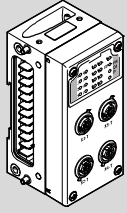


Input module CPX-F8DE-P



FESTO

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Brief description (Translation of the original instructions) 8035520
1505NH
[8035522]

Original: de

..... **English**

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1 Safety instructions



Warning

Non-observance of safety regulations 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 use to reliably acquire and evaluate signals of connected sensors.

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

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

The characteristics of the inputs correspond to the standard IEC 61131-2 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 named here (→ Section 5.5)
- within the limits of the product defined by the technical data (→ Section 7)
- in an industrial environment.



Note

Note that the safety 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 only in CPX terminals from Festo.

- Comply with all technical operating limits (→ Section 7). Otherwise, operative malfunctions can occur.

Operation of the CPX-F8DE-P is permissible only in combination with the following PROFI-safe-capable CPX bus nodes, recognisable on the product label of the bus node (→ Section 2).

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

1) → Description P.BE-CPX-FB13...

2) → Description P.BE-CPX-PN IO...

Fig. 1 Permissible PROFI-safe-capable CPX bus nodes

Operation of the CPX-F8DE-P is only permissible with the following connection blocks:

Connection block	Application examples
CPX-M-AB-4-M12X2-5POL-T	Connection of OSSD sensors with current consumption up to 0.7 A – Power connection via contacts T0, T2, T4, T6. Connection of sensors with mechanical switch contacts. – Clock signals via contacts T0 ... T7.
CPX-M-AB-4-M12X2-5POL	Connection of OSSD sensors with 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 via 8-off DIL switch. – Connection of sensors is not possible.

Fig. 2 Permissible connection blocks

Operation of the CPX-F8DE-P is only permissible with the following interlocking blocks:

Interlinking block	Power supply connection
CPX-M-GE-EV	none
CPX-M-GE-EV-S-7/8-CIP-4P	Power provided by system; connection: 7/8" (4-pin)
CPX-M-GE-EV-S-7/8-5POL	Power provided by system, connection: 7/8" (5-pin)
CPX-M-GE-EV-S-PP-5POL	Power provided by system, connection: push-pull (5-pin)
CPX-M-GE-EV-Z-7/8-5POL	With separate power supply, connection: 7/8" (5-pin)
CPX-M-GE-EV-Z-PP-5POL	With separate power supply, connection: push-pull (5-pin)

Fig. 3 Permissible interlinking blocks



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 misuses are not intended use:

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



Note

The use of connection and interlinking blocks that are not specified is **not permissible** (→ Section 1.2).



Note

In the following cases, the use of the input module CPX-F8DE-P for implementing of safety circuits is **not permissible**:

- in a CPX terminal equipped with CPX-FEC or CPX-CEC
- in a CPX terminal of variant P
- in configuration other than those named (→ Section 5.5).



Note

In the event of damage caused by unauthorised manipulation or unintended use, the guarantee is invalidated and the manufacturer is not liable for damages.

1.4 Attainable safety rating

With the CPX-F8DE-P, safety functions can be implemented 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 CL3 in accordance with EN 62061.

The attainable safety level of the overall safety system 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 document the required safety rating (safety integrity level, performance level and category) of the system.

- Note the residual risks that remain in your system despite the measures to integrate safety in the design, despite safety precautions and despite the supplementary safety measures.

These residual risks are determined, among other things, by your safety regulations and the safety characteristics of your system.



Note

- Test the safety equipment for flawless functioning at adequate intervals.
Recommendation:
 - at least once per year for PL d
 - at least once per month for PL e
- Selecting the type of test and time intervals between the tests is the responsibility of the operator.
- Choose the test so that flawless functioning of the safety equipment can be verified in interaction with all components and is documented.

1.5 Common cause failures (CCF)

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

Through the following measures, you ensure that common cause failures are avoided:

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

The application may require additional measures to be taken for avoiding common cause errors.

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 service life of the product.
- Make sure that the specifications of the documentation are always complied with. Also comply with the documentation for the other components and modules (e.g. bus nodes, pneumatic components).
- Take into consideration the legal regulations applicable for the installation site as well as:
 - Regulations and standards
 - regulations of the testing organisations and insurers
 - national specifications.
- Remove all transport packaging, such as foils, caps, cardboard. The material used in the packaging has been specifically chosen for its recyclability (exception: oil paper = residual waste).
- Make sure the components are mounted professionally. To maintain the IP degree of protection:
 - Screw the connection block on tight (→ Section 4.2)
 - Mount cable inlet and seals correctly
 - seal unused ports with cover caps.
- If the system had to be shutdown for safety reasons, make sure the safety controller monitors/controls all system restarts.
- Make sure that, after each safety request due to a self-diagnostic test, the system does not automatically eliminate errors and restart itself.

1.7 Technical prerequisites

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

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

1.8 Qualified personnel

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

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



Note

Work on safety-related systems may only be carried out by safety specialists.


1.9 Transport and storage conditions


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

1.10 Service

Consult your local Festo repair service if you have any technical problems.

1.11 Range of application and certifications

 This product is a safety device as defined in the Machinery Directive 2006/42/EC and carries the CE marking.

 **Safety-related standards and test values** which the product must comply with and fulfil can be found in the section Technical data. The product-relevant EC directives **and standards** can be found in the declaration of conformity → www.festo.com/sp

- Observe that compliance with the named standards is limited to the input module CPX-F8DE-P.

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 a NEC/CEC Class 2 supply.

Raccorder uniquement à un circuit de NEC/CEC Classe 2.



Note

Observe the following if the UL requirements are to be complied with in your application:

- Rules for complying with the UL certification can be found in the separate UL-specific special documentation. The relevant technical data in that documentation also apply with priority if they do not influence the safety characteristic values in an impermissible manner.
- The technical data in this documentation can show values deviating from this.

Specified directives and standards

EN ISO 13849-1:2008-06 + AC:2009	EN 61508 Part 1-7:2010
EN ISO 13849-2:2012	EN 62061:2005-04 + AC:2010 + A1:2013
EN 574:1996 + A1:2008	IEC 61131-2:2007-07
EN 60529:1991 + A1:1999 + A2:2013	IEC 60204-1:2005/A1:2009 + AC:2010

Fig. 4 Directives and standards specified in the document

2 Product identification

The module identifier and the product label are used to identify the product. The module identifier can be seen through the transparent cover of the connection block.

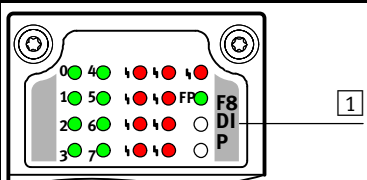
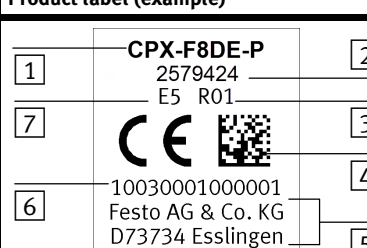
Module identifier	Significance
	– Module identifier 1 : F8DIP (F=safety; 8=number; D=digital; I=inputs; P=PROFIsafe)

Fig. 5

The product label of the electronics module CPX-F8DE-P (→ Fig. 6) includes the following information:


Product label (example)	Significance
	– Product designation 1
	– Part number 2 ¹⁾
	– Revision code (here R01) 3
	– Serial number represented as data matrix code 4 ²⁾
	– Manufacturer and manufacturer's address 5
	– 14-digit serial number 6 ²⁾
	– Production time period (encoded, here E5 = May 2014) 7 ³⁾

1) Part number of the electronics module CPX-F8DE-P.

2) The serial number makes it possible to trace the product.

3) → Description P.BE-CPX-F8DE-P...

Fig. 6 Product labelling of the electronics module CPX-F8DE-P

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

- Before using an input module, check whether the revision of the bus node corresponds to the requirements of the input module (→ Fig. 1).

This brief description applies to the following

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

1) xx stands for a number from 01 to 99 (→ Fig. 6 **3**)

Fig. 7 Product described in this documentation

3 Connection and display components

3.1 Structure of the input module

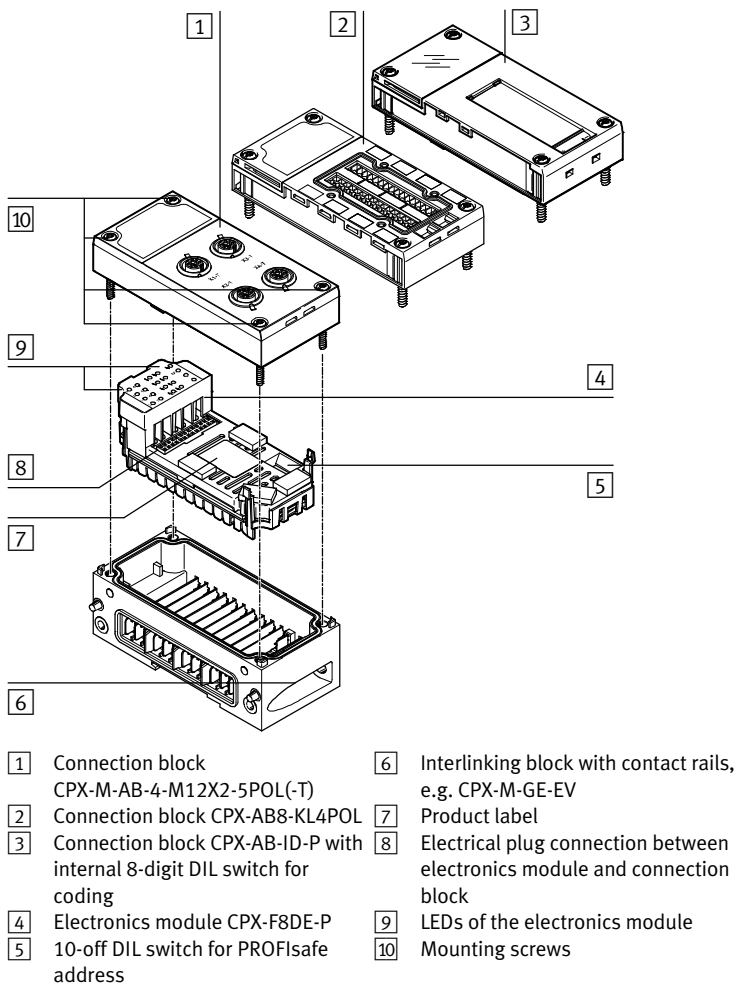


Fig. 8 Structure of the input module CPX-F8DE-P

Note

Malfunctions are possible due to inadequate shielding.
 • Use only interlinking blocks made of metal.

4 Installation

Warning

Electric voltage
 Risk of injuries caused by electric shock, damage to the machine and system.
 • For the electrical power supply, only use PELV power circuits in accordance with IEC 60204-1 (Protective Extra-Low Voltage, PELV).
 • Note the general requirements of IEC 60204-1 for PELV-power circuits.
 • Use only voltage sources that guarantee a reliable electric disconnection of operating and load voltage in accordance with IEC 60204-1.
 • Always connect all of the power circuits for operating and load voltage supplies $U_{EL/SEN}$, U_{VAL} and U_{OUT} .

By using of PELV circuits, protection from electric shock (protection from direct and indirect contact) is ensured in accordance with IEC 60204-1 (refer to Electrical Equipment of Machines. General Requirements).

Electronic modules include electrostatically sensitive devices. Incorrect handling can cause damage to the electronics modules.
 • Observe the handling specifications for electrostatically sensitive devices.
 • Discharge yourself electrostatically before assembling or disassembling modules to protect the modules.

Observe the regulations for providing voltage (Protective Extra-Low Voltage, PELV) to CPX terminals in the CPX system description P.BE-CPX-SYS-....

Monitoring of the sensor wiring for cross circuits depends on the function modes used (→ Section 5.5).

- Switch off the supply voltage before carrying out any mounting or installation work.
- Switch on the electrical supply voltage only when the product is completely mounted and all installation work is finished and checked.

4.1 Set PROFI-safe address

A 10-way DIL switch on the electronics module of the CPX-F8DE-P is used to set an address for PROFI-safe communication. To change this address, disconnect the CPX-F8DE-P.

Note

Damage to the electronics module due to incorrect handling. Before disconnecting or mounting (→ Section 4.2):
 • Switch off operating voltage supply.

1. Disconnect the connection block (→ Section 4.2).
2. Carefully set the PROFI-safe address at the 10-way DIL switch with a small screwdriver (→ Fig. 9). Permitted addresses: 1 ... 1022 (binary coded).

10-way 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	

Fig. 9 10-way DIL switch of the electronics module

3. Remount the connection block (→ Section 4.2).

4.2 Dismounting and mounting

The plugs connected to the connection block can remain attached when dismantling the connection block.

To dismount (→ Fig. 8):

1. Switch off the operating and load voltage supply of the CPX terminal.
2. Unscrew mounting screws [10].
3. Carefully lift off connection block [1], [2] or [3].
4. If necessary: pull the electronics module [4] carefully off the contact rails.

To mount:

- Before mounting, make sure that the PROFI-safe address is correctly set at the electronics module (→ Section 4.1).

Note

- Make sure that the interlinking block (→ Fig. 8 [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 maintains the sealing effect and avoids contact errors.

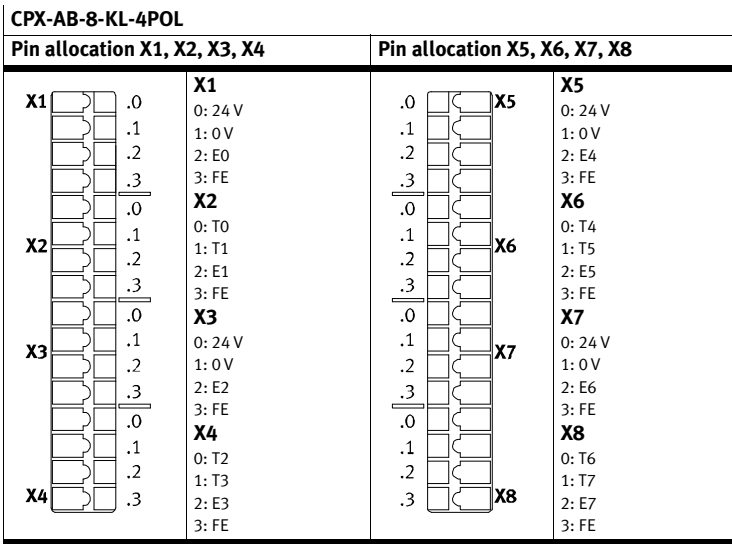
1. Place the electronics module [4] in the correct position without jamming into the interlinking block [6] and press it in until it stops.
2. Align connection block [1], [2] or [3] and place on the electronics module.
3. Screw mounting screws [10] into the existing threads.
4. Tighten the mounting screws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

4.3 Pin allocation on the connection block

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

1) On this connection block, never connect Pin 5 to functional earth (FE).

Fig. 10 Pin allocation on the connection block CPX-M-AB-4-M12X2-5POL(-T)



FE = functional earth

Fig. 11 Pin allocation on the connection block CPX-AB-8-KL-4POL

5 Commissioning

5.1 Starting the input module

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

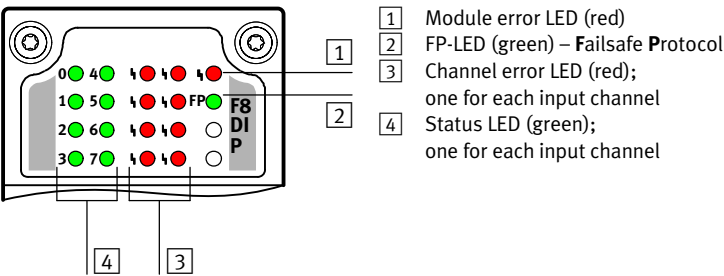


Fig. 12 LED display of the input module CPX-F8DE-P

→ Note

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

- Make sure not to evaluate these LEDs for safety-related activities.

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

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

During normal operation, the following LEDs light up:

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

The status LEDs of inactive input channels as well as the module error LED **1** and the channel error LEDs **3** do not light up.

→ Note

The designations of the LEDs correspond to the physical contacts E0 to E7.

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

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

5.2 Parameters

CBUS parameter ¹⁾									
Offset	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Comments
22	0	0	0	0	0	0	0	0	Set PROFIsafe address (→ Section 4.1) low, high 16 bits = 2 bytes
23	0	0	0	0	0	0	0	0	

¹⁾ Read-only access

Fig. 13

5.3 I/O image

Due to the safety features of PROFIsafe, the input module CPX-F8DE-P occupies 7 bytes for outputs and 6 bytes for inputs in the process map of the CPX terminal.

Output image (PAA)

The output image consists of 7 bytes, as follows:

- 3 bytes of output data (F-user data) → Fig. 14
- 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-wise passivation, 0 = module-wise passivation								
1 = Acknowledgment of a channel fault								
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				

Fig. 14 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 of input data (F-user data) → Fig. 15
- 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 fault								

Fig. 15 Bit pattern of the input data (F-user data, bytes 0 and 1)

5.4 Safe system status

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

- For the operating mode "module-wise passivation" (PAA byte 0, bit 1 = 0), module passivation takes place in accordance with PROFIsafe specification.
- For the operating mode "channel-wise passivation" (PAA byte 0, bit 1 = 1), the affected channel bits (Ex, Qx) in the input image (PAE byte 0 and 1) are set to logic 0.

For a diagnosed internal module error, module passivation takes place in accordance with PROFIsafe specification.

In the case of a massive, stochastic failure of the module hardware, the PROFIsafe timeout occurs as a system reaction.

5.5 Function modes of the input module

To create safety circuits with recommended sensors (→ Fig. 29), the input module CPX-F8DE-P provides various function modes. These function modes can be set separately for each channel pair.

→ Note

For all applications of sensors and switches in combination with the corresponding function modes of the input module CPX-F8DE-P, the following applies: 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 requirements of the application.
- When using proven components in accordance with EN 13849-2 Table D.3, calculate the safety category from the relevant manufacturer's specifications. The specifications of the switches and sensors include information on safety considerations and operating conditions.

→ Note

Some function modes limit the choice of connection blocks.

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



Note

Malfunctions at unused inputs are possible.

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



For function modes with clock signals:

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

Function mode 0 – no signal evaluation

Circuit diagram	Channel pair ports	Comments			
	T0/24 V	T2/24 V	T4/24 V	T6/24 V	<p>No signal evaluation is made at channel pairs with this function mode.</p> <p>When the input module is switched on, all channel pairs are preset to this mode. 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>
	E1	E3	E5	E7	
	0 V				
	E0	E2	E4	E6	
	T1/FE	T3/FE	T5/FE	T7/FE	

Functional safety

No safety-related evaluation is conducted in function mode 0.

Fig. 16 Function mode 0

Function mode 1 – 1001 (T0, T2, T4, T6 static on)

Circuit diagram	Channel pair ports	Comments			
	T0/24 V	T2/24 V	T4/24 V	T6/24 V	<p>Signal evaluation of up to 2 independent single-channel switches/sensors (NO or NC) per channel pair. In this function mode, T0, T2, T4 and T6 are at static 24 V DC.</p>
	E1	E3	E5	E7	
	0 V				
	E0	E2	E4	E6	
	T1/FE	T3/FE	T5/FE	T7/FE	

Functional safety

- PL c, Cat. 1 / SIL 1
- with** switch/sensor operationally tried and tested in accordance with EN 13849-2 Table D.3
- and with** wiring protection of customer application in accordance with EN 13849-2, Table D.4

Fig. 17 Function mode 1 – 1001

Function mode 2 – 1001 Test (T0, T2, T4, T6 static off)

Circuit diagram	Channel pair ports	Comments			
	T0	T2	T4	T6	<p>Signal evaluation of up to 2 single-channel switches/sensors (NO or NC) per channel pair. In this function mode, T0, T2, T4 and T6 are not connected to voltage.</p> <p>Function mode 2 can be used as test mode for sensor wiring of function mode 1.</p> <p>A safety controller that alternately uses the function mode 1 and 2 can thus 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 connection blocks:</p> <ul style="list-style-type: none"> – CPX-M-AB-4-M12X2-5POL-T – CPX-AB-8-KL-4POL. <p>During the testing time period, no safety requirements can be evaluated by the safety controller.</p> <p>Function mode 2 can alternatively be used for resetting sensors with self-monitoring electronic outputs.</p>
	E1	E3	E5	E7	
	0 V				
	E0	E2	E4	E6	
	T1/FE	T3/FE	T5/FE	T7/FE	

Functional safety

- PL c, Cat. 1 / SIL 1
- with** switch/sensor operationally tried and tested in accordance with EN 13849-2 Table D.3
- and with** wiring protection of customer application in accordance with EN 13849-2, Table D.4

Fig. 18 Function mode 2 – 1001 test

Function mode 3 – 1001 T (with clock signal monitoring)

Circuit diagrams	Channel pair ports	Comments			
	T0	T2	T4	T6	<p>Signal evaluation of up to 2 independent single-channel switches/sensors per channel pair with individually clocked sensor supply 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 and cross circuits.</p> <p>Example A</p> <p>2 single-channel switches/sensors (NO or NC).</p> <p>Safety evaluation only with connection blocks:</p> <ul style="list-style-type: none"> – CPX-M-AB-4-M12X2-5POL-T – CPX-AB-8-KL-4POL. <p>Example B</p> <p>2 single-channel safety sensors with test input.</p> <p>Safety evaluation only with connection block CPX-AB-8-KL-4POL.</p> <p>8 safety sensors can be connected to this connection block.</p>
	E1	E3	E5	E7	
0 V					
E0	E2	E4	E6		
T1	T3	T5	T7		

Functional safety

- PL c, Cat. 1 / SIL 1
- with** switch/sensor operationally tried and tested in accordance with EN 13849-2 Table D.3
- up to** PL c, Cat. 3 / SIL 2
- with** certified switch/sensor of suitable safety classification
- and with** wiring protection of customer application in accordance with EN 13849-2 Table D.4
- and with** testing of the safety application once a year
- up to** PL e, cat. 3 / SIL 3
- with** certified sensor appropriate for the given safety rating
- and with** wiring monitoring by the connected sensor (example B).

Fig. 19 Function mode 3 – 1001 T

Function mode 4 – 1001 D (antivalent)

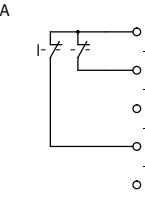
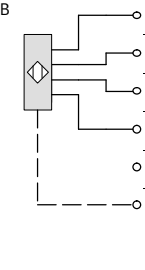
Circuit diagrams	Channel pair ports	Comments			
	T0	T2	T4	T6	<p>Signal evaluation of up to 2 independent dual-channel switches/sensors (internally antivalent, NO or NC) or up to 4 operationally tested switches per channel pair.</p> <p>At E1, E3, E5 and E7, the clock signals are wired as a mirror image of E0, E2, E4, E6.</p> <p>This function mode serves to check switching 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. • Make sure that the NO or NC switches of the sensors are connected with the matching clock signal connections of the channel pair (→ Circuit diagram). • Note that before each actuation a zero crossover is required (normally closed contact of the NC switch closed). <p>Safety evaluation only with the following connection blocks:</p> <ul style="list-style-type: none"> – CPX-M-AB-4-M12X2-5POL-T – CPX-AB-8-KL-4POL.
	E1	E3	E5	E7	
0 V					
E0	E2	E4	E6		
T1	T3	T5	T7		

Functional safety

- PL e, cat. 3 / SIL 3
- with** 2 independent switches/sensors operationally tried and tested in accordance with EN 13849-2 Table D.3;
- these switches/sensors must be implemented as independent systems in the customer application
- up to** PL e, cat. 3 / SIL 3
- with** certified switch/sensor appropriate for the given safety rating.

Fig. 20 Function mode 4 – 1001D

Function mode 5 – 1oo2 (equivalent)

Circuit diagrams	Channel pair ports	Comments																				
	<table border="1"> <tr><td>T0/24 V</td><td>T2/24 V</td><td>T4/24 V</td><td>T6/24 V</td></tr> <tr><td>E1</td><td>E3</td><td>E5</td><td>E7</td></tr> <tr><td colspan="4">0 V</td></tr> <tr><td>E0</td><td>E2</td><td>E4</td><td>E6</td></tr> <tr><td>T1/FE</td><td>T3/FE</td><td>T5/FE</td><td>T7/FE</td></tr> </table>	T0/24 V	T2/24 V	T4/24 V	T6/24 V	E1	E3	E5	E7	0 V				E0	E2	E4	E6	T1/FE	T3/FE	T5/FE	T7/FE	<p>Example A A dual-channel switch/sensor (internally equivalent) per channel pair with uniformly unlocked sensor supply. In this function mode, T0, T2, T4 and T6 are at static 24 V DC.</p>
	T0/24 V	T2/24 V	T4/24 V	T6/24 V																		
E1	E3	E5	E7																			
0 V																						
E0	E2	E4	E6																			
T1/FE	T3/FE	T5/FE	T7/FE																			
	<table border="1"> <tr><td>24 V</td><td>24 V</td><td>24 V</td><td>24 V</td></tr> <tr><td>E1</td><td>E3</td><td>E5</td><td>E7</td></tr> <tr><td colspan="4">0 V</td></tr> <tr><td>E0</td><td>E2</td><td>E4</td><td>E6</td></tr> <tr><td>T1</td><td>T3</td><td>T5</td><td>T7</td></tr> </table> <p>FE connection of the sensor via the M12 plug connector fitting of the module</p>	24 V	24 V	24 V	24 V	E1	E3	E5	E7	0 V				E0	E2	E4	E6	T1	T3	T5	T7	<p>Example B OSSD sensor</p>
	24 V	24 V	24 V	24 V																		
E1	E3	E5	E7																			
0 V																						
E0	E2	E4	E6																			
T1	T3	T5	T7																			

Functional safety

- up to PL d, Cat. 2 / SIL 2
with certified switch/sensor of an appropriate safety category
and with automatic testing of the safety function by the machine within 24 hours
- up to PL d, Cat. 2 / SIL 3
with certified switch/sensor of appropriate safety category
and with wiring protection of the customer application in accordance with EN 13849-2 Table D.4
and with automatic testing of the safety function by the machine within 24 hours
- up to PL e, cat. 4 / SIL 3
with certified sensor (OSSD) appropriate for the safety rating
and with wiring monitoring through the connected sensor (example B).

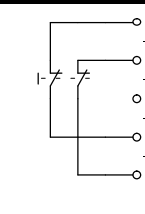
Fig. 21 Function mode 5 – 1oo2

→ Note on function mode 5

Malfunction if OSSD sensors are used at the connection 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 would result in interference with the signals T1, T3, T5 and T7.
The input module reports module fault 02: “Short circuit 0 V at clock signal output T1357”.

- Connect the FE contact of a sensor only to the M12 plug connector fitting of the module.

Function mode 6 – 1oo2 T (equivalent, with clock monitoring)

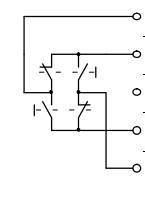
Circuit diagram	Channel pair ports	Comments																				
	<table border="1"> <tr><td>T0</td><td>T2</td><td>T4</td><td>T6</td></tr> <tr><td>E1</td><td>E3</td><td>E5</td><td>E7</td></tr> <tr><td colspan="4">0 V</td></tr> <tr><td>E0</td><td>E2</td><td>E4</td><td>E6</td></tr> <tr><td>T1</td><td>T3</td><td>T5</td><td>T7</td></tr> </table>	T0	T2	T4	T6	E1	E3	E5	E7	0 V				E0	E2	E4	E6	T1	T3	T5	T7	<p>Safety evaluation only with the following connection blocks: – CPX-M-AB-4-M12X2-5POL-T – CPX-AB-8-KL-4POL.</p>
	T0	T2	T4	T6																		
E1	E3	E5	E7																			
0 V																						
E0	E2	E4	E6																			
T1	T3	T5	T7																			
<p>Functional safety</p> <ul style="list-style-type: none"> – up to PL e, cat. 3 / SIL 2 with certified switch/sensor appropriate for the given safety rating – up to PL e, cat. 4 / SIL 3 with certified switch/sensor appropriate for the safety rating and with automatic testing of the safety function by the machine within 24 hours – up to PL e, cat. 4 / SIL 3 with certified switch/sensor appropriate for the given safety rating and with wiring protection of the customer application in accordance with EN 13849-2 Table D.4. 																						

Functional safety

- up to PL e, cat. 3 / SIL 2
with certified switch/sensor appropriate for the given safety rating
- up to PL e, cat. 4 / SIL 3
with certified switch/sensor appropriate for the safety rating
and with automatic testing of the safety function by the machine within 24 hours
- up to PL e, cat. 4 / SIL 3
with certified switch/sensor appropriate for the given safety rating
and with wiring protection of the customer application in accordance with EN 13849-2 Table D.4.

Fig. 22 Function mode 6 – 1oo2T

Function mode 7 – 1oo2 D (two-hand control device EN 574 type IIIC)

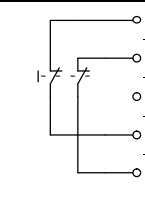
Circuit diagram	Channel pair ports	Comments																				
	<table border="1"> <tr><td>T0</td><td>T2</td><td>T4</td><td>T6</td></tr> <tr><td>E1</td><td>E3</td><td>E5</td><td>E7</td></tr> <tr><td colspan="4">0 V</td></tr> <tr><td>E0</td><td>E2</td><td>E4</td><td>E6</td></tr> <tr><td>T1</td><td>T3</td><td>T5</td><td>T7</td></tr> </table>	T0	T2	T4	T6	E1	E3	E5	E7	0 V				E0	E2	E4	E6	T1	T3	T5	T7	<p>– If both pushbuttons are actuated within 500 ms, a logic 1 is set in the input image of the channel pair. – Before each actuation, a zero crossover is required (both normally closed contacts NC closed). • Use only antivalent switches in which the one contact opens before the other contact closes. • Make sure that the NO or NC switches of the sensors are connected with the matching clock signal connections of the channel pair (→ Circuit diagram).</p> <p>Safety evaluation only with the following connection blocks: – CPX-M-AB-4-M12X2-5POL-T – CPX-AB-8-KL-4POL.</p>
	T0	T2	T4	T6																		
E1	E3	E5	E7																			
0 V																						
E0	E2	E4	E6																			
T1	T3	T5	T7																			
<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 574 type IIIC. 																						

Functional safety

- PL e, cat. 4 / SIL 3
with 2 switches/sensors, wiring and safety function in accordance with EN 574 type IIIC.

Fig. 23 Function mode 7 – 1oo2D

Function mode 8 – 1oo2 T (equivalent, with clock monitoring, robust)

Circuit diagram	Channel pair ports	Comments																				
	<table border="1"> <tr><td>T0</td><td>T2</td><td>T4</td><td>T6</td></tr> <tr><td>E1</td><td>E3</td><td>E5</td><td>E7</td></tr> <tr><td colspan="4">0 V</td></tr> <tr><td>E0</td><td>E2</td><td>E4</td><td>E6</td></tr> <tr><td>T1</td><td>T3</td><td>T5</td><td>T7</td></tr> </table>	T0	T2	T4	T6	E1	E3	E5	E7	0 V				E0	E2	E4	E6	T1	T3	T5	T7	<p>• Observe the extended reaction time. • Use this function mode only with an intended maximum request rate of 1 per 60 s.</p> <p>Safety evaluation only with the following connection blocks: – CPX-M-AB-4-M12X2-5POL-T – CPX-AB-8-KL-4POL.</p>
	T0	T2	T4	T6																		
E1	E3	E5	E7																			
0 V																						
E0	E2	E4	E6																			
T1	T3	T5	T7																			
<p>Functional safety</p> <ul style="list-style-type: none"> – up to PL e, cat. 3 / SIL 2 with certified switch/sensor appropriate for the given safety rating or 2 independent, tested switches in accordance with EN 13849-2 Table D.3 – up to PL e, cat. 4 / SIL 3 with certified switch/sensor appropriate for the safety rating or 2 independent, 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 – up to PL e, cat. 4 / SIL 3 with certified switch/sensor appropriate for the safety rating or two independent, tested switches in accordance with EN 13849-2 Table D.3 and with wiring protection of the customer application in accordance with EN 13849-2, Table D.4. 																						

Functional safety

- up to PL e, cat. 3 / SIL 2
with certified switch/sensor appropriate for the given safety rating or 2 independent, tested switches in accordance with EN 13849-2 Table D.3
- up to PL e, cat. 4 / SIL 3
with certified switch/sensor appropriate for the safety rating or 2 independent, 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
- up to PL e, cat. 4 / SIL 3
with certified switch/sensor appropriate for the safety rating or two independent, tested switches in accordance with EN 13849-2 Table D.3
and with wiring protection of the customer application in accordance with EN 13849-2, Table D.4.

Fig. 24 Function mode 8 – 1oo2T (robust)

Function mode 9 – 1 of N (one of N)

Circuit diagram	Contacts	Comments
	T2/24 V	Evaluation of one of a maximum of 8 signals with monitoring of the signal change over time. The input image is switched 100 ms after actuation.
	E3	
	0 V	This function mode serves to evaluate an operating mode switch or a rotary indexing table.
	E2	
	T3/FE	<ul style="list-style-type: none"> Use for channel bundling of consecutive channel pairs. Activate this function mode for all channel pairs used. Variants: 1 of 2, 1 of 4, 1 of 6 or 1 of 8.
	T4/24 V	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 switched optionally from T2 or 24 V to one of the inputs E2, E3, E4, E5.
	E5	
	0 V	
	E4	Prerequisite for this example: channel pairs E0/E1 and E6/E7 are not configured for function mode 9 → Fig. 26.
	T5/FE	

Functional safety

- PL c, Cat. 1 / SIL 2
- with** tried and tested switches/sensors in accordance with EN 13849-2 Table D.3
- up to PL e, cat. 3 / SIL 3
- with** certified switches/sensors appropriate for the safety rating.

Fig. 25 Function mode 9 – 1 of N

Several channel pairs in function mode 9

→ **Note**

Ensuring operational reliability.

When evaluating more than two signals in a circuit:

- Use directly consecutive channel pairs.

For configuration of 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 the 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			
“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	

Fig. 26 Function mode 9 for several 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

8-way DIL switch	DIL	Value	Input	Comments
	8	Parity	E7	Evaluation of a coded identifier through DIL switch in the connection block CPX-AB-ID-P. To use the coded identifier: <ul style="list-style-type: none"> Switch all channel pairs to function mode 10. Setting coded identifier <ol style="list-style-type: none"> Set the desired identifier with the switches 1 to 7. Use only values from 1 to 126. If an odd number of switches are set to ON (1 to 7): also set parity bit (switch 8) to ON. Input image In the input image, a 0 is always output instead of the parity bit, so that the set identifier in the safety controller 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/sensor appropriate for the safety rating or independent, proven switches in accordance with EN 13849-2 Table D.3
- and with** protection of the application against simple tampering.

The connection block CPX-AB-ID-P meets these conditions regarding functional safety without any supplementary measures.

Fig. 27 Function mode 10 – coded identifier

6 Service, repair, disposal

The input module includes no parts requiring service and no parts subject to wear and tear.

→ **Note**

Repairs are not allowed. The conformity of the input module is cancelled by repairs. The electronics module may be replaced by a duly trained technician.

→ **Note**

If the input module is defective.

- Always replace the input module if there is an internal error.
- Send the unmodified defective input module, including a description of the error and the application, back to Festo for analysis.

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 management company for electronic waste.

7 Technical data

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

Safety characteristics	Function mode									
	1	2	3	4	5	6	7	8	9	10
Safety rating CPX-F8DE-P										
– in accordance with EN ISO 13849-1	PL d, cat. 2 ¹⁾		to PL e, cat. 4							
– in accordance with EN 61508	SIL 2 ¹⁾		to SIL 3							
– in accordance with EN 62061	SIL CL 2 ¹⁾		to SIL CL 3							
Worst case delay time (Max. internal reaction time to input signal) T_{WCDT} [ms]	15	15	60	120	15	60	120	580	15	15
Average diagnostic coverage DC_{AVG} [%]	80 ²⁾		99							
Safe failure fraction SFF [%]	84 ³⁾		99							
Minimum period of request	> Internal reaction time									
PROFIsafe watchdog time [ms]	F_WD_TIME									
Max. reaction time to input change	F_WD_TIME + T_{WCDT}									
Device acknowledge time (Internal PROFIsafe processing time) T_{DAT} [ms]	< 20									
Mean time To dangerous failure $MTTF_d$ [Years]	> 2500									
Probability of dangerous failure per hour PFH_D	1.0×10^{-9}									
Hardware fault tolerance HFT	1									
Classification according to EN 61508-2:2010-05	Type B									
Beta factor for failures resulting from common cause CCF (common cause failure) β [%]	2									
Max. useful life [Years]	20									
Safety protocol	Profile for safety technology on PROFIBUS DP and PROFINET IO; Version 2.4, March 2007									
Type test → www.festo.com/sp	The functional safety technology of the product has been certified by an independent testing body; see EC type test certificate.									
CE marking (→ Declaration of conformity) → www.festo.com/sp	In accordance with EU Machinery Directive 2006/42/EC In accordance with EU EMC Directive 2004/108/EC									
Certificate issuing authority	01/205/5444.00/15									

- 1) Characteristic value if the application is tested within 24 hours: to PL e cat 3, SIL 3, SIL CL 3
- 2) Characteristic value if the application is tested within 24 hours: $DC_{AVG} = 94\%$
- 3) Characteristic value if the application is tested within 24 hours: $SFF = 95\%$

Fig. 28 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 readiness delay of < 23 ms or Electronic two-wire sensors with a readiness delay of < 2 ms	–	–	◇	–	–	◇	–	◇	–	–
Additionally: – with reverse polarity protection in the positive power supply or – without free-wheeling diode at the sensor output.	–	–	–	●	–	–	–	–	–	–

- Recommended function mode
- ◇ Can be used if the safety requirements are low

Fig. 29 Recommended sensors

Electrical characteristic values

Nominal operating voltage DC	[V DC]	24
Residual ripple (peak-peak) in operating voltage range $U_{EL/SEN}$	[V _{SS}]	2
Permitted voltage tolerance	[%]	–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 channels		no
Input characteristic in accordance with IEC 61131-2 for digital inputs		Typ e2
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. resultant current per input module	[A]	3
Cable lengths to sensor		
– Cable type LiFY11Y-OB, unshielded, 3 x 0.14 sq. mm	[m]	< 200
– Cable type LiFY9Y11Y, unshielded, 4 x 0.10 sq. mm	[m]	< 200
– Cable type LiYCY, shielded, 4 x 0.14 sq. mm	[m]	< 200

Fig. 30 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)										
Number 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

Fig. 31 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
Degree of contamination in accordance with DIN EN 60664-1:2007		≤ 2
Degree of protection in accordance with IEC 60529		Depends on the connection block ¹⁾
Electromagnetic compatibility (EMC) – Resistance to interference and emitted interference		Declaration of Conformity (→ www.festo.com/sp)
UL certification		c UL us - Recognized (OL)

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

Fig. 32 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 broken cable	–	–	–	–	✓	–	–	✓	–	–	–
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 error parameter	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
75	Module error, overtemperature	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
80	Channel error channel function	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
145	Module error in self test	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Fig. 33 Error messages