EtherNet/IP

CPC20EN *ControlPlex*® CONTROLLER

Instruction manual

E-T-A®
ENGINEERING TECHNOLOGY

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CONTENTS

1 GENERAL INFORMATION

1.1 Safety Instructions

This manual points out possible danger for your personal safety and gives instruction how to avoid property damage. The following safety symbols are used to draw the reader's attention to the safety instructions included in this manual.

DANGER!
Danger to life and limb unless the following safety precautions are taken.

WARNING!
Danger to machinery, materials or the environment unless the following safety precautions are taken.

NOTE!
Information is provided to allow a better understanding.

CAUTION!
Electrostatically sensitive devices (ESD). Devices must exclusively be opened by the manufacturer.

DISPOSAL GUIDELINES
Packaging can be recycled and should generally be brought to re-use.

1.2 Qualified Personnel

This user manual must exclusively be used by qualified personnel, who are able - based on their training and experience - to realise arising problems when handling the product and to avoid related hazards. These persons must ensure that the use of the product described here meets the safety requirements as well as the requirements of the presently valid directives, standards and laws.

1.3 Use

The product is part of a continuous enhancement process. Therefore, there might be deviations between the product in hand and this documentation. These deviations will be remedied by a regular review and resulting corrections in future editions. The right to make changes without notice is reserved. Errors and omissions excepted.

1.4 Delivery State

The product is supplied with a defined hardware and software configuration. Any changes in excess of the documented options are not permitted and lead to liability exclusion.

2 GENERAL DESCRIPTION

The requirements for transparency and flexibility in industrial applications are becoming higher and higher. The modern world of automation meets these demands with its interconnected components and communication capabilities across different company levels. The focus is not only on control systems and computer solutions, but also increasingly on the monitoring of individual components and processes. The intelligent and fieldbus-compatible ***ControlPlex***® power distribution system is designed for this area. It is used to protect industrial applications and to monitor and control them. The CPC20 bus controller is the heart of the system. It analyzes the measurement data, reports errors, and transmits this information to the higher-level control systems using standard fieldbus systems.

The CPC20 is designed as a system in combination with the 18plus module. This consists of a supply module for supplying a maximum of 80 A. Up to 16 connection modules can be connected to this, each of which can be equipped with an electronic circuit breaker with two channels. This provides the user with a maximum of 32 channels for protection.

When using a transfer module, the number of channels can be doubled. This gives the CPC20 a maximum of 64 channels, which it controls with a cycle time of 280 ms. In addition to transmitting the device status, measured values, and device information of the connected components, this also includes changing device-specific parameters such as current and performing actions like switching on and off.

The information can be transferred cyclically or acyclically to the higher-level control system, the Ethernet interface, or to the connected service computer via an existing service interface. If there is no connection to a higher-level control system, this has no effect on the behavior of the connected circuit breakers. The bus controller is able to ensure functionality even without a connection to a higher-level control system. For this purpose the stored parameters are used.

The intelligent power distribution system ***ControlPlex***® offers the renowned quality and safety in the field of overcurrent protection from E-T-A in combination with innovative functions in the field of automation technology.

2.1 Design of the Entire System

The CPC20 bus controller is the centre piece of the ***ControlPlex***® system. It allows consistent communication between the ESX60D electronic circuit protectors and the superordinate control level, connected HMIs and even into the Cloud.

The EtherNet/IP interface to the superordinate control unit is implemented as two RJ45 connectors. It allows connection of the required control unit with the ***ControlPlex***® system, This enables display, analysis as well as diagnosis of the individual measuring values. In addition, it allows control of the individual electronic circuit protectors. An additional Ethernet interface enables direct access of the integral web server of the bus controller. Service staff can thus directly access the system on site. Moreover, access via the connected infrastructure of the company is enables and thus global access. OPC UA and MQTT allow transmission of all measuring values and status information e.g. to a superordinate cloud application, independently of the control system. Revised measuring values of all electronic circuit protectors are also forwarded to the automation system. This enables the user to have unrestricted access to the safety-relevant functions even in the event of an interruption. Any occurring failures will be detected quickly and can be remedied without delay. The ***ControlPlex***® system effectively reduces system downtimes and significantly increases the productivity.

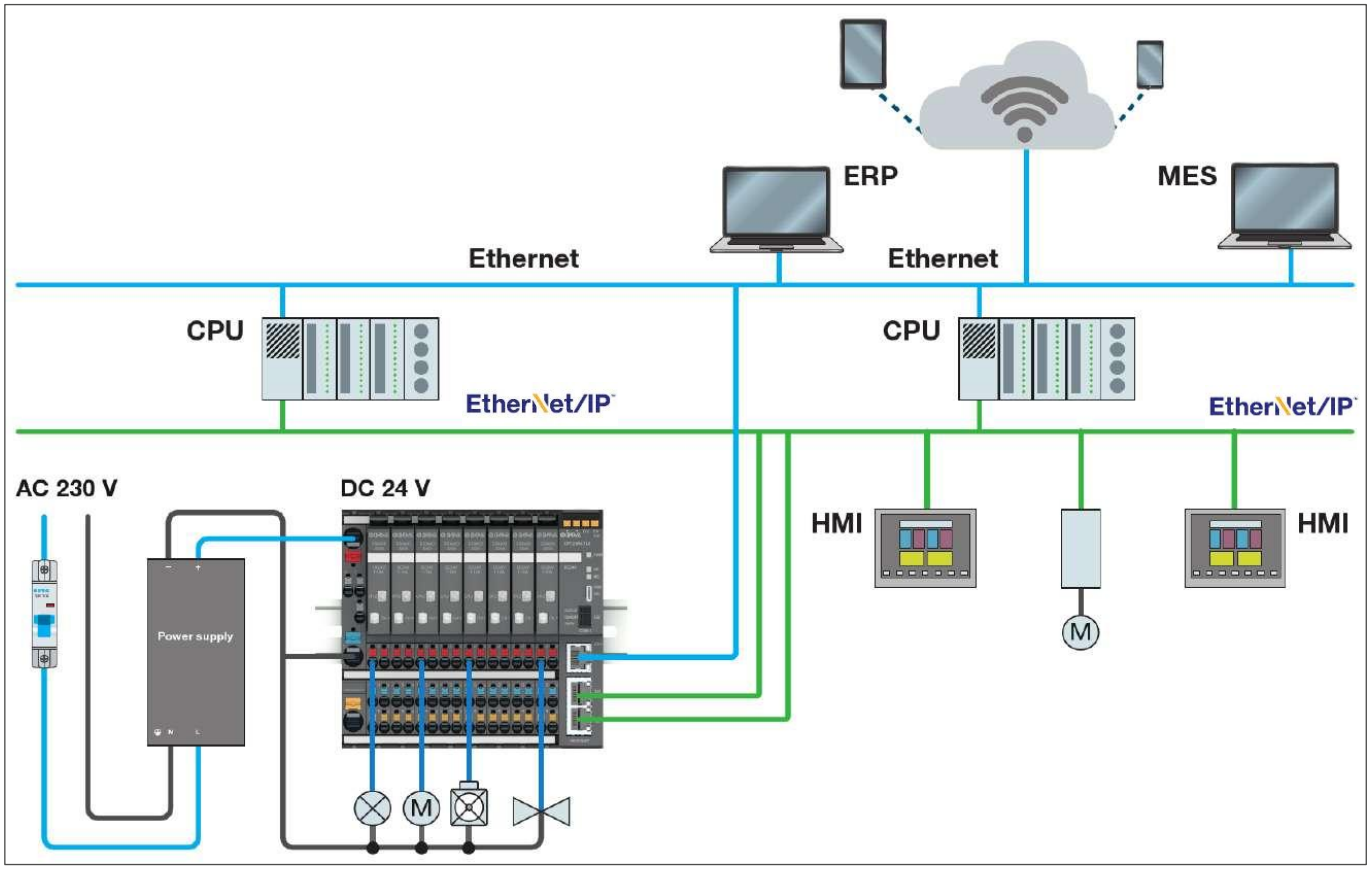

Figure 1: System overview

2.2 Dimensions
Bus controller CPC20

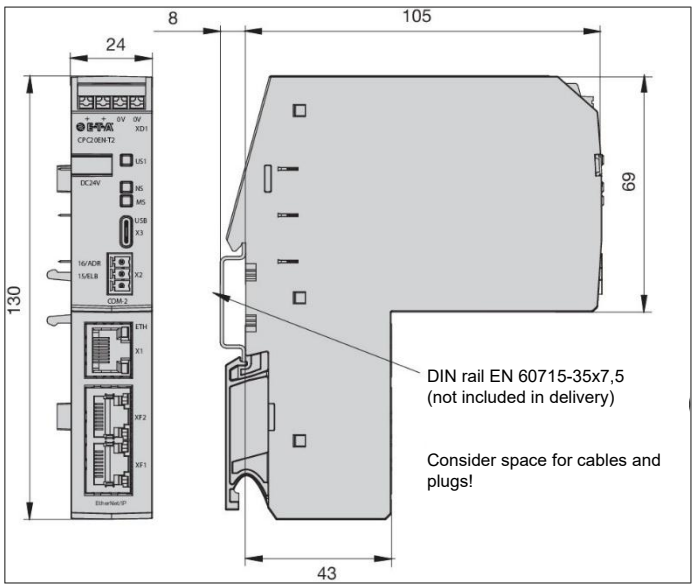

Figure 2: CPC20 dimensions

Supply module 18plus-EM03

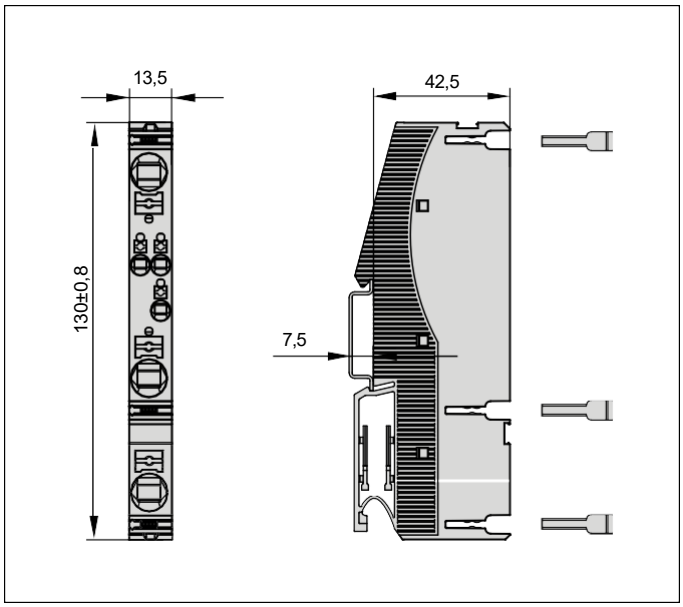

Figure 3: Supply module 18plus-EM03 dimensions

Connection module 18plus-AM03

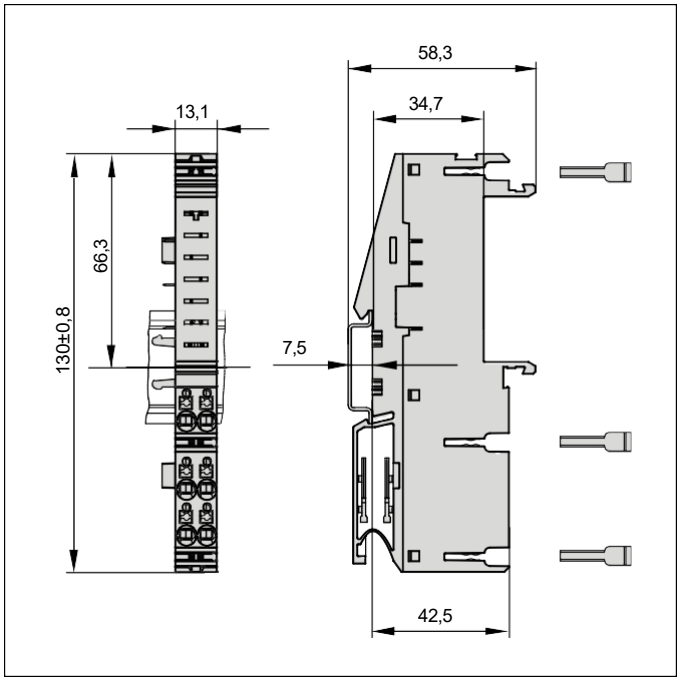

Figure 4: Connection module 18plus-AM03 dimensions

Connection module 18plus-AM03 with ESX60D circuit breaker

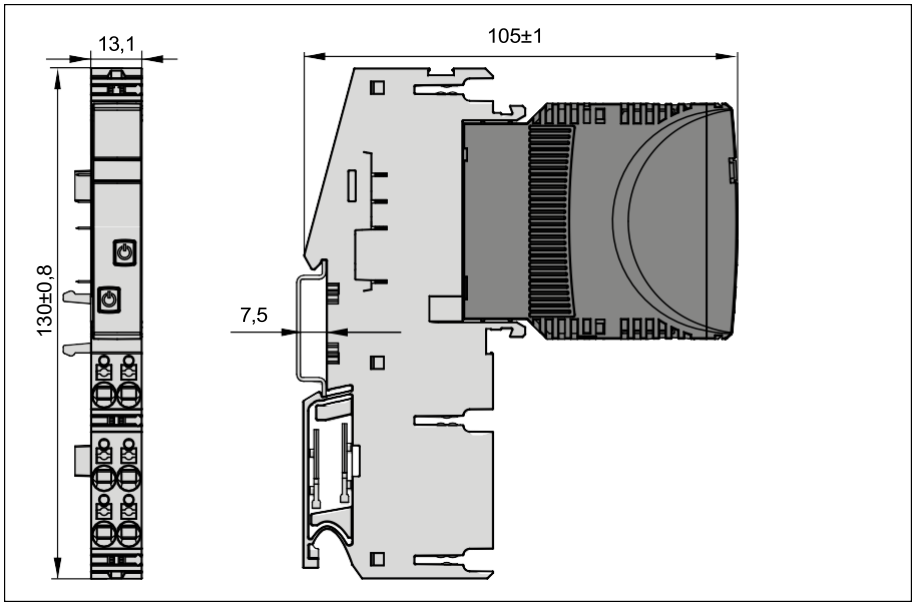

Figure 5: Dimensions of connection module 18plus-AM03 equipped with ESX60D

Transfer module 18plus-TM03

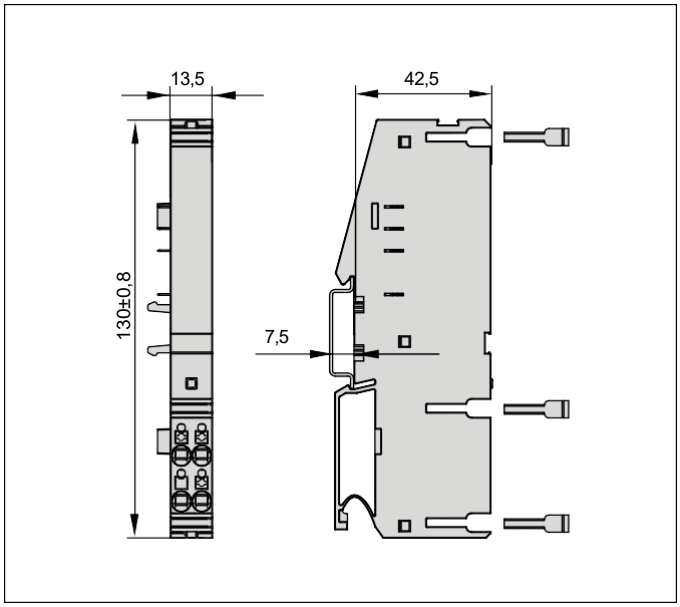

Figure 6: Transfer module 18plus-TM03 dimensions

2.3 Status Indication and Terminals

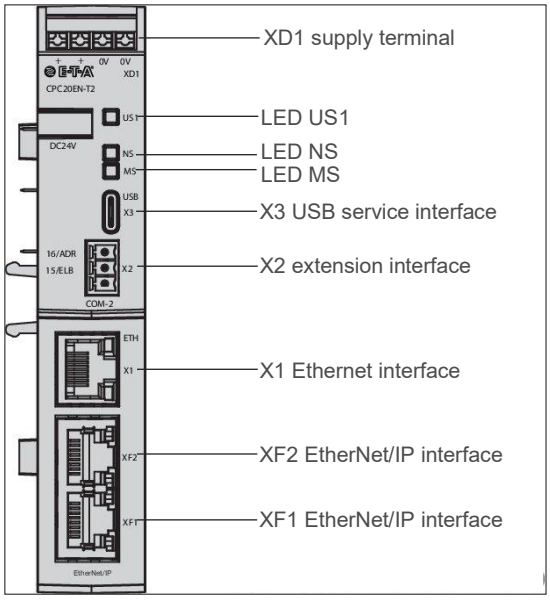

Figure 7: Status indication and terminals CPC20

2.3.1 Terminals for Voltage Supply

XD1 supply

Rated voltage:	DC 24 V (±10 % → 18 ... 30 V)	
Rated current:	typ. 160 mA	
Terminal design:	4 x push-in terminals (+/+/0V/0V)	
	Cable cross section rigid	0,2 – 2,5 mm²
	Cable cross section flexible	0,2 – 2,5 mm²
	Flexible with wire end ferrule (without plastic sleeve)	0,25 – 2,5 mm²
	Flexible with wire end ferrule (with plastic sleeve)	0,25 – 2,5 mm²
	Cable cross section (without plastic sleeve)	AWG24 – AWG14
	Cable cross section (with plastic sleeve)	AWG23 – AWG14
	Stripping length	10 mm

Using a supply voltage outside the indicated operating range can lead to malfunctions or the destruction of the device.

The CPC20 has a direct and fixed connection between the housing shield of the RJ45 sockets (XF1, XF2, and X1) and the 0V of XD1.

2.3.2 USB Service and Maintenance Interface X3

The USB Type C interface is used to connect a service computer with the help of a USB-C to USB-A cable. Firmware updates can be performed using the ***ControlPlex***® Views user software provided. For more information on firmware updates, see chapter 4.6 Operating Mode: Firmware Update Mode.

2.3.3 Expansion Interface X2

The X2 socket on the CPC20 is connected directly to the 18plus-TM03 transfer module using the 3-wire connector.

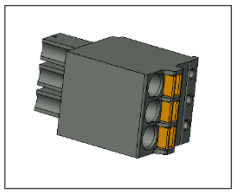

Figure 8: 3-pole terminal strip

The 3-wire connector is the 3-pin terminal strip FK-MCP 1.5/3-ST-3, which is included when ordering the transfer module.

Cable length max. 3 m
Typically H07V-K 1,5 mm²
Push-in terminal 16/ADR: Addressing
Push-in terminal 15/ELB: Data line **ELBus**®

Use of the terminals for applications not provided for in the instruction manual or improper connection can lead to malfunction or destruction of the device.

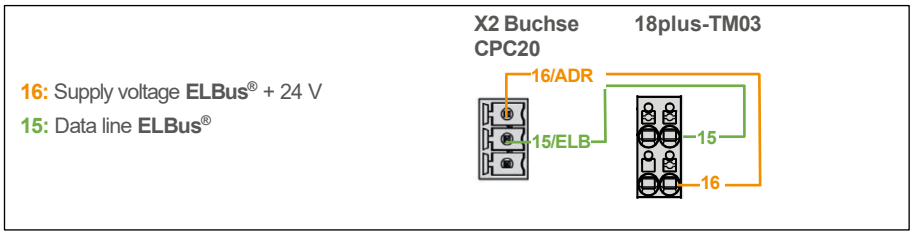

*Figure 9: **ELBus**® connection*

Further information on system expansion via the X2 socket is provided in chapter 3.2 System Installation.

2.3.4 Ethernet Interface, Socket X1

X1 Connection to the CPC20 bus controller and the integrated web server
Type: RJ45

2.3.5 EtherNet/IP Interfaces with Integrated Switch, Sockets XF1, XF2

XF1 Connection to bus system EtherNet/IP
Type: RJ45

XF2 Connection to bus system EtherNet/IP
Type: RJ45

When wiring and connecting to the bus system EtherNet/IP™, the installation and wiring regulations of the EtherNet/IP™ Specification have to be observed.

2.3.6 LED Status Indication

Visual status indication by means of multicoloured LED:

LED US1: Indicates the applied supply voltage
LED NS: Indicates network status
LED MS: Indicates module status

Operating mode	Indication of operating mode		
	LED US1	LED NS	LED MS
Start-up mode	Orange	Orange	Orange
Connect CIP	Green	Green	Green
No IP address	Green	OFF	Blinking green
IP address valid, no CIP connected	Green	Blinking green	Green
System error	n.a.	n.a.	Red
Firmware Update	Blinking red	Blinking red	Blinking red

Figure 10: LED status indication

Optical signalling of the RJ45 interface X1

LED LNK

Operating mode	Indication of operating mode
Link available	Green
No Link available	OFF

LED ACT

Operating mode	Indication of operating mode
Act available	Blinking orange
No Act available	OFF

Figure 11: RJ45 socket X1 LED indication

Optical signalling of the RJ45 interfaces XF1 & XF2

LED LNK

Operating mode	Indication of operating mode
Link available	Green
No Link available	OFF

LED ACT

Operating mode	Indication of operating mode
Act available	Blinking green
No Act available	OFF

Figure 12: RJ45 sockets XF1 & XF2 LED indication

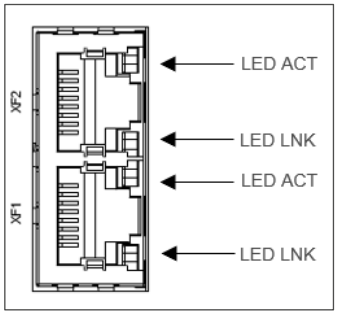

Figure 13: Signalling RJ45 sockets

3 MOUNTING AND INSTALLATION

3.1 Mounting of the System

The preferred mounting position of the ***ControlPlex***® system is horizontal.

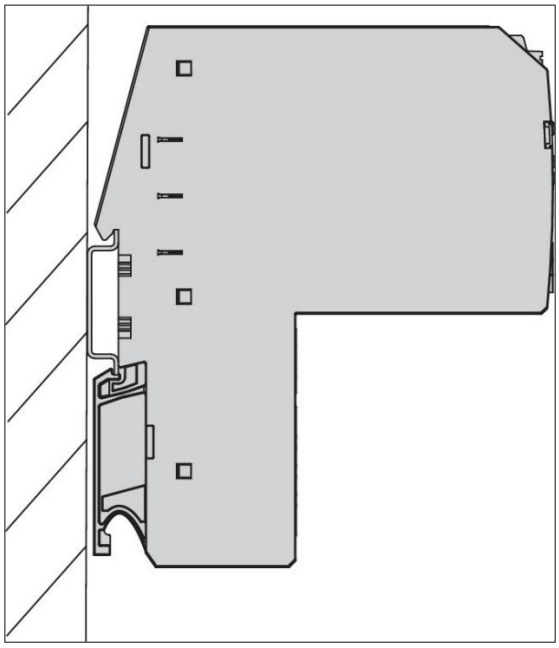

Figure 14: CPC20 installation drawing

3.2 System Installation

Connecting the CPC20 bus controller to the 18plus-TM03 transfer module allows for the addition of 16 circuit breakers, bringing the total to 32 2-channel ESX60D units.
The connection between the CPC20 and the 18plus-TM03 must be done manually.

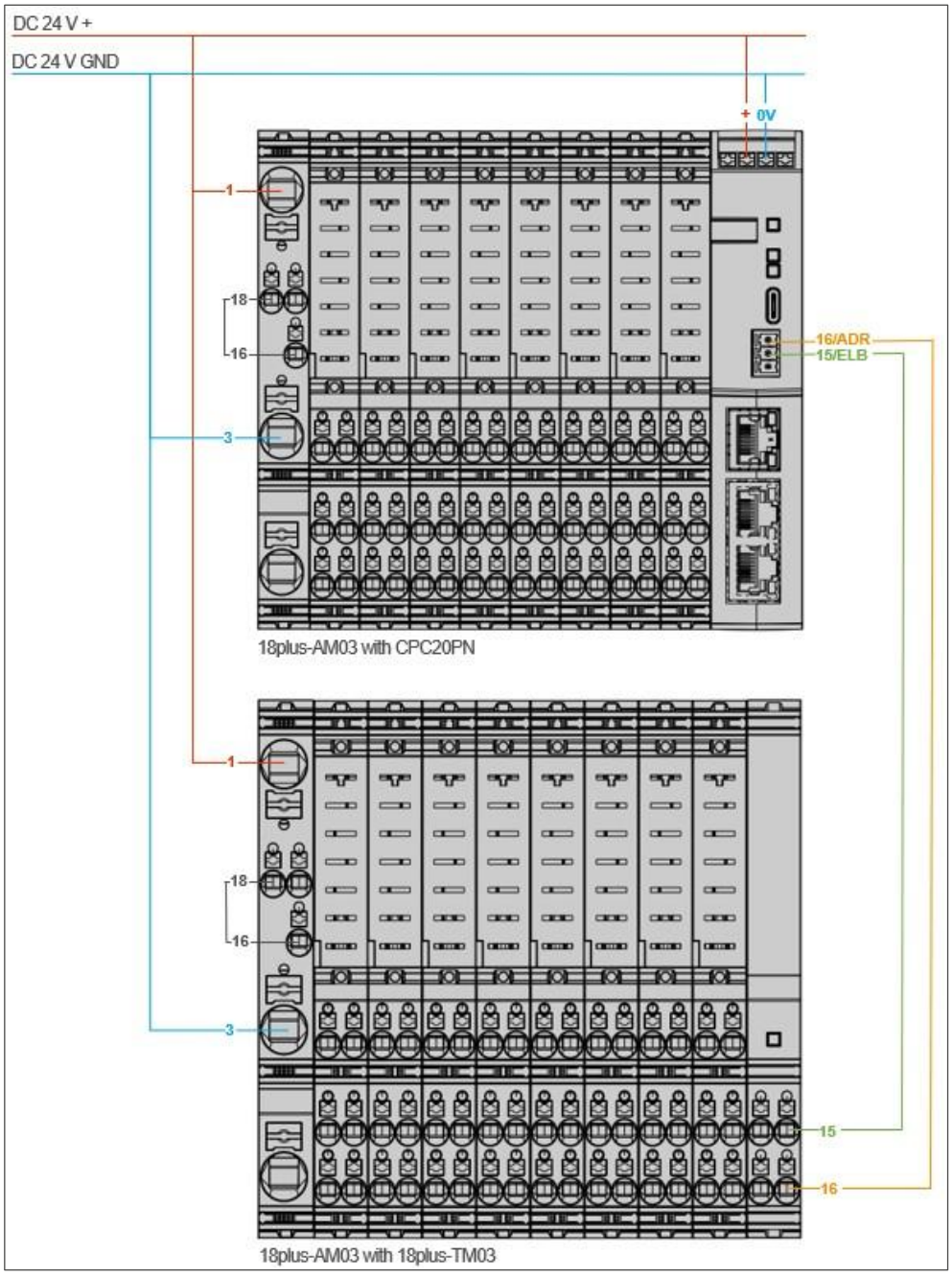

Figure 15: System installation with transfer module 18plus-TM03

4 OPERATING MODES OF THE CPC20 BUS CONTROLLER

Independent of the respective operating mode, the system has a basic safety function. As soon as a circuit protector channel is switched off manually, it cannot be switched on again via the PLC or the web server. The channel must be switched on manually again.

4.1 Operating Mode: Start-Up Mode

The CPC20 bus controller is initialised by applying the supply voltage. The device will carry out implemented programme memory tests and self test routines. During this time a communication via the interfaces is not possible.

4.2 Operating Mode: System Error Mode

If a failure is detected during the self test routines, the bus controller will change into operating mode System Error. This operating mode can only be discontinued by way of re-starting the device and it prevents the data exchange via the interfaces. If the bus controller is in this operating mode, it is unable to control the electronic circuit protectors and these will stay in the stand-alone mode (overcurrent protection).

4.3 Operating Mode: Configuration Error Mode

If there are no valid or invalid configuration data available in the bus controller, it will change into this operating mode. This operating mode only allows non-cyclical data exchange. Cyclical data exchange is prevented. Leave this operating mode upon receipt of the correct slot parameters and configuration data.

4.4 Operating Mode: Standalone Mode

In this operating mode, there is no connection between the bus controller and the higher-level control system. Therefore, the CPC20 bus controller independently takes control of the PLC and the parameterization of the electronic circuit breakers, as it stores all the necessary data records. With the help of the web server, the electronic circuit breakers, their status, and their parameters can be accessed via the Ethernet interface. This makes it possible for example to change parameter data for the various electronic circuit breakers. Once the connection to the higher-level control system has been established, this operating mode is exited and the control system takes over control again as the master. If a parameter was changed during the period when there was no communication, this is reported to the higher-level control system. In this case, the user can define the behavior of the control system accordingly and program it in their programmable logic controller. This allows the user to choose a reaction that is tailored to their needs.

4.5 Operating Mode: Slave Mode

In this operating mode, the CPC20 bus controller is integrated into a EtherNet/IP system. Communication with the CPC20 bus controller functions without errors and it can be addressed and controlled by the higher-level controller. If communication fails, this has no effect on the protective behavior of the circuit breakers. The behavior of the bus controller when using the fieldbus interface and the web server or the USB service and maintenance interface simultaneously can be defined via the configuration of the device in the higher-level controller.
There, you can preselect whether the Ethernet interface or web server is granted read-only rights or read and write rights. If write rights are granted, changes to the parameterization of the electronic circuit breakers can be made in parallel with the fieldbus system. These parameter changes are then communicated to the higher-level control system and can be accepted or overwritten by it. The user can select the behavior accordingly.

4.6 Operating Mode: Firmware Update Mode

The devices are supplied with a software programmed according to their functionality. If the function scope of the devices is extended, the new functions are added via the firmware update. If you want to use the new function, you must carry out a firmware update.

The firmware updates of the bus controller can be downloaded via the integral web server. You can find further information on this in the instruction manual of the web server. The current firmware file is available in the download portal of the ***ControlPlex***® systems via the E-T-A homepage.

DOWNLOAD PORTAL LINK
CONTROLPLEX SYSTEMS

5 BASIC FUNCTIONS OF THE ENTIRE SYSTEM

5.1 Internal Cycle Times

The cycle time of the system depends on the number of slots for the ESX60D electronic circuit breakers.

The amount of data communicated to the higher-level control system can also be selected. This can be achieved by using different data models.
It is therefore possible to either transmit the status, the measured values for the load current and the output voltage of the electronic circuit breaker, or alternatively to send only the status of the circuit breaker to the higher-level control system. This choice between the different data models is made available to the user in the GSDML file of the control system. This is configuration data that is transferred to the PLC with the hardware configuration of the CPC20.

The cycle time per bus when using 16 connection modules 18plus-AM03 is 280 ms for cyclic data.
A window of 70 ms is kept free for acyclic data.
This results in a maximum cycle time of 350 ms.

5.2 Hot Swap of Circuit Protectors

An ESX60D electronic circuit breaker can be plugged into the 18plus-AM03 power distribution module at any time. After the circuit breaker has been inserted, it is automatically parameterized, provided that parameters are available for this slot. The parameters are transferred without interrupting the cyclical data exchange between the CPC20 and the ESX60D electronic circuit breaker.

5.3 About the additional Ethernet Interface

The additional Ethernet interface (X1) extends the functional scope of the bus controller. The following functionalities are provided via this interface.

5.3.1 Web Server

The web server offers the entire scope of measuring data, status information, parameterisation options and control function of the CPC20 bus controller.

5.3.2 Default IP address X1

The default IP address of the CPC20 is:

IP address	192.168.1.1
Netmask	255.255.255.0
Gateway	192.168.1.254

The web server can be accessed via this IP address.

5.3.3 Username and Password

The user must have the necessary access authorisation to be able to carry out configurations via the web server. This authorisation is defined in the user administration.

The default setting is:

Username	admin
Password	admin

It is highly recommended to individually adjust the device settings during the first operation. Please note that it is not possible to automatically reset the user and password to the default settings.

6 COMMUNICATION VIA ETHERNET/IP

EtherNet/IP™ is a network adaption of the Common Industrial Protocol (CIP™) developed by the ODVA organization. CIP uses abstract object modeling to describe the available communication services and data provided by a product. Objects and their components are addressed by an addressing scheme consisting of Node Address (IP-Address), Class Identifier (Class ID), Instance Identifier (Instance ID), Attribute Identifier (Attribute ID) and a Service Code. Assembly objects are used for I/O messages by combining several I/O data into one block.

The IP-Address is typically assigned by a DHCP-server within the network.

6.1 *ControlPlex*® Device Model

Up to two power distribution systems can be connected to the CPC20 controller. They consist of the 18plus-EM-03 supply, the 18plus-AM03 connection modules and for the external system, communication is run via the 18plus-TM03 transfer module. These blocks are purely passive.

The power distribution system ***ControlPlex***® uses the following EtherNet/IP™ model:

EtherNet/IP™	CPC20EN
Class 0x01, 0x06, 0x47, 0xF5, 0xF6	The EtherNet/IP™ interface requires several mandatory objects. These are the identity object (0x01), the connection manager object (0x06), the device level ring object (DLR, 0x47), the TCP/IP interface object (0xF5) and the Ethernet link object (0xF6).
Class 100	Class 100 represents the CPC20EN controller. All system wide information and settings can be accessed through this class. Details are described in chapter 8. The I/O data of the CPC20EN are described in chapter 7.1.
Class 101	Class 101 represents the circuit protectors connected to the CPC20EN on the first power distribution system. All circuit breaker specific information and settings can be accessed through this class. Details are described in chapter 8. The I/O data of each circuit protector contain the control byte, the status byte and measuring values. The process data image of the PLC holds 10 input bytes and 2 output bytes for each circuit protector. Details are described in chapter 7.3. The quantity of cyclically exchanged process data is adjustable. If fewer circuit protectors are connected than configured, the status of the missing circuit protectors is marked as »not available«. If more circuit protectors than configured are connected, these cannot be accessed by the PLC.
Class 102	Class 102 represents the circuit protectors connected to the CPC20EN on the second power distribution system. All circuit breaker specific information and settings can be accessed through this class. Details are described in chapter 8. The I/O data of each circuit protector contain the control byte, the status byte and measuring values. The process data image of the PLC holds 10 input bytes and 2 output bytes for each circuit protector. Details are described in chapter 7.3. The quantity of cyclically exchanged process data is adjustable. If fewer circuit protectors are connected than configured, the status of the missing circuit protectors is marked as »not available«. If more circuit protectors than configured are connected, these cannot be accessed by the PLC.

Figure 16: Device model

6.2 EDS File

The EDS file is provided in the download area of the E-T-A website and can be downloaded there.

6.3 Identity Object (Class ID: 0x01)

The identity object supports only instance 1.
Service codes Get_Attributes_All (1) and Get_Attribute_Single (14) are supported.
Further details are provided by the EtherNet/IP™ Specification

Name	Attribute ID	Data type	Description
Vendor ID	1	UINT	Vendor identification
Device Type	2	UINT	General type of product
Product Code	3	UINT	Product code of vendor
Revision	4	USINT, USINT	Revision of the item
Status	5	WORD	Summary status of device
Serial Number	6	UDINT	Serial number of device
Product Name	7	SHORT_ STRING	Profile ID
Active Language	11	STRUCT of: USINT USINT USINT	Active language
Supported Language List	12	ARRAY of: STRUCT of: USINT USINT UISNT	List of all supported languages

Figure 17: Identity object attributes

6.4 TCP/IP Interface Object (Class ID: 0xF5)

The TCP/IP interface object supports only instance 1.
Service codes Get_Attributes_All (1), Get_Attribute_Single (14) and Set_Attribute_Single (16) are supported.
Further details are provided by the EtherNet/IP™ Specification.

Name	Attribute ID	Data type	Description
Status	1	DWORD	Status Interface
Configuration Capability	2	DWORD	Interface capability flags
Configuration Control	3	DWORD	0 = Statically-assigned IP configuration 1 = IP-configuration via BOOTP 2 = IP-configuration via DHCP
Physical Link Object	4	STRUCT	Path to physical link object
Interface Configuration: **IP Address,** **Network Mask,** **Gateway Address,** **Name Server,** **Name Server 2,** **Domain Name**	5	STRUCT of: UDINT, UDINT, UDINT, UDINT, UDINT, STRING	IP-configuration
Host Name	6	STRING	Host name
TTL Value	8	USINT	TTL Value for EtherNet/IP multicast packets
Mcast Config	9	STRUCT of: USINT USINT UINT UDINT	IP multicast configuration
Encapsulation inactivity time-out	13	UINT	Number of seconds of inactivity before a TCP connection is closed. 0: Disabled

Figure 18: TCP/IP interface object attributes

7 CYCLICAL I/O DATA

EtherNet/IP™ provides the exchange of cyclical process data from an originator (e.g. PLC) to the target (CPC20EN) O→T and vice versa T→O. The number of exchanged I/O data bytes can be varied.
The Forward_Open request to the connection manager initiates the I/O communication and determines the requested packet interval (RPI), the priority, the data size and the connection path. Valid RPI range for the CPC20EN is between 1 ms and 1000 ms. One exclusive owner, one listen only and one input only connection is supported simultaneously.The O→T connection includes a Run/Idle Header which account for the first 4 bytes.
The O→T assembly (100) data size is adjustable between 0 and 64 bytes.
The T→O assembly (101) data size is adjustable between 0 and 326 bytes.
The connection path must be set to 0x20 04 24 00 2C 64 2C 65 because no configuration assembly is used.

If you plan not to use the maximum configuration, the system will always start to cut off last bytes. That means that 32nd channel of the second **ELBus®** Board will always be the first one to be cut off. So it is impossible to receive data of the second **ELBus®** Board without receiving all data of the first **ELBus®** Board.

7.1 I/O Data Input: CPC20 Controller

Originator→Target bytes 0 … 1
The 2 input bytes contain the following global error and diagnostic messages.

	Byte	Type	Range	Description
Status controller	0 HighByte 1 LowByte	Word	0xFFFF	Bit0 = No configuration data available Bit1 = Invalid configuration data Bit2 = Reserve Bit3 = Reserve Bit4 = Command buffer overflow Bit5 = Reserve Bit6 = Reserve Bit7 = no communication with at least one 18plus-Board Bit8 = Reserve Bit9 = CPC temporary error Bit10 = CPC hardware error Bit11 = Reserve Bit12 = Reserve Bit13 = Reserve Bit14 = Reserve Bit15 = Reserve

Figure 19: Cyclical diagnostic data CPC20

7.2 I/O Data Input: Total Current

Originator→Target bytes 2 … 3 (**ELBus®** Board 1)
Originator→Target bytes 164 … 165 (**ELBus®** Board 2)
The total current supplies a standardized 16-bit value with the calculated total current of all circuit protectors (2 byte input data).

The measuring value is indicated as follows:

	Byte	Type	Range	Description
Total current	0 HighByte 1 LowByte	UInt16	0 … 65535	A standardised 16-bit-value with a resolution of 10 mA is made available. Example for calculation of the measuring value: value (1320)/ 100 ≙ 13.20 Amps

Figure 20: Total current

7.3 I/O Data Input: Circuit Protectors

Originator→Target bytes 4 … 163 (**ELBus®** Board 1)
Originator→Target bytes 166 … 325 (**ELBus®** Board 2)
Each circuit protector has up to two channels. The input and output data are always transmitted for both possible channels.
10 bytes input data are exchanged for each circuit breaker containing the status of the channel, the load current and the load voltage.

Design of the input bytes per circuit protector is as follows:

	Byte	Type	Range	Description
Status channel 1	0	Byte	0…255	0xFF (255) ≙ no device available or wrong configuration bit 0 = load output ON bit 1 = short circuit bit 2 = overload bit 3 = low voltage bit 4 = reserve bit 5 = reserve bit 6 = limit value current bit 7 = event / or button pressed »True« means the status is active.
Load current channel 1	1 HighByte 2 LowByte	UInt16	0 … 65535	A standardised 16-bit-value with a resolution of 10 mA is made available. Example for calculation of the measuring value: value (150)/100 ≙ 1.50 Amps
Load voltage way 1	3 HighByte 4 LowByte	UInt16	0 … 65535	A standardised 16-bit-value with a resolution of 10 mV is made available. Example for calculation of the measuring value: value (2512)/100 ≙ 25.12 Volt

	Byte	Type	Range	Description
Status channel 2	5	Byte	0 … 255	0xFF (255) ≙ no device available, wrong configuration or 1-channel device used bit 0 = load output ON bit 1 = short circuit bit 2 = overload bit 3 = low voltage bit 4 = reserve bit 5 = reserve bit 6 = limit value current bit 7 = event / or button pressed »True« means the status is active.
Load current channel 2	6 HighByte 7 LowByte	UInt16	0 … 65535	A standardised 16-bit-value with a resolution of 10 mA is made available. Example for calculation of the measuring value: value (150)/100 ≙ 1.50 Amps
Load voltage way 2	8 HighByte 9 LowByte	UInt16	0 … 65535	A standardised 16-bit-value with a resolution of 10 mV is made available. Example for calculation of the measuring value: value (2512)/100 ≙ 25.12 Volt

Figure 21: Input data circuit protector

7.4 Output Data: Circuit Protectors

Target→Originator bytes 0 … 31 (ELBus Board 1)
Target→Originator bytes 32 … 63 (ELBus Board 2)
2 bytes output data are exchanged controlling the circuit protector.

Design of the output byte per circuit protector slot is as follows (control circuit protector):

	Byte	Type	Range	Description
Control channel 1	0	Byte	0…255	bit 0 = Load output ON/OFF bit 1 = Reset load output (only responds to rising edge 0 -> 1) bit 2 = Reserve bit 3 = Reserve bit 4 = Reserve bit 5 = Reserve bit 6 = Reserve bit 7 = Enable for cyclic commands »True« means the status is active.
Control channel 2	1	Byte	0…255	bit 0 = Load output ON/OFF bit 1 = Reset load output (only responds to rising edge 0 -> 1) bit 2 = Reserve bit 3 = Reserve bit 4 = Reserve bit 5 = Reserve bit 6 = Reserve bit 7 = Enable for cyclic commands »True« means the status is active.

Figure 22: Output data circuit protector

Sample configuration:

1)
8 pcs. 18plus-AM03 connection modules are connected directly to the CPC20EN, this results in 16 channels connected to the first **ELBus®** board.
The O→T data size can be configured to 84 input bytes and 16 bytes T→O data is provided.

Addressing of the output data is corresponding to the ESX sequence.
circuit protector 1, **ELBus®** board 1: channel 1.1 control input byte address[0]
circuit protector 1, **ELBus®** board 1: channel 1.2 control input byte address[1]
circuit protector 2, **ELBus®** board 1: channel 2.1 control input byte address[2]
circuit protector 2, **ELBus®** board 1: channel 2.2 control input byte address[3]
circuit protector 3, **ELBus®** board 1: channel 3.1 control input byte address[4]

……

Addressing of the input data is corresponding to the ESX sequence.
Status controller: address [0..1],
total current **ELBus®** board 1: address[2..3]
circuit prot. 1, **ELBus®** board 1: channel 1.1 status: address [4], load current: address [5..6], load voltage: address [7..8]
circuit prot. 1, **ELBus®** board 1: channel 1.2 status: address [9], load current: address [10..11], load voltage: address [12..13]
circuit prot. 2, **ELBus®** board 1: channel 2.1 status: address [14], load current: address [15..16], load voltage: address [17..18]
circuit prot. 2, **ELBus®** board 1: channel 2.2 status: address [15], load current: address [19..20], load voltage: address [21..22]

……

2)
8 pcs. 18plus-AM03 connection modules are connected directly to the CPC20EN, this results in 16 channels connected to the first **ELBus®** board.
8 pcs. 18plus-AM03 connection modules are connected to the second **ELBus®** port of the CPC20EN, this results in 16 channels connected to the second **ELBus®** board.
The O→T data size can be configured to 244 input bytes and 48 bytes T→O data is provided.

Addressing of the output data is corresponding to the ESX sequence.
circuit protector 1, **ELBus®** board 1: channel 1.1 control input byte address[0]
circuit protector 1, **ELBus®** board 1: channel 1.2 control input byte address[1]
circuit protector 2, **ELBus®** board 1: channel 2.1 control input byte address[2]

……

circuit protector 16, **ELBus®** board 1: channel 32.2 control input byte address[31]
circuit protector 1, **ELBus®** board 2: channel 1.1 control input byte address[32]
circuit protector 1, **ELBus®** board 2: channel 1.2 control input byte address[33]

……

circuit protector 8, **ELBus®** board 2: channel 8.2 control input byte address[47]

Addressing of the input data is corresponding to the ESX sequence.
Status controller: address [0..1],
total current: address[2..3]
circuit prot. 1, **ELBus®** board 1: channel 1.1 status: address [4], load current: address [5..6], load voltage: address [7..8]
circuit prot. 1, **ELBus®** board 1: channel 1.2 status: address [9], load current: address [10..11], load voltage: address [12..13]
circuit prot. 2, **ELBus®** board 1: channel 2.1 status: address [14], load current: address [15..16], load voltage: address [17..18]

……

circuit prot. 16, **ELBus®** board 1: channel 32.2 status: address [159], load current: address [160..161], load voltage: address [162..163]
total current **ELBus®** board 2: address[164..165]
circuit prot. 1, **ELBus®** board 2: channel 1.1 status: address [166], load current: address [167..168], load voltage: address [169..170]
circuit prot. 1, **ELBus®** board 2: channel 1.2 status: address [171], load current: address [172..173], load voltage: address [174..175]

…….

circuit prot. 8, **ELBus®** board 2: channel 8.2 status: address [201], load current: address [202..203], load voltage: address [204..205]

8 NON-CYCLICAL DATA

Explicit EtherNet/IP™ messages services allow exchange of further data with the CPC20 controller and the circuit protectors. EtherNet/IP™ Class, Instance and Attribute are required. For reading and editing controller data, Class 100 is used. Class 101 is used for reading and editing the data of the circuit protectors on the first **ELBus®** board. Class 102 is used for reading and editing the data of the circuit protectors on the extension board.

The index is set up as follows:

Class ID	Instance ID	Attribute ID	Number of Data Bytes	Reading (R) Writing (W)	Description
100	1	1	19	R	Device information of CPC20 controller (see chapter 8.1.1)
100	1	3	9	R/W	Configuration data of CPC20 controller (see chapter 8.1.2)
100	1	4	1	W	Action commands for all channels and the CPC20 controller (see chapter 8.1.3)
100	1	2	4	R	Dynamic information of CPC20 controller (see chapter 0)

Figure 23: CPC20 object attributes

The non-cyclical access to the data of circuit protectors and/or channels is divided as follows:

Class ID	Instance ID	Attribute ID	Number of Data Bytes	Reading (R) Writing (W)	Description
101 ... 102	01 … 32	3	8	R/W	Device parameters of a channel (see chapter 8.2.1)
101 ... 102	01 … 32	1	19	R	Device information of a channel (see chapter 8.2.2)
101 ... 102	01 … 32	6	2	R/W	Configuration data of a channel (see chapter 8.2.3)
101 ... 102	01 … 32	5	1	R	Event message of a channel (see chapter 8.2.4)
101 ... 102	01 … 32	4	1	W	Action commands for a channel (see chapter 8.2.5)
101 ... 102	01 … 32	2	22	R	Diagnosis data of a channel (see chapter 8.2.6)
101 ... 102	01 … 32	7	800	R	History data of a channel (see chapter 8.2.7)

Figure 24: Channel object attributes

8.1 CPC20 Controller

The non-cyclical parameters of the controller are described in the following chapters.

8.1.1 CPC20 Controller Device Information

The device information of the controller consists of 19 bytes.
Class ID = 100, Instance ID = 1 and Attribute ID = 1
Service Code: Get_Attribute_Single (14)
All device information with possible conditions are described in the following table.

	Byte	Type	Range	Description
Device Type	0 HighByte 1 LowByte	UInt16	0 … 65535	16406 = CPC20PN-T2 16470 = CPC20EN-T2 This list may be extended by future controllers.
Hardware version	2 HighByte 3 LowByte	UInt16	0 ... 65535	Contains the hardware version of the installed product
Internal assembly order numbers	4 HwHb 5 HwLB 6 LwHB 7 LwLB	UInt16	0 ... 4294967295	Contains the assembly order number of the installed product
Internal order number	8 HighByte 9 LowByte	UInt16	0 … 65535	Contains the internal order number of the installed product
Production facilities number	10 HighByte 11 LowByte	UInt16	0 … 65535	Contains the production facilities number of the installed product
Serial number	12 HwHb 13 HwLB 14 LwHB 15 LwLB	UInt32	0 ... 4294967295	Contains the serial number of the installed product
Software version (major.x.x)	16	Byte	0 ... 255	Contains the major software version of the installed product
Software version (x.minor.x)	17	Byte	0 ... 255	Contains the minor software version of the installed product
Software version (x.x.build)	18	Byte	0 ... 255	Contains the build software version of the installed product

Figure 25: Device information CPC20

8.1.2 CPC20 Controller Configuration Data

The device configuration data for the controller consists of 17 bytes.
Class ID = 100, Instance ID = 1 and Attribute ID = 3
Service Code: Get_Attribute_Single (14), Set_Attribute_Single (16)
All parameters with possible conditions are described in the following table.

	Byte	Type	Range	Description
Configuration data CPC20	0	Byte	0 … 255	Bit0 = writing via USB or web server. Allows changing of parameters via the interfaces even when the bus connection is active. Bit1 TRUE: In the event of a bus interruption, the status of the load outputs is maintained. FALSE: In the event a bus interruption, all load outputs will be set to the status OFF. Bit2 = power saving mode: the LEDs will be dimmed for power reduction. Bit3 = Reserve Bit4 = Reserve Bit5 = Reserve Bit6 = Reserve Bit7 = Reserve If not described otherwise, “True” means that the function is active.
PLC Lock: Control commands disable ELBus® 1 at the CPC channel 1 ... 16	1 HigByte 2 LowByte	UInt16	0 … 65535	Each bit represents a channel. (Bit0 = channel 1; Bit1 = channel 2 …..) If the bit is set, this means that the channel is not switched on or off via the control unit or the web server.
PLC Lock: Control commands disable ELBus® 1 at the CPC channel 17 ... 32	3 HigByte 4 LowByte	UInt16	0 … 65535	Each bit represents a channel. (Bit0 = channel 17; Bit1 = channel 18 …..) If the bit is set, this means that the channel is not switched on or off via the control unit or the web server.
PLC Lock: Control commands disable ELBus® 2 at the CPC channel 1 ... 16	5 HigByte 6 LowByte	UInt16	0 … 65535	Each bit represents a channel. (Bit0 = channel 1; Bit1 = channel 2 …..) If the bit is set, this means that the channel is not switched on or off via the control unit or the web server.
PLC Lock: Control commands disable ELBus® 2 at the CPC channel 17 ... 32	7 HigByte 8 LowByte	UInt16	0 … 65535	Each bit represents a channel. (Bit0 = channel 17; Bit1 = channel 18 …..) If the bit is set, this means that the channel is not switched on or off via the control unit or the web server.
PLC Lock: Control commands disable ELBus® 3 at the CPC channel 1 ... 16	9 HigByte 10 LowByte	UInt16	0 … 65535	Each bit represents a channel. (Bit0 = channel 1; Bit1 = channel 2 …..) If the bit is set, this means that the channel is not switched on or off via the control unit or the web server.

	Byte	Type	Range	Description
PLC Lock: Control commands disable ELBus® 3 at the CPC channel 17 ... 32	11 HigByte 12 LowByte	UInt16	0 … 65535	Each bit represents a channel. (Bit0 = channel 17; Bit1 = channel 18 …..) If the bit is set, this means that the channel is not switched on or off via the control unit or the web server.
PLC Lock: Control commands disable ELBus® 4 at the CPC channel 1 ... 16	13 HigByte 14 LowByte	UInt16	0 … 65535	Each bit represents a channel. (Bit0 = channel 1; Bit1 = channel 2 …..) If the bit is set, this means that the channel is not switched on or off via the control unit or the web server.
PLC Lock: Control commands disable ELBus® 4 at the CPC channel 17 ... 32	15 HigByte 16 LowByte	UInt16	0 … 65535	Each bit represents a channel. (Bit0 = channel 17; Bit1 = channel 18 …..) If the bit is set, this means that the channel is not switched on or off via the control unit or the web server.

Figure 26: CPC20 configuration data

8.1.3 CPC20 Controller Action Commands

The action commands of the controller consist of 1 byte. All action commands being sent to the CPC20 carry out the action for all channels.
Class ID = 100, Instance ID = 1 and Attribute ID = 4
Service Code: Set_Attribute_Single (16)
All parameters with possible conditions are described in the following table.

	Byte	Type	Range	Description
Action commands	0	Byte	0 ... 255	115 = Reset error memory 118 = Reset device parameters to factory settings including CPC20 192 = Reset statistics minimum values 196 = Reset statistics maximum values 204 = Reset device parameters to factory settings 212 = Switch off load output 216 = Reset load output 200 = Reset trip counter 220 = Reset statistics mean value Other values will not be accepted.

Figure 27: Action commands CPC20

8.1.4 CPC20 Controller Dynamic Information

The dynamic information for the controller consists of 4 bytes.
Class ID = 100, Instance ID = 1 and Attribute ID = 2
Service Code: Get_Attribute_Single (14)

	Byte	Type	Range	Description
Cycle time ELBus® 1	0 HighByte 1 LowByte	UInt16	0 … 65535	Contains the internal cycle time of the ELBus® in milliseconds [ms].
Cycle time ELBus® 2	2 HighByte 3 LowByte	UInt16	0 … 65535	Contains the internal cycle time of the ELBus® in milliseconds [ms].

Figure 28: Dynamic information CPC20

8.2 Circuit Protector Channels

The parameters of the circuit protectors are described in the following chapters. The parameters are organized in channels.

8.2.1 Device Parameters for one Channel

The device parameters for one channel consist of 8 bytes.
Class ID = 101, Instance ID = 1 … 32 and Attribute ID = 3
Service Code: Get_Attribute_Single (14), Set_Attribute_Single (16)
All parameters with possible conditions are described in the following table.

	Byte	Type	Range	Description
Rated current	0	Byte	161…170	Contains the current rating of the channel. With adjustable devices, you can set a new current rating here and transmit with a write command. 161 = 1 A current rating (default value) 162 = 2 A current rating 163 = 3 A current rating 164 = 4 A current rating 165 = 5 A current rating 166 = 6 A current rating 167 = 7 A current rating 168 = 8 A current rating 169 = 9 A current rating 170 = 10 A current rating
Switch-on behaviour	1	Byte	161…163	Defines behaviour when connecting the supply voltage 161 = condition before power off (default value) 162 = off 163 = on
Switch-off after overload	2	Byte	105…135	Here it is determined at what percentage of rated current of the channel overload shall be signalled. The default value is 120 %.
Trip time at overload	3	Byte	0…255	Here it is determined after which period of time in the overload range the load output shall be disconnected. The range is from 50 ms up to 10,000 ms. It is calculated with the factor 50. Example for 3000 ms: Trip time at overload (60) * 50 = 3000 ms The default value is 3000 ms.

	Byte	Type	Range	Description
Trip time under short-circuit conditions	4	Byte	0…255	Here it is determined after which period of time the load output is switched off under short-circuit conditions. The range is from 50 ms to 1,000 ms, calculated using a factor of 10. Example for 100 ms: Trip time at overload (10) * 10 = 100 ms The default value is 400 ms.
ON delay	5	Byte	0…255	This parameter specifies that a channel is not switched on immediately after the supply voltage is applied, but only after a defined period of time. The range is from 50 ms to 2,500 ms, calculated using a factor of 10. Example for 50 ms: Trip time at overload (5) * 10 = 50 ms The default value is 100 ms.
limit value load current	6	Byte	50…100	Determines at which percentage of the current rating of a channel the message »limit value exceeded« (bit in status of cyclical data) is signalled. The range is from 80 % to 100 %. The default value is 80 %.
Hysteresis for the limit value load current	7	Byte	0…255	This parameter determines the hysteresis of the limit value current. The range is from 5 % to 20 %. The default value is 5 %.

Figure 29: Device parameters channel

8.2.2 Device Information for one Channel

The device information for one channel consists of 19 bytes.
Class ID = 101 … 102, Instance ID = 1 … 32 and Attribute ID = 1
Service Code: Get_Attribute_Single (14)

All parameters with possible conditions are described in the following table.

	Byte	Type	Range	Description
Device type	0 HighByte 1 LowByte	Int		36894 = ESX60D This list may be extended by future controllers.
Hardware version	2 HighByte 3 LowByte	Int	0 ... 65535	Contains the hardware version of the installed product
Internal order number	4 HwHb 5 HwLB 6 LwHB 7 LwLB	DInt	0 ... 4294967295	Contains the internal order number of the installed product
Production facilities number	8 HwHb 9 HwLB 10 LwHB 11 LwLB	DInt	0 ... 4294967295	Contains the production facilities number of the installed product
Serial number	12 HwHb 13 HwLB 14 LwHB 15 LwLB	DInt	0 ... 4294967295	Contains the serial number of the installed product

	Byte	Type	Range	Description
Software version (major.x.x)	16	Byte	0 ... 255	Contains the major software version of the installed product
Software version (x.minor.x)	17	Byte	0 ... 255	Contains the minor software version of the installed product
Software version (x.x.build)	18	Byte	0 ... 255	Contains the build software version of the installed product

Figure 30: Device information channel

8.2.3 Configuration Data for one Channel

The configuration data for one channel consist of 2 bytes.
Class ID = 101 … 102, Instance ID = 1 … 32 and Attribute ID = 6
Service Code: Get_Attribute_Single (14), Set_Attribute_Single (16)
All parameters with possible conditions are described in the following table.

	Byte	Type	Range	Description
Device type	0 HighByte 1 LowByte	Word	36894	36894 = ESX60D This list may be extended by future circuit protectors.

Figure 31: Configuration data channel

8.2.4 Event Message for one Channel

The event messages for one channel consist of 1 byte.
Class ID = 101 … 102, Instance ID = 1 … 32 and Attribute ID = 5
Service Code: Get_Attribute_Single (14)
All parameters with possible conditions are described in the following table.

	Byte	Type	Range	Description
Event	0	Byte	0 … 255	bit 0 = Waiting for parameterisation bit 1 = Bar chart available bit 2 = New current rating available bit 3 = Channel off via momentary switch/switch bit 4 = Reserve bit 5 = Reserve bit 6 = Reserve bit 7 = Device error detected »True« means the status is active.

Figure 32: Event messages channel

8.2.5 Action Commands for one Channel

The action commands for one channel consist of 1 byte.
Class ID = 101 … 102, Instance ID = 1 … 32 and Attribute ID = 4
Service Code: Set_Attribute_Single (16)
All parameters with possible conditions are described in the following table.

	Byte	Type	Range	Description
Action commands	0	Byte	0 … 255	117 = Delete bar chart 192 = Reset minimum values 196 = Reset maximum values 200 = Reset trip counter 204 = Reset parameters to factory setting 208 = Switch on load output 212 = Switch off load output 216 = Reset load output 220 = Reset mean values Other values will not be accepted

Figure 33: Action commands channel

8.2.6 Dynamic Information for one Channel

The dynamic information for one channel consist of 22 bytes.
Class ID = 101 … 102, Instance ID = 1 … 32 and Attribute ID = 2
Service Code: Get_Attribute_Single (14)
All parameters with possible conditions are described in the following table.

	Byte	Type	Range	Description
Error memory	0 HighByte 1 LowByte	UInt16	0 … 65535	bit 0 = No parameters available bit 1 = Error parameter memory bit 2 = Error program memory bit 3 = Error data memory bit 4 = Error control unit bit 5 = Reset through watchdog bit 6 = Reserve bit 7 = Reserve bit 8 = Error current sensor bit 9 = Error fail-safe element bit 10 = Reserve bit 11 = Reserve bit 12 = Reserve bit 13 = Reserve bit 14 = Reserve bit 15 = Reserve »True« means the status is active.
Trip counter	2 HighByte 3 LowByte	UInt16	0 … 65535	The number of trippings since the last reset is shown here.
Reason for last trip	4	Byte	0 … 255	0 = No trip 1 = Short circuit 2 = Overload 3 = Device temperature too high 4 = Internal device failure
Min. load voltage	5 HighByte 6 LowByte	UInt16	0 … 65535	Contains the lowest measured voltage of the channel since the last reset. A standardised 16-bit-value with a resolution of 10 mV is made available. Example for calculation of the measuring value: Value (2512): 100 ≙ 25.12 Volt
Max. load voltage	7 HighByte 8 LowByte	UInt16	0 … 65535	Contains the highest measured voltage of the channel since the last reset. A standardised 16-bit-value with a resolution of 10 mV is made available. Example for calculation of the measuring value: Value (2512): 100 ≙ 25.12 Volt
Medium value load voltage	9 HighByte 10 LowByte	UInt16	0 … 65535	Contains the mean voltage value of the channel since the last re-set. A standardised 16-bit-value with a resolution of 10 mV is made available. Example for calculation of the measuring value: Value (2512): 100 ≙ 25.12 Volt
Min. load current	11 High-Byte 12 LowByte	UInt16	0 … 65535	Contains the lowest measured current of the channel since the last reset. A standardised 16-bit-value with a resolution of 10 mA is made available. Example for calculation of the measuring value: Value (150): 100 ≙ 1.50 Ampere

	Byte	Type	Range	Description
Max. load current	13 HighByte 14 LowByte	UInt16	0 … 65535	Contains the highest measured current of the channel since the last reset. A standardised 16-bit-value with a resolution of 10 mA is made available. Example for calculation of the measuring value: Value (150): 100 ≙ 1.50 Ampere
Medium value load current	15 HighByte 16 LowByte	UInt16	0 … 65535	Contains the mean current value of the channel since the last reset. A standardised 16-bit-value with a resolution of 10 mA is made available. Example for calculation of the measuring value: Value (150): 100 ≙ 1.50 Ampere
Supply voltage	17 HighByte 18 LowByte	UInt16	0 … 65535	Shows the operating voltage of the channel. A standardised 16-bit-value with a resolution of 10 mV is made available. Example for calculation of the measuring value: Value (2512): 100 ≙ 25.12 Volt
Device temperature	19 HighByte 20 LowByte	UInt16	0 … 65535	The device temperature is shown directly. Example: 25 corresponds to 25 °C
Diagnostic information of channel	21	Byte	0 … 255	0 = OK 1 = Available device type does not match the configured type 2 = No device detected 144 = Device parameters not plausible 145 = Do bar chart 146 = Slide switch is in OFF position 147 = Detected undervoltage 148 = Detected excess temperature 149 = Reset command required 150 = Command was processed correctly 151 = Parameterisation required 152 = Internal failure detected 153 = Unknown command 154 = Set length error 155 = Rated current available, check sum error 156 = Current rating selector switch was actuated

Figure 34: Dynamic information channel

8.2.7 Histogram for one Channel

The bar chart of a circuit protector contains 400 data sets with the measuring values of load voltage (Uload) and load current (Iload). The measuring values are saved as 8 bit values, i.e. a total of 800 data bytes.

The measuring values are permanently saved in the circuit protector with a frequency of 100 Hz. Recording is stopped with disconnection of the load through short circuit, overload or excess temperature (trip). The bar chart will then contain the measuring values of the last 4 seconds. If for example the trip time at overload is parameterised to be 3 seconds, the measuring values will be saved 1 second before and 3 seconds after overload detection of the circuit protector.

Class ID = 101 … 102, Instance ID = 1 … 32 and Attribute ID = 7 … 10
Service Code: Get_Attribute_Single (14)

Measuring values 1..200 are picked up with attribute 7, the measuring values 201 … 400 with attribute 8, the measuring values 401..600 with attribute 9 and the measuring values 601..800 with attribute 10.

All parameters with possible conditions are described in the following table.

	Byte	Type	Range	Description
Load voltage 1	0	Byte	0…255	The load voltage is calculated as follows: value (148) * 0.2 = 24.864 Volt
Load current 1	1	Byte	0…255	The load current is calculated as follows: (value (151) – 128) * 0.155 = 3.565 Amps
Load voltage 2	2	Byte	0…255	The load voltage is calculated as follows: value (148) * 0.2 = 24.864 Volt
Load current 2	3	Byte	0…255	The load current is calculated as follows: (value (151) – 128) * 0.155 = 3.565 Amps
…	4…197	Byte	0…255	
Load voltage 200	198	Byte	0…255	The load voltage is calculated as follows: value (148) * 0.2 = 24.864 Volt
Load current 200	199	Byte	0…255	The load current is calculated as follows: (value (151) – 128) * 0.155 = 3.565 Amps

Figure 35: Histogram channel

9 APPENDIX

List of Figures

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