

Universal bus node CTEU-EC

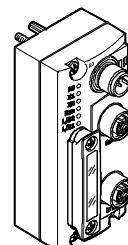
FESTO

Description,
functions and
maintenance

Bus node

Type CTEU-EC

Network protocol
EtherCAT



Description
575401
en 1208NH
[758875]

Contents and general safety instructions

Original de
Version en 1208NH
Designation P.BE-CTEU-EC-OP+MAINT-EN
Order no. 575401

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Internet: <http://www.festo.com>

E-mail: service_international@festo.com

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Contents and general safety instructions

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Designated use

The bus node type CTEU-EC described in this manual has been designed exclusively for use as a participant (slave device) in an EtherCAT network.

The bus node may only be used as follows:

- In industrial environments according to its intended use; outside of industrial environments, e.g. in commercial and mixed-residential areas, measures to suppress interference may be required
- 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 limit values specified for pressures, temperatures, electrical data, torques etc. must be observed.

Comply with the legal rules and regulations and standards, rules of the testing organisations and insurance companies and national specifications applicable for the location.



Warning

- Use only PELV circuits for the electrical power supply in accordance with IEC/EN 60204-1 (Protective Extra-Low Voltage, PELV).
- Observe also the general requirements for PELV circuits in accordance with IEC/EN 60204-1.
- Use only voltage sources that ensure a reliable electrical isolation of operating voltage in accordance with IEC/EN 60204-1.
- Always connect the circuits for both operating and load voltage supply.

Through the use of PELV circuits, protection against electric shock (protection against direct and indirect contact) is ensured in accordance with IEC/EN 60204-1.

Range of application and certifications

The product fulfils the requirements of EU directives and is marked with the CE marking.



Standards and test values which the product complies with and fulfils can be found in the section "Technical appendix". The product-relevant EU directives can be found in the declaration of conformity.



You can find certificates and declarations of conformity for this product online at:

➔ www.festo.com

You can find information on EtherCAT online at:

➔ www.ethercat.org



Target group

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

Service

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

Notes on this manual

This manual is Part II of the product documentation for the bus node, and contains specific information about the configuration, parameterisation, commissioning, programming and diagnostics of the bus node with the EtherCAT fieldbus protocol.



Information relating to installation of the bus node can be found in Part I of the product documentation entitled “Universal bus node CTEU-EC – Installation and Interface manual”, which is supplied with the bus node.

All information relating to installation and to the interfaces can also be found in chapter 1 of this manual.

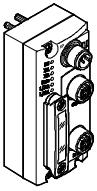
Information on mounting the bus node on the electrical connection box CAPC-... can be found in the assembly instructions that accompany the electrical connection box.

Information about other bus nodes and components of the CTEU... product family can be found in the user documentation for the respective product.

You can also find all documents online at:

➔ www.festo.com ➔ Support portal: enter search term, e.g. “CTEU” ➔ user documentation

This manual contains information about the following module:

EtherCAT bus node	Type designation	Description	Connection technology
	CTEU-EC	<p>Ethernet-based bus node for EtherCAT</p> <p>The EtherCAT field bus technology uses the Ethernet standards for real-time communication in an industrial environment.</p> <p>Data transmission:</p> <ul style="list-style-type: none"> – EtherCAT, based on the Ethernet protocol (IEEE 802.3), optimised for process data, real-time capable – Transmission of process data in the Ethernet framework – Industrial Ethernet, Switched Fast Ethernet, 100 Mbit/s <p>Standards and norms containing reference to EtherCAT:</p> <ul style="list-style-type: none"> – IEC 61158 – IEC 61784 – IEC 61918 – ISO/IEC 8802-3 <p>Additional information: http://www.ethercat.org </p>	2 x M12 socket, D-coded, female, 4-pin, corresponding to IEC 61076-2-101

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

Important user instructions

Danger categories

This manual contains instructions on the possible dangers which can 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

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



Caution

... means that failure to observe this instruction may result in personal injury or material damage.



Note

... means that failure to observe this instruction may result in material damage.

In addition, the following pictogram denotes passages in the text which describe activities involving electrostatically sensitive devices:



Electrostatically sensitive devices: Incorrect handling may cause damage to devices.

Marking of special information

The following pictograms denote passages in the text which contain special information.

Pictograms



Information:

Recommendations, tips and references to other information sources.



Accessories:

Information on necessary or useful accessories for the Festo product.



Environment:

Information on the environmentally friendly use of Festo products.

Text designations

- Bullet points denote activities that may be carried out in any sequence.
- 1. Numerals denote activities that must be carried out in the sequence specified.
 - Arrowheads indicate general lists.

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

Term/abbreviation	Meaning
Box	Field device, e.g. bus node
Bus nodes	Create the connection to certain networks or fieldbuses, transmit control signals to the connected modules and monitor their functioning
CoE	CANopen over EtherCAT
DIL switches	Miniature switches; dual-in-line switches usually consist of several switch elements which can be used to implement settings
ESI	EtherCAT slave information
EtherCAT	An industrial-Ethernet based fieldbus system for data exchange between system controller (PLC/IPC), equipment controller and field devices (slave/I/O devices) or drives; transmission of process data in data objects (based on the fieldbus protocol CANopen); embedding of process data in Ethernet frames (Frames) or datagrams (via UDP/IP); additional information: www.ethercat.org
FoE	File access over EtherCAT
Hold last state	defines the status which outputs or valves are to assume following fieldbus and/or communication errors
I	Digital input
I/Os	Digital inputs and outputs
IB	Input byte
IPC	Industrial PC
I-port	Festo-specific port for the transfer of communication data (process data, sensor signals, pilot signals) and supply voltages

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

Contents and general safety instructions

Term/abbreviation	Meaning
Load voltage	includes the power supply for connected devices and outputs, e.g. solenoid coils of valves (load voltage supply as distinct from operating voltage supply for electronics and sensors)
LSB	Byte with the lowest importance (<u>Least Significant Byte</u>)
MDP	Information model in which hardware and software components are represented as individual modules (<u>Modular Device Profile</u>)
MSB	Byte with the highest importance (<u>Most Significant Byte</u>)
O	Digital output
OB	Output byte
Object directory	makes all important participant parameters accessible in a standardised manner
PDO	<u>Process Data Objects</u> provide fast transfer of process data and are transmitted by simple EtherCAT messages with no protocol overhead. Process Data Objects may be transmitted based on event control, synchronised to a system clock, or on request.
PLC	Programmable Logic Controller, same as SPS
Power supply	Umbrella term for operating and load voltage supplies
SDO	<u>Service Data Objects</u> form point-to-point connections between the server and client, primarily for the exchange of parameters for device configuration. These permit write and read access to any entry in the object directory of a bus node.
TwinCAT	Beckhoff configuration and programming software (TwinCAT: The Windows Control and Automation Technology)

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

Contents and general safety instructions

Installation

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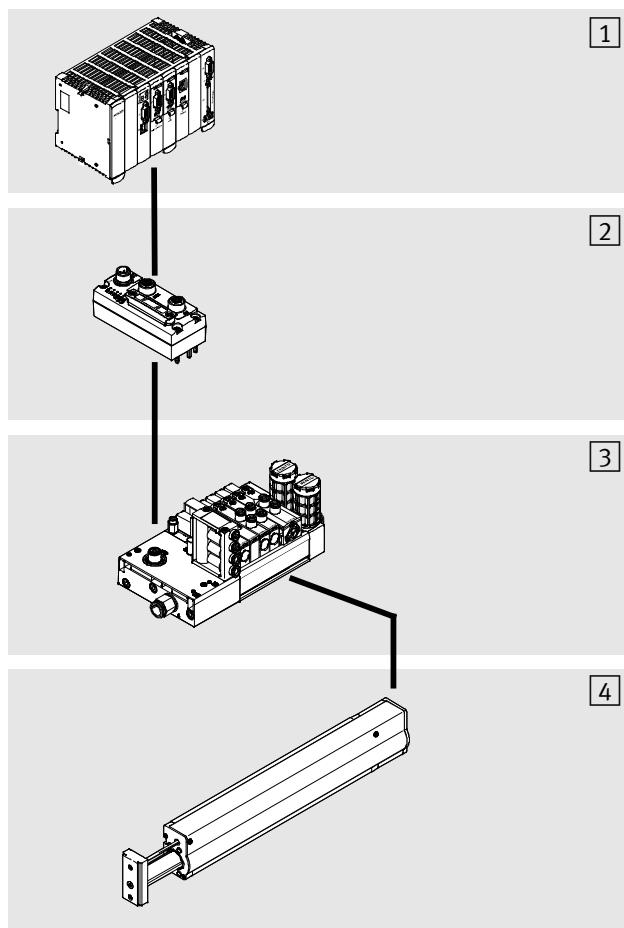
1. Installation

1.1 General information on the CTEU product family

The CTEU... product family is used to set up a decentralised automation system in an EtherCAT fieldbus network.

1.1.1 Hardware components

- [1] Higher-order controller (master/PLC/IPC)
- [2] Fieldbus level: bus node CTEU
- [3] Device level: e.g. valve terminal VTUB-12
- [4] Drive level: e.g. linear module HME



1. Installation

The fieldbus and device levels are connected via an I-port. I-port is a Festo-specific port for the transmission of communication data (process data, sensor signals, pilot signals) and supply voltage. The I-port communication protocol is based on the IO-Link protocol. The electrical and mechanical connections between the bus node and I-port device are standardised.

1.1.2 Scope of functions (brief overview)

- Real-time Ethernet communication (EtherCAT)
- Deterministic data transmission
- Master-slave system architecture
- Modular valve terminal configuration (MDP)
- Diagnostic data via CoE
- Parameter data via CoE
- Hot Connect function for connecting and disconnecting devices during operation
- Module address can be altered via DIL switches
- Adjustable fail state behaviour
- Activation of module diagnostics via DIL switches

1. Installation

1.2 General information on the EtherCAT fieldbus protocol

1.2.1 Key elements of the fieldbus protocol

Participant features

When you place a new EtherCAT participant, i.e. an EtherCAT device, into operation for the first time, you must inform the configuration and programming software about certain properties of the participant. The properties of the various participants are managed in a configuration file - the EtherCAT slave information file (ESI file).

The file/its contents are available in Extensible Markup Language (XML).

Communication protocol

The EtherCAT protocol enhances the Ethernet standard by adding real-time capability.

In the EtherCAT protocol, data are transported within a standard Ethernet frame. When the standard Ethernet frame is sent, the EtherCAT slaves only remove the data that are intended for them as the telegram passes through the device, and add input data to the telegram at the same time. For this, each slave requires two EtherCAT interfaces (one for transmission and one for reception).

The CTEU-EC bus node supports the CANopen over EtherCAT (CoE) and File Access over EtherCAT (FoE) protocols.

Participant addressing

In an EtherCAT network, the slaves are automatically assigned addresses. If desired the bus node can be assigned an EtherCAT address using the DIL switches.

1. Installation

1.2.2 EtherCAT specifications

Further information on EtherCAT is available online:

EtherCAT specifications	
EtherCAT Technology Group	http://www.ethercat.org/en/publications.html

Tab. 1/1: EtherCAT specifications

1.2.3 Conformance with the EtherCAT specifications

The CTEU-EC bus node gave a positive result in testing with the “EtherCAT Conformance Test Tool” (CTT, Version 1.20.52.0).

1.3 General information on installation



Warning

Danger of injury due to uncontrolled movements of connected equipment.

Make sure that electrical and pneumatic equipment are in a de-energised and pressureless state.

Before working on the pneumatics:

- Switch off the compressed air supply
- Vent the valve terminal

Before working on the electrical components, e.g. before installation or maintenance work:

- Switch off the power supply

In this way, you can avoid:

- uncontrolled movements of loose tubing
- unexpected and uncontrolled movements of the connected actuators
- non-defined switching states of the electronics



Note

The EtherCAT bus node contains electrostatically sensitive components.

- Do not touch any electrical or electronic components.
- Observe the handling specifications for electrostatically sensitive devices.

This will help to prevent damage to the electronics.



Note

Use cover caps to seal unused connections. In this way you can attain IP65 protection.



Mounting the bus node

Information on mounting the bus node on the electrical connection box **CAPC-...** can be found in the assembly instructions supplied with the connection box.

For H-rail mounting, you will also need mounting kit **CAF... (CAPC and CAFM)**.

For mounting the bus node, a valve terminal from Festo, or electrical connection box type **CAPC-...** with I-port interface, is required.

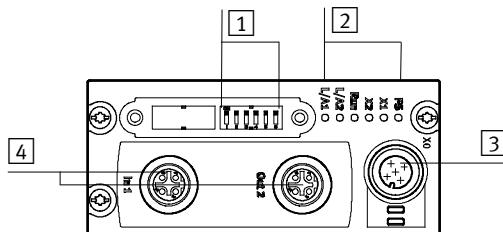
1. Inspect the seals and sealing surfaces on the bus node and valve terminal.
2. Push the bus node onto the valve terminal in the correct position with no tilt.
3. First, lightly screw in the three self-tapping screws with a TORX screwdriver (size T10): use existing threads, if applicable.
4. Tighten the screws to 1.0 Nm.

1. Installation

1.4 Interfaces

1.4.1 Connection and display components

The following electrical connection and display components can be found on the bus node:



- [1] DIL switch group (→ section 1.4.5)
- [2] **Status LEDs:**
bus status LEDs, CTEU-specific LEDs;
status indicator and diagnostics
(→ section 3.2)
- [3] **Power supply connection** for bus node and any connected devices, e.g. valve terminal;
M12, 5-pin, A-coded, pin plug connector
(→ section 1.4.2)
- [4] **Fieldbus connections (fieldbus interfaces):**
2x M12, 4-pin, socket plug connector, D-coded
(→ section 1.4.4)

1. Installation

1.4.2 Power supply

The bus node has separate operating and load voltage supplies. The bus node also supplies voltage to equipment connected via the I-port interface.

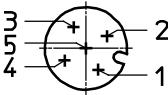


Warning

- Only use PELV circuits compliant with IEC/EN 60204-1 (protective extra-low voltage, PELV) for the electrical power supply.
- Also observe the general requirements for PELV circuits as per IEC/EN 60204-1.
- Only use voltage sources which ensure reliable electrical isolation of the operating voltage in accordance with IEC/EN 60204-1.
- Always connect the circuits for both operating and load voltage supply.

The use of PELV circuits ensures protection from electric shock (protection from direct and indirect contact) in accordance with IEC/EN 60204-1 (Electrical equipment of machines, General requirements).

1. Installation

Power supply connection (M12, A-coded)	Pin	Assignment 1)
	1	$24\text{ V}_{\text{EL/SEN}}$ (PS)
	2	$24\text{ V}_{\text{VAL/OUT}}$ (PL)
	3	$0\text{ V}_{\text{EL/SEN}}$ (PS)
	4	$0\text{ V}_{\text{VAL/OUT}}$ (PL)
	5	FE ²⁾
<ol style="list-style-type: none"> 1) $\text{V}_{\text{EL/SEN}}$: Operating voltage, electronics/sensors (power system, PS) $\text{V}_{\text{VAL/OUT}}$: Load voltage, outputs/valves (power load, PL) FE: Earth terminal (functional earth) 2) The connection to functional earth must be additionally ensured via the connected device or electrical connection box CAPC-... 		

For the connection to power supply units or the power supply, use cables with M12 coupling (socket plug connector), A-coded, in accordance with IEC 61076-2
 ➔ Accessories ➔ www.festo.com/catalogue.

1. Installation

1.4.3 Functional test – without network connection

Check the operating status of the bus node on the PS and X1/X2 status LEDs:

- The **PS** LED is illuminated green when the power supply is correctly connected to both circuits.
- The **X1/X2** LEDs are illuminated green when a device is connected (→ section 3.2).

1.4.4 Fieldbus connection

General information on EtherCAT networks



Note

Modules with EtherCAT interfaces may only be operated in networks where all connected network components are supplied with PELV power supplies or integrated power supplies with equivalent protection.

Installation instructions



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

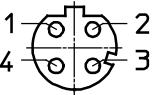
- EtherCAT Technology Group:
<http://www.ethercat.org/>
- EtherCAT-specifications (“EtherCAT Specification”, “Profiles”), guidelines (“Guidelines”) and instructions (e.g. “How to Configure an EtherCAT Slave Device”):
<http://www.ethercat.org/en/publications.html>

Observe the instructions in these documents.

1. Installation

Fieldbus interface – connection technology and pin allocation

There are two 4-pin M12 socket plug connectors with D-coding (for industrial Ethernet use, corresponding to IEC 61076-2-101) for connecting the bus node to the fieldbus.

Socket (M12, D-coded)	Pin	Allocation (signal)	Explanation
	1 2 3 4 Housing	TD+ RD+ TD- RD- FE	Transmission data (transmit data, TD) + Receive data (receive data, RD) + Transmitted data – Received data – Shield/functional earth (FE)

Tab. 1/2: Pin assignment of the network interface

Fieldbus connecting cable – specifications and configuration

- Use shielded industrial Ethernet round cable of category Cat 5 or higher.
- Cable length:
max. 100 m between network participants
(corresponding to specifications for Ethernet networks, ISO/IEC 11801 and ANSI/TIA/EIA-568-B).
- Wire cross section for max. line length:
22 AWG (for 100 m link length, based on ISO/IEC 11801).



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 attenuations.

1. Installation

1.4.5 Basic settings for fieldbus communication

The following basic fieldbus communication settings must be made using the DIL switches on the bus node
(→ following sections):

- EtherCAT address (“station number”, optional)
- Diagnostic functionality (transmission of diagnostic information as emergency messages (EM) into the diagnostic history)
- Fail state mode

To set the DIL switches, you must remove the cover.

1. Installation

Removal of the DIL switch cover



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 mounting screws with a max. torque of 0.4 Nm.

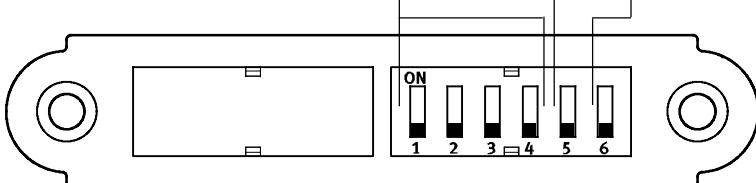
Proceed as follows:

1. Switch off the power supply.
2. Unscrew the two mounting screws of the transparent cover and remove the cover.

1. Installation

Setting the DIL switches

The following table provides an overview of the possible settings.

DIL switch	Function		
	ON	OFF	
	[1]	[2]	[3]
1 ... 4: EtherCAT address, 0 ... 15, binary coded (factory setting: 0) ¹⁾			
1: 2^0 2: 2^1 3: 2^2 4: 2^3	1 x 2^0 1 x 2^1 1 x 2^2 1 x 2^3	0 x 2^0 0 x 2^1 0 x 2^2 0 x 2^3	
[2]	5: Diagnostics	Diagnostics activated: transmission of diagnostic information as emergency messages (EM) and storage in diagnosis history	Diagnostics off (factory setting)
[3]	6: Fail state mode ²⁾	Hold last state	Reset (factory setting)
¹⁾ Optional, e.g. for Hot Connect function ²⁾ If the PLC is in stop (EtherCAT: PRE-OPERATIONAL) mode or the fieldbus connection is interrupted (fail state); applies for all outputs Note: Fail-state mode is also known as "fail-safe mode"			

1. Installation

Proceed as follows:

1. Assign an unused EtherCAT address (device identification value) to the bus node.

Setting an EtherCAT address is optional (e.g. for the Hot Connect function).

→ see the following example settings.

Example: EtherCAT address set: 05	Example: EtherCAT address set: 14
A diagram showing four DIL switches labeled 1 through 4. Above the switches, the word "ON" is written above the first switch. Below each switch is a small number from 1 to 4. The first switch (1) has its top contact highlighted in black, indicating it is ON. The second switch (2) has its bottom contact highlighted in black, indicating it is OFF. The third switch (3) has its top contact highlighted in black, indicating it is ON. The fourth switch (4) has its bottom contact highlighted in black, indicating it is OFF.	A diagram showing four DIL switches labeled 1 through 4. Above the switches, the word "ON" is written above the first switch. Below each switch is a small number from 1 to 4. The first switch (1) has its bottom contact highlighted in black, indicating it is OFF. The second switch (2) has its top contact highlighted in black, indicating it is ON. The third switch (3) has its top contact highlighted in black, indicating it is ON. The fourth switch (4) has its bottom contact highlighted in black, indicating it is OFF.

Tab. 1/3: Setting the binary coded EtherCAT address

2. Select diagnostics mode.
3. Select fail state mode.

Mounting the DIL switch cover

1. Place the cover carefully on the bus node. Make sure that the seal is seated correctly.
2. Tighten the two mounting screws with a max. torque of 0.4 Nm.

1. Installation

Commissioning

Chapter 2

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2. Commissioning

2.1 Configuration

General commissioning instructions

Configuration of the higher-order controller demands a very accurate procedure, as different configuration specifications are sometimes necessary for each participant, i.e. for each device and each “box” in the EtherCAT network, due to the modular structure.

2.1.1 Hot Connect functionality

Hot Connect functionality makes it possible to connect and disconnect parts of the network during operation. This can be done by disconnecting/connecting the communication line, switching the participant on/off, or by other means.

Hot Connect can access this predefined address thanks to the option of address reservation in the CTEU-EC bus node using DIL switches (→ section 1.4.5).



The first EtherCAT participant after the master should not be a Hot Connect-configured participant, as this will slow down link detection at the master.

2.1.2 Registering participant properties (“ESI file”) in the configuration program

When you place a new EtherCAT participant, i.e. an EtherCAT device, into operation for the first time, you must inform the configuration and programming software about certain properties of the participant.

The properties of the various participants are managed in a configuration file - the EtherCAT slave information file (ESI file).

2. Commissioning

EtherCAT slave information file (“ESI file”) The file/its contents are available in Extensible Markup Language (XML).

The ESI file serves to identify the bus node in the EtherCAT network. The ESI file sends basic properties of the EtherCAT device, and manufacturer information, to the configuration program.

The ESI file contains all the information needed for the configuration and settings of the higher-order controller using configuration and programming software, e.g. Beckhoff TwinCAT.

The ESI file for the CTEU-EC bus node is available in two variants.

Modular ESI file

This file requires that the I/O data are configured according to the devices connected to the I-port. Two slots are available, representing the respective I-ports. It is possible to read out the existing configuration. Manual configuration is also possible. Here the connected device is selected from a module list in the configuration interface. If configuration has been performed incorrectly, an error will be output when switching from PRE-OPERATIONAL to SAFE-OPERATIONAL status. This will take the form of an “invalid SM IN cfg” or “invalid SM OUT cfg” message.
This error message indicates the cause of the failed startup.

Fixed ESI file

This file works with the full I/O register of the CTEU-EC bus node (16 byte I/O data), without precisely defining on the user interface which devices are connected to the I-port. I/O assignment must be performed manually by the user.

2. Commissioning



The CTEU-EC bus node is supplied ready for use with the modular ESI file. In order for the fixed ESI file to be used, the EEPROM must be updated (→ section A.3) with the help of the configuration and programming software.

Source
(download link)

You will find the latest EtherCAT configuration files (ESI files) for the CTEU-EC bus node on the Festo website at:

→ www.festo.com → Support portal: enter search term, e.g. “CTEU” → Firmware and drivers

File name	Variant	Description
Festo CTEU-EtherCAT Modular.xml	Modular ESI file	“EtherCAT Slave Information File” for Beckhoff TwinCAT or other compatible configuration and programming software
Festo CTEU-EtherCAT Fix.xml	Fixed ESI file	“EtherCAT Slave Information File” for Beckhoff TwinCAT or other compatible configuration and programming software

Tab. 2/4: EtherCAT configuration files (“ESI files”) for the CTEU-EC bus node

Adding the ESI file

- To add an ESI file to the ESI library of your configuration program, copy the bus node-specific ESI file into the program directory of your configuration program – e.g. for Beckhoff TwinCAT:

C:\TwinCAT\Io\EtherCAT

Importing the ESI file

- Then import the ESI file into your configuration program – e.g. in Beckhoff TwinCAT System Manager:
Actions > Import XML descriptions...

2. Commissioning

Participant properties

When the ESI file is imported, e.g. the following information is sent to the configuration program via the bus node/EtherCAT participant.

Information	Description
Vendor name	Festo SE & Co. KG
Vendor ID	0x0000001D
Product code	572556
Version number	Hardware version: V1.11 Software version: V4.42.3
Product name	CTEU-EC

Tab. 2/5: EtherCAT participant properties

Once the ESI file has been imported, i.e. after the participant properties have been added to the configuration program, the bus node is included as a possible EtherCAT participant. You can now integrate the bus node into your EtherCAT network.

2. Commissioning

2.1.3 Configuration of the operating modes

Depending on the application, the CTEU-EC bus node permits manual configuration as an alternative to automatic configuration. In automatic configuration (auto mode), the connected devices are automatically read in. In this case, however, the configuration defined must match the connected devices. If other participants are detected, or a participant is missing, an error will be output.

Tool change mode permits flexibility in the integration/re-placement of participants. Here only an anonymous data range is created, which is occupied by a participant. It is not defined which devices will actually be connected. This allows different devices to be used as desired.



Configuration of operating modes must be complete before SAFE-OPERATIONAL status is activated.

Automatic configuration (auto mode)

In auto mode, the I-ports are checked for devices at startup. The I/O data lengths are read from the I-port device and transmitted to EtherCAT. The I/O data length for both I-ports must not exceed 16 bytes. Devices connected to the I-port can only be replaced with devices of the same type.

2. Commissioning

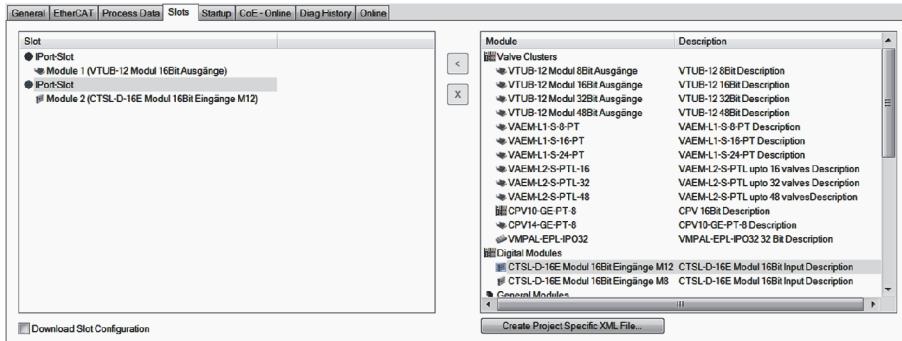


Fig. 2/1: Example: configuration for a valve terminal and an input module in auto mode

Tool change mode

In tool change mode, only the data width of each I-port is defined; the specific components that can be connected are not.

The startup parameters are configured by activating tool change mode for each I-port and defining the data width. This ensures that the correct module configuration, i.e. data width, is requested after each startup. Each I-port is assigned a fixed I/O data length.

The I/O data lengths are configured via the CoE objects 0x8200 and 0x820A (→ section A.4). The I/O data length for both I-ports must not exceed 16 bytes. If the image table exceeds the defined I/O data length, the excess bytes will be excluded. If the modular ESI file is used, the number of bytes must correspond to the formula 2^n where $n = 0, 1, 2, 3$ or 4 (i.e.: 1, 2, 4, 8 or 16 bytes).

The connected I-port devices can be exchanged freely. No diagnostics messages are generated when devices are replaced. Only if the I-port configuration “expect device” is selected is the message

“Output data size is greater than configured” generated when a device with an I/O length greater than that configured in tool change mode is connected (→ section 2.1.4).

2. Commissioning

In the below example, slot 1 is to be used for tool change mode. A VTUB valve terminal is connected to slot 2 in auto mode. Configuration is carried out via Modular Device Profile (MDP).

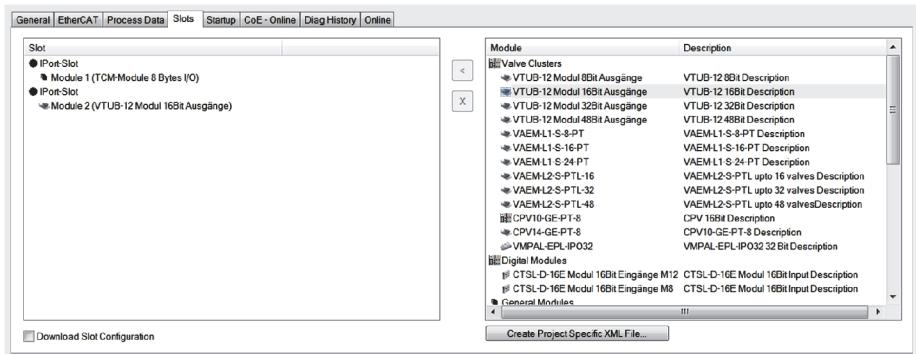


Fig. 2/2: Example: configuration of slot 1 in tool change mode and slot 2 in auto mode (VTUB valve terminal)

2. Commissioning

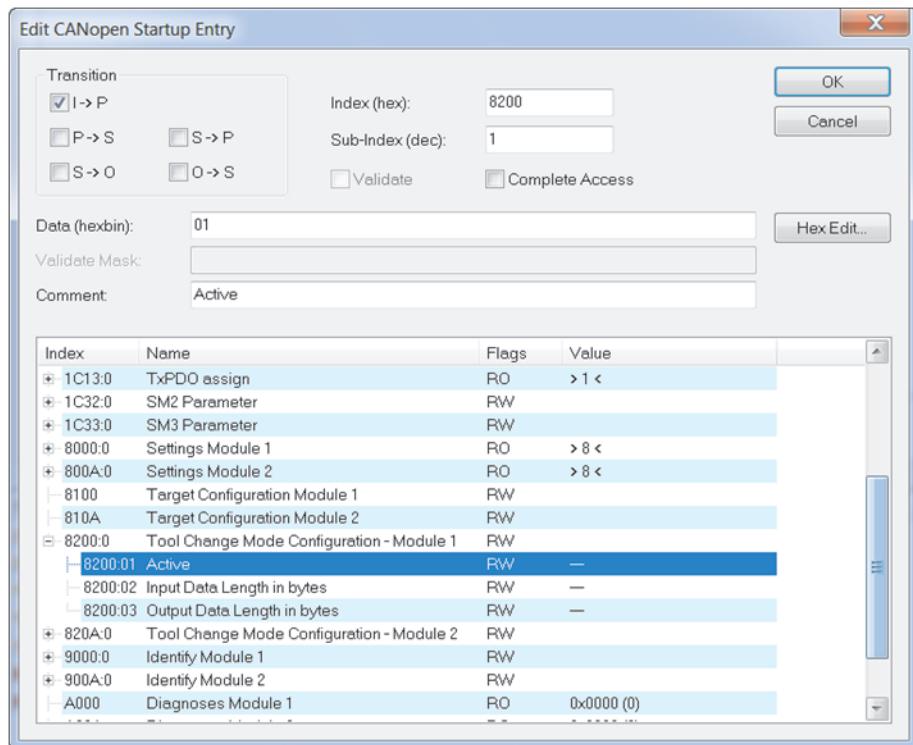


Fig. 2/3: Activation of tool change mode for slot 1

2. Commissioning

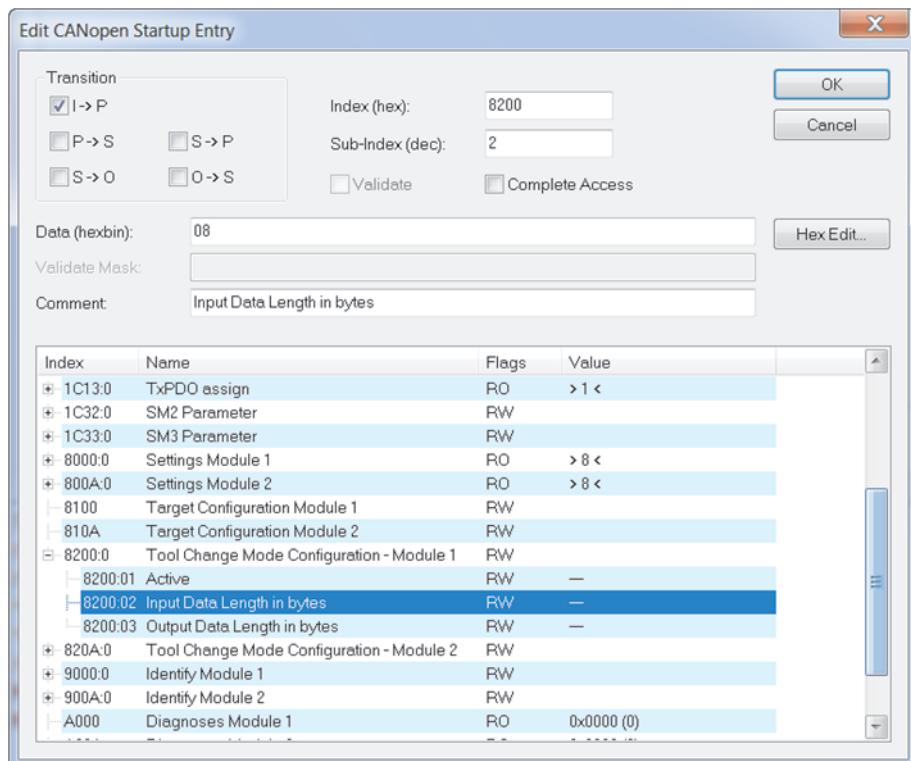


Fig. 2/4: Definition of input data (here 8 bytes)

2. Commissioning

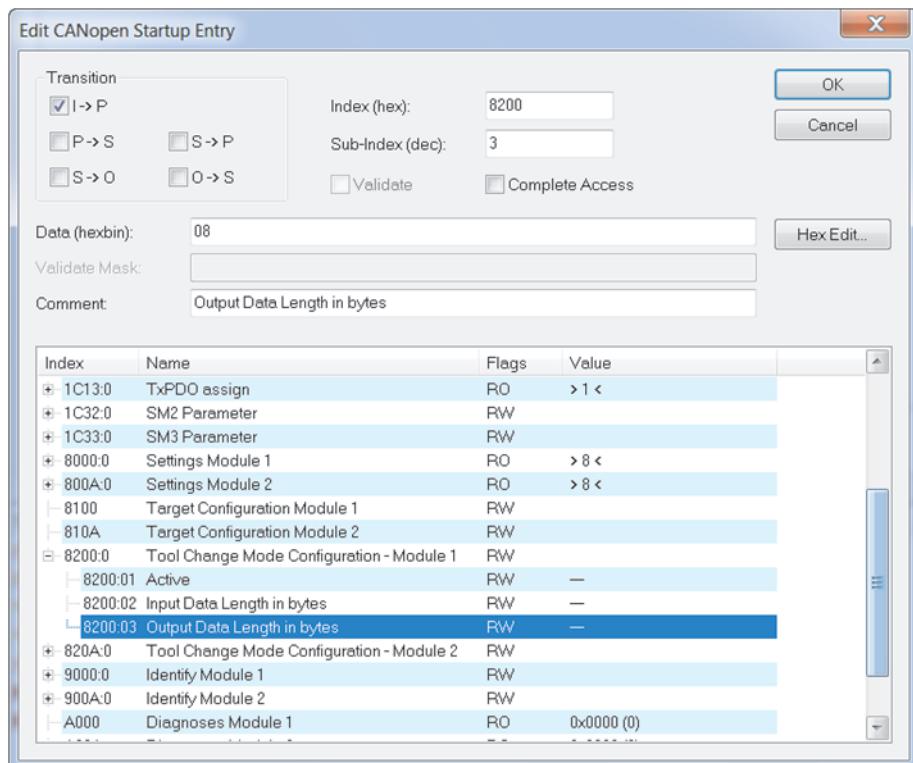


Fig. 2/5: Definition of output data (here 8 bytes)

General	EtherCAT	Process Data	Slots	Startup	CoE - Online	Diag History	Online
Transition	Protocol	Index	Data	Comment			
IP	CoE	0x8200:01	0x01 (1)	Active			
IP	CoE	0x8200:02	0x08 (8)	Input Data Length in bytes			
IP	CoE	0x8200:03	0x08 (8)	Output Data Length in bytes			

Fig. 2/6: Defined startup configuration for a slot

2. Commissioning

2.1.4 Configuration of operating behaviour (target configuration)

In addition to operating modes, operating behaviour can also be defined.

The defined operating behaviour has different effects depending on the operating mode selected (automatic configuration or tool change mode).

The operating behaviour of the respective I-port can be altered via the CoE objects 0x8100 and 0x810A (→ section A.4).

I-port	CoE object (hex.)	Value	Operating behaviour
1	0x8100	0x00	Use responding device (standard setting)
		0x01	Expect device
		0x02	Port disabled
2	0x810A	0x00	Use responding device (standard setting)
		0x01	Expect device
		0x02	Port disabled

Tab. 2/6: Operating behaviour

2. Commissioning

Use responding device (standard setting)

The CTEU-EC bus node starts up in this operating mode by default. A device can be connected to the I-port, but this is not essential.

Auto mode	Tool change mode
<p>If a device is disconnected from the I-port during operation, the “device disconnected” diagnosis will be activated. This error is automatically reset as soon as the connection to the device is reestablished.</p> <p>If a device is connected to an I-port after a startup, the bus node temporary outputs “device wrongly connected”. This error is automatically reset as soon as the device is disconnected again.</p>	<p>A fixed address space is reserved in the image table for each I-port. As soon as a device is detected at an I-port, its I/O data are mapped to the image table.</p> <p>The lack of a connection to the device and configuration errors (e.g. device I/O length is greater than tool change mode I/O length) do not trigger diagnostic messages.</p>

2. Commissioning

Expect device

This I-port configuration always requires a device to be connected to the corresponding I-port. An I-port with this configuration must always be connected to a device. Otherwise an error will be output.

Auto mode	Tool change mode
<p>If no device was present at the respective I-port at startup, no I/O data will have been mapped to the image table. “Device configuration failed” will be output. All other I-ports are then likewise inactive and can no longer be used.</p> <p>This error can only be reset by eliminating the cause of the error and subsequently restarting the system.</p> <p>If a device was detected at the I-port at startup, the “device disconnected” diagnosis will be activated if the device is disconnected during operation.</p> <p>This error is automatically reset (diagnosis: “device reconnected”) as soon as the connection to the device is reestablished.</p>	<p>A fixed address space is reserved in the image table for each I-port. As soon as a device is detected at an I-port, its I/O data are mapped to the image table.</p> <p>The “device disconnected” diagnosis will be activated if the device is disconnected during operation.</p> <p>This error is automatically reset as soon as the connection to the device is reestablished.</p> <p>If a device with an I/O length greater than that configured in tool change mode is connected, an “output data size is greater than configured” error is signalled at the relevant port until the device is disconnected from that port.</p> <p>All other I-ports will remain active and usable.</p>

2. Commissioning

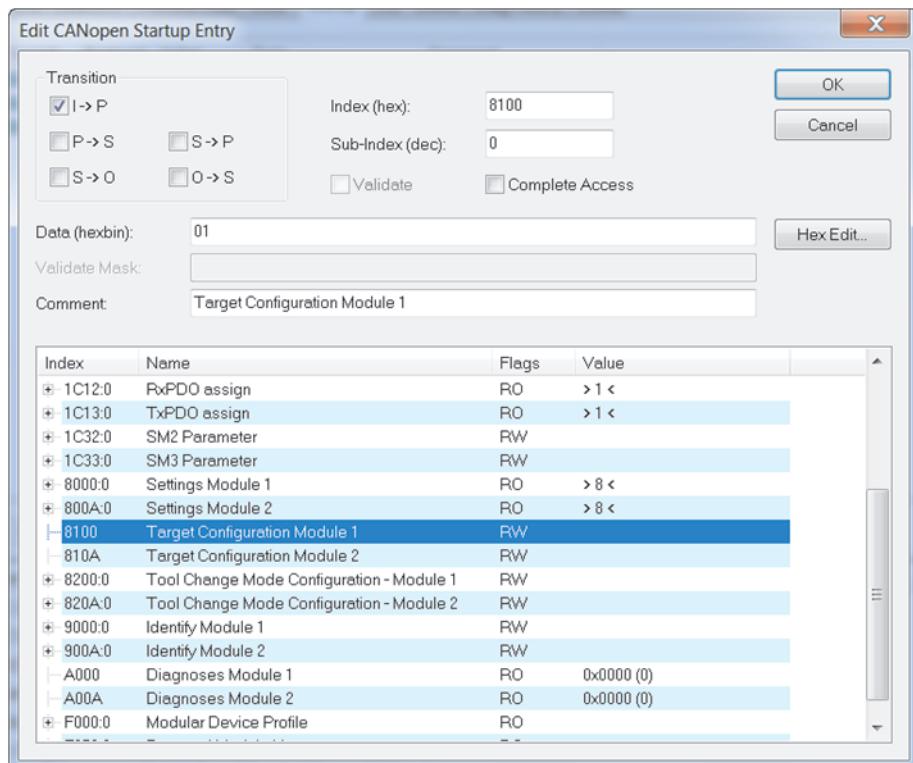


Fig. 2/7: Example: value 01 for slot 1 means “expect device” (➔ Tab. 2/6)

2. Commissioning

Port disabled

The I-port is deactivated and cannot be used. There must be no device active at this I-port. If a device is, however, active in auto mode at startup, all other I-ports will also cease to be usable because the I/O mapping will no longer be consistent.

Auto mode	Tool change mode
<p>If a device was detected at the I-port at startup, a “device wrongly connected” message is generated. All other I-ports are then likewise inactive and can no longer be used. This error can only be reset by eliminating the cause of the error and subsequently restarting the system.</p> <p>If this parameter is set at any time without a device having been connected to the I-port at startup, a “device wrongly connected” message will be generated for the respective port on a temporary basis only. All other ports can continue to be used. If the device is disconnected again from the respective I-port, this configuration error is automatically reset.</p>	<p>When a device is detected at an I-port for which this parameter has been set, a “device wrongly connected” message will be temporarily output. All other I-ports will remain active and usable. If the respective device is disconnected again, the diagnostic message is automatically reset.</p>

2. Commissioning

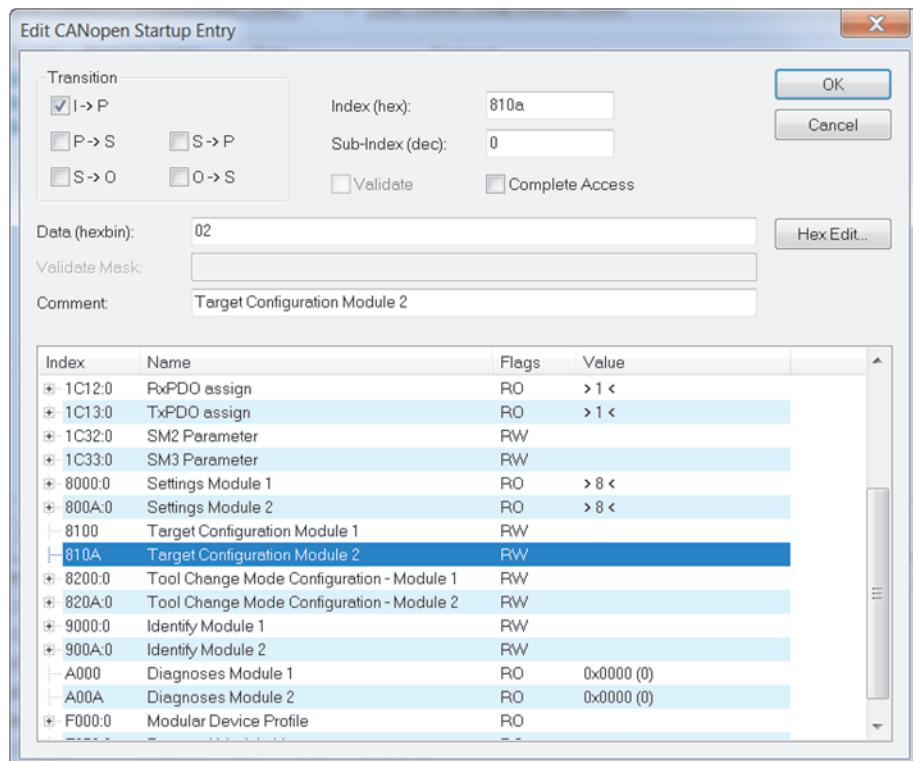


Fig. 2/8: Example: value 02 for slot 2 means “port disabled” (→ Tab. 2/6)

2. Commissioning

2.1.5 Addressing and data access (data objects)

Addressing

The higher-order controller is responsible for addressing the individual modules: the EtherCAT master determines the position of the EtherCAT devices within the network. Block-oriented addressing (i.e. not module-oriented addressing as used by other fieldbus systems) is used.

Alternatively, the CTEU-EC bus node can be assigned an EtherCAT address using the DIL switches (→ section 1.4.5). To activate the defined hardware address, the following setting must be made e.g. in the TwinCAT configuration tool → EtherCAT → Advanced settings → General → Identification → Use Configured Station Alias (0x0012).

The controller uses the following for local addressing:

- The physical position of the device in the EtherCAT network (“auto increment address”)
- An independent EtherCAT device address (“EtherCAT address”)

The EtherCAT device address can be changed using the configuration tool if necessary.

Data access (data objects)

Internal EtherCAT data are accessed via protocol-specific data objects (based on the CANopen fieldbus protocol).

EtherCAT devices (I/O devices) have an object directory which makes all the key participant parameters accessible in a standardised way. An EtherCAT system is configured mainly by accessing the object directory of the individual participants.

2. Commissioning

The access mechanism is provided by Service Data Objects (SDOs).

There are two different communication mechanisms in an EtherCAT system.

Process Data Objects (PDO) provide fast transfer of process data and are transmitted by simple EtherCAT messages with no protocol overhead. Process Data Objects can be transmitted based on event control, synchronised to a system clock, or on request.

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

Access these data objects with the help of user programs created according to your specific requirements.



Caution

Danger of malfunctions, damage or personal injury

A valve terminal will be put into operation even if it is incorrectly configured.

- Before commissioning, ensure that the connected elements (e.g. actuators) do not perform any unexpected or uncontrollable movements.
- If necessary, disconnect the load power supply and compressed air supply.

2.2 Replacing the device

2.2.1 Replacing the bus node

Procedure

1. Stop the process controller (PLC/master).
2. Disconnect the power supply and, if relevant, the compressed air supply.
3. Replace the bus node (Dismantling/Mounting:
→ section 1.3).
4. Switch the power supply back on.
5. Start up the process controller (PLC/master), selecting the EtherCAT operating status “PRE-OPERATIONAL” (network configuration).
6. If relevant, switch the compressed air supply back on.
7. Start the program sequence (PLC/master); do this by selecting the EtherCAT operating status “OPERATIONAL”.

Your EtherCAT system is again in normal operating mode.

2. Commissioning

2.2.2 Replacing the I-port device – same device type (substitute)

Procedure in auto mode

1. Switch off the bus node power supply.
2. Remove the bus node from the I-port device
(Dismantling/Mounting: → section 1.3).
3. Mount the bus node on the new I-port device
(Dismantling/Mounting: → section 1.3).
4. Switch the bus node power supply on again.

The bus node detects the connected I-port device.



In this case it is also possible to replace the I-port device without switching off the bus node power supply.

Procedure in tool change mode

1. Do **not** switch off the bus node power supply.
2. Remove the bus node from the I-port device
(Dismantling/Mounting: → section 1.3).
3. Mount the bus node on the new I-port device
(Dismantling/Mounting: → section 1.3).

The bus node detects the connected I-port device.

2. Commissioning

2.2.3 Replacing the I-port device – different device type (replacement)

Procedure in auto mode

1. Switch off the bus node power supply.
2. Remove the bus node from the I-port device
(Dismantling/Mounting: → section 1.3).
3. Mount the bus node on the new I-port device
(Dismantling/Mounting: → section 1.3).
4. Switch the bus node power supply on again.
5. Configure and parameterise the new I-port device

Procedure in tool change mode

1. Do **not** switch off the bus node power supply.
2. Remove the bus node from the I-port device
(Dismantling/Mounting: → section 1.3).
3. Mount the bus node on the new I-port device
(Dismantling/Mounting: → section 1.3).

The bus node detects the connected I-port device. If the image table exceeds the currently defined I/O data length, the excess bytes will be excluded.

Notes on tool change mode → section 2.1.3



2. Commissioning

2.2.4 Replacing the electrical connection box CAPC-...

Procedure in auto mode

1. Switch off the bus node power supply.
2. Remove the bus node from the electrical connection box
(Dismantling/Mounting: ➔ section 1.3).
3. Replace the electrical connection box

For removal/installation of the electrical connection box,
follow the accompanying product documentation:
assembly instructions CAPC-F1-E-M12-D2
➔ www.festo.com ➔ Support portal: enter search term,
e.g. “CAPC-F1-E-M12-D2” ➔ User documentation.

4. Mount the bus node on the new electrical connection box
(Dismantling/Mounting: ➔ section 1.3).
5. Switch the bus node power supply on again.

The bus node detects the connected I-port devices.

2. Commissioning

Procedure in tool change mode

1. Switch off the bus node power supply.
2. Remove the bus node from the electrical connection box
(Dismantling/Mounting: → section 1.3).
3. Replace the electrical connection box

For removal/installation of the electrical connection box, follow the accompanying product documentation:
assembly instructions CAPC-F1-E-M12-D2
→ www.festo.com → Support portal: enter search term,
e.g. “CAPC-F1-E-M12-D2” → User documentation.

4. Mount the bus node on the new electrical connection box
(Dismantling/Mounting: → section 1.3).
5. Switch the bus node power supply on again.

The bus node detects the connected I-port devices.

2. Commissioning

Diagnostics

Chapter 3

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3. Diagnostics

3.1 Summary of diagnostics options

The following possibilities for diagnostics and error handling are available, depending on the configuration of the bus node:

Diagnostics option	Brief description	Benefits	Detailed description
LED display	The LEDs show hardware faults, configuration errors, bus faults, etc. immediately	Fast “on-the-spot” error detection	Section 3.2
Diagnostics via fieldbus	Diagnostics via <ul style="list-style-type: none">– SDO access– Diagnosis history– Emergency message	Detailed error detection	Section 3.3

Tab. 3/1: Overview of the diagnostic options of the bus node

3.2 Diagnostics via LED display

There are LEDs on the bus node to assist in diagnostics on the bus node and any connected devices (→ Fig. 3/1).

The LEDs can assume the following states (sometimes in different colours):



3. Diagnostics

3.2.1 Normal operating status display

[1] Device-specific LEDs

PS: Power system

X1: Internal communication between bus node and device 1

X2: Internal communication between bus node and device 2

[2] EtherCAT-specific LEDs

Run: EtherCAT operating status

L/A2: Connection status
(Link/Activity)
Out2

L/A1: Connection status
(Link/Activity)
In1

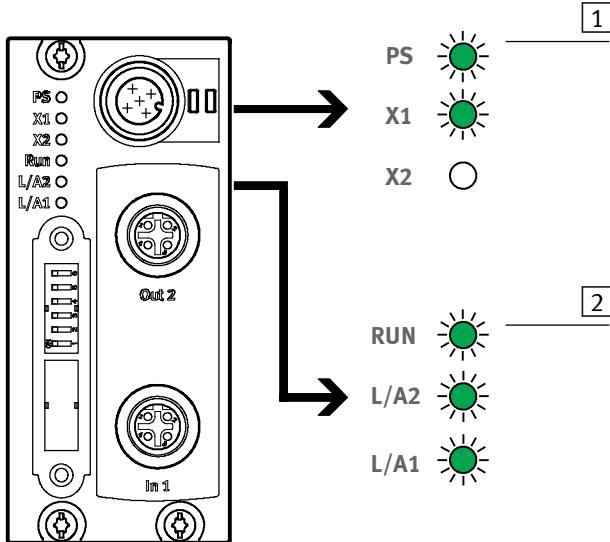


Fig. 3/1: LEDs on the bus node

After the switch-on procedure the status LEDs indicate the operating status and correct function of the bus node and of fieldbus communication.

3. Diagnostics

3.2.2 PS LED status display

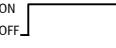
PS (power system) – power sensor/logic supply			
LED	Process	Status	Meaning/error elimination
 LED illuminated green	ON OFF	Normal operating status: - Operating voltage present (in the approved range) - Load voltage present (in the approved range) ¹⁾	-
 LED flashes green	ON OFF	- Operating voltage is below the required voltage - Load voltage is below the required voltage ¹⁾	• Eliminate undervoltage at the connected device
 LED is off	ON OFF	Operating voltage not present	• Check the power supply

¹⁾ Display depends on whether the connected device monitors the load voltage and reports this to the bus node

Tab. 3/2: Status displays of the device-specific “PS” LED

3. Diagnostics

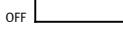
3.2.3 Status display X1/X2 LEDs

X1 or X2 ¹⁾ - Internal communication between bus node and device 1 or 2 ¹⁾			
LED	Process	Status	Meaning/error elimination
 LED illuminated green		Normal operating status	-
 LED flashes green		<ul style="list-style-type: none"> - Connected device reports diagnostics status - Connection between bus node and device OK 	Device diagnostics can be read out via fieldbus communication (if activated on DIL switches on the bus node)
 LED illuminated red		<ul style="list-style-type: none"> - Device is connected correctly to the bus node, but internal communication is faulty - A connected device has been removed after commissioning. 	<ul style="list-style-type: none"> • Check I-port cable/mounting • Restart the bus node (by switching the power off → on)

1) Separate accessory (electrical connection box, type CAPC-...) with two interfaces for connecting another device is required.

Tab. 3/3: Status displays of the device-specific "X1" LEDs if a device 1 is connected and "X2" if a device 2 is connected

3. Diagnostics

X1 or X2¹⁾ - Internal communication between bus node and device 1 or 2¹⁾			
LED	Process	Status	Meaning/error elimination
LED flashes red	ON OFF		<ul style="list-style-type: none"> - Incorrect device connected (device detected that is not I-port compatible) - Non-configured device - Device replaced with another type after commissioning - If only LED X1 flashes red: error in the bus node - If X1 and X2 flash red simultaneously: no device is connected to the bus node, or configuration error (target configuration) <ul style="list-style-type: none"> • Use an I-port compatible device (e.g. suitable valve terminal) from Festo • Connect at least one device • Check target configuration • Restart the bus node (by switching the power off -> on)
LED is off	ON OFF		<ul style="list-style-type: none"> - No device is connected to the corresponding I-port interface.
1) Separate accessory (electrical connection box, type CAPC-...) with two interfaces for connecting another device is required.			

Tab. 3/4: Status displays of the device-specific "X1" LEDs if a device 1 is connected and "X2" if a device 2 is connected (continuation of Tab. 3/3)

3. Diagnostics

3.2.4 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)	Process	Status	Meaning/error elimination
 LED illuminated	ON OFF	OPERATIONAL	Bus node is in OPERATIONAL status (normal operating status)
 LED flickers	ON OFF	BOOTSTRAP	Bus node is in correct status to accept a firmware update A firmware update is being performed
 LED flashes	ON OFF	PRE-OPERATIONAL	Bus node is in PRE-OPERATIONAL status (configuration of the EtherCAT network)
 LED flashes 1x ¹⁾	ON OFF	SAFE-OPERATIONAL	Bus node is in SAFE-OPERATIONAL status (e.g. due to a network fault). Only the input signals (e.g. sensor data) are updated. Outputs and valves remain in the current state (signal is “frozen”).
 LED not illuminated	ON OFF	INIT	Bus node is in INIT status (normal state after switch-on or after a restart or reboot)

¹⁾ Single brief flash (1 x flash, pause, 1 x flash, etc.) is designated as single flash.

Tab. 3/5: Error diagnostics with the run LED

3. Diagnostics

L/A2, L/A1 – Connection status (link/activity) Out2/In1			
LED (green)	Process	Status	Meaning/error elimination
 LED illuminated	ON OFF	Network connection OK and no data transmission	–
 LED flashes	ON OFF	Network connection OK and data transmission is running (traffic) ¹⁾	–
 LED not illuminated	ON OFF	No physical network connection	<ul style="list-style-type: none"> Check network connection/network cable

¹⁾ Rapid flickering gives impression that LED is lit; light intensity depends on data traffic

Tab. 3/6: Error diagnostics with the LEDs L/A2, L/A1

3. Diagnostics

3.3 Diagnostics via EtherCAT

3.3.1 Diagnostics via SDO access

The master controller can request diagnostic information from the bus node via SDO access. The corresponding objects can be found in the object directory in section A.4.

3.3.2 Diagnostics via diagnosis history

The 20 most recent diagnostics messages can be called up with the help of the diagnostics object 0x10F3. For every event stored in the device (warning, error, information), an error message referenced with a code is displayed. Diagnostics messages are decoded via the ESI file and can be read e.g. by the TwinCAT system manager. The following table shows the structure of the diagnostics object 0x10F3.

The following abbreviations are used:

RO =	read only
RW =	read/write
RO P =	read only (PDO mappable)

3. Diagnostics

Index	Sub-index	Description	Type	Values	Access
0x10F3	0	Diagnosis history			RO
	1	Maximum messages	U8	20	RO
	2	Newest message	U8		RO
	3	Newest acknowledged message	U8		RW
	4	New message available	BOOL		RO P
	5	Flags	U16	0x0000	RW
	6 ... 26	Subindex 006 ... 026	BYTE[23]		RO

Tab. 3/7: Structure of the diagnostics object

Diagnostics messages are written to a data buffer (20 bytes). Two operating modes are available for handling diagnostics messages:

- | | |
|-------------------|---|
| Overwrite mode: | When the number of diagnostics messages reaches 20, the oldest diagnostics messages are overwritten. |
| Acknowledge mode: | An existing diagnostics message must first be acknowledged before it can be overwritten with a new diagnostics message. When the number of unconfirmed diagnostics messages reaches 20, subsequent diagnostics messages will not be saved and will be lost. |

3. Diagnostics

3.3.3 Diagnostics via emergency message

If an error occurs, the bus node will send an emergency message (EM) with a defined structure (→ Tab. 3/8) provided that the “diagnostics” DIL switch is activated (→ section 1.4.5).

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Error code	Error register	I-port 1 event code	I-port 2 event code		Diagnosis number		

Tab. 3/8: Structure of an emergency message (EM)

 **Note**

If several emergency messages from Tab. 3/9 are present, only the most recently reported is transmitted to the master controller.

The following sections describe the components of the emergency message and the error causes (→ Tab. 3/9 ... Tab. 3/11).

3. Diagnostics

3.3.4 Error codes

Error code (hex.)		Explanation	Remark/possible causes
Byte 0	Byte 1		
00	00	No error	–
00	12	Invalid I/O configuration	<ul style="list-style-type: none">• Compare I/O data lengths
FF	00	Configuration error	<ul style="list-style-type: none">– Device replaced during operation– Configuration error during operation– No device at either I-port
FF	70	Built-in self test failed	<ul style="list-style-type: none">• Restart device• Contact support
FF	FF	Other diagnostic message	<ul style="list-style-type: none">– Diagnostic bytes from I-port telegram present (I-port event codes, → Tab. 3/11)

Tab. 3/9: Bus node error codes

3. Diagnostics

3.3.5 Error register

Bit	Meaning	Explanation
0	Generic error	Set for each error
1	Current	Short circuit (link with error code)
2	Voltage	Undervoltage (link with error code)
3	-	Not used
4	Communication error	Node guard, heartbeat – fieldbus-specific only
5	-	Not used
6	Reserved (always 0)	Always 0
7	Manufacturer specific	Always set if error is not 1 ... 6 or diagnostics program from I-port

Tab. 3/10: Error register

3. Diagnostics

3.3.6 I-port event code

The content for I-port 1 is in bytes 3 and 4; the content for I-port 2 is in bytes 5 and 6.

Event code (hex.)		Explanation	Description/remedy
MSB	LSB		
00	00	Device OK (Default), no malfunction	I-port device is OK, no errors
10	00	Device NOK, unknown error	I-port device is not OK, unknown error
40	00	Temperature fault – Overload	Temperature fault – Overload
42	10	Device temperature overrun – Clear source of heat	I-port device temperature exceeded <ul style="list-style-type: none"> • Remove heat source
42	20	Device temperature underrun – Insulate device	I-port device temperature too low <ul style="list-style-type: none"> • Thermally insulate the device
50	00	Device hardware fault – Exchange device	Hardware fault in the I-port device <ul style="list-style-type: none"> • Replace device
50	10	Component malfunction – Repair or exchange	A component is malfunctioning <ul style="list-style-type: none"> • Repair or replace
50	11	Non-volatile memory loss – Check batteries	Loss of data from non-volatile memory <ul style="list-style-type: none"> • Check batteries
50	12	Batteries low – Exchange batteries	Batteries are low <ul style="list-style-type: none"> • Replace batteries
51	00	General power supply fault – Check availability	General fault in power supply <ul style="list-style-type: none"> • Check availability
51	01	Fuse blown/open - Exchange fuse	Fuse has tripped or is not correctly inserted <ul style="list-style-type: none"> • Replace fuse or insert correctly

3. Diagnostics

Event code (hex.)		Explanation	Description/remedy
MSB	LSB		
51	10	Primary supply voltage overrun – Check tolerance	Primary supply voltage is too high • Check voltage tolerance
51	11	Primary supply voltage underrun – Check tolerance	Primary supply voltage is too low • Check voltage tolerance
51	12	Secondary supply voltage fault – Check tolerance	Fault in the secondary power supply • Check voltage tolerance
51	14	Undervoltage in load supply PL (provided supervisory function is enabled)	Load voltage (PL) too low (only when PL monitoring is activated in device)
60	00	Device software fault – Check firmware revision	Device software fault • Check firmware version
63	20	Parameter error – Check data sheet and values	Parameter error • Check data sheet and values
63	21	Parameter missing – Check data sheet	Missing parameters • Check data sheet
63	50	Parameter changed – Check configuration	Changed parameter • Check configuration
77	00	Wire break of a subordinate device – Check configuration	Wire break in a subordinate device • Check configuration
77	01 ... 0F	Wire break of subordinate device 1 ... 15 – Check installation	Wire break in subordinate device 1 ... 15 • Check installation
77	10	Short circuit – Check installation	Short circuit • Check installation
77	11	Ground fault – Check installation	Earth connection • Check installation

3. Diagnostics

Event code (hex.)		Explanation	Description/remedy
MSB	LSB		
8C	00	Technology specific application fault – Reset device	Technology-specific application error • Reset device
8C	01	Simulation active – Check operational mode	Simulation active • Check operating mode
8C	10	Process variable range overrun – Process data uncertain	Process variable range exceeded, process data uncertain
8C	20	Measurement range overrun – Check application	Measuring range exceeded • Check application
8C	30	Process variable range underrun – Process data uncertain	Process variable range underrun, process data uncertain
8C	40	Maintenance required – Cleaning	Maintenance required • Cleaning
8C	41	Maintenance required – Refill	Maintenance required • Refill
8C	42	Maintenance required – Exchange wear and tear parts	Maintenance required • Replace wearing parts
8D	00	Test mode enabled	Test mode is active
FF	50	I-Port-Device disconnected	I-port device is disconnected
FF	51	I-Port-Device reconnected	Connection to I-port device reestablished
FF	52	Device configuration failed	<ul style="list-style-type: none"> Compare target configuration with the I-ports used Then restart
FF	53	Device wrongly connected	<ul style="list-style-type: none"> Remove device from the respective I-port
FF	54	Device missing	<ul style="list-style-type: none"> Connect device to I-port

3. Diagnostics

Event code (hex.)		Explanation	Description/remedy
MSB	LSB		
FF	55	Input data size greater than configured	Input data are greater than those configured in tool change mode <ul style="list-style-type: none">• No action required
FF	56	Output data size greater than configured	Output data are greater than those configured in tool change mode <ul style="list-style-type: none">• No action required

Tab. 3/11: I-port event code

3. Diagnostics

3.3.7 Error reaction (fail-state settings)

The reaction of the bus node to the following errors is dependent on the parameterised fail-safe setting and the (configured) reaction of the controller, i.e. the PLC, the IPC or the application program:

- (Master) controller stops
- Network interruption
- Telegram failure

Depending on the parameterisation, the outputs (valves and electrical outputs) will be:

- switched off (output signal reset, in the case of analogue outputs to 0; factory setting)
- switched on (output signal set, in the case of analogue outputs to the parameterised value)
- kept in the same state (“freezing” of output signal)

You can define two types of error reaction for the controller (or the application program):

- Hard error reaction:
The controller switches to “STOP”/PRE-OPERATIONAL mode when a fault occurs
- Soft error reaction:
The controller remains in “RUN”/SAFE-OPERATIONAL (or, if relevant, OPERATIONAL) mode when a fault occurs



Warning

Accidental activation of actuators!

Incorrect statuses of valves and outputs can lead to dangerous situations!

- Make sure that valves and outputs are put in a safe state when malfunctions occur.
- In the context of your EMERGENCY STOP concept and fail-state settings, check what measures are necessary in order to put your machine/system in a safe state.

Typical safety measures required to put system in safe state:

- Switch off the load voltage for the valves and output modules in the secondary circuit of the power unit
- Switch off the compressed air supply to the valve terminal

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

Take this situation into account, for example by:

- using an input signal in the controller to check whether the load voltage has been switched off
- blocking the valve switching signal by locking the output signal with the “load voltage” input signal

3. Diagnostics



Note

Take account of valve behaviour in your EMERGENCY STOP concept/fail-safe settings!

If the outputs are reset when the controller stops or in case of network interruption, telegram failure or a terminal fault, the valves will behave as follows:

- Monostable valves will move to their normal position
- Double-solenoid valves will remain in their current position
- Mid-position valves will move to their neutral position (pressurised, exhausted or closed, depending on valve type)

3. Diagnostics

Technical appendix

Appendix A

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A. Technical appendix

A.1 Technical data

General	
Degree of protection provided by housing ¹⁾ according to IEC/EN 60529, completely mounted, plug connector inserted or provided with cover cap	IP65
Protection against electric shock protection against direct and indirect contact as per IEC/DIN 60204-1	through the use of PELV circuits
Electromagnetic compatibility (EMC) ²⁾ – Emitted interference – Resistance to interference	See declaration of conformity → www.festo.com
Ambient temperature ¹⁾ – Operation – Storage/transport	–5 ... +50 °C –20 ... +70 °C
Vibration and shock ³⁾ tested as per IEC/EN 60068 – Vibration (part 2 - 6) – Shock (part 2 - 27) – Continuous shock (part 2 - 29)	Severity level (SL) for mounting on ... Wall: SL 2, H-rail: SL 1 Wall: SL 2, H-rail: SL 1 Wall and H-rail: SG 1
Dimensions – Width – Length – Height	40 mm 91 mm 50 mm
Weight (bus node without cable and substructure)	90 g
1) Please note that connected devices may only satisfy a lower protection class, be suitable for a smaller temperature range, etc. 2) The device is intended for use in an industrial environment. Outside of industrial environments, e.g. in commercial and mixed-residential areas, measures to suppress interference may be required. 3) Explanation of severity level → following table “Explanation of vibration and shock – severity level”	

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General	
Materials <ul style="list-style-type: none">- Housing- Housing cover, cover for DIL switches- Threaded sleeve M12- Threaded bush M3- Seals- Screws	RoHS-compliant PA, reinforced PC Brass, galvanically nickel-plated Brass Nitrile rubber Galvanised steel
Explanation on vibration and shock – severity level	
Severity level 1 (SL1, in accordance with EN 60068, part 2 – 29)	Vibration: 0.15 mm path at 10 ... 58 Hz; 2 g acceleration at 58 ... 150 Hz
	Shock: ±15 g at 11 ms duration; 5 shocks per direction
	Continuous shock: ± 15 g at 6 ms duration; 1000 shocks per direction
Severity level 2 (SG2, in accordance with EN 60068, part 2 – 27)	Vibration: 0.35 mm path at 10 ... 60 Hz; 5 g acceleration at 60 ... 150 Hz
	Shock: ±30 g at 11 ms duration; 5 shocks per direction
	Continuous shock: n. a.

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Power supply	
Operating voltage for bus nodes and connected I-port devices¹⁾	
<ul style="list-style-type: none"> – Nominal value – Tolerance range 	DC 24 V DC 18 ... 30 V
Load voltage for connected devices¹⁾	DC 18 ... 30 V ²⁾
Bus node intrinsic current consumption from operating voltage supply for electronics/ sensors ($U_{EL/SEN}$)	max. 60 mA at 24 V (internal electronics)
Load capacity of the operating and load voltage supply^{1) 3)}	
<ul style="list-style-type: none"> – Bus node on device (e.g. valve terminal) – Bus node on electrical connection box, type CAPC-... (X_1 and X_2) 	max. 4 A max. 2 A
Isolation EtherCAT interfaces for $U_{EL/SEN}$	Galvanically isolated
Mains buffering time	10 ms

¹⁾ Separate external fuses are required for operating and load voltage supply
²⁾ Dependent on the connected device (e.g. valve terminal)
³⁾ Load capacity with regard to the connected equipment, e.g. the valve terminal, including the bus node

I-port interface signal transmission	
– Internal cycle time	1 ms per 1 byte of user data

A. Technical appendix

Network-specific characteristics	
Fieldbus protocol	EtherCAT, based on the Ethernet protocol (IEEE 802.3), optimised for process data, real-time capable
Specification	Standards and norms containing reference to EtherCAT: <ul style="list-style-type: none">– IEC 61158– IEC 61784– IEC 61918– ISO/IEC 8802-3 Additional information: http://www.ethernetcat.org
Baud rate	100 Mbit/s
Cross-over detection	Auto-MDI
EtherCAT input/output size	max. 16 bytes/max. 16 bytes

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A.2 EtherCAT CANopen object model

The following table shows the general address space of the Modular Device Profile, which is used for both ESI file variants.

Index (hex.)	Object dictionary area
0x0000 – 0x0FFF	Data type area
0x1000 – 0x1FFF	Communication profile area
0x2000 – 0x5FFF	Manufacturer specific profile area
0x6000 – 0x6FFF	Input area
0x7000 – 0x7FFF	Output area
0x8000 – 0x8FFF	Configuration area
0x9000 – 0x9FFF	Information area
0xA000 – 0xAF00	Diagnosis area
0xB000 – 0xBFFF	Service transfer area
0xC000 – 0xEFFF	Reserved area
0xF000 – 0xFFFF	Device area

A.3 Updating the bus node EEPROM

In its delivery status, the CTEU-EC bus node uses a Modular Device Profile (MDP) for both I-ports.

Because some EtherCAT masters do not yet support an MDP, it may be necessary to rewrite the bus node EEPROM from MDP to a fixed I/O configuration.

For this the fixed ESI file (→ chapter 2) is required.

Depending on the configuration and programming software used, the actual procedure may vary slightly from the one described below. The basic procedure is as follows:

1. Select the CTEU-EC bus node from “I/O configuration” in the configuration and programming software.
2. Select “EEPROM Update”.
3. Overwrite the EEPROM with the fixed ESI file.
4. Perform a cold start of the bus node.
5. Find the bus node in your configuration and programming software, and reparameterise it.

A.4 Object directories

The following tables list the communication profile (CoE communication protocol) objects. These objects are described in the EtherCAT configuration (ESI) files. Two different ESI files are available from Festo (→ chapter 2). The following abbreviations are used:

RO =	read only
RW =	read/write
RO P =	read only (PDO mappable)

A.4.1 Objects common to both communication profiles

The objects in the following table are available in both ESI files (fixed and modular)



The module parameters can be set from index 0x8000 onwards.

Index	Sub-index	Description	Type	Values	Explanation/note	Access
0x1001	0	Error register	U8			RO
0x1008	0	Device name	String	CTEU-EC		RO
0x1009	0	Hardware version	String			RO
0x100A	0	Software version	String			RO
0x10F1	0	Error settings				RO
	1	Local error reaction	U32			RO
	2	Sync error counter limit	U32			RO

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Index	Sub-index	Description	Type	Values	Explanation/note	Access
0x10F3	0	Diagnosis history				RO
	1	Maximum messages	U8	20		RO
	2	Newest message	U8			RO
	3	Newest acknowledged message	U8			RW
	4	New message available	BOOL			RO P
	5	Flags	U16	0x0000		RW
	6 ... 26	Subindex 006 ... 026	BYTE[2 3]			RO
0x1100	0	EtherCAT address	U16			RO
0x1110	0	Virtual MAC address	U8			RO
0x1111	0	Virtual IP address	U8	5		RO
	1	IP-address	U32			RO
	2	Subnet mask	U32			RO
	3	Default gateway	U32			RO
	4	DNS server	U32			RO
	5	DNS name	String			RO
0x1C00	0	Sync manager type	U16	4		RO
	1	Mailbox write	U8	0x01		RO
	2	Mailbox read	U8	0x02		RO
	3	Process output data	U8	0x03		RO
	4	Process input data	U8	0x04		RO
0x1C32		SM 2 parameter				
0x1C33		SM 3 parameter				

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Index	Sub-index	Description	Type	Values	Explanation/note	Access
0x8000	0	Settings for module 1	U16	8		RO
	1	Settings byte 1	U8			RW

	16	Settings byte 16	U8			RW
0x8010	0	Settings for module 2	U16	8		RO
	1	Settings byte 1	U8			RW

	16	Settings byte 16	U8			RW
0x8100	0	Target configuration module 1	U8		➔ section 2.1.4	RW
0x810A	0	Target configuration module 2	U8		➔ section 2.1.4	RW
0x8200	0	Tool change mode configuration module 1	U16			RO
	1	Active	U8	0	0 = auto mode 1 = tool change mode	RW
	2	Input data length	U8	8	Length in bytes	RW
	3	Output data length	U8	8	Length in bytes	RW
0x820A	0	Tool change mode configuration module 2	U16			RO
	1	Active	U8	0	0 = auto mode 1 = tool change mode	RW
	2	Input data length	U8	8	Length in bytes	RW
	3	Output data length	U8	8	Length in bytes	RW

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Index	Sub-index	Description	Type	Values	Explanation/note	Access
0x9000	0	Identity module 1	U16	17		RO
	1	PDO input length	U8			RO
	2	PDO output length	U8			RO
	3	Vendor ID	U16			RO
	4	Device ID	U32			RO
	5	Function ID	U16			RO
	6	Vendor name	String (64+1)			RO
	7	Vendor URL	String (64+1)			RO
	8	Product name	String (64+1)			RO
	9	Order no.	String (64+1)			RO
	10	Product text	String (64+1)			RO
	11	Order code	String (64+1)			RO
	12	HW revision	String (64+1)			RO
	13	SW revision	String (64+1)			RO
	14	Slave attribute	U8			RO
	15	Extended parameter	U8			RO
	16	Diagnosis type	U16			RO
	17	I-port revision	U16			RO
	18	Type-ID	U8			RO

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Index	Sub-index	Description	Type	Values	Explanation/note	Access
0x900A	0	Identity module 2	U16	17		RO
	1	PDO input length	U8			RO
	2	PDO output length	U8			RO
	3	Vendor ID	U16			RO
	4	Device ID	U32			RO
	5	Function ID	U16			RO
	6	Vendor name	String (64+1)			RO
	7	Vendor URL	String (64+1)			RO
	8	Product name	String (64+1)			RO
	9	Order no.	String (64+1)			RO
	10	Product text	String (64+1)			RO
	11	Order code	String (64+1)			RO
	12	HW revision	String (64+1)			RO
	13	SW revision	String (64+1)			RO
	14	Slave attribute	U8			RO
	15	Extended parameter	U8			RO
	16	Diagnosis type	U16			RO
	17	I-port revision	U16			RO
	18	Type-ID	U8			RO

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Index	Sub-index	Description	Type	Values	Explanation/note	Access
0xA000	0	Diagnosis module 1	U16		→ section 3.3.3 (byte 3 and byte 4)	RO
0xA00A	0	Diagnosis module 2	U16		→ section 3.3.3 (byte 5 and byte 6)	RO

A.4.2 Communication profile – extensions, fixed variant

Index	Sub-index	Description	Type	Values	Access
0x1000	0	Device type	U32	0x00001389 (5001)	RO
0x1018	0	Identity object			RO
	1	Vendor ID	U32	0x0000001D	RO
	2	Product code	U32	Festo part number: 572556	RO
	3	Revision	U32	1	RO
	4	Serial number	U32		RO
0x1400 ... 0x15FF	0	RxD parameter			

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Index	Sub-index	Description	Type	Values	Access
0x1600	0	RxPDO mapping	U16	16	RO
	1	0x1600:01	U32	0x70000108	RO
	2	0x1600:02	U32	0x70000208	RO
	3	0x1600:03	U32	0x70000308	RO
	4	0x1600:04	U32	0x70000408	RO
	5	0x1600:05	U32	0x70000508	RO
	6	0x1600:06	U32	0x70000608	RO
	7	0x1600:07	U32	0x70000708	RO
	8	0x1600:08	U32	0x70000808	RO
	9	0x1600:09	U32	0x70000908	RO
	10	0x1600:0A	U32	0x70000A08	RO
	11	0x1600:0B	U32	0x70000B08	RO
	12	0x1600:0C	U32	0x70000C08	RO
	13	0x1600:0D	U32	0x70000D08	RO
	14	0x1600:0E	U32	0x70000E08	RO
	15	0x1600:0F	U32	0x70000F08	RO
	16	0x1600:10	U32	0x70001008	RO
0x1800 ... 0x19FF	0	TxD parameter			C

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Index	Sub-index	Description	Type	Values	Access
0x1A00	0	TxDPO mapping	U16	16	RO
	1	0x1A00:01	U32	0x60000108	RO
	2	0x1A00:02	U32	0x60000208	RO
	3	0x1A00:03	U32	0x60000308	RO
	4	0x1A00:04	U32	0x60000408	RO
	5	0x1A00:05	U32	0x60000508	RO
	6	0x1A00:06	U32	0x60000608	RO
	7	0x1A00:07	U32	0x60000708	RO
	8	0x1A00:08	U32	0x60000808	RO
	9	0x1A00:09	U32	0x60000908	RO
	10	0x1A00:0A	U32	0x60000A08	RO
	11	0x1A00:0B	U32	0x60000B08	RO
	12	0x1A00:0C	U32	0x60000C08	RO
	13	0x1A00:0D	U32	0x60000D08	RO
	14	0x1A00:0E	U32	0x60000E08	RO
	15	0x1A00:0F	U32	0x60000F08	RO
	16	0x1A00:10	U32	0x60001008	RO
0x1C12	0	RxDPO assign	U16	1	RO
	1	0x1C12:01	U16	0x1600	RO
0x1C13	0	TxDPO assign	U16	1	RO
	1	0x1C13:01	U16	0x1A00	RO
0x6000	0	Input entries	U16		RO P
	1	Output 1	U8		RO P
	U8		...
	16	Output 16	U8		RO P

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Index	Sub-index	Description	Type	Values	Access
0x7000	0	Output entries	U16	16	RO P
	1	Output 1	U8		RO P

	16	Output 16	U8		RO P

A.4.3 Communication profile – extensions, modular variant

Index	Sub-index	Description	Type	Values	Access
0x1000	0	Device type	U32	0x00001389 (5001)	RO
0x1018	0	Identity object			RO
	1	Vendor ID	U32	0x0000001D	RO
	2	Product code	U32	Festo part number: 572556	RO
	3	Revision	U32	2	RO
	4	Serial number	U32		RO
0x1600	0	RxDPO	U16	8	RO
	1	Subindex 001	U32	0x7000:01, 8	RO
	2	Subindex 002	U32	0x7000:02, 8	RO
	3	Subindex 003	U32	0x7000:03, 8	RO
	4	Subindex 004	U32	0x7000:04, 8	RO
	5	Subindex 005	U32	0x7000:05, 8	RO
	6	Subindex 006	U32	0x7000:06, 8	RO
	7	Subindex 007	U32	0x7000:07, 8	RO
	8	Subindex 008	U32	0x7000:08, 8	RO

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Index	Sub-index	Description	Type	Values	Access
0x160A	0	RxDPO	U16	8	RO
	1	Subindex 001	U32	0x700A:01, 8	RO
	2	Subindex 002	U32	0x700A:02, 8	RO
	3	Subindex 003	U32	0x700A:03, 8	RO
	4	Subindex 004	U32	0x700A:04, 8	RO
	5	Subindex 005	U32	0x700A:05, 8	RO
	6	Subindex 006	U32	0x700A:06, 8	RO
	7	Subindex 007	U32	0x700A:07, 8	RO
	8	Subindex 008	U32	0x700A:08, 8	RO
0x1A00	0	TxDPO	U16	8	RO
	1	Subindex 001	U32	0x6000:01, 8	RO
	2	Subindex 002	U32	0x6000:02, 8	RO
	3	Subindex 003	U32	0x6000:03, 8	RO
	4	Subindex 004	U32	0x6000:04, 8	RO
	5	Subindex 005	U32	0x6000:05, 8	RO
	6	Subindex 006	U32	0x6000:06, 8	RO
	7	Subindex 007	U32	0x6000:07, 8	RO
	8	Subindex 008	U32	0x6000:08, 8	RO

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Index	Sub-index	Description	Type	Values	Access
0x1A0A	0	TxPDO	U16	8	RO
	1	Subindex 001	U32	0x600A:01, 8	RO
	2	Subindex 002	U32	0x600A:02, 8	RO
	3	Subindex 003	U32	0x600A:03, 8	RO
	4	Subindex 004	U32	0x600A:04, 8	RO
	5	Subindex 005	U32	0x600A:05, 8	RO
	6	Subindex 006	U32	0x600A:06, 8	RO
	7	Subindex 007	U32	0x600A:07, 8	RO
	8	Subindex 008	U32	0x600A:08, 8	RO
0x1C12	0	RxPDO assign	U16	2	RO
	1	Subindex 001	U16	0x1600	RO
	2	Subindex 002	U16	0x160A	RO
0x1C13	0	TxPDO assign	U16	2	RO
	1	Subindex 001	U16	0x1A00	RO
	2	Subindex 002	U16	0x1A0A	RO
0x6000	0	Inputs	U16	8	RO P
	1	Input 1	U8		RO P

	8	Input 8	U8		RO P
0x600A	0	Inputs	U16	8	RO P
	1	Input 1	U8		RO P

	8	Input 8	U8		RO P

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Index	Sub-index	Description	Type	Values	Access
0x7000	0	Outputs	U16	8	RO P
	1	Output 1	U8		RO P

	8	Output 8	U8		RO P
0x700A	0	Outputs	U16	8	RO P
	1	Output 1	U8		RO P

	8	Output 8	U8		RO P
0xF000	0	Modular Device Profile	U8	2	RO
	1	Index distance	U8	10	RO
	2	Maximum number of modules	U16	2	RO
0xF050	0	Detected module list	U16	0 ... 2	RO
	1	Subindex 001	U32		RO
	2	Subindex 002	U32		RO

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Appendix B

B. Index

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