus controller default setting) |
| | | 01 | Interface 2 |
| | | 10 | Interface 3 |
| | | 11 | Interface 4 |
| 8 - 13 | Reserved | - | |
| 14 | Read / write | 0 | Read access (bus controller default setting) |
| | | 1 | Write access |
| 15 | Error response (only defined for read access, this bit should be set to "0" for write access) | 0 | Inactive (bus controller default setting) |
| | | 1 | Active |

9.26.14.8.8.3 Feedback from I/O object information

Name:

ParameterCmdIn

This register returns the number of bytes read during a read access.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|----------------------------|-------|-------------|
| 0 - 15 | Object index being used | x | |
| 16 - 23 | Object subindex being used | x | |
| 24 - 31 | Number of bytes read | x | |

9.26.14.8.8.4 Configuration of the I/O object information

Name:

ParameterCmdOut

This register is used to configure dynamic read/write access of the object directory.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UDINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|---------|-------------------------|------------|-----------------------------------|
| 0 - 15 | Object index | 0 to 65535 | Bus controller default setting: 0 |
| 16 - 23 | Object subindex | 0 to 255 | Bus controller default setting: 0 |
| 24 - 31 | Payload length in bytes | 0 to 255 | Bus controller default setting: 0 |

9.26.14.8.8.5 Runtime parameter data read

Name:

ParameterDataIn_0 to ParameterDataIn_57

The corresponding parameter data is written to this register during read access of the object directory for the IO-Link device.

The length specified in register "ParameterCmdOut" determines how many 4-byte registers are read from the object directory for the IO-Link device and how many in the last byte are still valid.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.14.8.8.6 Runtime parameter data written

Name:

ParameterDataOut_0 to ParameterDataOut_57

The parameter data from this register is written during write access of the object directory for the IO-Link device.

The length specified in register "ParameterCmdOut" on page 3282 determines how many 4-byte registers are written to the object directory for the IO-Link device and how many in the last byte are still valid.

| Data type | Values | Information |
|-----------|--------------------|-----------------------------------|
| UDINT | 0 to 4,294,967,295 | Bus controller default setting: 0 |

9.26.14.8.8.7 Boot parameter data

Name:

ODW_Data_0 to ODW_Data_127

This register contains parameter data for configuration of the IO-Link device.

| Data type | Values | Information |
|-----------|--------------------|-----------------------------------|
| UDINT | 0 to 4,294,967,295 | Bus controller default setting: 0 |

9.26.14.8.8.8 Boot I/O object information

Name:

ODW_Target_0 to ODW_Target_127

A write procedure on this register will transfer the parameter information from the corresponding "ODW_Data" on [page 3282](#) register to the IO-Link device.

Example:

If the ODW_Target_0 register is written to, the parameter data from ODW_Data_0 is applied by the module and transferred to the object dictionary of the IO-Link device.

Unlike short-term access, the values are also stored in RAM on the module in order to be able to reload these parameters in the object directory for the IO-Link device when restarting the IO-Link device.

Information:

"ODW_Data" must be defined before "ODW_Target".

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UDINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|---------|------------------|-------|--|
| 0 - 15 | Object index | x | |
| 16 - 23 | Subindex | x | |
| 24 - 27 | Interface number | 00 | Interface 1 (bus controller default setting) |
| | | 01 | Interface 2 |
| | | 10 | Interface 3 |
| | | 11 | Interface 4 |
| 28 - 30 | Length in bytes | x | |

9.26.14.8.9 Errors and warnings

Name:

ErrorsWarnings01 to ErrorsWarnings04

The counter is increased by one if the IO-Link device reports an error or warning.

An error is a fatal event if it causes an IO-Link device to lose its intended functionality. An error causes the IO-Link device to leave the OPERATE state (see ["Operating state" on page 3276](#)) and re-initialize.

The cause of a warning could be one-time communication disturbances. Warnings are events that deviate from normal operating behavior but do not necessarily result in loss of functionality. Several consecutively occurring warnings can result in an error.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------|-------|---|
| 0 - 3 | Warning counter | x | Counts the errors that do not immediately lead to ending the communication with the IO-Link device |
| 4-7 | Error counter | x | Counts the errors that causes the IO-Link device to change from status "10 = cyclic data exchange" and be reinitialized |

9.26.14.8.10 Event handling

If an event occurs on an IO-Link device, then the device retrieves it and stores the data in the following registers:

| Register | Description |
|----------------------------------|--|
| "EventPortSeq" on page 3285 | IO-Link device interface that triggered the event. Sequence number, incremented with each event |
| "Event description" on page 3284 | Event description: Instance, type and mode |
| "Event code" on page 3284 | Event code |

The sequence number for the event counter is incremented by 1 with each event in order to notify the application. After the application has read the event data, the module has to use the "EventQuit" on page 3285 register to signal that the values were retrieved from registers "EventQualifier" and "EventCode" and then the module can read the next event from IO-Link device. The value in register "EventPortSeq" is considered a correct acknowledgment value.

Events are available for interfaces in the OPERATE state. An event inhibit can also be set in Automation Studio. This is specified as a number of X2X Link cycles for an event before it can be overwritten by the next event. Events that occur during the inhibit time are cached on the module.

9.26.14.8.10.1 Event code

Name:

EventCode

This register is used to indicate the manufacturer-specific code for the IO-Link device.

In addition to manufacturer-specific codes, there are also the event codes specified for IO-Link in case the IO-Link device does not provide an EventCode.

| Data type | Value | Information |
|-----------|----------------|---------------------------------------|
| UINT | 0 to 65535 | Event code |
| | 0x34 / 0xFFFF0 | Invalid event from the IO-Link device |
| | 0x54 / 0xFF80 | IO-Link device message |
| | 0x74 / 0xFF80 | IO-Link device error |
| | 0x74 / 0x6320 | Parameter error |
| | 0x70 / 0xFF10 | Communication error |

9.26.14.8.10.2 Event description

Name:

EventQualifier

IO-Link devices can generate events (including manufacturer-specific events). Information about the instance, type and mode of the event can be read from this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------------------------------|------------|--|
| 0 - 2 | Instance layer generated by the event | 000 | Unknown |
| | | 001 | Hardware |
| | | 010 | Data exchange layer for the IO-Link device |
| | | 011 | Application layer for the IO-Link device |
| | | 100 | Application |
| | | 101 to 111 | Reserved |
| 3 | Reserved | - | |
| 4 - 5 | Type of event | 00 | Reserved |
| | | 01 | Information |
| | | 10 | Warning |
| | | 11 | Errors |
| 6 - 7 | Mode of the event | 00 | Reserved |
| | | 01 | One-time event |
| | | 10 | Pending event is gone |
| | | 11 | Pending event |

9.26.14.8.10.3 Event interface

Name:

EventPortSeq

IO-Link devices can generate events (including manufacturer-specific events). Information about the interface that caused the event can be read from this register. By reading the sequence number, the application can determine if a new event has occurred. For this topic, see also ["Event handling" on page 3284](#).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|---------|--|
| 0 - 3 | Interface | 0 | Interface 1 |
| | | 1 | Interface 2 |
| | | 2 | Interface 3 |
| | | 3 | Interface 4 |
| | | 4 - 7 | Reserved |
| 4 - 7 | Event counter | 0 to 15 | Sequence number is incremented with each new event that occurs |

9.26.14.8.10.4 Acknowledge events

Name:

EventQuit

Register for acknowledging events so that the module can retrieve the next event. The event that has been read must be acknowledged with the value from register ["EventPortSeq" on page 3285](#).

| Data type | Values |
|-----------|----------|
| USINT | 0 to 255 |

9.26.14.8.11 IO-Link cycle time

The I/O module automatically selects the best possible IO-Link cycle time per interface for the connected IO-Link device. This is always a multiple of the X2X cycle time. The cycle times of the 4 IO-Link interfaces are independent of one another. The module can read back which cycle time was selected for an IO-Link interface.

The minimum cycle time is 2.3 ms.

9.26.15 X20(c)DS438A

Data sheet version: 1.52

9.26.15.1 General information

The module is an IO-Link master that allows intelligent sensors and actuators to be connected to the X20 system in accordance with the IO-Link standard. The module can be used to operate up to 4 IO-Link devices. All IO-Link channels can be used either as standard digital inputs or outputs.

- 4 IO-Link devices
- 4 digital channels, can be configured as input or output
- 24 VDC and GND for sensor/actuator supply
- NetTime timestamps: IO-Link data

NetTime timestamps for IO-Link

Using these timestamps, applications can record value changes at on the IO-Link network and trigger events that have a higher resolution than the I/O cycle would allow.

The timestamp function is based on synchronized timers. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise time, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

Conversely, the CPU can predefine output events, apply a timestamp and transfer them to the module. The module then executes the predefined action at the precise time defined by the CPU.

9.26.15.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.26.15.3 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Other functions | |
| X20DS438A | X20 digital signal module, 4x IO-Link master V1.1, 4 digital channels configurable as inputs or outputs, 3-wire connections, NetTime function |  |
| X20cDS438A | X20 digital signal module, coated, 4x IO-Link master V1.1, 4 digital channels configurable as inputs or outputs, 3-wire connections, NetTime function | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 563: X20DS438A, X20cDS438A - Order data

Optional accessories for sensors

Connectors and cables from the X67 system accessories can be used to connect standard IO-Link sensors and devices.

Sensors/Devices with M12 connector

| M12 connector | |
|---------------|--|
| X67AC0C21 | X67 female M12 connector, 5-pin, A-keyed, shielded, cage clamp connection |
| X67AC2C21 | X67 female M12 connector, 5-pin, A-keyed, shielded, screw clamp connection |

Sensors/Devices with M8 connector

| M8 connector | |
|---|---|
| X67AC0P20 | Female M8 connector, 4-pin, piercing connection |
| M8 connector with cable, open on one side | |
| X67CA0P20.xxxx | M8 attachment cable, 4-pin, straight |
| X67CA0P30.xxxx | M8 attachment cable, 4-pin, angled |

9.26.15.4 Technical data

| Model number | X20DS438A | X20cDS438A |
|---|---|------------|
| Short description | | |
| I/O module | IO-Link master with 4 IO-Link interfaces | |
| General information | | |
| B&R ID code | 0xCAC0 | 0xEB57 |
| Status indicators | IO-Link, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| IO-Link operating state | Yes, using status LED and software | |
| C/Q status | Yes, using status LED and software | |
| Cable specification | | |
| Cable type | 3-pin standard sensor cable, unshielded | |
| Cable length | Max. 20 m | |
| Line capacitance | Max. 3 nF | |
| Loop resistance | Max. 6 Ω | |
| Power consumption | | |
| Bus | 0.01 W | |
| Internal I/O | 0.71 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| Sensor/Actuator power supply | | |
| Voltage | I/O power supply minus voltage drop for short circuit protection | |
| Voltage drop for short-circuit protection at 0.5 A | Max. 0.3 V | |
| Power consumption | Max. 12 W per IO-Link interface | |
| Short-circuit proof | Yes | |
| Overload protection | | |
| Switch-off delay | Configurable using software | |
| Switch-off duration | Configurable using software | |
| IO-Link in master mode | | |
| Transfer rates | | |
| COM1 | 4.8 kbaud | |
| COM2 | 38.4 kbaud | |
| COM3 | 230.4 kbaud | |
| Limit values for COM3 | | |
| Max. connection capacity | 22 nF (cable + IO-Link device) | |
| Max. load | 96 Ω / 250 mA | |
| Data format | 1 start bit, 8 data bits, 1 parity bit (even), 1 stop bit | |
| Bus level | 24 VDC (active), 0 VDC (resting voltage) | |
| IO-Link in master mode or in SIO mode "digital output" | | |
| Variant | Bipolar, positive and negative switching | |
| Peak short-circuit current | <1.3 A | |
| Residual voltage | <0.7 VDC at nominal current 0.25 A | |
| Switching voltage | I/O power supply minus voltage drop for short circuit protection and semiconductor switch | |
| Voltage drop on semiconductor switch | Max. 0.5 VDC at 0.25 A | |
| Switching frequency | Typ. 25 kHz 300 kHz in IO-Link master mode | |
| Switching delay | | |
| 0 → 1 | <10 μs | |
| 1 → 0 | <10 μs | |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Configurable with software | |
| Isolation voltage between IO-Link and bus | 500 V _{Eff} | |
| IO-Link in SIO mode "digital output" | | |
| Nominal voltage | 24 VDC | |
| Nominal output current | 0.25 A | |
| Total nominal current | Max. 1 A | |
| Output circuit | Sink or source | |
| Switching frequency (resistive load) | Max. 500 Hz | |
| Output protection ¹⁾ | Thermal cutoff if overcurrent or short circuit occurs, integrated protection for switching inductances | |
| IO-Link in SIO mode "digital input" | | |
| Nominal voltage | 24 VDC | |

Table 564: X20DS438A, X20cDS438A - Technical data


| Model number | X20DS438A | X20cDS438A |
|---|--|---|
| Input characteristics per EN 61131-2 | Type 1 | |
| Input filter | | |
| Hardware | 300 ns | |
| Software | - | |
| Input circuit | Sink | |
| Input voltage | 24 VDC -15% / +20% | |
| Input current at 24 VDC | Typ. 4 mA | |
| Input resistance | Typ. 6 kΩ | |
| Switching threshold | | |
| Low | <5 VDC | |
| High | >15 VDC | |
| Isolation voltage between IO-Link and bus | 500 V _{Eff} | |
| Electrical properties | | |
| Electrical isolation | Bus isolated from IO-Link IO-Link not isolated from IO-Link | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x terminal block X20TB12 separately Order 1x bus module X20BM11 separately | Order 1x terminal block X20TB12 separately Order 1x bus module X20cBM11 separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 564: X20DS438A, X20cDS438A - Technical data

1) Interrupting current during overload: Between 0.3 A and 0.8 A.


9.26.15.5 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

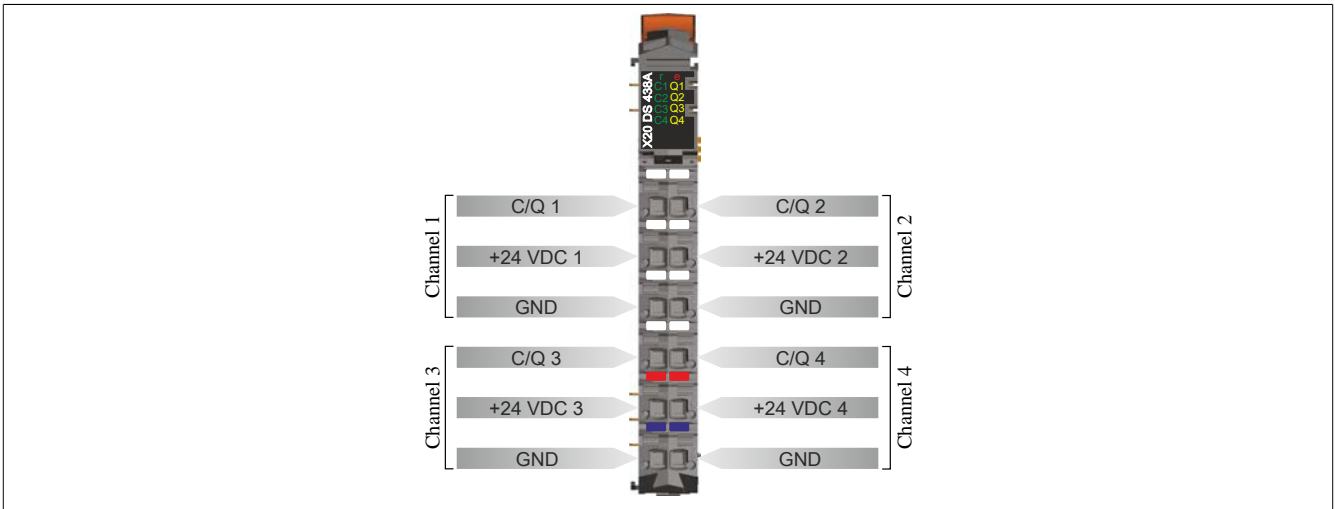
| Figure | LED | Color | Status | Description |
|---|---------|-----------|--------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | Mode BOOT (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | OPERATE mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | | | Double flash | One of the following errors has occurred: |
| | C1 - C4 | Red | On | Overload on the supply or on the channel's C/Q line |
| | | | Off | Interface in SIO mode |
| | | Green/Red | Single flash | Channel in OPERATE mode, no IO-Link communication |
| | | | Double flash | Channel in OPERATE mode, error on inspection level |
| | Q1 - Q4 | Green | On | Channel in OPERATE mode, IO-Link communication active |
| | | | Orange | Input/output state of corresponding IO-Link interface |

1) Depending on the configuration, a firmware update can take up to several minutes.

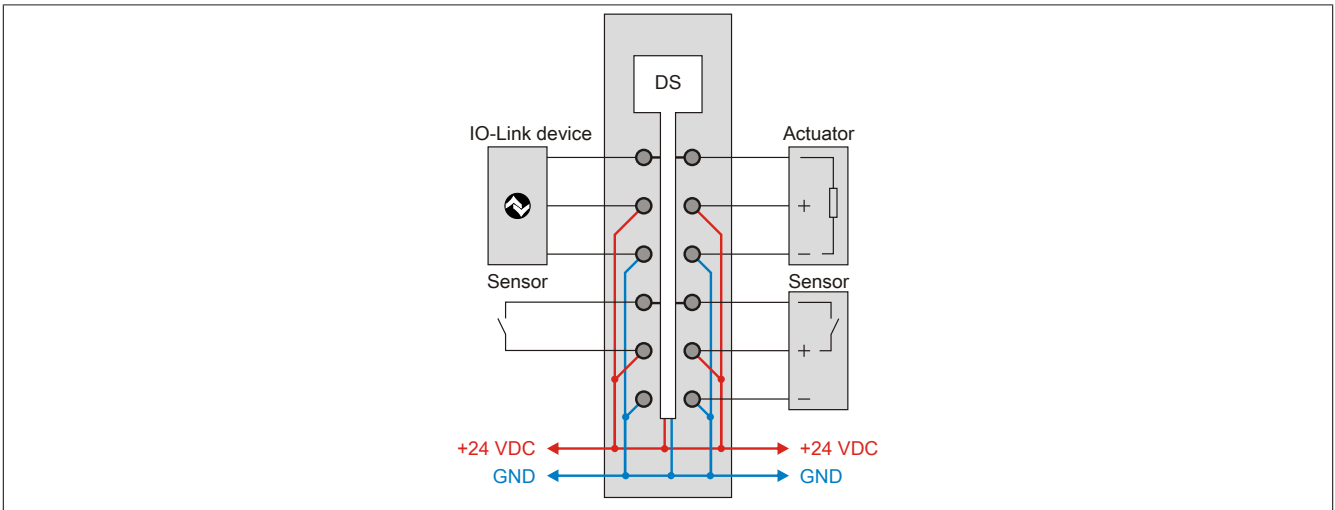
Blink times of LEDs C1 through C4 for single and double flash.

| | |
|--------------|---|
| Single flash |  |
| Double flash |  |
| | 1 second |

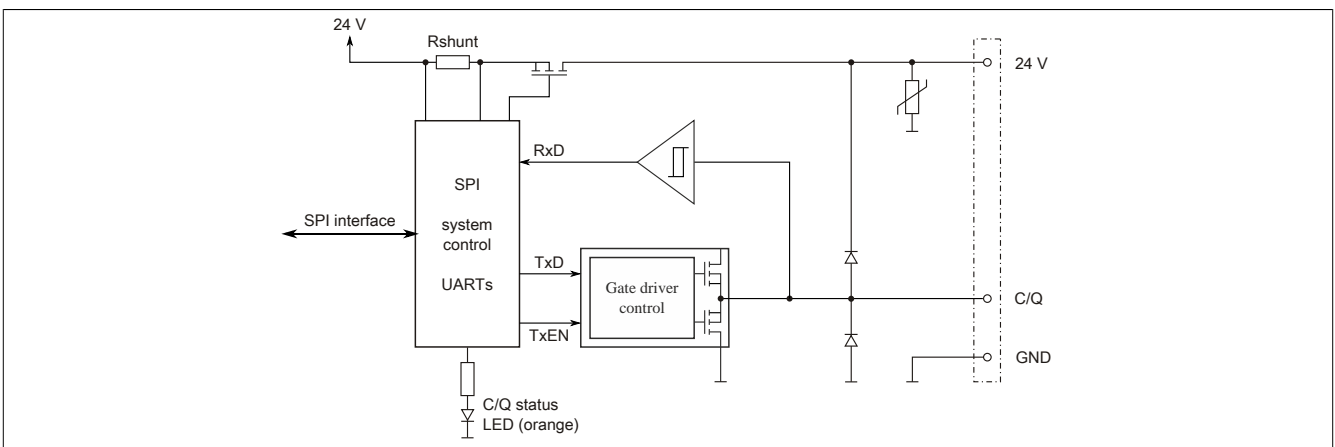
9.26.15.6 Pinout



9.26.15.7 Connection example



9.26.15.8 Input/output circuit diagram



9.26.15.9 SG3 support

This module does not support SG3 target systems.

9.26.15.10 Register description

9.26.15.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.26.15.10.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|--------------------------------|---|-----------------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module configuration | | | | | | |
| 513 | CfO_SupplyConfig | USINT | | | | • |
| 3073 + N * 1024 | CfO_OperatingMode0N (index N = 1 to 4) | USINT | | | | • |
| IO-Link configuration | | | | | | |
| 3076 + N * 1024 | CfO_ChannelMode0N (index N = 1 to 4) | UDINT | | | | • |
| 3099 + N * 1024 | CfO_IdentificationRevisionId0N (index N = 1 to 4) | USINT | | | | • |
| 3102 + N * 1024 | CfO_IdentificationVendorId0N (index N = 1 to 4) | UINT | | | | • |
| 3108 + N * 1024 | CfO_IdentificationDeviceId0N (index N = 1 to 4) | UDINT | | | | • |
| 3116 + N * 1024 | CfO_PDI_TypeInfo0N (index N = 1 to 4) | UDINT | | | | • |
| 3124 + N * 1024 | CfO_PDO_TypeInfo0N (index N = 1 to 4) | UDINT | | | | • |
| 15372 | CfO_TimerCycle | UDINT | | | | • |
| 15366 | CfO_TimerOffset | INT | | | | • |
| 3086 + N * 1024 | CfO_ReqCycleMultiple0N (index N = 1 to 4) | UINT | | | | • |
| 3090 + N * 1024 | CfO_ReqCycleDivisor0N (index N = 1 to 4) | UINT | | | | • |
| 3094 + N * 1024 | CfO_ReqCycleOffset0N (index N = 1 to 4) | UINT | | | | • |
| 3082 + N * 1024 | CfO_ReqCycleTime0N (index N = 1 to 4) | UINT | | | | • |
| IO-Link communication | | | | | | |
| 4473 + N * 8 | OutputData01_N (index N = 1 to 8) | (U)SINT | | | | • |
| 4474 + N * 8 | OutputData01_N (index N = 1 to 8) | (U)SINT | | | | |
| 4476 + N * 8 | OutputData01_N (index N = 1 to 8) | (U)DINT REAL | | | | |
| 5497 + N * 8 | OutputData02_N (index N = 1 to 8) | (U)SINT | | | | • |
| 5498 + N * 8 | OutputData02_N (index N = 1 to 8) | (U)SINT | | | | |
| 5500 + N * 8 | OutputData02_N (index N = 1 to 8) | (U)DINT REAL | | | | |
| 6521 + N * 8 | OutputData03_N (index N = 1 to 8) | (U)SINT | | | | • |
| 6522 + N * 8 | OutputData03_N (index N = 1 to 8) | (U)SINT | | | | |
| 6524 + N * 8 | OutputData03_N (index N = 1 to 8) | (U)DINT REAL | | | | |
| 7545 + N * 8 | OutputData04_N (index N = 1 to 8) | (U)SINT | | | | • |
| 7546 + N * 8 | OutputData04_N (index N = 1 to 8) | (U)SINT | | | | |
| 7548 + N * 8 | OutputData04_N (index N = 1 to 8) | (U)DINT REAL | | | | |
| 7 | SIO or digital outputs | USINT | | | | • |
| | DigitalOutput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalOutput04 | Bit 3 | | | | |
| | DisablePowerSupply01 | Bit 4 | | | | |
| | ... | ... | | | | |
| | DisablePowerSupply04 | Bit 7 | | | | |
| 4345 + N * 8 | InputData01_N (index N = 1 to 8) | (U)SINT | • | | | |
| 4346 + N * 8 | InputData01_N (index N = 1 to 8) | (U)INT | | | | |
| 4348 + N * 8 | InputData01_N (index N = 1 to 8) | (U)DINT REAL | | | | |
| 5369 + N * 8 | InputData02_N (index N = 1 to 8) | (U)SINT | • | | | |
| 5370 + N * 8 | InputData02_N (index N = 1 to 8) | (U)INT | | | | |
| 5372 + N * 8 | InputData02_N (index N = 1 to 8) | (U)DINT REAL | | | | |
| 6393 + N * 8 | InputData03_N (index N = 1 to 8) | (U)SINT | • | | | |
| 6394 + N * 8 | InputData03_N (index N = 1 to 8) | (U)INT | | | | |
| 6396 + N * 8 | InputData03_N (index N = 1 to 8) | (U)DINT REAL | | | | |
| 7417 + N * 8 | InputData04_N (index N = 1 to 8) | (U)SINT | • | | | |
| 7418 + N * 8 | InputData04_N (index N = 1 to 8) | (U)INT | | | | |
| 7420 + N * 8 | InputData04_N (index N = 1 to 8) | (U)DINT REAL | | | | |
| 1 | SIO or digital inputs | USINT | • | | | |
| | DigitalInput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalInput04 | Bit 3 | | | | |
| IO-Link status response | | | | | | |
| 3 | Sync (status byte) | USINT | • | | | |
| | Synchronized01 | Bit 0 | | | | |

| Register | Name | Data type | Read | | Write | |
|---------------------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| | ... | ... | | | | |
| | Synchronized04 | Bit 3 | | | | |
| | CycleEnd01 | Bit 4 | | | | |
| | ... | ... | | | | |
| | CycleEnd04 | Bit 7 | | | | |
| 5 | Overload (status byte) | USINT | • | | | |
| | Overload01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | Overload04 | Bit 3 | | | | |
| 17 + N * 16 | ChannelStatus0N (index N = 1 to 4) | USINT | • | | | |
| 22 + N * 16 | FrameCount0N (index N = 1 to 4) | SINT | • | | | |
| 3586 + N * 1024 | CycleStartNettime0N (index N = 1 to 4) | INT | • | | | |
| 3588 + N * 1024 | CycleStartNettime0N (index N = 1 to 4) | DINT | | | | |
| 3594 + N * 1024 | CycleEndNettime0N (index N = 1 to 4) | INT | • | | | |
| 3596 + N * 1024 | CycleEndNettime0N (index N = 1 to 4) | DINT | | | | |
| IO-Link event interface | | | | | | |
| 113 | EventPortSeq | USINT | • | • | | |
| 115 | EventQualifier | USINT | • | • | | |
| 118 | EventCode | UINT | • | • | | |
| 121 | EventsLeft | USINT | | • | | |
| 123 | EventQuit | USINT | | | • | • |
| 123 | EventQuitReadBack | USINT | | • | | |
| IO-Link parameter server | | | | | | |
| 19 + N * 16 | DsControl0N (index N = 1 to 4) | USINT | | | • | • |
| 3140 + N * 1024 | Cfo_DS_Config0N (index N = 1 to 4) | UDINT | | | | • |
| 3241 + N * 1024 | DsProgress0N (index N = 1 to 4) | USINT | | • | | |
| 3148 + N * 1024 | Cfo_DS_SaveCtrl0N (index N = 1 to 4) | UDINT | | | | • |
| 3156 + N * 1024 | Cfo_DS_SaveData0N (index N = 1 to 4) | UDINT | | | | • |
| IO-Link timestamp | | | | | | |
| 3610 + N * 1024 | IoLinkTimestampIn0N (index N = 1 to 4) | INT | • | | | |
| 3612 + N * 1024 | IoLinkTimestampIn0N (index N = 1 to 4) | DINT | | | | |
| 3617 + N * 1024 | IoLinkTimestampInStatusSeq0N (index N = 1 to 4) | USINT | • | | | |
| 3714 + N * 1024 | IoLinkTimestampOut0N (index N = 1 to 4) | INT | | | • | |
| 3716 + N * 1024 | IoLinkTimestampOut0N (index N = 1 to 4) | DINT | | | | |
| 3721 + N * 1024 | IoLinkTimestampOutCtrlSeq0N (index N = 1 to 4) | USINT | | | • | |
| 3619 + N * 1024 | IoLinkTimestampOutStatus0N (index N = 1 to 4) | USINT | • | | | |
| IO-Link device IDs | | | | | | |
| 3202 + N * 1024 | VendorId0N (index N = 1 to 4) | UINT | • | • | | |
| 3212 + N * 1024 | DeviceId0N (index N = 1 to 4) | UDINT | • | • | | |
| 3206 + N * 1024 | FunctionId0N (index N = 1 to 4) | UINT | • | • | | |
| 3218 + N * 1024 | CycleTime0N (index N = 1 to 4) | UINT | • | • | | |
| 3222 + N * 1024 | CycleMultiple0N (index N = 1 to 4) | UINT | | • | | |
| 3226 + N * 1024 | CycleDivisor0N (index N = 1 to 4) | UINT | | • | | |
| 3230 + N * 1024 | MinCycleTime0N (index N = 1 to 4) | UINT | | • | | |
| 3233 + N * 1024 | PDI_Size0N (index N = 1 to 4) | USINT | | • | | |
| 3235 + N * 1024 | PDO_Size0N (index N = 1 to 4) | USINT | | • | | |
| 3237 + N * 1024 | Baudrate0N (index N = 1 to 4) | USINT | | • | | |
| 3239 + N * 1024 | IoLinkVersionID0N (index N = 1 to 4) | USINT | | • | | |
| Command interface | | | | | | |
| 98 | ParameterIndexOut | UINT | | | • | • |
| 101 | ParameterSubIndexOut | USINT | | | • | • |
| 103 | ParameterCtrlOut | USINT | | | • | • |
| 108 | ParameterDataOut_0 | UDINT | | | • | • |
| 103 | ParameterCtrlIn | USINT | • | • | | |
| 108 | ParameterDataIn_0 | UDINT | • | • | | |
| Flatstream | | | | | | |
| 193 | Cfo_OutputMTU | USINT | | | | • |
| 195 | Cfo_InputMTU | USINT | | | | • |
| 197 | Cfo_FlatStreamMode | USINT | | | | • |
| 199 | Cfo_Forward | USINT | | | | • |
| 204 | Cfo_ForwardDelay | UDINT | | | | • |
| 129 | InputSequence | USINT | • | | | |
| 129 + N * 2 | RxByteN (index N = 1 to 27) | USINT | • | | | |
| 129 | OutputSequence | USINT | | | • | |
| 129 + N * 2 | TxByteN (index N = 1 to 27) | USINT | | | • | |

9.26.15.10.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|---------------------------------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module properties | | | | | | | |
| 513 | - | CfO_SupplyConfig | USINT | | | | • |
| 3073 + N * 1024 | - | CfO_OperatingMode0N (Index N = 1 to 4) | USINT | | | | • |
| IO-Link configuration | | | | | | | |
| 3076 + N * 1024 | - | CfO_ChannelMode0N (Index N = 1 to 4) | UDINT | | | | • |
| 3099 + N * 1024 | - | CfO_IdentificationRevisionId0N (index N = 1 to 4) | USINT | | | | • |
| 3102 + N * 1024 | - | CfO_IdentificationVendorId0N (Index N = 1 to 4) | UINT | | | | • |
| 3108 + N * 1024 | - | CfO_IdentificationDeviceId0N (Index N = 1 to 4) | UDINT | | | | • |
| 3116 + N * 1024 | - | CfO_PDI_TypeInfo0N (Index N = 1 to 4) | UDINT | | | | • |
| 3124 + N * 1024 | - | CfO_PDO_TypeInfo0N (Index N = 1 to 4) | UDINT | | | | • |
| 15372 | - | CfO_TimerCycle | UDINT | | | | • |
| 15366 | - | CfO_TimerOffset | INT | | | | • |
| 3086 + N * 1024 | - | CfO_ReqCycleMultiple0N (Index N = 1 to 4) | UINT | | | | • |
| 3090 + N * 1024 | - | CfO_ReqCycleDivisor0N (Index N = 1 to 4) | UINT | | | | • |
| 3094 + N * 1024 | - | CfO_ReqCycleOffset0N (Index N = 1 to 4) | UINT | | | | • |
| 3082 + N * 1024 | - | CfO_ReqCycleTime0N (Index N = 1 to 4) | UINT | | | | • |
| IO-Link communication | | | | | | | |
| 4473 + N * 8 | (N-1) | OutputData01_N (index N = 1 to 8) | USINT | | | • | |
| 5497 + N * 8 | 4 + (N-1) | OutputData02_N (index N = 1 to 8) | USINT | | | • | |
| 6521 + N * 8 | 8 + (N-1) | OutputData03_N (index N = 1 to 8) | USINT | | | • | |
| 7545 + N * 8 | 12 + (N-1) | OutputData04_N (index N = 1 to 8) | USINT | | | • | |
| 7 | - | SIO or digital outputs | USINT | | | | • |
| | | DigitalOutput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalOutput04 | Bit 3 | | | | |
| | | DisablePowerSupply01 | Bit 4 | | | | |
| | | ... | ... | | | | |
| 4345 + N * 8 | (N-1) | InputData01_N (index N = 1 to 8) | USINT | • | | | |
| 5369 + N * 8 | 4 + (N-1) | InputData02_N (index N = 1 to 8) | USINT | • | | | |
| 6393 + N * 8 | 8 + (N-1) | InputData03_N (index N = 1 to 8) | USINT | • | | | |
| 7417 + N * 8 | 12 + (N-1) | InputData04_N (index N = 1 to 8) | USINT | • | | | |
| 1 | 20 | SIO or digital inputs | USINT | • | | | |
| | | DigitalInput01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | DigitalInput04 | Bit 3 | | | | |
| | | ... | ... | | | | |
| IO-Link status response | | | | | | | |
| 3 | 21 | Sync (status byte) | USINT | • | | | |
| | | Synchronized01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | Synchronized04 | Bit 3 | | | | |
| | | CycleEnd01 | Bit 4 | | | | |
| | | ... | ... | | | | |
| 5 | 22 | Overload (status byte) | USINT | • | | | |
| | | Overload01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | Overload04 | Bit 3 | | | | |
| 17 + N * 16 | 15 + N | ChannelStatus0N (Index N = 1 to 4) | USINT | • | | | |
| 22 + N * 16 | - | FrameCount0N (Index N = 1 to 4) | SINT | | • | | |
| 3586 + N * 1024 | - | CycleStartNettime0N (Index N = 1 to 4) | INT | | • | | |
| 3588 + N * 1024 | - | CycleStartNettime0N (Index N = 1 to 4) | DINT | | | | |
| 3594 + N * 1024 | - | CycleEndNettime0N (Index N = 1 to 4) | INT | | • | | |
| 3596 + N * 1024 | - | CycleEndNettime0N (Index N = 1 to 4) | DINT | | | | |
| IO-Link event interface | | | | | | | |
| 113 | - | EventPortSeq | USINT | | • | | |
| 115 | - | EventQualifier | USINT | | • | | |
| 118 | - | EventCode | UINT | | • | | |
| 121 | - | EventsLeft | USINT | | • | | |
| 123 | - | EventQuit | USINT | | | | • |
| 123 | - | EventQuitReadBack | USINT | | • | | |
| IO-Link parameter server | | | | | | | |
| 19 + N * 16 | - | DsContol0N (Index N = 1 to 4) | USINT | | | | • |
| 3140 + N * 1024 | - | CfO_DS_Config0N (Index N = 1 to 4) | UDINT | | | | • |
| 3241 + N * 1024 | - | DsProgress0N (Index N = 1 to 4) | USINT | | • | | |
| 3148 + N * 1024 | - | CfO_DS_SaveCtrl0N (Index N = 1 to 4) | UDINT | | | | • |
| 3156 + N * 1024 | - | CfO_DS_SaveData0N (Index N = 1 to 4) | UDINT | | | | • |

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|---------------------------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| IO-Link timestamp | | | | | | | |
| 3610 + N * 1024 | - | IoLinkTimestampIn0N (Index N = 1 to 4) | INT | | • | | |
| 3612 + N * 1024 | - | IoLinkTimestampIn0N (Index N = 1 to 4) | DINT | | | | |
| 3617 + N * 1024 | - | IoLinkTimestampInStatusSeq0N (Index N = 1 to 4) | USINT | | • | | |
| 3714 + N * 1024 | - | IoLinkTimestampOut0N (Index N = 1 to 4) | INT | | | | • |
| 3716 + N * 1024 | - | IoLinkTimestampOut0N (Index N = 1 to 4) | DINT | | | | |
| 3721 + N * 1024 | - | IoLinkTimestampOutCtrlSeq0N (Index N = 1 to 4) | USINT | | | | • |
| 3619 + N * 1024 | - | IoLinkTimestampOutStatus0N (Index N = 1 to 4) | USINT | | • | | |
| IO-Link device IDs | | | | | | | |
| 3202 + N * 1024 | - | VendorId0N (Index N = 1 to 4) | UINT | | • | | |
| 3212 + N * 1024 | - | DeviceId0N (Index N = 1 to 4) | UDINT | | • | | |
| 3206 + N * 1024 | - | FunctionId0N (Index N = 1 to 4) | UINT | | • | | |
| 3218 + N * 1024 | - | CycleTime0N (Index N = 1 to 4) | UINT | | • | | |
| 3222 + N * 1024 | - | CycleMultiple0N (Index N = 1 to 4) | UINT | | • | | |
| 3226 + N * 1024 | - | CycleDivisor0N (Index N = 1 to 4) | UINT | | • | | |
| 3230 + N * 1024 | - | MinCycleTime0N (Index N = 1 to 4) | UINT | | • | | |
| 3233 + N * 1024 | - | PDI_Size0N (Index N = 1 to 4) | USINT | | • | | |
| 3235 + N * 1024 | - | PDO_Size0N (Index N = 1 to 4) | USINT | | • | | |
| 3237 + N * 1024 | - | Baudrate0N (Index N = 1 to 4) | USINT | | • | | |
| 3239 + N * 1024 | - | IoLinkVersionID0N (Index N = 1 to 4) | USINT | | • | | |
| Command interface | | | | | | | |
| 98 | - | ParameterIndexOut | UINT | | | | • |
| 101 | - | ParameterSubIndexOut | USINT | | | | • |
| 103 | - | ParameterCtrlOut | USINT | | | | • |
| 108 | - | ParameterDataOut_0 | UDINT | | | | • |
| 103 | - | ParameterCtrlIn | USINT | | • | | |
| 108 | - | ParameterDataIn_0 | UDINT | | • | | |
| FlatStream | | | | | | | |
| 193 | - | CfO_OutputMTU | USINT | | | | • |
| 195 | - | CfO_InputMTU | USINT | | | | • |
| 197 | - | CfO_FlatStreamMode | USINT | | | | • |
| 199 | - | CfO_Forward | USINT | | | | • |
| 204 | - | CfO_ForwardDelay | UDINT | | | | • |
| 129 | - | InputSequence | USINT | | • | | |
| 129 + N * 2 | - | RxByteN (Index N = 1 to 27) | USINT | | • | | |
| 129 | - | OutputSequence | USINT | | | • | |
| 129 + N * 2 | - | TxByteN (Index N = 1 to 27) | USINT | | | • | |

1) The offset specifies the position of the register within the CAN object.

9.26.15.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.26.15.10.3.2 CAN I/O bus controller

The module occupies 3 analog logical slots with CAN I/O.

9.26.15.10.4 Module configuration

The module can be used to connect IO-Link devices (IO-Link version 1.1). The power supply of 24 VDC for the IO-Link sensor/actuator is permitted to be obtained from the module. To avoid damage to the hardware, the module is equipped with overload protection.

Information:

Separate overload protection is implemented for each connection pin of the sensor/actuator power supply, i.e. the power supplies of each connected IO-Link device are galvanically isolated from one another.

If an IO-Link device triggers the overload protection on the module, the subsequent limitation of the supply current only affects this device. All other connected devices are unaffected.

9.26.15.10.4.1 Configuring overload protection for the IO-Link supply

Name:

CfO_SupplyConfig

This register can be used to define how the module supply behaves for all channels when an overload occurs. The following rules apply:

- The overload duration (bits 6-7) corresponds to the time that the supply remains switched on after an overload is detected. The supply is only cut off if the overcurrent occurs for the entire time configured.
- The switch-off duration (bits 4-5) corresponds to the time that the supply remains switched off after an overload-related cutoff until it is switched back on.

For this reason, an overload that occurs over a longer period can cause the module supply to cyclically switch on/off.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|---|-------|---------------------------------------|
| 0 - 3 | Reserved | - | |
| 4 - 5 | Switch-off duration after overload | 00 | 5 ms (bus controller default setting) |
| | | 01 | 20 ms |
| | | 10 | 50 ms |
| | | 11 | Forbidden |
| 6 - 7 | Overload duration until error detection | 00 | 1 ms (bus controller default setting) |
| | | 01 | 4 ms |
| | | 10 | 10 ms |
| | | 11 | Forbidden |

9.26.15.10.4.2 OperatingMode

Name:

CfO_OperatingMode01 to CfO_OperatingMode04

This register is the same as the first byte of register "[ChannelMode](#)" on page 3296 in the IO-Link configuration. It contains all settings of an IO-Link channel that are permitted to be changed at runtime.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------|-------|---|
| 0 - 1 | Channel mode | 00 | Mode: Inactive (bus controller default setting) |
| | | 01 | Mode: SIO output The channel's C/Q connector is configured as a digital output. |
| | | 10 | Mode: SIO input The channel's C/Q connector is configured as a digital input. |
| | | 11 | Mode: Operate The channel's C/Q connector is configured for IO-Link data transfer. |
| 2 - 7 | Reserved | - | |

9.26.15.10.5 IO-Link configuration

The module establishes communication with the IO-Link device if register "ChannelMode" on page 3296 of the corresponding channel is configured. The other registers in this section can be used to adapt the data exchange to the application requirements.

9.26.15.10.5.1 ChannelMode

Name:

CfO_ChannelMode01 to CfO_ChannelMode04

The user has the option of setting all channel-specific settings via this register.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UDINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Values | Information |
|---------|---|--------|---|
| 0 - 1 | Channel mode | 00 | Mode: Inactive (bus controller default setting) |
| | | 01 | Mode: SIO output The channel's C/Q connector is configured as a digital output. |
| | | 10 | Mode: SIO input The channel's C/Q connector is configured as a digital input. |
| | | 11 | Mode: Operate The channel's C/Q connector is configured for IO-Link data transfer. |
| 2 - 7 | Reserved | - | |
| 8 - 9 | Threshold value for overcurrent on the channel ¹⁾ (OverCurrentThreshold in Automation Studio configuration) | 00 | 250 mA (bus controller default setting) |
| | | 01 | 125 mA |
| | | 10 | 75 mA |
| | | 11 | 50 mA |
| 10 - 11 | Reserved | - | |
| 12 - 13 | Switch-off duration after overload ¹⁾ (OverloadOffTime in Automation Studio configuration) | 00 | 20 ms (bus controller default setting) |
| | | 01 | 12 ms |
| | | 10 | 6.4 ms |
| | | 11 | 32 ms |
| 14 - 15 | Reserved | - | |
| 16 - 17 | Mode for synchronization | 00 | Free-running (asynchronous) (bus controller default setting) |
| | | 01 | Synchronous (manual) |
| | | 10 | Synchronous (automatic) |
| | | 11 | Impermissible |
| 18 - 19 | Reserved | - | |
| 20 - 23 | Inspection level | 0 | Tests disabled (bus controller default setting) |
| | | 1 | Testing VendorID and DeviceID |
| 24 - 25 | IO-Link timestamp | 00 | No timestamp (bus controller default setting) |
| | | 01 | Input timestamp |
| | | 10 | Output timestamp |
| | | 11 | Input and output timestamps |
| 26 | Format of the IO-Link output timestamp ²⁾ | 0 | 32-bit (DINT) (bus controller default setting) |
| | | 1 | 16-bit (INT) |
| 27 - 32 | Reserved | - | |

- 1) This is overload protection for the C/Q connector of the IO-Link channels (IO-Link data line or SIO output) as opposed to overload protection of the IO-Link power supply.
- 2) This bit informs the module of the format used for the `IoLinkTimestampOut` output timestamp. In Automation Studio, this setting is made implicitly in the I/O configuration together with the selection of the data type for the IO-Link timestamp.

9.26.15.10.5.2 IdentificationRevisionID

Name:

CfO_IdentificationRevisionId01 to CfO_IdentificationRevisionId04

If the identifiers (IDs) of the connected device should be verified during startup, the IO-Link revision with which the check takes place can be disclosed in this register.

| Data type | Values | Information |
|---|--------|--|
| USINT | 0 | The revision read from the device is used. |
| | 16 | The connected device is checked per revision V1.0. |
| | 17 | The connected device is checked per revision V1.1. |
| <p>If the device does not support this standard, error code 41 is output in register "ChannelStatus" on page 3306.</p> | | |

9.26.15.10.5.3 IdentificationVendorID

Name:

CfO_IdentificationVendorId01 to CfO_IdentificationVendorId04

If the Vendor ID is to be verified during startup, then the expected value must be specified in this register. The verification can be enabled by setting the inspection level in the "ChannelMode" on page 3296 register.

Information:

If the expected ID does not match the actual ID of the connected IO-Link device, communication will not be started for this channel.

| Data type | Values | Information |
|-----------|-------------|-----------------------------------|
| UINT | 0 to 65,535 | Bus controller default setting: 0 |

9.26.15.10.5.4 IdentificationDeviceID

Name:

CfO_IdentificationDeviceId01 to CfO_IdentificationDeviceId04

If the device ID should be verified during startup, then the expected ID of the IO-Link device must be specified in this register. The verification can be enabled by setting the inspection level in the "ChannelMode" on page 3296 register.

Information:

If the expected ID does not match the actual ID of the connected IO-Link device, communication will not be started for this channel.

| Data type | Values | Information |
|-----------|--------------------|-----------------------------------|
| UDINT | 0 to 4,294,967,295 | Bus controller default setting: 0 |

9.26.15.10.5.5 PDI_TypeInfo

Name: CfO_PDI_TypeInfo01 to CfO_PDI_TypeInfo04

To transfer process data from the IO-Link device to the CPU (application), the information is first read from the module and saved temporarily. Typically, 4 bytes are reserved for each piece for registered information (see "IO-Link communication" on page 3303).

This register is used to configure how the incoming IO-Link process data stream (IO-Link frame) is divided. According to this configuration, the IO-Link process data is made available to the application via the corresponding InputData registers. The input data registers are assigned to individual data points with the corresponding data type in the I/O mapping.

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| UDINT | See bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|---------|-----------------------|-------------|--|
| 0 to 3 | IO-Link information 1 | 0000 | Array[4] of Bytes (bus controller default setting) |
| | | 0001 | USINT |
| | | 0010 | SINT |
| | | 0011 | UINT |
| | | 0100 | INT |
| | | 0101 | UDINT |
| | | 0110 | DINT |
| | | 0111 | REAL |
| | | 1000 - 1111 | Reserved |
| 4 - 7 | IO-Link information 2 | | Possible values are identical with IO-Link information 1 |
| 8 - 11 | IO-Link information 3 | | |
| 12 - 15 | IO-Link information 4 | | |
| 16 - 19 | IO-Link information 5 | | |
| 20 - 23 | IO-Link information 6 | | |
| 24 - 27 | IO-Link information 7 | | |
| 28 - 31 | IO-Link information 8 | | |

Information:

With setting 0 (Array[4] of Bytes), the bytes are copied from the IO-Link data stream unchanged. In all other modes, the byte order is changed (from big endian to little endian).

9.26.15.10.5.6 PDO_TypeInfo

Name: CfO_PDO_TypeInfo01 to CfO_PDO_TypeInfo04

In order to transfer process data to the IO-Link device, this register is used to configure which data type of the individual "OutputData" on page 3303 registers are used to merge the outgoing IO-Link process data stream (IO-Link frame, see "IO-Link communication" on page 3303). According to this configuration, OutputData registers are assigned to data points with the corresponding data types in Automation Studio (I/O mapping).

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| UDINT | See bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|---------|-----------------------|-------------|--|
| 0 to 3 | IO-Link information 1 | 0000 | Array[4] of Bytes (bus controller default setting) |
| | | 0001 | USINT |
| | | 0010 | SINT |
| | | 0011 | UINT |
| | | 0100 | INT |
| | | 0101 | UDINT |
| | | 0110 | DINT |
| | | 0111 | REAL |
| | | 1000 - 1111 | Reserved |
| 4 - 7 | IO-Link information 2 | | Possible values are identical with IO-Link information 1 |
| 8 - 11 | IO-Link information 3 | | |
| 12 - 15 | IO-Link information 4 | | |
| 16 - 19 | IO-Link information 5 | | |
| 20 - 23 | IO-Link information 6 | | |
| 24 - 27 | IO-Link information 7 | | |
| 28 - 31 | IO-Link information 8 | | |

Information:

With setting 0 (Array[4] of Bytes), the bytes are copied from the IO-Link data stream unchanged. In all other modes, the byte order is changed (from big endian to little endian).

9.26.15.10.5.7 Timing of IO-Link communication

At runtime, the module needs to manage data sets from 2 different communication standards. For efficient X2X Link communication, it is important to make sure that the cycle time of all X2X modules is the same as the bus cycle time.

Cycle times specified in IO-Link

The IO-Link specification defines the timing cycle for polling an IO-Link device. This cycle is called the IO-Link cycle. Valid IO-Link cycle times range from 0.4 ms to 132.8 ms. There are three ranges:

| Area | Increment | Calculation | Valid cycle times |
|------------------|-----------|-----------------------------------|-------------------------------------|
| 0.4 to 6.3 ms | 0.1 ms | Cycle time = 0.1 ms * n + 0.4 ms | 0.4, 0.5, 0.6 to 6.2, 6.3 ms |
| 6.4 to 32.6 ms | 0.4 ms | Cycle time = 0.4 ms * n + 6.4 ms | 6.4, 6.8, 7.2 to 32.2, 32.6 ms |
| 32.0 to 132.8 ms | 1.6 ms | Cycle time = 1.6 ms * n + 32.0 ms | 32.0, 33.6, 35.2 to 131.2, 132.8 ms |

Module timer

An internal module timer that applies globally to all channels serves as the bases for synchronizing the individual channels. Using this defined time basis, X2X and IO-Link communication can be synchronized with each other. The period duration for the module timer can be defined in μ s. To make communication as efficient and deterministic as possible, the module timer is configured in automatic mode to match the X2X Link cycle time by default. If necessary, the start of the module timer can be offset using the "TimerOffset" on page 3301.

The module timer's cycle is synchronized automatically with the X2X cycle. Depending of the ratio between the X2X and module timer cycle time, there may be different ratios between the cycles.

Examples

| | | |
|--------|------------------------------------|---|
| 1 to 1 | (X2X cycle 1000, cycle timer 1000) | → Always exactly one timer cycle per X2X cycle |
| 2 to 1 | (X2X cycle 2000, cycle timer 1000) | → Always exactly two timer cycles per X2X cycle |
| 1 to 2 | (X2X cycle 1000, cycle timer 2000) | → Always exactly one timer cycle per 2 X2X cycles |
| 3 to 5 | (X2X cycle 1500, cycle timer 2500) | → Always exactly 3 timer cycles per 5 X2X cycles |

Synchronous operation

Unlike to free-running operation, synchronous mode and the synchronization cycle time in this operating mode can be configured individually for each channel.

The SYNCHRONIZED operating mode optimizes the interaction between X2X and IO-Link communication. The module's resources were designed for this mode, so this configuration should be used for the module's channels.

- In the mode SYNCHRONIZED (automatic), the module calculates the necessary timing parameters itself. An IO-Link cycle is set that complies with the IO-Link specification. The selected IO-Link cycle time corresponds to the lowest possible multiple of the module timer cycle time that meets the following conditions:
 - Valid IO-Link cycle time
 - Greater than or equal to the minimum cycle time on the device
- In the mode SYNCHRONIZED (manual), the user can configure the module's timing manually. Both the synchronization cycle time and the IO-Link cycle can be defined manually by setting a factor.

Synchronization cycle time

$$\text{Synchronization cycle time} = \text{Timer cycle time} * \text{CfO_ReqCycleMultiple0x}$$

The synchronization ensures that synchronization cycles run parallel with the same synchronization cycle time and are not offset by timer cycles.

IO-Link cycle time

$$\text{IO-Link cycle time} = \text{Synchronization cycle time} / \text{CfO_ReqCycleDivisor0x}$$

The IO-Link cycle is set individually for each channel. If necessary, the IO-Link cycle of a channel can be offset using a channel-specific offset. This allows channels to be adjusted so that their queries end at the same time, for example.

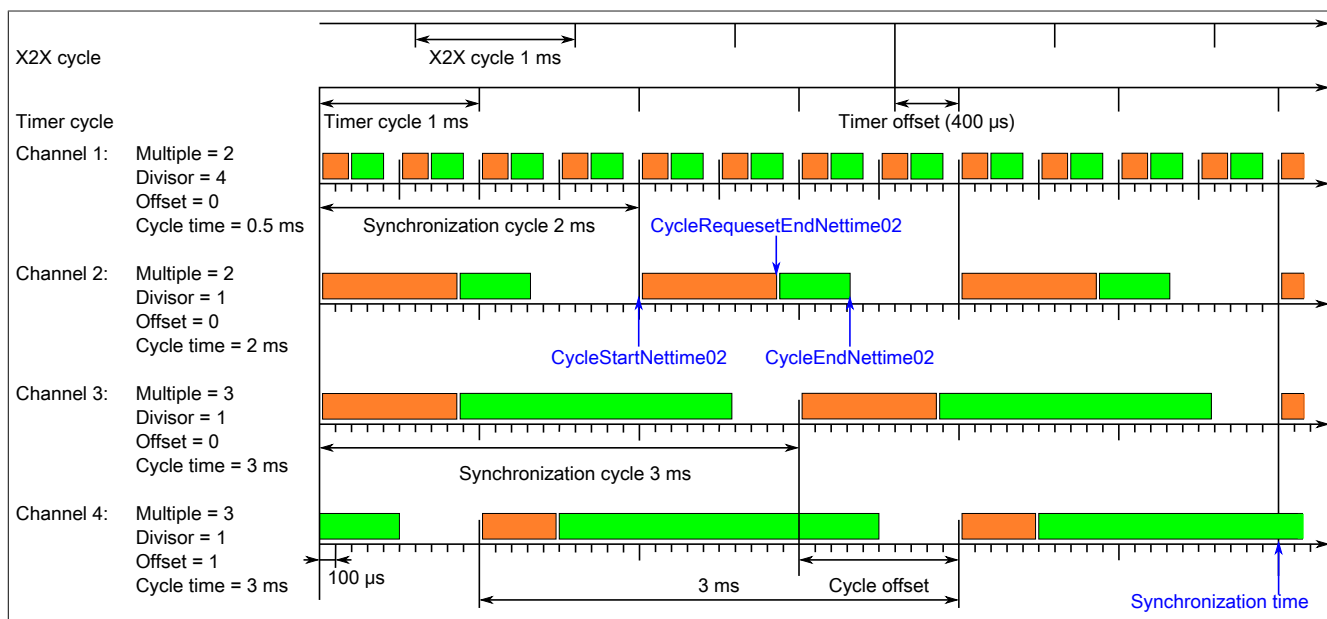
With very short cycle times (<1 ms) it is possible that the data cannot be processed fast enough. When this happens, the subsequent cycles are delayed, which is indicated by the status bit for synchronization being reset.

Information:

If the IO-Link cycle is configured to be less than the device's minimum cycle time, then a cycle that meets the following conditions is selected automatically:

- **Multiple of the module timer cycle**
- **Valid IO-Link cycle time**
- **Greater than or equal to the minimum cycle time on the device**

Example of a configuration



The module timer in this example

- The duration of the module timer period was not defined explicitly. In this case, it corresponds to the X2X Link cycle time.
- An offset of 400 µs was applied to the module timer; i.e. the module timer cycle begins 400 µs after the X2X Link cycle.

IO-Link communication in this example

- The parameters "Multiple" on page 3301 and "Divisor" on page 3301 produce a channel-specific cycle time for IO-Link communication.
- Channels 1 and 2 have a shared synchronization cycle of 2 ms. Channels 3 and 4 have a shared synchronization cycle of 3 ms, which is shifted due to the offset.
- Channels start their query together at the beginning of a shared synchronization cycle.
- The IO-Link cycle of the fourth channel was delayed with an offset of 1 ms.
- All channels have a shared synchronization cycle of 6 ms.

Free-running (asynchronous) mode

If the IO-Link and X2X Link cycle times cannot be synchronized, then the IO-Link cycle time can be specified explicitly. IO-Link communication then runs independently of the module timer and X2X cycle. Except for "CycleEndNettime" on page 3307, no other NetTime data points can be used. The cycle times of free-running IO-Link channels are defined directly via the corresponding registers. However, deviations may occur if the module's resources are exhausted.

TimerCycle

Name:

CfO_TimerCycle

This register can be used to configure synchronous IO-Link communication. If the module timer is not meant to be operated with the same cycle, then it is possible to define the period length of the module timer in μs using this register. This allows channels to be synchronized with one another even if using a very unusual X2X cycle time.

| Data type | Values | Information |
|-----------|--------------------|--|
| UDINT | 0 to 4,294,967,295 | Bus controller default setting: Current X2X cycle time |

TimerOffset

Name:

CfO_TimerOffset

This register can be used to configure synchronous IO-Link communication. If the module timer should run with a timing offset to X2X Link, this register can be used to define how many microseconds in front of or behind the module timer should be shifted.

| Data type | Values | Information |
|-----------|-----------------|-----------------------------------|
| INT | -32768 to 32767 | Bus controller default setting: 0 |

ReqCycleMultiple

Name:

CfO_ReqCycleMultiple01 to CfO_ReqCycleMultiple04

This register can be used to manually configure the synchronization cycle time. This cycle time can be used together with the "ReqCycleDivisor" on page 3301 register to define the IO-Link cycle time. See "Synchronous operation" on page 3299 for an example.

Information:

If this register is not defined for an IO-Link channel or predefined with zero, the values of the Cycle-Multiple and CycleDivisor registers are calculated automatically when the module is started.

| Data type | Values | Information |
|-----------|-------------|-----------------------------------|
| UINT | 0 to 65,535 | Bus controller default setting: 0 |

ReqCycleDivisor

Name:

CfO_ReqCycleDivisor01 to CfO_ReqCycleDivisor04

This register can be used together with "ReqCycleMultiple" on page 3301 to define the IO-Link cycle time. See "Synchronous operation" on page 3299 for an example.

Information:

If this register is not defined for an IO-Link channel or predefined with zero, the values of the Cycle-Multiple and CycleDivisor registers are calculated automatically when the module is started.

| Data type | Values | Information |
|-----------|-------------|-----------------------------------|
| UINT | 0 to 65,535 | Bus controller default setting: 0 |

ReqCycleOffset

Name:

CfO_ReqCycleOffset01 to CfO_ReqCycleOffset04

This register can be used to offset the IO-Link cycle of a channel with the synchronization cycle. This offset may be sensible if all channels are running with the same cycle time. In this case, all channels are finished at the same time, which could result in the module not being able to process all data in time. Offsets can be used to prevent these sorts of bottlenecks so that data traffic can be divided up more evenly.

| Data type | Value | Information |
|-----------|------------|--|
| UINT | 0 to 65535 | Configured in timer cycles. Bus controller default setting: 0 |

ReqCycleTime

Name:

CfO_ReqCycleTime01 to CfO_ReqCycleTime04

This register is used with free-running (asynchronous) IO-Link communication. It contains the explicitly defined cycle time for the IO-Link query in μs .

Information:

- In free-running mode, no **NetTime** data points are permitted to be used except for "**CycleEnd-Nettime**" on page 3307.
- If the cycle time predefined for IO-Link communication falls below the device's minimum cycle time, the IO-Link data is queried using the device's minimum cycle time.
- For efficient IO-Link communication, the configured query time should correspond to the specified IO-Link cycle times. If a value is unsuitable, the next suitable cycle time is used automatically.

| Data type | Value | Information |
|-----------|------------|--|
| UINT | 0 to 65535 | In 100 μs steps. Bus controller default setting: 0 |

9.26.15.10.6 IO-Link communication

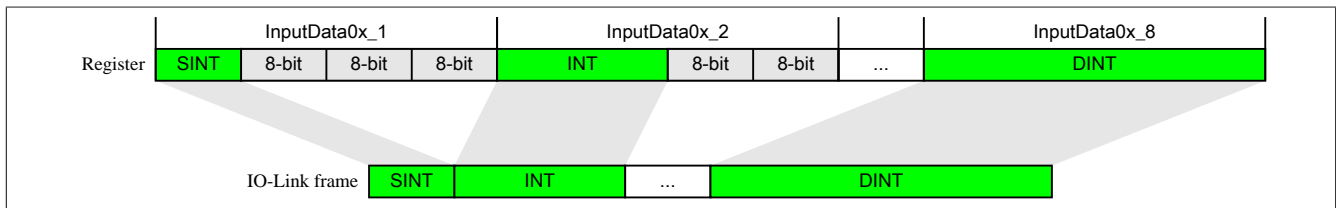
If the corresponding IO-Link channel of the module has been configured to "Operate" in Automation Studio, the IO-Link module attempts to exchange process data with the connected IO-Link device. For each active IO-Link channel, 8 `InputData0x_y` and 8 `OutputData0x_y` registers are allocated in the memory of the module.

| | | | | | | | | | | | | | |
|----------|---------------|-------|-------|-------|---------------|-------|-------|-------|-----|---------------|-------|-------|-------|
| Register | InputData0x_1 | | | | InputData0x_2 | | | | ... | InputData0x_8 | | | |
| | 8-bit | 8-bit | 8-bit | 8-bit | 8-bit | 8-bit | 8-bit | 8-bit | | 8-bit | 8-bit | 8-bit | 8-bit |

To define the actual IO-Link frame, you must define how many of the maximum 8 registers are used as well as the data type of the IO-Link data.

| | | | | | | | | | | | | | |
|----------|---------------|-------|-------|-------|---------------|-------|-------|-------|-----|---------------|-------|-------|-------|
| Register | InputData0x_1 | | | | InputData0x_2 | | | | ... | InputData0x_8 | | | |
| | SINT | 8-bit | 8-bit | 8-bit | INT | 8-bit | 8-bit | 8-bit | | DINT | 8-bit | 8-bit | 8-bit |

The IO-Link frame for communication with the IO-Link device results from these initialized data points.



In order to transfer the IO-Link data to the PLC, the bandwidth of the X2X Link network must also be taken into account when defining the data type for the IO-Link communication. This limitation can be minimized if the "OCTET" data points or "multiplexed OCTET" data points are used instead of the standard data types.

"OCTET" byte arrays:

8 registers with up to 32 bits are available per channel and direction. This way, 8 data points can be transferred. If this amount of data is insufficient, a byte array can be used to generate the IO-Link frame. The user must manage the distribution of IO-Link frames within the application and observe the byte order in the IO-Link device.

"Multiplexed OCTET" byte arrays:

When transferring the IO-Link data via the X2X Link network, it is important to note that not all 32 bytes of the 4 IO-Link channels can be simultaneously registered on the cyclic part of the X2X Link network. In the input direction, the module has been extended in this respect. Time-multiplexed data transfer can take place in the background. Depending on the amount of data, several X2X cycles may be required to transfer new data between the module and the controller. This mode is not available in the output direction. Therefore, IO-Link output data can only be generated with a maximum length of 27 bytes.

SIO mode

"SIO" stands for "standard I/O" and defines an alternative use for the C/Qx connection. If a channel of the module is not required for IO-Link communication, the pin can be used as standard I/O. The user can decide whether to use the standard I/O as input or output. The IO-Link standard also permits IO-Link communication to be stopped and restarted. If IO-Link communication is stopped at runtime, the C/Qx connection can be used as a standard output.

9.26.15.10.6.1 OutputData

Name:

OutputData01_1 to OutputData04_8

Output data from the IO-Link device in IO-Link communication mode. A byte array is also a possible alternative. The user then has to make sure that the bytes are divided up into the necessary data types.

The "[PDO_TypeInfo](#)" on page 3298 register can be used to configure how many bytes should be applied to the IO-Link frame from the output registers.

| Data type | Value |
|-----------|---------------------------------|
| USINT | 0 to 255 |
| SINT | -128 to 127 |
| UINT | 0 to 65535 |
| INT | -32,768 to 32,767 |
| UDINT | 0 to 4,294,967,295 |
| DINT | -2,147,483,648 to 2,147,483,647 |
| REAL | -3.4E38 – 3.4E38 |

9.26.15.10.6.2 Digital SIO outputs

Name:

DigitalOutput01 to DigitalOutput04

DisablePowerSupply01 to DisablePowerSupply04

If a channel is being operated in SIO mode (SIO output), this register can be used to control the SIO output of the IO-Link channel. It is also possible switch on/off the supply for each IO-Link channel individually.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|----------------------|-------|--|
| 0 | DigitalOutput01 | 0 | Reset digital SIO output 01 |
| | | 1 | Set digital SIO output 01 |
| ... | | ... | |
| 3 | DigitalOutput04 | 0 | Reset digital SIO output 04 |
| | | 1 | Set digital SIO output 04 |
| 4 | DisablePowerSupply01 | 0 | Switch on supply for IO-Link channel 01 |
| | | 1 | Switch off supply for IO-Link channel 01 |
| ... | | ... | |
| 7 | DisablePowerSupply04 | 0 | Switch on supply for IO-Link channel 04 |
| | | 1 | Switch off supply for IO-Link channel 04 |

9.26.15.10.6.3 InputData

Name:

InputData01_1 to InputData04_8

Input data from the IO-Link device in IO-Link communication mode. A byte array is also a possible alternative. The user then has to make sure that the bytes are divided up into the necessary data types.

| Data type | Value |
|-----------|---------------------------------|
| USINT | 0 to 255 |
| SINT | -128 to 127 |
| UINT | 0 to 65535 |
| INT | -32,768 to 32,767 |
| UDINT | 0 to 4,294,967,295 |
| DINT | -2,147,483,648 to 2,147,483,647 |
| REAL | -3.4E38 – 3.4E38 |

9.26.15.10.6.4 Digital SIO inputs

Name:

DigitalInput01 to DigitalInput04

If a channel is being operated in SIO mode (SOI input), this register can be used to read the input status of the channel.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------|-------|----------------------------|
| 0 | DigitalInput01 | 0 | Reset digital SIO input 01 |
| | | 1 | Set digital SIO input 01 |
| ... | | ... | |
| 3 | DigitalInput04 | 0 | Reset digital SIO input 04 |
| | | 1 | Set digital SIO input 04 |
| 4 - 7 | Reserved | - | |

9.26.15.10.7 IO-Link status response

The status registers for IO-Link communication are explained in the following chapter. The status information provides information about the current situation between the module and the IO-Link device. They can be retrieved from the controller and evaluated in the application task.

9.26.15.10.7.1 Sync (status byte)

Name:

Synchronized01 to Synchronized04

CycleEnd01 to CycleEnd04

The module uses this status register to report whether error-free communication with the device was possible during the last module cycle.

- The CycleEnd bits indicate whether the last data transmitted to the IO-Link device has been processed. The CycleEnd bits are reset after each X2X cycle.
- The synchronized bits indicate that the channel is synchronized without errors.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-----|----------------|-------|--|
| 0 | Synchronized01 | 0 | Synchronization for channel 1 not OK |
| | | 1 | Synchronization for channel 1 OK |
| ... | | ... | |
| 3 | Synchronized04 | 0 | Synchronization for channel 4 not OK |
| | | 1 | Synchronization for channel 4 OK |
| 4 | CycleEnd01 | 0 | I/O cycle end: No new IO-Link data |
| | | 1 | I/O cycle end: New data transmitted and received |
| ... | | ... | |
| 7 | CycleEnd04 | 0 | I/O cycle end: No new IO-Link data |
| | | 1 | I/O cycle end: New data transmitted and received |

9.26.15.10.7.2 Overload (status byte)

Name:

Overload01 to Overload04

This status register is used by the module to report whether an overload in the form of overcurrent or overtemperature occurred in the channel supply.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|------------------------|
| 0 | Overload01 | 0 | Channel 1: No overload |
| | | 1 | Channel 1: Overload |
| ... | | ... | |
| 3 | Overload04 | 0 | Channel 4: No overload |
| | | 1 | Channel 4: Overload |
| 4 - 7 | Reserved | - | |

9.26.15.10.7.3 ChannelStatus

Name:

ChannelStatus01 to ChannelStatus04

This register is used to show the current status of the IO-Link channel.

| Data type | Value | Information | Status |
|-----------|-----------|--|--|
| USINT | 0 | Channel inactive | Disabled |
| | 1 | Use as digital SIO output | SIO mode |
| | 2 | Use as digital SIO input | |
| | 3 | Startup of IO-Link device, PREOPERATIONAL mode | Communication is running but no process data is exchanged. However, acyclic access is also possible. |
| | 4 | Operation, OPERATE mode | Communication is running |
| | 5 | Operation, parameter server data OK | |
| | 6 | Parameter server: Upload active | Communication is running and process data is being returned. |
| | 7 | Parameter server: Download active | |
| | 8 | Parameter server: Deleting active | |
| | 9 | IODD parameters are written | |
| | 10 to 20 | Reserved | |
| | 21 | General error in the parameter server . For example: <ul style="list-style-type: none"> Parameter server not supported Error accessing an object that is managed by the parameter server Internal error | Communication is running. However, an error has occurred on the parameter server. Parameter server errors can be acknowledged via the " DsControl " on page 3310 register. |
| | 22 | Parameter server locked by IO-Link device | |
| | 23 | Parameter server empty: Tried to load data to the IO-Link device even though no data is saved in EEPROM | |
| | 24 | New serial number recognized: The user must decide via the " DsControl " on page 3310 register what has to be done (Upload – Download – Restore default values) | |
| | 25 | Parameter server not compatible (new DeviceID or new VendorID recognized): The data in EEPROM is not suitable for the connected IO-Link device. The user must decide via the " DsControl " on page 3310 register whether an upload should be carried out. | |
| | 26 | Upload request received. The user must decide via the " DsControl " on page 3310 register what must be done (Upload – Download – Restore default values). | |
| | 27 | The parameter checksum of the IO-Link device has changed: The user must decide via the " DsControl " on page 3310 register what must be done (Upload – Download – Restore default values). | |
| | 28 | Error when sending the SAVE command | |
| | 29 | Reserved | |
| | 30 | Process data invalid | Communication is running. However, process data was marked as invalid by the device. |
| | 31 - 39 | Reserved | |
| | 40 | No connection | No communication |
| | 41 | The configured revision ID is not supported by the connected device. | |
| | 42 | The DeviceID and VendorID of the connected IO-Link device do not match the predefined IDs. | Communication is running but no process data is exchanged. However, acyclic access is also possible. |
| | 43 | The configured serial number does not match the serial number of the connected device. | |
| | 44 | Timestamp error The IO-Link device does not support IO-Link timestamps. | |
| | 45 | Error starting up the device | No communication |
| | 46 to 255 | Reserved | |

9.26.15.10.7.4 FrameCount

Name:

FrameCount01 to FrameCount04

Received IO-Link frames are counted in this register. Unlike the [sync bits](#), the FrameCount register ensures that all frames are actually recognized. This is the case even if X2X cycles are lost or if the IO-Link cycle is faster than the X2X cycle.

| Data type | Values |
|-----------|-------------|
| SINT | -128 to 127 |

9.26.15.10.7.5 CycleStartNettime

Name:

CycleStartNettime01 to CycleStartNettime04

This register is used to read out the NetTime value at the start time of the last IO-Link cycle.

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

| Data type | Value |
|-----------|---------------------------------|
| INT | -32768 to 32767 |
| DINT | -2,147,483,648 to 2,147,483,647 |

9.26.15.10.7.6 CycleEndNettime

Name:

CycleEndNettime01 to CycleEndNettime04

This register is used to read out the NetTime value at the end time of the last IO-Link cycle.

For more information about NetTime and timestamps, see ["NetTime Technology" on page 3035](#).

| Data type | Value |
|-----------|---------------------------------|
| INT | -32768 to 32767 |
| DINT | -2,147,483,648 to 2,147,483,647 |

9.26.15.10.8 IO-Link event interface

The event interface involves interrupt-controlled background communication. It enables the connected IO-Link devices to transmit special messages, or "event codes", to the master.

The module can receive up to 16 of these messages, buffer them and make them available for retrieval from the controller. Essentially, FIFO memory is used for this; this is managed independently of the cyclic communication.

Information:

If a message is received via the event interface and the FIFO memory is full, the oldest message in the buffer is overwritten. In rare cases, this can lead to messages being lost before they have been evaluated.

Sequence for reading an event

- A new event was triggered by the device. This is indicated by an increase in ["EventPortSeq" on page 3308](#).
- Event data can be read using registers ["EventQualifier" on page 3308](#) and ["EventCode" on page 3308](#).
- The event must be acknowledged. To do so, the sequence number from ["EventPortSeq" on page 3308](#) must be copied to the sequence number from ["EventQuit" on page 3309](#).
- The next event is specified only after the event is acknowledged.

9.26.15.10.8.1 EventPortSeq

Name:
EventPortSeq

As soon as a new event is generated by an IO-Link device, the sequence number is increased in this register. The affected channel number is also displayed.

| Data type | Values |
|-----------|----------|
| USINT | 0 to 255 |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------|---------|-----------------|
| 0 - 3 | Sequence number | 0 to 15 | |
| 4 - 5 | IO-Link channel number | 00 | IF1 (channel 1) |
| | | 01 | IF2 (channel 2) |
| | | 10 | IF3 (channel 3) |
| | | 11 | IF4 (channel 4) |
| 6 - 7 | Reserved | 0 | |

9.26.15.10.8.2 EventQualifier

Name:
EventQualifier

This register contains additional information about the event.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------------------------------|-------|--|
| 0 - 2 | Instance layer generated by the event | 000 | Unknown |
| | | 001 | Hardware |
| | | 010 | Data exchange layer of the IO-Link device |
| | | 011 | Application layer of the IO-Link device |
| | | 100 | Application |
| 3 | Cause of the event | 0 | Device |
| | | 1 | Master |
| 4 - 5 | Type of event | 00 | Reserved |
| | | 01 | Information |
| | | 10 | Warning |
| | | 11 | Errors |
| 6 - 7 | Mode of the event | 00 | Reserved |
| | | 01 | One-time event |
| | | 10 | Event no longer reported (e.g. voltage OK again) |
| | | 11 | Event reported (e.g. voltage too low) |

9.26.15.10.8.3 EventCode

Name:
EventCode

The event code of the event being transferred is indicated in this register. The event codes may be vendor-specific event codes or event codes defined in the IO-Link specification.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.26.15.10.8.4 EventsLeft

Name:
EventsLeft

This register indicates the number of as yet unprocessed events in the FIFO buffer.

| Data type | Value |
|-----------|---------|
| USINT | 0 to 16 |

9.26.15.10.8.5 EventQuit

Name:
EventQuit

This register can be used to acknowledge events. This is done by copying the sequence number of the event to be acknowledged to this register.

| Data type | Values |
|-----------|---------|
| USINT | 0 to 15 |

9.26.15.10.8.6 EventQuitReadBack

Name:
EventQuitReadBack

This register contains the sequence number of the most recently acknowledged event.

| Data type | Value |
|-----------|---------|
| USINT | 0 to 15 |

9.26.15.10.9 IO-Link parameter server

The parameter server is a function that is defined by the IO-Link specification. This function is normally enabled in the module and can be managed with register "[CfO_DS_Config](#)" on page 3311.

The parameter server permits the module to read configuration parameters of the connected IO-Link device. The data of the third-party device is stored in the EEPROM and can then be restored automatically, e.g. after replacing the IO-Link device.

Information:

The selection of the transferred configuration data depends on the connected IO-Link device. The module only functions as data storage. It requests the configuration data of the IO-Link device, stores the response and transmits the received information back to the connected IO-Link device, if required.

A change to the read parameter server data in the memory of the module is not foreseen.

Event code 0xFF91

The module is able to process the "data memory upload request" (event code 0xFF91) of the connected IO-Link device in order to automatically manage the memory of the parameter server in the module.

The standard does not specify exactly when the event code must be generated. Most IO-Link devices generate it as soon as the configuration parameters change. With some IO-Link devices, it can be advantageous to request the upload and download processes manually. For this purpose the module includes an option for adapting the transfer of the parameter server data to the individual application requirements.

Information:

Automatic management can be used if the connected third-party IO-Link device supports the parameter server function and can generate the event code.

The parameter server

If supported by the IO-Link device, the IO-Link parameter server can be used to read the application-specific device configuration from the IO-Link master, for example. The parameter server of the module is generally activated and can be used with the help of a controller register.

Which data storage parameters are transferred depends on the connected IO-Link device. The read information is stored in EEPROM on the module and can be fed back automatically after replacing the device, for example.

The module is capable of processing the data storage upload request (event code 0xFF91) of the IO-Link specification. The request is usually triggered if parameters on the device are changed. In this case, depending on the configuration, an upload of data storage data can be started (standard).

Automatic management of data storage parameters

Automatic management has been designed according to IO-Link specification. Since the IO-Link standard exhibits a degree of tolerance here, it is possible that some IO-Link devices may have to be handled differently. This can be configured using the register.

An upload/download is performed under the following conditions:

- DsControl0x = 1
- While the device is starting up or if a data storage upload request has been received.

Offline configuration

With offline configuration, the configuration data set up for the device in Automation Studio is stored in the project. This data is then used to configure the CPU automatically when the project is downloaded or data is generated for the memory card. In contrast to the parameter server, where values are read from an existing device, the values in this case are defined explicitly in the application. The values are automatically configured only one time after the download. This procedure only occurs again if a new parameter file is received from Automation Studio, the device is replaced or if the download is started manually by the library.

This function works independently of the parameter server. If the parameter server is still enabled, however, it can be started as needed after the offline configuration to store the corresponding data. In the event of a replaced device, the data can be loaded to the device from the parameter server.

9.26.15.10.9.1 DsControl

Name:

DsControl01 to DsControl04

This register can be used to control the "parameter server" on page 3309 manually. Each action is carried out exactly once when the corresponding value is set. If the same action should be executed multiple times, then this register must be set to the value 0 beforehand.

| Data type | Value | Information |
|-----------|----------|--|
| USINT | 0 | No action (bus controller default setting) |
| | 1 | Operating mode of the parameter server: Automatic upload and download |
| | 2 | Upload if data storage parameters are available on the device |
| | 3 | Download if data storage parameters are available in the CPU's memory and the device can process them |
| | 4 | Acknowledge error status from parameter server (see "ChannelStatus" on page 3306: error messages 21 to 28) |
| | 5 | Delete data storage parameters on the CPU's memory |
| | 6 | Start dummy upload. Starts an upload without saving the data. This can be used to acknowledge an upload request. |
| | 7 to 255 | Reserved |

9.26.15.10.9.2 DsProgress

Name:

DsProgress01 to DsProgress04

The module uses this register to report the progress of the upload or download from the parameter server. The values from 0 to 100 can be used for implementing a progress display.

| Data type | Value |
|-----------|----------|
| USINT | 0 to 100 |

9.26.15.10.9.3 CfO_DS_Config

Name:

CfO_DS_Config01 to CfO_DS_Config04

This register can be used to set the behavior of the parameter server module (when operating the parameter server manually). By doing this, a corresponding reaction is assigned to every trigger event.

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| UDINT | See bit structure. | 0 |

Bit structure:

| Bit | Event | Value | Reaction |
|---------|---|-------|---|
| 0 - 3 | The device ID of the connected device no longer matches the device ID saved together with the parameters. | 000 | No reaction (bus controller default setting) |
| | | 001 | Cancel |
| | | 010 | User-defined reaction. See "ChannelStatus" on page 3306: Status message 25 |
| | | 011 | Upload |
| 4 - 7 | The device transmitted an upload request. | 000 | No reaction (bus controller default setting) |
| | | 001 | Cancel |
| | | 010 | User-defined reaction. See "ChannelStatus" on page 3306: Status message 26 |
| | | 011 | Upload |
| 8 - 11 | A new parameter checksum was detected when starting the device. | 000 | No reaction (bus controller default setting) |
| | | 001 | Cancel |
| | | 010 | User-defined reaction. See "ChannelStatus" on page 3306: Status message 27 |
| | | 011 | Upload |
| | | 100 | Download |
| 12 - 15 | The serial number of the connected device no longer matches the serial number saved together with the parameters. | 000 | No reaction (bus controller default setting) |
| | | 001 | Cancel |
| | | 010 | User-defined reaction. See "ChannelStatus" on page 3306: Status message 24 |
| | | 011 | Upload |
| | | 100 | Download |
| 16 - 23 | Reserved | - | |
| 24 - 26 | Specifies the order that individual events are checked | 000 | Device ID, serial number, upload request, parameter checksum (bus controller default setting) |
| | | 001 | DeviceID, serial number, parameter checksum, upload request |
| | | 010 | DeviceID, upload request, parameter checksum, serial number |
| | | 011 | DeviceID, upload request, serial number, parameter checksum |
| | | 100 | DeviceID, parameter checksum, upload request, serial number |
| | | 101 | DeviceID, parameter checksum, serial number, upload request |
| 27 - 31 | Reserved | - | |

9.26.15.10.9.4 CfO_DS_SaveCtrl

Name:

CfO_DS_SaveCtrl01 to CfO_DS_SaveCtrl04

This register is used together with "CfO_DS_SaveData" on page 3312.

Some IO-Link devices must be instructed to save transferred data storage parameters in remanent memory after a download. In order for these parameters to be applied to remanent memory on these devices, the recorded index and subindex in these registers must be sent together with the save command (e.g. value 163 on index 2, subindex 0).

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| UDINT | See bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|---------|-------------|----------|--|
| 0 - 15 | Index | 0 to 255 | Device-specific index for save command |
| 16 - 24 | Subindex | 0 to 255 | Device-specific subindex for save command |
| 24 - 26 | Data length | 0 | Save command disabled |
| | | 1 to 4 | The data length of the save command estimated by the device in bytes |
| 27 - 31 | Reserved | | |

9.26.15.10.9.5 CfO_DS_SaveData

Name:

CfO_DS_SaveData01 to CfO_DS_SaveData04

This register is used together with "[CfO_DS_SaveCtrl](#)" on page 3311 and contains the value written to the index configured in the CfO_DS_SaveCtrl register.

| Data type | Values | Information |
|-----------|--------------------|-----------------------------------|
| UDINT | 0 to 4,294,967,295 | Bus controller default setting: 0 |

9.26.15.10.10 IO-Link timestamp

The IO-Link timestamp registers allow the assignment of IO-Link timestamps to the NetTime of a controller, and vice versa.

This makes it possible for value changes of the IO-Link device to be assigned exactly to the NetTime of the controller, and vice versa. Events can be captured or triggered with a higher timing resolution than would be possible with the IO-Link cycle. This allows a highly precise timed response from the controller to signals from the sensor, and vice versa. The resolution depends on the devices being used.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

Examples

- For an input device, the timestamp is saved directly by the device when a certain event occurs (e.g. photo-electric sensor triggered) and then transferred via IO-Link. The IO-Link master converts this IO-Link-specific timestamp to a NetTime timestamp that can be used across the system.
- In the output direction, a converted timestamp is transferred to the device via IO-Link. The output device responds at the corresponding instant and executes the intended event (e.g. closes a switch).

Information:

- **The timestamp function is device-specific and not supported by every IO-Link device.**
- **This function cannot be used if the channel is being operated in free-running mode (asynchronous).**

9.26.15.10.10.1 IoLinkTimestampIn

Name:

IoLinkTimestampIn01 to IoLinkTimestampIn04

This register indicates the NetTime instant at which the application event occurred.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Value |
|-----------|---------------------------------|
| INT | -32768 to 32767 |
| DINT | -2,147,483,648 to 2,147,483,647 |

9.26.15.10.10.2 IoLinkTimestampInStatusSeq

Name:

IoLinkTimestampInStatusSeq01 to IoLinkTimestampInStatusSeq04

This register indicates information about the [input timestamp](#).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------------------------|---------|--|
| 0 - 3 | Sequence number | 0 to 15 | The sequence number is increased by 1 each time a valid timestamp is received. If the sequence number is increased by more than 1, it means that the event was lost. |
| 4 | Event 1 triggered by application | x | Signal state when timestamp occurs |
| 5 | Event 2 triggered by application | x | Signal state when timestamp occurs Example: Signal state when timestamp occurs <ul style="list-style-type: none"> – Photoelectric sensor triggered → This bit = 0 – Photoelectric sensor not triggered → This bit = 1 |
| 6 | Reserved | - | |
| 7 | Timestamp error | 0 | No error |
| | | 1 | An error occurred on the IO-Link device. Possible causes: <ul style="list-style-type: none"> • More timestamps were generated than could be transferred. • The value of the IO-Link timestamp exceeded the permitted range of values. In both cases, it may help to reduce the IO-Link cycle time. |

9.26.15.10.10.3 IoLinkTimestampOut

Name:

IoLinkTimestampOut01 to IoLinkTimestampOut04

The user can write the NetTime for the output timestamp to this register.

The NetTime is automatically converted to an IO-Link timestamp. The event is triggered at the defined NetTime. The "[IoLinkTimestampOutStatus](#)" on page 3314 register is used for acknowledgment.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

Information:

The NetTime must be at least three IO-Link cycles in the future; otherwise, a warning is set in [IoLinkTimestampOutStatus](#).

This register's data type must match the format configured in register "[ChannelMode](#)" on page 3296, bit 26.

| Data type | Values | Information |
|-----------|---------------------------------|-----------------------------------|
| INT | -32768 to 32767 | Bus controller default setting: 0 |
| DINT | -2,147,483,648 to 2,147,483,647 | |

9.26.15.10.10.4 IoLinkTimestampOutCtrlSeq

Name:

IoLinkTimestampOutCtrlSeq01 to IoLinkTimestampOutCtrlSeq04

This register is used to control how the [timestamp](#) is applied.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| USINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------------|---------|--|
| 0 - 3 | Sequence number | 0 to 15 | Output timestamp and application event bits applied when the sequence number is increased by 1 |
| 4 | Application event 1 | x | Output state at the timestamp |
| 5 | Application event 2 | x | Output state at the timestamp |
| 6 | Acknowledge warning | 0 | Do not acknowledge (bus controller default setting) |
| | | 1 | Acknowledge warning |
| 7 | Acknowledging errors | 0 | Do not acknowledge (bus controller default setting) |
| | | 1 | Acknowledging errors |

9.26.15.10.10.5 IoLinkTimestampOutStatus

Name:

IoLinkTimestampOutStatus01 to IoLinkTimestampOutStatus04

This register is used to indicate the status of the [output timestamp](#).

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------------------|---------|--|
| 0 - 3 | Acknowledgment of sequence number | 0 to 15 | When an output timestamp has been successfully applied, then the sequence number from "IoLinkTimestampOutCtrlSeq" on page 3313 is acknowledged here. |
| 4 - 5 | Reserved | - | |
| 6 | Warning | 0 | No warning |
| | | 1 | A timestamp was not at least 3 cycles in the future, so output may be delayed. |
| 7 | Errors | 0 | No error |
| | | 1 | More timestamps were transferred to the module than could be output. |

9.26.15.10.11 IO-Link device IDs

IO-Link device IDs are defined by the manufacturer of the IO-Link device and cannot be modified by the user. They can be used to clearly identify a connected IO-Link device.

9.26.15.10.11.1 VendorId

Name:

VendorId01 to VendorId04

This register contains the unique vendor ID of the IO-Link device.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.26.15.10.11.2 DeviceId

Name:

DeviceId01 to DeviceId04

This register contains the unique ID of the IO-Link device.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.15.10.11.3 FunctionId

Name:

FunctionId01 to FunctionId04

This register contains the device's function class provided by the vendor.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.26.15.10.11.4 CycleTime

Name:

CycleTime01 to CycleTime04

Some IO-Link devices cannot handle high-speed cycles and require a higher cycle time. This register can be used to read back the channel's IO-Link cycle time currently being used. The time used for communication is always a multiple of 100 μ s, e.g. 50 for 5 ms cycle time.

| Data type | Value | Information |
|-----------|------------|--------------------------------|
| UINT | 0 to 65535 | Specified in 100 μ s steps |

9.26.15.10.11.5 CycleMultible

Name: CycleMultible01 to CycleMultible04

This register can be used to read back the "multiplier" on page 3301 currently being used for the channel's IO-Link cycles.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.26.15.10.11.6 CycleDivisor

Name:

CycleDivisor01 to CycleDivisor04

This register can be used to read back the "divisor" on page 3301 currently being used for the channel's IO-Link cycles.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.26.15.10.11.7 MinCycleTime

Name:

MinCycleTime01 to MinCycleTime04

This register can be used to read back the minimum IO-Link cycle time. The minimum IO-Link cycle time depends on the IO-Link device and is read from the module after establishing communication with the IO-Link device.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.26.15.10.11.8 PDI_Size

Name:

PDI_Size01 to PDI_Size04

This register can be used to read back the size of the input process data defined by the device. This value is read when starting up the IO-Link device.

| Data type | Values |
|-----------|----------|
| USINT | 0 to 255 |

9.26.15.10.11.9 PDO_Size

Name:

PDO_Size01 to PDO_Size04

This register can be used to read back the size of the output process data defined by the device. This value is read when starting up the IO-Link device.

| Data type | Values |
|-----------|----------|
| USINT | 0 to 255 |

9.26.15.10.11.10 Baud rate

Name:

Baudrate01 to Baudrate04

This register can be used to read back the baud rate defined by the IO-Link device. This value is read when starting up the IO-Link device.

| Data type | Value | Information |
|-----------|-------|---------------------|
| USINT | 1 | COM1 = 4.8 kbit/s |
| | 2 | COM2 = 38.4 kbit/s |
| | 3 | COM3 = 230.4 kbit/s |

9.26.15.10.11.11 IoLinkVersionID

Name:

IoLinkVersionID01 to IoLinkVersionID04

This register can be used to read back the IO-Link version.

| Data type | Value | Information |
|-----------|-------------|-------------|
| USINT | 16 (= 0x10) | V1.0 |
| | 17 (= 0x11) | V1.1 |

9.26.15.10.12 IO-Link device configuration

The following possibilities are available for configuring an IO-Link device:

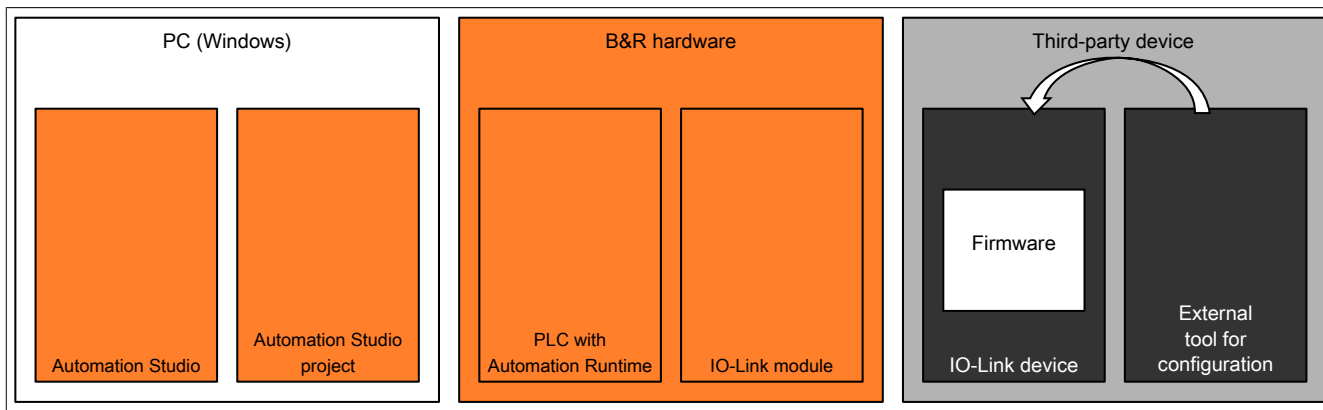
- Direct configuration
- Configuration via IODD/DTM support
The manufacturer must provide a corresponding IODD or DTM file for this.
- Restoring a configuration via parameter server
The IO-Link device must support the "Parameter server" function in accordance with the IO-Link V1.1 specification for this.

Information:

Another way to configure an IO-Link device is to use library "AsloLink". This library is not part of this description.

9.26.15.10.12.1 Direct configuration

Direct configuration takes place independently of the B&R hardware and software used. Parameters can be entered via an additional configuration device, integrated display or other operating elements on the IO-Link device, for example.



Advantage

It is advantageous for individual devices because it is possible to start up the IO-Link device using resources from the manufacturer.

If problems arise while configuring the IO-Link device, checking which software component is causing the error is not necessary.

Disadvantage

Each individual IO-Link device must be manually preconfigured.

In some circumstances, the user must have several development environments on one computer.

9.26.15.10.12.2 IODD/DTM support

Using the integrated FDT container, IO-Link devices can be configured using Automation Studio. IODD/DTM support for IO-Link devices is available online as well as offline.

Information:

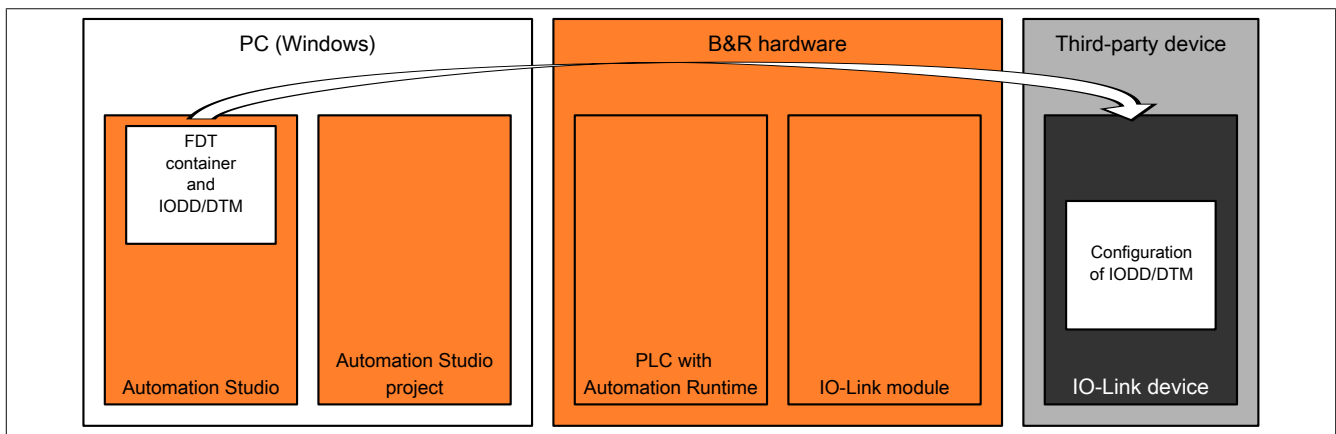
To use Automation Studio to configure IO-Link devices, a corresponding hardware description file (IODD or DTM) must be downloaded and installed.

Information:

This function is available in Automation Runtime V4.08 and later.

IODD/DTM (online)

During online configuration, the FDT container in Automation Studio communicates directly with the IO-Link device. After the connection is established, the configuration parameters can be modified as needed.



Advantage

No additional devices are usually required to configure the IO-Link device. All settings can be modified by the user in a single development environment.

Disadvantage

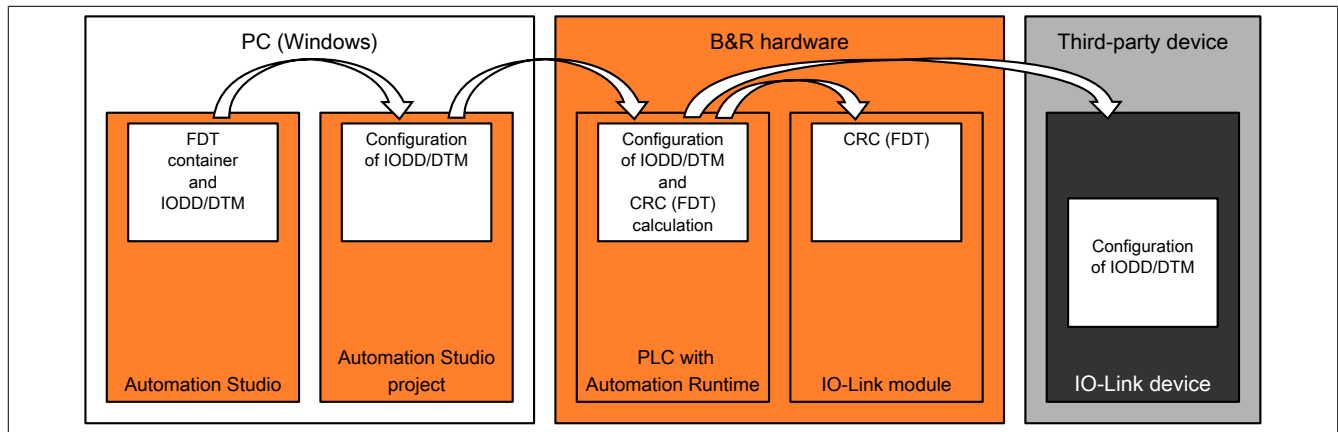
Each IO-Link device must be configured individually.

IODD/DTM (offline)

During offline configuration, the parameter set that can be entered via the IODD or DTM file is stored in the Automation Studio project. During the download, the parameter set for the IO-Link device is transferred to the controller and then from there to the IO-Link device via the module.

Procedure

- 1) When the IO-Link module is started, the checksum (CRC_{FDT}) for the current parameter set is calculated.
- 2) If the previously stored checksum deviates from the present calculated one, the parameter set is transferred to the IO-Link device.
- 3) After the parameter set has been transferred, the associated checksum (CRC_{FDT}) is saved on the IO-Link module and can be used for future comparisons.
- 4) If the parameter set changes, a new checksum (CRC_{FDT}) results from the succeeding reboot of the controller and steps 2 and 3 are repeated.



Advantage

The configuration parameters of the IO-Link device are stored as part of the Automation Studio project. The user can work within a development environment and define all settings.

For series-produced machine, the IO-Link devices used later do not have to be preconfigured individually.

Disadvantage

The configuration options for the IO-Link device depend on the extent of the IODD or DTM file.

Information:

Before the parameter set is transferred to the IO-Link device, the controller checks if the connected device has the correct device ID. If the device ID is incorrect, the procedure is canceled. The parameter set is not transferred, and the checksum is not saved.

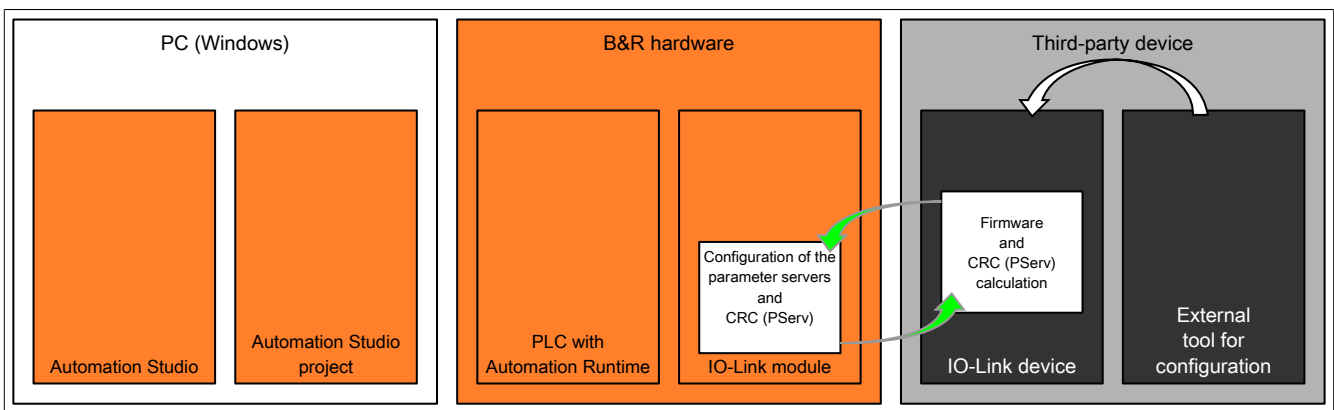
9.26.15.10.12.3 Parameter server

The function "parameter server" is defined in IO-Link specification V1.1 and later. This function allows an IO-Link device to be replaced without requiring any specialist knowledge on the part of maintenance personnel.

This is done by storing the configuration loaded on the IO-Link device on the IO-Link module. In addition, a checksum ($CRC_{P_{Serv}}$) is calculated to allow a simple comparison of the parameter sets.

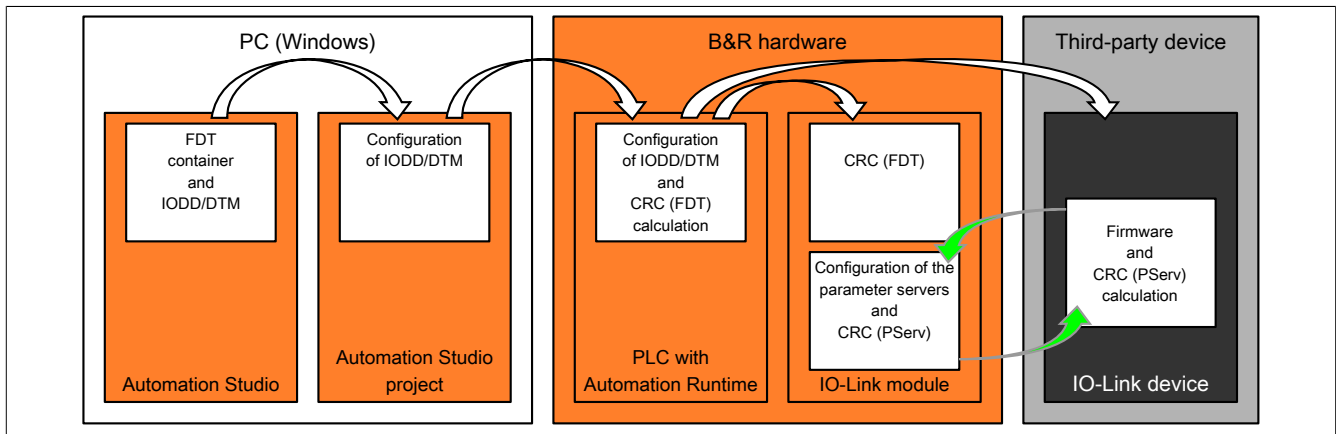
Procedure

- 1) If the IO-Link device supports the function "parameter server", on startup it calculates the checksum ($CRC_{P_{Serv}}$) for its current parameter set.
- 2) If the currently calculated checksum ($CRC_{P_{Serv}}$) deviates from the one previously stored on the IO-Link module, then there is a difference between the parameter set of the IO-Link device and the one currently stored on the module.
- 3) The device ID and serial number of the IO-Link device are evaluated in order to determine whether the parameter set must be uploaded by the device or downloaded by the IO-Link module.
 - a) If the device ID has been changed, then a different device type was recognized. In this case, the parameter set of the IO-Link device must be read out and saved on the IO-Link module. In addition, the current checksum ($CRC_{P_{Serv}}$) is stored on the IO-Link module.
 - b) If the device ID is unchanged but the serial number is different, it is assumed that the IO-Link device was replaced by a device of the same type. In this case, the parameter set stored on the IO-Link module is downloaded to the IO-Link device.
 - c) If the device ID and serial number remain unchanged, it is assumed that a new configuration has been loaded on the IO-Link device. In this case, the new parameter set on the IO-Link device is read out and saved on the IO-Link module. In addition, the current checksum ($CRC_{P_{Serv}}$) is stored on the IO-Link module.



9.26.15.10.12.4 Shared use of IODD/DTM and parameter server

IODD/DTM support and the parameter server can be used together. The two functions work independently of one another, but they also affect each other.



Changing the configuration using IODD/DTM support

If the IO-Link device is reconfigured using the FDT container (IODD/DTM), the IO-Link device then calculates the new checksum (CRC_{PServ}). Afterwards, the modified data is read back by the parameter server of the IO-Link module.

Replacing the IO-Link device

If the IO-Link device is replaced, the system only checks the checksum (CRC_{PServ}). The parameter set of the FDT container goes unnoticed because the checksum (CRC_{FDT}) in the project on the controller still matches the stored checksum (CRC_{FDT}) on the IO-Link module (for the sequence, see "[Parameter server](#)" on page 3319).

9.26.15.10.13 Error codes

Queries can be made via registers or FlatStream. If a query fails, the error bit is set and an error code generated. In addition to general error codes, vendor-specific error codes can also occur. Information about these can be found in the operating instructions for the corresponding IO-Link device.

Error indicators in the registers

- The error bit is set in "ParameterCtrlIn" on page 3323, whereas the length of the error code is indicated in the data length parameter.
- "ParameterDataIn" on page 3323 contains the error code.

Error indicators in FlatStream

If the error bit is set, the FlatStream bytes are put together as follows:

- Bytes 1 to 3: Module-specific FlatStream array
- Byte 4: Error code; if 8 (error reported by device), bytes 5 and 6 will include additional information.
- Bytes 5 and 6: Error code from IO-Link device
- ...

Error codes

| Code | Function |
|------|---|
| 1 | No device on this channel |
| 2 | IO-Link disabled |
| 3 | Communication error with device |
| 4 | Query buffer full |
| 5 | Event queue empty |
| 6 | Query not supported |
| 7 | Object access failed |
| 8 | Object access, error reported by device |
| 9 | Incorrect channel number |
| 10 | Write operation not possible |
| 11 | No input data available |
| 12 | Frame too short |
| 13 | One or more events discarded |
| 14 | Device has no input data |
| 15 | Device has no output data |

9.26.15.10.14 Command interface

The command interface offers the option of accessing the object dictionary of the IO-Link device using the index and subindex. Access is also possible using the AsIOLink library or FlatStream.

Information:

With this interface, up to the first 4 bytes of an object can be read or written.

Procedure for write operation:

- Set the object to be written using "ParameterIndexOut" on page 3322 and "ParameterSubIndexOut" on page 3322.
- Write the data to be written to "ParameterDataOut" on page 3323.
- Set read/write, IF and the sequence number increased by 1 in the "ParameterCtrlOut" on page 3322 register.
- Wait until the sequence acknowledgment in "ParameterCtrlIn" on page 3323 is the same as the sequence number.

Procedure for read operation:

- Set the object to be read using "ParameterIndexOut" on page 3322 and "ParameterSubIndexOut" on page 3322.
- Delete bit 7 in the "ParameterCtrlOut" on page 3322 parameter, set the channel number and increase the sequence number.
- Wait until the sequence acknowledgment in "ParameterCtrlIn" on page 3323 is the same as the sequence number.
- Read the error status from "ParameterCtrlIn" on page 3323. An error is indicated by a set error bit.
- Read the data from "ParameterCtrlIn" on page 3323.

For error-related behavior, see "Error codes" on page 3321.

9.26.15.10.14.1 ParameterIndexOut

Name:

ParameterIndexOut

This register defines the index of the object in the object dictionary that should be accessed.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

9.26.15.10.14.2 ParameterSubIndexOut

Name:

ParameterSubIndexOut

This register defines the subindex of the object in the object dictionary that should be accessed.

| Data type | Values |
|-----------|----------|
| USINT | 0 to 255 |

9.26.15.10.14.3 ParameterCtrlOut

Name:

ParameterCtrlOut

This register defines the type of access to be used.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------|--------|-----------------|
| 0 - 1 | Sequence number | 0 to 3 | |
| 2 - 3 | IO-Link channel number | 0 | IF1 (channel 1) |
| | | 1 | IF2 (channel 2) |
| | | 2 | IF3 (channel 3) |
| | | 3 | IF4 (channel 4) |
| 4 - 6 | Data length | 0 to 4 | |
| 7 | Read or write | 0 | Read |
| | | 1 | Write |

9.26.15.10.14.4 ParameterDataOut

Name:

ParameterDataOut_0

This register contains the data that should be written.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.26.15.10.14.5 ParameterCtrlIn

Name:

ParameterCtrlIn

This register monitors the status of the access.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|------------------------|--------|---|
| 0 - 1 | Sequence confirmation | 0 to 3 | |
| 2 - 3 | IO-Link channel number | 0 | IF1 (channel 1) |
| | | 1 | IF2 (channel 2) |
| | | 2 | IF3 (channel 3) |
| | | 3 | IF4 (channel 4) |
| 4 - 6 | Data length | 0 to 4 | |
| 7 | Error bit | 0 | No error |
| | | 1 | Error, the error code is indicated in "ParameterDataIn" on page 3323. |

9.26.15.10.14.6 ParameterDataIn

Name:

ParameterDataIn_0

After a successful read operation, this register contains the input data. In the event of an error, it contains the error codes.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

Error display

- If the "error code" on page 3321 does not equal 8 (e.g. error reported by device), then the LSB receives the error code.
- If an error is reported by the device, then the error specified by the IO-Link device is also indicated.

| UDINT | | | |
|----------|--------------------|-------------------------------|-----|
| MSB | | | LSB |
| Reserved | IO-Link error code | Additional IO-Link error code | 8 |

9.26.15.10.15 Using IO-Link with FlatStream

With this module, the user has the option of communicating with the connected IO-Link device via FlatStream.

Communication takes place separately with respect to timing, i.e. output data is transferred completely from the CPU to the module and checked. Only then does the module initiate the actual communication with the IO-Link device.

The module acts the same way in the input direction. Messages from the IO-Link device must have been received completely by the X2X module before the FlatStream message is generated and transmitted to the CPU.

9.26.15.10.15.1 General handling of FlatStream

| Input/Output sequence | Rx/Tx bytes | |
|-----------------------|--------------------------|---|
| (unchanged) | Control byte (unchanged) | Payload data for FlatStream (IO-Link information) |

The user has a choice when using FlatStream.

- Using FlatStream as described in "Flatstream communication" on page 3802
- Using library "AsFlatGen" to manage input/output sequences and the Flatstream control bytes automatically.

In both cases, a module-specific array with FlatStream payload data must be created in the application.

9.26.15.10.15.2 IO-Link information for the FlatStream

To be able to use IO-Link communication via FlatStream, you must define an individual array in the application.

The following must be defined for the query in the direction CPU → Module → IO-Link device:

- Module's channel number
- Frame number for the query
- Type of query
- The corresponding IO-Link data must then be attached depending on the query.

The response consists of the following parts:

- The frame number, access type and type of query are repeated.
- The module generates the error bit and manages the confirmation bit.
- The successfully received IO-Link information or corresponding "error code" on page 3321 is then appended.

Module-specific FlatStream array for IO-Link communication

| Bytes | Name | Value | Description |
|-------|----------------------------|----------|--|
| 1 | Channel number | 1 to 4 | |
| 2 | Frame number | 0 to 255 | This number is repeated in the module's response. This allows the later response from the module to be distinctly attributed to the request. |
| 3 | See Byte 3 | x | |
| ... | IO-Link data or error code | | Depends on byte 3 |

Byte 3

| Bit | Description | Value | Information |
|-------|---------------------------------|-------|---|
| 0 - 2 | Type of query | 0 | Access to object dictionary |
| | | 1 | Access to inputs' process data |
| | | 2 | Access to outputs' process data |
| | | 3 | Read individual event |
| | | 4 | Read multiple events |
| | | 5 | Enable event forwarding |
| | | 6 | Disable event forwarding |
| | | 7 | Announcement of automatically forwarded event |
| 3 - 4 | Reserved | - | |
| 5 | Confirm | 0 | Message without query |
| | | 1 | Response to query ¹⁾ |
| 6 | Status bit (for response frame) | 0 | No error |
| | | 1 | Error |
| 7 | Access types | 0 | Read |
| | | 1 | Write |

1) This confirmation bit is additionally set with the response to a query. The response for confirming a query frequently contains additional data that must be processed.

9.26.15.10.15.3 IO-Link data

Depending on the type of query, different IO-Link data results that must be appended to the FlatStream array.

Access to object dictionary

Request

| Bytes | Name | Value | Description |
|----------|--|----------|--|
| 1 to 3 | Module-specific FlatStream array for IO-Link communication | | |
| 4 | High index number | 0 to 255 | Index of the desired IO-Link parameter |
| 5 | Low index number | 0 to 255 | |
| 6 | Subindex number | 0 to 255 | Subindex of the IO-Link parameter |
| 7 to ... | Data | 0 to 255 | Optional, for write operation |

Response

| Bytes | Name | Value | Description |
|----------|--|----------|---|
| 1 to 3 | Module-specific FlatStream array for IO-Link communication | | |
| 4 to ... | Data / "Error code" on page 3321 | 0 to 255 | Omitted if data has been written successfully |

Accessing process data

Request

| Bytes | Name | Value | Description |
|--------|--|----------|-------------------------------|
| 1 to 3 | Module-specific FlatStream array for IO-Link communication | | |
| 4 | Data | 0 to 255 | Optional, for write operation |

Response

| Bytes | Name | Value | Description |
|--------|--|----------|---|
| 1 to 3 | Module-specific FlatStream array for IO-Link communication | | |
| 4 | Data / "Error code" on page 3321 | 0 to 255 | Omitted if data has been written successfully |

Accessing event data

Request

| Bytes | Name | Value | Description |
|--------|--|-------|-------------|
| 1 to 3 | Module-specific FlatStream array for IO-Link communication | | |

Response

| Bytes | Name | Value | Description |
|--------------|--|------------|------------------------------------|
| 1 to 3 | Module-specific FlatStream array for IO-Link communication | | |
| 4 | Event counter - Current | Bit 0 to 3 | Number of attached events |
| | Event counter - Pending | Bit 4 to 7 | Number of pending events |
| 5 | Event 0 – Event qualifier | 0 to 255 | See "EventQualifier" on page 3308. |
| 6 | Event 0 – High event data | 0 to 255 | |
| 7 | Event 0 – Low event data | 0 to 255 | |
| 8 - 10 | Event 1 | | |
| x to (x + 2) | Event n ¹⁾ | | |

1) Applies only if multiple events were queried with byte 3 (bits 0 to 2 = 4). Only 1 event comes with byte 3 (bits 0 to 2 = 3).

or

| Bytes | Name | Value | Description |
|--------|--|----------|-------------|
| 1 to 3 | Module-specific FlatStream array for IO-Link communication | | |
| 4 | "Error code" on page 3321 | 0 to 255 | |

Enable/Disable event forwarding

Request

| Bytes | Name | Value | Description |
|--------|--|-------|-------------|
| 1 to 3 | Module-specific FlatStream array for IO-Link communication | | |

Response

| Bytes | Name | Value | Description |
|--------|--|-------|-------------|
| 1 to 3 | Module-specific FlatStream array for IO-Link communication | | |

or

| Bytes | Name | Value | Description |
|--------|--|----------|-------------|
| 1 to 3 | Module-specific FlatStream array for IO-Link communication | | |
| 4 | "Error code" on page 3321 | 0 to 255 | |

Announcement of forwarded event

After enabling event forwarding, events no longer have to be queried cyclically. The module generates the event as soon as the corresponding event occurs.

Message

| Bytes | Name | Value | Description |
|--------------|--|------------|------------------------------------|
| 1 to 3 | Module-specific FlatStream array for IO-Link communication | | |
| 4 | Event counter - Current | Bit 0 to 3 | Number of attached events |
| | Event counter - Pending | Bit 4 to 7 | Number of pending events |
| 5 | Event 0 – Event qualifier | 0 to 255 | See "EventQualifier" on page 3308. |
| 6 | Event 0 – High event data | 0 to 255 | |
| 7 | Event 0 – Low event data | 0 to 255 | |
| 8 - 10 | Event 1 | | |
| x to (x + 2) | Event n ¹⁾ | | |

1) Applies only if multiple events were queried with byte 3 (bits 0 to 2 = 4). Only 1 event comes with byte 3 (bits 0 to 2 = 3).

OR

| Bytes | Name | Value | Description |
|--------|--|----------|-------------|
| 1 to 3 | Module-specific FlatStream array for IO-Link communication | | |
| 4 | "Error code" on page 3321 | 0 to 255 | |

9.26.15.10.16 Flatstream communication

For a description of Flatstream communication, see "[Flatstream communication](#)" on page 3802

9.26.15.10.17 NetTime Technology

For a description of NetTime Technology, see "[NetTime Technology](#)" on page 3035.

9.26.15.10.18 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|---|---------|
| Without IO-Link (all channels in SIO-Modus) | ≥200 µs |
| With IO-Link | ≥400 µs |

9.26.15.10.19 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|---|---|
| Without IO-Link (all channels in SIO-Modus) | ≥200 µs |
| With IO-Link | ≥400 µs (depends on the minimum IO-Link cycle time of the IO-Link device) |

9.26.16 X20PD0011

Data sheet version: 3.13

9.26.16.1 General information

The potential distributor module provides 12x ground (from the internal I/O supply) on the terminal connections and opens up additional wiring possibilities for actuators and sensors. The module is equipped with a replaceable microfuse between the GND potential on the terminal block and the X20 system I/O supply. The function of the fuse is monitored.

- Integrated exchangeable microfuse
- Monitoring of the fuse
- Potential for routing as needed

Information:

The wired load must be supplied with 24 VDC!

9.26.16.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Other functions |  |
| X20PD0011 | X20 potential distributor module, 12x GND, integrated microfuse | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 565: X20PD0011 - Order data

9.26.16.3 Technical data


| Model number | X20PD0011 |
|--|--|
| Short description | |
| Potential distributor module | 12x ground on the terminal connections |
| General information | |
| B&R ID code | 0x267D |
| Status indicators | Operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Fuse monitoring | Yes, using status LED and software |
| Power consumption ¹⁾ | |
| Bus | 0.12 W |
| Internal I/O | - |
| External I/O | 1 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| Output I/O power supply | |
| Nominal output voltage | Ground from the internal I/O supply |
| Fuse | Integrated 6.3 A, slow-blow, can be replaced |
| Behavior on short circuit | Integrated fuse |
| Permissible contact load | 10 A |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm |

Table 566: X20PD0011 - Technical data

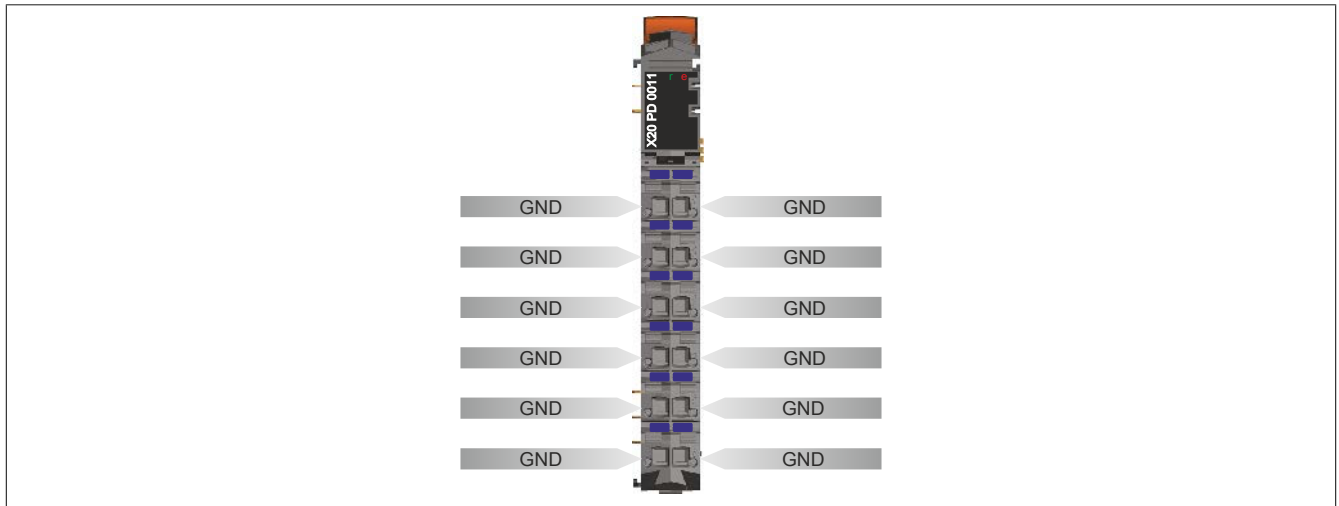
- 1) The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.

9.26.16.4 LED status indicators

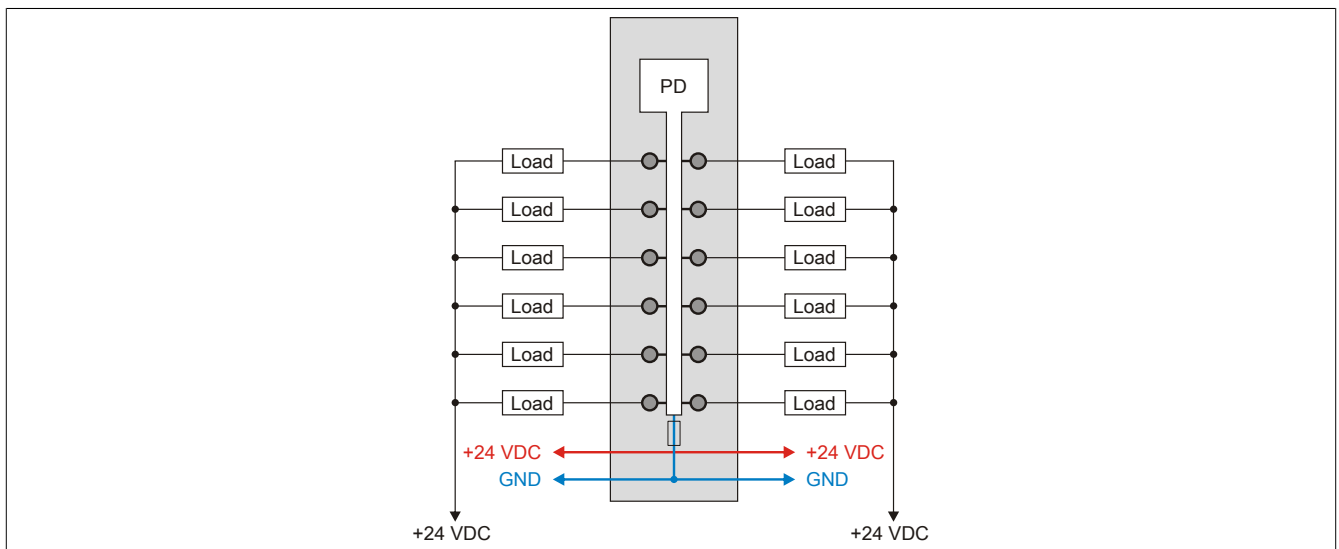
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|-------|-----------------------------|-------------------------------------|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | | | Single flash | Fuse defective or missing |
| | e + r | | Red on / Green single flash | Invalid firmware |

9.26.16.5 Pinout



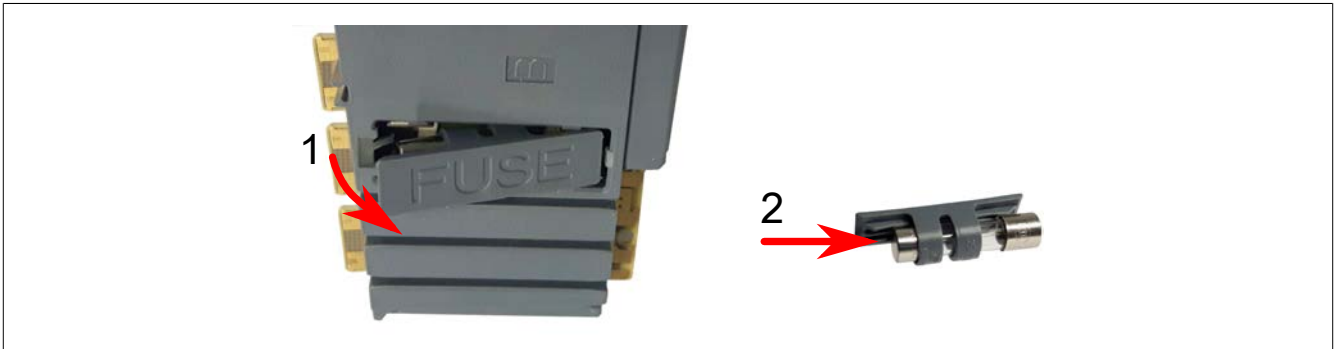
9.26.16.6 Connection example



9.26.16.7 Replacing the built-in fuse

The module is equipped with a 6.3 A built-in fuse. Proceed as follows to replace a defective fuse:

- 1) Remove the fuse cover with the fuse on the right side of the module using a screwdriver.
- 2) Slide the cylindrical fuse out of the fuse holder and slide the new fuse in.



9.26.16.8 Register description

9.26.16.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.26.16.8.2 Function model 1 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|---------------|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| 0 | 1 | Module status | USINT | • | | | |
| | | StatusFuse | Bit 0 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Non-cyclic access continues to be based on the register numbers.

9.26.16.8.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---------------|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| 0 | 0 | Module status | USINT | • | | | |
| | | StatusFuse | Bit 0 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.26.16.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.26.16.8.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.26.16.8.4 Module status

Name:
Module status
StatusFuse

This register can be used to read the status of the installed fuse.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|-------------|
| 0 | StatusFuse | 0 | Fuse OK |
| | | 1 | Fuse not OK |
| 1 - 7 | Reserved | - | |

9.26.16.8.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 µs |

9.26.16.8.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 100 µs |

9.26.17 X20PD0012

Data sheet version: 3.13

9.26.17.1 General information

The potential distributor module provides 12x 24 VDC (from the internal I/O supply) on the terminal connections and opens up additional wiring possibilities for actuators and sensors. The module is equipped with a replaceable microfuse between the 24 VDC potential on the terminal block and the X20 system I/O supply. The function of the fuse is monitored.

- Integrated exchangeable microfuse
- Monitoring of the fuse
- Potential for routing as needed

9.26.17.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Other functions |  |
| X20PD0012 | X20 potential distributor module, 12x 24 VDC, integrated microfuse | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 567: X20PD0012 - Order data

9.26.17.3 Technical data


| Model number | X20PD0012 |
|--|--|
| Short description | |
| Potential distributor module | 12x 24 VDC on the terminal connections |
| General information | |
| B&R ID code | 0x267E |
| Status indicators | Operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Fuse monitoring | Yes, using status LED and software |
| Power consumption ¹⁾ | |
| Bus | 0.12 W |
| Internal I/O | 1 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| Output I/O power supply | |
| Nominal output voltage | 24 VDC from the internal I/O supply |
| Fuse | Integrated 6.3 A, slow-blow, can be replaced |
| Behavior on short circuit | Integrated fuse |
| Permissible contact load | 10 A |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm |

Table 568: X20PD0012 - Technical data

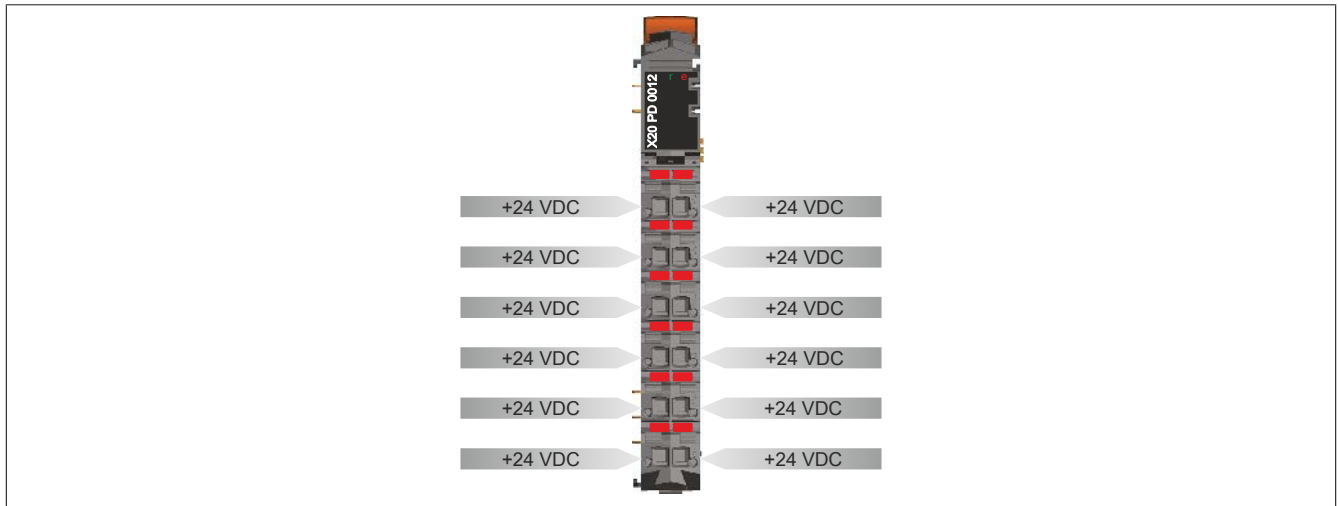
- 1) The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.

9.26.17.4 LED status indicators

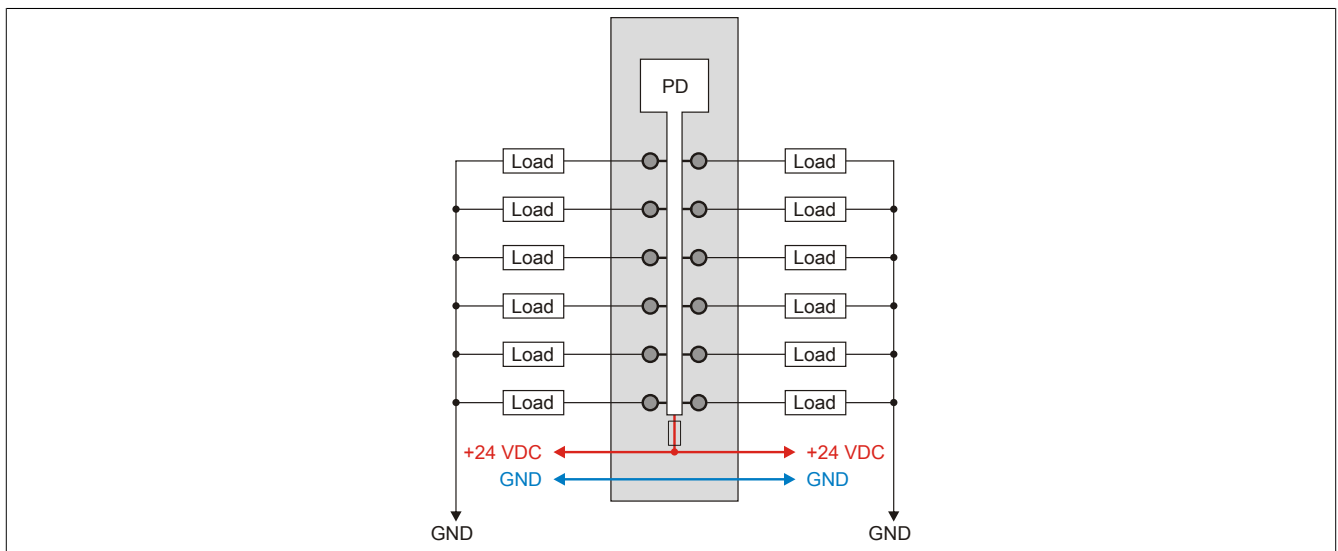
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|-------|-----------------------------|-------------------------------------|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | | | Single flash | Fuse defective or missing |
| | e + r | | Red on / Green single flash | Invalid firmware |

9.26.17.5 Pinout



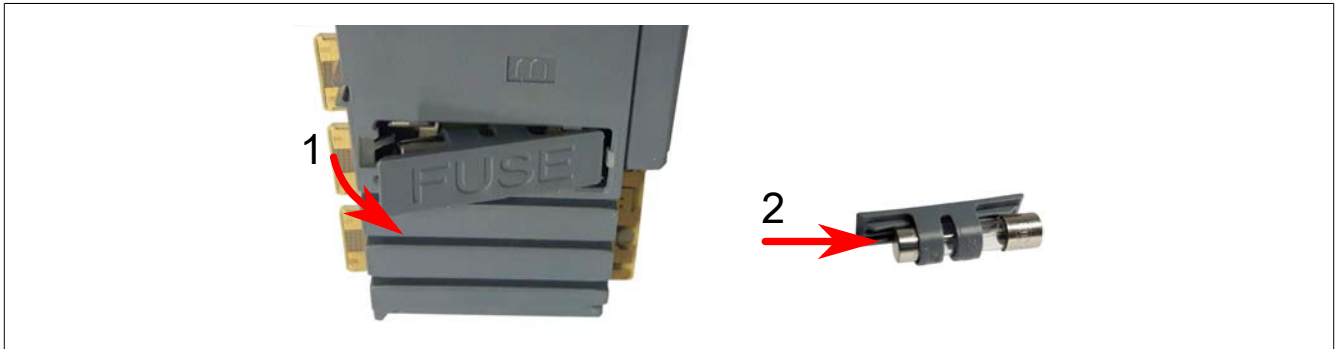
9.26.17.6 Connection example



9.26.17.7 Replacing the built-in fuse

The module is equipped with a 6.3 A built-in fuse. Proceed as follows to replace a defective fuse:

- 1) Remove the fuse cover with the fuse on the right side of the module using a screwdriver.
- 2) Slide the cylindrical fuse out of the fuse holder and slide the new fuse in.



9.26.17.8 Register description

9.26.17.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.26.17.8.2 Function model 1 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|---------------|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| 0 | 1 | Module status | USINT | • | | | |
| | | StatusFuse | Bit 0 | | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Non-cyclic access continues to be based on the register numbers.

9.26.17.8.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|---------------|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| 0 | 0 | Module status | USINT | • | | | |
| | | StatusFuse | Bit 0 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.26.17.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.26.17.8.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.26.17.8.4 Module status

Name:
Module status
StatusFuse

This register can be used to read the status of the installed fuse.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|-------------|
| 0 | StatusFuse | 0 | Fuse OK |
| | | 1 | Fuse not OK |
| 1 - 7 | Reserved | - | |

9.26.17.8.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 µs |

9.26.17.8.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 100 µs |

9.26.18 X20PD0016

Data sheet version: 3.13

9.26.18.1 General information

The potential distributor module provides 5x 24 VDC and 5x ground connections (from an external supply) at the terminals. There is no connection to the internal I/O supply, so this module only serves to distribute an external supply for the load and electronics supply. The externally fed 24 VDC supply is provided on the terminal connections through a replaceable microfuse. The 24 VDC feed and the functionality of the fuse are monitored.

- Integrated exchangeable microfuse
- Monitoring of the fuse
- Potential for routing as needed
- Distribution of the load and electronics supply
- Isolation from the internal I/O supply

9.26.18.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Other functions |  |
| X20PD0016 | X20 potential distributor module, 5x GND, 5x 24 VDC, each with 1x floating feed, integrated microfuse | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 569: X20PD0016 - Order data

9.26.18.3 Technical data


| Model number | X20PD0016 |
|--|--|
| Short description | |
| Potential distributor module | 5x 24 VDC on the terminal connections, 5x ground on the terminal connections |
| General information | |
| B&R ID code | 0x2680 |
| Status indicators | Operating state, module status |
| Diagnosics | |
| Module run/error | Yes, using status LED and software |
| Fuse monitoring | Yes, using status LED and software |
| Power consumption ¹⁾ | |
| Bus | 0.12 W |
| Internal I/O | - |
| External I/O | 1.15 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| Input supply | |
| Nominal input voltage | 24 VDC -15% / +20% external, external ground |
| Fuse | Integrated 6.3 A, slow-blow, can be replaced |
| Reverse polarity protection | No |
| Output supply | |
| Nominal output voltage | 24 VDC, ground |
| Permissible contact load | 10 A |
| Behavior on short circuit | |
| On 24 VDC power supply | Integrated fuse |
| On GND power supply | No protection available |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm |

Table 570: X20PD0016 - Technical data

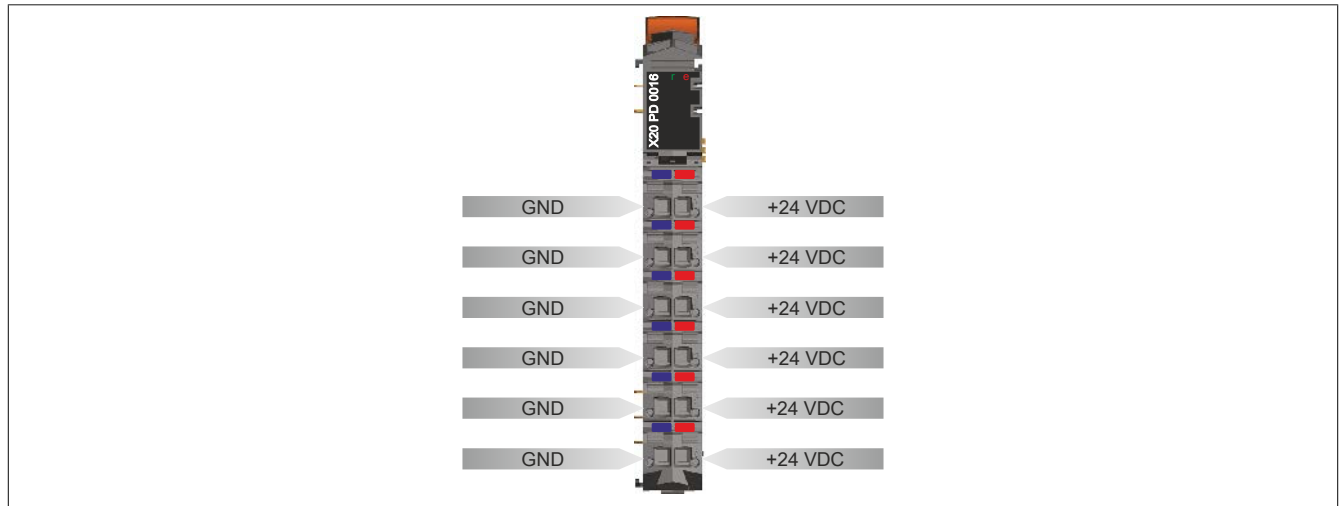
- 1) The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.

9.26.18.4 LED status indicators

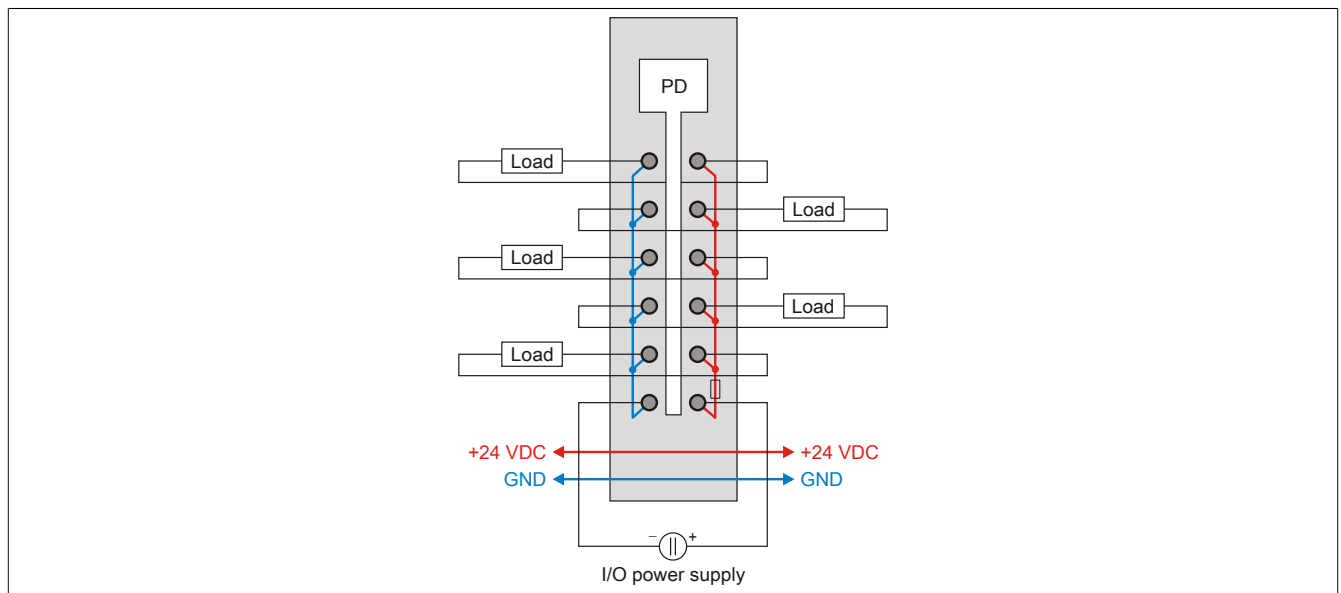
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|-------|-----------------------------|-------------------------------------|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | | | Single flash | Fuse defective or missing |
| | | | Double flash | Supply voltage too low |
| | e + r | | Red on / Green single flash | Invalid firmware |

9.26.18.5 Pinout



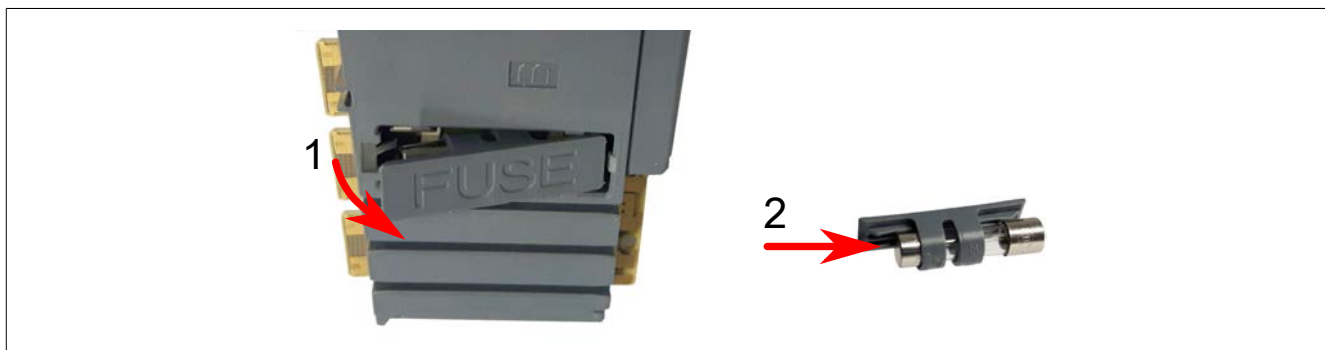
9.26.18.6 Connection example



9.26.18.7 Replacing the built-in fuse

The module is equipped with a 6.3 A built-in fuse. Proceed as follows to replace a defective fuse:

- 1) Remove the fuse cover with the fuse on the right side of the module using a screwdriver.
- 2) Slide the cylindrical fuse out of the fuse holder and slide the new fuse in.



9.26.18.8 Register description

9.26.18.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.26.18.8.2 Function model 1 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|-------------------------------|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| 0 | 1 | Module status | USINT | • | | | |
| | | StatusFuse | Bit 0 | | | | |
| | | StatusPowerSupply | Bit 1 | | | | |
| 2 | 2 | Counter01 | USINT | • | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Non-cyclic access continues to be based on the register numbers.

9.26.18.8.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|-------------------------------|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| 0 | 0 | Module status | USINT | • | | | |
| | | StatusFuse | Bit 0 | | | | |
| | | StatusPowerSupply | Bit 1 | | | | |
| 2 | 2 | Counter01 | USINT | • | | | |

1) The offset specifies the position of the register within the CAN object.

9.26.18.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.26.18.8.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.26.18.8.4 Module status

Name:

Module status

StatusFuse

StatusPowerSupply

This register can be used to read the status of the power supply.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------------|-------|-----------------------------|
| 0 | StatusFuse | 0 | Fuse OK |
| | | 1 | Fuse not OK |
| | StatusPowerSupply | 0 | Level of fed voltage OK |
| | | 1 | Level of fed voltage not OK |
| 2 - 7 | Reserved | - | |

9.26.18.8.5 Counter for the voltage dips

Name:

Counter01

This register is used to count how often the voltage dips on the PD module.

| Data type | Values |
|-----------|----------|
| USINT | 0 to 255 |

9.26.18.8.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.26.18.8.7 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 100 μ s |

9.26.19 X20(c)PD2113

Data sheet version: 3.23

9.26.19.1 General information

The potential distributor module with feed can provide 6x 24 VDC and 6x ground connections from the internal I/O supply on the terminals. This module can also be used instead of a special feed module for the internal I/O supply. The internal 24 VDC supply is connected to the terminal connections through a replaceable microfuse for protection. The 24 VDC feed and the functionality of the fuse are monitored.

Information:

Since the 6x 24 VDC terminals are interconnected and the fuse is located between the terminals and the internal I/O supply, the terminal potentials are not protected against short circuits from an external feed. If using an external feed, the respective 24 VDC terminals must be protected with an external fuse. In this case a X20BM01 bus module should be used.

- Integrated exchangeable microfuse
- Monitoring of the fuse
- Potential for routing as needed
- Can be used as feed module for the I/O supply

9.26.19.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.26.19.3 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Other functions |  |
| X20PD2113 | X20 potential distributor module, 6x GND, 6x 24 VDC, with feed option, integrated microfuse | |
| X20cPD2113 | X20 potential distributor, coated, 6x GND, 6x 24 VDC, with supply option, integrated microfuse | |
| | Required accessories | |
| | Bus modules | |
| X20BM01 | X20 power supply bus module, 24 VDC keyed, internal I/O supply interrupted to the left | |
| X20BM05 | X20 power supply bus module, with node number switch, 24 VDC keyed, internal I/O supply interrupted to the left | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM01 | X20 power supply bus module, coated, 24 VDC keyed, internal I/O supply interrupted to the left | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 571: X20PD2113, X20cPD2113 - Order data

9.26.19.4 Technical data


| Model number | X20PD2113 | X20cPD2113 |
|--|--|--|
| Short description | | |
| Potential distributor module with supply | 6x 24 VDC on the terminal connections, 6x ground on the terminal connections | |
| General information | | |
| B&R ID code | 0x267F | 0xE23B |
| Status indicators | Operating state, module status | |
| Diagnosics | | |
| Module run/error | Yes, using status LED and software | |
| Fuse monitoring | Yes, using status LED and software | |
| Power consumption ¹⁾ | | |
| Bus | 0.12 W | |
| Internal I/O | - | |
| External I/O | 1.15 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| KC | Yes | - |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| Input supply with feed | | |
| Nominal input voltage | 24 VDC -15% / +20% external, external ground | |
| Input current | Max. 6 A | |
| Fuse | Integrated 6.3 A, slow-blow, can be replaced | |
| Behavior on short circuit | No protection available Use external fuse | |
| Reverse polarity protection | No | |
| Output I/O power supply | | |
| Nominal output voltage | 24 VDC, ground | |
| Permissible contact load | 6 A | |
| Behavior on short circuit | | |
| On 24 VDC power supply | Integrated fuse | |
| On GND power supply | No protection available | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM01 or X20B-M11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM01 or X20cB-M11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 572: X20PD2113, X20cPD2113 - Technical data

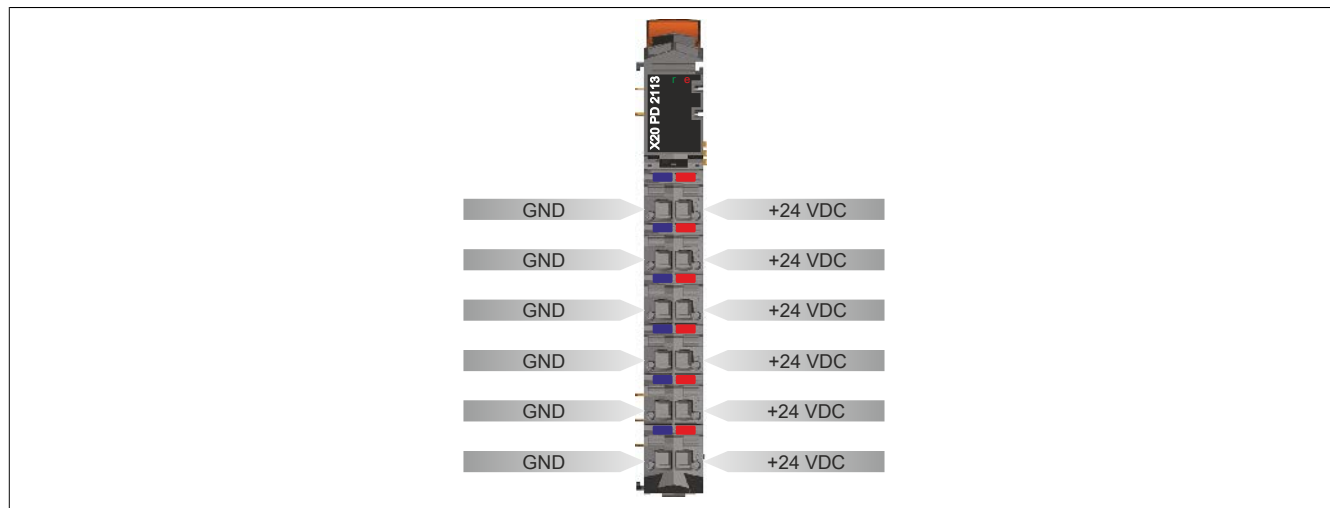
1) The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.

9.26.19.5 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

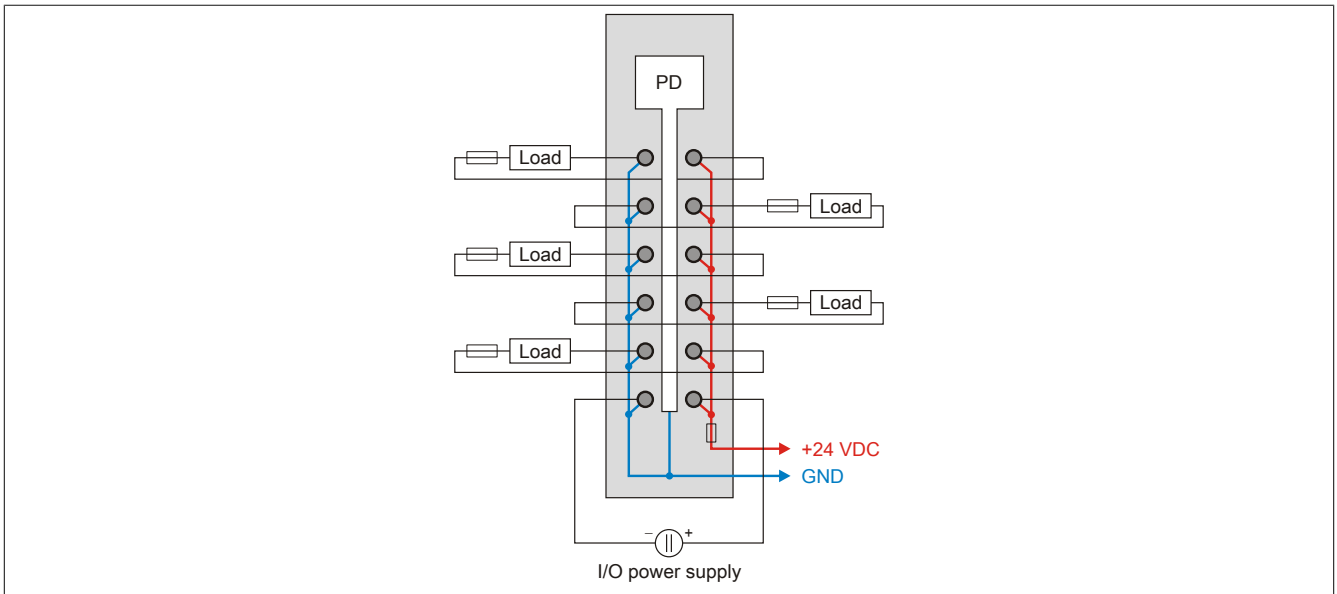
| Figure | LED | Color | Status | Description | |
|---|-------|-------|-----------------------------|-------------------------------------|--|
|  | r | Green | Off | No power to module | |
| | | | Single flash | RESET mode | |
| | | | Blinking | PREOPERATIONAL mode | |
| | | | On | RUN mode | |
| | e | Red | Off | No power to module or everything OK | |
| | | | On | Error or reset status | |
| | | | Single flash | Fuse defective or missing | |
| | | | Double flash | Supply voltage too low | |
| | e + r | | Red on / Green single flash | Triple flash | Internal I/O supply OK but fuse defective and supply voltage too low |
| | | | | | Invalid firmware |

9.26.19.6 Pinout

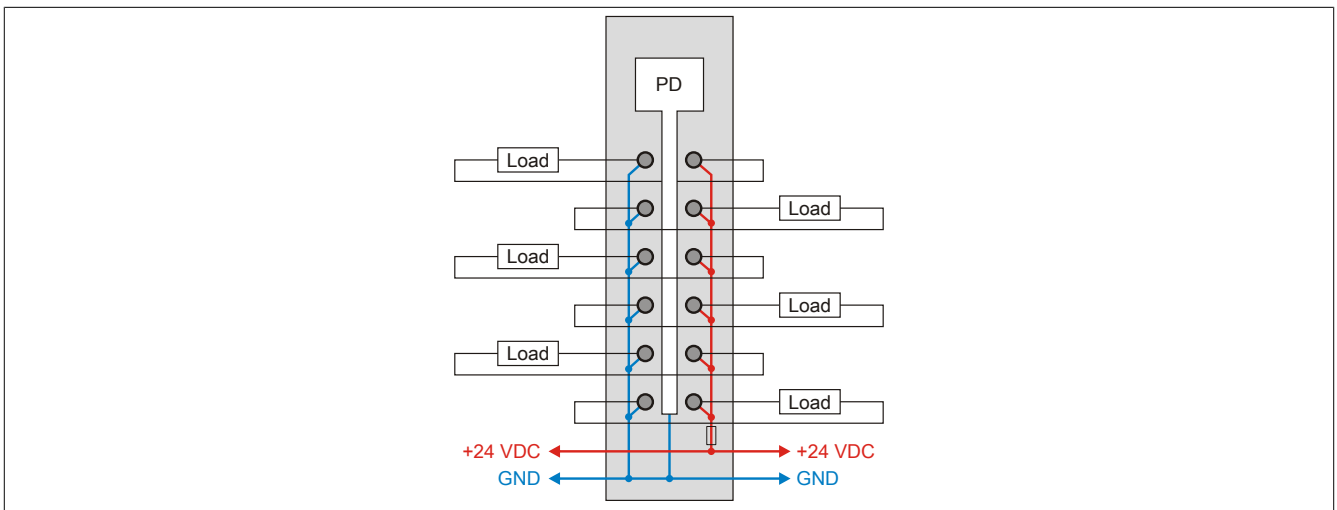


9.26.19.7 Connection examples

Connection example with external supply



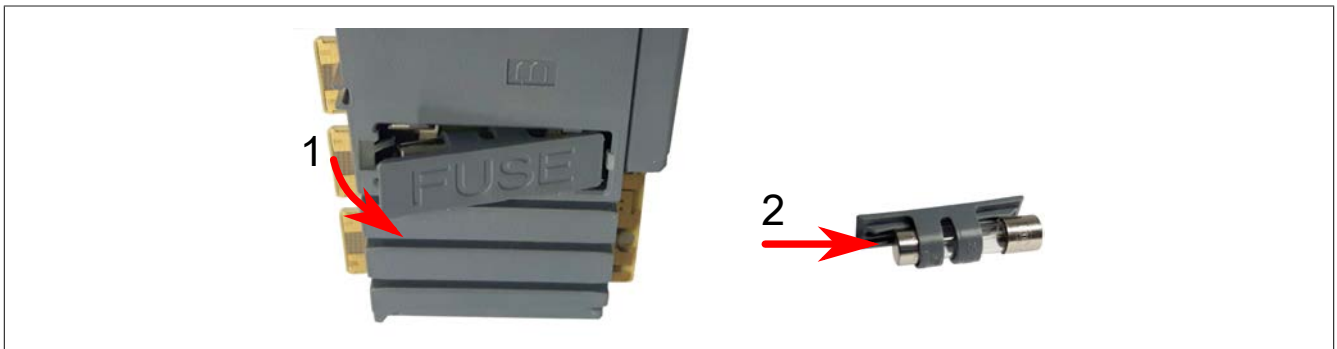
Connection example with internal supply



9.26.19.8 Replacing the built-in fuse

The module is equipped with a 6.3 A built-in fuse. Proceed as follows to replace a defective fuse:

- 1) Remove the fuse cover with the fuse on the right side of the module using a screwdriver.
- 2) Slide the cylindrical fuse out of the fuse holder and slide the new fuse in.



9.26.19.9 Register description

9.26.19.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.26.19.9.2 Function model 1 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|-------------------------------|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| 0 | 1 | Module status | USINT | • | | | |
| | | StatusFuse | Bit 0 | | | | |
| | | StatusPowerSupply | Bit 1 | | | | |
| 2 | 2 | Counter01 | USINT | • | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Non-cyclic access continues to be based on the register numbers.

9.26.19.9.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|-------------------------------|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| 0 | 0 | Module status | USINT | • | | | |
| | | StatusFuse | Bit 0 | | | | |
| | | StatusPowerSupply | Bit 1 | | | | |
| 2 | 2 | Counter01 | USINT | • | | | |

1) The offset specifies the position of the register within the CAN object.

9.26.19.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.26.19.9.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.26.19.9.4 Module status

Name:

Module status

StatusFuse

StatusPowerSupply

This register can be used to read the status of the power supply.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------------|-------|-----------------------------|
| 0 | StatusFuse | 0 | Fuse OK |
| | | 1 | Fuse not OK |
| | StatusPowerSupply | 0 | Level of fed voltage OK |
| | | 1 | Level of fed voltage not OK |
| 2 - 7 | Reserved | - | |

9.26.19.9.5 Counter for the voltage dips

Name:

Counter01

This register is used to count how often the voltage dips on the PD module.

| Data type | Values |
|-----------|----------|
| USINT | 0 to 255 |

9.26.19.9.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.26.19.9.7 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 100 μ s |

9.26.20 X20PS4951

Data sheet version: 3.14

9.26.20.1 General information

In order to connect potentiometers, modules must first be supplied with the appropriate voltage. The potentiometer supply module can be used to supply four potentiometers with ± 10 V. The data is evaluated using standard analog input modules.

- Open circuit and short circuit detection
- Simple implementation of potentiometer inputs
- 4x supply

9.26.20.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Other functions |  |
| X20PS4951 | X20 power supply module, for potentiometers, 4x ± 10 V for potentiometer supply | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 573: X20PS4951 - Order data

9.26.20.3 Technical data

| | |
|--|--|
| Model number | X20PS4951 |
| Short description | |
| System module | Supplies 4 potentiometers with ± 10 V |
| General information | |
| B&R ID code | 0x1F43 |
| Status indicators | Potentiometer supply monitoring by channel, operating state, module status |
| Diagnosics | |
| Module run/error | Yes, using status LED and software |
| Open circuit | Yes, using status LED and software |
| Overload | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.8 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Potentiometer power supply | |
| Number of power supplies | 4 |
| Voltage | ± 10 V |
| Potentiometer resistance | 1 k Ω to 10 k Ω |
| Load | Max. 20 mA per supply channel |
| Short-circuit proof | Yes |
| Basic accuracy | |
| +10 V | $\pm 0.12\%$ at 25°C |
| -10 V | $\pm 0.21\%$ at 25°C |
| 20 V | $\pm 0.165\%$ at 25°C |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Max. drift | |
| +10 V | $\pm 0.00012\%/^{\circ}\text{C}$ |
| -10 V | $\pm 0.00032\%/^{\circ}\text{C}$ |
| 20 V | $\pm 0.00022\%/^{\circ}\text{C}$ |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating" |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |


Table 574: X20PS4951 - Technical data

| | |
|------------------------------|--|
| Model number | X20PS4951 |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

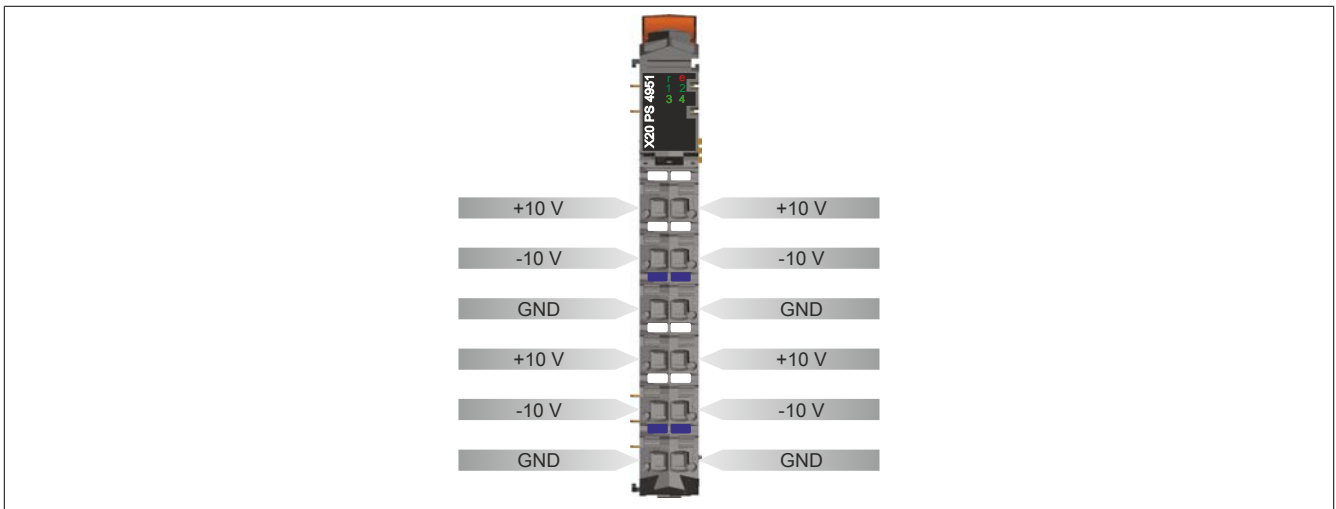
Table 574: X20PS4951 - Technical data

9.26.20.4 LED status indicators

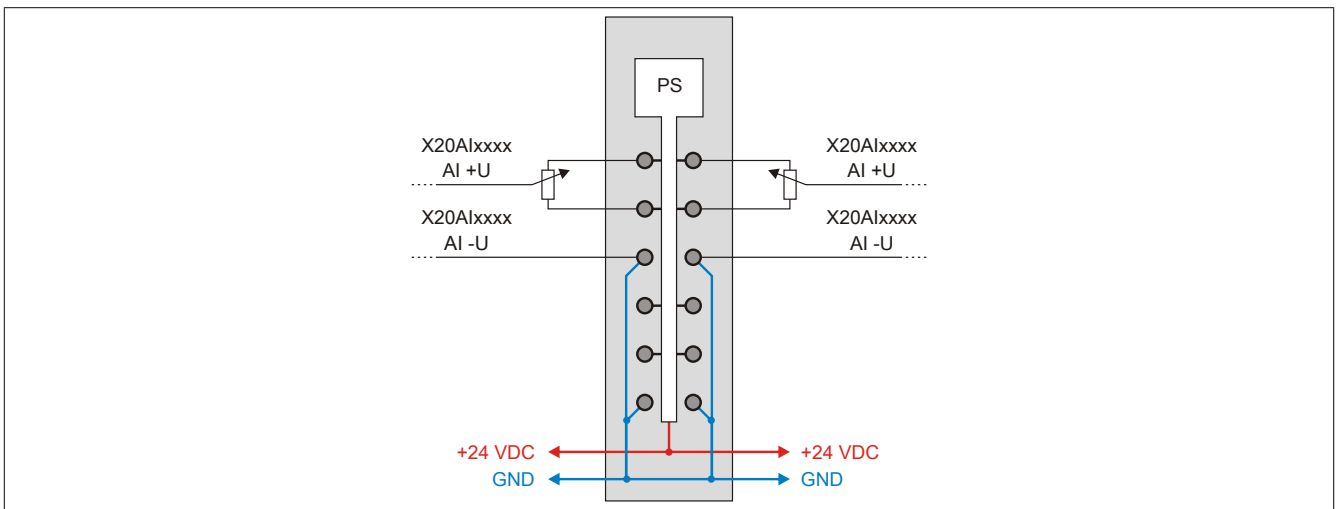
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|-----------------------------|------------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | | | Single flash | At least one supply channel overloaded |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1 - 4 | Green | Off | No power to module or open line |
| | | | Blinking | Overload: Output is off |
| | | | On | There is a load on the output, normal operation |

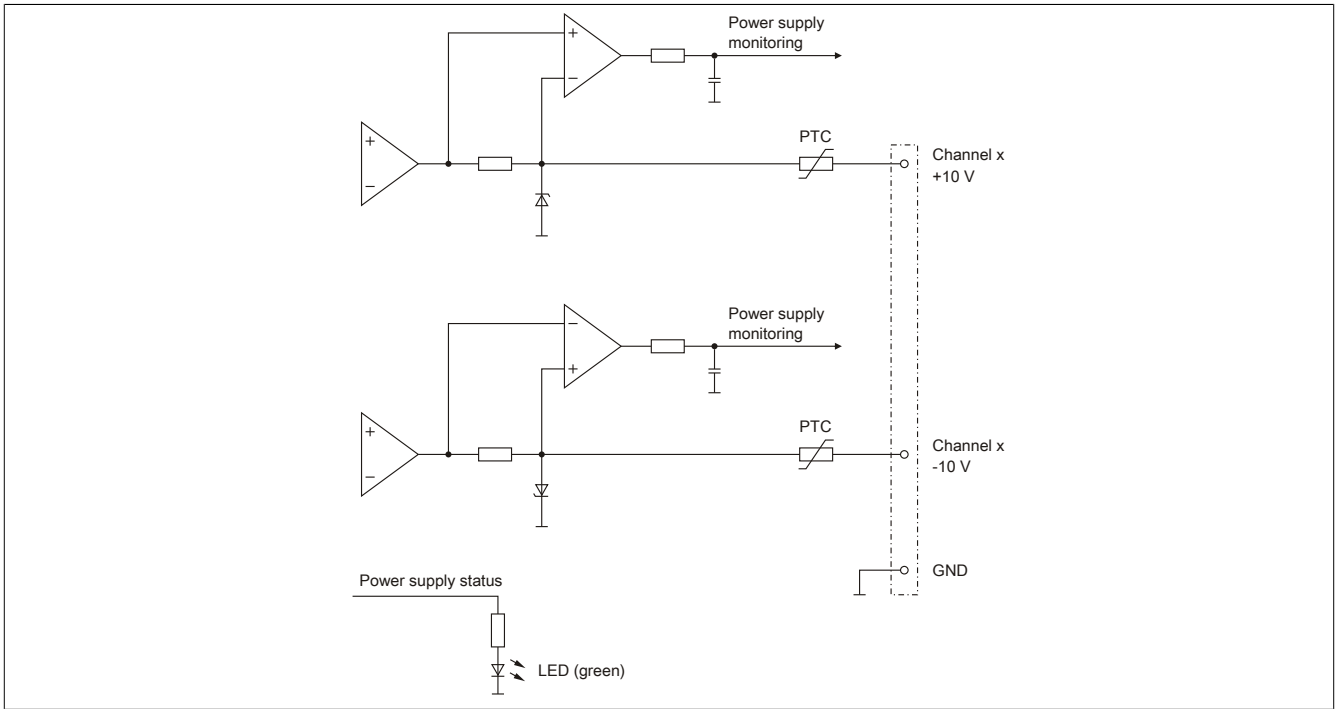
9.26.20.5 Pinout



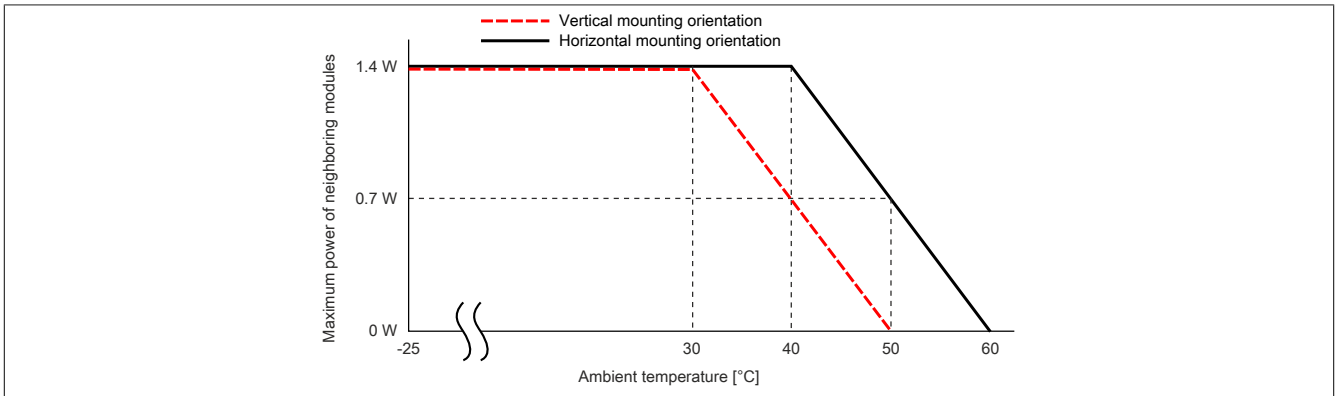
9.26.20.6 Connection example



9.26.20.7 Output circuit diagram



9.26.20.8 Derating



9.26.20.9 Register description

9.26.20.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.26.20.9.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------|-------------------------------|-----------|--------|------------|--------|------------|
| | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| 0 | Supply status | USINT | • | | | |
| | ShortCircuit01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | ShortCircuit01 | Bit 3 | | | | |
| | OpenLine01 | Bit 4 | | | | |
| | ... | ... | | | | |
| | OpenLine04 | Bit 7 | | | | |

9.26.20.9.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|-------------------------------|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| 0 | 0 | Supply status | USINT | • | | | |
| | | ShortCircuit01 | Bit 0 | | | | |
| | | ... | ... | | | | |
| | | ShortCircuit01 | Bit 3 | | | | |
| | | OpenLine01 | Bit 4 | | | | |
| | | ... | ... | | | | |
| | | OpenLine04 | Bit 7 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.26.20.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.26.20.9.3.2 CAN I/O bus controller

The module occupies 1 digital logical slot on CAN I/O.

9.26.20.9.4 Supply status

Name:

OpenLine01 to OpenLine04

ShortCircuit01 to ShortCircuit04

This register can be used to display the status of the respective channels.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|-------|----------------------------|
| 0 | ShortCircuit01 | 0 | No short circuit |
| | | 1 | Short circuit on channel 1 |
| ... | ... | ... | ... |
| 3 | ShortCircuit04 | 0 | No short circuit |
| | | 1 | Short circuit on channel 4 |
| 4 | OpenLine01 | 0 | No open line |
| | | 1 | Open line on channel 1 |
| ... | ... | ... | ... |
| 7 | OpenLine04 | 0 | No open line |
| | | 1 | Open line on channel 4 |

9.26.20.9.5 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.26.20.9.6 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 1 ms |

9.27 Power supply modules

The internal I/Os and the X2X Link are fed by the supply modules.

9.27.1 Summary

| Model number | Short description | Page |
|--------------|--|------|
| X20PS2100 | X20 power supply module, for internal I/O supply | 3356 |
| X20PS2110 | X20 power supply module, for internal I/O power supply, integrated microfuse | 3361 |
| X20PS3300 | X20 power supply module, for X2X Link and internal I/O power supply | 3367 |
| X20PS3310 | X20 power supply module, for X2X Link and internal I/O power supply, integrated microfuse | 3373 |
| X20cPS2100 | X20 power supply module, coated, for internal I/O supply | 3356 |
| X20cPS2110 | X20 power supply module, coated, for internal I/O power supply, integrated microfuse | 3361 |
| X20cPS3300 | X20 power supply module, coated, for X2X Link and internal I/O power supply | 3367 |
| X20cPS3310 | X20 power supply module, coated, for X2X Link and internal I/O power supply integrated microfuse | 3373 |

9.27.2 X20(c)PS2100

Data sheet version: 3.17

9.27.2.1 General information

The supply module is used for the internal I/O supply.

- 24 VDC supply module for internal I/O supply

9.27.2.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.27.2.3 Order data

| Model number | Short description | Figure |
|--------------|---|--------|
| | Power supplies | |
| X20PS2100 | X20 power supply module, for internal I/O supply | |
| X20cPS2100 | X20 power supply module, coated, for internal I/O supply | |
| | Required accessories | |
| | Bus modules | |
| X20BM01 | X20 power supply bus module, 24 VDC keyed, internal I/O supply interrupted to the left | |
| X20BM05 | X20 power supply bus module, with node number switch, 24 VDC keyed, internal I/O supply interrupted to the left | |
| X20cBM01 | X20 power supply bus module, coated, 24 VDC keyed, internal I/O supply interrupted to the left | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 575: X20PS2100, X20cPS2100 - Order data

9.27.2.4 Technical data


| Model number | X20PS2100 | X20cPS2100 |
|--|--|--|
| Short description | | |
| Power supply module | 24 VDC supply module for internal I/O supply | |
| General information | | |
| B&R ID code | 0x1BBF | 0xE23C |
| Status indicators | Operating state, module status | |
| Diagnosics | | |
| Module run/error | Yes, using status LED and software | |
| Power consumption ¹⁾ | | |
| Bus | 0.2 W | |
| Internal I/O | 0.6 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| KC | Yes | - |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| Input I/O power supply | | |
| Input voltage | 24 VDC -15% / +20% | |
| Fuse | Required line fuse: Max. 10 A, slow-blow | |
| Reverse polarity protection | No | |
| Output I/O power supply | | |
| Nominal output voltage | 24 VDC | |
| Behavior on short circuit | Required line fuse | |
| Permissible contact load | 10 A | |
| Electrical properties | | |
| Electrical isolation | I/O supply not isolated from I/O power supply | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | | |
| Storage | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM01 supply bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM01 supply bus module separately |
| Spacing | 12.5 ^{+0.2} mm | |

Table 576: X20PS2100, X20cPS2100 - Technical data

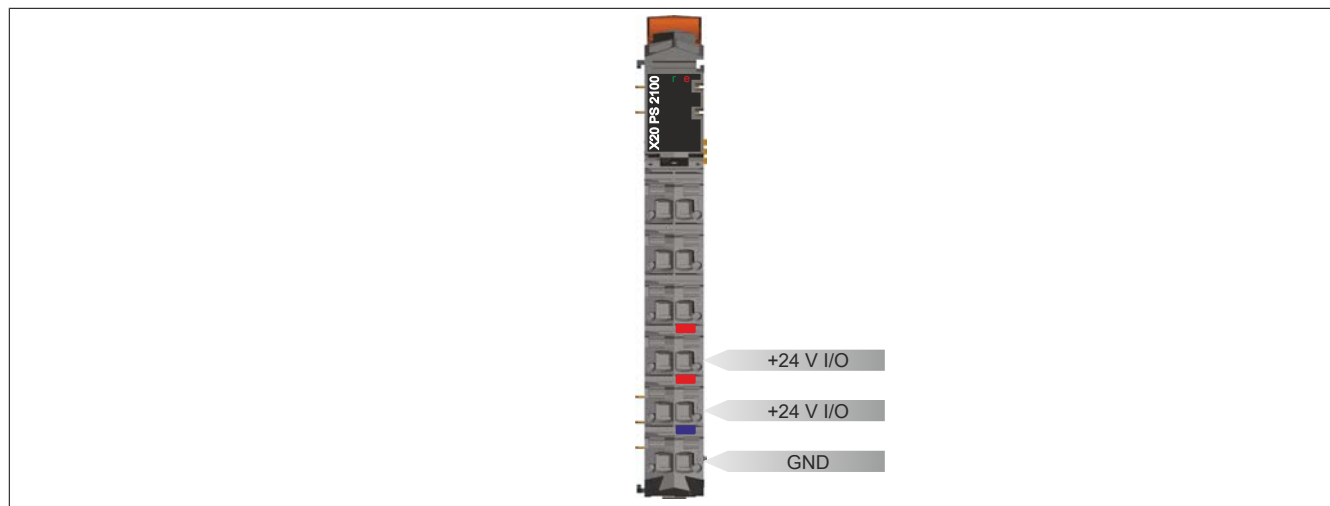
- 1) The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.

9.27.2.5 LED status indicators

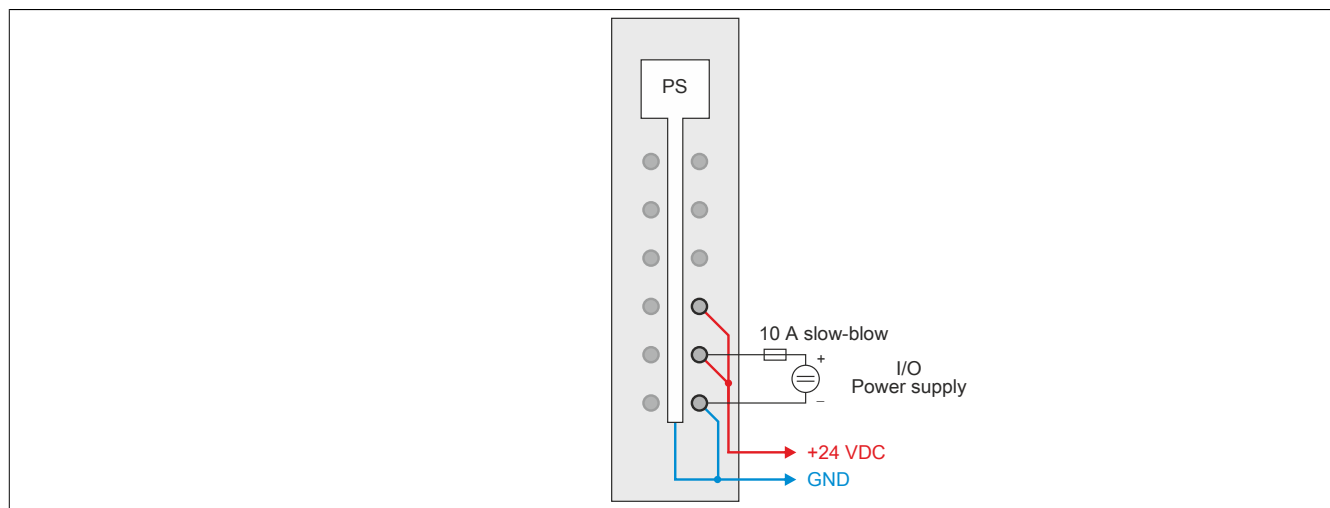
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-----|-----------------------------|------------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Double flash | LED indicates one of the following states: <ul style="list-style-type: none"> • I/O supply too low • X2X link voltage too low |
| e + r | | Red on / Green single flash | Invalid firmware | |

9.27.2.6 Pinout



9.27.2.7 Connection example



9.27.2.8 Safe shutdown of potential group

In safety-related applications, it must be guaranteed that the potential group is safely shut down in order to achieve a category 4 shutdown in accordance with EN ISO 13849-1. An X20PS2100 (rev.F0 or higher) or X20PS2110 (rev.C0 or higher) supply module must be used to do this.

For important notes concerning "safe shutdown", see section "Mechanical and electrical configuration" of the X20 system user's manual. The user's manual can be downloaded from the Downloads section of the B&R website (www.br-automation.com).

9.27.2.9 Register description

9.27.2.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.27.2.9.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|-------------------------------|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| 0 | 1 | Module status | USINT | • | | | |
| | | StatusInput01 | Bit 0 | | | | |
| | | StatusInput02 | Bit 2 | | | | |
| 4 | 3 | SupplyVoltage | USINT | • | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.27.2.9.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|-------------------------------|-----------|--------|------------|--------|------------|
| | | | | Cyclic | Non-cyclic | Cyclic | Non-cyclic |
| 0 | 0 | Module status | UINT | • | | | |
| | | StatusInput01 | Bit 0 | | | | |
| | | StatusInput02 | Bit 2 | | | | |
| 4 | 4 | SupplyVoltage | UINT | • | | | |

1) The offset specifies the position of the register within the CAN object.

9.27.2.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.27.2.9.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.27.2.9.4 Module status

Name:

Module status

The following module supply voltages are monitored in this register:

Bus supply voltage: Bus supply voltage <4.7 V is displayed as a warning.

24 VDC I/O supply voltage: I/O supply voltage <20.4 V is displayed as a warning.

| Function model | Data type | Values |
|----------------------|-----------|------------------------|
| 0 - Standard | USINT | See the bit structure. |
| 254 - Bus controller | UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---------------|-------|--|
| 0 | StatusInput01 | 0 | No error |
| | | 1 | Bus supply warning - Undervoltage (<4.7 V) |
| 1 | Reserved | 0 | |
| 2 | StatusInput02 | 0 | I/O power supply above the warning limit of 20.4 V |
| | | 1 | I/O power supply below the warning limit of 20.4 V |
| 3 - x | Reserved | 0 | |

9.27.2.9.5 Bus supply voltage

Name:

SupplyVoltage

This register indicates the bus supply voltage measured at a resolution of 0.1 V.

| Function model | Data type |
|----------------------|-----------|
| 0 - Standard | USINT |
| 254 - Bus controller | UINT |

9.27.2.9.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.27.2.9.7 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 2 ms |

9.27.3 X20(c)PS2110

Data sheet version: 3.26

9.27.3.1 General information

The power supply module is used for the internal I/O power supply. The module has an integrated replaceable fuse for the I/O power supply.

- 24 VDC supply module for internal I/O supply
- Fuse for I/O power supply integrated in module

9.27.3.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.27.3.3 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | Power supplies |  |
| X20PS2110 | X20 power supply module, for internal I/O power supply, integrated microfuse | |
| X20cPS2110 | X20 power supply module, coated, for internal I/O power supply, integrated microfuse | |
| | Required accessories | |
| | Bus modules | |
| X20BM01 | X20 power supply bus module, 24 VDC keyed, internal I/O supply interrupted to the left | |
| X20BM05 | X20 power supply bus module, with node number switch, 24 VDC keyed, internal I/O supply interrupted to the left | |
| X20cBM01 | X20 power supply bus module, coated, 24 VDC keyed, internal I/O supply interrupted to the left | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 577: X20PS2110, X20cPS2110 - Order data

9.27.3.4 Technical data


| Model number | X20PS2110 | X20cPS2110 |
|--|---|--|
| Short description | | |
| Power supply module | 24 VDC supply module for internal I/O supply | |
| General information | | |
| B&R ID code | 0x2016 | 0xE23D |
| Status indicators | Operating state, module status | |
| Diagnosics | | |
| Module run/error | Yes, using status LED and software | |
| Power consumption ¹⁾ | | |
| Bus | 0.2 W | |
| Internal I/O | 0.82 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| KC | Yes | - |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | |
| Input I/O power supply | | |
| Input voltage | 24 VDC -15% / +20% | |
| Input current | Max. 6 A | |
| Fuse | Integrated 6.3 A, slow-blow, can be replaced | |
| Reverse polarity protection | No | |
| Output I/O power supply | | |
| Nominal output voltage | 24 VDC | |
| Behavior on short circuit | Integrated fuse | |
| Permissible contact load | 6 A | |
| Electrical properties | | |
| Electrical isolation | I/O supply not isolated from I/O power supply | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM01 supply bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM01 supply bus module separately |
| Spacing | 12.5 ^{+0.2} mm | |

Table 578: X20PS2110, X20cPS2110 - Technical data

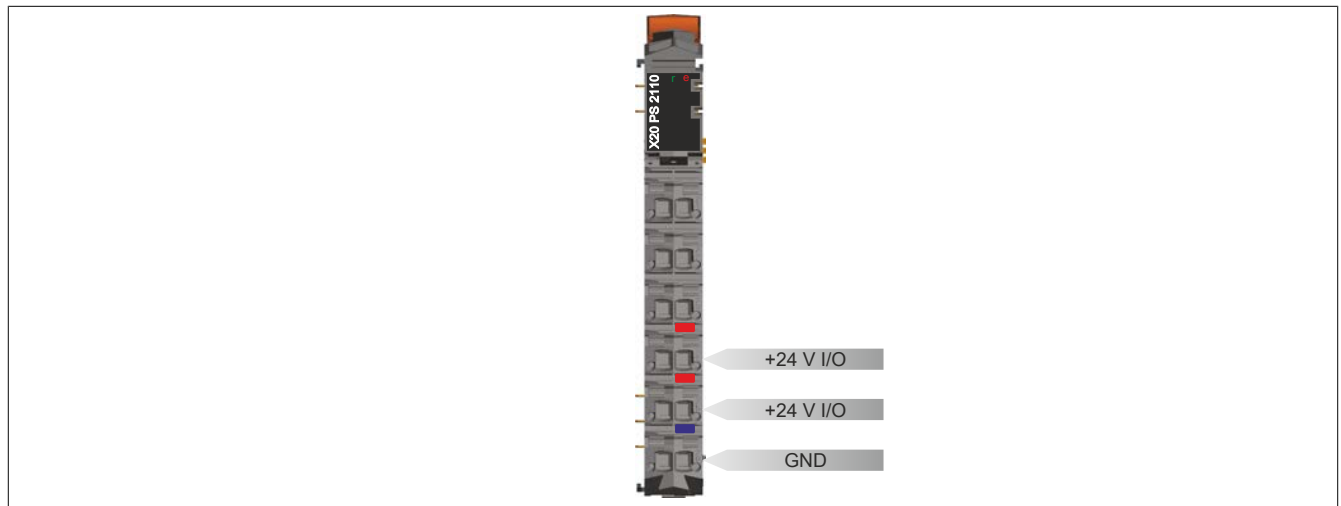
- 1) The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.

9.27.3.5 LED status indicators

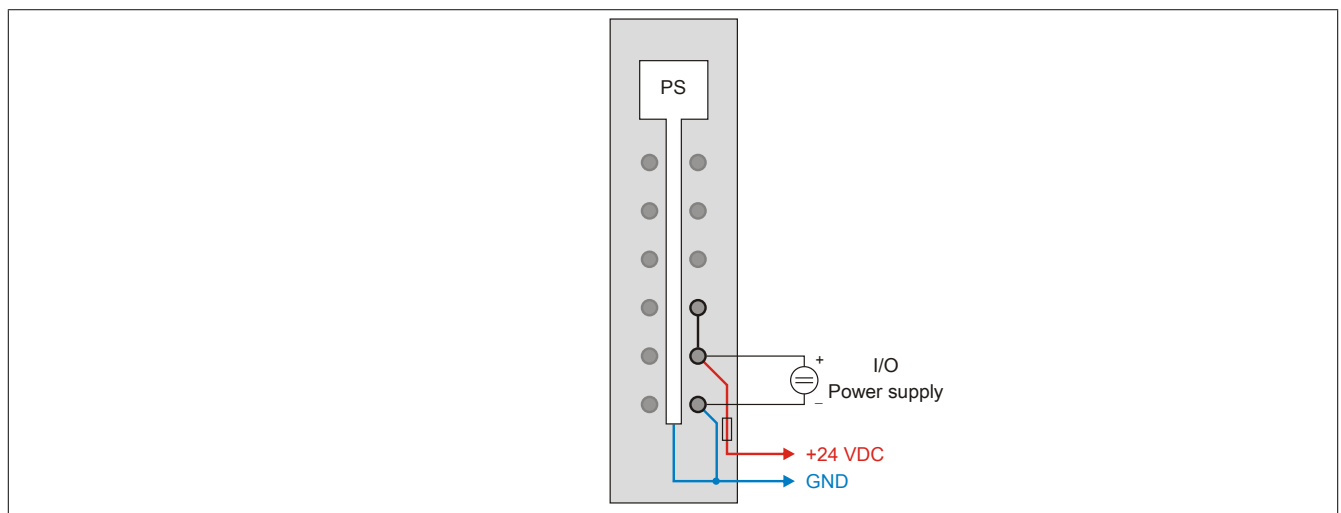
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-----|-----------------------------|------------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Double flash | LED indicates one of the following states: <ul style="list-style-type: none"> • I/O power supply too low • X2X Link voltage too low |
| e + r | | Red on / green single flash | Invalid firmware | |

9.27.3.6 Pinout



9.27.3.7 Connection example



9.27.3.8 Safe shutdown of potential group

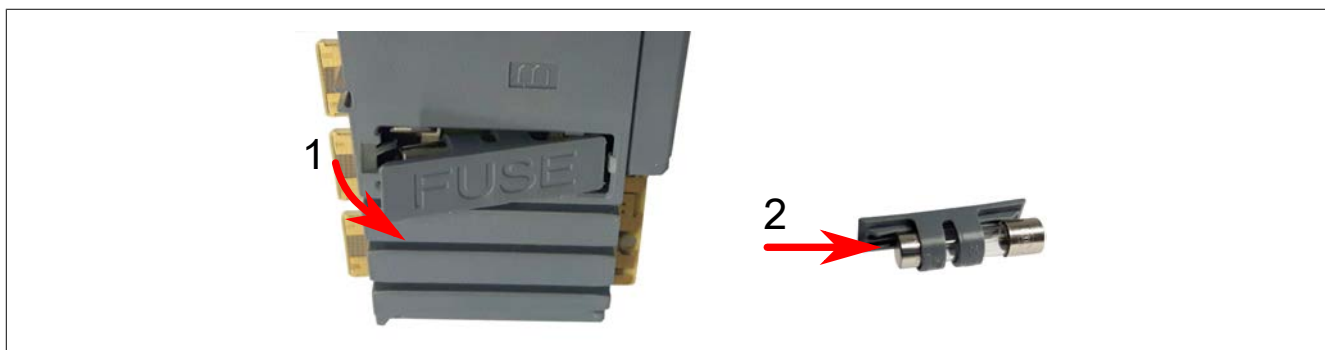
In safety-related applications, it must be guaranteed that the potential group is safely shut down in order to achieve a category 4 shutdown in accordance with EN ISO 13849-1. An X20PS2100 (rev.F0 or higher) or X20PS2110 (rev.C0 or higher) supply module must be used to do this.

For important notes concerning "safe shutdown", see section "Mechanical and electrical configuration" of the X20 system user's manual. The user's manual can be downloaded from the Downloads section of the B&R website (www.br-automation.com).

9.27.3.9 Replacing the built-in fuse

The module is equipped with a 6.3 A built-in fuse. Proceed as follows to replace a defective fuse:

- 1) Remove the fuse cover with the fuse on the right side of the module using a screwdriver.
- 2) Slide the cylindrical fuse out of the fuse holder and slide the new fuse in.



9.27.3.10 Register description

9.27.3.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.27.3.10.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 0 | 1 | Status of the module | USINT | • | | | |
| | | StatusInput01 | Bit 0 | | | | |
| | | StatusInput02 | Bit 1 | | | | |
| | | StatusInput03 | Bit 2 | | | | |
| 4 | 3 | SupplyVoltage | USINT | • | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.27.3.10.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 0 | 0 | Status of the module | UINT | • | | | |
| | | StatusInput01 | Bit 0 | | | | |
| | | StatusInput02 | Bit 1 | | | | |
| | | StatusInput03 | Bit 2 | | | | |
| 4 | 4 | SupplyVoltage | UINT | • | | | |

1) The offset specifies the position of the register within the CAN object.

9.27.3.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.27.3.10.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.27.3.10.4 Status of the module

Name:

Module status

The following module supply voltages are monitored in this register:

| | |
|----------------------------|--|
| Bus supply voltage: | A bus supply voltage of <4.7 V is displayed as a warning. |
| 24 VDC I/O supply voltage: | An I/O supply voltage of <20.4 V is displayed as a warning. |
| Safety status: | Applies to hardware revision C0 and later. When using modules <C0, a defective fuse is not detected! |

| Function model | Data type | Values |
|----------------------|-----------|------------------------|
| 0 - Standard | USINT | See the bit structure. |
| 254 - Bus controller | UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|---------------|-------|--|
| 0 | StatusInput01 | 0 | No error |
| | | 1 | Bus supply warning - Undervoltage (<4.7 V) |
| 1 | StatusInput02 | 0 | Fuse OK or hardware revision <C0 |
| | | 1 | Fuse defective |
| 2 | StatusInput03 | 0 | I/O power supply above the warning threshold of 20.4 V |
| | | 1 | I/O power supply below the warning threshold of 20.4 V |
| 3 - x | Reserved | 0 | |

9.27.3.10.5 Bus supply voltage

Name:

SupplyVoltage

This register indicates the bus supply voltage measured at a resolution of 0.1 V.

| Function model | Data type |
|----------------------|-----------|
| 0 - Standard | USINT |
| 254 - Bus controller | UINT |

9.27.3.10.6 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.27.3.10.7 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 2 ms |

9.27.4 X20(c)PS3300

Data sheet version: 3.17

9.27.4.1 General information

The supply module is equipped with a feed for the X2X Link as well as the internal I/O supply.

- Feed for X2X Link and internal I/O supply
- Electrical isolation of feed and X2X Link supply
- Redundancy of X2X Link supply possible by operating multiple supply modules simultaneously

9.27.4.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.27.4.3 Order data

| Model number | Short description | Figure |
|--------------|---|--------|
| | Power supplies | |
| X20PS3300 | X20 power supply module, for X2X Link and internal I/O power supply | |
| X20cPS3300 | X20 power supply module, coated, for X2X Link and internal I/O power supply | |
| | Required accessories | |
| | Bus modules | |
| X20BM01 | X20 power supply bus module, 24 VDC keyed, internal I/O supply interrupted to the left | |
| X20BM05 | X20 power supply bus module, with node number switch, 24 VDC keyed, internal I/O supply interrupted to the left | |
| X20cBM01 | X20 power supply bus module, coated, 24 VDC keyed, internal I/O supply interrupted to the left | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 579: X20PS3300, X20cPS3300 - Order data

9.27.4.4 Technical data

| Model number | X20PS3300 | X20cPS3300 |
|--|--|------------|
| Short description | | |
| Power supply module | 24 VDC supply module for I/O and bus | |
| General information | | |
| B&R ID code | 0x1BC0 | 0xDF13 |
| Status indicators | Overload, operating state, module status | |
| Diagnosics | | |
| Module run/error | Yes, using status LED and software | |
| Overload | Yes, using status LED and software | |
| Power consumption for X2X Link power supply ¹⁾ | 1.42 W | |
| Power consumption ¹⁾ | | |
| Internal I/O | 0.6 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| KC | Yes | - |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| X2X Link power supply input | | |
| Input voltage | 24 VDC -15% / +20% | |
| Input current | Max. 0.7 A | |
| Fuse | Integrated, cannot be replaced | |
| Reverse polarity protection | Yes | |
| X2X Link power supply output | | |
| Nominal output power | 7 W | |
| Parallel connection | Yes ²⁾ | |
| Redundant operation | Yes | |
| Overload characteristics | Short circuit, temporary overload | |
| Input I/O power supply | | |
| Input voltage | 24 VDC -15% / +20% | |
| Fuse | Required line fuse: Max. 10 A, slow-blow | |
| Reverse polarity protection | No | |
| Output I/O power supply | | |
| Nominal output voltage | 24 VDC | |
| Behavior on short circuit | Required line fuse | |
| Permissible contact load | 10 A | |
| Electrical properties | | |
| Electrical isolation | X2X Link supply isolated from X2X Link power supply I/O supply not isolated from I/O power supply | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating" | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |

Table 580: X20PS3300, X20cPS3300 - Technical data


| Model number | X20PS3300 | X20cPS3300 |
|------------------------------|---|--|
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM01 supply bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM01 supply bus module separately |
| Spacing | 12.5 ^{+0.2} mm | |

Table 580: X20PS3300, X20cPS3300 - Technical data

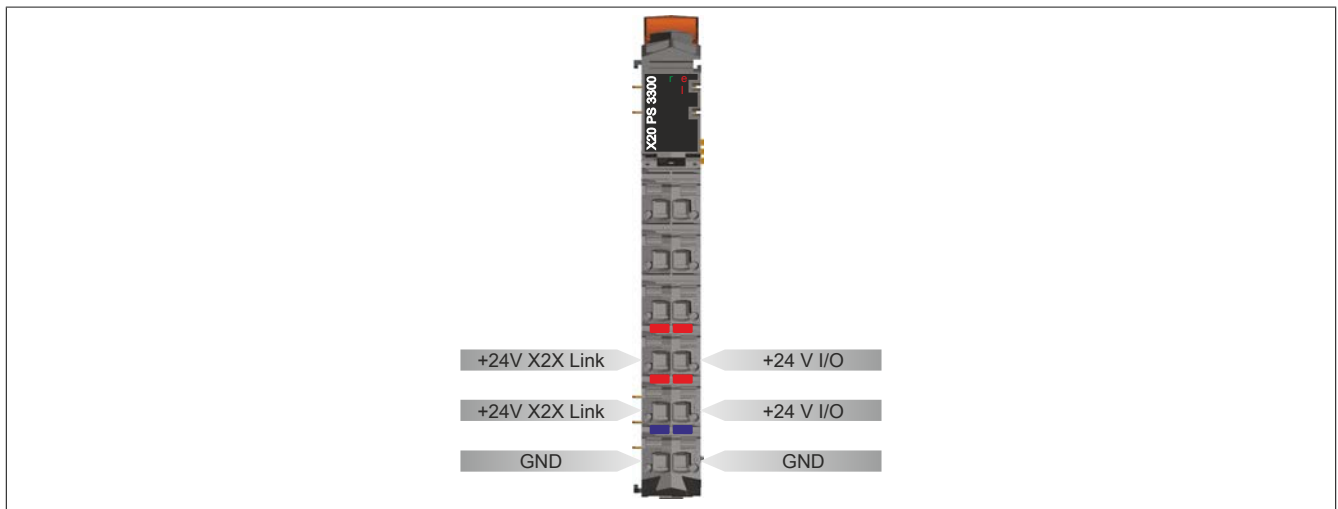
- 1) The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) In parallel operation, only 75% of the rated power can be assumed. It is important to make sure that all power supplies operated in parallel are switched on and off at the same time.

9.27.4.5 LED status indicators

For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

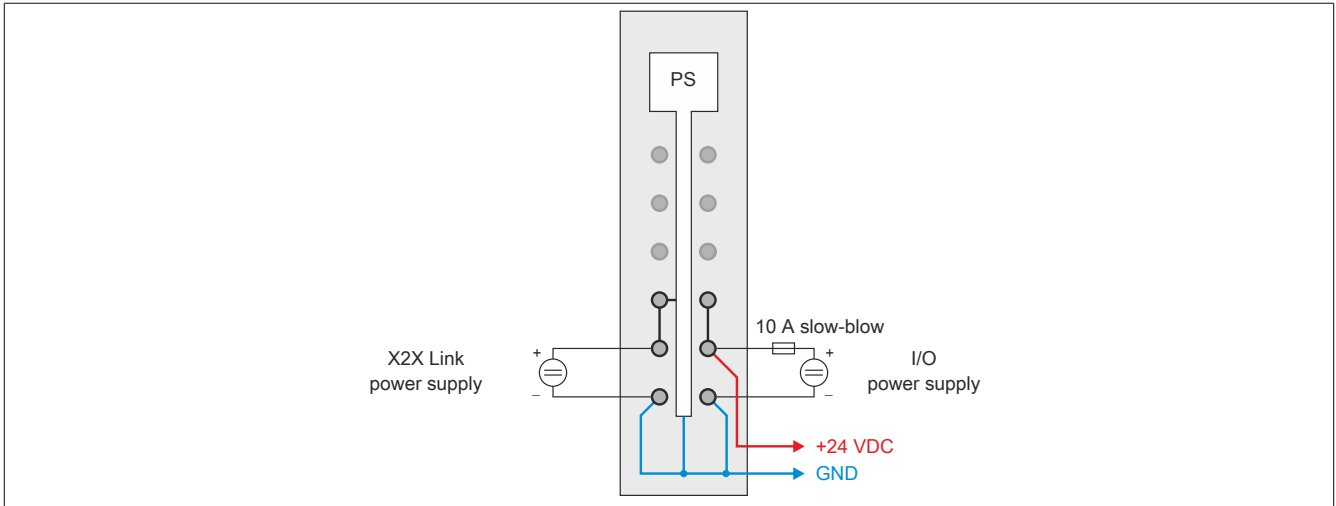
| Figure | LED | Color | Status | Description |
|---|-------|-------|--|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Double flash | LED indicates one of the following states: <ul style="list-style-type: none"> • The X2X Link supply for the power supply is overloaded • I/O supply too low • Input voltage for X2X Link supply too low |
| | e + r | | Red on / Green single flash | Invalid firmware |
| l | Red | Off | The X2X Link supply is within the valid limits | |
| | | On | The X2X Link supply for the power supply is overloaded | |

9.27.4.6 Pinout

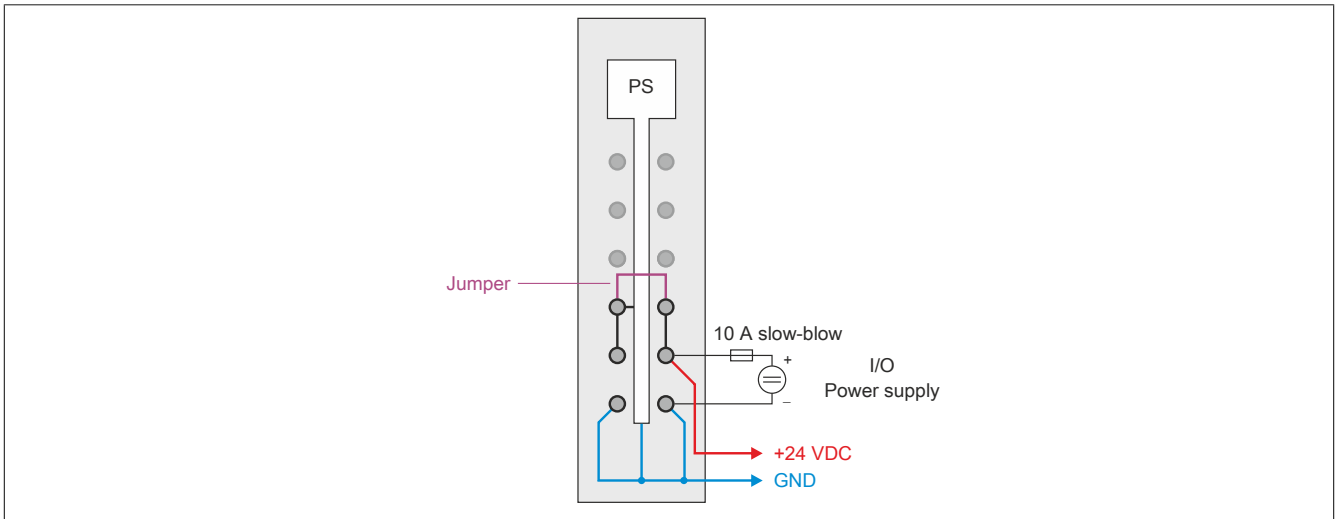


9.27.4.7 Connection examples

With 2 isolated power supplies

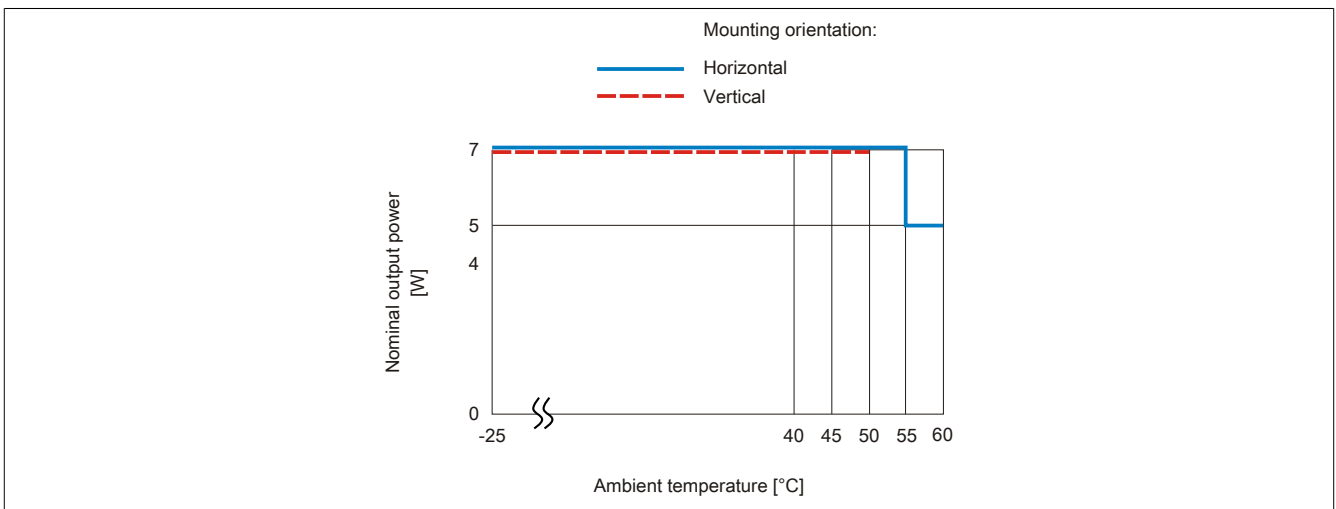


With 1 power supply and jumper



9.27.4.8 Derating

The nominal output power for the power supply is 7 W. Depending on the mounting orientation, derating must be taken into account.



9.27.4.9 Register description

9.27.4.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.27.4.9.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 0 | 1 | Status of the module | USINT | • | | | |
| | | StatusInput01 | Bit 0 | | | | |
| | | StatusInput02 | Bit 2 | | | | |
| 2 | 2 | SupplyCurrent | USINT | • | | | |
| 4 | 3 | SupplyVoltage | USINT | • | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.27.4.9.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 0 | 0 | Status of the module | UINT | • | | | |
| | | StatusInput01 | Bit 0 | | | | |
| | | StatusInput02 | Bit 2 | | | | |
| 2 | 2 | SupplyCurrent | UINT | • | | | |
| 4 | 4 | SupplyVoltage | UINT | • | | | |

1) The offset specifies the position of the register within the CAN object.

9.27.4.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "[Using I/O modules on the bus controller](#)" on page 3789.

9.27.4.9.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.27.4.9.4 Status of the module

Name:

Module status

The following voltage and current states of the module are monitored in this register:

| | |
|----------------------------|--|
| Bus power supply current: | Bus power supply current >2.3 A is displayed as a warning. |
| Bus supply voltage: | Bus supply voltage <4.7 V is displayed as a warning. |
| 24 VDC I/O supply voltage: | I/O supply voltage <20.4 V is displayed as a warning. |

| Function model | Data type | Values |
|----------------------|-----------|------------------------|
| 0 - Standard | USINT | See the bit structure. |
| 254 - Bus controller | UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|---|
| 0 | StatusInput01 | 0 | No error |
| | | 1 | Warning in the event of overcurrent (>2.3 A) or undervoltage (<4.7 V) |
| 1 | Reserved | 0 | |
| 2 | StatusInput02 | 0 | I/O power supply above the warning limit of 20.4 V |
| | | 1 | I/O power supply below the warning limit of 20.4 V |
| 3 - x | Reserved | 0 | |

9.27.4.9.5 Bus power supply current

Name:
SupplyCurrent

This register displays the bus power supply current measured at a resolution of 0.1 A.

| Function model | Data type |
|----------------------|-----------|
| 0 - Standard | USINT |
| 254 - Bus controller | UINT |

9.27.4.9.6 Bus supply voltage

Name:
SupplyVoltage

This register indicates the bus supply voltage measured at a resolution of 0.1 V.

| Function model | Data type |
|----------------------|-----------|
| 0 - Standard | USINT |
| 254 - Bus controller | UINT |

9.27.4.9.7 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.27.4.9.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 2 ms |

9.27.5 X20(c)PS3310

Data sheet version: 3.25

9.27.5.1 General information

The supply module is equipped with a feed for the X2X Link as well as the internal I/O supply. The module has an integrated replaceable fuse for the I/O supply.

- Feed for X2X Link and internal I/O supply
- Electrical isolation of feed and X2X Link supply
- Redundancy of X2X Link supply possible by operating multiple supply modules simultaneously
- Fuse for I/O supply integrated in module

9.27.5.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.27.5.3 Order data


| Model number | Short description | Figure |
|-----------------------------|---|---|
| X20PS3310 | X20 power supply module, for X2X Link and internal I/O power supply, integrated microfuse |  |
| X20cPS3310 | X20 power supply module, coated, for X2X Link and internal I/O power supply integrated microfuse | |
| Required accessories | | |
| Bus modules | | |
| X20BM01 | X20 power supply bus module, 24 VDC keyed, internal I/O supply interrupted to the left | |
| X20BM05 | X20 power supply bus module, with node number switch, 24 VDC keyed, internal I/O supply interrupted to the left | |
| X20cBM01 | X20 power supply bus module, coated, 24 VDC keyed, internal I/O supply interrupted to the left | |
| Terminal blocks | | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 581: X20PS3310, X20cPS3310 - Order data

9.27.5.4 Technical data

| Model number | X20PS3310 | X20cPS3310 |
|--|---|------------|
| Short description | | |
| Power supply module | 24 VDC supply module for I/O and bus | |
| General information | | |
| B&R ID code | 0x2017 | 0xDD46 |
| Status indicators | Overload, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Overload | Yes, using status LED and software | |
| Power consumption for X2X Link power supply ¹⁾ | 1.42 W | |
| Power consumption ¹⁾ | | |
| Internal I/O | 0.82 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| KC | Yes | - |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| X2X Link power supply input | | |
| Input voltage | 24 VDC -15% / +20% | |
| Input current | Max. 0.7 A | |
| Fuse | Integrated, cannot be replaced | |
| Reverse polarity protection | Yes | |
| X2X Link power supply output | | |
| Nominal output power | 7 W | |
| Parallel connection | Yes ²⁾ | |
| Redundant operation | Yes | |
| Overload characteristics | Short circuit, temporary overload | |
| Input I/O power supply | | |
| Input voltage | 24 VDC -15% / +20% | |
| Input current | Max. 6 A | |
| Fuse | Integrated 6.3 A, slow-blow, can be replaced | |
| Reverse polarity protection | No | |
| Output I/O power supply | | |
| Nominal output voltage | 24 VDC | |
| Behavior on short circuit | Integrated fuse | |
| Permissible contact load | 6 A | |
| Electrical properties | | |
| Electrical isolation | X2X Link supply isolated from X2X Link power supply I/O supply not isolated from I/O power supply | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating" | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |

Table 582: X20PS3310, X20cPS3310 - Technical data


| Model number | X20PS3310 | X20cPS3310 |
|------------------------------|---|--|
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x terminal block X20TB12 separately Order 1x power supply bus module X20BM01 separately | Order 1x terminal block X20TB12 separately Order 1x power supply bus module X20cBM01 separately |
| Spacing | 12.5 ^{+0.2} mm | |

Table 582: X20PS3310, X20cPS3310 - Technical data

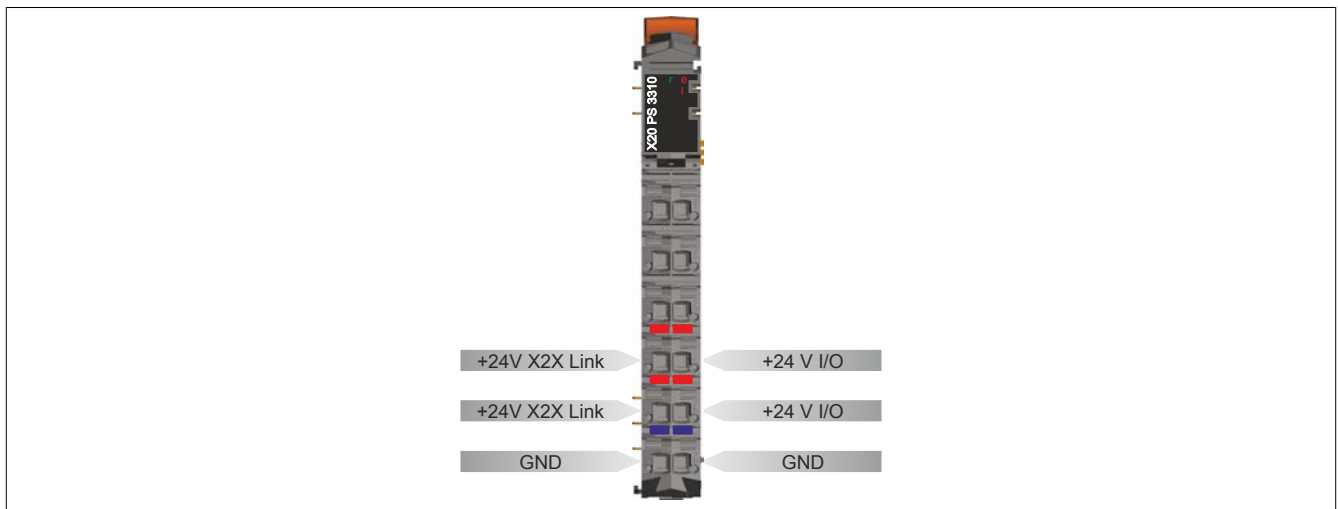
- 1) The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) In parallel operation, only 75% of the rated power can be assumed. It is important to make sure that all power supplies operated in parallel are switched on and off at the same time.

9.27.5.5 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

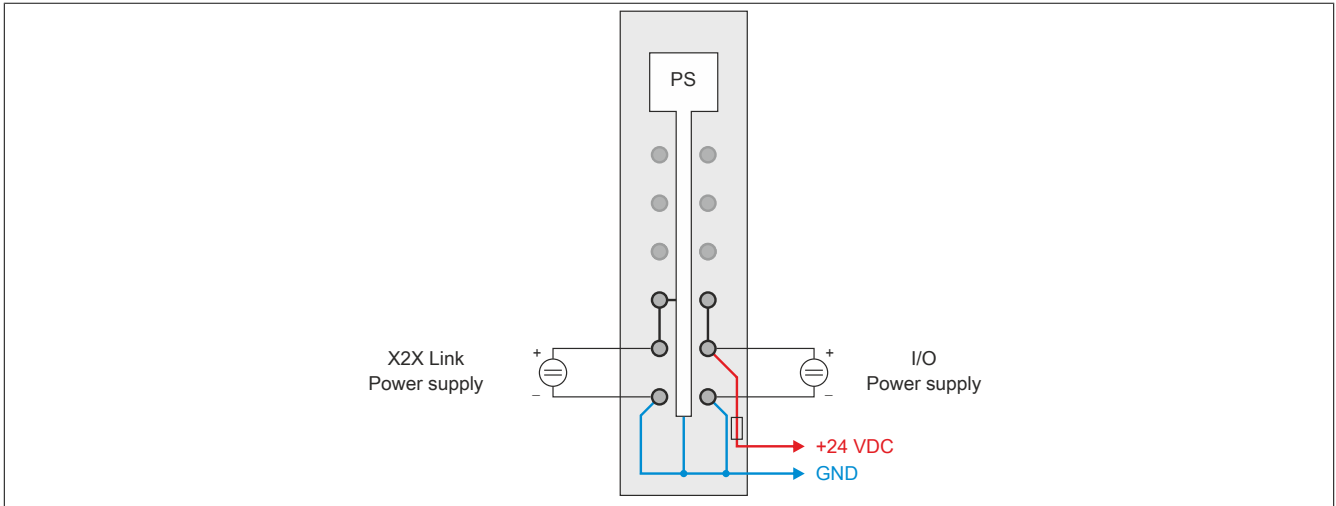
| Figure | LED | Color | Status | Description |
|---|-------|-------|--|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Double flash | LED indicates one of the following states: <ul style="list-style-type: none"> • The X2X Link supply for the power supply is overloaded • I/O supply too low • Input voltage for X2X Link supply too low |
| | e + r | | Red on / Green single flash | Invalid firmware |
| l | Red | Off | The X2X Link supply is within the valid limits | |
| | | On | The X2X Link supply for the power supply is overloaded | |

9.27.5.6 Pinout

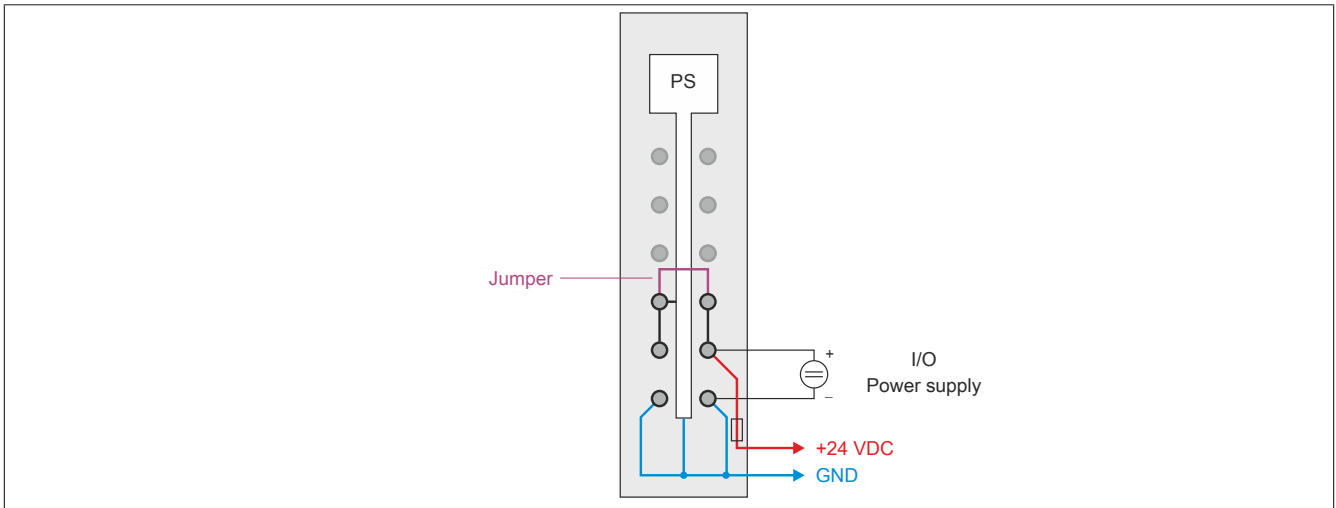


9.27.5.7 Connection examples

With 2 separate supplies

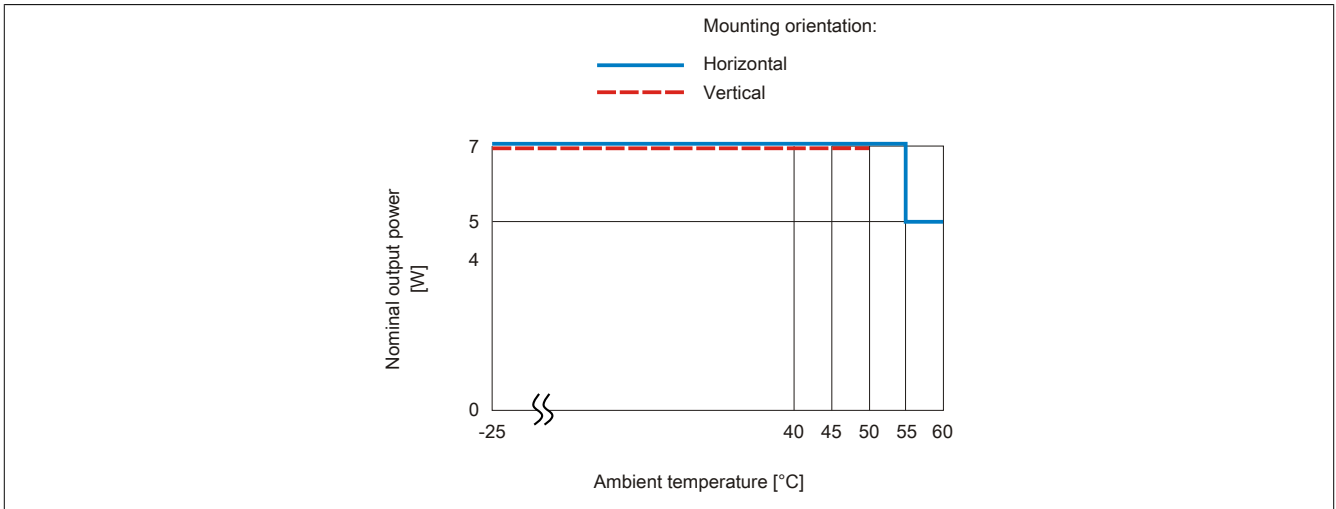


With a supply and jumper



9.27.5.8 Derating

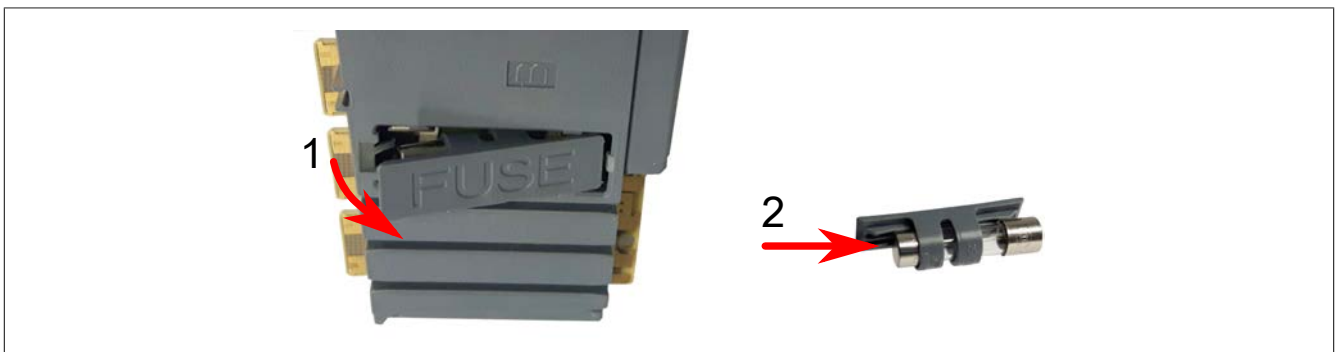
The nominal output power for the power supply is 7 W. Depending on the mounting orientation, derating must be taken into account.



9.27.5.9 Replacing the built-in fuse

The module is equipped with a 6.3 A built-in fuse. Proceed as follows to replace a defective fuse:

- 1) Remove the fuse cover with the fuse on the right side of the module using a screwdriver.
- 2) Slide the cylindrical fuse out of the fuse holder and slide the new fuse in.



9.27.5.10 Register description

9.27.5.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.27.5.10.2 Function model 0 - Standard

| Register | Fixed offset | Name | Data type | Read | | Write | |
|----------|--------------|----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 0 | 1 | Status of the module | USINT | • | | | |
| | | StatusInput01 | Bit 0 | | | | |
| | | StatusInput02 | Bit 2 | | | | |
| 2 | 2 | SupplyCurrent | USINT | • | | | |
| 4 | 3 | SupplyVoltage | USINT | • | | | |

Fixed modules require their data points to be in a specific order in the X2X frame. Cyclic access occurs according to a predefined offset, not based on the register address.

Acyclic access continues to be based on the register numbers.

9.27.5.10.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------|----------------------|----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 0 | 0 | Status of the module | UINT | • | | | |
| | | StatusInput01 | Bit 0 | | | | |
| | | StatusInput02 | Bit 2 | | | | |
| 2 | 2 | SupplyCurrent | UINT | • | | | |
| 4 | 4 | SupplyVoltage | UINT | • | | | |

1) The offset specifies the position of the register within the CAN object.

9.27.5.10.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.27.5.10.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.27.5.10.4 Status of the module

Name:

Module status

The following voltage and current states of the module are monitored in this register:

| | |
|----------------------------|--|
| Bus power supply current: | Bus power supply current >2.3 A is displayed as a warning. |
| Bus supply voltage: | Bus supply voltage <4.7 V is displayed as a warning. |
| 24 VDC I/O supply voltage: | I/O supply voltage <20.4 V is displayed as a warning. |

| Function model | Data type | Values |
|----------------------|-----------|------------------------|
| 0 - Standard | USINT | See the bit structure. |
| 254 - Bus controller | UINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---------------|-------|---|
| 0 | StatusInput01 | 0 | No error |
| | | 1 | Warning in the event of overcurrent (>2.3 A) or undervoltage (<4.7 V) |
| 1 | Reserved | 0 | |
| 2 | StatusInput02 | 0 | I/O power supply above the warning limit of 20.4 V |
| | | 1 | I/O power supply below the warning limit of 20.4 V |
| 3 - x | Reserved | 0 | |

9.27.5.10.5 Bus power supply current

Name:

SupplyCurrent

This register displays the bus power supply current measured at a resolution of 0.1 A.

| Function model | Data type |
|----------------------|-----------|
| 0 - Standard | USINT |
| 254 - Bus controller | UINT |

9.27.5.10.6 Bus supply voltage

Name:

SupplyVoltage

This register indicates the bus supply voltage measured at a resolution of 0.1 V.

| Function model | Data type |
|----------------------|-----------|
| 0 - Standard | USINT |
| 254 - Bus controller | UINT |

9.27.5.10.7 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 100 μ s |

9.27.5.10.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 2 ms |

9.28 reACTION I/O modules

A number of I/O modules are available featuring ultrafast reACTION technology. This allows the I/O channels integrated in the reACTION module to be controlled with response times down to 1 μ s. This new approach allows extremely time-critical subprocesses to be managed using standard hardware – which lowers hardware costs by reducing the load on the controller and allowing it to be scaled down.

All of the commands that can be used for reACTION programs are provided as function blocks in special libraries (e.g. AsIORTI). Programming using the standard Function Block Diagram (FBD) editor in Automation Studio is compliant with IEC 61131-3.

Documentation for reACTION technology is included in the Automation Studio help system.



9.28.1 Summary

| Model number | Short description | Page |
|---------------|---|------|
| X20CP1381-RT | X20 CPU, with integrated I/O, x86-200, 128 MB DDR3 RAM, 16 kB FRAM, 1 GB onboard flash drive, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 CAN bus interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, reACTION Technology, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 μ s, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μ s, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs \pm 10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included | 3382 |
| X20CP1382-RT | X20 CPU, with integrated I/O, x86-400, 256 MB DDR3 RAM, 32 kB FRAM, 2 GB onboard flash drive, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 CAN bus interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, reACTION Technology, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 μ s, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μ s, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs \pm 10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included | 3382 |
| X20RT8001 | X20 reACTION module, 4 digital inputs, 24 VDC, <1 μ s, 4 digital channels, 24 VDC, 0.1 A, <1 μ s, configurable as inputs or outputs, reACTION Technology module | 3448 |
| X20RT8201 | X20 reACTION module, 4 digital inputs, 24 VDC, <1 μ s, 4 digital channels, 24 VDC, 0.1 A, <1 μ s, configurable as inputs or outputs, 2 analog inputs \pm 10 V, 500 kHz sampling frequency, 13-bit converter resolution including sign, configurable input filter, reACTION Technology module | 3477 |
| X20RT8202 | X20 reACTION module, 4 digital inputs, 24 VDC, <1 μ s, 4 digital channels, 24 VDC, 0.1 A, <1 μ s, configurable as inputs or outputs, 2 analog outputs \pm 10 V, 2 μ s, 13-bit converter resolution including sign, reACTION Technology module | 3511 |
| X20RT8381 | X20 reACTION module, real computing function, 4 digital inputs, 24 VDC, <1 μ s, 4 digital channels, 24 VDC, 0.1 A, <1 μ s, configurable as inputs or outputs, 2 analog inputs \pm 10 V, 500 kHz sampling frequency, 13-bit converter resolution including sign, configurable input filter, 1 analog output \pm 10 V, 2 μ s, 13-bit converter resolution including sign, reACTION Technology module | 3543 |
| X20RT8401 | X20 reACTION module, 4 digital inputs, 24 VDC, <1 μ s, 4 digital channels, 24 VDC, 0.1 A, <1 μ s, configurable as inputs or outputs, 1 analog input \pm 10 V, 500 kHz sampling frequency, 13-bit converter resolution including sign, configurable input filter, 1 analog output \pm 10 V, 2 μ s, 13-bit converter resolution including sign, reACTION Technology module | 3577 |
| X20cCP1382-RT | X20 CPU, coated with integrated I/O, x86-400, 256 MB DDR3 RAM, 32 kB FRAM, 2 GB flash drive on board, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 CAN bus interface, 1 POWERLINK interface, 1 Ethernet interface 10/100 Base-T, reACTION Technology, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 μ s, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μ s, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs \pm 10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, including supply module, 3x X20TB1F terminal blocks, slot cover and X20AC0SR1 end cover plate (right) included | 3382 |

9.28.2 X20CP1381-RT and X20(c)CP1382-RT

Data sheet version: 1.23

9.28.2.1 General information

Compact CPUs are available with processor speeds of 200 MHz and 400 MHz. Depending on the variant, up to 256 MB RAM and up to 32 kB nonvolatile onboard RAM is available. A built-in flash drive is available to store up to 2 GB of application and other data.

These CPUs come equipped with POWERLINK, Ethernet, CAN bus, 2x USB and one RS232 interface. If additional fieldbus connections are needed, the CPU can be upgraded with an interface module from the standard X20 product range. These CPUs do not require fans or batteries and are therefore maintenance-free. 30 different digital inputs and outputs and 2 analog inputs are integrated in the devices. 1 analog input can be used for PT1000 resistance temperature measurement.

The CPUs are equipped with the new, ultrafast reACTION Technology. All integrated I/O channels are reACTION-capable and can be operated by the reACTION program. These I/O channels are controlled with a response time up to 1 μ s. All of the commands that can be used for reACTION programs are provided as function blocks in special libraries (e.g. AsIORTI). Programming using the standard Function Block Diagram (FBD) editor in Automation Studio is compliant with IEC 61131-3.

- CPU is Intel x86 200/400 MHz compatible with integrated I/O processor
- Ethernet, POWERLINK with poll-response chaining and USB onboard
- 1 slot for modular interface expansion
- Onboard reACTION Technology
- 30 digital inputs/outputs and 2 analog inputs integrated in the device
- 1/2 GB flash drive onboard
- 128/256 MB DDR3 SDRAM
- Fanless
- No battery
- Battery-backed real-time clock



9.28.2.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.28.2.3 Order data



| Model number | Short description |
|---------------|---|
| | X20 CPUs |
| X20CP1381-RT | X20 CPU, with integrated I/O, x86-200, 128 MB DDR3 RAM, 16 kB FRAM, 1 GB onboard flash drive, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 CAN bus interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, reACTION Technology, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 μ s, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μ s, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs \pm 10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included |
| X20CP1382-RT | X20 CPU, with integrated I/O, x86-400, 256 MB DDR3 RAM, 32 kB FRAM, 2 GB onboard flash drive, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 CAN bus interface, 1 POWERLINK interface, 1 Ethernet interface 10/100BASE-T, reACTION Technology, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 μ s, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μ s, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs \pm 10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, includes power supply module, 3x terminal block X20TB1F, slot cover and X20 end cover plate X20AC0SR1 (right) included |
| X20cCP1382-RT | X20 CPU, coated with integrated I/O, x86-400, 256 MB DDR3 RAM, 32 kB FRAM, 2 GB flash drive on board, 1 insert slot for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 CAN bus interface, 1 POWERLINK interface, 1 Ethernet interface 10/100 Base-T, reACTION Technology, 14 digital inputs, 24 VDC, sink, 4 digital inputs, 2 μ s, 24 VDC, sink, 4 digital outputs, 24 VDC, 0.5 A, source, 4 digital outputs, 2 μ s, 24 VDC, 0.2 A, 4 digital inputs/outputs, 24 VDC, 0.5 A, 2 analog inputs \pm 10 V or 0 to 20 mA / 4 to 20 mA, 1 PT1000 instead of an analog input, including supply module, 3x X20TB1F terminal blocks, slot cover and X20AC0SR1 end cover plate (right) included |

Table 583: Order data

Content of delivery

| Model number | Quantity | Short description |
|--------------|----------|--|
| - | 1 | Interface module slot cover |
| X20AC0SR1 | 1 | X20 end cover plate, right |
| X20TB1F | 3 | X20 terminal block, 16-pin, 24 VDC keyed |

Table 584: Content of delivery

9.28.2.4 Technical data

| Model number | X20CP1381-RT | X20CP1382-RT | X20cCP1382-RT |
|--|--|--------------|---------------|
| Short description | | | |
| Interfaces | 1x RS232, 1x Ethernet, 1x POWERLINK, 2x USB, 1x X2X Link, 1x CAN bus | | |
| System module | CPU | | |
| General information | | | |
| Cooling | Fanless | | |
| B&R ID code | 0xE35D | 0xE35E | 0xE707 |
| Status indicators | CPU function, Ethernet, POWERLINK, RS232, CAN bus, CAN bus terminating resistor, CPU supply, I/O power supply, I/O function per channel | | |
| Diagnostics | | | |
| Outputs | Digital outputs: Yes, using status LED and software (output error status) | | |
| CPU function | Yes, using status LED | | |
| CAN bus data transfer | Yes, using status LED | | |
| RS232 data transfer | Yes, using status LED | | |
| Inputs | Analog inputs: Yes, using status LED and software | | |
| Ethernet | Yes, using status LED | | |
| I/O power supply | Yes, using status LED | | |
| POWERLINK | Yes, using status LED | | |
| Supply voltage monitoring | Yes, using status LED | | |
| Overtemperature | Yes, using software | | |
| Terminating resistor | Yes, using status LED | | |
| Controller redundancy possible | No | | |
| ACOPOS support | Yes | | |
| reACTION-capable I/O channels | Yes | | |
| Visual Components support | Yes | | |
| Power consumption without interface module and USB | 5.1 W | 5.8 W | |
| Power consumption for X2X Link power supply ¹⁾ | 0.8 W | | |
| Power consumption ¹⁾ | 0.8 W | | |
| Internal I/O | 0.8 W | | |
| Additional power dissipation caused by actuators (resistive) [W] | - | | |
| Type of signal lines | Shielded cables must be used for all high-speed digital inputs/outputs, cable length: max. 20 m | | |
| Certifications | | | |
| CE | Yes | | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | | |
| UL | cULus E115267 Industrial control equipment | | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | | |
| KR | Yes | | |
| EAC | Yes | | |
| CPU and X2X Link power supply | | | |
| Input voltage | 24 VDC -15% / +20% | | |
| Input current | Max. 1 A | | |
| Fuse | Integrated, cannot be replaced | | |
| Reverse polarity protection | Yes | | |
| X2X Link power supply output | | | |
| Nominal output power | 2 W | | |
| Parallel connection | Yes ²⁾ | | |
| Redundant operation | Yes ³⁾ | | |
| Input I/O power supply | | | |
| Input voltage | 24 VDC -15% / +20% | | |
| Fuse | Required line fuse: Max. 10 A, slow-blow | | |
| Output I/O power supply | | | |
| Nominal output voltage | 24 VDC | | |
| Permissible contact load | 10 A | | |
| Controller | | | |
| Real-time clock | Buffering for at least 300 hours, typ. 1000 hours at 25°C, 1 s resolution, -18 to 28 ppm accuracy at 25°C | | |
| FPU | Yes | | |

Table 585: Technical data

| Model number | X20CP1381-RT | X20CP1382-RT | X20cCP1382-RT |
|--------------------------------|--|---|---------------|
| Processor | | | |
| Type | Vx86EX | | |
| Clock frequency | 200 MHz | 400 MHz | |
| L1 cache | | | |
| Data code | 16 kB | | |
| Program code | 16 kB | | |
| L2 cache | 128 kB | | |
| Integrated I/O processor | Processes I/O data points in the background | | |
| Modular interface slots | 1 | | |
| Remanent variables | 16 kB FRAM, buffering >10 years ⁴⁾ | 32 kB FRAM, buffering >10 years ⁴⁾ | |
| Shortest task class cycle time | 2 ms | 1 ms | |
| Typical instruction cycle time | 0.0419 µs | 0.0199 µs | |
| Standard memory | | | |
| RAM | 128 MB DDR3 SDRAM | 256 MB DDR3 SDRAM | |
| Application memory | | | |
| Type | 1 GB eMMC flash memory | 2 GB eMMC flash memory | |
| Data retention | 10 years | | |
| Writable data amount | | | |
| Guaranteed | 40 TB | | |
| Results for 5 years | 21.9 GB/day | | |
| Guaranteed erase/write cycles | 20,000 | | |
| Error-correcting code (ECC) | Yes | | |
| Interfaces | | | |
| Interface IF1 | | | |
| Signal | RS232 | | |
| Variant | Connection made using 16-pin X20TB1F terminal block | | |
| Max. distance | 900 m | | |
| Transfer rate | Max. 115.2 kbit/s | | |
| Interface IF2 | | | |
| Signal | Ethernet | | |
| Variant | 1x RJ45 shielded | | |
| Cable length | Max. 100 m between 2 stations (segment length) | | |
| Transfer rate | 10/100 Mbit/s | | |
| Transfer | | | |
| Physical layer | 10BASE-T/100BASE-TX | | |
| Half-duplex | Yes | | |
| Full-duplex | Yes | | |
| Autonegotiation | Yes | | |
| Auto-MDI/MDIX | Yes | | |
| Interface IF3 | | | |
| Fieldbus | POWERLINK managing or controlled node | | |
| Type | Type 4 ⁵⁾ | | |
| Variant | 1x RJ45 shielded | | |
| Cable length | Max. 100 m between 2 stations (segment length) | | |
| Transfer rate | 100 Mbit/s | | |
| Transfer | | | |
| Physical layer | 100BASE-TX | | |
| Half-duplex | Yes | | |
| Full-duplex | POWERLINK mode: No / Ethernet mode: Yes | | |
| Autonegotiation | Yes | | |
| Auto-MDI/MDIX | Yes | | |
| Interface IF4 | | | |
| Type | USB 1.1/2.0 | | |
| Variant | Type A | | |
| Max. output current | 0.5 A | | |
| Interface IF5 | | | |
| Type | USB 1.1/2.0 | | |
| Variant | Type A | | |
| Max. output current | 0.1 A | | |
| Interface IF6 | | | |
| Fieldbus | X2X Link master | | |
| Interface IF7 | | | |
| Signal | CAN bus | | |
| Variant | Connection made using 16-pin X20TB1F terminal block | | |
| Max. distance | 1000 m | | |
| Transfer rate | Max. 1 Mbit/s | | |
| Terminating resistor | Integrated in the module | | |
| Controller | SJA 1000 | | |
| Digital inputs | | | |
| Quantity | 14 standard inputs, 4 high-speed inputs and 4 mixed channels, configurable as inputs or outputs using software | | |
| Nominal voltage | 24 VDC | | |

Table 585: Technical data

| Model number | X20CP1381-RT | X20CP1382-RT | X20cCP1382-RT |
|--|--------------|---|---------------|
| Input voltage | | 24 VDC -15% / +20% | |
| Input current at 24 VDC | | X1 - Standard inputs: Typ. 3.5 mA X2 - Standard inputs: Typ. 2.68 mA X2 - High-speed inputs: Typ. 3.5 mA X3 - Mixed channels: Typ. 2.68 mA | |
| Input circuit | | Sink | |
| Input filter | | | |
| Hardware | | Standard inputs and mixed channels: ≤200 μs High-speed inputs: ≤2 μs, when used as standard inputs: ≤200 μs | |
| Software | | Default 1 ms, configurable between 0 and 25 ms in 0.1 ms intervals | |
| Connection type | | 1-wire connections | |
| Input resistance | | X1 - Standard inputs: 6.8 kΩ X2 - Standard inputs: 8.9 kΩ X2 - High-speed inputs: 6.8 kΩ X3 - Mixed channels: 8.9 kΩ | |
| Additional functions | | X2 - High-speed digital inputs: 2x 250 kHz event counting, 2x AB counter, ABR incremental encoder, direction/frequency, period measurement, gate measurement, differential time measurement, edge counters, edge times | |
| Switching threshold | | | |
| Low | | <5 VDC | |
| High | | >15 VDC | |
| AB incremental encoder | | | |
| Quantity | | 2 | |
| Encoder inputs | | 24 V, asymmetrical | |
| Counter size | | 32-bit | |
| Input frequency | | Max. 100 kHz | |
| Evaluation | | 4x | |
| Encoder power supply | | Module-internal, max. 300 mA | |
| Overload characteristics of encoder power supply | | Short circuit protection, overload protection | |
| ABR incremental encoder | | | |
| Quantity | | 1 | |
| Encoder inputs | | 24 V, asymmetrical | |
| Counter size | | 32-bit | |
| Input frequency | | Max. 100 kHz | |
| Evaluation | | 4x | |
| Encoder power supply | | Module-internal, max. 300 mA | |
| Overload characteristics of encoder power supply | | Short circuit protection, overload protection | |
| Event counters | | | |
| Quantity | | 2 | |
| Signal form | | Square wave pulse | |
| Evaluation | | 1x | |
| Input frequency | | Max. 250 kHz | |
| Counter frequency | | 250 kHz | |
| Counter size | | 32-bit | |
| Edge detection / Time measurement | | | |
| Possible measurements | | Period measurement, gate measurement, differential time measurement, edge counter, edge times | |
| Measurements per module | | Each function up to 2x | |
| Counter size | | 32-bit | |
| Input frequency | | Max. 10 kHz | |
| Timestamp | | 1 μs resolution | |
| Signal form | | Square wave pulse | |
| Analog inputs | | | |
| Input | | ±10 V or 0 to 20 mA / 4 to 20 mA, via different terminal connections | |
| Input type | | Differential input | |
| Digital converter resolution | | | |
| Voltage | | ±12-bit | |
| Current | | 12-bit | |
| Conversion time | | 1 channel enabled: 100 μs 2 channels enabled: 200 μs | |
| Output format | | | |
| Data type | | INT | |
| Voltage | | INT 0x8001 - 0x7FFF / 1 LSB = 0x0008 = 2.441 mV | |
| Current | | INT 0x0000 - 0x7FFF / 1 LSB = 0x0008 = 4.883 μA | |
| Input impedance in signal range | | | |
| Voltage | | 20 MΩ | |
| Current | | - | |
| Load | | | |
| Voltage | | - | |
| Current | | <300 Ω | |
| Input protection | | Protection against wiring with supply voltage | |
| Permissible input signal | | | |
| Voltage | | Max. ±30 V | |
| Current | | Max. ±50 mA | |
| Output of digital value during overload | | Configurable | |

Table 585: Technical data

| Model number | X20CP1381-RT | X20CP1382-RT | X20cCP1382-RT |
|---|--|--------------|---------------|
| Conversion procedure | SAR | | |
| Input filter | 3rd-order low pass / cutoff frequency 1 kHz | | |
| Max. error at 25°C | | | |
| Voltage | | | |
| Gain | 0.18% (Rev. <C0: 0.37%) ⁶⁾ | | |
| Offset | 0.04% (Rev. <C0: 0.25%) ⁷⁾ | | |
| Current | | | |
| Gain | 0 to 20 mA = 0.15% (Rev. <C0: 0.52%) / 4 to 20 mA = 0.25% ⁶⁾ | | |
| Offset | 0 to 20 mA = 0.1% (Rev. <C0: 0.4%) / 4 to 20 mA = 0.15% ⁸⁾ | | |
| Max. gain drift | | | |
| Voltage | 0.017 %/°C ⁶⁾ | | |
| Current | 0 to 20 mA = 0.015 %/°C / 4 to 20 mA = 0.023 %/°C ⁶⁾ | | |
| Max. offset drift | | | |
| Voltage | 0.008 %/°C ⁷⁾ | | |
| Current | 0 to 20 mA = 0.008 %/°C / 4 to 20 mA = 0.012 %/°C ⁸⁾ | | |
| Common-mode rejection | | | |
| DC | 70 dB | | |
| 50 Hz | 70 dB | | |
| Common-mode range | ±12 V | | |
| Crosstalk between channels | <-70 dB | | |
| Nonlinearity | | | |
| Voltage | <0.025% ⁷⁾ | | |
| Current | <0.05% ⁸⁾ | | |
| Resistance measurement temperature inputs | | | |
| Quantity | 1 | | |
| Input | Resistance measurement with constant current supply for 2-wire connections | | |
| Digital converter resolution | 13-bit | | |
| Conversion time | Only temperature input enabled: 200 µs Temperature and analog input enabled: 400 µs | | |
| Conversion procedure | SAR | | |
| Output format | INT or UINT for resistance measurement | | |
| Sensor | | | |
| PT1000 | -200 to 850°C | | |
| Resistance measurement range | 0.1 to 4000 Ω | | |
| Temperature sensor resolution | 1 LSB = 0x0005 = 0.16°C | | |
| Resistance measurement resolution | 1 LSB = 0x0005 = 0.49 Ω | | |
| Input filter | 1st-order low pass / cutoff frequency 7 Hz | | |
| Sensor standard | EN 60751 | | |
| Common-mode range | 1 V | | |
| Linearization method | Internal | | |
| Measurement current | 1 mA | | |
| Permissible input signal | Short-term max. ±30 V | | |
| Max. error at 25°C | | | |
| Gain | 0.3% (Rev. <C0: 1.93%) ⁹⁾ | | |
| Offset | 0.15% (Rev. <C0: 0.32%) ¹⁰⁾ | | |
| Max. gain drift | 0.023 %/°C ⁹⁾ | | |
| Max. offset drift | 0.012%/°C ¹⁰⁾ | | |
| Nonlinearity | <0.05% ¹⁰⁾ | | |
| Standardized range of values for resistance measurement | 0.1 to 4000.0 Ω | | |
| Crosstalk between channels | <-70 dB | | |
| Common-mode rejection | | | |
| 50 Hz | >60 dB | | |
| DC | - | | |
| Temperature sensor normalization | | | |
| PT1000 | -200 to 850°C | | |
| Digital outputs | | | |
| Quantity | 4 standard outputs, 4 high-speed outputs and 4 mixed channels, configurable as inputs or outputs using software | | |
| Variants | Standard outputs and mixed channels: FET positive switching High-speed outputs: Push-Pull | | |
| Nominal voltage | 24 VDC | | |
| Switching voltage | 24 VDC -15% / +20% | | |
| Nominal output current | Standard outputs and mixed channels: 0.5 A High-speed outputs: 0.2 A | | |
| Total nominal current | Standard outputs and mixed channels: 4 A High-speed outputs: 0.8 A | | |
| Connection type | 1-wire connections | | |
| Output circuit | Standard outputs and mixed channels: Source High-speed outputs: Sink or source | | |
| Output protection ¹¹⁾ | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short circuit current") Internal inverse diode for switching inductive loads (see section "Switching inductive loads") | | |

Table 585: Technical data

| Model number | X20CP1381-RT | X20CP1382-RT | X20cCP1382-RT |
|---|---|------------------------|---------------|
| Pulse width modulation ¹²⁾ | | | |
| Period duration | 5 to 65535 µs corresponds to 200 kHz to 15 Hz | | |
| Pulse duration | 0 to 100%, minimum 2.5 µs | | |
| Resolution for pulse duration | 0.1% of the configured frequency | | |
| Diagnostic status | Standard outputs and mixed channels: Output monitoring with 10 ms delay High-speed outputs: Output monitoring with 10 µs delay | | |
| Leakage current when the power is switched off | Standard outputs and mixed channels: 5 µA High-speed outputs: 25 µA | | |
| R _{DS(on)} | 140 mΩ ¹³⁾ | | |
| Residual voltage | Standard outputs and mixed channels: <0.1 V at 0.5 A rated current High-speed outputs: <0.9 V at 0.1 A rated current | | |
| Peak short-circuit current | Standard outputs and mixed channels: <3 A High-speed outputs: <20 A | | |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Standard outputs and mixed channels: Approx. 10 ms (depends on module temperature) High-speed outputs: No switch on | | |
| Switching delay | | | |
| 0 → 1 | Standard outputs and mixed channels: <300 µs High-speed outputs: <3 µs | | |
| 1 → 0 | Standard outputs and mixed channels: <300 µs High-speed outputs: <3 µs | | |
| Switching frequency | | | |
| Resistive load ¹⁴⁾ | Standard outputs and mixed channels: Max. 500 Hz High-speed outputs: 50 kHz, max. 200 kHz (see section "Switching frequency derating for high-speed digital outputs") | | |
| Inductive load | See section "Switching inductive loads" | | |
| Braking voltage when switching off inductive loads | Standard outputs and mixed channels: Typ. 45 VDC | | |
| Electrical properties | | | |
| Electrical isolation | Ethernet (IF2), POWERLINK (IF3) and X2X (IF6) isolated from each other, from other interfaces and from PLC Channel isolated from bus Channel not isolated from channel or PLC | | |
| Operating conditions | | | |
| Mounting orientation | | | |
| Horizontal | Yes | | |
| Vertical | Yes | | |
| Installation elevation above sea level | | | |
| 0 to 2000 m | No limitations | | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | | |
| Degree of protection per EN 60529 | IP20 | | |
| Ambient conditions | | | |
| Temperature | | | |
| Operation | | | |
| Horizontal mounting orientation | -25 to 60°C | | |
| Vertical mounting orientation | -25 to 50°C | | |
| Derating | See section "Switching frequency derating for high-speed digital outputs". | | |
| Storage | -40 to 85°C | | |
| Transport | -40 to 85°C | | |
| Relative humidity | | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing | |
| Storage | 5 to 95%, non-condensing | | |
| Transport | 5 to 95%, non-condensing | | |
| Mechanical properties | | | |
| Note | X20 end cover plate (right) included in delivery 3 X20 terminal blocks (16-pin) included in delivery Interface module slot cover included in delivery | | |
| Dimensions | | | |
| Width | 164 mm | | |
| Height | 99 mm | | |
| Depth | 75 mm | | |
| Weight | 310 g | | |

Table 585: Technical data

- 1) The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.
- 2) When operated in parallel, the nominal power of 2 W is not permitted to be added to the total power.
- 3) Up to 2 W bus load.
- 4) The size of the memory used for remanent variables is adjustable in Automation Studio.
- 5) See Automation Help under "Communication / POWERLINK / General information / Hardware - IF/LS" for more information.
- 6) Based on the current measured value.
- 7) Based on the 20 V measurement range.
- 8) Based on the 20 mA measurement range.
- 9) Based on the current resistance value.
- 10) Based on the entire resistance measurement range.
- 11) For high-speed digital outputs, derating must be applied at switching frequencies >50 kHz (see section "Switching frequency derating for high-speed digital outputs"). Overtemperature protection is not provided.

- 12) The high-speed digital outputs can be used for pulse width modulation.
 13) Only for standard outputs and mixed channels.
 14) Standard outputs and mixed channels: At loads $\leq 1\text{ k}\Omega$

9.28.2.5 LED status indicators

9.28.2.5.1 Slot X1


| Figure | LED | Color | Status | Description |
|---|---------|-----------|---------------------|---|
|  | E | Red | On | Operating mode SERVICE ¹⁾ or BOOT ¹⁾ |
| | | | Blinking | The "E" LED blinks red and the "RF" LED blinks yellow when there is a license violation. |
| | | | Double flash | Firmware update ²⁾ |
| | R | Green | On | Application running |
| | | | Blinking | System startup: The CPU is initializing the application, all bus systems and I/O modules. ²⁾ |
| | | Red | On | During reset |
| | RF | Yellow | On | Operating mode SERVICE ¹⁾ or BOOT ¹⁾ |
| | | | Blinking | The "RF" LED blinks yellow and the "E" LED blinks red when there is a license violation. |
| | SE | Green/Red | | Status/Error LED. LED states are described in section "LED "S/E" (LED "Status/Error")" on page 3388. |
| | ET | Green | On | A link to the Ethernet remote station has been established. |
| | | | Blinking | A link to the Ethernet remote station has been established. The LED blinks when Ethernet activity is taking place on the bus. |
| | PL | Green | On | A link to the POWERLINK peer station has been established. |
| | | | Blinking | A link to the POWERLINK peer station has been established. The LED blinks when Ethernet activity is taking place on the bus. |
| | A1 - A2 | Green | Off | Open circuit or disconnected sensor |
| | | | Blinking | Input signal overflow or underflow |
| | | | On | Analog/digital converter running, value OK |
| | 1 - 4 | Green | | Input state of the corresponding digital input |
| | C | Yellow | On | CPU transmitting or receiving data via the CAN bus interface |
| | S | Yellow | On | CPU transmitting or receiving data via the RS232 interface |
| | T | Yellow | On | The terminating resistor integrated in the CPU is switched on. |
| DC | Yellow | On | CPU power supply OK | |

Table 586: LED status indicators on the integrated X1 I/O slot

- 1) The operating states are described in Automation Help under "Real-time operating system - Method of operation - Operating states".
 2) The process can take several minutes depending on the configuration.

9.28.2.5.1.1 LED "S/E" (LED "Status/Error")

This LED is a green/red dual LED and indicates the state of the POWERLINK interface. The LED states have a different meaning depending on the operating mode of the POWERLINK interface.

Ethernet mode

In this mode, the interface is operated as an Ethernet interface.

| LED "S/E" | | Description |
|-----------|-----|---|
| Green | Red | |
| On | Off | The interface is operated as an Ethernet interface. |

Table: LED "S/E": Interface in Ethernet mode

POWERLINK V2 mode

Error message

| LED "S/E" | | Description |
|-----------|-----|--|
| Green | Red | |
| Off | On | The interface is in error mode (failed Ethernet frames, increased number of collisions on the network, etc.). Note: Several red blinking signals are displayed immediately after the device is switched on. These are not errors, however. |
| Blinking | On | If an error occurs in the following modes, then the green LED blinks over the red LED: <ul style="list-style-type: none"> • PRE_OPERATIONAL_1 • PRE_OPERATIONAL_2 • READY_TO_OPERATE |

Table: LED "S/E" - Error message (interface in POWERLINK mode)

Interface status

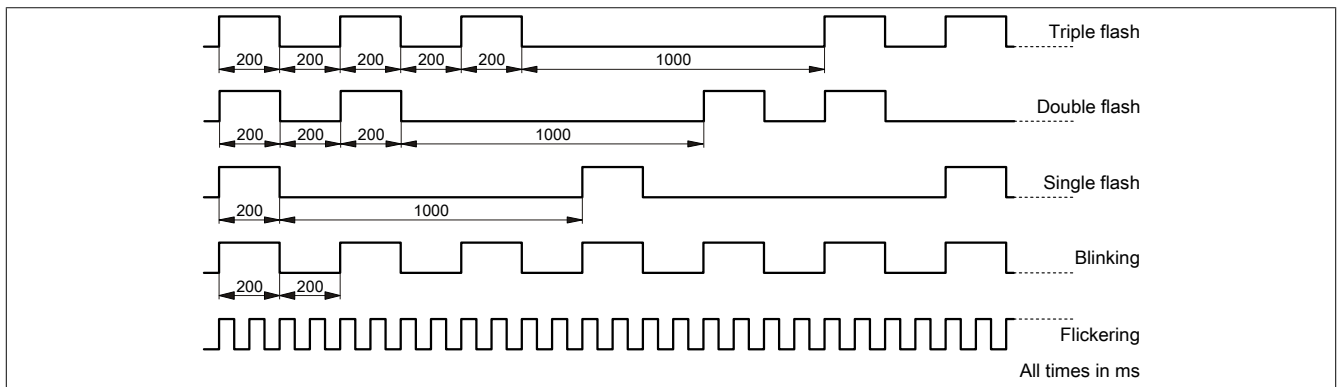
| LED "S/E" | | Description |
|--------------------------------|-----|---|
| Green | Red | |
| Off | Off | Mode: NOT_ACTIVE The interface is either in mode NOT_ACTIVE or one of the following modes or errors is present: <ul style="list-style-type: none"> • The device is switched off. • The device is in the startup phase. • The interface or device is not configured correctly in Automation Studio. • The interface or device is defective. Managing node (MN) The network is monitored for POWERLINK frames. If a frame is not received within the configured time window (timeout), the interface immediately enters mode PRE_OPERATIONAL_1. If POWERLINK communication is detected before the time has elapsed, however, the MN is not started. |
| Flickering (approx. 10 Hz) | Off | Mode: BASIC_ETHERNET The interface is in mode BASIC_ETHERNET. The interface is operated in Ethernet mode . |
| Single flash (approx. 1 Hz) | Off | Mode: PRE_OPERATIONAL_1 The interface is in mode PRE_OPERATIONAL_1. |
| | On | Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed. |
| Double flash (approx. 1 Hz) | Off | Mode: PRE_OPERATIONAL_2 The interface is in mode PRE_OPERATIONAL_2. |
| | On | Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed. |

Table: LED "S/E" - Interface state (interface in POWERLINK mode)

| LED "S/E" | | Description |
|--------------------------------|-----|--|
| Green | Red | |
| Triple flash (approx. 1 Hz) | Off | Mode: READY_TO_OPERATE The interface is in mode READY_TO_OPERATE. Managing node (MN) Cyclic and asynchronous communication. Received PDO data is ignored. Controlled node (CN) The configuration of the CN is completed. Normal cyclic and asynchronous communication. The transmitted PDO data corresponds to the PDO mapping. However, cyclic data is not yet evaluated. |
| | On | Controlled node (CN) If the red LED lights up in this mode, this means that the MN has failed. |
| On | Off | Mode: OPERATIONAL The interface is in mode OPERATIONAL. PDO mapping is active and cyclic data is evaluated. |
| Blinking (approx. 2.5 Hz) | Off | Mode: STOPPED The interface is in mode STOPPED. Managing node (MN) This mode does not occur for the MN. Controlled node (CN) Output data is not being output, and no input data is being provided. This mode can only be reached and exited by a corresponding command from the MN. |

Table: LED "S/E" - Interface state (interface in POWERLINK mode)

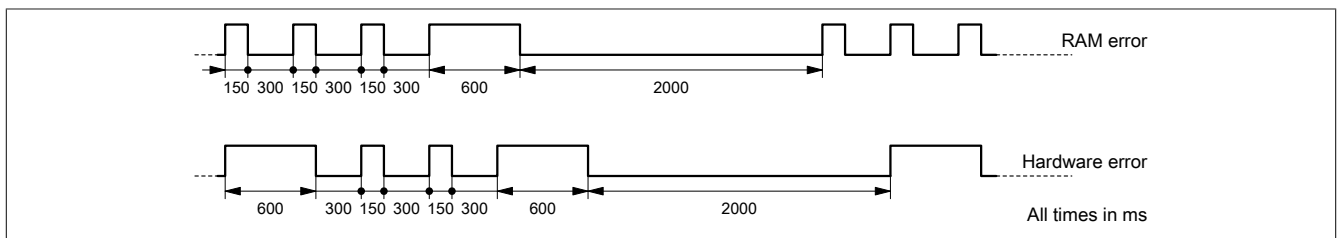
Blink times



9.28.2.5.1.2 System stop error codes

A system stop error can occur due to incorrect configuration or defective hardware.

The error code is indicated by LED "S/E" blinking red. The blinking signal of the error code consists of 4 switch-on phases with short (150 ms) or long (600 ms) duration. The error code is repeated every 2 seconds.



| Error | Error description |
|----------------|---|
| RAM error | The device is defective and must be replaced. |
| Hardware error | The device or a system component is defective and must be replaced. |

9.28.2.5.2 Slot X2


| Figure | LED | Color | Status | Description |
|---|--------|-------|--------|--|
|  | 1 - 14 | Green | | Input state of the corresponding digital input |

Table 587: LED status indicators on the integrated X2 I/O slot

9.28.2.5.3 Slot X3


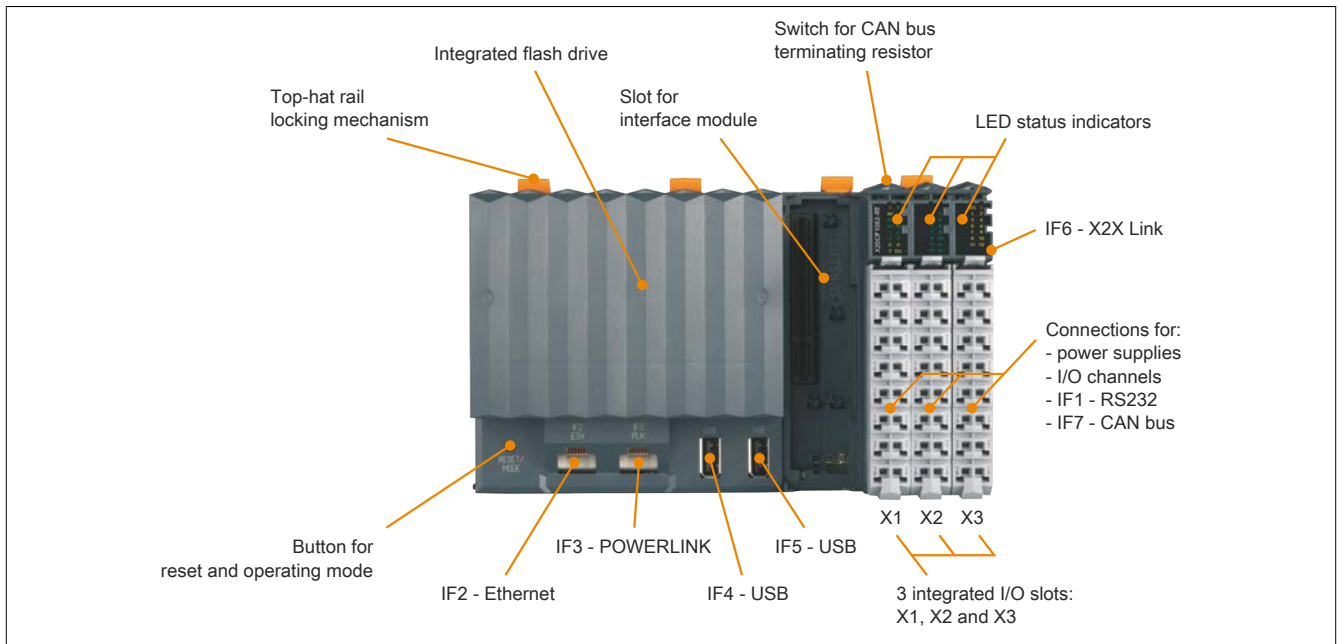
| Figure | LED | Color | Status | Description |
|---|--------|--------|--------------|---|
|  | DC | Yellow | On | I/O power supply OK |
| | E | Red | Off | Everything OK |
| | | | Double flash | No power to module |
| | 1 - 4 | Yellow | | Output status of the corresponding digital output |
| | 5 - 8 | Yellow | | Input or output status of the corresponding digital input or output |
| | 9 - 12 | Yellow | | Output status of the corresponding high-speed digital output |

Table 588: LED status indicators on the integrated X3 I/O slot

9.28.2.6 Operating and connection elements



9.28.2.6.1 Button for reset and operating mode



9.28.2.6.1.1 Reset

The button must be pressed for less than 2 seconds to trigger a reset. This triggers a hardware reset on the CPU, which means that:

- All application programs are stopped.
- All outputs are set to zero.

The controller then boots into service mode by default. The startup mode that follows after pressing the reset button can be set in Automation Studio.

- Service mode (default)
- Warm restart
- Cold restart
- Diagnostic mode

9.28.2.6.1.2 Operating mode

3 operating modes can be configured using different button sequences:

| Operating mode | Button sequence | Description |
|---------------------------|---|---|
| BOOT ¹⁾ | Boot mode is enabled by the following button sequence: <ul style="list-style-type: none"> • Press the button for less than 2 seconds. As soon as the "R" LED on the X1 I/O slot is lit RED, the button can be released. • Then press the button within 2 seconds for longer than 2 seconds. As soon as the "R" LED is no longer lit, the button can be released. | The default Automation Runtime system is started and the runtime system can be installed via the online interface (Automation Studio). User flash memory is deleted only after the download begins. |
| SERVICE/RUN ¹⁾ | Press the button for less than 2 seconds. As soon as the "R" LED on the X1 I/O slot is lit RED , the button can be released. | Mode SERVICE/RUN: Triggering and startup behavior correspond to triggering a hardware reset (see "Reset" on page 3392). |
| DIAGNOSE ¹⁾ | Press the button for more than 2 seconds. The "R" LED on the X1 I/O slot lights up RED and then goes out. As soon as the "R" LED is no longer lit, the button can be released. | Boots the CPU in diagnostic mode. Program sections in User RAM and User FlashPROM are not initialized. After diagnostic mode, the CPU always boots with a cold restart. |

1) The operating states are described in Automation Help under "Real-time operating system - Method of operation - Operating states".

9.28.2.6.2 Flash drive

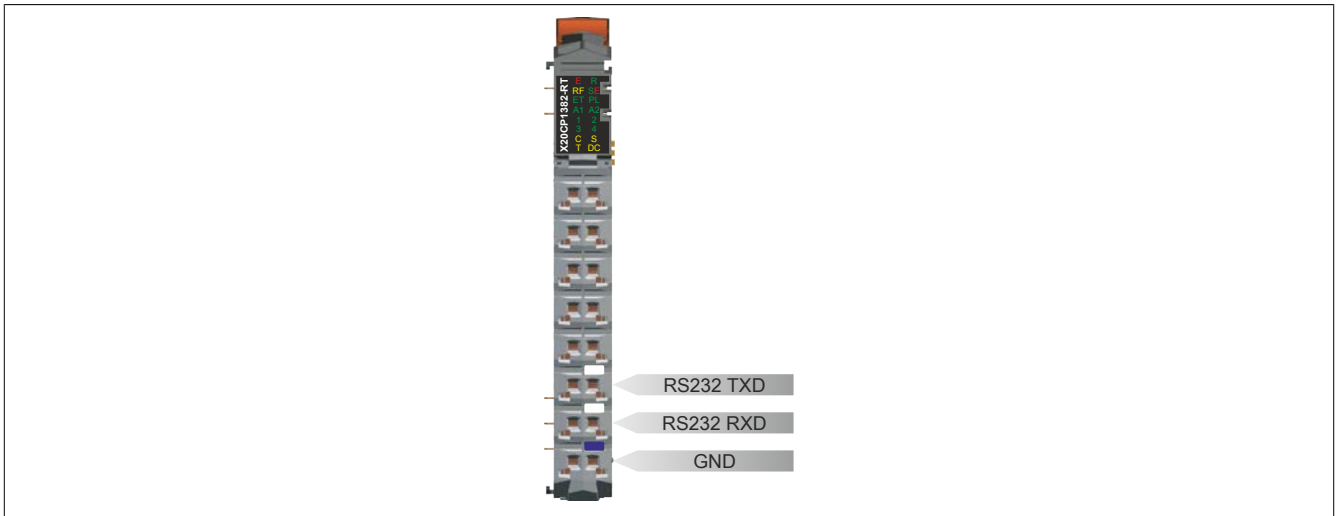
This application memory is implemented as an integrated flash drive.

9.28.2.6.3 Project installation

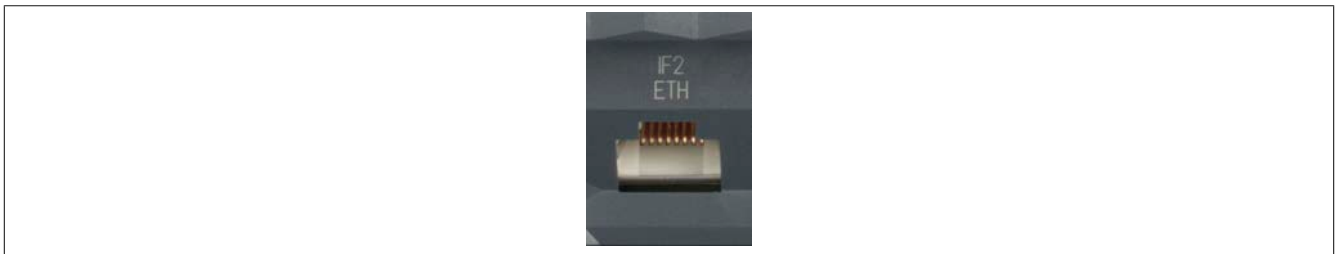
Project installation is described in Automation Help under "Project management / Project installation".

9.28.2.6.4 RS232 interface (IF1)

The non-electrically isolated RS232 interface is primarily intended to serve as an online interface for communication with the programming device. It is located on the X1 I/O slot.



9.28.2.6.5 Ethernet interface (IF2)



The IF2 interface is designed for 10BASE-T / 100BASE-TX transmission.

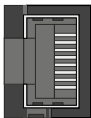
The INA2000 station number can be set using the Automation Studio software.

For information about wiring X20 modules with an Ethernet interface, see ["Cabling guidelines for X20 modules with an Ethernet cable" on page 58](#).

Information:

The Ethernet interface (IF2) is not suitable for POWERLINK (see ["POWERLINK interface \(IF3\)" on page 3394](#)).

Pinout

| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | TXD | Transmit data |
| | 2 | TXD\ | Transmit data\ |
| | 3 | RXD | Receive data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | RXD\ | Receive data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.28.2.6.6 POWERLINK interface (IF3)

The CPUs are equipped with a POWERLINK V2 interface.

POWERLINK

By default, the POWERLINK interface is operated as a managing node (MN). In the managing node, the node number is set to a fixed value of 240.

If the POWERLINK node is operated as a controlled node (CN), a node number from 1 to 239 can be set in the POWERLINK configuration in Automation Studio.

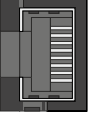
Ethernet mode

In this mode, the interface is operated as an Ethernet interface. The INA2000 station number is set using the B&R Automation Studio software.

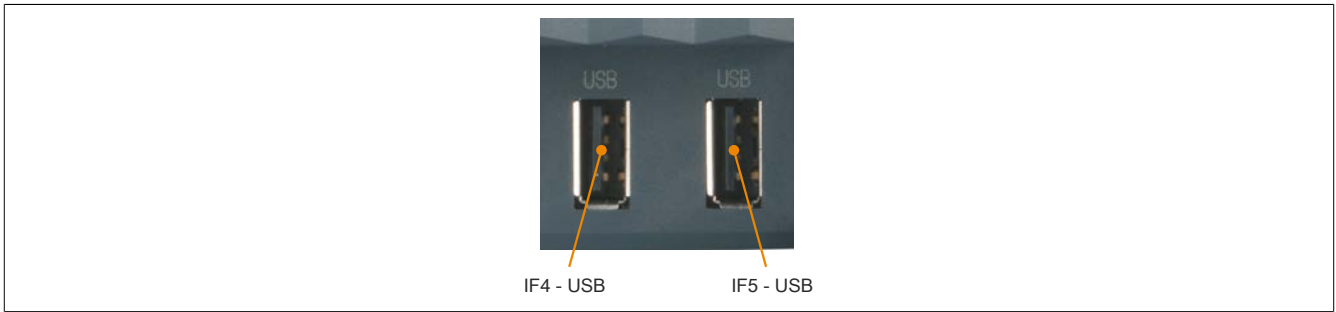
Pinout



For information about wiring X20 modules with an Ethernet interface, see ["Cabling guidelines for X20 modules with an Ethernet cable"](#) on page 58.

| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.28.2.6.7 USB interfaces (IF4 and IF5)



IF4 and IF5 are non-galvanically isolated USB interfaces. The abbreviation USB stands for "Universal Serial Bus". Both USB interfaces support the USB 1.1 and 2.0 standards.

Information:

USB peripheral devices can be connected to the USB interfaces. Due to the variety of USB devices available on the market, B&R cannot guarantee their functionality. The functionality of USB devices available from B&R is guaranteed.

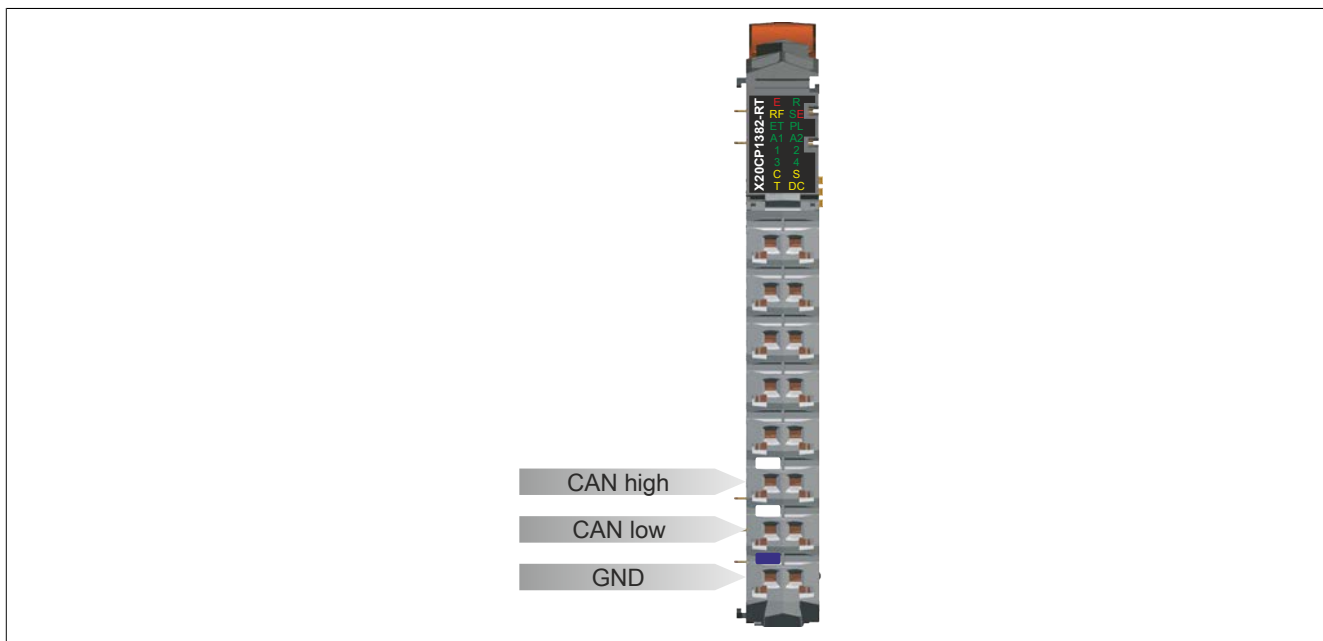
Information:

- The USB interfaces cannot be used as online communication interfaces.
- Only devices isolated from GND are permitted to be connected to the USB interfaces.
- Current-carrying capacity is listed in the technical data.

9.28.2.6.8 CAN bus interface (IF7)

The compact CPUs are equipped with a non-electrically isolated CAN bus interface. It is located on the X1 I/O slot.

9.28.2.6.8.1 Pinout



9.28.2.6.8.2 Terminating resistor

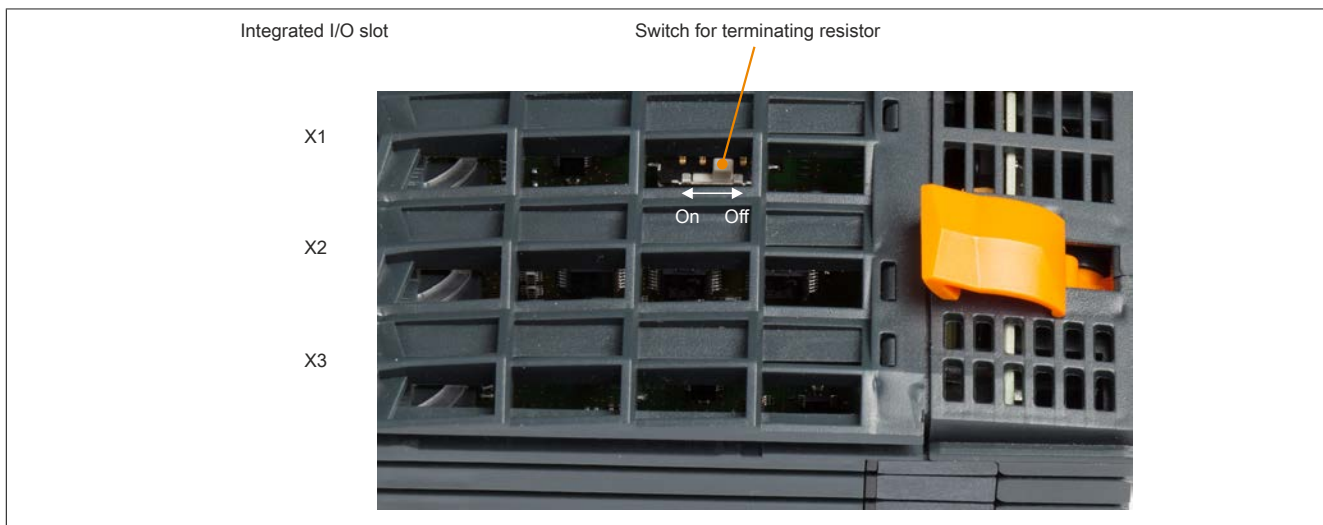


Figure 282: Switch positions for the CAN bus terminating resistor

A terminating resistor is already installed on the X1 I/O slot. It can be turned on and off with a switch on top of the housing. An active terminating resistor is indicated by the "T" LED.

9.28.2.6.9 Slot for interface modules

These CPUs are equipped with one slot for interface modules.

Various bus and network systems can easily be integrated into the X20 system by selecting the corresponding interface module.

9.28.2.6.10 Data and real-time clock retention

The CPUs do not use a battery. This makes them completely maintenance-free. The following measures make operation without a backup battery possible.

| Data and real-time clock retention | Backup type | Note |
|------------------------------------|---------------------|---|
| Remanent variables | FRAM | This FRAM stores its contents ferroelectrically. Unlike normal SRAM, this does not require a battery. |
| Real-time clock | Gold foil capacitor | The real-time clock is backed up for approx. 1000 hours @ 25°C by a gold foil capacitor. The gold foil capacitor is completely charged after 3 continuous hours of operation. |

9.28.2.7 CPU supply

A power supply is integrated in these compact CPUs. It has a feed for the CPU, X2X Link and the internal I/O power supply. The supply for the CPU and X2X Link is electrically isolated.

The connections are located on the X3 I/O slot.

Power supply concept of Compact CPUs

To ensure proper operation of compact CPUs, the following items must be taken into consideration:

| The supply concept | Description |
|-------------------------|--|
| CPU and I/O GND | The GND contact is provided 5 times on the terminal blocks of the integrated I/O slots. All GND contacts are connected to one another. The GND contacts of the CPU and I/O power supply therefore use the same voltage. |
| Plug-in X20 I/O modules | Supply of X20 I/O modules that can be connected to the compact CPU: <ul style="list-style-type: none"> X2X Link: Supplied by the CPU supply I/O channels: Supplied by the I/O power supply |
| Integrated X1 I/O slot | All digital and analog signals as well as the RS232 and CAN bus interface are supplied by the CPU supply. Their operation is therefore guaranteed even if there is no I/O power supply. |
| Integrated X2 I/O slot | <ul style="list-style-type: none"> All digital signals are supplied by the CPU supply. Their operation is therefore guaranteed even if there is no I/O power supply. The encoder supply is supplied by the I/O power supply. If the encoder is not to be connected to the E-stop chain, then it must be connected to an external power supply or it will be supplied by the CPU supply. |
| Integrated X3 I/O slot | <ul style="list-style-type: none"> All 12 digital signals are supplied by the I/O power supply. The status messages for each channel also work without an I/O power supply. This guarantees that status messages will continue to be transferred during an E-stop. The status of the I/O power supply is indicated by a separate status message. <p>Caution!</p> <p>Channels 5 to 8 are designed as mixed channels. If one of these channels is being used, it is absolutely essential to ensure that there is no external voltage present on the I/O channel when the I/O power supply is cut off. Otherwise, power will be regenerated back to the plus terminal of the I/O power supply via the I/O channel. This will result in defective components.</p> <p>The following solutions are available for preventing power regeneration from occurring:</p> <ul style="list-style-type: none"> The I/O power supply of the CPU is not permitted to be switched off, which allows the reference potential to be maintained. If the I/O power supply is switched off anyway (e.g. as part of the E-stop chain), then the sensor/actuator supplies must also be switched off. This prevents potential power regeneration and protects components from being destroyed. |

Pinout

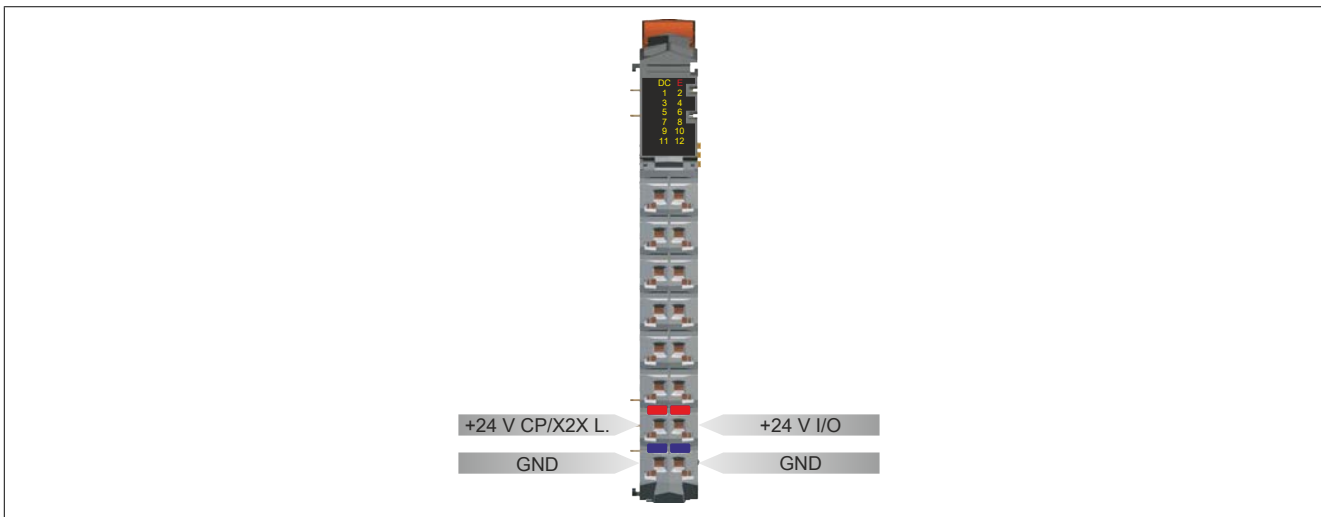


Figure 283: Integrated power supply - Pinout

Connection example

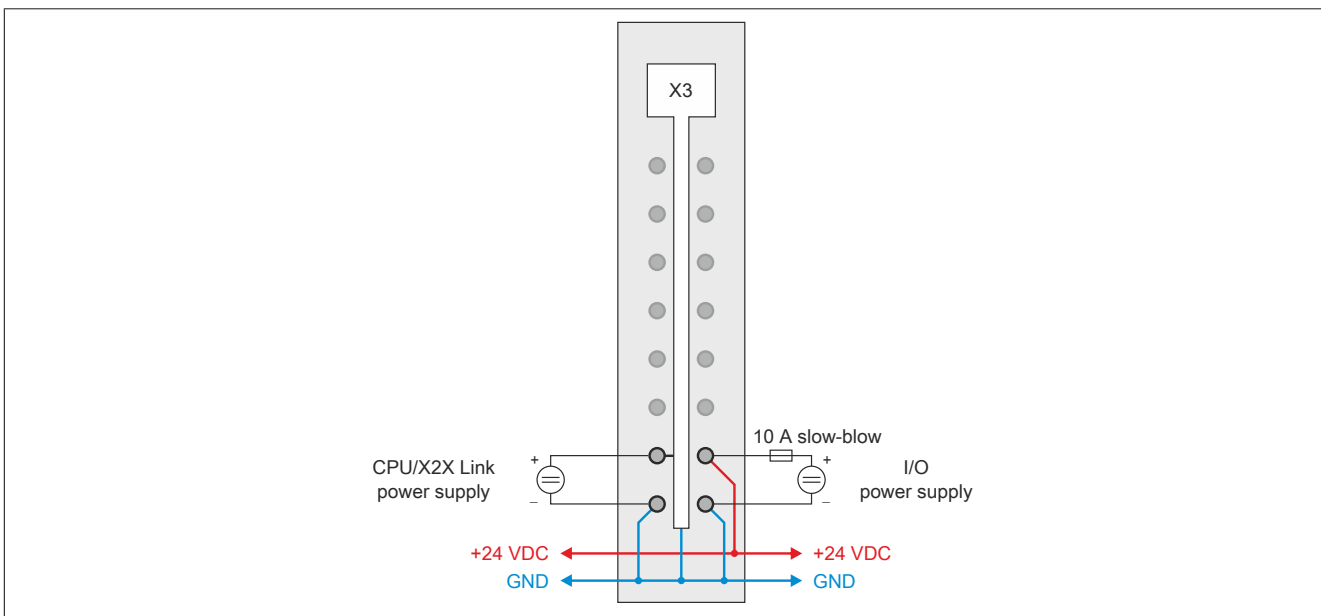


Figure 284: CPU supply - Connection example

9.28.2.8 Overtemperature cutoff

To prevent damage, a shutdown/reset is triggered on the CPU when the processor reaches 95°C.

The following errors are entered in the logbook in the event of shutdown:

| Error number | Short error text |
|--------------|--|
| 9204 | PLC restart triggered by the PLC CPU's temperature monitoring. |
| 9210 | Warning: Halt/Service after watchdog or manual reset. |

9.28.2.9 Local I/O channels

Compact CPUs are equipped with 3 integrated I/O slots. These devices have 30 digital inputs/outputs and 2 analog inputs.

Information about the functions of the high-speed digital inputs and outputs can be found in the section "[Functions of the high-speed digital inputs/outputs](#)" on page 3405.

The following table provides an overview of the connections to the I/O channels and their properties.

Digital inputs/outputs

| Connection | Terminal connection | Channel | Description |
|------------|---------------------|-------------|---|
| X1 | 14 | DI 1 | 24 VDC, sink, $\leq 200 \mu\text{s}$, configurable software filter |
| | 24 | DI 2 | 24 VDC, sink, $\leq 200 \mu\text{s}$, configurable software filter |
| | 15 | DI 3 | 24 VDC, sink, $\leq 200 \mu\text{s}$, configurable software filter |
| | 25 | DI 4 | 24 VDC, sink, $\leq 200 \mu\text{s}$, configurable software filter |
| X2 | 11 | DI 1 | 24 VDC, sink, $\leq 200 \mu\text{s}$, configurable software filter |
| | 21 | DI 2 | 24 VDC, sink, $\leq 200 \mu\text{s}$, configurable software filter |
| | ... | ... | ... |
| | 25 | DI 10 | 24 VDC, sink, $\leq 200 \mu\text{s}$, configurable software filter |
| | 16 | DI 11 | 24 VDC, sink, $\leq 2 \mu\text{s}$, configurable software filter |
| | 26 | DI 12 | 24 VDC, sink, $\leq 2 \mu\text{s}$, configurable software filter |
| | 17 | DI 13 | 24 VDC, sink, $\leq 2 \mu\text{s}$, configurable software filter |
| | 27 | DI 14 | 24 VDC, sink, $\leq 2 \mu\text{s}$, configurable software filter |
| X3 | 11 | DO 1 | 24 VDC, 0.5 A, source, $< 300 \mu\text{s}$ |
| | 21 | DO 2 | 24 VDC, 0.5 A, source, $< 300 \mu\text{s}$ |
| | 12 | DO 3 | 24 VDC, 0.5 A, source, $< 300 \mu\text{s}$ |
| | 22 | DO 4 | 24 VDC, 0.5 A, source, $< 300 \mu\text{s}$ |
| | 13 | DI 5 / DO 5 | DI: 24 VDC, sink, $\leq 200 \mu\text{s}$, configurable software filter DO: 24 VDC, 0.5 A, source, $< 300 \mu\text{s}$ |
| | 23 | DI 6 / DO 6 | DI: 24 VDC, sink, $\leq 200 \mu\text{s}$, configurable software filter DO: 24 VDC, 0.5 A, source, $< 300 \mu\text{s}$ |
| | 14 | DI 7 / DO 7 | DI: 24 VDC, sink, $\leq 200 \mu\text{s}$, configurable software filter DO: 24 VDC, 0.5 A, source, $< 300 \mu\text{s}$ |
| | 24 | DI 8 / DO 8 | DI: 24 VDC, sink, $\leq 200 \mu\text{s}$, configurable software filter DO: 24 VDC, 0.5 A, source, $< 300 \mu\text{s}$ |
| | 15 | DO 9 | 24 VDC, 0.2 A, push-pull, $< 3 \mu\text{s}$ |
| | 25 | DO 10 | 24 VDC, 0.2 A, push-pull, $< 3 \mu\text{s}$ |
| | 16 | DO 11 | 24 VDC, 0.2 A, push-pull, $< 3 \mu\text{s}$ |
| | 26 | DO 12 | 24 VDC, 0.2 A, push-pull, $< 3 \mu\text{s}$ |

Analog inputs

| Connection | Terminal connection | Channel | Description |
|------------|---------------------|---------|---|
| X1 | 11, 12, 13 | AI 1 | $\pm 10 \text{ V} / 0$ to 20 mA or 4 to 20 mA, 12-bit, 1 ms |
| | 21, 22, 23 | AI 2 | $\pm 10 \text{ V} / 0$ to 20 mA or 4 to 20 mA, 12-bit, 1 ms |

Analog input 1 can also be used for PT1000 resistance temperature measurement.

| Connection | Terminal connection | Channel | Description |
|------------|---------------------|---------|---|
| X1 | 11, 12, 13 | AI 1 | PT1000 resistance temperature measurement Measurement takes place using analog input A1. |

The following sections describe assigning I/O channels in a reACTION program:

| I/O channels | Assignment |
|----------------------|--|
| Digital I/O channels | Assignment of digital inputs/outputs (Page 3439) |
| Analog I/O channels | Assignment of analog inputs (Page 3439) |

9.28.2.10 Pinouts

Slot X1

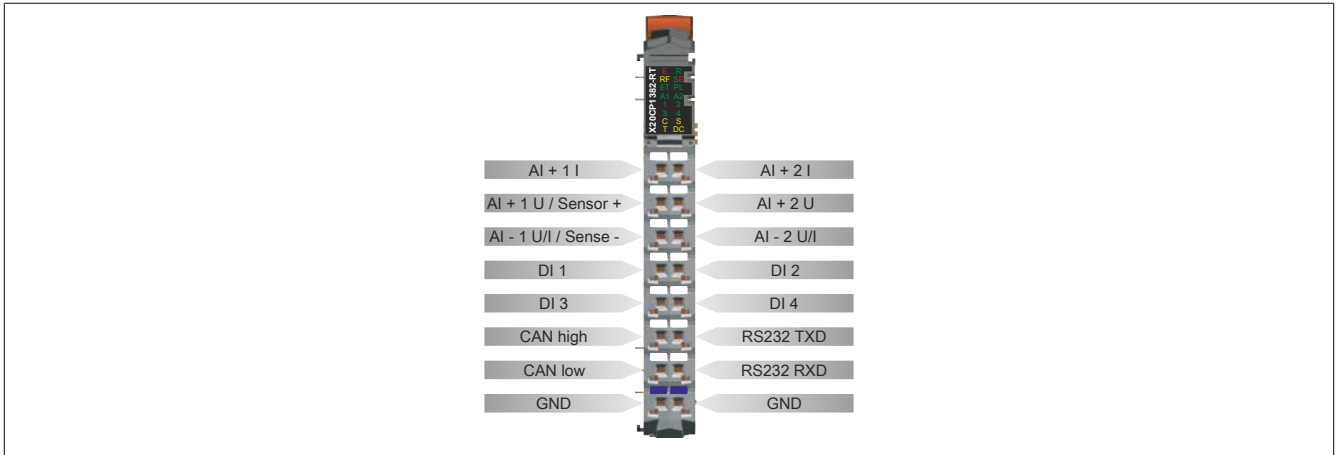


Figure 285: Pinout of the integrated X1 I/O slot

Slot X2

To prevent crosstalk, each signal line of the high-speed digital inputs should be shielded individually. The maximum cable length is 20 m.

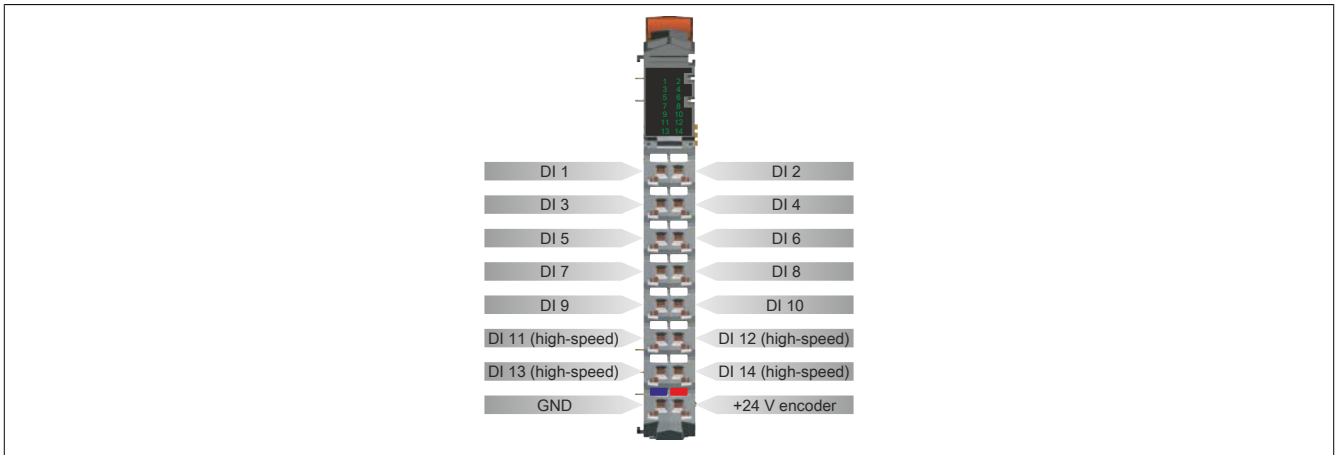


Figure 286: Pinout of the integrated X2 I/O slot

Slot X3

To ensure proper operation of the digital mixed channels (DI 5 / DO 5 to DI 8 / DO 8), it is important to observe the notes in section ["Power supply concept of Compact CPUs"](#) on page 3397.

To prevent crosstalk, each signal line of the high-speed digital outputs should be shielded individually. The maximum cable length is 20 m.

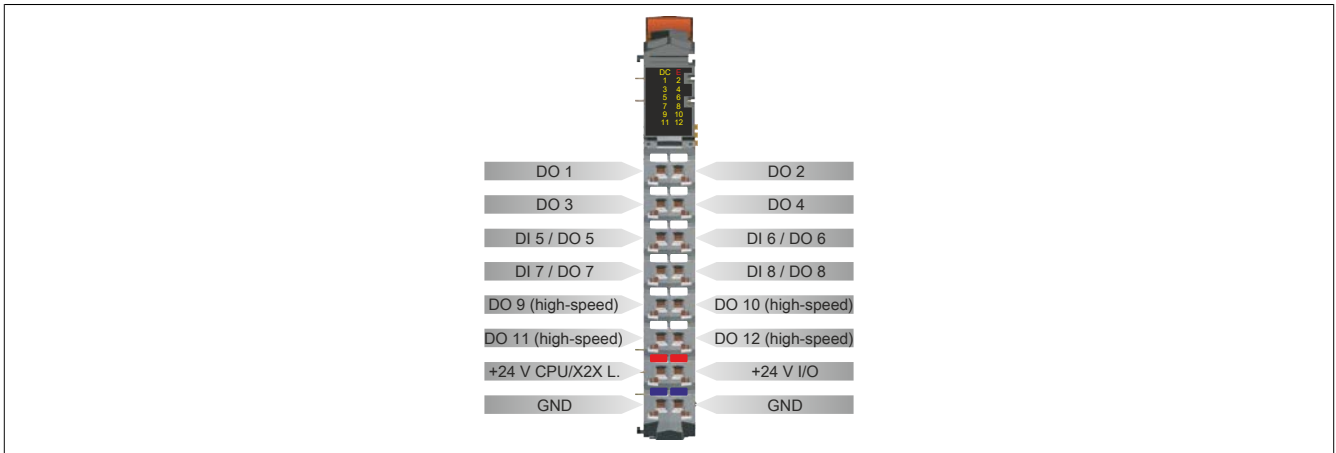


Figure 287: Pinout of the integrated X3 I/O slot

9.28.2.11 Connection examples

9.28.2.11.1 Slot X1

Voltage/Current measurement, digital inputs and CAN bus

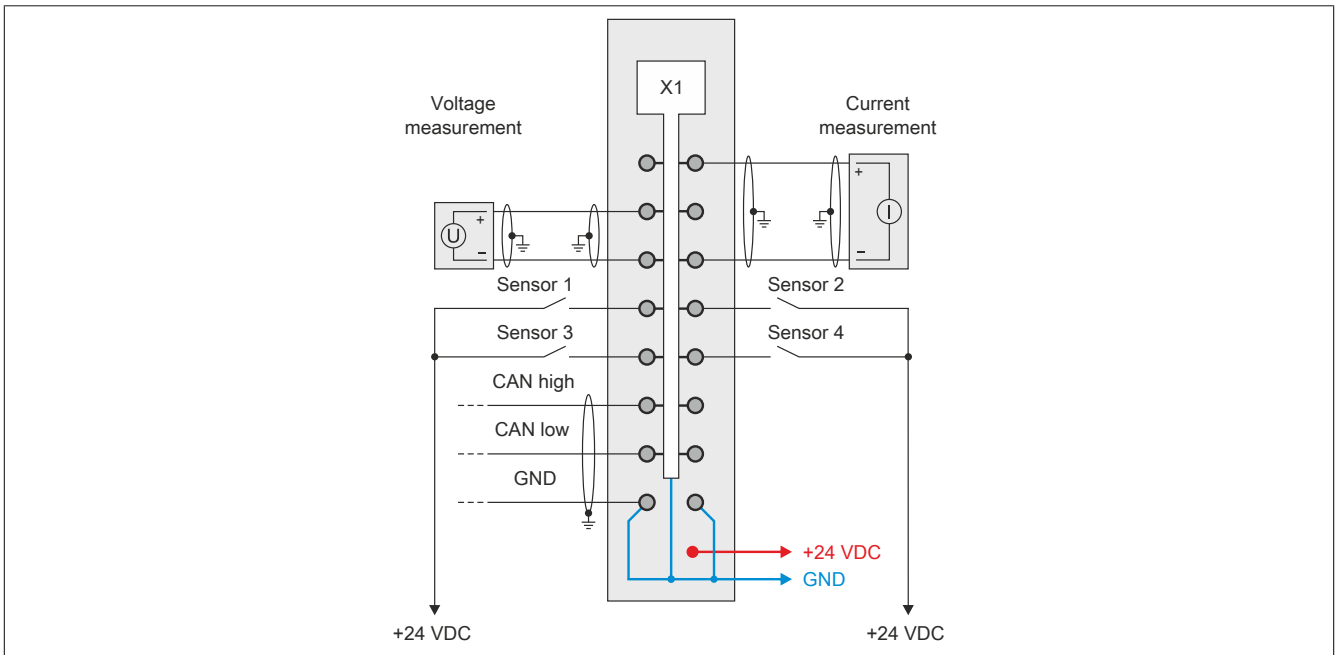


Figure 288: Connection example 1 for integrated I/O slot X1

PT1000 resistance temperature measurement, voltage measurement, digital inputs and RS232

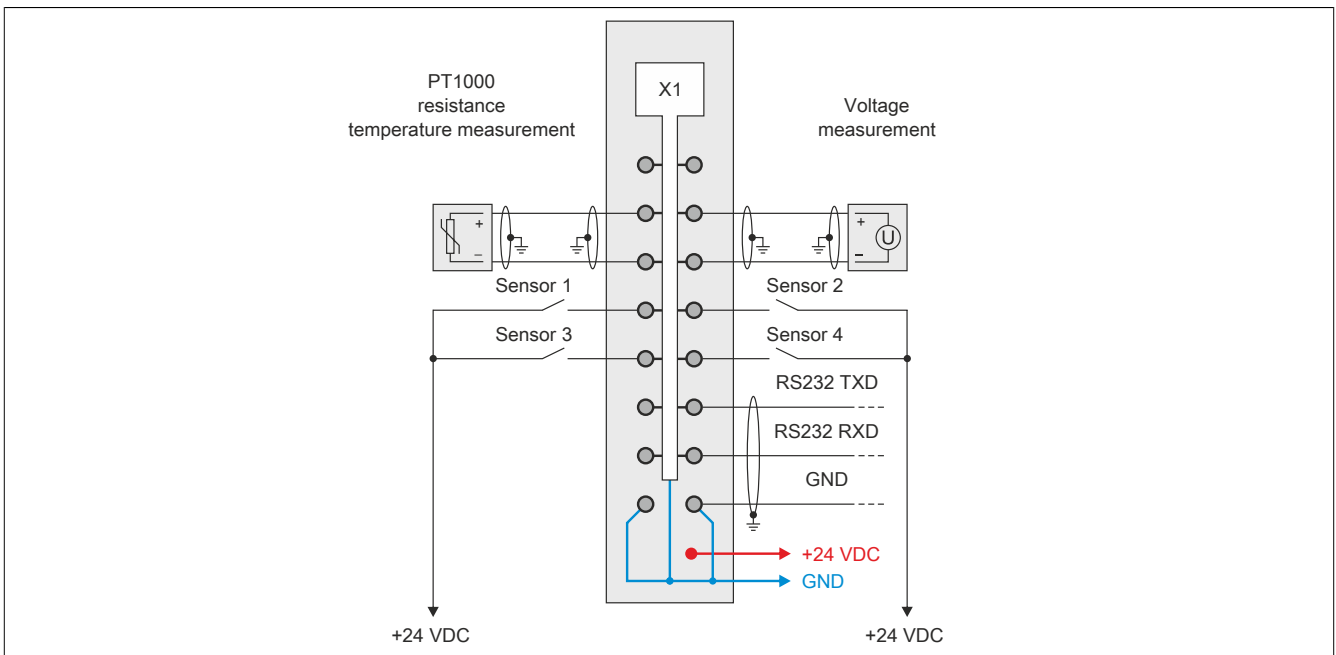


Figure 289: Connection example 2 for integrated I/O slot X1

9.28.2.11.2 Slot X2

Digital inputs and ABR incremental encoder

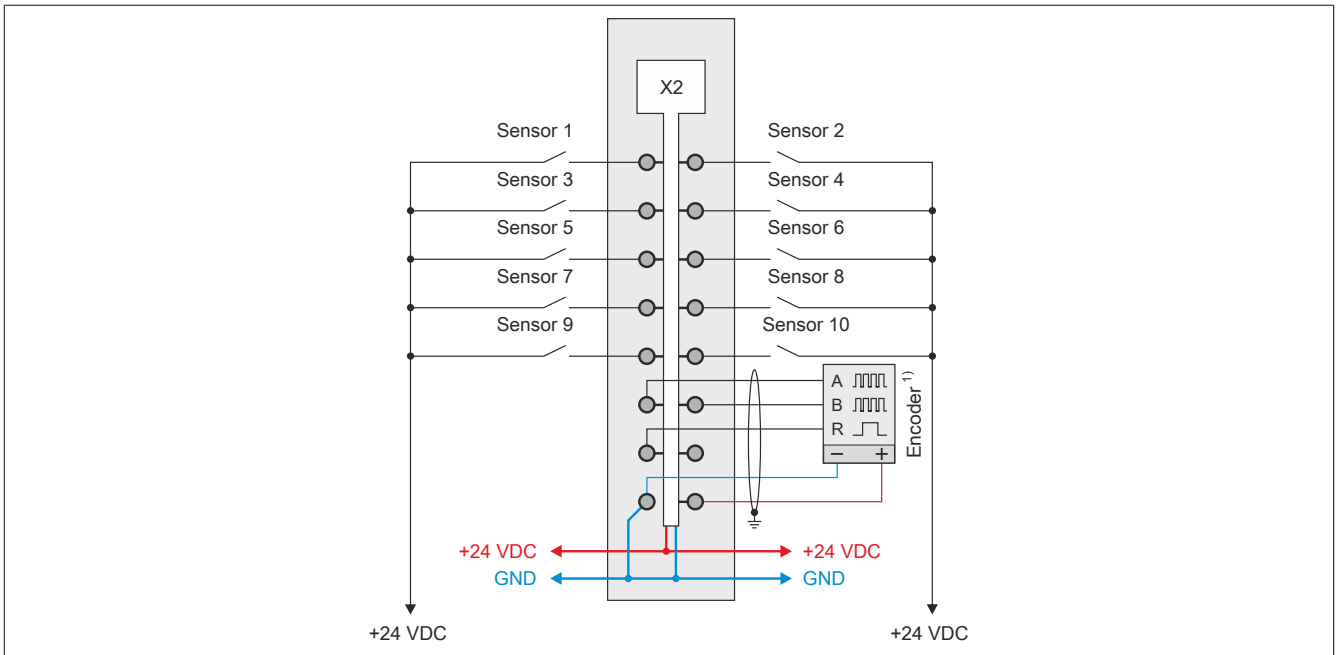


Figure 290: Connection example 1 for integrated X2 I/O slot

- 1) Observe the wiring guidelines from the encoder manufacturer.

DI11 to DI14 are used as high-speed digital inputs

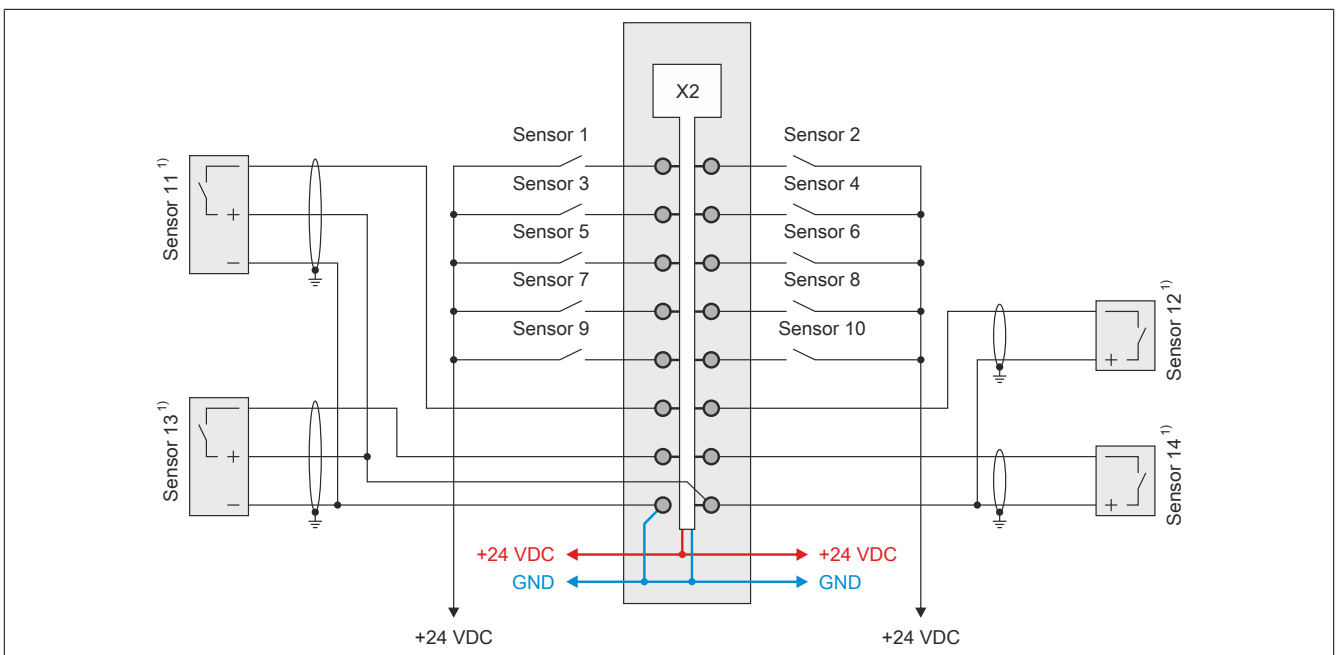


Figure 291: Anschlussbeispiel 2 für integrierten I/O-Steckplatz X2

- 1) Verdrahtungsvorschriften des Sensorherstellers beachten.

9.28.2.11.3 Slot X3

Digital inputs/outputs, direction/frequency (DF), PWM, CPU / X2X Link power supply and I/O power supply

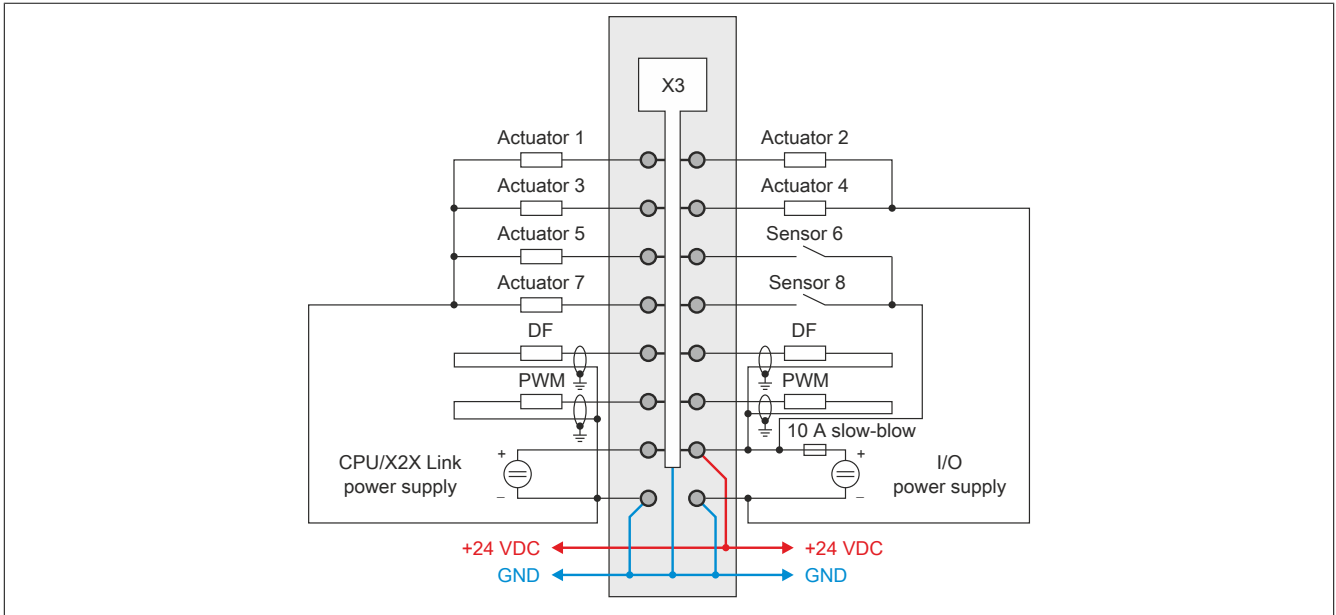


Figure 292: Connection example for integrated X3 I/O slot

9.28.2.12 Functions of the high-speed digital inputs/outputs

9.28.2.12.1 Functions of the high-speed digital inputs

Possible functions

The high-speed digital inputs DI 11 to DI 14 can be configured for the following functions: It is important to note that maximum 2 functions of the same type are possible with edge detection.

| Channel | Counter function | | | Edge detection ¹⁾ |
|---------|------------------|---|----------------------|---|
| DI 11 | Event counter 1 | A | A | D - Direction <ul style="list-style-type: none"> • Period measurement • Gate measurement • Differential time measurement <ul style="list-style-type: none"> • Edge counters • Edge times |
| DI 12 | | B | B | F - Frequency <ul style="list-style-type: none"> • Period measurement • Gate measurement • Differential time measurement <ul style="list-style-type: none"> • Edge counters • Edge times |
| DI 13 | Event counter 2 | A | R | R <ul style="list-style-type: none"> • Period measurement • Gate measurement • Differential time measurement <ul style="list-style-type: none"> • Edge counters • Edge times |
| DI 14 | | B | E - Reference enable | E - Reference enable <ul style="list-style-type: none"> • Period measurement • Gate measurement • Differential time measurement <ul style="list-style-type: none"> • Edge counters • Edge times |

Table 589: Possible functions of the high-speed digital inputs DI 11 to DI 14

1) Maximum 2 functions of the same type can be configured.

Please note

The following points must be taken into account to correctly configure the high-speed digital inputs:

- The counter functions are mutually exclusive. Only one type of counter function can be selected at a time. It is not possible to select 2 event counters (DI 11 and DI 13) at the same time together with an AB or DF counter (each on DI 13 and DI 14)!
- It is possible to select a counter function and edge detection at the same time.
- A position or counter latch is possible when configuring the high-speed inputs as a 2x event counter, ABR incremental encoder or DF function.

Examples of possible configurations

| Channel | Configuration 1 | Configuration 2 | Configuration 3 | Configuration 4 |
|---------|---|---|----------------------|----------------------|
| DI 11 | Event counter 1 | <ul style="list-style-type: none"> • Edge counters • Edge times | A | D |
| DI 12 | <ul style="list-style-type: none"> • Period measurement • Gate measurement • Differential time measurement | <ul style="list-style-type: none"> • Edge counters • Edge times | B | F |
| DI 13 | Event counter 2 | A | R | R |
| DI 14 | <ul style="list-style-type: none"> • Period measurement • Gate measurement • Differential time measurement | B | E - Reference enable | E - Reference enable |

| Channel | Configuration 5 | Configuration 6 | Configuration 7 | Configuration 8 |
|---------|---|---|---|---|
| DI 11 | Event counter 1 | A | <ul style="list-style-type: none"> • Period measurement • Gate measurement • Differential time measurement | D - Direction |
| DI 12 | <ul style="list-style-type: none"> • Edge counters • Edge times | B | <ul style="list-style-type: none"> • Period measurement • Gate measurement • Differential time measurement | F - Frequency |
| DI 13 | Event counter 2 | <ul style="list-style-type: none"> • Period measurement • Gate measurement • Differential time measurement | <ul style="list-style-type: none"> • Edge counters • Edge times | <ul style="list-style-type: none"> • Edge counters • Edge times |
| DI 14 | <ul style="list-style-type: none"> • Period measurement • Gate measurement • Differential time measurement | <ul style="list-style-type: none"> • Edge counters • Edge times | <ul style="list-style-type: none"> • Edge counters • Edge times | <ul style="list-style-type: none"> • Period measurement • Gate measurement • Differential time measurement |

9.28.2.12.2 Functions of the high-speed digital outputs

Possible functions

The high-speed digital outputs DO 9 to DO 12 can be configured for the following functions:

| Channel | Function | |
|---------|------------------------------|---------------|
| DO 9 | PWM - Pulse width modulation | D - Direction |
| DO 10 | PWM - Pulse width modulation | F - Frequency |
| DO 11 | PWM - Pulse width modulation | D - Direction |
| DO 12 | PWM - Pulse width modulation | F - Frequency |

Table 590: Possible functions of the high-speed digital inputs DO 9 to DO 12

Examples of possible configurations

| Channel | Configuration 1 | Configuration 2 | Configuration 3 | Configuration 4 |
|---------|------------------------------|------------------------------|------------------------------|-----------------|
| DO 9 | PWM - Pulse width modulation | D - Direction | PWM - Pulse width modulation | D - Direction |
| DO 10 | PWM - Pulse width modulation | F - Frequency | PWM - Pulse width modulation | F - Frequency |
| DO 11 | D - Direction | PWM - Pulse width modulation | PWM - Pulse width modulation | D - Direction |
| DO 12 | F - Frequency | PWM - Pulse width modulation | PWM - Pulse width modulation | F - Frequency |

9.28.2.13 Input/Output circuit diagram

9.28.2.13.1 Digital inputs (X1) and high-speed digital inputs (X2)

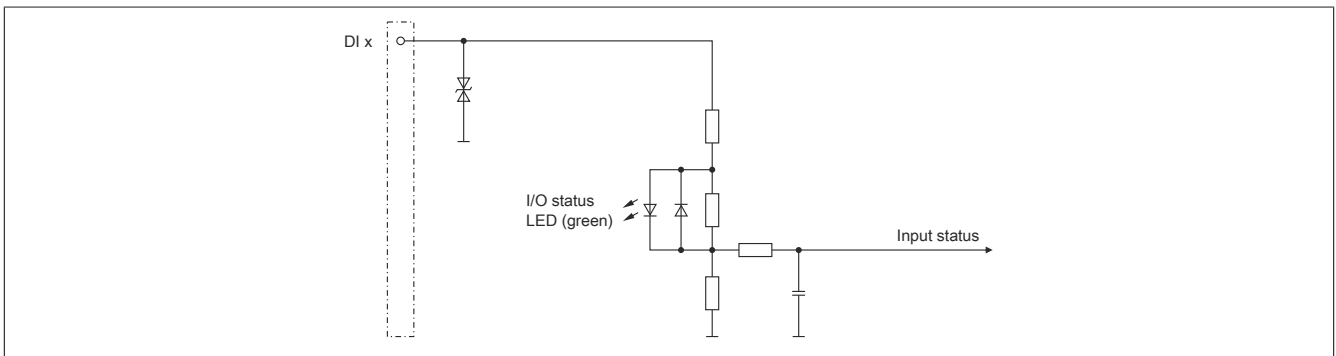


Figure 293: Input circuit diagram of the digital inputs on the integrated X1 I/O slot and the high-speed digital inputs on the integrated X2 I/O slot

9.28.2.13.2 Digital inputs (X2)

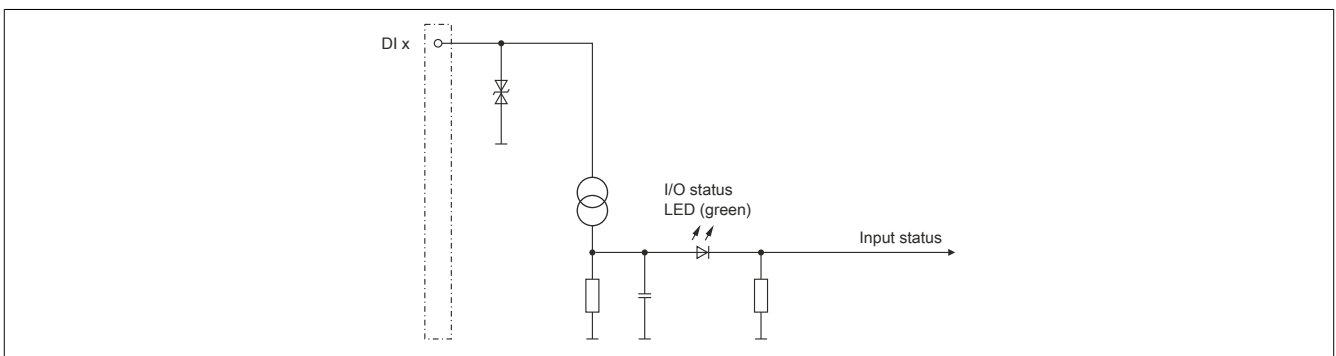


Figure 294: Input circuit diagram of the digital inputs on the integrated X2 I/O slot

9.28.2.13.3 Digital outputs (X3)

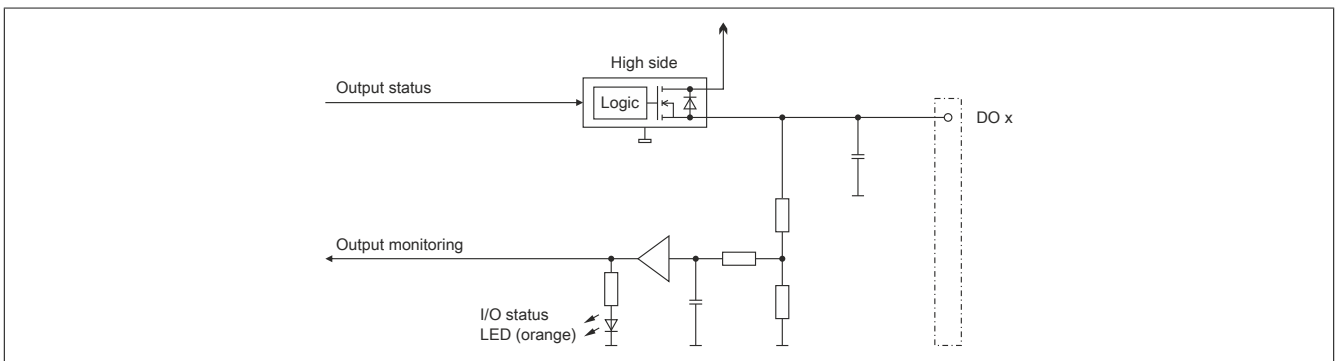


Figure 295: Output circuit diagram of the digital outputs on the integrated X3 I/O slot

9.28.2.13.4 High-speed digital outputs (X3)

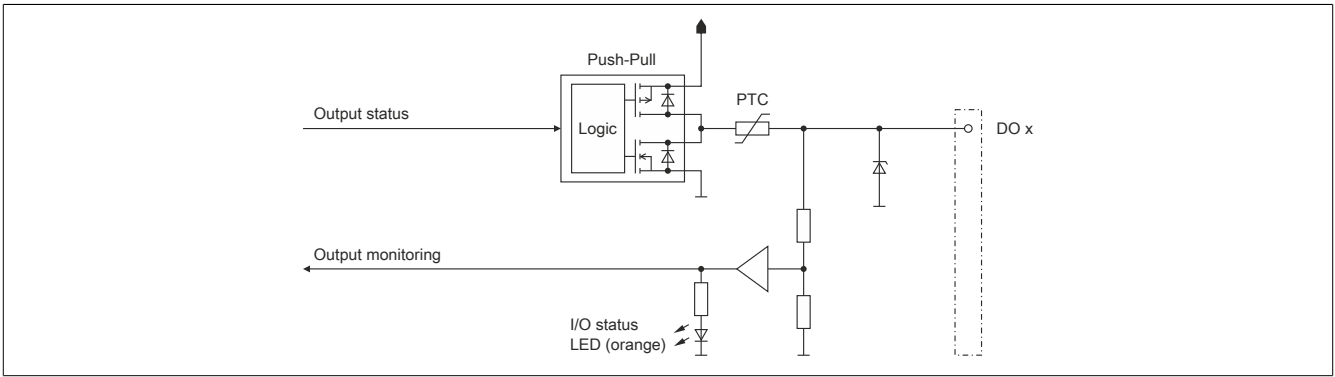


Figure 296: Output circuit diagram of the high-speed digital outputs on the integrated X3 I/O slot

9.28.2.13.5 Digital inputs/outputs (X3)

To ensure proper operation of the digital mixed channels (DI 5 / DO 5 to DI 8 / DO 8), it is important to observe the notes in section "Power supply concept of Compact CPUs" on page 3397.

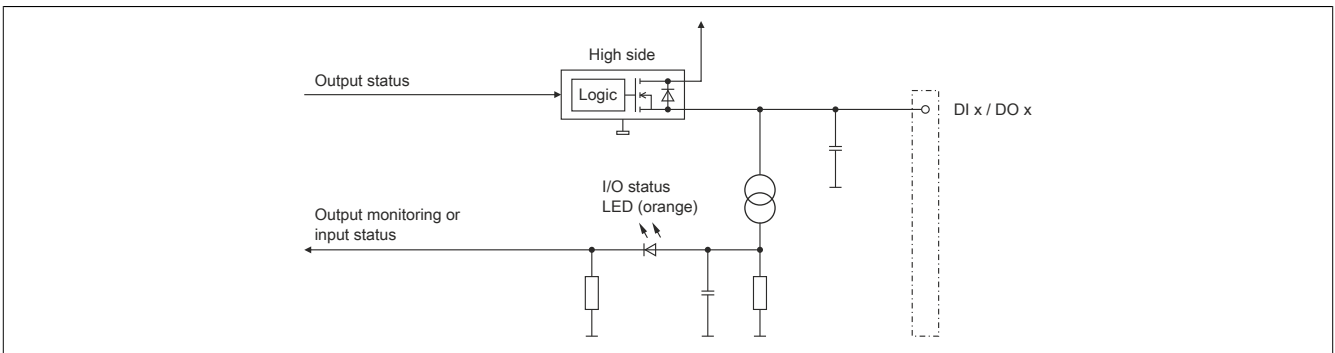


Figure 297: Input/Output circuit diagram of the digital mixed channels on the integrated X3 I/O slot

9.28.2.13.6 Analog inputs (X1)

A PT1000 resistance temperature sensor can be connected to analog input AI 1 and used for temperature measurement.

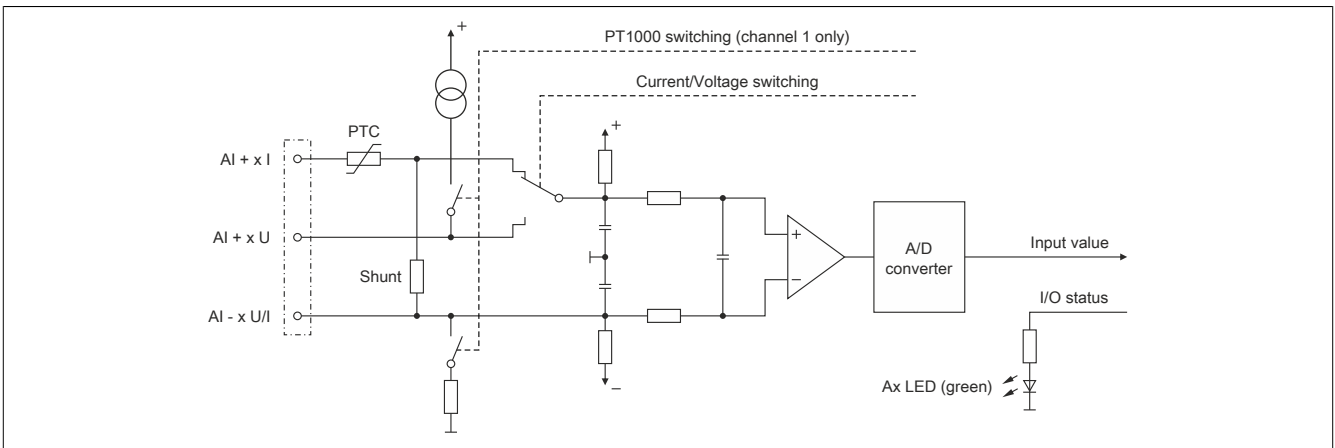


Figure 298: Input circuit diagram of the analog inputs and temperature input on the integrated X1 I/O slot

9.28.2.13.7 Encoder power supply (X2)

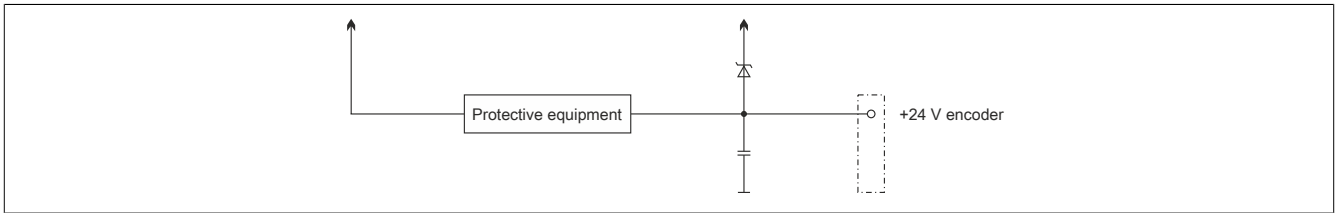


Figure 299: Circuit diagram of the encoder supply on the integrated X2 I/O slot

9.28.2.13.8 CPU, X2X Link and I/O power supply (X3)

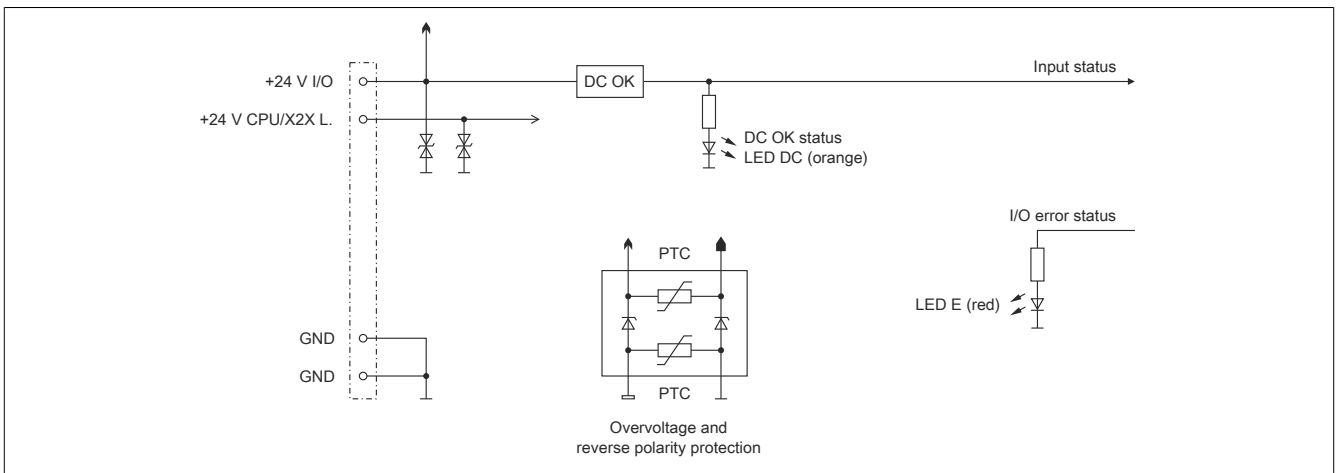


Figure 300: Circuit diagram of the CPU, X2X Link and I/O power supply on the integrated X3 I/O slot

9.28.2.14 Switching frequency derating for high-speed digital outputs

The high-speed digital outputs can be switched with a frequency of max. 200 kHz. Derating may be necessary depending on the mounting orientation and operating temperature.

Switching frequency derating for horizontal mounting orientations

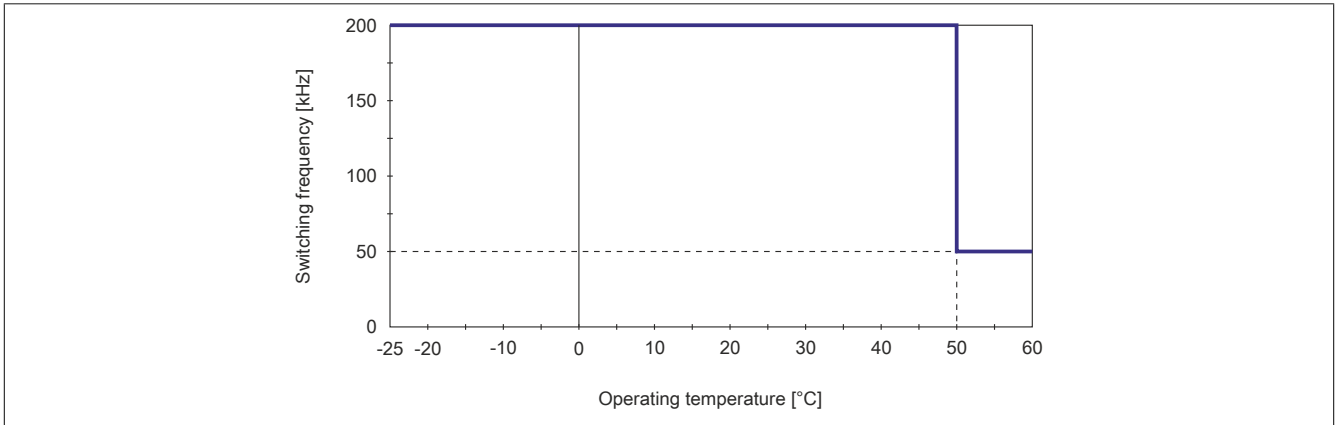


Figure 301: Switching frequency derating for high-speed digital outputs with horizontal mounting orientations

Switching frequency derating for vertical mounting orientations

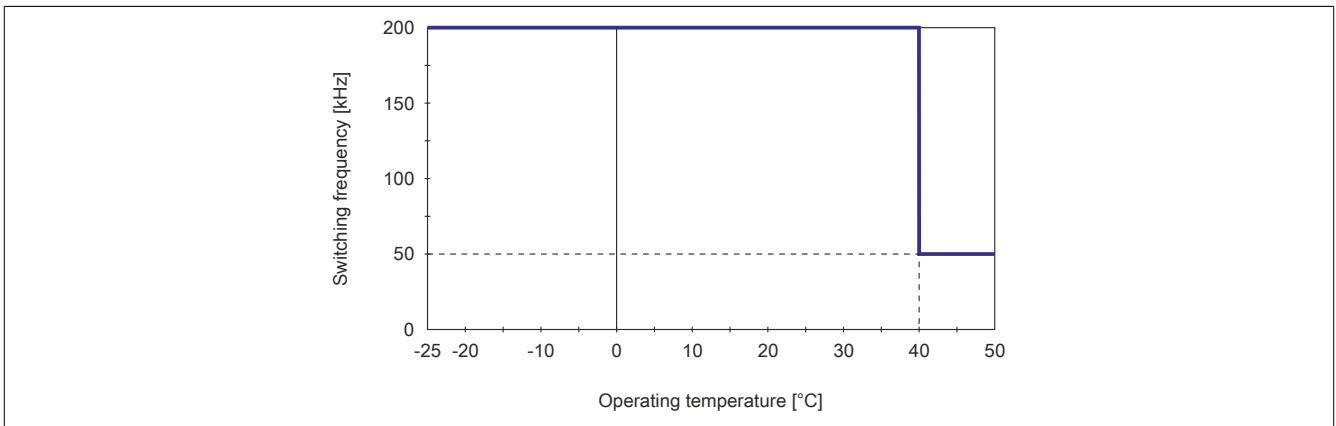
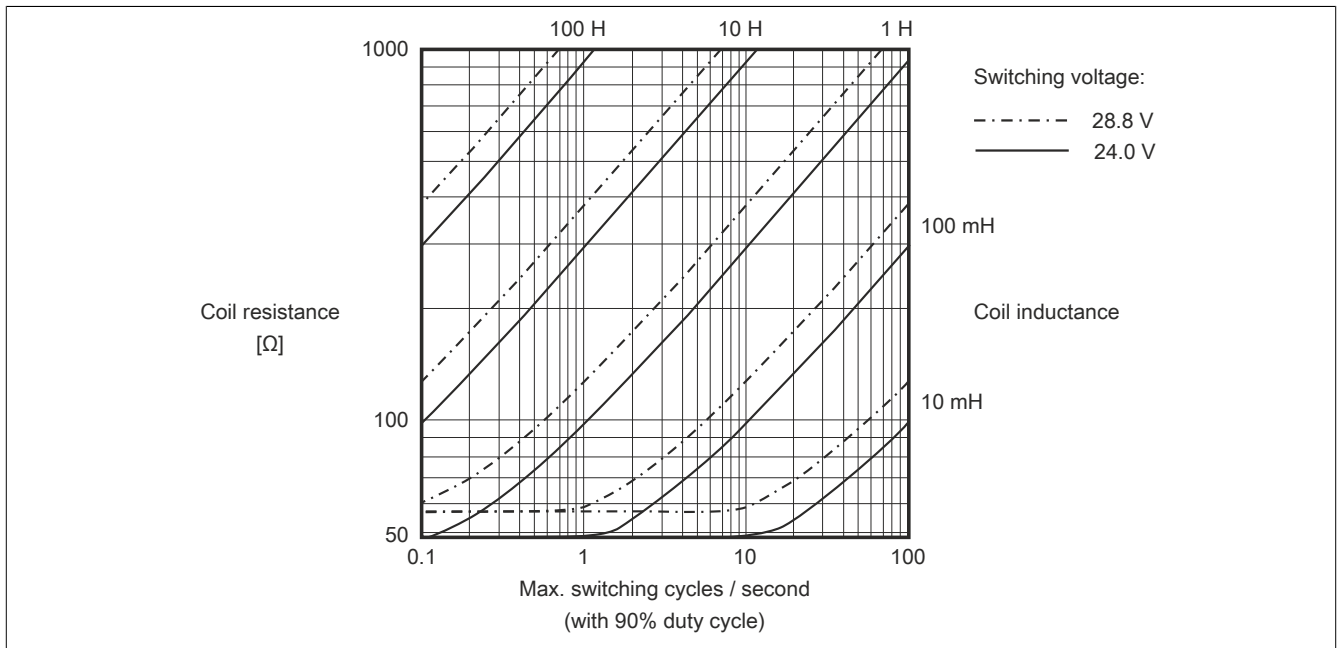


Figure 302: Switching frequency derating for high-speed digital outputs with vertical mounting orientations

9.28.2.15 Switching inductive loads

**Information:**

If the maximum number of operating cycles per second is exceeded, an external inverse diode must be used.

Operating conditions outside of the area in the diagram are not permitted!

9.28.2.16 Register description

9.28.2.16.1 System requirements

The following minimum versions are recommended to generally be able to use all functions:

- Automation Studio 4.1.4.402
- Automation Runtime M4.10 for X20cCP1382-RT
- Automation Runtime D4.10 for all other variants

9.28.2.16.2 General data points

This CPU is equipped with general data points. These are not CPU-specific; instead, they contain general information such as system time and heat sink temperature.

General data points are described in section "[General CPU data points](#)" on page 3792.

9.28.2.16.3 Register overview of the I/O data points on the integrated X1 I/O slot

| Register | Name | Data type | Read | | Write | |
|---------------------------|--------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| X1 - Configuration | | | | | | |
| 2048 | X1CfO_DI_Filter | USINT | | | | • |
| 2128 | X1CfO_AI_Mode | USINT | | | | • |
| 2112 | X1CfO_AI1_Filter | USINT | | | | • |
| 2116 | X1CfO_AI1_LowerLim | INT | | | | • |
| 2118 | X1CfO_AI1_UpperLim | INT | | | | • |
| 2120 | X1CfO_AI2_Filter | USINT | | | | • |
| 2124 | X1CfO_AI2_LowerLim | INT | | | | • |
| 2126 | X1CfO_AI2_UpperLim | INT | | | | • |
| X1 - Communication | | | | | | |
| 0 | Digital inputs | USINT | • | | | |
| | DigitalInput01 | Bit 0 | | | | |
| | DigitalInput02 | Bit 1 | | | | |
| | DigitalInput03 | Bit 2 | | | | |
| | DigitalInput04 | Bit 3 | | | | |
| 64 | AnalogInput01 | INT | • | | | |
| | | UINT | • | | | |
| 66 | AnalogInput02 | INT | • | | | |
| 80 | StatusInput01 | USINT | • | | | |

9.28.2.16.3.1 Digital inputs**Unfiltered**

The input status is recorded in a 100 µs cycle.

Filtered

The filtered status is transferred in a 100 µs cycle.

Filtering takes place asynchronously in an interval of 100 µs.

Digital input filter

Name:

X1CfO_DI_Filter

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 µs.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No SW filter |
| | 1 | 0.1 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

Input state of digital inputs 1 to 4

Name:

DigitalInput01 to DigitalInput04

This register indicates the input state of digital inputs 1 to 4.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|--------|---------------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input status of digital input 1 |
| ... | | ... | |
| 3 | DigitalInput04 | 0 or 1 | Input status of digital input 4 |

9.28.2.16.3.2 Analog inputs

Analog input values are recorded in a fixed interval. The time required for conversion/updating depends on the number of analog inputs and on the input signal:

| Input signal | Time required for conversion/updating |
|--|---------------------------------------|
| 1 current/voltage input | 100 µs |
| 1 temperature/resistance input | 200 µs |
| 2 current/voltage inputs | 200 µs |
| 1 current/voltage input and 1 temperature/resistance input | 400 µs |

Input values of analog inputs

Name:

AnalogInput01

The analog input value is mapped in this register depending on the configured operating mode.

| Data type | Value | Input signal |
|-----------|-----------------|---|
| INT | -32768 to 32767 | Voltage signal -10 to 10 VDC |
| | 0 to 32767 | Current signal 0 to 20 mA (with 0 to 20 mA configuration) |
| | -8192 to 32767 | Current signal 0 to 20 mA (with 4 to 20 mA configuration) |
| | -2000 to 8500 | PT1000 signal -200.0 to 850.0°C |
| UINT | 0 to 40000 | Resistance signal 0 to 4000.0 Ω |

Name:

AnalogInput02

The analog input value is mapped in this register depending on the configured operating mode.

| Data type | Value | Input signal |
|-----------|-----------------|---|
| INT | -32768 to 32767 | Voltage signal -10 to 10 VDC |
| | 0 to 32767 | Current signal 0 to 20 mA (with 0 to 20 mA configuration) |
| | -8192 to 32767 | Current signal 0 to 20 mA (with 4 to 20 mA configuration) |

Status of the inputs

Name:

StatusInput01

This register holds the status of the analog inputs. A change in the monitoring status generates an error message. The following states are monitored depending on the settings:

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|-------------------------|
| 0 - 1 | Channel 1 | 00 | No error |
| | | 01 | Below lower limit value |
| | | 10 | Above upper limit value |
| | | 11 | Open circuit |
| 2 - 3 | Channel 2 | 00 | No error |
| | | 01 | Below lower limit value |
| | | 10 | Above upper limit value |
| | | 11 | Open circuit |
| 4 - 7 | Reserved | 0 | |

Limiting the analog value

In addition to the status information, the analog value is set to the limit values listed below by default when an error occurs (see "Limit values" on page 3419). The analog value is limited to the new values if the limit values were changed.

Input filter

The analog inputs are equipped with a configurable input filter.

Input ramp limiting

Input ramp limiting can only be performed in conjunction with filtering. Input ramp limiting is performed before filtering.

The difference of the input value change is checked for exceeding the specified limit. In the event of overshoot, the tracked input value is equal to the old value \pm the limit value.

Configurable limit values:

| Value | Limit value |
|-------|---|
| 0 | The input value is used without limitation. |
| 1 | 0x3FFF = 16383 |
| 2 | 0x1FFF = 8191 |
| 3 | 0x0FFF = 4095 |
| 4 | 0x07FF = 2047 |
| 5 | 0x03FF = 1023 |
| 6 | 0x01FF = 511 |
| 7 | 0x00FF = 255 |

Input ramp limiting is well suited for suppressing disturbances (spikes). The following examples show the functionality of input ramp limiting based on an input step and a disturbance.

Example 1

The input value jumps from 8000 to 17000. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = 0x07FF = 2047

Filter level = 2

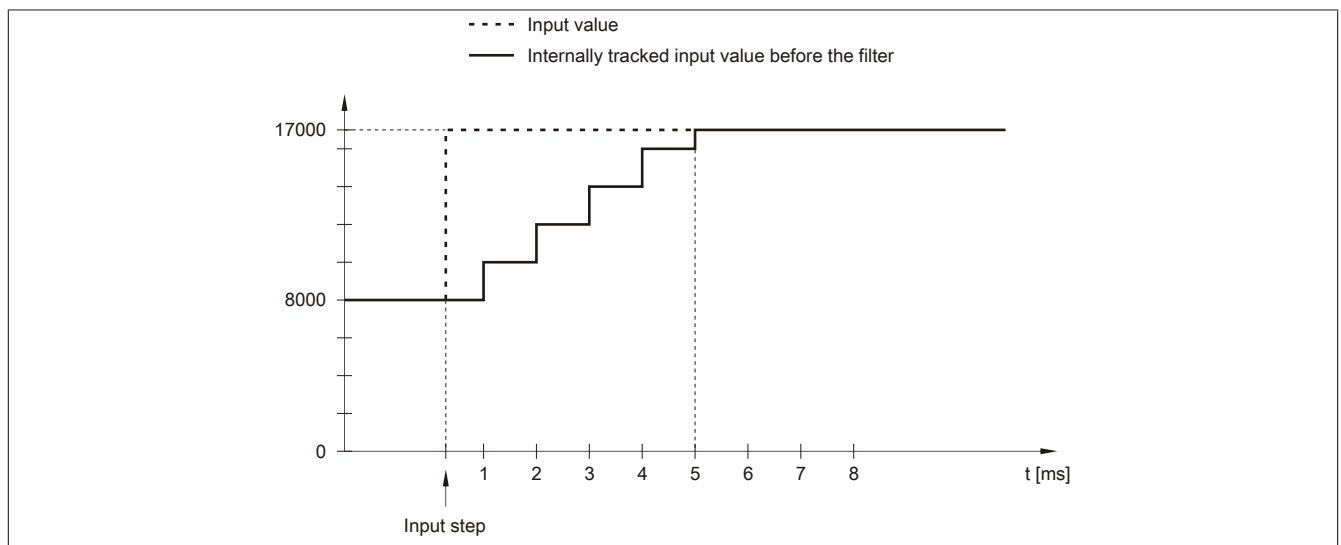


Figure 303: Tracked input value for input step

Example 2

A disturbance interferes with the input value. The diagram shows the tracked input value with the following settings:

Input ramp limiting = 4 = 0x07FF = 2047

Filter level = 2

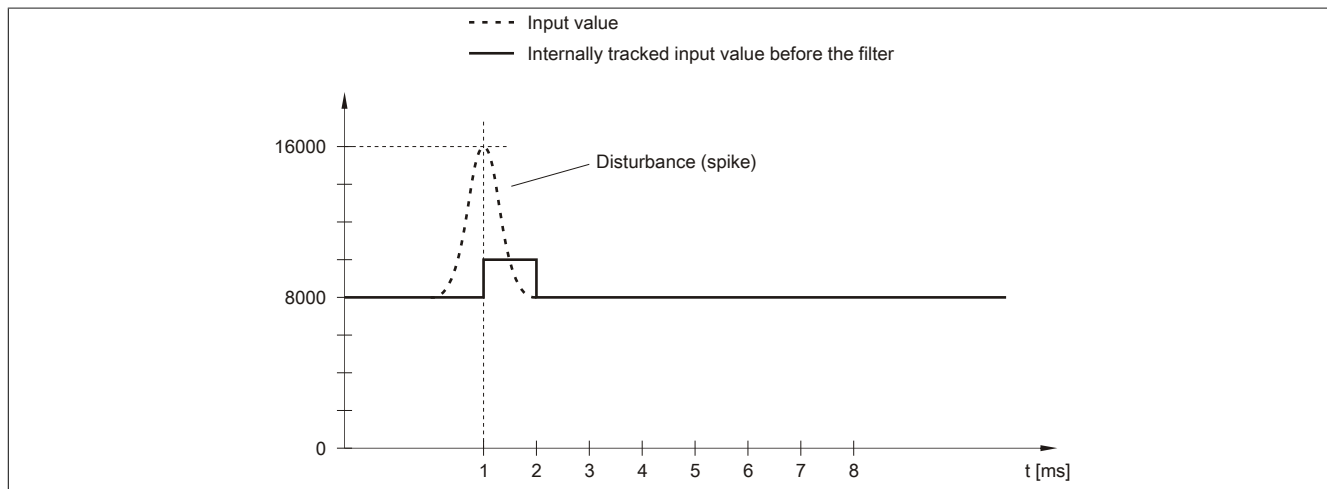


Figure 304: Tracked input value for disturbance

Filter level

A filter can be defined to prevent large input jumps. This filter is used to bring the input value closer to the actual analog value over a period of several bus cycles.

Filtering takes place after input ramp limitation.

Formula for calculating the input value:

$$\text{Value}_{\text{New}} = \text{Value}_{\text{Old}} - \frac{\text{Value}_{\text{Old}}}{\text{Filter level}} + \frac{\text{Input value}}{\text{Filter level}}$$

Adjustable filter levels:

| Value | Filter level |
|-------|---------------------|
| 0 | Filter switched off |
| 1 | Filter level 2 |
| 2 | Filter level 4 |
| 3 | Filter level 8 |
| 4 | Filter level 16 |
| 5 | Filter level 32 |
| 6 | Filter level 64 |
| 7 | Filter level 128 |

The following examples show how filtering works in the event of an input jump or disturbance.

Example 1

The input value jumps from 8000 to 16000. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

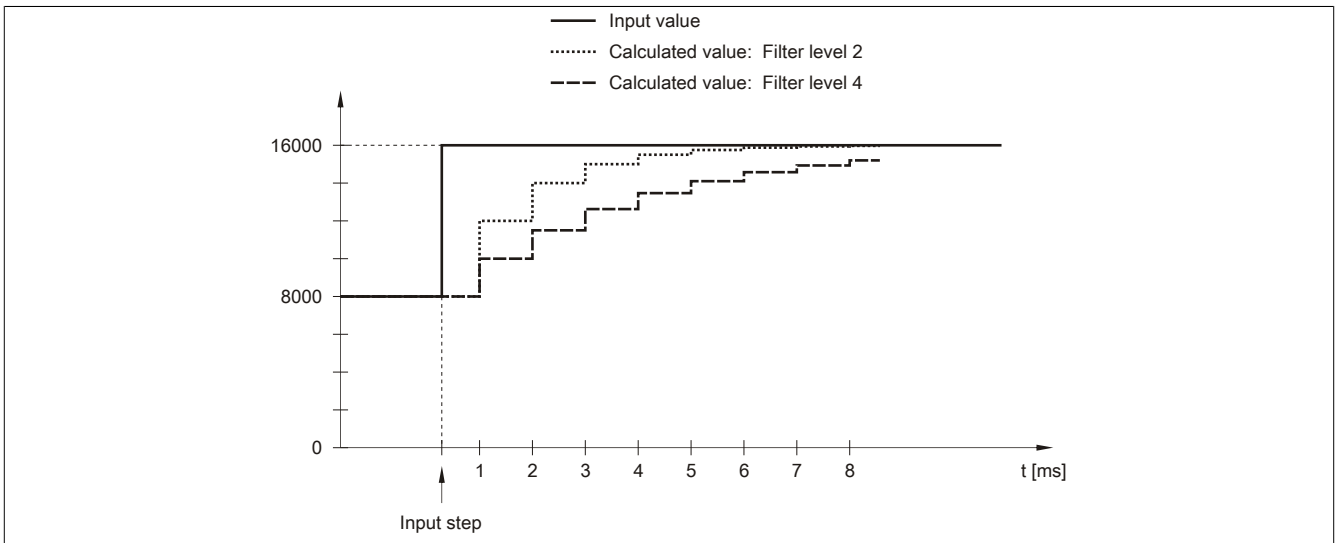


Figure 305: Calculated value during input step

Example 2

A disturbance interferes with the input value. The diagram shows the calculated value with the following settings:

Input ramp limiting = 0

Filter level = 2 or 4

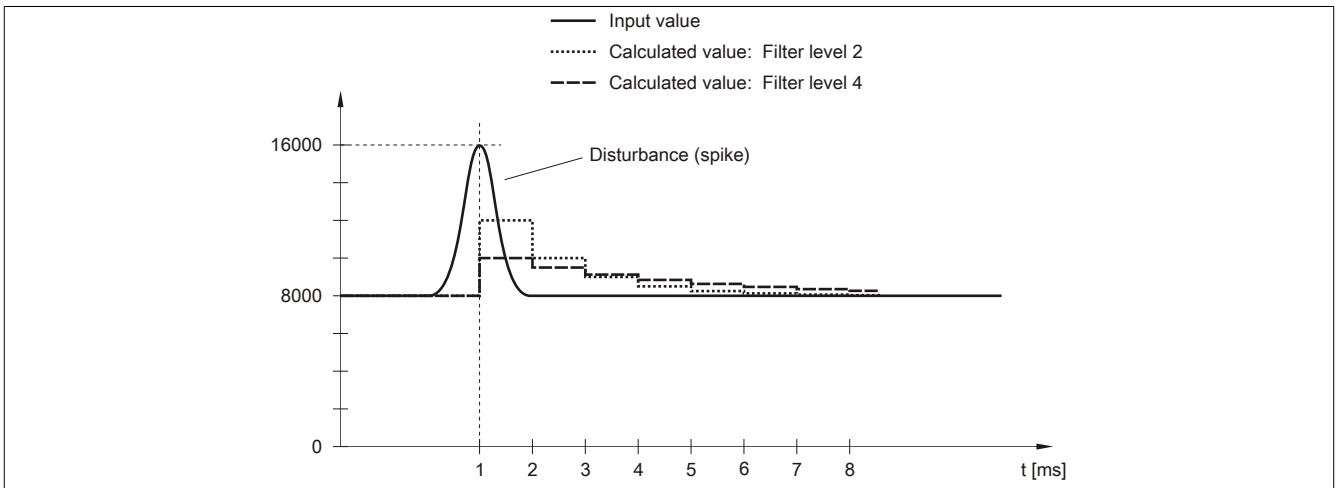


Figure 306: Calculated value during disturbance

Configuring the input filter

Name:

X1CfO_AI1_Filter

X1CfO_AI2_Filter

This register is used to define the filter level and input ramp limitation of the input filter.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------------|-------|--|
| 0 - 2 | Defines the filter level | 000 | Filter disabled (bus controller default setting) |
| | | 001 | Filter level 2 |
| | | 010 | Filter level 4 |
| | | 011 | Filter level 8 |
| | | 100 | Filter level 16 |
| | | 101 | Filter level 32 |
| | | 110 | Filter level 64 |
| | | 111 | Filter level 128 |
| 3 | Reserved | 0 | |
| 4 - 6 | Defines input ramp limiting | 000 | The input value is applied without limitation (bus controller default setting) |
| | | 001 | Limit value = 0x3FFF (16383) |
| | | 010 | Limit value = 0x1FFF (8191) |
| | | 011 | Limit value = 0x0FFF (4095) |
| | | 100 | Limit value = 0x07FF (2047) |
| | | 101 | Limit value = 0x03FF (1023) |
| | | 110 | Limit value = 0x01FF (511) |
| 111 | Limit value = 0x00FF (255) | | |
| 7 | Reserved | 0 | |

Channel type

Name:

X1CfO_AI_Mode

This register defines the type and range of signal measurement.

Each channel is capable of handling current, voltage or resistance signals. This differentiation is made using different terminal connections and an integrated switch. The switch is automatically activated depending on the specified configuration. The following input signals can be set:

| Input signal | On channel |
|--------------------------------|------------|
| ±10 V voltage signal (default) | 1 and 2 |
| 0 to 20 mA current signal | 1 and 2 |
| 4 to 20 mA current signal | 1 and 2 |
| PT1000 measurement | 1 |
| Resistance measurement | 1 |

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------|-------|---------------------------|
| 0 - 2 | Analog input - Channel 1 | 000 | Channel switched off |
| | | 001 | ±10 V voltage signal |
| | | 010 | 0 to 20 mA current signal |
| | | 011 | 4 to 20 mA current signal |
| | | 100 | PT1000 measurement |
| | | 101 | Resistance measurement |
| 3 | Reserved | 0 | |
| 4 - 5 | Analog input - Channel 2 | 00 | Channel switched off |
| | | 01 | ±10 V voltage signal |
| | | 10 | 0 to 20 mA current signal |
| | | 11 | 4 to 20 mA current signal |
| 6 - 7 | Reserved | 0 | |

Limit values

The input signal is monitored at the upper and lower limit values. By default the following limits are set for each mode:

| Limit value (default) | Voltage signal ± 10 V | | Current signal 0 to 20 mA | | Current signal 4 to 20 mA | |
|---------------------------|---------------------------|-----------------|---------------------------|-----------------|---------------------------|-----------------|
| Upper maximum limit value | 10 V | 32767 (0x7FFF) | 20 mA | 32767 (0x7FFF) | 20 mA | 32767 (0x7FFF) |
| Lower minimum limit value | -10 V | -32767 (0x8001) | 0 mA | 0 ¹⁾ | 4 mA | 0 ²⁾ |

Table 591: Limit values for voltage and current signals

- 1) The analog value is limited down to 0.
- 2) Due to the default limit value, the analog value is limited to a minimum of 0 at currents <4 mA.

| Limit value (default) | Temperature measurement | | Resistance measurement | |
|---------------------------|-------------------------|----------------|------------------------|----------------|
| Upper maximum limit value | 800.0°C | 8000 (0x1F40) | 4000.0 Ω | 32767 (0x7FFF) |
| Lower minimum limit value | -200.0°C | -2000 (0xF830) | 0 Ω | 0 |

Table 592: Limit values for temperature and resistance measurement

Other limit values can be defined if necessary. These are activated automatically by writing the limit value register (see "[Lower limit value](#)" on page 3419 and "[Upper limit value](#)" on page 3419). From this point on, the analog values will be monitored and limited according to the new limits. The results of monitoring are displayed in the status register (see "[Status of the inputs](#)" on page 3414).

Application example of setting limit values

A negative limit value must be configured in order to measure values <4 mA with a current signal of 4 to 20 mA: 0 mA corresponds to the value -8192 (0xE000).

Lower limit value

Name:

X1CfO_AI1_LowerLim

X1CfO_AI2_LowerLim

These registers can be used to configure the lower limit value for analog values. If the analog value goes below the limit value, it is frozen at this value and the corresponding error status bit is set (see "[Status of the inputs](#)" on page 3414).

| Data type | Value |
|-----------|-----------------|
| INT | -32768 to 32767 |
| UINT | 0 to 65535 |

Information:

When configured as 4 to 20 mA, this value can be set to -8192 (corresponds to 0 mA) in order to display values <4 mA.

Upper limit value

Name:

X1CfO_AI1_UpperLim

X1CfO_AI2_UpperLim

These registers can be used to configure the upper limit value for analog values. If the analog value goes above the limit value, it is frozen at this value and the corresponding error status bit is set (see "[Status of the inputs](#)" on page 3414).

| Data type | Value |
|-----------|------------|
| INT | 0 to 32767 |
| UINT | 0 to 65535 |

9.28.2.16.4 Register overview of the I/O data points on the integrated X2 I/O slot

| Register | Name | Data type | Read | | Write | |
|---------------------------|------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| X2 - Configuration | | | | | | |
| 7168 | X2CfO_EdgeDetectUnit01Mode | USINT | | | | • |
| 7169 | X2CfO_EdgeDetectUnit01Master | USINT | | | | • |
| 7170 | X2CfO_EdgeDetectUnit01Slave | USINT | | | | • |
| 7184 | X2CfO_EdgeDetectUnit02Mode | USINT | | | | • |
| 7185 | X2CfO_EdgeDetectUnit02Master | USINT | | | | • |
| 7186 | X2CfO_EdgeDetectUnit02Slave | USINT | | | | • |
| 6144 | X2CfO_DI_Filter | USINT | | | | • |
| 6528 | X2CfO_CounterMode | USINT | | | | • |
| 6400 | X2CfO_Latch01Mode | USINT | | | | • |
| 6401 | X2CfO_Latch01Comparator | USINT | | | | • |
| 6416 | X2CfO_Latch02Mode | USINT | | | | • |
| 6417 | X2CfO_Latch02Comparator | USINT | | | | • |
| X2 - Communication | | | | | | |
| 4096 | Digital inputs | USINT | • | | | |
| | DigitalInput01 | Bit 0 | | | | |
| | DigitalInput02 | Bit 1 | | | | |
| | DigitalInput03 | Bit 2 | | | | |
| | DigitalInput04 | Bit 3 | | | | |
| | DigitalInput05 | Bit 4 | | | | |
| | DigitalInput06 | Bit 5 | | | | |
| | DigitalInput07 | Bit 6 | | | | |
| 4097 | Digital inputs | USINT | • | | | |
| | DigitalInput09 | Bit 0 | | | | |
| | DigitalInput10 | Bit 1 | | | | |
| | DigitalInput11 | Bit 2 | | | | |
| | DigitalInput12 | Bit 3 | | | | |
| | DigitalInput13 | Bit 4 | | | | |
| 5120 | EdgeDetect01Mastertime | DINT | • | | | |
| | EdgeDetect01Difference | DINT | • | | | |
| 5128 | EdgeDetect01Mastercount | INT | • | | | |
| 5136 | EdgeDetect02Mastertime | DINT | • | | | |
| 5140 | EdgeDetect02Difference | DINT | • | | | |
| 5144 | EdgeDetect02Mastercount | INT | • | | | |
| 4384 | Counter 1 | USINT | | | • | |
| | Counter01Reset | Bit 0 | | | | |
| | Latch01Enable | Bit 1 | | | | |
| 4352 | Counter01Value | DINT | • | | | |
| 4356 | Counter01Latch | DINT | • | | | |
| 4360 | Counter01TimeChanged | DINT | • | | | |
| 4364 | Counter01TimeValid | DINT | • | | | |
| 4368 | Latch01Count | SINT | • | | | |
| 4448 | Counter 2 | USINT | | | • | |
| | Counter02Reset | Bit 0 | | | | |
| | Latch02Enable | Bit 1 | | | | |
| 4416 | Counter02Value | DINT | • | | | |
| 4420 | Counter02Latch | DINT | • | | | |
| 4424 | Counter02TimeChanged | DINT | • | | | |
| 4428 | Counter02TimeValid | DINT | • | | | |
| 4432 | Latch02Count | SINT | • | | | |

9.28.2.16.4.1 Digital inputs**Unfiltered**

The input status is recorded in a 100 µs cycle.

Filtered

The filtered status is transferred in a 100 µs cycle.

Filtering takes place asynchronously in an interval of 100 µs.

Digital input filter

Name:

X2CfO_DI_Filter

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 µs.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No SW filter |
| | 1 | 0.1 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

Input state of digital inputs 1 to 14

Name:

DigitalInput01 to DigitalInput14

These registers are used to indicate the input state of digital inputs 1 to 14.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure of register 4096:

| Bit | Name | Value | Information |
|-----|----------------|--------|---------------------------------|
| 0 | DigitalInput01 | 0 or 1 | Input status of digital input 1 |
| ... | ... | ... | ... |
| 7 | DigitalInput08 | 0 or 1 | Input status of digital input 8 |

Bit structure of register 4097:

| Bit | Name | Value | Information |
|-----|----------------|--------|----------------------------------|
| 0 | DigitalInput09 | 0 or 1 | Input status of digital input 9 |
| ... | ... | ... | ... |
| 5 | DigitalInput14 | 0 or 1 | Input status of digital input 14 |

9.28.2.16.4.2 Edge detection

Digital inputs 11 to 14 can be used for high-speed edge detection. This runs parallel to all other functions such as counters, etc. This function does not use the digital input filter.

The edge detection function measures edges with μs precision. 2 units are available. A master and a slave edge can be configured for each unit. At each master edge, the timestamp of the master edge and the differential time to the previous slave edge (if present) are logged. A "Master count" can always be utilized to determine how many edges have been detected since the last task class cycle. The timestamp is based on the system time of the CPU.

The combination of rising/falling edges of each channel can be used to configure the following functions for each unit:

| Function | Description |
|-----------------|---|
| Edge time | Measure an edge time |
| Period duration | Measure the master and differential time |
| Gate time | Measure the master and differential time |
| Time offset | Measure the master and differential time of edges on different channels |

Edge detection unit - Mode settings

The edge detection unit needs to be configured according to the desired function.

| Function | Description |
|--|---|
| Basic timestamp, master edge mode | The current system time is saved as the master time at the time of the edge. |
| Timestamp and/or differential time, master and slave edge mode | The slave edge starts the measurement and the system time is saved temporarily. When the master edge occurs, the current system time is saved as the master time and the difference between the master and slave edges is calculated. |

Name:

X2CfO_EdgeDetectUnit01Mode

X2CfO_EdgeDetectUnit02Mode

These registers are used to configure the mode of the basic function for either just the master edge or both master and slave edges.

| Data type | Value | Information |
|-----------|-------|---|
| USINT | 0x00 | Edge detection disabled on Unit0x: Time measurement not possible |
| | 0x80 | Edge detection enabled on Unit0x: Reaction only possible for master edge, no differential measurement possible |
| | 0xC0 | Edge detection enabled on Unit0x: Reaction possible for configured master and slave edges |

Edge detection unit - Selection of master edge

Name:

X2CfO_EdgeDetectUnit01Master

X2CfO_EdgeDetectUnit02Master

These registers are used to select the source of the master edge for the respective unit. Either the rising or falling edge of one of the 4 high-speed digital input channels can be selected. Only one edge can be selected for each unit.

| Data type | Value | Information |
|-----------|-------|--|
| USINT | 0 | Digital input channel 11: Rising edge |
| | 2 | Digital input channel 12: Rising edge |
| | 4 | Digital input channel 13: Rising edge |
| | 6 | Digital input channel 14: Rising edge |
| | 1 | Digital input channel 11: Falling edge |
| | 3 | Digital input channel 12: Falling edge |
| | 5 | Digital input channel 13: Falling edge |
| | 7 | Digital input channel 14: Falling edge |

Edge detection unit - Selection of slave edge

Name:

X2CfO_EdgeDetectUnit01Slave

X2CfO_EdgeDetectUnit02Slave

These registers are used to select the source of the slave edge for the respective unit. Either the rising or falling edge of one of the 4 high-speed digital input channels can be selected. Only one edge can be selected for each unit.

| Data type | Value | Information |
|-----------|-------|--|
| USINT | 0 | Digital input channel 11: Rising edge |
| | 2 | Digital input channel 12: Rising edge |
| | 4 | Digital input channel 13: Rising edge |
| | 6 | Digital input channel 14: Rising edge |
| | 1 | Digital input channel 11: Falling edge |
| | 3 | Digital input channel 12: Falling edge |
| | 5 | Digital input channel 13: Falling edge |
| | 7 | Digital input channel 14: Falling edge |

Edge detection unit - Master edge counter

Name:

EdgeDetect01Mastercount

EdgeDetect02Mastercount

These registers hold the counter values of the detected master edges. The counter value is used to detect new measurements.

| Data type | Value | Information |
|-----------|-----------------|--|
| INT | -32768 to 32767 | Running counter: Number of detected master edges |

Edge detection unit - Master edge timestamp

Name:

EdgeDetect01Mastertime

EdgeDetect02Mastertime

The exact CPU system time of the respective unit is saved to these registers when a master edge occurs. If multiple master edges occur within a single cycle (task class), then the time of the last edge is shown.

| Data type | Value | Information |
|-----------|---------------------------------|---|
| DINT | -2,147,483,648 to 2,147,483,647 | CPU system time of master edge [μ s] |

Edge detection unit - Time difference

Name:

EdgeDetect01Difference

EdgeDetect02Difference

The difference between the master edge and the slave edge of the respective unit is saved to these registers. If multiple measurement periods are completed within a single cycle (task class), then the time difference from the last period is shown.

| Data type | Value | Information |
|-----------|---------------------------------|---|
| DINT | -2,147,483,648 to 2,147,483,647 | Time difference between master edge and slave edge [μ s] |

9.28.2.16.4.3 Counter functions

High-speed digital inputs 11 to 14 can be used for counter functions. This function does not use the digital input filter. The following functions are available. Only one of these basic configurations can be enabled at a time:

- 2x event counter with latch function
- 2x AB incremental counter without latch function
- DF counter function
- ABR counter function

Configuring the counter function

The following counter functions can be configured:

| Counter function | Description |
|--|--|
| 2x event counter with latch function | Input 11 for event counter 1 and input 13 for event counter 2 can be used simultaneously as event counters. Both rising and falling edges are counted. The latch function of all 4 inputs can be used. |
| 2x AB incremental counter without latch function | Inputs 11 and 12 as AB counter 1 and inputs 13 and 14 as AB counter 2. Since no more high-speed inputs are available, the latch function is not available. |
| DF counter: Direction/Frequency with latch function | The D, F and R signals are linked to inputs 11, 12 and 13. Signal D defines the positive (Level = 0) or negative (Level = 1) counting direction. The latch function of all 4 inputs can be used. |
| ABR counter with latch function | The A, B and R signals are linked to inputs 11, 12 and 13. The latch function of all 4 inputs can be used. |

Name:

X2CfO_CounterMode

This register configures the counter function:

| Data type | Value | Information |
|-----------|-------|--|
| USINT | 0 | 2x event counter with latch function |
| | 1 | 2x AB incremental counter without latch function |
| | 2 | DF counter with latch function |
| | 3 | ABR counter with latch function |

Configuring the mode of the latch function

Name:

X2CfO_Latch01Mode

X2CfO_Latch02Mode

This register sets the mode of the latch function. The following latch functions can be configured:

| Latch function | Description |
|------------------------|--|
| Single shot latch mode | The latch function must be enabled/set. After a successful latch procedure the function must first be reset. Then it can be enabled again. |
| Continuous latch mode | The latch function only has to be enabled/set as long as latching is desired. |

A changed counter value on "LatchCount" indicates that the latch procedure has been performed (see "[Counter value of latch events](#)" on page 3426). The counter value is stored in the latch register (see "[Latched counter value](#)" on page 3426).

| Data type | Value | Information |
|-----------|-------|------------------------|
| USINT | 0 | Single shot latch mode |
| | 1 | Continuous latch mode |

Configuring the latch signals

Name:

X2CfO_Latch01Comparator

X2CfO_Latch02Comparator

This register defines the inputs and their level for triggering the latch procedure.

- This defines which inputs are linked to generate the latch event. All 4 digital input signals can be used for an "AND" connection.
- The "active voltage level" needed for the latch procedure can be defined to adjust for the physical signals. It is not possible to configure a high and low level at the same time.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Value | Information |
|-----|-------|--|
| 0 | 0 | Input 11 high level disabled |
| | 1 | Input 11 high level enabled for comparator |
| 1 | 0 | Input 12 high level disabled |
| | 1 | Input 12 high level enabled for comparator |
| 2 | 0 | Input 13 high level disabled |
| | 1 | Input 13 high level enabled for comparator |
| 3 | 0 | Input 14 high level disabled |
| | 1 | Input 14 high level enabled for comparator |
| 4 | 0 | Input 11 low level disabled |
| | 1 | Input 11 low level enabled for comparator |
| 5 | 0 | Input 12 low level disabled |
| | 1 | Input 12 low level enabled for comparator |
| 6 | 0 | Input 13 low level disabled |
| | 1 | Input 13 low level enabled for comparator |
| 7 | 0 | Input 14 low level disabled |
| | 1 | Input 14 low level enabled for comparator |

Clear counter value and enable/disable latch function

Name:

Counter01Reset

Counter02Reset

Latch01Enable

Latch02Enable

The respective bits in these registers clear the counter value or start the latch procedure.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------|-------|--------------------------|
| 0 | Counter0xReset | 0 | Do not reset the counter |
| | | 1 | Reset the counter |
| 1 | Latch0xEnable | 0 | Do not latch the counter |
| | | 1 | Latch the counter |
| 2 - 7 | Reserved | 0 | |

Counter value

Name:

Counter01Value

Counter02Value

The current counter values are saved in these registers.

| Data type | Value | Information |
|-----------|---------------------------------|-----------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | Current counter value |

Latched counter value

Name:

Counter01Latch

Counter02Latch

As soon as the latch conditions have been met, the value of the respective counter is copied to these registers.

| Data type | Value | Information |
|-----------|---------------------------------|-----------------------|
| DINT | -2,147,483,648 to 2,147,483,647 | Latched counter value |

Counter value of latch events

Name:

Latch01Count

Latch02Count

These registers hold the counter values of the latch events. This allows detection of whether a new latched counter value has been saved.

| Data type | Value | Information |
|-----------|-------------|--|
| SINT | -128 to 127 | Running counter: Number of detected latch events |

Timestamp of last counter change

Name:

Counter01TimeChanged

Counter02TimeChanged

The CPU system time at the time of the last change to the counter value is saved in these registers.

| Data type | Value | Information |
|-----------|---------------------------------|---|
| DINT | -2,147,483,648 to 2,147,483,647 | The CPU system time at the time of the last change to the counter value |

Timestamp of last valid counter value

Name:

Counter01TimeValid

Counter02TimeValid

The CPU system time at the time of the last valid counter value is saved in these registers.

| Data type | Value | Information |
|-----------|---------------------------------|--|
| DINT | -2,147,483,648 to 2,147,483,647 | CPU system time of current counter value |

9.28.2.16.5 Register overview of the I/O data points on the integrated X3 I/O slot

| Register | Name | Data type | Read | | Write | |
|---------------------------|-----------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| X3 - Configuration | | | | | | |
| 10240 | X3CfO_DI_Filter | USINT | | | | • |
| 10752 | X3CfO_Mov01Mode | USINT | | | | • |
| 10756 | X3CfO_Mov01SpeedLimit | UDINT | | | | • |
| 10768 | X3CfO_Mov02Mode | USINT | | | | • |
| 10772 | X3CfO_Mov02SpeedLimit | UDINT | | | | • |
| 12032 | X3CfO_PhylOConfigCh01 | USINT | | | | • |
| 12033 | X3CfO_PhylOConfigCh02 | USINT | | | | • |
| 12034 | X3CfO_PhylOConfigCh03 | USINT | | | | • |
| 12035 | X3CfO_PhylOConfigCh04 | USINT | | | | • |
| 12036 | X3CfO_PhylOConfigCh05 | USINT | | | | • |
| 12037 | X3CfO_PhylOConfigCh06 | USINT | | | | • |
| 12038 | X3CfO_PhylOConfigCh07 | USINT | | | | • |
| 12039 | X3CfO_PhylOConfigCh08 | USINT | | | | • |
| 12040 | X3CfO_PhylOConfigCh09 | USINT | | | | • |
| 12041 | X3CfO_PhylOConfigCh10 | USINT | | | | • |
| 12042 | X3CfO_PhylOConfigCh11 | USINT | | | | • |
| 12043 | X3CfO_PhylOConfigCh12 | USINT | | | | • |
| X3 - Communication | | | | | | |
| 8192 | Digital inputs | USINT | • | | | |
| | DigitalInput05 | Bit 0 | | | | |
| | DigitalInput06 | Bit 1 | | | | |
| | DigitalInput07 | Bit 2 | | | | |
| 8208 | Digital outputs | USINT | | | • | |
| | DigitalOutput01 | Bit 0 | | | | |
| | DigitalOutput02 | Bit 1 | | | | |
| | DigitalOutput03 | Bit 2 | | | | |
| | DigitalOutput04 | Bit 3 | | | | |
| | DigitalOutput05 | Bit 4 | | | | |
| | DigitalOutput06 | Bit 5 | | | | |
| 8209 | Digital outputs | USINT | | | • | |
| | DigitalOutput09 | Bit 0 | | | | |
| | DigitalOutput10 | Bit 1 | | | | |
| | DigitalOutput11 | Bit 2 | | | | |
| 8193 | Status feedback | USINT | • | | | |
| | StatusDigitalOutput01 | Bit 0 | | | | |
| | StatusDigitalOutput02 | Bit 1 | | | | |
| | StatusDigitalOutput03 | Bit 2 | | | | |
| | StatusDigitalOutput04 | Bit 3 | | | | |
| | StatusDigitalOutput05 | Bit 4 | | | | |
| | StatusDigitalOutput06 | Bit 5 | | | | |
| | StatusDigitalOutput07 | Bit 6 | | | | |
| 8194 | Status feedback | USINT | • | | | |
| | StatusDigitalOutput09 | Bit 0 | | | | |
| | StatusDigitalOutput10 | Bit 1 | | | | |
| | StatusDigitalOutput11 | Bit 2 | | | | |
| | StatusDigitalOutput12 | Bit 3 | | | | |
| 4864 | PWMPeriod09 | UINT | | | • | |
| 4866 | PWMOutput09 | INT | | | • | |
| 4880 | PWMPeriod10 | UINT | | | • | |
| 4882 | PWMOutput10 | INT | | | • | |
| 4896 | PWMPeriod11 | UINT | | | • | |
| 4898 | PWMOutput11 | INT | | | • | |
| 4912 | PWMPeriod12 | UINT | | | • | |
| 4914 | PWMOutput12 | INT | | | • | |
| 8704 | Movement 1 | USINT | | | • | |
| | Mov01Enable | Bit 1 | | | | |
| 8706 | Mov01Speed | INT | | | • | |
| 8708 | Mov01Position | DINT | • | | | |
| 8720 | Movement 2 | USINT | | | • | |
| | Mov02Enable | Bit 2 | | | | |
| 8722 | Mov02Speed | INT | | | • | |
| 8724 | Mov02Position | DINT | • | | | |
| 8196 | StatusInput01 | BOOL | • | | | |

9.28.2.16.5.1 Physical configuration of I/O channels

These registers are used to define the functionality of the channels. Depending on the desired configuration, the following assignments can be made with respect to the existing software and hardware:

- A physical configuration as input or output for mixed channels
- An explicit assignment as direct I/O channel: i.e. digital input or digital output
- An explicit assignment as PWM output
- An explicit assignment as D or F movement output
- An explicit assignment for reACTION Technology

Information:

For all input signals of slots X1 and X2, explicit assignment is not necessary, since the channels can be read simultaneously from the I/O map and reACTION Technology.

Physical configuration

Name:

X3CfO_PhylIOConfigCh01 to X3CfO_PhylIOConfigCh12

These registers are used to configure the functionality of the channels.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

Name:

X3CfO_PhylIOConfigCh01 to X3CfO_PhylIOConfigCh04

Channels 1 to 4 are digital outputs and can only be used as direct I/O channel or for reACTION Technology.

| Bit | Description | Value | Information |
|-------|-------------|-------|-----------------------------------|
| 0 - 5 | Reserved | 0 | |
| 6 | | 0 | Direct I/O operation of output |
| | | 1 | Operation via reACTION Technology |
| 7 | Reserved | 0 | |

Name:

X3CfO_PhylIOConfigCh05 to X3CfO_PhylIOConfigCh08

Channels 5 to 8 are digital mixed channels and can be configured as either input or output. They can be operated either as direct I/O channels or via reACTION Technology.

| Bit | Description | Value | Information |
|-------|-------------|-------|-----------------------------------|
| 0 - 1 | | 00 | Configured as digital output |
| | | 01 | Reserved |
| | | 10 | Reserved |
| | | 11 | Configured as digital input |
| 2 - 5 | Reserved | 0 | |
| 6 | | 0 | Direct I/O operation of output |
| | | 1 | Operation via reACTION Technology |
| 7 | Reserved | 0 | |

Name:

X3CfO_PhylIOConfigCh09 to X3CfO_PhylIOConfigCh12

Channels 9 to 12 are high-speed digital outputs and can be configured as direct I/O, PWM or movement channels or used for reACTION Technology.

| Bit | Description | Value | Information |
|-------|-------------|-------|-----------------------------------|
| 0 - 3 | Reserved | 0 | |
| 4 - 6 | | 000 | Direct I/O operation of output |
| | | 001 | Output operated as PWM |
| | | 010 | Reserved |
| | | 011 | Output operated as D/F movement |
| | | 100 | Operation via reACTION Technology |
| | | 101 | Reserved |
| | | 110 | Reserved |
| | | 111 | Reserved |
| 7 | Reserved | 0 | |

9.28.2.16.5.2 Monitoring of the I/O power supply voltage

Name:

StatusInput01

The state of the I/O supply voltage is indicated in this register.

| Data type | Values | Information |
|-----------|--------|--|
| USINT | 0 | I/O power supply voltage within permissible range |
| | 1 | I/O power supply voltage not connected or outside of the permissible range |

9.28.2.16.5.3 Digital inputs**Unfiltered**

The input status is recorded in a 100 µs cycle.

Filtered

The filtered status is transferred in a 100 µs cycle.

Filtering takes place asynchronously in an interval of 100 µs.

Digital input filter

Name:

X3CfO_DI_Filter

This register can be used to specify the filter value for all digital inputs.

The filter value can be configured in steps of 100 µs.

| Data type | Value | Filter |
|-----------|-------|---|
| USINT | 0 | No SW filter |
| | 1 | 0.1 ms |
| | ... | ... |
| | 250 | 25 ms - Higher values are limited to this value |

Input state of digital inputs 5 to 8

Name:

DigitalInput05 to DigitalInput08

This register indicates the input state of digital inputs 5 to 8.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|--------|---------------------------------|
| 0 | DigitalInput05 | 0 or 1 | Input status of digital input 5 |
| ... | | ... | |
| 3 | DigitalInput08 | 0 or 1 | Input status of digital input 8 |

9.28.2.16.5.4 Digital outputs

The output status is processed in a 100 µs cycle.

Switching state of digital outputs 1 to 12

Name:

DigitalOutput01 to DigitalOutput12

These registers are used to store the switching state of digital outputs 1 to 12.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

Register 8208:

| Bit | Description | Value | Information |
|-----|-----------------|-------|------------------------|
| 0 | DigitalOutput01 | 0 | Digital output 1 reset |
| | | 1 | Digital output 1 set |
| ... | | ... | |
| 7 | DigitalOutput08 | 0 | Digital output 8 reset |
| | | 1 | Digital output 8 set |

Register 8209:

| Bit | Description | Value | Information |
|-----|-----------------|-------|-------------------------|
| 0 | DigitalOutput09 | 0 | Digital output 9 reset |
| | | 1 | Digital output 9 set |
| ... | | ... | |
| 3 | DigitalOutput12 | 0 | Digital output 12 reset |
| | | 1 | Digital output 12 set |

9.28.2.16.5.5 Monitoring status of the digital outputs

The error states of the outputs must be programmed in the application. The status information that is read is the actual voltage state on the channel (set or reset). The error state is therefore determined by a difference between the data points "DigitalOutputxx" and the corresponding "StatusDigitalOutputxx".

At least 3 system ticks are needed internally to read the output status. This is the reason for the delay after which the earliest possible comparison can be made after a change in the status of the output.

The digital input filter is not applied to this status information.

Status of digital outputs 1 to 12

Name:

StatusDigitalOutput01 to StatusDigitalOutput12

These registers are used to indicate the status of digital outputs 1 to 12.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

Register 8193:

| Bit | Description | Value | Information |
|-----|-----------------------|-------|---|
| 0 | StatusDigitalOutput01 | 0 | Channel 1: Digital output reset or short circuit |
| | | 1 | Channel 1: Digital output set or voltage feedback |
| ... | | ... | |
| 7 | StatusDigitalOutput08 | 0 | Channel 8: Digital output reset or short circuit |
| | | 1 | Channel 8: Digital output set or voltage feedback |

Register 8194:

| Bit | Description | Value | Information |
|-----|-----------------------|-------|--|
| 0 | StatusDigitalOutput09 | 0 | Channel 9: Digital output reset or short circuit |
| | | 1 | Channel 9: Digital output set or voltage feedback |
| ... | | ... | |
| 3 | StatusDigitalOutput12 | 0 | Channel 12: Digital output reset or short circuit |
| | | 1 | Channel 12: Digital output set or voltage feedback |

9.28.2.16.5.6 Pulse width modulation (PWM) function

Digital inputs 9 to 12 can be configured as PWM outputs. 2 data points are available per channel for controlling the PWM signal.

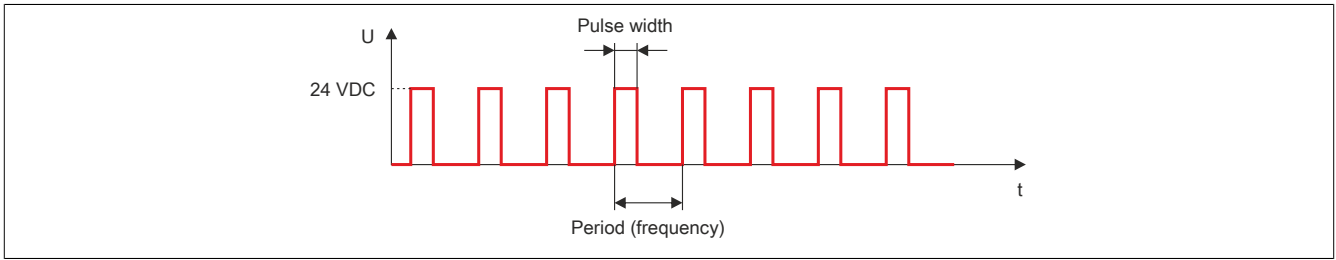


Figure 307: The PWM signal is controlled by setting the pulse width and period duration

Period duration of the PWM outputs

Name:

PWMPeriod09 to PWMPeriod12

These registers are used to define the duration of the period duration, i.e. the time base for the respective PWM output. This time represents the 100% value, which can be resolved to 0.1% through the duty cycle.

| Data type | Value | Information |
|-----------|------------|--|
| UINT | 5 to 65535 | Period duration, between 5 and 65535 μ s: Corresponds to a frequency of 200 kHz to \approx 15 Hz |

Duty cycle of the PWM outputs

Name:

PWMOutput09 to PWMOutput12

These registers output the duty cycle of the respective PWM output in a resolution of 0.1% of the period duration.

| Data type | Value | Information |
|-----------|-----------|---|
| INT | 0 to 1000 | Duty cycle of the output in 0 to 100.0% |

Example: Period duration T [μ s] with a duty cycle of 25% equals a duty time of t_1 [μ s].

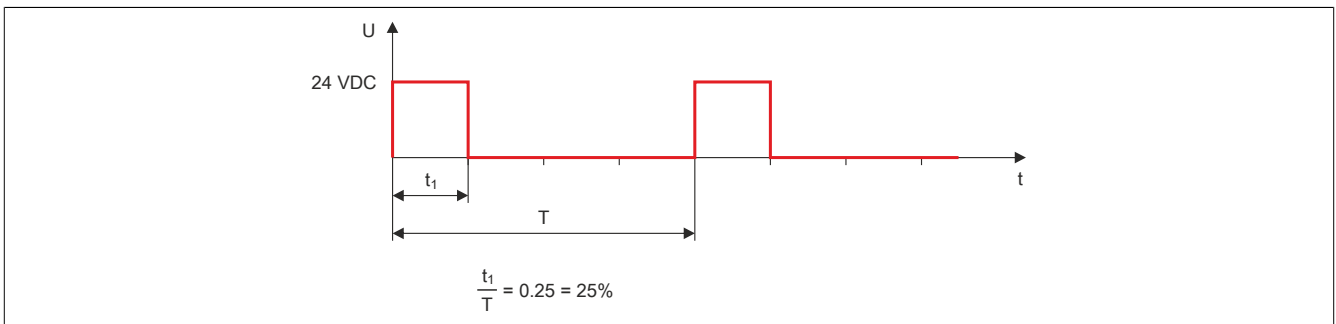


Figure 308: Switch-on time depending on the period duration and duty cycle

9.28.2.16.5.7 DF movement generator function

Digital output channels 9 to 12 can be configured as 2 independently functioning movement generators (Direction/Frequency) for stepper motor control. The movement generators are assigned to the following channels:

| Movement generator | Channel | Function |
|--------------------|---------|--------------|
| 1 | DO 9 | D: Direction |
| | DO 10 | F: Frequency |
| 2 | DO 11 | D: Direction |
| | DO 12 | F: Frequency |

The frequency is output via the respective F channel, and the direction is output via the respective D channel. The switchover between directions (movement/counter) takes place via the sign of the speed setpoint.

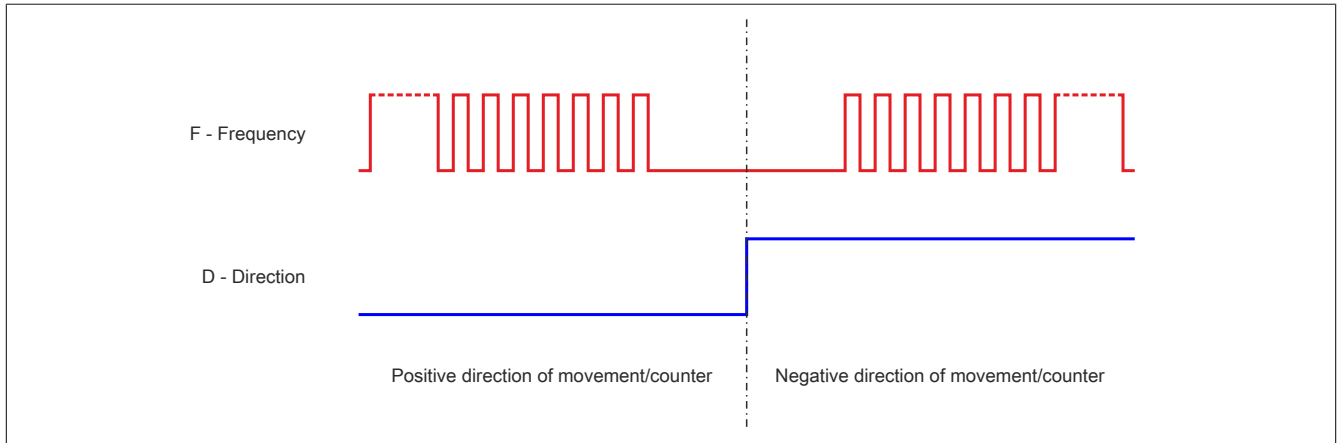


Figure 309: Frequency output via F channel, direction output via D channel

The respective output must be configured correctly in order to completely process the motion function (see ["Physical configuration" on page 3428](#)).

The data points described below are available for configuring and controlling the respective movements.

Configuring the movement mode

Name:

X3Cfo_Mov01Mode

X3Cfo_Mov02Mode

These registers are used to configure how the speed setpoint is interpreted. The difference between the two modes is whether edges or periods are output for each increment of the setpoint.

| Data type | Value | Information |
|-----------|-------|---|
| USINT | 0 | Edge mode: Each increment generates an edge on the output |
| | 1 | Pulse mode: Each increment generates a period on the output |

Edge mode

4 increments of the speed setpoint correspond to 2 periods on the output:

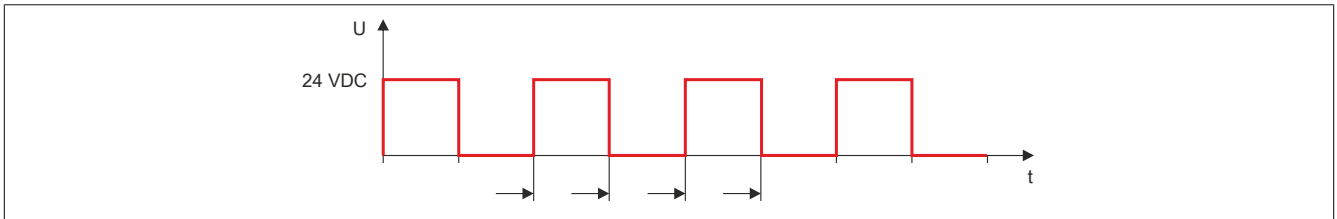


Figure 310: Interpretation of the speed setpoint with edge output for each increment

Pulse mode

2 increments of the speed setpoint correspond to 2 periods on the output:

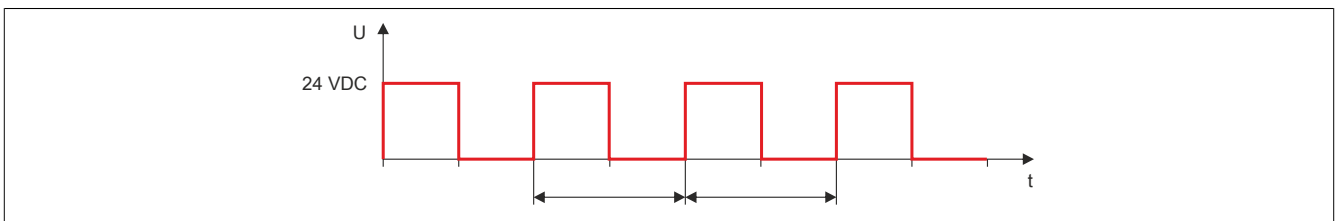


Figure 311: Interpretation of the speed setpoint with period output for each increment

Configuring the maximum speed of the movement

The maximum speed or output frequency of the movement is configured in order to protect the digital output, the actuator/drive being controlled and/or the mechanical system.

Name:

X3Cfo_Mov01SpeedLimit

X3Cfo_Mov02SpeedLimit

These registers are used to configure the maximum speed / output frequency permitted in the system. It is important that the limit values for edge and pulse mode are different.

Edge mode

| Data type | Value | Information |
|-----------|--------------|-------------------------------|
| UDINT | 10 to 400000 | Speed [increments per second] |

Pulse mode

| Data type | Value | Information |
|-----------|-------------|-------------------------------|
| UDINT | 5 to 200000 | Speed [increments per second] |

Activates the movement

When a movement is active, the two channels are operated according to the preset values.

Name:

Mov01Enable

Mov02Enable

These registers are used to enable or disable the motion function.

Mov01Enable

| Data type | Value | Information |
|-----------|-------|---|
| USINT | 0 | Movement 1 disabled |
| | 2 | Movement 1 enabled: The speed setpoint is evaluated |

Mov02Enable

| Data type | Value | Information |
|-----------|-------|---|
| USINT | 0 | Movement 2 disabled |
| | 4 | Movement 2 enabled: The speed setpoint is evaluated |

Speed and direction control of the movement

The following parameters are important for speed and direction control of the movement:

| Characteristic value | Description |
|----------------------------------|---|
| Speed control | The predefined speed is specified as a percentage of the configured maximum speed. 0 to ± 32767 correspond to 0 to $\pm 100\%$ of the configured maximum speed |
| Direction control | The direction of movement is defined by the sign of the speed setpoint: 0 to +32767 correspond to 0 to the maximum speed in the positive direction of movement 0 to -32767 correspond to 0 to the maximum speed in the negative direction of movement |
| Resolution of the speed setpoint | The resolution of the speed setpoint is: $\text{Maximum speed} / 32767$ |
| Relationship: Speed / Frequency | The relationship between speed and output frequency is: $(\text{Speed setpoint} / \text{Maximum speed}) * 32767$ |

Table 593: Parameters for speed and direction control of the movement

Name:

Mov01Speed

Mov02Speed

These registers are used to set the speed of the movement.

| Data type | Value | Information |
|-----------|-------------|--|
| INT | 0 to 32767 | Speed setpoint 0 to 100%: Movement output F = 0 to maximum speed Positive direction of movement: Movement output D = 0 |
| | 0 to -32767 | Speed setpoint 0 to 100%: Movement output F = 0 to maximum speed Negative direction of movement: Movement output D = 1 |

Position feedback for movement

The position feedback is represented by a fixed point value [16.16]:

- HighWord = whole number increments
- LowWord = positions after the decimal of the increments

Name:

Mov01Position

Mov02Position

These registers show the current position of the movement.

| Data type | Value | Information |
|-----------|---------------------------------|--|
| DINT | -2,147,483,648 to 2,147,483,647 | Position value in fixed point format [16.16] |

9.28.2.16.6 reACTION Technology

All integrated I/O channels are reACTION-capable and can be operated by the reACTION program. These I/O channels are controlled with a response time up to 1 μ s. All of the commands that can be used for reACTION programs are provided as function blocks in special libraries (e.g. AsIORTI). Programming using the standard Function Block Diagram (FBD) editor in Automation Studio is compliant with IEC 61131-3.

When using the "reACTION" function, an individual reACTION program must be created. This makes it possible to manage individual machine tasks decentrally and with extremely short reaction times. Interaction registers are used to exchange information between the CPU and the reACTION program.



9.28.2.16.6.1 Register overview - reACTION Technology

| Register | Name | Data type | Read | | Write | |
|--|--|---|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| reACTION - Configuration | | | | | | |
| 772 | ReActionCycleTimeValue | DINT | | | | • |
| 780 | ReActionCycleTimeMultiplier | DINT | | | | • |
| Index * 8 + 252 | CfO_PARType01 to CfO_PARType04 | UDINT | | | | • |
| reACTION - Function block configuration | | | | | | |
| 512 | CfO_Config_ABR1 | UDINT | | | | • |
| 16777732 | CfO_ScalingIncrements_ABR1 | UDINT | | | | • |
| 33554952 | CfO_ScalingUnits_ABR1 | UDINT | | | | • |
| 528 | CfO_ChannelMapping1_ABR1 | UDINT | | | | • |
| 532 | CfO_ChannelMapping2_ABR1 | UDINT | | | | • |
| reACTION - Communication | | | | | | |
| 129 | reACTION - Control byte RTEnable | USINT Bit 0 | | | • | |
| 145 | reACTION - Status byte RTEngineRun RTCycleTimeOverrun RTFileInvalid RTFunctionInvalid RTInstanceInvalid RTFileNotLoaded | USINT Bit 0 Bit 1 Bit 4 Bit 5 Bit 6 Bit 7 | • | | | |
| 154 | RTCycleCounter | UINT | • | | | |
| 150 | RTCycleTime | UINT | • | | | |
| reACTION - Interaction | | | | | | |
| Index * 8 + 4095 | PAR01 to PAR32 PAR01_Bit1 to PAR32_Bit1 PAR01_Bit2 to PAR32_Bit2 PAR01_Bit3 to PAR32_Bit3 PAR01_Bit4 to PAR32_Bit4 PAR01_Bit5 to PAR32_Bit5 PAR01_Bit6 to PAR32_Bit6 PAR01_Bit7 to PAR32_Bit7 PAR01_Bit8 to PAR32_Bit8 | (U)SINT Bit 0 Bit 1 Bit 2 Bit 3 Bit 4 Bit 5 Bit 6 Bit 7 | | | • | |
| Index * 8 + 4094 | PAR01 to PAR32 | (U)INT | | | • | |
| Index * 8 + 4092 | PAR01 to PAR32 | (U)DINT | | | • | |
| Index * 8 + 5119 | RES01 to RES32 RES01_Bit1 to RES32_Bit1 RES01_Bit2 to RES32_Bit2 RES01_Bit3 to RES32_Bit3 RES01_Bit4 to RES32_Bit4 RES01_Bit5 to RES32_Bit5 RES01_Bit6 to RES32_Bit6 RES01_Bit7 to RES32_Bit7 RES01_Bit8 to RES32_Bit8 | (U)SINT Bit 0 Bit 1 Bit 2 Bit 3 Bit 4 Bit 5 Bit 6 Bit 7 | • | | | |
| Index * 8 + 5118 | RES01 to RES32 | (U)INT | • | | | |
| Index * 8 + 5116 | RES01 to RES32 | (U)DINT | • | | | |
| Index * 4 + 2044 | PVAR1 to PVAR256 | DINT | | | | • |
| Index * 4 + 2044 | RVAR1 to RVAR256 | DINT | | • | | |

9.28.2.16.6.2 reACTION - Configuration

The reACTION program is executed with its own time base. The desired cycle time must be defined. If the cycle time cannot be achieved, the reACTION program is executed with the smallest possible cycle time.

Configuring the cycle time

The following 2 registers are used to define the desired cycle time for the reACTION program. The "TimeValue" register contains the value, while the "Multiplier" register contains the associated units.

Name:

ReActionCycleTimeMultiplier

This register must be set to a fixed value of 1000, which sets the units to [μ s].

| Data type | Value |
|-----------|-------|
| DINT | 1000 |

Name:

ReActionCycleTimeValue

The cycle time of the reACTION program is set using this register.

| Data type | Value |
|-----------|----------------------|
| DINT | 1 to 1000 [μ s] |

Configuring the PAR data points

Name:

CfO_PARType01 to CfO_PARType04

PAR data points can be defined for the reACTION program. In order to enable them, the desired data type must be made known according to the configuration in Automation Studio.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|-----------------|-------|-------------|
| 0 - 3 | Type01 - PAR 1 | 0000 | Inactive |
| | Type02 - PAR 9 | 0001 | USINT, BOOL |
| | Type03 - PAR 17 | 0010 | UINT |
| | Type04 - PAR 25 | 0011 | UDINT |
| 4 - 7 | Type01 - PAR 2 | 0100 | Reserved |
| | Type02 - PAR 10 | 0101 | SINT |
| | Type03 - PAR 18 | 0110 | INT |
| | Type04 - PAR 26 | 0111 | DINT |
| 8 - 11 | Type01 - PAR 3 | 1000 | Reserved |
| | Type02 - PAR 11 | 1001 | Reserved |
| | Type03 - PAR 19 | 1010 | Reserved |
| | Type04 - PAR 27 | 1011 | Reserved |
| 12 - 15 | Type01 - PAR 4 | 1100 | Reserved |
| | Type02 - PAR 12 | 1101 | Reserved |
| | Type03 - PAR 20 | 1110 | Reserved |
| | Type04 - PAR 28 | 1111 | Reserved |
| 16 - 19 | Type01 - PAR 5 | | |
| | Type02 - PAR 13 | | |
| | Type03 - PAR 21 | | |
| | Type04 - PAR 29 | | |
| 20 - 23 | Type01 - PAR 6 | | |
| | Type02 - PAR 14 | | |
| | Type03 - PAR 22 | | |
| | Type04 - PAR 30 | | |
| 24 - 27 | Type01 - PAR 7 | | |
| | Type02 - PAR 15 | | |
| | Type03 - PAR 23 | | |
| | Type04 - PAR 31 | | |
| 28 - 31 | Type01 - PAR 8 | | |
| | Type02 - PAR 16 | | |
| | Type03 - PAR 24 | | |
| | Type04 - PAR 32 | | |

9.28.2.16.6.3 reACTION function blocks - General

The following table provides an overview of I/O channel assignments to reACTION function blocks.

Digital inputs/outputs

| Channel | Function block | | |
|-----------------|-----------------------|-------------|----------------------|
| | Mapping ¹⁾ | rtiDin | rtiDout, rtiDoutTime |
| X1: DI 1 | 0x00 | Channel 101 | |
| X1: DI 2 | 0x01 | Channel 102 | |
| X1: DI 3 | 0x02 | Channel 103 | |
| X1: DI 4 | 0x03 | Channel 104 | |
| X2: DI 1 | 0x08 | Channel 201 | |
| X2: DI 2 | 0x09 | Channel 202 | |
| X2: DI 3 | 0x0A | Channel 203 | |
| X2: DI 4 | 0x0B | Channel 204 | |
| X2: DI 5 | 0x0C | Channel 205 | |
| X2: DI 6 | 0x0D | Channel 206 | |
| X2: DI 7 | 0x0E | Channel 207 | |
| X2: DI 8 | 0x0F | Channel 208 | |
| X2: DI 9 | 0x10 | Channel 209 | |
| X2: DI 10 | 0x11 | Channel 210 | |
| X2: DI 11 | 0x12 | Channel 211 | |
| X2: DI 12 | 0x13 | Channel 212 | |
| X2: DI 13 | 0x14 | Channel 213 | |
| X2: DI 14 | 0x15 | Channel 214 | |
| X3: DO 1 | 0x00 | | Channel 301 |
| X3: DO 2 | 0x01 | | Channel 302 |
| X3: DO 3 | 0x02 | | Channel 303 |
| X3: DO 4 | 0x03 | | Channel 304 |
| X3: DI 5 / DO 5 | 0x04 | Channel 305 | Channel 305 |
| X3: DI 6 / DO 6 | 0x05 | Channel 306 | Channel 306 |
| X3: DI 7 / DO 7 | 0x06 | Channel 307 | Channel 307 |
| X3: DI 8 / DO 8 | 0x07 | Channel 308 | Channel 308 |
| X3: DO 9 | 0x08 | | Channel 309 |
| X3: DO 10 | 0x09 | | Channel 310 |
| X3: DO 11 | 0x0A | | Channel 311 |
| X3: DO 12 | 0x0B | | Channel 312 |

- 1) The "Mapping" specification is needed in the event that multiple physical inputs/outputs must be grouped together in order to be processed by a reACTION function block (e.g. rtiABRPos) (see "reACTION function blocks - Configuration" on page 3440).

Analog inputs

| Channel | Function block | | |
|----------|-----------------------|-----------|---------|
| | Mapping ¹⁾ | rtiAin | rtiAout |
| X1: AI 1 | 0x00 | Channel 1 | |
| X1: AI 2 | 0x01 | Channel 2 | |

- 1) The "Mapping" specification is needed in the event that multiple physical inputs/outputs must be grouped together in order to be processed by a reACTION function block (e.g. rtiABRPos) (see "reACTION function blocks - Configuration" on page 3440).

9.28.2.16.6.4 reACTION function blocks - Configuration

Some function blocks in library AsIoRti must be configured before they can be used.

| Function block | Information |
|----------------|--|
| rtiABRPos | The module offers the option of using function block rtiABRPos once in the reACTION program. To do so, the function block must be assigned 3 digital inputs that are no longer available for rtiDin. |
| rtiABCnt | The module offers the option of using function block rtiABCnt up to 3 times in the reACTION program. To do so, the function blocks must be assigned 2 digital inputs as an A or B track that are no longer available for rtiDin. In addition, an external event can be defined for each rtiABCnt function block. The input used for this is also no longer available for rtiDin. |

Table 594: List of function blocks requiring prior configuration

Function blocks rtiABRPos and rtiABCnt

Function blocks rtiABRPos and rtiABCnt can be used to process the position value of an ABR incremental encoder in a reACTION task. Several hardware channels of the module are used for this. The incoming signals are interpreted by the reACTION engine and converted into a location.

The update rate depends on both the reACTION engine and the hardware used. The reACTION engine is basically able to calculate positions with an update rate of up to 8 MHz. The input frequencies of the hardware inputs can be taken from the technical data of the respective module.

These function blocks can be used separately or in combination.

Using function block rtiABRPos

The following points are important to keep in mind when using function block rtiABRPos in a reACTION program:

- The function block can only be used once in a reACTION program.
- 3 digital inputs must be defined on the module for input signals A, B and R.
- In addition, a digital input of the module can be defined as an event input.

Example diagram of input signals:

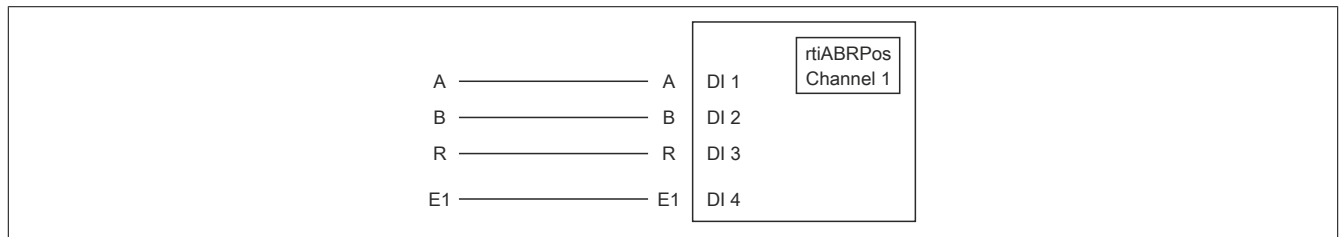


Figure 312: Schematic diagram of input signals for rtiABRPos

Using function block rtiABCnt

The following points must be taken into account when using function block rtiABCnt in a reACTION program:

- The function block can be used up to 3 times in a reACTION program.
- 2 digital inputs must be defined on the module for input signals A and B.
- In addition, up to 3 digital inputs on the module can be defined as event inputs E1, E2 and E3.

Example diagram of input signals:

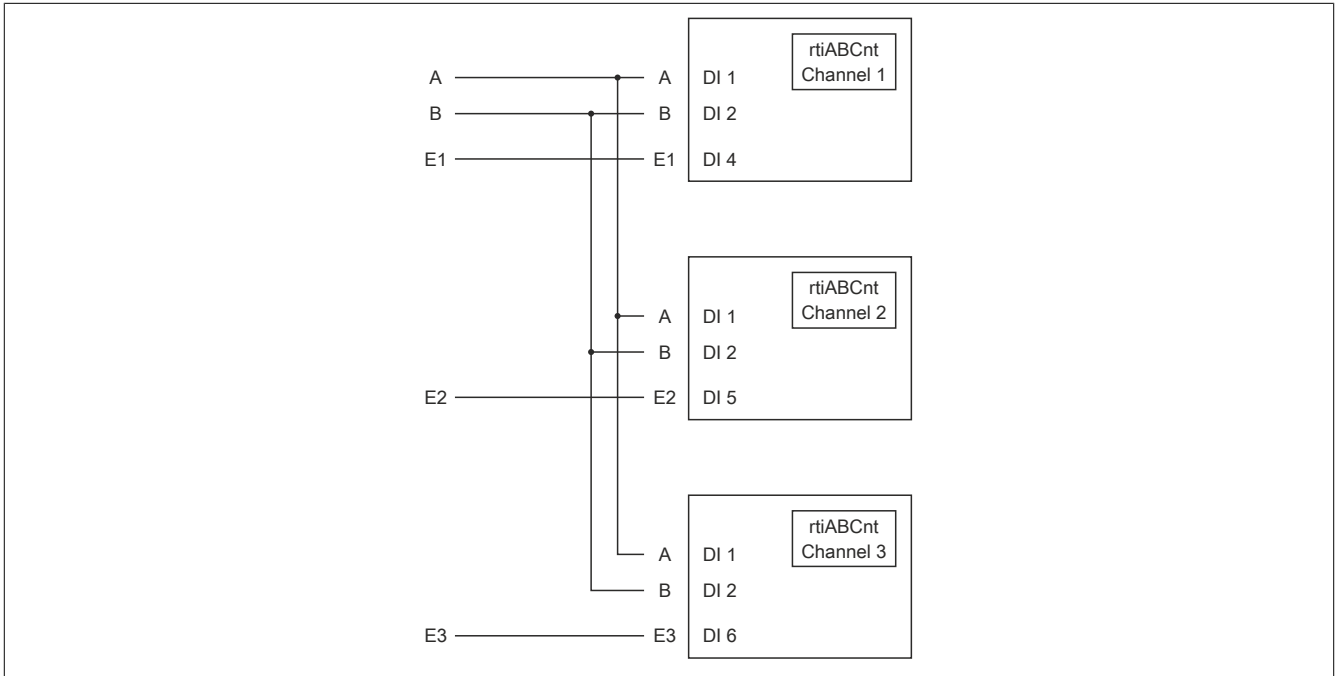


Figure 313: Schematic diagram of input signals for rtiABCnt

Using function blocks rtiABRPos and rtiABCnt in combination

The following points should be kept in mind when using function blocks rtiABRPos and rtiABCnt together in a reACTION program.

- Function block rtiABRPos can only be used once in a reACTION program.
- Function block rtiABCnt can be used up to 2 times in a reACTION program.
- 3 digital inputs must be defined for input signals A, B and R (rtiABRPos).
- The same digital inputs are used for input signals A and B (rtiABCnt).
- In addition, up to 3 event inputs E1, E2 and E3 can be defined (rtiABCnt).
- E1 is used for the event input (rtiABRPos).

Example diagram of input signals:

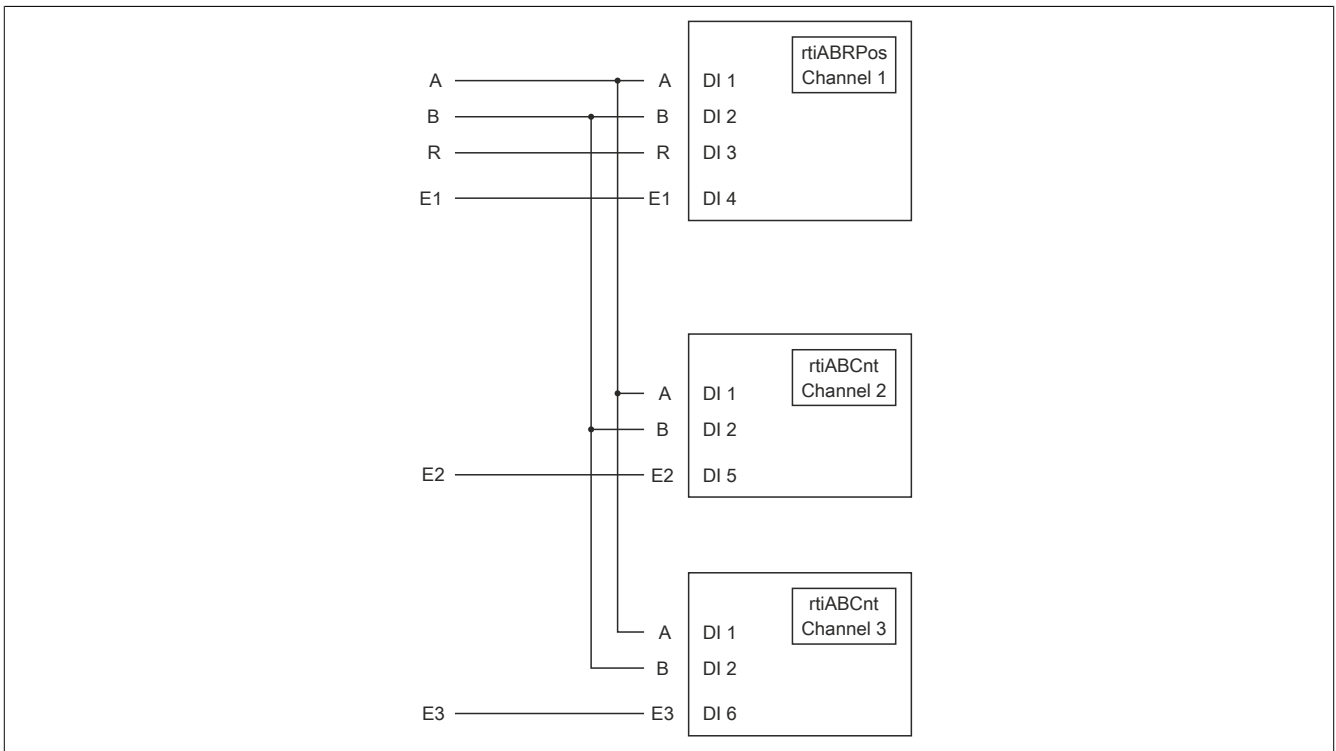


Figure 314: Diagram of input signals when using rtiABRPos and rtiABCnt at the same time

Registering the position encoder (rtiABRPos/rtiABCnt)

Name:

CfO_Config_ABR1

This register specifies the technical characteristics of the connected ABR incremental encoder.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|--|------------|---|
| 0 - 15 | Increments per revolution | 0 to 65535 | Reference pulse monitoring: If the reference pulse is different than defined here, this is indicated on the status output of function block rtiABRPos. |
| 16 | Inversion of the counting direction set by signals A and B | 0 | Positive counting direction |
| | | 1 | Negative counting direction |
| 17 - 31 | Reserved | 0 | |

Wiring the position encoder (rtiABRPos/rtiABCnt)

Name:

CfO_ChannelMapping1_ABR1

CfO_ChannelMapping2_ABR1

Before function blocks rtiABRPos/rtiABCnt can be processed by the reACTION engine, the hardware inputs to be used by the ABR incremental encoder must be defined on the module. The "ChannelMapping" registers specify which inputs are interpreted as the A, B, R, E1, E2 and E3 signals.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure of CfO_ChannelMapping1_ABR1:

| Bit | Description | Value | Information |
|---------|-------------|----------|---------------------------------------|
| 0 - 7 | Input E1 | 0 | Mapped to digital input 1 |
| | | 1 | Mapped to digital input 2 |
| | | ... | ... |
| | | 7 | Mapped to digital input 8 |
| | | 8 to 255 | Reserved |
| 8 - 15 | Input R | 0 to 255 | For possible values, see bits 0 to 7. |
| 16 - 23 | Input B | 0 to 255 | For possible values, see bits 0 to 7. |
| 24 - 31 | Input A | 0 to 255 | For possible values, see bits 0 to 7. |

Bit structure of CfO_ChannelMapping2_ABR1:

| Bit | Description | Value | Information |
|---------|-------------|----------|---|
| 0 - 15 | Reserved | 0 | |
| 16 - 23 | Input E3 | 0 | Mapped to digital input 1 |
| | | 1 | Mapped to digital input 2 |
| | | ... | ... |
| | | 7 | Mapped to digital input 8 |
| | | 8 to 255 | Reserved |
| 24 - 31 | Input E2 | 0 to 255 | For possible values, see bits 16 to 23. |

Information:

For information about the relationship between the input on the module and the channel name, see section "reACTION function blocks - General".

Scaling the position encoder (rtiABRPos)

Name:

CfO_ScalingUnits_ABR1

CfO_ScalingIncrements_ABR1

An optional gear ratio can be configured using registers "Units" and "Increments". The dividend for scaling is defined in register "Units"; the divisor is defined in register "Increments".

| Data type | Value | Information |
|-----------|--------------------|--|
| UDINT | 0 to 4,294,967,295 | CfO_ScalingUnits_ABR1: Units per interval CfO_ScalingIncrements_ABR1: Increments per interval |

Formula for calculation

$$\text{Gear ratio} = \text{ScalingUnits} / \text{ScalingIncrements}$$
Example 1

ScalingUnits = 1

ScalingIncrements = 1

$$\text{Position value (Pos)} = \text{ABR increments} * \text{ScalingUnits} / \text{ScalingIncrements}$$

$$\text{Position value (Pos)} = \text{ABR increments} * 1/1$$

In this example, the ABR position value is output unchanged on output "Pos".

Example 2

ScalingUnits = 10

ScalingIncrements = 4

$$\text{Position value (Pos)} = \text{ABR increments} * \text{ScalingUnits} / \text{ScalingIncrements}$$

$$\text{Position value (Pos)} = \text{ABR increments} * 10/4$$

In this example, the ABR position value is multiplied by 2.5 and output on output "Pos".

Information:

The encoder values are calculated internally as INT64 values in 32.32 format. On output "Pos" of function block "rtiABRPos", only the whole number value (INT32) is output for the user. The fixed point decimal places are used internally to calculate a higher resolution.

9.28.2.16.6.5 reACTION - Communication

During runtime, the reACTION program is started and stopped via the program sequence in the CPU. Once the reACTION program has been started, it is executed independently of the program sequence in the CPU.

Controlling the reACTION program

Name:
RTEnable

The reACTION program is started and stopped using this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|-----------------------------|
| 0 | RTEnable | 0 | Stops the reACTION program |
| | | 1 | Starts the reACTION program |
| 1 - 7 | Reserved | - | |

reACTION module status messages

Name:
RTEngineRun
RTCycleTimeOverrun
RTFileInvalid
RTFunctionInvalid
RTInstanceInvalid
RTFileNotLoaded

This register is used to output various status messages.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|---|-------|--|
| 0 | RTEngineRun | 0 | reACTION program inactive |
| | | 1 | reACTION program active |
| 1 | RTCycleTimeOverrun | 0 | Configured RT cycle time observed |
| | | 1 | RT cycle time configuration too short |
| 2 - 3 | Reserved | - | |
| 4 | RTFileInvalid Invalid reACTION program preloaded | 0 | reACTION program OK in RAM |
| | | 1 | reACTION program invalid in RAM |
| 5 | RTFunctionInvalid Invalid software function | 0 | reACTION program okay |
| | | 1 | reACTION program requesting invalid function block |
| 6 | RTInstanceInvalid Invalid hardware instance | 0 | reACTION program okay |
| | | 1 | reACTION program requesting invalid I/O |
| 7 | RTFileNotLoaded | 0 | Valid reACTION program in reACTION processor |
| | | 1 | Loaded reACTION program invalid |

Cycle counter for the active reACTION program

Name:
RTCycleCounter

This register shows how many times the reACTION program has been executed.

| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

Cycle time of the active reACTION program

Name:
RTCycleTime

This register shows how much time the reACTION module needs to cycle through the loaded program once.

| Data type | Value |
|-----------|--|
| UINT | The resolution of the value shown is 10 ns: 0 to 655.35 [µs] |

9.28.2.16.6.6 reACTION - Interaction

Once started, the reACTION program in the module runs independently. It reads the mappings of the required inputs and manages the outputs assigned to it. In addition, the reACTION program can interact with the CPU. There are 3 different data point types available for this:

| Data point | Description |
|------------|---|
| PAR | Used to transfer information from the CPU to the reACTION program. Data is transferred cyclically. |
| RES | Used to transfer information from the reACTION program to the CPU. Data is transferred cyclically. |
| VAR | VAR data points are transferred non-cyclically. <ul style="list-style-type: none"> PVAR data points: Information transferred from the CPU to the reACTION program RVAR data points: Feedback from reACTION program to the CPU |

PAR data points

Name:

PAR01 to PAR32

PAR01_Bit1 to PAR32_Bit1

PAR01_Bit2 to PAR32_Bit2

PAR01_Bit3 to PAR32_Bit3

PAR01_Bit4 to PAR32_Bit4

PAR01_Bit5 to PAR32_Bit5

PAR01_Bit6 to PAR32_Bit6

PAR01_Bit7 to PAR32_Bit7

PAR01_Bit8 to PAR32_Bit8

Once enabled, the PAR data points are transported cyclically. They are used to transfer information from the CPU to the reACTION program. They can be used to intervene in the execution of the reACTION program.

Information:

PAR data points DO NOT control the outputs directly!

| Data type | Value |
|---------------|------------------------------------|
| (U)SINT, BOOL | Corresponds to the range of values |
| (U)INT | |
| (U)DINT | |

| Register | Name | Data type | Read | | Write | |
|------------------|--------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Index * 8 + 4095 | PAR01 to PAR32 | (U)SINT | | | • | |
| | PAR01_Bit1 to PAR32_Bit1 | Bit 0 | | | | |
| | PAR01_Bit2 to PAR32_Bit2 | Bit 1 | | | | |
| | PAR01_Bit3 to PAR32_Bit3 | Bit 2 | | | | |
| | PAR01_Bit4 to PAR32_Bit4 | Bit 3 | | | | |
| | PAR01_Bit5 to PAR32_Bit5 | Bit 4 | | | | |
| | PAR01_Bit6 to PAR32_Bit6 | Bit 5 | | | | |
| | PAR01_Bit7 to PAR32_Bit7 | Bit 6 | | | | |
| | PAR01_Bit8 to PAR32_Bit8 | Bit 7 | | | | |
| Index * 8 + 4094 | PAR01 to PAR32 | (U)INT | | | • | |
| Index * 8 + 4092 | PAR01 to PAR32 | (U)DINT | | | • | |

RES data points

Name:

RES01 to RES32

RES01_Bit1 to RES32_Bit1

RES01_Bit2 to RES32_Bit2

RES01_Bit3 to RES32_Bit3

RES01_Bit4 to RES32_Bit4

RES01_Bit5 to RES32_Bit5

RES01_Bit6 to RES32_Bit6

RES01_Bit7 to RES32_Bit7

RES01_Bit8 to RES32_Bit8

Once enabled, the RES data points are transported cyclically. They are used to transfer information from the reACTION program to the CPU. They can be used to monitor execution of the reACTION program.

Information:**RES data points DO NOT map the inputs directly!**

| Data type | Value |
|---------------|------------------------------------|
| (U)SINT, BOOL | Corresponds to the range of values |
| (U)INT | |
| (U)DINT | |

| Register | Name | Data type | Read | | Write | |
|------------------|--------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Index * 8 + 5119 | RES01 to RES32 | (U)SINT | • | | | |
| | RES01_Bit1 to RES32_Bit1 | Bit 0 | | | | |
| | RES01_Bit2 to RES32_Bit2 | Bit 1 | | | | |
| | RES01_Bit3 to RES32_Bit3 | Bit 2 | | | | |
| | RES01_Bit4 to RES32_Bit4 | Bit 3 | | | | |
| | RES01_Bit5 to RES32_Bit5 | Bit 4 | | | | |
| | RES01_Bit6 to RES32_Bit6 | Bit 5 | | | | |
| | RES01_Bit7 to RES32_Bit7 | Bit 6 | | | | |
| | RES01_Bit8 to RES32_Bit8 | Bit 7 | | | | |
| Index * 8 + 5118 | RES01 to RES32 | (U)INT | • | | | |
| Index * 8 + 5116 | RES01 to RES32 | (U)DINT | • | | | |

PVAR and RVAR data points

Name:

PVAR1 to PVAR256

RVAR1 to RVAR256

In addition to PAR and RES data points, PVAR/RVAR data points can also be defined in the reACTION program. They are a direct component of the reACTION program and can be accessed acyclically by the CPU.

Like the PAR and RES data points, the PVAR data points are used to transfer information from the CPU to the reACTION program. The RVAR data points are used to transfer feedback from the reACTION program to the CPU.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

| Register | Name | Data type | Read | | Write | |
|------------------|------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Index * 4 + 2044 | PVAR1 to PVAR256 | DINT | | | | • |
| Index * 4 + 2044 | RVAR1 to RVAR256 | DINT | | • | | |

9.28.3 X20RT8001

Data sheet version: 1.24

9.28.3.1 General information

This reACTION technology module has four high-speed digital inputs and four high-speed digital mixed channels. All connections are designed for 1-wire connections. All inputs are designed for sink connections, the outputs for push-pull connections.

Ultrafast reACTION Technology makes it possible to control the integrated I/O channels with response times down to 1 μ s. All of the commands that can be used for reACTION programs are provided as function blocks in special libraries (e.g. AsIORTI). Programming in compliance with IEC 61131-3 requirements takes place in the Function Block Diagram editor in Automation Studio.

The module supports blackout mode. In blackout mode, programmable module functionality persists even if the network fails.

- reACTION technology module
- 4 high-speed digital inputs
- 4 high-speed digital channels, configurable as inputs or outputs
- 1 ABR incremental encoder input 24 V
- Pulse width modulation
- 24 VDC and GND for encoder supply
- Supports blackout mode



9.28.3.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | reACTION Technology modules |  |
| X20RT8001 | X20 reACTION module, 4 digital inputs, 24 VDC, <1 μ s, 4 digital channels, 24 VDC, 0.1 A, <1 μ s, configurable as inputs or outputs, reACTION Technology module | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 595: X20RT8001 - Order data

9.28.3.3 Technical data

| | |
|--|---|
| Model number | X20RT8001 |
| Short description | |
| I/O module | 4 digital input channels, 4 digital channels configurable as inputs or outputs, reACTION Technology |
| General information | |
| B&R ID code | 0xE559 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Outputs | Yes, using status LED and software (output error status) |
| reACTION-capable I/O channels | Yes |
| Blackout mode | |
| Scope | Module |
| Function | Programmable |
| Standalone mode | No |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1 W |
| Additional power dissipation caused by actuators (resistive) [W] | +0.6 |
| Type of signal lines ¹⁾ | Shielded cables must be used for all signal lines, cable length: Max. 20 m |
| Application memory | |
| Type | 64 Mbit flash memory |
| Data retention | 20 years at 55°C |
| Guaranteed erase/write cycles | 100,000 |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| Encoder power supply | |
| Output voltage | 24 VDC -15% / +20% |
| Output current ²⁾ | Module-internal, max. 600 mA |
| Short-circuit proof, overload protection | Yes |
| Digital inputs | |
| Quantity | 4 inputs and 4 mixed channels, configurable as inputs or outputs using software |
| Nominal voltage | 24 VDC |
| Input voltage | 24 VDC -15% / +20% |
| Input current at 24 VDC | Typ. 1.3 mA |
| Input circuit | Sink |
| Input filter | |
| Hardware | <3 µs |
| Software | Default 200 ns, configurable between 200 ns and 5 ms in 10 ns intervals |
| Connection type | 1-wire connections |
| Input resistance | 18.16 kΩ |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| ABR incremental encoder | |
| Quantity | 2 |
| Encoder inputs | 24 V, asymmetrical |
| Counter size | 32-bit |
| Input frequency | Max. 333 kHz |
| Evaluation | 4x |
| Digital outputs | |
| Quantity ²⁾ | 4 mixed channels, configurable as inputs or outputs using software |
| Variant | Push-Pull |
| Nominal voltage | 24 VDC |
| Switching voltage | 24 VDC -15% / +20% |
| Nominal output current | 100 mA |
| Total nominal current | 400 mA |
| Connection type | 1-wire connections |
| Output circuit | Sink or source |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short circuit current") |
| Diagnostic status | Output monitoring with delay <700 ns |

Table 596: X20RT8001 - Technical data

| Model number | X20RT8001 | |
|---|--|--|
| Leakage current when switched off | Approx. 25 µA | |
| $R_{DS(on)}$ | 140 mΩ | |
| Residual voltage | <0.4 V at nominal current 100 mA | |
| Max. continuous current | 100 mA | |
| Peak short-circuit current | <10 A | |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 3 ms | |
| Switching delay | | |
| 0 → 1 | <1 µs | |
| 1 → 0 | <1 µs | |
| Switching frequency | | |
| Resistive load | Min. 50 kHz, max. 500 kHz | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitation | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating and hardware configuration" | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x terminal block X20TB12 separately Order 1x bus module X20BM11 separately | |
| Spacing | 12.5 ^{+0.2} mm | |

Table 596: X20RT8001 - Technical data

- 1) See section "X20 shielding brackets".
- 2) See section "Derating and hardware configuration".

9.28.3.4 LED status indicators

For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.


| Figure | LED | Color | Status | Description |
|---|------------|-----------------------------|------------------|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode or blackout mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring of digital outputs has been triggered. |
| | | | Double flash | Supply voltage not in valid range or no reACTION program loaded |
| | | | Triple flash | Test of internal memory failed (limited functionality, module must be replaced) |
| | | | On | Error or reset state (reACTION program using functions or channels that are not permitted on this hardware) |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1, 2, 5, 6 | Green | | Input state of the corresponding digital input |
| | 3, 4, 7, 8 | Green | | Input or output status of the corresponding digital input or output |

Table 597: LED status indicators (X1)

- 1) A firmware update can take several minutes depending on the configuration.

9.28.3.5 Pinout

To prevent crosstalk, each individual signal line should be shielded. The maximum cable length is 20 m.

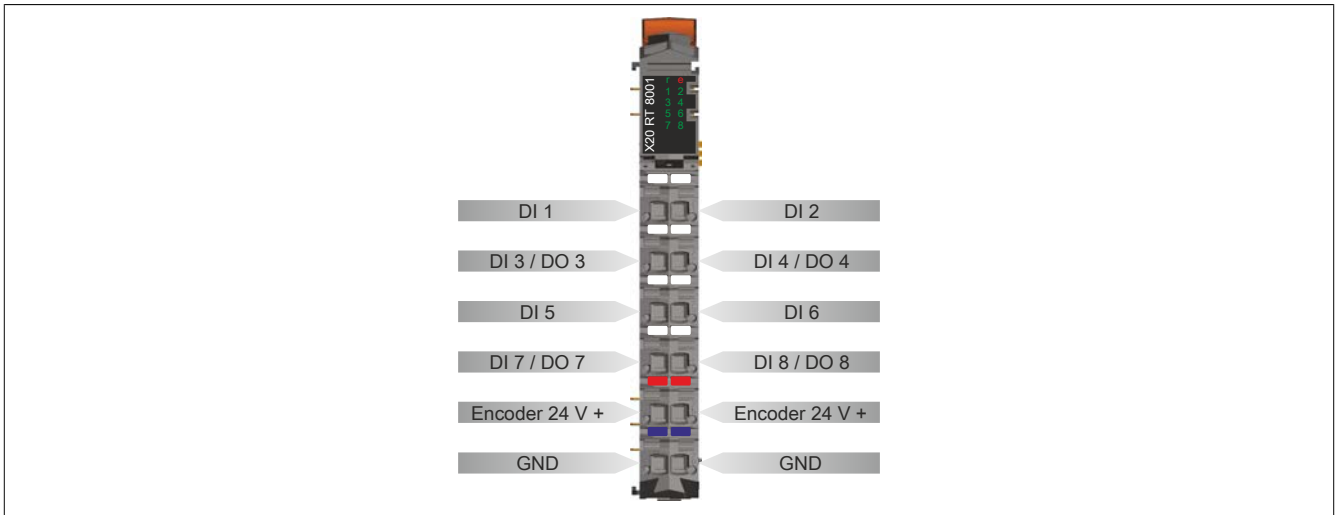


Figure 315: Pinout (X1)

9.28.3.6 Local I/O channels

The following table provides an overview of the connections to the I/O channels.

Digital inputs/outputs

| Connection | Terminal connection | Channel |
|------------|---------------------|-------------|
| X1 | 11 | DI 1 |
| | 21 | DI 2 |
| | 12 | DI 3 / DO 3 |
| | 22 | DI 4 / DO 4 |
| | 13 | DI 5 |
| | 23 | DI 6 |
| | 14 | DI 7 / DO 7 |
| | 24 | DI 8 / DO 8 |

The following section describes assigning I/O channels in a reACTION program:

| I/O channels | Assignment |
|----------------------|--|
| Digital I/O channels | Assignment of digital inputs/outputs |

9.28.3.7 Connection examples

Digital inputs and digital outputs

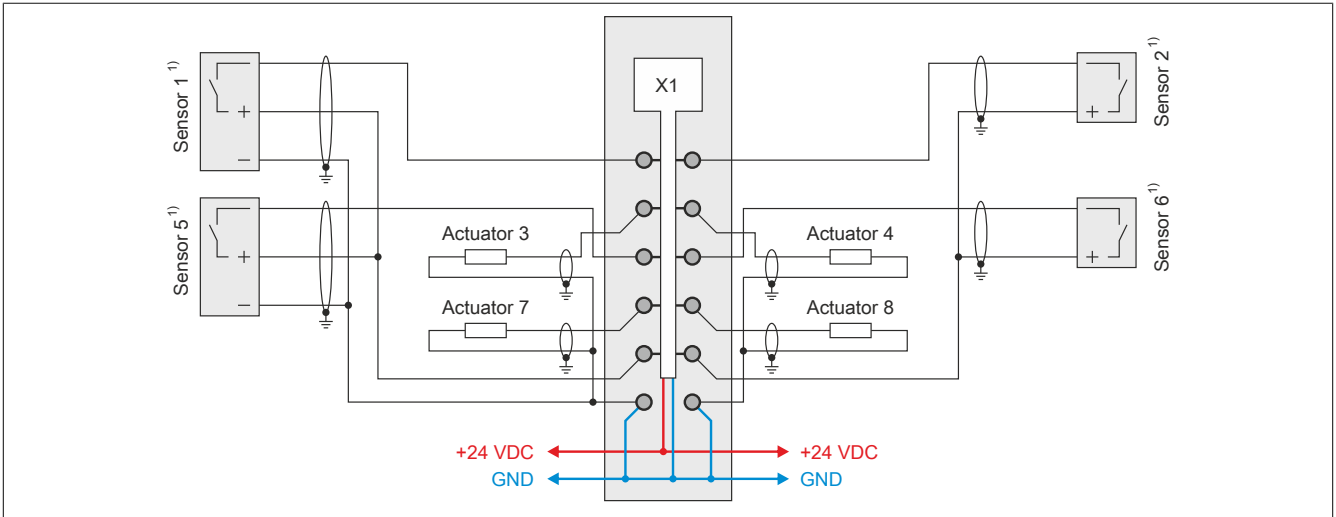


Figure 316: Connection example 1 (X1)

- 1) Observe the wiring guidelines from the sensor manufacturer.

Digital inputs, PWM and ABR incremental encoder

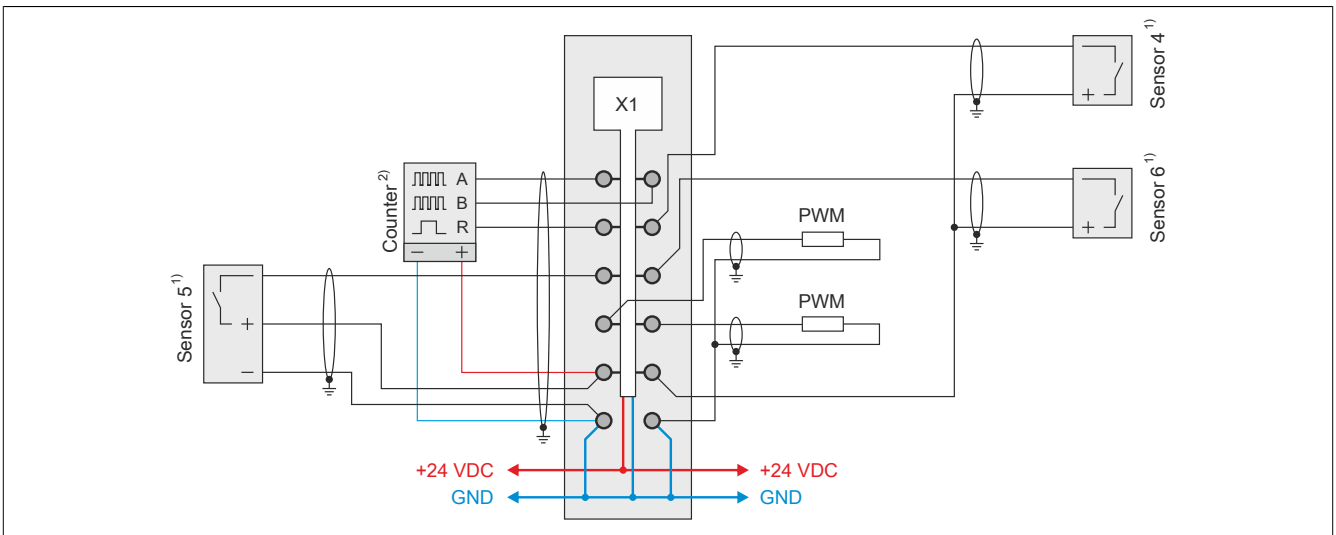


Figure 317: Connection example 2 (X1)

- 1) Observe the wiring guidelines from the sensor manufacturer.
- 2) Observe the wiring guidelines from the encoder manufacturer.

9.28.3.8 Input/Output circuit diagram

9.28.3.8.1 Digital inputs (X1)

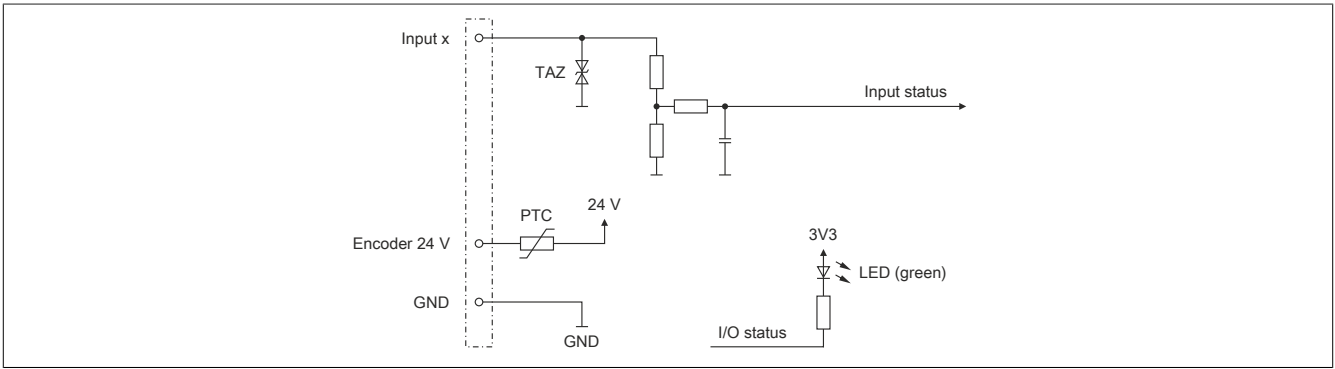


Figure 318: Input circuit diagram of digital inputs (X1)

9.28.3.8.2 Digital mixed channels (X1)

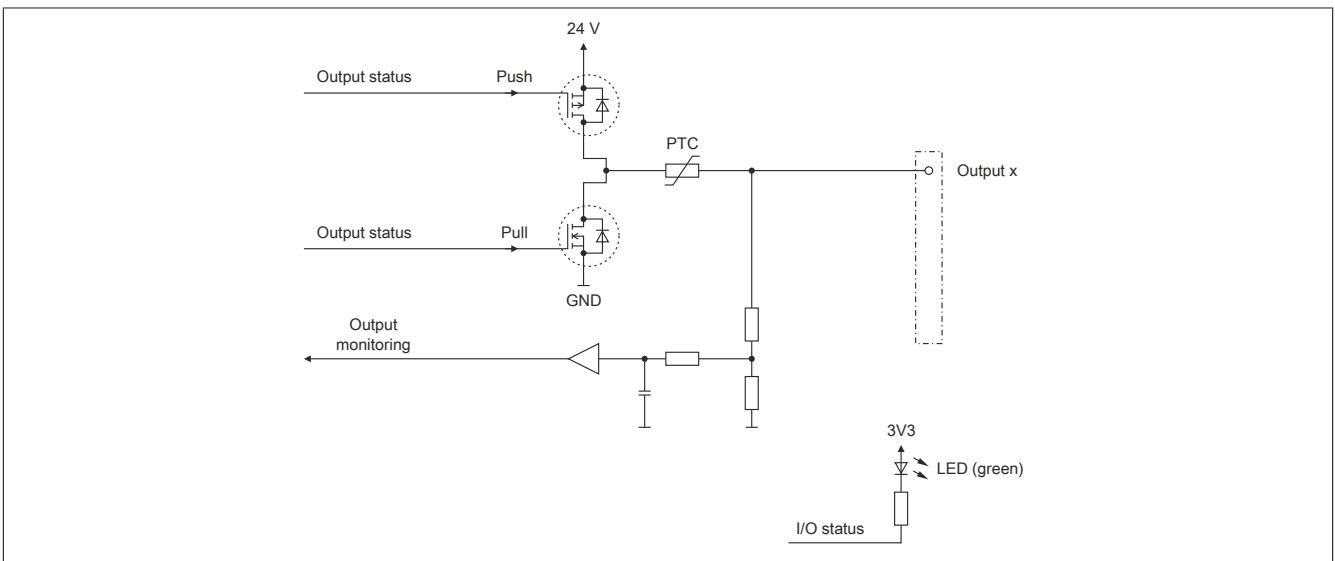


Figure 319: Input/Output circuit diagram of digital mixed channels (X1)

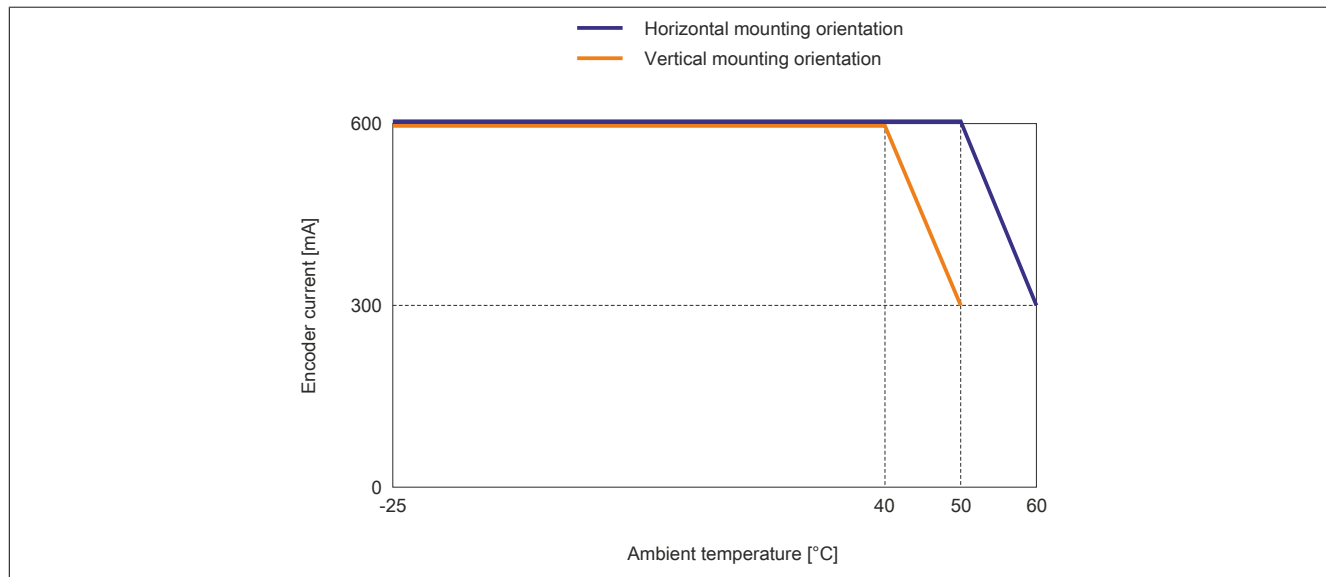
9.28.3.9 Derating and hardware configuration

To ensure proper operation, observe the points listed below:

- Derating of the encoder current
- Number of operable digital outputs
- Hardware configurations

9.28.3.9.1 Derating of the encoder current

Observe the following derating values for the encoder current depending on the mounting orientation:



9.28.3.9.2 Number of operable digital outputs

Depending on the mounting orientation, not all 4 digital outputs of the module can be operated starting at a certain ambient temperature.

Information:

To ensure operation of the module with the ambient temperatures listed below, it is absolutely necessary to disconnect channels.

Reducing the output current per channel does not increase the number of digital output channels that can be operated in the corresponding ambient temperature class.

Horizontal installation

| Ambient temperature | Number of operable digital outputs |
|---------------------|------------------------------------|
| <45°C | 4 |
| Starting at 45°C | 3 |
| Starting at 55°C | 2 |

Vertical installation

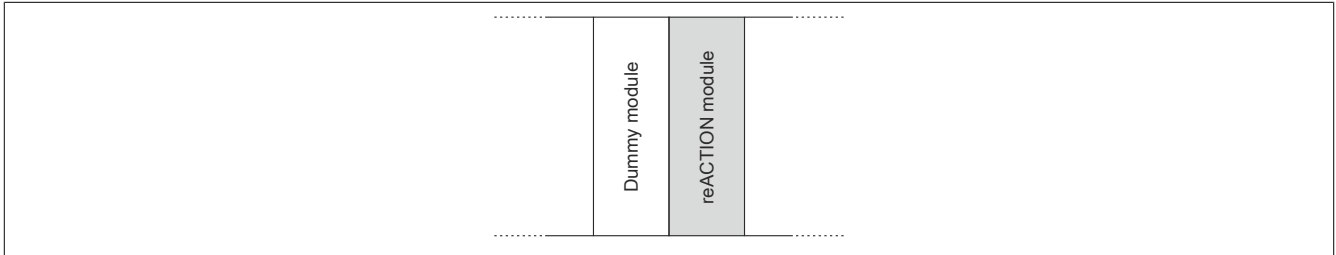
| Ambient temperature | Number of operable digital outputs |
|---------------------|------------------------------------|
| <35°C | 4 |
| Starting at 35°C | 3 |
| Starting at 45°C | 2 |

9.28.3.9.3 Hardware configuration for horizontal installation

9.28.3.9.3.1 Hardware configuration starting at an ambient temperature of 50°C

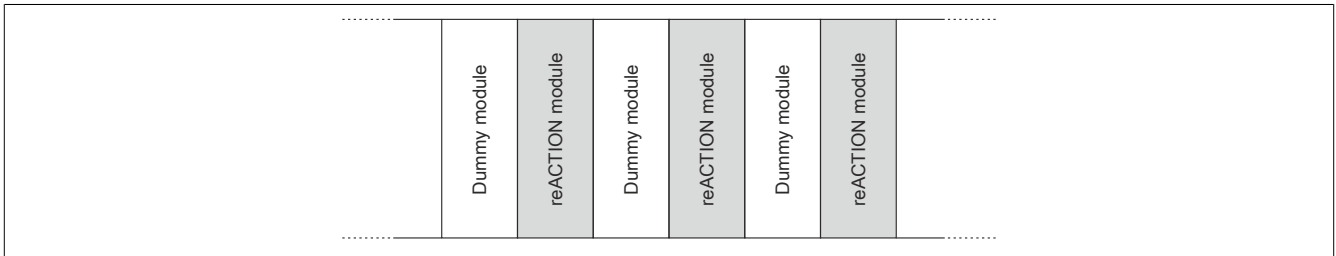
Operating a reACTION module

Starting at an ambient temperature of 50°C, a dummy module must be connected to the left of the reACTION module if installed horizontally.



Operating multiple reACTION modules side by side

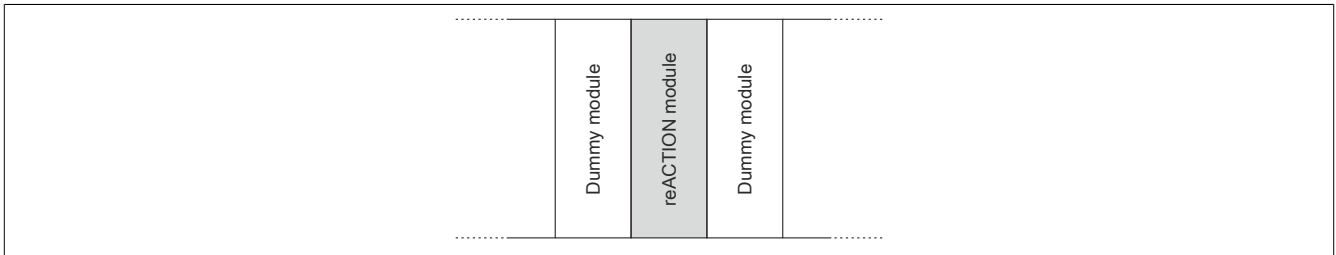
If 2 or more horizontal reACTION modules are being operated in a cluster, the following arrangement of modules must be observed.



9.28.3.9.3.2 Hardware configuration starting at an ambient temperature of 55°C

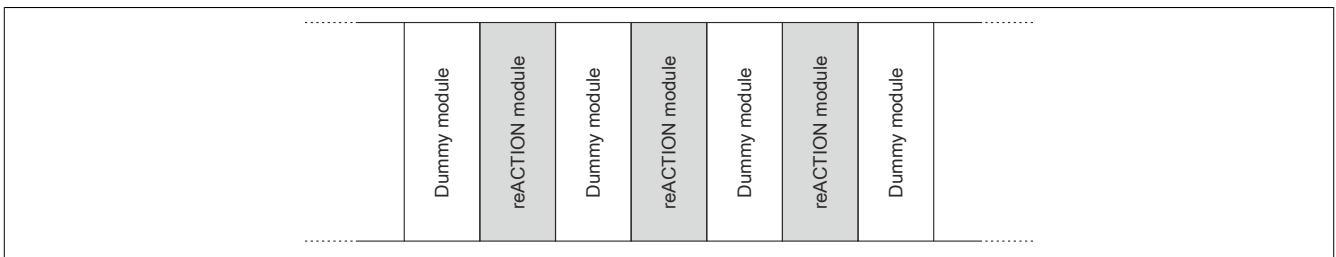
Operating a reACTION module

Starting at an ambient temperature of 55°C, a dummy module must be connected to the left and right of the reACTION module if installed horizontally.



Operating multiple reACTION modules side by side

If 2 or more horizontal reACTION modules are being operated in a cluster, the following arrangement of modules must be observed.

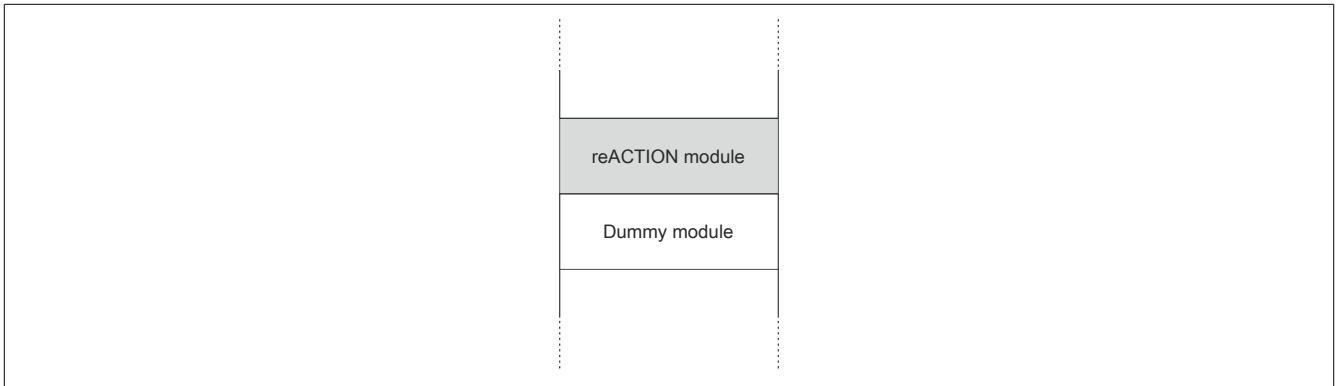


9.28.3.9.4 Hardware configuration for vertical installation

9.28.3.9.4.1 Hardware configuration starting at an ambient temperature of 40°C

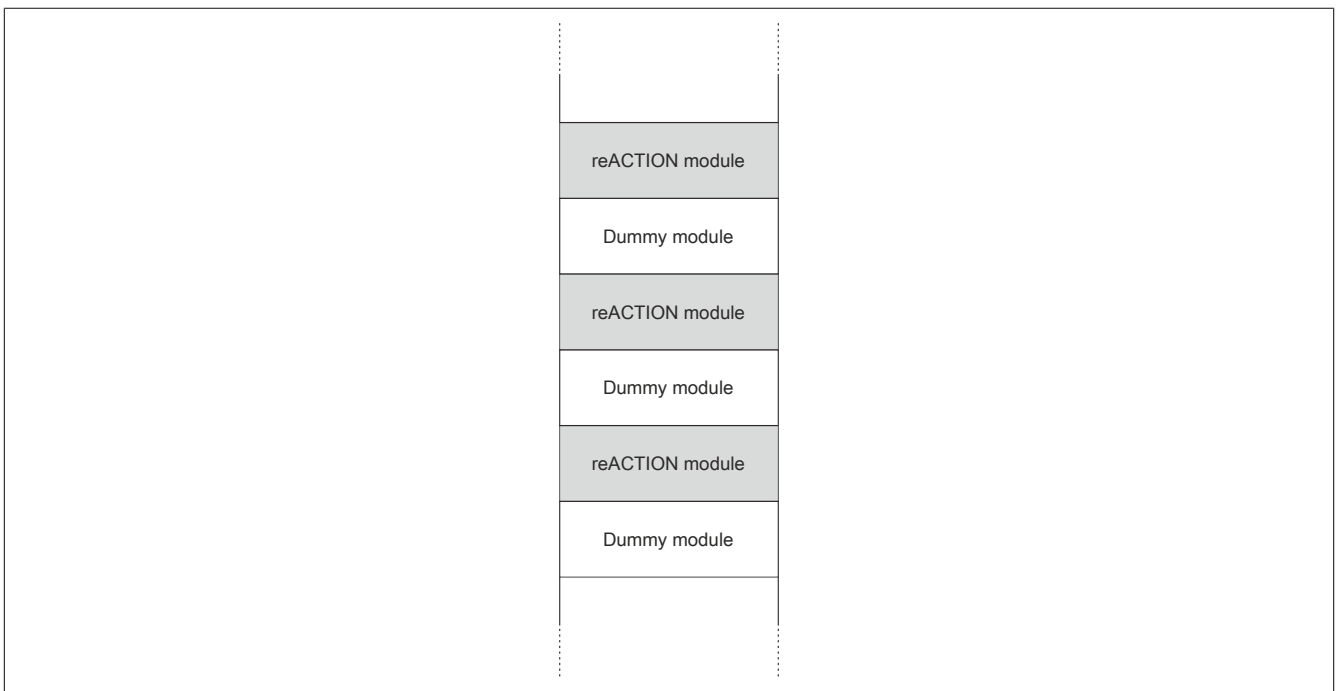
Operating a reACTION module

At ambient temperatures starting at 40°C, a dummy module must be installed below the reACTION module if installed vertically.



Operating multiple reACTION modules side by side

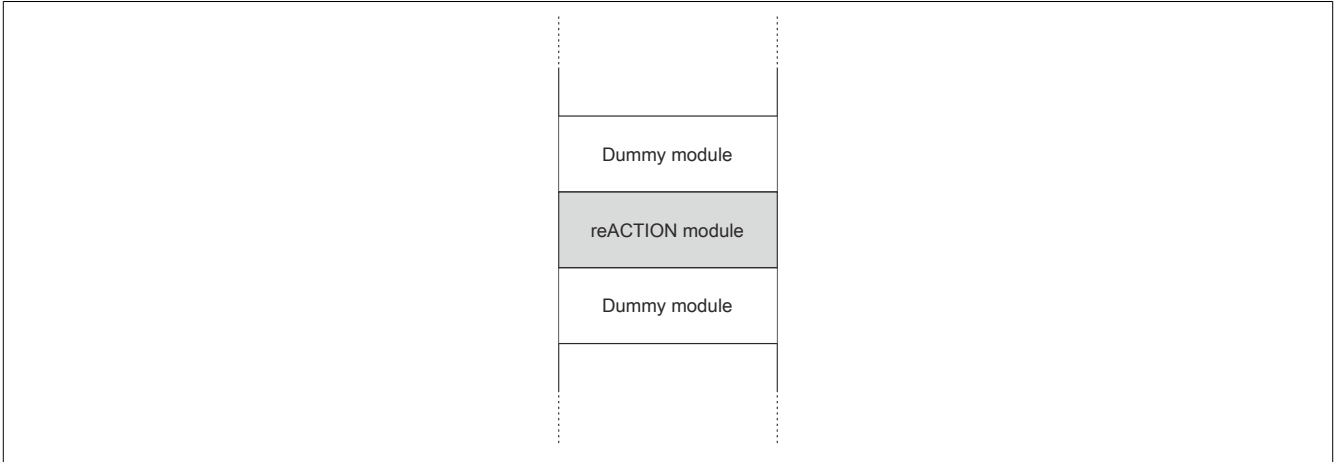
If 2 or more vertical reACTION modules are being operated in a cluster, the following arrangement of modules must be observed.



9.28.3.9.4.2 Hardware configuration starting at an ambient temperature of 45°C

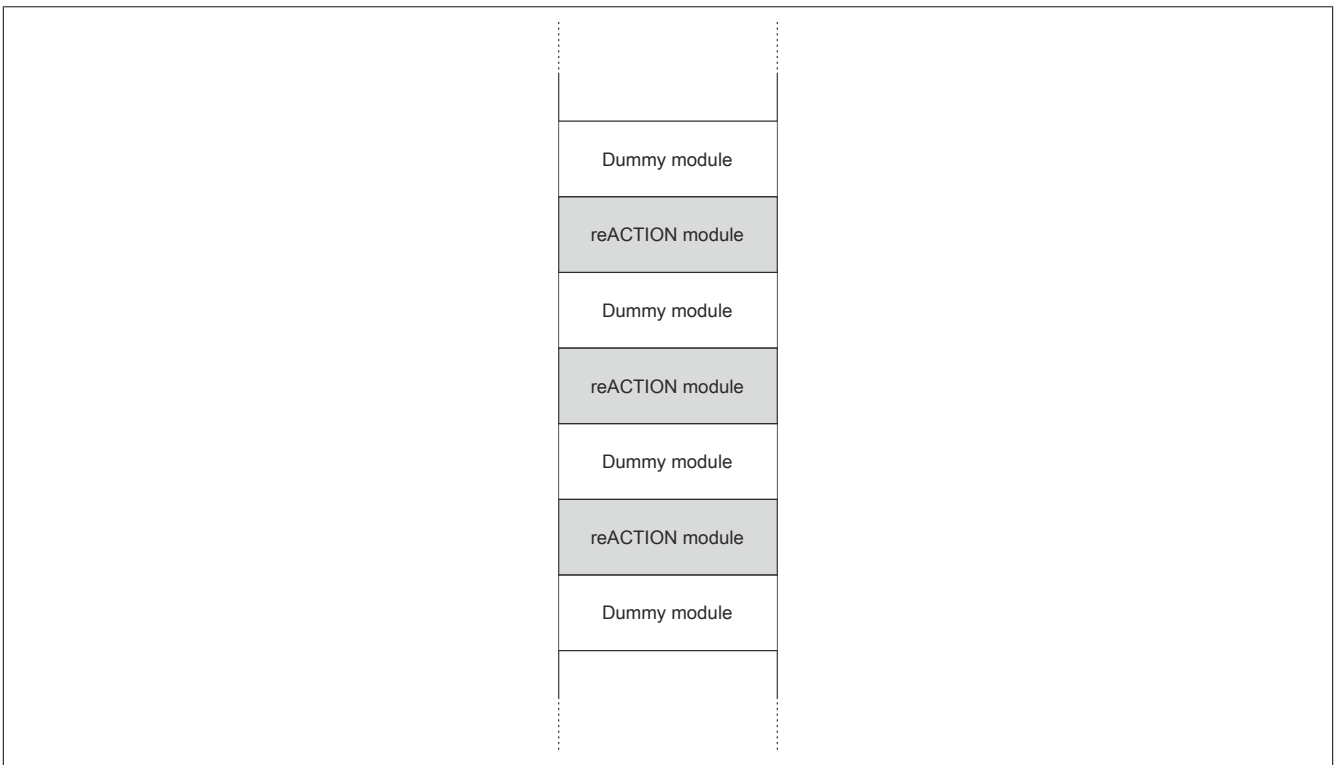
Operating a reACTION module

At ambient temperatures starting at 45°C, dummy modules must be installed above and below the reACTION module if installed vertically.



Operating multiple reACTION modules side by side

If 2 or more vertical reACTION modules are being operated in a cluster, the following arrangement of modules must be observed.



9.28.3.10 Enabling blackout mode

The following steps must be carried out to enable blackout mode.

Requirements

- reACTION program transferred to reACTION module
- Reset triggered on reACTION module:
This ensures that the program stored in the reACTION memory will be loaded with every subsequent reset.

Enabling

- Set the enable register for blackout mode.
- Control bit "RTEnable" must be set. This bit starts the reACTION engine.

Activation

- A connection error triggers a reset on the reACTION module.
- PAR and VAR data points are set to 0.
- Blackout mode is enabled on the reACTION module.

9.28.3.10.1 Blackout mode

For a description of blackout mode, see ["Blackout mode" on page 3794](#).

9.28.3.11 Register description

9.28.3.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.28.3.11.2 Function model 0 - "reACTION"

When using the "reACTION" function model, an individual reACTION program must be created for the module. This program will be executed by the reACTION module later on, not by the CPU. This allows individual machine tasks to be managed decentrally and with a very short response time.

The inputs and outputs of a reACTION module can only be operated by an enabled reACTION program. Interaction registers allow information to be exchanged between the CPU and the reACTION program in the module.

In addition to communication with the CPU, the cyclic interaction registers can also be used for "cross-mapping". In this way, inputs/outputs can also be read/controlled by external modules across the entire X2X Link or POWERLINK network.

| Register | Name | Data type | Read | | Write | |
|---------------------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module communication | | | | | | |
| 158 | ModuleStatus | UINT | | • | | |
| 162 | DigitalStatus | UINT | | • | | |
| reACTION - Configuration | | | | | | |
| 772 | ReActionCycleTimeValue | UDINT | | | | • |
| 780 | ReActionCycleTimeMultiplier | UDINT | | | | • |
| Index * 8 + 508 | CfO_PARType01 to CfO_PARType04 | UDINT | | | | • |
| reACTION - Communication | | | | | | |
| 129 | reACTION - Control byte | USINT | | | • | |
| | RTEnable | Bit 0 | | | | |
| | RTHardwareWarningQuit | Bit 2 | | | | |
| 145 | reACTION - Status byte | USINT | • | | | |
| | RTEngineRun | Bit 0 | | | | |
| | RTCycleTimeOverrun | Bit 1 | | | | |
| | RTHardwareWarning | Bit 2 | | | | |
| | RTFileInvalid | Bit 4 | | | | |
| | RTFunctionInvalid | Bit 5 | | | | |
| | RTInstanceInvalid | Bit 6 | | | | |
| | RTFileNotLoaded | Bit 7 | | | | |
| 154 | RTCycleCounter | UINT | • | | | |
| 150 | RTCycleTime | UINT | • | | | |
| reACTION - Interaction | | | | | | |
| Index * 8 + 4095 | PAR01 to PAR32 | (U)SINT | | | • | |
| | PAR01_Bit1 to PAR32_Bit1 | Bit 0 | | | | |
| | PAR01_Bit2 to PAR32_Bit2 | Bit 1 | | | | |
| | PAR01_Bit3 to PAR32_Bit3 | Bit 2 | | | | |
| | PAR01_Bit4 to PAR32_Bit4 | Bit 3 | | | | |
| | PAR01_Bit5 to PAR32_Bit5 | Bit 4 | | | | |
| | PAR01_Bit6 to PAR32_Bit6 | Bit 5 | | | | |
| | PAR01_Bit7 to PAR32_Bit7 | Bit 6 | | | | |
| | PAR01_Bit8 to PAR32_Bit8 | Bit 7 | | | | |
| Index * 8 + 4094 | PAR01 to PAR32 | (U)INT | | | • | |
| Index * 8 + 4092 | PAR01 to PAR32 | (U)DINT | | | • | |
| Index * 8 + 5119 | RES01 to RES32 | (U)SINT | • | | | |
| | RES01_Bit1 to RES32_Bit1 | Bit 0 | | | | |
| | RES01_Bit2 to RES32_Bit2 | Bit 1 | | | | |
| | RES01_Bit3 to RES32_Bit3 | Bit 2 | | | | |
| | RES01_Bit4 to RES32_Bit4 | Bit 3 | | | | |
| | RES01_Bit5 to RES32_Bit5 | Bit 4 | | | | |
| | RES01_Bit6 to RES32_Bit6 | Bit 5 | | | | |
| | RES01_Bit7 to RES32_Bit7 | Bit 6 | | | | |
| | RES01_Bit8 to RES32_Bit8 | Bit 7 | | | | |
| Index * 8 + 5118 | RES01 to RES32 | (U)INT | • | | | |
| Index * 8 + 5116 | RES01 to RES32 | (U)DINT | • | | | |
| Index * 8 + 6140 | PVAR1 to PVAR256 | DINT | | | | • |
| Index * 8 + 6140 | RVAR1 to RVAR256 | DINT | | • | | |

| Register | Name | Data type | Read | | Write | |
|--|----------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| reACTION - Function block configuration | | | | | | |
| 1028 | CfO_Config_ABR1 | UDINT | | | | • |
| 1036 | CfO_ScalingIncrements_ABR1 | UDINT | | | | • |
| 1044 | CfO_ScalingUnits_ABR1 | UDINT | | | | • |
| 1052 | CfO_ChannelMapping1_ABR1 | UDINT | | | | • |
| 1060 | CfO_ChannelMapping2_ABR1 | UDINT | | | | • |

9.28.3.11.3 Function model 254 - "Direct I/O"

In the "Direct I/O" function model, a special reACTION program is executed in the module in order to manage the I/O. In addition, cyclic registers are used to exchange information with the CPU. This reproduces the behavior of a standard module.

| Register | Name | Data type | Read | | Write | |
|---------------------------------|--------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module communication | | | | | | |
| 129 | Status - Acknowledgment | USINT | | | • | |
| | RTHardwareWarningQuit | Bit 2 | | | | |
| 145 | Status - Composite message | USINT | • | | | |
| | RTHardwareWarning | Bit 2 | | | | |
| 159 | Status word - Module (L byte) | USINT | • | | | |
| | SensorSupplyOk_X1 | Bit 0 | | | | |
| 163 | Status word - Digital (L byte) | USINT | • | | | |
| | DigitalOutput3Overload | Bit 2 | | | | |
| | DigitalOutput4Overload | Bit 3 | | | | |
| | DigitalOutput7Overload | Bit 6 | | | | |
| | DigitalOutput8Overload | Bit 7 | | | | |
| Direct I/O configuration | | | | | | |
| 556 | CfO_DigitalDirection | UDINT | | | | • |
| 548 | CfO_DigitalFilter | UDINT | | | | • |
| Direct I/O communication | | | | | | |
| 5 | Digital outputs | USINT | | | • | |
| | DigitalOutput03 | Bit 2 | | | | |
| | DigitalOutput04 | Bit 3 | | | | |
| | DigitalOutput07 | Bit 6 | | | | |
| | DigitalOutput08 | Bit 7 | | | | |
| 1 | Digital inputs | USINT | • | | | |
| | DigitalInput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalInput08 | Bit 7 | | | | |

9.28.3.11.4 Module communication

9.28.3.11.4.1 Module status messages

Name:

ModuleStatus

This register is used to transfer general status messages for the module.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|--------------------------------------|-------------------|-------|-----------------------|
| Status word - Module (L byte) | | | |
| 0 | SensorSupplyOk_X1 | 0 | Encoder supply faulty |
| | | 1 | No error |
| 1 - 7 | Reserved | - | |

9.28.3.11.4.2 Status messages for the digital channels

Name:

DigitalStatus

This register is used to transfer general status messages for the digital channels.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|---------------------------------------|------------------------|-------|---|
| Status word - Digital (L byte) | | | |
| 0 - 1 | Reserved | - | |
| 2 | DigitalOutput3Overload | 0 | Digital output 3 OK |
| | | 1 | Requested voltage 0 V/24 V not achieved |
| 3 | DigitalOutput4Overload | 0 | Digital output 4 OK |
| | | 1 | Requested voltage 0 V/24 V not achieved |
| 4 - 5 | Reserved | - | |
| 6 | DigitalOutput7Overload | 0 | Digital output 7 OK |
| | | 1 | Requested voltage 0 V/24 V not achieved |
| 7 | DigitalOutput8Overload | 0 | Digital output 8 OK |
| | | 1 | Requested voltage 0 V/24 V not achieved |

9.28.3.11.5 reACTION - Configuration

9.28.3.11.5.1 reACTION cycle time

Name:

ReActionCycleTimeValue

ReActionCycleTimeMultiplier

Registers "TimeValue" and "Multiplier" predefine the desired cycle time for the reACTION program. Register "TimeValue" contains the value, while register "Multiplier" contains the associated units.

Register "Multiplier" is currently permanently set to 1000 in order to predefine the cycle time with μ s precision.

| Data type | Value |
|-----------|------------|
| UDINT | 1 to 10000 |

9.28.3.11.5.2 Configuring the PAR data points

Name:

CfO_PARType01

CfO_PARType[02...04]

PAR data points can be defined for the reACTION program. To enable them, the desired data type must be made known according to the configuration in Automation Studio.

| Data type | Value |
|-----------|-------------------|
| UDINT | See bit structure |

Bit structure:

| Bit | Name | Value | Information |
|---------|-----------------|-------|-------------|
| 0 - 3 | Type01 - PAR 1 | 0000 | Inactive |
| | Type02 - PAR 9 | 0001 | USINT, BOOL |
| | Type03 - PAR 17 | | |
| | Type04 - PAR 25 | | |
| 4 - 7 | Type01 - PAR 2 | 0010 | UINT |
| | Type02 - PAR 10 | 0011 | UDINT |
| | Type03 - PAR 18 | | |
| | Type04 - PAR 26 | | |
| 8 - 11 | Type01 - PAR 3 | 0100 | Reserved |
| | Type02 - PAR 11 | 0101 | SINT |
| | Type03 - PAR 19 | | |
| | Type04 - PAR 27 | | |
| 12 - 15 | Type01 - PAR 4 | 0110 | INT |
| | Type02 - PAR 12 | 0111 | DINT |
| | Type03 - PAR 20 | | |
| | Type04 - PAR 28 | | |
| 16 - 19 | Type01 - PAR 5 | 1000 | Reserved |
| | Type02 - PAR 13 | ... | |
| | Type03 - PAR 21 | 1111 | |
| | Type04 - PAR 29 | | |
| 20 - 23 | Type01 - PAR 6 | | |
| | Type02 - PAR 14 | | |
| | Type03 - PAR 22 | | |
| | Type04 - PAR 30 | | |
| 24 - 27 | Type01 - PAR 7 | | |
| | Type02 - PAR 15 | | |
| | Type03 - PAR 23 | | |
| | Type04 - PAR 31 | | |
| 28 - 31 | Type01 - PAR 8 | | |
| | Type02 - PAR 16 | | |
| | Type03 - PAR 24 | | |
| | Type04 - PAR 32 | | |

9.28.3.11.6 reACTION - Communication

At runtime, the reACTION module program is controlled via the program sequence in the CPU. In its active state, the reACTION program is then executed independently of the program sequence in the CPU.

9.28.3.11.6.1 Controlling the reACTION module

Name:

RTEnable

RTHardwareWarningQuit

This register controls the reACTION program.

| Data type | Value |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|-----------------------|-------|--|
| 0 | RTEnable | 0 | Stops the reACTION program |
| | | 1 | Starts the reACTION program |
| 1 | Reserved | - | |
| 2 | RTHardwareWarningQuit | 0 | No effect |
| | | 1 | Acknowledges warning messages for the inputs and outputs |
| 3 - 7 | Reserved | - | |

9.28.3.11.6.2 reACTION module status messages

Name:

RTEngineRun

RTCycleTimeOverrun

RTHardwareWarning

RTFileInvalid

RTFunctionInvalid

RTInstanceInvalid

RTFileNotLoaded

This register is used to output various status messages.

| Data type | Value |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|---|-------|--|
| 0 | RTEngineRun | 0 | reACTION program inactive |
| | | 1 | reACTION program active |
| 1 | RTCycleTimeOverrun | 0 | Configured RT cycle time observed |
| | | 1 | RT cycle time set too short |
| 2 | RTHardwareWarning (group bit for acyclic status data points) | 0 | No status messages |
| | | 1 | Warning message for the inputs and outputs |
| 3 | Reserved | - | |
| 4 | RTFileInvalid (invalid RT program preloaded) | 0 | RT program in RAM OK |
| | | 1 | RT program in RAM invalid |
| 5 | RTFunctionInvalid (invalid software function) | 0 | RT program OK |
| | | 1 | RT program requesting invalid function block |
| 6 | RTInstanceInvalid (invalid hardware instance) | 0 | RT program OK |
| | | 1 | RT program requesting invalid I/O |
| 7 | RTFileNotLoaded | 0 | Valid RT program in RT engine |
| | | 1 | No RT program loaded |

9.28.3.11.6.3 Cycle counter for the active reACTION program

Name:

RTCycleCounter

Register "CycleCounter" can be used to determine how often the reACTION program has cycled.

| Data type | Value |
|-----------|------------|
| UINT | 0 to 65535 |

9.28.3.11.6.4 Minimum cycle time of the active reACTION program

Name:

RTCycleTime

Register "RTCycleTime" can be used to determine how much time the reACTION module needs to cycle through the loaded program once.

| Data type | Value |
|-----------|-------------------------|
| UINT | 0 to 65535: Units 10 ns |

9.28.3.11.7 reACTION - Interaction

After startup, the reACTION program in the module runs independently. It reads the images of the required inputs and manages its assigned outputs throughout the entire network. In addition, the reACTION program can interact with the CPU. There are 3 different data point types available for this.

9.28.3.11.7.1 PAR data points

Name:

PAR[01...32]
 PAR[01...32]_Bit1
 PAR[01...32]_Bit2
 PAR[01...32]_Bit3
 PAR[01...32]_Bit4
 PAR[01...32]_Bit5
 PAR[01...32]_Bit6
 PAR[01...32]_Bit7
 PAR[01...32]_Bit8

Once enabled, the PAR data points are transported cyclically via X2X Link. They are used to transfer information from the CPU to the reACTION program. They can be used to intervene in the execution of the reACTION program.

Information:

PAR data points DO NOT control the module's outputs directly!

| Data type | Value |
|---------------|-------------------------------|
| (U)SINT, BOOL | Corresponding range of values |
| (U)INT | |
| (U)DINT | |

| Register | Name | Data type | Read | | Write | |
|------------------|---------------------------------|-----------------------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 4095 + Index * 8 | PAR01 PAR[02...32] | (U)SINT | | | • | |
| | PAR01_Bit1 PAR[02...32]_Bit1 | Bit 0 | | | | |
| | PAR01_Bit2 PAR[02...32]_Bit2 | Bit 1 | | | | |
| | PAR01_Bit3 PAR[02...32]_Bit3 | Bit 2 | | | | |
| | PAR01_Bit4 PAR[02...32]_Bit4 | Bit 3 | | | | |
| | PAR01_Bit5 PAR[02...32]_Bit5 | Bit 4 | | | | |
| | PAR01_Bit6 PAR[02...32]_Bit6 | Bit 5 | | | | |
| | PAR01_Bit7 PAR[02...32]_Bit7 | Bit 6 | | | | |
| | PAR01_Bit8 PAR[02...32]_Bit8 | Bit 7 | | | | |
| | 4094 + Index * 8 | PAR01 PAR[02...32] | (U)INT | | | • |
| 4092 + Index * 8 | PAR01 PAR[02...32] | (U)DINT | | | • | |

9.28.3.11.7.2 RES data points

Name:

RES[01...32]

RES[01...32]_Bit1

RES[01...32]_Bit2

RES[01...32]_Bit3

RES[01...32]_Bit4

RES[01...32]_Bit5

RES[01...32]_Bit6

RES[01...32]_Bit7

RES[01...32]_Bit8

Once enabled, the RES data points are transported cyclically via X2X Link. They are used to transfer information from the reACTION program to the CPU.

Information:

RES data points DO NOT map the module's input directly!

| Data type | Value |
|---------------|-------------------------------|
| (U)SINT, BOOL | Corresponding range of values |
| (U)INT | |
| (U)DINT | |

| Register | Name | Data type | Read | | Write | |
|-------------------|-------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 5119 + Index * 8 | RES01 | (U)SINT | • | | | |
| | RES[02...32] | | | | | |
| | RES01_Bit1 | Bit 0 | | | | |
| | RES[02...32]_Bit1 | | | | | |
| | RES01_Bit2 | Bit 1 | | | | |
| | RES[02...32]_Bit2 | | | | | |
| | RES01_Bit3 | Bit 2 | | | | |
| | RES[02...32]_Bit3 | | | | | |
| | RES01_Bit4 | Bit 3 | | | | |
| | RES[02...32]_Bit4 | | | | | |
| | RES01_Bit5 | Bit 4 | | | | |
| | RES[02...32]_Bit5 | | | | | |
| | RES01_Bit6 | Bit 5 | | | | |
| RES[02...32]_Bit6 | | | | | | |
| RES01_Bit7 | Bit 6 | | | | | |
| RES[02...32]_Bit7 | | | | | | |
| RES01_Bit8 | Bit 7 | | | | | |
| RES[02...32]_Bit8 | | | | | | |
| 5118 + Index * 8 | RES01 | (U)INT | • | | | |
| | RES[02...32] | | | | | |
| 5116 + Index * 8 | RES01 | (U)DINT | • | | | |
| | RES[02...32] | | | | | |

9.28.3.11.7.3 PVAR and RVAR data points

Name:

PVAR[1...256]

RVAR[1...256]

In addition to PAR and RES data points, VAR data points can also be defined in the reACTION program. They are a direct component of the reACTION program and can be accessed acyclically by the CPU. Like the PAR and RES data points, the PVAR data points are used to transfer information from the CPU to the reACTION program. The RVAR data points are used to transfer feedback from the reACTION program to the CPU.

| Data type | Value |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

| Register | Name | Data type | Read | | Write | |
|------------------|------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 6140 + Index * 8 | PVAR1 PVAR[2...256] | DINT | | | | • |
| 6140 + Index * 8 | RVAR1 RVAR[2...256] | DINT | | • | | |

9.28.3.11.8 reACTION function blocks - General

The following table provides an overview of I/O channel assignments to reACTION function blocks.

Digital inputs/outputs

| Channel | Function block | | |
|-----------------|-----------------------|-----------|----------------------|
| | Mapping ¹⁾ | rtiDin | rtiDout, rtiDoutTime |
| X1: DI 1 | 0x00 | Channel 1 | |
| X1: DI 2 | 0x01 | Channel 2 | |
| X1: DI 3 / DO 3 | 0x02 | Channel 3 | Channel 3 |
| X1: DI 4 / DO 4 | 0x03 | Channel 4 | Channel 4 |
| X1: DI 5 | 0x04 | Channel 5 | |
| X1: DI 6 | 0x05 | Channel 6 | |
| X1: DI 7 / DO 7 | 0x06 | Channel 7 | Channel 7 |
| X1: DI 8 / DO 8 | 0x07 | Channel 8 | Channel 8 |

- 1) The "Mapping" specification is needed in the event that multiple physical inputs/outputs must be grouped together in order to be processed by a reACTION function block (e.g. rtiABRPos) (see ["reACTION function blocks - Configuration" on page 3469](#)).

9.28.3.11.9 reACTION function blocks - Configuration

Some function blocks in library AsIoRti must be configured before they can be used.

| Function block | Information |
|----------------|--|
| rtiABRPos | The module offers the option of using function block rtiABRPos once in the reACTION program. To do so, the function block must be assigned 3 digital inputs that are no longer available for rtiDin. |
| rtiABCnt | The module offers the option of using function block rtiABCnt up to 3 times in the reACTION program. To do so, the function blocks must be assigned 2 digital inputs as an A or B track that are no longer available for rtiDin. In addition, an external event can be defined for each rtiABCnt function block. The input used for this is also no longer available for rtiDin. |

Table 598: List of function blocks requiring prior configuration

9.28.3.11.9.1 Function blocks rtiABRPos and rtiABCnt

Function blocks rtiABRPos and rtiABCnt can be used to process the position value of an ABR incremental encoder in a reACTION task. Several hardware channels of the module are used for this. The incoming signals are interpreted by the reACTION engine and converted into a location.

The update rate depends on both the reACTION engine and the hardware used. The reACTION engine is basically able to calculate positions with an update rate of up to 8 MHz. The input frequencies of the hardware inputs can be taken from the technical data of the respective module.

These function blocks can be used separately or in combination.

Using function block rtiABRPos

The following points are important to keep in mind when using function block rtiABRPos in a reACTION program:

- The function block can only be used once in a reACTION program.
- 3 digital inputs must be defined on the module for input signals A, B and R.
- In addition, a digital input of the module can be defined as an event input.

Example diagram of input signals:

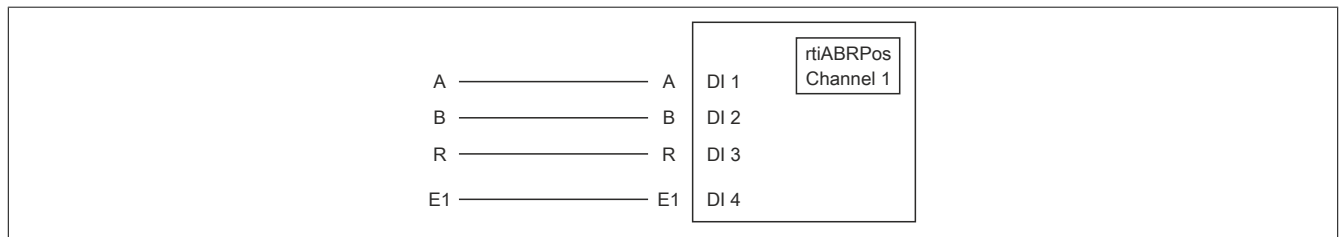


Figure 320: Schematic diagram of input signals for rtiABRPos

Using function block rtiABCnt

The following points must be taken into account when using function block rtiABCnt in a reACTION program:

- The function block can be used up to 3 times in a reACTION program.
- 2 digital inputs must be defined on the module for input signals A and B.
- In addition, up to 3 digital inputs on the module can be defined as event inputs E1, E2 and E3.

Example diagram of input signals:

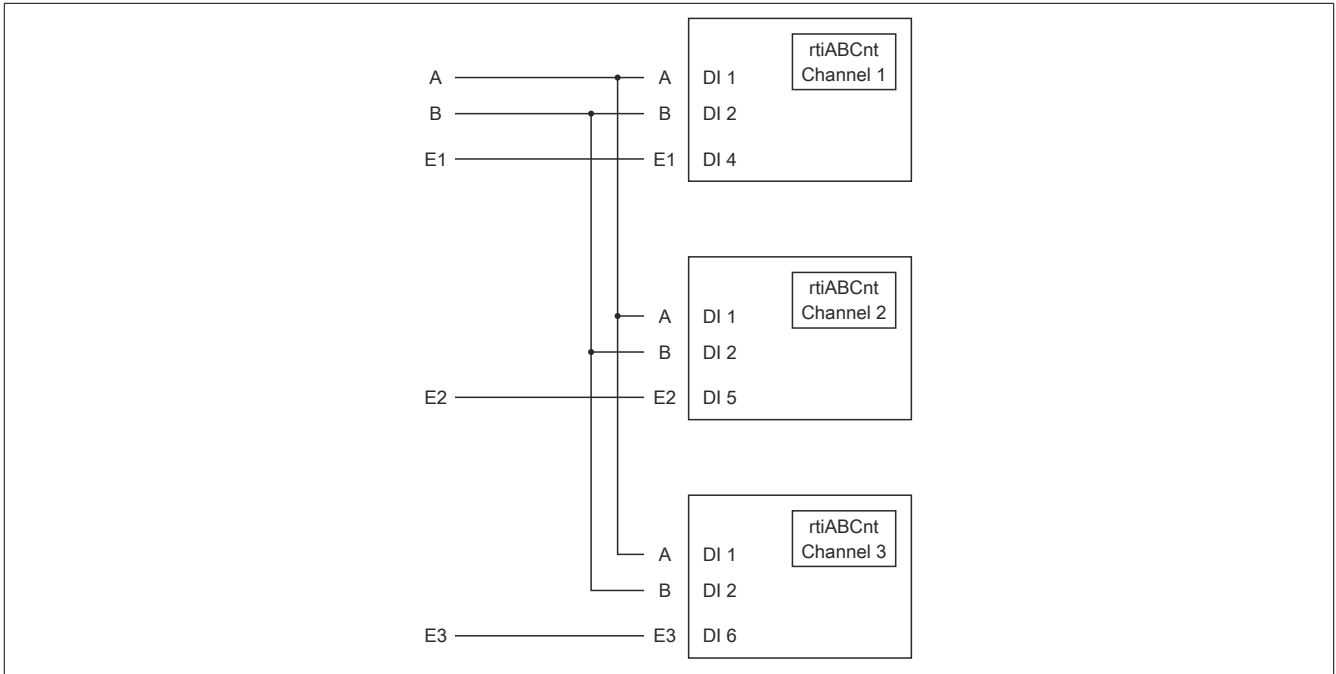


Figure 321: Schematic diagram of input signals for rtiABCnt

Using function blocks rtiABRPos and rtiABCnt in combination

The following points should be kept in mind when using function blocks rtiABRPos and rtiABCnt together in a reACTION program.

- Function block rtiABRPos can only be used once in a reACTION program.
- Function block rtiABCnt can be used up to 2 times in a reACTION program.
- 3 digital inputs must be defined for input signals A, B and R (rtiABRPos).
- The same digital inputs are used for input signals A and B (rtiABCnt).
- In addition, up to 3 event inputs E1, E2 and E3 can be defined (rtiABCnt).
- E1 is used for the event input (rtiABRPos).

Example diagram of input signals:

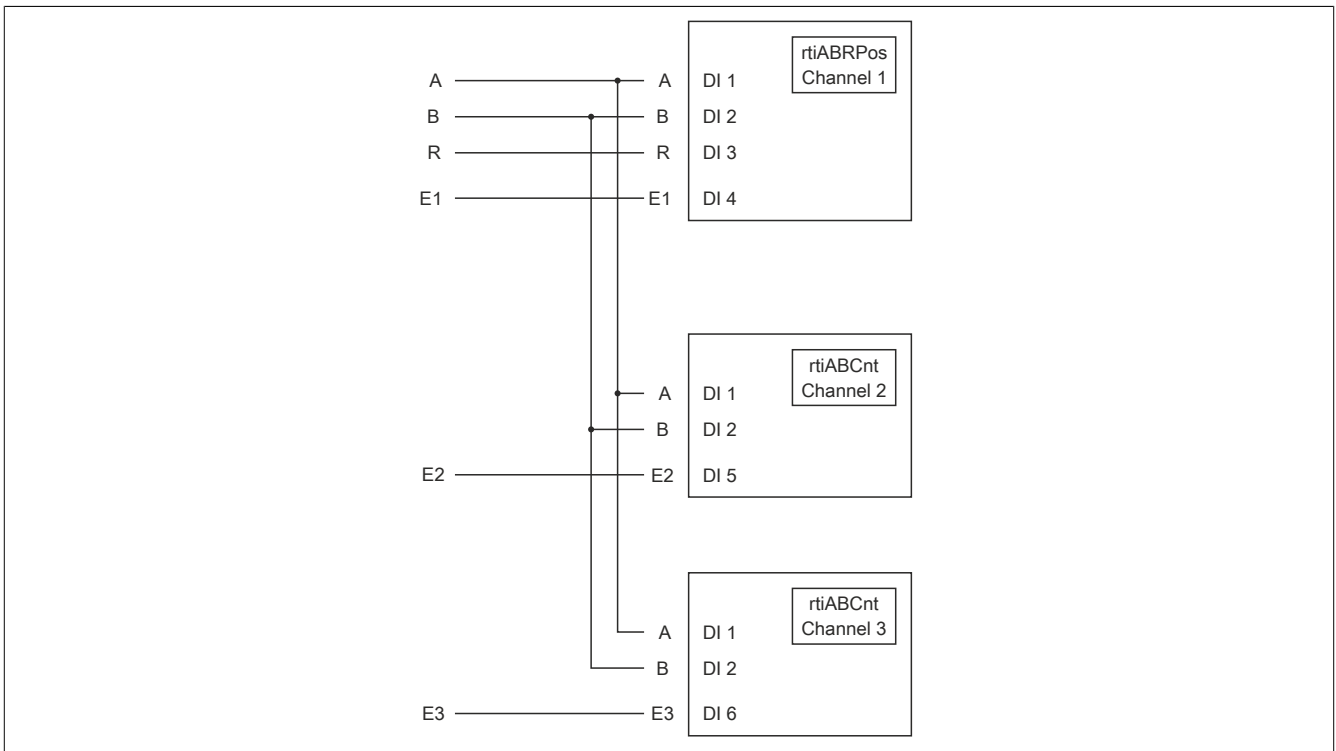


Figure 322: Diagram of input signals when using rtiABRPos and rtiABCnt at the same time

Registering the position encoder (rtiABRPos/rtiABCnt)

Name:

CfO_Config_ABR1

This register specifies the technical characteristics of the connected ABR incremental encoder.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|--|------------|---|
| 0 - 15 | Increments per revolution | 0 to 65535 | Reference pulse monitoring: If the reference pulse is different than defined here, this is indicated on the status output of function block rtiABRPos. |
| 16 | Inversion of the counting direction set by signals A and B | 0 | Positive counting direction |
| | | 1 | Negative counting direction |
| 17 - 31 | Reserved | 0 | |

Wiring the position encoder (rtiABRPos/rtiABCnt)

Name:

CfO_ChannelMapping1_ABR1

CfO_ChannelMapping2_ABR1

Before function blocks rtiABRPos/rtiABCnt can be processed by the reACTION engine, the hardware inputs to be used by the ABR incremental encoder must be defined on the module. The "ChannelMapping" registers specify which inputs are interpreted as the A, B, R, E1, E2 and E3 signals.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure of CfO_ChannelMapping1_ABR1:

| Bit | Description | Value | Information |
|---------|-------------|----------|---------------------------------------|
| 0 - 7 | Input E1 | 0 | Mapped to digital input 1 |
| | | 1 | Mapped to digital input 2 |
| | | ... | ... |
| | | 7 | Mapped to digital input 8 |
| | | 8 to 255 | Reserved |
| 8 - 15 | Input R | 0 to 255 | For possible values, see bits 0 to 7. |
| 16 - 23 | Input B | 0 to 255 | For possible values, see bits 0 to 7. |
| 24 - 31 | Input A | 0 to 255 | For possible values, see bits 0 to 7. |

Bit structure of CfO_ChannelMapping2_ABR1:

| Bit | Description | Value | Information |
|---------|-------------|----------|---|
| 0 - 15 | Reserved | 0 | |
| 16 - 23 | Input E3 | 0 | Mapped to digital input 1 |
| | | 1 | Mapped to digital input 2 |
| | | ... | ... |
| | | 7 | Mapped to digital input 8 |
| | | 8 to 255 | Reserved |
| 24 - 31 | Input E2 | 0 to 255 | For possible values, see bits 16 to 23. |

Information:

For information about the relationship between the input on the module and the channel name, see section "reACTION function blocks - General".

Scaling the position encoder (rtiABRPos)

Name:

CfO_ScalingUnits_ABR1

CfO_ScalingIncrements_ABR1

An optional gear ratio can be configured using registers "Units" and "Increments". The dividend for scaling is defined in register "Units"; the divisor is defined in register "Increments".

| Data type | Value | Information |
|-----------|--------------------|--|
| UDINT | 0 to 4,294,967,295 | CfO_ScalingUnits_ABR1: Units per interval CfO_ScalingIncrements_ABR1: Increments per interval |

Formula for calculation

$$\text{Gear ratio} = \text{ScalingUnits} / \text{ScalingIncrements}$$
Example 1

ScalingUnits = 1

ScalingIncrements = 1

$$\text{Position value (Pos)} = \text{ABR increments} * \text{ScalingUnits} / \text{ScalingIncrements}$$

$$\text{Position value (Pos)} = \text{ABR increments} * 1/1$$

In this example, the ABR position value is output unchanged on output "Pos".

Example 2

ScalingUnits = 10

ScalingIncrements = 4

$$\text{Position value (Pos)} = \text{ABR increments} * \text{ScalingUnits} / \text{ScalingIncrements}$$

$$\text{Position value (Pos)} = \text{ABR increments} * 10/4$$

In this example, the ABR position value is multiplied by 2.5 and output on output "Pos".

Information:

The encoder values are calculated internally as INT64 values in 32.32 format. On output "Pos" of function block "rtiABRPos", only the whole number value (INT32) is output for the user. The fixed point decimal places are used internally to calculate a higher resolution.

9.28.3.11.10 Direct I/O configuration

In the "Direct I/O" function model, behavior is based on that of a standard module. The I/O channels are managed by an extremely simplified reACTION program. The function model primarily serves to check that the I/O channels are functioning properly. This module is equipped with 8 digital channels.

9.28.3.11.10.1 Direction of digital channels

Name:

CfO_DigitalDirection

This register determines the signal direction of digital channels 3, 4, 7 and 8.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|-------------------------------|-------|-------------|
| 0 - 1 | Reserved | 0 | |
| 2 | Direction - Digital channel 3 | 0 | Input |
| | | 1 | Output |
| 3 | Direction - Digital channel 4 | 0 | Input |
| | | 1 | Output |
| 4 - 5 | Reserved | 0 | |
| 6 | Direction - Digital channel 7 | 0 | Input |
| | | 1 | Output |
| 7 | Direction - Digital channel 8 | 0 | Input |
| | | 1 | Output |

9.28.3.11.10.2 Filtering digital channels

Name:

CfO_DigitalFilter

This register defines the filter time of the digital channels. The filter value affects both the switching delay as well as the immunity of the channels.

| Data type | Value |
|-----------|--------------------------|
| UDINT | 0 to 500000: Units 10 ns |

9.28.3.11.11 Direct I/O communication

This module is equipped with the following inputs and outputs:

- 4 digital inputs (sink) for 24 VDC
- 4 digital channels configurable as inputs (sink) or outputs (sink or source) for 24 VDC

9.28.3.11.11.1 Digital outputs

Name:

DigitalOutput03

DigitalOutput04

DigitalOutput07

DigitalOutput08

This register is used to predefine the value that should be output on the digital output.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|-----------------|-------|-------------|
| 0 - 1 | Reserved | 0 | |
| 2 | DigitalOutput03 | 0 | FALSE |
| | | 1 | TRUE |
| 3 | DigitalOutput04 | 0 | FALSE |
| | | 1 | TRUE |
| 4 - 5 | Reserved | 0 | |
| 6 | DigitalOutput07 | 0 | FALSE |
| | | 1 | TRUE |
| 7 | DigitalOutput08 | 0 | FALSE |
| | | 1 | TRUE |

9.28.3.11.11.2 Digital inputs

Name:

DigitalInput01

DigitalInput02

DigitalInput03

DigitalInput04

DigitalInput05

DigitalInput06

DigitalInput07

DigitalInput08

This register indicates the value read for the respective digital input.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|-------|-------------|
| 0 | DigitalInput01 | 0 | FALSE |
| | | 1 | TRUE |
| 1 | DigitalInput02 | 0 | FALSE |
| | | 1 | TRUE |
| 2 | DigitalInput03 | 0 | FALSE |
| | | 1 | TRUE |
| 3 | DigitalInput04 | 0 | FALSE |
| | | 1 | TRUE |
| 4 | DigitalInput05 | 0 | FALSE |
| | | 1 | TRUE |
| 5 | DigitalInput06 | 0 | FALSE |
| | | 1 | TRUE |
| 6 | DigitalInput07 | 0 | FALSE |
| | | 1 | TRUE |
| 7 | DigitalInput08 | 0 | FALSE |
| | | 1 | TRUE |

9.28.3.11.12 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μ s |

9.28.3.11.13 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 200 μ s |

9.28.4 X20RT8201

Data sheet version: 1.14

9.28.4.1 General information

This reACTION technology module has 4 high-speed digital inputs and 4 high-speed digital mixed channels. All connections are designed for 1-wire connections. All inputs are designed for sink connections, the outputs for push-pull connections.

A voltage signal of ± 10 V can be read using 2 analog inputs.

Ultrafast reACTION Technology makes it possible to control the integrated I/O channels with response times down to 1 μ s. All of the commands that can be used for reACTION programs are provided as function blocks in special libraries (e.g. AsIORTI). Programming in compliance with IEC 61131-3 requirements takes place in the Function Block Diagram editor in Automation Studio.

The module supports blackout mode. In blackout mode, programmable module functionality persists even if the network fails.

- reACTION technology module
- 4 high-speed digital inputs
- 4 high-speed digital channels, configurable as inputs or outputs
- 2 high-speed analog inputs ± 10 V
- 1 ABR incremental encoder input 24 V
- Pulse width modulation
- 24 VDC and GND for encoder supply
- Supports blackout mode



9.28.4.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | reACTION Technology modules |  |
| X20RT8201 | X20 reACTION module, 4 digital inputs, 24 VDC, <1 μ s, 4 digital channels, 24 VDC, 0.1 A, <1 μ s, configurable as inputs or outputs, 2 analog inputs ± 10 V, 500 kHz sampling frequency, 13-bit converter resolution including sign, configurable input filter, reACTION Technology module | |
| | Required accessories | |
| | Bus modules | |
| X20BM31 | X20 bus module for double-width modules, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 599: X20RT8201 - Order data

9.28.4.3 Technical data

| | |
|--|---|
| Model number | X20RT8201 |
| Short description | |
| I/O module | 4 digital input channels, 4 digital channels configurable as inputs or outputs, 2 analog inputs ± 10 V, reACTION Technology |
| General information | |
| B&R ID code | 0xE55A |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Outputs | Yes, using status LED and software (output error status) |
| Inputs | Yes, using status LED and software |
| reACTION-capable I/O channels | Yes |
| Blackout mode | |
| Scope | Module |
| Function | Programmable |
| Standalone mode | No |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.6 W |
| Additional power dissipation caused by actuators (resistive) [W] | +0.8 |
| Type of signal lines ¹⁾ | Shielded cables must be used for all signal lines, cable length: Max. 20 m |
| Application memory | |
| Type | 64 Mbit flash memory |
| Data retention | 20 years at 55°C |
| Guaranteed erase/write cycles | 100,000 |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| Encoder power supply | |
| Output voltage | 24 VDC -15% / +20% |
| Output current ²⁾ | Module-internal, max. 600 mA |
| Short-circuit proof, overload protection | Yes |
| Digital inputs | |
| Quantity | 4 inputs and 4 mixed channels, configurable as inputs or outputs using software |
| Nominal voltage | 24 VDC |
| Input voltage | 24 VDC -15% / +20% |
| Input current at 24 VDC | Typ. 1.3 mA |
| Input circuit | Sink |
| Input filter | |
| Hardware | <3 μ s |
| Software | Default 200 ns, configurable between 200 ns and 5 ms in 10 ns intervals |
| Connection type | 1-wire connections |
| Input resistance | 18.16 k Ω |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| ABR incremental encoder | |
| Quantity | 2 |
| Encoder inputs | 24 V, asymmetrical |
| Counter size | 32-bit |
| Input frequency | Max. 333 kHz |
| Evaluation | 4x |
| Analog inputs | |
| Quantity | 2 ³⁾ |
| Input | ± 10 V |
| Input type | Differential input |
| Digital converter resolution | ± 12 -bit |
| Output format | |
| Data type | INT |
| Voltage | INT 0x8001 - 0x7FFF / 1 LSB = 0x0008 = 2.441 mV |
| Input impedance in signal range | 20 M Ω |
| Input protection | Protection against wiring with supply voltage |
| Permissible input signal | Max. ± 30 V |

Table 600: X20RT8201 - Technical data

| Model number | X20RT8201 |
|---|--|
| Output of digital value during overload | |
| Undershoot | 0x8001 |
| Overshoot | 0x7FFF |
| Conversion procedure | SAR |
| Input filter | 3rd-order low pass / cutoff frequency 130 kHz |
| Max. error at 25°C | |
| Gain | 0.08% ⁴⁾ |
| Offset | 0.018% ⁵⁾ |
| Max. gain drift | 0.003 %/°C ⁴⁾ |
| Max. offset drift | 0.001 %/°C ⁵⁾ |
| Common-mode rejection | |
| DC | 86 dB |
| 50 Hz | 84 dB |
| Common-mode range | ±12 V |
| Nonlinearity | 0.015% ⁵⁾ |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Sampling frequency | 500 kHz |
| Digital outputs | |
| Quantity ²⁾ | 4 mixed channels, configurable as inputs or outputs using software |
| Variant | Push-Pull |
| Nominal voltage | 24 VDC |
| Switching voltage | 24 VDC -15% / +20% |
| Nominal output current | 100 mA |
| Total nominal current | 400 mA |
| Connection type | 1-wire connections |
| Output circuit | Sink or source |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short circuit current") |
| Diagnostic status | Output monitoring with delay <700 ns |
| Leakage current when switched off | Approx. 25 µA |
| R _{DS(on)} | 140 mΩ |
| Residual voltage | <0.4 V at nominal current 100 mA |
| Max. continuous current | 100 mA |
| Peak short-circuit current | <10 A |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 3 ms |
| Switching delay | |
| 0 → 1 | <1 µs |
| 1 → 0 | <1 µs |
| Switching frequency | |
| Resistive load | Min. 50 kHz, max. 500 kHz |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating and hardware configuration" |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 2x terminal block X20TB12 separately Order 1x bus module X20BM31 separately |
| Spacing | 25 ^{+0.2} mm |

Table 600: X20RT8201 - Technical data

- 1) See section "X20 shielding brackets".
- 2) See section "Derating and hardware configuration".
- 3) To reduce power dissipation, B&R recommends bridging unused inputs on the terminal.
- 4) Based on the current measured value.
- 5) Based on the 20 V measurement range.

9.28.4.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.


| Figure | LED | Color | Status | Description |
|---|------------|---|------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode or blackout mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring of digital outputs has been triggered. |
| | | | Double flash | Supply voltage not in valid range or no reACTION program loaded |
| | | | Triple flash | Test of internal memory failed (limited functionality, module must be replaced) |
| | On | Error or reset state (reACTION program using functions or channels that are not permitted on this hardware) | | |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1, 2, 5, 6 | Green | | Input state of the corresponding digital input |
| | 3, 4, 7, 8 | Green | | Input or output status of the corresponding digital input or output |

Table 601: LED status indicators (X1)

1) A firmware update can take several minutes depending on the configuration.


| Figure | LED | Color | Status | Description |
|--|------|-------|----------|--|
|  | 1, 2 | Green | Off | Open line or disconnected sensor |
| | | | Blinking | Input signal overflow or underflow |
| | | | On | Analog/digital converter running, value OK |
| | | | | |

Table 602: LED status indicators (X2)

9.28.4.5 Pinout

9.28.4.5.1 X1 - Pinout

To prevent crosstalk, each individual signal line should be shielded. The maximum cable length is 20 m.

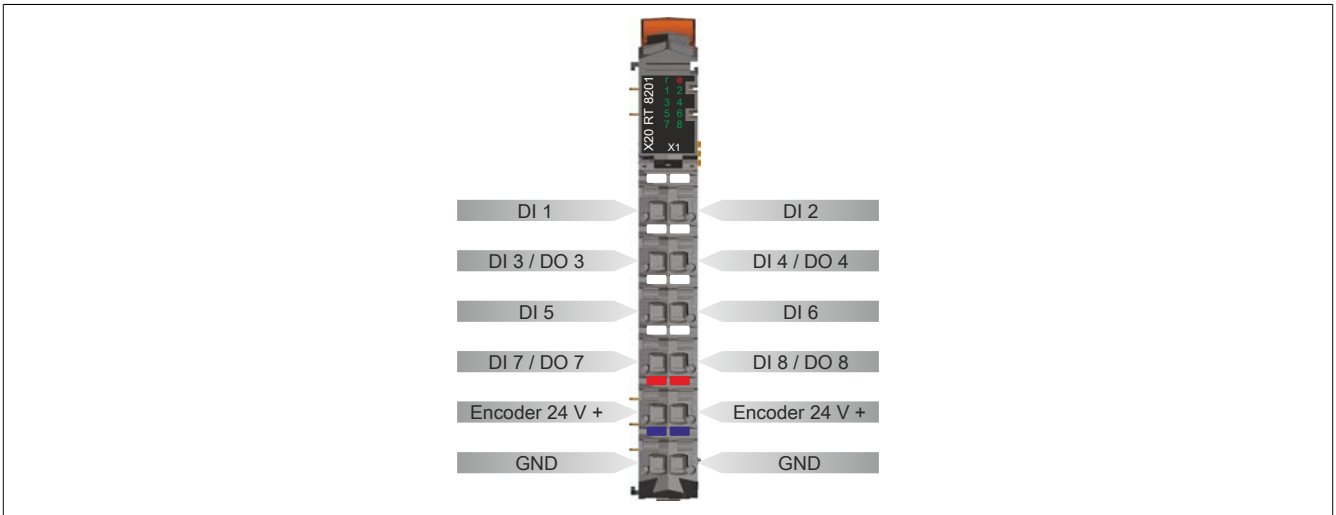


Figure 323: X1 - Pinout

9.28.4.5.2 X2 - Pinout

To prevent crosstalk, each individual signal line should be shielded. The maximum cable length is 20 m.

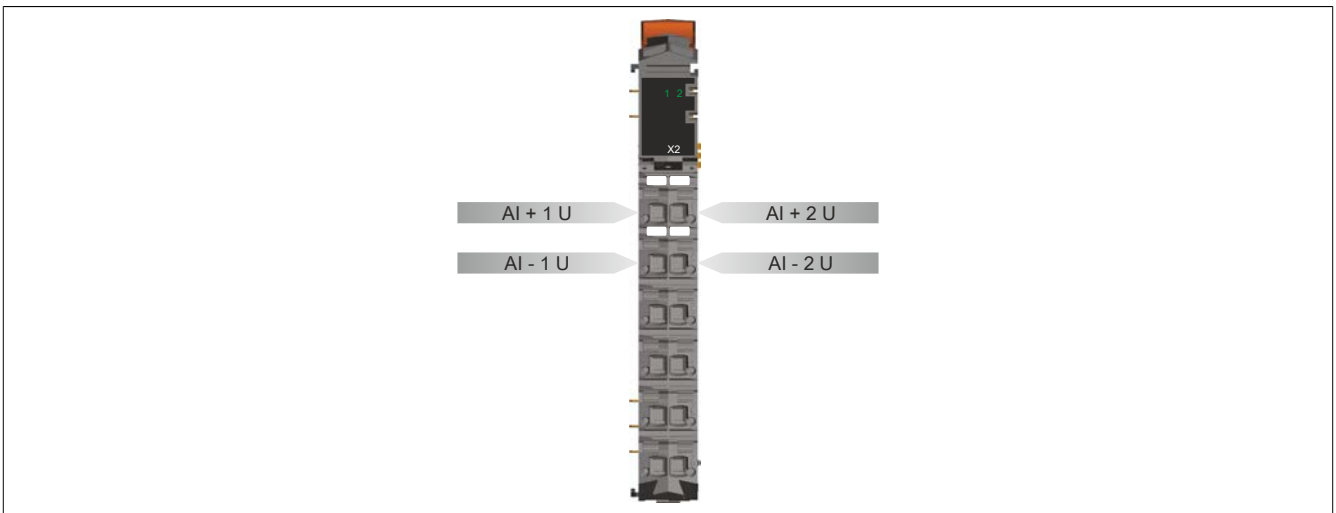


Figure 324: X2 - Pinout

9.28.4.6 Local I/O channels

The following tables provide an overview of the connections to the I/O channels.

Digital inputs/outputs

| Connection | Terminal connection | Channel |
|------------|---------------------|-------------|
| X1 | 11 | DI 1 |
| | 21 | DI 2 |
| | 12 | DI 3 / DO 3 |
| | 22 | DI 4 / DO 4 |
| | 13 | DI 5 |
| | 23 | DI 6 |
| | 14 | DI 7 / DO 7 |
| | 24 | DI 8 / DO 8 |

Analog inputs

| Connection | Terminal connection | Channel |
|------------|---------------------|---------|
| X2 | 11 and 12 | AI 1 |
| | 21 and 22 | AI 2 |

The following sections describe assigning I/O channels in a reACTION program:

| I/O channels | Assignment |
|-----------------------|--|
| Digital I/O channels | Assignment of digital inputs/outputs |
| Analog input channels | Assignment of analog inputs |

9.28.4.7 Connection examples

9.28.4.7.1 X1 - Connection examples

Digital inputs and digital outputs

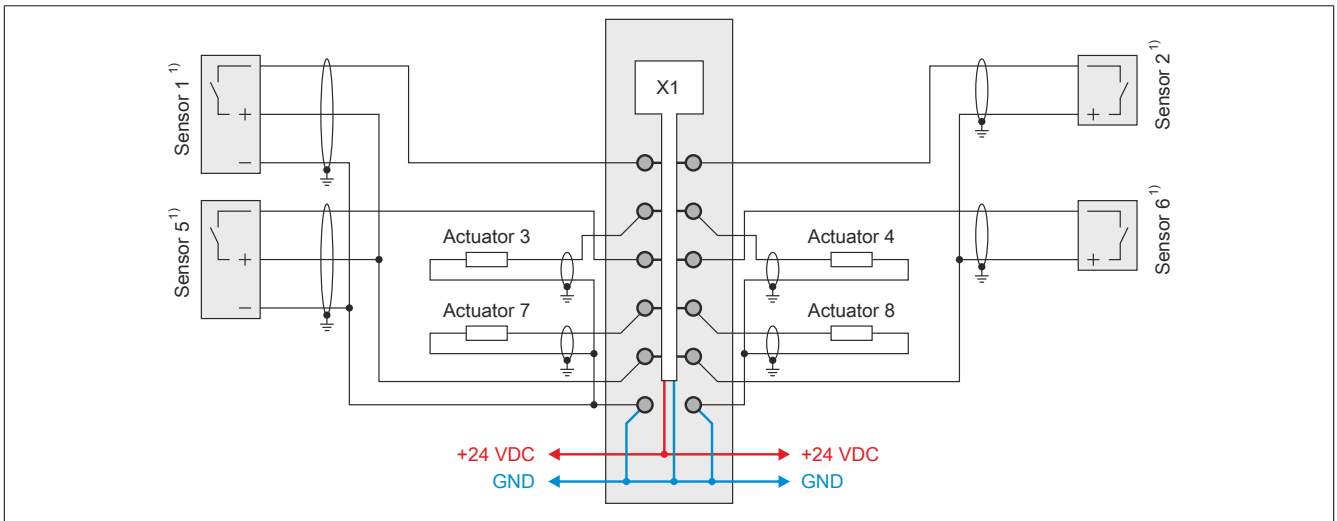


Figure 325: Connection example 1 (X1)

- 1) Observe the wiring guidelines from the sensor manufacturer.

Digital inputs, PWM and ABR incremental encoder

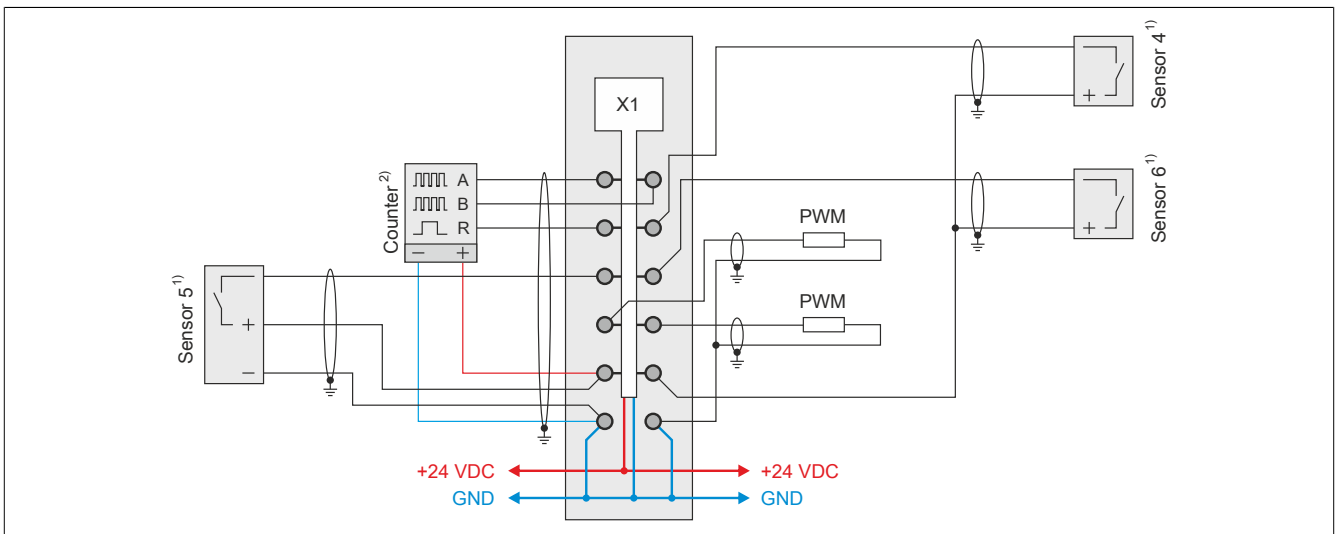


Figure 326: Connection example 2 (X1)

- 1) Observe the wiring guidelines from the sensor manufacturer.
- 2) Observe the wiring guidelines from the encoder manufacturer.

9.28.4.7.2 X2 - Connection example

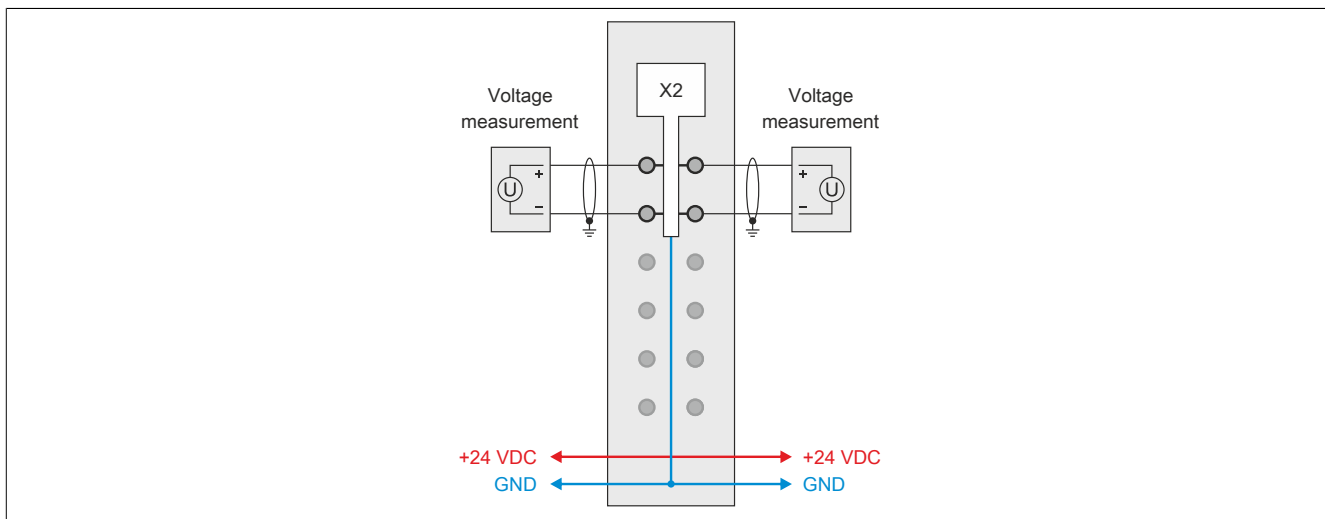


Figure 327: X2 - Connection example

9.28.4.8 Input/Output circuit diagram

9.28.4.8.1 Digital inputs (X1)

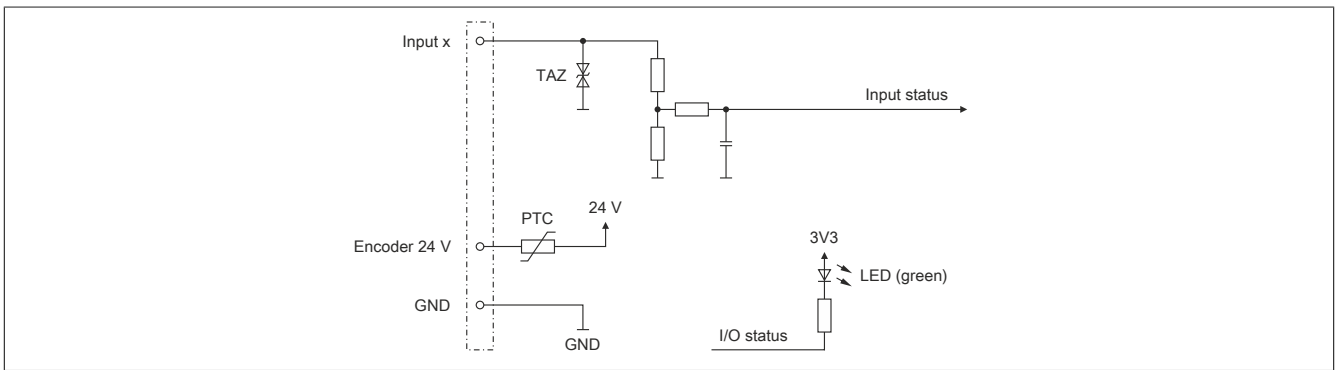


Figure 328: Input circuit diagram of digital inputs (X1)

9.28.4.8.2 Digital mixed channels (X1)

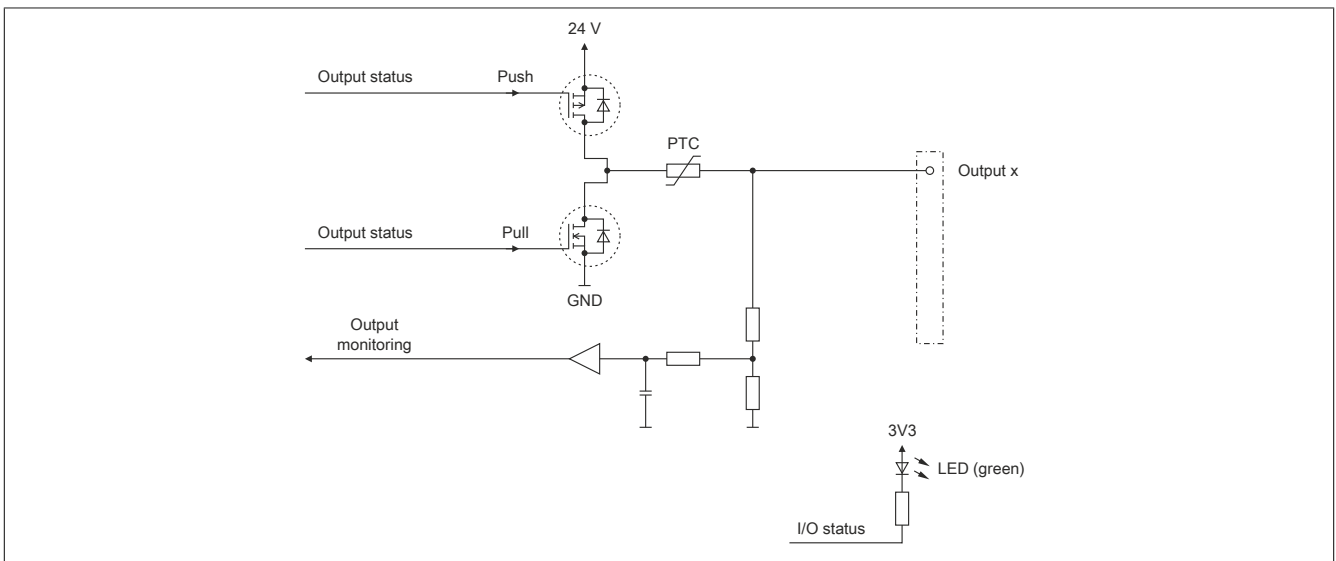


Figure 329: Input/Output circuit diagram of digital mixed channels (X1)

9.28.4.8.3 Analog inputs (X2)

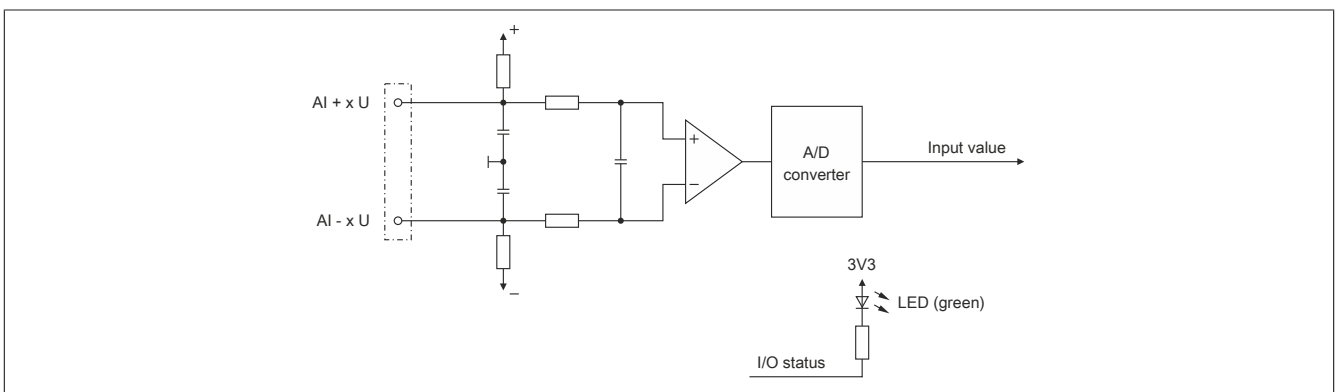


Figure 330: Input circuit diagram of analog inputs (X2)

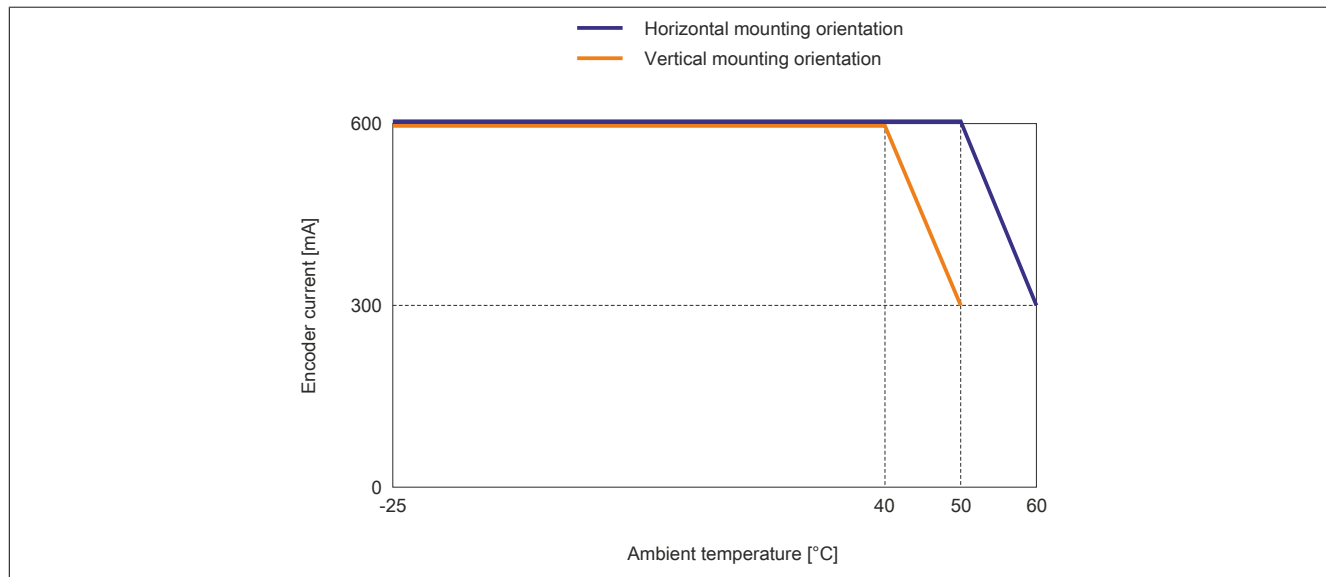
9.28.4.9 Derating and hardware configuration

To ensure proper operation, observe the points listed below:

- Derating of the encoder current
- Number of operable digital outputs
- Hardware configurations

9.28.4.9.1 Derating of the encoder current

Observe the following derating values for the encoder current depending on the mounting orientation:



9.28.4.9.2 Number of operable digital outputs

Depending on the mounting orientation, not all 4 digital outputs of the module can be operated starting at a certain ambient temperature.

Information:

To ensure operation of the module with the ambient temperatures listed below, it is absolutely necessary to disconnect channels.

Reducing the output current per channel does not increase the number of digital output channels that can be operated in the corresponding ambient temperature class.

Horizontal installation

| Ambient temperature | Number of operable digital outputs |
|---------------------|------------------------------------|
| <45°C | 4 |
| Starting at 45°C | 3 |
| Starting at 55°C | 2 |

Vertical installation

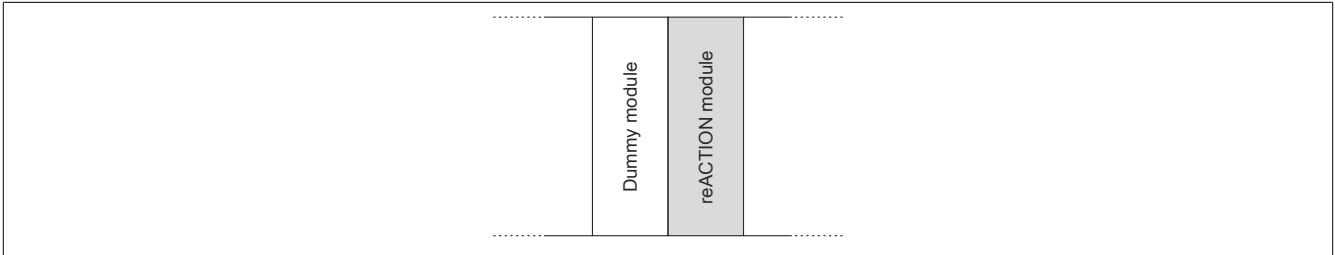
| Ambient temperature | Number of operable digital outputs |
|---------------------|------------------------------------|
| <35°C | 4 |
| Starting at 35°C | 3 |
| Starting at 45°C | 2 |

9.28.4.9.3 Hardware configuration for horizontal installation

9.28.4.9.3.1 Hardware configuration starting at an ambient temperature of 50°C

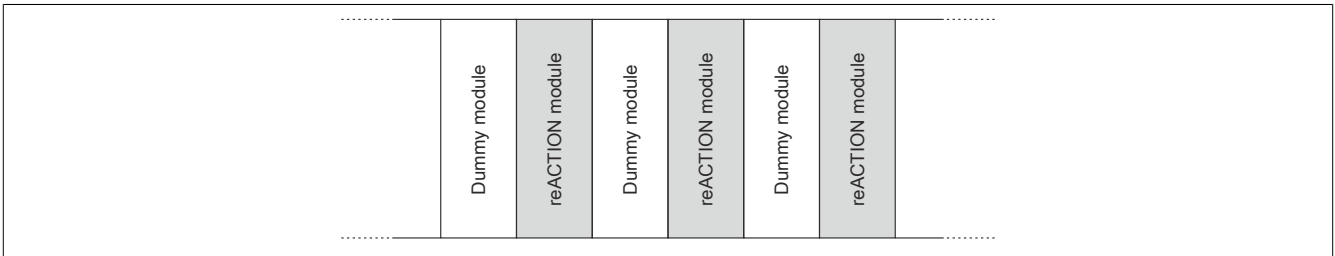
Operating a reACTION module

Starting at an ambient temperature of 50°C, a dummy module must be connected to the left of the reACTION module if installed horizontally.



Operating multiple reACTION modules side by side

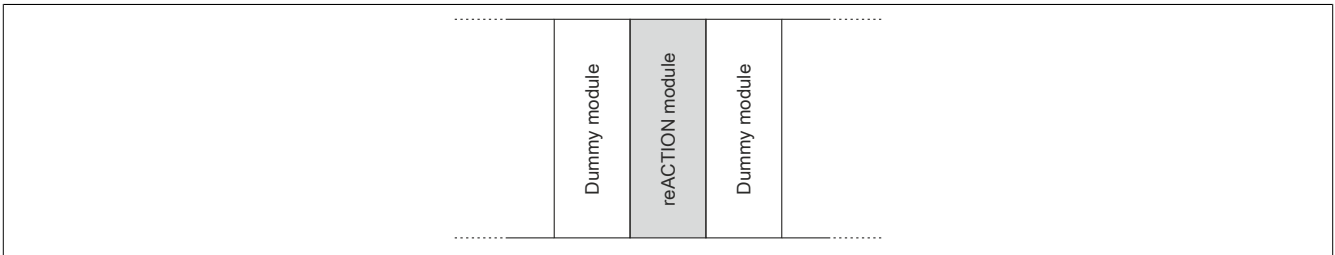
If 2 or more horizontal reACTION modules are being operated in a cluster, the following arrangement of modules must be observed.



9.28.4.9.3.2 Hardware configuration starting at an ambient temperature of 55°C

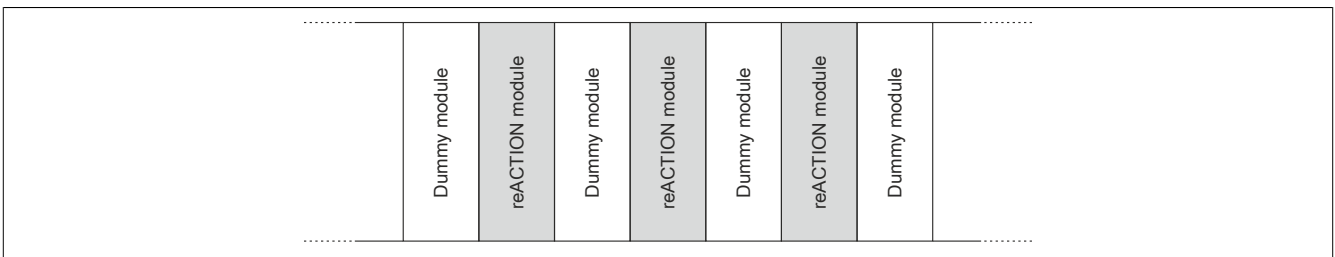
Operating a reACTION module

Starting at an ambient temperature of 55°C, a dummy module must be connected to the left and right of the reACTION module if installed horizontally.



Operating multiple reACTION modules side by side

If 2 or more horizontal reACTION modules are being operated in a cluster, the following arrangement of modules must be observed.

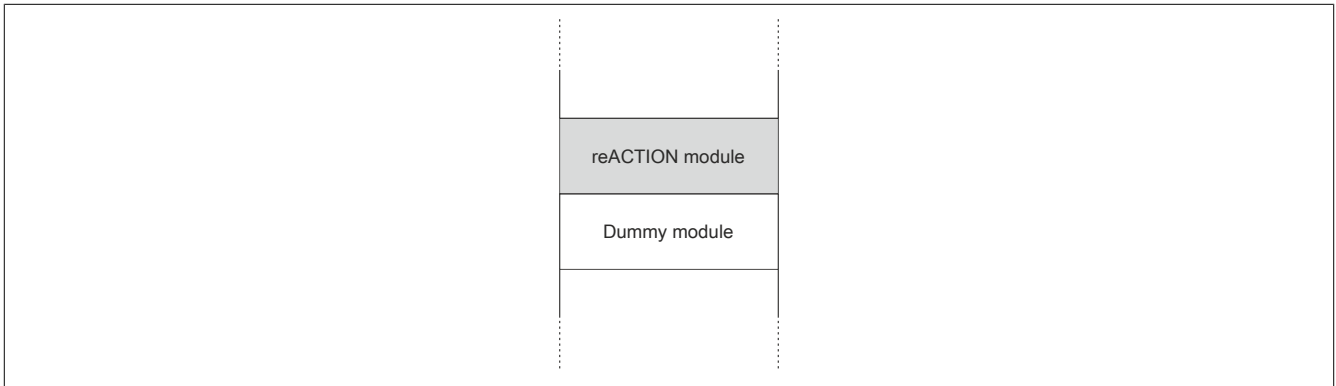


9.28.4.9.4 Hardware configuration for vertical installation

9.28.4.9.4.1 Hardware configuration starting at an ambient temperature of 40°C

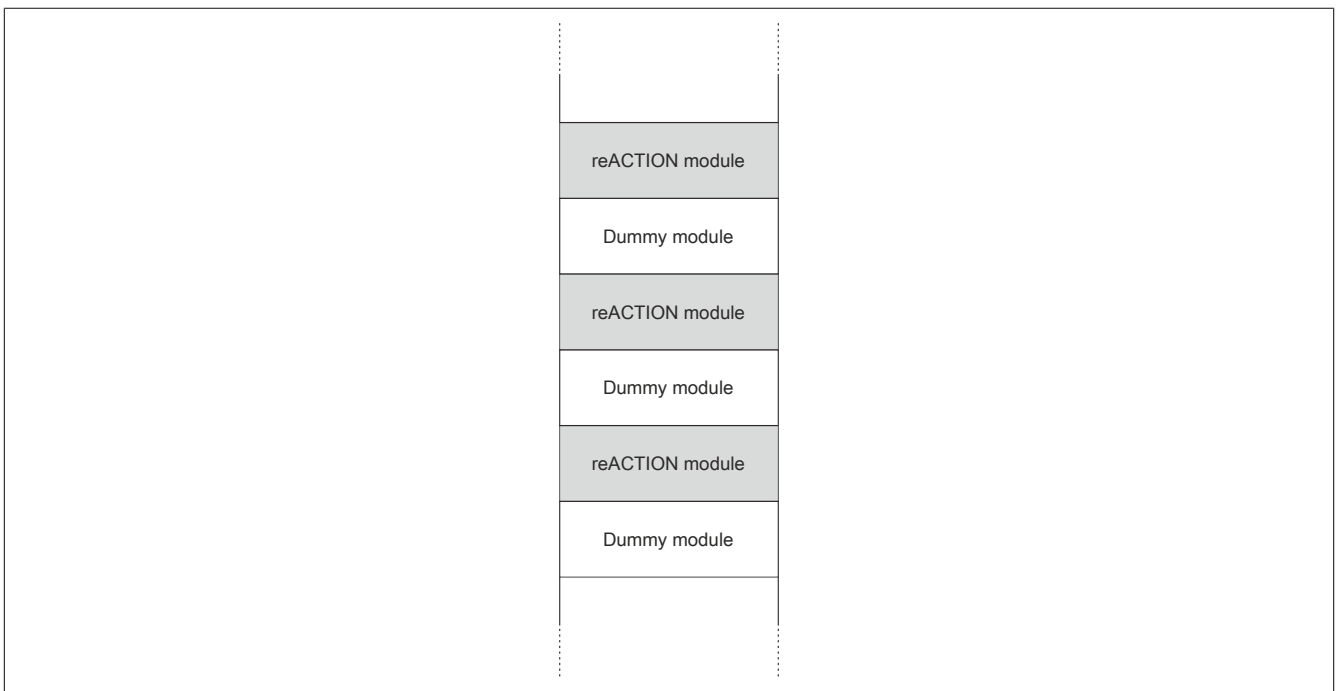
Operating a reACTION module

At ambient temperatures starting at 40°C, a dummy module must be installed below the reACTION module if installed vertically.



Operating multiple reACTION modules side by side

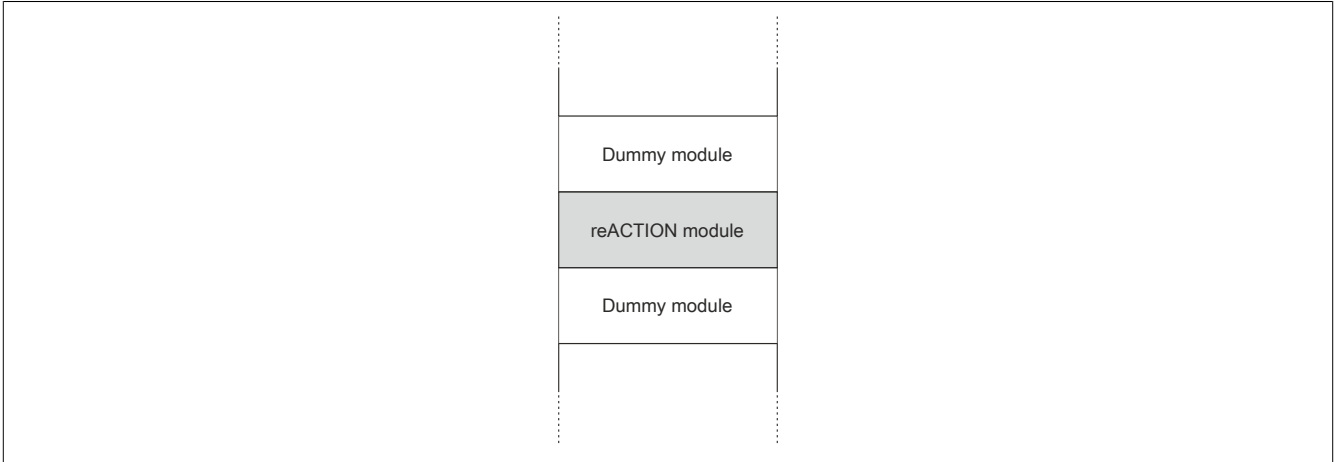
If 2 or more vertical reACTION modules are being operated in a cluster, the following arrangement of modules must be observed.



9.28.4.9.4.2 Hardware configuration starting at an ambient temperature of 45°C

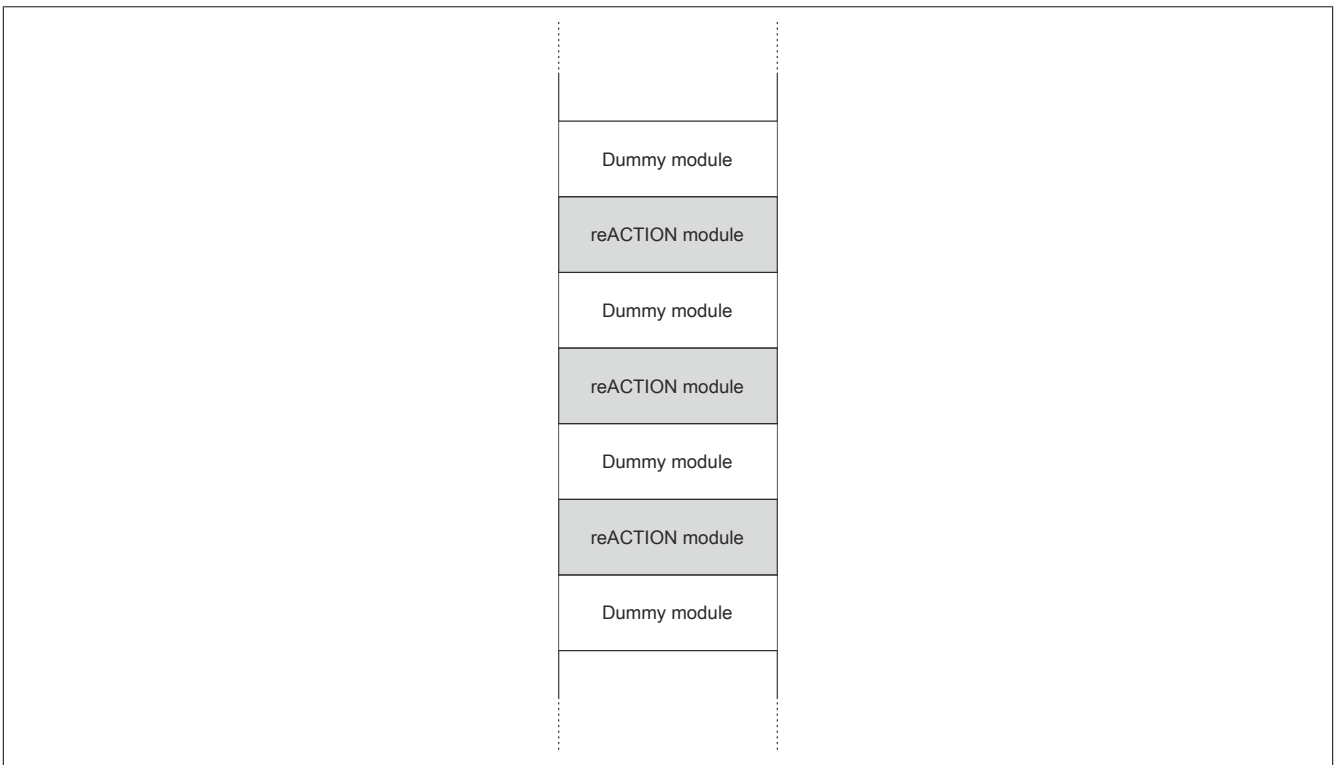
Operating a reACTION module

At ambient temperatures starting at 45°C, dummy modules must be installed above and below the reACTION module if installed vertically.



Operating multiple reACTION modules side by side

If 2 or more vertical reACTION modules are being operated in a cluster, the following arrangement of modules must be observed.



9.28.4.10 Enabling blackout mode

The following steps must be carried out to enable blackout mode.

Requirements

- reACTION program transferred to reACTION module
- Reset triggered on reACTION module:
This ensures that the program stored in the reACTION memory will be loaded with every subsequent reset.

Enabling

- Set the enable register for blackout mode.
- Control bit "RTEnable" must be set. This bit starts the reACTION engine.

Activation

- A connection error triggers a reset on the reACTION module.
- PAR and VAR data points are set to 0.
- Blackout mode is enabled on the reACTION module.

9.28.4.10.1 Blackout mode

For a description of blackout mode, see ["Blackout mode" on page 3794](#).

9.28.4.11 Register description

9.28.4.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.28.4.11.2 Function model 0 - "reACTION"

When using the "reACTION" function model, an individual reACTION program must be created for the module. This program will be executed by the reACTION module later on, not by the CPU. This allows individual machine tasks to be managed decentrally and with a very short response time.

The inputs and outputs of a reACTION module can only be operated by an enabled reACTION program. Interaction registers allow information to be exchanged between the CPU and the reACTION program in the module.

In addition to communication with the CPU, the cyclic interaction registers can also be used for "cross-mapping". In this way, inputs/outputs can also be read/controlled by external modules across the entire X2X Link or POWERLINK network.

| Register | Name | Data type | Read | | Write | |
|---------------------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module communication | | | | | | |
| 158 | ModuleStatus | UINT | | • | | |
| 162 | DigitalStatus | UINT | | • | | |
| 166 | AnalogInputStatus | UINT | | • | | |
| reACTION - Configuration | | | | | | |
| 772 | ReActionCycleTimeValue | UDINT | | | | • |
| 780 | ReActionCycleTimeMultiplier | UDINT | | | | • |
| Index * 8 + 508 | CfO_PARType01 to CfO_PARType04 | UDINT | | | | • |
| reACTION - Communication | | | | | | |
| 129 | reACTION - Control byte | USINT | | | • | |
| | RTEnable | Bit 0 | | | | |
| | RTHardwareWarningQuit | Bit 2 | | | | |
| 145 | reACTION - Status byte | USINT | • | | | |
| | RTEngineRun | Bit 0 | | | | |
| | RTCycleTimeOverrun | Bit 1 | | | | |
| | RTHardwareWarning | Bit 2 | | | | |
| | RTFileInvalid | Bit 4 | | | | |
| | RTFunctionInvalid | Bit 5 | | | | |
| | RTInstanceInvalid | Bit 6 | | | | |
| | RTFileNotLoaded | Bit 7 | | | | |
| 154 | RTCycleCounter | UINT | • | | | |
| 150 | RTCycleTime | UINT | • | | | |
| reACTION - Interaction | | | | | | |
| Index * 8 + 4095 | PAR01 to PAR32 | (U)SINT | | | • | |
| | PAR01_Bit1 to PAR32_Bit1 | Bit 0 | | | | |
| | PAR01_Bit2 to PAR32_Bit2 | Bit 1 | | | | |
| | PAR01_Bit3 to PAR32_Bit3 | Bit 2 | | | | |
| | PAR01_Bit4 to PAR32_Bit4 | Bit 3 | | | | |
| | PAR01_Bit5 to PAR32_Bit5 | Bit 4 | | | | |
| | PAR01_Bit6 to PAR32_Bit6 | Bit 5 | | | | |
| | PAR01_Bit7 to PAR32_Bit7 | Bit 6 | | | | |
| | PAR01_Bit8 to PAR32_Bit8 | Bit 7 | | | | |
| Index * 8 + 4094 | PAR01 to PAR32 | (U)INT | | | • | |
| Index * 8 + 4092 | PAR01 to PAR32 | (U)DINT | | | • | |
| Index * 8 + 5119 | RES01 to RES32 | (U)SINT | • | | | |
| | RES01_Bit1 to RES32_Bit1 | Bit 0 | | | | |
| | RES01_Bit2 to RES32_Bit2 | Bit 1 | | | | |
| | RES01_Bit3 to RES32_Bit3 | Bit 2 | | | | |
| | RES01_Bit4 to RES32_Bit4 | Bit 3 | | | | |
| | RES01_Bit5 to RES32_Bit5 | Bit 4 | | | | |
| | RES01_Bit6 to RES32_Bit6 | Bit 5 | | | | |
| | RES01_Bit7 to RES32_Bit7 | Bit 6 | | | | |
| | RES01_Bit8 to RES32_Bit8 | Bit 7 | | | | |
| Index * 8 + 5118 | RES01 to RES32 | (U)INT | • | | | |
| Index * 8 + 5116 | RES01 to RES32 | (U)DINT | • | | | |
| Index * 8 + 6140 | PVAR1 to PVAR256 | DINT | | | | • |
| Index * 8 + 6140 | RVAR1 to RVAR256 | DINT | | • | | |

| Register | Name | Data type | Read | | Write | |
|--|----------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| reACTION - Function block configuration | | | | | | |
| 1028 | CfO_Config_ABR1 | UDINT | | | | • |
| 1036 | CfO_ScalingIncrements_ABR1 | UDINT | | | | • |
| 1044 | CfO_ScalingUnits_ABR1 | UDINT | | | | • |
| 1052 | CfO_ChannelMapping1_ABR1 | UDINT | | | | • |
| 1060 | CfO_ChannelMapping2_ABR1 | UDINT | | | | • |

9.28.4.11.3 Function model 254 - "Direct I/O"

In the "Direct I/O" function model, a special reACTION program is executed in the module in order to manage the I/O. In addition, cyclic registers are used to exchange information with the CPU. This reproduces the behavior of a standard module.

| Register | Name | Data type | Read | | Write | |
|---------------------------------|---------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module communication | | | | | | |
| 129 | Status - Acknowledgment | USINT | | | • | |
| | RTHardwareWarningQuit | Bit 2 | | | | |
| 145 | Status - Composite message | USINT | • | | | |
| | RTHardwareWarning | Bit 2 | | | | |
| 159 | Status word - Module (L byte) | USINT | • | | | |
| | SensorSupplyOk_X1 | Bit 0 | | | | |
| | InternalSupplyOk_X1 | Bit 1 | | | | |
| | SensorSupplyOk_X2 | Bit 2 | | | | |
| | InternalSupplyOk_X2 | Bit 3 | | | | |
| | X1ToX2ComError | Bit 6 | | | | |
| | X2ToX1ComError | Bit 7 | | | | |
| 157 | Status word - Module (H byte) | USINT | • | | | |
| | AnalogIn01ComError | Bit 0 | | | | |
| | AnalogIn02ComError | Bit 1 | | | | |
| 163 | Status word - Digital (L byte) | USINT | • | | | |
| | DigitalOutput3Overload | Bit 2 | | | | |
| | DigitalOutput4Overload | Bit 3 | | | | |
| | DigitalOutput7Overload | Bit 6 | | | | |
| 167 | Status word - AnalogIn (L byte) | USINT | • | | | |
| | AnalogIn01Underflow | Bit 0 | | | | |
| | AnalogIn01Overflow | Bit 1 | | | | |
| | AnalogIn01OpenLoop | Bit 2 | | | | |
| 165 | Status word - AnalogIn (H byte) | USINT | • | | | |
| | AnalogIn02Underflow | Bit 0 | | | | |
| | AnalogIn02Overflow | Bit 1 | | | | |
| | AnalogIn02OpenLoop | Bit 2 | | | | |
| Direct I/O configuration | | | | | | |
| 556 | CfO_DigitalDirection | UDINT | | | | • |
| 548 | CfO_DigitalFilter | UDINT | | | | • |
| 564 | CfO_AnalogFilter01 | UDINT | | | | • |
| 588 | CfO_AnalogFilter02 | UDINT | | | | • |
| 572 | CfO_LowerLimit01 | DINT | | | | • |
| 596 | CfO_LowerLimit02 | DINT | | | | • |
| 580 | CfO_UpperLimit01 | DINT | | | | • |
| 604 | CfO_UpperLimit02 | DINT | | | | • |
| Direct I/O communication | | | | | | |
| 5 | Digital outputs | USINT | | | • | |
| | DigitalOutput03 | Bit 2 | | | | |
| | DigitalOutput04 | Bit 3 | | | | |
| | DigitalOutput07 | Bit 6 | | | | |
| | DigitalOutput08 | Bit 7 | | | | |
| 1 | Digital inputs | USINT | • | | | |
| | DigitalInput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalInput08 | Bit 7 | | | | |
| 14 | AnalogInput01 | INT | • | | | |
| 16 | AnalogInput02 | INT | • | | | |

9.28.4.11.4 Module communication

9.28.4.11.4.1 Module status messages

Name:
ModuleStatus

This register is used to transfer general status messages for the module.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|--------------------------------------|---------------------|-------|---|
| Status word - Module (L byte) | | | |
| 0 | SensorSupplyOk_X1 | 0 | (Encoder) power supply for X1 faulty |
| | | 1 | No error |
| 1 | InternalSupplyOk_X1 | 0 | Internal voltage conversion for X1 faulty |
| | | 1 | No error |
| 2 | SensorSupplyOk_X2 | 0 | Power supply for X2 faulty |
| | | 1 | No error |
| 3 | InternalSupplyOk_X2 | 0 | Internal voltage conversion for X2 faulty |
| | | 1 | No error |
| 4 - 5 | Reserved | - | |
| 6 | X1ToX2ComError | 0 | No error |
| | | 1 | X1 → X2 communication faulty |
| 7 | X2ToX1ComError | 0 | No error |
| | | 1 | X2 → X1 communication faulty |
| Status word - Module (H byte) | | | |
| 0 | AnalogIn01ComError | 0 | No error |
| | | 1 | Value from analog input 1 faulty |
| 1 | AnalogIn02ComError | 0 | No error |
| | | 1 | Value from analog input 2 faulty |
| 2 - 7 | Reserved | - | |

9.28.4.11.4.2 Status messages for the digital channels

Name:
DigitalStatus

This register is used to transfer general status messages for the digital channels.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|---------------------------------------|------------------------|-------|---|
| Status word - Digital (L byte) | | | |
| 0 - 1 | Reserved | - | |
| 2 | DigitalOutput3Overload | 0 | Digital output 3 OK |
| | | 1 | Requested voltage 0 V/24 V not achieved |
| 3 | DigitalOutput4Overload | 0 | Digital output 4 OK |
| | | 1 | Requested voltage 0 V/24 V not achieved |
| 4 - 5 | Reserved | - | |
| 6 | DigitalOutput7Overload | 0 | Digital output 7 OK |
| | | 1 | Requested voltage 0 V/24 V not achieved |
| 7 | DigitalOutput8Overload | 0 | Digital output 8 OK |
| | | 1 | Requested voltage 0 V/24 V not achieved |

9.28.4.11.4.3 Status messages from analog inputs

Name:

AnalogInputStatus

This register transfers general status messages of analog inputs.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|--|---------------------|-------|--|
| Status word - AnalogIn (L byte) | | | |
| 0 | AnalogIn01Underflow | 0 | No error |
| | | 1 | Lower limit value from analog input 1 underrun |
| 1 | AnalogIn01Overflow | 0 | No error |
| | | 1 | Upper limit value from analog input 1 exceeded |
| 2 | AnalogIn01OpenLoop | 0 | No error |
| | | 1 | Open line determined on analog input 1 |
| 3 - 7 | Reserved | - | |
| Status word - AnalogIn (H byte) | | | |
| 0 | AnalogIn02Underflow | 0 | No error |
| | | 1 | Lower limit value from analog input 2 underrun |
| 1 | AnalogIn02Overflow | 0 | No error |
| | | 1 | Upper limit value from analog input 2 exceeded |
| 2 | AnalogIn02OpenLoop | 0 | No error |
| | | 1 | Open line determined on analog input 2 |
| 3 - 7 | Reserved | - | |

9.28.4.11.5 reACTION - Configuration

9.28.4.11.5.1 reACTION cycle time

Name:

ReActionCycleTimeValue

ReActionCycleTimeMultiplier

Registers "TimeValue" and "Multiplier" predefine the desired cycle time for the reACTION program. Register "TimeValue" contains the value, while register "Multiplier" contains the associated units.

Register "Multiplier" is currently permanently set to 1000 in order to predefine the cycle time with μ s precision.

| Data type | Value |
|-----------|------------|
| UDINT | 1 to 10000 |

9.28.4.11.5.2 Configuring the PAR data points

Name:

CfO_PARType01

CfO_PARType[02...04]

PAR data points can be defined for the reACTION program. To enable them, the desired data type must be made known according to the configuration in Automation Studio.

| Data type | Value |
|-----------|-------------------|
| UDINT | See bit structure |

Bit structure:

| Bit | Name | Value | Information |
|---------|-----------------|-------|-------------|
| 0 - 3 | Type01 - PAR 1 | 0000 | Inactive |
| | Type02 - PAR 9 | 0001 | USINT, BOOL |
| | Type03 - PAR 17 | | |
| | Type04 - PAR 25 | | |
| 4 - 7 | Type01 - PAR 2 | | |
| | Type02 - PAR 10 | 0011 | UDINT |
| | Type03 - PAR 18 | | |
| | Type04 - PAR 26 | | |
| 8 - 11 | Type01 - PAR 3 | | |
| | Type02 - PAR 11 | 0101 | SINT |
| | Type03 - PAR 19 | | |
| | Type04 - PAR 27 | | |
| 12 - 15 | Type01 - PAR 4 | | |
| | Type02 - PAR 12 | 0111 | DINT |
| | Type03 - PAR 20 | | |
| | Type04 - PAR 28 | | |
| 16 - 19 | Type01 - PAR 5 | | |
| | Type02 - PAR 13 | ... | |
| | Type03 - PAR 21 | 1111 | |
| | Type04 - PAR 29 | | |
| 20 - 23 | Type01 - PAR 6 | | |
| | Type02 - PAR 14 | | |
| | Type03 - PAR 22 | | |
| | Type04 - PAR 30 | | |
| 24 - 27 | Type01 - PAR 7 | | |
| | Type02 - PAR 15 | | |
| | Type03 - PAR 23 | | |
| | Type04 - PAR 31 | | |
| 28 - 31 | Type01 - PAR 8 | | |
| | Type02 - PAR 16 | | |
| | Type03 - PAR 24 | | |
| | Type04 - PAR 32 | | |

9.28.4.11.6 reACTION - Communication

At runtime, the reACTION module program is controlled via the program sequence in the CPU. In its active state, the reACTION program is then executed independently of the program sequence in the CPU.

9.28.4.11.6.1 Controlling the reACTION module

Name:

RTEnable

RTHardwareWarningQuit

This register controls the reACTION program.

| Data type | Value |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|-----------------------|-------|--|
| 0 | RTEnable | 0 | Stops the reACTION program |
| | | 1 | Starts the reACTION program |
| 1 | Reserved | - | |
| 2 | RTHardwareWarningQuit | 0 | No effect |
| | | 1 | Acknowledges warning messages for the inputs and outputs |
| 3 - 7 | Reserved | - | |

9.28.4.11.6.2 reACTION module status messages

Name:

RTEngineRun

RTCycleTimeOverrun

RTHardwareWarning

RTFileInvalid

RTFunctionInvalid

RTInstanceInvalid

RTFileNotLoaded

This register is used to output various status messages.

| Data type | Value |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|---|-------|--|
| 0 | RTEngineRun | 0 | reACTION program inactive |
| | | 1 | reACTION program active |
| 1 | RTCycleTimeOverrun | 0 | Configured RT cycle time observed |
| | | 1 | RT cycle time set too short |
| 2 | RTHardwareWarning (group bit for acyclic status data points) | 0 | No status messages |
| | | 1 | Warning message for the inputs and outputs |
| 3 | Reserved | - | |
| 4 | RTFileInvalid (invalid RT program preloaded) | 0 | RT program in RAM OK |
| | | 1 | RT program in RAM invalid |
| 5 | RTFunctionInvalid (invalid software function) | 0 | RT program OK |
| | | 1 | RT program requesting invalid function block |
| 6 | RTInstanceInvalid (invalid hardware instance) | 0 | RT program OK |
| | | 1 | RT program requesting invalid I/O |
| 7 | RTFileNotLoaded | 0 | Valid RT program in RT engine |
| | | 1 | No RT program loaded |

9.28.4.11.6.3 Cycle counter for the active reACTION program

Name:

RTCycleCounter

Register "CycleCounter" can be used to determine how often the reACTION program has cycled.

| Data type | Value |
|-----------|------------|
| UINT | 0 to 65535 |

9.28.4.11.6.4 Minimum cycle time of the active reACTION program

Name:

RTCycleTime

Register "RTCycleTime" can be used to determine how much time the reACTION module needs to cycle through the loaded program once.

| Data type | Value |
|-----------|-------------------------|
| UINT | 0 to 65535: Units 10 ns |

9.28.4.11.7 reACTION - Interaction

After startup, the reACTION program in the module runs independently. It reads the images of the required inputs and manages its assigned outputs throughout the entire network. In addition, the reACTION program can interact with the CPU. There are 3 different data point types available for this.

9.28.4.11.7.1 PAR data points

Name:

PAR[01...32]

PAR[01...32]_Bit1

PAR[01...32]_Bit2

PAR[01...32]_Bit3

PAR[01...32]_Bit4

PAR[01...32]_Bit5

PAR[01...32]_Bit6

PAR[01...32]_Bit7

PAR[01...32]_Bit8

Once enabled, the PAR data points are transported cyclically via X2X Link. They are used to transfer information from the CPU to the reACTION program. They can be used to intervene in the execution of the reACTION program.

Information:

PAR data points DO NOT control the module's outputs directly!

| Data type | Value |
|---------------|-------------------------------|
| (U)SINT, BOOL | Corresponding range of values |
| (U)INT | |
| (U)DINT | |

| Register | Name | Data type | Read | | Write | | |
|------------------|---------------------------------|-----------------------|---------|---------|--------|---------|--|
| | | | Cyclic | Acyclic | Cyclic | Acyclic | |
| 4095 + Index * 8 | PAR01 PAR[02...32] | (U)SINT | | | • | | |
| | PAR01_Bit1 PAR[02...32]_Bit1 | Bit 0 | | | | | |
| | PAR01_Bit2 PAR[02...32]_Bit2 | Bit 1 | | | | | |
| | PAR01_Bit3 PAR[02...32]_Bit3 | Bit 2 | | | | | |
| | PAR01_Bit4 PAR[02...32]_Bit4 | Bit 3 | | | | | |
| | PAR01_Bit5 PAR[02...32]_Bit5 | Bit 4 | | | | | |
| | PAR01_Bit6 PAR[02...32]_Bit6 | Bit 5 | | | | | |
| | PAR01_Bit7 PAR[02...32]_Bit7 | Bit 6 | | | | | |
| | PAR01_Bit8 PAR[02...32]_Bit8 | Bit 7 | | | | | |
| | 4094 + Index * 8 | PAR01 PAR[02...32] | (U)INT | | | • | |
| | 4092 + Index * 8 | PAR01 PAR[02...32] | (U)DINT | | | • | |

9.28.4.11.7.2 RES data points

Name:

RES[01...32]

RES[01...32]_Bit1

RES[01...32]_Bit2

RES[01...32]_Bit3

RES[01...32]_Bit4

RES[01...32]_Bit5

RES[01...32]_Bit6

RES[01...32]_Bit7

RES[01...32]_Bit8

Once enabled, the RES data points are transported cyclically via X2X Link. They are used to transfer information from the reACTION program to the CPU.

Information:

RES data points DO NOT map the module's input directly!

| Data type | Value |
|---------------|-------------------------------|
| (U)SINT, BOOL | Corresponding range of values |
| (U)INT | |
| (U)DINT | |

| Register | Name | Data type | Read | | Write | |
|-------------------|-------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 5119 + Index * 8 | RES01 | (U)SINT | • | | | |
| | RES[02...32] | | | | | |
| | RES01_Bit1 | Bit 0 | | | | |
| | RES[02...32]_Bit1 | | | | | |
| | RES01_Bit2 | Bit 1 | | | | |
| | RES[02...32]_Bit2 | | | | | |
| | RES01_Bit3 | Bit 2 | | | | |
| | RES[02...32]_Bit3 | | | | | |
| | RES01_Bit4 | Bit 3 | | | | |
| | RES[02...32]_Bit4 | | | | | |
| | RES01_Bit5 | Bit 4 | | | | |
| | RES[02...32]_Bit5 | | | | | |
| | RES01_Bit6 | Bit 5 | | | | |
| RES[02...32]_Bit6 | | | | | | |
| RES01_Bit7 | Bit 6 | | | | | |
| RES[02...32]_Bit7 | | | | | | |
| RES01_Bit8 | Bit 7 | | | | | |
| RES[02...32]_Bit8 | | | | | | |
| 5118 + Index * 8 | RES01 | (U)INT | • | | | |
| | RES[02...32] | | | | | |
| 5116 + Index * 8 | RES01 | (U)DINT | • | | | |
| | RES[02...32] | | | | | |

9.28.4.11.7.3 PVAR and RVAR data points

Name:

PVAR[1...256]

RVAR[1...256]

In addition to PAR and RES data points, VAR data points can also be defined in the reACTION program. They are a direct component of the reACTION program and can be accessed acyclically by the CPU. Like the PAR and RES data points, the PVAR data points are used to transfer information from the CPU to the reACTION program. The RVAR data points are used to transfer feedback from the reACTION program to the CPU.

| Data type | Value |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

| Register | Name | Data type | Read | | Write | |
|------------------|------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 6140 + Index * 8 | PVAR1 PVAR[2...256] | DINT | | | | • |
| 6140 + Index * 8 | RVAR1 RVAR[2...256] | DINT | | • | | |

9.28.4.11.8 reACTION function blocks - General

The following tables provide an overview of I/O channel assignments to reACTION function blocks.

Digital inputs/outputs

| Channel | Function block | | |
|-----------------|-----------------------|-----------|----------------------|
| | Mapping ¹⁾ | rTiDin | rTiDout, rTiDoutTime |
| X1: DI 1 | 0x00 | Channel 1 | |
| X1: DI 2 | 0x01 | Channel 2 | |
| X1: DI 3 / DO 3 | 0x02 | Channel 3 | Channel 3 |
| X1: DI 4 / DO 4 | 0x03 | Channel 4 | Channel 4 |
| X1: DI 5 | 0x04 | Channel 5 | |
| X1: DI 6 | 0x05 | Channel 6 | |
| X1: DI 7 / DO 7 | 0x06 | Channel 7 | Channel 7 |
| X1: DI 8 / DO 8 | 0x07 | Channel 8 | Channel 8 |

- 1) The "Mapping" specification is needed in the event that multiple physical inputs/outputs must be grouped together in order to be processed by a reACTION function block (e.g. rTiABRPos) (see ["reACTION function blocks - Configuration" on page 3502](#)).

Analog inputs

| Channel | Function block | | |
|----------|-----------------------|-----------|---------|
| | Mapping ¹⁾ | rTiAin | rTiAout |
| X2: AI 1 | 0x00 | Channel 1 | |
| X2: AI 2 | 0x01 | Channel 2 | |

- 1) The "Mapping" specification is needed in the event that multiple physical inputs/outputs must be grouped together in order to be processed by a reACTION function block (e.g. rTiABRPos) (see ["reACTION function blocks - Configuration" on page 3502](#)).

9.28.4.11.9 reACTION function blocks - Configuration

Some function blocks in library AsIoRti must be configured before they can be used.

| Function block | Information |
|----------------|--|
| rtiABRPos | The module offers the option of using function block rtiABRPos once in the reACTION program. To do so, the function block must be assigned 3 digital inputs that are no longer available for rtiDin. |
| rtiABCnt | The module offers the option of using function block rtiABCnt up to 3 times in the reACTION program. To do so, the function blocks must be assigned 2 digital inputs as an A or B track that are no longer available for rtiDin. In addition, an external event can be defined for each rtiABCnt function block. The input used for this is also no longer available for rtiDin. |

Table 603: List of function blocks requiring prior configuration

9.28.4.11.9.1 Function blocks rtiABRPos and rtiABCnt

Function blocks rtiABRPos and rtiABCnt can be used to process the position value of an ABR incremental encoder in a reACTION task. Several hardware channels of the module are used for this. The incoming signals are interpreted by the reACTION engine and converted into a location.

The update rate depends on both the reACTION engine and the hardware used. The reACTION engine is basically able to calculate positions with an update rate of up to 8 MHz. The input frequencies of the hardware inputs can be taken from the technical data of the respective module.

These function blocks can be used separately or in combination.

Using function block rtiABRPos

The following points are important to keep in mind when using function block rtiABRPos in a reACTION program:

- The function block can only be used once in a reACTION program.
- 3 digital inputs must be defined on the module for input signals A, B and R.
- In addition, a digital input of the module can be defined as an event input.

Example diagram of input signals:

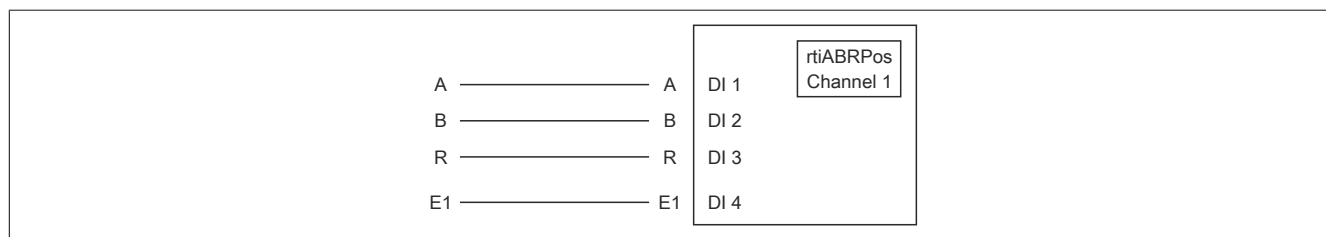


Figure 331: Schematic diagram of input signals for rtiABRPos

Using function block rtiABCnt

The following points must be taken into account when using function block rtiABCnt in a reACTION program:

- The function block can be used up to 3 times in a reACTION program.
- 2 digital inputs must be defined on the module for input signals A and B.
- In addition, up to 3 digital inputs on the module can be defined as event inputs E1, E2 and E3.

Example diagram of input signals:

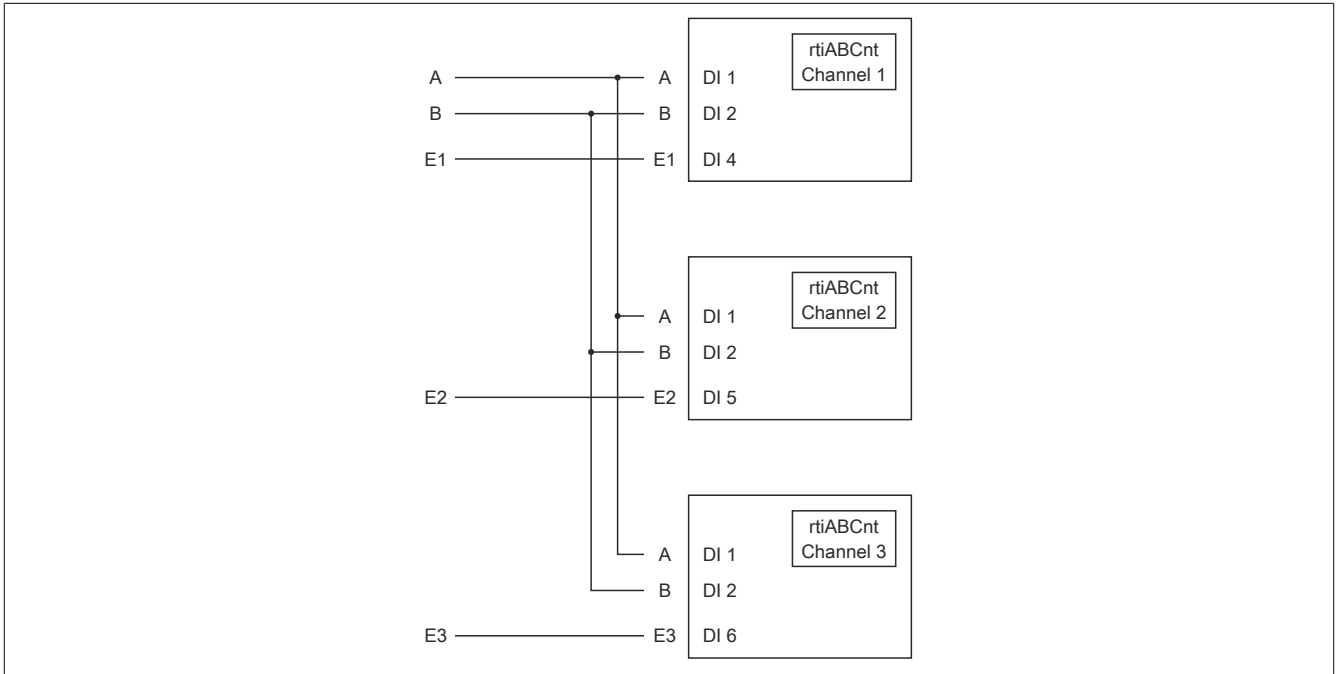


Figure 332: Schematic diagram of input signals for rtiABCnt

Using function blocks rtiABRPos and rtiABCnt in combination

The following points should be kept in mind when using function blocks rtiABRPos and rtiABCnt together in a reACTION program.

- Function block rtiABRPos can only be used once in a reACTION program.
- Function block rtiABCnt can be used up to 2 times in a reACTION program.
- 3 digital inputs must be defined for input signals A, B and R (rtiABRPos).
- The same digital inputs are used for input signals A and B (rtiABCnt).
- In addition, up to 3 event inputs E1, E2 and E3 can be defined (rtiABCnt).
- E1 is used for the event input (rtiABRPos).

Example diagram of input signals:

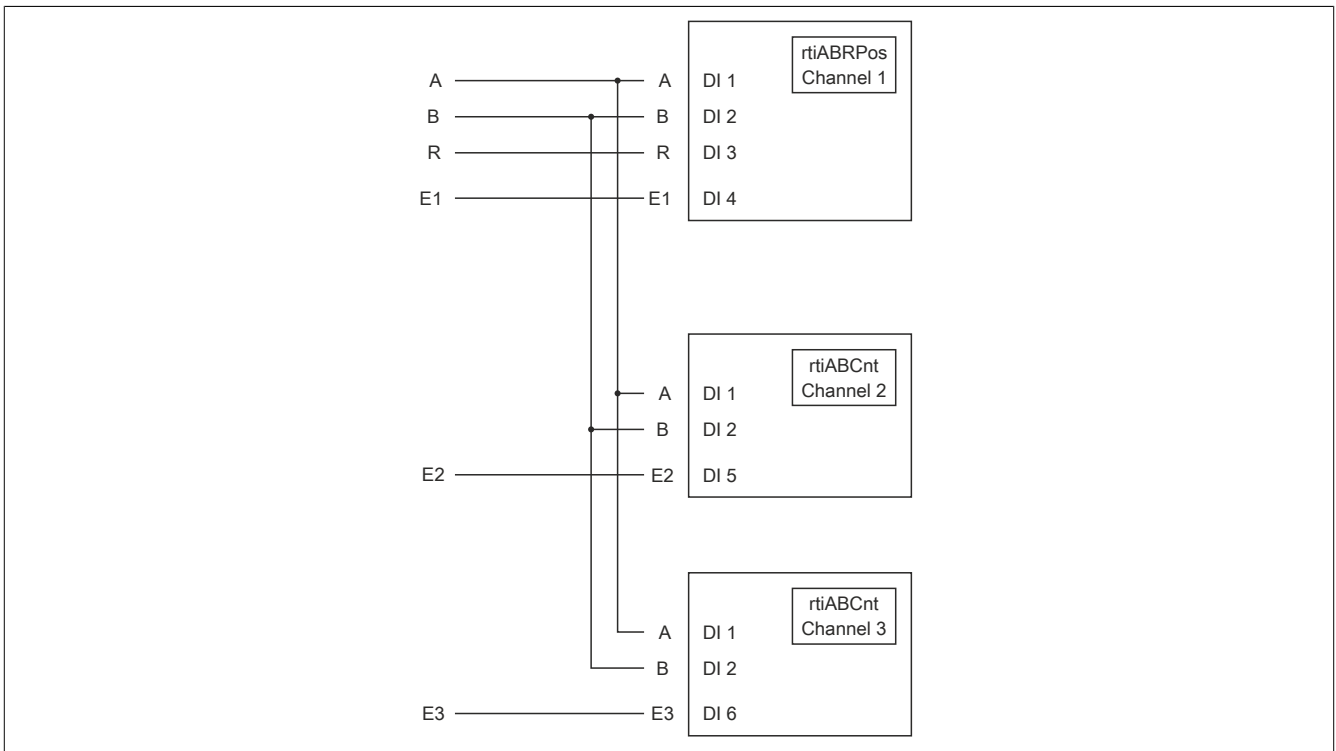


Figure 333: Diagram of input signals when using rtiABRPos and rtiABCnt at the same time

Registering the position encoder (rtiABRPos/rtiABCnt)

Name:

CfO_Config_ABR1

This register specifies the technical characteristics of the connected ABR incremental encoder.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|--|------------|---|
| 0 - 15 | Increments per revolution | 0 to 65535 | Reference pulse monitoring: If the reference pulse is different than defined here, this is indicated on the status output of function block rtiABRPos. |
| 16 | Inversion of the counting direction set by signals A and B | 0 | Positive counting direction |
| | | 1 | Negative counting direction |
| 17 - 31 | Reserved | 0 | |

Wiring the position encoder (rtiABRPos/rtiABCnt)

Name:

CfO_ChannelMapping1_ABR1

CfO_ChannelMapping2_ABR1

Before function blocks rtiABRPos/rtiABCnt can be processed by the reACTION engine, the hardware inputs to be used by the ABR incremental encoder must be defined on the module. The "ChannelMapping" registers specify which inputs are interpreted as the A, B, R, E1, E2 and E3 signals.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure of CfO_ChannelMapping1_ABR1:

| Bit | Description | Value | Information |
|---------|-------------|----------|---------------------------------------|
| 0 - 7 | Input E1 | 0 | Mapped to digital input 1 |
| | | 1 | Mapped to digital input 2 |
| | | ... | ... |
| | | 7 | Mapped to digital input 8 |
| | | 8 to 255 | Reserved |
| 8 - 15 | Input R | 0 to 255 | For possible values, see bits 0 to 7. |
| 16 - 23 | Input B | 0 to 255 | For possible values, see bits 0 to 7. |
| 24 - 31 | Input A | 0 to 255 | For possible values, see bits 0 to 7. |

Bit structure of CfO_ChannelMapping2_ABR1:

| Bit | Description | Value | Information |
|---------|-------------|----------|---|
| 0 - 15 | Reserved | 0 | |
| 16 - 23 | Input E3 | 0 | Mapped to digital input 1 |
| | | 1 | Mapped to digital input 2 |
| | | ... | ... |
| | | 7 | Mapped to digital input 8 |
| | | 8 to 255 | Reserved |
| 24 - 31 | Input E2 | 0 to 255 | For possible values, see bits 16 to 23. |

Information:

For information about the relationship between the input on the module and the channel name, see section "reACTION function blocks - General".

Scaling the position encoder (rtiABRPos)

Name:

CfO_ScalingUnits_ABR1

CfO_ScalingIncrements_ABR1

An optional gear ratio can be configured using registers "Units" and "Increments". The dividend for scaling is defined in register "Units"; the divisor is defined in register "Increments".

| Data type | Value | Information |
|-----------|--------------------|--|
| UDINT | 0 to 4,294,967,295 | CfO_ScalingUnits_ABR1: Units per interval CfO_ScalingIncrements_ABR1: Increments per interval |

Formula for calculation

$$\text{Gear ratio} = \text{ScalingUnits} / \text{ScalingIncrements}$$
Example 1

ScalingUnits = 1

ScalingIncrements = 1

$$\text{Position value (Pos)} = \text{ABR increments} * \text{ScalingUnits} / \text{ScalingIncrements}$$

$$\text{Position value (Pos)} = \text{ABR increments} * 1/1$$

In this example, the ABR position value is output unchanged on output "Pos".

Example 2

ScalingUnits = 10

ScalingIncrements = 4

$$\text{Position value (Pos)} = \text{ABR increments} * \text{ScalingUnits} / \text{ScalingIncrements}$$

$$\text{Position value (Pos)} = \text{ABR increments} * 10/4$$

In this example, the ABR position value is multiplied by 2.5 and output on output "Pos".

Information:

The encoder values are calculated internally as INT64 values in 32.32 format. On output "Pos" of function block "rtiABRPos", only the whole number value (INT32) is output for the user. The fixed point decimal places are used internally to calculate a higher resolution.

9.28.4.11.10 Direct I/O configuration

This module is equipped with 8 digital channels and 2 analog inputs. In the "Direct I/O" function model, behavior is based on that of a standard module. The I/O channels are managed by an extremely simplified reACTION program. The function model primarily serves to check that the I/O channels are functioning properly.

9.28.4.11.10.1 Direction of digital channels

Name:

CfO_DigitalDirection

This register determines the signal direction of digital channels 3, 4, 7 and 8.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|-------------------------------|-------|-------------|
| 0 - 1 | Reserved | 0 | |
| 2 | Direction - Digital channel 3 | 0 | Input |
| | | 1 | Output |
| 3 | Direction - Digital channel 4 | 0 | Input |
| | | 1 | Output |
| 4 - 5 | Reserved | 0 | |
| 6 | Direction - Digital channel 7 | 0 | Input |
| | | 1 | Output |
| 7 | Direction - Digital channel 8 | 0 | Input |
| | | 1 | Output |

9.28.4.11.10.2 Filtering digital channels

Name:

CfO_DigitalFilter

This register defines the filter time of the digital channels. The filter value affects both the switching delay as well as the immunity of the channels.

| Data type | Value |
|-----------|--------------------------|
| UDINT | 0 to 500000: Units 10 ns |

9.28.4.11.10.3 Filtering analog channels

Name:

CfO_AnalogFilter01

CfO_AnalogFilter02

This register sets the filter level of the corresponding analog channel.

| Data type | Value |
|-----------|--------|
| UDINT | 0 to 7 |

$$2^{\text{AnalogFilter}} = \text{FilterLevel} = \frac{\text{Out(ADC)}_t - \text{Out(Filter)}_{t-1}}{\text{Out(Filter)}_t - \text{Out(Filter)}_{t-1}} \cong \frac{\Delta \text{Out(ADC)}}{\Delta \text{Out(Filter)}}$$

The filter level results as the exponent to base 2 and corresponds to the ratio of the change of the digitalized input value to the change of the filtered analog value.

9.28.4.11.10.4 Limit values of analog channels

Name:

CfO_LowerLimit01

CfO_LowerLimit02

CfO_UpperLimit01

CfO_UpperLimit02

These registers define the upper and lower user-specific limit values for analog inputs.

| Data type | Value |
|-----------|---|
| DINT | LowerLimit: -32767 to 32767 (default: -32767) |
| | UpperLimit: -32767 to 32767 (default: 32767) |

9.28.4.11.11 Direct I/O communication

This module is equipped with the following inputs and outputs:

- 4 digital inputs (sink) for 24 VDC
- 4 digital channels configurable as inputs (sink) or outputs (sink or source) for 24 VDC
- 2 analog inputs of type ± 10 V

9.28.4.11.11.1 Digital outputs

Name:

DigitalOutput03

DigitalOutput04

DigitalOutput07

DigitalOutput08

This register is used to predefine the value that should be output on the digital output.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|-----------------|-------|-------------|
| 0 - 1 | Reserved | 0 | |
| 2 | DigitalOutput03 | 0 | FALSE |
| | | 1 | TRUE |
| 3 | DigitalOutput04 | 0 | FALSE |
| | | 1 | TRUE |
| 4 - 5 | Reserved | 0 | |
| 6 | DigitalOutput07 | 0 | FALSE |
| | | 1 | TRUE |
| 7 | DigitalOutput08 | 0 | FALSE |
| | | 1 | TRUE |

9.28.4.11.11.2 Digital inputs

Name:

DigitalInput01

DigitalInput02

DigitalInput03

DigitalInput04

DigitalInput05

DigitalInput06

DigitalInput07

DigitalInput08

This register indicates the value read for the respective digital input.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|-------|-------------|
| 0 | DigitalInput01 | 0 | FALSE |
| | | 1 | TRUE |
| 1 | DigitalInput02 | 0 | FALSE |
| | | 1 | TRUE |
| 2 | DigitalInput03 | 0 | FALSE |
| | | 1 | TRUE |
| 3 | DigitalInput04 | 0 | FALSE |
| | | 1 | TRUE |
| 4 | DigitalInput05 | 0 | FALSE |
| | | 1 | TRUE |
| 5 | DigitalInput06 | 0 | FALSE |
| | | 1 | TRUE |
| 6 | DigitalInput07 | 0 | FALSE |
| | | 1 | TRUE |
| 7 | DigitalInput08 | 0 | FALSE |
| | | 1 | TRUE |

9.28.4.11.11.3 Analog inputs

Name:

AnalogInput01

AnalogInput02

The analog input value is mapped in this register.

| Data type | Value |
|-----------|-----------------|
| INT | -32767 to 32767 |

9.28.4.11.12 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μ s |

9.28.4.11.13 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 200 μ s |

9.28.5 X20RT8202

Data sheet version: 1.14

9.28.5.1 General information

This reACTION technology module has 4 high-speed digital inputs and 4 high-speed digital mixed channels. All connections are designed for 1-wire connections. All inputs are designed for sink connections, the outputs for push-pull connections.

A voltage signal of ± 10 V can be output using 2 analog outputs.

Ultrafast reACTION Technology makes it possible to control the integrated I/O channels with response times down to 1 μ s. All of the commands that can be used for reACTION programs are provided as function blocks in special libraries (e.g. AsIORTI). Programming in compliance with IEC 61131-3 requirements takes place in the Function Block Diagram editor in Automation Studio.

The module supports blackout mode. In blackout mode, programmable module functionality persists even if the network fails.

- reACTION technology module
- 4 high-speed digital inputs
- 4 high-speed digital channels, configurable as inputs or outputs
- 2 high-speed analog outputs ± 10 V
- 1 ABR incremental encoder input 24 V
- Pulse width modulation
- 24 VDC and GND for encoder supply
- Supports blackout mode



9.28.5.2 Order data


| Model number | Short description | Figure |
|--------------|---|---|
| | reACTION Technology modules |  |
| X20RT8202 | X20 reACTION module, 4 digital inputs, 24 VDC, <1 μ s, 4 digital channels, 24 VDC, 0.1 A, <1 μ s, configurable as inputs or outputs, 2 analog outputs ± 10 V, 2 μ s, 13-bit converter resolution including sign, reACTION Technology module | |
| | Required accessories | |
| | Bus modules | |
| X20BM31 | X20 bus module for double-width modules, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 604: X20RT8202 - Order data

9.28.5.3 Technical data

| Model number | X20RT8202 |
|--|--|
| Short description | |
| I/O module | 4 digital input channels, 4 digital channels configurable as inputs or outputs, 2 analog outputs ± 10 V, reACTION Technology |
| General information | |
| B&R ID code | 0xE55B |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Outputs | Yes, using status LED and software (output error status) |
| reACTION-capable I/O channels | Yes |
| Blackout mode | |
| Scope | Module |
| Function | Programmable |
| Standalone mode | No |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.6 W |
| Additional power dissipation caused by actuators (resistive) [W] | +0.8 |
| Type of signal lines ¹⁾ | Shielded cables must be used for all signal lines, cable length: Max. 20 m |
| Application memory | |
| Type | 64 Mbit flash memory |
| Data retention | 20 years at 55°C |
| Guaranteed erase/write cycles | 100,000 |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| Encoder power supply | |
| Output voltage | 24 VDC -15% / +20% |
| Output current ²⁾ | Module-internal, max. 600 mA |
| Short-circuit proof, overload protection | Yes |
| Digital inputs | |
| Quantity | 4 inputs and 4 mixed channels, configurable as inputs or outputs using software |
| Nominal voltage | 24 VDC |
| Input voltage | 24 VDC -15% / +20% |
| Input current at 24 VDC | Typ. 1.3 mA |
| Input circuit | Sink |
| Input filter | |
| Hardware | <3 μ s |
| Software | Default 200 ns, configurable between 200 ns and 5 ms in 10 ns intervals |
| Connection type | 1-wire connections |
| Input resistance | 18.16 k Ω |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| ABR incremental encoder | |
| Quantity | 2 |
| Encoder inputs | 24 V, asymmetrical |
| Counter size | 32-bit |
| Input frequency | Max. 333 kHz |
| Evaluation | 4x |
| Digital outputs | |
| Quantity ²⁾ | 4 mixed channels, configurable as inputs or outputs using software |
| Variant | Push-Pull |
| Nominal voltage | 24 VDC |
| Switching voltage | 24 VDC -15% / +20% |
| Nominal output current | 100 mA |
| Total nominal current | 400 mA |
| Connection type | 1-wire connections |
| Output circuit | Sink or source |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short circuit current") |
| Diagnostic status | Output monitoring with delay <700 ns |
| Leakage current when switched off | Approx. 25 μ A |
| R _{DS(on)} | 140 m Ω |
| Residual voltage | <0.4 V at nominal current 100 mA |

Table 605: X20RT8202 - Technical data

| Model number | X20RT8202 |
|---|--|
| Max. continuous current | 100 mA |
| Peak short-circuit current | <10 A |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 3 ms |
| Switching delay | |
| 0 → 1 | <1 µs |
| 1 → 0 | <1 µs |
| Switching frequency | |
| Resistive load | Min. 50 kHz, max. 500 kHz |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Analog outputs | |
| Quantity | 2 |
| Output | ±10 V |
| Digital converter resolution | ±12-bit |
| Conversion time | 2 µs |
| Settling time for output changes over entire range | 5 µs |
| Switch on/off behavior | Internal enable relay for startup |
| Max. error at 25°C | |
| Gain | 0.15% ³⁾ |
| Offset | 0.05% ⁴⁾ |
| Output protection | Short circuit protection |
| Output format | |
| Data type | INT |
| Voltage | INT 0x8000 - 0x7FFF / 1 LSB = 0x0008 = 2.441 mV |
| Load per channel | Max. ±10 mA, load ≥1 kΩ |
| Short-circuit proof | Current limiting ±65 mA |
| Output filter | 1st-order low pass / cutoff frequency 22 kHz |
| Max. gain drift | 0.022 %/°C ³⁾ |
| Max. offset drift | 0.032 %/°C ⁴⁾ |
| Error caused by load change | Max. 0.14%, from 10 MΩ → 1 kΩ, resistive |
| Nonlinearity | 0.005% ⁵⁾ |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating and hardware configuration" |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 2x terminal block X20TB12 separately Order 1x bus module X20BM31 separately |
| Spacing | 25 ^{+0.2} mm |

Table 605: X20RT8202 - Technical data

- 1) See section "X20 shielding brackets".
- 2) See section "Derating and hardware configuration".
- 3) Based on the current output value.
- 4) Based on the entire output range.
- 5) Based on the output range.

9.28.5.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.


| Figure | LED | Color | Status | Description |
|---|------------|-----------------------------|---|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode or blackout mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring of digital outputs has been triggered. |
| | | | Double flash | Supply voltage not in valid range or no reACTION program loaded |
| | | | Triple flash | Test of internal memory failed (limited functionality, module must be replaced) |
| | | On | Error or reset state (reACTION program using functions or channels that are not permitted on this hardware) | |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1, 2, 5, 6 | Green | | Input state of the corresponding digital input |
| 3, 4, 7, 8 | Green | | Input or output status of the corresponding digital input or output | |

Table 606: LED status indicators (X1)

1) A firmware update can take several minutes depending on the configuration.


| Figure | LED | Color | Status | Description |
|--|------|--------|--------|-------------|
|  | 1, 2 | Orange | Off | Value = 0 |
| | | | On | Value ≠ 0 |

Table 607: LED status indicators (X2)

9.28.5.5 Pinout

9.28.5.5.1 X1 - Pinout

To prevent crosstalk, each individual signal line should be shielded. The maximum cable length is 20 m.

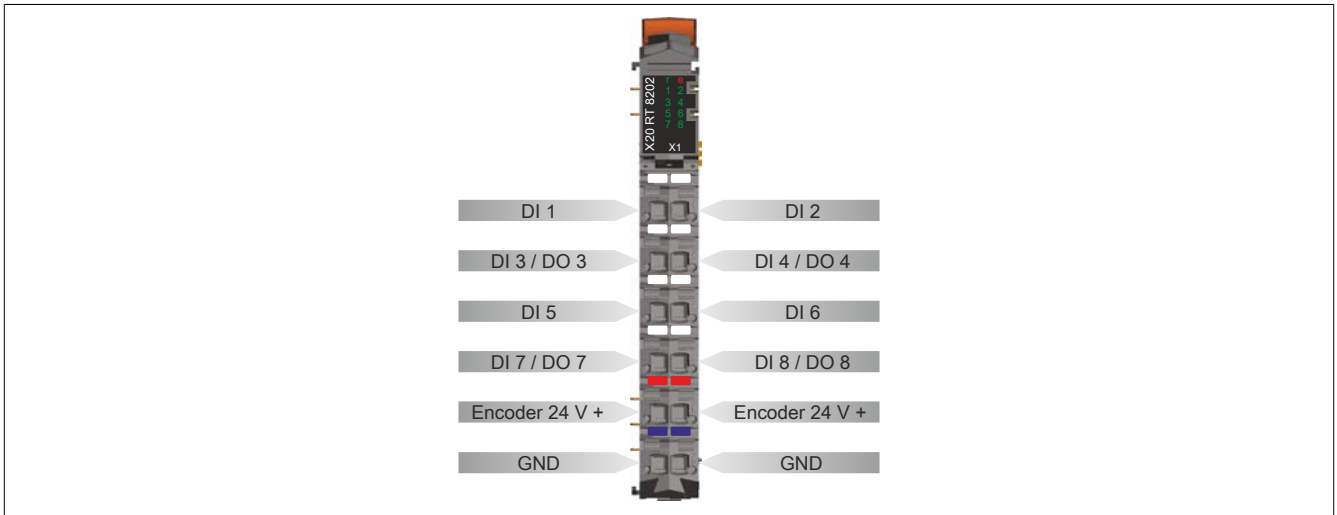


Figure 334: X1 - Pinout

9.28.5.5.2 X2 - Pinout

To prevent crosstalk, each individual signal line should be shielded. The maximum cable length is 20 m.

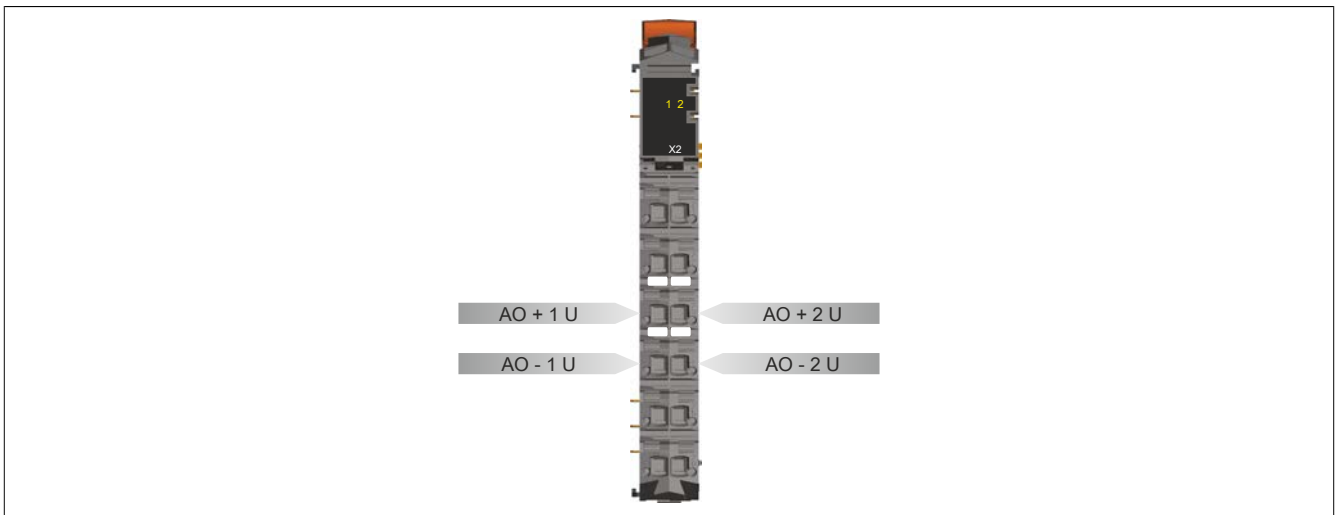


Figure 335: X2 - Pinout

9.28.5.6 Local I/O channels

The following tables provide an overview of the connections to the I/O channels.

Digital inputs/outputs

| Connection | Terminal connection | Channel |
|------------|---------------------|-------------|
| X1 | 11 | DI 1 |
| | 21 | DI 2 |
| | 12 | DI 3 / DO 3 |
| | 22 | DI 4 / DO 4 |
| | 13 | DI 5 |
| | 23 | DI 6 |
| | 14 | DI 7 / DO 7 |
| | 24 | DI 8 / DO 8 |

Analog outputs

| Connection | Terminal connection | Channel |
|------------|---------------------|---------|
| X2 | 13 and 14 | AO 1 |
| | 23 and 24 | AO 2 |

The following sections describe assigning I/O channels in a reACTION program:

| I/O channels | Assignment |
|------------------------|--|
| Digital I/O channels | Assignment of digital inputs/outputs |
| Analog output channels | Assignment of analog outputs |

9.28.5.7 Connection examples

9.28.5.7.1 X1 - Connection examples

Digital inputs and digital outputs

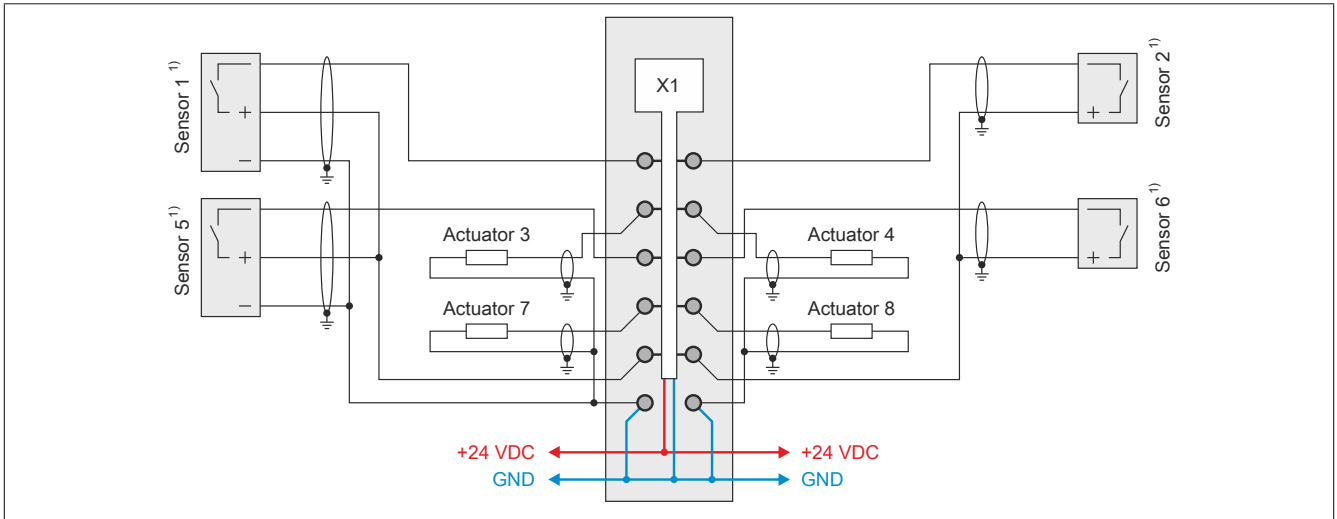


Figure 336: Connection example 1 (X1)

- 1) Observe the wiring guidelines from the sensor manufacturer.

Digital inputs, PWM and ABR incremental encoder

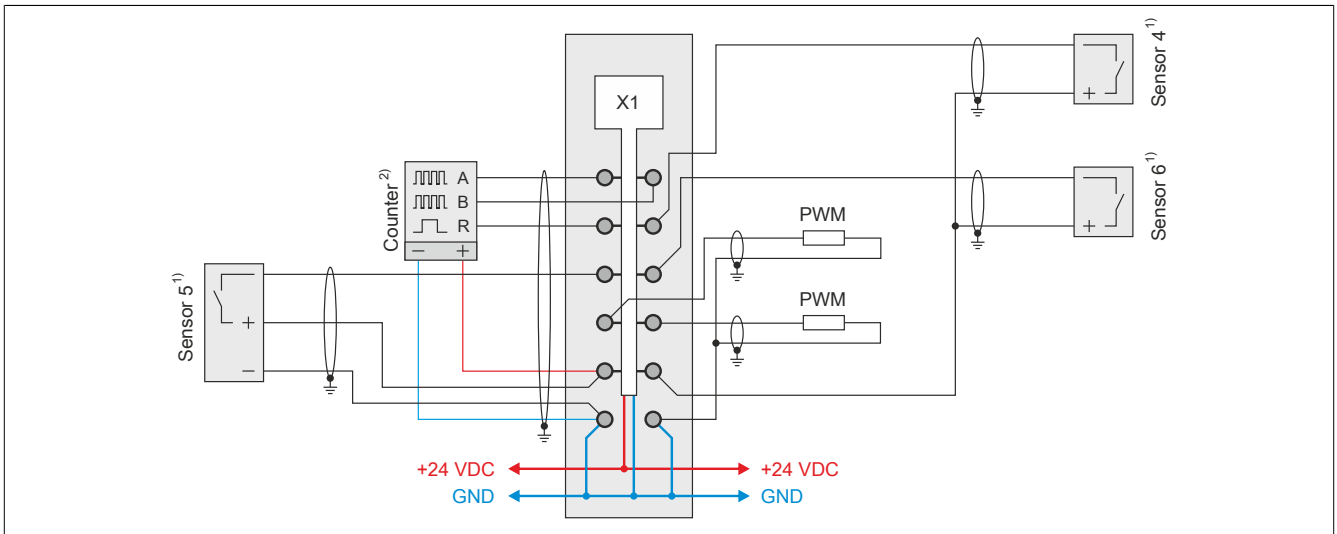


Figure 337: Connection example 2 (X1)

- 1) Observe the wiring guidelines from the sensor manufacturer.
- 2) Observe the wiring guidelines from the encoder manufacturer.

9.28.5.7.2 X2 - Connection example

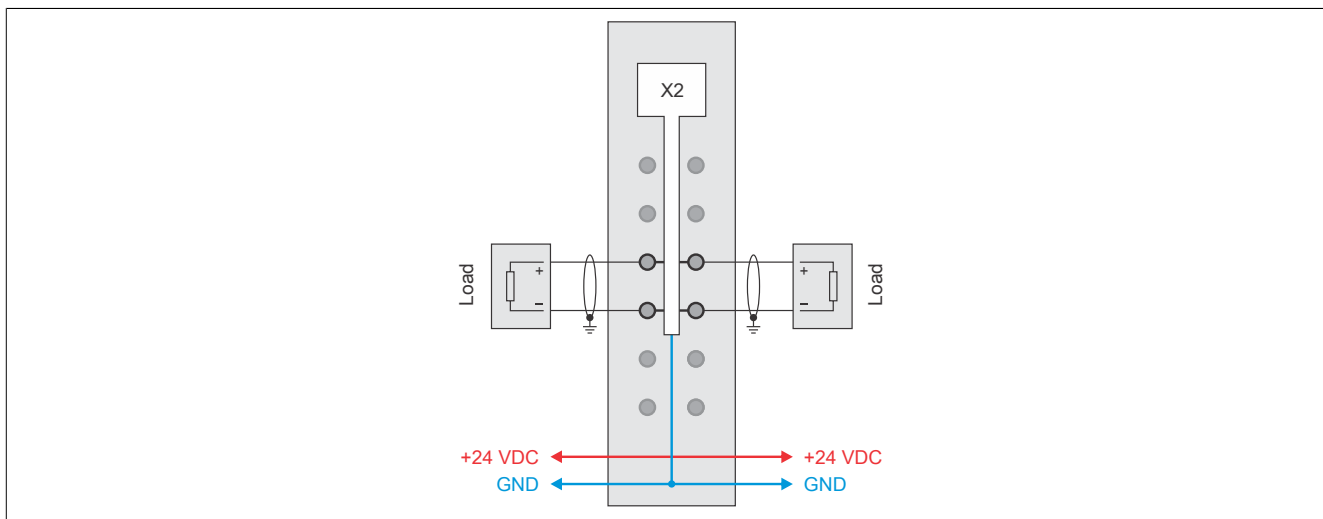


Figure 338: X2 - Connection example

9.28.5.8 Input/Output circuit diagram

9.28.5.8.1 Digital inputs (X1)

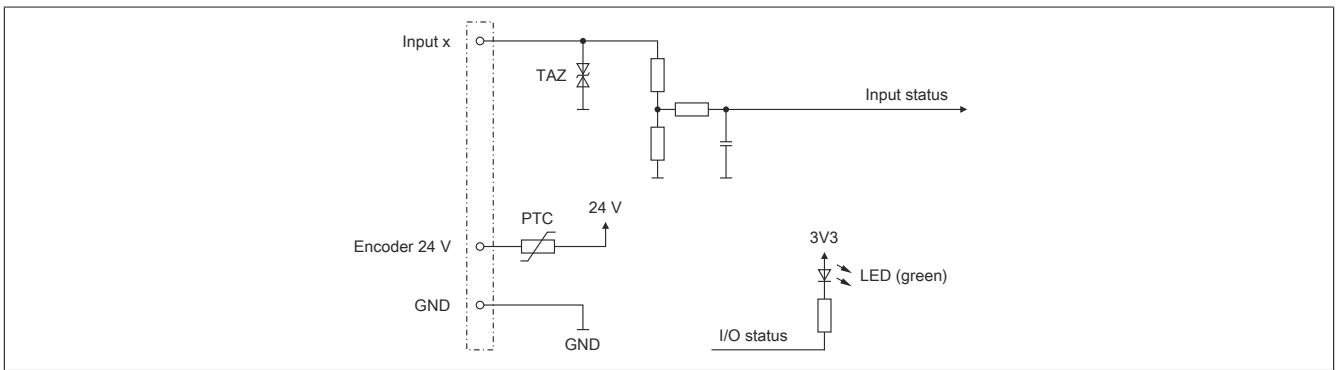


Figure 339: Input circuit diagram of digital inputs (X1)

9.28.5.8.2 Digital mixed channels (X1)

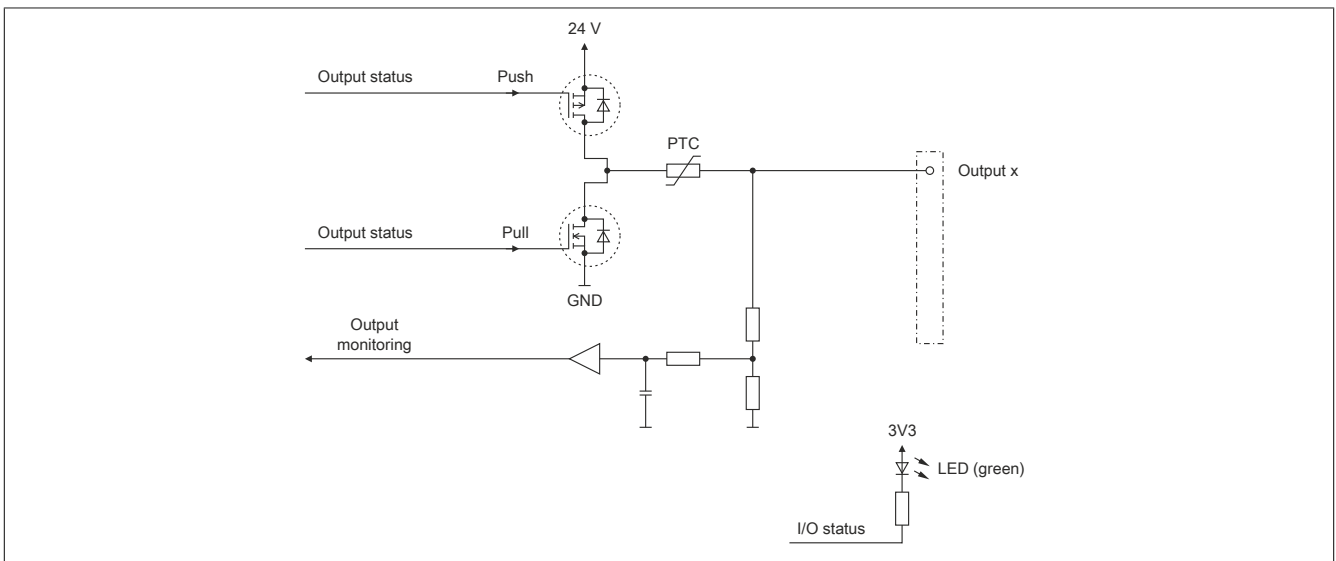


Figure 340: Input/Output circuit diagram of digital mixed channels (X1)

9.28.5.8.3 Analog outputs (X2)

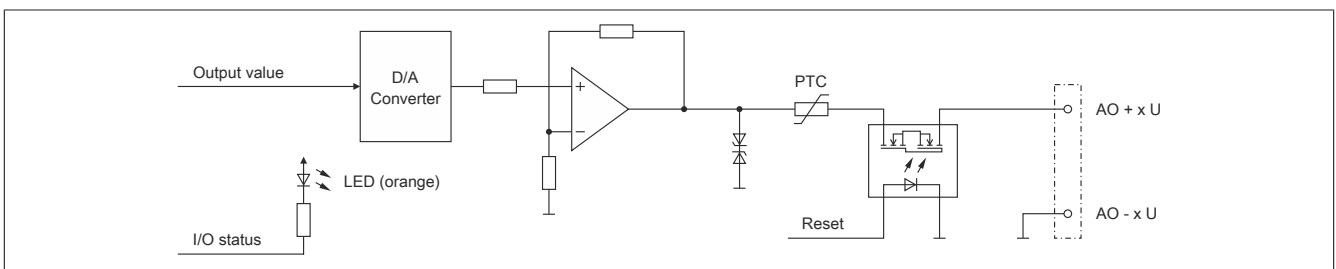


Figure 341: Output circuit diagram of analog outputs (X2)

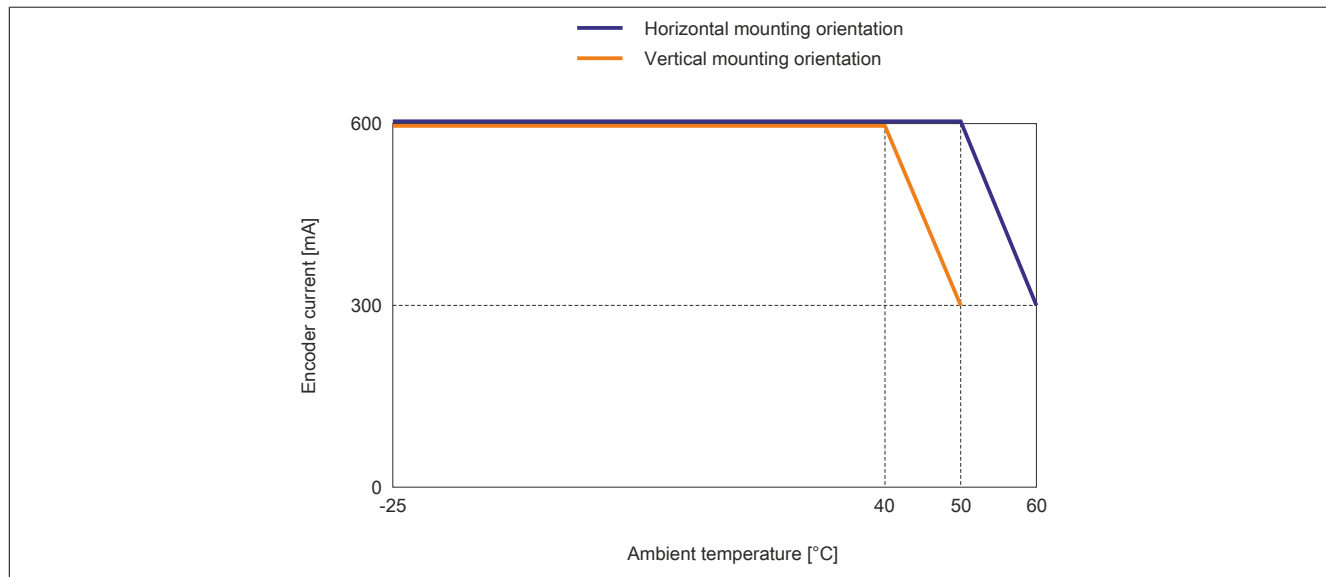
9.28.5.9 Derating and hardware configuration

To ensure proper operation, observe the points listed below:

- Derating of the encoder current
- Number of operable digital outputs
- Hardware configurations

9.28.5.9.1 Derating of the encoder current

Observe the following derating values for the encoder current depending on the mounting orientation:



9.28.5.9.2 Number of operable digital outputs

Depending on the mounting orientation, not all 4 digital outputs of the module can be operated starting at a certain ambient temperature.

Information:

To ensure operation of the module with the ambient temperatures listed below, it is absolutely necessary to disconnect channels.

Reducing the output current per channel does not increase the number of digital output channels that can be operated in the corresponding ambient temperature class.

Horizontal installation

| Ambient temperature | Number of operable digital outputs |
|---------------------|------------------------------------|
| <45°C | 4 |
| Starting at 45°C | 3 |
| Starting at 55°C | 2 |

Vertical installation

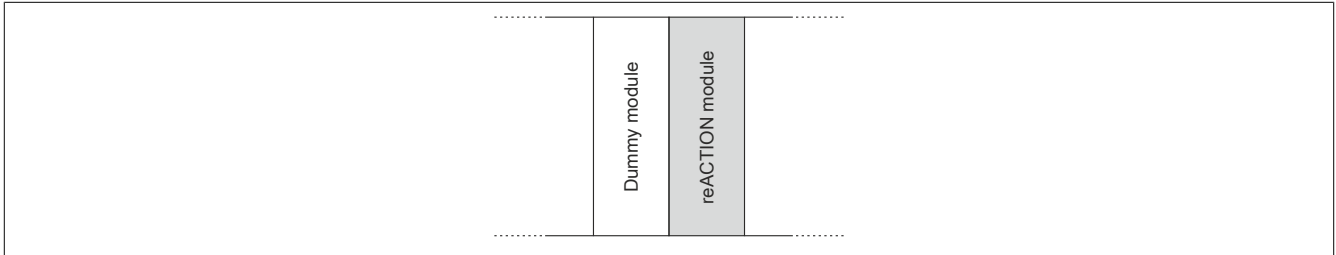
| Ambient temperature | Number of operable digital outputs |
|---------------------|------------------------------------|
| <35°C | 4 |
| Starting at 35°C | 3 |
| Starting at 45°C | 2 |

9.28.5.9.3 Hardware configuration for horizontal installation

9.28.5.9.3.1 Hardware configuration starting at an ambient temperature of 50°C

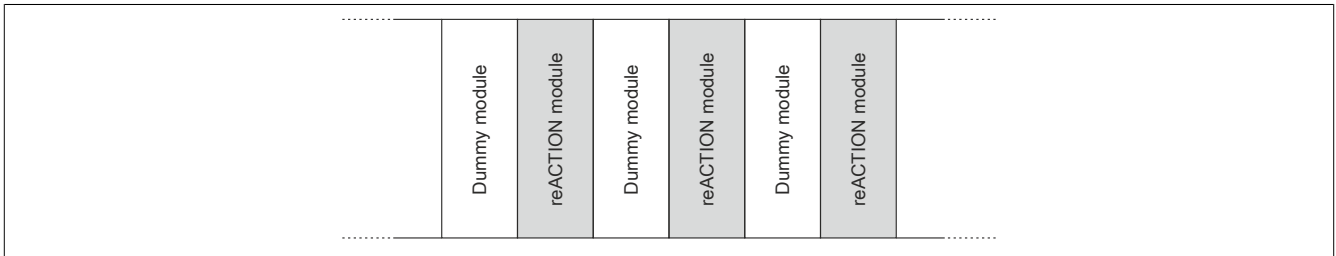
Operating a reACTION module

Starting at an ambient temperature of 50°C, a dummy module must be connected to the left of the reACTION module if installed horizontally.



Operating multiple reACTION modules side by side

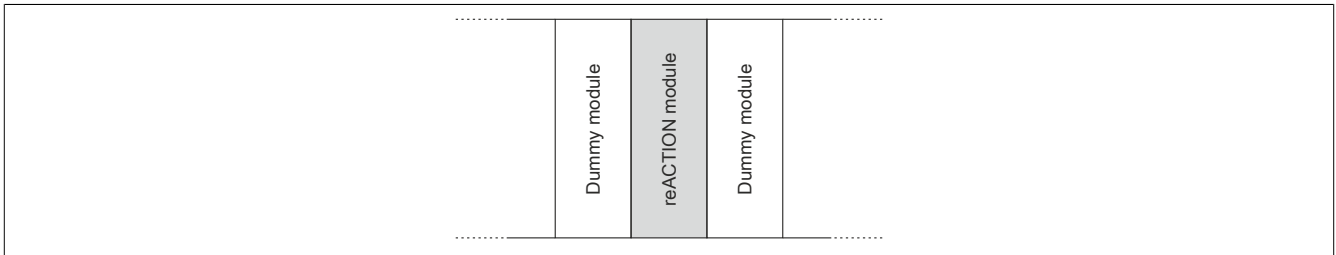
If 2 or more horizontal reACTION modules are being operated in a cluster, the following arrangement of modules must be observed.



9.28.5.9.3.2 Hardware configuration starting at an ambient temperature of 55°C

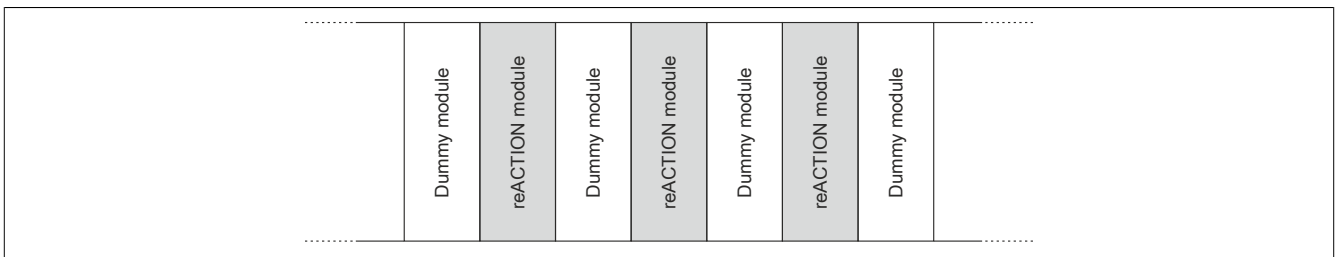
Operating a reACTION module

Starting at an ambient temperature of 55°C, a dummy module must be connected to the left and right of the reACTION module if installed horizontally.



Operating multiple reACTION modules side by side

If 2 or more horizontal reACTION modules are being operated in a cluster, the following arrangement of modules must be observed.

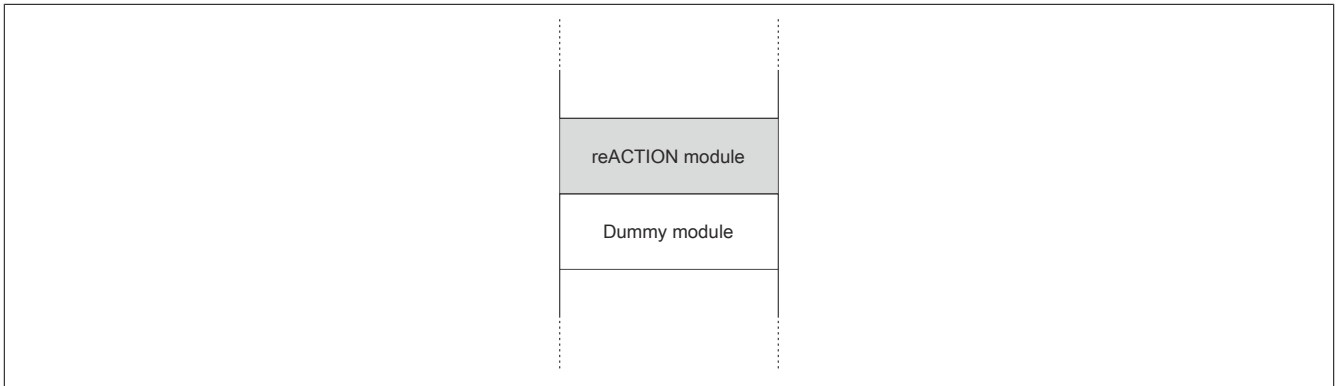


9.28.5.9.4 Hardware configuration for vertical installation

9.28.5.9.4.1 Hardware configuration starting at an ambient temperature of 40°C

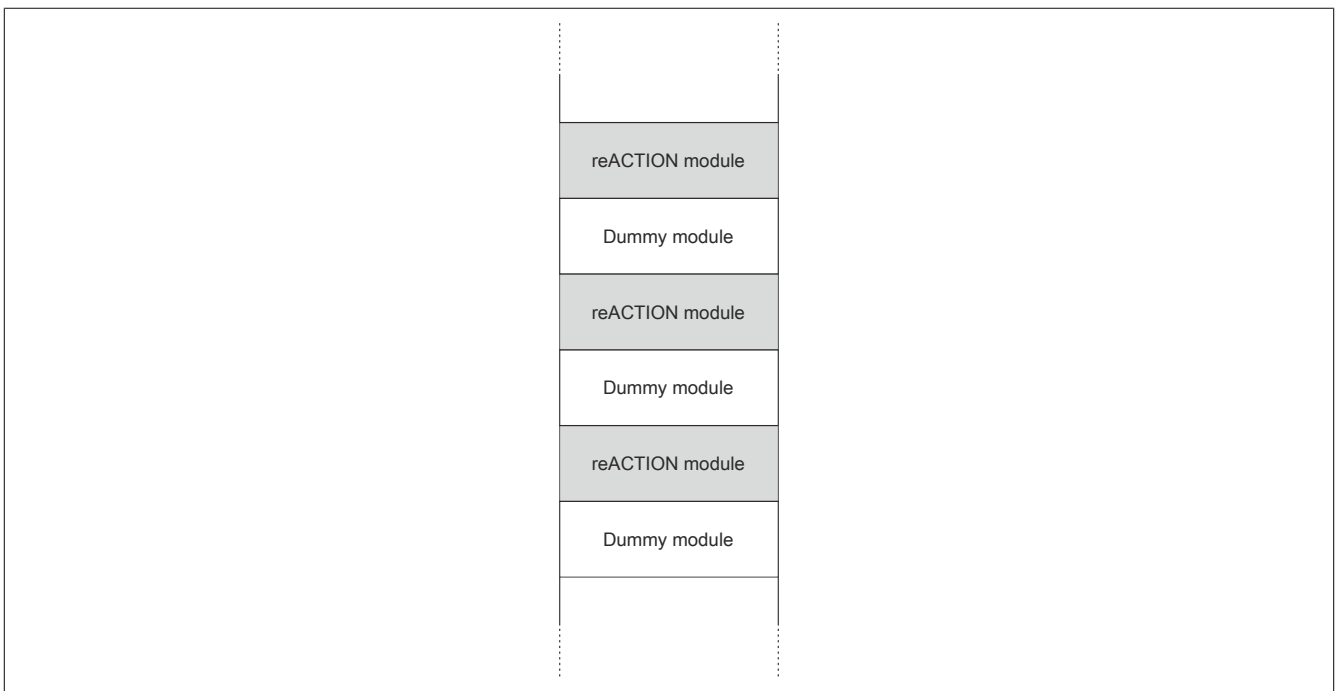
Operating a reACTION module

At ambient temperatures starting at 40°C, a dummy module must be installed below the reACTION module if installed vertically.



Operating multiple reACTION modules side by side

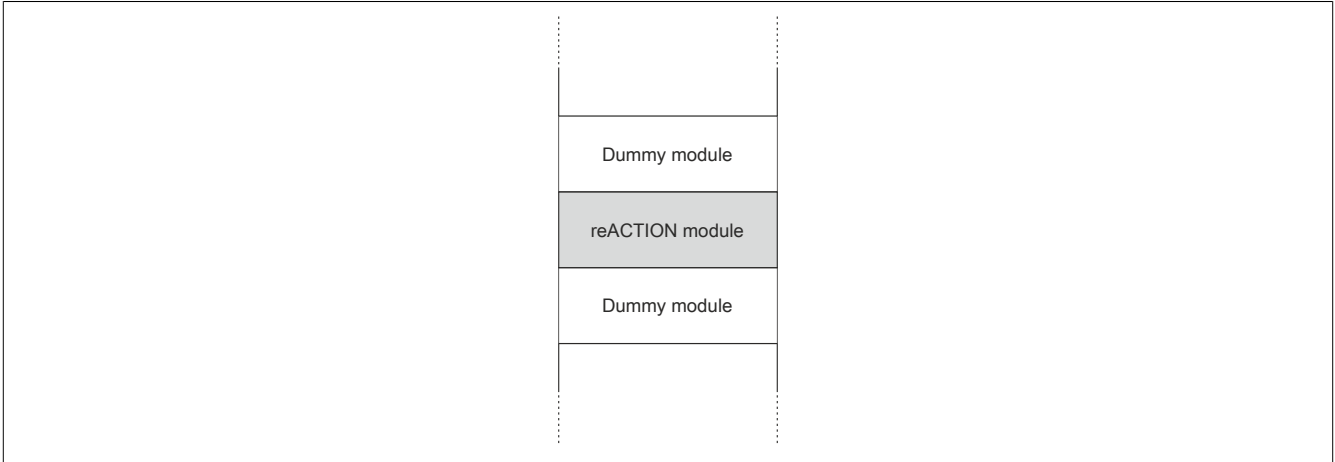
If 2 or more vertical reACTION modules are being operated in a cluster, the following arrangement of modules must be observed.



9.28.5.9.4.2 Hardware configuration starting at an ambient temperature of 45°C

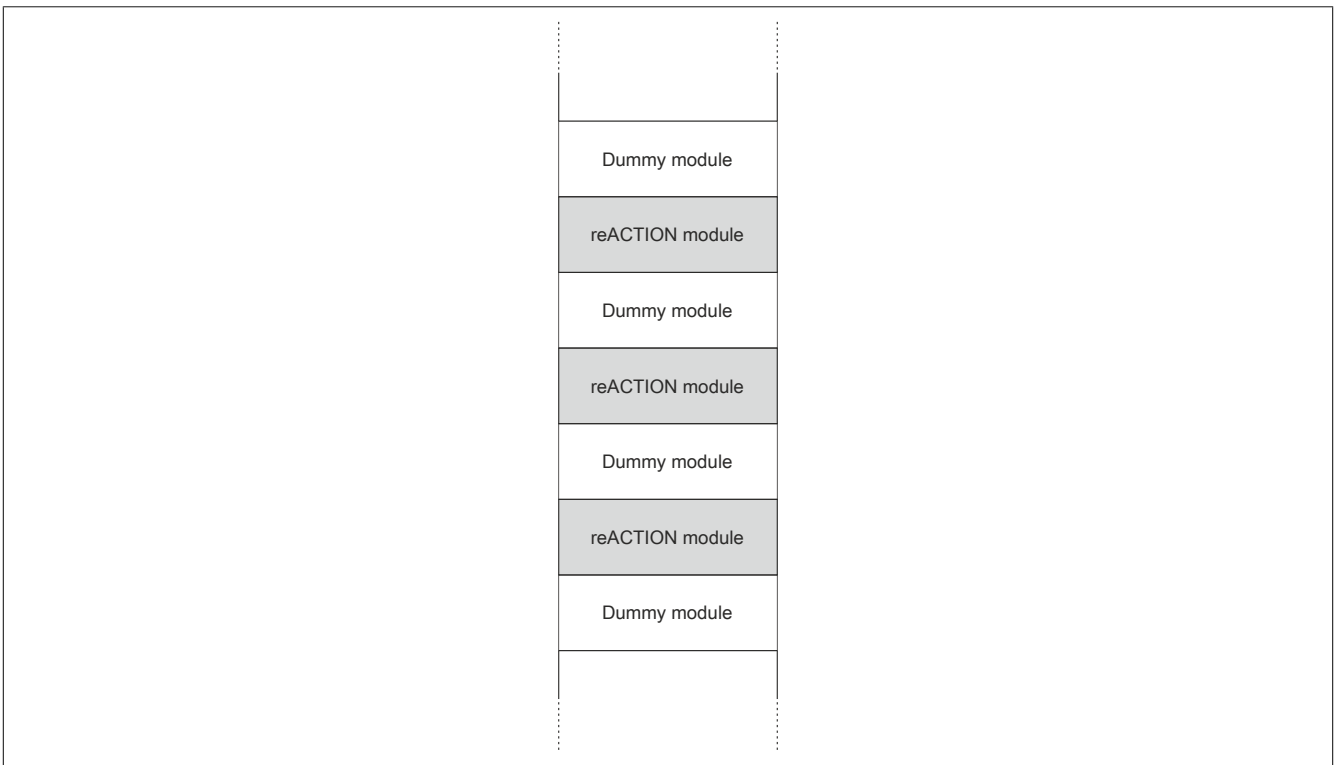
Operating a reACTION module

At ambient temperatures starting at 45°C, dummy modules must be installed above and below the reACTION module if installed vertically.



Operating multiple reACTION modules side by side

If 2 or more vertical reACTION modules are being operated in a cluster, the following arrangement of modules must be observed.



9.28.5.10 Enabling blackout mode

The following steps must be carried out to enable blackout mode.

Requirements

- reACTION program transferred to reACTION module
- Reset triggered on reACTION module:
This ensures that the program stored in the reACTION memory will be loaded with every subsequent reset.

Enabling

- Set the enable register for blackout mode.
- Control bit "RTEnable" must be set. This bit starts the reACTION engine.

Activation

- A connection error triggers a reset on the reACTION module.
- PAR and VAR data points are set to 0.
- Blackout mode is enabled on the reACTION module.

9.28.5.10.1 Blackout mode

For a description of blackout mode, see ["Blackout mode" on page 3794](#).

9.28.5.11 Register description

9.28.5.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.28.5.11.2 Function model 0 - "reACTION"

When using the "reACTION" function model, an individual reACTION program must be created for the module. This program will be executed by the reACTION module later on, not by the CPU. This allows individual machine tasks to be managed decentrally and with a very short response time.

The inputs and outputs of a reACTION module can only be operated by an enabled reACTION program. Interaction registers allow information to be exchanged between the CPU and the reACTION program in the module.

In addition to communication with the CPU, the cyclic interaction registers can also be used for "cross-mapping". In this way, inputs/outputs can also be read/controlled by external modules across the entire X2X Link or POWERLINK network.

| Register | Name | Data type | Read | | Write | |
|---------------------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module communication | | | | | | |
| 158 | ModuleStatus | UINT | | • | | |
| 162 | DigitalStatus | UINT | | • | | |
| reACTION - Configuration | | | | | | |
| 772 | ReActionCycleTimeValue | UDINT | | | | • |
| 780 | ReActionCycleTimeMultiplier | UDINT | | | | • |
| Index * 8 + 508 | CfO_PARType01 to CfO_PARType04 | UDINT | | | | • |
| reACTION - Communication | | | | | | |
| 129 | reACTION - Control byte | USINT | | | • | |
| | RTEnable | Bit 0 | | | | |
| | RTHardwareWarningQuit | Bit 2 | | | | |
| 145 | reACTION - Status byte | USINT | • | | | |
| | RTEngineRun | Bit 0 | | | | |
| | RTCycleTimeOverrun | Bit 1 | | | | |
| | RTHardwareWarning | Bit 2 | | | | |
| | RTFileInvalid | Bit 4 | | | | |
| | RTFunctionInvalid | Bit 5 | | | | |
| | RTInstanceInvalid | Bit 6 | | | | |
| | RTFileNotLoaded | Bit 7 | | | | |
| 154 | RTCycleCounter | UINT | • | | | |
| 150 | RTCycleTime | UINT | • | | | |
| reACTION - Interaction | | | | | | |
| Index * 8 + 4095 | PAR01 to PAR32 | (U)SINT | | | • | |
| | PAR01_Bit1 to PAR32_Bit1 | Bit 0 | | | | |
| | PAR01_Bit2 to PAR32_Bit2 | Bit 1 | | | | |
| | PAR01_Bit3 to PAR32_Bit3 | Bit 2 | | | | |
| | PAR01_Bit4 to PAR32_Bit4 | Bit 3 | | | | |
| | PAR01_Bit5 to PAR32_Bit5 | Bit 4 | | | | |
| | PAR01_Bit6 to PAR32_Bit6 | Bit 5 | | | | |
| | PAR01_Bit7 to PAR32_Bit7 | Bit 6 | | | | |
| | PAR01_Bit8 to PAR32_Bit8 | Bit 7 | | | | |
| Index * 8 + 4094 | PAR01 to PAR32 | (U)INT | | | • | |
| Index * 8 + 4092 | PAR01 to PAR32 | (U)DINT | | | • | |
| Index * 8 + 5119 | RES01 to RES32 | (U)SINT | • | | | |
| | RES01_Bit1 to RES32_Bit1 | Bit 0 | | | | |
| | RES01_Bit2 to RES32_Bit2 | Bit 1 | | | | |
| | RES01_Bit3 to RES32_Bit3 | Bit 2 | | | | |
| | RES01_Bit4 to RES32_Bit4 | Bit 3 | | | | |
| | RES01_Bit5 to RES32_Bit5 | Bit 4 | | | | |
| | RES01_Bit6 to RES32_Bit6 | Bit 5 | | | | |
| | RES01_Bit7 to RES32_Bit7 | Bit 6 | | | | |
| | RES01_Bit8 to RES32_Bit8 | Bit 7 | | | | |
| Index * 8 + 5118 | RES01 to RES32 | (U)INT | • | | | |
| Index * 8 + 5116 | RES01 to RES32 | (U)DINT | • | | | |
| Index * 8 + 6140 | PVAR1 to PVAR256 | DINT | | | | • |
| Index * 8 + 6140 | RVAR1 to RVAR256 | DINT | | • | | |

| Register | Name | Data type | Read | | Write | |
|--|----------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| reACTION - Function block configuration | | | | | | |
| 1028 | CfO_Config_ABR1 | UDINT | | | | • |
| 1036 | CfO_ScalingIncrements_ABR1 | UDINT | | | | • |
| 1044 | CfO_ScalingUnits_ABR1 | UDINT | | | | • |
| 1052 | CfO_ChannelMapping1_ABR1 | UDINT | | | | • |
| 1060 | CfO_ChannelMapping2_ABR1 | UDINT | | | | • |

9.28.5.11.3 Function model 254 - "Direct I/O"

In the "Direct I/O" function model, a special reACTION program is executed in the module in order to manage the I/O. In addition, cyclic registers are used to exchange information with the CPU. This reproduces the behavior of a standard module.

| Register | Name | Data type | Read | | Write | |
|---------------------------------|--------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module communication | | | | | | |
| 129 | Status - Acknowledgment | USINT | | | • | |
| | RTHardwareWarningQuit | Bit 2 | | | | |
| 145 | Status - Composite message | USINT | • | | | |
| | RTHardwareWarning | Bit 2 | | | | |
| 159 | Status word - Module (L byte) | USINT | • | | | |
| | SensorSupplyOk_X1 | Bit 0 | | | | |
| | InternalSupplyOk_X1 | Bit 1 | | | | |
| | SensorSupplyOk_X2 | Bit 2 | | | | |
| | InternalSupplyOk_X2 | Bit 3 | | | | |
| | X1ToX2ComError | Bit 6 | | | | |
| | X2ToX1ComError | Bit 7 | | | | |
| 157 | Status word - Module (H byte) | USINT | • | | | |
| | AnalogOut01ComError | Bit 4 | | | | |
| | AnalogOut02ComError | Bit 5 | | | | |
| 163 | Status word - Digital (L byte) | USINT | • | | | |
| | DigitalOutput3Overload | Bit 2 | | | | |
| | DigitalOutput4Overload | Bit 3 | | | | |
| | DigitalOutput7Overload | Bit 6 | | | | |
| | DigitalOutput8Overload | Bit 7 | | | | |
| Direct I/O configuration | | | | | | |
| 556 | CfO_DigitalDirection | UDINT | | | | • |
| 548 | CfO_DigitalFilter | UDINT | | | | • |
| Direct I/O communication | | | | | | |
| 5 | Digital outputs | USINT | | | • | |
| | DigitalOutput03 | Bit 2 | | | | |
| | DigitalOutput04 | Bit 3 | | | | |
| | DigitalOutput07 | Bit 6 | | | | |
| | DigitalOutput08 | Bit 7 | | | | |
| 1 | Digital inputs | USINT | • | | | |
| | DigitalInput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| | DigitalInput08 | Bit 7 | | | | |
| 22 | AnalogOutput01 | INT | • | | | |
| 26 | AnalogOutput02 | INT | • | | | |

9.28.5.11.4 Module communication

9.28.5.11.4.1 Module status messages

Name:

ModuleStatus

This register is used to transfer general status messages for the module.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|--------------------------------------|---------------------|-------|---|
| Status word - Module (L byte) | | | |
| 0 | SensorSupplyOk_X1 | 0 | (Encoder) power supply for X1 faulty |
| | | 1 | No error |
| 1 | InternalSupplyOk_X1 | 0 | Internal voltage conversion for X1 faulty |
| | | 1 | No error |
| 2 | SensorSupplyOk_X2 | 0 | Power supply for X2 faulty |
| | | 1 | No error |
| 3 | InternalSupplyOk_X2 | 0 | Internal voltage conversion for X2 faulty |
| | | 1 | No error |
| 4 - 5 | Reserved | - | |
| 6 | X1ToX2ComError | 0 | No error |
| | | 1 | X1 → X2 communication faulty |
| 7 | X2ToX1ComError | 0 | No error |
| | | 1 | X2 → X1 communication faulty |
| Status word - Module (H byte) | | | |
| 0 - 3 | Reserved | - | |
| 4 | AnalogOut01ComError | 0 | No error |
| | | 1 | Value from analog output 1 faulty |
| 5 | AnalogOut02ComError | 0 | No error |
| | | 1 | Value from analog output 2 faulty |
| 6 - 7 | Reserved | - | |

9.28.5.11.4.2 Status messages for the digital channels

Name:

DigitalStatus

This register is used to transfer general status messages for the digital channels.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|---------------------------------------|------------------------|-------|---|
| Status word - Digital (L byte) | | | |
| 0 - 1 | Reserved | - | |
| 2 | DigitalOutput3Overload | 0 | Digital output 3 OK |
| | | 1 | Requested voltage 0 V/24 V not achieved |
| 3 | DigitalOutput4Overload | 0 | Digital output 4 OK |
| | | 1 | Requested voltage 0 V/24 V not achieved |
| 4 - 5 | Reserved | - | |
| 6 | DigitalOutput7Overload | 0 | Digital output 7 OK |
| | | 1 | Requested voltage 0 V/24 V not achieved |
| 7 | DigitalOutput8Overload | 0 | Digital output 8 OK |
| | | 1 | Requested voltage 0 V/24 V not achieved |

9.28.5.11.5 reACTION - Configuration**9.28.5.11.5.1 reACTION cycle time**

Name:

ReActionCycleTimeValue

ReActionCycleTimeMultiplier

Registers "TimeValue" and "Multiplier" predefine the desired cycle time for the reACTION program. Register "TimeValue" contains the value, while register "Multiplier" contains the associated units.

Register "Multiplier" is currently permanently set to 1000 in order to predefine the cycle time with μ s precision.

| Data type | Value |
|-----------|------------|
| UDINT | 1 to 10000 |

9.28.5.11.5.2 Configuring the PAR data points

Name:

CfO_PARType01

CfO_PARType[02...04]

PAR data points can be defined for the reACTION program. To enable them, the desired data type must be made known according to the configuration in Automation Studio.

| Data type | Value |
|-----------|-------------------|
| UDINT | See bit structure |

Bit structure:

| Bit | Name | Value | Information |
|---------|-----------------|-------|-------------|
| 0 - 3 | Type01 - PAR 1 | 0000 | Inactive |
| | Type02 - PAR 9 | 0001 | USINT, BOOL |
| | Type03 - PAR 17 | | |
| | Type04 - PAR 25 | | |
| 4 - 7 | Type01 - PAR 2 | 0010 | UINT |
| | Type02 - PAR 10 | 0011 | UDINT |
| | Type03 - PAR 18 | | |
| | Type04 - PAR 26 | | |
| 8 - 11 | Type01 - PAR 3 | 0100 | Reserved |
| | Type02 - PAR 11 | 0101 | SINT |
| | Type03 - PAR 19 | | |
| | Type04 - PAR 27 | | |
| 12 - 15 | Type01 - PAR 4 | 0110 | INT |
| | Type02 - PAR 12 | 0111 | DINT |
| | Type03 - PAR 20 | | |
| | Type04 - PAR 28 | | |
| 16 - 19 | Type01 - PAR 5 | 1000 | Reserved |
| | Type02 - PAR 13 | ... | |
| | Type03 - PAR 21 | 1111 | |
| | Type04 - PAR 29 | | |
| 20 - 23 | Type01 - PAR 6 | | |
| | Type02 - PAR 14 | | |
| | Type03 - PAR 22 | | |
| | Type04 - PAR 30 | | |
| 24 - 27 | Type01 - PAR 7 | | |
| | Type02 - PAR 15 | | |
| | Type03 - PAR 23 | | |
| | Type04 - PAR 31 | | |
| 28 - 31 | Type01 - PAR 8 | | |
| | Type02 - PAR 16 | | |
| | Type03 - PAR 24 | | |
| | Type04 - PAR 32 | | |

9.28.5.11.6 reACTION - Communication

At runtime, the reACTION module program is controlled via the program sequence in the CPU. In its active state, the reACTION program is then executed independently of the program sequence in the CPU.

9.28.5.11.6.1 Controlling the reACTION module

Name:

RTEnable

RTHardwareWarningQuit

This register controls the reACTION program.

| Data type | Value |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|-----------------------|-------|--|
| 0 | RTEnable | 0 | Stops the reACTION program |
| | | 1 | Starts the reACTION program |
| 1 | Reserved | - | |
| 2 | RTHardwareWarningQuit | 0 | No effect |
| | | 1 | Acknowledges warning messages for the inputs and outputs |
| 3 - 7 | Reserved | - | |

9.28.5.11.6.2 reACTION module status messages

Name:

RTEngineRun

RTCycleTimeOverrun

RTHardwareWarning

RTFileInvalid

RTFunctionInvalid

RTInstanceInvalid

RTFileNotLoaded

This register is used to output various status messages.

| Data type | Value |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|---|-------|--|
| 0 | RTEngineRun | 0 | reACTION program inactive |
| | | 1 | reACTION program active |
| 1 | RTCycleTimeOverrun | 0 | Configured RT cycle time observed |
| | | 1 | RT cycle time set too short |
| 2 | RTHardwareWarning (group bit for acyclic status data points) | 0 | No status messages |
| | | 1 | Warning message for the inputs and outputs |
| 3 | Reserved | - | |
| 4 | RTFileInvalid (invalid RT program preloaded) | 0 | RT program in RAM OK |
| | | 1 | RT program in RAM invalid |
| 5 | RTFunctionInvalid (invalid software function) | 0 | RT program OK |
| | | 1 | RT program requesting invalid function block |
| 6 | RTInstanceInvalid (invalid hardware instance) | 0 | RT program OK |
| | | 1 | RT program requesting invalid I/O |
| 7 | RTFileNotLoaded | 0 | Valid RT program in RT engine |
| | | 1 | No RT program loaded |

9.28.5.11.6.3 Cycle counter for the active reACTION program

Name:

RTCycleCounter

Register "CycleCounter" can be used to determine how often the reACTION program has cycled.

| Data type | Value |
|-----------|------------|
| UINT | 0 to 65535 |

9.28.5.11.6.4 Minimum cycle time of the active reACTION program

Name:

RTCycleTime

Register "RTCycleTime" can be used to determine how much time the reACTION module needs to cycle through the loaded program once.

| Data type | Value |
|-----------|-------------------------|
| UINT | 0 to 65535: Units 10 ns |

9.28.5.11.7 reACTION - Interaction

After startup, the reACTION program in the module runs independently. It reads the images of the required inputs and manages its assigned outputs throughout the entire network. In addition, the reACTION program can interact with the CPU. There are 3 different data point types available for this.

9.28.5.11.7.1 PAR data points

Name:

PAR[01...32]
 PAR[01...32]_Bit1
 PAR[01...32]_Bit2
 PAR[01...32]_Bit3
 PAR[01...32]_Bit4
 PAR[01...32]_Bit5
 PAR[01...32]_Bit6
 PAR[01...32]_Bit7
 PAR[01...32]_Bit8

Once enabled, the PAR data points are transported cyclically via X2X Link. They are used to transfer information from the CPU to the reACTION program. They can be used to intervene in the execution of the reACTION program.

Information:

PAR data points DO NOT control the module's outputs directly!

| Data type | Value |
|---------------|-------------------------------|
| (U)SINT, BOOL | Corresponding range of values |
| (U)INT | |
| (U)DINT | |

| Register | Name | Data type | Read | | Write | | |
|------------------|---------------------------------|-----------------------|---------|---------|--------|---------|--|
| | | | Cyclic | Acyclic | Cyclic | Acyclic | |
| 4095 + Index * 8 | PAR01 PAR[02...32] | (U)SINT | | | • | | |
| | PAR01_Bit1 PAR[02...32]_Bit1 | Bit 0 | | | | | |
| | PAR01_Bit2 PAR[02...32]_Bit2 | Bit 1 | | | | | |
| | PAR01_Bit3 PAR[02...32]_Bit3 | Bit 2 | | | | | |
| | PAR01_Bit4 PAR[02...32]_Bit4 | Bit 3 | | | | | |
| | PAR01_Bit5 PAR[02...32]_Bit5 | Bit 4 | | | | | |
| | PAR01_Bit6 PAR[02...32]_Bit6 | Bit 5 | | | | | |
| | PAR01_Bit7 PAR[02...32]_Bit7 | Bit 6 | | | | | |
| | PAR01_Bit8 PAR[02...32]_Bit8 | Bit 7 | | | | | |
| | 4094 + Index * 8 | PAR01 PAR[02...32] | (U)INT | | | • | |
| | 4092 + Index * 8 | PAR01 PAR[02...32] | (U)DINT | | | • | |

9.28.5.11.7.2 RES data points

Name:

RES[01...32]

RES[01...32]_Bit1

RES[01...32]_Bit2

RES[01...32]_Bit3

RES[01...32]_Bit4

RES[01...32]_Bit5

RES[01...32]_Bit6

RES[01...32]_Bit7

RES[01...32]_Bit8

Once enabled, the RES data points are transported cyclically via X2X Link. They are used to transfer information from the reACTION program to the CPU.

Information:

RES data points DO NOT map the module's input directly!

| Data type | Value |
|---------------|-------------------------------|
| (U)SINT, BOOL | Corresponding range of values |
| (U)INT | |
| (U)DINT | |

| Register | Name | Data type | Read | | Write | |
|-------------------|-------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 5119 + Index * 8 | RES01 | (U)SINT | • | | | |
| | RES[02...32] | | | | | |
| | RES01_Bit1 | Bit 0 | | | | |
| | RES[02...32]_Bit1 | | | | | |
| | RES01_Bit2 | Bit 1 | | | | |
| | RES[02...32]_Bit2 | | | | | |
| | RES01_Bit3 | Bit 2 | | | | |
| | RES[02...32]_Bit3 | | | | | |
| | RES01_Bit4 | Bit 3 | | | | |
| | RES[02...32]_Bit4 | | | | | |
| | RES01_Bit5 | Bit 4 | | | | |
| | RES[02...32]_Bit5 | | | | | |
| | RES01_Bit6 | Bit 5 | | | | |
| RES[02...32]_Bit6 | | | | | | |
| RES01_Bit7 | Bit 6 | | | | | |
| RES[02...32]_Bit7 | | | | | | |
| RES01_Bit8 | Bit 7 | | | | | |
| RES[02...32]_Bit8 | | | | | | |
| 5118 + Index * 8 | RES01 | (U)INT | • | | | |
| | RES[02...32] | | | | | |
| 5116 + Index * 8 | RES01 | (U)DINT | • | | | |
| | RES[02...32] | | | | | |

9.28.5.11.7.3 PVAR and RVAR data points

Name:

PVAR[1...256]

RVAR[1...256]

In addition to PAR and RES data points, VAR data points can also be defined in the reACTION program. They are a direct component of the reACTION program and can be accessed acyclically by the CPU. Like the PAR and RES data points, the PVAR data points are used to transfer information from the CPU to the reACTION program. The RVAR data points are used to transfer feedback from the reACTION program to the CPU.

| Data type | Value |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

| Register | Name | Data type | Read | | Write | |
|------------------|------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 6140 + Index * 8 | PVAR1 PVAR[2...256] | DINT | | | | • |
| 6140 + Index * 8 | RVAR1 RVAR[2...256] | DINT | | • | | |

9.28.5.11.8 reACTION function blocks - General

The following tables provide an overview of I/O channel assignments to reACTION function blocks.

Digital inputs/outputs

| Channel | Function block | | |
|-----------------|-----------------------|-----------|----------------------|
| | Mapping ¹⁾ | rTiDin | rTiDout, rTiDoutTime |
| X1: DI 1 | 0x00 | Channel 1 | |
| X1: DI 2 | 0x01 | Channel 2 | |
| X1: DI 3 / DO 3 | 0x02 | Channel 3 | Channel 3 |
| X1: DI 4 / DO 4 | 0x03 | Channel 4 | Channel 4 |
| X1: DI 5 | 0x04 | Channel 5 | |
| X1: DI 6 | 0x05 | Channel 6 | |
| X1: DI 7 / DO 7 | 0x06 | Channel 7 | Channel 7 |
| X1: DI 8 / DO 8 | 0x07 | Channel 8 | Channel 8 |

- 1) The "Mapping" specification is needed in the event that multiple physical inputs/outputs must be grouped together in order to be processed by a reACTION function block (e.g. rTiABRPos) (see ["reACTION function blocks - Configuration" on page 3535](#)).

Analog outputs

| Channel | Function block | | |
|----------|-----------------------|--------|-----------|
| | Mapping ¹⁾ | rTiAin | rTiAout |
| X2: AO 1 | 0x00 | | Channel 1 |
| X2: AO 2 | 0x01 | | Channel 2 |

- 1) The "Mapping" specification is needed in the event that multiple physical inputs/outputs must be grouped together in order to be processed by a reACTION function block (e.g. rTiABRPos) (see ["reACTION function blocks - Configuration" on page 3535](#)).

9.28.5.11.9 reACTION function blocks - Configuration

Some function blocks in library AsIoRti must be configured before they can be used.

| Function block | Information |
|----------------|--|
| rtiABRPos | The module offers the option of using function block rtiABRPos once in the reACTION program. To do so, the function block must be assigned 3 digital inputs that are no longer available for rtiDin. |
| rtiABCnt | The module offers the option of using function block rtiABCnt up to 3 times in the reACTION program. To do so, the function blocks must be assigned 2 digital inputs as an A or B track that are no longer available for rtiDin. In addition, an external event can be defined for each rtiABCnt function block. The input used for this is also no longer available for rtiDin. |

Table 608: List of function blocks requiring prior configuration

9.28.5.11.9.1 Function blocks rtiABRPos and rtiABCnt

Function blocks rtiABRPos and rtiABCnt can be used to process the position value of an ABR incremental encoder in a reACTION task. Several hardware channels of the module are used for this. The incoming signals are interpreted by the reACTION engine and converted into a location.

The update rate depends on both the reACTION engine and the hardware used. The reACTION engine is basically able to calculate positions with an update rate of up to 8 MHz. The input frequencies of the hardware inputs can be taken from the technical data of the respective module.

These function blocks can be used separately or in combination.

Using function block rtiABRPos

The following points are important to keep in mind when using function block rtiABRPos in a reACTION program:

- The function block can only be used once in a reACTION program.
- 3 digital inputs must be defined on the module for input signals A, B and R.
- In addition, a digital input of the module can be defined as an event input.

Example diagram of input signals:

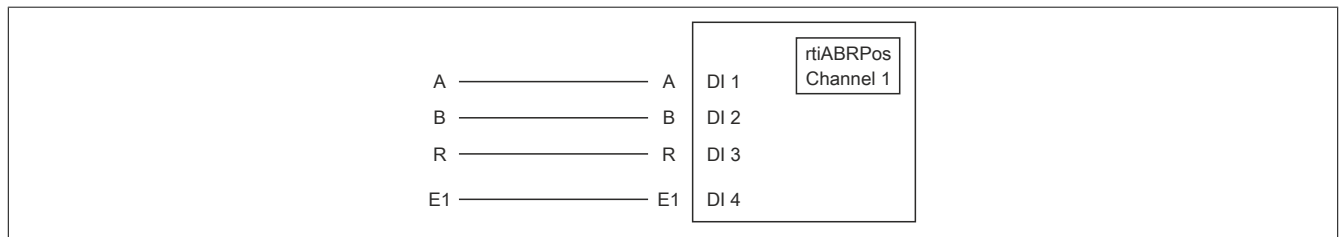


Figure 342: Schematic diagram of input signals for rtiABRPos

Using function block rtiABCnt

The following points must be taken into account when using function block rtiABCnt in a reACTION program:

- The function block can be used up to 3 times in a reACTION program.
- 2 digital inputs must be defined on the module for input signals A and B.
- In addition, up to 3 digital inputs on the module can be defined as event inputs E1, E2 and E3.

Example diagram of input signals:

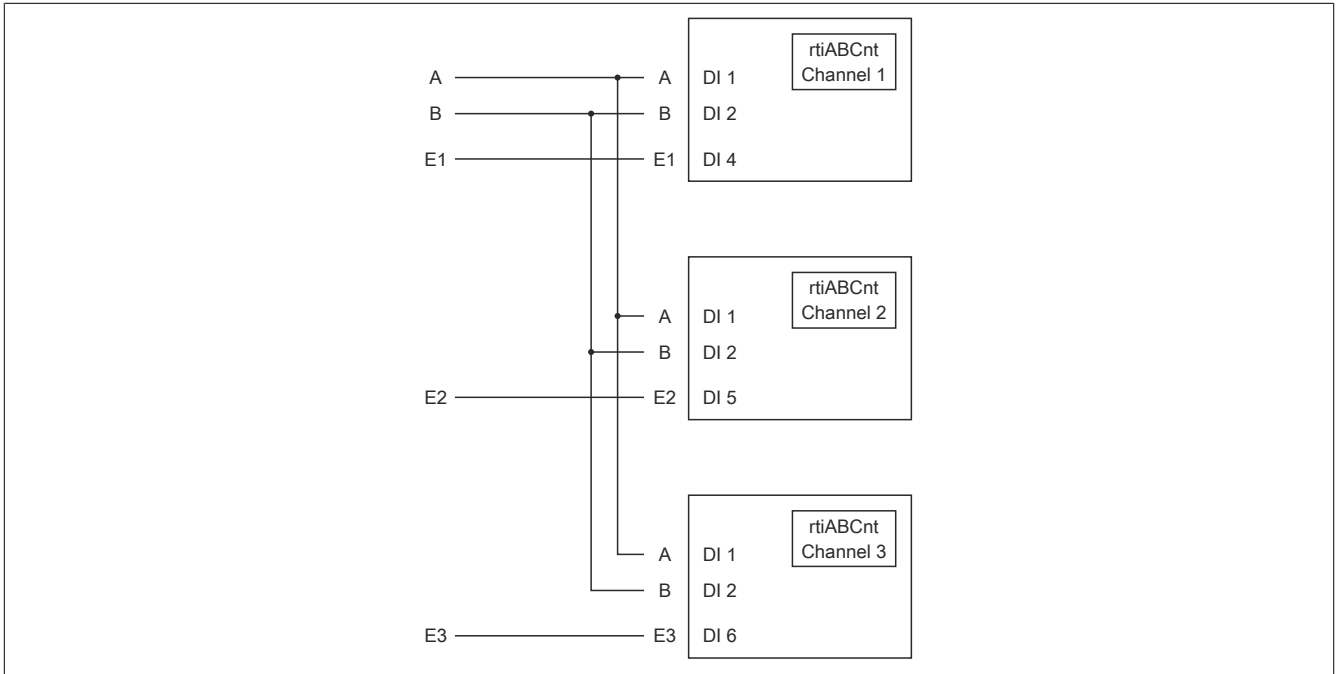


Figure 343: Schematic diagram of input signals for rtiABCnt

Using function blocks rtiABRPos and rtiABCnt in combination

The following points should be kept in mind when using function blocks rtiABRPos and rtiABCnt together in a reACTION program.

- Function block rtiABRPos can only be used once in a reACTION program.
- Function block rtiABCnt can be used up to 2 times in a reACTION program.
- 3 digital inputs must be defined for input signals A, B and R (rtiABRPos).
- The same digital inputs are used for input signals A and B (rtiABCnt).
- In addition, up to 3 event inputs E1, E2 and E3 can be defined (rtiABCnt).
- E1 is used for the event input (rtiABRPos).

Example diagram of input signals:

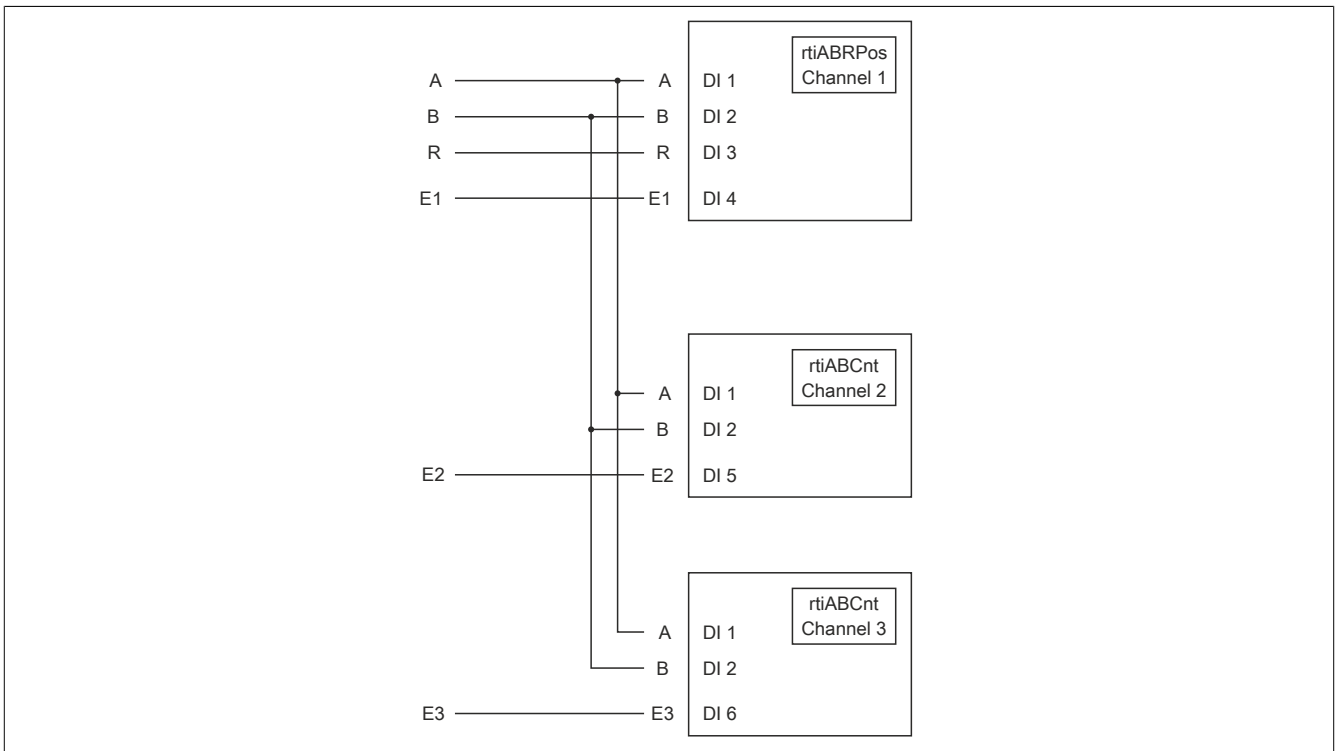


Figure 344: Diagram of input signals when using rtiABRPos and rtiABCnt at the same time

Registering the position encoder (rtiABRPos/rtiABCnt)

Name:

CfO_Config_ABR1

This register specifies the technical characteristics of the connected ABR incremental encoder.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|--|------------|---|
| 0 - 15 | Increments per revolution | 0 to 65535 | Reference pulse monitoring: If the reference pulse is different than defined here, this is indicated on the status output of function block rtiABRPos. |
| 16 | Inversion of the counting direction set by signals A and B | 0 | Positive counting direction |
| | | 1 | Negative counting direction |
| 17 - 31 | Reserved | 0 | |

Wiring the position encoder (rtiABRPos/rtiABCnt)

Name:

CfO_ChannelMapping1_ABR1

CfO_ChannelMapping2_ABR1

Before function blocks rtiABRPos/rtiABCnt can be processed by the reACTION engine, the hardware inputs to be used by the ABR incremental encoder must be defined on the module. The "ChannelMapping" registers specify which inputs are interpreted as the A, B, R, E1, E2 and E3 signals.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure of CfO_ChannelMapping1_ABR1:

| Bit | Description | Value | Information |
|---------|-------------|----------|---------------------------------------|
| 0 - 7 | Input E1 | 0 | Mapped to digital input 1 |
| | | 1 | Mapped to digital input 2 |
| | | ... | ... |
| | | 7 | Mapped to digital input 8 |
| | | 8 to 255 | Reserved |
| 8 - 15 | Input R | 0 to 255 | For possible values, see bits 0 to 7. |
| 16 - 23 | Input B | 0 to 255 | For possible values, see bits 0 to 7. |
| 24 - 31 | Input A | 0 to 255 | For possible values, see bits 0 to 7. |

Bit structure of CfO_ChannelMapping2_ABR1:

| Bit | Description | Value | Information |
|---------|-------------|----------|---|
| 0 - 15 | Reserved | 0 | |
| 16 - 23 | Input E3 | 0 | Mapped to digital input 1 |
| | | 1 | Mapped to digital input 2 |
| | | ... | ... |
| | | 7 | Mapped to digital input 8 |
| | | 8 to 255 | Reserved |
| 24 - 31 | Input E2 | 0 to 255 | For possible values, see bits 16 to 23. |

Information:

For information about the relationship between the input on the module and the channel name, see section "reACTION function blocks - General".

Scaling the position encoder (rtiABRPos)

Name:

CfO_ScalingUnits_ABR1

CfO_ScalingIncrements_ABR1

An optional gear ratio can be configured using registers "Units" and "Increments". The dividend for scaling is defined in register "Units"; the divisor is defined in register "Increments".

| Data type | Value | Information |
|-----------|--------------------|--|
| UDINT | 0 to 4,294,967,295 | CfO_ScalingUnits_ABR1: Units per interval CfO_ScalingIncrements_ABR1: Increments per interval |

Formula for calculation

$$\text{Gear ratio} = \text{ScalingUnits} / \text{ScalingIncrements}$$
Example 1

ScalingUnits = 1

ScalingIncrements = 1

$$\text{Position value (Pos)} = \text{ABR increments} * \text{ScalingUnits} / \text{ScalingIncrements}$$

$$\text{Position value (Pos)} = \text{ABR increments} * 1/1$$

In this example, the ABR position value is output unchanged on output "Pos".

Example 2

ScalingUnits = 10

ScalingIncrements = 4

$$\text{Position value (Pos)} = \text{ABR increments} * \text{ScalingUnits} / \text{ScalingIncrements}$$

$$\text{Position value (Pos)} = \text{ABR increments} * 10/4$$

In this example, the ABR position value is multiplied by 2.5 and output on output "Pos".

Information:

The encoder values are calculated internally as INT64 values in 32.32 format. On output "Pos" of function block "rtiABRPos", only the whole number value (INT32) is output for the user. The fixed point decimal places are used internally to calculate a higher resolution.

9.28.5.11.10 Direct I/O configuration

This module is equipped with 8 digital channels and 2 analog outputs. In the "Direct I/O" function model, behavior is based on that of a standard module. The I/O channels are managed by an extremely simplified reACTION program. The function model primarily serves to check that the I/O channels are functioning properly.

9.28.5.11.10.1 Direction of digital channels

Name:

CfO_DigitalDirection

This register determines the signal direction of digital channels 3, 4, 7 and 8.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|-------------------------------|-------|-------------|
| 0 - 1 | Reserved | 0 | |
| 2 | Direction - Digital channel 3 | 0 | Input |
| | | 1 | Output |
| 3 | Direction - Digital channel 4 | 0 | Input |
| | | 1 | Output |
| 4 - 5 | Reserved | 0 | |
| 6 | Direction - Digital channel 7 | 0 | Input |
| | | 1 | Output |
| 7 | Direction - Digital channel 8 | 0 | Input |
| | | 1 | Output |

9.28.5.11.10.2 Filtering digital channels

Name:

CfO_DigitalFilter

This register defines the filter time of the digital channels. The filter value affects both the switching delay as well as the immunity of the channels.

| Data type | Value |
|-----------|--------------------------|
| UDINT | 0 to 500000: Units 10 ns |

9.28.5.11.11 Direct I/O communication

This module is equipped with the following inputs and outputs:

- 4 digital inputs (sink) for 24 VDC
- 4 digital channels configurable as inputs (sink) or outputs (sink or source) for 24 VDC
- 2 analog outputs of type ± 10 V

9.28.5.11.11.1 Digital outputs

Name:

DigitalOutput03

DigitalOutput04

DigitalOutput07

DigitalOutput08

This register is used to predefine the value that should be output on the digital output.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|-----------------|-------|-------------|
| 0 - 1 | Reserved | 0 | |
| 2 | DigitalOutput03 | 0 | FALSE |
| | | 1 | TRUE |
| 3 | DigitalOutput04 | 0 | FALSE |
| | | 1 | TRUE |
| 4 - 5 | Reserved | 0 | |
| 6 | DigitalOutput07 | 0 | FALSE |
| | | 1 | TRUE |
| 7 | DigitalOutput08 | 0 | FALSE |
| | | 1 | TRUE |

9.28.5.11.11.2 Digital inputs

Name:

DigitalInput01

DigitalInput02

DigitalInput03

DigitalInput04

DigitalInput05

DigitalInput06

DigitalInput07

DigitalInput08

This register indicates the value read for the respective digital input.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|-------|-------------|
| 0 | DigitalInput01 | 0 | FALSE |
| | | 1 | TRUE |
| 1 | DigitalInput02 | 0 | FALSE |
| | | 1 | TRUE |
| 2 | DigitalInput03 | 0 | FALSE |
| | | 1 | TRUE |
| 3 | DigitalInput04 | 0 | FALSE |
| | | 1 | TRUE |
| 4 | DigitalInput05 | 0 | FALSE |
| | | 1 | TRUE |
| 5 | DigitalInput06 | 0 | FALSE |
| | | 1 | TRUE |
| 6 | DigitalInput07 | 0 | FALSE |
| | | 1 | TRUE |
| 7 | DigitalInput08 | 0 | FALSE |
| | | 1 | TRUE |

9.28.5.11.11.3 Analog outputs

Name:

AnalogOutput01

AnalogOutput02

This register is used to specify the value for the respective analog output.

| Data type | Value |
|-----------|-----------------|
| INT | -32767 to 32767 |

9.28.5.11.12 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μ s |

9.28.5.11.13 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 200 μ s |

9.28.6 X20RT8381

Data sheet version: 1.02

9.28.6.1 General information

This reACTION Technology module is equipped with 4 high-speed digital inputs and 4 high-speed digital mixed channels. All connections are designed for 1-wire connections. All inputs are designed for sink connections; the outputs are designed for push-pull connections.

A voltage signal of ± 10 V can be read or output using 2 analog inputs and 1 analog output, respectively.

Ultrafast reACTION Technology makes it possible to control the integrated I/O channels with response times down to 1 μ s. All of the commands that can be used for reACTION programs are provided as function blocks in special libraries (e.g. AsIORTI). Programming in compliance with IEC 61131-3 requirements takes place in the Function Block Diagram editor in Automation Studio.

The module supports blackout mode. In blackout mode, programmable module functionality persists even if the network fails.

- reACTION Technology module
- 4 high-speed digital inputs
- 4 high-speed digital channels, configurable as inputs or outputs
- 2 high-speed analog inputs ± 10 V
- 1 high-speed analog output ± 10 V
- 1 ABR incremental encoder input 24 V
- Pulse width modulation
- Support of data type "REAL" for arithmetic operations
- Supports blackout mode



9.28.6.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | reACTION Technology modules |  |
| X20RT8381 | X20 reACTION module, real computing function, 4 digital inputs, 24 VDC, <1 μ s, 4 digital channels, 24 VDC, 0.1 A, <1 μ s, configurable as inputs or outputs, 2 analog inputs ± 10 V, 500 kHz sampling frequency, 13-bit converter resolution including sign, configurable input filter, 1 analog output ± 10 V, 2 μ s, 13-bit converter resolution including sign, reACTION Technology module | |
| | Required accessories | |
| | Bus modules | |
| X20BM31 | X20 bus module for double-width modules, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 609: X20RT8381 - Order data

9.28.6.3 Technical data

| Model number | X20RT8381 |
|--|---|
| Short description | |
| I/O module | 4 digital input channels, 4 digital channels configurable as inputs or outputs, 2 analog inputs ± 10 V, 1 analog output ± 10 V, reACTION Technology |
| General information | |
| B&R ID code | 0xF24E |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Outputs | Yes, using status LED and software (output error status) |
| Inputs | Yes, using status LED and software |
| Channel type | Yes, using software |
| reACTION-capable I/O channels | Yes |
| Blackout mode | |
| Scope | Module |
| Function | Programmable |
| Standalone mode | No |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.7 W |
| Additional power dissipation caused by actuators (resistive) [W] | +1.1 |
| Type of signal lines ¹⁾ | Shielded cables must be used for all signal lines, cable length: Max. 20 m |
| Application memory | |
| Type | 64 Mbit flash memory |
| Data retention | 20 years at 55°C |
| Guaranteed erase/write cycles | 100,000 |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| Digital inputs | |
| Quantity | 4 inputs and 4 mixed channels, configurable as inputs or outputs using software |
| Nominal voltage | 24 VDC |
| Input voltage | 24 VDC -15% / +20% |
| Input current at 24 VDC | Typ. 1.3 mA |
| Input circuit | Sink |
| Input filter | |
| Hardware | <3 μ s |
| Software | Default 200 ns, configurable between 200 ns and 5 ms in 10 ns intervals |
| Connection type | 1-wire connections |
| Input resistance | 18.16 k Ω |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| ABR incremental encoder | |
| Quantity | 2 |
| Encoder inputs | 24 V, asymmetrical |
| Counter size | 32-bit |
| Input frequency | Max. 333 kHz |
| Evaluation | 4x |
| Analog inputs | |
| Quantity | 2 ²⁾ |
| Input | ± 10 V |
| Input type | Differential input |
| Digital converter resolution | ± 12 -bit |
| Output format | |
| Data type | INT |
| Voltage | INT 0x8001 - 0x7FFF / 1 LSB = 0x0008 = 2.441 mV |
| Input impedance in signal range | 20 M Ω |
| Input protection | Protection against wiring with supply voltage |
| Permissible input signal | Max. ± 30 V |
| Output of digital value during overload | |
| Undershoot | 0x8001 |
| Overshoot | 0x7FFF |
| Conversion procedure | SAR |
| Input filter | 3rd-order low pass / cutoff frequency 130 kHz |
| Max. error at 25°C | |
| Gain | 0.08% ³⁾ |
| Offset | 0.018% ⁴⁾ |

Table 610: X20RT8381 - Technical data

| Model number | X20RT8381 |
|---|--|
| Max. gain drift | 0.003 %/°C ³⁾ |
| Max. offset drift | 0.001 %/°C ⁴⁾ |
| Common-mode rejection | |
| DC | 86 dB |
| 50 Hz | 84 dB |
| Common-mode range | ±12 V |
| Nonlinearity | 0.015% ⁴⁾ |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Sampling frequency | 500 kHz |
| Digital outputs | |
| Quantity ⁵⁾ | 4 mixed channels, configurable as inputs or outputs using software |
| Variant | Push-Pull |
| Nominal voltage | 24 VDC |
| Switching voltage | 24 VDC -15% / +20% |
| Nominal output current | 100 mA |
| Total nominal current | 400 mA |
| Connection type | 1-wire connections |
| Output circuit | Sink or source |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short circuit current") |
| Diagnostic status | Output monitoring with delay <700 ns |
| Leakage current when switched off | Approx. 25 µA |
| R _{DS(on)} | 140 mΩ |
| Residual voltage | <0.4 V at nominal current 100 mA |
| Max. continuous current | 100 mA |
| Peak short-circuit current | <10 A |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 3 ms |
| Switching delay | |
| 0 → 1 | <1 µs |
| 1 → 0 | <1 µs |
| Switching frequency | |
| Resistive load | Min. 50 kHz, max. 500 kHz |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Analog outputs | |
| Quantity | 1 |
| Output | ±10 V |
| Digital converter resolution | ±12-bit |
| Conversion time | 2 µs |
| Settling time for output changes over entire range | 5 µs |
| Switch on/off behavior | Internal enable relay for startup |
| Max. error at 25°C | |
| Gain | 0.15% ⁶⁾ |
| Offset | 0.05% ⁷⁾ |
| Output protection | Short circuit protection |
| Output format | |
| Data type | INT |
| Voltage | INT 0x8000 - 0x7FFF / 1 LSB = 0x0008 = 2.441 mV |
| Load per channel | Max. ±10 mA, load ≥1 kΩ |
| Short-circuit proof | Current limiting ±65 mA |
| Output filter | 1st-order low pass / cutoff frequency 22 kHz |
| Max. gain drift | 0.022 %/°C ⁶⁾ |
| Max. offset drift | 0.032 %/°C ⁷⁾ |
| Error caused by load change | Max. 0.14%, from 10 MΩ → 1 kΩ, resistive |
| Nonlinearity | 0.005% ⁸⁾ |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |

Table 610: X20RT8381 - Technical data

| Model number | X20RT8381 |
|---------------------------------|--|
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating and hardware configuration" |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 2x terminal block X20TB12 separately Order 1x bus module X20BM31 separately |
| Spacing | 25 ^{+0.2} mm |

Table 610: X20RT8381 - Technical data

- 1) See section "X20 shielding brackets".
- 2) To reduce power dissipation, B&R recommends bridging unused inputs on the terminal.
- 3) Based on the current measured value.
- 4) Based on the 20 V measurement range.
- 5) See section "Derating and hardware configuration".
- 6) Based on the current output value.
- 7) Based on the entire output range.
- 8) Based on the output range.

9.28.6.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.


| Figure | LED | Color | Status | Description |
|---|-------|--------------------------------|---|---|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode or blackout mode |
| | | | Double flash | Mode BOOT (during firmware update) ¹⁾ |
| | | | Blinking | Mode PREOPERATIONAL |
| | | | On | Mode RUN |
| | e | Red | Off | Module not supplied with power or everything OK |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring of digital outputs has been triggered. |
| | | | Double flash | Supply voltage not in valid range or no reACTION program loaded |
| | | | Triple flash | Test of internal memory failed (limited functionality, module must be replaced) |
| | e + r | Solid red / Single green flash | Off | Error or reset state (reACTION program using functions or channels that are not permitted on this hardware) |
| | | | Single flash | Invalid firmware |
| | | | Double flash | Invalid firmware |
| | | | Triple flash | Invalid firmware |
| 1, 2, 5, 6 | Green | | Input state of the corresponding digital input | |
| 3, 4, 7, 8 | Green | | Input or output status of the corresponding digital input or output | |

Table 611: LED status indicators (X1)

1) A firmware update can take several minutes depending on the configuration.


| Figure | LED | Color | Status | Description |
|--|-------|--------|----------|--|
|  | 1 - 2 | Green | Off | Open circuit or disconnected sensor |
| | | | Blinking | Input signal overflow or underflow |
| | | | On | Analog/Digital converter running, value OK |
| | 1 | Orange | Off | Value = 0 |
| | | | Blinking | Value = 0 |
| | | | On | Value ≠ 0 |

Table 612: LED status indicators (X2)

9.28.6.5 Pinout

9.28.6.5.1 X1 - Pinout

To prevent crosstalk, each individual signal line should be shielded. The maximum cable length is 20 m.

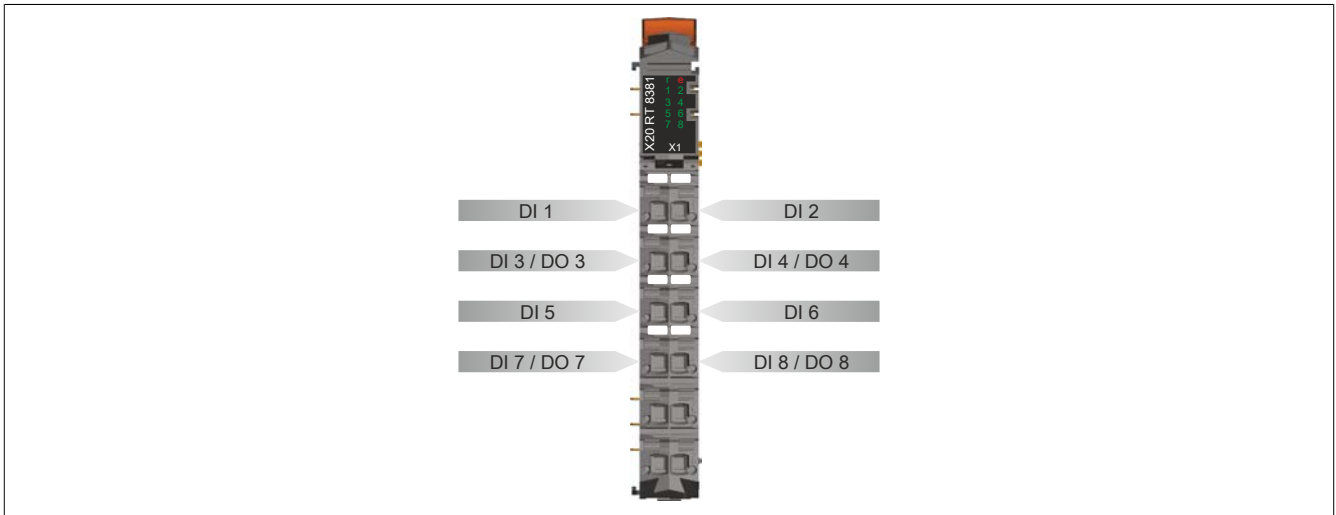


Figure 345: X1 - Pinout

9.28.6.5.2 X2 - Pinout

To prevent crosstalk, each individual signal line should be shielded. The maximum cable length is 20 m.

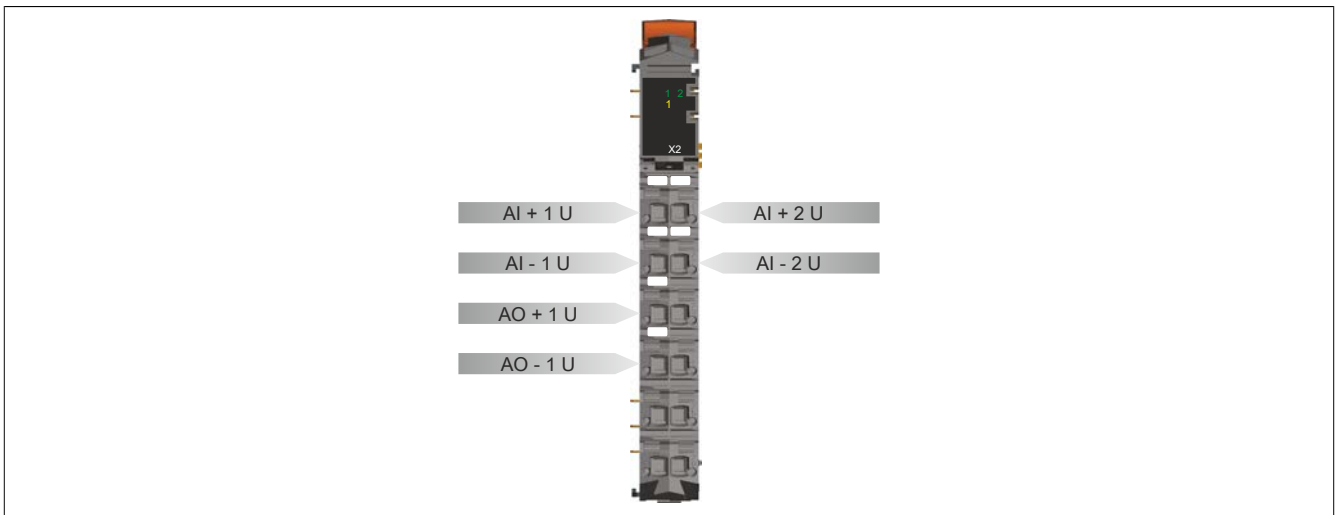


Figure 346: X2 - Pinout

9.28.6.6 Local I/O channels

The following tables provide an overview of the connections to the I/O channels.

Digital inputs/outputs

| Connection | Terminal connection | Channel |
|------------|---------------------|-------------|
| X1 | 11 | DI 1 |
| | 21 | DI 2 |
| | 12 | DI 3 / DO 3 |
| | 22 | DI 4 / DO 4 |
| | 13 | DI 5 |
| | 23 | DI 6 |
| | 14 | DI 7 / DO 7 |
| | 24 | DI 8 / DO 8 |

Analog inputs

| Connection | Terminal connection | Channel |
|------------|---------------------|---------|
| X2 | 11 and 12 | AI 1 |
| | 21 and 22 | AI 2 |

Analog output

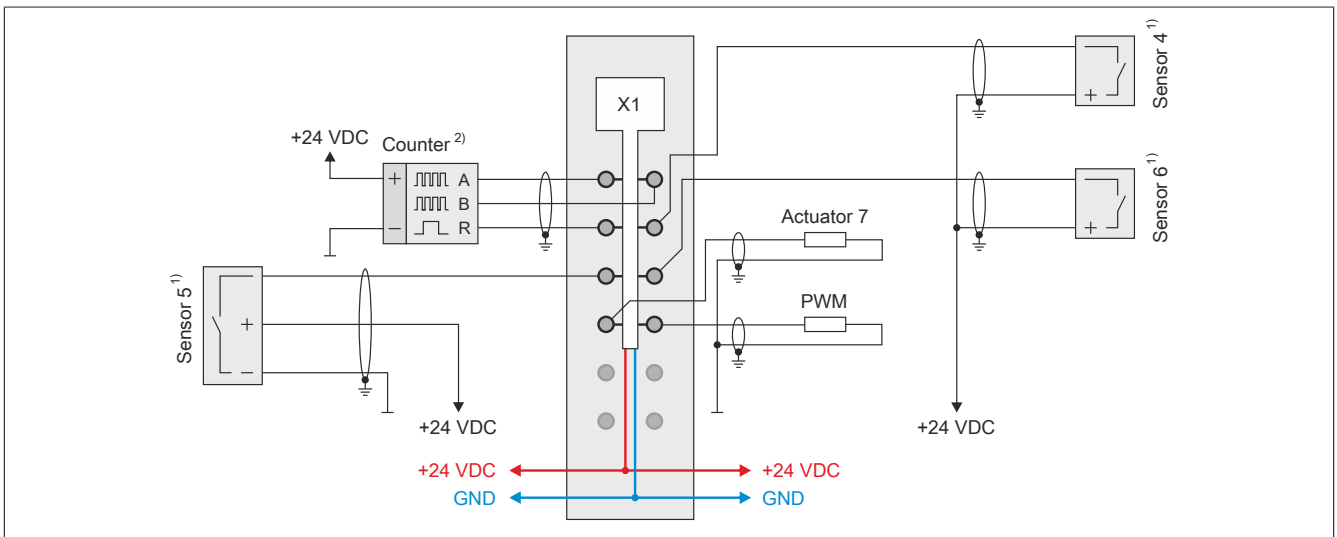
| Connection | Terminal connection | Channel |
|------------|---------------------|---------|
| X2 | 13 and 14 | AO 1 |

The following sections describe assigning I/O channels in a reACTION program:

| I/O channels | Assignment |
|-----------------------|--|
| Digital I/O channels | Assignment of digital inputs/outputs |
| Analog input channels | Assignment of analog inputs |
| Analog output channel | Assignment of analog output |

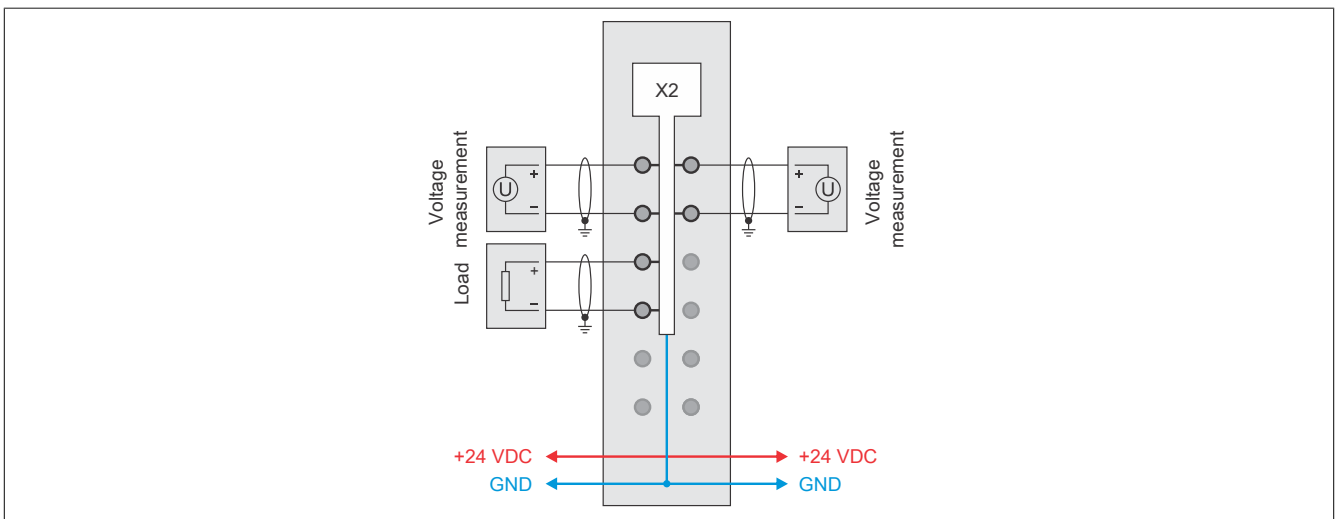
9.28.6.7 Connection examples

9.28.6.7.1 X1 - Connection example



- 1) Observe the cabling guidelines from the sensor manufacturer.
- 2) Observe the cabling guidelines from the encoder manufacturer.

9.28.6.7.2 X2 - Connection example



9.28.6.8 Input/Output circuit diagram

9.28.6.8.1 Digital inputs (X1)

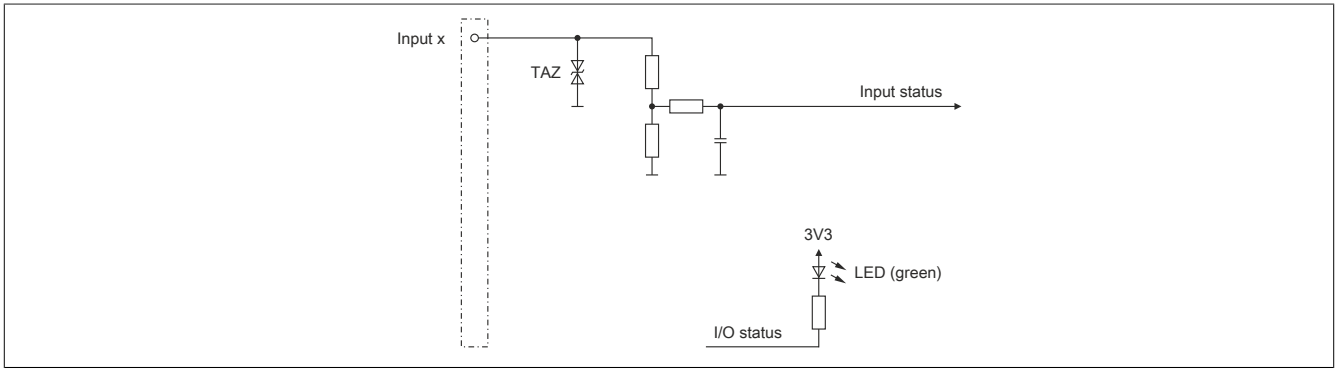


Figure 347: Input circuit diagram of digital inputs (X1)

9.28.6.8.2 Digital mixed channels (X1)

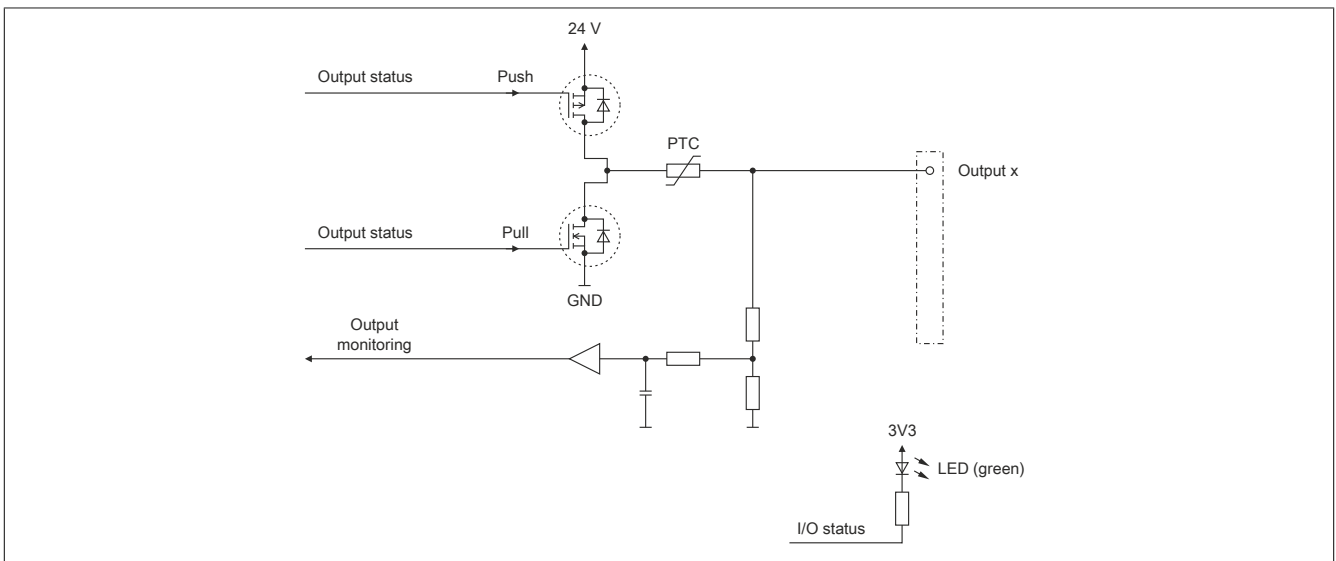


Figure 348: Input/Output circuit diagram of digital mixed channels (X1)

9.28.6.8.3 Analog inputs (X2)

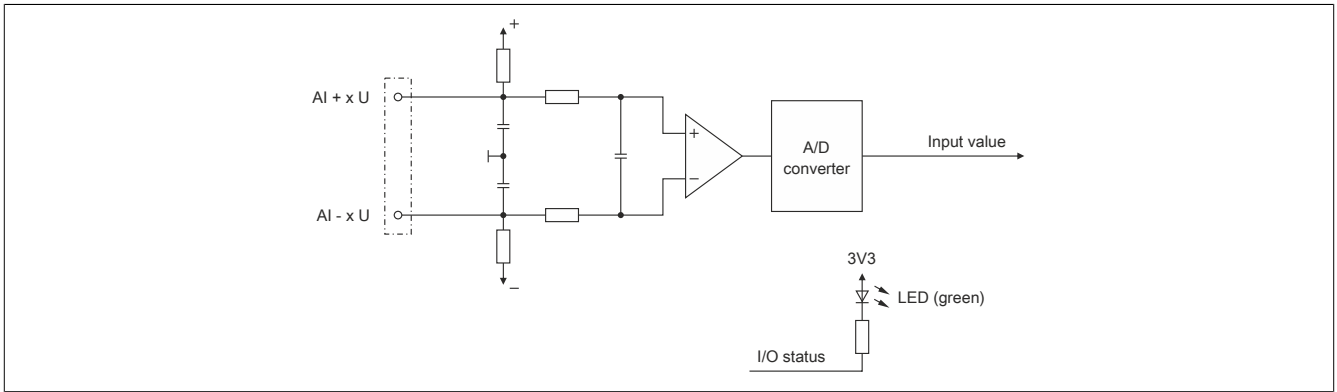


Figure 349: Input circuit diagram of analog inputs (X2)

9.28.6.8.4 Analog output (X2)

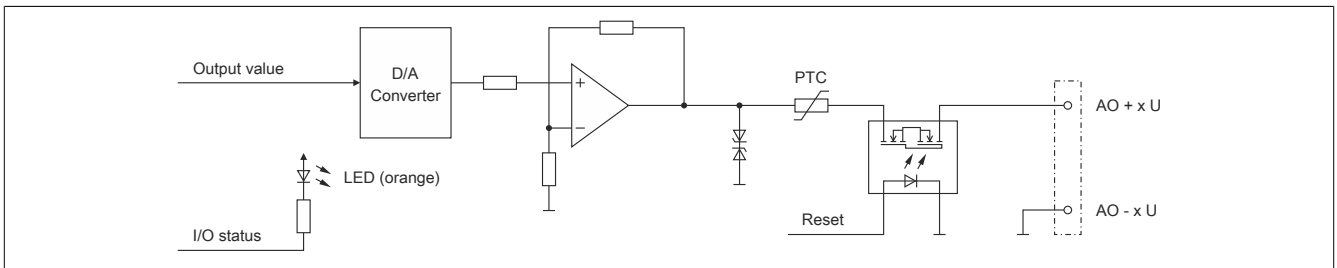


Figure 350: Output circuit diagram of the analog output (X2)

9.28.6.9 Derating and hardware configuration

To ensure proper operation, observe the points listed below:

- Number of operable digital outputs
- Hardware configurations

9.28.6.9.1 Number of operable digital outputs

Depending on the mounting orientation, not all 4 digital outputs of the module can be operated starting at a certain ambient temperature.

Information:

To ensure operation of the module with the ambient temperatures listed below, it is absolutely necessary to disconnect channels.

Reducing the output current per channel does not increase the number of digital output channels that can be operated in the corresponding ambient temperature class.

Horizontal installation

| Ambient temperature | Number of operable digital outputs |
|---------------------|------------------------------------|
| <45°C | 4 |
| Starting at 45°C | 3 |
| Starting at 55°C | 2 |

Vertical installation

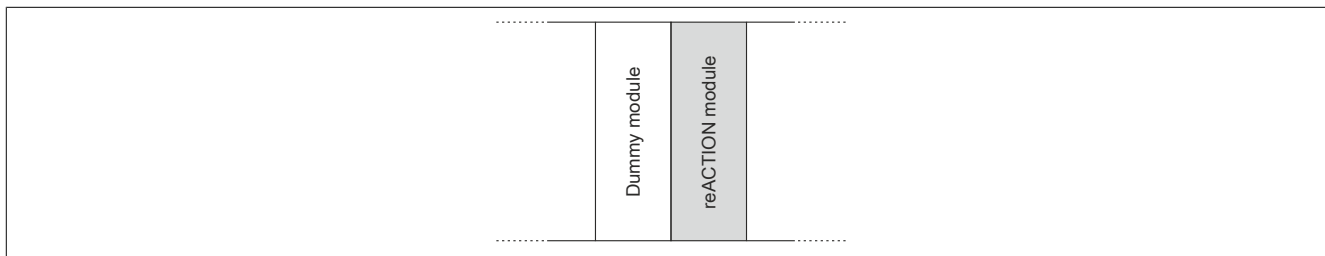
| Ambient temperature | Number of operable digital outputs |
|---------------------|------------------------------------|
| <35°C | 4 |
| Starting at 35°C | 3 |
| Starting at 45°C | 2 |

9.28.6.9.2 Hardware configuration for horizontal installation

9.28.6.9.2.1 Hardware configuration starting at an ambient temperature of 50°C

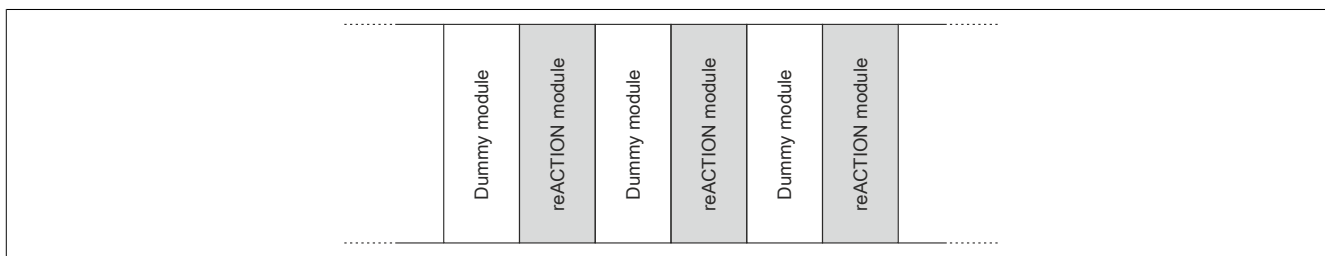
Operating a reACTION module

Starting at an ambient temperature of 50°C, a dummy module must be connected to the left of the reACTION module if installed horizontally.



Operating multiple reACTION modules side by side

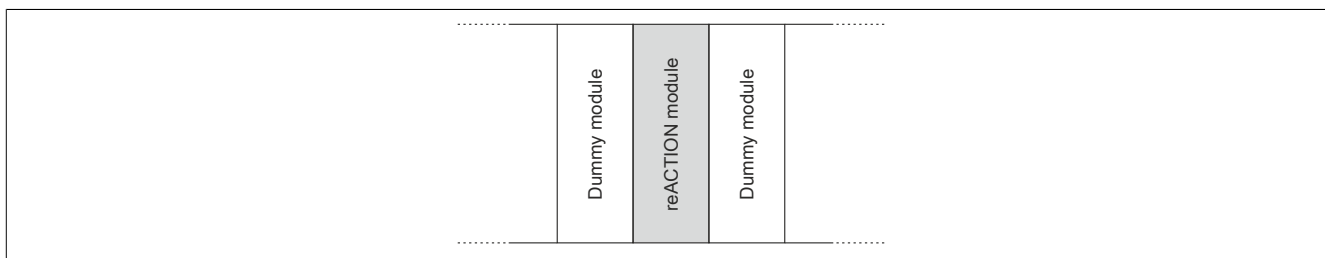
If 2 or more horizontal reACTION modules are being operated in a cluster, the following arrangement of modules must be observed.



9.28.6.9.2.2 Hardware configuration starting at an ambient temperature of 55°C

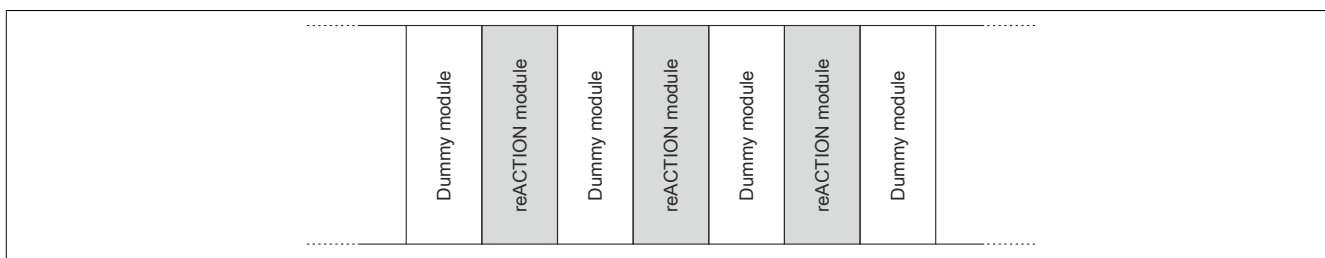
Operating a reACTION module

Starting at an ambient temperature of 55°C, a dummy module must be connected to the left and right of the reACTION module if installed horizontally.



Operating multiple reACTION modules side by side

If 2 or more horizontal reACTION modules are being operated in a cluster, the following arrangement of modules must be observed.

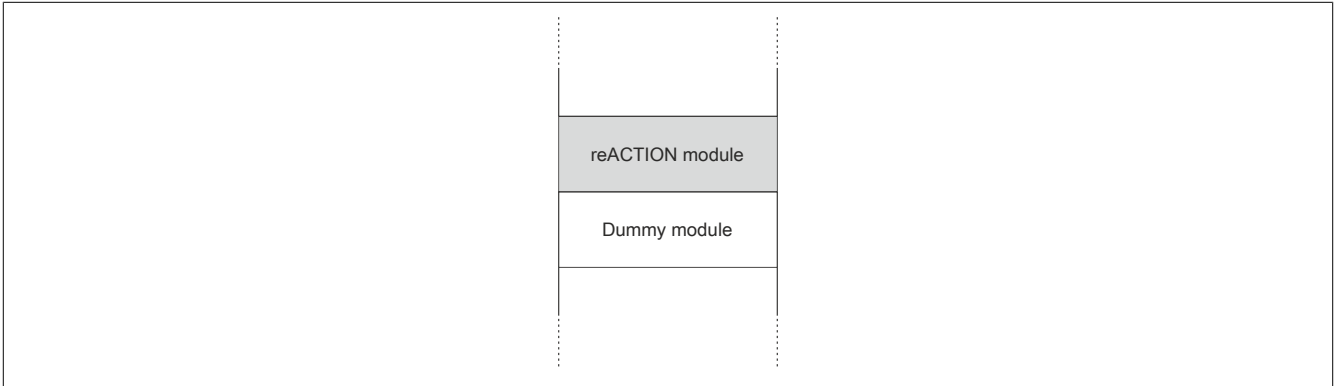


9.28.6.9.3 Hardware configuration for vertical installation

9.28.6.9.3.1 Hardware configuration starting at an ambient temperature of 40°C

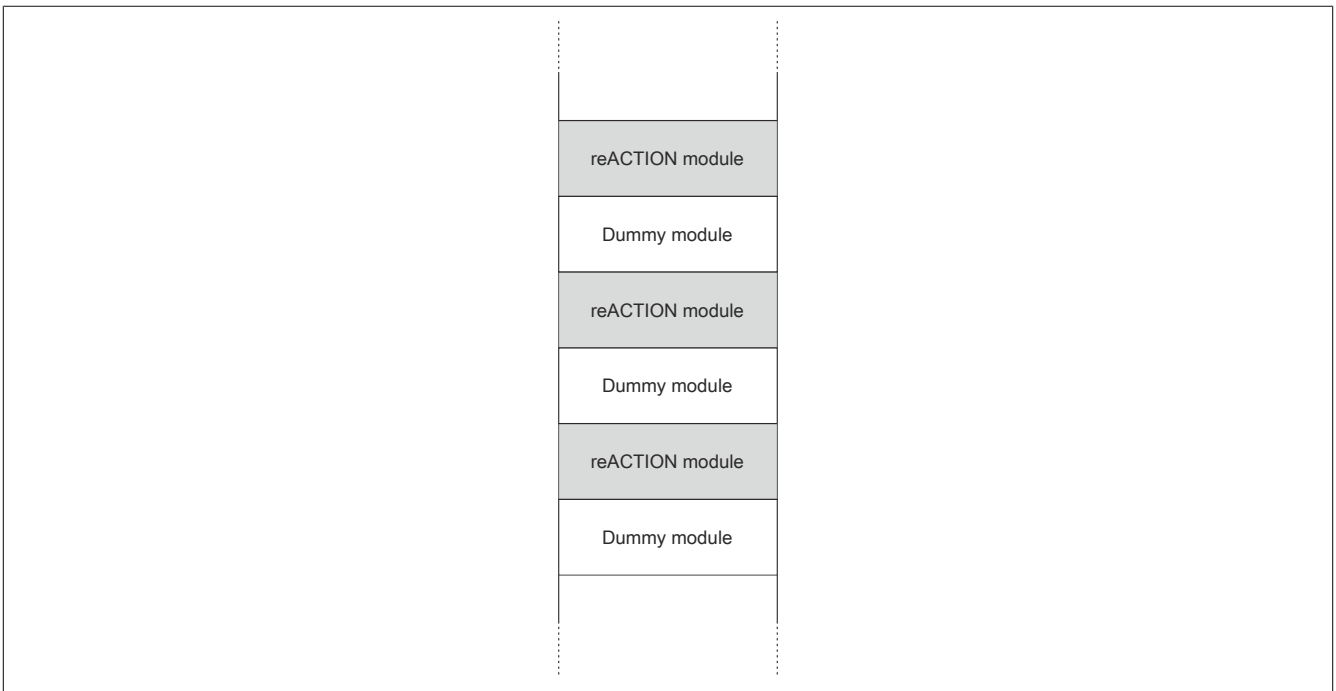
Operating a reACTION module

At ambient temperatures starting at 40°C, a dummy module must be installed below the reACTION module if installed vertically.



Operating multiple reACTION modules side by side

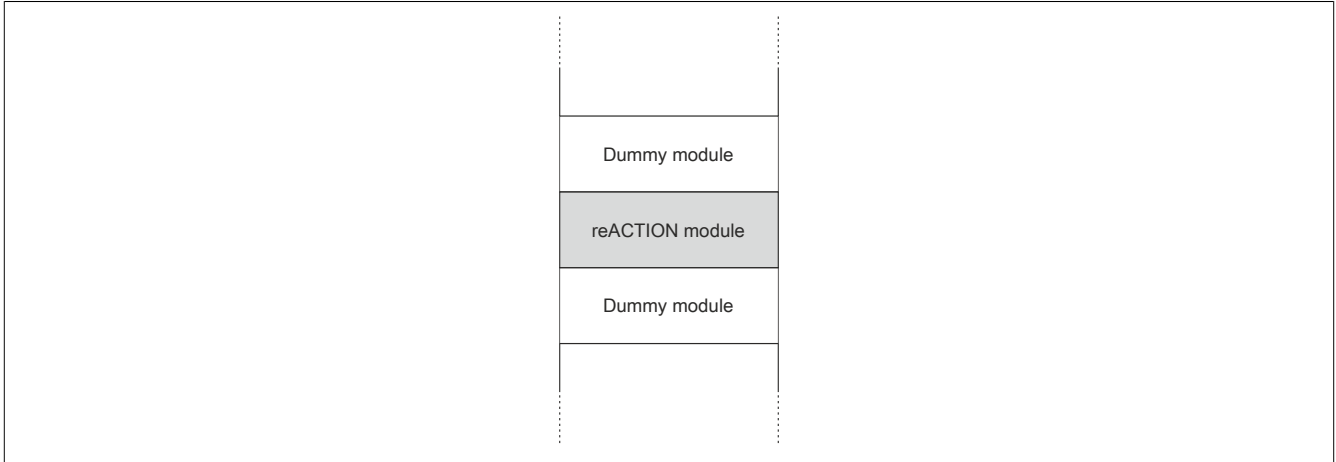
If 2 or more vertical reACTION modules are being operated in a cluster, the following arrangement of modules must be observed.



9.28.6.9.3.2 Hardware configuration starting at an ambient temperature of 45°C

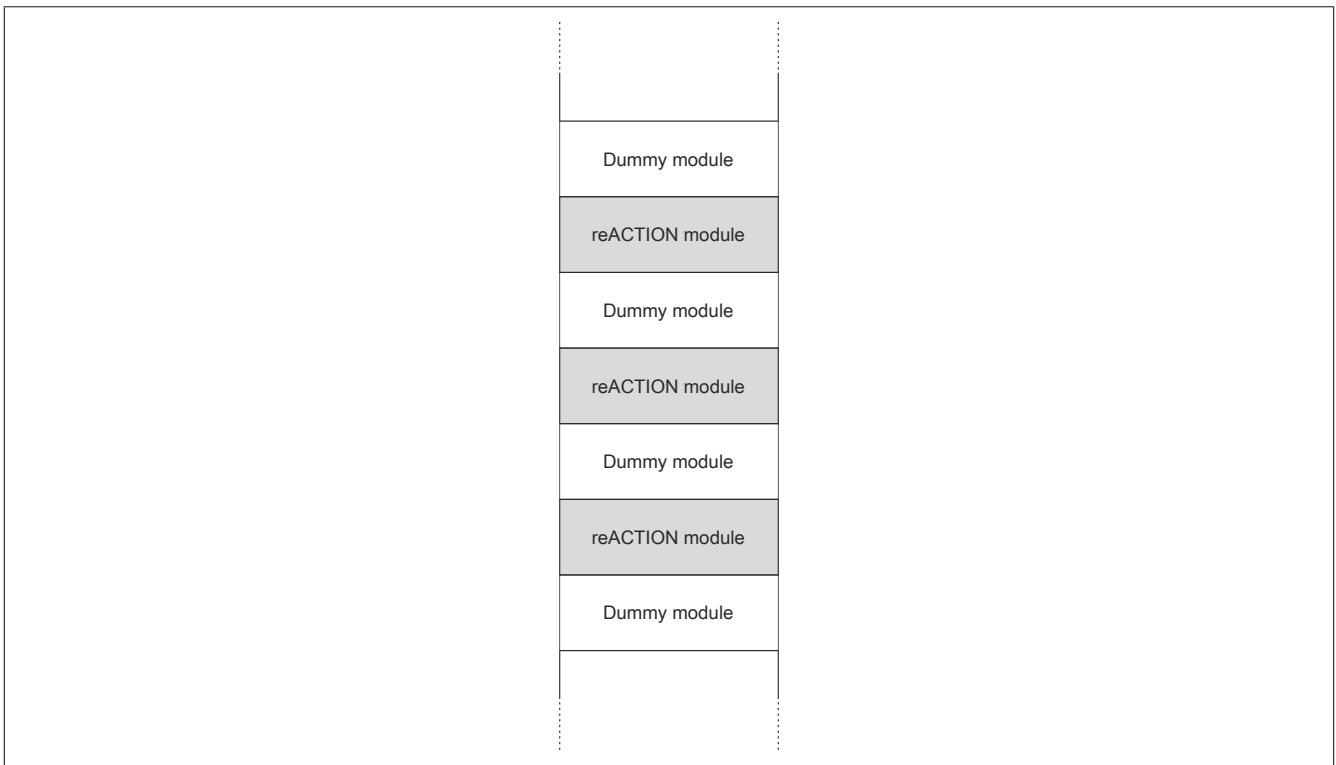
Operating a reACTION module

At ambient temperatures starting at 45°C, dummy modules must be installed above and below the reACTION module if installed vertically.



Operating multiple reACTION modules side by side

If 2 or more vertical reACTION modules are being operated in a cluster, the following arrangement of modules must be observed.



9.28.6.10 Enabling blackout mode

The following steps must be carried out to enable blackout mode.

Requirements

- reACTION program transferred to reACTION module
- Reset triggered on reACTION module:
This ensures that the program stored in the reACTION memory will be loaded with every subsequent reset.

Enabling

- Set the enable register for blackout mode.
- Control bit "RTEnable" must be set. This bit starts the reACTION engine.

Activation

- A connection error triggers a reset on the reACTION module.
- PAR and VAR data points are set to 0.
- Blackout mode is enabled on the reACTION module.

9.28.6.10.1 Blackout mode

For a description of blackout mode, see ["Blackout mode" on page 3794](#).

9.28.6.11 Register description

9.28.6.11.1 System requirements

The following minimum versions are recommended to generally be able to use all functions:

- Automation Studio 4.4.3
- Automation Runtime 4.08

9.28.6.11.2 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.28.6.11.3 Function model 0 - "reACTION"

When using function model "reACTION", a reACTION program must be created specifically for the module. Later, this program will be executed by the reACTION module, not by the CPU. This allows certain machine tasks to be managed decentrally and with a very short response time.

The inputs and outputs of a reACTION module can only be operated by an enabled reACTION program. Interaction registers allow information to be exchanged between the CPU and the reACTION program on the module.

In addition to communication with the CPU, the cyclic interaction registers can also be used for "cross-mapping". In this way, inputs/outputs can also be read/controlled by external modules across the entire X2X Link or POWERLINK network.

| Register | Name | Data type | Read | | Write | |
|---------------------------------|--------------------------------|------------------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module communication | | | | | | |
| 158 | ModuleStatus | UINT | | • | | |
| 162 | DigitalStatus | UINT | | • | | |
| 166 | AnalogInputStatus | UINT | | • | | |
| reACTION - Configuration | | | | | | |
| 772 | ReActionCycleTimeValue | UDINT | | | | • |
| 780 | ReActionCycleTimeMultiplier | UDINT | | | | • |
| Index * 8 + 508 | CfO_PARType01 to CfO_PARType04 | UDINT | | | | • |
| reACTION - Communication | | | | | | |
| 129 | reACTION - Control byte | USINT | | | • | |
| | RTEnable | Bit 0 | | | | |
| | RTHardwareWarningQuit | Bit 2 | | | | |
| 145 | reACTION - Status byte | USINT | • | | | |
| | RTEngineRun | Bit 0 | | | | |
| | RTCycleTimeOverrun | Bit 1 | | | | |
| | RTHardwareWarning | Bit 2 | | | | |
| | RTFileInvalid | Bit 4 | | | | |
| | RTFunctionInvalid | Bit 5 | | | | |
| | RTInstanceInvalid | Bit 6 | | | | |
| RTFileNotLoaded | Bit 7 | | | | | |
| 154 | RTCycleCounter | UINT | • | | | |
| 150 | RTCycleTime | UINT | • | | | |
| reACTION - Interaction | | | | | | |
| Index * 8 + 4095 | PAR01 to PAR32 | (U)SINT | | | • | |
| | PAR01_Bit1 to PAR32_Bit1 | Bit 0 | | | | |
| | PAR01_Bit2 to PAR32_Bit2 | Bit 1 | | | | |
| | PAR01_Bit3 to PAR32_Bit3 | Bit 2 | | | | |
| | PAR01_Bit4 to PAR32_Bit4 | Bit 3 | | | | |
| | PAR01_Bit5 to PAR32_Bit5 | Bit 4 | | | | |
| | PAR01_Bit6 to PAR32_Bit6 | Bit 5 | | | | |
| | PAR01_Bit7 to PAR32_Bit7 | Bit 6 | | | | |
| PAR01_Bit8 to PAR32_Bit8 | Bit 7 | | | | | |
| Index * 8 + 4094 | PAR01 to PAR32 | (U)INT | | | • | |
| Index * 8 + 4092 | PAR01 to PAR32 | (U)DINT, REAL | | | • | |
| Index * 8 + 5119 | RES01 to RES32 | (U)SINT | • | | | |
| | RES01_Bit1 to RES32_Bit1 | Bit 0 | | | | |
| | RES01_Bit2 to RES32_Bit2 | Bit 1 | | | | |
| | RES01_Bit3 to RES32_Bit3 | Bit 2 | | | | |
| | RES01_Bit4 to RES32_Bit4 | Bit 3 | | | | |
| | RES01_Bit5 to RES32_Bit5 | Bit 4 | | | | |
| | RES01_Bit6 to RES32_Bit6 | Bit 5 | | | | |
| | RES01_Bit7 to RES32_Bit7 | Bit 6 | | | | |

| Register | Name | Data type | Read | | Write | |
|--|----------------------------|------------------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| | RES01_Bit8 to RES32_Bit8 | Bit 7 | | | | |
| Index * 8 + 5118 | RES01 to RES32 | (U)INT | • | | | |
| Index * 8 + 5116 | RES01 to RES32 | (U)DINT, REAL | • | | | |
| Index * 8 + 6140 | PVAR1 to PVAR256 | DINT, REAL | | | | • |
| Index * 8 + 6140 | RVAR1 to RVAR256 | DINT, REAL | | • | | |
| reACTION - Function block configuration | | | | | | |
| 1028 | CfO_Config_ABR1 | UDINT | | | | • |
| 1036 | CfO_ScalingIncrements_ABR1 | UDINT | | | | • |
| 1044 | CfO_ScalingUnits_ABR1 | UDINT | | | | • |
| 1052 | CfO_ChannelMapping1_ABR1 | UDINT | | | | • |
| 1060 | CfO_ChannelMapping2_ABR1 | UDINT | | | | • |

9.28.6.11.4 Function model 254 - "Direct I/O"

In function model "Direct I/O", a special reACTION program is executed in the module in order to manage the I/O channels. In addition, cyclic registers are used to exchange information with the CPU. This simulates the behavior of a standard module.

| Register | Name | Data type | Read | | Write | |
|-----------------------------------|---------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module communication | | | | | | |
| 129 | Status - Acknowledgment | USINT | | | • | |
| | RTHardwareWarningQuit | Bit 2 | | | | |
| 145 | Status - Composite message | USINT | • | | | |
| | RTHardwareWarning | Bit 2 | | | | |
| 159 | Status word - Module (L byte) | USINT | • | | | |
| | InternalSupplyOk_X1 | Bit 1 | | | | |
| | SensorSupplyOk_X2 | Bit 2 | | | | |
| | InternalSupplyOk_X2 | Bit 3 | | | | |
| | X1ToX2ComError | Bit 6 | | | | |
| | X2ToX1ComError | Bit 7 | | | | |
| 157 | Status word - Module (H byte) | USINT | • | | | |
| | AnalogIn01ComError | Bit 0 | | | | |
| | AnalogIn02ComError | Bit 1 | | | | |
| | AnalogOut01ComError | Bit 4 | | | | |
| 163 | Status word - Digital (L byte) | USINT | • | | | |
| | DigitalOutput3Overload | Bit 2 | | | | |
| | DigitalOutput4Overload | Bit 3 | | | | |
| | DigitalOutput7Overload | Bit 6 | | | | |
| | DigitalOutput8Overload | Bit 7 | | | | |
| 167 | Status word - AnalogIn (L byte) | USINT | • | | | |
| | AnalogIn01Underflow | Bit 0 | | | | |
| | AnalogIn01Overflow | Bit 1 | | | | |
| | AnalogIn01OpenLoop | Bit 2 | | | | |
| 169 | Status word - AnalogIn (H byte) | USINT | • | | | |
| | AnalogIn02Underflow | Bit 0 | | | | |
| | AnalogIn02Overflow | Bit 1 | | | | |
| | AnalogIn02OpenLoop | Bit 2 | | | | |
| Direct I/O - Configuration | | | | | | |
| 556 | CfO_DigitalDirection | UDINT | | | | • |
| 548 | CfO_DigitalFilter | UDINT | | | | • |
| 564 | CfO_AnalogFilter01 | UDINT | | | | • |
| 572 | CfO_LowerLimit01 | DINT | | | | • |
| 580 | CfO_UpperLimit01 | DINT | | | | • |
| 588 | CfO_AnalogFilter02 | UDINT | | | | • |
| 596 | CfO_LowerLimit02 | DINT | | | | • |
| 604 | CfO_UpperLimit02 | DINT | | | | • |
| Direct I/O - Communication | | | | | | |
| 5 | Digital outputs | USINT | | | • | |
| | DigitalOutput03 | Bit 2 | | | | |
| | DigitalOutput04 | Bit 3 | | | | |
| | DigitalOutput07 | Bit 6 | | | | |
| | DigitalOutput08 | Bit 7 | | | | |
| 1 | Digital inputs | USINT | • | | | |
| | DigitalInput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| 14 | AnalogInput01 | INT | • | | | |
| 18 | AnalogInput02 | INT | • | | | |
| 22 | AnalogOutput01 | INT | | | • | |

9.28.6.11.5 Module communication

9.28.6.11.5.1 Module status messages

Name:

ModuleStatus

This register is used to transfer general status messages for the module.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|--------------------------------------|---------------------|-------|---|
| Status word - Module (L byte) | | | |
| 0 | Reserved | - | |
| 1 | InternalSupplyOk_X1 | 0 | Internal voltage conversion for X1 faulty |
| | | 1 | No error |
| 2 | SensorSupplyOk_X2 | 0 | Power supply for X2 faulty |
| | | 1 | No error |
| 3 | InternalSupplyOk_X2 | 0 | Internal voltage conversion for X2 faulty |
| | | 1 | No error |
| 4 - 5 | Reserved | - | |
| 6 | X1ToX2ComError | 0 | No error |
| | | 1 | X1 → X2 communication faulty |
| 7 | X2ToX1ComError | 0 | No error |
| | | 1 | X2 → X1 communication faulty |
| Status word - Module (H byte) | | | |
| 0 | AnalogIn01ComError | 0 | No error |
| | | 1 | Value from analog input 1 faulty |
| 1 | AnalogIn02ComError | 0 | No error |
| | | 1 | Value from analog input 2 faulty |
| 2 - 3 | Reserved | - | |
| 4 | AnalogOut01ComError | 0 | No error |
| | | 1 | Value from analog output 1 faulty |
| 5 - 7 | Reserved | - | |

9.28.6.11.5.2 Status messages for the digital channels

Name:

DigitalStatus

This register is used to transfer general status messages for the digital channels.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|---------------------------------------|------------------------|-------|---|
| Status word - Digital (L byte) | | | |
| 0 - 1 | Reserved | - | |
| 2 | DigitalOutput3Overload | 0 | Digital output 3 OK |
| | | 1 | Requested voltage 0 V/24 V not achieved |
| 3 | DigitalOutput4Overload | 0 | Digital output 4 OK |
| | | 1 | Requested voltage 0 V/24 V not achieved |
| 4 - 5 | Reserved | - | |
| 6 | DigitalOutput7Overload | 0 | Digital output 7 OK |
| | | 1 | Requested voltage 0 V/24 V not achieved |
| 7 | DigitalOutput8Overload | 0 | Digital output 8 OK |
| | | 1 | Requested voltage 0 V/24 V not achieved |

9.28.6.11.5.3 Status messages from analog inputs

Name:

AnalogInputStatus

This register transfers general status messages of analog inputs.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|--|---------------------|-------|--|
| Status word - AnalogIn (L byte) | | | |
| 0 | AnalogIn01Underflow | 0 | No error |
| | | 1 | Lower limit value from analog input 1 underrun |
| 1 | AnalogIn01Overflow | 0 | No error |
| | | 1 | Upper limit value from analog input 1 exceeded |
| 2 | AnalogIn01OpenLoop | 0 | No error |
| | | 1 | Open circuit determined on analog input 1 |
| 3 - 7 | Reserved | - | |
| Status word - AnalogIn (H byte) | | | |
| 0 | AnalogIn02Underflow | 0 | No error |
| | | 1 | Lower limit value from analog input 2 underrun |
| 1 | AnalogIn02Overflow | 0 | No error |
| | | 1 | Upper limit value from analog input 2 exceeded |
| 2 | AnalogIn02OpenLoop | 0 | No error |
| | | 1 | Open circuit determined on analog input 2 |
| 3 - 7 | Reserved | - | |

9.28.6.11.6 reACTION - Configuration

9.28.6.11.6.1 reACTION cycle time

Name:

ReActionCycleTimeValue

ReActionCycleTimeMultiplier

Registers "TimeValue" and "Multiplier" predefine the desired cycle time for the reACTION program. Register "TimeValue" contains the value, while register "Multiplier" contains the associated units.

Register "Multiplier" is currently permanently set to 1000 in order to predefine the cycle time with μ s precision.

| Data type | Value |
|-----------|------------|
| UDINT | 1 to 10000 |

9.28.6.11.6.2 Configuring PAR data points

Name:

CfO_PARType01

CfO_PARType[02...04]

PAR data points can be defined for the reACTION program. To enable them, the desired data type must be made known according to the configuration in Automation Studio.

| Data type | Value |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|---------|-----------------|-------|-------------|
| 0 - 3 | Type01 - PAR 1 | 0000 | Inactive |
| | Type02 - PAR 9 | 0001 | USINT, BOOL |
| | Type03 - PAR 17 | | |
| | Type04 - PAR 25 | | |
| 4 - 7 | Type01 - PAR 2 | 0010 | UINT |
| | Type02 - PAR 10 | 0011 | UDINT, REAL |
| | Type03 - PAR 18 | | |
| | Type04 - PAR 26 | | |
| 8 - 11 | Type01 - PAR 3 | 0100 | Reserved |
| | Type02 - PAR 11 | 0101 | SINT |
| | Type03 - PAR 19 | | |
| | Type04 - PAR 27 | | |
| 12 - 15 | Type01 - PAR 4 | 0110 | INT |
| | Type02 - PAR 12 | 0111 | DINT |
| | Type03 - PAR 20 | | |
| | Type04 - PAR 28 | | |
| 16 - 19 | Type01 - PAR 5 | 1000 | Reserved |
| | Type02 - PAR 13 | ... | |
| | Type03 - PAR 21 | 1111 | |
| | Type04 - PAR 29 | | |
| 20 - 23 | Type01 - PAR 6 | | |
| | Type02 - PAR 14 | | |
| | Type03 - PAR 22 | | |
| | Type04 - PAR 30 | | |
| 24 - 27 | Type01 - PAR 7 | | |
| | Type02 - PAR 15 | | |
| | Type03 - PAR 23 | | |
| | Type04 - PAR 31 | | |
| 28 - 31 | Type01 - PAR 8 | | |
| | Type02 - PAR 16 | | |
| | Type03 - PAR 24 | | |
| | Type04 - PAR 32 | | |

9.28.6.11.7 reACTION - Communication

At runtime, the reACTION module program is controlled via the program sequence in the CPU. In its active state, the reACTION program is then executed independently of the program sequence in the CPU.

9.28.6.11.7.1 Controlling the reACTION module

Name:

RTEnable

RTHardwareWarningQuit

This register controls the reACTION program.

| Data type | Value |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|-----------------------|-------|--|
| 0 | RTEnable | 0 | Stops the reACTION program |
| | | 1 | Starts the reACTION program |
| 1 | Reserved | - | |
| 2 | RTHardwareWarningQuit | 0 | No effect |
| | | 1 | Acknowledges warning messages for the inputs and outputs |
| 3 - 7 | Reserved | - | |

9.28.6.11.7.2 reACTION module status messages

Name:

RTEngineRun

RTCycleTimeOverrun

RTHardwareWarning

RTFileInvalid

RTFunctionInvalid

RTInstanceInvalid

RTFileNotLoaded

This register is used to output various status messages.

| Data type | Value |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|---|-------|--|
| 0 | RTEngineRun | 0 | reACTION program inactive |
| | | 1 | reACTION program active |
| 1 | RTCycleTimeOverrun | 0 | Configured RT cycle time observed |
| | | 1 | RT cycle time set too short |
| 2 | RTHardwareWarning (group bit for acyclic status data points) | 0 | No status messages |
| | | 1 | Warning message for the inputs and outputs |
| 3 | Reserved | - | |
| 4 | RTFileInvalid (invalid RT program preloaded) | 0 | RT program in RAM OK |
| | | 1 | RT program in RAM invalid |
| 5 | RTFunctionInvalid (invalid software function) | 0 | RT program OK |
| | | 1 | RT program requesting invalid function block |
| 6 | RTInstanceInvalid (invalid hardware instance) | 0 | RT program OK |
| | | 1 | RT program requesting invalid I/O |
| 7 | RTFileNotLoaded | 0 | Valid RT program in RT engine |
| | | 1 | No RT program loaded |

9.28.6.11.7.3 Cycle counter for the active reACTION program

Name:

RTCycleCounter

Register "CycleCounter" can be used to determine how often the reACTION program has cycled.

| Data type | Value |
|-----------|------------|
| UINT | 0 to 65535 |

9.28.6.11.7.4 Minimum cycle time of the active reACTION program

Name:

RTCycleTime

Register "RTCycleTime" can be used to determine how much time the reACTION module needs to cycle through the loaded program once.

| Data type | Value |
|-----------|-------------------------|
| UINT | 0 to 65535: Units 10 ns |

9.28.6.11.8 reACTION - Interaction

After startup, the reACTION program in the module runs independently. It reads the images of the required inputs and manages its assigned outputs throughout the entire network. In addition, the reACTION program can interact with the CPU. There are 3 different data point types available for this.

9.28.6.11.8.1 PAR data points

Name:

PAR[01...32]

PAR[01...32]_Bit1

PAR[01...32]_Bit2

PAR[01...32]_Bit3

PAR[01...32]_Bit4

PAR[01...32]_Bit5

PAR[01...32]_Bit6

PAR[01...32]_Bit7

PAR[01...32]_Bit8

Once enabled, the PAR data points are transported cyclically via X2X Link. They are used to transfer information from the CPU to the reACTION program. They can be used to intervene in the execution of the reACTION program.

Information:

PAR data points DO NOT control the module's outputs directly!

| Data type | Value |
|---------------|-------------------------------|
| (U)SINT, BOOL | Corresponding range of values |
| (U)INT | |
| (U)DINT | |

| Register | Name | Data type | Read | | Write | |
|------------------|---------------------------------|-----------------------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 4095 + Index * 8 | PAR01 PAR[02...32] | (U)SINT | | | • | |
| | PAR01_Bit1 PAR[02...32]_Bit1 | Bit 0 | | | | |
| | PAR01_Bit2 PAR[02...32]_Bit2 | Bit 1 | | | | |
| | PAR01_Bit3 PAR[02...32]_Bit3 | Bit 2 | | | | |
| | PAR01_Bit4 PAR[02...32]_Bit4 | Bit 3 | | | | |
| | PAR01_Bit5 PAR[02...32]_Bit5 | Bit 4 | | | | |
| | PAR01_Bit6 PAR[02...32]_Bit6 | Bit 5 | | | | |
| | PAR01_Bit7 PAR[02...32]_Bit7 | Bit 6 | | | | |
| | PAR01_Bit8 PAR[02...32]_Bit8 | Bit 7 | | | | |
| | 4094 + Index * 8 | PAR01 PAR[02...32] | (U)INT | | | • |
| 4092 + Index * 8 | PAR01 PAR[02...32] | (U)DINT, REAL | | | • | |

9.28.6.11.8.2 RES data points

Name:

RES[01...32]

RES[01...32]_Bit1

RES[01...32]_Bit2

RES[01...32]_Bit3

RES[01...32]_Bit4

RES[01...32]_Bit5

RES[01...32]_Bit6

RES[01...32]_Bit7

RES[01...32]_Bit8

Once enabled, the RES data points are transported cyclically via X2X Link. They are used to transfer information from the reACTION program to the CPU.

Information:

RES data points DO NOT map the module's input directly!

| Data type | Value |
|---------------|-------------------------------|
| (U)SINT, BOOL | Corresponding range of values |
| (U)INT | |
| (U)DINT | |

| Register | Name | Data type | Read | | Write | |
|-------------------|-------------------|------------------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 5119 + Index * 8 | RES01 | (U)SINT | • | | | |
| | RES[02...32] | | | | | |
| | RES01_Bit1 | Bit 0 | | | | |
| | RES[02...32]_Bit1 | | | | | |
| | RES01_Bit2 | Bit 1 | | | | |
| | RES[02...32]_Bit2 | | | | | |
| | RES01_Bit3 | Bit 2 | | | | |
| | RES[02...32]_Bit3 | | | | | |
| | RES01_Bit4 | Bit 3 | | | | |
| | RES[02...32]_Bit4 | | | | | |
| | RES01_Bit5 | Bit 4 | | | | |
| | RES[02...32]_Bit5 | | | | | |
| | RES01_Bit6 | Bit 5 | | | | |
| RES[02...32]_Bit6 | | | | | | |
| 5118 + Index * 8 | RES01 | (U)INT | • | | | |
| | RES[02...32] | | | | | |
| 5116 + Index * 8 | RES01 | (U)DINT, REAL | • | | | |
| | RES[02...32] | | | | | |

9.28.6.11.8.3 PVAR and RVAR data points

Name:

PVAR[1...256]

RVAR[1...256]

In addition to PAR and RES data points, VAR data points can also be defined in the reACTION program. They are a direct component of the reACTION program and can be accessed acyclically by the CPU. Like the PAR and RES data points, PVAR data points are used to transfer information from the CPU to the reACTION program. RVAR data points are used to transfer feedback from the reACTION program to the CPU.

| Data type | Value |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

| Register | Name | Data type | Read | | Write | |
|------------------|------------------------|------------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 6140 + Index * 8 | PVAR1 PVAR[2...256] | DINT, REAL | | | | • |
| 6140 + Index * 8 | RVAR1 RVAR[2...256] | DINT, REAL | | • | | |

9.28.6.11.9 reACTION function blocks - General

The following tables provide an overview of I/O channel assignments to reACTION function blocks.

Digital inputs/outputs

| Channel | Function block | | |
|-----------------|-----------------------|-----------|----------------------|
| | Mapping ¹⁾ | rTiDin | rTiDout, rTiDoutTime |
| X1: DI 1 | 0x00 | Channel 1 | |
| X1: DI 2 | 0x01 | Channel 2 | |
| X1: DI 3 / DO 3 | 0x02 | Channel 3 | Channel 3 |
| X1: DI 4 / DO 4 | 0x03 | Channel 4 | Channel 4 |
| X1: DI 5 | 0x04 | Channel 5 | |
| X1: DI 6 | 0x05 | Channel 6 | |
| X1: DI 7 / DO 7 | 0x06 | Channel 7 | Channel 7 |
| X1: DI 8 / DO 8 | 0x07 | Channel 8 | Channel 8 |

- 1) The "Mapping" specification is needed in the event that multiple physical inputs/outputs must be grouped together in order to be processed by a reACTION function block (e.g. rTiABRPos) (see "reACTION function blocks - Configuration" on page 3569).

Analog inputs

| Channel | Function block | | |
|----------|-----------------------|-----------|---------|
| | Mapping ¹⁾ | rTiAin | rTiAout |
| X2: AI 1 | 0x00 | Channel 1 | |
| X2: AI 2 | 0x01 | Channel 2 | |

- 1) The "Mapping" specification is needed in the event that multiple physical inputs/outputs must be grouped together in order to be processed by a reACTION function block (e.g. rTiABRPos) (see "reACTION function blocks - Configuration" on page 3569).

Analog output

| Channel | Function block | | |
|----------|-----------------------|--------|-----------|
| | Mapping ¹⁾ | rTiAin | rTiAout |
| X2: AO 1 | 0x00 | | Channel 1 |

- 1) The "Mapping" specification is needed in the event that multiple physical inputs/outputs must be grouped together in order to be processed by a reACTION function block (e.g. rTiABRPos) (see "reACTION function blocks - Configuration" on page 3569).

9.28.6.11.10 reACTION function blocks - Configuration

Some function blocks in library AsIoRti must be configured before they can be used.

| Function block | Information |
|----------------|--|
| rtiABRPos | The module offers the option of using function block rtiABRPos once in the reACTION program. To do so, the function block must be assigned 3 digital inputs that are no longer available for rtiDin. |
| rtiABCnt | The module offers the option of using function block rtiABCnt up to 3 times in the reACTION program. To do so, the function blocks must be assigned 2 digital inputs as an A or B track that are no longer available for rtiDin. In addition, an external event can be defined for each rtiABCnt function block. The input used for this is also no longer available for rtiDin. |

Table 613: List of function blocks requiring prior configuration

9.28.6.11.10.1 Function blocks rtiABRPos and rtiABCnt

Function blocks rtiABRPos and rtiABCnt can be used to process the position value of an ABR incremental encoder in a reACTION task. Several hardware channels of the module are used for this. The incoming signals are interpreted by the reACTION engine and converted into a location.

The update rate depends on both the reACTION engine and the hardware used. The reACTION engine is basically able to calculate positions with an update rate of up to 8 MHz. The input frequencies of the hardware inputs can be taken from the technical data of the respective module.

These function blocks can be used separately or in combination.

Using function block rtiABRPos

The following points are important to keep in mind when using function block rtiABRPos in a reACTION program:

- The function block can only be used once in a reACTION program.
- 3 digital inputs must be defined on the module for input signals A, B and R.
- In addition, a digital input of the module can be defined as an event input.

Example diagram of input signals:

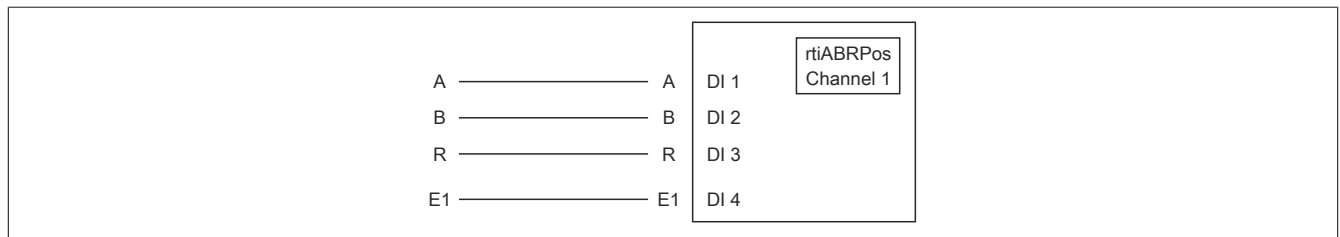


Figure 351: Schematic diagram of input signals for rtiABRPos

Using function block rtiABCnt

The following points must be taken into account when using function block rtiABCnt in a reACTION program:

- The function block can be used up to 3 times in a reACTION program.
- 2 digital inputs must be defined on the module for input signals A and B.
- In addition, up to 3 digital inputs on the module can be defined as event inputs E1, E2 and E3.

Example diagram of input signals:

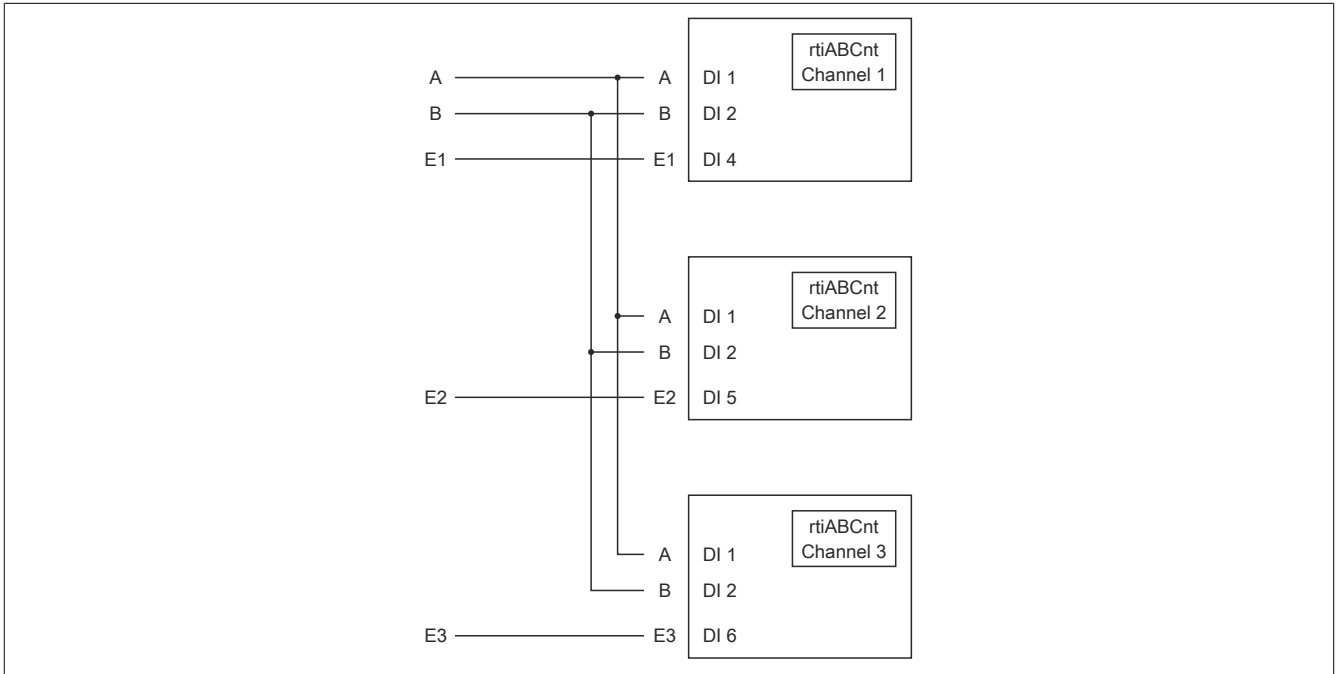


Figure 352: Schematic diagram of input signals for rtiABCnt

Using function blocks rtiABRPos and rtiABCnt in combination

The following points should be kept in mind when using function blocks rtiABRPos and rtiABCnt together in a reACTION program.

- Function block rtiABRPos can only be used once in a reACTION program.
- Function block rtiABCnt can be used up to 2 times in a reACTION program.
- 3 digital inputs must be defined for input signals A, B and R (rtiABRPos).
- The same digital inputs are used for input signals A and B (rtiABCnt).
- In addition, up to 3 event inputs E1, E2 and E3 can be defined (rtiABCnt).
- E1 is used for the event input (rtiABRPos).

Example diagram of input signals:

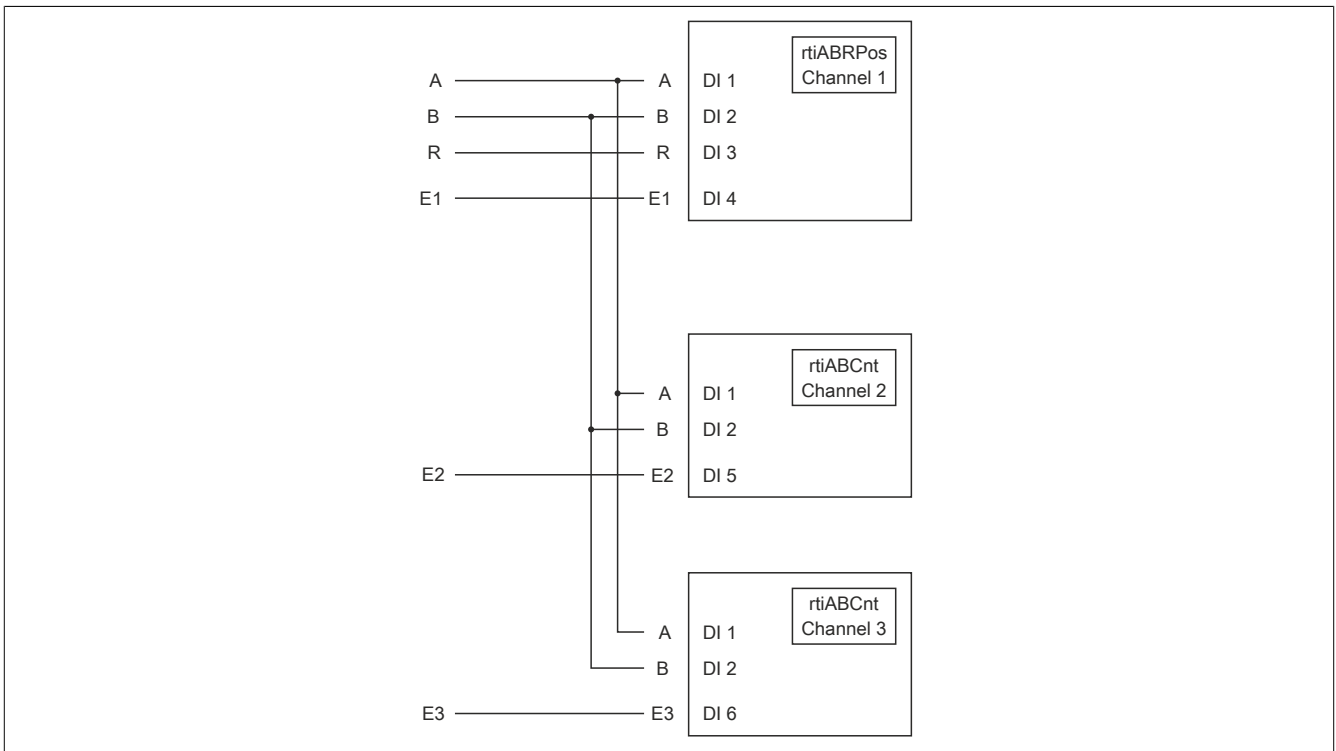


Figure 353: Diagram of input signals when using rtiABRPos and rtiABCnt at the same time

Registering the position encoder (rtiABRPos/rtiABCnt)

Name:

CfO_Config_ABR1

This register specifies the technical characteristics of the connected ABR incremental encoder.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|--|------------|---|
| 0 - 15 | Increments per revolution | 0 to 65535 | Reference pulse monitoring: If the reference pulse is different than defined here, this is indicated on the status output of function block rtiABRPos. |
| 16 | Inversion of the counting direction set by signals A and B | 0 | Positive counting direction |
| | | 1 | Negative counting direction |
| 17 - 31 | Reserved | 0 | |

Wiring the position encoder (rtiABRPos/rtiABCnt)

Name:

CfO_ChannelMapping1_ABR1

CfO_ChannelMapping2_ABR1

Before function blocks rtiABRPos/rtiABCnt can be processed by the reACTION engine, the hardware inputs to be used by the ABR incremental encoder must be defined on the module. The "ChannelMapping" registers specify which inputs are interpreted as the A, B, R, E1, E2 and E3 signals.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure of CfO_ChannelMapping1_ABR1:

| Bit | Description | Value | Information |
|---------|-------------|----------|---------------------------------------|
| 0 - 7 | Input E1 | 0 | Mapped to digital input 1 |
| | | 1 | Mapped to digital input 2 |
| | | ... | ... |
| | | 7 | Mapped to digital input 8 |
| | | 8 to 255 | Reserved |
| 8 - 15 | Input R | 0 to 255 | For possible values, see bits 0 to 7. |
| 16 - 23 | Input B | 0 to 255 | For possible values, see bits 0 to 7. |
| 24 - 31 | Input A | 0 to 255 | For possible values, see bits 0 to 7. |

Bit structure of CfO_ChannelMapping2_ABR1:

| Bit | Description | Value | Information |
|---------|-------------|----------|---|
| 0 - 15 | Reserved | 0 | |
| 16 - 23 | Input E3 | 0 | Mapped to digital input 1 |
| | | 1 | Mapped to digital input 2 |
| | | ... | ... |
| | | 7 | Mapped to digital input 8 |
| | | 8 to 255 | Reserved |
| 24 - 31 | Input E2 | 0 to 255 | For possible values, see bits 16 to 23. |

Information:

For information about the relationship between the input on the module and the channel name, see section "reACTION function blocks - General".

Scaling the position encoder (rtiABRPos)

Name:

CfO_ScalingUnits_ABR1

CfO_ScalingIncrements_ABR1

An optional gear ratio can be configured using registers "Units" and "Increments". The dividend for scaling is defined in register "Units"; the divisor is defined in register "Increments".

| Data type | Value | Information |
|-----------|--------------------|--|
| UDINT | 0 to 4,294,967,295 | CfO_ScalingUnits_ABR1: Units per interval CfO_ScalingIncrements_ABR1: Increments per interval |

Formula for calculation

$$\text{Gear ratio} = \text{ScalingUnits} / \text{ScalingIncrements}$$
Example 1

ScalingUnits = 1

ScalingIncrements = 1

$$\text{Position value (Pos)} = \text{ABR increments} * \text{ScalingUnits} / \text{ScalingIncrements}$$

$$\text{Position value (Pos)} = \text{ABR increments} * 1/1$$

In this example, the ABR position value is output unchanged on output "Pos".

Example 2

ScalingUnits = 10

ScalingIncrements = 4

$$\text{Position value (Pos)} = \text{ABR increments} * \text{ScalingUnits} / \text{ScalingIncrements}$$

$$\text{Position value (Pos)} = \text{ABR increments} * 10/4$$

In this example, the ABR position value is multiplied by 2.5 and output on output "Pos".

Information:

The encoder values are calculated internally as INT64 values in 32.32 format. On output "Pos" of function block "rtiABRPos", only the whole number value (INT32) is output for the user. The fixed point decimal places are used internally to calculate a higher resolution.

9.28.6.11.11 Direct I/O - Configuration

This module is equipped with 8 digital channels, 2 analog inputs and 1 analog output. In the "Direct I/O" function model, behavior is based on that of a standard module. The I/O channels are managed by an extremely simplified reACTION program. The function model primarily serves to check that the I/O channels are functioning properly.

9.28.6.11.11.1 Direction of digital channels

Name:

CfO_DigitalDirection

This register determines the signal direction of digital channels 3, 4, 7 and 8.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|-------------------------------|-------|-------------|
| 0 - 1 | Reserved | 0 | |
| 2 | Direction - Digital channel 3 | 0 | Input |
| | | 1 | Output |
| 3 | Direction - Digital channel 4 | 0 | Input |
| | | 1 | Output |
| 4 - 5 | Reserved | 0 | |
| 6 | Direction - Digital channel 7 | 0 | Input |
| | | 1 | Output |
| 7 | Direction - Digital channel 8 | 0 | Input |
| | | 1 | Output |

9.28.6.11.11.2 Filtering digital channels

Name:

CfO_DigitalFilter

This register defines the filter time of the digital channels. The filter value affects both the switching delay as well as the immunity of the channels.

| Data type | Value |
|-----------|--------------------------|
| UDINT | 0 to 500000: Units 10 ns |

9.28.6.11.11.3 Filtering analog inputs

Name:

CfO_AnalogFilter01 to CfO_AnalogFilter02

This register sets the filter level of the analog input.

| Data type | Values |
|-----------|--------|
| UDINT | 0 to 7 |

$$2^{\text{AnalogFilter}} = \text{FilterLevel} = \frac{\text{Out(ADC)}_t - \text{Out(Filter)}_{t-1}}{\text{Out(Filter)}_t - \text{Out(Filter)}_{t-1}} \cong \frac{\Delta \text{Out(ADC)}}{\Delta \text{Out(Filter)}}$$

The filter level results as the exponent to base 2 and corresponds to the ratio of the change of the digitalized input value to the change of the filtered analog value.

9.28.6.11.11.4 Limit values of the analog inputs

Name:

CfO_LowerLimit01 to CfO_LowerLimit02

CfO_UpperLimit01 to CfO_UpperLimit02

These registers define the upper and lower user-specific limit values for the analog input.

| Data type | Values |
|-----------|---|
| DINT | LowerLimit: -32767 to 32767 (Default: -32767) UpperLimit: -32767 to 32767 (Default: 32767) |

9.28.6.11.12 Direct I/O - Communication

This module is equipped with the following inputs and outputs:

- 4 digital inputs (sink) for 24 VDC
- 4 digital channels configurable as inputs (sink) or outputs (sink or source) for 24 VDC
- 2 analog inputs of type ± 10 V
- 1 analog output of type ± 10 V

9.28.6.11.12.1 Digital outputs

Name:

DigitalOutput03

DigitalOutput04

DigitalOutput07

DigitalOutput08

This register is used to predefine the value that should be output on the digital output.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|-----------------|-------|-------------|
| 0 - 1 | Reserved | 0 | |
| 2 | DigitalOutput03 | 0 | FALSE |
| | | 1 | TRUE |
| 3 | DigitalOutput04 | 0 | FALSE |
| | | 1 | TRUE |
| 4 - 5 | Reserved | 0 | |
| 6 | DigitalOutput07 | 0 | FALSE |
| | | 1 | TRUE |
| 7 | DigitalOutput08 | 0 | FALSE |
| | | 1 | TRUE |

9.28.6.11.12.2 Digital inputs

Name:

DigitalInput01

DigitalInput02

DigitalInput03

DigitalInput04

DigitalInput05

DigitalInput06

DigitalInput07

DigitalInput08

This register indicates the value read for the respective digital input.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|-------|-------------|
| 0 | DigitalInput01 | 0 | FALSE |
| | | 1 | TRUE |
| 1 | DigitalInput02 | 0 | FALSE |
| | | 1 | TRUE |
| 2 | DigitalInput03 | 0 | FALSE |
| | | 1 | TRUE |
| 3 | DigitalInput04 | 0 | FALSE |
| | | 1 | TRUE |
| 4 | DigitalInput05 | 0 | FALSE |
| | | 1 | TRUE |
| 5 | DigitalInput06 | 0 | FALSE |
| | | 1 | TRUE |
| 6 | DigitalInput07 | 0 | FALSE |
| | | 1 | TRUE |
| 7 | DigitalInput08 | 0 | FALSE |
| | | 1 | TRUE |

9.28.6.11.12.3 Analog inputs

Name:

AnalogInput01 to AnalogInput02

This register contains the analog input value.

| Data type | Values |
|-----------|-----------------|
| INT | -32767 to 32767 |

9.28.6.11.12.4 Analog output

Name:

AnalogOutput01

This register defines the value for the analog output.

| Data type | Values |
|-----------|-----------------|
| INT | -32767 to 32767 |

9.28.6.11.13 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μ s |

9.28.6.11.14 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 200 μ s |

9.28.7 X20RT8401

Data sheet version: 1.14

9.28.7.1 General information

This reACTION technology module has 4 high-speed digital inputs and 4 high-speed digital mixed channels. All connections are designed for 1-wire connections. All inputs are designed for sink connections; the outputs are designed for push-pull connections.

A voltage signal of ± 10 V can be read or output using an analog input and analog output, respectively.

Ultrafast reACTION Technology makes it possible to control the integrated I/O channels with response times down to 1 μ s. All of the commands that can be used for reACTION programs are provided as function blocks in special libraries (e.g. AsIORTI). Programming in compliance with IEC 61131-3 requirements takes place in the Function Block Diagram editor in Automation Studio.

The module supports blackout mode. In blackout mode, programmable module functionality persists even if the network fails.

- reACTION technology module
- 4 high-speed digital inputs
- 4 high-speed digital channels, configurable as inputs or outputs
- 1 high-speed analog input ± 10 V
- 1 high-speed analog output ± 10 V
- 1 ABR incremental encoder input 24 V
- Pulse width modulation
- 24 VDC and GND for encoder supply
- Supports blackout mode



9.28.7.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | reACTION Technology modules |  |
| X20RT8401 | X20 reACTION module, 4 digital inputs, 24 VDC, <1 μ s, 4 digital channels, 24 VDC, 0.1 A, <1 μ s, configurable as inputs or outputs, 1 analog input ± 10 V, 500 kHz sampling frequency, 13-bit converter resolution including sign, configurable input filter, 1 analog output ± 10 V, 2 μ s, 13-bit converter resolution including sign, reACTION Technology module | |
| | Required accessories | |
| | Bus modules | |
| X20BM31 | X20 bus module for double-width modules, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 614: X20RT8401 - Order data

9.28.7.3 Technical data

| Model number | X20RT8401 |
|--|--|
| Short description | |
| I/O module | 4 digital input channels, 4 digital channels configurable as inputs or outputs, 1 analog input ± 10 V, 1 analog output ± 10 V, reACTION Technology |
| General information | |
| B&R ID code | 0xE55C |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Outputs | Yes, using status LED and software (output error status) |
| Inputs | Yes, using status LED and software |
| Channel type | Yes, using software |
| reACTION-capable I/O channels | Yes |
| Blackout mode | |
| Scope | Module |
| Function | Programmable |
| Standalone mode | No |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.7 W |
| Additional power dissipation caused by actuators (resistive) [W] | +1.1 |
| Type of signal lines ¹⁾ | Shielded cables must be used for all signal lines, cable length: Max. 20 m |
| Application memory | |
| Type | 64 Mbit flash memory |
| Data retention | 20 years at 55°C |
| Guaranteed erase/write cycles | 100,000 |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| Encoder power supply | |
| Output voltage | 24 VDC -15% / +20% |
| Output current ²⁾ | Module-internal, max. 600 mA |
| Short-circuit proof, overload protection | Yes |
| Digital inputs | |
| Quantity | 4 inputs and 4 mixed channels, configurable as inputs or outputs using software |
| Nominal voltage | 24 VDC |
| Input voltage | 24 VDC -15% / +20% |
| Input current at 24 VDC | Typ. 1.3 mA |
| Input circuit | Sink |
| Input filter | |
| Hardware | <3 μ s |
| Software | Default 200 ns, configurable between 200 ns and 5 ms in 10 ns intervals |
| Connection type | 1-wire connections |
| Input resistance | 18.16 k Ω |
| Switching threshold | |
| Low | <5 VDC |
| High | >15 VDC |
| Isolation voltage between channel and bus | 500 V _{eff} |
| ABR incremental encoder | |
| Quantity | 2 |
| Encoder inputs | 24 V, asymmetrical |
| Counter size | 32-bit |
| Input frequency | Max. 333 kHz |
| Evaluation | 4x |
| Analog inputs | |
| Quantity | 1 ³⁾ |
| Input | ± 10 V |
| Input type | Differential input |
| Digital converter resolution | ± 12 -bit |
| Output format | |
| Data type | INT |
| Voltage | INT 0x8001 - 0x7FFF / 1 LSB = 0x0008 = 2.441 mV |
| Input impedance in signal range | 20 M Ω |
| Input protection | Protection against wiring with supply voltage |
| Permissible input signal | Max. ± 30 V |

Table 615: X20RT8401 - Technical data

| Model number | X20RT8401 |
|---|--|
| Output of digital value during overload | |
| Undershoot | 0x8001 |
| Overshoot | 0x7FFF |
| Conversion procedure | SAR |
| Input filter | 3rd-order low pass / cutoff frequency 130 kHz |
| Max. error at 25°C | |
| Gain | 0.08% ⁴⁾ |
| Offset | 0.018% ⁵⁾ |
| Max. gain drift | 0.003 %/°C ⁴⁾ |
| Max. offset drift | 0.001 %/°C ⁵⁾ |
| Common-mode rejection | |
| DC | 86 dB |
| 50 Hz | 84 dB |
| Common-mode range | ±12 V |
| Nonlinearity | 0.015% ⁵⁾ |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Sampling frequency | 500 kHz |
| Digital outputs | |
| Quantity ²⁾ | 4 mixed channels, configurable as inputs or outputs using software |
| Variant | Push-Pull |
| Nominal voltage | 24 VDC |
| Switching voltage | 24 VDC -15% / +20% |
| Nominal output current | 100 mA |
| Total nominal current | 400 mA |
| Connection type | 1-wire connections |
| Output circuit | Sink or source |
| Output protection | Thermal cutoff if overcurrent or short circuit occurs (see value "Peak short circuit current") |
| Diagnostic status | Output monitoring with delay <700 ns |
| Leakage current when switched off | Approx. 25 µA |
| R _{DS(on)} | 140 mΩ |
| Residual voltage | <0.4 V at nominal current 100 mA |
| Max. continuous current | 100 mA |
| Peak short-circuit current | <10 A |
| Switch-on in the event of overload shutdown or short-circuit shutdown | Approx. 3 ms |
| Switching delay | |
| 0 → 1 | <1 µs |
| 1 → 0 | <1 µs |
| Switching frequency | |
| Resistive load | Min. 50 kHz, max. 500 kHz |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Analog outputs | |
| Quantity | 1 |
| Output | ±10 V |
| Digital converter resolution | ±12-bit |
| Conversion time | 2 µs |
| Settling time for output changes over entire range | 5 µs |
| Switch on/off behavior | Internal enable relay for startup |
| Max. error at 25°C | |
| Gain | 0.15% ⁶⁾ |
| Offset | 0.05% ⁷⁾ |
| Output protection | Short circuit protection |
| Output format | |
| Data type | INT |
| Voltage | INT 0x8000 - 0x7FFF / 1 LSB = 0x0008 = 2.441 mV |
| Load per channel | Max. ±10 mA, load ≥1 kΩ |
| Short-circuit proof | Current limiting ±65 mA |
| Output filter | 1st-order low pass / cutoff frequency 22 kHz |
| Max. gain drift | 0.022 %/°C ⁶⁾ |
| Max. offset drift | 0.032 %/°C ⁷⁾ |
| Error caused by load change | Max. 0.14%, from 10 MΩ → 1 kΩ, resistive |
| Nonlinearity | 0.005% ⁸⁾ |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |

Table 615: X20RT8401 - Technical data

| Model number | X20RT8401 |
|-----------------------------------|--|
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | See section "Derating and hardware configuration" |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 2x terminal block X20TB12 separately Order 1x bus module X20BM31 separately |
| Spacing | 25 ^{+0.2} mm |

Table 615: X20RT8401 - Technical data

- 1) See section "X20 shielding brackets".
- 2) See section "Derating and hardware configuration".
- 3) To reduce power dissipation, B&R recommends bridging unused inputs on the terminal.
- 4) Based on the current measured value.
- 5) Based on the 20 V measurement range.
- 6) Based on the current output value.
- 7) Based on the entire output range.
- 8) Based on the output range.

9.28.7.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.


| Figure | LED | Color | Status | Description |
|---|------------|---|------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode or blackout mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | Single flash | Warning/Error on an I/O channel. Level monitoring of digital outputs has been triggered. |
| | | | Double flash | Supply voltage not in valid range or no reACTION program loaded |
| | | | Triple flash | Test of internal memory failed (limited functionality, module must be replaced) |
| | On | Error or reset state (reACTION program using functions or channels that are not permitted on this hardware) | | |
| | e + r | Solid red / Single green flash | Invalid firmware | |
| | 1, 2, 5, 6 | Green | | Input state of the corresponding digital input |
| | 3, 4, 7, 8 | Green | | Input or output status of the corresponding digital input or output |

Table 616: LED status indicators (X1)

1) A firmware update can take several minutes depending on the configuration.


| Figure | LED | Color | Status | Description |
|--|-----|--------|----------|--|
|  | 1 | Green | Off | Open circuit or disconnected sensor |
| | | | Blinking | Input signal overflow or underflow |
| | | | On | Analog/digital converter running, value OK |
| | 1 | Orange | Off | Value = 0 |
| | | | On | Value ≠ 0 |

Table 617: LED status indicators (X2)

9.28.7.5 Pinout

9.28.7.5.1 X1 - Pinout

To prevent crosstalk, each individual signal line should be shielded. The maximum cable length is 20 m.

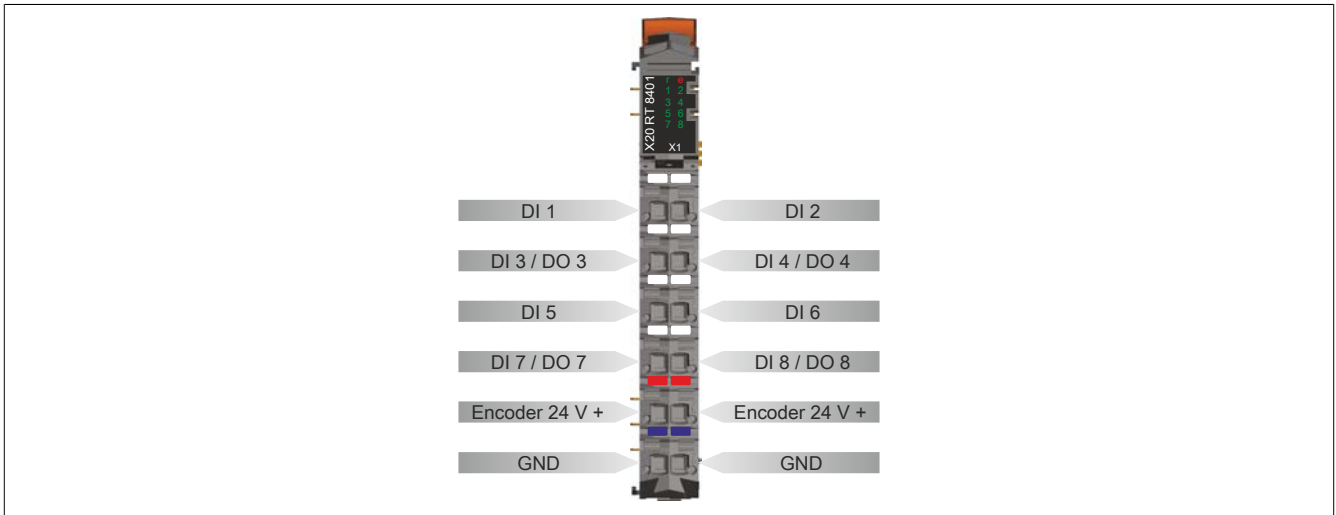


Figure 354: X1 - Pinout

9.28.7.5.2 X2 - Pinout

To prevent crosstalk, each individual signal line should be shielded. The maximum cable length is 20 m.



Figure 355: X2 - Pinout

9.28.7.6 Local I/O channels

The following tables provide an overview of the connections to the I/O channels.

Digital inputs/outputs

| Connection | Terminal connection | Channel |
|------------|---------------------|-------------|
| X1 | 11 | DI 1 |
| | 21 | DI 2 |
| | 12 | DI 3 / DO 3 |
| | 22 | DI 4 / DO 4 |
| | 13 | DI 5 |
| | 23 | DI 6 |
| | 14 | DI 7 / DO 7 |
| | 24 | DI 8 / DO 8 |

Analog input

| Connection | Terminal connection | Channel |
|------------|---------------------|---------|
| X2 | 11 and 12 | AI 1 |

Analog output

| Connection | Terminal connection | Channel |
|------------|---------------------|---------|
| X2 | 13 and 14 | AO 1 |

The following sections describe assigning I/O channels in a reACTION program:

| I/O channels | Assignment |
|-----------------------|--|
| Digital I/O channels | Assignment of digital inputs/outputs |
| Analog input channel | Assignment of analog input |
| Analog output channel | Assignment of analog output |

9.28.7.7 Connection examples

9.28.7.7.1 X1 - Connection examples

Digital inputs and digital outputs

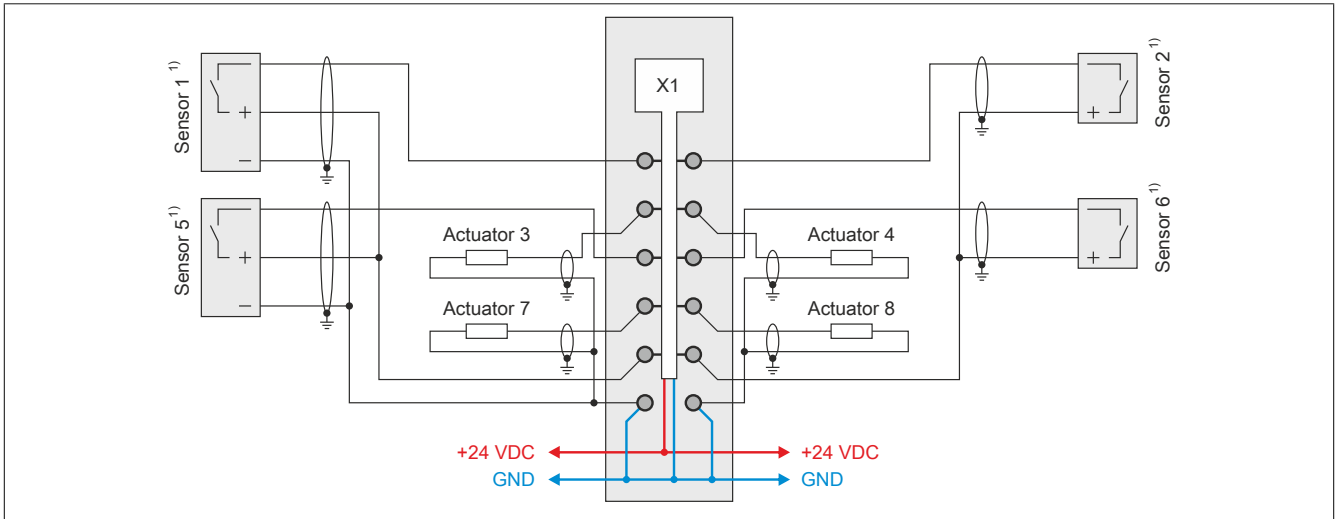


Figure 356: Connection example 1 (X1)

- 1) Observe the wiring guidelines from the sensor manufacturer.

Digital inputs, PWM and ABR incremental encoder

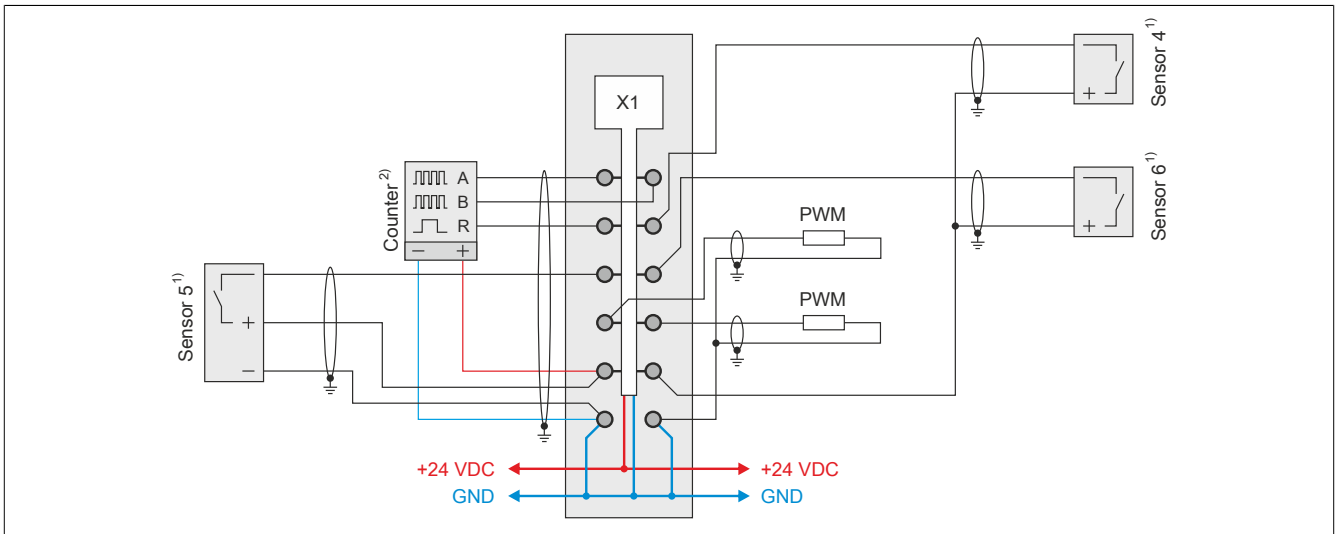


Figure 357: Connection example 2 (X1)

- 1) Observe the wiring guidelines from the sensor manufacturer.
- 2) Observe the wiring guidelines from the encoder manufacturer.

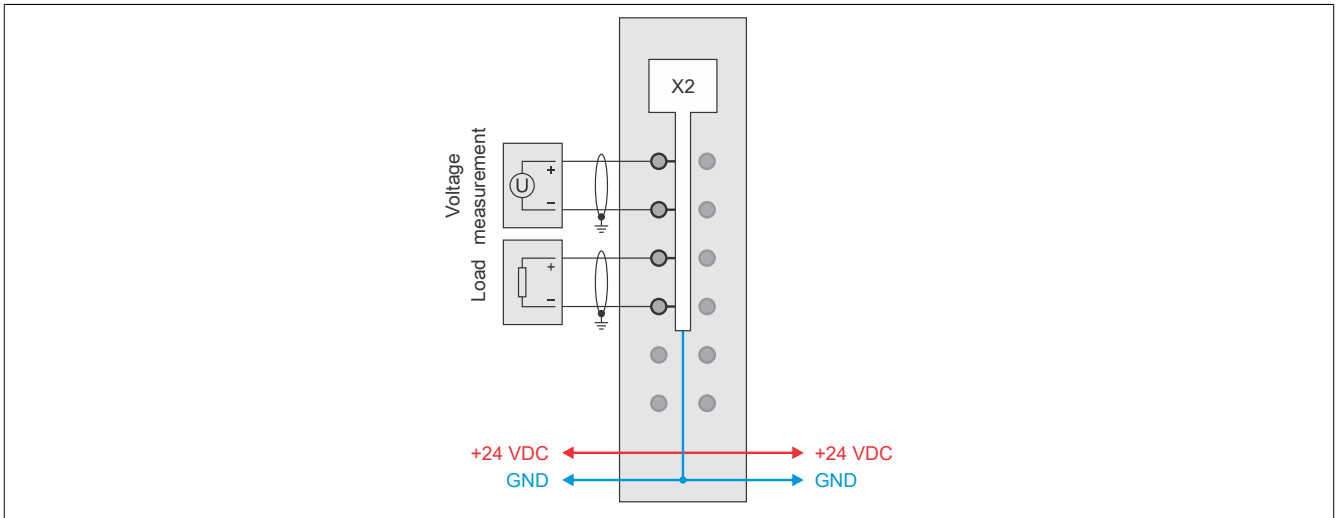
9.28.7.7.2 X2 - Connection example

Figure 358: X2 - Connection example

9.28.7.8 Input/Output circuit diagram

9.28.7.8.1 Digital inputs (X1)

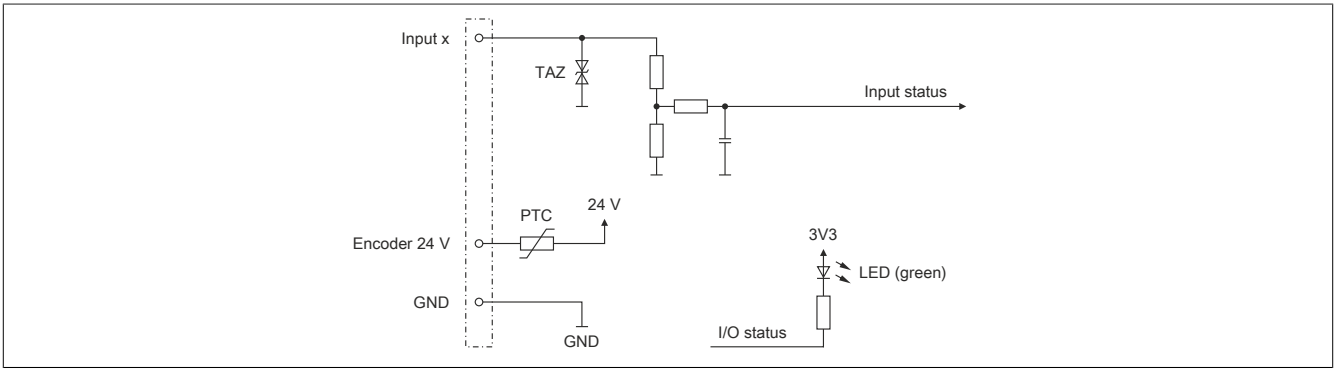


Figure 359: Input circuit diagram of digital inputs (X1)

9.28.7.8.2 Digital mixed channels (X1)

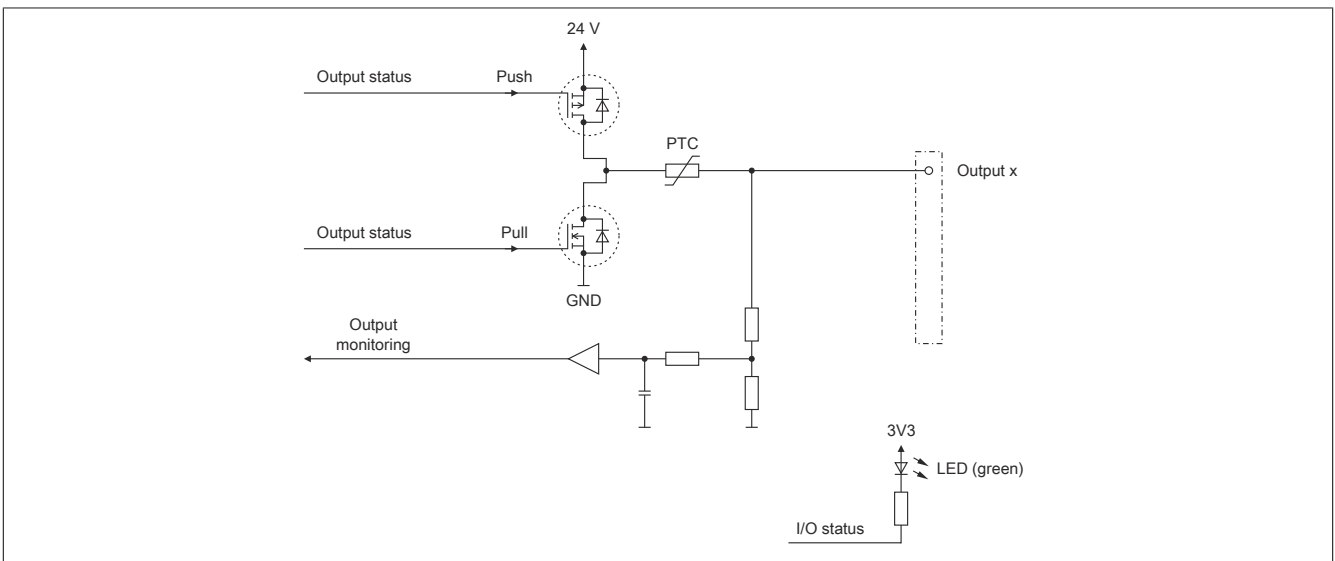


Figure 360: Input/Output circuit diagram of digital mixed channels (X1)

9.28.7.8.3 Analog input (X2)

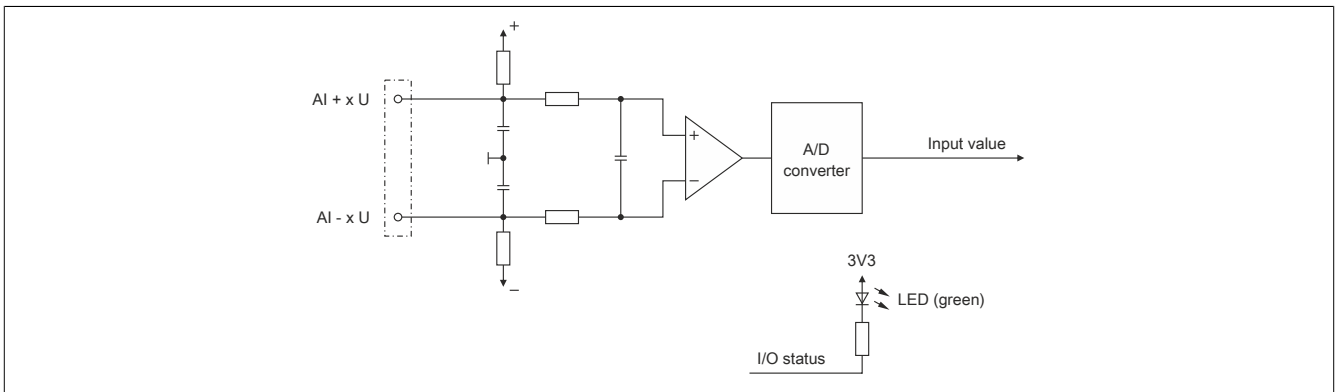


Figure 361: Input circuit diagram of the analog input (X2)

9.28.7.8.4 Analog output (X2)

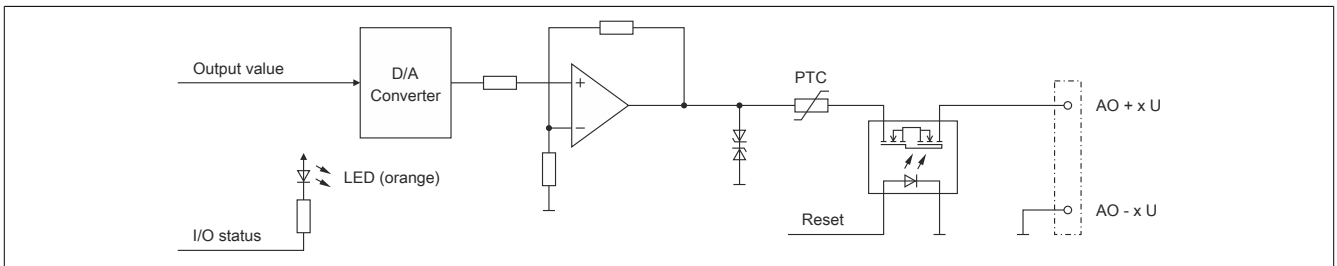


Figure 362: Output circuit diagram of the analog output (X2)

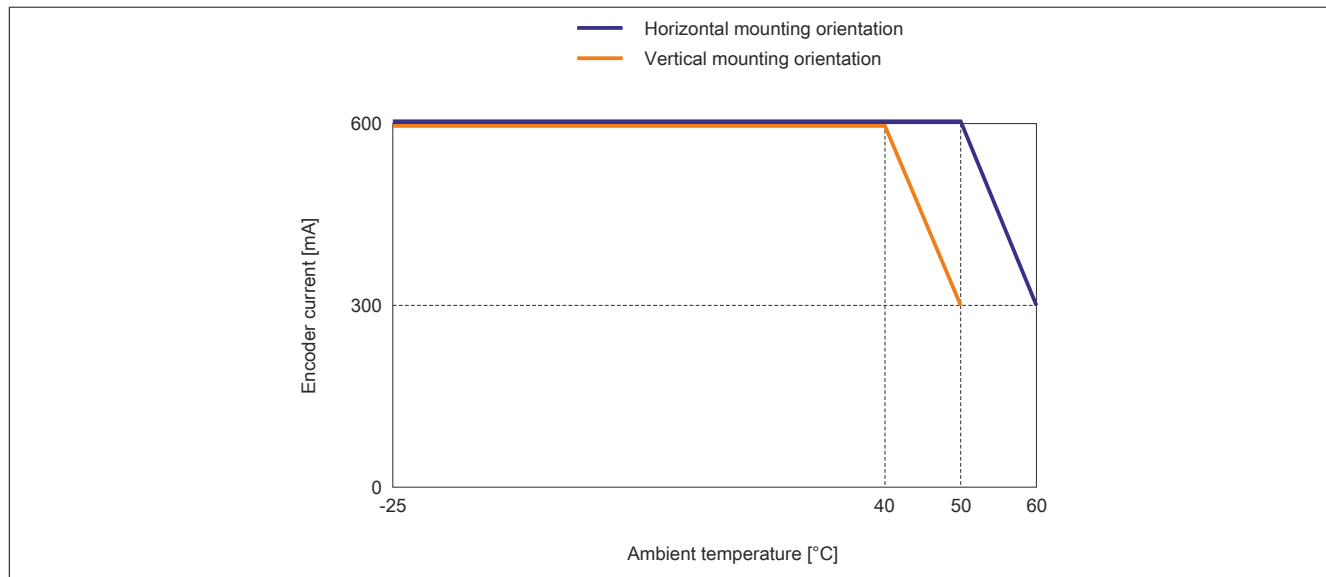
9.28.7.9 Derating and hardware configuration

To ensure proper operation, observe the points listed below:

- Derating of the encoder current
- Number of operable digital outputs
- Hardware configurations

9.28.7.9.1 Derating of the encoder current

Observe the following derating values for the encoder current depending on the mounting orientation:



9.28.7.9.2 Number of operable digital outputs

Depending on the mounting orientation, not all 4 digital outputs of the module can be operated starting at a certain ambient temperature.

Information:

To ensure operation of the module with the ambient temperatures listed below, it is absolutely necessary to disconnect channels.

Reducing the output current per channel does not increase the number of digital output channels that can be operated in the corresponding ambient temperature class.

Horizontal installation

| Ambient temperature | Number of operable digital outputs |
|---------------------|------------------------------------|
| <45°C | 4 |
| Starting at 45°C | 3 |
| Starting at 55°C | 2 |

Vertical installation

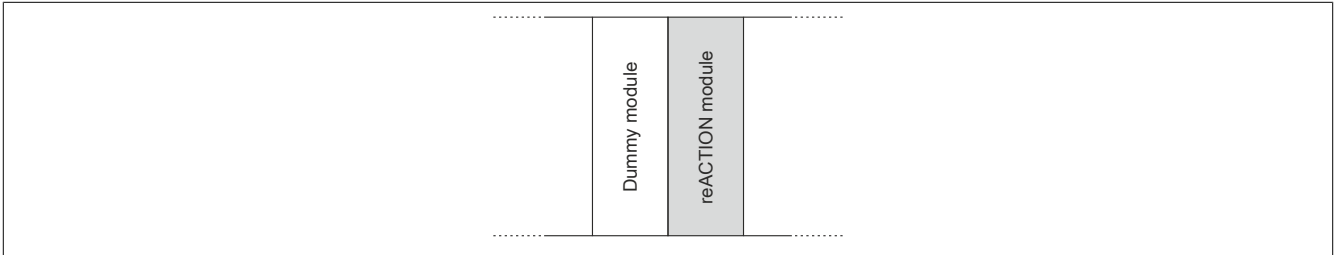
| Ambient temperature | Number of operable digital outputs |
|---------------------|------------------------------------|
| <35°C | 4 |
| Starting at 35°C | 3 |
| Starting at 45°C | 2 |

9.28.7.9.3 Hardware configuration for horizontal installation

9.28.7.9.3.1 Hardware configuration starting at an ambient temperature of 50°C

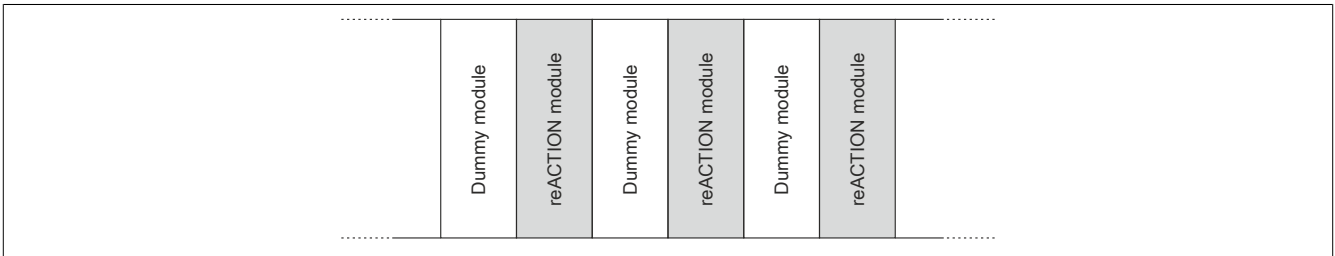
Operating a reACTION module

Starting at an ambient temperature of 50°C, a dummy module must be connected to the left of the reACTION module if installed horizontally.



Operating multiple reACTION modules side by side

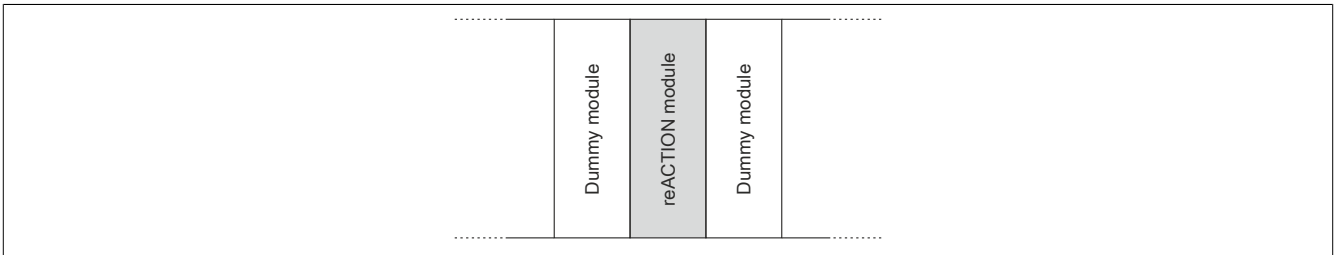
If 2 or more horizontal reACTION modules are being operated in a cluster, the following arrangement of modules must be observed.



9.28.7.9.3.2 Hardware configuration starting at an ambient temperature of 55°C

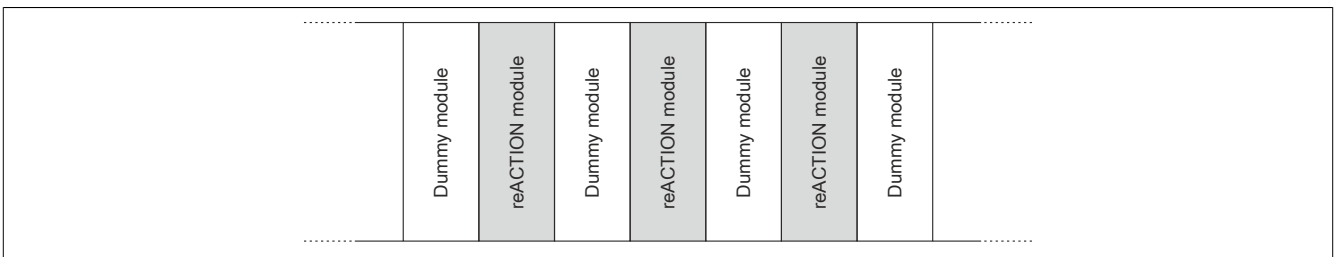
Operating a reACTION module

Starting at an ambient temperature of 55°C, a dummy module must be connected to the left and right of the reACTION module if installed horizontally.



Operating multiple reACTION modules side by side

If 2 or more horizontal reACTION modules are being operated in a cluster, the following arrangement of modules must be observed.

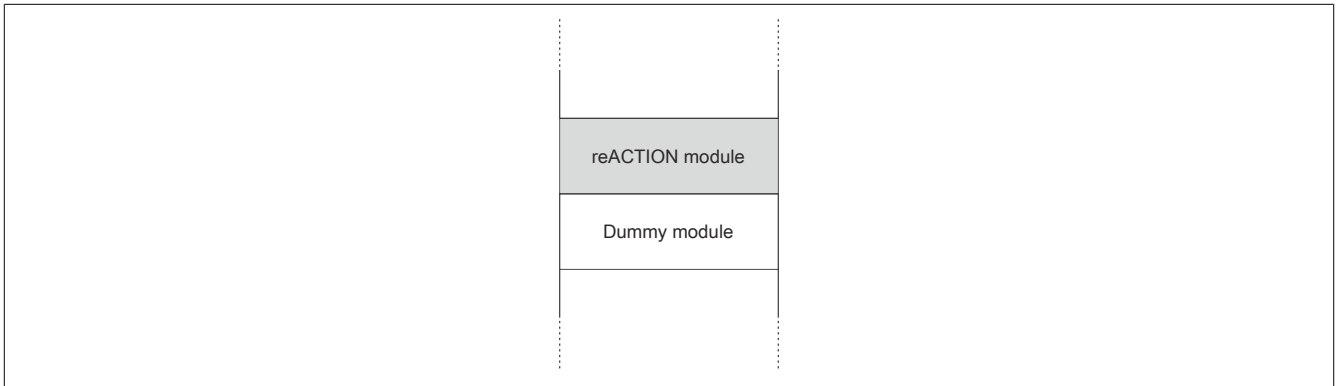


9.28.7.9.4 Hardware configuration for vertical installation

9.28.7.9.4.1 Hardware configuration starting at an ambient temperature of 40°C

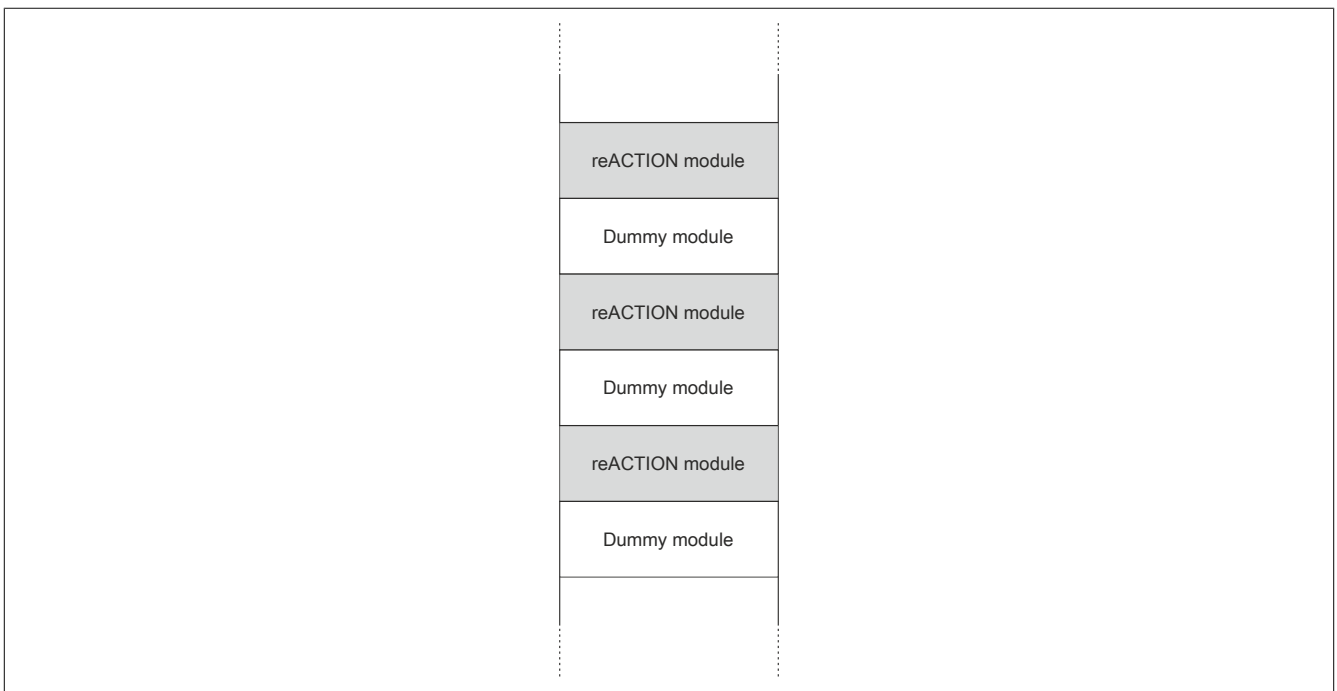
Operating a reACTION module

At ambient temperatures starting at 40°C, a dummy module must be installed below the reACTION module if installed vertically.



Operating multiple reACTION modules side by side

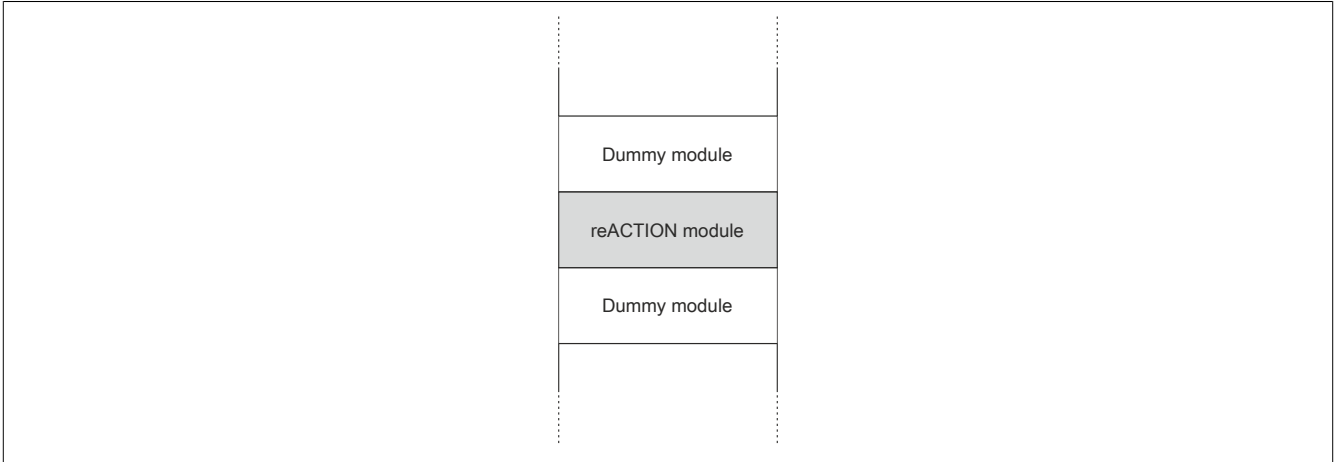
If 2 or more vertical reACTION modules are being operated in a cluster, the following arrangement of modules must be observed.



9.28.7.9.4.2 Hardware configuration starting at an ambient temperature of 45°C

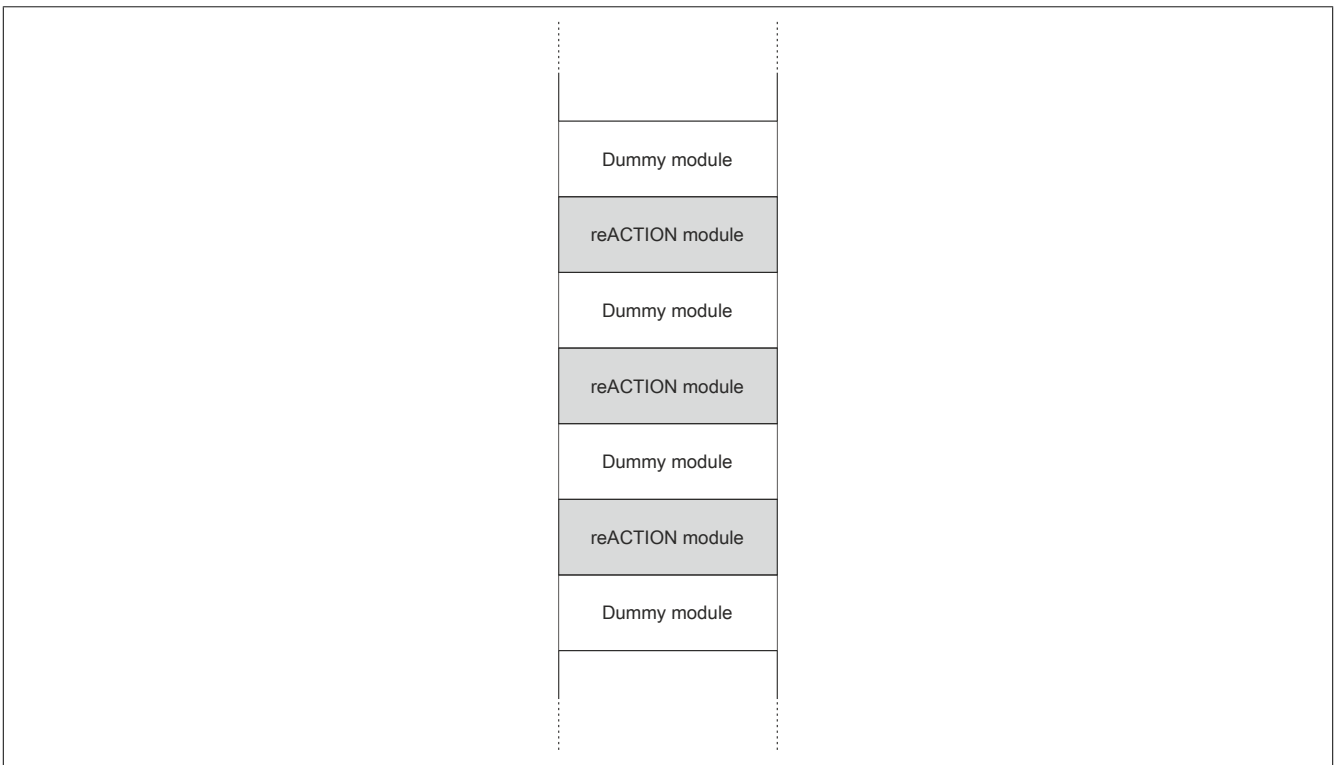
Operating a reACTION module

At ambient temperatures starting at 45°C, dummy modules must be installed above and below the reACTION module if installed vertically.



Operating multiple reACTION modules side by side

If 2 or more vertical reACTION modules are being operated in a cluster, the following arrangement of modules must be observed.



9.28.7.10 Enabling blackout mode

The following steps must be carried out to enable blackout mode.

Requirements

- reACTION program transferred to reACTION module
- Reset triggered on reACTION module:
This ensures that the program stored in the reACTION memory will be loaded with every subsequent reset.

Enabling

- Set the enable register for blackout mode.
- Control bit "RTEnable" must be set. This bit starts the reACTION engine.

Activation

- A connection error triggers a reset on the reACTION module.
- PAR and VAR data points are set to 0.
- Blackout mode is enabled on the reACTION module.

9.28.7.10.1 Blackout mode

For a description of blackout mode, see ["Blackout mode" on page 3794](#).

9.28.7.11 Register description

9.28.7.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.28.7.11.2 Function model 0 - "reACTION"

When using the "reACTION" function model, an individual reACTION program must be created for the module. This program will be executed by the reACTION module later on, not by the CPU. This allows individual machine tasks to be managed decentrally and with a very short response time.

The inputs and outputs of a reACTION module can only be operated by an enabled reACTION program. Interaction registers allow information to be exchanged between the CPU and the reACTION program in the module.

In addition to communication with the CPU, the cyclic interaction registers can also be used for "cross-mapping". In this way, inputs/outputs can also be read/controlled by external modules across the entire X2X Link or POWERLINK network.

| Register | Name | Data type | Read | | Write | |
|---------------------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module communication | | | | | | |
| 158 | ModuleStatus | UINT | | • | | |
| 162 | DigitalStatus | UINT | | • | | |
| 166 | AnalogInputStatus | UINT | | • | | |
| reACTION - Configuration | | | | | | |
| 772 | ReActionCycleTimeValue | UDINT | | | | • |
| 780 | ReActionCycleTimeMultiplier | UDINT | | | | • |
| Index * 8 + 508 | CfO_PARType01 to CfO_PARType04 | UDINT | | | | • |
| reACTION - Communication | | | | | | |
| 129 | reACTION - Control byte | USINT | | | • | |
| | RTEnable | Bit 0 | | | | |
| | RTHardwareWarningQuit | Bit 2 | | | | |
| 145 | reACTION - Status byte | USINT | • | | | |
| | RTEngineRun | Bit 0 | | | | |
| | RTCycleTimeOverrun | Bit 1 | | | | |
| | RTHardwareWarning | Bit 2 | | | | |
| | RTFileInvalid | Bit 4 | | | | |
| | RTFunctionInvalid | Bit 5 | | | | |
| | RTInstanceInvalid | Bit 6 | | | | |
| | RTFileNotLoaded | Bit 7 | | | | |
| 154 | RTCycleCounter | UINT | • | | | |
| 150 | RTCycleTime | UINT | • | | | |
| reACTION - Interaction | | | | | | |
| Index * 8 + 4095 | PAR01 to PAR32 | (U)SINT | | | • | |
| | PAR01_Bit1 to PAR32_Bit1 | Bit 0 | | | | |
| | PAR01_Bit2 to PAR32_Bit2 | Bit 1 | | | | |
| | PAR01_Bit3 to PAR32_Bit3 | Bit 2 | | | | |
| | PAR01_Bit4 to PAR32_Bit4 | Bit 3 | | | | |
| | PAR01_Bit5 to PAR32_Bit5 | Bit 4 | | | | |
| | PAR01_Bit6 to PAR32_Bit6 | Bit 5 | | | | |
| | PAR01_Bit7 to PAR32_Bit7 | Bit 6 | | | | |
| | PAR01_Bit8 to PAR32_Bit8 | Bit 7 | | | | |
| Index * 8 + 4094 | PAR01 to PAR32 | (U)INT | | | • | |
| Index * 8 + 4092 | PAR01 to PAR32 | (U)DINT | | | • | |
| Index * 8 + 5119 | RES01 to RES32 | (U)SINT | • | | | |
| | RES01_Bit1 to RES32_Bit1 | Bit 0 | | | | |
| | RES01_Bit2 to RES32_Bit2 | Bit 1 | | | | |
| | RES01_Bit3 to RES32_Bit3 | Bit 2 | | | | |
| | RES01_Bit4 to RES32_Bit4 | Bit 3 | | | | |
| | RES01_Bit5 to RES32_Bit5 | Bit 4 | | | | |
| | RES01_Bit6 to RES32_Bit6 | Bit 5 | | | | |
| | RES01_Bit7 to RES32_Bit7 | Bit 6 | | | | |
| | RES01_Bit8 to RES32_Bit8 | Bit 7 | | | | |
| Index * 8 + 5118 | RES01 to RES32 | (U)INT | • | | | |
| Index * 8 + 5116 | RES01 to RES32 | (U)DINT | • | | | |
| Index * 8 + 6140 | PVAR1 to PVAR256 | DINT | | | | • |
| Index * 8 + 6140 | RVAR1 to RVAR256 | DINT | | • | | |

| Register | Name | Data type | Read | | Write | |
|--|----------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| reACTION - Function block configuration | | | | | | |
| 1028 | CfO_Config_ABR1 | UDINT | | | | • |
| 1036 | CfO_ScalingIncrements_ABR1 | UDINT | | | | • |
| 1044 | CfO_ScalingUnits_ABR1 | UDINT | | | | • |
| 1052 | CfO_ChannelMapping1_ABR1 | UDINT | | | | • |
| 1060 | CfO_ChannelMapping2_ABR1 | UDINT | | | | • |

9.28.7.11.3 Function model 254 - "Direct I/O"

In the "Direct I/O" function model, a special reACTION program is executed in the module in order to manage the I/O. In addition, cyclic registers are used to exchange information with the CPU. This reproduces the behavior of a standard module.

| Register | Name | Data type | Read | | Write | |
|---------------------------------|---------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module communication | | | | | | |
| 129 | Status - Acknowledgment | USINT | | | • | |
| | RTHardwareWarningQuit | Bit 2 | | | | |
| 145 | Status - Composite message | USINT | • | | | |
| | RTHardwareWarning | Bit 2 | | | | |
| 159 | Status word - Module (L byte) | USINT | • | | | |
| | SensorSupplyOk_X1 | Bit 0 | | | | |
| | InternalSupplyOk_X1 | Bit 1 | | | | |
| | SensorSupplyOk_X2 | Bit 2 | | | | |
| | InternalSupplyOk_X2 | Bit 3 | | | | |
| | X1ToX2ComError | Bit 6 | | | | |
| | X2ToX1ComError | Bit 7 | | | | |
| 157 | Status word - Module (H byte) | USINT | • | | | |
| | AnalogIn01ComError | Bit 0 | | | | |
| | AnalogOut01ComError | Bit 4 | | | | |
| 163 | Status word - Digital (L byte) | USINT | • | | | |
| | DigitalOutput3Overload | Bit 2 | | | | |
| | DigitalOutput4Overload | Bit 3 | | | | |
| | DigitalOutput7Overload | Bit 6 | | | | |
| 167 | Status word - AnalogIn (L byte) | USINT | • | | | |
| | AnalogIn01Underflow | Bit 0 | | | | |
| | AnalogIn01Overflow | Bit 1 | | | | |
| | AnalogIn01OpenLoop | Bit 2 | | | | |
| Direct I/O configuration | | | | | | |
| 556 | CfO_DigitalDirection | UDINT | | | | • |
| 548 | CfO_DigitalFilter | UDINT | | | | • |
| 564 | CfO_AnalogFilter01 | UDINT | | | | • |
| 572 | CfO_LowerLimit01 | DINT | | | | • |
| 580 | CfO_UpperLimit01 | DINT | | | | • |
| Direct I/O communication | | | | | | |
| 5 | Digital outputs | USINT | | | • | |
| | DigitalOutput03 | Bit 2 | | | | |
| | DigitalOutput04 | Bit 3 | | | | |
| | DigitalOutput07 | Bit 6 | | | | |
| | DigitalOutput08 | Bit 7 | | | | |
| 1 | Digital inputs | USINT | • | | | |
| | DigitalInput01 | Bit 0 | | | | |
| | ... | ... | | | | |
| 14 | AnalogInput01 | INT | • | | | |
| 22 | AnalogOutput01 | INT | | | • | |

9.28.7.11.4 Module communication

9.28.7.11.4.1 Module status messages

Name:

ModuleStatus

This register is used to transfer general status messages for the module.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|--------------------------------------|---------------------|-------|---|
| Status word - Module (L byte) | | | |
| 0 | SensorSupplyOk_X1 | 0 | (Encoder) power supply for X1 faulty |
| | | 1 | No error |
| 1 | InternalSupplyOk_X1 | 0 | Internal voltage conversion for X1 faulty |
| | | 1 | No error |
| 2 | SensorSupplyOk_X2 | 0 | Power supply for X2 faulty |
| | | 1 | No error |
| 3 | InternalSupplyOk_X2 | 0 | Internal voltage conversion for X2 faulty |
| | | 1 | No error |
| 4 - 5 | Reserved | - | |
| 6 | X1ToX2ComError | 0 | No error |
| | | 1 | X1 → X2 communication faulty |
| 7 | X2ToX1ComError | 0 | No error |
| | | 1 | X2 → X1 communication faulty |
| Status word - Module (H byte) | | | |
| 0 | AnalogIn01ComError | 0 | No error |
| | | 1 | Value from analog input 1 faulty |
| 1 - 3 | Reserved | - | |
| 4 | AnalogOut01ComError | 0 | No error |
| | | 1 | Value from analog output 1 faulty |
| 5 - 7 | Reserved | - | |

9.28.7.11.4.2 Status messages for the digital channels

Name:

DigitalStatus

This register is used to transfer general status messages for the digital channels.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|---------------------------------------|------------------------|-------|---|
| Status word - Digital (L byte) | | | |
| 0 - 1 | Reserved | - | |
| 2 | DigitalOutput3Overload | 0 | Digital output 3 OK |
| | | 1 | Requested voltage 0 V/24 V not achieved |
| 3 | DigitalOutput4Overload | 0 | Digital output 4 OK |
| | | 1 | Requested voltage 0 V/24 V not achieved |
| 4 - 5 | Reserved | - | |
| 6 | DigitalOutput7Overload | 0 | Digital output 7 OK |
| | | 1 | Requested voltage 0 V/24 V not achieved |
| 7 | DigitalOutput8Overload | 0 | Digital output 8 OK |
| | | 1 | Requested voltage 0 V/24 V not achieved |

9.28.7.11.4.3 Status messages of the analog input

Name:

AnalogInputStatus

This register transfers general status messages of the analog input.

| Data type | Values |
|-----------|------------------------|
| UINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|--|---------------------|-------|--|
| Status word - AnalogIn (L byte) | | | |
| 0 | AnalogIn01Underflow | 0 | No error |
| | | 1 | Lower limit value from analog input 1 underrun |
| 1 | AnalogIn01Overflow | 0 | No error |
| | | 1 | Upper limit value from analog input 1 exceeded |
| 2 | AnalogIn01OpenLoop | 0 | No error |
| | | 1 | Open circuit determined on analog input 1 |
| 3 - 7 | Reserved | - | |

9.28.7.11.5 reACTION - Configuration

9.28.7.11.5.1 reACTION cycle time

Name:

ReActionCycleTimeValue

ReActionCycleTimeMultiplier

Registers "TimeValue" and "Multiplier" predefine the desired cycle time for the reACTION program. Register "TimeValue" contains the value, while register "Multiplier" contains the associated units.

Register "Multiplier" is currently permanently set to 1000 in order to predefine the cycle time with μ s precision.

| Data type | Value |
|-----------|------------|
| UDINT | 1 to 10000 |

9.28.7.11.5.2 Configuring the PAR data points

Name:

CfO_PARType01

CfO_PARType[02...04]

PAR data points can be defined for the reACTION program. To enable them, the desired data type must be made known according to the configuration in Automation Studio.

| Data type | Value |
|-----------|-------------------|
| UDINT | See bit structure |

Bit structure:

| Bit | Name | Value | Information |
|---------|-----------------|-------|-------------|
| 0 - 3 | Type01 - PAR 1 | 0000 | Inactive |
| | Type02 - PAR 9 | 0001 | USINT, BOOL |
| | Type03 - PAR 17 | | |
| | Type04 - PAR 25 | | |
| 4 - 7 | Type01 - PAR 2 | 0010 | UINT |
| | Type02 - PAR 10 | 0011 | UDINT |
| | Type03 - PAR 18 | | |
| | Type04 - PAR 26 | | |
| 8 - 11 | Type01 - PAR 3 | 0100 | Reserved |
| | Type02 - PAR 11 | 0101 | SINT |
| | Type03 - PAR 19 | | |
| | Type04 - PAR 27 | | |
| 12 - 15 | Type01 - PAR 4 | 0110 | INT |
| | Type02 - PAR 12 | 0111 | DINT |
| | Type03 - PAR 20 | | |
| | Type04 - PAR 28 | | |
| 16 - 19 | Type01 - PAR 5 | 1000 | Reserved |
| | Type02 - PAR 13 | ... | |
| | Type03 - PAR 21 | 1111 | |
| | Type04 - PAR 29 | | |
| 20 - 23 | Type01 - PAR 6 | | |
| | Type02 - PAR 14 | | |
| | Type03 - PAR 22 | | |
| | Type04 - PAR 30 | | |
| 24 - 27 | Type01 - PAR 7 | | |
| | Type02 - PAR 15 | | |
| | Type03 - PAR 23 | | |
| | Type04 - PAR 31 | | |
| 28 - 31 | Type01 - PAR 8 | | |
| | Type02 - PAR 16 | | |
| | Type03 - PAR 24 | | |
| | Type04 - PAR 32 | | |

9.28.7.11.6 reACTION - Communication

At runtime, the reACTION module program is controlled via the program sequence in the CPU. In its active state, the reACTION program is then executed independently of the program sequence in the CPU.

9.28.7.11.6.1 Controlling the reACTION module

Name:

RTEnable

RTHardwareWarningQuit

This register controls the reACTION program.

| Data type | Value |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|-----------------------|-------|--|
| 0 | RTEnable | 0 | Stops the reACTION program |
| | | 1 | Starts the reACTION program |
| 1 | Reserved | - | |
| 2 | RTHardwareWarningQuit | 0 | No effect |
| | | 1 | Acknowledges warning messages for the inputs and outputs |
| 3 - 7 | Reserved | - | |

9.28.7.11.6.2 reACTION module status messages

Name:

RTEngineRun

RTCycleTimeOverrun

RTHardwareWarning

RTFileInvalid

RTFunctionInvalid

RTInstanceInvalid

RTFileNotLoaded

This register is used to output various status messages.

| Data type | Value |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|---|-------|--|
| 0 | RTEngineRun | 0 | reACTION program inactive |
| | | 1 | reACTION program active |
| 1 | RTCycleTimeOverrun | 0 | Configured RT cycle time observed |
| | | 1 | RT cycle time set too short |
| 2 | RTHardwareWarning (group bit for acyclic status data points) | 0 | No status messages |
| | | 1 | Warning message for the inputs and outputs |
| 3 | Reserved | - | |
| 4 | RTFileInvalid (invalid RT program preloaded) | 0 | RT program in RAM OK |
| | | 1 | RT program in RAM invalid |
| 5 | RTFunctionInvalid (invalid software function) | 0 | RT program OK |
| | | 1 | RT program requesting invalid function block |
| 6 | RTInstanceInvalid (invalid hardware instance) | 0 | RT program OK |
| | | 1 | RT program requesting invalid I/O |
| 7 | RTFileNotLoaded | 0 | Valid RT program in RT engine |
| | | 1 | No RT program loaded |

9.28.7.11.6.3 Cycle counter for the active reACTION program

Name:

RTCycleCounter

Register "CycleCounter" can be used to determine how often the reACTION program has cycled.

| Data type | Value |
|-----------|------------|
| UINT | 0 to 65535 |

9.28.7.11.6.4 Minimum cycle time of the active reACTION program

Name:

RTCycleTime

Register "RTCycleTime" can be used to determine how much time the reACTION module needs to cycle through the loaded program once.

| Data type | Value |
|-----------|-------------------------|
| UINT | 0 to 65535: Units 10 ns |

9.28.7.11.7 reACTION - Interaction

After startup, the reACTION program in the module runs independently. It reads the images of the required inputs and manages its assigned outputs throughout the entire network. In addition, the reACTION program can interact with the CPU. There are 3 different data point types available for this.

9.28.7.11.7.1 PAR data points

Name:

PAR[01...32]

PAR[01...32]_Bit1

PAR[01...32]_Bit2

PAR[01...32]_Bit3

PAR[01...32]_Bit4

PAR[01...32]_Bit5

PAR[01...32]_Bit6

PAR[01...32]_Bit7

PAR[01...32]_Bit8

Once enabled, the PAR data points are transported cyclically via X2X Link. They are used to transfer information from the CPU to the reACTION program. They can be used to intervene in the execution of the reACTION program.

Information:

PAR data points DO NOT control the module's outputs directly!

| Data type | Value |
|---------------|-------------------------------|
| (U)SINT, BOOL | Corresponding range of values |
| (U)INT | |
| (U)DINT | |

| Register | Name | Data type | Read | | Write | | |
|------------------|---------------------------------|-----------------------|---------|---------|--------|---------|--|
| | | | Cyclic | Acyclic | Cyclic | Acyclic | |
| 4095 + Index * 8 | PAR01 PAR[02...32] | (U)SINT | | | • | | |
| | PAR01_Bit1 PAR[02...32]_Bit1 | Bit 0 | | | | | |
| | PAR01_Bit2 PAR[02...32]_Bit2 | Bit 1 | | | | | |
| | PAR01_Bit3 PAR[02...32]_Bit3 | Bit 2 | | | | | |
| | PAR01_Bit4 PAR[02...32]_Bit4 | Bit 3 | | | | | |
| | PAR01_Bit5 PAR[02...32]_Bit5 | Bit 4 | | | | | |
| | PAR01_Bit6 PAR[02...32]_Bit6 | Bit 5 | | | | | |
| | PAR01_Bit7 PAR[02...32]_Bit7 | Bit 6 | | | | | |
| | PAR01_Bit8 PAR[02...32]_Bit8 | Bit 7 | | | | | |
| | 4094 + Index * 8 | PAR01 PAR[02...32] | (U)INT | | | • | |
| | 4092 + Index * 8 | PAR01 PAR[02...32] | (U)DINT | | | • | |

9.28.7.11.7.2 RES data points

Name:

RES[01...32]

RES[01...32]_Bit1

RES[01...32]_Bit2

RES[01...32]_Bit3

RES[01...32]_Bit4

RES[01...32]_Bit5

RES[01...32]_Bit6

RES[01...32]_Bit7

RES[01...32]_Bit8

Once enabled, the RES data points are transported cyclically via X2X Link. They are used to transfer information from the reACTION program to the CPU.

Information:

RES data points DO NOT map the module's input directly!

| Data type | Value |
|---------------|-------------------------------|
| (U)SINT, BOOL | Corresponding range of values |
| (U)INT | |
| (U)DINT | |

| Register | Name | Data type | Read | | Write | |
|-------------------|-------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 5119 + Index * 8 | RES01 | (U)SINT | • | | | |
| | RES[02...32] | | | | | |
| | RES01_Bit1 | Bit 0 | | | | |
| | RES[02...32]_Bit1 | | | | | |
| | RES01_Bit2 | Bit 1 | | | | |
| | RES[02...32]_Bit2 | | | | | |
| | RES01_Bit3 | Bit 2 | | | | |
| | RES[02...32]_Bit3 | | | | | |
| | RES01_Bit4 | Bit 3 | | | | |
| | RES[02...32]_Bit4 | | | | | |
| | RES01_Bit5 | Bit 4 | | | | |
| | RES[02...32]_Bit5 | | | | | |
| | RES01_Bit6 | Bit 5 | | | | |
| RES[02...32]_Bit6 | | | | | | |
| RES01_Bit7 | Bit 6 | | | | | |
| RES[02...32]_Bit7 | | | | | | |
| RES01_Bit8 | Bit 7 | | | | | |
| RES[02...32]_Bit8 | | | | | | |
| 5118 + Index * 8 | RES01 | (U)INT | • | | | |
| | RES[02...32] | | | | | |
| 5116 + Index * 8 | RES01 | (U)DINT | • | | | |
| | RES[02...32] | | | | | |

9.28.7.11.7.3 PVAR and RVAR data points

Name:

PVAR[1...256]

RVAR[1...256]

In addition to PAR and RES data points, VAR data points can also be defined in the reACTION program. They are a direct component of the reACTION program and can be accessed acyclically by the CPU. Like the PAR and RES data points, the PVAR data points are used to transfer information from the CPU to the reACTION program. The RVAR data points are used to transfer feedback from the reACTION program to the CPU.

| Data type | Value |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

| Register | Name | Data type | Read | | Write | |
|------------------|------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| 6140 + Index * 8 | PVAR1 PVAR[2...256] | DINT | | | | • |
| 6140 + Index * 8 | RVAR1 RVAR[2...256] | DINT | | • | | |

9.28.7.11.8 reACTION function blocks - General

The following tables provide an overview of I/O channel assignments to reACTION function blocks.

Digital inputs/outputs

| Channel | Function block | | |
|-----------------|-----------------------|-----------|----------------------|
| | Mapping ¹⁾ | rTiDin | rTiDout, rTiDoutTime |
| X1: DI 1 | 0x00 | Channel 1 | |
| X1: DI 2 | 0x01 | Channel 2 | |
| X1: DI 3 / DO 3 | 0x02 | Channel 3 | Channel 3 |
| X1: DI 4 / DO 4 | 0x03 | Channel 4 | Channel 4 |
| X1: DI 5 | 0x04 | Channel 5 | |
| X1: DI 6 | 0x05 | Channel 6 | |
| X1: DI 7 / DO 7 | 0x06 | Channel 7 | Channel 7 |
| X1: DI 8 / DO 8 | 0x07 | Channel 8 | Channel 8 |

- 1) The "Mapping" specification is needed in the event that multiple physical inputs/outputs must be grouped together in order to be processed by a reACTION function block (e.g. rTiABRPos) (see ["reACTION function blocks - Configuration" on page 3604](#)).

Analog input

| Channel | Function block | | |
|----------|-----------------------|-----------|---------|
| | Mapping ¹⁾ | rTiAin | rTiAout |
| X2: AI 1 | 0x00 | Channel 1 | |

- 1) The "Mapping" specification is needed in the event that multiple physical inputs/outputs must be grouped together in order to be processed by a reACTION function block (e.g. rTiABRPos) (see ["reACTION function blocks - Configuration" on page 3604](#)).

Analog output

| Channel | Function block | | |
|----------|-----------------------|--------|-----------|
| | Mapping ¹⁾ | rTiAin | rTiAout |
| X2: AO 1 | 0x00 | | Channel 1 |

- 1) The "Mapping" specification is needed in the event that multiple physical inputs/outputs must be grouped together in order to be processed by a reACTION function block (e.g. rTiABRPos) (see ["reACTION function blocks - Configuration" on page 3604](#)).

9.28.7.11.9 reACTION function blocks - Configuration

Some function blocks in library AsIoRti must be configured before they can be used.

| Function block | Information |
|----------------|--|
| rtiABRPos | The module offers the option of using function block rtiABRPos once in the reACTION program. To do so, the function block must be assigned 3 digital inputs that are no longer available for rtiDin. |
| rtiABCnt | The module offers the option of using function block rtiABCnt up to 3 times in the reACTION program. To do so, the function blocks must be assigned 2 digital inputs as an A or B track that are no longer available for rtiDin. In addition, an external event can be defined for each rtiABCnt function block. The input used for this is also no longer available for rtiDin. |

Table 618: List of function blocks requiring prior configuration

9.28.7.11.9.1 Function blocks rtiABRPos and rtiABCnt

Function blocks rtiABRPos and rtiABCnt can be used to process the position value of an ABR incremental encoder in a reACTION task. Several hardware channels of the module are used for this. The incoming signals are interpreted by the reACTION engine and converted into a location.

The update rate depends on both the reACTION engine and the hardware used. The reACTION engine is basically able to calculate positions with an update rate of up to 8 MHz. The input frequencies of the hardware inputs can be taken from the technical data of the respective module.

These function blocks can be used separately or in combination.

Using function block rtiABRPos

The following points are important to keep in mind when using function block rtiABRPos in a reACTION program:

- The function block can only be used once in a reACTION program.
- 3 digital inputs must be defined on the module for input signals A, B and R.
- In addition, a digital input of the module can be defined as an event input.

Example diagram of input signals:

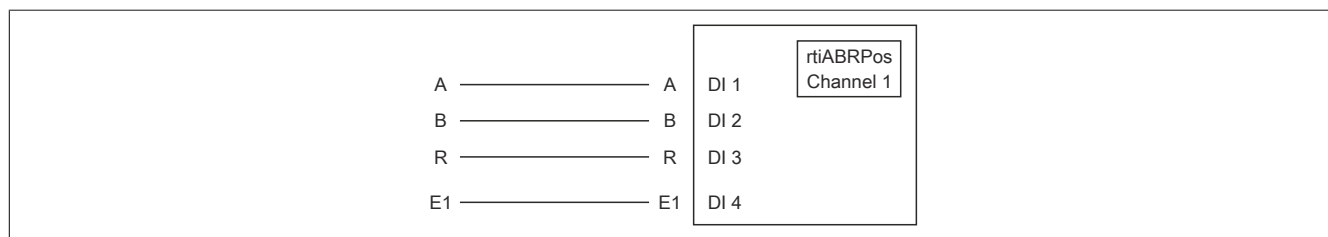


Figure 363: Schematic diagram of input signals for rtiABRPos

Using function block rtiABCnt

The following points must be taken into account when using function block rtiABCnt in a reACTION program:

- The function block can be used up to 3 times in a reACTION program.
- 2 digital inputs must be defined on the module for input signals A and B.
- In addition, up to 3 digital inputs on the module can be defined as event inputs E1, E2 and E3.

Example diagram of input signals:

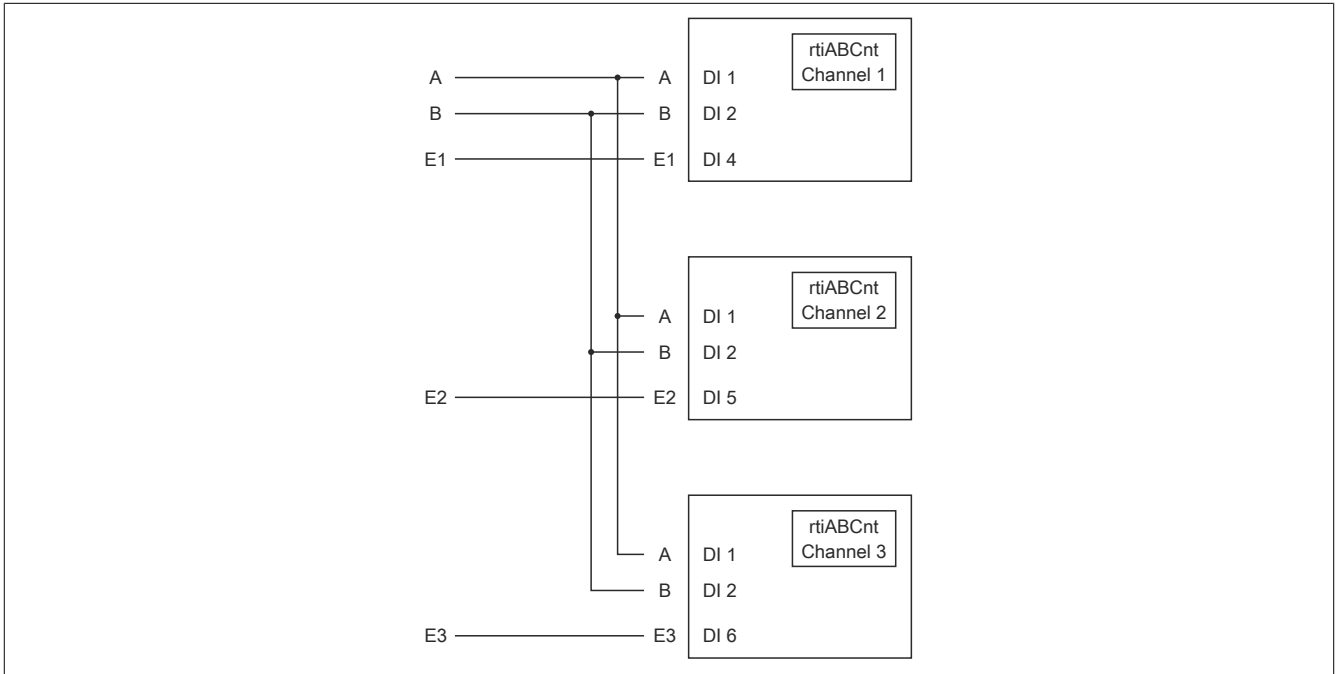


Figure 364: Schematic diagram of input signals for rtiABCnt

Using function blocks rtiABRPos and rtiABCnt in combination

The following points should be kept in mind when using function blocks rtiABRPos and rtiABCnt together in a reACTION program.

- Function block rtiABRPos can only be used once in a reACTION program.
- Function block rtiABCnt can be used up to 2 times in a reACTION program.
- 3 digital inputs must be defined for input signals A, B and R (rtiABRPos).
- The same digital inputs are used for input signals A and B (rtiABCnt).
- In addition, up to 3 event inputs E1, E2 and E3 can be defined (rtiABCnt).
- E1 is used for the event input (rtiABRPos).

Example diagram of input signals:

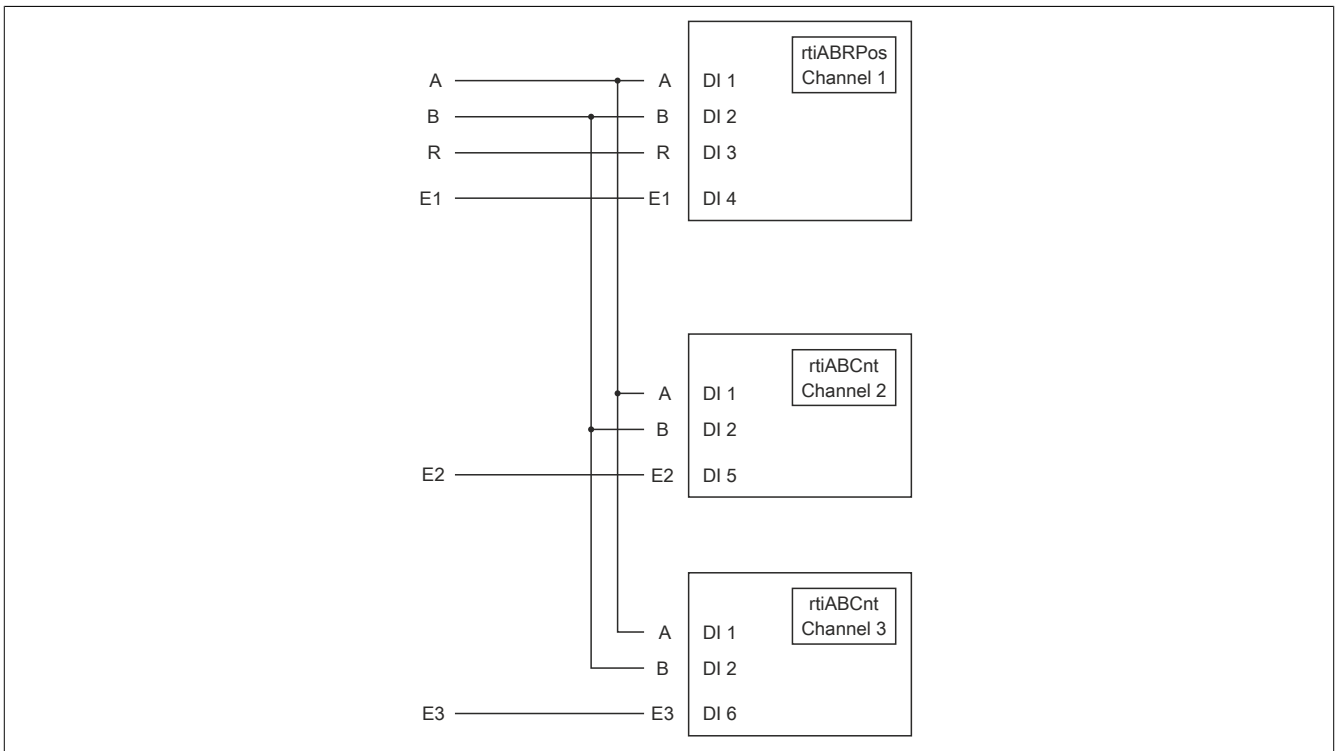


Figure 365: Diagram of input signals when using rtiABRPos and rtiABCnt at the same time

Registering the position encoder (rtiABRPos/rtiABCnt)

Name:

CfO_Config_ABR1

This register specifies the technical characteristics of the connected ABR incremental encoder.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|---------|--|------------|---|
| 0 - 15 | Increments per revolution | 0 to 65535 | Reference pulse monitoring: If the reference pulse is different than defined here, this is indicated on the status output of function block rtiABRPos. |
| 16 | Inversion of the counting direction set by signals A and B | 0 | Positive counting direction |
| | | 1 | Negative counting direction |
| 17 - 31 | Reserved | 0 | |

Wiring the position encoder (rtiABRPos/rtiABCnt)

Name:

CfO_ChannelMapping1_ABR1

CfO_ChannelMapping2_ABR1

Before function blocks rtiABRPos/rtiABCnt can be processed by the reACTION engine, the hardware inputs to be used by the ABR incremental encoder must be defined on the module. The "ChannelMapping" registers specify which inputs are interpreted as the A, B, R, E1, E2 and E3 signals.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure of CfO_ChannelMapping1_ABR1:

| Bit | Description | Value | Information |
|---------|-------------|----------|---------------------------------------|
| 0 - 7 | Input E1 | 0 | Mapped to digital input 1 |
| | | 1 | Mapped to digital input 2 |
| | | ... | ... |
| | | 7 | Mapped to digital input 8 |
| | | 8 to 255 | Reserved |
| 8 - 15 | Input R | 0 to 255 | For possible values, see bits 0 to 7. |
| 16 - 23 | Input B | 0 to 255 | For possible values, see bits 0 to 7. |
| 24 - 31 | Input A | 0 to 255 | For possible values, see bits 0 to 7. |

Bit structure of CfO_ChannelMapping2_ABR1:

| Bit | Description | Value | Information |
|---------|-------------|----------|---|
| 0 - 15 | Reserved | 0 | |
| 16 - 23 | Input E3 | 0 | Mapped to digital input 1 |
| | | 1 | Mapped to digital input 2 |
| | | ... | ... |
| | | 7 | Mapped to digital input 8 |
| | | 8 to 255 | Reserved |
| 24 - 31 | Input E2 | 0 to 255 | For possible values, see bits 16 to 23. |

Information:

For information about the relationship between the input on the module and the channel name, see section "reACTION function blocks - General".

Scaling the position encoder (rtiABRPos)

Name:

CfO_ScalingUnits_ABR1

CfO_ScalingIncrements_ABR1

An optional gear ratio can be configured using registers "Units" and "Increments". The dividend for scaling is defined in register "Units"; the divisor is defined in register "Increments".

| Data type | Value | Information |
|-----------|--------------------|--|
| UDINT | 0 to 4,294,967,295 | CfO_ScalingUnits_ABR1: Units per interval CfO_ScalingIncrements_ABR1: Increments per interval |

Formula for calculation

$$\text{Gear ratio} = \text{ScalingUnits} / \text{ScalingIncrements}$$
Example 1

ScalingUnits = 1

ScalingIncrements = 1

$$\text{Position value (Pos)} = \text{ABR increments} * \text{ScalingUnits} / \text{ScalingIncrements}$$

$$\text{Position value (Pos)} = \text{ABR increments} * 1/1$$

In this example, the ABR position value is output unchanged on output "Pos".

Example 2

ScalingUnits = 10

ScalingIncrements = 4

$$\text{Position value (Pos)} = \text{ABR increments} * \text{ScalingUnits} / \text{ScalingIncrements}$$

$$\text{Position value (Pos)} = \text{ABR increments} * 10/4$$

In this example, the ABR position value is multiplied by 2.5 and output on output "Pos".

Information:

The encoder values are calculated internally as INT64 values in 32.32 format. On output "Pos" of function block "rtiABRPos", only the whole number value (INT32) is output for the user. The fixed point decimal places are used internally to calculate a higher resolution.

9.28.7.11.10 Direct I/O configuration

This module is equipped with 8 digital channels, 1 analog input and 1 analog output. In the "Direct I/O" function model, behavior is based on that of a standard module. The I/O channels are managed by an extremely simplified reACTION program. The function model primarily serves to check that the I/O channels are functioning properly.

9.28.7.11.10.1 Direction of digital channels

Name:

CfO_DigitalDirection

This register determines the signal direction of digital channels 3, 4, 7 and 8.

| Data type | Values |
|-----------|------------------------|
| UDINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|-------------------------------|-------|-------------|
| 0 - 1 | Reserved | 0 | |
| 2 | Direction - Digital channel 3 | 0 | Input |
| | | 1 | Output |
| 3 | Direction - Digital channel 4 | 0 | Input |
| | | 1 | Output |
| 4 - 5 | Reserved | 0 | |
| 6 | Direction - Digital channel 7 | 0 | Input |
| | | 1 | Output |
| 7 | Direction - Digital channel 8 | 0 | Input |
| | | 1 | Output |

9.28.7.11.10.2 Filtering digital channels

Name:

CfO_DigitalFilter

This register defines the filter time of the digital channels. The filter value affects both the switching delay as well as the immunity of the channels.

| Data type | Value |
|-----------|--------------------------|
| UDINT | 0 to 500000: Units 10 ns |

9.28.7.11.10.3 Filter of the analog input

Name:

CfO_AnalogFilter01

This register sets the filter level of the analog input.

| Data type | Value |
|-----------|--------|
| UDINT | 0 to 7 |

$$2^{\text{AnalogFilter}} = \text{FilterLevel} = \frac{\text{Out(ADC)}_t - \text{Out(Filter)}_{t-1}}{\text{Out(Filter)}_t - \text{Out(Filter)}_{t-1}} \cong \frac{\Delta\text{Out(ADC)}}{\Delta\text{Out(Filter)}}$$

The filter level results as the exponent to base 2 and corresponds to the ratio of the change of the digitalized input value to the change of the filtered analog value.

9.28.7.11.10.4 Limit values of the analog input

Name:

CfO_LowerLimit01

CfO_UpperLimit01

These registers define the upper and lower user-specific limit values for the analog input.

| Data type | Value |
|-----------|---|
| DINT | LowerLimit: -32767 to 32767 (default: -32767) |
| | UpperLimit: -32767 to 32767 (default: 32767) |

9.28.7.11.11 Direct I/O communication

This module is equipped with the following inputs and outputs:

- 4 digital inputs (sink) for 24 VDC
- 4 digital channels configurable as inputs (sink) or outputs (sink or source) for 24 VDC
- 1 analog input of type ± 10 V
- 1 analog output of type ± 10 V

9.28.7.11.11.1 Digital outputs

Name:

DigitalOutput03

DigitalOutput04

DigitalOutput07

DigitalOutput08

This register is used to predefine the value that should be output on the digital output.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|-----------------|-------|-------------|
| 0 - 1 | Reserved | 0 | |
| 2 | DigitalOutput03 | 0 | FALSE |
| | | 1 | TRUE |
| 3 | DigitalOutput04 | 0 | FALSE |
| | | 1 | TRUE |
| 4 - 5 | Reserved | 0 | |
| 6 | DigitalOutput07 | 0 | FALSE |
| | | 1 | TRUE |
| 7 | DigitalOutput08 | 0 | FALSE |
| | | 1 | TRUE |

9.28.7.11.11.2 Digital inputs

Name:

DigitalInput01

DigitalInput02

DigitalInput03

DigitalInput04

DigitalInput05

DigitalInput06

DigitalInput07

DigitalInput08

This register indicates the value read for the respective digital input.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|----------------|-------|-------------|
| 0 | DigitalInput01 | 0 | FALSE |
| | | 1 | TRUE |
| 1 | DigitalInput02 | 0 | FALSE |
| | | 1 | TRUE |
| 2 | DigitalInput03 | 0 | FALSE |
| | | 1 | TRUE |
| 3 | DigitalInput04 | 0 | FALSE |
| | | 1 | TRUE |
| 4 | DigitalInput05 | 0 | FALSE |
| | | 1 | TRUE |
| 5 | DigitalInput06 | 0 | FALSE |
| | | 1 | TRUE |
| 6 | DigitalInput07 | 0 | FALSE |
| | | 1 | TRUE |
| 7 | DigitalInput08 | 0 | FALSE |
| | | 1 | TRUE |

9.28.7.11.11.3 Analog input

Name:

AnalogInput01

The analog input value is mapped in this register.

| Data type | Value |
|-----------|-----------------|
| INT | -32767 to 32767 |

9.28.7.11.11.4 Analog output

Name:

AnalogOutput01

This register defines the value for the analog output.

| Data type | Values |
|-----------|-----------------|
| INT | -32767 to 32767 |

9.28.7.11.12 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μ s |

9.28.7.11.13 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 200 μ s |

9.29 Redundancy system

Redundant network cabling is often essential to safe operation, especially in processing plants. The potential for danger, especially to the lines that run through the plant, can be disproportionately high in relation to the need to keep communication active in all operating situations. Redundant cabling and separate cable routing are effective ways to help reduce this risk.

POWERLINK cable redundancy is based on the principle of doubling the communication lines as well as providing continuous and simultaneous monitoring. A mechanism feeds data simultaneously into two cable lines. The same mechanisms are used to receive this data from the redundant network.

The following modules can be used to set up a POWERLINK network with cable redundancy:

- X20IF2181-2 interface module
- X20HB8884 compact link selector
- X20BC8084 bus controller

9.29.1 Summary

| Model number | Short description | Page |
|--------------|--|------|
| X20HB8884 | X20 compact link selector, 2x RJ45, order bus base, power supply module and terminal block separately. | 3614 |
| X20cHB8884 | X20 compact link selector, coated, 2x RJ45, order bus base, power supply module and terminal block separately. | 3614 |

9.29.2 X20(c)HB8884

Data sheet version: 2.24

9.29.2.1 General information

POWERLINK is a standard protocol for Fast Ethernet with hard real-time properties. The Ethernet POWERLINK Standardization Group (EPSSG) ensures that the standard remains open and is continually developed. www.ether-net-powerlink.org

Systems with redundant cabling can be implemented easily using POWERLINK. Unlike ring redundancy, cable redundancy does not require cable looping, which can sometimes be problematic. This allows the creation of all types of tree structures. When using a device with the link selector function, data is always transferred via the highest quality network lines. The link selector function is integrated in the module compact link selector. This makes it easy to connect any POWERLINK device to a redundant POWERLINK network.

- Connecting POWERLINK devices to the POWERLINK cable redundancy system
- Integrated compact link selector function

9.29.2.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.29.2.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.29.2.3 Order data

| Model number | Short description | Figure |
|--------------|--|---|
| | X20 redundancy systems |  |
| X20HB8884 | X20 compact link selector, 2x RJ45, order bus base, power supply module and terminal block separately. | |
| X20cHB8884 | X20 compact link selector, coated, 2x RJ45, order bus base, power supply module and terminal block separately. | |
| | Required accessories | |
| | System modules for X20 redundancy system | |
| X20HB2885 | X20 hub expansion module, integrated active 2-port hub, 2x RJ45 | |
| X20cHB2885 | X20 hub expansion module, coated, integrated active 2-port hub, 2x RJ45 | |
| | System modules for expandable bus controllers | |
| X20BB81 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with one expansion slot for an X20 add-on module (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20BB82 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with 2 expansion slots for 2 X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cBB81 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with one expansion slot for an X20 add-on module (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cBB82 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with two expansion slots for two X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| | System modules for the X20 hub system | |
| X20HB2880 | X20 hub expansion module, integrated 2-port hub, 2x RJ45 | |
| X20PS8002 | X20 power supply module for standalone hub and compact link selector | |
| X20cHB2880 | X20 hub expansion module, coated, integrated 2-port hub, 2x RJ45 | |
| X20cPS8002 | X20 power supply module, coated, for standalone hub and compact link selector | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 619: X20HB8884, X20cHB8884 - Order data

9.29.2.4 Technical data

| Model number | X20HB8884 | X20cHB8884 |
|--|--|------------------------|
| Short description | | |
| POWERLINK compact link selector | Connects POWERLINK devices to a redundant POWERLINK network | |
| General information | | |
| Status indicators | Module status, bus function | |
| Diagnostics | | |
| Module status | Yes, using status LED | |
| Bus function | Yes, using status LED | |
| Power consumption | 2 W | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Interfaces | | |
| Type | POWERLINK compact link selector | |
| Variant | 2x shielded RJ45 | |
| Cable length | Max. 100 m between 2 stations (segment length) | |
| Transfer rate | 100 Mbit/s | |
| Transfer | | |
| Physical layer | 100BASE-TX | |
| Half-duplex | Yes | |
| Full-duplex | No | |
| Autonegotiation | Yes | |
| Auto-MDI/MDIX | Yes | |
| Hub propagation delay | 0.96 to 1 µs | |
| Electrical properties | | |
| Electrical isolation | Power supply isolated from POWERLINK (IF1 and IF2) | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |

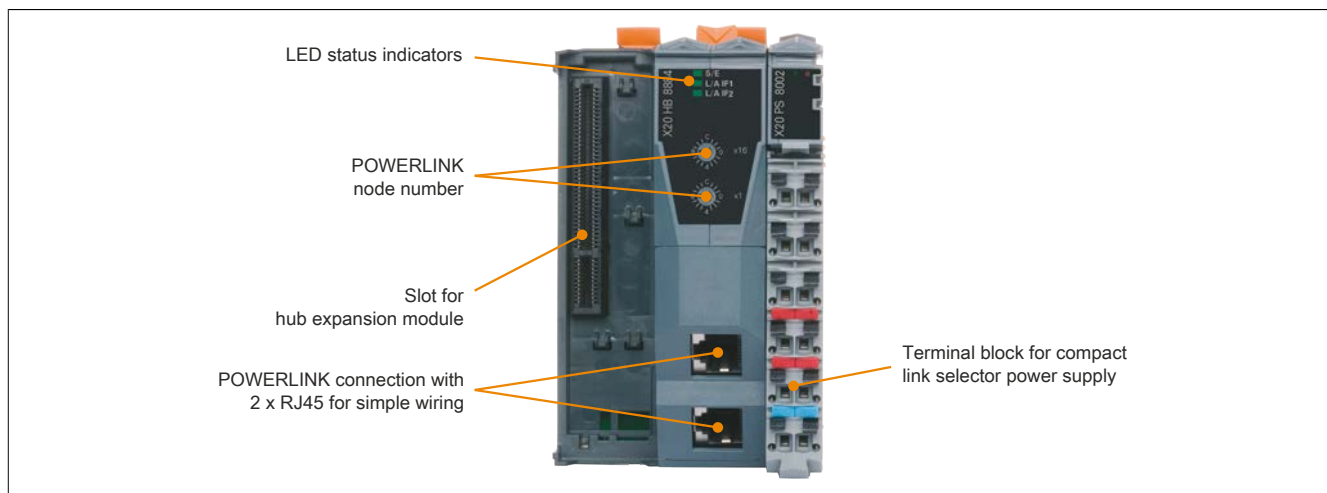
Table 620: X20HB8884, X20cHB8884 - Technical data

| Model number | X20HB8884 | X20cHB8884 |
|------------------------------|---|--|
| Mechanical properties | | |
| Note | Order 1x terminal block X20TB12 separately Order 1x power supply module X20PS8002 separately Order 1x hub expansion module X20HB2880 or 2x hub expansion module X20HB2885 separately Order 1x bus base X20BB81 or X20BB82 separately | Order 1x terminal block X20TB12 separately Order 1x power supply module X20cPS8002 separately Order 1x hub expansion module X20cHB2880 or 2x hub expansion module X20cHB2885 separately Order 1x bus base X20cBB81 or X20cBB82 separately |
| Pitch ¹⁾ | | |
| X20BB81 | | 62.5 ^{+0.2} mm |
| X20BB82 | | 87.5 ^{+0.2} mm |

Table 620: X20HB8884, X20cHB8884 - Technical data

1) Spacing is based on the width of bus base X20BB81 or X20BB82. 1 X20HB2880 hub expansion module or 2 X20HB2885 hub expansion modules and 1 X20PS8002 power supply module are also always required for the compact link selector.

9.29.2.5 Operating and connection elements



9.29.2.5.1 LED status indicators

| Figure | LED | Color | Status | Description |
|--------|-------------------|-------|--------------|--|
| | S/E ¹⁾ | Green | On | An active POWERLINK network was detected on both networks. |
| | | Red | Single flash | Network 2 is active. Disturbances detected on network 1 or there is no POWERLINK network active. |
| | | Red | Double flash | Network 1 is active. Disturbances detected on network 2 or there is no POWERLINK network active. |
| | | Red | On | Failure of both networks. |
| | L/A IFx | Green | Blinking | A link to the peer station has been established. The LED blinks when Ethernet activity is taking place on the bus. |
| | | | On | A link to the remote station has been established. |

1) The Status/Error LED is a green/red dual LED.

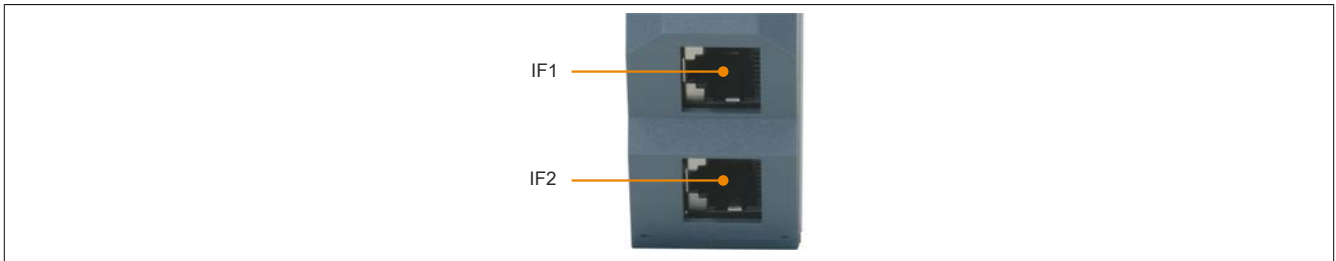
9.29.2.5.2 POWERLINK node numbers

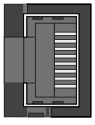


The number switches have no function during operation. They are only used for product testing.

9.29.2.5.3 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see "Cabling guidelines for X20 modules with an Ethernet cable" on page 58.



| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.29.2.6 POWERLINK cable redundancy system

It is often indispensable to have redundant network cabling, especially in systems that handle technical processes. The potential for danger, especially to the lines that run through the system, is disproportionately high in relation to the need to keep communication active in all operating situations. This risk is effectively reduced with double cabling that is routed separately.

The POWERLINK cable redundancy system is based on the principle of doubling the transfer routing as well as providing continual and simultaneous monitoring. That means data is simultaneously fed into two cable lines using a corresponding mechanism. The same mechanisms are used to receive these telegrams from the redundant network.

Information:

Details about the structure of a redundancy system can be found in the "Redundancy for control systems" user's manual. The user's manual is available in the Downloads section of the B&R website www.br-automation.com.

9.30 System modules for the X20 hub system

The X20 hub system has a modular structure. In addition to the basis modules, the following system modules are also required,

- Bus base
- Hub expansion module(s)
- Power supply module for standalone hub

9.30.1 Summary

| Model number | Short description | Page |
|--------------|--|------|
| X20HB1881 | X20 hub expansion module, integrated 1-port hub, for multimode fiber optic cable | 3619 |
| X20HB1882 | X20 hub expansion module, integrated 1-port hub, for monomode fiber optic cables | 3623 |
| X20HB2880 | X20 hub expansion module, integrated 2-port hub, 2x RJ45 | 3627 |
| X20HB2881 | X20 hub expansion module, integrated 2-port hub, for fiber optic cable | 3632 |
| X20PS8002 | X20 power supply module for standalone hub and compact link selector | 3636 |
| X20cHB1881 | X20 hub expansion module, coated, integrated 1-port hub, for fiber optic cable | 3619 |
| X20cHB2880 | X20 hub expansion module, coated, integrated 2-port hub, 2x RJ45 | 3627 |
| X20cHB2881 | X20 hub expansion module, coated, integrated 2-port hub, for fiber optic cable | 3632 |
| X20cPS8002 | X20 power supply module, coated, for standalone hub and compact link selector | 3636 |

9.30.2 X20(c)HB1881

Data sheet version: 1.41

9.30.2.1 General information

The POWERLINK bus controllers X20BC8083, X20BC8084 (revision D0 or higher) and the stand-alone hub X20H-B8880 are equipped with a modular hub expansion. An additional 1 or 2 slots are available, depending on the bus base used. The X20HB1881 hub expansion module can be operated in these slots. Note that the hardware revision of the X20BC8083 and the X20HB8880 must be \geq F0.

The hub expansion module is a 1x hub. The Ethernet connection is made using 62.5/125 μ m or 50/125 μ m fiber optic multimode cable with a duplex LC connection. The module and network status is indicated using LEDs.

- Hub expansion module
- 1x hub 100 BASE-FX
- Hot-swap-capable

Information:

This module is not suitable for POWERLINK ring redundancy applications.

9.30.2.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.30.2.3 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | System modules for the X20 hub system | |
| X20HB1881 | X20 hub expansion module, integrated 1-port hub, for multimode fiber optic cable |  |
| X20cHB1881 | X20 hub expansion module, coated, integrated 1-port hub, for fiber optic cable | |

Table 621: X20HB1881, X20cHB1881 - Order data

9.30.2.4 Technical data

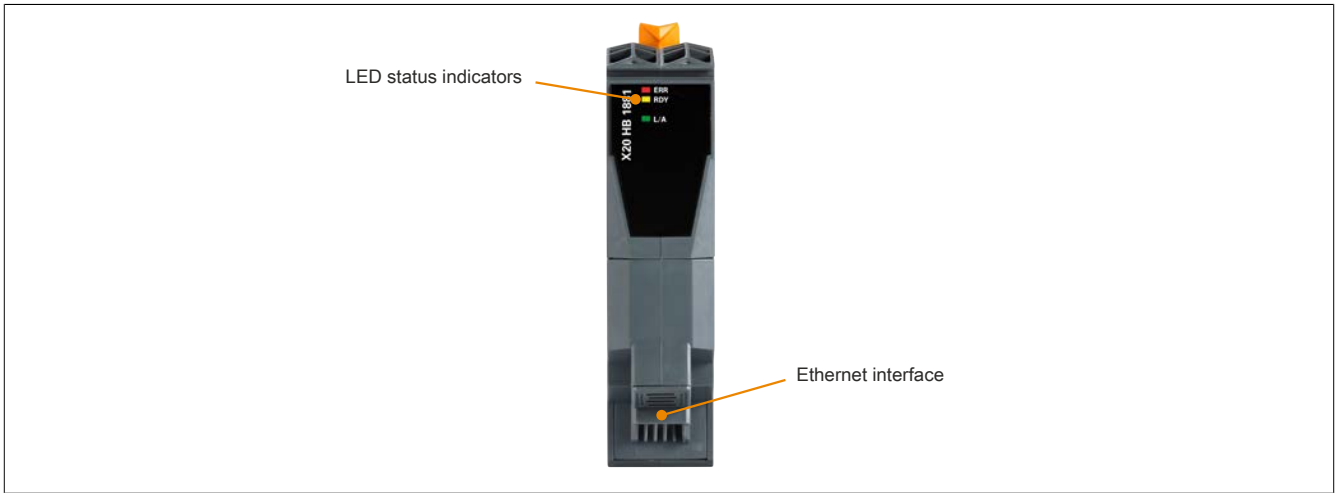
| Model number | X20HB1881 | X20cHB1881 |
|--|---|--|
| Short description | | |
| Hub | 1 Fast Ethernet interface for fiber optic cable for hub expansion | |
| General information | | |
| Status indicators | Module status, bus function | |
| Diagnostics | | |
| Module status | Yes, using status LED | |
| Bus function | Yes, using status LED | |
| Power consumption | 1.45 W (Rev. <D0: 1.65 W) | 1.45 W |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| EAC | Yes | |
| KC | Yes | - |
| Interfaces | | |
| Type | Hub expansion module | |
| Variant | 1x duplex LC female | |
| Transfer rate | 100 Mbit/s | |
| Transfer | | |
| Physical layer | 100BASE-FX | |
| Half-duplex | Yes | |
| Full-duplex | No | |
| Autonegotiation | No | |
| Auto-MDI/MDIX | No | |
| Hub propagation delay | 0.96 to 1 µs | |
| Wave length | Typ. 1300 nm Rx range: 1270 to 1380 nm Tx range: 1270 to 1380 nm | |
| Cable fiber type | Multimode fiber with 62.5/125 µm or 50/125 µm core diameter On both sides: Duplex LC male connector | |
| Optical power budget | | |
| Glass fiber 62.5/125 µm, NA = 0.275 | 11 dB | |
| Glass fiber 50/125 µm, NA = 0.200 | 7.5 dB | |
| Cable length | | |
| Half-duplex | Max. 175 m between 2 stations (segment length) | |
| POWERLINK | Max. 2 km between 2 stations (segment length) | |
| Electrical properties | | |
| Electrical isolation | Power supply isolated from Ethernet | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | | |
| - | | |
| Storage | | |
| -40 to 85°C | | |
| Transport | | |
| -40 to 85°C | | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Slot | Hub expansion for X20BC8083, X20BC8084 and X20HB8880 ¹⁾ | Hub expansion for X20BC8084 and X20cHB8880 ²⁾ |

Table 622: X20HB1881, X20cHB1881 - Technical data

1) The hardware revision of X20BC8083 and X20HB8880 must be ≥F0 and the hardware revision of X20BC8084 must be ≥D0.

2) The hardware revision of X20cHB8880 must be ≥F0 and the hardware revision of X20BC8084 must be ≥D0.

9.30.2.5 Operating and connection elements



9.30.2.5.1 LED status indicators

| Figure | LED | Color | Status | Description |
|--------|-----|--------|----------|--|
| | ERR | Red | On | Slot not detected |
| | RDY | Orange | On | Slot detected, module active |
| | L/A | Green | On | The link to the remote station is established. |
| | | | Blinking | The link to the remote station is established. The LED blinks if Ethernet activity is taking place on the bus. |

9.30.2.5.2 Ethernet interface

| Figure | Description |
|--------|------------------------------|
| | 100BASE-FX, female duplex LC |

9.30.2.5.2.1 Wiring guidelines for X20 modules with fiber optic cable

The following wiring guidelines must be observed:

- Cable fiber type: Multimode fiber with 62.5/125 µm or 50/125 µm core diameter
- On both sides: Duplex LC male connector
- Observe minimum cable flex radius (see data sheet for the cable)

9.30.2.6 Network size and collision detection

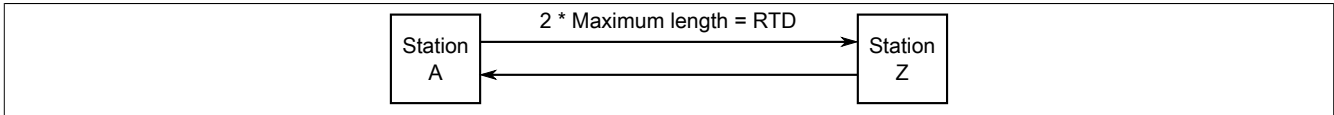
Information:

This section applies to the use of Ethernet networks, not POWERLINK networks.

According to Ethernet specification IEEE 802.3, the transmission duration of a frame of minimum length must always be greater than the round-trip delay time (RTD). RTD is the time needed by a data packet to travel from one end of the network to the other.

If this is not observed, collision detection can no longer be guaranteed.

Illustration of RTD



When using fiber optic cables, the default maximum size is 175 m. Since there are often different devices in a network using different PHYs, the propagation delay of the frames changes since each PHY has different latency. This also affects the network size, and collision detection can no longer be guaranteed at 175 m.

For this reason, it is necessary to re-check whether the transmission duration of a frame of minimum length is actually greater than the maximum RTD.

Example for calculating network size

- Transfer rate: 100 Mbit/s
- Length of the fiber optic cable: 175 m
- Number of hubs: 2
- Hub propagation delay of a frame: 1 μ s
- Minimum frame size in the Ethernet network: 72 bytes

Calculation procedure

| | |
|--|--|
| 1. How long does 1 byte need at 100 Mbit/s – 100 Mbit/s / 8 = 12.5 MB/s | $\frac{12,500,000}{1} = \frac{1}{x}$ $x = \frac{1s}{12,500,000} = 80ns$ |
| 2. Propagation delay of minimum Ethernet frame – Minimum frame in Ethernet network: 72 bytes | $72 * 80ns = 5.76\mu s$ |
| 3. Propagation delay in cable and hub (100 m cable = 0.5 μ s) – 175 m cable = 1.75 x 0.5 μ s – 2 hubs = 2 x 1 μ s | $\frac{175}{100}m * 0.5\mu s + 2\mu s = 2.875\mu s$ |
| 4. Calculation of total propagation delay – Outbound/Inbound propagation delay | $2.875\mu s * 2 = 5.75\mu s$ |

Result

Collision detection is possible since the total time of 5.75 μ s is less than the minimum Ethernet propagation delay of 5.76 μ s.

With a longer cable or device with different latency, collision detection would no longer exist.

9.30.3 X20HB1882

Data sheet version: 1.03

9.30.3.1 General information

POWERLINK bus controllers X20BC8083 and X20BC8084 (revision D0 and later) and standalone hub X20HB8880 are equipped with a modular hub expansion. An additional 1 or 2 slots are available depending on the bus base being used. Hub expansion module X20HB1882 can be operated in these slots. Note that the hardware revision of the X20BC8083 and X20HB8880 must be \geq F0.

The hub expansion module is designed as a 1-port hub. The Ethernet connection is made using 9/125 μ m single-mode glass fiber cables with a duplex LC connector. The module state and network status are indicated using LEDs.

- Hub expansion module
- 1-port hub, 100BASE-FX
- Single-mode glass fiber cables
- Range up to 50 km
- Hot-swappable

Information:

This module is not suitable for POWERLINK ring redundancy applications.

9.30.3.2 Order data


| Model number | Short description | Figure |
|--------------|--|--|
| | System modules for the X20 hub system | |
| X20HB1882 | X20 hub expansion module, integrated 1-port hub, for monomode fiber optic cables |  |

Table 623: X20HB1882 - Order data

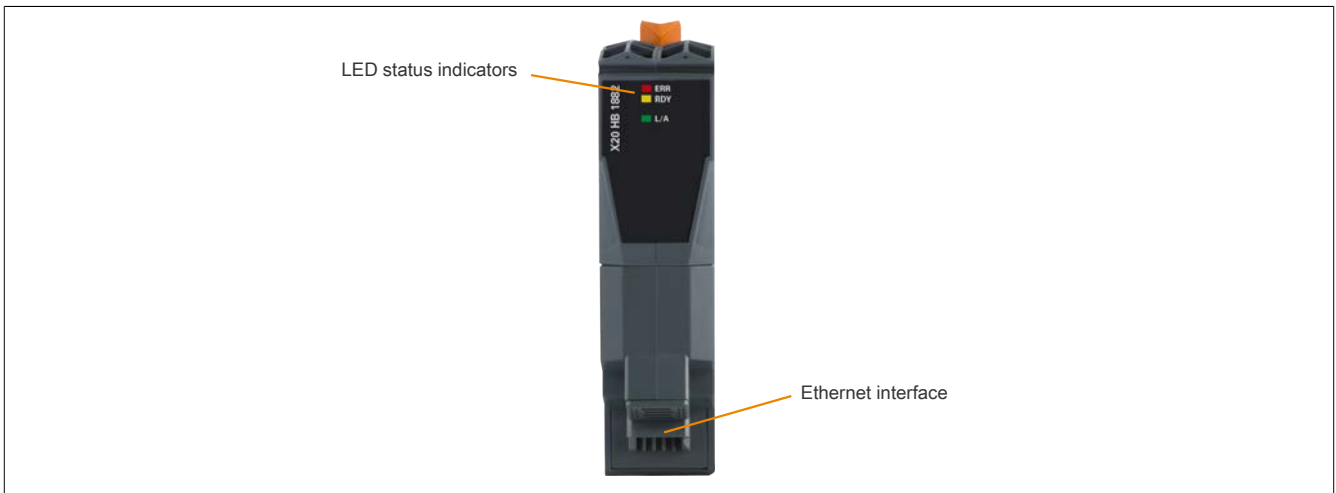
9.30.3.3 Technical data

| Model number | X20HB1882 |
|--|--|
| Short description | |
| Hub | 1 Fast Ethernet interface for single-mode fiber optic cables for hub expansion |
| General information | |
| Status indicators | Module status, bus function |
| Diagnostics | |
| Module status | Yes, using LED status indicator |
| Bus function | Yes, using LED status indicator |
| Power consumption | 1.65 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| UL | cULus E115267 Industrial control equipment |
| EAC | Yes |
| Interfaces | |
| Type | Hub expansion module |
| Variant | 1x female duplex LC |
| Transfer rate | 100 Mbit/s |
| Transfer | |
| Physical layer | 100BASE-FX |
| Half-duplex | Yes |
| Full-duplex | No |
| Autonegotiation | No |
| Auto-MDI/MDIX | No |
| Hub propagation delay | 0.96 to 1 µs |
| Wave length | Typ. 1300 nm Rx range: 1270 to 1380 nm Tx range: 1270 to 1380 nm |
| Cable fiber type | Single-mode fiber with 9/125 µm core diameter On both sides: Male duplex LC connector |
| Optical power budget | 30 dB |
| Cable length | |
| Half-duplex | Max. 175 m between 2 stations (segment length) |
| POWERLINK | Max. 50 km between 2 stations (segment length) |
| Electrical properties | |
| Electrical isolation | Power supply isolated from Ethernet |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 55°C |
| Vertical mounting orientation | -25 to 45°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Slot | Hub expansion for X20BC8083, X20BC8084 and X20HB8880 ¹⁾ |

Table 624: X20HB1882 - Technical data

1) The hardware revision of X20BC8083 and X20HB8880 must be ≥F0, and the hardware revision of X20BC8084 must be ≥D0.

9.30.3.4 Operating and connection elements



9.30.3.4.1 LED status indicators

| Figure | LED | Color | Status | Description |
|--------|-----|--------|----------|---|
| | ERR | Red | On | Slot not detected |
| | RDY | Orange | On | Slot detected, module active |
| | L/A | Green | On | Link to remote station established |
| | | | Blinking | Link to remote station established. The LED blinks if Ethernet activity is taking place on the bus. |

9.30.3.4.2 Ethernet interface

| Figure | Description |
|--------|------------------------------|
| | 100BASE-FX, female duplex LC |

9.30.3.4.2.1 Cabling guidelines for X20 modules with fiber optic cables

The following cabling guidelines must be observed:

- Cable fiber type: Single-mode fiber with 9/125 μm core diameter
- On both sides: Male duplex LC connector
- Observe the minimum cable bend radius (see data sheet for the cable).

9.30.3.5 Network size and collision detection

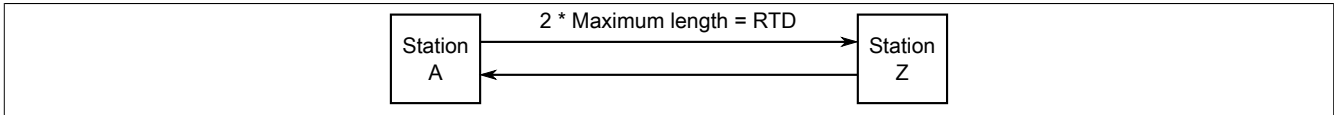
Information:

This section applies to the use of Ethernet networks, not POWERLINK networks.

According to Ethernet specification IEEE 802.3, the transmission duration of a frame of minimum length must always be greater than the round-trip delay time (RTD). RTD is the time needed by a data packet to travel from one end of the network to the other.

If this is not observed, collision detection can no longer be guaranteed.

Illustration of RTD



When using fiber optic cables, the default maximum size is 175 m. Since there are often different devices in a network using different PHYs, the propagation delay of the frames changes since each PHY has different latency. This also affects the network size, and collision detection can no longer be guaranteed at 175 m.

For this reason, it is necessary to re-check whether the transmission duration of a frame of minimum length is actually greater than the maximum RTD.

Example for calculating network size

- Transfer rate: 100 Mbit/s
- Length of the fiber optic cable: 175 m
- Number of hubs: 2
- Hub propagation delay of a frame: 1 μ s
- Minimum frame size in the Ethernet network: 72 bytes

Calculation procedure

| | |
|--|--|
| 1. How long does 1 byte need at 100 Mbit/s – 100 Mbit/s / 8 = 12.5 MB/s | $\frac{12,500,000}{1} = \frac{1}{x}$ $x = \frac{1s}{12,500,000} = 80ns$ |
| 2. Propagation delay of minimum Ethernet frame – Minimum frame in Ethernet network: 72 bytes | $72 * 80ns = 5.76\mu s$ |
| 3. Propagation delay in cable and hub (100 m cable = 0.5 μ s) – 175 m cable = 1.75 x 0.5 μ s – 2 hubs = 2 x 1 μ s | $\frac{175}{100}m * 0.5\mu s + 2\mu s = 2.875\mu s$ |
| 4. Calculation of total propagation delay – Outbound/Inbound propagation delay | $2.875\mu s * 2 = 5.75\mu s$ |

Result

Collision detection is possible since the total time of 5.75 μ s is less than the minimum Ethernet propagation delay of 5.76 μ s.

With a longer cable or device with different latency, collision detection would no longer exist.

9.30.4 X20(c)HB2880

Data sheet version: 2.42

9.30.4.1 General information

The POWERLINK bus controller X20BC8083 and the stand-alone hubs X20HB8880 and X20HB8815 are equipped with a modular hub expansion. An additional 1 or 2 slots are available, depending on the bus base used. The X20HB2880 hub expansion module can be operated in these slots.

The status of the module and network are indicated by LEDs.

- Hub expansion module
- 2x hub 100 BASE-TX

9.30.4.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.30.4.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.30.4.3 Order data

| Model number | Short description | Figure |
|--------------|--|--------|
| | System modules for the X20 hub system | |
| X20HB2880 | X20 hub expansion module, integrated 2-port hub, 2x RJ45 | |
| X20cHB2880 | X20 hub expansion module, coated, integrated 2-port hub, 2x RJ45 | |


Table 625: X20HB2880, X20cHB2880 - Order data

9.30.4.4 Technical data

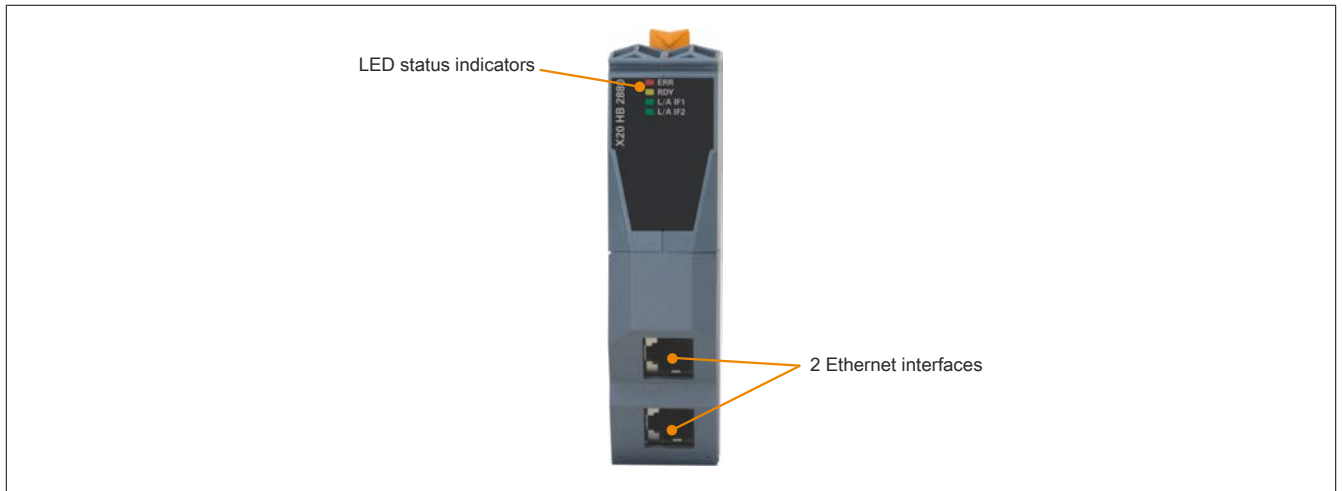
| Model number | X20HB2880 | X20cHB2880 |
|--|--|---|
| Short description | | |
| Hub | 2 Fast Ethernet hubs for hub expansion | |
| General information | | |
| Status indicators | Module status, bus function | |
| Diagnostics | | |
| Module status | Yes, using status LED | |
| Bus function | Yes, using status LED | |
| Power consumption | 1.17 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Interfaces | | |
| Type | Hub expansion module | |
| Variant | 2x shielded RJ45 | |
| Cable length | Max. 100 m between 2 stations (segment length) | |
| Transfer rate | 100 Mbit/s | |
| Transfer | | |
| Physical layer | 100BASE-TX | |
| Half-duplex | Yes | |
| Full-duplex | No | |
| Autonegotiation | Yes | |
| Auto-MDI/MDIX | Yes | |
| Hub propagation delay | 0.96 to 1 µs | |
| Electrical properties | | |
| Electrical isolation | Power supply isolated from Ethernet (IF1 and IF2) | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Slot | Hub expansion for X20BC8083 and X20HB8880 | Hub expansion for X20cBC8083 and X20cHB8880 |

Table 626: X20HB2880, X20cHB2880 - Technical data

9.30.4.5 LED status indicators

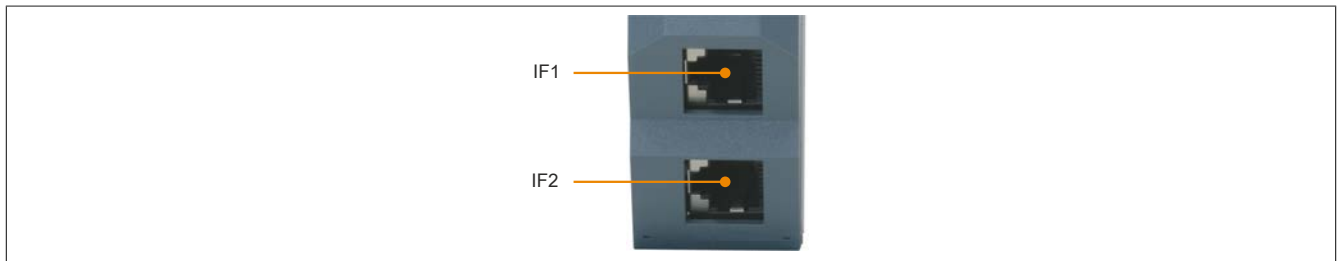
| Figure | LED | Color | Status | Description |
|---|---------|--------|----------|--|
|  | ERR | Red | On | Slot not detected |
| | RDY | Orange | On | Slot detected, module is active |
| | L/A IFx | Green | On | A link to the remote station has been established. |
| | | | Blinking | A link to the remote station has been established. Indicates Ethernet activity is taking place on the bus. |

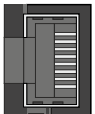
9.30.4.6 Operating and connection elements



9.30.4.7 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see ["Cabling guidelines for X20 modules with an Ethernet cable"](#) on page 58.



| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | Pinout |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.30.4.8 Network size and collision detection

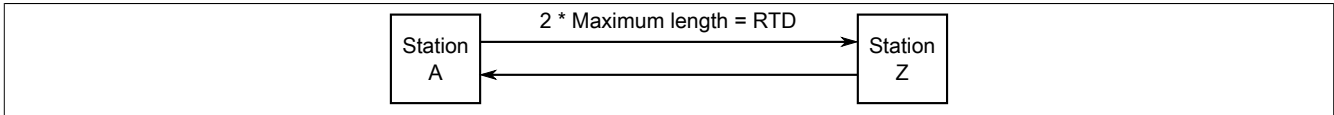
Information:

This section applies to the use of Ethernet networks, not POWERLINK networks.

According to Ethernet specification IEEE 802.3, the transmission duration of a frame of minimum length must always be greater than the round-trip delay time (RTD). RTD is the time needed by a data packet to travel from one end of the network to the other.

If this is not observed, collision detection can no longer be guaranteed.

Illustration of RTD



When using copper cables, the maximum distance is generally 100 m. Since there are often many different devices with different PHYs in a network, the propagation delay of the frames changes due to the different latency of each PHY. This also affects the network size, and collision detection can no longer be guaranteed at 100 m.

Example for calculating network size

The following parameters are specified for a network:

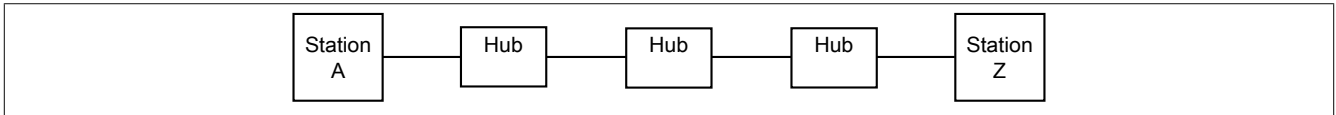
- Transfer rate: 100 Mbit/s
- Cable length: 100 m
- Number of hubs: 2
- Hub propagation delay of a frame: 1 μ s
- Minimum frame size in the Ethernet network: 72 bytes

Calculation procedure

| | |
|--|---|
| 1. How long does 1 byte take at 100 Mbit/s – 100 Mbit/s / 8 = 12.5 MB/s | $\frac{12,500,000}{1} = \frac{1}{x}$ $x = \frac{1\text{s}}{12,500,000} = 80\text{ns}$ |
| 2. Propagation delay of minimum Ethernet frame – Minimum frame in Ethernet network: 72 bytes | $72 * 80\text{ns} = 5.76\mu\text{s}$ |
| 3. Propagation delay in cable and hub – 100 m cable = 0.5 μ s – 2 hubs = 2 x 1 μ s | $2\mu\text{s} + 0.5\mu\text{s} = 2.5\mu\text{s}$ |
| 4. Calculation of total propagation delay – Outbound/Inbound propagation delay | $2.5\mu\text{s} * 2 = 5\mu\text{s}$ |

Result

Collision detection is possible since the total time of 5 μ s is less than the minimum Ethernet propagation delay of 5.76 μ s.

Example for calculating the network reach with devices between 2 stations

Corresponding to the previous example, the following situation occurs in a network with 3 hubs and 100 m cables:

- The transmission duration of a frame of minimum length is 5.76 μ s.

Calculation procedure

| | |
|--|--|
| 1. Propagation delay in cable and hub – 100 m cable = 0.5 μ s – 3 hubs = 3 x 1 μ s | $3\mu\text{s} + 0.5\mu\text{s} = 3.5\mu\text{s}$ |
| 2. Calculation of total propagation delay – Outbound/Inbound propagation delay | $3.5\mu\text{s} * 2 = 7\mu\text{s}$ |

Result

Collision detection is not possible since the total time of 7 μ s is greater than the minimum Ethernet propagation delay of 5.76 μ s.

The ≈ 1.3 μ s missing for collision detection can only be recovered by removing a hub.

9.30.5 X20(c)HB2881

Data sheet version: 1.41

9.30.5.1 General information

The POWERLINK bus controller X20BC8083 and the stand-alone hubs X20HB8880 and X20HB8815 are equipped with a modular hub expansion. An additional 1 or 2 slots are available, depending on the bus base used. The X20HB2881 hub expansion module can be operated in these slots. Note that the hardware revision of the X20BC8083 and the X20HB8880 must be $\geq F0$.

The hub expansion module is a 2x hub. The Ethernet connection is made using 62.5/125 μm or 50/125 μm fiber optic multimode cable with a duplex LC connection. The status of the module and network are indicated by LEDs.

- Hub expansion module
- 2x Hub 100 BASE-FX

Information:

This module is not suitable for POWERLINK ring redundancy applications.

9.30.5.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.30.5.3 Order data

| Model number | Short description | Figure |
|--------------|--|--------|
| | System modules for the X20 hub system | |
| X20HB2881 | X20 hub expansion module, integrated 2-port hub, for fiber optic cable | |
| X20cHB2881 | X20 hub expansion module, coated, integrated 2-port hub, for fiber optic cable | |

Table 627: X20HB2881, X20cHB2881 - Order data

9.30.5.4 Technical data

| Model number | X20HB2881 | X20cHB2881 |
|--|---|-------------|
| Short description | | |
| Hub | 2 Fast Ethernet interfaces for fiber optic cable for hub expansion | |
| General information | | |
| Status indicators | Module status, bus function | |
| Diagnostics | | |
| Module status | Yes, using status LED | |
| Bus function | Yes, using status LED | |
| Power consumption | 2.3 W (Rev. <E0: 2.8 W) | 2.3 W |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| EAC | Yes | |
| KC | Yes | - |
| Interfaces | | |
| Type | Hub expansion module | |
| Variant | 2x duplex LC female | |
| Transfer rate | 100 Mbit/s | |
| Transfer | | |
| Physical layer | 100BASE-FX | |
| Half-duplex | Yes | |
| Full-duplex | No | |
| Autonegotiation | No | |
| Auto-MDI/MDIX | No | |
| Hub propagation delay | 0.96 to 1 µs | |
| Wave length | Typ. 1300 nm Rx range: 1270 to 1380 nm Tx range: 1270 to 1380 nm | |
| Cable fiber type | Multimode fiber with 62.5/125 µm or 50/125 µm core diameter On both sides: Duplex LC male connector | |
| Optical power budget | | |
| Glass fiber 62.5/125 µm, NA = 0.275 | 11 dB | |
| Glass fiber 50/125 µm, NA = 0.200 | 7.5 dB | |
| Cable length | | |
| Half-duplex | Max. 175 m between 2 stations (segment length) | |
| POWERLINK | Max. 2 km between 2 stations (segment length) | |
| Electrical properties | | |
| Electrical isolation | Power supply isolated from Ethernet (IF1 and IF2) | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation (with 1 hub) | -25 to 55°C (Rev. <E0: 0 to 45°C) | -25 to 55°C |
| Horizontal mounting orientation (with ≥2 hubs) | -25 to 50°C (Rev. <E0: 0 to 40°C) | -25 to 50°C |
| Vertical mounting orientation (with 1 hub) | -25 to 40°C (Rev. <E0: 0 to 40°C) | -25 to 40°C |
| Vertical mounting orientation (with ≥2 hubs) | -25 to 35°C (Rev. <E0: 0 to 35°C) | -25 to 35°C |
| Derating | | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |

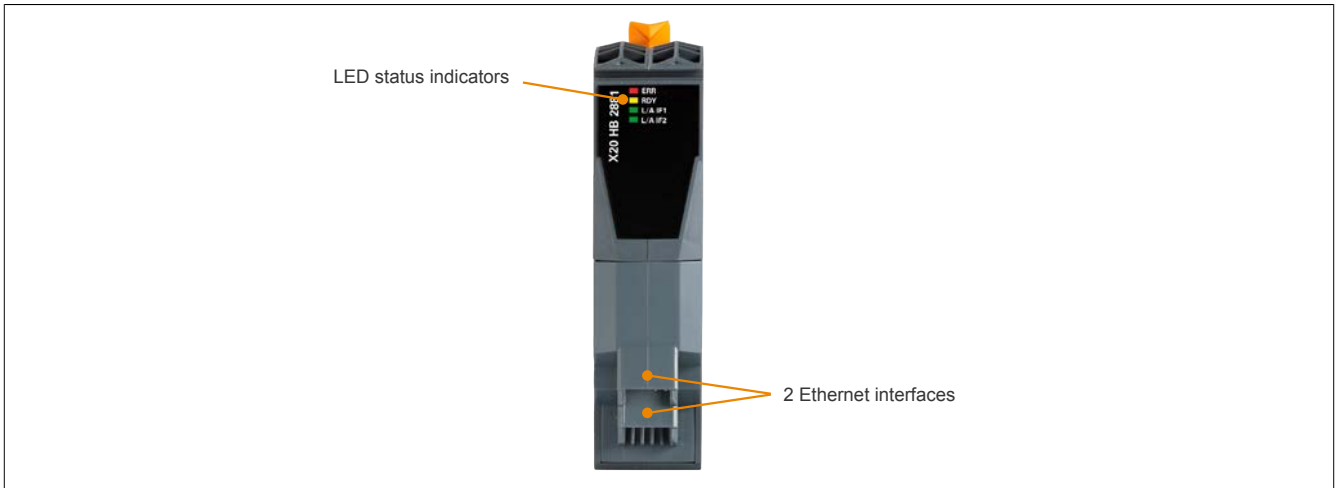
Table 628: X20HB2881, X20cHB2881 - Technical data

| Model number | X20HB2881 | X20cHB2881 |
|------------------------------|---|---|
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | | 5 to 95%, non-condensing |
| Transport | | 5 to 95%, non-condensing |
| Mechanical properties | | |
| Slot | Hub expansion for X20BC8083 and X20HB8880 ¹⁾ | Hub expansion for X20cBC8083 and X20cHB8880 ²⁾ |

Table 628: X20HB2881, X20cHB2881 - Technical data

- 1) The hardware revision of X20BC8083 and X20HB8880 must be ≥F0.
- 2) The hardware revision of X20cBC8083 and X20cHB8880 must be ≥F0.

9.30.5.5 Operating and connection elements



9.30.5.5.1 LED status indicators

| Figure | LED | Color | Status | Description |
|--------|---------|--------|----------|--|
| | ERR | Red | On | Slot not detected |
| | RDY | Orange | On | Slot detected, module is active |
| | L/A IFx | Green | On | A link to the remote station has been established. |
| | | | Blinking | A link to the remote station has been established. Indicates Ethernet activity is taking place on the bus. |

9.30.5.5.2 Ethernet interfaces

| Figure | Description |
|--------|-------------------------------|
| | 100 BASE-FX, Duplex LC female |

9.30.5.5.2.1 Wiring guidelines for X20 modules with fiber optic cable

The following wiring guidelines must be observed:

- Cable fiber type: Multimode fiber with 62.5/125 μm or 50/125 μm core diameter
- On both sides: Duplex LC male connector
- Observe minimum cable flex radius (see data sheet for the cable)

9.30.5.6 Network size and collision detection

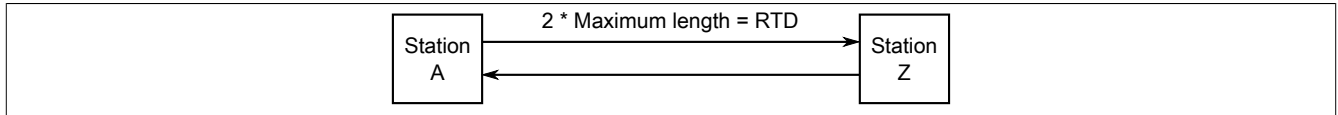
Information:

This section applies to the use of Ethernet networks, not POWERLINK networks.

According to Ethernet specification IEEE 802.3, the transmission duration of a frame of minimum length must always be greater than the round-trip delay time (RTD). RTD is the time needed by a data packet to travel from one end of the network to the other.

If this is not observed, collision detection can no longer be guaranteed.

Illustration of RTD



When using fiber optic cables, the default maximum size is 175 m. Since there are often different devices in a network using different PHYs, the propagation delay of the frames changes since each PHY has different latency. This also affects the network size, and collision detection can no longer be guaranteed at 175 m.

For this reason, it is necessary to re-check whether the transmission duration of a frame of minimum length is actually greater than the maximum RTD.

Example for calculating network size

- Transfer rate: 100 Mbit/s
- Length of the fiber optic cable: 175 m
- Number of hubs: 2
- Hub propagation delay of a frame: 1 μ s
- Minimum frame size in the Ethernet network: 72 bytes

Calculation procedure

| | |
|--|--|
| 1. How long does 1 byte need at 100 Mbit/s – 100 Mbit/s / 8 = 12.5 MB/s | $\frac{12,500,000}{1} = \frac{1}{x}$ $x = \frac{1s}{12,500,000} = 80ns$ |
| 2. Propagation delay of minimum Ethernet frame – Minimum frame in Ethernet network: 72 bytes | $72 * 80ns = 5.76\mu s$ |
| 3. Propagation delay in cable and hub (100 m cable = 0.5 μ s) – 175 m cable = 1.75 x 0.5 μ s – 2 hubs = 2 x 1 μ s | $\frac{175}{100}m * 0.5\mu s + 2\mu s = 2.875\mu s$ |
| 4. Calculation of total propagation delay – Outbound/Inbound propagation delay | $2.875\mu s * 2 = 5.75\mu s$ |

Result

Collision detection is possible since the total time of 5.75 μ s is less than the minimum Ethernet propagation delay of 5.76 μ s.

With a longer cable or device with different latency, collision detection would no longer exist.

9.30.6 X20(c)PS8002

Data sheet version: 2.35

9.30.6.1 General information

The supply module is used to supply X20 stand-alone devices. These include e.g. the X20HB8884 POWERLINK compact link selector and the X20HB8880 stand alone hub.

- Supply for X20 stand-alone devices
- No electrical isolation between the I/O supply and the device power supply

9.30.6.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.30.6.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.30.6.3 Order data

| Model number | Short description | Figure |
|--------------|---|--------|
| | System modules for the X20 hub system | |
| X20PS8002 | X20 power supply module for standalone hub and compact link selector | |
| X20cPS8002 | X20 power supply module, coated, for standalone hub and compact link selector | |
| | Required accessories | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 629: X20PS8002, X20cPS8002 - Order data


9.30.6.4 Technical data

| Model number | X20PS8002 | X20cPS8002 |
|--|--|------------------------|
| Short description | | |
| Power supply module | 24 VDC power supply module for X20 standalone devices | |
| General information | | |
| Status indicators | Operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED | |
| Overload | Yes, using status LED | |
| Power consumption ¹⁾ | 1.34 W | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Input power supply | | |
| Input voltage | 24 VDC -15% / +20% | |
| Input current | Max. 0.7 A | |
| Fuse | Integrated, cannot be replaced | |
| Reverse polarity protection | Yes | |
| Output power supply | | |
| Overload characteristics | Short circuit, temporary overload | |
| Nominal output power | | |
| Horizontal mounting orientation | 7 W at 45°C and 5 W at 55°C | |
| Vertical mounting orientation | 7 W at 40°C and 5 W at 50°C | |
| Electrical properties | | |
| Electrical isolation | I/O power supply not isolated from device power supply | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | See section "Derating" | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately | |
| Pitch | 12.5 ^{+0.2} mm | |

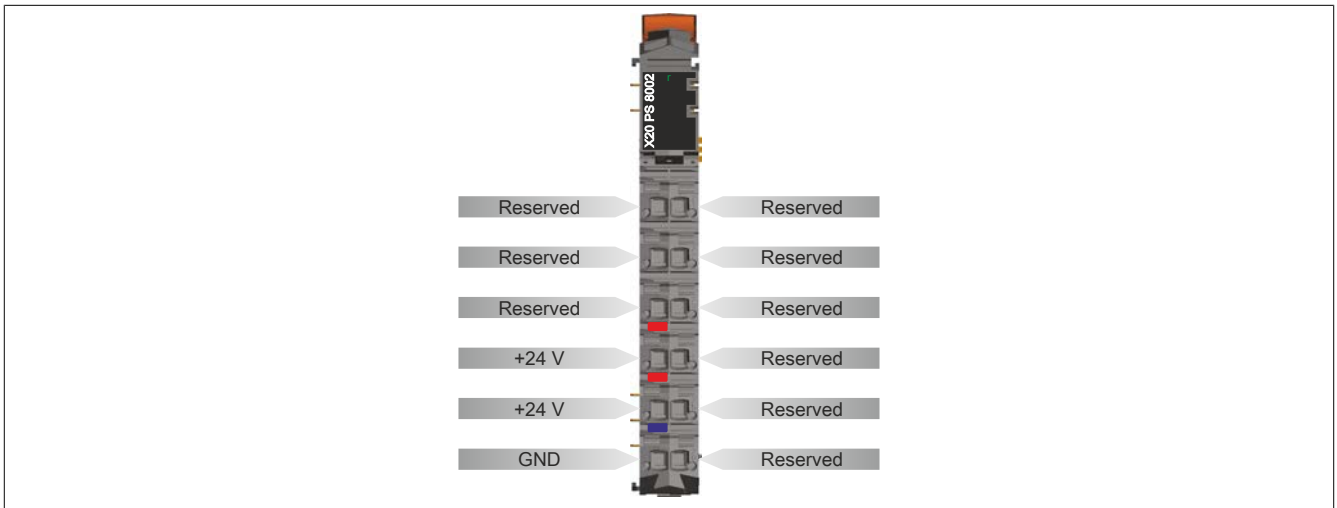
Table 630: X20PS8002, X20cPS8002 - Technical data

- 1) The specified values are maximum values. For examples of the exact calculation, see section "Mechanical and electrical configuration" of the X20 system user's manual.

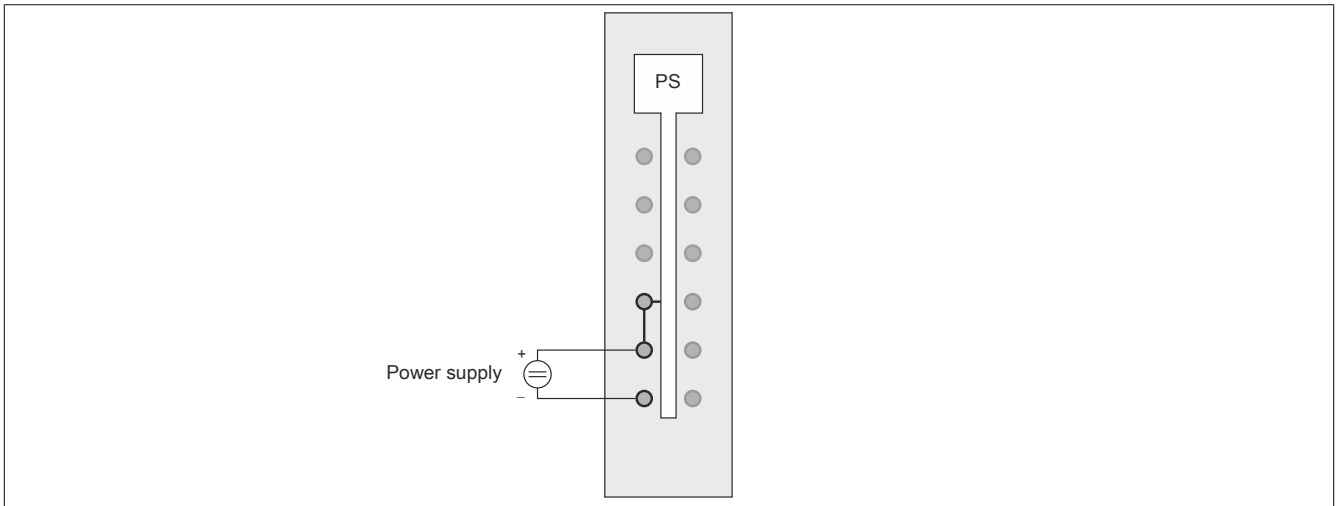
9.30.6.5 LED status indicators

| Figure | LED | Color | Status | Description |
|---|-----|-------|--------|------------------------|
|  | r | Green | On | Input voltage > 19.2 V |

9.30.6.6 Pinout

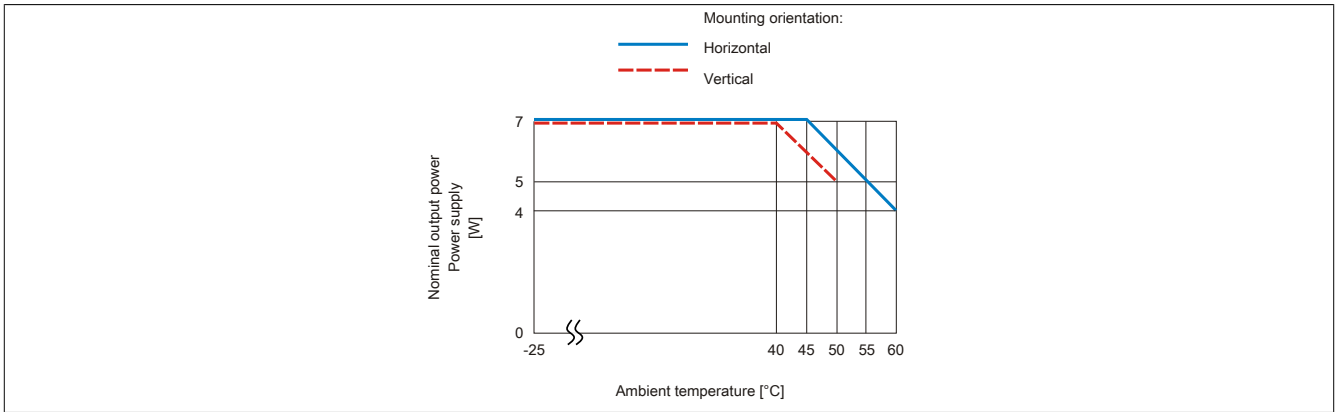


9.30.6.7 Connection example



9.30.6.8 Derating

The rated output current for the supply is 7 W. Derating must be taken into consideration based on mounting orientation.



9.31 System modules for the X20 redundancy system

The X20 redundancy system has a modular structure. In addition to the basis modules, the following system modules are also required,

- Bus base
- Hub expansion module(s)
- Power supply module for standalone hub

9.31.1 Summary

| Model number | Short description | Page |
|--------------|--|------|
| X20HB2885 | X20 hub expansion module, integrated active 2-port hub, 2x RJ45 | 3641 |
| X20HB2886 | X20 hub expansion module, integrated active 2-port hub, 2 fiber optic interfaces | 3644 |
| X20cHB2885 | X20 hub expansion module, coated, integrated active 2-port hub, 2x RJ45 | 3641 |
| X20cHB2886 | X20 hub expansion module, coated, integrated active 2-port hub, 2 fiber optic interfaces | 3644 |

9.31.2 X20(c)HB2885

Data sheet version: 2.34

9.31.2.1 General information

The X20BC8084 POWERLINK bus controller and the X20HB8884 module are equipped with an integrated link selector function. An additional 1 or 2 slots are available, depending on the bus base used. The active X20HB2885 hub expansion module can be operated in these slots.

The active hub expansion module is equipped with one integrated 2x hub and allows redundant wiring. This means that the connection between the two ports remains intact if there is a failure in the bus controller or Compact Link Selector. The status of the module and network are indicated by LEDs.

- Active hub expansion module
- 2x Fast Ethernet hub for redundant wiring
- Hot-swap-capable

9.31.2.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.31.2.3 Order data

| Model number | Short description | Figure |
|--------------|---|--------|
| | System modules for X20 redundancy system | |
| X20HB2885 | X20 hub expansion module, integrated active 2-port hub, 2x RJ45 | |
| X20cHB2885 | X20 hub expansion module, coated, integrated active 2-port hub, 2x RJ45 | |
| | Required accessories | |
| | Expandable bus controllers | |
| X20BC8084 | X20 bus controller, 1 POWERLINK interface, 1x link selector for POWERLINK cable redundancy, supports expansion with enabled X20 hub modules, 2x RJ45, order bus base, power supply module and terminal block separately! | |
| X20cBC8084 | X20 bus controller, coated, 1 POWERLINK interface, 1x link selector for POWERLINK cable redundancy, supports expansion with active X20 hub modules, 2x RJ45, order bus base, power supply module and terminal block separately! | |
| | System modules for expandable bus controllers | |
| X20BB82 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with 2 expansion slots for 2 X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cBB82 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with two expansion slots for two X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| | X20 redundancy systems | |
| X20HB8884 | X20 compact link selector, 2x RJ45, order bus base, power supply module and terminal block separately. | |
| X20cHB8884 | X20 compact link selector, coated, 2x RJ45, order bus base, power supply module and terminal block separately. | |


Table 631: X20HB2885, X20cHB2885 - Order data

9.31.2.4 Technical data

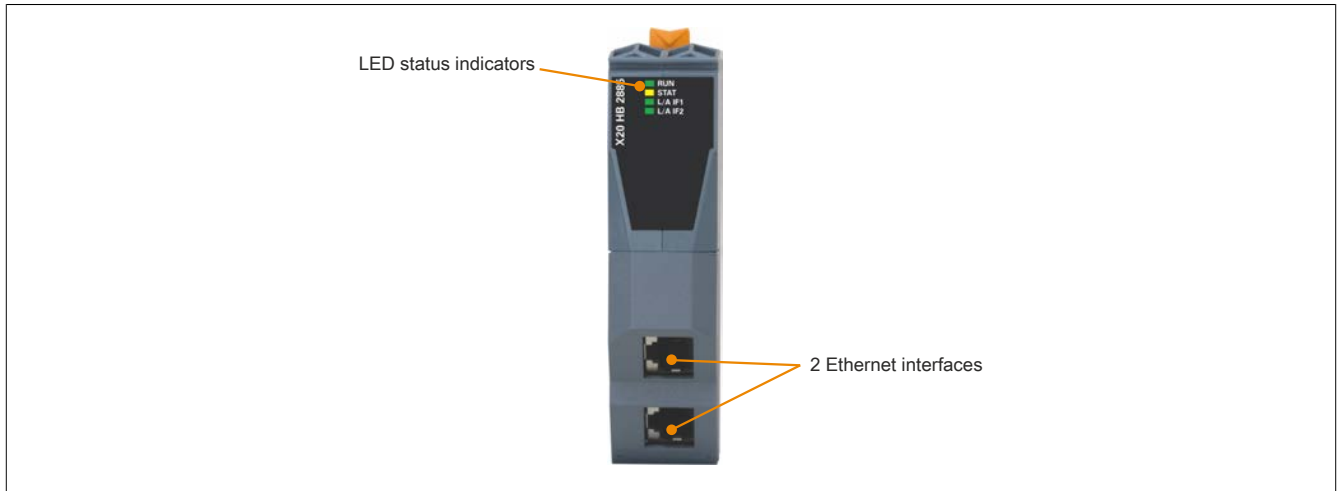
| Model number | X20HB2885 | X20cHB2885 |
|--|---|---|
| Short description | | |
| Hub | 2 Fast Ethernet hubs for redundant wiring | |
| General information | | |
| Status indicators | Module status, bus function | |
| Diagnostics | | |
| Module status | Yes, using status LED | |
| Bus function | Yes, using status LED | |
| Power consumption | 1.17 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| EAC | Yes | |
| KC | Yes | - |
| Interfaces | | |
| Type | Active hub expansion module | |
| Variant | 2x shielded RJ45 | |
| Cable length | Max. 100 m between 2 stations (segment length) | |
| Transfer rate | 100 Mbit/s | |
| Transfer | | |
| Physical layer | 100BASE-TX | |
| Half-duplex | Yes | |
| Full-duplex | No | |
| Autonegotiation | Yes | |
| Auto-MDI/MDIX | Yes | |
| Hub propagation delay | 0.96 to 1 µs | |
| Electrical properties | | |
| Electrical isolation | Power supply isolated from Ethernet (IF1 and IF2) | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | | |
| Storage | | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Slot | Hub expansion for X20BC8084 and X20HB8884 | Hub expansion for X20cBC8084 and X20cHB8884 |

Table 632: X20HB2885, X20cHB2885 - Technical data

9.31.2.5 LED status indicators

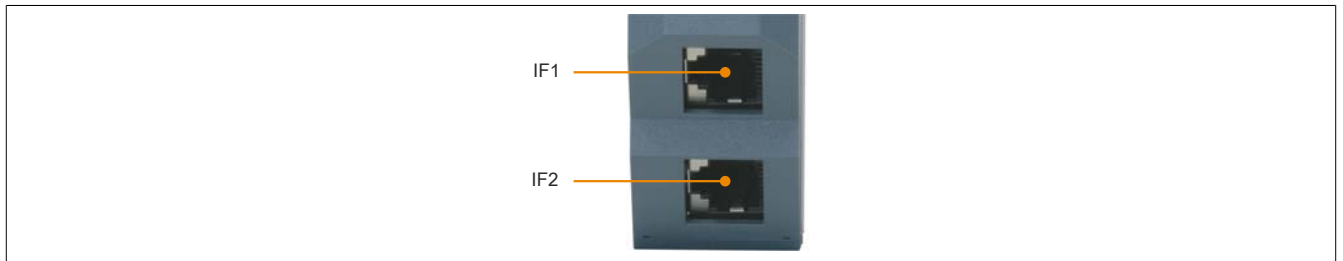
| Figure | LED | Color | Status | Description |
|---|---------|--------|----------|--|
|  | RUN | Red | On | Module inactive. Module is in the reset state. |
| | | Green | On | Module active |
| | STAT | Orange | Off | Normal operation |
| | | | Blinking | No X20BC8084 or X20HB8884 found. |
| | | Green | On | Normal operation. However, the X20BC8084 or X20HB8884 was inserted after the system had booted. |
| | L/A IFx | Green | On | A link to the remote station has been established. |
| | | | Blinking | A link to the remote station has been established. Indicates Ethernet activity is taking place on the bus. |

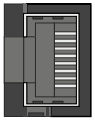
9.31.2.6 Operating and connection elements



9.31.2.7 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see ["Cabling guidelines for X20 modules with an Ethernet cable"](#) on page 58.



| Interface | Pinout | | |
|--|--------|-------------|----------------|
| | Pin | Ethernet | |
|  Shielded RJ45 | 1 | RXD | Receive data |
| | 2 | RXD\ | Receive data\ |
| | 3 | TXD | Transmit data |
| | 4 | Termination | |
| | 5 | Termination | |
| | 6 | TXD\ | Transmit data\ |
| | 7 | Termination | |
| | 8 | Termination | |

9.31.3 X20(c)HB2886

Data sheet version: 1.31

9.31.3.1 General information

The X20BC8084 POWERLINK bus controller and the X20HB8884 module are equipped with an integrated link selector function. An additional 1 or 2 slots are available, depending on the bus base used. The active X20HB2886 hub expansion module can be operated in these slots. Note that the hardware revision of the X20BC8084 and the X20HB8884 must be $\geq E0$.

The active hub expansion module is equipped with one integrated 2x hub and allows redundant wiring. This means that the connection between the two 100 Base-FX interfaces remains intact if there is a failure in the bus controller or Compact Link Selector. The Ethernet connection is made using 62.5/125 μm or 50/125 μm fiber optic multimode cable with a duplex LC connection. The status of the module and network are indicated by LEDs.

- Active hub expansion module
- 2x 100 BASE-FX hub for redundant wiring
- Hot-swap-capable

9.31.3.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.31.3.3 Order data

| Model number | Short description | Figure |
|--------------|---|--------|
| | System modules for X20 redundancy system | |
| X20HB2886 | X20 hub expansion module, integrated active 2-port hub, 2 fiber optic interfaces | |
| X20cHB2886 | X20 hub expansion module, coated, integrated active 2-port hub, 2 fiber optic interfaces | |
| | Required accessories | |
| | Expandable bus controllers | |
| X20BC8084 | X20 bus controller, 1 POWERLINK interface, 1x link selector for POWERLINK cable redundancy, supports expansion with enabled X20 hub modules, 2x RJ45, order bus base, power supply module and terminal block separately! | |
| X20cBC8084 | X20 bus controller, coated, 1 POWERLINK interface, 1x link selector for POWERLINK cable redundancy, supports expansion with active X20 hub modules, 2x RJ45, order bus base, power supply module and terminal block separately! | |
| | System modules for expandable bus controllers | |
| X20BB82 | X20 bus base, for X20 base module (BC, HB, etc.) and X20 power supply module, with 2 expansion slots for 2 X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| X20cBB82 | X20 bus base, coated, for X20 base module (BC, HB, etc.) and X20 power supply module, with two expansion slots for two X20 add-on modules (IF, HB, etc.), X20 locking plates (left and right) X20AC0SL1/X20AC0SR1 included | |
| | X20 redundancy systems | |
| X20HB8884 | X20 compact link selector, 2x RJ45, order bus base, power supply module and terminal block separately. | |
| X20cHB8884 | X20 compact link selector, coated, 2x RJ45, order bus base, power supply module and terminal block separately. | |

Table 633: X20HB2886, X20cHB2886 - Order data

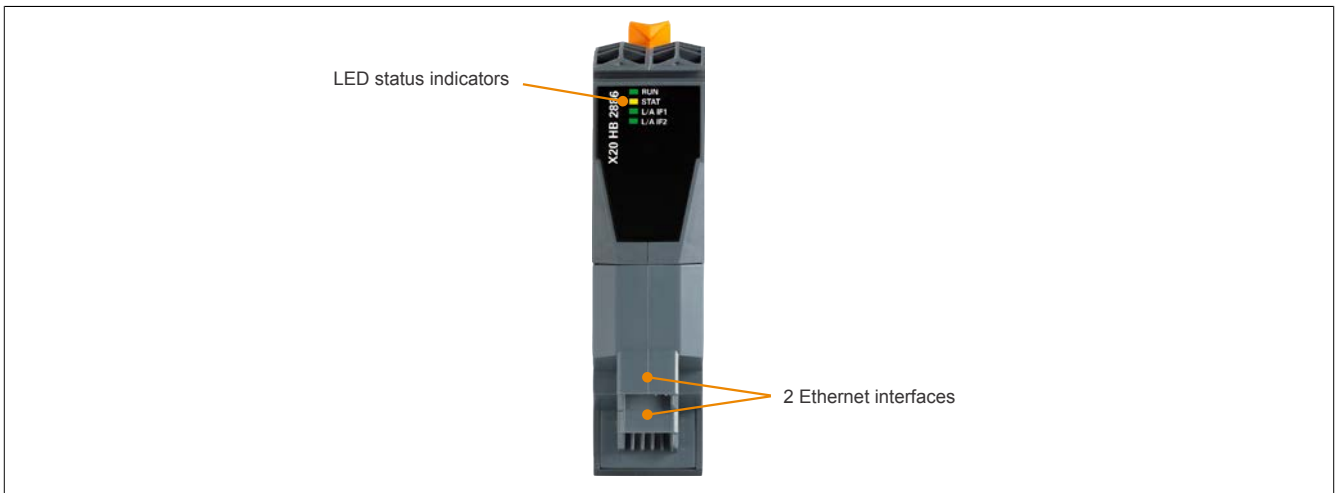
9.31.3.4 Technical data

| Model number | X20HB2886 | X20cHB2886 |
|--|---|---|
| Short description | | |
| Hub | 2 Fast Ethernet interfaces for fiber optic cable for redundant wiring | |
| General information | | |
| Status indicators | Module status, bus function | |
| Diagnostics | | |
| Module status | Yes, using status LED | |
| Bus function | Yes, using status LED | |
| Power consumption | 2.3 W (Rev. <D0: 2.8 W) | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| EAC | Yes | |
| KC | Yes | - |
| Interfaces | | |
| Type | Active hub expansion module | |
| Variant | 2x duplex LC female | |
| Transfer rate | 100 Mbit/s | |
| Transfer | | |
| Physical layer | 100BASE-FX | |
| Half-duplex | Yes | |
| Full-duplex | No | |
| Autonegotiation | No | |
| Auto-MDI/MDIX | No | |
| Hub propagation delay | 0.96 to 1 µs | |
| Wave length | Typ. 1300 nm Rx range: 1270 to 1380 nm Tx range: 1270 to 1380 nm | |
| Cable fiber type | Multimode fiber with 62.5/125 µm or 50/125 µm core diameter On both sides: Duplex LC male connector | |
| Optical power budget | | |
| Glass fiber 62.5/125 µm, NA = 0.275 | 11 dB | |
| Glass fiber 50/125 µm, NA = 0.200 | 7.7 dB | |
| Cable length | | |
| Half-duplex | Max. 400 m between 2 stations (segment length) | |
| POWERLINK | Max. 2 km between 2 stations (segment length) | |
| Electrical properties | | |
| Electrical isolation | Power supply isolated from Ethernet (IF1 and IF2) | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation (with ≥2 hubs) | -25 to 50°C (Rev. <D0: 0 to 40°C) | |
| Vertical mounting orientation (with ≥2 hubs) | -25 to 35°C (Rev. <D0: 0 to 35°C) | |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Slot | Hub expansion for X20BC8084 and X20HB8884 ¹⁾ | Hub expansion for X20cBC8084 and X20cHB8884 ²⁾ |

Table 634: X20HB2886, X20cHB2886 - Technical data

- 1) The hardware revision of X20BC8084 and X20HB8884 must be ≥E0.
2) The hardware revision of X20cBC8084 and X20cHB8884 must be ≥E0.

9.31.3.5 Operating and connection elements



9.31.3.5.1 LED status indicators

| Figure | LED | Color | Status | Description |
|----------|---------|--------|--|---|
| | RUN | Red | On | Module inactive. Module is in the reset state. |
| | | Green | On | Module active |
| | STAT | Orange | Off | Normal operation |
| | | | Blinking | No X20BC8084 or X20HB8884 found. |
| | | | On | Normal operation. However, the X20BC8084 or X20HB8884 was inserted after the system had booted. |
| | L/A IFx | Green | On | A link to the remote station has been established. |
| Blinking | | | A link to the remote station has been established. Indicates Ethernet activity is taking place on the bus. | |

9.31.3.5.2 Ethernet interfaces

| Figure | Description |
|---|-------------------------------|
| <p>Duplex LC (IF1) Tx Rx</p> <p>Duplex LC (IF2) Tx Rx</p> | 100 BASE-FX, Duplex LC female |

9.31.3.5.2.1 Wiring guidelines for X20 modules with fiber optic cable

The following wiring guidelines must be observed:

- Cable fiber type: Multimode fiber with 62.5/125 µm or 50/125 µm core diameter
- On both sides: Duplex LC male connector
- Observe minimum cable flex radius (see data sheet for the cable)

9.32 Temperature modules

Temperature measurement values are converted into number values which can be processed by the PLC using temperature modules.

In the PLC, the number values are always in 16-bit 2s complement, regardless of the resolution. In this way, the resolution (number of steps) of the temperature module does not have to be considered when creating the application program.

For temperature measurements, the temperature module returns the measured value in 0.1°C steps. That means, a result of 750 corresponds to 75.0°C. The data format 0.1°C is supported as standard by all temperature modules.

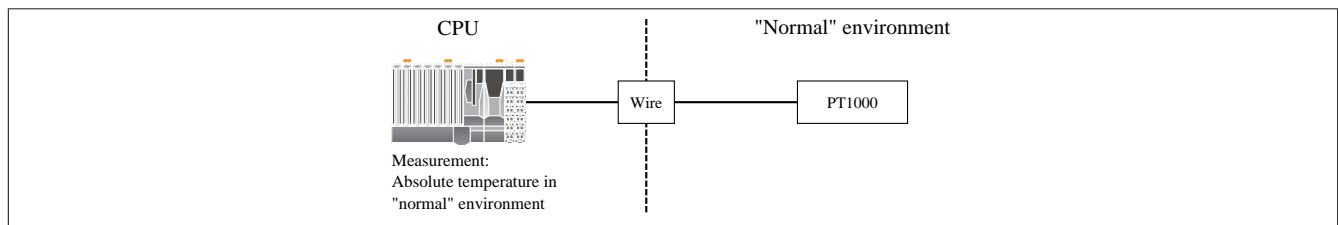
Every channel on temperature module has a status LED.

Measurement methods

Depending on the area to be measured, there are two different methods for determining the temperature.

Method 1: Direct measurement using measurement resistor

The temperature module measures an electrical value that makes it possible to directly infer the current absolute temperature.

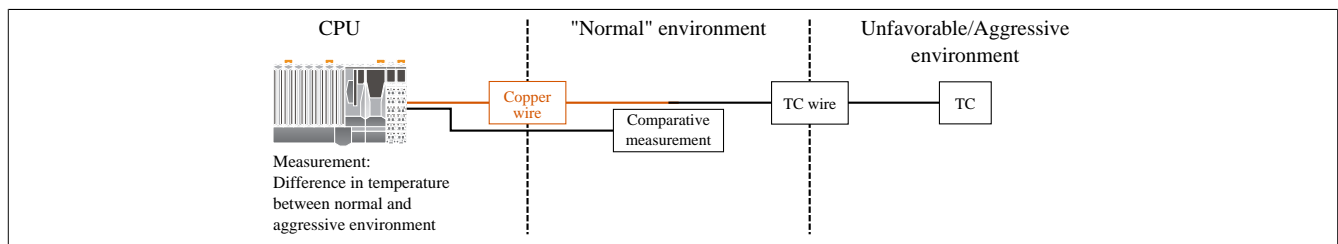


A measurement resistor often used in this method is the PT1000. Measuring the electrical resistance can be used to determine the absolute temperature at the measurement point for a temperature range of approximately -200°C to 850°C.

Method 2: Indirect measurement using thermocouples

Thermocouples are primarily used whenever it is not possible to use measurement resistors, for example because the environment directly around the measurement point contains aggressive gases.

This method of measuring bears on the basics of the thermoelectric effect. The module measures an electrical voltage, which can then be used to derive the difference in temperature.



Thermocouple modules from B&R prepare the temperature value at the measurement point as an absolute value. The measured temperature difference is referenced against another temperature that is usually measured directly at another location (see method 1).

Information:

In the best case, the temperature at the location where the thermocouple crosses an inexpensive copper cable is used as the reference or compensation value.

9.32.1 Summary

| Model number | Short description | Page |
|--------------|--|------|
| X20AT2222 | X20 temperature input module, 2 inputs for resistance measurement, PT100, PT1000, resolution 0.1°C, 3-wire connections | 3649 |
| X20AT2311 | X20 temperature input module, 2 resistance measurement inputs, PT100, resolution 0.001°C, 4-wire connections | 3659 |
| X20AT2402 | X20 temperature input module, 2 thermocouple inputs, Type J, K, N, S, B, R, resolution 0.1°C | 3667 |
| X20AT4222 | X20 temperature input module, 4 inputs for resistance measurement, PT100, PT1000, resolution 0.1°C, 3-wire connections | 3679 |
| X20AT4232 | X20 temperature input module, 4 inputs for resistance measurement, NTC 10 kΩ, resolution 0.1°C, 2-wire connections | 3689 |
| X20AT6402 | X20 temperature input module, 6 thermocouple inputs, Type J, K, N, S, B, R, resolution 0.1°C | 3698 |
| X20ATA312 | X20 temperature input module, 2 inputs for resistance measurement, PT100, resolution 0.01°C, 4-wire connections, NetTime function | 3710 |
| X20ATA492 | X20 temperature input module, 2 thermocouple inputs, type J, K, N, S, B, R, E, C, T, single-channel isolation, NetTime function, 2x PT1000 integrated in terminal block X20TB1E for temperature compensation, order terminal block separately. | 3723 |
| X20ATB312 | X20 temperature input module, 4 inputs for resistance measurement, PT100, resolution 0.01°C, 4-wire connections, NetTime function | 3742 |
| X20ATC402 | X20 temperature input module, 6 thermocouple inputs, type J, K, N, S, B, R, E, C, T, NetTime function, 2x PT1000 integrated in terminal block X20TB1E for temperature compensation, order terminal block separately. | 3755 |
| X20cAT2311 | X20 temperature input module, coated, 2 resistance measurement inputs, PT100, resolution 0.001°C, 4-wire connections | 3659 |
| X20cAT4222 | X20 temperature input module, coated, 4 inputs for resistance measurement, PT100, PT1000, resolution 0.1°C, 3-wire connections | 3679 |
| X20cAT6402 | X20 temperature input module, coated, 6 thermocouple inputs, Type J, K, N, S, B, R, resolution 0.1°C | 3698 |

9.32.2 X20AT2222

Data sheet version: 3.19

9.32.2.1 General information

The module is equipped with 2 inputs for PT100/PT1000 resistance temperature measurement.

This module is designed for X20 6-pin terminal blocks. If needed (e.g. for logistical reasons), the 12-pin terminal block can also be used.

- 2 inputs for resistance temperature measurement
- For PT100 and PT1000
- Configurable sensor type per channel
- Direct resistance measurement
- Configurable 2- or 3- wire connections per module
- Configurable filter time

9.32.2.2 Order data


| Model number | Short description | Figure |
|--------------|--|--|
| | Temperature measurement |  |
| X20AT2222 | X20 temperature input module, 2 inputs for resistance measurement, PT100, PT1000, resolution 0.1°C, 3-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |

Table 635: X20AT2222 - Order data

9.32.2.3 Technical data

| Model number | X20AT2222 |
|--|--|
| Short description | |
| I/O module | 2 inputs for PT100 or PT1000 resistance temperature measurement |
| General information | |
| B&R ID code | 0x1BA6 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Inputs | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 1.1 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Resistance measurement temperature inputs | |
| Input | Resistance measurement with constant current supply for 2- or 3-wire connections |
| Digital converter resolution | 16-bit |
| Filter time | Configurable between 1 ms and 66.7 ms |
| Conversion time | |
| 1 channel | 20 ms with 50 Hz filter |
| 2 channels | 80 ms with 50 Hz filter |
| Conversion procedure | Sigma Delta |
| Output format | INT or UINT for resistance measurement |
| Sensor | |
| Sensor type | Configurable per channel |
| PT100 | -200 to 850°C |
| PT1000 | -200 to 850°C |
| Resistance measurement range | 0.1 to 4500 Ω / 0.05 to 2250 Ω |
| Input filter | 1st-order low pass / cutoff frequency 500 Hz |
| Sensor standard | EN 60751 |
| Common-mode range | >0.7 V |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Linearization method | Internal |
| Measurement current | 250 μA ±1.25% |
| Reference | 4530 Ω ±0.1% |
| Permissible input signal | Short-term max. ±30 V |
| Max. error at 25°C | |
| Gain | 0.037% ¹⁾ |
| Offset | 0.0015% ²⁾ |
| Max. gain drift | 0.004 %/°C ¹⁾ |
| Max. offset drift | 0.00015 %/°C ²⁾ |
| Nonlinearity | <0.001% ²⁾ |
| Crosstalk between channels | <-93 dB |
| Temperature sensor resolution | |
| PT100 | 1 LSB = 0.1°C |
| PT1000 | 1 LSB = 0.1°C |
| Resistance measurement resolution | |
| G = 1 | 0.1 Ω |
| G = 2 | 0.05 Ω |
| Common-mode rejection | |
| 50 Hz | >80 dB |
| DC | >95 dB |

Table 636: X20AT2222 - Technical data


| Model number | X20AT2222 |
|---|---|
| Standardized range of values for resistance measurement | |
| G = 1 | 0.1 to 4500 Ω |
| G = 2 | 0.05 to 2250 Ω |
| Temperature sensor normalization | |
| PT100 | -200.0 to 850.0°C |
| PT1000 | -200.0 to 850.0°C |
| Temperature measurement monitoring | |
| Range undershoot | 0x8001 |
| Range overshoot | 0x7FFF |
| Open circuit | 0x7FFF |
| General fault | 0x8000 |
| Open inputs | 0x7FFF |
| Resistance measurement monitoring | |
| Range overshoot | 0xFFFF |
| Open circuit | 0xFFFF |
| General fault | 0xFFFF |
| Open inputs | 0xFFFF |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB06 or X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 636: X20AT2222 - Technical data

- 1) Based on the current resistance value.
- 2) Based on the entire resistance measurement range.

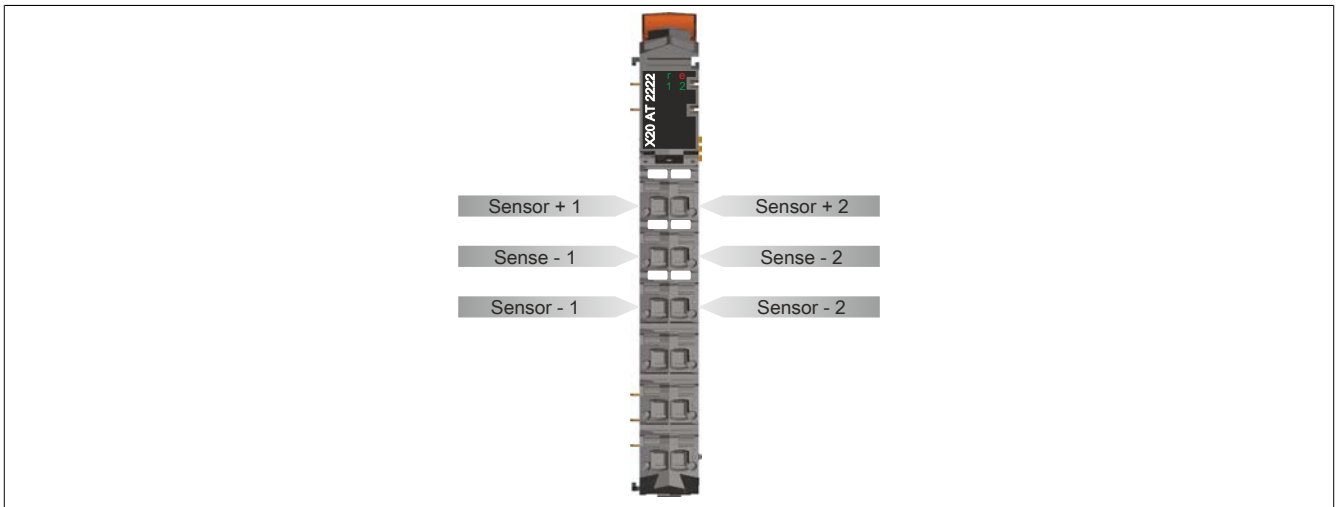
9.32.2.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

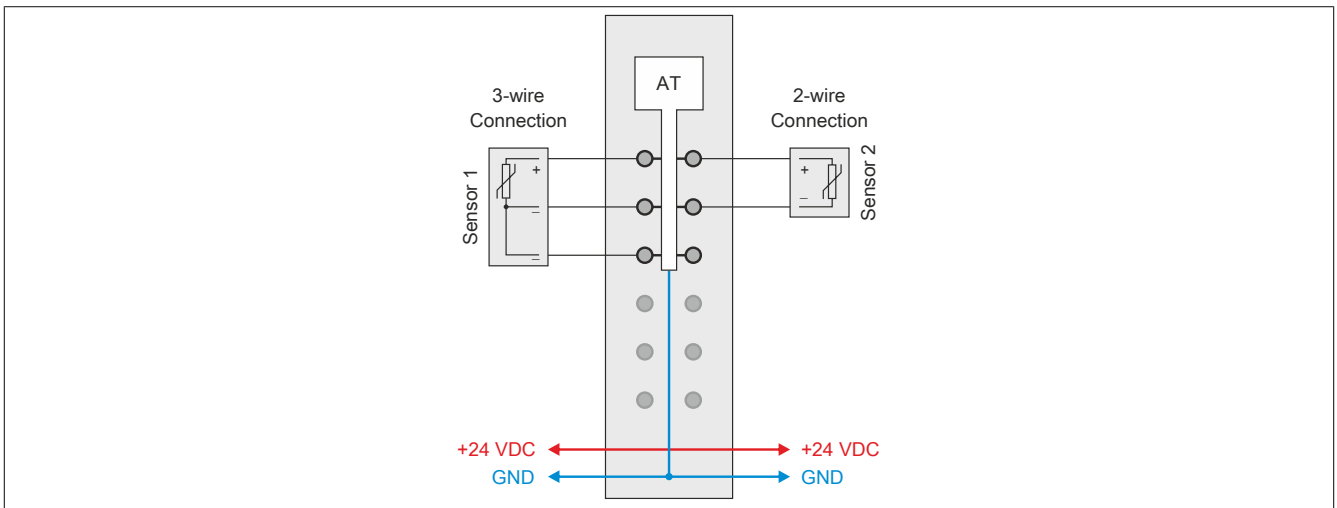
| Figure | LED | Color | Status | Description |
|---|-------|-----------------------------|--|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | | | Single flash | Warning/Error on an I/O channel. Overflow or underflow of the analog inputs. |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1 - 2 | Green | Off | The input is switched off |
| | | | Blinking | Overflow, underflow or open line |
| On | | | Analog/digital converter running, value OK | |

9.32.2.5 Pinout

Channels that are not being used should be disabled.

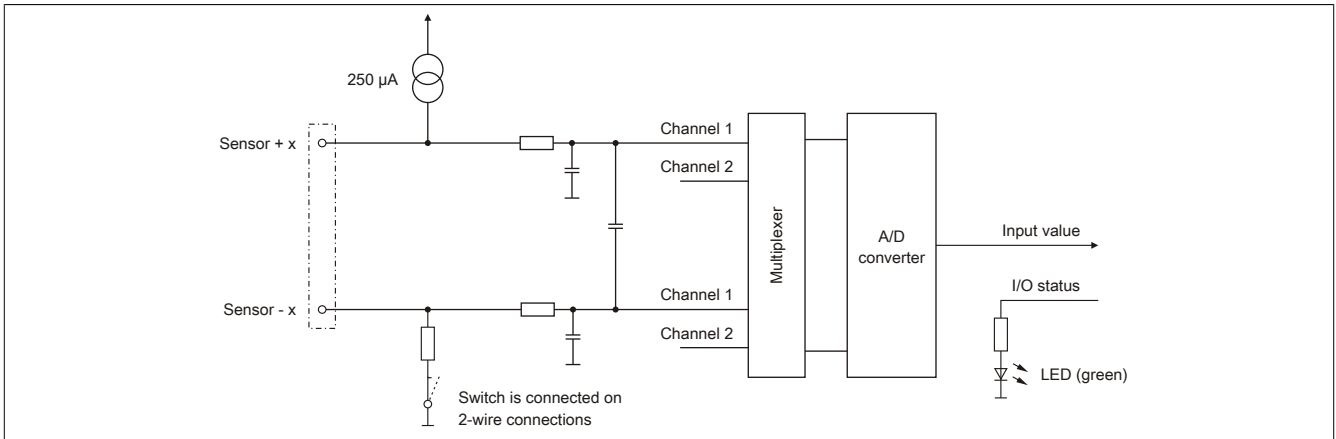


9.32.2.6 Connection example

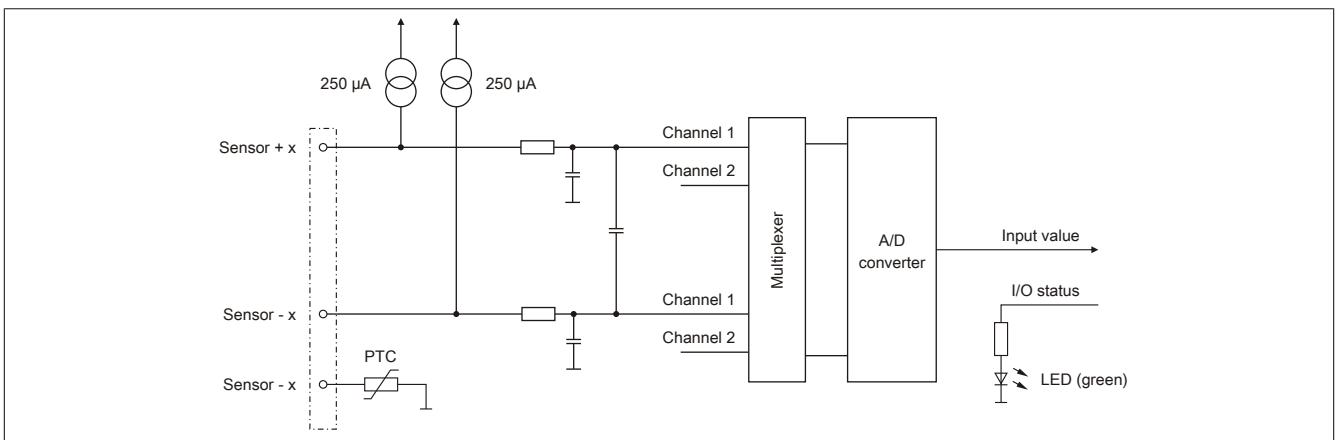


9.32.2.7 Input circuit diagram

2-wire connections



3-wire connections



9.32.2.8 Register description

9.32.2.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.32.2.8.2 Function model 0 - "3-wire connections" and function model 1 - "2-wire connections"

For this module, the connection type is selected using function models 0 and 1.

| Function model | Connection type |
|----------------|-------------------------------|
| 0 | 3-wire connections (standard) |
| 1 | 2-wire connections |

The registers used are identical for both function models:

| Register | Name | Data type | Read | | Write | |
|----------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 16 | ConfigOutput01 (Input filter) | USINT | | | | • |
| 18 | ConfigOutput02 (Sensor configuration) | USINT | | | | • |
| Communication | | | | | | |
| 0 | Temperature01 | INT | • | | | |
| | Resistor01 | UINT | | | | |
| 2 | Temperature02 | INT | • | | | |
| | Resistor02 | UINT | | | | |
| 28 | IOCycleCounter | USINT | • | | | |
| 30 | StatusInput01 | USINT | • | | | |

9.32.2.8.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 16 | - | ConfigOutput01 (Input filter) | USINT | | | | • |
| 18 | - | ConfigOutput02 (Sensor configuration) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | Temperature01 | INT | • | | | |
| | 0 | Resistor01 | UINT | | | | |
| 2 | 2 | Temperature02 | INT | • | | | |
| | 2 | Resistor02 | UINT | | | | |
| 28 | - | IOCycleCounter | USINT | | • | | |
| 30 | - | StatusInput01 | USINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.32.2.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.32.2.8.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.32.2.8.4 General information

9.32.2.8.4.1 Analog inputs

The module outputs the converted analog values to the registers. Other ranges of values or data types result depending on resistance or temperature measurement.

Information:

Operating channels outside specifications can affect neighboring channels.

9.32.2.8.4.2 Timing

The timing for acquiring measured values is controlled by the converter hardware. All switched-on inputs are converted during each conversion cycle and transferred halfway through the X2X Link cycle.

9.32.2.8.4.3 Conversion time

The conversion time for the channels depends on their use. For the formulas listed in the table, "n" corresponds to the number of channels that are switched on.

| Use of the channels | Conversion time |
|--|--|
| 1 channel | 1 · Filter time |
| n channels with the same sensor type | $n \cdot (20 \text{ ms} + \text{Filter time})$ |
| n channels with different sensor types | $n \cdot (20 \text{ ms} + 2 \cdot \text{Filter time})$ |

9.32.2.8.4.4 Reduced update time

Any inputs that are not needed can be switched off, which reduces the I/O update time. Inputs can also be only switched off temporarily.

The time saved corresponds to the following:

$$\text{Time saved} = 2 \cdot 20 \text{ ms} + \text{Filter time}$$

The conversion time for the remaining channel corresponds to the filter time.

Examples

Inputs are filtered using a 60 Hz filter.

| | Example 1 | Example 2 |
|--------------------|-----------|-----------|
| Switched on inputs | 1 | 1 to 2 |
| Conversion time | 16.7 ms | 73.4 ms |

9.32.2.8.5 Configuration

9.32.2.8.5.1 Input filter

Name:

ConfigOutput01

The filter time of all analog inputs is defined in this register.

| Data type | Value | Filter | Filter time |
|-----------|-------|--|-------------|
| USINT | 0 | 15 Hz | 66.7 ms |
| | 1 | 25 Hz | 40 ms |
| | 2 | 30 Hz | 33.3 ms |
| | 3 | 50 Hz (bus controller default setting) | 20 ms |
| | 4 | 60 Hz | 16.7 ms |
| | 5 | 100 Hz | 10 ms |
| | 6 | 500 Hz | 2 ms |
| | 7 | 1000 Hz | 1 ms |

9.32.2.8.5.2 Sensor configuration

Name:

ConfigOutput02

This register can be used to configure the sensor type for individual channels.

This module is designed for temperature and resistance measurement. The sensor type must be specified because of the different calibration values for temperature and resistance.

The default setting for all channels is ON. To save time, individual channels can be switched off (see "[Reduced update time](#)" on page 3655).

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| USINT | See bit structure. | 34 |

Bit structure:

| Bit | Name | Value | Information | | |
|-------------|--|-------------|--|-------------|--|
| 0 - 3 | Channel 1 | 0000 - 0001 | Reserved | | |
| | | 0010 | Sensor type PT100 (bus controller default setting) | | |
| | | 0011 | PT1000 sensor type | | |
| | | 0100 | Reserved (channel switched off) | | |
| | | 0101 | Resistance measurement 0.1 to 4500 Ω | | |
| | | 0110 | Resistance measurement 0.05 to 2250 Ω | | |
| | | 0111 | Channel switched off | | |
| | | 1000 - 1111 | Reserved | | |
| | | 4 - 7 | Channel 2 | 0000 - 0001 | Reserved |
| | | | | 0010 | Sensor type PT100 (bus controller default setting) |
| 0011 | PT1000 sensor type | | | | |
| 0100 | Reserved (channel switched off) | | | | |
| 0101 | Resistance measurement 0.1 to 4500 Ω | | | | |
| 0110 | Resistance measurement 0.05 to 2250 Ω | | | | |
| 0111 | Channel switched off | | | | |
| 1000 - 1111 | Reserved | | | | |

9.32.2.8.6 Communication

9.32.2.8.6.1 Input values of analog inputs

Name:

Temperature01 to Temperature02

Resistor01 to Resistor02

This register contains the analog input values depending on the configured operating mode.

| Data type | Digital value | Input signal |
|-----------|---------------------------------------|---------------------------------------|
| INT | -2000 to 8500 (for -200.0 to 850.0°C) | PT100 sensor type |
| | -2000 to 8500 (for -200.0 to 850.0°C) | PT1000 sensor type |
| UINT | 1 to 45000 (resolution 0.1 Ω) | Resistance measurement 0.1 to 4500 Ω |
| | 1 to 45000 (resolution 0.05 Ω) | Resistance measurement 0.05 to 2250 Ω |

In order for the user to always be supplied with a defined output value, the following must be taken into consideration:

- Up to the first conversion, 0x8000 is output.
- After switching the operating mode until the first conversion:
 - From "Resistance measurement" to "Sensor type PTxx": 0x8000
 - From "Sensor type PTxx" to "Resistance measurement": 0xFFFF
- If the input is not switched on, 0x8000 is output.

9.32.2.8.6.2 I/O cycle counter

Name:

IOCycleCounter

The cyclic counter increases after all input data has been updated.

| Data type | Values | Information |
|-----------|----------|-------------------|
| USINT | 0 to 255 | Repeating counter |

9.32.2.8.6.3 Input status

Name:

StatusInput01

The module's inputs are monitored. A change in the monitoring status generates an error message.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|----------------------------|
| 0 - 1 | Channel 1 | 00 | No error |
| | | 01 | Lower limit value exceeded |
| | | 10 | Upper limit value exceeded |
| | | 11 | Open line |
| 2 - 3 | Channel 2 | 00 | No error |
| | | 01 | Lower limit value exceeded |
| | | 10 | Upper limit value exceeded |
| | | 11 | Open line |
| 4 - 7 | | 0 | |

Limiting the analog value

In addition to the status information, the analog value is set to the values listed below by default when an error occurs.

| Error status | Temperature measurement Digital value for error | Resistance measurement Digital value for error |
|----------------------------|---|---|
| Open line | 32767 (0x7FFF) | 65535 (0xFFFF) |
| Upper limit value exceeded | 32767 (0x7FFF) | 65535 (0xFFFF) |
| Lower limit value exceeded | -32767 (0x8001) | 0 (0x0000) |
| Invalid value | -32768 (0x8000) ¹⁾ 32767 (0x7FFF) ²⁾ 65535 (0xFFFF) ³⁾ | 65535 (0xFFFF) |

- 1) Default value or channel was disabled in the I/O configuration.
- 2) After switching off the channel during operation.
- 3) Value in function model 254 - Bus controller.

9.32.2.8.7 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|--|
| 100 μ s | |

9.32.2.8.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|--|
| 1 input | Equal to the filter time |
| 2 inputs | $2 \cdot 20 \text{ ms} + \text{filter time}$ |

9.32.3 X20(c)AT2311

Data sheet version: 3.20

9.32.3.1 General information

The module is equipped with 2 inputs for PT100 4-line resistance temperature measurement.

- 2 inputs for resistance temperature measurement
- PT100 sensor
- Direct resistance measurement
- 4-wire measurement
- Configurable filter time

9.32.3.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.32.3.3 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Temperature measurement |  |
| X20AT2311 | X20 temperature input module, 2 resistance measurement inputs, PT100, resolution 0.001°C, 4-wire connections | |
| X20cAT2311 | X20 temperature input module, coated, 2 resistance measurement inputs, PT100, resolution 0.001°C, 4-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 637: X20AT2311, X20cAT2311 - Order data

9.32.3.4 Technical data

| Model number | X20AT2311 | X20cAT2311 |
|--|--|------------|
| Short description | | |
| I/O module | 2 inputs for PT100 resistance temperature measurement | |
| General information | | |
| B&R ID code | 0xA4AA | 0xF3B6 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using LED status indicator and software | |
| Inputs | Yes, using LED status indicator and software | |
| Power consumption | | |
| Bus | 0.35 W | |
| Internal I/O | 0.85 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| KC | Yes | - |
| EAC | Yes | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | - |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| KR | Yes | |
| Resistance measurement temperature inputs | | |
| Input | Resistance measurement with constant current supply for 4-wire connections | |
| Digital converter resolution | 24-bit | |
| Filter time | Configurable between 1 ms and 400 ms | |
| Conversion time | | |
| 1000 Hz filter | 1 ms for all inputs | |
| 50 Hz filter | 20 ms for all inputs | |
| Conversion procedure | Sigma-delta | |
| Output format | DINT or UDINT for resistance measurement | |
| Temperature measurement range | -200 to 850°C | |
| Resistance measurement range | 0.5 to 390 Ω | |
| Temperature sensor resolution | 1 LSB = 0.001°C | |
| Resistance measurement resolution | 0.001 Ω | |
| Input filter | First-order low-pass filter / cutoff frequency 1050 Hz | |
| Sensor standard | EN 60751 | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Isolation voltage between channel and channel | 500 V _{eff} | |
| Linearization method | Internal | |
| Measurement current | 1 mA | |
| Temperature sensor normalization | -200.0 to 850.0°C | |
| Reference | 1568 Ω ±0.1% | |
| Permissible input signal | Short-term max. 28.8 V | |
| Max. error at 25°C ¹⁾ | | |
| Gain | 0.0059% ²⁾ | |
| Offset | 0.0015% ³⁾ | |
| Max. gain drift | <0.00065 %/°C ²⁾ | |
| Max. offset drift | <0.000025 %/°C ³⁾ | |
| Nonlinearity | <0.001% ³⁾ | |
| Standardized range of values for resistance measurement | 0.5 Ω to 390 Ω | |
| Temperature measurement monitoring | | |
| Range undershoot | 0x80000001 | |
| Range overshoot | 0x7FFFFFFF | |
| Open circuit | 0x7FFFFFFF | |
| General fault | 0x80000000 | |
| Open inputs | 0x7FFFFFFF | |
| Resistance measurement monitoring | | |
| Range undershoot | 0x80000001 | |
| Range overshoot | 0xFFFFFFFF | |
| Open circuit | 0xFFFFFFFF | |
| General fault | 0x80000000 | |

Table 638: X20AT2311, X20cAT2311 - Technical data


| Model number | X20AT2311 | X20cAT2311 |
|--|--|---|
| Electrical properties | | |
| Electrical isolation | Channel isolated from channel and bus | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitation | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | -25 to 60°C | |
| Vertical mounting orientation | -25 to 50°C | |
| Derating | | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x terminal block X20TB12 separately. Order 1x bus module X20BM11 separately. | Order 1x terminal block X20TB12 separately. Order 1x bus module X20cBM11 separately. |
| Spacing | 12.5 ^{+0.2} mm | |

Table 638: X20AT2311, X20cAT2311 - Technical data

- 1) To ensure accuracy, dummy module ZF0000 must be connected to the left and right of module AT2311.
- 2) Based on the current resistance value.
- 3) Based on the entire resistance measurement range.

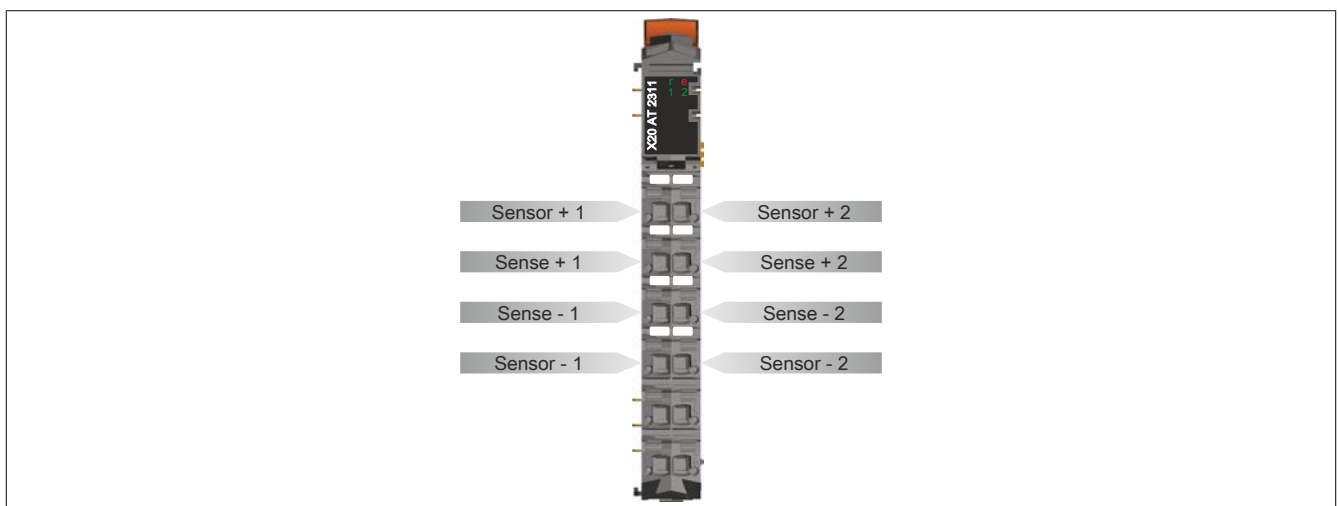
9.32.3.5 LED status indicators

For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|-----------------------------|------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | | | Single flash | Warning/Error on an I/O channel. Overflow or underflow of the analog inputs. |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1 - 2 | Green | Off | The input is switched off |
| | | | Blinking | Overflow, underflow or open line |
| | | | On | Analog/digital converter running, value OK |

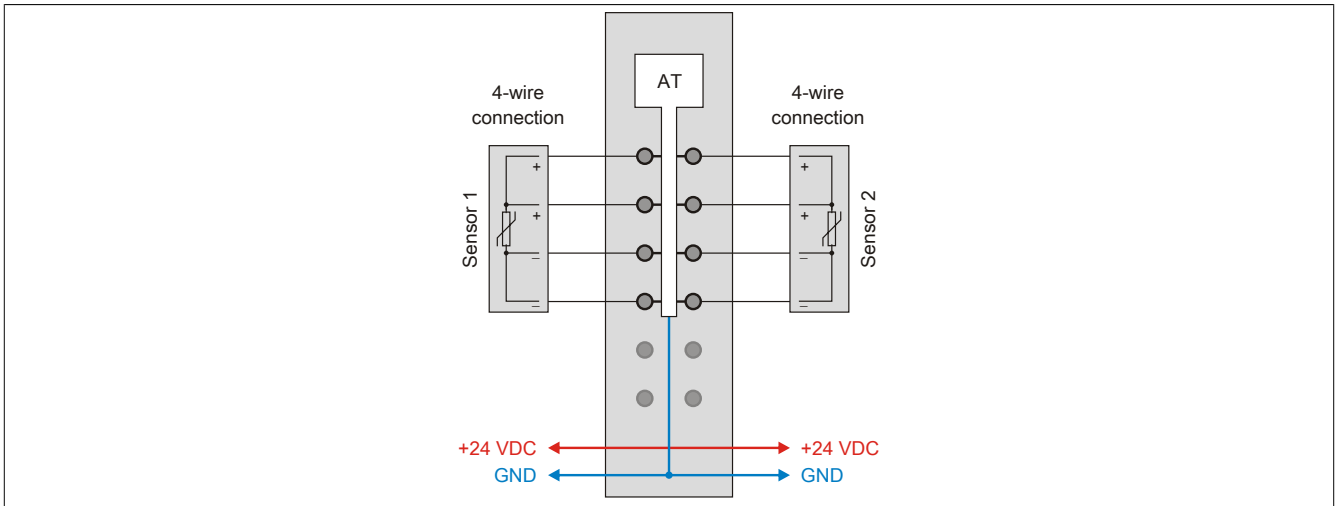
- 1) Depending on the configuration, a firmware update can take up to several minutes.

9.32.3.6 Pinout

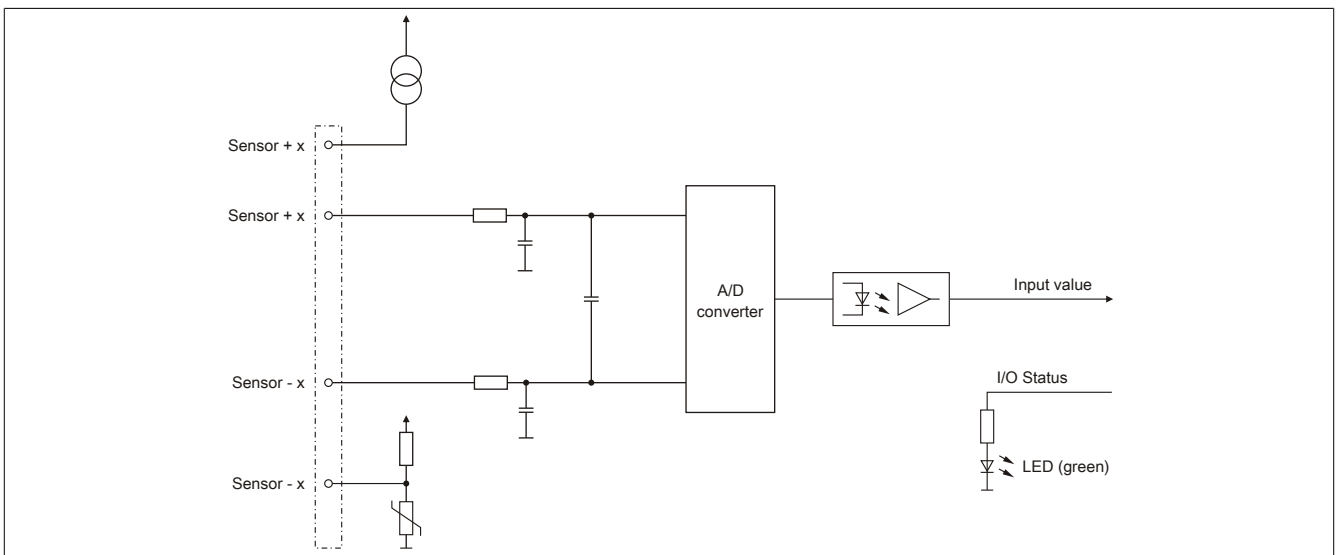


9.32.3.7 Connection example

To ensure accuracy, a ZF dummy module must be inserted on the left and right of the module.



9.32.3.8 Input circuit diagram



9.32.3.9 Register description

9.32.3.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.32.3.9.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 2049 | ConfigOutput01 (input filter) | USINT | | | | • |
| 2051 | ConfigOutput02 (sensor type and channel disabling) | USINT | | | | • |
| Communication | | | | | | |
| 2308 | Temperature01 | DINT | • | | | |
| | Resistor01 | UDINT | | | | |
| 2316 | Temperature02 | DINT | • | | | |
| | Resistor02 | UDINT | | | | |
| 2337 | IOCycleCounter | USINT | • | | | |
| 2345 | StatusInput01 | USINT | • | | | |

9.32.3.9.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 2049 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| 2051 | - | ConfigOutput02 (sensor type and channel disabling) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | Temperature01 | DINT | • | | | |
| | | Resistor01 | UDINT | | | | |
| 4 | 4 | Temperature02 | DINT | • | | | |
| | | Resistor02 | UDINT | | | | |
| 2337 | - | IOCycleCounter | USINT | | • | | |
| 2345 | - | StatusInput01 | USINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.32.3.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.32.3.9.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.32.3.9.4 General information

9.32.3.9.4.1 Timing

The timing for acquiring measured values is controlled by the converter hardware. All switched-on inputs are converted during each conversion cycle and transferred halfway through the X2X Link cycle.

9.32.3.9.4.2 Conversion time

The conversion time for the channels depends on the filter time configured in the "ConfigOutput1" on page 3664 register.

| Channel uses | Conversion time |
|---|-----------------|
| All channels independent of the configuration | 1x filter time |

9.32.3.9.4.3 Ratio of filter time to resolution

The following table shows the maximum frequency with which the specified resolution can be achieved.

| Filter / Filter time | Resolution |
|----------------------|------------|
| 5 Hz / 200 ms | 0.001°C |
| 50 Hz / 20 ms | 0.01°C |
| 1000 Hz / 1 ms | 0.1°C |

9.32.3.9.5 Configuration

9.32.3.9.5.1 Input filter

Name:
ConfigOutput01

This register can be used to configure the filter time for all analog inputs.

| Data type | Value | Filter | Filter time |
|-----------|-------|--|-------------|
| USINT | 0 | 15 Hz | 66.7 ms |
| | 1 | 25 Hz | 40 ms |
| | 2 | 30 Hz | 33.3 ms |
| | 3 | 50 Hz | 20 ms |
| | 4 | 60 Hz | 16.7 ms |
| | 5 | 100 Hz | 10 ms |
| | 6 | 500 Hz | 2 ms |
| | 7 | 1000 Hz | 1 ms |
| | 8 | 10 Hz (bus controller default setting) | 100 ms |
| | 9 | 5 Hz | 200 ms |
| | 10 | 25 Hz | 400 ms |

9.32.3.9.5.2 Sensor type and channel disabling

Name:

ConfigOutput02

This register can be used to configure the sensor type for individual channels.

This module is designed for temperature and resistance measurement. The sensor type must be specified because of the different calibration values for temperature and resistance.

The default setting for all channels is ON.

| Data type | Value | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| USINT | See bit structure. | 17 |

Bit structure:

| Bit | Name | Value | Information |
|-------|-----------|--------------|---|
| 0 - 3 | Channel 1 | 0000 | Reserved |
| | | 0001 | Sensor type PT100 resolution 1mK (bus controller default setting) |
| | | 0010 | Resistance measurement 0.5 Ω to 390 Ω , resolution 1 m Ω |
| | | 0011 to 0110 | Reserved |
| | | 0111 | Channel disabled |
| | | 1xxx | Reserved |
| 4 - 7 | Channel 2 | 0000 | Reserved |
| | | 0001 | Sensor type PT100 resolution 1mK (bus controller default setting) |
| | | 0010 | Resistance measurement 0.5 Ω to 390 Ω , resolution 1 m Ω |
| | | 0011 to 0110 | Reserved |
| | | 0111 | Channel disabled |
| | | 1xxx | Reserved |

9.32.3.9.6 Communication

9.32.3.9.6.1 Analog measurement inputs

Name:

Temperatur01 to Temperatur02

Resistor01 to Resistor02

These registers are used to indicate the analog input values depending on the configured operating mode. Different resistance or temperature measurements will result in different value ranges and data types.

| Name | Data type | Input signal | Digital value |
|------------------------------|-----------|--|--|
| Temperatur01 to Temperatur02 | DINT | PT100 sensor type | -200000 to +850000 (for -200 to +850°C) |
| Resistor01 to Resistor02 | UDINT | Resistance measurement 0.5 to 390 Ω | 500 to 390000 (resolution 0.001 Ω) |

In order for the user to always be supplied with a defined output value, the following must be taken into consideration:

- Up to the first conversion, 0x80000000 is output.
- After switching the sensor type, 0x80000000 is output until the first conversion.
- If the input is not switched on, 0x80000000 is output.

9.32.3.9.6.2 I/O cycle counter

Name:

IOCycleCounter

The cyclic counter increases after all input data has been updated.

| Data type | Values | Information |
|-----------|----------|-------------------|
| USINT | 0 to 255 | Repeating counter |

9.32.3.9.6.3 Input status

Name:
StatusInput01

The module's inputs are monitored. A change in the monitoring status generates an error message.
After an error, it takes about 15 filter times until a valid value is available again.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|-----------|-------|----------------------------|
| 0 - 1 | Channel 1 | 00 | No error |
| | | 01 | Lower limit value exceeded |
| | | 10 | Upper limit value exceeded |
| | | 11 | Open line |
| 2 - 3 | Channel 2 | 00 | No error |
| | | 01 | Lower limit value exceeded |
| | | 10 | Upper limit value exceeded |
| | | 11 | Open line |
| 4 - 7 | Reserved | 0 | |

Analog value in the event of error

In addition to the status info, the error type also sets the analog value as follows:

| Error status | Temperature measurement - Digital value for error | Resistance measurement - Digital value for error |
|----------------------------|---|--|
| Open line | +2147483647 (0x7FFFFFFF) | +4294967295 (0xFFFFFFFF) |
| Upper limit value exceeded | +2147483647 (0x7FFFFFFF) | +4294967295 (0xFFFFFFFF) |
| Lower limit value exceeded | -2147483647 (0x80000001) | -2147483647 (0x80000001) |
| Invalid value | -2147483648 (0x80000000) | -2147483648 (0x80000000) |

9.32.3.9.7 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μ s |

9.32.3.9.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time |
|-------------------------|
| 1x filter time |

9.32.4 X20AT2402

Data sheet version: 3.09

9.32.4.1 General information

The module is equipped with 2 inputs for J, K, N, S, B and R thermocouple sensors. The module has an integrated terminal temperature compensation.

This module is designed for X20 6-pin terminal blocks. If needed (e.g. for logistical reasons), the 12-pin terminal block can also be used.

- 2 inputs for thermocouples
- For sensor types J, K, N, S, B, R
- Additional direct raw value measurement
- Integrated terminal temperature compensation
- Configurable filter time

9.32.4.2 Order data


| Model number | Short description | Figure |
|--------------|--|--|
| | Temperature measurement |  |
| X20AT2402 | X20 temperature input module, 2 thermocouple inputs, Type J, K, N, S, B, R, resolution 0.1°C | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |

Table 639: X20AT2402 - Order data

9.32.4.3 Technical data

| | |
|--|--|
| Model number | X20AT2402 |
| Short description | |
| I/O module | 2 inputs for thermocouples |
| General information | |
| B&R ID code | 0x1BA8 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Inputs | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 0.72 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Thermocouple temperature inputs | |
| Input | Thermocouple |
| Digital converter resolution | 16-bit |
| Filter time | Configurable between 1 ms and 66.7 ms |
| Conversion time | |
| 1 channel | 80.4 ms with 50 Hz filter |
| 2 channels | 120.6 ms with 50 Hz filter |
| Output format | INT |
| Measurement range | |
| Sensor temperature | |
| Type J: Fe-CuNi | -210 to 1200°C |
| Type K: NiCr-Ni | -270 to 1372°C |
| Type N: NiCrSi-NiSi | -270 to 1300°C (Rev. ≥D0) |
| Type S: PtRh10-Pt | -50 to 1768°C |
| Type B: PtRh30-PtRh6 | 0 to 1820°C |
| Type R: PtRh13-Pt | -50 to 1664°C |
| Terminal temperature | -25 to 85°C |
| Raw value | ±65.534 mV |
| Terminal temperature compensation | Internal |
| Sensor standard | EN 60584 |
| Resolution | |
| Sensor temperature | 1 LSB = 0.1°C |
| Terminal temperature | 1 LSB = 0.1°C |
| Raw value output with respect to gain | 1 LSB = 1 µV or 2 µV |
| Normalization | |
| Type J | -210.0 to 1200.0°C |
| Type K | -270.0 to 1372.0°C |
| Type N (Rev. ≥D0) | -270.0 to 1300.0°C |
| Type S | -50.0 to 1768.0°C |
| Type B | 0 to 1820.0°C |
| Type R | -50.0 to 1664.0°C |
| Terminal temperature | -25.0 to 85.0°C |
| Monitoring | |
| Range undershoot | 0x8001 |
| Range overshoot | 0x7FFF |
| Open circuit | 0x7FFF |
| Open inputs | 0x7FFF |
| General fault | 0x8000 |
| Conversion procedure | Sigma-delta |
| Linearization method | Internal |

Table 640: X20AT2402 - Technical data


| Model number | X20AT2402 |
|---|---|
| Permissible input signal | Max. ± 5 V |
| Input filter | 1st-order low pass / cutoff frequency 500 Hz |
| Max. error at 25°C | |
| Gain | 0.06% ¹⁾ |
| Offset | |
| Type J | 0.04% ²⁾ |
| Type K | 0.05% ²⁾ |
| Type N (Rev. $\geq D0$) | 0.05% ²⁾ |
| Type S | 0.11% ²⁾ |
| Type B | 0.13% ²⁾ |
| Type R | 0.09% ²⁾ |
| Max. gain drift | 0.01 %/°C ¹⁾ |
| Max. offset drift | |
| Type J | 0.0019 %/°C ²⁾ |
| Type K | 0.0024 %/°C ²⁾ |
| Type N (Rev. $\geq D0$) | 0.0029 %/°C ²⁾ |
| Type S | 0.0079 %/°C ²⁾ |
| Type B | 0.0114 %/°C ²⁾ |
| Type R | 0.0074 %/°C ²⁾ |
| Nonlinearity | $\pm 0.001\%$ ²⁾ |
| Common-mode rejection | |
| DC | >70 dB |
| 50 Hz | >70 dB |
| Common-mode range | ± 15 V |
| Crosstalk between channels | <-70 dB |
| Isolation voltage | |
| Between channel and bus | 500 V _{eff} |
| Terminal temperature compensation precision | |
| With artificial convection | $\pm 4^\circ\text{C}$ after 10 min |
| With natural convection | $\pm 2^\circ\text{C}$ after 10 min |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | 0 to 55°C |
| Vertical mounting orientation | 0 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB06 or X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 640: X20AT2402 - Technical data

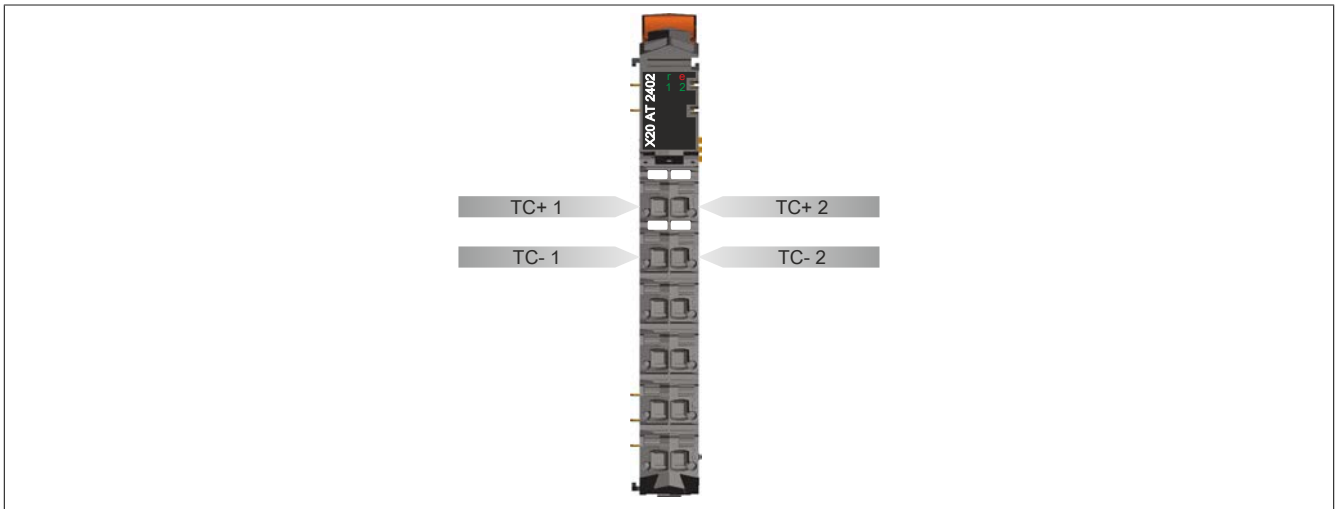
- 1) Based on the current measured value.
2) Based on the entire measurement range.

9.32.4.4 LED status indicators

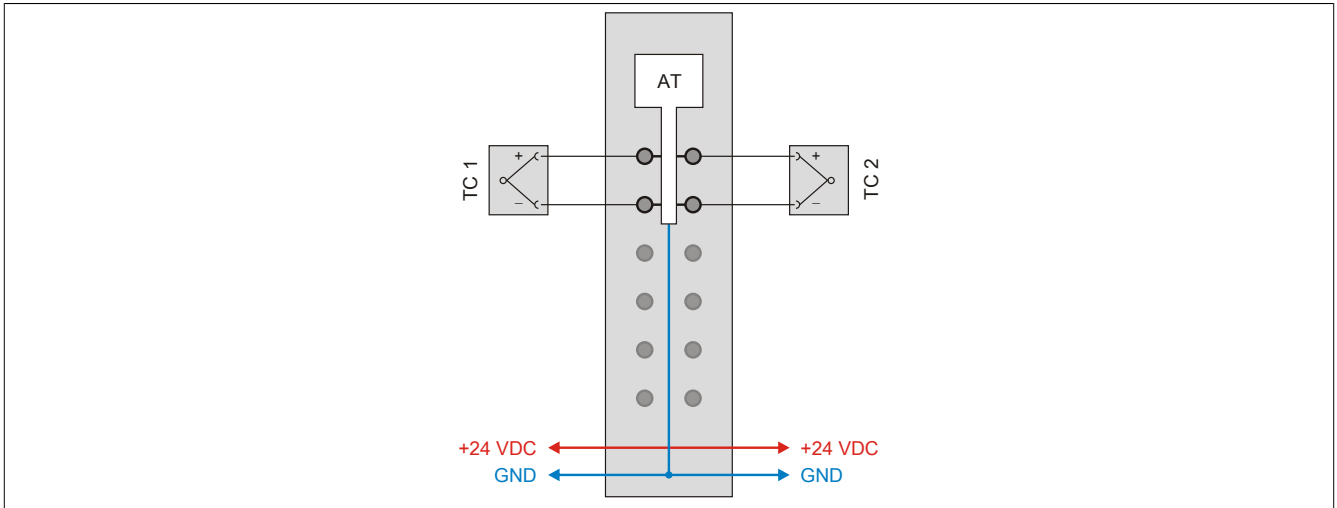
For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|-----------------------------|------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | | | Single flash | Warning/Error on an I/O channel. Overflow or underflow of the analog inputs. |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1 - 2 | Green | Off | The input is switched off |
| | | | Blinking | Overflow, underflow or open line |
| | | | On | Analog/digital converter running, value OK |

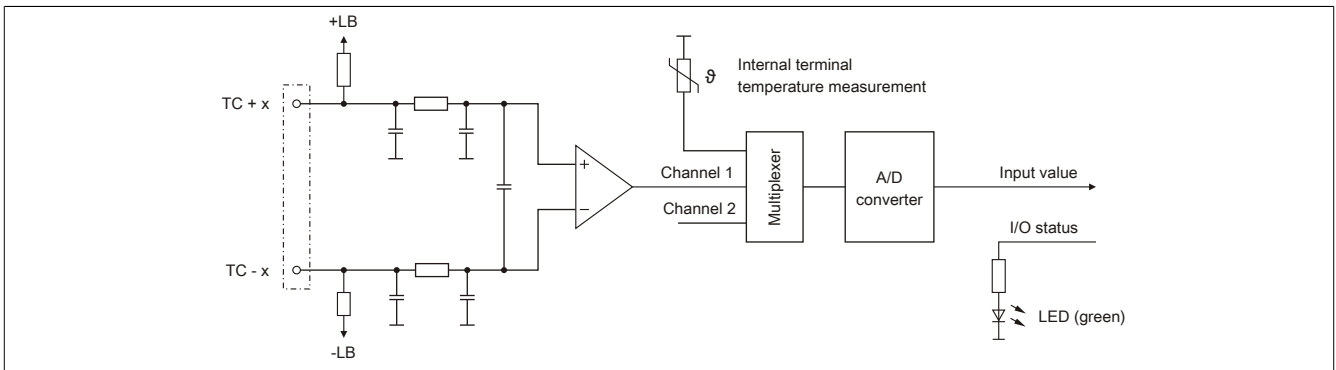
9.32.4.5 Pinout



9.32.4.6 Connection example

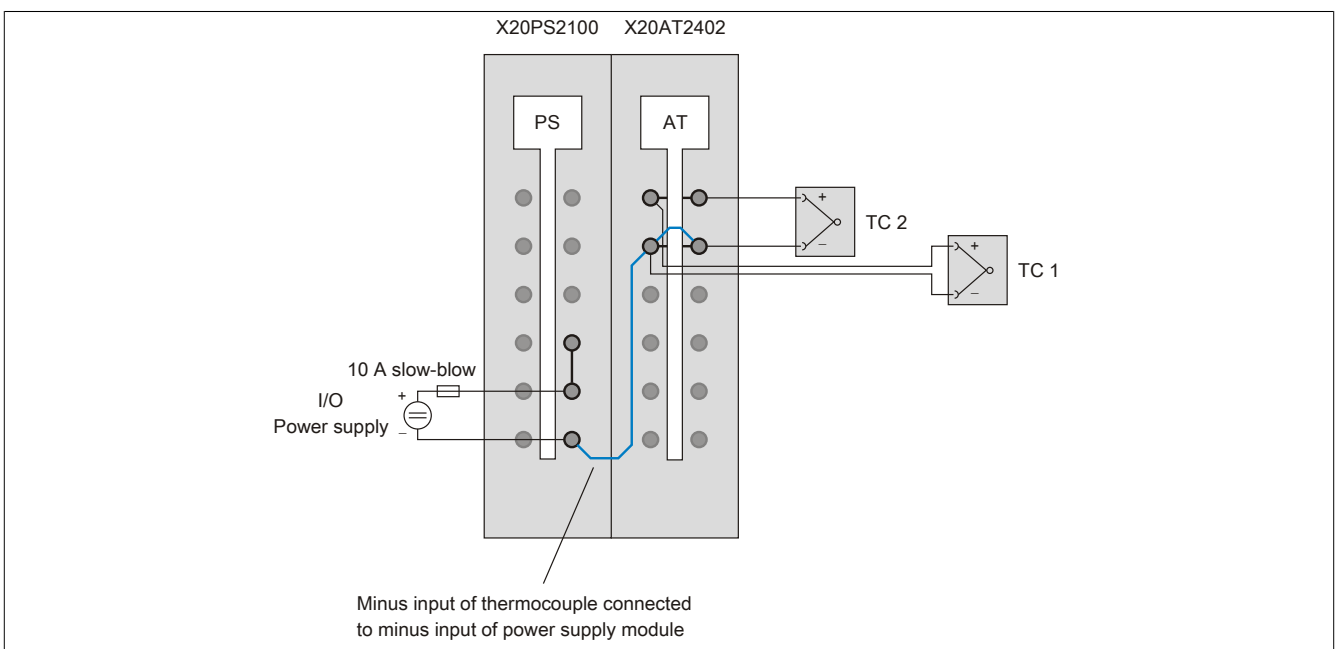


9.32.4.7 Input circuit diagram



9.32.4.8 Ceramic heating element with integrated thermo elements

We recommend connecting the minus input of the thermo element to the minus input of the supply feed module. This prevents potential measurement errors caused by ripple voltage effects in the measurement signal.



9.32.4.9 External cold junction

General information

An external cold junction temperature value can be predefined for the module for measurement value correction. This makes it possible to set up an external cold junction. The same external cold junction temperature is used for measurement value correction on all channels.

An external cold junction makes sense in the following applications and situations:

- Large distances between the controller and measurement point
- To increase precision

To bridge large distances

Setting up an external cold junction is recommended when there are large distances between the controller and the measurement point. The thermocouple voltage is routed from the external cold junction to the terminal on the X20AT2402 via copper wires. The temperature measured at the external cold junction (e.g. with PT100 - X20AT2222) is stored in the I/O area of the X20AT2402 module. The X20AT2402 uses the measured voltage and the cold junction temperature to internally calculate the needed thermocouple temperature.

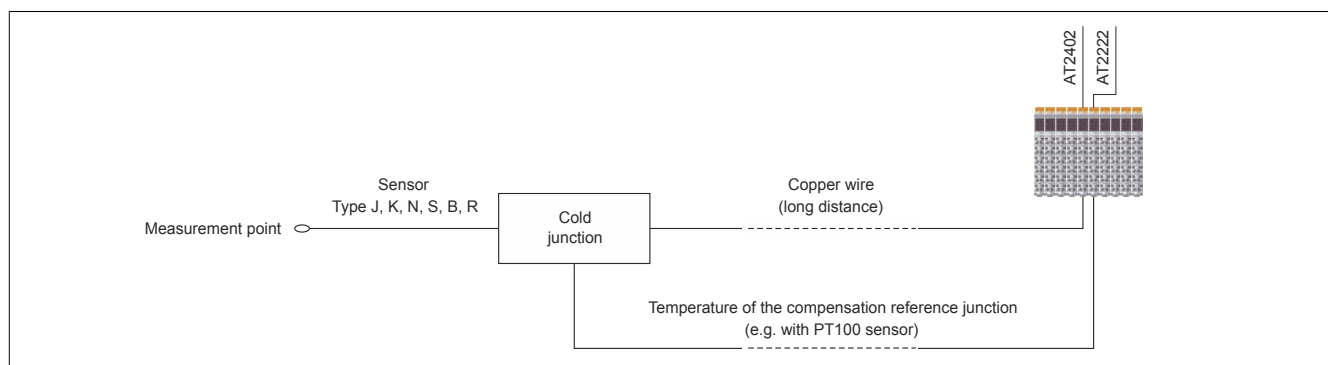


Figure 366: External cold junction for bridging large distances

Increased precision

Setting up an external cold junction is recommended to increase precision. The external cold junction is set up as described above. The installation of an external cold junction is especially helpful in the following cases:

- A module consuming more power than 1 W is connected in addition to the X20AT2402.
- No modules but the X20AT2402 are connected
- With strongly fluctuating ambient conditions (draft, temperature)

9.32.4.10 Register description

9.32.4.10.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.32.4.10.2 Function model 0 - default

| Register | Name | Data type | Read | | Write | |
|----------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 24 | ConfigOutput01 (Input filter / ambient conditions) | USINT | | | | • |
| 26 | ConfigOutput02 (Sensor type) | USINT | | | | • |
| 27 | ConfigOutput03 (Channel disabling) | USINT | | | | • |
| Communication | | | | | | |
| 0 | Temperature01 | INT | • | | | |
| 2 | Temperature02 | INT | • | | | |
| 28 | IOCycleCounter | USINT | • | | | |
| 30 | StatusInput01 | USINT | • | | | |
| 14 | CompensationTemperature | INT | | • | | |

9.32.4.10.3 Function model 1 - External cold junction temperature

| Register | Name | Data type | Read | | Write | |
|----------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 24 | ConfigOutput01 (Input filter / ambient conditions) | USINT | | | | • |
| 26 | ConfigOutput02 (Sensor type) | USINT | | | | • |
| 27 | ConfigOutput03 (Channel disabling) | USINT | | | | • |
| Communication | | | | | | |
| 12 | ExternalCompensationTemperature | INT | | | • | |
| 0 | Temperature01 | INT | • | | | |
| 2 | Temperature02 | INT | • | | | |
| 28 | IOCycleCounter | USINT | • | | | |
| 30 | StatusInput01 | USINT | • | | | |

9.32.4.10.4 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 24 | - | ConfigOutput01 (Input filter / ambient conditions) | USINT | | | | • |
| 26 | - | ConfigOutput02 (Sensor type) | USINT | | | | • |
| 27 | - | ConfigOutput03 (Channel disabling) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | Temperature01 | INT | • | | | |
| 2 | 2 | Temperature02 | INT | • | | | |
| 28 | - | IOCycleCounter | USINT | | • | | |
| 30 | - | StatusInput01 | USINT | | • | | |
| 14 | - | CompensationTemperature | INT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.32.4.10.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "[Using I/O modules on the bus controller](#)" on page 3789.

9.32.4.10.4.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.32.4.10.5 General information

9.32.4.10.5.1 Raw value measurement

If a sensor type other than J, K, N, S, B or R is used, the terminal temperature must be measured on at least one input. Based on this value, the user must then implement terminal temperature compensation.

9.32.4.10.5.2 Timing

The timing for acquiring measurement values is determined by the converter hardware. All enabled inputs are converted during each conversion cycle. In addition, the terminal temperature is measured (not in function model 1).

Any inputs that are not needed can be switched off, which reduces the I/O update time. Inputs can also be only switched off temporarily. Measuring the terminal temperature is switched off in function model 1.

9.32.4.10.5.3 Conversion time

The conversion time depends on the number of channels and the function model. For the formulas listed in the table, "n" corresponds to the number of channels that are switched on.

| Function model | Conversion time |
|----------------------|--|
| Model 0 - n channels | $(n + 1) \cdot (2 \cdot \text{Filter time} + 200 \mu\text{s})$ |
| Model 1 - n channels | $n \cdot (2 \cdot \text{Filter time} + 200 \mu\text{s})$ |
| Model 1 - 1 channel | Equal to the filter time |

Examples

Inputs are filtered using a 50 Hz filter.

| | Example 1 | | Example 2 | |
|--|------------------|------------------|------------------|------------------|
| | Function model 0 | Function model 1 | Function model 0 | Function model 1 |
| Switched on inputs | 1 | 1 | 1 - 2 | 1 - 2 |
| Input conversion times | 40.2 ms | 20 ms | 80.4 ms | 80.4 ms |
| Conversion time for the terminal temperature | 40.2 ms | - | 40.2 ms | - |
| Total conversion time | 80.4 ms | 20 ms | 120.6 ms | 80.4 ms |

9.32.4.10.6 Configuration

9.32.4.10.6.1 Input filter and ambient conditions

Name:

ConfigOutput01

This register configures input filters and ambient conditions.

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| USINT | See bit structure. | 3 |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------|--------------|---|
| 0 - 3 | Input filter | 0000 | 15 Hz |
| | | 0001 | 25 Hz |
| | | 0010 | 30 Hz |
| | | 0011 | 50 Hz (bus controller default setting) |
| | | 0100 | 60 Hz |
| | | 0101 | 100 Hz |
| | | 0110 | 500 Hz |
| | | 0111 | 1000 Hz |
| | | 1000 to 1111 | Not permitted |
| 4 - 7 | Environmental conditions | 0000 | Default, no calculation for adjustment (bus controller default setting) |
| | | 0001 | Power dissipation less than 0.2 W |
| | | 0010 | Power dissipation less than 1 W |
| | | 0011 | Power dissipation more than 1 W |
| | | 0100 to 1111 | Not permitted |

Input filter

The filter time for all analog inputs is defined using the input filter parameter.

| Value | Filter | Filter time | Digital converter resolution |
|-------|---------|-------------|------------------------------|
| 0 | 15 Hz | 66.7 ms | 16-bit |
| 1 | 25 Hz | 40 ms | 16-bit |
| 2 | 30 Hz | 33.3 ms | 16-bit |
| 3 | 50 Hz | 20 ms | 16-bit |
| 4 | 60 Hz | 16.7 ms | 16-bit |
| 5 | 100 Hz | 10 ms | 16-bit |
| 6 | 500 Hz | 2 ms | 16-bit |
| 7 | 1000 Hz | 1 ms | 16-bit |

Environmental conditions

Ambient conditions are set in order to adjust the internal terminal temperature characteristic curve to the type and amount of generated heat dissipated to the module.

This selection is based on the power consumption of the modules connected immediately to the left and right on the X2X Link. Power consumption values can also be found in the technical data for the corresponding module. The higher value is used for the configuration.

9.32.4.10.6.2 Sensor type

Name:

ConfigOutput02

This module is designed for a wide range of sensor types. The sensor type must be configured because of the different alignment values.

| Data type | Value | Information |
|-----------|----------|--|
| USINT | 0 | Conversion switched off |
| | 1 | Sensor type J (bus controller default setting) |
| | 2 | Sensor type K |
| | 3 | Sensor type S |
| | 4 | Sensor type N |
| | 5 | Conversion switched off |
| | 6 | Raw value without linearization and terminal temperature compensation: Resolution 1.0625 μ V for a measurement range of ± 35 mV |
| | 7 | Raw value without linearization and terminal temperature compensation: Resolution 2.125 μ V for a measurement range of ± 70 mV |
| | 8 - 63 | Conversion switched off |
| | 64 | Sensor type R |
| | 65 - 71 | Conversion switched off |
| | 72 | Sensor type B |
| | 73 - 255 | Conversion switched off |

9.32.4.10.6.3 Channel disabling

Name:

ConfigOutput03

By default, all channels are switched on. To save time, individual channels can be switched off (see "[Conversion time](#)" on page 3674).

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| USINT | See bit structure. | 3 |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|--|
| 0 | Channel 1 | 0 | Off |
| | | 1 | Switched on (bus controller default setting) |
| 1 | Channel 2 | 0 | Off |
| | | 1 | Switched on (bus controller default setting) |
| 2 - 7 | Reserved | 0 | |

9.32.4.10.7 Communication

9.32.4.10.7.1 Analog inputs

Name:

Temperature01 to Temperature02

Analog input value depending on the configured sensor type:

| Data type | Values | Input signal |
|-----------|---|--|
| INT | -2100 to +12000 (for -210.0°C to +1200.0°C) | Type J (FeCuNi) |
| | -2700 to +13720 (for -270.0°C to +1372.0°C) | Type K (NiCrNi) |
| | -2700 to +13000 (for -270.0°C to +1300.0°C) | Type N (NiCrSi) |
| | -500 to +17680 (for -50.0°C to +1768.0°C) | Type S (PtRhPt) |
| | 0 to +18200 (for 0°C to +1820.0°C) | Type B (PtRhPt) |
| | -500 to +16640 (for -50.0°C to +1664.0°C) | Type R (PtRhPt) |
| | -32,768 to +32,767 | Raw value without linearization and terminal temperature compensation: Resolution 1.0625 µV for a measurement range of ±35 mV |
| | -32,768 to +32,767 | Raw value without linearization and terminal temperature compensation: Resolution 2.125 µV for a measurement range of ±70 mV |

In order for the user to always be supplied with a defined output value, the following must be taken into consideration:

- Up to the first conversion, 0x8000 is output.
- After switching the sensor type, 0x8000 is output until the first conversion.
- If the input is not switched on, 0x8000 is output.

9.32.4.10.7.2 I/O cycle counter

Name:

IOCycleCounter

The cyclic counter increases after all input data has been updated.

| Data type | Values | Information |
|-----------|----------|-------------------|
| USINT | 0 to 255 | Repeating counter |

9.32.4.10.7.3 Input status

Name:

StatusInput01

The module's inputs are monitored. A change in the monitoring status generates an error message.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|-----------------------------|
| 0 - 1 | Channel 1 | 00 | No error |
| | | 01 | Lower limit value undershot |
| | | 10 | Upper limit value overshoot |
| | | 11 | Open circuit |
| 2 - 3 | Channel 2 | 00 | No error |
| | | 01 | Lower limit value undershot |
| | | 10 | Upper limit value overshoot |
| | | 11 | Open circuit |
| 4 - 7 | Reserved | 0 | |

Analog value in the event of error

In addition to the status info, the error type also sets the analog value as follows:

| Error status | Digital value for error |
|----------------------------|-------------------------|
| Open line | +32767 (0x7FFF) |
| Upper limit value exceeded | +32767 (0x7FFF) |
| Lower limit value exceeded | -32767 (0x8001) |
| Invalid value | -32768 (0x8000) |

9.32.4.10.7.4 Reads the internal cold junction temperature

Name:

CompensationTemperature

The internal cold junction temperature is stored in this register.

| Data type | Value | Information |
|-----------|-------------|--|
| INT | -250 to 850 | Internal cold junction temperature (PT1000): -25.0 to 85.0°C |

9.32.4.10.7.5 Defines the external cold junction temperature

Name:

ExternalCompensationTemperature

The external cold junction temperature is defined in this register.

| Data type | Value | Information |
|-----------|-------------|---|
| INT | -250 to 850 | External cold junction temperature: -25.0 to 85.0°C |

9.32.4.10.8 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 150 µs |

9.32.4.10.9 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

For the formulas listed in the table, 'n' corresponds to the number of channels that are switched on.

| Function model 0 | |
|------------------|---|
| n inputs | $(n + 1) \cdot (2 \times \text{Filter time} + 200 \mu\text{s})$ |
| Function model 1 | |
| 1 input | Equal to the filter time |
| n inputs | $n \cdot (2 \times \text{Filter time} + 200 \mu\text{s})$ |

9.32.5 X20(c)AT4222

Data sheet version: 3.20

9.32.5.1 General information

The module is equipped with 4 inputs for PT100/PT1000 resistance temperature measurement.

- 4 inputs for resistance temperature measurement
- For PT100 and PT1000
- Configurable sensor type per channel
- Direct resistance measurement
- Configurable 2- or 3- wire connections per module
- Configurable filter time

9.32.5.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.32.5.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.32.5.3 Order data

| Model number | Short description | Figure |
|--------------|--|--------|
| | Temperature measurement | |
| X20AT4222 | X20 temperature input module, 4 inputs for resistance measurement, PT100, PT1000, resolution 0.1°C, 3-wire connections | |
| X20cAT4222 | X20 temperature input module, coated, 4 inputs for resistance measurement, PT100, PT1000, resolution 0.1°C, 3-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 641: X20AT4222, X20cAT4222 - Order data

9.32.5.4 Technical data

| Model number | X20AT4222 | X20cAT4222 |
|--|--|------------|
| Short description | | |
| I/O module | 4 inputs for PT100 or PT1000 resistance temperature measurement | |
| General information | | |
| B&R ID code | 0x1BA7 | 0xE215 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Inputs | Yes, using status LED and software | |
| Power consumption | | |
| Bus | 0.01 W | |
| Internal I/O | 1.1 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | - |
| KR | | Yes |
| EAC | | Yes |
| KC | Yes | - |
| Resistance measurement temperature inputs | | |
| Input | Resistance measurement with constant current supply for 2- or 3-wire connections | |
| Digital converter resolution | 16-bit | |
| Filter time | Configurable between 1 ms and 66.7 ms | |
| Conversion time | | |
| 1 channel | 20 ms with 50 Hz filter | |
| 2 - 4 channels | 40 ms per channel with 50 Hz filter | |
| Conversion procedure | Sigma-delta | |
| Output format | INT or UINT for resistance measurement | |
| Sensor | | |
| Sensor type | Configurable per channel | |
| PT100 | -200 to 850°C | |
| PT1000 | -200 to 850°C | |
| Resistance measurement range | 0.1 to 4500 Ω / 0.05 to 2250 Ω | |
| Input filter | 1st-order low pass / cutoff frequency 500 Hz | |
| Sensor standard | EN 60751 | |
| Common-mode range | >0.7 V | |
| Isolation voltage between channel and bus | 500 V _{eff} | |
| Linearization method | Internal | |
| Measurement current | 250 μA ±1.25% | |
| Reference | 4530 Ω ±0.1% | |
| Permissible input signal | Short-term max. ±30 V | |
| Max. error at 25°C | | |
| Gain | 0.037% ¹⁾ | |
| Offset | 0.0015% ²⁾ | |
| Max. gain drift | 0.004 %/°C ¹⁾ | |
| Max. offset drift | 0.00015 %/°C ²⁾ | |
| Nonlinearity | <0.001% ²⁾ | |
| Crosstalk between channels | <-93 dB | |
| Temperature sensor resolution | | |
| PT100 | 1 LSB = 0.1°C | |
| PT1000 | 1 LSB = 0.1°C | |
| Resistance measurement resolution | | |
| G = 1 | 0.1 Ω | |
| G = 2 | 0.05 Ω | |
| Common-mode rejection | | |
| 50 Hz | >80 dB | |
| DC | >95 dB | |

Table 642: X20AT4222, X20cAT4222 - Technical data


| Model number | X20AT4222 | X20cAT4222 |
|---|--|---|
| Standardized range of values for resistance measurement | | |
| G = 1 | | 0.1 to 4500 Ω |
| G = 2 | | 0.05 to 2250 Ω |
| Temperature sensor normalization | | |
| PT100 | | -200.0 to 850.0°C |
| PT1000 | | -200.0 to 850.0°C |
| Temperature measurement monitoring | | |
| Range undershoot | | 0x8001 |
| Range overshoot | | 0x7FFF |
| Open circuit | | 0x7FFF |
| General fault | | 0x8000 |
| Open inputs | | 0x7FFF |
| Resistance measurement monitoring | | |
| Range overshoot | | 0xFFFF |
| Open circuit | | 0xFFFF |
| General fault | | 0xFFFF |
| Open inputs | | 0xFFFF |
| Electrical properties | | |
| Electrical isolation | | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | | Yes |
| Vertical | | Yes |
| Installation elevation above sea level | | |
| 0 to 2000 m | | No limitations |
| >2000 m | | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | | IP20 |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | | -25 to 60°C |
| Vertical mounting orientation | | -25 to 50°C |
| Derating | | - |
| Storage | | -40 to 85°C |
| Transport | | -40 to 85°C |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | | 5 to 95%, non-condensing |
| Transport | | 5 to 95%, non-condensing |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | | 12.5 ^{+0.2} mm |

Table 642: X20AT4222, X20cAT4222 - Technical data

- 1) Based on the current resistance value.
- 2) Based on the entire resistance measurement range.

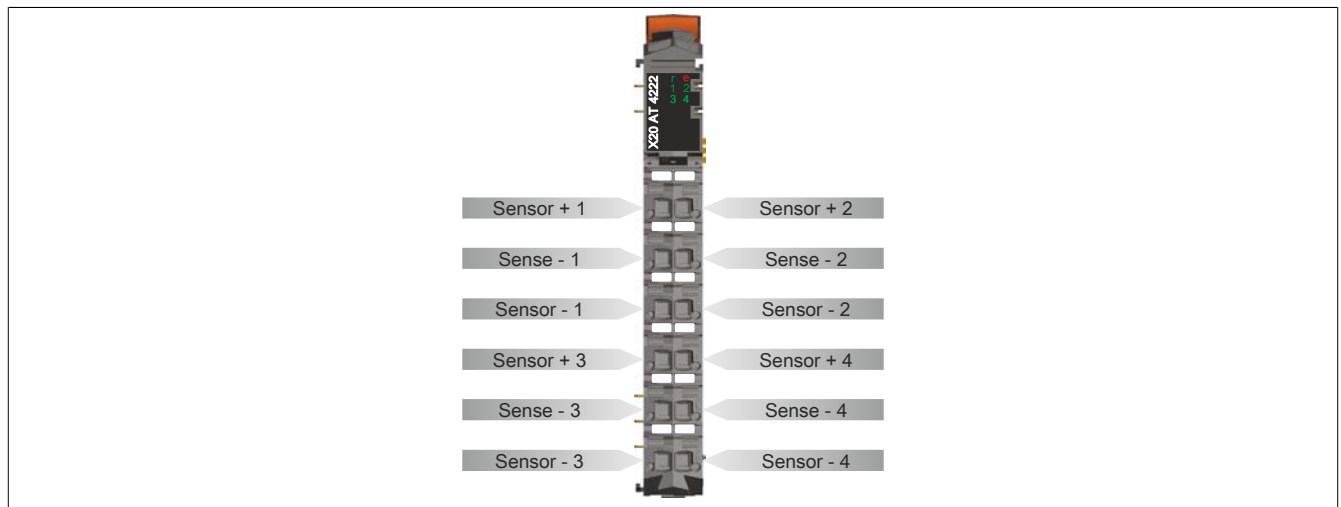
9.32.5.5 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

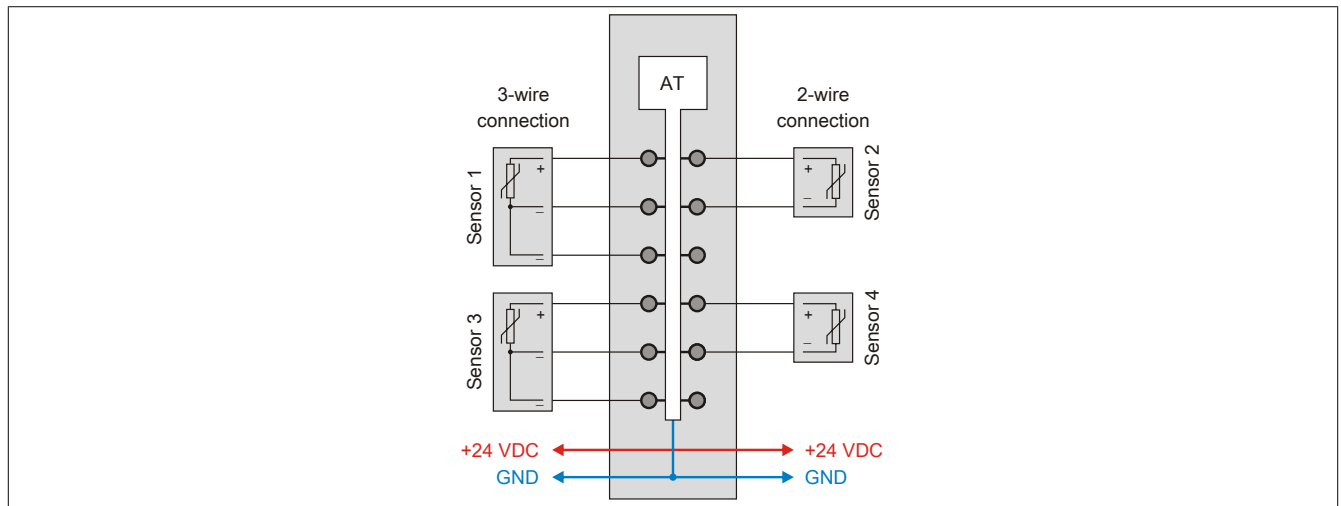
| Figure | LED | Color | Status | Description |
|---|-------|-----------------------------|------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | | | Single flash | Warning/Error on an I/O channel. Overflow or underflow of the analog inputs. |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1 - 4 | Green | Off | The input is switched off |
| | | | Blinking | Overflow, underflow or open line |
| | | | On | Analog/digital converter running, value OK |

9.32.5.6 Pinout

Channels that are not being used should be disabled.

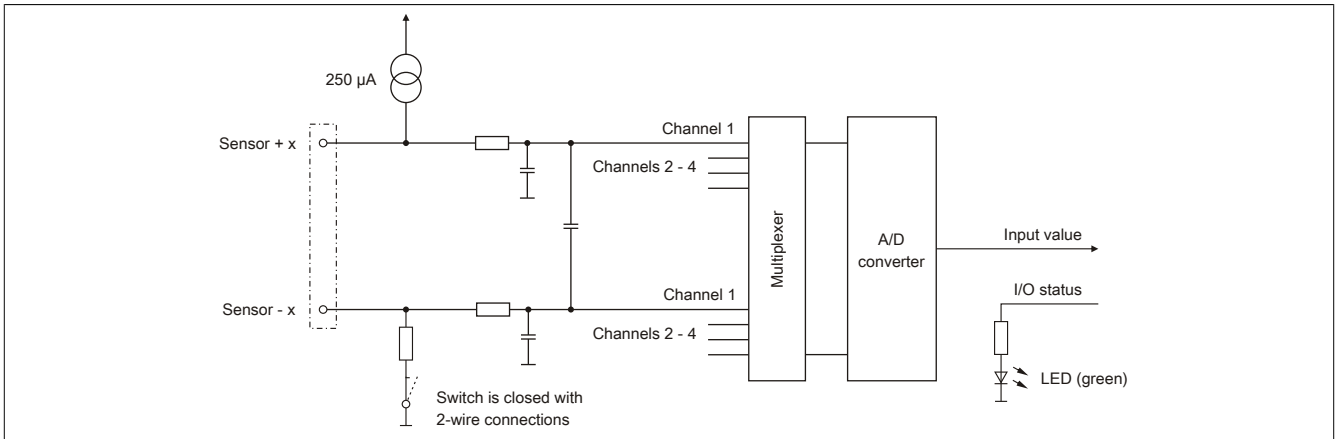


9.32.5.7 Connection example

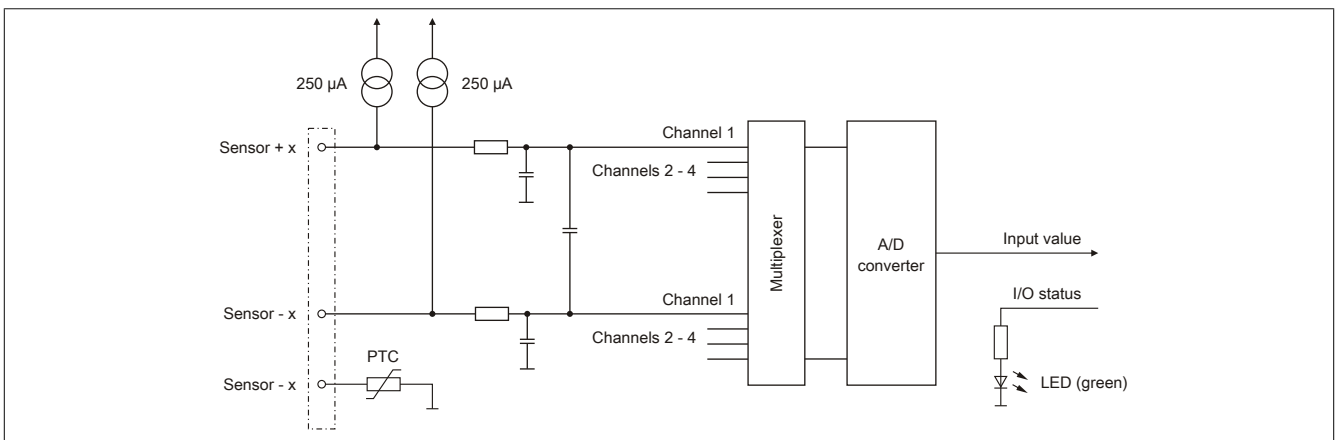


9.32.5.8 Input circuit diagram

2-wire connections



3-wire connections



9.32.5.9 Register description

9.32.5.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.32.5.9.2 Function model 0 - "3-wire connections" and function model 1 - "2-wire connections"

With this module, the type of connection is selected using function models 0 and 1.

| Function model | Connection type |
|----------------|-------------------------------|
| 0 | 3-wire connections (standard) |
| 1 | 2-wire connections |

The registers applied are identical for both function models:

| Register | Name | Data type | Read | | Write | |
|----------------------|---|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 16 | ConfigOutput01 (input filter) | USINT | | | | • |
| 18 | ConfigOutput02 (sensor configuration) | UINT | | | | • |
| Communication | | | | | | |
| 0 | Temperature01 | INT | • | | | |
| | Resistor01 | UINT | | | | |
| 2 | Temperature02 | INT | • | | | |
| | Resistor02 | UINT | | | | |
| 4 | Temperature03 | INT | • | | | |
| | Resistor03 | UINT | | | | |
| 6 | Temperature04 | INT | • | | | |
| | Resistor04 | UINT | | | | |
| 28 | IOCycleCounter | USINT | • | | | |
| 30 | StatusInput01 | USINT | • | | | |

9.32.5.9.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|---|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 16 | - | ConfigOutput01 (input filter) | USINT | | | | • |
| 18 | - | ConfigOutput02 (sensor configuration) | UINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | Temperature01 | INT | • | | | |
| | 0 | Resistor01 | UINT | | | | |
| 2 | 2 | Temperature02 | INT | • | | | |
| | 2 | Resistor02 | UINT | | | | |
| 4 | 4 | Temperature03 | INT | • | | | |
| | 4 | Resistor03 | UINT | | | | |
| 6 | 6 | Temperature04 | INT | • | | | |
| | 6 | Resistor04 | UINT | | | | |
| 28 | - | IOCycleCounter | USINT | | • | | |
| 30 | - | StatusInput01 | USINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.32.5.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.32.5.9.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.32.5.9.4 General information

9.32.5.9.4.1 Analog inputs

The module outputs the converted analog values to the registers. Other ranges of values or data types result depending on resistance or temperature measurement.

Information:

Operating channels outside specifications can affect neighboring channels.

9.32.5.9.4.2 Timing

The timing for acquiring measured values is controlled by the converter hardware. All switched-on inputs are converted during each conversion cycle and transferred halfway through the X2X Link cycle.

9.32.5.9.4.3 Conversion time

The conversion time for the channels depends on their use. For the formulas listed in the table, "n" corresponds to the number of channels that are switched on.

| Use of the channels | Conversion time |
|--|--|
| 1 channel | 1 · Filter time |
| n channels with the same sensor type | $n \cdot (20 \text{ ms} + \text{Filter time})$ |
| n channels with different sensor types | $n \cdot (20 \text{ ms} + 2 \cdot \text{Filter time})$ |

9.32.5.9.4.4 Reduced update time

Any inputs that are not needed can be switched off, which reduces the I/O update time. Inputs can also be only switched off temporarily.

Calculating the time saved

The amount of time saved can be calculated with the following formula. And "n" corresponds to the number of inputs that are switched off.

$$\text{Time saved} = n \cdot (20 \text{ ms} + \text{filter time})$$

Examples

Inputs are filtered using a 60 Hz filter.

| | Example 1 | Example 2 | Example 3 |
|--------------------|-----------|-----------|-----------|
| Switched on inputs | 1 | 1 and 3 | 1 to 4 |
| Conversion time | 16.7 ms | 73.4 ms | 146.8 ms |

9.32.5.9.5 Configuration

9.32.5.9.5.1 Input filter

Name:

ConfigOutput01

The filter time of all analog inputs is defined in this register.

| Data type | Value | Filter | Filter time |
|-----------|-------|--|-------------|
| USINT | 0 | 15 Hz | 66.7 ms |
| | 1 | 25 Hz | 40 ms |
| | 2 | 30 Hz | 33.3 ms |
| | 3 | 50 Hz (bus controller default setting) | 20 ms |
| | 4 | 60 Hz | 16.7 ms |
| | 5 | 100 Hz | 10 ms |
| | 6 | 500 Hz | 2 ms |
| | 7 | 1000 Hz | 1 ms |

9.32.5.9.5.2 Sensor configuration

Name:

ConfigOutput02

The sensor type of the individual channels is configured in this register.

This module is designed for temperature and resistance measurement. Due to different adjustment values for temperature and resistance, the sensor type must be selected.

By default, all channels are switched on. To save time, individual channels can be switched off (see "[Reduced update time](#)" on page 3685).

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 8738 |

Bit structure:

| Bit | Description | Value | Information |
|---------|-------------|-------------|--|
| 0 - 3 | Channel 1 | 0000 - 0001 | Reserved |
| | | 0010 | Sensor type PT100 (bus controller default setting) |
| | | 0011 | PT1000 sensor type |
| | | 0100 | Reserved (channel switched off) |
| | | 0101 | Resistance measurement 0.1 to 4500 Ω |
| | | 0110 | Resistance measurement 0.05 to 2250 Ω |
| | | 0111 | Channel switched off |
| | | 1000 - 1111 | Reserved |
| ... | ... | ... | ... |
| 12 - 15 | Channel 4 | 0000 - 0001 | Reserved |
| | | 0010 | Sensor type PT100 (bus controller default setting) |
| | | 0011 | PT1000 sensor type |
| | | 0100 | Reserved (channel switched off) |
| | | 0101 | Resistance measurement 0.1 to 4500 Ω |
| | | 0110 | Resistance measurement 0.05 to 2250 Ω |
| | | 0111 | Channel switched off |
| | | 1000 - 1111 | Reserved |

9.32.5.9.6 Communication

9.32.5.9.6.1 Input values of analog inputs

Name:

Temperature01 to Temperature04

Resistor01 to Resistor04

This register contains the analog input values depending on the configured operating mode.

| Data type | Digital value | Input signal |
|-----------|---------------------------------------|---------------------------------------|
| INT | -2000 to 8500 (for -200.0 to 850.0°C) | PT100 sensor type |
| | -2000 to 8500 (for -200.0 to 850.0°C) | PT1000 sensor type |
| UINT | 1 to 45000 (resolution 0.1 Ω) | Resistance measurement 0.1 to 4500 Ω |
| | 1 to 45000 (resolution 0.05 Ω) | Resistance measurement 0.05 to 2250 Ω |

In order for the user to always be supplied with a defined output value, the following must be taken into consideration:

- Up to the first conversion, 0x8000 is output.
- After switching the operating mode until the first conversion:
 - From "Resistance measurement" to "Sensor type PTxx": 0x8000
 - From "Sensor type PTxx" to "Resistance measurement": 0xFFFF
- If the input is not switched on, 0x8000 is output.

9.32.5.9.6.2 I/O cycle counter

Name:

IOCycleCounter

The cyclic counter increases after all input data has been updated.

| Data type | Values | Information |
|-----------|----------|-------------------|
| USINT | 0 to 255 | Repeating counter |

9.32.5.9.6.3 Status of the inputs

Name:

StatusInput01

The module's inputs are monitored. A change in the monitoring status is actively transmitted as an error message.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|-----------------------------|
| 0 - 1 | Channel 1 | 00 | No error |
| | | 01 | Lower limit value undershot |
| | | 10 | Upper limit value overshoot |
| | | 11 | Open circuit |
| ... | ... | ... | ... |
| 6 - 7 | Channel 4 | 00 | No error |
| | | 01 | Lower limit value undershot |
| | | 10 | Upper limit value overshoot |
| | | 11 | Open circuit |

Limiting the analog value

In addition to the status information, the analog value is fixed to the values listed below by default in an error state.

| Error state | Temperature measurement Digital value on error | Resistance measurement Digital value on error |
|------------------------------|---|--|
| Open circuit | 32767 (0x7FFF) | 65535 (0xFFFF) |
| Upper limit value overshoot | 32767 (0x7FFF) | 65535 (0xFFFF) |
| Lower limit value undershoot | -32767 (0x8001) | 0 (0x0000) |
| Invalid value | -32768 (0x8000) ¹⁾ | 65535 (0xFFFF) |
| | 32767 (0x7FFF) ²⁾ | |
| | 65535 (0xFFFF) ³⁾ | |

1) Default value or channel was disabled in the I/O configuration.

2) After switching off the channel during operation.

3) Value in function model 254 - Bus controller.

9.32.5.9.7 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|--|
| 100 μ s | |

9.32.5.9.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|--|
| 1 input | Equal to the filter time |
| n inputs | $n \cdot (20 \text{ ms} + \text{filter time})$ |

9.32.6 X20AT4232

Data sheet version: 1.11

9.32.6.1 General information

This module is equipped with 4 inputs for NTC resistance temperature measurement (10 k Ω at 25°C). In addition, this module can measure resistance from 0 to 200 k Ω .

- 4 inputs for resistance temperature measurement
- For NTC resistance type 10 k Ω
- Resistance measurement 0 to 200 k Ω
- Configurable measurement type per channel
- 2-wire measurement
- Configurable filter time

9.32.6.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| | Temperature measurement |  |
| X20AT4232 | X20 temperature input module, 4 inputs for resistance measurement, NTC 10 k Ω , resolution 0.1°C, 2-wire connections | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |
| | | |
| | | |

Table 643: X20AT4232 - Order data

9.32.6.3 Technical data

| Model number | X20AT4232 |
|--|---|
| Short description | |
| I/O module | 4 inputs for NTC (10 kΩ) resistance temperature measurement |
| General information | |
| B&R ID code | 0xEA85 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Inputs | Yes, using status LED and software |
| Cable specification | |
| Cable type | Shielded twisted pair cable |
| Line capacitance | Max. 1 nF |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 0.72 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| Resistance measurement temperature inputs | |
| Input | Resistance measurement with constant current supply for 2-wire connections |
| Digital converter resolution | 16-bit |
| Filter time | Configurable between 16.7 and 66.7 ms |
| Conversion time | |
| 1 channel | 20 ms with 50 Hz filter |
| 2 - 4 channels | 40 ms per channel with 50 Hz filter |
| Conversion procedure | Sigma-delta |
| Output format | INT or UINT for resistance measurement |
| Sensor | |
| Sensor type | Configurable per channel |
| NTC10K type 1 | Vishay: NTCLE100E3103GB0, B _{25/85} = 3977 |
| NTC10K type 2 | Vishay: NTCLE413E2103F400L, B _{25/85} = 3435 |
| Temperature measurement range | -30 to 100°C for NTC with 10 kΩ ¹⁾ |
| Resistance measurement range | 0 to 200 kΩ |
| Temperature sensor resolution | 1 LSB = 0.1°C for NTC with 10 kΩ ¹⁾ |
| Resistance measurement resolution | 5 Ω |
| Input filter | 1st-order low pass / cutoff frequency 1.35 kHz |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Linearization method | Internal |
| Measurement current | 9.1 μA ±1.5% |
| Reference | 103,125 Ω ±0.1% |
| Permissible input signal | Short-term max. ±30 V |
| Max. error at 25°C | |
| Gain | 0.35% ²⁾ |
| Offset | 0.004% ³⁾ |
| Max. gain drift | 0.006 %/°C ²⁾ |
| Max. offset drift | 0.00009 %/°C ³⁾ |
| Nonlinearity | <0.15% ³⁾ |
| Standardized range of values for resistance measurement | 0 to 200,000 Ω |
| Crosstalk between channels | <-70 dB |
| Temperature sensor normalization | |
| NTC10K type 1 | -30.0 to 100.0°C |
| NTC10K type 2 | -30.0 to 100.0°C |
| Temperature measurement monitoring | |
| Range undershoot | 0x8001 |
| Range overshoot | 0x7FFF |
| Open circuit | 0x7FFF |
| General fault | 0x8000 |
| Open inputs | 0x7FFF |

Table 644: X20AT4232 - Technical data


| Model number | X20AT4232 |
|--|--|
| Resistance measurement monitoring | |
| Range overshoot | 0xFFFF |
| Open circuit | 0xFFFF |
| General fault | 0xFFFF |
| Open inputs | 0xFFFF |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 644: X20AT4232 - Technical data

- 1) Depends on the temperature sensor. This value applies when using Vishay sensor NTCLE100E3103GB0 $B_{25/85} = 3977$ and Vishay sensor NTCLE413E2103F400L $B_{25/85} = 3435$.
- 2) Based on the current resistance value.
- 3) Based on the entire resistance measurement range.

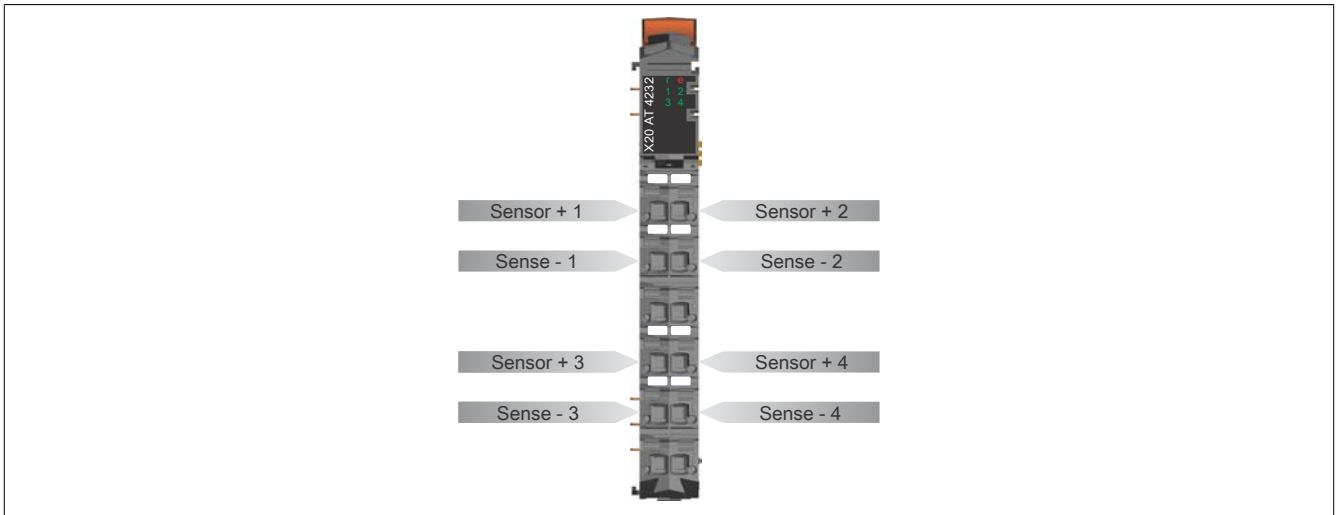
9.32.6.4 LED status indicators

For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

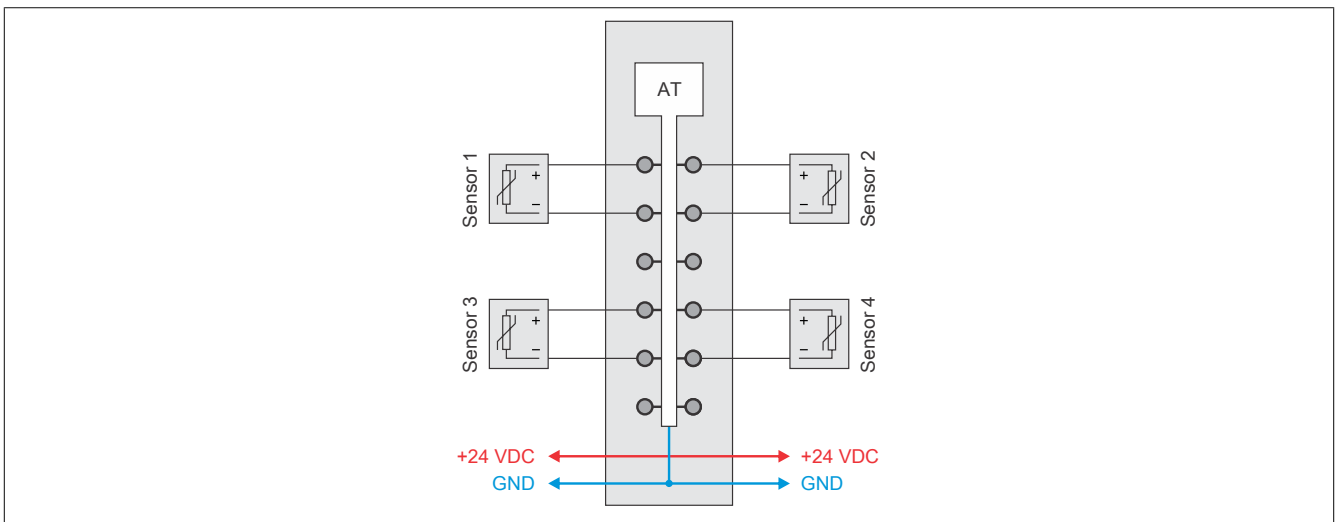
| Figure | LED | Color | Status | Description |
|---|-------|--------------------------------|------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | | | Single flash | Warning/Error on an I/O channel. Overflow or underflow of the analog inputs. |
| | e + r | Solid red / Single green flash | Invalid firmware | |
| | 1 - 4 | Green | Off | The input is switched off |
| | | | Blinking | Overflow, underflow or open circuit |
| | | | On | Analog/digital converter running, value OK |

9.32.6.5 Pinout

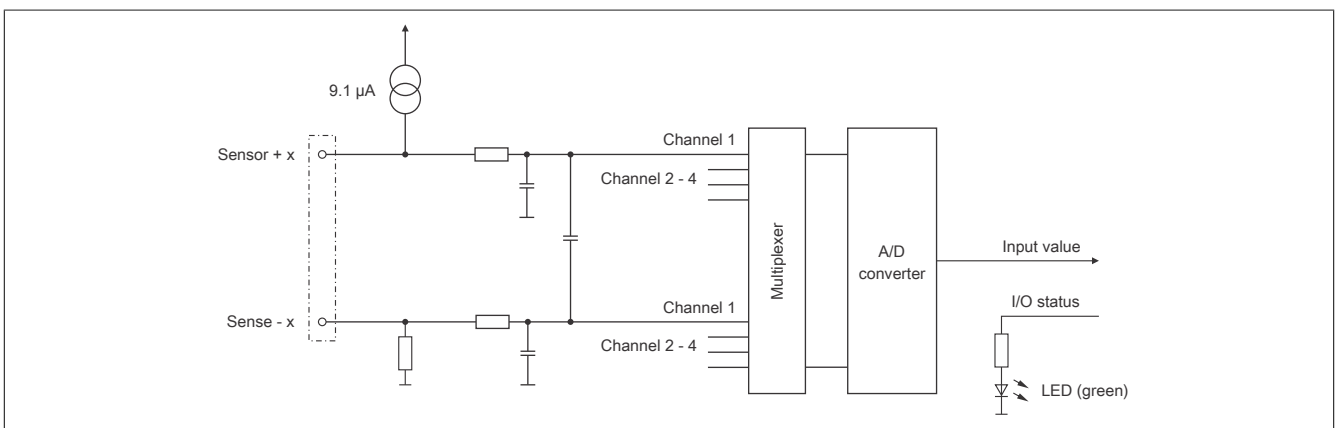
Channels that are not being used should be disabled.



9.32.6.6 Connection example



9.32.6.7 Input circuit diagram



9.32.6.8 Register description

9.32.6.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "[General data points](#)" on page 3790.

9.32.6.8.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|---------------------------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 16 | ConfigOutput01 (Input filter) | USINT | | | | • |
| 18 | ConfigOutput02 (Sensor configuration) | UINT | | | | • |
| Communication | | | | | | |
| 0 | Temperature01 | INT | • | | | |
| | Resistor01 | UINT | | | | |
| 2 | Temperature02 | INT | • | | | |
| | Resistor02 | UINT | | | | |
| 4 | Temperature03 | INT | • | | | |
| | Resistor03 | UINT | | | | |
| 6 | Temperature04 | INT | • | | | |
| | Resistor04 | UINT | | | | |
| 28 | IOCycleCounter | USINT | • | | | |
| 30 | StatusInput01 | USINT | • | | | |

9.32.6.8.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|---------------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 16 | - | ConfigOutput01 (Input filter) | USINT | | | | • |
| 18 | - | ConfigOutput02 (Sensor configuration) | UINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | Temperature01 | INT | • | | | |
| | | Resistor01 | UINT | | | | |
| 2 | 2 | Temperature02 | INT | • | | | |
| | | Resistor02 | UINT | | | | |
| 4 | 4 | Temperature03 | INT | • | | | |
| | | Resistor03 | UINT | | | | |
| 6 | 6 | Temperature04 | INT | • | | | |
| | | Resistor04 | UINT | | | | |
| 28 | - | IOCycleCounter | USINT | | • | | |
| 30 | - | StatusInput01 | USINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.32.6.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "[Using I/O modules on the bus controller](#)" on page 3789.

9.32.6.8.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.32.6.8.4 General information

9.32.6.8.4.1 Analog inputs

The module outputs the converted analog values to the registers. Other ranges of values or data types result depending on resistance or temperature measurement.

Information:

Operating channels outside specifications can affect neighboring channels.

9.32.6.8.4.2 Timing

The timing for acquiring measured values is controlled by the converter hardware. All switched-on inputs are converted during each conversion cycle and transferred halfway through the X2X Link cycle.

9.32.6.8.4.3 Conversion time

The conversion time for the channels depends on their use. For the formulas listed in the table, "n" corresponds to the number of channels that are switched on.

| Use of the channels | Conversion time |
|--|--|
| 1 channel | 1 · Filter time |
| n channels with the same sensor type | $n \cdot (20 \text{ ms} + \text{Filter time})$ |
| n channels with different sensor types | $n \cdot (20 \text{ ms} + 2 \cdot \text{Filter time})$ |

9.32.6.8.4.4 Reduced update time

Any inputs that are not needed can be switched off, which reduces the I/O update time. Inputs can also be only switched off temporarily.

Calculating the time saved

The amount of time saved can be calculated with the following formula. And "n" corresponds to the number of inputs that are switched off.

$$\text{Time saved} = n \cdot (20 \text{ ms} + \text{filter time})$$

Examples

Inputs are filtered using a 60 Hz filter.

| | Example 1 | Example 2 | Example 3 |
|--------------------|-----------|-----------|-----------|
| Switched on inputs | 1 | 1 and 3 | 1 to 4 |
| Conversion time | 16.7 ms | 73.4 ms | 146.8 ms |

9.32.6.8.5 Configuration

9.32.6.8.5.1 Input filter

Name:

ConfigOutput01

The filter time of all analog inputs is defined in this register.

| Data type | Value | Filter | Filter time |
|-----------|-------|--|-------------|
| USINT | 0 | 15 Hz | 66.7 ms |
| | 1 | 25 Hz | 40 ms |
| | 2 | 30 Hz | 33.3 ms |
| | 3 | 50 Hz (bus controller default setting) | 20 ms |
| | 4 | 60 Hz | 16.7 ms |

9.32.6.8.5.2 Sensor configuration

Name:

ConfigOutput02

This register can be used to configure the sensor type for individual channels.

This module is designed for temperature and resistance measurement. The sensor type must be specified because of the different calibration values for temperature and resistance.

The default setting for all channels is ON. To save time, individual channels can be switched off (see "[Reduced update time](#)" on page 3694).

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Name | Value | Information |
|---------|-----------|-------------|--|
| 0 - 3 | Channel 1 | 0000 | Sensor: NTC10K type 1 (bus controller default setting) ¹⁾ |
| | | 0001 | Sensor: NTC10K type 2 ²⁾ |
| | | 0010 | Reserved |
| | | 0011 | Reserved |
| | | 0100 | Channel switched off |
| | | 0101 | Resistance measurement 0 to 200 kΩ |
| | | 0110 | Reserved |
| | | 0111 | Channel switched off |
| | | 1000 - 1111 | Reserved |
| ... | ... | ... | ... |
| 12 - 15 | Channel 4 | 0000 | Sensor: NTC10K type 1 (bus controller default setting) ¹⁾ |
| | | 0001 | Sensor: NTC10K type 2 ²⁾ |
| | | 0010 | Reserved |
| | | 0011 | Reserved |
| | | 0100 | Channel switched off |
| | | 0101 | Resistance measurement 0 to 200 kΩ |
| | | 0110 | Reserved |
| | | 0111 | Channel switched off |
| | | 1000 - 1111 | Reserved |

1) Sensor NTC10K type 1: Vishay NTCLE100E3103GB0, $B_{25/85} = 3977$

2) Sensor NTC10K type 2: Vishay NTCLE413E2103F400L, $B_{25/85} = 3435$

9.32.6.8.6 Communication

9.32.6.8.6.1 Input values of analog inputs

Name:

Temperature01 to Temperature04

Resistor01 to Resistor04

This register is used to indicate the analog input values depending on the configured operating mode.

| Data type | Digital value | Input signal |
|-----------|-------------------------------------|------------------------------------|
| INT | -300 to 1000 (for -30.0 to 100.0°C) | Sensor NTC10K type 1 |
| | -300 to 1000 (for -30.0 to 100.0°C) | Sensor NTC10K type 2 |
| UINT | 0 to 40000 (resolution 5 Ω) | Resistance measurement 0 to 200 kΩ |

In order for the user to always be supplied with a defined output value, the following must be taken into consideration:

- Up to the first conversion, 0x8000 is output.
- After switching the sensor type, 0x8000 is output until the first conversion.
- If the input is not switched on, 0xFFFF is output.

9.32.6.8.6.2 I/O cycle counter

Name:

IOCycleCounter

The cyclic counter increases after all input data has been updated.

| Data type | Values | Information |
|-----------|----------|-------------------|
| USINT | 0 to 255 | Repeating counter |

9.32.6.8.6.3 Status of the inputs

Name:

StatusInput01

The module's inputs are monitored. A change in the monitoring status is actively transmitted as an error message.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|-----------------------------|
| 0 - 1 | Channel 1 | 00 | No error |
| | | 01 | Lower limit value undershot |
| | | 10 | Upper limit value overshoot |
| | | 11 | Open circuit |
| ... | | ... | |
| 6 - 7 | Channel 4 | 00 | No error |
| | | 01 | Lower limit value undershot |
| | | 10 | Upper limit value overshoot |
| | | 11 | Open circuit |

Limiting the analog value

In addition to the status information, the analog value is fixed to the values listed below by default in an error state.

| Error state | Temperature measurement Digital value on error | Resistance measurement Digital value on error |
|-----------------------------|---|--|
| Open circuit | 32767 (0x7FFF) | 65535 (0xFFFF) |
| Upper limit value overshoot | 32767 (0x7FFF) | 65535 (0xFFFF) |
| Lower limit value undershot | -32767 (0x8001) | 0 (0x0000) |
| Invalid value | -32768 (0x8000) ¹⁾ 32767 (0x7FFF) ²⁾ 65535 (0xFFFF) ³⁾ | 65535 (0xFFFF) |

- 1) Default value or channel was disabled in the I/O configuration.
- 2) After switching off the channel during operation.
- 3) Value in function model 254 - Bus controller.

9.32.6.8.7 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time | |
|--------------------|--|
| 100 μ s | |

9.32.6.8.8 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

| Minimum I/O update time | |
|-------------------------|--|
| 1 input | Equal to the filter time |
| n inputs | $n \cdot (20 \text{ ms} + \text{filter time})$ |

9.32.7 X20(c)AT6402

Data sheet version: 3.10

9.32.7.1 General information

The module is equipped with 6 inputs for J, K, N, S, B and R thermocouple sensors. The module has an integrated terminal temperature compensation.

- 6 inputs for thermocouples
- For sensor types J, K, N, S, B, R
- Additional direct raw value measurement
- Integrated terminal temperature compensation
- Configurable filter time

9.32.7.2 Coated modules

Coated modules are X20 modules with a protective coating for the electronics component. This coating protects X20c modules from condensation and corrosive gases.

The modules' electronics are fully compatible with the corresponding X20 modules.

For simplification purposes, only images and module IDs of uncoated modules are used in this data sheet.

The coating has been certified according to the following standards:

- Condensation: BMW GS 95011-4, 2x 1 cycle
- Corrosive gas: EN 60068-2-60, method 4, exposure 21 days



9.32.7.2.1 -40°C starting temperature

The starting temperature describes the minimum permissible ambient temperature when the power is switched off at the time the coated module is switched on. This is permitted to be as low as -40°C. During operation, the conditions as specified in the technical data continue to apply.

Information:

It is important to absolutely ensure that there is no forced cooling by air currents in a closed control cabinet, for example using a fan or ventilation slots.

9.32.7.3 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Temperature measurement |  |
| X20AT6402 | X20 temperature input module, 6 thermocouple inputs, Type J, K, N, S, B, R, resolution 0.1°C | |
| X20cAT6402 | X20 temperature input module, coated, 6 thermocouple inputs, Type J, K, N, S, B, R, resolution 0.1°C | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| X20cBM11 | X20 bus module, coated, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | |

Table 645: X20AT6402, X20cAT6402 - Order data

9.32.7.4 Technical data

| Model number | X20AT6402 | X20cAT6402 |
|--|--|------------|
| Short description | | |
| I/O module | 6 inputs for thermocouples | |
| General information | | |
| B&R ID code | 0x1BA9 | 0xDD57 |
| Status indicators | I/O function per channel, operating state, module status | |
| Diagnostics | | |
| Module run/error | Yes, using status LED and software | |
| Inputs | Yes, using status LED and software | |
| Power consumption | | |
| Bus | 0.01 W | |
| Internal I/O | 0.91 W | |
| Additional power dissipation caused by actuators (resistive) [W] | - | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| EAC | Yes | |
| KC | Yes | - |
| Thermocouple temperature inputs | | |
| Input | Thermocouple | |
| Digital converter resolution | 16-bit | |
| Filter time | Configurable between 1 ms and 66.7 ms | |
| Conversion time | | |
| 1 channel | 80.4 ms with 50 Hz filter | |
| N channels | (n + 1) x 40.2 ms at 50 Hz filter | |
| Output format | INT | |
| Measurement range | | |
| Sensor temperature | | |
| Type J: Fe-CuNi | -210 to 1200°C | |
| Type K: NiCr-Ni | -270 to 1372°C | |
| Type N: NiCrSi-NiSi | -270 to 1300°C (Rev. ≥D0) | |
| Type S: PtRh10-Pt | -50 to 1768°C | |
| Type B: PtRh30-PtRh6 | 0 to 1820°C | |
| Type R: PtRh13-Pt | -50 to 1664°C | |
| Terminal temperature | -25 to 85°C | |
| Raw value | ±65.534 mV | |
| Terminal temperature compensation | Internal | |
| Sensor standard | EN 60584 | |
| Resolution | | |
| Sensor temperature | 1 LSB = 0.1°C | |
| Terminal temperature | 1 LSB = 0.1°C | |
| Raw value output with respect to gain | 1 LSB = 1 µV or 2 µV | |
| Normalization | | |
| Type J | -210.0 to 1200.0°C | |
| Type K | -270.0 to 1372.0°C | |
| Type N (Rev. ≥D0) | -270.0 to 1300.0°C | |
| Type S | -50.0 to 1768.0°C | |
| Type B | 0 to 1820.0°C | |
| Type R | -50.0 to 1664.0°C | |
| Terminal temperature | -25.0 to 85.0°C | |
| Monitoring | | |
| Range undershoot | 0x8001 | |
| Range overshoot | 0x7FFF | |
| Open circuit | 0x7FFF | |
| Open inputs | 0x7FFF | |
| General fault | 0x8000 | |
| Conversion procedure | Sigma-delta | |
| Linearization method | Internal | |

Table 646: X20AT6402, X20cAT6402 - Technical data


| Model number | X20AT6402 | X20cAT6402 |
|---|--|---|
| Permissible input signal | Max. ± 5 V | |
| Input filter | 1st-order low pass / cutoff frequency 500 Hz | |
| Max. error at 25°C | | |
| Gain | 0.06% ¹⁾ | |
| Offset | | |
| Type J | 0.04% ²⁾ | |
| Type K | 0.05% ²⁾ | |
| Type N (Rev. \geq D0) | 0.05% ²⁾ | |
| Type S | 0.11% ²⁾ | |
| Type B | 0.13% ²⁾ | |
| Type R | 0.09% ²⁾ | |
| Max. gain drift | 0.01 %/°C ¹⁾ | |
| Max. offset drift | | |
| Type J | 0.0019 %/°C ²⁾ | |
| Type K | 0.0024 %/°C ²⁾ | |
| Type N (Rev. \geq D0) | 0.0029 %/°C ²⁾ | |
| Type S | 0.0079 %/°C ²⁾ | |
| Type B | 0.0114 %/°C ²⁾ | |
| Type R | 0.0074 %/°C ²⁾ | |
| Nonlinearity | $\pm 0.001\%$ ²⁾ | |
| Common-mode rejection | | |
| DC | >70 dB | |
| 50 Hz | >70 dB | |
| Common-mode range | ± 15 V | |
| Crosstalk between channels | <-70 dB | |
| Isolation voltage | | |
| Between channel and bus | 500 V _{eff} | |
| Terminal temperature compensation precision | | |
| With artificial convection | $\pm 4^\circ\text{C}$ after 10 min | |
| With natural convection | $\pm 2^\circ\text{C}$ after 10 min | |
| Electrical properties | | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel | |
| Operating conditions | | |
| Mounting orientation | | |
| Horizontal | Yes | |
| Vertical | Yes | |
| Installation elevation above sea level | | |
| 0 to 2000 m | No limitations | |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m | |
| Degree of protection per EN 60529 | IP20 | |
| Ambient conditions | | |
| Temperature | | |
| Operation | | |
| Horizontal mounting orientation | 0 to 55°C | -25 to 60°C |
| Vertical mounting orientation | 0 to 50°C | -25 to 50°C |
| Derating | - | |
| Storage | -40 to 85°C | |
| Transport | -40 to 85°C | |
| Relative humidity | | |
| Operation | 5 to 95%, non-condensing | Up to 100%, condensing |
| Storage | 5 to 95%, non-condensing | |
| Transport | 5 to 95%, non-condensing | |
| Mechanical properties | | |
| Note | Order 1x X20TB12 terminal block separately Order 1x X20BM11 bus module separately | Order 1x X20TB12 terminal block separately Order 1x X20cBM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm | |

Table 646: X20AT6402, X20cAT6402 - Technical data

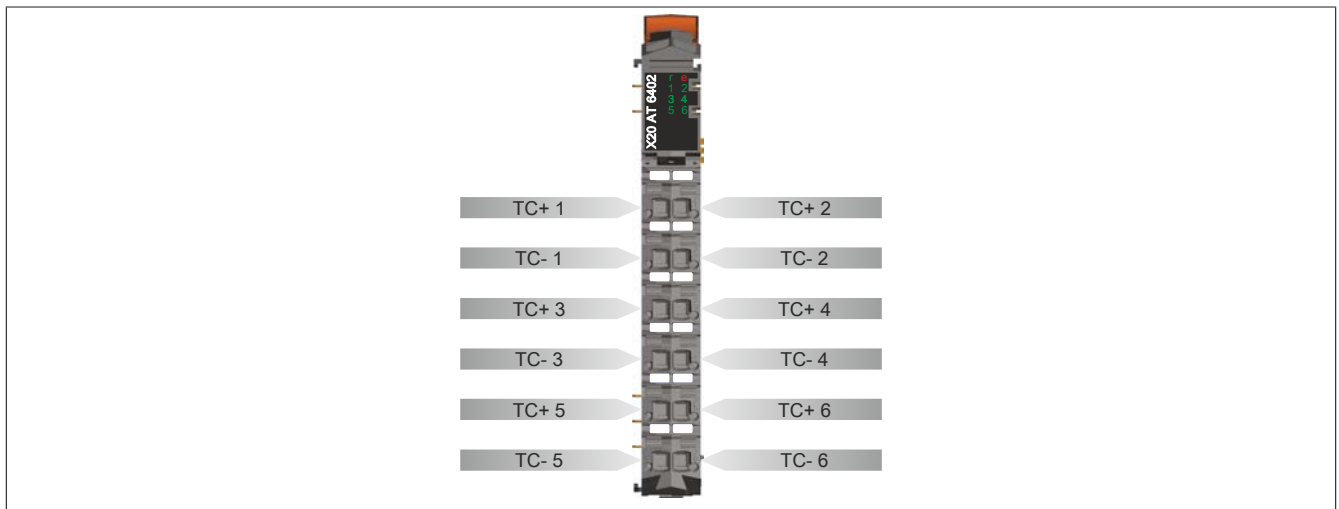
- 1) Based on the current measured value.
2) Based on the entire measurement range.

9.32.7.5 LED status indicators

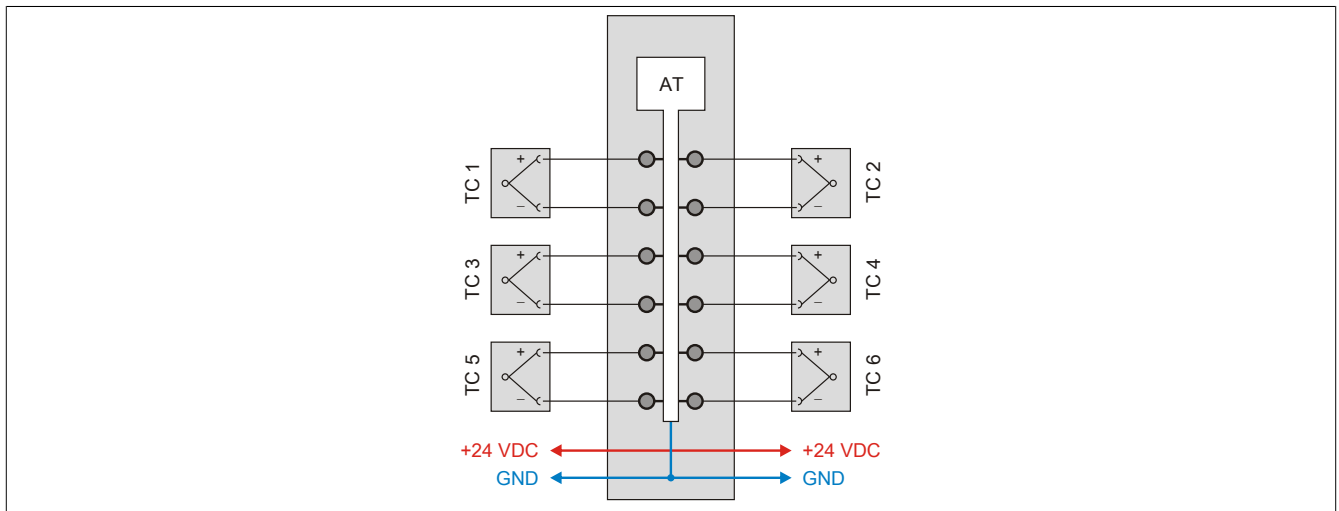
For a description of the various operating modes, see "[Diagnostic LEDs](#)" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|-----------------------------|------------------|--|
|  | r | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | e | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | | | Single flash | Warning/Error on an I/O channel. Overflow or underflow of the analog inputs. |
| | e + r | Red on / Green single flash | Invalid firmware | |
| | 1 - 6 | Green | Off | The input is switched off |
| | | | Blinking | Overflow, underflow or open line |
| | | | On | Analog/digital converter running, value OK |

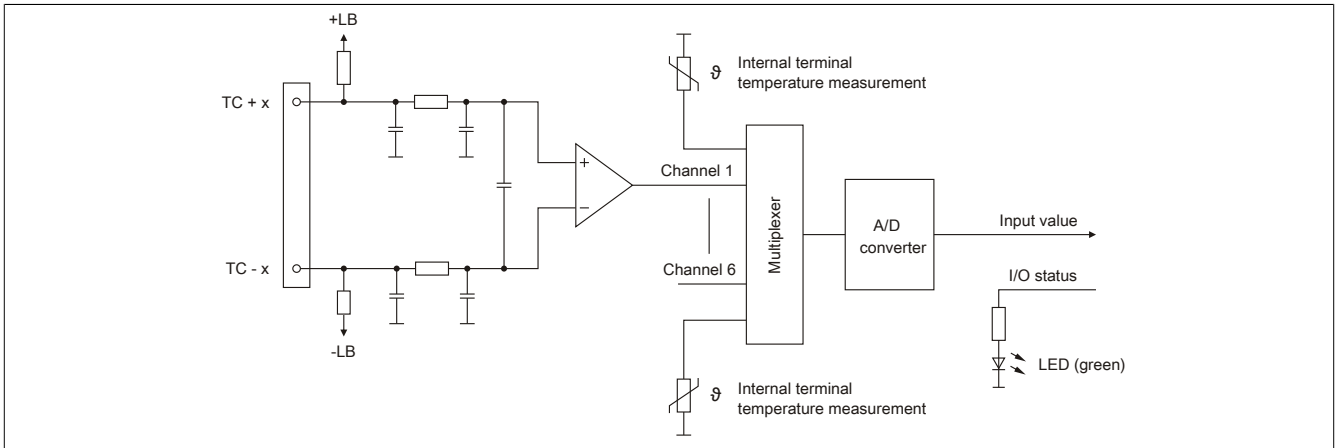
9.32.7.6 Pinout



9.32.7.7 Connection example

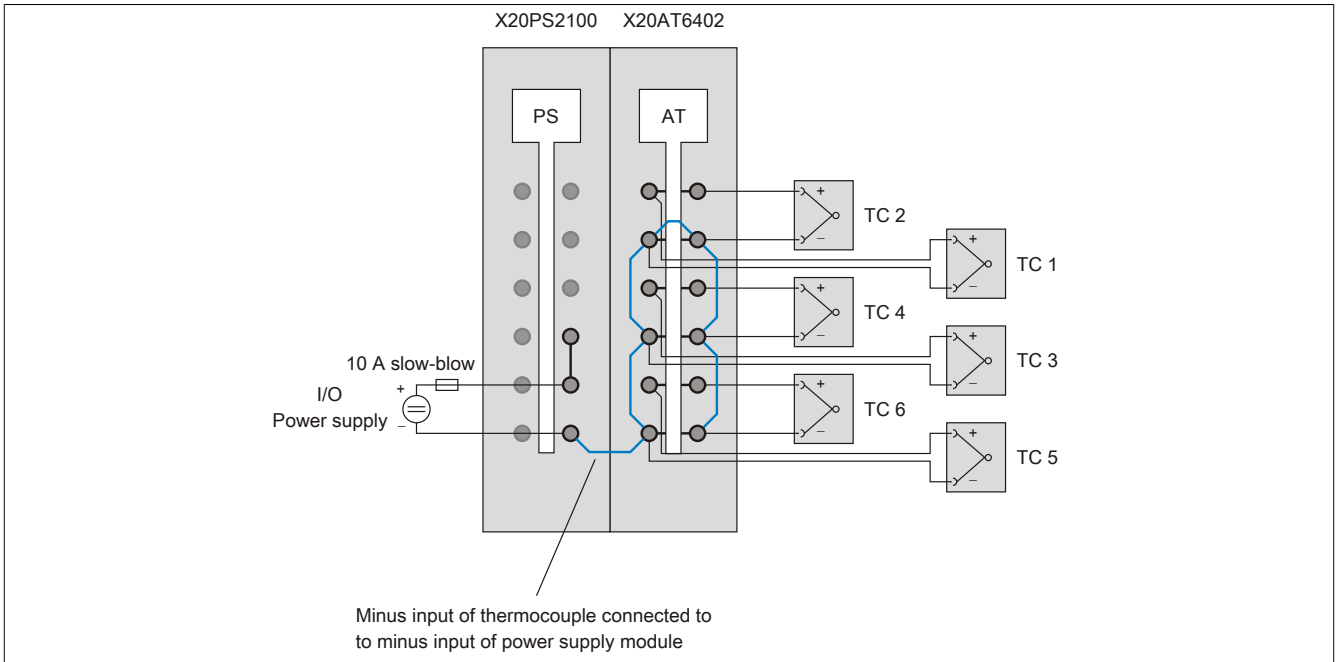


9.32.7.8 Input circuit diagram



9.32.7.9 Ceramic heating element with integrated thermo elements

We recommend connecting the minus input of the thermo element to the minus input of the supply feed module. This prevents potential measurement errors caused by ripple voltage effects in the measurement signal.



9.32.7.10 External cold junction

General information

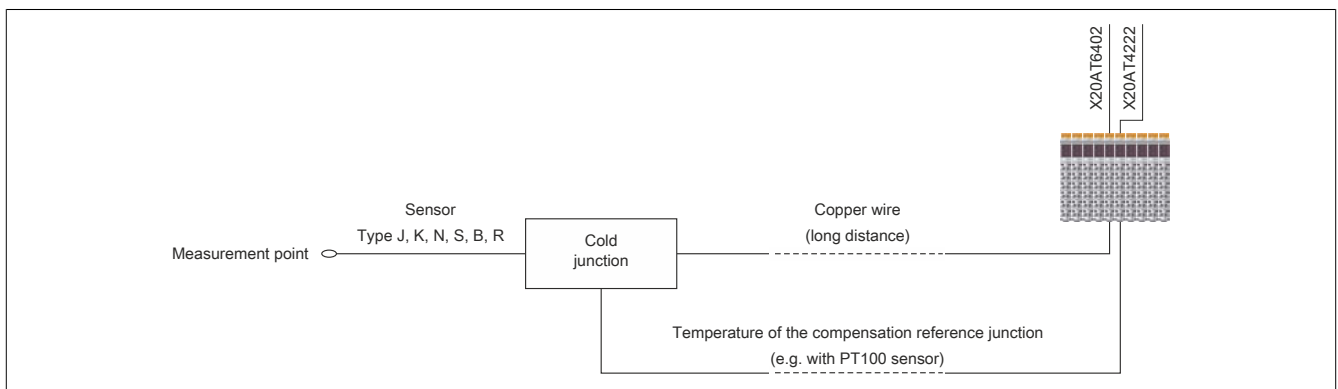
An external cold junction temperature value can be predefined for the module for measurement value correction. This makes it possible to set up an external cold junction. The same external cold junction temperature is used for measurement value correction on all channels.

An external cold junction makes sense in the following applications and situations:

- Large distances between the controller and measurement point
- To increase precision

To bridge large distances

Setting up an external cold junction is recommended when there are large distances between the controller and the measurement point. The thermocouple voltage is routed from the external cold junction to the terminal on the X20AT6402 via copper wires. The temperature measured at the external cold junction (e.g. with PT100 - X20AT4222) is stored in the I/O area of the X20AT6402 module. The X20AT6402 uses the measured voltage and the cold junction temperature to internally calculate the needed thermocouple temperature.



Increased precision

Setting up an external cold junction is recommended to increase precision. The external cold junction is set up as described above. The installation of an external cold junction is especially helpful in the following cases:

- A module consuming more power than 1 W is connected in addition to the X20AT6402.
- No modules but the X20AT6402 are connected
- With strongly fluctuating ambient conditions (draft, temperature)

9.32.7.11 Register description

9.32.7.11.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.32.7.11.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 24 | ConfigOutput01 (input filter / ambient conditions) | USINT | | | | • |
| 26 | ConfigOutput02 (sensor type) | USINT | | | | • |
| 27 | ConfigOutput03 (channel disabling) | USINT | | | | • |
| Communication | | | | | | |
| 0 | Temperature01 | INT | • | | | |
| 2 | Temperature02 | INT | • | | | |
| 4 | Temperature03 | INT | • | | | |
| 6 | Temperature04 | INT | • | | | |
| 8 | Temperature05 | INT | • | | | |
| 10 | Temperature06 | INT | • | | | |
| 28 | IOCycleCounter | USINT | • | | | |
| 30 | StatusInput01 | USINT | • | | | |
| 31 | StatusInput02 | USINT | • | | | |
| 22 | CompensationTemperature | INT | | • | | |

9.32.7.11.3 Function model 1 - External cold junction temperature

| Register | Name | Data type | Read | | Write | |
|----------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 24 | ConfigOutput01 (input filter / ambient conditions) | USINT | | | | • |
| 26 | ConfigOutput02 (sensor type) | USINT | | | | • |
| 27 | ConfigOutput03 (channel disabling) | USINT | | | | • |
| Communication | | | | | | |
| 12 | ExternalCompensationTemperature | INT | | | • | |
| 0 | Temperature01 | INT | • | | | |
| 2 | Temperature02 | INT | • | | | |
| 4 | Temperature03 | INT | • | | | |
| 6 | Temperature04 | INT | • | | | |
| 8 | Temperature05 | INT | • | | | |
| 10 | Temperature06 | INT | • | | | |
| 28 | IOCycleCounter | USINT | • | | | |
| 30 | StatusInput01 | USINT | • | | | |
| 31 | StatusInput02 | USINT | • | | | |

9.32.7.11.4 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 24 | - | ConfigOutput01 (Input filter / ambient conditions) | USINT | | | | • |
| 26 | - | ConfigOutput02 (Sensor type) | USINT | | | | • |
| 27 | - | ConfigOutput03 (Channel disabling) | USINT | | | | • |
| Communication | | | | | | | |
| 0 | 0 | Temperature01 | INT | • | | | |
| 2 | 2 | Temperature02 | INT | • | | | |
| 4 | 4 | Temperature03 | INT | • | | | |
| 6 | 8 | Temperature04 | INT | • | | | |
| 8 | 10 | Temperature05 | INT | • | | | |
| 10 | 12 | Temperature06 | INT | • | | | |
| 28 | - | IOCycleCounter | USINT | | • | | |
| 30 | - | StatusInput01 | USINT | | • | | |
| 31 | - | StatusInput02 | USINT | | • | | |
| 22 | - | CompensationTemperature | INT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.32.7.11.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.32.7.11.4.2 CAN I/O bus controller

The module occupies 2 analog logical slots on CAN I/O.

9.32.7.11.5 General information

9.32.7.11.5.1 Raw value measurement

If a sensor type other than J, K, N, S, B or R is used, the terminal temperature must be measured on at least one input. Based on this value, the user must then implement terminal temperature compensation.

9.32.7.11.5.2 Timing

The timing for acquiring measurement values is determined by the converter hardware. All enabled inputs are converted during each conversion cycle. In addition, the terminal temperature is measured (not in function model 1).

Any inputs that are not needed can be switched off, which reduces the I/O update time. Inputs can also be only switched off temporarily. Measuring the terminal temperature is switched off in function model 1.

9.32.7.11.5.3 Conversion time

The conversion time depends on the number of channels and the function model. For the formulas listed in the table, "n" corresponds to the number of channels that are switched on.

| Function model | Conversion time |
|----------------------|--|
| Model 0 - n channels | $(n + 1) \cdot (2 \cdot \text{Filter time} + 200 \mu\text{s})$ |
| Model 1 - n channels | $n \cdot (2 \cdot \text{Filter time} + 200 \mu\text{s})$ |
| Model 1 - 1 channel | Equal to the filter time |

Examples

Inputs are filtered using a 50 Hz filter.

| | Example 1 | | Example 2 | |
|--|------------------|------------------|------------------|------------------|
| | Function model 0 | Function model 1 | Function model 0 | Function model 1 |
| Switched on inputs | 1 | 1 | 1 - 6 | 1 - 6 |
| Input conversion times | 40.2 ms | 20 ms | 241.2 ms | 241.2 ms |
| Conversion time for the terminal temperature | 40.2 ms | - | 40.2 ms | - |
| Total conversion time | 80.4 ms | 20 ms | 281.4 ms | 241.2 ms |

9.32.7.11.6 Configuration

9.32.7.11.6.1 Input filter and ambient conditions

Name:

ConfigOutput01

This register configures input filters and ambient conditions.

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| USINT | See bit structure. | 3 |

Bit structure:

| Bit | Description | Value | Information |
|-------|--------------------------|--------------|---|
| 0 - 3 | Input filter | 0000 | 15 Hz |
| | | 0001 | 25 Hz |
| | | 0010 | 30 Hz |
| | | 0011 | 50 Hz (bus controller default setting) |
| | | 0100 | 60 Hz |
| | | 0101 | 100 Hz |
| | | 0110 | 500 Hz |
| | | 0111 | 1000 Hz |
| | | 1000 to 1111 | Not permitted |
| 4 - 7 | Environmental conditions | 0000 | Default, no calculation for adjustment (bus controller default setting) |
| | | 0001 | Power dissipation less than 0.2 W |
| | | 0010 | Power dissipation less than 1 W |
| | | 0011 | Power dissipation more than 1 W |
| | | 0100 to 1111 | Not permitted |

Input filter

The filter time for all analog inputs is defined using the input filter parameter.

| Value | Filter | Filter time | Digital converter resolution |
|-------|---------|-------------|------------------------------|
| 0 | 15 Hz | 66.7 ms | 16-bit |
| 1 | 25 Hz | 40 ms | 16-bit |
| 2 | 30 Hz | 33.3 ms | 16-bit |
| 3 | 50 Hz | 20 ms | 16-bit |
| 4 | 60 Hz | 16.7 ms | 16-bit |
| 5 | 100 Hz | 10 ms | 16-bit |
| 6 | 500 Hz | 2 ms | 16-bit |
| 7 | 1000 Hz | 1 ms | 16-bit |

Environmental conditions

Ambient conditions are set in order to adjust the internal terminal temperature characteristic curve to the type and amount of generated heat dissipated to the module.

This selection is based on the power consumption of the modules connected immediately to the left and right on the X2X Link. Power consumption values can also be found in the technical data for the corresponding module. The higher value is used for the configuration.

9.32.7.11.6.2 Sensor type

Name:

ConfigOutput02

This module is designed for a wide range of sensor types. The sensor type must be configured because of the different alignment values.

| Data type | Value | Information |
|-----------|----------|--|
| USINT | 0 | Conversion switched off |
| | 1 | Sensor type J (bus controller default setting) |
| | 2 | Sensor type K |
| | 3 | Sensor type S |
| | 4 | Sensor type N |
| | 5 | Conversion switched off |
| | 6 | Raw value without linearization and terminal temperature compensation: Resolution 1.0625 μ V for a measurement range of ± 35 mV |
| | 7 | Raw value without linearization and terminal temperature compensation: Resolution 2.125 μ V for a measurement range of ± 70 mV |
| | 8 - 63 | Conversion switched off |
| | 64 | Sensor type R |
| | 65 - 71 | Conversion switched off |
| | 72 | Sensor type B |
| | 73 - 255 | Conversion switched off |

9.32.7.11.6.3 Channel disabling

Name:

ConfigOutput03

By default, all channels are switched on. To save time, individual channels can be switched off (see "[Conversion time](#)" on page 3705).

| Data type | Values | Bus controller default setting |
|-----------|--------------------|--------------------------------|
| USINT | See bit structure. | 63 |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|--|
| 0 | Channel 1 | 0 | Off |
| | | 1 | Switched on (bus controller default setting) |
| | ... | ... | |
| 5 | Channel 6 | 0 | Off |
| | | 1 | Switched on (bus controller default setting) |
| 6 - 7 | Reserved | 0 | |

9.32.7.11.7 Communication

9.32.7.11.7.1 Analog inputs

Name:

Temperature01 to Temperature06

Analog input value depending on the configured sensor type:

| Data type | Values | Input signal |
|-----------|---|--|
| INT | -2100 to +12000 (for -210.0°C to +1200.0°C) | Type J (FeCuNi) |
| | -2700 to +13720 (for -270.0°C to +1372.0°C) | Type K (NiCrNi) |
| | -2700 to +13000 (for -270.0°C to +1300.0°C) | Type N (NiCrSi) |
| | -500 to +17680 (for -50.0°C to +1768.0°C) | Type S (PtRhPt) |
| | 0 to +18200 (for 0°C to +1820.0°C) | Type B (PtRhPt) |
| | -500 to +16640 (for -50.0°C to +1664.0°C) | Type R (PtRhPt) |
| | -32768 to +32767 | Raw value without linearization and terminal temperature compensation: Resolution 1.0625 μ V for a measurement range of ± 35 mV |
| | -32768 to +32767 | Raw value without linearization and terminal temperature compensation: Resolution 2.125 μ V for a measurement range of ± 70 mV |

In order for the user to always be supplied with a defined output value, the following must be taken into consideration:

- Up to the first conversion, 0x8000 is output.
- After switching the sensor type, 0x8000 is output until the first conversion.
- After switching the sensor type from raw value measurement to "type x" measurement, 0x7FFF is output until the internal terminal temperature measurements have been performed (see "Input circuit diagram" on page 3702). In addition, the [StatusInput](#) bit "Upper limit value exceeded" associated with the channel is set.
- If the input is not switched on, 0x8000 is output.

9.32.7.11.7.2 I/O cycle counter

Name:

IOCycleCounter

The cyclic counter increases after all input data has been updated.

| Data type | Values | Information |
|-----------|----------|-------------------|
| USINT | 0 to 255 | Repeating counter |

9.32.7.11.7.3 Input status

The module's inputs are monitored. A change in the monitoring status generates an error message.

In addition to the status info, the error type also sets the analog value as follows:

| Error status | Digital value for error |
|----------------------------|-------------------------|
| Open line | +32767 (0x7FFF) |
| Upper limit value exceeded | +32767 (0x7FFF) |
| Lower limit value exceeded | -32767 (0x8001) |
| Invalid value | -32768 (0x8000) |

Status of inputs 1 to 4

Name:

StatusInput01

The state of analog inputs 1 to 4 is represented in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|-----------------------------|
| 0 - 1 | Channel 1 | 00 | No error |
| | | 01 | Lower limit value undershot |
| | | 10 | Upper limit value overshoot |
| | | 11 | Open circuit |
| 2 - 3 | Channel 2 | x | Values, see channel 1 |
| 4 - 5 | Channel 3 | x | Values, see channel 1 |
| 6 - 7 | Channel 4 | x | Values, see channel 1 |

Status of inputs 5 to 6

Name:
StatusInput02

The state of analog inputs 5 to 6 is represented in this register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-------------|-------|-----------------------------|
| 0 - 1 | Channel 5 | 00 | No error |
| | | 01 | Lower limit value undershot |
| | | 10 | Upper limit value overshoot |
| | | 11 | Open circuit |
| 2 - 3 | Channel 6 | x | Values, see channel 5 |
| 4 - 7 | Reserved | 0 | |

9.32.7.11.7.4 Reads the internal cold junction temperature

Name:
CompensationTemperature

The internal cold junction temperature is stored in this register.

| Data type | Value | Information |
|-----------|-------------|--|
| INT | -250 to 850 | Internal cold junction temperature (PT1000): -25.0 to 85.0°C |

9.32.7.11.7.5 Defines the external cold junction temperature

Name:
ExternalCompensationTemperature

The external cold junction temperature is defined in this register.

| Data type | Value | Information |
|-----------|-------------|---|
| INT | -250 to 850 | External cold junction temperature: -25.0 to 85.0°C |

9.32.7.11.8 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 150 µs |

9.32.7.11.9 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

For the formulas listed in the table, 'n' corresponds to the number of channels that are switched on.

| Function model 0 | |
|------------------|---|
| n inputs | $(n + 1) \cdot (2 \times \text{Filter time} + 200 \mu\text{s})$ |
| Function model 1 | |
| 1 input | Equal to the filter time |
| n inputs | $n \cdot (2 \times \text{Filter time} + 200 \mu\text{s})$ |

9.32.8 X20ATA312

Data sheet version: 1.42

9.32.8.1 General information

The module is equipped with 2 inputs for PT100 4-line resistance temperature measurement.

- 2 inputs for resistance temperature measurement
- PT100 sensor
- Direct resistance measurement as well
- 4-wire measurement
- Filter time can be configured
- NetTime timestamp: Moment of measurement

NetTime timestamp of the measurement

For many applications, not only the measured value is important, but also the exact time of the measurement. The module is equipped with a NetTime timestamp function for this that supplies a timestamp for the recorded position and trigger time with microsecond accuracy.

The timestamp function is based on synchronized timers. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

9.32.8.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| X20ATA312 | X20 temperature input module, 2 inputs for resistance measurement, PT100, resolution 0.01°C, 4-wire connections, NetTime function |  |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB1F | X20 terminal block, 16-pin, 24 VDC keyed | |

Table 647: X20ATA312 - Order data

9.32.8.3 Technical data

| Model number | X20ATA312 |
|--|---|
| Short description | |
| I/O module | 2 inputs for PT100 resistance temperature measurement |
| General information | |
| B&R ID code | 0xE0E4 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| Inputs | Yes, using LED status indicator and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 0.4 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| EAC | Yes |
| Resistance measurement temperature inputs | |
| Input | Resistance measurement with constant current supply for 4-wire connections |
| Digital converter resolution | 24-bit |
| Filter time | Configurable between 1 and 200 ms |
| Conversion time | |
| 1 channel | 20 ms with 50 Hz filter |
| 2 channels | 40 ms per channel with 50 Hz filter |
| Conversion procedure | Sigma-delta |
| Output format | DINT or UDINT for resistance measurement |
| Temperature measurement range | -200 to 850 °C |
| Resistance measurement range | 0.5 to 390 Ω |
| Temperature sensor resolution | 1 LSB = 0.01 °C |
| Resistance measurement resolution | 0.001 Ω |
| Input filter | First-order low-pass filter / cutoff frequency 1050 Hz |
| Sensor standard | EN 60751 |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Linearization method | Internal |
| Measurement current | 1 mA |
| Temperature sensor normalization | -200.0 to 850.0 °C |
| Reference | 1568 Ω ±0.1% |
| Permissible input signal | Short-term max. 28.8 V |
| Max. error at 25 °C ¹⁾ | |
| Gain | 0.0059% ²⁾ |
| Offset | 0.0015% ³⁾ |
| Max. gain drift | <0.00065 %/°C ²⁾ |
| Max. offset drift | <0.000025 %/°C ³⁾ |
| Nonlinearity | <0.001% ³⁾ |
| Standardized range of values for resistance measurement | 19 to 390 Ω |
| Temperature measurement monitoring | |
| Range undershoot | 0x80000001 |
| Range overshoot | 0x7FFFFFFF |
| Open circuit | 0x7FFFFFFF |
| General fault | 0x80000000 |
| Open inputs | 0x7FFFFFFF |
| Resistance measurement monitoring | |
| Range undershoot | 0x80000001 |
| Range overshoot | 0xFFFFFFFF |
| Open circuit | 0xFFFFFFFF |
| General fault | 0x80000000 |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |

Table 648: X20ATA312 - Technical data


| Model number | X20ATA312 |
|--|--|
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB1F separately. Order 1x bus module X20BM11 separately. |
| Pitch | 12.5 ^{+0.2} mm |

Table 648: X20ATA312 - Technical data

- 1) To guarantee accuracy, modules with a power dissipation < 1.2 W must be connected to the left and right of this module.
- 2) Based on the current resistance value.
- 3) Based on the entire resistance measurement range.

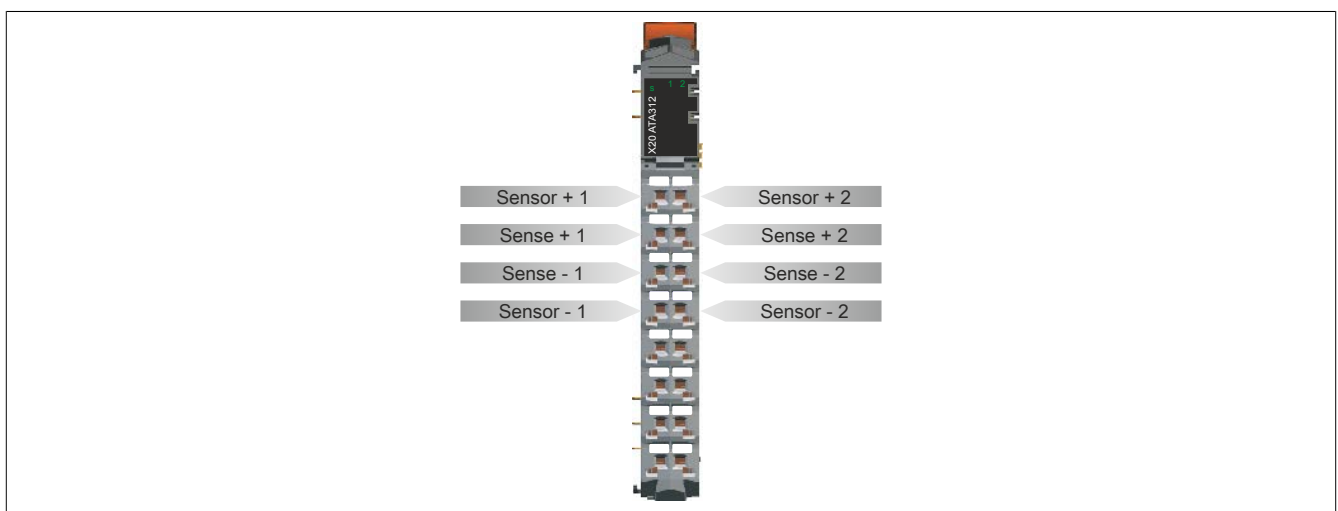
9.32.8.4 Status LEDs

For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

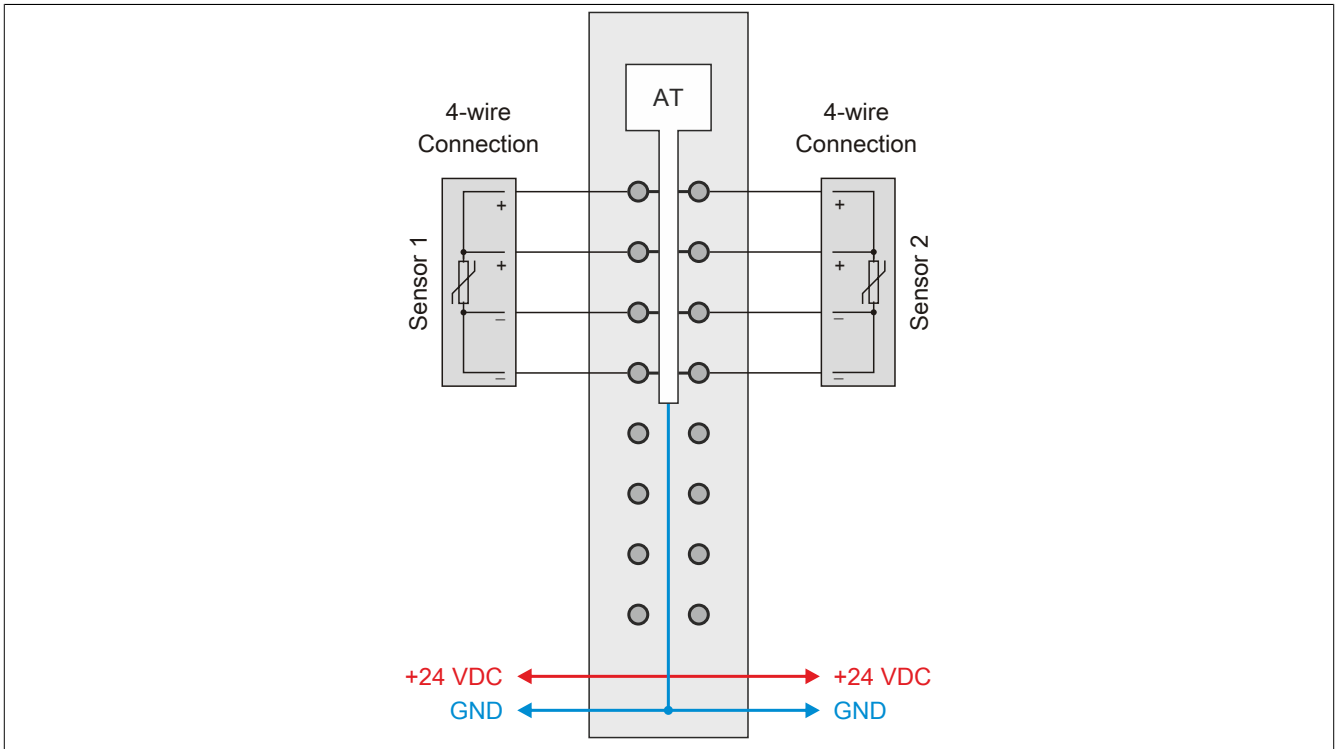
| Image | LED | Color | Status | Description |
|---|-----------------------------|------------------|----------------------------------|--|
|  | s | Green | Off | Module supply not connected |
| | | | Single flash | Reset mode |
| | | | Double flash | Mode BOOT (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | On | RUN mode | |
| | | Red | Off | Module supply not connected or everything OK |
| | | | On | Error or reset status |
| | | | Single flash | Parameter or conversion error ²⁾ |
| | Red on / Green single flash | Invalid firmware | | |
| | 1 - 2 | Green | Off | Input turned off or not supplied |
| | | | Single flash | Parameter error ²⁾ |
| | | | Double flash | Conversion error ²⁾ |
| Blinking | | | Overflow, underflow or open line | |
| On | | | A/D converter running, value OK | |

- 1) Depending on the configuration, a firmware update can take up to several minutes.
- 2) Parameter or converter errors are indicated simultaneously on the red "s" LED and the channel LED of the respective output.

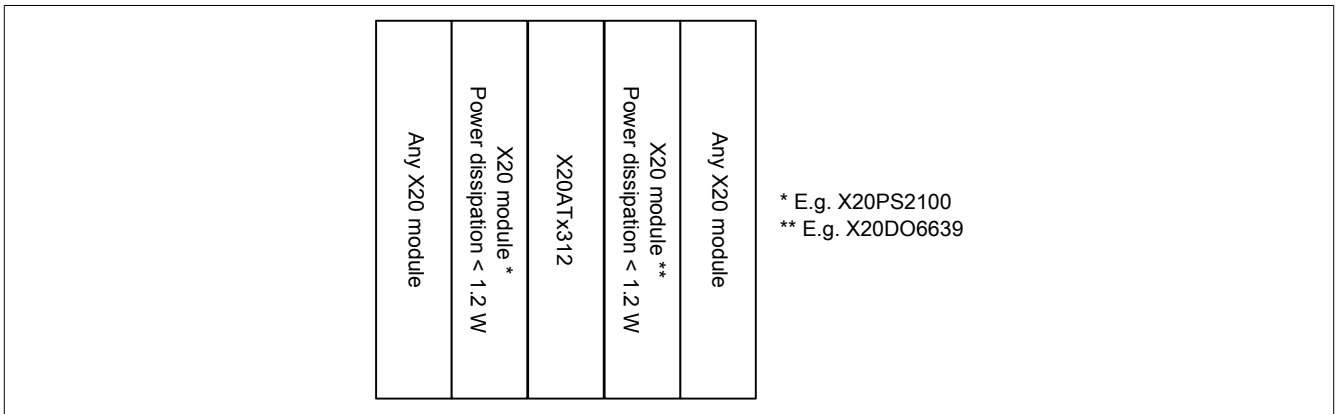
9.32.8.5 Pinout



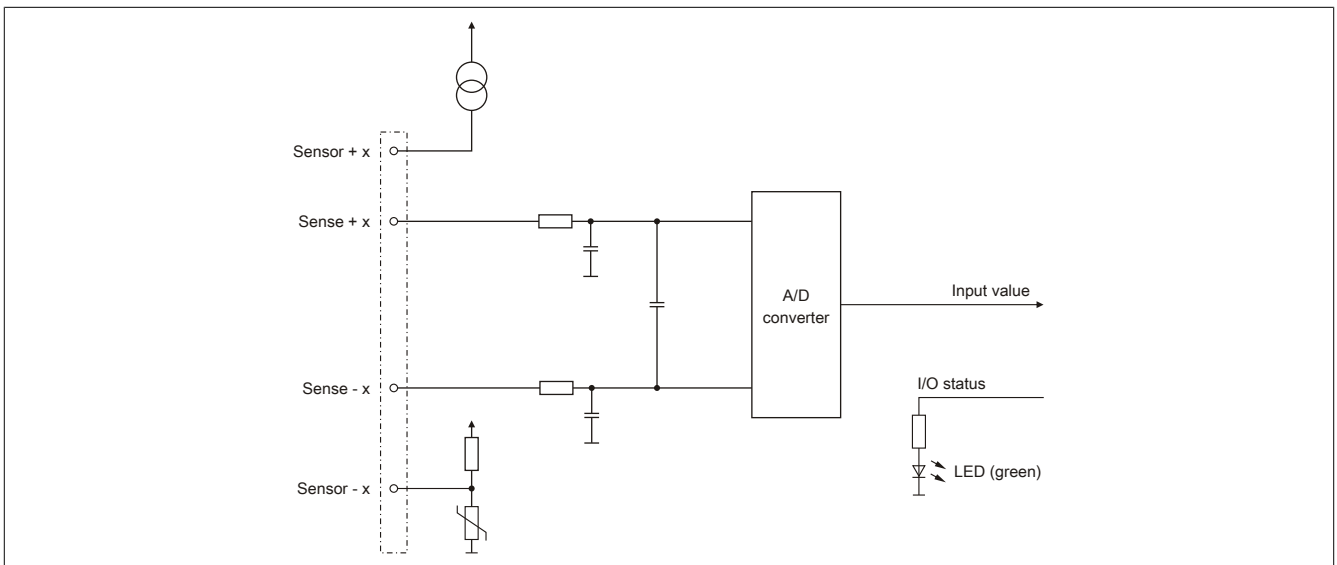
9.32.8.6 Connection example



To ensure accuracy, modules with a power consumption <math>< 1.2\text{ W}</math> must be inserted to the left and right of this modules.



9.32.8.7 Input circuit diagram



9.32.8.8 Register description

9.32.8.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.32.8.8.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|----------------------|-----------------------|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 130 | InputFilter | UINT | | | | • |
| 134 | ModeADC | UINT | | | | • |
| 514 | SensorType01 | UINT | | | | • |
| 578 | SensorType02 | | | | | |
| 566 | PreparationInterval01 | UINT | | | | • |
| 630 | PreparationInterval02 | | | | | |
| 548 | ReplaceUpper01 | DINT | | | | • |
| 612 | ReplaceUpper02 | | | | | |
| 540 | ReplaceLower01 | DINT | | | | • |
| 604 | ReplaceLower02 | | | | | |
| 532 | UpperLimit01 | DINT | | | | • |
| 596 | UpperLimit02 | | | | | |
| 524 | LowerLimit01 | DINT | | | | • |
| 588 | LowerLimit02 | | | | | |
| 554 | Hysteresis01 | UINT | | | | • |
| 618 | Hysteresis02 | | | | | |
| 558 | ErrorDelay01 | UINT | | | | • |
| 622 | ErrorDelay02 | | | | | |
| 562 | SumErrorDelay01 | UINT | | | | • |
| 626 | SumErrorDelay02 | | | | | |
| Communication | | | | | | |
| 0 | Temperature01 | DINT | • | | | |
| | Resistor01 | UDINT | | | | |
| 4 | Temperature02 | DINT | • | | | |
| | Restistor02 | UDINT | | | | |
| 260 | Measurand01 | DINT | | • | | |
| 324 | Measurand02 | | | | | |
| 281 | IOCycleCounter01 | USINT | • | | | |
| 345 | IOCycleCounter02 | | | | | |
| 282 | IOCycleCounter01 | UINT | • | | | |
| 346 | IOCycleCounter02 | | | | | |
| 274 | Sampletime01 | INT | • | | | |
| 338 | Sampletime02 | | | | | |
| 276 | Sampletime01 | DINT | • | | | |
| 340 | Sampletime02 | | | | | |
| 297 | Status01 | USINT | • | | | |
| | Underrun01 | Bit 0 | | | | |
| | Overrun01 | Bit 1 | | | | |
| | OpenLine01 | Bit 2 | | | | |
| | ConverterFault01 | Bit 4 | | | | |
| | SumFault01 | Bit 5 | | | | |
| | ParameterFault01 | Bit 6 | | | | |
| IoSupplyFault01 | Bit 7 | | | | | |
| 361 | Status02 | USINT | • | | | |
| | Underrun02 | Bit 0 | | | | |
| | Overrun02 | Bit 1 | | | | |
| | OpenLine02 | Bit 2 | | | | |
| | ConverterFault02 | Bit 4 | | | | |
| | SumFault02 | Bit 5 | | | | |
| | ParameterFault02 | Bit 6 | | | | |
| IoSupplyFault02 | Bit 7 | | | | | |

9.32.8.8.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|-----------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 130 | - | InputFilter | UINT | | | | • |
| 134 | - | ModeADC | UINT | | | | • |
| 514 | - | SensorType01 | UINT | | | | • |
| 578 | - | SensorType02 | | | | | |
| 566 | - | PreparationInterval01 | UINT | | | | • |
| 630 | - | PreparationInterval02 | | | | | |
| 548 | - | ReplaceUpper01 | DINT | | | | • |
| 612 | - | ReplaceUpper02 | | | | | |
| 540 | - | ReplaceLower01 | DINT | | | | • |
| 604 | - | ReplaceLower02 | | | | | |
| 532 | - | UpperLimit01 | DINT | | | | • |
| 596 | - | UpperLimit02 | | | | | |
| 524 | - | LowerLimit01 | DINT | | | | • |
| 588 | - | LowerLimit02 | | | | | |
| 554 | - | Hysteresis01 | UINT | | | | • |
| 618 | - | Hysteresis02 | | | | | |
| 558 | - | ErrorDelay01 | UINT | | | | • |
| 622 | - | ErrorDelay02 | | | | | |
| 562 | - | SumErrorDelay01 | UINT | | | | • |
| 626 | - | SumErrorDelay02 | | | | | |
| Communication | | | | | | | |
| 0 | 0 | Temperature01 | DINT | • | | | |
| | | Resistor01 | UDINT | | | | |
| 4 | 4 | Temperature02 | DINT | • | | | |
| | | Restistor02 | UDINT | | | | |
| 281 | - | IOCycleCounter01 | USINT | | • | | |
| 345 | - | IOCycleCounter02 | | | | | |
| 30 | - | Status01To02 | USINT | | • | | |

1) The offset specifies where the register is within the CAN object.

9.32.8.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.32.8.8.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.32.8.8.4 Configuration of the A/D converter

9.32.8.8.4.1 Setting the conversion rate

Name:

InputFilter

Mit Hilfe dieses Registers wird die Abtastzeit des A/D-Wandlers konfiguriert.

| Datentyp | Werte | Filterzeit in ms | Wandelrate in s ⁻¹ |
|----------|-------|-----------------------------|-------------------------------|
| UINT | 4 | 1 | 1000 |
| | 9 | 2 | 500 |
| | 48 | 10 | 100 |
| | 80 | 16,7 | 60 |
| | 96 | 20 (Bus Controller Default) | 50 |
| | 160 | 33,3 | 30 |
| | 192 | 40 | 25 |
| | 320 | 66,7 | 15 |
| | 480 | 100 | 10 |
| | 960 | 200 | 5 |

Information:

Je geringer die Wandelrate konfiguriert wird, desto genauer kann der Wert gewandelt werden. Allerdings wird dadurch auch die I/O-Updatezeit erhöht.

9.32.8.8.4.2 Operating mode of the A/D converter

Name:

ModeADC

The operating mode for the A/D converter can be configured in this register.

The individual options allow faster digitalization of the analog values, but this also reduces the precision of the measured values.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|--------|--------------------------|-------|---|
| 0 | Chopper mode | 0 | Alternating gain of the analog value (bus controller default setting) |
| | | 1 | Chopper mode off |
| 1 | Order of the SINC filter | 0 | SINC4 (bus controller default setting) |
| | | 1 | SINC3 |
| 2 - 15 | Reserved | - | - |

The following applies:

$$\begin{aligned} \text{ConversionTime(SINC3)} &= \text{ConversionTime(SINC4)} - 1 \times \text{ConversionCycle} \\ \text{ConversionTime(without Chop)} &= 0.5 \times \text{ConversionTime(Chop)} \end{aligned}$$

9.32.8.8.5 Configuring the measurement channels

Each temperature measurement channel can be configured independently. All the registers required for this purpose by each channel are arranged separately.

9.32.8.8.5.1 General channel configuration

Name:

SensorType01 to SensorType02

This register defines the basic behavior of the channel.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 129 |

Bit structure:

| Bit | Description | Value | Information |
|--------|--|------------|--|
| 0 - 2 | Sensor type with unit and resolution | 001 | PT100 [10 mK/bit] - Temperature measurement (bus controller default setting) |
| | | 010 | PT100 [1 mΩ/bit] - Resistance measurement |
| | | 011 to 111 | Reserved |
| 3 - 4 | Reserved | - | |
| 5 | Replacement value strategy | 0 | Replace statically |
| | | 1 | Retain last valid value |
| 6 | Monitoring the user-defined limit values | 0 | Switch off additional limits |
| | | 1 | Switch on additional limits |
| 7 | Channel (on/off) | 0 | Switch off the entire channel |
| | | 1 | Switch on channel (bus controller default setting) |
| 8 - 15 | Reserved | - | |

9.32.8.8.6 Configuring the replacement value strategy

If a measured value is detected that is outside the permitted value range, the behavior of the input register must still remain clearly defined. The module provides the user two different options for this purpose.

Retain last valid value

With this strategy, the determined measured value is stored temporarily for a specific time and written to the input register after a delay. If an invalid measured value is detected, this value and all values that have been stored temporarily are discarded. The last valid input register value is retained. To update the value in the input register, there must be enough valid values stored in the temporary buffer. The number needed is determined by the time period specified in "PreparationInterval0x".

Replace with static value

With this strategy, the measured value is written to the input register without delay. If an invalid value occurs, it is replaced by a static value that has been predefined by the user.

9.32.8.8.6.1 Preparation interval

Name:

PreparationInterval01 to PreparationInterval02

This register defines the time interval in which the measured value is checked before being passed on.

| Data type | Value | Information |
|-----------|-------------|--|
| UINT | 0 to 65,535 | Unit in 0.1 ms. Bus controller default setting: 0 |

Information:

This register only needs to be defined if replacement value strategy "Retain last valid value" was selected in register "SensorType0x" on page 3717.

9.32.8.8.6.2 Static replacement value for upper limit

Name:

ReplaceUpper01 to ReplaceUpper02

This register is used to defined a replacement value that is output in place of the invalid measured value if the upper limit is violated.

| Data type | Values | Information |
|-----------|------------------------------------|---|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: 2,147,483,647 |

Information:

This register must be defined if the replacement value strategy "Replace with static value" was selected in register "[SensorType0x](#)" on page 3717.

9.32.8.8.6.3 Static replacement value for lower limit

Name:

ReplaceLower01 to ReplaceLower02

This register is used to defined a replacement value that is output in place of the invalid measured value if the lower limit is violated.

| Data type | Values | Information |
|-----------|------------------------------------|--|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: -2,147,483,647 |

Information:

This register must be defined if the replacement value strategy "Replace with static value" was selected in register "[SensorType0x](#)" on page 3717.

9.32.8.8.7 Configuring the user-defined limit values

This module provides the user the option to specify user-defined limits. If the valid measurement range is reduced in this way, the behavior of the replacement value strategy is more likely to be applied.

Valid measurement range

The valid range is derived from the properties of the sensor being used or the hardware and firmware of the respective B&R module. These values cannot be changed by the user.

Valid range of values

The range of values is always within the valid measurement range. The range of values can be adapted to the requirements of the application by specifying the [upper](#) and [lower](#) limit value.

9.32.8.8.7.1 Upper limit value

Name:

UpperLimit01 to UpperLimit02

This register specifies the upper limit value. The values entered should be within the valid measurement range.

| Data type | Values | Information |
|-----------|------------------------------------|---|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: 2,147,483,647 |

9.32.8.8.7.2 Lower limit value

Name:

LowerLimit01 to LowerLimit02

This register specifies the lower limit value. The values entered should be within the valid measurement range.

| Data type | Values | Information |
|-----------|------------------------------------|--|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: -2,147,483,647 |

9.32.8.8.7.3 Hysteresis

Name

Hysteresis01 to Hysteresis02

A hysteresis can be set in order to avoid frequent status changes in the measurement range close to the limit value. Here, a small section is defined at the edge of the valid range of values where the measured values retain the status (valid or invalid) of the previous measured value.

| Data type | Values | Information |
|-----------|-------------|------------------------------------|
| UINT | 0 to 65,535 | Bus controller default setting: 16 |

9.32.8.8.8 Configuring status messages

Errors are detected by the module and sent to the application. When using Function model 0 - Standard, the trigger behavior of these error messages can be influenced by the "Delay" register.

In Automation Studio, an error message can be read either packed as the entire register or individually as bits.

9.32.8.8.8.1 Delaying error messages

Name:

ErrorDelay01 to ErrorDelay02

In order to avoid false alarms due to short-term measurement variations, the status messages transmitted to the PLC can be delayed. This register determines the number of A/D conversions in which an error must exist before an error message is transmitted.

| Data type | Values | Information |
|-----------|-------------|--|
| UINT | 0 to 65,535 | AD conversions. Bus controller default setting: 2 |

9.32.8.8.8.2 Delaying the sum error message

Name:

SumErrorDelay01 to SumErrorDelay02

This register can be used to set the delay used when sending bit 5 of the "Status0x" on page 3721 register to the PLC independent of the other status messages.

| Data type | Values | Information |
|-----------|-------------|--------------------------------------|
| UINT | 0 to 65,535 | Bus controller default setting: 4000 |

9.32.8.8.9 Communication

The received temperature data is stored with a [timestamp](#) and, depending on the configuration, is made available under various register names and data types.

9.32.8.8.9.1 Measured value – Temperature

Name:

Temperature01 to Temperature02

If the channel is configured for resistance measurement, the current temperature value is made available in this register.

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

9.32.8.8.9.2 Measured value – Resistance

Name:

Resistor01 to Resistor02

If the channel is configured for resistance measurement, the current resistance value is made available in this register.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.32.8.8.9.3 Measured value – Unweighted

Name:

Measurand01 to Measurand02

When using the AsloAcc library, the unweighted measurement can be accessed via this register. This refers to a measured value that is within the valid measurement range and has not yet been compared with the user-defined limits.

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

Information:

If no user-defined limits are configured, the value of this register does not differ from the temperature or resistance value.

9.32.8.8.9.4 Cycle counter

Name:

IOCycleCounter01 to IOCycleCounter02

This register is used to provide a continuous counter for the application that is incremented each time a temperature value is read.

| Data type | Value | Information |
|-----------|-------------|----------------|
| USINT | 0 to 32,767 | AD conversion. |
| UINT | 0 to 65,535 | AD conversion. |

9.32.8.8.9.5 Sampling time - Timestamp

Name:

Sampletime01 to Sampletime02

This register provides the application with the NetTime at the time of temperature recording.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Value | Information |
|-----------|---------------------------------|------------------------------|
| INT | -32,768 to 32,767 | NetTime timestamp in μ s |
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime timestamp in μ s |

Information:

The SDC library requires a 16-bit value for the sampling time. It is therefore also prepared as a 16-bit value.

9.32.8.8.9.6 Status messages

Name:

Status01 to Status02

The register bits are set if an error has been diagnosed and the error remains longer than the delay configured in the "ErrorDelay0x" on page 3719 register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|--------------------------------------|-------|--|
| 0 | Underrun01 to Underrun02 | 0 | No error |
| | | 1 | Value below the permitted range |
| 1 | Overrun01 to Overrun02 | 0 | No error |
| | | 1 | Value above the permitted range |
| 2 | OpenLine01 to OpenLine02 | 0 | No error |
| | | 1 | Sensor is not connected correctly |
| 3 | Reserved | - | |
| 4 | ConverterFault01 to ConverterFault02 | 0 | No error |
| | | 1 | Invalid A/D converter output |
| 5 | SumFault01 to SumFault02 | 0 | No error |
| | | 1 | Composite error |
| 6 | ParameterFault01 to ParameterFault02 | 0 | No error |
| | | 1 | The "SensorType0x" on page 3717 register is faulty |
| 7 | IoSupplyFault01 to IoSupplyFault02 | 0 | No error |
| | | 1 | The I/O supply voltage is faulty |

9.32.8.8.9.7 Status messages for function model 254

Name:

Status01To02

The bits in this register are set if an error has been detected.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-------|------------------------|-------|---------------------------------|
| 0 | Underrun on channel 01 | 0 | No error |
| | | 1 | Value below the permitted range |
| 1 | Overrun on channel 01 | 0 | No error |
| | | 1 | Value above the permitted range |
| 2 | Underrun on channel 02 | 0 | No error |
| | | 1 | Value below the permitted range |
| 3 | Overrun on channel 02 | 0 | No error |
| | | 1 | Value above the permitted range |
| 4 - 7 | Reserved | - | |

Information:

If an open line is detected on a channel, then both error messages will be displayed at the same time.

9.32.8.8.10 NetTime Technology

For a description of NetTime Technology, see "NetTime Technology" on page 3035.

9.32.8.8.11 Minimum cycle time

The minimum cycle time defines how far the bus cycle can be reduced without causing a communication error or impaired functionality. It should be noted that very fast cycles decrease the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μ s |

9.32.8.8.12 Minimum I/O update time

The minimum I/O update time defines how far the bus cycle can be reduced while still allowing an I/O update to take place in each cycle.

| Minimum I/O update time |
|-------------------------|
| 1 ms |

9.32.9 X20ATA492

Data sheet version: 1.41

9.32.9.1 General information

The module is equipped with 2 inputs for J, K, N, S, B, R, E, C and T thermocouple sensors. The 2 measurement channels are electrically isolated from each other.

This module can also be equipped with the X20TB1E thermocouple terminal block with integrated PT1000 temperature sensors. This makes it possible to achieve optimal terminal temperature compensation.

- Single-channel electrical isolation
- Integrated terminal temperature compensation
- 2x PT1000 sensor integrated in the terminal
- 2x external PT1000 sensor can be connected, 2-wire or 4-wire connections
- NetTime timestamp: Moment of measurement

NetTime timestamp of the measurement

For many applications, not only the measured value is important, but also the exact time of the measurement. The module is equipped with a NetTime timestamp function for this that supplies a timestamp for the recorded position and trigger time with microsecond accuracy.

The timestamp function is based on synchronized timers. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

9.32.9.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Temperature measurement |  |
| X20ATA492 | X20 temperature input module, 2 thermocouple inputs, type J, K, N, S, B, R, E, C, T, single-channel isolation, NetTime function, 2x PT1000 integrated in terminal block X20TB1E for temperature compensation, order terminal block separately. | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB1E | X20 terminal block, 12-pin, 24 VDC keyed, 2x PT1000 integrated for terminal temperature compensation | |
| X20TB1F | X20 terminal block, 16-pin, 24 VDC keyed | |

Table 649: X20ATA492 - Order data

9.32.9.3 Technical data

| Model number | X20ATA492 |
|--|--|
| Short description | |
| I/O module | 2 inputs for thermocouples |
| General information | |
| B&R ID code | 0xBB98 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Inputs | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.35 W |
| Internal I/O | 0.5 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations |
| ATEX | Class I, Division 2, Groups ABCD, T5 Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| Thermocouple temperature inputs | |
| Input | Thermocouple |
| Digital converter resolution | 16-bit |
| Filter time | Configurable between 1 ms and 200 ms |
| Conversion time | |
| Internal terminal temperature comp. | 2 * 4 * x ms ¹⁾ |
| External terminal temperature comp. | x ms ¹⁾ |
| Remote temperature comp. | 2 * 4 * x ms ¹⁾ |
| Output format | INT |
| Measurement range | |
| Sensor temperature | |
| Type J: Fe-CuNi | -210 to 1200°C |
| Type K: NiCr-Ni | -270 to 1372°C |
| Type N: NiCrSi-NiSi | -270 to 1298°C |
| Type S: PtRh10-Pt | -50 to 1768°C |
| Type B: PtRh30-PtRh6 | 0 to 1820°C |
| Type R: PtRh13-Pt | -50 to 1760°C |
| Type E: NiCr-CuNi | -270 to 997°C |
| Type C: WRe5-WRe26 | 0 to 2310°C |
| Type T: Cu-CuNi | -270 to 400°C |
| Terminal temperature | -40 to 130°C |
| Voltage | ±65.534 mV |
| Sensor standard | EN 60584 |
| Resolution | |
| Sensor temperature | 1 LSB = 0.1°C |
| Terminal temperature | 1 LSB = 0.1°C |
| Voltage | Depending on gain, 1 LSB = 1 µV or 2 µV |
| Normalization | |
| Type J | -210.0 to 1200.0°C |
| Type K | -270.0 to 1372.0°C |
| Type N | -270.0 to 1298.0°C |
| Type S | -50.0 to 1768.0°C |
| Type B | 0 to 1820.0°C |
| Type R | -50.0 to 1760.0°C |
| Type E | -270.0 to 997.0°C |
| Type C | 0 to 2310.0°C |
| Type T | -270.0 to 400.0°C |
| Terminal temperature (PT1000) | -40.0 to 130.0°C |
| Voltage | Depending on gain ±32.767 mV or ±65.534 mV |
| Monitoring | |
| Range undershoot | 0x8001 |
| Range overshoot | 0x7FFF |
| Open circuit | 0x7FFF |
| Open inputs | 0x7FFF |
| General fault | 0x8000 |

Table 650: X20ATA492 - Technical data

| Model number | X20ATA492 |
|--|---|
| Conversion procedure | Sigma-delta |
| Linearization method | Internal |
| Permissible input signal | Max. ± 5 V |
| Input filter | 1st-order low pass / cutoff frequency 500 Hz |
| Max. error at 25°C | |
| Gain | 0.07% ²⁾ |
| Offset | |
| Type J | 0.03% ³⁾ |
| Type K | 0.04% ³⁾ |
| Type N | 0.04% ³⁾ |
| Type S | 0.1% ³⁾ |
| Type B | 0.12% ³⁾ |
| Type R | 0.08% ³⁾ |
| Type E | 0.03% ³⁾ |
| Type C | 0.05% ³⁾ |
| Type T | 0.08% ³⁾ |
| Voltage | 0.017% ³⁾ |
| Max. gain drift | |
| Channel | 0.01 %/°C ²⁾ |
| Terminal temperature (PT1000) | 0.003 %/°C ²⁾ |
| Max. offset drift | |
| Type J | 0.0019 %/°C ³⁾ |
| Type K | 0.0025 %/°C ³⁾ |
| Type N | 0.003 %/°C ³⁾ |
| Type S | 0.0081 %/°C ³⁾ |
| Type B | 0.0111 %/°C ³⁾ |
| Type R | 0.0072 %/°C ³⁾ |
| Type E | 0.0017 %/°C ³⁾ |
| Type C | 0.0039 %/°C ³⁾ |
| Type T | 0.0072 %/°C ³⁾ |
| Terminal temperature (PT1000) | 0.005 %/°C ³⁾ |
| Voltage | 0.001 %/°C ³⁾ |
| Nonlinearity | |
| Channel | $\pm 0.004\%$ ³⁾ |
| Terminal temperature | $\pm 0.004\%$ ²⁾ |
| Terminal temperature compensation | |
| Operating modes | Internal/remote or external |
| Basic accuracy at 25°C not taking PT1000 sensor into account | $\pm 0.06\%$ |
| Accuracy of internal terminal temperature | |
| With natural convection | $\pm 1.5^\circ\text{C}$ after 20 min |
| With artificial convection | $\pm 3^\circ\text{C}$ after 20 min |
| Common-mode rejection | |
| DC | >110 dB |
| 50 Hz | >110 dB |
| 60 Hz | >110 dB |
| Common-mode range | ± 50 V |
| Crosstalk between channels | <-70 dB |
| Isolation voltage | |
| Between channel and bus | 500 V _{eff} |
| Between channel and channel | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from channel and bus |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |

Table 650: X20ATA492 - Technical data


| Model number | X20ATA492 |
|------------------------------|---|
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB1E terminal block for internal/remote terminal temperature compensation separately Order 1x X20TB1F terminal block for external terminal temperature compensation separately Order 1x X20BM11 bus module separately |
| Spacing | 12.5 ^{+0.2} mm |

Table 650: X20ATA492 - Technical data

- 1) With a 50 Hz filter, x = 20 ms (1 / 50 Hz = 20 ms)
- 2) Based on the current measured value.
- 3) Based on the entire measurement range.

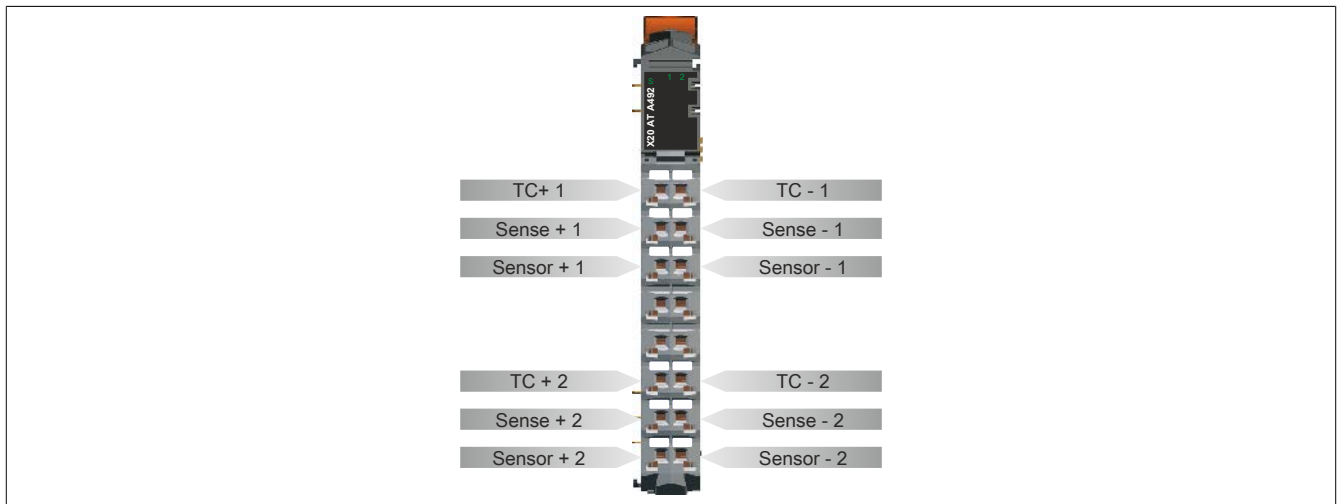
9.32.9.4 LED status indicators

For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description |
|---|-------|-------|--------------------------------|---|
|  | S | Green | Off | No power to module |
| | | | Single flash | RESET mode |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | | Red | Off | No power to module or everything OK |
| | | | On | Error or reset status |
| | 1 - 2 | Green | Single flash | A parameter or conversion error has occurred. This status is output in addition to a single/double flash on the channel LED of the analog input where the error occurs. |
| | | | Solid red / Single green flash | Invalid firmware |
| | | | Off | Input turned off or not supplied |
| | | | Single flash | A parameter error has occurred. A single flash is output on the red "s" module status LED. |
| | | | Double flash | A conversion error has occurred. A single flash is output on the red "s" module status LED. |
| | | | Blinking | Overflow, underflow or open line |
| | | | On | Analog/digital converter running, value OK |

- 1) Depending on the configuration, a firmware update can take up to several minutes.

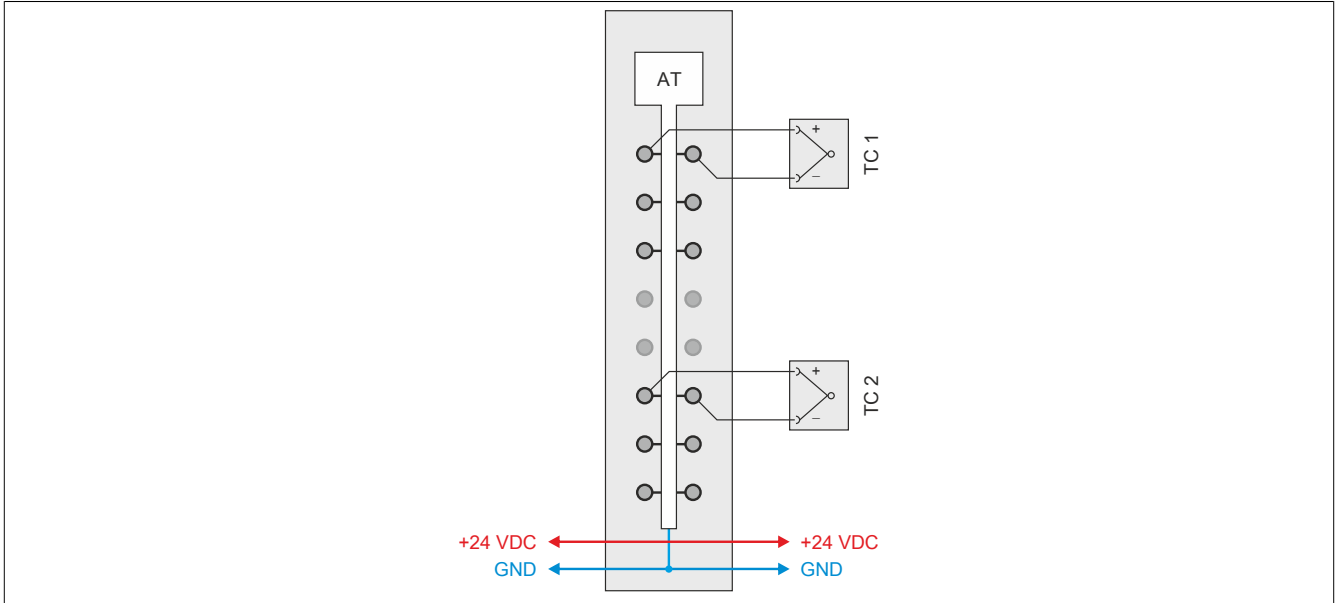
9.32.9.5 Pinout



9.32.9.6 Connection examples

Internal temperature compensation

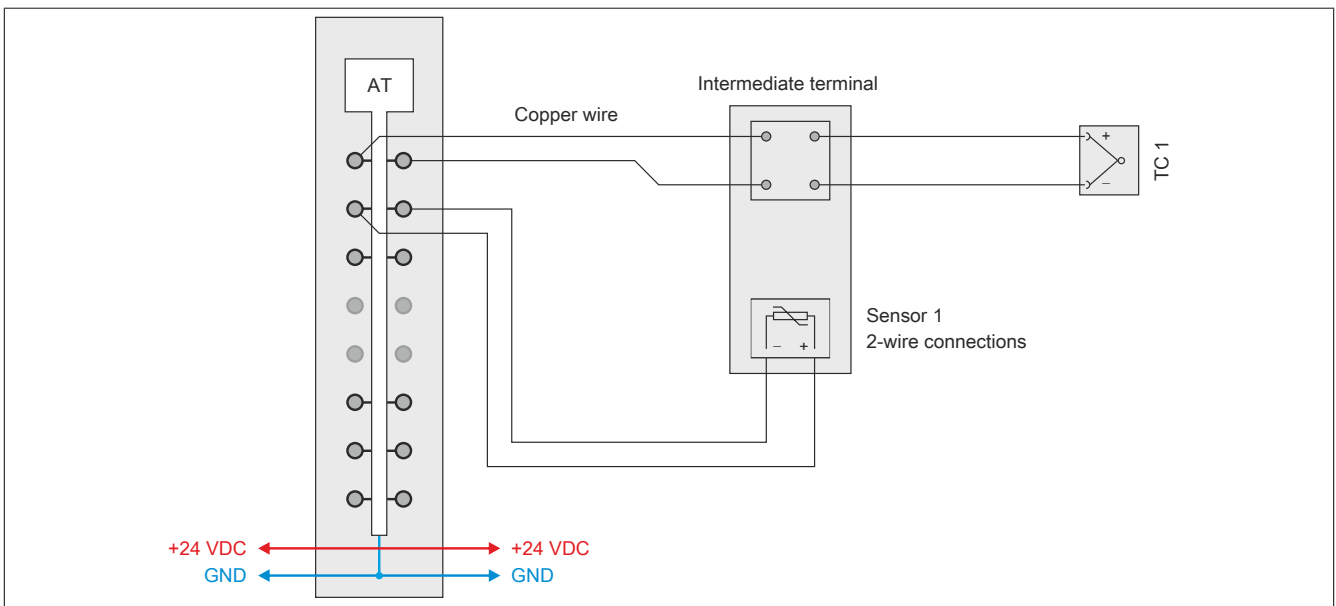
The thermocouple terminal block X20TB1E with integrated PT1000 sensors is used for internal temperature compensation.



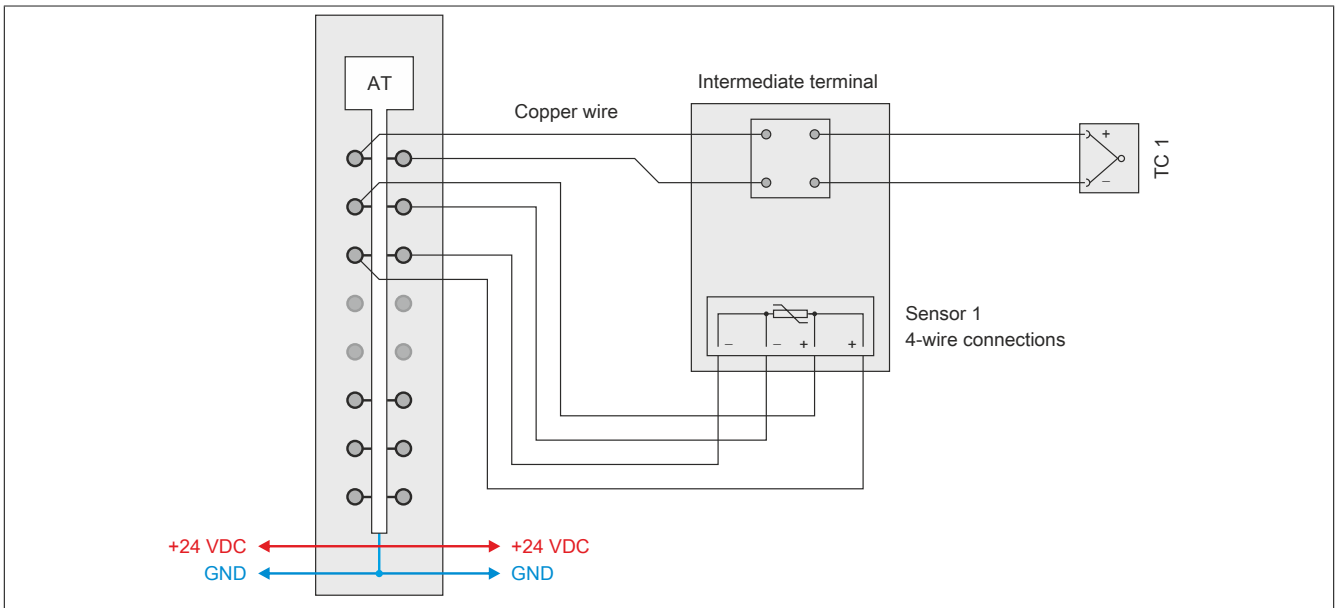
Remote temperature compensation

The 16-pin X20TB1F standard terminal block is used for remote temperature compensation. The external PT1000 sensors are connected to the module using 2-wire or 4-wire connections.

2-wire connections



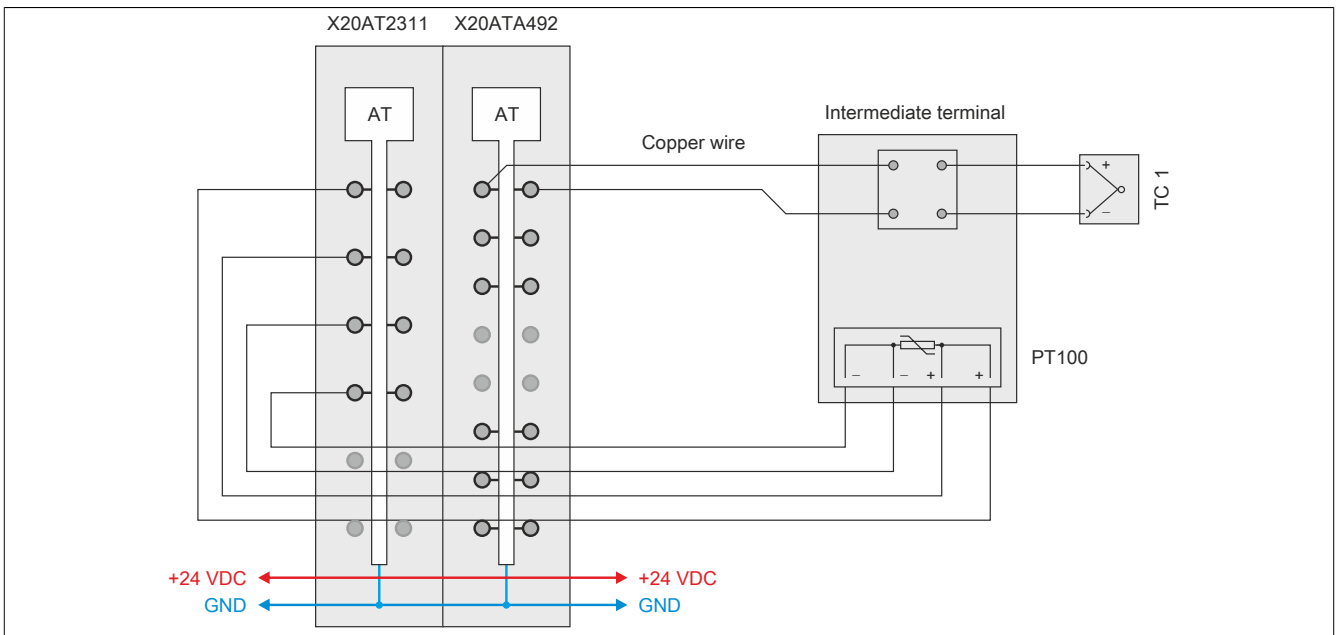
4-wire connections



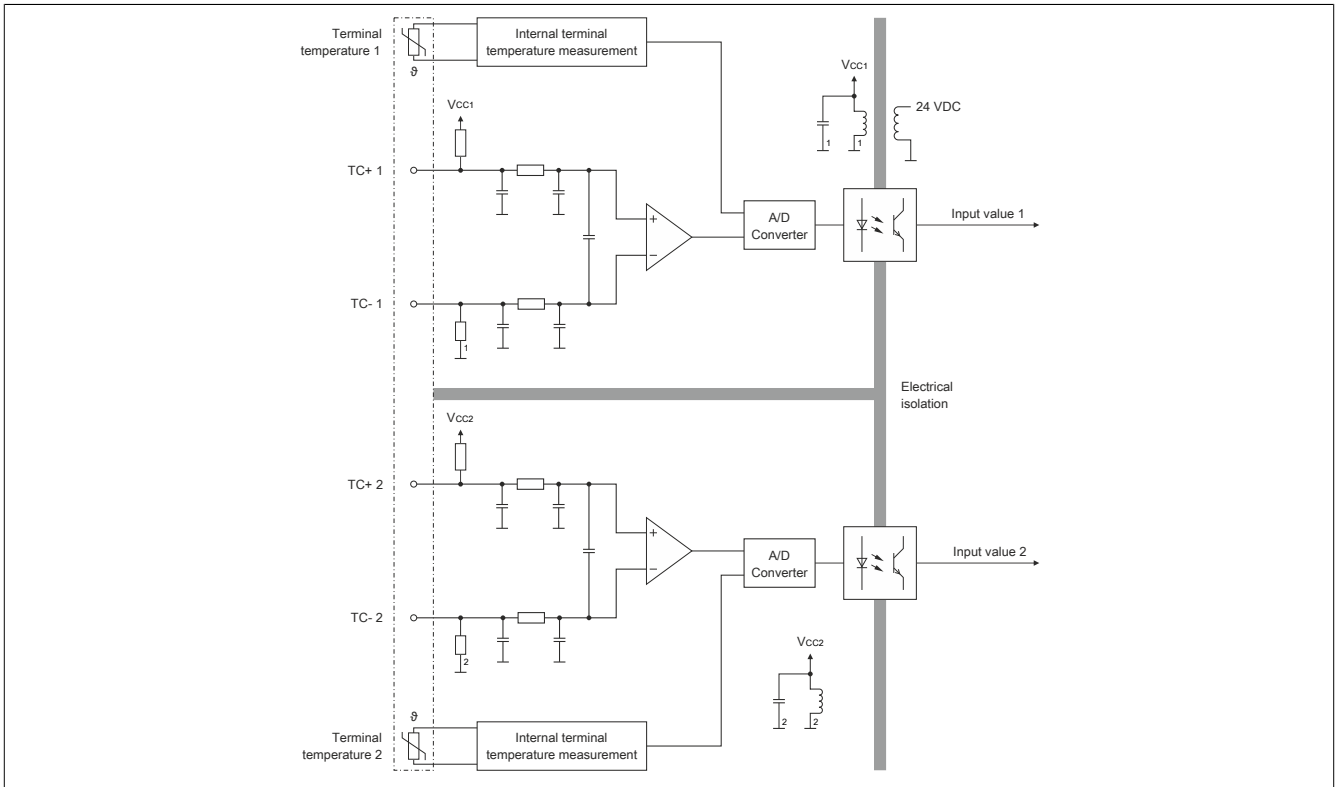
External temperature compensation

External compensation does not require the PT1000 values to be converted internally in the module. Instead, the reference temperatures have to be pre-processed in the program before being stored in the module. A separate register is available for each temperature channel to transfer an externally pre-processed compensation value.

In the following example, the compensation value is determined using the X20AT2311 temperature input module and a PT100 sensor on the intermediate terminal. The cold junction temperature determined externally is then made available to the X20ATA492 module via the respective I/O data points.



9.32.9.7 Input circuit diagram



9.32.9.8 Increased precision

9.32.9.8.1 Internal temperature compensation

When using internal terminal temperature compensation, a temperature model must be defined in order to increase precision. A temperature model should be selected according to the following criteria:

- Thermal power loss of neighboring modules
- X20 system - Mounting orientation

9.32.9.8.1.1 Neighboring modules with low thermal power loss

The temperature model listed in the table must be configured according to the mounting orientation.

| Horizontal installation | Vertical installation | | | | | | | | | | | |
|--|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|--|---------------------------------------|---|---------------------------------------|---------------------------------------|-------------|---------------------------------------|---------------------------------------|
| <table border="1"> <tr> <td>X20 module Power dissipation > 1 W</td> <td>This module</td> <td>X20 module Power dissipation ≤ 1 W</td> </tr> <tr> <td>X20 module Power dissipation ≤ 1 W</td> <td></td> <td>X20 module Power dissipation > 1 W</td> </tr> </table> | X20 module Power dissipation > 1 W | This module | X20 module Power dissipation ≤ 1 W | X20 module Power dissipation ≤ 1 W | | X20 module Power dissipation > 1 W | <table border="1"> <tr> <td>X20 module Power dissipation > 1 W</td> </tr> <tr> <td>X20 module Power dissipation ≤ 1 W</td> </tr> <tr> <td>This module</td> </tr> <tr> <td>X20 module Power dissipation ≤ 1 W</td> </tr> <tr> <td>X20 module Power dissipation > 1 W</td> </tr> </table> | X20 module Power dissipation > 1 W | X20 module Power dissipation ≤ 1 W | This module | X20 module Power dissipation ≤ 1 W | X20 module Power dissipation > 1 W |
| X20 module Power dissipation > 1 W | This module | X20 module Power dissipation ≤ 1 W | | | | | | | | | | |
| X20 module Power dissipation ≤ 1 W | | X20 module Power dissipation > 1 W | | | | | | | | | | |
| X20 module Power dissipation > 1 W | | | | | | | | | | | | |
| X20 module Power dissipation ≤ 1 W | | | | | | | | | | | | |
| This module | | | | | | | | | | | | |
| X20 module Power dissipation ≤ 1 W | | | | | | | | | | | | |
| X20 module Power dissipation > 1 W | | | | | | | | | | | | |

The following temperature model must be set in the "Cfo_SensorTypeCh0x" on page 3736 register.

| Bit 6 and 7 | Temperature model | Bit 6 and 7 | Temperature model |
|-------------|---|-------------|---|
| 00 | Horizontal installation, low thermal radiance <1W | 10 | Vertical installation, low thermal radiance <1W |

Information:

The best results are achieved by placing a dummy module on both sides.

9.32.9.8.1.2 Neighboring modules with higher thermal power loss

The temperature model listed in the table must be configured according to the mounting orientation.

| Horizontal installation | | Vertical installation | |
|--|---|-----------------------|---|
| | | | |
| The following temperature model must be set in the "Cfo_SensorTypeCh0x" on page 3736 register. | | | |
| Bit 6 and 7 | Temperature model | Bit 6 and 7 | Temperature model |
| 01 | Horizontal installation, high thermal radiance >1 W | 11 | Vertical installation, high thermal radiance >1 W |

9.32.9.8.2 Remote or external terminal temperature compensation

Setting up a remote or external cold junction can provide the most accurate temperature measurement in a machine or system.

The installation of a remote or external cold junction is especially helpful in the following cases.

- There is no module next to the temperature module
- With strongly fluctuating environmental conditions (draft, temperature)
- External fan is used in the control cabinet

9.32.9.9 Register description

9.32.9.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.32.9.9.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|--|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module configuration | | | | | | |
| 390 430 | Cfo_InputFilterCh01 Cfo_InputFilterCh02 | UINT | | | | • |
| Compensation | | | | | | |
| 4 6 | CompensationValue01 CompensationValue02 | INT | • | | | |
| 285 287 | CompensationStatus01 CompensationStatus02 | USINT | | • | | |
| | CompUnderflow0x | Bit 0 | | | | |
| | CompOverflow0x | Bit 1 | | | | |
| | CompOpenLine0x | Bit 2 | | | | |
| | CompConversionError0x | Bit 3 | | | | |
| | CompSumError0x | Bit 4 | | | | |
| | CompParameterError0x | Bit 5 | | | | |
| | ComploSuppError0x | Bit 6 | | | | |
| 514 518 | ExternalCompensationTemperature01 ExternalCompensationTemperature02 | INT | | | • | |
| Temperature measurement - Configuration | | | | | | |
| 386 426 | Cfo_SensorTypeCh01 Cfo_SensorTypeCh02 | UINT | | | | • |
| 466 482 | Cfo_PreparationInterval01 Cfo_PreparationInterval02 | UINT | | | | • |
| 410 450 | Cfo_ReplaceUpperCh01 Cfo_ReplaceUpperCh02 | INT | | | | • |
| 406 446 | Cfo_ReplaceLowerCh01 Cfo_ReplaceLowerCh02 | INT | | | | • |
| 398 438 | Cfo_UpperLimitCh01 Cfo_UpperLimitCh02 | INT | | | | • |
| 394 434 | Cfo_LowerLimitCh01 Cfo_LowerLimitCh02 | INT | | | | • |
| 402 442 | Cfo_HysteresisCh01 Cfo_HysteresisCh02 | INT | | | | • |
| 414 454 | Cfo_ErrorDelayCh01 Cfo_ErrorDelayCh02 | UINT | | | | • |
| 418 458 | Cfo_SumErrorDelayCh01 Cfo_SumErrorDelayCh02 | UINT | | | | • |
| Temperature measurement | | | | | | |
| 0 2 | Temperature01 Temperature02 | INT | • | | | |
| 258 262 | Measurand01 Measurand02 | INT | | • | | |
| 292 300 | SampleTime01 SampleTime02 | DINT | | • | | |
| 290 298 | SampleTime01 SampleTime02 | INT | | • | | |
| 305 313 | IOCycleCount01 IOCycleCount02 | SINT | | • | | |
| 306 314 | IOCycleCount01 IOCycleCount02 | INT | | • | | |
| 281 283 | StatusInput01 StatusInput02 | USINT | | • | | |
| | Underflow0x | Bit 0 | | | | |
| | Overflow0x | Bit 1 | | | | |
| | OpenLine0x | Bit 2 | | | | |
| | CompTemperaturError0x | Bit 3 | | | | |
| | ConversionError0x | Bit 4 | | | | |
| | SumError0x | Bit 5 | | | | |
| | ParameterError0x | Bit 6 | | | | |
| | IoSuppError0x | Bit 7 | | | | |

9.32.9.9.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--|----------------------|-----------------------------------|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module configuration | | | | | | | |
| 390 | - | Cfo_InputFilterCh01 | UINT | | | | • |
| 430 | - | Cfo_InputFilterCh02 | | | | | |
| Compensation | | | | | | | |
| 4 | 4 | CompensationValue01 | INT | • | | | |
| 6 | 6 | CompensationValue02 | | | | | |
| 285 | - | CompensationStatus01 | USINT | | • | | |
| 287 | - | CompensationStatus02 | | | | | |
| | | CompUnderflow0x | Bit 0 | | | | |
| | | CompOverflow0x | Bit 1 | | | | |
| | | CompOpenLine0x | Bit 2 | | | | |
| | | CompConversionError0x | Bit 3 | | | | |
| | | CompSumError0x | Bit 4 | | | | |
| | | CompParameterError0x | Bit 5 | | | | |
| | | CompIoSuppError0x | Bit 6 | | | | |
| 514 | - | ExternalCompensationTemperature01 | INT | | | | • |
| 518 | - | ExternalCompensationTemperature02 | | | | | |
| Temperature measurement - Configuration | | | | | | | |
| 386 | - | Cfo_SensorTypeCh01 | UINT | | | | • |
| 426 | - | Cfo_SensorTypeCh02 | | | | | |
| 466 | - | Cfo_PreparationInterval01 | UINT | | | | • |
| 482 | - | Cfo_PreparationInterval02 | | | | | |
| 410 | - | Cfo_ReplaceUpperCh01 | INT | | | | • |
| 450 | - | Cfo_ReplaceUpperCh02 | | | | | |
| 406 | - | Cfo_ReplaceLowerCh01 | INT | | | | • |
| 446 | - | Cfo_ReplaceLowerCh02 | | | | | |
| 398 | - | Cfo_UpperLimitCh01 | INT | | | | • |
| 438 | - | Cfo_UpperLimitCh02 | | | | | |
| 394 | - | Cfo_LowerLimitCh01 | INT | | | | • |
| 434 | - | Cfo_LowerLimitCh02 | | | | | |
| 402 | - | Cfo_HysteresisCh01 | INT | | | | • |
| 442 | - | Cfo_HysteresisCh02 | | | | | |
| 414 | - | Cfo_ErrorDelayCh01 | UINT | | | | • |
| 454 | - | Cfo_ErrorDelayCh02 | | | | | |
| 418 | - | Cfo_SumErrorDelayCh01 | UINT | | | | • |
| 458 | - | Cfo_SumErrorDelayCh02 | | | | | |
| Temperature measurement | | | | | | | |
| 0 | 0 | Temperature01 | INT | • | | | |
| 2 | 2 | Temperature02 | | | | | |
| 258 | - | Measurand01 | INT | | • | | |
| 262 | - | Measurand02 | | | | | |
| 292 | - | SampleTime01 | DINT | | • | | |
| 300 | - | SampleTime02 | | | | | |
| 290 | - | SampleTime01 | INT | | • | | |
| 298 | - | SampleTime02 | | | | | |
| 305 | - | IOCycleCount01 | SINT | | • | | |
| 313 | - | IOCycleCount02 | | | | | |
| 306 | - | IOCycleCount01 | INT | | • | | |
| 314 | - | IOCycleCount02 | | | | | |
| 281 | - | StatusInput01 | USINT | | • | | |
| 283 | - | StatusInput02 | | | | | |
| | | Underflow0x | Bit 0 | | | | |
| | | Overflow0x | Bit 1 | | | | |
| | | OpenLine0x | Bit 2 | | | | |
| | | CompTemperaturError0x | Bit 3 | | | | |
| | | ConversionError0x | Bit 4 | | | | |
| | | SumError0x | Bit 5 | | | | |
| | | ParameterError0x | Bit 6 | | | | |
| | | IoSuppError0x | Bit 7 | | | | |

1) The offset specifies the position of the register within the CAN object.

9.32.9.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.32.9.9.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

9.32.9.9.4 Module configuration

The module is an I/O module for temperature measurement and requires a 16-pin standard terminal block or the 16-pin terminal block with 2 integrated PT1000 inputs for temperature compensation.

2 measuring resistors (PT1000) can be connected via pin pairs 12/22 and 17/27 to record the absolute compensation temperature. This comparative value is used as a reference for the actual temperature measurement.

9.32.9.9.4.1 Input filter

Name:

Cfo_InputFilterCh01 bis Cfo_InputFilterCh02

Mit Hilfe dieser Register wird die Abtastzeit des A/D-Wandlers konfiguriert. Die eingestellte Filter-/Abtastzeit gilt gleichermaßen für die Eingänge der Thermoelemente als auch des Temperaturwiderstandes.

| Datentyp | Werte | Filterzeit in ms | Wandelrate in s ⁻¹ |
|----------|-------|-----------------------------|-------------------------------|
| UINT | 4 | 1 | 1000 |
| | 9 | 2 | 500 |
| | 48 | 10 | 100 |
| | 80 | 16,7 | 60 |
| | 96 | 20 (Bus Controller Default) | 50 |
| | 160 | 33,3 | 30 |
| | 192 | 40 | 25 |
| | 320 | 66,7 | 15 |
| | 480 | 100 | 10 |
| | 960 | 200 | 5 |

Information:

Je geringer die Wandelrate konfiguriert wird, desto genauer kann der Wert gewandelt werden. Allerdings wird dadurch auch die I/O-Updatezeit erhöht.

9.32.9.9.5 Compensation

The measurement process is based on the interaction between the temperature sensors and the thermocouples. The converted voltage value of a thermocouple has a linear relationship with the difference in temperature between the measurement point and the transition point. To calculate the absolute temperature at the measurement point, the measured value must then be placed in relation to an absolute reference temperature.

The compensation value required for this can be determined as follows:

- Value determined directly on the module using a PT1000 temperature sensor. ("[Internal compensation](#)" on page 3734)
- Value provided via a cyclic data point. ("[External compensation](#)" on page 3736)

9.32.9.9.5.1 Internal compensation

The inputs of the temperature resistors are used for internal compensation. The module can be used with the 16-pin terminal block (X20TB1E), which has 2 PT1000 temperature sensors.

When operating the module with the X20TB1E, the temperature distribution on the terminal block must be taken into account. To do this, various models for calculating the temperature distribution have been implemented on the module. They account for both the ambient temperature in the control cabinet, as well as the mounting orientation of the module. This helps minimize measurement error.

Alternatively, the module can be operated with the standard 16-pin terminal block (X20TB1F). For a detailed description of this procedure, see "[Remote terminal block](#)" on page 3735.

Information:

To avoid unnecessary traffic on the X2X Link network, the compensation registers should only be transferred cyclically during the fine-tuning process and for service and maintenance purposes. The information is generally not required during normal operation.

Compensation value

Name:

CompensationValue01 to CompensationValue02

These registers can be used to read the compensation value. Depending on how the "[Cfo_SensorType](#)" on page 3736 register is set, it is output as either a temperature or resistance value.

| Data type | Value | Information |
|-----------|-----------------|-------------------|
| INT | -32767 to 32767 | in 0.1°C or 0.1 Ω |

In order for the user to always be supplied with a defined output value, the following must be taken into consideration:

- Up to the first conversion, 0x8000 is output.
- After switching the sensor type, 0x8000 is output until the first conversion.
- If the input is switched off, 0x8000 is output.
- If an I/O voltage supply failure occurs, 0x8001 is output.

Status of the compensation value

Name:

CompensationStatus01 to CompensationStatus02
 CompUnderflow01 to CompUnderflow02
 CompOverflow01 to CompOverflow02
 CompOpenLine01 to CompOpenLine02
 CompConversionError01 to CompConversionError02
 CompSumError01 to CompSumError02
 CompParameterError01 to CompParameterError02
 ComploSuppError01 to ComploSuppError02

These registers provide information about the current status of the respective compensation value. The structure is based on the "StatusInput" on page 3740 register.

| Data type | Value |
|-----------|-------------------|
| USINT | See bit structure |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------------|-------|---------------------------------|
| 0 | CompUnderflow0x | 0 | No error |
| | | 1 | Value below the permitted range |
| 1 | CompOverflow0x | 0 | No error |
| | | 1 | Value above the permitted range |
| 2 | CompOpenLine0x | 0 | No error |
| | | 1 | Open line |
| 3 | Reserved | - | |
| 4 | CompConversionError0x | 0 | No error |
| | | 1 | Conversion error |
| 5 | CompSumError0x | 0 | No error |
| | | 1 | Composite error (undelayed) |
| 6 | CompParameterError0x | 0 | No error |
| | | 1 | Configuration not permitted |
| 7 | ComploSuppError0x | 0 | No error |
| | | 1 | I/O power supply error |

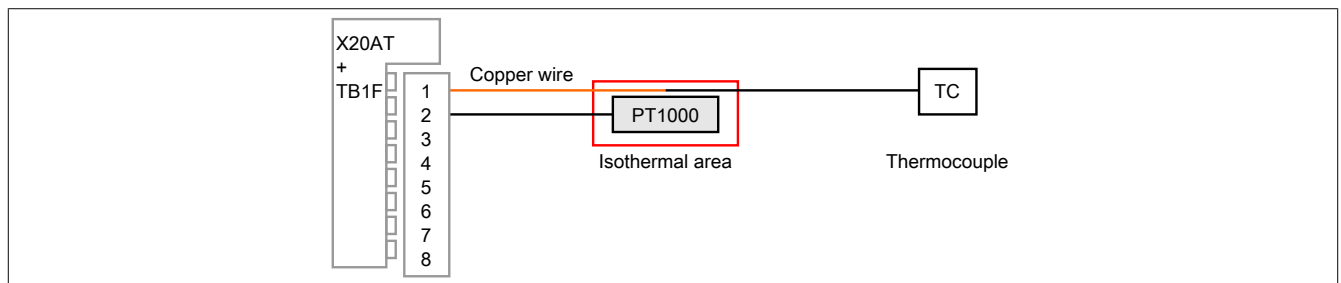
In addition to the status info, the error type also sets the analog value as follows:

| Error status | Digital value for error |
|---|-------------------------|
| Open line | 32767 (0x7FFF) |
| Above upper limit value | 32767 (0x7FFF) |
| Below lower limit value | -32767 (0x8001) |
| Invalid value or I/O power supply error | -32767 (0x8001) |

Remote terminal block

The 16-pin standard terminal block (X20TB1F) is used. The reference point for temperature measurements can be moved from the terminal to a more thermally stable location. This can help to minimize measurement error and increase accuracy.

Principle of remote terminal block



The thermocouple provides $V_{(\Delta T)}$ between the end of the thermocouple and the transition to the copper wire.

The PT1000 sensor provides the absolute temperature of the isothermal area.

Calculation: $T(\text{TC}) = T(\text{PT1000}) + \Delta T$

9.32.9.9.5.2 External compensation

For external compensation, the reference temperatures must be prepared in the application and transferred to the module via X2X Link. There is no need for internal conversion of the PT1000 values in the module.

External compensation value

Name:

ExternalCompensationTemperature01 to ExternalCompensationTemperature02

These registers can be used to send an externally generated compensation value to the module.

| Data type | Value | Information |
|-----------|-----------------|-------------|
| INT | -32767 to 32767 | in 0.1°C |

9.32.9.9.6 Temperature measurement - Configuration

The temperature measurement channels can be configured independently of each other. The "[Cfo_SensorTypeCh](#)" on page 3736 register needs to be adjusted in order to enable a temperature channel. The rest of the registers complement this configuration and only need to be defined if required in the application.

9.32.9.9.6.1 Configuring temperature measurement

Name:

Cfo_SensorTypeCh01 to Cfo_SensorTypeCh02

These registers control the basic functionality of a temperature channel.

| Data type | Value | Information |
|-----------|-------------------|---------------------------------------|
| UINT | See bit structure | Bus controller default setting: 36864 |

Bit structure:

| Bit | Name | Value | Information |
|-------|--|----------|--|
| 0 - 5 | Sensor type | 0 | Sensor J (Fe-CuNi) (bus controller default setting) |
| | | 1 | Sensor K (NiCr-Ni) |
| | | 2 | Sensor N (NiCrSi-NiSi) |
| | | 3 | Sensor S (PtRh10-Pt) |
| | | 4 | Sensor R (PtRh13-Pt) |
| | | 5 | Sensor C (WRe5-WRe26) |
| | | 6 | Sensor T (Cu-CuNi) |
| | | 7 | Sensor B (PtRh30-PtRh6) |
| | | 8 | Sensor E (NiCr-CuNi) |
| | | 9 to 60 | Reserved |
| 6 - 7 | Temperature model for X20TB1E ¹⁾ | 00 | Horizontal mounting orientation, low thermal radiation ≤1 W (bus controller default setting) |
| | | 01 | Horizontal installation, high thermal radiance >1 W |
| | | 10 | Vertical installation, low thermal radiance ≤1W |
| 8 - 9 | Reference method | 11 | Vertical installation, high thermal radiance >1 W |
| | | 00 | PT1000 sensor (bus controller default setting) |
| | | 01 to 10 | Not permitted |
| 10 | Unit for cold junction value | 11 | External compensation |
| | | 0 | 0.1°C (bus controller default setting) |
| 11 | Method of compensation | 1 | 0.1 Ω |
| | | 0 | Internal compensation (bus controller default setting) |
| 12 | Temperature model for X20TB1E ²⁾ | 1 | External compensation |
| | | 0 | Disabled |
| 13 | Replacement value strategy | 1 | Enabled according to bits 6 and 7 (bus controller default setting) |
| | | 0 | Replace with static default value (bus controller default setting) |
| 14 | Additional user-defined limits for permitted range of values | 1 | Retain last valid value |
| | | 0 | Permissible range of values of the thermocouple (bus controller default setting) |
| 15 | Temperature channel | 1 | Range of values as configured ³⁾ |
| | | 0 | Channel not converted by the AD converter |
| | | 1 | Channel registered on the AD converter (bus controller default setting) |

- 1) This setting is used to adjust the internal terminal temperature characteristic curve to the type and amount of generated heat dissipated to the module. This selection is based on the power consumption of the modules connected immediately to the left and right on the X2X Link. This data can be found in the modules' data sheet. The higher value is used for the configuration.
- 2) To enable the temperature model, both PT1000 cold junction sensors must be connected.
- 3) The user-defined limit values can further reduce the permitted range of values for the sensor, depending on the requirements of the application. It is not permitted to define a measurement range larger than the range supported by the sensor.

9.32.9.9.6.2 Defining the preparation interval

Name:

Cfo_PreparationInterval01 to Cfo_PreparationInterval02

If the last valid measured value should be kept when violating the limit value, then PreparationInterval must be defined. The measured values continue to be acquired and converted according to the configured I/O update time. They are then checked and discarded if they do not meet the specifications. When an error does not occur, therefore, the measured value acquired 2 preparation intervals ago is constantly output.

| Data type | Value | Information |
|-----------|------------|---|
| UINT | 0 to 65535 | In 0.1 ms. Bus controller default setting: 0 |

| | |
|--|--|
| <p>Functionality: Measured values are continuously converted and stored to measured value memory depending on the configured input filter. The current contents of the measured value memory are checked within the configured interval. If a permissible value is present, then the contents of the buffer memory are passed to output memory and the contents of the measured value memory are passed to the buffer. If the check turns up an impermissible value, then the contents of the measured value memory are discarded. The copy direction between the output and buffer memory reverses and the last valid value continues to be output.</p> <p>Information: If configured to keep the last valid value, the delay time from measuring to outputting the value will be at least twice the preparation interval. In the worst case scenario, this can also take twice the interval time plus the configured conversion rate of the A/D converter.</p> | <p>"Application" Value being measured (analog)</p> |
| | <p>↓ Condition: - Conversion interval (A/D converter) elapsed</p> |
| | <p>"Measured value memory" Measured value (digital)</p> |
| | <p>↓ Condition: - PreparationInterval elapsed - Measured value permissible</p> |
| | <p>"Buffer" Last valid value</p> |
| <p>↓ Condition: - PreparationInterval elapsed - Measured value permissible</p> | |
| <p>"Output memory" Next-to-last valid/ displayed value</p> | |

Information:

The registers are only set for the channel when bit 13 is set in the "Cfo_SensorType" on page 3736 register.

9.32.9.9.6.3 Upper replacement value

Name:

Cfo_ReplaceUpper01 to Cfo_ReplaceUpper02

This register is used to define the static values to be displayed instead of the current measured value when the limit is violated.

| Data type | Value | Information |
|-----------|-----------------|---------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 32767 |

Information:

The registers are only set for the channel when bit 13 is not set in the "Cfo_SensorType" on page 3736 register.

9.32.9.9.6.4 Lower replacement value

Name:

Cfo_ReplaceLower01 to Cfo_ReplaceLower02

This register is used to define the lower static values to be displayed instead of the current measured value when the limit is violated.

| Data type | Value | Information |
|-----------|-----------------|--|
| INT | -32767 to 32767 | Bus controller default setting: -32767 |

Information:

The registers are only set for the channel when bit 13 is not set in the "Cfo_SensorType" on page 3736 register.

9.32.9.9.6.5 Lower limit value

Name:

Cfo_UpperLimit01 to Cfo_UpperLimit02

If the value range needs to be restricted further, these registers can be used to enter new user-specific upper limit values.

| Data type | Value | Information |
|-----------|-----------------|---------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 32767 |

9.32.9.9.6.6 Upper limit value

Name:

Cfo_LowerLimit01 to Cfo_LowerLimit02

If the value range needs to be restricted further, these registers can be used to enter new user-specific lower limit values.

| Data type | Value | Information |
|-----------|-----------------|--|
| INT | -32767 to 32767 | Bus controller default setting: -32767 |

9.32.9.9.6.7 Hysteresis

Name:

Cfo_Hysteresis01 to Cfo_Hysteresis02

If the user-specific limit values are being used, then a hysteresis range should also be defined. These registers configure how far a limit value can be exceeded before a response is triggered.

| Data type | Value | Information |
|-----------|-----------------|------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 16 |

9.32.9.9.6.8 Error delay

Name:

Cfo_ErrorDelay01 to Cfo_ErrorDelay02

This register specifies the number of consecutive conversion procedures where an error is pending until the corresponding individual error status bit is set. The delay applies to underflow, overflow and open circuit errors. This delay can be used to hide temporary measured value deviations, for example.

| Data type | Values | Information |
|-----------|-------------|-----------------------------------|
| UINT | 0 to 65,535 | Bus controller default setting: 2 |

9.32.9.9.6.9 Error delay for composite error bit

Name:

Cfo_SumErrorDelay01 to Cfo_SumErrorDelay02

These registers can be used to set the time that an error must remain pending before the composite error bit is set.

| Data type | Values | Information |
|-----------|-------------|--------------------------------------|
| UINT | 0 to 65,535 | Bus controller default setting: 4000 |

9.32.9.9.7 Temperature measurement

The received temperature data is prepared in 2 different formats and given a [timestamp](#). For each channel there are 2 separate registers for transmitting the measured values to the PLC.

9.32.9.9.7.1 Temperature measurements

Name:

Temperature01 to Temperature02

Measurand01 to Measurand02

These registers contain the analog input values according to the sensor type set in the "[Cfo_SensorType](#)" on page 3736 register:

| Data type | Value | Information | Sensor type |
|------------------|--|---|-----------------------|
| INT | -2,100 to 12,000 | (for -210.0 to 1200.0 °C) | Type J (Fe-CuNi) |
| | -2,700 to 13,720 | (for -270.0 to 1372.0 °C) | Type K (NiCr-Ni) |
| | -2,700 to 12,980 | (for -270.0 to 1298.0 °C) | Type N (NiCrSi-NiSi) |
| | -500 to 17,680 | (for -50.0 to 1768.0 °C) | Type S (PtRh10-Pt) |
| | -500 to 17,600 | (for -50.0 to 1760.0 °C) | Type R (PtRh13-Pt) |
| | 0 to 23,100 | (for 0 to 2310.0 °C) | Type C (WRe5-WRe26) |
| | -2,700 to 4,000 | (for -270.0 to 400.0 °C) | Type T (Cu-CuNi) |
| | 0 to 18,200 | (for 0 to 1820.0 °C) | Type B (PtRh30-PtRh6) |
| | -2,700 to 9,970 | (for -270.0 to 997.0 °C) | Type E (NiCr-CuNi) |
| | -32,768 to 32767 | Voltage without linearization and terminal temperature compensation Resolution 1.0625 µV for a measurement range of ±35 mV | |
| -32,768 to 32767 | Voltage without linearization and terminal temperature compensation Resolution 2.125 µV for a measurement range of ±70 mV | | |

In order for the user to always be supplied with a defined output value, the following must be taken into consideration:

- Up to the first conversion, 0x8000 is output.
- After switching the sensor type, 0x8000 is output until the first conversion.
- If the input is switched off, 0x8000 is output.
- If an I/O voltage supply failure occurs, 0x8001 is output.

9.32.9.9.7.2 Sample time

Name:

SampleTime01 to SampleTime02

These registers return the timestamp for when the module reads the current channel mapping. The values are provided as signed 2-byte or 4-byte values.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Values | Information |
|-----------|---------------------------|--|
| INT | -32,768 to 32767 | NetTime timestamp of the current input value in µs |
| DINT | -2147483648 to 2147483647 | NetTime timestamp of the current input value in µs |

9.32.9.9.7.3 I/O cycle counter

Name:

IOCycleCount01 to IOCycleCount02

This register is a cyclic counter that is incremented each time a value is converted. It can be used as either a 1-byte or 2-byte counter.

| Data type | Value |
|-----------|------------|
| USINT | 0 to 255 |
| UINT | 0 to 65535 |

9.32.9.9.7.4 Status messages

Name:

StatusInput01 to StatusInput02

Underflow01 to Underflow02

Overflow01 to Overflow02

OpenLine01 to OpenLine02

CompTemperaturError01 to CompTemperaturError02

ConversionError01 to ConversionError02

SumError01 to SumError02

ParameterError01 to ParameterError02

IoSuppError01 to IoSuppError02

The current error status of the module channels is displayed in these registers, regardless of the configured replacement value strategy. Some error information may be delayed according to the conditions configured previously in the "Cfo_ErrorDelay" on page 3738 and "Cfo_SumErrorDelay" on page 3738 registers.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|-----------------------------|-------|---|
| 0 | Underflow0x | 0 | No error |
| | | 1 | Value below the permitted range |
| 1 | Overflow0x | 0 | No error |
| | | 1 | Value above the permitted range |
| 2 | OpenLine0x | 0 | No error |
| | | 1 | Open line |
| 3 | CompTemperaturError0x | 0 | Reference temperature is OK |
| | | 1 | Compensation error; See "CompensationStatus" on page 3735 register for a detailed error description |
| 4 | ConversionError0x | 0 | No error |
| | | 1 | Converter error |
| 5 | SumError0x | 0 | No error |
| | | 1 | Undelayed composite error |
| 6 | ParameterError0x | 0 | No error |
| | | 1 | Invalid setting for "Cfo_SensorType" on page 3736 register |
| 7 | IoSuppError0x ¹⁾ | 0 | No error |
| | | 1 | I/O power supply error |

1) If the supply falls below 20 VDC, then the I/O power supply error is reported in these bits for the respective temperature channel. The following actions also take place:

- Channel LEDs are turned off
- Temperature values are set to an invalid value = 0x8001
- "IOCycleCount" on page 3739 and "SampleTime" on page 3739 stop changing

In addition to the status information, the analog value is permanently defined to the following value in an error state:

| Fehlerzustand | Digital value for error |
|--|-------------------------|
| Drahtbruch | 32767 (0x7FFF) |
| Above upper limit value | 32767 (0x7FFF) |
| Unterer Grenzwert unterschritten | -32767 (0x8001) |
| Ungültiger Wert oder I/O-Versorgungsfehler | -32767 (0x8001) |

9.32.9.9.8 NetTime Technology

For a description of NetTime Technology, see "NetTime Technology" on page 3035.

9.32.9.9.9 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μ s |

9.32.9.9.10 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

The A/D converter must convert multiple values. After switching between 2 inputs there are 4 measurements in order to obtain a meaningful value. Since not all inputs need to be used, the actual I/O update time may vary.

The following formulas can be used to calculate the minimum required I/O update time:

$$\text{I/O update time} = 4 * \text{Conversions} * \text{Filter time}$$

$$\text{Filter time} = (1024 / 4920000) * C_{fo_InputFilter}$$

$$\text{Conversions} = \text{Number of thermocouples} + \text{Number of temperature resistors}$$

9.32.10 X20ATB312

Data sheet version: 1.43

9.32.10.1 General information

The module is equipped with 4 inputs for PT100 4-line resistance temperature measurement.

- 4 inputs for resistance temperature measurement
- PT100 sensor
- Direct resistance measurement as well
- 4-wire measurement
- Filter time can be configured
- NetTime timestamp: Moment of measurement

NetTime timestamp of the measurement

For many applications, not only the measured value is important, but also the exact time of the measurement. The module is equipped with a NetTime timestamp function for this that supplies a timestamp for the recorded position and trigger time with microsecond accuracy.

The timestamp function is based on synchronized timers. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

9.32.10.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| X20ATB312 | X20 temperature input module, 4 inputs for resistance measurement, PT100, resolution 0.01°C, 4-wire connections, NetTime function |  |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB1F | X20 terminal block, 16-pin, 24 VDC keyed | |

Table 651: X20ATB312 - Order data

9.32.10.3 Technical data

| Model number | X20ATB312 |
|--|---|
| Short description | |
| I/O module | 4 inputs for PT100 resistance temperature measurement |
| General information | |
| B&R ID code | 0xE0EF |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using LED status indicator and software |
| Inputs | Yes, using LED status indicator and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 0.5 W (Rev. ≥ D0), 0.6 W (Rev. < D0) |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5 |
| EAC | Yes |
| Resistance measurement temperature inputs | |
| Input | Resistance measurement with constant current supply for 4-wire connections |
| Digital converter resolution | 24-bit |
| Filter time | Configurable between 1 and 200 ms |
| Conversion time ¹⁾ | |
| 1 channel | 20 ms with 50 Hz filter |
| 2 channels | 40 ms per channel with 50 Hz filter |
| Conversion procedure | Sigma-delta |
| Output format | DINT or UDINT for resistance measurement |
| Temperature measurement range | -200 to 850 °C |
| Resistance measurement range | 0.5 to 390 Ω |
| Temperature sensor resolution | 1 LSB = 0.01 °C |
| Resistance measurement resolution | 0.001 Ω |
| Input filter | First-order low-pass filter / cutoff frequency 1050 Hz |
| Sensor standard | EN 60751 |
| Isolation voltage between channel and bus | 500 V _{eff} |
| Linearization method | Internal |
| Measurement current | 1 mA |
| Temperature sensor normalization | -200.0 to 850.0 °C |
| Reference | 1568 Ω ±0.1% |
| Permissible input signal | Short-term max. 28.8 V |
| Max. error at 25 °C ²⁾ | |
| Gain | 0.0059% ³⁾ |
| Offset | 0.0015% ⁴⁾ |
| Max. gain drift | <0.00065 %/°C ³⁾ |
| Max. offset drift | <0.000025 %/°C ⁴⁾ |
| Nonlinearity | <0.001% ⁴⁾ |
| Standardized range of values for resistance measurement | 19 to 390 Ω |
| Temperature measurement monitoring | |
| Range undershoot | 0x80000001 |
| Range overshoot | 0x7FFFFFFF |
| Open circuit | 0x7FFFFFFF |
| General fault | 0x80000000 |
| Open inputs | 0x7FFFFFFF |
| Resistance measurement monitoring | |
| Range undershoot | 0x80000001 |
| Range overshoot | 0xFFFFFFFF |
| Open circuit | 0xFFFFFFFF |
| General fault | 0x80000000 |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |

Table 652: X20ATB312 - Technical data


| Model number | X20ATB312 |
|--|--|
| Installation elevation above sea level | |
| 0 to 2000 m | No limitation |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x terminal block X20TB1F separately. Order 1x bus module X20BM11 separately. |
| Pitch | 12.5 ^{+0.2} mm |

Table 652: X20ATB312 - Technical data

- 1) The module is equipped with two independent converters (sensors 1 and 2, sensors 3 and 4). The conversion time applies to the number of channels connected to the respective converter.
- 2) To guarantee accuracy, modules with a power dissipation < 1.2 W must be connected to the left and right of this module.
- 3) Based on the current resistance value.
- 4) Based on the entire resistance measurement range.

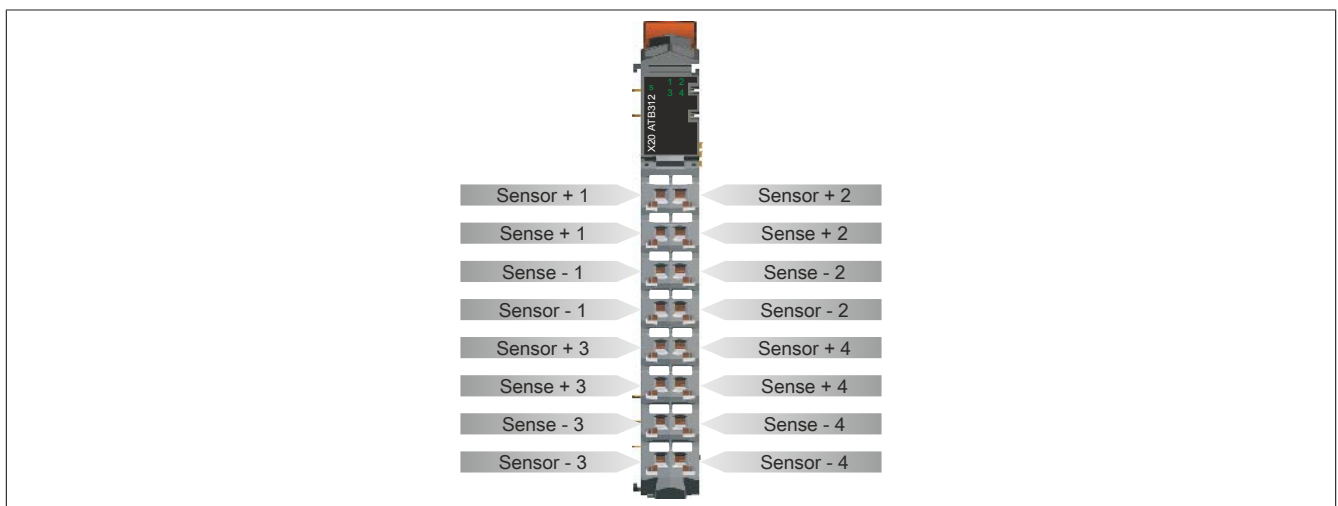
9.32.10.4 Status LEDs

For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

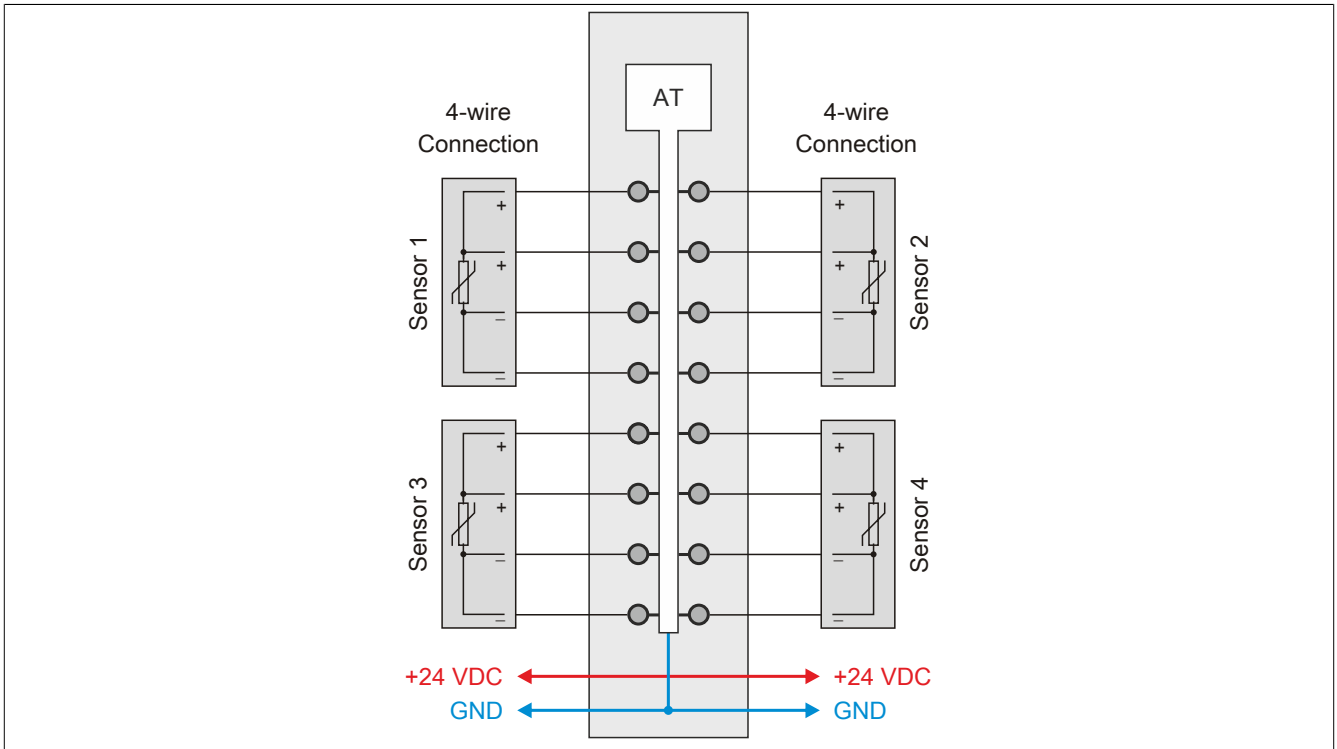
| Image | LED | Color | Status | Description |
|---|-------|-------|-----------------------------|--|
|  | s | Green | Off | Module supply not connected |
| | | | Single flash | Reset mode |
| | | | Double flash | Mode BOOT (during firmware update) ¹⁾ |
| | | | Blinking | PREOPERATIONAL mode |
| | | | On | RUN mode |
| | | Red | Off | Module supply not connected or everything OK |
| | On | | Error or reset status | |
| | 1 - 4 | Green | Single flash | Parameter or conversion error ²⁾ |
| | | | Red on / Green single flash | Invalid firmware |
| | | | Off | Input turned off or not supplied |
| | | | Single flash | Parameter error ²⁾ |
| | | | Double flash | Conversion error ²⁾ |
| | | | Blinking | Overflow, underflow or open line |
| | | | On | A/D converter running, value OK |

- 1) Depending on the configuration, a firmware update can take up to several minutes.
- 2) Parameter or converter errors are indicated simultaneously on the red "s" LED and the channel LED of the respective output.

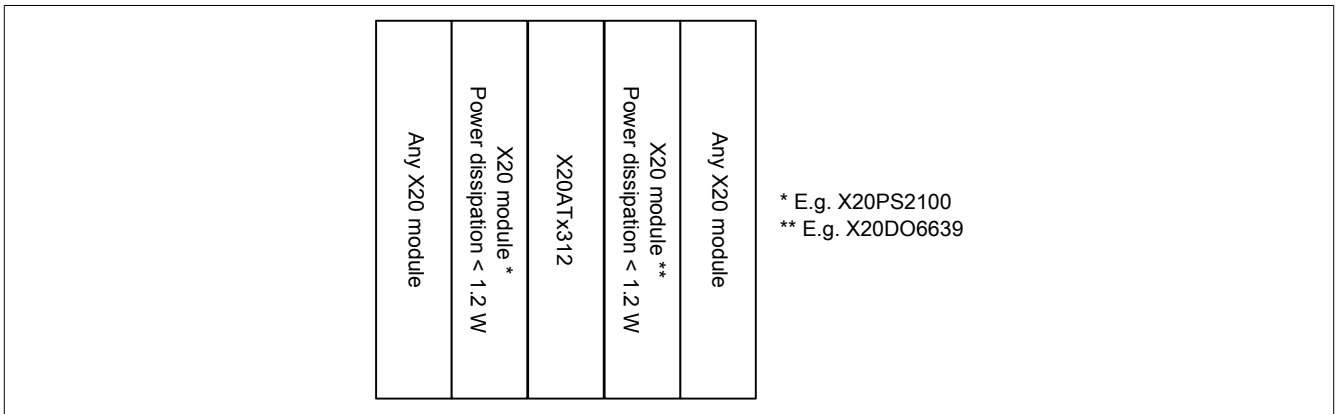
9.32.10.5 Pinout



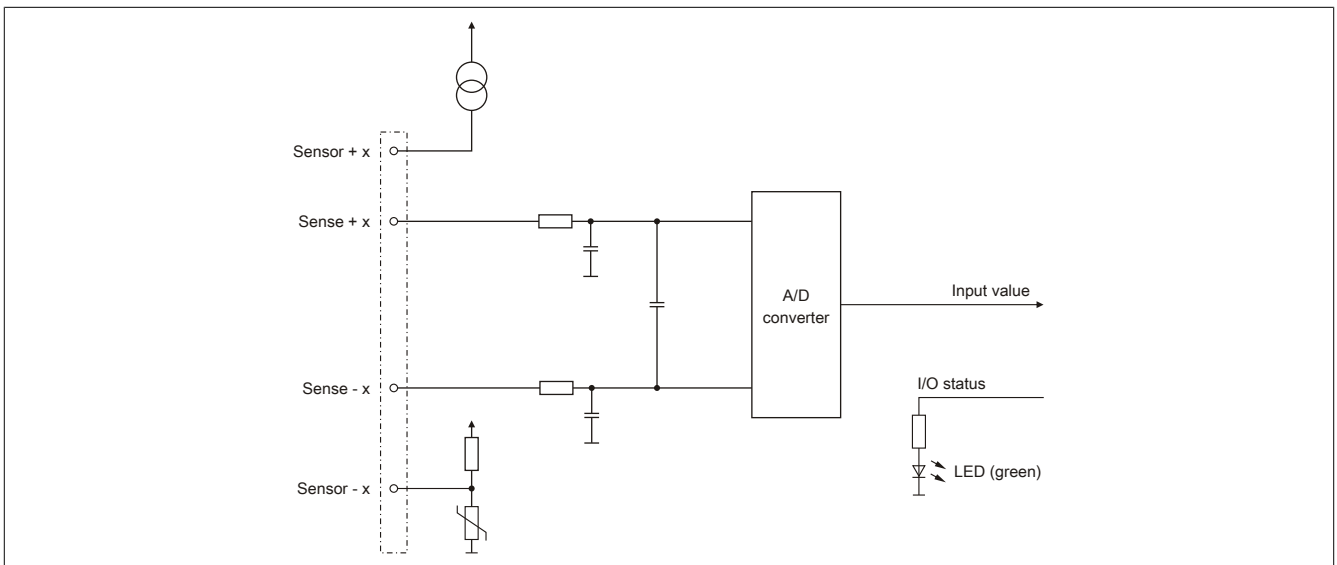
9.32.10.6 Connection example



To ensure accuracy, modules with a power consumption <math>< 1.2\text{ W}</math> must be inserted to the left and right of this modules.



9.32.10.7 Input circuit diagram



9.32.10.8 Register description

9.32.10.8.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section ["General data points" on page 3790](#).

9.32.10.8.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|---------------------|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | |
| 130 | InputFilter | UINT | | | | • |
| 134 | ModeADC | UINT | | | | • |
| Index * 64 + 450 | SensorType0x (Index x = 1 to 4) | UINT | | | | • |
| Index * 64 + 502 | PreparationInterval0x (Index x = 1 to 4) | UINT | | | | • |
| Index * 64 + 484 | ReplaceUpper0x (Index x = 1 to 4) | DINT | | | | • |
| Index * 64 + 476 | ReplaceLower0x (Index x = 1 to 4) | DINT | | | | • |
| Index * 64 + 468 | UpperLimit0x (Index x = 1 to 4) | DINT | | | | • |
| Index * 64 + 460 | LowerLimit0x (Index x = 1 to 4) | DINT | | | | • |
| Index * 64 + 490 | Hysteresis0x (Index x = 1 to 4) | UINT | | | | • |
| Index * 64 + 494 | ErrorDelay0x (Index x = 1 to 4) | UINT | | | | • |
| Index * 64 + 498 | SumErrorDelay0x (Index x = 1 to 4) | UINT | | | | • |
| Communication | | | | | | |
| Index * 4 - 4 | Temperature0x (Index x = 1 to 4) | DINT | • | | | |
| | Resistor0x (Index x = 1 to 4) | UDINT | | | | |
| Index * 64 + 196 | Measurand0x (Index x = 1 to 4) | DINT | | • | | |
| Index * 64 + 217 | IOCycleCounter0x (Index x = 1 to 4) | USINT | • | | | |
| Index * 64 + 218 | IOCycleCounter0x (Index x = 1 to 4) | UINT | • | | | |
| Index * 64 + 210 | Sampletime0x (Index x = 1 to 4) | INT | • | | | |
| Index * 64 + 212 | Sampletime0x (Index x = 1 to 4) | DINT | • | | | |
| Index * 64 + 233 | Status0x (Index x = 1 to 4) | USINT | • | | | |
| | Underrun0x | Bit 0 | | | | |
| | Overrun0x | Bit 1 | | | | |
| | OpenLine0x | Bit 2 | | | | |
| | ConverterFault0x | Bit 4 | | | | |
| | SumFault0x | Bit 5 | | | | |
| | ParameterFault0x | Bit 6 | | | | |
| | IoSupplyFault0x | Bit 7 | | | | |

9.32.10.8.3 Function model 254 - Bus Controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|----------------------|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Configuration | | | | | | | |
| 130 | - | InputFilter | UINT | | | | • |
| 134 | - | ModeADC | UINT | | | | • |
| Index * 64 + 450 | - | SensorType0x (Index x = 1 to 4) | UINT | | | | • |
| Index * 64 + 502 | - | PreparationInterval0x (Index x = 1 to 4) | UINT | | | | • |
| Index * 64 + 484 | - | ReplaceUpper0x (Index x = 1 to 4) | DINT | | | | • |
| Index * 64 + 476 | - | ReplaceLower0x (Index x = 1 to 4) | DINT | | | | • |
| Index * 64 + 468 | - | UpperLimit0x (Index x = 1 to 4) | DINT | | | | • |
| Index * 64 + 460 | - | LowerLimit0x (Index x = 1 to 4) | DINT | | | | • |
| Index * 64 + 490 | - | Hysteresis0x (Index x = 1 to 4) | UINT | | | | • |
| Index * 64 + 494 | - | ErrorDelay0x (Index x = 1 to 4) | UINT | | | | • |
| Index * 64 + 498 | - | SumErrorDelay0x (Index x = 1 to 4) | UINT | | | | • |
| Communication | | | | | | | |
| Index * 4 - 4 | Index * 4 - 4 | Temperature0x (Index x = 1 to 4) | DINT | • | | | |
| | | Resistor0x (Index x = 1 to 4) | UDINT | | | | |
| Index * 64 + 217 | - | IOCycleCounter0x (Index x = 1 to 4) | USINT | | • | | |
| 30 | - | Status01To04 | USINT | | • | | |

1) The offset specifies where the register is within the CAN object.

9.32.10.8.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see ["Using I/O modules on the bus controller" on page 3789](#).

9.32.10.8.3.2 CAN I/O bus controller

The module occupies the following analog logical slots on CAN I/O.

- Upgrade version <1.1.3.0: 1
- Upgrade version ≥1.1.3.0: 2

9.32.10.8.4 Configuration of the A/D converter

9.32.10.8.4.1 Setting the conversion rate

Name:

InputFilter

Mit Hilfe dieses Registers wird die Abtastzeit des A/D-Wandlers konfiguriert.

| Datentyp | Werte | Filterzeit in ms | Wandelrate in s ⁻¹ |
|----------|-------|-----------------------------|-------------------------------|
| UINT | 4 | 1 | 1000 |
| | 9 | 2 | 500 |
| | 48 | 10 | 100 |
| | 80 | 16,7 | 60 |
| | 96 | 20 (Bus Controller Default) | 50 |
| | 160 | 33,3 | 30 |
| | 192 | 40 | 25 |
| | 320 | 66,7 | 15 |
| | 480 | 100 | 10 |
| | 960 | 200 | 5 |

Information:

Je geringer die Wandelrate konfiguriert wird, desto genauer kann der Wert gewandelt werden. Allerdings wird dadurch auch die I/O-Updatezeit erhöht.

9.32.10.8.4.2 Operating mode of the A/D converter

Name:

ModeADC

The operating mode for the A/D converter can be configured in this register.

The individual options allow faster digitalization of the analog values, but this also reduces the precision of the measured values.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 0 |

Bit structure:

| Bit | Description | Value | Information |
|--------|--------------------------|-------|---|
| 0 | Chopper mode | 0 | Alternating gain of the analog value (bus controller default setting) |
| | | 1 | Chopper mode off |
| 1 | Order of the SINC filter | 0 | SINC4 (bus controller default setting) |
| | | 1 | SINC3 |
| 2 - 15 | Reserved | - | - |

The following applies:

$$\text{ConversionTime(SINC3)} = \text{ConversionTime(SINC4)} - 1 \times \text{ConversionCycle}$$

$$\text{ConversionTime(without Chop)} = 0.5 \times \text{ConversionTime(Chop)}$$

9.32.10.8.5 Configuring the measurement channels

Each temperature measurement channel can be configured independently. All the registers required for this purpose by each channel are arranged separately.

9.32.10.8.5.1 Channel parameters

Name:

SensorType01 to SensorType04

This register defines the basic behavior of the channel.

| Data type | Values | Bus controller default setting |
|-----------|------------------------|--------------------------------|
| UINT | See the bit structure. | 129 |

Bit structure:

| Bit | Description | Value | Information |
|--------|--|------------|--|
| 0 - 2 | Sensor type with unit and resolution | 001 | PT100 [10 mK/bit] - Temperature measurement (bus controller default setting) |
| | | 010 | PT100 [1 mΩ/bit] - Resistance measurement |
| | | 011 to 111 | Reserved |
| 3 - 4 | Reserved | - | |
| 5 | Replacement value strategy | 0 | Replace statically |
| | | 1 | Retain last valid value |
| 6 | Monitoring the user-defined limit values | 0 | Switch off additional limits |
| | | 1 | Switch on additional limits |
| 7 | Channel (on/off) | 0 | Switch off the entire channel |
| | | 1 | Switch on channel (bus controller default setting) |
| 8 - 15 | Reserved | - | |

9.32.10.8.6 Configuring the replacement value strategy

If a measured value is detected that is outside the permitted value range, the behavior of the input register must still remain clearly defined. The module provides the user two different options for this purpose.

Retain last valid value

With this strategy, the determined measured value is stored temporarily for a specific time and written to the input register after a delay. If an invalid measured value is detected, this value and all values that have been stored temporarily are discarded. The last valid input register value is retained. To update the value in the input register, there must be enough valid values stored in the temporary buffer. The number needed is determined by the time period specified in "PreparationInterval0x".

Replace with static value

With this strategy, the measured value is written to the input register without delay. If an invalid value occurs, it is replaced by a static value that has been predefined by the user.

9.32.10.8.6.1 Preparation interval

Name:

PreparationInterval01 to PreparationInterval04

This register defines the time interval in which the measured value is checked before being passed on.

| Data type | Value | Information |
|-----------|-------------|--|
| UINT | 0 to 65,535 | Unit in 0.1 ms. Bus controller default setting: 0 |

Information:

This register must be defined if the replacement value strategy "Retain last valid value" was selected in register "SensorType0x" on page 3749.

9.32.10.8.6.2 Static replacement value when exceeding the upper limit

Name:

ReplaceUpper01 to ReplaceUpper04

This register is used to defined a replacement value that is output in place of the invalid measured value if the upper limit is violated.

| Data type | Values | Information |
|-----------|------------------------------------|---|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: 2,147,483,647 |

Information:

This register must be defined if the replacement value strategy "Replace with static value" was selected in register "[SensorType0x](#)" on page 3749.

9.32.10.8.6.3 Static replacement value when falling below the lower limit

Name:

ReplaceLower01 to ReplaceLower04

This register is used to defined a replacement value that is output in place of the invalid measured value if the lower limit is violated.

| Data type | Values | Information |
|-----------|------------------------------------|--|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: -2,147,483,647 |

Information:

This register must be defined if the replacement value strategy "Replace with static value" was selected in register "[SensorType0x](#)" on page 3749.

9.32.10.8.7 Configuring the user-defined limit values

This module provides the user the option to specify user-defined limits. If the valid measurement range is reduced in this way, the behavior of the replacement value strategy is more likely to be applied.

Valid measurement range

The valid range is derived from the properties of the sensor being used or the hardware and firmware of the respective B&R module. These values cannot be changed by the user.

Valid range of values

The range of values is always within the valid measurement range. The range of values can be adapted to the requirements of the application by specifying the [upper](#) and [lower](#) limit value.

9.32.10.8.7.1 Upper limit value

Name:

UpperLimit01 to UpperLimit04

This register specifies the upper limit value. The values entered should be within the valid measurement range.

| Data type | Values | Information |
|-----------|------------------------------------|---|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: 2,147,483,647 |

9.32.10.8.7.2 Lower limit value

Name:

LowerLimit01 to LowerLimit04

This register specifies the lower limit value. The values entered should be within the valid measurement range.

| Data type | Values | Information |
|-----------|------------------------------------|--|
| DINT | -2,147,483,648 to 2,147,483,647 | Bus controller default setting: -2,147,483,647 |

9.32.10.8.7.3 Hysteresis

Name

Hysteresis01 to Hysteresis04

A hysteresis can be set in order to avoid frequent status changes in the measurement range close to the limit value. Here, a small section is defined at the edge of the valid range of values where the measured values retain the status (valid or invalid) of the previous measured value.

| Data type | Values | Information |
|-----------|-------------|------------------------------------|
| UINT | 0 to 65,535 | Bus controller default setting: 16 |

9.32.10.8.8 Configuring status messages

Errors are detected by the module and sent to the application. When using Function model 0 - Standard, the trigger behavior of these error messages can be influenced by the "Delay" register.

In Automation Studio, an error message can be read either packed as the entire register or individually as bits.

9.32.10.8.8.1 Delaying error messages

Name:

ErrorDelay01 to ErrorDelay04

In order to avoid false alarms due to short-term measurement variations, the status messages transmitted to the PLC can be delayed. This register determines the number of A/D conversions in which an error must exist before an error message is transmitted.

| Data type | Values | Information |
|-----------|-------------|--|
| UINT | 0 to 65,535 | AD conversions. Bus controller default setting: 2 |

9.32.10.8.8.2 Delaying the sum error message

Name:

SumErrorDelay01 to SumErrorDelay04

This register can be used to set the delay used when sending bit 5 of the "Status0x" on page 3753 register to the PLC independent of the other status messages.

| Data type | Values | Information |
|-----------|-------------|--------------------------------------|
| UINT | 0 to 65,535 | Bus controller default setting: 4000 |

9.32.10.8.9 Communication

The received temperature data is stored with a [timestamp](#) and, depending on the configuration, is made available under various register names and data types.

9.32.10.8.9.1 Measured value – Temperature

Name:

Temperature01 to Temperature04

If the channel is configured for resistance measurement, the current temperature value is made available in this register.

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

9.32.10.8.9.2 Measured value – Resistance

Name:

Resistor01 to Resistor04

If the channel is configured for resistance measurement, the current resistance value is made available in this register.

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

9.32.10.8.9.3 Measured value – Unweighted

Name:

Measurand01 to Measurand04

When using the AsloAcc library, the unweighted measurement can be accessed via this register. This refers to a measured value that is within the valid measurement range and has not yet been compared with the user-defined limits.

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

Information:

If no user-defined limits are configured, the value of this register does not differ from the temperature or resistance value.

9.32.10.8.9.4 Cycle counter

Name:

IOCycleCounter01 to IOCycleCounter04

This register is used to provide a continuous counter for the application that is incremented each time a temperature value is read.

| Data type | Value | Information |
|-----------|-------------|----------------|
| USINT | 0 to 32,767 | AD conversion. |
| UINT | 0 to 65,535 | AD conversion. |

9.32.10.8.9.5 Sampling time

Name:

Sampletime01 to Sampletime04

This register provides the application with the NetTime at the time of temperature recording.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Value | Information |
|-----------|---------------------------------|------------------------------|
| INT | -32,768 to 32,767 | NetTime timestamp in μ s |
| DINT | -2,147,483,648 to 2,147,483,647 | NetTime timestamp in μ s |

Information:

The SDC library requires a 16-bit value for the sampling time. It is therefore also prepared as a 16-bit value.

9.32.10.8.9.6 Status messages

Name:

Status01 to Status04

The register bits are set if an error has been diagnosed and the error remains longer than the delay configured in the "ErrorDelay0x" on page 3751 register.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|--------------------------------------|-------|--|
| 0 | Underrun01 to Underrun04 | 0 | No error |
| | | 1 | Value below the permitted range |
| 1 | Overrun01 to Overrun04 | 0 | No error |
| | | 1 | Value above the permitted range |
| 2 | OpenLine01 to OpenLine04 | 0 | No error |
| | | 1 | Sensor is not connected correctly |
| 3 | Reserved | - | |
| 4 | ConverterFault01 to ConverterFault04 | 0 | No error |
| | | 1 | Invalid A/D converter output |
| 5 | SumFault01 to SumFault04 | 0 | No error |
| | | 1 | Composite error |
| 6 | ParameterFault01 to ParameterFault04 | 0 | No error |
| | | 1 | The "SensorType0x" on page 3749 register is faulty |
| 7 | IoSupplyFault01 to IoSupplyFault04 | 0 | No error |
| | | 1 | The supply voltage (I/O) is faulty |

9.32.10.8.9.7 Status messages for function model 254

Name:

Status01To04

The bits in this register are set if an error has been detected.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|------------------------|-------|---------------------------------|
| 0 | Underrun on channel 01 | 0 | No error |
| | | 1 | Value below the permitted range |
| 1 | Overrun on channel 01 | 0 | No error |
| | | 1 | Value above the permitted range |
| ... | | ... | |
| 6 | Underrun on channel 04 | 0 | No error |
| | | 1 | Value below the permitted range |
| 7 | Overrun on channel 04 | 0 | No error |
| | | 1 | Value above the permitted range |

Information:

If an open line is detected on a channel, then both error messages will be displayed at the same time.

9.32.10.8.10 NetTime Technology

For a description of NetTime Technology, see "NetTime Technology" on page 3035.

9.32.10.8.11 Minimum cycle time

The minimum cycle time defines how far the bus cycle can be reduced without causing a communication error or impaired functionality. It should be noted that very fast cycles decrease the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 μ s |

9.32.10.8.12 Minimum I/O update time

The minimum I/O update time defines how far the bus cycle can be reduced while still allowing an I/O update to take place in each cycle.

| Minimum I/O update time |
|-------------------------|
| 1 ms |

9.32.11 X20ATC402

Data sheet version: 1.31

9.32.11.1 General information

The module is equipped with 6 inputs for J, K, N, S, B, R, E, C and T thermocouple sensors.

This module can also be equipped with the X20TB1E thermocouple terminal block with integrated PT1000 temperature sensors. This makes it possible to achieve optimal terminal temperature compensation.

- 6 channels for thermocouples
- For sensor types J, K, N, S, B, R, E, C, T, raw value measurement
- Integrated terminal temperature compensation
- 2x PT1000 sensor integrated in the terminal (X20TB1E)
- 2x external PT1000 sensor can be connected (X20TB1F)
- Configurable filter time
- NetTime timestamp: Moment of measurement

NetTime timestamp of the measurement

For many applications, not only the measured value is important, but also the exact time of the measurement. The module is equipped with a NetTime timestamp function for this that supplies a timestamp for the recorded position and trigger time with microsecond accuracy.

The timestamp function is based on synchronized timers. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

9.32.11.2 Order data


| Model number | Short description | Figure |
|--------------|--|---|
| | Temperature measurement |  |
| X20ATC402 | X20 temperature input module, 6 thermocouple inputs, type J, K, N, S, B, R, E, C, T, NetTime function, 2x PT1000 integrated in terminal block X20TB1E for temperature compensation, order terminal block separately. | |
| | Required accessories | |
| | Bus modules | |
| X20BM11 | X20 bus module, 24 VDC keyed, internal I/O supply continuous | |
| X20BM15 | X20 bus module, with node number switch, 24 VDC keyed, internal I/O supply continuous | |
| | Terminal blocks | |
| X20TB1E | X20 terminal block, 12-pin, 24 VDC keyed, 2x PT1000 integrated for terminal temperature compensation | |
| X20TB1F | X20 terminal block, 16-pin, 24 VDC keyed | |
| | | |

Table 653: X20ATC402 - Order data

9.32.11.3 Technical data

| Model number | X20ATC402 |
|--|--|
| Short description | |
| I/O module | 6 inputs for thermocouples |
| General information | |
| B&R ID code | 0xBB99 |
| Status indicators | I/O function per channel, operating state, module status |
| Diagnostics | |
| Module run/error | Yes, using status LED and software |
| Inputs | Yes, using status LED and software |
| Power consumption | |
| Bus | 0.01 W |
| Internal I/O | 0.85 W |
| Additional power dissipation caused by actuators (resistive) [W] | - |
| Certifications | |
| CE | Yes |
| KC | Yes |
| EAC | Yes |
| UL | cULus E115267 Industrial control equipment |
| HazLoc | cCSAus 244665 Process control equipment for hazardous locations |
| ATEX | Class I, Division 2, Groups ABCD, T5 Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X |
| Thermocouple temperature inputs | |
| Input | Thermocouple |
| Digital converter resolution | 16-bit |
| Filter time | Configurable between 1 and 200 ms |
| Conversion time | |
| Internal terminal temperature comp. | |
| N channels | $(n + 2) * 4 * x \text{ ms}^{-1}$ |
| External terminal temperature comp. | |
| 1 channel | $x \text{ ms}^{-1}$ |
| N channels | $n * 4 * x \text{ ms}^{-1}$ |
| Remote temperature comp. | |
| N channels | $(n + 2) * 4 * x \text{ ms}^{-1}$ |
| Output format | INT |
| Measurement range | |
| Sensor temperature | |
| Type J: Fe-CuNi | -210 to 1200°C |
| Type K: NiCr-Ni | -270 to 1372°C |
| Type N: NiCrSi-NiSi | -270 to 1298°C |
| Type S: PtRh10-Pt | -50 to 1768°C |
| Type B: PtRh30-PtRh6 | 0 to 1820°C |
| Type R: PtRh13-Pt | -50 to 1760°C |
| Type E: NiCr-CuNi | -270 to 997°C |
| Type C: WRe5-WRe26 | 0 to 2310°C |
| Type T: Cu-CuNi | -270 to 400°C |
| Terminal temperature | -40 to 130°C |
| Voltage | ±65.534 mV |
| Sensor standard | EN 60584 |
| Resolution | |
| Sensor temperature | 1 LSB = 0.1°C |
| Terminal temperature | 1 LSB = 0.1°C |
| Voltage | Depending on gain, 1 LSB = 1 µV or 2 µV |
| Normalization | |
| Type J | -210.0 to 1200.0°C |
| Type K | -270.0 to 1372.0°C |
| Type N | -270.0 to 1298.0°C |
| Type S | -50.0 to 1768.0°C |
| Type B | 0 to 1820.0°C |
| Type R | -50.0 to 1760.0°C |
| Type E | -270.0 to 997.0°C |
| Type C | 0 to 2310.0°C |
| Type T | -270.0 to 400.0°C |
| Terminal temperature | -145.0 to 840.0°C |
| Voltage | Depending on gain ±32.767 mV or ±65.534 mV |

Table 654: X20ATC402 - Technical data

| Model number | X20ATC402 |
|--|--|
| Monitoring | |
| Range undershoot | 0x8001 |
| Range overshoot | 0x7FFF |
| Open circuit | 0x7FFF |
| Open inputs | 0x7FFF |
| General fault | 0x8000 |
| Conversion procedure | Sigma-delta |
| Linearization method | Internal |
| Permissible input signal | Max. ± 15 V |
| Input filter | 1st-order low pass / cutoff frequency 500 Hz |
| Max. error at 25°C | |
| Gain | 0.04% ²⁾ |
| Offset | |
| Type J | 0.06% ³⁾ |
| Type K | 0.07% ³⁾ |
| Type N | 0.07% ³⁾ |
| Type S | 0.13% ³⁾ |
| Type B | 0.15% ³⁾ |
| Type R | 0.11% ³⁾ |
| Type E | 0.06% ³⁾ |
| Type C | 0.08% ³⁾ |
| Type T | 0.11% ³⁾ |
| Voltage | 0.015% ³⁾ |
| Max. gain drift | |
| Channel | 0.01 %/°C ²⁾ |
| Terminal temperature | 0.03 %/°C ²⁾ |
| Max. offset drift | |
| Type J | 0.0033 %/°C ³⁾ |
| Type K | 0.0042 %/°C ³⁾ |
| Type N | 0.0048 %/°C ³⁾ |
| Type S | 0.0123 %/°C ³⁾ |
| Type B | 0.0166 %/°C ³⁾ |
| Type R | 0.0109 %/°C ³⁾ |
| Type E | 0.003 %/°C ³⁾ |
| Type C | 0.0062 %/°C ³⁾ |
| Type T | 0.011 %/°C ³⁾ |
| Terminal temperature | 0.005 %/°C ³⁾ |
| Voltage | 0.003 %/°C ³⁾ |
| Nonlinearity | |
| Channel | $\pm 0.004\%$ ³⁾ |
| Terminal temperature | $\pm 0.004\%$ ²⁾ |
| Terminal temperature compensation | |
| Operating modes | Internal/remote or external |
| Basic accuracy at 25°C not taking PT1000 sensor into account | $\pm 0.06\%$ |
| Accuracy of internal terminal temperature | |
| With natural convection | $\pm 1.5^\circ\text{C}$ after 20 min |
| With artificial convection | $\pm 3^\circ\text{C}$ after 20 min |
| Common-mode rejection | |
| DC | >100 dB |
| 50 Hz | >100 dB |
| 60 Hz | >100 dB |
| Common-mode range | ± 14 V |
| Crosstalk between channels | <-70 dB |
| Isolation voltage | |
| Between channel and bus | 500 V _{eff} |
| Electrical properties | |
| Electrical isolation | Channel isolated from bus Channel not isolated from channel |
| Operating conditions | |
| Mounting orientation | |
| Horizontal | Yes |
| Vertical | Yes |
| Installation elevation above sea level | |
| 0 to 2000 m | No limitations |
| >2000 m | Reduction of ambient temperature by 0.5°C per 100 m |
| Degree of protection per EN 60529 | IP20 |

Table 654: X20ATC402 - Technical data


| Model number | X20ATC402 |
|---------------------------------|---|
| Ambient conditions | |
| Temperature | |
| Operation | |
| Horizontal mounting orientation | -25 to 60°C |
| Vertical mounting orientation | -25 to 50°C |
| Derating | - |
| Storage | -40 to 85°C |
| Transport | -40 to 85°C |
| Relative humidity | |
| Operation | 5 to 95%, non-condensing |
| Storage | 5 to 95%, non-condensing |
| Transport | 5 to 95%, non-condensing |
| Mechanical properties | |
| Note | Order 1x X20TB1E terminal block for internal/remote terminal temperature compensation separately Order 1x X20TB1F terminal block for external terminal temperature compensation separately Order 1x X20BM11 bus module separately |
| Pitch | 12.5 ^{+0.2} mm |

Table 654: X20ATC402 - Technical data

- 1) With a 50 Hz filter, x = 20 ms (1 / 50 Hz = 20 ms)
- 2) Based on the current measured value.
- 3) Based on the entire measurement range.

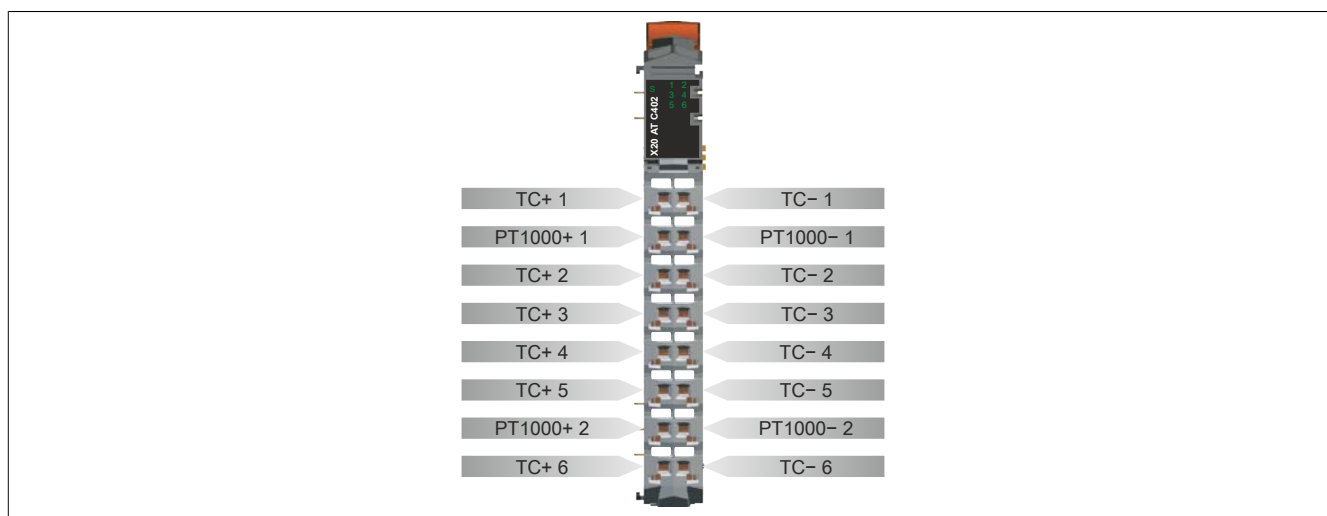
9.32.11.4 LED status indicators

For a description of the various operating modes, see "Diagnostic LEDs" on page 3787.

| Figure | LED | Color | Status | Description | |
|--|--------------|---|--------------------------------|---|------------------|
|  | S | Green | Off | No power to module | |
| | | | Single flash | RESET mode | |
| | | | Double flash | BOOT mode (during firmware update) ¹⁾ | |
| | | | Blinking | PREOPERATIONAL mode | |
| | | | On | RUN mode | |
| | | Red | Off | No power to module or everything OK | |
| | | | On | Error or reset status | |
| | | | Single flash | A parameter or conversion error has occurred. This status is output in addition to a single/double flash on the channel LED of the analog input where the error occurs. | |
| | | | Solid red / Single green flash | | Invalid firmware |
| | | | 1 - 6 | Green | Off |
| | Single flash | A parameter error has occurred. A single flash is output on the red "s" module status LED. | | | |
| | Double flash | A conversion error has occurred. A single flash is output on the red "s" module status LED. | | | |
| | Blinking | Overflow, underflow or open line | | | |
| | On | Analog/digital converter running, value OK | | | |

1) Depending on the configuration, a firmware update can take up to several minutes.

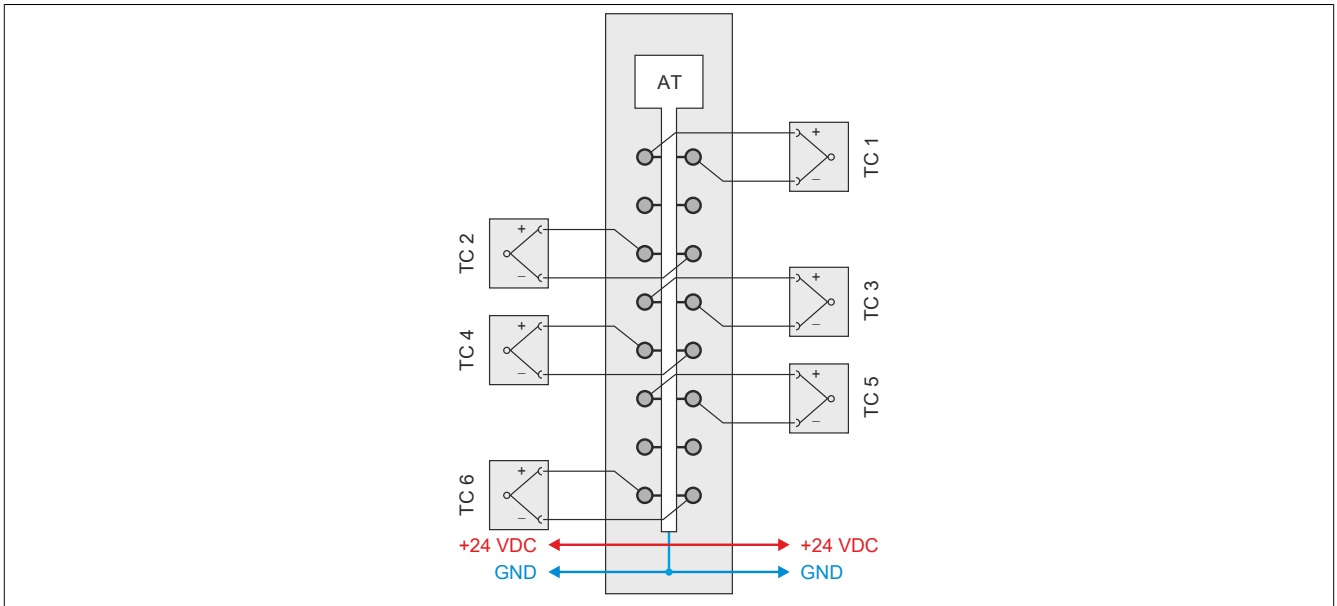
9.32.11.5 Pinout



9.32.11.6 Connection examples

Internal temperature compensation

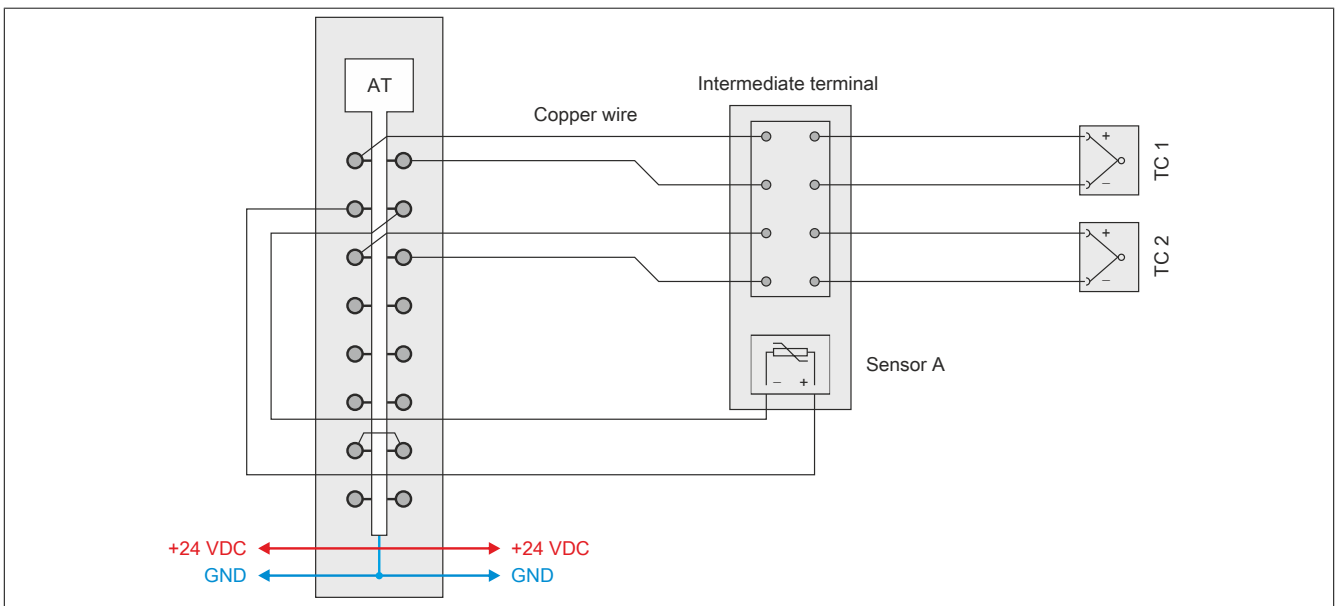
The thermocouple terminal X20TB1E with integrated PT1000 sensors is used for internal temperature compensation.



Remote temperature compensation

The 16-pin X20TB1F standard terminal block is used for remote temperature compensation. The external PT1000 sensors are connected to the module using 2-wire connections.

If Sensor B is not needed for temperature compensation, then the terminal points need to be bypassed.

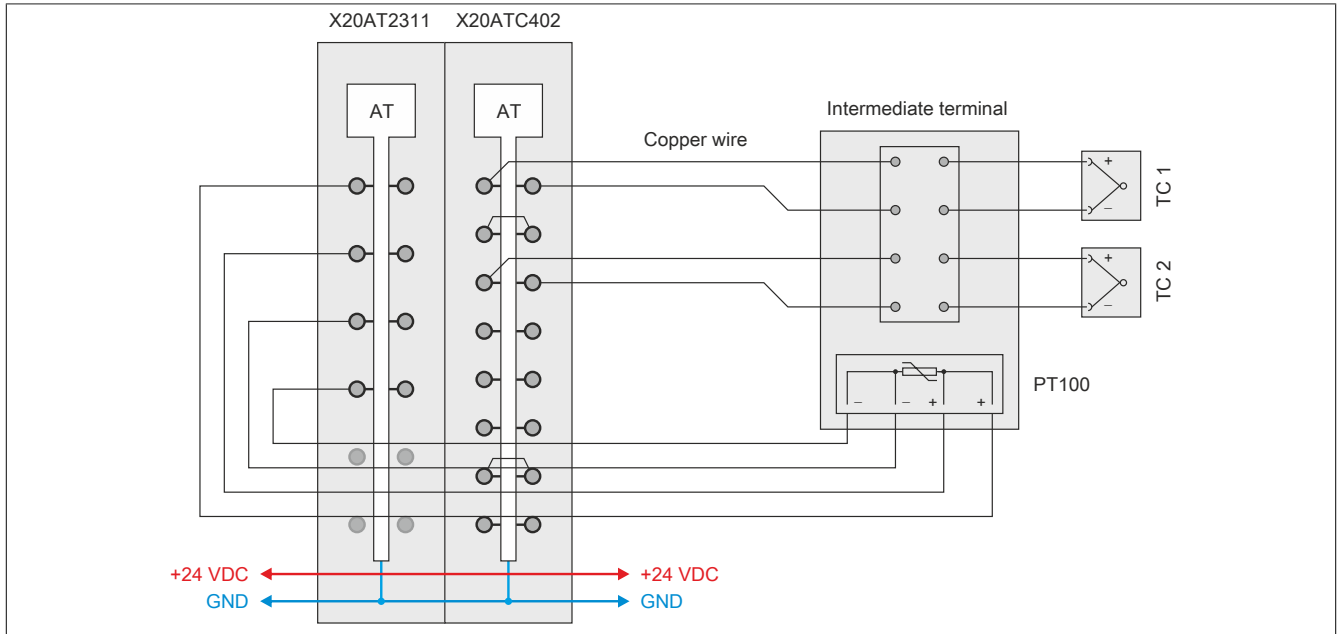


External temperature compensation

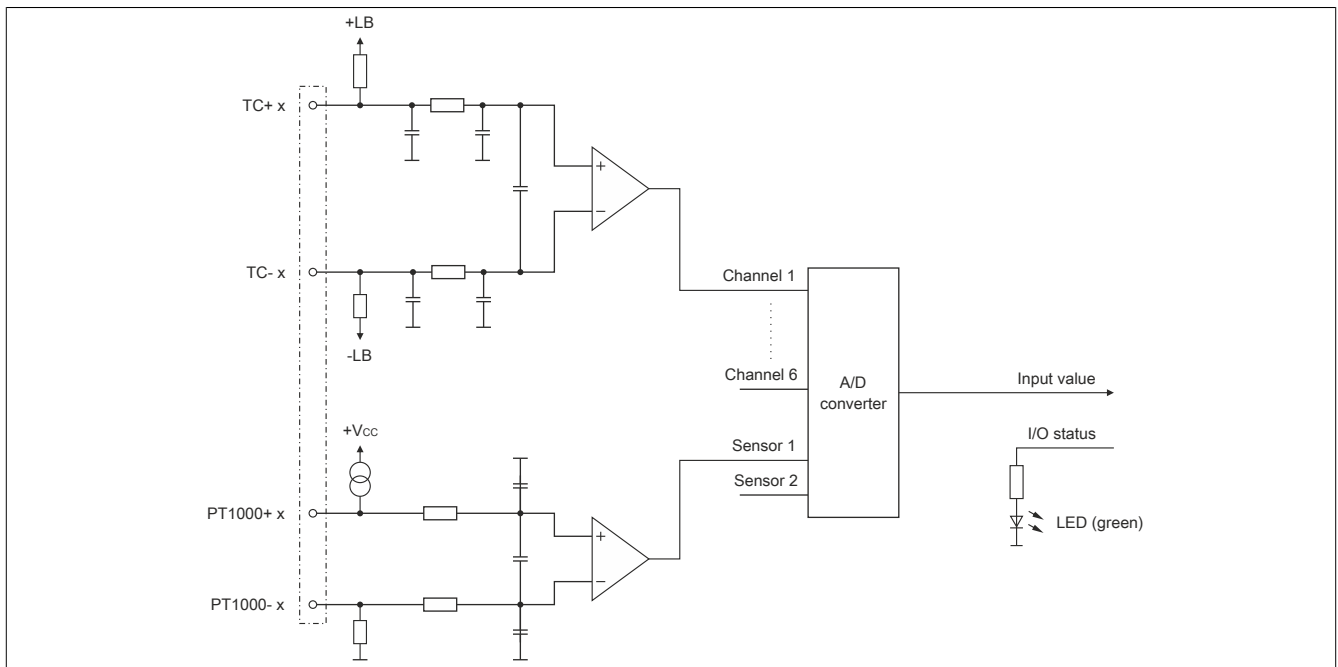
External compensation does not require the PT1000 values to be converted internally in the module. Instead, the reference temperatures have to be pre-processed in the program before being stored in the module. A separate register is available for each temperature channel to transfer an externally pre-processed compensation value.

In the following example, the compensation value is determined using the X20AT2311 temperature input module and a PT100 sensor on the intermediate terminal. The cold junction temperature determined externally is then made available to the X20ATC402 module via the respective I/O data points.

Since sensors A and B aren't needed for temperature compensation, the respective terminal points need to be bypassed.



9.32.11.7 Input circuit diagram



9.32.11.8 Remote or external terminal temperature compensation

Setting up a remote or external cold junction can provide the most accurate temperature measurement in a machine or system.

The installation of a remote or external cold junction is especially helpful in the following cases.

- There is no module next to the temperature module
- With strongly fluctuating environmental conditions (draft, temperature)
- External fan is used in the control cabinet

9.32.11.9 Register description

9.32.11.9.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "General data points" on page 3790.

9.32.11.9.2 Function model 0 - Standard

| Register | Name | Data type | Read | | Write | |
|--|--|-----------|--------|---------|--------|---------|
| | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module configuration | | | | | | |
| 1026 | Cfo_InputFilter | UINT | | | | • |
| Compensation | | | | | | |
| 1030 1034 | Cfo_ClampTypeA Cfo_ClampTypeB | UINT | | | | • |
| 1038 1042 | Cfo_ClampOffsetA Cfo_ClampOffsetB | INT | | | | • |
| 266 270 | CompensationValueA CompensationValueB | INT | | • | | |
| 261 263 | CompensationStatusA CompensationStatusB | USINT | | • | | |
| | UnderrunA, UnderrunB | Bit 0 | | | | |
| | OverrunA, OverrunB | Bit 1 | | | | |
| | OpenLineA, OpenLineB | Bit 2 | | | | |
| | ConverterFaultA, ConverterFaultB | Bit 4 | | | | |
| | SumFaultA, SumFaultB | Bit 5 | | | | |
| | ParameterFaultA, ParameterFaultB | Bit 6 | | | | |
| N * 4 + 766 | ExternalCompensation0N (index N = 1 to 6) | INT | | | • | |
| Temperature measurement - Configuration | | | | | | |
| N * 64 + 1026 | Cfo_SensorType0N (index N = 1 to 6) | UINT | | | | • |
| N * 64 + 1058 | Cfo_PreparationInterval0N (index N = 1 to 6) | UINT | | | | • |
| N * 64 + 1046 | Cfo_ReplaceUpper0N (index N = 1 to 6) | INT | | | | • |
| N * 64 + 1042 | Cfo_ReplaceLower0N (index N = 1 to 6) | INT | | | | • |
| N * 64 + 1034 | Cfo_UpperLimit0N (index N = 1 to 6) | INT | | | | • |
| N * 64 + 1030 | Cfo_LowerLimit0N (index N = 1 to 6) | INT | | | | • |
| N * 64 + 1038 | Cfo_Hysteresis0N (index N = 1 to 6) | INT | | | | • |
| N * 64 + 1050 | Cfo_ErrorDelay0N (index N = 1 to 6) | UINT | | | | • |
| N * 64 + 1054 | Cfo_SumErrorDelay0N (index N = 1 to 6) | UINT | | | | • |
| Temperature measurement | | | | | | |
| N * 64 + 262 | Temperature0N (index N = 1 to 6) | INT | • | | | |
| N * 64 + 258 | Measurand0N (index N = 1 to 6) | INT | | • | | |
| N * 64 + 274 | SampleTime0N (index N = 1 to 6) | INT | • | | | |
| N * 64 + 276 | SampleTime0N (index N = 1 to 6) | DINT | • | | | |
| N * 64 + 281 | IOCycleCounter0N (index N = 1 to 6) | USINT | | • | | |
| N * 64 + 282 | IOCycleCounter0N (index N = 1 to 6) | UINT | • | | | |
| N * 64 + 269 | Status0N (index N = 1 to 6) | USINT | • | | | |
| | Underrun0N | Bit 0 | | | | |
| | Overrun0N | Bit 1 | | | | |
| | OpenLine0N | Bit 2 | | | | |
| | CompensationFault0N | Bit 3 | | | | |
| | ConverterFault0N | Bit 4 | | | | |
| | SumFault0N | Bit 5 | | | | |
| | ParameterFault0N | Bit 6 | | | | |

9.32.11.9.3 Function model 254 - Bus controller

| Register | Offset ¹⁾ | Name | Data type | Read | | Write | |
|--|----------------------|--|-----------|--------|---------|--------|---------|
| | | | | Cyclic | Acyclic | Cyclic | Acyclic |
| Module configuration | | | | | | | |
| 1026 | - | Cfo_InputFilter | UINT | | | | • |
| Compensation | | | | | | | |
| 1030 1034 | - | Cfo_ClampTypeA Cfo_ClampTypeB | UINT | | | | • |
| 1038 1042 | - | Cfo_ClampOffsetA Cfo_ClampOffsetB | INT | | | | • |
| 266 270 | - | CompensationValueA CompensationValueB | INT | | • | | |
| 261 263 | - | CompensationStatusA CompensationStatusB | USINT | | • | | |
| | | UnderrunA, UnderrunB | Bit 0 | | | | |
| | | OverrunA, OverrunB | Bit 1 | | | | |
| | | OpenLineA, OpenLineB | Bit 2 | | | | |
| | | ConverterFaultA, ConverterFaultB | Bit 4 | | | | |
| | | SumFaultA, SumFaultB | Bit 5 | | | | |
| | | ParameterFaultA, ParameterFaultB | Bit 6 | | | | |
| N * 4 + 766 | - | ExternalCompensation0N (index N = 1 to 6) | INT | | | | • |
| Temperature measurement - Configuration | | | | | | | |
| N * 64 + 1026 | - | Cfo_SensorType0N (index N = 1 to 6) | UINT | | | | • |
| N * 64 + 1058 | - | Cfo_PreparationInterval0N (index N = 1 to 6) | UINT | | | | • |
| N * 64 + 1046 | - | Cfo_ReplaceUpper0N (index N = 1 to 6) | INT | | | | • |
| N * 64 + 1042 | - | Cfo_ReplaceLower0N (index N = 1 to 6) | INT | | | | • |
| N * 64 + 1034 | - | Cfo_UpperLimit0N (index N = 1 to 6) | INT | | | | • |
| N * 64 + 1030 | - | Cfo_LowerLimit0N (index N = 1 to 6) | INT | | | | • |
| N * 64 + 1038 | - | Cfo_Hysteresis0N (index N = 1 to 6) | INT | | | | • |
| N * 64 + 1050 | - | Cfo_ErrorDelay0N (index N = 1 to 6) | UINT | | | | • |
| N * 64 + 1054 | - | Cfo_SumErrorDelay0N (index N = 1 to 6) | UINT | | | | • |
| Temperature measurement | | | | | | | |
| N * 64 + 262 | N * 2 - 2 N * 2 | Temperature0N (index N = 1 to 3) Temperature0N (index N = 4 to 6) | INT | • | | | |
| N * 64 + 258 | - | Measurand0N (index N = 1 to 6) | INT | | • | | |
| N * 64 + 281 | - | IOCycleCounter0N (index N = 1 to 6) | USINT | | • | | |
| 30 | - | ModuleStatus01 | USINT | | • | | |
| 31 | - | ModuleStatus02 | USINT | | • | | |

1) The offset specifies the position of the register within the CAN object.

9.32.11.9.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see "Using I/O modules on the bus controller" on page 3789.

9.32.11.9.3.2 CAN I/O bus controller

The module occupies 2 analog logical slots on CAN I/O.

9.32.11.9.4 Module configuration

The module is an I/O module for temperature measurement and requires a 16-pin standard terminal block or the 16-pin terminal block with 2 integrated PT1000 inputs for temperature compensation.

2 measuring resistors (PT1000) can be connected via pin pairs 12/22 and 17/27 to record the absolute compensation temperature. This comparative value is used as a reference for the actual temperature measurement.

9.32.11.9.4.1 Input filter

Name:

Cfo_InputFilter

Mit Hilfe dieses Registers wird die Abtastzeit des A/D-Wandlers konfiguriert. Die eingestellte Filter-/Abtastzeit gilt gleichermaßen für die Eingänge der Thermoelemente als auch des Temperaturwiderstandes.

| Datentyp | Werte | Filterzeit in ms | Wandelrate in s ⁻¹ |
|----------|-------|-----------------------------|-------------------------------|
| UINT | 4 | 1 | 1000 |
| | 9 | 2 | 500 |
| | 48 | 10 | 100 |
| | 80 | 16,7 | 60 |
| | 96 | 20 (Bus Controller Default) | 50 |
| | 160 | 33,3 | 30 |
| | 192 | 40 | 25 |
| | 320 | 66,7 | 15 |
| | 480 | 100 | 10 |
| | 960 | 200 | 5 |

Information:

Je geringer die Wandelrate konfiguriert wird, desto genauer kann der Wert gewandelt werden. Allerdings wird dadurch auch die I/O-Updatezeit erhöht.

9.32.11.9.5 Compensation

The measurement process is based on the interaction between the temperature sensors and the thermocouples. The converted voltage value of a thermocouple has a linear relationship with the difference in temperature between the measurement point and the transition point. To calculate the absolute temperature at the measurement point, the measured value must then be placed in relation to an absolute reference temperature.

The compensation value required for this can be determined as follows:

- Value determined directly on the module using a PT1000 temperature sensor. ("[Internal compensation on page 3765](#)")
- Value provided via a cyclic data point. ("[External compensation on page 3767](#)")

9.32.11.9.5.1 Internal compensation

The inputs of the temperature resistors are used for internal compensation. The module can be used with the 16-pin terminal block (X20TB1E), which has 2 PT1000 temperature sensors.

When operating the module with the X20TB1E, the temperature distribution on the terminal block must be taken into account. To do this, various models for calculating the temperature distribution have been implemented on the module. They account for both the ambient temperature in the control cabinet, as well as the mounting orientation of the module. This helps minimize measurement error.

Alternatively, the module can be operated with the standard 16-pin terminal block (X20TB1F). For a detailed description of this procedure, see "[Remote terminal block on page 3767](#)".

Information:

To avoid unnecessary traffic on the X2X Link network, the compensation registers should only be transferred cyclically during the fine-tuning process and for service and maintenance purposes. The information is generally not required during normal operation.

Setting the compensation parameters

Name:

Cfo_ClampTypeA, Cfo_ClampTypeB

These registers specify the type of sensor and registers the conversion of the compensation value on the A/D converter.

Four different temperature distribution models have been built into the module, optimized for the various ways the module can be installed. The respective model is selected using bits 4 (installation parameter) and 5 (thermal radiance).

| Data type | Value | Information |
|-----------|-------------------|---|
| UINT | See bit structure | Bus controller default setting value: 0 |

Bit structure:

| Bit | Name | Value | Information |
|--------|--|-------|--|
| 0 | Sensor type | 0 | PT1000 (bus controller default setting) |
| | | 1 | Reserved |
| 1 | Compensation channel (on/off) | 0 | Channel not converted by the AD converter (bus controller default setting) |
| | | 1 | Channel registered on the AD converter |
| 2 | Compensation value (see register " Compensation value on page 3766 ") | 0 | Prepare as temperature value (bus controller default setting) |
| | | 1 | Prepare as resistance value |
| 3 | Reserved | - | |
| 4 | Installation parameter | 0 | Horizontal mounting orientation (bus controller default setting) |
| | | 1 | Vertical mounting orientation |
| 5 | Thermal radiance ¹⁾ | 0 | Low (bus controller default setting) |
| | | 1 | High |
| 6 - 15 | Reserved | - | |

1) If an active module that generates additional heat is installed in the immediate vicinity of the temperature module, then this parameter should be set to 1.

Compensation offset

Name:

Cfo_ClampOffsetA, Cfo_ClampOffsetB

These registers define the offsets that are deducted from the respective compensation values.

| Data type | Value | Information |
|-----------|-----------------|--|
| INT | -32767 to 32767 | In 0.1 Ω . Bus controller default setting: 0 |

Compensation value

Name:

CompensationValueA, CompensationValueB

These registers can be used to read the compensation value. Depending on how the "Cfo_ClampType" on page 3765 register is set, it is output as either a temperature or resistance value.

| Data type | Value | Information |
|-----------|-----------------|--------------------------|
| INT | -32767 to 32767 | in 0.1°C or 0.1 Ω |

Status of the compensation value

Name:

CompensationStatusA, CompensationStatusB

UnderrunA, UnderrunB

OverrunA, OverrunB

OpenLineA, OpenLineB

ConverterFaultA, ConverterFaultB

SumFaultA, SumFaultB

ParameterFaultA, ParameterFaultB

These registers provide information about the current status of the respective compensation value. The structure is based on the "Status" on page 3772 register.

| Data type | Value |
|-----------|-------------------|
| USINT | See bit structure |

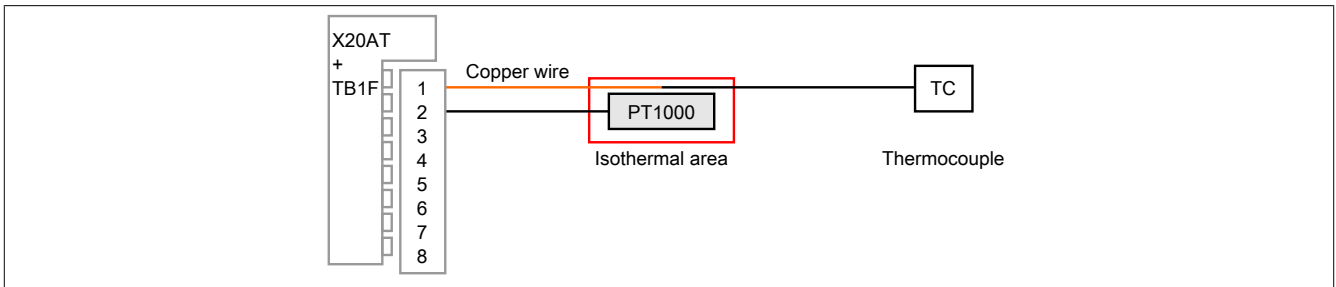
Bit structure:

| Bit | Name | Value | Information |
|-----|----------------------|-------|---|
| 0 | UnderrunA | 0 | No error |
| | UnderrunB | 1 | Value below the permitted range |
| 1 | OverrunA | 0 | No error |
| | OverrunB | 1 | Value above the permitted range |
| 2 | OpenLineA | 0 | No error |
| | OpenLineB | 1 | Open line |
| 3 | (Compensation error) | - | No meaning |
| 4 | ConverterFaultA | 0 | No error |
| | ConverterFaultB | 1 | Converter error |
| 5 | SumFaultA | 0 | No error |
| | SumFaultB | 1 | Undelayed composite error |
| 6 | ParameterFaultA | 0 | No error |
| | ParameterFaultB | 1 | Invalid setting for "ClampType" on page 3765 register |
| 7 | Reserved | - | |

Remote terminal block

The 16-pin standard terminal block (X20TB1F) is used. The reference point for temperature measurements can be moved from the terminal to a more thermally stable location. This can help to minimize measurement error and increase accuracy.

Principle of remote terminal block



The thermocouple provides $V(\Delta T)$ between the end of the thermocouple and the transition to the copper wire.

The PT1000 sensor provides the absolute temperature of the isothermal area.

Calculation: $T(\text{TC}) = T(\text{PT1000}) + \Delta T$

9.32.11.9.5.2 External compensation

For external compensation, the reference temperatures must be prepared in the application and transferred to the module via X2X Link. There is no need for internal conversion of the PT1000 values in the module.

External compensation value

Name:

ExternalCompensation01 to ExternalCompensation06

These registers can be used to send an externally generated compensation value to the module.

| Data type | Value | Information |
|-----------|-----------------|-------------|
| INT | -32767 to 32767 | in 0.1°C |

9.32.11.9.6 Temperature measurement - Configuration

The temperature measurement channels can be configured independently of each other. The "Cfo_SensorType" on page 3768 register needs to be adjusted in order to enable a temperature channel. The rest of the registers complement this configuration and only need to be defined if required in the application.

9.32.11.9.6.1 Configuring temperature measurement

Name:

Cfo_SensorType01 to Cfo_SensorType06

These registers control the basic functionality of a temperature channel.

| Data type | Value | Bus controller default setting |
|-----------|-------------------|--------------------------------|
| UINT | See bit structure | 33792 |

Bit structure:

| Bit | Name | Value | Information |
|-------|--|---------|--|
| 0 - 5 | Sensor type | 0 | Sensor J (Fe-CuNi) (bus controller default setting) |
| | | 1 | Sensor K (NiCr-Ni) |
| | | 2 | Sensor N (NiCrSi-NiSi) |
| | | 3 | Sensor S (PtRh10-Pt) |
| | | 4 | Sensor R (PtRh13-Pt) |
| | | 5 | Sensor C (WRe5-WRe26) |
| | | 6 | Sensor T (Cu-CuNi) |
| | | 7 | Sensor B (PtRh30-PtRh6) |
| | | 8 | Sensor E (NiCr-CuNi) |
| | | 9 to 60 | Reserved |
| 6 - 7 | Reserved | - | |
| | | 61 | Resolution 1.0625 μ V; measurement range \pm 35 mV |
| | | 62 | Resolution 2.125 μ V; measurement range \pm 70 mV |
| 8 - 9 | Reference method | 63 | Reserved |
| | | 0 | PT1000 sensor (bus controller default setting) |
| | | 1 to 2 | Not permitted |
| 10 | Temperature model for X20TB1E ¹⁾ | 3 | External compensation |
| | | 0 | Disabled (bus controller default setting) |
| 11 | Method of compensation | 1 | Enabled |
| | | 0 | Internal compensation (bus controller default setting) |
| 12 | Reserved | 1 | External compensation |
| | | - | |
| 13 | Replacement value strategy | 0 | Replace with static default value (bus controller default setting) |
| | | 1 | Retain last valid value |
| 14 | Additional user-defined limits for permitted range of values | 0 | Permissible range of values of the thermocouple (bus controller default setting) |
| | | 1 | Range of values as configured ²⁾ |
| 15 | Temperature channel | 0 | Channel not converted by the AD converter |
| | | 1 | Channel registered on the AD converter (bus controller default setting) |

1) To enable the temperature model, both PT1000 cold junction sensors must be connected.

2) The user-defined limit values can further reduce the permitted range of values for the sensor, depending on the requirements of the application. It is not permitted to define a measurement range larger than the range supported by the sensor.

9.32.11.9.6.2 Defining the preparation interval

Name:

Cfo_PreparationInterval01 to Cfo_PreparationInterval06

If the last valid measured value should be kept when violating the limit value, then PreparationInterval must be defined. The measured values continue to be acquired and converted according to the configured I/O update time. They are then checked and discarded if they do not meet the specifications. When an error does not occur, therefore, the measured value acquired 2 preparation intervals ago is constantly output.

| Data type | Value | Information |
|-----------|------------|---|
| UINT | 0 to 65535 | In 0.1 ms. Bus controller default setting: 0 |

| | |
|--|--|
| <p>Functionality: Measured values are continuously converted and stored to measured value memory depending on the configured input filter. The current contents of the measured value memory are checked within the configured interval. If a permissible value is present, then the contents of the buffer memory are passed to output memory and the contents of the measured value memory are passed to the buffer. If the check turns up an impermissible value, then the contents of the measured value memory are discarded. The copy direction between the output and buffer memory reverses and the last valid value continues to be output.</p> <p>Information: If configured to keep the last valid value, the delay time from measuring to outputting the value will be at least twice the preparation interval. In the worst case scenario, this can also take twice the interval time plus the configured conversion rate of the A/D converter.</p> | <p>"Application" Value being measured (analog)</p> |
| | <p>↓ Condition: - Conversion interval (A/D converter) elapsed</p> |
| | <p>"Measured value memory" Measured value (digital)</p> |
| | <p>↓ Condition: - PreparationInterval elapsed - Measured value permissible</p> |
| | <p>"Buffer" Last valid value</p> |
| <p>↓ Condition: - PreparationInterval elapsed - Measured value permissible</p> | |
| <p>"Output memory" Next-to-last valid/ displayed value</p> | |

Information:

The registers are only set for the channel when bit 13 is set in the "Cfo_SensorType" on page 3768 register.

9.32.11.9.6.3 Upper replacement value

Name:

Cfo_ReplaceUpper01 to Cfo_ReplaceUpper06

This register is used to define the static values to be displayed instead of the current measured value when the limit is violated.

| Data type | Value | Information |
|-----------|-----------------|---------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 32767 |

Information:

The registers are only set for the channel when bit 13 is not set in the "Cfo_SensorType" on page 3768 register.

9.32.11.9.6.4 Lower replacement value

Name:

Cfo_ReplaceLower01 to Cfo_ReplaceLower06

This register is used to define the lower static values to be displayed instead of the current measured value when the limit is violated.

| Data type | Value | Information |
|-----------|-----------------|--|
| INT | -32767 to 32767 | Bus controller default setting: -32767 |

Information:

The registers are only set for the channel when bit 13 is not set in the "Cfo_SensorType" on page 3768 register.

9.32.11.9.6.5 Upper limit value

Name:

Cfo_UpperLimit01 to Cfo_UpperLimit06

If the value range needs to be restricted further, these registers can be used to enter new user-specific upper limit values.

| Data type | Value | Information |
|-----------|-----------------|---------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 32767 |

9.32.11.9.6.6 Lower limit value

Name:

Cfo_LowerLimit01 to Cfo_LowerLimit06

If the value range needs to be restricted further, these registers can be used to enter new user-specific lower limit values.

| Data type | Value | Information |
|-----------|-----------------|--|
| INT | -32767 to 32767 | Bus controller default setting: -32767 |

9.32.11.9.6.7 Hysteresis

Name:

Cfo_Hysteresis01 to Cfo_Hysteresis06

If the user-specific limit values are being used, then a hysteresis range should also be defined. These registers configure how far a limit value can be exceeded before a response is triggered.

| Data type | Value | Information |
|-----------|-----------------|------------------------------------|
| INT | -32767 to 32767 | Bus controller default setting: 16 |

9.32.11.9.6.8 Error delay

Name:

Cfo_ErrorDelay01 to Cfo_ErrorDelay06

These registers describe the number of consecutive conversion procedures where an error is pending until the corresponding individual error status bit is set. The delay applies to underflow, overflow and open circuit errors. This delay can be used to hide temporary measured value deviations, for example.

| Data type | Values | Information |
|-----------|-------------|--|
| UINT | 0 to 65,535 | AD conversions. Bus controller default setting: 2 |

9.32.11.9.6.9 Error delay for composite error bit

Name:

Cfo_SumErrorDelay01 to Cfo_SumErrorDelay06

These registers can be used to set the time that an error must remain pending before the composite error bit is set.

| Data type | Values | Information |
|-----------|-------------|--------------------------------------|
| UINT | 0 to 65,535 | Bus controller default setting: 4000 |

9.32.11.9.7 Temperature measurement

The received temperature data is prepared in 2 different formats and given a [timestamp](#). For each channel there are 2 separate registers for transmitting the measured values to the PLC.

9.32.11.9.7.1 Temperature measurements

Name:

Temperature01 to Temperature06

Measurand01 to Measurand06

These registers contain the analog input values according to the sensor type set in the "[Cfo_SensorType](#)" on page 3768 register:

| Data type | Value | Information | Sensor type |
|------------------|--|---|-----------------------|
| INT | -2,100 to 12,000 | (for -210.0 to 1200.0 °C) | Type J (Fe-CuNi) |
| | -2,700 to 13,720 | (for -270.0 to 1372.0 °C) | Type K (NiCr-Ni) |
| | -2,700 to 12,980 | (for -270.0 to 1298.0 °C) | Type N (NiCrSi-NiSi) |
| | -500 to 17,680 | (for -50.0 to 1768.0 °C) | Type S (PtRh10-Pt) |
| | -500 to 17,600 | (for -50.0 to 1760.0 °C) | Type R (PtRh13-Pt) |
| | 0 to 23,100 | (for 0 to 2310.0 °C) | Type C (WRe5-WRe26) |
| | -2,700 to 4,000 | (for -270.0 to 400.0 °C) | Type T (Cu-CuNi) |
| | 0 to 18,200 | (for 0 to 1820.0 °C) | Type B (PtRh30-PtRh6) |
| | -2,700 to 9,970 | (for -270.0 to 997.0 °C) | Type E (NiCr-CuNi) |
| | -32,768 to 32767 | Voltage without linearization and terminal temperature compensation Resolution 1.0625 µV for a measurement range of ±35 mV | |
| -32,768 to 32767 | Voltage without linearization and terminal temperature compensation Resolution 2.125 µV for a measurement range of ±70 mV | | |

In order for the user to always be supplied with a defined output value, the following must be taken into consideration:

- Up to the first conversion, 0x8000 is output.
- After switching the sensor type, 0x8000 is output until the first conversion.
- If the input is switched off, 0x8000 is output.
- If an I/O voltage supply failure occurs, 0x8000 is output.

9.32.11.9.7.2 Sample time

Name:

SampleTime01 to SampleTime06

These registers return the timestamp for when the module reads the current channel mapping. The values are provided as signed 2-byte or 4-byte values.

For more information about NetTime and timestamps, see "[NetTime Technology](#)" on page 3035.

| Data type | Values | Information |
|-----------|---------------------------|--|
| INT | -32,768 to 32767 | NetTime timestamp of the current input value in µs |
| DINT | -2147483648 to 2147483647 | NetTime timestamp of the current input value in µs |

9.32.11.9.7.3 I/O cycle counter

Name:

IOCycleCounter01 to IOCycleCounter06

These registers are cyclic counters that are incremented each time a value is converted. They can be used as either 1-byte or 2-byte counters.

| Data type | Value |
|-----------|------------|
| USINT | 0 to 255 |
| UINT | 0 to 65535 |

9.32.11.9.7.4 Status messages (Function model 0)

Name:

Status01 to Status06

Underrun01 to Underrun06

Overrun01 to Overrun06

OpenLine01 to OpenLine06

CompensationFault01 to CompensationFault06

ConverterFault01 to ConverterFault06

SumFault01 to SumFault06

ParameterFault01 to ParameterFault06

The current error status of the module channels is displayed in these registers, regardless of the configured replacement value strategy. Some error information may be delayed according to the conditions configured previously in the "[Cfo_ErrorDelay](#)" on page 3770 and "[Cfo_SumErrorDelay](#)" on page 3770 registers.

| Data type | Value |
|-----------|--------------------|
| USINT | See bit structure. |

Bit structure:

| Bit | Name | Value | Information |
|-----|---------------------|-------|---|
| 0 | Underrun0x | 0 | No error |
| | | 1 | Value below the permitted range |
| 1 | Overrun0x | 0 | No error |
| | | 1 | Value above the permitted range |
| 2 | OpenLine0x | 0 | No error |
| | | 1 | Open line |
| 3 | CompensationFault0x | 0 | No error |
| | | 1 | Compensation error; See " CompensationStatus " on page 3766 register for a detailed error description |
| 4 | ConverterFault0x | 0 | No error |
| | | 1 | Converter error |
| 5 | SumFault0x | 0 | No error |
| | | 1 | Undelayed composite error |
| 6 | ParameterFault0x | 0 | No error |
| | | 1 | Invalid configuration for " Cfo_ClampType " on page 3765 |
| 7 | Reserved | - | |

9.32.11.9.7.5 Status messages (Function model 254)

Name:

ModuleStatus01 to ModuleStatus06

In function model 254, error detection does not have to be preconfigured. It is enabled at every startup. To streamline the transfer, however, only the 4 basic error messages were implemented.

The bits of these registers are set when one of the implemented error diagnostics is triggered.

| Data type | Value |
|-----------|--|
| USINT | Channels 1 to 4: see bit structure I |
| | Channels 5 and 6: see bit structure II |

Bit structure I:

| Bit | Name | Value | Information |
|-------|-----------|----------|--|
| 0 - 1 | Channel 1 | 00 | No error |
| | | 01 | Underflow (lower value limit violated) |
| | | 10 | Overflow (upper value limit violated) |
| | | 11 | Open line |
| 2 - 3 | Channel 2 | 00 to 11 | See channel 1 |
| 4 - 5 | Channel 3 | 00 to 11 | See channel 1 |
| 6 - 7 | Channel 4 | 00 to 11 | See channel 1 |

Bit structure II:

| Bit | Name | Value | Information |
|-------|-----------|----------|--|
| 0 - 1 | Channel 5 | 00 | No error |
| | | 01 | Underflow (lower value limit violated) |
| | | 10 | Overflow (upper value limit violated) |
| | | 11 | Open line |
| 2 - 3 | Channel 6 | 00 to 11 | See channel 5 |
| 4 - 7 | Reserved | - | |

9.32.11.9.8 NetTime Technology

For a description of NetTime Technology, see ["NetTime Technology" on page 3035](#).

9.32.11.9.9 Minimum cycle time

The minimum cycle time defines how far the bus cycle can be reduced without causing a communication error or impaired functionality. It should be noted that very fast cycles decrease the idle time available for handling monitoring, diagnostics and acyclic commands.

| Minimum cycle time |
|--------------------|
| 200 µs |

9.32.11.9.10 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

The A/D converter must convert multiple values. After switching between 2 inputs there are 4 measurements in order to obtain a meaningful value. Since not all inputs need to be used, the actual I/O update time may vary.

The following formulas can be used to calculate the minimum required I/O update time:

$$\text{I/O update time} = 4 * \text{Conversions} * \text{Filter time}$$

$$\text{Filter time} = (1024 / 4920000) * C_{fo_InputFilter}$$

$$\text{Conversions} = \text{Number of thermocouples} + \text{Number of temperature resistors}$$

9.33 Terminal blocks

Various terminal blocks are available for wiring X20 modules.

9.33.1 Summary

| Model number | Short description | Page |
|--------------|--|------|
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed | 3775 |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed | 3775 |
| X20TB1E | X20 terminal block, 12-pin, 24 VDC keyed, 2x PT1000 integrated for terminal temperature compensation | 3778 |
| X20TB1F | X20 terminal block, 16-pin, 24 VDC keyed | 3781 |
| X20TB32 | X20 terminal block, 12-pin, 240 VAC keyed | 3784 |

9.33.2 X20TB06/X20TB12

Data sheet version: 2.65

9.33.2.1 General information

The X20 24 VDC modules are wired using the X20TB06 and X20TB12 terminal blocks.

- Tool-free wiring with push-in technology
- Simple wire release using lever
- Ability to label each terminal
- Plain text labeling also possible
- Test access for standard probes
- Can be customer-coded

9.33.2.2 Order data

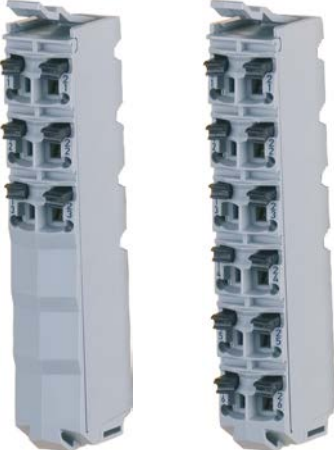
|  | |
|--|--|
| X20TB06 X20TB12 | |
| Model number | Short description |
| Terminal blocks | |
| X20TB06 | X20 terminal block, 6-pin, 24 VDC keyed |
| X20TB12 | X20 terminal block, 12-pin, 24 VDC keyed |

Table 655: X20TB06, X20TB12 - Order data

9.33.2.3 Technical data

| Model number | X20TB06 | X20TB12 |
|---|--|---------|
| General information | | |
| Certifications | | |
| CE | Yes | |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X | |
| UL | cULus E115267 Industrial control equipment | |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) | |
| LR | ENV1 | |
| KR | Yes | |
| Terminal block | | |
| Number of pins | 6 | 12 |
| Type of terminal block | Push-in terminal | |
| Push-in force per contact | Typ. 10 N | |
| Cable type | Only copper wires (no aluminum wires!) | |
| Wire stripping length | 7 to 9 mm | |
| Connection cross section | | |
| Solid wires | 0.08 to 2.50 mm ² / 28 to 14 AWG | |
| Fine-stranded wires | 0.25 to 2.50 mm ² / 24 to 14 AWG | |
| With wire end sleeves | 0.25 to 1.50 mm ² / 24 to 16 AWG | |
| With double wire end sleeves | Up to 2x 0.75 mm ² | |
| Distance between contacts | | |
| Left - Right | 4.2 mm | |
| Above - Below | 10.96 mm | |
| Electrical properties | | |
| Nominal voltage | 240 VAC | |
| Max. voltage | 300 VAC | |
| Nominal current ¹⁾ | 10 A / contact | |
| Contact resistance | ≤5 mΩ | |
| Ambient conditions ²⁾ | | |
| Temperature | | |
| Operation | Corresponds to the X20 module used | |
| Relative humidity | | |
| Operation | Corresponds to the X20 module used | |

Table 656: X20TB06, X20TB12 - Technical data

- 1) Take the respective limit data for the I/O modules into consideration!
2) Identical for operation, storage and transport.

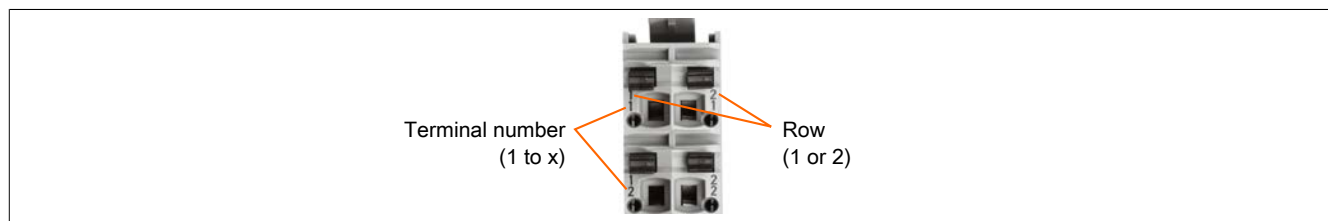
Warning!

It is possible to come into contact with parts that carry voltage when the terminal block is disconnected. For this reason, working on a disconnected terminal block is not permitted at voltages starting at 50 V.

9.33.2.4 Unique terminal numbering

Each terminal connection is unique and can be identified by the numbers in the plastic. In this way, terminal assignments can be clearly assigned in the planning stage without any danger of mix-up.

- Upper number: Row number 1 or 2
- Lower number: Terminal numbers 1 to 3 (6-pin terminal block), 1 to 6 (12-pin terminal block), 1 to 8 (16-pin terminal block)



9.33.2.5 Wiring

In order to achieve a secure connection in the terminal blocks, wires must be stripped accordingly.

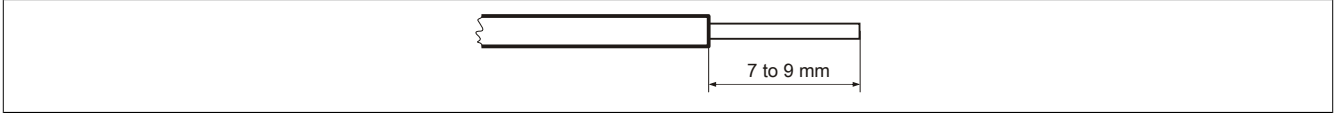


Figure 367: Wire stripping length for a secure connection

Information:

The wire stripping length is not permitted to be more or less than 7 to 9 mm.

9.33.2.6 Cable holding force of contacts

To ensure secure contact of a cable with the terminal block, it is not permitted to be subjected to too much tension. If the cable holding force is exceeded, the cable will disconnect from the terminal block and result in a malfunction.

| Cable in mm ² | Fine-stranded wires | | | Solid wires | | | | With wire end sleeves | |
|--|---------------------|-----|-----|-------------|------|-----|-----|-----------------------|-----|
| | 0.25 | 1.5 | 2.5 | 0.08 | 0.25 | 1.5 | 2.5 | 0.25 | 1.5 |
| Standard specification (min. value in newtons) | 12.5 | 40 | 50 | 4 | 12.5 | 40 | 50 | 12.5 | 40 |

Information:

Fine-stranded wires must be twisted in order to maintain the cable holding forces.

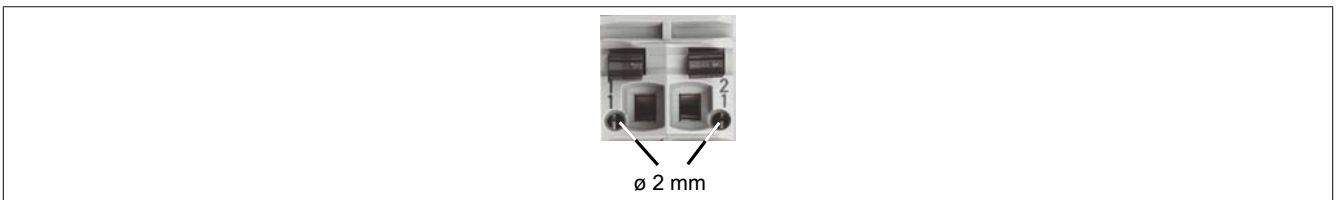
Use of wire end sleeves

In order to achieve an optimal cable holding force, the following points must be observed:

- Square crimping with the roughest possible surface should be carried out.
- The end of the wire end sleeve should not be cut in order to avoid a reduction of the cross section.
- No wires should protrude at the end of the sleeve.
- The wire end sleeve must be inserted completely to the end.
- The length of the wire end sleeve corresponds to the [wire stripping length](#).

9.33.2.7 Access for test probes

Each contact is equipped with an additional opening for using a test probe.



9.33.3 X20TB1E

Data sheet version: 1.55

9.33.3.1 General information

The X20TB1E terminal block is equipped with two integrated PT1000 sensors. It is therefore optimally suited for internal terminal temperature compensation.

- Integrated terminal temperature compensation
- Tool-free wiring with push-in technology
- Simple wire release using a screwdriver
- Ability to label each terminal
- Plain text labeling also possible
- Test access for standard probes
- Can be customer-coded

9.33.3.2 Order data


| Model number | Short description | Figure |
|--------------|--|--|
| X20TB1E | X20 terminal block, 12-pin, 24 VDC keyed, 2x PT1000 integrated for terminal temperature compensation |  |

Table 657: X20TB1E - Order data

9.33.3.3 Technical data

| Model number | X20TB1E |
|---|--|
| General information | |
| Certifications | |
| CE | Yes |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| UL | cULus E115267 Industrial control equipment |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Terminal block | |
| Number of pins | 12 |
| Type of terminal block | Push-in terminal |
| Push-in force per contact | Typ. 10 N |
| Cable type | Only copper wires (no aluminum wires!) |
| Wire stripping length | 7 to 9 mm |
| Connection cross section | |
| Solid wires | 0.08 to 1.50 mm ² / 28 to 16 AWG |
| Fine-stranded wires | 0.25 to 1.50 mm ² / 24 to 16 AWG |
| With wire end sleeves | 0.25 to 0.75 mm ² / 24 to 20 AWG |
| Distance between contacts | |
| Left - Right | 4.2 mm |
| Above - Below | 8.25 mm |
| Terminal temperature compensation | 2x PT1000 integrated in the terminal |
| Electrical properties | |
| Nominal voltage | 24 VDC |
| Max. voltage | 50 VDC |
| Nominal current ¹⁾ | 2 A / contact |
| Contact resistance | ≤5 mΩ |
| Ambient conditions ²⁾ | |
| Temperature | |
| Operation | Corresponds to the X20 module used |
| Relative humidity | |
| Operation | Corresponds to the X20 module used |

Table 658: X20TB1E - Technical data

- 1) Take the respective limit data for the I/O modules into consideration!
2) Identical for operation, storage and transport.

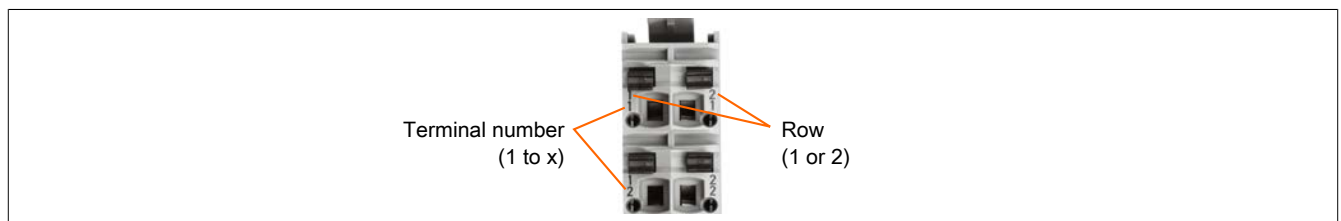
Warning!

It is possible to come into contact with parts that carry voltage when the terminal block is disconnected. For this reason, working on a disconnected terminal block is not permitted at voltages starting at 50 V.

9.33.3.4 Unique terminal numbering

Each terminal connection is unique and can be identified by the numbers in the plastic. In this way, terminal assignments can be clearly assigned in the planning stage without any danger of mix-up.

- Upper number: Row number 1 or 2
- Lower number: Terminal numbers 1 to 3 (6-pin terminal block), 1 to 6 (12-pin terminal block), 1 to 8 (16-pin terminal block)



9.33.3.5 Wiring

In order to achieve a secure connection in the terminal blocks, wires must be stripped accordingly.

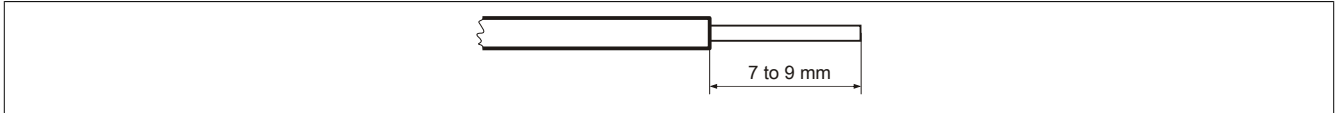


Figure 368: Wire stripping length for a secure connection

Information:

The wire stripping length is not permitted to be more or less than 7 to 9 mm.

9.33.3.6 Cable holding force of contacts

To ensure secure contact of a cable with the terminal block, it is not permitted to be subjected to too much tension. If the cable holding force is exceeded, the cable will disconnect from the terminal block and result in a malfunction.

| Cable in mm ² | Fine-stranded wires | | | Solid wires | | | | With wire end sleeves | |
|--|---------------------|-----|-----|-------------|------|-----|-----|-----------------------|-----|
| | 0.25 | 1.5 | 2.5 | 0.08 | 0.25 | 1.5 | 2.5 | 0.25 | 1.5 |
| Standard specification (min. value in newtons) | 12.5 | 40 | 50 | 4 | 12.5 | 40 | 50 | 12.5 | 40 |

Information:

Fine-stranded wires must be twisted in order to maintain the cable holding forces.

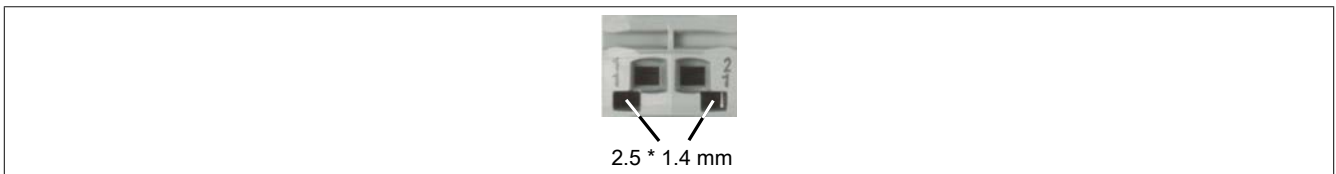
Use of wire end sleeves

In order to achieve an optimal cable holding force, the following points must be observed:

- Square crimping with the roughest possible surface should be carried out.
- The end of the wire end sleeve should not be cut in order to avoid a reduction of the cross section.
- No wires should protrude at the end of the sleeve.
- The wire end sleeve must be inserted completely to the end.
- The length of the wire end sleeve corresponds to the [wire stripping length](#).

9.33.3.7 Access for test probes

Each contact is equipped with an additional opening for using a test probe.



9.33.4 X20TB1F

Data sheet version: 1.55

9.33.4.1 General information

X20 24 VDC modules with 16 connections are wired using the X20TB1F terminal block.

- Tool-free wiring with push-in technology
- Simple wire release using a screwdriver
- Ability to label each terminal
- Plain text labeling also possible
- Test access for standard probes
- Can be customer-coded

9.33.4.2 Order data


| Model number | Short description | Figure |
|--------------|--|--|
| | Terminal blocks | |
| X20TB1F | X20 terminal block, 16-pin, 24 VDC keyed |  |

Table 659: X20TB1F - Order data

Information:

To avoid damaging the terminals, the **B&R X20AC0SD1** screw driver should be used.

9.33.4.3 Technical data

| Model number | X20TB1F |
|---|--|
| General information | |
| Certifications | |
| CE | Yes |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| UL | cULus E115267 Industrial control equipment |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Terminal block | |
| Number of pins | 16 |
| Type of terminal block | Push-in terminal |
| Push-in force per contact | Typ. 10 N |
| Cable type | Only copper wires (no aluminum wires!) |
| Wire stripping length | 7 to 9 mm |
| Connection cross section | |
| Solid wires | 0.08 to 1.50 mm ² / 28 to 16 AWG |
| Fine-stranded wires | 0.25 to 1.50 mm ² / 24 to 16 AWG |
| With wire end sleeves | 0.25 to 0.75 mm ² / 24 to 20 AWG |
| Distance between contacts | |
| Left - Right | 4.2 mm |
| Above - Below | 8.25 mm |
| Electrical properties | |
| Nominal voltage | 24 VDC |
| Max. voltage | 50 VDC |
| Nominal current ¹⁾ | 2 A / contact |
| Contact resistance | ≤5 mΩ |
| Ambient conditions ²⁾ | |
| Temperature | |
| Operation | Corresponds to the X20 module used |
| Relative humidity | |
| Operation | Corresponds to the X20 module used |

Table 660: X20TB1F - Technical data

- 1) Take the respective limit data for the I/O modules into consideration!
- 2) Identical for operation, storage and transport.

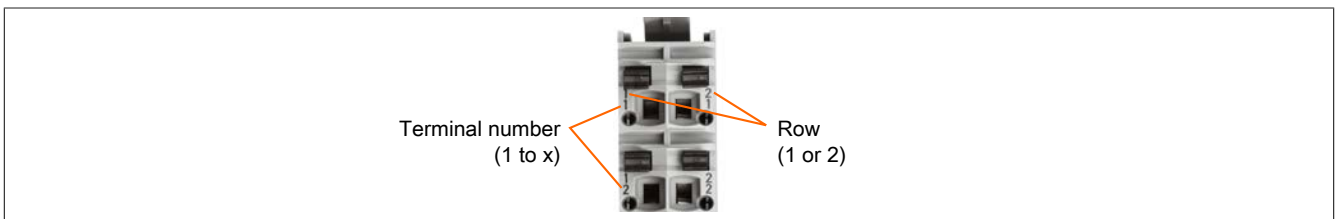
Warning!

It is possible to come into contact with parts that carry voltage when the terminal block is disconnected. For this reason, working on a disconnected terminal block is not permitted at voltages starting at 50 V.

9.33.4.4 Unique terminal numbering

Each terminal connection is unique and can be identified by the numbers in the plastic. In this way, terminal assignments can be clearly assigned in the planning stage without any danger of mix-up.

- Upper number: Row number 1 or 2
- Lower number: Terminal numbers 1 to 3 (6-pin terminal block), 1 to 6 (12-pin terminal block), 1 to 8 (16-pin terminal block)



9.33.4.5 Wiring

In order to achieve a secure connection in the terminal blocks, wires must be stripped accordingly.

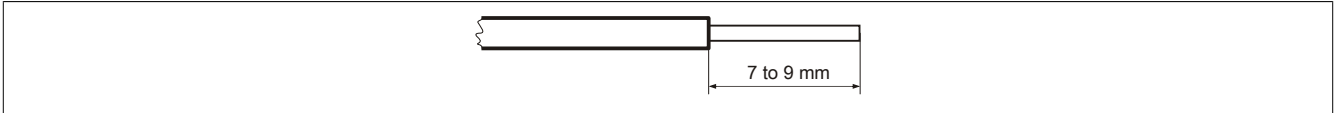


Figure 369: Wire stripping length for a secure connection

Information:

The wire stripping length is not permitted to be more or less than 7 to 9 mm.

9.33.4.6 Cable holding force of contacts

To ensure secure contact of a cable with the terminal block, it is not permitted to be subjected to too much tension. If the cable holding force is exceeded, the cable will disconnect from the terminal block and result in a malfunction.

| Cable in mm ² | Fine-stranded wires | | | Solid wires | | | | With wire end sleeves | |
|--|---------------------|-----|-----|-------------|------|-----|-----|-----------------------|-----|
| | 0.25 | 1.5 | 2.5 | 0.08 | 0.25 | 1.5 | 2.5 | 0.25 | 1.5 |
| Standard specification (min. value in newtons) | 12.5 | 40 | 50 | 4 | 12.5 | 40 | 50 | 12.5 | 40 |

Information:

Fine-stranded wires must be twisted in order to maintain the cable holding forces.

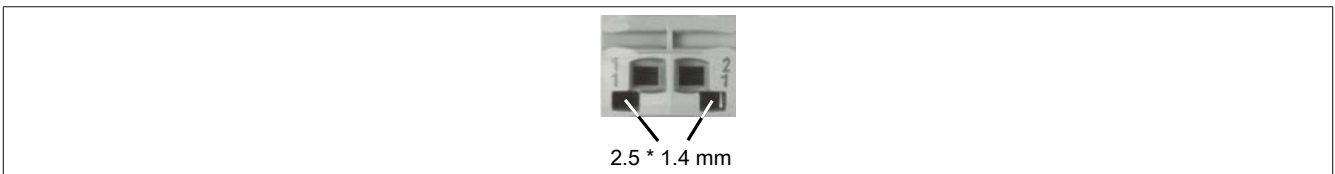
Use of wire end sleeves

In order to achieve an optimal cable holding force, the following points must be observed:

- Square crimping with the roughest possible surface should be carried out.
- The end of the wire end sleeve should not be cut in order to avoid a reduction of the cross section.
- No wires should protrude at the end of the sleeve.
- The wire end sleeve must be inserted completely to the end.
- The length of the wire end sleeve corresponds to the [wire stripping length](#).

9.33.4.7 Access for test probes

Each contact is equipped with an additional opening for using a test probe.



9.33.5 X20TB32

Data sheet version: 2.65

9.33.5.1 General information

The X20 240 VAC modules are wired using X20TB32 terminal blocks.

- Tool-free wiring with push-in technology
- Simple wire release using lever
- Ability to label each terminal
- Plain text labeling also possible
- Test access for standard probes
- Can be customer-coded
- Special color
- 240 V coding

9.33.5.2 Order data


| Model number | Short description | Figure |
|--------------|---|--|
| X20TB32 | Terminal blocks X20 terminal block, 12-pin, 240 VAC keyed |  |

Table 661: X20TB32 - Order data

9.33.5.3 Technical data

| Model number | X20TB32 |
|---|--|
| General information | |
| Certifications | |
| CE | Yes |
| ATEX | Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZU 09 ATEX 0083X |
| UL | cULus E115267 Industrial control equipment |
| DNV GL | Temperature: B (0 - 55°C) Humidity: B (up to 100%) Vibration: B (4 g) EMC: B (bridge and open deck) |
| LR | ENV1 |
| KR | Yes |
| Terminal block | |
| Number of pins | 12 |
| Type of terminal block | Push-in terminal |
| Push-in force per contact | Typ. 10 N |
| Cable type | Only copper wires (no aluminum wires!) |
| Wire stripping length | 7 to 9 mm |
| Connection cross section | |
| Solid wires | 0.08 to 2.50 mm ² / 28 to 14 AWG |
| Fine-stranded wires | 0.25 to 2.50 mm ² / 24 to 14 AWG |
| With wire end sleeves | 0.25 to 1.50 mm ² / 24 to 16 AWG |
| With double wire end sleeves | Up to 2x 0.75 mm ² |
| Distance between contacts | |
| Left - Right | 4.2 mm |
| Above - Below | 10.96 mm |
| Electrical properties | |
| Nominal voltage | 240 VAC |
| Max. voltage | 300 VAC |
| Nominal current ¹⁾ | 10 A / contact |
| Contact resistance | ≤5 mΩ |
| Ambient conditions ²⁾ | |
| Temperature | |
| Operation | Corresponds to the X20 module used |
| Relative humidity | |
| Operation | Corresponds to the X20 module used |

Table 662: X20TB32 - Technical data

- 1) Take the respective limit data for the I/O modules into consideration!
2) Identical for operation, storage and transport.

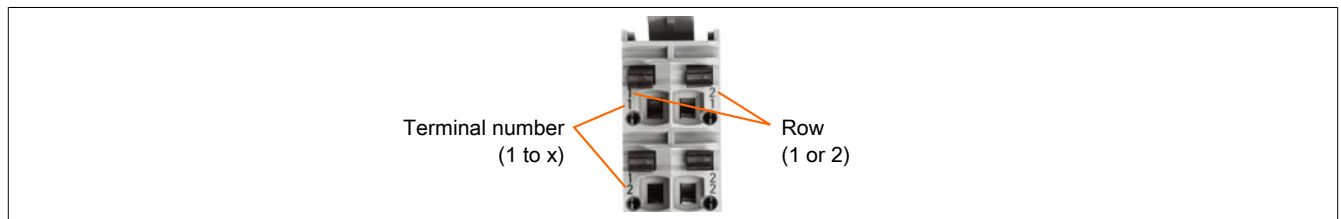
Warning!

It is possible to come into contact with parts that carry voltage when the terminal block is disconnected. For this reason, working on a disconnected terminal block is not permitted at voltages starting at 50 V.

9.33.5.4 Unique terminal numbering

Each terminal connection is unique and can be identified by the numbers in the plastic. In this way, terminal assignments can be clearly assigned in the planning stage without any danger of mix-up.

- Upper number: Row number 1 or 2
- Lower number: Terminal numbers 1 to 3 (6-pin terminal block), 1 to 6 (12-pin terminal block), 1 to 8 (16-pin terminal block)



9.33.5.5 Wiring

In order to achieve a secure connection in the terminal blocks, wires must be stripped accordingly.

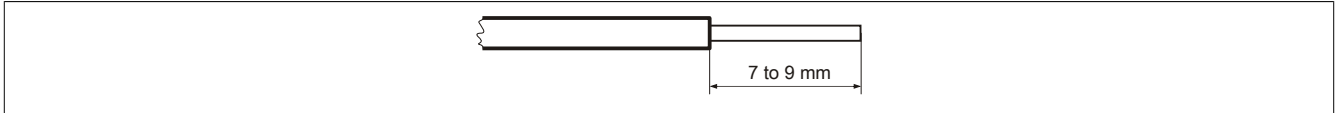


Figure 370: Wire stripping length for a secure connection

Information:

The wire stripping length is not permitted to be more or less than 7 to 9 mm.

9.33.5.6 Cable holding force of contacts

To ensure secure contact of a cable with the terminal block, it is not permitted to be subjected to too much tension. If the cable holding force is exceeded, the cable will disconnect from the terminal block and result in a malfunction.

| Cable in mm ² | Fine-stranded wires | | | Solid wires | | | | With wire end sleeves | |
|--|---------------------|-----|-----|-------------|------|-----|-----|-----------------------|-----|
| | 0.25 | 1.5 | 2.5 | 0.08 | 0.25 | 1.5 | 2.5 | 0.25 | 1.5 |
| Standard specification (min. value in newtons) | 12.5 | 40 | 50 | 4 | 12.5 | 40 | 50 | 12.5 | 40 |

Information:

Fine-stranded wires must be twisted in order to maintain the cable holding forces.

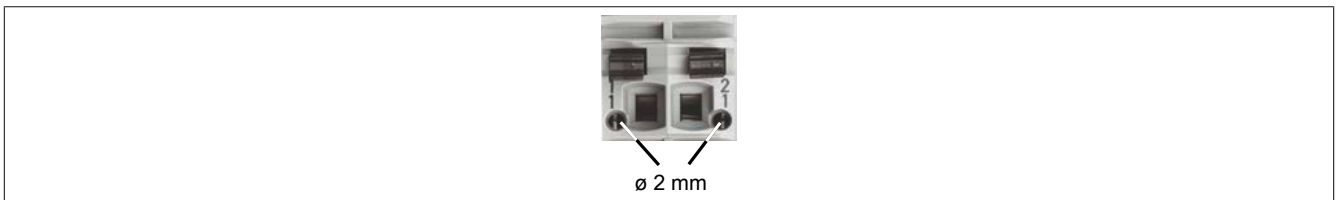
Use of wire end sleeves

In order to achieve an optimal cable holding force, the following points must be observed:

- Square crimping with the roughest possible surface should be carried out.
- The end of the wire end sleeve should not be cut in order to avoid a reduction of the cross section.
- No wires should protrude at the end of the sleeve.
- The wire end sleeve must be inserted completely to the end.
- The length of the wire end sleeve corresponds to the [wire stripping length](#).

9.33.5.7 Access for test probes

Each contact is equipped with an additional opening for using a test probe.



10 Additional information

10.1 Diagnostic LEDs


LEDs for diagnostics are located at the top of most X20 I/O modules. The following LEDs are available depending on the module to indicate the operating state:

- LEDs "r" (green) and "e" (red)
- LED "s" (red/green) LED

Additional LEDs are module-specific and usually indicate the state of I/O channels. Green LEDs are usually used for inputs, while orange LEDs are usually used for outputs. These I/O LED status indicators are only operational in mode RUN on some modules.

Operating states and error states

The following table provides a complete description of all operating states and error states for X20 I/O modules. The operating state and error state actually indicated by the I/O module depends on the type of module as well as how it is being used.

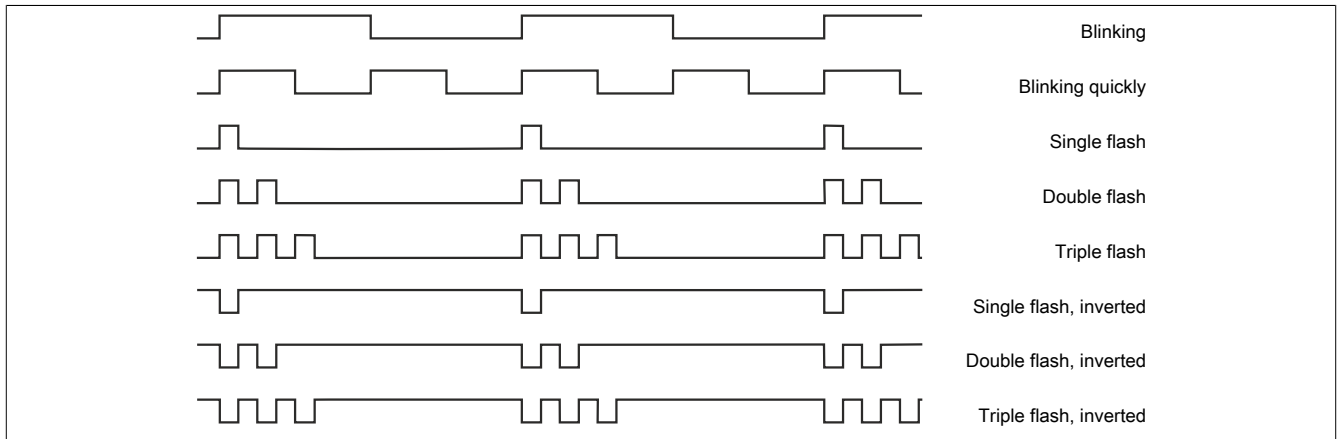
| | LED | Description | Note | |
|--|---|--|--|--|
|  | All LEDs off | No power to module | The module does not have power. | |
| | Module status: Green LED | | | |
| | Single flash (red LED = Off) | Mode RESET | No connection to the X2X Link master, or the X2X Link master is not yet running. Some modules remain in single flash mode during a firmware update. | |
| | | Not configured | The module was connected behind bus receiver X20BR7300, but it is not configured. ²⁾ | |
| | Single flash (red LED = On) | Invalid firmware | Invalid firmware: Occurs when a firmware update has been interrupted. The firmware is reloaded as soon as the X2X Link master is active again. It is only loaded if the module is also entered in the configuration, however. | |
| | Double flash | BOOT mode (mode RESET with communication) | Firmware update. A firmware update usually only takes place once after the module has been replaced or if new firmware has been loaded to the master CPU during a project update. Depending on the configuration, a firmware update can take several minutes. | |
| | | Not configured | The module was connected behind bus receiver X20BR7300, but it is not configured. ²⁾ | |
| | Blinking | Mode PREOPERATIONAL | Modules whose slot is configured for a different module (or none at all) remain in mode PREOPERATIONAL. Possible errors: <ul style="list-style-type: none"> • Incorrect module connected or slot not configured • Incorrect slot number for bus modules with node number switches | |
| | Blinking quickly | Mode SYNC | Module synchronizing with X2X Link network | |
| | On | Mode RUN | No error | |
| | Error status: Red LED (green LED = On) | | | |
| | Off | | Everything OK | |
| | On | Fatal error | It is not possible for the module to continue functioning correctly. Possible errors: <ul style="list-style-type: none"> • Power supply outside warning range • Operating temperature outside permissible range Monitoring for fatal errors is not integrated into all modules. | |
| | Single flash or blinking | I/O channel error | An error or warning is present on one or more I/O channels. Which channel error on the module is being indicated depends on the module and can be determined with the respective module description. | |
| | Double flash | System errors | A system error occurred in the module. The cause of error depends on the module and can be determined with the respective module description. | |
| | Triple flash | I/O error and system error | An I/O error and system error occurred at the same time. | |
| | Single flash, inverted ¹⁾ | Fatal error and I/O error | A fatal error and I/O error occurred at the same time. | |
| | Double flash, inverted ¹⁾ | Fatal error and system error | A fatal error and system error occurred at the same time. | |
| Triple flash, inverted ¹⁾ | Fatal error, I/O error and system error | A fatal error, I/O error and system error occurred at the same time. | | |

1) Only on modules that monitor for fatal errors.

2) The blinking behavior (single or double flash) depends on the X20 module being used.

LED status indicators - Blinking patterns

The blinking patterns shown in this image specify only the principle ratio between the switch-on and switch-off time for the LED. The actual ratio of blink times to each other can vary depending on the module.



10.2 Using I/O modules on the bus controller

If an I/O module is used after a bus controller, the X2X module registers and functions that can be used depend on the bus controller used.

- **Non-configurable bus controllers**

By default, "Function model 254 - Bus controller" is used here. This includes:

- **CAN I/O bus controllers:** X20BC0073, X67BC7321, X67BC7321-1
- **DeviceNet bus controllers:** X20BC0053, X67BC5321

- **PROFIBUS bus controllers**

Only the X2X module registers listed in the PROFIBUS user's manual can be used for the supported modules. The PROFIBUS user's manual can be downloaded from the B&R website.

- **PROFINET bus controllers**

Only the X2X module registers listed in the GSDML file can be used for the supported modules. This file can be downloaded from the B&R website. The PDF document included in the GSDML package lists all available X2X module registers.

- **Using the automatic configuration**

With all other bus controllers, "Function model 254 - Bus controller" is used by default when using the automatic configuration.

- **Fully configurable bus controllers**

When operating an I/O module on a fully configurable bus controller (e.g. X20BC0043-10), all available functions and registers of the respective I/O module can be used. In this case, "Function model 0 - Standard" is used as the default setting when adding X2X modules in Automation Studio.

If additional function models are available in the I/O module (e.g. "Function model OSP" for digital output modules), they can also be used as long as it makes sense to use them with the bus controller. Full configurations for CANopen, Modbus, EtherCAT, EtherNet/IP and POWERLINK can be made with Automation Studio V4.3 or later.

Information:

Automation Studio can be downloaded at no cost from the B&R website (www.br-automation.com). The evaluation license is permitted to be used to create complete configurations for fieldbus bus controllers at no cost.

Overview of possible configuration types

| | CANopen | EtherNet/IP | PROFIBUS | OPC UA | EtherCAT |
|-------------------------|--|-------------------------------|--|---------------------------------------|----------------------------|
| | X20BC0043-10 X20BC0143-10 X67BC4321-10 X67BC4321.L08-10 X67BC4321.L12-10 | X20(c)BC0088 X67BCD321.L12 | X20BC0063 X67BC6321 X67BC6321.L08 X67BC6321.L12 | X20BC008U | X20BC00G3 X67BCG321.L12 |
| Automatic configuration | • | • | | • | • |
| Full configuration | • | • | • | • | • |
| | Modbus | PROFINET | DeviceNet | CAN I/O | POWERLINK |
| | X20(c)BC0087 X20BC0087-10 X67BCJ321 X67BCJ321.L12 | X20(c)BC00E3 X67BCE321.L12 | X20BC0053 X67BC5321 | X20BC0073 X67BC7321 X67BC7321-1 | X20BC0083 |
| Automatic configuration | • | | • | • | • |
| Full configuration | • | • | | | • |

10.3 General data points

In addition to the registers listed in the register description, X20 modules also have other more general data points. These registers are not specific to the module but contain general information such as serial number and hardware version.

10.3.1 FirmwareVersion

Name:

FirmwareVersion

The firmware version of the module can be read using this data point.

The last two positions correspond to the number after the decimal point.

Example: 345 corresponds to 3.45.

| Data type | Values | Information |
|-----------|----------------|---|
| UINT | 1 to 99 | Release version of older modules or developmental versions of new modules |
| | 100 to 29999 | Release version |
| | 30000 to 59999 | Test version |

10.3.2 HardwareVariant

Name:

HardwareVariant

The hardware variant of the module can be read using this data point.

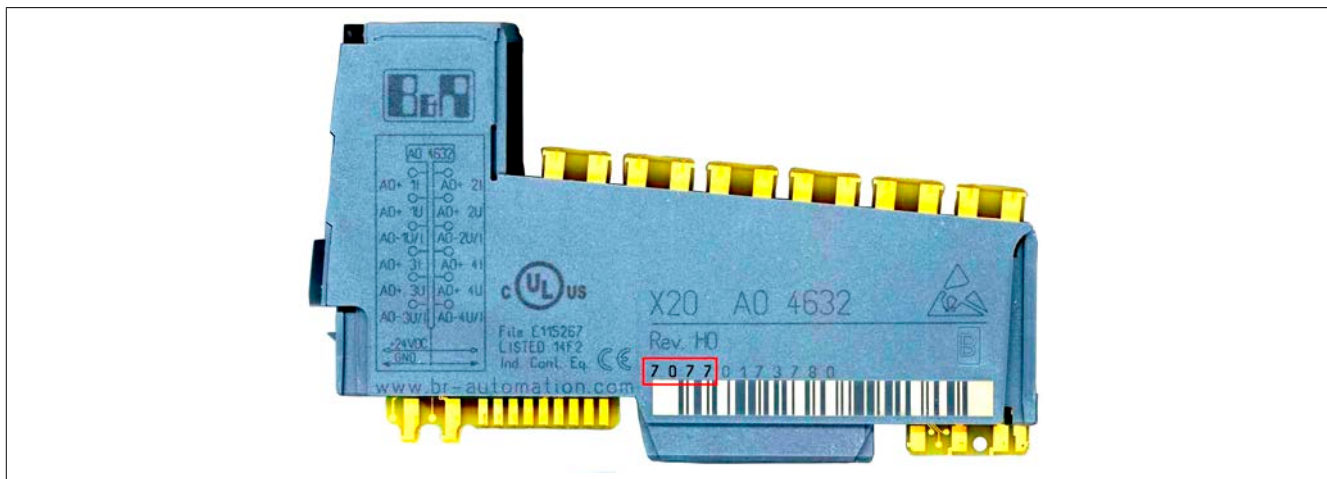
| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

10.3.3 ModuleID

Name:

ModuleID

The module ID of the module can be read using this data point. For the module hardware ID, see the respective module documentation. In addition, a serial number is printed on each electronics module; the module hardware ID corresponds to the first four positions of the serial number. (See figure: Hardware ID is also colored black.)



| Data type | Values |
|-----------|-------------|
| UINT | 0 to 65,535 |

Information:

IDs starting with 9999 are printed as hexadecimal numbers and must be converted to their decimal values for comparison!

10.3.4 SerialNumber

Name:
SerialNumber

The module's unique serial number can be read using this data point.

The complete serial number is made up of **ModuleID** and **SerialNumber** as follows: Serial number = (Hardware ID * 1E+7) + SerialNumber

The serial number is printed in decimal form on the module's housing.

Example

Hardware ID = (decimal) 1213

Serial number = (decimal) 671339

Serial number = 1213 * 10000000 + 671339 = 12130671339

| Data type | Values |
|-----------|--------------------|
| UDINT | 0 to 4,294,967,295 |

10.3.5 ModuleOK

Name:
ModuleOK

Whether the module is physically present in the slot or not can be read from this register.

| Data type | Value | Information |
|-----------|-------|---------------------------------|
| BOOL | 0 | Module not ready for operation |
| | 1 | Module connected and configured |

10.3.6 StaleData

Name:
StaleData

Whether the transferred data originates from the current cycle or a previous cycle can be read using this data point.

This error can result from cycle times that are too short or disturbances in module communication, for example.

Information:

This data point is only valid if **ModuleOK = 1**.

| Data type | Value | Information |
|-----------|-------|--|
| BOOL | 0 | Data originates from the current cycle |
| | 1 | Data does not originate from the current cycle |

10.4 General CPU data points

Although X20 CPUs do not normally have a register description, they do have several general data points. These are not CPU-specific; instead, they contain general information such as system time and heat sink temperature.

Information:

Some data points and data types are CPU-specific. Not every X20 CPU provides all data points.

10.4.1 BatteryStatusCPU

Name:

BatteryStatusCPU

The state of the battery contained in the CPU can be read from this data point.

| Data type | Values | Information |
|-----------|--------|--|
| USINT | 0 | Battery voltage too low or battery missing |
| | 1 | Battery OK |

10.4.2 ModeSwitch

Name:

ModeSwitch

The operating mode of the CPU can be read from this data point.

| Data type | Values | Information |
|-----------|---------|-------------------------|
| USINT | 0 | Mode BOOT ¹⁾ |
| | 1 to 2 | Reserved ²⁾ |
| | 4 | Mode RUN |
| | 3 to 14 | Reserved ²⁾ |
| | 15 | Mode DIAG ¹⁾ |

1) Value cannot be read since data points can only be evaluated in mode RUN.

2) Currently also used for mode RUN.

10.4.3 StatusInput01

Name:

StatusInput01

The state of the supply voltage can be read from this data point.

| Data type | Values | Information |
|-----------|--------|------------------------------------|
| BOOL | 0 | Supply voltage OK |
| | 1 | Supply voltage outside valid range |

10.4.4 SystemTime

Name:

SystemTime

The starting time of a specific task class in μ s can be read from this data point. The system time is latched at the beginning of the cycle of the task class that contains this data point.

Information:

Because the DINT counter overflows and resets approximately every 70 minutes, it is only possible to read out the relative system time.

| Data type | Values |
|-----------|---------------------------------|
| DINT | -2,147,483,648 to 2,147,483,647 |

10.4.5 TemperatureCPU

Name:

TemperatureCPU

The internal temperature of the CPU can be read from this data point. The data type depends on the CPU family:

- UINT: Older CPU families (e.g. X20CPx48x), temperature range starts at 0°C
- INT: Newer CPU families (e.g. X20CPx58X, Compact-S CPUs), temperature range starts at -20°C.

| Data type | Values | Information |
|-----------|-----------------|-----------------------|
| UINT | 0 to 65535 | Temperature in 1/10°C |
| INT | -32768 to 32767 | |

10.4.6 TemperatureENV

Name:

TemperatureENV

The temperature of the CPU heat sink can be read from this data point. The data type depends on the CPU family:

- UINT: Older CPU families (e.g. X20CPx48x), temperature range starts at 0°C
- INT: Newer CPU families (e.g. X20CPx58X, Compact-S CPUs), temperature range starts at -20°C.

| Data type | Values | Information |
|-----------|-----------------|-----------------------|
| UINT | 0 to 65535 | Temperature in 1/10°C |
| INT | -32768 to 32767 | |

10.4.7 SupplyVoltage

Name:

SupplyVoltage

This register indicates the bus supply voltage measured at a resolution of 0.1 V.

| Data type | Values | Information |
|-----------|----------|-------------------|
| USINT | 0 to 255 | Voltage in 1/10 V |

10.4.8 SupplyCurrent

Name:

SupplyCurrent

This register displays the bus power supply current measured at a resolution of 0.1 A.

| Data type | Values | Information |
|-----------|----------|-------------------|
| USINT | 0 to 255 | Current in 1/10 A |

10.5 Blackout mode

Blackout mode allows users to continue execution of the application in lower-level subsystems if components of the B&R system fail. In this way, the B&R system – independently of redundancy technology – makes it possible to respond to system-critical situations based on the specific application.

The use of blackout-capable modules is recommended for the following requirements:

- Exit routines on system failure, e.g. to enable the opening of a press if the system fails.
- Stopping or controlled setting of an output on system failure, e.g. to automatically close inflow valves.
- Deceleration sequences on system failure, e.g. to reduce motor speeds before transmitting a stop command.

If blackout-capable modules are configured accordingly, blackout mode will be carried out if the network connection to the higher-level controller or CPU is interrupted.

As soon as the network disturbance has been corrected, blackout mode is stopped by the modules and bumpless synchronization with the network takes place.

Requirements for operation

The following requirements must be met in order to use blackout mode:

- The module being used must support blackout mode.
- Parameter "Blackout mode" must be enabled in Automation Studio.

10.5.1 Areas of use

Through the use of blackout-capable modules, a part of the control system can also remain functional if a disturbance in the network or X2X Link connection between the modules occurs.

10.5.1.1 Loss of POWERLINK connection

Initial situation

Several stations in an application are connected to the CPU via network cables. A fault occurs that interrupts data transfer between the CPU and stations.

Effect

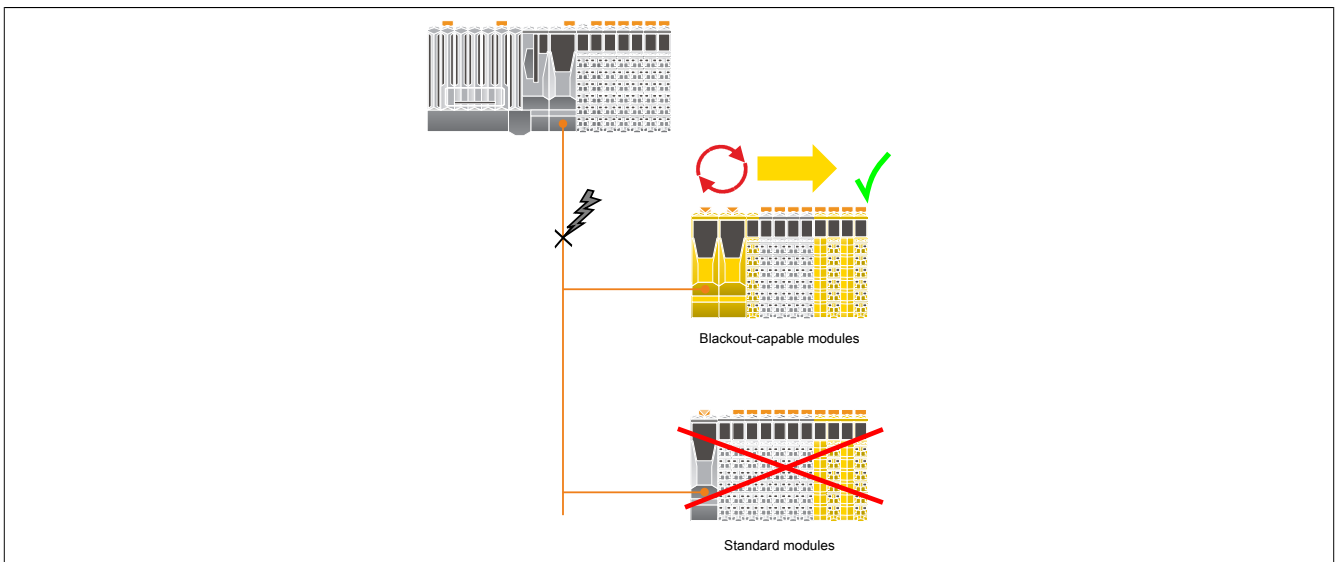
Non-blackout modules are reset and operated according to their default characteristics.

Blackout-capable modules show the following behavior:

- The programmed function continues to be executed.
- Subordinate networks continue to work.
- Data from the CPU is initialized with "0".
- After the disturbance has been corrected, the module bumplessly returns to the higher-level network.

Warning!

Blackout mode causes data from the CPU to be initialized with "0". If blackout mode is used in combination with "output inversion", this can lead to the unwanted setting of outputs.



10.5.1.2 Loss of X2X Link connection

Initial situation

Modules in an application are connected to the network via X2X Link cables. A defect in the X2X Link cable causes the data transfer between the CPU and modules to be interrupted.

Effect

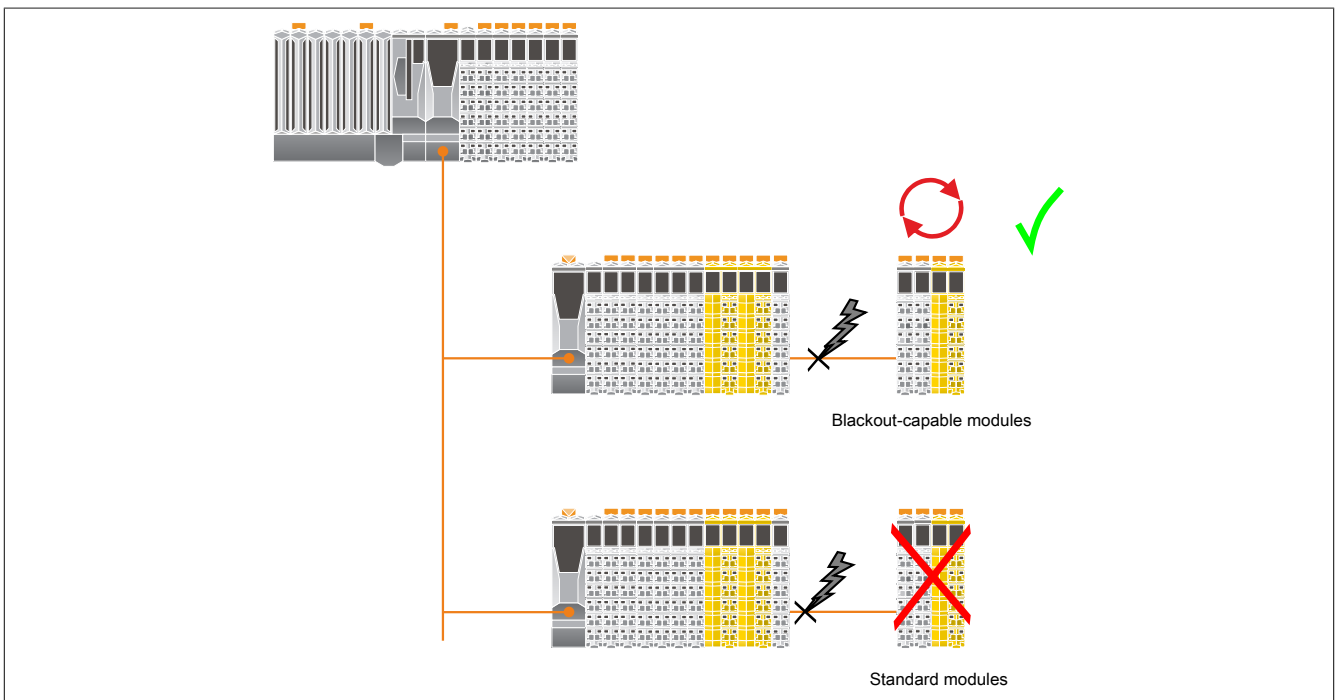
Non-blackout modules are reset and operated according to their default characteristics.

Blackout-capable modules show the following behavior:

- The programmed function continues to be executed.
- Subordinate networks continue to work.
- Data from the CPU is initialized with "0".
- After the disturbance has been corrected, the module bumplessly returns to the higher-level network.

Warning!

Blackout mode causes data from the CPU to be initialized with "0". If blackout mode is used in combination with "output inversion", this can lead to the unwanted setting of outputs.



10.5.2 Programming blackout mode

Blackout mode cannot be detected by the blackout-capable modules themselves. If it is necessary to program specific blackout behavior in an application, an indirect method must therefore be chosen.

One possibility is to implement a counter in the blackout-capable module's higher-level CPU and query it cyclically. Blackout mode would make itself noticeable in this case by a counter value that no longer changes or a counter value of zero.

Blackout-capable modules can be divided into 2 categories:

- **Programmable modules**
The blackout function is programmed using existing function blocks. In other words, the existing technologies for application programming or reACTION Technology are used.
The blackout function is executed largely independently of other system components.
- **Standard function modules**
These modules are not programmable and maintain their default behavior in blackout mode.

10.5.3 Standalone function

The standalone function is an extension of blackout mode. After switching on the power supply, blackout mode is enabled immediately regardless of whether a network connection exists. This means that after switching on the power supply, the module begins executing the most recently saved configuration or application without waiting for activity or synchronization with a higher-level CPU or SafeLOGIC controller.

As soon as the network is active, bumpless synchronization between the module and existing network takes place.

Warning!

Standalone modules act identically to blackout mode on system startup and until the network connection is established. Their use therefore requires extreme caution!

Requirements for operation

The following requirements must be met in order to use the standalone function:

- The module being used must support the standalone function.
- Parameter "Standalone mode" must be enabled in Automation Studio.
- For the standalone function on the bus controller (e.g. X20SL8101), blackout mode is enabled for at least 1 module on the local X2X Link network.
- The module must have been operated with a CPU at least once in order to have a valid configuration.

Information:

The use of the standalone function in connection with DNA is not permitted. Static addresses must be used.

Warning!

The following aspects need to be taken into account in particular:

- **The module must be clearly (and permanently) identified to highlight its distinctive behavior from the standard.**
- **Service technicians must be well-versed with the special characteristics of these modules.**
- **Before connecting the terminal block to a module with an enabled standalone function, at least one of the following conditions must be met:**
 - **It must be ensured that the module is really meant to be operated with the standalone function and the configuration on the module has been checked for correctness.**
 - **The flashing sequence of the module indicates the "normal, network-connected operational state" of the module.**

10.5.3.1 Area of application

Initial situation

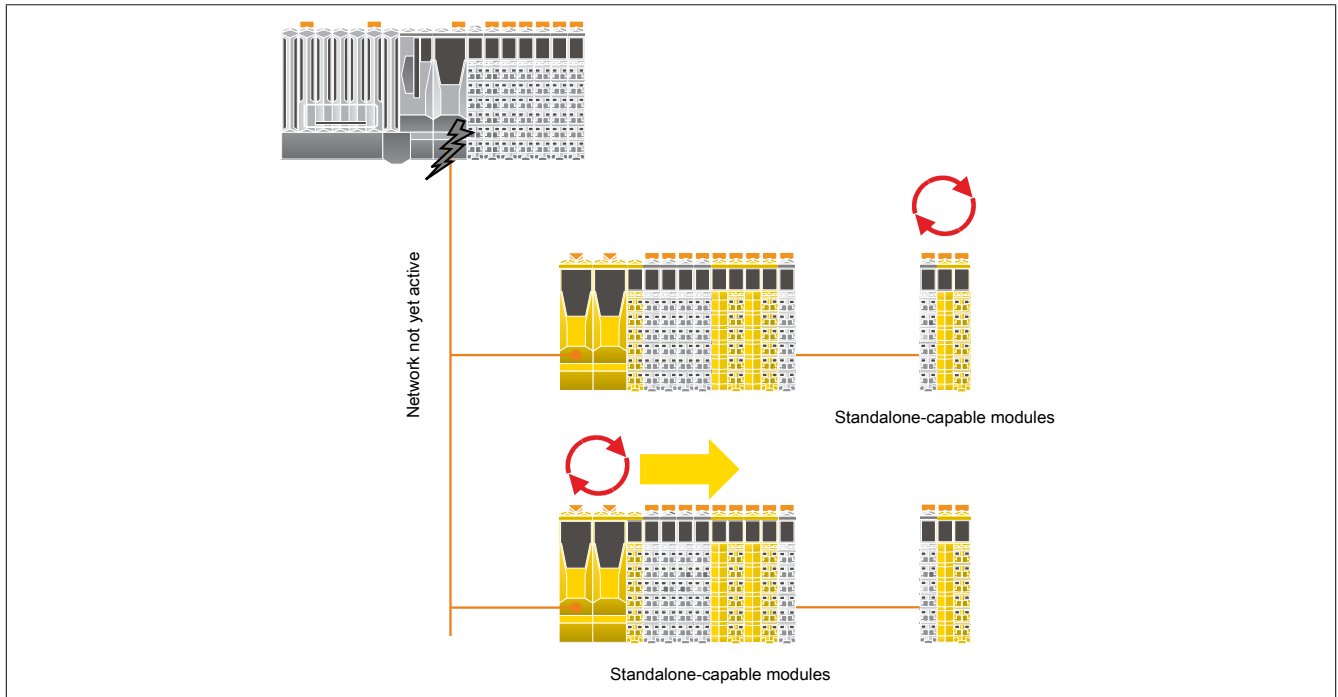
Several stations in an application are connected to the CPU via network cables. After the entire system has been switched off and on, a fault results in the network connection not being established.

Effect

Non-standalone modules are put into the active state only after the application starts up.

Standalone-capable modules show the following behavior:

- The boot procedure is started without waiting on a higher-level network.
- The module behaves identically to blackout mode.
- As soon as the network becomes active, it is bumplessly added to the higher-level network.



10.6 NetTime Technology

NetTime refers to the ability to precisely synchronize and transfer system times between individual components of the controller or network (CPU, I/O modules, X2X Link, POWERLINK, etc.).

This allows the moment that events occur to be determined system-wide with microsecond precision. Upcoming events can also be executed precisely at a specified moment.



10.6.1 Time information

Various time information is available in the controller or on the network:

- System time (on the PLC, Automation PC, etc.)
- X2X Link time (for each X2X Link network)
- POWERLINK time (for each POWERLINK network)
- Time data points of I/O modules

The NetTime is based on 32-bit counters, which are increased with microsecond resolution. The sign of the time information changes after 35 min, 47 s, 483 ms and 648 μ s; an overflow occurs after 71 min, 34 s, 967 ms and 296 μ s.

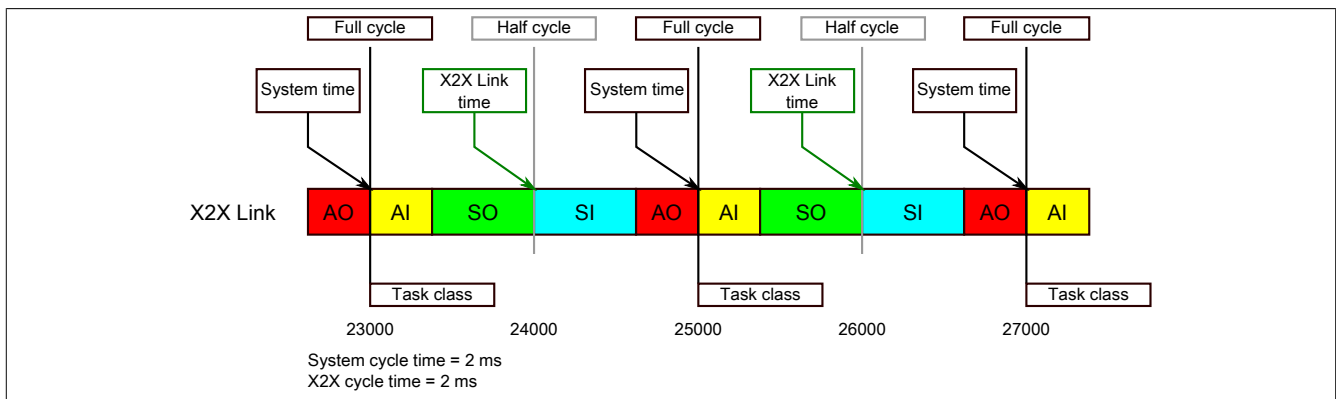
The initialization of the times is based on the system time during the startup of the X2X Link, the I/O modules or the POWERLINK interface.

Current time information in the application can also be determined via library AsIOTime.

10.6.1.1 PLC/Controller data points

The NetTime I/O data points of the PLC or the controller are latched to each system clock and made available.

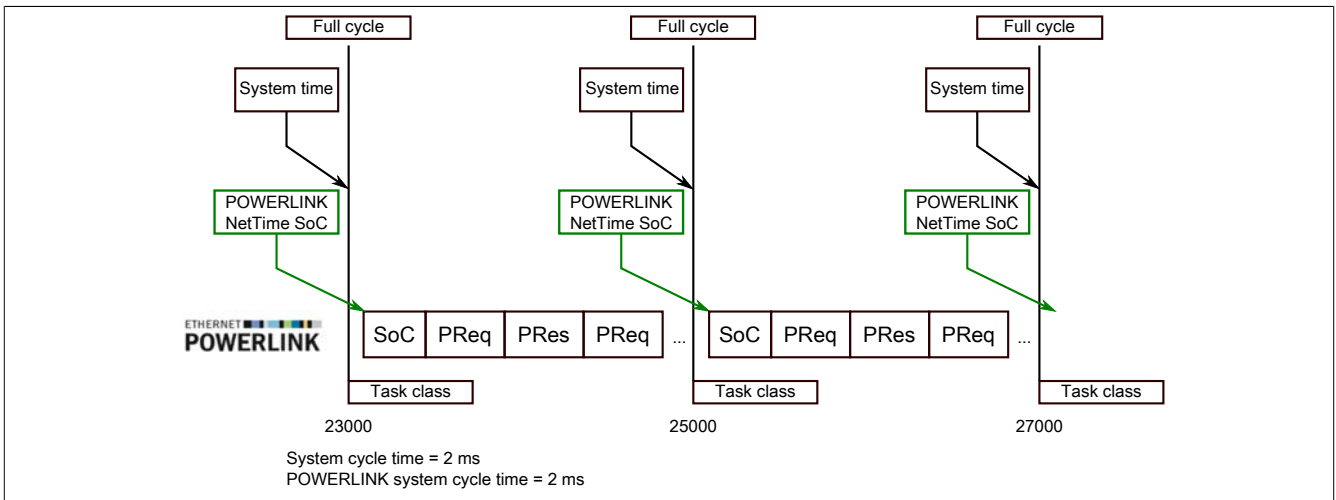
10.6.1.2 X2X Link reference moment



The reference moment on the X2X Link network is always calculated at the half cycle of the X2X Link cycle. This results in a difference between the system time and the X2X Link reference moment when the reference time is read out.

In the example above, this results in a difference of 1 ms, i.e. if the system time and X2X Link reference moment are compared at time 25000 in the task, then the system time returns the value 25000 and the X2X Link reference moment returns the value 24000.

10.6.1.3 POWERLINK reference moment

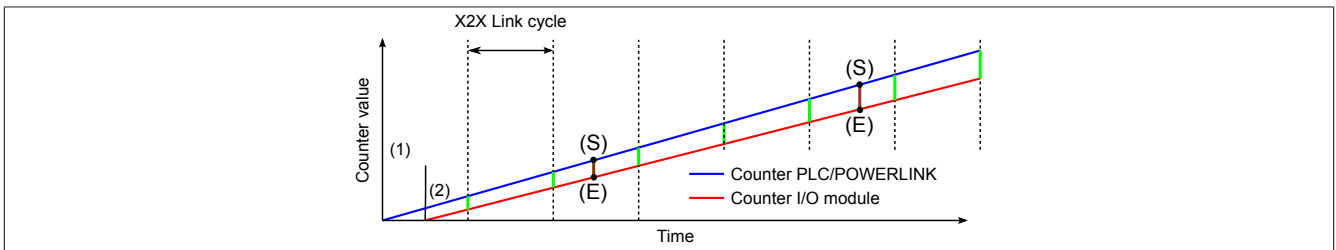


The reference moment on the POWERLINK network is always calculated at the start of cycle (SoC) of the POWERLINK network. The SoC starts 20 µs after the system tick. This results in the following difference between the system time and the POWERLINK reference time:

$$\text{POWERLINK reference time} = \text{System time} - \text{POWERLINK cycle time} + 20 \mu\text{s}.$$

In the example above, this means a difference of 1980 µs, i.e. if the system time and POWERLINK reference moment are compared at time 25000 in the task, then the system time returns the value 25000 and the POWERLINK reference moment returns the value 23020.

10.6.1.4 Synchronization of system time/POWERLINK time and I/O module



At startup, the internal counters for the PLC/POWERLINK (1) and the I/O module (2) start at different times and increase the values with microsecond resolution.

At the beginning of each X2X Link cycle, the PLC or the POWERLINK network sends time information to the I/O module. The I/O module compares this time information with the module's internal time and forms a difference (green line) between the two times and stores it.

When a NetTime event (E) occurs, the internal module time is read out and corrected with the stored difference value (brown line). This means that the exact system moment (S) of an event can always be determined, even if the counters are not absolutely synchronous.

Note

The deviation from the clock signal is strongly exaggerated in the picture as a red line.

10.6.2 Timestamp functions

NetTime-capable modules provide various timestamp functions depending on the scope of functions. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise moment, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

For details, see the respective module documentation.

10.6.2.1 Time-based inputs

NetTime Technology can be used to determine the exact moment of a rising edge at an input. The rising and falling edges can also be detected and the duration between 2 events can be determined.

Information:

The determined moment always lies in the past.

10.6.2.2 Time-based outputs

NetTime Technology can be used to specify the exact moment of a rising edge on an output. The rising and falling edges can also be specified and a pulse pattern generated from them.

Information:

The specified time must always be in the future, and the set X2X Link cycle time must be taken into account for the definition of the moment.

10.6.2.3 Time-based measurements

NetTime Technology can be used to determine the exact moment of a measurement that has taken place. Both the starting and end moment of the measurement can be transmitted.

10.7 Flatstream communication

10.7.1 Introduction

B&R offers an additional communication method for some modules. "Flatstream" was designed for X2X and POWERLINK networks and allows data transmission to be adapted to individual demands. Although this method is not 100% real-time capable, it still allows data transfer to be handled more efficiently than with standard cyclic polling.

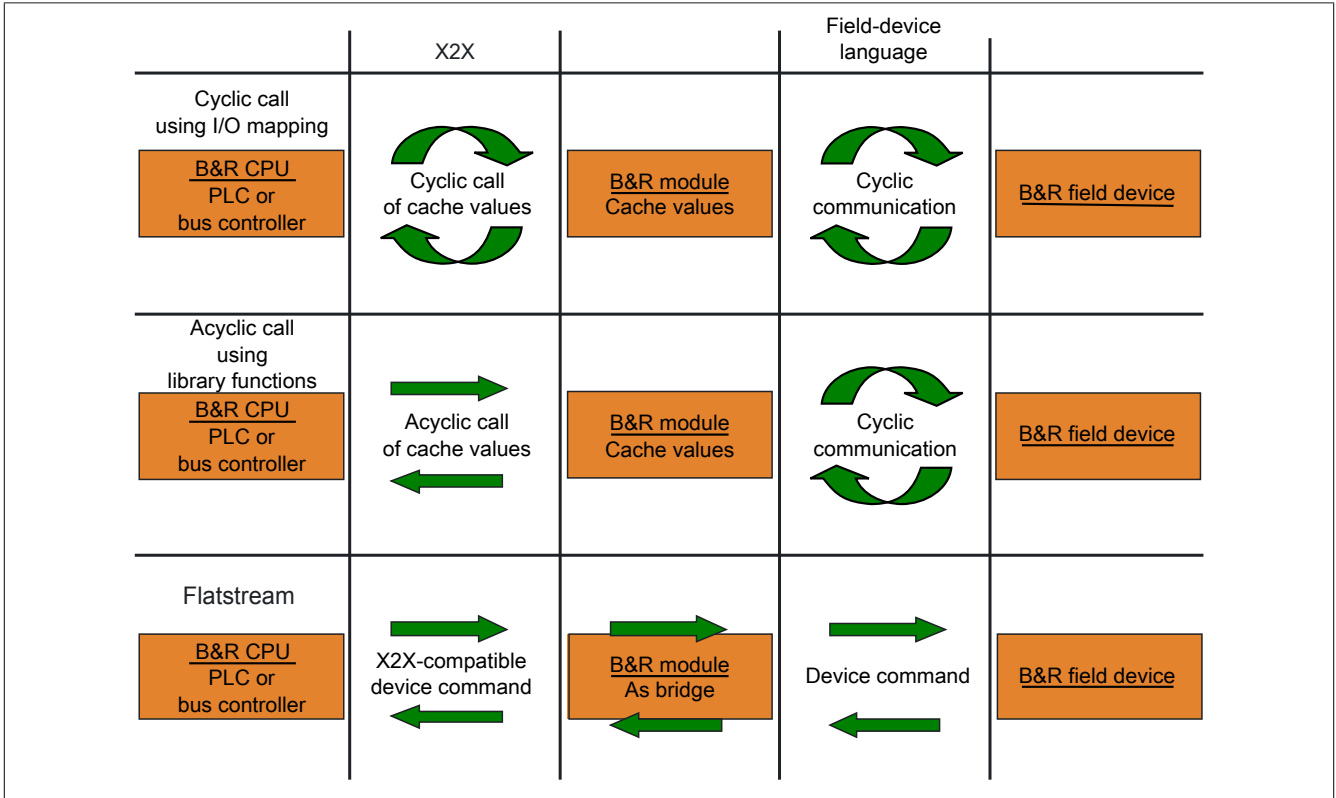


Figure 371: 3 types of communication

Flatstream extends cyclic and acyclic data queries. With Flatstream communication, the module acts as a bridge. The module is used to pass CPU queries directly on to the field device.

10.7.2 Message, segment, sequence, MTU

The physical properties of the bus system limit the amount of data that can be transmitted during one bus cycle. With Flatstream communication, all messages are viewed as part of a continuous data stream. Long data streams must be broken down into several fragments that are sent one after the other. To understand how the receiver puts these fragments back together to get the original information, it is important to understand the difference between a message, a segment, a sequence and an MTU.

Message

A message refers to information exchanged between 2 communicating partner stations. The length of a message is not restricted by the Flatstream communication method. Nevertheless, module-specific limitations must be considered.

Segment (logical division of a message):

A segment has a finite size and can be understood as a section of a message. The number of segments per message is arbitrary. So that the recipient can correctly reassemble the transferred segments, each segment is preceded by a byte with additional information. This control byte contains information such as the length of a segment and whether the approaching segment completes the message. This makes it possible for the receiving station to interpret the incoming data stream correctly.

Sequence (how a segment must be arranged physically):

The maximum size of a sequence corresponds to the number of enabled Rx or Tx bytes (later: "MTU"). The transmitting station splits the transmit array into valid sequences. These sequences are then written successively to the MTU and transferred to the receiving station where they are put back together again. The receiver stores the incoming sequences in a receive array, obtaining an image of the data stream in the process.

With Flatstream communication, the number of sequences sent are counted. Successfully transferred sequences must be acknowledged by the receiving station to ensure the integrity of the transfer.

MTU (Maximum Transmission Unit) - Physical transport:

MTU refers to the enabled USINT registers used with Flatstream. These registers can accept at least one sequence and transfer it to the receiving station. A separate MTU is defined for each direction of communication. OutputMTU defines the number of Flatstream Tx bytes, and InputMTU specifies the number of Flatstream Rx bytes. The MTUs are transported cyclically via the X2X Link network, increasing the load with each additional enabled USINT register.

Properties

Flatstream messages are not transferred cyclically or in 100% real time. Many bus cycles may be needed to transfer a particular message. Although the Rx and Tx registers are exchanged between the transmitter and the receiver cyclically, they are only processed further if explicitly accepted by register "InputSequence" or "OutputSequence".

Behavior in the event of an error (brief summary)

The protocol for X2X and POWERLINK networks specifies that the last valid values should be retained when disturbances occur. With conventional communication (cyclic/acyclic data queries), this type of error can generally be ignored.

In order for communication to also take place without errors using Flatstream, all of the sequences issued by the receiver must be acknowledged. If Forward functionality is not used, then subsequent communication is delayed for the length of the disturbance.

If Forward functionality is being used, the receiving station receives a transmission counter that is incremented twice. The receiver stops, i.e. it no longer returns any acknowledgments. The transmitting station uses SequenceAck to determine that the transmission was faulty and that all affected sequences must be repeated.

10.7.3 The Flatstream principle

Requirement

Before Flatstream can be used, the respective communication direction must be synchronized, i.e. both communication partners cyclically query the sequence counter on the opposite station. This checks to see if there is new data that should be accepted.

Communication

If a communication partner wants to transmit a message to its opposite station, it should first create a transmit array that corresponds to Flatstream conventions. This allows the Flatstream data to be organized very efficiently without having to block other important resources.

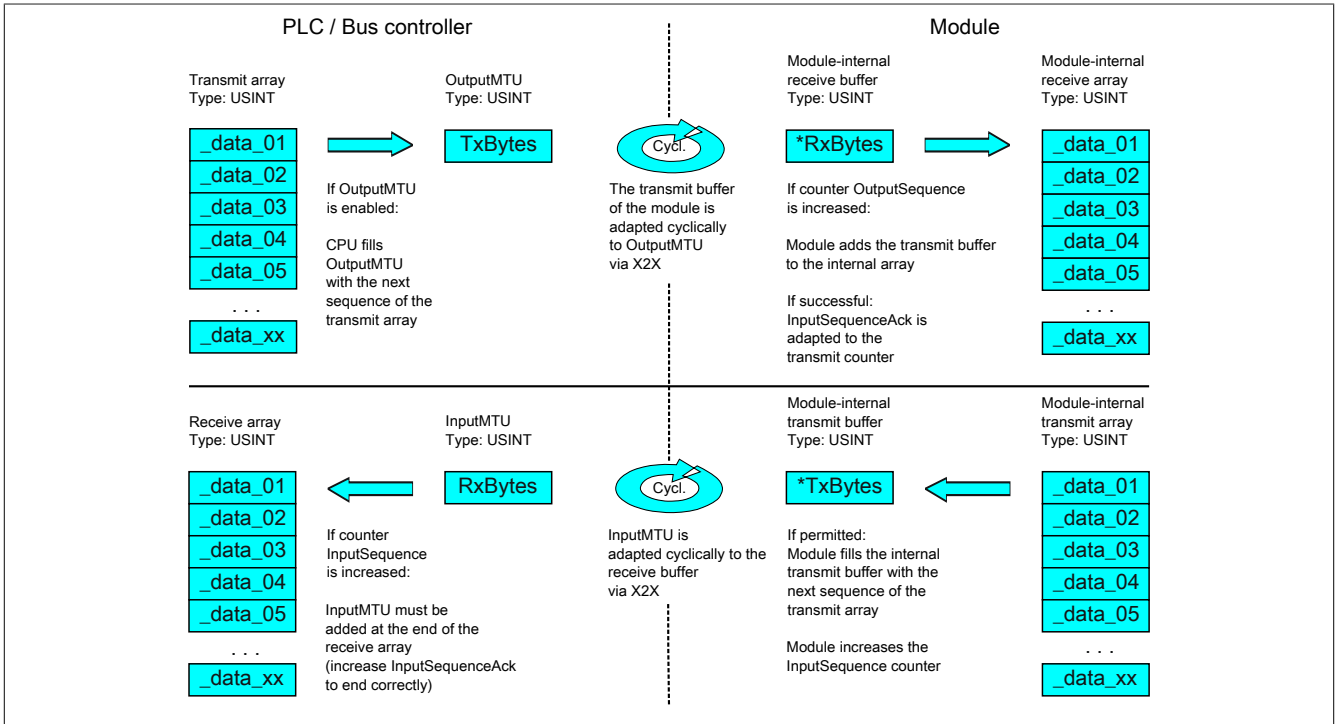


Figure 372: Flatstream communication

Procedure

The first thing that happens is that the message is broken into valid segments of up to 63 bytes, and the corresponding control bytes are created. The data is formed into a data stream made up of one control bytes per associated segment. This data stream can be written to the transmit array. The maximum size of each array element matches that of the enabled MTU so that one element corresponds to one sequence.

If the array has been completely created, the transmitter checks whether the MTU is permitted to be refilled. It then copies the first element of the array or the first sequence to the Tx byte registers. The MTU is transported to the receiver station via X2X Link and stored in the corresponding Rx byte registers. To signal that the data should be accepted by the receiver, the transmitter increases its SequenceCounter.

If the communication direction is synchronized, the opposite station detects the incremented SequenceCounter. The current sequence is appended to the receive array and acknowledged by SequenceAck. This acknowledgment signals to the transmitter that the MTU can now be refilled.

If the transfer is successful, the data in the receive array will correspond 100% to the data in the transmit array. During the transfer, the receiving station must detect and evaluate the incoming control bytes. A separate receive array should be created for each message. This allows the receiver to immediately begin further processing of messages once they have been completely transferred.

10.7.4 Registers for Flatstream mode

5 registers are available for configuring Flatstream. The default configuration can be used to transmit small amounts of data relatively easily.

Information:

The CPU communicates directly with the field device via registers "OutputSequence" and "InputSequence" as well as the enabled Tx and Rx bytes. For this reason, the user needs to have sufficient knowledge of the communication protocol being used on the field device.

10.7.4.1 Flatstream configuration

To use Flatstream, the program sequence must first be expanded. The cycle time of the Flatstream routines must be set to a multiple of the bus cycle. Other program routines should be implemented in Cyclic #1 to ensure data consistency.

At the absolute minimum, registers "InputMTU" and "OutputMTU" must be set. All other registers are filled in with default values at the beginning and can be used immediately. These registers are used for additional options, e.g. to transfer data in a more compact way or to increase the efficiency of the general procedure.

The Forward registers extend the functionality of the Flatstream protocol. This functionality is useful for substantially increasing the Flatstream data rate, but it also requires quite a bit of extra work when creating the program sequence.

10.7.4.1.1 Number of enabled Tx and Rx bytes

Name:

OutputMTU

InputMTU

These registers define the number of enabled Tx or Rx bytes and thus also the maximum size of a sequence. The user must consider that the more bytes made available also means a higher load on the bus system.

Information:

In the rest of this description, the names "OutputMTU" and "InputMTU" do not refer to the registers explained here. Instead, they are used as synonyms for the currently enabled Tx or Rx bytes.

| Data type | Values |
|-----------|---|
| USINT | See the module-specific register overview (theoretically: 3 to 27). |

10.7.4.2 Flatstream operation

When using Flatstream, the communication direction is very important. For transmitting data to a module (output direction), Tx bytes are used. For receiving data from a module (input direction), Rx bytes are used.

Registers "OutputSequence" and "InputSequence" are used to control and ensure that communication is taking place properly, i.e. the transmitter issues the directive that the data should be accepted and the receiver acknowledges that a sequence has been transferred successfully.

10.7.4.2.1 Format of input and output bytes

Name:

"Format of Flatstream" in Automation Studio

On some modules, this function can be used to set how the Flatstream input and output bytes (Tx or Rx bytes) are transferred.

- **Packed:** Data is transferred as an array.
- **Byte-by-byte:** Data is transferred as individual bytes.

10.7.4.2.2 Transport of payload data and control bytes

Name:

TxByte1 to TxByteN

RxByte1 to RxByteN

(The value the number N is different depending on the bus controller model used.)

The Tx and Rx bytes are cyclic registers used to transport the payload data and the necessary control bytes. The number of active Tx and Rx bytes is taken from the configuration of registers "OutputMTU" and "InputMTU", respectively.

In the user program, only the Tx and Rx bytes from the CPU can be used. The corresponding counterparts are located in the module and are not accessible to the user. For this reason, the names were chosen from the point of view of the CPU.

- "T" - "Transmit" →CPU *transmits* data to the module.
- "R" - "Receive" →CPU *receives* data from the module.

| Data type | Values |
|-----------|----------|
| USINT | 0 to 255 |

10.7.4.2.3 Control bytes

In addition to the payload data, the Tx and Rx bytes also transfer the necessary control bytes. These control bytes contain additional information about the data stream so that the receiver can reconstruct the original message from the transferred segments.

Bit structure of a control byte

| Bit | Description | Value | Information |
|-------|---------------|--------|--|
| 0 - 5 | SegmentLength | 0 - 63 | Size of the subsequent segment in bytes (default: Max. MTU size - 1) |
| 6 | nextCBPos | 0 | Next control byte at the beginning of the next MTU |
| | | 1 | Next control byte directly after the end of the current segment |
| 7 | MessageEndBit | 0 | Message continues after the subsequent segment |
| | | 1 | Message ended by the subsequent segment |

SegmentLength

The segment length lets the receiver know the length of the coming segment. If the set segment length is insufficient for a message, then the information must be distributed over several segments. In these cases, the actual end of the message is detected using bit 7 of the control byte.

Information:

The control byte is not included in the calculation to determine the segment length. The segment length is only derived from the bytes of payload data.

nextCBPos

This bit indicates the position where the next control byte is to be expected. This information is especially important when using option "MultiSegmentMTU".

When using Flatstream communication with multi-segment MTUs, the next control byte is no longer expected in the first Rx byte of the subsequent MTU, but transferred directly after the current segment.

MessageEndBit

"MessageEndBit" is set if the subsequent segment completes a message. The message has then been completely transferred and is ready for further processing.

Information:

In the output direction, this bit must also be set if one individual segment is enough to hold the entire message. The module will only process a message internally if this identifier is detected.

The size of the message being transferred can be calculated by adding all of the message's segment lengths together.

Flatstream formula for calculating message length:

| | | |
|---|----|---------------|
| Message [bytes] = Segment lengths (all CBs without ME) + Segment length (of the first CB with ME) | CB | Control byte |
| | ME | MessageEndBit |

10.7.4.2.4 Communication status of the CPU

Name:

OutputSequence

Register "OutputSequence" contains information about the communication status of the CPU. It is written by the CPU and read by the module.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------------|-------|--|
| 0 - 2 | OutputSequenceCounter | 0 - 7 | Counter for the sequences issued in the output direction |
| 3 | OutputSyncBit | 0 | Output direction disabled |
| | | 1 | Output direction enabled |
| 4 - 6 | InputSequenceAck | 0 - 7 | Mirrors InputSequenceCounter |
| 7 | InputSyncAck | 0 | Input direction not ready (disabled) |
| | | 1 | Input direction ready (enabled) |

OutputSequenceCounter

The OutputSequenceCounter is a continuous counter of sequences that have been issued by the CPU. The CPU uses OutputSequenceCounter to direct the module to accept a sequence (the output direction must be synchronized when this happens).

OutputSyncBit

The CPU uses OutputSyncBit to attempt to synchronize the output channel.

InputSequenceAck

InputSequenceAck is used for acknowledgment. The value of InputSequenceCounter is mirrored if the CPU has received a sequence successfully.

InputSyncAck

The InputSyncAck bit acknowledges the synchronization of the input channel for the module. This indicates that the CPU is ready to receive data.

10.7.4.2.5 Communication status of the module

Name:

InputSequence

Register "InputSequence" contains information about the communication status of the module. It is written by the module and should only be read by the CPU.

| Data type | Values |
|-----------|------------------------|
| USINT | See the bit structure. |

Bit structure:

| Bit | Description | Value | Information |
|-------|----------------------|-------|---|
| 0 - 2 | InputSequenceCounter | 0 - 7 | Counter for sequences issued in the input direction |
| 3 | InputSyncBit | 0 | Not ready (disabled) |
| | | 1 | Ready (enabled) |
| 4 - 6 | OutputSequenceAck | 0 - 7 | Mirrors OutputSequenceCounter |
| 7 | OutputSyncAck | 0 | Not ready (disabled) |
| | | 1 | Ready (enabled) |

InputSequenceCounter

The InputSequenceCounter is a continuous counter of sequences that have been issued by the module. The module uses InputSequenceCounter to direct the CPU to accept a sequence (the input direction must be synchronized when this happens).

InputSyncBit

The module uses InputSyncBit to attempt to synchronize the input channel.

OutputSequenceAck

OutputSequenceAck is used for acknowledgment. The value of OutputSequenceCounter is mirrored if the module has received a sequence successfully.

OutputSyncAck

The OutputSyncAck bit acknowledges the synchronization of the output channel for the CPU. This indicates that the module is ready to receive data.

10.7.4.2.6 Relationship between OutputSequence and InputSequence

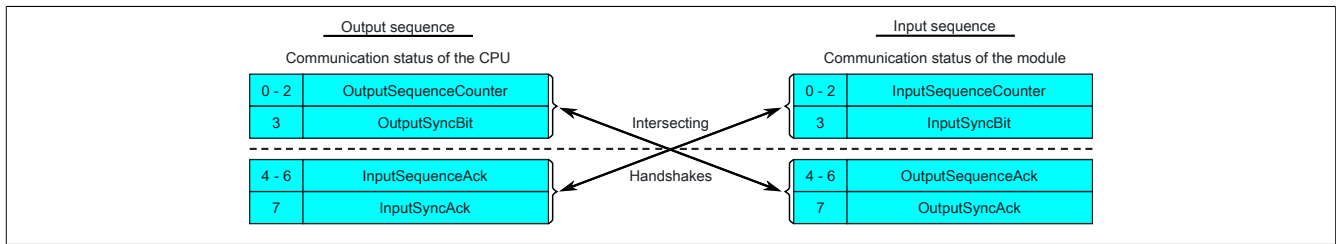


Figure 373: Relationship between OutputSequence and InputSequence

Registers "OutputSequence" and "InputSequence" are logically composed of 2 half-bytes. The low part signals to the opposite station whether a channel should be opened or if data should be accepted. The high part is to acknowledge that the requested action was carried out.

SyncBit and SyncAck

If SyncBit and SyncAck are set in one communication direction, then the channel is considered "synchronized", i.e. it is possible to send messages in this direction. The status bit of the opposite station must be checked cyclically. If SyncAck has been reset, then SyncBit on that station must be adjusted. Before new data can be transferred, the channel must be resynchronized.

SequenceCounter and SequenceAck

The communication partners cyclically check whether the low nibble on the opposite station changes. When one of the communication partners finishes writing a new sequence to the MTU, it increments its SequenceCounter. The current sequence is then transmitted to the receiver, which acknowledges its receipt with SequenceAck. In this way, a "handshake" is initiated.

Information:

If communication is interrupted, segments from the unfinished message are discarded. All messages that were transferred completely are processed.

10.7.4.3 Synchronization

During synchronization, a communication channel is opened. It is important to make sure that a module is present and that the current value of SequenceCounter is stored on the station receiving the message.

Flatstream can handle full-duplex communication. This means that both channels / communication directions can be handled separately. They must be synchronized independently so that simplex communication can theoretically be carried out as well.

Synchronization in the output direction (CPU as the transmitter):

The corresponding synchronization bits (OutputSyncBit and OutputSyncAck) are reset. Because of this, Flatstream cannot be used at this point in time to transfer messages from the CPU to the module.

Algorithm

| |
|--|
| 1) The CPU must write 000 to OutputSequenceCounter and reset OutputSyncBit. The CPU must cyclically query the high nibble of register "InputSequence" (checks for 000 in OutputSequenceAck and 0 in OutputSyncAck). |
| <i>The module does not accept the current contents of InputMTU since the channel is not yet synchronized.</i> <i>The module matches OutputSequenceAck and OutputSyncAck to the values of OutputSequenceCounter and OutputSyncBit.</i> |
| 2) If the CPU registers the expected values in OutputSequenceAck and OutputSyncAck, it is permitted to increment OutputSequenceCounter. The CPU continues cyclically querying the high nibble of register "OutputSequence" (checks for 001 in OutputSequenceAck and 0 in InputSyncAck). |
| <i>The module does not accept the current contents of InputMTU since the channel is not yet synchronized.</i> <i>The module matches OutputSequenceAck and OutputSyncAck to the values of OutputSequenceCounter and OutputSyncBit.</i> |
| 3) If the CPU registers the expected values in OutputSequenceAck and OutputSyncAck, it is permitted to increment OutputSequenceCounter. The CPU continues cyclically querying the high nibble of register "OutputSequence" (checks for 001 in OutputSequenceAck and 1 in InputSyncAck). |
| Note: Theoretically, data can be transferred from this point forward. However, it is still recommended to wait until the output direction is completely synchronized before transferring data. |
| <i>The module sets OutputSyncAck.</i> |
| The output direction is synchronized, and the CPU can transmit data to the module. |

Synchronization in the input direction (CPU as the receiver):

The corresponding synchronization bits (InputSyncBit and InputSyncAck) are reset. Because of this, Flatstream cannot be used at this point in time to transfer messages from the module to the CPU.

Algorithm

| |
|---|
| <i>The module writes 000 to InputSequenceCounter and resets InputSyncBit.</i> <i>The module monitors the high nibble of register "OutputSequence" and expects 000 in InputSequenceAck and 0 in InputSyncAck.</i> |
| 1) The CPU is not permitted to accept the current contents of InputMTU since the channel is not yet synchronized. The CPU has to match InputSequenceAck and InputSyncAck to the values of InputSequenceCounter and InputSyncBit. |
| <i>If the module registers the expected values in InputSequenceAck and InputSyncAck, it increments InputSequenceCounter.</i> <i>The module monitors the high nibble of register "OutputSequence" and expects 001 in InputSequenceAck and 0 in InputSyncAck.</i> |
| 2) The CPU is not permitted to accept the current contents of InputMTU since the channel is not yet synchronized. The CPU has to match InputSequenceAck and InputSyncAck to the values of InputSequenceCounter and InputSyncBit. |
| <i>If the module registers the expected values in InputSequenceAck and InputSyncAck, it sets InputSyncBit.</i> <i>The module monitors the high nibble of register "OutputSequence" and expects 1 in InputSyncAck.</i> |
| 3) The CPU is permitted to set InputSyncAck. |
| Note: Theoretically, data could already be transferred in this cycle. If InputSyncBit is set and InputSequenceCounter has been increased by 1, the values in the enabled Rx bytes must be accepted and acknowledged (see also "Communication in the input direction"). |
| The input direction is synchronized, and the module can transmit data to the CPU. |

10.7.4.4 Transmitting and receiving

If a channel is synchronized, then the opposite station is ready to receive messages from the transmitter. Before the transmitter can send data, it needs to first create a transmit array in order to meet Flatstream requirements.

The transmitting station must also generate a control byte for each segment created. This control byte contains information about how the subsequent part of the data being transferred should be processed. The position of the next control byte in the data stream can vary. For this reason, it must be clearly defined at all times when a new control byte is being transmitted. The first control byte is always in the first byte of the first sequence. All subsequent positions are determined recursively.

Flatstream formula for calculating the position of the next control byte:

$$\text{Position (of the next control byte)} = \text{Current position} + 1 + \text{Segment length}$$

Example

3 autonomous messages (7 bytes, 2 bytes and 9 bytes) are being transmitted using an MTU with a width of 7 bytes. The rest of the configuration corresponds to the default settings.

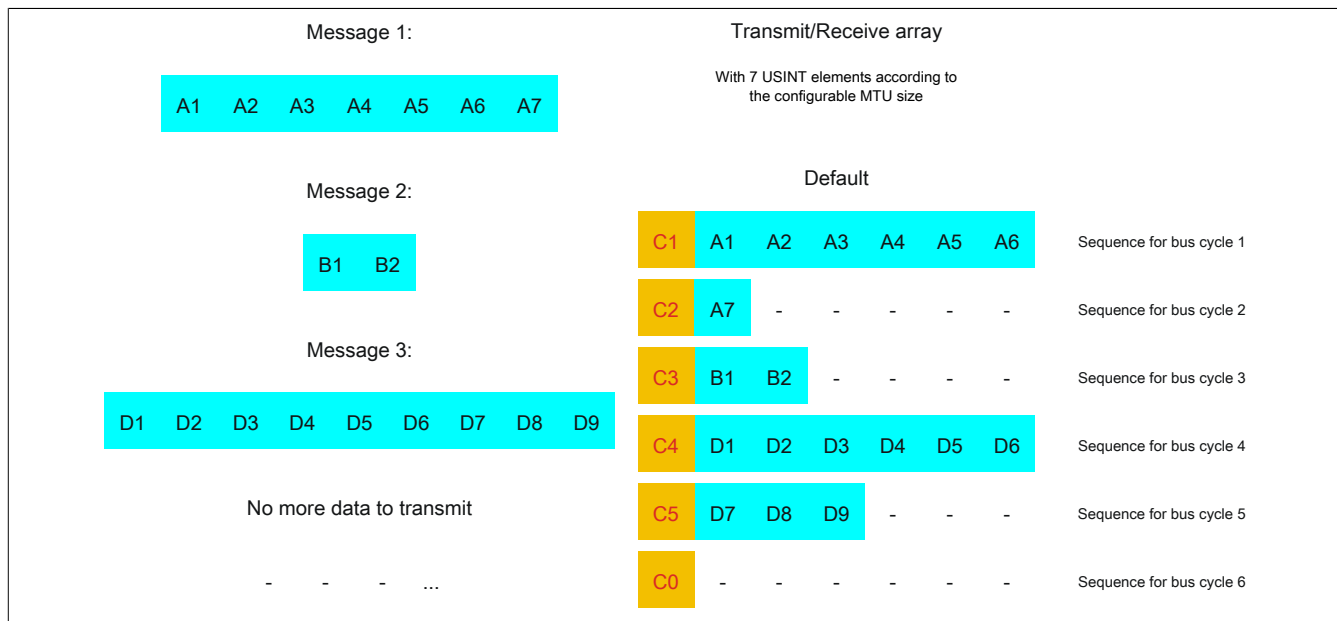


Figure 374: Transmit/Receive array (default)

Additional information

First, the messages must be split into segments. In the default configuration, it is important to ensure that each sequence can hold an entire segment, including the associated control byte. The sequence is limited to the size of the enable MTU. In other words, a segment must be at least 1 byte smaller than the MTU.

MTU = 7 bytes → Max. segment length = 6 bytes

- Message 1 (7 bytes)
 - ⇒ First segment = Control byte + 6 bytes of data
 - ⇒ Second segment = Control byte + 1 data byte
- Message 2 (2 bytes)
 - ⇒ First segment = Control byte + 2 bytes of data
- Message 3 (9 bytes)
 - ⇒ First segment = Control byte + 6 bytes of data
 - ⇒ Second segment = Control byte + 3 data bytes
- No more messages
 - ⇒ C0 control byte

A unique control byte must be generated for each segment. In addition, the C0 control byte is generated to keep communication on standby.

| C0 (control byte 0) | | C1 (control byte 1) | | C2 (control byte 2) | |
|---------------------|-----|---------------------|-----|---------------------|-------|
| - SegmentLength (0) | = 0 | - SegmentLength (6) | = 6 | - SegmentLength (1) | = 1 |
| - nextCBPos (0) | = 0 | - nextCBPos (0) | = 0 | - nextCBPos (0) | = 0 |
| - MessageEndBit (0) | = 0 | - MessageEndBit (0) | = 0 | - MessageEndBit (1) | = 128 |
| Control byte | Σ 0 | Control byte | Σ 6 | Control byte | Σ 129 |

Table 663: Flatstream determination of the control bytes for the default configuration example (part 1)

| C3 (control byte 3) | | C4 (control byte 4) | | C5 (control byte 5) | |
|---------------------|-------|---------------------|-----|---------------------|-------|
| - SegmentLength (2) | = 2 | - SegmentLength (6) | = 6 | - SegmentLength (3) | = 3 |
| - nextCBPos (0) | = 0 | - nextCBPos (0) | = 0 | - nextCBPos (0) | = 0 |
| - MessageEndBit (1) | = 128 | - MessageEndBit (0) | = 0 | - MessageEndBit (1) | = 128 |
| Control byte | Σ 130 | Control byte | Σ 6 | Control byte | Σ 131 |

Table 664: Flatstream determination of the control bytes for the default configuration example (part 2)

10.7.4.5 Transmitting data to a module (output)

When transmitting data, the transmit array must be generated in the application program. Sequences are then transferred one by one using Flatstream and received by the module.

Information:

Although all B&R modules with Flatstream communication always support the most compact transfers in the output direction, it is recommended to use the same design for the transfer arrays in both communication directions.

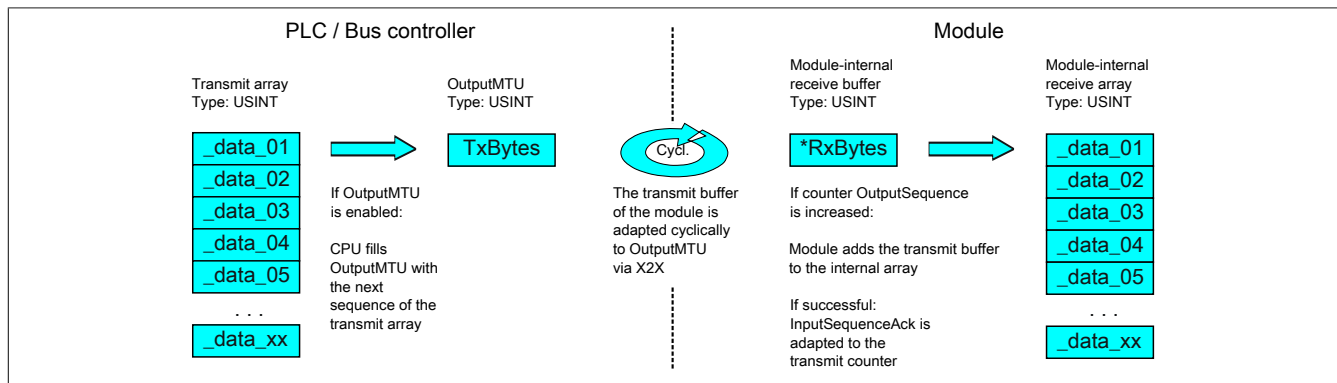


Figure 375: Flatstream communication (output)

Message smaller than OutputMTU

The length of the message is initially smaller than OutputMTU. In this case, one sequence would be sufficient to transfer the entire message and the necessary control byte.

Algorithm

| |
|---|
| <p><i>Cyclic status query:</i></p> <ul style="list-style-type: none"> - The module monitors <i>OutputSequenceCounter</i>. |
| <p>0) Cyclic checks:</p> <ul style="list-style-type: none"> - The CPU must check <i>OutputSyncAck</i>. → If <i>OutputSyncAck</i> = 0: Reset <i>OutputSyncBit</i> and resynchronize the channel. - The CPU must check whether <i>OutputMTU</i> is enabled. → If <i>OutputSequenceCounter</i> > <i>InputSequenceAck</i>: <i>MTU</i> is not enabled because the last sequence has not yet been acknowledged. |
| <p>1) Preparation (create transmit array):</p> <ul style="list-style-type: none"> - The CPU must split up the message into valid segments and create the necessary control bytes. - The CPU must add the segments and control bytes to the transmit array. |
| <p>2) Transmit:</p> <ul style="list-style-type: none"> - The CPU transfers the current element of the transmit array to <i>OutputMTU</i>. → The <i>OutputMTU</i> is transferred cyclically to the module's transmit buffer but not processed further. - The CPU must increase <i>OutputSequenceCounter</i>. |
| <p><i>Reaction:</i></p> <ul style="list-style-type: none"> - The module accepts the bytes from the internal receive buffer and adds them to the internal receive array. - The module transmits acknowledgment and writes the value of <i>OutputSequenceCounter</i> to <i>OutputSequenceAck</i>. |
| <p>3) Completion:</p> <ul style="list-style-type: none"> - The CPU must monitor <i>OutputSequenceAck</i>. → A sequence is only considered to have been transferred successfully if it has been acknowledged via <i>OutputSequenceAck</i>. In order to detect potential transfer errors in the last sequence as well, it is important to make sure that the length of the <i>Completion</i> phase is run through long enough. |
| <p>Note:</p> <p>To monitor communication times exactly, the task cycles that have passed since the last increase of <i>OutputSequenceCounter</i> should be counted. In this way, the number of previous bus cycles necessary for the transfer can be measured. If the monitoring counter exceeds a predefined threshold, then the sequence can be considered lost.</p> <p>(The relationship of bus to task cycle can be influenced by the user so that the threshold value must be determined individually.)</p> <ul style="list-style-type: none"> - Subsequent sequences are only permitted to be transmitted in the next bus cycle after the completion check has been carried out successfully. |

Message larger than OutputMTU

The transmit array, which must be created in the program sequence, consists of several elements. The user has to arrange the control and data bytes correctly and transfer the array elements one after the other. The transfer algorithm remains the same and is repeated starting at the point *Cyclic checks*.

General flow chart

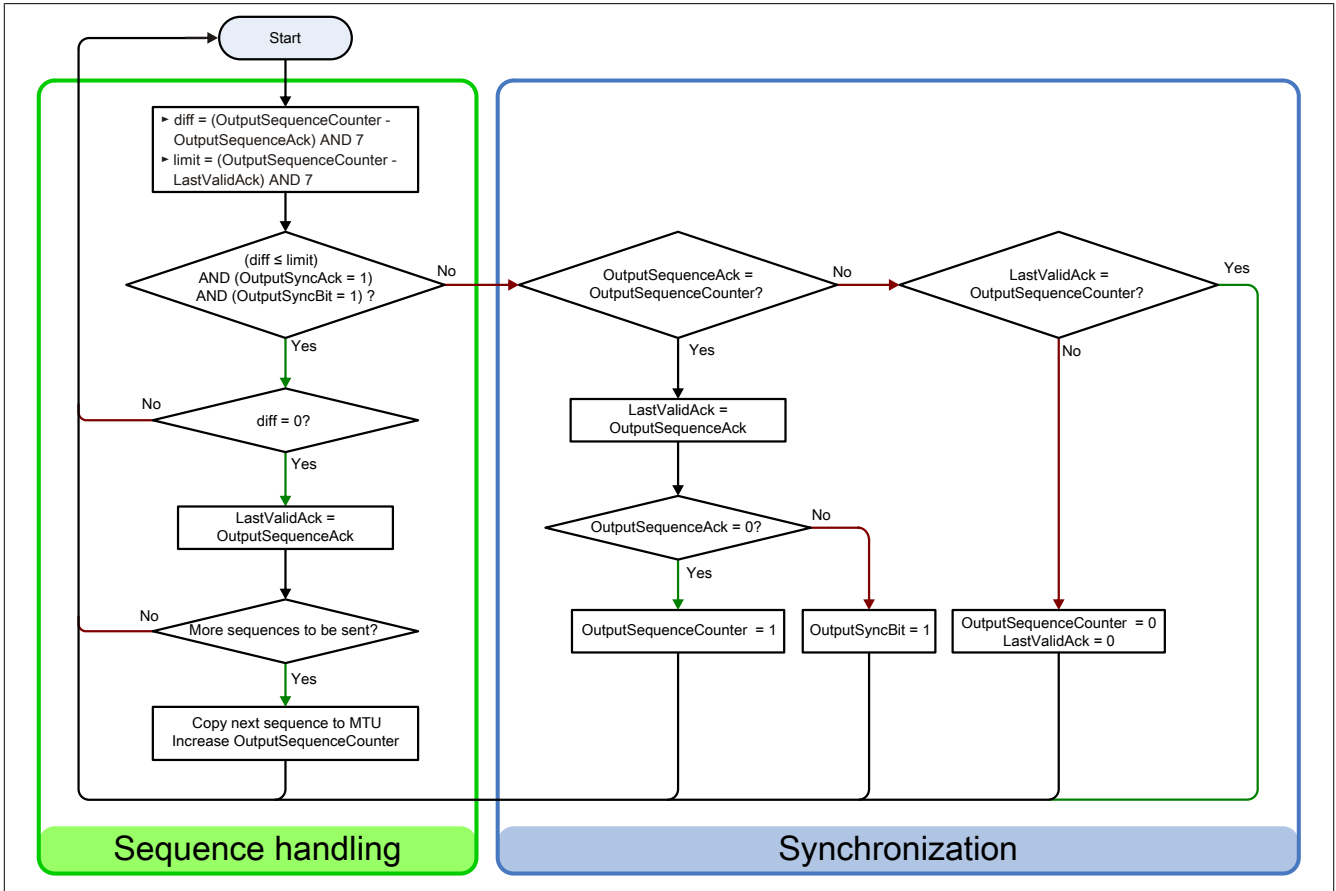


Figure 376: Flow chart for the output direction

10.7.4.6 Receiving data from a module (input)

When receiving data, the transmit array is generated by the module, transferred via Flatstream and must then be reproduced in the receive array. The structure of the incoming data stream can be set with the mode register. The algorithm for receiving the data does not change in this regard.

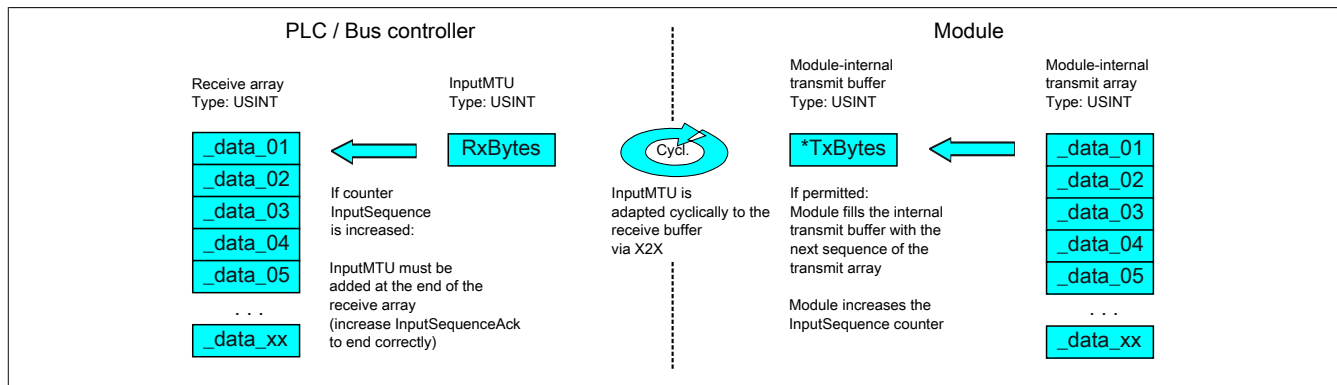


Figure 377: Flatstream communication (input)

Algorithm

| |
|--|
| <p>0) Cyclic status query:</p> <ul style="list-style-type: none"> - The CPU must monitor <code>InputSequenceCounter</code>. |
| <p><i>Cyclic checks:</i></p> <ul style="list-style-type: none"> - The module checks <code>InputSyncAck</code>. - The module checks <code>InputSequenceAck</code>. |
| <p><i>Preparation:</i></p> <ul style="list-style-type: none"> - The module forms the segments and control bytes and creates the transmit array. |
| <p><i>Action:</i></p> <ul style="list-style-type: none"> - The module transfers the current element of the internal transmit array to the internal transmit buffer. - The module increases <code>InputSequenceCounter</code>. |
| <p>1) Receiving (as soon as <code>InputSequenceCounter</code> is increased):</p> <ul style="list-style-type: none"> - The CPU must apply data from <code>InputMTU</code> and append it to the end of the receive array. - The CPU must match <code>InputSequenceAck</code> to <code>InputSequenceCounter</code> of the sequence currently being processed. |
| <p><i>Completion:</i></p> <ul style="list-style-type: none"> - The module monitors <code>InputSequenceAck</code>. <p>→ A sequence is only considered to have been transferred successfully if it has been acknowledged via <code>InputSequenceAck</code>.</p> <ul style="list-style-type: none"> - Subsequent sequences are only transmitted in the next bus cycle after the completion check has been carried out successfully. |

General flow chart

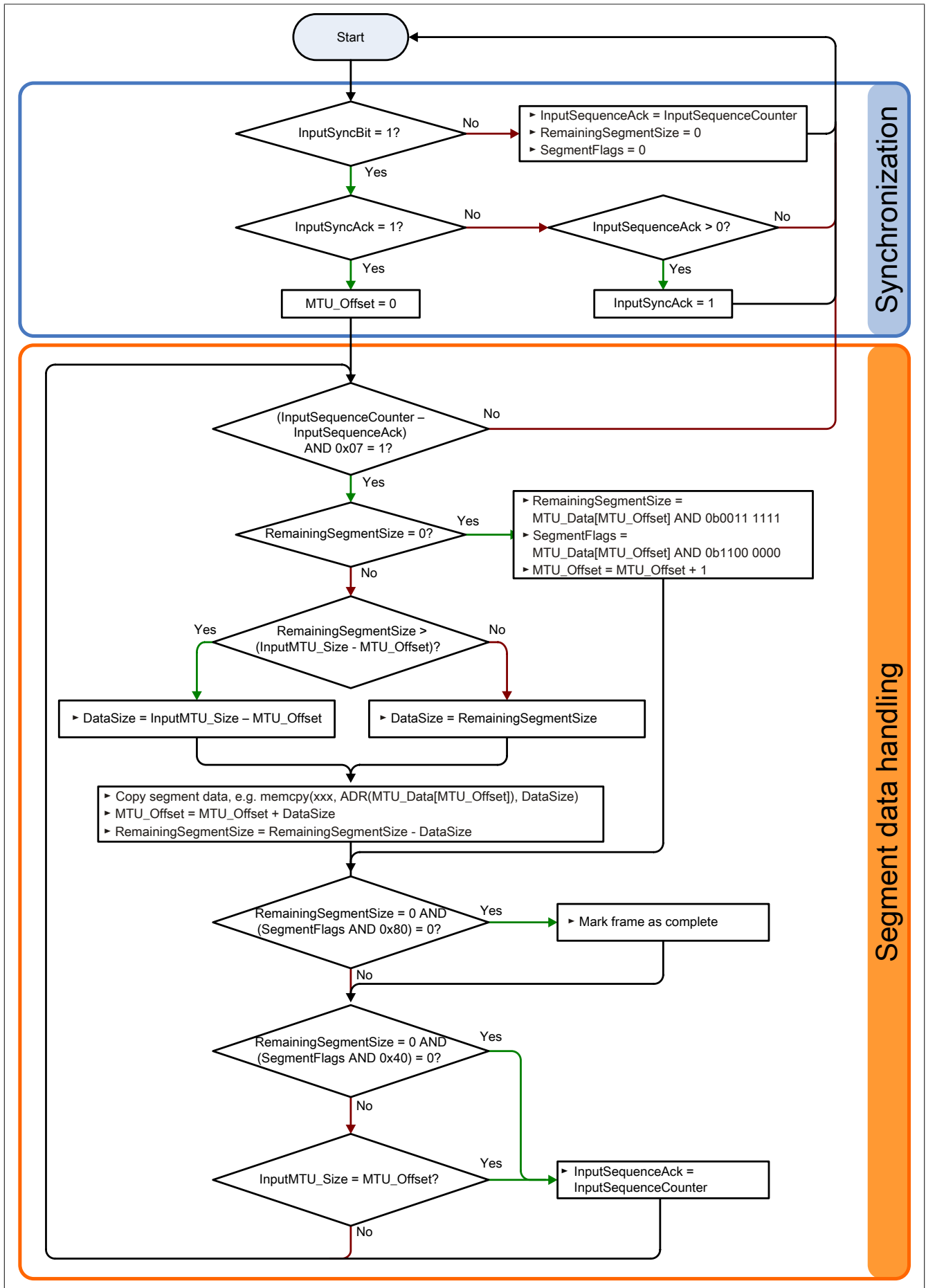


Figure 378: Flow chart for the input direction

10.7.4.7 Details

It is recommended to store transferred messages in separate receive arrays.

After a set MessageEndBit is transmitted, the subsequent segment should be added to the receive array. The message is then complete and can be passed on internally for further processing. A new/separate array should be created for the next message.

Information:

When transferring with MultiSegmentMTUs, it is possible for several small messages to be part of one sequence. In the program, it is important to make sure that a sufficient number of receive arrays can be managed. The acknowledge register is only permitted to be adjusted after the entire sequence has been applied.

If SequenceCounter is incremented by more than one counter, an error is present.

Note: This situation is very unlikely when operating without "Forward" functionality.

In this case, the receiver stops. All additional incoming sequences are ignored until the transmission with the correct SequenceCounter is retried. This response prevents the transmitter from receiving any more acknowledgments for transmitted sequences. The transmitter can identify the last successfully transferred sequence from the opposite station's SequenceAck and continue the transfer from this point.

Acknowledgments must be checked for validity.

If the receiver has successfully accepted a sequence, it must be acknowledged. The receiver takes on the value of SequenceCounter sent along with the transmission and matches SequenceAck to it. The transmitter reads SequenceAck and registers the successful transmission. If the transmitter acknowledges a sequence that has not yet been dispatched, then the transfer must be interrupted and the channel resynchronized. The synchronization bits are reset and the current/incomplete message is discarded. It must be sent again once the channel has been resynchronized.

10.7.4.8 Flatstream mode

Name:

FlatstreamMode

In the input direction, the transmit array is generated automatically. This register offers 2 options to the user that allow an incoming data stream to have a more compact arrangement. Once enabled, the program code for evaluation must be adapted accordingly.

Information:

All B&R modules that offer Flatstream mode support options "Large segments" and "MultiSegmentMTUs" in the output direction. Compact transfer must be explicitly allowed only in the input direction.

Bit structure:

| Bit | Description | Value | Information |
|-------|-----------------|-------|-----------------------|
| 0 | MultiSegmentMTU | 0 | Not allowed (default) |
| | | 1 | Permitted |
| 1 | Large segments | 0 | Not allowed (default) |
| | | 1 | Permitted |
| 2 - 7 | Reserved | | |

Standard

By default, both options relating to compact transfer in the input direction are disabled.

1. The module only forms segments that are at least one byte smaller than the enabled MTU. Each sequence begins with a control byte so that the data stream is clearly structured and relatively easy to evaluate.
2. Since a Flatstream message is permitted to be any length, the last segment of the message frequently does not fill up all of the MTU's space. By default, the remaining bytes during this type of transfer cycle are not used.

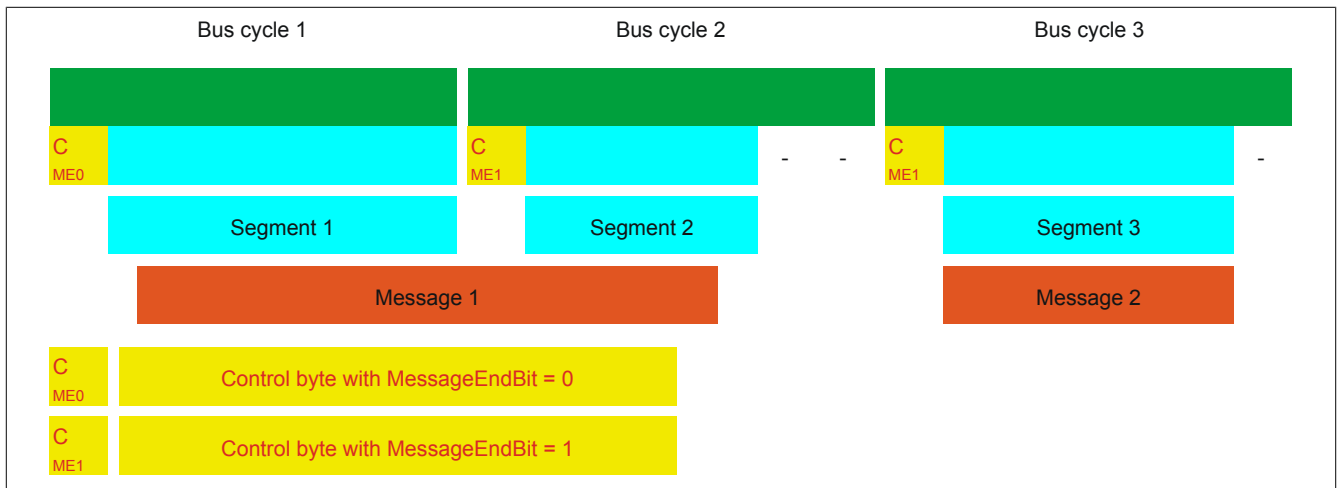


Figure 379: Message arrangement in the MTU (default)

MultiSegmentMTUs allowed

With this option, InputMTU is completely filled (if enough data is pending). The previously unfilled Rx bytes transfer the next control bytes and their segments. This allows the enabled Rx bytes to be used more efficiently.

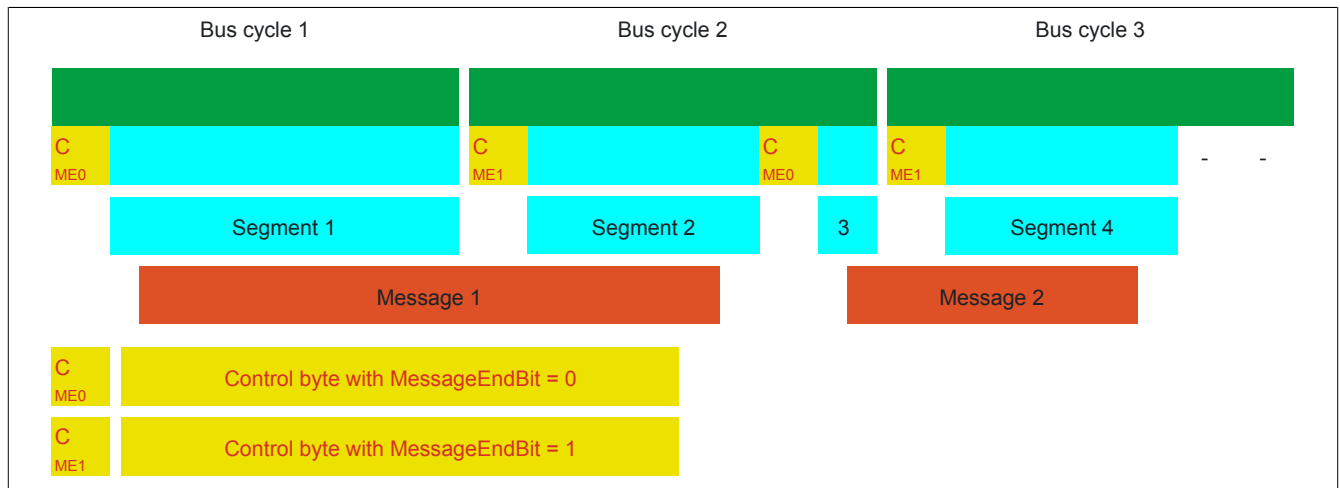


Figure 380: Arrangement of messages in the MTU (MultiSegmentMTUs)

Large segments allowed:

When transferring very long messages or when enabling only very few Rx bytes, then a great many segments must be created by default. The bus system is more stressed than necessary since an additional control byte must be created and transferred for each segment. With option "Large segments", the segment length is limited to 63 bytes independently of InputMTU. One segment is permitted to stretch across several sequences, i.e. it is possible for "pure" sequences to occur without a control byte.

Information:

It is still possible to split up a message into several segments, however. If this option is used and messages with more than 63 bytes occur, for example, then messages can still be split up among several segments.

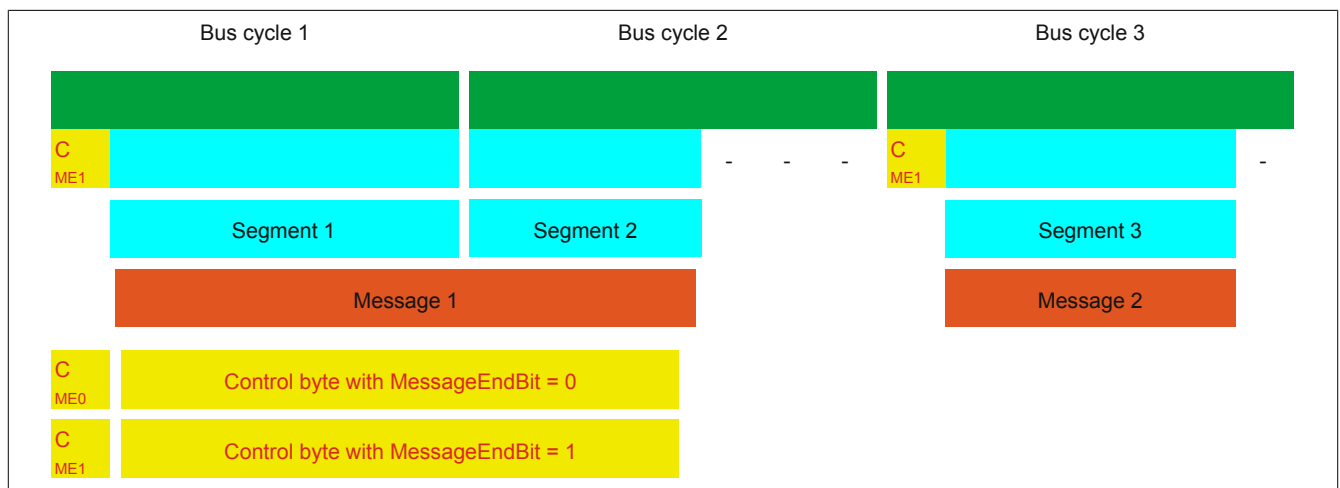


Figure 381: Arrangement of messages in the MTU (large segments)

Using both options

Using both options at the same time is also permitted.

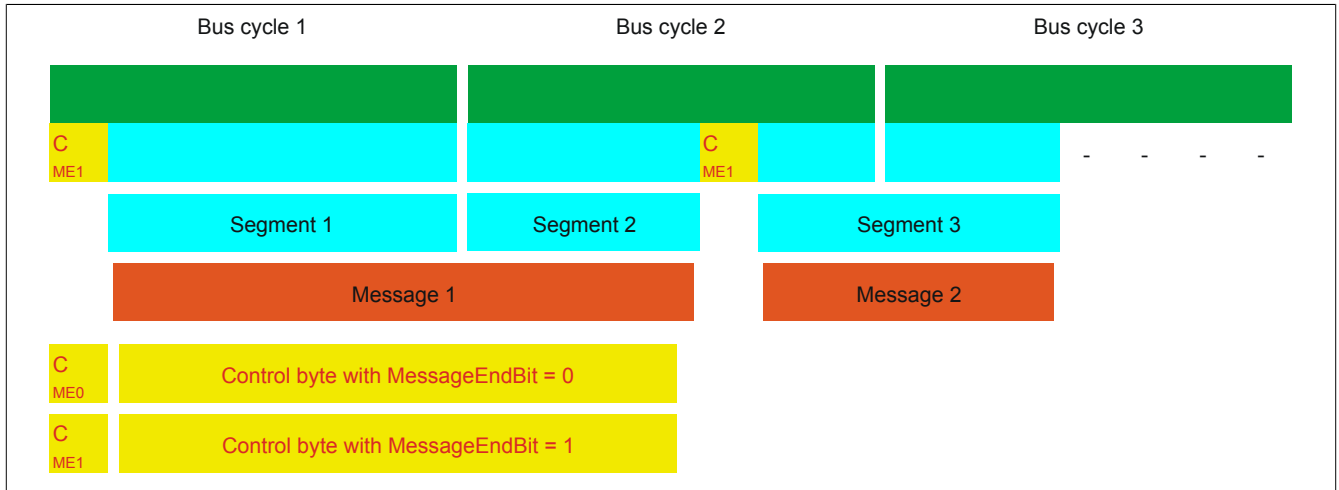


Figure 382: Arrangement of messages in the MTU (large segments and MultiSegmentMTUs)

10.7.4.9 Adjusting the Flatstream

If the way messages are structured is changed, then the way data in the transmit/receive array is arranged is also different. The following changes apply to the example given earlier.

MultiSegmentMTU

If MultiSegmentMTUs are allowed, then "open positions" in an MTU can be used. These "open positions" occur if the last segment in a message does not fully use the entire MTU. MultiSegmentMTUs allow these bits to be used to transfer the subsequent control bytes and segments. In the program sequence, the "nextCBPos" bit in the control byte is set so that the receiver can correctly identify the next control byte.

Example

3 autonomous messages (7 bytes, 2 bytes and 9 bytes) are being transmitted using an MTU with a width of 7 bytes. The configuration allows the transfer of MultiSegmentMTUs.

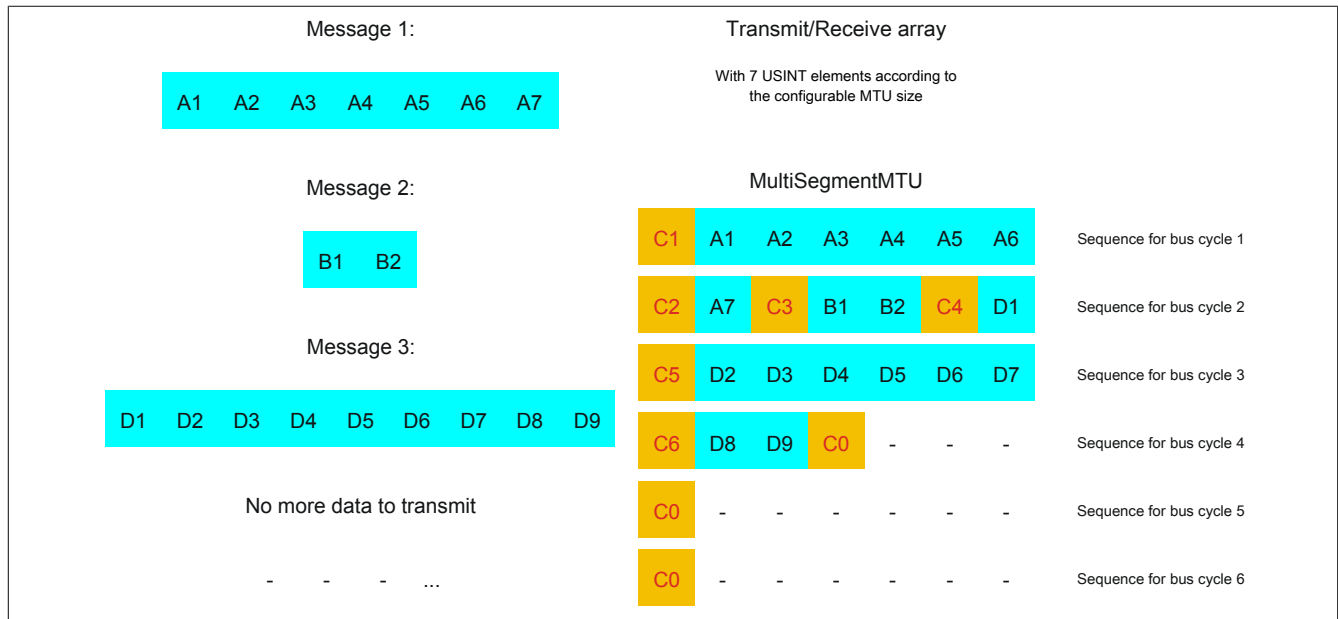


Figure 383: Transmit/receive array (MultiSegmentMTUs)

First, the messages must be split into segments. As in the default configuration, it is important for each sequence to begin with a control byte. The free bits in the MTU at the end of a message are filled with data from the following message, however. With this option, the "nextCBPos" bit is always set if payload data is transferred after the control byte.

MTU = 7 bytes → Max. segment length = 6 bytes

- Message 1 (7 bytes)
 - ⇒ First segment = Control byte + 6 bytes of data (MTU full)
 - ⇒ Second segment = Control byte + 1 byte of data (MTU still has 5 open bytes)
- Message 2 (2 bytes)
 - ⇒ First segment = Control byte + 2 bytes of data (MTU still has 2 open bytes)
- Message 3 (9 bytes)
 - ⇒ First segment = Control byte + 1 byte of data (MTU full)
 - ⇒ Second segment = Control byte + 6 bytes of data (MTU full)
 - ⇒ Third segment = Control byte + 2 bytes of data (MTU still has 4 open bytes)
- No more messages
 - ⇒ C0 control byte

A unique control byte must be generated for each segment. In addition, the C0 control byte is generated to keep communication on standby.

| C1 (control byte 1) | | C2 (control byte 2) | | C3 (control byte 3) | |
|---------------------|------|---------------------|-------|---------------------|-------|
| - SegmentLength (6) | = 6 | - SegmentLength (1) | = 1 | - SegmentLength (2) | = 2 |
| - nextCBPos (1) | = 64 | - nextCBPos (1) | = 64 | - nextCBPos (1) | = 64 |
| - MessageEndBit (0) | = 0 | - MessageEndBit (1) | = 128 | - MessageEndBit (1) | = 128 |
| Control byte | Σ 70 | Control byte | Σ 193 | Control byte | Σ 194 |

Table 665: Flatstream determination of the control bytes for the MultiSegmentMTU example (part 1)

Warning!

The second sequence is only permitted to be acknowledged via SequenceAck if it has been completely processed. In this example, there are 3 different segments within the second sequence, i.e. the program must include enough receive arrays to handle this situation.

| C4 (control byte 4) | | C5 (control byte 5) | | C6 (control byte 6) | |
|---------------------|-----|---------------------|------|---------------------|-------|
| - SegmentLength (1) | = 1 | - SegmentLength (6) | = 6 | - SegmentLength (2) | = 2 |
| - nextCBPos (6) | = 6 | - nextCBPos (1) | = 64 | - nextCBPos (1) | = 64 |
| - MessageEndBit (0) | = 0 | - MessageEndBit (1) | = 0 | - MessageEndBit (1) | = 128 |
| Control byte | Σ 7 | Control byte | Σ 70 | Control byte | Σ 194 |

Table 666: Flatstream determination of the control bytes for the MultiSegmentMTU example (part 2)

Large segments

Segments are limited to a maximum of 63 bytes. This means they can be larger than the active MTU. These large segments are divided among several sequences when transferred. It is possible for sequences to be completely filled with payload data and not have a control byte.

Information:

It is still possible to subdivide a message into several segments so that the size of a data packet does not also have to be limited to 63 bytes.

Example

3 autonomous messages (7 bytes, 2 bytes and 9 bytes) are being transmitted using an MTU with a width of 7 bytes. The configuration allows the transfer of large segments.

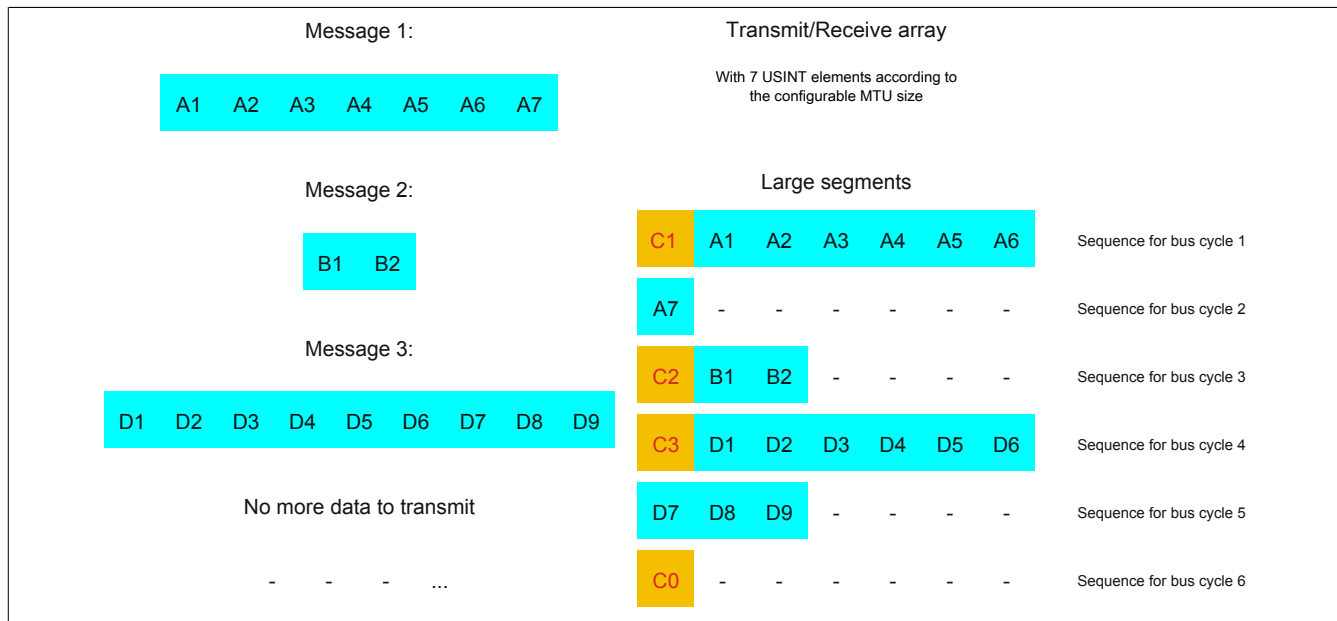


Figure 384: Transmit/receive array (large segments)

First, the messages must be split into segments. The ability to form large segments means that messages are split up less frequently, which results in fewer control bytes generated.

Large segments allowed → Max. segment length = 63 bytes

- Message 1 (7 bytes)
 - ⇒ First segment = Control byte + 7 bytes of data
- Message 2 (2 bytes)
 - ⇒ First segment = Control byte + 2 bytes of data
- Message 3 (9 bytes)
 - ⇒ First segment = Control byte + 9 bytes of data
- No more messages
 - ⇒ C0 control byte

A unique control byte must be generated for each segment. In addition, the C0 control byte is generated to keep communication on standby.

| C1 (control byte 1) | | C2 (control byte 2) | | C3 (control byte 3) | |
|---------------------|-------|---------------------|-------|---------------------|-------|
| - SegmentLength (7) | = 7 | - SegmentLength (2) | = 2 | - SegmentLength (9) | = 9 |
| - nextCBPos (0) | = 0 | - nextCBPos (0) | = 0 | - nextCBPos (0) | = 0 |
| - MessageEndBit (1) | = 128 | - MessageEndBit (1) | = 128 | - MessageEndBit (1) | = 128 |
| Control byte | Σ 135 | Control byte | Σ 130 | Control byte | Σ 137 |

Table 667: Flatstream determination of the control bytes for the large segment example

Large segments and MultiSegmentMTU

Example

3 autonomous messages (7 bytes, 2 bytes and 9 bytes) are being transmitted using an MTU with a width of 7 bytes. The configuration allows transfer of large segments as well as MultiSegmentMTUs.

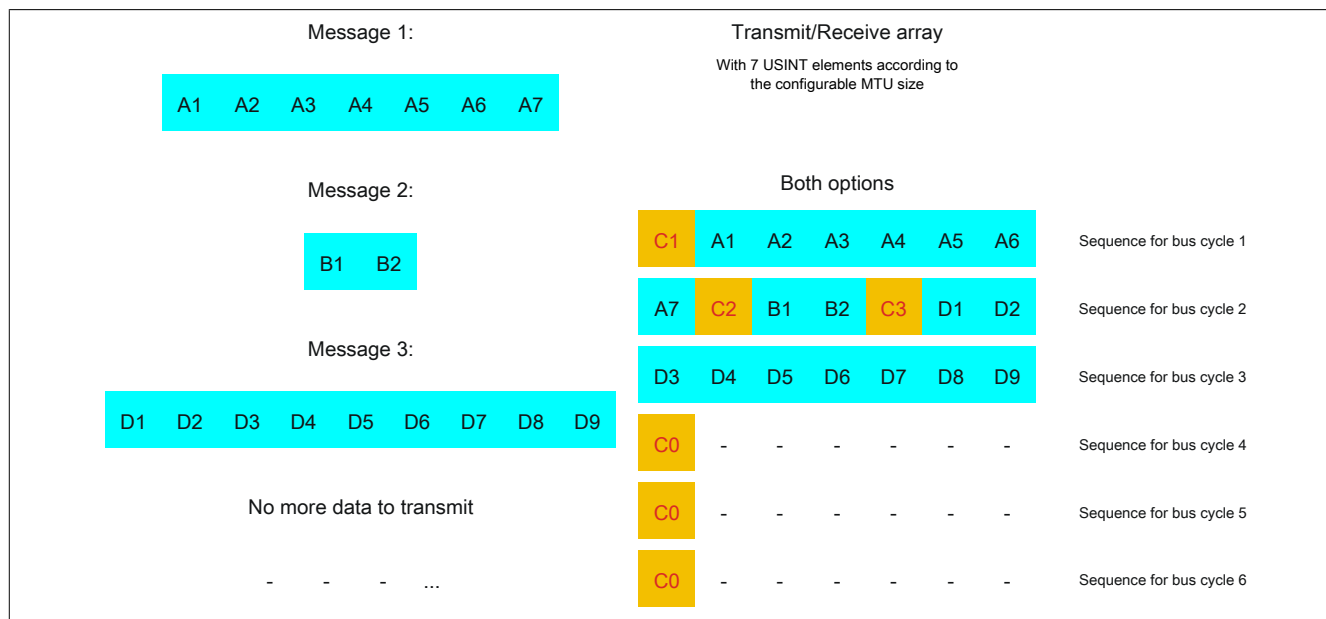


Figure 385: Transmit/receive array (large segments and MultiSegmentMTUs)

First, the messages must be split into segments. If the last segment of a message does not completely fill the MTU, it is permitted to be used for other data in the data stream. Bit "nextCBPos" must always be set if the control byte belongs to a segment with payload data.

The ability to form large segments means that messages are split up less frequently, which results in fewer control bytes generated. Control bytes are generated in the same way as with option "Large segments".

Large segments allowed → Max. segment length = 63 bytes

- Message 1 (7 bytes)
 - ⇒ First segment = Control byte + 7 bytes of data
- Message 2 (2 bytes)
 - ⇒ First segment = Control byte + 2 bytes of data
- Message 3 (9 bytes)
 - ⇒ First segment = Control byte + 9 bytes of data
- No more messages
 - ⇒ C0 control byte

A unique control byte must be generated for each segment. In addition, the C0 control byte is generated to keep communication on standby.

| C1 (control byte 1) | | C2 (control byte 2) | | C3 (control byte 3) | |
|---------------------|-------|---------------------|-------|---------------------|-------|
| - SegmentLength (7) | = 7 | - SegmentLength (2) | = 2 | - SegmentLength (9) | = 9 |
| - nextCBPos (0) | = 0 | - nextCBPos (0) | = 0 | - nextCBPos (0) | = 0 |
| - MessageEndBit (1) | = 128 | - MessageEndBit (1) | = 128 | - MessageEndBit (1) | = 128 |
| Control byte | Σ 135 | Control byte | Σ 130 | Control byte | Σ 137 |

Table 668: Flatstream determination of the control bytes for the large segment and MultiSegmentMTU example

10.7.5 Example of Forward functionality on X2X Link

Forward functionality is a method that can be used to substantially increase the Flatstream data rate. The basic principle is also used in other technical areas such as "pipelining" for microprocessors.

10.7.5.1 Function principle

X2X Link communication cycles through 5 different steps to transfer a Flatstream sequence. At least 5 bus cycles are therefore required to successfully transfer the sequence.

| | Step I | Step II | Step III | Step IV | Step V |
|-----------------|---|--|--|--|--------------------------------|
| Actions | Transfer sequence from transmit array, increase SequenceCounter | Cyclic matching of MTU and module buffer | Append sequence to receive array Adjust SequenceAck | Cyclic matching of MTU and module buffer | Check SequenceAck |
| Resource | Sender (task to transmit) | Bus system (direction 1) | Recipient (task to receive) | Bus system (direction 2) | Sender (task for Ack checking) |

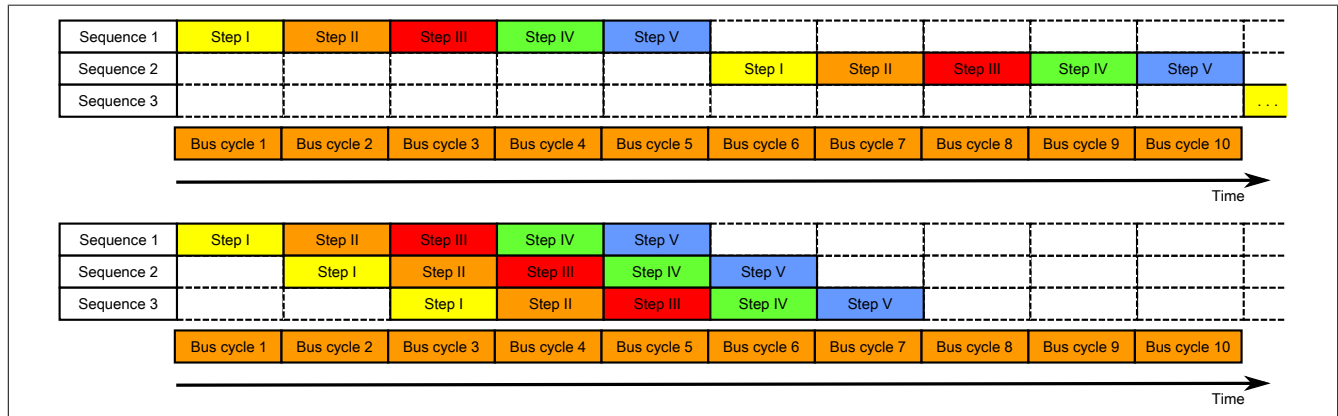


Figure 386: Comparison of transfer without/with Forward

Each of the 5 steps (tasks) requires different resources. If Forward functionality is not used, the sequences are executed one after the other. Each resource is then only active if it is needed for the current sub-action.

With Forward, a resource that has executed its task can already be used for the next message. The condition for enabling the MTU is changed to allow for this. Sequences are then passed to the MTU according to the timing. The transmitting station no longer waits for an acknowledgment from SequenceAck, which means that the available bandwidth can be used much more efficiently.

In the most ideal situation, all resources are working during each bus cycle. The receiver still has to acknowledge every sequence received. Only when SequenceAck has been changed and checked by the transmitter is the sequence considered as having been transferred successfully.

10.7.5.2 Configuration

The Forward function must only be enabled for the input direction. 2 additional configuration registers are available for doing so. Flatstream modules have been optimized in such a way that they support this function. In the output direction, the Forward function can be used as soon as the size of OutputMTU is specified.

10.7.5.2.1 Number of unacknowledged sequences

Name:
Forward

With register "Forward", the user specifies how many unacknowledged sequences the module is permitted to transmit.

Recommendation:
X2X Link: Max. 5
POWERLINK: Max. 7

| Data type | Values |
|-----------|----------------------|
| USINT | 1 to 7 Default: 1 |

10.7.5.2.2 Delay time

Name:
ForwardDelay

Register "ForwardDelay" is used to specify the delay time in μs . This is the amount of time the module has to wait after sending a sequence until it is permitted to write new data to the MTU in the following bus cycle. The program routine for receiving sequences from a module can therefore be run in a task class whose cycle time is slower than the bus cycle.

| Data type | Values |
|-----------|--|
| UINT | 0 to 65535 [μs] Default: 0 |

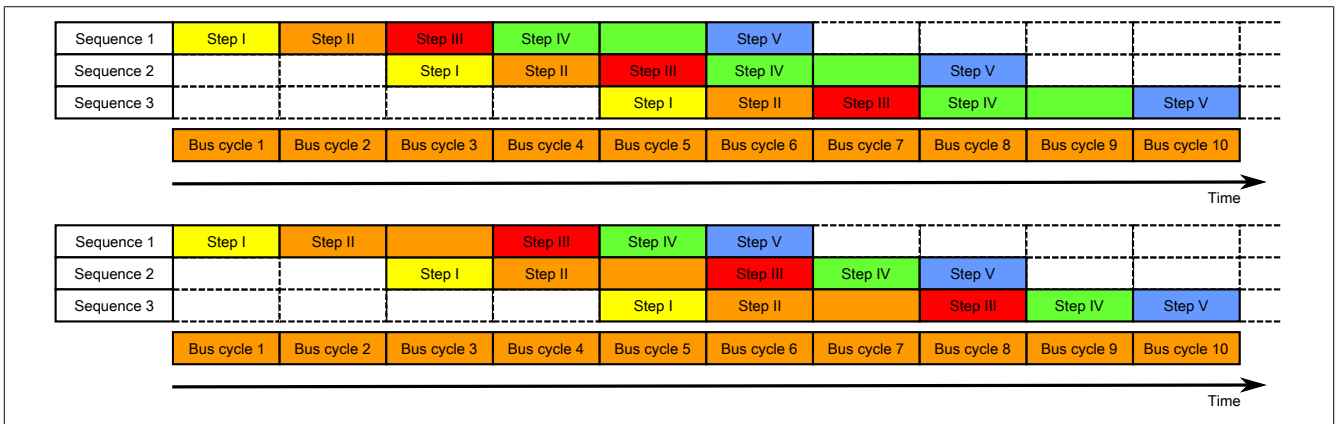


Figure 387: Effect of ForwardDelay when using Flatstream communication with the Forward function

In the program, it is important to make sure that the CPU is processing all of the incoming InputSequences and InputMTUs. The ForwardDelay value causes delayed acknowledgment in the output direction and delayed reception in the input direction. In this way, the CPU has more time to process the incoming InputSequence or InputMTU.

10.7.5.3 Transmitting and receiving with Forward

The basic algorithm for transmitting and receiving data remains the same. With the Forward function, up to 7 unacknowledged sequences can be transmitted. Sequences can be transmitted without having to wait for the previous message to be acknowledged. Since the delay between writing and response is eliminated, a considerable amount of additional data can be transferred in the same time window.

Algorithm for transmitting

| |
|--|
| <p><i>Cyclic status query:</i></p> <ul style="list-style-type: none"> - The module monitors <i>OutputSequenceCounter</i>. |
| <p>0) Cyclic checks:</p> <ul style="list-style-type: none"> - The CPU must check <i>OutputSyncAck</i>. → If <i>OutputSyncAck</i> = 0: Reset <i>OutputSyncBit</i> and resynchronize the channel. - The CPU must check whether <i>OutputMTU</i> is enabled. → If <i>OutputSequenceCounter</i> > <i>OutputSequenceAck</i> + 7, then it is not enabled because the last sequence has not yet been acknowledged. |
| <p>1) Preparation (create transmit array):</p> <ul style="list-style-type: none"> - The CPU must split up the message into valid segments and create the necessary control bytes. - The CPU must add the segments and control bytes to the transmit array. |
| <p>2) Transmit:</p> <ul style="list-style-type: none"> - The CPU must transfer the current part of the transmit array to <i>OutputMTU</i>. - The CPU must increase <i>OutputSequenceCounter</i> for the sequence to be accepted by the module. - The CPU is then permitted to <i>transmit</i> in the next bus cycle if the MTU has been enabled. |
| <p><i>The module responds since $OutputSequenceCounter > OutputSequenceAck$:</i></p> <ul style="list-style-type: none"> - The module accepts data from the internal receive buffer and appends it to the end of the internal receive array. - The module is acknowledged and the currently received value of <i>OutputSequenceCounter</i> is transferred to <i>OutputSequenceAck</i>. - The module queries the status cyclically again. |
| <p>3) Completion (acknowledgment):</p> <ul style="list-style-type: none"> - The CPU must check <i>OutputSequenceAck</i> cyclically. → A sequence is only considered to have been transferred successfully if it has been acknowledged via <i>OutputSequenceAck</i>. In order to detect potential transfer errors in the last sequence as well, it is important to make sure that the algorithm is run through long enough. <p>Note:</p> <p>To monitor communication times exactly, the task cycles that have passed since the last increase of <i>OutputSequenceCounter</i> should be counted. In this way, the number of previous bus cycles necessary for the transfer can be measured. If the monitoring counter exceeds a predefined threshold, then the sequence can be considered lost (the relationship of bus to task cycle can be influenced by the user so that the threshold value must be determined individually).</p> |

Algorithm for receiving

| |
|--|
| <p>0) Cyclic status query:</p> <ul style="list-style-type: none"> - The CPU must monitor <i>InputSequenceCounter</i>. |
| <p><i>Cyclic checks:</i></p> <ul style="list-style-type: none"> - The module checks <i>InputSyncAck</i>. - The module checks if <i>InputMTU</i> for enabling. → Enabling criteria: $InputSequenceCounter > InputSequenceAck + Forward$ |
| <p><i>Preparation:</i></p> <ul style="list-style-type: none"> - The module forms the control bytes / segments and creates the transmit array. |
| <p><i>Action:</i></p> <ul style="list-style-type: none"> - The module transfers the current part of the transmit array to the receive buffer. - The module increases <i>InputSequenceCounter</i>. - The module waits for a new bus cycle after time from <i>ForwardDelay</i> has expired. - The module repeats the action if <i>InputMTU</i> is enabled. |
| <p>1) Receiving ($InputSequenceCounter > InputSequenceAck$):</p> <ul style="list-style-type: none"> - The CPU must apply data from <i>InputMTU</i> and append it to the end of the receive array. - The CPU must match <i>InputSequenceAck</i> to <i>InputSequenceCounter</i> of the sequence currently being processed. |
| <p><i>Completion:</i></p> <ul style="list-style-type: none"> - The module monitors <i>InputSequenceAck</i>. → A sequence is only considered to have been transferred successfully if it has been acknowledged via <i>InputSequenceAck</i>. |

Details/Background

1. Illegal SequenceCounter size (counter offset)

Error situation: MTU not enabled

If the difference between SequenceCounter and SequenceAck during transmission is larger than permitted, a transfer error occurs. In this case, all unacknowledged sequences must be repeated with the old SequenceCounter value.

2. Checking an acknowledgment

After an acknowledgment has been received, a check must verify whether the acknowledged sequence has been transmitted and had not yet been unacknowledged. If a sequence is acknowledged multiple times, a severe error occurs. The channel must be closed and resynchronized (same behavior as when not using Forward).

Information:

In exceptional cases, the module can increment OutputSequenceAck by more than 1 when using Forward.

An error does not occur in this case. The CPU is permitted to consider all sequences up to the one being acknowledged as having been transferred successfully.

3. Transmit and receive arrays

The Forward function has no effect on the structure of the transmit and receive arrays. They are created and must be evaluated in the same way.

10.7.5.4 Errors when using Forward

In industrial environments, it is often the case that many different devices from various manufacturers are being used side by side. The electrical and/or electromagnetic properties of these technical devices can sometimes cause them to interfere with one another. These kinds of situations can be reproduced and protected against in laboratory conditions only to a certain point.

Precautions have been taken for X2X Link transfers if this type of interference occurs. For example, if an invalid checksum occurs, the I/O system will ignore the data from this bus cycle and the receiver receives the last valid data once more. With conventional (cyclic) data points, this error can often be ignored. In the following cycle, the same data point is again retrieved, adjusted and transferred.

Using Forward functionality with Flatstream communication makes this situation more complex. The receiver receives the old data again in this situation as well, i.e. the previous values for SequenceAck/SequenceCounter and the old MTU.

Loss of acknowledgment (SequenceAck)

If a SequenceAck value is lost, then the MTU was already transferred properly. For this reason, the receiver is permitted to continue processing with the next sequence. The SequenceAck is aligned with the associated SequenceCounter and sent back to the transmitter. Checking the incoming acknowledgments shows that all sequences up to the last one acknowledged have been transferred successfully (see sequences 1 and 2 in the image).

Loss of transmission (SequenceCounter, MTU):

If a bus cycle drops out and causes the value of SequenceCounter and/or the filled MTU to be lost, then no data reaches the receiver. At this point, the transmission routine is not yet affected by the error. The time-controlled MTU is released again and can be rewritten to.

The receiver receives SequenceCounter values that have been incremented several times. For the receive array to be put together correctly, the receiver is only permitted to process transmissions whose SequenceCounter has been increased by one. The incoming sequences must be ignored, i.e. the receiver stops and no longer transmits back any acknowledgments.

If the maximum number of unacknowledged sequences has been sent and no acknowledgments are returned, the transmitter must repeat the affected SequenceCounter and associated MTUs (see sequence 3 and 4 in the image).

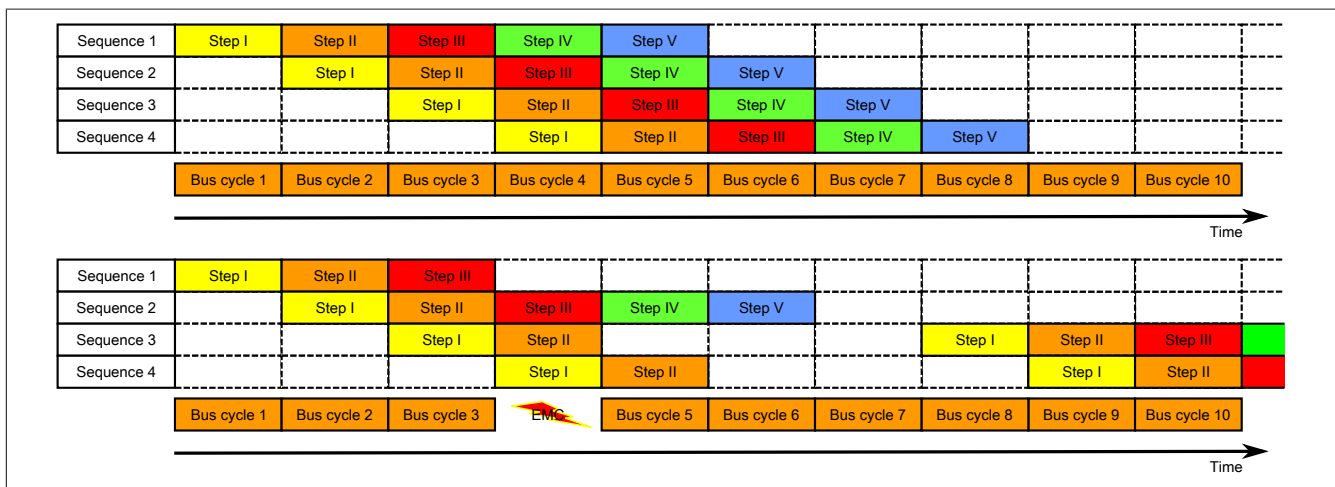


Figure 388: Effect of a lost bus cycle

Loss of acknowledgment

In sequence 1, the acknowledgment is lost due to disturbance. Sequences 1 and 2 are therefore acknowledged in Step V of sequence 2.

Loss of transmission

In sequence 3, the entire transmission is lost due to disturbance. The receiver stops and no longer sends back any acknowledgments.

The transmitting station continues transmitting until it has issued the maximum permissible number of unacknowledged transmissions.

5 bus cycles later at the earliest (depending on the configuration), it begins resending the unsuccessfully sent transmissions.

Publishing information

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