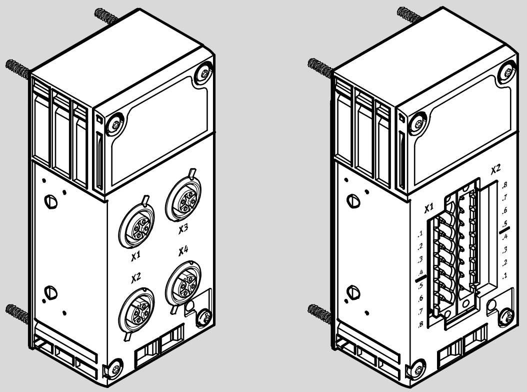
Terminal CPX

CPX-4AE-4AA-H



FESTO

en **Description**

8083250
2017-12
[8083252]

Translation of the original instructions
E/A-Modul CPX-4AE-4AA-H-EN

Other symbols:

➔ **Note**
Material damage or loss of function

i Recommendations, tips, references to other documentation

Text designations:
- Activities that may be carried out in any order

1. Activities that should be carried out in the order stated

– General lists

➔ Result of an action/References to more detailed information

Table of contents

1 About this document

This document describes the mode of operation, mounting, installation and commissioning of the product. Certain aspects of use are described in other documents and must be observed
➔ 1.1 Further applicable documents.

1.1 Further applicable documents

For all available product documentation ➔ www.festo.com/pk

Document	Table of contents
Brief description	Instructions and important information on use and safe application
Description of system CPX (CPX-SYS)	Mode of operation, mounting, installation and commissioning of CPX terminals
Description of bus node	Commissioning, parameterisation and diagnostics of terminal CPX with the bus node
Documentation for the components and the connected peripherals	Usage of components
Documentation for the higher-order controller and the additional participants in the network	Commissioning and parameterisation of the components
Operating conditions for explosion protection	For product versions with corresponding approval: operating conditions in potentially explosive atmospheres

Tab. 1 Further applicable documents

1.2 Product labelling

1	Data Matrix Code	4	Production time period (encoded)
2	Revision code	5	Part number
3	14-character serial number	6	Product description

Fig. 1 Product label – example

The product label is located on the top of the fibre-optic cable ➔ Fig. 3.
Scanning the printed Data Matrix Code with an appropriate device calls the Festo Support Portal, with information appropriate for the product. Alternatively, the Product Key (11-digit alphanumeric code on the product label) can be entered in the search field of the Support Portal.

1.3 Specified standards

Version status
NAMUR NE43:2003-02

Tab. 2 Specified standards

2 Safety

2.1 General safety information

- Only use the product if it is in perfect technical condition.
- Observe product labelling.
- Take into consideration the ambient conditions at the location of use.
- Prior to mounting, installation and maintenance work: switch off the power supply.
- Observe the handling specifications for electrostatically sensitive devices.
- Seal unused connections with cover caps to achieve the required degree of protection.
- Use connection hardware with the required degree of protection.
- Store the product in a cool, dry, UV-protected and corrosion-protected environment. Ensure that storage times are kept to a minimum.

2.2 Intended use

The analogue module is determined only for use in terminal CPX and terminal CPX-P of Festo.

- Operate the product only at suitable bus nodes CPX ➔ Tab. 3.
  Connect a maximum of 5 analogue modules with HART functionality to the bus nodes CPX-FB13 (PROFIBUS).
- Use only permissible combinations of module components ➔ Tab. 4.
- The product may only be used in its original status without unauthorized modifications.
  Only the conversions or modifications described in this and further applicable documents are permitted.
- Use the product only in an industrial environment. Outside of industrial environments, e.g. in commercial and mixed-residential areas, actions to suppress interference may have to be taken.

Bus node	Required revision
CPX-FB13 (PROFIBUS)	from Rev 34
CPX-FB33 (PROFINET IO)	from Rev 33
CPX-M-FB34 (PROFINET IO)	from Rev 33
CPX-M-FB35 (PROFINET IO)	from Rev 33

Tab. 3 Suitable bus nodes and required revisions

Interlinking block	Connection block CPX-P-AB-4XM12-4POL	Connection block CPX-P-AB-2XKL-8POL
Metal version	Permissible	Permissible
Plastic version	Not permissible	Permissible

Tab. 4 Permissible combination of connection block and interlinking block

2.3 Training of specialised personnel

This document is intended for qualified personnel. Experience with electrical control systems is required in order to understand this documentation.

3 Additional information

– Accessories ➔ www.festo.com/catalogue
– Spare parts ➔ www.festo.com/spareparts
– Documents and literature ➔ www.festo.com/sp

4 Service

Contact your regional Festo contact person if you have technical questions ➔ www.festo.com

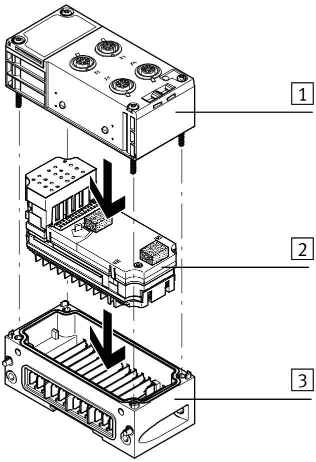
5 Product overview

5.1 Function

The analogue module with HART functionality provides analogue current inputs and current outputs and enables the recording and further processing of analogue current signals.

– 4 analogue current channels, configurable as input or output by DIL switch
– LED indicators for status and fault indications on the module
– Error control parameterisable
– Scalable range of values (16 bits)
– Channel-wise signal range configurable:
  – Without HART: 0 ... 20 mA or 4 ... 20 mA
  – With HART: 4 ... 20 mA
– Connection of the following field devices possible:
  – 2-, 3- or 4-wire sensors
  – 2-, 3- or 4-wire actuators
– HART functionality according to HART Communication Protocol Specification 7.5
– Support of the HART protocol in versions 5, 6 and 7

5.2 Structure of analogue module



1 Connection block
2 Electronics module
3 Interlinking block with contact rails

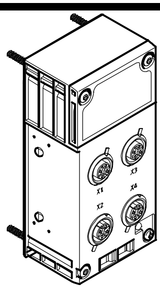
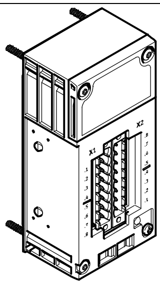
Fig. 2 Structure of the analogue module — example

Module component	Description
Connection block	– Provides the connections for field devices ➔ Chap. 5.3.
Electronics module	– Contains the electronic components of the module – Connects to the connection block and interlinking block through the plug connector
Interlinking block	– Housing bottom part for electrical and mechanical linking of the CPX modules – Variant with connection possible for operating and load voltage – Mounting option for entire terminal CPX

Tab. 5 Module components of analogue module

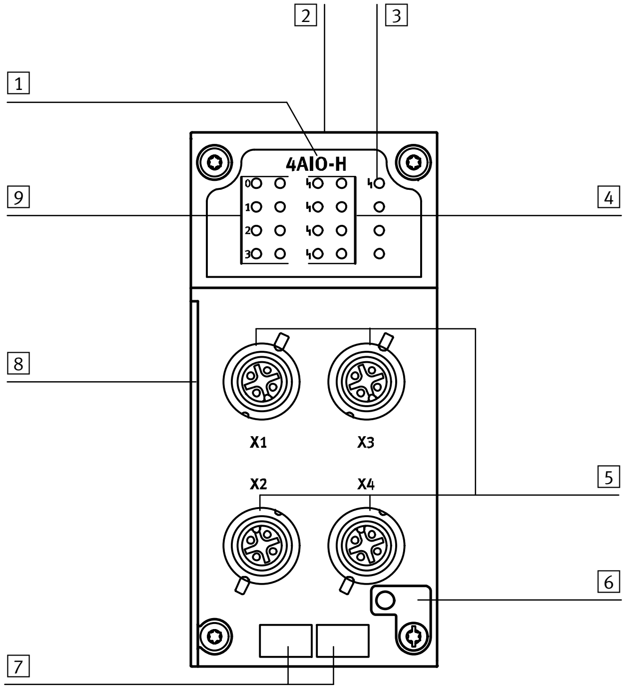
5.3 Connection block

5.3.1 Types

Connection block type	Description
 CPX-P-AB-4XM12-4POL	M12 connection block – 4 M12 sockets, 4-pin – For round plug connector M12x1 and SPEEDCON M12 – Screening possible using metal thread
 CPX-P-AB-2XKL-8POL	Terminal connection block – 2 pin strips COMBICON, 8-pin – For terminal strips in spring-loaded and screw terminal technology

Tab. 6 Connection blocks

5.3.2 Connection and display components



1	Module identifier	6	Earth terminal
2	Product labelling, connection block (on the top side of the fibre-optic cable)	7	Inscription labels
3	Module error indicator (red LED)	8	Slot for insulating plate
4	Channel error indicator (red LED)	9	Channel status indicator (1 LED per channel) LED 0 … 3 (green): input LED 0 … 3 (yellow): output
5	Electrical connections (here: M12)		

Fig. 3 Connection and display components – example of M12 connection block

5.4 Product-specific terms and abbreviations

Term/ abbreviation	Significance
O	Output
CPX terminal (-P)	Modular electrical terminal which is particularly suitable for use in the process industry (intrinsically safe electronics modules available)
HART	Highway Addressable Remote Transducer
HART protocol	Bidirectional, platform-independent data transfer protocol that permits access to the data of intelligent field devices
I	Input
PII	Process image of inputs ➔ process image.
PIO	Process image of outputs ➔ process image.
Process image	The process image is part of a controller's system memory. At the start of the cyclical program, the signal states of the input modules are transferred to the process image for the inputs (PII). At the end of the cyclical program, the process image for the outputs (PIO) is transferred to the output modules as a signal status.
PV	Primary Value
QV	Quaternary Value
SV	Secondary Value
TV	Tertiary Value

Tab. 7 Product-specific terms and abbreviations

6 Mounting

6.1 General instructions

CPX terminals are delivered in mounted form. For expansion or conversion, remounting may be necessary:

- Dismounting or remounting of the connection block when exchanging the connection technology
- Dismounting and remounting of the electronics module by setting the DIL switches or exchanging the electronics module

Arrangement on terminal CPX

For further information on the arrangement of the modules, observe the description of system CPX and the module documents ➔ Chap. 1.1.

6.2 Mechanically coding the connection block

To prevent an incorrect allocation of the connection block to the electronics module, this connection can be mechanically coded.

- The electronics module has a permanently attached coding pin at the top ➔ Fig. 4, 1.
- The connection block has a recess for a coding piece at the bottom.
- Connection block in pre-assembled CPX terminals are mechanically coded at the factory.

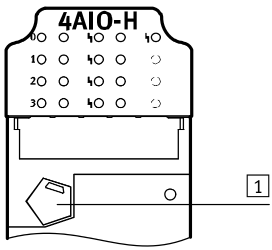
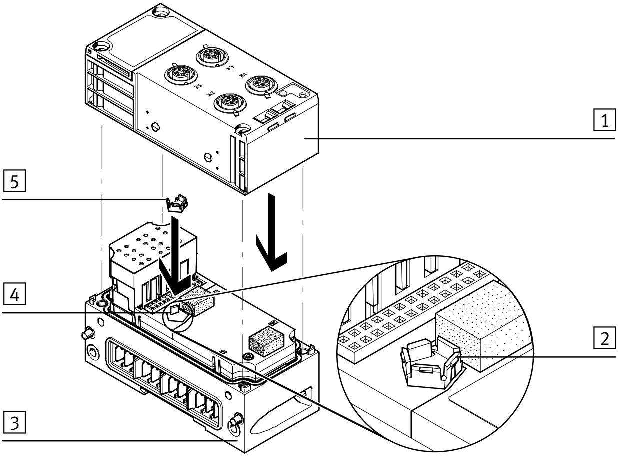


Fig. 4 Coding pin on the electronics module

Inserting the coding piece into the connection block



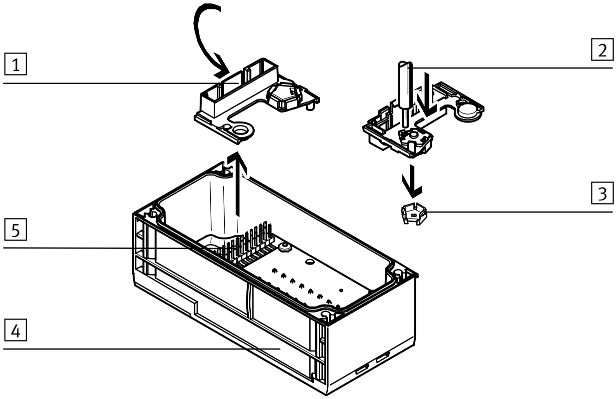
1 Connection block
2 Latching hook on coding piece
3 Interlinking block with electronics module
4 Coding pin
5 Coding piece

Fig. 5 Mechanical coding of connection block – example

1. Lay the interlinking block and electronics module 3 horizontally on a flat surface.
2. With the latching hook 2 facing upward, place the coding piece on the coding pin 4.
3. Align the plug connector of the connection block with the plug connector of the electronics module.
4. Push the connection block onto the electronics module without tilting until the coding piece in the connection block engages.

Removing a coding piece from the connection block

To change the device configuration, the coding piece might have to be removed from the connection block.



1	Cover with interlock	4	Connection block
2	Tool (e.g. pin)	5	Plug connectors
3	Coding piece		

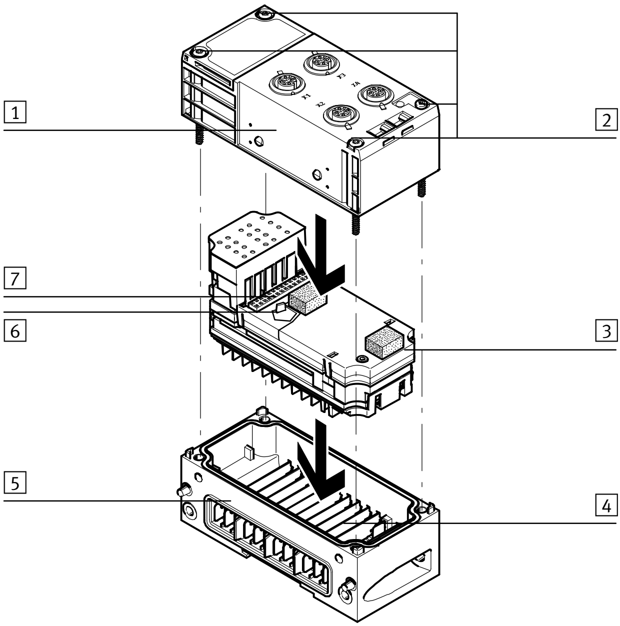
Fig. 6 Remove the coding piece

1. Lay the connection block 4 on a flat surface, top side first.
2. Unlock and remove the cover 1.
3. Press out the coding piece 3 using a suitable tool 2.
4. Push the cover onto the plug connector of the connection block 5.

6.3 Mounting the electronics module and connection block

Requirements

– Supply voltage is switched off.
– The interlinking block is clean and free of foreign matter.
– DIL switches are set ➔ Tab. 8.



1 Connection block
2 Screws (Torx T10)
3 Electronics module
4 Contact rails
5 Interlinking block
6 Coding pin
7 Plug connectors

Fig. 7 Mounting of the electronics module and connection block – example

Mounting the electronics module and connection block

Note
If threads are damaged or seals are defective, the device cannot achieve its specified IP degree of protection.

- Before mounting, check the seals and thread.
  Replace damaged parts.

1. Check seal and seal surfaces. Replace damaged parts.
2. Place the electronics module in the interlinking block without tilting.
3. Press on the electronics module to the limit stop.
4. Align the connection block on the interlinking block with the electronics module.
5. Push the connection block onto the interlinking block without tilting.
6. Insert the screws and tighten them crosswise:
   – Plastic interlinking block: thread-cutting screws
   – Metal interlinking block: screws with metric thread
   – Tightening torque 0.9 ... 1.1 Nm

6.4 Dismounting the electronics module and connection block

1. Switch off the power supply of the entire terminal CPX:
   – Compressed air
   – Operating voltage for electronics and sensors
   – Load voltage of valves
2. Loosen the screws of the connection block.
3. Pull the connection block out of the plug connector of the electronics module without tilting.
4. Pull the electronics module out of the contact rails of the interlinking block without tilting.

7 Installation

7.1 Prerequisites for installation

- Switch off the power supply of the entire terminal CPX:
  - Compressed air
  - Operating voltage for electronics and sensors
  - Load voltage of valves

7.2 Power supply

The operating and load voltage supply is fed through interlinking blocks or end plates (Protective Extra-Low Voltage, PELV) ➔ Description of system CPX.

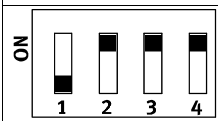
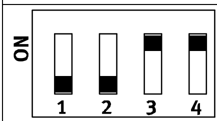
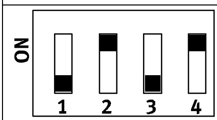
7.3 Changing the configuration of the analogue current channels (DIL switches)

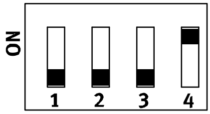
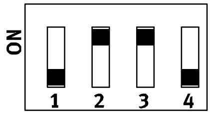
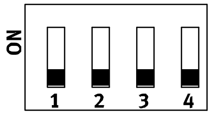
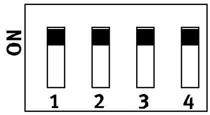
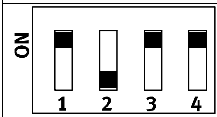
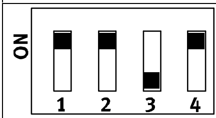
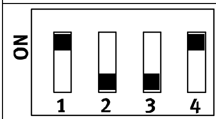
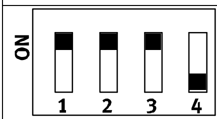
Description of the switch positions

Using the DIL switches, the following analogue current channel functions can be configured:

- Input or output channel
- Expansion of the process image by HART variables (+16 bytes)

If the configuration of the analogue current channels is changed, observe the maximum address range of the terminal CPX – e.g. if the process image is expanded by HART variables.

Switch setting	Variant	PII	PIO	Description
Without HART variables				
	4AE-H	8 bytes	0 bytes	Channel 0: input Channel 1: input Channel 2: input Channel 3: input
	3AE1AA-H	6 bytes	2 bytes	Channel 0: input Channel 1: input Channel 2: input Channel 3: output
	2AE2AA-H	4 bytes	4 bytes	Channel 0: input Channel 1: input Channel 2: output Channel 3: output

Switch setting	Variant	PII	PIO	Description
Without HART variables				
	1AE3AA-H	2 bytes	6 bytes	Channel 0: input Channel 1: output Channel 2: output Channel 3: output
	4AA-H	0 bytes	8 bytes	Channel 0: output Channel 1: output Channel 2: output Channel 3: output
	Reserved for test mode	–	–	–
With HART variables				
	4AE-H + 4HV	24 bytes	0 bytes	Channel 0: input Channel 1: input Channel 2: input Channel 3: input
	3AE1AA-H + 4HV	22 bytes	2 bytes	Channel 0: input Channel 1: input Channel 2: input Channel 3: output
	2AE2AA-H + 4HV	20 bytes	4 bytes	Channel 0: input Channel 1: input Channel 2: output Channel 3: output
	1AE3AA-H + 4HV	18 bytes	6 bytes	Channel 0: input Channel 1: output Channel 2: output Channel 3: output
	4AA-H + 4HV	16 bytes	8 bytes	Channel 0: output Channel 1: output Channel 2: output Channel 3: output

Tab. 8 DIL switch settings

Setting the DIL switches

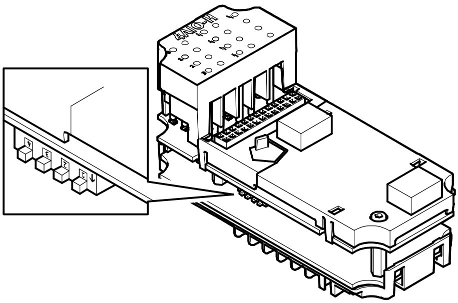


Fig. 8 DIL switches for the configuration of the analogue current channels

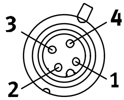
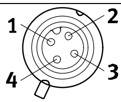
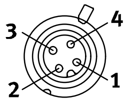
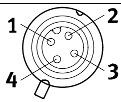
1. Switch off the power supply of the entire terminal CPX:
   – Compressed air
   – Operating voltage for electronics and sensors
   – Load voltage of valves
2. Loosen the screws of the connection block.
3. Pull the connection block out of the plug connector of the electronics module without tilting.
4. Set the DIL switches on the electronics module.
5. Mount the connection block ➔ Chap. 6.3.
   ➔ The process image becomes effective after switching on the power supply.

7.4 Electrical system

7.4.1 Notices regarding the cable connection

- For the connection of HART field devices: observe the wiring requirements according to the HART specification.
- Observe the maximum line lengths for the connection of field devices: 500 m.

7.4.2 Attaching connecting cables to the connection block M12

Socket contact M12	Pin[1)]	Function	Signal
X1 	X1.1	24 V_{SEN} /IO0	AOUT0
	X1.2	0 V_{SEN}	XGND
	X1.3	II0	AIN0
	X1.4	0 V_{SEN}	XGND
X2 	X2.1	24 V_{SEN} /IO1	AOUT1
	X2.2	0 V_{SEN}	XGND
	X2.3	II1	AIn1
	X2.4	0 V_{SEN}	XGND
X3 	X3.1	24 V_{SEN} /IO2	AOUT2
	X3.2	0 V_{SEN}	XGND
	X3.3	II2	AIN2
	X3.4	0 V_{SEN}	XGND
X4 	X4.1	24 V_{SEN} /IO3	AOUT3
	X4.2	0 V_{SEN}	XGND
	X4.3	II3	AIN3
	X4.4	0 V_{SEN}	XGND

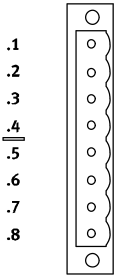
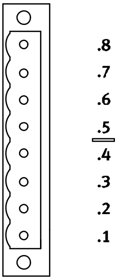
1) Connection and display components ➔ Fig. 3.

Tab. 9 Pin allocation on connection block CPX-P-AB-4XM12-4POL

The metal thread of socket contact M12 is internally connected to the earth terminal of terminal CPX and can be used as a screen connection.

- Only use suitable plug connectors ➔ www.festo.com/catalogue
- Seal unused connections with protective caps ISK-M12 ➔ Accessories.

7.4.3 Attaching connecting cables to the terminal connection block

Connection block	Pin[1)]	Function	Signal
X1 	X1.1	24 V_{SEN} /IO0	AOUT0
	X1.2	0 V_{SEN}	XGND
	X1.3	II0	AIN0
	X1.4	0 V_{SEN}	XGND
	X1.5	24 V_{SEN} /IO1	AOUT1
	X1.6	0 V_{SEN}	XGND
	X1.7	II1	AIn1
	X1.8	0 V_{SEN}	XGND
X2 	X2.1	24 V_{SEN} /IO2	AOUT2
	X2.2	0 V_{SEN}	XGND
	X2.3	II2	AIN2
	X2.4	0 V_{SEN}	XGND
	X2.5	24 V_{SEN} /IO3	AOUT3
	X2.6	0 V_{SEN}	XGND
	X2.7	II3	AIN3
	X2.8	0 V_{SEN}	XGND

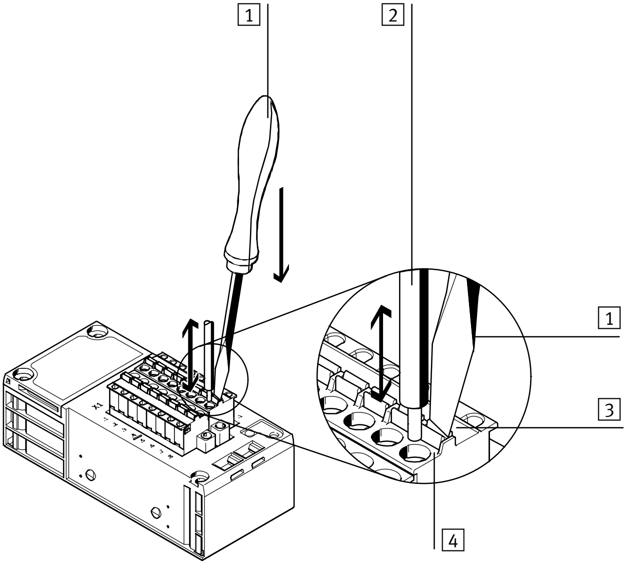
1) Connection and display components ➔ Fig. 3.

Tab. 10 Pin allocation on terminal connection block CPX-P-AB-2XKL-8POL

Connection blocks CPX-P-AB-2XKL-8POL do not feature a connection for the cable screening.

- Set up the screening or equipotential bonding separately.

Connecting the plug connector in spring-loaded terminal technology



1 Screwdriver, blade 2.5 x 0.4 mm
2 Cable
3 Unlocking
4 Terminal opening

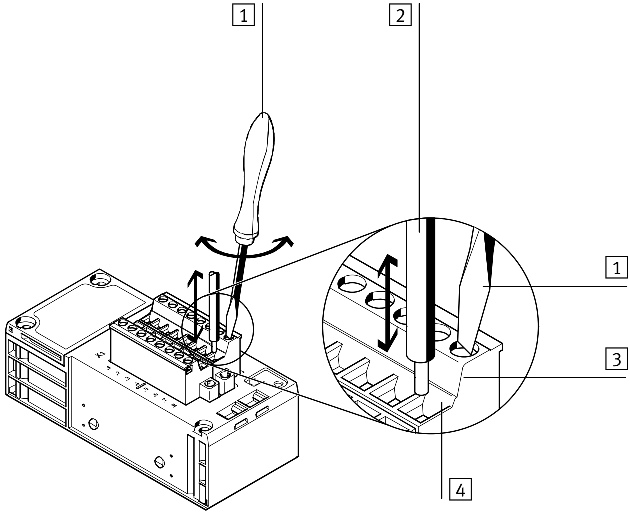
Fig. 9 Connection of the connecting cable in spring-loaded terminal technology

Spring-loaded terminal NECU-L3G8-C1-...		
Conductor cross section with wire end sleeve	[mm^2]	0.25 ... 2.5
Strip length	[mm]	10

Tab. 11 Specifications for spring-loaded terminal

- Only use suitable terminal strips → www.festo.com/catalogue
- Connect only one conductor per spring-loaded terminal.
- With a screwdriver, press the unlocking pin and insert the conductor end with the wire end sleeve into the terminal opening to the limit stop.

Connecting the plug connector in screw terminal technology



1 Screwdriver	3 Screw terminal
2 Cable	4 Terminal opening

Fig. 10 Connection of the connecting cable in screw terminal technology

Screw terminal NECU-L3G8-C2-...		
Conductor cross section with wire end sleeve	[mm^2]	0.25 ... 2.5
Strip length	[mm]	10

Tab. 12 Specifications for screw terminal

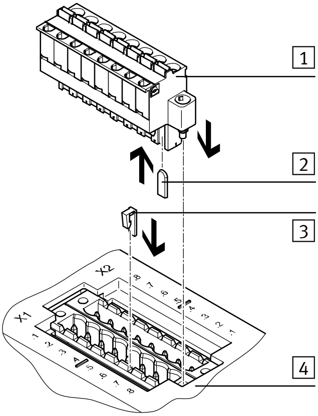
- Only use suitable terminal strips ➔ www.festo.com/catalogue
- Connect only one conductor per screw terminal.
- Loosen the screw terminal, insert the conductor end with wire end sleeve and tighten the screw terminal (tightening torque: 0.5 ... 0.6 Nm).

7.4.4 Mechanically coding the terminal connection

The terminal connection can be mechanically coded with a coding system.

The coding system is optionally available ➔ www.festo.com/catalogue.

- Recommendation: provide each contact with a coding element.

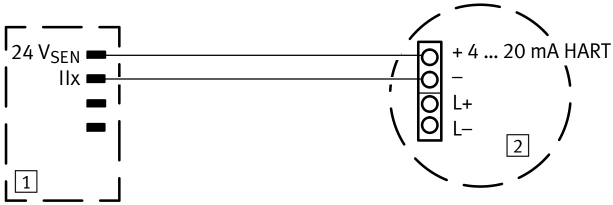


1	Terminal strip	3	Coding tab for the recess on the box header
2	Coding profile for the groove of the terminal strip	4	Box header

Fig. 11 Use of the mechanical coding system

7.5 Connection scenarios

7.5.1 2-wire connection of passive HART transmitters



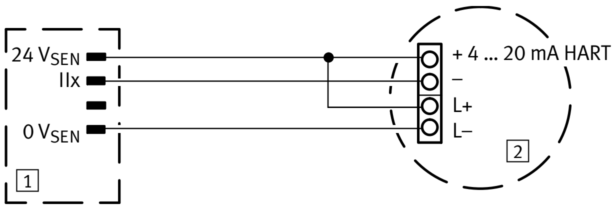
1 HART input module: active

2 HART transmitter: passive

Fig. 12 2-wire connection of a passive HART transmitter

Power supply for the HART transmitter, HART communication and actual values in the same circuit

7.5.2 3-wire connection of passive HART transmitters



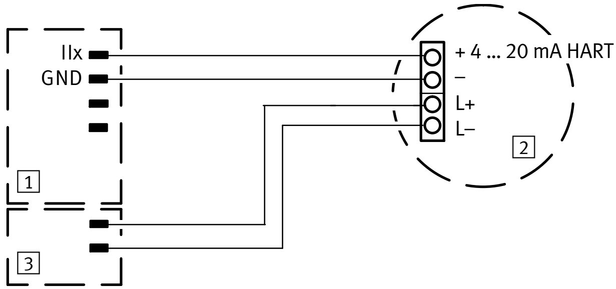
1 HART input module: active

2 HART transmitter: passive

Fig. 13 3-wire connection of a passive HART transmitter

Power supply for the HART transmitter via the HART input module

7.5.3 4-wire connection of active HART transmitters

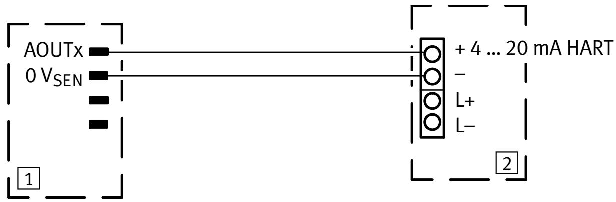


1 HART input module: passive
2 HART transmitter: active
3 Auxiliary energy

Fig. 14 4-wire connection of an active HART transmitter

Power supply for the HART transmitter via the auxiliary energy

7.5.4 2-wire connection of passive HART actuators

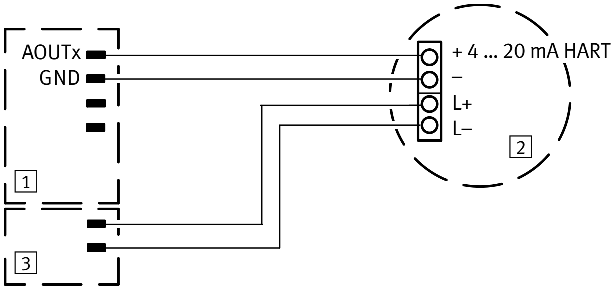


1 HART output module: active
2 HART actuator: passive

Fig. 15 2-wire connection of a passive HART actuator

Power supply for the HART actuator, HART communication and setpoint in the same circuit

7.5.5 4-wire connection of active HART actuators



1 HART output module: passive
2 HART actuator: active
3 Auxiliary energy

Fig. 16 4-wire connection of an active HART actuator

Power supply for the HART actuator via the auxiliary energy

8 Commissioning

8.1 Requirements for commissioning

– DIL switches for the configuration of the analogue current channels are set ➔ Chap. 7.3.
– The analogue module is completely installed into terminal CPX and connected.

8.2 Process image and address space allocation

For each terminal CPX, 64 bytes are available for the cyclic data exchange of the inputs and outputs.

Variant	**I/O**	**Contents of bytes[1)]**								**Address space allocation**
		7	**6**	**5**	**4**	**3**	**2**	**1**	**0**	
4AE-H	Input	IW CH3		IW CH2		IW CH1		IW CH0		8 bytes
	Output	–		–		–		–		0 bytes
3AE1AA-H	Input	–		IW CH2		IW CH1		IW CH0		6 bytes
	Output	–		–		–		SW CH3		2 bytes
2AE2AA-H	Input	–		–		IW CH1		IW CH0		4 bytes
	Output	–		–		SW CH3		SW CH2		4 bytes
1AE3AA-H	Input	–		–		–		IW CH0		2 bytes
	Output	–		SW CH3		SW CH2		SW CH1		6 bytes
4AA-H	Input	–		–		–		–		0 bytes
	Output	SW CH3		SW CH2		SW CH1		SW CH0		8 bytes

1) IW CH0 = actual value of channel 0 (input), SW CH1 = setpoint value of channel 1 (output), etc.

Tab. 13 Process image for variants without HART variables

<table>
<tr><th rowspan="2">Variant</th><th rowspan="2">I/O</th><th colspan="12">Contents of bytes[1]</th><th rowspan="2">Address space allocation</th></tr>
<tr><th>22
23</th><th>20
21</th><th>18
19</th><th>16
17</th><th>14
15</th><th>12
13</th><th>10
11</th><th>8
9</th><th>6
7</th><th>4
5</th><th>2
3</th><th>0
1</th></tr>
<tr><td rowspan="2">4AE-H
+ 4HV</td><td>Input</td><td colspan="2">HV4</td><td colspan="2">HV3</td><td colspan="2">HV2</td><td colspan="2">HV1</td><td>IW
CH3</td><td>IW
CH2</td><td>IW
CH1</td><td>IW
CH0</td><td>24 bytes</td></tr>
<tr><td>Output</td><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td><td>0 bytes</td></tr>
<tr><td rowspan="2">3AE1AA-H
+ 4HV</td><td>Input</td><td>–</td><td colspan="2">HV4</td><td colspan="2">HV3</td><td colspan="2">HV2</td><td colspan="2">HV1</td><td>IW
CH2</td><td>IW
CH1</td><td>IW
CH0</td><td>22 bytes</td></tr>
<tr><td>Output</td><td>–</td><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td><td>SW
CH3</td><td>2 bytes</td></tr>
<tr><td rowspan="2">2AE2AA-H
+ 4HV</td><td>Input</td><td colspan="2">–</td><td colspan="2">HV4</td><td colspan="2">HV3</td><td colspan="2">HV2</td><td colspan="2">HV1</td><td>IW
CH1</td><td>IW
CH0</td><td>20 bytes</td></tr>
<tr><td>Output</td><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td><td colspan="2">–</td><td>SW
CH3</td><td>SW
CH2</td><td>4 bytes</td></tr>
<tr><td rowspan="2">1AE3AA-H
+ 4HV</td><td>Input</td><td colspan="3">–</td><td colspan="2">HV4</td><td colspan="2">HV3</td><td colspan="2">HV2</td><td colspan="2">HV1</td><td>IW
CH0</td><td>18 bytes</td></tr>
<tr><td>Output</td><td colspan="4">–</td><td colspan="2">–</td><td colspan="2">–</td><td>–</td><td>SW
CH3</td><td>SW
CH2</td><td>SW
CH1</td><td>6 bytes</td></tr>
<tr><td rowspan="2">4AA-H
+ 4HV</td><td>Input</td><td colspan="4">–</td><td colspan="2">HV4</td><td colspan="2">HV3</td><td colspan="2">HV2</td><td colspan="2">HV1</td><td>16 bytes</td></tr>
<tr><td>Output</td><td colspan="4">–</td><td colspan="2">–</td><td colspan="2">–</td><td>SW
CH3</td><td>SW
CH2</td><td>SW
CH1</td><td>SW
CH0</td><td>8 bytes</td></tr>
</table>

1) IW CH0 = actual value of channel 0 (input), SW CH1 = setpoint value of channel 1 (output), etc.; HV= HART variable

Tab. 14 Process image for variants with HART variables

8.3 HART variables

The process image can be expanded by a total of 4 HART variables ➔ Tab. 14.

– Quantity per HART variable: 4 bytes
– Data format: 16-bit value
  Depending on the higher-order control system, low byte and high byte may be organised differently.
– If an invalid value has been determined, 0xFFFF is transmitted.
– Determination of the HART variables to be transferred during parameterisation ➔ Chap. 8.4.

8.4 Parameterisation

The CPX terminal and the module described here can be parameterised with the operator unit (CPX-MMI), the Festo Maintenance Tool (CPX-FMT) software or the higher-level system.

8.4.1 Recommended parameterisation sequence

Changed parameters are not valid until a complete check and saving procedure have been performed (max. 30 ms).
Until saving and in case of invalid values, the previous settings apply.
To prevent parameterisation errors, observe the following sequence when changing the parameterisation:

1. Activate the “Module CPX monitoring, parameterisation of error control” module parameter ➔ Tab. 16.
2. Activate the “Channel 0 ... 3 monitoring” for the channel to be changed ➔ Tab. 19.
3. Set the data format ➔ Tab. 18.
4. Set the limit values for each channel ➔ Tab. 20, Tab. 21.
   - When the upper limit value is positive, set the upper limit value before setting the lower limit value.
   - If the upper limit value is negative, set the lower limit value before setting the upper limit value.

Further information on parameterisation ➔ Description of system CPX and description of the bus node.

8.4.2 Overview of parameters

Tab. 15 shows an overview of the parameters contained in the analogue module. Detailed parameter description ➔ Chap. 8.4.3.

Function number	Bit	Parameter	Presetting	Details
4828 + m* 64 + **0**	0	Monitoring of short circuit/overload	Active	Tab. 16
	1 … 6	Reserved	–	
	7	Monitoring of parameterisation errors	Active	
4828 + m* 64 + **1**	0	Behaviour after short circuit/overload	Automatic return	Tab. 17
	1 … 7	Reserved	–	
4828 + m* 64 + **2**	0 … 7	Reserved	–	
4828 + m* 64 + **3**	0 … 7	Reserved	–	
4828 + m* 64 + **4**	0 … 7	Reserved	–	
4828 + m* 64 + **5**	0 … 7	Reserved	–	
4828 + m* 64 + **6**	0	Data format	Sign + 15 bits	Tab. 18
	1 … 3	Reserved	–	
	4	Monitoring according to NAMUR NE43	Inactive	
	5 … 6	Reserved	–	
	7	Reserved	–	
4828 + m* 64 + **7 … 10**	0 … 7	Monitoring of channel 0 … 3	–	Tab. 19
4828 + m* 64 + **11 … 18**	0 … 7	Lower limit value of channel 0 … 3	-27648	Tab. 20
4828 + m* 64 + **19 … 26**	0 … 7	Upper limit value of channel 0 … 3	27648	Tab. 21
4828 + m* 64 + **27**	0 … 3	Number of HART repetitions	0	Tab. 22
	4 … 7	Reserved	–	
4828 + m* 64 + **28 … 29**	0 … 7	Limit monitoring hysteresis of channel 0 … 3	0	Tab. 23
4828 + m* 64 + **30**	0 … 7	Signal range of channel 0 … 3	Inactive	Tab. 24
4828 + m* 64 + **31**	0 … 7	Smoothing factor	Inactive	Tab. 26
4828 + m* 64 + **32** 4828 + m* 64 + **33**	0 … 7	IEEE variable 0 … 3	PV, channel 0	Tab. 28
Access via protocol-specific functions		Fail-safe of channel 0 … 3	–	Tab. 31
		Idle mode of channel 0 … 3	–	Tab. 32
		Forcing of channel 0 … 3	–	Tab. 33

Tab. 15 Overview of the module and channel parameters

8.4.3 Description of the module and channel parameters

Module parameters: monitoring of short circuit/overload, monitoring of parameter errors	
Function number	4828 + m* 64 + 0 m = module number (0 ... 47)
Description	Monitoring of the analogue module for the following errors: – Short circuit or overload – Parameterisation errors for the lower and upper limit value, hysteresis The monitoring of the errors can be individually activated or deactivated. Active monitoring has the following effect: – Error message at the CPX bus nodes – The error LED is illuminated ➔ Fig. 18. **SCS monitoring** The SCS monitoring can be activated for the entire terminal CPX ➔ Description of system CPX. **Monitoring of parameterisation errors** Prerequisites for the monitoring of channel-specific parameterisation: – The “Monitoring of parameterisation errors” module parameter is active. – The “Monitoring of parameterisation errors” channel parameter is active ➔ Tab. 19.
Allocation	Bit 0: SCS monitoring (sensor supply short-circuit/overload) Bit 1 ... 6: Reserved Bit 7: Monitoring of parameterisation errors
Values	Bit 0, 7: 0 = Inactive 1 = Active (default)

Tab. 16 Description of the “Module CPX monitoring, parameterisation of error control” module parameter

Module parameter: behaviour after short circuit/overload				
Function number	4828 + m* 64 + 1			m = module number (0 ... 47)
Description	Determination of the behaviour of the power supply after short circuit or overload in an input or output			
Allocation	Bit 0:	Behaviour after short circuit/overload		
	Bit 1 ... 7:	Reserved		
Values	Bit 0:	0 =	Leave voltage deactivated For voltage recovery, “Power On” or a reparameterisation of the module parameter is required.	
		1 =	Restart voltage The voltage is restarted automatically after the cause of the error is remedied (presetting).	

Tab. 17 Description of the “Behaviour after short circuit/overload” module parameter

Module parameter: data format, monitoring according to NAMUR NE43				
Function number	4828 + m* 64 + 6			m = module number (0 ... 47)
Description	Setting of the data format Activation of monitoring according to NAMUR NE43: – Monitoring effective for signal range 4 ... 20 mA (with and without HART) – Error message if the input value undershoots or exceeds the limit values according to NAMUR NE43			
Allocation	Bit 0:	Data format setting		
	Bit 1 ... 3:	Reserved		
	Bit 4:	Monitoring according to NAMUR NE43		
	Bit 7:	Reserved		
Values	Bit 0:	0 =	Sign + 15 bits (presetting)	
		1 =	Linear scaling	
	Bit 4:	0 =	Inactive (presetting)	
		1 =	Active	

Tab. 18 Description of the “Data format, monitoring according to NAMUR NE43” module parameter

Channel parameter: monitoring of channel 0 … 3	
Function number	4828 + m* 64 + 7 m = module number (0 … 47) 4828 + m* 64 + 8 4828 + m* 64 + 9 4828 + m* 64 + 10
Description	Monitoring of the individual channels of the analogue module for the following errors: – Lower and upper limit value – Wire break (idling) – Overflow/underflow – Parameterisation error for the lower and upper limit value The monitoring of the errors can be individually activated or deactivated. Active monitoring has the following effect: – Error message at the CPX bus nodes – The error LED is illuminated ➔ Fig. 18. **Monitoring of lower and upper limit values** – Error message when the lower limit value is undershot ➔ Tab. 20. – Error message when the upper limit value is exceeded ➔ Tab. 21. **Monitoring of wire break (idling)** – Effective for signal range 4 … 20 mA (with and without HART) – Range of values for wire break detection at inputs ➔ Chap. 8.5. – The wire break detection at outputs is effective only if the current value output amounts to at least 1 mA. **Monitoring of overflow/underflow** Error message when the range of values is left ➔ Chap. 8.5. **Monitoring of parameterisation errors** Prerequisites for the monitoring of channel-specific parameterisation: – The “Monitoring of parameterisation errors” module parameter is active ➔ Tab. 16. – The “Monitoring of parameterisation errors” channel parameter is active.
Allocation	Bit 0: Monitoring of lower limit value Bit 1: Monitoring of upper limit value Bit 2: Monitoring of wire break (idling) Bit 3: Monitoring of overflow/underflow Bit 4 … 6: Reserved Bit 7: Monitoring of parameterisation errors
Values	Bit 0 … 3: 0 = Inactive (presetting) 1 = Active Bit 7: 0 = Inactive 1 = Active (default)

Tab. 19 Description of “Monitoring of channel 0 … 3” channel parameter

Channel parameter: lower limit value of channel 0 … 3		
Function number	4828 + m * 64 + 11 (channel 0, low byte) 4828 + m * 64 + 13 (channel 1, low byte) 4828 + m * 64 + 15 (channel 2, low byte) 4828 + m * 64 + 17 (channel 3, low byte)	4828 + m * 64 + 12 (channel 0, high byte) 4828 + m * 64 + 14 (channel 1, high byte) 4828 + m * 64 + 16 (channel 2, high byte) 4828 + m * 64 + 18 (channel 3, high byte) m = module number (0 … 47)
Description	Setting of the lower limit value for the individual channels of the analogue input module ➔ Chap. 8.6. – The lower limit value must be smaller than the upper limit value. – The permissible values depend on the set data format ➔ Tab. 18. – With data format “linear scaling,” the limit values have the function of scaling end values. Prerequisites for the monitoring of channel-specific parameterisation: – The “Monitoring of parameterisation errors” module parameter is active ➔ Tab. 16. – The “Monitoring of parameterisation errors” channel parameter is active ➔ Tab. 19. Active monitoring has the following effect: – Invalid values are not assumed. The last valid value is kept.	
Allocation	Bit 0 … 7:	Low byte or high byte as limit value
Values	Presetting:	-27648 (low byte = 0, high byte = 148)

Tab. 20 Description of “Lower limit value of channel 0 … 3” channel parameter

Channel parameter: upper limit value of channel 0 ... 3		
Function number	4828 + m * 64 + 19 (channel 0, low byte) 4828 + m * 64 + 21 (channel 1, low byte) 4828 + m * 64 + 23 (channel 2, low byte) 4828 + m * 64 + 25 (channel 3, low byte)	4828 + m * 64 + 20 (channel 0, high byte) 4828 + m * 64 + 22 (channel 1, high byte) 4828 + m * 64 + 24 (channel 2, high byte) 4828 + m * 64 + 26 (channel 3, high byte) m = module number (0 ... 47)
Description	Setting of the upper limit value for the individual channels of the analogue input module ➔ Chap. 8.6. – The upper limit value must be greater than the lower limit value. – The permissible values depend on the set data format ➔ Tab. 18. – With data format “linear scaling”, the limit values have the function of scaling end values. Prerequisites for the monitoring of channel-specific parameterisation: – The “Monitoring of parameterisation errors” module parameter is active ➔ Tab. 16. – The “Monitoring of parameterisation errors” channel parameter is active ➔ Tab. 19. Active monitoring has the following effect: – Invalid values are not assumed. The last valid value is kept.	
Allocation	Bit 0 ... 7:	Low byte or high byte as limit value
Values	Presetting:	27648 (low byte = 0, high byte = 108)

Tab. 21 Description of “Upper limit value of channel 0 ... 3” channel parameter

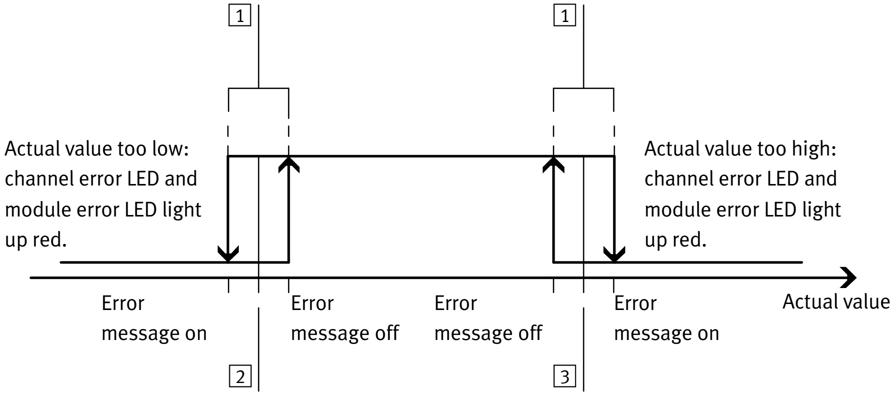
Module parameter: HART repetition		
Function number	4828 + m* 64 + 27	m = module number (0 … 47)
Description	If the analogue module receives a faulty or no answer from a HART telegram sent to the field device, the telegram is sent repeatedly according to the set value (0 … 10).	
Allocation	Bit 0 … 3:	Number of repetitions
Values	Presetting:	0
	Range of values:	0 … 10
	Recommended setting:	5

Tab. 22 Description of the “HART repetition” module parameter

Module parameter: limit monitoring hysteresis of channel 0 … 3		
Function number	4828 + m* 64 + 28 (low byte) 4828 + m* 64 + 29 (high byte)	m = module number (0 … 47)
Description	Setting of the hysteresis behaviour for limit monitoring: – The hysteresis applies to all channels simultaneously. – The set hysteresis value must not be larger than the difference between the upper and lower limit values. – The hysteresis value is not checked during entry. If an invalid value has been assumed, the analogue module can react unexpectedly. Prerequisites for the monitoring of channel-specific parameterisation: – The “Monitoring of parameterisation errors” module parameter is active ➔ Tab. 16. Active monitoring has the following effect: – Error message (limit values and hysteresis ➔ Fig. 17)	
Allocation	Bit 0 … 7:	Low byte or high byte of hysteresis
Values	Presetting:	0 (low byte = 0, high byte = 0)

Tab. 23 Description of the “Limit monitoring hysteresis” module parameter

Limit values and hysteresis



1 Hysteresis
2 Lower limit value
3 Upper limit value

Fig. 17 Error messages at hysteresis

The hysteresis has the same variable for both limit values and is located in the middle between the values.
If a hysteresis is set, the analogue module behaves as follows:

– If the lower limit value is undershot by the half hysteresis value, an error message is output.
– If the lower limit value is exceeded by the half hysteresis value, an error message extinguishes.
– If the upper limit value is exceeded by the half hysteresis value, an error message is output.
– If the upper limit value is undershot by the half hysteresis value, an error message extinguishes.

Channel parameter: signal range of channel 0 ... 3		
Function number	4828 + m* 64 + 30	m = module number (0 ... 47)
Description	Setting of the signal range of the inputs and outputs for the individual channels of the analogue input module ➔ Chap. 8.5.	
Allocation	Bit 0 ... 1: Signal range of channel 0 Bit 2 ... 3: Signal range of channel 1 Bit 4 ... 5: Signal range of channel 2 Bit 6 ... 7: Signal range of channel 3	
Values	➔ Tab. 25.	

Tab. 24 Description of "Signal range of channel 0 ... 3" channel parameter

Allocation and values 4828 + m* 64 + 30 (m = module number)										
Bit	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**	**Channel**	**Signal range**
	x	x	x	x	x	x	0	0	Channel 0	Inactive
	x	x	x	x	x	x	0	1		4 ... 20 mA without HART
	x	x	x	x	x	x	1	0		4 ... 20 mA with HART
	x	x	x	x	x	x	1	1		0 ... 20 mA
	x	x	x	x	0	0	x	x	Channel 1	Inactive
	x	x	x	x	0	1	x	x		4 ... 20 mA without HART
	x	x	x	x	1	0	x	x		4 ... 20 mA with HART
	x	x	x	x	1	1	x	x		0 ... 20 mA
	x	x	0	0	x	x	x	x	Channel 2	Inactive
	x	x	0	1	x	x	x	x		4 ... 20 mA without HART
	x	x	1	0	x	x	x	x		4 ... 20 mA with HART
	x	x	1	1	x	x	x	x		0 ... 20 mA
	0	0	x	x	x	x	x	x	Channel 3	Inactive
	0	1	x	x	x	x	x	x		4 ... 20 mA without HART
	1	0	x	x	x	x	x	x		4 ... 20 mA with HART
	1	1	x	x	x	x	x	x		0 ... 20 mA

Tab. 25 Allocation and values of the "Signal range" channel parameter

Channel parameter: smoothing factor of channel 0 … 3		
Function number	4828 + m* 64 + 31	m = module number (0 … 47)
Description	Setting of the smoothing factor for the individual channels of the analogue input module: – With the smoothing factor, malfunctions can be suppressed. – Calculation of the smoothing factor: arithmetic mean value from n values	
Allocation	Bit 0 … 1: Smoothing factor of channel 0 Bit 2 … 3: Smoothing factor of channel 1 Bit 4 … 5: Smoothing factor of channel 2 Bit 6 … 7: Smoothing factor of channel 3	
Values	➔ Tab. 27.	

Tab. 26 Description of the "Smoothing factor of channel 0 … 3" channel parameter

Allocation and values 4828 + m* 64 + 31 (m = module number)										
Bit	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**	**Channel**	**Smoothing factor**
	x	x	x	x	x	x	0	0	Channel 0	Inactive
	x	x	x	x	x	x	0	1		Smoothing over 2 values
	x	x	x	x	x	x	1	0		Smoothed over 4 values
	x	x	x	x	x	x	1	1		Smoothing over 8 values
	x	x	x	x	0	0	x	x	Channel 1	Inactive
	x	x	x	x	0	1	x	x		Smoothing over 2 values
	x	x	x	x	1	0	x	x		Smoothed over 4 values
	x	x	x	x	1	1	x	x		Smoothing over 8 values
	x	x	0	0	x	x	x	x	Channel 2	Inactive
	x	x	0	1	x	x	x	x		Smoothing over 2 values
	x	x	1	0	x	x	x	x		Smoothed over 4 values
	x	x	1	1	x	x	x	x		Smoothing over 8 values
	0	0	x	x	x	x	x	x	Channel 3	Inactive
	0	1	x	x	x	x	x	x		Smoothing over 2 values
	1	0	x	x	x	x	x	x		Smoothing over 4 values
	1	1	x	x	x	x	x	x		Smoothing over 8 values

Tab. 27 Allocation and values of the "Smoothing factor" channel parameter

Channel parameter: IEEE variable of channel 0 ... 3	
Function number	4828 + m* 64 + 32 m = module number (0 ... 47) (HART variable 1, HART variable 2) 4828 + m* 64 + 33 (HART variable 3, HART variable 4)
Description	For each HART variable in the process image, the channel and source can be determined: – HART variables can be set individually for each channel. – To use the HART variables: set the DIL switch ➔ Chap. 7.3.
Allocation	Bit 0, 1 Source of HART variable 1 or HART variable 3 Bit 2, 3 Channel of HART variable 1 or HART variable 3 Bit 4, 5 Source of HART variable 2 or HART variable 4 Bit 6, 7 Channel of HART variable 2 or HART variable 4
Values	➔ Tab. 29, Tab. 30.

Tab. 28 Description of "IEEE variable of channel 0 ... 3" channel parameter

Allocation and values 4828 + m* 64 + 32 (m = module number)									
Bit	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**	**HART variable 1, HART variable 2**
	x	x	x	x	x	x	0	0	Source of HART variable 1 = PV (presetting)
	x	x	x	x	x	x	0	1	Source of HART variable 1 = SV
	x	x	x	x	x	x	1	0	Source of HART variable 1 = TV
	x	x	x	x	x	x	1	1	Source of HART variable 1 = QV
	x	x	x	x	0	0	x	x	Channel of HART variable 1 = channel 0 (presetting)
	x	x	x	x	0	1	x	x	Channel of HART variable 1 = channel 1
	x	x	x	x	1	0	x	x	Channel of HART variable 1 = channel 2
	x	x	x	x	1	1	x	x	Channel of HART variable 1 = channel 3
	x	x	0	0	x	x	x	x	Source of HART variable 2 = PV (presetting)
	x	x	0	1	x	x	x	x	Source of HART variable 2 = SV
	x	x	1	0	x	x	x	x	Source of HART variable 2 = TV
	x	x	1	1	x	x	x	x	Source of HART variable 2 = QV
	0	0	x	x	x	x	x	x	Channel of HART variable 2 = channel 0 (presetting)
	0	1	x	x	x	x	x	x	Channel of HART variable 2 = channel 1
	1	0	x	x	x	x	x	x	Channel of HART variable 2 = channel 2
	1	1	x	x	x	x	x	x	Channel of HART variable 2 = channel 3

Tab. 29 Allocation and values of "IEEE variable of HART variable 1, HART variable 2" channel parameter

Allocation and values 4828 + m* 64 + 33 (m = module number)									
Bit	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**	**HART variable 3, HART variable 4**
	x	x	x	x	x	x	0	0	Source of HART variable 3 = PV (presetting)
	x	x	x	x	x	x	0	1	Source of HART variable 3 = SV
	x	x	x	x	x	x	1	0	Source of HART variable 3 = TV
	x	x	x	x	x	x	1	1	Source of HART variable 3 = QV
	x	x	x	x	0	0	x	x	Channel of HART variable 3 = channel 0 (presetting)
	x	x	x	x	0	1	x	x	Channel of HART variable 3 = channel 1
	x	x	x	x	1	0	x	x	Channel of HART variable 3 = channel 2
	x	x	x	x	1	1	x	x	Channel of HART variable 3 = channel 3
	x	x	0	0	x	x	x	x	Source of HART variable 4 = PV (presetting)
	x	x	0	1	x	x	x	x	Source of HART variable 4 = SV
	x	x	1	0	x	x	x	x	Source of HART variable 4 = TV
	x	x	1	1	x	x	x	x	Source of HART variable 4 = QV
	0	0	x	x	x	x	x	x	Channel of HART variable 4 = channel 0 (presetting)
	0	1	x	x	x	x	x	x	Channel of HART variable 4 = channel 1
	1	0	x	x	x	x	x	x	Channel of HART variable 4 = channel 2
	1	1	x	x	x	x	x	x	Channel of HART variable 4 = channel 3

Tab. 30 Allocation and values of “IEEE variable of HART variable 3, HART variable 4” channel parameter

Module parameter: Fail-Safe channel 0 … 3	
Function number	Access to this module parameter is made via protocol-specific functions ➔ Description for the bus node.
Description	Channel-specific determination as to which signal status the outputs have during fieldbus communication errors. Fail-Safe can be defined for the entire terminal CPX via the “Fail-Safe” system parameter ➔ Description of system CPX. **Parameterisation of “Fault-Mode of channel x”** Depending on the fieldbus protocol, “Fault-Mode” is parameterised as follows: – By setting a parameter bit (e.g., for CPX-FB11) – By setting all parameter bits of the pertinent work to “Hold Last State” or “Fault State” (e.g. for CPX-FB13) **Parameterisation of “Fault State of channel x”** The desired output word must be mapped in the “Fault State” parameter bits of the respective channel.
Values	Fault-Mode of channel 0 … 3: 0 = Hold Last State 1 = Fault State (presetting) Fault State of channel 0 … 3: 0 = Reset value (presetting) 1 = Set value

Tab. 31 Description of “Fail-Safe of channel 0 … 3” module parameter

Module parameter: Idle-Mode channel 0 … 3	
Function number	Access to this module parameter is made via protocol-specific functions ➔ Description for the bus node.
Description	Channel-specific determination as to which signal status the outputs have during the call of the idle function. Idle-Mode can be defined for the entire terminal CPX via the “System Idle-Mode” system parameter ➔ Description of system CPX. **Parameterisation of “Idle-Mode of channel x”** “Idle-Mode” is parameterised by setting a parameter bit. **Parameterisation of “Idle State of channel x”** The desired output word must be mapped in the “Idle State” parameter bits of the respective channel.
Values	Idle-Mode of channel 0 … 3: 0 = Hold Last State 1 = Fault State (presetting) Idle State of channel 0 … 3: 0 = Reset value (presetting) 1 = Set value

Tab. 32 Description of “Idle-Mode of channel 0 … 3” module parameter

Module parameter: forcing of channel 0 … 3	
Function number	Access to this module parameter is made via protocol-specific functions ➔ Description for the bus node.
Description	With the forcing function, the digital input and output values can be influenced independently of the actually pending input and output signal. Forcing can be defined for the entire terminal CPX via the "Force Mode" system parameter ➔ Description of system CPX. **Parameterisation of "Force-Mode of channel x"** Depending on the fieldbus protocol, "Force-Mode" is parameterised as follows: – By setting a parameter bit (e.g., for CPX-FB11) – By setting all parameter bits of the pertinent word to "blocked" or "Force State" (e.g. for CPX-FB13) **Parameterisation of "Force State of channel x"** The desired output word must be mapped in the "Force State" parameter bits of the respective channel.
Values	Force-Mode of channel 0 … 3: 0 = Disabled (presetting) 1 = Force State Force State of channel 0 … 3: 0 = Reset value (presetting) 1 = Set value

Tab. 33 Description of the "Forcing of channel 0 … 3" module parameter

8.5 Data format and range of values of the actual values

8.5.1 Data format

The data format determines how the actual values (analogue values) are transferred by terminal CPX to the control system.

Data format																
Input data field	D15	D14 MSB	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0 LSB
Value	VZ[1)]	Digital input value														

1) VZ = sign (0 = positive, 1 = negative)

Tab. 34 Data format of the module CPX-4AE-4AA-H

– Range of values -32768 ... 0 ... 32767

8.5.2 Input 4 ... 20 mA - fixed data format

– Measuring range 4 ... 20 mA
– Data format: sign + 15 bits
– Data format not scalable
– Conversion of analogue actual value to the digital input value:

$$\text{Digital input value} = (\text{Actual value} - 4) \times \frac{27648}{16}$$

Actual value	Digital input value	Significance
› 22.81 mA	32767	Overflow
22.81 mA	32511	End of the measuring range
› 20 mA	27649 ... 32511	Overdrive range
4 ... 20 mA	0 ... 27648	Nominal range
‹ 4 mA	-1 ... -4864	Underdrive range
1.19 mA	-4864	End of the measuring range

Tab. 35 Range of values for fixed data format (input 4 ... 20 mA)

8.5.3 Input 4 ... 20 mA – scalable data format

– Measuring range 4 ... 20 mA
– Scalable data format -32768 ... 0 ... 32767
– Scaling above the lower and upper limit value
– Use of the limit values for diagnostics
– Conversion of the current values 1.19 ... 22.81 mA (for sufficiently scaled data range)
– Overflow or underflow for values outside of the data range for actual values (› 22.81 mA or ‹ 1.19 mA) or digital input value (› 32767 or ‹ -32768)
– Conversion of analogue actual value to the digital input value:

$$\text{Digital input value} = (\text{Actual value} - 4) \times \frac{\text{Upper limit value} - \text{Lower limit value}}{16} + \text{Lower limit value}$$

To perform complete diagnostics: do not scale the measuring range above the complete data range.

Actual value	Digital input value	Significance
4 ... 20 mA	-32768 ... 32767	Nominal range, freely scalable
‹ 1.19 mA	-32768	Underflow

Tab. 36 Range of values for scalable data format (input 4 ... 20 mA)

8.5.4 Input 0 ... 20 mA – fixed data format

- Measuring range 0 ... 20 mA
- Data format not scalable
- No underflow: actual values < 0 mA not possible (reverse polarity protection)
- Conversion of analogue actual value to the digital input value:

$$\text{Digital input value} = \text{Actual value} \times \frac{27648}{20}$$

Actual value	Digital input value	Significance
23.52 mA	32511	End of the measuring range
> 20 mA	27649 ... 32511	Overdrive range
0...20 mA	0 ... 27648	Nominal range
< 0 mA	–	Underflow not possible: reverse polarity protection

Tab. 37 Range of values for fixed data format (input 0 ... 20 mA)

8.5.5 Input 0 ... 20 mA – scalable data format

- Measuring range 0 ... 20 mA
- Scalable data format -32768 ... 0 ... 32767
- Scaling above the lower and upper limit value
- Use of the limit values for diagnostics
- Conversion of the current values 0 ... 23.52 mA (for sufficiently scaled data range)
- Overflow or underflow for values outside of the data range (> 32767 or < -32768)
- No underflow: actual values < 0 mA not possible (reverse polarity protection)
- Conversion of analogue actual value to the digital input value:

$$\text{Digital input value} = \text{Actual value} \times \frac{\text{Upper limit value} - \text{Lower limit value}}{20} + \text{Lower limit value}$$

Actual value	Digital input value	Significance
> 23.52 mA (hysteresis < 23.42 mA)	32767	Overflow
0 ... 20 mA	-32768 ... 32767	Nominal range, freely scalable
< 0 mA	< -32768	Underflow not possible: reverse polarity protection

Tab. 38 Range of values for scalable data format (input 0 ... 20 mA)

8.5.6 Output 4 ... 20 mA – fixed data format

- Range of values 4 ... 20 mA
- Data format not scalable
- Current value output 0 ... 22 mA
- Current value output in case of overflow (› 22 mA): 22 mA
- Current value output in case of underflow (‹ 0 mA): 0 mA
- Conversion of the digital output value to the analogue setpoint value (current value output)

$$\text{Current value} = 4 + 16 \times \frac{\text{Digital output value}}{27648}$$

Digital output value	Current value output	Significance
› 31104	22 mA	Overflow
31104	22 mA	End of output range
27649 ... 31104	› 20 mA	Overdrive range
0 ... 27648	4 ... 20 mA	Nominal range
-1 ... -6912	‹ 4 mA	Underdrive range
-6912	0 mA	End of output range
‹ -6912	0 mA	Underflow

Tab. 39 Range of values in case of fixed data format (output 4 ... 20 mA)

8.5.7 Output 4 ... 20 mA – scalable data format

- Range of values -32768 ... 0 ... 32767
- Scalable data format -32768 ... 0 ... 32767
- Scaling above the lower and upper limit value
- Use of the limit values for diagnostics
- Current value output 0 ... 22 mA (for sufficiently scaled data range)
- Current value output in case of overflow (› 22 mA): 22 mA
- Current value output in case of underflow (‹ 0 mA): 0 mA
- Conversion of the digital output value to the analogue setpoint value (current value output)

$$\text{Current value} = 4 + 16 \times \frac{\text{Digital output value} - \text{Lower limit value}}{\text{Upper limit value} - \text{Lower limit value}}$$

Digital output value	Current value output	Significance
› 32767	22 mA	Overflow
-32768 ... 0 ... 32767	4 ... 20 mA	Nominal range, freely scalable
‹ -32768	0 mA	Underflow

Tab. 40 Range of value for scalable data format (output 4 ... 20 mA)

8.5.8 Output 0 ... 20 mA – fixed data format

- Range of values 0 ... 20 mA
- Data format not scalable
- Current value output in case of overflow (> 22 mA): 22 mA
- Current value output in case of underflow (< 0 mA): 0 mA
- Conversion of the digital output value to the analogue setpoint value (current value output)

$$\text{Current value} = 20 \times \frac{\text{Digital output value}}{27648}$$

Digital output value	Current value output	Significance
> 30413	22 mA	Overflow
30413	22 mA	End of output range
27649 ... 30413	> 20 mA	Overdrive range
0 ... 27648	0 ... 20 mA	Nominal range
0	0 mA	End of output range
< 0	0 mA	Underflow

Tab. 41 Range of values in case of fixed data format (output 0 ... 20 mA)

8.5.9 Output 0 ... 20 mA – scalable data format

- Range of values 0 ... 20 mA
- Data format scalable from -32768 ... 0 ... 32767
- Scaling above the lower and upper limit value
- Use of the limit values for diagnostics
- Current value output in case of overflow (> 22 mA): 22 mA
- Current value output in case of underflow (< 0 mA): 0 mA
- Conversion of the digital output value to the analogue setpoint value (current value output)

$$\text{Current value} = 20 \times \frac{\text{Digital output value} - \text{Lower limit value}}{\text{Upper limit value} - \text{Lower limit value}}$$

Digital output value	Current value output	Significance
> 32767	22 mA	Overflow
-32768 ... 0 ... 32767	0 ... 20 mA	Nominal range, freely scalable
< -32768	0 mA	Underflow

Tab. 42 Range of values for scalable data format (output 0 ... 20 mA)

8.6 Scaling the range of values

For the scalable data format, the range of values can be scaled by setting the limit values. To process the diagnostics correctly, the distance between both limit values should amount to at least 100_{dec}.

1. Set the “linear scaling” data format ➔ Tab. 18.
2. Set the limit values for each channel ➔ Tab. 20, Tab. 21.
   The limit values represent the scaling end values:
   – When the upper limit value is positive, set the upper limit value before setting the lower limit value.
   – If the upper limit value is negative, set the lower limit value before setting the upper limit value.

Example: scaling appropriate for a pressure sensor

The sensor linearly converts the measuring range 0 ... 6 bar to analogue current values 0 ... 20 mA.

Actual value (example)	Digital input value	Significance
0 mA	0	Lower limit value
10 mA	3000	Value in nominal range
20 mA	6000	Upper limit value
22 mA	6600	Limit value exceeded

Tab. 43 Example of scaling and limit monitoring for a pressure sensor

9 Diagnostics

9.1 General remarks

Specific errors of the analogue module are reported or suppressed dependent on the module parameterisation ➔ Tab. 16.
The monitoring of the errors can be activated or deactivated independently of each other.
Active monitoring has the following effect:

- ➔ The error is sent to the CPX bus node.
- ➔ The module error LED and channel error LED light up.

The representation of errors in the bus nodes depends on the bus protocol ➔ Description of bus nodes.
A further possibility for diagnostics is the operator unit CPX-MMI. The operator unit displays the error messages in clear text ➔ Description of operator unit CPX-MMI.

9.2 Error messages

Error number	Error description	Error elimination
2	**Short circuit or overload at the input or output[1)]** – The behaviour in case of short circuit/overload and the error elimination measures depend on the parameterisation of the "Behaviour after short circuit/overload" module parameter. – Parameter description ➔ Tab. 17.	1. Check the cables and connected devices. Replace defective cables and devices. 2. Switch voltage on again.
3	**Wire break (idling) of current input or current output[1)]** – Only for signal range 4 ... 20 mA – Input: I_{IN} < 1.2 mA – Output: no signal is present. – Parameter description ➔ Tab. 19.	• Check the cables and connected devices. Replace defective cables and devices.
9	**Lower limit value undershot[1)]** – The parameterised lower limit value has been undershot. – Parameter description ➔ Tab. 19.	• Check analogue input. • Check parameterised limit value.
10	**Upper limit value exceeded[1)]** – The parameterised upper limit value has been exceeded. – Parameter description ➔ Tab. 19.	• Check analogue input. • Check parameterised limit value.
29	**Error in parameterisation[1)]** – Parameterisation is implausible. – The previous parameter setting of the channel is kept.	• Reparameterise with valid parameters ➔ Chap. 8.5.
60	**Overflow/underflow[2)]** – The actual value or setpoint value lies outside of the measuring range or displayable range of values. – Parameter description ➔ Tab. 19.	• Check analogue input. • Check the cables and connected devices. Replace defective cables and devices.
100	**Configuration error** – The DIL switch is incorrectly set.	• Correct the setting of the DIL switch ➔ Chap. 7.3.

1) The module displays the error depending on the parameterisation. The digital input values are processed again.

2) The diagnostics are output with the first recorded input value and kept until valid input values have been recorded for at least 200 ms.

Error number	Error description	Error elimination
121	**Limit value according to NAMUR NE43 exceeded** – Only for signal range 4 ... 20 mA – Input: I_{IN} ≥ 21.00 mA – Parameter description ➔ Tab. 18.	• Check analogue input. • Reparameterise with valid parameters.
122	**Limit value according to NAMUR NE43 undershot** – Only for signal range 4 ... 20 mA – Input: I_{IN} ≤ 3.6 mA – Parameter description ➔ Tab. 18.	• Check analogue input. • Reparameterise with valid parameters.

1) The module displays the error depending on the parameterisation. The digital input values are processed again.

2) The diagnostics are output with the first recorded input value and kept until valid input values have been recorded for at least 200 ms.

Tab. 44 Error messages of the analogue module

9.3 LED indicator

1 Module error indicator (red LED) ➔ Tab. 45.
2 Channel error indicator (red LED) ➔ Tab. 46.
3 Channel status indicator of input ➔ Tab. 47.
4 Channel status indicator of output ➔ Tab. 48.

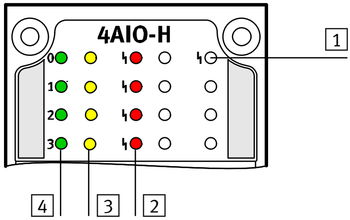


Fig. 18 LED indicator of analogue module

The display of errors can be suppressed during parameterisation ➔ Tab. 16, Tab. 19.

Module error indicator

LED (red)	Description
Off	Error-free operation
Lights up	Module error – All channel-specific errors – Parameterisation errors of hysteresis ➔ Tab. 17. – The DIL switch is incorrectly set.

Tab. 45 Indicator: module error LED

Channel error indicator

Each channel is assigned an LED.

LED (red)	Description
Off	Error-free operation
Lights up	Channel-specific errors ➔ Tab. 44.

Tab. 46 Indicator: channel error LED

Channel status indicator of input

The LEDs 0 … 3 (green) indicate the status of the individual channels.

LED (green)	Description
Off	Channel inactive or active as output
Flashes	Channel active as input: – Signal range 4 … 20 mA with HART – HART communication error-free
Lights up	Channel active as input

Tab. 47 Indicator: status LED for channel status of input

Channel status indicator of output

The LEDs 0 … 3 (yellow) indicate the status of the individual channels.

LED (yellow)	Description
Off	Channel inactive or active as input
Flashes	Channel active as output: – Signal range 4 … 20 mA with HART – HART communication error-free
Lights up	Channel active as output

Tab. 48 Indicator: status LED for channel status of output

10 Technical data

Technical data of terminal CPX ➔ Description of system CPX.

Feature		Specification/value
Dimensions (Length x Width x Height)	[mm]	107 x 50 x 70, including interlinking block and connection block
Product weight, including interlinking	[g]	78
Type of mounting		On interlinking block
Ambient temperature	[°C]	-5 ... 50
Storage temperature	[°C]	-20 ... 70
Air humidity (non-condensing)	[%]	95
Degree of protection to EN 60529		Depending on connection block
Electromagnetic compatibility		To EN 61000-6-2/-4
CE marking (Declaration of conformity ➔ www.festo.com/sp)		In accordance with EU explosion protection guideline (ATEX) In accordance with EU EMC Directive
Note on materials		RoHS compliant
Information on materials		
– Housing		PA reinforced PC

Tab. 49 General technical data

Feature		Specification/value
Power supply		
Nominal operating voltage	[V DC]	24
Operating voltage range	[V DC]	18 … 30
Intrinsic current consumption at nominal operating voltage	[mA]	Typically 170, max. 200
Electrical connection		– M12 4-pin – Spring-loaded terminal – Screw terminal
Reverse polarity protection		– For operating voltage – Per channel for inputs and outputs
Analogue current channels		
Quantity		4, selectable as inputs or outputs
Signal range	[mA]	– 0 … 20 without HART – 4 … 20 without HART – 4 … 20 with HART
Repetition accuracy at 25 °C	[%]	0.05
Operating error limit related to the ambient temperature range	[%]	± 0.3
Basic error limit at 25 °C	[%]	± 0.1
Analogue inputs		
Input resistance	[Ω]	300
Open circuit voltage	[V DC]	Max. 28.8
Short circuit current	[mA]	Max. 22
Available sensor voltage	[V]	Min. 20.7 at 20 mA
Sensor cable length	[m]	Max. 500 (screened)
Electrical isolation between channels		None
Electrical isolation between channel and internal bus		Yes
Fuse protection (short circuit)		Per channel
Analogue outputs		
Load resistance	[Ω]	Max. 750

Tab. 50 Electrical data

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