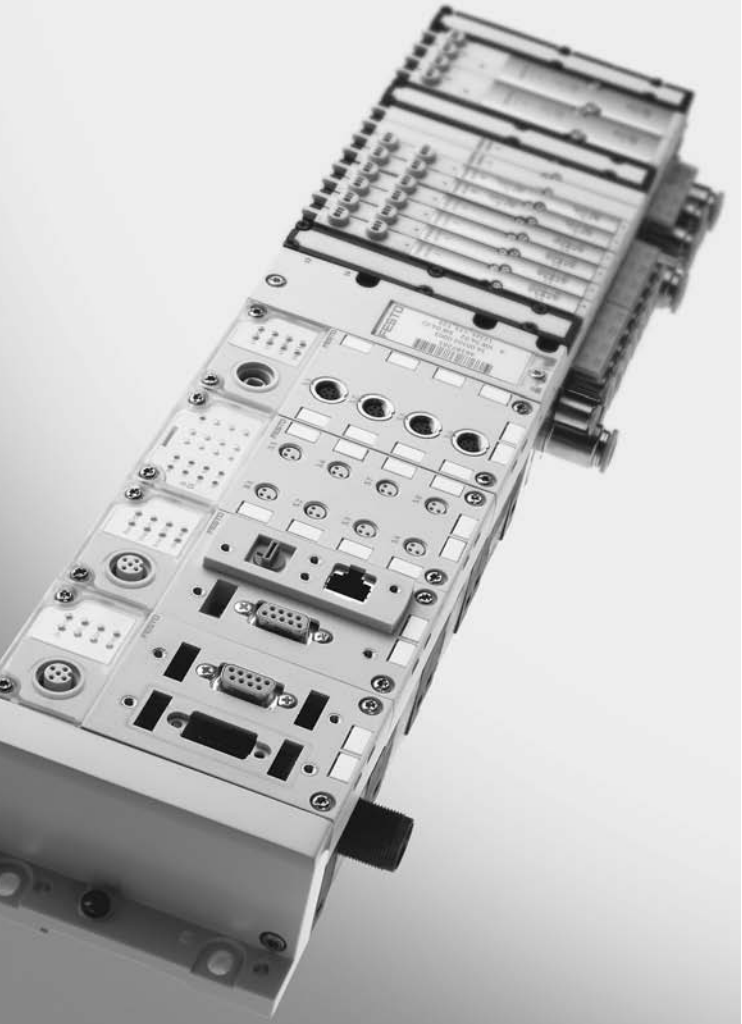
CPX terminal



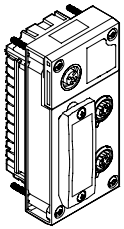
FESTO

Manual
Electronics

CPX bus node

Type CPX-FB38

Network protocol
EtherCAT



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Internet: http://www.festo.com
E-Mail: service_international@festo.com

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SPEEDCON®	is a registered trademark of PHOENIX Contact GmbH & Co. KG, Blomberg, Germany
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Contents

Intended use

The field bus node type CPX-FB38 described in this manual has been designed exclusively for use as a slave (I/O device or “Box”) in an EtherCAT network.

The CPX terminal must only be used as follows:

– as designated in industrial applications

– in original condition without modification (only the conversions or modifications described in the documentation supplied with the product are permitted).

– in faultless technical condition.

The maximum values specified for pressures, temperatures, electrical data, torques etc. must be observed.

If additional commercially available components such as sensors and actuators are connected, the specified limits for pressures, temperatures, electrical data, torques, etc. must not be exceeded.

Also observe the standards specified in the relevant chapters, as well as national and local laws and technical regulations.

Warning

- In order to provide the electric power supply, use only PELV **circuits** as per IEC/DIN EN 60204-1 (Protective Extra-Low Voltage, PELV).
  Take into account also the general requirements for PELV circuits as per IEC/DIN EN 60204-1.
- Use only **power packs** which guarantee reliable electrical isolation of the operating voltage as per IEC/DIN EN 60204-1.

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

If implementing an emergency stop function, note the measures listed in the sections 2.5.1, 2.8 and 3.1.

Target group

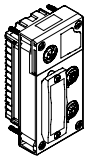
This manual is intended exclusively for technicians trained in control and automation technology, who have experience in installing, commissioning, programming and diagnosing programmable logic controllers (PLC) and Fieldbus systems.

Service

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

Notes about the use of this manual

This manual contains information about the following module:

CPX bus node	Type designation	Manual	Connections
	CPX-FB38	Ethernet-based CPX bus node for EtherCAT. The EtherCAT field bus technology uses the Ethernet standards for real-time communication in an industrial environment. Data transmission: – EtherCAT, based on the Ethernet protocol (IEEE 802.3), optimised for process data, real time possible – Transmission of process data in the Ethernet framework – Industrial Ethernet, Switched Fast Ethernet, 100 Mbit/s Standards and norms with regard to EtherCAT: – IEC 61158 – IEC 61784 – IEC 61918 – ISO/IEC 8802-3 Further information: http://ethercat.org	2 x M12 socket, D-coded, female, 4-pin, according to IEC 61076-2-101, SPEEDCON® compatible

Tab. 0/1: Overview of CPX bus node for EtherCAT

This manual contains information about installation and configuration of the CPX bus node for EtherCAT as well as EtherCAT-specific informationen regarding parameterisation, start-up, programming and diagnosis of a CPX terminal in an EtherCAT network.

Further information about EtherCAT can be found in the Internet:

– EtherCAT Technology Group: http://www.ethercat.org/

– EtherCAT-specifications (“EtherCAT Specification”, “Profiles”), guidelines (“Guidelines”) and instructions (e.g. “How to configure an EtherCAT Slave Device”): http://www.ethercat.org/en/publications.html

General basic information about the method of operation, fitting, installing and commissioning CPX terminals can be found in the CPX system manual P.BE-CPX-SYS-...

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

An overview of the structure of the CPX terminal user documentation is contained in the CPX system manual P.BE-CPX-SYS-...

Product specific information about the control system (IPC, PLC or I/O controller) can be found in the manufacturer’s product documentation.

Important user instructions

Danger categories

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

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

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

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

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

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

Marking special information

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

Pictograms

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

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

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

Text markings

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

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

– Hyphens indicate general activities.

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

Term/abbreviation	Meaning
$A0_h$	Hexadecimal numbers are marked by a low-set “h”
AB	Output byte
Bus nodes	Create the connection to certain networks or field busses, pass on control signals to the connected modules and monitor their functioning
CP	Compact Performance
CPX terminal	Complete system consisting of CPX modules with or without pneumatics
CPX modules	Common term for the various modules which can be incorporated in a CPX terminal
DIL switches	Miniature switch; dual-in-line switches consist of several switch elements with which settings can be made
FEC	Front End Controller, e.g. CPX-FEC, can be installed as: – independent system controller (PLC, Stand Alone operating mode) – system controller (PLC, Stand Alone operating mode) – field bus slave (Remote I/O operating mode)
FMT	Festo Maintenance Tool (CPX-FMT); configuration and programming software for CPX modules for start-up and service purposes
Handheld control unit (MMI)	Manual control unit (handheld control unit, CPX-MMI) for CPX modules for start-up and service purposes (Man-Machine Interface, MMI)
I	Digital input
IB	Input byte
I/O modules	Collective term for the CPX modules which provide digital inputs and outputs
I/Os	Digital inputs and outputs
O	Digital output
Octet	Number of address words assigned by the CPX terminal

Tab. 0/2: Specific terms and abbreviations – part 1

Term/abbreviation	Meaning
EtherCAT	An industrial-Ethernet based field-bus system for data exchange between system controller (IPC), equipment controller (e.g. CPX-FEC) and field devices (I/O devices) or drives; transmission of process data into data objects (following the field-bus protocol CANopen); embedding of process data into Ethernet frames (Frames) or datagrams (via UDP/IP); additional information: www.ethercat.org
PLC	Programmable Logic Controller
PLC/IPC	Programmable Logic Controller / Industrial PC
Pneumatic interface	The pneumatic interface is the interface between the modular electrical periphery and the pneumatics
STI	I/O diagnostic interface (system table interface)

Tab. 0/3: Specific terms and abbreviations – part 2

Installation

Chapter 1

Contents

1.1 General instructions on installation

Warning
Switch off the following equipment before undertaking installation and/or maintenance work:
– the compressed air supply
– the operating voltage supply for the electronics/sensors
– the load voltage supply for the outputs/valves.

You can thereby avoid:

– uncontrolled movements of loose tubing.

– unexpected movements of the connected actuators.

– non-defined switching states of the electronic components.

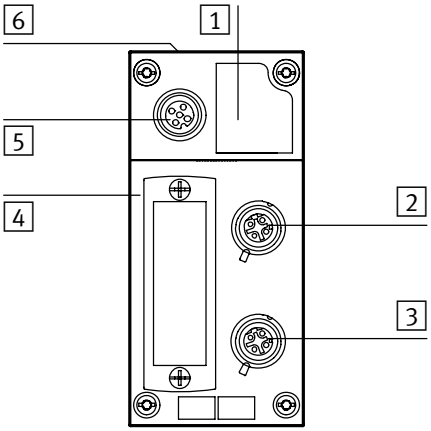
Caution
The CPX bus node contains electrostatically sensitive components.
- Therefore, do not touch any contacts.
- Observe the handling specifications for electrostatically sensitive components.

You avoid malfunctions of and damage to the electronics by doing so.

Information about fitting the CPX terminal can be found in the CPX system manual (P.BE-CPX-SYS-...).

Electrical connection and display elements

You will find the following connection and display elements on the CPX bus node for EtherCAT:



CPX-FB38

1 EtherCAT-specific network status LEDs and CPX-specific LEDs

2 Network connection 2 (output “Out2”) *)

3 Network connection 1 (input “In1”) *)

4 Cover for DIL switches

5 Service interface for the handheld control unit (V.24)

6 Type plate

*) Connecting socket: Type M12, D-coded, female, 4-pin

Fig. 1/1: Connecting and display elements on the CPX bus node

Please note
Use protective caps or blanking plugs to seal unused connections. You will then comply with protection class IP65/IP67 (see section 1.4).

Dismantling and fitting

When installed, the bus node is located in a manifold sub-base of the CPX terminal (see Fig. 1/2).

Dismantling

Dismantle the bus node as follows:

1. Undo the four screws of the bus node with a TORX screwdriver size T10.
2. Pull the bus node carefully and without tilting away from the contact rails of the manifold base.

1 CPX bus node
2 Manifold base
3 Contact rails
4 TORX T10 screws

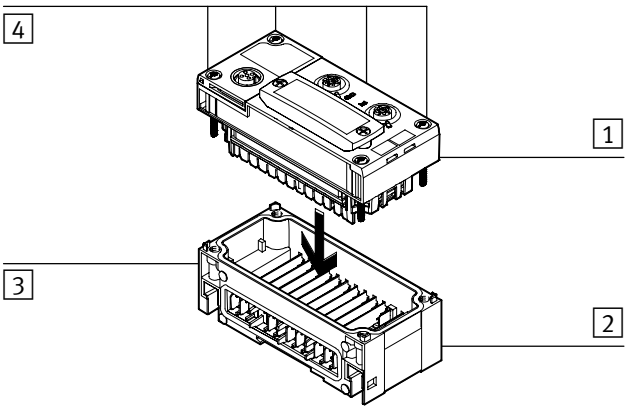


Fig. 1/2: Dismantling/installing the bus node

Please note
Always use the correct screws for the manifold base, which depend on whether the base is made of metal or plastic:
– for **plastic** manifold bases: thread-cutting screws
– Ffor **metal** manifold bases: screws with metric thread.

Both types of screws are enclosed respectively when ordering the bus node as a single part.

Installation

Install the bus node as follows:

1. Check seal and seal surfaces
2. Place the bus node in the manifold base. Make sure that the grooves (with the bus node power contact terminals) on the bottom of the bus node are above the contact rails.
3. Push the bus node carefully and without tilting as far as possible into the manifold base.
4. Tighten the screws at first only by hand. Place the screws so that the self-cutting threads can be used.
5. Tighten the screws with a TORX screwdriver size T10 with torque 0.9 ... 1.1 Nm.

1.2 Settings of the DIL switches on the bus node

To set the CPX bus node, the cover for the DIL switches must be removed.

Caution
The CPX bus node contains electrostatically sensitive components.

- Therefore, do not touch any contacts.
- Observe the handling specifications for electrostatically sensitive components.

You avoid malfunctions of and damage to the electronics by doing so.

1.2.1 Removing and fitting the cover over the DIL switches

You need a screwdriver in order to remove or fit the cover.

Please note
Observe the following instructions when removing or fitting the cover:

- Disconnect the power supply before removing the cover.
- Make sure that the seal is seated correctly when fitting the cover.
- Tighten the two fastening screws at first by hand and then with max. 0.4 Nm.

1.2.2 Setting the DIL switches

You can set the following parameters with the DIL switches under the cover (see Fig. 1/3):

– bus node operating mode

– diagnostic mode.

Proceed as follows:

1. Switch off the power supply.
2. Remove the cover (see section 1.2.1).
3. Make the required settings (see Tab. 1/1 and Tab. 1/2).
4. Replace the cover (see section 1.2.1).

[1] DIL switch 1: bus node operating mode

[2] DIL switch 2: for Remote I/O operating mode: Diagnostic mode

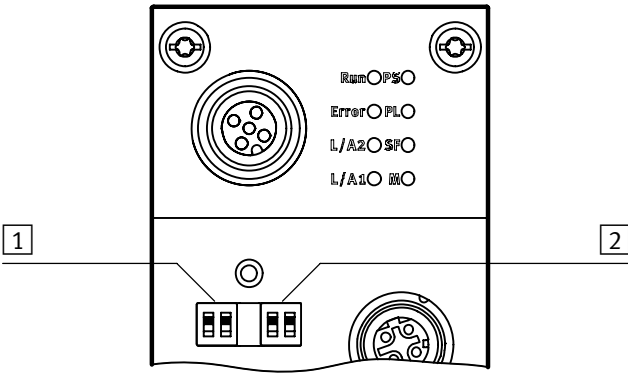


Fig. 1/3: Settings of the DIL switches on the bus node

Setting the operating mode with DIL switch 1

You can set the operating mode of the bus node with switch element 1.1 of DIL switch 1 (see Tab. 1/1):

– Remote I/O operating mode

– Operating mode Remote Controller

Operating mode	Setting DIL switch 1	
Remote I/O operating mode All functions of the CPX terminal are controlled directly by the EtherCAT-IO controller or a superordinate PLC. The bus node thereby takes over the connection to the EtherCAT network.		DIL 1.1: OFF DIL 1.2: OFF (factory setting)
Operating mode Remote Controller **Requirement:** a CPX-FEC is an integral part of the CPX terminal. The FEC integrated in the terminal controls all functions. The bus node thereby takes over the connection to the EtherCAT network.		DIL 1.1: ON DIL 1.2: OFF

Tab. 1/1: Setting the bus node operating mode with DIL switch 1

Remote I/O – Explanation of the operating mode

All functions of the CPX terminal are controlled directly by the EtherCAT controller or a superordinate PLC:

- Control of the CPX valve terminal (also described as IO Controller)
- Data exchange between controller and modules
- Parameterisation of the modules
- Diagnostics.

Controller and CPX valve terminal communicate via EtherCAT. The bus node thereby takes over the connection to the EtherCAT network and processing of the data exchange:

- Protocol implementation
- Forwarding of incoming and outgoing data.

EtherCAT protokol (in both operating modes)

The real-time-capable EtherCAT protocol is used for this.

An FEC integrated in the CPX terminal works as a passive module, i.e. without controller. In this case, the FEC can be used for connection to other networks, for example: The FEC takes over the forwarding of incoming and outgoing data and thus behaves like an I/O module.

Remote Controller – Explanation of the operating mode

A CPX-FEC integrated into the CPX terminal takes over control of the terminal (also described as IO Controller), as the local controller of a larger system, for example.

Requirements for this operating mode:

– A CPX-FEC is an integral part of the CPX terminal.

– For its part, the FEC is in the Remote Controller operating mode. Ensure that the bus node and FEC DIL switches are set according to the operating mode. If necessary, settings at the program level must also be adjusted, e.g. in the program side hardware configuration.

The bus node also takes over the connection to EtherCAT network in this configuration:

– The FEC can communicate at the field bus level using an 8-byte IO data field, e.g. with an EtherCAT controller.

– A superordinate controller can call up, e.g. status information of the valve terminal using this interface and match or optimise the controller accordingly with other system parts.

In Remote I/O operating mode:
Setting the diagnostics mode with DIL switch 2

The function of the DIL switch 2 depends on the setting of the DIL switch 1 or the set operating mode of the CPX terminal (see Tab. 1/1): The diagnostics mode is set in the Remote I/O operating mode.

Diagnostic mode (Remote I/O operating mode)	**Setting DIL switch 2**	
The I/O diagnostic interface and the status bits are switched off (+ 0 I/O bits)		2.1: OFF 2.2: OFF (factory setting)
The status bits are switched on (+ 8 (16) I bits) [1)]		2.1: OFF 2.2: ON
The I/O diagnostic interface is switched on (+ 16 I/O bits) [1)]		2.1: ON 2.2: OFF
Reserved for future extensions		2.1: ON 2.2: ON
[1] Diagnostic mode (status bits or I/O diagnostic interface) occupies 2 bytes or 4 bytes of address space (16 I bits or 16 I/O bits; in the Status Bits mode, 8 I bits remain unused)		

Tab. 1/2: Setting the diagnostic mode with DIL switch 2 (Remote I/O operating mode)

Please note
(1) Use of the diagnostic mode (status bits or I/O diagnostic interface) occupies **16 I** or 16 **I/O bits** and thus reduces the number of I/O bits which are available for module communication. In this way, the number of addressable modules is reduced in favour of additional status or diagnostic information.

Take account of this fact for the planning of your CPX terminal.

(2) Subsequent activation requires a new configuration
In the subsequent activation of the diagnosis mode (status bits or I/O diagnosis interface), the CPX-internal I/O image can be displaced.
In this case, repeat the EtherCAT network configuration in your configuration and programming software, e.g. Beckhoff TwinCAT, in particular the assignment of inputs and outputs.

In Remote Controller operating mode:
Function of the DIL switch 2

The function of the DIL switch 2 depends on the setting of the DIL switch 1 or the set operating mode of the CPX terminal (see Tab. 1/1):

In the Remote Controller operating mode, DIL switch 2 is reserved for future expansions.

1.3 Connecting to the network

1.3.1 General information about EtherCAT networks

Please note
Components with EtherCAT interfaces may be operated only in networks where all connected network components are supplied with PELV power supplies or integrated power supplies with similar protection.

Installation instructions

You can obtain specifications, installation notes and instructions through the EtherCAT user organisation:

– EtherCAT Technology Group:
  http://www.ethercat.org/

– EtherCAT-specifications (“EtherCAT Specification”, “Profiles”), guidelines (“Guidelines”) and instructions (e.g. “How to Configure an EtherCAT Slave Device”):
  http://www.ethercat.org/en/publications.html

Observe the instructions there.

1.3.2 Overview of connections, network connectors and cables

Bus nodes	Connections	Network connectors	Cable specification
CPX-FB38	2x M12 socket, D-coded, female, 4-pin, according to IEC 61076-2-101, SPEEDCON® compatible	Plug from Festo, type NECU-M-S-D12G4-C2-ET, for Ethernet lines with cable diameters of 6 ... 8 mm	– Cable type: Shielded industrial Ethernet line (at least category Cat 5) – Cable length: max. 100 m between network participants (corresponding to specifications for Ethernet networks, ISO/IEC 11801 and ANSI/TIA/EIA-568-B) – Core cross section for max. line length: 22 AWG (for 100 m link length, based on ISO/IEC 11801)

Tab. 1/3: Overview of connections, network connectors and network cables

Please note

If installation has not been carried out correctly and if high baud rates are used, data transmission errors may occur as a result of signal reflections and attenuation.

Causes of transmission faults may be:

– incorrect screening/shield connection

– branches

– transmission over long distances

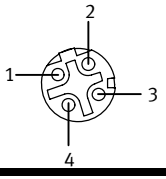
– unsuitable cables.

Observe the cable specification!

Refer to the manual of your controller for information about the required type of cable.

1.3.3 Network interface

To connect to the network, there are two 4-pin M12 sockets with D-coding on the bus node CPX-FB38 (for industrial Ethernet use, corresponding to IEC 61076-2-101). The sockets are compatible with SPEEDCON® plugs.

Socket	Pin	Signal	Explanation
M12, D-coded			
	1 2 3 4 Housing	TD+ RD+ TD– RD– FE	Transmission data (Transmit Data, TD) + Receive data (Receive Data, RD) + Send data – Receive data – Shield/functional earth (Shield/functional earth, FE)

Tab. 1/4: Pin assignment of the network interface

1.3.4 Network connection

Connection with plug from Festo

Connect the CPX terminal to the network with Festo plugs type NECU-M-S-D12G4-C2-ET. The plug is designed for Ethernet lines with cable diameters of 6 ... 8 mm.

To comply with protection class IP65/IP67:

– Use Festo plugs.

– Seal unused interfaces, see section 1.4.

M12 to RJ45 converter

For EtherCAT installations, it may be necessary to change between RJ45 and M12 connectors.

Application example: Connections between devices in the switch cabinet with RJ45 connection and IP65/IP67 devices with M12 connection.

Adapter examples:

– Lumberg: 0981 ENC 100
(RJ45/M12 adapter, M12 coupler, D-coded, mounting thread PG9, RJ45 coupling, 90 degrees)

– HARTING: eCon 6050 -BA

Cable specification

Use shielded industrial Ethernet round cable of category Cat 5 or higher. You can find details regarding cable specification in Tab. 1/3.

The CPX bus node FB38 supports crossover detection:
You can optionally use patch cables or crossover cables (Auto-MDI) for connecting your bus node to the network, controller or a PC.

Please note
If the CPX terminal is fitted onto the moving part of a machine, the network cable on the moving part must be provided with strain relief. Please also observe the relevant regulations in EN 60204 part 1.

1.4 You will then comply with protection class IP65/IP67

In order to comply with protection class IP65/IP67, seal unused sockets with the appropriate plugs and covers.

Port	Port IP65/IP67	Cover IP65/IP67 [1]
L/A1, L/A2 (M12)	Plug from Festo, type NECU-M-S-D12G4-C2-ET	Protective cap from Festo, type ISK-M12
Service interface (M12)	Connecting cable and plug of the handheld control unit (CPX-MMI)	Protective cap from Festo, type ISK-M12 [2]

[1] if connection is not used
[2] included in scope of delivery

Tab. 1/5: Connections and covers for protection class IP65/IP67

1.5 Pin assignment of power supply

Warning

- Only use PELV **circuits** according to IEC/DIN EN 60204-1 (Protective Extra-Low Voltage, PELV) for the power supply.
  Take into account also the general requirements for PELV circuits as per IEC/DIN EN 60204-1.
- Use only **power packs**which guarantee reliable electrical isolation of the operating voltage as per IEC/DIN EN 60204-1.

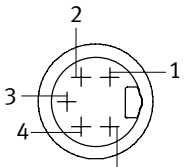
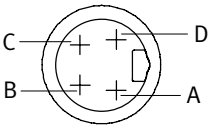
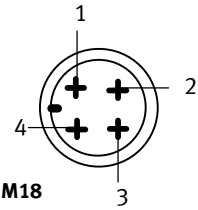
Due to the use of PELV power units, protection against electric shock (protection against direct and indirect contact) is guaranteed in accordance with IEC/DIN EN 60204-1 (electrical equipment of machines, general requirements).

The current consumption of a CPX terminal depends on the number and type of integrated modules and components.

Read the information about the power supply as well as on the earthing measures to be carried out in the CPX system manual (P.BE-CPX-SYS-...).

System supply, additional supply and valve supply

The CPX terminal is supplied with operating and load power via the manifold base with system, additional and valve supply.

Plugs	**Pin assignment of manifold base with**		
	System supply type CPX-GE-EV-S... type CPX-M-GE-EV-S...	**Additional power supply type CPX-GE-EV-Z... type CPX-M-GE-EV-Z...**	**Valve supply module type CPX-GE-EV-V...**
 **7/8"-5POL**	1: 0 V_{VAL} / 0 V_{OUT} 2: 0 $V_{EL/SEN}$ 3: Earth connection (incoming) 4: 24 $V_{EL/SEN}$ 5: 24 V_{VAL} / 24 V_{OUT}	1: 0 V_{OUT} 2: not connected 3: Earth connection (incoming) 4: not connected 5: 24 V_{OUT}	–
 **7/8"-4POL** [1]	A: 24 $V_{EL/SEN}$ B: 24 V_{VAL} / 24 V_{OUT} C: Earth connection D: 0 $V_{EL/SEN}$ / 0 V_{VAL} / 0 V_{OUT} (incoming)	A: not connected B: 24 V_{OUT} C: Earth connection D: 0 V_{OUT} (incoming)	A: not connected B: 24 V_{VAL} C: Earth connection D: 0 V_{VAL} (incoming)
 **M18**	1: 24 $V_{EL/SEN}$ 2: 24 V_{VAL} / 24 V_{OUT} 3: 0 $V_{EL/SEN}$ / 0 V_{VAL} / 0 V_{OUT} 4: Earth connection	1: not connected 2: 24 V_{OUT} 3: 0 V_{OUT} 4: Earth connection	1: not connected 2: 24 V_{VAL} 3: 0 V_{VAL} 4: Earth connection

[1] Note the specifications on the plug
$V_{EL/SEN}$: Operating voltage for electronics/sensors
V_{OUT}: Load voltage for outputs
V_{VAL}: Load voltage for valves

Tab. 1/6: Pin assignment for system supply, additional supply and valve supply

Commissioning

Chapter 2

Contents

2.1 General information

Switching on the power supply

Please note
Please observe the switching-on instructions in the manual of your control system (PLC/IPC).

Separate supply

If the control system and the field bus slaves have separate power supplies, the devices must be switched on in the following sequence:

1. Switch on the operating voltage supply of all bus subscribers (I/O Devices).
2. Switch on the operating voltage supply for the controller.

Addressing, configuration and parameterisation

Addressing

The address space of a CPX terminal in the EtherCAT network is limited. Before starting up or configuring the CPX terminal, determine the number of assigned inputs and outputs.

Configuration

Configuration of a CPX terminal and the related CPX bus node depends on the control system used. The basic procedure and the required configuration data are presented in the following pages.

Parameterisation

A CPX terminal in the EtherCAT network can be parameterised only with a handheld control unit (CPX-MMI) or the Festo Maintenance Tool (CPX-FMT) (no parameterization through the control system).

2.2 Address assignment

Please note
The address space of a CPX terminal in the EtherCAT network is limited.

The CPX bus node for EtherCAT provides the CPX terminal with an address space of up to 64 bytes for inputs (I) and 64 bytes for outputs (O).

Each module of the CPX terminal occupies a certain number of I/O bits, bytes or words in the context of module communication.

Please refer to Tab. 2/1 to Tab. 2/6 for the number of I/O bytes occupied (of the respective module).

Also, certain functions, e.g. the I/O diagnostics interface (STI), reduce the number of available I/O bytes (in favour of status or diagnostics functions).

Take account of this fact for the planning of your CPX terminal.

Before starting up or configuring the CPX terminal, determine the number of assigned inputs and outputs. Tab. 2/7 provides help with this.

Use the configuration documents, the handheld control unit (CPX-MMI) or the Festo Maintenance Tool (CPX-FMT) to determine address assignment or terminal set-up.

In the handheld control unit, the individual modules of the CPX terminal are displayed with the respective module identifiers. Using the module identifier and the following tables, you can determine the module type and, with it, the number of inputs and outputs occupied by the module.

Module identifiers

Each module, including the bus node, has its own identifier, the so-called module identifier. It serves to determine and localise the module type, for example as part of configuration. Apply the module identifiers – from left to right corresponding to the physical order as installed in the CPX terminal – in your configuration program (e.g. Beckhoff TwinCAT, see section 2.4).

In graphically oriented configuration programs, the module identifiers are typically found in a separate listing of all available hardware modules or field devices, e.g. in a module directory or module catalogue.

Electric modules

Tab. 2/1 and Tab. 2/2 give an overview of the assigned address spaces of different electrical modules and of the bus node in the Remote I/O operating mode.

Tab. 2/3 shows the assigned address space of the bus node in the Remote Controller operating mode.

The address assignment within the individual CPX I/O modules can be found in the manual for the I/O module (P.BE-CPX-EA-...).

Details on the CP interface can be found in the manual for the CP interface (P.BE-CPX-CP-...).

Electric modules Description	Module type	Module identifier [1]	Assigned address space Inputs	 Outputs
Bus node for EtherCAT in operating mode Remote I/O [2] **without diagnostics access**	CPX-FB38	FB38-RIO...	–	–
Bus node for EtherCAT in operating mode Remote I/O [2] **with status bits [Status]**	CPX-FB38	FB38-RIO...	2 bytes/ 8 (16) I [3] (8 bits used)	–
Bus node for EtherCAT in operating mode Remote I/O [2] **with I/O diagnostic interface [System Table Interface, STI]**	CPX-FB38	FB38-RIO...	2 bytes/16 I	2 bytes/16 O
Digital 4-input module	CPX-4DE	4DI	1 byte/ 4 (8) I [3]	–
Digital 8-input module	CPX-8DE	8DI	1 byte/8 I	–
Digital 8-input module with channel diagnosis	CPX-8DE-D	8DI-D	1 byte/8 I	–
Digital 8-input module, n-switching	CPX-8NDE	8NDI	1 byte/8 I	–
Digital 16-input module	CPX-16DE	16DI	2 bytes/16 I	–
Digital 16-input module with channel diagnosis	CPX-M-16DE-D	16DI-D	2 bytes/16 I	–
Digital 4-output module	CPX-4DA	4DO	–	1 byte/ 4 (8) O [3]
Digital 8-output module	CPX-8DA	8DO	–	1 byte/8 O
Digital 8-output high current output module	CPX-8DA-H	8DO-H	–	1 byte/8 O

[1] Module identifier in the handheld unit or in the hardware config. of the programming software.
[2] Number of occupied I/O bytes in the Remote Controller operating mode: see Tab. 2/3
[3] Diagnostic mode status bits assigned 8 I or 2 bytes of address space (8 I or 8 bits remain unused); 4-way modules CPX-4DE and CPX-4DA always occupy 8 I or 8 O or 1 byte of address space (4 I/O or 8 bits of address space remain unused)

Tab. 2/1: Address assignment of electric CPX modules (overview; bus node in Remote I/O operating mode) – part 1

Electric modules Description	Module type	Module identifier [1]	Assigned address space Inputs	 Iutputs
Digital multi I/O module	CPX-8DE-8DA	8DI/8DO	1 bytes/8 I	1 bytes/8 O
Analogue 2-input module	CPX-2AE-U-I	2AI	2 words/32 I	–
Analogue 4-input module	CPX-4AE-I	4AI-I	4 words/64 I	–
Analogue 4-input module (Temp. module for RTD sensors)	CPX-4AE-T	4AI-T	2 words or 4 words/ 32/64 I [4]	–
Analogue 4-way input module (Temp. module for TC sensors)	CPX-4AE-TC	4AI-TC	4 words/64 I	–
Analogue 2-output module	CPX-2AA-U-I	2AO	–	2 words/32 O
CP interface	CPX-CP-4-FB	CPI	max. 8 words/ 128 I [5]	max. 8 words/ 128 O [5]

[1] Module identifier in the handheld unit or in the hardware configuration of the programming software.
[4] Number of inputs which can be switched between 2 and 4.
[5] Address space assignment depends on the string assignment.

Tab. 2/2: Address assignment of electric CPX modules (overview; bus node in Remote I/O operating mode) – part 2

Configuration of the bus node

The identification of the bus node and the diagnostics mode are configured in the Remote I/O operating mode (see Tab. 2/1).

In the Remote Controller operating mode only the identifier of the bus node will be configured (see Tab. 2/3):

Electric modules	**Module type**	**Module identifier** [1]	**Assigned address space**	
Description			**Inputs**	**Outputs**
Bus node for EtherCAT In Remote Controller operating mode	CPX-FB38	FB38-RC	8 bytes/64 I	8 bytes/64 O

[1] Module identifier in the handheld unit or in the hardware configuration of the programming software.

Tab. 2/3: Address assignment of the bus node in the Remote Controller operating mode

Pneumatic interfaces and pneumatic modules

Tab. 2/5 and Tab. 2/6 give an overview of the assigned address spaces of different pneumatic interfaces and modules.

Configuration of the pneumatics (valves)

The valves are configured according to the pneumatic interface used:

– Valves of type 03 (Midi/Maxi), type 12 (CPA) and type 44/45 (VTSA/VTSA-F or ISO):

  When extensions are added to the valve side, only **one** configuration is required for the pneumatic interface. In the pneumatic interface, the number of valve coils is set using a DIL switch.

– Valves of type 32 and 33 (MPA, MPA-F and MPA-P or VPPM pneumatic modules):

  From the technical point of view, the individual MPA pneumatic modules each represent an electric module for controlling the attached valves.

  A configuration is required for **each** pneumatic module of type MPA:

  – pneumatic modules of type **MPA1** each occupy 1 byte of address space or 8 outputs regardless of how many valves are attached to the pneumatic module.

  – pneumatic modules of type **MPA2** each occupy 1 byte of address space or 8 outputs, but only 4 bits are used.

  – pneumatic modules of type **MPA-P** occupy 1 byte of address space or 16 inputs.

  – pneumatic modules of type **VPPM** occupy 2 bytes of address space or 1 byte I/O or 16 inputs and 16 outputs.

  Pneumatic modules of type **MPA-P** and **VPPM** are analogue modules. Note the order of the modules in addressing or I/O mapping (see Tab. 2/8).

Further information about the pneumatics can be found in the corresponding pneum. descriptions (see document overview, manuals for the CPX terminal in the CPX system manual CPX-P.BE-CPX-SYS-...).

The manuals for the pneumatic valve cluster (Midi/Maxi, CPA, MPA and VTSA/VTSA-F or ISO) contain the address assignment within the pneumatic modules.

For further inform. on MPA pneum. modules and the pneum. interfaces: see manual for the CPX I/O modules (P.BE-CPX-EA-...).

CPX pneumatic interfaces for MPA and related modules	**Module type**	**Module identifier** [1]	**Assigned address space**	
			Inputs	**Outputs**
Pneumatic interface for MPA or MPA-F valves (type 32/33)	VMPA-FB-EPL-...	–	–	–
MPA1 pneumatic module (type 32/33) **without** electrical isolation	VMPA1-FB-EMS-8 [2] (CPX type 32/33: **1-8V...**)	MPA1S	–	1 byte/ 8 O
MPA1 pneumatic module (type 32/33) **with** electrical isolation	VMPA1-FB-EMG-8 [2] (CPX type 32/33-**G: 1-8V...**)	MPA1G	–	1 byte/ 8 O
MPA2 pneumatic module (type 32/33) **without** electrical isolation	VMPA2-FB-EMS-4 [2] (CPX type 32/33: **1-4V...**)	MPA2S	–	1 byte/ 4 (8) O [3]
MPA2 pneumatic module (type 32/33) **with** electrical isolation	VMPA2-FB-EMG-4 [2] (CPX type 32/33-**G: 1-4V...**)	MPA2G	–	1 byte/ 4 (8) O [3]
MPA1 pneumatic module (type 32/33) **without** electrical isolation, with diagnostic function D2	VMPA1-FB-EMS-D2-8 [2] (CPX type 32/33: **1-8V...**)	MPA1S-D	–	1 byte/ 8 O
MPA1 pneumatic module (type 32/33) **with** electrical isolation, with diagnostic function D2	VMPA1-FB-EMG-D2-8 [2] (CPX type 32/33-**G: 1-8V...**)	MPA1G-D	–	1 byte/ 8 O
MPA2 pneumatic module (type 32/33) **without** electrical isolation, with diagnostic function D2	VMPA2-FB-EMS-D2-4 [2] (CPX type 32/33: **1-4V...**)	MPA2S-D	–	1 byte/ 4 (8) O [3]
MPA2 pneumatic module (type 32/33) **with** electrical isolation, with diagnostic function D2	VMPA2-FB-EMG-D2-4 [2] (CPX type 32/33-**G: 1-4V...**)	MPA2G-D	–	1 byte/ 4 (8) O [3]

[1] Module identifier in the handheld unit or in the hardware config. of the programming software
[2] Type of electronic module used
[3] 4-way modules MPA2 always occupy 8 I (1 byte) of address space (4 I or 8 bits remain unused)

Tab. 2/4: Overview of CPX pneumatic interfaces and pneumatic modules (part 1)

CPX pneumatic interfaces for MPA and related modules	Module type	Module identifier [1]	Assignd addr. space	
			Inputs	Outputs
VPPM proportional pressure-regulating valve (type 32)	VPPM-6TA-L-1-F-...	VPPM	1 word/ 16 I	1 word/ 16 O
MPA-P pressure sensor module	VMPA-FB-PS-...	MPA-P	1 word/16 I	–
[1] Module identifier in the handheld unit or in the hardware config. of the programming software				

Tab. 2/5: Overview of CPX pneumatic interfaces and pneumatic modules (part 2)

Pneumatic interfaces for Midi/Maxi, CPA, VTSA (ISO)	Module type	Module identifier [1]	Assignd addr. space	
			Inputs	Outputs
Pneumatic interface for Midi/Maxi valves (type 03) with setting [2] – 1 ... 8 valve coils – 1 ... 16 valve coils – 1 ... 24 valve coils – 1 ... 32 valve coils (26 can be used)	CPX-GP-03-4.0 (CPX type 03: **1-...-...**)	TYPE3	–	 1 byte/8 O 2 bytes/16 O 3 bytes/24 O 4 bytes/32 O
Pneumatic interface for CPA valves (type 12) with setting [2] – 1 ... 8 valve coils – 1 ... 16 valve coils – 1 ... 24 valve coils (22 can be used)	CPX-GP-CPA-10 CPX-GP-CPA-14 (CPX type 12: **1-...-...**)	CPA10/14	–	 1 byte/8 O 2 bytes/16 O 3 bytes/24 O
Pneumatic interface for VTSA or VTSA-F pneumatic (ISO, type 44/45) with adjustment [2] – 1 ... 8 valve coils – 1 ... 16 valve coils – 1 ... 24 valve coils – 1 ... 32 valve coils	VABA-10S6-x1 (CPX type 44/45: **1-...-...**)	ISO PlugIn or type 44 or type 45 [3]	–	 1 byte/8 O 2 bytes/16 O 3 bytes/24 O 4 bytes/32 O
[1] Module identifier in the handheld unit or in the hardware config. of the programming software [2] Setting with DIL switch in the pneumatic interface [3] Display text (module identifier) dependent on the version of the handheld unit				

Tab. 2/6: Overview of CPX pneumatic interfaces and pneumatic modules (part 3)

Calculating the number of inputs/outputs

Use Tab. 2/7 to calculate the number of inputs and outputs (of address assignment) of your CPX terminal.

Input/output modules and system diagnosis		Inputs	Outputs
1. Status bits or I/O diagnostic interface [1]		+ _____ I	+ _____ O
2. Number of input modules CPX-4DE	+ __ x 8 I [2]	+ _____ I	
3. Number of input modules CPX-8DE, 8DE-D,-8NDE	+ __ x 8 I	+ _____ I	
4. Number of input modules CPX-16DE, 16DE-D	+ __ x 16 I	+ _____ I	
5. Number of output modules CPX-4DA	+ __ x 8 O [2]		+ _____ O
6. Number of output modules CPX-8DA, 8DA-H	+ __ x 8 O		+ _____ O
7. Nnumber of multi-I/O modules CPX-8DE-8DA	+ __ x 8 IO	+ _____ I	+ _____ O
8. Number of analogue input modules CPX-2AE-U-I	+ __ x 32 I	+ _____ I	
9. Number of analogue input modules CPX-4AE-I	+ __ x 64 I	+ _____ I	
10. Number of analogue input modules CPX-4AE-T	+ __ x 32 I/ x 64 I	+ _____ I	
11. Number of analogue input modules CPX-4AE-TC	+ __ x 64 I	+ _____ I	
12. Number of analogue output modules CPX-2AA-U-I	+ __ x 32 O		+ _____ O
13. Number of inputs and outputs of other modules (e.g. CP interface, VPPM-/MPA-P pneumatic module)	+ __ IO	+ _____ I	+ _____ O
14. Midi/Maxi, CPA and VTSA/VTSA-F pneumatic interface: Number of configured valve magnet coils (+ 8 ... 32 O; 32 O (Midi/Maxi, VTSA/VTSA-F) or 24 O (CPA) are configured at the factory)			+ _____ O
15. Number of MPA1 or MPA2 pneumatic modules	+ __ x 8 O [2]		+ _____ O
16. Total sum of inputs/outputs to be configured Total from 1. to 15.		= Σ _____ I	= Σ _____ O

[1] Number of occupied inputs /outputs: see Tab. 1/2
[2] 4-way modules CPX-4DE and CPX-4DA as well as MPA modules (MPA2 and VPPM) always occupy 8 inputs or outputs (1 byte; available address space remains partially unused)

Tab. 2/7: Identifying the assigned address space (total of inputs and outputs)

2.3 Addressing

2.3.1 Basic rules for addressing

- The field bus node counts as a module with 0 inputs and 0 outputs when the status bits and the I/O diagnostic interface are deactivated.
- Note the remarks regarding address assignment in section 2.2.
- The address assignment of the inputs does **not depend** on the address assignment of the outputs.
- Counting is from left to right, addressing **in bytes**: Modules with less than 8 bits occupy 8 bits of address space, but do not use all this space.
- The I/Os of different module types are assigned separately from each other. Observe the sequence of addressing: see Tab. 2/8.

Please note
If necessary, status bits or an I/O diagnostic interface can be activated by DIL switch (see Tab. 1/2):
- If the 8 status bits are activated, they will occupy the first 16 inputs in the address range (8 used).
- If the I/O diagnostic interface is activated, it will occupy the first 16 inputs and outputs in the address range.

Sequence of addressing		Description
1.	Status bits or I/O diagnostic interface [1]	Delivers status and diagnostic information; activate through DIL switches; occupies the **first** 16 inputs or inputs and outputs [2]
2.	Analogue modules	Modules with analogue inputs/outputs
3.	Technology modules	e.g. CP interface, front end controller (CPX-FEC)
4.	Digital modules	Modules with digital inputs/outputs

[1] See also note above as well as Tab. 1/2 and Tab. 2/1.
[2] Depending on the setting, you can also occupy this address space **with modules** (see also following information).

Tab. 2/8: Sequence of addressing

If the status bits or I/O diagnostic interface are activated later, that is, after the initial start-up, the module configuration for the first 16 inputs or 16 inputs and outputs must be adjusted.

Move the modules originally **configured in this address space** into another area. Configuration of these modules must be repeated, if necessary (see also section 2.4 regarding configuration with EtherCAT configuration and program software, e.g. Beckhoff TwinCAT).

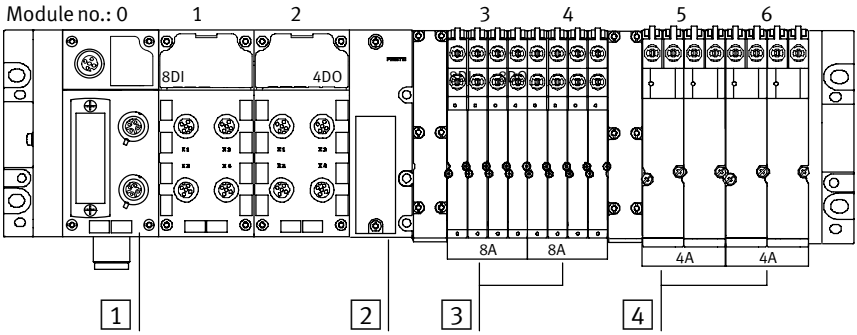
Configuration examples

Example 1: CPX terminal with MPA1 and MPA2 pneumatic

Fig. 2/1 shows as an example a CPX terminal with MPA pneumatics and the following setting:

– Status bits and I/O diagnostic interface deactivated

The address assignment for this example terminal (in Fig. 2/1) is shown in Tab. 2/9.



1 Bus node CPX-FB38

2 MPA pneumatic interface

3 MPA1 pneumatic modules (8 O each)

4 MPA2 pneumatic modules (4 O each)

Fig. 2/1: Example terminal 1 (with MPA1 and MPA2 pneumatics)

Module no.	Module	Input address	Output address
0	Bus node CPX-FB38	–	–
1	Digital 8-input module CPX-8DE	I0 ... I7	–
2	Digital 4-output module CPX-4DA	–	O0 ... O7 *)
3	MPA1 pneumatic module (8 O)	–	O8 ... O15
4	MPA1 pneumatic module (8 O)	–	O16 ... O23
5	MPA2 pneumatic module (4 O)	–	O24 ... O31 *)
6	MPA2 pneumatic module (4 O)	–	O32 ... O39 *)
*) 8 bits (1 byte) assigned, 4 bits used – when the Festo XML file is used, the addresses are occupied bytewise (refers to module no. 2, 5 and 6)			

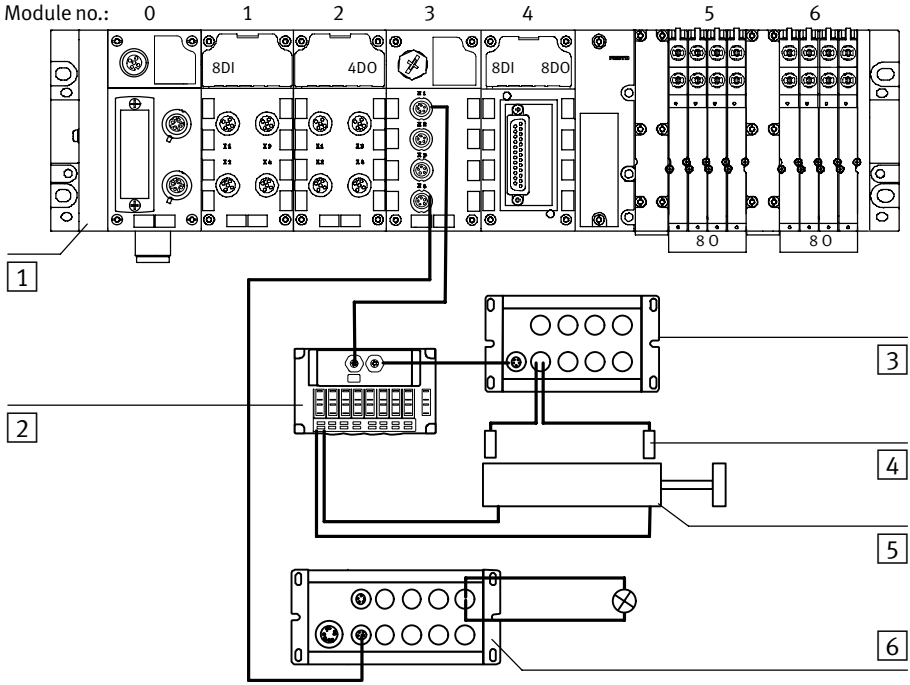
Tab. 2/9: Addressing the example terminal 1 (see Fig. 2/1)

Example 2: CPX terminal with CP interface

Fig. 2/2 shows as an example a CPX terminal with CP interface and the following setting:

– Status bits and I/O diagnostic interface deactivated

The address assignment for this example terminal (in Fig. 2/2) is shown in Tab. 2/10.



1 Bus node CPX-FB38

2 CPV valve terminal (16 O) on the CP interface (string 1)

3 CP input module (16DI)

4 Sensor

5 Cylinders

6 CP output module (16DO) on the CP interface (string 4)

Fig. 2/2: Example terminal 2 (with CP interface)

Module no.	Module	Input address	Output address
0	Bus node CPX-FB38	–	–
1	Digital 8-input module CPX-8DE	I32 ... I39	–
2	Digital 4-output module CPX-4DA	–	O128 ... O135 *)
3	CP interface CPX-CP... (In this case: 4 bytes I, 16 bytes O)	I0 ... I32	O0 ... O127
4	Digital multi-I/O module CPX-8DE-8DA	I40 ... I47	O136 ... O143
5	MPA1 pneumatic module (8 O)	–	O144 ... O151
6	MPA1 pneumatic module (8 O)	–	O152 ... O159
*) 8 bits occupied, 4 bits used			

Tab. 2/10: Addressing the example terminal 2 (see Fig. 2/2)

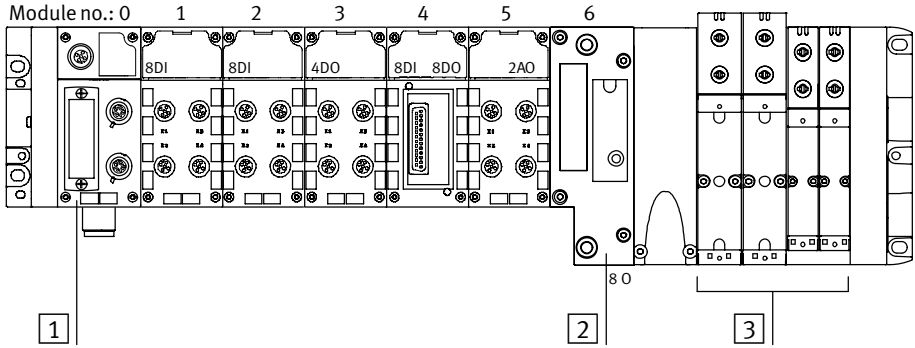
Example 3: CPX terminal with analogue module and VTSA pneumatics

Fig. 2/3 shows as an example a CPX terminal with analogue module and VSTA pneumatics as well as the following setting:

– Status bits activated

– VTSA pneumatic interface set to 1 ... 8 valve coils (8 O)

The address assignment for this example terminal (in Fig. 2/3) is shown in Tab. 2/11.



1 Bus node CPX-FB38 (with status bits)

2 VTSA pneumatic interface (set to 1 ... 8 valve coils)

3 VTSA pneumatics (type 44)

Fig. 2/3: Example terminal 3 (with analogue module and VTSA pneumatics)

Module no.	Module	Input address	Output address
0	Bus node CPX-FB38 (with status bits)	I0 ... I15 [1]	–
1	Digital 8-input module CPX-8DE	I16 ... I23	–
2	Digital 8-input module CPX-8DE	I24 ... I31	–
3	Digital 4-output module CPX-4DA	–	O32 ... O39 [2]
4	Digital multi-I/O module CPX-8DE-8DA	I32 ... I39	O40 ... O47
5	Analogue 2-output module CPX-2AA	–	O0 ... O31
6	VTSA pneumatic interface set to 1 ... 8 valve coils	–	O48 ... O55

[1] 16 bits assigned, 8 bits used
[2] 8 bits assigned, 4 bits used

Tab. 2/11: Addressing the example terminal 3 (see Fig. 2/3)

2.3.2 Address assignment after extension or conversion

A speciality of the CPX terminal is its flexibility. If the demands placed on the machine change, the equipment fitted on the CPX terminal can also be modified.

Caution
If the CPX terminal is extended or converted at a later stage, the input/output addresses may be shifted.
This applies in the following cases:

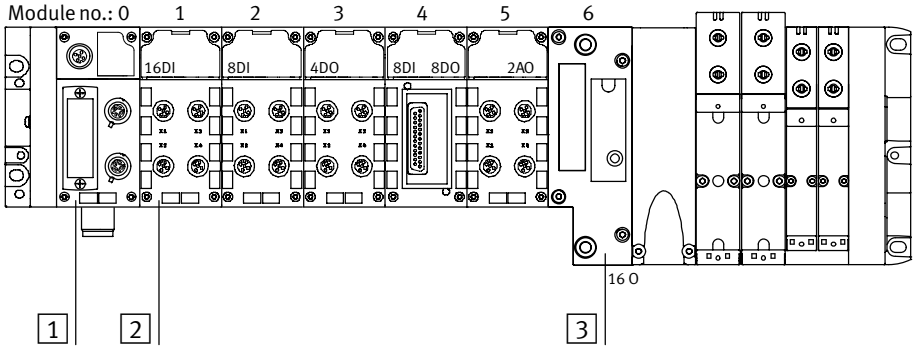
- if additional modules are inserted between existing modules
- if existing modules are removed or replaced by other modules which have more or fewer input/output addresses
- if manifold sub-bases (CPA) or pneumatic sub-bases (Midi/Maxi) for single-solenoid valves are replaced by manifold bases for double-solenoid valves or vice versa (see pneumatics manual)
- if additional manifold sub-bases (CPA) or sub-bases (Midi/Maxi) are inserted between existing sub-bases
- the diagnostic mode (status bits or the I/O diagnostic interface) is activated/deactivated.

Example terminal 3 modified

The next diagram shows with terminal 3 as an example (Fig. 2/4) the effects of modifications to the address assignment (compare with Fig. 2/3).

The following has been changed:

- The status bits have been deactivated.
- In the case of module no. 1 an 8-input module has been replaced by a 16-input module.
- The pneumatic interface has been set to 16 outputs (16 O) in order to reserve addresses for an extension to the pneumatics.



1 Modified: Status bits deactivated

2 Modified: 8DI module replaced by 16DI module

3 Modified: Pneumatic interface (now set with DIL switch to 1 ... 16 valve coils)

Fig. 2/4: Example terminal 3 after extension/conversion (compare with Fig. 2/3)

Module no.	Module	Input address	Output address
0	**Field bus node CPX-FB38 with deactivated status bits**	Depends on DIL switch settings (see Tab. 1/2)	
1	**Digital 16-input module CPX-16DE**	I0 ... I15	–
2	Digital 8-input module CPX-8DE	I16 ... I23	–
3	Digital 4-output module CPX-4DA	–	O32 ... O39 [1]
4	Digital multi-I/O module CPX-8DE-8DA	I24 ... I31	O40 ... O47
5	Analogue 2-output module CPX-2AA	–	O0 ... O31
6	**VTSA pneumatic interface with DIL switch set to 1 ... 16 valve coils**	–	O48 ... O63

bold = changed module or changed setting
[1] 8 bits occupied, 4 bits used

Tab. 2/12: Addressing the example terminal 3 after extension/conversion (see Fig. 2/4)

2.4 Configuration

General instructions on commissioning

Configuration of the CPX terminal demands a very accurate procedure, as different configuration specifications are some times necessary for each slave, i.e. for each device and each “Box” on the EtherCAT network, due to the modular structure.

Note here the specifications in the sections which follow (as from section 2.4.1 regarding the configuration, and in section 2.3 as well as 2.4.2 regarding the addressing).

2.4.1 Registering slave properties (“XML file”) in the configuration program

When you commission a new EtherCAT slave, i.e. an EtherCAT device the first time, you must inform your configuration and programming software about certain properties of the slave.

The properties of the various slaves are usually administered by the configuration program in a configuration file, i.e. the EtherCAT Device Description File (in Beckhoff TwinCAT referred to as System Manager Tree Item Description).

Device Description File (“XML file”)

This file or their corresponding contents have been made available using the “Extensible Markup Language” (XML). Therefore, the EtherCAT Device Description File is commonly known as “XML file”.

The XML file is used to identify the bus node in the EtherCAT network. Using the XML file, basic properties of the EtherCAT device as well as information concerning the manufacturer are provided to the configuration program.

Source (download link)

You will find the most recent EtherCAT configuration file (XML file) for CPX terminals and bus node CPX-FB38 on the Festo website at:

– www.festo.com/fieldbus

Inserting the XML file

- To extend the XML library of your configuration program, insert the bus node-specific XML file into the program directory of the configuration program, in Beckhoff TwinCAT in:

  C:\programs\TwinCAT\Io**EtherCAT**

Importing the XML file

- Afterwards, import the XML file into your configuration program, in the Beckhoff TwinCAT System Manager in:

  “Actions” › “Import XML Descriptions...”

Note
You will find a detailed description of the XML file import in the subsequent section “XML file import – detailed information”.

Slave properties

In the framework of importing the XML file, subsequent information about the bus node or the EtherCAT slave is provided to the configuration program.

Information	Description
Vendor Name	Festo AG & Co. KG
Vendor ID	0000001Dh
Product Code	00000026h
Version Number	00000002h
EtherCAT-Input/Output-Size	64 Byte/64 Byte (independent of the operating mode)
Product Name	CPX-FB38 (CPX-FB38 EtherCAT Bus module)
Catalog Number	552 046

Tab. 2/13: EtherCAT slave properties

When the XML file has been imported, i.e. after incorporation of the device properties into the configuration program, the bus node is registered as potential EtherCAT device. Hence, you can integrate the bus node into your EtherCAT network, and configure the CPX terminal.

XML file import – detailed information

You require an EtherCAT configuration file, i.e. the “XML file”, to configure and programme the CPX terminal with a PC or a corresponding software package, e.g. Beckhoff TwinCAT.
The XML file contains all the required information to configure and adjust (set up) the CPX terminal using configuration and programming software, e.g. TwinCAT.

You will find explanations regarding the XML file in section 2.4.1.

Source (download link)

You will find the most recent EtherCAT configuration file (XML file) for CPX terminals and bus node CPX-FB38 on the Festo website at:

– www.festo.com/fieldbus

File type	File name	Language	Description
XML	Festo CPX-FB38.xml (check the link mentioned above for the latest version of the XML file)	Language-independent	“EtherCAT Device Description File” for Beckhoff TwinCAT or compatible configuration and programming software (“Beckhoff TwinCAT System Manager Tree Item Description”)

Tab. 2/14: EtherCAT configuration file (“XML file”) for CPX terminals and bus node CPX-FB38

Download

- Download the current XML file onto your PLC system.

Note
Check the above mentioned link casually regarding most recent version of the XML file.

- Copy the bus node-specific XML file into the program directory of your configuration program – in Beckhoff TwinCAT in:

  – C:\programs\TwinCAT\Io**EtherCAT**

  To ensure that TwinCAT uploads the configuration file, the subseqeuntly desribed import of the XML file is required (see also Fig. 2/5).

Import

1. Start the configuration program of your PLC, e.g. the Beckhoff TwinCAT System Manager (1 in Fig. 2/5).

2. Import (incorporate) the XML file into the configuration program – in TwinCAT by using:

   – “Actions” › “Import XML Descriptions...” (2 in Fig. 2/5)

   A file selection Pop-up window 3 opens (is displayed).

3. Select the Festo XML file 4, and click “Open” 5 to confirm and cause the selection.

Having completed the import of the XML file, i.e. after incorporation of the device properties into the configuration program, the bus node is registered as potential EtherCAT device. Hence, you can integrate the bus node into your EtherCAT network, and configure the CPX terminal (see section 2.4.3).

Symbolic representation of the CPX terminal

The Festo XML file comprises a symbolic representation of the bus node and the corresponding CPX terminal which is reflected in the EtherCAT topology display, for instance (see section 2.4.5). The topology display however is first available after completion of the EtherCAT network configuration. (The network configuration is described in section 2.4.3.)

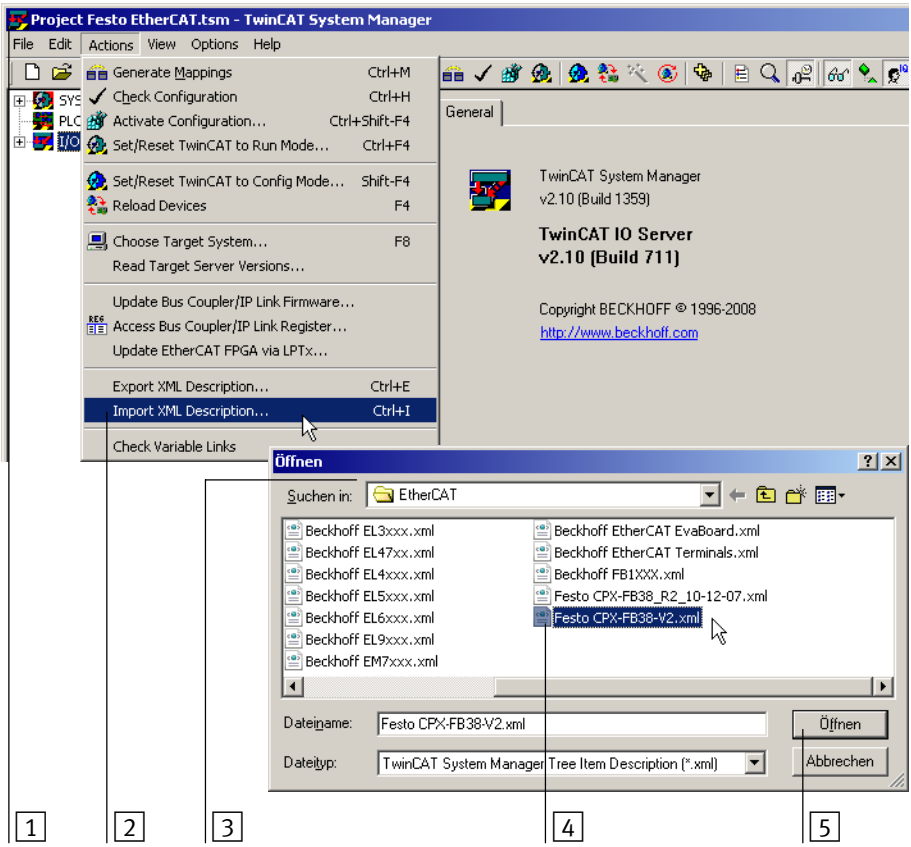


Fig. 2/5: Registering slave properties in the configuration program (importing XML file)

2.4.2 Addressing and data access (data objects)

Addressing

Addressing the individual modules requires the supervisory controller: The EtherCAT master determines the position of the EtherCAT devices within the network. Thereby, block-oriented addressing is applied (in contrast to block-oriented addressing of other field bus systems).

The controller uses the following for local addressing:

– the physical position of the devices within the EtherCAT network (Auto Increment Address)

– an independent EtherCAT device address (EtherCAT address).

If required, the EtherCAT address can be changed.

The global addressing is supported by a Field bus Memory Management Unit (FMMU).

Note
You will find CPX specific information regarding the addressing in the section 2.3.

Data access (data objects)

EtherCAT internal data is retrieved based on protocol-specific data objects (according to the fieldbus protocol CANopen).

EtherCAT devices have an object directory which makes all important slave parameters accessible in a standardized manner. An EtherCAT system is configured mainly by access to the object directory of the individual slaves.

The access mechanism is provided by means of Service Data Objects (SDO).

There are two different communication mechanisms in a CANopen system.

The **Process Data Objects** (PDO) serve the fast transfer of processing data and are transmitted by simple EtherCAT messages without protocol overhead. Process Data Objects can be transmitted event-controlled, synchronous to a system pulse sequence or on demand.

The **Service Data Objects** (SDO) form a point-to-point connection and permit access to every entry in the object directory of a node.

Use application-specific programs created according to your preferences to access these data objects.

2.4.3 CPX terminal configuration using Beckhoff TwinCAT (EtherCAT network configuration)

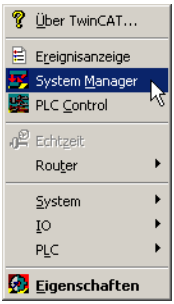
The subsequent sections describe the major configuration steps using the configuration and programming software Beckhoff TwinCAT.

Other PLC systems may require different settings or procedures.

Configuration examples presented in this section are based on the utilization of a typical office PC and the configuration and programming software package Beckhoff TwinCAT (PLC) Version 2.10.

Prerequisites for the subsequent explanations:

- It is assumed that the operation of the Beckhoff TwinCAT software is as understood.
- The PC is equipped with an Ethernet interface card comprising an Intel IC chip set.
- The Ethernet card, i.e. the I/O Device, has been incorporated into the the EtherCAT system (in TwinCAT by using Append Device...).
- The XML file for the CPX terminal has been imported (see section 2.4.1).



The configuration and programming software Beckhoff TwinCAT comprises several programm elements. The configuration program, i.e. the TwinCAT System Manager, and the related programming software or PLC, i.e. TwinCAT PLC Control, form the main elements of the software package or the TwinCAT system environment, respectively.

Main functions of the TwinCAT System Manager:

– EtherCAT network configuration
– Configuration of the network elements, like interface cards or I/O Devices, as well as field bus devices or “Boxes”
– Assignment of the I/O Devices and “Boxes” to PLC projects

Main functions of TwinCAT PLC Control:

– Configuration and programming software for TwinCAT PLC projects

Please note
This manual refers to the TwinCAT language settings “English” and “German”.

Other language versions typically use different indications or names for the program and function calls, as well as menu items referred to in the framework of this document.

You will find the language settings in the TwinCAT System Manager under:

Options › Language

Caution
Danger of malfunctions, damage or injuries to people

A valve terminal with defective configuration will also be put into operation.

Before commissioning, ensure that the connected elements (e.g. actuators) do not perform any undesired or uncontrollable movements.

If necessary, disconnect the load power supply and compressed air supply.

See also section 2.8, Check list for commissioning the CPX terminal.

Creating automation project

1. Start the TwinCAT System Manager:

   Start › Programs › TwinCAT System › **TwinCAT System Manager** (subsequently referred to as System Manager)

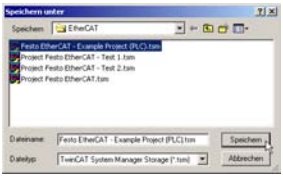
   Note: The program path of your TwinCAT installation can be different from the example shown here.

2. Create a new project in the System Manager:

   “File” › “New”

3. Save the new project:

   “File” › “Save as...”



4. Enter a project name and confirm the input with OK or “Save”.

Adding field device (“Box”), e.g. CPX bus node

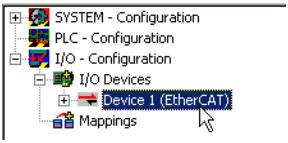
1. Ensure that the configuration mode (“Config Mode”) is activated. The System Manager displays the activated Config Mode within the TwinCAT program window on the lower right.

2. In case the Config Mode is not activated.

   Click the corresponding symbol (see adjoining figure in the margin) or press [Shift] + [F4] to switch over to the Config Mode.

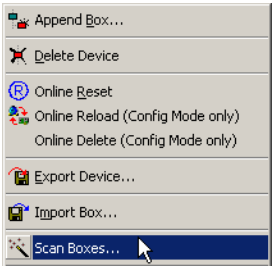
3. Except for “Activate Free Run”, confirm all subsequent queries with Yes (“Ja”):

   – “Restart TwinCAT TwinCAT System in Config Mode”
   – “Load I/O Devices”



4. Using the right mouse button, click on the device icon, here “Device 1 (EtherCAT)”.

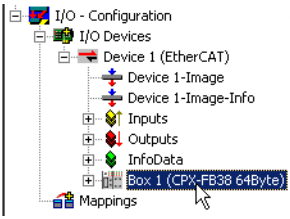
   A function menu opens.



5. Select “Scan Boxes”.

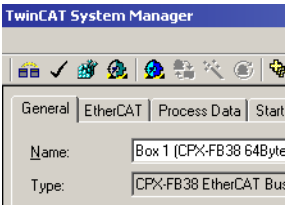
   The System Manager searches to find field Devices (“Boxes”).

   The field Devices (here “Box 1”) are listed below the related device entry (here “Device 1”): see subsequent figure in the margin.



6. Using the left mouse button, click on the box icon, here “Box 1 (CPX-FB38 64 Byte)”, to display the related properties, e.g. EtherCAT-specific settings or process data.

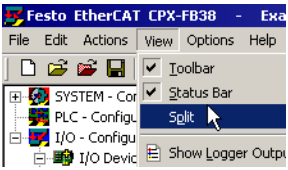
   The properties are displayed in the right area of the System Manager window.



– You will find EtherCAT-specific settings, e.g. EtherCAT characteristics of the box or bus node in:

  EtherCAT › “Advanced Settings”

– Typically, changes of the box properties are **not required**.



7. If the box properties are not displayed:

   Use the display function “Split” to set the window partition:

   “View” › “Split”

Functional test in the framework of the Free Run State

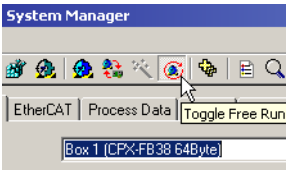
The Free Run State supports the set-up and check-up of your automation project.

The functional capability of the EtherCAT network and embedded I/O Devices can be checked in the framework of the Free Run State to input and output level: Also each particular input and output of a CPX terminal can be read or activated (forced) for test purposes.

1. Ensure that the configuration mode (“Config Mode”) is activated. The System Manager displays the activated Config Mode within the TwinCAT program window on the lower right.

   Click the corresponding symbol (see 1 in Fig. 2/6) or press [Shift] + [F4] to switch over to the Config Mode.

Note
If the Config Mode is not activated, the Free Run State is not available.
In this case, the Free Run Symbol (2 in Fig. 2/6) is displayed in grey colour, e.g. when the EtherCAT system is in state “Stopped”.



2. Activate the “Free Run State” in TwinCAT System Manager:

   Click the corresponding symbol (see adjoining figure or 2 in Fig. 2/6) or press [Ctrl] + [F5] to switch over to the Free Run State.

The System Manager displays the activated Free Run State within the TwinCAT program window on the lower right.

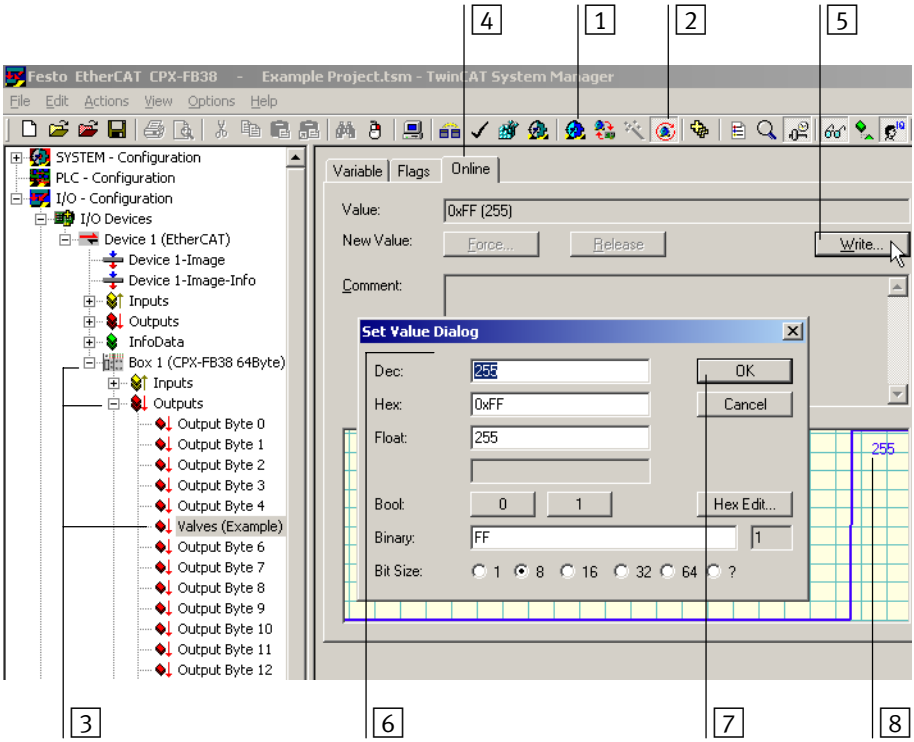


Fig. 2/6: Functional test in the frame work of the Free Run State

3. Select the input or output to be checked (see 3 in Fig. 2/6):

   Using the left mouse button, click on the symbol representing the input or output, here “Valves (Example)”, to display the related properties.

   The properties are displayed in the right area of the System Manager window.

4. Click on “Online” [4] to display the current input or output data or the corresponding “Value”.

   In the bottom part of the window, the current value is displayed graphically: see [8] in Fig. 2/6.

5. Click on “Write” [5] to change the value.

   The window “Set Value Dialog” [6] is displayed.

6. Enter the required value.

7. Confirm your entry with “OK” [7].

8. The current value changes accordingly: see graphical representation [8]. In this example, the “Valves” of a CPX terminal are set.

9. Check the execution of the value change directly at the terminal.

2.4.4 Linking automation project (PLC project)

By means of its “Inputs” and “Outputs”, i.e. registers and objects, the PLC project forms the software interface between the automation program and the inputs and outputs of the EtherCAT network, i.e. the I/O Devices and “Boxes”.

The integration of an EtherCAT automation project into the system environment, here Beckhoff TwinCAT, is implemented using logical interconnections (links). For this purpose, the particular hardware elements, I/O Devices and “Boxes” are linked to software elements (see example in Fig. 2/7).

The varied functions and options of the TwinCAT system form thereby the basis for EtherCAT automation projects providing multitudinous optimization opportunities.

Example projects (“Samples”) and **master projects** (“Templates”) are available in the TwinCAT directory of your system environment or using the TwinCAT help or the “TwinCAT Information System” (requires separate software installation).

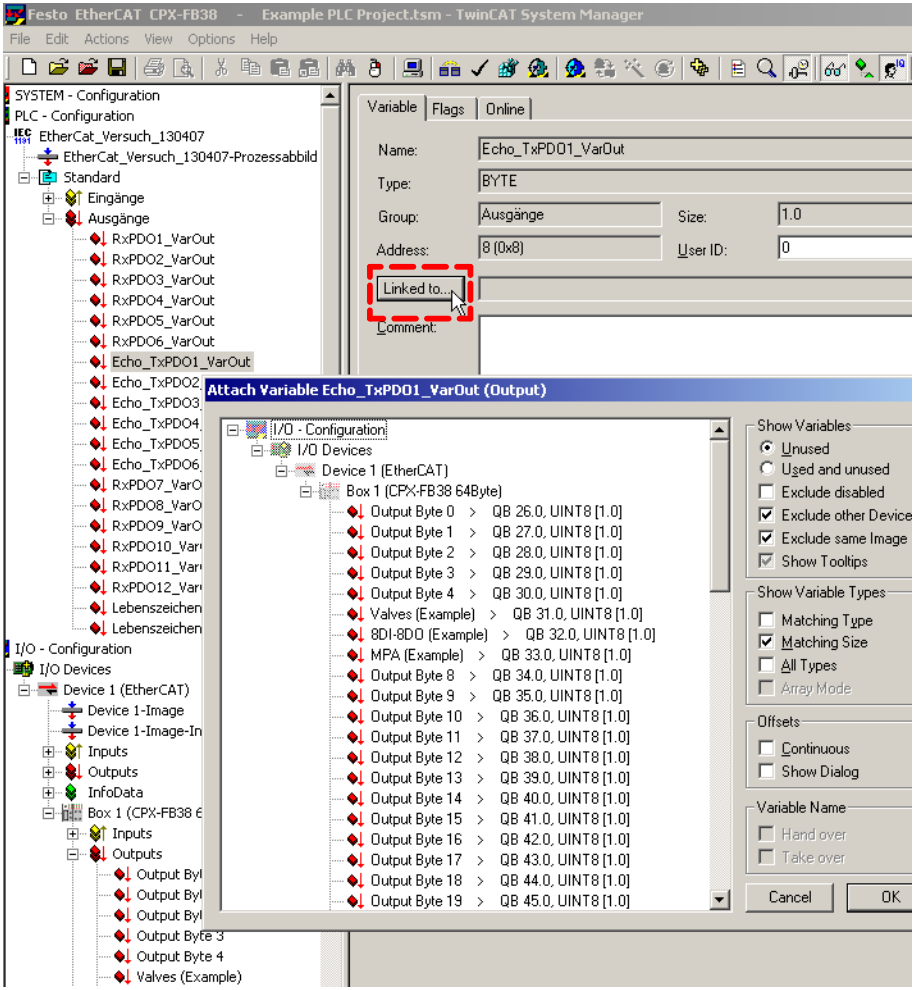


Fig. 2/7: Linking of the EtherCAT network with a TwinCAT automation project or “PLC project” (example)

You can obtain the software for the “TwinCAT Information System” in the internet at:

– http://www.Beckhoff.de

Detailed information as well as example projects and master projects can be retrieved using the following keywords:

– “PLC”, “Project”, “Library”, “Sample”, “Configuration”, “Template”, “Tutorial” etc.

For further support, please contact your Festo service, e.g. by mail:

– service_international@festo.com

2.4.5 EtherCAT topology representation

Symbolic representation of the EtherCAT topology and the CPX terminal

The topology display represents the structure of the EtherCAT network and the “Devices” and “Boxes”, e.g. the CPX bus node and the corresponding CPX terminal (4 in Fig. 2/8).

The subsequent explanation describes the calling of the topology display using Beckhoff TwinCAT.

→

Please note
The topology display however is first available **after completion of the EtherCAT network configuration**.
The network configuration is described in section 2.4.3.

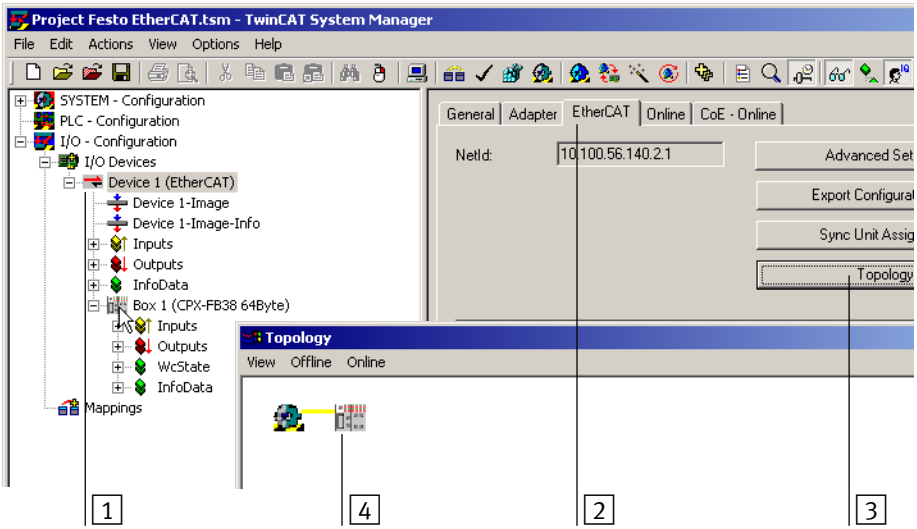


Fig. 2/8: EtherCAT topology display

1. In TwinCAT System Manager, click on the device symbol of the bus node [1] to display the device properties.
2. In the device properties windows, click on “EtherCAT” [2] to open the EtherCAT tab.
3. Click on “Topology” [3]:

   A separate window displays the topology of the EtherCAT network and the “Devices” and “Boxes”, e.g. the CPX bus node and the corresponding CPX terminal [4].

2.4.6 Configuration in the Remote Controller operating mode

If there is a CPX-FEC in your CPX terminal, you can operate the bus node in the Remote Controller operating mode. The bus node then occupies 8 input bytes and 8 output bytes. These are available to the control program in the CPX-FEC and the EtherCAT Master (IPC/PLC).

Configuration in the Remote Controller bus node operating mode

1. Make sure that DIL switch DIL 1.1 of the bus node is in the remote controller position (DIL 1.1 = ON, DIL 1.2 = OFF; see section 1.2.2, Tab. 1/1).

   As a result, the bus node CPX-FB38 is configured as a remote controller.

   To configure the CPX-FEC and CPX terminal, the use of Festo Software Tools Version 4 (FST 4) is required (see step 2.).

2. Configure the CPX terminal with the Festo Software Tools FST 4 via the CPX-FEC.

3. Start your configuration and programming software, e.g. Beckhoff TwinCAT.

4. Open the hardware configuration (I/O Configuration).

5. Configure the EtherCAT network.

2.5 Parameterisation

2.5.1 Introduction to parameterisation

The system reaction of a CPX terminal can be largely adapted to the relevant application. You can individually set the reaction of the entire terminal as well as of individual modules and channels through parameterisation. A distinction is made between the following parameterisation functions:

– System parameterisation, e.g. switching off fault messages, setting reaction times

– Module parameterisation (module- and channel-specific), e.g. monitoring functions, settings for error handling, settings for forcing

– Parameterising the diagnostics memory.

A detailed description of the individual parameters as well as basic information on application can be found in the CPX system manual (P.BE-CPX-SYS-...).

Which parameters are available for the used modules are explained in the manual for the respective module, e.g. manual for CPX I/O modules (P.BE-CPX-EA-...). An example of application can be found in section 2.7.

Please note
The CPX terminal is supplied with factory-preset parameters (default parameterisation).

Please note
Please observe the specific notes on parameterising the bus node CPX-FB38 in section 2.5.3.

Caution
Changes in parameterisation or application-specific paramter settings result in changes to the module or system behaviour. Check especially when replacing CPX terminals to see which settings are necessary and make sure that these are restored, if necessary (e.g. in the start-up phase by appropriate system-start parameterisation).

Warning
Undesired activation of actuators!

An incorrect status of the valves and outputs can lead to dangerous situations.

- Make sure that valves and outputs are put into a safe state when faults occur.
- Check within the framework of your EMERGENCY STOP concept and the Fail safe setting to ascertain the measures necessary for putting your machine/system into a safe state (see also section 2.6.1).

Typical safety measures for safe system condition:

– switching off the load voltage for the valves and output modules in the secondary circuit of the power unit

– switching off the compressed air supply for the valve terminal.

Due to energy stored in the input circuitry of valve terminals, there may be a delayed reaction of the valves when the load voltage is switched off.

Take this situation into account, for example by:

– using an input signal in the controller for checking whether the load voltage has been switched off

– blocking the control signal for the valves by locking the output signal with the input signal “Load voltage”.

2.5.2 General prerequisite for parameterisation

Please note
A CPX terminal can only be parameterised if the function “System start with default parameterisation and current CPX expansion” is activated (set “System start” system parameter accordingly).

With the “System start” system parameter, you can determine the starting reaction of the CPX terminal. Select the “System start with default parameterisation and current CPX expansion” setting to permit the required parameterisation. To perform the parameterisation, use the CPX-FMT or CPX-MMI. If the parameterisation is not changed, the factory settings are used.

After parameterisation, you change the setting of the “System start” system parameter to “System start with saved parameterisation and saved CPX expansion”. This fixes the settings and stores them in the module.

After a new start of the CPX terminal, the bus node diagnostic LED “Modify” (M) lights up permanently. The terminal uses the saved parameter settings.

Caution
In the case of CPX terminals on which the M LED lights up permanently, parameterisation will not be restored automatically by the higher-order system **upon replacement**. In these cases, check before replacement to see which settings are required and carry out these settings.

2.5.3 Methods of parameterisation

A CPX terminal with bus node CPX-FB38 can be parameterised in various ways. A brief explanation of the available methods can be found in Tab. 2/15 and the following sections.

Parameterisation of the CPX terminal via a PLC user program or EtherCAT configuration and programming software, e.g. Beckhoff TwinCAT, is not possible.

Methods and description	Advantages	Disadvantages
Method 1: **Parametrizing via the Festo Maintenance Tool (CPX-FMT)** Menu-guided parameter entries via PC software (by means of USB adapter)	– Easy parameter entry guided by menu in plain text	– Parameterisation is saved locally in the CPX terminal and is lost if the CPX terminal or bus node is replaced. [1)]
Method 2: **Parameterisation with the handheld unit (CPX-MMI)** Menu-guided parameter entry	– Easy parameter entry guided by menu in plain text using a compact handheld unit	– Parameterisation is saved locally in the CPX terminal and is lost if the CPX terminal or bus node is replaced. [1)]
[1)] Copying and saving of parameter settings is possible, such as for transmission of parameter data as part of a module exchange.		

Tab. 2/15: Methods of parameterisation (overview)

2.5.4 Parameterisation via the Festo Maintenance Tool (method 1)

With the PC software Festo Maintenance Tool (CPX-FMT), you can easily parameterise the CPX terminal over a USB connection.

You receive the necessary USB adapter with the CPX-FMT software.

2.5.5 Parameterisation with the handheld unit (method 2)

The Festo handheld unit (CPX-MMI) offers menu-guided access for parameterisation without configuration software.

Information about general operation of the handheld unit can be found in the related manual (P.BE-CPX-MMI-1-...).

Please note
The last parameterisation set or received in the CPX terminal is always valid.

A CPX terminal can only be parameterised if the function “System start with default parameterisation and current CPX expansion” is activated (set “System start” system parameter accordingly).

In this case, the factory-set parameter settings are valid in the CPX terminal after the power supply is switched on (Power ON).

If you wish to specifically change individual parameter values – without inputting again settings that have already been made:

1. “Approve” parameterisation (permit), that is, activate function “System start with default programming and current CPX expansion” (see above).
2. Do **NOT** restart system or CPX terminal (this ensures that parameterisation already performed is not reset to factory settings).
3. Change or enter parameters.
4. “Block” parameterisation again, that is, activate function “System start with saved parameterisation and saved CPX expansion”.

Please note
Change the setting of the system parameter “System start” to “System start with saved parameterisation and saved CPX expansion” after completion of parameter entry to ensure that parameterisation remains intact even after a system restart or after changes to the control program (of the higher-level system controller).

If the function “System start with saved parameterisation and saved CPX expansion” is activated, the entered or changed parameter settings become valid immediately after the power supply is switched on (Power ON).

2.6 Remarks on parameters of the CPX system settings

2.6.1 Parameterisation of the Fail safe mode

Fail safe mode

This operating mode defines the status which digital output signals (outputs and valves) are to assume in the event of field bus communication faults.

You can determine the status to be assumed for each output channel (output or solenoid coil or valve) separately. The standard setting is “Reset output channel”.

Without parameterisation of the output channels, the following communication condition applies:

– Input signals are transferred.

– Output signals are reset (factory setting); note that for analogue outputs, the analogue value 0 is set.

Behaviour of the outputs in the Fail safe mode (parameterisation)

In the Fail safe mode, output channels can assume one of the following states:

Digital outputs/valves	Analogue outputs
Maintaining the current condition (“freeze” signal)	Maintaining the current condition (“freeze” signal)
Resetting the output channel (factory setting)	Resetting of the output channel to the analogue value 0 (factory setting)
Setting the output signal	Setting the required analogue value (output signal)

Tab. 2/16: Possible states of the output channels in the Fail safe mode

If necessary, parameterise the required state of individual or all output channels (outputs or solenoid coils or valves).

The status is set with the channel-specific module parameters “Faul mode” and Fault state”.

In doing so, make sure that you assign the suitable setting to each output.

Further information: see CPX system manual P.BE-CPX-SYS-...

2.6.2 CPX-FB38-specific process of start parameterisation during switching on (system start)

Due to the CPX-FB38-specific limitations regarding parameterisation (no parameterization by means of the higher-level controller), start parameters can only be entered using the handheld display (CPX-MMI) or Festo Maintenance Tool (CPX-FMT).

The parameterisation during system start of the CPX terminal is therefore **dependent on the setting** of the system start parameter stored in the bus node. This parameter establishes whether the start parameterisation is loaded by the controller, the master or the FEC, or from the CPX bus node.

In the Festo Maintenance Tool, you will find the corresponding setting under “CPX” – “System settings”, register “System parameters” – “System start”: After the required start parameters are set, choose the system start option “Saved parameters”.

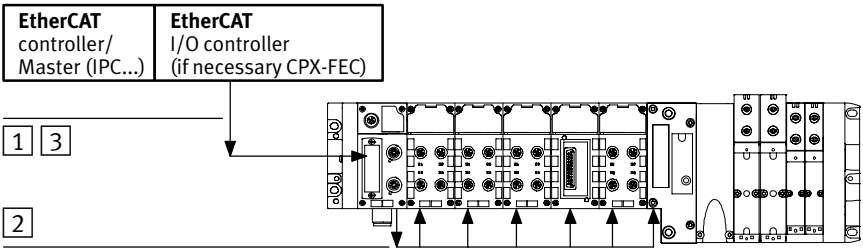
Process details can be found in Fig. 2/9 and the following explanations.

Substantial differences from the standard process:

– No start parameterisation by means of the controller or master, but possibly by means of the CPX-FEC controller program (FEC in the remote controller operating mode).

– Process with “default parameter set” uses the factory-programmed default parameter set (standard process uses in this case the parameterisation from the field bus control program).

Further information on parameterisation using CPX-FMT or CPX-MMI can be found in the sections 2.5.4 and 2.5.5.



1 With default parameter set:
The controller or the I/O Controller initiates use of the **factory-programmed** default parameter set; the bus node then distributes the parameter set to the modules.

2 With saved parameter set:
The CPX bus node distributes the parameter set **saved in the bus node**, which may have been changed or adapted by means of CPX-MMI or CPX-FMT.

3 With "default" parameter set using a CPX-FEC in the remote controller operating mode (parameterisation from the control program of the FEC):
The CPX-FEC loads the **programmed** start parameter set into the CPX bus node; the bus node then distributes the parameter set to the modules.

Fig. 2/9: Sequence of start parameterisation during switch-on of a CPX terminal with bus node CPX-FB38

2.7 Application example for the parameterisation

1 Input for 1st sensor (with default parameterisation)

2 Parameterised input for 2nd sensor (see text)

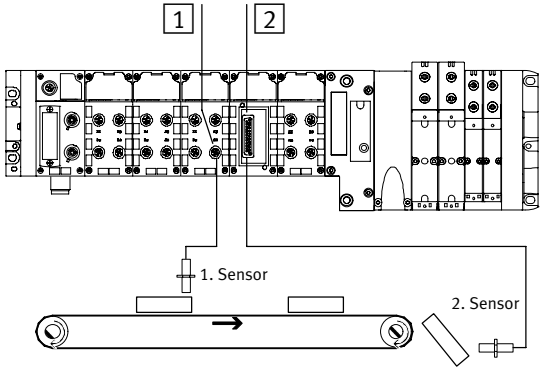


Fig. 2/10: Application example for parameterisation of the input debounce time and signal extension time on the 2nd sensor

In the above application, packets are transported on a fast-moving conveyor belt.

The input for the 2nd sensor is parameterised as follows for improvement of the signal recording and processing:

– Reduction of the input debounce time from 3 ms (factory setting) to 0.1 ms: Recording shorter signals is possible.

  This parameter is set for the complete module.

– Signal extension time set to 50 ms: Reliable recording of the signals by the controller.

  The value of this parameter is set for the complete module but must be activated or deactivated separately for each input channel.

2.8 Checklist for starting up the CPX terminal

Providing the safety concept of your machine/system permits, start up the CPX terminal with both operating voltages – but without compressed air. In this way, you can then test the CPX terminal without triggering unintended reactions.

Please note
Pay attention to start-up information!

Please observe the general start-up instructions in the CPX system manual (P.BE-CPX-SYS-...) and in the manual of your controller.

Caution
Undesired activation of actuators!

An incorrect status of the valves and outputs can lead to dangerous situations!

The CPX terminal with bus node for EtherCAT also starts with **incomplete** configuration.

Check the configuration and address assignment of the I/Os on the CPX terminal.
In order to do this, you can, if necessary, force the I/Os (see CPX system manual).

Proceed as follows

- Check the DIL switch settings as well as the hardware and network configuration before using and replacing the bus node or CPX terminal.
- Make sure that the desired parameterisation of the CPX terminal is automatically carried out in the “start-up” phase, that is, during initialisation (EtherCAT status Initialisation), (see section 2.6.2).

Please note
Perform configuration and parameterisation again after a module replacement!

Recreate the necessary hardware and network configuration and CPX terminal parameterisation after replacement of the bus node or CPX terminal.

To do this, use the EtherCAT controller or the Festo Maintenance Tool (CPX-FMT) or handheld unit (CPX-MMI).

CPX-specific configuration and parameter data can be entered only with CPX-FMT or CPX-MMI.

- Check the parameterisation, using spot checks if necessary.

2.9 Bus node replacement

Procedure

1. Stop the process controller (PLC/Master):
2. If necessary, disconnect the power supply and compressed air supply.
3. Replace the bus node (Dismantling/Installation: see section 1.1).
4. Switch the power supply back on.
5. Start your configuration and programming software (e.g. Beckhoff TwinCAT).
6. Perform a new configuration (hardware and network configuration).
7. Start the process controller (PLC/Master); choose the EtherCAT operating status **Pre-operational** (network configuration).

   The controller loads all required EtherCAT data into the bus node.
8. Recreate the required parameterisation; to do this, use the CPX-MMI or CPX-FMT.
9. If necessary, switch the compressed air supply back on.
10. Start the program process (PLC/Master); choose the EtherCAT operating status **Operational**.

    The CPX terminal or your EtherCAT system is again in normal operating condition.

Diagnosis

Chapter 3

Contents

3.1 Overview of diagnostic possibilities

The CPX terminal provides extensive and user-friendly possibilities for diagnostics and error handling. The following options are available depending on the configuration:

Diagnostic option	Brief description	Advantages	Detailed description
LED display	The LEDs show configuration faults, hardware faults, bus faults, etc. immediately.	Fast “on-the-spot” recognition of faults	Section 3.2
Status bits	Internal inputs, which supply coded common diagnostic messages; the 8 status bits are cyclically transmitted to the module as “inputs” with the normal inputs.	Fast access to fault messages in the PLC user program regardless of the module and I/O controller	Section 3.3
I/O diagnostic interface	Bus-independent diagnostic interface at I/O level which enables access to the internal data of the CPX terminal; for this function, 16 inputs and 16 outputs (2 byte) are available.	Read access to internal parameters and data at I/O level	CPX system manual, section on diagnostics and fault clearance (P.BE-CPX-SYS-...), instructions in section 3.4 (P.BE-CPX-FB38-...)
Diagnostics via the handheld unit	Diagnostic information can be shown on the handheld unit in a user-friendly manner by means of menus.	Fast “on-the-spot” recognition of faults in plain text without programming	Manual for the handheld unit (P.BE-CPX-MMI-1-...)

Tab. 3/1: Overview of the diagnostic options of the CPX terminal

Please note
Availability of diagnosis information

Note that the diagnostic information shown depends on the settings (see section 1.2.2) and the parameterisation (see section 2.5) of the CPX terminal.

- Make sure that, in particular, **system** and **module** parameters are set so that the required information is passed on to the higher-level control system (PLC, SPS or IPC).

Usage case example:
System parameters SCS/SCO/SCV, $V_{OUT/VAL}$ *)

The short-circuitoverload and undervoltage diagnostic messages for the complete CPX terminal can be suppressed using the monitoring system parameter (function no. 4401).

The settings made separately for each module with the **module** parameter CPX module monitoring are not affected by the setting of the **system** parameters monitoring. The “local” setting of the module parameters remains until there is a change in the “global” system parameter.

But diagnostic messages of the monitoring **module**, e.g. short-circuit error messages, are only forwarded to the control system if the **system** parameter is activated.

Additional information on parameterisation can be found in the CPX system manual (P.BE-CPX-SYS-...) in appendix B.

*) SCS short circuit/overload – sensor/logic provision
SCO short circuit/overload – outputs (load supply)
SCO short circuit/overload – valves (load supply)
$V_{OUT/VAL}$ undervoltage – outputs/valves (load supply)

Warning
Undesired activation of actuators!

An incorrect status of the valves and outputs can lead to dangerous situations!

- Make sure that valves and outputs are put into a safe state when faults occur.
- Check within the framework of your EMERGENCY STOP concept and the fail-safe setting to ascertain the measures necessary for putting your machine or system into a safe state.

Typical safety measures for safe system condition:

– switching off the load voltage for the valves and output modules in the secondary circuit of the power unit.

– switching off the compressed air supply for the valve terminal.

Due to energy stored in the input circuitry of valve terminals, there may be a delayed reaction of the valves when the load voltage is switched off.

Take this situation into account, for example by:

– using an input signal in the controller for checking whether the load voltage has been switched off.

– blocking the control signal for the valves by locking the output signal with the input signal “Load voltage”.

3.2 Diagnostics via LEDs

LEDs for diagnosing the CPX terminal are available on the bus node as well as on the individual modules.

The meaning of the LEDs on the electric modules can be found in the manual for the relevant module.

LEDs on the CPX bus node for EtherCAT

The light emitting diodes on the cover indicate the operating status of the CPX bus node.

[1] CPX-specific LEDs

PS: Power system

PL: Power load

SF: System Failure

M: Modify

[2] EtherCAT-specific LEDs

Run: EtherCAT operating status

Error: EtherCAT errors

L/A2: Connection status (link/activity) Out2

L/A2: Connection status (link/activity) In1

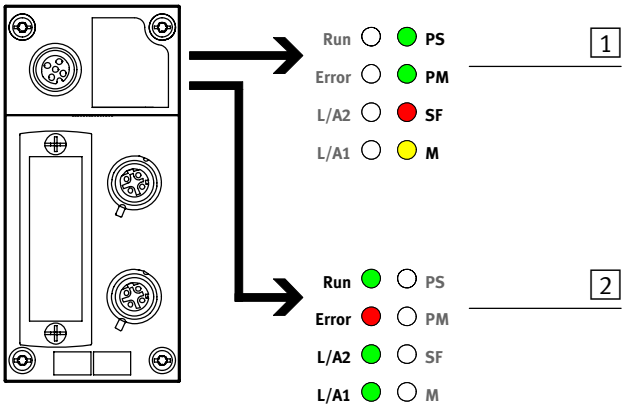


Fig. 3/1: LEDs on the CPX bus node

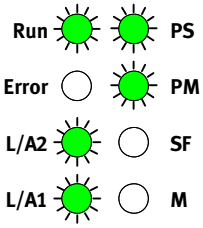
The LEDs are shown in their various states as follows:

 lights;  flashes or flickers; ◯ off

Normal operating status

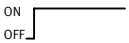
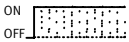
In normal operating status, the following LEDs light green: Run, PS and PL; the LEDs L/A1 and L/A2 light up or flash green when the connection is used. The error and SF LEDs do not light up.

The M LED only lights or flashes for the changed parameterisation setting (system start with saved parameterisation and saved CPX expansion) or force active (force mode, function No. 4402; see CPX System Manual P.BE-CPX-SYS-..., onsite diagnostics).

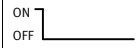
LED display		**Operating status**
	The following LEDs light green: – Run – PS – PM – L/A2 [1)] – L/A1 [1)] The following LEDs do not light: – Error – SF The M LED lights or flashes if parameterisation is changed or force mode is active	Standard
[1)] Only if connection is used: – Constant light: connection active – Flashing/blinking: Data transmission is running		

Tab. 3/2: Normal operating status

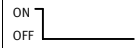
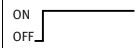
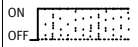
3.2.1 EtherCAT operating status display (LED run), EtherCAT error (LED Error), connection status (LEDs L/A2, L/A1)

Run – EtherCAT operating status (communication status)			
LED (green)	**Sequence**	**Status**	**Meaning/error handling**
 LED is off		Init	Bus node is in the the Init status (normal condition after switch-on or after a restart or reboot)
 LED flashes		Pre-operational	Bus node is in the pre-operational status (network configuration)
 LED flashes 1x [1]		Safe-operational	Bus node is in the safe-operational status (e.g. due to a network disturbance). Only the input signals (e.g. sensor data) are updated. Outputs and valves maintain the current state (signal is “frozen”).
 LED lights up		Operational	Bus node is in the Operational status (normal operating status)
 LED flickers		Initialisation	Bus node carries out a restart (reboot) and is **not yet** in the Init status (designated as Initialisation status)
[1] One-time short flashing (1x flash, pause, 1x flash, etc.) is designated as single flash.			

Tab. 3/3: Fault diagnosis with the Run LED

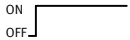
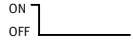
Error – EtherCAT error (communication error)			
LED (red)	**Sequence**	**Status**	**Meaning/error handling**
LED is off		No fault	EtherCAT communication of the bus node is in normal operating state
LED flashes		Invalid configuration No connection to the EtherCAT network Possible causes: – Cable/connection disconnected (interrupted) – Device has no connection to the EtherCAT Master (for control) – Master is not active	Error handling – check: • The network connection (interrupted, short-circuited or disturbed network connection) • The configuration, in particular the physical and logical position and addressing of the bus node

Tab. 3/4: Fault diagnosis with the LED error

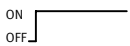
L/A2, L/A1 – Connection status (link/activity) Out2/In1			
LED (green)	**Sequence**	**Status**	**Meaning/error handling**
LED is off		No physical network connection	Check network connection / network cable
LED lights up		Network connection OK	–
LED flickers [1)]		Flickering: Data transmission is running	–
[1)] Rapid flickering seems to be lighting; the light intensity depends on the data traffic			

Tab. 3/5: Fault diagnosis with the LEDs L/A2, L/A1

3.2.2 Fault displays of the LEDs for system diagnosis (LED PS, PL, SF, M)

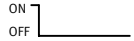
PS (power system) – power sensor/logic supply			
LED (green)	**Sequence**	**Status**	**Fault treatment**
 LED lights up		No fault, operating voltage/sensor supply applied	–
 LED flashes		Operating voltage/sensor supply outside the tolerance range	1. Eliminate short circuit/overload 2. Dependent on the parameterisation: • The sensor supply voltage will be switched on again **automatically** after the short circuit has been eliminated (default) • Power Off/On is necessary
 LED is off		The operating voltage/ sensor supply is not applied	Check the operating voltage connection of the electronics

Tab. 3/6: Fault diagnosis with the LED PS

PL (Power Load) – power load supply (outputs/valves)			
LED (green)	**Sequence**	**Status**	**Fault treatment**
 LED lights up		No fault, load voltage applied	None
 LED flashes		Load voltage outside tolerance range	1. Eliminate undervoltage 2. Dependent on the parameterisation: • The load voltage supply will be switched on again **automatically** after the undervoltage has been eliminated (default) • Power Off/On is necessary

Tab. 3/7: Fault diagnosis with the LED PL

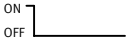
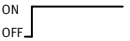
SF (system failure) – system fault

LED (red)	Sequence	Status [1]	Meaning/error handling
LED is off		No fault	–
LED flashes once		Minor error or information (error class 1)	See description of the error numbers in the CPX system manual (P.BE-CPX-SYS-...)
LED flashes twice		Error (error class 2)	
LED flashes three times		Serious error (error class 3)	

[1] The system error LED flashes depending on the class of error which has occurred.
Error class 1 (minor error): one flash, pause
Error class 2 (error): flash twice, pause
Error class 3 (serious error): flash three times, pause

Tab. 3/8: Fault diagnostics using the SF LED

M (modify) – parameterising modified or forcing active

LED (yellow)	Sequence	Status	Meaning/error handling
LED is off		System start with default parameterisation (factory setting) and current CPX expansion has been set; external parameterisation possible (presetting)	None
LED lights up		System start with saved parameterisation and saved CPX expansion has been set; parameters and CPX expansion are retained; external parameterisation is blocked [1)]	**Be careful** when replacing CPX terminals with saved parameterisation: Parameterisation is not carried out automatically for these CPX terminals by the higher-order controller when the terminal is replaced. In these cases, check which settings are required before the replacement and make these settings if necessary.
LED flashes		Force is active [1)]	The Force function has been activated (Force mode; Function No. 4402, see CPX System Manual P.BE-CPX-SYS-...).

[1)] The display of the Force function (LED flashes) has priority over the display of the setting for the system start (LED lights).

Tab. 3/9: Messages of the LED M

3.3 Diagnostics via status bits

The CPX terminal provides 8 status bits if you activate this function using DIL switches (see section 1.2.2).

The status bits are used for displaying common diagnostics messages (global error messages). Status bits are configured like inputs. If the status bits function is activated, it occupies the first 16 inputs in the address range (8 inputs or 8 bits remain unused; see Tab. 1/2 or Tab. 2/1).

Please note
Note the instructions on addressing and configuration in the sections 2.3 and 2.4.

The following table provides an overview of the available diagnostic information.

Bit	Diagnostic information with 1-signal	Manual
0	Fault at valve or pneumatic module	Module type in which a fault has occurred.
1	Fault on output module	
2	Fault on input module	
3	Fault on analogue module or technology module	
4	Undervoltage	Type of fault
5	Short circuit/overload	
6	Wire break	
7	Other faults	

Tab. 3/10: Overview Status bits of the CPX bus node (optional)

If all status bits supply a 0-signal, no fault will be registered. If, in contrast, a status bit supplies a 1 -signal, there is a fault.

If various faults occur simultaneously on various types of modules, these faults cannot be assigned via the status bits. In contrast, faults can be uniquely determined via the I/O diagnostic interface.

Diagnostic information or error messages of the status bits functions (or I/O diagnostic interface) can be read out using the handheld unit (CPX-MMI), Festo Maintenance Tool (CPX-FMT) and via the EtherCAT network.

Please note
Limited availability of diagnosis information

Status bits forwarded over the EtherCAT network, that is, diagnostic information or error messages of the CPX terminal, are almost always **not** displayed in EtherCAT configuration and programming software, e.g. TwinCAT.

Display of CPX-specific diagnostic information and error messages in the online mode of the EtherCAT software is available – to a limited extent – only by means of the I/O diagnostic interface.

Use the handheld unit, the Festo Maintenance Tool or your requirements according to application programs for detailed diagnostic functions.

Further instructions on the function and content of the status bits can be found in the CPX system manual (P.BE-CPX-SYS-...) in the Diagnostics and error handling section.

3.4 Diagnostics via the I/O diagnostic interface (STI)

The CPX terminal provides 16 I/O status bits (System table interface, STI) if you activate this function using DIL switches (see section 1.2.2).

Detailed diagnostic information can be accessed via the I/O diagnostic interface. You can ascertain this exactly, e.g. by noting on which module and channel a fault has occurred. 16 input bits and 16 output bits, via which all diagnostic data can be read, are available for accessing the system diagnosis.

If the I/O diagnostic interface is active, it will occupy the first 16 inputs and outputs in the address range (see Tab. 1/2 and Tab. 2/1).

Please note
Note the instructions on addressing and configuration in the sections 2.3 and 2.4.

The following table provides an overview of the available diagnostic information.

Diagnostic data	Contents/description
Global diagnostic data	– General overview of faults
Module diagnostic data	– Detail diagnosis per module
Status of diagnostic memory	– Number of entries in the diagnostic memory – Operation mode
Diagnostic memory data	– Long-term memory – Detail diagnosis + relative time stamp per fault event

Tab. 3/11: Overview of diagnosis data or I/O diagnostic interface (optional)

Diagnostic information or error messages of the status bits functions (or I/O diagnostic interface) can be read out using the handheld unit (CPX-MMI), Festo Maintenance Tool (CPX-FMT) and via the EtherCAT network.

Please note
Limited availability of diagnosis information

Diagnostic information or error messages of the CPX terminal are almost always only displayed in EtherCAT configuration and programming software, e.g. TwinCAT.

Use the handheld unit, the Festo Maintenance Tool or your requirements according to application programs for detailed diagnostic functions.

Further instructions on the I/O diagnosis interface (diagnostic information, function numbers) can be found in the CPX system manual (P.BE-CPX-SYS-...) in the Diagnostics and error handling section.

3.5 Diagnosis via EtherCAT

3.5.1 Basic information

Please note
Availability of diagnosis information via the EtherCAT network

- Note that the diagnostic information shown depends on the settings (see section 1.2.2) and the parameterisation (see section 2.5) of the CPX terminal (see also section 3.1).
- Detailed diagnosis information about the status of the CPX terminal are available to the EtherCAT network only by means of the I/O diagnosis interface.
- Activate the I/O diagnosis interface to ensure that error messages of the CPX terminal are automatically displayed in the EtherCAT configuration software, e.g. Beckhoff TwinCAT.
- Diagnostics information is availabie to Beckhoff TwinCAT only to a limited extent even with activated I/O diagnosis interface. For detailed error analysis, use the handheld unit, the Festo Maintenance Tool or your requirements according to application programs for detailed diagnostic functions.

3.5.2 Fail safe behaviour (Fail safe settings)

The reaction of the CPX terminal for the following errors is dependent on the configured reaction of the controller (of the Master), i.e. of the PLC, the SPS, the IPC or the application program and the parameterised Fail safe setting:

– stop of the controller (of the master)

– network interruption

– telegram elimination.

Depending on the parameterisation, the outputs (valves and electric outputs) will be switched off (factory setting), switched on or retain their status.

Further information about the Fails safe setting can be found in the section 2.6.1 the CPX system manual P.BE-CPX-SYS-...

You can set two types of fault reactions of the controller (or the application program):

– Hard fault reaction:
  The controller switches to the operating mode “STOP” or pre-operational when a fault occurs.

– Soft fault reaction:
  The controller switches to the operating mode “RUN” or safe-operational (or possibly operational) when a fault occurs.

Warning
Undesired activation of actuators!

An incorrect status of the valves and outputs can lead to dangerous situations!

- Make sure that valves and outputs are put into a safe state when faults occur.
- Check within the framework of your EMERGENCY STOP concept and the fail safe setting to ascertain the measures necessary for putting your machine or system into a safe state.

Typical safety measures for safe system condition:

– switching off the load voltage for the valves and output modules in the secondary circuit of the power unit

– switching off the compressed air supply for the valve terminal.

Due to energy stored in the input circuitry of valve terminals, there may be a delayed reaction of the valves when the load voltage is switched off.

Take this situation into account, for example by:

– using an input signal in the controller for checking whether the load voltage has been switched off

– blocking the control signal for the valves by locking the output signal with the input signal “Load voltage”.

Please note
Take into account valve behaviour as part of the EMERGENCY STOP concept or of the Fail safe setting!

If the outputs are reset in the case of a controller stop, network interruption, telegram elimination or terminal disturbance, the following valve behaviour occurs:

– Single-solenoid valves move to the basic position.
– Double-solenoid valves remain in the current position.
– Mid-position valves move to the mid-position (depending on valve type: pressurised, exhausted or blocked).

3.5.3 Fault types

A listing of all error types as well as additional diagnosis information can be found in the CPX system manual (P.BE-CPX-SYS-...).

Technical appendix

Appendix A

Contents

A.1 Technical specifications of bus node CPX-FB38

General information	
General technical data	see CPX system manual P.BE-CPX-SYS-...
Protection class through housing according to EN 60529, completely installed, plug connector inserted or provided with protective cap	IP65/IP67 protection
Protection against electric shock Protection against direct and indirect contact as per IEC/DIN EN 60204-1	by means of a PELV circuit
Module code (CPX-specific) – Remote I/O – Remote controller	 220 169
Module identifier (in the Handheld) – Remote I/O – Remote controller	 FB38-RIO EtherCAT remote I/O FB38-RC EtherCAT remote controller

Voltage supply	
Operating voltage / load voltage	see CPX system manual P.BE-CPX-SYS-...
Bus node own-current consumption from operating voltage supply for electronics/ sensors ($V_{EL/SEN}$)	max. 80 mA at 24 V (internal electronics)
Electrical isolation EtherCAT interfaces for $V_{EL/SEN}$	electrically isolated
Power failure bridging time	10 ms

Network-specific characteristics	
Field bus protocol	EtherCAT, based on the Ethernet protocol (IEEE 802.3), optimised for process data Real-time-capable
Specification	Standards and norms with regard to EtherCAT: – IEC 61158 – IEC 61784 – IEC 61918 – ISO/IEC 8802-3 Further information: http://www.ethercat.org
Baud rate	100 Mbit/s
Cross-over recognition	Auto-MDI
EtherCAT input/output size	64 bytes/64 bytes, regardless of operating mode

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Appendix B

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