

Universal bus node CTEU-CO



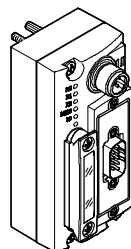
FESTO

Manual Functions and maintenance

Bus node

Type CTEU-CO

Fieldbus Protocol
CANopen



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Intended use

The bus node type CTEU-CO described in this manual has been designed exclusively for use as a slave on the CANopen field bus.

The bus node may only be used as follows:

- as intended
- in original condition, without any modifications by the user.
Only the conversions or modifications described in the documentation supplied with the product are permitted.
- in perfect technical condition.
The limit values specified for pressures, temperatures, electrical data, torques etc. should be observed.

Observe the regulations of the trade associations, German Technical Control Board (TÜV), VDE stipulations or corresponding national laws and regulations.



Warning

- Use only **PELV circuits** as per IEC/EN 60204-1 for the electric power supply (protective extra-low voltage, PELV).
Also observe the general requirements for PELV circuits in accordance with IEC/EN 60204-1.
- Use only **power sources** that guarantee reliable electrical isolation of the operating voltage as per IEC/EN 60204-1.

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

Range of application and certifications

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



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



Certificates and declarations of conformity for this product can be found at www.festo.com.

Target group

This manual is intended exclusively for technicians trained in control and automation technology who have experience in installing, commissioning, programming and diagnosing programmable logic controllers (PLCs) and slaves on the CANopen fieldbus.

Service

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

Notes on this manual

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



Information relating to installing the bus node can be found in Part I of the product documentation entitled “Installation and Interface manual”, which is supplied with the bus node. Information for mounting the bus node on the CAPC... electric sub-base can be found in the assembly instructions supplied with the electric sub-base.



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

Important user instructions

Danger categories

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



Warning

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



Caution

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



Note

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



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

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

Marking 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 and fieldbus-specific terms and abbreviations are used in this manual:

Term/abbreviation	Meaning
Bus nodes	create the connection to certain field busses/networks, pass on control signals to the connected devices/modules and monitor their functioning.
COB-ID	<u>C</u> ommunication <u>O</u> bject <u>I</u> dentifiers consist of the function code and address of the activated field bus slave (Node ID).
DCF	Device Configuration File = these files contain additional project data which extends beyond EDS content/scope.
DIL switches	<u>D</u> ual- <u>I</u> n- <u>L</u> ine switches usually consist of several switching elements which can be used to implement hardware settings.
EDS	<u>E</u> lectronic <u>D</u> ata <u>S</u> heets include product-specific data about the bus node.
Fail state	This is a function which automatically activates the “Hold last state” function in the event of an abortion of the network connection, and it is also designated “fail safe” in some cases.
FO _h	Hexadecimal numbers are marked by a low-set “h”.
Heartbeat	The bus node sends a telegram cyclically to the network which can be monitored by any station, compare with node guarding.
Hold last state	defines the status which outputs/valves are to assume after field bus and/or communication errors
I/Os	Digital inputs and outputs
Load voltage	includes the power supply for connected devices and (digital) outputs, e. g. solenoid coils of valves
Node guarding	Cyclic monitoring of the fieldbus station by the master controller by requesting a response within a specified time period.
Node ID	Address of the fieldbus station
OB	Output byte
Object Directory	makes all important slave parameters accessible in a standardised manner
O, I	Digital output, digital input

Term/abbreviation	Meaning
Operating voltage	also referred to as signal voltage; includes the power supply for electronics and sensors
PDO	<u>P</u> rocess <u>D</u> ata <u>O</u> bjects serve for the fast transfer of processing data via Multicast connection and are transmitted by simple CAN messages without protocol overhead. Process Data Objects can be transmitted event-controlled, synchronous to a system pulse sequence or on demand. PDOs are divided into TPDOs and RPDOs.
PLC/IPC	Programmable logic controller/industrial PC
RPDO	Receive PDO
SC/O SCS, SCO, SCV	Short circuit/overload Short circuit/overload sensor supply, outputs, valves
SDO	<u>S</u> ervice <u>D</u> ata <u>O</u> bjects predominantly form point-to-point connections between the server and client for the exchange of parameters for device configuration. They enable write and read access to any entry in the object directory of a bus node.
Status bits	Internal inputs which supply coded common diagnostic messages.
TPDO	Transmit-PDO
Voltage supply	Umbrella term for operating and load voltage supplies

Tab. 0/1: Terms and abbreviations

Commissioning

Chapter 1

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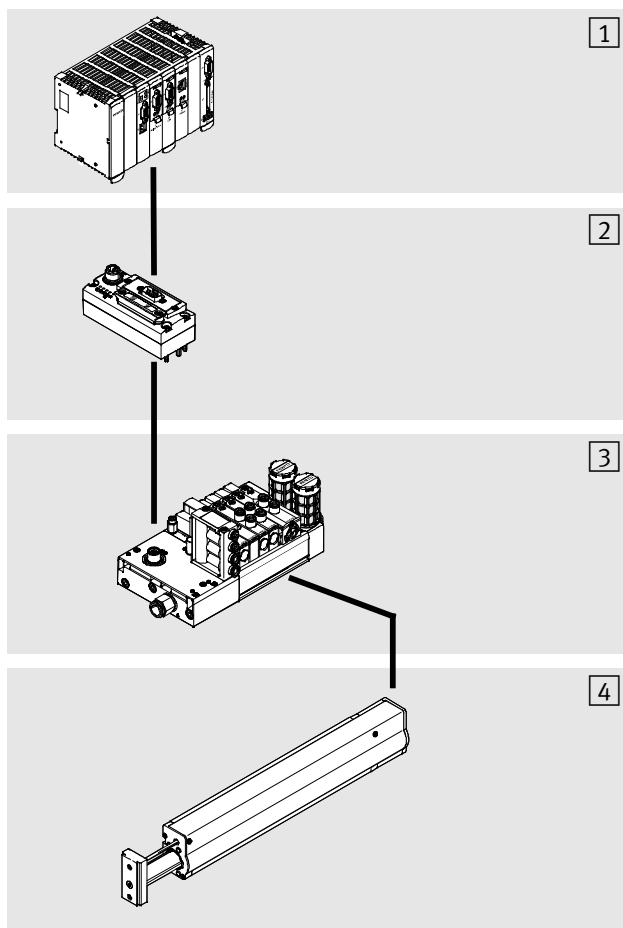
1. Commissioning

1.1 General information about the CANopen fieldbus protocol

The CTEU... product family enables the creation of a decentralised automation system in a CANopen fieldbus network.

1.1.1 Components

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



1. Commissioning

1.1.2 Data exchange with the CANopen fieldbus protocol

Communication profile	The fieldbus protocol uses a communication profile (documented in CiA DS301, see Tab. 1/1) to regulate how data is exchanged among the fieldbus stations. A distinction is made between real-time data and parameter data in this process.
Object directory	CANopen devices have an object directory which makes all important slave parameters accessible in a standardised manner. A CANopen system is essentially configured by accessing the objects in the object directory of the individual fieldbus stations.
SDO, PDO	The data exchange in CANopen is in the form of telegrams with which the work data is transmitted. A distinction is made between low-priority Service Data Objects (SDO), which are used for transmitting service data from and to the object directory, and between high-priority Process Data Objects (PDO), which serve for the fast transfer of current process states. In addition, Network Management Telegrams (NMT), among others, are used for managing the fieldbus network and global fault messages.

1.1.3 CANopen specifications

The following specifications are supported by the bus node:

CANopen specifications	
DS201 DS207	CAN Application Layer CAL
DS301, V4.0.2	The <u>D</u> raft <u>S</u> tandard 301 is based on the CAL communication profile
DS401, V3.0	The <u>D</u> raft <u>S</u> tandard 401 defines the device profiles for input and output modules within CANopen

Tab. 1/1: Supported CANopen specifications

1. Commissioning

Correct commissioning of the bus node requires you to be familiar with CANopen and be acquainted with the above- mentioned specifications.

1.1.4 Brief overview of the scope of functions

- Module states and boot-up as per Communication Profile DS301
- 1 Service Data Object for read and write access to the object directory: Send and Receive SDO
- 2 Process Data Objects for access to digital inputs: Transmit PDO 1 and 2
- 2 Process Data Objects for access to digital outputs: Receive PDO 1 and 2
- Emergency telegram for fault message to the master controller
- Node guarding and Heartbeat
- Default setting of all identifiers as per DS301 and the station number (predefined connection set)
- Variable mapping

1. Commissioning

1.2 Commissioning of a master controller

1.2.1 Installing the EDS file

Electronic Data Sheets (EDS), which are accessible via the network and describe the features and functions of the bus node, are available for configuring the master controller (also designated “CAN-Master”).



The current EDS file can be found on the Festo website at
➔ www.festo.com ➔ Support/Downloads.

Install this file by using the configuration software of your master controller. Please refer to the manuals for this software for detailed procedures.

1.3 Configuration by using process data

1.3.1 Predefined process data for establishing connections

The bus node can use up to two PDO telegrams for process data (Fig. 1/1), for both inputs (TxPDO) and outputs (RxPDO).

Both telegrams are continuously filled with process data of one or two connected devices (max. 2 x 8 bytes = 128 logical I/Os for inputs and outputs).

Transmit PDO 1	I0 ... E7	I8 ... I15	I16 ... I23	I24 ... I31	I32 ... I39	I40 ... I47	I48 ... I55	I56 ... I63
Transmit PDO 2	I64 ... I71	I72 ... I79	I80 ... I87	I88 ... I95	I88 ... I95	I104 ... I111	I112 ... I119	I120 ... I127
Receive PDO 1	O0 ... O7	O8 ... O15	O16 ... O23	O24 ... O31	O32 ... O39	O40 ... O47	O48 ... O55	O56 ... O63
Receive PDO 2	O64 ... O71	O72 ... O79	O80 ... O87	O88 ... O95	O88 ... O95	O104 ... O111	O112 ... O119	O120 ... O127

Fig. 1/1: Overview of PDO 1 and 2 for inputs and outputs



Note

When filling the process data telegrams please note that CANopen specification DS401 is only observed if you fill PDO 1 exclusively with input and output bytes.

1. Commissioning

1.3.2 Rules for internal I/O mapping

The following rules are applied when using the PDOs:

- The telegrams are filled in ascending order.
- Mapping can be used individually via both PDOs.
- The inputs and outputs are factory-arranged according to the standard mapping function.
- The I/Os are arranged according to the standard mapping function when a device is connected and the bus node is switched on.
- Process data allocation between the bus node and valve terminal remains in effect even if the two modules are separated, provided that the bus node remains under voltage during the separation. Otherwise the mapping information of connected devices is deleted.

1.3.3 I/O linking by COB-IDs

COB-IDs are made up of the function code (see Tab. 1/3) and the address of the respective fieldbus station (Node ID):

10	9	8	7	6	5	4	3	2	1	0
Function Code					Node ID					

Tab. 1/2: Configuration of COB-IDs

1. Commissioning

Object	Object designation	Value range of the COB identifier
SYNC ¹⁾	Broadcast object	080 _h 128 _d
EMERGENCY	For procedures with high priority, e.g. undervoltage	080 _h 128 _d
Transmit PDO 1	PDO1 (tx)	181 _h 1FF _h 385 _d ... 511 _d
Transmit PDO 2	PDO2 (tx)	281 _h 2FF _h 641 _d ... 767 _d
Receive PDO 1	PDO1 (rx)	201 _h 27F _h 513 _d ... 639 _d
Receive PDO 2	PDO2 (rx)	301 _h 37F _h 769 _d ... 895 _d
Transmit SDO	SDO1 (tx)	581 _h 5FF _h 1409 _d ... 1535 _d
Receive SDO	SDO1 (rx)	601 _h 67F _h 1537 _d ... 1663 _d
Node guarding / Heartbeat	Cyclic interrogation (guarding) or life sign message:	701 _h 77F _h 1793 _d ... 1919 _d
¹⁾ "0" is used as the Node ID.		

Tab. 1/3: Function Code

Examples for using the COB-IDs can be found in section 1.5.3.

1. Commissioning

1.4 Device parameters

Identification information for connected devices is stored in the object directory of the bus node in object 3101 for a device connected to I-Port 1 or in object 3102 for a device connected to I-Port 2.

Extended device parameters are available via SDO access to object 3301 for a device connected to I-Port 1 or object 3302 for a device connected to I-Port 2.



Information about the structure of the device parameters can be found in the appendix, section A, and in the documentation for your device.

1. Commissioning

1.5 Communication

When the fieldbus stations are switched on they all assume the “pre-operational” status and wait for instruction from the master controller.

1.5.1 Structure of communication

Pre-operational	Only SDOs can be parameterised in this status. This parameterisation corresponds to the asynchronous transmission which is standard with most PLC controllers. Conversion to e.g. synchronous transmission is possible if the communication parameters are written with the appropriate values from the DS301 communication profile, but modifying the mapping is not possible.
Operational	After successful parameterisation the master controller can switch the fieldbus stations to the “operational” status with a special Network Management Telegram (NMT). Communication via both SDOs and PDOs is possible in this status. With the aid of the NMT telegrams you can switch between the different states, if required.

1. Commissioning

1.5.2 CANopen status transitions

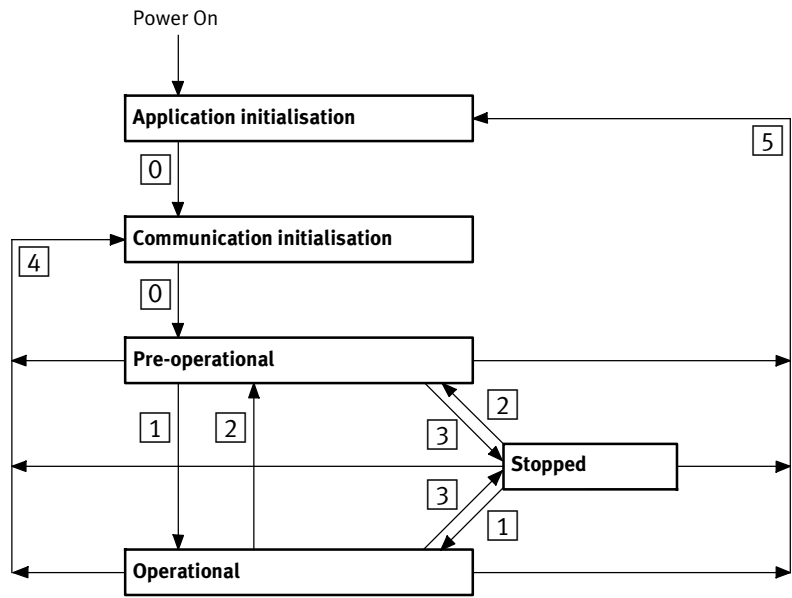


Fig. 1/2: CANopen status transitions (for a description refer to Tab. 1/4)

1. Commissioning

Description of the status transitions

Status transition	Designation	Command Specifier (cs)	Function
0	—	—	Automatic boot-up after power on The saved parameters 2000 ... 5FFF are only loaded after power on ¹⁾
1	Start_Remote_ Node_Indication	01 _h	Starts the bus node in operational mode: – SDO transmission valid – PDO transmission (outputs active) – Node guarding / Heartbeat valid (Node guarding response: Toggle + 05_h)
2	Enter_Pre_ Operation_State_ Indication	80 _h	Bus node in pre-operational mode: – SDO transmission valid – PDO transmission invalid (Outputs assume error status ²⁾) – Node guarding / Heartbeat valid (Node guarding response: Toggle + 7F_h)
3	Stop_Node_ Indication	02 _h	Bus node in stopped mode: – SDO transmission invalid – PDO transmission invalid (Outputs assume error status ²⁾) – Node guarding / Heartbeat valid (Node guarding response: Toggle + 04_h)
4	Reset_ Communication_ Indication	82 _h	Resetting the communication functions: – Outputs are reset – Communication parameters are reset (objects 1000 ... 1FFF)
5	Reset_Node_ Indication	81 _h	Module reset including application: – Outputs are reset – Maskings of the outputs are reset to default – Communication parameters are reset (objects 1000 ... 1FFF) – Stored parameters (2000 ... 5FFF) are not reloaded.
¹⁾ The objects 6000 ... are always loaded with the default settings after power-on ²⁾ Only after the transition from operational mode to stopped or pre-operational mode			

Tab. 1/4: Status transitions (for an overview refer to Fig. 1/2)

1. Commissioning

1.5.3 Examples of the communication sequence

The following examples refer to module ID = 1, i. e. the preset station number of the bus node is “1”.

Example 1: Start CANopen network

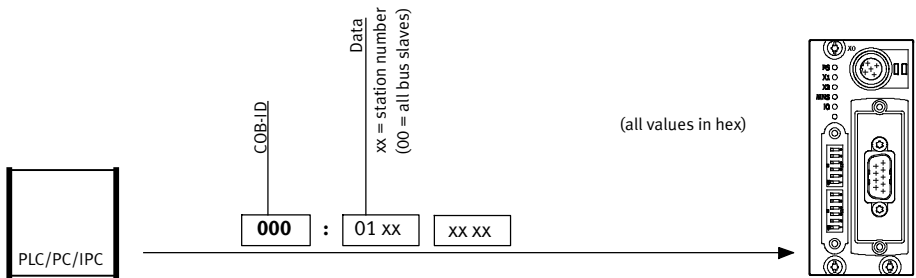


Fig. 1/3: Example 1, start CANopen network

Example 2: Set output

To set outputs or valves via the bus node the receive PDO must be sent from the master controller. In the example, only output 0 is set, any outputs already set will be reset.

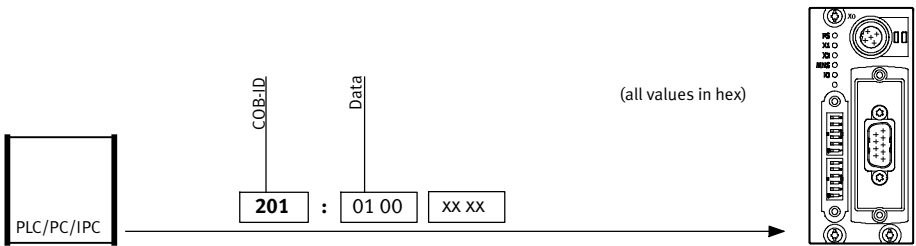


Fig. 1/4: Example 2, set output 0 of the bus node

Example 3: Load objects

The following objects of the bus node can be loaded or read via SDO transfer:

- Upload command
- Index and subindex

The bus node then sends:

- Index and subindex
- Data bytes

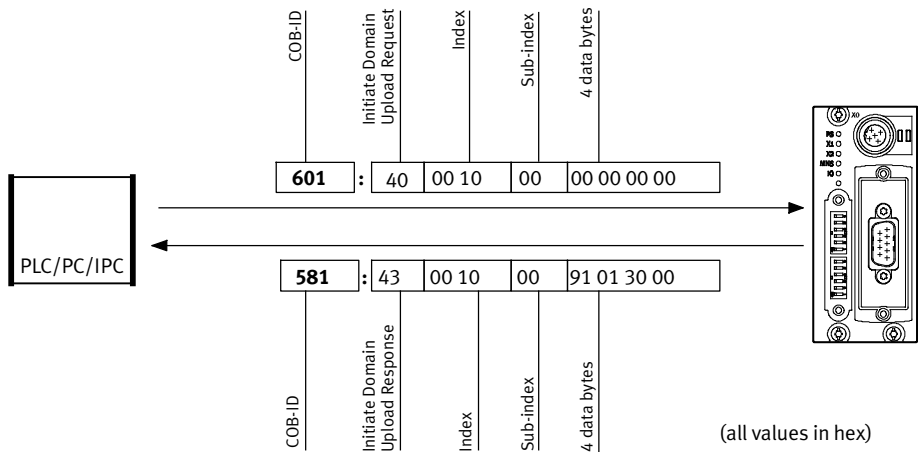


Fig. 1/5: Example 3, index 1000_h, read subindex 0 (device type: device profile, device extension)

1. Commissioning

Example 4: Write objects

To write in objects of a bus node the following information must be read first from the bus node via SDO:

- Download command
- Index and subindex
- Value

The bus node then sends as acknowledgement:

- Index and subindex
- data bytes (not relevant)

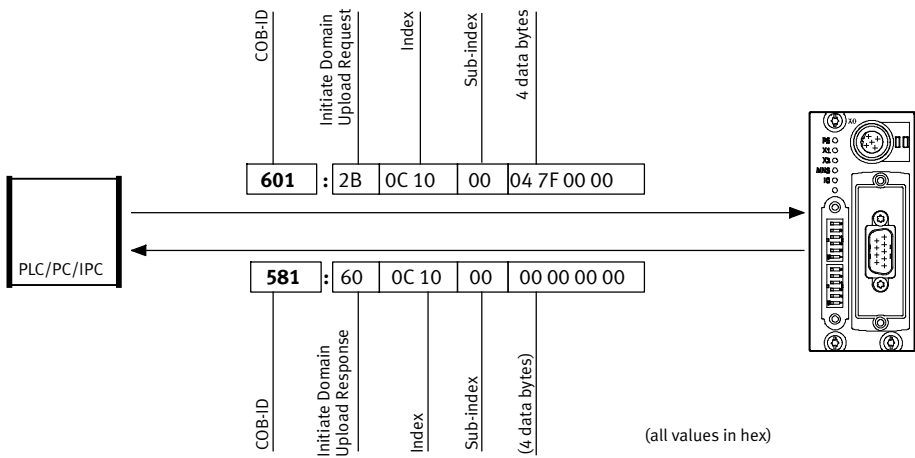


Fig. 1/6: Example 4: Index 100C_H, Subindex 0 written (Guard Time)

1. Commissioning

Example 5: Start “Node guarding” monitoring

Load first the indices 100C and 100D via SDO transfer (see example 3). The “Node guarding” monitoring of the bus node starts when the first “Node guarding” telegram is received. This telegram must be cyclically repeated within the timeout time:

$$\begin{aligned}\text{Timeout time} &= \text{guard time} \cdot \text{life time factor} \\ &= \text{Index 100C} \cdot \text{index 100D}\end{aligned}$$

If this time is exceeded, the valves/outputs will be switched off or they will assume the “Fail state” status.



Note

The timeout monitoring in the bus node is inactive until the first “Node guarding” telegram is received: Outputs that have been set (e.g. switched valves) remain set even after a loss of communication, fieldbus interruptions, et c.

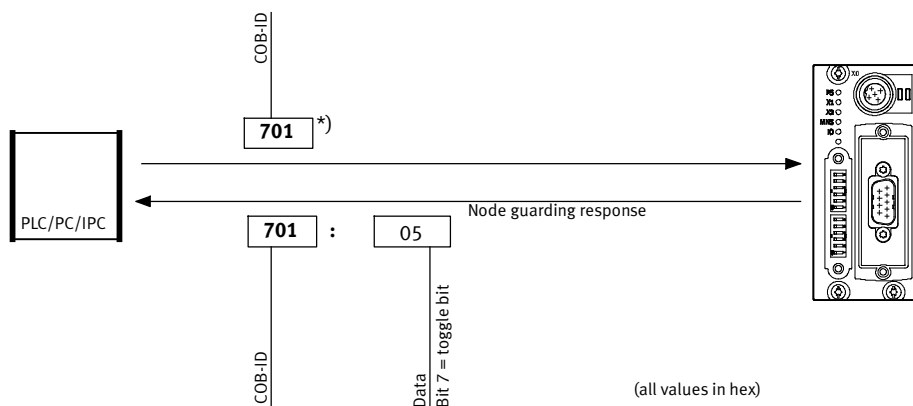


Fig. 1/7: Example 5, start “Node guarding” monitoring (*) Remote request)

1.6 Switching on

1.6.1 Information concerning the switch-on behaviour of the bus node

In order to avoid connecting and addressing errors, you should carry out commissioning in steps as follows. Observe the following information concerning the switch-on behaviour:

- Please note that any devices to be connected must be logically connected to the bus node before switching on the CTEU bus node, otherwise it will result in an error message and no process data will be available for transmission.
- Only mount the bus node to the same or an identical and equally-configured device while maintaining the operating voltage supply in order to avoid any malfunctions. The configuration of connected devices is lost as soon as the operating voltage supply of the bus node is disconnected.
- Disconnect the operating voltage from the bus node before connecting other devices, as the configuration process is only retransmitted after the bus node is switched on again.
- Before switching it on, make sure the details regarding the fieldbus configuration are complete and correct.
- Connect any devices to the bus node via the I-Port, as these are only recognised by the bus node when the operating voltage is switched on.

1. Commissioning

1.6.2 Switching on the operating voltage

**Note**

Please observe the switch-on instructions in the manual for your PLC.

Observe the following points before switching on the power supply:

Common supply

The master controller and all fieldbus stations are switched on via a central power supply unit or a central switch.

Separate supply

If the master controller and the fieldbus stations have separate power supplies, they should be switched on in the following sequence:

1. Switch on the operating voltage supply for all fieldbus stations.
2. Switch on the operating voltage supply for the controller.

1. Commissioning

1.6.3 Normal operating status

After an error-free commissioning procedure and during normal operation the operating status LEDs on the bus node illuminate as follows:

LED display	Status
	PS illuminates green when the voltage supply is established.
	X1/X2 illuminates green when the device has been connected correctly.
	
	MNS is off during normal operation.
	IO illuminates green as soon as commissioning of fieldbus communication has been successful and the bus node is controlled by the master controller.
	

Tab. 1/5: Operating status LEDs when switching-on

Information about diagnosing using the LED displays can be found in section 2.2.

1.7 Fail state behaviour

Fail state regulates the behaviour of the bus node and the connected devices in the event of communication errors (see section 2.3.3).



Note
As a prerequisite Node guarding or Heartbeat must be activated on the master controller.

Behaviour of the fieldbus	of the connected device	DIL switches Fail state switching position	Device: Signals applied by the bus node	Diagnostics
Ok	Timeout	Off	are reset	Master controller reports a connection fault The “X1” and/or “X2” LED on the bus node illuminate red
		On	remain set (“Hold last state”)	
Timeout	Ok	Off	are reset	“MNS” LED on the bus node illuminates red
		On	remain set (“Hold last state”)	
	Timeout	Off	are reset	The “X1” and/or “X2” LED on the bus node illuminate red and “MNS” LED on the bus node illuminates red
		On	remain set (“Hold last state”)	

Tab. 1/6: Constellations of Fail state behaviour

1. Commissioning

- 1** DIL switch settings:
Off = reset (default)
On = Hold last state

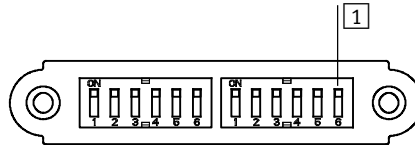


Fig. 1/8: DIL switches for Fail state behaviour



Further information relating to the DIL switches on the bus node can be found in Part I of the product documentation entitled “Installation and Interface manual”, which is supplied with the bus node.

Diagnosis

Chapter 2

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2. Diagnosis

2.1 Summary of diagnostics options

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

Diagnostic possibility	Brief description	Advantages	Detailed description
LED display	The LEDs show directly configuration faults, hardware faults, bus faults, etc.	Fast “on-the-spot” recognition of errors	Section 2.2
Diagnostics via fieldbus	– Diagnostics via SDO – Emergency message	Detailed fault recognition	Section 2.3

Tab. 2/1: Diagnostics options

- 1** DIL switch settings:
Off = no diagnostic messages (default)
On = Emergency Message is sent

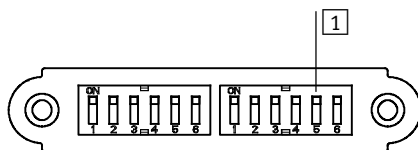


Fig. 2/1: DIL switches for diagnostic messages



Further information relating to the DIL switches on the bus node can be found in Part I of the product documentation entitled “Installation and Interface manual”, which is supplied with the bus node.

2. Diagnosis

2.2 Diagnostics via LED display

LEDs are located on the bus node for diagnosing the bus node and any connected devices (see Fig. 2/2).

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

 illuminates  flashes  off

2. Diagnosis

2.2.1 Normal operating status display

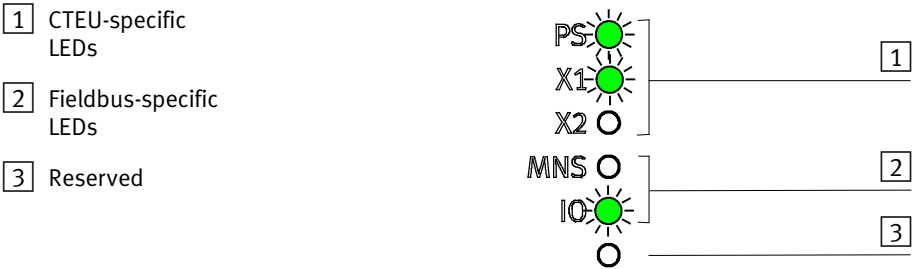
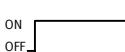


Fig. 2/2: LEDs on the bus node

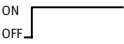
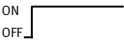
2.2.2 PS-LED status display

PS (power system) – power sensor/logic supply			
LED	Procedure	Status	Meaning/error elimination
 LED illuminates green	ON OFF 	Normal operating status: Operating voltages are in the permissible range.	–
 LED flashes green	ON OFF 	Undervoltage for the signal or load voltage supply or short circuit of the bus node's I-Port	• Eliminate short circuit on the bus node • Eliminate undervoltage on the connected device
 LED is off	ON OFF 	Signal voltage is not present.	Check signal voltage supply (pin 1 and 3)

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

2. Diagnosis

2.2.3 Status display X1-/X2-LEDs

X1 or X2 ¹⁾ – Internal communication between the bus node and device 1 or 2 ¹⁾			
LED	Procedure	Status	Meaning/error elimination
 LED illuminates green		– Normal operating status – Device is connected correctly to the bus node. – Load voltage applied. – There is no error.	–
 LED flashes green		– Diagnostics is running and/or diagnostic data is being transferred. – Undervoltage of the additional power supply. – Connection between bus node and device ok	• Device diagnostics can be read via fieldbus communication (if activated via DIL switches on the bus node) • Eliminate undervoltage
 LED illuminates red		– Device is connected to the bus node but communication is disrupted. – An incorrect device has been connected after commissioning.	• Check fieldbus: cables, plug connectors, signal transmission (error counter overrun) • Restart the bus node (by switching the power off -> on)
 LED flashes red		– Incorrect device connected (device detected that is not I-Port compatible) – In addition with LED X1: Error in the bus module	• Use an I-Port compatible device (e. g. suitable valve terminal) from Festo • If no device is connected, X1 and X2 flash red
 LED is off		– Connection is being established. – No device is connected to the bus node	–
¹⁾ Separate accessory with two interfaces for connecting another device is required.			

Tab. 2/3: Status displays of the device-specific “X1” LED if device 1 is connected and “X2” if device 2 is connected.

2. Diagnosis

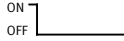
2.2.4 Status display MNS-LED

MNS (network status)			
LED	Procedure	Status	Meaning/error elimination
 LED illuminates red	ON OFF 	– Fieldbus communication is not available or has failed. – Voltage supply to / via the fieldbus has failed.	• Fieldbus is offline • CAN error • CAN short circuit • Check connection to network • Check the setting of the DIL switches • Check the voltage supply to / via the fieldbus
 LED flashes red	ON OFF 	Communication error - fieldbus communication is defective	• Timeout ascertained • Check connection to network
 LED is off	ON OFF 	Normal operating status/no communication error on the fieldbus	• Diagnosis is possible • Access to connected devices is possible through PDO/SDO access

Tab. 2/4: Status displays of the fieldbus-specific “MNS” LED

2. Diagnosis

2.2.5 I/O-LED status display

I/O (I/O status)			
LED	Procedure	Status	Meaning/error elimination
 LED illuminates green	ON OFF 	– Bus node is in operational mode.	Normal operating status/ready status when the bus node is controlled by the master controller.
 LED flashes	ON OFF 	– Bus node is in pre-operational mode.	Ready status is in preparation.
	ON OFF 	– Fieldbus communication is interrupted and automatically restored. – Amend the incorrect station number on the bus node or the controller	Ready status has been stopped.
 LED is off	ON OFF 	– No commissioning of the fieldbus – No fieldbus connected	• No device connected • Station number (Node ID) = 0 is set

Tab. 2/5: Status displays of the fieldbus-specific “I/O” LED

2. Diagnosis

2.3 Diagnostics via fieldbus

2.3.1 Diagnostics via SDO

The master controller can query diagnostic information via SDO access on the bus node. The corresponding SDOs can be found in the object directory in section A.2.

2.3.2 The Emergency Message

If an error occurs the bus node can send an emergency message with a defined structure (see Tab. 2/6) when the “diagnostics” DIL switch is activated (see section 2.1). The following sections describe the components of the emergency message and the error causes (see Tab. 2/9).



Note
As a prerequisite Node guarding or Heartbeat must be activated on the master controller.

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Error code		Error Re- gister	Device 1		Device 2		Reserved
			Dia- gnostics byte 1	Dia- gnostics byte 2	Dia- gnostics byte 1	Dia- gnostics byte 2	
		Obj. 1001	Obj. 1002 Manufacturer status register				
CANopen standard			Manufacturer specific error field				

Tab. 2/6: Composition of the Emergency Message Object

2. Diagnosis

The pre-defined error field as fault memory

If the Emergency Message is transmitted, a compressed form of the fault information will be saved parallel in the Pre-Defined Error Field (Index 1003).

Device 1 + 2 DIAG, Error Code

The Pre-defined Error Field serves as fault memory for the last faults ascertained.

Error Codes



Note
If several Emergency Messages from Tab. 2/7 are present, only the most recently reported is transmitted to the master controller.

Byte 0	Byte 1	Explanation
00	00	No error
20	22	Short circuit diagnostics
20	23	Short circuit at outputs
20	31	Operating voltage too low
20	33	Load voltage too low
00	50	Hardware fault
30	81	Node guarding or Heartbeat error
00	FF	Configuration error
FF	FF	Diagnostic message from I-Port telegram

Tab. 2/7: Bus node Error Codes (as per DS401)

2. Diagnosis

Error register



Note

One or more Error Codes for each Emergency Message can be transferred to the master controller with the help of the Emergency Messages from Tab. 2/8.

Bit	Meaning	Explanation
0	Generic error	Bit is set for each error
1	Current	– Short circuit/overload of sensor supply – Short circuit/overload of connected devices
2	Voltage	– Operating voltage too low – Load voltage too low – Load voltage not applied
3	–	–
4	Communication Error	– Node guarding, Heartbeat, CANopen error
5 ... 6	–	–
7	Manufacturer specific	– Wire fracture – other errors

Tab. 2/8: Error Register (Object 1001 with bit assignment as per DS301/401)

Manufacturer Status Register

Error causes of the devices connected to the bus node are transmitted via bytes 3 and 4 or 5 and 6 of the Emergency Message (Manufacturer Status Register, Object 1002).

Transmittable error causes

The following error causes are reported to the master controller by the bus node (Tab. 2/9):

2. Diagnosis

Error causes	Device on the bus node	Byte (Structure as per Tab. 2/6)							
		0	1	2	3	4	5	6	7
No error	X	00	00	00	00	00	00	00	res.
Device short circuit	I-Port 1	20	22	83	10	77	00	00	
Device short circuit	I-Port 2	20	22	83	00	00	10	77	
I-Port Pin4 short circuit	I-Port 1	20	23	83	A0	8C	00	00	
I-Port Pin 4 short circuit	I-Port 2	20	23	83	00	00	A0	8C	
No load voltage or insufficient load voltage	I-Port 1	20	33	85	12	51	00	00	
No load voltage or insufficient load voltage	I-Port 2	20	33	85	00	00	12	51	
No operating voltage or insufficient operating voltage	X	20	31	85	00	00	00	00	
Hardware error	X	00	50	01	00	10	00	00	
Hardware error	X	00	50	01	00	00	00	10	
Configuration error	X	00	FF	01	00	00	00	00	
Configuration error	I-Port 1	00	FF	01	00	10	00	00	
Configuration error	I-Port 2	00	FF	01	00	00	00	10	
Other I-Port diagnostic message	I-Port 1	FF	FF	81	Event C. Low	Event C.High	00	00	
Other I-Port diagnostic message	I-Port 2	FF	FF	81	00	00	Event C. Low	Event C.High	
Node guarding or Heartbeat error	X	30	81	11	00	00	00	00	
X = Error is present on the bus node itself or is not clearly assigned to a device that is connected to the bus node via the I-Port interface.									

Tab. 2/9: Transmittable error causes via Emergency Message

2. Diagnosis

2.3.3 Reaction to network communication faults



Note

Please observe the following if the outputs are reset in the event of a PLC stop or field bus interruption or malfunction:

- 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 the valve type: pressurised, exhausted or blocked).

You can parameterise the behaviour of connected devices in the event of a fault. All valves/outputs of connected devices are reset as standard when the following faults and operating states occur as soon as Node guarding or Heartbeat are activated via the configuration:

- Communication error (Node guarding, Heartbeat)
- Transition from operational to pre-operational or stopped

The behaviour of connected devices in the event of communication errors can be changed using the corresponding DIL switches (see section 1.7).

2.3.4 Node guarding

In order for CANopen to recognise a fieldbus failure Node guarding must be activated on the master controller (default: switched off).

In the case of actuators it is advisable to monitor the master controller for failure in order to provide an appropriate emergency shutdown strategy.

2. Diagnosis

Then the master controller is monitored based on monitoring of activation with the configured monitoring time (see DS 301). When monitoring is activated, the configured emergency stop response (Fault reaction option code object 605Eh, PNU 1021) is executed and the drive is stopped.

Select the “Guard Time” with reference to the dynamics of the system.

Refer to your master controller documentation for details on how to activate Node guarding.



Error treatment

Chapter 3

Contents

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3.1.2 Check the power supply 3-4

3.1.3 Restart communication between the bus node and the device ... 3-5

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3.1.5 Check the CANopen configuration 3-6

3.1.6 Read out diagnostic messages via CANopen 3-7

3. Error treatment

3.1 Fault finding and error elimination

This section is meant as a checklist to help you inspect your installation and commissioning steps if an error occurs. You will find important information and references here to the respective sections of the two-part product documentation for the bus node.

Exclude potential sources of error by working through the following sections completely and in the specified order.

3.1.1 Check the installation

- Check the correct installation of the bus node on the device or the CAPC... electric sub-base and the correct earthing of all of the components involved.
- Make sure that all of the necessary cables are fitted correctly.



Information relating to installing the bus node can be found in Part I of the product documentation entitled “Installation and Interface manual”, which is supplied with the bus node. Information for mounting the bus node on the CAPC... electric sub-base can be found in the assembly instructions supplied with the electric sub-base.

3. Error treatment

3.1.2 Check the power supply



Warning

- Use only PELV **circuits** as per IEC/EN 60204-1 for the electric power supply (protective extra-low voltage, PELV).
Also observe the general requirements for PELV circuits in accordance with IEC/EN 60204-1.
- Use only **power sources** that guarantee reliable electrical isolation of the operating voltage as per IEC/EN 60204-1.

- Check to make sure **both** power supplies for the operating and load voltage are connected.
The devices connected to the bus node are powered exclusively via the load voltage connection.
- Check the pin assignment of self-assembled cables.



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

Normal status LED

PS-LED illuminates green and the X1 and/or X2 LED illuminate green.

Error status 1

The operating voltage supply for the bus node exhibits under-voltage:

- PS-LED flashes green

3. Error treatment

Error status 2

The load voltage supply for the connected device(s) is missing or exhibits undervoltage:

- PS-LED flashes green and
- X1 and/or X2-LED flash green

Prerequisite: That connected device(s) must support this diagnostic function (see device description).

3.1.3 Restart communication between the bus node and the device

Problem description:

X1 and X2 flash red simultaneously despite checking the mechanical connection between the bus node and the device (disassembly -> assembly)

Remedy:

Proceed as follows:

1. Disconnect the operating voltage.
 2. Check the assembly and/or re-establish the cable connection between the bus node and connected devices.
 3. Switch voltage on again.
- X1 and/or illuminate or flash green.

3.1.4 Check fieldbus communication

- Compare the desired baud rate with the baud rate set on the bus node (DIL switch setting).
- Compare the desired Node ID with the Node ID set on the bus node (DIL switch setting).



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

3. Error treatment

- Compare your selected cable lengths with the technical data in the appendix and the recommendations of the CiA specification.
- Check the installation of the terminating resistors at both ends of the fieldbus.
- Test the fieldbus communication using the object directory (see section A.2).

Normal status LED MNS-LED is off and I/O-LED illuminates green (in operational mode) or is off (in the event of defective fieldbus communication).

3.1.5 Check the CANopen configuration

Problem description: Process data is faulty.

Remedy: Proceed as follows:

1. Check whether the mapping element conforms to the settings of the master controller (see section A.2).
2. Check whether the status of the bus node, e. g. operational mode, complies with the settings of the master controller (see section 2.2.5).

Problem description: Outputs do not switch to the desired state in the event of fieldbus communication malfunctions.

Remedy: Proceed as follows:

1. Check whether Node guarding or Heartbeat is activated on the master controller.
This ensures that the bus node can detect malfunctions in fieldbus communication and that the outputs are set to a defined state after fieldbus communication is restored.
2. Check whether Fail State is activated on the bus node (DIL switch position).
Fail State off: the outputs are set to “0” after fieldbus communication is restored.

3. Error treatment

Fail State on: after fieldbus communication is restored the outputs resume the status assumed before the failure (“hold last state”).

3.1.6 Read out diagnostic messages via CANopen

The devices connected to the bus nodes can offer advanced diagnostic options, which extend beyond the LED displays, if LED X1 and/or X2 flashes green.

Option 1

Proceed as follows:

- 1. Activate Node guarding or Heartbeat on the master controller.
- 2. Wait for the display of the Emergency Messages (see Tab. 3/10) on the master controller.

Error causes	Device on the bus node	Byte							
		0	1	2	3	4	5	6	7
No load voltage or insufficient load voltage	I-Port 1	20	33	85	12	51	00	00	res.
No load voltage or insufficient load voltage	I-Port 2	20	33	85	00	00	12	51	

Tab. 3/10: Extract from the Emergency Message table (see section 2.3.2)

Option 2

Proceed as follows:

- Retrieve the SDO telegrams manually from the bus node and evaluate them (see object directory in section A.2)

3. Error treatment

Technical appendix

Appendix A

Contents

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A.2 Object directories A-6

A.1 Technical data

General	
Temperature range – Operation – Storage/transport	–5 ... +50 °C –20 ...+70 °C
Relative air humidity as per IEC 60770	93 % at 40 °C
Protection class as per EN 60529, bus node fitted completely, plug connector inserted or provided with protective cap	IP65/67 ¹⁾ with appropriate cable from Festo accessories
Protection against electric shock (protection against direct and indirect contact as per EN 60204-1/IEC 204)	through PELV power supply unit (Protected Extra Low Voltage)
Electromagnetic compatibility (EMC) ²⁾ – Emitted interference – Resistance to interference	See declaration of conformity ➔ www.festo.com
Vibration and shock tested as per DIN/IEC 68/EN 60068 – Vibration (part 2 - 6) – Shock (part 2 - 27) – Continuous shock (part 2 - 29)	Severity level (SL) for assembly on ... Wall: SL 2, H-rail: SL 1 Wall: SL 2, H-rail: SL 1 Wall and H-rail: SL 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, a smaller temperature range, etc. ²⁾ The bus node is intended for industrial usage. In residential areas, interference suppression measures might have to be taken.	

A. Technical appendix

General	
Materials – Housing – Fibre-optic, cover DIL switch – Threaded sleeve M12 – Threaded bush M3 – Seals – Screws	RoHS-compliant PA, reinforced PC Brass, electro nickel-plated Brass NBR Galvanized steel
Corrosion protection	CRC 2

Voltage supply	
Operating voltage ¹⁾ – Nominal value – Tolerance	24 V DC 18 ... 30 V DC
Load voltage ¹⁾ of connected devices – Range	18 ... 30 V DC ²⁾
Current supply – Power rating for operating and load voltage (residual current) – Intrinsic current consumption of the bus node (at 24 V DC) – Current consumption (at 24 V DC) of the bus node with operation of a connected device – Current consumption (at 24 V DC) of the bus node with operation of one/two connected devices via electric sub-base CAPC-...	Max. 4 A Max. 65 mA Max. 120 mA Max. 175 mA
Galvanic isolation	Bus interface
¹⁾ External fuse required ²⁾ Dependent on the connected device (e. g. valve terminal)	

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

CANopen signal transmission				
Max. cable lengths	Baud rate			
	125 kbps	250 kbps	500 kbps	1 000 kbps
– Fieldbus cable (“trunk cables”)	500 m	250 m	100 m	40 m
– Branch line cable (“drop cables”)	3,75 m	2,00 m	0,75 m	0,3 m

A.2 Object directories

The following tables show the objects of the communication part (values and examples with node ID = 1). The following abbreviations mean:

- U= unsigned
- ro = read only
- rw = read/write
- Map = mapping possible
- Attr. = attribute



Note
For mapping the rules as per CiA DS301 apply: Mapping entries are only possible if the number of parameters has previously been set to zero.
(Example: index 1A00, subindex 3 ... 8:
Set subindex 0 to “0”).
After entering the mapping values set the number of parameters to the appropriate value again.



Note
Note that basic settings can only be changed via DIL switches.

Index (hex)	Sub-index	Designation	Type	Attr.	Map.	Values (hex)	Explanation
1000	0	Device type	U32	ro	–	00030191 (fixed)	01 91 = device profile DS401 3 = Digital inputs and digital outputs
1001	0	Error register	U8	ro	–	Nn	

A. Technical appendix

Index (hex)	Sub-index	Designation	Type	Attr.	Map.	Values (hex)	Explanation
1002	0	Manufacturer Status Register	U32	ro	Yes	00 00 00 00	- First 2 bytes with diagnostics-telegram from Device 1 - Last 2 bytes with diagnostics-telegram from Device 2
1005	0	COB-ID SYNC Message	U32	rw	–	80 00 00 80	Default SYNC message COB-ID 80 _h
1008	0	Manufacturer Device Name	Str.	ro	–	“CTEU-CO”	Bus node designation
1009	0	Manufacturer Hardware Version	Str.	ro	–	“r03” (example)	As 1018.3
100A	0	Manufacturer Software Version	Str.	ro	–	“r03” (example)	As 1018.3
100C	0	Guard Time	U16	rw	–	00 00	Timeout monitoring [ms]
100D	0	Life Time Factor	U8	rw	–	00	Timeout monitoring (Guard time x life time factor = complete node guarding time)
1014	0	COB-ID Emergency Message	U32	rw	–	00 00 00 80	Default emergency object COB-ID 80 _h + node ID
1015	0	Inhibit Time Emergency Message	U16	rw	–	00 00	Transmit Blocking Time Emergency Message [100µs]

A. Technical appendix

Index (hex)	Sub-index	Designation	Type	Attr.	Map.	Values (hex)	Explanation
1016	0	Consumer Heartbeat Time 0 ... 3	U8	ro	–	03	Number of entries/ Heartbeat ID &Time [ms]
	1		U32	rw		00 00 00 00	Heartbeat ID and Heartbeat Time [ms]
	2						
	3						
1017	0	Producer Heartbeat Time	U16	rw	–	00 00	Heartbeat Time [ms] COB-ID = Node guard ID Status (pre-operational, operational, stopped)
1018	0	Identity Object	U8	ro	–	04	Number of entries
	1	Vendor ID	U32			00 00 00 1D	Vendor ID (from CiA)
	2	Product code				570038	Product code
	3	Revision number				“r03” (example)	CANopen Revision
	4	Serial number				xx xx xx xx	Value from production process
1200	0	Server SDO parameter	U8	ro	–	02	Number of entries
	1	COB_ID Client → Server (rx)	U32			600 + Node ID	Default COB-ID + Node ID
	2	COB_ID Server → Client (tx)				580 + Node ID	Default COB-ID + Node ID

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Index (hex)	Sub-index	Designation	Type	Attr.	Map.	Values (hex)	Explanation
1400	0	Receive PDO Communication Parameter 0	U8	ro	—	05	Output PDO 0 Communication Parameter
	1	COB-ID	U32	rw		200 + Node ID	Default COB-ID of the outputs
	2	Transmission Type	U8			FF	
	3	Inhibit Time	U16			0000	
	5	Event Timer				0	
1401	0	Receive PDO Communication Parameter 1	U8	ro	—	05	Output PDO 1 Communication Parameter
	1	COB-ID	U32	rw		300 + Node ID	Default COB-ID of the outputs
	2	Transmission Type	U8			FF	
	3	Inhibit Time	U16			0000	
	5	Event Timer				0	

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Index (hex)	Sub-index	Designation	Type	Attr.	Map.	Values (hex)	Explanation
1600	0	Receive PDO Communication Mapping Parameter 1	U8	ro	–	08	Output PDO 0-Mapping
	1		U32	rw		62 00 01 08	Pointer at Index A0 ... A7
	2					62 00 02 08	... Index A8 ... A15
	3					62 00 03 08	... Index A16 ... A23
	4					62 00 04 08	... Index A24 ... A31
	5					62 00 05 08	... Index A32 ... A39
	6					62 00 06 08	... Index A40 ... A47
	7					62 00 07 08	... Index A48 ... A55
	8					62 00 08 08	... Index A56 ... A63
1601	0	Receive PDO Communication Mapping Parameter 1	U8	ro	–	08	Output PDO 1-Mapping
	1		U32	rw		62 00 09 08	Pointer at Index A0 ... A7
	2					62 00 0A 08	... Index A8 ... A15
	3					62 00 0B 08	... Index A16 ... A23
	4					62 00 0C 08	... Index A24 ... A31
	5					62 00 0D 08	... Index A32 ... A39
	6					62 00 0E 08	... Index A40 ... A47
	7					62 00 0F 08	... Index A48 ... A55
	8					62 00 10 08	... Index A56 ... A63

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Index (hex)	Sub-index	Designation	Type	Attr.	Map.	Values (hex)	Explanation
1800	0	Transmit PDO Communication Mapping Parameter 0	U8	ro	–	05	Input PDO 0 Communication Parameter
	1	COB-ID	U32	rw		180 + Node ID	Default COB-ID of the inputs
	2	Transmission type	U8			FF	Default: acyclic
	3	Inhibit Time	U16			00 00	Transmit blocking time inputs
	5	Event Timer				0	Time-controlled transmission of the inputs [ms]
1801	0	Transmit PDO Communication Mapping Parameter 1	U8	ro	–	05	Input PDO 1 Communication Parameter
	1	COB-ID	U32	rw		280 + Node ID	Default COB-ID of the inputs
	2	Transmission type	U8			FF	Default: acyclic
	3	Inhibit Time	U16			00 00	Transmit blocking time inputs
	5	Event Timer				0	Time-controlled transmission of the inputs [ms]

A. Technical appendix

Index (hex)	Sub-index	Designation	Type	Attr.	Map.	Values (hex)	Explanation
1A00	0	Transmit PDO Communication Mapping Parameter 0	U8	ro	–	08	Input PDO 0-Mapping
	1		U32	rw		60 00 01 08	Pointer at Index E0 ... E7
	2					60 00 02 08	... Index E8 ... E15
	3					60 00 03 08	... Index E16 ... E23
	4					60 00 04 08	... Index E24 ... E31
	5					60 00 05 08	... Index E32 ... E39
	6					60 00 06 08	... Index E40 ... E47
	7					60 00 07 08	... Index E48 ... E55
	8					60 00 08 08	... Index E56 ... E63
1A01	0	Transmit PDO Communication Mapping Parameter 1	U8	ro	–	08	Input PDO 0-Mapping
	1		U32	rw		60 00 09 08	Pointer at Index E0 ... E7
	2					60 00 0A 08	... Index E8 ... E15
	3					60 00 0B 08	... Index E16 ... E23
	4					60 00 0C 08	... Index E24 ... E31
	5					60 00 0D 08	... Index E32 ... E39
	6					60 00 0E 08	... Index E40 ... E47
	7					60 00 0F 08	... Index E48 ... E55
	8					60 00 10 08	... Index E56 ... E63

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Index (hex)	Sub-index	Designation	Type	Attr.	Map.	Values (hex)	Explanation
3101	0	Module Identity Device 1	U8	ro	—	16	Number of entries
	1						Process data: Number of inputs in bytes
	2						Process data: Number of outputs in bytes
	3		U16				Manufacturer ID
	4		U32				Device ID
	5		U16				Function ID
	6		Str.				Manufacturer name
	7						Manufacturer URL
	8						Product name
	9						Part no.
	10						Product text
	11						Serial number
	12						Hardware revision
	13						Software revision
	14		U8	rw			Slave Attribute (I-Port)
	15					Extended parameters dependent on the connected device (see product description)	
	16		U16				Diagnosis types

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Index (hex)	Sub-index	Designation	Type	Attr.	Map.	Values (hex)	Explanation
3102	0	Module Identity Device 2	U8	ro	—	16	Number of entries
	1						Process data: Number of inputs in bytes
	2						Process data: Number of outputs in bytes
	3		U16				Manufacturer ID
	4		U32				Device ID
	5		U16				Function ID
	6		Str.				Manufacturer name
	7						Manufacturer URL
	8						Product name
	9						Part no.
	10						Product text
	11						Serial number
	12						Hardware revision
	13						Software revision
	14		U8	rw			Slave Attribute (I-Port)
	15					Extended parameters dependent on the connected device (see product description)	
	16		U16			Diagnosis types	
3301	0	Parameter Device 1	U8	ro	—	8	Number of entries
	1 ... 8		U8	rw			Parameter byte 1 ... Parameter byte 8 (Use dependent on the connected device, see product description)

A. Technical appendix

Index (hex)	Sub-index	Designation	Type	Attr.	Map.	Values (hex)	Explanation
3302	0	Parameter Device 2	U8	ro	–	8	Number of entries
	1 ... 8		U8	rw	–		Parameter byte 1 ... Parameter byte 8 (Use dependent on the connected device, see product description)
6000	0	Digital Inputs (available in EDS)	U16	ro	–	4	Number of input registers
	1 ... 16			ro	Yes	Xx	<u>Read</u> Input 16 Bytes Input 1 ... 16 (Sequence dependent on standard mapping or individual mapping)
6200	0	Digital Outputs (available in EDS)	U16	ro	–	4	Number of outputs
	1 ... 16			ro	Yes	Xx	<u>Write</u> Output 16 Bytes Output 1 ... 16 (Sequence dependent on standard mapping or individual mapping)

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