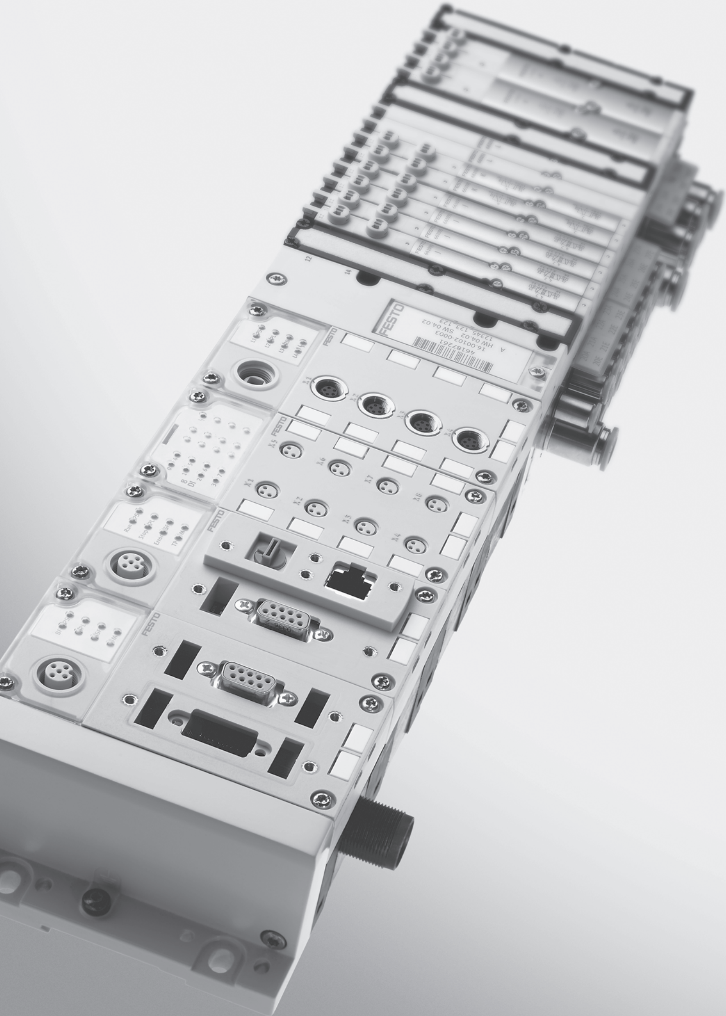
CPX Terminal



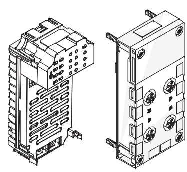
FESTO

Manual Electronics

CPX analogue
I/O modules

I/O modules
– CPX-2AE-U-I
– CPX-4AE-U-I
– CPX-4AE-I
– CPX-4AE-T
– CPX-4AE-TC
– CPX-4AE-P
– CPX-2AA-U-I

Sub-bases
– CPX-AB-...
– CPX-M-...



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Order no. 526 416

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E-Mail: service_international@festo.com

Contents

Intended use

The CPX analogue I/O modules described in this manual have been designed exclusively for use in conjunction with CPX terminals from Festo. The analogue I/O modules must only be used as follows:

- as intended
- in perfect technical condition
- without any modifications by the user.

If commercially available accessory components such as sensors and actuators are connected, the specified limits for pressures, temperatures, electrical data, torques etc. must be observed.

Please observe the standards specified in the relevant chapters and comply with the regulations of the trade associations and the German Technical Control Board (TÜV), the VDE conditions as well as the relevant national regulations.

Warning

- Only use PELV power **circuits** according to IEC/DIN EN 60204-1 (Protective Extra-Low Voltage, PELV) for the power supply.
  Also take into account the general requirements for PELV power circuits according to IEC/DIN EN 60204-1.
- Only use **power sources** that guarantee reliable electrical isolation of the operating voltage according to IEC/DIN EN 60204-1.

Protection against electric shock (protection against direct and indirect contact) is guaranteed in accordance with IEC/DIN EN 60204-1 (electrical equipment of machines, general requirements) by using PELV power circuits.

Areas of application and certification

The products fulfil the requirements of EU directives and bear the CE marking.

Standards and test values, which the products must comply with and fulfil, can be found in the section "Technical appendix". The product-relevant EU directives can be found in the declaration of conformity.

Certificates and declarations of conformity for these products can be found at www.festo.com.

Target group

This manual is intended exclusively for technicians trained in control and automation technology, who have experience in installing, commissioning, programming and diagnosing programmable logic controllers (PLC) and fieldbus systems/networks.

Service

Please consult your local Festo Service agent if you have any technical problems.

Important user instructions

Danger categories

This manual contains instructions on the possible dangers which may occur if the product is not used correctly. These instructions are marked (Warning, Caution, etc.), printed on a shaded background and marked additionally with a pictogram. A distinction is made between the following danger warnings:

Warning
This means that failure to observe this instruction may result in serious personal injury or damage to property.

Caution
This means that failure to observe this instruction may result in personal injury or damage to property.

Note
This means that failure to observe this instruction may result in damage to property.

The following pictogram marks passages in the text which describe activities with electrostatically sensitive components.

Electrostatically sensitive components may be damaged if they are not handled correctly.

Marking specific information

The following pictograms mark passages in the text containing specific information.

Pictograms

Information:
Recommendations, tips and references to other sources of information.

Accessories:
Information on necessary or sensible accessories for the Festo product.

Antipollution:
Information on environment-friendly use of Festo products.

Text markings

- The bullet indicates activities which may be carried out in any order.

1. Figures denote activities which must be carried out in the numerical order specified.

– Hyphens indicate general activities.

Notes on the use of this manual

This manual contains general basic information about the mode of operation, fitting and installation of analogue CPX I/O modules, CPX connection blocks and CPX pneumatic interfaces.

General basic information about the mode of operation, fitting, installation and commissioning of CPX terminals can be found in the CPX system description.

Specific information about commissioning, parameterisation and diagnostics of CPX terminal with the bus node you are using can be found in the appropriate manual for the bus node.

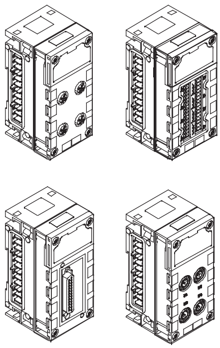
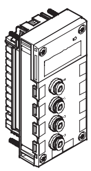
Information about further CPX modules can be found in the manual for the respective module.

Information about MPA pneumatic and electronic modules can be found in a separate description of type P.BE-MPA-ELEKTRONIK-...

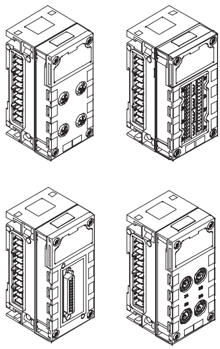
An overview of the structure of the CPX terminal user documentation is contained in the CPX system description.

CPX analogue I/O modules

The I/O modules each consist of the electronic module as well as a connection block and an interlinking block. Note the possible combinations of connection blocks and electronics modules in section 1.2.2.
This manual contains information on the mode of operation, the fitting and installation of the following modules:

Analogue input modules	**Type**	**Description**
 Modules with various connection blocks	– CPX-2AE-U-I	Input module with 2 analogue inputs, signal range optional per input channel: – 0 ... 10 V – 0 ... 20 mA – 4 ... 20 mA
	– CPX-4AE-U-I	Input module with 4 analogue inputs, signal range optional per input channel: – 0 ... 10 V, -10 ... +10 V – 1 ... 5 V, -5 ... +5 V – 0 ... 20 mA, -20 ... +20 mA – 4 ... 20 mA
	– CPX-4AE-I	Input module with 4 analogue inputs, signal range optional per input channel: – 0 ... 20 mA – 4 ... 20 mA
	– CPX-4AE-T	Input module with up to 4 analogue inputs for registering the temperature. Number of inputs can be selected with DIL switch (2 or 4).
	– CPX-4AE-TC	Input module with 4 analogue inputs for registering the temperature with temperature coupler sensors
	– CPX-4AE-P-...	Input module with 4 pneumatic connections for recording pressure values. The pressure values are provided as analogue input signals in the CPX terminal. – 0 ... 10 bar – Relative pressure measurement on up to 4 channels – Differential pressure measurement between any 2 channels is possible

Tab. 0/1: Overview of analogue input modules

Analogue output modules	**Type designation**	**Description**
 Modules with various connection blocks	– CPX-2AA-U-I	Output module with 2 analogue outputs, signal range optional per output channel: – 0 ... 10 V – 0 ... 20 mA – 4 ... 20 mA

Tab. 0/2: Overview of analogue output modules

Information about the interlinking blocks can be found in the CPX system manual.

Diagnosis via the field bus or a network

Depending on the parameterisation, CPX I/O modules report the specific errors via the field bus or your network.

These can be evaluated via the:

- status bits (system status)
- I/O diagnostic interface (system diagnosis)
- module diagnosis
- error numbers.

Further information on diagnosis can be found in the CPX system manual or in the manual for the bus node.

The following product-specific terms and abbreviations are used in this manual:

Term/abbreviation	Meaning
AI	Analogue input (input channel, 16 bits)
AO	Analogue output (output channel, 16 bits)
Analogue I/Os	Analogue inputs and outputs
Analogue output module	CPX output module with analogue outputs
Analogue input module	CPX input module with analogue inputs
Connection block	Exchangeable housing upper part of modules with connection technology
CPX terminal	Modular electric terminal type 50
CPX modules	Common term for the various modules which can be incorporated in a CPX terminal
Data	The CPX terminal provides settings and diagnostic information in the form of data; the data can be read but not changed
DIL switch	Dual-in-line switches usually consist of several switch elements with which settings can be made
I/O diagnostic interface	The I/O diagnostic interface is a bus-independent diagnostic interface at I/O level, permitting access to internal data of the CPX terminal
I/O modules	Common term for the CPX modules which provide inputs and outputs (CPX input modules and CPX output modules)
IU / II	Analogue voltage input / analogue current input
OU / OI	Analogue voltage output / analogue current output

Tab. 0/3: Product-specific abbreviations – part 1

Term/abbreviation	Meaning
Field bus nodes / Bus nodes	Provide the connection to specific field buses/networks. They transmit control signals to the connected modules and monitor their functioning
Interlinking block	Lower part of the housing of a module or block for linking the module electrically with the terminal
Parameter	Using parameterisation, the behaviour of the CPX terminal or the behaviour of the individual modules and I/O channels can be adapted to each particular application; parameters can be read and changed
PLC / IPC	Programmable Logic Controller / Industrial PC
RTD	Resistance Temperature Device
Status bits	Internal inputs which supply coded common diagnostic messages
TC	Thermocouple

Tab. 0/4: Product-specific abbreviations – part 2

Overview and connection technology I/O modules

Chapter 1

Contents

1.1 Components of an I/O module

All I/O modules consist of three parts:

- The sub-base provides the electrical connections in the form of different sockets or terminal strips.
- The electronic module contains the printed circuit board with the electronics and the LED display of the I/O module. The electronic module is fitted into the sub-base and is connected to this and to the manifold sub-base by means of electric plug connectors.
- The manifold sub-base as the lower part of the housing provides the mechanical and electrical link between the module and the CPX terminal.

1 Sub-base with specific connections

2 Electronics module

3 Manifold base

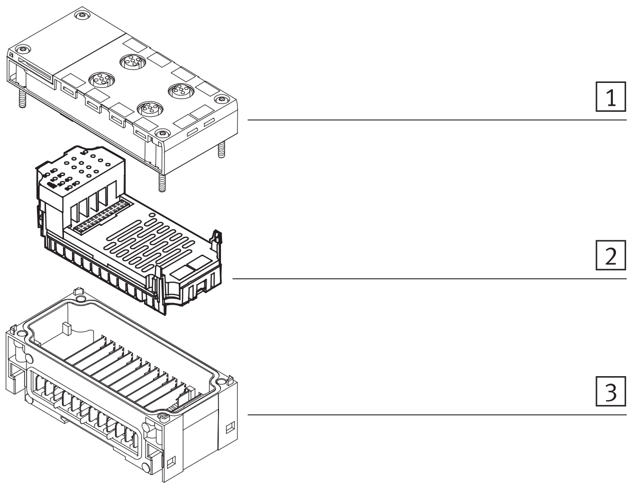
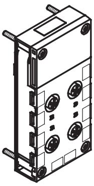
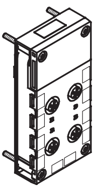
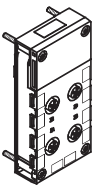


Fig. 1/1: Components of an I/O module

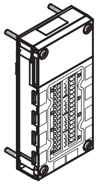
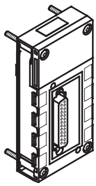
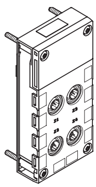
1.2 Connection technology

Individual connection requirements can be fulfilled with different sub-bases. These sub-bases provide the required sockets or terminal strips for connecting the sensors and actuators, irrespective of the I/O module used.

Sub-base	Type	Description
	CPX-M-4-M12x2-5POL	4 M12 sockets with metal thread, 5-pin, 4 A load capacity – Protection class IP65/IP67 1) – One functional earth connection per socket – Screening/shielding possibility via metal thread – Sub-base housing in metal design
	CPX-AB-4-M12x2-5POL	4 M12 sockets, 5-pin, 3 A load capacity – Protection class IP65/IP67 1) – One functional earth connection per socket – Screening/shielding possibility via screening/ shield plate (see “Accessories”, appendix A.11)
	CPX-AB-4-M12x2-5POL-R	4 M12 sockets with metal thread, 5-pin, 4 A load capacity – Protection class IP65/IP67 2) – One functional earth connection per socket – Screening/shielding possibility via metal thread – Enables M12 connectors and SPEEDCON quick connectors to be used

1) With plug connector inserted or with protective cap ISK-M12
2) With plug connector inserted or with protective cap ISK-M12; when using quick connectors, follow the manufacturer’s instructions

Tab. 1/1: Connection technology – part 1

Sub-base	Type	Description
	CPX-AB-8-KL-4POL	2 terminal strips, 16-pin (4 x 4-pin), 4 A load capacity – Protection class IP20 [3] – Protection class IP65/IP67 with cover AK-8KL and screw connector set VG-K-M9 – All cores can be laid individually in spring-clip terminals – Connections are in groups of 4, one functional earth connection per group
	CPX-AB-1-SUB-BU-25POL	1 Sub-D socket, 25-pin, 4 A load capacity – Protection class IP20 [4] – Protection class IP65 with plug SD-SUB-D-ST25 (see “Accessories”, appendix A.11)
	CPX-AB-4-HAR-4POL (in the case of CPX analogue modules can only be used for module 4AE-T)	4 HARAX sockets, 4-pin, 3 A load capacity – Protection class IP65/IP67 [1] with the intended plugs – Connection of the cable cores in the plug using insulation displacement technology

1) With plug connector inserted or with protective cap ISK-M12
2) With plug connector inserted or with protective cap ISK-M12; when using quick connectors, follow the manufacturer’s instructions
3) With cover AK-8KL and screw connector set VG-K-M9: IP65 / IP67
4) With plug SD-SUB-D-ST25: IP65

Tab. 1/2: Connection technology – part 2

1.2.1 Display and connecting elements

On all input and output modules the status LEDs can be seen through the transparent cover of the sub-base.

The analogue I/O modules have the following display and connecting elements:

1 Type plate of sub-base

2 Identification of module (e.g. 2AO = 2 analogue outputs – module type CPX-2AA-U-I)

3 Electrical connections (example)

4 Inscription fields for addresses

5 Error LED (red) module error

6 Channel-related error LEDs (only CPX-4AE-U-I, CPX-4AE-T and CPX-4AE-TC)

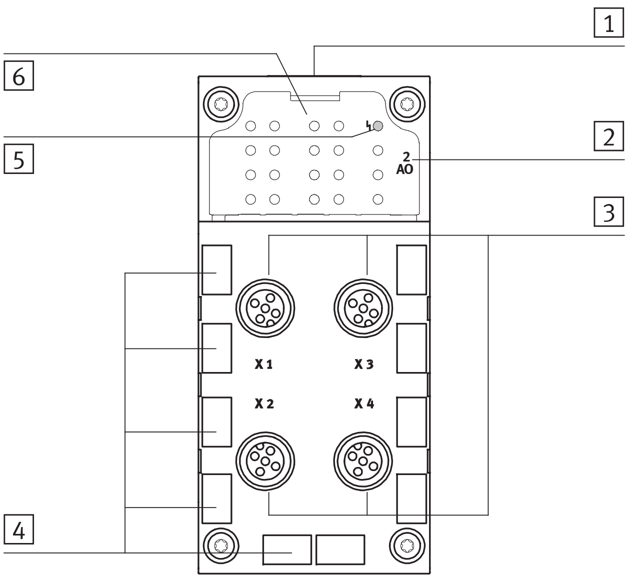


Fig. 1/2: Display and connecting elements

■ ■ ■ Use identity labels type IBS 6x10 for marking the addresses.

1.2.2 Combinations of analogue I/O modules and sub-bases

The following table shows the permissible combinations of modules and sub-bases.

Sub-base CPX...	Input module, CPX-...				Output module
	2AE-U-I 4AE-U-I	4AE-I	4AE-T	4AE-TC	2AA-U-I
-M-4-M12x2-5POL (4 M12 sockets, 5-pin, metal housing)	•	•	•	•	•
-AB-4-M12x2-5POL (4 M12 sockets, 5-pin)	•	•	•	•	•
-AB-4-M12x2-5POL-R (4 M12 sockets, 5-pin, metal thread)	•	•	•	•	•
-AB-8-M8-3POL (8 M8 sockets, 3-pin)	–	–	–	–	–
-AB-8-M8-4POL (8 M8 sockets, 4-pin)	–	–	–	–	–
-AB-8-KL-4POL (2 terminal strips, 16-pin)	•	•	•	•	•
-AB-1-SUB-BU-25POL (1 SUB-D socket, 25-pin)	•	•	–	–	•
-AB-4-HAR-4POL (4 M12 sockets, 4-pin)	–	–	•	–	–
-AB-4-M12-8POL (4 M12 sockets, 8-pin)	–	–	–	–	–
• Can be combined – Cannot be combined					

Tab. 1/3: Combinations of I/O modules and sub-bases

1.2.3 Connecting the cables and plugs to the sub-bases

Sensors and actuators must be connected to the CPX I/O modules only at the sub-bases. In this way, e.g. when an electronic module is replaced, the plugs and cables remain fitted in the sub-base.

Warning
Unintentional movement of the connected actuators and uncontrollable movements of loose tubing can cause injury to human beings or damage to property.

Switch off the following equipment before undertaking installation and/or maintenance work:

- Compressed air supply
- Operating and load voltage supplies

The protection class of the I/O modules depends on the sub-base, as well as on the plugs and protective caps used. Instructions can be found on the following pages and in the appendix A.8.

Use plugs and cables from the Festo range for connecting sensors and actuators (see appendix A.11).

If you wish to use your own cables, use only screened/shielded cables for transmitting analogue signals.

Caution
Long signal cables reduce the immunity to interference. Do not exceed the maximum permitted I/O signal cable length:

- CPX-2AE-U-I, 4AE-U-I, 2AA-U-I, 4AE-I: 30 m
- CPX-4AE-T: 10 m (with measuring error max. 200 m)
- CPX-4AE-TC: 10 m (with measuring error max. 50 m)

The measuring accuracy of modules CPX-4AE-T and 4AE-TC diminishes at cable lengths over 10 m; the measuring error cannot be compensated for.

Screening

Note
For transmitting analogue signals:
- Connect the cable screening/shield to FE.
  Use only screened/shielded cables and plugs with metallic housing.
- Observe the instructions on the following pages for connecting the cable screening/shield depending on the connections.

In this way, you will avoid interference caused by electromagnetic influences.

The following variants are permitted for connecting the cable screening/shield:

– screening/shield connection on the FE pin of the I/O plug without connection to further potentials

– screening/shield connection to an external FE connection without connection to the FE pin of the I/O plug.

Recommendation:

- Connect the cable screening/shield to both sides of the FE with sufficient potential equalization.

- If the cable screening/shield is connected only to one side of the FE, it should be connected to the "signal receiver side:"

  – analogue input modules:
    connect the cable screening/shield on the CPX side

  – analogue output modules:
    connect the cable screening/shield on the actuator side.

Sub-base CPX-M-4-M12x2-5POL...

Note
In order that the completely fitted modules with sub-base CPX-M-4-M12x2-5POL... comply with protection class IP65/IP67:

- Use plugs and cables specified from the Festo range for connecting sensors and actuators (see appendix A.11)
- Tighten the union nuts of the plugs at first by hand.
- Seal unused sockets with protective caps type ISK-M12 (Accessories).

Screening

– On plugs without metal housing:

  - Connect the cable screening/shield to pin 5 (functional earth FE).

– On plugs with metal housing:

  - Connect the cable screening via the plug housing with FE. If necessary, additionally connect the cable screening/shield to pin 5.

Sub-base CPX-AB-4-M12x2-5POL (-R)

➔

Note
In order that the completely fitted modules with sub-base CPX-AB-4-M12x2-5POL (-R) comply with protection class IP65/IP67:

- Use plugs and cables specified from the Festo range for connecting sensors and actuators (see appendix A.11)
- Tighten the union nuts of the plugs at first by hand.
- Seal unused sockets with protective caps type ISK-M12 (Accessories).

The connector sockets of sub-base CPX-AB-4-M12x2-5POL**-R** (with metal thread) enable fast locking systems to be used, e.g. SPEEDCON from Phoenix Contact.

- When using fast locking systems follow the manufacturer's instructions in order to comply with protection class IP65/IP67.

Screening

– On plugs without metal housing:

  - Connect the cable screening/shield to pin 5 (functional earth FE).

– On plugs with metal housing:

  - Use sub-base CPX-AB-4-M12x2-5POL**-R**.
    The metal thread of the connector sockets is connected internally to pin 5 (FE).

    or

  - Connect the cable screening/shield via the plug housing and the screening plate (see below) to FE.
    If necessary, additionally connect the cable screening/shield to pin 5.

Screening plate type CPX-AB-S-4-12

Sub-base CPX-AB-4-M12x2-5POL (sockets without metal thread) can be combined with a screening/shield plate. Depending on what you have ordered, this may already be fitted on the sub-base.

Instructions on subsequent fitting of the screening/shield plate can be found in section 1.3.2.

The electromagnetic compatibility can be improved with screening/shield plates, e.g. in environments heavily subjected to interference or for analogue signals. For this purpose the screening/shield plates must be earthed at the flat contact intended for this purpose as per DIN 46 244 B2, 8-1 (2.8 x 1 mm).

- Connect the earth cable of the screening/shield plate with low impedance to the functional earth connection (FE) as per Fig. 1/3.

  Screening/shield plates lying next to each other are connected together by spring clips and must not be connected individually to FE.

If the intended plugs are used (see “Accessories”, appendix A.11), the plug housing will be connected to functional earth via the screening/shield plate by means of the spring contacts.

- Before fitting the plugs screw the spring contacts as far as possible onto the thread of the plug.

1 Plug

2 Spring contact

3 Screening plate

4 Functional earth connection (FE) with blade connector as per DIN 46 245 B2, 8-1

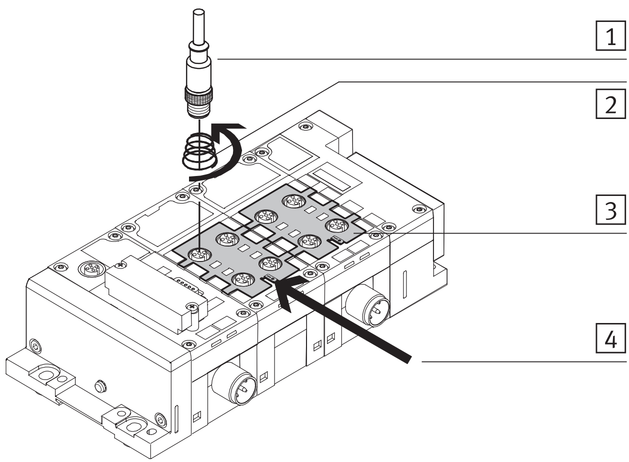


Fig. 1/3: Connecting the screening/shield plate

Note
To comply with protection class IP65/IP67:
- Do not use the spring contacts if you have sealed unused sockets with protective caps.

Sub-base CPX-AB-8-KL-4POL

The completely fitted sub-base CPX-AB-8-KL-4POL complies with protection class IP20.

Screening

- Use a cable as short as possible to connect the cable screening/shield to the FE terminal of the sub-base. Use suitable core end sleeves for the connection.

Specification of the cable terminals

- Cable cross-sectional area: 0.08 ... 1.5 mm^2
- Max. current: 1.5 A
- Insulation removed: 5 ... 6 mm

Permitted copper conductors

- Single wire, multi-wire, fine wire, also with tin-plated individual cores
- Fine wire strands compressed
- Fine wire with core end sleeves (sealed against gas, crimped on) *)
- Fine wire with pin cable socket (sealed against gas, crimped on) *)

*) If necessary, use next smaller cross-sectional area

Fitting and removing the cables

➔

Note

- To ensure reliable contact, connect only one conductor per spring terminal.
- Insert only cables into the terminal opening. The terminal will be damaged if a screwdriver is inserted into the opening.

When connecting and disconnecting the cables:

1. Press the screwdriver with a light rotary movement towards the centre of the unlocking opening (see Fig. 1/4). The cable terminal will then be unlocked.

1 Screwdriver, blade 2.5 x 0.4 mm

2 Unlocking opening (inside)

3 Cable

4 Terminal opening for inserting the conductors (outside)

5 Terminal strips

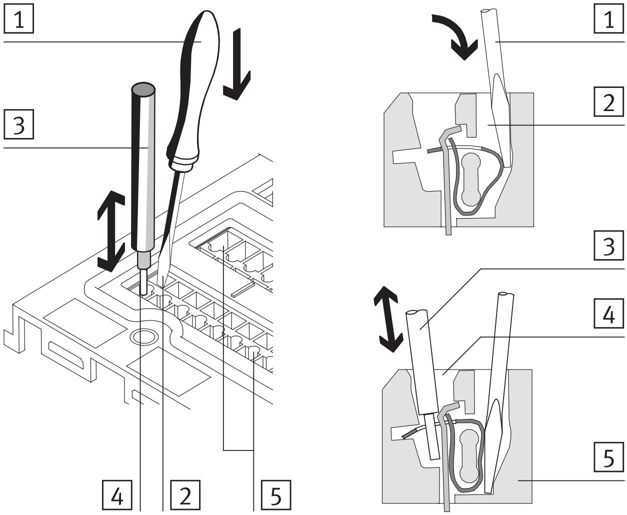


Fig. 1/4: Connecting the terminal strips

2. When the terminal is unlocked you can insert or pull out the ends of the cable through the opening.

3. Remove the screwdriver from the unlocking opening. The cable will then be securely locked.

You will then comply with protection class IP65/IP67

In order that sub-base CPX-AB-8-KL-4POL complies with protection class IP65/IP67, use cover type AK-8KL and the screw connector set type VG-K-M9 from Festo. Note the relevant fitting instructions.

1 Cover AK-8KL

2 Screw connector set VG-K-M9

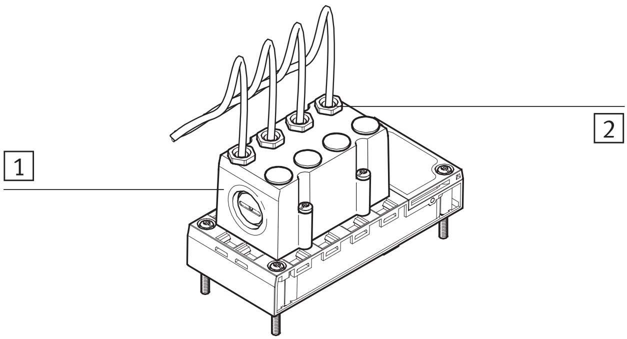


Fig. 1/5: Cover and screw connector set for sub-base CPX-AB-8-KL-4POL (for complying with protection class IP65/67)

Sub-base CPX-AB-1-SUB-BU-25POL

The completely fitted sub-base CPX-AB-1-SUB-BU-25POL complies with protection class IP20.

In order that sub-base CPX-AB-1-SUB-BU-25POL complies with protection class IP65/IP67, use plug type SD-SUB-D-ST25 from Festo.
When fitting the plug onto the sub-base, observe the maximum tightening torque of 0.5 Nm.

Screening

- Use a cable as short as possible to connect the cable screening/shield to the FE pin of the Festo sub-D plug.

  If other screened plugs are used, the metal flange (housing) of the sub-D plug can also be used for connecting the cable screening/shield.

Sub-base CPX-AB-4-HAR-4POL

Note
In order that the completely fitted modules with sub-base CPX-AB-4-HAR-4POL comply with protection class IP65/IP67:

- Use plugs type SEA-GS-HAR-4POL from the Festo range (consisting of union nut, strain relief and splicing ring) for connecting sensors and actuators.
- Tighten the union nuts of the plugs at first by hand.
- Seal the unused connecting sockets with protective caps from Harting (see Accessories, appendix A.11).

Specifications of the cables for the sub-base CPX-AB-4-HAR-4POL

– Cable cross-sectional area: 0.25 ... 0.5 mm^2

– Strand cross-section: up to 0.1 mm

– Insulation material: PVC/PUR/PE

– Insulation thickness: max. 1.6 mm

– Core diameter: 1.2 ... 1.6 mm

– Cable outer diameter: 4.0 ... 5.1 mm

Fitting

1 Cut the cable to length, remove the coating. Push the union nut and the seal insert onto the end of the cable.

2 Insert the ends of the core into the appropriate slots of the splicing ring.

3 Place the seal and the splicing ring together and cut off the projecting core ends flush with the splicing ring.

4 Insert the pre-fitted splicing seal element into the contact support in the sub-base. Screw in the union nut as far as possible.

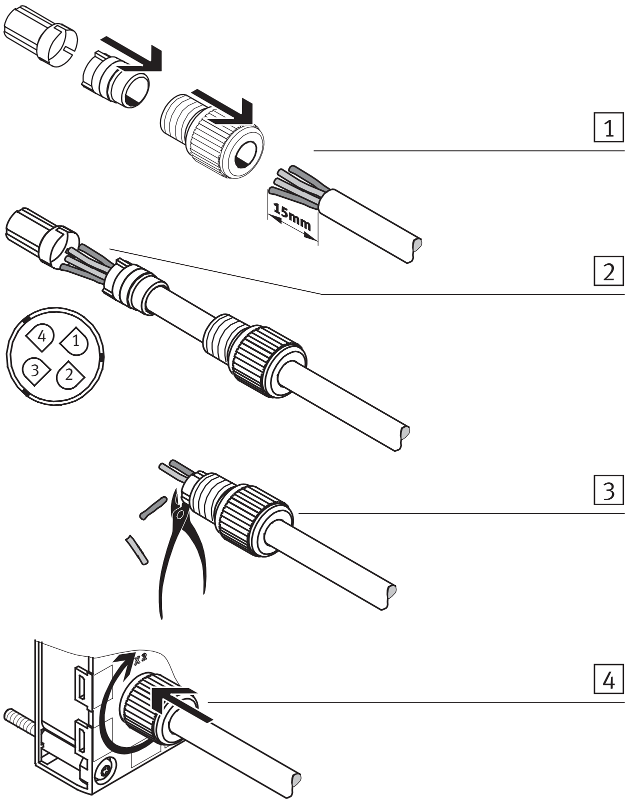


Fig. 1/6: Connect the cable to sub-base CPX-AB-4-HAR-4POL

Dismantling

- Loosen the screw connector and remove the cores by pulling them out of the contacts.

The cores can be connected up to 10 times if the contact ends are cut away each time (if the same core diameter is used). Cut off the used cable ends and repeat steps 2 to 4.

1.3 Fitting

Warning
Unintentional movement of the connected actuators and uncontrollable movements of loose tubing can cause injury to human beings or damage to property.

Switch off the following equipment before undertaking installation and/or maintenance work:

– Compressed air supply
– Operating and load voltage supplies

Caution
Inappropriate handling can result in damage to the modules.

- Do not touch the electrical contacts of the modules.
- Observe the handling instructions for electrostatically sensitive components.
- Discharge yourself before installing or removing sub-assemblies to protect the sub-assemblies from static discharges.

Before the CPX terminal can be extended or converted, it must first be unscrewed and dismantled. Instructions on this can be found in the CPX system manual.

The CPX terminal does not need to be dismantled when sub-bases or electronic modules are fitted or removed. This also applies to the plugs and cables on the sub-base.

1.3.1 Fitting the sub-bases

Note
Handle all modules and components of the CPX terminal with great care. Please note particularly the following points:

- Screws must be fitted accurately (otherwise threads will be damaged).
  Screws must be fastened at first only by hand. Screws must be placed so that the self-cutting threads can be used.
- The specified torques must be observed.
- Screw connections must be fitted free of offset and mechanical tension.
- Check the seals for damage (IP65/IP67).
- Connecting surfaces must be clean (to ensure sealing effect, avoid leakage and contact errors).

The screw connection between the sub-base and the manifold sub-base is designed to withstand at least 10 fitting/removal cycles under observance of the instructions.

Observe also the installation instructions supplied with modules and components ordered at a later stage.

CPX terminals are supplied from the factory completely fitted. It may be necessary to fit or remove the sub-bases for the following reasons:

– for replacing the connections

– to simplify fitting the sensor plugs or cables.

It may be necessary to fit or remove the electronic modules for the following reasons:

– for modifying the function of the I/O module (e.g. CPX-2AE-U-I instead of CPX-2AA-U-I).

– for replacing defective electronic modules.

Dismantling

Dismantle the sub-base as follows (see Fig. 1/7):

1. Loosen the 4 screws in the relevant sub-base with a TORX screwdriver size T10.
2. Pull the sub-base carefully and without tilting away from the electrical plug connection of the electronic module.

Only in cases where the electronic module is to be removed:

- Pull the electronic module carefully and without tilting away from the contact rails of the manifold sub-base.

1 Sub-base

2 Screws

3 Electrical plug connector

4 Electronics module

5 Contact rails

6 Manifold base

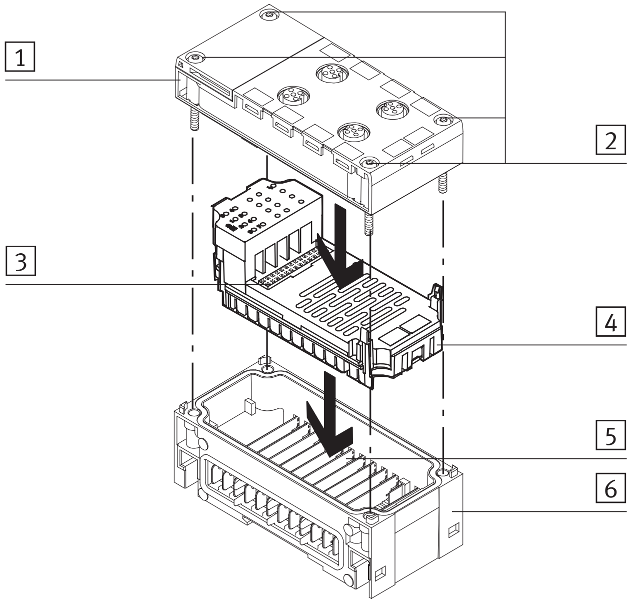


Fig. 1/7: Fitting/removing the I/O module

Fitting

Fit the modules as follows (see Fig. 1/7):

Note
- Please observe the instructions on combining I/O modules and sub-bases in section 1.2.2.
- Please observe the instructions on combining and arranging modules on the CPX terminal in the CPX system manual.

Only in cases where the electronic module has been removed:

- Place the electronic module in the manifold sub-base. Make sure that the grooves with the contact terminals on the bottom of the electronic module lie above the contact rails. Then push the electronic module carefully and without tilting as far as possible into the manifold sub-base.

Fitting the sub-base:

1. Align the sub-base over the manifold sub-base with the electronic module. Make sure that the plug connectors of the sub-base are aligned exactly with the connectors of the electronic module. Then push the sub-base carefully and without tilting onto the manifold sub-base.

2. Tighten the screws at first only by hand. Place the screws so that the self-cutting threads can be used.
   Tighten the screws with a TORX screwdriver size T10 with torque 0.9 ... 1.1 Nm.

1.3.2 Fitting the screening/shield plates

A screening/shield plate type CPX-AB-S-4-12 can be fitted on sub-base CPX-AB-4-M12x2-5POL. The sub-base must be removed before the screening/shield plate is fitted or dismantled.

Fitting

Fit the screening plate as follows (see Fig. 1/8):

1. Dismantle the sub-base (see section 1.3.1).
2. Snap the spring clips of the screening/shield plate from above into the appropriate recesses on the dismantled sub-base.
3. Fit the sub-base.

Instructions on earthing the screening/shield plate can be found in section 1.2.3.

Dismantling

The screening/shield plate must be removed in the opposite sequence to the fitting procedure.

1 Spring contact

2 Screening plate

3 Spring clip

4 Sub-base type CPX-AB-4-M12x2-5POL

5 CPX Terminal

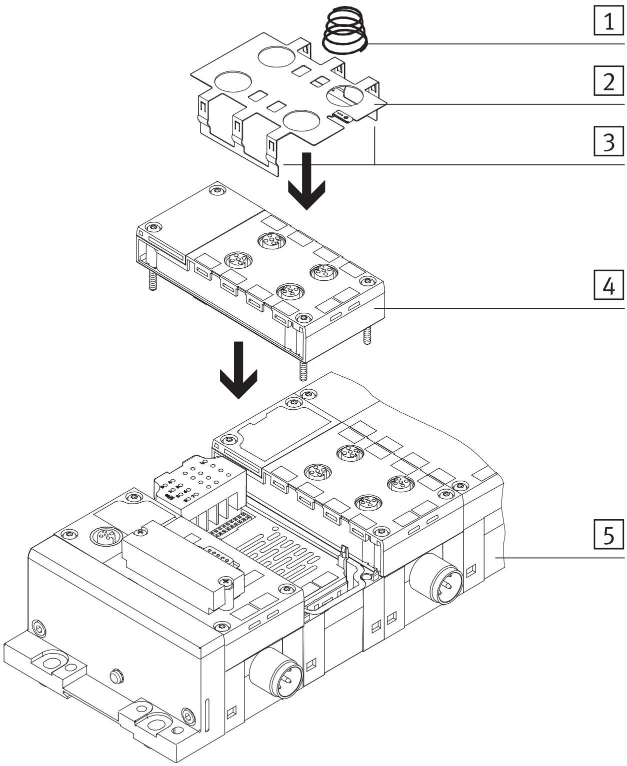


Fig. 1/8: Fitting screening/shield plate type CPX-AB-S-4-12

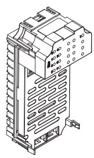
Analogue input module CPX-2AE-U-I

Chapter 2

Contents

2.1 Function of the analogue input modules

Analogue input modules provide analogue voltage inputs or current inputs for connecting sensors and enable the registering and processing of analogue current and voltage signals. At present the following type is available:

Type		**Description**
	CPX-2AE-U-I	This type provides 2 analogue inputs (input channels) with scalable value ranges. The input signal range can be configured channel by channel, either electrically isolated or non-floating: – 0 ... 10 V – 0 ... 20 mA – 4 ... 20 mA Sensor supply 24 V / 0.7 A per module.

Tab. 2/1: Overview of analogue input modules CPX-2AE-U-I

2.2 Fitting

See section 1.3.

2.3 Installation

Warning
Unintentional movement of the connected actuators and uncontrollable movements of loose tubing can cause injury to human beings or damage to property.

Before carrying out installation and maintenance work, switch off the following:

- the compressed air supply
- the operating and load voltage supplies.

In the following sections you will find the pin allocation of the analogue input modules for the different sub-bases.

Instructions on connecting the cables and plugs to the sub-bases can be found in section 1.2.3.
Note in particular the instructions on connecting the cable screening to functional earth (FE).

Power supply

The 24 V sensor supply for the inputs as well as the power supply for the electronics of the input modules is provided via the operating voltage supply for the electronics/sensors ($V_{EL/SEN}$).

The sensors can also be supplied externally (electrical isolation, see section 2.3.3, Fig. 2/2).

2.3.1 DIL switch settings

2 DIL switches are available for configuring the analogue input modules. These are located on the top of the electronic module.

1 DIL switch 0: Signal range of analogue input 0

2 DIL switch 1: Signal range of analogue input 1

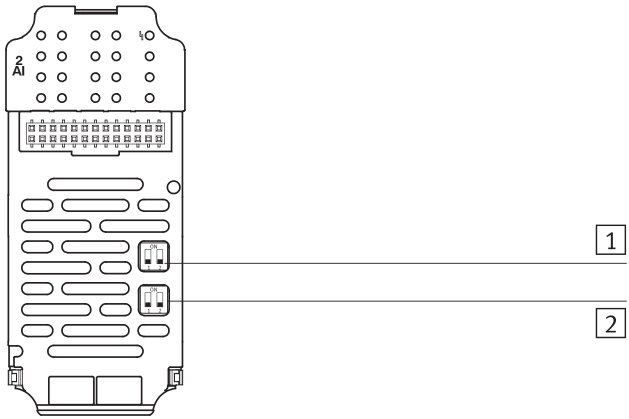


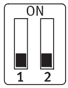
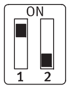
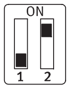
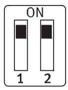
Fig. 2/1: DIL switches in the electronic module (further information on 1 and 2 see following pages)

Proceed as follows:

1. Switch off the power supply.
2. Remove if necessary the fitted sub-base (see “Fitting” section 1.3).
3. Set the DIL switch elements in accordance with the instructions on the following pages.
4. Refit if necessary the sub-base (see “Fitting” section 1.3, tightening torque 0.9 ... 1.1 Nm).

Setting the input signal range

You can set the signal range of the relevant analogue input with the 2-element DIL switches 0 and 1.

Signal range	Setting the DIL switches 1)		
	Setting	DIL switch 0	DIL switch 1
0 ... 10 V		0.1: OFF 2) 0.2: OFF 2)	1.1: OFF 2) 1.2: OFF 2)
		0.1: ON 0.2: OFF	1.1: ON 1.2: OFF
0 ... 20 mA		0.1: OFF 0.2: ON	1.1: OFF 1.2: ON
4 ... 20 mA		0.1: ON 0.2: ON	1.1: ON 1.2: ON

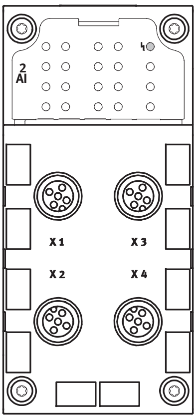
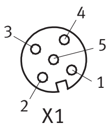
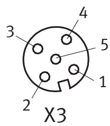
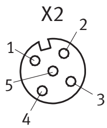
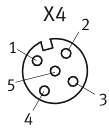
1) DIL switch 0 for input channel 0
DIL switch 1 for input channel 1
2) Default (factory setting)

Tab. 2/2: DIL switches of the analogue input module 2AE-U-I

Note
The setting of the signal range with the DIL switches can be modified by parameterisation (see section 2.4). Parameterisation has precedence over the DIL switch setting.

2.3.2 Pin allocation

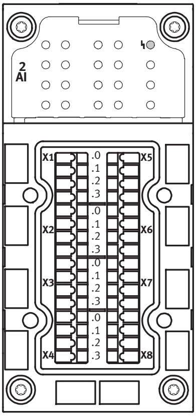
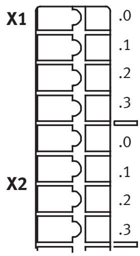
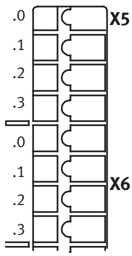
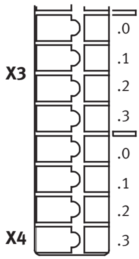
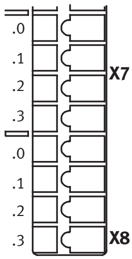
Pin allocation of CPX-2AE-U-I with sub-base CPX-AB-4-M12x2-5POL(-R)

<table>
<tr><th colspan="3">Analogue input module type CPX-2AE-U-I with sub-base CPX-AB-4-M12x2-5POL(-R)</th></tr>
<tr><th>Sub-base</th><th>Pin allocation X1, X2 (input I...0)</th><th>Pin allocation X3, X4 (input I...1)</th></tr>
<tr><td rowspan="5"></td><td colspan="2">Voltage inputs [1]</td></tr>
<tr><td>Socket X1:
1: 24 V_{SEN}
2: IU0+
3: 0 V_{SEN}
4: IU0-
5: FE (screening) [2]</td><td>Socket X3:
1: 24 V_{SEN}
2: IU1+
3: 0 V_{SEN}
4: IU1-
5: FE (screening) [2]</td></tr>
<tr><td colspan="2">Current inputs [1]</td></tr>
<tr><td>Socket X2:
1: 24 V_{SEN}
2: II0+
3: 0 V_{SEN}
4: II0-
5: FE (screening) [2]</td><td>Socket X4:
1: 24 V_{SEN}
2: II1+
3: 0 V_{SEN}
4: II1-
5: FE (screening) [2]</td></tr>
<tr><td colspan="2">IUx+ = Positive voltage input signal
IUx- = Negative voltage input signal
IIx+ = Positive current input signal
IIx- = Negative current input signal
FE = Functional earth</td></tr>
<tr><td colspan="3">[1] Allocation depends on the DIL switch setting and on parameterisation (see section 2.3.1), a total of 2 input channels are available per module (I...0 and I...1, connection X1 or X2 as well as connection X3 or X4).
[2] With CPX-AB-4-M12x2-5POL-R the metal thread is connected to FE</td></tr>
</table>

Tab. 2/3: Pin allocation of analogue input module type CPX-2AE-U-I with sub-base CPX-AB-4-M12x2-5POL(-R)

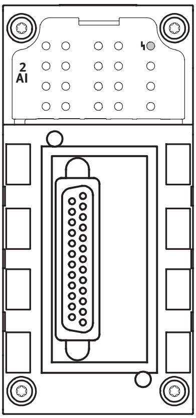
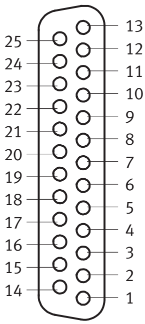
CPX-AB-4-M12x2-5POL**-R** The metal thread ("...-R") of this sub-base is connected internally with pin 5 (Functional earth FE).

Pin allocation of CPX-2AE-U-I with sub-base CPX-AB-8-KL-4POL

Analogue input module type CPX-2AE-U-I with sub-base CPX-AB-8-KL-4POL		
Sub-base	**Pin allocation X1 ... X4 (input I...0)**	**Pin allocation X5 ... X8 (input I...1)**
	Voltage inputs [1)]  X1.0: 24 V_{SEN} X1.1: 0 V_{SEN} X1.2: IU0- X1.3: FE (screening) X2.0: n.c. X2.1: n.c. X2.2: IU0+ X2.3: FE (screening)	 X5.0: 24 V_{SEN} X5.1: 0 V_{SEN} X5.2: IU1- X5.3: FE (screening) X6.0: n.c. X6.1: n.c. X6.2: IU1+ X6.3: FE (screening)
	Current inputs [1)]  X3.0: 24 V_{SEN} X3.1: 0 V_{SEN} X3.2: II0- X3.3: FE (screening) X4.0: n.c. X4.1: n.c. X4.2: II0+ X4.3: FE (screening)	 X7.0: 24 V_{SEN} X7.1: 0 V_{SEN} X7.2: II1- X7.3: FE (screening) X8.0: n.c. X8.1: n.c. X8.2: II1+ X8.3: FE (screening)
	IUx+ = Positive voltage input signal IUx- = Negative voltage input signal IIx+ = Positive current input signal IIx- = Negative current input signal n.c. = Not connected FE = Functional earth	
[1)] Allocation depends on the DIL switch setting and on parameterisation (see section 2.3.1), a total of 2 input channels are available per module (I...0 and I...1, connection X1/X2 or X3/X4 as well as connection X5/X6 or X7/X8).		

Tab. 2/4: Pin allocation of analogue input module type CPX-2AE-U-I with sub-base CPX-AB-8-KL-4POL

Pin allocation of CPX-2AE-U-I with sub-base CPX-AB-1-SUB-BU-25POL

Analogue input module type CPX-2AE-U-I with sub-base CPX-AB-1-SUB-BU-25POL			
Sub-base	**Pin allocation [1]**		
		1: IU0- 2: IU0+ 3: II0- 4: II0+ 5: n.c. 6: n.c. 7: n.c. 8: n.c. 9: 24 V_{SEN} 10: 24 V_{SEN} 11: 0 V_{SEN} 12: 0 V_{SEN} 13: FE	14: IU1- 15: IU1+ 16: II1- 17: II1+ 18: 24 V_{SEN} 19: n.c. 20: 24 V_{SEN} 21: n.c. 22: 0 V_{SEN} 23: 0 V_{SEN} 24: 0 V_{SEN} 25: FE Housing: FE (screening)
	Pin 1/2, 14/15 = Voltage inputs Pin 3/4, 16/17 = Current inputs IUx+ = Positive voltage input signal IUx- = Negative voltage input signal IIx+ = Positive current input signal IIx- = Negative current input signal n.c. = Not connected FE = Functional earth		
[1] Allocation depends on the DIL switch setting and on parameterisation (see section 2.3.1), a total of 2 input channels are available per module (I...0 and I...1)			

Tab. 2/5: Pin allocation of analogue input module type CPX-2AE-U-I with sub-base CPX-AB-1-SUB-BU-25POL

2.3.3 Connecting the analogue intputs

Only screened cables are usually permitted for the transmission of analogue signals (see section 1.2.3).

1 Without electrical isolation:
The sensors are supplied via the CPX module

2 With electrical isolation:
If an external sensor supply is used

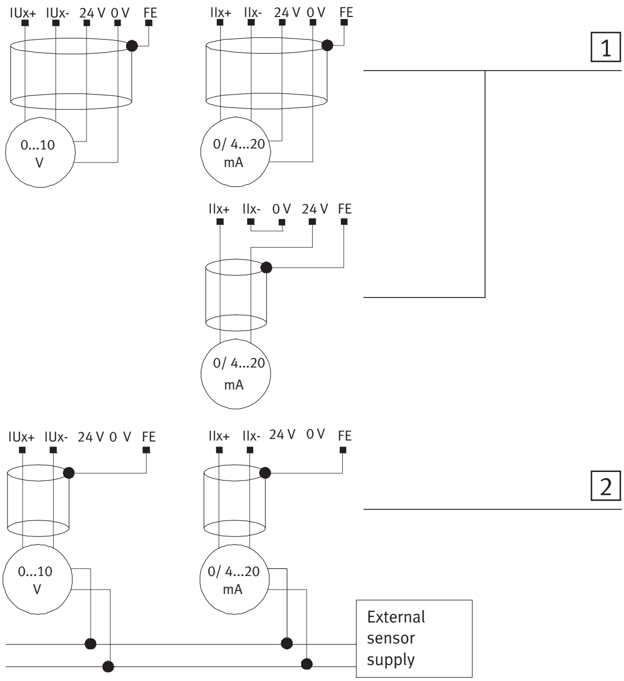


Fig. 2/2: Examples of analogue input connections (screening connection on FE pin)

Note
Make sure that cables which are not used, but which are connected to the sub-base, are short-circuited by voltage inputs at the unused end of the cable.

Further connection examples can be found in appendix A.10.1.

2.4 Instructions on commissioning

2.4.1 Processing analogue input signals

The analogue values are transmitted from the CPX terminal to the control system as input words (2 bytes, 16 bits). Each analogue input module occupies 2 input words for this procedure in the address range.

The position of the input words in the address range depends on the field bus used (see manual for the field bus node).

Parameterisation

The data format as well as the limit values and, where applicable, also the scaling of the analogue input signals can be adapted by parameterisation. Instructions on this can be found in the sections 2.4.2 and 2.4.3.

The reaction with the default settings is described below.

Reaction with the default settings

The module parameter “Input analogue-value data format” possesses the default setting “VZ + 12 bits right-justified” (compatible with valve terminal type 03). With this setting the analogue values will be saved in the input word as follows:

Data format “VZ + 12 bits right-justified” (compatible with valve terminal type 03)															
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
VZ	0	0	0	B11 MSB	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0 LSB
Abbreviations used: VZ: Sign (with data format “VZ + 12 bits right-justified” always = 0, i.e. a positive value) B0 ... B11: Input value D0 ... D15: 16 bits input data field MSB/LSB: Most significant bit / least significant bit															

Tab. 2/6: Data format “VZ + 12 bits right-justified”

The channel-specific parameters “Lower limit” and “Upper limit” possess the following default settings:

– Lower limit = 0

– Upper limit = 4095

These correspond to the scaling end values (data range) of the default data format.

The following diagram shows the processing of the analogue input signals with the default data format "VZ + 12 bits right-justified". The example shows a sensor which converts the range of the physical measuring variables from 0 ... 6 bar linear into the analogue signals 0 ... 10 V, 0 ... 20 mA or 4 ... 20 mA.

1 Lower limit of rated range

2 Measured value (example)

3 Upper limit of rated range

4 Physical measuring variables

5 Assigned analogue signal

6 Digital value range after A-D conversion (linear scaling)

7 Digital input value (example)

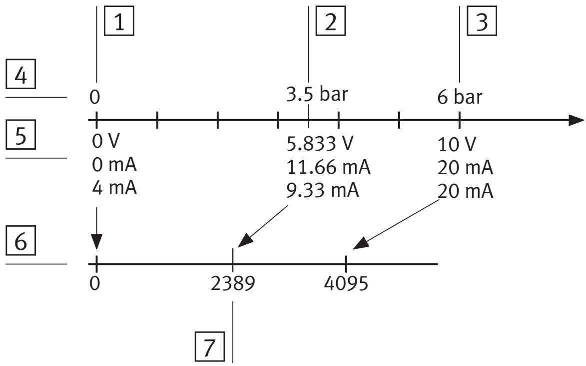


Fig. 2/3: Example of default data format "VZ + 12 bits right-justified"

Allocation of analogue input signal ranges to the digital value range is shown in the table below.

Analogue input signal range			**Digital data preparation**		
0 ... 10 V	**0 ... 20 mA**	**4 ... 20 mA**	**Ranges**	**Digital values**	
> 9.9975 V	> 19.995 mA	> 19.995 mA	Rated range exceeded	Limiting to the upper scaling end value	4095
9.9975 V	19.995 mA	19.995 mA	Upper limit		4095
...	...	...	Rated range	Linear value range	1 ... 4094
0 V	0 mA	4 mA	Lower limit of rated range		0
< 0 V	< 0 mA	< 4 mA	Less than rated range	Limiting to the lower scaling end value	0

Tab. 2/7: Scaling end values of the analogue input modules with default settings

2.4.2 General information on parameterisation

The reaction of the analogue input modules can be parameterized.

Further information on parameterisation can be found in the system manual or in the manual for the field bus node.

Due to in some cases necessary calculations, modified parameters are not valid until they have been thoroughly checked and saved. Until then, as in the case of invalid parameters, the previous settings apply.

Depending on the parameter, no valid analogue values are available for up to max. 30 ms after a value modification.

Specific instructions for the prevention of parameterisation errors

In order to prevent parameterisation errors, note the sequence described below when modifying the following parameters:

- Input analogue-value data format
- Lower limit channel x
- Upper limit channel x

Sequence for first or startup parameterisation (CPX terminal in delivery status, monitoring of parameterisation errors active):

1. First set the desired data format (parameter “Input analogue-value data format”).

2. Then set the upper and lower limits for both channels:

   – If the new upper limit value is positive, set first the upper limit; then the lower limit.

   – If the new upper limit is negative (only in the case of data format “VZ + 15 bits linear scaled”), set first the lower limit, then the upper limit.

Sequence for modifying the parameterisation:

1. Activate, if applicable, the monitoring of parameterisation errors (module parameter “Monitoring CPX module – monitoring parameterisation errors” and channel-specific module parameter “Monitoring channel x – monitoring parameterisation errors”).

2. Set the lower limit to 0 and the upper limit to 4095 for both channels.

3. Then set the desired data format (parameter “Input analogue-value data format”).

4. If required, then set the upper and lower limits for both channels:

   – If the new upper limit value is positive, set first the upper limit; then the lower limit.

   – If the new upper limit is negative (only in the case of data format “VZ + 15 bits linear scaled”), set first the lower limit, then the upper limit.

2.4.3 Parameters of the analogue input module type CPX-2AE-U-I

The tables below give an overview of the module parameters of the analogue input modules.

Function number [1]	Module parameters
4828 + m * 64 + **0**	Monitoring the CPX module
4828 + m * 64 + **1**	Behaviour after short circuit/overload
4828 + m * 64 + **2**	Reserved
4828 + m * 64 + **3**	Input analogue-value data format
[1] m = module number (counting from left to right, beginning with 0)	

Tab. 2/8: Overview – module parameters

Function number [1]	Channel-specific module parameters
4828 + m * 64 + **6 ... 7**	Monitoring channel 0, 1
4828 + m * 64 + **8**	Signal range channel 0, 1
4828 + m * 64 + **9**	Measured value smoothing channel 0, 1
4828 + m * 64 + **10 ... 11**	Lower limit channel 0
4828 + m * 64 + **12 ... 13**	Lower limit channel 1
4828 + m * 64 + 1**4 ... 15**	Upper limit channel 0
4828 + m * 64 + **16 ... 17**	Upper limit channel 1
– [2]	Force channel x (see also CPX system manual)
[1] m = module number (counting from left to right, beginning with 0) [2] Access is protocol-specific (see manual for field bus node)	

Tab. 2/9: Overview – channel-specific module parameters

Description of the parameters

Module parameters: Monitoring the CPX module	
Function no.	4828 + m * 64 + **0** m = module number (0 ... 47)
Description	With the analogue input modules, monitoring of individual errors can be activated or deactivated (suppressed) independently of each other. Active monitoring causes the following: The error is: – sent to the CPX field bus node – displayed by the module common error LED.
Bit	Bit 0: monitoring short circuit/overload in the sensor supply Bit 1 ... 6: reserved Bit 7: monitoring parameterisation errors
Values	1 = active (presetting); 0 = inactive
Comment	– Monitoring short circuit at sensors: Monitoring can also be set for the complete CPX terminal (see CPX system manual, system parameter "Monitoring"). – Monitoring parameterisation errors: Some parameters are checked for inadmissible values during parameterisation: – Data format – Measured value smoothing – Lower limit – Upper limit The setting of the module parameter "Monitoring parameterisation errors" is only effective for channel-specific parameterisations if the corresponding channel parameter "Monitoring parameterisation errors" is set to "active".

Tab. 2/10: Monitoring the CPX module

Module parameters: Behaviour after short circuit/overload	
Function no.	4828 + m * 64 + **1** m = module number (0 ... 47)
Description	Determines after a short circuit in the sensor supply whether the power is to remain switched off or whether it is to be switched on again automatically.
Bit	Bit 0: behaviour after short circuit/overload in the sensor supply
Values	0 = leave voltage/current switched off 1 = switch voltage on again (presetting) Bit 1 ... 7: reserved
Comment	With the setting "Leave voltage switched off", Power off/on is necessary for switching the power on again. Ascertain the setting which is necessary for reliable operation of your machine or system. Further information can be found in section 2.5.1.

Tab. 2/11: Behaviour after short circuit/overload

Module parameters: Input analogue-value data format	
Function no.	4828 + m * 64 + **3** m = module number (0 ... 47)
Description	Determines the format in which the analogue input signals are provided by the CPX terminal.
Bit	Bit 0, 1: input analogue-value data format Bit 2 ... 7: reserved (= 0)
Values	Bit 1 Bit 0 0 0 VZ + 15 bits linear scaled 0 1 VZ + 12 bits right-justified (compatible with valve terminal type 03, presetting) 1 0 VZ + 15 bits left-justified (Simatic S7) 1 1 VZ + 12 bits left-justified + diagnosis (Simatic S5) (VZ = sign)
Comment	The reserved bits 2 ... 7 must always be 0. If one or several bits are set to "1" during parametrisation, the parametrisation carried out is invalid and therefore not effective. If the module parameter "Monitoring parametrisation errors" is set to "active", the relevant error will be displayed. Further information on this parameter can be found in section 2.4.4.

Tab. 2/12: Input analogue-value data format

Channel parameters: Monitoring channel x	
Function no.	4828 + m * 64 + **6** (channel 0) m = module number (0 ... 47) 4828 + m * 64 + **7** (channel 1)
Description	For the individual channels of the analogue input modules, monitoring of individual errors can be activated or deactivated (suppressed) independently of each other. Active monitoring causes the following: The error is: – sent to the CPX field bus node – displayed by the module common error LED. Further infomation on these monitorings can be found under the description of the relevant error in section 2.5.1.
Bit	Bit 0: monitoring lower limit (or less than rated range) Bit 1: monitoring upper limit (or rated range exceeded) Bit 2: monitoring wire break Bit 3 ... 6: reserved Bit 7: monitoring parameterisation errors
Values	1 = active; 0 = inactive Presetting bit 0 ... 2: 0 (inactive) Presetting bit 7: 1 (active)
Comment	– Monitoring the upper/lower limit: Monitoring the input signals for less than or exceeding the rated range or monitoring the range limits defined with the parameters "Lower limit ..." as well as "Upper limit ..." (depending on the data format used, see sections 2.4.4 and 2.4.5). – Monitoring wire breaks: Only effective for the signal range 4 ... 20 mA. A drop below the minimum input current (I_{IN} < 2.0 mA) counts as a wire breaks. – Monitoring parameterisation errors: Some channel-specific parameters are checked for inadmissible values during parameterisation: – Measured value smoothing – Lower limit – Upper limit The setting of the channel parameter "Monitoring parameterisation errors" is only effective if the module parameter "Monitoring parameterisation errors" is set to "active".

Tab. 2/13: Monitoring channel x

Channel parameters: Signal range channel x	
Function no.	4828 + m * 64 + **8** m = module number (0 ... 47)
Description	For the individual channels of the analogue input modules, the signal ranges of the analogue inputs can be set independently of each other.
Bit	Bit 0/1: setting of DIL switch 0 for channel 0 (read only) switch 0.1 = bit 0 switch 0.2 = bit 1 Bit 2/3: signal range channel 0 (AI0) Bit 4/5: setting of DIL switch 1 for channel 1 (read only) switch 1.1 = bit 4 switch 1.2 = bit 5 Bit 6/7: signal range channel 1 (AI1)
Values	Channel 0 Channel 1 Bit 3 Bit 2 Bit 7 Bit 6 0 0 0 0 Using the setting of the DIL switches (presetting) 0 1 0 1 0 ... 10 V 1 0 1 0 0 ... 20 mA 1 1 1 1 4 ... 20 mA
Comment	Bits 0/1 as well as 4/5 represent the status of the DIL switches for setting the signal range. With bits 2/3 and 6/7 other signal ranges can be parameterized irrespective of the DIL switch setting. Modified parameter settings have precedence over the DIL switch settings. The setting of the DIL switches is carried out with the presetting (bit 2/3 = 0; bit 6/7 = 0).

Tab. 2/14: Signal range channel x

Channel parameters: Measured value smoothing channel x	
Function no.	4828 + m * 64 + **9** m = module number (0 ... 47)
Description	For the individual channels of the analogue input modules, the filter for measured values can be set independently of each other.
Bit	Bit 0, 1: measured value smoothing channel 0 Bit 2, 3: reserved (= 0) Bit 4, 5: measured value smoothing channel 1 Bit 6, 7: reserved (= 0)
Values	Channel 0 / Channel 1 Bit 1 Bit 0 / Bit 5 Bit 4 0 0 0 0 No measured value smoothing (presetting) 0 1 0 1 Measured value smoothing over 2 values 1 0 1 0 Measured value smoothing over 4 values 1 1 1 1 Measured value smoothing over 8 values
Comment	Errors can be suppressed with measured value smoothing (see section 2.5.1). The reserved bits 2/3 and 6/7 must always be 0. If these bits are set to “1” during parameterisation, the parameterisation carried out is invalid and therefore not effective. If the module parameter “Monitoring parameterisation errors” as well as the relevant channel parameter “Monitoring parameterisation errors” is set to “active”, the relevant error will be displayed.

Tab. 2/15: Measured value smoothing channel x

Channel parameters: Lower limit channel x / Upper limit channel x	
Function no.	Lower limit: m = module number (0 ... 47) 4828 + m * 64 + 10 (channel 0, low byte) 4828 + m * 64 + 11 (channel 0, high byte) 4828 + m * 64 + 12 (channel 1, low byte) 4828 + m * 64 + 13 (channel 1, high byte) Upper limit: 4828 + m * 64 + 14 (channel 0, low byte) 4828 + m * 64 + 15 (channel 0, high byte) 4828 + m * 64 + 16 (channel 1, low byte) 4828 + m * 64 + 17 (channel 1, high byte)
Description	A lower as well as an upper limit value can be set for the individual channels of the analogue input modules (see section 2.4.5). With data format "VZ + 15 bits linear scaled", the limits have the function of scaling end values.
Bit	Bit 0 ... 7: high byte or low byte of the limit value
Values	Presettings: – Lower limit = 0 (low byte = 0; high byte: 0) – Upper limit = 4095 (low byte = 255; high byte: 15) Low byte: 0 ... 255 High byte: 0 ... 15
Comment	If the input value is less than the parameterized lower limit or exceeds the parameterized upper limit, an appropriate error is displayed (providing the relevant channel parameter "Monitoring channel x – monitoring lower limit" or "Monitoring channel x – monitoring upper limit" is active). The upper limit must always be more than the lower limit. Modifications to the limits must be made in steps of 16 bits. Permissible limits: The limits are checked for validity during parameterisation. Invalid parameterisations are not accepted – the module uses the previous (last valid) parameterisations. The permitted values depend on the parameterized data format (see section 2.4.5). If the module parameter "Monitoring parameterisation errors" as well as the relevant channel parameter "Monitoring parameterisation errors" is set to "active", the relevant error will be displayed.

Tab. 2/16: Lower and upper limits channel x

Module parameters: Force channel x	
Function no.	Access to these module parameters is made via protocol-specific functions (see the manual for the field bus node).
Description	The Force function permits the manipulation of analogue values irrespective of the actual input value (see also CPX system manual). This can be accomplished with the following parameters: – Force mode inputs channel x – Force state inputs channel x
Values	– Force mode inputs channel x 0 = blocked (presetting) 1 = Force state – Force state inputs channel x 0 = reset value (presetting) 1 = set value
Comment	The enabling of the Force function with the parameter "Force mode inputs channel x" depends on the field bus protocol and is accomplished: – by an individual parameter setting or bit (e.g. CPX-FB11), – by setting all parameter bits of the relevant word (e.g. CPX-FB6) to "blocked" or "Force state". For parameterisation of the Force state, the desired input word must be correspondingly mapped in the parameter bits "Force state inputs channel x". The enabling of the Force function for the complete CPX terminal is made by means of the system parameter "Force mode" (see CPX system manual).

Tab. 2/17: Force channel x (channel-specific)

2.4.4 Module parameter “Input analogue-value data format”

The parameterized data format determines how the analogue values are transferred by the CPX terminal to the control system. The setting applies to all analogue input channels. Irrespective of the data format the data width is always 16 bits (2 bytes, 1 word).

Supported data formats of the analogue input modules															
VZ + 15 bits linear scaled															
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
VZ	B14 MSB	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0 LSB
VZ + 12 bits right-justified (compatible with valve terminal type 03, presetting)															
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
VZ	0	0	0	B11 MSB	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0 LSB
VZ + 15 bits left-justified (compatible with Simatic S7)															
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
VZ	B11 MSB	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0 LSB	x	x	x
VZ + 12 bits left-justified + diagnosis (compatible with Simatic S5)															
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
VZ	B11 MSB	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0 LSB	0	F	0

Abbreviations used:

VZ:	Sign (0 = positive value, 1 = negative value)	
B0 ... B14:	Input value	
D0 ... D15:	16 bits input data field	
MSB/LSB:	Most significant bit / least significant bit	
F:	Wire break monitoring with signal range 4 ... 20 mA:	F = 1 wire break exists
x:	Not relevant	F = 0 no wire break exists

Tab. 2/18: Supported data formats of the analogue input modules

Note
For the fieldbus node CPX-FB13 (PROFIBUS-DP) the byte sequence with which the analogue values are transferred to the controller can be reversed by parameterising the value "Analogue process value representation":
- Factory setting: LSB-MSB (INTEL format)
- Reversal: MSB-LSB (MOTOROLA format)

Check this setting in the bus node if you obtain implausible values; also refer to the CPX-FB13 description in chapter 2 under the section entitled "Parameters of CPX-FB13".

Data format "VZ + 15 bits linear scaled"

The 12-bit digital values, which exist after the A-D conversion of the analogue input signals, are linearly scaled to the data range defined by the scaling end values (limit values) and output in the input word (see section 2.4.5, Fig. 2/5).

Data format "VZ + 12 bits right-justified"

The 12-bit digital values, which exist after the A-D conversion of the analogue input signals, are output unmodified in the input word (see also example in section 2.4.1, Fig. 2/3).

Data format "VZ + 15 bits left-justified" and data format "VZ + 12 bits left-justified + diagnosis"

The 12-bit digital values, which exist after the A-D conversion of the analogue input signals, plus the preceding sign bit are arranged left-justified in the data format. The three zeros at the end cause the output data word to correspond to the 12-bit digital value after A-D conversion multiplied by 8 (providing there is no wire break diagnosis).

The following diagram shows an example of the data format "VZ + 15 bits left-justified":

1 Analogue input values

2 Digital signals after A-D conversion

3 Available digital signals scaled to the end value of the data range

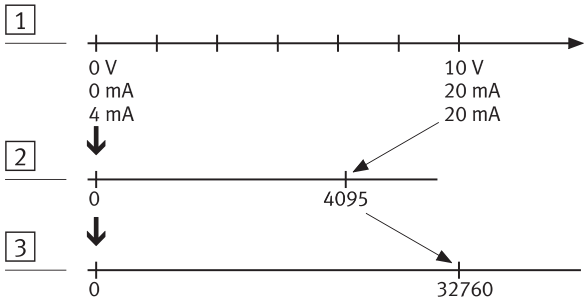


Fig. 2/4: Example of data format "VZ + 15 bits left-justified"

2.4.5 Channel-specific module parameters – Limits

You can determine limits with the channel-specific parameters "Lower limit" and "Upper limit". The meaning of the limit parameters depends on the parameterized data format of the module.

With data format "VZ + 15 bits linear scaled", the limits have the function of defining the scaling end values of the data range. This results in an additional scaling of the analogue values.
If the input data lie outside this data range, a diagnostic message can be generated with appropriate parameterisation.

With other data formats the data range is already defined by the scaling end values. In this case, the limits permit data monitoring even within the data range.

Data format [1]	Data range	Limits/scaling end values [2]	
VZ + 15 bits linear scaled	-30000 ... +30000	Lower scaling end value: -30000 ... +29999	Upper scaling end value: -29999 ... +30000
VZ + 12 bits right-justified	0 ... 4095	Lower limit: 0 ... 4094	Upper limit: 1 ... 4095
VZ + 15 bits left-justified	0 ... 32760	Lower limit: 0 ... 32759	Upper limit: 1 ... 32760
VZ + 12 bits left- justified + diagnosis [3]	0 ... 32760	Lower limit: 0 ... 32752	Upper limit: 1 ... 32760

[1] VZ = Sign
As the analogue inputs with the “Fixed value” data formats “VZ + 12 bits right-justified”, “VZ + 15 bits left-justified” and “VZ + 12 bits left-justified + diagnosis” generate only positive signals, the sign bit with these formats is always 0.
[2] The lower limit/scaling end value must always be less than the upper limit/scaling end value.
[3] If the max. voltage or current values are exceeded, values greater than 4095 will also be output.

Tab. 2/19: Limits or scaling end values of the analogue input modules

Scaling end values with data format “VZ + 15 bits linear scaled”

The following diagram shows an example of the data format “VZ + 15 bits linear scaled” with the scaling end values:

- Lower limit = 0
- Upper limit = 6000

The example shows a sensor which converts the range of the physical measuring variables from 0 ... 6 bar linear into the analogue signals 0 ... 10 V or 0 ... 20 mA.

1 Physical measuring variables

2 Digital signals after A-D conversion (resolution: 12 bits)

3 Available digital signals after scaling by the scaling end values

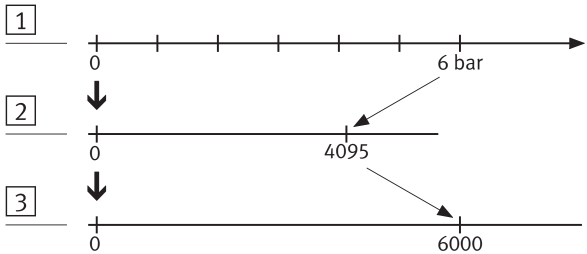


Fig. 2/5: Example scaling data format “VZ + 15 bits linear scaled”

The scaling end values in this data format are identical with the limits for less than or exceeding the rated range:

1 Digital input signal after scaling

2 Limits

3 Less than or exceeding the limits

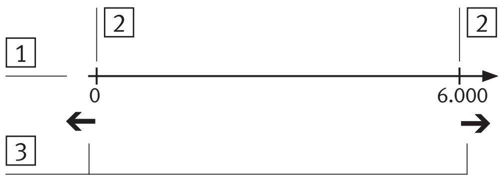


Fig. 2/6: Limit monitoring with data format “VZ + 15 bits linear scaled”

Limits with the "Fixed value" data formats

The following diagram shows an example of the data format "VZ + 12 bits right-justified" with the scaling end values:

– Lower limit = 500

– Upper limit = 3500

The principle of the limits also applies to the data formats "VZ + 15 bits left-justified" and "VZ + 12 bits left-justified + diagnosis".

1 End values of the data range

2 Lower limit

3 Upper limit

4 Less than or exceeding the limits

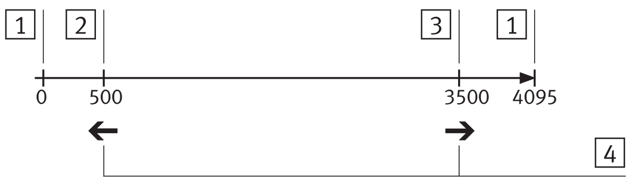


Fig. 2/7: Monitoring of limits with the "Fixed value" data formats

2.4.6 Channel-specific module parameters – Measured value smoothing

In order to suppress errors, the input data can be filtered digitally, whereby the degree of filtering can be set by means of parameterisation.

Filtering is carried out as follows:

- by forming the sum of n values,
- by subtracting an average value,
- by adding the current input value.

The following applies here: the greater n, the more the signal will be filtered.

2.4.7 Channel-specific module parameters – Monitoring wire break

Wire break monitoring (Open Loop) can be activated by means of appropriate parameterisation for the signal range 4 ... 20 mA.

The criterion for a wire break is a software-like monitoring in order to ensure that the value does not drop below the lower limit ($I_{IN} \leq 2.0$ mA). If the value drops below the lower limit, the module will send an appropriate error message to the field bus node.

2.5 Diagnosis

Specific errors of the analogue input modules are reported or suppressed depending on the module parameterisation.

The errors are shown on-the-spot by means of the Error LED and, if necessary, can be evaluated with the handheld.

Depending on the module parameterisation the errors are sent to the field bus node, where they can be evaluated according to the field bus protocol used.

Representation of the errors in the various field bus nodes depends on the field bus protocol (see manual for the field bus node).

2.5.1 Error messages of the analogue input modules

An analogue input module can register the following errors:

Error number	Description	Error treatment
2	**Error short circuit/overload** [1)] Short circuit/overload in sensor supply ($V_{EL/SEN}$). (See “Parameters” “Monitoring the CPX module – monitoring short circuit/overload at sensor”)	1. Eliminate short circuit/overload or check connected sensors 2. Depending on parametrization (Parameters “Behaviour after short circuit/overload”): • Setting “Switch on voltage again”: Power supply for sensors will be switched on again **automatically** when short circuit is eliminated. • Setting “Leave voltage switched off”: – Power off/on necessary or – Modify parameter “Behaviour after short circuit/overload” to “Leave voltage switched off”.
3	**Wire break at current input** [1)] Only with voltage inputs with signal range 4 ... 20 mA: The input currennt I_{IN} is less than 2.0 mA. (See parameter “Monitoring channel x – monitoring wire break”)	• Check and, if necessary, replace the cable and connected sensors.
9	**Less than the rated range** [1)] Lower limit exceeded. (See parameter “Lower limit channel x – low byte/high byte” or “Monitoring channel x – monitoring below rated range”)	• Check signal range of input. • Check input signal present. • Check parameterized limit. • If necessary, deactivate monitoring.
[1)] The module displays the relevant error depending on the parameterisation. The analogue input signals, however, will be processed further.		

Tab. 2/20: Error messages of the input modules – part 1

Error number	Description	Error treatment
10	**Rated range exceeded** [1)] Upper limit exceeded. (See parameter “Upper limit channel x – low byte/high byte” or “Monitoring channel x – monitoring rated range exceeded”)	• Check signal range of input. • Check input signal present. • Check parameterized limit. • If necessary, deactivate monitoring.
15	**Module/channel failed** [2)] General error, module faulty.	• Power off/on necessary • If this error occurs again: check and, if necessary, replace the analogue input module. Evaluation of the analogue input signals has stopped.
   21 23 24 25	**Parameterisation error** [1) 3)] An error has occurred in the setting of the relevant parameter. – Parameter data format – Parameter measured value smoothing – Parameter lower limit – Parameter upper limit (See parameter “Monitoring the CPX module – monitoring parameterisation error” or “Monitoring channel x – monitoring parameterisation error”)	• Check the parameterisation undertaken and, if necessary, repeat the parameterisation using the correct parameters (valid parameters see section 2.4.3). The analogue input module will be operated further with the last valid parameterisation.

1) The module displays the relevant error depending on the parameterisation. The analogue input signals, however, will be processed further.
2) Processing of the analogue input signals will be stopped.
3) The parameters entered will be ignored, the module operates with the last valid parameters.

Tab. 2/21: Error messages of the input modules – part 2

→

Note

Please note the following when using the input modules:

– If there is a short circuit, all sensor supplies of the module will be switched off **together**.

– If not parameterized otherwise, the sensor supply voltage will be switched on again **automatically** when the short circuit is eliminated.

2.5.2 LED display

There is an LED under the transparent cover of the module for diagnosing the input modules.

1 Error LED (red)

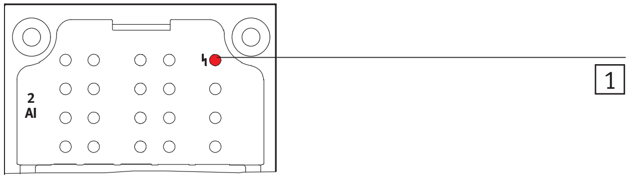


Fig. 2/8: LED display of the analogue input module CPX-2AE-U-I

Error LED

The red error LED indicates a module error depending on the parameterisation (short circuit or overload of the sensor supply, wire break or parameterisation error).

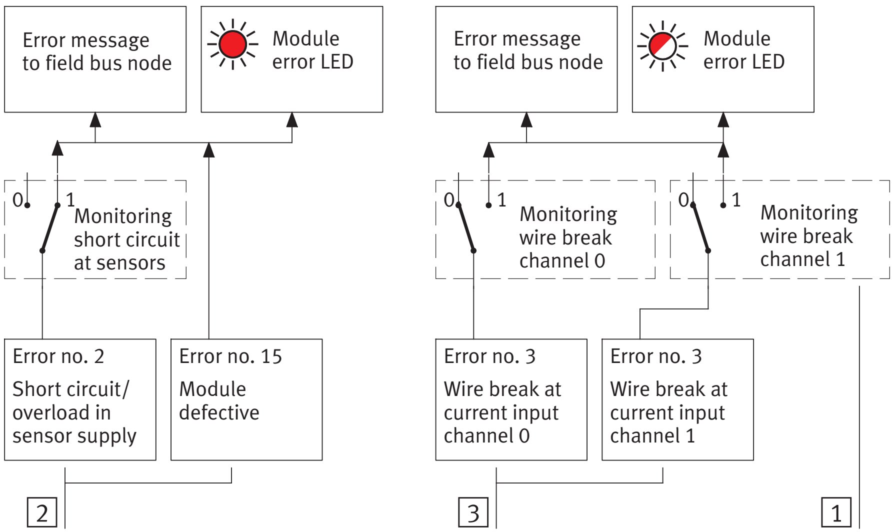
Error LED (red)	**Sequence**	**Status**	**Error number**	**Error treatment**
 LED is out		Trouble-free operation	–	None
 LED lights up		**Error short circuit/overload** Short circuit/overload in sensor supply ($V_{EL/SEN}$). or **Module defective**	2 15	See section 2.5.1, Tab. 2/21 Check and, if necessary, replace component
 LED flashes	 1 flash 1)  2 flashes 1)	**Wire break at current input** I_{IN} < 2.0 mA or **Lower limit exceeded** Input signal is less than the parameterized limit or **Upper limit exceeded** Input signal is greater than the parameterized limit or **Parameterisation error** – Parameter data format – Parameter measured value smoothing – Parameter lower limit – Parameter upper limit	3 9 10 21 23 24 25	See section 2.5.1, Tab. 2/21

1) The number of flash pulses indicates the input channel concerned.
1 flash = channel 0 (or both channels)
2 flashes = channel 1

Tab. 2/22: Error LED of analogue input modules

2.5.3 Error treatment and parameterisation

The following diagrams show the error treatment in the analogue input modules. Further registering and display of the error can be suppressed as desired with the appropriate module parameter, represented in the diagram as a switch. A description of the parameter can be found in section 2.4.3.

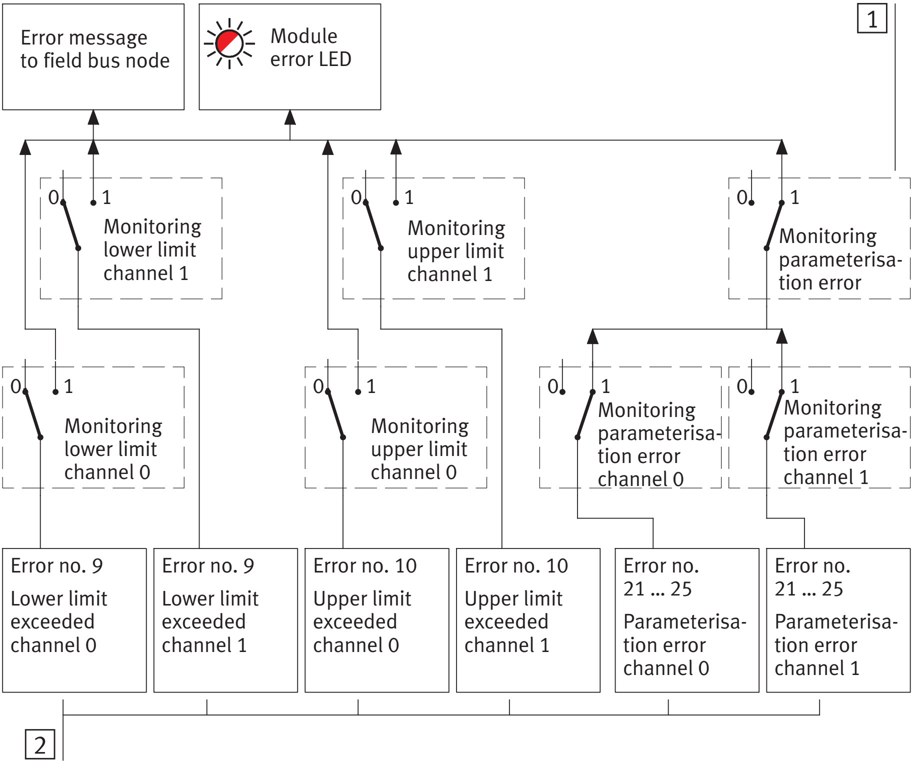


1 Module parameters (switch position represented = default setting)

2 Module-specific errors

3 Channel-specific errors

Fig. 2/9: Principle of error treatment and parameterisation of the analogue input modules – part 1



1 Module parameters (switch position represented = default setting)

2 Channel-specific errors

Fig. 2/10: Principle of error treatment and parameterisation of the analogue input modules – part 2

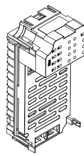
Analogue input module CPX-4AE-U-I

Chapter 3

Contents

3.1 Function of the analogue input modules

Analogue input modules provide analogue voltage inputs or current inputs for connecting sensors and enable the recording and processing of analogue current and voltage signals.

Type		Description
	CPX-4AE-U-I	This type provides 4 analogue inputs (input channels) with scalable value ranges (16 Bit). The input signal range can be configured channel by channel, either electrically isolated or non-floating: – 0 ... 10 V – 1 ... 5 V – - 5 ... + 5 V – - 10 ... + 10 V – 0 ... 20 mA – 4 ... 20 mA – - 20 ... + 20 mA Sensor supply 24 V / 1.4 A per module.

Tab. 3/1: Overview of analogue input module CPX-4AE-U-I

3.2 Fitting

See section 1.3.

3.3 Installation

Warning
Unintentional movements of the connected actuators and uncontrollable movements of loose tubing can cause injury to human beings or damage to property.

Before carrying out installation and maintenance work, switch off the following:

- Compressed air supply
- The operating and load voltage supplies.

In the following sections you will find the pin allocation of the analogue input modules for the different connection blocks.

Instructions on connecting the cables and plugs to the connection blocks can be found in section 1.2.3.
Note in particular the instructions on connecting the cable screening to functional earth (FE).

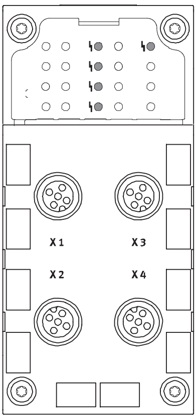
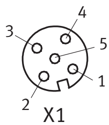
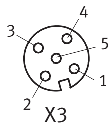
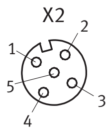
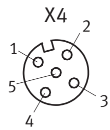
Power supply

The 24 V sensor supply for the inputs as well as the power supply for the electronics of the input modules is provided via the operating voltage supply for the electronics/sensors ($V_{EL/SEN}$).

The sensors can also be supplied externally (electrical isolation, see section 3.3.2, Fig. 3/1).

3.3.1 Pin allocation

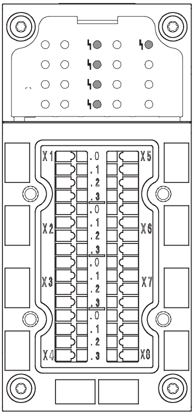
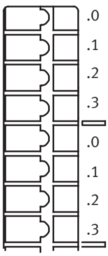
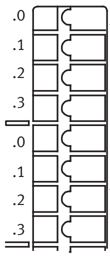
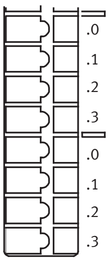
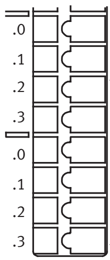
Pin allocation CPX-4AE-U-I with connection block CPX-AB-4-M12x2-5POL (-R)

Analogue I-module type CPX-4AE-U-I with connection block CPX-AB-4-M12x2-5POL (-R)		
Connection block	**Pin allocation X1, X2[1)] (Input E0 ... E1)**	**Pin allocation X3, X4[1)] (Input E2 ... E3)**
	 Socket X1: 1: 24 V_{SEN} 2: IU0+ / II0+ 3: 0 V_{SEN} 4: IU0- / II0- 5: FE (screening)[2)]	 Socket X3 1: 24 V_{SEN} 2: IU2+ / II2+ 3: 0 V_{SEN} 4: IU2- / II2- 5: FE (screening)[2)]
	 Socket X2: 1: 24 V_{SEN} 2: IU1+ / II1+ 3: 0 V_{SEN} 4: IU1- / II1- 5: FE (screening)[2)]	 Socket X4: 1: 24 V_{SEN} 2: IU3+ / II3+ 3: 0 V_{SEN} 4: IU3- / II3- 5: FE (screening)[2)]
	IUx+ = Positive voltage input signal IUx- = Negative voltage input signal IIx+ = Positive current input signal IIx- = Negative current input signal FE = Functional earth	
1) A total of 4 input channels are available per module (IU0 ... IU3 and II0 ... II3 at connections X1 ... X3) 2) With CPX-AB-4-M12x2-5POL-R the metal thread is connected to FE		

Tab. 3/2: Pin allocation for analogue input module type CPX-4AE-U-I with connection block CPX-AB-4-M12x2-5POL (-R)

CPX-AB-4-M12x2-5POL**-R** The metal thread ("...-R") of this connection block is connected internally with pin 5 (functional earth FE).

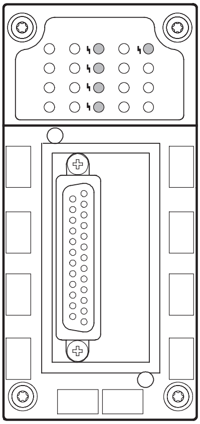
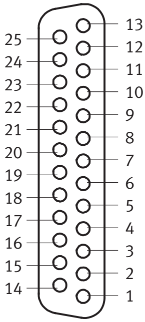
Pin allocation CPX-4AE-U-I with connection block CPX-AB-8-KL-4POL

Analogue input module type CPX-4AE-U-I with connection block CPX-AB-8-KL-4POL		
Connection block	**Pin allocation X1...X4[1)] (Input E0 ... E1)**	**Pin allocation X5...X8[1)] (Input E2 ... E3)**
	**X1** **X2**  X1.0: 24 V_{SEN} X1.1: 0 V_{SEN} X1.2: IU0- / II0- X1.3: FE (screening) X2.0: n.c. X2.1: n.c. X2.2: IU0+ / II0+ X2.3: FE (screening)	 **X5** **X6** X5.0: 24 V_{SEN} X5.1: 0 V_{SEN} X5.2: IU2- / II2- X5.3: FE (screening) X6.0: n.c. X6.1: n.c. X6.2: IU2+ / II2+ X6.3: FE (screening)
	X3 **X4**  X3.0: 24 V_{SEN} X3.1: 0 V_{SEN} X3.2: IU1- / II1- X3.3: FE (screening) X4.0: n.c. X4.1: n.c. X4.2: IU1+ / II1+ X4.3: FE (screening)	 **X7** **X8** X7.0: 24 V_{SEN} X7.1: 0 V_{SEN} X7.2: IU3- / II3- X7.3: FE (screening) X8.0: n.c. X8.1: n.c. X8.2: IU3+ / II3+ X8.3: FE (screening)
	IUx+ = Positive voltage input signal IUx- = Negative voltage input signal IIx+ = Positive current input signal IIx- = Negative current input signal n.c. = not connected FE = Functional earth	
[1)] A total of 4 input channels are available per module (IU0 ... IU3 and II0 ... II3 at connections X1 ... X3)		

Tab. 3/3: Pin allocation of analogue input module type CPX-4AE-U-I with connection block CPX-AB-8-KL-4POL

Pin allocation of CPX-4AE-U-I with connection block CPX-AB-1-SUB-BU-25POL

Analogue input module type CPX-4AE-U-I with connection block CPX-AB-1-SUB-BU-25POL

Connection block	**Pin allocation [1]**		
		1: IU0- / II0- 2: IU0+ / II0+ 3: IU1- / II1- 4: IU1+ / II1+ 5: n.c. 6: n.c. 7: n.c. 8: n.c. 9: 24 V_{SEN} 10: 24 V_{SEN} 11: 0 V_{SEN} 12: 0 V_{SEN} 13: FE	14: IU2- / II2- 15: IU2+ / II2+ 16: IU3- / II3- 17: IU3+ / II3+ 18: 24 V_{SEN} 19: n.c. 20: 24 V_{SEN} 21: n.c. 22: 0 V_{SEN} 23: 0 V_{SEN} 24: 0 V_{SEN} 25: FE Housing: FE (screening)
	IUx+ = Positive voltage input signal IUx- = Negative voltage input signal IIx+ = Positive current input signal IIx- = Negative current input signal n.c. = not connected FE = Functional earth		

[1] A total of 4 input channels are available per module (IU0 ... IU3 and II0 ... II3)

Tab. 3/4: Pin allocation of analogue input module type CPX-4AE-U-I with connection block CPX-AB-1-SUB-BU-25POL

3.3.2 Connecting the analogue inputs

Only screened/shielded cables are permitted for the transmission of analogue signals (see section 1.2.3).

1 Without electrical isolation: The sensors are supplied via the CPX module

2 With electrical isolation: if an external sensor supply is used

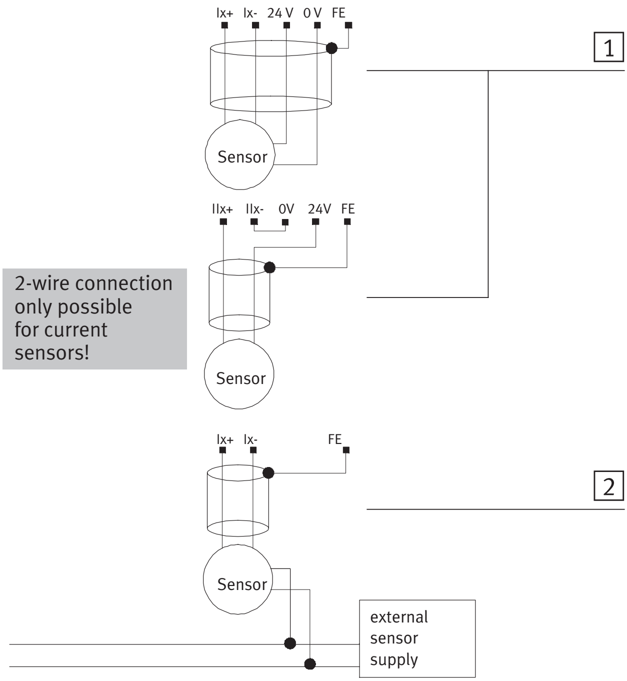


Fig. 3/1: Examples of analogue input connections (screening connection on FE pin)

Further connection examples can be found in appendix A.10.1.

3.4 Instructions on commissioning

3.4.1 Processing analogue input signals

The analogue values are transmitted from the CPX terminal to the control system as input words (2 bytes, 16 bits). Each analogue input module CPX-4AE-U-I occupies 4 input words for this procedure in the address range.

The position of the input words in the address range depends on the field bus or network used (see manual for the bus node).

3.4.2 Procedure for commissioning

All settings of the module CPX-4AE-U-I are effected by means of parameterisation. The majority of parameters are provided with preset values.
The preset value for the parameter "Signal range" (connected sensor type) is "No sensor connected". These parameters **must** be set:

1. Set a signal range for each channel to which a sensor is connected.
2. Conduct further settings with the parameters if required (see section 3.4.3).

3.4.3 General information on parameterisation

Due to in some cases necessary calculations, modified parameters are not valid until they have been thoroughly checked and saved. Until then, as in the case of invalid parameters, the previous settings apply. Conduct in the event of invalid parameters can be found in Tab. 3/23.

Prevention of parameterisation errors

Observe the following sequence when setting or changing parameters in order to prevent errors:

1. Connected sensor type,
   Parameter: "Signal range channel x"

2. Desired data format,
   Parameter: "Data format"

3. Switch on the sensor supply if necessary.
   Parameter: "Sensor supply"

4. Then set the upper and lower limits for the channels:

   – If the new upper limit value is positive, first set the upper limit, then the lower limit.

   – If the new upper limit value is negative, first set the lower limit, then the upper limit.

5. Activate limit value monitoring
   Parameter: "Monitoring channel x"

Further information on parameterisation can be found in the system manual and in the manual for the bus node.

3.4.4 Parameters of analogue input module type CPX-4AE-U-I

An overview of the module parameters is included in the following tables Tab. 3/5 and Tab. 3/6. A detailed description can be found in the following section.

Function number 1)	Module parameters
4828 + m * 64 + **0**	Monitoring the CPX module, parameterisation error
4828 + m * 64 + **1**	Behaviour after short circuit/overload
4828 + m * 64 + **2 ... 5**	Reserved
4828 + m * 64 + **6**	Data format, sensor supply, overload monitoring, behaviour after overload
4828 + m * 64 + **7 ... 8**	Hysteresis of limit value monitoring for all channels
1) m = module number (counting from left to right, beginning with 0)	

Tab. 3/5: Overview - module parameters

Function number 1)	Channel-specific module parameters (channel parameters)
4828 + m * 64 + **9 ... 12**	Monitoring channel 0 ... 3
4828 + m * 64 + **13 ... 14**	Signal range channel 0 ... 3
4828 + m * 64 + **15**	Measured value smoothing channel 0 ... 1
4828 + m * 64 + **16**	Measured value smoothing channel 2 ... 3
4828 + m * 64 + **17 ... 24**	Lower limit channel 0 ... 3
4828 + m * 64 + **25 ... 32**	Upper limit channel 0 ... 3
– 2)	Force channel x (also see CPX system manual)
1) m = module number (counting from left to right, beginning with 0) 2) Access is protocol-specific (see manual for the field bus node)	

Tab. 3/6: Overview – channel-specific module parameters

Description of the parameters

Module parameters: Monitoring the CPX module, parameterisation error	
Function no.	4828 + m * 64 + **0** m = module number (0 ... 47)
Description	With the analogue input modules, monitoring of individual errors can be activated or deactivated (suppressed) independently of each other. Active monitoring causes the following. The error is: – sent to the CPX Fieldbus node – displayed by the module common error LED.
Bit	Bit 0: Monitoring short circuit/overload in the sensor supply Bit 1 ... 6: Reserved Bit 7: Monitoring parameterisation errors
Values	1 = active (presetting); 0 = inactive
Comment	– Monitoring short circuit/overload in the sensor supply: Monitoring can also be set for the complete CPX terminal (see CPX system manual, system parameter “Monitoring”). – Monitoring parameterisation errors: Some parameters are checked for impermissible values during parameterisation: Module parameters: – Hysteresis < 0 is not permissible Channel parameters: – Signal range (sensor type) – The following is not permissible: Lower limit value > upper limit value The setting of the module parameter “Monitoring parameterisation errors” is only effective for channel-specific parameterisation if the corresponding channel parameter “Monitoring parameterisation errors” is set to “active”.

Tab. 3/7: Monitoring the CPX module

Module parameters: Behaviour after short circuit/overload	
Function no.	4828 + m * 64 + **1** m = module number (0 ... 47)
Description	Determines after a short circuit in the sensor supply whether the power is to remain switched off or whether it is to be switched on again automatically.
Bit	Bit 0: Reaction after short circuit/overload in the sensor supply
Values	0 = Leave voltage switched off 1 = Switch voltage on again (presetting) Bit 1 ... 7: Reserved
Comment	With the setting "Leave voltage switched off", Power Off/On is necessary for switching the power on again. Check which setting is necessary for reliable operation of your system. Further information can be found in section 3.5.1.

Tab. 3/8:   Behaviour after short circuit/overload

Module parameters: Data format, sensor supply, overload monitoring, behaviour after overload	
Function no.	4828 + m * 64 + **6** m = module number (0 ... 47)
Description	This parameter enables different settings to be changed.
Bit	Bit 0: Data format Bit 1 ... 4: Reserved Bit 5: Sensor supply Bit 6: Overload monitoring of analogue input Bit 7: Behaviour after overload of analogue input
Values	Bit 7 6 5 4 3 2 1 0 Data format x x x x x x x **0** 15 bit + sign (presetting) x x x x x x x 1 linear scaled Sensor supply x x 0 x x x x x switched off x x **1** x x x x x switched on (presetting) Overload monitoring x 0 x x x x x x inactive x **1** x x x x x x active (presetting) Behaviour after overload 0 x x x x x x x Leave measuring resistor switched off **1** x x x x x x x Switch measuring resistor on again (presetting)
Explanations:	Sensor supply: The sensors can be switched to a de-energised state during operation. Overload monitoring: Only for current measuring ranges. A diagnostic message is generated if an input current of 30 mA is exceeded. Behaviour after overload: With the setting "Leave measuring resistor switched off", Power Off/On is necessary for switching the power on again. Check which setting is necessary for reliable operation of your system. Further information can be found in section 3.5.1.

Tab. 3/9: Data format, sensor supply, overload monitoring, behaviour after overload

Module parameters: Hysteresis of limit value monitoring	
Function no.	4828 + m * 64 + **7** m = module number (0 ... 47) 4828 + m * 64 + **8**
Description	This parameter defines the hysteresis behaviour **of all** channels for limit value monitoring.
Bit	Bit 0 ... 7: High byte and low byte of the hysteresis
Values	Default setting: Hysteresis = 0 (Low Byte = 0; High Byte = 0) Minimum value: 0 Maximum value: Upper limit value - lower limit value Presetting: Hysteresis = 0 (Low Byte = 0; High Byte = 0)
Comment	The defined hysteresis value must not be larger than the difference between the upper and lower limit values. The hysteresis value is not checked for validity during parameterisation. Unsuitable parameterisations are adopted – in this case the module can react unexpectedly. Check the parameterisation! If the “Monitoring of parameterisation errors” module parameter is active, then a corresponding error is signalled. Tab. 7/3 shows the possible parameterisation errors.

Tab. 3/10: Setting the hysteresis for limit value monitoring

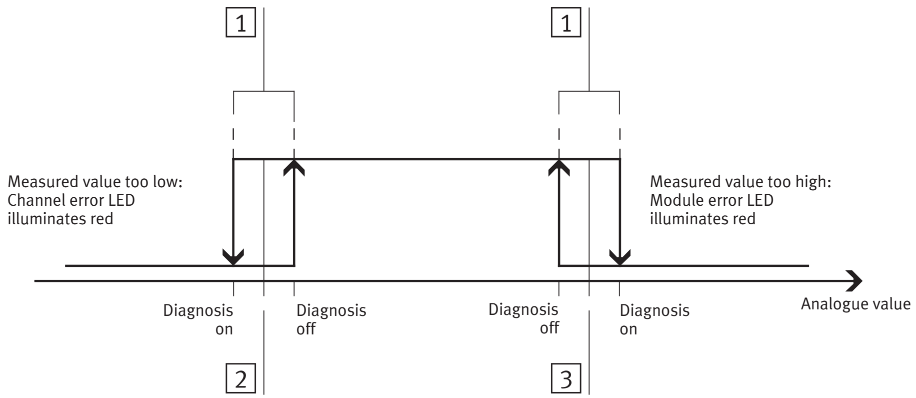
Hysteresis behaviour

If hysteresis is defined, then the analogue input module CPX-4AE-U-I behaves as follows (also see Fig. 3/2):

– The **lower** limit value must be **less** than half the hysteresis value before a diagnostic message occurs. The diagnostic message disappears when the set limit value becomes greater than half the hysteresis value again.

– The **upper** limit value must be **more** than half the hysteresis value before a diagnostic message occurs. The diagnostic message disappears when the set limit value becomes less than half the hysteresis value again.

The hysteresis applies to all channels simultaneously.



1 Defined hysteresis

2 Defined lower limit value

3 Defined upper limit value

Fig. 3/2: Hysteresis behaviour of analogue input module CPX-4AE-U-I

Channel parameters: Monitoring channel x	
Function no.	4828 + m * 64 + **9** (channel 0) m = module number (0 ... 47) 4828 + m * 64 + **10** (channel 1) 4828 + m * 64 + **11** (channel 2) 4828 + m * 64 + **12** (channel 3)
Description	For the individual channels of the analogue input modules, monitoring of individual errors can be activated or deactivated (suppressed) independently of each other. Active monitoring causes the following. The error is: – sent to the CPX Fieldbus node – displayed by the module common error LED and the corresponding channel error LED. Further information on monitoring can be found under the description of the relevant error in section 4.5.1.
Bit	Bit 0: Monitoring lower limit Bit 1: Monitoring upper limit Bit 2: Monitoring wire break Bit 3: Monitoring underrun/overrun Bit 4 ... 6: Reserved Bit 7: Monitoring parameterisation errors
Values	Bit 7 6 5 4 3 2 1 0 Monitoring channel x Monitoring of lower limit value x x x x x x x **0** inactive (presetting) x x x x x x x 1 active Monitoring of upper limit value x x x x x x **0** x inactive (presetting) x x x x x x 1 x active Monitoring wire break x x x x x **0** x x inactive (presetting) x x x x x 1 x x active Monitoring underrun/overrun x x x x x **0** x x inactive (presetting) x x x x x 1 x x active Monitoring parameterisation errors 0 x x x x x x x inactive **1** x x x x x x x active (presetting)

Tab. 3/11: Setting monitoring for individual channels

Channel parameters: Monitoring channel x	
Comment	– Monitoring the upper/lower limit: Monitoring the input signals for less than or exceeding the nominal range or monitoring the range limits defined with the parameters “Lower limit ...” as well as “Upper limit ...” (depending on the data format used, see Tab. 3/9 and section 3.4.5). – Monitoring wire break: Only effective for the signal range 4 ... 20 mA. A drop below the minimum input current (I_{IN} < 1.2 mA) counts as a wire break. – Monitoring underrun/overrun: Monitoring the input signals for less than or exceeding the overrun and under-run value range. The values for overrun and underrun can be found in tables Tab. 3/18 to Tab. 3/21. – Monitoring parameterisation errors: Some channel-specific parameters are checked for impermissible values during parameterisation: – Signal range – Lower limit value – Upper limit value The setting of the channel parameter “Monitoring parameterisation errors” is only effective if the module parameter “Monitoring parameterisation errors” is set to “active”.

Tab. 3/12: Comments on parameter monitoring channel x

Channel parameters: Signal range channel x	
Function no.	4828 + m * 64 + **13** (channel 0 ... 1) m = module number (0 ... 47) 4828 + m * 64 + **14** (channel 2 ... 3)
Description	For the individual channels of the analogue input modules, the signal ranges of the analogue inputs can be set independently of each other. Channel 0: Function number 13 Bit 0 ... 3 Channel 1: Function number 13 Bit 4 ... 7 Channel 2: Function number 14 Bit 0 ... 3 Channel 3: Function number 14 Bit 4 ... 7
Bit	Bit 0 ... 3: Signal range channel 0 or channel 2 Bit 4 ... 7: Signal range channel 1 or channel 3
Values	Bit 7 6 5 4 3 2 1 0 Channel 0 / channel 2 - - - - **0 0 0 0** No sensor connected (presetting) - - - - 0 0 0 1 0 ... 10 V - - - - 0 0 1 0 -10 ... +10 V - - - - 0 0 1 1 -5 ... +5 V - - - - 0 1 0 0 1 ... 5 V - - - - 0 1 0 1 0 ... 20 mA - - - - 0 1 1 0 4 ... 20 mA - - - - 0 1 1 1 -20 ... +20 mA - - - - 1 0 0 0 0 ... 10 V (negative values suppressed) - - - - 1 0 0 1 0 ... 20 mA (negative values suppressed) - - - - 1 0 1 0 4 ... 20 mA (negative values suppressed) Bit 7 6 5 4 3 2 1 0 Channel 1 / channel 3 **0 0 0 0** - - - - No sensor connected (presetting) 0 0 0 1 - - - - 0 ... 10 V 0 0 1 0 - - - - -10 ... +10 V 0 0 1 1 - - - - -5 ... +5 V 0 1 0 0 - - - - 1 ... 5 V 0 1 0 1 - - - - 0 ... 20 mA 0 1 1 0 - - - - 4 ... 20 mA 0 1 1 1 - - - - -20 ... +20 mA 1 0 0 0 - - - - 0 ... 10 V (negative values suppressed) 1 0 0 1 - - - - 0 ... 20 mA (negative values suppressed) 1 0 1 0 - - - - 4 ... 20 mA (negative values suppressed)
Comment	Detailed information regarding the effect of the set signal range can be found in section 3.4.5

Tab. 3/13: Setting the signal range for individual channels

Channel parameters: Measured value smoothing channel x	
Function no.	4828 + m * 64 + **15** 4828 + m * 64 + **16** m = module number (0 ... 47)
Description	For the individual channels of the analogue input modules, the measured value smoothing can be set independently of each other. Channel 0: Function number 15 Bit 0 ... 3 Channel 1: Function number 15 Bit 4 ... 7 Channel 2: Function number 16 Bit 0 ... 3 Channel 3: Function number 16 Bit 4 ... 7
Bit	Bit 0 ... 3: Measured value smoothing for channel 0 or channel 2 Bit 4 ... 7: Measured value smoothing for channel 1 or channel 3
Values	Bit 7 6 5 4 3 2 1 0 — Channel 0 / channel 2 - - - - **0 0 0 0** — No measured value smoothing (presetting) - - - - 0 0 0 1 — Smoothing over 2 values (2^{1}) - - - - 0 0 1 0 — Smoothing over 4 values (2^{2}) - - - - 0 0 1 1 — Smoothing over 8 values (2^{3}) ... ... - - - - 1 1 1 1 — Smoothing over 32768 values (2^{15}) Bit 7 6 5 4 3 2 1 0 — Channel 1 / channel 3 **0 0 0 0** - - - - — No measured value smoothing (presetting) 0 0 0 1 - - - - — Smoothing over 2 values (2^{1}) 0 0 1 0 - - - - — Smoothing over 4 values (2^{2}) 0 0 1 1 - - - - — Smoothing over 8 values (2^{3}) ... ... 1 1 1 1 - - - - — Smoothing over 32768 values (2^{15})
Comment	Errors can be suppressed with the measured value smoothing (see section 4.5.1).

Tab. 3/14: Setting measured value smoothing for individual channels

Channel parameters: Lower limit channel x / Upper limit channel x	
Function no.	Lower limit: m = module number (0 ... 47) 4828 + m * 64 + **17** (channel 0, Low Byte) ... + **18** (channel 0, High Byte) 4828 + m * 64 + **19** (channel 1, Low Byte) ... + **20** (channel 1, High Byte) 4828 + m * 64 + **21** (channel 2, Low Byte) ... + **22** (channel 2, High Byte) 4828 + m * 64 + **23** (channel 3, Low Byte) ... + **24** (channel 3, High Byte) Upper limit values: 4828 + m * 64 + **25** (channel 0, Low Byte) ... + **26** (channel 0, High Byte) 4828 + m * 64 + **27** (channel 1, Low Byte) ... + **28** (channel 1, High Byte) 4828 + m * 64 + **29** (channel 2, Low Byte) ... + **30** (channel 2, High Byte) 4828 + m * 64 + **31** (channel 3, Low Byte) ... + **32** (channel 3, High Byte)
Description	A lower as well as an upper limit value can be set for the individual channels of the analogue input modules (see section 3.4.6). The limit values have the function of scaling end values for the "linear scaled" data format.
Bit	Bit 0 ... 7: High byte or low byte of the limit value
Values	Default settings: – Lower limit = -27648 (low byte = 0; high byte: 148) – Upper limit = +27648 (low byte = 0; high byte: 108)
Comment	If the input value is less than the parameterised lower limit or exceeds the parameterised upper limit, an appropriate error is displayed (providing the relevant channel parameter "Monitoring channel x – monitoring lower limit" or "Monitoring channel x – monitoring upper limit" is active). The upper limit must always be more than the lower limit. Permissible limits: The limits are checked for validity during parameterising. Invalid parameterisation is not accepted - the module uses the previous (last valid) parameterisation settings. The permitted values depend on the parameterised data format (see section 3.4.5). If the module parameter "Monitoring parameterisation errors" as well as the relevant channel parameter "Monitoring parameterisation errors" is set to "active", the corresponding error will be displayed.

Tab. 3/15: Lower and upper limits channel x

Module parameters: Force channel x	
Function no.	Access to these module parameters is made via protocol-specific functions (see the field bus node manual).
Description	The Force function permits the manipulation of analogue values irrespective of the actual input signal (see also CPX system manual). This can be accomplished with the following parameters: – Force mode inputs channel x – Force state inputs channel x
Values	– Force mode inputs channel x 0 = blocked (presetting) 1 = Force state – Force state inputs channel x: 0 = reset value (presetting) 1 = set value
Comment	Enabling of the Force function with the parameter "Force mode outputs channel x" is effected depending on the field bus protocol: – by means of an individual parameter setting or bit. – by setting all parameter bits of the relevant word to "blocked" or "Force state". For parameterisation of the Force state, the desired input word must be correspondingly mapped in the parameter bits "Force state inputs channel x". Enabling of the Force function for the complete CPX terminal is carried out with the system parameter "Force mode" (see CPX system manual).

Tab. 3/16: Force channel x (channel-specific)

3.4.5 Representation and value ranges of the analogue values

The data format determines how the analogue values are transferred from the CPX terminal to the control system. Tab. 3/17 shows how the analogue values are saved in the input word.

Data format “VZ + 15 Bit”															
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
VZ	B14 MSB	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0 LSB
VZ: Prefix D0 ... D15: 16-bit input data field B0 ... B14: input value MSB/LSB: most significant bit / least significant bit															

Tab. 3/17: Data format of the module CPX-4AE-U-I

The channel-specific parameters “Lower limit” and “Upper limit” feature the following default settings:

– lower limit = -27648

– upper limit = +27648

These correspond to the scaling end values (data range) of the data format.

Note
For the fieldbus node CPX-FB13 (PROFIBUS-DP) the byte sequence with which the analogue values are transferred to the controller can be reversed by parameterising the value “Analogue process value representation”:

– Factory setting: LSB-MSB (INTEL format)
– Reversal: MSB-LSB (MOTOROLA format)

Check this setting in the bus node if you obtain implausible values; also refer to the CPX-FB13 description in chapter 2 under the section entitled “Parameters of CPX-FB13”.

The following tables show the correspondence between the analogue input signal and the digital value ranges for the various signal ranges. Setting of the signal range by means of parameterisation shows Tab. 3/13.

Signal range		**Digital values**		**Range**
0 ... 10 V	**0 ... 20 mA**	**decimal**	**hex**	
> 11.76 V	> 23.52 mA	32767	7FFF	Overrun
11.76 V	23.52 mA	32511	7EFF	End of the measuring range
> 10 V	> 20 mA	>27648	>6C00	Overload range
0 ... 10 V	0 ... 20 mA	0 ... 27648	0 ... 6C00	Nominal range
< 0 V	< 0 mA	< -1	< FFFF	Underload range [1)]
-1.76 V	-3.52 mA	-4864	ED00	End of the measuring range [1)]
< -1.76 V	< -3.52 mA	-32768	8000	Underrun [1)]

[1)] No negative values are output for data formats “0 ... 10 V (negative values suppressed)” and “0 ... 20 mA (negative values suppressed)”. An application example can be found in section 3.4.7.

Tab. 3/18: Value ranges for signal ranges 0 ... 10 V and 0 ... 20 mA

Signal range	**Digital values**		**Range**
4 ... 20 mA	**decimal**	**hex**	
> 22.81 mA	32767	7FFF	Overrun
22.81 mA	32511	7EFF	End of the measuring range
> 20 mA	> 27648	> 6C00	Overload range
4 ... 20 mA	0 ... 27648	0 ... 6C00	Nominal range
< 4 mA	< -1	< FFFF	Underload range [1)]
1.19 mA	-4864	ED00	End of the measuring range [1)]
< 1.19 mA	-32768	8000	Underrun [1)] (Diagnostics wire break inactive)
< 1.19 mA	32767	7FFF	Underrun [1)] (Diagnostics wire break active)

[1)] No negative values are output for data format “4 ... 20 mA (negative values suppressed)”. An application example can be found in section 3.4.7.

Tab. 3/19: Value ranges for signal range 4 ... 20 mA

Signal range			**Digital values**		**Range**
-10 ... 10 V	**-5 ... +5 V**	**-20 ... +20 mA**	**decimal**	**hex**	
› 11.76 V	› 5.88 V	› 23.52 mA	32767	7FFF	Overrun
11.76 V	5.88 V	23.52 mA	32511	7EFF	End of the measuring range
› 10 V	› 5 V	› 20 mA	› 27648	› 6C00	Overload range
-10 ... +10 V	-5 ... +5 V	-20 ... +20 mA	-27648 ... 27648	6C00 ... 9400	Nominal range
‹ -10 V	‹ -5 V	‹ -20 mA	‹ -27648	‹ 9400	Underload range
-11.76 V	-5.88 V	-23.52 mA	-32512	8100	End of the measuring range
‹ -11.76 V	‹ -5.88 V	‹ -23.52 mA	-32768	8000	Underrun

Tab. 3/20: Value ranges for signal ranges -10...+10 V, -5...+5 V and -20...+20 mA

Signal range	**Digital values**		**Range**
1 ... 5 V	**decimal**	**hex**	
› 5.70 V	32767	7FFF	Overrun
5.7 V	32511	7EFF	End of the measuring range
› 5 V	› 27648	› 6C00	Overload range
1 ... 5 V	0 ... 27648	0 ... 6C00	Nominal range
‹ 1 V	‹ -1	‹ FFFF	Underload range
0.30 V	-4864	ED00	End of the measuring range
‹ 0.30 V	‹ -32768	8000	Underrun

Tab. 3/21: Value ranges for signal range 1 ... 5 V

Fig. 3/3 shows the processing of the analogue input signals with the data format “VZ + 15 Bit” (i.e. without scaling). An example is a sensor which converts the range of the physical measuring variables from 0 ... 6 bar linear into the analogue signals 0 ... 10 V, 0 ... 20 mA or 4 ... 20 mA.

1 Lower limit of the nominal range

2 Measured value (example)

3 Upper limit of the nominal range

4 Physical measuring variables

5 Assigned analogue signal

6 Digital value range after A-D conversion

7 Digital input value (example)

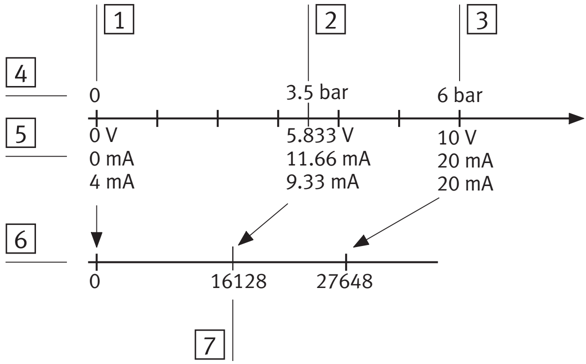


Fig. 3/3: Example data format “VZ + 15 Bit” for a pressure sensor with 0 ... 6 bar and signal ranges 0 ... 10 V, 0 ... 20 mA and 4 ... 20 mA

3.4.6 Scaling of the value range with limit values

The channel-specific “ower limit value”l and “upper limit value” parameters can be used to define the scaling of your value range.
The distance between the lower and upper limit value should be at least 100_{dec} in order to ensure correct diagnostic processing.

1. Set the data format module parameter: “linear scaled” (see Tab. 3/9).

2. Set the lower and upper limit value to the desired scaling end values (see Tab. 3/15).

3. If desired, you can use the parameterisation “Monitoring channel x” to generate a diagnostic message if the input data lies outside the scaled value range (see Tab. 3/11).

3.4.7 Examples for scaling of the value range

Example 1: Scaling suitable for a pressure sensor

The following diagram shows an example of the data format “linear scaled” with the scaling end values:

– lower limit = 0

– upper limit = 6000

The example shows a sensor which converts the range of the physical measuring variables from 0 ... 6 bar linear into the analogue signals 0 ... 10 V or 0 ... 20 mA.

1 Physical measuring variables

2 Available digital signals after scaling by the scaling end values

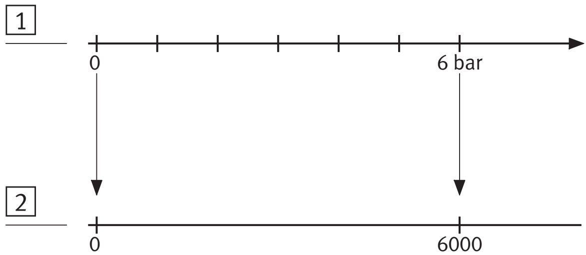


Fig. 3/4: Example of scaling for a pressure sensor

The scaling end values in this data format are identical with the limits for less than or exceeding the nominal range:

1 Digital input signal after scaling

2 Limit values

3 Less than or exceeding the limits

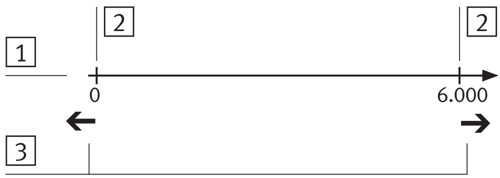


Fig. 3/5: Limit value monitoring

Example 2: Scaling for compatibility with other CPX analogue modules

If you want to replace an earlier module of type CPX-2AE-U-I with a new module type CPX-4AE-U-I, you can adjust the latter to ensure it is compatible by using parameterisation:

1. Set the “data format” module parameter: “linear scaled” (see Tab. 3/9)

2. Use a signal range with the property “negative values suppressed” (see Tab. 3/13).

3. Set the lower limit value to “0” and the upper limit value to “4095” (see Tab. 3/15).

Doing this will ensure the CPX-4AE-U-I module behaves in the same way as a CPX-2AE-U-I module, without you having to make any changes to your control system.

3.5 Diagnosis

Specific errors of the analogue input modules are reported or suppressed depending on module parameterisation.

The errors are indicated locally via the Module error LED and the corresponding Channel error LED and they can be evaluated, if necessary, by using the handheld unit.

Depending on module parameterisation, the errors are sent to the field bus node, where they can be evaluated according to the field bus protocol used.

i The representation of the errors in the various bus nodes depends on the bus protocol (see manual for the bus node).

3.5.1 Error messages of the analogue input modules

The CPX-4AE-U-I module can register the following errors:

Error no.	Description	Error handling
2	**Error short circuit/overload** [1)] Short circuit/overload in sensor supply ($V_{EL/SEN}$). (see parameter "Monitoring the CPX module – monitoring SCS" in Tab. 3/7)	1. Eliminate short circuit/overload or check connected sensors 2. Depending on parameterisation (parameter "Behaviour after short circuit"): • Setting "Switch voltage on again": Power supply for sensors will be switched on again **automatically** when the short circuit is eliminated. • Setting "Leave voltage switched off": – Power Off/On necessary or – Modify parameter "Behaviour after short circuit" to "Switch voltage on again".
3	**Wire break at current input** [1)] Only for voltage inputs with signal range 4 ... 20 mA: The input current I_{IN} is less than 1.2 mA. (see parameter "Monitoring channel x – monitoring wire break")	• Check and, if necessary, replace the cable and connected sensors.
9	**Value below nominal range** [1)] Lower limit exceeded. (see parameter "Lower limit channel x – low byte/high byte" or "Monitoring channel x – monitoring value below nominal range")	• Check signal range of input. • Check input signal present. • Check parameterised limit value. • If necessary, deactivate monitoring.
[1)] The module will report the appropriate error depending on the parameterisation. The analogue input signals will, however, be processed further.		

Tab. 3/22: Error messages of the CPX-4AE-U-I module - part 1

Error no.	Description	Error handling
10	**Value exceeding nominal range** [1)] Upper limit exceeded. (see parameter “Upper limit channel x – low byte/high byte” or “Monitoring channel x – monitoring value exceeding nominal range”)	• Check signal range of input. • Check input signal present. • Check parameterised limit value. • If necessary, deactivate monitoring.
15	**Module/channel failed** General error, module faulty. Evaluation of the analogue input signals has stopped.	• Power Off/On necessary • If this error occurs again: check and, if necessary, replace the analogue input module.
29	**Error during parameterisation** [1)] An error has occurred in the setting of the relevant parameter. – Sensor type parameter (value $7FFF_h$ is issued) – Scaling end values for “linear scaled” invalid (value $7FFF_h$ is issued) – Parameter for lower limit value › upper limit value – Parameter for hysteresis ‹ 0 (see parameter “Monitoring the CPX module – parameterisation errors” or “Monitoring channel x – monitoring parameterisation errors”)	• Check the parameterisation process implemented and, if necessary, implement it again with the correct parameters (for valid parameters see section 3.4.4). The parameters entered are ignored, the module operates with the last valid parameters.
59	**Input overload**	• Check signal range of input • Check input signal present • Check wiring of input
60	**Over/underrun** [2)] The measured analogue value lies outside the measuring range or the presentable value range (see Tab. 3/18 ... Tab. 3/21).	• Check signal range of input • Check input signal present • Check wiring of input

1) The module will register the appropriate error depending on the parameterisation. The analogue input signals will, however, be processed further.
2) Diagnosis is issued with the first recorded input value and is maintained for at least 200 ms until valid input values are recorded.

Tab. 3/23: Error messages of the CPX-4AE-U-I module - part 2

→

Note
Please observe the following when using the input modules:

– If there is a short circuit, all sensor supplies of the module will be switched off **together**.
– Providing it is not programmed otherwise, the sensor supply voltage will be switched on again **automatically** when the short circuit is eliminated.

3.5.2 LED display

LEDs are situated under the transparent cover of the module for diagnosing the input modules.

1 Channel error LEDs (red)

2 Module error LED (red)

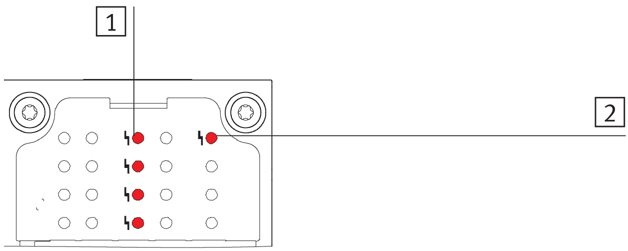


Fig. 3/6: LED display of the CPX-4AE-U-I module (16 Bit)

Error LED

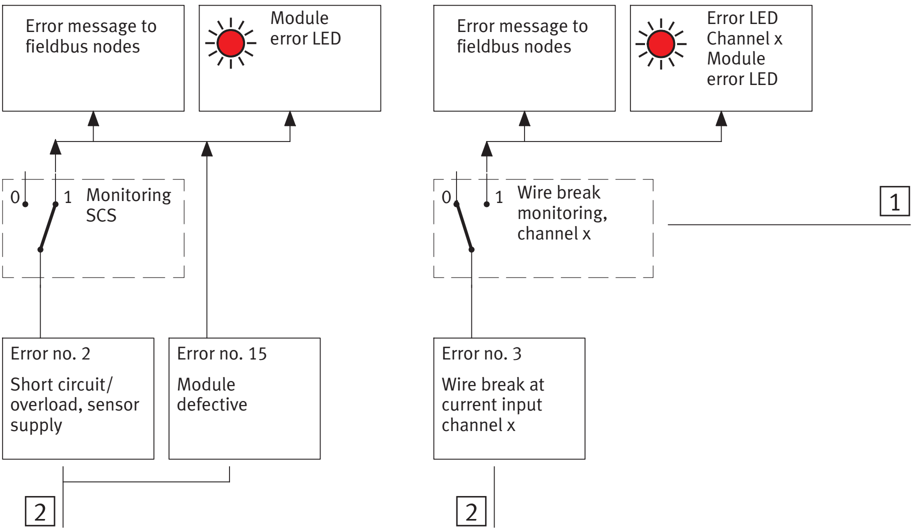
The red error LEDs indicate channel or module errors depending on parameterisation.

Channel error LED (red)	**Module error LED (red)**	**Status**	**Error number**	**Error handling**
LED is off	LED is off	Trouble-free operation.	–	None
LED is off	LED illuminates	**Error short circuit/overload** Short circuit/overload in sensor supply ($V_{EL/SEN}$). or **Module defective**	2 15	See section 3.5.1, Tab. 3/22 ... Tab. 3/23
LED illuminates	LED illuminates	**Wire break at current input** **Value below nominal range** **Value exceeding nominal range** **Error in parameterisation** **Input overload** **Over/underrun**	3 9 10 29 59 60	

Tab. 3/24: Error LED of analogue input modules

3.5.3 Error handling and parameterisation

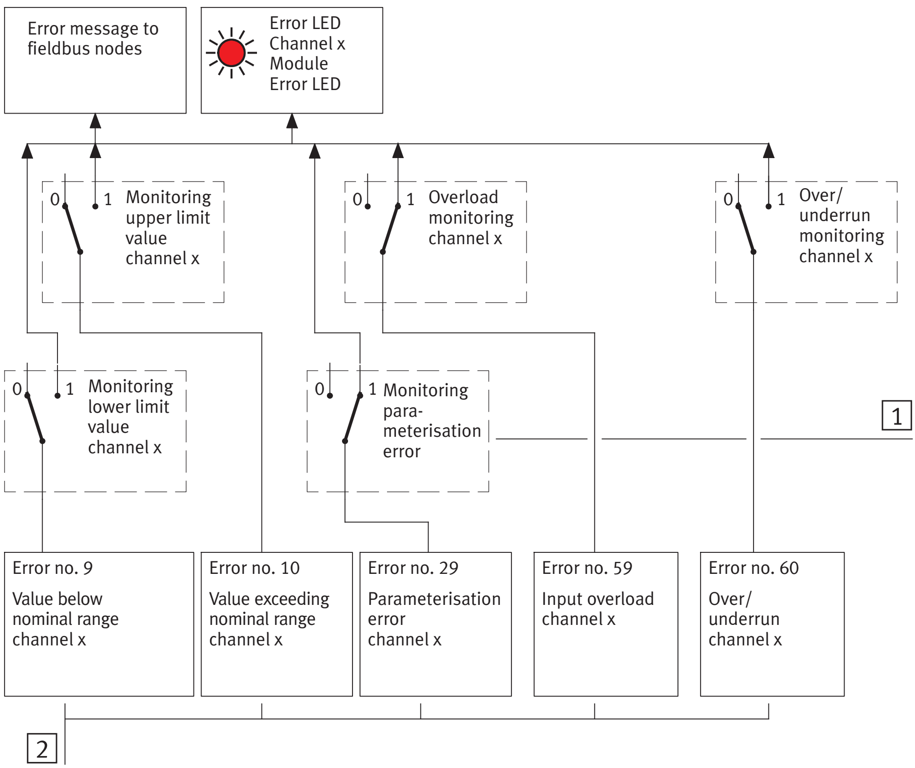
The following diagrams show error handling in the analogue input modules. Further registering and display of the errors can be suppressed as desired with the appropriate module parameter (represented in the diagram as a switch). The parameters are described in section 3.4.4.



1 Channel-specific parameters (switch position represented = default setting)

2 Channel-specific errors

Fig. 3/7: Principle of error handling and parameterisation of the analogue input modules – part 1



1 Module parameters (switch position represented = default setting)

2 Channel-specific errors

Fig. 3/8: Principle of error handling and parameterisation of the analogue input modules – part 2

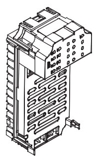
Analogue input module CPX-4AE-I

Chapter 4

Contents

4.1 Function of the analogue input modules

Analogue input modules provide analogue voltage inputs or current inputs for connecting sensors and enable the registering and processing of analogue current and voltage signals. At present the following type is available:

Type		Description
	CPX-4AE-I	This type provides 4 analogue inputs (input channels) with scalable value ranges. The input signal range can be configured channel by channel, either electrically isolated or non-floating: – 0 ... 20 mA – 4 ... 20 mA Sensor supply 24 V / 0.7 A per module.

Tab. 4/1: Overview of analogue input modules CPX-4AE-I

4.2 Fitting

See section 1.3.

4.3 Installation

Warning
Unintentional movement of the connected actuators and uncontrollable movements of loose tubing can cause injury to human beings or damage to property.

Before carrying out installation and maintenance work, switch off the following:

- the compressed air supply
- the operating and load voltage supplies.

In the following sections you will find the pin allocation of the analogue input modules for the different sub-bases.

Instructions on connecting the cables and plugs to the sub-bases can be found in section 1.2.3.
Note in particular the instructions on connecting the cable screening to functional earth (FE).

Power supply

The 24 V sensor supply for the inputs as well as the power supply for the electronics of the input modules is provided via the operating voltage supply for the electronics/sensors ($V_{EL/SEN}$).

The sensors can also be supplied externally (electrical isolation, see section 4.3.3, Fig. 4/2).

4.3.1 DIL switch settings

2 DIL switches are available for configuring the analogue input modules. These are located on the top of the electronic module.

1 DIL switch 0: Signal range of analogue input 0, 1

2 DIL switch 1: Signal range of analogue input 2, 3

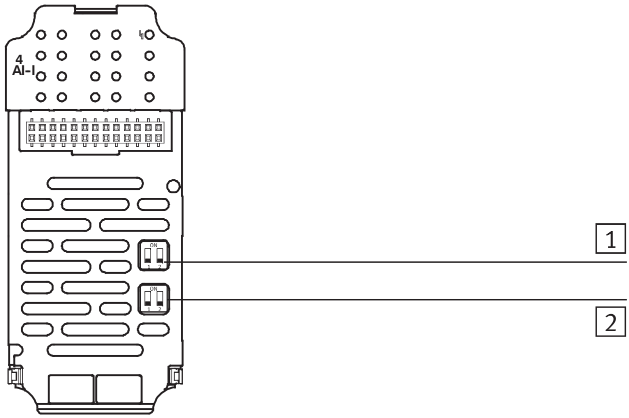


Fig. 4/1: DIL switches in the electronic module (further information on 1 and 2 see following pages)

Proceed as follows:

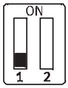
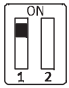
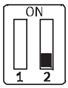
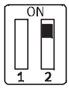
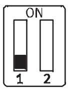
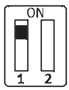
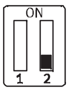
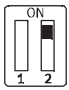
1. Switch off the power supply.
2. Remove if necessary the fitted sub-base (see “Fitting” section 1.3).
3. Set the DIL switch elements in accordance with the instructions on the following pages.
4. Refit if necessary the sub-base (see “Fitting” section 1.3, tightening torque 0.9 ... 1.1 Nm).

Setting the input signal range

On the 4AE-I module each channel has a DIL switch element for setting the signal range.

– DIL switch 0: channels 0 and 1

– DIL switch 1: channels 2 and 3

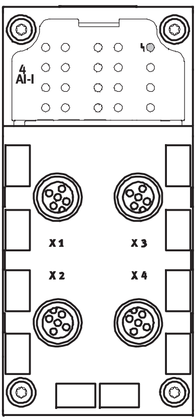
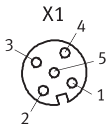
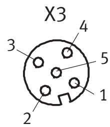
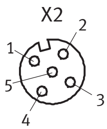
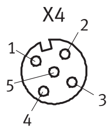
Channel	**Signal range**			
	0 ... 20 mA		**4 ... 20 mA**	
0		DIL 0.1: OFF [1)]		DIL 0.1: ON
1		DIL 0.2: OFF [1)]		DIL 0.2: ON
2		DIL 1.1: OFF [1)]		DIL 1.1: ON
3		DIL 1.2: OFF [1)]		DIL 1.2: ON
[1)] Default (factory setting)				

Tab. 4/2: DIL switches of the analogue input module 4AE-I

Note
The setting of the signal range with the DIL switches can be modified by means of parameterisation (see section 4.4). Parameterisation has precedence over the DIL switch setting.

4.3.2 Pin allocation

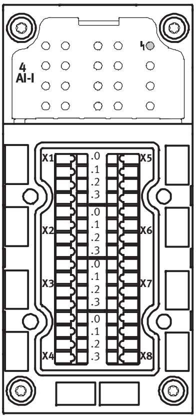
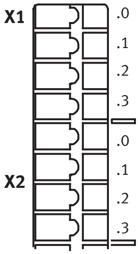
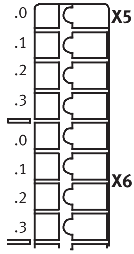
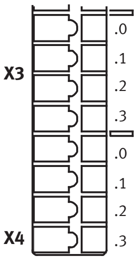
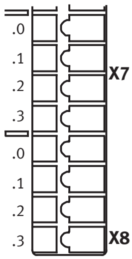
Pin allocation of CPX-4AE-I with sub-base CPX-AB-4-M12x2-5POL(-R)

Analogue input module type CPX-4AE-I with sub-base CPX-AB-4-M12x2-5POL(-R)				
Sub-base	**Pin allocation X1, X2 (input II0, II1)**		**Pin allocation X3, X4 (input II2, II3)**	
		Socket X1: 1: 24 V_{SEN} 2: II0+ 3: 0 V_{SEN} 4: II0- 5: FE (screening) 1)		Socket X3: 1: 24 V_{SEN} 2: II2+ 3: 0 V_{SEN} 4: II2- 5: FE (screening) 1)
		Socket X2: 1: 24 V_{SEN} 2: II1+ 3: 0 V_{SEN} 4: II1- 5: FE (screening) 1)		Socket X4: 1: 24 V_{SEN} 2: II3+ 3: 0 V_{SEN} 4: II3- 5: FE (screening) 1)
	IIx+ = Positive current input signal IIx- = Negative current input signal FE = Functional earth 1) With CPX-AB-4-M12x2-5POL-R the metal thread is connected to FE			

Tab. 4/3: Pin allocation of analogue input module type CPX-4AE-I with sub-base CPX-AB-4-M12x2-5POL(-R)

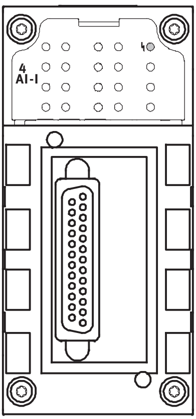
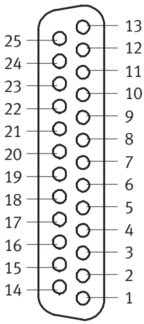
CPX-AB-4-M12x2-5POL**-R** The metal thread ("...-R") of this sub-base is connected internally with pin 5 (Functional earth FE).

Pin allocation of CPX-4AE-I with sub-base CPX-AB-8-KL-4POL

Analogue input module type CPX-4AE-I with sub-base CPX-AB-8-KL-4POL		
Sub-base	**Pin allocation X1 ... X4 (input II0, II1)**	**Pin allocation X5 ... X8 (input II2, II3)**
	 X1.0: 24 V_{SEN} X1.1: 0 V_{SEN} X1.2: II0- X1.3: FE (screening) X2.0: n.c. X2.1: n.c. X2.2: II0+ X2.3: FE (screening)	 X5.0: 24 V_{SEN} X5.1: 0 V_{SEN} X5.2: II2- X5.3: FE (screening) X6.0: n.c. X6.1: n.c. X6.2: II2+ X6.3: FE (screening)
	 X3.0: 24 V_{SEN} X3.1: 0 V_{SEN} X3.2: II1- X3.3: FE (screening) X4.0: n.c. X4.1: n.c. X4.2: II1+ X4.3: FE (screening)	 X7.0: 24 V_{SEN} X7.1: 0 V_{SEN} X7.2: II3- X7.3: FE (screening) X8.0: n.c. X8.1: n.c. X8.2: II3+ X8.3: FE (screening)
	IIx+ = Positive current input signal IIx- = Negative current input signal n.c. = Not connected FE = Functional earth	

Tab. 4/4: Pin allocation of analogue input module type CPX-4AE-I with sub-base CPX-AB-8-KL-4POL

Pin allocation of CPX-4AE-I with sub-base CPX-AB-1-SUB-BU-25POL

Analogue input module type CPX-4AE-I with sub-base CPX-AB-1-SUB-BU-25POL			
Sub-base	**Pin allocation**		
		1: II0- 2: II0+ 3: II1- 4: II1+ 5: n.c. 6: n.c. 7: n.c. 8: n.c. 9: 24 V_{SEN} 10: 24 V_{SEN} 11: 0 V_{SEN} 12: 0 V_{SEN} 13: FE	14: II2- 15: II2+ 16: II3- 17: II3+ 18: 24 V_{SEN} 19: n.c. 20: 24 V_{SEN} 21: n.c. 22: 0 V_{SEN} 23: 0 V_{SEN} 24: 0 V_{SEN} 25: FE Housing: FE (screening)
	IIx+ = Positive current input signal IIx- = Negative current input signal n.c. = Not connected FE = Functional earth		

Tab. 4/5: Pin allocation of analogue input module type CPX-4AE-I with sub-base CPX-AB-1-SUB-BU-25POL

4.3.3 Connecting the analogue intputs

Only screened cables are usually permitted for the transmission of analogue signals (see section 1.2.3).

1 Without electrical isolation:
The sensors are supplied via the CPX module

2 With electrical isolation:
If an external sensor supply is used

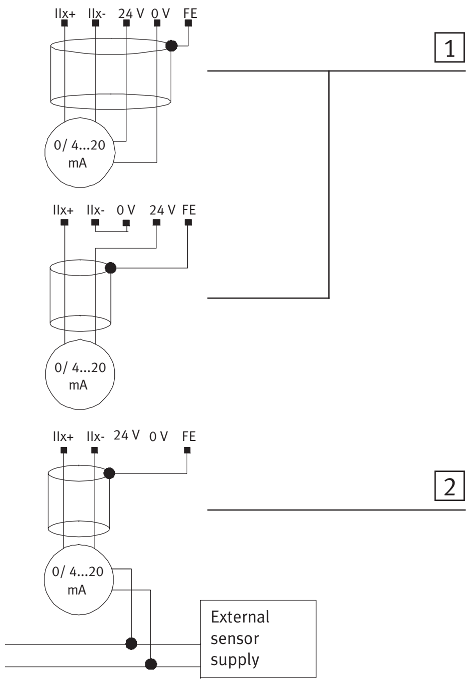


Fig. 4/2: Examples of analogue input connections (screening connection on FE pin)

Further connection examples can be found in appendix A.7.1.

4.4 Instructions on commissioning

4.4.1 Processing analogue input signals

The analogue values are transmitted from the CPX terminal to the control system as input words (2 bytes, 16 bits). Each analogue 4-input module occupies 4 input words for this procedure in the address range (4 inputs, 64 bits).

The position of the input words in the address range depends on the field bus used (see manual for the field bus node).

Parameterisation

The data format as well as the limit values and, where applicable, also the scaling of the analogue input signals can be adapted by means of parameterisation. Instructions on this can be found in the sections 4.4.2 and 4.4.3.

The reaction with the default settings is described below.

Reaction with the default settings

The module parameter "Input analogue-value data format" possesses the default setting "VZ + 12 bits right-justified" (compatible with valve terminal type 03). With this setting the analogue values will be saved in the input word as follows:

Data format "VZ + 12 bits right-justified" (compatible with valve terminal type 03)

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
VZ	0	0	0	B11 MSB	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0 LSB

Abbreviations used:
VZ: Sign (with data format "VZ + 12 bits right-justified" always = 0, i.e. a positive value)
B0 ... B11: Input value
D0 ... D15: 16 bits input data field
MSB/LSB: Most significant bit / least significant bit

Tab. 4/6: Data format "VZ + 12 bits right-justified"

The channel-specific parameters "Lower limit" and "Upper limit" possess the following default settings:

- Lower limit = 0
- Upper limit = 4095

These correspond to the scaling end values (data range) of the default data format.

The following diagram shows the processing of the analogue input signals with the default data format "VZ + 12 bits right-justified". The example shows a sensor which converts the range of the physical measuring variables from 0 ... 6 bar linear into the analogue signals 0 ... 20 mA or 4 ... 20 mA.

1 Lower limit of rated range

2 Measured value (example)

3 Upper limit of rated range

4 Physical measuring variables

5 Assigned analogue signal

6 Digital value range after A-D conversion (linear scaling)

7 Digital input value (example)

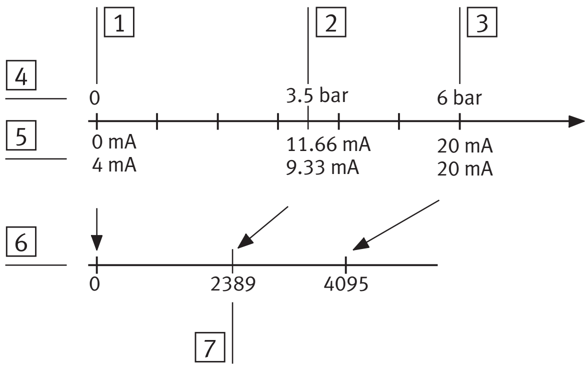


Fig. 4/3: Example of default data format "VZ + 12 bits right-justified"

Allocation of analogue input signal ranges to the digital value range is shown in the table below.

Analogue input signal range		**Digital data preparation**		
0 … 20 mA	**4 … 20 mA**	**Ranges**	**Digital values**	
> 19.995 mA	> 19.995 mA	Rated range exceeded	Limiting to the upper scaling end value	4095
19.995 mA	19.995 mA	Upper limit	Linear value range	4095
…	…	Rated range		1 … 4094
0 mA	4 mA	Lower limit of rated range		0
< 0 mA	< 4 mA	Less than rated range	Limiting to the lower scaling end value	0

Tab. 4/7: Scaling end values of the analogue input modules with default settings

4.4.2 General information on parameterisation

The reaction of the analogue input modules can be parameterized.

Further information on parameterisation can be found in the system manual or in the manual for the field bus node.

Due to in some cases necessary calculations, modified parameters are not valid until they have been thoroughly checked and saved. Until then, as in the case of invalid parameters, the previous settings apply.

Depending on the parameter, no valid analogue values are available for up to max. 30 ms after a value modification.

Specific instructions for the prevention of parameterisation errors

In order to prevent parameterisation errors, note the sequence described below when modifying the following parameters:

- Input analogue-value data format
- Lower limit channel x
- Upper limit channel x

Sequence for first or startup parameterisation (CPX terminal in delivery status, monitoring of parameterisation errors active):

1. First set the desired data format (parameter "Input analogue-value data format").

2. Then set the upper and lower limits for both channels:

   – If the new upper limit value is positive, set first the upper limit; then the lower limit.

   – If the new upper limit is negative (only in the case of data format "VZ + 15 bits linear scaled"), set first the lower limit, then the upper limit.

Sequence for modifying parameterisation:

1. Activate, if applicable, the monitoring of parameterisation errors (module parameter "Monitoring CPX module – monitoring parameterisation errors" and channel-specific module parameter "Monitoring channel x – monitoring parameterisation errors").

2. Set the lower limit to 0 and the upper limit to 4095 for both channels.

3. Then set the desired data format (parameter "Input analogue-value data format").

4. If required, then set the upper and lower limits for both channels:

   – If the new upper limit value is positive, set first the upper limit; then the lower limit.

   – If the new upper limit is negative (only in the case of data format "VZ + 15 bits linear scaled"), set first the lower limit, then the upper limit.

4.4.3 Parameters of the analogue input module type CPX-4AE-I

The tables below give an overview of the module parameters of the analogue input modules.

Function number [1]	Module parameters
4828 + m * 64 **+ 0**	Monitoring the CPX module
4828 + m * 64 **+ 1**	Behaviour after short circuit/overload
4828 + m * 64 **+ 2**	Reserved
4828 + m * 64 **+ 3**	Input analogue-value data format
[1] m = module number (counting from left to right, beginning with 0)	

Tab. 4/8: Overview – module parameters

Function number [1]	Channel-specific module parameters
4828 + m * 64 + **6 ... 9**	Monitoring channel 0 ... 3
4828 + m * 64 + **10**	Signal range channel 0 ... 3
4828 + m * 64 + **11**	Measured value smoothing channel 0 ... 3
4828 + m * 64 + **12 ... 13**	Lower limit channel 0
4828 + m * 64 + **14 ... 15**	Lower limit channel 1
4828 + m * 64 + **16 ... 17**	Lower limit channel 2
4828 + m * 64 + **18 ... 19**	Lower limit channel 3
4828 + m * 64 + **20 ... 21**	Upper limit channel 0
4828 + m * 64 + **22 ... 23**	Upper limit channel 1
4828 + m * 64 + **24 ... 25**	Upper limit channel 2
4828 + m * 64 + **26 ... 27**	Upper limit channel 3
– [2]	Force channel x (see also CPX system manual)
[1] m = module number (counting from left to right, beginning with 0) [2] Access is protocol-specific (see manual for field bus node)	

Tab. 4/9: Overview – channel-specific module parameters

Description of the parameters

Module parameters: Monitoring the CPX module	
Function no.	4828 + m * 64 **+ 0** m = module number (0 ... 47)
Description	With the analogue input modules, monitoring of individual errors can be activated or deactivated (suppressed) independently of each other. Active monitoring causes the following: The error is: – sent to the CPX field bus node – displayed by the module common error LED.
Bit	Bit 0: monitoring short circuit/overload in the sensor supply Bit 1 ... 6: reserved Bit 7: monitoring parameterisation errors
Values	1 = active (presetting); 0 = inactive
Comment	– Monitoring short circuit at sensors: Monitoring can also be set for the complete CPX terminal (see CPX system manual, system parameter “Monitoring”). – Monitoring parameterisation errors: Some parameters are checked for inadmissible values during parameterisation: – Data format – Lower limit – Upper limit The setting of the module parameter “Monitoring parameterisation errors” is only effective for channel-specific parameterisation if the corresponding channel parameter “Monitoring parameterisation errors” is set to “active”.

Tab. 4/10: Monitoring the CPX module

Module parameters: Behaviour after short circuit/overload	
Function no.	4828 + m * 64 + **1** m = module number (0 ... 47)
Description	Determines after a short circuit in the sensor supply whether the power is to remain switched off or whether it is to be switched on again automatically.
Bit	Bit 0: behaviour after short circuit/overload in the sensor supply
Values	0 = leave voltage/current switched off 1 = switch voltage on again (presetting) Bit 1 ... 7: reserved
Comment	With the setting "Leave voltage switched off", Power off/on is necessary for switching the power on again. Ascertain the setting which is necessary for reliable operation of your machine or system. Further information can be found in section 4.5.1.

Tab. 4/11: Behaviour after short circuit/overload

Module parameters: Input analogue-value data format	
Function no.	4828 + m * 64 + **3** m = module number (0 ... 47)
Description	Determines the format in which the analogue input signals are provided by the CPX terminal.
Bit	Bit 0, 1: input analogue-value data format Bit 2 ... 7: reserved (= 0)
Values	Bit 1 Bit 0 0 0 VZ + 15 bits linear scaled 0 1 VZ + 12 bits right-justified (compatible with valve terminal type 03, presetting) 1 0 VZ + 15 bits left-justified (Simatic S7) 1 1 VZ + 12 bits left-justified + diagnosis (Simatic S5) (VZ = sign)
Comment	The reserved bits 2 ... 7 must always be 0. If one or several bits are set to "1" during parameterisation, the parameterisation carried out is invalid and therefore not effective. If the module parameter "Monitoring parameterisation errors" is set to "active", the relevant error will be displayed. Further information on this parameter can be found in section 4.4.4.

Tab. 4/12: Input analogue-value data format

Channel parameters: Monitoring channel x	
Function no.	4828 + m * 64 + **6** (channel 0) m = module number (0 ... 47) 4828 + m * 64 + **7** (channel 1) 4828 + m * 64 + **8** (channel 2) 4828 + m * 64 + **9** (channel 3)
Description	For the individual channels of the analogue input modules, monitoring of individual errors can be activated or deactivated (suppressed) independently of each other. Active monitoring causes the following: The error is: – sent to the CPX field bus node – displayed by the module common error LED. Further infomation on these monitorings can be found under the description of the relevant error in section 4.5.1.
Bit	Bit 0: monitoring lower limit (or less than rated range) Bit 1: monitoring upper limit (or rated range exceeded) Bit 2: monitoring wire break Bit 3 ... 6: reserved Bit 7: monitoring parameterisation errors
Values	1 = active; 0 = inactive Presetting bit 0 ... 2: 0 (inactive) Presetting bit 7: 1 (active)
Comment	– Monitoring the upper/lower limit: Monitoring the input signals for less than or exceeding the rated range or monitoring the range limits defined with the parameters "Lower limit ..." as well as "Upper limit ..." (depending on the data format used, see sections 4.4.4 and 4.4.5). – Monitoring wire break: Only effective for the signal range 4 ... 20 mA. A drop below the minimum input current (I_{IN} < 2.0 mA) counts as a wire break. – Monitoring parameterisation errors: Some channel-specific parameters are checked for inadmissible values during parameterisation: – Lower limit – Upper limit The setting of the channel parameter "Monitoring parameterisation errors" is only effective if the module parameter "Monitoring parameterisation errors" is set to "active".

Tab. 4/13: Monitoring channel x

Channel parameters: Signal range channel x	
Function no.	4828 + m * 64 + **10** m = module number (0 ... 47)
Description	For the individual channels of the analogue input modules, the signal ranges of the analogue inputs can be set independently of each other.
Bit	Bit 0/2: Setting of DIL switch 0 for channel 0 or 1 (read only) bit 0 = switch 0.1 (channel 0) bit 2 = switch 0.2 (channel 1) Bit 4/6: Setting of DIL switch 1 for channel 2 or 3 (read only) bit 4 = switch 1.0 (channel 2) bit 6 = switch 1.1 (channel 3) Bit 1, 3, 5, 7: Signal range for channel 0, 1, 2, 3 can be set independently of each other.
Values	Channel 3 (Bit 7, Bit 6) · Channel 2 (Bit 5, Bit 4) · Channel 1 (Bit 3, Bit 2) · Channel 0 (Bit 1, Bit 0) 0 0 0 0 0 0 0 0 Use the setting of the DIL switches (presetting) (see Tab. 4/2) 0 1 0 1 0 1 0 1 0 ... 20 mA 1 0 1 0 1 0 1 0 4 ... 20 mA 1 1 1 1 1 1 1 1 Reserved
Comment	Modified parameter settings have precedence over the DIL switch settings. The setting of the DIL switches (bit 0 ... 7 = 0) is carried out with the presetting.

Tab. 4/14: Signal range channel x

Channel parameters: Measured value smoothing channel x	
Function no.	4828 + m * 64 + **11** m = module number (0 ... 47)
Description	For the individual channels of the analogue input modules, the filter for measured values can be set independently of each other.
Bit	Bit 0/1: measured value smoothing channel 0 Bit 2/3: measured value smoothing channel 1 Bit 4/5: measured value smoothing channel 2 Bit 6/7: measured value smoothing channel 3
Values	see below
Comment	Errors can be suppressed with measured value smoothing (see section 4.5.1). If the module parameter “Monitoring parameterisation errors” as well as the relevant channel parameter “Monitoring parameterisation errors” is set to “active”, the relevant error will be displayed.

Values:

Channel 3		Channel 2		Channel 1		Channel 0		
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
0	0	0	0	0	0	0	0	No measured value smoothing (presetting)
0	1	0	1	0	1	0	1	Measured value smoothing over 2 values
1	0	1	0	1	0	1	0	Measured value smoothing over 4 values
1	1	1	1	1	1	1	1	Measured value smoothing over 8 values

Tab. 4/15: Measured value smoothing channel x

Channel parameters: Lower limit channel x / Upper limit channel x	
Function no.	Lower limit: m = module number (0 ... 47) 4828 + m * 64 + **12** (channel 0, low byte) 4828 + m * 64 + **13** (channel 0, high byte) 4828 + m * 64 + **14** (channel 1, low byte) 4828 + m * 64 + **15** (channel 1, high byte) 4828 + m * 64 + **16** (channel 2, low byte) 4828 + m * 64 + **17** (channel 2, high byte) 4828 + m * 64 + **18** (channel 3, low byte) 4828 + m * 64 + **19** (channel 3, high byte) Upper limit: 4828 + m * 64 + **20** (channel 0, low byte) 4828 + m * 64 + **21** (channel 0, high byte) 4828 + m * 64 + **22** (channel 1, low byte) 4828 + m * 64 + **23** (channel 1, high byte) 4828 + m * 64 + **24** (channel 2, low byte) 4828 + m * 64 + **25** (channel 2, high byte) 4828 + m * 64 + **26** (channel 3, low byte) 4828 + m * 64 + **27** (channel 3, high byte)
Description	A lower as well as an upper limit value can be set for the individual channels of the analogue input modules (see section 4.4.5). With data format "VZ + 15 bits linear scaled", the limits have the function of scaling end values.
Bit	Bit 0 ... 7: high byte or low byte of the limit value
Values	Presettings: – Lower limit = 0 (low byte = 0; high byte: 0) – Upper limit = 4095 (low byte = 255; high byte: 15) Low byte: 0 ... 255 High byte: 0 ... 15

Channel parameters: Lower limit channel x / Upper limit channel x	
Comment	If the input value is less than the parameterized lower limit or exceeds the parameterized upper limit, an appropriate error is displayed (providing the relevant channel parameter "Monitoring channel x – monitoring lower limit" or "Monitoring channel x – monitoring upper limit" is active). The upper limit must always be more than the lower limit. Modifications to the limits must be made in steps of 16 bits. Permitted limits: The limits are checked for validity during parameterisation. Invalid parameterisations are not accepted – the module uses the previous (last valid) parameterisations. The permitted values depend on the parameterized data format (see section 4.4.5). If the module parameter "Monitoring parameterisation errors" as well as the relevant channel parameter "Monitoring parameterisation errors" is set to "active", the relevant error will be displayed.

Tab. 4/16: Lower and upper limits channel x

Module parameters: Force channel x	
Function no.	Access to these module parameters is made via protocol-specific functions (see the manual for the field bus node).
Description	The Force function permits the manipulation of analogue values irrespective of the actual input value (see also CPX system manual). This can be accomplished with the following parameters: – Force mode inputs channel x – Force state inputs channel x
Values	– Force mode inputs channel x 0 = blocked (presetting) 1 = Force state – Force state inputs channel x 0 = reset value (presetting) 1 = set value
Comment	The enabling of the Force function with the parameter “Force mode outputs channel x” depends on the field bus protocol and is accomplished: – by an individual parameter setting or bit (e.g. CPX-FB11), – by setting all parameter bits of the relevant word (e.g. CPX-FB6) to “blocked” or “Force state”. For parameterisation of the Force state, the desired input word must be correspondingly mapped in the parameter bits “Force state inputs channel x”. The enabling of the Force function for the complete CPX terminal is made by means of the system parameter “Force mode” (see CPX system manual).

Tab. 4/17: Force channel x (channel-specific)

4.4.4 Module parameter “Input analogue-value data format”

The parameterized data format determines how the analogue values are transferred by the CPX terminal to the control system. The setting applies to all analogue input channels. Irrespective of the data format the data width is always 16 bits (2 bytes, 1 word).

Supported data formats of the analogue input modules															
VZ + 15 bits linear scaled															
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
VZ	B14 MSB	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0 LSB
VZ + 12 bits right-justified (compatible with valve terminal type 03, presetting)															
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
VZ	0	0	0	B11 MSB	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0 LSB
VZ + 15 bits left-justified (compatible with Simatic S7)															
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
VZ	B11 MSB	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0 LSB	x	x	x
VZ + 12 bits left-justified + diagnosis (compatible with Simatic S5)															
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
VZ	B11 MSB	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0 LSB	0	F	0

Abbreviations used:
VZ: Sign (0 = positive value, 1 = negative value)
B0 ... B14: Input value
D0 ... D15: 16 bits input data field
MSB/LSB: Most significant bit / least significant bit
F: Wire break monitoring with signal range 4 ... 20 mA: F = 1 wire break exists; F = 0 no wire break exists
x: Not relevant

Tab. 4/18: Supported data formats of the analogue input modules

Note
For the fieldbus node CPX-FB13 (PROFIBUS-DP) the byte sequence with which the analogue values are transferred to the controller can be reversed by parameterising the value "Analogue process value representation":

- Factory setting: LSB-MSB (INTEL format)
- Reversal: MSB-LSB (MOTOROLA format)

Check this setting in the bus node if you obtain implausible values; also refer to the CPX-FB13 description in chapter 2 under the section entitled "Parameters of CPX-FB13".

Data format "VZ + 15 bits linear scaled"

The 12-bit digital values, which exist after the A-D conversion of the analogue input signals, are linearly scaled to the data range defined by the scaling end values (limit values) and output in the input word (see section 4.4.5, Fig. 4/5).

Data format "VZ + 12 bits right-justified"

The 12-bit digital values, which exist after the A-D conversion of the analogue input signals, are output unmodified in the input word (see also example in section 4.4.1, Fig. 4/3).

Data format "VZ + 15 bits left-justified" and data format "VZ + 12 bits left-justified + diagnosis"

The 12-bit digital values, which exist after the A-D conversion of the analogue input signals, plus the preceding sign bit are arranged left-justified in the data format. The three zeros at the end cause the output data word to correspond to the 12-bit digital value after A-D conversion multiplied by 8 (providing there is no wire break diagnosis).

The following diagram shows an example of the data format "VZ + 15 bits left-justified":

1 Analogue input values

2 Digital signals after A-D conversion

3 Available digital signals scaled to the end value of the data range

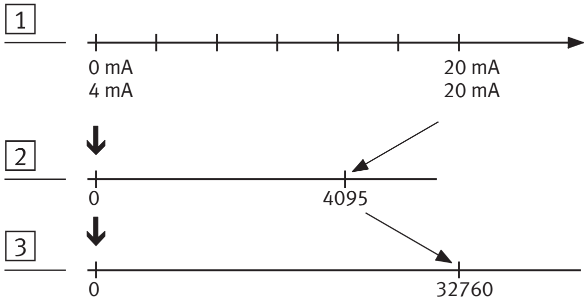


Fig. 4/4: Example of data format "VZ + 15 bits left-justified"

4.4.5 Channel-specific module parameters – Limits

You can determine limits with the channel-specific parameters "Lower limit" and "Upper limit". The meaning of the limit parameters depends on the parameterized data format of the module.

With data format "VZ + 15 bits linear scaled", the limits have the function of defining the scaling end values of the data range. This results in an additional scaling of the analogue values.
If the input data lie outside this data range, a diagnostic message can be generated with appropriate parameterisation.

With other data formats the data range is already defined by the scaling end values. In this case, the limits permit data monitoring even within the data range.

Data format [1]	Data range	Limits/scaling end values [2]	
VZ + 15 bits linear scaled	-30000 ... +30000	Lower scaling end value: -30000 ... +29999	Upper scaling end value: -29999 ... +30000
VZ + 12 bits right-justified	0 ... 4095	Lower limit: 0 ... 4094	Upper limit: 1 ... 4095
VZ + 15 bits left-justified	0 ... 32760	Lower limit: 0 ... 32759	Upper limit: 1 ... 32760
VZ + 12 bits left-justified + diagnosis [3]	0 ... 32760	Lower limit: 0 ... 32752	Upper limit: 1 ... 32760

[1] VZ = Sign
As the analogue inputs with the "Fixed value" data formats "VZ + 12 bits right-justified", "VZ + 15 bits left-justified" and "VZ + 12 bits left-justified + diagnosis" generate only positive signals, the sign bit with these formats is always 0.
[2] The lower limit/scaling end value must always be less than the upper limit/scaling end value.
[3] If the max. current values are exceeded, values greater than 4095 will also be output.

Tab. 4/19: Limits or scaling end values of the analogue input modules

Scaling end values with data format "VZ + 15 bits linear scaled"

The following diagram shows an example of the data format "VZ + 15 bits linear scaled" with the scaling end values:

– Lower limit = 0

– Upper limit = 6000

The example shows a sensor which converts the range of the physical measuring variables from 0 ... 6 bar linear into the analogue signals 0 ... 20 mA.

1 Physical measuring variables

2 Digital signals after A-D conversion (resolution: 12 bits)

3 Available digital signals after scaling by the scaling end values

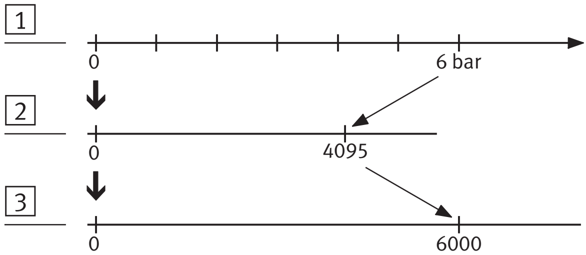


Fig. 4/5: Example scaling data format “VZ + 15 bits linear scaled”

The scaling end values in this data format are identical with the limits for less than or exceeding the rated range:

1 Digital input signal after scaling

2 Limits

3 Less than or exceeding the limits

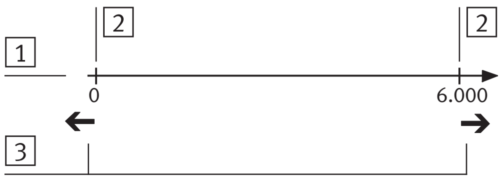


Fig. 4/6: Limit monitoring with data format “VZ + 15 bits linear scaled”

Limits with the "Fixed value" data formats

The following diagram shows an example of the data format "VZ + 12 bits right-justified" with the scaling end values:

– Lower limit = 500

– Upper limit = 3500

The principle of the limits also applies to the data formats "VZ + 15 bits left-justified" and "VZ + 12 bits left-justified + diagnosis".

1 End values of the data range

2 Lower limit

3 Upper limit

4 Less than or exceeding the limits

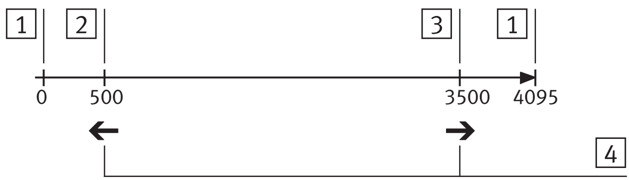


Fig. 4/7: Monitoring of limits with the "Fixed value" data formats

4.4.6 Channel-specific module parameters – Measured value smoothing

In order to suppress errors, the input data can be filtered digitally, whereby the degree of filtering can be set by means of parameterisation.

Filtering is carried out as follows:

- by forming the sum of n values,
- by subtracting an average value,
- by adding the current input value.

The following applies here: the greater n, the more the signal will be filtered.

4.4.7 Channel-specific module parameters – Monitoring wire break

Wire break monitoring (Open Loop) can be activated by means of appropriate parameterisation for the signal range 4 ... 20 mA.

The criterion for a wire break is software monitoring to ensure that the value does not drop below the lower limit ($I_{IN} \leq 2.0$ mA). If the value drops below the lower limit, the module will send an appropriate error message to the field bus node.

4.5 Diagnosis

Specific errors of the analogue input modules are reported or suppressed depending on the module parameterisation.

The errors are shown locally by means of the Error LED and, if necessary, can be evaluated with the handheld.

Depending on the module parameterisation the errors are sent to the field bus node, where they can be evaluated according to the field bus protocol used.

Representation of the errors in the various field bus nodes depends on the field bus protocol (see manual for the field bus node).

4.5.1 Error messages of the analogue input modules

An analogue input module can register the following errors:

Error number	Description	Error treatment
2	**Error short circuit/overload** [1)] Short circuit/overload in sensor supply ($V_{EL/SEN}$). (See "Parameters" "Monitoring the CPX module – monitoring short circuit/overload at sensor")	1. Eliminate short circuit/overload or check connected sensors 2. Depending on parameterisation (Parameters "Behaviour after short circuit/overload"): • Setting "Switch on voltage again": Power supply for sensors will be switched on again **automatically** when short circuit is eliminated. • Setting "Leave voltage switched off": – Power off/on necessary or – Modify parameter "Behaviour after short circuit/overload" to "Leave voltage switched off".
3	**Wire break at current input** [1)] Only with voltage inputs with signal range 4 ... 20 mA: The input currennt I_{IN} is less than 2.0 mA. (See parameter "Monitoring channel x – monitoring of wire break")	• Check and, if necessary, replace the cable and connected sensors.
9	**Less than the rated range** [1)] Lower limit exceeded. (See parameter "Lower limit channel x – low byte/high byte" or "Monitoring channel x – monitoring below rated range")	• Check signal range of input. • Check input signal present. • Check parameterized limit. • If necessary, deactivate monitoring.

1) The module displays the relevant error depending on the parameterisation. The analogue input signals, however, will be processed further.

Tab. 4/20: Error messages of the input modules – part 1

Error number	Description	Error treatment
10	**Rated range exceeded** [1] Upper limit exceeded. (See parameter "Upper limit channel x – low byte/high byte" or "Monitoring channel x – monitoring rated range exceeded")	• Check signal range of input. • Check input signal present. • Check parameterized limit. • If necessary, deactivate monitoring.
15	**Module/channel failed** [2] General error, module faulty.	• Power off/on necessary • If this error occurs again: check and, if necessary, replace the analogue input module. Evaluation of the analogue input signals has stopped.
   21 24 25	**Parameterisation error** [1] [3] An error has occurred in the setting of the relevant parameter. – Parameter data format – Parameter lower limit – Parameter upper limit (See parameter "Monitoring the CPX module – monitoring parameterisation error" or "Monitoring channel x – monitoring parameterisation error")	• Check the parameterisation undertaken and, if necessary, repeat the parameterisation using the correct parameters (valid parameters see section 4.4.3). The analogue input module will be operated further with the last valid parameterisation.

[1] The module displays the relevant error depending on the parameterisation. The analogue input signals, however, will be processed further.
[2] Processing of the analogue input signals will be stopped.
[3] The parameters entered will be ignored, the module operates with the last valid parameters.

Tab. 4/21: Error messages of the input modules – part 2

→

Note
Please note the following when using the input modules:

– If there is a short circuit, all sensor supplies of the module will be switched off **together**.

– If not parameterized otherwise, the sensor supply voltage will be switched on again **automatically** when the short circuit is eliminated.

4.5.2 LED display

There is an LED under the transparent cover of the module for diagnosing the input modules.

1 Error LED (red)

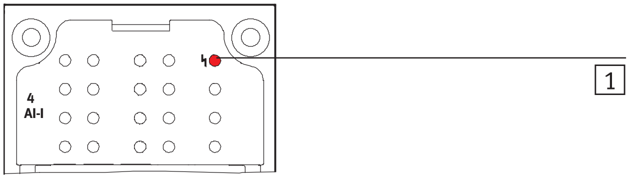


Fig. 4/8: LED display of analogue input module CPX-4AE-I

Error LED

The red error LED indicates a module error depending on the parameterisation (short circuit or overload of the sensor supply, wire break or parameterisation error).

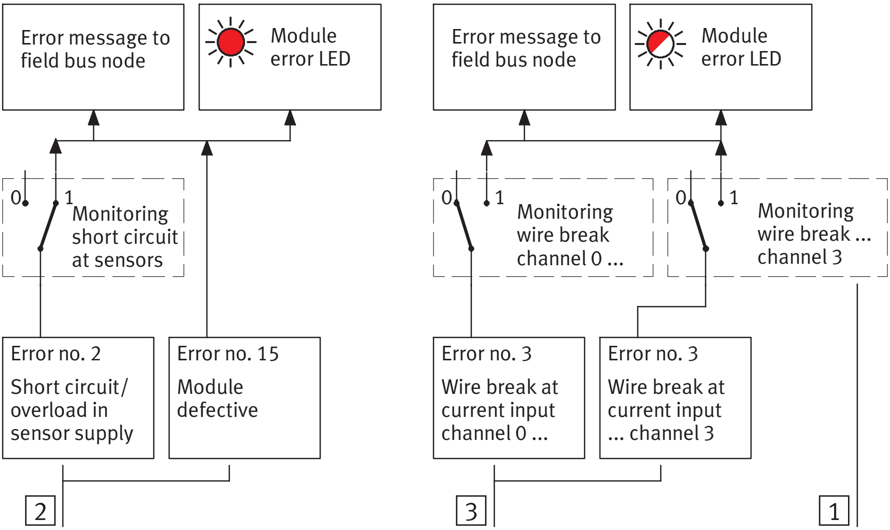
Error LED (red)	Sequence	Status	Error number	Error treatment
 LED is out		Trouble-free operation	–	None
 LED lights up		**Error short circuit/overload** Short circuit/overload in sensor supply ($V_{EL/SEN}$). or **Module defective**	2 15	See section 4.5.1, Tab. 4/21 Check and, if necessary, replace component
 LED flashes	1 flash [1]	**Wire break at current input** I_{IN} < 2.0 mA or **Lower limit exceeded** Input signal is less than the parameterized limit or	3 9	See section 4.5.1, Tab. 4/21
	2 flashes [1] 3 flashes [1] 4 flashes [1]	**Upper limit exceeded** Input signal is greater than the parameterized limit or **Parameterisation error** – Parameter data format – Parameter lower limit – Parameter upper limit	10 21 24 25	

[1] The number of flash pulses indicates the input channel concerned (1 flash = channel 0, 2 flashes = channel 1 ...). In the case of several channels with error messages, the channel which first had the error will be shown.

Tab. 4/22: Error LED of analogue input modules

4.5.3 Error treatment and parameterisation

The following diagrams show the error treatment in the analogue input modules. Further reporting and display of the error can be suppressed as desired with the appropriate module parameter, represented in the diagram as a switch. A description of the parameter can be found in section 4.4.3.

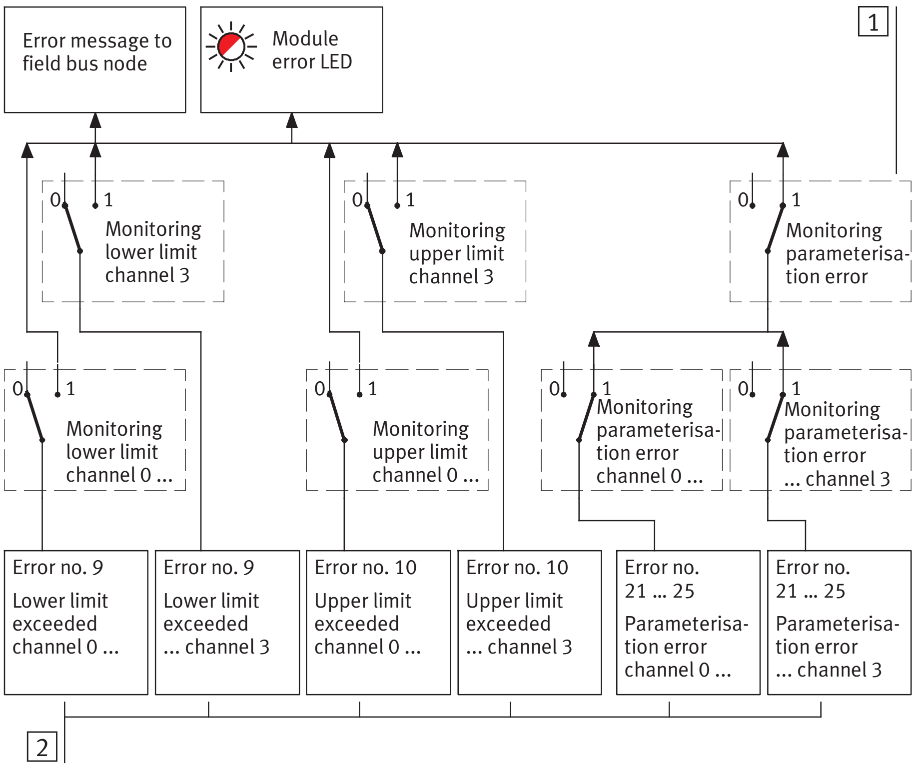


1 Module parameters (switch position represented = default setting)

2 Module-specific errors

3 Channel-specific errors

Fig. 4/9: Principle of error treatment and parameterisation of the analogue input modules – part 1



1 Module parameters (switch position represented = default setting)

2 Channel-specific errors

Fig. 4/10: Principle of error treatment and parameterisation of the analogue input modules – part 2

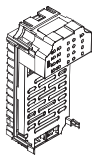
Analogue input module CPX-4AE-T

Chapter 5

Contents

5.1 Function of analogue input module CPX-4AE-T

Module CPX- 4AE-T provides 4 inputs for connecting temperature sensors.

Type		Description
	CPX-4AE-T	Provides 2 or 4 analogue inputs (input channels) for registering the temperature. – The sensors can be connected in 2-cable, 3-cable or 4-cable design – Conversion time: 250 ms for each channel Supported platinum sensors: – Pt 100, Pt 200, Pt 500, Pt 1000 – Temperature coefficients TK = 0.00385 or 0.00391 Supported nickel sensors: – Ni 100, Ni 120, Ni 500, Ni 1000

Tab. 5/1: Overview of analogue input module CPX-4AE-T

5.2 Fitting

See section 1.3.

5.3 Installation

Warning
Unintentional movement of the connected actuators and uncontrollable movements of loose tubing can cause injury to human beings or damage to property.

Before carrying out installation and maintenance work, switch off the following:

- the compressed air supply
- the operating and load voltage supplies.

In the following sections you will find the pin allocation of the analogue input modules for the different sub-bases.

Instructions on connecting the cables and plugs to the sub-bases can be found in section 1.2.3.
Note in particular the instructions on connecting the cable screening to functional earth (FE).

5.3.1 DIL switch settings

A DIL switch is available for configuring the analogue input module. This is located on the top of the electronic module.

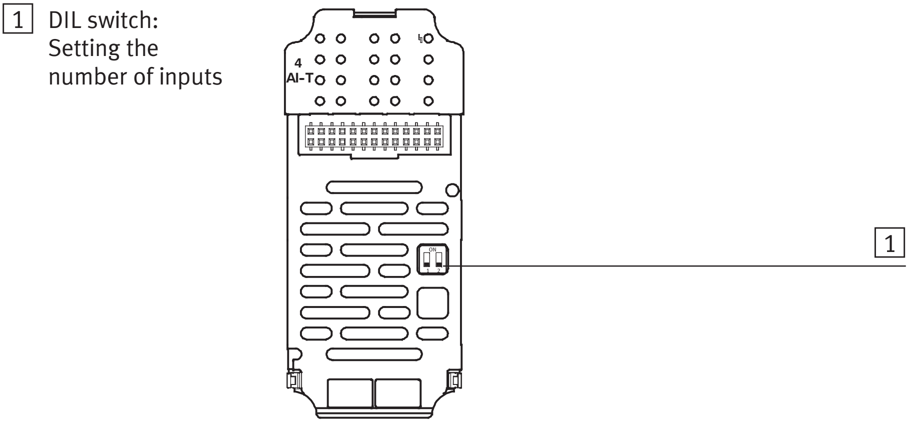
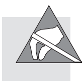


Fig. 5/1: DIL switches in the electronic module



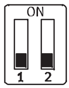
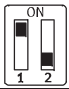
Proceed as follows:

1. Switch off the power supply.
2. Remove if necessary the fitted sub-base (see “Fitting” section 1.3).
3. Set the DIL switch in accordance with the instructions on the following pages.
4. Refit if necessary the sub-base (see “Fitting” section 1.3), tightening torque 0.9 ... 1.1 Nm).

Setting the number of inputs

In the case of module 4AE-T, the number of inputs can be selected with a DIL switch:

- 4 inputs (standard)
- 2 inputs.

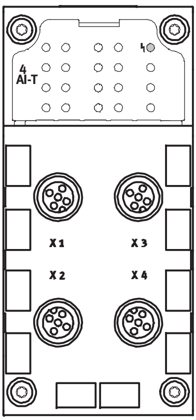
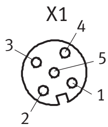
Number of inputs	Setting the DIL switch	
4		DIL 1.1: OFF DIL 1.2: OFF (factory setting)
2		DIL 1.1: ON DIL 1.2: OFF

Tab. 5/2: DIL switch for analogue input module 4AE-T

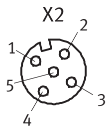
Note
In the case of input module 4AE-T, the setting of the DIL switch **cannot** be modified by means of parameterisation.

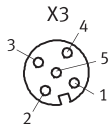
5.3.2 Pin allocation

Pin allocation of CPX-4AE-T with sub-base CPX-AB-4-M12x2-5POL(-R)

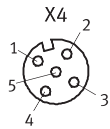
<table>
<tr><th colspan="3">Analogue input module type CPX-4AE-T with sub-base CPX-AB-4-M12x2-5POL(-R)</th></tr>
<tr><th>Sub-base</th><th>Pin allocation X1, X2
(inputs 0, 1)</th><th>Pin allocation X3, X4
(inputs 2, 3)</th></tr>
<tr>
<td rowspan="2">
</td>
<td>

Socket X1:
1: II0+
2: IU0+
3: II0-
4: IU0-
5: FE (screening/ shield) 1)



Socket X2:
1: II1+
2: IU1+
3: II1-
4: IU1-
5: FE (screening/ shield) 1)</td>
<td>

Socket X3:
1: II2+
2: IU2+
3: II2-
4: IU2-
5: FE (screening/ shield) 1)

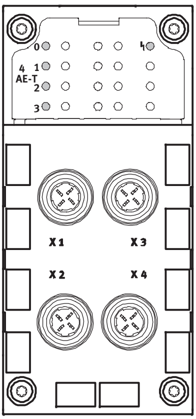
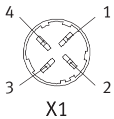
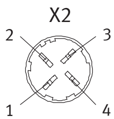
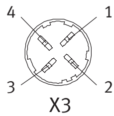
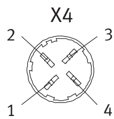


Socket X4:
1: II3+
2: IU3+
3: II3-
4: IU3-
5: FE (screening/ shield) 1)</td>
</tr>
<tr><td colspan="2">IIx+ = Positive current input signal
IIx- = Negative current input signal
IUx+ = Positive voltage input signal
IUx- = Negative voltage input signal
FE = Functional earth
1) With CPX-AB-4-M12x2-5POL-R the metal thread is connected to FE</td></tr>
</table>

Tab. 5/3: Pin allocation of analogue input module type CPX-4AE-T with sub-base CPX-AB-4-M12x2-5POL(-R)

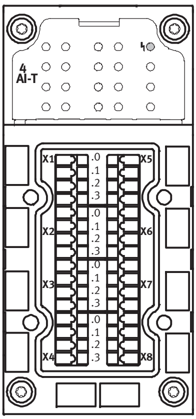
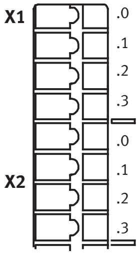
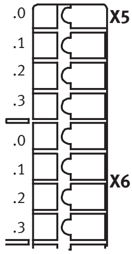
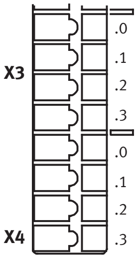
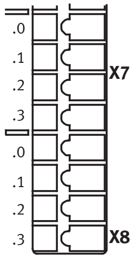
CPX-AB-4-M12x2-5POL**-R** The metal thread ("...-R") of this sub-base is connected internally with pin 5 (Functional earth FE).

Pin allocation CPX-4AE-T with sub-base CPX-AB-4-HAR-4POL

Analogue input module type CPX-4AE-T with sub-base CPX-AB-4-HAR-4POL		
Sub-base	**Pin allocation X1, X2 (inputs 0, 1)**	**Pin allocation X3, X4 (inputs 2, 3)**
	 Socket X1: 1: II0+ 2: IU0+ 3: II0- 4: IU0-  Socket X2: 1: II1+ 2: IU1+ 3: II1- 4: IU1-	 Socket X3: 1: II2+ 2: IU2+ 3: II2- 4: IU2-  Socket X4: 1: II3+ 2: IU3+ 3: II3- 4: IU3-
	IIx+ = Positive current input signal IIx- = Negative current input signal IUx+ = Positive voltage input signal IUx- = Negative voltage input signal	

Tab. 5/4: Pin allocation of analogue input module type CPX-4AE-T with sub-base CPX-AB-4-HAR-4POL

Pin allocation CPX-4AE-T with sub-base CPX-AB-8-KL-4POL

Analogue input module type CPX-4AE-T with sub-base CPX-AB-8-KL-4POL		
Sub-base	**Pin allocation X1 ... X4 (inputs 0, 1)**	**Pin allocation X5 ... X8 (inputs 2, 3)**
	 X1.0: II0+ X1.1: II0- X1.2: IU0- X1.3: FE (screening/ shield) X2.0: n.c. X2.1: n.c. X2.2: IU0+ X2.3: FE (screening/ shield)	 X5.0: II2+ X5.1: II2- X5.2: IU2- X5.3: FE (screening/ shield) X6.0: n.c. X6.1: n.c. X6.2: IU2+ X6.3: FE (screening/ shield)
	 X3.0: II1+ X3.1: II1- X3.2: IU1- X3.3: FE (screening/ shield) X4.0: n.c. X4.1: n.c. X4.2: IU1+ X4.3: FE (screening/ shield)	 X7.0: II3+ X7.1: II3- X7.2: IU3- X7.3: FE (screening/ shield) X8.0: n.c. X8.1: n.c. X8.2: IU3+ X8.3: FE (screening/ shield)
	IIx+ = Positive current input signal IIx- = Negative current input signal IUx+ = Positive voltage input signal IUx- = Negative voltage input signal FE = Functional earth	

Tab. 5/5: Pin allocation of analogue input module type CPX-4AE-T with sub-base CPX-AB-8KL-4POL

5.3.3 Connecting temperature sensors to the analogue inputs

Each input provides a constant source of current and two connections for measuring the voltage drop at the sensor. The voltage drop can be measured at various points, dependng on the degree of accuracy desired. A distinction is therefore made between various connecting methods:

4-cable design

The highest degree of accuracy is achieved with the 4-cable design:

– 2 cables transmit the current from the constant source of current (connections lx+, lx-) through the sensor,

– 2 cables serve for measuring the voltage drop directly on the sensor. Connections Ux+ and Ux- are highly-resistive, so that the cable resistance does not lead to incorrect measurement.

1 Constant source of current in the module

2 Connecting pin of the CPX module

3 Current supply for sensor

4 Separate voltage cable

5 Temperature sensor

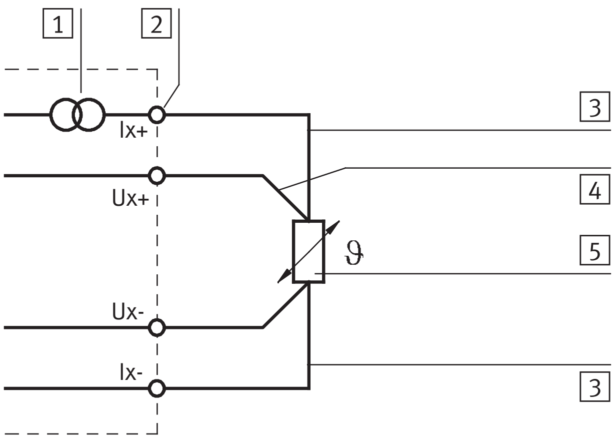


Fig. 5/2: Connection in 4-cable design

3-cable design

Alternatively, connections Ix+ and Ux+ can be linked together in the plug, whereby only 3 cables must be connected to the sensor.

1. Constant source of current in the module
2. Connecting pin of the CPX module
3. Linked current/voltage connection l
4. Combined current/voltage cable
5. Temperature sensor
6. Separate voltage cable

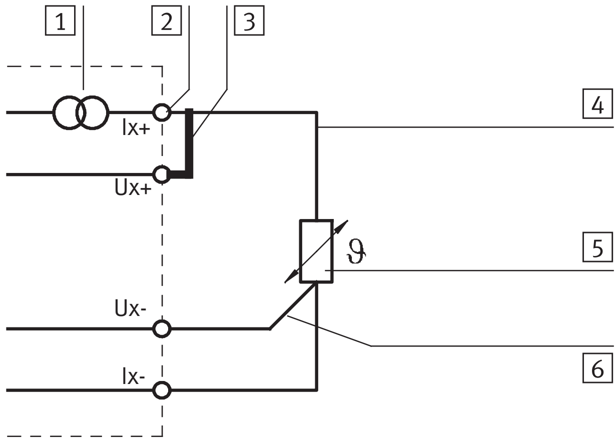


Fig. 5/3: Connection in 3-cable design

2-cable design

If Ix+ is linked to Ux+ and if Ix- is linked to Ux- in the plug, there remain only 2 cables which must be connected to the sensor. With this most simple connection method, accuracy is less because the voltage drop is no longer measured at the sensor.

1 Constant source of current in the module

2 Connecting pin of CPX module

3 Linked current/voltage connection

4 Combined current/voltage cable

5 Temperature sensor

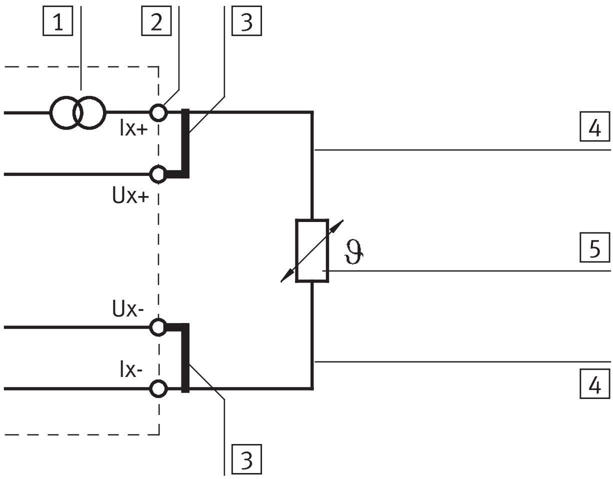


Fig. 5/4: Connection in 2-cable design

Usually only screened/shielded cables are permitted for the transmission of analogue signals (see section 1.2.3).

5.4 Instructions on commissioning

5.4.1 Processing the input signals of temperature sensors

The analogue values are transmitted to the control system by the CPX terminal as input words (4 inputs, 64 bits or 2 inputs, 32 bits). Each temperature module occupies 2 or 4 input words in the address range for this procedure.

The position of the input words in the address range depends on the field bus used (see manual for the field bus node).

Temperature sensors

Pt temperature sensors can be operated in two temperature ranges:

- Standard (-200 ... +850 °C)
- Climate (-120 ... +130 °C)

Ni temperature sensors always operate in the temperature range -60 ... +180 °C.

Parameterisation

By means of parameterisation, the CPX temperature module can be set to different temperature sensors and sensor connection methods.

In addition, the unit of measurement, the diagnostic reaction, limit value monitoring, etc. can be adapted by means of parameterisation. Instructions on this can be found in the sections 5.4.2 and 5.4.3.

Reaction with default settings

The module parameters are set as standard to these values:

– Unit of measurement: °C

– Interference frequency suppression: 50 Hz

The channel-specific parameters are set as standard to these values:

– Sensor type: Pt 100 with temperature coefficient 0.00385

– Temperature range: Standard (-200 ... +850 °C)

– Connection design: 2-cable

The temperature values are stored in the input word with the data format "VZ + 15 bits binary complement of two":

Data format "VZ +15 bits complement of two binary numbers"															
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
VZ	B14 MSB	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0 LSB
Abbreviations used: VZ: Mathematical sign (0 = positive value, 1 = negative value) B0 ... B14: Input value D0 ... D15: 16 bits input data field MSB/LSB: Most significant bit / least significant bit															

Tab. 5/6: Data format of temperature module CPX-4AE-T

The complete parameter settings can be found in section 5.4.3.

> **Note**
> For the fieldbus node CPX-FB13 (PROFIBUS-DP) the byte sequence with which the analogue values are transferred to the controller can be reversed by parameterising the value “Analogue process value representation”:
> – Factory setting: LSB-MSB (INTEL format)
> – Reversal: MSB-LSB (MOTOROLA format)
>
> Check this setting in the bus node if you obtain implausible values; also refer to the CPX-FB13 description in chapter 2 under the section entitled “Parameters of CPX-FB13“.

The diagram below shows the processing of the input signals of a temperature sensor. A Pt 100 sensor in the standard temperature range is used as an example. (temperature coefficient TK = 0.00385 Ω/°C).

1 Lower limit of rated range
2 Measured value (example)
3 Upper limit of rated range
4 Physical measuring variables
5 Resistance of the sensor
6 Digital value range after A-D conversion
7 Digital input value (example)

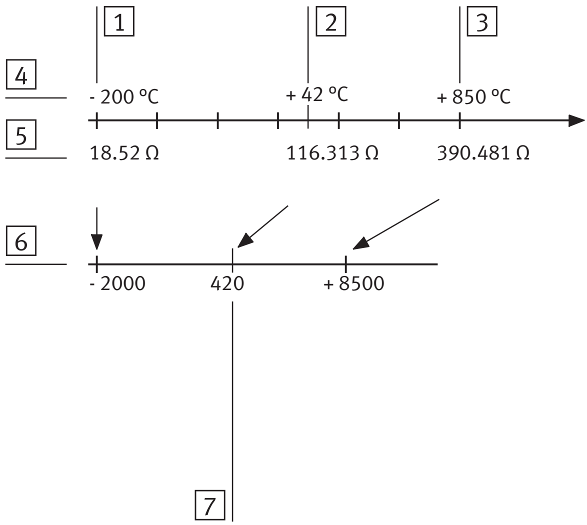


Fig. 5/5: Example: Representing the temperaturesfor a Pt 100 sensor

5.4.2 General information on parameterisation

If necessary, use parameterisation to set other temperature sensors, connection designs, diagnostic reactions, etc.

Due to in some cases necessary calculations, modified parameters are not valid until they have been thoroughly checked and saved. Until then, as in the case of invalid parameters, the previous settings apply.

Depending on the parameter, no valid analogue values are available for up to max. 30 ms after a value modification.

Specific instructions for the prevention of parameterisation errors

Parametrize in this sequence:

1. set the temperature sensor and the temperature coefficients

2. set limit values

3. activate limit value monitoring.

5.4.3 Parameters of the analogue input module type CPX-4AE-T

The tables below give an overview of the module parameters of the analogue input module.

Function number [1]	Module parameters
4828 + m * 64 + **0 ... 5**	Reserved
4828 + m * 64 + **6**	– Measuring unit (°C, °Fahrenheit) – Interference frequency suppression (50 Hz, 60 Hz)
[1] m = module number (counting from left to right, beginning with 0)	

Tab. 5/7: Overview – module parameters

Function number [1]	Channel-specific module parameters
4828 + m * 64 + **7**	Diagnostic message in the event of wire break or short circuit in channel 0 ... 3
4828 + m * 64 + **8**	Limit value monitoring channel 0 ... 3
4828 + m * 64 + **9**	Measured value smoothing channel 0 ... 3
4828 + m * 64 + **10**	Connection designs of temperature sensors channel 0 ... 3
4828 + m * 64 + **11**	Sensor type/temperature coefficient, temperature range channel 0
4828 + m * 64 + **12**	Sensor type/temperature coefficient, temperature range channel 1
4828 + m * 64 + **13**	Sensor type/temperature coefficient, temperature range channel 2
4828 + m * 64 + **14**	Sensor type/temperature coefficient, temperature range channel 3
4828 + m * 64 + **15 ... 16**	Limit values channel 0
4828 + m * 64 + **17 ... 18**	Limit values channel 1
4828 + m * 64 + **19 ... 20**	Limit values channel 2
4828 + m * 64 + **21 ... 22**	Limit values channel 3
– [2]	Force channel x (see also CPX system manual)
[1] m = module number (counting from left to right, beginning with 0) [2] Access is protocol-specific (see manual for the field bus node)	

Tab. 5/8: Overview – channel-specific module parameters

Description of the parameters

Module parameters: Measuring unit and interference frequency suppression	
Function no.	4828 + m * 64 + **6** m = module number (0 ... 47)
Description	The measuring unit for the temperature can be switched to either: – °Centigrade or °Fahrenheit The interference frequency suppression specifies the frequency at which power units etc. are to be operated in order that interference resulting therefrom can be suppressed. – 50 Hz or 60 Hz
Bit	Bit 3: Measuring unit for temperature Bit 4: Interference frequency suppression
Values	Bit 3: 0 = °C (presetting); 1 = °Fahrenheit Bit 4: 0 = 50 Hz (presetting); 1 = 60 Hz
Comment	– Converting temperature units: °F = (°C * 9/5) + 32 °C = (°F - 32) * 5/9

Tab. 5/9: Module parameters

Channel parameters:	**Diagnostic message in the event of wire break or short circuit channel x**
Function no.	4828 + m * 64 + **7** (channel 0 ... 3) m = module number (0 ... 47)
Description	Sets whether or not a diagnostic message is to be displayed after wire break or short circuit. The parameter can be set for the individual channels independently of each other.
Bit	Bit 0/1: channel 0 Bit 2/3: channel 1 Bit 4/5: channel 2 Bit 6/7: channel 3
Values	see below
Comment	–

Channel 3		Channel 2		Channel 1		Channel 0		
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
0	0	0	0	0	0	0	0	No diagnostic message (presetting)
0	1	0	1	0	1	0	1	Diagnostic message in the event of wire break or short circuit

Tab. 5/10: Diagnostic message channel x

Channel parameters: Limit value monitoring channel x	
Function no.	4828 + m * 64 + **8** (channel 0 ... 3) m = module number (0 ... 47)
Description	Sets whether or not a diagnostic message is to be displayed after – a limit value set with parameters 15 ... 22 is exceeded or not reached – value falls below the minimum sensor temperature range – value exceeds the maximum sensor temperature range. The limit value monitoring can be set for the individual channels independently of each other.
Bit	Bit 0/1: channel 0 Bit 2/3: channel 1 Bit 4/5: channel 2 Bit 6/7: channel 3
Values	see below
Comment	Only the falling below or exceeding the limit value can be monitored. The limit value is set separately for each channel with parameters 15 ... 22 (see Tab. 5/15). The limit value monitoring of the sensor temperature range is activated as soon as the diagnosis for the set limit value becomes active.

Values:

Channel 3		Channel 2		Channel 1		Channel 0		
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
0	0	0	0	0	0	0	0	No limit value monitoring (presetting)
0	1	0	1	0	1	0	1	Diagnostic message in value falls below the set limit value
1	0	1	0	1	0	1	0	Diagnostic message if value exceeds the the set limit value

Tab. 5/11: Activating the limit value monitoring channel x

Channel parameters: Measured value smoothing channel x	
Function no.	4828 + m * 64 + **9** (channel 0 ... 3) m = module number (0 ... 47)
Description	Sets whether or not the measured values of the individual channels are to be smoothed. The parameter can be set for the individual channels independently of each other.
Bit	Bit 0/1: channel 0 Bit 2/3: channel 1 Bit 4/5: channel 2 Bit 6/7: channel 3
Values	Channel 3 (Bit 7, Bit 6) – Channel 2 (Bit 5, Bit 4) – Channel 1 (Bit 3, Bit 2) – Channel 0 (Bit 1, Bit 0): 0 0 0 0 0 0 0 0 No measured value smoothing (presetting) 0 1 0 1 0 1 0 1 Smoothing 2 values 1 0 1 0 1 0 1 0 Smoothing 4 values 1 1 1 1 1 1 1 1 Smoothing 8 values
Comment	Interference can be suppressed with the measured value smoothing.

Tab. 5/12: Measured value smoothing channel x

Channel parameters: Sensor connection designs channel x	
Function no.	4828 + m * 64 + **10** m = module number (0 ... 47)
Description	Set the connection design of the temperature sensor for the channels. The parameter can be set for the individual channels independently of each other.
Bit	Bit 0/1: sensor connection design channel 0 Bit 2/3: sensor connection design channel 1 Bit 4/5: sensor connection design channel 2 Bit 6/7: sensor connection design channel 3
Values	Channel 3 (Bit 7, Bit 6) – Channel 2 (Bit 5, Bit 4) – Channel 1 (Bit 3, Bit 2) – Channel 0 (Bit 1, Bit 0): 0 0 0 0 0 0 0 0 2-cable (presetting) 0 1 0 1 0 1 0 1 3-cable 1 0 1 0 1 0 1 0 4-cable
Comment	For sensor connection designs see section 5.3.3

Tab. 5/13: Sensor connection designs channel x

Channel parameters:	**Sensor type/temperature coefficient, temperature range channel x**
Function no.	4828 + m * 64 + **11** (channel 0) m = module number (0 ... 47) 4828 + m * 64 + **12** (channel 1) 4828 + m * 64 + **13** (channel 2) 4828 + m * 64 + **14** (channel 3)
Description	Sets the temperature sensor used for the channels. If necessary, set the temperature range for Pt sensors. The parameters can be set for the individual channels independently of each other.
Bit	Bit 0 ... 3: sensor type with temperature coefficient (TK) Bit 4 ... 6: reserved Bit 7: temperature range (only for Pt sensors)
Values	see below
Comment	The temperature range can only be set for Pt sensors: Temperature range standard: -200 ... +850 °C (-328 ... 1562 °Fahrenheit) Temperature range climate: -120 ... +130 °C (-184 ... 266 °Fahrenheit)

Values:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
0	0	0	0	0	0	0	0	Channel is deactivated
Sensor type Pt sensors:								
–	0	0	0	0	0	0	1	Pt 100 with TK = 0.00385 (presetting)
–	0	0	0	0	0	1	0	Pt 200 TK = 0.00385
–	0	0	0	0	0	1	1	Pt 500 TK = 0.00385
–	0	0	0	0	1	0	0	Pt 1000 TK = 0.00385
–	0	0	0	0	1	0	1	Pt 100 TK = 0.00391
–	0	0	0	0	1	1	0	Pt 200 TK = 0.00391
–	0	0	0	0	1	1	1	Pt 500 TK = 0.00391
–	0	0	0	1	0	0	0	Pt 1000 TK = 0.00391
Sensor type Ni sensors:								
–	0	0	0	1	0	0	1	Ni 100 TK = 0.00617
–	0	0	0	1	0	1	0	Ni 120 TK = 0.00617
–	0	0	0	1	0	1	1	Ni 500 TK = 0.00617
–	0	0	0	1	1	0	0	Ni 1000 TK = 0.00617
Temperature range for Pt sensors:								
0	0	0	0	–	–	–	–	Standard (presetting)
1	0	0	0	–	–	–	–	Climate

– = not relevant here

Tab. 5/14: Sensor type/temperature coefficient, temperature range channel x

Channel parameters: Definition Limit value for channel x	
Function no.	Limit values: m = module number (0 ... 47) 4828 + m * 64 + **15** (channel 0, low byte) 4828 + m * 64 + **16** (channel 0, high byte) 4828 + m * 64 + **17** (channel 1, low byte) 4828 + m * 64 + **18** (channel 1, high byte) 4828 + m * 64 + **19** (channel 2, low byte) 4828 + m * 64 + **20** (channel 2, high byte) 4828 + m * 64 + **21** (channel 3, low byte) 4828 + m * 64 + **22** (channel 3, high byte)
Description	One limit value can be set for each of the individual channels.
Bit	Bit 0 ... 7: high byte or low byte of the limit value
Values	Complement of two binary format in 1/10 °C or °Fahrenheit. Presetting: Limit value = 0 (low byte = 0; high byte: 0)
Comment	With parameter 8 you can set whether a diagnostic message is to be displayed when the limit value is exceeded or not reached (see Tab. 5/11 and section 5.4.5).

Tab. 5/15: Definition limit value for channel x

Module parameters: Force channel x	
Function no.	Access to these module parameters is made via protocol-specific functions (see the manual for the field bus node).
Description	The Force function permits the manipulation of analogue values irrespective of the actual input signal (see also CPX system manual). This can be accomplished with the following parameters: – Force mode inputs channel x – Force state inputs channel x
Values	– Force mode inputs channel x: 0 = blocked (presetting) 1 = Force state – Force state inputs channel x: 0 = reset value (presetting) 1 = set value
Comment	The enabling of the Force function with the parameter "Force mode outputs channel x" depends on the field bus protocol and is accomplished: – by an individual parameter setting or bit (e.g. CPX-FB11), – by setting all parameter bits of the relevant word (e.g. CPX-FB6) to "blocked" or "Force state". For parameterisation of the Force state, the desired input word must be correspondingly mapped in the parameter bits "Force state inputs channel x". The enabling of the Force function for the complete CPX terminal is carried out with the system parameter "Force mode" (see CPX system manual).

Tab. 5/16: Force channel x (channel-specific)

5.4.4 Monitoring wire break/short circuit

Wire break (Open Loop) and short-circuit monitoring can be activated by means of appropriate parameterisation (see Tab. 5/10).

5.4.5 Limit value monitoring by means of parameterisation

With the channel-specific parameters “Definition limit value” (parameters 15 ... 22) you can define a limit value for each channel. With the parameter “Limit value monitoring” (parameter 8) you can define whether a diagnostic message is to be displayed when the limit value is exceeded or not reached.

Note
If you are using a different temperature sensor from the Pt 100: Set the sensor used with the parameterisation. Monitoring of the sensor temperature range functions correctly as follows:

<table>
<tr><th>Parameterisation of the limit value monitoring 1)</th><th>Set limit value 2) is not reached</th><th>Set limit value 2) is exceeded</th><th>Sensor temperature range</th></tr>
<tr><td>“No diagnosis”</td><td>No message</td><td>No message</td><td>No message</td></tr>
<tr><td>“Message if limit value is not reached”</td><td>Diagnostic message error no. 9</td><td>No message</td><td rowspan="2">Diagnostic message
If limit value is not reached 9
If limit value is exceeded 10</td></tr>
<tr><td>“Message if limit value is exceeded”</td><td>No message</td><td>Diagnostic message error no. 10</td></tr>
<tr><td colspan="4">1) See Tab. 5/11
2) See Tab. 5/15</td></tr>
</table>

Tab. 5/17: Effect of limit value monitoring on the diagnostic messages

The following table shows examples for setting limit values with parameters. The limit values are specified in 1/10 °C or °Fahrenheit.

Setting of limit value = 42° = 42 * 10 = 420								
D7	D6	D5	D4	D3	D2	D1	D0	
1	0	1	0	0	1	0	0	Channel x, low byte
0	0	0	0	0	0	0	1	Channel x, high byte
Setting of limit value = -30° = -30 * 10 = -300								
D7	D6	D5	D4	D3	D2	D1	D0	
1	1	0	1	0	1	0	0	Channel x, low byte
1	1	1	1	1	1	1	0	Channel x, high byte

Tab. 5/18: Example: Parameterisation of limit values for channel x

5.4.6 Measured value smoothing by parameterisation

In order to suppress interference, there is the possibility of digitally smoothing the input data, whereby the degree of smoothing can be set by means of parameterisation (see Tab. 5/12).

Smoothing is carried out as follows:

– by forming the sum of n values,

– by subtracting an average value,

– by adding the current input value.

The following applies here: the greater n, the more the signal will be smoothed.

5.5 Diagnosis

Specific errors of the analogue input modules are reported or suppressed depending on the module parameterisation.

The errors are shown locally by means of the Module Error LED and the relevant Channel Error LED (see Fig. 5/6) and can be evaluated with the handheld device.

Depending on the module parameterisation, the errors are sent to the field bus node, where they can be evaluated according to the field bus protocol used.

Representation of the errors in the various field bus nodes depends on the field bus protocol (see manual for the field bus node).

5.5.1 Error messages of the analogue input modules

An analogue input module can register the following errors:

Error number	Description	Error treatment
2	**Short circuit/overload** [1)] Short circuit in sensor supply ($V_{EL/SEN}$). (see parameter “Diagnostic message in the event of wire break or short circuit”)	• Eliminate short circuit or check connected sensors The sensor power supply will be switched on again **automatically** when the short circuit is eliminated.
3	**Wire break** [1)]	• Check and, if necessary, replace the cable and connected sensors
9	**Limit value not reached** [1)] Set limit value not reached or sensor temperature range not reached (see parameter “Limit value monitoring channel x” or “Definition limit value channel x”)	• Check parameterisation of sensor type and connection design • Check input signal present • Check parameterized limit value • If necessary, deactivate monitoring
10	**Limit value exceeded** [1)] Set limit value exceeded or sensor temperature range exceeded (see parameter “Limit value monitoring channel x” or “Definition limit value channel x”)	• Check parameterisation of sensor type and connection design • Check input signal present • Check parameterized limit value • If necessary, deactivate monitoring
[1)] The module will register the appropriate error depending on the parameterisation. The analogue input signals will, however, be processed further.		

Tab. 5/19: Error messages of the input modules – part 1

Error number	Description	Error treatment
15	**Module/channel failed** 2) General error, module faulty.	• Power off/on necessary • If this error occurs again: check and, if necessary, replace the analogue input module. Evaluation of the analogue input signals has stopped.
29	**Parameterisation error** 1) 3) An error has occurred in the setting of a parameter: – wire break – connection design of the sensor – sensor type and temperature range.	• Check the parameterisation undertaken and, if necessary, repeat the parameterisation using the correct parameters (valid parameters see section 5.4.3). The analogue input module will be operated further with the last valid parameterisation.

1) The analogue input signals will, however, be processed further.
2) Processing of the analogue input signals will be stopped. This error message will be triggered by the field bus node.
3) The parameters entered will be ignored, the module operates with the last valid parameters.

Tab. 5/20: Error messages of the input modules – part 2

Note

Please note the following when using the input modules:

– If there is a short circuit, all sensor supplies of the module will be switched off **together**.

– The sensor power supply will be switched on again **automatically** when the short circuit is eliminated.

5.5.2 LED display

LEDs are situated under the transparent cover of the module for diagnosing the input modules.

1 Channel error LEDs (red)

2 Module error LED (red)

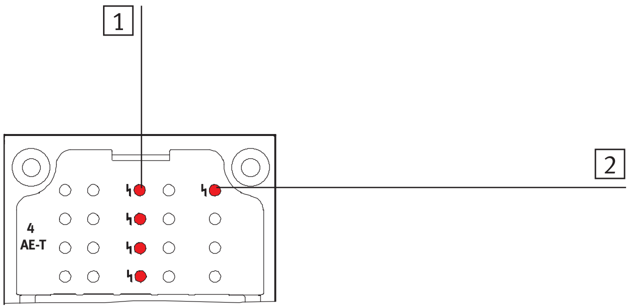


Fig. 5/6: LED displays of the temperature module CPX-4AE-T

Error LEDs

The red error LEDs indicate channel or module errors depending on the parameterisation.

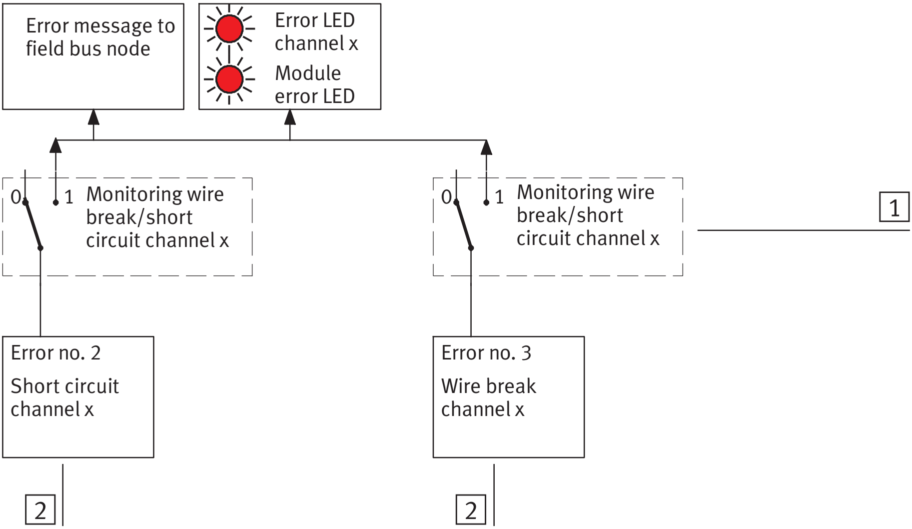
Error LED channel x [1)]	Module error LED	Installation	Error number	Error treatment
LED is out	LED is out	Trouble-free operation	–	None
LED lights up	LED lights up	**Error short circuit channel x** or **Error wire break channel x**	2 3	Eliminate short circuit or check connected sensors Check and, if necessary, replace the cable and connected sensors.
LED flashes	LED lights up	**Limit value not reached** Set limit value not reached or sensor temperature range not reached or **Limit value exceeded** Set limit value exceeded or sensor temperature range exceeded	9 10	See section 5.5.1, Tab. 5/19
LED lights up	LED flashes	**Parameterisation error**	29	See section 5.5.1, Tab. 5/20
LED flashes	LED is out	**Servicing required**	255	Replace module

1) One LED per channel

Tab. 5/21: Error LEDs of the temperature module CPX-4AE-T

5.5.3 Error treatment and parameterisation

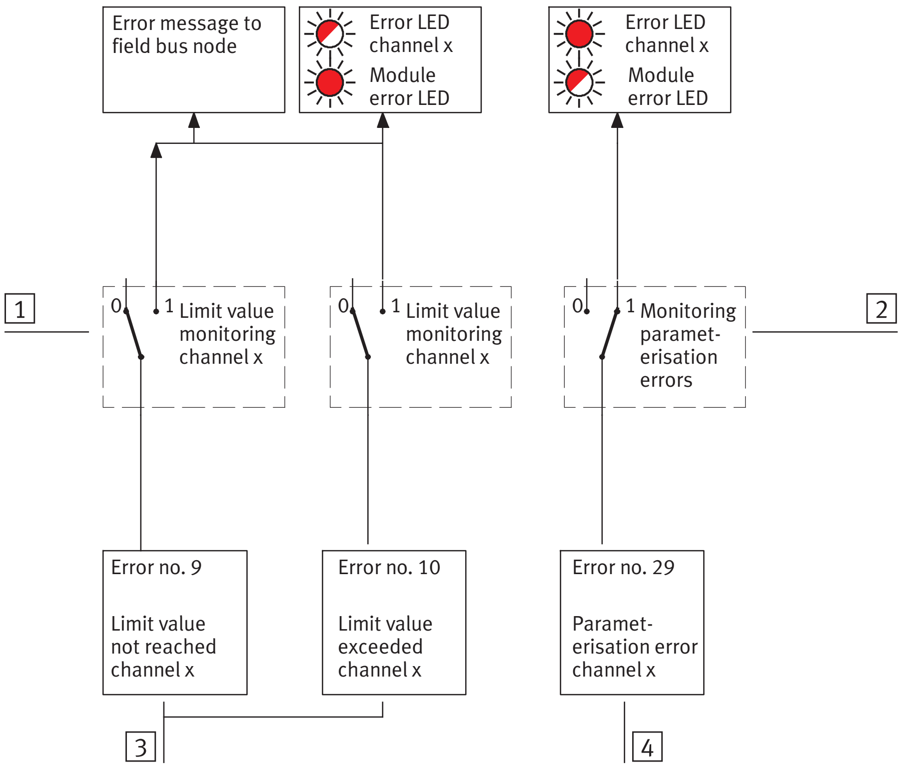
The following diagrams show the error treatment in the analogue input modules. With the appropriate module parameter, represented in the diagram as a switch, further reporting and display of the error can be suppressed as desired. The parameters are described in section 5.4.3.



1 Channel-specific parameter (switch position represented = default setting)

2 Channel-specific errors

Fig. 5/7: Principle of error treatment and parameterisation CPX-4AE-T – part 1



1 Channel-specific parameter
(switch position represented = default setting)

2 Module-specific parameter

3 Channel-specific errors

4 Module error

Fig. 5/8: Principle of error treatment and parameterisation CPX-4AE-T – part 2

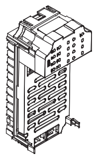
Analogue input module CPX-4AE-TC

Chapter 6

Contents

6.1 Function of the analogue input module CPX-4AE-TC

The module CPX-4AE-TC makes available 4 inputs for connecting thermocouple temperature sensors.

Type		Description
	CPX-4AE-TC	Provides 4 analogue inputs (input channels) for registering the temperature. – Connecting thermocouples (TC) in 2-cable design – Module cycle time: 250 ms TC sensors supported: – E, J, T, K, N, S, B, R Signal ranges of the individual sensor types: E -200 ... 900 °C 60 µV/°C J -200 ...1200 °C 51 µV/°C T -200 ... 400 °C 40 µV/°C K -200 ...1370 °C 40 µV/°C N 0 ... 1300 °C 38 µV/°C S 0 ...1760 °C 11 µV/°C B 400 ...1820 °C 8 µV/°C R 0 ...1760 °C 12 µV/°C

Tab. 6/1: Overview of analogue input module CPX-4AE-TC

6.2 Fitting

See section 1.3.

6.3 Installation

Warning
Unintentional movements of the connected actuators and uncontrollable movements of loose tubing can cause injury to human beings or damage to property.

Switch off the following equipment before undertaking installation and/or maintenance work:

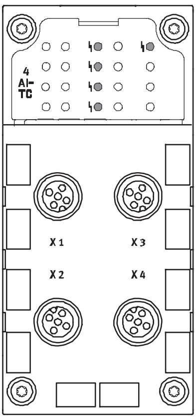
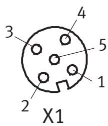
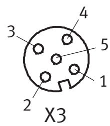
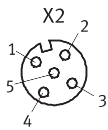
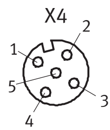
– Compressed air supply
– Operating and load voltage supplies

In the following sections you will find the pin allocation of the analogue input modules for the different sub-bases.

Instructions on connecting the cables and plugs to the sub-bases can be found in section 1.2.3.
Note in particular the instructions on connecting the cable screening to functional earth (FE).

6.3.1 Pin allocation

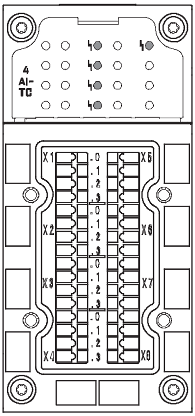
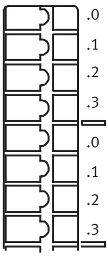
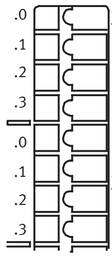
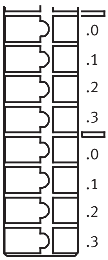
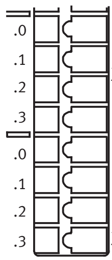
Pin allocation CPX-4AE-TC with sub-base CPX-M-4-M12x2-5POL or CPX-AB-4-M12x2-5POL (-R)

Analogue I-module type CPX-4AE-TC with sub-base CPX-AB-4-M12x2-5POL (-R)		
Sub-base	**Pin allocation X1, X2 (inputs 0, 1)**	**Pin allocation X3, X4 (inputs 2, 3)**
	 Socket X1: 1: CJC0 2: U0+ 3: CJC0' 4: U0- 5: FE (screening) 1)	 Socket X3: 1: CJC2 2: U2+ 3: CJC2' 4: U2- 5: FE (screening) 1)
	 Socket X2: 1: CJC1 2: U1+ 3: CJC1' 4: U1- 5: FE (screening) 1)	 Socket X4: 1: CJC3 2: U3+ 3: CJC3' 4: U3- 5: FE (screening) 1)
	CJC = cold junction compensation (CJC), by means of RTD temperature sensor Pt 1000) Ux+ = input signal (TC sensor, cable 1) Ux- = input signal (TC sensor, cable 2) FE = functional Earth 1) With CPX-AB-4-M12x2-5POL-R the metal thread is connected to FE	

Tab. 6/2: Pin allocation for analogue input module type CPX-4AE-TC with sub-base CPX-AB-4-M12x2-5POL (-R)

CPX-AB-4-M12x2-5POL**-R** The metal thread ("...-R") of this sub-base is connected internally with pin 5 (Functional earth FE).

Pin allocation CPX-4AE-TC with sub-base CPX-AB-8-KL-4POL

Analogue input module type CPX-4AE-TC with sub-base CPX-AB-8-KL-4POL		
Sub-base	**Pin allocation X1 ... X4 (inputs 0, 1)**	**Pin allocation X5 ... X8 (inputs 2, 3)**
	X1 X2  X1.0: CJC0 X1.1: CJC0' X1.2: U0- X1.3: FE (screening) X2.0: n.c. X2.1: n.c. X2.2: U0+ X2.3: FE (screening)	X5 X6  X5.0: CJC2 X5.1: CJC2' X5.2: U2- X5.3: FE (screening) X6.0: n.c. X6.1: n.c. X6.2: U2+ X6.3: FE (screening)
	X3 X4  X3.0: CJC1 X3.1: CJC1' X3.2: U1- X3.3: FE (screening) X4.0: n.c. X4.1: n.c. X4.2: U1+ X4.3: FE (screening)	X7 X8  X7.0: CJC3 X7.1: CJC3' X7.2: U3- X7.3: FE (screening) X8.0: n.c. X8.1: n.c. X8.2: U3+ X8.3: FE (screening)
	CJC = cold junction compensation (CJC), by means of RTD temperature sensor Pt 1000) Ux+ = input signal (TC sensor, cable 1) Ux- = input signal (TC sensor, cable 2) FE = functional Earth	

Tab. 6/3: Pin allocation for analogue input module type CPX-4AE-TC with sub-base CPX-AB-8-KL-4POL

6.3.2 Introduction to temperature measurement by means of thermocouples

Thermocouples (TCs) consist of two different metal conductors that are connected (e.g. soldered or welded) at one end ([1] and [2] in Fig. 6/1). At the connection point [3] a touch voltage is created that depends on the conductor materials and the ambient temperature, the so-called thermoelectric voltage.

If one connects the free ends of the two conductors ([4] in Fig. 6/1), a temperature-dependent touch voltage/thermoelectric voltage is also created at this connection point.

If there is a temperature difference between the two TC connection points ([3] and [4]), then the result is a thermoelectric current.

This thermoelectric effect, which is also called the "Seebeck effect" for its discoverer, Thomas Johann Seebeck, can be used for measuring purposes, e.g. for registering temperatures.

[1] Thermocouple cable 1 of material 1, e.g. iron

[2] Thermocouple cable 2 of material 2, e.g. copper/nickel

Together cables 1 and 2 form a thermocouple (TC)

[3] "Measuring junction" (sensor tip)

[4] Reference junction ("Cold junction")

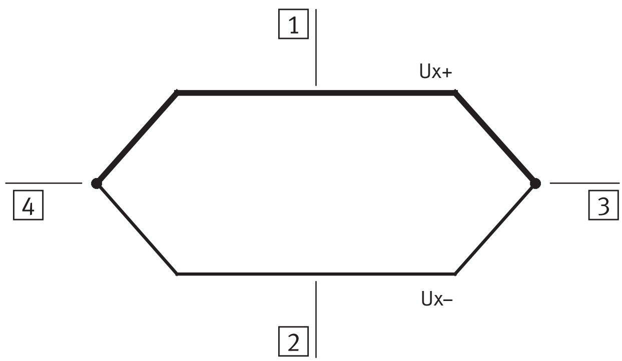


Fig. 6/1: Fundamental principle of a thermocouple (TC)

The thermoelectric effect ("Seebeck effect") in technical applications

Two different metal conductors are connected to each other at one end. At the other end, the so-called reference junction or connection point to a measurement device (see 4 in Fig. 6/2) a thermoelectric voltage can be created if there is a temperature difference between the connection point, i.e. the measuring junction or sensor tip, and the connection point of the measurement device.

This thermoelectric voltage is temperature-dependent, and for metals (pure metals or alloys) has a value of a few microvolts per kelvin. The relationship between voltage and temperature (U-T characteristic) is nearly linear for most pure metals.

1 Thermocouple cable 1 (of metal 1)

2 Thermocouple cable 2 (of metal 2)

3 Measuring junction (sensor tip)

4 Reference junction (connection point)

5 Measurement device (e.g. voltmeter or CPX-4AE-TC)

6 Standard connecting cable

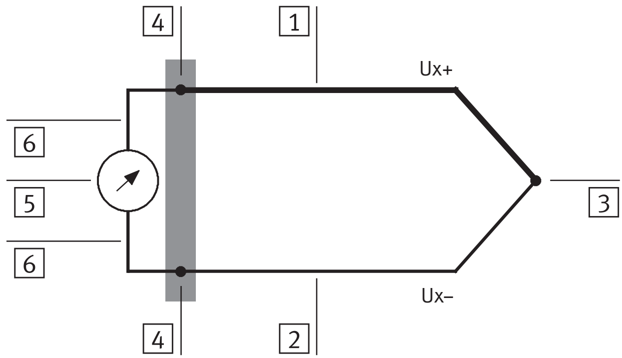


Fig. 6/2: Fundamental principle of temperature measurement by means of thermocouples

When selecting a pair of materials for measuring purposes, the goals are a high thermoelectric voltage, high linearity and high corrosion resistance/low oxidation at high temperatures. These goals cannot be achieves with any one thermocouple or combination of materials. Therefore different combinations of materials are used depending on the intended application.

Typical TC sensors

Widely used thermocouple combinations (sensor types):

- nickel-chrome/nickel-aluminium (-200 to 1370 °C) or nickel-chrome/nickel:
  Type K, frequently used sensor type with a broad range of application temperatures
- iron/copper-nickel (-200 to 1200 °C):
  Type J, one of the most commonly used thermocouples for industrial applications due to relatively high Seebeck coefficients and low costs
- platinum-rhodium/platinum (0 to 1760 °C):
  Type S, for high temperatures.

Because of the different characteristics of the thermocouple pairings, the sensor type must be selected very carefully.
For points of reference and general conditions, please see the relevant standards and specifications, e.g. in IEC standard (DIN) EN 60584 and DIN 43722.

Advantages of thermocouple sensors

Thermocouple sensors are notable for their:

- Extensive temperature measuring ranges
- Quick registering of temperature changes (response time)
- Simple mechanical installation
- Ability to be used at high temperatures and in harsh environments (if necessary in a sheathed thermocouple design or with the use of protective tubes).

Avoid extending TC sensor cables. If necessary, extend thermocouple sensor cables exclusively with thermocouple cables (of original materials) or compensating cables (substitute materials) corresponding to the type of the thermocouple sensor, i.e. that have identical or compatible characteristics, in order to keep the measuring errors resulting from the extension small. For further information see e.g. the above-mentioned IEC standard or the corresponding national version.

The temperature at the connection point of the TC sensor, i.e. at the reference junction or "cold junction" (4 in Fig. 6/3/ Fig. 6/1) must either be kept constant or recorded, and in both cases is included in the evaluation of the measurement results. The temperature module CPX-4AE-TC has the "cold junction compensation" required for this (see section 6.3.3).

1 TC sensor cbl. 1 (of metal 1)

2 TC sensor cbl. 2 (of metal 2)

3 Measuring junction (sensor tip)

4 Connection point (connecting pins of CPX module)

5 Temperature sensor (RTD, Pt 1000, Class A) for cold junction compensation (CJC)

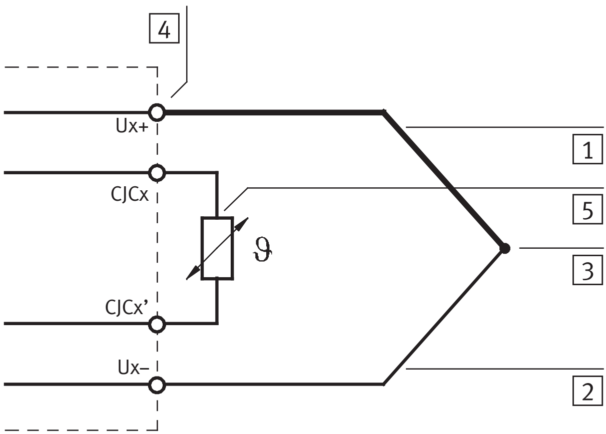


Fig. 6/3: Connecting a thermocouple (TC) with cold junction compensation (CJC) to temperature module CPX-4AE-TC

6.3.3 Cold junction compensation

Cold junction compensation (CJC) is – besides selection of the a suitable sensor – one of the essential requirements for precise measurements using thermocouples (TC). It eliminates the influence of the ambient temperature in the area surrounding the connection point on the module, i.e. in the area around the plug connectors or the terminal strip of the subbase.

The cold junction compensation is necessary in order to precisely measure the absolute temperature at the measuring junction, i.e. at the sensor tip. Without cold junction compensation the thermocouple measurement provides only "relative" measurement results: The measured value corresponds to the difference between the temperature/thermoelectric voltage at the sensor tip ([3] in Fig. 6/3) and the temperature (thermoelectric voltage) at the sensor connection point ([4]).

The ambient temperature at the connection point, the reference junction or the so-called "cold junction" ([4] in Fig. 6/3/ Fig. 6/1) thus has a considerable effect on the measurement result.

The temperature model of the CPX-4EA-TC has an internal cold junction compensation which may provide sufficient measuring accuracy for certain applications, such as where there are low requirements for measuring accuracy and an approximately constant ambient temperature of about 25 °C (at the connection point of the module).

To do this, the internal cold junction compensation uses the internally stored reference value of 25 °C. If the actual ambient temperature deviates from this reference value, then the internal cold junction compensation has a negative effect on the accuracy of the measured values.

Please note that any deviation from this reference value is reflected 1:1 in the measurement results. 1 °C (or 1 °F) of difference leads to a 1 °C (or 1 °F) shift in the measured temperature values!

If the temperature at the connection point significantly deviates from the internal reference value, or if high accuracy, i.e. exact temperature indications, are required, then a Pt 1000 temperature sensor of Class A must be used for cold junction compensation at each input. The Pt 1000 determines the actual temperature at the connection point.

The so-called external cold junction compensation of module CPX-4AE-TC takes into account the actual ambient temperature as part of the evaluation of the measured results, and makes the appropriately corrected measured temperature values (measurement data) available at the module output.

For external cold junction compensation, all inputs must be provided with their own Pt 1000.

Pt 1000 resistance temperature devices (RTDs) can be obtained from Festo as an individual sales item (see appendix A.11).

Fit the Pt 1000 temperature sensors in the immediate vicinity of the connection point of the thermocoupler (in the plug or on the terminal; see appendix A.10.3).

You can use parameter settings to choose between internal and external cold junction compensation.

Make sure that the value of the parameter “Cold junction compensation” has been set appropriately: for external cold junction compensation to “0” or “external (PT1000)” (see Tab. 6/12).

Further information on cold junction compensation, e.g. accessories, installation instructions and connection examples can be found in the following sections:

– Accessories: appendix A.11
– Installation instructions and connection examples: appendix A.10.3
– Introduction to temperature measurement by means of thermocouples: section 6.3.2.

6.3.4 Connecting temperature sensors to the analogue inputs

Detailed information on connecting temperature sensors (thermocouples) to module CPX-4AE-TC can be found in appendix A.10.3.

The signal of a thermocouple is very vulnerable to interference. Therefore only screened/shielded cables are permitted for transmission of the sensor signals (see section 1.2.3).

6.4 Instructions on commissioning

Basic setting (parameterisation)

By means of parameterisation it is possible to set the CPX temperature module for the temperature sensors being used (see Tab. 6/16).

The individual channels can be set separately; it is thus possible to use up to four different thermocouples per module.

The signal ranges of the individual temperature sensors are shown in Tab. 6/1.

In addition, the unit of measurement, limit value monitoring, the diagnostic reaction, and other functions can be adapted by means of parameterisation. Instructions on this can be found in the sections 6.4.2 and 6.4.3.

Tab. 6/7 and Tab. 6/8 provide an overview of the available parameters.

Monitoring open load/ short circuit

If desired, parameterisation can be used to activate the open load (OL) monitoring and short circuit (SC) monitoring for each channel (see Tab. 6/13).

Measured value smoothing

In order to suppress interference, there is the possibility of digitally smoothing the input data, whereby the degree of smoothing can be set by means of parameterisation (see Tab. 6/15).

Limit value monitoring

The channel-specific "Limit value" parameters can be used to define a limit value for each channel (see Tab. 6/17).

With the parameter "Limit value monitoring", you can define whether a diagnostic message is to be displayed when the limit value is overrun or underrun (see Tab. 6/14).

Monitoring 1)	**Limit value** 2)	
	underrun	**overrun**
Inactive (disabled)	No diagnostic message	
Limit value overrun	Diagnostic message error no. 9	No diagnostic message
Limit value overrun	No diagnostic message	Diagnostic message error no. 10

1) see Tab. 6/14
2) see Tab. 6/17

Tab. 6/4: Effect of limit value monitoring on the diagnostic messages

6.4.1 Processing the input signals of temperature sensors

The analogue values are transmitted from the CPX terminal to the control system as input words (4 inputs, 64 bits). Each temperature module occupies 4 input words for this procedure in the address range.

The position of the input words in the address range depends on the field bus used (see manual for the field bus node, P.BE-CPX-SYS-...).

Reaction with default settings

The module parameters are set as standard to these values:

- Unit of measurement: °C
- Interference frequency suppression: 50 Hz
- Cold junction compensation, abbreviated CJC: external CJC by means of Pt 1000 resistance temperature device, RTD).

The channel-specific parameters are set as standard to these values:

- Sensor type K – with the following specification:
  - Cable 1 (Ux+): Ni-Cr sensor cable
  - Cable 2 (Ux-): Ni-Al sensor cable

    Further information can be found in IEC standard EN 60584.
- Temperature range -200 ... +1370 °C

The complete parameter settings can be found in section 6.4.3.

The temperature values are transferred in the input word in the data format "mathematical sign (VZ) + 15 bits, complement of two, binary notation in tenths of a degree" (see Tab. 6/5).

This means that measured data from -32767 to +32767 and measured values from -3276.7 °C/°F to +3276.7 °C/°F can be depicted (possible range of values, see Tab. 6/6). The permitted range of values depends on the sensor being used (see Tab. 6/1).

Data format "VZ + 15 bits compliment of two, binary notation in tenths of a degree"															
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Sign	B14 MSB	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0 LSB
Abbreviations used: VZ: mathematical sign (0 = positive value, 1 = negative value) B0 ... B14: input value D0 ... D15: 16 bits input data field MSB/LSB: most significant bit / least significant bit															

Tab. 6/5: Data format of temperature module CPX-4AE-TC

Note

For the fieldbus node CPX-FB13 (PROFIBUS-DP) the byte sequence with which the analogue values are transferred to the controller can be reversed by parameterising the value "Analogue process value representation":

– Factory setting: LSB-MSB (INTEL format)

– Reversal: MSB-LSB (MOTOROLA format)

Check this setting in the bus node if you obtain implausible values; also refer to the CPX-FB13 description in chapter 2 under the section entitled "Parameters of CPX-FB13".

Type of measurement	Possible value range	Permitted value range
Temperature measurement with thermocouple (TC)	±3276.7 °C	Depending on the sensor type (see Tab. 6/1)

Tab. 6/6: Value ranges

Fig. 6/4 shows the processing of the input signals of a type K thermocouple in the nominal temperature range (example).

1 End values of the nominal temperature range

2 Temperature at the measuring junction (example)

3 Signal representation after the A-D converter and measured value acquisition

4 Digital input word (in decimal notation, example)

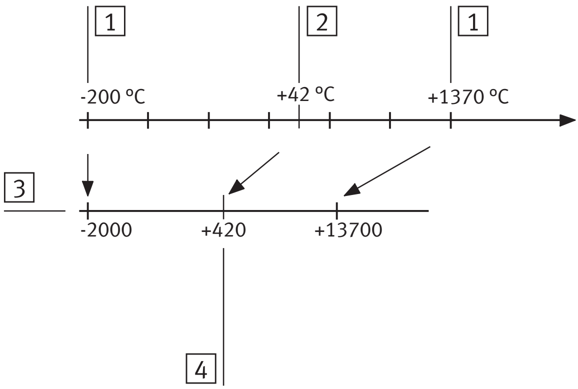


Fig. 6/4: Representation of measured values (example)

6.4.2 General information on parameterisation

If desired, you can use parameterisation to set the sensor type, the unit of measurement, the diagnostic reaction, a limit value monitoring function and if necessary additional functions.

Due to in some cases necessary calculations, modified parameters are not valid until they have been thoroughly checked and saved. Until then, as in the case of invalid parameters, the previous settings apply.

Depending on the parameter, no valid analogue values are available a max. of 30 ms after a value modification.

Specific instructions for the prevention of parameterisation errors

Parameterize in this sequence:

1. Set temperature sensor.
2. Set limit value.
3. Activate limit value monitoring.

6.4.3 Parameters of analogue input module type CPX-4AE-TC

An overview of all parameters

The following tables (Tab. 6/7 and Tab. 6/8) contain an overview of the module parameters of the analogue input module CPX-4AE-TC.

Module parameters of CPX-4AE-TC – overview

Function number [1]	Bit	Module parameters	Presetting	Value
4828 + m * 64 + **0**	0 ... 6 7	Reserved Monitoring the CPX module, here parameterisation errors	– active	– 1
4828 + m * 64 + **1 ... 5**	0 ... 7	Reserved	–	–
4828 + m * 64 + **6**	0 ... 2 3 4 5 ... 6 7	Reserved Unit of measurement for temperature (° Celsius or ° Fahrenheit) Interference frequency suppression (50 Hz or 60 Hz) Reserved Cold junction compensation (external, by means of Pt 1000-RTD, or internal, fixed to reference temperature 25 °C)	– °C 50 Hz – external (Pt 1000)	– 0 0 – 0

[1] m = module number (counting mode: from left to right, beginning with 0)

Tab. 6/7: Module parameters – overview

Channel-specific module parameters of CPX-4AE-TC – overview

Function number [1]	Bit	Module parameters	Presetting	Value
4828 + m * 64 + **7**	0 ... 7	Monitoring open load/short circuit, each separately for channels 0 ... 3	disabled	0
4828 + m * 64 + **8**	0 ... 7	Monitoring of limit values each separately for channels 0 ... 3	disabled	0
4828 + m * 64 + **9**	0 ... 7	Measured value smoothing, each separately for channels 0 ... 3	None	0
4828 + m * 64 + **10 ... 13**	0 ... 7	Setting the sensor type, each separately for channels 0 ... 3	Type K	4
4828 + m * 64 + **14 ... 21**	0 ... 7	Limit values, each separately for channels 0 ... 3	0	0
– [2]	– [2]	Forcing, channel x [2]	–	–

[1] m = module number (counting mode: from left to right, beginning with 0)
[2] Access is protocol-specific (see manual for the field bus node, P.BE-CPX-FB..., and CPX system manual, P.BE-CPX-SYS...)

Tab. 6/8: Channel-specific module parameters – overview

Detailed description of the individual parameters

Module parameter: Monitoring the CPX module, here parameterisation errors		**Handheld display**
Function no.	4828 + m * 64 + **0**; m = module number (0 ... 47)	
Description	For this input module the monitoring of parameterisation errors can be activated or deactivated (suppressed). When monitoring is active, parameterisation errors: – are indicated by the module error LED – sent to the CPX field bus node	
Bit	Monitoring Bit 0 ... 6: Reserved Bit 7: Monitoring parameterisation errors	[Monitor] [Monitor parameters]
Values	0 = inactive 1 = active (presetting)	[Inactive] [Active]
Note	The following parameters are checked for invalid values when the parameter settings are made: – Sensor type channel x – Unit of measurement for temperature – Interference frequency suppression – Cold junction compensation	

Tab. 6/9: Monitoring the CPX module, here parameterisation errors

Module parameter: Unit of measurement for temperature		**Handheld display**
Function no.	4828 + m * 64 + **6**; m = module number (0 ... 47)	
Description	The the unit of measurement for temperature values can be switched to either: – °Celsius – °Fahrenheit	
Bit	Bit 3: Measuring unit for temperature	[Temp. scale]
Values	0 = °Celsius (presetting) 1 = °Fahrenheit	[°C] [°F]
Note	The setting for the unit of measurement refers to all temperature specifications, e.g. to the recorded measured values, and also to limit values (see Tab. 6/17). Limit values already saved are not automatically converted. After conversion of the unit of measurement it is therefore necessary to convert the limit values and re-enter them. Converting temperature units: – (x °C * 9/5) + 32 ≙ y °F – (m °F - 32) * 5/9 ≙ n °C	

Tab. 6/10: Unit of measurement for temperature

Module parameter: Interference frequency suppression		**Handheld display**
Function no.	4828 + m * 64 + **6**; m = module number (0 ... 47)	
Description	The module-internal interference frequency suppression has to be set to the mains frequency of the power supply. Select the appropriate value: – 50 Hz – 60 Hz	
Bit	Bit 4: Interference frequency suppression	[Noise rejection]
Values	0 = 50 Hz (presetting) 1 = 60 Hz	[50 Hz] [60 Hz]

Tab. 6/11: Interference frequency suppression

Module parameter: Cold junction compensation		Handheld display
Function no.	4828 + m * 64 + **6**; m = module number (0 ... 47)	
Description	Defines whether the following is used for cold junction compensation (CJC): – external Pt 1000 resistance temperature devices (RTDs), – or the internal reference value (25 °C) is used	
Bit	Bit 7: cold junction compensation	[Cold junction compensation]
Values	0 = external cold junction compensation (Pt 1000 resistors connected; pre-setting) 1 = internal cold junction compensation (fixed to 25 °C)	[external (PT1000)] [internal (25 °C)]
Note	Cold junction compensation (CJC) is necessary for precise measurements using thermocouples (TC). Cold junction compensation eliminates the effect of the ambient temperature in the area surrounding the connection point on the module. With the setting “internal (25 °C)”, the module uses the internally stored reference value of 25 °C from cold junction compensation. If the temperature at the connection point significantly deviates from the internal reference value, or if high accuracy, i.e. exact temperature indications, are required, then a Pt 1000 temperature sensor of Class A must be used for cold junction compensation at each input. Make sure that the value of the parameter “Cold junction compensation” is set to “0” or “external (PT1000)” Further information on cold junction compensation and a brief introduction to the measuring method can be found in the following sections: – Accessories: appendix A.11 – Installation instructions and connection examples: appendix A.10.3 – Explanation of cold junction compensation: section 6.3.3 – Introduction to temperature measurement by means of thermocouples: section 6.3.2	

Tab. 6/12: Cold junction compensation

Module parameter: Monitoring open load/short circuit		Handheld display
Function no.	4828 + m * 64 + **7** (channel 0 ... 3); m = module number (0 ... 47)	
Description	Defines whether or not a diagnostic message is to be displayed after wire open load or short circuit. The parameter can be set for the individual channels independently of each other.	
Bit	Diagnosis of open load/short circuit sensor Bits 0/1: channel 0 Bits 2/3: channel 1 Bits 4/5: channel 2 Bits 6/7: channel 3	[Monitoring OL/SC Sensor]
Values	Channel 3 (Bit 7, Bit 6) / Channel 2 (Bit 5, Bit 4) / Channel 1 (Bit 3, Bit 2) / Channel 0 (Bit 1, Bit 0) 0 0 0 0 0 0 0 0 — No diagnostic message (presetting) 0 1 0 1 0 1 0 1 — Diagnostic message in the event of open load or short circuit	
	00 = disabled (presetting) 01 = enabled	[Disabled] [Enabled]

Tab. 6/13: Monitoring open load/short circuit (channel-specific)

Module parameter: Monitoring of limit values		Handheld display
Function no.	4828 + m * 64 + **8** (channel 0 ... 3); m = module number (0 ... 47)	
Description	Defines whether or not a diagnostic message is to be displayed after – Underrunning a limit value set with parameter 15 ... 22 and leaving the sensor temperature range – Overrunning a limit value set with parameter 15 ... 22 and leaving the sensor temperature range The limit value monitoring can be set for the individual channels independently of each other.	
Bit	Limit value monitoring Bits 0/1: channel 0 Bits 2/3: channel 1 Bits 4/5: channel 2 Bits 6/7: channel 3	[Monitoring limit value]
Values	Channel 3 (Bit 7, Bit 6) / Channel 2 (Bit 5, Bit 4) / Channel 1 (Bit 3, Bit 2) / Channel 0 (Bit 1, Bit 0): 0 0 0 0 0 0 0 0 – No limit value monitoring (presetting) 0 1 0 1 0 1 0 1 – Diagnostic message if value underruns the set limit value and leaving the sensor temperature range 1 1 1 1 1 1 1 1 – Diagnostic message if value overruns the set limit value and leaving the sensor temperature range	
	00 = disabled (presetting) 01 = diagnostic message if underrun 10 = diagnostic message if overrun	[disabled] : [Diag at limit underrun] [Diag at limit overrun]
Note	Only the underrunning or overrunning of the limit value can be monitored. The limit value is set separately for each channel with parameters 14 ... 21 (see Tab. 6/17). The limit value monitoring of the sensor temperature range is activated as soon as the diagnosis for the set limit value becomes active.	

Channel 3		Channel 2		Channel 1		Channel 0		
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
0	0	0	0	0	0	0	0	No limit value monitoring (presetting)
0	1	0	1	0	1	0	1	Diagnostic message if value underruns the set limit value and leaving the sensor temperature range
1	1	1	1	1	1	1	1	Diagnostic message if value overruns the set limit value and leaving the sensor temperature range

Tab. 6/14: Monitoring limit values (channel-specific)

<table>
<tr><th colspan="2">Module parameter: Measured value smoothing</th><th>Handheld display</th></tr>
<tr><td>Function no.</td><td colspan="2">4828 + m * 64 + **9** (channel 0 ... 3); m = module number (0 ... 47)</td></tr>
<tr><td>Description</td><td colspan="2">To suppress errors, the input data can be smoothed digitally. You can activate and set this function and the necessary degree of smoothing separated for each channel.
The smoothing is performed using the averaging method over a certain number of measured values (so-called moving average method, here over two, four or eight values, see “Values” line in the table).</td></tr>
<tr><td>Bit</td><td>Measured value smoothing
Bits 0/1: channel 0
Bits 2/3: channel 1
Bits 4/5: channel 2
Bits 6/7: channel 3</td><td>[Measured value smoothing]</td></tr>
<tr><td>Values</td><td colspan="2">
<table>
<tr><th colspan="2">Channel 3</th><th colspan="2">Channel 2</th><th colspan="2">Channel 1</th><th colspan="2">Channel 0</th><th></th></tr>
<tr><th>Bit 7</th><th>Bit 6</th><th>Bit 5</th><th>Bit 4</th><th>Bit 3</th><th>Bit 2</th><th>Bit 1</th><th>Bit 0</th><th></th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>no measured value smoothing (presetting)</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>Smoothing 2 values</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>Smoothing 4 values</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>Smoothing 8 values</td></tr>
</table>
</td></tr>
<tr><td>Note</td><td colspan="2">The following applies here: the greater the number of measured values, the more the signal will be smoothed.
The measured value smoothing has no effect on the continuous transmission of the measured data or the module cycle time.</td></tr>
</table>

Tab. 6/15: Measured value smoothing (channel-specific)

<table>
<tr><th colspan="2">Module parameter: Sensor type</th><th>Handheld display</th></tr>
<tr><td>Function no.</td><td colspan="2">4828 + m * 64 + 10 (channel 0); m = module number (0 ... 47)
4828 + m * 64 + 11 (channel 1)
4828 + m * 64 + 12 (channel 2)
4828 + m * 64 + 13 (channel 3)</td></tr>
<tr><td>Description</td><td colspan="2">The sensor type can be set separately for each channel.</td></tr>
<tr><td>Bit</td><td>Setting the sensor type
Bits 0 ... 4: sensor type
Bits 5 ... 7: reserved</td><td>[Sensor setup]</td></tr>
<tr><td>Values</td><td colspan="2">
<table>
<tr><th>Bit 7</th><th>Bit 6</th><th>Bit 5</th><th>Bit 4</th><th>Bit 3</th><th>Bit 2</th><th>Bit 1</th><th>Bit 0</th><th></th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>no sensor
(channel deactivated)</td></tr>
<tr><td colspan="8">Sensor type thermocouples</td><td>[Type ...] *) :</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>Type E</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>Type J</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>Type T</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>Type K</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>Type N</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>Type S</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>Type B</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>Type R</td></tr>
</table>
</td></tr>
<tr><td>Note</td><td colspan="2">*) Type indication on handheld
Further information on the individual sensor types can be found in Tab. 6/1.</td></tr>
</table>

Tab. 6/16: Sensor type (channel-specific)

Module parameter: Limit value		**Handheld display**
Function no.	Limit value channels 0 ... 3; 4828 + m * 64 + **14** (channel 0, low byte) 4828 + m * 64 + **15** (channel 0, high byte) 4828 + m * 64 + **16** (channel 1, low byte) 4828 + m * 64 + **17** (channel 1, high byte) 4828 + m * 64 + **18** (channel 2, low byte) 4828 + m * 64 + **19** (channel 2, high byte) 4828 + m * 64 + **20** (channel 3, low byte) 4828 + m * 64 + **21** (channel 3, high byte)	m = module number (0 ... 47)
Description	One limit value can be set for each of the individual channels.	
Bit	Limit value Bits 0 ... 7: high byte or low byte of the limit value	[Limit value]
Values	Complement of two binary format in 1/10 °Celsius or °Fahrenheit. Presetting: Limit value = 0 (low byte: 0; high byte: 0).	
Note	With parameter 8 you can set whether a diagnostic message is to be displayed when the limit value is underrun or overrun (see Tab. 6/14).	

Tab. 6/17: Limit value (channel-specific)

The temperature unit (° Celsius or ° Fahrenheit) is dependent on the setting for the parameter "Unit of measure for temperature" (see Tab. 6/10). Make sure that the necessary setting has been saved in the module.

The following table shows examples for setting limit values with parameters. The limit values are specified in tenths of a degree (1/10 °).

Example: "420" = 42.0 °

Setting of limit value = 42° = 42 * 10 = 420								
D7	D6	D5	D4	D3	D2	D1	D0	
1	0	1	0	0	1	0	0	Channel x, low byte
0	0	0	0	0	0	0	1	Channel x, high byte

Tab. 6/18: Example 1: Parameterisation of limit values for channel x

Setting of limit value = -30° = -30 * 10 = -300								
D7	D6	D5	D4	D3	D2	D1	D0	
1	1	0	1	0	1	0	0	Channel x, low byte
1	1	1	1	1	1	1	0	Channel x, high byte

Tab. 6/19: Example 2: Parameterisation of limit values for channel x

Module parameter: Forcing channel x	
Function no.	Access to these module parameters is made via protocol-specific functions (see the manual for the field bus node, P.BE-CPX-FB...).
Description	The Force function permits the manipulation of analogue values irrespective of the actual input signal (see also CPX system manual, P.BE-CPX-SYS-...). This can be accomplished with the following parameters: – Force mode inputs channel x – Force state inputs channel x
Values	– Force mode inputs channel x: 0 = blocked (presetting) 1 = Force state – Force state inputs channel x: 0 = reset value (presetting) 1 = set value
Note	The enabling of the Force function for the complete CPX terminal is carried out with the system parameter “Force mode” (see CPX system manual P.BE-CPX-SYS-...). Channel-specific enabling (for forcing) is performed with the parameter “Force mode inputs channel x” (in accordance with the field bus protocol – see description for field bus node P.BE-CPX-FB...). For parameterisation of the Force state, the desired input word must be mapped in the parameter bits “Force state inputs channel x.”

Tab. 6/20: Force channel x (channel-specific)

6.5 Diagnosis

Specific errors of the analogue input modules are reported or suppressed depending on the module parameterisation.

The errors are locally by means of the Module Error LED and the relevant Channel Error LED (see Fig. 6/5) and can be evaluated with the handheld device.

Depending on the module parameterisation, the errors are sent to the field bus node, where they can be evaluated according to the field bus protocol used.

Representation of the errors in the various field bus nodes depends on the field bus protocol (see manual for the field bus node).

6.5.1 Error messages of the analogue input modules

An analogue input module can register the following errors:

Error no.	Description	Error treatment
2	**Short circuit/overload** [1)] Short circuit of a sensor for cold junction compensation (CJC; see parameter “Diagnostic message after open load or short circuit”)	• Eliminate short circuit or check connected CJC sensors
3	**Open load** [2)] Open load of a thermocouple (TC) or of a sensor for cold junction compensation (CJC; see parameter “Diagnostic message after open load or short circuit”)	• Check and, if necessary, replace the cable and connected sensors
9	**Limit value underrun** [1)] Set limit value underrun or sensor temperature range underrun (see parameter “Limit value monitoring channel x” or “Definition limit value channel x”)	• Check parameterisation of sensor type and connection design • Check input signal present • Check parameterized limit value • If necessary, deactivate monitoring
10	**Limit value overrun** [1)] Set limit value overrun or sensor temperature range overrun (see parameter “Limit value monitoring channel x” or “Definition limit value channel x”)	• Check parameterisation of sensor type and connection design • Check input signal present • Check parameterized limit value • If necessary, deactivate monitoring

[1)] The module will register the appropriate error depending on the parameterisation. The analogue input signals will, however, be processed further.
[2)] The analogue input signals is set to the value 32767 (“Overflow”).

Tab. 6/21: Error messages of the input modules – part 1

Error no.	Description	Error treatment
15	**Module/channel failed** 3) General error, module faulty	• Power Off/On is necessary • If this error occurs again: check and, if necessary, replace the analogue input module
29	**Parameterisation error** 1) 4) An error has occurred in the setting of a parameter (monitored parameters: see Tab. 6/9)	• Check the parameterisation undertaken and, if necessary, repeat the parameterisation using the correct parameters (valid parameters: see section 6.4.3.
1) The module will register the appropriate error depending on the parameterisation. The analogue input signals will, however, be processed further. 3) This error message is triggered by the field bus node. Processing of the analogue input signals will be stopped. 4) The (faulty) param. entered will be ignored, the module operates with the last valid parameters.		

Tab. 6/22: Error messages of the input modules – part 2

6.5.2 LED displays

Various LEDs are situated under the transparent cover of the device for diagnosing the input modules.

1 Channel error LEDs (red)

2 Module error LED (red)

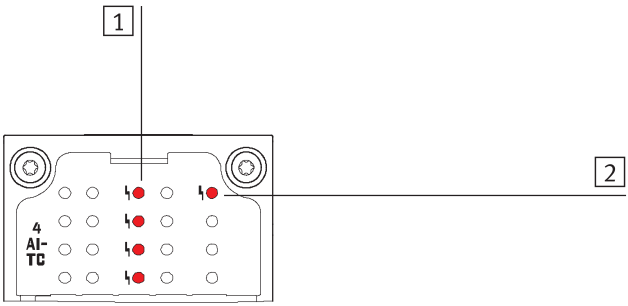


Fig. 6/5: LED displays of the temperature module CPX-4AE-TC

Error LEDs

The red error LEDs indicate channel or module errors depending on the parameterisation.

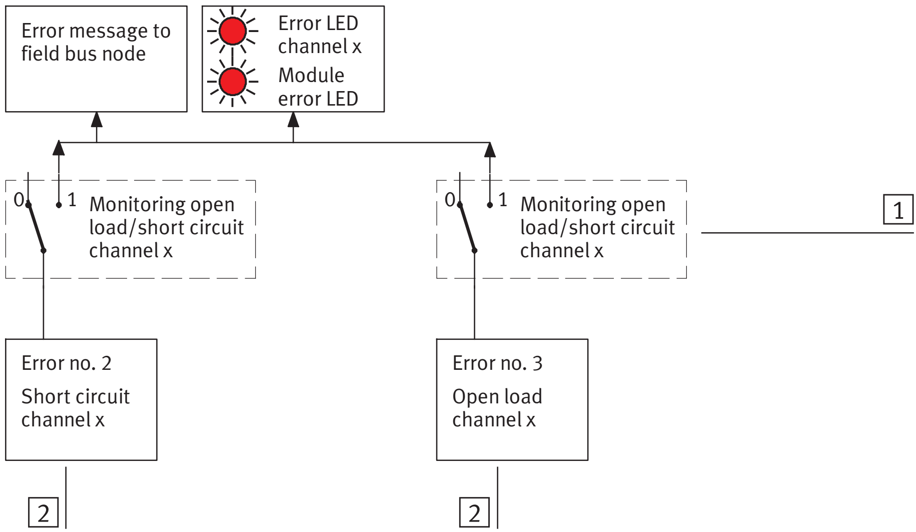
Error LED channel x [1]	**Module error LED**	**Status**	**Error number**	**Error treatment**
LED is off	LED is off	Trouble-free operation	–	None
LED lights	LED lights	**Error short circuit channel x** or **Error wire break channel x**	2 3	Check cables and sensors, eliminate short circuit Check and, if necessary, replace the cable and sensors
LED flashes	LED lights	**Limit value overrun** Set limit value underrun or sensor temperature range underrun or **Limit value overrun** Set limit value overrun or sensor temperature range overrun	9 10	See section 6.5.1, Tab. 6/21
LED lights	LED flashes	**Parameterisation errors**	29	See section 6.5.1, Tab. 6/22
LED is off	LED flashes	**Servicing required**	255	Replace module

[1] One LED per channel

Tab. 6/23: Error LEDs of the temperature module CPX-4AE-TC

6.5.3 Error treatment and parameterisation

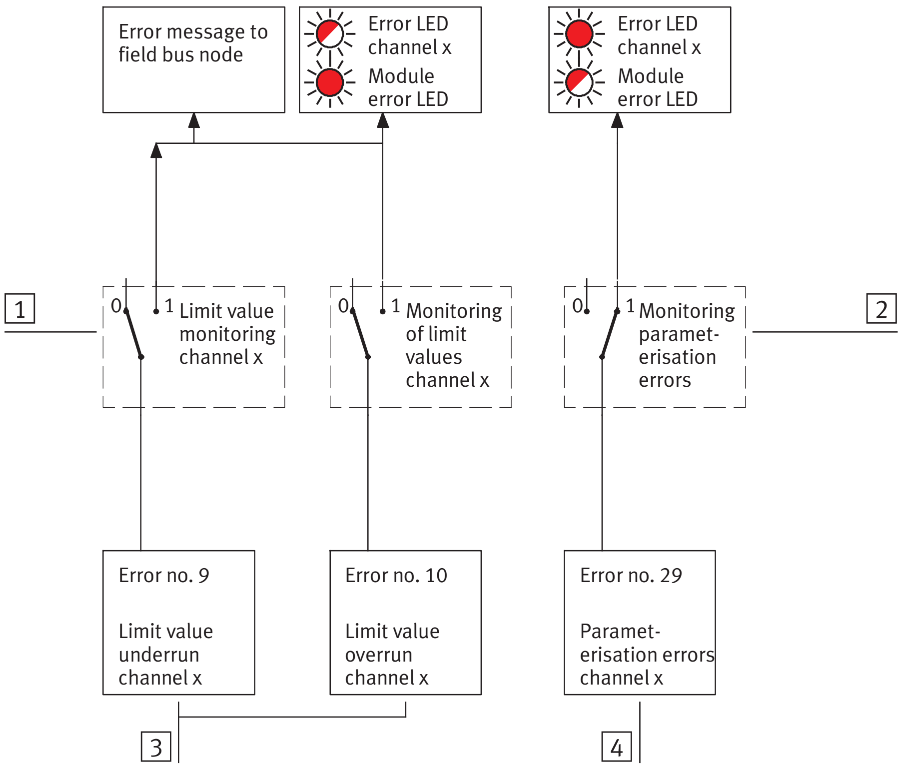
The following diagrams show the error treatment in the analogue input modules. With the appropriate module parameter, represented in the diagram as a switch, further reporting and display of the error can be suppressed as desired. The parameters are described in section 6.4.3.



1 Channel-specific module parameters (switch position represented = default setting)

2 Channel-specific module errors

Fig. 6/6: Principle of error treatment and parameterisation CPX-4AE-TC – part 1



1 Channel-specific module parameters (switch position represented = default setting)

2 Module-specific parameter

3 Channel-specific module errors

4 Module error

Fig. 6/7: Principle of error treatment and parameterisation CPX-4AE-TC – part 2

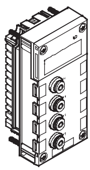
Pressure sensor module CPX-4AE-P

Chapter 7

Contents

7.1 Function of the pressure sensor module CPX-4AE-P

The pressure sensor module CPX-4AE-P provides 4 pneumatic connections for the pressure measurement. The module is intended to measure pressures at decentralised places.

Type		Description
	CPX-4AE-P-D10	4 pneumatic connections for the pressure measurement – Pressure range 0 ... 10 bar – 4 channels P0 ... P3 – Calculation of the differential pressure between P0 and P1 and between P2 and P3 is possible
	CPX-4AE-P-B2	4 pneumatic connections for the pressure measurement – Pressure range -1 ... +1 bar – 4 channels P0 ... P3 – Calculation of the differential pressure between P0 and P1 and between P2 and P3 is possible

Tab. 7/1: Overview of the pressure sensor module CPX-4AE-P

Caution
Extreme pneumatic conditions (rapid pressure change with large pressure amplitudes) can damage the pressure sensors of the module.

Example:
Pressure changes at one second intervals with pressure amplitudes of 10 bar result in a temperature increase of 50 K.

1 4 Pneumatic connections (QS connections for hose diameter 4 mm)

2 LCD display

3 Module error LED

4 Identification plate

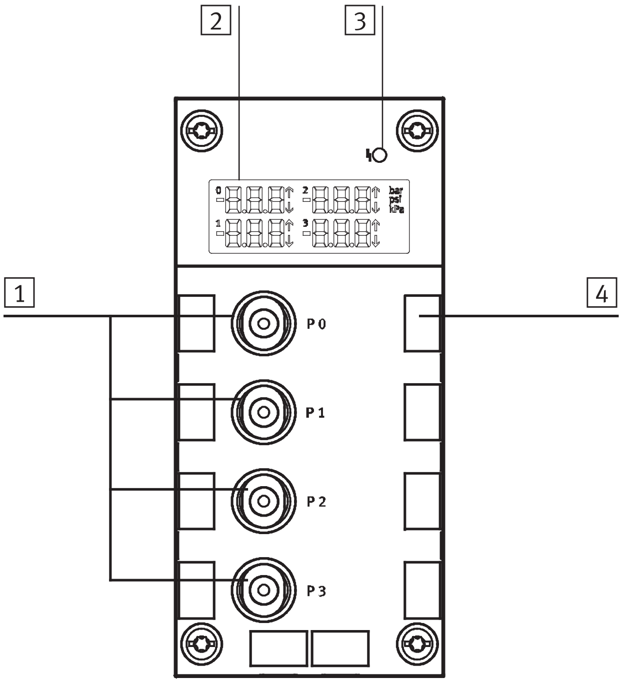


Fig. 7/1: Connections and indicators of the pressure sensor module CPX-4AE-P

7.2 Fitting

The pressure sensor module does not have a separate electrical connection block. Information about installing a CPX terminal can be found in the CPX system manual.

7.3 Installation

Warning
If the pneumatic tubing is under pressure when dismantled, it may perform sudden unexpected movements, causing injury to persons. Carry out the following steps before disconnecting the pneumatic tubing on the pressure sensor module:

- Switch off the compressed air supply.
- Make sure that all pneumatic tubing is pressureless.
- Exhaust all actuators controlled by valves that are blocked in the rest or middle positions.

7.3.1 Installing the pneumatic tubing

Connecting

Proceed as follows:

1. Cut off the end of the hose **straight**. Use a suitable hose cutter for this.
2. Press the hose into the QS connector as far as the stop (see Fig. 7/2).
3. Group the tubing together with tube ties or a tube holder for a better overview of the system.

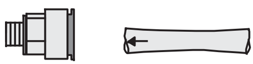


Fig. 7/2: Fitting the pneumatic hoses

Disconnecting

Proceed as follows:

1. Mark all pneumatic tubing.
2. Press the locking ring of the QS connector [1], e. g. using a screwdriver or the QSO releasing tool from Festo.
3. Remove the tubing from the QS connector.
4. Close all connections not needed with blanking plugs (type QSC-4H, part number 153 267) [2].

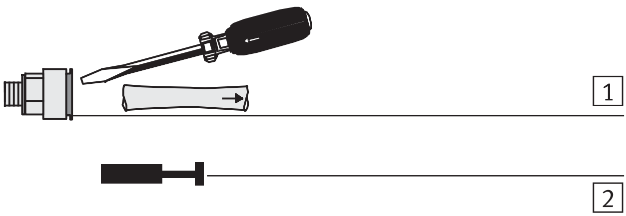


Fig. 7/3: Removing the pneumatic hoses

7.4 Commissioning

7.4.1 Processing the input signals of pressure sensors

The analogue values of the 4 pressure sensors are transmitted from the CPX terminal to the control system as input words (4 analogue inputs, 64 bits). Each pressure sensor module occupies 4 input words for this in the address range.

The position of the input words in the address range depends on the field bus used (see manual for the field bus node).

7.4.2 Procedure for commissioning

An overview of setting up the pressure sensor module CPX-4AE-P is provided in the following section. Detailed information about making settings via parameterisation is provided in section 7.4.3.

1. Connect the pneumatic hoses and close the unused connections with blanking plugs.
2. Settings for the pressure sensor module can be made via the Handheld (CPX-MMI), a PC (with the Festo Maintenance Tool CPX-FMT) or via the field bus or the network:
   - Connect the Handheld or a PC to the CPX terminal or establish a field bus or network connection with your PLC.

3. Make the following settings as necessary:
   - Unit for pressure specifications (default is mbar)
   - Differential pressure calculation
   - Upper and lower pressure limit values
   - Activate the pressure diagnosis by selecting whether failure to reach a limit or exceeding a limit should be signaled.
   - If necessary, make the following further settings: sensor limit diagnosis, delay for pressure diagnosis, measured value smoothing and hysteresis.
4. The current pressure values or the differential pressure values are shown on the LCD display and notified to the field bus or the network.

Pressure monitoring

If pressure diagnosis is activated, limit value overruns or underruns (dependent on the parameterisation) are shown on the LCD display with ↑ or ↓ and notified via the field bus or the network (see section 7.5.1).

7.4.3 Parameters of the pressure sensor module type CPX-4AE-P

The following table shows an overview of the parameters of the pressure sensor module CPX-4AE-P. The Tab. 7/3 to Tab. 7/6 show detailed information.

Function number [1]	Parameters of the pressure sensor module
4828 + m * 64 + **0**	Monitoring parameterisation errors
4828 + m * 64 + **6**	Unit for pressure specifications (limit values, hysteresis, current pressure values)
	Differential pressure calculation setting
	Sensor limit diagnostics setting
4828 + m * 64 + **7** 4828 + m * 64 + **8**	Hysteresis Low Byte Hysteresis High Byte
4828 + m * 64 + **9**	Measured value smoothing
4828 + m * 64 + **10**	Delay for pressure diagnostics
4828 + m * 64 + **11**	Activate and set limit value monitoring
4828 + m * 64 + **12** 4828 + m * 64 + **13** 4828 + m * 64 + **14** 4828 + m * 64 + **15** 4828 + m * 64 + **16** 4828 + m * 64 + **17** 4828 + m * 64 + **18** 4828 + m * 64 + **19**	Channel 0: Lower limit value Low Byte Channel 0: Lower limit value High Byte Channel 1: Lower limit value Low Byte Channel 1: Lower limit value High Byte Channel 2: Lower limit value Low Byte Channel 2: Lower limit value High Byte Channel 3: Lower limit value Low Byte Channel 3: Lower limit value High Byte
4828 + m * 64 + **20** 4828 + m * 64 + **21** 4828 + m * 64 + **22** 4828 + m * 64 + **23** 4828 + m * 64 + **24** 4828 + m * 64 + **25** 4828 + m * 64 + **26** 4828 + m * 64 + **27**	Channel 0: Upper limit value Low Byte Channel 0: Upper limit value High Byte Channel 1: Upper limit value Low Byte Channel 1: Upper limit value High Byte Channel 2: Upper limit value Low Byte Channel 2: Upper limit value High Byte Channel 3: Upper limit value Low Byte Channel 3: Upper limit value High Byte
[1] m = module number (0 ... 47)	

Tab. 7/2: Overview of the parameters of the pressure sensor module CPX-4AE-P

Module parameter: Monitoring parameterisation errors		**Handheld**
Function no.	4828 + m * 64 + **0** m = module number (0 ... 47)	
Description	Monitors the parameterisation of the module (plausibility checking of the values set for limits and hysteresis) An error message is generated for the following implausible settings: – Upper limit value < lower limit value – CPX-4AE-P-**D10**: upper limit value > 10000 or < 55536 [1] lower limit value > 10000 or < 55536 [1] – CPX-4AE-P-**B2**: upper limit value > 2000 or < 63536 [2] lower limit value > 2000 or < 63536 [2] – Hysteresis < 0 or > (upper limit value – lower limit value)	
Bit	Bit 7	[Monitor parameters]
Values	Bit 7 Setting: 0 inactive 1 active (default)	
1) Process value (corresponds to -10000 mbar) 2) Process value (corresponds to -2000 mbar)		

Tab. 7/3: Monitoring parameterisation errors

Module parameter: unit for pressure specifications, differential pressure calculation and sensor limit diagnostics settings		**Handheld**
Function no.	4828 + m * 64 + **6** m = module number (0 ... 47)	
Description	Sets: – Unit for pressure specifications – Whether and between which channels a differential pressure calculation is performed and displayed – Sensor limit diagnostics	
Bit	Bits 0, 1: Unit for pressure specifications Bits 2, 3: Differential pressure calculation setting Bits 4 ... 7: Sensor limit diagnostics setting	[Dimension unit] [Pressure difference calc.] [Monitor sensor limit]
Values	Bit 7 6 5 4 3 2 1 0 — Unit setting: — Resolution: x x x x x x 0 0 — mbar (default) 1) — 1 mbar/bit x x x x x x 0 1 — kPa — 1 kPa/bit x x x x x x 1 0 — psi — 0.1 psi/bit x x x x x x 1 1 — VZ + 15 Bit 1) Differential pressure calculation setting: x x x x 0 0 x x — no differential pressure calculation (default) x x x x 0 1 x x — Differential pressure display P0 – P1 on channel 0 x x x x 1 0 x x — Differential pressure display P2 – P3 on channel 2 Sensor limit diagnostics setting: x x x 1 x x x x — Sensor limit diag. active for channel 0 (default) x x 1 x x x x x — Sensor limit diag. active for channel 1 (default) x 1 x x x x x x — Sensor limit diag. active for channel 2 (default) 1 x x x x x x x — Sensor limit diag. active for channel 3 (default) 0 = inactive	
Note	**When changing the unit for pressure specifications, the parameters for the limit values and hysteresis are not automatically converted. When changing the unit, you must therefore also change the parameters for the upper/lower limit values and the hysteresis.**	
1) Process value for field bus; the pressure is shown in bar on the display		

Tab. 7/4: Parameterising the unit for pressure specifications, differential pressure calculation and sensor limit diagnostics settings

Sensor limit diagnostics

The direct pressure at the pressure sensor is monitored with the sensor limit diagnostics. If the pressure exceeds the specified limit value (see Technical appendix A.6), a diagnostics message is generated (see section 7.5.1).

Differential pressure calculation

You can configure the module so that the differential pressure between two channels is calculated and displayed. Both settings (P0 – P1 and P2 – P3) can be active simultaneously. The parameters for the configuration are named in Tab. 7/4.

Setting [1]	Display
No differential pressure calculation	Pressure values are displayed separately for each channel
Differential pressure P0 – P1 on channel 0	– Display channel 0: Differ.. pressure P0 – P1 [2] – Display channel 1: Pressure value channel P1
Differential pressure P2 – P3 on channel 2	– Display channel 2: Differ. pressure P2 – P3 [2] – Display channel 3: Pressure value channel P3
[1] See Tab. 7/4 [2] The 2nd value is subtracted from the 1st value for the calculation, even if the 2nd value is larger. The result is then negative.	

Tab. 7/5: Display of the differential pressure calculation

➔ **Note**
Take account of the overload pressure of the sensors for the differential pressure calculation.

Module parameter: Hysteresis		Handheld
Function no.	Hysteresis: m = module number (0 ... 47) 4828 + m * 64 + **7** (Low Byte) 4828 + m * 64 + **8** (High Byte)	
Description	This parameter defines the hysteresis behaviour **of all** channels for the pressure diagnosis (see Tab. 7/10). The data format is described in Tab. 7/11.	
Bit	Bit 0 ... 7: High byte or low byte of the hysteresis	[Hysteresis]
Values	Default setting: Hysteresis = 0 (Low Byte = 0; High Byte: 0) Minimum value: 0 Maximum value: Upper limit value – Lower limit value	
Note	The defined hysteresis value must not be larger than the difference between the upper and lower limit values. The hysteresis value is not checked for validity during parameterisation! Unsuitable parameterisations are adopted – in this case the module can react unexpectedly. Check the parameterisation! If the “Monitoring of parameterisation errors” module parameter is active, then a corresponding error is signaled. Tab. 7/3 shows the possible parameterisation errors.	

Tab. 7/6: Set hysteresis for all channels

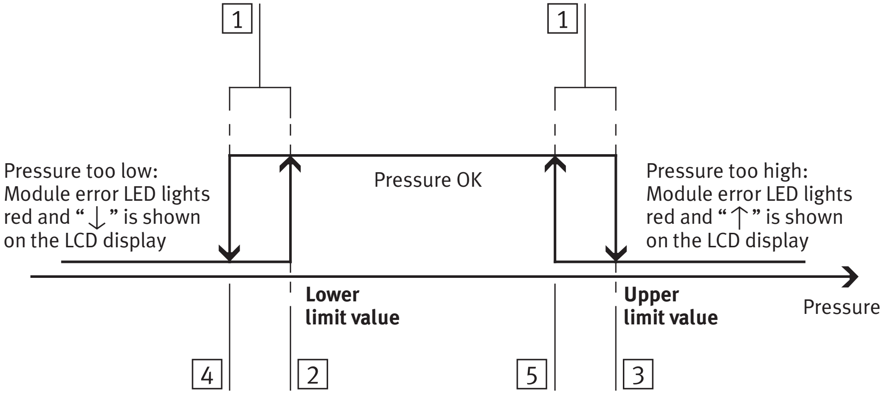
Hysteresis behaviour

If hysteresis is defined, then the pressure sensor module CPX-4AE-P behaves as follows (see also Fig. 7/4):

– The measured value must be less than the lower limit value minus the hysteresis before a diagnostic signal **occurs**.

– The measured value must be greater than the upper limit value plus the hysteresis before a diagnostic signal **occurs**.

The hysteresis behaviour provides you with more flexibility in setting the limit values. The hysteresis applies to all channels simultaneously.



1 Hysteresis

2 Defined lower limit value

3 Defined upper limit value

4 The actual pressure, defined by the hysteresis setting, at which the "Pressure is less than lower limit value" diagnostic message **occurs**

5 The actual pressure, defined by the hysteresis setting, at which the "Pressure is greater than upper limit value" diagnostic message **occurs**

Fig. 7/4: Hysteresis behaviour of the pressure sensor module CPX-4AE-P

Module parameter: Measured value smoothing		Handheld
Function no.	4828 + m * 64 + **9** m = module number (0 ... 47)	
Description	Sets the level of smoothing of measured values for limit value monitoring separately for each channel. This can suppress possible spurious values.	
Bit	Bits 0 ... 7	[Filter]
Values	P3 P2 P1 P0 P... = channel 0 ... 3 Bit 7 6 5 4 3 2 1 0 Setting: x x x x x x 0 0 no measured value smoothing, channel 0, (default) x x x x x x 0 1 smoothing over 2 values, channel 0 x x x x x x 1 0 smoothing over 4 values, channel 0 x x x x x x 1 1 smoothing over 8 values, channel 0 x x x x 0 0 x x no measured value smoothing, channel 1, (default) x x x x 0 1 x x smoothing over 2 values, channel 1 x x x x 1 0 x x smoothing over 4 values, channel 1 x x x x 1 1 x x smoothing over 8 values, channel 1 Setting corresponding to bits 4.5 and 6,7 for the channels 2 and 3	

Tab. 7/7: Setting the measured value smoothing channel by channel

Module parameter: Delay for pressure diagnosis		**Handheld**
Function no.	4828 + m * 64 + **10** m = module number (0 ... 47)	
Description	Defines the time delay separately for each channel before a message is generated when a limit value is exceeded or not reached. This avoids faulty diagnostic messages because the limit must be exceeded or not reached for somewhat longer before a diagnostic message is generated. Only the occurrence of the diagnosis is signaled delayed! When the pressure returns to the limit range, this is always signaled immediately.	
Bit	Bits 0 ... 7	[Diagnostic delay]
Values	P3 P2 P1 P0 — P... = channel 0 ... 3 Bit 7 6 5 4 3 2 1 0 — Setting: x x x x x x 0 0 — no delay (default) x x x x x x 0 1 — 40 ms, channel 0 x x x x x x 1 0 — 160 ms, channel 0 x x x x x x 1 1 — 640 ms, channel 0 x x x x 0 0 x x — no delay, channel 1 (default) x x x x 0 1 x x — 40 ms, channel 1 x x x x 1 0 x x — 160 ms, channel 1 x x x x 1 1 x x — 640 ms, channel 1 Setting corresponding to bits 4.5 and 6,7 for the channels 2 and 3	

Tab. 7/8: Setting the delay for pressure diagnosis channel by channel

Module parameter: Activate limit value monitoring		**Handheld**
Function no.	4828 + m * 64 + **11** m = module number (0 ... 47)	
Description	Defines which limit values are to be monitored.	
Bit	Bits 1, 0	[Monitor lower limit] [Monitor upper limit]
Values	Bit 1 0 Setting: 0 0 No limit value monitoring (default setting) 0 1 Monitoring of lower limit value 1 0 Monitoring of upper limit value 1 1 Monitoring of upper and lower limit values P3 P2 P1 P0 P... = channel 0 ... 3 Bit 7 6 5 4 3 2 1 0 Setting: x x x x x x 0 0 no limit value monitoring (default) x x x x x x 0 1 monitoring of lower limit value, channel 0 x x x x x x 1 0 monitoring of upper limit value, channel 0 x x x x x x 1 1 monitoring of upper + lower limit values, channel 0 x x x x 0 0 x x no delay, channel 1 (default) x x x x 0 1 x x monitoring of lower limit value, channel 1 x x x x 1 0 x x monitoring of upper limit value, channel 1 x x x x 1 1 x x monitoring of upper + lower limit values, channel 1 Setting corresponding to bits 4.5 and 6,7 for the channels 2 and 3	
Note	The limit value monitoring of the channels 0 ... 3 is performed independently from any specified differential pressure calculation.	

Tab. 7/9: Activate and set limit value monitoring channel by channel

Setting pressure values for limit values

Module parameter: Lower limit values / Upper limit values		Handheld
Function no.	Lower limit value: m = module number (0 ... 47) channel 0: 4828 + m * 64 + **12** (Low Byte) channel 0: 4828 + m * 64 + **13** (High Byte) channel 1: 4828 + m * 64 + **14** (Low Byte) channel 1: 4828 + m * 64 + **15** (High Byte) channel 2: 4828 + m * 64 + **16** (Low Byte) channel 2: 4828 + m * 64 + **17** (High Byte) channel 3: 4828 + m * 64 + **18** (Low Byte) channel 3: 4828 + m * 64 + **19** (High Byte) Upper limit value: channel 0: 4828 + m * 64 + **20** (Low Byte) channel 0: 4828 + m * 64 + **21** (High Byte) channel 1: 4828 + m * 64 + **22** (Low Byte) channel 1: 4828 + m * 64 + **23** (High Byte) channel 2: 4828 + m * 64 + **24** (Low Byte) channel 2: 4828 + m * 64 + **25** (High Byte) channel 3: 4828 + m * 64 + **26** (Low Byte) channel 3: 4828 + m * 64 + **27** (High Byte)	HB LB | 13	12 | | 15	14 | | 17	16 | | 19	18 | HB LB | 21	20 | | 23	22 | | 25	24 | | 27	26	
Description	The lower and upper limit values for the pressure diagnostics notifications are specified separately for each channel with these parameters. Undershooting or overshooting of limit values is only signaled if pressure diagnosis is activated via the the limit value monitoring parameter for the corresponding channel (see Tab. 7/9) and no parameterisation error exists.	
Bit	Bit 0 ... 7: High Byte or Low Byte of the limit values	[Lower limit] [Upper limit]
Values	Defaults for each channel CPX-4AE-P-**D10**: – lower limit values = -10000_d (Low Byte = $F0_h$; High Byte: $D8_h$) – upper limit values = $+10000_d$ (Low Byte = 10_h; High Byte: 27_h) Defaults for each channel CPX-4AE-P-**B2**: – lower limit values = -2000_d (Low Byte = 30_h; High Byte: $F8_h$) – upper limit values = $+2000_d$ (Low Byte = $D0_h$; High Byte: 07_h)	
Note	The limit values are not checked for validity during parameterisation! Unsuitable parameterisations are adopted – in this case, the module can react unexpectedly. Check the parameterisation! If the “Monitoring of parameterisation errors” module parameter is active, then a corresponding error is signaled. Tab. 7/3 shows the possible parameterisation errors.	

Tab. 7/10: Setting lower and upper limit values channel by channel

Data format for pressure specifications

The data format for setting and specifying pressure values via parameterisation is “VZ + 15 Bit”. Negative values are represented in twos-complement format.

Data format															
VZ + 15 Bit, negative values represented as twos-complement															
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
VZ	B14 MSB	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0 LSB
Abbreviations used: VZ: mathematical sign (0 = positive value, 1 = negative value) B0 ... B14: input value D0 ... D15: 16-bit input data field MSB/LSB: most significant bit / least significant bit															

Tab. 7/11: Data format for pressure specifications (limit values, hysteresis, current pressure and differential pressure)

The current pressure values are shown directly as a numeric value in the input word. Conversion or scaling is not required. The data can be input directly as numeric values with the handheld for setting the limit values and the hysteresis.

The unit for pressure specifications, defined via the parameter in Tab. 7/4, applies to all pressure values (upper/lower limit values, hysteresis, current pressure values and differential pressure values).

➔

Note
When changing the unit for pressure specifications, the parameters for the limit values and hysteresis are **not** automatically converted.

When changing the unit, you must therefore also change the parameters for the upper and lower limit values and the hysteresis.

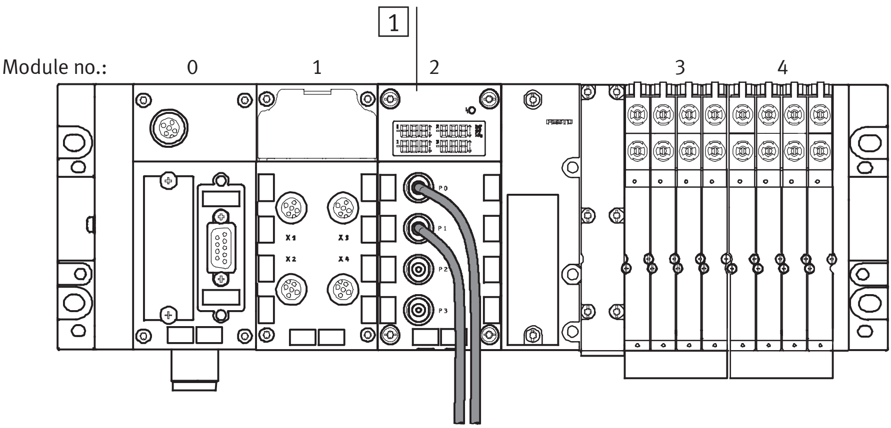
Note
For the fieldbus node CPX-FB13 (PROFIBUS-DP) the byte sequence with which the analogue values are transferred to the controller can be reversed by parameterising the value "Analogue process value representation":

– Factory setting: LSB-MSB (INTEL format)
– Reversal: MSB-LSB (MOTOROLA format)

Check this setting in the bus node if you obtain implausible values; also refer to the CPX-FB13 description in chapter 2 under the section entitled "Parameters of CPX-FB13".

7.4.4 Parameterisation example

An example parameterisation of the pressure sensor module CPX-4AE-P-D10 is shown in the following.



1 Pressure sensor module CPX-4AE-P, with module number 2 in the example

Fig. 7/5: Parameterisation example for pressure sensor module CPX-4AE-P-D10

The following parameters for the pressure sensor module CPX-4AE-P-D10 in Fig. 7/5 are changed:

Parameter	**Function no.** [1]	**Setting**	**Values** [2]	**Values** [3] Bit 7... 0
Unit for pressure specifications Differential pressure calculation Sensor limit diagnostics	4956 + 6 = **4962**	mbar [4] Differential pressure display P0 – P1 active for channels 0 and 1		00**110100**$_b$
Hysteresis Low Byte Hysteresis High Byte	4956 + 7 = **4963** 4956 + 8 = **4964**	500 mbar	F4$_h$ 01$_h$	11110100$_b$ 00000001$_b$
Measured value smoothing	4956 + 9 = **4965**	For P0 and P1: Smoothed over 2 values		0000**0101**$_b$
Delay for pressure diagnostics	4956 + 10 = **4966**	For P0 and P1: 160 ms		0000**1010**$_b$
Activate limit value monitoring	4956 + 11 = **4967**	For P0 and P1: Monitor the upper and lower limit values		0000**1111**$_b$
Lower limit value P0 Low Byte Lower limit value P0 High Byte	4956 + 12 = **4968** 4956 + 13 = **4969**	7000 mbar	58$_h$ 1B$_h$	01011000$_b$ 00011011$_b$
Lower limit value P1 Low Byte Lower limit value P1 High Byte	4956 + 14 = **4970** 4956 + 15 = **4971**	7000 mbar	58$_h$ 1B$_h$	01011000$_b$ 00011011$_b$
Upper limit value P0 Low Byte Upper limit value P0 High Byte	4956 + 16 = **4972** 4956 + 17 = **4973**	9500 mbar	1C$_h$ 25$_h$	00011100$_b$ 00100101$_b$
Upper limit value P1 Low Byte Upper limit value P1 High Byte	4956 + 18 = **4974** 4956 + 19 = **4975**	9500 mbar	1C$_h$ 25$_h$	00011100$_b$ 00100101$_b$

[1] The function numbers are produced using the module number 2 (see Fig. 7/5) and from the calculation 4828 + 2 * 64 + x = 4956 + x (x: see tables in section 7.4.3).
[2] Hexadecimal, can be useful with numerical values as an intermediate step for calculating the binary values
[3] Binary values
[4] Process values are transmitted in mbar; bar values are shown on the LCD display

Tab. 7/12: Example: Setting parameters for pressure sensor module CPX-4AE-P using function numbers

In this example, the settings for all other parameters remain at their default values.

With the settings from Tab. 7/12, the CPX-4AE-P behaves as follows:

– Display of the differential pressure P0 – P1 on the display of channel 0 and P1 on the display of channel 1.

– Sensor limit diagnostics active for P0 and P1.

– Measured value smoothing over 2 values for P0 and P1.

– Pressure undershooting or overshooting is signaled after a delay of 160 ms. Pressure undershooting or overshooting for periods less than 160 ms are not signaled.

– Diagnostics messages for channels P0 and P1 on the LCD display with the respective display ↑ of the corresponding channel above 9.5 bar.
The indicator ↑ goes out as soon as the pressure drops below 9 bar (because the hysteresis is set to 0.5 bar).

– Diagnostics messages for channels P0 and P1 on the LCD display with the display of the respective ↓ of the corresponding channel below 6.5 bar (because the hysteresis is set to 0.5 bar).
The indicator ↓ goes out as soon as the pressure rises above 7 bar.

7.5 Diagnosis

Specific errors of the pressure sensor module are reported or suppressed depending on the module parameterisation.

The errors are shown locally using the Module Error LED or on the LCD display (see Fig. 7/6) and can be evaluated with the handheld device if necessary.

Depending on the module parameterisation, the errors are sent to the bus node and can be evaluated there depending on the protocol used.

The representation of the errors in the various bus nodes depends on the protocol (see manual for the bus node).

7.5.1 Error messages of the pressure sensor module CPX-4AE-P

The pressure sensor module CPX-4AE-P can notify the following errors:

Error number	Description [1]	Error handling
9	**Limit value underrun**	• Check compressed air supply • Check the parameterisation (see Tab. 7/9 and Tab. 7/10) • Undertake planned remedy
10	**Limit value overrun**	
27	**Incorrect device type fitted**	• Servicing required
29	**Parameterisation error** [2] An error has occurred in the setting of a parameter (monitored parameters: see Tab. 7/3).	• Check the parameterisation made and if necessary make the parameterisation again with the correct parameters (valid parameters see Tab. 7/2)
51	**Sensor limit diagnostics** Physical limit value of a sensor has been exceeded – Process value invalid (see error number 55) The output measured value no longer corresponds to the physical pressure present – Hardware damage is possible	• Ensure that the maximum permitted pressure is not exceeded • Check module for damage; replace if necessary
55	**Invalid process value** Creation of the process value is not valid: e.g. during the differential pressure calculation (see Tab. 7/5), if the sensor limit diagnostics are signaled for one of the pressure sensors.	• See error number 51

[1] The module will register the appropriate error depending on the parameterisation. However, the input signals will be processed further.
[2] The (faulty) parameters entered will be ignored; the module operates with the last valid parameters.

Tab. 7/13: Error messages of the pressure sensor module CPX-4AE-P

7.5.2 LCD display and LED indicators

The local diagnostics are performed using the LED indicators and the LCD display.

1 Module error LED (red)

2 LCD display (blue)

3 Arrows for limit value overrun/underrun

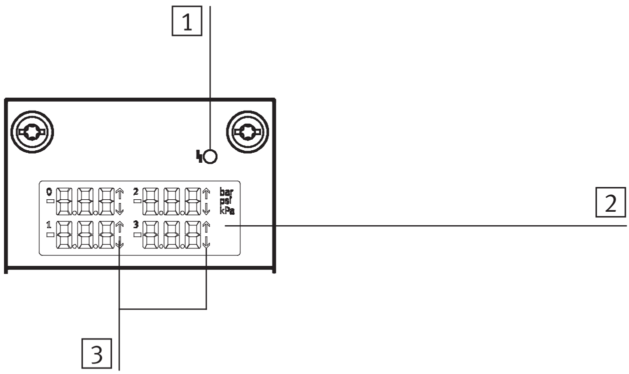


Fig. 7/6: Displays of pressure sensor module CPX-4AE-P

Error LED

The red error LED indicates channel or module errors depending on the parameterisation.

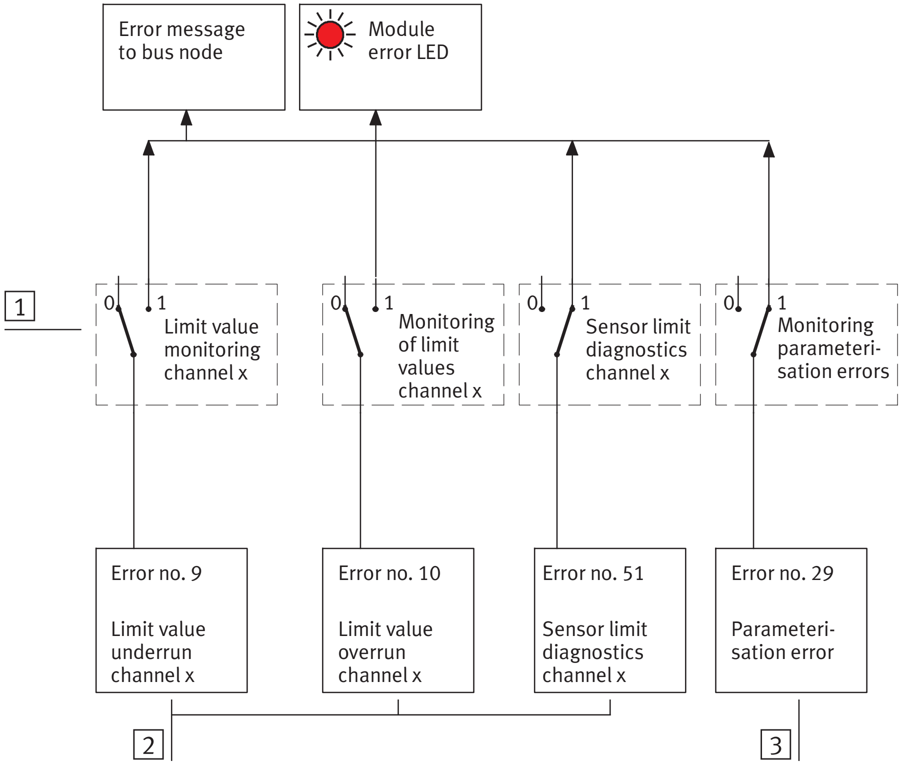
Module error LED	LCD display	Status	Error number	Error handling
LED is off	Pressure values	Trouble-free operation	–	None
LED lights	↓ next to the pressure values	**Limit value underrun** Specified limit value not reached	9	See Tab. 7/13
	↑ next to the pressure values	**Limit value overrun** Specified limit value exceeded	10	
	"Err" flashes 1)	**Sensor limit diagnostics**	51	
	Maximum value	**Invalid process value**	55	
	–	**Parameterisation error**	29	
	–	**Incorrect device type fitted**	27	
	–	**Module defective**	15	Check module; replace if necessary

1) In the case of sensor limit diagnostics, the corresponding channel in the display flashes alternately between "Err" and "1_._"

Tab. 7/14: Module error LED of the pressure sensor module CPX-4AE-P

7.5.3 Error handling and parameterisation

The following diagram shows the error handling principle in the pressure sensor modules. With the appropriate parameters, shown as switches in the diagram, further registering and display of errors can be suppressed as desired.



1 Parameterisation (switch position shown = default setting)

2 Channel-specific module errors

3 Module error

Fig. 7/7: Principle of error handling and parameterisation of the CPX-4AE-P

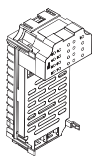
Analogue output module CPX-2AA-U-I

Chapter 8

Contents

8.1 Function of the analogue output modules

Analogue output modules provide analogue voltage outputs or current outputs in the valve terminal for connecting actuators and other current-consuming devices (e.g. proportional directional control valves). At present the following type is available:

Type		**Description**
	CPX-2AA-U-I	This type provides 2 analogue outputs (output channels) with scalable value ranges. The output signal range can be configured channel by channel, either electrically isolated or non-floating: – 0 ... 10 V – 0 ... 20 mA – 4 ... 20 mA Actuator supply 24 V / 2.8 A per module.

Tab. 8/1: Overview of analogue output modules CPX-2AA-U-I

8.2 Fitting

See section 1.3.

8.3 Installation

Warning
Unintentional movement of the connected actuators and uncontrollable movements of loose tubing can cause injury to human beings or damage to property.

Before carrying out installation and maintenance work, switch off the following:

- the compressed air supply
- the operating and load voltage supplies.

In the following sections you will find the pin allocation of the analogue output modules for the different sub-bases.

Instructions on connecting the cables and plugs to the sub-bases can be found in section 1.2.3.
Note in particular the instructions on connecting the cable screening to functional earth (FE).

Power supply

The supply for the output channels as well as the 24 V supply for the electronics of the output modules is provided via the operating voltage supply for the electronics/sensors ($V_{EL/SEN}$).

The 24 V supply for the actuators is provided via the load voltage supply for the outputs of the CPX terminal (V_{OUT}).

The actuators can also be supplied externally (electrical isolation, see section 8.3.3, Fig. 8/2).

8.3.1 DIL switch settings

2 DIL switches are available for configuring the analogue output modules. These are located on the top of the electronic module.

1 DIL switch 0: Signal range of analogue output 0

2 DIL switch 1: Signal range of analogue output 1

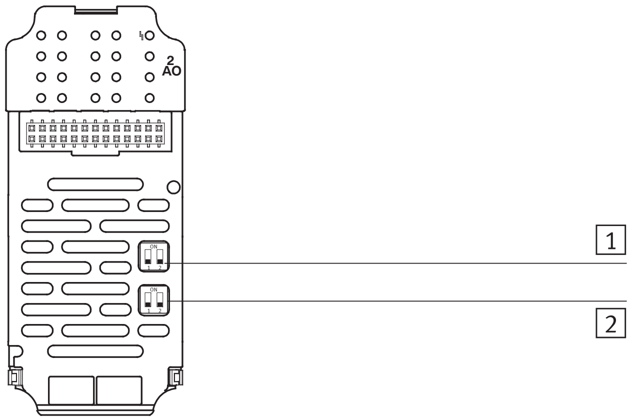
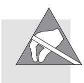


Fig. 8/1: DIL switches in the electronic module (further information on 1 and 2 see following pages)

Proceed as follows:

1. Switch off the power supply.



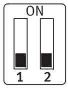
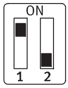
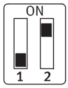
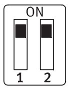
2. Remove if necessary the fitted sub-base (see “Fitting” section 1.3).

3. Set the DIL switch elements in accordance with the instructions on the following pages.

4. Refit the sub-base if necessary (see “Fitting” section 1.3, tightening torque 0.9 ... 1.1 Nm).

Setting the output signal range

You can set the signal range of the relevant analogue output with the 2-element DIL switches 0 and 1.

Signal range	**Setting the DIL switches** [1]		
	Setting	**DIL switch 0**	**DIL switch 1**
0 ... 10 V		0.1: OFF [2] 0.2: OFF [2]	1.1: OFF [2] 1.2: OFF [2]
		0.1: ON 0.2: OFF	1.1: ON 1.2: OFF
0 ... 20 mA		0.1: OFF 0.2: ON	1.1: OFF 1.2: ON
4 ... 20 mA		0.1: ON 0.2: ON	1.1: ON 1.2: ON

[1] DIL switch 0 for output channel 0
DIL switch 1 for output channel 1
[2] Default (factory setting)

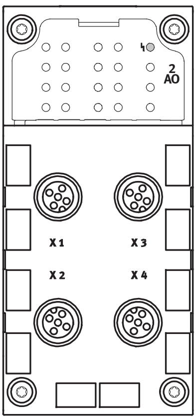
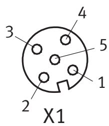
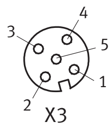
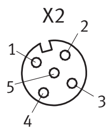
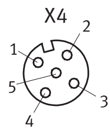
Tab. 8/2: DIL switches of the analogue output module

→

Note
The setting of the signal range with the DIL switches can be modified by means of parameterisation (see section 8.4). Parameterisation has precedence over the DIL switch setting.

8.3.2 Pin allocation

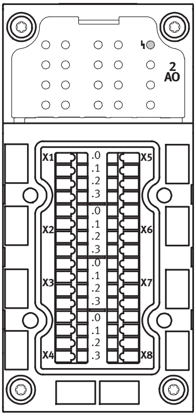
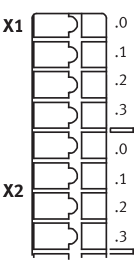
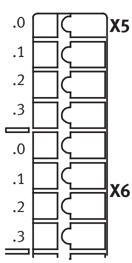
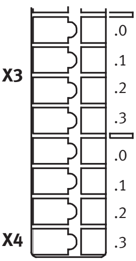
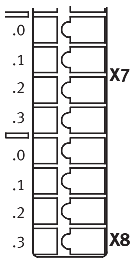
Pin allocation of CPX-2AA-U-I with sub-base CPX-AB-4-M12x2-5POL(-R)

Analogue output module type CPX-2AA-U-I with sub-base CPX-AB-4-M12x2-5POL(-R)		
Sub-base	**Pin allocation X1, X2 (output O...0)**	**Pin allocation X3, X4 (output O...1)**
	Voltage outputs [1]	
	 Socket X1: 1: 24 V_{OUT} 2: OU0+ 3: 0 V_{OUT} 4: OGND 5: Screening (FE) [2]	 Socket X3: 1: 24 V_{OUT} 2: OU1+ 3: 0 V_{OUT} 4: OGND 5: Screening (FE) [2]
	Current outputs [1]	
	 Socket X2: 1: 24 V_{OUT} 2: OI0+ 3: 0 V_{OUT} 4: OGND 5: Screening (FE) [2]	 Socket X4: 1: 24 V_{OUT} 2: OI1+ 3: 0 V_{OUT} 4: OGND 5: Screening (FE) [2]
	OUx+ = Positive voltage output signal OIx+ = Positive current output signal OGND = Reference potential for the analogue output signals FE = Functional earth	
[1] Allocation depends on the DIL switch setting and on parameterisation (see section 8.3.1), a total of 2 output channels are available per module (O...0 and O...1, connection X1 or X2 as well as connec-tion X3 or X4). [2] With CPX-AB-4-M12x2-5POL-R the metal thread is connected to FE		

Tab. 8/3: Pin allocation of analogue output module type CPX-2AA-U-I with sub-base CPX-AB-4-M12x2-5POL(-R)

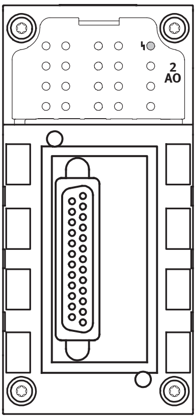
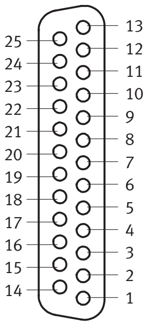
CPX-AB-4-M12x2-5POL**-R** The metal thread ("...-R") of this sub-base is connected internally with pin 5 (Functional earth FE).

Pin allocation of CPX-2AA-U-I with sub-base CPX-AB-8-KL-4POL

Analogue output module type CPX-2AA-U-I with sub-base CPX-AB-8-KL-4POL		
Sub-base	**Pin allocation X1 ... X4 (output O...0)**	**Pin allocation X5 ... X8 (output O...1)**
	Voltage outputs [1]  X1.0: 24 V_{OUT} X1.1: 0 V_{OUT} X1.2: OGND X1.3: Screening (FE) X2.0: n.c. X2.1: n.c. X2.2: OU0+ X2.3: Screening (FE)	 X5.0: 24 V_{OUT} X5.1: 0 V_{OUT} X5.2: OGND X5.3: Screening (FE) X6.0: n.c. X6.1: n.c. X6.2: OU1+ X6.3: Screening (FE)
	Current outputs [1]  X3.0: 24 V_{OUT} X3.1: 0 V_{OUT} X3.2: OGND X3.3: Screening (FE) X4.0: n.c. X4.1: n.c. X4.2: OI0+ X4.3: Screening (FE)	 X7.0: 24 V_{OUT} X7.1: 0 V_{OUT} X7.2: OGND X7.3: Screening (FE) X8.0: n.c. X8.1: n.c. X8.2: OI1+ X8.3: Screening (FE)
	OUx+ = Positive voltage output signal OIx+ = Positive current output signal OGND = Reference potential for the analogue output signals n.c. = Not connected FE = Functional earth	
[1] Allocation depends on the DIL switch setting and on parameterisation (see section 8.3.1), a total of 2 output channels are available per module (O...0 and O...1, connection X1/X2 or X3/X4 as well as connection X5/X6 or X7/X8).		

Tab. 8/4: Pin allocation of analogue output module type CPX-2AA-U-I with sub-base CPX-AB-8-KL-4POL

Pin allocation of CPX-2AA-U-I with sub-base CPX-AB-1-SUB-BU-25POL

Analogue output module type CPX-2AA-U-I with sub-base CPX-AB-1-SUB-BU-25POL			
Sub-base	**Pin allocation [1)]**		
		1: OGND 2: OU0+ 3: OGND 4: OI0+ 5: n. c. 6: n. c. 7: n. c. 8: n. c. 9: 24 V_{OUT} 10: 24 V_{OUT} 11: 0 V_{OUT} 12: 0 V_{OUT} 13: FE	14: OGND 15: OU1+ 16: OGND 17: OI1+ 18: 24 V_{OUT} 19: n. c. 20: 24 V_{OUT} 21: n. c. 22: 0 V_{OUT} 23: 0 V_{OUT} 24: 0 V_{OUT} 25: FE Housing: FE (screening)
	Pins 1/2, 14/15 = Voltage outputs Pins 3/4, 16/17 = Current outputs OUx+ = Positive voltage output signal OIx+ = Positive current output signal OGND = Reference potential for the analogue output signals n.c. = Not connected FE = Functional earth		
[1)] Allocation depends on the DIL switch setting and on parameterisation (see section 8.3.1), a total of 2 output channels are available per module (O...0 and O...1).			

Tab. 8/5: Pin allocation of analogue output module type CPX-2AA-U-I with sub-base CPX-AB-1-SUB-BU-25POL

8.3.3 Connecting the analogue outputs

Only screened cables are usually permitted for the transmission of analogue signals (see section 1.2.3).

1 Without electrical isolation: The actuators are supplied via the CPX module

2 With electrical isolation: Without actuator supply or if an external actuator supply is used

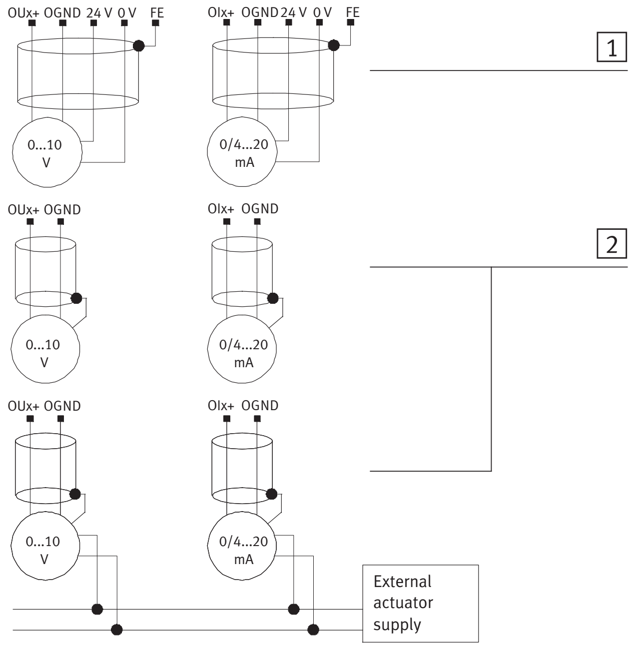


Fig. 8/2: Examples of analogue output connections (screening connection on FE pin)

Further connection examples can be found in appendix A.7.1.

8.4 Instructions on commissioning

8.4.1 Processing analogue output signals

The analogue values are transmitted from the control system to the CPX terminal as output words (2 bytes, 16 bits). Each analogue output module occupies 2 output words for this in the address range.

The position of the output words in the address range depends on the field bus used (see manual for the field bus node).

Parameterisation

The data format as well as the limit values and, where applicable, also the scaling of the analogue output signals can be adapted by means of parameterisation. Instructions on this can be found in the sections 8.4.2 and 8.4.3.

The reaction with the default settings is described below.

Reaction with the default settings

The module parameter "Output analogue-value data format" possesses the default setting "VZ + 12 bits right-justified" (compatible with valve terminal type 03). With this setting the output words will be output as analogue values as follows:

Data format "VZ + 12 bits right-justified" (compatible with valve terminal type 03)															
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
VZ	0	0	0	B11 MSB	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0 LSB
Abbreviations used: VZ: Sign (with data format "VZ + 12 bits right-justified" always = 0, i.e. a positive value) B0 ... B11: Output value D0 ... D15: 16 bits output data field MSB/LSB: Most significant bit / least significant bit															

Tab. 8/6: Data format "VZ + 12 bits right-justified"

The channel-specific parameters "Lower limit" and "Upper limit" possess the following default settings:

– Lower limit = 0

– Upper limit = 4095

These correspond to the scaling end values (data range) of the default data format.

The following diagram shows the processing of the output words with the default data format “VZ + 12 bits right-justified”.

1 Lower limit of rated range

2 Digital output value (example)

3 Upper limit of rated range

4 Digital output values

5 Assigned analogue signals

6 Output voltage or current

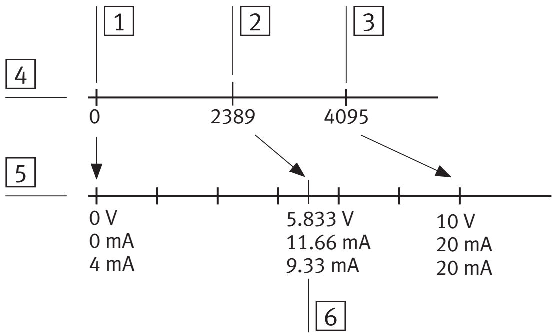


Fig. 8/3: Example of default data format “VZ + 12 bits right-justified”

The allocation of the digital value range and the analogue output signal ranges is shown in the table below.

Digital data preparation		**Analogue output signal range**		
Output data	**Output values**	**0 ... 10 V**	**0 ... 20 mA**	**4 ... 20 mA**
Output value > 4095	Rated range exceeded	Output of last valid value		
Output value 4095	Linear value range	9.9975 V	19.995 mA	19.995 mA
Output value 1 ... 4094		...	...	...
Output value 0		0 V	0 mA	4 mA
Output value < 0	Value less than rated range	Output of last valid value		

Tab. 8/7: Output signals of the analogue output modules with default settings

8.4.2 General information on parameterisation

The reaction of the analogue output modules can be parameterized.

Further information on parameterisation can be found in the system manual or in the manual for the field bus node.

Due to in some cases necessary calculations, modified parameters are not valid until they have been thoroughly checked and saved. Until then, as in the case of invalid parameters, the previous settings apply.

Depending on the parameter, no valid analogue values are available for up to max. 30 ms after a value modification.

Specific instructions for the prevention of parameterisation errors

In order to prevent parameterisation errors, note the sequence described below for modifying the following parameters:

- Output analogue-value data format
- Lower limit channel x
- Upper limit channel x

Sequence for first or startup parameterisation (CPX terminal in delivery status, monitoring of parameterisation errors active):

1. First set the desired data format (parameter “Output analogue-value data format”).
2. Then set the upper and lower limits for both channels:
   - If the new upper limit value is positive, set first the upper limit; then the lower limit.
   - If the new upper limit is negative (only in the case of data format “VZ + 15 bits linear scaled”), set first the lower limit, then the upper limit.

Sequence for modifying the parameterisation:

1. Activate, if applicable, the monitoring of parameterisation errors (module parameter “Monitoring CPX modules – monitoring parameterisation errors” and channel-specific module parameter “Monitoring channel x – monitoring parameterisation errors”).
2. Set the lower limit to 0 and the upper limit to 4095 for both channels.
3. Then set the desired data format (parameter “Output analogue-value data format”).
4. If required, then set the upper and lower limits for both channels:
   - If the new upper limit value is positive, set first the upper limit; then the lower limit.
   - If the new upper limit is negative (only in the case of data format “VZ + 15 bits linear scaled”), set first the lower limit, then the upper limit.

8.4.3 Parameter with analogue output module type CPX-2AA-U-I

The tables below give an overview of the module parameters of the analogue output modules.

Function number [1]	Module parameters
4828 + m * 64 + **0**	Monitoring the CPX module
4828 + m * 64 + **1**	Reaction after short circuit/overload
4828 + m * 64 + **2**	Reserved
4828 + m * 64 + **3**	Output analogue-value data format
[1] m = module number (counting from left to right, beginning with 0)	

Tab. 8/8: Overview – Module parameters

Function number [1]	Channel-specific module parameters
4828 + m * 64 + **6**	Monitoring channel 0
4828 + m * 64 + **7**	Monitoring channel 1
4828 + m * 64 + **8**	Signal range channel 0/1
4828 + m * 64 + **9/10**	Lower limit channel 0
4828 + m * 64 + **11/12**	Lower limit channel 1
4828 + m * 64 + **13/14**	Upper limit channel 0
4828 + m * 64 + **15/16**	Upper limit channel 1
– [2]	Fail safe channel x (see also CPX system manual)
– [2]	Idle mode channel x (see also CPX system manual)
– [2]	Force channel x (see also CPX system manual)
[1] m = module number (counting from left to right, beginning with 0) [2] Access is protocol-specific (see manual for field bus node)	

Tab. 8/9: Overview – Channel-specific module parameters

Description of the parameters

Module parameters: Monitoring the CPX module	
Function no.	4828 + m * 64 + **0** m = module number (0 ... 47)
Description	With the analogue output modules, monitoring of individual errors can be activated or deactivated (suppressed) independently of each other. Active monitoring causes the following: The error is: – sent to the CPX field bus node – displayed by the module common error LED.
Bit	Bit 0: reserved Bit 1: monitoring actuator supply (short circuit/overload or undervoltage) Bit 2 ... 6: reserved Bit 7: monitoring parameterisation errors
Values	1 = active (presetting); 0 = inactive
Comment	– Monitoring short circuit at outputs: Monitoring can also be set for the complete CPX terminal (see CPX system manual, system parameter “Monitoring”). – Monitoring parameterisation errors: Some parameters are checked for inadmissible values during parameterisation: – Data format – Lower limit – Upper limit With the exception of the parameter “Data format”, the setting of the module parameter “Monitoring parameterisation errors” is only effective if the appropriate channel parameter “Monitoring parameterisation errors” is set to “active”.

Tab. 8/10: Monitoring the CPX module

Module parameters: Behaviour after short circuit/overload	
Function no.	4828 + m * 64 + **1** m = module number (0 ... 47)
Description	Determines after a short circuit at an output or in the actuator supply whether the power is to remain switched off or whether it is to be switched on again automatically.
Bit	Bit 0: reserved Bit 1: behaviour after short circuit at an output (short circuit/overload in actuator supply) Bit 2: reserved Bit 3: behaviour after short circuit/overload at analogue output Bit 4 ... 7: reserved
Values	0 = Leave voltage/current switched off 1 = Switch voltage/current on again Presetting bit 1: 1 (switch voltage on again) Presetting bit 3: 0 (leave voltage/current switched off)
Comment	With the setting "Leave voltage/current switched off", Power off/on is necessary for switching the power on again. Ascertain which setting is necessary for reliable operation of your machine or system. Further information can be found in section 8.5.1.

Tab. 8/11: Behaviour after short circuit/overload

Module parameters: Output analogue-value data format	
Function no.	4828 + m * 64 + **3** m = module number (0 ... 47)
Description	Determines the format in which the digital output words from the output module are interpreted for the analogue output signals.
Bit	Bit 0 ... 3: reserved (= 0) Bit 4, 5: output analogue-value data format Bit 6, 7: reserved (= 0)
Values	Bit 5 Bit 4 0 0 VZ + 15 bits linear scaled 0 1 VZ + 12 bits right-justified (compatible with valve terminal type 03, presetting) 1 0 VZ + 15 bits left-justified, linear scaled (Simatic S7) 1 1 VZ + 12 bits left-justified + diagnosis (Simatic S5) (VZ = sign)
Comment	The reserved bits 0 ... 3 and 6, 7 must always be 0. If one or several bits are set to “1” during parameterisation, the parameterisation carried out is invalid and therefore not effective. If the module parameter “Monitoring parameterisation errors” is set to “active”, the relevant error will be displayed. Further information on this parameter can be found in section 8.4.4.

Tab. 8/12: Output analogue-value data format

Channel parameters: Monitoring channel x	
Function no.	4828 + m * 64 + **6** (channel 0) m = module number (0 ... 47) 4828 + m * 64 + **7** (channel 1)
Description	For the individual channels of the analogue output modules, monitoring of individual errors can be activated or deactivated (suppressed) independently of each other. Active monitoring causes the following: The error is: – sent to the CPX field bus node – displayed by the module common error LED. Further infomation on these monitorings can be found under the description of the relevant error in section 8.5.1.
Bit	Bit 0: monitoring lower limit Bit 1: monitoring upper limit Bit 2: behaviour after short circuit/overload at analogue output Bit 3: monitoring wire break/idling Bit 4 ... 6: reserved Bit 7: monitoring parameterisation errors
Values	1 = active; 0 = inactive Presetting bit 0 ... 2: 1 (active) Presetting bit 3: 0 (inactive) Presetting bit 7: 1 (active)
Comment	– Monitoring the upper/lower limit: Monitoring the output values on the range limits defined with the parameters “Lower limit ...” as well as “Upper limit ...” (depending on the data format used, see sections 8.4.4 and 8.4.5). – Monitoring short circuit/overload at output: Only effective for the signal range 0 ... 10 V. – Monitoring wire break (idling): Only effective for the signal range 0/4 ... 20 mA. Wire break monitoring is only effective if more than approx. 1 mA output current is output. – Monitoring parameterisation errors: The channel specific parameters “Lower limit” and “Upper limit” are checked for inadmissible values during parameterisation. The setting of the channel parameter “Monitoring parameterisation errors” is only effective if the module parameter “Monitoring parameterisation errors” is set to “active”.

Tab. 8/13: Monitoring channel x

Channel parameters: Signal range channel x	
Function no.	4828 + m * 64 + **8** m = module number (0 ... 47)
Description	For the individual channels of the analogue output modules, the signal ranges of the analogue outputs can be set independently of each other.
Bit	Bit 0/1: setting of DIL switch 0 for channel 0 (read only) switch 0.1 = bit 0 switch 0.2 = bit 1 Bit 2/3: signal range channel 0 (AO0) Bit 4/5: setting of DIL switch 1 for channel 1 (read only) switch 1.1 = bit 4 switch 1.2 = bit 5 Bit 6/7: signal range channel 1 (AO1)
Values	Channel 0 / Channel 1 Bit 3 Bit 2 / Bit 7 Bit 6 0 0 0 0 Using the setting of the DIL switches (presetting) 0 1 0 1 0 ... 10 V 1 0 1 0 0 ... 20 mA 1 1 1 1 4 ... 20 mA
Comment	Bits 0/1 as well as 4/5 represent the status of the DIL switches for setting the signal ranges. With bits 2/3 and 6/7 other signal ranges can be parameterized irrespective of the DIL switch setting. Modified parameter settings have precedence over the DIL switch settings. The setting of the DIL switches is carried out with the presetting (bit 2/3 = 0; bit 6/7 = 0).

Tab. 8/14: Signal range channel x

Channel parameters: Lower limit channel x / Upper limit channel x	
Function no.	Lower limits: m = module number (0 ... 47) 4828 + m * 64 + **9** (channel 0, low byte) 4828 + m * 64 + **10** (channel 0, high byte) 4828 + m * 64 + **11** (channel 1, low byte) 4828 + m * 64 + **12** (channel 1, high byte) Upper limits: 4828 + m * 64 + **13** (channel 0, low byte) 4828 + m * 64 + **14** (channel 0, high byte) 4828 + m * 64 + **15** (channel 1, low byte) 4828 + m * 64 + **16** (channel 1, high byte)
Description	A lower limit can be set for the individual channels of the analogue output modules (see section 8.4.5).
Bit	Bit 0 ... 7: high byte or low byte of the limit value
Values	Presettings: – Lower limit = 0 (low byte = 0; high byte: 0) – Upper limit = 4095 (low byte = 255; high byte: 15) Low byte: 0 ... 255 High byte: 0 ... 15
Comment	The output signals which are output are always limited to the parameterized values. If the output value is less than the parameterized lower limit or exceeds the parameterized upper limit, an appropriate error is displayed (providing the relevant channel parameter “Monitoring channel x – monitoring lower limit” or “Monitoring channel x – monitoring upper limit” is active). The upper limit must always be greater than the lower limit. Modifications to the limits must be made in steps of 16 bits. Permitted limits: The limits are checked for validity during parameterisation. Invalid parameterisations are not accepted – the module uses the previous (last valid) parameterisation. The permitted values depend on the parameterized data format (see section 8.4.5). If the module parameter “Monitoring parameterisation errors” as well as the relevant channel parameter “Monitoring parameterisation errors” is set to “active”, the relevant error will be displayed.

Tab. 8/15: Lower and upper limits channel x

Module parameters: Fail safe channel x	
Function no.	Access to these module parameters is made via protocol-specific functions (see the manual for the field bus node).
Description	With the aid of the so-called Fail safe parameterisation, you can specify the signal status which the outputs are to assume in the event of field bus communication faults (see also CPX system manual). This can be accomplished with the following parameters: – Fault mode channel x – Fault state channel x
Values	– Fault mode channel x: 0 = Hold last state 1 = Fault state (presetting) – Fault state channel x: 0 = Reset value (presetting) 1 = Set value
Comment	Parameterisation of the fault mode for an analogue output channel depends on the field bus protocol and is carried out: – by an individual parameter setting or bit (e.g. CPX-FB11), – by setting all parameter bits of the relevant word (e.g. CPX-FB6) to "Hold last state" or "Fault state". For parameterisation the Fault state, the desired output word must be correspondingly mapped in the parameter bits "Fault state channel x". The Fail safe reaction is determined for the complete CPX terminal by means of the system parameter "Fail safe" (see CPX system manual).

Tab. 8/16: Fail safe channel x (channel-specific)

Module parameters: Idle mode channel x	
Function no.	Access to these module parameters is made via protocol-specific functions (see the manual for the field bus node).
Description	The Idle mode parameterisation is only relevant with certain field bus protocols. With the aid of the so-called Idle mode, you can determine the signal status which the outputs are to assume when the Idle function is accessed (see also CPX system manual). This can be accomplished with the following parameters: – Idle mode channel x – Idle state channel x
Values	– Idle mode channel x: 0 = Hold last state 1 = Idle state (presetting) – Idle state channel x: 0 = Reset value (presetting) 1 = Set value
Comment	The parameterisation of the Idle mode for an analogue output channel is accomplished in the case of the field bus node CPX-FB11 by means of an individual parameter setting or bit. For parameterisation of the Idle state, the desired output word must be correspondingly mapped in the parameter bits "Idle state channel x". The Idle mode reaction is determined for the complete CPX terminal by means of the system parameter "System Idle mode" (see CPX system manual).

Tab. 8/17: Idle mode channel x (channel specific)

Module parameters: Force channel x	
Function no.	Access to these module parameters is made via protocol-specific functions (see the manual for the field bus node).
Description	The Force function permits the manipulation of analogue values irrespective of the actual output value (see also CPX system manual). This can be accomplished with the following parameters: – Force mode outputs channel x – Force state outputs channel x
Values	– Force mode outputs channel x: 0 = Blocked (presetting) 1 = Force state – Force state outputs channel x: 0 = Reset value (presetting) 1 = Set value
Comment	The enabling of the Force function with the parameter “Force mode outputs channel x” depends on the field bus protocol and is carried out: – by an individual parameter setting or bit (e.g. CPX-FB11), – by setting all parameter bits of the relevant word (e.g. CPX-FB6) to “blocked” or “Force state”. For parameterisation of the Force state, the desired output word must be correspondingly mapped in the parameter bits “Force state outputs channel x”. The enabling of the Force function for the complete CPX terminal is made by means of the system parameter “Force mode” (see CPX system manual).

Tab. 8/18: Force channel x (channel-specific)

8.4.4 Module parameter “Output analogue-value data format”

The parameterized data format determines how the values transferred by the control system are to be processed by the CPX analogue module. The setting applies to all analogue output channels. Irrespective of the data format the data width is always 16 bits (2 bytes, 1 word).

Supported data formats of the analogue output modules															
VZ + 15 bits linear scaled															
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
VZ	B14 MSB	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0 LSB
VZ + 12 bits right-justified (compatible with valve terminal type 03, presetting)															
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
VZ	0	0	0	B11 MSB	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0 LSB
VZ + 15 bits left-justified (compatible with Simatic S7)															
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
VZ	B11 MSB	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0 LSB	x	x	x
VZ + 12 bits left-justified (compatible with Simatic S5)															
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
VZ	B11 MSB	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0 LSB	0	0	0
Abbreviations used: VZ: Sign (0 = positive value, 1 = negative value) B0 ... B14: Output value D0 ... D15: 16 bits output data field MSB/LSB: Most significant bit / least significant bit x: Not relevant															

Tab. 8/19: Data format analogue output modules

Note
For the fieldbus node CPX-FB13 (PROFIBUS-DP) the byte sequence with which the analogue values are transferred to the controller can be reversed by parameterising the value “Analogue process value representation”:
- Factory setting: LSB-MSB (INTEL format)
- Reversal: MSB-LSB (MOTOROLA format)

Check this setting in the bus node if you obtain implausible values; also refer to the CPX-FB13 description in chapter 2 under the section entitled “Parameters of CPX-FB13“.

Data format “VZ + 15 bits linear scaled”

The data range defined by the scaling end values (limits) of the 15-bit digital value in the output word is scaled linearly to 12 bits. The resulting value is available after D-A conversion as an analogue output signal (see section 8.4.5, Fig. 8/5).

Data format “VZ + 12 bits right-justified”

The 12-bit digital value in the output word is available after D-A conversion as an analogue output signal (see also section 8.4.1, Fig. 8/3).

Data format “VZ +15 bits left-justified” and data format “VZ + 12 bits left-justified”

The 12-bit digital values in the output word plus the preceding sign bit are arranged left-justified in the data format (with the three zeros at the end this results in a 15-bit data word which, divided by 8, corresponds to the 12-bit digital value). The 12-bit digital value is available after D-A conversion as an analogue output signal.

The following diagram shows an example of the data format "VZ + 15 bits left-justified":

1 Digital output values 15-bit

2 Digital output values 12-bit (without three zeros at the end)

3 Analogue output signals

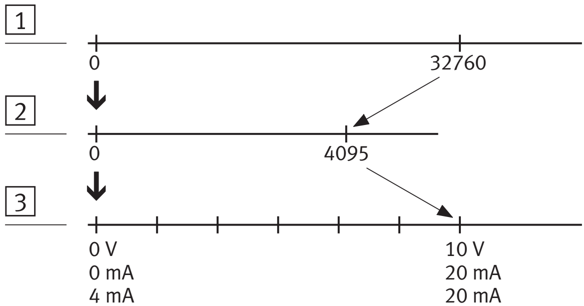


Fig. 8/4: Example of data format "VZ + 15 bits left-justified"

8.4.5 Channel-specific module parameters – Limits

You can determine limits with the channel-specific parameters "Lower limit" and "Upper limit". The meaning of the limit parameters depends on the parameterized data format of the module.

With data format "VZ + 15 bits linear scaled", the limits have the function of defining the scaling end values of the data range. This results in an additional scaling of the analogue values.
If the output data lie outside this data range, a diagnostic message can be generated with appropriate parameterisation.

With other data formats the data range is already defined by the scaling end values. In this case, the limits permit data monitoring even within the data range.

Data format [1]	**Data range**	**Limits/scaling end values [2]**	
VZ + 15 bits linear scaled	-30000 ... +30000	Lower scaling end value: -30000 ... +29999	Upper scaling end value: -29999 ... +30000
VZ + 12 bits right-justified	0 ... 4095	Lower limit: 0 ... 4094	Upper limit: 1 ... 4095
VZ + 15 bits left-justified	0 ... 32760	Lower limit: 0 ... 32759	Upper limit: 1 ... 32760
VZ + 12 bits left-justified	0 ... 32760	Lower limit: 0 ... 32752	Upper limit: 1 ... 32760

[1] (VZ = sign)
As the analogue outputs can only output positive signals and as there is no scaling on the data range with the "Fixed value" data formats "VZ + 12 bits right-justified", "VZ + 15 bits left-justified" and "VZ + 12 bits left-justified", the sign bit with these formats is always 0.
[2] The lower limit/scaling end value must always be less than the upper limit/scaling end value.

Tab. 8/20: Limits or scaling end values of the analogue output modules

Scaling end values with data format "VZ + 15 bits linear scaled"

The following diagram shows an example of the data format "VZ + 15 bits linear scaled" with the scaling end values:

- Lower limit = 400
- Upper limit = 2000

With these values the output signal corresponds to e.g. for the signal range 4 ... 20 mA the digital output value multiplied by 0.01 mA.

[1] Digital output value

[2] Digital signals after A-D conversion (resolution: 12 bits)

[3] Analogue output signal after scaling

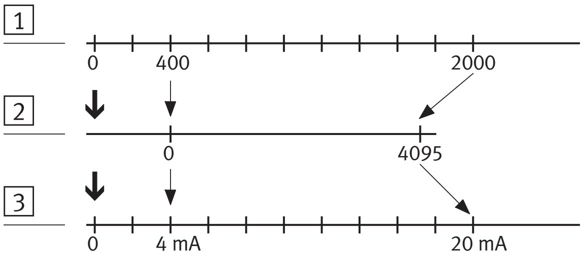


Fig. 8/5: Example scaling data format "VZ + 15 bits linear scaled"

The scaling end values in this data format are identical with the limits for less than or exceeding the rated range:

[1] Digital output signal after scaling

[2] Limits

[3] Less than or exceeding the limits

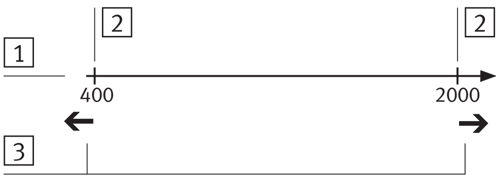


Fig. 8/6: Limit monitoring with data format "VZ + 15 bits linear scaled"

Limits with the “Fixed value” data formats

The following diagram shows an example of the data format “VZ + 12 bits right-justified” with the scaling end values:

- Lower limit = 500
- Upper limit = 3500

The principle of the limits also applies to the data formats “VZ + 15 bits left-justified” and “VZ + 12 bits left-justified”.

1 End value of the data range

2 Lower limit

3 Upper limit

4 Less than or exceeding the limits

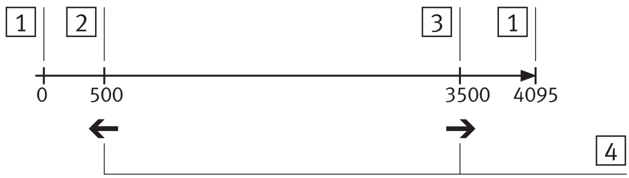


Fig. 8/7: Monitoring of limits with the “Fixed value” data formats

8.4.6 Channel-specific module parameters – Monitoring wire break

Wire break/open loop monitoring can be activated by means of appropriate parameterisation for the signal range 0/ 4 ... 20 mA. The messages are made available as diagnostic information (see section 8.5.1).

8.5 Diagnosis

Specific errors of the analogue output modules are reported or suppressed depending on the module parameterisation.

The errors are locally by means of the Error LED and, if necessary, can be evaluated with the handheld device.

Depending on the module parameterisation the errors are reported by the field bus node, where they can be evaluated according to the field bus protocol used.

Representation of the errors in the various field bus nodes depends on the field bus protocol (see manual for the field bus node).

8.5.1 Error messages of the anaolgue output modules

An analogue output module can register the following errors:

Error number	Description	Error treatment
2	**Short circuit/overload in voltage supply** [1)] Only with voltage outputs with signal range 0 ... 10 V: Short circuit/overload at an output (see “Parameters“ “Monitoring the CPX module – monitoring short circuit/overload at output”). The reaction depends on the parameterisation, parameter “Behaviour after short circuit/overload at output”:	1. Check actuators, eliminate short circuit/overload (number of faulty channel: see LED display or module diagnostic data). 2. Depending on parameterisation: (Parameter “Behaviour after short circuit/overload at output”)
	– Setting “Leave voltage/current switched off”: The output is switched off.	• Power off/on necessary (operating voltage supply for electronics/sensors $V_{EL/SEN}$), or change parameter “Behaviour after short circuit/overload at output” to “Switch voltage on again”.
	– Setting “Switch on voltage/current again”: The output current is limited to approx. 15 mA.	• The voltage will be switched on again **automatically** when the short circuit is eliminated.

1) The module displays the relevant error depending on the parameterisation. The analogue output signals, however, will be processed further.

Tab. 8/21: Error messages of the output modules – part 1

Error number	Description	Error treatment
3	**Wire break/idling Current output** [1] Only with current outputs with signal range 0/4 ... 20 mA: Wire break monitoring is only effective if more than approx. 1 mA output current is output. (See parameter "Monitoring channel x – monitoring wire break/idling")	• Check and, if necessary, replace the cable and connected actuators.
9	**Less than the rated range** [1] Lower limit exceeded. (See parameter "Lower limit channel x – low byte/high byte" or "Monitoring channel x – monitoring below rated range")	• Check signal range of output. • Check parameterized limit. • If necessary, deactivate monitoring.
10	**Rated range exceeded** [1] Upper limit exceeded. (See parameter "Upper limit channel x – low byte/high byte" or "Monitoring channel x – monitoring rated range exceeded")	• Check signal range of output. • Check parameterized limit. • If necessary, deactivate monitoring.
15	**Module/channel failed** [2] General error, module faulty.	• Power off/on necessary • If this error occurs again: check and, if necessary, replace the analogue output module. Evaluation of the analogue output signals has stopped.
[1] The module displays the relevant error depending on the parameterisation. The analogue output signals, however, will be processed further. [2] Processing of the analogue output signals will be stopped.		

Tab. 8/22: Error messages of the output modules – part 2

<table>
<tr><th>Error number</th><th>Description</th><th>Error treatment</th></tr>
<tr><td>

21
24
25</td><td>Parameterisation error [1) 2)]
An error has occurred in the setting of the relevant parameter.
– Parameter data format
– Parameter lower limit
– Parameter upper limit</td><td>• Check the parameterisation undertaken and, if necessary, repeat the parameterisation using the correct parameters.
The analogue output module will be operated further with the last valid parameterisation.</td></tr>
<tr><td>26</td><td>Error in actuator supply [1)]
Short circuit/overload or undervoltage in actuator supply (V_{OUT}).
(See parameter “Monitoring the CPX module – monitoring short circuit/overload at output”)

– Setting “Leave voltage switched off”:

The actuator supply is switched off.

– Setting “Switch on voltage again”: The output current is limited to approx. 250 mA.</td><td>1. Eliminate short circuit/overload or check actuator supply, if necessary, check connected actuators
2. Depending on parameterisation (parameter “Behaviour after short circuit/overload at output”):

• Power off/on necessary (load voltage supply for outputs V_{OUT}), or change parameter “Behaviour after short circuit/overload at output” to “Switch voltage on again”.

• If the actuator current supply is less than 400 mA:
The voltage will be switched on again automatically when the short circuit is eliminated.
If the actuator current supply is more than 400 mA:
Power off/on is necessary (V_{OUT}).</td></tr>
<tr><td colspan="3">1) The module displays the relevant error depending on the parameterisation. The analogue output signals, however, will be processed further.
2) The parameters entered will be ignored, the module operates with the last valid parameters.</td></tr>
</table>

Tab. 8/23: Error messages of the output modules – part 3

Note
Please note the following when using the output modules:
- If there is a short circuit, all actuator supplies of the module will be switched off **together**.
- If not parameterized otherwise, the actuator supply voltage will be switched on again **automatically** when the short circuit is eliminated.

8.5.2 LED display

There is an LED under the transparent cover of the module for diagnosing the output modules.

1 Error LED (red)

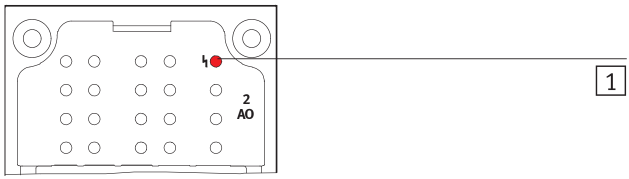


Fig. 8/8: LED display of analogue output module CPX-2AA-U-I

Error LED

The red error LED indicates a module error due to short circuit or overload of the actuator supply or an output, by a wire break or a parameterisation error, depending on the parameterisation.

Error LED (red)	Sequence	Status	Error number	Error treatment
LED is out	ON / OFF	Trouble-free operation	–	None
LED lights up	ON / OFF	**Error in actuator supply** Short circuit/overload or under-voltage in actuator supply (V_{OUT}). or **Component defective**	26 15	See section 8.5.1, Tab. 8/23 Check and, if necessary, replace component

Tab. 8/24: Error LED analogue output modules – part 1

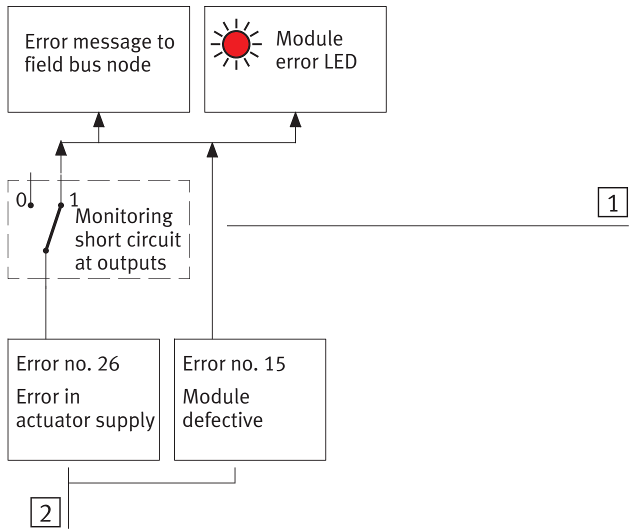
Error LED (red)	Sequence	Status	Error number	Error treatment
 LED flashes	 1 flash 1)	**Overload/short circuit** **Voltage output** Short circuit/overload at the output or	2	See section 8.5.1, Tab. 8/21, Tab. 8/22 and Tab. 8/23
		Wire break/idling **Current output** Output current below nominal value or	3	
		Lower limit exceeded Output value is less than the parameterized limit or	9	
	 2 flashes 1)	**Upper limit exceeded** Output value is greater than the parameterized limit or	10	
		Parameterisation error – Parameter data format – Parameter lower limit – Parameter upper limit	 21 24 25	

1) The number of flash pulses indicates the output channel concerned.
1 flash = channel 0 (or both channels)
2 flashes = channel 1

Tab. 8/25: Error LED analogue output modules – part 2

8.5.3 Error treatment and parameterisation

The following diagrams show the error treatment in the analogue output modules. Further reporting and display of the error can be suppressed as desired with the appropriate module parameter, represented in the diagram as a switch. A description of the parameter can be found in section 8.4.3.

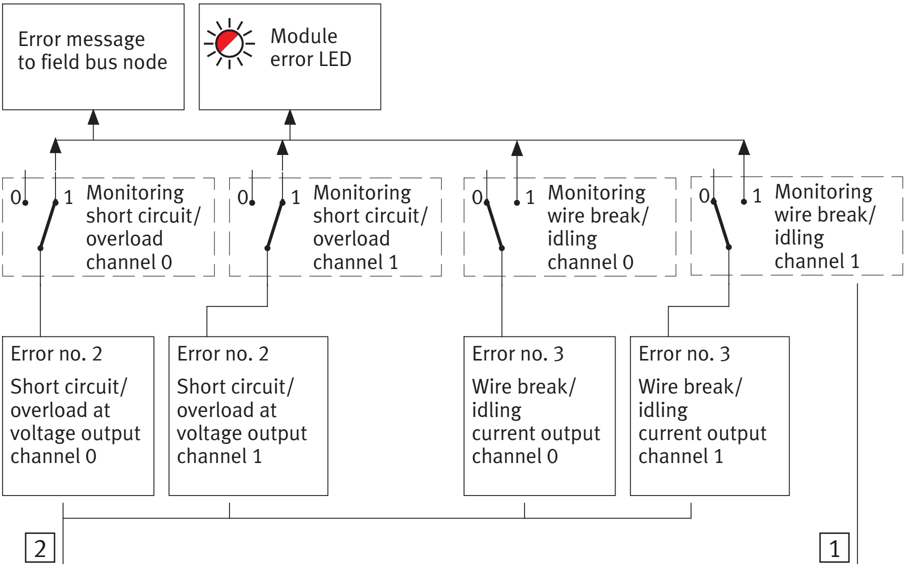


1 Module parameters (switch position represented = default setting)

2 Module-specific errors

3 Channel-specific errors

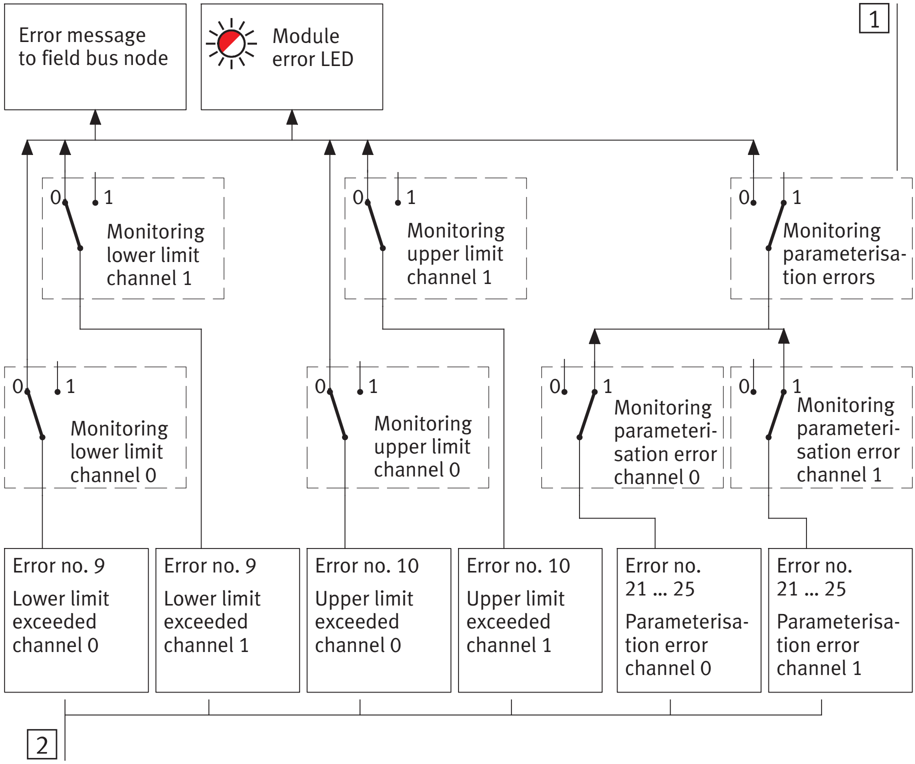
Fig. 8/9: Principle of error treatment and parameterisation of the analogue output modules – part 1



1 Module parameters (switch position represented = default setting)

2 Channel-specific errors

Fig. 8/10: Principle of error treatment and parameterisation of the analogue output modules – part 2



1 Module parameters (switch position represented = default setting)

2 Channel-specific errors

Fig. 8/11: Principle of error treatment and parameterisation of the analogue output modules – part 3

Technical appendix

Appendix A

Contents

A.1 Technical data of analogue input module CPX-2AE-U-I

Technical data	CPX-2AE-U-I Voltage inputs	 Current inputs
General technical data of the CPX terminal	See CPX System Description	
Protection class to EN 60 529	See technical data of the mounted connection block (section A.8)	
Operating voltage supply for electronics/sensors ($V_{EL/SEN}$) – Nominal voltage – Intrinsic current consumption at 24 V (internal electronics)	 DC 24 V ± 25% Typically 50 mA	
Analogue inputs	Total of max. 2 input channels per module	
– Channels – Signal ranges	Max. 2 channels 0 ... 10 V	Max. 2 channels 0 ... 20 mA / 4 ... 20 mA

– Signal range selection
 	
– Line length
– Resolution (A-D converter, internal)
– Potential connection
– Analogue value formation
  – Measuring principle
  – Conversion time per channel
  – Module cycle time
– Interference suppression
  – Common-mode interference (Vpp)
  – Crosstalk between inputs
	Can be selected channel by channel with DIL switch or software
	Max. 30 m, screened/shielded
	12 bits
	Highly resistive + capacitive connection to FE
	
	Suc. approximation
	Typ. 150 µs
	≤ 4 ms
	
	Min. 70 dB
	Min. -50dB	

– Permissible potential differences
  – between input channels
  – between inputs and FE
	
	AC 1 V
	DC 30 V
		
		AC 0 V
		DC 30 V

Technical data	CPX-2AE-U-I	
	Voltage inputs	Current inputs

Analogue inputs (cont.)
– Error limits
  – Operational limit (Tmin..Tmax)
  – Basic error limit (25°C)
  – Temperature error
  – Linearity error (without scaling)
  – Repetition accuracy at 25°C
– Specifications on sensor selection
  – Input resistance
  – Permissible input voltage or input current (destruction limit)
	
	± 0.5 %
	± 0.3 %
	± 0.015 % / K
	± 0.05 %
	0.15 %
	
	≥ 100 kΩ
	30 V constant
		
		± 0.6 %
		± 0.4 %
		± 0.015 % / K
		± 0.05 %
		0.15 %
		
		≤ 100 Ω (50 Ω)
		40 mA

Sensor supply
 	
– Load capacity
– Output voltage
– Protection
  – Response current
  – Response time
– Reaction after end of overload
– Protection against incorrect polarity at 24 V load input
– Protection against reverse voltage
	One connection per analogue input, identical supply potential at all inputs, sensor supply generated from 24 $V_{EL/SEN}$
	Max. sum continuous current per module: 0.7 A
	24 V ± 25%
	Electronic, thermal
	0.7 ... 2.4 A
	Max. 20 ms
	Can be parameterised (see parameters)
	Yes
	
	Max. 30 V	

– Galvanic isolation
 	
  – between channel and 24 V_{SEN}
 	
  – between the channels
	The logic supply of the electrically isolated analogue part is branched from the analogue voltage which is generated by a DC-DC converter from the 24 $V_{EL/SEN}$.
	Yes (no potential isolation if internal sensor supply is used)
	No	

Module code (CPX-specific) Module identification (Handheld)	128 2AI	

A.2 Technical data of analogue input module CPX-4AE-U-I

Technical data	CPX-4AE-U-I	
	Voltage inputs	Current inputs
General technical data of the CPX terminal	See CPX System Description	
Protection class to EN 60 529	See technical data of the mounted connection block (section A.8)	
Operating voltage supply for electronics/sensors ($V_{EL/SEN}$) – Nominal voltage – Intrinsic current consumption at 24 V (internal electronics)	 DC 24 V ± 25% Max. 70 mA	
Analogue inputs	Total of max. 4 input channels per module	
– Signal ranges	0 ... 10 V 1 ... 5 V -5 ... +5 V -10 ... +10 V	0 ... 20 mA 4 ... 20 mA -20 ... +20 mA

– Signal range selection
– Line length
– Resolution (A-D converter, internal)
– Potential connection
– Analogue value formation
  – Measuring principle
  – Conversion time per channel
  – Module cycle time
– Interference suppression
  – Common-mode interference (Vpp)
  – Crosstalk between inputs
	Can be selected channel by channel per parameter
	Max. 30 m, screened/shielded
	15 bits + sign
	Highly resistive + capacitive connection to FE
	
	Suc. approximation
	Typ. 150 µs
	≤ 500 µs
	
	Min. 70 dB
	Min. -50dB	

– Permissible potential differences
  – between input channels
  – between inputs and FE
	
	AC 1 V
	DC 30 V
		
		AC 0 V
		DC 30 V

Technical data	CPX-4AE-U-I	
	Voltage inputs	Current inputs
Analogue inputs (cont.) – Error limits – Operational limit (Tmin..Tmax) – Basic error limit (25°C) – Temperature error – Linearity error (without scaling) – Repetition accuracy at 25°C – Specifications on sensor selection – Input resistance – Permissible input voltage or input current	 ± 0.3 % ± 0.2 % ± 0.01 % / K ± 0.025 % ± 0.1 % ≥ 100 kΩ 30 V constant	 ± 0.3 % ± 0.2 % ± 0.01 % / K ± 0.025 % ± 0.1 % ≤ 100 Ω (typ. 70 Ω) Current internally limited (max. 60 mA constant)
Sensor supply – Load capacity – Output voltage – Protection – Response current – Response time – Reaction after end of overload – Protection against incorrect polarity at 24 V load input – Protection against reverse voltage	One connection per analogue input, identical supply potential at all inputs, sensor supply generated from 24 $V_{EL/SEN}$ Max. sum continuous current per module: 1.4 A 24 V ± 25% Electronic, thermal 1.4 ... 4.5 A Max. 20 ms Can be parameterised (see parameters) Yes max. 30 V	
– Galvanic isolation – between channel and 24 V_{SEN} – between the channels	The logic supply of the electrically isolated analogue part is branched from the analogue voltage which is generated by a DC-DC converter from the 24 $V_{EL/SEN}$. Yes (no potential isolation if internal sensor supply is used) No	
Module code / sub-module code (CPX-specific) Module identification (Handheld)	137/1 4AI-U-I	

A.3 Technical data of analogue input module CPX-4AE-I

Technical data	CPX-4AE-I Current inputs
General technical data of the CPX terminal	See CPX System Description
Protection class to EN 60 529	See technical data of the mounted connection block (section A.8)
Operating voltage supply for electronics/sensors ($V_{EL/SEN}$) – Nominal voltage – Intrinsic current consumption at 24 V (internal electronics)	 DC 24 V ± 25% Typically 50 mA

Analogue inputs
 	
– Channels
– Signal ranges
– Signal range selection
 	
– Line length
– Resolution (A-D converter, internal)
– Potential connection
– Analogue value formation
  – Measuring principle
  – Conversion time per channel
  – Module cycle time
– Interference suppression
  – Common-mode interference (Vpp)
  – Crosstalk between inputs
	
	Total of 4 input channels per module
	0 ... 20 mA / 4 ... 20 mA
	Can be selected channel by channel with DIL switch or software
	Max. 30 m, screened/shielded
	12 bits
	Highly resistive + capacitive connection to FE
	
	Suc. approximation
	Typ. 150 μs
	≤ 10 ms
	
	Min. 70 dB
	Min. -50dB

– Permissible potential differences
  – between input channels
  – between inputs and FE
	
	AC 0 V
	DC 30 V

Technical data	CPX-4AE-I **Current inputs**
Analogue inputs (cont.) – Error limits – Operational limit (Tmin ... Tmax) – Basic error limit (25°C) – Temperature error – Linearity error (without scaling) – Repetition accuracy at 25°C – Specifications on sensor selection – Input resistance – Permissible input voltage or input current (destruction limit)	 ± 0.6 % ± 0.5 % ± 0.015 % / K ± 0.05 % 0.15 % ≤ 100 Ω (50 Ω) 40 mA
Sensor supply – Load capacity – Output voltage – protection – Response current – Response time – Reaction after end of overload – Protection against incorrect polarity at 24 V load input – Protection against reverse voltage	One connection per analogue input, the same supply potential at all inputs, sensor supply generated from 24 $V_{EL/SEN}$ Max. sum continuous current per module: 0.7 A 24 V ± 25% Electronic, thermal 0.7 ... 2.4 A Max. 20 ms Can be parameterised (see parameters) Yes Max. 30 V
– Galvanic isolation – between channel and 24 V_{SEN} – between the channels	The logic supply of the electrically isolated analogue part is branched from the analogue voltage which is generated by a DC-DC converter from the 24 $V_{EL/SEN}$. Yes (no potential isolation if internal sensor supply is used) No
Module code (CPX-specific) Module identification (Handheld)	130 4AI-I

A.4 Technical data of analogue input module CPX-4AE-T (temperature module)

Technical data	CPX-4AE-T	
	Pt sensors	Ni sensors
General technical data of the CPX terminal	See CPX System Description	
Protection class to EN 60 529	See technical data of the mounted connection block (section A.8)	
Operating voltage supply for electronics/sensors ($V_{EL/SEN}$) – Nominal voltage – Intrinsic current consumption at 24 V (internal electronics)	 DC 24 V ± 25% Typically 50 mA	
Analogue inputs – Channels	 Optional: 2 or 4 input channels per module	
– Signal ranges	Pt 100, 200, 500, 1000	Ni 100, 120, 500, 1000

– Signal range selection
 	
– Line length
 	
– Sensor connection design
– Resolution (A-D converter, internal)
– Potential connection
– Analogue value formation
  – Module cycle time
– Interference suppression
  – Common-mode interference (Vpp)
  – Crosstalk between inputs
	Can be selected channel-by-channel by means of software (parameterisation)
	Max. 200 m, screened/shielded (accuracy diminishes at cable length over 10 m)
	2, 3 or 4-cable designs (to be set by parameterisation)
	15 bits + sign
	High resistive, capacitive connection to FE
	
	≤ 250 ms
	
	Min. 70 dB
	Min. -50dB	

– Permissible potential differences
  – between input channels
  – between inputs and FE
	
	AC 0 V
	DC 30 V	

Technical data	CPX-4AE-T	
	Pt sensors	Ni sensors
Analogue inputs (cont.) – Error limits – Operational limit (Tmin ... Tmax) relative to input range – Basic error limit (25°C)	 ± 0.06 % Pt standard ± 0.6 K Pt climate ± 0.2 K	 ± 0.06 % ± 0.2 K
– Temperature error related to input range – Linearity error (without scaling) – Repetition accuracy at 25°C	± 0.001 % ± 0.02 % ± 0.05 %	
Module code (CPX-specific) Module identification (Handheld)	132 4AI-T	

A.5 Technical data of analogue input module CPX-4AE-TC (temperature module)

Technical data	CPX-4AE-TC **TC sensors**
General technical data of the CPX terminal	See CPX System Description
Protection class to EN 60 529	See technical data of the mounted connection block (section A.8)
Operating voltage supply for electronics/sensors ($V_{EL/SEN}$) – Nominal voltage – Intrinsic current consumption at 24 V (internal electronics)	 DC 24 V ± 25 % Typically 25 mA
Analogue inputs – Channels	 4
– Signal ranges of the individual sensor types	E -200 – 900 °C 60 µV/°C J -200 – 1200 °C 51 µV/°C T -200 – 400 °C 40 µV/°C K -200 – 1370 °C 40 µV/°C N 0 – 1300 °C 38 µV/°C S 0 – 1760 °C 11 µV/°C B 400 – 1820 °C 8 µV/°C R 0 – 1760 °C 12 µV/°C
– Sensor selection – Line length	Can be selected channel-by-channel per parameter Max. 50 m, screened/shielded (accuracy diminishes at cable length over 10 m; measurement error cannot be compensated for)

– Resolution (A-D converter)
– Data format
 	
– Analogue value formation
  – Measuring principle
  – Module cycle time
	16 bits (internal)
	15 bits + prefix, complement of two, binary notation in tenths of a degree
	
	Registering of the thermoelectric voltage (Seebeck effect)
	≤ 250 ms

– Interference suppression
  – Common mode attenuation
  – Crosstalk attenuation
	
	Min. -70 dB
	Min. -50 dB (between inputs)

Technical data	CPX-4AE-TC TC sensors

– Permissible potential difference
  – between input channels
  – between inputs and FE
	
	0 V (no potential isolation)
	AC 60 V / DC 75 V

– Potential connection to FE	High resistive, capacitive connection
– Internal current consumption at 24 V (internal electronics)	Typically 25 mA
– Permissible voltage on measurement and power supply line	Max. 30 V
– Resolution	0.1 °C / 0.1 °F
– Operating error limit	< ± 0.6 % (relative to ambient temperature range)
– Basic error limit	< ± 0.4 % (at 25 °C, without sensor error)
– Temperature error	± 0.005 %/K (relative to ambient temperature range, when an RTD auxiliary sensor Pt 1000 Class A is used for cold junction compensation)
– Compensation error	< ± 0.5 K
– Linearity error	± 0.02 % (without scaling)
– Repetition accuracy	< ± 0.05 % (at 25 °C, relative to input range)
Module code (CPX-specific) Module identification (Handheld)	134 4AI-TC

A.6 Technical data of analogue input module CPX-4AE-P (pressure input module)

Technical data	CPX-4AE-P-D10	CPX-4AE-P-B2
General technical data of the CPX terminal	See CPX System Description	
Protection class to EN 60 529	IP65/IP67	
Operating voltage supply for the electronics – Nominal voltage – Intrinsic current consumption at 24 V (internal electronics)	 18 ... 30 V Typically 50 mA	
Pressure inputs – Channels – Pneumatic connection – Medium – Temperature range of the medium	 4 QS connections for hose diameter 4 mm Compressed air, filtered (40 µm), unlubricated or lubricated 0 ... +50 °C	
– Measurement range relative to the ambient pressure	0 ... 10 bar 0 ... 1000 kPa 0 ... 145 psi	-1 ... 1 bar -100 ... 100 kPa -14.5 ... 14.5 psi
– Measurement range for differential pressure calculation	-10 ... 10 bar -1000 ... 1000 kPa -145 ... 145 psi	-2 ... 2 bar -200 ... 200 kPa -29 ... 29 psi
– Maximum measurement range for differential pressure calculation	-10.28 ... 10.28 bar -1028 ... 1028 kPa -149 ... 149 psi	-2.05 ... 2.05 bar -205 ... 205 kPa -30.4 ... 30.4 psi
– Maximum permissible gauge pressure range of the pressure sensors	15 bar 1500 kPa 217.5 psi	5 bar 500 kPa 72.5 psi
– Pressure for sensor limit diagnostic	≥ 10.30 bar ≥ 1030 kPa ≥ 149.4 psi	≥ 1.051 bar ≥ 105 kPa ≥ 15.24 psi

Technical data	CPX-4AE-P-D10	CPX-4AE-P-B2
– Accuracy – Internal cycle time – Data format of the process values	±3 % of the maximum measured value 5 ms VZ + 15 Bit, negative values represented as twos-complement	
Module identification (Handheld)	4AI-P-D10	4AI-P-B2
Module code / sub-module code (CPX-specific)	133/1	133/2

A.7 Technical data of analogue output module CPX-2AA-U-I

Technical data	CPX-2AA-U-I	
	Voltage outputs	Current outputs
General technical data of the CPX terminal	See CPX System Description	
Protection class to EN 60 529	See technical data of the mounted connection block (section A.8)	
Operating voltage supply for electronics/sensors ($V_{EL/SEN}$) – Nominal voltage – Internal current consumption at 24 V (internal electronics, no current supply at outputs) – Maximum current consumption at 24 V (maximum current supply at outputs)	 DC 24 V ± 25% Typically 50 mA Typically 100 mA	
Load voltage supply at outputs (V_{OUT}) – Nominal voltage – Maximum current consumption at 24 V – Diagnostic message undervoltage V_{OUT} (monitoring V_{OUT}, load voltage outside function range)	 DC 24 V ± 25% 4 ... 10 A (response current of fuse) 17 ... 14 V	
Analogue outputs	Total of 2 output channels per module	
– Channels – Output ranges	Max. 2 channels (single-ended outputs) 0 ... 10 V	Max. 2 channels (single-ended outputs) 0 ... 20 mA / 4 ... 20 mA
– Output range selection – Line length – Resolution (D-A converter, internal) – Analogue value formation – Cycle time	Can be selected channel by channel with DIL switch or software Max. 30 m, screened/shielded 12 bits ≤ 4 ms	
– Response time – for ohmic load – for capacitive load – for inductive load	 0.1 ms (min. 1 kΩ) 0.7 ms (max. 1 µF) –	 0.1 ms (max. 600 Ω) – 0.5 ms (max. 1 mH)

Technical data	CPX-2AA-U-I	
	Voltage outputs	Current outputs

Analogue outputs (cont.)
– Interference suppression
  – Crosstalk between outputs
– Permissible potential differences
  – between the output channels
  – between AGND and FE
	
	Min. -40 dB
	
	AC 0 V
	DC 30 V	

– Error limits
  – Operational limit (Tmin ... Tmax)
  – Basic error limit (25°C)
  – Temperature error
  – Linearity error (without scaling)
  – Repetition accuracy at 25°C
– Specifications on sensor selection
  – Load resistance
    – for ohmic load
    – for capacitive load
    – for inductive load
    – short-circuit protection
    – short circuit current
    – idling voltage
  – Destruction limit against voltages applied externally
  – Connecting the actuators
	
	± 0.6 %
	± 0.5 %
	± 0.015 % / K
	± 0.1 %
	0.05 %
	
	Min. 1 kΩ
	Max. 1 µF
	–
	Yes
	Approx. 20 mA
	–
	Max. 30 V constant
	2 wire connection
		
		± 0.6 %
		± 0.5 %
		± 0.015 % / K
		± 0.1 %
		0.05%
		
		Max. 600 Ω
		–
		Max. 1 mH
		–
		–
		18 V
		Max. 30 V constant
		2 wire connection

Actuator supply – Load capacity – Protection – Response current – Reaction after end of overload – Protection against incorrect polarity 24 V actuator supply – Protection against reverse voltage	24 V_{OUT}, one connection per analogue output, the same supply potential at all outputs Max. sum continuous current per module: 2.8 A Electronic, thermal 2.8 ... 10 A Can be parameterised (see parameters) Yes Max. 30 V	

– Galvanic isolation
 	
  – between channel and 24V_{OUT}
 	
  – between the channels
	The logic supply of the electrically isolated analogue part is branched from the analogue voltage which is generated by a DC-DC converter from the 24 $V_{EL/SEN}$.
	Yes (no potential isolation if internal actuator supply is used)
	No	

Module code (CPX-specific) Module identification (Handheld)	129 2AA	

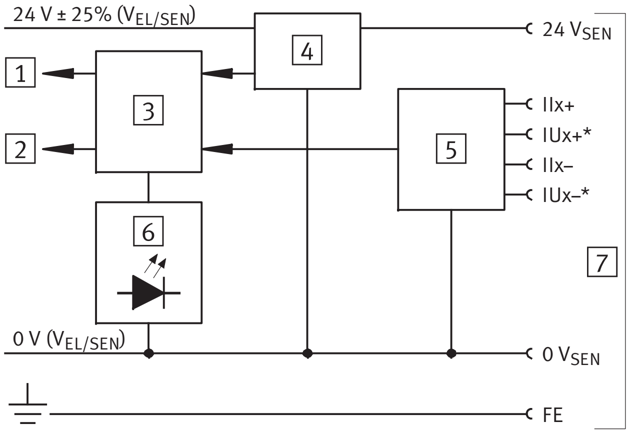
A.8 Technical data of the connection blocks

Connection block type CPX...	Technical data *)	
	Protection class EN 60529	Connections, contact loading
-M-4-M12x2-5POL	IP65/67 1)	4 M12 sockets, metal thread, 5-pin, 4 A, connection block housing in a metal design
-AB-4-M12x2-5POL	IP65/67 1)	4 M12 sockets, 5-pin, 3 A
-AB-4-M12x2-5POL-R	IP65/67 2)	4 M12 sockets, metal thread, 5-pin, 4 A
-AB-8-KL-4POL	IP20 3)	2 terminal strips (spring clip terminals), 16-pin (4x4-pin), 4 A, for cable cross section 0.08 ... 1.5 mm^2, conductor specification: See section 1.2.3
-AB-1-SUB-BU-25POL	IP20 4)	1 Sub-D socket, 25-pin, 4 A
-AB-4-HAR-4POL	IP65/67 1)	4 HARAX sockets, 4-pin, 3 A, connection using insulation displacement technology, for cable cross section 0.5 ... 1.0 mm^2, conductor specification: See section 1.2.3

*) General technical data of the CPX terminal see CPX system manual P.BE-CPX-SYS...
1) With plug connector inserted or with protective cap ISK-M12
2) With plug connector inserted or with protective cap ISK-M12; when using quick connectors, follow the manufacturer's instructions
3) With cover AK-8KL and screw connector set VG-K-M9: IP65/IP67
4) With plug SD-SUB-D-ST25: IP65

A.9 Internal structure of the CPX modules

Internal structure of CPX-2AE-U-I, CPX-4AE-I and CPX-4AE-U-I



1 Diagnostic information

2 Input values (measured data for the inputs)

I...x= Input x

* only CPX-2AE-U-I and CPX-4AE-U-I

(Data transfer between module and PLC/IPC via field bus)

3 Logic

4 Power supply unit

5 A-D converter

6 Module fault LED, channel fault LED (only CPX-4AE-U-I)

7 Connections on the connection block

Fig. A/1: Internal structure of CPX-2AE-U-I and CPX-4AE-I

Internal structure of CPX-4AE-T

1 Diagnostic information

2 Input values (measured data for the inputs)

I...x= Input x

* Depending on the sensor connection, certain inputs must be bridged (see section A.10.2).

(Data transfer between module and PLC/IPC via field bus)

3 Logic

4 Power supply unit

5 A-D converter

6 Channel and module fault LEDs

7 Connections on the connection block

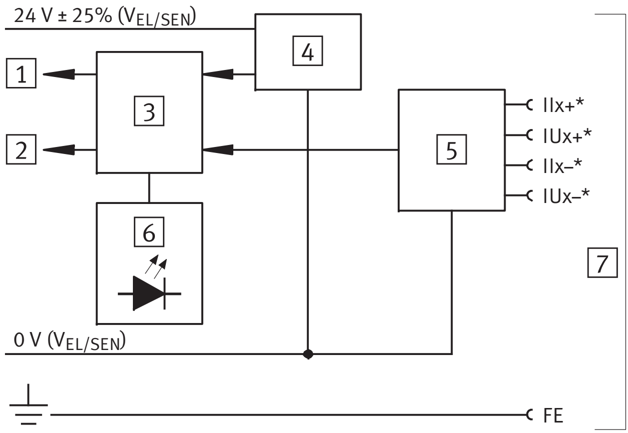
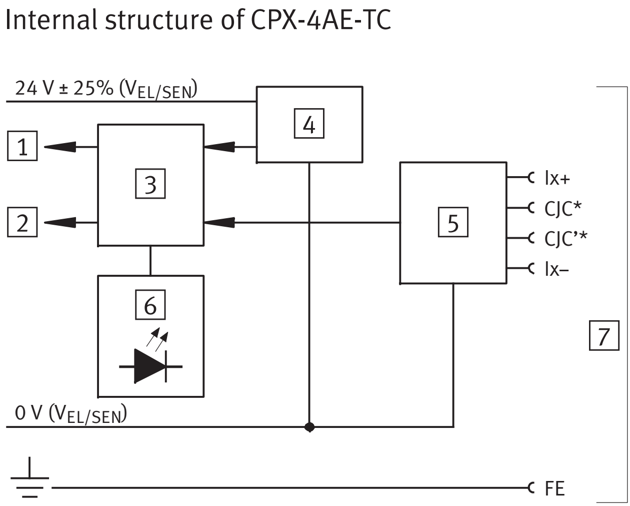


Fig. A/2: Internal structure of CPX-4AE-T



1 Diagnostic information

2 Input values (measured data for the inputs)

Ix = Input x

* Connections for the cold junction compensation (CJC, CJC') by means of RTD (Pt 1000; see sec. A.10.3)

(Data transfer between module and PLC/IPC via field bus)

3 Logic

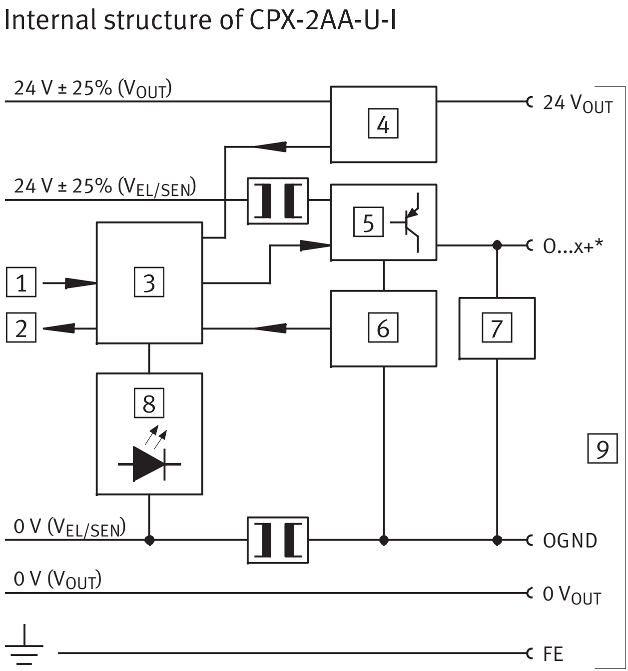
4 Power supply unit

5 A-D converter

6 Channel and module fault LEDs

7 Connections on the connection block

Fig. A/3: Internal structure of CPX-4AE-TC



1 Initial values (signal data)

O...x = Output x

* O**I**x+ or O**U**x+

(Data transfer between module and PLC/IPC via field bus)

2 Diagnostic information (status data) regarding
- Actuator supply
- Output status
- Overload
- Idling (open load)

3 Logic, D-A conversion

4 Power supply unit, monitoring actuator supply

5 Output driver

6 Monitoring output

7 Limiting inductive voltage peaks

8 Module error LED

9 Connections on the connection block

Fig. A/4: Internal structure of CPX-2AA-U-I

A.10 Connection examples

A.10.1 Analogue input and output modules

Connection variants of current sensors

1 Sensor 4 ... 20 mA

2 Connections to analogue CPX module

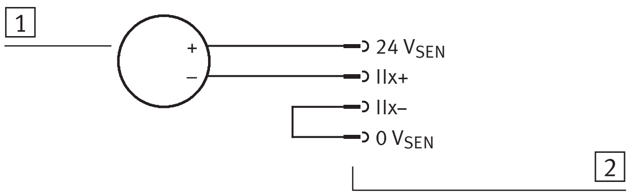


Fig. A/5: Connecting 4 ... 20 mA sensors with internal 24 V power supply (CPX-2AE-U-I, CPX-4AE-I)

1 24 V power unit

2 Sensor 4 ... 20 mA

3 Voltage difference max. 30 V

4 Connections to analogue CPX module

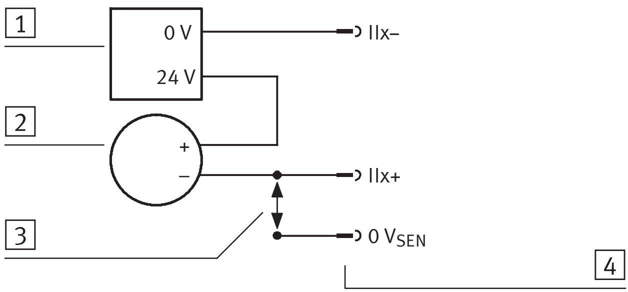


Fig. A/6: Connecting 4 ... 20 mA sensors with external 24 V power supply (CPX-2AE-U-I, CPX-4AE-I)

Note
Interference on the 24 V_{SEN} cable can influence the analogue signal of the sensor.

Connecting the sensor for bipolar voltage signals

Note
With this connection variant, the following measuring errors occur when the analogue value is reported:
– overlapping of the value range in the vicinity of 0 V (offset error of the input amplifier)
– symmetry error in respect of the zero point (0 V).

1 Sensor 4 ... 20 mA

2 Positive sensor voltage

3 Negative sensor voltage

4 Connections to analogue CPX module

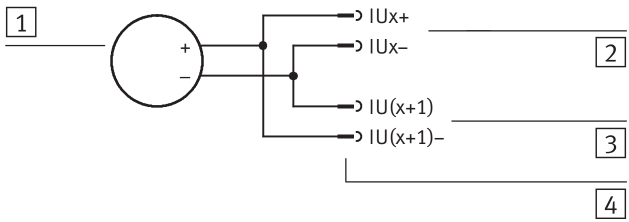
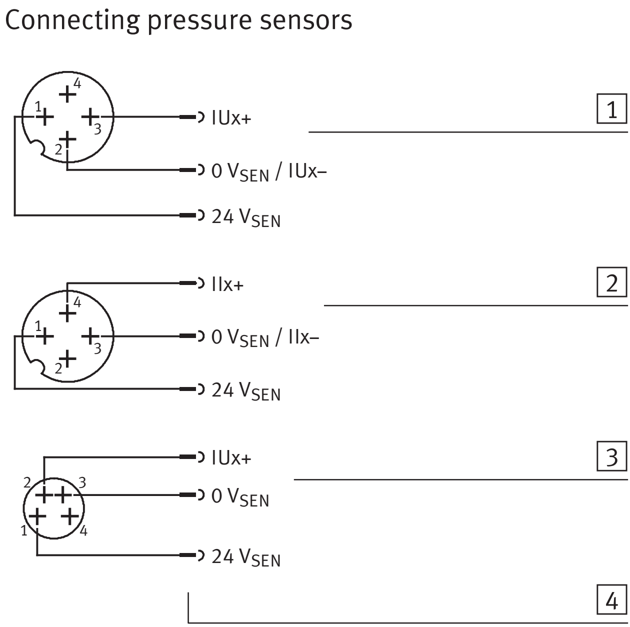


Fig. A/7: Connecting 4 ... 20 mA sensors for reporting of bipolar voltage signals with 2 inputs (CPX-2AE-U-I, CPX-4AE-I)



1 Pressure sensor type SDE, voltage output

2 Pressure sensor type SDE, current output

3 Pressure sensor type SDE1-...-PU-... or SDE1-...-NU-...

4 Connections to analogue CPX module

Fig. A/8: Connecting pressure sensors (CPX-2AE-U-I, CPX-4AE-I)

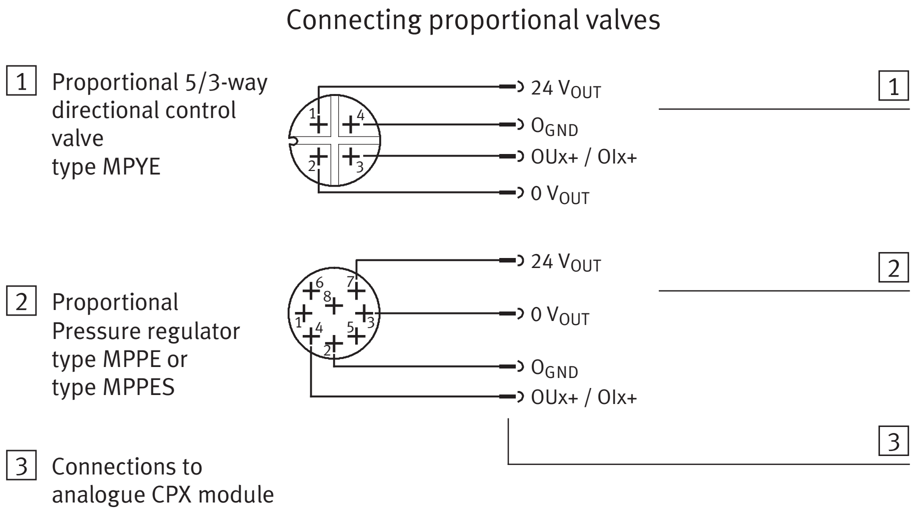


Fig. A/9: Connection proportional valves (CPX-2AA-U-I)

A.10.2 Connecting temperature sensors to the module CPX-4AE-T

The following illustrations show the connection of temperature sensors to the module CPX-4AE-T in 2-, 3- and 4-cable designs.

Explanations of the various connection designs and pin allocation can be found in sections 5.3.3 and 5.3.2.

Only screened/shielded cables are permitted for the transmission of analogue signals (see section 1.2.3).

1 Constant source of current in the module
2 Connecting pin of CPX module
3 Sensor power supply
4 Separate voltage cable
5 Temperature sensor

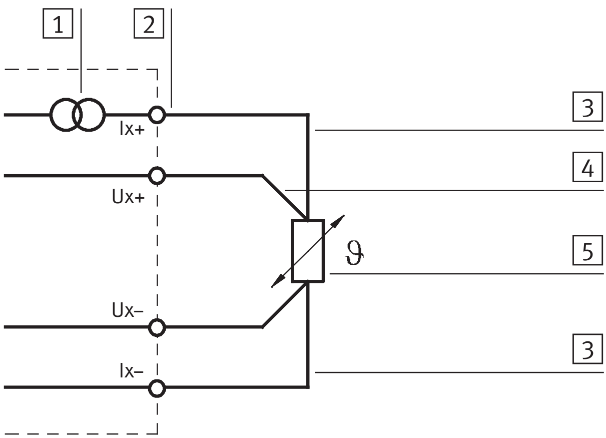


Fig. A/10: Connecting temperature sensors in 4-cable design (CPX-4AE-T)

1 Constant source of current in the module

2 Connecting pin of CPX module

3 Linked current/voltage connection

4 Combined current/voltage cable

5 Temperature sensor

6 Separate voltage cable

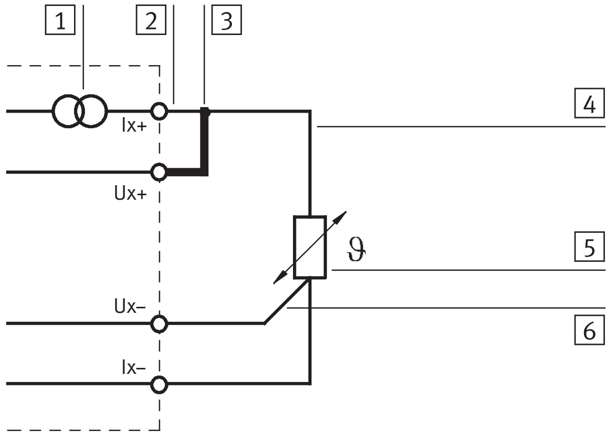


Fig. A/11: Connecting temperature sensors in 3-cable design (CPX-4AE-T)

1 Constant source of current in the module

2 Connecting pin of CPX module

3 Linked current/voltage connection

4 Combined current/voltage cable

5 Temperature sensor

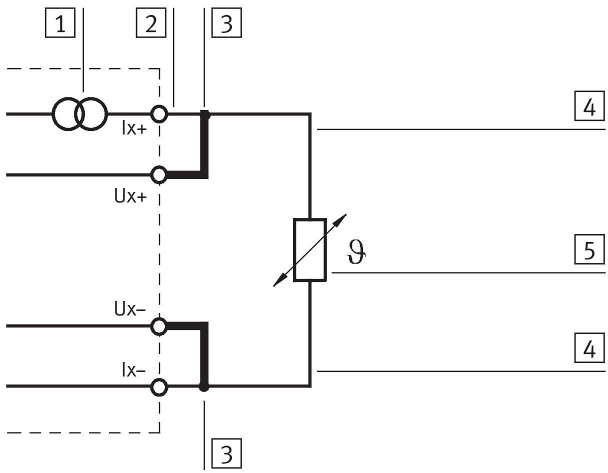


Fig. A/12: Connecting temperature sensors in 2-cable design (CPX-4AE-T)

A.10.3 Connecting temperature sensors to the module CPX-4AE-TC

The following illustrations show the connection of temperature sensors (thermocouples with cold junction compensation) to the module CPX-4AE-TC.

Explanations regarding pin allocation can be found in section 6.3.1.

Further information on temperature measurement by means of thermocouples can be found in the following sections:

- Introduction to the measuring method: Section 6.3.2
- Explanation of cold junction compensation: Section 6.3.3
- Accessories: Appendix A.11

Only screened/shielded cables are permitted for the transmission of analogue signals (see section 1.2.3).

1 Connecting pin of CPX module

2 Sensor cable 1 (of metal 1)

3 Sensor cable 2 (of metal 2)

4 Temperature sensor (RTD, Pt 1000, Class A) for cold junction compensation (CJC)

5 Measuring point (sensor tip)

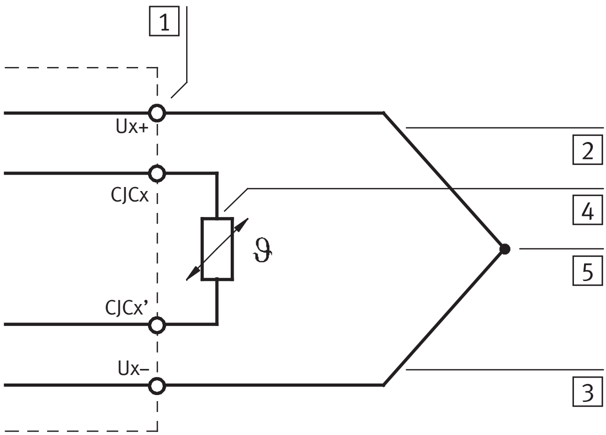


Fig. A/13: Connecting a thermocouple (TC) with cold junction compensation (CJC); CPX-4AE-TC)

The Pt-1000 temperature sensor for cold junction compensation must be mounted in the immediate proximity of the connection point for the thermocouple (in the plug or on the terminal) (connecting pins CJCx, CJCx').

For each input you will need a Pt 1000 in the design Class A, which you can obtain as an individual sales item via Festo (part number TN 553 596).

For external cold junction compensation, all inputs must be provided with their own Pt 1000.

The following schematic diagrams (Fig. A/14 and Fig. A/15) show the connection of the Pt 1000:

– in an M12 plug (Fig. A/14)

– directly to a connection block with terminal strips (spring clip terminals; Fig. A/15).

1 Measuring point (sensor tip)

2 Measuring cable (sensor cable)

3 M12 plug

4 Resistor (RTD) for cold junction compensation (Pt 1000, Class A)

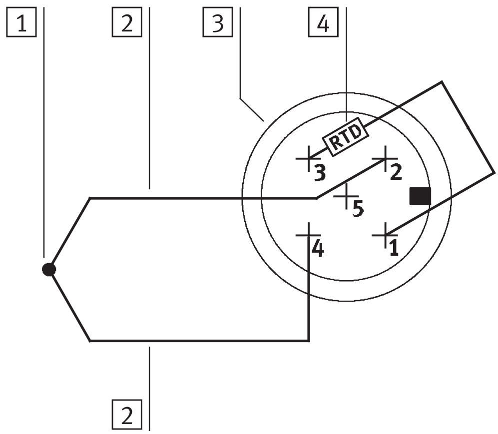


Fig. A/14: Connecting a thermocouple and Pt-1000-RTDs for cold junction compensation by means of an M12 plug to the module CPX-4AE-TC (with connection block CPX-**M**-4-M12x2-5POL or CPX-AB-4-M12x2-5POL(**-R**))

1 Measuring point (sensor tip)

2 Measuring cable (sensor cable)

3 Terminal strip (spring clip terminals) of connection block CPX-AB-8-KL-4POL

4 Resistor (RTD) for cold junction compensation (Pt 1000, Class A)

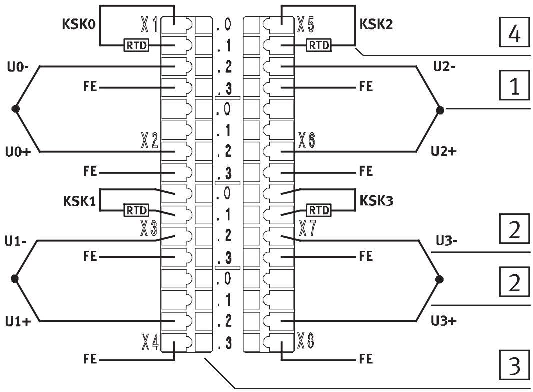


Fig. A/15: Connecting thermocouples and Pt-1000-RTDs for cold junction compensation by means of a terminal strip (spring clip terminals) to the module CPX-4AE-TC (with connection block CPX-AB-8-KL-4POL)

A.11 Accessories (CPX terminal)

→ www.festo.com/catalogue

Keyword index

Appendix B

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