

ifm electronic



Operating instructions

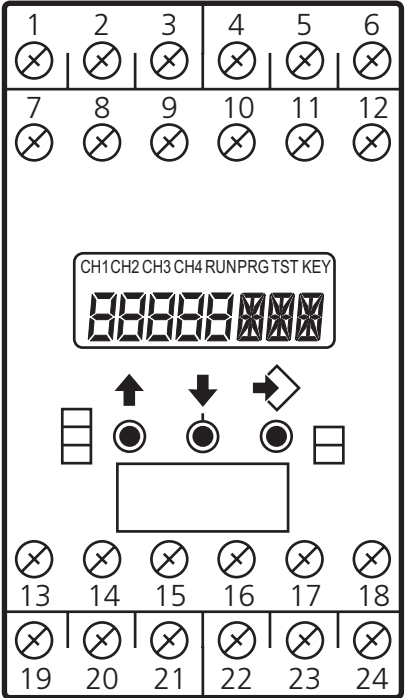
**ecomat200**

Monitor

FR-1 / FR-1N

**UK**

7390339 / 01 02 / 2011



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# 1 Preliminary note

This document applies to all units of the monitor type FR-1 / FR-1N.

It is part of the device and contains information about the correct handling of the product.

This document is intended for specialists. These specialists are people who are qualified by their training and their experience to see risks and to avoid possible hazards that may be caused during operation or maintenance of the device.

Read this document before use to familiarise yourself with operating conditions, installation and operation. Keep this document during the entire duration of use of the device.

## 1.1 Symbols used

► Instruction

> Reaction, result

[...] Designation of pushbuttons, buttons or indications

→ Cross-reference



Important note

Non-respect can result in malfunctions or interference



Information

Supplementary note

## 1.2 Warning signs used

### **WARNING**

Warning of serious personal injury.

Death or serious irreversible injuries may result.

### **CAUTION**

Warning of personal injury.

Slight reversible injuries may result.

### **NOTE**

Warning of damage to property.

## 2 Safety instructions

Follow the operating instructions. Non-observance of the instructions, operation which is not in accordance with use as prescribed below, wrong installation or handling can affect the safety of people and machinery.

The installation and connection must comply with the applicable national and international standards. Responsibility lies with the person installing the unit.

The unit must only be installed, connected and put into operation by a qualified electrician as

- during the installation dangerous contact voltage occurs and
- the safe function of the unit and the plant is only guaranteed when installation is carried out correctly.

Disconnect the unit externally before handling it. Also disconnect any independently supplied relay load circuits.

Be careful when handling the connected unit. This is only allowed by qualified personnel due to the protection rating IP 20.

The design of the unit corresponds to the protection class II except for the terminal blocks where protection against accidental contact (safety from finger contact to IP20) for operation by qualified personnel is only guaranteed if the terminal screw has been completely screwed in. For the correct operation the unit must be mounted in a housing (protection rating IP40 or higher) which can only be opened using a tool or in a closed control cabinet.

If the unit has an external 24 V DC supply, this voltage must be generated and supplied externally according to the requirements for safety extra-low voltage (SELV) since this voltage is supplied without further measures near the operating elements and at the terminals for the supply of connected pulse pick-ups.

The wiring of all signals in connection with the SELV circuit of the unit must also comply with the SELV criteria (safety extra-low voltage, safe electrical separation from other electric circuits).

If the externally supplied or internally generated SELV voltage is externally grounded, the responsibility lies with the user in accordance with the applicable national installation regulations. All statements in these operating instructions refer to the unit the SELV voltage of which is not grounded.

It is not allowed to supply external voltage to the terminals for the pulse pick-up supply. The consumption of current which exceeds the value given in the technical data is not allowed.

An external main switch must be installed for the unit, which can switch off the unit and all related circuits. This main switch must be clearly assigned to the unit.

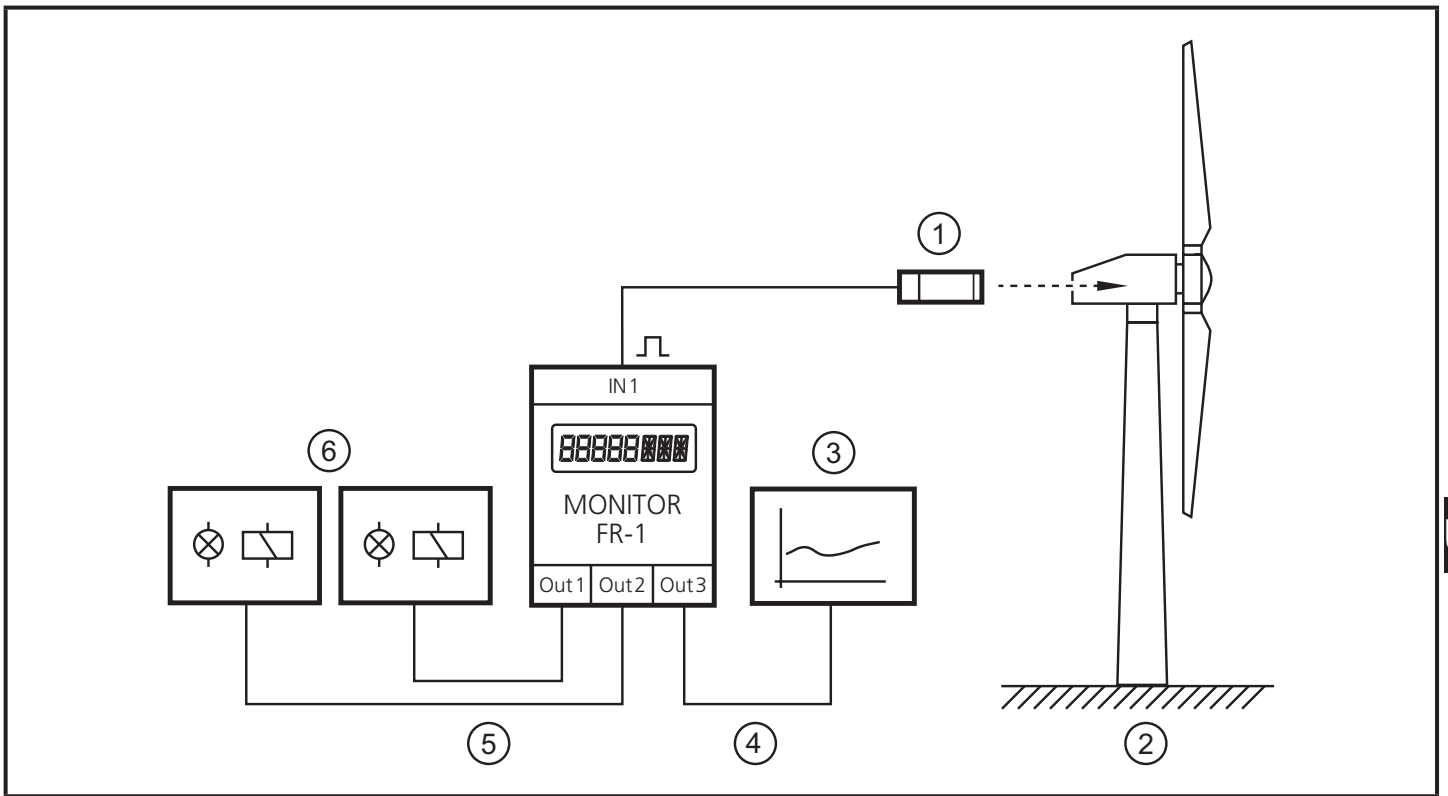
According to the technical specifications below, the unit can be operated in a wide operating temperature range. Because of the additional internal heating, the operating elements and the housing walls can have high perceptible temperatures when touched in hot environments.

In case of malfunction of the unit or queries please contact the manufacturer. Tampering with the unit can seriously affect the safety of operators and machinery. This is not permitted and leads to an exclusion of liability and warranty.

### **3 Functions and features**

The monitor FR-1/FR-1N is a pulse evaluation system. It monitors rotating, linear, vibrating or oscillating movements.

It receives the pulses from external sensors, measures the pulse interval and calculates the input frequency. This value is compared with the set switch points; the outputs are switched in accordance with the set parameters. The integrated frequency-to-current converter converts the input frequency into an analogue output signal.



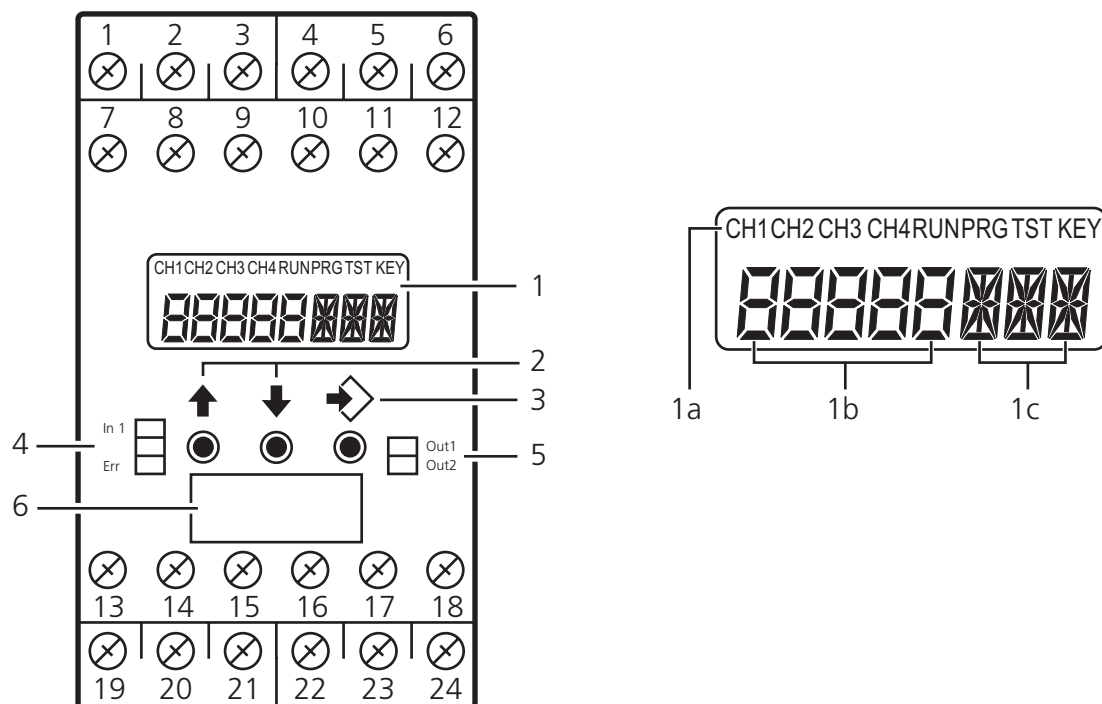
Example: speed monitoring in a wind power station

- 1: sensor at the rotor or generator shaft
- 2: wind power station
- 3: recording or display
- 4: analogue output
- 5: switching outputs
- 6: messages

**⚠ WARNING**

FR-1/FR-1N monitors have a one-channel design. By means of an electrical connection of the outputs of two or several units to achieve a redundant circuit, they can also be used for safety-related tasks. The applicable technical standards must be adhered to.

## 4 Operating and display elements



1	Display (7/14-segment)	
1a	Indicators for input channels and operating modes	
	<b>CH1...CH4</b>	Input channels (here: CH1)
	<b>RUN</b>	Run mode (normal operating mode)
	<b>PRG</b>	Programming mode (setting of the parameter values)
	<b>TST</b>	Test mode (offline check of the switching characteristics) not for DD2010
	<b>KEY</b>	Status of the unit (locking)
1b	Display	
	Actual values and parameter values (5-digit, numerical)	
	Rotational speed	0...60,000 RPM
	Pulses	0.1...1000.0 Hz
	Analogue value	0/4...20.5 mA
	Outside the value ranges the display shows "----".	
1c	Display	
	Parameter abbreviation and units (3-digit, alphanumeric)	
2	[▲] and [▼] buttons	
	Selection of the actual value display, parameter selection, setting of the parameter values	



3	[Mode/Enter] button	
	Selection of the operating mode, acknowledgement of the parameter value, front reset	
4	LED In1 (yellow)	Input pulses
	LED Err (red)	(Only FR-1N) lights in case of wire break or short circuit on the cable of the pulse pick-up
5	LEDs Out1/2 (green)	Switching status of the outputs 1 and 2
	Off	Output is not switched (relay deenergised, transistor blocked)
	On	Output is switched (relay energised, transistor switched)
	Quickly flashing	Output is kept latched (parameter SOx, Store Output)
	Slowly flashing	The delay time is effective for the output. The output switches when the delay time has elapsed and the trigger event is still present (parameter DTx, Delay Time).
6	Label	

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## 5 Mounting

Mount the unit on a DIN rail or by means of a mounting base. Leave enough space between the unit and the top and bottom of the control cabinet to enable air circulation and to avoid excessive heating.

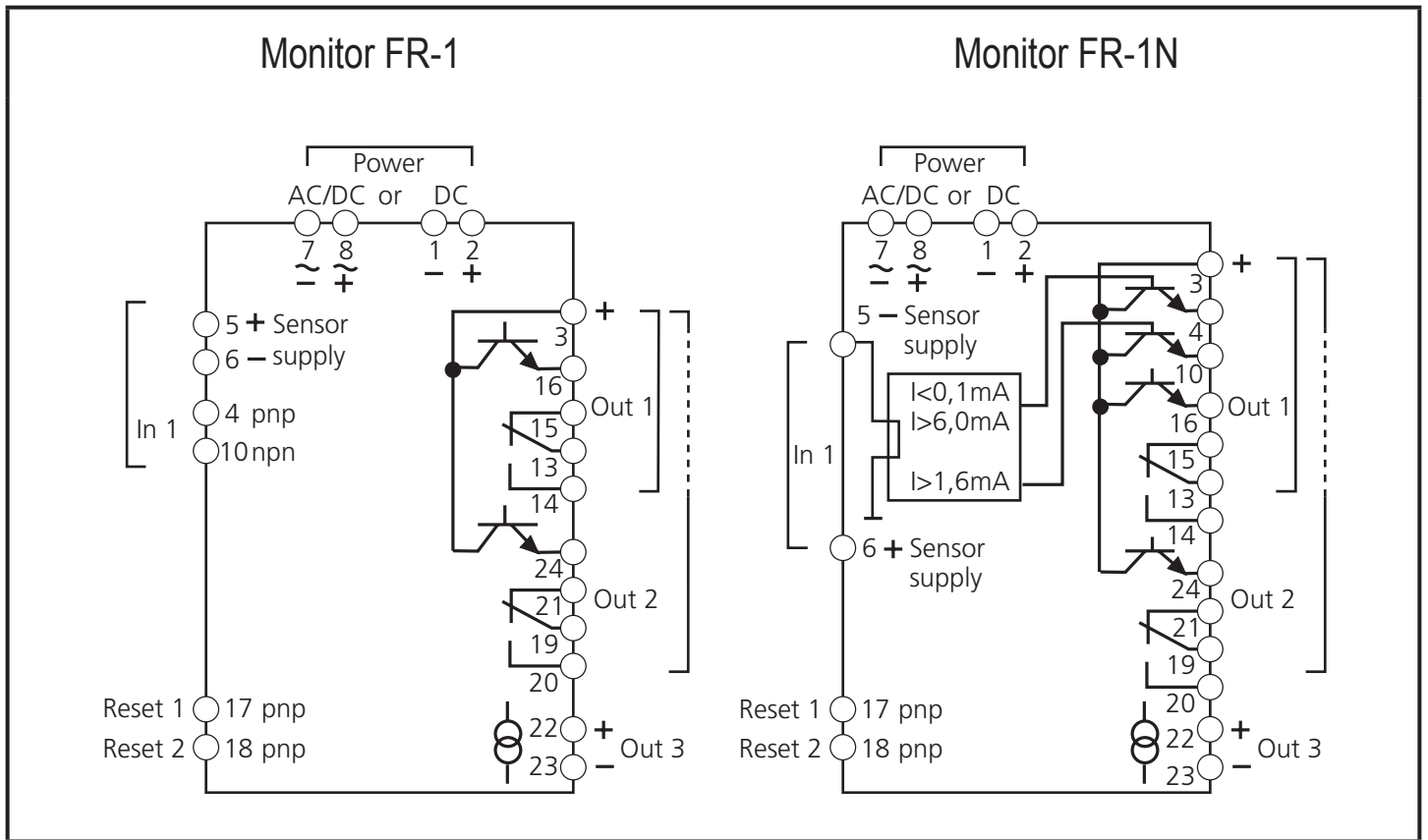
Take into account the internal heating of all units when mounting several units side by side. The environmental conditions must be observed for every unit.

### 5.1 Mounting of the sensors

Adhere to the installation instructions of the manufacturer.

# 6 Electrical connection

## 6.1 Terminal connection



## 6.2 Voltage supply (power)

It is only allowed to operate the unit via one of the possible voltage connections, i.e. either terminals 7/8, AC/DC or terminals 1/2, 24 V DC.

The supply cable must be protected externally according to the cross-section used (max. 16 A).

The terminals of the DC supply are directly connected to the terminals of the sensor supply. The SELV criteria must therefore be met for the DC supply (safety extra-low voltage, circuit electrically isolated from other circuits, not grounded).

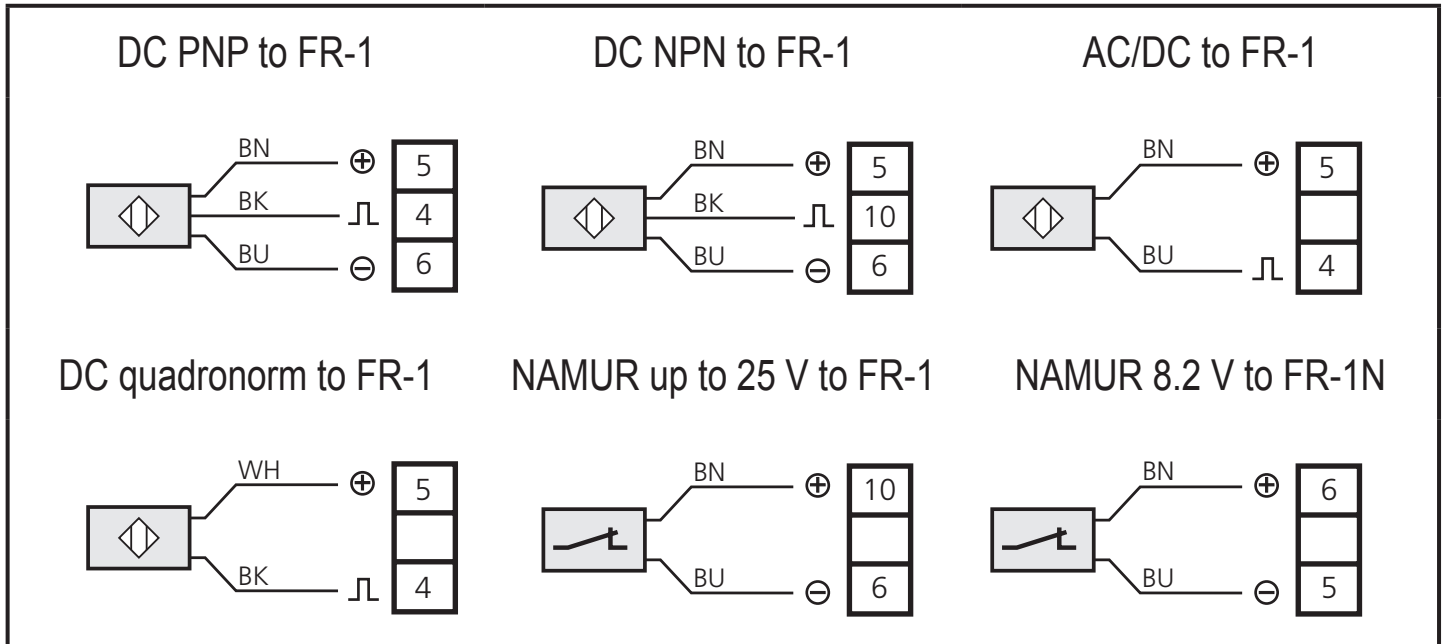
The device shall be supplied from an isolating source and protected by an overcurrent protection device such that the limited voltage requirements in accordance with UL 508 are met.

If the DC circuit is to be grounded (e.g. due to national regulations), the respective directives must be adhered to (safety extra-low voltage, circuit electrically isolated from other circuits).

If the unit is AC supplied, the low voltage provided for the sensor supply meets the SELV criteria according to EN 601010, overvoltage category II, soiling degree 2.

To guarantee safe functioning, signal cables (sensors, transistor outputs, 24 V digital inputs) and load cables (supply, relay outputs) should be laid separately. If necessary, use a screened cable.

### 6.3 Connection of the sensors (In1)



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The connection of mechanical switch contacts is not recommended since they tend to bounce and produce faulty pulses.

The terminals 5/6 can be used for the supply of the pulse pick-up or control of the reset inputs (only FR-1).

### 6.4 Relay outputs (Out1, 2)

To prevent excessive wear and to comply with the EMC standards, interference suppression of the contacts is required for switching inductive loads.

If the relay outputs are used for switching very small currents (e.g. PLC inputs), considerable contact resistance can arise. In this case use the transistor outputs.

### 6.5 Transistor outputs (Out1, 2)

The transistor outputs need a common external voltage of 24 V DC at terminal 3. It is normally not allowed to take this voltage from the unit. The reference point (GND) of the external power supply must be connected to terminal 1 of the monitor, otherwise no switching operation is possible.

The device shall be supplied from an isolating source and protected by an overcurrent protection device such that the limited voltage requirements in accordance with UL 508 are met.

## **6.6 Analogue output (Out 3)**

The analogue output is not electrically separated from the pulse pick-up supply and the 24 V DC supply voltage.

No dangerous contact circuits must be connected to the analogue output.

## **6.7 Reset inputs (reset 1 and 2)**

By means of a 24 V DC signal at terminal 17/18, the start-up delay or the memory reset can be started externally. For the FR-1 monitor terminal 5 can be connected with terminal 17/18 via a closing contact (not for the FR-1 N monitor).

The negative reference point of this voltage must be terminal 1 of the monitor.

A 24 V continuous signal leads to a permanent bridging of the monitoring, i.e. the same state as during the start-up delay is indicated. When the voltage is no longer applied and the set start-up delay has elapsed, monitoring starts.

Note on FR-1N:

The 24 V signal voltage required for the reset inputs is not available to the FR-1N. It must be taken from an external voltage source. The reference point (GND) of the external power supply must be connected to terminal 1 of the monitor, otherwise no switching operation is possible.

## **6.8 Fault output (only FR-1N)**

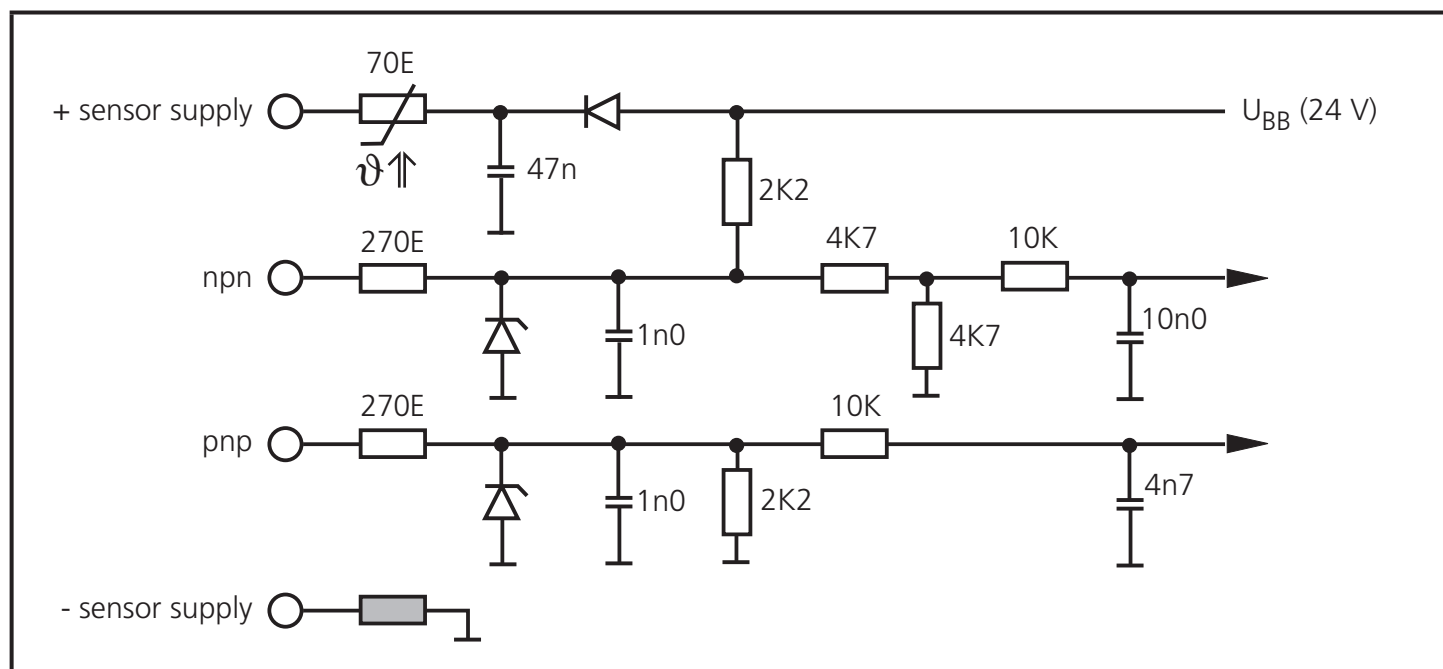
The fault output (terminal 4) indicates a wire fault between monitor and sensor (wire break/short circuit). In case of a fault the respective output is blocked.

## **6.9 Stepping output (only FR-1N)**

Signals from NAMUR sensors cannot be transferred to the inputs of other systems by simple cable links.

To use the signals for other inputs, the FR-1N monitor provides a copy of the input pulses at the stepping output (terminal 10, ratio 1:1).

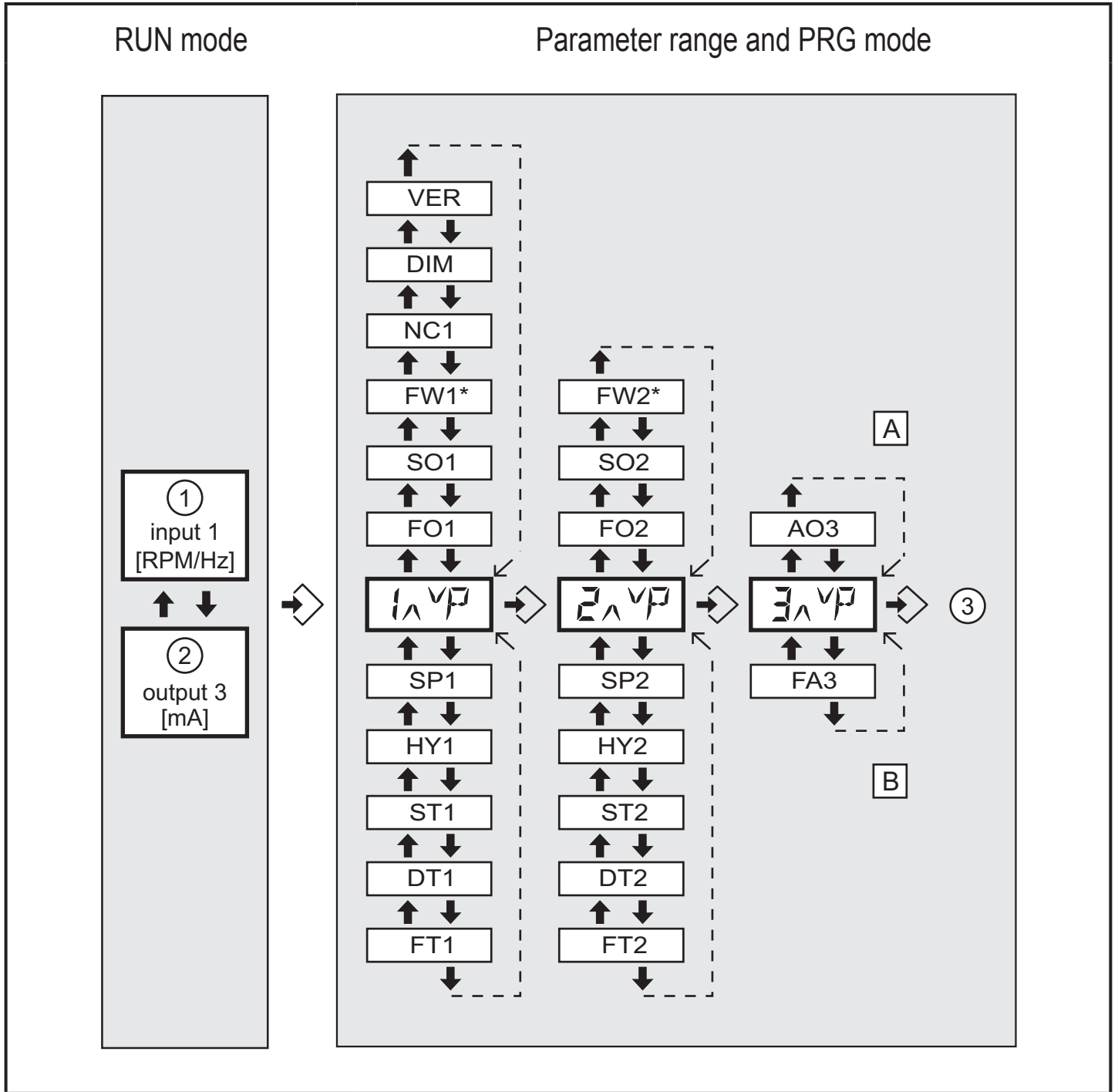
## 6.10 Typical input circuit FR-1



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# 7 Navigation and parameter overview

The pushbuttons [▲] / [▼] and [Mode/Enter] are used for the navigation, entry of values and acknowledgement within the parameters arranged in columns.



- 1: actual value input 1
- 2: actual value output 3
- 3: back to the RUN mode
- A: system parameters
- B: application parameters
- \*) only FR-1N

## 7.1 System parameters

### 7.1.1 FOx

Function Output (switching function of the outputs 1/2)

1	Relay energised (transistor output conductive) when the current value is below the switch point SPx (signalled state "minimum speed"/"blocked").	
2	Relay deenergised (transistor output blocked) when the current value is below the switch point SPx (error message: "too low speed"/"blocked").	
3	Relay energised (transistor output conductive) when the current value is above the switch point SPx (signalled state: "speed reached").	
4	Relay deenergised (transistor output blocked) when the current value is above the switch point SPx (error message: "overspeed").	
5	Relay is energised (transistor output conductive) within a frequency range (acceptable range).	
6	Relay is deenergised (transistor output blocked) within the frequency range. With the functions 5 and 6 a frequency range above and below the switch point SPx is defined in connection with the parameter <b>HYx</b> (hysteresis).	
	$SPx = (f_{max} + f_{min}) \div 2$	
	$HY = ((SP - SP_{min}) \div SP) \times 100 [\%]$	
	Values	1...6
	Default value	FO1 = 2 FO2 = 3

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### 7.1.2 SOx

Store Output (latching function outputs 1/2)

When this parameter is active, the respective output does not switch back automatically but must be reset.	
Values	0 = inactive
	1 = front reset ([Mode/Enter] > 3 s)
	2 = front reset and external reset
Default value	0 (inactive)

### 7.1.3 FWx

Function Wire Break (wire break monitoring, only FR-1N)

Relay characteristics for wire fault or short circuit, i.e. input frequency = 0		
<b>frequency &gt; SPx</b>	FWx = inactive (0)	FWx = active (1)
FOx = 1 or 4	relay energised	relay deenergised
FOx = 2 or 3	relay deenergised	relay remains deenergised
<b>frequency &lt; SPx</b>	FWx = inactive (0)	FWx = active (1)
FOx = 1 or 4	relay energised	relay deenergised
FOx = 2 or 3	relay deenergised	relay remains deenergised
<b>frequency in the range</b>	FWx = inactive (0)	FWx = active (1)
FOx = 5	relay deenergised	relay remains deenergised
FOx = 6	relay energised	relay deenergised
In case of fault the preset analogue initial value AO3 is available at the analogue output.		
Values	0 = inactive	
	1 = active	
Default value	0	

### 7.1.4 NC1

Number of Cams (input 1)

Number of cams detected per revolution. On the basis of this value the monitor calculates the rotational speed (measured frequency ÷ NC1 = displayed speed in RPM). For frequency measurements NC1 = 1 should remain set.	
Values	1...999
Default value	1

### 7.1.5 DIM

Dimension (display format)

Indication in Hz or RPM (revolutions per minute) When a new unit is selected the monitor converts all existing values into the new unit!	
Values	0 = RPM
	1 = Hz
Default value	0 = RPM



## 7.1.6 VER

### Software Version

The installed software version is displayed (5-digit number with abbreviation VCO)

## 7.1.7 AO3

### Analogue Offset (for analogue output 3)

Current value displayed and provided for an input value of 0 Hz/RPM.

Value range	0.0...20 mA (typical setting: 0.0 or 4.0 mA)
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Default value	4.0 mA
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## 7.2 Application parameters

### 7.2.1 SPx

#### Switch Point (outputs 1/2)

Value at which the output 1/2 changes its switching state according to switching function FOx.

Values	0.1 ... 1000.0 Hz or 1 ... 60000 RPM (unit depends on DIM)
--------	--

Default value	SP1 = 100 RPM, SP2 = 1000 RPM
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### 7.2.2 HYx

#### Hysteresis (for switch points SP1/SP2)

The hysteresis value determines the distance between the switch-off point and the switch point SPx. Prevents a possible chattering of the switching output. In connection with the switching functions 5 and 6 (FOx) an acceptable range or an error range can be defined.

Values	0.0...1000.0 % of the value for SPx
--------	-------------------------------------

Default value	5.0
---------------	-----

### 7.2.3 STx

#### Start-Up Delay Time (for outputs 1/2)

Enables the suppression of error messages when a plant is started. When the device is switched on or when the 24 V signal is removed from the reset input the respective output for the time set here is in the "good" state (= no fault).

Values	0.0...1000.0 s
--------	----------------

Default value	0.0 (no start-up delay)
---------------	-------------------------

## 7.2.4 DTx

### Delay Time (for outputs 1/2)

Enables a delayed switching of the outputs 1/2. The respective output switches only if the current value is above or below the switch point for more than the time set here.	
Values	0.0...1000.0 s
Default value	0.0 (no delay time)

## 7.2.5 FTx

### Fleeting Time (for outputs 1/2)

If an event occurs, the output changes its state during the set time and then switches back to the initial state.	
Values	0.0...1000.0 a
Default value	0.0 (fleeting time not active)

## 7.2.6 FA3

### Final Value Analogue (for analogue output 3)

Input value in Hz or RPM at which the final value 20 mA is displayed or provided. The output signal is limited to 20.5 mA.	
Value range	0.1 ... 1000.0 Hz or 1 ... 60000 RPM (unit depends on DIM)
Default value	1000 RPM

# 8 Programming

## WARNING

If programming takes place during operation, dangerous contact voltage may occur. Therefore ensure that programming is done by a qualified electrician.



Parameter changes during operation, especially changes to the switching function and the switch points can lead to malfunction in the plant.







Therefore disconnect it during the change and then check the function.

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Programming consists of 6 steps:

1. Change from the RUN mode to the parameter range 1, 2 or 3	[Mode/Enter]
2. Selection of the requested parameter (FOx, SOx, NCx, etc.)	[▲] / [▼]
3. Change to the PRG mode	[Mode/Enter]
4. Setting or changing the parameter value	[▲] / [▼]
5. Acknowledgement of the set parameter value	[Mode/Enter] > 3 s
6. Return to the RUN mode	[Mode/Enter] > 3 s

## 8.1 Programming example DT2 (Delay Time, output 2)

Operation	Display
<p><b>Change from the RUN mode to the parameter range (here 2)</b></p> <ul style="list-style-type: none"> <li>▶ Briefly press [Mode/Enter] twice.</li> <li>&gt; The 2nd parameter range is displayed.</li> </ul>	
<p><b>Selection of the requested parameter (here DT2)</b></p> <ul style="list-style-type: none"> <li>▶ Press [▼] until the parameter DT2 is displayed with the currently set value (here default value 0.0).</li> </ul>	
<p><b>Change to the PRG mode</b></p> <ul style="list-style-type: none"> <li>▶ Briefly press [Mode/Enter] once.</li> <li>&gt; The unit is in the programming mode.</li> <li>&gt; PRG indicator visible, parameter abbreviation flashes.</li> </ul>	
<p><b>Setting or changing the parameter value</b></p> <ul style="list-style-type: none"> <li>▶ Press [▲] / [▼] until the requested parameter value is displayed (→ 8.2.3 Numerical entries).</li> </ul>	
<p><b>Acknowledgement of the set parameter value</b></p> <ul style="list-style-type: none"> <li>▶ Press [Mode/Enter] until the parameter abbreviation no longer flashes and the indicator PRG has disappeared.</li> <li>&gt; The new parameter value is indicated and effective.</li> </ul>	
<p><b>Return to the RUN mode</b></p> <ul style="list-style-type: none"> <li>▶ Press [Mode/Enter] for about 3 s or wait for the time-out function (approx. 15 s).</li> <li>&gt; The unit is again in the RUN mode, the current value is indicated.</li> </ul>	

## 8.2 Notes on programming

### 8.2.1 RUN mode

During programming the unit internally remains in the RUN mode! (RUN indicator visible). This means that until a new value is acknowledged with [Mode/Enter], the unit carries out its monitoring function on the basis of the previously set parameters and switches the relay and transistor outputs accordingly.



The monitoring function of the monitor is deactivated by continuously pressing [Mode/Enter] in the RUN mode. The deactivation is effective as long as the button is pressed.

### 8.2.2 Time-out function

If during programming no pushbutton is pressed for approx. 15 s, this is seen as a cancellation.

Parameter changes which are not acknowledged with [Mode/Enter] are rejected. The previously set parameter value is restored and remains effective for the monitoring functions.

### 8.2.3 Numerical entries

Press [▲] or [▼] and hold it.

The smallest decade becomes active and is counted up or down depending on the selected pushbutton (e.g. 1, 2, 3,...0). Then comes the next decade, etc.

As soon as the pushbutton is released, the active decade flashes. It is set by pressing [▲] or [▼] several times. The preceding decade then flashes and can be set.

### 8.2.4 Factory reset

The factory default values can be restored by pressing [▲] and [▼] simultaneously during power on. All entered parameter values are lost.

### 8.2.5 KEY function

The unit can be locked to prevent incorrect entries.

Locking	Unlocking
<ul style="list-style-type: none"> <li>▶ Press [▲] and [▼] simultaneously and hold them pressed.</li> <li>&gt; The KEY indicator flashes.</li> <li>▶ Release the pushbuttons when the KEY indicator is continuously indicated.</li> </ul>	<ul style="list-style-type: none"> <li>▶ Press [▲] and [▼] simultaneously and hold them pressed.</li> <li>&gt; The KEY indicator flashes.</li> <li>▶ Release the pushbuttons when the KEY indicator is no longer indicated.</li> </ul>

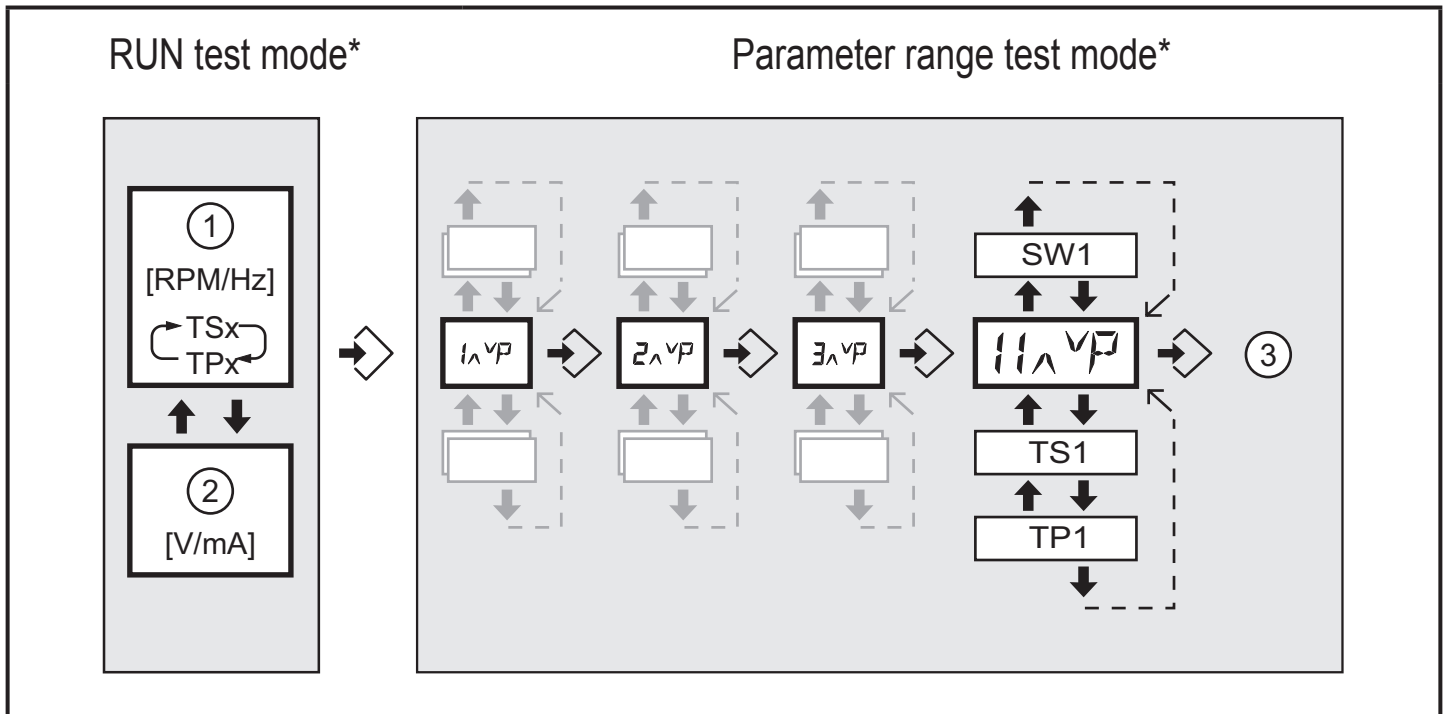
## 9 Test mode

In the test mode the switching behaviour of the monitor can be checked, set and stored offline. The monitor runs through a freely definable frequency range and switches the outputs according to the selected switching function and switch points.

### 9.1 Activate / terminate the test mode

For activation apply the operating voltage and press [Mode/Enter] simultaneously. The display indicates "TST".

In addition to the system and application parameters(→ 7.1 System parameters and 7.2 Application parameters), the test parameters SW, TS and TP are available. The test mode is terminated when the unit is switched off.



- 1: Test frequency
- 2: Analogue output
- 3: Return to the RUN test mode

\*) not for DD2010

## 9.2 Test parameters

SW1	Sweep on input 1	
	Change of speed of the test frequency	
	Values	1...5 (1 = fast, 5 = slow)
	Default value	1
TS1	Test Start on input 1	
	Initial value of the test frequency	
	Values	1...60,000 RPM or 0.1...1000.0 Hz
	Default value	50 RPM
TP1	Test Stop on input 1	
	Final value of the test frequency	
	Values	1...60,000 RPM or 0.1...1000.0 Hz
	Default value	1500 RPM

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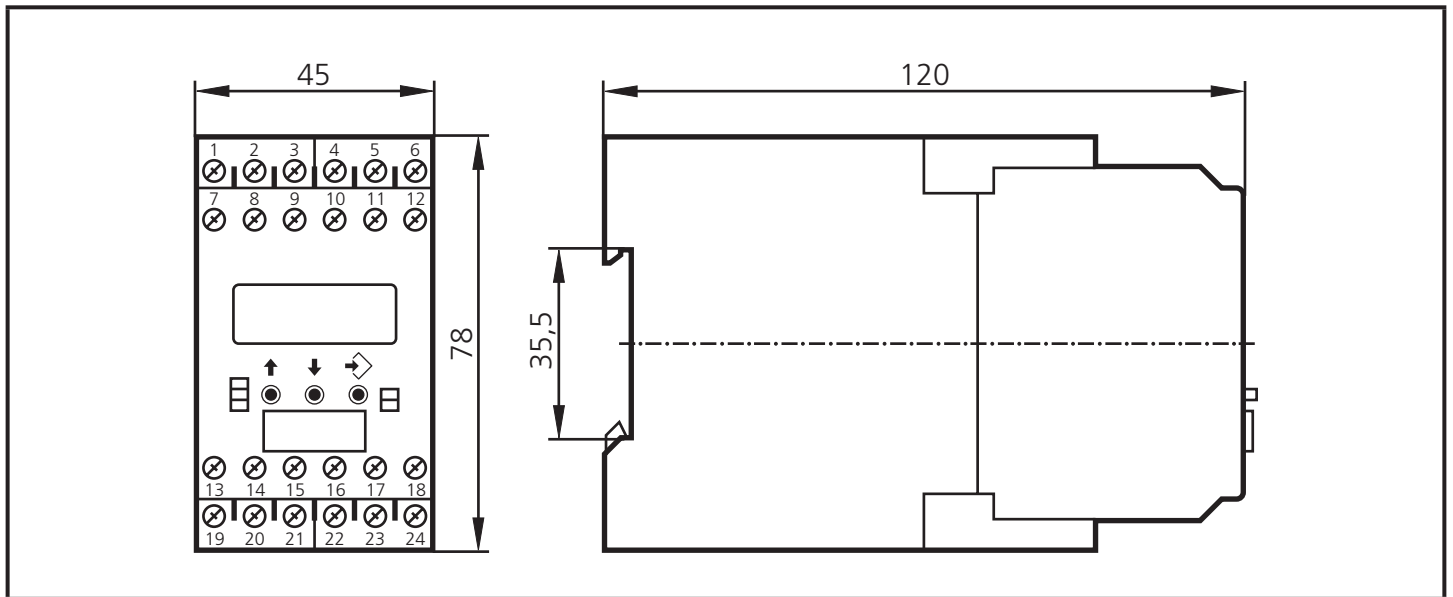
## 10 Technical data

Voltage supply	(acc. to type label)
Supply voltage AC/DC	110...240 V AC/DC (50...60 Hz)
Supply voltage DC	27 V DC (typ. 24 V DC) (DD2001, DD2010: 24 V DC)
Voltage tolerance	-20...+10 % (DD2001, DD2010: $\pm 10$ %)
Power consumption	AC/DC input: 5 VA / DC input: 3 W
Sensor inputs FR-1	
Sensor types	PNP/NPN; NAMUR (24 V DC)
Sensor supply	24 V DC; short-circuit proof and overload protected
Load current sensor input	approx. 10 mA
Current consumption sensor	max. 15 mA
Switch point for PNP sensor	> 12 V ON; < 5 V OFF
Switch point for NPN sensor	> 15 V OFF; < 8 V ON
Input frequency (max.)	5 kHz (this corresponds to a min. pulse/space duration of 0.1 ms) (DD2010: 3 kHz, this corresponds to a min. pulse/space duration of 0,15 ms)
Sensor inputs FR-1N	
Sensor type	NAMUR (to EN 50227)
Sensor supply	8.2 V DC
Switch point	< 1.55 mA ON; > 1.75 mA OFF
Wire monitoring	wire break: < 0.1 mA short circuit: > 6 mA
Input frequency (max.)	5 kHz (this corresponds to a min. pulse/space duration of 0.1 ms)
Characteristics	
Accuracy of the frequency measurement	< 1%
Power-on delay time	300 ms (this corresponds to the display refresh time)
Reset inputs 1 and 2	
External auxiliary voltage	24 V DC
Current consumption	typ. 2.5 mA
Switch point for PNP circuit	> 14 V



Outputs	
Relay outputs (Out1/2)	2 changeover contacts; volt-free
Switching capacity	6 A (250 V AC); B300, R300 (DD2010: 4 A)
Relay switching times	10...20 ms (energising), 30...40 ms (deenergising)
Cycles	> 10 <sup>7</sup> (without load) 3 x 10 <sup>5</sup> (250 V AC, 4 A, ohmic resistance)
Transistor outputs (Out1/2)	PNP switching; externally supplied; short-circuit proof
Switching voltage/switching current	24 V DC (± 20 %) / max. 15 mA
Analogue output (Out3)	0/4...20 mA, short-circuit proof, no feedback
Load	max. 500 Ohm
Accuracy	1 % FS
Unit data	
Housing	housing for DIN rail mounting; plastic
Dimensions (H x W x D)	78 x 45 x 120 mm
Weight	490 g
Protection housing / terminals	IP 50/20
Connection	21 dual-chamber terminals; 2 x 2.5 mm <sup>2</sup> (AWG 14)
Display	LC display; 7/14-segment
Ambient conditions	
Ambient/storage temperature	-20...+60°C / -25...+80°C (DD2010: -10...+60°C / -25...+80°C)
Air pressure	75...106 kPa
Permissible relative air humidity	max. 75 % (35°C)
Maximum operating altitude	2000 m above sea level
cULus test conditions	housing dimensions for temperature rise test: 200 x 200 x 150 mm
CE mark	to EN 61010 (1993); +A2 (1995; EMC 89/336/EEC), EN 50081-1; EN 61000-6-2

## 11 Scale drawing



## 12 Maintenance, repair and disposal

If used correctly no maintenance and repair measures are necessary. Only the manufacturer is allowed to repair the unit.

If necessary, the unit can be cleaned by qualified personnel using a dry cloth after disconnecting all connected circuits.

After use dispose of the unit in an environmentally friendly way in accordance with the applicable national regulations.