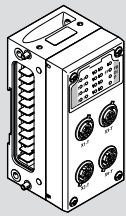


CPX-F8DE-P

Input module



FESTO

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Operating instruction

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Translation of the original instructions

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1 Safety instructions

⚠ WARNING

Non-observance of safety instructions can result in death, serious injuries or major material damage.

- Observe the safety instructions and warnings.

1.1 Intended use

The input module CPX-F8DE-P is intended for reliable recording and evaluation of signals of connected sensors.

The input module provides up to eight secure inputs that can be used by a higher-order safety controller in a safety function. The communication with the higher-level safety control is implemented by the secure PROFIsafe protocol via a PROFIBUS or PROFINET IO fieldbus connection.

The inputs on the input module can be combined for multi-channel sensor applications. Two inputs combined form a channel pair, which is set separately with one of 11 function modes. The function modes influence the evaluation of the input signals and optionally the generation of clock signals.

The characteristics of the inputs comply with the IEC 61131-2 standard for Type 2 digital inputs.

The input module CPX-F8DE-P is a product with safety-relevant functions. The input module is intended for installation in machines or automation-technology systems and may be used only as follows:

- in excellent technical condition
- in its original condition, without unauthorised modifications
- exclusively in the configurations stated here
→ 5.5 Function modes of the input module
- within the limits of the product defined by the technical data
→ 7 Technical data
- in an industrial environment.

NOTICE

Note that the safety engineering system limits of the input module are also its physical limits.

1.2 Rules for product configuration

Operation of the input module CPX-F8DE-P is permissible exclusively in Festo CPX terminals.

- Comply with all technical operating limits → 7 Technical data.

Otherwise, malfunctions can occur.

Operation of the CPX-F8DE-P is permitted only in combination with the following PROFIsafe-capable bus nodes, recognisable by the product labelling on the bus nodes → 2 Product identification.

Bus node	from revision	Network protocol
CPX-FB13 ¹⁾	30	PROFIBUS
CPX-FB33 ²⁾	21	PROFINET IO
CPX-M-FB34 ²⁾	21	PROFINET IO
CPX-M-FB35 ²⁾	21	PROFINET IO
CPX-FB43 ²⁾	50	PROFINET IO
CPX-M-FB44 ²⁾	50	PROFINET IO
CPX-M-FB45 ²⁾	50	PROFINET IO

1) → Description of CPX-FB13

2) → Description of CPX-(M)-FB33/34/35/43/44/45

Tab. 1: Permissible PROFIsafe-compatible CPX bus nodes

The CPX-F8DE-P may only be operated with the following manifold blocks:

Manifold block	Application examples
CPX-M-AB-4-M12X2-5POL-T	Connection of OSSD sensors with a current consumption up to 0.7 A – Power supply via contacts T0, T2, T4, T6. – Connection of sensors for mechanical switch contacts. – Clock signals via contacts T0 ... T7.
CPX-M-AB-4-M12X2-5POL	Connection of OSSD sensors with a current consumption up to 2 A.
CPX-AB-8-KL-4POL	Connection of sensors via the terminal strip.
CPX-AB-ID-P	Setting of a coded identifier using an 8x DIL switch. – It is not possible to connect sensors.

Tab. 2: Permissible manifold blocks

The CPX-F8DE-P may only be operated with the following interlinking blocks:

Interlinking block	Power supply
CPX-M-GE-EV	without
CPX-M-GE-EV-S-7/8-CL-P-4P	with system supply, connection: 7/8" (4-pin)
CPX-M-GE-EV-S-7/8-5POL	with system supply, connection: 7/8" (5-pin)
CPX-M-GE-EV-S-PP-5POL	with system supply, connection: push-pull (5-pin)
CPX-M-GE-EV-S-M12-5POL	with system supply, connection: M12 (5-pin)
CPX-M-GE-EV-Z-7/8-5POL	with additional supply, connection: 7/8" (5-pin)
CPX-M-GE-EV-Z-PP-5POL	with additional supply, connection: push-pull (5-pin)
CPX-M-GE-EV-W-M12-5POL	with forwarding supply, connection: M12 (5-pin)

Tab. 3: Permissible interlinking blocks

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Detailed information about the product, the supported product versions and required software versions as well as the permissible components of the CPX terminal can be found in the CPX system description P.BE-CPX-SYS-...

→ www.festo.com/sp.

Information about permissible configurations of the CPX terminal in combination with the input module can also be found in the catalogue

→ www.festo.com/catalogue.

1.3 Foreseeable misuse

The following foreseeable misuse is among those not approved as intended use:

- outdoor operation
- use in non-industrial areas
- use outside the limits of the product defined in the technical data
- use with inappropriate function modes
- unauthorised modifications.

NOTICE

The use of connection and interlinking blocks that are not specified is **not permissible** → 1.2 Rules for product configuration.

NOTICE

The use of the input module CPX-F8DE-P for implementation of safety circuits is **not permissible** in the following cases:

- in a CPX terminal equipped with CPX-FEC or CPX-CEC
- in a CPX terminal of variant P
- in configurations other than the configurations stated
→ 5.5 Function modes of the input module.

NOTICE

In the event of damage caused by unauthorised manipulation or use other than the intended use, the guarantee will be invalidated and the manufacturer will not be liable for damages.

1.4 Achievable safety classification

The CPX-F8DE-P can be used to implement safety functions up to:

- Performance Level e, Cat. 4 in accordance with EN ISO 13849-1
- Safety integrity level SIL 3 in accordance with EN 61508
- Performance Limit SIL CL 3 in accordance with EN 62061.

The achievable safety classification of the overall safety device depends on the set function mode as well as other components used to implement the safety function.

- Make sure that the overall safety function of the system is analysed and validated.
It is the responsibility of the operator to determine and verify the required safety classification (safety integrity level, performance level and category) of the system.
- Be aware of the residual risks that remain in your system despite the measures to integrate safety in the design, despite safety precautions and despite the supplementary protective measures.
The residual risks are determined, among other things, by your safety regulations and the safety characteristics of your system.

NOTICE

- Test the functionality of the safety device at adequate intervals. Recommendation:

- at least 1x per year for PL d
- at least 1x per month for PL e

The operator is responsible for selection of the type of test and the time intervals between the tests.

- Choose the test so that smooth functioning of the safety device in interaction with all components can be verified and is documented.

1.5 Failures due to a common cause (Common Cause Failure – CCF)

Common cause failures cause the loss of the safety function, since all channels in a multichannel system fail simultaneously.

The following measures ensure that common cause failures are prevented:

- Comply with operating voltage limits
- Comply with signal voltage limits
- Comply with temperature and environmental conditions.

The application may result in additional measures to avoid common cause failures.

1.6 Requirements for product use

- Make this brief description available to the design engineer, installation technician and personnel responsible for commissioning the machine or system in which this product is used.
- Keep this brief description throughout the entire product lifecycle.
- Make sure that the specifications in the documentation are observed at all times. Also comply with the documentation for the other components and modules (e.g. bus nodes, pneumatics).
- Take into consideration the legal regulations applicable for the location as well as:
 - instructions and standards
 - regulations of the testing organisations and insurers
 - national specifications.
- Remove all packaging, such as foils, caps and cardboard. The material used in the packaging has been specifically chosen for its recyclability (exception: oiled paper = residual waste).
- Assembly must be performed in a professionally correct manner. To maintain the IP degree of protection:
 - screw the manifold block tightly to seal it → 4.2 Disassembly and mounting
 - mount cable entry and seals in a professionally correct manner
 - seal unused connections with cover caps.
- Make sure that after a safety requirement the safety control unit monitors and controls the restart of the system.
- Make sure that, after every safety requirement resulting from a self-diagnostic test, the system does not automatically eliminate errors and restart itself.

1.7 Technical prerequisites

General information on correct and safe use of the product, which must be observed at all times:

- Comply with the technical operating limits → 7 Technical data. Only then is operation of the product guaranteed in accordance with the relevant safety regulations.
- When connecting standard auxiliary components, also observe the specified critical limits for temperatures, electrical data and torques.

1.8 Training of qualified personnel

The device may only be commissioned by trained, qualified control and automation technology technicians, who are familiar with:

- the installation and operation of control systems
- the applicable instructions for operating safety engineering systems
- the applicable instructions for accident prevention and occupational safety
- the documentation for the product.

NOTICE

Work on safety engineering systems may only be carried out by qualified personnel trained in safety engineering.

1.9 Product conformity

The product-relevant directives are listed in the declaration of conformity → www.festo.com/sp.

Product conformity

	in accordance with EU EMC Directive in accordance with EU Machinery Directive in accordance with EU RoHS Directive
	to UK EMC Regulations to UK Supply of Machinery Regulations to UK RoHS Regulations

Tab. 4: Product conformity

1.10 UL/CSA certification

Certain configurations of the product have been certified by Underwriters Laboratories Inc. (UL) for the USA and Canada.

These configurations bear the following mark:



UL Recognized Component Mark for Canada and the United States

Only for connection to an NEC Class 2 supply.

Raccorder Uniquement a un circuit de Classe 2.

Observe the following if your application must be in compliance with the UL requirements:

- Regulations for compliance with the UL certification can be found in the separate UL-specific special documentation. The relevant technical data in that documentation also takes priority if it does not influence the safety engineering values in an impermissible manner.
- The technical data in this documentation may show values deviating from this.

1.11 Specified standards

Version	
EN ISO 13849-1:2015	EN 61508 Part 1-7:2010
EN ISO 13849-2:2012	EN 62061:2021
EN 13851:2019	IEC 61131-2:2017
EN 60529:1991 + A1:1999 + A2:2013 + AC:2019	IEC 60204-1:2018

Tab. 5: Standards specified in the document

1.12 Transport and storage conditions

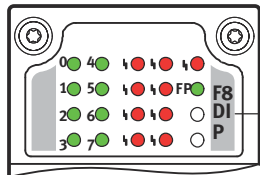
- Protect the product from excessive stress factors during transport and storage, such as:
 - mechanical loads
 - impermissible temperatures
 - moisture
 - aggressive atmospheres.
- Store and transport the product in its original packaging. The original packaging offers sufficient protection from typical stresses.

1.13 Service

Contact your local Festo Service centre in the event of technical problems.

2 Product identification

The product identification is the module identifier plus the product labelling. The module identifier can be seen through the transparent covering on the manifold block.

Module identifier	Meaning
	- Module identifier 1 : F8DIP (F=Safety; 8=Number; D=Digital; I=Inputs; P=PROFIsafe)

Tab. 6: Module identifier

The product labelling enables identification of the product and shows the following information, for example:

Product labelling (example)	Meaning
CPX-F8DE-P	Order reference
2597424	Part number
MM-YYYY:XX Rev XX	MM = manufacturing month YYYY = manufacturing year XX = plant number Rev XX = revision code
CE, UKCA and DataMatrix code	Identification
12345678901234	14-character serial number
Festo SE & Co. KG	Manufacturer
DE-73734 Esslingen	Manufacturer's address

Tab. 7: Product labelling (example)

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Additional information can be found in the CPX system description CPX-SYS-...

- Before using an input module, check whether the revision of the bus node corresponds to the requirements of the input module → Tab. 1 Permissible PROFIsafe-compatible CPX bus nodes.

This brief description applies to the following product

Product	Part number	Revision ¹⁾
CPX-F8DE-P	2597424	Rxx

1) xx stands for a number from 01 to 99

Tab. 8: Applicability

3 Connection and display components

3.1 Design of the input module

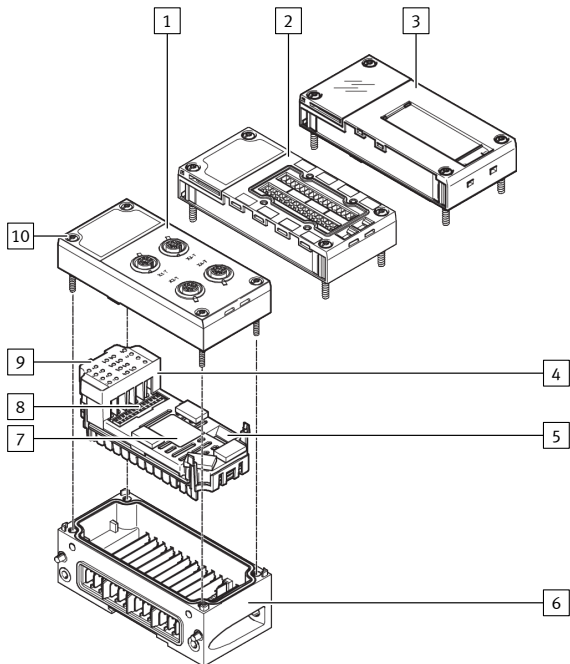


Fig. 1: Design of the input module CPX-F8DE-P

- | | | | |
|---|---|----|---|
| 1 | Manifold block CPX-M-AB-4-M12X2-5POL(-T) | 6 | Interlinking block with busbars, e.g. CPX-M-GE-EV |
| 2 | Manifold block CPX-AB-8-KL-4POL | 7 | Product labelling |
| 3 | Manifold block CPX-AB-ID-P with internal 8x DIL switch for coding | 8 | Electrical plug connector between electronics module and manifold block |
| 4 | Electronics module CPX-F8DE-P | 9 | LEDs of the electronics module |
| 5 | 10-way DIL switch for PROFIsafe address | 10 | Retaining screws |

NOTICE

Malfunctions possible due to missing shielding.

- Use only metal interlinking blocks.

4 Installation

WARNING

Electric voltage

Injury caused by electric shock, damage to machine and to system.

- Only use PELV circuits in accordance with IEC 60204-1 (protective extra-low voltage, PELV) for the electrical power supply.
- Observe the general requirements of IEC 60204-1 for PELV circuits.
- Use only voltage sources that guarantee a reliable electrical separation of operating and load voltage in accordance with IEC 60204-1.
- Always connect all power circuits for the operating and load voltage supplies $U_{EL/SEN}$, U_{VAL} and U_{OUT} .

Protection from electric shock (protection from direct and indirect contact) in accordance with IEC 60204-1 (Electrical equipment of machines, General requirements) is guaranteed with the use of PELV circuits.

NOTICE

Electronics modules include electrostatically sensitive devices.

Incorrect handling can cause damage to the electronics modules.

- Observe the handling specifications for electrostatically sensitive devices.
- Discharge static electricity from your body before assembling or disassembling modules to protect the modules.



Observe the instructions for electrical power supply (Protective Extra-Low Voltage, PELV) to CPX terminals in the CPX system description CPX-SYS-....



Monitoring of the sensor wiring for cross circuits depends on the functional modes used → 5.5 Function modes of the input module.

- Switch off the supply voltages before assembly or installation.
- Switch on the electrical supply voltage only when the product is completely mounted and all installation work is finished and checked.

4.1 Setting the PROFIsafe address

The electronics module of the CPX-F8DE-P includes a 10x DIL switch for setting an address for the PROFIsafe communications. The CPX-F8DE-P must be disassembled in order to change the address.

NOTICE

Damage to the electronics module due to incorrect handling.

Before mounting and removal → 4.2 Disassembly and mounting:

- Switch off operating voltage supply.

NOTICE

This PROFIsafe module accepts every PROFIsafe host address and thus fulfils the requirements for PROFIsafe address type 1.

1. Remove manifold block → 4.2 Disassembly and mounting.
2. Carefully set the PROFIsafe address at the 10x DIL switch with a small screwdriver. Permitted addresses: 1 ... 1022 (binary coded).

10x DIL switch	Address value	Addressing example
	DIL 1 = 1	+ 2
	DIL 2 = 2	
	DIL 3 = 4	
	DIL 4 = 8	
	DIL 5 = 16	+ 64
	DIL 6 = 32	
	DIL 7 = 64	
	DIL 8 = 128	
	DIL 9 = 256	+ 512
	DIL 0 = 512	
	= 578	

3. Replace the manifold block → 4.2 Disassembly and mounting.

4.2 Disassembly and mounting

The plugs connected to the manifold block can remain attached while disassembling the manifold block.

For disassembly → Fig. 1:

1. Switch off the operating and load voltage supply of the CPX terminal.
2. Unscrew retaining screws [10].
3. Carefully lift off manifold block [1], [2] or [3].
4. If required: carefully remove the electronics module [4] from the busbars.

For mounting:

- Prior to mounting make sure that the PROFIsafe address on the electronics module is set correctly → 4.1 Setting the PROFIsafe address.

NOTICE

- Make sure that the interlinking block (→ Fig. 1, [6]) is clean and free from foreign matter, especially in the area of the contact rails.
- Check seal and seal surfaces. Replace damaged parts.
- Make sure the connecting surfaces are clean. This serves to maintain the sealing effect and avoid contact errors.

1. Place the electronics module [4] in the proper position and without jamming into the interlinking block [6] and press it in until it stops.
2. Align manifold block [1], [2] or [3] and place it on the electronics module.
3. Screw retaining screws [10] into the existing threads.
4. Tighten retaining screws crosswise.
Tightening torque: 0.9 ... 1.1 Nm.

4.3 Pin allocation on the manifold block

Pin allocation	CPX-M-AB-4-M12X2-5POL		CPX-M-AB-4-M12X2-5POL-T ¹⁾	
	X1	X3	X1-T	X3-T
	1: 24 V	1: 24 V	1: T0	1: T4
	2: E1	2: E5	2: E1	2: E5
	3: 0 V	3: 0 V	3: 0 V	3: 0 V
	4: E0	4: E4	4: E0	4: E4
	5: FE	5: FE	5: T1 ¹⁾	5: T5 ¹⁾
	X2	X4	X2-T	X4-T
	1: 24 V	1: 24 V	1: T2	1: T6
	2: E3	2: E7	2: E3	2: E7
	3: 0 V	3: 0 V	3: 0 V	3: 0 V
	4: E2	4: E6	4: E2	4: E6
	5: FE	5: FE	5: T3 ¹⁾	5: T7 ¹⁾

1) Never connect pin 5 to functional earth (FE) on this manifold block.

Tab. 9: Pin allocation on the manifold block CPX-M-AB-4-M12X2-5POL(-T)

CPX-AB-8-KL-4POL			
Pin allocation X1, X2, X3, X4		Pin allocation X5, X6, X7, X8	
X1	.0 .1 .2 .3 .0 .1 .2 .3 .0 .1 .2 .3 .0 .1 .2 .3	X1 0: 24 V 1: 0 V 2: E0 3: FE ¹⁾ X2 0: T0 1: T1 2: E1 3: FE ¹⁾ X3 0: 24 V 1: 0 V 2: E2 3: FE ¹⁾ X4 0: T2 1: T3 2: E3 3: FE ¹⁾	X5 0: 24 V 1: 0 V 2: E4 3: FE ¹⁾ X6 0: T4 1: T5 2: E5 3: FE ¹⁾ X7 0: 24 V 1: 0 V 2: E6 3: FE ¹⁾ X8 0: T6 1: T7 2: E7 3: FE ¹⁾

1) FE = functional earth

Tab. 10: Pin allocation on the manifold block CPX-AB-8-KL-4POL

5 Commissioning

5.1 Starting behaviour of the input module

The following LEDs are used for commissioning and on-site diagnostics and are located under the transparent cover of the input module:

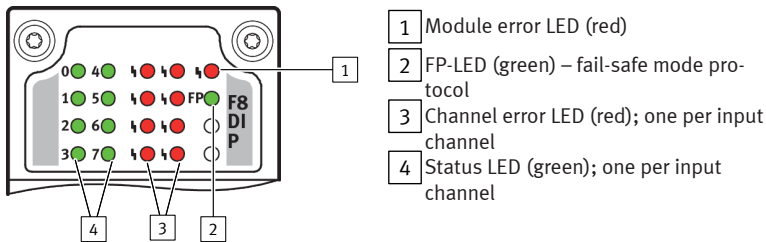


Fig. 2: LED display of the input module CPX-F8DE-P

NOTICE

The LED display of the input module is not designed for safety purposes.

- Please note that these LEDs should not be used for evaluation during safety-related activities.

When the operating voltage supply $U_{EL/SEN}$ is switched on, the module error LED **1** lights for approx. 500 ms.

The FP-LED **2** flashes until the input module is correctly parameterised by a PROFIsafe master.

The following LEDs are on in the normal operating status:

- FP-LED **2**
- Status LEDs **4** of the active input channels

The status LEDs on inactive input channels and the module error LEDs **1** and channel error LEDs **3** do not light.

NOTICE

The identifier of the LEDs corresponds to the physical contacts E0 to E7.

- Note the special position of the input signals in the input image of the CPX-F8DE-P.

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Additional information can be found in the CPX system description CPX-SYS-...

5.2 Parameter

CBUS parameter ¹⁾									
Offset	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Comment
22	0	0	0	0	0	0	0	0	Defined PROFIsafe address (→ 4.1 Setting the PROFIsafe address) low, high 16 bits = 2 bytes
23	0	0	0	0	0	0	0	0	

1) Read-only access

Tab. 11: Parameter

5.3 I/O image

The safety features of PROFIsafe mean that the input module CPX-F8DE-occupies 7 bytes for outputs and 6 bytes for inputs in the process image of the CPX terminal.

Output image (PAA)

The output image consists of 7 bytes as follows:

- 3 bytes output data (F-user data) → Tab. 12 Bit pattern of the output data (F-user data, bytes 0, 1 and 2)
- 1 control byte in the PAA (for PROFIsafe communication)
- 3 CRC bytes (for PROFIsafe communication).

Bit pattern of the output data

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	0	0	1/0	1/0
1 = channel-based passivation, 0 = module-based passivation								
1 = acknowledgment of a channel error								
1	8	4	2	1	8	4	2	1
Function mode for channel pair 7/6				Function mode for channel pair 5/4				
2	8	4	2	1	8	4	2	1
Function mode for channel pair 3/2				Function mode for channel pair 1/0				

Tab. 12: Bit pattern of the output data (F-user data, bytes 0, 1 and 2)

Input image (PAE)

The input image consists of 6 bytes as follows:

- 2 bytes input data (F-user data) → Tab. 13 Bit pattern of the input data (F-user data, byte 0 and byte 1)
- 1 status byte in the PAE (for PROFIsafe communication)
- 3 CRC bytes (for PROFIsafe communication).

Bit pattern of the input data: byte 0 and byte 1

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	E7	E5	E3	E1	E6	E4	E2	E0
Input image								
1	Q7	Q5	Q3	Q1	Q6	Q4	Q2	Q0
Qx = 1: signal Ex is valid Qx = 0: signal Ex is invalid, incorrect input function due to function mode/channel error/module error								

Tab. 13: Bit pattern of the input data (F-user data, byte 0 and byte 1)

5.4 Safe system status

Whenever an error is diagnosed in the input information for the module, the reaction depends on the selected module operating mode:

- With the "module-based passivation" operating mode (PAA byte 0, bit 1 = 0), the module passivation is performed in accordance with the PROFIsafe specification.
- For the operating mode "channel-based passivation" (PAA byte 0, bit 1 = 1), the relevant channel bits (Ex, Qx) in the input image (PAE byte 0 and 1) are set to logic zero.

Module passivation is based on the PROFIsafe specification in the case of a diagnosed internal module error.

The PROFIsafe timeout is the system reaction to a massive, stochastic failure of the module hardware.

5.5 Function modes of the input module

The input module CPX-F8DE-P includes various function modes for implementation of safety circuits with recommended sensors (→ Tab. 28 Recommended sensors). The function modes can be set separately for every channel pair.

NOTICE

The following applies for all applications of sensors and switches in combination with the corresponding function modes of the input module CPX-F8DE-P: The achievable safety integrity level, performance level and category of your system are limited by the component of the safety chain with the lowest characteristic value.

- Use only switches and sensors that meet the safety engineering requirements of the application.
- When using well-tried components in accordance with EN 13849-2, Table D.3, calculate the safety classification from the manufacturer's specifications.

The specifications of the switches and sensors include information on safety engineering considerations and operating conditions.

NOTICE

Some function modes may restrict the manifold blocks that can be selected.

- Make sure that the manifold block required for the safety function is used.

NOTICE

Malfunctions at unused inputs are possible.

- Make sure that function mode 0 is always set for unused channel pairs.

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For function modes with clock signals:

- Clock outputs T1, T3, T5 and T7 have the same clock signal.
- Clock outputs T0, T2, T4, and T6 are out of phase to one other and to T1/T3/T5/T7.

Function mode 0 – no signal evaluation	
Circuit diagram /channel pair connections	Comment
<p>The diagram shows a 24V supply connected to terminals T0, T2, T4, and T6. Terminals E1, E3, E5, and E7 are connected to 0V. Terminals E0, E2, E4, and E6 are also connected to 0V. Terminals T1, T3, T5, and T7 are connected to FE (Fault Enable).</p>	<p>Signals are not evaluated on channel pairs with this function mode.</p> <p>When switching on the input module, all channel pairs are in this mode by default.</p> <p>This function mode is used for initial commissioning of wiring and sensors.</p> <p>Both channels always generate a logic 0 as input information and a logic 1 as qualifier in the input image.</p> <p>The signals of connected sensors are displayed only at the status LEDs.</p>
Functional safety There is no safety-oriented evaluation in function mode 0.	

Tab. 14: Function mode 0

Function mode 1 – 1oo1 (T0, T2, T4, T6 static on)	
Circuit diagram /channel pair connections	Comment
<p>The diagram shows a 24V supply connected to terminals T0, T2, T4, and T6. Terminals E1, E3, E5, and E7 are connected to 0V. Terminals E0, E2, E4, and E6 are also connected to 0V. Terminals T1, T3, T5, and T7 are connected to FE.</p>	<p>Signal evaluation of up to 2 independent single-channel switches/sensors (N/O or N/C) per channel pair.</p> <p>In this function mode, T0, T2, T4 and T6 are at static 24 V DC.</p>
Functional safety – PL c, Cat. 1/SIL 1 with switch/sensor tried and tested in accordance with EN 13849-2, Table D.3, and with wiring protection of the customer application according to EN 13849-2, Table D.4	

Tab. 15: Function mode 1 – 1oo1

Function mode 2 – 1oo1 test (T0, T2, T4, T6 static off)	
Circuit diagram /channel pair connections	Comment
<p>The diagram shows a 24V supply connected to terminals T0, T2, T4, and T6. Terminals E1, E3, E5, and E7 are connected to 0V. Terminals E0, E2, E4, and E6 are also connected to 0V. Terminals T1, T3, T5, and T7 are connected to FE.</p>	<p>Signal evaluation of up to 2 single-channel switches/sensors (N/O or N/C) per channel pair.</p> <p>In this function mode, T0, T2, T4 and T6 are not connected to voltage.</p> <p>Function mode 2 can be used as a test mode when you connect sensors for function mode 1.</p> <p>A safety control that alternately uses the function mode 1 and 2 can in this way generate user-specific test signals and evaluate whether a zero crossover has taken place.</p> <p>Software-generated test signals only work with the following manifold blocks:</p> <ul style="list-style-type: none"> – CPX-M-AB-4-M12X2-5POL-T – CPX-AB-8-KL-4POL. <p>Safety requirements cannot be evaluated by the safety control unit during the test period.</p> <p>Function mode 2 can be alternatively used to reset sensors with self-monitored electronic outputs.</p>
Functional safety – PL c, Cat. 1/SIL 1 with switch/sensor tried and tested in accordance with EN 13849-2, Table D.3, and with wiring protection of the customer application according to EN 13849-2, Table D.4	

Tab. 16: Function mode 2 – 1oo1 test

Function mode 3 – 1oo1 T (with clock signal monitoring)	
Circuit diagrams /channel pair connections	Comment
<p>Diagram A shows a 24V supply connected to terminals T0, T2, T4, and T6. Terminals E1, E3, E5, and E7 are connected to 0V. Terminals E0, E2, E4, and E6 are also connected to 0V. Terminals T1, T3, T5, and T7 are connected to FE.</p>	<p>Signal evaluation of up to 2 independent single-channel switches/sensors per channel pair with individually clocked sensor power via T0, T2, T4, T6 and with common clock signal via T1, T3, T5, T7.</p> <p>This function mode is used to detect short circuits and cross circuits.</p> <p>Circuit diagram A 2 single-channel switches/sensors (N/O or N/C). Safety-related evaluation only with manifold blocks: – CPX-M-AB-4-M12X2-5POL-T – CPX-AB-8-KL-4POL.</p>
<p>Diagram B shows a 24V supply connected to terminals T0, T2, T4, and T6. Terminals E1, E3, E5, and E7 are connected to 0V. Terminals E0, E2, E4, and E6 are also connected to 0V. Terminals T1, T3, T5, and T7 are connected to FE.</p>	<p>Circuit diagram B 2 single-channel safety sensors with test input. Safety-related evaluation only with manifold block CPX-AB-8-KL-4POL. 8 safety sensors can be connected to this manifold block.</p>
Functional safety – PL c, Cat. 1/SIL 1 with switch/sensor tried and tested in accordance with EN 13849-2, Table D.3 – to PL c, Cat. 3/SIL 2 with certified switches/sensors of an appropriate safety classification and with wiring protection of the customer application according to EN 13849-2, Table D.4, and with testing of the safety application once a year – to PL e, Cat. 3/SIL 3 with certified sensor of an appropriate safety classification and with wiring monitoring by the connected sensor (circuit diagram B).	

Tab. 17: Function mode 3 – 1oo1 T

Function mode 4 – 1oo1 D (antivalent)	
Circuit diagrams /channel pair connections	Comment
<p>Diagram A shows a 24V supply connected to terminals T0, T2, T4, and T6. Terminals E1, E3, E5, and E7 are connected to 0V. Terminals E0, E2, E4, and E6 are also connected to 0V. Terminals T1, T3, T5, and T7 are connected to FE.</p>	<p>Signal evaluation of up to two independent dual-channel switches/sensors (internally antivalent, N/O or N/C) or up to 4 operationally tested switches per channel pair.</p> <p>The clock signals at E1, E3, E5 and E7 are wired as a mirror image of E0, E2, E4, E6. This function mode tests the switch function and wiring of the sensors.</p> <ul style="list-style-type: none"> – Use only sensors with antivalent outputs in which the one contact opens before the other contact closes. – Ensure that the N/O and/or N/C switches of sensors are connected with the appropriate clock signal connections for the channel pair → Circuit diagram. – Note that before every actuation a zero crossover is required (normally closed contact of the N/C switch closed). <p>Safety-related evaluation only with the following manifold blocks:</p> <ul style="list-style-type: none"> – CPX-M-AB-4-M12X2-5POL-T – CPX-AB-8-KL-4POL.
<p>Diagram B shows a 24V supply connected to terminals T0, T2, T4, and T6. Terminals E1, E3, E5, and E7 are connected to 0V. Terminals E0, E2, E4, and E6 are also connected to 0V. Terminals T1, T3, T5, and T7 are connected to FE.</p>	<p>Functional safety – PL e, Cat. 3/SIL 3 with 2 independent switches/sensors operationally tested according to EN 13849-2, Table D.3, these switches/sensors are to be implemented as independent systems in the customer application – to PL e, Cat. 3/SIL 3 with certified switches/sensors of an appropriate safety classification. </p>

Tab. 18: Function mode 4 – 1oo1 D

Function mode 5 – 1oo2 (equivalent)	
Circuit diagram /channel pair connections	Comment
<p>A</p> <p>Circuit diagram A A dual-channel switch/sensor (internally equivalent) per channel pair with uniformly unlocked sensor power. In this function mode, T0, T2, T4 and T6 are at static 24 V DC.</p> <p>Circuit diagram B OSSD sensor FE connection of the sensor via the M12 plug connector fitting of the module</p>	<p>Signal evaluation of a sensor (typically OSSD), which switches both signals of the channel pair simultaneously. The sensor can monitor short circuits and cross circuits.</p> <p>Circuit diagram A A dual-channel switch/sensor (internally equivalent) per channel pair with uniformly unlocked sensor power. In this function mode, T0, T2, T4 and T6 are at static 24 V DC.</p> <p>Circuit diagram B OSSD sensor FE connection of the sensor via the M12 plug connector fitting of the module</p>
<p>Functional safety</p> <ul style="list-style-type: none"> – to PL d, cat. 2 / SIL 2 with certified switches/sensors of an appropriate safety classification and with automatic testing of the safety function by the machine within 24 hours – to PL d, cat. 2 / SIL 3 with certified switches/sensors of an appropriate safety classification and with wiring protection of the customer application according to EN 13849-2, Table D.4, and with automatic testing of the safety function by the machine within 24 hours – to PL e, Cat. 4/SIL 3 with certified sensor (OSSD) of an appropriate safety classification and with wiring monitoring by the connected sensor (circuit diagram B). 	

Tab. 19: Function mode 5 – 1oo2

NOTICE

Note on function mode 5

Malfunction during use of OSSD sensors on the manifold block

CPX-M-AB-4-M12X2-5POL-T.

The connection of an FE contact to Pin 5 on an M12 socket causes a short circuit.

This causes malfunctioning signals T1, T3, T5 and T7.

The input module reports module error 02: “Short circuit 0 V at clock signal output T1357”.

- Connect the FE contact of a sensor only to the M12 plug screw connection of the module.

Function mode 6 – 1oo2 T (equivalent, with clock signal monitoring)	
Circuit diagram /channel pair connections	Comment
	<p>Signal evaluation of a dual-channel switch/sensor (internally equivalent) per channel pair with individually clocked power supply. This function mode is used to detect short circuits and cross circuits. This function mode is particularly suitable for applications that expect fast reactions (e.g. emergency stop, certified switches/sensors). Safety-related evaluation only with the following manifold blocks: – CPX-M-AB-4-M12X2-5POL-T – CPX-AB-8-KL-4POL.</p>
<p>Functional safety</p> <ul style="list-style-type: none"> – to PL e, Cat. 3/SIL 2 with certified switches/sensors of an appropriate safety classification – to PL e, Cat. 4/SIL 3 with certified switches/sensors of an appropriate safety classification and with automatic testing of the safety function by the machine within 24 hours – to PL e, Cat. 4/SIL 3 with certified switches/sensors of an appropriate safety classification and with wiring protection of the customer application according to EN 13849-2, Table D.4. 	

Tab. 20: Function mode 6 – 1oo2 T

Function mode 7 – 1oo2 D (two-hand control device EN 13851 Type IIIC)	
Circuit diagram /channel pair connections	Comment
	<p>Signal evaluation of up to 2 dependent two-channel switches/sensors (internally antivalent, N/O or N/C) per channel pair, with time monitoring of signal change. The clock signals at E1, E3, E5 and E7 are wired as a mirror image of E0, E2, E4, E6. – Pressing both pushbuttons within 500 ms generates a logic 1 in the input image of the channel pair. – Note that a zero crossing is required before every actuation (both N/C standby contacts closed). – Use only antivalent switches in which the one contact opens before the other contact closes. – Ensure that the N/O and/or N/C switches of sensors are connected with the appropriate clock signal connections for the channel pair → Circuit diagram. Safety-related evaluation only with the following manifold blocks: – CPX-M-AB-4-M12X2-5POL-T – CPX-AB-8-KL-4POL.</p>
<p>Functional safety</p> <ul style="list-style-type: none"> – PL e, Cat. 4/SIL 3 with 2 switches/sensors, wiring and safety function in accordance with EN 13851 Type IIIC. 	

Tab. 21: Function mode 7 – 1oo2 D

Function mode 8 – 1oo2 T (equivalent, with clock signal monitoring, robust)	
Circuit diagram /channel pair connections	Comment
	<p>Signal evaluation of mechanical contacts on a two-channel switch/sensor (internally equivalent) or of 2 independent, tried and tested switches. This function mode is equivalent to function mode 6, but is insensitive to bouncing contacts due to extended evaluation time. This function mode is thus not suitable for applications that expect fast reactions (e.g. light curtain). – Note the extended reaction time. – Use this function mode only with an intended maximum request rate of 1 per 60 s. Safety-related evaluation only with the following manifold blocks: – CPX-M-AB-4-M12X2-5POL-T – CPX-AB-8-KL-4POL.</p>
<p>Functional safety</p> <ul style="list-style-type: none"> – to PL e, Cat. 3/SIL 2 with certified switch/sensor of an appropriate safety classification or 2 independent tried and tested switches in accordance with EN 13849-2, Table D.3 – to PL e, Cat. 4/SIL 3 with certified switch/sensor of an appropriate safety classification or 2 independent tried and tested switches in accordance with EN 13849-2, Table D.3, and with automatic testing of the safety function by the machine within 24 hours – to PL e, Cat. 4/SIL 3 with certified switch/sensor of an appropriate safety classification or 2 independent tried and tested switches in accordance with EN 13849-2, Table D.3, and with wiring protection of the customer application according to EN 13849-2, Table D.4. 	

Tab. 22: Function mode 8 – 1oo2T (robust)

Function mode 9 – 1 of N (one of N)	
Circuit diagram /contacts	Comment
	<p>Evaluation of one of max. 8 signals with monitoring of signal change over time. The input image is switched 100 ms after actuation. This function mode serves to evaluate a mode selector switch or a rotary indexing table. – Use only consecutive channel pairs for channel bundling. – Activate this function mode for all channel pairs in use. Variants: 1 of 2, 1 of 4, 1 of 6 or 1 of 8. The circuit diagram shows the variant “1 of 4” as an example. The directly consecutive channel pairs E2/E3 and E4/E5 are used, which must both be set to function mode 9. The power supply can be optionally switched from T2 or 24 V to one of the inputs E2, E3, E4, E5. Required for this example: channel pairs E0/E1 and E6/E7 are not configured to function mode 9 → Tab. 24 Function mode 9 for multiple channel pairs for up to 2 circuits.</p>
<p>Functional safety</p> <ul style="list-style-type: none"> – PL c, Cat. 1/SIL 2 with tried and tested switches/sensors in accordance with EN 13849-2, Table D.3 – to PL e, Cat. 3/SIL 3 with certified switches/sensors of an appropriate safety classification. 	

Tab. 23: Function mode 9 – 1 of N

Multiple channel pairs in function mode 9

NOTICE

Ensuring operational reliability.

When evaluating more than two signals in a circuit:

- Use directly consecutive channel pairs.

When configuring two independent "1 of N" circuits on one input module:

- Ensure that the channel pairs used for the different circuits are **not** directly consecutive to one another.









The following table shows all permitted configurations for setting function mode 9 for several channel pairs.

Channel pair	E0	E1	E2	E3	E4	E5	E6	E7
"1 of 4" circuits	Mode 9		Mode 9					
			Mode 9		Mode 9			
					Mode 9		Mode 9	
"1 of 4" and "1 of 2" circuits	Mode 9				Mode 9		Mode 9	
	Mode 9		Mode 9				Mode 9	
"1 of 6" circuits	Mode 9		Mode 9		Mode 9			
			Mode 9		Mode 9		Mode 9	
"1 of 8" circuits	Mode 9		Mode 9		Mode 9		Mode 9	
Two independent "1 of 2" circuits	Mode 9				Mode 9			
			Mode 9				Mode 9	
	Mode 9						Mode 9	

Tab. 24: Function mode 9 for multiple channel pairs for up to 2 circuits

- Set the remaining channel pairs as desired – but not to function mode 9 –.

Function mode 10 – coded identifier

8x DIL switch	DIL	Value	Input	Comment
	8	Parity	E7	Evaluation of a coded identifier by DIL switch in manifold block CPX-AB-ID-P. To use the coded identifier: – Switch all channel pairs to function mode 10. Set coded identifier: 1. Set the desired identifier with switches 1 to 7. Then use values from 1 to 126. 2. If you have an odd number of switches (1 to 7) set to ON: also set parity bit (switch 8) to ON. Input image A 0 is always output in the input image instead of the parity bit so the set identifier in the safety control can always be used directly.
	7	64	E5	
	6	32	E3	
	5	16	E1	
	4	8	E6	
	3	4	E4	
	2	2	E2	
	1	1	E0	

Functional safety
 – PL e, Cat. 3/SIL 3
with certified switch of an appropriate safety classification or independent tried and tested switches in accordance with EN 13849-2, Table D.3
and with protection of the application against simple manipulation.
 The manifold block CPX-AB-ID-P meets these requirements for functional safety without any supplementary measures.

Tab. 25: Function mode 10 – coded identifier

6 Service, repair, disposal

The input module does not include parts requiring service or wearing parts.

NOTICE

Repairs are not allowed. Repairs will result in a lapse in conformity of the input module. A professional replacement of the electronics module is permissible.

NOTICE

Incorrect behaviour is possible.

- Always replace the input module if there is an internal fault.
- Return the unmodified defective input module to Festo for analysis with a description of the error and the application.

The material used in the packaging has been specifically chosen for its recyclability.

For final disposal of the input module, please contact a certified waste disposal business for electronic (WEE) scrap.

7 Technical data

i

General technical data of the CPX terminal → CPX-SYS-... system description

Approval information

CE	
Type-examination	The functional safety engineering of the product has been certified by an independent testing body, see EC-type examination certificate → www.festo.com/sp
Certificate issuing authority	TÜV Rheinland, Certification Body of Machinery, NB 0035

Approval information

Certificate no.	01/205/5444.01/21
UKCA	
Type-examination	The functional safety engineering of the product has been certified by an independent body, see UK-type examination certificate → www.festo.com/sp
Certificate issuing authority	TÜV Rheinland UK Ltd, UK Approved Body No. 2571
Certificate no.	01/205U/5444.00/22

Tab. 26: Approval information

Safety characteristics	Function mode										
	1	2	3	4	5	6	7	8	9	10	
T _{WCDT} Worst Case Delay Time (Max. internal reaction time to input signal)	[ms]	15	15	60	120	15	60	120	580	15	15
DC _{AVG} Average Diagnostic Coverage (average diagnostic coverage)	[%]	80 ¹⁾		99							
SFF Safe Failure Fraction (safe failure fraction)	[%]	84 ²⁾		99							
Minimum period of request		> Internal reaction time									
PROFIsafe Watchdog time	[ms]	F_WD_TIME									
Max. reaction time to input change	[ms]	F_WD_TIME + T _{WCDT}									
T _{DAT} Device Acknowledge Time (Internal PROFIsafe processing time)	[ms]	< 20									
MTTF _d Mean Time To dangerous Failure (Mean time to dangerous failure)	[years]	> 2500									
PFH _D Probability of dangerous Failure per Hour (probability of dangerous failure per hour)	[1/h]	1.0 x 10 ⁻⁹									
HFT Hardware Fault Tolerance (Hardware fault tolerance)		1									
Classification in accordance with EN 61508-2:2010-05		Type B									
β Beta factor for failures resulting from common cause CCF (Common Cause Failure)	[%]	2									
Max. useful life	[years]	20									
Safety protocol		Profile for Safety Technology on PROFIBUS DP and PROFINET IO; Version 2.4, March 2007									
Safety classification CPX-F8DE-P											
in accordance with EN ISO 13849-1	PL d, Cat. 2 ³⁾	to PL e, Cat. 4									
in accordance with EN 61508	SIL 2 ³⁾	bis SIL 3									
in accordance with EN 62061	SIL CL 2 ³⁾	to SIL CL 3									

1) Characteristic value if the application is tested within 24 hours: DCAVG = 94%

2) Characteristic value if the application is tested within 24 hours: SFF = 95%

3) Characteristic value if the application is tested within 24 h: to PL e Cat. 3, SIL 3, SIL CL 3

Tab. 27: Safety characteristics

Recommended sensors	Function mode									
	1	2	3	4	5	6	7	8	9	10
Sensors with mechanical switch contacts	–	–	◇	●	–	●	●	●	●	●
Sensors with self-monitored electronic outputs	◇	◇	–	–	●	–	–	–	●	●
Electronic three-wire sensors with a ready-state delay of < 23 ms	–	–	◇	–	–	◇	–	◇	–	–
or										
Electronic two-wire sensors with a ready-state delay of < 2 ms	–	–	–	–	–	–	–	–	–	–
Additionally:										
– with reverse polarity protection at the positive supply connection				●	–	–	–	–	–	–
or										
– without free-wheeling diode at the sensor output										
● Recommended function mode										
◇ Can be used with low safety requirement										

Tab. 28: Recommended sensors

Electrical characteristic values		
Nominal operating voltage DC	[V DC]	24
Residual ripple (tip to tip) in operating voltage range $U_{EL/SEN}$	[V _{SS}]	2
Permitted voltage tolerance		
– In metal interlinking blocks (CPX-M-GE...)	[%]	–15 ... +20
Voltage drop bypass time for the internal electronics	[ms]	10
Intrinsic current consumption at nominal operating voltage	[mA]	typ. 35
Undervoltage monitoring $U_{EL/SEN}$	[V]	$U < 19.5$ for $t > 250$ ms
Overvoltage monitoring $U_{EL/SEN}$	[V]	$U < 29.5$ for $t > 250$ ms
Potential reference of the input channels		$U_{EL/SEN}$
Electrical isolation between the channels		no
Input characteristics in accordance with IEC 61131-2 for digital inputs		Type 2
Max. accepted test pulse duration at the input	[ms]	0.7
Max. load current per clock line T0, T2, T4, T6	[A]	0.7
Max. resultant current at T1, T3, T5, T7	[A]	0.2
Max. output current at 24 V terminals	[A]	2
Max. residual current per input module	[A]	3
Cable lengths to sensor		
Cable type LiFY11Y-OB, unshielded, 3 x 0.14 mm ²	[m]	< 200
Cable type LiF9Y11Y, unshielded, 4 x 0.10 mm ²	[m]	< 200
Cable type LiYCY, shielded, 4 x 0.14 mm ²	[m]	< 200

Tab. 29: Electrical characteristic values

Module characteristic values	Function mode										
	0	1	2	3	4	5	6	7	8	9	10
Module code	28d (1Ch)										
Sub-module code	1d (01h)										
No. of inputs	8										
Switching logic at inputs	PNP (positive switching)										
Compatible with fast start-up (FSU)	Yes										
Time for switch-on phase until input module ready (start up) [s]	< 2										
Max. tolerance time until diagnostic message of channel fault [s]	–	–	–	0.5	10	0.5	0.5	10	2	2	2

Tab. 30: Module characteristic values

Ambient characteristics		
Ambient operating temperature	[°C]	–5 ... +50
Ambient temperature during storage and transportation	[°C]	–20 ... +70
Relative humidity (non-condensing)	[%]	5 ... 90
Contamination level in accordance with DIN EN 60664-1:2007		≤ 2
Degree of protection in accordance with IEC 60529		Dependent on the connection block ¹⁾
UL certification		c UL us - Recognised (OL)

1) → Description CPX-F8DE-P-..., "Technical data of the manifold blocks"

Tab. 31: Ambient characteristics

No	Error messages	Function mode										
		0	1	2	3	4	5	6	7	8	9	10
02	Channel error short circuit 24 V	–	–	–	✓	✓	–	✓	✓	✓	–	–
02	Module error short circuit 0 V clock output T1357	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
03	Channel error wire break	–	–	–	–	✓	–	–	✓	–	–	–
05	Module error undervoltage	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
29	Channel error configuration e.g. invalid function mode	–	–	–	–	–	–	–	–	–	–	–
55	Channel error process value	–	–	–	–	–	✓	✓	–	✓	✓	✓
61	Module error overvoltage	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
65	Module error F_DEST_ADD different	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
66	Module error communication	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
67	Module error communication timeout	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
68	Channel error cross circuit	–	–	–	✓	✓	–	✓	✓	✓	–	–
69	Module fault, parameters	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
75	Module error excessive temperature	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
80	Channel error channel function	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
145	Module error in self test	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Tab. 32: Error messages