16.3 NC154

16.3.1 General Information

The NC154 axis controller is an active axis module, which includes all functions for operating three servo axes:

- Encoder Input
- Servo output (±10 V, 12-bit)
- Closed loop position controller (digital sampling controller)
- Limit and reference switch inputs
- Input "Controller Ready"
- Output "Enable Controller"

In addition, three fast trigger inputs are provided to latch the actual position for measurements.

Positioning Software

The software for axis control is found in the axis controller FlashPROM. The software can be downloaded. Therefore, positioning software can be updated if necessary.

Controller

The NC154 axis controller has a lag-free predictable PI closed loop controller. This algorithm guarantees a high degree of dynamic rigidity and excellent path precision.

Positioning Types

The user has a choice between several types of positioning:

- **Online Positioning**

  Changing the values for a movement (position, speed and acceleration) is possible at any sampling instant.

- **Electronic Gears**

  One or more gear axes have a certain relationship to a reference axis. The gear ratio and the angles of the gear axes to each other can be changed during a movement. The gear ratio or axes coupling (turning gear axes on and off) can be defined when the movement is stopped.

- **Electronic Cam Profile**

  Electronic cam profiles allow a non-linear connection between two drives (coupling functions) to be easily created. Several cam profiles can exist simultaneously on the NC154 and they can be switched when needed. Up and down synchronization is also possible when the reference axis is not stopped. All limits are taken into consideration during this procedure (speed, acceleration).

Additional Applications:

- **Flying Saw**
  - Optimized timing for movements
  - Immediate return when cut is completed

- **Cross Cutter**
  - Optimized movement
  - Print mark control

- **Interpolation**
  - Extensive NC interpreter
  - Linear, circular and helix interpolation with tangential axis
  - Dynamic "Look Ahead"
  - Gantry axes
  - Real-time intervention using virtual axes

- **Axis Synchronization**
  - Real-time positioning
  - Varied synchronization conditions

- **Virtual Axes**
  - Virtual master
  - Real-time intervention in active processes (to superimpose real axes)

- **Remote Axes**
  - Distributed axis controller according to machine functions
  - Connected via fieldbus

CNC Functions

Languages

In addition to the standard DIN 66025 syntax, the user is also provided very useful language expansions. Therefore, e.g. statements such as IF, ELSE, WHILE, SWITCH or arithmetic and trigonometric instructions (e.g. +, *, /, sin, cos, arctan) can be used. Up to 1000 R parameters are available as variables.

Interpolation

Straight, circular (helix) with tangential axes, level tool radian correction.

"Look Ahead" Function

A "Look Ahead" function is implemented which is used to make sure that axes limits are not exceeded.

Object-oriented Axis Programming

Tasks can be created quickly and reused using the new type of object-oriented axis programming. Thoroughly tested, high performance tools are used for this purpose.

The success of this new principle has been indicated by solutions in the main areas of automation technology.

Synchronization

If several NC154 axis controllers are used in a system, the sampling instant can be synchronized by linking the "Sync" connections. This guarantees high precision even when coupling gears between different NC154 modules.

Axis Coupling over Multiple Modules

When coupling axes over multiple modules (gears, cams, CNC), the set positions of the master axes are sent to the NC154 modules with the slave axes in an interrupt routine running on the main CPU. The interrupt routine is not allowed to be stopped. These requirements are fulfilled by the following CPUs:

- CP260
- IF260 when it is used as a main CPU

Restrictions

If electronic gears or cam profiles which are coupled between different modules or racks [1] are used in the application, no other interrupt capable modules (e.g. IF050, IF060, IF260 or IP161 as a parallel processor, EX150 and NW150) can be used in combination with the NC154.
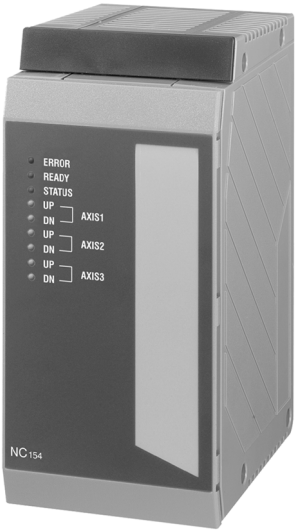
16.3.2 Order Data

Model Number	Short Description	Image
	Axis Controller	
3NC154.60-2	2005 axis controller, 3 axes. Each axis has the following data: Input frequency 150 kHz, incremental or absolute, 32-bit, encoder supply 5 VDC or 24 VDC, 5 digital inputs 24 VDC, sink, 1 relay output 24 VAC / 24 VDC, 1 A, 1 analog output +/- 10 V, 12-bit, 12-pin. Order 3 x TB162 terminal blocks separately.	
3TB162.9	2005 terminal block, 12-pin, screw clamps	
	Software	
1A3502.01	2005 Positioning Software, NC154.60-2 standard operating system	
Terminal blocks are not included in the delivery (see "Accessories").		

Table 378: NC154 order data

16.3.3 Technical Data

Product ID	NC154
C-UL-US Listed	Yes
B&R ID Code	$61
RAM	2 MB DRAM
System PROM	2 MB FlashPROM
NC154 Axis Coupling over Multiple Modules Supported by	CP260, IF260
Status Display	LEDs
Number of Axes	3
Operating Temperature	0 to 55° C

Table 379: NC154 technical data

1) Coupling between racks: The data exchange required for axes coupling takes place via the CPU's CAN bus.

Product ID	NC154

Power Consumption
   5 V
   24 V
   Total
	
	Max. 6 W
	--- 	
	Max. 6 W

Axis Data	**Entries are Valid for all Three Axes**
Encoder Input	15-pin DSUB socket Incremental encoder or SSI absolute encoder (both electrically isolated)

Incremental encoder
   Signal Form
   Evaluation
   Input Frequency
   Count Frequency
   Counter Size
   Inputs
   Input Level
   Distance between Edges
   Monitoring
	
	Square wave pulse
	4-fold
	Max. 150 kHz
	Max. 600 kHz
	32-bit
	A, A\, B, B\, R, R\
	5 V (differential input)
	Min. 0.8 µs
	Broken Connection, Signal Disturbance

SSI Absolute Encoder
   Coding
   Word Size
   Baud Rate
   Data Input Level
   Clock Output Level
   Monitoring
	
	Gray, Binary
	Max. 31-bit
	230 kBaud
	5 V (differential signal)
	5 V (differential signal)
	Signal disturbance, parity, plausibility

Encoder Supply
   External Input Voltage
   Load at Output Level
      5 VDC
      24 VDC
   Protection
	
	24 VDC
	
	Max. 400 mA per axis
	Max. 250 mA per axis
	Short circuit and overload protection

Servo Output	**Entries are Valid for all Three Axes**
Output Voltage	±10 V, electrically isolated
Load	5 mA
Resolution	12-bit
Output Filter	Low pass 1st order
Disturbance Suppression	Disturbance compensation
Digital Inputs	**Entries are Valid for all Three Axes**
Amount	5
Electrical Isolation	Yes (optocoupler)
Input Voltage	24 VDC
Input Current	Approx. 10 mA
Wiring	Sink

Table 379: NC154 technical data (cont.)

Chapter 3
B&R 2005 Modules

Product ID	NC154
Digital Output	**Entries are Valid for all Three Axes**
Type	Relay
Switching Voltage	Max. 30 VDC / VAC
Continuous Current	Max. 1 A
Short Circuit Protection	Soldered fuse 1.5 A
Mechanical Characteristics	
Dimensions	B&R 2005 double-width

Table 379: NC154 technical data (cont.)

16.3.4 Status LEDs

Image	LED	Description
	ERROR	The ERROR LED blinks in a 500 ms cycle (READY LED goes out, UP and DN continue to function). The ERROR LED is constantly lit during a hardware reset.
	READY	The READY LED blinks slowly (once every 2 seconds) if the software module BOOT is not present. The READY LED blinks quickly (5 time per second) if the software module BOOT is present, but the operating system is not present. The READY LED is lit constantly after a successful initialization i.e. the NC154 is ready for operation.
	STATUS	The STATUS LED indicates the individual boot phases.
	UP	The UP LED indicates an increasing actual position for axis n.
	DN	The DN LED indicates a decreasing actual position for axis n.

Table 380: NC154 status LEDs

16.3.5 Operational and Connection Elements

The connections for the individual axes, status LEDs and terminals for encoder supply and synchronization can be found behind the module door.

① Status LEDs

② Interface used to download the BOOT software module

③ 4-pin terminal block (encoder supply, connection for synchronization with other NC154 modules)

④ Encoder inputs for each axis

⑤ 12-pin terminal blocks to connect digital inputs and outputs for individual axes (e.g. limit switch, reference switch, etc.)
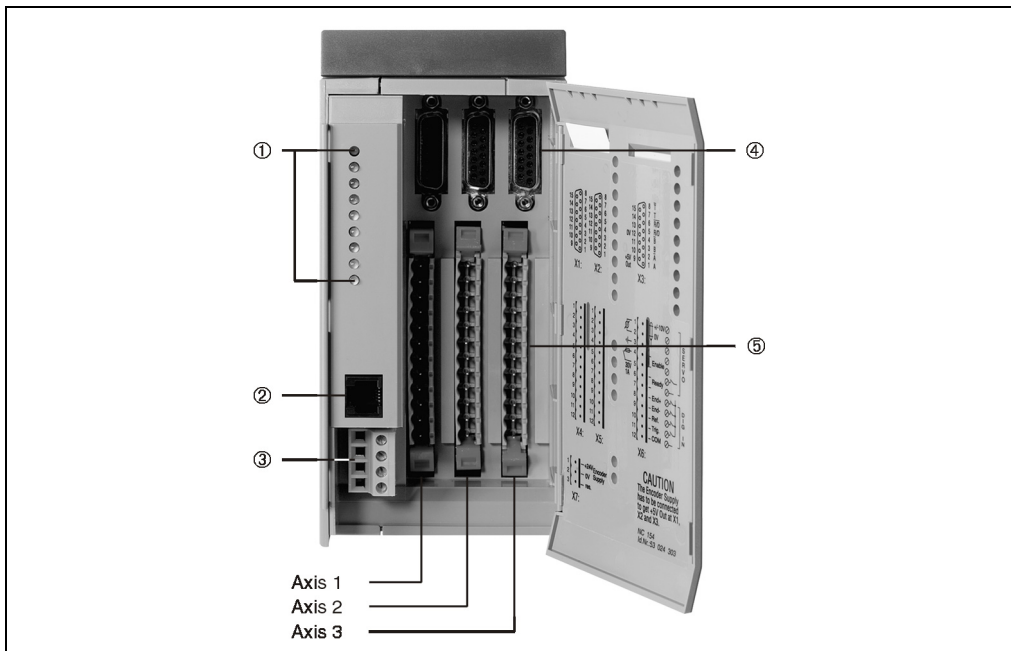

Figure 211: NC154 operational and connection elements

16.3.6 Encoder Connection

An encoder connection is available for each of the three axes. Either an incremental or SSI absolute encoder can be used.
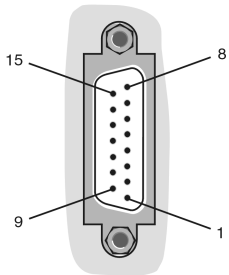
Pin Assignments

15-pin DSUB socket	Pin	Name	Incremental encoder	Name	Absolute encoder	Name	Encoder Supply
	1	A	Channel A				
	2	A\	A inverted				
	3	B	Channel B				
	4	B\	B inverted				
	5	R	Reference Pulse	D	Data input		
	6	R\	R inverted	D\	D inverted		
	7			T	Clock output		
	8			T\	C inverted		
	9					ES_5V	Encoder Supply +5 V / 400 mA
	10						
	11						
	12					COM	Encoder Supply ⊥
	13					ES_24V	Encoder Supply +24 V / 250 mA external voltage from terminals
	14						
	15						

Table 381: NC154 pin assignments for encoder connections

16.3.7 Encoder Supply / Synchronization

Pin Assignments
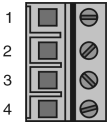
4-pin Terminal Block	Terminal	Description
	1	Encoder Supply: +24 VDC supply
	2	Encoder Supply: ⊥
	3	Synchronization +
	4	Synchronization -

Table 382: NC154 pin assignments for encoder supply /synchronization

16.3.8 I/O Connection

On each axis of the NC154 module there is a 12-pin terminal block with connections for 5 digital inputs, 1 digital output and 1 analog output. The terminal blocks can be removed with the help of ejection levers (12-pin terminal block, model number 3TB162.9).
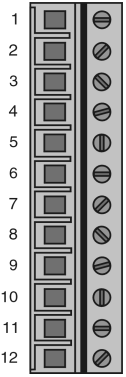
Pin Assignments

12-pin Terminal Block	Terminal	Description
	1	Analog output ±10V
	2	Analog output GND
	3	Shield
	4	Controller enable (relay output)
	5	Controller enable (relay output)
	6	Controller ready - input
	7	Controller ready - common
	8	Limit switch in positive direction
	9	Limit switch in negative direction
	10	Reference switch for search home
	11	Trigger input
	12	Common for pins 8 to 11

<p align="center">Table 383: NC154 pin assignments for I/O connection</p>

16.3.9 Interface Used to Download the BOOT Software Module

The BOOT software module is required to update the NC154 operating system (operating system update). This module is already installed on NC154 modules starting from revision number 54.23.

For NC154 modules with a revision number <54.23, the software module BOOT has to be installed in the module before the operating system update.

A PC can be connected to the NC154 via this interface using a cable available from B&R (0G2001.00-090). The software module BOOT (NC154.S1) can be downloaded using this connection.

The operating system is updated using the programming device via the CPU's online interface.
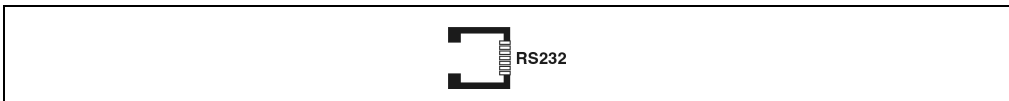
RS232

<p align="center">Figure 212: NC154 interface used to download the BOOT software module</p>

Chapter 3
B&R 2005 Modules