CPC20PN *ControlPlex*® CONTROLLER

Instruction manual

ENGINEERING TECHNOLOGY

CONTENTS

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 PROFINET 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.

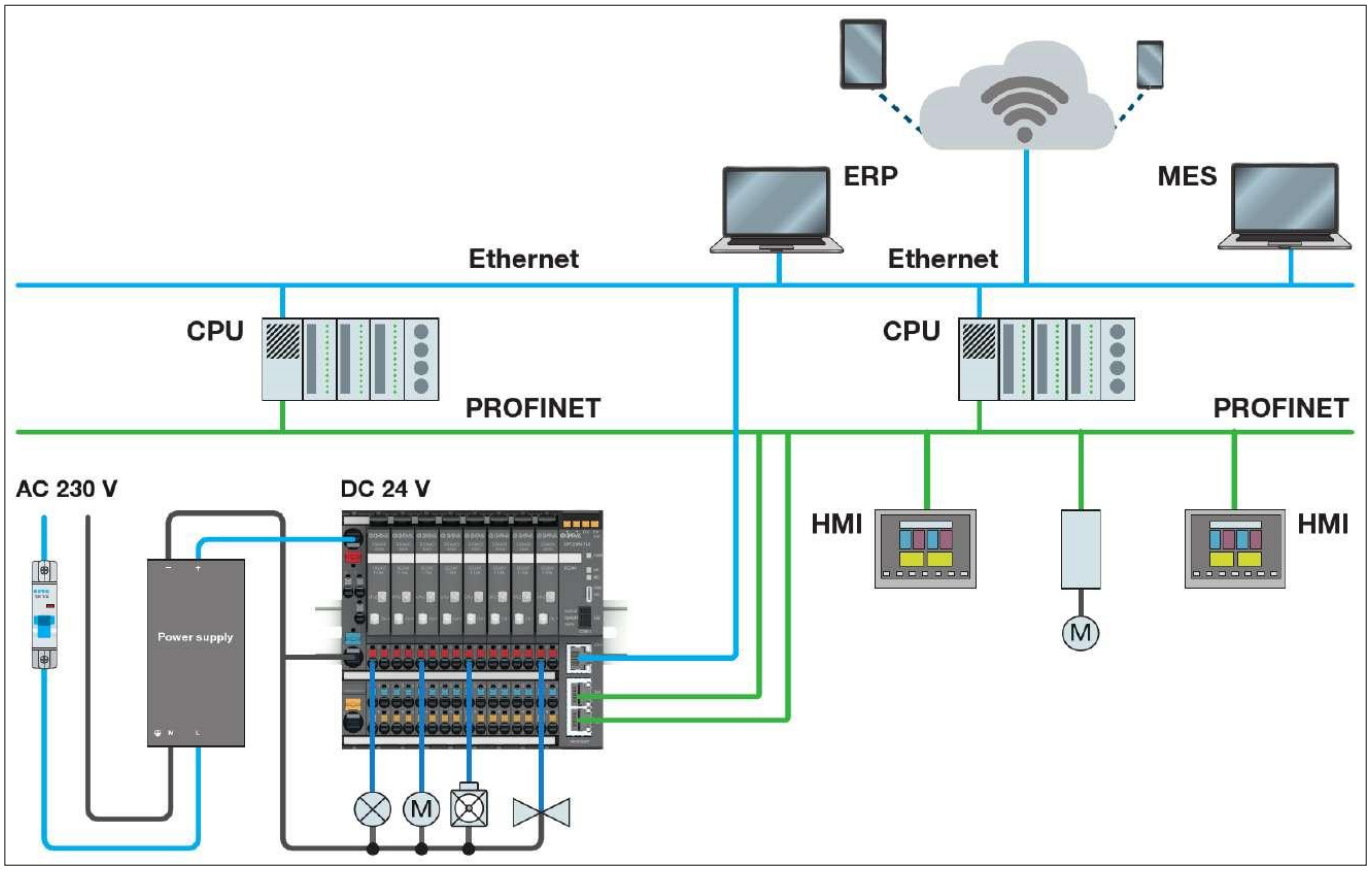


Figure 1: System overview

2.2 Dimensions
Bus controller CPC20

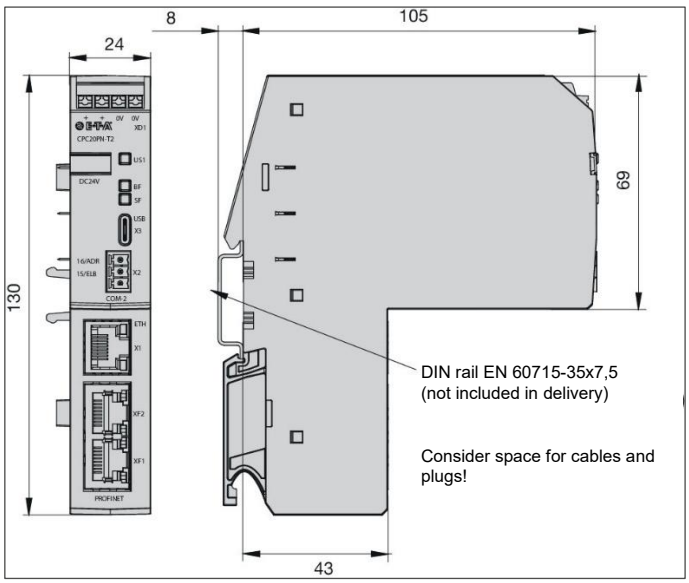


Figure 2: CPC20 dimensions

Supply module 18plus-EM03

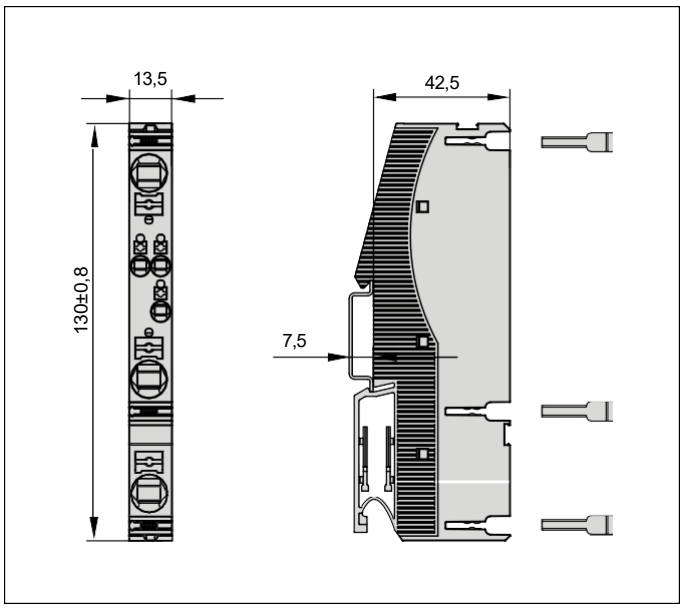


Figure 3: Supply module 18plus-EM03 dimensions

Connection module 18plus-AM03

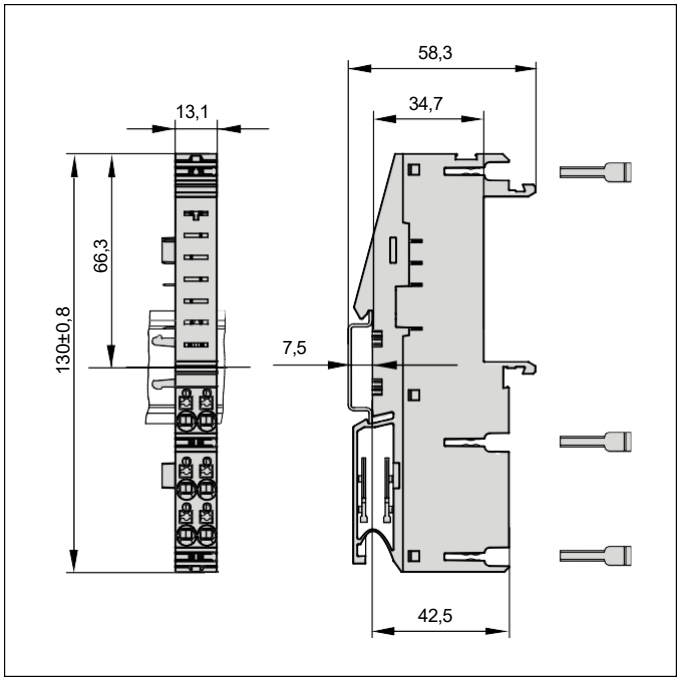


Figure 4: Connection module 18plus-AM03 dimensions

Connection module 18plus-AM03 with ESX60D circuit breaker

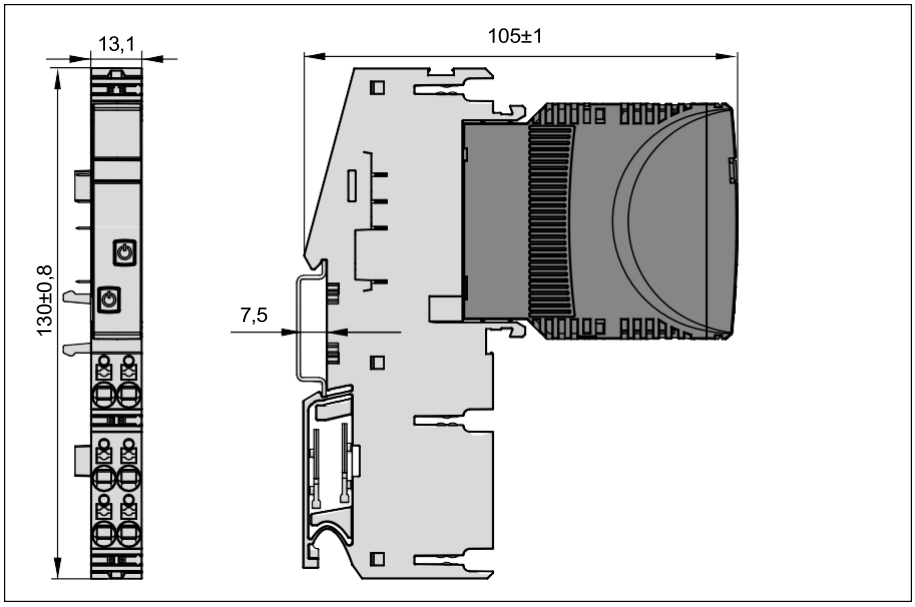


Figure 5: Dimensions of connection module 18plus-AM03 equipped with ESX60D

Transfer module 18plus-TM03

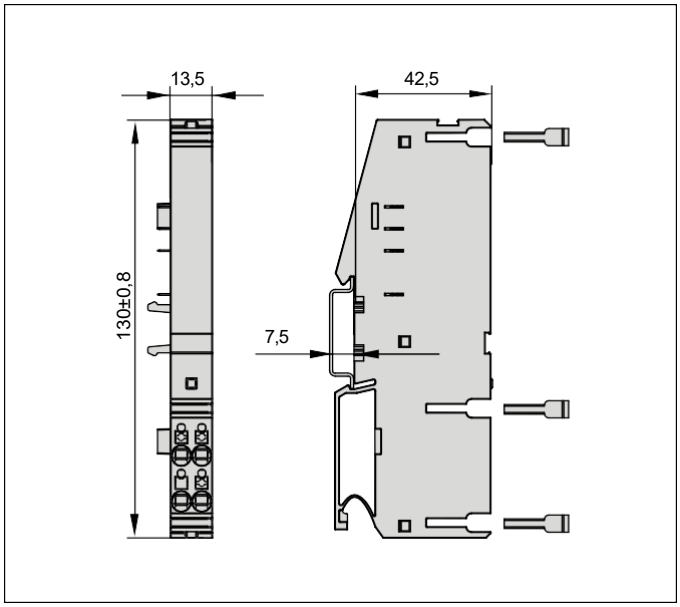


Figure 6: Transfer module 18plus-TM03 dimensions

2.3 Status Indication and Terminals

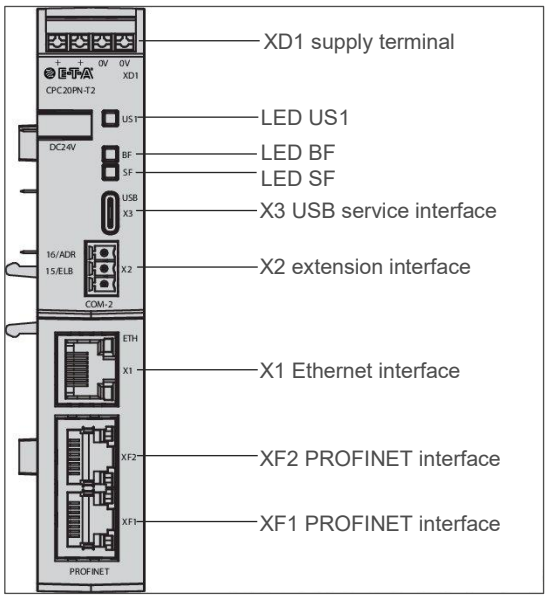


Figure 7: Status indication and terminals CPC20

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.

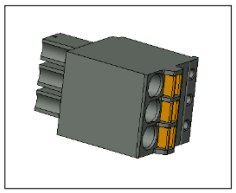


Figure 8: 3-pole terminal strip

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.

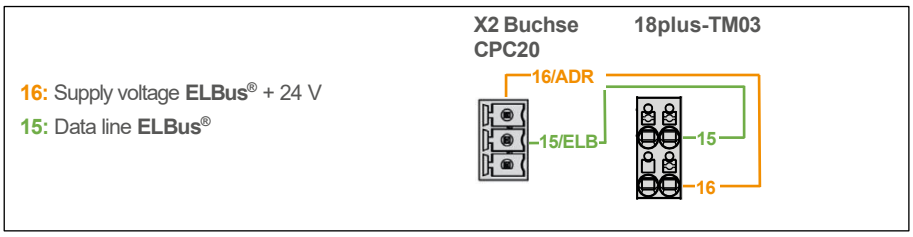


*Figure 9: **ELBus**® connection*

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 PROFINET Interfaces with Integrated Switch, Sockets XF1, XF2

XF1 Connection to bus system PROFINET
Type: RJ45

XF2 Connection to bus system PROFINET
Type: RJ45

When wiring and connecting to the bus system PROFINET the installation and wiring regulations of the PROFIBUS User Organisation (PNO) 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 BF: Indicates bus fault
LED SF: Indicates system fault

Operating mode	Indication of operating mode		
	LED US1	LED BF	LED SF
Start-up mode	Orange	Orange	Orange
Fieldbus fault	Green	Red	OFF
System fault	Green	OFF	Red
Firmware update	Blinking red	Blinking red	Blinking red
PROFINET connection active	Green	OFF	OFF

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
PROFINET device localization	Blinking green

LED ACT

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

Figure 13: RJ45 sockets XF1 & XF2 LED indication

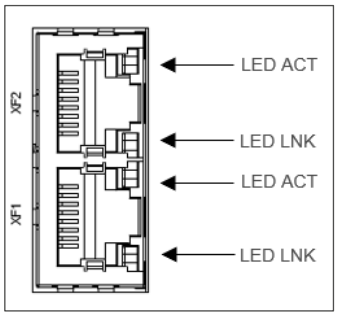


Figure 12: Signalling RJ45 sockets

3 MOUNTING AND INSTALLATION

3.1 Mounting of the System

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

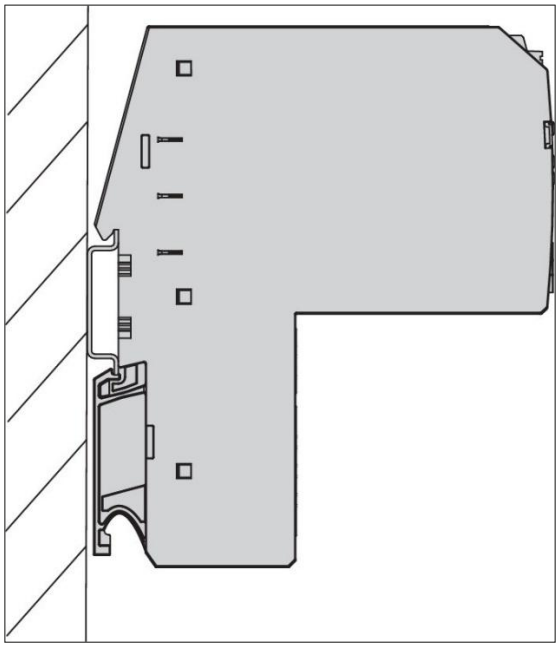


Figure 14: CPC20 installation drawing

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.

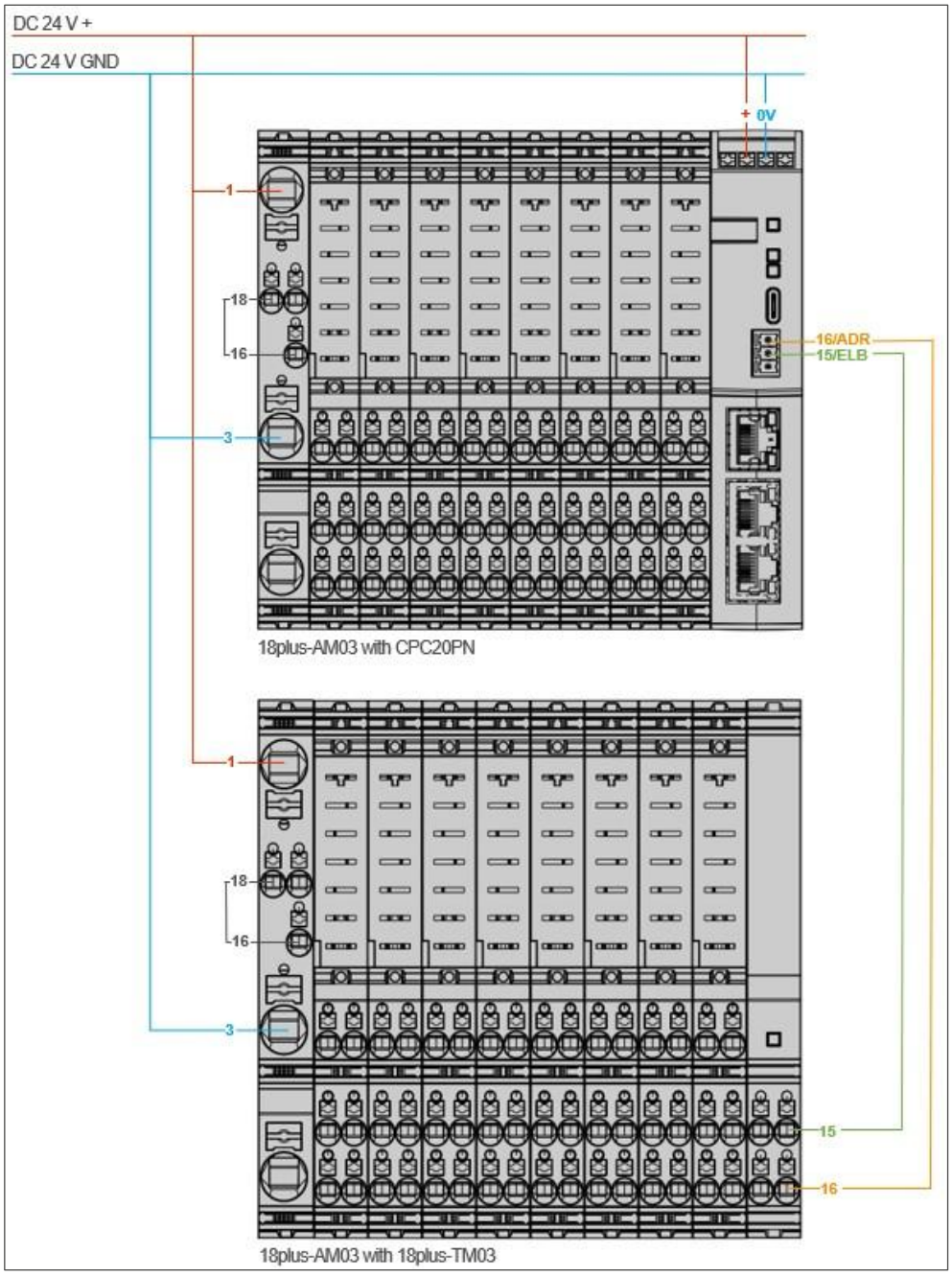


Figure 15: System installation with transfer module 18plus-TM03

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 PROFINET 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 PROFINET

6.1 *ControlPlex*® Device Model

Up to two power distribution systems can be connected to the CPC20 controller. These consist of the 18plus-EM03 supply module, the 18plus-AM03 connection modules, and, in the case of the external system, communication is implemented via the 18plus-TM03 transfer module. These blocks are purely passive. Up to 16 18plus-AM03 connection modules can be configured in slots 2 and 3. The 18plus-AM03 connection modules, which can be connected directly to the CPC20, are configured in slot 2. The 18plus-AM03 connection modules connected to the 18plus-TM03 transfer module are configured in slot 3.

The ***ControlPlex***® power distribution system uses the following PROFINET device model.

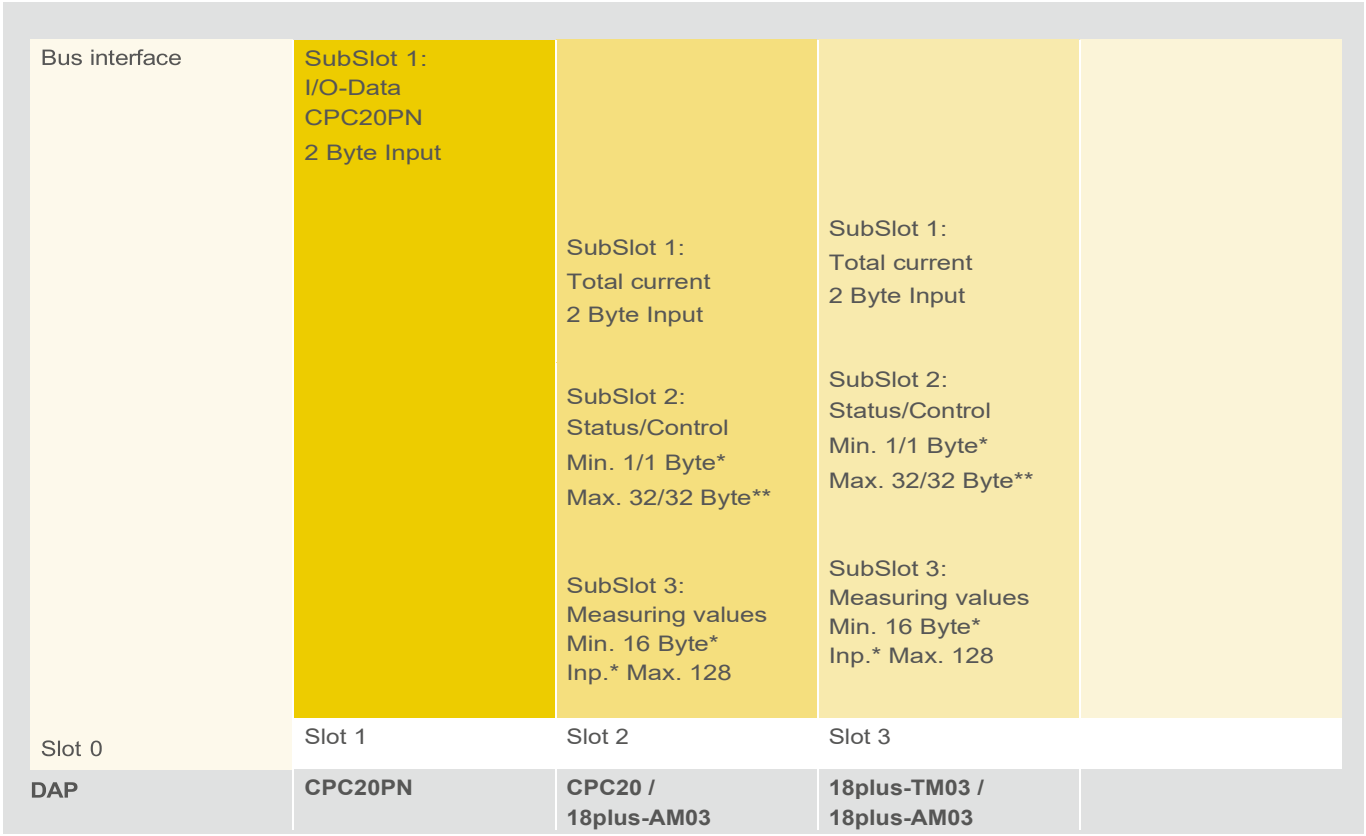


Figure 16: Device model

The CPC20PN controller has the following features:

- The PROFINET interface (DAP). The master communicates with the CPC20PN controller via this interface.
- CPC20PN contains the status of the controller.
- CPC20 / Connection Module 18plus-AM03: It is possible to configure 1 to 16 modules.
- Transfer module 18plus-TM03 / Connection module 18plus-AM03: It is possible to configure 1 to 16 modules.

PROFINET	CPC20PN
Slot 0	Modules are shown here which are required for the PROFINET communication. They do not have to be configured further.
Slot 1	Here are the I/O data of the CPC20 controller. A sub-module with firm I/O assignment has already been »plugged« in this slot. This sub-module contains 2 input and output bytes which are described in more detail in the chapter 7.1 CPC20 Controller I/O Data Module. This slot is firmly installed and cannot be removed.
Slot 2 - 3	 The slots 2-3 correspond to the terminals of the 18plus-AM03 and hold three sub-module slots which can be occupied dynamically by the PLC configuration. The module type is not directly checked, i.e. if 4 x- AM03 modules are »plugged-in« during the project planning stage, but eventually 8 x 18plus modules are connected, this configuration will boot correctly. However, in this case only the first 4 circuit protectors will be included in the cyclical data exchange, the remaining 4 will not be contained in the process data image. The reverse case is equally allowed (8 x 18plus- AM03 module planned, but only 4 x 18plus-AM03 connected. In this case the lacking circuit protectors will be signalled as »not available« in the cyclical process data image).
Subslots 1 - 3	Each module has three subslots: **SubSlot 1:** Total current of all connected channels **SubSlot 2:** Status and control bytes of the circuit protectors **SubSlot 3:** Measuring values of the circuit protectors A corresponding sub-module (from the GSDML file) can be »plugged« into each slot or the slot can remain empty. If the slot remains empty, no cyclical process data will be exchanged for the slot. The quantity of the cyclically to be exchanged process data can be determined via this mechanism (on the level of the number of 18plus modules) depending on the application.

Figure 17: Communication properties

6.2 GSDML File

The GSDML file is located in the download area of the E-T-A homepage and can be downloaded from there.

6.3 I&M Data – Identification & Maintenance

The following I&M data are made available by the CPC20 controller:

I&M Data	Length	Data Set	Meaning	
MANUFACTURER_ID	2 bytes	I&M0	Manufacturer identification	0696h
ORDER_ID	20 bytes	I&M0	Purchase order number	
SERIAL_NUMBER	16 bytes	I&M0	Serial number	
HARDWARE_REVISION	2 bytes	I&M0	Revision index	
SOFTWARE_REVISION	4 bytes	I&M0	Firmware version	
REVISION_COUNTER	2 bytes	I&M0	Revision counter	
PROFILE_ID	2 bytes	I&M0	Profile ID	0000h
PROFILE_SPECIFIC_TYPE	2 bytes	I&M0	Profile-specific coding	0004h
IM_VERSION	2 bytes	I&M0	Version of the I&M data	0101h
IM_SUPPORTED	2 bytes	I&M0	Supported data sets	002Eh
TAG_FUNCTION	32 bytes	I&M1	Clear indication throughout the entire system	
TAG_LOCATION	22 bytes	I&M1	Installation area	
INSTALLATION_DATE	16 bytes	I&M2	Installation date and time YYYY-MM-DD HH:MM	
DESCRIPTOR	54 bytes	I&M3	Comments	

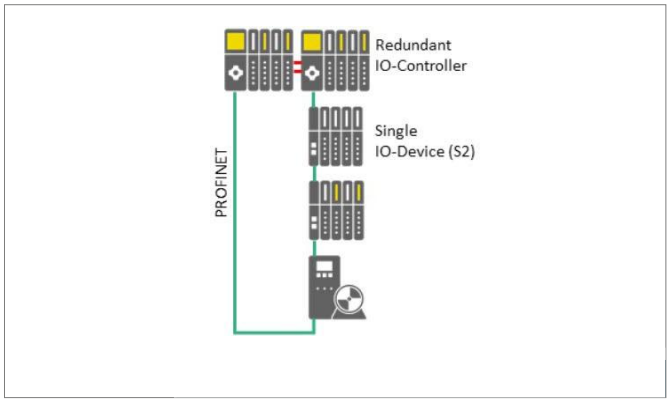
Figure 18: I&M data

6.4 System Redundancy

The CPC20PN bus controller supports the system redundancy S2 and the MRP media redundancy.

6.4.1 S2 System Redundancy

The S2 system redundancy enables a simple communication between the CPC20 and a redundant control. The redundant IO controller is connected at the end of the PROFINET line, see Figure 19. The IO devices provide two connections to this controller, one to the “left”, one to the “right”. One of the two connections is active and connects the IO device to the active part of the redundant IO controller. If the active connection is interrupted or if the active control fails, a quick change to the second connection takes place.



Source: PROFIBUS Nutzerorganisation e. V. (PROFIBUS User Organisation e. V), PROFINET system description - Technology and application, p. 20, fig. 28

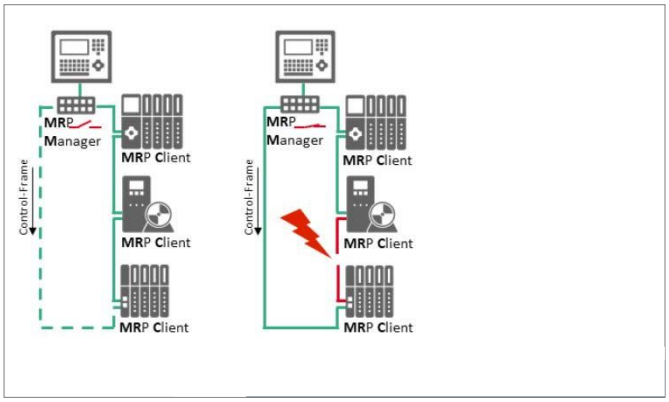
Figure 19: S2 System Redundancy with PROFINET

6.4.2 MRP Media Redundancy

The acronym MRP stands for Media Redundancy Protocol and refers to a PROFINET redundancy function. For this function, the typical time for the new configuration of the communication paths for TCP/IP and RT frames in the event of a failure are below 200 ms. Several media redundancy clients (MRC) and a media redundancy man- ager (MRM) are arranged in a ring structure to increase the fail-safety, see Figure 20. The role of the redundancy Manager (MRM) is to test the defined ring structure for its functionality. For this purpose, test frames are sent in regular intervals. When the MRM receives the sent test frames back, the ring structure is intact. For all other data packages the redundancy manager interrupts the ring structure.

As soon as the ring is interrupted, the redundancy manager cannot receive back the sent test frames. In order to recreate the line structure it closes the switch. This is where the media redundancy clients come into play that serve as switch and therefore as “transit station” for frames. They can be integrated into the ring structure if they have at least two switch ports.

The next Media Redundancy for Planned Duplication (MRPD) development version, that is specifically used for IRT connections, is not supported by the CPC20PN.



Source: PROFIBUS Nutzerorganisation e. V. (PROFIBUS User Organisation e. V), PROFINET system description - Technology and application, p. 19, fig. 27

Figure 20: MRP Media Redundancy with PROFINET

7 CYCLICAL I/O DATA

Depending on the planned module type and the selected submodules, a varying number of data bytes are exchanged in the cyclical data traffic.

The system allows individual determination per slot if I/O data (status/control), measuring values and/or total current shall be transmitted. The GSDML file made available for the projecting tool allows the related configuration the system recognises all permitted configurations and processes the cyclical data defined in the projection.

Only the module I/O data CPC20 controller is firmly pre-set and cannot be removed because the input bytes hold vital failure and diagnostic information as described in the following.

7.1 CPC20 Controller I/O Data Module

The 2 bytes input data contain the following global error and diagnostic messages. This module does not contain any output data.

	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 = **ELBus®** 1 error Bit6 = **ELBus®** 2 error Bit7 = Reserve Bit8 = Reserve Bit9 = Reset through Watchdog Bit10 = CPC hardware error Bit11 = Reserve Bit12 = Reserve Bit13 = Reserve Bit14 = Reserve Bit15 = Reserve

Figure 21: Cyclical diagnostic data CPC20

7.2 Submodule 1: Total Current

The submodule total current supplies a standardised 16 Bit value with the calculated total current of all 18plus-AM03 modules in slot (2 byte input data).
The submodule does not have output data.
The measuring value is indicated as follows:

	Byte	Type	Range	Description
Total Current	0 HighByte 1 LowByte	Int		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 Ampere

Figure 22: Total current

7.3 Submodule 2: Status/Control

Depending on the number of 18plus-AM03 connection modules used (one 18plus-AM03 module corresponds to two channels), per channel one byte input data with the status of the circuit protector and one byte output data for control of the circuit protector are exchanged here.

Example:

8 pcs. 18plus-AM03 connection modules equal 16 channels. This results in 16 bytes for status information and 16 bytes for control for the data exchange.
Addressing is effected according to the 18plus-AM03 sequence:

18plus-AM03 1, Channel 1.1 Byte Address [0]
18plus-AM03 1, Channel 1.2 Byte Address [1]
18plus-AM03 2, Channel 2.1 Byte Address [2]

…….

7.3.1 Status Circuit Protector ESX60D

Design of the input byte per channel is as follows (status circuit protector):

	Byte	Type	Range	Description
Status	Byte	Word	0…255	Bit0 = Load output Bit1 = Short circuit Bit2 = Overload Bit3 = Undervoltage Bit4 = Overvoltage Bit5 = Excessive temperature Bit6 = Limit value current Bit7 = Event “True” means the status is active.

Figure 23: Status channel

7.3.2 Control Circuit Protector ESX60D

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

	Byte	Type	Range	Description
Control	0	Byte	0…255	Bit0 = Switch load output ON/OFF Bit1 = Reset load output (only responds to rising edge) Bit2 = Reserve Bit3 = Reserve Bit4 = Reserve Bit5 = Reserve Bit6 = Reserve Bit7 = Release for cyclic commands “True” means the status is active.

Figure 24: Control channel

7.4 Submodule 3: Measuring Values

Depending on the number of 18plus-AM03 connection modules used (one 18plus-AM03 connection module equals two channels) four bytes input data with measuring values of load current and load voltage of the corresponding circuit protector are made available per channel. The sub-module does not have output data. The sequence of the measuring values is load current (2 bytes), followed by load voltage (2 bytes).

Example:

8 pcs. 18plus-AM03 connection modules equal 16 channels. This results in 16*4, i.e. 64 bytes for the data exchange.
Addressing is effected according to the 18plus-AM03 sequence.

18plus-AM03 1, Channel 1.1 Byte Address [0..1] Load current, Byte Address [2..3] Load voltage
18plus-AM03 1, Channel 1.2 Byte Address [4..5] Load current, Byte Address [6..7] Load voltage
18plus-AM03 1, Channel 2.1 Byte Address [8..9] Load current, Byte Address [10..11] Load voltage

…….

7.4.1 Load Current of Circuit Protector ESX60D

Design of the input bytes per channel is as follows (measuring value load current):

	Byte	Type	Range	Description
Load Current	0 HighByte 1 LowByte	Int		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

Figure 25: Load current channel

7.4.2 Load Voltage of Circuit Protector ESX60D

Design of the input bytes per channel is as follows (measuring value load voltage):

	Byte	Type	Range	Description
Load Voltage	0 HighByte 1 LowByte	Int		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 26: Load voltage channel

8 NON-CYCLICAL DATA

Non-cyclical PROFINET services allow additional data to be exchanged with the CPC20 controller and the circuit protectors. Access also allows direct addressing of a circuit protector. The PROFINET index and slot number are used for this purpose. Slot 1 is used to read and write the CPC20 data. Slot 2 is used to read and write the data of the circuit protectors. Slot 3 is used to read and write the channels on the expansion board. (For an overview of slots, see 6.1 *ControlPlex*® Device Model). Access to the circuit protectors is divided into channels. Two channels are provided per circuit protector.

The PROFINET index is composed as follows:

Scope	Index Item	Description
Channel number at the ELBUS®	Decimal numbers 10^3 and 10^2	Number of channel to be requested. Valid value range: 00…32
Parameter Index	Decimal numbers 10^1 and 10^0	The parameter index defines the data range and the data type of the data to be read or written. Valid value range: 01…10

Figure 27: PROFINET index structure

02 01

Parameter index

Channel number (1-32)

Profinet Index = Channel number * 100 + Parameter index

Example for calculating channel 1 and parameter index 2:

102 = 1*100+2

Non-cyclical access to CPC20 data is divided as follows:

Parameter Index	Slot	Slot number	Number of data bytes	Reading (R) Writing (W)	Description
02	1	00	19	R	device information of CPC20 controller (see chapter 8.1.1)
03	1	00	2	R/W	Configuration data of CPC20 controller (see chapter 8.1.2)
05	1	00	1	W	Action commands for all channels and the CPC20 (see chapter 8.1.3)

Figure 28: Division of parameter index CPC20

Non-cyclical access to the data of the circuit protector channels is divided as follows:

Parameter Index	Slot	Slot number	Number of data bytes	Reading (R) Writing (W)	Description
01	2…3	01…32	8	R/W	device parameters of a channel (see chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**)
02	2…3	01…32	19	R	device information of a channel (see chapter 8.2.2)
03	2…3	01…32	17	R/W	configuration data of a channel (see chapter 8.2.3)
04	2…3	01…32	1	R	event of a channel (see chapter 8.2.4)
05	2…3	01…32	1	W	action commands for a channel (see chapter 8.2.5)
06	2…3	01…32	22	R	diagnosis data of a channel (see chapter 8.2.6)
07	2…3	01…32	200	R	Histogram (measuring values 0…199) of a channel (see chapter 8.2.7)
08	2…3	01…32	200	R	Histogram (measuring values 200…399) of a channel (see chapter 8.2.7)
09	2…3	01…32	200	R	Histogram (measuring values 400…599) of a channel (see chapter 8.2.7)
10	2…3	01…32	200	R	Histogram (measuring values 600…799) of a channel (see chapter 8.2.7)

Figure 29: Division of parameter index channel

8.1 CPC20 Controller

The 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.
They will be read with COM = 0, channel = 0 and Index 2.
All parameters with possible conditions are described in the following table.

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

Figure 30: CPC20 device information

8.1.2 CPC20 Controller Configuration Data

The device configuration data for the controller consists of 17 bytes.
They will be read and written with COM = 0, channel = 0 and Index 3.
All parameters with possible conditions are described in the following table.

	Byte	Type	Range	Description
Configuration data CPC20	0	Byte	0xFF	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	Word	0xFFFF	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	Word	0xFFFF	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	Word	0xFFFF	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	Word	0xFFFF	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	Word	0xFFFF	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	Word	0xFFFF	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	Word	0xFFFF	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	Word	0xFFFF	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 31: CPC20 configuration data

8.1.3 CPC20 Controller Action Commands

The action commands of the controller consist of 1 byte.
They will be written with COM = 0, channel = 0 and index 5.
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 minimally 196 = Reset statistics maximally 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 32: CPC20 action commands

8.2 Circuit Protectors / Channels

The following chapters describe the parameters of the circuit protectors. The parameters are organized into channels.

8.2.1 Device Parameters for one Channel

The device parameters for a channel consist of 8 bytes.
They are read and written with COM = 1..2, channel = 1..32, and index 1.
All parameters with their possible conditions are described in the following table.

	Byte	Type	Range	Description
Rated Current	0	Byte	161…170	Holds 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
Disconnection 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 factor 50. Example for 3000 ms: Trip time at overload (60) * 50 = 3000 ms The default value is 3000 ms.
Trip time under short-circuit conditions	4	Byte	0…255	This determines the time after which the load output is switched off under short-circuit conditions. The range is from 50 ms up to 1,000 ms. It is calculated with factor 10. Example for 100 ms: Trip time at overload (10) * 10 = 100 ms The default value is 400 ms

	Byte	Type	Range	Description
Switch-on delay	5	Byte	0…255	This parameter specifies that a channel is not switched on immediately after the supply voltage is connected, but only after a defined period of time. The range is from 50 ms up to 2,500 ms. It is calculated with factor 10. Example for 50 ms: Trip time at overload (5) * 10 = 50 ms The default value is 100 ms
Limit value load current (Threshold)	6	Byte	50…100	Specifies the percentage of the rated current of a channel at which “limit value exceeded” (bit in the status of the cyclic data) is reported. The range is between 80% and 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 load current (threshold). The range is from 5 % to 20 %. The default value is 5 %.

Figure 33: Device parameters channel

8.2.2 Device Information for one Channel

The device information for one channel consists of 19 bytes.
It is read with COM = 1...2, channel = 1...32 and index 2.
All parameters with their 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 circuit breakers.
Hardware version	2 HighByte 3 LowByte	Int	0 ... 65535	Holds the hardware version of the installed product
Internal production order number	4 HwHb 5 HwLB 6 LwHB 7 LwLB	DInt	0 ... 4294967295	Holds the production order number of the installed product
Production plant number	8 HwHb 9 HwLB 10 LwHB 11 LwLB	DInt	0 ... 4294967295	Holds the production plant number of the installed product
Serial number	12 HwHb 13 HwLB 14 LwHB 15 LwLB	DInt	0 ... 4294967295	Holds the serial number of the installed product
Software version (major.x.x)	16	Byte	0 ... 255	Holds the major software version of the installed product
Software version (x.minor.x)	17	Byte	0 ... 255	Holds the minor software version of the installed product
Software version (x.x.build)	18	Byte	0 ... 255	Holds the build software version of the installed product

Figure 34: Device information channel

8.2.3 Configuration Data for one Channel

The configuration data for one channel consist of 3 bytes.
They are read and written with COM = 1...2, channel = 1...32 and index 3.
All parameters with their 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.
Channel Release	2	Byte	0xFF	Bit0 Releases the circuit protector. If the bit is not set, the channel is blocked. The remaining bits are not used currently.

Figure 35: Configuration data channel

8.2.4 Event Message for one Channel

The event messages for one channel consist of 1 byte.
They are read with COM = 1...2, channel = 1...32 and index 5.
All parameters with their possible conditions are described in the following table.

	Byte	Type	Range	Description
Event	0	Byte	0 … 255	Bit0 = Waiting for parameterisation Bit1 = Histogram available Bit2 = New current rating available Bit3 = Channel off via momentary switch/switch Bit4 = Reserve Bit5 = Reserve Bit6 = Reserve Bit7 = Device error detected “True” means the status is active.

Figure 36: Event messages channel

8.2.5 Action Commands for one Channel

The action commands for one channel consist of 1 byte.
They are written with COM = 1...2, channel = 1...32 and index 5.
All parameters with their possible conditions are described in the following table.

	Byte	Type	Range	Description
Action Commands	0	Byte	0 … 255	117 = Delete histogram 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 37: Action commands channel

8.2.6 Diagnostic Data for one Channel

The diagnostic data for a channel consists of 22 bytes.
It is read with COM = 1...2, channel = 1...32, and index 6.
All parameters with their possible conditions are described in the following table.

	Byte	Type	Range	Description
Error Memory	0 HighByte 1 LowByte	Int		Bit0 = No parameters available Bit1 = Error parameter memory Bit2 = Error programme memory Bit3 = Error data memory Bit4 = Error control unit Bit5 = Reset through Watchdog Bit6 = Reserve Bit7 = Reserve Bit8 = Error current sensor Bit9 = Error fail-safe element Bit10 = Reserve Bit11 = Reserve Bit12 = Reserve Bit13 = Reserve Bit14 = Reserve Bit15 = Reserve “True” means the status is active.
Trip Counter	2 HighByte 3 LowByte	Int		The number of trippings since the last reset is shown here.
Reason for 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	Int		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	Int		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	Int		Contains the mean voltage value 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
Min. Load Current	11 HighByte 12 LowByte	Int		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 Amps

	Byte	Type	Range	Description
Max. Load Current	13 HighByte 14 LowByte	Int		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 Amps
Medium Value Load Current	15 HighByte 16 LowByte	Int		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 Amps
Supply Voltage	17 HighByte 18 LowByte	Int		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	Int		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 = No histogram available 146 = Slide switch is in OFF position 147 = Undervoltage detected 148 = Excess temperature detected 149 = Reset command required 150 = Command was processed correctly 151 = Parameterisation required 152 = Internal failure detected 153 = Unknown command 154 = Sentence length error 155 = Rated current available, check sum error 156 = Current rating selector switch was actuated

Figure 38: Diagnostic data 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.

As the data quantity is too big for a non-cyclical query, the entire bar chart has to be read with the four indices:

They are read with COM = 1...2, channel = 1...32 and index 7...10. Measuring values 1..200 are picked up with index 7, the measuring values 201...400 with index 8, the measuring values 401..600 with index 9 and the measuring values 601..800 with index 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: (128 - value (80)) * 0.1639 = 7.107 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: (128 - value (80)) * 0.1639 = 7.107 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: (128 - value (80)) * 0.1639 = 7.107 Amps

Figure 39: Histogram channel

9 APPENDIX

List of Figures

E-T-A Elektrotechnische Apparate GmbH
Industriestraße 2-8
90518 Altdorf
Phone: +49 9187 10-0
Fax: +49 9187 10-397
mail: info@e-t-a.de

global.e-t-a.com