



# Voltage regulator TAPCON<sup>®</sup> 250 Pro

## Operating instructions

8595017/04 EN



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Generally the information provided and agreements made when processing the individual quotations and orders are binding.

The original operating instructions were written in German.



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## 1 Introduction

This technical file contains detailed descriptions on the safe and proper installation, connection, commissioning and monitoring of the product.

It also includes safety instructions and general information about the product.

This technical file is intended solely for specially trained and authorized personnel.

### 1.1 Manufacturer

The product is manufactured by:

Maschinenfabrik Reinhausen GmbH

Falkensteinstraße 8

93059 Regensburg

Tel.: (+49) 9 41/40 90-0

E-mail: [sales@reinhausen.com](mailto:sales@reinhausen.com)

Further information on the product and copies of this technical file are available from this address if required.

### 1.2 Completeness

This technical document is incomplete without the following supporting documents:

- Connection diagrams
- Operating Instructions
  - Available as a download on the device
  - Available for download at [www.reinhausen.com](http://www.reinhausen.com)
  - Available for download in the MR Customer Portal

### 1.3 Safekeeping

Keep this technical document and all supporting documents ready at hand and accessible for future use at all times. Download the operating instructions from the device. The operating instructions are also available on the Maschinenfabrik Reinhausen GmbH website and in the MR Customer Portal.

### 1.4 Notation conventions

#### 1.4.1 Hazard communication system

Warnings in this technical file are displayed as follows.





#### 1.4.1.1 Warning relating to section

Warnings relating to sections refer to entire chapters or sections, sub-sections or several paragraphs within this technical file. Warnings relating to sections use the following format:

##### **WARNING**



##### **Type of danger!**

Source of the danger and outcome.

- Action
- Action

#### 1.4.1.2 Embedded warning information

Embedded warnings refer to a particular part within a section. These warnings apply to smaller units of information than the warnings relating to sections. Embedded warnings use the following format:

 **DANGER!** Instruction for avoiding a dangerous situation.

#### 1.4.1.3 Signal words in warning notices

Signal word	Meaning
DANGER	Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
WARNING	Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION	Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
NOTICE	Indicates measures to be taken to prevent damage to property.

Table 1: Signal words in warning notices

#### 1.4.2 Information system

Information is designed to simplify and improve understanding of particular procedures. In this technical file it is laid out as follows:



Important information.

#### 1.4.3 Instruction system

This technical file contains single-step and multi-step instructions.



### Single-step instructions

Instructions which consist of only a single process step are structured as follows:

Aim of action

✓ Requirements (optional).

► Step 1 of 1.

⇒ Result of step (optional).

⇒ Result of action (optional).

### Multi-step instructions

Instructions which consist of several process steps are structured as follows:

Aim of action

✓ Requirements (optional).

1. Step 1.

⇒ Result of step (optional).

2. Step 2.

⇒ Result of step (optional).

⇒ Result of action (optional).

## 1.4.4 Typographic conventions

Typographic convention	Purpose	Example
UPPERCASE	Operating controls, switches	ON/OFF
[Brackets]	PC keyboard	[Ctrl] + [Alt]
<b>Bold</b>	Software operating controls	Press <b>Continue</b> button
...>...>...	Menu paths	Parameter > Control parameter
<i>Italics</i>	System messages, error messages, signals	<i>Function monitoring</i> alarm triggered
[► Number of pages]	Cross reference	[► Page 41].
Dotted underscore .....	Glossary entry, abbreviations, definitions, etc.	<u>Glossary entry</u> .

Table 2: Typographic conventions used in this technical file



## 2 Safety

- Read this technical file through to familiarize yourself with the product.
- This technical file is a part of the product.
- Read and observe the safety instructions provided in this chapter.
- Read and observe the warnings in this technical file in order to avoid function-related dangers.
- The product is manufactured on the basis of state-of-the-art technology. Nevertheless, risks to life and limb for the user or impairment of the product and other material assets due to the function may arise in the event of improper use.

### 2.1 Appropriate use

The device keeps the output voltage of a transformer with an on-load tap-changer constant. The product is designed solely for use in stationary large-scale electrical energy systems and facilities.

If used as intended, in compliance with the requirements and conditions specified in this technical document and observing the warning notices in this technical document and attached to the product, the product does not pose a risk of injury or damage to property or the environment. This applies throughout the service life of the product, from delivery, installation and operation to removal and disposal.

The following is considered intended use:

- You will find the standard valid for the product and the year of issue on the nameplate.
- Operate the product in accordance with this technical document, the agreed-upon delivery conditions and the technical data.
- Ensure that all necessary work is performed by qualified personnel only.
- Only use the equipment and special tools included in the scope of delivery for the intended purpose and in accordance with the specifications of this technical document.
- Only operate the product in industrial areas.
- Observe the notices in this technical document regarding electromagnetic compatibility and the technical data.
- The product is intended for installation. Make sure that all fire safety precautions and protection against electric shock are met.
- Make sure that the resistance to mechanical stress is met.
- The product is intended for indoor use in non-hazardous areas.



## 2.2 Inappropriate use

Use is considered to be inappropriate if the product is used other than as described in the Intended use section. In addition, observe the following:

- The product is not a protective device. Do not use it to handle safety-related functions.
- Do not operate the product in potentially explosive areas.

## 2.3 Fundamental safety instructions

To prevent accidents, malfunctions and damage as well as unacceptable adverse effects on the environment, those responsible for transport, installation, operation, maintenance and disposal of the product or parts of the product must ensure the following:

### Personal protective equipment

Loosely worn or unsuitable clothing increases the danger of becoming trapped or caught up in rotating parts and the danger of getting caught on protruding parts. This poses a danger to life and limb.

- Wear appropriate personal protective equipment such as a helmet, work gloves, etc. for the respective activity.
- Never wear damaged personal protective equipment.
- Never wear rings, necklaces, or other jewelry.
- If you have long hair, wear a hairnet.

### Work area

Untidy and poorly lit work areas can lead to accidents.

- Keep the work area clean and tidy.
- Make sure that the work area is well lit.
- Observe the applicable laws for accident prevention in the relevant country.

### Working during operation

The product may only be operated in a sound, operational condition. Otherwise it poses a danger to life and limb.

- Regularly check the operational reliability of safety equipment.
- Comply with the inspection work, maintenance work and maintenance intervals described in this technical file.





### Invisible laser radiation

Looking directly into the beam or the reflected beam can cause eye damage. The beam is emitted at the optical connections or at the end of the fiber-optic cables connected to them on the assemblies. Read the chapter "Technical Data" [► Section 13, Page 154] for further information.

- Never look directly into the beam or the reflected beam.
- Never look into the beam with the aid of optical instruments such as a magnifying glass or a microscope.
- In the event that the laser beam strikes your eyes, close your eyes immediately and move your head out of the path of the beam.

### Working with current transformers

Dangerous high voltages may occur when a current transformer is operated with an open secondary circuit. This can lead to injuries and property damage.

- Never operate a current transformer with an open secondary circuit; short-circuit the current transformer to prevent this.
- Do not open plug connections or screw connections on the measuring card without first short-circuiting the actual transformer or the current transformer on the secondary side using the short-circuit bridges provided.
- Observe the information in the current transformer operating instructions.

### Handling electrical components

Electrical components can be damaged by electrostatic discharge.

- Never touch electrical components during commissioning, operation or maintenance work.
- Take suitable measures (such as covers) to ensure that personnel cannot touch components.
- Wear suitable personal protective equipment.

### Explosion protection

Highly flammable or explosive gases, vapors and dusts can cause serious explosions and fire.

- Do not install or operate the product in areas where a risk of explosion is present.

### Safety markings

Warning signs and safety information plates are safety markings on the product. They are an important aspect of the safety concept.



- Observe all safety markings on the product.
- Make sure all safety markings on the product remain intact and legible.
- Replace safety markings that are damaged or missing.

### **Ambient conditions**

To ensure reliable and safe operation, the product must only be operated under the ambient conditions specified in the technical data.

- Observe the specified operating conditions and requirements for the installation location.

### **Modifications and conversions**

Unauthorized or inappropriate changes to the product may lead to personal injury, material damage and operational faults.

- Only modify the product after consultation with Maschinenfabrik Reinhausen GmbH.

### **Spare parts**

Spare parts not approved by Maschinenfabrik Reinhausen GmbH may lead to physical injury, damage to the product and malfunctions.

- Only use spare parts that have been approved by Maschinenfabrik Reinhausen GmbH.
- Contact Maschinenfabrik Reinhausen GmbH.

## **2.4 Personnel qualification**

The person responsible for assembly, commissioning, operation, maintenance and inspection must ensure that the personnel are sufficiently qualified.

### **Electrically skilled person**

The electrically skilled person has a technical qualification and therefore has the required knowledge and experience, and is also conversant with the applicable standards and regulations. The electrically skilled person is also proficient in the following:

- Can identify potential dangers independently and is able to avoid them.
- Is able to perform work on electrical systems.
- Is specially trained for the working environment in which (s)he works.
- Must satisfy the requirements of the applicable statutory regulations for accident prevention.



### Electrically trained persons

An electrically trained person receives instruction and guidance from an electrically skilled person in relation to the tasks undertaken and the potential dangers in the event of inappropriate handling as well as the protective devices and safety measures. The electrically trained person works exclusively under the guidance and supervision of an electrically skilled person.

### Operator

The operator uses and operates the product in line with this technical file. The operating company provides the operator with instruction and training on the specific tasks and the associated potential dangers arising from improper handling.

### Technical Service

We strongly recommend having maintenance, repairs and retrofitting carried out by our Technical Service department. This ensures that all work is performed correctly. If maintenance is not carried out by our Technical Service department, please ensure that the personnel who carry out the maintenance are trained and authorized by Maschinenfabrik Reinhausen GmbH to carry out the work.

### Authorized personnel

Authorized personnel are trained by Maschinenfabrik Reinhausen GmbH to carry out special maintenance.

## 2.5 Personal protective equipment

Personal protective equipment must be worn during work to minimize risks to health.

- Always wear the personal protective equipment required for the job at hand.
- Never wear damaged personal protective equipment.
- Observe information about personal protective equipment provided in the work area.

<b>Protective clothing</b>	Close-fitting work clothing with a low tearing strength, with tight sleeves and with no protruding parts. It mainly serves to protect the wearer against being caught by moving machine parts.
<b>Safety shoes</b>	To protect against falling heavy objects and slipping on slippery surfaces.
<b>Safety glasses</b>	To protect the eyes from flying parts and splashing liquids.



<b>Visor</b>	To protect the face from flying parts and splashing liquids or other dangerous substances.
<b>Hard hat</b>	To protect against falling and flying parts and materials.
<b>Hearing protection</b>	To protect against hearing damage.
<b>Protective gloves</b>	To protect against mechanical, thermal, and electrical hazards.

Table 3: Personal protective equipment





### 3 IT security

Observe the following recommendations to operate the product safely.

#### 3.1 General

- Ensure that only authorized personnel have access to the device.
- Only use the device within an ESP (electronic security perimeter). Do not connect the device to the Internet in an unprotected state. Use mechanisms for vertical and horizontal network segmentation and security gateways (firewalls) at the transition points.
- Ensure that the device is only operated by trained personnel who are familiar with IT security.
- Check regularly whether software updates are available for the device and perform the updates.

#### 3.2 Operation

Observe the following recommendations during device operation:

- Change the password at regular intervals.
- Export the security log at regular intervals.
- Check the log files regularly for unauthorized system access and other security-related events.

#### 3.3 Commissioning

Observe the following recommendations for device commissioning:

- User IDs must be unique and assignable. Do not use a "Group account" function or the "Auto login" function.
- Activate the "Auto logout" function.
- Restrict the rights of the individual user groups as much as is feasible; this helps avoid errors during operations. A user with the "Operator" role, for example, should only perform operations and should not be able to change any device settings.
- Delete or disable the default "admin" user ID. This requires first creating a new user account with the "Administrator" role. You can then use it to delete or disable the default "admin" account.
- Deactivate service user access.
- Enable SSL/TLS encryption [► Section 9.1.1, Page 76]; access to the device is then only possible using the SSL/TLS protocol. In addition to encrypting communication, this protocol also checks the authenticity of the server.

- Use TLS version 1.2 or higher wherever possible.
- Integrate the device into a public key infrastructure. Create your own SSL certificates for this if necessary and then import them.
- Connect the device to a central log server by using the syslog interface.

### 3.4 Communication interfaces

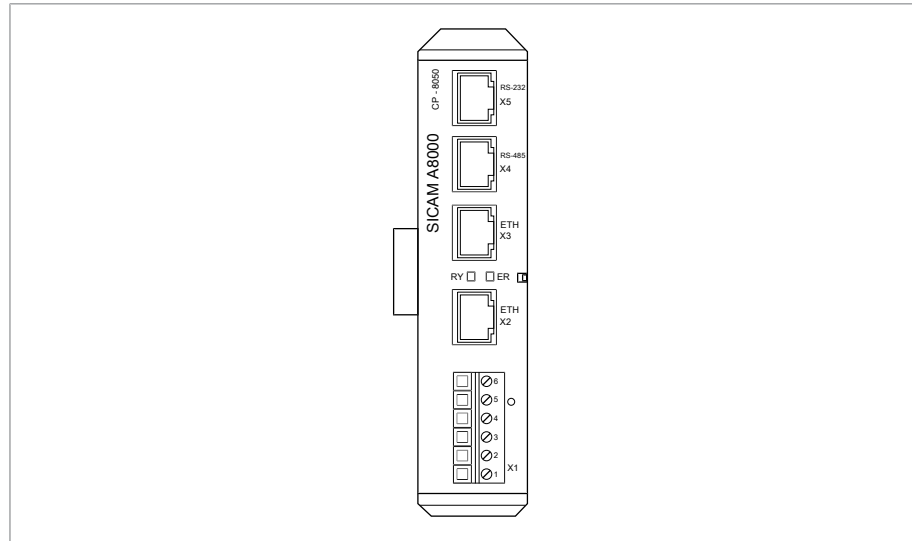


Figure 1: Interfaces: CPU

Interface	Protocol	Port	Description
X2	-	-	Internal system interface
X3	TCP	80	HTTP for web-based visualization <sup>2)</sup>
X3	TCP	443	HTTPS for web-based visualization <sup>3)</sup>
X4	-	-	Port deactivated
X5	-	-	Port deactivated

Table 4: Interfaces and open ports of the CPU assembly

<sup>2)</sup> Port is closed if you activate the device's SSL encryption.

<sup>3)</sup> Port is opened if you activate the device's SSL encryption.

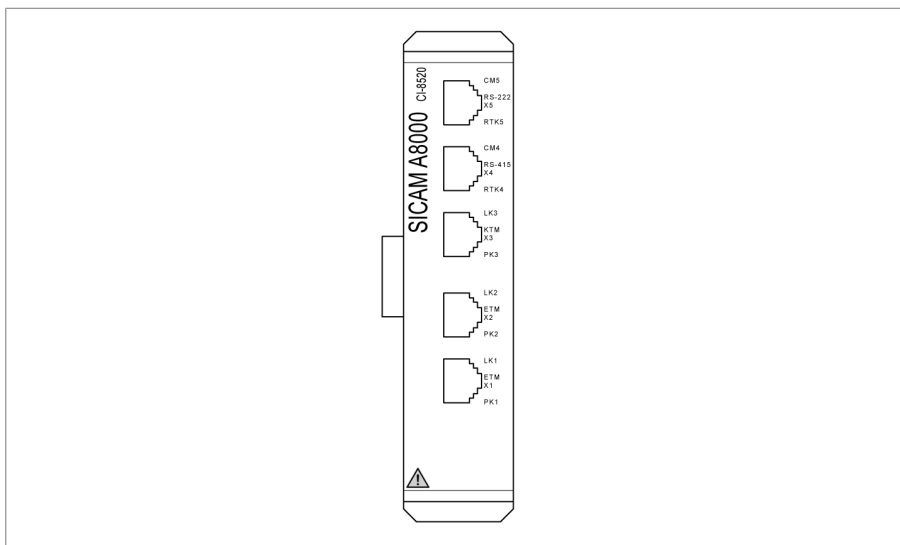


Figure 2: Interfaces: COM-ETH

Interface	Protocol	Port	Description
X1	-	-	Port deactivated
X2	TCP	80	HTTP for web-based visualization <sup>2)</sup>
X2	TCP	443	HTTPS for web-based visualization <sup>3)</sup>
X3	TCP	80	Internal system interface (display) <sup>2)</sup>
X3	TCP	443	Internal system interface (display) <sup>3)</sup>
X4	TCP	80	HTTP for web-based visualization <sup>2)</sup>
X4	TCP	443	HTTPS for web-based visualization <sup>3)</sup>
X5	TCP	10003	Internal system interface
X5	TCP	10004	Internal system interface

Table 5: Interfaces and open ports of the COM-ETH assembly

<sup>2)</sup> Port is closed if you activate the device's SSL encryption.

<sup>3)</sup> Port is opened if you activate the device's SSL encryption.

### 3.5 Encryption standards

The device supports the following TLS versions:

- TLS 1.0
- TLS 1.1
- TLS 1.2



The device uses the following cipher suites for a TLS-secured connection:

	Key exchange	Authentication		Encryption	Key length	Operating mode	Hash function
TLS	ECDHE	RSA	WITH	AES	128	CBC	SHA
	DHE						SHA256
	ECDHE	ECDSA			256	GCM	SHA256
	ECDH					CBC	SHA
		RSA					SHA256
						GCM	SHA384

Table 6: Cipher suite

The device uses the SHA512 hash function to save passwords.





## 4 Product description

### 4.1 Scope of delivery

Check the shipment for completeness based on the shipping documents.

- Automatic voltage regulator
- RJ45 Ethernet patch cable
- RJ45/M12 Ethernet patch cable
- Cap rail assemblies including connection plug for front plate
- Front plate including connection socket
- Additional nameplate

#### Device-type dependent

- CAN assembly including RJ45 Ethernet patch cable
- Interface module for Ethernet RJ45 to RS232/RS485
- Coupling module system networking BES including RJ45 Ethernet patch cable

#### Optional

- Serial to FO converter (CM-0847)
- Ethernet to FO converter (MC2-2)
- Auxiliary current transformer MR-169 ACT
- Extension cable 3 m between cap rail assemblies and front plate
- Shield connection terminal(s)

### 4.2 Function description of the voltage regulation

The device keeps the output voltage of a transformer with an on-load tap-changer constant.

The device compares the transformer's measured voltage ( $U_{\text{actual}}$ ) with a defined reference voltage ( $U_{\text{desired}}$ ). The difference between  $U_{\text{actual}}$  and  $U_{\text{desired}}$  is the control deviation  $dU$ .

The device parameters can be adjusted to the line voltage behavior to achieve a balanced control response with the on-load tap-changer only performing a small number of tap-change operations.

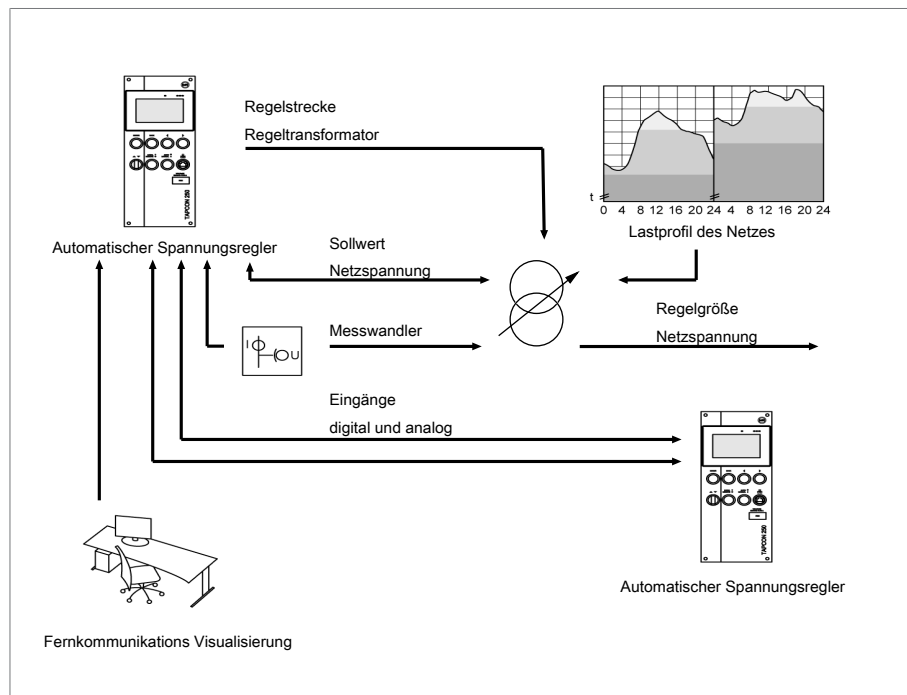


Figure 3: TC250 operating principle

### 4.3 Performance features

- Web-based visualization
- Automatic voltage regulation
  - 1 to 5 desired values
- Desired value setting
  - Analog
  - Digital
  - Using TDSC
- Peak memory
- Measured value memory
- Voltage balance
- Hunting counter
- Reverse power flow
- Line drop compensation
  - R&X compensation: Compensation for voltage drops on the line
  - Z compensation: Compensation for voltage fluctuations in the meshed grid

- Integrated monitoring functions:
  - Voltage monitoring
  - Current monitoring
  - Apparent power monitoring
  - Active power monitoring
  - Reactive power monitoring
  - Power factor monitoring
- Display of all measured values such as voltage, current, active power, apparent power and reactive power

### 4.4 Design

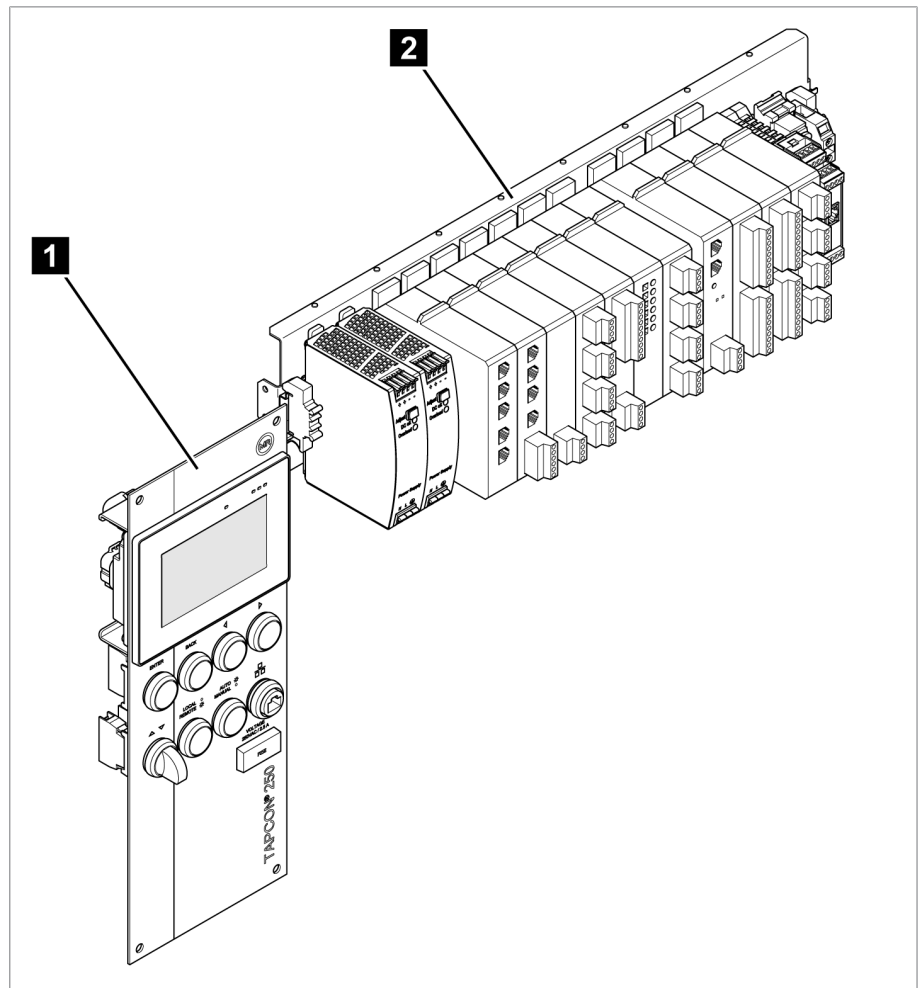


Figure 4: Example TC250 setup

The complete system consists of the following subassemblies:

1 Display	2 Assemblies on cap rail
-----------	--------------------------

### 4.4.1 Display, operating elements and front interface

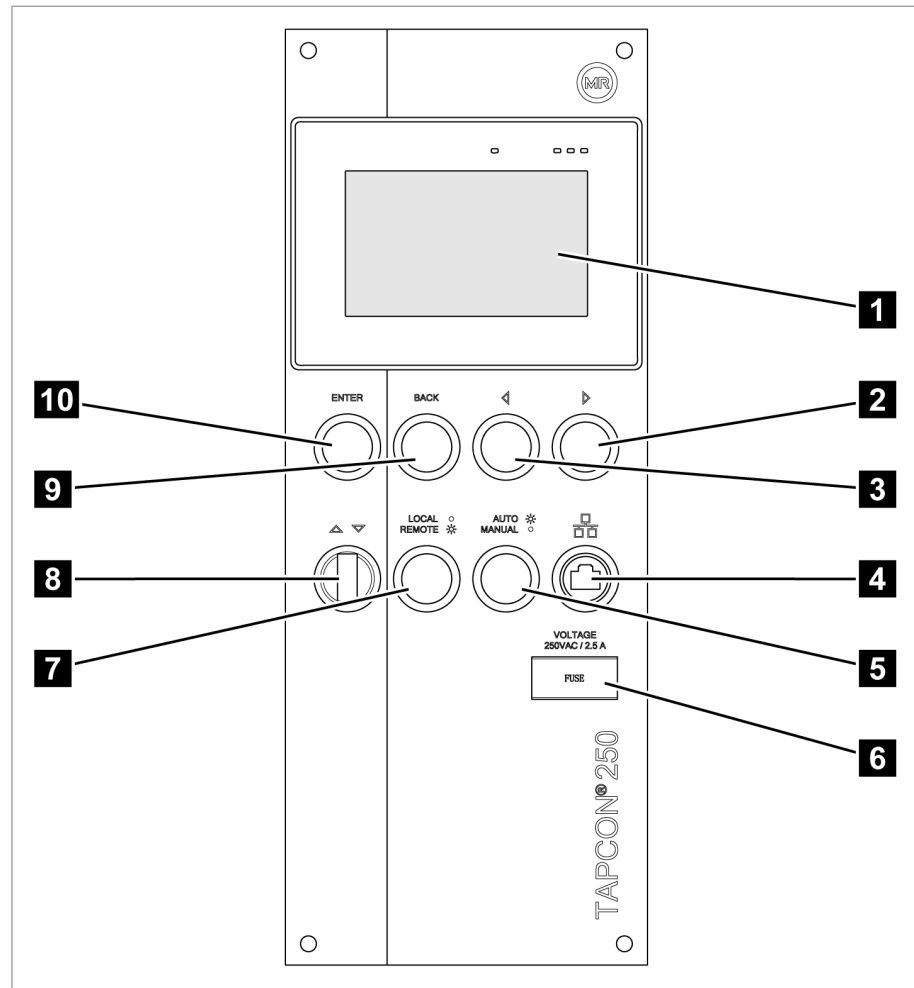


Figure 5: TAPCON®250 display

1 Display	-
2 RIGHT cursor	Navigate to the right in the menu
3 LEFT cursor	Navigate to the left in the menu
4 Front interface	RJ45 Ethernet interface
5 AUTO/MANUAL key <sup>1)</sup>	Switches between AUTO/MANUAL operating mode
6 Miniature circuit breaker	Voltage 250 VAC / 2.5 A



7	LOCAL/REMOTE key <sup>2)</sup>	Switches between LOCAL/REMOTE operating mode
8	RAISE/LOWER key	Sends a command to the motor-drive unit to raise/lower the voltage. <sup>3)</sup>
9	BACK key	Exit the current menu. Return to the previous menu level
10	ENTER key	Confirm selection

<sup>1)</sup> Key without function if a digital input is used to switch between AUTO/MANUAL and this is activated with the parameter **Pulse type digital input** set to Continuous signal.

<sup>2)</sup> Key without function if a digital input is used to switch between LOCAL/REMOTE and this is activated with the parameter **Pulse type digital input** set to Continuous signal.

<sup>3)</sup> Only possible with user authorization and in the local (manual mode) operating mode.

4.4.2 LEDs

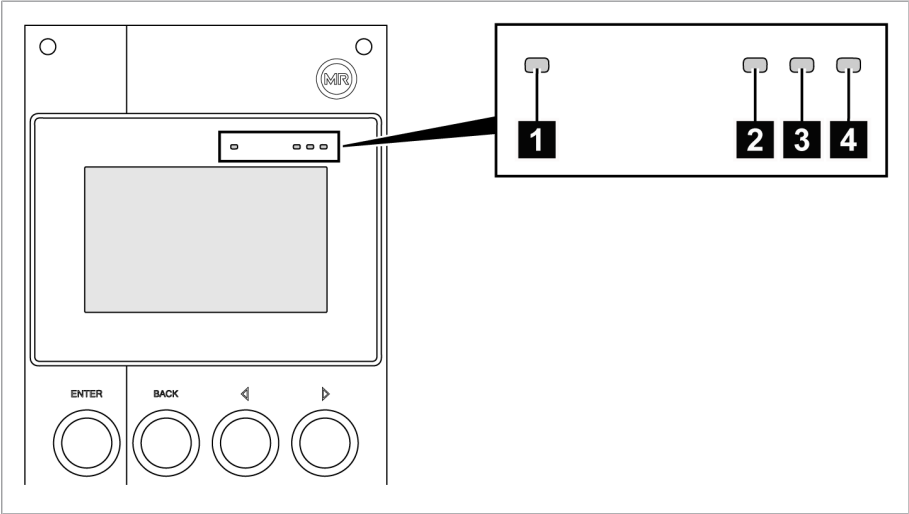


Figure 6: LEDs

1	Light-level sensor	-	-
2	Power supply LED	Green	Lights up during commissioning / voltage connection of the display.

3	AVR STATUS LED	Red	Illuminates when the device is in the error state.
		Yellow	Illuminates when the device starts or has been paused; e.g. during a software update.
		Blue	Illuminates when the device is in the operating state.
4	LED Event	Red	Illuminates as soon as a red event is present.
		Yellow	Illuminates as soon as a yellow event is present.
		Blue	Illuminates if there are no events or a gray event is present.

### 4.4.3 ISM® assemblies

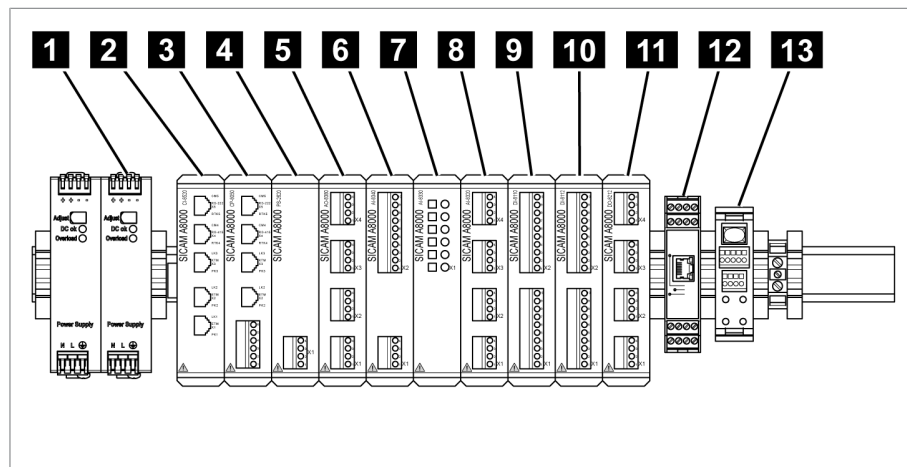


Figure 7: Cap rail with assemblies (single-row installation)

1	Mains unit G1	2	System networking COM-ETH
3	CPU	4	Power supply PS
5	AO 4	6	U 3
7	I 3	8	AI 4
9	DI 16-24V	10	DI 16-110V
11	DO 8	12	CAN module
13	RJ45 interface module		

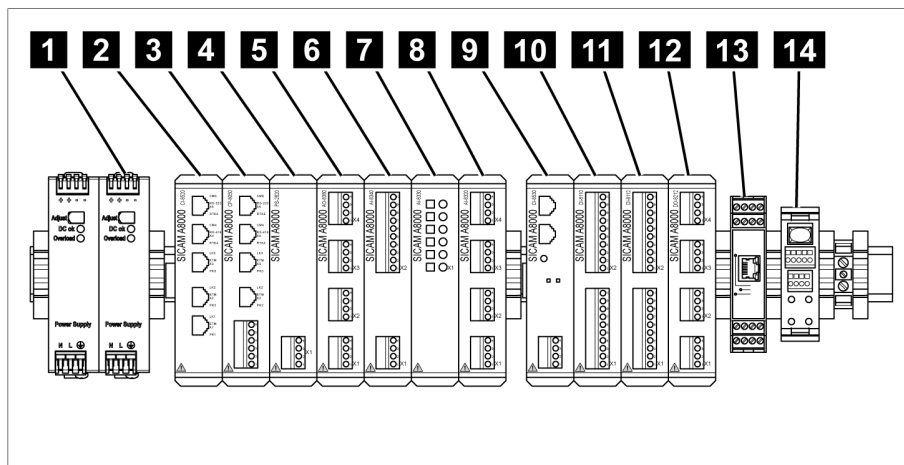


Figure 8: Cap rail with assemblies (two-row installation)

1 Mains unit G1	2 System networking COM-ETH
3 CPU	4 Power supply PS
5 AO 4	6 U 3
7 I 3	8 AI 4
9 System networking BES	10 DI 16-24V
11 DI 16-110V	12 DO 8
13 CAN module	14 RJ45 interface module

#### 4.4.3.1 Assemblies

Depending on configuration, the device may have various assemblies which perform the functions required. The functions of the assemblies are described in the following sections. You will find more information about the assemblies in the Technical data [► Section 13, Page 154] section.

### 4.4.3.1.1 System networking COM-ETH

The COM-ETH assembly provides you with 5 Ethernet interfaces.

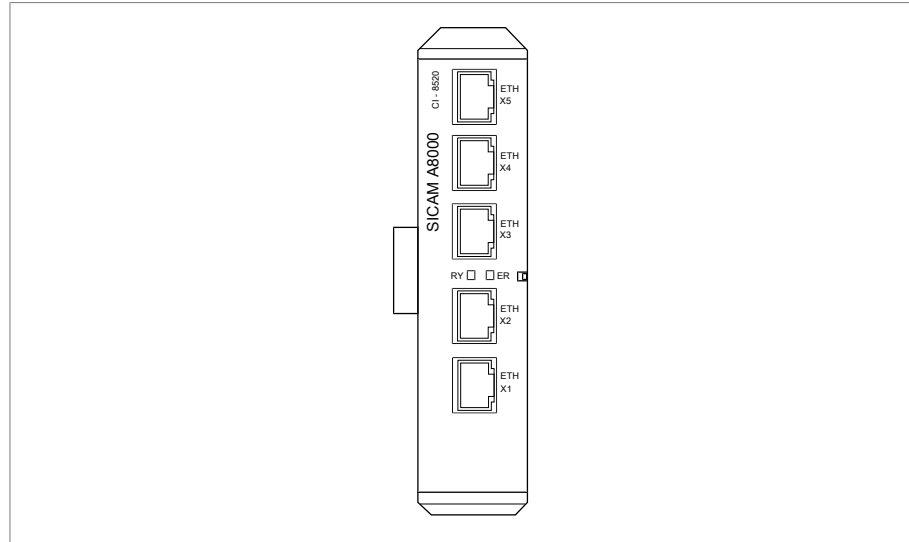


Figure 9: COM-ETH assembly

### 4.4.3.1.2 CPU (central processing unit)

The CPU assembly is the central processing unit for the device. It contains the following interfaces:

- Serial interface RS485/422 (electrically isolated, X4)
- Internal system interface RS232 (X5)
- 2x Ethernet 10/100 Mbps (electrically isolated, X2, X3)

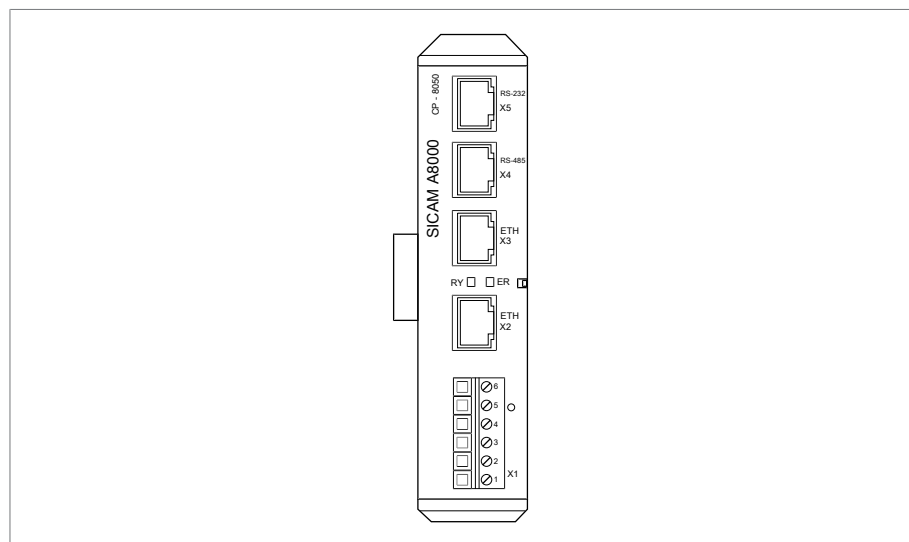


Figure 10: CPU assembly



### 4.4.3.1.3 G1 power supply

The G1 assembly provides the energy supply of the product.

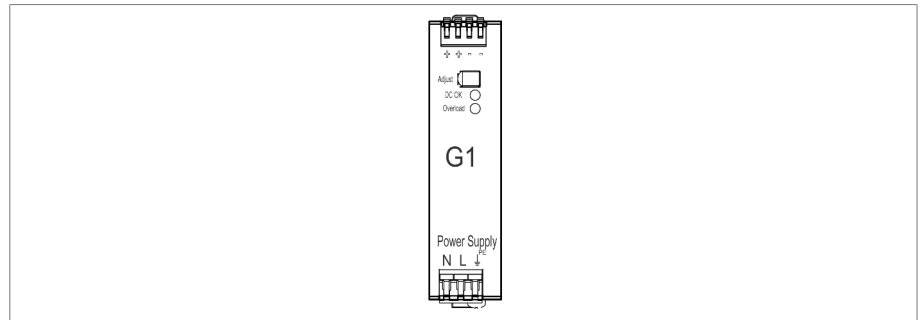


Figure 11: G1 assembly

### 4.4.3.1.4 Power supply PS

The PS assembly contains the power supply unit for supplying power to the ISM® assemblies. The *RY* LED signals that the assembly is ready for operation.

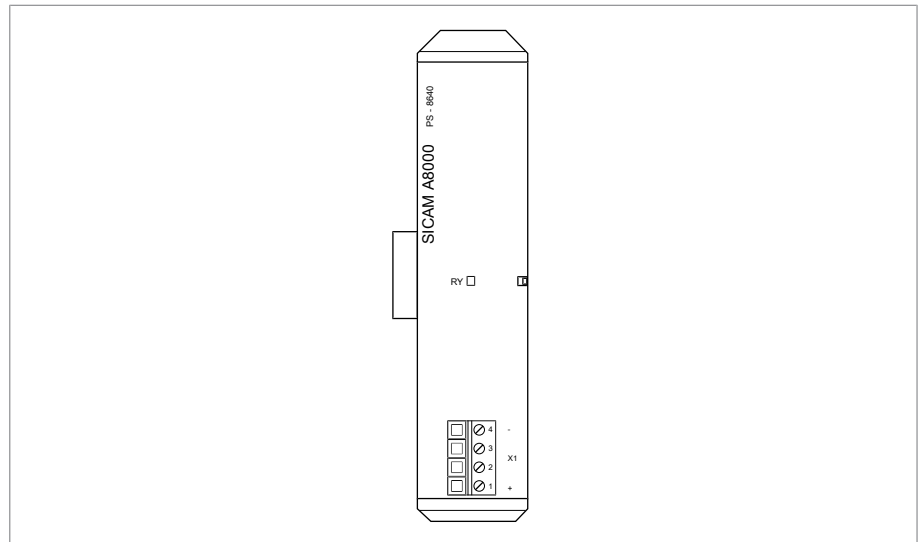


Figure 12: PS assembly

### 4.4.3.1.5 Digital inputs DI 16-24 V

The DI 16-24V assembly has 16 digital inputs with a nominal voltage of 24 V DC. The RY LED signals that the assembly is ready for operation.

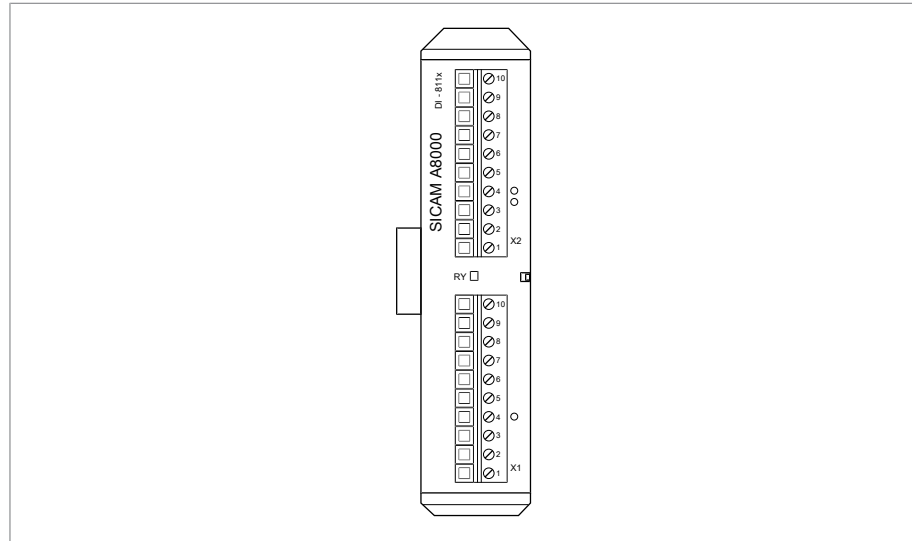


Figure 13: DI 16-24V assembly

### 4.4.3.1.6 Digital inputs DI 16-110 V

The DI 16-110V assembly has 16 digital inputs with a nominal voltage of 110 V DC/AC. The RY LED signals that the assembly is ready for operation.

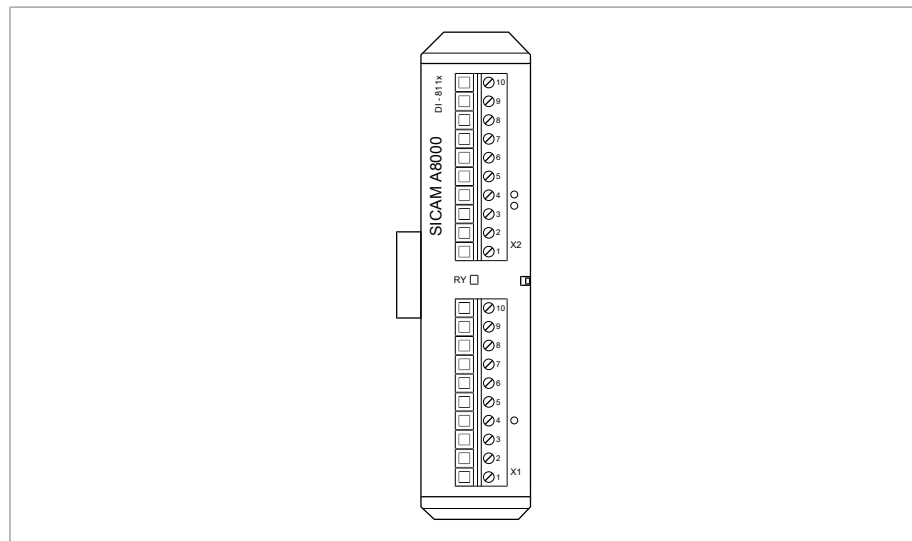


Figure 14: DI 16-110V assembly

#### 4.4.3.1.7 Digital outputs DO 8

The DO 8 assembly provides you with 8 digital outputs (relays). The *RY* LED signals that the assembly is ready for operation.

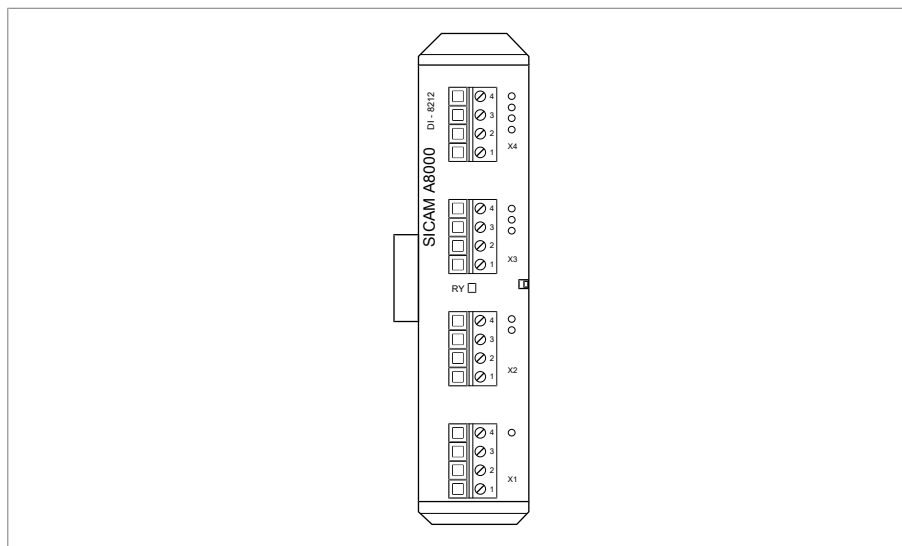


Figure 15: DO 8 assembly

#### 4.4.3.1.8 Analog inputs AI 4

The AI 4 assembly provides you with 4 analog inputs for measuring the current (-20...+20 mA) or voltage (-10...+10 V) of analog sensors. The *RY* LED signals that the assembly is ready for operation.

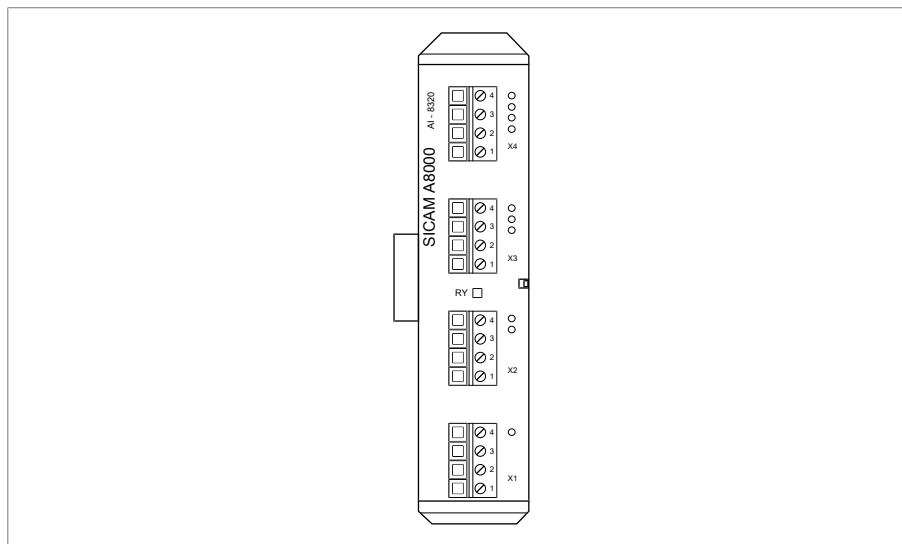


Figure 16: AI 4 assembly

### 4.4.3.1.9 Analog outputs AO 4

The AO 4 assembly provides you with 4 analog outputs for issuing measurement values ( $-20...+20$  mA,  $-10...+10$  V). The RY LED signals that the assembly is ready for operation.

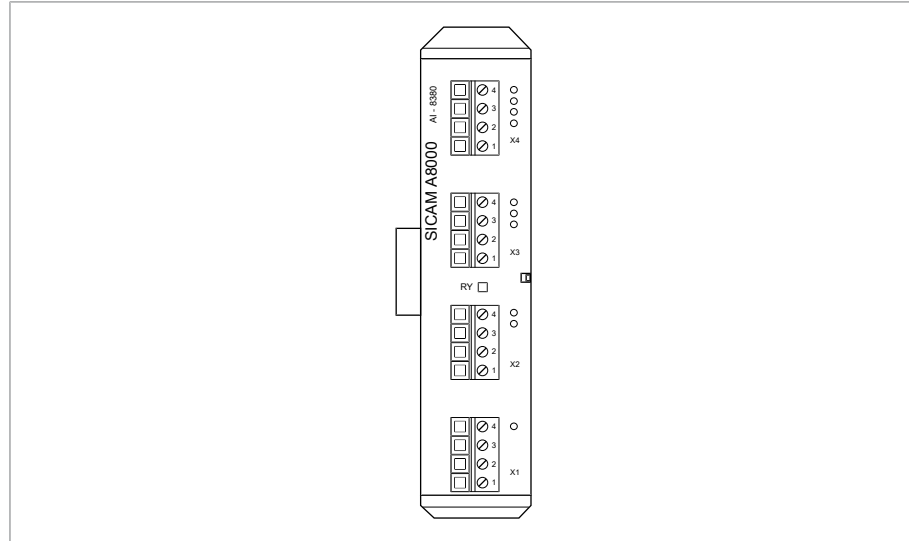


Figure 17: AO 4 assembly

### 4.4.3.1.10 Voltage measurement U 3

The U3 assembly is used for measuring 1-phase voltage. The RY LED signals that the assembly is ready for operation.

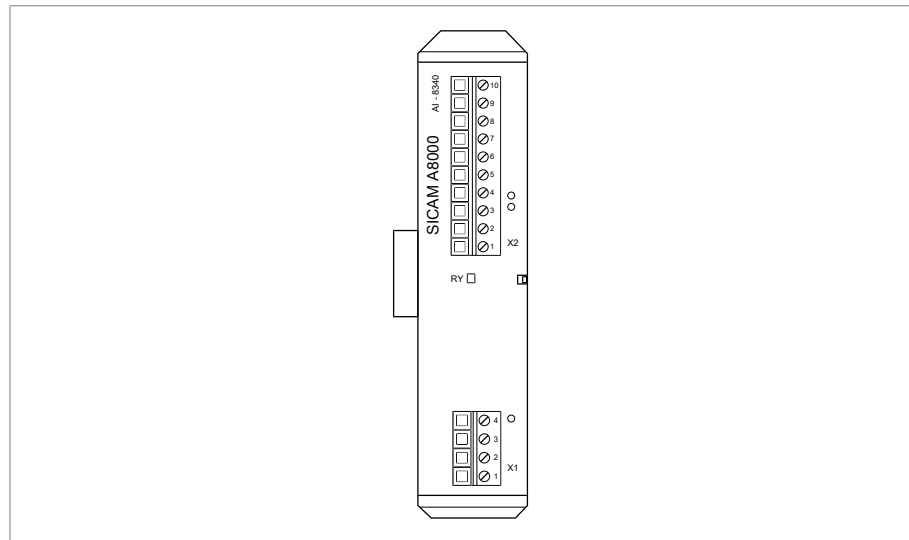


Figure 18: U 3 assembly

#### 4.4.3.1.11 Current measurement I 3

The I 3 assembly is used for measuring 1-phase voltage and current. The *RY* LED signals that the assembly is ready for operation.

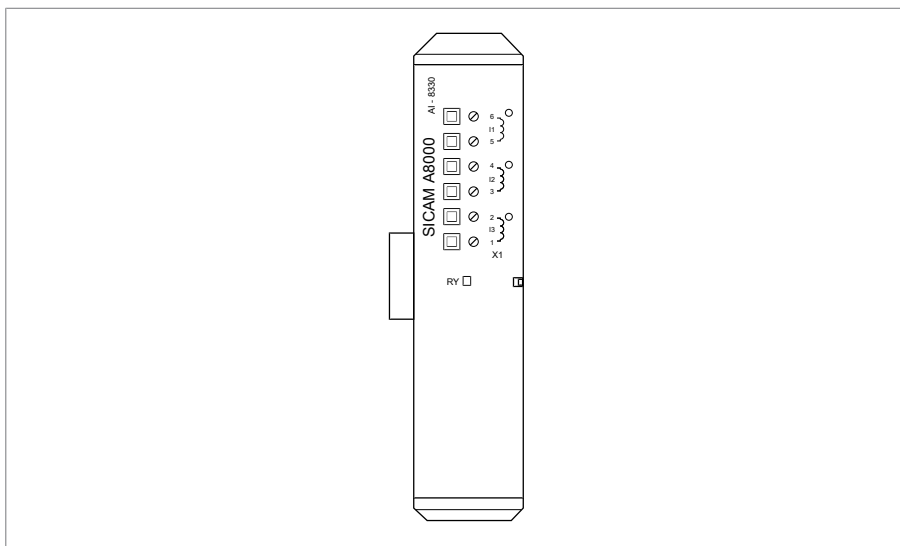


Figure 19: I 3 assembly

#### 4.4.3.1.12 System networking BES

The BES assembly is a bus extension module and extends the device by one additional bus rail with additional assemblies. The *RY* LED signals that the assembly is ready for operation. The *ER* LED signals that the device has detected an error.

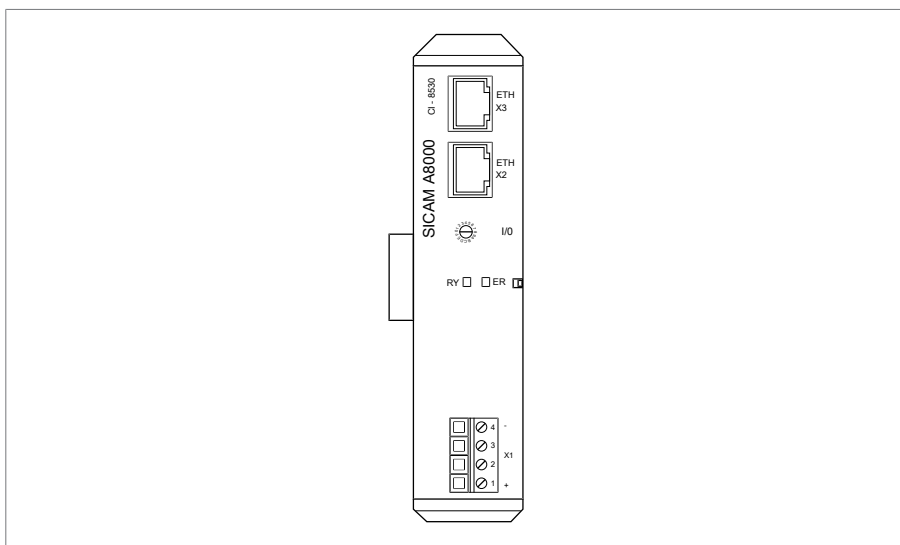


Figure 20: BES assembly

### 4.4.3.1.13 PE terminal

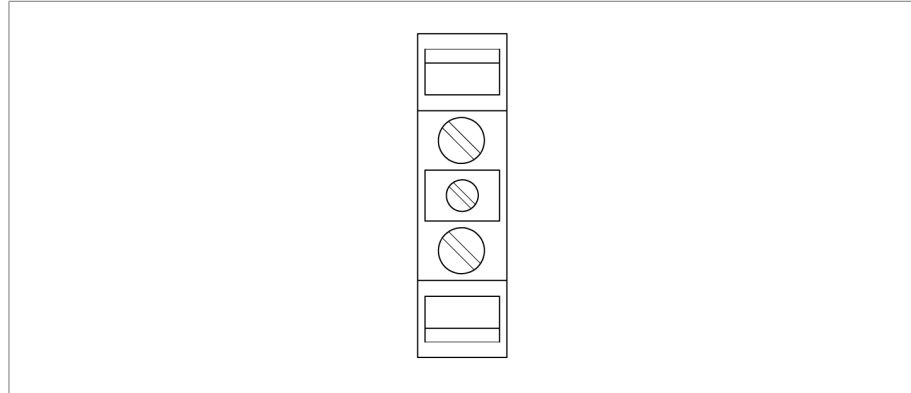


Figure 21: PE terminal

### 4.4.3.1.14 System networking MC 2-2

The MC 2-2 assembly is a media converter, which converts 2 electrical connections (RJ45) to one fiber-optic cable connection each. Each is converted independently of the other. The following interfaces are available:

- 2x RJ45 (ETH12, ETH22)
- 2x Duplex-LC (SFP module) (ETH11, ETH21)



The media converter is designed to be transparent for the network and does not have its own IP address.

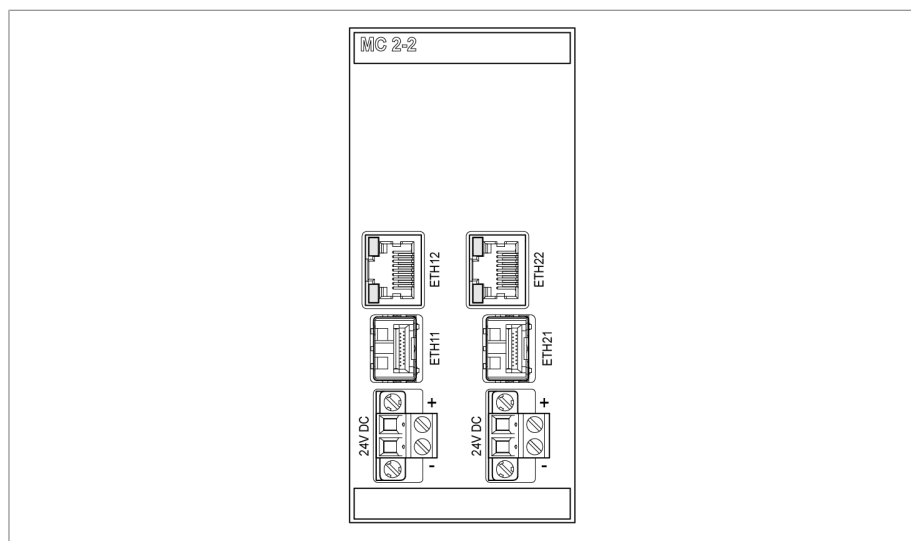


Figure 22: MC 2-2 assembly

#### 4.4.4 Connections and fuses

The connections are located on the rear of the device. You will find more information on the connections in the Technical data [► Section 13, Page 154] section.

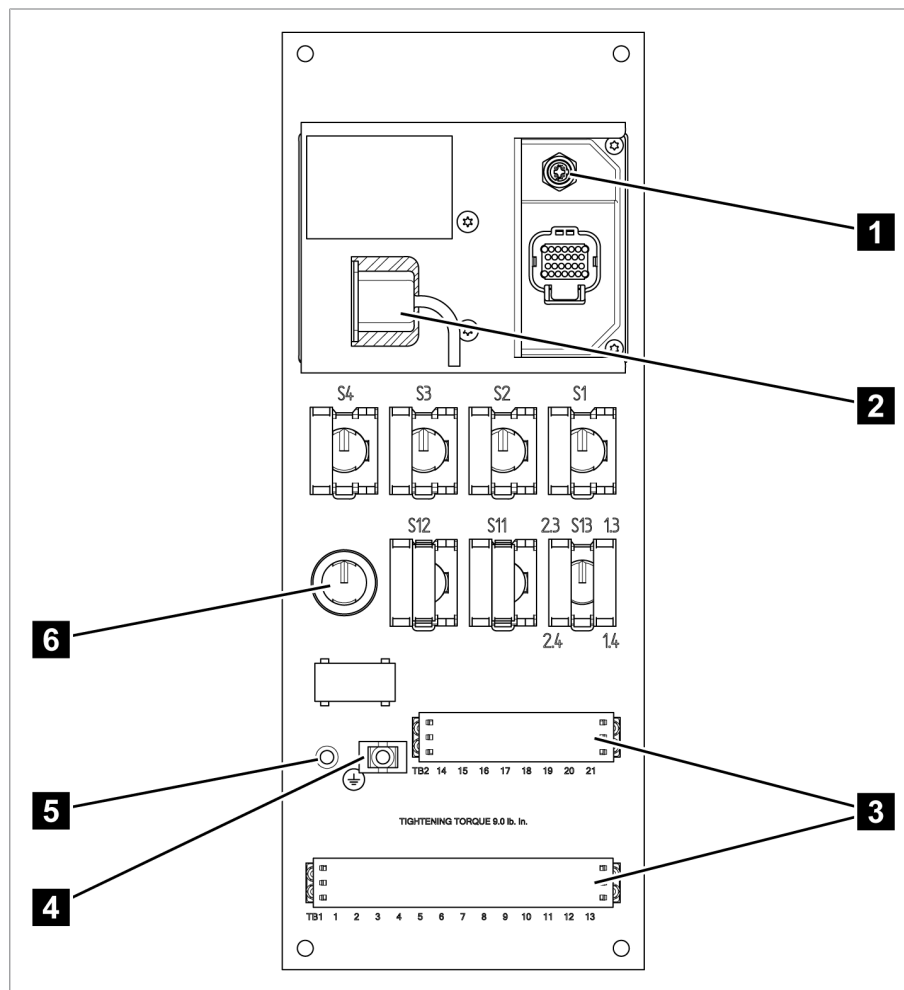


Figure 23: Rear

1 WEB panel Ethernet M12	2 WEB panel USB
3 Customer connection	4 Strain relief
5 Grounding screw	6 Ethernet service port

#### 4.4.5 Nameplate

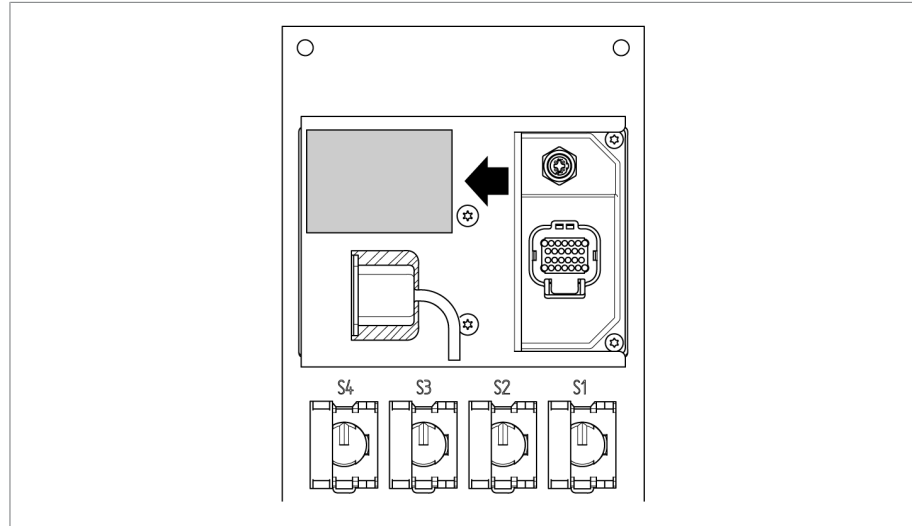


Figure 24: Nameplate on the rear of the device

#### 4.4.6 Safety markings



Warning of a danger point. Read the information given in the product operating instructions.

#### 4.4.7 Connection diagram and grounding screw

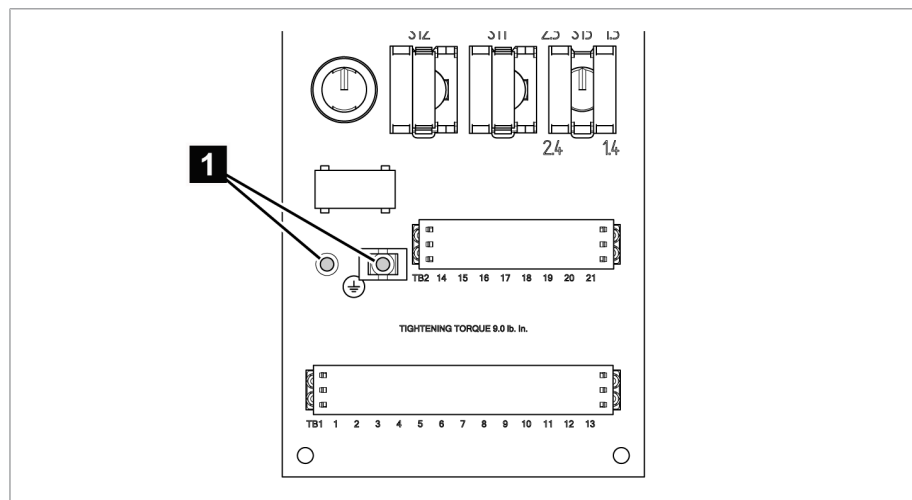


Figure 25: Connection diagram/grounding screw

1 Grounding screw and strain relief





4.4.8 Visualization

4.4.8.1 Main screen

Home

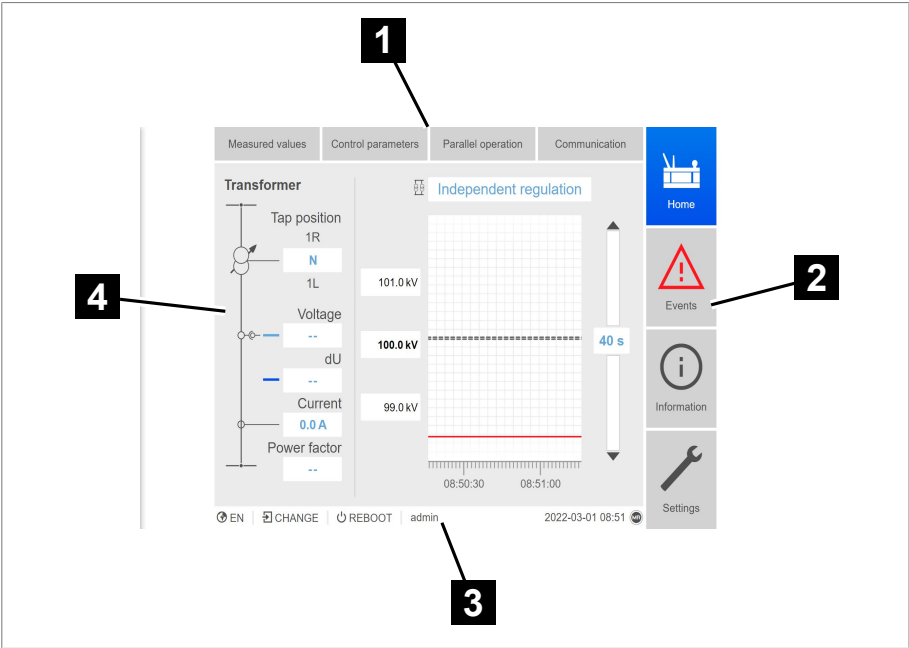


Figure 26: Home

1 Secondary navigation or navigation path	2 Primary navigation
3 Status bar	4 Display area

### Measured values/display

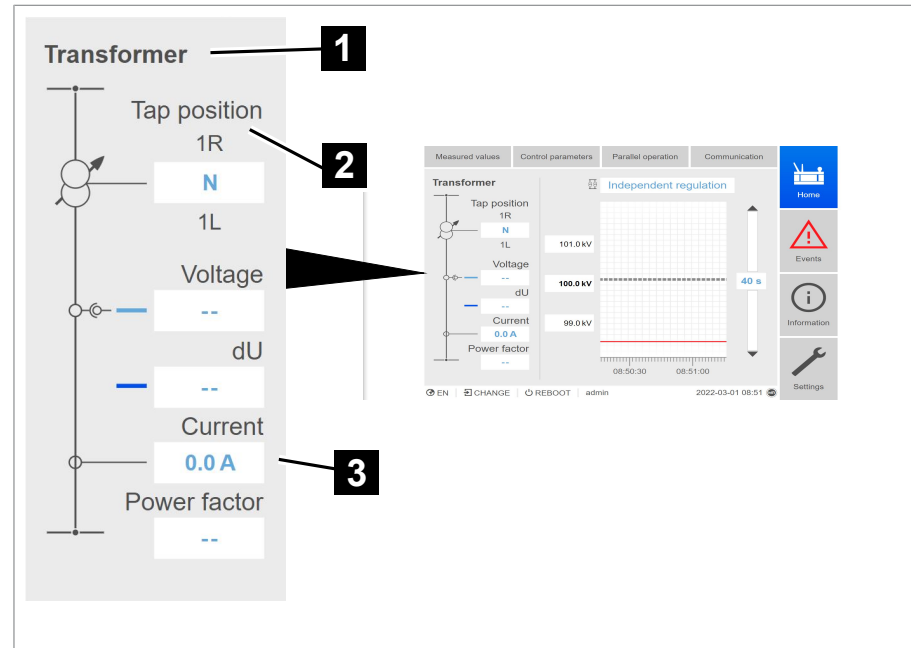


Figure 27: Measured values

- |   |                |
|---|----------------|
| 1 Transformer name (can be edited)  | 2 Tap position |
| 3 Actual measured values: Voltage, control deviation with correction, current, power factor |                |

## Desired values/actual values/delay time

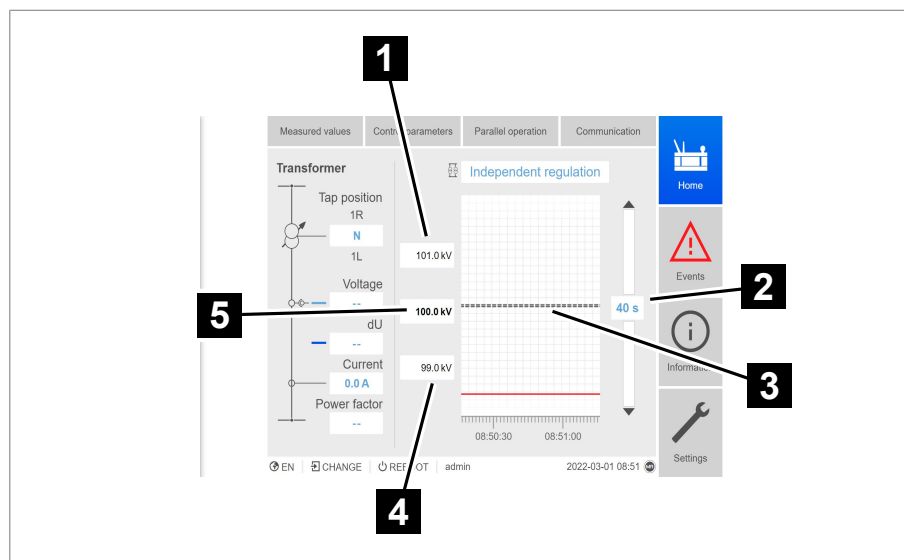


Figure 28: Display

1 Upper limit of bandwidth	2 Delay time T1/T2
3 Display of the measured voltage and corrected voltage (correction due to compensation or parallel operation)	4 Lower limit of bandwidth
5 Desired value	

## 4.4.8.2 Operating concept

You can operate the device using the controls on the front panel or using the web-based Intuitive Control Interface visualization on a PC. The scope of function and structure of both options is virtually identical.

## User rights and user roles

The device is equipped with a rights system and a roles system. The display and access rights to device settings or events can therefore be controlled at the user level. You can configure the rights system and roles system to meet your requirements. You will find more information in the User administration section.



You can only modify the device settings or parameters if you have the necessary user rights.



### Logging in, logging out and changing users

The control of access rights to device settings and parameters is user-based. Several users can log in at the same time via the visualization and access the device.







If you want to operate the device via the controls and visualization at the same time, you have to log in on the device and via the visualization.

1. Select the **LOGIN** or **CHANGE** button in the status line.
  2. Enter your user name and password and select the **OK** button.
- ⇒ The name of the logged-in user appears in the status line.

To log out as a user, proceed as follows:

- Press the **LOGOUT** button in the status line.

### Navigation

If you are operating the device using the operating controls on the front panel, you can use the keys  and  to navigate through the entire menu. The menu currently selected has a blue border. To open the highlighted menu, you have to press the  key. Pressing the  key returns you to the previous menu level.

If you are operating the device using the web-based visualization, you can navigate by clicking on the appropriate buttons:






1. Go to **Settings**.
2. Go to **Parameters**.
3. Go to **System**.
4. Go to **Time synchronization**.
5. Select **Time**.

In these operating instructions, the path for navigating to a parameter is always shown in an abridged form: Go to **Settings > Parameters > System > Time synchronization**.

### Setting parameters

There are various ways to configure the settings, depending on the parameter.

#### Selecting from a list

1. Use  to navigate to the list and press .
2. Use  or  to highlight the list entry and press .
3. Press the **Accept** button to save the modified parameter.



### Entering a value

1. Use or to select the value field and press .  
⇒ If operating via the front panel, the numerical keypad appears.

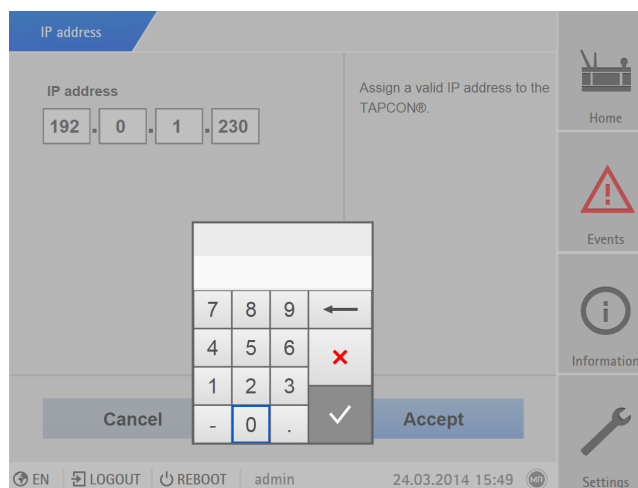


Figure 29: Entering a value

2. Enter the desired value and confirm with .
3. Press the **Accept** button to save the modified parameter.

### Entering text

1. Use or to select the text box and press .  
⇒ If operating via the front panel, the keyboard appears.

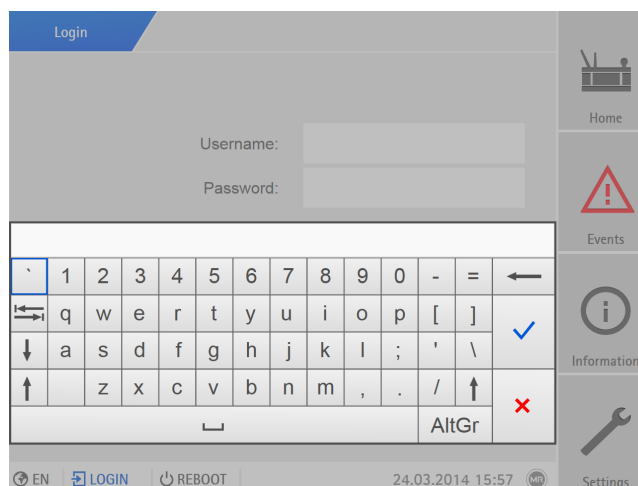


Figure 30: Entering text

2. Enter the desired text and confirm with .
3. Press the **Accept** button to save the modified parameter.



### Parameter search

You can use the quick search function in the parameter menu to search for a parameter. Enter the name of the desired parameter in the **Search** entry field.

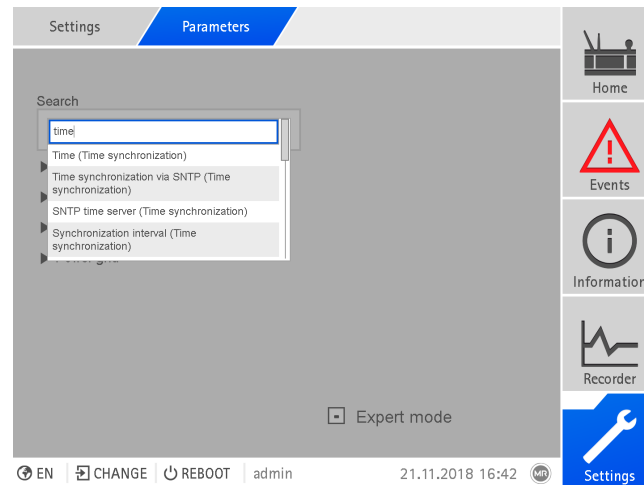


Figure 31: Quick search

### Expert mode

The device has an expert mode for entering the parameters. You can enter the parameters directly on the overview screen of the respective menu in this mode.

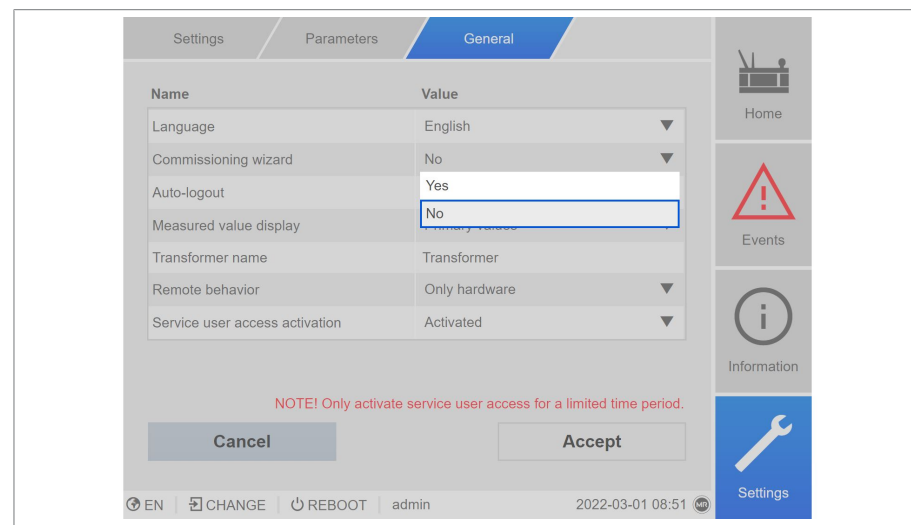


Figure 32: Expert mode



To activate the expert mode, proceed as follows:

1. Go to **Settings > Parameters**.
  2. Select the **Expert mode** checkbox.
- ⇒ Expert mode is active.

### Hiding/showing parameters

Depending on how you set the parameters, the device will hide or show additional parameters related to this function.

## 5 Packaging, transport and storage

### 5.1 Suitability, structure and production

The goods are packaged in a sturdy cardboard box. This ensures that the shipment is secure when in the intended transportation position and that none of its parts touch the loading surface of the means of transport or touch the ground after unloading.

The box is designed for a maximum load of 10 kg.

Inlays inside the box stabilize the goods, preventing impermissible changes of position, and protect them from vibration.

### 5.2 Markings

The packaging bears a signature with instructions for safe transport and correct storage. The following symbols apply to the shipment of non-hazardous goods. Adherence to these symbols is mandatory.

				
Protect against moisture	Top	Fragile	Attach lifting gear here	Center of mass

Table 7: Shipping pictograms

### 5.3 Transportation, receipt and handling of shipments

In addition to oscillation stress, jolts must also be expected during transportation. In order to prevent possible damage, avoid dropping, tipping, knocking over and colliding with the product.

If a crate tips over, falls from a certain height (e.g. when slings tear) or is subject to an unbroken fall, damage must be expected regardless of the weight.

Every delivered shipment must be checked for the following by the recipient before acceptance (acknowledgment of receipt):

- Completeness based on the delivery slip
- External damage of any type

The checks must take place after unloading when the crate or transport container can be accessed from all sides.





**Visible damage** If external transport damage is detected on receipt of the shipment, proceed as follows:

- Immediately record the transport damage found in the shipping documents and have this countersigned by the carrier.
- In the event of severe damage, total loss or high damage costs, immediately notify the sales department at Maschinenfabrik Reinhausen and the relevant insurance company.
- After identifying damage, do not modify the condition of the shipment further and retain the packaging material until an inspection decision has been made by the transport company or the insurance company.
- Record the details of the damage immediately onsite together with the carrier involved. This is essential for any claim for damages!
- If possible, photograph damage to packaging and packaged goods. This also applies to signs of corrosion on the packaged goods due to moisture inside the packaging (rain, snow, condensation).
- Be absolutely sure to also check the sealed packaging.

**Hidden damage** When damages are not determined until unpacking after receipt of the shipment (hidden damage), proceed as follows:

- Make the party responsible for the damage liable as soon as possible by telephone and in writing, and prepare a damage report.
- Observe the time periods applicable to such actions in the respective country. Inquire about these in good time.

With hidden damage, it is very hard to make the transportation company (or other responsible party) liable. Any insurance claims for such damages can only be successful if relevant provisions are expressly included in the insurance terms and conditions.

### 5.4 Storage of shipments

When selecting and setting up the storage location, ensure the following:

- Protect stored goods against moisture (flooding, water from melting snow and ice), dirt, pests such as rats, mice, termites and so on, and against unauthorized access.
- Store the crates on timber beams and planks as a protection against rising damp and for better ventilation.
- Ensure sufficient carrying capacity of the ground.
- Keep entrance paths free.
- Check stored goods at regular intervals. Also take appropriate action after storms, heavy rain or snow and so on.

## 6 Mounting

### ⚠ DANGER



#### Electric shock!

Risk of fatal injury due to electrical voltage. Always observe the following safety regulations when working in or on electrical equipment.

- ▶ Disconnect the equipment.
- ▶ Lock the equipment to prevent an unintentional restart.
- ▶ Make sure all poles are de-energized.
- ▶ Ground and short-circuit.
- ▶ Cover or cordon off adjacent energized parts.

### ⚠ WARNING



#### Electric shock!

Dangerous high voltages may occur when a current transformer is operated with an open secondary circuit. This can lead to death, injuries and property damage.

- ▶ Never operate a current transformer with an open secondary circuit; short-circuit the current transformer to prevent this.
- ▶ Observe the information in the current transformer operating instructions.

### NOTICE

#### Damage to the device!

Electrostatic discharge may cause damage to the device.

- ▶ Take precautionary measures to prevent the build-up of electrostatic charges on work surfaces and personnel.

### 6.1 Preparation



Depending on the installation site and mounting version, you may need additional tools and corresponding attachment material, such as screws, nuts and washers which are not included in the scope of delivery.

Depending on the mounting version, you need the following tools for mounting:

- Drill for wall mounting.
- Tool and material suitable for attaching the cap rail. (e.g. screwdriver for the fixing screws)
- Screwdriver for connecting the signal lines and supply lines.

## 6.2 Minimum distances

### NOTICE

#### Damage to the device!

Insufficient circulation of ambient air can result in damage to the device due to overheating.

- Keep the ventilation slots clear.
- Ensure sufficient distance to neighboring components.
- Only mount device in horizontal position (ventilation slots are at the top and bottom).

To the base of the control cabinet	Minimum clearance:
To the roof of the control cabinet	Above/below: 30 mm (1.18 in)
Between the device and other assemblies on offset cap rails	Left/right 30 mm (1.18 in) Depth 30 mm (1.38 in)

Table 8: Minimum clearances in the control cabinet

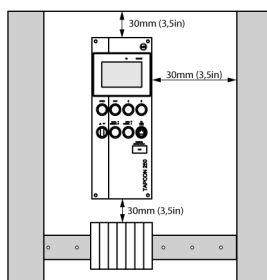


Figure 33: Minimum clearances

Attach the control cabinet to the transformer such that you can actuate display and control elements such as handles and push buttons at a height of 0.2...2 m above the floor space of the switchgear assembly.

For other installation types, contact Maschinenfabrik Reinhausen GmbH.

## 6.3 Assembly variants

### 6.3.1 Flush panel mounting

The device can be mounted in a control panel using tension clamps. The recommended wall thickness is 2...5 mm.

### Dimensions for the control panel cutout

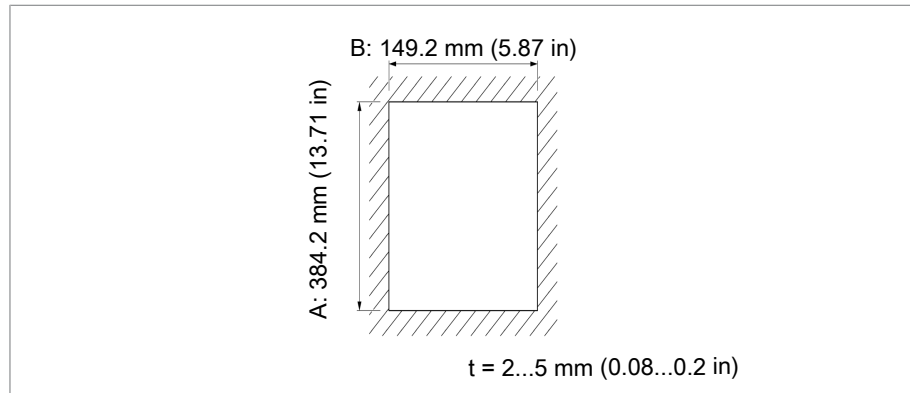


Figure 34: Dimensions for the cutout

### 1. Cut out the section for the control panel.

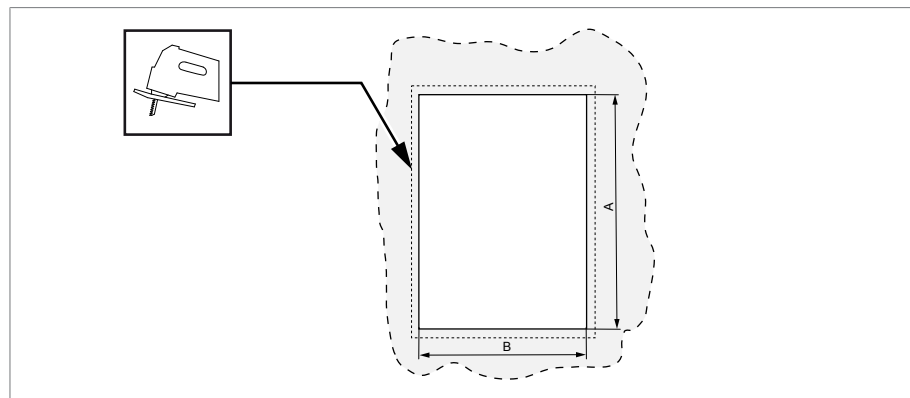


Figure 35: Cutting out the section for the control panel

2. Slide the device into the cutout from the front and secure using the recommended screws.

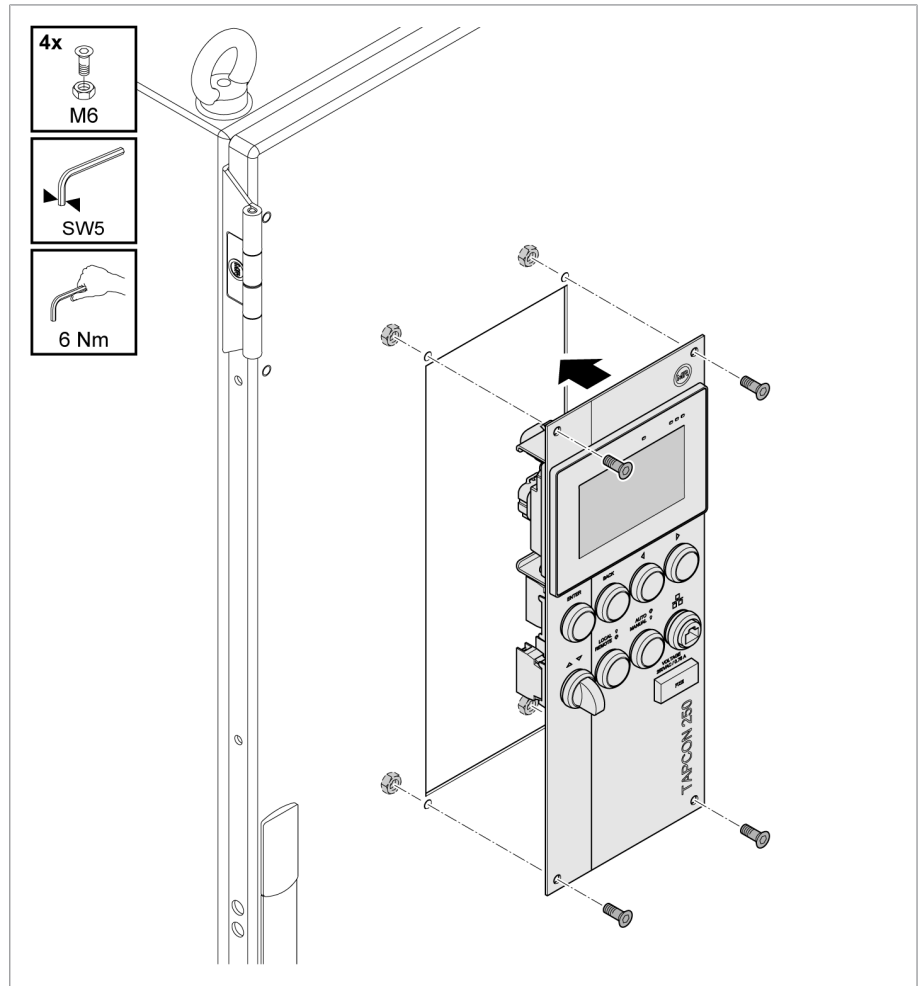


Figure 36: Inserting and screwing in the device

⇒ The device is mounted and can be wired up.

### 6.3.2 Fastening the cap rail

The cap rail is required to mount a bus bar or a device's remote assemblies in a control cabinet. Only use the following types of cap rails in accordance with EN 60715:

- TH 35-7.5
- TH 35-15

The cap rail may not be painted or lacquered.

### ⚠ WARNING



### Electric shock!

Risk of fatal injury due to electrical voltage if the cap rail is not connected to the protective ground.

- ▶ Connect the cap rail to the protective ground securely (e.g. with a protective conductor line-up terminal).
- ▶ Ensure that the cap rail is connected securely to the protective ground via a ground test after installation.
- ▶ Fasten the cap rail to the rear panel of the switch cabinet using screws and contact washers or lock washers. The distance between the screws may be no more than 10 cm (3.94 in).

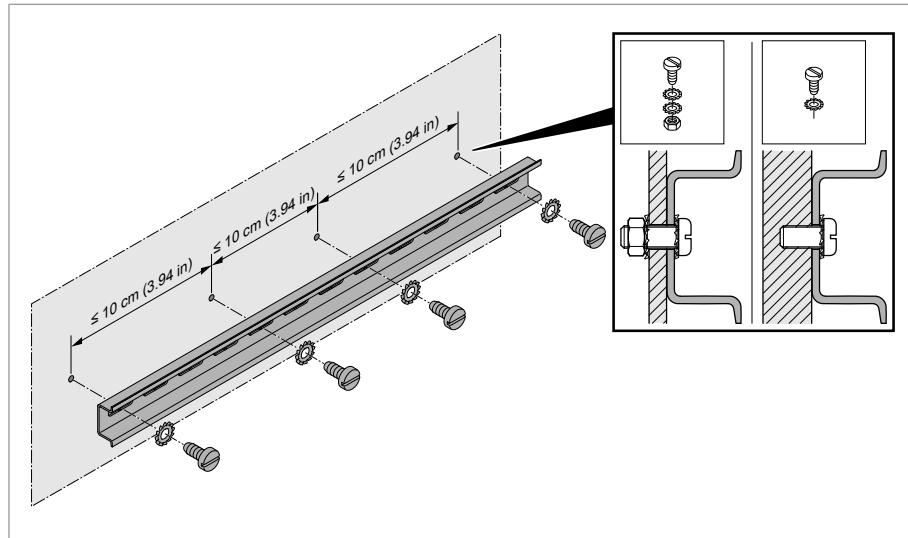


Figure 37: Fastening the cap rail

### 6.3.3 Installing modules in the control cabinet

The modules are delivered ex-works mounted on a cap rail. You can install this in your control cabinet with the modules already installed, or you can remove the individual modules and mount them on your own cap rail.

In a two-row version, the assemblies can be mounted on two cap rails one above the other using the BES system networking module.

### Mounting the cap rail in the control cabinet

- Insert the cap rail into the control cabinet and secure it using the 4 self-tapping screws supplied (tightening torque 4 Nm).

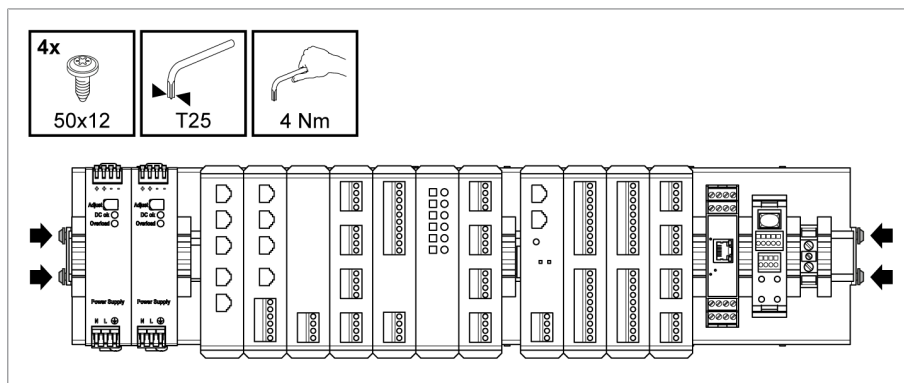


Figure 38: Example of a cap rail with mounted assemblies

### Mounting modules on your own cap rail

#### ⚠ WARNING



#### Electric shock!

Risk of fatal injury due to electrical voltage if the cap rail is not connected to the protective ground.

- Connect the cap rail to the protective ground securely (e.g. with a protective conductor line-up terminal).
- Ensure that the cap rail is connected securely to the protective ground via a ground test after installation.



If there are operating elements in your control cabinet, you must take suitable measures (e.g. covering) to ensure that the device components cannot be touched.



The arrangement of the individual modules must be in accordance with the ex-works arrangement and alignment, otherwise function errors may arise.

Only use the following types of cap rails in accordance with IEC 60715. The cap rail may not be painted or lacquered.

- TH 35-7.5
- TH 35-15

1. Latch the bus socket onto the cap rail.

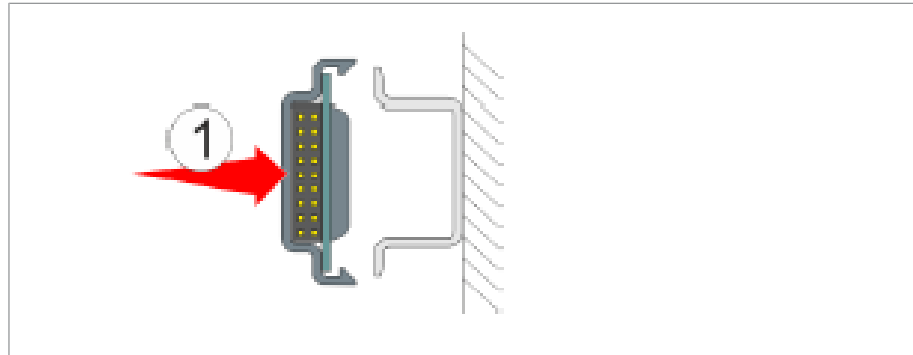


Figure 39: Bus connector on cap rail

2. Push the module onto the bus connector.

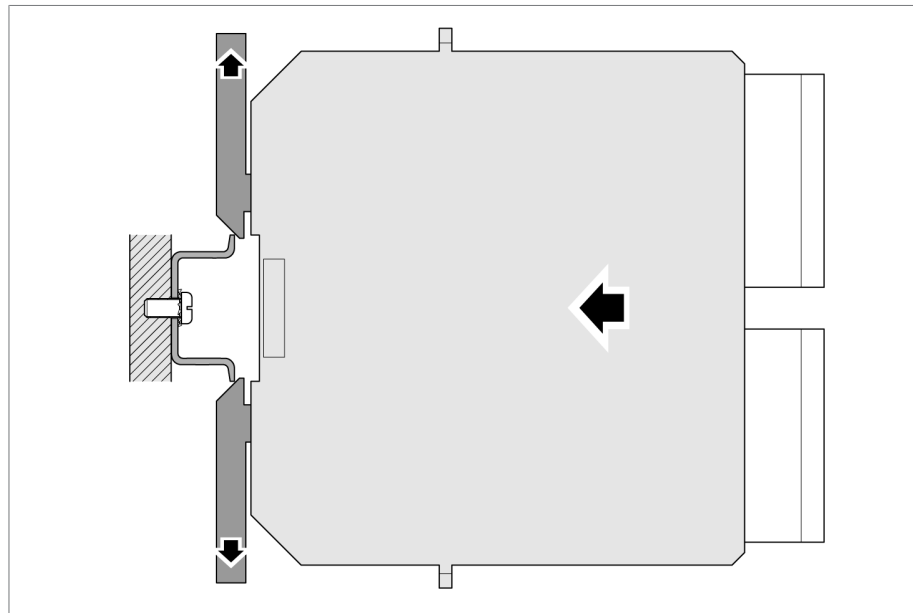


Figure 40: Module on bus connector

⇒ The locking latches latch into place on the bus socket or cap rail.



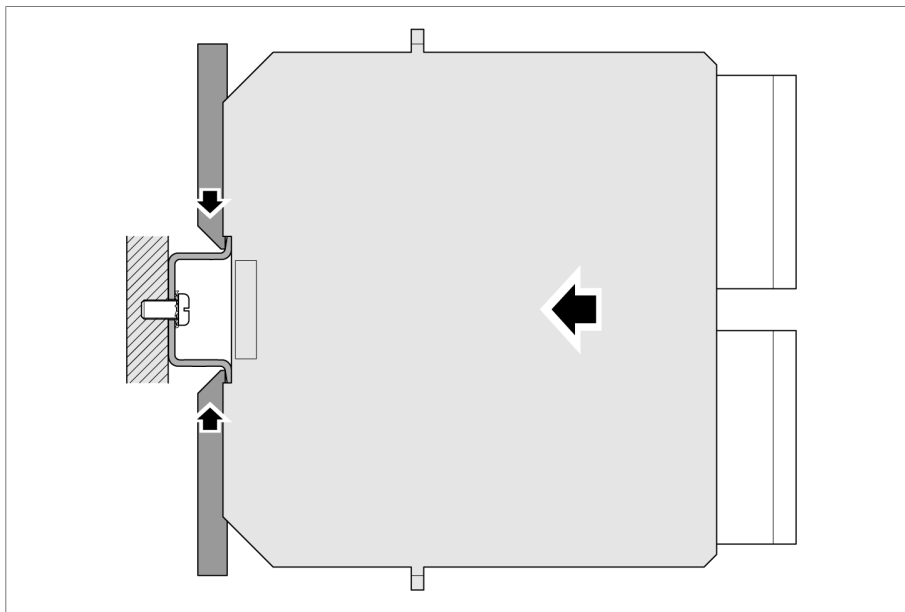


Figure 41: Latching locking latches

- ▶ **⚠ WARNING!** A faulty connection to the protective ground can lead to an electric shock in the event of faults. Ensure that the module latches in correctly.

## 6.4 Connecting the device

### ⚠ WARNING



#### Electric shock!

Connection errors can lead to death, injury or property damage.

- ▶ Ground the device with a protective conductor using the grounding screw on the housing.
- ▶ Note the phase difference of the secondary terminals for the current transformer and voltage transformer.
- ▶ Connect the output relays correctly to the motor-drive unit.



Supply the voltage via separators and ensure that current paths can be short-circuited. Fit the separator, clearly labeled and freely accessible, close to the device's power supply. This ensures that the device can be replaced with ease in the event of a defect.

#### Wiring information

- To obtain a better overview when connecting cables, only use as many cables as necessary.
  - Observe the connection diagram.
  - Only use the specified cables for wiring. Note the cable recommendation.
  - Wire the leads to the system periphery.
  - For wall mounting with housing (optional):
    - When wiring the device, use the cable glands below the housing if necessary.
    - **NOTICE!** Damage to the device! If any cable glands remain open, the IP degree of protection cannot be assured. Close off unused cable glands using dummy plugs.
1. Disconnect the connectors required.
  2. Strip insulation from cables and wires.
  3. Crimp stranded wires with wire end sleeves.
  4. Guide leads into corresponding connector terminals.
  5. Fasten screws for the corresponding terminals using a screwdriver.
  6. Plug connectors into the correct slots.

### 6.4.1 Cable recommendation

Please note the following Maschinenfabrik Reinhausen recommendation when wiring the device.



Excessive line capacitance can prevent the relay contacts from interrupting the contact current. In control circuits operated with alternating current, take into account the effect of the line capacitance of long control cables on the function of the relay contacts.

If you want to route Ethernet connections from a control cabinet or building, we recommend using fiber-optic cables (in accordance with the IEC 61850-90-4 recommendation).

Cable	Interface	Cable type	Conductor cross-section	Max. length
Power supply (external)	X9	Unshielded	2.5 mm <sup>2</sup>	
Voltage measurement	UI-X7	Shielded	2.5 mm <sup>2</sup>	
Current measurement	UI-X7	Unshielded	4 mm <sup>2</sup>	
Digital signal inputs 110 V AC	DI 8	Shielded	1.5 mm <sup>2</sup>	400 m (<25 Ω/km)
Digital signal inputs 24V DC	DI 8	Shielded	1.5 mm <sup>2</sup>	400 m (<25 Ω/km)
Auxiliary voltage output 24V DC	DI 8	Shielded	1.5 mm <sup>2</sup>	400 m (<25 Ω/km)
Digital signal outputs	DO 8	Shielded	1.5 mm <sup>2</sup>	
Analog signal inputs	AI 4	Shielded	1 mm <sup>2</sup>	400 m (<25 Ω/km)
Analog signal outputs	AO 4	Shielded	1 mm <sup>2</sup>	400 m (<25 Ω/km)
RS232, D-SUB 9-pole	X3	Shielded	0.25 mm <sup>2</sup>	25 m
RS485	X5	Shielded	0.25 mm <sup>2</sup>	140 m
CAN bus	COM-X6	Shielded	0.75 mm <sup>2</sup>	2000 m (total CAN bus)
Ethernet RJ45	COM-X6	Min. CAT5, shielded S/FTP		100 m
Ethernet FO	COM X4	Duplex LC multi- mode, Om3, 1310 nm		2000 m
RJ45 patch cables		Min. CAT5, shielded S/FTP		approx. 30 cm
Ground connection	PE terminal	Unshielded	6 mm <sup>2</sup>	

Table 9: Recommendation for connection cables

#### 6.4.2 Electromagnetic compatibility

The device has been developed in accordance with applicable EMC standards. The following points must be noted in order to maintain the EMC standards.

### 6.4.2.1 Wiring requirement of installation site

Note the following when selecting the installation site:

- The system's overvoltage protection must be effective.
- The system's ground connection must comply with all technical regulations.
- Separate system parts must be joined by a potential equalization.
- The device and its wiring must be at least 10 m away from circuit-breakers, load disconnectors and busbars.

### 6.4.2.2 Wiring requirement of operating site

Note the following when wiring the operating site:

- Route the connecting leads in grounded metal cable ducts.
- Do not route lines which cause interference (e.g. power lines) and lines susceptible to interference (e.g. signal lines) in the same cable duct.
- Maintain a distance of more than 100 mm between lines which cause interference and those which are susceptible to interference.

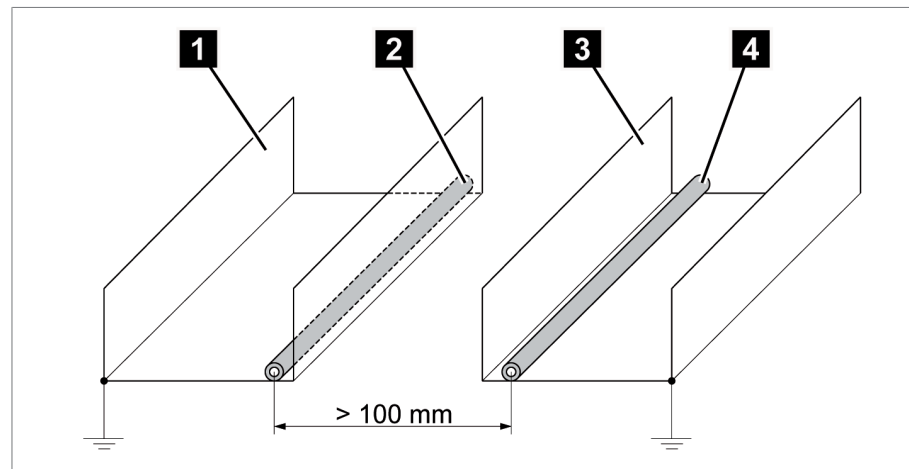


Figure 42: Recommended wiring

1 Cable duct for lines causing interference	3 Cable duct for lines susceptible to interference
2 Line causing interference (e.g. power line)	4 Line susceptible to interference (e.g. signal line)

- Short-circuit and ground reserve lines.
- Never connect the device with a multi-wire collective pipe.
- For signal transmission, use shielded lines with individual conductors (outgoing conductor / return conductor) twisted in pairs.
- Connect full surface of shielding (360°) to device or to a nearby grounding bar.



Using single conductors may limit the effectiveness of the shielding. Connect close-fitting shielding to cover all areas.

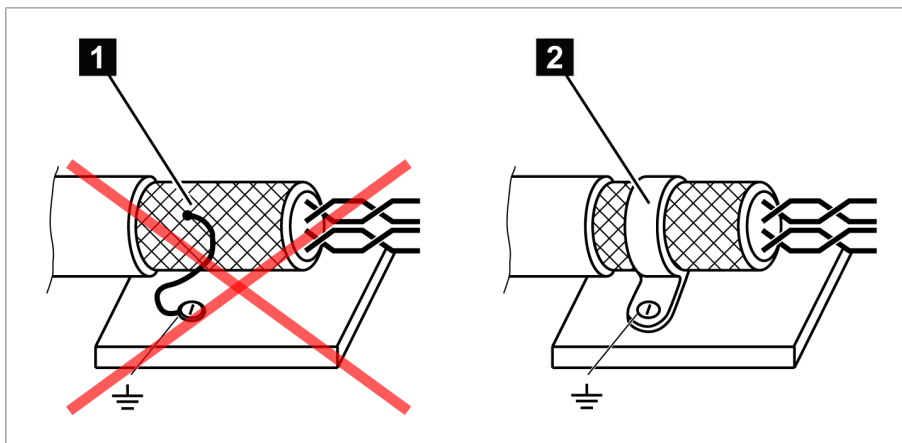


Figure 43: Recommended connection of the shielding

1 Connection of the shielding via a single conductor

2 Full-surface connection of the shielding

#### 6.4.2.3 Wiring requirement in control cabinet

Note the following when wiring in the control cabinet:

- The control cabinet where the device will be installed must be prepared in accordance with EMC requirements:
  - Functional division of the control cabinet (physical separation)
  - Constant potential equalization (all metal parts are joined)
  - Line routing in accordance with EMC requirements (separation of lines which cause interference and those susceptible to interference)
  - Optimum shielding (metal housing)
  - Overvoltage protection (lightning protection)
  - Collective grounding (main grounding rail)
  - Cable bushings in accordance with EMC requirements
  - Any contactor coils present must be interconnected
- The device's connection cables must be laid in close contact with the grounded metal housing or in metallic cable ducts with a ground connection.
- Signal lines and power lines/switching lines must be laid in separate cable ducts.

- The cap rails used must be networked with each other and connected to the system ground over a large area.
- The device must be grounded on the provided screw, the protective ground connection, with a ground strap (cross-section of min. 8 mm<sup>2</sup> (0.32 in<sup>2</sup>)).

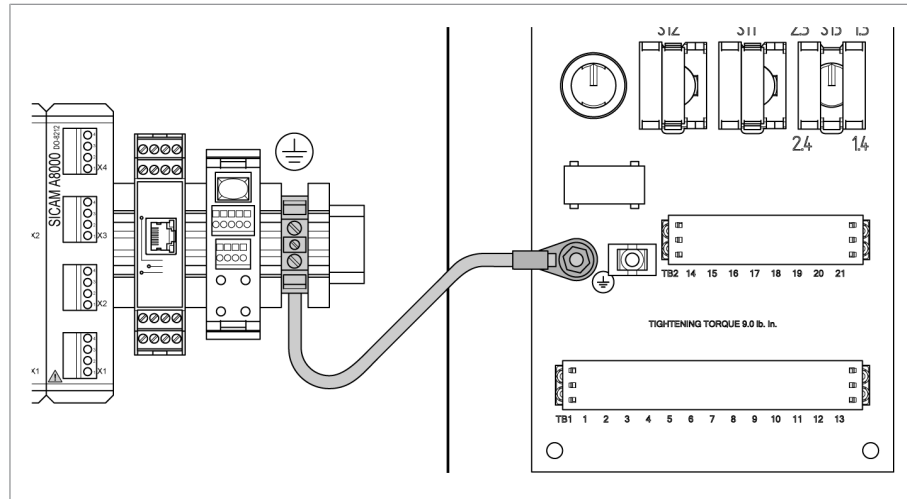


Figure 44: Ground strap connection

### 6.4.3 Connecting cables to the system periphery



To obtain a better overview when connecting cables, only use as many leads as necessary.

To connect cables to the system periphery, proceed as follows:

- ✓ Use only the specified cables for wiring. Note the cable recommendation.
- Connect the lines to be wired to the device to the system periphery as shown in the connection diagrams supplied.

### 6.4.4 Connecting the CAN bus

#### 6.4.4.1 Shielding the CAN bus

In order for the CAN bus to operate faultlessly, you have to connect the shielding using one of the following variants. If you are not able to use any of the variants detailed below, we recommend using fiber-optic cables. Fiber-optic cables decouple the devices and are not sensitive to electromagnetic interference (surge and burst).



### NOTICE

#### Damage to the device!

If you connect the CAN bus cable to devices with different potentials, current may flow across the shielding. This current may damage the device.

- Connect the devices to a potential equalization rail to equalize the potential.
- If both devices have different potentials, only connect the CAN bus cable shielding to one device.

#### Variant 1: The connected devices share the same potential

1. Connect all devices to a potential equalization rail to equalize the potential.
2. Connect the CAN bus cable shielding to all connected devices.

#### Variant 2: The connected devices have different potential levels



Note that the shielding is less effective with this variant.

1. Connect the CAN bus cable shielding to **just one** device.
2. Connect the wires of the shielded CAN bus cable in accordance with the connection diagram supplied.

#### 6.4.4.2 Mounting terminating resistor of CAN bus

If you want to operate the device in parallel operation, you need to mount a 120  $\Omega$  terminating resistor at both ends of the CAN bus between CAN\_L and CAN\_H (see supplied connection diagram).

#### 6.4.5 Wiring voltage measurement/current measurement UI

You must fuse the voltage measurement circuit in accordance with the conductor cross section used. You can use the following fuse types:

	Miniature circuit breaker	Safety fuse
Standard	IEC 60947-2	IEC 60269
Rated voltage	110/230 V (L-N)	
Rated current	1.6 mA...16 A	

	Miniature circuit breaker	Safety fuse
Characteristics	B, C, K or Z	Fast-acting, medium-acting or delayed-acting
Rated switching capacity	50 kA	
	For installation in accordance with IEC 61010-2-30 CAT II: 10 kA	

Table 10: Permissible fuse types

1. Voltage measurement: Feed the wires into the terminals in accordance with the connection diagram and fasten them using a screwdriver.
2. Current measurement: Feed the wires into the terminals in accordance with the connection diagram and fasten them using a screwdriver.

### 6.4.6 Wiring the MC 2-2/SW3-3 assembly

1. Insert the supplied SFP module into the corresponding Ethernet interface **1** in accordance with the connection diagram and fold the clasp **2** down.

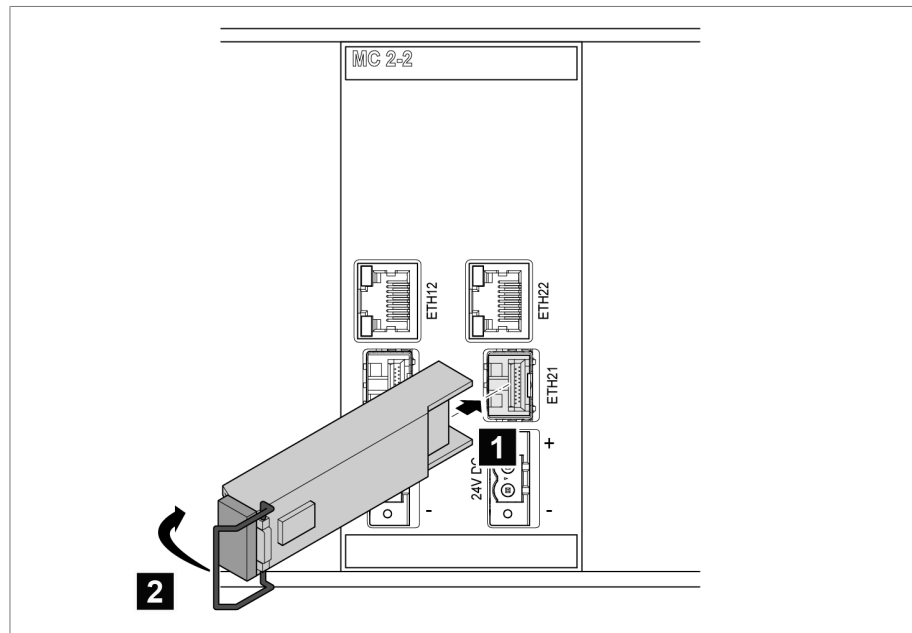


Figure 45: Engaging the SFP module



2. Remove the SFP module dust plug.

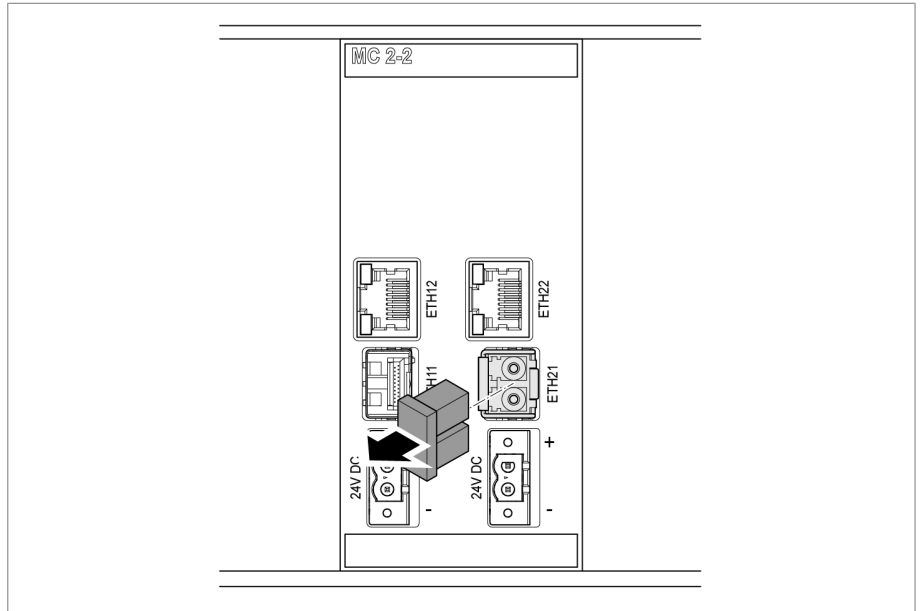


Figure 46: Removing the dust plug

3. Insert the fiber-optic cable into the SFP module.

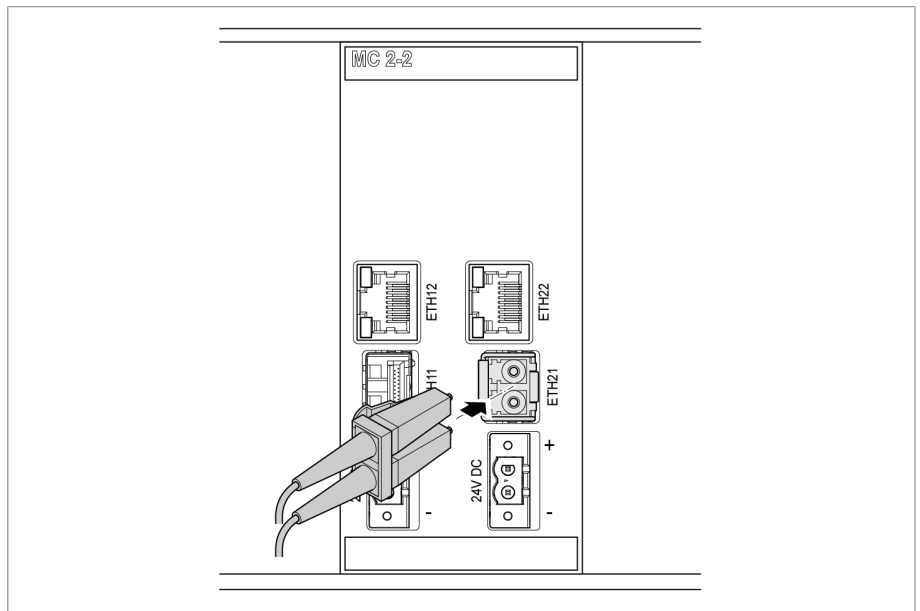


Figure 47: Inserting the fiber-optic cable

### 4. Insert the network cable.

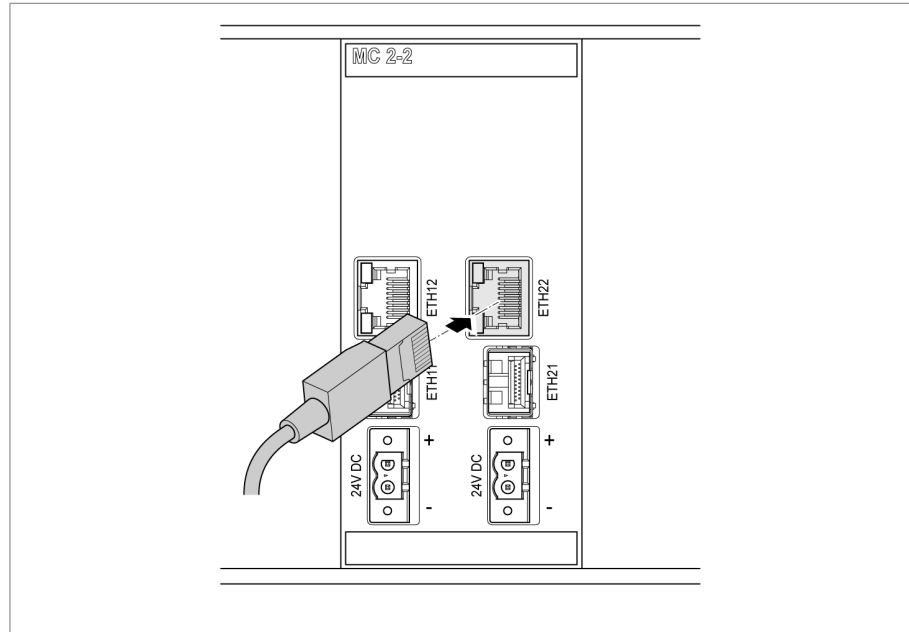


Figure 48: Inserting the network cable

### Voltage supply

Connect the MC2-2/SW3-3 assembly to the voltage supply of the voltage supply unit:

1. Guide the leads into the respective plug terminals for the voltage supply and fasten them using a screwdriver.

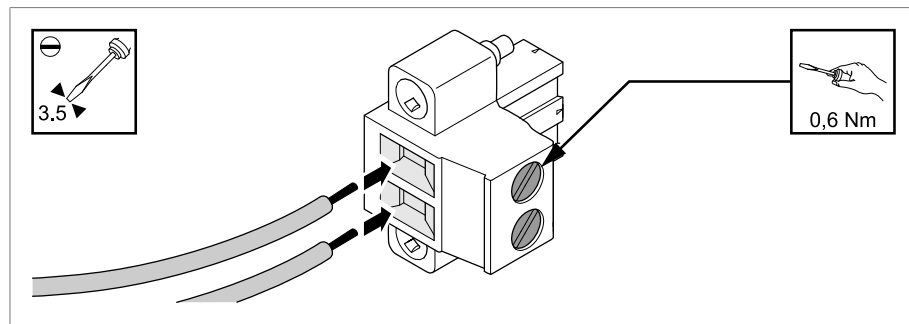


Figure 49: Inserting the leads

2. Insert and fasten the plug into the respective "24V DC" slot.

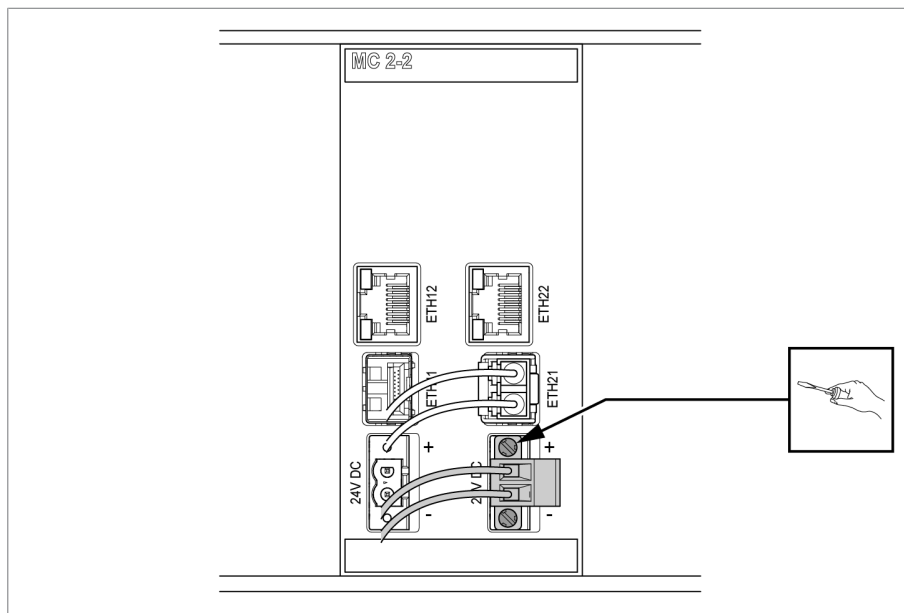


Figure 50: Fastening the 24 V DC plug

#### 6.4.7 Wiring analog inputs AI

##### **NOTICE**

##### **Damage to the device and sensors!**

Incorrectly connected and configured analog inputs/outputs may result in damage to the device and sensor.

- Follow information about connecting analog sensors.
- Configure analog inputs and outputs according to the connected sensors.

You can connect the following types of analog sensors:

- 0/4...20 mA
- 0 to 10 V

In order to correctly record the analog signals, you must place the cable shielding on the grounding bar. In order to correctly record the analog signals, you must place the cable shielding on the grounding bar. The cable shielding should only be removed just prior to connecting to ensure that the section with unshielded cables is kept as short as possible. The shielding must be connected with shielding clips.

## Block diagram and wiring versions

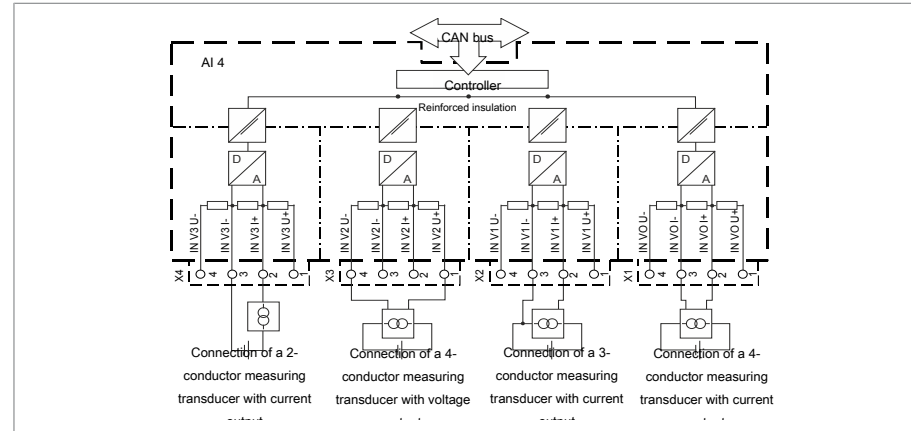


Figure 51: Block diagram for analog inputs

1. Lead the wires into the connector and fasten them using a screwdriver.
2. Insert the plug into the respective slot in accordance with the connection diagram and screw into place.

### 6.4.8 Wiring digital inputs DI

If you use digital inputs, these have to be supplied with an auxiliary voltage of 110 V DC for the DI 16-110 V and 24 V for the DI 16-24 V.

If the tap position capture method [► Section 9.4.1.2, Page 131] is changed, ensure that all inputs are connected to the same card DI 16-110 V or DI 16-24 V.

1. Feed the wires into the terminal of the DI 16-110V and DI 16-24 V in accordance with the connection diagram and fasten them using a screwdriver.
2. Plug the connector into the respective slot and screw it into place.

#### Auxiliary power supply for digital inputs

1. Feed the wires into the terminals X8:2 and X8:1 of the X8 plug in accordance with the connection diagram and fasten them using a screwdriver.
2. Plug the connector into the respective slot and screw it into place.

### 6.4.9 Wiring digital outputs DO

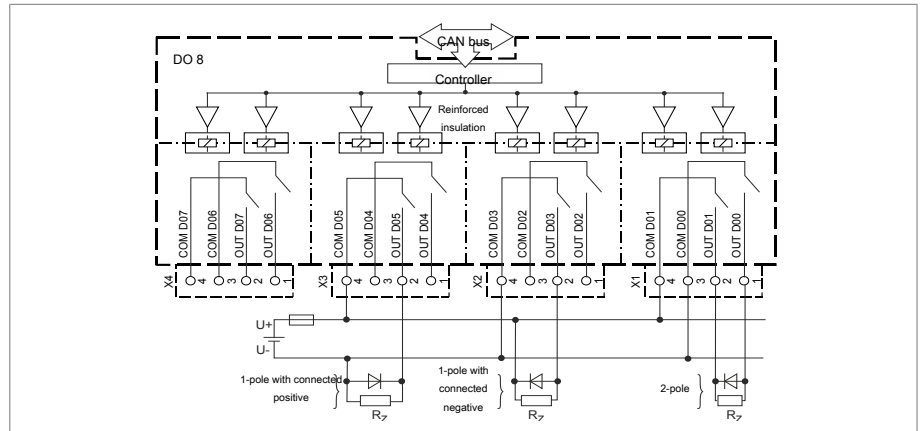


Figure 52: Block diagram for digital outputs

1. Feed the wires into the terminal of the plug in accordance with the connection diagram and fasten them using a screwdriver.
2. Plug the connector into the respective slot and screw it into place.

### 6.4.10 Wiring resistor contact series

Connect the resistor contact series to the AO 4 and AI 4 interfaces in accordance with the connection diagram [► Section 13.3, Page 175].

### 6.4.11 Connecting the power supply

You may only connect the device to circuits with an external overcurrent protective device and an all-pole isolating device, allowing the equipment to be fully de-energized if required (service, maintenance etc.).

Suitable equipment includes isolating devices in accordance with IEC 60947-1 and IEC 60947-3 (e.g. circuit breakers). Observe the properties of the relevant circuits (voltage, maximum currents) when selecting the circuit breaker type. In addition, observe the following:

- It must be easy for the operator to access the isolating device
- The isolating device must be labeled for the device and the circuits to be isolated
- The isolating device may not be a part of the power line
- The isolating device may not interrupt the main protective conductor

**Miniature circuit breaker** You must fuse the power supply circuit with a miniature circuit breaker. The miniature circuit breaker must have the following properties:

- Rated current: 1.6 mA...16 A
- Triggering characteristic: B, C, K or Z



**Conductor cross-section** For the power supply circuit, use a conductor cross-section suitable for the miniature circuit breaker that you have selected, but at least 1.5 mm<sup>2</sup> (AWG 15).

**Connecting the power supply**

► Connect the power supply in accordance with the connection diagram.



### 6.5 Performing tests

#### **NOTICE**

#### **Damage to device and system periphery**

An incorrectly connected device can lead to damage to the device and system periphery.

- ▶ Check the entire configuration before commissioning.
- ▶ Prior to commissioning, check the supply voltage and the measured voltage.
  
- ▶ Connecting the device to mains.
  - ⇒ The display shows the MR logo and then the operating screen.
  - ⇒ The *voltage display* LED on the top right on the device's display lights up.



## 7 Initial steps

### NOTICE

#### Damage to device and system periphery

An incorrectly connected device can cause damage to the device and system periphery.

- Check the entire configuration before commissioning.

As soon as the device has powered up and the start screen is displayed, you will be asked to make the following settings:

### 7.1 Establishing connection to visualization

A connection to the visualization can be established using two interfaces:

- Front interface (for local access)
- Optional: Interface X2 of COM-ETH on the rear of the device (for access via remote display, control center etc.)

The interfaces do not use a DHCP server. Therefore, you must assign a static IP address to your PC. To do this, observe the following configuration example:

- Interface configuration example

Interface		Configuration
Basic	CPU X2	IP address: 192.168.165.1
	PC	IP address: 192.168.165.200
		Subnet mask: 255.255.255.0

#### System requirements

To access the web-based visualization, you need a PC with an HTML5-capable browser. The display is optimized for the following browsers:

- Microsoft Edge
- Google Chrome™





**Establishing a connection via front interface**

- 1. Remove the interface cover on the front of the device.
- 2. Connect the PC and the device via the front interface using an Ethernet cable (RJ45 plug).

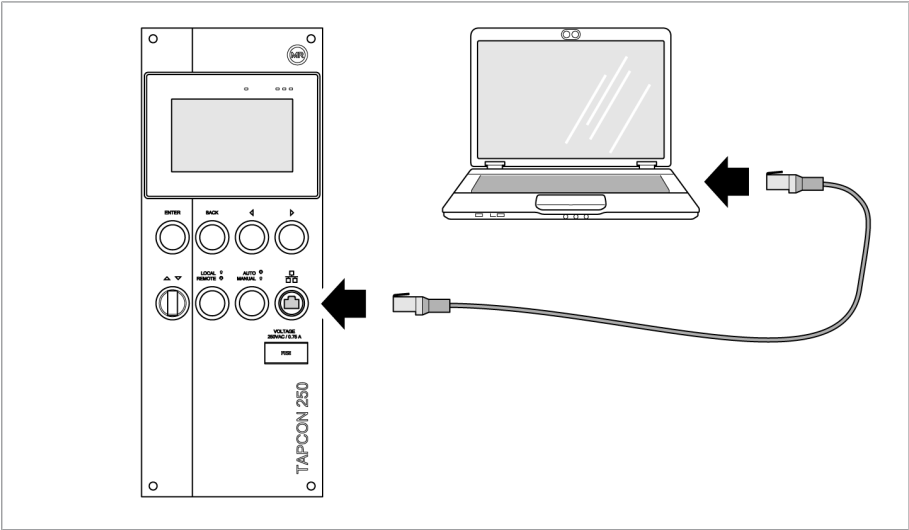


Figure 53: Establishing a connection via front interface

- 3. Enter the visualization's IP address `http://192.168.165.1`, or if SSL encryption is active, enter `https://192.168.165.1` in the browser on the PC.
- ⇒ The visualization is accessed.

**Establishing a connection via the rear CPU-X3 interface**


- 1. Connect the PC and device.
  - 2. Go to **Communication** on the device to display the device's IP address.
  - 3. Assign a unique IP address to the PC in the same subnet as the device (e.g. `192.0.1.100`).
  - 4. Enter the visualization's IP address in your PC's browser.
- ⇒ The visualization is accessed.

**Setting the language**

English	Italian
German	Portuguese
French	Russian
Spanish	Chinese
Korean	Polish


Table 11: Available display languages



1. Press the  EN button in the status bar.
2. Select the desired language from the list field.
3. Press the Accept button to adopt the parameter.  
⇒ The "Restart device" dialog is displayed.
4. Restart the device to apply the changed language setting.

### 7.2 Downloading the operating instructions

Download the operating instructions from the device to start device commissioning and parameterization.

► Select  in the status line.

⇒ The operating instructions will be downloaded.

The document is also available for download in the MR Customer Portal and on our website [www.reinhausen.com](http://www.reinhausen.com).



## 8 Commissioning

### NOTICE

#### Damage to device and system periphery

An incorrectly connected device can cause damage to the device and system periphery.

► Check the entire configuration before commissioning.

### 8.1 Commissioning wizard

If you want the device to help when setting the relevant parameters, you can use the commissioning wizard. The commissioning wizard provides a selection of parameters that you can configure in order.

A detailed description of each of the parameters can be found in the Operation [► Section 9, Page 76] chapter.



To call up the commissioning wizard, you will need the necessary access rights.

When in delivery status, you can log in as the administrator as follows:

- User name: `admin`
- Password: `admin`

1. Log in as a user with the necessary access rights.
2. Go to **Settings > Commissioning wizard**.
3. Press the **Next** button to launch the commissioning wizard.
4. Follow the on-screen instructions.

Once you have entered all of the parameters relevant to commissioning, continue with the function test.

### 8.2 Performing tests



Please contact Maschinenfabrik Reinhausen GmbH (MR) if any aspect of the tests is not clear.

### 8.2.1 Ground test

For commissioning, carry out a ground test (check of the protective bonding impedance) in accordance with IEC 61010-1. Observe the following information when testing:

- Test current: 2 times the rated current of the overcurrent protection device in the supply line.
- Test duration: 1 minute for each measurement point.
- The measured voltage between the measurement point and the protective conductor must be less than 10 V.

To carry out the ground test, proceed as follows:

- Apply the test current at the grounding terminal of the G1 PULS DIMENSION QS3.241 assembly using a constant current source and measure the voltage between the measurement point and the protective conductor.
- ⇒ The measured voltage must remain less than 10 V for a period of 1 minute.

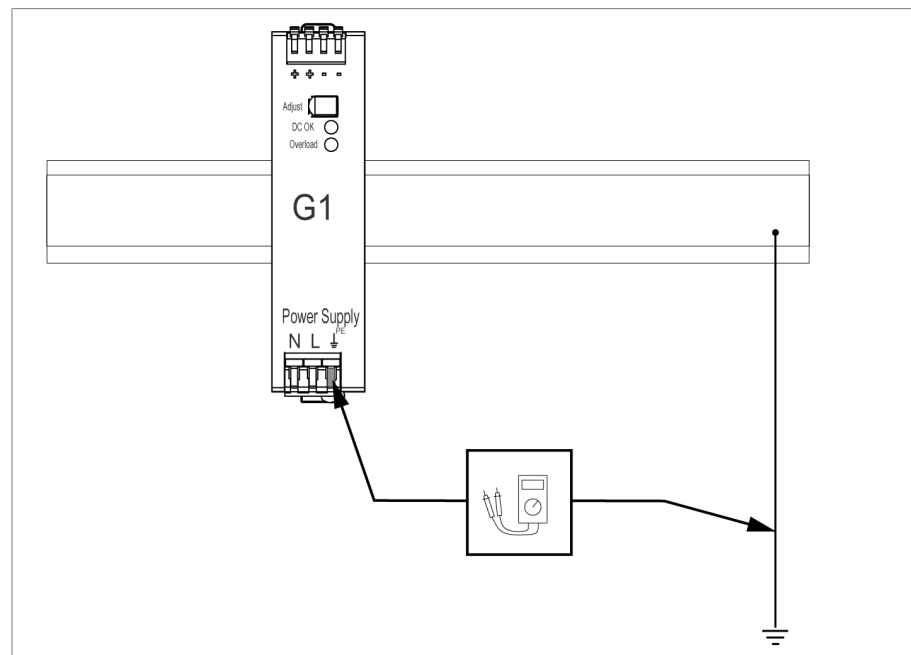


Figure 54: Perform a ground test on the G1 PULS DIMENSION QS3.241 assembly

### 8.2.2 Performing a dielectric test

The device is tested before delivery. Note the following points if you would like to perform a dielectric test:

**NOTICE****Damage to the device!**

A dielectric test with a test voltage that is greater than the maximum permitted test voltage can lead to the device being damaged.

- Perform the dielectric test with a test voltage that is less than or equal to the maximum permitted test voltage.
- Perform the dielectric test using the permitted interfaces only.

Depending on the device configuration, you may only test the assemblies listed below. You may not test any other assemblies.



Assembly	Interfaces	Test parameters			
		Max. test voltage	Max. test duration	Ramp	Breaking current threshold
AI-8340	X2-9 to 8 X2-7 to 6 X2-5 to 4	2.0 kV AC	2 s	5 s	> 4 mA
DO-8212	DO	2.0 kV AC	2 s	5 s	> 1 mA
G1 (PULS) and G2	N, L	2.0 kV AC	2 s	5 s	> 4 mA

Table 12: Permitted interfaces and test parameters for the dielectric test



### 8.3 Function tests

Before switching from manual mode to auto mode, Maschinenfabrik Reinhausen recommends carrying out function tests. These function tests are described in the following sections. Note the following points for all function tests:

- You have to change the pulse type [► Page 140] to time-controlled switching pulse in order to activate the operating keys.
- You must ensure that LOCAL mode is activated before you can control the on-load tap-changer manually in manual mode.
- You can only activate the on-load tap-changer manually in manual mode using the  and  keys.
- You have to be logged in to the device as a user with a parameter configurator or administrator user role.

When in delivery status, you can log in as the administrator as follows:

- User name: `admin`
- Password: `admin`

During the function test, you must set the most important parameters. Details on the parameters listed can be found in the Operation [► Section 9, Page 76] chapter.

#### 8.3.1 Checking measured values and status of digital inputs and outputs












Upon commissioning the device, check whether the measured values and status of digital inputs and outputs are plausible. To do so, use an additional measuring device if necessary to check the individual measured values.

1. Go to **Information > Hardware**.
2. Select the individual **assemblies** one after another and check the individual measured values or the status of digital inputs and outputs.
3. If errors arise, check the measurement path and the wiring.

#### 8.3.2 Testing the device control function

- ✓ Supply voltage must be present.
  - ✓ Switch pulse type to time-controlled pulse (default = continuous pulse).
1. Press the **AUTO/MANUAL key** to select manual mode.
  2. Set the transmission ratio for the voltage transformer, current transformer and transformer circuit.
  3. Measure actual voltage and compare with the measured value displayed on the device's main screen.



4. Select the **Measured values** menu item to display the operating values for current and power and compare them with the values of the operation measurement instruments.
5. Control the on-load tap-changer manually using the  or  keys until the measured voltage  $U_{\text{actual}}$  reaches the desired voltage  $U_{\text{desired}}$  ("desired value 1").
6. Set the desired value to the value you want.
7. Set the bandwidth depending on the step voltage.
8. Set the delay time T1 to 20 seconds [► Page 122].
9. Set the time response T1 to linear [► Page 122].
10. Press  to raise the on-load tap-changer one step.
11. Press  to select auto mode.
  - ⇒ If the actual voltage is outside the bandwidth, the device returns the on-load tap-changer to the original operating position after 20 seconds.
12. Press  to select manual mode.
13. Press  to lower the on-load tap-changer one step.
14. Press  to select auto mode.
  - ⇒ If the actual voltage is outside the bandwidth, the device returns the on-load tap-changer to the original operating position after 20 seconds.
15. Press  to select manual mode.
16. Set the delay time T2 to 10 seconds and activate it [► Page 123].
17. Press  twice to raise the on-load tap-changer two steps.
18. Press  to select auto mode.
  - ⇒ If the actual voltage is outside the bandwidth, after 20 seconds the device lowers the on-load tap-changer one step and after another 10 seconds another step.
19. Press  to select manual mode.
20. Set the delay time T1 [► Page 122] and delay time T2 [► Page 123] to the desired value.



We recommend a temporary setting of 100 seconds for **delay time T1** when commissioning the transformer. Depending on the operating conditions, you can also specify the delay time following a longer observation period. In this regard, it is useful to register how the actual voltage progresses and the number of tap-change operations per day.



## 9 Operation

### 9.1 System

#### 9.1.1 General

You can set general parameters in this menu item.

##### 9.1.1.1 Setting general device functions

You can set general device functions with the following parameters.

1. Go to **Settings > Parameters > System > General**.
2. Select the desired parameter.
3. Set the parameter.
4. Press the **Accept** button to save the modified parameter.

##### Commissioning wizard

You can use this parameter to set whether the commissioning wizard is to launch automatically when the device is restarted.

##### Measured value display

You can use this parameter to set whether the displayed measured values and control parameters are to refer to the primary side or secondary side of the measuring transducers.

##### Transformer name

You can use this parameter to enter a transformer name for identification purposes. The transformer name will be displayed on the main screen in the visualization.

##### 9.1.1.2 Set up automatic logout

You can change the settings so that the device of a logged-in user automatically logs the user out after a certain period of inactivity.



These settings apply to all users. If you have activated the Auto login function for a user, then this user will not be automatically logged out.

1. Go to **Settings > Parameters > System > General**.
2. Select the desired parameter.
3. Set the parameter.





4. Press the **Accept** button to save the modified parameter.

### Auto logout

You can use this parameter to activate the automatic logout function.

### Time until auto logout

You can use this parameter to set the time period of inactivity after which a user is automatically logged out.

### 9.1.1.3 Activating/deactivating service user access

The device is equipped with user access for the Maschinenfabrik Reinhausen GmbH Technical Service department. This access is for error diagnostics and troubleshooting in the event of device faults.

You can use this parameter to activate or deactivate service user access. To safeguard IT security, only activate service user access for a limited time period for remedying faults.



If you deactivate the service user access and lose your password for the administrator role, it is not possible to reset the administrator password. If the administrator password is lost, the device must be reset to the default settings. When doing so, all information stored on the device (parameters, measured values, etc.) will be lost.

You must be assigned the administrator role to set parameters.

When in delivery status, you can log in as the administrator as follows:

- User name: `admin`
- Password: `admin`

1. Go to **Settings > Parameters > System > General > Service user access activation**.
2. Select the desired option.
3. Press the **Accept** button to save the modified parameter.
4. Restart the device to adopt the change.

### Service user access activation

You can use this parameter to activate or deactivate service user access.

### 9.1.2 Configuring the network

You can use this menu item to configure the necessary network interface.

1. Go to **Settings > Parameters > System > Network settings**.
2. Select the desired parameter.



3. Set the parameter.
4. Press the **Accept** button to save the modified parameter.

### IP address

You can use this parameter to assign an IP address to the device.



Assign IP addresses in various subnets for each case for the web-based visualization. Otherwise you will not be able to establish a connection.

### Subnet mask

You can use this parameter to set the subnet mask.



Be sure to enter a valid network mask that is not 0.0.0.0, otherwise it will not be possible to connect to the device.

### Gateway address

You can use this parameter to set the gateway's IP address.



If you set the value to 0.0.0.0, no gateway is used.

### SSL/TLS encryption

You can use this parameter to set whether the process for accessing the visualization should be carried out over an SSL/TLS-encrypted connection.



### TLS version

You can use this parameter to set the accepted TLS versions. If you would like to establish an encrypted connection to the visualization, you must use an accepted TLS version. You can select the following options:

Option	Accepted TLS versions
>= 1.0	<ul style="list-style-type: none"> <li>▪ 1.0</li> <li>▪ 1.1</li> <li>▪ 1.2</li> </ul>
>= 1.1	<ul style="list-style-type: none"> <li>▪ 1.1</li> <li>▪ 1.2</li> </ul>
>= 1.2 <sup>1)</sup>	<ul style="list-style-type: none"> <li>▪ 1.2</li> </ul>

Table 13: TLS version

<sup>1)</sup> This option can be selected only if the TLS version is supported by the connected peripheral equipment.

### 9.1.3 Setting the device time

You can set the the device time manually or automatically via an SNTP time server. The device must be connected to an SNTP time server via Ethernet for this purpose.

1. Go to **Settings > Parameters > System > Time synchronization**.
2. Select the desired parameter.
3. Set the parameter.
4. Press the **Accept** button to save the modified parameter.

#### Time synchronization via SNTP

You can use this parameter to activate time synchronization using an SNTP time server.

#### SNTP time server

You can use this parameter to enter the IP address of a SNTP time server. If you are using a time server, the device uses the time of the time server as the system time.



Be sure to enter a valid time server address that is not 0.0.0.0, otherwise it will not be possible to connect to the device.



### Synchronization interval

You can use this parameter to set the interval at which the device is to call up the time from the time server.

### Time zone

To adjust the device time to your local time, you can use the time shift parameter to set the time shift to UTC.

Example:

Region	Time shift to UTC
Mumbai, India	UTC +5:30 h
Beijing, China	UTC +8:00 h
Brasilia, Brazil	UTC -3:00 h

Table 14: Time shift to UTC (Coordinated Universal Time)

### Time

You can use this parameter to set the date and time manually.

### SNTP time server 2

You can use this parameter to enter the IP address of the second time server (optional).

## 9.1.4 Setting the screensaver

To increase the service life of the display on the front panel of the device, you can activate and set a screensaver. The following functions are available for this purpose:

- Screensaver waiting time
1. Go to **Settings > Parameters > System > Screensaver**.
  2. Select the desired parameter.
  3. Set the parameter.
  4. Press the **Accept** button to save the modified parameter.

### Screensaver

If you activate this function, the device fully switches off the display when the adjustable waiting period has expired if no key is pressed. The display switches on again if you press any key.



Deactivating the screensaver has a negative impact on the service life of the display. Maschinenfabrik Reinhausen recommends that you activate the screensaver and set a waiting period of 15 minutes.



### Screensaver waiting time

You can use this parameter to set the screensaver waiting time.

## 9.1.5 Configuring syslog

The device supports the transmission of log messages via the syslog protocol in accordance with the following standards

- RFC 5425
- RFC 3164
- RFC 5426
- RFC 6587

1. Go to **Settings > Parameters > System > Syslog**.
2. Select the desired parameter.
3. Set the parameter.
4. Press the **Accept** button to save the modified parameter.

### Activate syslog

You can use this parameter to activate transmission of syslog messages via the device.

### Syslog standard

You can use this parameter to adjust the transmission process and the format for the syslog messages. You can select the following options:

Standard	Transport	Message format
RFC 5425 (recommended)	TLS	RFC 5424
RFC 5426	UDP	
RFC 6587	TCP	
RFC 3164	UDP	RFC 3164

Table 15: Syslog standard



If you use the standard RFC 5425 (TLS), you have to import the root certificate and the client certificate with the corresponding key to the syslog server. For more information, refer to the section titled Importing data.

### Syslog server

You can use this parameter to set the IP address of the syslog server.



### Syslog server port

You can use this parameter to set the port of the syslog server.

### Reconnect delay time

You can use this parameter to determine how long the device will wait before it attempts to reconnect after the connection has been interrupted earlier or a syslog message could not be transmitted (only for TCP or TLS).

### Device designation

You can use this parameter to set the device designation that the device will be identified with on the syslog server.

### Severity level

You can set which syslog messages the device will send. You can also activate or deactivate messages for each severity level.

Severity level	Description
Emergency	The system is unusable.
Alert	Immediate intervention required.
Critical	Critical state
Error	Error state
Warning	Warning state
Notice	Notice state
Info	Information state
Debug	Debug state

Table 16: Severity levels

### 9.1.6 Setting the measured value recorder

Depending on the set average value interval, the measured value recorder can display the measured values over a shorter or longer time period:

- Average value interval = 1 s: approx. 1 day and 8 hours
- Average value interval = 86,400 s (= 24 h): approx. 315 years

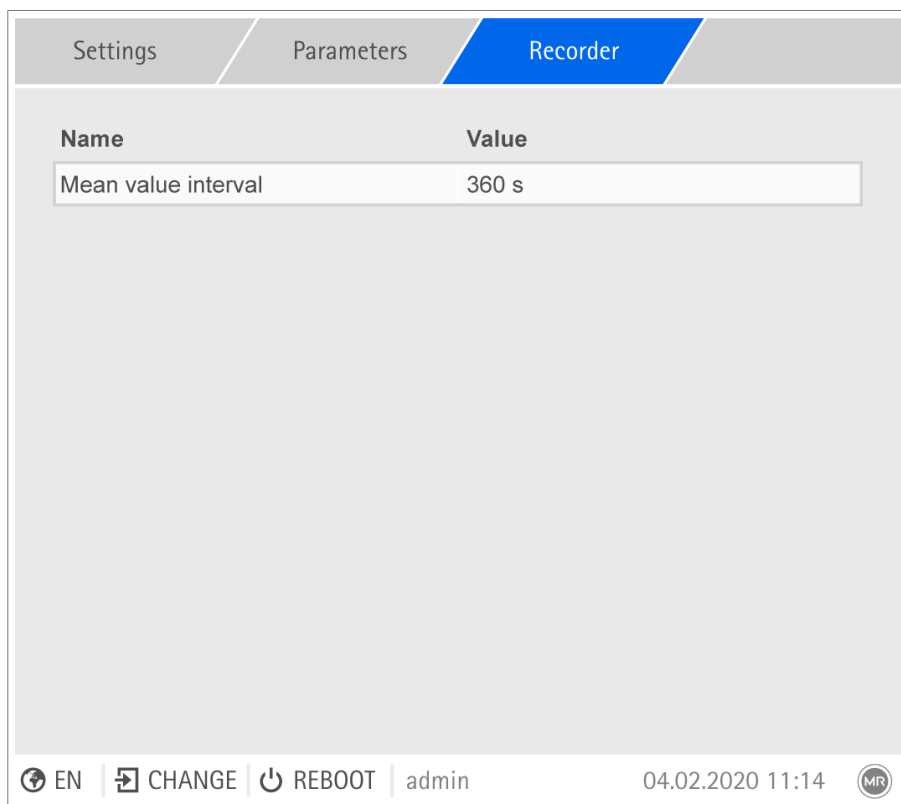


Figure 55: Recorder

1. Go to **Settings > Parameters > System > Recorder**.
2. Select the desired parameter.
3. Set the parameter.
4. Press the **Accept** button to save the modified parameter.

### Average value interval

You can use this parameter to set the average value interval of the measured value recorder for electrical measured variables (current, voltage, phase angle etc.).

### 9.1.7 Linking signals and events

The device allows you to link 28 digital inputs (GPI) with device functions and 5 digital outputs (GPO).

The digital inputs available are each permanently linked to a *General purpose input* event message for this purpose.

Input/command	Event message
Digital input 1	General purpose input 1
Digital input 2	General purpose input 2
...	...

Table 17: Links between digital inputs and event messages

You can link the event messages with device functions and digital outputs. You can also link all other event messages (e.g., *Undervoltage U<*) with digital outputs. Corresponding parameters, for which you need to enter the relevant event number, are provided for this purpose.

### 9.1.7.1 Linking functions

You can link the *General purpose input* events with device functions. This allows you to control the device remotely via digital inputs.

To establish the link, you have to enter the corresponding event number in the desired parameter.



Note that you can only enter the event numbers of the *General purpose input* events.

If you enter event number 500, the link is disabled.

✓ The desired event number is known.

1. Go to **Settings > Parameters > System > Link functions**.
2. Select the desired parameter.
3. Enter the desired event number.
4. Press the **Accept** button to save the modified parameter.

#### Local/Remote

The assigned event activates LOCAL or REMOTE mode on the device.

#### Blocking

If the assigned event is active, automatic control is blocked.

#### Independent regulation

If the assigned event is active, the device activates the independent regulation independent mode.

#### Master parallel operation method

If the assigned event is active, the device activates the master parallel operation method.





### **Follower parallel operation method**

If the assigned event is active, the device activates the follower parallel operation method.

### **Automatic tap synchronization parallel operation method**

If the assigned event is active, the device activates the automatic tap synchronization parallel operation method.

### **Parallel operation group 1**

If the assigned event is active, parallel operation group 1 activates.

### **Parallel operation group 2**

If the assigned event is active, parallel operation group 2 activates.

### **Target-tap-position operation**

If the assigned event is active, the device switches to the defined target tap position.

### **Activate desired value 1**

If the assigned event is active, the device activates the desired value 1.

### **Activate desired value 2**

If the assigned event is active, the device activates the desired value 2.

### **Activate desired value 3**

If the assigned event is active, the device activates the desired value 3.

### **Activate desired value 4**

If the assigned event is active, the device activates the desired value 4.

### **Activate desired value 5**

If the assigned event is active, the device activates the desired value 5.

#### **9.1.7.2 Digital inputs**

The device features the option of assigning the following functions to the digital inputs.



	Description
I: Desired value setting release	If the input is active, the device activates the release of the desired value.
I: Blocking	If the input is active, the device activates blocking.
I: Autom. tap synchronization	If the input is active, the device activates the input automatic tap synchronization.
I: Desired value 1	If the input is active, the device activates desired value 1
I: Desired value 2	If the input is active, the device activates desired value 2.
I: Desired value 3	If the input is active, the device activates desired value 3
I: Desired value 4	If the input is active, the device activates desired value 4
I: Desired value 5	If the input is active, the device activates desired value 5
I: High-speed return	If the input is active, the device activates high-speed return.
I: Follower	If the input is active, the device activates the input parallel operation follower.
I: Independent	If the input is active, the device activates the input parallel operation independent
I: K1 feedback	If the input is active the tap position is increased.
I: Master	If the input is active, the device activates the input parallel operation master.
I: Motor-drive unit in operation	If the input is active, the device activates the input motor-drive unit in operation.
I: Motor prot. sw. trigg.	If the input is active, the device activates the input motor protective switch at capacity.
I: Parallel group 1	If the input is active, the device activates the input parallel operation group 1.
I: Parallel group 2	If the input is active, the device activates the input parallel operation group 2.
I: K2 feedback	If the input is active the tap position is increased.
I: TDSC® off	If the input is active, the device activates the input TDSC® off.
I: TDSC® on	If the input is active, the device activates the input TDSC® on.



	Description
I: VIM vacuum interrupter error (red)	If the input is active, the device activates the input VIM error vacuum interrupter.
I: VIM left	If the input is active, the device activates the input VIM left.
I: VIM center	If the input is active, the device activates the input VIM center.
I: VIM right	If the input is active, the device activates the input VIM right.
I: LOCAL / REMOTE	If the input is active, the device activates the input LOCAL/REMOTE.
I: AUTO / MANUAL	If the input is active, the device activates the input AUTO/MANUAL.
I: OLTC neutral position	If the input is active, the device activates the input tap position neutral position (Keep Track).
I: Raise	If the input is active the voltage is increased.
I: Lower	If the input is active the voltage is decreased.

### 9.1.7.3 Digital outputs

The device features the option of assigning the following functions to the digital outputs

	Description
O: Analog desired value capture active	If a signal is present at the input, the device activates desired value active.
O: Analog desired value capture defective	If a signal is present at the input, the device activates desired value problem.
O: Auto.	Auto mode active
O: Bandwidth <	If a signal is present at the input, the device activates the function bandwidth value above limit.
O: Bandwidth >	If a signal is present at the input, the device activates the function bandwidth value below limit.
O: Desired value 1	If a signal is present at the input, the device activates desired value 1.
O: Desired value 2	If a signal is present at the input, the device activates desired value 2.
O: Desired value 3	If a signal is present at the input, the device activates desired value 3.



	Description
O: Desired value 4	If a signal is present at the input, the device activates desired value 4.
O: Desired value 5	If a signal is present at the input, the device activates desired value 5.
O: Function monitoring	If a signal is present at the input, the device activates function monitoring.
O: Collective error	If a signal is present at the input, the device activates the event active function.
O: Undercurrent	If a signal is present at the input, the device activates undercurrent blocking.
O: Overcurrent	If a signal is present at the input, the device activates overcurrent blocking.
O: Undervoltage	If a signal is present at the input, the device activates undervoltage blocking.
O: Overvoltage	If a signal is present at the input, the device activates overvoltage blocking.
O: Motor runtime exceeded	If a signal is present at the input, the device activates the function motor runtime value above limit.
O: Parallel error	If a signal is present at the input, the device activates the function parallel operation error.
O: Follower	If a signal is present at the input, the device activates the function assign follower.
O: Independent	If a signal is present at the input, the device activates the function assign independent.
O: Master	If a signal is present at the input, the device activates the function assign master.
O: Motor protective switch (pulse)	If a signal is present at the input, the device activates the motor protective switch.
O: AVR Local/Remote	If a signal is present at the input, the device activates the LOCAL/REMOTE function.
O: Status Ok	If a signal is present at the input, the device activates the device status.
O: Lower	If a signal is present at the input, the device activates the LOWER function.
O: Raise	If a signal is present at the input, the device activates the RAISE function.



	Description
O: TDSC® active	If a signal is present at the input, the device activates the TDSC® function.
O: Manual mode	Manual mode active

#### 9.1.7.4 Linking digital outputs

You can link each event with a digital output. The device provides 5 digital outputs (GPO) for this purpose. When you link a digital output to an event, the device issues a signal to this output if the event occurs. The signal persists until the event stops. A parameter is available for each available digital output.



To forward input signals, you need to link the digital outputs with the *General purpose input* events.

✓ The desired event number is known.

1. Go to **Settings > Parameters > System > Link outputs**.
2. Select the desired parameter.
3. Enter the desired event number.
4. Press the **Accept** button to save the modified parameter.

#### Generic digital output X

You can use this parameter to link the digital output with an event message. To do so, enter the desired event number.



If you enter event number 500, the link is disabled.

#### 9.1.8 Configuring analog inputs

You can flexibly configure the device's analog inputs and assign device functions.

The device supports analog sensors with linear characteristic curves and only outputs analog signals with linear characteristic curves.

**Correction factor and offset** Setting a correction offsets systematic errors of the analog signals. The correction is determined by multiplying a factor by the sum of the offset. The minimum and maximum values of the function values apply as a limit value for the correction. There is no limit for the correction offset.

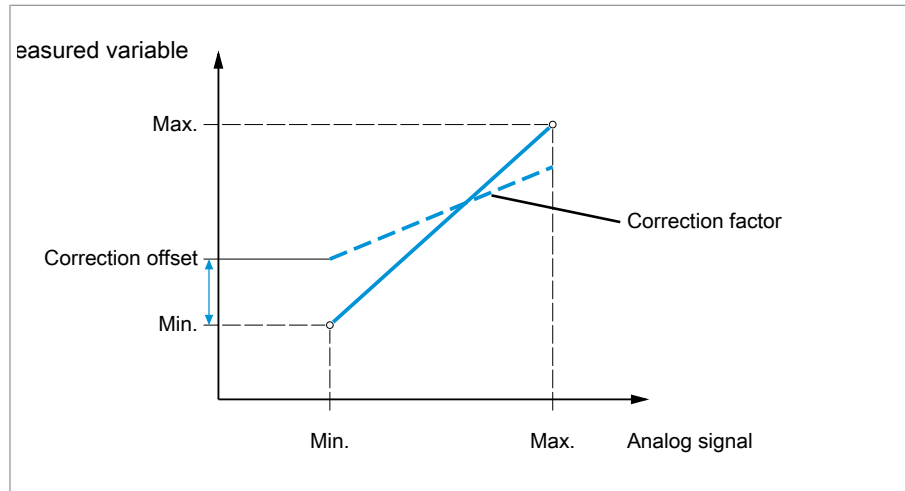


Figure 56: Analog signal with linear characteristic curve, correction factor < 1 and correction offset

## NOTICE

### Damage to the device and sensors!

Incorrectly connected and configured analog inputs may result in damage to the device and sensor.

- Follow the information about connecting analog sensors.
- Configure analog inputs according to the connected sensors.

The following information is displayed to you in tabular form for configuring the analog inputs. Grayed-out elements cannot be changed.

Property	Options
Function	Function of the analog input (I: ...). You can adjust the designation.
Signal type	Select signal type of analog sensor or deactivate analog input. <ul style="list-style-type: none"> <li>▪ 4...20 mA</li> <li>▪ 0...20 mA</li> <li>▪ 0...10 V</li> </ul>
Card/channel	Select the slot and channel of the analog sensor. Note the connection diagram supplied.
Unit <sup>1)</sup>	Set the unit of the signal.
Decimal places <sup>1)</sup>	Set up to three decimal places.



Property	Options
Minimum/maximum value	Set the minimum and maximum values of the sensor, e.g. with a 4...20 mA signal, the corresponding measured value for 4 mA and the corresponding value for 20 mA.
Correction factor <sup>2)</sup>	Set the correction factor (m) for the correction of the function value (x). The corrected function value (y) is: $y = (m * x) + t$
Correction offset <sup>2)</sup>	Set the offset (t) for the correction of the function value (x). The corrected function value (y) is: $y = (m * x) + t$

Table 18: Configuration of the analog inputs and outputs

<sup>1)</sup> Only available for AIO.

<sup>2)</sup> Only available for inputs.



You can only change the configuration of the analog inputs if you have a Parameter Configurator or Administrator role.

When in delivery status, you can log in as the administrator as follows:


- User name: `admin`
- Password: `admin`

### Creating a backup

You need to create a backup to be able to reset the system in the event that any incorrect configuration settings are made.

1. Go to **Settings > Export**.
2. Go to the option **Settings** to export a backup copy of the current settings.
3. Select the desired **interface**.
4. Press the **Export** button to start the export.

### Configuring AIO

1. Go to **Settings > AIO configuration**.
2. Configure properties such as **function**, **signal type** and **card/channel**.
3. Select the  button to configure the values as desired.
4. Press the **Accept** button.
5. Confirm the security prompt with **Save** to save the changes.

### 9.1.9 Configuring digital inputs and outputs

Upon delivery, the configurable digital inputs and outputs of the device are configured as follows:

- Input: High active
- Output: N/O contact (NO)

You can change this configuration if necessary.



Ensure that the configuration of the digital inputs and outputs is suitable for the functions used. Otherwise, malfunctions may occur in the device and the connected periphery.

The following information is displayed in tabular form for configuring the digital inputs and outputs. Grayed-out elements cannot be changed.

Property	Options
Function	Function of the digital input (I: ...) or the digital output (O: ...). You can adjust the designation.
Signal type	Select signal type: Digital input
Configuration	DI: High active or low active DO: N/O contact (NO), N/C contact (NC); Note: If the device is disconnected or in the event of an error, the digital outputs are always open (no bi-stable relay).
Assembly/channel	Channel of the DI/DO interfaces to which the function is linked. Functions that are not linked with a channel are identified with "-". Note the connection diagram supplied.

Table 19: Configuration of the digital inputs and outputs



The operation described below is only possible if you access the visualization using a computer. You can only change the configuration of the digital inputs and outputs if you have a Parameter Configurator or Administrator role.

When in delivery status, you can log in as the administrator as follows:

- User name: `admin`
- Password: `admin`

#### Creating a backup

You need to create a backup to be able to reset the system in the event that any incorrect configuration settings are made.

1. Go to **Settings > Export**.
2. Go to the option **Settings** to export a backup copy of the current settings.
3. Select the desired **interface**.
4. Press the **Export** button to start the export.





- Configuring DIOs**
1. Go to menu item **Settings > DIO configuration**.
  2. Where necessary, select the buttons ▲ or ▼ to sort the properties in a column alphabetically.
  3. Configure the properties as desired.
  4. Press the **Accept** button.
  5. Confirm the security prompt with **Yes** to save the changes.

### 9.1.10 Event management

The device is equipped with event management, which allows you to detect various device operating statuses and to adapt the behavior of the device. An overview of all possible events is given in the Event messages chapter.

#### 9.1.10.1 Displaying and acknowledging events

##### Displaying events

###### ► Go to **Events**.

⇒ A list of currently pending events appears.

##### Acknowledging events

Acknowledgeable events must be acknowledged in the event overview so that they are no longer displayed. All other events are automatically removed once the cause has been fixed (e.g. limit value is no longer exceeded).


To acknowledge the events, proceed as follows:

###### ► To acknowledge the events, highlight the desired events in the column, then press the **Acknowledge** button.

⇒ The events have been acknowledged.

#### 9.1.10.2 Displaying event memory

Past events are stored in the event memory. The following information is displayed:

Column	Description
#	Consecutive number of events
No.	Event number for clear identification
	Event category: <ul style="list-style-type: none"> <li>▪ Error (red)</li> <li>▪ Warning (yellow)</li> <li>▪ Info (gray)</li> </ul>
Event	Event text




Column	Description
Time	Date and time of event (DD-MM-YYYY, HH:MM:SS/ms)
	Event coming/going: <ul style="list-style-type: none"> <li> Event coming</li> <li> Event going</li> </ul>

Table 20: Event memory

1. Go to **Events**.
2. Press the **Log** button.

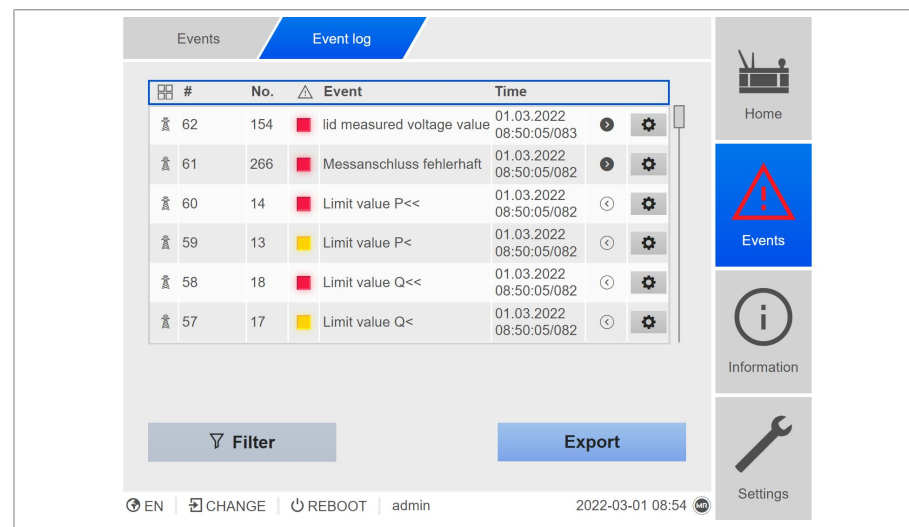


Figure 57: Event memory

## Filtering events

1. Press the **Filter** button.
2. Enter the desired time period.
3. Select the checkbox and enter the desired event number.
  - ⇒ The event text is displayed.
4. Select the desired event categories and the desired event status.
5. Press the **Search** button to display the desired events.

## Exporting events

You can export the event memory entries currently displayed as a csv file. If you first create a filter, only the filtered entries are exported.



To export the events, proceed as follows:

✓ First connect via PC.

1. Click on the **Export** button.
  2. Select the desired option for data transmission.
- ⇒ The data is exported.

### 9.1.11 User administration

User administration is based on a system of roles. You must assign a role to every user. You can define access rights to parameters and events for each role.

### 9.1.12 Hardware

Under Hardware, you can display information about the device's hardware. You will find information about the signal level of the individual channels for the assemblies.

1. Go to **Information > System > Hardware**.
2. Select the desired **Assembly** in order to display the signal levels of the channels.

### 9.1.13 Software

Under Software, you can display the version status of the software components of the device.

► Go to **Information > System > Software**.

### 9.1.14 Import/export manager

The device is equipped with an import/export manager which can be used to transmit data using a PC via the web-based visualization system.

#### 9.1.14.1 Exporting data

You can export the following data from the device:

Option	Description
System image	Complete image of the system (software and configuration). If you are using the option "with history", all of the event memory entries are also exported.
System configuration	System configuration
Event log	All event memory entries.
Recorder	Measured value memory export.



Option	Description
Parameter list	Parameter list with descriptive text and values (min, max, current).
Event list	Complete list of all possible events.
Operating instructions	Operating Instructions.
Settings	Configuration of parameters and events.
Security log	Logbook of all instances of access and changes relating to security.
Licenses	Copyright and disclaimers of the software components used.

Table 21: Exporting data

1. Go to **Settings > Export**.
2. Select the desired option for the export.



### 9.1.14.2 Importing data

You can import the following data:

Option	Description
System image	Complete image of the system (software and configuration), with or without history.
Settings	<p>You can import device settings from a backup file of this device, an update file or a different device. During import, you can select which of the following settings are to be imported:</p> <ul style="list-style-type: none"> <li>Parameters (settings, access rights)</li> <li>Events (category, behavior, text)</li> <li>User configuration</li> <li>Topology</li> <li>Certificates</li> </ul>
SSL certificate	<p>Import of an SSL certificate with associated key:</p> <ul style="list-style-type: none"> <li>Server certificate (.crt + .pem)</li> <li>Client certificate (.crt + .pem)</li> <li>Client CA (.crt)</li> </ul> <p>To import your own certificate, the certificate must contain the IP address 192.168.166.1 in the Subject Alternative Name (SAN) to avoid error messages on the display.</p> <p>For the import, you will have to compress the certificate (*.crt) and key (*.pem) in a zip file.</p> <p>You can import certificates with the following key authentication:</p> <ul style="list-style-type: none"> <li>RSA with 1024 bits</li> <li>ECDSA with 256 bits ("secp256r1" or "prime256v1" curve).</li> </ul>

Table 22: Importing data



If you do not want to retain the certificate settings when importing a new software file and want to deselect them, you have to reload the server certificate onto the device manually (see Importing server certificate update [► Section 9.1.14.3, Page 98]).

## NOTICE

### Damage to the file system!

The file system can become damaged due to an incorrect data transmission process. A damaged file system can lead to the device no longer being functional.

► Do not disconnect the device from the power supply during the import.



1. Go to **Settings > Import**.
2. Select the desired option for data transmission.
3. Select the file to be imported.  
⇒ The file is checked.
4. Press the **Import** button.  
⇒ The data is imported, then the device is restarted.

**Also refer to**

- 📄 Importing server certificate update [► 98]

**9.1.14.3 Importing server certificate update**

The product allows you to import your own trustworthy certificates.

The interfaces do not use a DHCP server. Therefore, you must assign a static IP address to your PC. To do this, observe the following configuration example:

- Interface configuration example

Interface	Configuration
PC	IP address: 192.168.166.199 Subnet mask: 255.255.255.0

**Connecting the network drive**

- ✓ Unplug the Ethernet RJ45 cable from COM-ETH assembly port X3 and connect it to the PC.
1. Open **File Explorer** via the taskbar or press **Windows key+E**.
  2. Select **This PC**.
  3. Select the **Computer** tab and click on **Connect network**.
  4. Enter the login details.
    - Drive: Select available drive
    - Folder: \\192.168.166.200\usershare
    - Set a checkmark next to **Establish connection with other login details**.
- Select **Finish**.
- ⇒ The **Windows security** window opens.

**Windows security window**

1. Enter the **User name** "**USADR\pmt50-user**".
  2. Enter the **Password** "**CERT-Upload**".
  3. Confirm your entry with **OK**.
- ⇒ The network is set up.



### Copying certificates

1. Call up file path \\192.168.166.200\usershare.
2. Copy your certificates (file suffix ".crt" or ".cer") to the **cert** directory via drag and drop.

⇒ The certificate has been imported successfully.

### Disconnecting the network drive

Upon successful import, the drive is to be disconnected from the PC and the network properties reset to the standard.

1. Select the network drive and right-click on **Disconnect network drive**.
2. Reset the network connection properties to standard.
3. Unplug the Ethernet RJ45 cable from the PC and connect it to COM-ETH assembly port X3.

⇒ The browser will be restarted.

### Also refer to

- Establishing connection to visualization [► 68]



## 9.2 Power grid

### 9.2.1 Transformer data

The transformation ratios and measuring set-up for the voltage and current transformers used in the system can be set with the following parameters. The device uses this information to calculate the corresponding measured values on the primary side of the current transformer (and therefore the transformer) from the recorded measured values. These are then displayed.

#### 9.2.1.1 Setting transformer data

You can use the following parameters to set the transformer data. Also note the Examples for standard circuits for current transformers and voltage transformers.

1. Go to **Settings > Parameters > Grid > Transformer data**.
2. Select the desired parameter.
3. Set the desired parameter.
4. Press the **Accept** button to save the modified parameter.

#### Primary transformer voltage

You can use this parameter to set the primary voltage of the voltage transformer in kV.

#### Secondary transformer voltage

You can use this parameter to set the secondary voltage of the voltage transformer in kV.

#### Primary transformer current

You can use this parameter to set the primary current of the current transformer.

#### Secondary transformer current

You can use this parameter to set the secondary current of the current transformer. You can select the following options:

- 0.2 A
- 1 A
- 5 A

#### Phase angle correction

You can use this parameter to set the phase angle correction for your transformer circuit.





### Voltage-transformer circuit

You can use this parameter to set your voltage transformer's circuit. You can select the following options:

Option	Description
1 Ph phase voltage	Measurement in 1-phase grid between the conductor and neutral conductor.
3 Ph differential voltage	Measurement in 3-phase grid between 2 conductors
3 Ph phase voltage	Measurement in 3-phase grid between the conductor and neutral conductor

Table 23: Voltage-transformer circuit

### Current-transformer circuit

You can use this parameter to set the circuit for your current transformer. You can select the following options:

Option	Description
1 Ph phase current	Measurement of phase current in 1-phase grid.
3 Ph total current	Measurement of differential current in 3-phase grid.
3 Ph phase current	Measurement of phase current in 3-phase grid.

Table 24: Current-transformer circuit

### Voltage balance

You can use this parameter to set a correction value for the voltage measurement in order to compensate for deviations through the measuring section. The device adds the correction value to the measured voltage (secondary side).

### Power supply frequency

You can use this parameter to select the power supply frequency.

#### 9.2.1.2 Circuit examples for voltage transformers and current transformers

Below you will find different examples of circuits for voltage transformers and current transformers and the corresponding settings.

### 9.2.1.2.1 1-phase measurement

#### Circuit 1-A

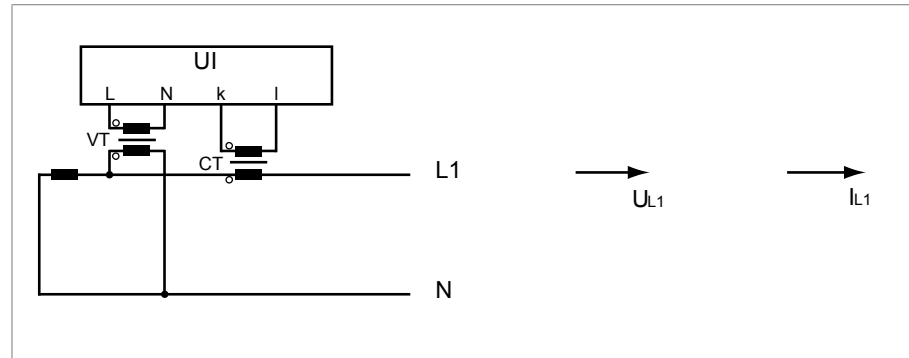


Figure 58: Circuit 1-A

- The voltage transformer VT is connected to the phase conductor and the neutral conductor.
- The current transformer CT is looped into the phase conductor.
- The voltage  $U_{L1}$  and current  $I_{L1}$  are in phase.
- The voltage drop on a phase conductor is determined by the current  $I_{L1}$ .

If you use this circuit, set the device as follows:

Parameter	Option
Voltage-transformer circuit	1 Ph phase voltage
Current-transformer circuit	1 Ph phase current
Phase angle correction	0°

Table 25: Circuit 1-A

#### Circuit 1-B

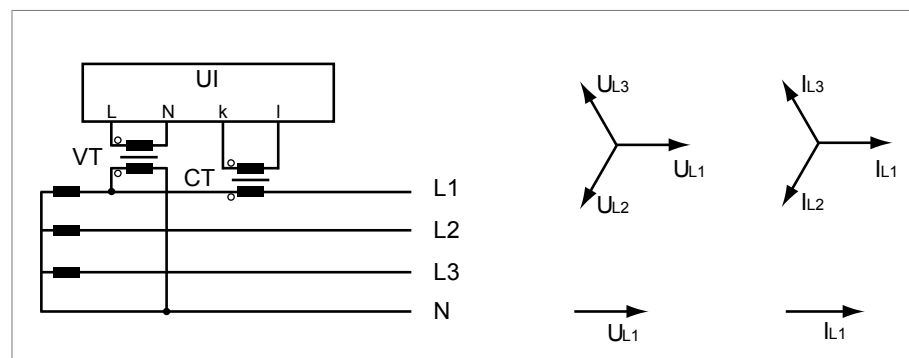


Figure 59: Circuit 1-B

- The voltage transformer VT is connected to the phase conductor L1 and the neutral conductor.
- The current transformer CT is looped into the phase conductor L1.
- The voltage U and current I are in phase.
- The voltage drop on a phase conductor is determined by the current  $I_{L1}$ .

If you use this circuit, set the device as follows:

Parameter	Option
Voltage-transformer circuit	3 Ph phase voltage
Current-transformer circuit	3 Ph phase current
Phase angle correction	0°

Table 26: Circuit 1-B

### Circuit 1-C

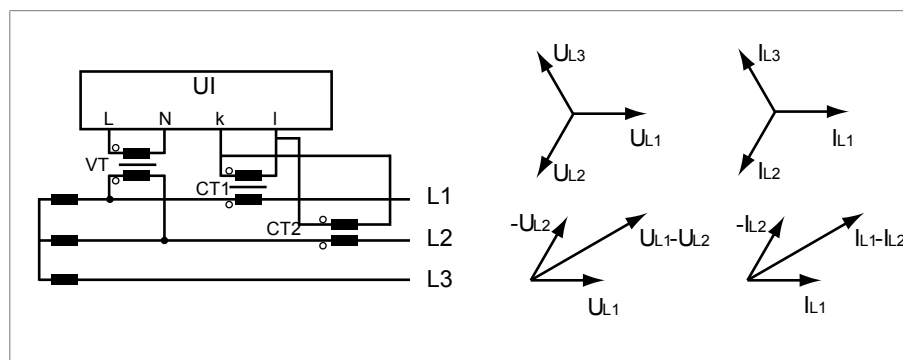


Figure 60: Circuit 1-C

- The voltage transformer VT is connected to the phase conductors L1 and L2.
- The current transformer CT1 is looped into the phase conductor L1 and CT2 is looped into the phase conductor L2.
- The current transformers CT1 and CT2 are connected crosswise in parallel (total current =  $I_{L1} + I_{L2}$ ).
- The total current  $I_{L1} + I_{L2}$  and voltage  $U_{L1}-U_{L2}$  are in phase.
- The voltage drop on a phase conductor is determined by the current:  $(I_{L1} + I_{L2}) / \sqrt{3}$ .

If you use this circuit, set the device as follows:

Parameter	Option
Voltage-transformer circuit	3 Ph differential voltage
Current-transformer circuit	3 Ph total current
Phase angle correction	0°

Table 27: Circuit 1-C

### Circuit 1-D

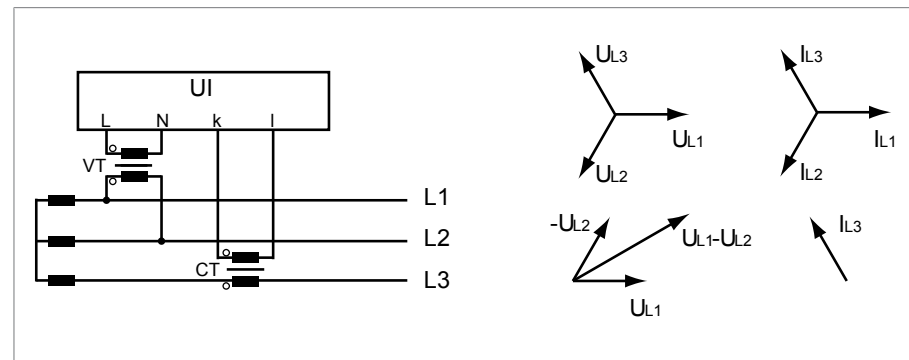


Figure 61: Circuit 1-D

- The voltage transformer VT is connected to the phase conductors L1 and L2.
- The current transformer CT is looped into the phase conductor L3.
- The current  $I_{L3}$  is ahead of voltage  $U_{L1}-U_{L2}$  by 90°. This corresponds to a phase shift of -90°.
- The voltage drop on a phase conductor is determined by the current  $I_{L3}$ .

If you use this circuit, set the device as follows:

Parameter	Option
Voltage-transformer circuit	3 Ph differential voltage
Current-transformer circuit	3 Ph phase current
Phase angle correction	90°

Table 28: Circuit 1-D

### Circuit 1-E

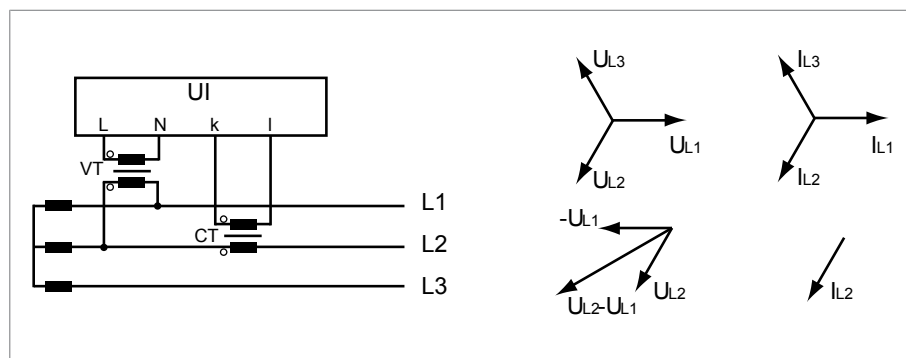


Figure 62: Circuit 1-E

- The voltage transformer VT is connected to the phase conductors L1 and L2.
- The current transformer CT is looped into the phase conductor L2.
- The current  $I_{L2}$  is ahead of voltage  $U_{L2}-U_{L1}$  by  $30^\circ$ . This corresponds to a phase shift of  $-30^\circ$ .
- The voltage drop on a phase conductor is determined by the current  $I_{L2}$ .

If you use this circuit, set the device as follows:

Parameter	Option
Voltage-transformer circuit	3 Ph differential voltage
Current-transformer circuit	3 Ph phase current
Phase angle correction	$30^\circ$

Table 29: Circuit 1-E

### Circuit 1-F

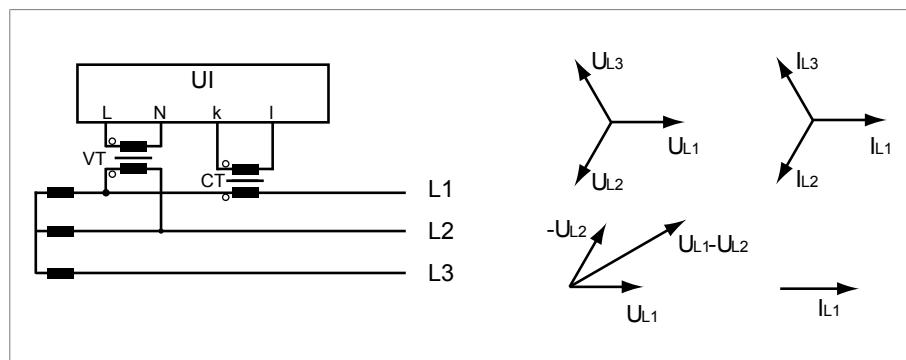


Figure 63: Circuit 1-F

- The voltage transformer VT is connected to the phase conductors L1 and L2.
- The current transformer CT is looped into the phase conductor L1.
- The current  $I_{L1}$  lags behind voltage  $U_{L1}-U_{L2}$  by  $30^\circ$ . This corresponds to a phase shift of  $+30^\circ$  and a correction value of  $-30^\circ$ .
- The voltage drop on a phase conductor is determined by the current  $I_{L1}$ .

If you use this circuit, set the device as follows:

Parameter	Option
Voltage-transformer circuit	3 Ph differential voltage
Current-transformer circuit	3 Ph phase current
Phase angle correction	$-30^\circ$

Table 30: Circuit 1-F

### 9.2.2 Voltage monitoring

In order to monitor the transformer's current output voltage, you can set 4 limit values:

- Undervoltage  $U<$ : Lower limit 2
- Undervoltage  $U<$ : Lower limit 1
- Overvoltage  $U>$ : Upper limit 1
- Overvoltage  $U>$ : Upper limit 2

If the measured value is higher than the upper limit ( $>$  or  $>>$ ) or lower than the lower limit ( $<$  or  $<<$ ), the device transmits an event message.

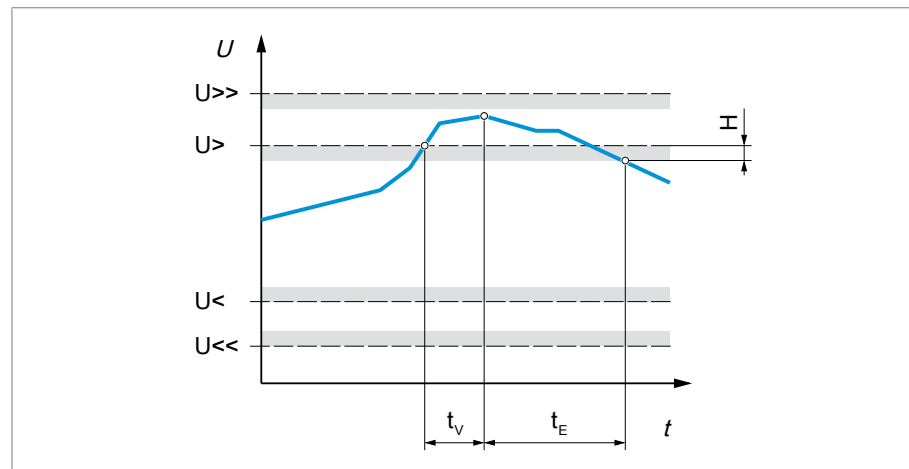


Figure 64: Example of voltage monitoring with the limit value Overvoltage  $U>$  being exceeded

$U>>$ Overvoltage $U>>$	$U>$ Overvoltage $U>$
$U<$ Undervoltage $U<$	$U<<$ Undervoltage $U<<$



$t_v$ Delay time	$t_E$ Event duration
H Hysteresis	

1. Go to **Settings > Parameters > Grid > Voltage monitoring**.
2. Select the desired parameter.
3. Set the desired parameter.
4. Press the **Accept** button to save the modified parameter.

You can set additional parameters for each limit value:

### Mode

You can use this parameter to set which limit value you would like to use:

- Absolute: The device uses the absolute limit value in V.
- Relative: The device uses the relative limit value in %, relative to the desired voltage value.

### Behavior

You can use this parameter to set the behavior of the device if the measured value is higher than the upper limit ( $>$  or  $>>$ ) or lower than the lower limit ( $<$  or  $<<$ ). You can select the following options:

Setting	Behavior
Off	No reaction.
High-speed return	<p>For <math>U &lt; /U &lt;&lt;</math>: The device performs tap-change operations in the raise voltage direction (U+) until the measured voltage is back above the limit value.</p> <p>For <math>U &gt; /U &gt;&gt;</math>: The device performs tap-change operations in the lower voltage direction (U-) until the measured voltage is back below the limit value.</p> <p>With high-speed return, the device ignores the set delay time of automatic voltage regulation.</p>
Auto blocking	<p>Automatic regulation is blocked.</p> <p>You can continue to perform tap-change operations in manual mode.</p>
Auto/manual blocking	<p>Automatic regulation is blocked.</p> <p>You <b>cannot</b> perform tap-change operations in manual mode.</p>
Auto blocking position+	<p>The automatic control does not perform a tap-change operation in the direction of a higher tap position (position+).</p> <p>You can still perform a tap-change operation in the direction of a higher tap position (position+) in manual mode.</p>



Setting	Behavior
Auto blocking position-	<p>The automatic control does not perform a tap-change operation in the direction of a lower tap position (position-).</p> <p>You can still perform a tap-change operation in the direction of a lower tap position (position-) in manual mode.</p>
Auto/manual blocking position+	<p>The automatic control does not perform a tap-change operation in the direction of a higher tap position (position+).</p> <p>You cannot perform a tap-change operation in the direction of a higher tap position (position+) in manual mode.</p>
Auto/manual blocking position-	<p>The automatic control does not perform a tap-change operation in the direction of a lower tap position (position-).</p> <p>You cannot perform a tap-change operation in the direction of a lower tap position (position-) in manual mode.</p>

Table 31: Behavior when an event message is issued

### Hysteresis

You can use this parameter to set the hysteresis. You can use this to avoid the unnecessary generation of messages if the measured value fluctuates around a threshold value.

### Delay time

You can use this parameter to set the delay time in order to delay the issuing of the event message.

### 9.2.3 Current monitoring

For monitoring the transformer's current load current, you can set 4 limit values:

- I<<: Lower limit 2
- I<: Lower limit 1
- I>: Upper limit 1
- I>>: Upper limit 2





If the measured value is higher than the upper limit (> or >>) or lower than the lower limit (< or <<), the device transmits an event message.

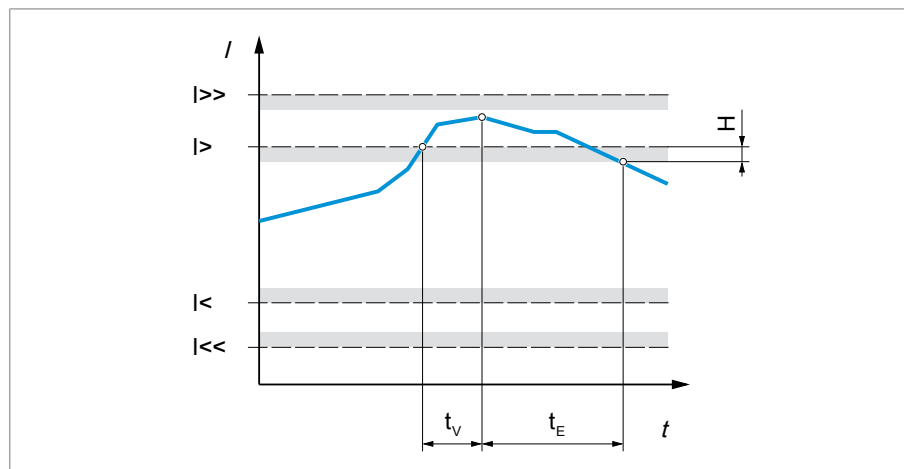


Figure 65: Example of current monitoring with the limit value  $I>$  being exceeded

$I>>$ Upper limit 2	$I>$ Upper limit 1
$I<$ Lower limit 1	$I<<$ Lower limit 2
$t_v$ Delay time	$t_E$ Event duration
H Hysteresis	

1. Go to **Settings > Parameters > Grid > Current monitoring**.
2. Select the desired parameter.
3. Set the desired parameter.
4. Press the **Accept** button to save the modified parameter.

You can set additional parameters for each limit value:

### Mode

You can use this parameter to set which limit value you would like to use:

- Absolute: The device uses the absolute limit value in A/kA.
- Relative: The device uses the relative limit value in %, relative to the rated current of current transformer.

### Hysteresis

You can use this parameter to set the hysteresis. You can use this to avoid the unnecessary generation of messages if the measured value fluctuates around a threshold value.



### Delay time

You can use this parameter to set the delay time in order to delay the issuing of the event message.

### Reaction

You can use this parameter to set the behavior of the device if the measured value is higher than the upper limit (> or >>) or lower than the lower limit (< or <<). You can select the following options:

Setting	Behavior
Off	No reaction.
Auto blocking	Automatic regulation is blocked. You can continue to perform tap-change operations in manual mode.
Auto/manual blocking	Automatic regulation is blocked. You <b>cannot</b> perform tap-change operations in manual mode.

Table 32: Behavior when an event message is issued

## 9.2.4 Power monitoring

For monitoring the transformer's current power, you can set the following limit values:

Measured value	Lower limit 2	Lower limit 1	Upper limit 1	Upper limit 2
Apparent power	S<<	S<	S>	S>>
Active power	P<<	P<	P>	P>>
Reactive power	Q<<	Q<	Q>	Q>>
Power factor (amount)	cos $\phi$  <<	cos $\phi$  <	-	-

Table 33: Limit values for power monitoring

1. Go to **Settings > Parameters > Grid > Power monitoring**.
2. Select the desired parameter.
3. Set the desired parameter.
4. Press the **Accept** button to save the modified parameter.

You can set additional parameters for each limit value:

### Absolute

You can use this parameter to specify a limit value.



### Hysteresis

You can use this parameter to set the hysteresis. You can use this to avoid the unnecessary generation of messages if the measured value fluctuates around a threshold value.

### Delay time

You can use this parameter to set the delay time in order to delay the issuing of the event message.

### Reaction

You can use this parameter to set the behavior of the device if the measured value is higher than the upper limit ( $>$  or  $>>$ ) or lower than the lower limit ( $<$  or  $<<$ ). You can select the following options:

Setting	Behavior
Off	No reaction.
Auto blocking	Automatic regulation is blocked. You can continue to perform tap-change operations in manual mode.
Auto blocking position-	The automatic control does not perform a tap-change operation in the direction of a lower tap position (position-). You can continue to perform tap-change operations in manual mode.
Auto blocking position+	The automatic control does not perform a tap-change operation in the direction of a higher tap position (position+). You can continue to perform tap-change operations in manual mode.
Auto/manual blocking	Automatic regulation is blocked. You <b>cannot</b> perform tap-change operations in manual mode.
Auto/manual blocking position-	The automatic control does not perform a tap-change operation in the direction of a lower tap position (position-). You <b>cannot</b> perform a tap-change operation in the direction of a lower tap position (position-) in manual mode.
Auto/manual blocking position+	The automatic control does not perform a tap-change operation in the direction of a higher tap position (position+). You <b>cannot</b> perform a tap-change operation in the direction of a higher tap position (position+) in manual mode.

Table 34: Behavior when an event message is issued



### 9.2.5 Power flow monitoring

A reversal of power flow occurs if the active power is negative. You can set the following parameters for this:

- Hysteresis
- Delay time
- Behavior

1. Go to **Settings > Parameters > Grid > Power flow monitoring**.
2. Select the desired parameter.
3. Set the desired parameter.
4. Press the **Accept** button to save the modified parameter.

#### Hysteresis

You can use this parameter to set the hysteresis. You can use this to avoid the unnecessary generation of messages if the measured value fluctuates around a threshold value.

#### Delay time

You can use this parameter to set the delay time in order to delay the issuing of the event message.



### Behavior for reversal of power flow

You can use this parameter to set the behavior in the event of a reversal of power flow. You can select the following options:

Setting	Behavior
Off	<ul style="list-style-type: none"> <li>The negative power flow is ignored.</li> <li>Automatic regulation remains active.</li> </ul>
Auto blocking	<ul style="list-style-type: none"> <li>The <i>Reversal of power flow</i> event is issued.</li> <li>If Z compensation is activated, this function is deactivated.</li> <li>Automatic regulation is blocked.</li> </ul>
Auto/manual blocking	<ul style="list-style-type: none"> <li>The <i>Reversal of power flow</i> event is issued.</li> <li>If Z compensation is activated, this function is deactivated.</li> <li>Automatic regulation is blocked.</li> <li>You cannot perform tap-change operations in manual mode.</li> </ul>
Target tap position	<ul style="list-style-type: none"> <li>The <i>Reversal of power flow</i> event is issued.</li> <li>If Z compensation is activated, this function is deactivated.</li> <li>The device triggers a tap-change operation to the tap position you defined in the "Target tap position" parameter.</li> <li>The device blocks further tap-change operations.</li> <li>The target-tap-position operation is ignored if there is no tap-position capture. Automatic regulation is blocked.</li> </ul>

Table 35: Behavior in the event of a reversal of power flow

### 9.2.6 Monitoring settings

Go to **Settings > Parameters > Power grid > Monitoring settings**.

### Monitoring $U < 30\text{ V}$

You can use this parameter to activate events and function monitoring. You can select the following options:

Setting	Behavior
Activate	Monitoring is activated, even if the measured voltage $U < 30\text{ V}$ .
Deactivate	Monitoring is activated. Between $19\text{ V} < U < 30\text{ V}$ , the following monitoring processes are suppressed: <ul style="list-style-type: none"> <li>▪ Voltage monitoring</li> <li>▪ Power monitoring</li> <li>▪ Power flow monitoring</li> <li>▪ Function monitoring</li> </ul>

Table 36: Activate function monitoring

### 9.2.7 TAPCON® 2xx retrofit

The TAPCON® 2xx retrofit function allows you to operate the device in parallel operation with existing devices. Parallel operation with the following existing devices is supported:

- TAPCON® 230 pro/expert up to year of construction 2021-08
- TAPCON® 240
- TAPCON® 250 predecessor device up to year of construction 2022-06
- TAPCON® 260
- TRAFOGUARD® with "Voltage regulation" options package

If you wish to operate several devices in parallel operation with existing devices, you have to activate the TAPCON® 2xx retrofit function on each device.

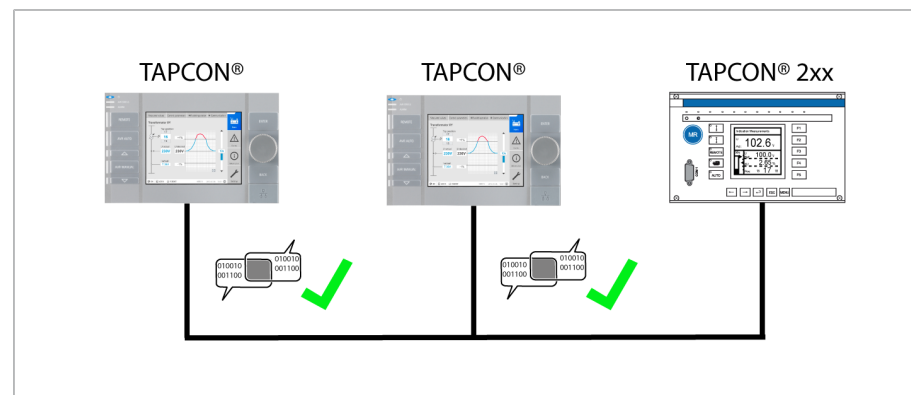


Figure 66: Parallel operation of 2 devices with one TAPCON® 2xx. The TAPCON® 2xx retrofit function must be active on both devices.

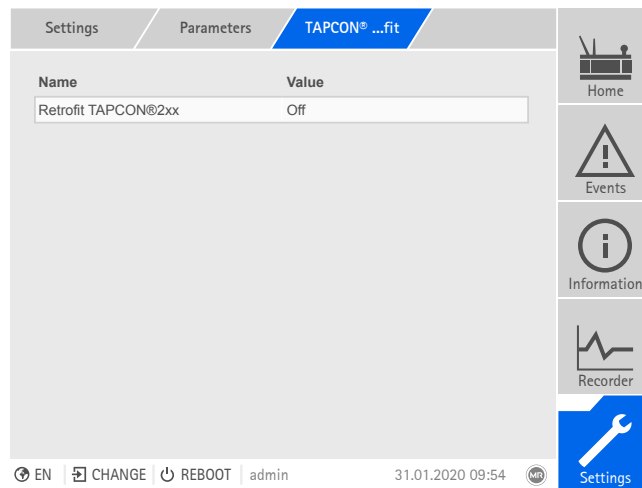


Figure 67: Retrofit TAPCON® 2xx

1. Go to **Settings > Parameters > Grid > TAPCON® 2xx retrofit**.
2. Select the desired parameter.
3. Set the desired parameter.
4. Press the **Accept** button to save the modified parameter.

#### TAPCON® 2xx retrofit

You can use this parameter to activate or deactivate the Retrofit TAPCON® 2xx function.



If you activate this parameter, you have to reverse the prefix of the "Phase angle correction" parameter for the transformer data (from - to + or from + to -).



## 9.3 On-load tap-changer regulator

### 9.3.1 Voltage regulation

All of the parameters required for the control function are described in this section.

1. Go to **Settings > Parameters > On-load tap-changer regulator > Voltage regulation**.
2. Select the desired parameter.
3. Set the desired parameter.
4. Press the **Accept** button to save the modified parameter.

#### 9.3.1.1 Setting the desired value

The device always uses one of the set desired values for control. You can define which desired value is used for regulation with the "Change remote desired value setting" parameter. You can define 5 desired values.

##### Setting desired value 1...5

You can set the desired value with this parameter.

1. Go to **Settings > Parameters > On-load tap-changer > Voltage regulation > Desired value**.
2. Enter the desired value.
3. Press the **Accept** button to save the modified parameter.

##### Changing the remote desired value setting

You can use this parameter to select the type of remote desired value setting which the device is to use for regulation. You can select between the following options:

- Remote desired value setting using 5 digital desired values
    - For this option, make sure that the corresponding digital inputs are connected.
  - Remote desired value setting using analog desired values
    - For this option, make sure that the corresponding analog input is connected.
  - Remote desired value setting using TDSC
1. Go to **Settings > Parameters > On-load tap-changer > Voltage regulation > Change remote desired value setting**.
  2. Select the desired option in the list.
  3. Press the **Accept** button to save the modified parameter.





### Selecting a desired value

You can use this parameter to select the desired value used for control. You can choose between desired value 1... 5.

✓ Type of remote desired value setting selected.

1. Go to **Settings > Parameters > On-load tap-changer > Voltage regulation > Desired value**.
2. Select the desired value from the list.
3. Press the **Accept** button to save the modified parameter.

#### 9.3.1.1.1 Analog setting of the desired value

With the analog setting of the desired value, the desired value for the automatic voltage regulation can be variably adapted using an analog signal (e.g. 4...20 mA).

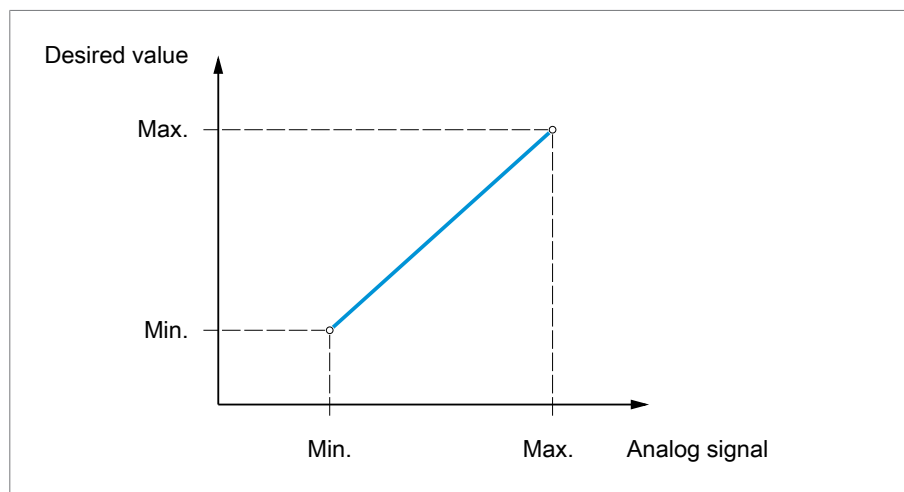


Figure 68: Analog setting of the desired value

In order to configure the analog setting of the desired value, you can set the parameters as described below.



To specify the desired value using an analog signal, you need to create a signal at the *Desired value setting release* input. If this is not done, the device uses the set desired value 1.



You have to set the parameters for both winding 1 (W1) and winding 2 (W2).

**Setting desired value 1**

1. Go to **Settings > Parameters > Grid > Control > Desired value**.
2. Enter the desired value.
3. Press the **Accept** button to save the modified parameter.

**Setting max. desired value setting**

With this parameter, you can set the desired value that corresponds to the maximum level of the analog signal level (e.g. 20 mA for 4...20 mA signal).

1. Go to **Settings > Parameters > Control > Setting max. desired value**.
2. Enter desired value.
3. Press the **Accept** button to save the modified parameter.

**Setting min. desired value setting**

With this parameter, you can set the desired value that corresponds to the minimum level of the analog signal (e.g. 4 mA for 4...20 mA signal).

1. Go to **Settings > Parameters > Control > Setting min. desired value**.
2. Enter desired value.
3. Press the **Accept** button to save the modified parameter.

**9.3.1.1.2 Active power-dependent adjustment of desired voltage value**

The TAPCON® Dynamic Setpoint Control (TDSC) function is used to adapt the desired voltage value depending on the measured active power. This allows you to compensate for a voltage drop during increased load or a voltage increase due to a decentralized feed-in.

Depending on whether positive or negative active power is measured, the desired value calculation is based on 2 linear equations (see example in diagram below).

Parameter	Function	Settings (see diagram below)
$U_{\max}$ : Maximum desired value	Maximum set desired value is activated when $P_{\max}$ is exceeded.	103.0 V
$U_{\min}$ : Minimum desired value	Minimum set desired value is activated when value falls below $P_{\min}$ .	99.0 V
$U_0$ : Desired value at 0 active power	Set desired value is activated when measured active power is 0 MW.	100.00 V

Parameter	Function	Settings (see diagram below)
$P_{\max}$ : Active power at max. desired value	Set maximum active power value above which the power-dependent desired value is to attain the maximum value $U_{\max}$ .	20.0 MW
$P_{\min}$ : Active power at min. desired value	Set minimum active power value below which the power-dependent desired value is to attain the minimum value $U_{\min}$ .	-20.0 MW

Table 37: Parameters to be set for active power-dependent adjustment of desired voltage value

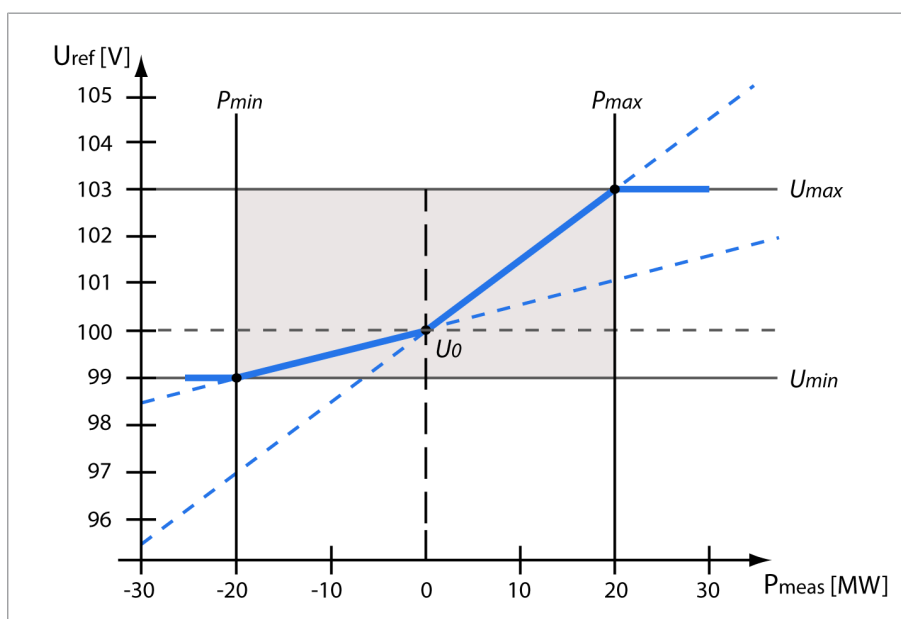


Figure 69: Active power-dependent adjustment of desired voltage value

$U_{\text{ref}}$	Desired value	$U_{\min}$	Minimum desired value
$P_{\text{meas}}$	Measured active power	$U_{\max}$	Maximum desired value
$P_{\min}$	Active power at minimum desired value	$U_0$	Set desired value when measured active power = 0
$P_{\max}$	Active power at maximum desired value		

### Response to active power $P_{\max}$ being exceeded

If the measured active power  $P_{\text{meas}}$  exceeds the set parameter  $P_{\max}$ , the value  $U_{\max}$  is adopted as the desired value.

$$U_{\text{ref}} = U_{\max}$$

### Response to value falling below active power $P_{min}$

If the measured active power  $P_{meas}$  falls below the set parameter  $P_{min}$ , the value  $U_{min}$  is adopted as the desired value.

$$U_{ref} = U_{min}$$

### Response to a measured active power $P_{meas} = 0$ MW:

If the measured active power  $P_{meas} = 0$ , the set parameter  $U_0$  is adopted.

$$U_{ref} = U_0$$

### Linear dependency with negative active power:

If the measured active power  $P_{min} \leq P_{meas} \leq 0$ , the desired value is calculated using the following equation:

$$U_{ref} = \frac{U_0 - U_{min}}{0 - P_{min}} \times P_{meas} + U_0$$

### Linear dependency with positive active power:

If the measured active power  $0 \leq P_{meas} \leq P_{max}$ , the desired value is calculated using the following equation:

$$U_{ref} = \frac{U_{max} - U_0}{P_{max}} \times P_{meas} + U_0$$

To activate the active power-dependent adjustment of the desired voltage value, you need to set the following parameters:

### Activating TDSC

The TDSC function is only active when the device can calculate the active power (correct current measurement and voltage measurement) and the required parameters are set. If this is not the case, voltage regulation is in accordance with the set desired value. You can activate or deactivate the power-dependent adjustment of the desired voltage value as follows:

- Parameter
- Digital inputs *TDSC on* and *TDSC off*



If you activate TDSC, the line drop compensation (R&X compensation or Z compensation) function is deactivated.



To activate/deactivate TDSC using parameters, proceed as follows:

1. Go to **Settings > Parameters > Control > Activate TDSC**.
2. Select the desired option.
3. Press the **Accept** button to save the modified parameter.

#### TDSC U<sub>max</sub>/U<sub>min</sub>

You can use these parameters to set the maximum and minimum desired value. The maximum or minimum desired value is activated when the measured active power reaches the set minimum or maximum active power.

1. Go to **Settings > Parameters > Control > TDSC U<sub>max</sub>/U<sub>min</sub>**.
2. Enter maximum/minimum desired value.
3. Press the **Accept** button to save the modified parameter.

#### TDSC U<sub>0</sub>

You can use this parameter to set the desired value which is to be used when the measured active power is 0.

1. Go to **Settings > Parameters > Control > TDSC U<sub>0</sub>**.
2. Enter desired value at active power 0.
3. Press the **Accept** button to save the modified parameter.

#### TDSC P<sub>max</sub>/P<sub>min</sub>

You can use these parameters to set the maximum and minimum active power value at which the maximum and minimum active power-dependent desired value is to be used for regulation.

1. Go to **Settings > Parameters > Control > TDSC P<sub>max</sub>/P<sub>min</sub>**.
2. Enter active power for maximum/minimum desired value.
3. Press the **Accept** button to save the modified parameter.

#### Bandwidth

You can use this parameter to set the maximum permissible deviation of the measured voltage  $U_{\text{actual}}$  from the desired value  $U_{\text{desired}}$ .



In order to set the correct value, the transformer step voltage and nominal voltage must be known. Note that a large bandwidth will result in a large control deviation.

The bandwidth must always be greater than the following value:

$$|\pm B| \geq 0,6 \times \frac{U_{n-1} - U_n}{U_N} \times 100 \%$$

$U_{n-1}$	Step voltage of tap position n-1
$U_n$	Step voltage of tap position n
$U_N$	Nominal voltage

The following transformer values are used to determine the minimum bandwidth:

*Nominal voltage  $U_N = 11000 \text{ V}$*

*Step voltage in tap position 4  $U_{\text{Step4}} = 11275 \text{ V}$*

*Step voltage in tap position 5  $U_{\text{Step5}} = 11000 \text{ V}$*

$$[\pm B\%] \geq 0,6 \cdot \frac{U_{\text{Step4}} - U_{\text{Step5}}}{U_{\text{nom}}} \cdot 100\%$$

$$[\pm B\%] \geq 0,6 \cdot \frac{11275 \text{ V} - 11000 \text{ V}}{11000 \text{ V}} \cdot 100\%$$

$$[\pm B\%] \geq 1,5\%$$



## Delay time T1

Delay time T1 delays the issuing of a tap-change command for a defined period. This prevents unnecessary tap-change operations if the tolerance bandwidth is exited briefly.

**Response to delay time T1** If the control variable **5** is within the set bandwidth **6**, no control commands are issued to the motor drive unit for the tap change. Control commands will also not be issued to the motor-drive unit if the control variable returns to the bandwidth **4** within the set delay time T1 **6**. However, if the control variable deviates from the set bandwidth for a long period **C**, a tap-change command **D** is issued after expiration of the set delay time T1. The on-load tap-changer carries out a tap-change in a raise or lower direction to return to the tolerance bandwidth.

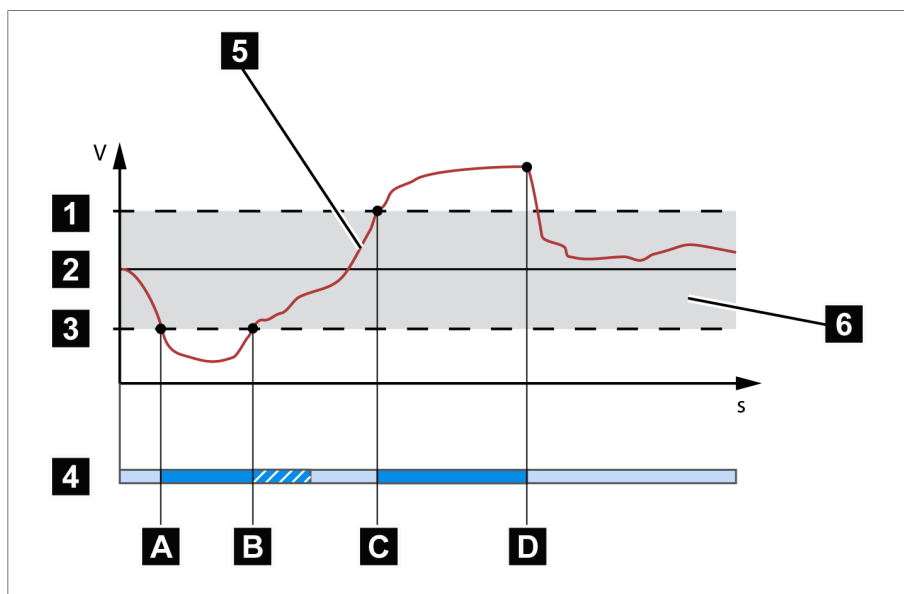


Figure 70: Behavior of the control function with delay time T1

1 Upper limit of bandwidth	4 Set delay time T1
2 Desired value	5 Control variable measured value
3 Lower limit of bandwidth	6 Bandwidth range
A Control variable is outside of the bandwidth. Delay time T1 starts.	B Control variable returned to within the bandwidth before delay time T1 has expired.
C Control variable is outside of the bandwidth. Delay time T1 starts.	D Control variable is still outside the bandwidth after delay time T1 has expired. Tap-change operation is initiated.

### Delay time T2

You can use this parameter to set delay time T2. Delay time T2 is used to compensate for large control deviations faster.

The delay time T2 only takes effect if more than one tap-change operation is required to correct the control deviation. The first output pulse occurs after the set delay time T1. After the set tap-change delay time T2 has elapsed, additional pulses occur in order to correct the existing control deviation.

The following requirements must be noted to set delay time T2:

- The delay time T2 must be greater than the switching pulse time.
- The delay time T2 must be greater than the maximum operating time of the motor-drive unit.
- The delay time T2 must be less than the value set for delay time T1.

#### Behavior with delay times T1 and T2

If the control variable **5** deviates from the set bandwidth for a long period **A**, a control impulse is output to the motor-drive unit after the set delay time T1 **B**. If the control variable is still outside the bandwidth, delay time T2 **B** starts to count down. Once delay time T2 is complete, a control impulse is again issued to the motor-drive unit for the tap change **C** to return to the tolerance bandwidth.

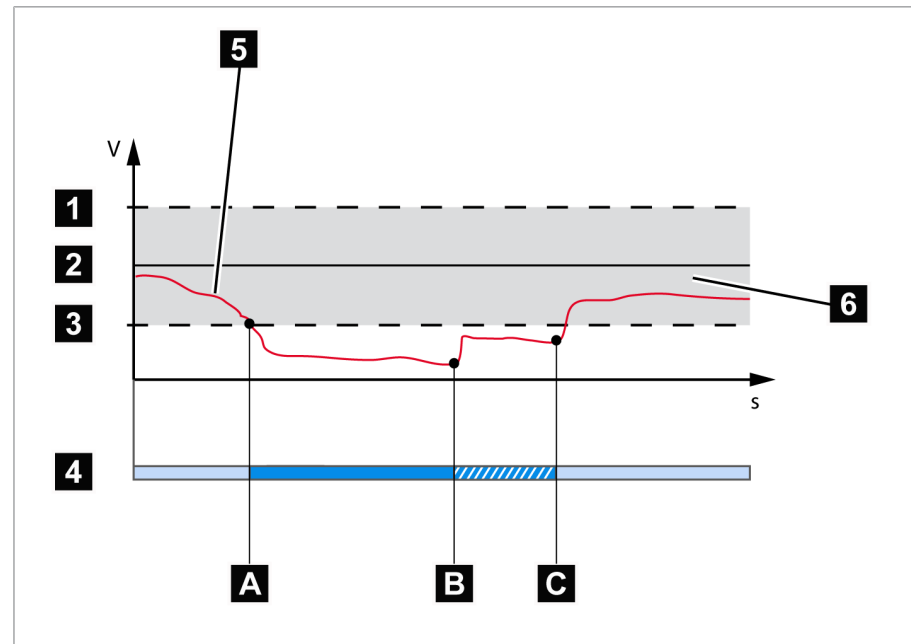


Figure 71: Behavior of the regulation function with delay times T1 and T2

1 Upper limit of bandwidth	4 Set delay times T1 and T2.
2 Desired value	5 Control variable measured value
3 Lower limit of bandwidth	6 Bandwidth range
A Control variable is outside of the bandwidth. Delay time T1 starts.	B Delay time T1 complete. Tap change triggered.
C Delay time T2 complete. Tap change triggered.	



### 9.3.2 Line drop compensation

You can use the compensation function to compensate for the load-dependent voltage drop between the transformer and consumer. The device provides 2 methods of compensation for this purpose:

- R&X compensation
- Z compensation

#### 9.3.2.1 R&X compensation

R&X compensation can compensate for voltage losses on the lines and therefore ensure correct voltage at the load. This requires precise line data. After you have entered all of the line data, the device automatically calculates the ohmic and inductive voltage drop and takes this into account for automatic voltage regulation.

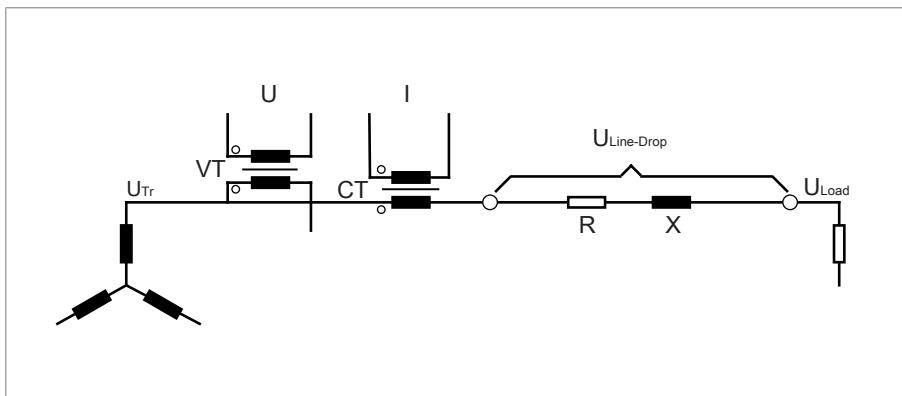


Figure 72: Equivalent circuit of R&X compensation

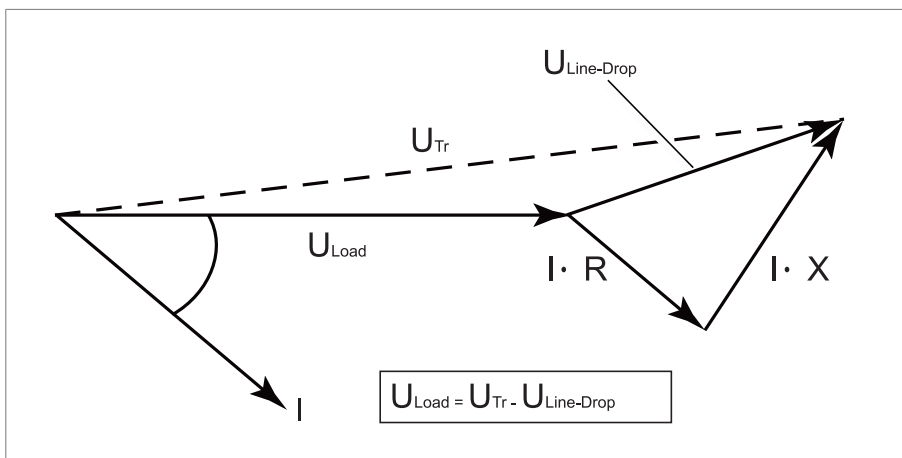


Figure 73: Phasor diagram of R&X compensation

To use R&X compensation, you have to enter the following line data:

- Ohmic resistance load in  $\text{m}\Omega/\text{m}$
  - Inductive resistance load in  $\text{m}\Omega/\text{m}$
  - Length of line in km
1. Go to **Settings > Parameters > On-load tap-changer regulator > Compensation**.
  2. Select the desired parameter.
  3. Set the desired parameter.
  4. Press the **Accept** button to save the modified parameter.

#### Ohmic resistance load

You can use this parameter to set the ohmic resistance load.

#### Inductive resistance load

You can use this parameter to set the inductive resistance load.

#### Length of line

You can use this parameter to set the length of line.

#### 9.3.2.2 Z compensation

To keep the voltage constant for the consumer, you can use Z compensation to activate a current-dependent voltage increase. You can also define a limit value to avoid excess voltage on the transformer.

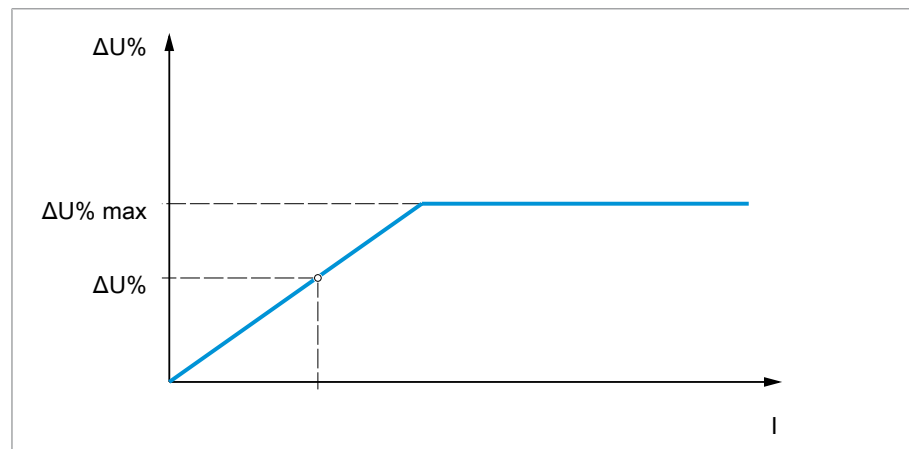


Figure 74: Z compensation

To use Z compensation, you need to calculate the voltage increase ( $\Delta U$ ) taking the current into account. Use the following formula for this purpose:



$$\Delta U = \frac{U_{Tr} - U_{Load} \times \frac{I_N \times k_{CT}}{I}}{U_{Load}} \times 100\%$$

$\Delta U$	Voltage increase	$I$	Load current in A
$U_{Tr}$	Transformer voltage at current $I$	$I_N$	Nominal current of current-transformer connection in A
$U_{Load}$	Voltage on line end at current $I$ and on-load tap-changer in same operating position	$k_{CT}$	Current transformer transmission ratio



Sample calculation:  $U_{Tr} = 100.1 \text{ V}$ ,  $U_{Load} = 100.0 \text{ V}$ ,  $I_N = 5 \text{ A}$ ,  $k_{CT} = 200 \text{ A/5 A}$ ,  $I = 100 \text{ A}$

Produces a voltage increase  $\Delta U$  of 0.2%

1. Go to **Settings > Parameters > On-load tap-changer regulator > Compensation**.
2. Select the desired parameter.
3. Set the desired parameter.
4. Press the **Accept** button to save the modified parameter.

### Voltage increase

You can use this parameter to set the current-dependent voltage increase  $\Delta U$ .

### Voltage limit value

You can use this parameter to define the maximum permissible voltage increase to avoid excess voltage on the transformer.

## 9.3.3 U bandwidth monitoring

The following limit values are monitored via bandwidth monitoring. The set bandwidth (upper/lower) of the voltage regulation is used for this purpose.

**Behavior** If the measured value is higher than the upper limit or lower than the lower limit, the device triggers the *Upper bandwidth limit value / Lower bandwidth limit value* message.

The "Function monitoring" function is used to detect long periods when values are above or below the bandwidth. Long periods when values are above or below the bandwidth indicate a problem with the device function because the device is not able to correct the control deviation.

If the value is above or below the set bandwidth, the *Function monitoring* event is displayed after the set delay time for function monitoring has elapsed. The event is automatically acknowledged as soon as the measured value is back within the set bandwidth.



The following parameters are available for setting function monitoring:

- Function monitoring
  - Hysteresis
  - Delay time
1. Go to **Settings > Parameters > On-load tap-changer regulator > U bandwidth monitoring**.
  2. Select the desired parameter.
  3. Set the desired parameter.
  4. Press the **Accept** button to save the modified parameter.

You can set additional parameters for each limit value:

### Function monitoring

You can use this parameter to activate function monitoring. When doing so, also observe the monitoring settings [► Page 114].

You can select the following options:

Setting	Behavior
Off	Function monitoring is deactivated.
Only Auto	Function monitoring is only active in AVR AUTO operating mode.
Auto and Manual	Function monitoring is active in AVR AUTO and AVR MANUAL operating modes

Table 38: Activate function monitoring

### Hysteresis

You can use this parameter to set the hysteresis. You can use this to avoid the unnecessary generation of messages if the measured value fluctuates around a threshold value.

### Delay time

You can use this parameter to set the delay time in order to delay the issuing of the event message.



## 9.4 On-load tap-changer

### 9.4.1 Tap position monitoring

You can set the limit value parameter for tap position monitoring:

1. Go to **Settings > Parameters > On-load tap-changer > Tap position monitoring**.
2. Select the desired parameter.
3. Set the desired parameter.
4. Press the **Accept** button to save the modified parameter.

#### Delay time

You can use this parameter to set the delay time in order to delay the issuing of the event message.

#### Behavior limit value

You can use this parameter to set the behavior of the device when the event message is issued. You can select the following options:

Setting	Behavior
Off	Tap position monitoring is disabled.
Auto blocking position+	The automatic control does not perform a tap-change operation in the direction of a higher tap position (position+). You can still perform a tap-change operation in the direction of a higher tap position (position+) in manual mode.
Auto blocking position-	The automatic control does not perform a tap-change operation in the direction of a lower tap position (position-). You can still perform a tap-change operation in the direction of a lower tap position (position-) in manual mode.
Auto/manual blocking position+	The automatic control does not perform a tap-change operation in the direction of a higher tap position (position+). You cannot perform a tap-change operation in the direction of a higher tap position (position+) in manual mode.
Auto/manual blocking position-	The automatic control does not perform a tap-change operation in the direction of a lower tap position (position-). You cannot perform a tap-change operation in the direction of a lower tap position (position-) in manual mode.

#### Operations counter

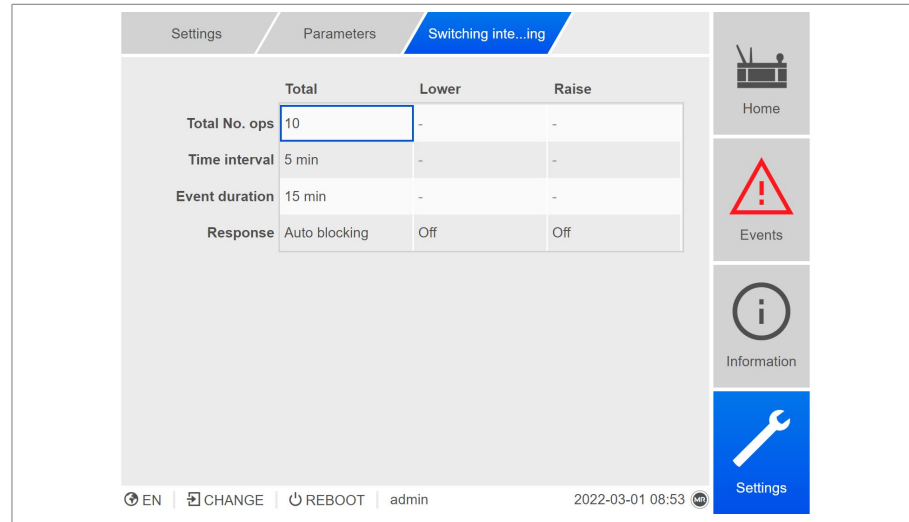
The device's operations counter is automatically increased with every tap-change operation. You can use this parameter to set the number of tap-change operations, such as for a comparison with the operations counter of the motor-drive unit.

## 9.4.1.1 Switching interval monitoring

You can use this function to monitor the typical tap-change behavior of your transformer. Furthermore, you can set the number of consecutive tap-change operations permissible in auto mode within a defined time period.

You can have the following operations monitored:

- Total operations: Total RAISE operations and LOWER operations
- LOWER operations: Total LOWER operations
- RAISE operations: Total RAISE operations



	Total	Lower	Raise
Total No. ops	10	-	-
Time interval	5 min	-	-
Event duration	15 min	-	-
Response	Auto blocking	Off	Off

Figure 75: Switching interval monitoring

1. Go to **Settings > Parameters > On-load tap-changer > Switching interval monitoring**.
2. Select the desired parameter.
3. Set the desired parameter.
4. Press the **Accept** button to save the modified parameter.

### Total tap-change operations

If the maximum permissible number of tap-change operations within the set time interval is exceeded, the device triggers a corresponding response.

### Time interval

You can use this parameter to set the time interval in which the maximum number of tap-change operations may not be exceeded.



### Event duration

You can use this parameter to set how long the device is to respond with the set behavior.

### Behavior

You can use this parameter to set the behavior of the device if the maximum permissible number of tap-change operations is exceeded:

Setting	Behavior
Off	Switching interval monitoring is disabled.
Switching to manual mode	The event is displayed for the set duration of the response. The device automatically switches to manual mode.
Auto blocking	The event is displayed for the set duration of the response. Automatic voltage regulation is blocked. You can wait for the blocking time to expire or switch to manual mode by hand and then to auto mode. The event is reset and blocking is disabled.

Table 39: Behavior

### Counting behavior (only with raise or lower tap-change operations)

You can use this parameter to set whether intermediate RAISE or LOWER tap-change operations reset the internal counter. You can select the following options:

- On:
  - The internal counter for consecutive LOWER tap-change operations is reset during a RAISE operation.
  - The internal counter for consecutive RAISE tap-change operations is reset during a LOWER operation.
- Off: The internal counter is not reset by intermediate RAISE or LOWER tap-change operations.

#### 9.4.1.2 Tap position capture method

The current tap position of the on-load tap-changer is transmitted from the motor-drive unit to the device. You can use this parameter to select the type of tap position capture.

- Dual code
- Gray code
- BCD
- Analog
- N/O contact series
- Resistor contact series

- Keep Track
- Decade



In order to ensure proper function of the tap position capture, make sure that the inputs of the corresponding tap position capture method are activated and correctly wired.



To ensure that the tap position capture functions correctly, ensure that when you change the tap position capture method, the previously set DIO or AIO configurations of the tap position are deleted and set for the new tap position detection.

1. Go to **Settings > Parameters > On-load tap-changer > Tap position monitoring > Tap position capture method**.
2. Select the desired tap position method.
3. Press the **Accept** button to save the modified parameter.

The tap position is transmitted in one of the following ways:

### 9.4.1.2.1 Analog tap position capture

The tap position can be transmitted as an analog signal from the motor-drive unit to the device. The following variants are available:

#### 9.4.1.2.1.1 Injected current

For the analog tap position capture, you must set which tap positions correspond to the minimum analog signal and maximum analog signal.

##### **Pos. at max. analog signal**

You can use this parameter to set the tap position of the on-load tap-changer corresponding to the maximum analog signal (e.g. 20 mA for 4...20 mA signal).

1. Go to **Settings > Analog tap position capture > Pos. at max. analog signal**.
2. Set the tap position.
3. Press the **Accept** button to save the modified parameter.





### Pos. at min. analog signal

You can use this parameter to set the tap position of the on-load tap-changer corresponding to the minimum analog signal (e.g. 4 mA for 4...20 mA signal).

1. Go to **Settings > Analog tap position capture > Pos. at min. analog signal**.
2. Set the tap position.
3. Press the **Accept** button to save the modified parameter.

#### 9.4.1.2.1.2 Resistor contact series



Carry out the calibration at an ambient temperature that corresponds to normal operating conditions. This allows you to reduce measurement errors due to temperature fluctuations.

To capture the tap positions via resistor contact series, you need to perform a calibration. In order to do this, you have to set the on-load tap-changer's tap positions corresponding to the maximum and minimum analog signal. Then you have to carry out on-load tap-change operations across the entire tap position range. The entire calibration process is performed using wizards.

1. Go to **Settings > Calibrate hardware > Calibrate RCS**.
2. Select the **Pos. at max. analog signal** parameter.
3. Set the tap position.
4. Press the **Accept** button to save the modified parameter.
5. Select the **Pos. at min. analog signal** parameter.
6. Set the tap position.
7. Press the **Accept** button to save the modified parameter.
8. Click on the **Start** button.
  - ⇒ The calibration wizard is started.
9. Press the **Next** button.
10. Step 1: Manually switch on-load tap-changer to the highest tap position.
11. Press the **Next** button.
  - ⇒ Step 2: The device calibrates the current output and once complete moves on to step 3.
12. Step 3: Manually switch the on-load tap-changer to the lowest tap position.
  - ⇒ Step 4: The device determines the offset and once complete moves on to step 5.

13. Step 5: Press the **Next** button to complete calibration.

⇒ Calibration of tap position capture using the resistor contact series has been performed successfully.

#### 9.4.1.2.2 Keep Track



In the event of a power failure on the ISM, the display value has to be adjusted to the actual value of the tap position on the OLTC via the Keep Track parameter.

You can use this menu item to update the tap position indirectly based on characteristics.

- Keep Track tap position
- Neutral position

1. Go to **Settings > Parameters > On-load tap-changer > Tap position capture**.
2. Select the desired parameter.
3. Set the desired parameter.
4. Press the **Accept** button to save the modified parameter.

##### Keep Track tap position

You can use this parameter to enter the actual tap position of the on-load tap-changer.

##### Neutral position

You can use this parameter to enter the neutral position of the on-load tap-changer.

#### 9.4.2 Target-tap-position operation

When target-tap-position operation is activated, the device automatically switches to this target tap position.

1. Go to **Settings > Parameters > On-load tap-changer > Move to the defined target tap position**.
2. Enter the target tap position.
3. Press the **Accept** button to save the modified parameter.

##### Target tap position

You can use this parameter to define a target tap position.



### Target-tap-position operation allowed

You can use this parameter to set in which operating mode the Target-tap-position operation function is allowed or blocked.

Option	Behavior with the operating mode			
	AVR Auto		AVR Manual	
	Local	Remote	Local	Remote
AVR Auto	Allowed	Allowed	Blocked	Blocked
AVR Manual	Blocked	Blocked	Blocked	Allowed
AVR Auto + Manual	Allowed	Allowed	Blocked	Allowed

Table 40: Behavior of the Target-tap-position operation function depending on the selected option and the operating mode of the device

### 9.4.3 Information about the on-load tap-changer

Under "OLTC" you can display information about the on-load tap-changer:

- Current tap position
  - Total tap-change operations (operations counter)
- Go to **Information > On-load tap-changer > OLTC**.

### 9.4.4 OLTC data

In this menu, you can set parameters for the on-load tap-changer (OLTC).

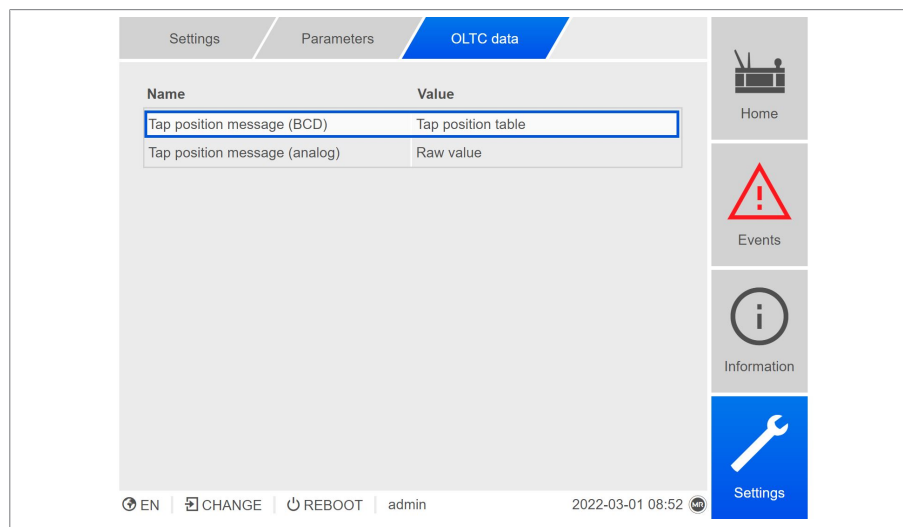


Figure 76: OLTC data

1. Go to **Settings > Parameters > On-load tap-changer > OLTC data**.
2. Select the desired parameter.

3. Set the desired parameter.
4. Press the **Accept** button to save the modified parameter.

## OLTC A/B/C serial number

You can use this parameter to set the serial number of the on-load tap-changer.



In applications with several columns, you can enter a unique serial number for each on-load tap-changer.

### 9.4.4.1 Setting the tap position message (optional)

If you issue the tap position of the on-load tap-changer via an analog output or digital outputs (BCD, gray, etc.), you can set whether the device is to use the raw value or the adjusted value for the control system in accordance with the tap position table. You can use this setting to ensure that pass-through positions of the on-load tap-changer are not reported as a separate tap position.

If you issue the tap position via several outputs, you can set this behavior for each output separately.

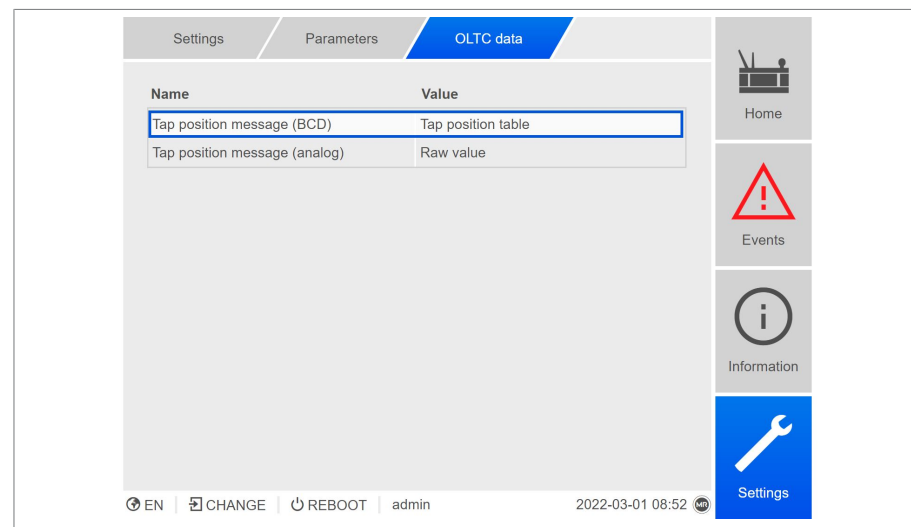


Figure 77: OLTC data (example with 2x tap position message)

1. Go to **Settings > Parameters > On-load tap-changer > OLTC data**.
2. Select the desired parameter.
3. Set the desired parameter.



4. Press the **Accept** button to save the modified parameter.

#### Tap position message (analog)

You can use this parameter to set which range of values from the tap position table the device should use for the tap position message using the analog output.



If you change this parameter, you must then ensure that the configured analog output value range matches the value range in the tap position table. Otherwise, the tap position will not be reported correctly.

#### BCD tap position message

You can use this parameter to set which range of values from the tap position table the device is to use for the tap position message via digital outputs (BCD).

### 9.4.5 U bandwidth monitoring

The following limit values are monitored via bandwidth monitoring. The set bandwidth of the voltage regulation is used for this purpose.

- Upper bandwidth
- Lower bandwidth

You can set the following parameters for each limit value:

- Hysteresis limit value: Specification as a percentage relative to the desired voltage value.
- Delay time limit value

**Behavior** If the measured value is higher than the upper limit or lower than the lower limit, the device triggers the *Upper bandwidth limit value / Lower bandwidth limit value* message.

The "Function monitoring" function is used to detect long periods when values are above or below the bandwidth. Long periods when values are above or below the bandwidth indicate a problem with the device function because the device is not able to correct the control deviation.

If the value is above or below the set bandwidth, the *Function monitoring* event is displayed after the set delay time for function monitoring has elapsed. The event is automatically acknowledged as soon as the measured value is back within the set bandwidth.

The following parameters are available for setting function monitoring:

- Function monitoring
- Hysteresis

- Delay time
- Monitoring U < 30 V

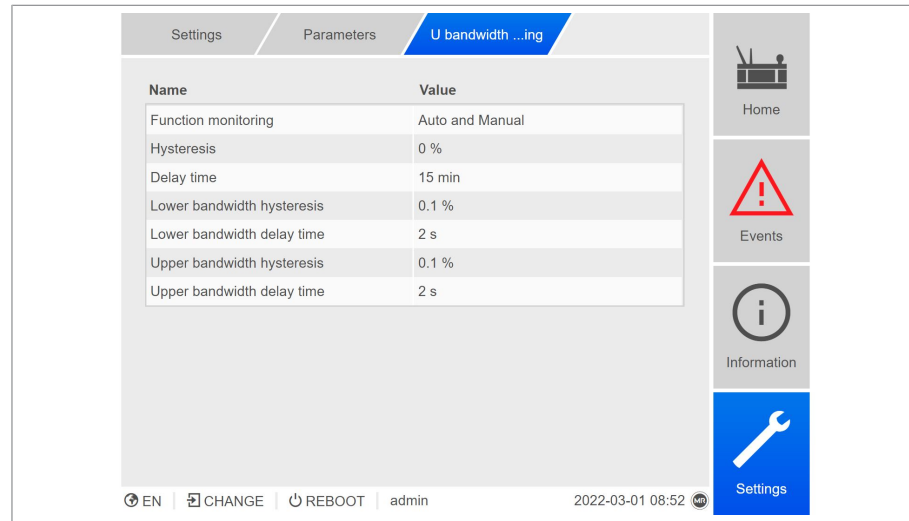


Figure 78: U bandwidth monitoring

1. Go to **Settings > Parameters > On-load tap-changer regulator > U bandwidth monitoring**.
2. Select the desired parameter.
3. Set the desired parameter.
4. Press the **Accept** button to save the modified parameter.

#### Also refer to

Monitoring U < 30 V [► 114]

#### Function monitoring

You can use this parameter to activate function monitoring. When doing so, also observe the monitoring settings [► Page 114].

You can select the following options:

Setting	Behavior
Off	Function monitoring is deactivated.
Only Auto	Function monitoring is only active in AVR AUTO operating mode.
Auto and Manual	Function monitoring is active in AVR AUTO and AVR MANUAL operating modes

Table 41: Activate function monitoring



### Hysteresis

You can use this parameter to set the hysteresis. You can use this to avoid the unnecessary generation of messages if the measured value fluctuates around a threshold value.

### Delay time

You can use this parameter to set the delay time in order to delay the issuing of the event message.

#### 9.4.6 Displaying the minimum and maximum tap position

You can display the minimum and maximum tap position reached and the corresponding time.

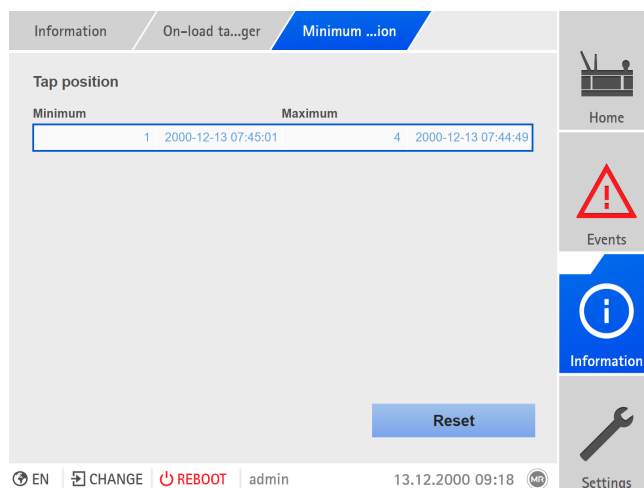


Figure 79: Minimum and maximum tap position

1. Go to **Information > On-load tap-changer > Minimum and maximum tap position**.
2. As needed, select the **Reset** button to reset the minimum and maximum values.

## 9.5 Motor-drive unit and control cabinet

### 9.5.1 Control of the motor-drive unit

The following parameters let you configure control of the motor-drive unit. You can set the following:

- Switching pulse
- Motor runtime
- Switching direction

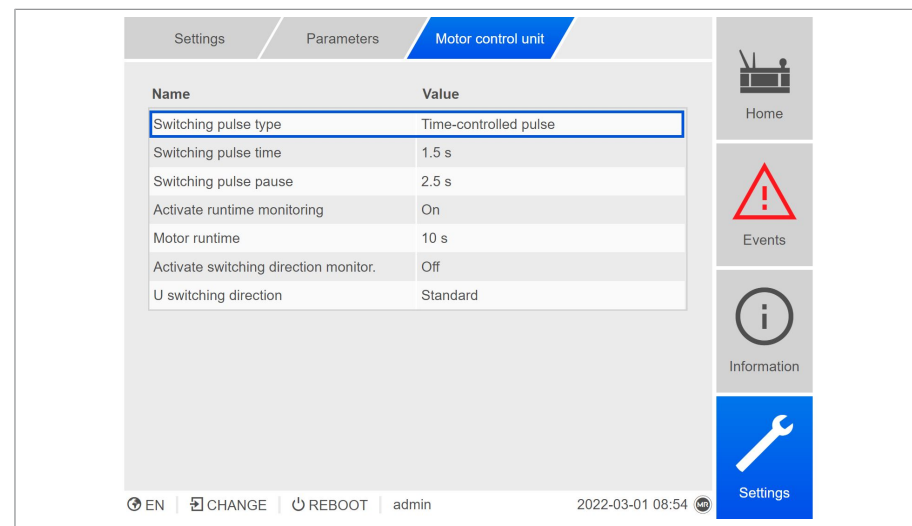


Figure 80: Motor control unit

► Go to **Settings > Parameters > Motor and control cabinet > Torque monitoring** .

#### 9.5.1.1 Setting the switching pulse for controlling the motor-drive unit

You can use the parameters Switching pulse type, Switching pulse time and Switching pulse pause to adapt the device switching pulse to the requirements of the motor-drive unit controller.

1. Go to **Settings > Parameters > Motor and control cabinet > Motor control**.
2. Select the desired parameter.
3. Set the parameter.
4. Press the **Accept** button to save the modified parameter.

#### Switching pulse type

You can use this parameter to toggle the switching pulse between a continuous pulse or a time-controlled switching pulse.





**Continuous pulse** Selecting the "Continuous pulse" option causes the device to issue the switching pulse in AVR Auto operating mode until the measured value is back within the bandwidth. In AVR Manual operating mode, the device issues the switching pulse for as long as you press the or key.

If the device is operated as a follower in parallel operation in this case, then the TAPCON® will issue the switching pulse until one of the following requirements has been met:

- The set motor runtime has been reached
- The *Motor running* signal switches from state 1 to 0
- The tap position required by the master has been reached

A pause is enforced after every switching pulse before another switching pulse is issued.

**Time-controlled switching pulse** Selecting the "Time-controlled switching pulse" option causes the device to issue the switching pulse for a set duration. A pause **1** is enforced after every switching pulse **2** before another switching pulse is issued.



If you use a motor-drive unit from Maschinenfabrik Reinhausen GmbH, you need to select the "Time-controlled switching pulse" option.

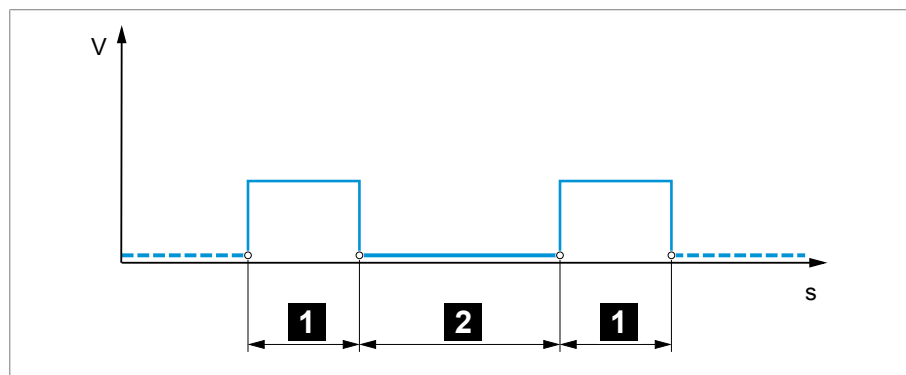


Figure 81: Switching pulse time and switching pulse pause

1 Switching pulse time

2 Switching pulse pause

### Switching pulse time

You can use this parameter to set the maximum duration of the switching pulse. The switching pulse resets after the switching pulse time has elapsed or if the device receives the *Motor running* signal beforehand or the tap position is changed.

### Switching pulse pause

You can use this parameter to set the switching pulse pause between 2 switching pulses. The device can only issue another switching pulse once the switching pulse pause has elapsed.

#### 9.5.1.2 Setting motor runtime monitoring

The motor-drive unit's runtime can be monitored by the device. This function is used to identify motor-drive unit malfunctions during the tap-change operation and to trigger any actions needed.

**Behavior** The motor-drive unit issues the *Motor-drive unit running* signal during the tap-change operation. This signal is present until the tap-change operation is complete. The device compares the duration of this signal with the set motor runtime. If the set motor runtime is exceeded, the device triggers the following actions:

1. *Motor runtime exceeded* event.
2. Pulse signal via *Trigger motor protective switch* output relay



Note that motor-drive units with pass-through positions or motor-drive units without stepped switching behavior will run for longer under certain circumstances. Set a longer motor runtime for such units.

1. Go to **Settings > Parameters > Motor and control cabinet > Motor control**.
2. Select the desired parameter.
3. Set the parameter.
4. Press the **Accept** button to save the modified parameter.

### Motor runtime

You can use this parameter to set the motor runtime.

### Motor runtime monitoring

You can use this parameter to activate or deactivate motor runtime monitoring.

#### 9.5.1.3 Setting the switching direction

You can set the switching direction of the motor-drive unit.

1. Go to **Settings > Parameters > Motor and control cabinet > Motor control**.
2. Select the desired parameter.
3. Set the parameter.



4. Press the **Accept** button to save the modified parameter.

### U switching direction

You can use this parameter to set the switching direction for voltage regulation. You can use this to adjust the behavior of the device based on how your on-load tap-changer and motor-drive unit are configured. You can select the following options:

Setting	Meaning
Standard	<p>The device issues a signal via the <i>Raise</i> output to increase the voltage.</p> <p>The device issues a signal via the <i>Lower</i> output to reduce the voltage.</p>
Swapped	<p>The device issues a signal via the <i>Lower</i> output to increase the voltage.</p> <p>The device issues a signal via the <i>Raise</i> output to reduce the voltage.</p>

Table 42: Behavior

### Switching direction monitoring

You can use this parameter to set the switching direction monitoring. This function monitors whether a tap-change operation in the wrong direction has been undertaken (e.g. due to a wiring mistake).

If a tap-change operation in the wrong direction is detected, the device issues the event message *Switching direction monitoring* and blocks automatic regulation. Automatic regulation is blocked until you acknowledge the event.



Switching direction monitoring is not active if you control the motor-drive unit with a continuous pulse [► Section 9.5.1.1, Page 140].

### Also refer to

- Setting the switching pulse for controlling the motor-drive unit [► 140]

## 9.5.2 Setting the switching pulse for controlling the motor-drive unit



You can use the parameters Switching pulse type, Switching pulse time and Switching pulse pause to adapt the device switching pulse to the requirements of the motor-drive unit controller.

- Go to **Settings > Parameters > Motor and control cabinet > Motor control**.
- Select the desired parameter.
- Set the parameter.

4. Press the **Accept** button to save the modified parameter.

### Switching pulse type

You can use this parameter to toggle the switching pulse between a continuous pulse or a time-controlled switching pulse.

**Continuous pulse** Selecting the "Continuous pulse" option causes the device to issue the switching pulse in AVR Auto operating mode until the measured value is back within the bandwidth. In AVR Manual operating mode, the device issues the switching pulse for as long as you press the  or  key.

If the device is operated as a follower in parallel operation in this case, then the TAPCON® will issue the switching pulse until one of the following requirements has been met:

- The set motor runtime has been reached
- The *Motor running* signal switches from state 1 to 0
- The tap position required by the master has been reached

A pause is enforced after every switching pulse before another switching pulse is issued.

**Time-controlled switching pulse** Selecting the "Time-controlled switching pulse" option causes the device to issue the switching pulse for a set duration. A pause **1** is enforced after every switching pulse **2** before another switching pulse is issued.



If you use a motor-drive unit from Maschinenfabrik Reinhausen GmbH, you need to select the "Time-controlled switching pulse" option.

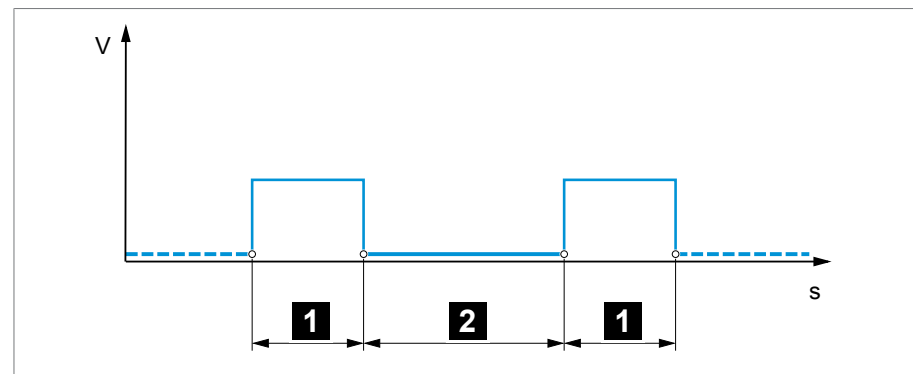


Figure 82: Switching pulse time and switching pulse pause

1 Switching pulse time

2 Switching pulse pause



### Switching pulse time

You can use this parameter to set the maximum duration of the switching pulse. The switching pulse resets after the switching pulse time has elapsed or if the device receives the *Motor running* signal beforehand or the tap position is changed.

### Switching pulse pause

You can use this parameter to set the switching pulse pause between 2 switching pulses. The device can only issue another switching pulse once the switching pulse pause has elapsed.



## 10 Maintenance and care

### 10.1 Cleaning the device

You can clean the device with a dry cloth.

### 10.2 Maintenance

Maintenance of the monitoring system is not required. However, check the state and functionality of the monitoring system as part of maintenance work on the transformer.

#### Technical Service

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Internet: [www.reinhausen.com](http://www.reinhausen.com)



## 11 Fault elimination

This chapter describes how to rectify simple operating faults.

### 11.1 General faults

Characteristics/details	Cause	Remedy
No function	No power supply.	Check the power supply.
▪ <i>Power supply</i> LED does not light up	Fuse tripped.	Contact Maschinenfabrik Reinhausen GmbH.
No function	Configuration error	Contact Maschinenfabrik Reinhausen GmbH.
▪ <i>AVR STATUS</i> LED does not light up	No connection to display.	Check connection to the display.
Relay chatter	High EMC load.	Use shielded cables or external filters.
	Poor grounding.	Check the functional ground.

Table 43: General faults

### 11.2 No regulation in AUTO mode

Characteristics/details	Cause	Remedy
Device control commands have no effect.	Local/Remote switch in motor-drive unit switched to LOCAL.	Check operating mode. Correct if necessary.
	No connection	Check wiring as per connection diagram.
Automatic voltage regulation is blocked. ▪ <i>ALARM</i> LED lights up in accordance with event configuration and a corresponding event is active.	Limit value with auto blocking or auto/manual blocking behavior has been exceeded.	Check parameters. Correct if necessary.
	The switching direction monitoring has recorded a malfunction and triggered the associated event.	Check cause of event and then acknowledge event.
	The motor protective switch has triggered. Motor protective switch event active.	Check what caused the motor protective switch to trigger and engage motor protective switch if necessary.
Automatic voltage regulation is blocked.	Signal at "Block automatic voltage regulation" input.	Check signal source.
	Target-tap-position operation active	Check configuration of target-tap-position operation function. If necessary, remedy cause.
	"Blocking" function is linked to a digital input or control system message.	Check signal source or control system. If necessary, reset.
Automatic voltage regulation is blocked. ▪ Measured voltage too low (< 30 V)	Voltage measurement incorrect	Check voltage measurement.



Characteristics/details	Cause	Remedy
Bandwidth set too high	-	Determine the recommended bandwidth.
Parallel operation active.	Device is follower in parallel operation.	No error. If necessary, deactivate parallel operation.
CAN bus communication failure	"Auto blocking" behavior is set.	Check configuration.

Table 44: No regulation in AUTO mode

### 11.3 Unwanted on-load tap-change operation

Characteristics/detail	Cause	Remedy
Compensation activated	Setting:	Check parameters.
	▪ R-X compensation	Correct if necessary.
	▪ Z compensation	

Table 45: Unexplained tap change

### 11.4 Human-machine interface

#### Display

Characteristics/details	Cause	Remedy
▪ No display.	Power supply interrupted.	Check the power supply.
	Fuse faulty.	Contact Maschinenfabrik Reinhausen.
	Maximum permissible operating temperature of 80°C exceeded.	Allow the device to cool down.
No display and voltage supply LED flashing red	Maximum permissible operating temperature of 70°C exceeded.	Allow the device to cool down.
		Set screensaver waiting time to 15 minutes.
Connection to the visualization cannot be established.	Connection cable defective.	Check connection cable.
SSL certificate warning.	SSL certificate of the display and of the ISM do not match / SSL certificate has expired.	Accept SSL certificate in browser.
		Upload correct server certificate to the display.
		Deactivate SSL encryption.

Table 46: Display





### Web browser

Characteristics/details	Cause	Remedy
Connection to the visualization cannot be established.	Connection cable defective.	Check connection cable.
	SSL encryption active.	Accept SSL certificate in browser.
		Call up IP address using <code>https://</code> .
		Deactivate SSL encryption.
	PC not in same subnet as visualization.	Check the setting of IP addresses of the device and PC and correct if necessary.
Incorrect display of visualization in the web browser.	Access to the visualization using a web browser after a software update.	Delete the web browser's cache.

Table 47: Web browser

## 11.5 Incorrect measured values

Characteristics/details	Cause	Remedy
Measured voltage ▪ No measured value available.	Connection has no contact in the plug terminal.	Check the wiring and plug terminal.
	Insulation trapped.	
	Wire is not inserted far enough.	
	Miniature circuit breaker has tripped.	Check the fuse.
	Connection faulty.	Check wiring. Connect as shown in the connection diagram.
Measured voltage ▪ Measured value too low	Voltage drop on the measuring line.	Check the measured voltage.
Measured voltage ▪ Measured value fluctuates	Possible sources of interference:	Check the measured voltage.
	▪ Cables laid in parallel.	Increase the distance from the source of interference.
	▪ Tap-change operations.	Install a filter if necessary.
Measured current ▪ No measured value	Line to the current transformer interrupted.	Check wiring.
	Short-circuiting jumper in current transformer is not removed.	Remove the short-circuiting jumper.
Measured current ▪ Measured value too high ▪ Measured value too low	Current transformer not correctly parameterized.	Correct parameterization.

Table 48: Incorrect measured values



## 11.6 Parallel operation faults

Characteristics/details	Cause	Remedy
Problem with CAN bus. ▪ Device not listed.	Device incorrectly connected.	Check connections. Connect as shown in the connection diagram.
	Devices have the same CAN bus address.	Set different CAN bus addresses.
	CAN bus address of device set to "0".	Set CAN bus address (anything but 0).
	CAN module connection to CPU interrupted	Check connections.
Problem with parallel operation.	Different parallel operation methods set for devices in the parallel operation group.	Check configuration.
Problem with master/follower parallel operation method.	More than 1 device is configured as master in the parallel operation group.	Check configuration.
	No device configured as master in the parallel operation group.	Check configuration.
	Invalid tap position of master or follower.	Check tap position. Check wiring. Connect as shown in the connection diagram.
Problem with master/follower parallel operation method: ▪ Master/follower switching characteristics set to "in synch".	Master and followers have different tap positions.	Check tap position capture or check why the tap-change operation has not been undertaken (e.g. mechanical defect), then perform one of the following steps: <ul style="list-style-type: none"> <li>▪ Manually correct the master's tap position.</li> <li>▪ Restart master.</li> <li>▪ Set master/follower switching characteristics to "sequential".</li> <li>▪ Change master device to follower and define a different device as the master.</li> </ul>
Problem with circulating reactive current minimization parallel operation method.	Circulating reactive current cannot be calculated.	Check wiring. Connect as shown in the connection diagram.
	Circulating reactive current blocking limit exceeded.	Check configuration.

Table 49: Parallel operation faults



### 11.7 Tap position capture incorrect

Characteristics/details	Cause	Remedy
Position indicator incorrect. ▪ Leading sign incorrect.	Incorrect wiring.	Check wiring. Connect as shown in the connection diagram.
	Minimum value of the analog input signal not configured correctly.	Check parameters.
	Minimum value of the analog input signal not configured correctly.	Check parameters.
	Faulty tap position table.	Check the tap position table.
Position indicator incorrect. ▪ Display fluctuates.	Interference.	Shield the line.
		Increase the distance from the source of interference.
		Lay interference lines separately.
No position indicator. ▪ "- -" is displayed.	No measurement signal. No L- for digital input.	Route the signal in separate lines (filter, shielded lines).
		Connect the signal as shown in the connection diagram.
		Check wiring.
		Connect as shown in the connection diagram.
Tap position capture over resistor contact series faulty.	Faulty calibration.	Check parameters and activated signals.
	Modified contact resistance values of the resistor contact series (e.g. due to weather or age).	Calibrate the tap position capture over resistor contact series.

Table 50: Tap position capture

### 11.8 Other faults

If you cannot resolve a problem, please contact Maschinenfabrik Reinhausen. Please have the following data ready:

- Serial number
  - Nameplate
  - Info screen
- Software version



Please provide answers to the following questions:

- Has the software been updated?
- Has there previously been a problem with this device?
- Have you previously contacted Maschinenfabrik Reinhausen about this issue? If yes, then who was the contact?



## 12 Disposal

Observe the national requirements applicable in the country of use.



## 13 Technical data

### 13.1 TC250 technical data

#### 13.1.1 Display elements

Display	5" TFT colour display
LEDs	3 LEDs for operation display and messages <ul style="list-style-type: none"><li>▪ POWER, AVR STATUS, ALARM</li></ul>

#### 13.1.2 Materials

Front	Aluminum, plastic
-------	-------------------

#### 13.1.3 Dimensions

Front panel display:	161.9 mm x 419.1 mm x 2.3 mm
W x H x D	Mating connector: 20 mm
Cap rail assemblies (dimensions without cap rail)	
Single-row W x H x D	Basic: 340 mm x 124 mm x 124 mm
	Pro/Expert: 455 mm x 124 mm x 124 mm
Two-row W x H x D	Basic: 200/100 mm x 124 mm x 124 mm
Row 1/row 2	Pro/Expert: 290/200 mm x 124 mm x 124 mm

#### 13.1.4 Voltage supply

##### Power supply

Permissible voltage range	85...150 V AC
	88...150 V DC
	U <sub>N</sub> : 100...140 V AC
	U <sub>N</sub> : 100...150 V DC
Max. nominal power consumption	24 W
Permissible frequency range	50/60 Hz
Overvoltage category	OC III
Surge test voltage	4 kV, 1.2 µs/50 µs
External fuse	Type: 3AG (fast-acting)
	Rated voltage: 250 V
	Rated current: 2.5 A

Table 51: Power supply



### Auxiliary supply voltage AUX DC DI 24V DC for digital inputs

The auxiliary supply voltage is used exclusively for detecting up to 16 floating contacts.

Output voltage	$U_N$ : 24 V DC $\pm$ 2% (short-circuit proof)
Max. output power	120 W
Overvoltage category	OC III
Fuse	Design: 5 x 20 mm, Time-Lag T Rated voltage: 250 V AC/300 V DC Rated current: 1.25 Min. braking capacity: 1.5 kA Operating temperature: -30 °C...+100 °C (e.g. Schurter; SPT 5X20; 0001.2505)

Table 52: Auxiliary supply voltage

## 13.1.5 Voltage measurement and current measurement

### Voltage measurement

Measuring range	Nominal voltage: $U_N$ 100...140 V AC Measuring range (RMS): 85...150 V AC Accuracy: $<\pm 0.5\% U_N$ CAT II at an altitude of 2,000 m CAT III at an altitude of 3,000 m
Surge test voltage	4 kV
Continuous overvoltage	275 V

### Current measurement

Frequency	50...65 Hz $\pm 15\%$
Nominal current $I_N$	0.2 A; 1 A or 5 A (switchable)
Accuracy	$< \pm 0.5\% \times I_N$ (1 A, 5 A) $< \pm 1\% \times I_N$ (0.2 A) max. measured current 200% $I_N$
Load resistance	$< 0.1$ W at $I = 0.2$ A $I = 1$ A
Overload capability continuous	25 A (directly on the test tap of the measurement card)



Overload capacity short-term	120 A/1 s (directly on the test tap of the measurement card)
Surge test voltage	4 kV, measurement category III

### 13.1.6 Ambient conditions

Operating temperature	-25...+70°C
Storage temperature	-30...+85°C
Relative humidity	5...95%, condensation not permitted
Maximum installation altitude	<3,000 m above mean sea level
Minimum clearance to other devices / control cabinet	Cap rail modules: Above/below: 30 mm (3.5 in; equivalent to 2RU), behind 30 mm (1.2 in) Left/right: 30 mm WEB panel: Rear 30 mm (1.2 in)
Contamination level	2
Protection class	1 (protective conductor connection)

Table 53: Permissible ambient conditions

### 13.1.7 Standards and directives

Electromagnetic compatibility	IEC 61000-6-2; IEC 61000-6-4; IEC 61000-6-5; KS C 9610-6-2; KS C 9610-6-4 FCC 47 CFR Part 15 B Radiocommunication Act – IECS-003
Electrical safety	IEC 61010-1; UL 61010-1; CSA-C22.2 No. 61010-1 IEEE CB scheme procedure
Climatic ambient conditions	IEC 60068-2-1 (-25°C; 96 h) cold IEC 60068-2-2 (+70°C; 96 h) dry heat IEC 60068-2-78 (+40°C / 93% rH, 96 h) moist heat, constant IEC 60068-2-30 (+55°C, 6 cycles 12 + 12 hours) moist heat, cyclical
Degree of protection	IP20 in accordance with IEC 60529 <sup>1</sup>





Environmental durability tests	IEC 60255-21-1 or IEC 60068-2-6 vibration <sup>2</sup>
	IEC 60255-21-2 or IEC 60068-2-27 shock <sup>2</sup>
	IEC 60255-21-3 seismic <sup>3</sup>

<sup>1)</sup> Assemblies: Display, operating elements and front interface

<sup>2)</sup> Assemblies: G1, G2, PS, U3, I3, BES, DI, DO, AI, AO, MC2-2, display, CPU, COM-ETH

<sup>3)</sup> Assemblies: PS, U3, I3, BES, DI, DO, AI, AO, MC2-2, CPU, COM-ETH

## 13.2 ISM® assemblies technical data

### 13.2.1 System networking COM-ETH

COM-ETH	
Interfaces	5x Ethernet via RJ45
RJ45	Max. 100 m (per section) 10/100 Mbps
Redundancy protocols	HSR, <u>PRP</u> , <u>RSTP</u>

Table 54: COM-ETH assembly technical data

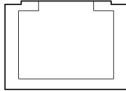
Interface	Pin	Description
	1	TxD+
	2	TxD-
	3	RxD+
	4	NC
	5	NC
	6	RxD-
	7	NC
	8	NC-

Table 55: Connectors X1...X5 (Ethernet)

### 13.2.2 Central processing unit

Processor	ARM Cortex A9 processor 800 MHz
RAM	512 MB
NVRAM (SRAM with battery backup)	256 kB
Application memory	2 GB
Digital relay outputs	2; galvanically isolated
Nominal voltage	DC 24/48/60 V
Max. continuous current	1 A (ohmic load)
Max. switching capacity	30 W
Rated impulse voltage	2.0 kV

**Response behavior of the watchdog/error relay:**

	Error relay	Watchdog relay
Power off	OFF	OFF
Startup	ON	OFF
Ready (no error pending)	OFF	ON
Ready (pending error)	ON	ON

ON: Relay is energized

OFF: Relay is de-energized

**Interfaces**

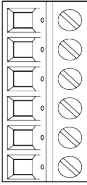
Interface	Pin	Description
	6	ER_NO
	5	ER_NC
	4	ER_COM
	3	WD_NO
	2	WD_NC
	1	WD_COM

Table 56: Plug terminal CPU:X1


Interface X2, X3	Pin	Description
	8	NC
	7	NC
	6	GND
	5	NC
	4	NC
	3	RXD+
	2	TXD-
	1	TXD+

Table 57: Ethernet interface CPU:X2/X3

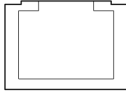
Interface X4	Pin	Description
	8	NC
	7	NC
	6	GND
	5	NC
	4	NC
	3	NC
	2	TXD+/RXD+
	1	TXD-/RXD-

Table 58: Serial interface RS485 CPU:X4

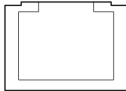
Interface X5	Pin	Description
	8	DTR (O)
	7	DCD (I)
	6	GND
	5	RXD (I)
	4	TXD (O)
	3	VCC/OUT 5 V/12 V
	2	RTS (O)
	1	CTS (I)

Table 59: Serial interface RS232 CPU:X5

### 13.2.3 System networking BES

	BES
Interfaces	2x Ethernet via RJ45
RJ45	Max. 100 m (per section) 10/100 Mbps
Input voltage	18...78 VDC U <sub>N</sub> 24...60 VDC
Input current	0.6/0.3/0.25 A (24/48/60 VDC)

Table 60: BES assembly technical data



Interface	Pin	Description
	1	Power supply (+)
	2	Not used
	3	Not used
	4	Power supply (-)

Table 61: Terminal X1


Interface	Pin	Description
	1	TxD+
	2	TxD-
	3	RxD+
	4	NC
	5	NC
	6	RxD-
	7	NC
	8	NC-

Table 62: Jacks X2, X3 (Ethernet)

### 13.2.4 Power supply PS

8620	
Permissible voltage range	18...78 V DC U <sub>N</sub> : 24...60 V DC
Permissible frequency range	-
Nominal power consumption	19.2 W
Power output	12 W

Table 63: PS assembly technical data

### 13.2.5 G1 power supply

G1	
Permissible voltage range	90...264 V AC
Permissible frequency range	47...63 Hz
Maximum inrush current impulse	60 A

Table 64: Power supply



### 13.2.6 Digital inputs DI 16-24 V

DI 16-24V	
Inputs	2 x 8, plug-based electrical isolation
Nominal voltage	24 V DC 24 VAC (at 50 Hz +-10%; 60 Hz +-10%)
Max. operating voltage	31.2 V DC 28 VAC
Logical 0	≤ 12 V
Logical 1	≥ 18 V
Input current	2.4 mA
Simultaneity factor (at 65 °C ambient temperature)	-

Table 65: DI 16-24V assembly technical data

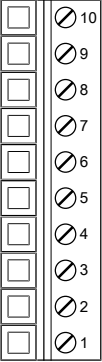
Interface	Pin	Description
	10	Common reference (common)
	9	Common reference (common)
	8	Input 7
	7	Input 6
	6	Input 5
	5	Input 4
	4	Input 3
	3	Input 2
	2	Input 1
	1	Input 0

Table 66: Connector X1 (group 0)



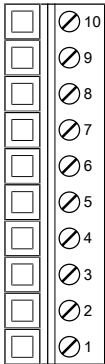
Interface	Pin	Description
	10	Common reference (common)
	9	Common reference (common)
	8	Input 17
	7	Input 16
	6	Input 15
	5	Input 14
	4	Input 13
	3	Input 12
	2	Input 11
	1	Input 10

Table 67: Connector X2 (group 1)

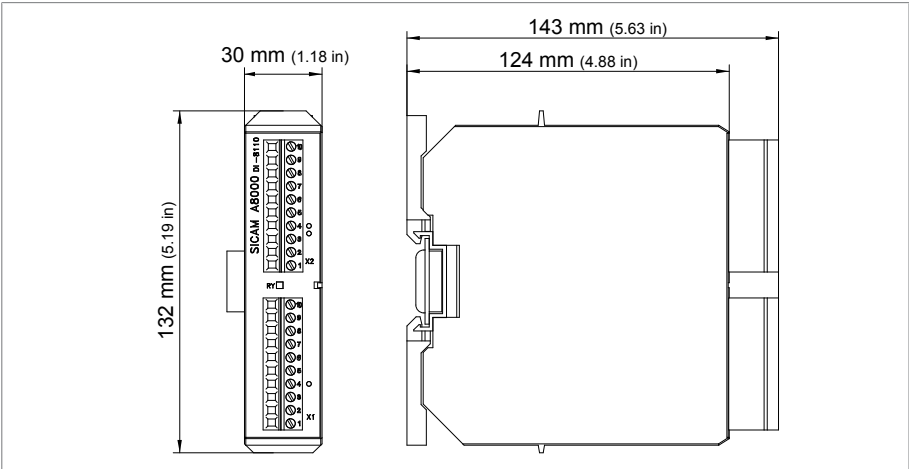


Figure 83: DI 16-24V dimensions

13.2.7 Digital inputs DI 16-110 V

DI 16-110V	
Inputs	2 x 8, plug-based electrical isolation
Nominal voltage	110 V DC 120 VAC (at 50 Hz +-10%; 60 Hz +-10%)
Max. operating voltage	143 V DC 144 VAC
Logical 0	≤ 55 V
Logical 1	≥ 82.5 V



DI 16-110V	
Input current	0.9 mA
Simultaneity factor (at 65 °C ambient temperature)	Max. 13 inputs

Table 68: DI 16-110V assembly technical data

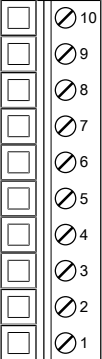
Interface	Pin	Description
	10	Common reference (common)
	9	Common reference (common)
	8	Input 7
	7	Input 6
	6	Input 5
	5	Input 4
	4	Input 3
	3	Input 2
	2	Input 1
	1	Input 0

Table 69: Connector X1 (group 0)


Interface	Pin	Description
	10	Common reference (common)
	9	Common reference (common)
	8	Input 17
	7	Input 16
	6	Input 15
	5	Input 14
	4	Input 13
	3	Input 12
	2	Input 11
	1	Input 10

Table 70: Connector X2 (group 1)



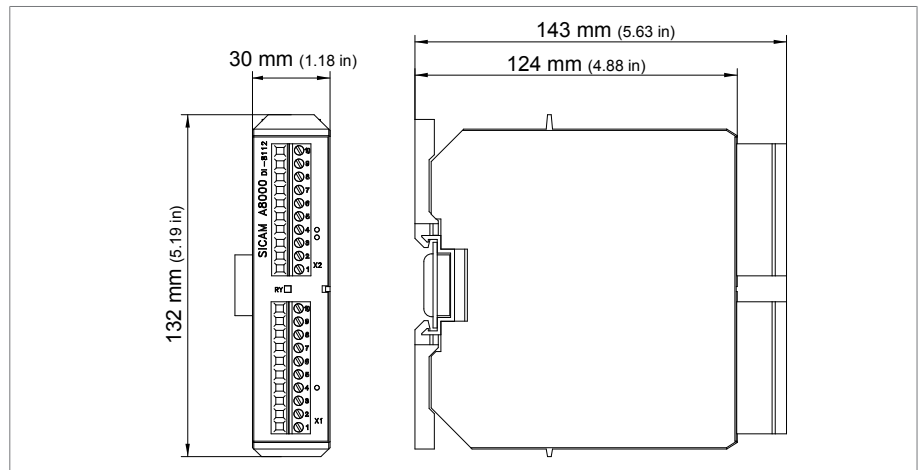


Figure 84: DI 16-110V dimensions

### 13.2.8 Digital outputs DO 8

	DO 8
Outputs (plug-based electrical isolation)	8 relays 4 groups per module
Switching voltage	DC: 24 V, 48 V, 60 V, 110 V AC: 110 V
Contact load capacity	Min.: 5 V DC, 10 mA Max. DC: See diagram Max. AC: 150 V; 3 A (8 active outputs) or 5 A (4 active outputs)

Table 71: DO 8 assembly technical data

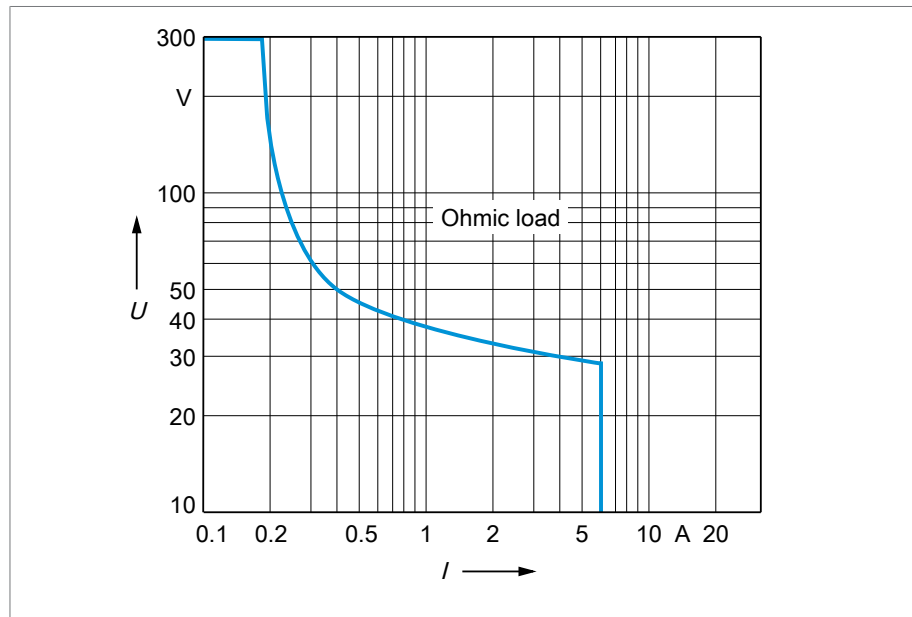


Figure 85: Contact load capacity of digital outputs with resistive load

**CAUTION**

**Electric shock!**

The outputs of the DO assembly have plug-based electrical isolation. A mixture of voltage ranges (e.g. extra low voltage and low voltage) or various phases within a plug can lower the protection against electric shock.

- Use the same voltage ranges within a plug.
- Use the same phase within a plug.

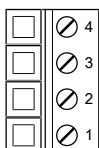
Interface	Pin	Description
	4	Common reference (common) output 1
	3	Common reference (common) output 0
	2	Output 1
	1	Output 0

Table 72: Connector X1 (group 0)

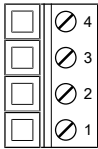
Interface	Pin	Description
	4	Common reference (common) output 3
	3	Common reference (common) output 2
	2	Output 3
	1	Output 2

Table 73: Connector X2 (group 1)

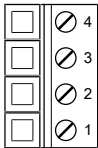
Interface	Pin	Description
	4	Common reference (common) output 5
	3	Common reference (common) output 4
	2	Output 5
	1	Output 4

Table 74: Connector X3 (group 2)

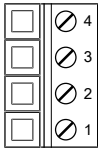
Interface	Pin	Description
	4	Common reference (common) output 7
	3	Common reference (common) output 6
	2	Output 7
	1	Output 6

Table 75: Connector X4 (group 3)

### 13.2.9 Analog inputs AI 4

AI 4	
Inputs (electrically isolated)	4 x 1
Measuring range	-20...+20 mA, overcurrent approx. 20% -10...+10 V, overvoltage approx. 30%
Accuracy	0.15% at 25°C Current 0.2% at 0...50°C 0.3% at -20...70°C 0.4% at -40...70°C Voltage 0.4% at 0...50°C 0.5% at -20...70°C 0.6% at -40...70°C
Input impedance	52 Ω at ±20 mA 20.5 kΩ at ±10 V

Table 76: AI 4 assembly technical data

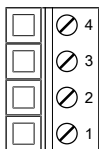
Interface	Pin	Description
	4	V0 U- voltage input
	3	V0 I- current input
	2	V0 I+ current output
	1	V0 U+ voltage output

Table 77: Connector X1 (group 0)

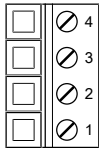
Interface	Pin	Description
	4	V1 U- voltage input
	3	V1 I- current input
	2	V1 I+ current output
	1	V1 U+ voltage output

Table 78: Connector X2 (group 1)



Interface	Pin	Description
	4	V2 U- voltage input
	3	V2 I- current input
	2	V2 I+ current output
	1	V2 U+ voltage output

Table 79: Connector X3 (group 2)

Interface	Pin	Description
	4	V3 U- voltage input
	3	V3 I- current input
	2	V3 I+ current output
	1	V3 U+ voltage output

Table 80: Connector X4 (group 3)

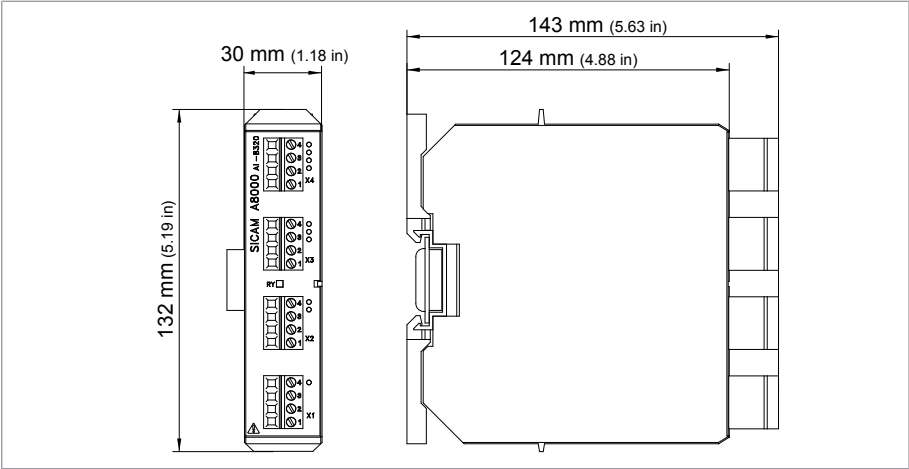


Figure 86: AI 4 dimensions

### 13.2.10 Analog outputs AO 4

	AI 4
Outputs (electrically isolated)	4 x 1 <sup>1</sup>
Signal range	Max. -10...+10 V on min. 1 k $\Omega$ load Max. -10...+10 mA on max. 500 $\Omega$ load Max. -20...+20 mA on max. 1 k $\Omega$ load
Accuracy	0.3% at 25°C 0.4% at 0°C to 50°C 0.7% at -20°C to 70°C 0.8% at -40°C to 70°C

Table 81: AO 4 assembly technical data

<sup>1)</sup> In combination with PS-8620, 2 of 4 outputs will be used at the same time

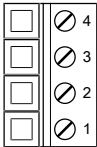
Interface	Pin	Description
	4	Not used
	3	V0- current input
	2	V0+ current output
	1	Not used

Table 82: Connector X1 (group 0)

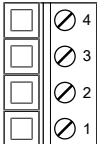
Interface	Pin	Description
	4	Not used
	3	V1- current input
	2	V1+ current output
	1	Not used

Table 83: Connector X2 (group 1)

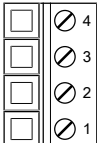
Interface	Pin	Description
	4	Not used
	3	V2- current input
	2	V2+ current output
	1	Not used

Table 84: Connector X3 (group 2)

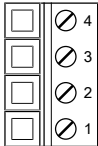
Interface	Pin	Description
	4	Not used
	3	V3- current input
	2	V3+ current output
	1	Not used

Table 85: Connector X4 (group 3)

### 13.2.11 Current measurement I 3

I 3	
Measurement	3-phase
Nominal current $I_N$	0.5...6 A 1 A / 2 A / 5 A / 6 A
Overload capability	$2 \times I_N$
Measuring accuracy	Deviation $< \pm 0.5\% \cdot I_N$
Rated frequency	50 / 60 / 16.7 Hz
Intrinsic consumption	$< 0.1 \text{ W}$ up to $I = 1 \text{ A}$ $< 0.3 \text{ W}$ up to $I = 5 \text{ A}$

Table 86: I 3 assembly technical data

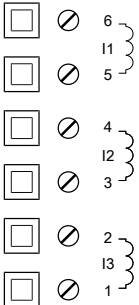
Interface	Pin	Description
	6	Current input phase 1
	5	Current input neutral conductor 1
	4	Current input phase 2
	3	Current input neutral conductor 2
	2	Current input phase 3
	1	Current input neutral conductor 3

Table 87: Connector X1

### 13.2.12 Voltage measurement U 3

U 3	
Measurement	3-phase
Voltage inputs	4 (electrically isolated)
Nominal voltage $U_N$ (AC)	10...250 V
$U_N$ typical (AC)	110 V, 110 V/ $\sqrt{3}$ , 230 V
Max. measured voltage	150% $U_N$ when $U_N \leq 110$ V 110% $U_N$ when $U_N \leq 250$ V
Measuring accuracy	Deviation $< \pm 0.3\% \cdot U_N$
Frequency measurement	$f_N$ : 16.7, 50 or 60 Hz Measuring range: $f_N \pm 15\%$

Table 88: U 3 assemblies technical data

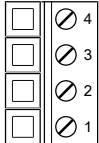
Interface	Pin	Description
	4	Common reference output 1
	3	Common reference output 0
	2	Digital output 1
	1	Digital output 0

Table 89: Connector X1

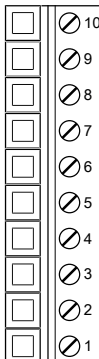
Interface	Pin	Description
	10	Not used
	9	Voltage input phase 1
	8	Voltage input neutral conductor 1
	7	Voltage input phase 2
	6	Voltage input neutral conductor 3
	5	Voltage input phase 3
	4	Voltage input neutral conductor 3
	3	Not used
	2	Voltage input phase 4
	1	Voltage input neutral conductor 4

Table 90: Connector X2



### 13.2.13 System networking MC 2-2

MC 2-2	
Description	Media converter
Interfaces	2x RJ45 2x duplex LC (SFP)
RJ45	Max. 100 m (per section) 10/100 Mbit/s Cable impedance 100 $\Omega$
Fiber-optic cable	Max. 2,000 m 100 Mbit/s Light-emitting diode: class 1 Wave length: 1310 nm Max. optical output power: <1 mW (in accordance with IEC 60825-1:2014)

Table 91: Technical data for the MC 2-2 assembly


Interface	Pin	Description
	1	TxD+
	2	TxD-
	3	RxD+
	4	NC
	5	NC
	6	RxD-
	7	NC
	8	NC-

Table 92: ETHxx (RJ45)

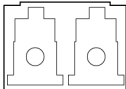
Interface	Description
	Fiber glass 50/125 and 62.5/125 multimode

Table 93: ETHxx (duplex LC SFP)

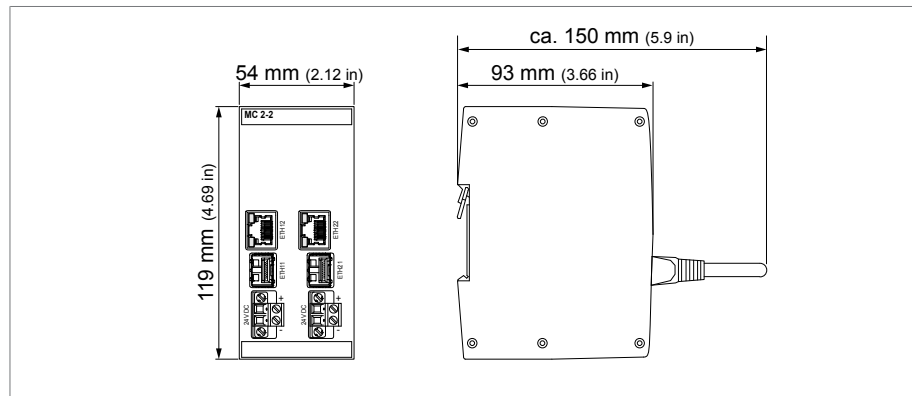


Figure 87: MC2-2 dimensions

### 13.2.14 SCADA/communication interfaces

#### Media converter: SCADA ETH RJ45 – duplex LC

Conversion of SCADA Ethernet to fiber-optic cable	Duplex LC SFP module for connecting the SCADA system Duplex LC connector, 1310 nm, multi-mode fiber
Transmission rate	10/100 Mbps
Ethernet RJ45	-
Duplex LC connector, 1310 nm, multi-mode fiber via MC 1-1	-
Serial RS232	-
Serial RS485	Electrically isolated
Serial FO	F-ST

### 13.2.15 Tap position capture / resistor contact series

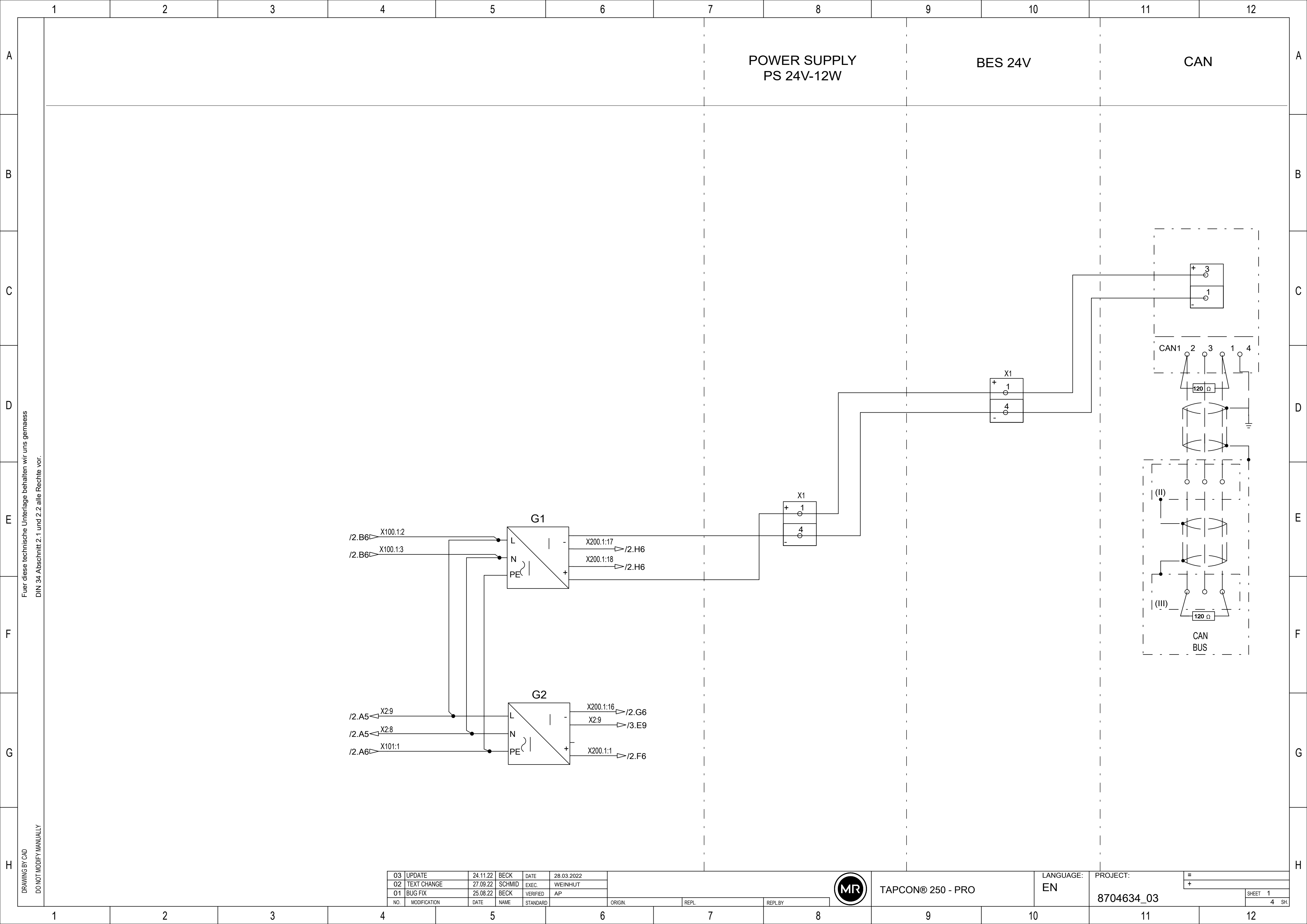
Tap position capture	35 tap positions, 600 ohms
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### 13.3 Connection diagrams

**Also refer to**

📄 TAPCON® 250 PRO [▶ 176]



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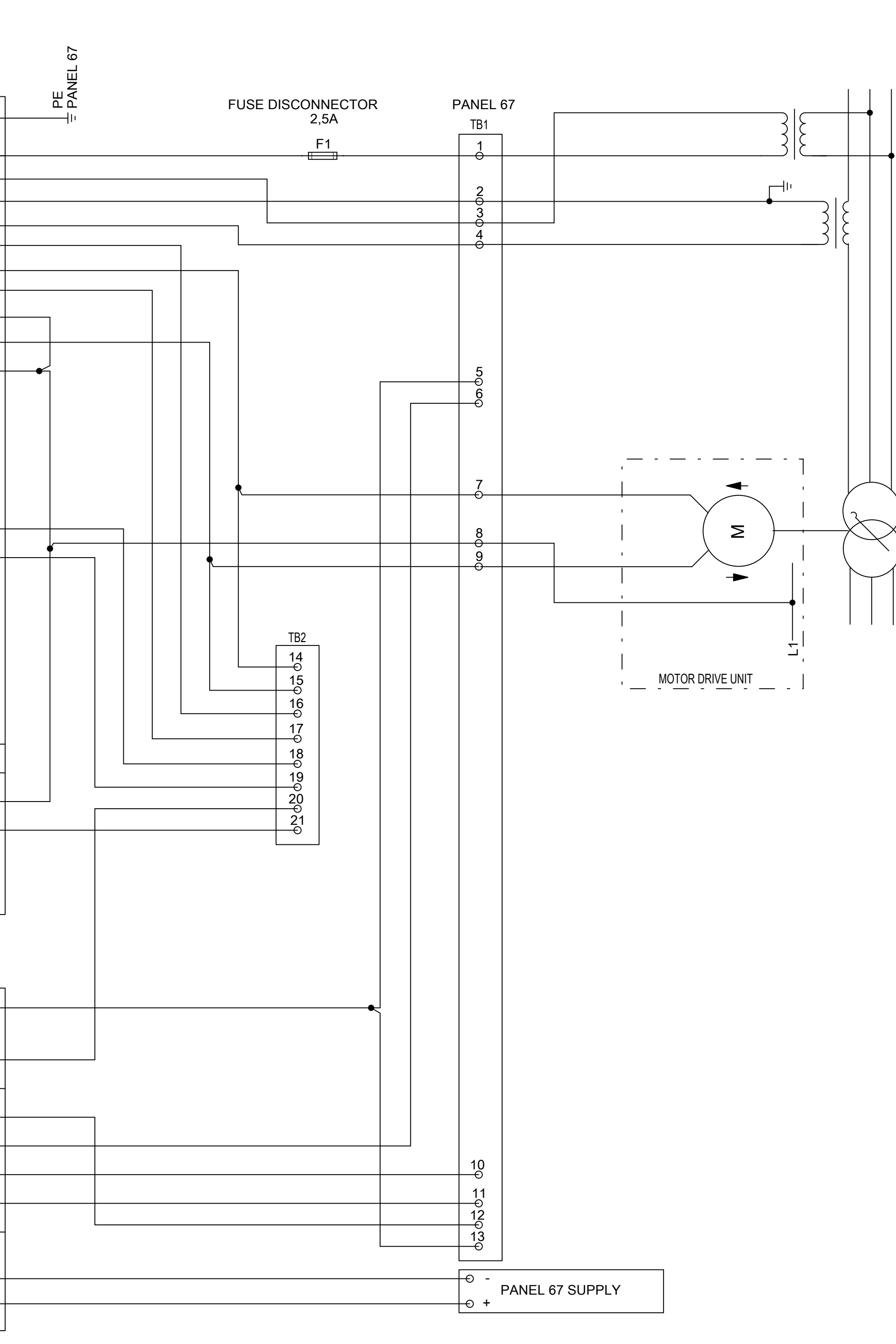
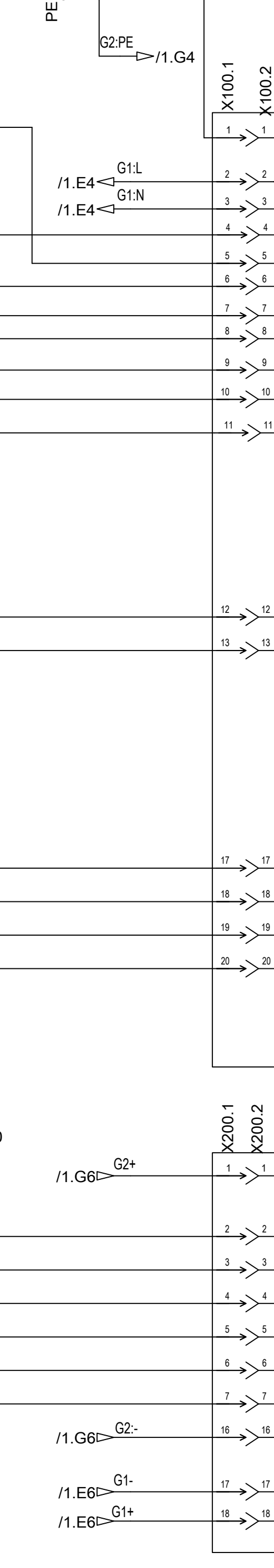
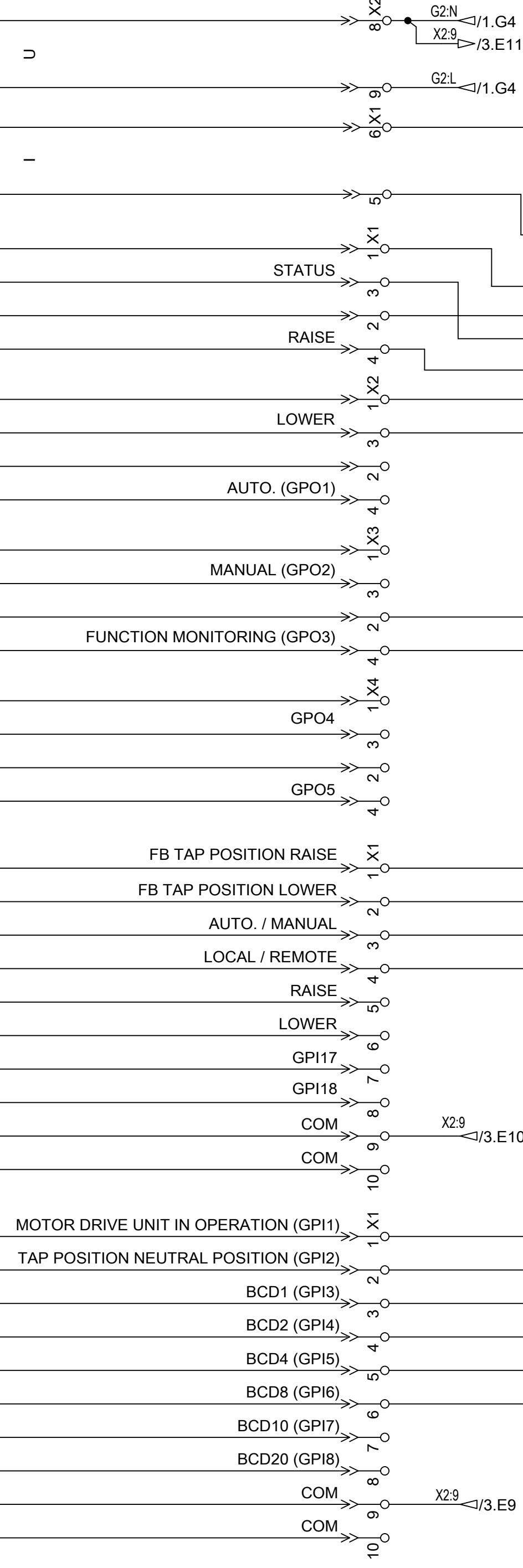
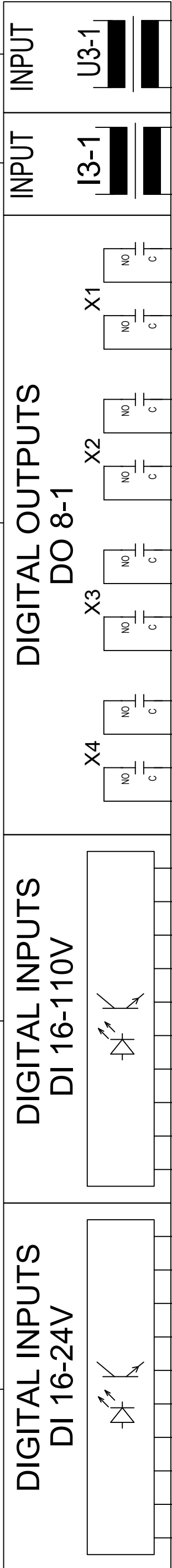
# TAPCON® 250 - PRO

## CENTRAL PROCESSING UNIT CPU

### DIGITAL OUTPUTS DO 8-1

### DIGITAL INPUTS DI 16-110V

### DIGITAL INPUTS DI 16-24V



03	UPDATE	24.11.22	BECK	DATE	28.03.2022
02	TEXT CHANGE	27.09.22	SCHMID	EXEC.	WEINHUT
01	BUG FIX	25.08.22	BECK	VERIFIED	AP
NO.	MODIFICATION	DATE	NAME	STANDARD	

ORIGIN	REPL	REPL BY
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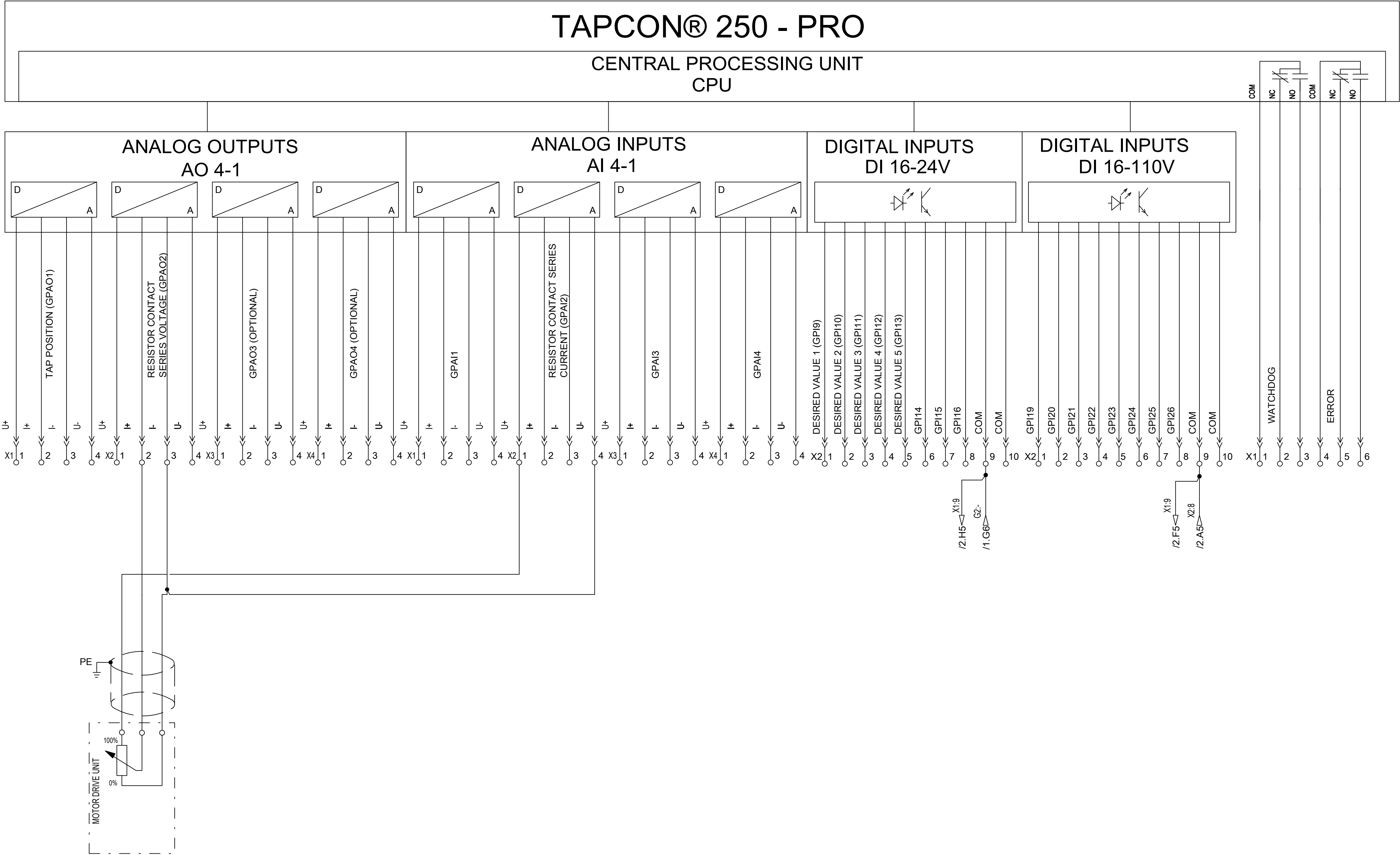
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03	UPDATE	24.11.22	BECK	DATE	28.03.2022
02	TEXT CHANGE	27.09.22	SCHMID	EXEC.	WEINHUT
01	BUG FIX	25.08.22	BECK	VERIFIED	AP
NO.	MODIFICATION	DATE	NAME	STANDARD	

ORIGIN	REPL	REPL BY
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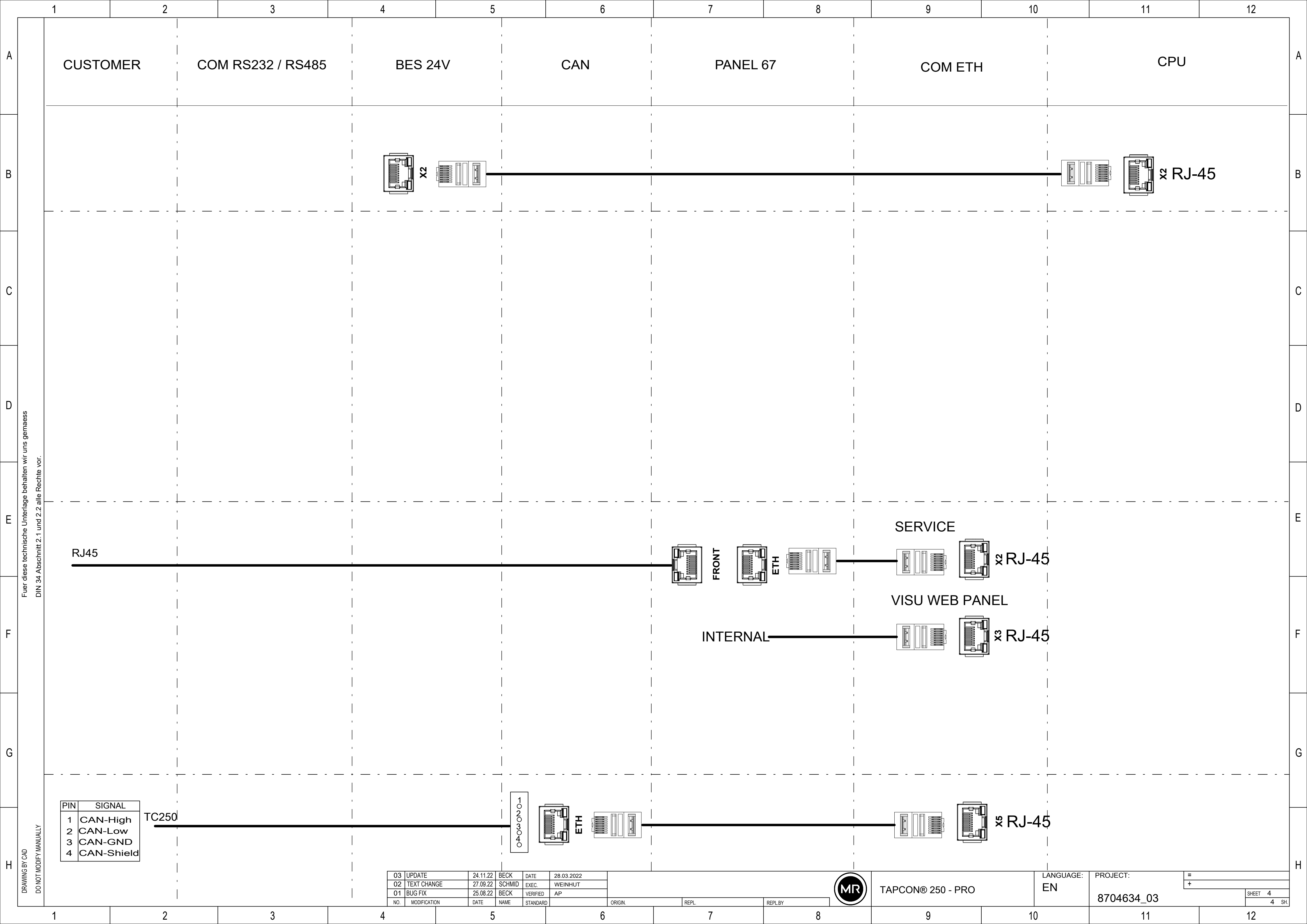


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PROJECT:  
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## Glossary

### EMC

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Electromagnetic compatibility

### GPI

---

General Purpose Input

### GPO

---

General Purpose Output

### IP

---

Internet Protocol

### OF

---

Abbreviation for fiber-optic cable

### PRP

---

Redundancy protocol in accordance with IEC 62439-3 (Parallel Redundancy Protocol)

### RSTP

---

Redundancy protocol in accordance with IEEE 802.1D-2004 (Rapid Spanning Tree Protocol)

### SNTP

---

NTP (Network Time Protocol) is a standard for synchronizing clocks in computer systems using packet-based communication networks. SNTP (Simple Network Time Protocol) is the simplified version of NTP.

### TDSC

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TAPCON® Dynamic Set Point Control





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