



Operating instructions

TAPCON®. Voltage regulator

Bank parallel operation
4016640/19 EN



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We reserve the right to change the technical data, design and scope of supply.

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

The product is delivered in accordance with MR's technical specifications, which are based on information provided by the customer. The customer has a duty of care to ensure the compatibility of the specified product with the customer's planned scope of application.

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

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sales@reinhausen.com
reinhausen.com

MR Reinhausen customer portal: <https://portal.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 file is incomplete without the supporting documents.

The following documents are considered supporting documents:

- Connection diagrams
- Supplement (optional)

1.3 Safekeeping

Keep this technical file and all supporting documents ready at hand and accessible for future use at all times.

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]
Bold	Software operating controls	Press Continue 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 TAPCON® serves to keep the output voltage of a bank of transformers 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 file and observing the warning notices in this technical file and attached to the product, the product does not pose risk of injury or damage to property or the environment. This applies across the entire service life of the product, from delivery to installation and operation through to disassembly and disposal.

The following is considered appropriate 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 file, 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 delivery for the intended purpose and in accordance with the specifications of this technical file.
- Only operate the product in industrial areas.
- Observe the notices in this technical file regarding electromagnetic compatibility and the technical data.

2.2 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 14, Page 257] 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.
- 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.

2.3 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.

2.4 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.

Protective clothing	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.
Safety shoes	To protect against falling heavy objects and slipping on slippery surfaces.
Safety glasses	To protect the eyes from flying parts and splashing liquids.
Visor	To protect the face from flying parts and splashing liquids or other dangerous substances.
Hard hat	To protect against falling and flying parts and materials.
Hearing protection	To protect against hearing damage.
Protective gloves	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 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 [► Section 9.2.1.2, Page 81]" 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 [► Section 9.2.1.3, Page 82].
- Enable SSL/TLS encryption [► Section 9.2.1, Page 80]; 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.
- 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 [► Section 9.2.5, Page 88].
- Media converter with managed switch (assembly SW 3-3) [► Section 9.2.18, Page 126]:
 - Change user account and password.
 - Disable unnecessary services.

3.3 Operation

Observe the following recommendations during device operation:

- Change the password at regular intervals.
- Export the security log [► Section 9.2.17.1, Page 123] at regular intervals.
- Check the log files regularly for unauthorized system access and other security-related events.

- Media converter with managed switch (assembly SW 3-3): Check at regular intervals whether the manufacturer Belden/Hirschmann has released an update for the product "EES 25" and, where necessary, perform a firmware update [▶ Section 9.2.18.3, Page 128].

3.4 Interfaces

The device uses the following interfaces for communication:

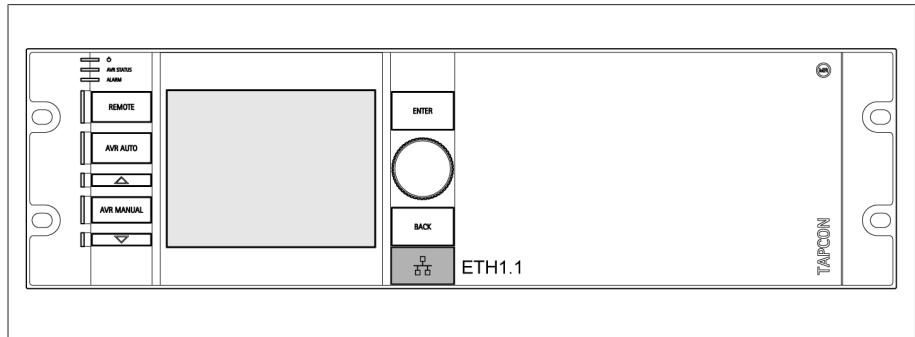


Figure 1: ETH1.1 interface on the OT1205 assembly

Interface	Protocol	Port	Description
ETH1.1	TCP	21	FTP service access ¹⁾
ETH1.1	TCP	80	Web visualization ¹⁾
ETH1.1	TCP	443	SSL-protected web visualization
ETH1.1	TCP	990	SSL-protected FTP service access
ETH1.1	TCP	8080	Web visualization (alternative port) ¹⁾
ETH1.1	TCP	8081	SSL-protected web visualization (alternative port)
ETH1.1	UDP	67	DHCP server

Table 4: Interfaces and open ports of the OT1205 assembly

¹⁾ Port is closed if you activate the device's SSL encryption.

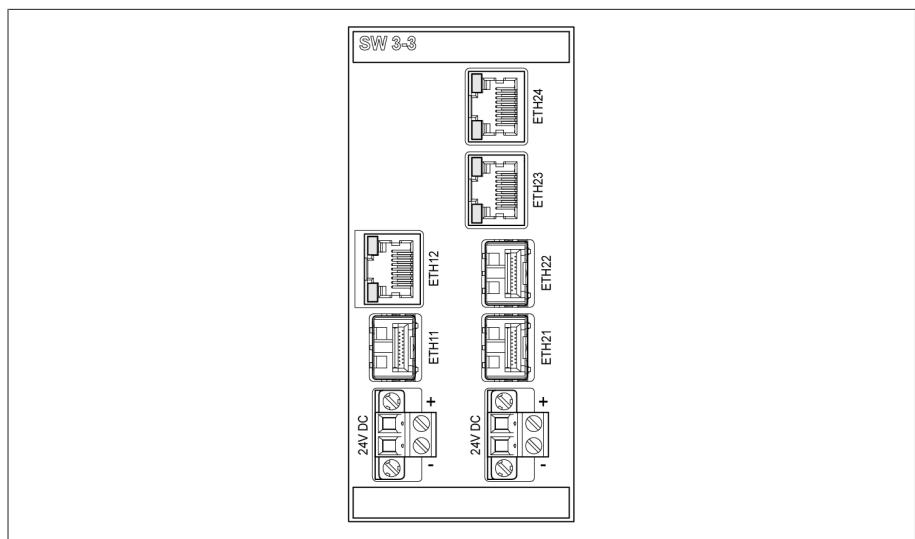


Figure 2: Assembly SW 3-3 interfaces

Interface	Protocol	Port	Description
ETH 2.3, ETH 2.4	TCP	22	SSH ¹
		23	Telnet ¹
		80	HTTP for web-based visualization ¹
		443	HTTPS for web-based visualization ¹
	UDP	161	SNMP ¹

Table 5: Interfaces and open ports of the SW 3-3 assembly

3.5 Encryption standards

The device supports the following TLS versions:

- TLS 1.2
- TLS 1.3

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

The device uses the SHA256 hash function to save passwords.

The SW 3-3 assembly supports the following TLS version:

- TLS 1.2

The assembly 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	GCM	SHA256
	DHE					CBC	SHA

Table 6: Cipher suite

The device uses the following encryption standards in accordance with technical directive TR-02102-4 from Germany's Federal Office for Information Security:

- Key agreement:
 - diffie-hellman-group1-sha1
 - diffie-hellman-group14-sha1
 - diffie-hellman-group16-sha512
 - diffie-hellman-group18-sha512
 - diffie-hellman-group-exchange-sha256
 - ecdh-sha2-nistp256
- Server authentication:
 - ssh-rsa
 - rsa-sha2-512
 - rsa-sha2-256
- Encryption algorithms:
 - aes128-ctr
 - aes128-gcm@openssh.com
 - chacha20-poly1305@openssh.com
- MAC protection:
 - hmac-sha1
 - hmac-sha2-256

¹ Port is closed if the corresponding service is disabled.

- hmac-sha1-etm@openssh.com
- hmac-sha2-256-etm@openssh.com
- Compression:
 - None
 - zlib@openssh.com
 - Zlib

Also refer to

📄 TLS version [▶ 84]

4 Product description

4.1 Scope of delivery

The following items are included in the scope of delivery:

- TAPCON®
- Terminating resistor for CAN bus (optional)
- Technical documents
- Additional nameplate

Please note the following:

- Check the shipment for completeness on the basis of the shipping documents.
- Store the parts in a dry place until installation.

4.2 Function description of the voltage regulation

The TAPCON® serves to keep constant the output voltage of a bank of transformers. The bank of transformers consists of 3 single-phase transformers, each with an on-load tap-changer and motor-drive unit.

The TAPCON® compares the measured voltage of the bank of transformers (U_{actual}) with a defined reference voltage ($U_{desired}$). The difference between U_{actual} and $U_{desired}$ is the control deviation (dU).

The TAPCON® parameters can be optimally adjusted to the line voltage response to achieve a balanced control response with a small number of tap-change operations by the on-load tap-changer.

The following diagram shows an overview of voltage regulation.

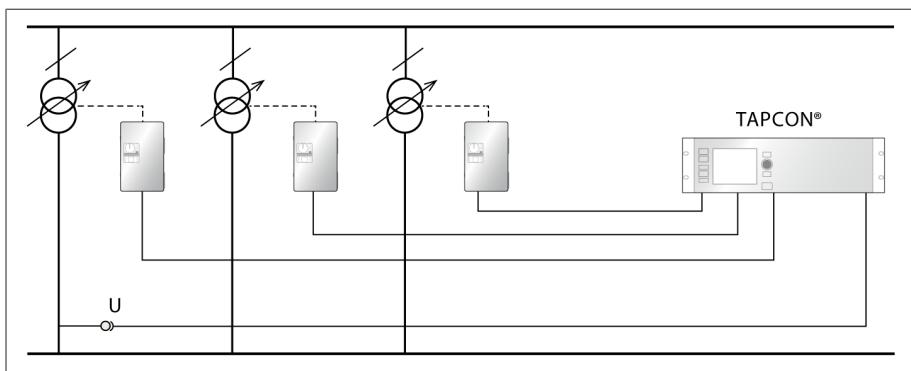


Figure 3: Overview of voltage regulation of a bank of transformers

4.3 Performance features

The device features the following functions:

- Automatic voltage regulation
- 1 desired value
- 3 desired values
- 5 desired values

- Analog setting of the desired value
- Step-by-step setting of the desired value
- Active power-dependent adjustment of desired voltage value (TDSC)
- Active power-dependent adjustment of desired voltage value with 3 different desired values (TDSC)
- Desired value setting via BCD
- 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
- Tap position capture via BCD code
- Tap position capture via analog signals (4...20 mA)
- Tap position capture via analog signals (0...20 mA)
- Tap position capture via analog signals (0...10 V)
- Tap position capture via N/O contact series
- Tap position capture via resistor contact series
- Tap position capture via dual code
- Tap position capture via decadic contact series
- Tap position capture via gray code
- Parallel operation of up to 16 transformers in 2 groups using the following methods:
 - Master/follower
 - Circulating reactive current minimization
- Freely configurable events
- Web-based visualization
- SCADA: IEC 60870-5-101
- SCADA: IEC 60870-5-103
- SCADA: IEC 60870-5-104
- SCADA: IEC 61850 (edition 1 and edition 2)
- SCADA: Modbus RTU
- SCADA: Modbus TCP
- SCADA: Modbus ASCII
- SCADA: DNP3
- On-load tap-changer monitoring
 - Contact wear calculation (only for OILTAP® V, M, R, RM, MS, G)
 - Maintenance interval calculation
 - Oil carbonization (only for OILTAP® V, M, R)
 - Monitoring of OLTC temperature (optional)
 - Tap-change statistics of on-load tap-changer
 - Optional: on-load tap-changer oil level
 - Optional: oil filter unit
 - Status of the motor-drive unit (motor protective switch, motor is running)

4.4 Operating modes

The device can be operated in the following operating modes:

Auto mode (AVR AUTO)

In auto mode, the device automatically regulates the voltage in accordance with the set parameters. It is not possible to perform manual tap-change operations using operating controls, inputs or a control system.

Manual mode (AVR MANUAL)

In manual mode, you can perform manual tap-change operations to increase or decrease the voltage. There is no automatic voltage regulation.

Local mode (LOCAL)

In local mode, you can make entries and issue commands using the device's operating controls. You cannot use inputs or the control system to make entries or issue commands.

Remote mode (REMOTE)

In remote mode, you can make entries and issue commands using digital inputs or the control system, depending on the setting of the Remote behavior [►Page 81] parameter.

	AVR AUTO		AVR MANUAL	
	LOCAL	REMOTE	LOCAL	REMOTE
Automatic regulation	Yes	Yes	No	No
Tap-change operation via operating controls	No	No	Yes	No
Tap-change operation via inputs	No	No	No	Yes ²⁾
Tap-change operation via SCADA ¹⁾	No	No	No	Yes ²⁾
Value adjustment via SCADA ¹⁾	No	Yes	No	Yes ²⁾

Table 7: Overview of operating modes

¹⁾ Optional when connecting TAPCON® to a control system (SCADA)

²⁾ You can use the Remote behavior [►Page 81] parameter to set the behavior

4.5 Design

Depending on the order, the device is either designed as a 19-inch plug-in housing or supplied as individual components for assembly on a cap rail.

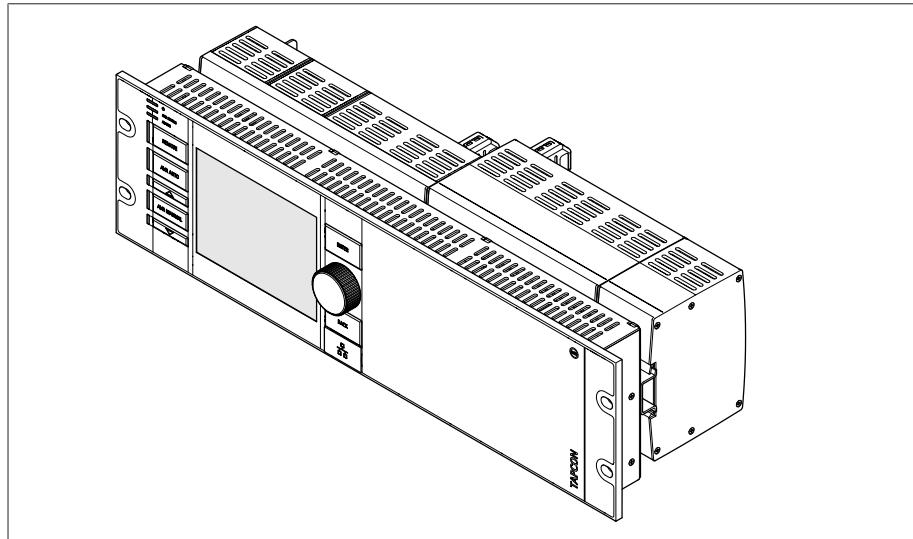


Figure 4: 19-inch plug-in housing

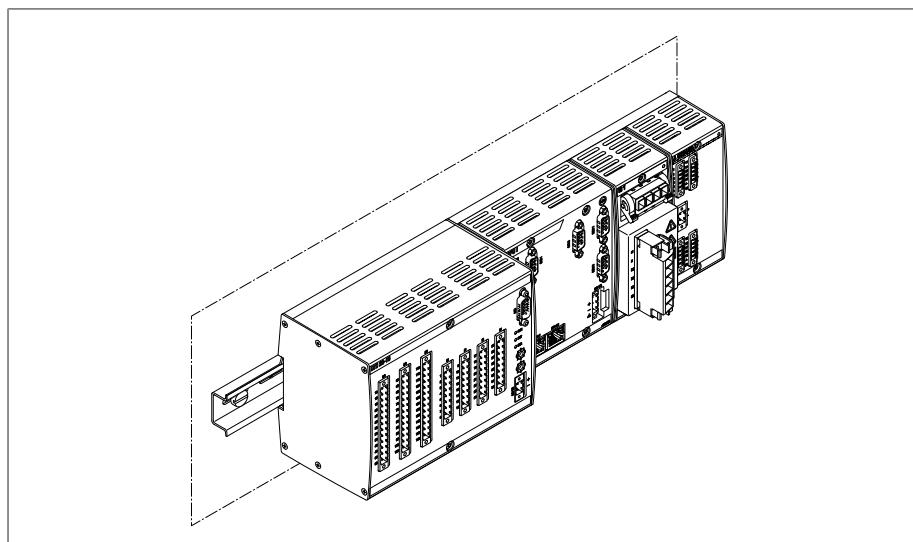


Figure 5: Individual components for assembly on a cap rail

4.5.1 Operating elements

The device has seven pushbuttons and one rotary knob. The illustration below is an overview of all the device's operating controls.

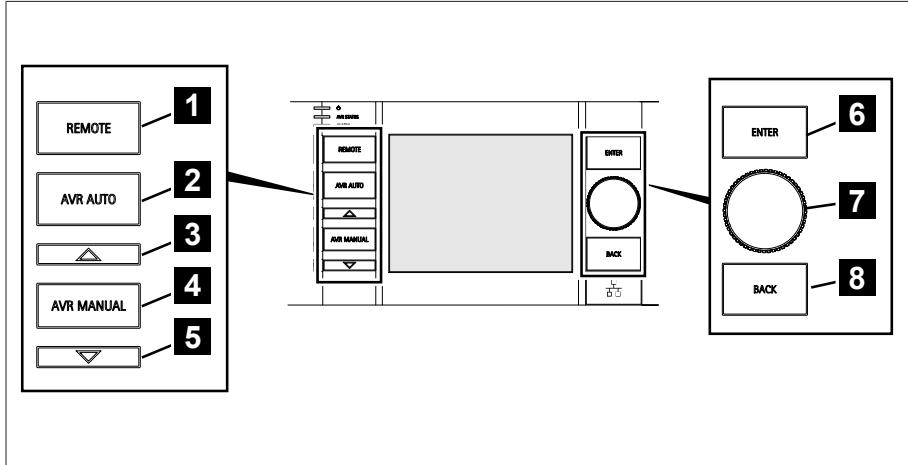


Figure 6: Operating elements

1	REMOTE key ¹⁾	Select the operating mode: – On: REMOTE – Off: LOCAL
2	AVR AUTO key	Activate auto mode.
3	RAISE key	Send a control command to the motor-drive unit to increase the voltage. Only possible in manual mode.
4	AVR Manual key	Activate manual mode.
5	LOWER key	Send a control command to the motor-drive unit to reduce the voltage. Only possible in manual mode.
6	ENTER key	Confirm selection and save modified parameters.
7	Rotary knob	Navigation through individual menu items and parameters.
8	BACK key	Exit the current menu. Go to the previous menu level.

¹⁾ Key without function if a digital input is used to toggle between local/remote.

4.5.2 Display elements

Display elements on the device

The device has a graphics display and 8 LEDs, which indicate the various operating statuses and events.

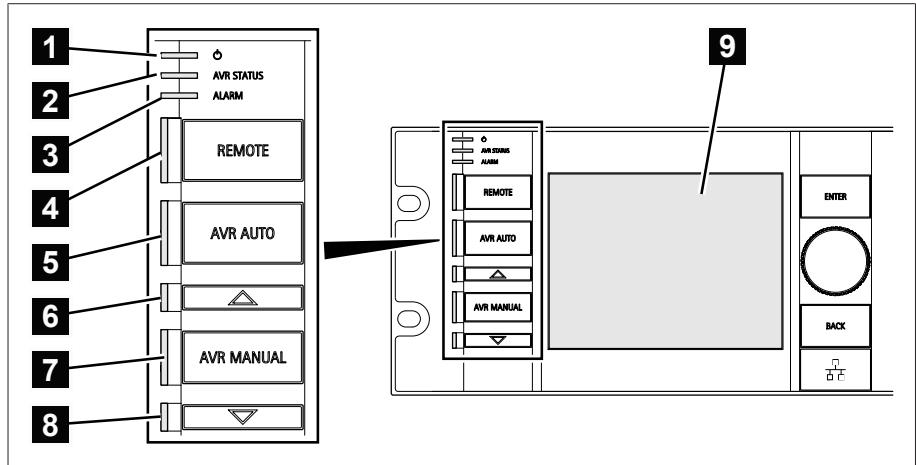


Figure 7: Display elements

1	Power supply LED	2	AVR STATUS LED
3	ALARM LED	4	REMOTE LED
5	AVR AUTO LED	6	Raise VOLTAGE LED
7	AVR MANUAL LED	8	Lower VOLTAGE LED
9	Display		

4.5.2.1 Display

The TAPCON® display is divided into the following areas:

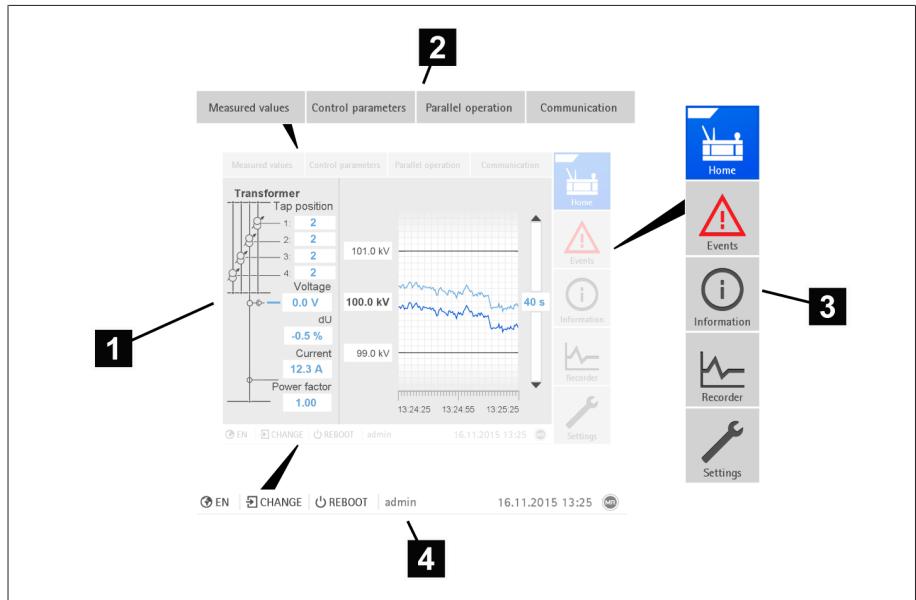


Figure 8: Display

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

4.5.2.2 Display showing measured value trend

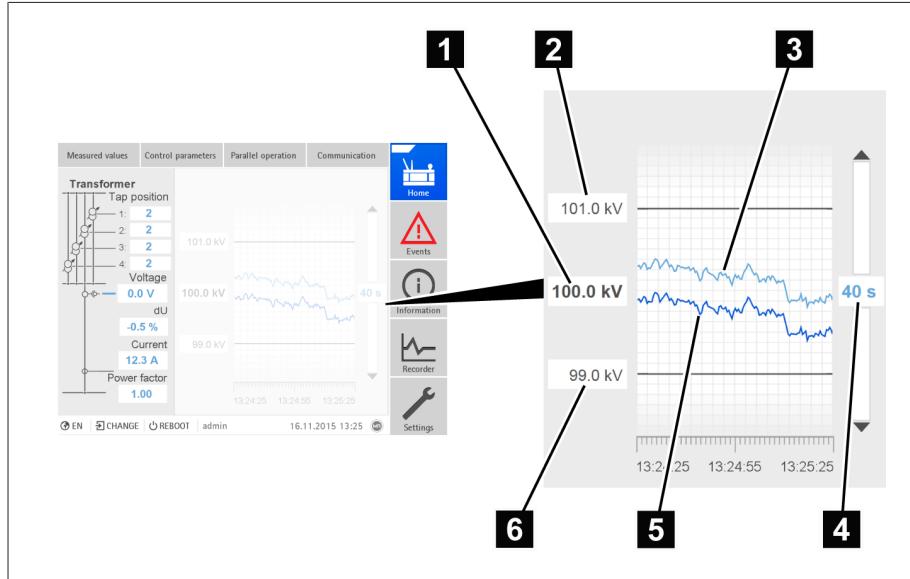


Figure 9: Measured value trend

1	Desired value	2	Upper limit of bandwidth
3	Trend of measured voltage	4	Delay time T1/T2
5	Trend of corrected voltage (correction due to compensation or parallel operation)	6	Lower limit of bandwidth

4.5.2.3 Transformer overview with current measured values

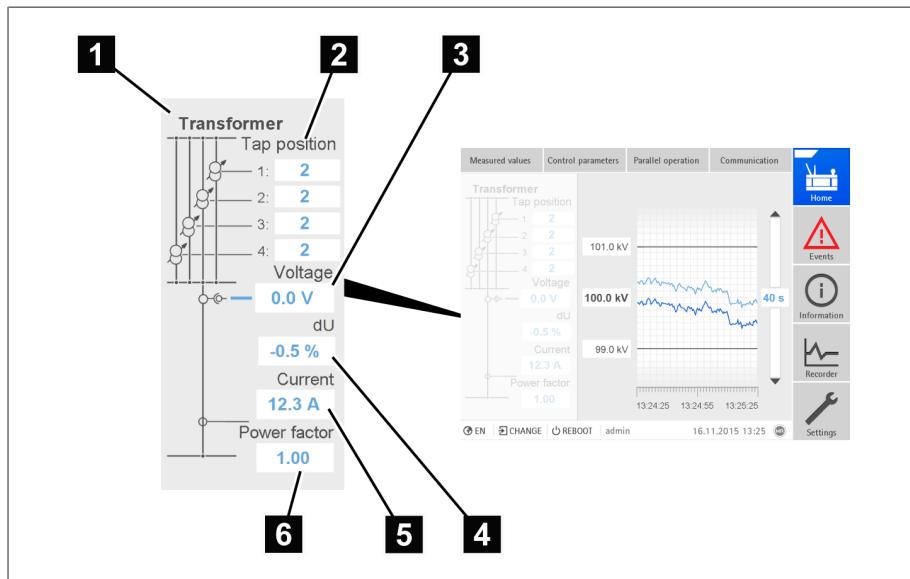


Figure 10: Transformer overview with display showing the current measured values

1	Description of bank of transformers	2	Current tap position of on-load tap-changer (transformers 1...4)
3	Voltage	4	Control deviation in % (with correction)
5	Current	6	Power factor

4.5.3 Additional operating controls and display elements when using the MControl touch panel (optional)

If you are using the device with the optionally available MControl touch panel, additional operating controls and display elements are displayed on the left edge of the screen

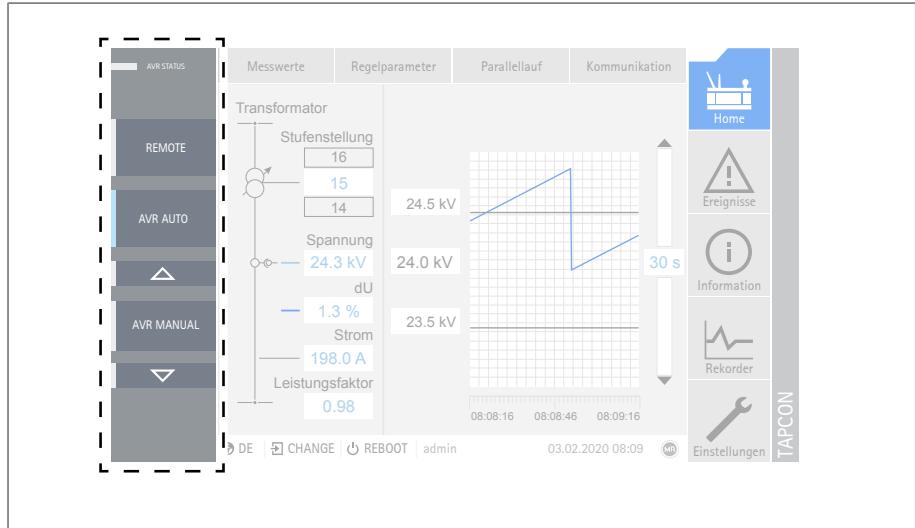


Figure 11: Additional display elements and operating controls

Status	LED status	Status display
	REMOTE key	Select the operating mode: - On: REMOTE - Off: LOCAL
	AVR AUTO key	Activate auto mode.
	RAISE key	Send a control command to the motor-drive unit to increase the voltage. Only possible in manual mode.
	AVR Manual key	Activate manual mode.
	LOWER key	Send a control command to the motor-drive unit to reduce the voltage. Only possible in manual mode.

¹⁾ Not available if local/remote is toggled using a digital input.

4.5.4 Front interface

The parameters for the device can be set using a PC. The RJ45 Ethernet interface on the front panel is provided for this purpose. To establish a connection with the device, refer to the Visualization section.

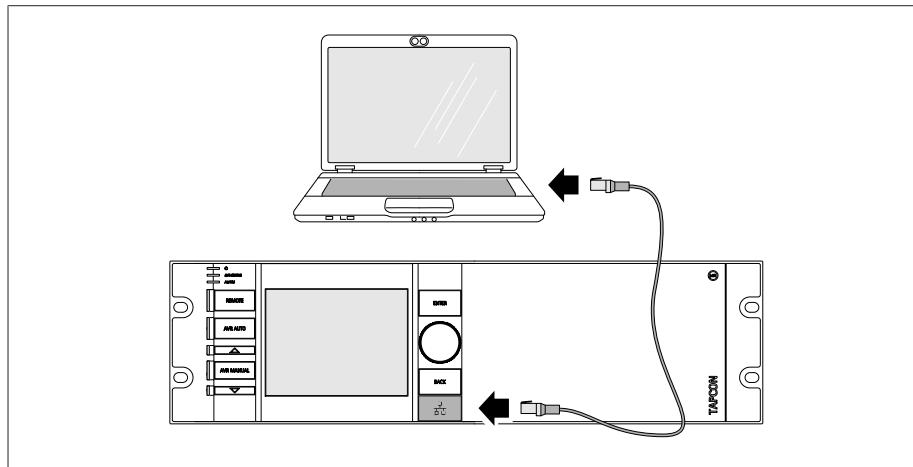


Figure 12: Device connection to a PC

4.5.5 ISM® assemblies

4.5.5.1 Power supply OT1205

The OT1205 assembly contains the power supply unit for powering the device. Depending on configuration, the device is equipped with one of the following power supply unit variants:

- Multi-voltage mains unit 85...265 V AC/V DC
- DC voltage power supply unit 20...70 V DC

4.5.5.2 CPU (central processing unit) I

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

- Internal system interface RS232 (COM1)
- Serial interface RS232/485 (COM2)
- 3x Ethernet (ETH 1, ETH 2.1, ETH 2.2)
- USB (USB 2.0)
- 2x CAN bus (CAN 1, CAN 2)

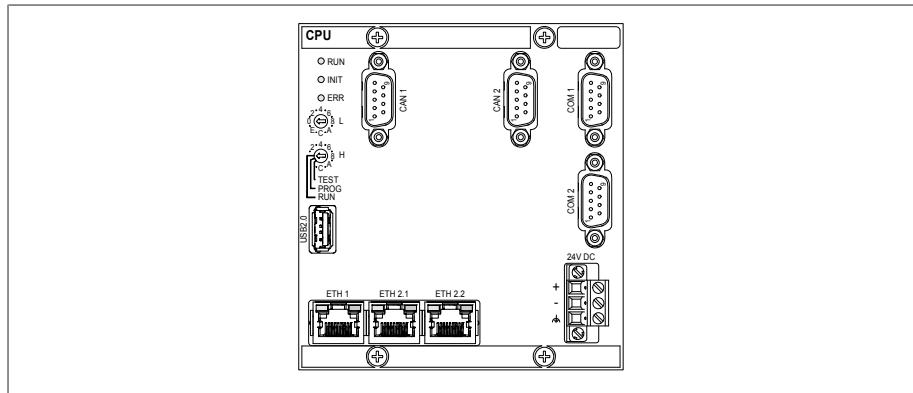


Figure 13: CPU I assembly

4.5.5.3 UI 1 voltage measurement and current measurement

The UI 1 assembly is used for measuring 1-phase voltage and current.

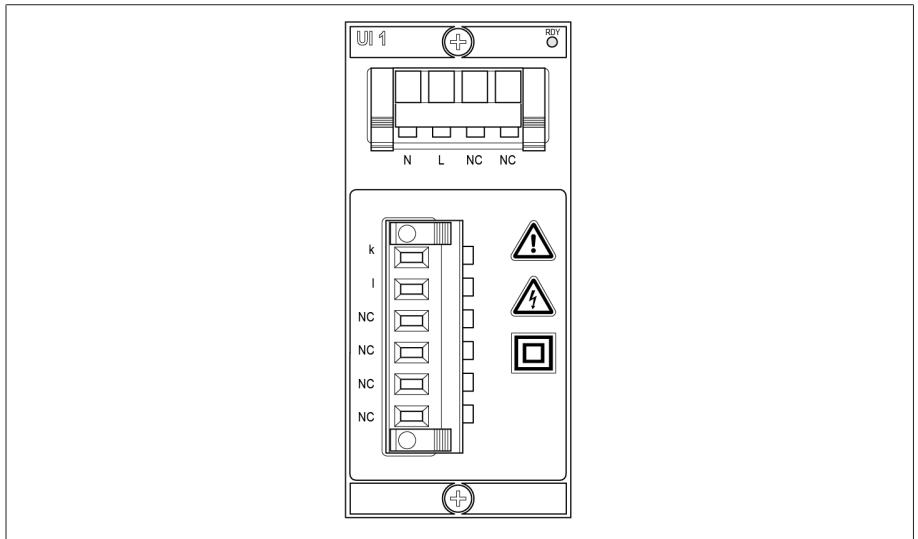


Figure 14: UI 1 assembly

	Warning of a danger point. Read the information given in the product operating instructions.
	Warning of dangerous electrical voltage.
	This assembly is protected via double insulation or reinforced insulation.

Table 8: Safety-relevant symbols on the assembly

4.5.5.4 UI 3 voltage measurement and current measurement

The UI 3 assembly is used for measuring 3-phase voltage and current.

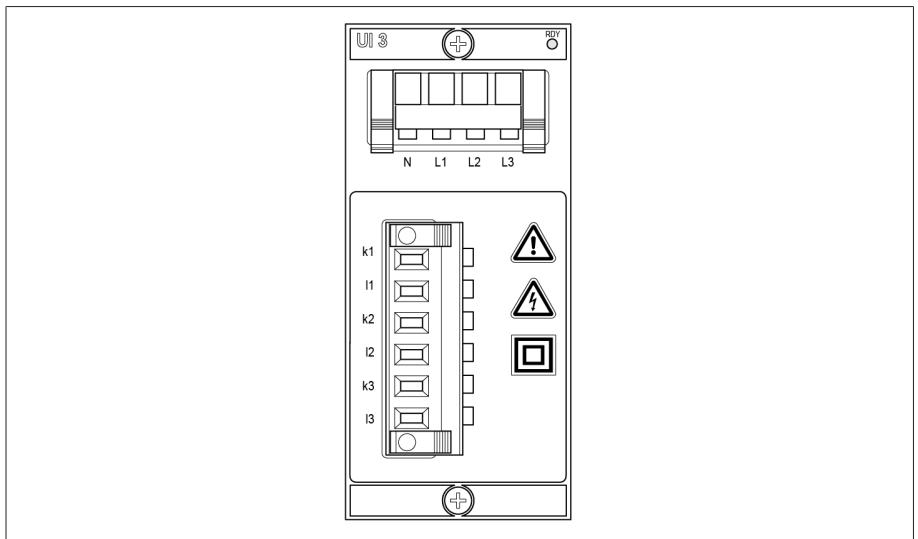


Figure 15: UI 3 assembly

	Warning of a danger point. Read the information given in the product operating instructions.
	Warning of dangerous electrical voltage.
	This assembly is protected via double insulation or reinforced insulation.

Table 9: Safety-relevant symbols on the assembly

4.5.5.5 DIO 28-15 digital inputs and outputs

The DIO 28-15 assembly makes 28 inputs and 15 outputs (6 N/O contacts, 9 change-over contacts) available.

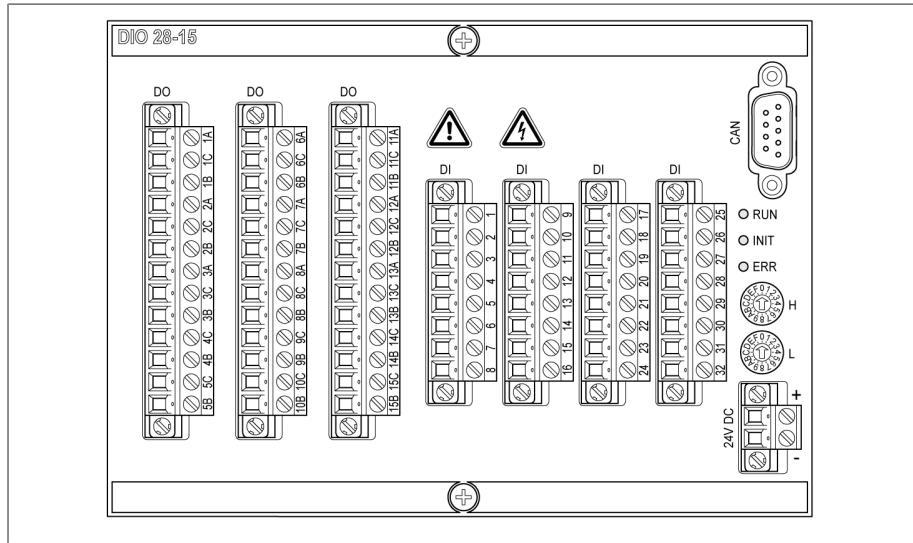


Figure 16: DIO 28-15 assembly

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

Table 10: Safety-relevant symbols on the assembly

4.5.5.6 Digital inputs and outputs DIO 42-20 (HL)

The assembly DIO 42-20/DIO 42-20 HL makes 42 inputs and 20 outputs (8 N/O contacts, 12 change-over contacts) available.

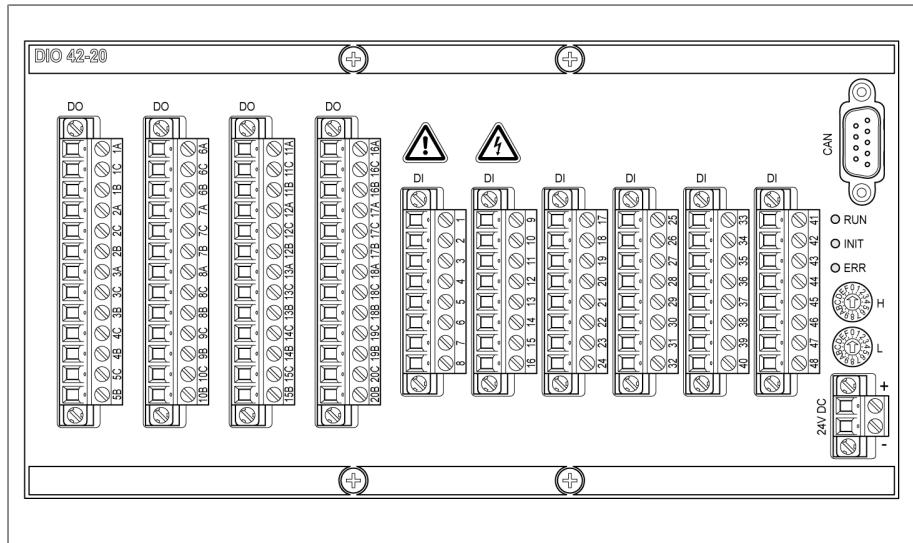


Figure 17: Assembly DIO 42-20/DIO 42-20 HL

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

Table 11: Safety-relevant symbols on the assembly

4.5.5.7 AIO 2 analog inputs and outputs

The AIO 2 assembly provides 2 channels for analog inputs and outputs.

In accordance with the device configuration, the AIO assembly supports one of the following signal types:

Input		Output	
Voltage	Current	Voltage	Current
0 to 10 V	0...20 mA 4...20 mA	0 to 10 V	0...20 mA 4...20 mA
Resistance measurement (e.g. PT100, resistor contact series)			

Table 12: Signal types supported by the AIO assembly

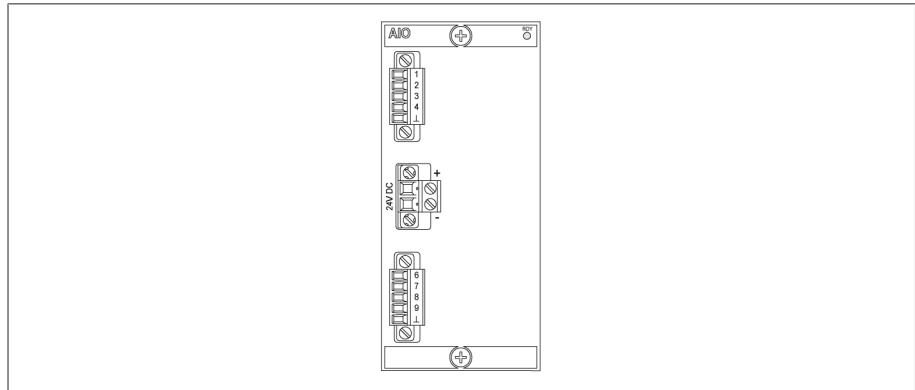


Figure 18: AIO 2 assembly

4.5.5.8 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)

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

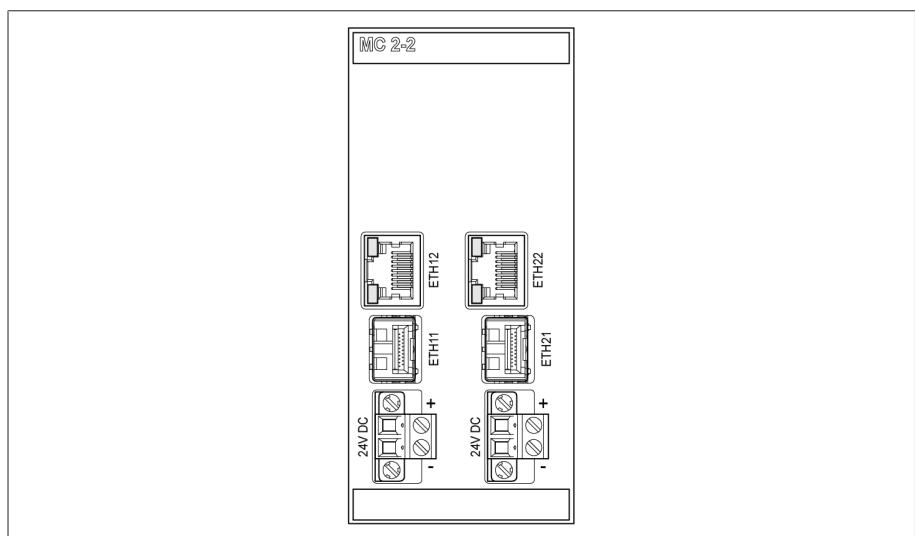


Figure 19: MC 2-2 assembly

4.5.5.9 System networking SW 3-3

The assembly SW 3-3 is a media converter with managed switch. It combines two independent functions and provides you with the following interfaces:

- A media converter converts an electric connection (RJ45) into a fiber-optic cable connection
 - RJ45 (ETH12)
 - Duplex-LC (SFP module) (ETH11)
- Managed switch with redundancy function (PRP or RSTP)
 - 2x RJ45 (ETH23, ETH24), device-internal connection
 - 2x Duplex-LC (SFP module) (ETH21, ETH22), redundancy connection

The following redundancy functions are available to you according to your order:

- PRP (standard setting)
- RSTP

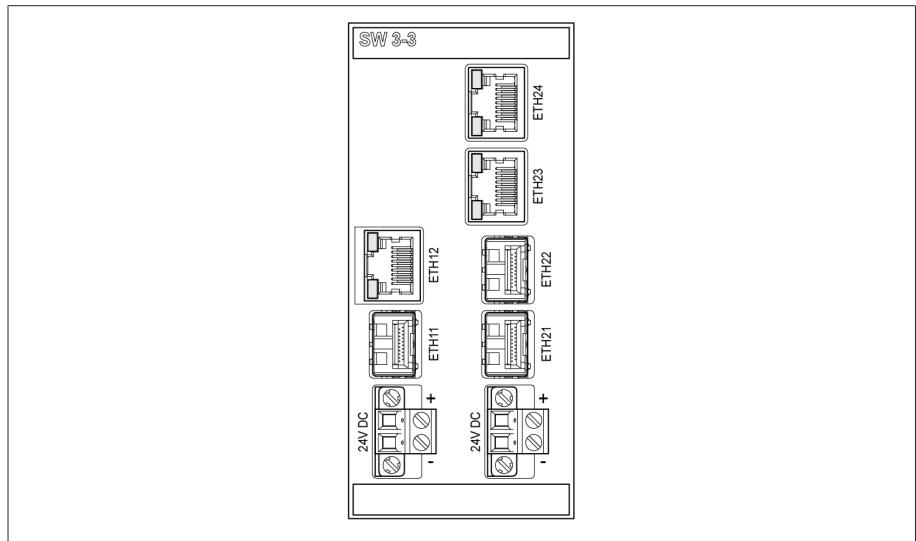


Figure 20: SW 3-3 assembly

4.6 Operating concept

You can operate the device using the controls on the front panel or using the web-based ISM™ 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 on user rights in the User administration [▶ [Section 9.2.14, Page 116](#)] section.

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

Logging on, logging off and changing users

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

i 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 controls on the front panel, you can use the rotary knob to navigate through the entire menu. The menu currently selected has a blue border. To open the highlighted menu, you have to press the **ENTER** key. Pressing the **BACK** 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.

Example

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 To select a list entry, proceed as follows:

1. Use the rotary knob to navigate to the list and press the **ENTER** key.

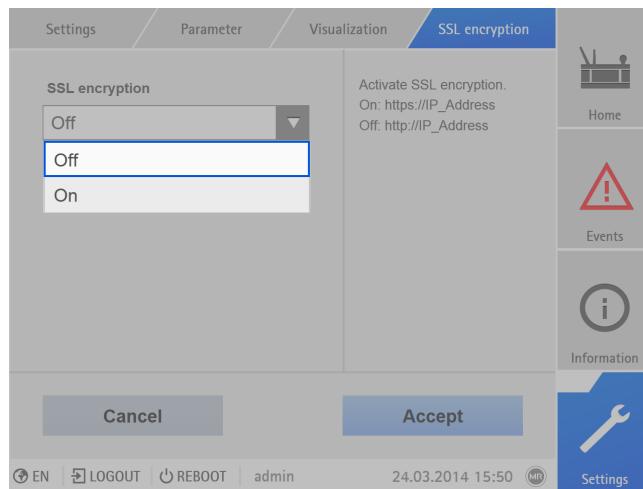


Figure 21: Select an entry from a list

2. Use the rotary knob to highlight the list entry and press the **ENTER** key.
3. Press the **Accept** button to save the modified parameter.

Entering a value To enter a value, proceed as follows:

1. Use the rotary knob to select the value field and press the **ENTER** key.
 - » If operating via the front panel, the numerical keypad appears.

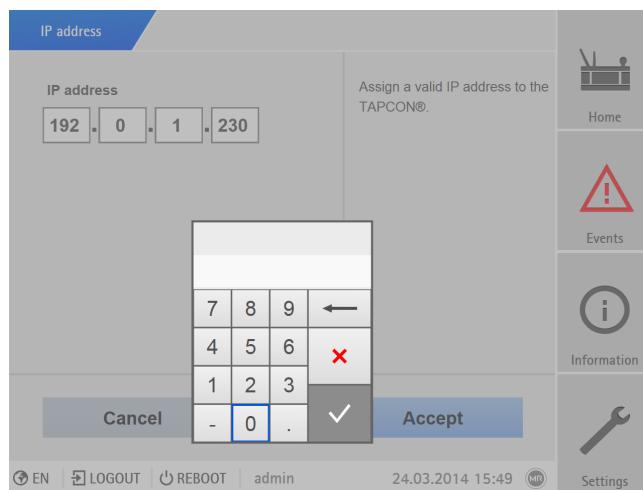


Figure 22: Entering a value

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

Entering text 1. Use the rotary knob to select the text box and press the **ENTER** key.
» If operating via the front panel, the keyboard appears.

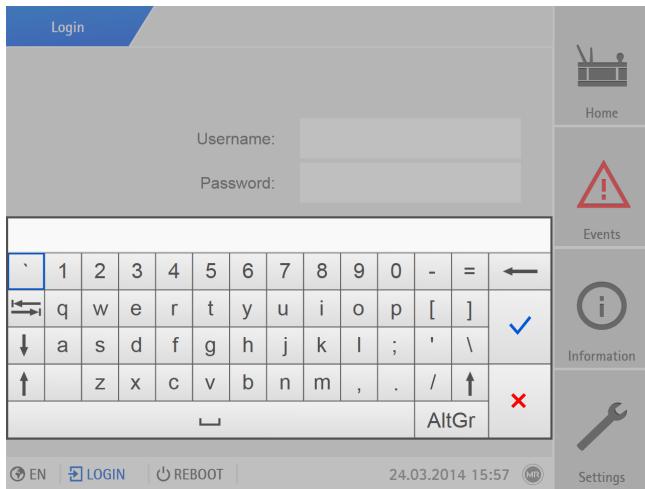


Figure 23: Entering text

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.

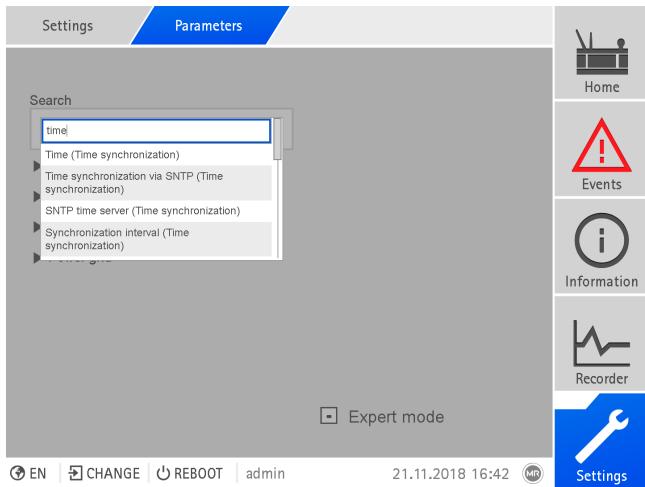


Figure 24: Quick search

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.

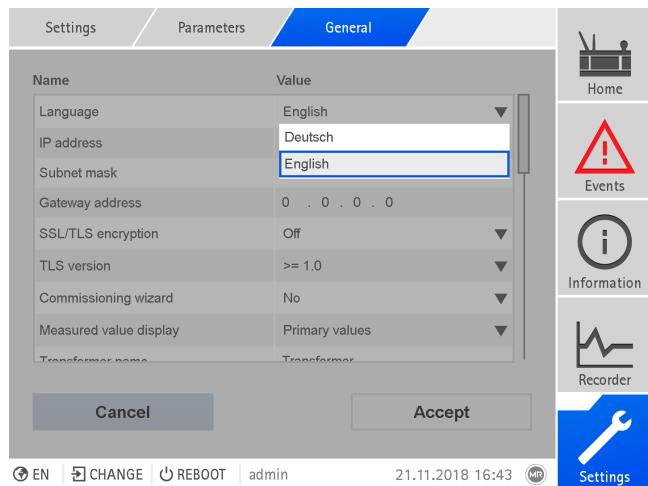


Figure 25: Expert mode

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 and structure

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 13: 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 experiences 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: <ul style="list-style-type: none"> - 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: <ul style="list-style-type: none"> - 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. <p>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.</p>

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

This chapter describes how to correctly mount and connect the device. Observe the connection diagrams provided.

⚠ 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

The following tools are needed for installation:

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



Depending on the installation site and assembly variant, you may need additional tools and corresponding attachment material (screws, nuts, washers) which are not included in the scope of delivery.

6.2 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.

6.2.1 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.

6.2.2 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.

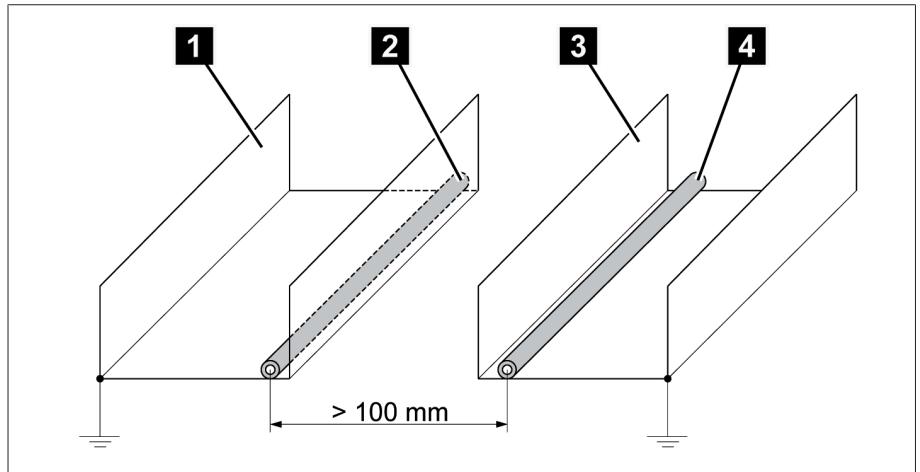


Figure 26: Recommended wiring

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.

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

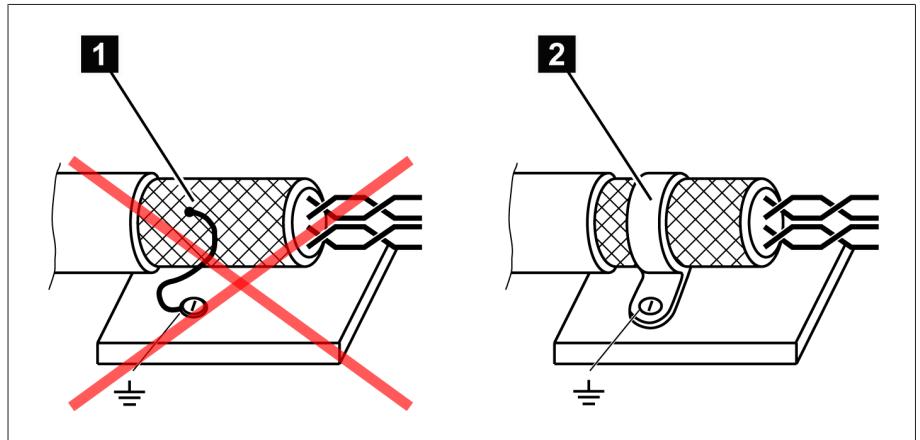


Figure 27: Recommended connection of the shielding

1	Connection of the shielding via a single conductor	2	Full-surface connection of the shielding
---	--	---	--

6.2.3 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 supply lines / switching lines must be laid in separate cable ducts.

6.2.4 Information about 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

If the devices to be connected share the same potential, proceed as follows:

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.

If the devices to be connected have different potential levels, proceed as follows:

- > Connect the CAN bus cable shielding **to just one** device.

Connecting shielding

Connect the shielding for the CAN bus cable to the 9-pin D-sub connector:

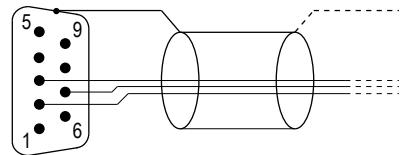


Figure 28: Connection of CAN bus cable shielding to the 9-pin D-sub connector

6.3 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).

Reliable operation of the device in the permitted temperature range requires that you maintain the following minimum distances to the control cabinet and to neighboring components:

	Minimum distance
To the floor of the control cabinet	88.9 mm (3.5 in)
To the roof of the control cabinet	Corresponds to 2 RU
Between assemblies on the bus bar and assemblies on the remote cap rail	

Table 14: Minimum distances in the control cabinet

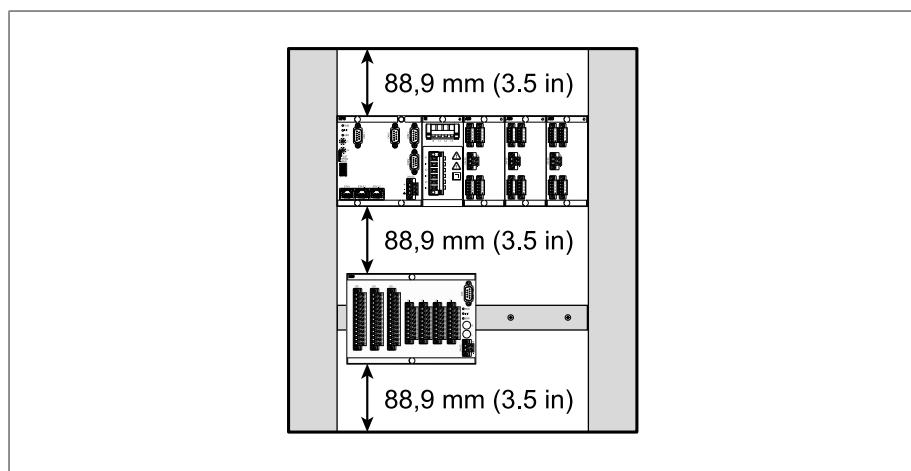


Figure 29: Example depiction of the minimum distances in a control cabinet

For other installation types, contact Maschinenfabrik Reinhausen GmbH.

6.4 Installing the 19-inch plug-in housing

Mounting in a 19" frame (in accordance with DIN 41494 Part 5)

To mount the device in a 19" frame, proceed as follows:

1. Place cage nuts in the desired locations on the 19" frame.
2. Place device in 19" frame and screw down.

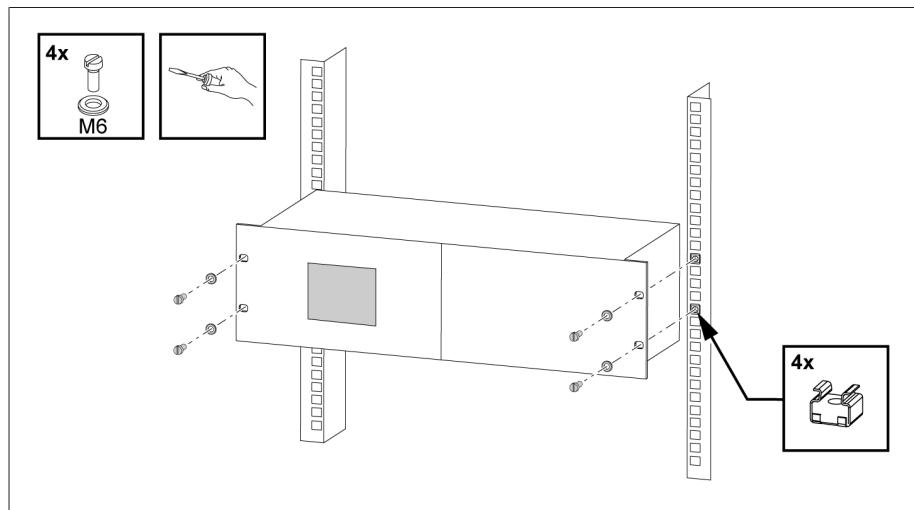


Figure 30: Example of device mounting in a 19" frame

Mounting in a control panel with a 19" flush control panel frame (optional)

To mount the device in a control panel, proceed as follows:

- ✓ Scope of delivery is complete.

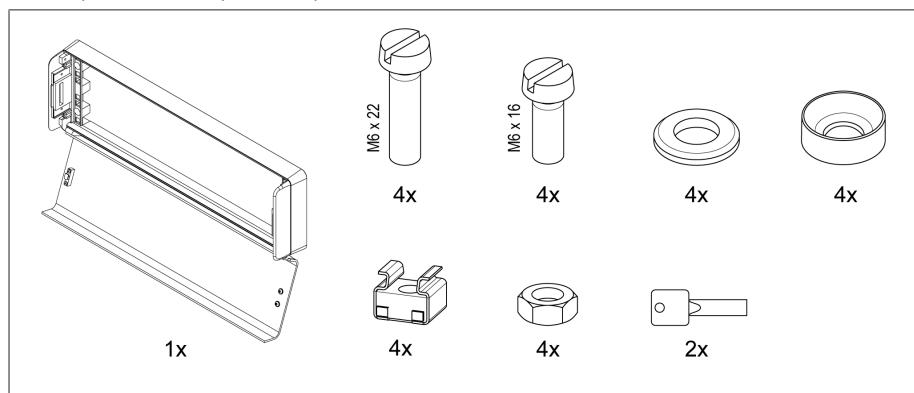


Figure 31: Scope of delivery

1. Produce the cut-out in the control panel.

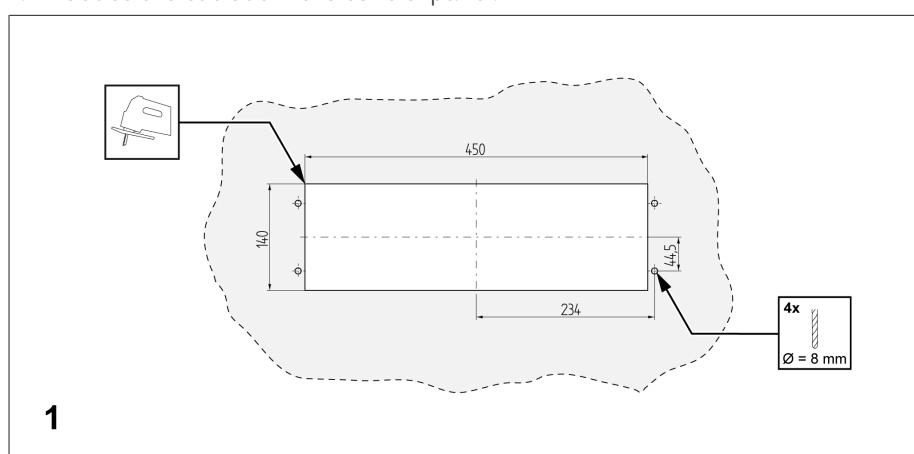


Figure 32: Producing the cut-out in the control panel

2. Mounting cage nuts

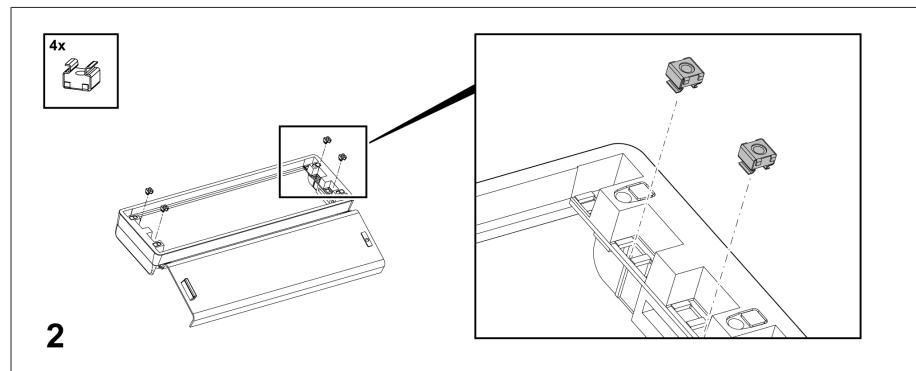


Figure 33: Mounting cage nuts

3. Secure frame to control panel.

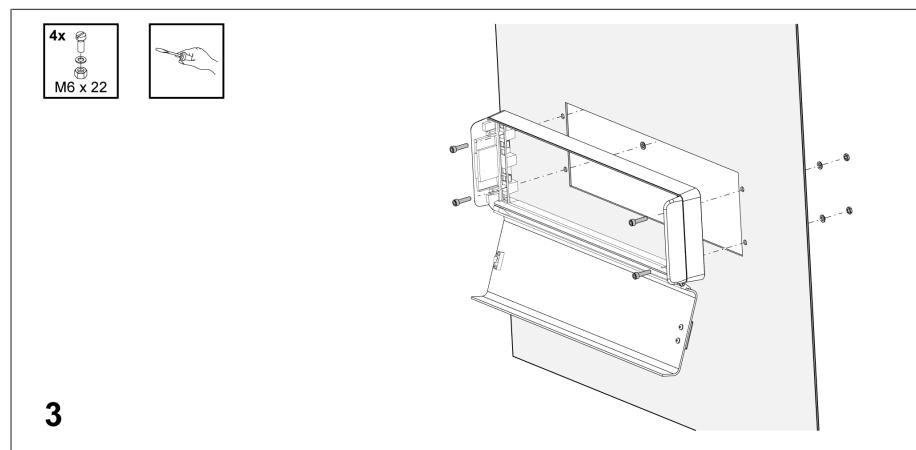


Figure 34: Securing frame to control panel

4. Slide device into flush control panel frame and secure.

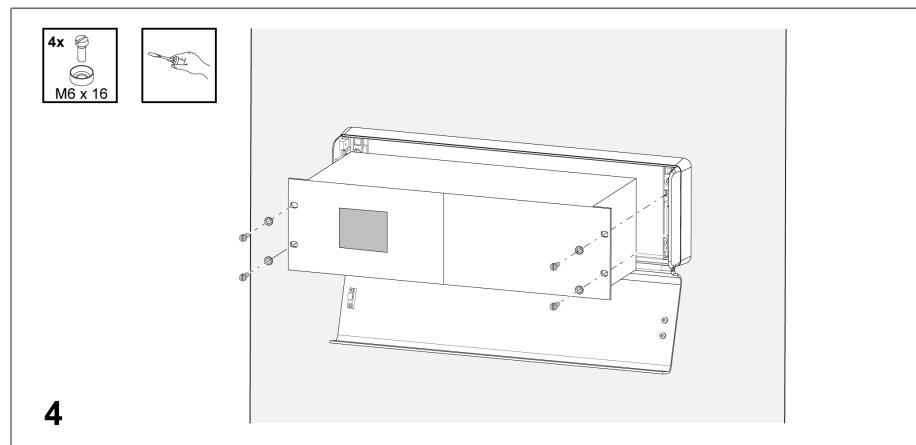


Figure 35: Securing device

5. Close cover of flush control panel frame.

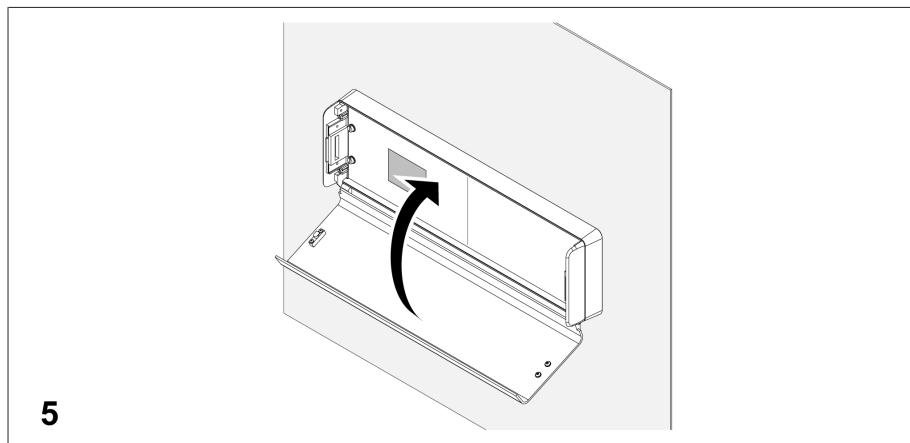


Figure 36: Closing cover

6.5 Installing the individual components on a cap rail

If you want to install individual components on a cap rail, you must install the cap rail in a control cabinet.



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.

6.5.1 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 IEC 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.

NOTICE

Damage to screw terminals!

Tightening the screws too tightly can damage the screw terminals.

- > When fastening the screw terminals, make sure that the tightening torque is 0.4 Nm.

- > 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).

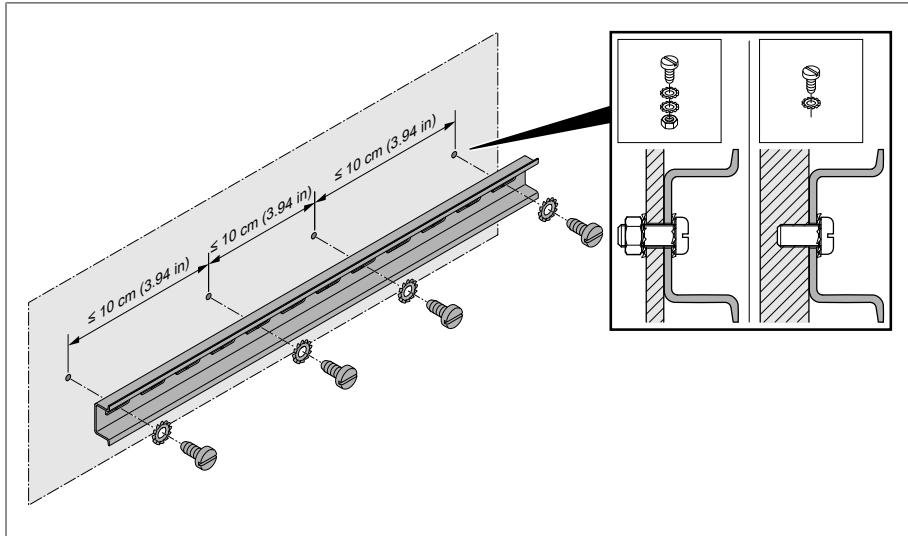


Figure 37: Fastening the cap rail

6.5.2 Installing the bus rail on the cap rail

The bus rail connects assemblies, such as the CPU, UI and AIO, to each other mechanically and electrically. The bus bar can contain different assemblies according to your order.

- > **⚠ WARNING!** Mount the bus rail on the cap rail, ensuring that the bus rail engages correctly. Otherwise, it can result in electric shock due to a faulty connection to the protective ground.

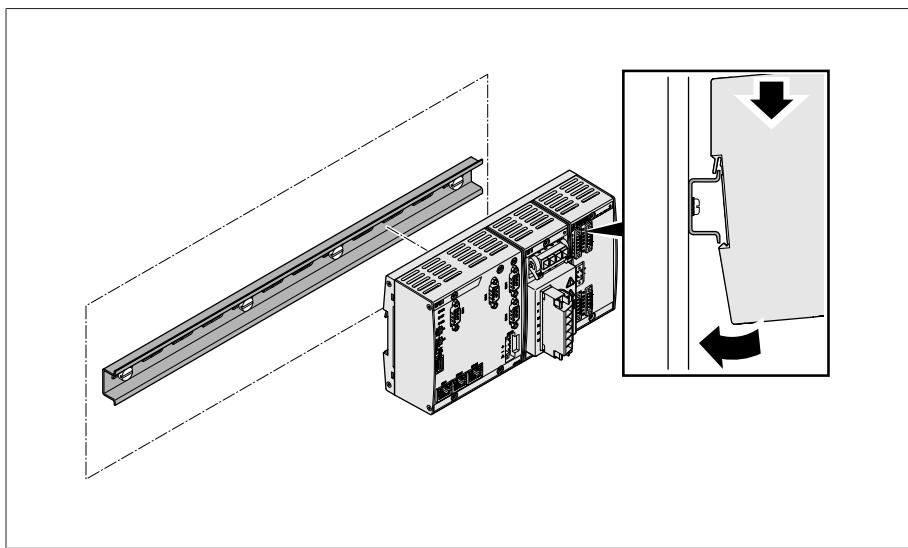


Figure 38: Hooking the bus rail into position

6.5.3 Installing the assembly at a distance on the cap rail

As an option, the device can have the following assemblies that must be mounted at a distance on the cap rail:

- DIO 28-15
- DIO 42-20

- MC 2-2
- SW 3-3
- G1 (PULS)

✓ Cap rail fastened to the rear panel of the cabinet [►Section 6.5.1, Page 42].

> **⚠ WARNING!** A faulty connection to the protective ground can lead to an electric shock in the event of faults. Hook the assembly onto the cap rail at the specified location, ensuring that the assembly engages correctly.

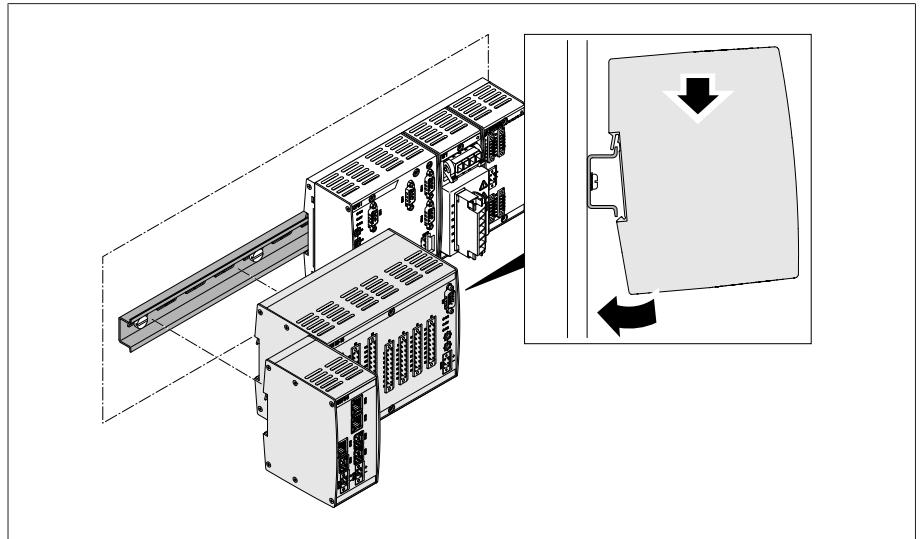


Figure 39: Example: Hooking on DIO and SW assemblies

6.6 Connecting the device

The following section describes how to establish the electrical connection to 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, close to the device's power supply so that it is freely accessible. This ensures that the device can be replaced with ease in the event of a defect.

Wiring information

Note this procedure for the wiring:

- 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.
- **NOTICE!** Damage to the terminals! Tightening the screws too tightly can damage the screw terminals. When fastening the screw terminals, make sure that the tightening torque is 0.5 Nm.

6.6.1 Cable recommendation

Please note the following Maschinenfabrik Reinhausen GmbH 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).
- Ensure that the copper cables used have a temperature resistance of 70°C.

Cable	Assembly	Type	Cross section	Material	Max. length
Power supply (external)	OT1205, G1 PULS QS3.241	Unshielded	1.5 mm ²	Copper	-
Power supply (internal, 24 V DC)	CPU, DIO, AIO, MC, SW	Unshielded	1.5 mm ²	Copper	-
Voltage measurement	UI	Shielded	2.5 mm ²	Copper	-
Current measurement	UI	Unshielded	4 mm ²	Copper	-
Digital signal inputs	DIO	Shielded	1.5 mm ²	Copper	400 m (<25 Ω/km)
Digital signal outputs*	DIO	Shielded	1.5 mm ²	Copper	-
Analog signal inputs	AIO	Shielded	1 mm ²	Copper	400 m (<25 Ω/km)

Cable	Assembly	Type	Cross section	Material	Max. length
Analog signal outputs	AIO	Shielded	1 mm ²	Copper	-
RS232, SUB-D	CPU	Shielded	0.25 mm ²	-	25 m
RS485; SUB-D	CPU	Shielded	0.25 mm ²	-	140 m
CAN bus	CPU	Shielded	0.75 mm ²	-	2000 m (entire CAN bus)
Ethernet RJ45	CPU	Min. CAT5, shielded S/FTP	-	-	100 m
Ethernet FO	MC, SW	Duplex LC Multimode, OM3, 1310 nm	-		2000 m

Table 15: Recommendation for connection cables

*) Observe line capacitance, see note above.

6.6.2 Information about connecting serial interfaces RS232 and RS485 (with 9-pin data cable)

NOTICE

Damage to the device!

Using the wrong data cable may damage the device.

- > Only use data cables which comply with the description below.

RS232 (D-SUB 9-pin)

To connect the device via the RS232 interface (COM2), use a data cable with the following structure:

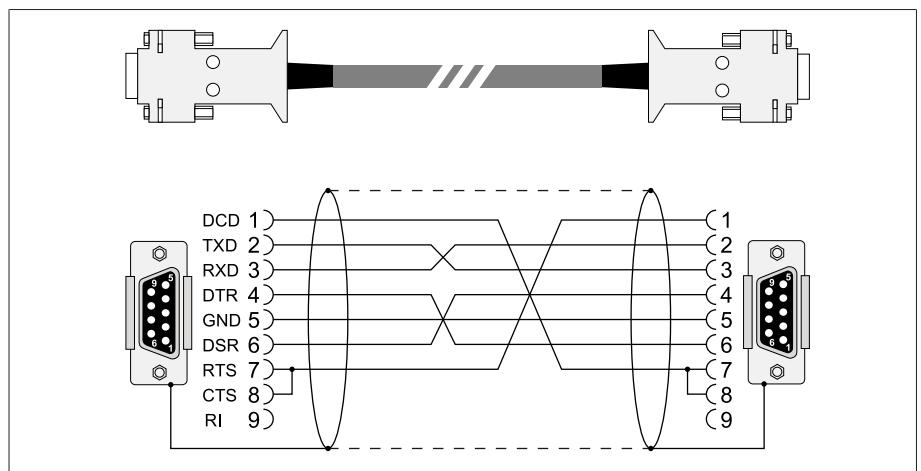


Figure 40: RS232 data cable (9-pin)

RS485 (D-SUB 9-pin)

To connect the device via the RS485 interface (COM2), use a data cable with the following structure:

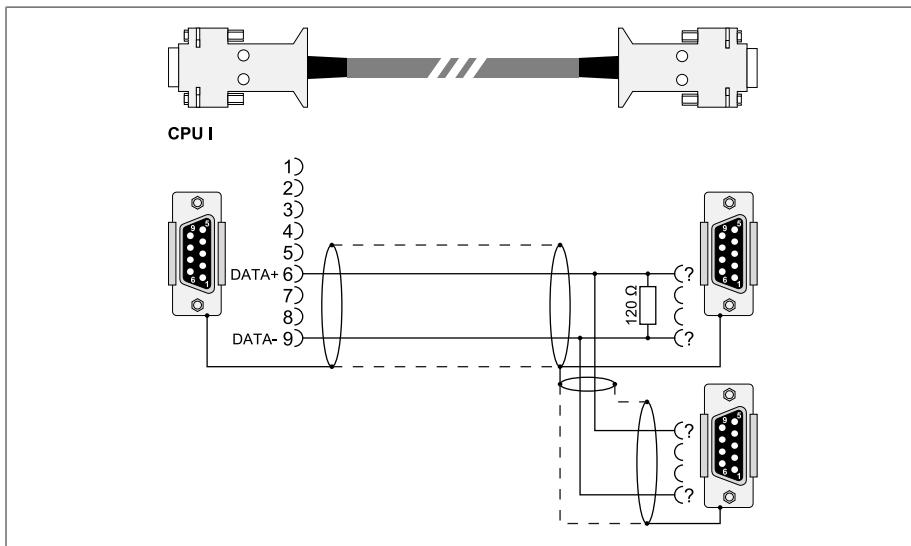


Figure 41: RS485 data cable

D-SUB 9-pin plug connection

Only use 9-pin D-SUB plugs with the following characteristics:

- Plug housing is metallic or metal-plated
- Cable shielding is connected with the plug using one of the following two variants:
 - Shielding is screwed down with traction relief.
 - Shielding is soldered to the plug housing.

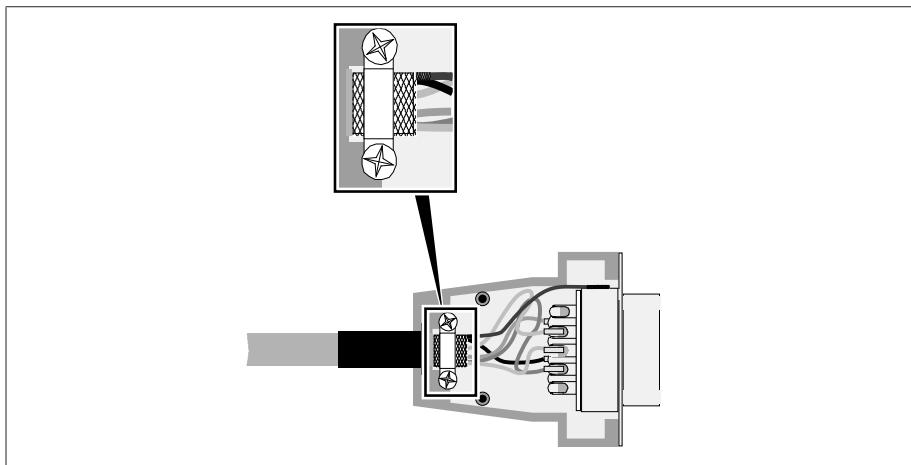


Figure 42: Example of a soldered shielding on a plug housing

6.6.3 Information about laying fiber-optic cable

To ensure the smooth transfer of data via the fiber-optic cable, you must ensure that mechanical loads are avoided when laying the fiber-optic cable and later on during operation. Also observe the information from the manufacturer of the fiber-optic cable and the following instructions:

- Radii must not fall below the minimum permissible bend radii (do not bend fiber-optic cable).
- The fiber-optic cables must not be over-stretched or crushed. Observe the permissible load values.
- The fiber-optic cables must not be twisted.

- Be aware of sharp edges because they can damage the fiber-optic cable's coating during laying or can place mechanical loads on the coating later on.
- Provide a sufficient cable reserve near distributor cabinets. Lay the reserve such that the fiber-optic cable is neither bent nor twisted when tightened.

6.6.4 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. Use the plug connector with terminating resistor provided as an option.

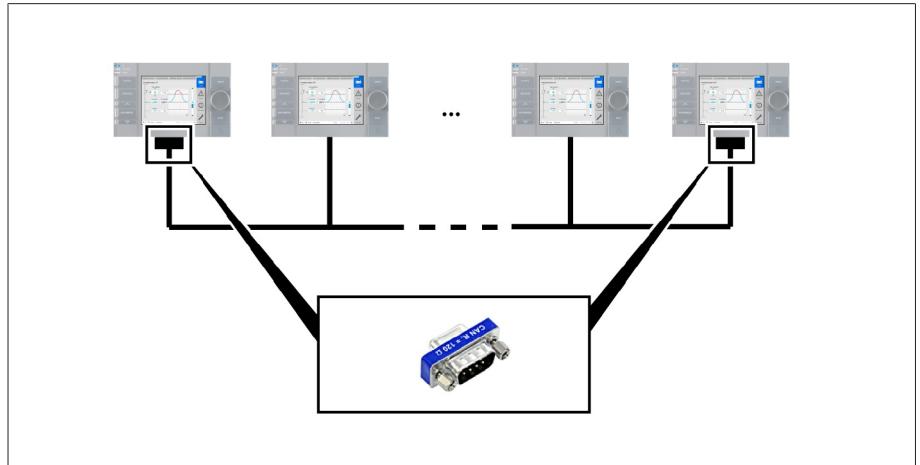


Figure 43: Terminating resistor of CAN bus

6.6.5 Connecting cables to the system periphery

- i** 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.

6.6.6 Wiring the CPU assembly

1. Connect the ETH 2.2 interface to a PC to access the web-based visualization.

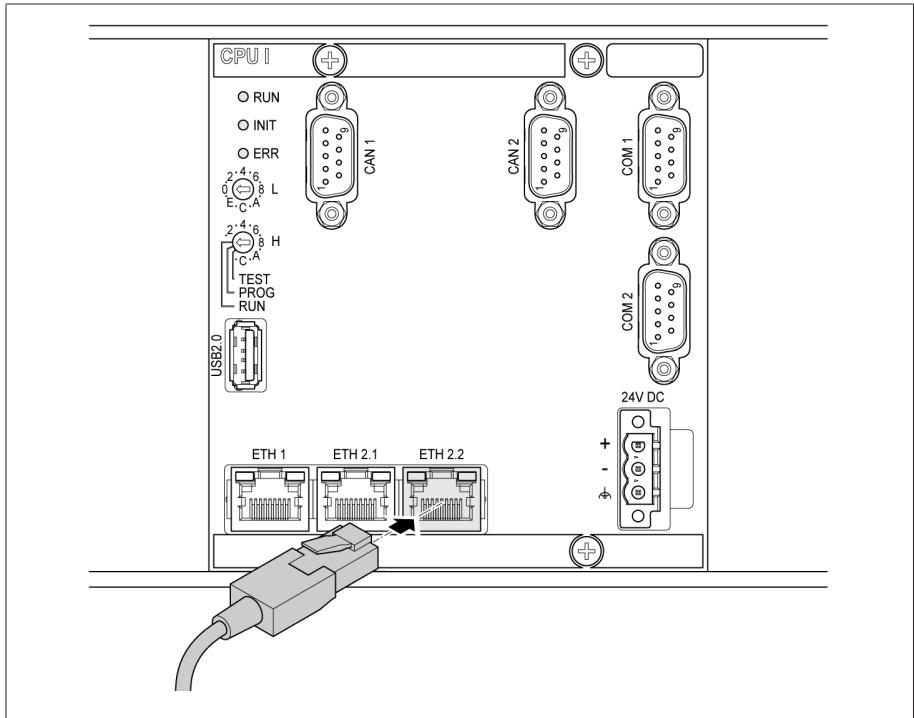


Figure 44: Connection to a PC via Ethernet interface

2. Connect the ETH 1 interface to the control system (SCADA) in accordance with the connection diagram.

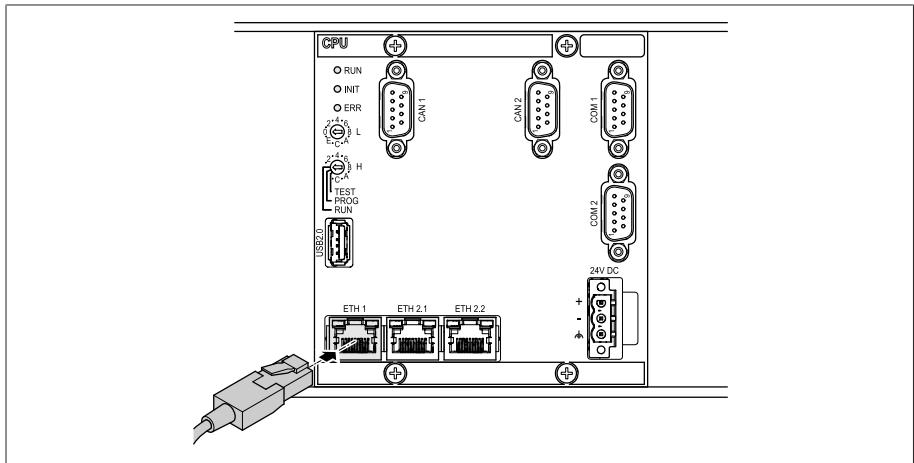


Figure 45: SCADA connection



Observe the information on connecting serial interfaces [► Section 6.6.2, Page 46].

- As an alternative to step 2, connect the COM 2 interface (D-Sub 9-pole) to the control system (SCADA) in accordance with the connection diagram.

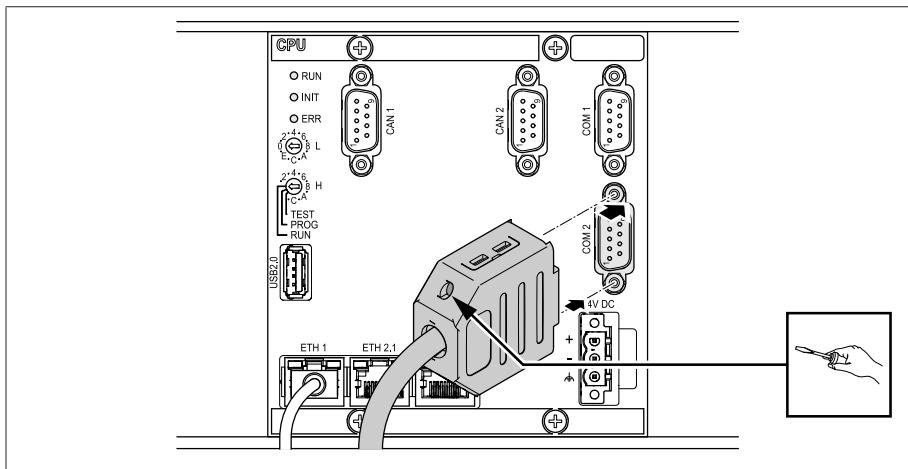


Figure 46: Serial SCADA connection via COM 2 interface

6.6.7 Wiring the UI 1 assembly

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	400 V (L-L) or 230 V (L-N)	
Rated current	30 mA...16 A	
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 16: Permissible fuse types

- Guide the cables into the corresponding plug terminals and fasten them using a screwdriver.

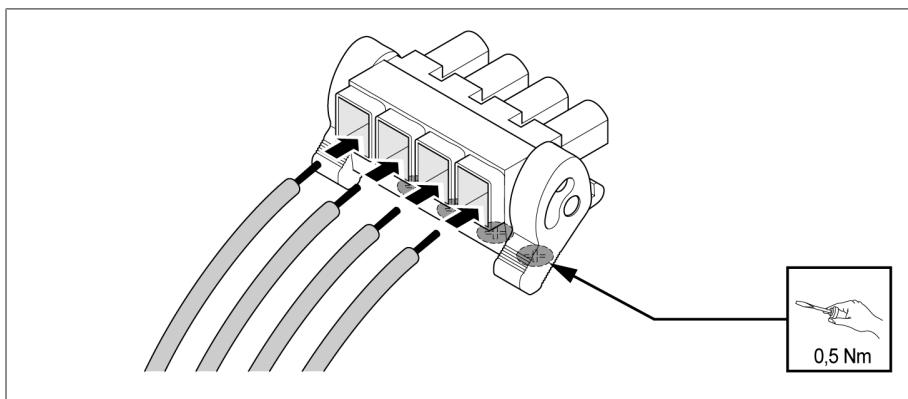


Figure 47: Example: Plug for voltage measurement

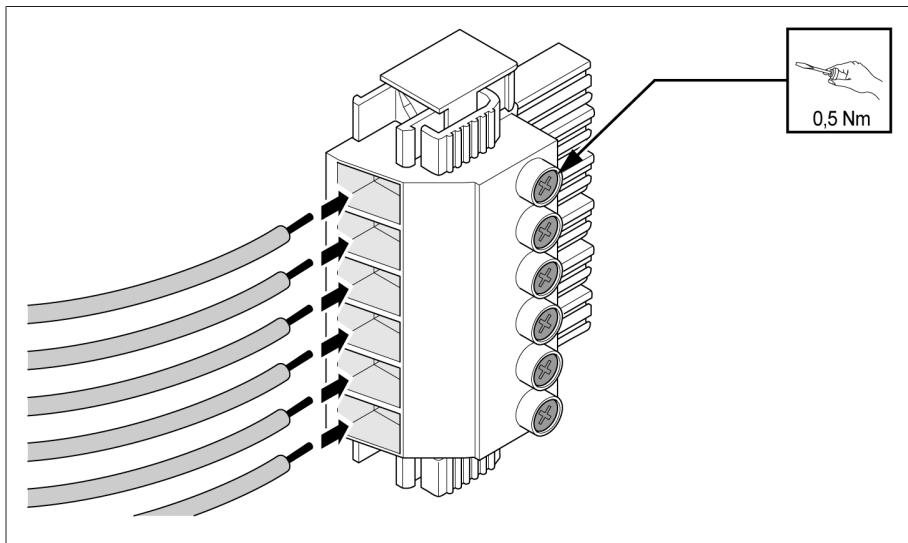


Figure 48: Example: Plug for current measurement

2. Insert the plugs into the respective slots and engage the plug.

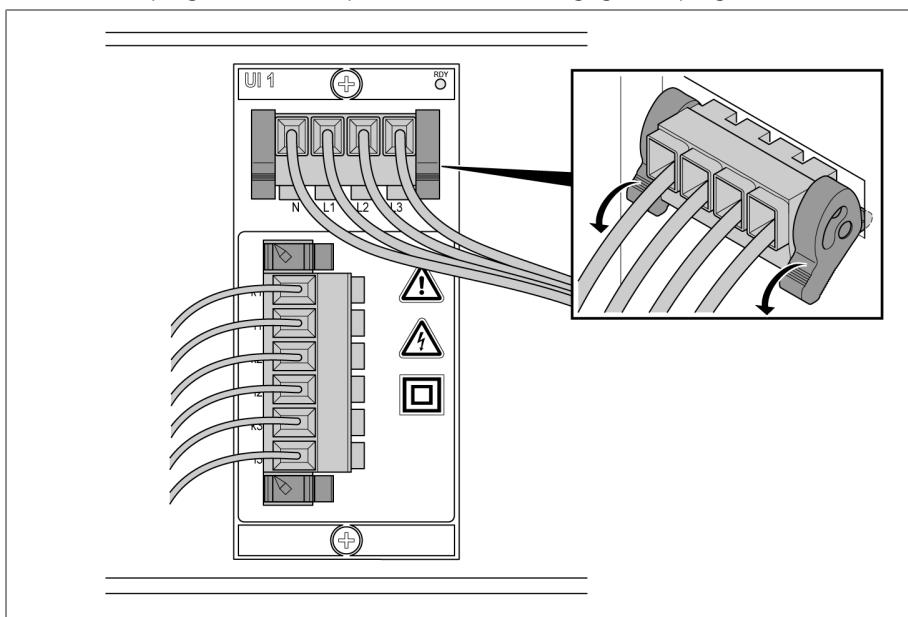


Figure 49: Engaging the plug

6.6.8 Wiring the UI 3 assembly

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	400 V (L-L) or 230 V (L-N)	
Rated current	30 mA...16 A	
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 17: Permissible fuse types

1. Guide the cables into the corresponding plug terminals and fasten them using a screwdriver.

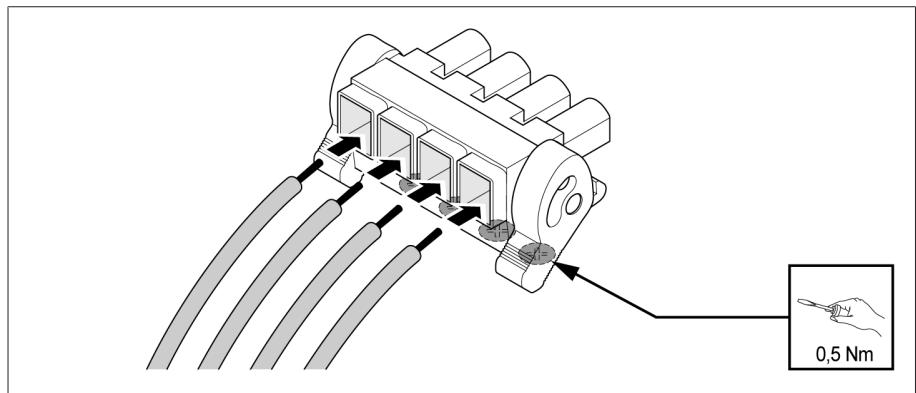


Figure 50: Example: Plug for voltage measurement

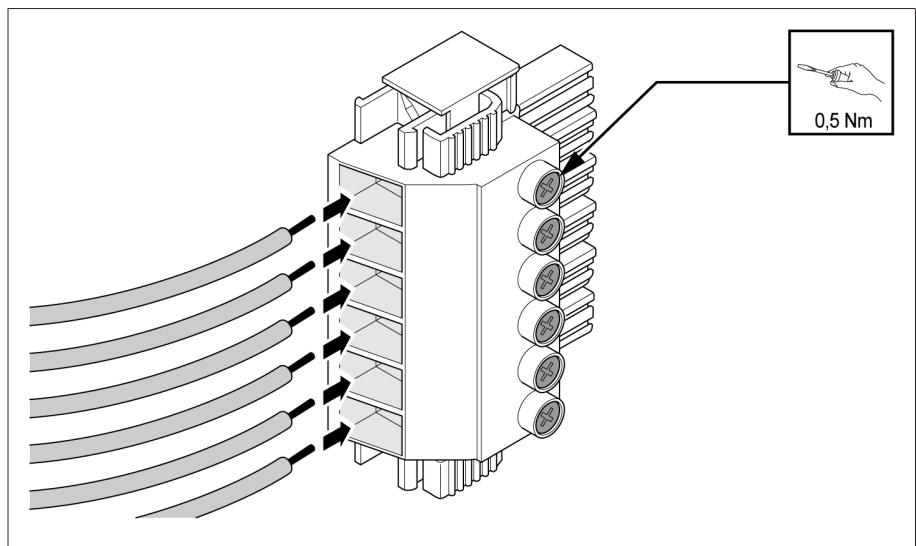


Figure 51: Example: Plug for current measurement

2. Insert the plugs into the respective slots and engage the plug.

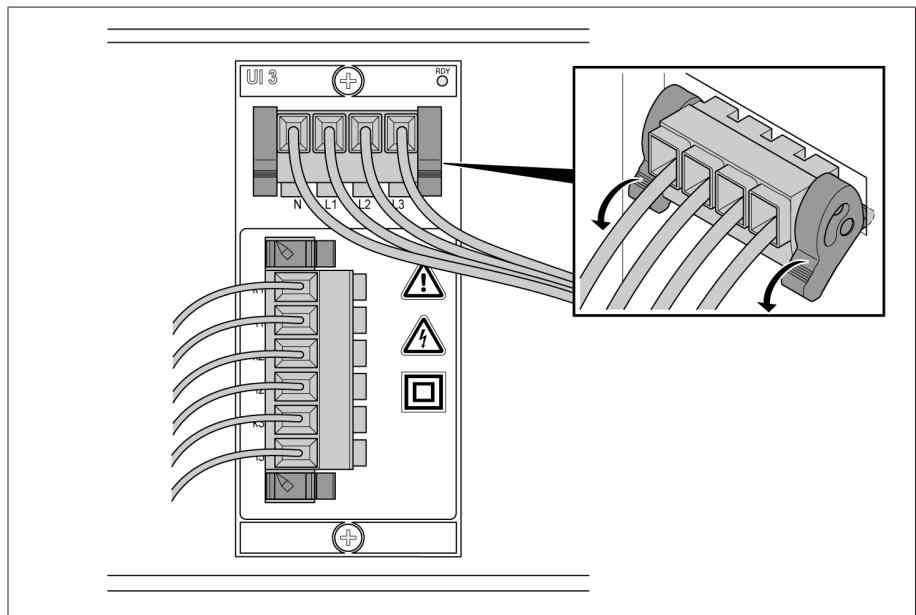


Figure 52: Engaging the plug

6.6.9 Wiring the AIO 2 assembly

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.

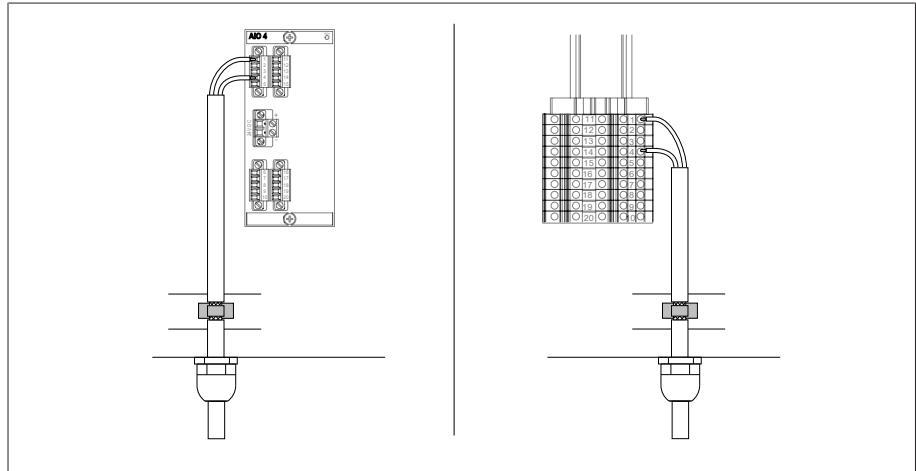


Figure 53: Examples of supporting shielding on grounding bar (on left: Direct connection to AIO2/AIO4 assembly, on right: Connection using line-up terminal)

Plug assignment

The AIO assembly has a separate plug connector for each channel (input or output). The plugs are assigned as follows:

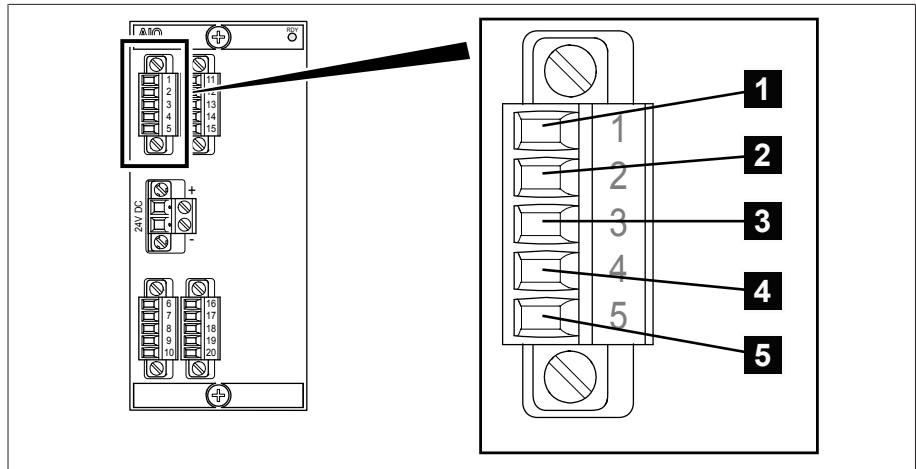


Figure 54: Plug assignment of the AIO 2/AIO 4 assemblies

Interface	Pin				Description
	1	6	11	16	I OUT (+): Current output +
	2	7	12	17	I/U IN (+) U OUT (+): Voltage input +, current input +, voltage output +
	3	8	13	18	I/U IN (-): Voltage input -, current input -
	4	9	14	19	I/U OUT (-): Voltage output -, current output -
	5	10	15	20	Not used

Table 18: Analog inputs and outputs

You can connect the following types of analog sensors:

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

- PT100/PT1000 (2-wire, 3-wire, 4-wire)

0/4...20 mA sensor

You must connect a 4...20 mA sensor to the pins **2** and **3**. You must also connect the included bridge to the pins **3**, **4** and **5**.

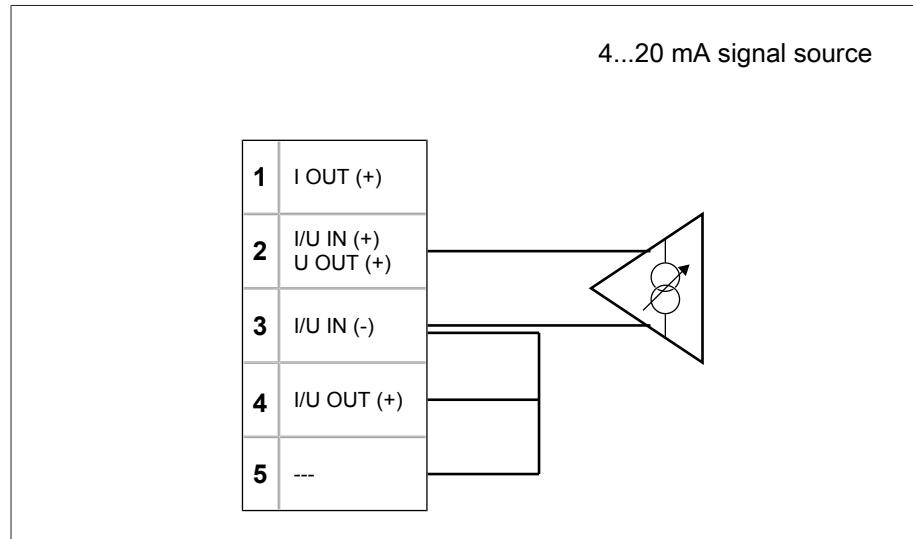


Figure 55: Connection example for a 4...20 mA sensor

PT100/PT1000 sensor

Depending on type, you must connect a PT100 sensor or PT1000 sensor as follows:

- 2-wire: pin **1** and **4**
- 3-wire: pin **1**, **3** and **4**
- 4-wire: pin **1**, **2**, **3** and **4**

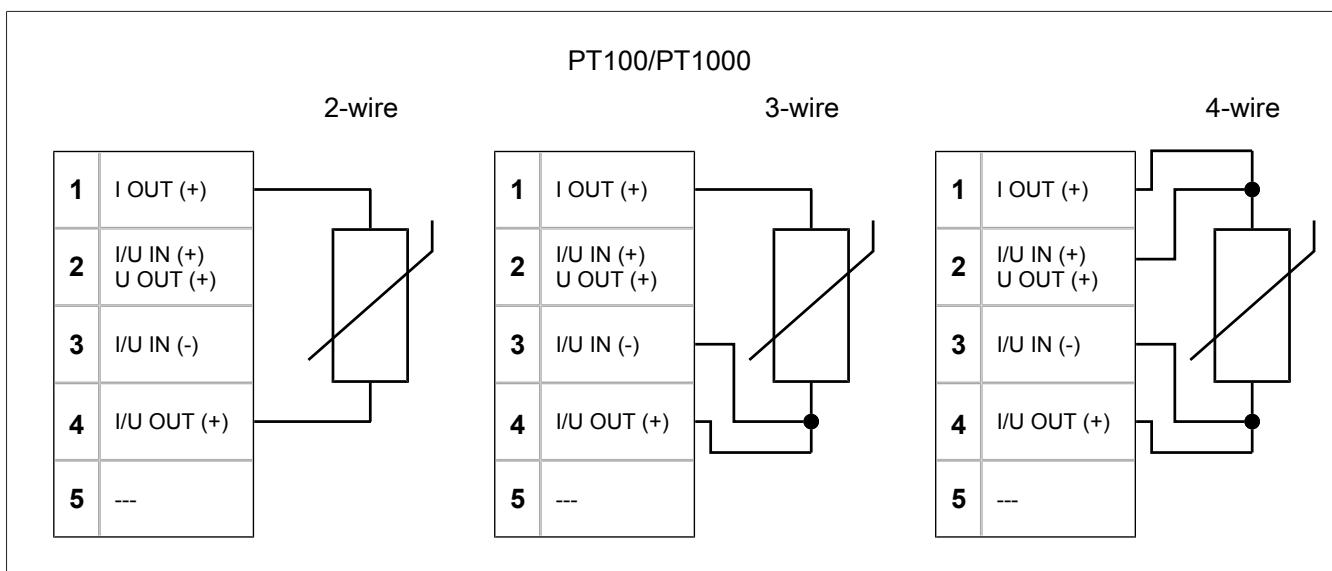


Figure 56: Connection example for a PT100/PT1000 sensor

Wiring analog inputs/outputs

1. Lead the wires into the connector and fasten them using a screwdriver.

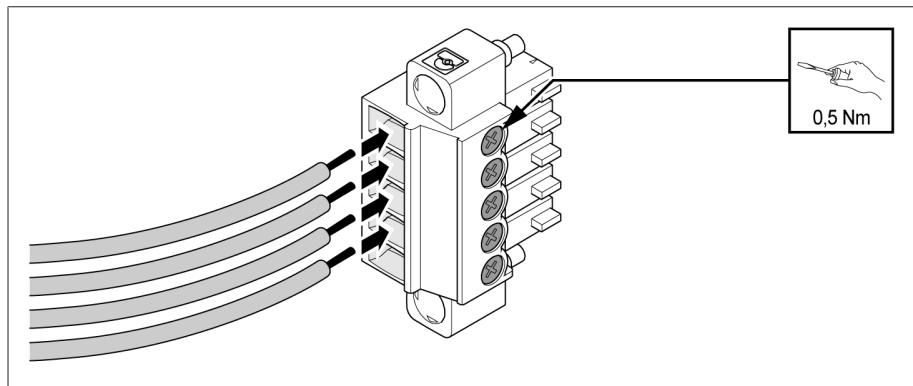


Figure 57: Inserting the leads into the plug connector

2. Insert and screw the plug into the respective slot in accordance with the supplied connection diagram.

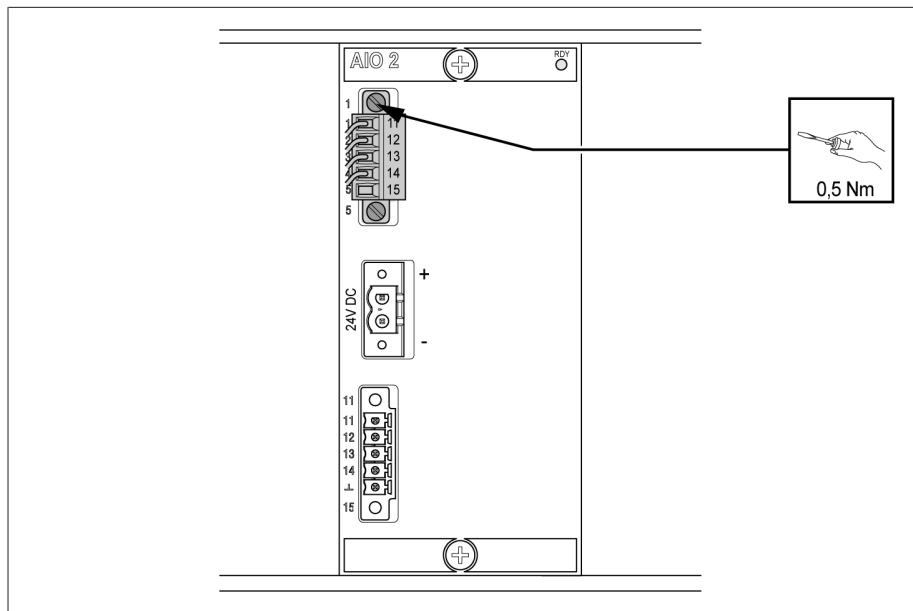


Figure 58: Fastening the plug (analog inputs/outputs)

6.6.10 Wiring the AIO 4 assembly

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.

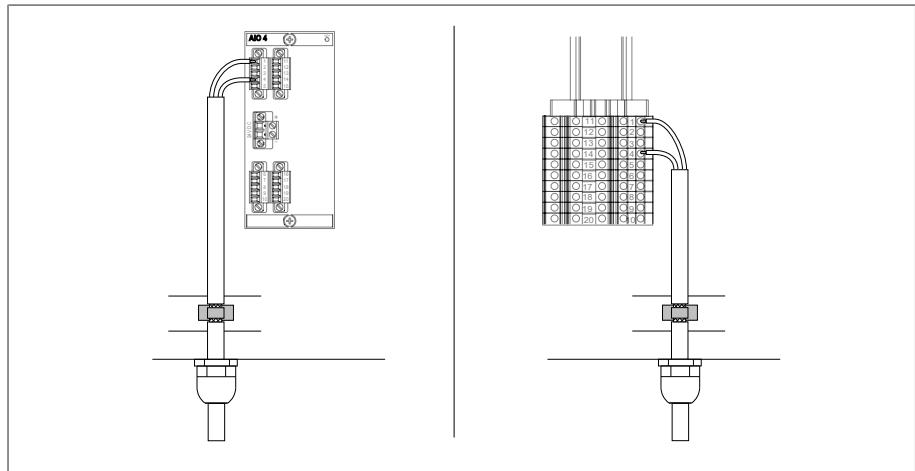


Figure 59: Examples of supporting shielding on grounding bar (on left: Direct connection to AIO2/AIO4 assembly, on right: Connection using line-up terminal)

Plug assignment

The AIO assembly has a separate plug connector for each channel (input or output). The plugs are assigned as follows:

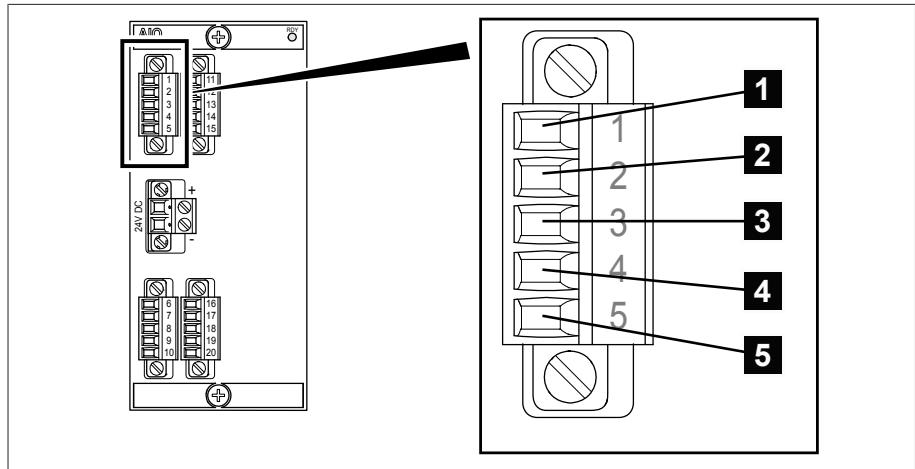


Figure 60: Plug assignment of the AIO 2/AIO 4 assemblies

Interface	Pin				Description
	1	6	11	16	I OUT (+): Current output +
	2	7	12	17	I/U IN (+) U OUT (+): Voltage input +, current input +, voltage output +
	3	8	13	18	I/U IN (-): Voltage input -, current input -
	4	9	14	19	I/U OUT (-): Voltage output -, current output -
	5	10	15	20	Not used

Table 19: Analog inputs and outputs

You can connect the following types of analog sensors:

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

- PT100/PT1000 (2-wire, 3-wire, 4-wire)

0/4...20 mA sensor

You must connect a 4...20 mA sensor to the pins **2** and **3**. You must also connect the included bridge to the pins **3**, **4** and **5**.

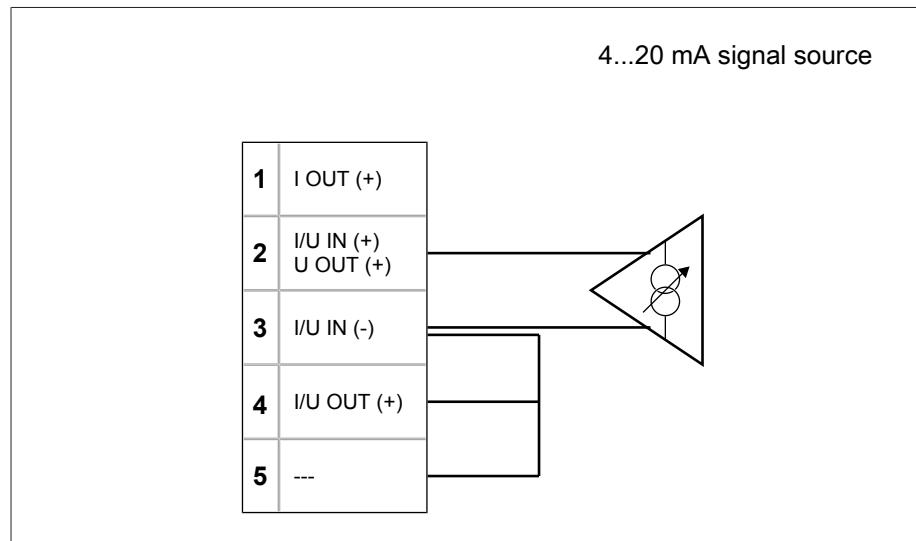


Figure 61: Connection example for a 4...20 mA sensor

PT100/PT1000 sensor

Depending on type, you must connect a PT100 sensor or PT1000 sensor as follows:

- 2-wire: pin **1** and **4**
- 3-wire: pin **1**, **3** and **4**
- 4-wire: pin **1**, **2**, **3** and **4**

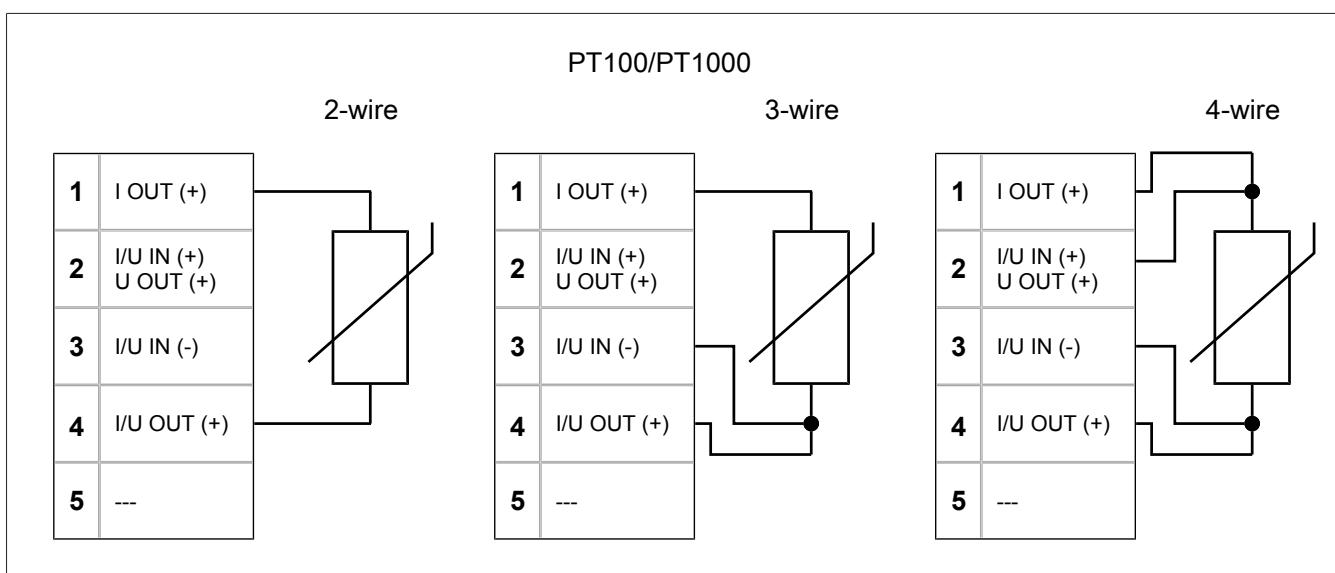


Figure 62: Connection example for a PT100/PT1000 sensor

Wiring analog inputs/outputs

1. Lead the wires into the connector and fasten them using a screwdriver.

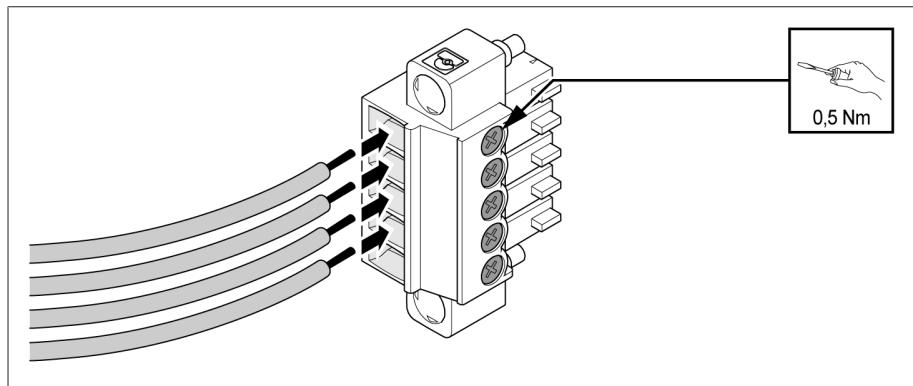


Figure 63: Inserting the leads into the plug connector

2. Insert and screw the plug into the respective slot in accordance with the supplied connection diagram.

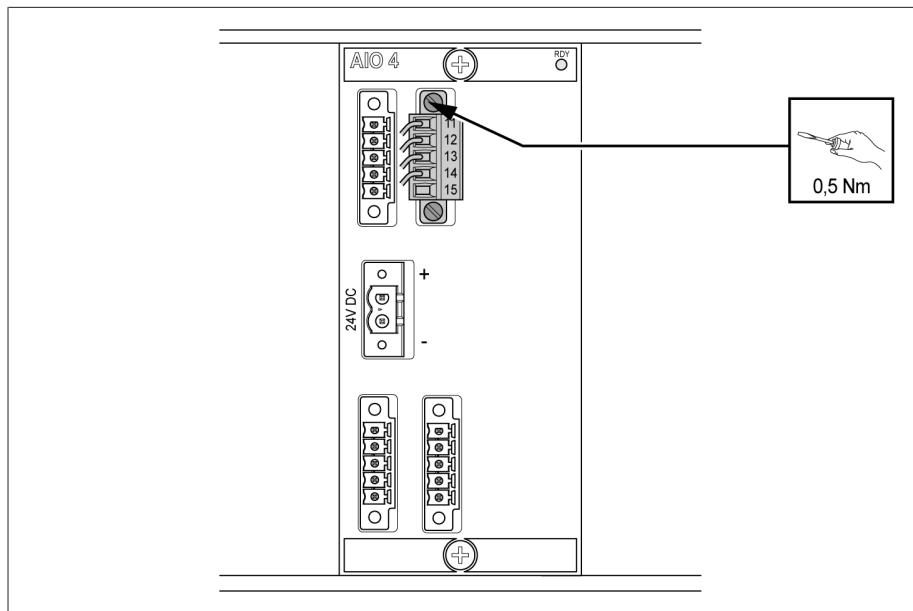


Figure 64: Fastening the plug (analog inputs/outputs)

6.6.11 Wiring the DIO 28-15 assembly

1. Guide the leads into the plug terminal in accordance with the supplied connection diagram and fasten them using a screwdriver.

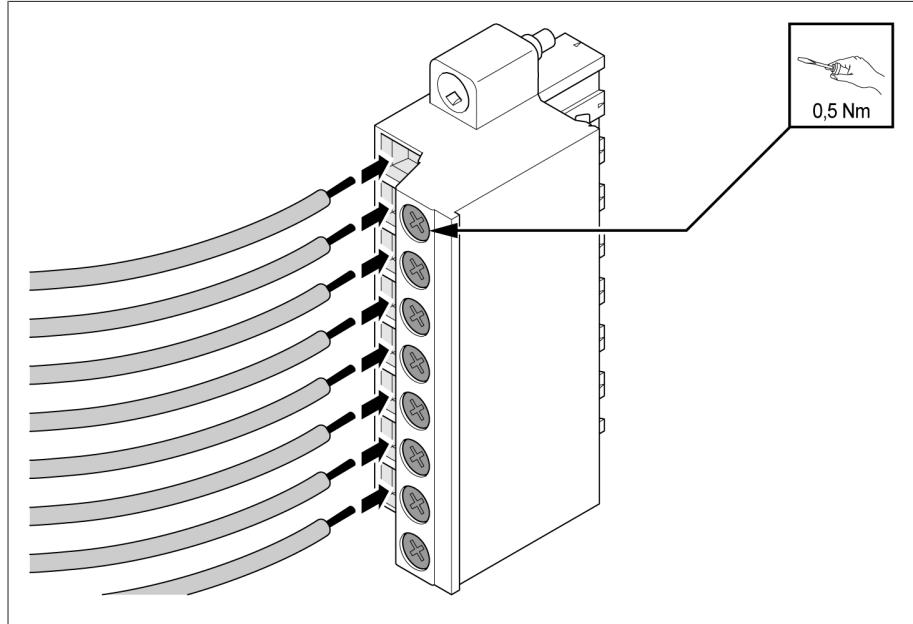


Figure 65: Inserting the leads

2. Insert and screw the plug into the respective slot in accordance with the supplied connection diagram.

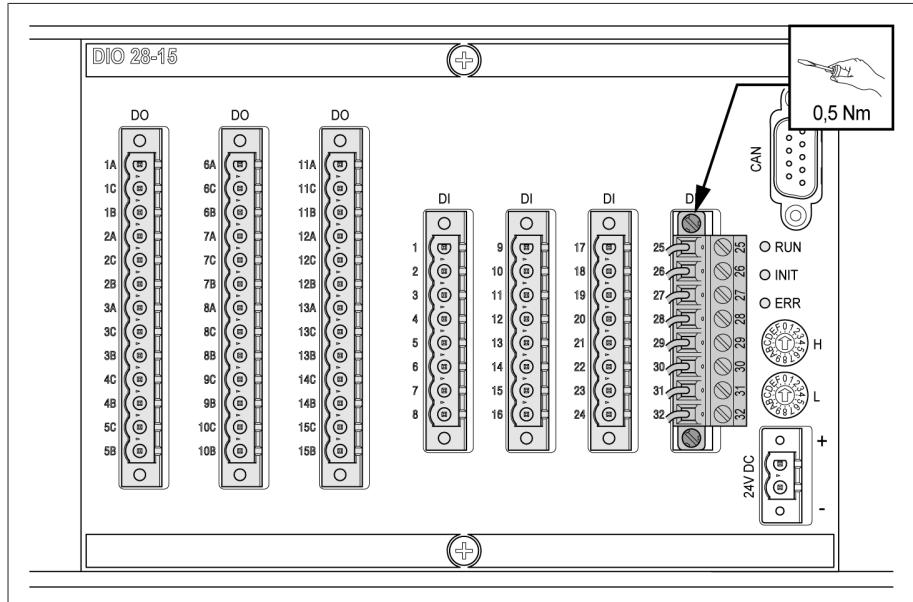


Figure 66: Fastening the plug

6.6.12 Wiring the DIO 42-20 assembly

1. Guide the leads into the plug terminal in accordance with the supplied connection diagram and fasten them using a screwdriver.

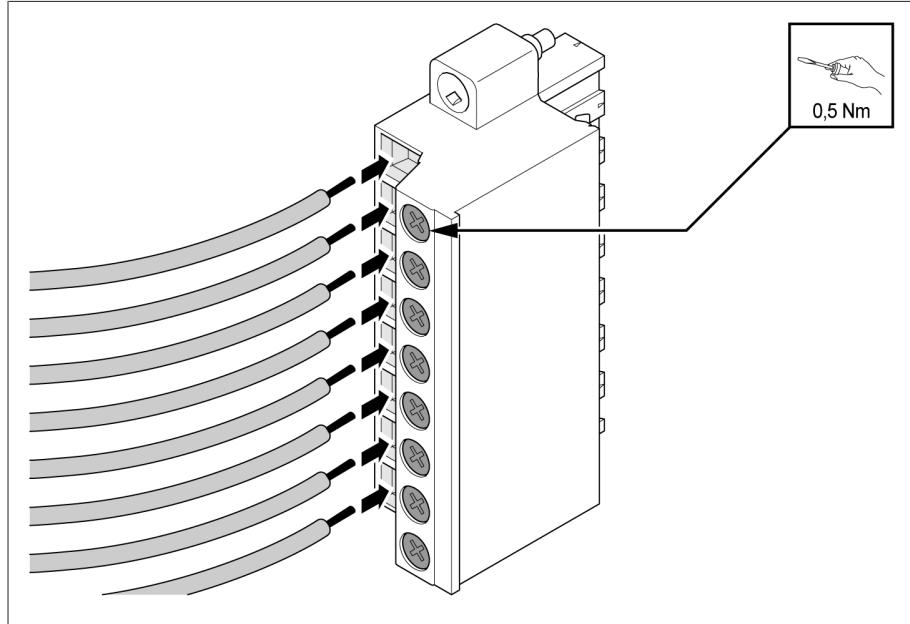


Figure 67: Inserting the leads

2. Insert and screw the plug into the respective slot in accordance with the supplied connection diagram.

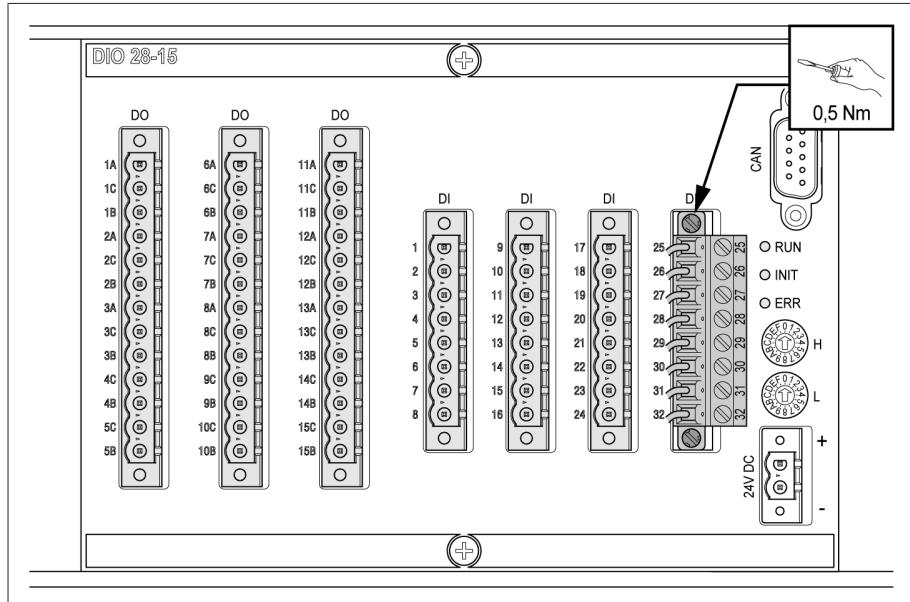


Figure 68: Fastening the plug

6.6.13 Wiring the MC 2-2 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.

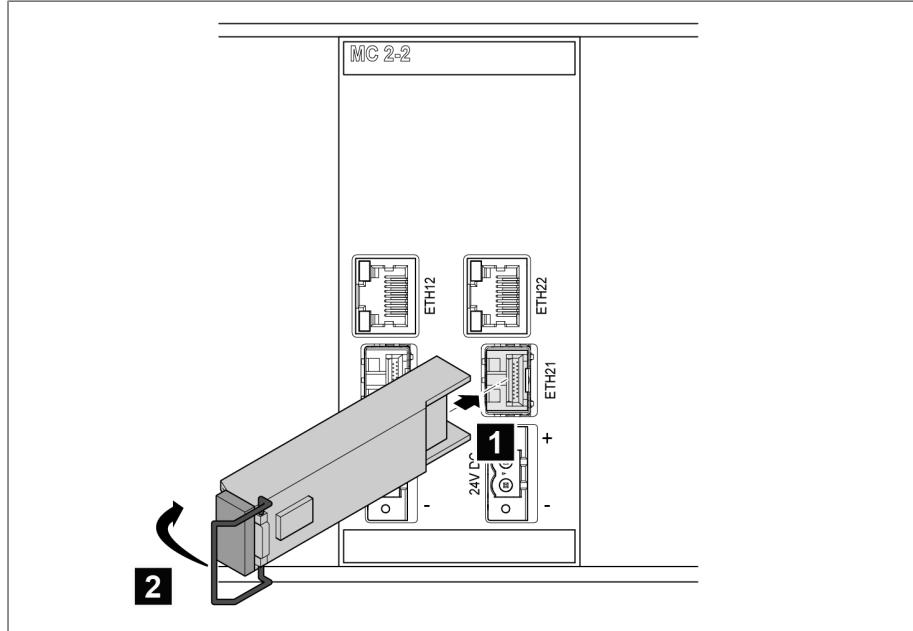


Figure 69: Engaging the SFP module

2. Remove the SFP module dust plug.

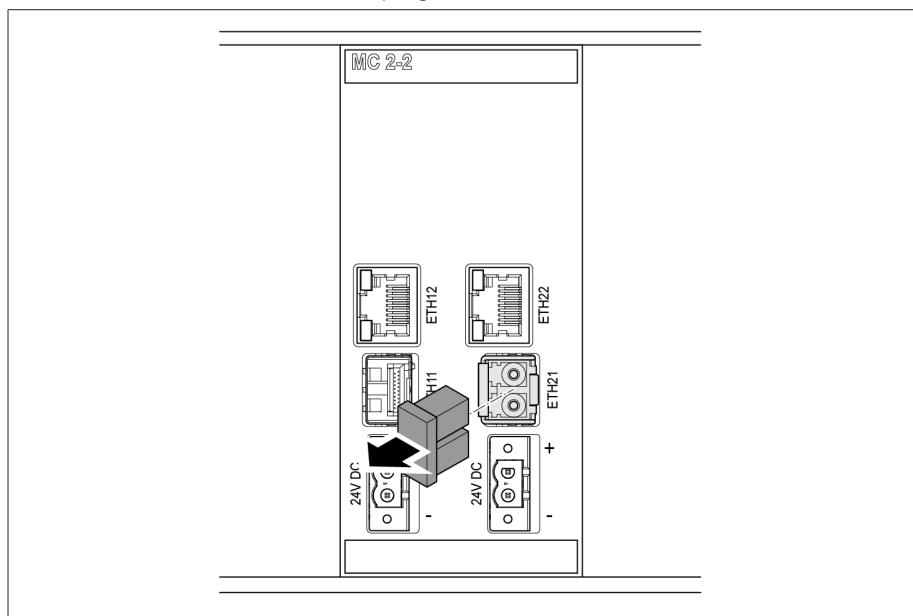


Figure 70: Removing the dust plug

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

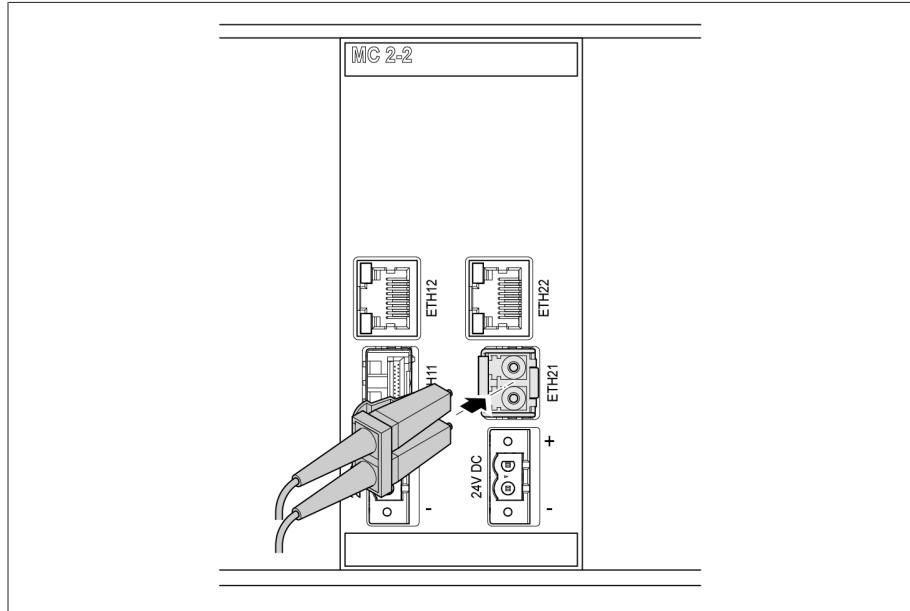


Figure 71: Inserting the fiber-optic cable

4. Insert the network cable.

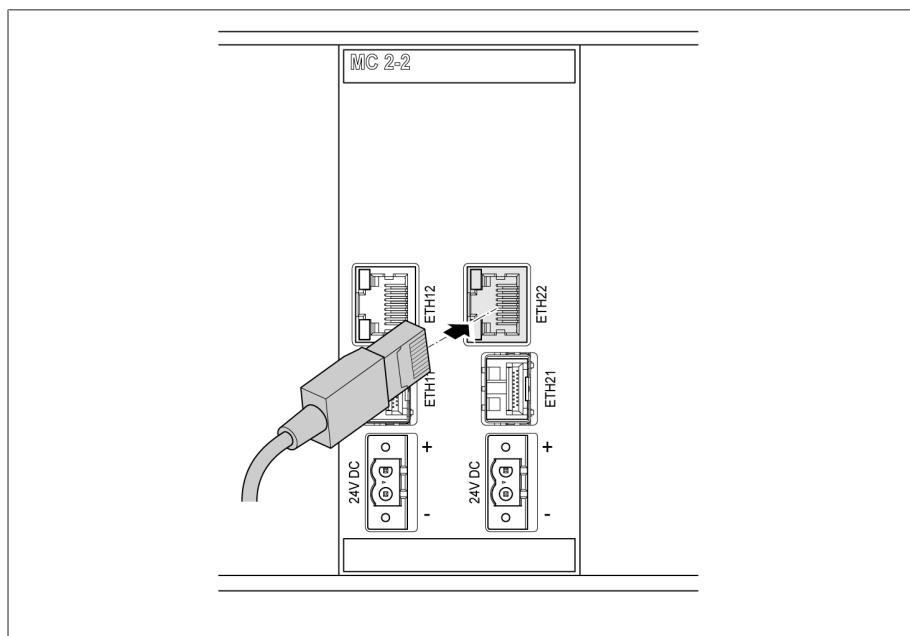


Figure 72: Inserting the network cable

6.6.14 Wiring the 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.

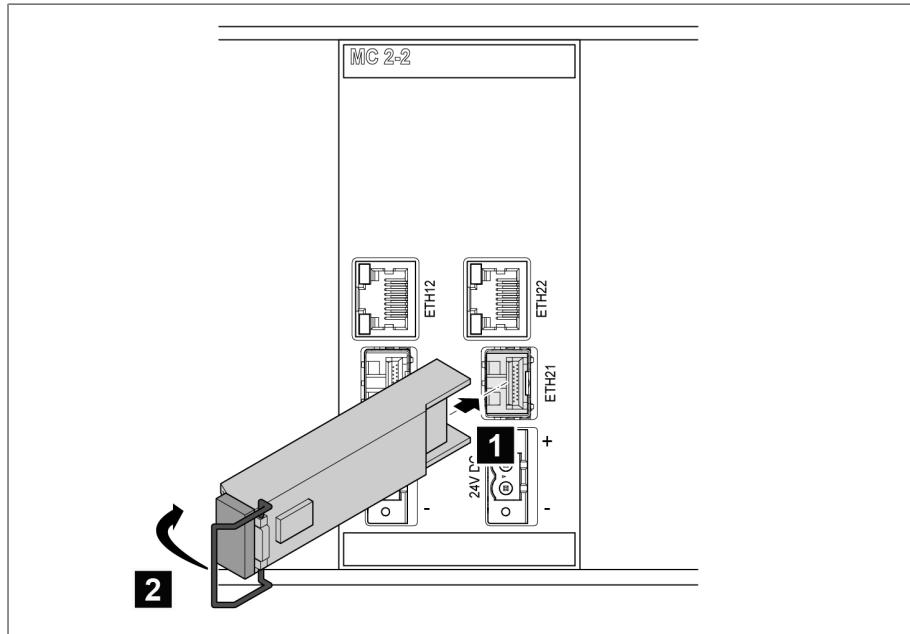


Figure 73: Engaging the SFP module

2. Remove the SFP module dust plug.

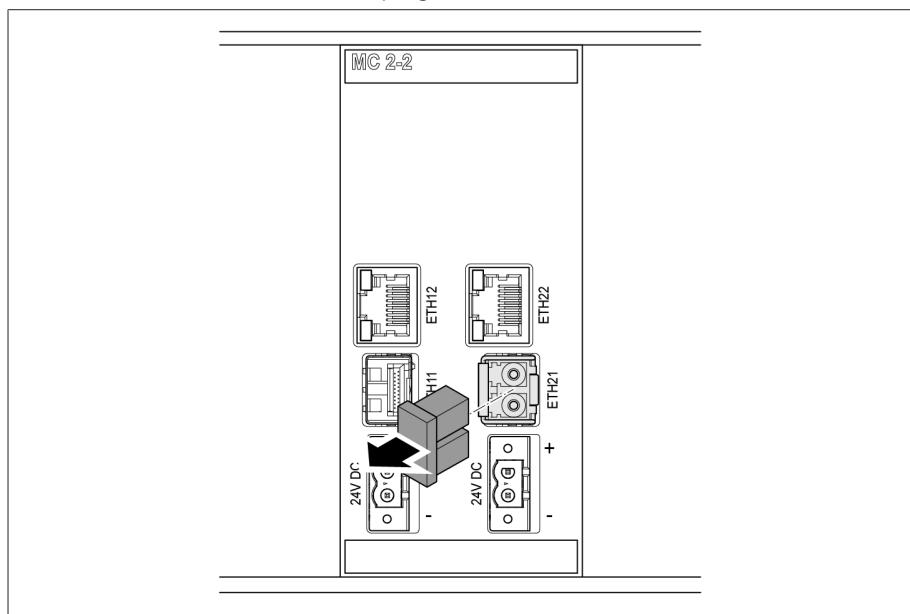


Figure 74: Removing the dust plug

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

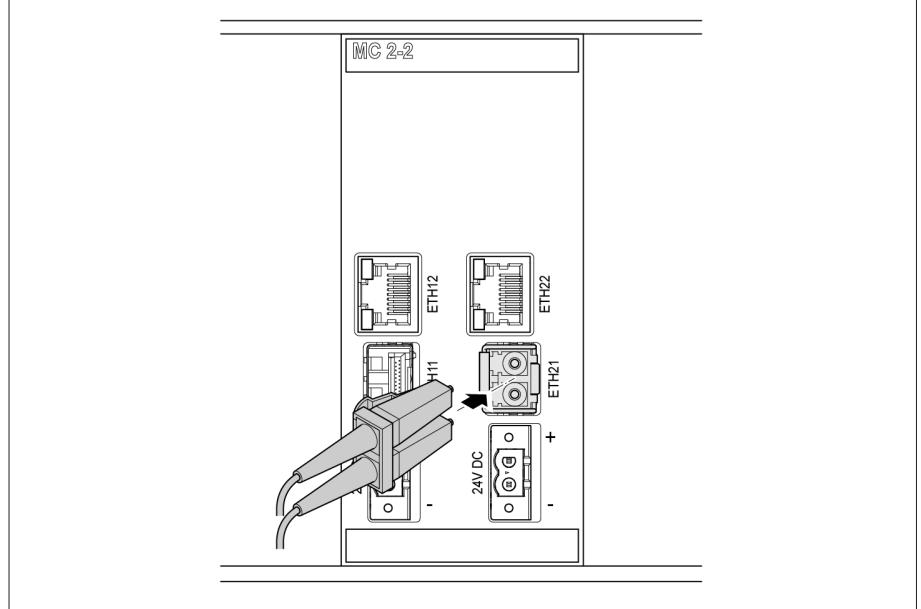


Figure 75: Inserting the fiber-optic cable

4. Insert the network cable.

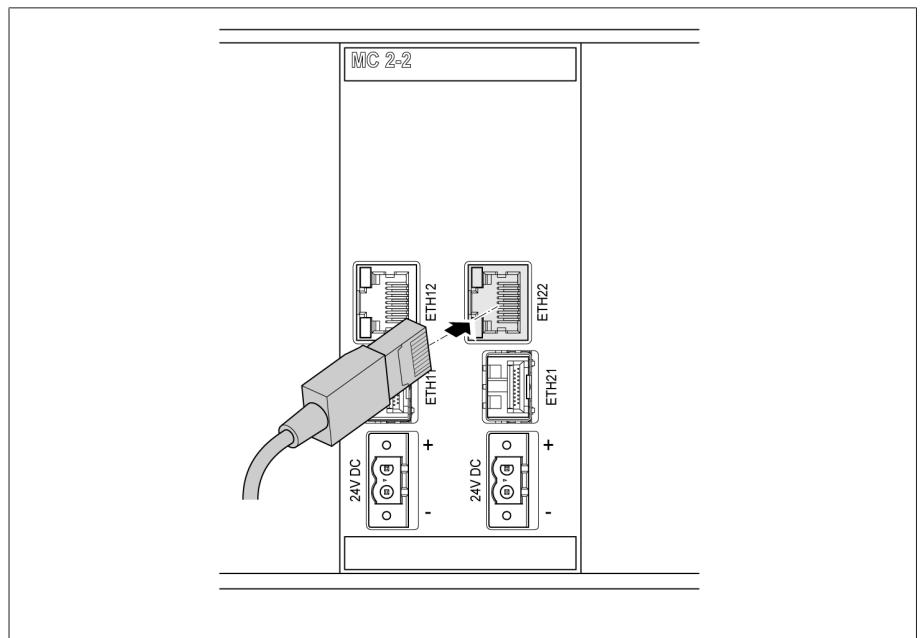


Figure 76: Inserting the network cable

6.6.15 Connecting the power supply

You may only connect the device to circuits with an external overcurrent protection device and an all-pole isolating device, enabling 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 breaker). Note 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 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: 6 to 20 A
- Triggering characteristic: B or C

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 mm² (AWG 15).

Connecting the voltage supply

To connect the voltage supply, proceed as follows:

- › Connect the voltage supply in accordance with the connection diagram provided.

6.7 Checking functional reliability

To ensure that the device is wired correctly, check its functionality.

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.
- › Prior to commissioning, check the supply voltage and the measured voltage.

Check the following:

- Once you have connected the device to the grid, the display shows the MR logo and then the operating screen.
- The *voltage display* LED on the top left of the device's front panel lights up. The device is fully mounted and can be configured. The actions required for this are described in the following chapter.

6.8 Performing tests



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

6.8.1 Ground test

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

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

Proceed as follows to carry out the ground test:

1. Feed the test current at the fixing screw of assembly DIO 28-15 or DIO 42-20 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 over a duration of 1 minute.

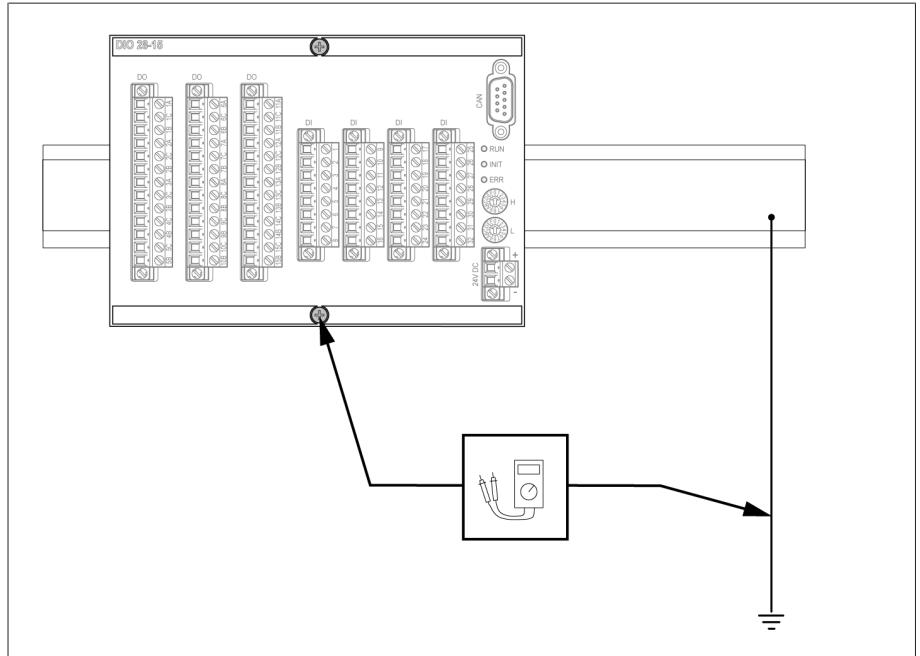


Figure 77: Perform a ground test on the DIO assembly (sample representation of the DIO 28-15 assembly).

2. Feed 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 over a duration of 1 minute.

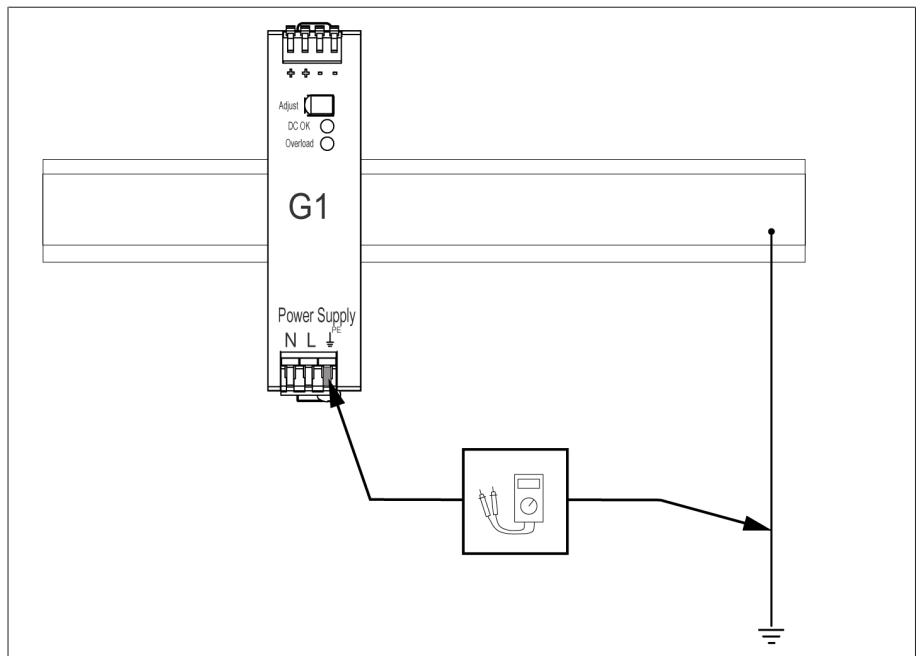


Figure 78: Perform a ground test on the G1 PULS DIMENSION QS3.241 assembly

6.8.2 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
OT1205 (MR/N) ¹	N, L	2.2 kV AC	2 s	5 s	> 10 mA
UI 1	N, L k, l	2.2 kV AC	2 s	5 s	> 4 mA
UI 3	N, L1, L2, L3 k1, l1, k2, l2, k3, l3	2.2 kV AC	2 s	5 s	> 4 mA
UI 5-3, UI 5-4	N, L1, L2, L3 k1, l1, k2, l2, k3, l3	2.2 kV AC	2 s	5 s	> 4 mA
DIO 28-15 DIO 42-20 DIO 42-20 HL	any DI, DO	2.2 kV AC	2 s	5 s	> 1 mA
G1 (PULS)	N, L	2.2 kV AC	2 s	5 s	> 4 mA

Table 20: Permitted interfaces and test parameters for the dielectric test

¹⁾ only the version with 85...265 V AC/V DC wide-range power supply, otherwise the device may be damaged. Note the nameplate.

Sample dielectric test set-up

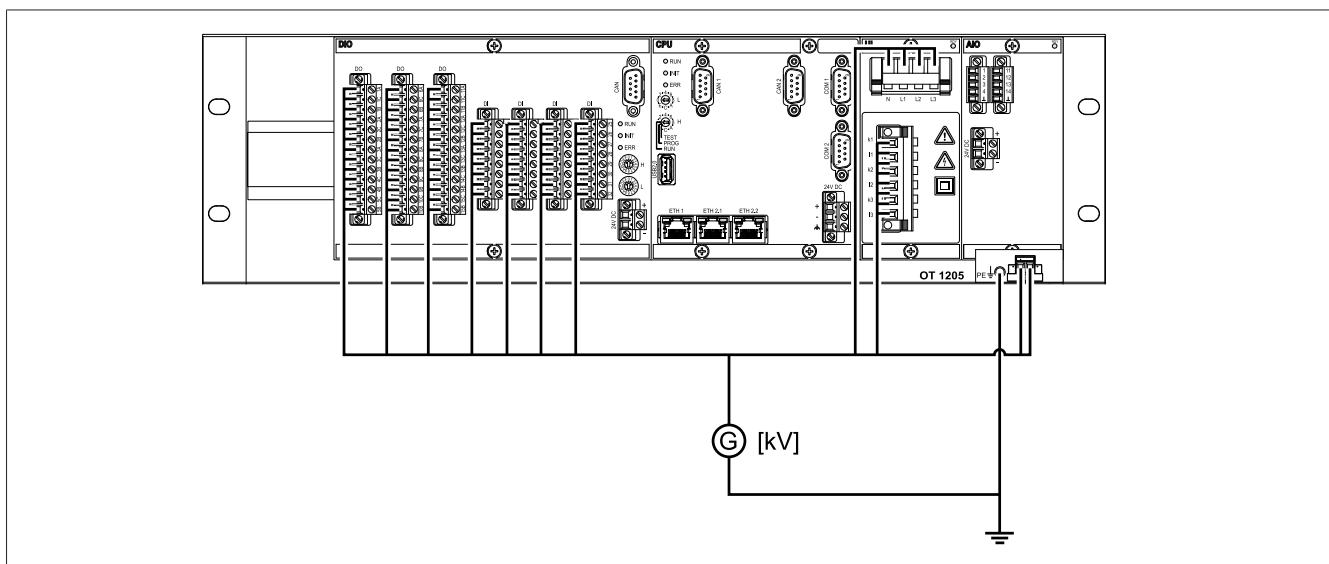


Figure 79: Sample set-up of the dielectric test for a device designed with the OT 1205 wide-range power supply

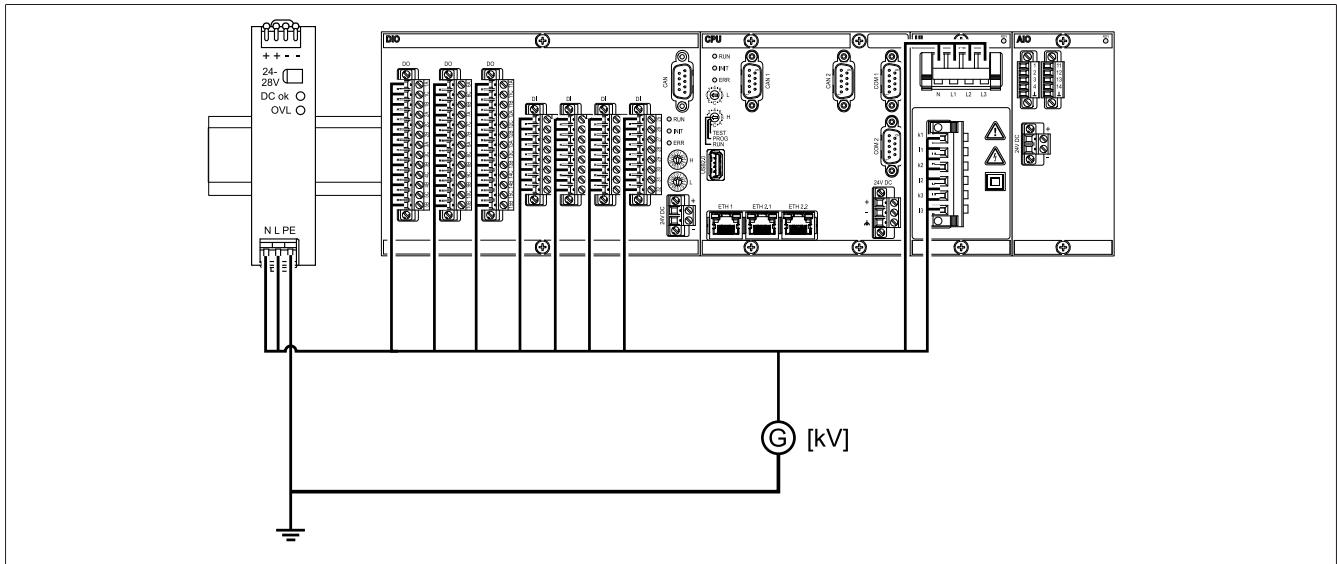


Figure 80: Sample dielectric test set-up for a device designed with the G1 (PULS) power supply

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.

7.1 Establishing connection to visualization

A connection to the visualization can be established as follows:

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

The device is equipped with a DHCP server for connection via the front interface. To establish a connection via the front interface, proceed as follows:

1. Connect the PC and the device via the front interface using an Ethernet cable (RJ45 plug).

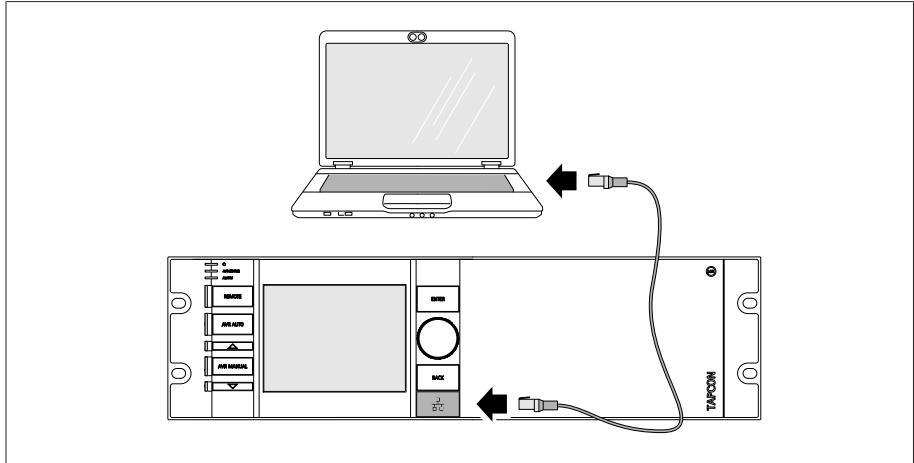


Figure 81: Establishing a connection via the front interface

2. Activate automatic assignment of the IP address via DHCP on the PC.
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 connection via the rear ETH2.2 interface on the CPU I module

To connect via the rear interface, proceed as follows:

1. Connect PC and device via rear ETH2.2 interface using Ethernet cable (RJ45 plug).

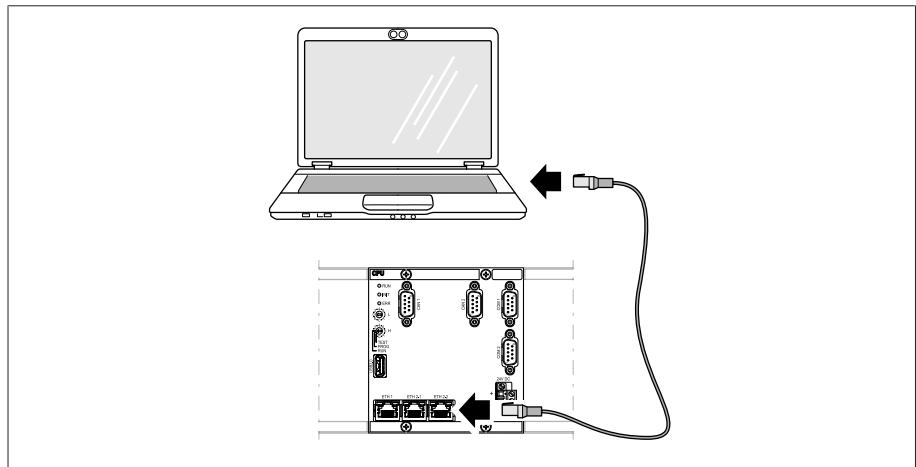


Figure 82: Establishing a connection via the rear ETH2.2 interface

2. Go to **Communication** on the device to display the device's IP address.

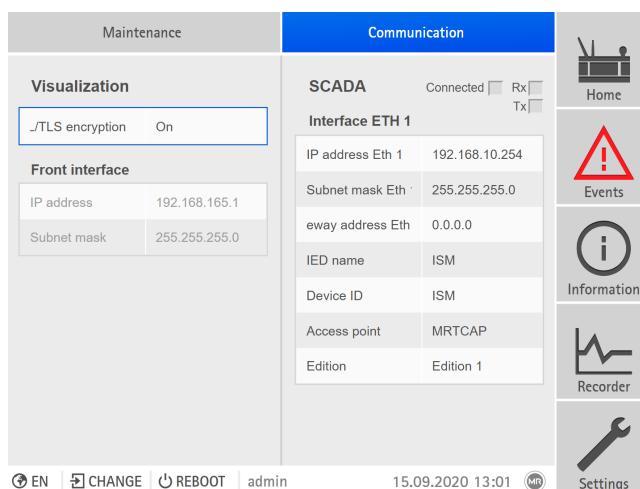


Figure 83: Displaying the Communication menu item

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 (e.g. <http://192.0.1.230>; if SSL encryption is active enter <https://192.0.1.230>) in the browser on the PC.
» The visualization is accessed.

7.2 Setting the language

You can use this parameter to set the display language for the device. Depending on the device configuration, a variety of languages are available.

English	Italian
German	Portuguese
French	Russian

Spanish	Chinese
Korean	Polish

Table 21: Available display languages

1. Select the **Language** button in the status bar, or as an alternative go to **Settings > Parameters > System > General > Language**.

Figure 84: Setting the language

2. Select the desired language from the list field.
3. Press the **Accept** button to save the modified parameter.
» The "Restart device" dialog appears.
4. Restart the device to apply the changed language setting.

7.3 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.

8 Commissioning

You need to set several parameters and perform function tests before commissioning the device. These are described in the following sections.

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.

8.1 Setting date and time

You can set the date and time in the following ways:

- Manually
- Time synchronization via control system (SCADA)
- Time synchronization via SNTP time server

If you are using a control system, the device automatically synchronizes the date and time with the control system. If you would like to use an SNTP time server, you must set the required parameters.

For more information, refer to the information in the section Setting the device time [▶ [Section 9.2.4, Page 86](#)].

8.2 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 80](#)] chapter.



To call up the commissioning wizard, you will need the necessary access rights [▶ [Section 9.2.14, Page 116](#)].

To set the parameters with the help of the commissioning wizard, proceed as follows:

1. Log in as a user with the necessary access rights.
2. Go to **Settings > Commissioning wizard**.

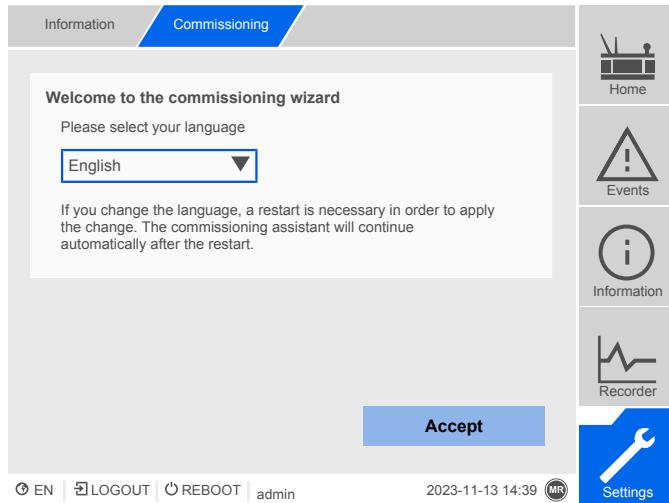


Figure 85: Commissioning wizard

3. Press the **Accept** 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 [▶ Section 8.3, Page 74].

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 must ensure that REMOTE mode is disabled 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 80] 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.

To display the measured values and status of the digital inputs and outputs, proceed as follows:

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 [▶ [Section 6.6, Page 45](#)].

8.3.2 Testing a control function

This section describes how you can check the device's control functions:

- ✓ Supply voltage must be present.
1. Press **AVR MANUAL** to select manual mode.
 2. Set transmission ratio for 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_{actual} reaches the desired voltage $U_{desired}$ ("desired value 1").
 6. Set desired value to the value you want [▶ [Section 9.4.2.1, Page 175](#)].
 7. Set bandwidth depending on step voltage [▶ [Page 185](#)].
 8. Set delay time T1 to 20 seconds [▶ [Page 186](#)].
 9. Set time response T1 to linear [▶ [Page 186](#)].
 10. Press **△** to raise the on-load tap-changer 1 step.
 11. Press **AVR AUTO** to select auto mode.
 - ð 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 **AVR MANUAL** to select manual mode.
 13. Press **▽** to lower the on-load tap-changer 1 step.
 14. Press **AVR AUTO** to select auto mode.
 - ð 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 **AVR MANUAL** to select manual mode.
 16. Set delay time T2 to 10 seconds and activate it [▶ [Page 188](#)].
 17. Press **△** twice to raise the on-load tap-changer 2 steps.
 18. Press **AVR AUTO** to select auto mode.
 - ð 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 **AVR MANUAL** to select manual mode.
 20. Set delay time T1 [▶ [Page 186](#)] and delay time T2 [▶ [Page 188](#)] 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.

8.3.3 Checking parallel operation

This section describes how you can run the function test for parallel operation.

- Requirements** To obtain perfect functioning in parallel operation, the device must be commissioned in independent mode. Make sure that the conditions below have been fulfilled.
- All devices are set to the same operating parameters for "desired value" and "delay time T1" [▶ Page 186].
 - The "Activate parallel operation" [▶ Page 198] parameter is set to **ON**.
 - The desired Parallel operation method is selected.
 - A different CAN bus address [▶ Page 199] ($\neq 0$) is set for all devices.
 - All devices are in the same parallel operation group:
 - With parallel operation detection via group input: A signal is present at the same group input on all devices.
 - With parallel operation detection via topology: The circuit breakers are configured and connected such that the devices participate in parallel operation.

8.3.3.1 Setting circulating reactive current sensitivity

This section describes how you set the circulating reactive current sensitivity to check the function of the "circulating reactive current minimization" parallel operation method.

Note that the following prerequisites must be met for the "circulating reactive current minimization" parallel operation method:

- You have to use current transformers with the same rated values for all transformers in parallel operation.
- If you wish to operate in parallel operation with existing devices, you have to activate the Retrofit TAPCON® 2xx [▶ Section 9.3.8, Page 169] parameter.

Consult the section Circulating reactive current minimization [▶ Section 9.4.4.1.2, Page 193] for more information.

To set the circulating reactive current sensitivity, proceed as follows:

1. Select the "Circulating reactive current" parallel operation method [▶ Page 199].
2. Set circulating reactive current sensitivity to a value of 0% [▶ Page 199].
3. If necessary, activate the Retrofit TAPCON® 2xx function [▶ Section 9.3.8, Page 169].
4. Adjust both transformers in independent mode to the same actual voltage using on-load tap-changers.
5. Connect the transformers in parallel and enable the parallel control.
 - » The status display in the **Parallel operation** menu lights up blue.
 - » The two TAPCON® must be within the bandwidth.
6. Set the desired value of both TAPCON® to the voltage currently measured [▶ Section 9.4.2.1, Page 175].
7. On one of the two transformers, raise the tap position of the on-load tap-changer by one setting; on the second transformer, lower the tap position of the on-load tap-changer by one setting.
 - » The two TAPCON® are still within the bandwidth.
8. Increase the circulating reactive current sensitivity in small steps until the control deviation dU in the main screen is outside the bandwidth (depending on TAPCON® greater than or less than the bandwidth).
9. Press **AVR AUTO** to select auto mode for all TAPCON® units.
 - » All of the TAPCON® units return the on-load tap-changer units to the original tap positions.

- i If an on-load tap-changer does not switch back to its original tap position, you have to increase the circulating reactive current sensitivity.
If one of the on-load tap-changer units switches one or more tap positions higher and the other switches the same amount lower, you need to reduce the circulating reactive current sensitivity.

After you have set the circulating reactive current sensitivity, continue with the function test for the circulating reactive current blocking limit described in the next section.

8.3.3.2 Testing the circulating reactive current blocking limit

This section describes how to run the function test for circulating reactive current blocking.

- ✓ Set the circulating reactive current blocking limit to a value of 20% [► Page 199].

1. Press **AVR MANUAL** on a TAPCON® to select manual mode.
2. Using manual control, adjust the relevant motor-drive unit upwards (for example 1...2 steps) by the maximum permitted tap difference in operating positions between the parallel operating transformers.

- i When setting the circulating reactive current blocking in the following process step, wait approximately 2 to 3 seconds between the individual steps.

3. In the **Parallel operation > Parallel operation method** menu item, set the **circulating reactive current** parallel operation method.
4. Reduce the circulating reactive current blocking limit parameter from the set value of 20% in steps of 1% until the message *Circulating reactive current blocking limit exceeded* is displayed.
 - » Any further regulation is blocked.
 - » After the set delay time for the parallel operation error message has elapsed, the circulating reactive current blocking message is displayed.
5. Increase the circulating reactive current blocking limit parameter again until the message *Circulating reactive current limit exceeded* disappears.
6. Press **AVR AUTO** to select auto mode.
 - » The motor-drive unit automatically returns to the original operating position.
7. Set the value determined for the "circulating reactive current blocking limit" for the TAPCON® units in parallel operation as well.

- i If one TAPCON® or all of the TAPCON® units indicate *Circulating reactive current blocking limit exceeded* even though the control inputs are correctly connected for all TAPCON® units, all of the TAPCON® units block. This could be due to various causes. Further information is given in the chapter Troubleshooting [► Section 11, Page 231].

- » The function test for the circulating reactive current blocking limit is complete.

8.3.3.3 Checking tap synchronization method

This section describes how to run the function test for tap synchronization (master/follower).

i In parallel operation in accordance with the **Automatic tap synchronization** method, the tap positions of the transformers running in parallel are compared. It is therefore necessary that the transformers have the same position designation and that the *Raise* and *Lower* signals produce the same voltage change in all transformers.

NOTICE

Damage resulting from formation of circulating reactive current

If the parameters are not set correctly, damage may result from the formation of circulating reactive current and the resulting overload of transmission lines and transformers.

- > Check transformer nameplate.
- > Set TAPCON® parameters in accordance with the configuration of the transformers.

Before starting the function test, you must carry out the following steps:

1. Assign the master function to one TAPCON® [▶ Page 199].
2. Assign the follower function to the other TAPCON® units.
3. Compare the tap position displays **3** of master **1** and follower **2**. All of the TAPCON® units must display the same tap position. If this is not the case, switch all TAPCON® units to the same tap position.

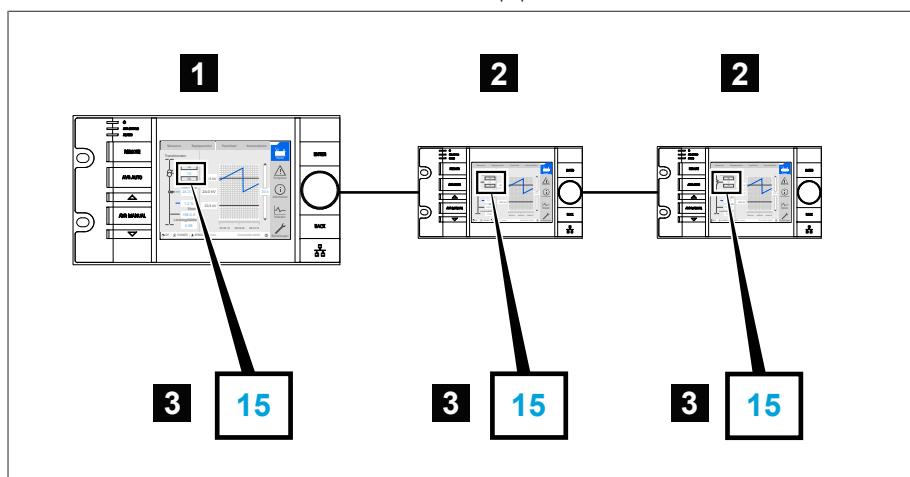


Figure 86: Comparing the tap position

1	Master	3	Tap position display
2	Follower		

To perform the function test, proceed as follows:

1. Press **AVR MANUAL** on the follower to select manual mode.
2. If necessary, set the follower tapping direction.
3. Press **AVR MANUAL** on the master to select manual mode.
4. Press **△** or **▽** on the master to manually change the tap position.
5. Press **AVR AUTO** on the follower to select auto mode.
 - » The follower switches to the same tap position as the master.
6. Press **AVR AUTO** on the master to select auto mode.
7. Press **AVR MANUAL** on the follower to select manual mode.
8. Press **△** or **▽** on the follower to manually change the tap position.
 - » After expiry of the set delay time for parallel operation errors [▶ Page 201], there is a tap difference from the follower to the master.

9. Press  several times on the follower to manually increase the tap position by the number of permitted steps ("Maximum permitted tap difference") and then one further step.
 - » After expiry of the set delay time for parallel operation errors, there is a tap difference to follower on the master.
 - » After expiry of the set delay time for parallel operation errors, there is a tap difference to master on the follower.
10. Press  on the follower to select auto mode.
 - ð There is no response. All devices remain blocked.
11. Press  on the master and follower to select manual mode.
12. Press  or  on the master and follower to manually set the desired step.
 - » The function tests for the tap synchronization method are complete.

Installation and commissioning of the device is complete.

9 Operation

9.1 Carrying out tap-change operation manually

In manual mode, you can manually carry out an on-load tap-changer tap-change operation. To do this, you can choose whether you want to switch 1 motor-drive unit individually (depending on configuration, transformers 1...4) or all motor-drive units at the same time (all transformers).

i To undertake a manual tap-change operation, you will need the necessary access rights [▶ Section 9.2.14, Page 116].

To carry out a tap-change operation manually, proceed as follows:

1. If necessary, press **AVR MANUAL** to activate manual mode.
2. Press and hold down **△** or **▽**.
 - » The transformer selection display appears.
3. Select the desired transformer or all transformers as required.
 - » The tap-change operation is carried out.

9.2 System

9.2.1 General

You can set general parameters in this menu item.

9.2.1.1 Setting general device functions

You can set general device functions with the following parameters.

Settings	Parameters	General
Name	Value	
Language	English	 Home
Commissioning wizard	Yes	 Events
Auto-logout	Off	 Information
Time until auto-logout	15.0 min	 Recorder
Measured value display	Primary values	
Transformer name	Transformer	
Remote behavior	Hardware and SCADA	
USB interface	Off	
Service user access activation	Activated	
SNMP Agent	Off	

 EN |  CHANGE |  REBOOT | admin 14.04.2020 14:22 

Figure 87: General

› Go to **Settings > Parameters > System > General**.

Commissioning wizard

You can use this parameter to set whether the commissioning wizard [▶ Section 8.2, Page 73] 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.

Remote behavior

You can use this parameter to select the behavior of the device in remote operating mode. Depending on the device configuration, you can set the remote behavior as follows:

- Through the visualization (optional)
- By setting the digital inputs (optional)

You can select the following settings:

Setting	Description
Hardware only	The device accepts commands through digital inputs.
SCADA only	The device accepts commands via SCADA.
Hardware and SCADA	The device accepts commands via digital inputs and SCADA.

Table 22: Selecting remote behavior

USB interface

You can use this parameter to deactivate the USB interface. You can select the following options:

- On: USB interface is activated
- Off: USB interface is deactivated

9.2.1.1.1 Temperature unit

You can use this parameter to set whether the device is to display the temperature in degrees Celsius (°C) or degrees Fahrenheit (°F).

9.2.1.2 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 [►Section 9.2.14.3, Page 118] function for a user, then this user will not be automatically logged out.

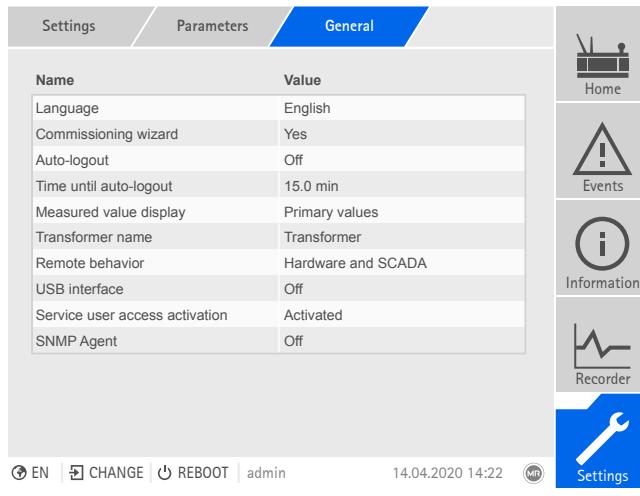


Figure 88: General

› Go to **Settings > Parameters > System > General**.

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.

9.2.1.3 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. To safeguard IT security, only activate service user access for a limited time period for remedying faults.

i 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.

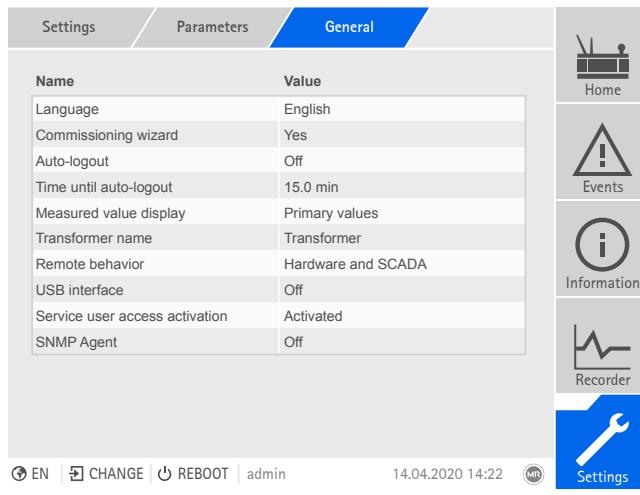


Figure 89: General

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**.
2. Set the parameter.
3. Restart the device to apply the change.

Service user access activation

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

9.2.2 Configuring the network

You can use this menu item to configure the network interfaces of the CPU assembly.

You can only set the parameters for ETH 1 if the device is equipped with the optional control system connection via Ethernet (TCP/IP):

- IEC 61850
- IEC 60870-5-104
- Modbus (Modbus type TCP active)
- DNP3 (DNP3 transmission type TCP active)
- MQTT

You can only set the parameters for ETH 2.2 if the device is equipped with the optional interface for visualization.

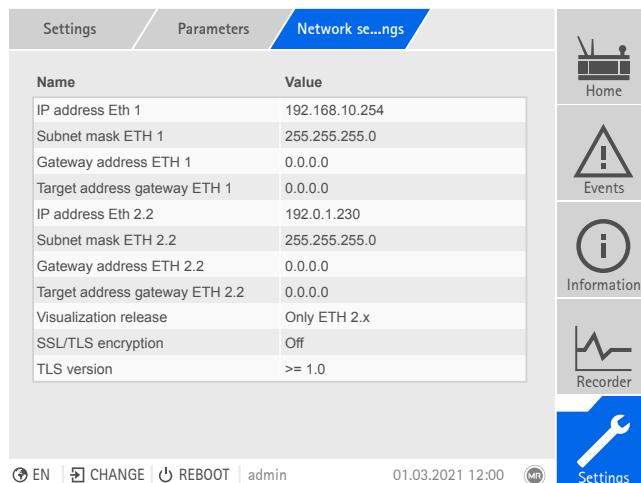


Figure 90: Network settings

> Go to **Settings > Parameters > System > Network settings**.

IP address ETH 1/ETH 2.2

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

i Assign IP addresses to both web-based visualization and SCADA (optional) in different subnets. Otherwise you will not be able to establish a connection.

Subnet mask ETH 1/ETH 2.2

You can use this parameter to set the subnet mask.

i 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 ETH 1/ETH 2.2

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

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

Gateway ETH 1/ETH 2.2 target address

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

Visualization release

You can use this parameter to set the interfaces via which you can access the visualization:

- Only ETH 2.x
- ETH 1 and ETH 2.x

- i** You can only set this parameter if the device is equipped with the optional control system connection via Ethernet (TCP/IP) and the optional interface for visualization.

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
$\geq 1.2^2$	<ul style="list-style-type: none">- 1.2- 1.3
$\geq 1.3^2$	<ul style="list-style-type: none">- 1.3

Table 23: TLS version

Activate DNS (optional)

You can use this parameter to activate DNS for name resolution. If you would like to use the MQTT protocol, you can establish the connection to the MQTT via a DNS server as an option. Also set the parameters necessary for the MQTT [▶ Section 9.2.3, Page 84] protocol.

DNS server (optional)

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

9.2.3 MQTT

You can activate and configure the MQTT message protocol in this menu point. To do so, you must connect the device to an MQTT server (Broker) via Ethernet via the ETH 1 or ETH2.x interface on the CPU assembly. Note that the device will only send messages (publish). The receive messages function is not active.

- i** The device is prepared for communication with the TESSA® server by default.

2 This option can be selected only if the TLS version is supported by the connected peripheral equipment.

There are 2 options available for configuring the protocol:

- Via the IP address of the MQTT server:
 - Enter the IP address as the broker address.
 - It is not necessary to configure a DNS server.
- Via DNS server:
 - Configure the DNS server in "Network settings".
 - Enter the URL as the broker address.

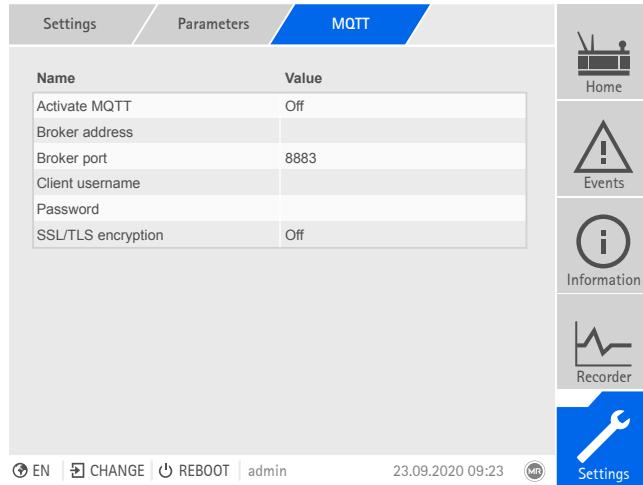


Figure 91: MQTT

- ✓ When using a URL on the broker, it may be necessary to enter and activate [▶ Page 84] the IP address [▶ Page 84] of the DNS server.
 - ✓ If a DNS server is not available, enter the IP address [▶ Page 83] of the MQTT server.
- > Go to **Settings > Parameters > System > MQTT**.

Also refer to

Configuring the network [▶ 83]

Activate MQTT

You can use this parameter to activate the transmission of messages to the MQTT server (broker).

Broker address

If you use a URL address, you can use this parameter to enter the domain name of the MQTT server (broker). Otherwise, you can enter the IP address of the MQTT server.

Broker port

You can use this parameter to set the port of the MQTT server (broker). The following ports are used as standard:

- 8883 (SSL/TLS)
- 1883

Client username (optional)

You can use this parameter to set the client user name for authentication at the broker. When using authentication, you must configure the broker accordingly.

Password (optional)

You can use this parameter to set the password for authentication at the broker. When using authentication, you must configure the broker accordingly.

SSL/TLS encryption

You can use this parameter to set whether the data should be transmitted over an SSL/TLS-encrypted connection.

i Note that an encrypted data transmission does not work if you are using an SSL proxy.

9.2.4 Setting the device time

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

The device displays the date and time in accordance with ISO 8601 as follows:

YYYY-MM-DDThh:mm:ss.000+00:00

YYYY	Year
MM	Month
DD	Day
T	Separator character for time
hh	Hours
mm	Minutes
ss	Seconds
.000	Milliseconds
+00:00	Time shift to UTC

Table 24: Date and time format

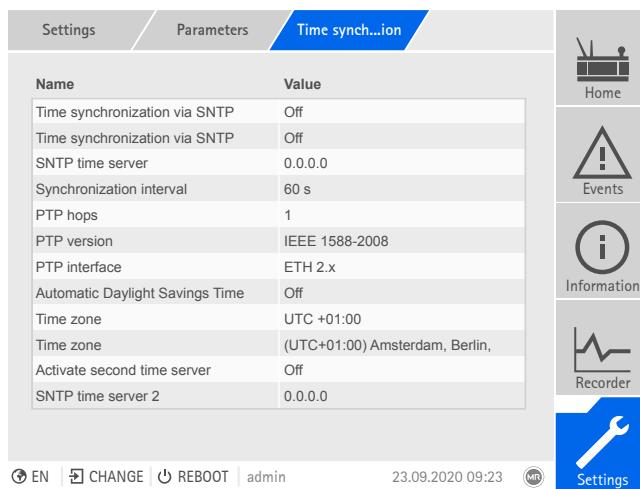


Figure 92: Time synchronization

› Go to **Settings > Parameters > System > Time synchronization**.

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

If the time information is transmitted to the device by a network service (SNTP or SCADA), this time is transferred depending on the set reference time. 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 25: Time shift to UTC (Coordinated Universal Time)

Time

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

SNTP time server 2 (optional)

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

9.2.5 Configuring syslog

The device supports the transmission of log messages via the syslog protocol in accordance with the standards RFC 5424 and RFC 3164.



Figure 93: Syslog

› Go to **Settings > Parameters > System > Syslog**.

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
RFC 3164	UDP	

Table 26: Syslog standard

i If you use the standard RFC 5245 (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 [▶Section 9.2.17.2, Page 124].

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 27: Severity levels

9.2.6 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:

- Switching off the display
- Dimming the brightness of the display

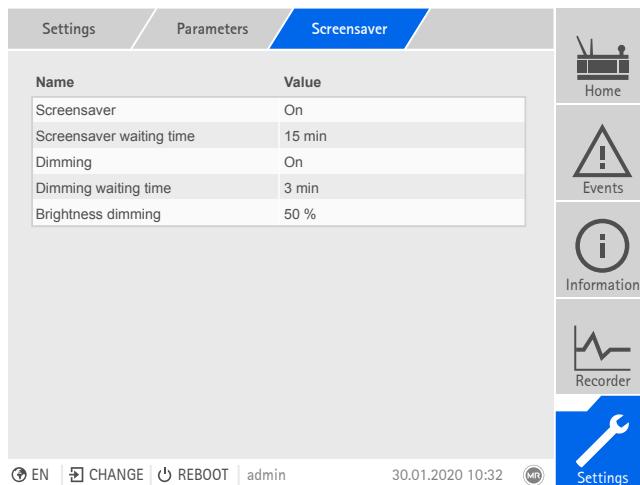


Figure 94: Setting the screensaver

› Go to **Settings > Parameters > System > Screensaver**.

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.

Dimming

When you activate this function, the device reduces the brightness of the display when the adjustable waiting time has expired if no key is pressed. The device then switches back to full brightness when you subsequently press any key.



If the screensaver and brightness dimming are activated, you have to press any key twice in order to reactivate the display at full brightness.

Dimming waiting time

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

Brightness dimming

Setting for the brightness when the display is dimmed. 100% corresponds to full brightness, 10% to the lowest brightness.

9.2.7 SCADA

The following section describes how you can configure the device to connect to a control system (SCADA). You can download the data points with the help of the export manager [▶ Section 9.2.17, Page 122].

9.2.7.1 Configuring IEC 61850 (optional)

If you want to use the IEC 61850 control system protocol, you must set the following parameters. Also refer to the section Configuring the network [▶ Section 9.2.2, Page 83].

› Go to **Settings > Parameters > System > IEC 61850**.

IED name

You can use this parameter to assign the device an IED name in order for it to be identified in the IEC 61850 network.

9.2.7.1.1 Downloading an ICD file

You can download the ICD file from the device via the Import/Export Manager [▶ Section 9.2.17, Page 122]. To do this, you have to establish an Ethernet connection between the device and your PC.

9.2.7.2 Configuring IEC 60870-5-101 (optional)

If you want to use the IEC 60870-5-101 control system protocol, you must set the following parameters.

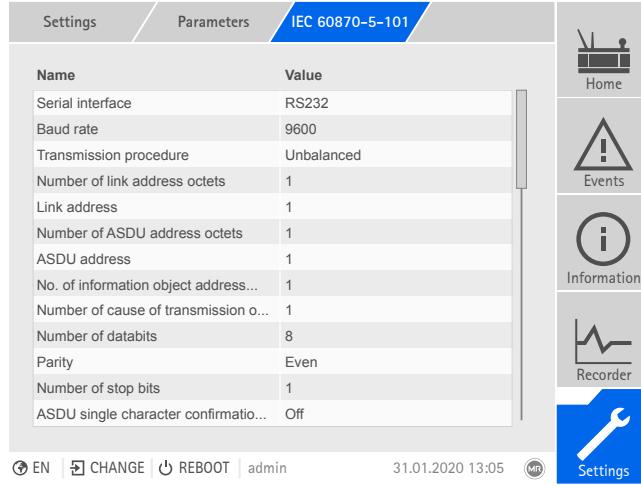


Figure 95: IEC 60870-5-101

> Go to **Settings > Parameters > System > IEC 60870-5-101**.

Serial interface

You can use this parameter to select the serial interface for data transmission.

You can select the following options:

- RS232
- RS485

Baud rate

You can use this parameter to set the serial interface's baud rate. You can select the following options:

- 9600 baud
- 19200 baud
- 38400 baud
- 57600 baud
- 115200 baud

Transmission procedure

You can use this parameter to set the transmission procedure. You can select the following options:

- Unbalanced transmission
- Balanced transmission

Number of link address octets

You can use this parameter to set how many octets are provided for the link address.

Link address

You can use this parameter to set the link address.

Number of ASDU address octets

You can use this parameter to set how many octets are provided for the ASDU address.

ASDU address

You can use this parameter to set the address of the ASDU.

No. of information object address octets

You can use this parameter to set how many octets are provided for the information object address.

Number of cause of transmission octets

You can use this parameter to set how many octets are provided for the cause of transmission.

Number of data bits

You can use this parameter to set the number of databits.

Parity

You can use this parameter to set the parity. You can select the following options:

- None
- Even
- Odd

Number of stop bits

You can use this parameter to set the number of stop bits.

ASDU single character confirmation

You can use this parameter to set whether a confirmation is to be sent as single characters instead of as a complete message. Single character confirmation is only possible for requesting data of class 2 (Class 2 Request).

ASDU sequence optimization

With this parameter, you can set which method is to be used for optimizing the ASDU types. The standard enables optimization in order to be able to transfer multiple value changes in a telegram in a sequence of ascending information object addresses. This is displayed by the sequence bit. The selection of ASDU types for which this optimization is allowed is based on the edition of the standard.

You can select the following options:

Option	Description
None	The device does not optimize the ASDU types.
Ed. 1	Optimization in accordance with IEC 60870 Edition 1 (type 1, 3, 9, 11, 21, 126).
Ed. 1 Amendment 2	Optimization in accordance with IEC 60870 Edition 1, Amendment 2 (type 1, 3, 9, 11, 13, 15 21, 126).
Ed. 2	Optimization in accordance with IEC 60870 Edition 2 (type 1, 3, 5, 7, 9, 11, 13, 15, 20, 21, 126).

Table 28: ASDU sequence optimization

9.2.7.3 Configuring IEC 60870-5-103 (optional)

If you want to use the IEC 60870-5-103 control system protocol, you must set the following parameters.

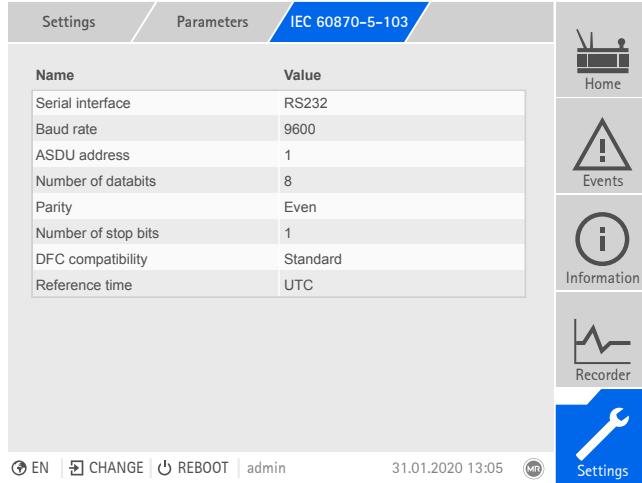


Figure 96: IEC 60870-5-103

› Go to **Settings > Parameters > System > IEC 60870-5-103**.

Serial interface

You can use this parameter to select the serial interface for data transmission.

You can select the following options:

- RS232
- RS485

Baud rate

You can use this parameter to set the serial interface's baud rate. You can select the following options:

- 9600 baud
- 19200 baud
- 38400 baud
- 57600 baud
- 115200 baud

ASDU address

You can use this parameter to set the address of the ASDU.

Number of data bits

You can use this parameter to set the number of databits.

Parity

You can use this parameter to set the parity. You can select the following options:

- None
- Even
- Odd

Number of stop bits

You can use this parameter to set the number of stop bits.

DFC compatibility

You can use this parameter to set how the device is to use the DFC bit (Data Flow Control) in the control field. You can select the following options:

Option	Description
Standard	The device sets the DFC bit in each response to a command. The device thus indicates that the master may not send any further commands. The master must react to the ACD bit (Access Demand) and retrieve the response to the command e.g. via a request for data of class 1 from the slave queue.
Alternative	The device sets the DFC bit in a response if a second command is received without the master having previously sent a request for data of class 1.

Table 29: DFC compatibility

9.2.7.4 Configuring IEC 60870-5-104 (optional)

If you want to use the IEC 60870-5-104 control system protocol, you must set the following parameters. Also refer to the section Configuring the network [▶ [Section 9.2.2, Page 83](#)].

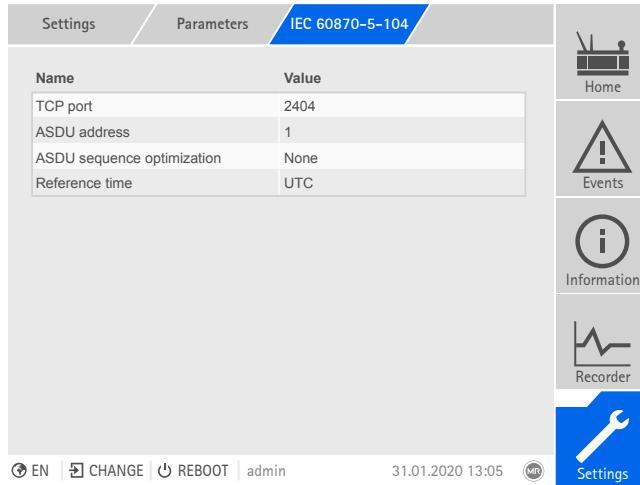


Figure 97: IEC 60870-5-104

› Go to **Settings > Parameters > System > IEC 60870-5-104**.

TCP port

You can use this parameter to set the TCP port.

ASDU address

You can use this parameter to set the address of the ASDU.

ASDU sequence optimization

With this parameter, you can set which method is to be used for optimizing the ASDU types. The standard enables optimization in order to be able to transfer multiple value changes in a telegram in a sequence of ascending information object addresses. This is displayed by the sequence bit. The selection of ASDU types for which this optimization is allowed is based on the edition of the standard.

You can select the following options:

Option	Description
None	The device does not optimize the ASDU types.
Ed. 1	Optimization in accordance with IEC 60870 Edition 1 (type 1, 3, 9, 11, 21, 126).
Ed. 1 Amendment 2	Optimization in accordance with IEC 60870 Edition 1, Amendment 2 (type 1, 3, 9, 11, 13, 15 21, 126).
Ed. 2	Optimization in accordance with IEC 60870 Edition 2 (type 1, 3, 5, 7, 9, 11, 13, 15, 20, 21, 126).

Table 30: ASDU sequence optimization

IP address Client 1/2/3 (optional)

If you use the optional "Multi-client" function, you can use these parameters to set the IP addresses of the SCADA clients. The device only accepts commands through the control system from end devices that have their IP addresses set here.

i Note that all SCADA clients communicate with the device on an equal basis, because the device does not prioritize commands. If you transmit commands from several SCADA clients to the device at the same time, the device will execute the last transmitted command.

9.2.7.5 Configuring Modbus (optional)

If you want to use the Modbus control system protocol, you must set the corresponding parameters depending on the Modbus type selected. Also refer to the section Configuring the network [▶ Section 9.2.2, Page 83] if you want to use Modbus TCP.

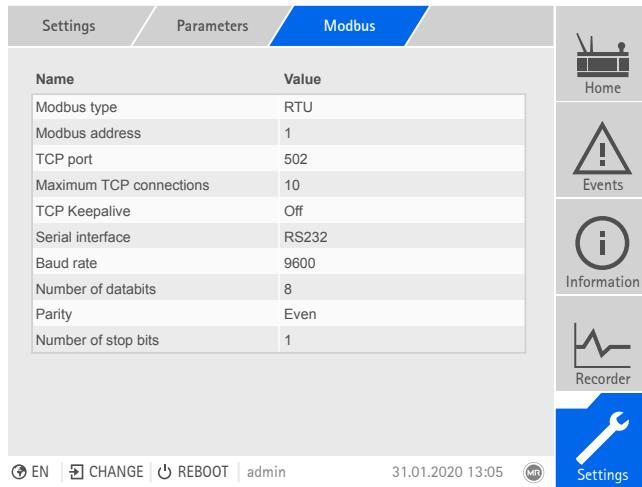


Figure 98: Modbus

› Go to **Settings > Parameters > System > Modbus**.

Modbus type

You can use this parameter to set the Modbus type. You can select the following options:

- RTU
- TCP

Modbus address

You can use this parameter to set the Modbus address.

TCP port

You can use this parameter to set the TCP port.

Serial interface

You can use this parameter to select the serial interface for data transmission.

You can select the following options:

- RS232
- RS485

Baud rate

You can use this parameter to set the serial interface's baud rate. You can select the following options:

- 9600 baud
- 19200 baud
- 38400 baud
- 57600 baud
- 115200 baud

Number of data bits

You can use this parameter to set the number of databits.

Parity

You can use this parameter to set the parity. You can select the following options:

- None
- Even
- Odd

Number of stop bits

You can use this parameter to set the number of stop bits.

9.2.7.6 Configuring DNP3 (optional)

If you would like to use the DNP3 control system protocol, you must set the parameters listed below. Also refer to the section Configuring the network [▶ Section 9.2.2, Page 83] if you want to use the DNP3 via TCP.

Settings	Parameters	DNP3	
			 Home
			 Events
			 Information
			 Recorder
			 Settings
Name	Value		
DNP3 transmission type	TCP		
TCP port	20000		
Device address	1		
Timeout for response confirmation	5 s		
Unsolicited messages	Off		
Destination address	10000		
Timeout confirmation	5 s		
Indefinite unsolicited retries	Off		
Number of unsolicited retries	3		
User ID code	ISM		
Reference time	UTC		

EN | CHANGE | REBOOT | admin

31.01.2020 13:05



Figure 99: DNP3

Go to **Settings > Parameters > System > DNP3**.

9.2.7.6.1 DNP3 transmission type

You can use this parameter to set the transmission type. You can select the following options:

- TCP
- Serial

TCP port

You can use this parameter to set the TCP port.

Serial interface

You can use this parameter to select the serial interface for data transmission.

You can select the following options:

- RS232
- RS485

Baud rate

You can use this parameter to set the serial interface's baud rate. You can select the following options:

- 9600 baud
- 19200 baud
- 38400 baud
- 57600 baud
- 115200 baud

Device address

You can use this parameter to set the device link address.

Destination address

You can use this parameter to set the destination master link address.

Unsolicited messages

You can use this parameter to set whether the device is to support unsolicited messages. If you activate unsolicited messages, the device sends a message via the control system every time a value is changed.

Repetition of unsolicited messages

You can use this parameter to set how often the device is to send an unsolicited message until it receives a response from the DNP3 master.

Timeout

You can use this parameter to set the timeout for unsolicited messages.

Timeout for response confirmation

You can use this parameter to set the timeout for response confirmation for unsolicited messages.

9.2.7.7 Configure data points (optional)

You can use the optional "Configure data points" function to adjust the control system data points of the device. You can only configure the data points on a PC using the web-based visualization.

9.2.7.7.1 Configuring IEC 60870-5-101 data points

You can adjust the following data point properties for the IEC 60870-5-101 control system protocol:

Column	Description	Modifiable	Setting range
Active	You can use the checkbox to set whether the data point is to be transferred via the control system protocol or not.	Yes	Active/inactive
IOA	Data point address. The setting range is based on the setting for the "Octet number of information object address" parameter (octet 2 or 3).	Yes	Octet 2: 1...65535 Octet 3: 1...16777215
Name	Data point designation.	No	-
Type	Data point type.	No	-
Group	Data point group or groups. You must enter the group membership as a binary code (5 bits). A maximum of 5 groups is possible. Example: <ul style="list-style-type: none"> - 00000: belongs to no groups - 00001: group 1 - 01000: group 4 - 01001: group 1 and group 4 	Yes	00000...11111
INTG	The value indicates whether the data point is to be included in a general query (1) or not (0).	Yes	0, 1
TH	Threshold value for measured values. The data point is only transferred again if the change of value is greater than the threshold value. <ul style="list-style-type: none"> - If you enter the value 0, no threshold value is active. - If you do not enter any value, the device adopts the threshold value defined by the device parameter. If no device parameter is available for the threshold value, no threshold value is active either. - Notice: You can only enter a threshold value for data points of type 9, 10, 11, 12, 13, 14, 21, 34, 35 or 36. 	Yes	0...32768
CT	Interval in ms for periodic transmission of the data point. If you set 0, the data point is not transmitted periodically. Notice: You can only enter an interval for data points of type 9, 11 or 13.	Yes	0...10000

Table 31: Configuring IEC 60870-5-101 data points

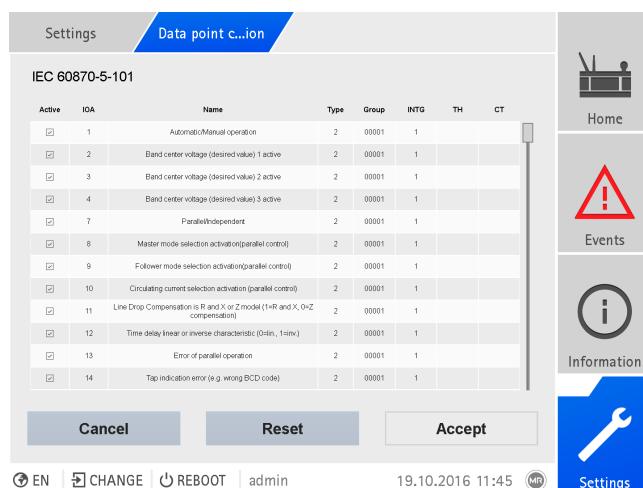


Figure 100: Configuring IEC 60870-5-101 data points

1. Go to **Settings > Data point configuration**.
2. Adjust the data points as required.
3. Press the **Accept** button to adopt the modified list of data points.
4. Restart the device to activate the modified list of data points.

9.2.7.7.2 Configuring IEC 60870-5-103 data points

You can adjust the following data point properties for the IEC 60870-5-103 control system protocol:

Column	Description	Modifiable	Setting range
Active	You can use the checkbox to set whether the data point is to be transferred via the control system protocol or not.	Yes	Active/inactive
TYP	Data point type code.	No	-
FUN	Data point function type. Notice: You can only use function type 254 for data points with type code 10 or 11.	Yes	0...255
INF	Data point information number. Notice: You can only use information number 0 for data points with function type 254.	Yes	0...255
GIN	Data point generic identification number. Notice: You can only use generic identification number 0 for data points with a function type other than 254.	Yes	0...65535
Data Type	Data point data type.	No	-
Name	Data point designation.	No	-
Interrogation	The value indicates whether the data point is to be included in a general query (1) or not (0).	Yes	0, 1
Threshold	Threshold value for measured values. The data point is only transferred again if the change of value is greater than the threshold value. <ul style="list-style-type: none"> - If you enter the value 0, no threshold value is active. - If you do not enter any value, the device adopts the threshold value defined by the device parameter. If no device parameter is available for the threshold value, no threshold value is active either. 	Yes	0...1000000000

Table 32: Configuring IEC 60870-5-103 data points

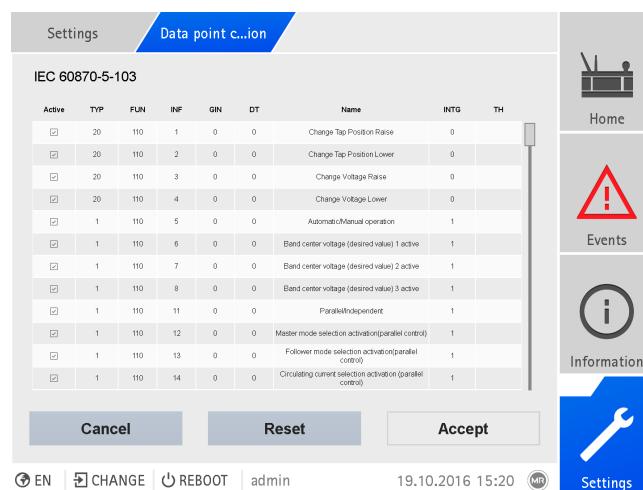


Figure 101: Configuring IEC 60870-5-103 data points

1. Go to **Settings > Data point configuration**.
2. Adjust the data points as required.
3. Press the **Accept** button to adopt the modified list of data points.
4. Restart the device to activate the modified list of data points.

9.2.7.7.3 Configuring IEC 60870-5-104 data points

You can adjust the following data point properties for the IEC 60870-5-104 control system protocol:

Column	Description	Modifiable	Setting range
Active	You can use the checkbox to set whether the data point is to be transferred via the control system protocol or not.	Yes	Active/inactive
IOA	Data point address.	Yes	1...16777215
Name	Data point designation.	No	-
Type	Data point type.	No	-
Group	Data point group or groups. You must enter the group membership as a binary code (5 bits). A maximum of 5 groups is possible. Example: <ul style="list-style-type: none"> - 00000: belongs to no groups - 00001: group 1 - 01000: group 4 - 01001: group 1 and group 4 	Yes	00000...11111
INTG	The value indicates whether the data point is to be included in a general query (1) or not (0).	Yes	0, 1
TH	Threshold value for measured values. The data point is only transferred again if the change of value is greater than the threshold value. <ul style="list-style-type: none"> - If you enter the value 0, no threshold value is active. - If you do not enter any value, the device adopts the threshold value defined by the device parameter. If no device parameter is available for the threshold value, no threshold value is active either. <p>Notice: You can only enter a threshold value for data points of type 9, 10, 11, 12, 13, 14, 21, 34, 35 or 36.</p>	Yes	0...32768
CT	Interval in ms for periodic transmission of the data point. If you set 0, the data point is not transmitted periodically. <p>Notice: You can only enter an interval for data points of type 9, 11 or 13.</p>	Yes	0...10000

Table 33: Configuring IEC 60870-5-104 data points

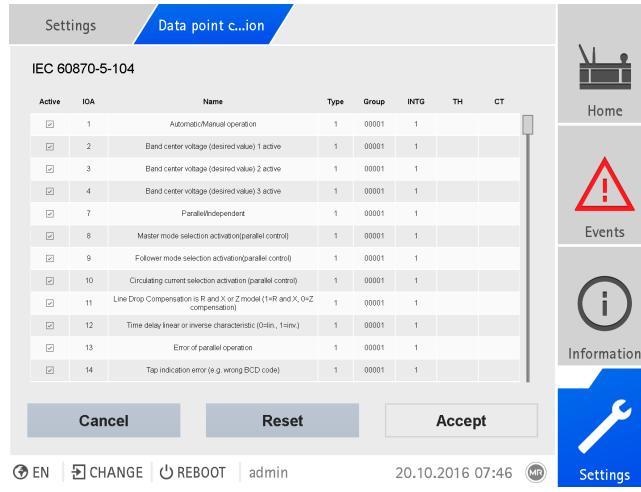


Figure 102: Configuring IEC 60870-5-104 data points

1. Go to **Settings > Data point configuration**.
2. Adjust the data points as required.
3. Press the **Accept** button to adopt the modified list of data points.
4. Restart the device to activate the modified list of data points.

9.2.7.7.4 Configuring Modbus data points

You can adjust the following data point properties for the Modbus control system protocol:

Column	Description	Modifiable	Setting range
Active	You can use the checkbox to set whether the data point is to be transferred via the control system protocol or not.	Yes	Active/inactive
Type	Data point type	No	-
Index1	Data point address	Yes	0...65535
Index2	Optional second data point address. This is used automatically for data points able to transfer values greater than 16 bits. Please note that the Index2 address always follows on from the Index1 address exactly.	No	-
Name	Data point designation	No	-

Table 34: Configuring Modbus data points

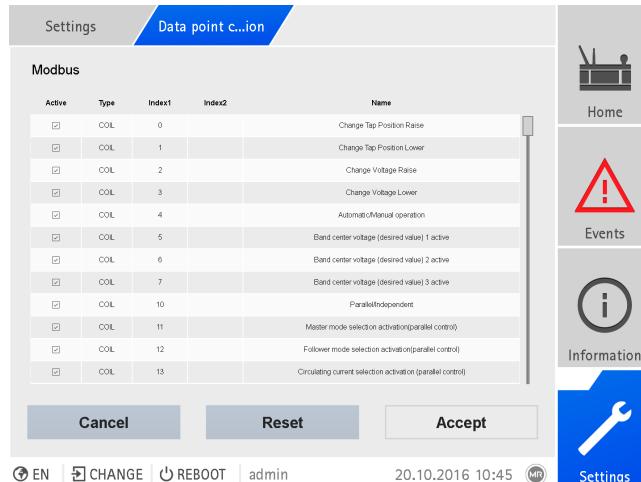


Figure 103: Configuring Modbus data points

1. Go to **Settings > Data point configuration**.
2. Adjust the data points as required.

3. Press the **Accept** button to adopt the modified list of data points.
4. Restart the device to activate the modified list of data points.

9.2.7.7.5 Configuring DNP3 data points

You can adjust the following data point properties for the DNP3 control system protocol:

Column	Description	Modifiable	Setting range
Active	You can use the checkbox to set whether the data point is to be transferred via the control system protocol or not.	Yes	Active/inactive
OBJGROUP	The OBJGROUP column indicates the data point object group: - AI = Analog Input - AO = Analog Output - BI = Binary Input - BO = Binary Output - CT = Counter	No	-
INDEXADDR	Data point address.	Yes	0...4294967296
CLASS	Data point class. - 0: Static - 1...3: Event Notice: You can only set the data point class for data points of object groups AI, BI, and CT.	Yes	0...3
PREFSTATICVAR	For a data point of class 0 (Static), you can define the following variation depending on the object group: - BI: 1, 2 - BO: 2 - AI: 2, 4 - AO: 2 - CT: 1, 2, 5, 6	Yes	0...6
PREFEVENTVAR	For a data point of classes 1...3 (Event), you can define the following variation depending on the object group: - BI: 1, 2, 3 - BO: no value - AI: 2, 4 - AO: no value - CT: 1, 2, 5, 6	Yes	0...6
NAME	Data point designation.	No	-
Deadband	Threshold value for analog inputs. The data point is only transferred again if the change of value is greater than the threshold value. - If you enter the value 0, no threshold value is active. - If you do not enter any value, the device adopts the threshold value defined by the device parameter. If no device parameter is available for the threshold value, no threshold value is active either. Notice: The threshold value has the same unit as the data point value. Take note of the list of data points.	Yes	0...32768

Table 35: Configuring DNP3 data points

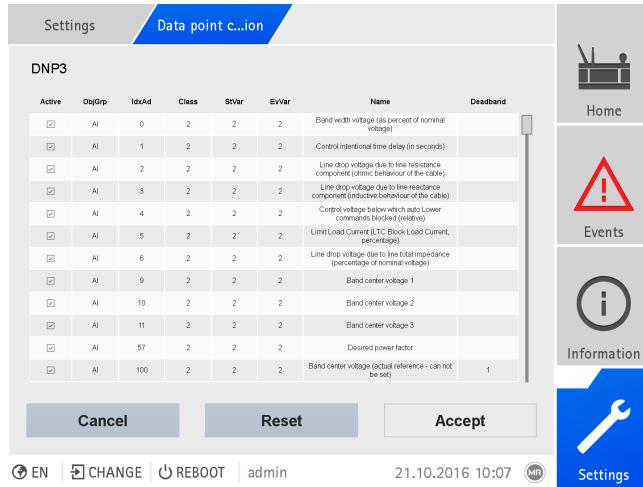


Figure 104: Configuring DNP3 data points

1. Go to **Settings > Data point configuration**.
2. Adjust the data points as required.
3. Press the **Accept** button to adopt the modified list of data points.
4. Restart the device to activate the modified list of data points.

9.2.7.7.6 Resetting the data point configuration to factory settings

If you want to reset the data point configuration to factory settings, proceed as follows:

1. Go to **Settings > Data point configuration**.
2. Press the **Reset** button.
» The message **Reset** appears.
3. Press the **Yes** button to reset the data point configuration to the factory settings.
4. Restart the device to activate the modified list of data points.

9.2.7.7.7 Exporting and importing the data point configuration

You can export the data point configuration, e.g., to back it up or import it into another device. You will find more information in the Import/Export Manager [▶ Section 9.2.17, Page 122] section.

9.2.8 Displaying current measured values

The current measured values can be displayed on the measured value screen. Note that the displayed measured values may differ from the raw values displayed in the information display of the UI assembly. The measured values are prepared for the measured value display by the device as follows:

- The tap-change operation set for the current transformer and voltage transformer is taken into account, as is a corresponding phase displacement.
- The UI assemblies use the generator sign convention. The device displays the measured values using the load sign convention.

- | You can change the measured value display to the generator sign convention by activating the Retrofit TAPCON® 2xx [▶ Section 9.3.8, Page 169] parameter.

The following measured values are displayed:

- Voltage
- Current
- Power factor ($\cos \phi$)
- Frequency
- Reactive power

- Active power
- Apparent power

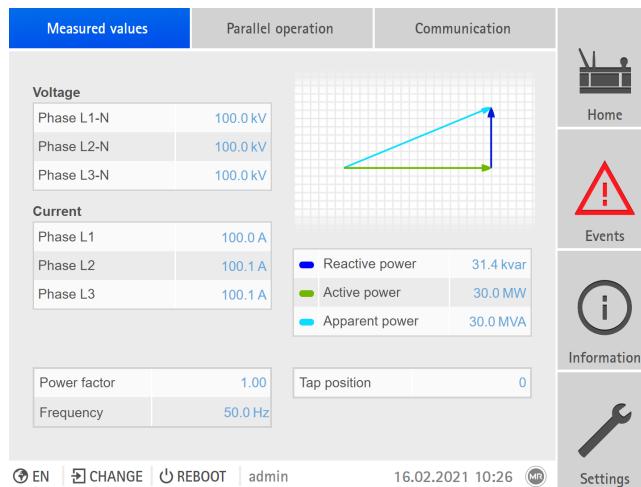


Figure 105: Measured values

› Go to **Information > Power grid > Measured values.**

Also refer to

„TAPCON® 2xx retrofit [► 169]“

9.2.9 Displaying measured value recorder (optional)

You can use the optional measured value recorder function to display the progress of measured values and signals over time.

i If you call up the measured value recorder directly on the device display, you can select a maximum of 3 measured values. If you access it via the web visualization, you can select a maximum of 10 measured values.

To display the measured value recorder, proceed as follows:

1. Go to **Recorder**.

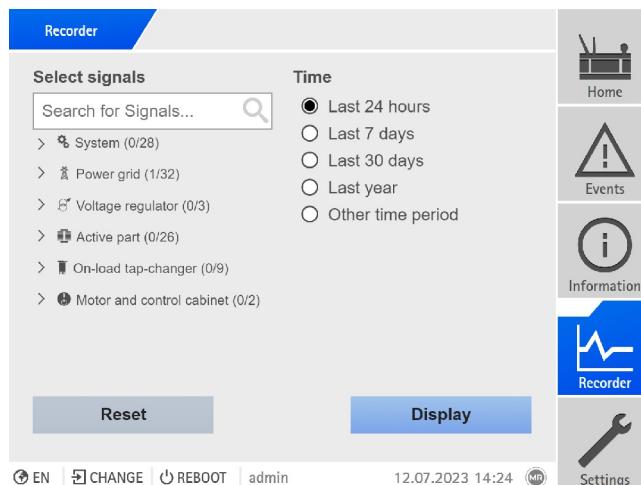


Figure 106: Recorder

2. Select the **signals** to be displayed.
3. If necessary, set the desired **Axis** for each signal.
4. Set the **Time period** for the measured value display.

5. Press **Display** to call up the measured value display (data log).

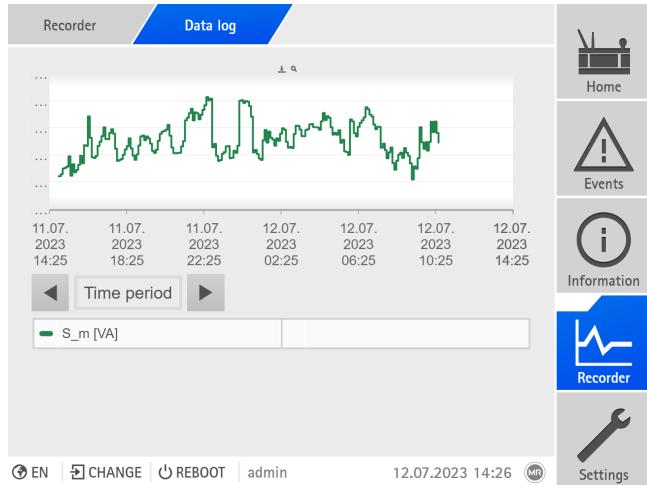


Figure 107: Data log

i The operation described below is only possible if you access the visualization using a computer.

6. Move the mouse indicator to a **measurement point** for more information.
7. Use the mouse to drag a selection window in order to zoom into the diagram. Select the button to reduce the diagram back to its original size.
8. Select the button to save the displayed measured values as a csv file.

Trend curves

If you call up the measured value recorder using a PC, you can display a trend curve instead of the measured values. The trend curve can, for example, be a moving average over a configurable time period.

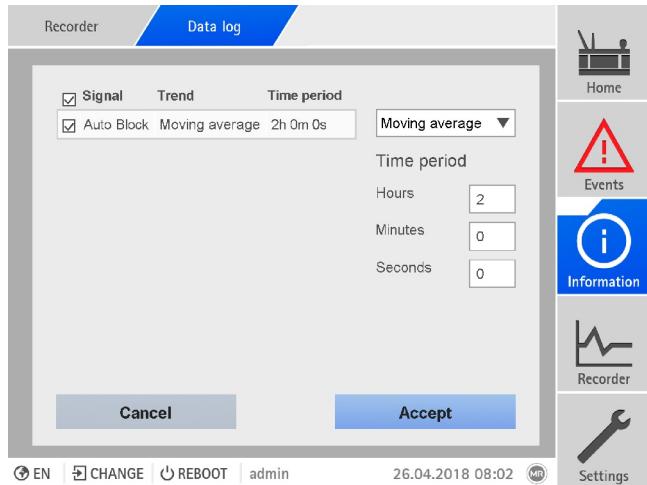


Figure 108: Creating trend curves

To create the trend curves, proceed as follows:

1. Call up the measurement recorder and the desired measured value series.
2. Press the **Trend** button.
3. Select the desired **measured values**.
4. Select the desired **trend function**.
5. Enter the desired **Time period** for the calculation of the trend curve.
6. Press the **Accept** button to display the trend curves.
» The trend curve is displayed. Measured values that are displayed as trend curves are marked with the symbol.

9.2.10 Linking signals and events

The device allows you to link digital inputs (GPI) and control system commands (SCADA) with device functions, digital outputs (GPO), and control system messages.

The digital inputs available are each permanently linked to a *General purpose input* event message and the control system commands available are each permanently linked to a *Generic SCADA command* event message for this purpose.

Input/command	Event message
Digital input 1 ³	General purpose input 1
Digital input 2 ³	General purpose input 2
...	...
Digital input 42 ³	General purpose input 42
Generic SCADA command 1	Generic SCADA command 1
Generic SCADA command 2	Generic SCADA command 2
...	...
Generic SCADA command 10	Generic SCADA command 10

Table 36: Linking of digital inputs and control system commands with event messages

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

9.2.10.1 Linking functions

You can link the *General purpose input* or *Generic SCADA command* events with device functions. This allows you to remotely control the device using digital inputs or commands via the control system (SCADA). Depending on your device configuration, various functions are available for this purpose via parameters.

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

i Note that you can only enter the event numbers of the *General purpose input* or *Generic SCADA command* events.
If you enter event number 500, the link is disabled.

³ The number of available digital inputs depends on the order-specific device configuration.

Settings	Parameters	Link functions
Name	Value	
Master parallel operation method	500	
Follower parallel operation metho...	500	
Parallel op. meth. auto. tap sync...	500	
Independent regulation	500	
Blocking	500	
High-speed return	500	
Target-tap-position operation	500	
Activate desired value 1	500	
Activate desired value 2	500	
Activate desired value 3	500	

 Home
 Events
 Information
 Recorder
 Settings

🕒 EN | ⚏ CHANGE | ⚡ REBOOT | admin 04.02.2020 11:14 (MR)

Figure 109: Linking functions

- ✓ The desired event number is known [► Section 9.2.13, Page 113].
1. Go to **Settings > Parameter > System > Link functions**.
 2. Select the desired parameter.
 3. Enter the desired event number.
 4. Press the **Accept** button to save the modified parameter.

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.

Independent regulation

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

Deactivate parallel operation

If the assigned event is active, the device deactivates the parallel operation.

Blocking

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

Activate remote mode

If the assigned event is active, the device activates remote mode.

High-speed return

If the assigned event is active, the device activates high-speed return. With high-speed return, the device ignores the set delay time of automatic voltage regulation.

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.

Increase desired value

If the assigned event is active, the device prompts an increase in the desired value.

Decrease desired value

If the assigned event is active, the device prompts a decrease in the desired value.

9.2.10.2 Linking digital outputs

You can link each event with a digital output. The device provides a maximum of 20 digital outputs 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 or control system commands, you need to link the digital outputs or control system messages with the *General purpose input* or *Generic SCADA command* events.

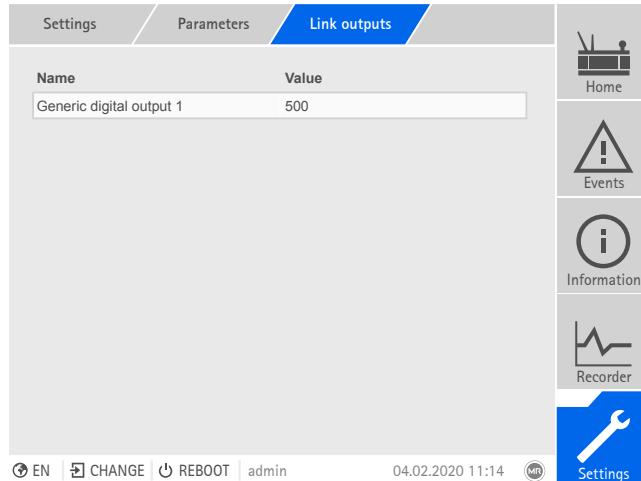


Figure 110: Linking digital outputs

- The desired event number is known [► Section 9.2.13, Page 113].
- Go to **Settings > Parameter > System > Link outputs**.
- Select the desired parameter.
- Enter the desired event number.
- 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.

9.2.10.3 Linking control system messages

You can link each event with a control system message. The device provides 25 SCADA messages for this purpose. When you link a SCADA message to an event, the device sets the data point to "On" when the event occurs. When the event stops, the device sets the data point to "Off". A parameter is available for each available SCADA message.



To forward control system commands, you need to link the control system messages to the *General purpose input* or *Generic SCADA command* events.

Name	Value
Generic status message 1	500
Generic status message 2	500
Generic status message 3	500
Generic status message 4	500
Generic status message 5	500
Generic status message 6	500
Generic status message 7	500
Generic status message 8	500
Generic status message 9	500
Generic status message 10	500
Generic status message 11	500
Generic status message 12	500
Generic status message 13	500

EN | CHANGE | REBOOT | admin 02.05.2022 08:37 MFT

Figure 111: Linking SCADA messages

- ✓ The desired event number is known.
- > Go to **Settings > Parameters > System > Link messages**.

Generic status message X

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



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

9.2.11 Configuring analog inputs and outputs (optional)

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

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

9.2.11.1 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. To do so, proceed as follows:

1. Go to **Settings > Export**.
2. Select the option **Settings** to export a backup copy of the current settings.

3. Select the desired **Interface** (USB or PC).
4. Press the **Export** button to start the export.

9.2.11.2 AIO configuration

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

The screenshot shows the 'AIO configuration' tab of a software interface. On the left is a table with columns: Function, Signal type, and Card/channel. The table lists various analog inputs (I) with their respective types (e.g., PT100-2, 4-20mA, 0-10V) and card/channel assignments (e.g., AIO4 / 1, AIO4 / 2). Below the table are 'Cancel' and 'Accept' buttons. At the bottom, there's a status bar with EN, CHANGE, REBOOT, admin, and a date/time stamp (27.01.2010 23:36). To the right of the table is a vertical sidebar with icons for Home, Events, Information, Recorder, and Settings.

Function	Signal type	Card/channel
I: Ambient temp.	PT100-2	AIO4 / 1
I: Top-oil temp.	PT100-3	AIO4 / 2
O: Ventilator actuat.	0-10V	AIO4 / 3
I: GPAI 1	4-20mA	AIO4 / 4
I: Gen. temp. 1	Deact.	-
I: Gen. temp. 2	Deact.	-
I: Gen. temp. 3	Deact.	-
I: Gen. temp. 4	Deact.	-
I: Gen. temp. 5	Deact.	-

Figure 112: Configuring analog inputs/outputs

i You can only change the configuration of the analog 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
1. Go to **Settings > AIO configuration**.
 2. Configure the properties such as **Function**, **Sign. type** and **Card/channel**.
 3. Select the **gear** button to configure the values as desired.

The screenshot shows a detailed configuration dialog for 'Input: GPAI 1'. It includes fields for Unit (with dropdown menus), Decimal places (set to 1), Minimum value (0.0), Maximum value (1.0), and Correction factor (1.000). Below the dialog are 'Cancel' and 'Accept' buttons. At the bottom, there's a status bar with EN, CHANGE, REBOOT, admin, and a date/time stamp (27.01.2010 23:37). To the right of the dialog is a vertical sidebar with icons for Home, Events, Information, Recorder, and Settings.

Figure 113: Entering values

4. Press the **Accept** button.
5. Confirm the security prompt with **Save** to save the changes.

Signal type

Select signal type of analog sensor or deactivate analog input.

- 4...20 mA
- 0...10 V
- PT100-2/3/4, PT1000-2/3/4

Card/channel

Select the slot and channel of the analog sensor. Note the connection diagram supplied. This property is only available for GPAI.

Unit

Set the unit of the signal. This property is only available for GPAI.

Decimal places

Set up to three decimal places. This property is only available for GPAI.

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.

This property is not available if the sensors are connected over the MR sensor bus (Modbus).

Correction factor and correction 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.

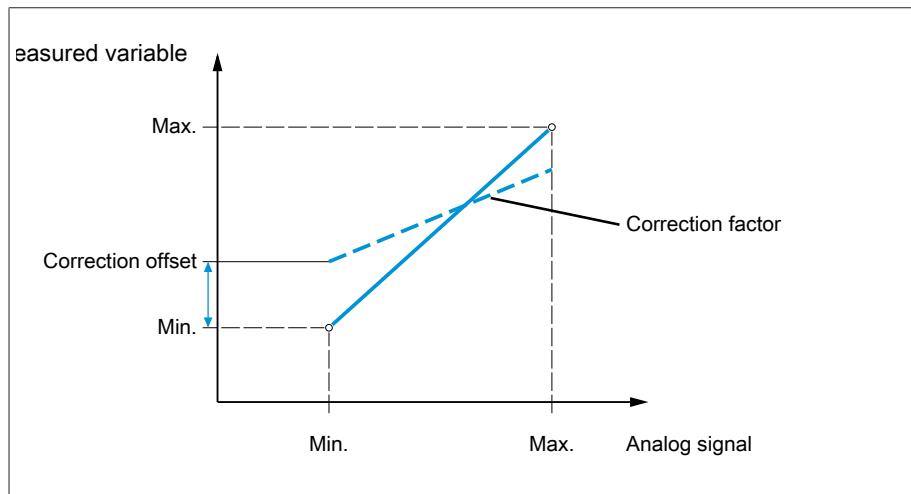


Figure 114: Analog signal with linear characteristic curve, correction factor <1 and correction offset

Correction factor

Set the correction factor (m) for the correction of the function value (x). The corrected function value (y) is: $y = (m * x) + t$. This property is only available for inputs.

Correction offset

Set the offset (t) for the correction of the function value (x). The corrected function value (y) is: $y = (m * x) + t$. This property is only available for inputs.

9.2.12 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.

9.2.12.1 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. To do so, proceed as follows:

1. Go to **Settings > Export**.
2. Select the option **Settings** to export a backup copy of the current settings.
3. Select the desired **Interface** (USB or PC).
4. Press the **Export** button to start the export.

9.2.12.2 DIO configuration

i 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.

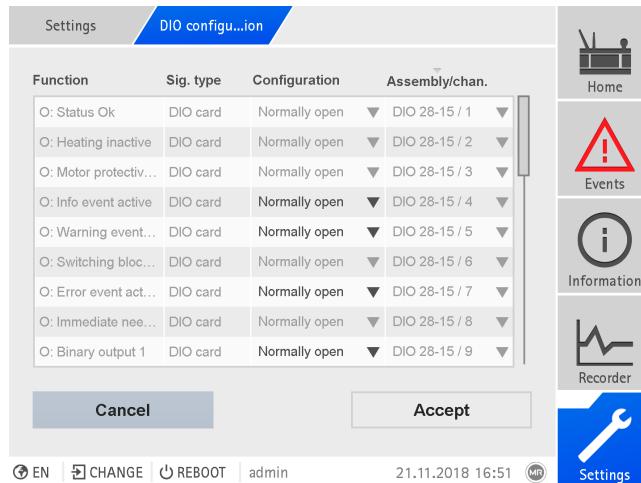


Figure 115: Configuring digital inputs and outputs

i 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

To configure the device's digital inputs and outputs, proceed as follows:

1. Go to **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.

Function

Function of the digital input (I: ...) or the digital output (O: ...). You can adjust the designation.

Signal type

Select the signal type:

- Digital: Digital input

Configuration

Configure the device's digital inputs and outputs as follows:

- 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 DIO assembly to which the function is linked. Functions that are not linked with a channel are identified with "-". Note the connection diagram supplied.

9.2.13 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. You can call up an overview of the possible events in the device.

9.2.13.1 Displaying and acknowledging events

To display the events currently active, proceed as follows:

- > Go to **Events**.
 - » A list of currently pending events appears.

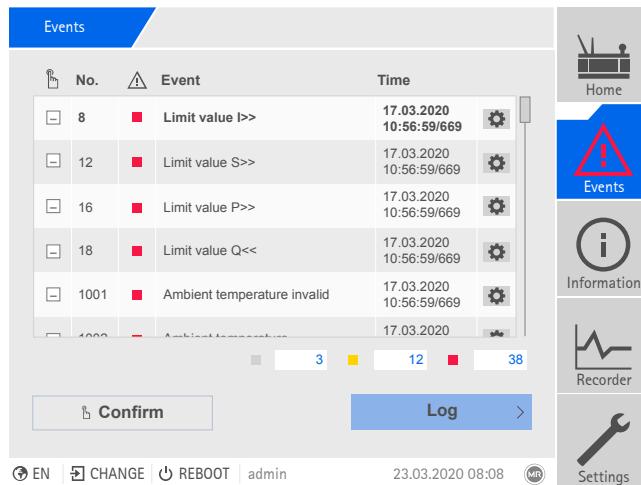


Figure 116: Overview of events currently active

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.

9.2.13.2 Configuring events

The events have the following properties:

Property	Description
Event name	Brief name of event. If you delete all of the text, the standard text is displayed.
Event description	Description of event. If you delete all of the text, the standard text is displayed.
Event troubleshooting	Instructions for troubleshooting the cause of an event. If you delete all of the text, the standard text is displayed.
Category	<ul style="list-style-type: none"> - Error (red) - Warning (yellow) - Info (gray) <p>This setting affects the color of the <i>Alarm</i> LED and the event symbol in the primary navigation.</p>
Report	If you activate this option, the event is shown on the display and, if configured accordingly, issued via an output and the control system protocol.
Save	If you activate this option, the event is stored in the event memory.
Multi-set (not configurable)	The event can be triggered several times without having been deactivated in the meantime.
High active (not configurable)	High active: The device generates a signal if the event is pending. Low active: The device generates a signal so long as the event is not pending. If the event is pending, the signal is reset.
Acknowledgeable (not configurable)	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).
Blocking (not configurable)	If the event is active, it blocks automatic voltage regulation.

Table 37: Properties of events

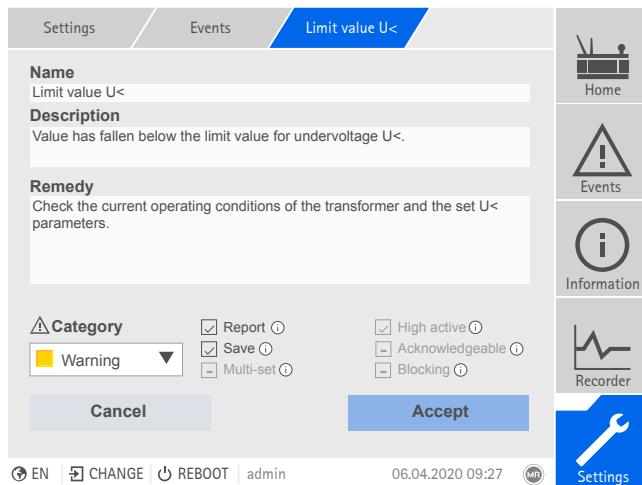


Figure 117: Configuring events

To configure an event, proceed as follows:

1. Go to **Settings > Events**.
2. Select the event to be changed in the list.

3. Select the desired options.
4. Press the **Accept** button to save the change.

9.2.13.3 Displaying event memory

Past events are stored in the event memory. You can adjust the display of events using different filters. The following filters are available for this purpose:

Filter	Description
Time	Date and time of event
Category	Event category: – Error (red) – Warning (yellow) – Info (gray)
Status	Event coming/going: ➤ Event coming ◀ Event going
Components	System components
Event	Up to 3 events can be selected

To call up the event memory, proceed as follows:

1. Go to **Events > Event memory**.

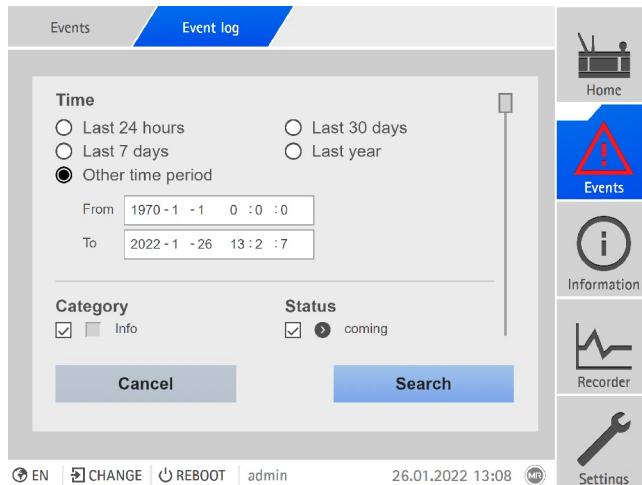


Figure 118: Event memory

2. Set the desired **Filter**.
3. Select the desired events in the **Events** list.
4. 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 using Connect PC [►Section 7.1, Page 70] or connect a storage medium to the USB port on the CPU I/CPU II module.
1. Press the **Export** button.
 2. Select the desired option for data transmission (PC or USB).
 - » The data is exported.

9.2.14 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.

9.2.14.1 User roles

The access rights to device functions and settings are controlled using a hierarchical system of roles. The system has 5 different roles with different access rights. Some of these access rights are fixed, but you can configure the access rights to particular parameters and events. Note the Setting access rights to parameters and events [▶ Section 9.2.14.4, Page 119] section.

i If you are not logged in on the device, you will assume the "Data display" user role.

Upon delivery, the following roles are provided:

Role	Description
Data display	User who can only view data of relevance to operation. <ul style="list-style-type: none">- Display all parameters- Display all events
Diagnostics	User who can view data and log data of relevance to operation. <ul style="list-style-type: none">- Display all parameters- Display all events- Export log data
Operator	User who can view data of relevance to operation and acknowledge events. The user can perform manual tap-change operations using the device's controls. <ul style="list-style-type: none">- Display all parameters- Display and acknowledge all events
Parameter configurator	User who can view and modify data of relevance to operation. <ul style="list-style-type: none">- Display and modify all parameters- Import and export parameters- Display, modify, and acknowledge all events
Administrator	User who can view and modify all data. <ul style="list-style-type: none">- Read all parameters- Display, modify, and acknowledge all events

Table 38: Roles in delivery status

Access to the following areas of the device is linked to the roles:

Function	Data display	Diagnostics	Operator	Parameter configurator	Administrator
Administration	-	-	-	-	+
Restart device	-	-	+	+	+
Import	-	-	-	+	+
Export	-	+	-	+	+
Set date and time	-	-	+	+	+
Calling up the commissioning wizard	-	-	-	+	+
Calibrate resistor contact series	-	-	-	+	+

Function	Data display	Diagnostics	Operator	Parameter configurator	Administrator
Actuation of the RAISE, LOWER, REMOTE, AVR AUTO, and AVR MANUAL keys	-	-	+	+	+
Setting topology	-	-	-	+	+
Configuring analog inputs and outputs	-	-	-	+	+
Configuring digital inputs and outputs	-	-	-	+	+
Setting TPLE	-	-	-	+	+
Configuring data points	-	-	-	+	+
Calling up the maintenance wizard	-	-	-	+	+
Changing tap position table	-	-	-	+	+
Enabling ECOTAP Modbus	-	-	-	+	+
Adding sensors to the MR sensor bus	-	-	-	+	+

Table 39: Access rights permanently linked to the roles

9.2.14.2 Changing the password

All users can change their passwords provided that the user account is not set up as a group account. You can only change a group account's password if you are logged in as the administrator.

Note that the password must satisfy the following requirements:

- At least eight characters
- At least three of the four following character types
 - Upper case letters
 - Lower case letters
 - Numbers
 - Special characters

To change the password, proceed as follows:

1. Select **Username** in the status line.

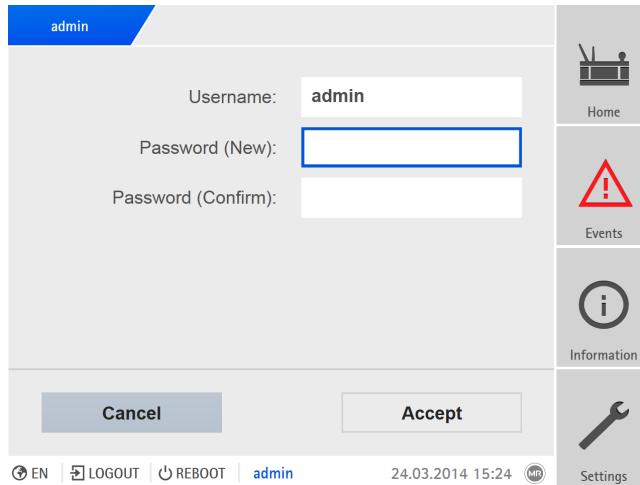


Figure 119: Changing the password

2. Enter the new **Password** twice.

3. Press the **Accept** button to save the changed password.

9.2.14.3 Creating, editing and deleting users

You can set the following options for all users:

- Username and password
- User role: You can assign a role to every user. The access rights to parameters and events are linked to the roles.
- Group access: With this option, you can declare a user account to be a group account (e.g. for access by different people). Users with group access cannot change their own password. The password can only be changed by the administrator.
- Active: You can activate or deactivate the user. Deactivated users cannot log in. The user data is still stored in the device.
- Auto login: You can activate the Auto-login function for a user. This user is automatically logged in when the system is restarted or another user logs out.

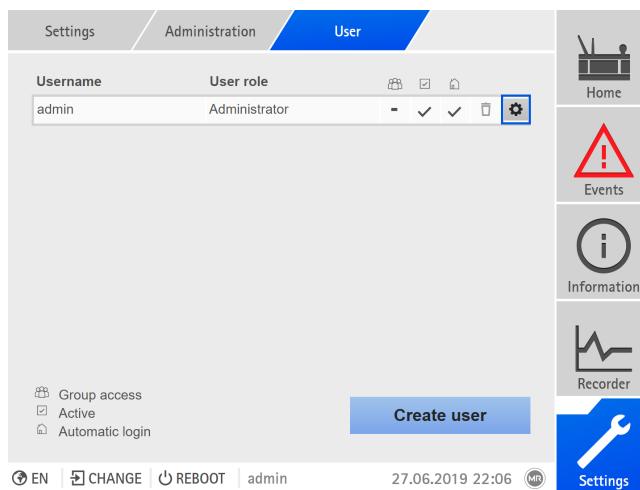


Figure 120: Overview of users created

i You can only create, edit, and delete users if you are assigned an administrator role.

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

- User name: admin
- Password: admin

Creating users

To create a new user, proceed as follows:

1. Go to **Settings > User administration > User accounts**.
2. Press the **Create user** button.
3. Enter the **Username** and then the **Password** twice.
4. Select the desired **User role**.
5. If necessary, activate the **Group access**, **Active** or **Automatic login** options.
6. Press the **Accept** button to save the user.

Editing users

To edit an existing user, proceed as follows:

1. Go to **Settings > User administration > User accounts**.
2. In the list, select the button for the desired user.
3. Make the amendments desired.
4. Press the **Accept** button to save the user.

Deleting a user

To delete an existing user, proceed as follows:

1. Go to **Settings > User administration > User accounts**.
2. In the list, select the  button for the desired user.
3. Press the **Accept** button to delete the user.

9.2.14.4 Setting access rights to parameters and events

You can configure access rights to parameters and events for the available roles. The following options are available for this purpose:

- Read: Parameter/event may be displayed.
- Write: Parameter/event may be modified.
- Acknowledge: Event may be acknowledged.

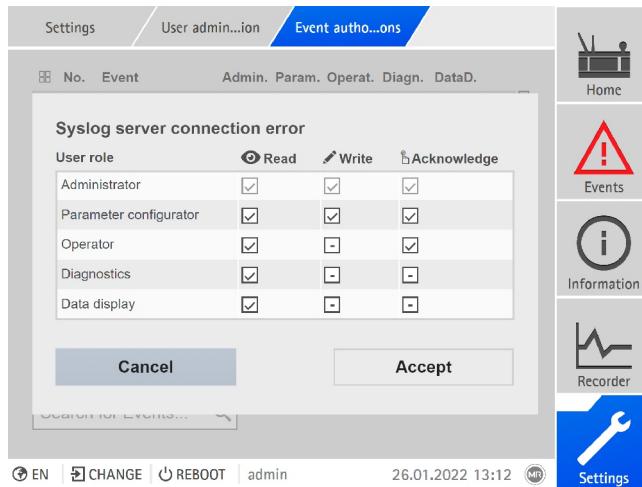


Figure 121: Setting access rights for an event

i You can only change access rights if you are assigned an administrator role.

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

- User name: admin
- Password: admin

Setting access rights to parameters/events

1. Go to **Settings > User administration > Parameter authorizations or Event authorizations**.
 - » A list of all parameters or events appears.
2. Edit the desired entry in the list using the  button.
3. Select the desired options.
4. Press the **Accept** button to save the change.
5. Restart the device to apply the changed rights.

9.2.14.5 User authentication via RADIUS (optional)

The device supports user authentication via RADIUS in accordance with RFC 2865. In this case, the device also functions as a RADIUS client. To use RADIUS, you must create a dictionary for ISM® devices on your RADIUS server and set the parameters for RADIUS on the device.

Note the following information:

- Only use RADIUS in a secure network, as sensitive information is transmitted.
- If a user ID has been created both on the RADIUS server and locally on the device, the device first tries to log in via the RADIUS server. If it is not possible to log in, the device will use the locally saved login data.
- If a user ID has not been created on the RADIUS server, the device uses the locally saved login data.

9.2.14.5.1 Creating a dictionary on the RADIUS server

You must create a dictionary for ISM® devices on your RADIUS server in accordance with the following specification.

```
VENDOR MR 34559
BEGIN-VENDOR MR
# Attributes
ATTRIBUTE MR-ISM-User-Group 1 integer
# Predefined values for attribute 'MR-ISM-User-Group'
VALUE MR-ISM-User-Group Administrator 1
VALUE MR-ISM-User-Group Parameter-configurator 2
VALUE MR-ISM-User-Group Operator 3
VALUE MR-ISM-User-Group Diagnostics 4
VALUE MR-ISM-User-Group Data-display 5
END-VENDOR MR
```

If your RADIUS server supports the importing of a dictionary, you can export the dictionary for ISM® devices from the device and import it onto your RADIUS server. For more information, refer to the information in the section titled Exporting data [▶ Section 9.2.17.1, Page 123].

The user groups of the dictionary correspond to the user roles [▶ Section 9.2.14.1, Page 116] of the device and the corresponding authorizations.

9.2.14.5.2 Configuring RADIUS

To establish a connection to the RADIUS server, you must set the following parameters.

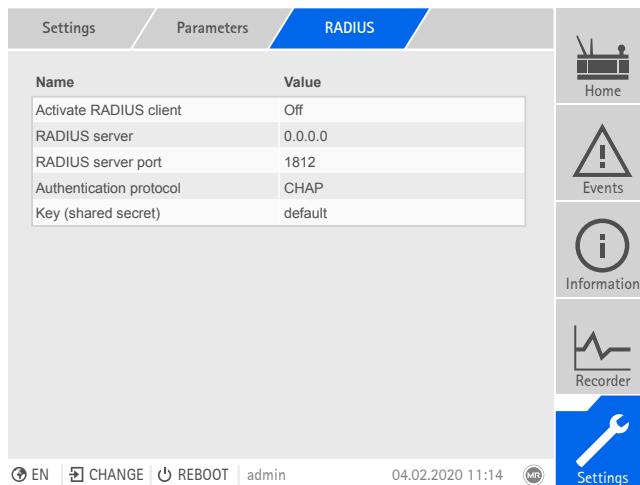


Figure 122: Configuring RADIUS

i You can only configure RADIUS if you are assigned an administrator role.

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

- User name: admin
 - Password: admin
- > Go to **Settings > Parameters > System > RADIUS.**

9.2.15 Hardware

Under Hardware, you can display information on 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.

9.2.15.1 Status of the DIO assembly

You can display the status of the digital inputs and outputs of the DIO assembly.

- Terminal pin
- Status of the input (I: ...) or output (O: ...)
 - Blue: There is a signal (logical 1) at the input or output.
 - Gray: There is no signal (logical 0) at the input or output.
- Linked function

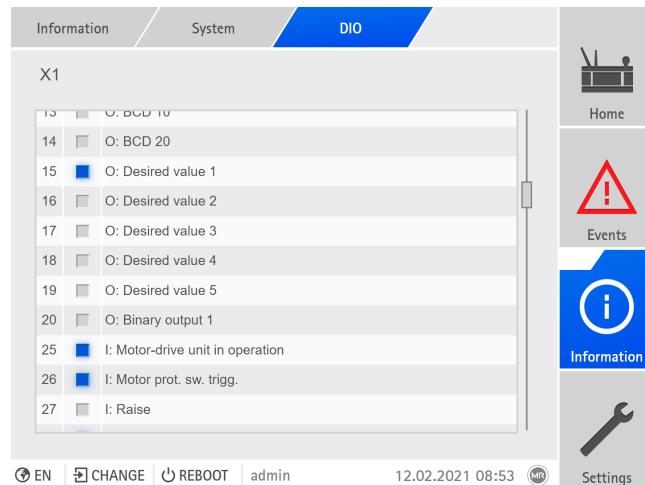


Figure 123: Status of the DIO assembly

9.2.15.2 Status of the AIO assembly

You can display the status of the analog inputs and outputs of the AIO assembly. If a value is not within the permitted range, this value will be displayed in red.

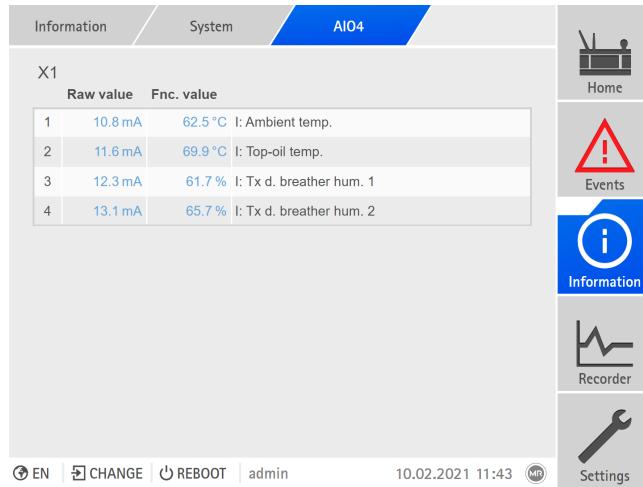


Figure 124: Status of the AIO assembly

9.2.16 Software

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

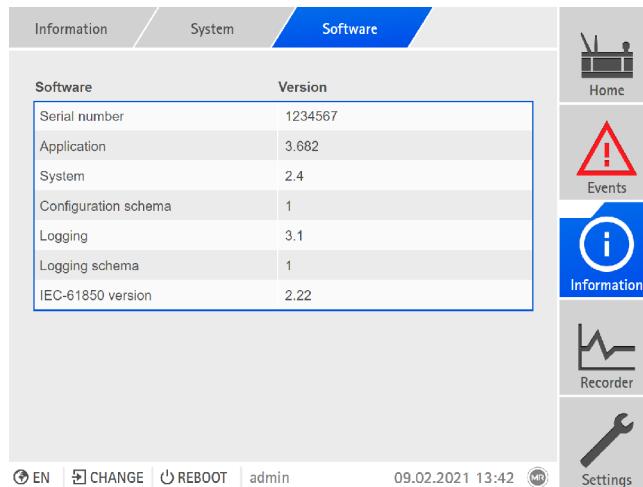


Figure 125: Information about the device's software

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

9.2.17 Import/export manager

The device is equipped with an import/export manager, which can be used to export and import various data.

To transfer the data, the following options are available:

Option	Description
USB	Data transfer via USB port on rear of CPU I/CPU II assembly.
PC	Data transfer via PC using web-based visualization.

Table 40: Data transfer options

9.2.17.1 Exporting data

	The device stops logging the measured value log data for the duration of the export.
---	--

You can export the following data from the device, depending on your device configuration:

Backup

Option	Description
System image (.rhi / .rhp)	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. If you select the "with TPLE" option, the customer program is exported. You can select whether you would like to export all records or only records from the last 10 days.
Settings (.rhi / .rhp)	<p>Device settings:</p> <ul style="list-style-type: none"> - Parameters (settings, access rights) - Events (category, behavior, text, access rights) - User configuration <p>If available, the settings of the following functions are also exported:</p> <ul style="list-style-type: none"> - Topology - AIO configuration - DIO configuration - Tap position table - Sensor bus
Customer program (TPLE) (.rhi)	Customer program export (TPLE).

Table 41: Exporting data: Backup group

Information

Option	Description
Operating instructions (.zip)	Operating instructions, protocol specifications.
Licenses (.zip)	License text of the software components used.
SCADA configuration (.zip)	Control system configuration (e.g. ICD file for IEC 61850).

Table 42: Exporting data: Information group

System

Option	Description
Event list (.csv)	Complete list of all possible events.
Parameter list (.csv)	Parameter list with descriptive text and values (min, max, current).
System configuration (.xml)	System configuration.
RADIUS library (.zip)	Dictionary for importing on a RADIUS server.

Table 43: Exporting data: System group

Records

Option	Description
Event log (.csv)	All event memory entries.
Security log (.csv) Optional: System log (.csv)	Logbook of all instances of access and changes relating to security.
Recorder (.zip)	Measured value memory export.
VAM export (.zip)	Export of vibro-acoustic records. You can export the data in its entirety or select certain records.
Maintenance logbook (.xml)	Export of entries in the maintenance logbook.

Table 44: Exporting data: Records group

- Only remove the USB stick once the data transfer is complete. Otherwise, data may be lost.

To export data, proceed as follows:

1. Go to **Settings > Export**.
2. Select the desired option for the export and follow the instructions on the screen.

9.2.17.2 Importing data (software version 3.800 and later)

Depending on your device configuration, you can import the following data:

Option	Description
System image	Complete image of the system (software and configuration), with or without history (recorded data). During import, you can select which of the following settings are to be imported: <ul style="list-style-type: none"> - Parameters (settings, access rights) - Events (category, behavior, text, access rights) - User configuration If available, you can also import the settings of the following functions: <ul style="list-style-type: none"> - Topology - AIO configuration - DIO configuration - Tap position table - Sensor bus - Certificates
Customer program	Customer program import (TPLE).
Language	Import of additional languages. You can install a maximum of five different languages on the device. If five languages are already installed, you will be asked to delete one during the import process.

Option	Description
SSL certificate	<p>Import of an SSL certificate with associated key:</p> <ul style="list-style-type: none"> - Server certificate (.crt + .pem) - Client certificate (.crt + .pem) - Client CA (.crt) <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"> - RSA with 1,024 bits - ECDSA with 256 bits ("secp256r1" or "prime256v1" curve).
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"> - Parameters (settings, access rights) - Events (category, behavior, text, access rights) - User configuration <p>If available, you can also import the settings of the following functions:</p> <ul style="list-style-type: none"> - Topology - AIO configuration - DIO configuration - Tap position table - Sensor bus - Certificates
SCADA configuration	Import of the control system configuration (e.g. SCD file for IEC 61850).

Table 45: Importing data

NOTICE

Damage to the file system!

The file system can be 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.
- › In addition, during the download, do not remove the USB flash drive or disconnect the network connection.

To import data, proceed as follows:

1. Go to **Settings > Import**.
2. Select the desired option for data transmission (PC or USB).
3. Select **Browse**, select the file to be imported and select **Start upload**.
 - » The file is checked.
4. Optional: Select the desired options for the import.
5. Press the **Start update** button.
 - » **NOTICE!** The device function (monitoring/control) is stopped.
 - » The data is imported, then the device is restarted. During the restart, the relays are reset.

Also refer to

- █ Configuring analog inputs and outputs (optional) [▶ 109]
- █ Configuring digital inputs and outputs [▶ 112]

9.2.18 Configuring media converter with managed switch

Observe the following information on configuring the media converter with managed switch SW 3-3. Use the following browser to call up web-based visualization:

- Firmware version 02.0.01: Internet Explorer 11
- Firmware version 07.1.00 or higher: HTML5-compatible browser, e.g., Google Chrome

9.2.18.1 Commissioning

Before integrating the Ethernet switch into your network, you must review the most important settings and adjust them if necessary. During this process, follow the information outlined in this chapter for commissioning the Ethernet switch.

Establishing a connection to the web-based visualization

i The Ethernet switch is supplied with the following factory default settings:
IP address 192.168.1.1; subnet mask 255.255.255.0; gateway address 0.0.0.0.

For commissioning the Ethernet switch, proceed as follows:

1. Establish connection with a computer via an Ethernet connection.
2. Configure the computer so that it is in the same subnet as the Ethernet switch.
3. Access the IP address 192.168.1.1 using a browser.
4. Login with the user information (login = admin; password = private). Switch the language if necessary (German/English).

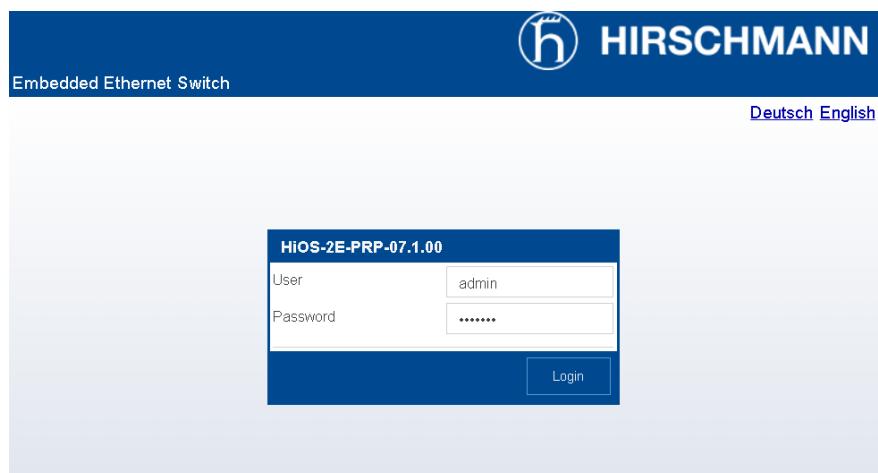


Figure 126: Login using a web interface

Changing the user name and password

1. Go to **Device security > User administration**.
2. Create a new user with the administrator user role. Activate the user and assign a password.
3. **NOTICE!** Ensure that an additional user with the administrator user role is present in addition to the "admin" user. Then delete the "admin" user.
4. Click on the button or **Write** to save the change.

NOTICE

Disabling unnecessary services Damage to the device

If you disable all services, you will no longer be able to access the device later to configure or update it.

- > Leave at least one service for secure communication enabled (e.g., SN-MPV3, SSH or HTTPS).

1. Go to **Device security > Management Access**.

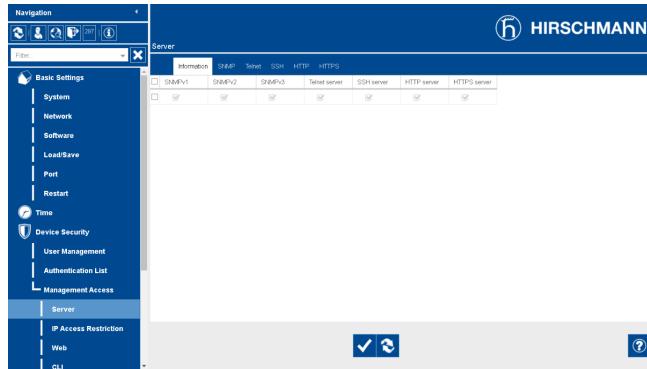


Figure 127: Management Access

2. Select the tab for the desired service.
3. Select **Off** to disable a service or use the checkboxes to disable sub-functions of a service.
4. Click on the button or **Write** to save the change.

Setting network settings

1. Go to **Basic settings > Grid > Global**.

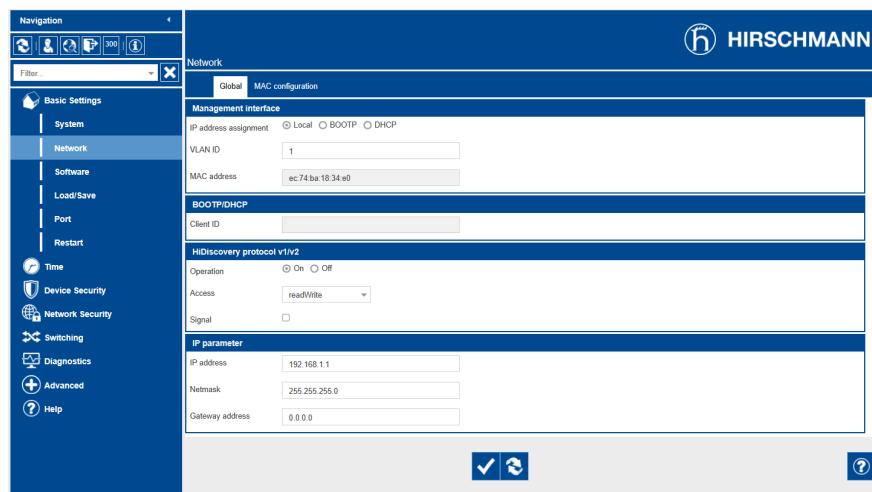


Figure 128: Network settings

2. Adjust the network settings and click on the button or **Write** to save the changes.
3. In the **Basic settings > Load/Save** menu, click on the **Save** button to permanently store the settings.
4. If necessary, establish a connection to the new IP address to continue changing settings. Click on the **Help** button to find out more information.
5. Attach the cable for connecting to your network.

9.2.18.2 Configuration

You can use the web interface to configure the Ethernet switch. You can find more information about the configuration using the online help in the web interface.

Calling up the web interface

To access the web interface, follow the instructions outlined in the Commissioning [▶ Section 9.2.18.1, Page 126] chapter.

Selecting the redundancy protocol

To select the redundancy protocol, proceed as follows:

1. Go to **Redundancy**.
2. Select the specific menu item for the redundancy protocol.
3. Change the configuration and select the **On** option in the **Function** group field.
4. In the **Basic settings > Load/Save** menu, click on the **Save** button to permanently store the settings.

i Deactivate the unused redundancy protocols by selecting the **Off** option in the **Function** group field.

Resetting to factory settings

To reset the Ethernet switch to its factory default settings, proceed as follows:

1. Go to **Basic settings > Load/Save** and click on the **Reset to factory defaults...** button.
2. Reestablish the connection to the IP address of 192.168.1.1 if necessary.
3. Set the MR factory settings in accordance with the following table.

Menu	Parameter	MR factory setting
Redundancy	Redundancy protocol	PRP
Security > Pre-login banner	Login banner	MR-specific
Basic setting > Port configuration	Ports 5+6	Deactivated

Table 46: MR factory setting

9.2.18.3 Updating the Firmware

To ensure the IT security of the device, we recommend always keeping the SW 3-3 assembly firmware up to date. The SW 3-3 assembly is based on the Belden/Hirschmann EES-25 product. Therefore, follow the information in the security bulletins published by Belden/Hirschmann:

- <https://www.belden.com/security-assurance>

You can obtain the firmware updates directly from the manufacturer Belden/Hirschmann:

- https://catalog.belden.com/index.cfm?event=pd&p=PF_942050003

Install the updates as described by the manufacturer Belden/Hirschmann.

Establishing a Connection

1. Establish connection with a computer via an Ethernet connection.
2. Configure the computer so that it is in the same subnet as the Ethernet switch.
3. Access the IP address 192.168.1.1 using a browser.

4. Log in with the user data (default settings: login = admin; password = private). Switch the language if necessary (German/English).

Exporting the configuration

Prior to any update, the device configuration should be saved so that it can be reloaded if necessary.

1. Go to **Basic settings > Load/Save**.
2. Select the NVM storage type and click on the [...] > **Export** button. Save the file to the PC.

Installing firmware updates

To update the firmware, proceed as follows:

- ✓ The firmware update has been downloaded.

1. Go to **Basic settings > Software** and click on the [...] button or .

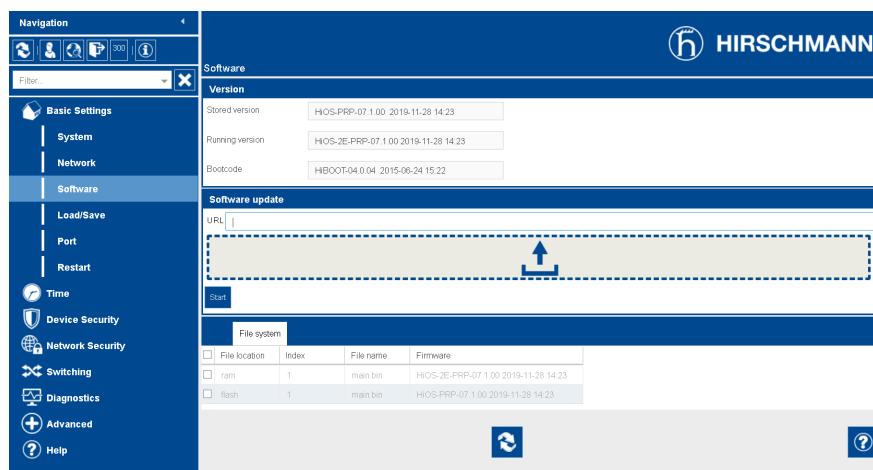


Figure 129: Uploading a firmware update

2. Select the downloaded firmware update file. When doing so, ensure you select the correct version (HSR or PRP).
 - » The file will be loaded onto the assembly.
3. Click on the **update** or **start** button to start the update.
 - » The firmware will be updated.
4. Once the update has been completed successfully: Go to **Basic setting > Restart** and click on the **Cold start** button to restart the assembly.

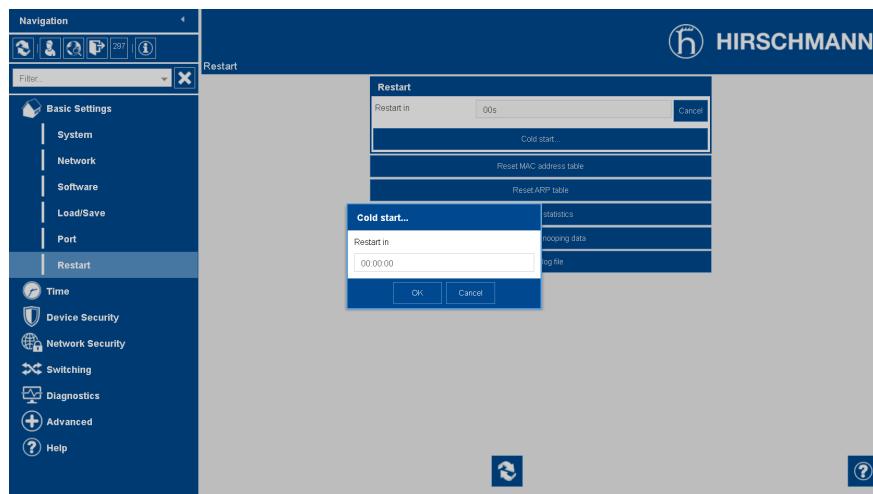


Figure 130: Restarting the assembly

5. Disconnect the PC connection via the Ethernet connection and re-establish connection to your network.

9.2.19 Transformer Personal Logic Editor (TPLE)

You can use the Transformer Personal Logic Editor (TPLE) function to program simple logical links via the web-based visualization. You can also link the inputs and outputs available on the device using function modules.



Note that the device does not meet the requirements of a protective device. Therefore, do not use TPLE to produce protective functions.

9.2.19.1 Function

9.2.19.1.1 Function groups

There are 10 function groups available that you can use to combine various sub-tasks into one function. In one function group, you can link up to 12 function modules with variables. You can rename function groups and activate or deactivate them individually.

9.2.19.1.2 Variables

The following types of variables for information processing are available for TPLE:

- Event inputs: You can use all the device's events as inputs for a function.
- Event outputs: 100 generic events are available as outputs for functions.
- Binary inputs: You can use all the device's configured digital inputs and up to 42 generic inputs of the device as inputs for a function.
- Binary outputs: You can use all the device's configured digital outputs and up to 20 generic outputs of the device as outputs for a function. If there is a control system present, 10 generic control system messages are available.
- Analog inputs: You can use all the device's configured analog inputs as inputs for a function.
- Binary flags: You can use up to 100 binary flags as variables to store intermediate values. You can use binary flags as inputs and outputs for a function.
- Analog flags: You can use up to 50 analog flags as variables to store intermediate values. You can use analog flags as inputs and outputs for a function.
- Discrete inputs: You can use all the device's available discrete inputs as inputs for a function.

9.2.19.1.3 Function modules

TPLE provides various function modules for processing the information.

9.2.19.1.3.1 AND

Description	AND, logical AND link
Inputs	Input 1...4 (BOOL)
Outputs	Output (BOOL)
Parameter	None
Function	If all configured inputs are TRUE, the output is TRUE, otherwise it is FALSE.
Initial state	All inputs and outputs are FALSE. Non-configured inputs are assumed to be TRUE. If no input is configured, the module is not run so it remains in its initial state.

Table 47: AND function module

9.2.19.1.3.2 NAND

Description	NAND, logical NOT-AND link
Inputs	Input 1...4 (BOOL)
Outputs	Output (BOOL)
Parameter	None
Function	If all configured inputs are TRUE, the output is FALSE, otherwise it is TRUE.
Initial state	All inputs and outputs are FALSE. Non-configured inputs are assumed to be TRUE so that they have no impact on the output. If no input is configured, the output therefore remains in the initial state of FALSE.

Table 48: NAND function module

9.2.19.1.3.3 OR

Description	OR, logical OR link
Inputs	Input 1...4 (BOOL)
Outputs	Output (BOOL)
Parameter	None
Function	If one of configured inputs is TRUE, the output is TRUE, otherwise it is FALSE.
Initial state	All inputs and outputs are FALSE. Non-configured inputs are assumed to be FALSE.

Table 49: OR function module

9.2.19.1.3.4 NOR

Description	NOR, logical NOT-OR link
Inputs	Input 1...4 (BOOL)
Outputs	Output (BOOL)
Parameter	None
Function	If all configured inputs are FALSE, the output is TRUE, otherwise it is FALSE.
Initial state	All inputs and outputs are FALSE. Non-configured inputs are assumed to be FALSE so that they have no impact on the output. If no input is configured, the output remains in the initial state of FALSE anyway.

Table 50: NOR function module

9.2.19.1.3.5 XOR

Description	XOR, logical EXCLUSIVE-OR link
Inputs	Input 1...2 (BOOL)
Outputs	Output (BOOL)
Parameter	None

Function	If an odd number of inputs is TRUE, the output is TRUE, otherwise it is FALSE.
Initial state	All inputs and outputs are FALSE. Non-configured inputs are assumed to be FALSE so that they have no impact on the output. If no input is configured, the output therefore remains in the initial state of FALSE.

Table 51: XOR function module

9.2.19.1.3.6 NOT

Description	NOT, logical NOT link
Inputs	Input (BOOL)
Outputs	Output (BOOL)
Parameter	None
Function	If the input is TRUE, the output is FALSE, otherwise it is TRUE.
Initial state	All inputs and outputs are FALSE. If the input is not configured, it is assumed to be TRUE so that the output remains in the initial state of FALSE.

Table 52: NOT function module

9.2.19.1.3.7 Current impulse relay

Description	RS, current impulse relay
Inputs	Trigger (BOOL) Set (BOOL) Reset (BOOL)
Outputs	Output (BOOL)
Parameter	None
Function	If the Reset input is TRUE, Output forcibly becomes FALSE. If the Reset input is FALSE and the Set input is TRUE, Output forcibly becomes TRUE. If the Reset and Set inputs are FALSE, the status of Output changes when there is a rising edge at the Trigger input. If there is no edge at the Trigger input, Output remains unchanged.
Initial state	All inputs and outputs are FALSE. Non-configured inputs are assumed to be FALSE so that they have no impact on the output.

Table 53: Current impulse relay function module

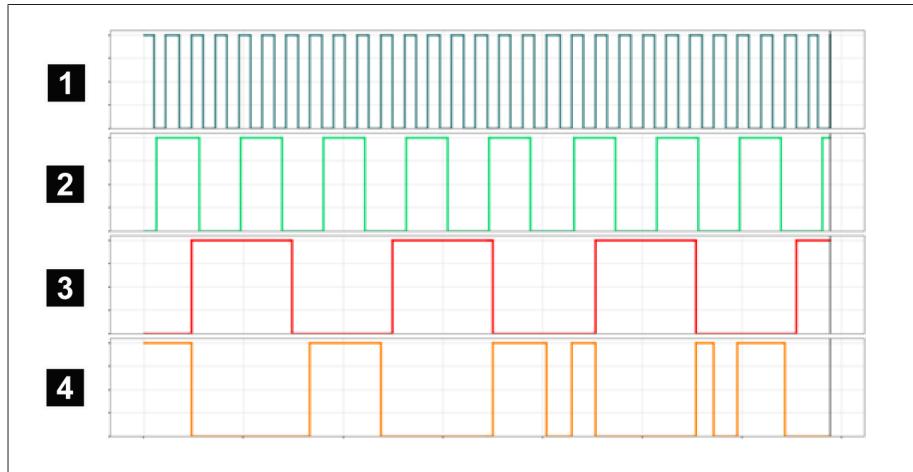


Figure 131: Example of RS

1	Trigger	2	Set
3	Reset	4	Output

9.2.19.1.3.8 Switch-on delay

Description	TON, switch-on delay
Inputs	Input (BOOL)
Outputs	Output (BOOL)
Parameter	Time ms (UINT32), 1...1,000,000, default = 1,000
Function	If Input has a rising edge, the internal timer is set to zero and starts to run. When the internal timer has reached or exceeded the parameter value, Output becomes TRUE and the counter stops running. If Input becomes FALSE, Output also instantly becomes FALSE. If the value of Time_ms is less than the cycle time, the cycle time applies instead.
Initial state	All inputs and outputs are FALSE.

Table 54: Switch-on delay function module

9.2.19.1.3.9 Switch-off delay

Description	TOFF, switch-off delay
Inputs	Trigger (BOOL) Reset (BOOL)
Outputs	Output (BOOL)
Parameter	Time ms (UINT32), 1...1,000,000, default = 1,000

Function	If Input becomes TRUE, Output also instantly becomes TRUE, this condition takes priority. If Input has a falling input, the internal timer is set to zero and starts to run. When the internal timer has reached or exceeded the parameter value, Output becomes FALSE and the counter stops running. If Input is FALSE and the Reset input becomes TRUE, Output instantly and forcibly becomes FALSE and the internal timer is set to the configured desired value. If the value of Time_ms is less than the cycle time, the cycle time applies instead.
Initial state	All inputs and outputs are FALSE.

Table 55: Switch-off delay function module

9.2.19.1.3.10 Pulse

Description	PLSE, pulse
Inputs	Trigger (BOOL)
Outputs	Output (BOOL)
Parameter	Time ms (UINT32), 1...1,000,000, default = 1,000
Function	If there is a rising edge at the Trigger input at any time, the internal timer is set to zero and starts to run, the output becomes TRUE. If the Trigger input becomes FALSE again during the pulse time, this has no impact on the expiration of the pulse time. Once the internal timer has expired, the output becomes FALSE. If the value of Time_ms is less than the cycle time, the cycle time applies instead.
Initial state	All inputs and outputs are FALSE.

Table 56: Pulse function module

9.2.19.1.3.11 Symmetrical pulse generator

Description	CLK, symmetrical pulse generator
Inputs	Enable (BOOL)
Outputs	Output (BOOL)
Parameter	Time ms (UINT32), 1...1,000,000, default = 1,000
Function	The internal timer runs for a long as Enable is TRUE. When the internal timer has reached or exceeded the configured time value, the status of the output changes and the timer is restarted. The configured time therefore corresponds to half the period duration of the resulting signal. If the Enable input becomes FALSE, the output also instantly becomes FALSE and the internal timer is reset. If the value of Time_ms is less than the cycle time, the cycle time applies instead.
Initial state	All inputs and outputs are FALSE.

Table 57: Symmetrical pulse generator function module

9.2.19.1.3.12 Counter (forwards/backwards)

Description	COUNT, incremental counter
Inputs	Trigger (BOOL) Direction (BOOL) Reset (BOOL) Lock (BOOL)
Outputs	SINT32 (SINT32) REAL32 (REAL32)
Parameter	Reset value (SINT32), -10,000,000... +10,000,000, default = 0
Function	If there is a rising edge at Reset, the output value is set to the value of the Reset value parameter. A rising edge at Reset takes priority over all other inputs. For as long as Lock is TRUE, the pulse signal is not evaluated and the counter reading is retained. If no input is assigned, the default value FALSE is assumed. When Direction input = FALSE, the output value is incremented by one with every rising edge at the Trigger input. When Direction input = TRUE, the output value is decremented by one with every rising edge at the Trigger input.
Initial state	All inputs and outputs are zero or FALSE.

Table 58: Counter (forwards/backwards) function module

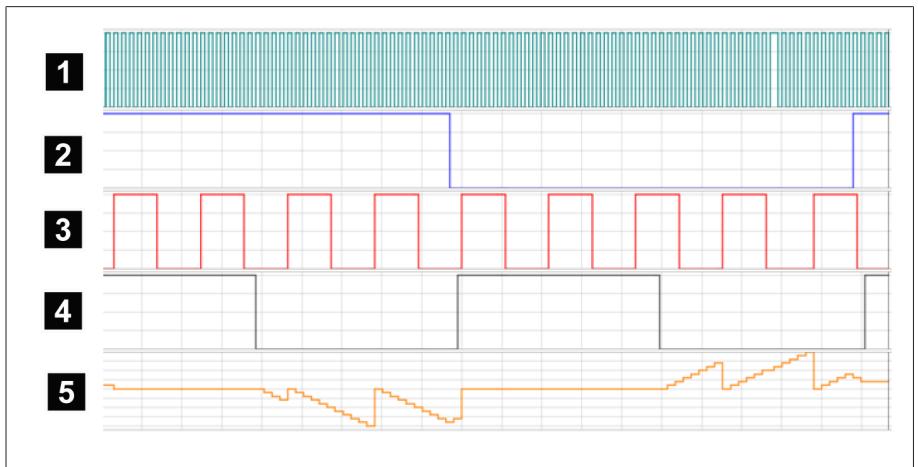


Figure 132: Example of COUNT

1	Trigger	2	Direction
3	Reset	4	Lock
5	Output		

9.2.19.1.3.13 Analog threshold value switch with hysteresis

Designation	THRES, threshold value switch with hysteresis
Inputs	Input (REAL32)
Outputs	Output (BOOL) Error (BOOL)
Parameter	On Limit (REAL32), -10,000,000... +10,000,000, default = 10,000,000 Off Limit (REAL32), -10,000,000 ... +10,000,000, default = -10,000,000

Function	<p>On Limit \geq Off Limit setting:</p> <ul style="list-style-type: none"> - If the value of Input is greater than On Limit, Output becomes TRUE. - If the value of Input is less than or equal to Off Limit, Output becomes FALSE. <p>On Limit $<$ Off Limit setting:</p> <ul style="list-style-type: none"> - If the value of Input is greater than On Limit and at the same time less than Off Limit, Output becomes TRUE. Otherwise, the Output is FALSE.
Initial state	All inputs and outputs are zero or FALSE.

Table 59: Analog threshold value switch with hysteresis function module

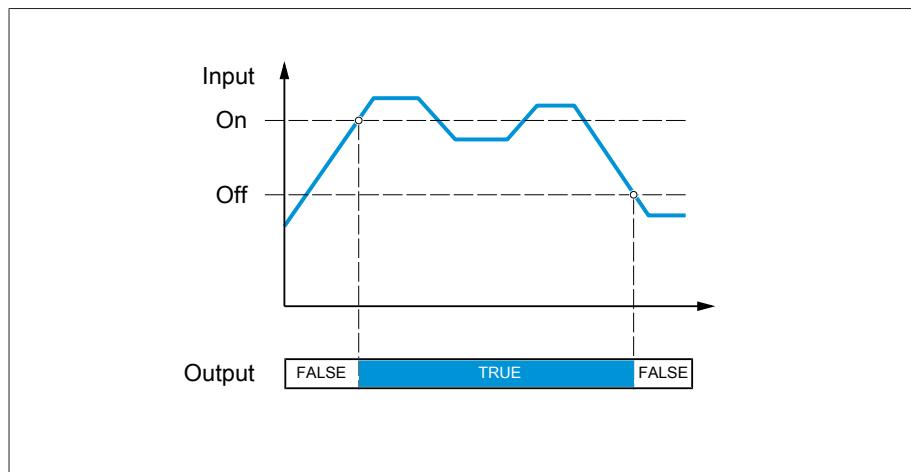


Figure 133: Analog threshold value switch with the On Limit $>$ Off Limit setting

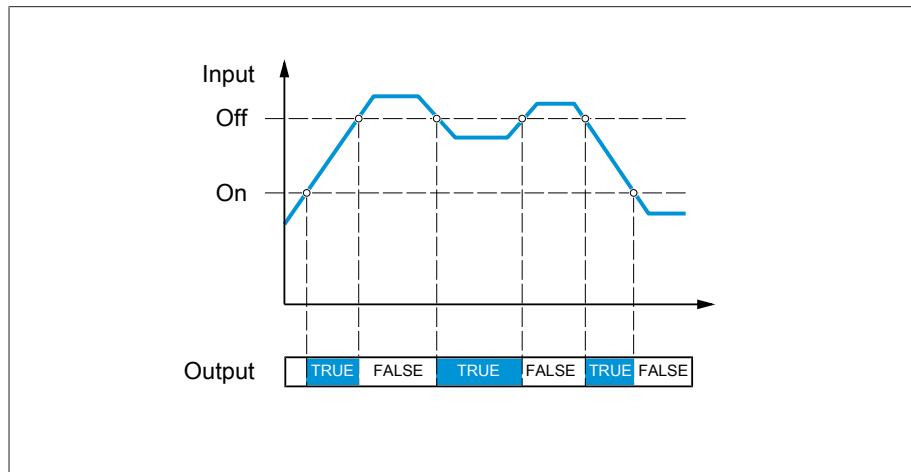


Figure 134: Analog threshold value switch with the On Limit $<$ Off Limit setting

9.2.19.1.3.14 Analog multiplication

Description	MUL, analog multiplication
Inputs	Value (REAL32) Multiplier (REAL32)
Outputs	Result (REAL32) Overflow (BOOL)
Parameter	Constant multiplier (REAL32), -1,000,000...+1,000,000; default = 1

Function	Result = Value * Multiplier * Constant multiplier If the REAL32 range of numbers is exceeded, the Overflow output becomes TRUE.
Initial state	All inputs and outputs are zero or FALSE.

Table 60: Analog multiplication function module

9.2.19.1.3.15 Analog division

Description	DIV, analog division
Inputs	Dividend (REAL32) Divisor (REAL32)
Outputs	Result (REAL32) DivByZero (BOOL) Overflow (BOOL)
Parameter	Constant divisor (REAL32), -1,000,000...+1,000,000; default = 1
Function	Result = Dividend / Divisor / Constant Divisor If dividing by zero, the DivByZero output becomes TRUE and Result is set to zero. If the REAL32 range of numbers is exceeded, the Overflow output becomes TRUE and Result is set to zero.
Initial state	All inputs and outputs are zero or FALSE.

Table 61: Analog division function module

9.2.19.1.3.16 Analog addition

Description	ADD, analog addition
Inputs	Input 1 (REAL32) Input 2 (REAL32)
Outputs	Result (REAL32) Overflow (BOOL)
Parameter	Offset (REAL32), -1,000,000...+1,000,000; default = 0
Function	Result = Input 1 + Input 2 + Offset If the REAL32 range of numbers is exceeded, the Overflow output becomes TRUE.
Initial state	All inputs and outputs are zero or FALSE.

Table 62: Analog addition function module

9.2.19.1.3.17 Analog subtraction

Description	SUB, analog subtraction
Inputs	Input 1 (REAL32) Input 2 (REAL32)
Outputs	Result (REAL32) Overflow (BOOL)
Parameter	Offset (REAL32), -1,000,000...+1,000,000; default = 0

Function	$\text{Result} = \text{Input 1} - \text{Input 2} - \text{Offset}$ If the REAL32 range of numbers is exceeded, the Overflow output becomes TRUE.
Initial state	All inputs and outputs are zero or FALSE.

Table 63: Analog subtraction function module

9.2.19.1.3.18 Rising edge

Description	RTRG, rising edge trigger
Inputs	Input (BOOL)
Outputs	Output (BOOL)
Parameter	-
Function	When the input changes from FALSE to TRUE, the output becomes TRUE for one cycle of the function group and then changes back to FALSE.
Initial state	All inputs and outputs are FALSE.

Table 64: Rising edge function module

9.2.19.1.3.19 Falling edge

Description	FTRG, falling edge trigger
Inputs	Input (BOOL)
Outputs	Output (BOOL)
Parameter	-
Function	When the input changes from TRUE to FALSE, the output becomes TRUE for one cycle of the function group and then changes back to FALSE.
Initial state	All inputs and outputs are FALSE.

Table 65: Falling edge function module

9.2.19.1.3.20 Average value

Description	AVRG, average value
Inputs	Input (REAL32) Enable (BOOL) Reset (BOOL) Autorepeat (BOOL)
Outputs	Average (REAL32) Done (BOOL) Started (BOOL) SampleCount (UINT32)
Parameter	Time ms (UINT32): 1...2,000,000,000, default = 10,000 Sample time ms (UINT32): 1...10,000,000, default = 1,000

Function	<p>Averaging starts with a rising edge of Enable. This does not affect averaging which is already underway. Any output value remaining from earlier is retained. The Done output becomes FALSE, the Started output becomes TRUE.</p> <p>Active averaging is interrupted with a rising edge of Reset. Average is set to zero, Done and Started become FALSE. If Enable is also TRUE during the rising Reset edge, a new averaging process is started.</p> <p>Done becomes TRUE and Started becomes FALSE once averaging is complete. Done remains TRUE until a Reset is detected or new averaging is triggered by a rising edge of Enable.</p> <p>If AutoRepeat and Enable are TRUE, a new averaging process is automatically started each time averaging is completed. Done is set for one cycle each time averaging is completed.</p> <p>The SampleCount output states how many samples have already been recorded.</p> <p>Sample time ms is the desired sample time in milliseconds. It is rounded up to the next whole multiple of the task cycle time and has a lower limit of at least one task cycle time.</p> <p>Time ms is the time period desired for averaging. It is internally rounded up to the next whole multiple of the sample time and has a lower limit of at least one sample time.</p>
Initial state	All inputs and outputs are FALSE.

Table 66: Average value function module

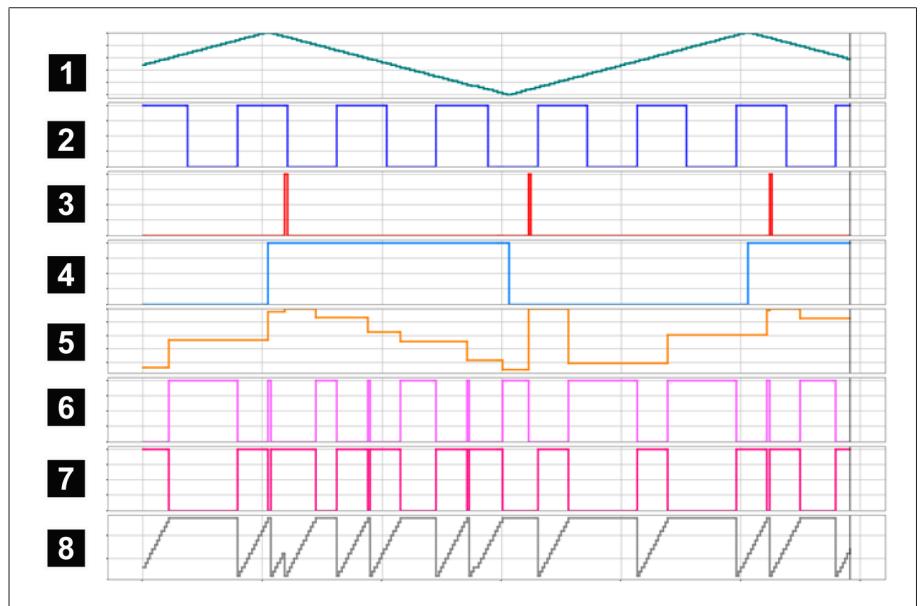


Figure 135: AVRG

1	Input	2	Enable
3	Reset	4	AutoRepeat
5	Average	6	Done
7	Started	8	SampleCount

9.2.19.1.3.21 Scaling

Description	SCAL, scaling
Inputs	Input (REAL32)
Outputs	Output (REAL32) Error (BOOL)
Parameter	Min In (REAL32): -10,000,000...+10,000,000, default = -10,000,000 Max In (REAL32): -10,000,000...+10,000,000, default = +10,000,000 Min Out (REAL32): -10,000,000...+10,000,000, default = -10,000,000 Max Out (REAL32): -10,000,000...+10,000,000, default = +10,000,000
Function	Output is calculated using the following formula: $\text{Output} = \text{Min Out} + (\text{Max Out} - \text{Min Out}) \times (\text{Input} - \text{Min In}) / (\text{Max In} - \text{Min In})$ Output is set to 0 and Error = TRUE when: <ul style="list-style-type: none">- Input is not within the parameters Min In and Max In- Min In is greater than Max In- Min Out is greater than Max Out- Max In is the same size as Min In (division by zero)
Initial state	All inputs and outputs are FALSE.

Table 67: Scaling function module

9.2.19.1.3.22 Bridge

Designation	BRDG, Bridge
Inputs	Analog Input (REAL32) Digital Input (BOOL)
Outputs	Analog Output (REAL32) Digital Output (BOOL)
Parameter	-
Function	Copies the value of Analog Input to Analog Output and Digital Input to Digital Output.
Initial state	All inputs and outputs are zero or FALSE.

Table 68: Bridge function module

9.2.19.1.3.23 RTOI

Description	RTOI, Real-to-Integer conversion
Inputs	Analog Input (REAL32)
Outputs	Analog Output (SINT32)
Parameter	-
Function	Copies the value of Analog Input to Analog Output and converts REAL32 to SINT32.
Initial state	All inputs and outputs are zero.

Table 69: RTOI function module

9.2.19.1.3.24 ITOR

Description	ITOR, Integer-to-real conversion
Inputs	UINT32 (UINT32) SINT32 (SINT32)
Outputs	Output U (REAL32) Output S (REAL32)
Parameter	-
Function	The value of UINT32 is output converted to Output U, the value of SINT32 is output converted to Output S.
Initial state	All inputs and outputs are zero.

Table 70: NAND function module

9.2.19.2 Configuring TPLE

You can configure TPLE on a PC using the web-based visualization. Only a live view is available on the device's display. To configure TPLE, you have to hold the role of Administrator or Parameterizer.

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

- User name: admin
- Password: admin

9.2.19.2.1 Editing variables

You can adapt the name and description of the following variables:

- Binary inputs
- Binary outputs
- Analog inputs
- Binary flags
- Analog flags
- Discrete inputs

i The names and descriptions of the generic events can also be adapted like all other device events. Note the Event management [▶ Section 9.2.13, Page 113] section.

The permissible number of characters is limited:

- Name: Maximum of 20 characters
- Description: Maximum of 80 characters

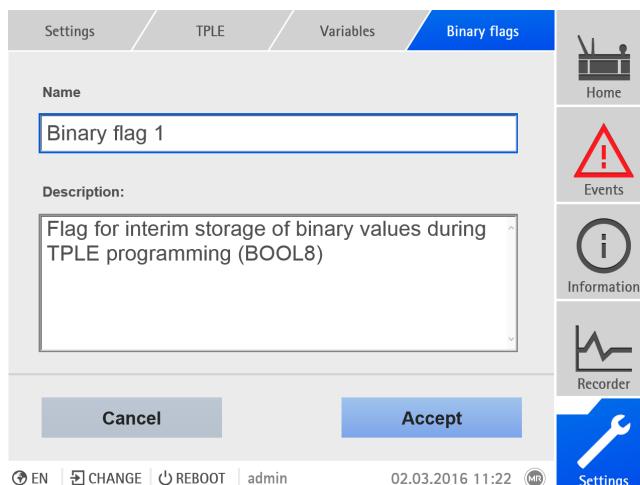


Figure 136: Editing variable

To edit the variable, proceed as follows:

1. Go to **Settings > TPLE > Variables**.
2. Select the **variable** you want.
3. Enter the **Name** and **Description**.
4. Press the **Accept** button to save the modified variable.

9.2.19.2.2 Creating functions

Within one function group, you can create up to 12 function modules to depict one function. To create, edit or delete a function, you have to call up the function group you want. To do so, proceed as follows:

1. Go to **Settings > TPLE > Function group**.
2. Select the desired **Function group**.

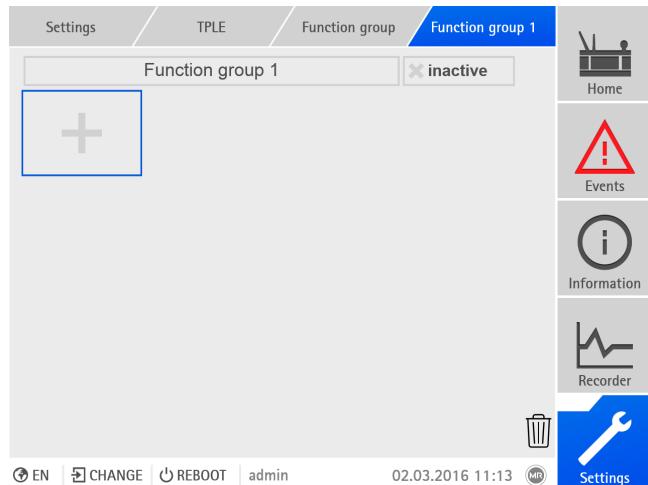


Figure 137: Function group

Creating function modules

To create a function module, proceed as follows:

- › Press the **+** button to create a new function module.

Deleting function modules

To delete a function module, proceed as follows:

- › Drag the desired **function module** to the trash can using drag & drop.

Sorting function modules

To sort a function module, proceed as follows:

- › Drag the desired **function module** to the desired position using drag & drop.

Editing function module

To edit a function module, proceed as follows:

1. Select the desired **function module**.
2. Press the **Edit** button.

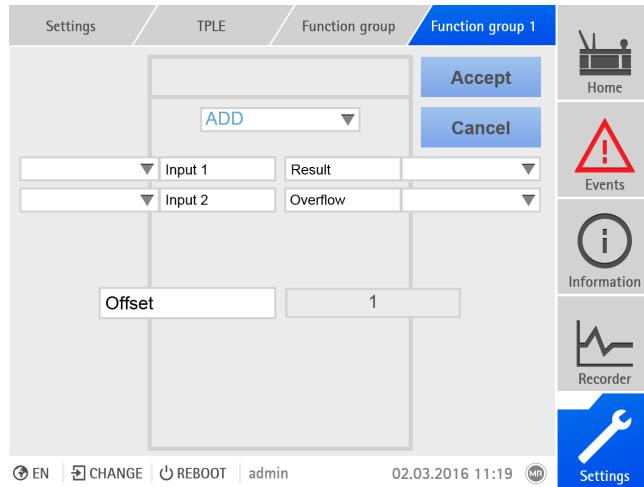


Figure 138: Editing function module

3. Select the **inputs** and **outputs** you want and set the **parameters**.
4. Press the **Accept** button to save the change to the function module.

9.2.19.2.3 Renaming function group

If necessary, you can rename the function group in order to better assign it.

To rename a function group, proceed as follows:

1. Go to **Settings** > **TPLE** > **Function group**.
2. Select the desired **Function group**.
3. Select the text field with the **name of the function group** and enter the name you want.

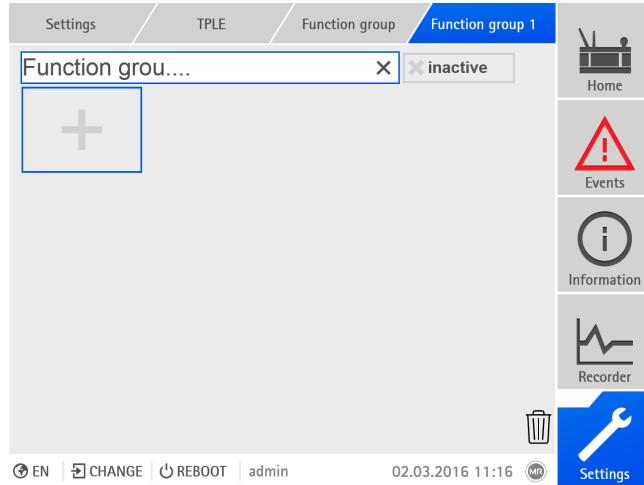


Figure 139: Renaming function group

4. Press [Enter] to accept the change.

9.2.19.2.4 Activating/deactivating function group

You can fully activate or deactivate a function group. When you deactivate a function group, none of the function group's function modules are processed.

To activate/deactivate a function group, proceed as follows:

1. Go to **Settings** > **TPLE** > **Function group**.
2. Select the desired **Function group**.

3. Press the **inactive** button.

» Red X: Function group is inactive; gray X: Function group is active.

9.2.20 Displaying temperature curve (optional)

If you are using additional temperature sensors (generic temperature 1...8), you can display the temperature curve for these temperatures over the last 10 days. To do so, proceed as follows:

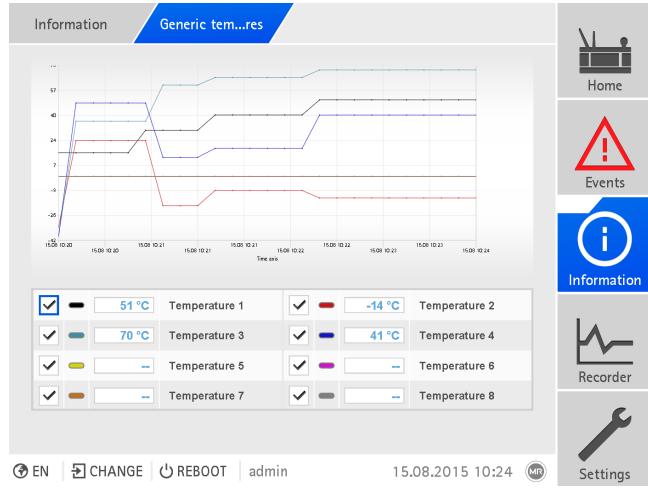


Figure 140: Generic temperatures

› Go to [Information System > Gener. temperatures](#).

9.2.21 Linking to the visualization of external devices

You can create links to the web-based visualization of up to 5 devices. This enables you to call up the visualizations of other devices directly from the visualization of the ISM® device without having to know their IP address.

i You can only call up the link to the visualization of an external device if you call up the visualization via a PC web browser. If you want to call up the visualizations of external devices via the MControl touch panel, you must add the IP addresses of the external devices as additional "servers" in the touch panel configuration.

9.2.21.1 Setting up an external visualization

To set up a link to the visualization of an external device, you must set the parameters described in the following.

Name	Value
External visualization 1 name	External Visualization 1
External visualization 1 product	Generic IP address
External visualization 1 protocol	https
External visualization 1 IP address	0.0.0.0
External visualization 2 name	External Visualization 2
External visualization 2 product	Generic IP address
External visualization 2 protocol	https
External visualization 2 IP address	0.0.0.0
External visualization 3 name	External Visualization 3
External visualization 3 product	Generic IP address
External visualization 3 protocol	https
External visualization 3 IP address	0.0.0.0

Figure 141: External visualization

> Go to **Settings > Parameters > System > External visualization**.

External visualization name

Use this parameter to set the designation for the link to the visualization of the external device (e.g., the designation of the external device).

External visualization product

Use this parameter to select the product whose visualization is to be called up. By doing so, depending on the product, a defined path is linked to the IP address of the external visualization (e.g., <IP address>/visu/home). If you select the "Generic IP address" option, a path will not be used.

External visualization protocol

Use this parameter to set the protocol for calling up the external visualization. You can select the following options:

- https
- http

External visualization IP address

Use this parameter to set the IP address of the external visualization.

9.2.21.2 Calling up an external visualization

To call up an external visualization, proceed as follows:

1. Go to **Information > System > External visualization**.

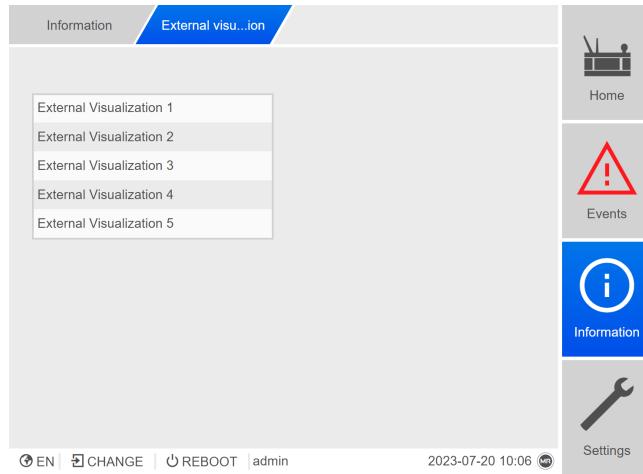


Figure 142: External visualization

2. Select the desired visualization.
 - » The visualization will be opened in a new tab in the browser.
3. If necessary, select the **Reopen** button to reopen the external visualization.

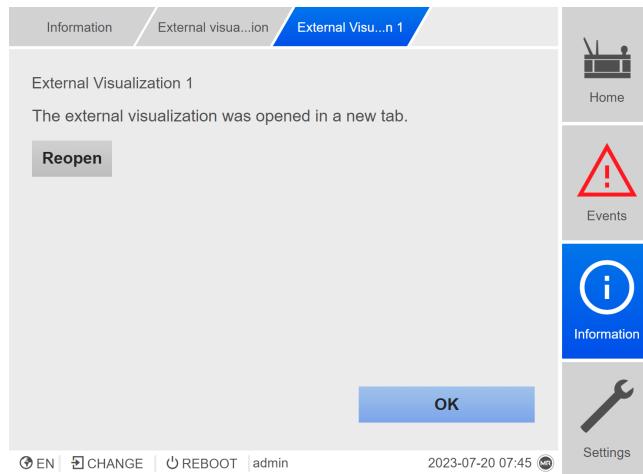


Figure 143: Visualization 1

9.3 Power grid

9.3.1 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.

9.3.1.1 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 [▶ Section 9.3.1.2, Page 148].

Name	Value
Primary transformer voltage	100 kV
Secondary transformer voltage	100 V
Primary transformer current	100 A
Secondary transformer current	1 A
Phase angle correction	0°
Voltage-transformer circuit	1 Ph phase voltage
Current-transformer circuit	1 Ph phase current

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Figure 144: Transformer data

› Go to **Settings > Parameters > Power grid > Transformer data**.

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

Measurement mode

If you are measuring the voltage and current with the 3-phase measuring module, you can use this parameter to set whether you have connected the voltage transformer between two phases or between a phase and neutral.

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 71: 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 72: 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).

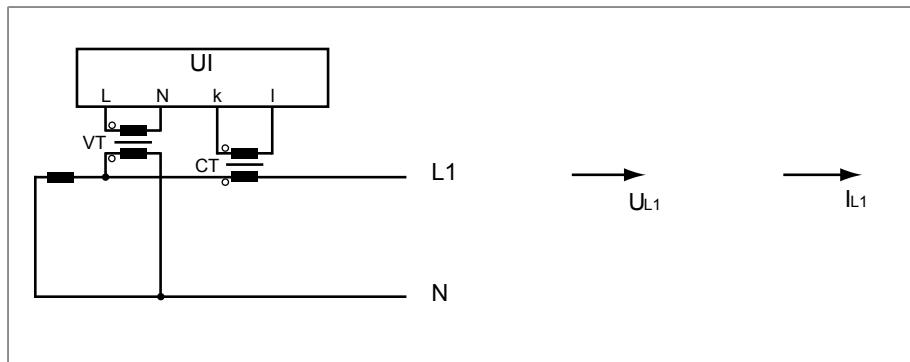
If the voltage is measured with a 3-phase measurement module, you can only set the voltage balance if you select the "1-ph. measurement" option for the parameter UI measuring channels [▶ Page 160].

9.3.1.2 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.

9.3.1.2.1 1-phase measurement

Circuit 1-A



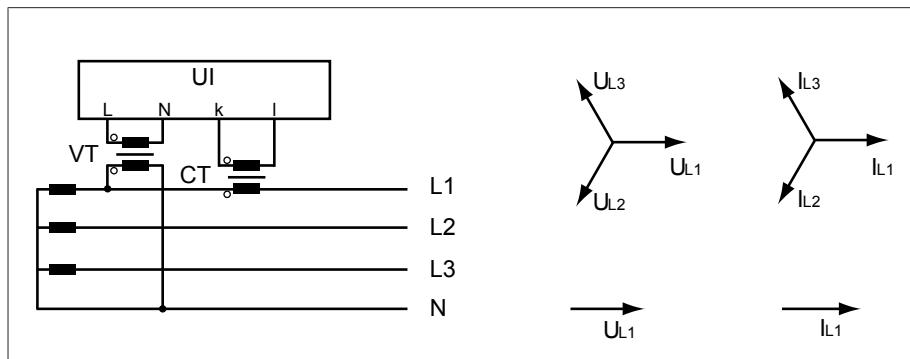
- The voltage transformer VT is connected to the phase conductor and neutral conductor.
- The current transformer CT is looped into the phase conductor.
- The voltage U_{L1} and current I_{L1} are in phase.
- The voltage drop on a phase conductor is determined by the current I_{L1} .

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

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

Table 73: Circuit 1-A

Circuit 1-B



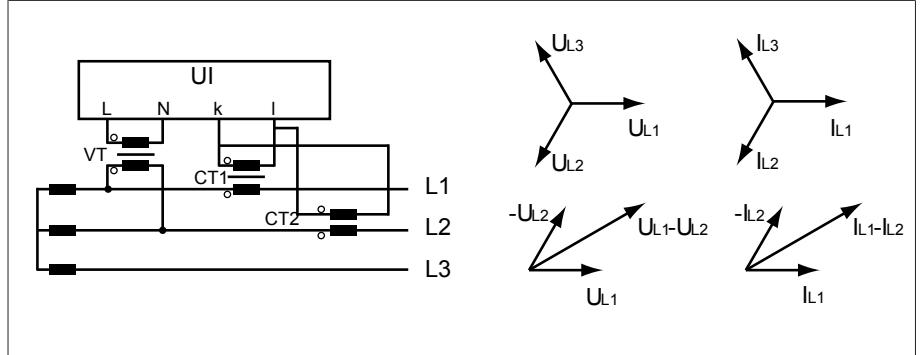
- The voltage transformer VT is connected to the phase conductor L1 and the neutral conductor.
- The current transformer CT is looped into the phase conductor L1.
- The voltage U and current I are in phase.
- The voltage drop on a phase conductor is determined by the current I_{L1} .

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

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

Table 74: Circuit 1-B

Circuit 1-C



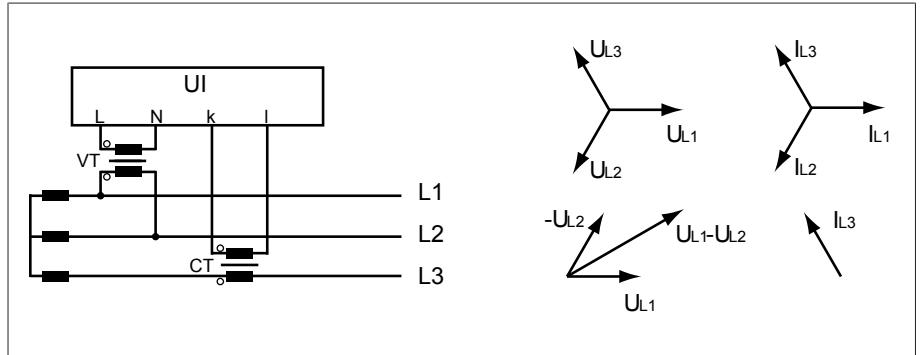
- The voltage transformer VT is connected to the phase conductors L1 and L2.
- The current transformer CT1 is looped into the phase conductor L1 and CT2 into the phase conductor L2.
- The current transformers CT1 and CT2 are connected crosswise in parallel (total current = $I_{L1} + I_{L2}$).
- The total 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:

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

Table 75: Circuit 1-C

Circuit 1-D



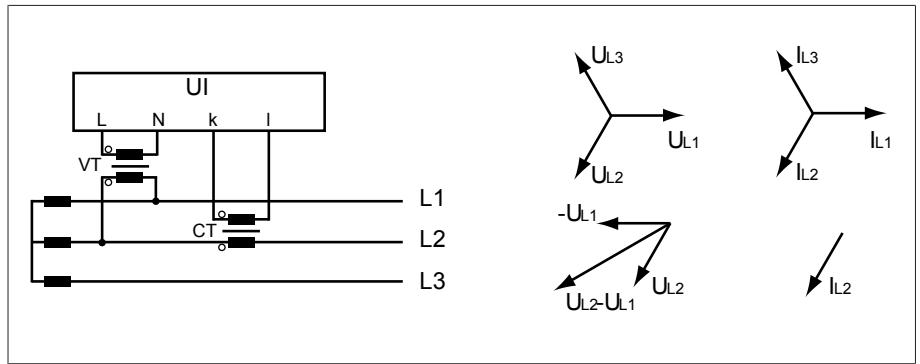
- The voltage transformer VT is connected to the phase conductors L1 and L2.
- The current transformer CT is looped into the phase conductor L3.
- The current I_{L3} is ahead of voltage $U_{L1}-U_{L2}$ by 90°. This corresponds to a phase shift of -90°.
- The voltage drop on a phase conductor is determined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

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

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

Table 76: Circuit 1-D

Circuit 1-E



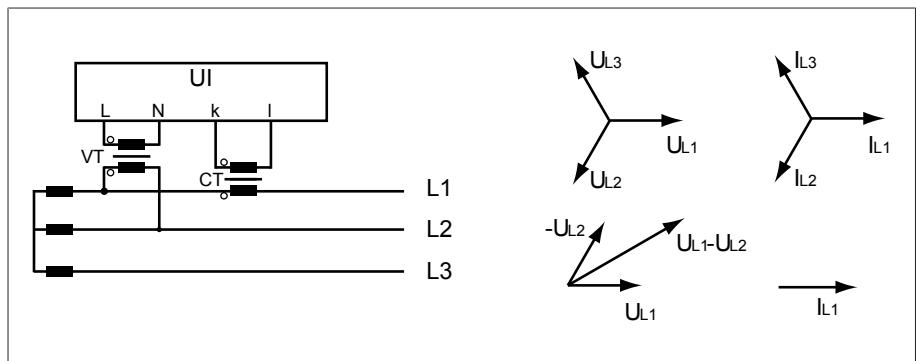
- The voltage transformer VT is connected to the phase conductors L1 and L2.
- The current transformer CT is looped into the phase conductor L2.
- The current I_{L2} is ahead of voltage $U_{L2} - U_{L1}$ by 30° . This corresponds to a phase shift of -30° .
- The voltage drop on a phase conductor is determined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

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

Parameters	Option
Voltage-transformer circuit	3 Ph differential voltage
Current-transformer circuit	3 Ph phase current
Phase angle correction	30°

Table 77: Circuit 1-E

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° . This corresponds to a phase shift of $+30^\circ$ and a correction value of -30° .
- The voltage drop on a phase conductor is determined by the current I_{L1} .

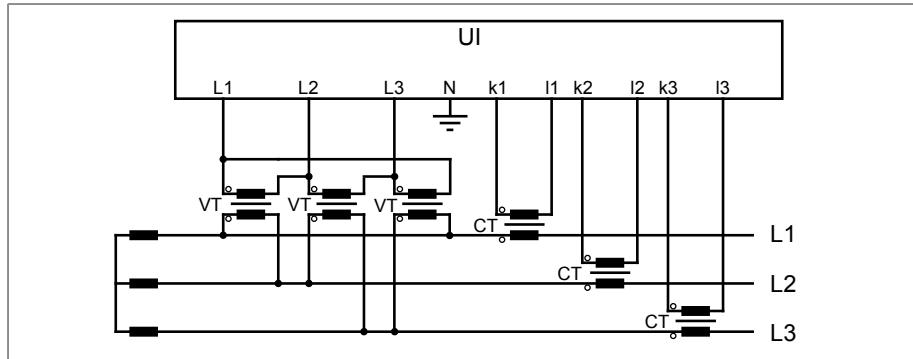
If you use this circuit, set the device as follows:

Parameters	Option
Voltage-transformer circuit	3 Ph differential voltage
Current-transformer circuit	3 Ph phase current
Phase angle correction	-30°

Table 78: Circuit 1-F

9.3.1.2.2 3-phase measurement

Circuit 3-A



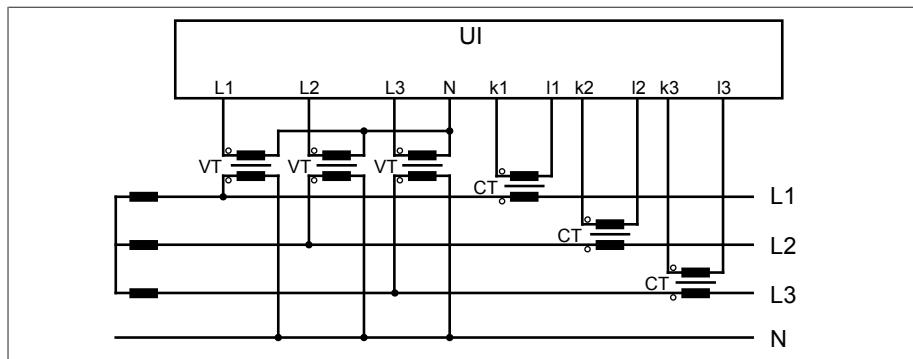
- Three-phase measurement.
- The voltage transformers are connected between the phases.
- The current lags behind the voltage by 30°.

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

Parameters	Option
Voltage-transformer circuit	-
Current-transformer circuit	-
Phase angle correction	0°
UI measuring channels	3-phase measurement (channels 1, 2, 3)
Measurement mode	Phase-phase

Table 79: Circuit 3-A

Circuit 3-B



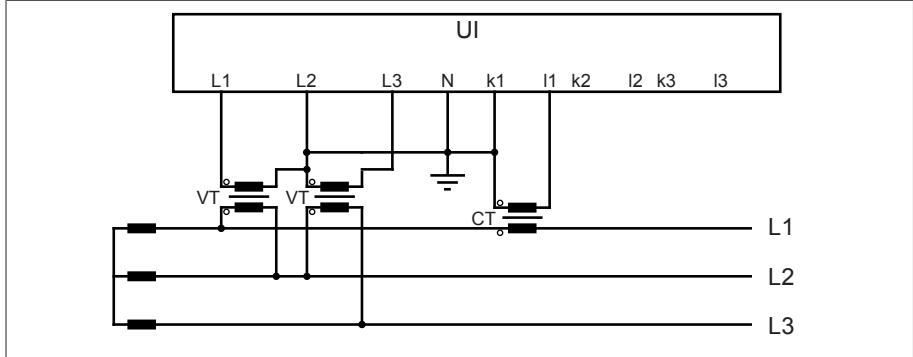
- Three-phase measurement.
- The voltage transformers are connected between the phase and neutral conductor.

Parameters	Option
Voltage-transformer circuit	-
Current-transformer circuit	-
Phase angle correction	0°
UI measuring channels	3-phase measurement (channels 1, 2, 3)
Measurement mode	Phase-neutral

Table 80: Circuit 3-B

i Only use the circuits 3-C, 3-D and 3-E on symmetrical grids. Otherwise the device will calculate incorrect performance values.

Circuit 3-C



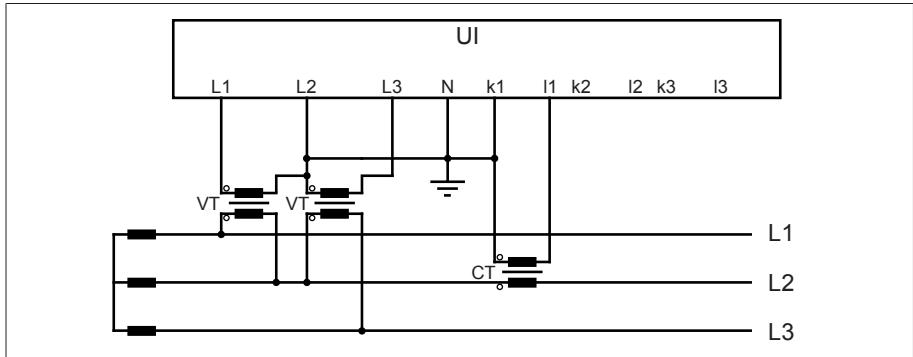
- Three-phase voltage measurement, single-phase current measurement.
- The voltage transformers are connected between the phases.
- The current transformer is connected to phase L1.

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

Parameters	Option
Voltage-transformer circuit	-
Current-transformer circuit	-
Phase angle correction	-30°
UI measuring channels	3-ph. voltage, 1-ph. current
Measurement mode	Phase-phase

Table 81: Circuit 3-C

Circuit 3-D



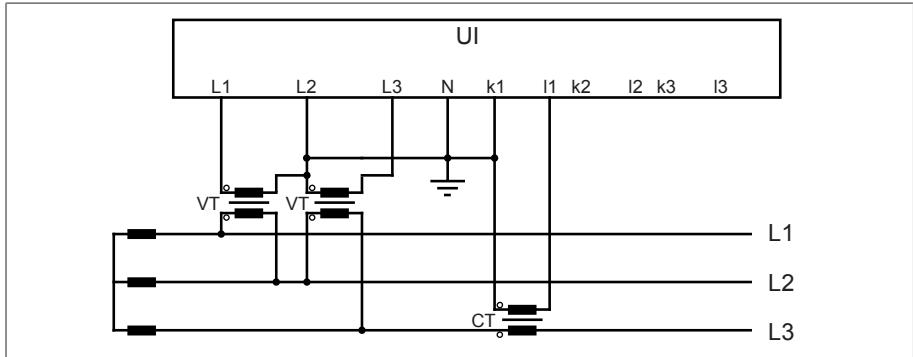
- Three-phase voltage measurement, single-phase current measurement.
- The voltage transformers are connected between the phases.
- The current transformer is connected to phase L2.

Parameters	Option
Voltage-transformer circuit	-
Current-transformer circuit	-
Phase angle correction	-150°

Parameters	Option
UI measuring channels	3-ph. voltage, 1-ph. current
Measurement mode	Phase-phase

Table 82: Circuit 3-D

Circuit 3-E

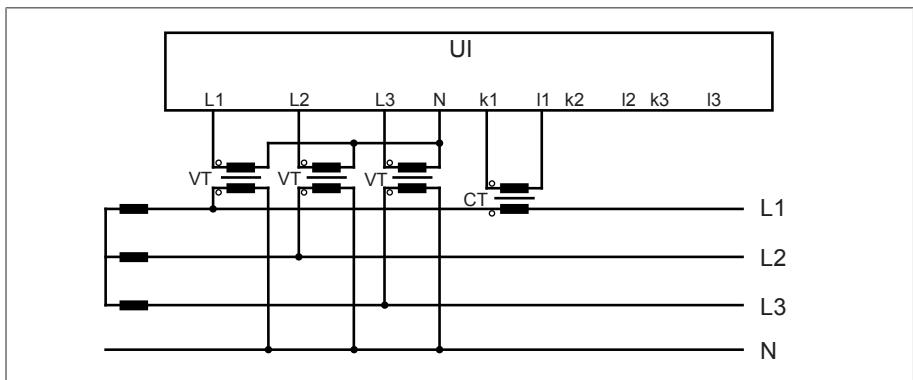


- Three-phase voltage measurement, single-phase current measurement.
- The voltage transformers are connected between the phases.
- The current transformer is connected to phase L3.

Parameters	Option
Voltage-transformer circuit	-
Current-transformer circuit	-
Phase angle correction	90°
UI measuring channels	3-ph. voltage, 1-ph. current
Measurement mode	Phase-phase

Table 83: Circuit 3-E

Circuit 3-F



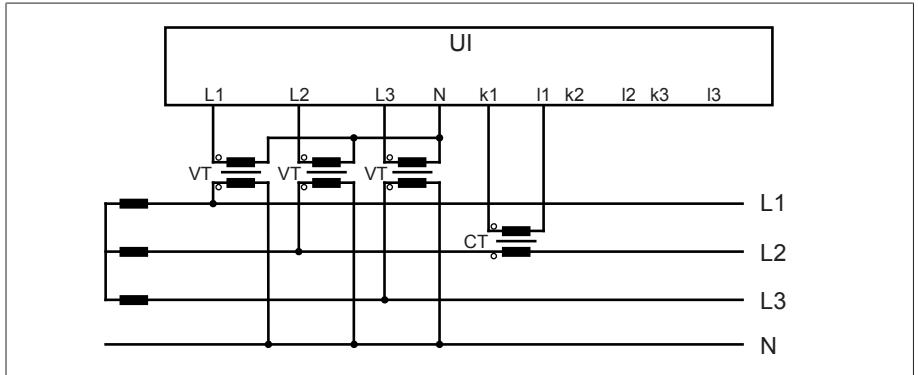
- Three-phase voltage measurement, single-phase current measurement.
- The voltage transformers are connected between the phase and neutral conductor.
- The current transformer is connected to phase L1.

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

Parameters	Option
UI measuring channels	3-ph. voltage, 1-ph. current
Measurement mode	Phase-neutral

Table 84: Circuit 3-F

Circuit 3-G

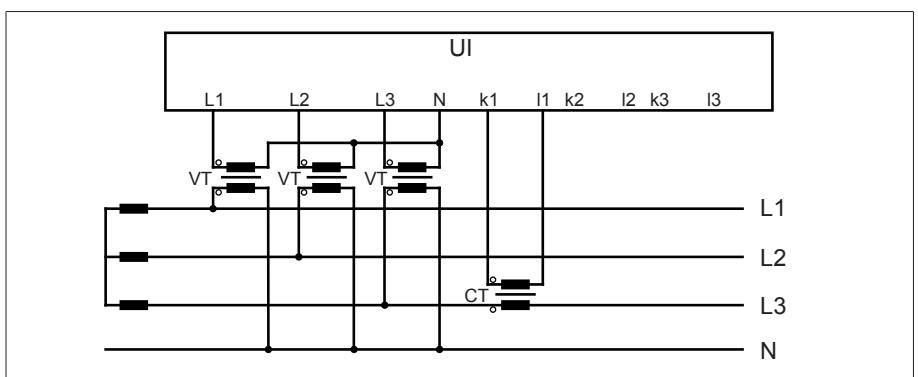


- Three-phase voltage measurement, single-phase current measurement.
- The voltage transformers are connected between the phase and neutral conductor.
- The current transformer is connected to phase L2.

Parameters	Option
Voltage-transformer circuit	3 Ph phase voltage
Current-transformer circuit	3 Ph phase current
Phase angle correction	-120°
UI measuring channels	3-ph. voltage, 1-ph. current
Measurement mode	Phase-neutral

Table 85: Circuit 3-G

Circuit 3-H



- Three-phase voltage measurement, single-phase current measurement.
- The voltage transformers are connected between the phase and neutral conductor.
- The current transformer is connected to phase L3.

Parameters	Option
Voltage-transformer circuit	3 Ph phase voltage
Current-transformer circuit	3 Ph phase current
Phase angle correction	120°
UI measuring channels	3-ph. voltage, 1-ph. current
Measurement mode	Phase-neutral

Table 86: Circuit 3-H

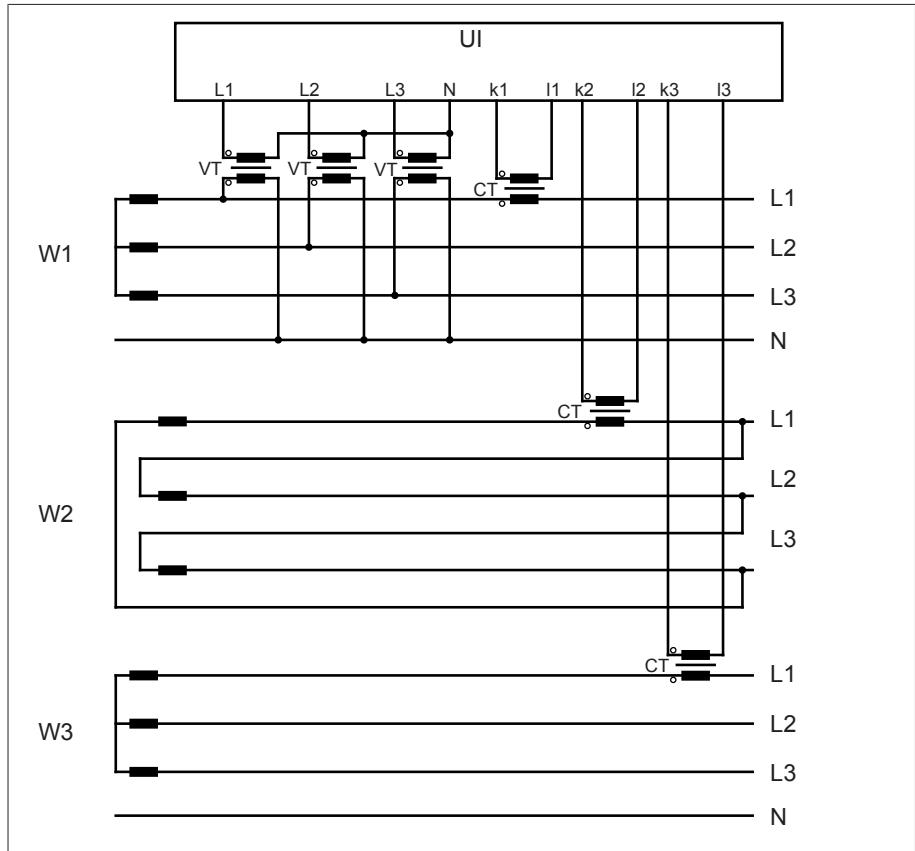
9.3.1.2.3 Current measurement for hot-spot calculation on 3 different windings (optional)

The following circuits (S-1, S-2, S-3 and S-4) describe special cases of current measurement for hot-spot calculation on 3 different windings (e.g. three-winding transformer or transformer with tertiary winding).

Only use these circuits in symmetrical grids. Note that you must always take the W1 voltage and current measurements on the low-voltage side of the transformer.

- W1: Voltage measurement and current measurement for the power calculation and hot-spot calculation on winding 1
- W2: Current measurement for hot-spot calculation on winding 2
- W3: Current measurement for hot-spot calculation on winding 3

Circuit S-1

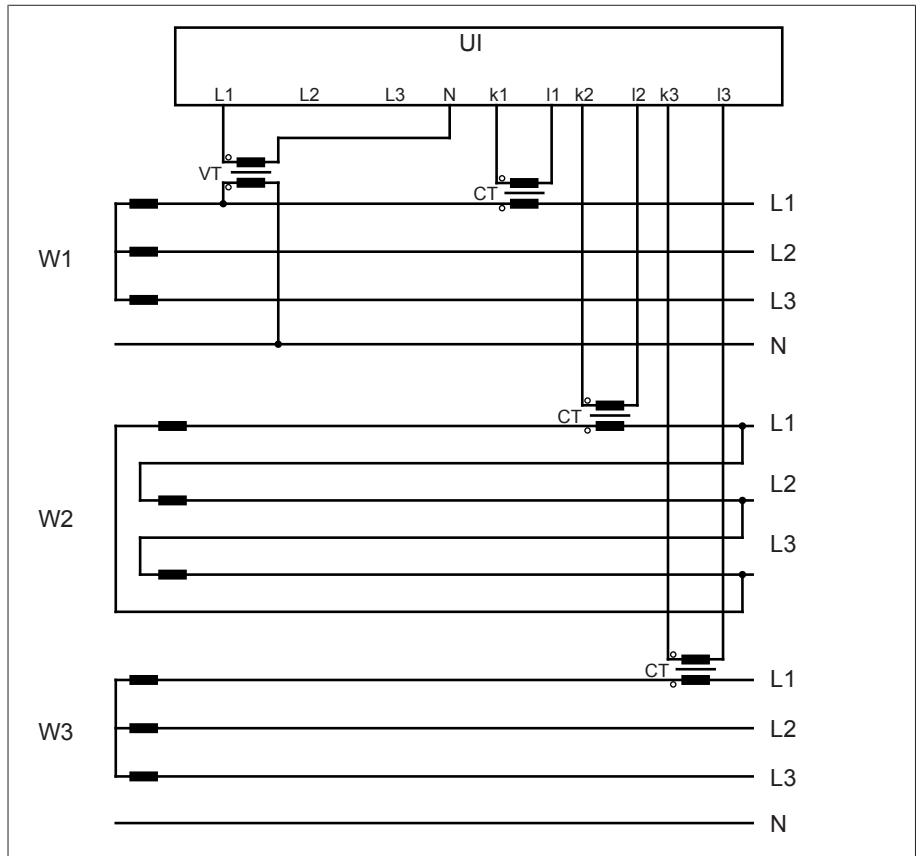


If you use this circuit, set the device as follows:

Parameters	Option
Voltage-transformer circuit	-
Current-transformer circuit	3 Ph phase current
Current-transformer circuit W2	Total current
Current-transformer circuit W3	Phase current
Phase angle correction	0°
UI measuring channels	3-ph. voltage, 1-ph. current
Measurement mode	Phase-neutral

Table 87: Circuit S-1

Circuit S-2

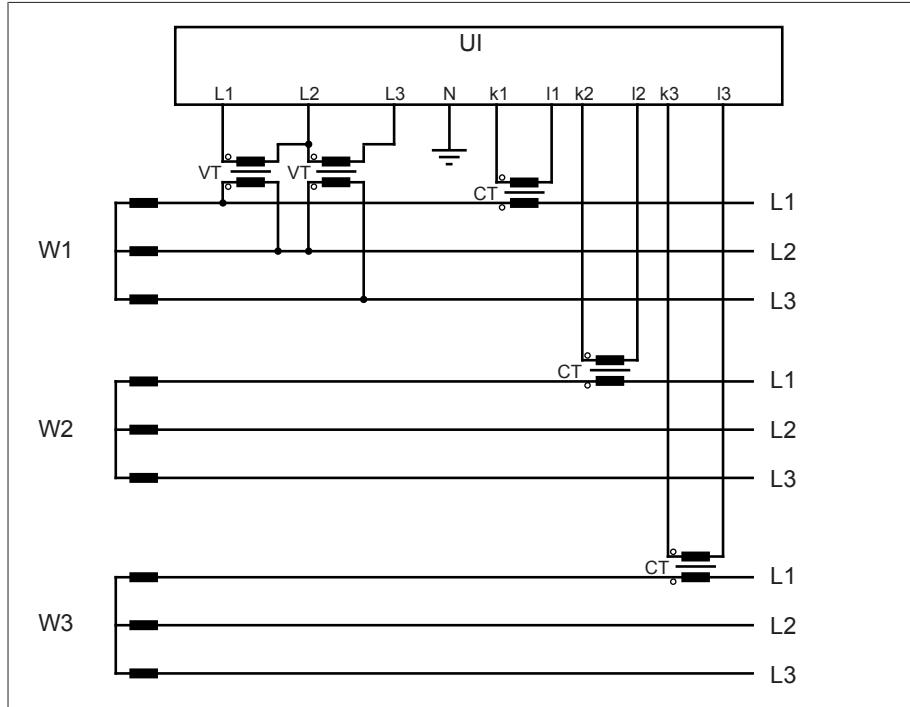


If you use this circuit, set the device as follows:

Parameters	Option
Voltage-transformer circuit	3 Ph phase voltage
Current-transformer circuit	3 Ph phase current
Current-transformer circuit W2	Total current
Current-transformer circuit W3	Phase current
Phase angle correction	0°
UI measuring channels	1-ph. measurement: Channel 1, 2, 3
Measurement mode	-

Table 88: Circuit S-2

Circuit S-3

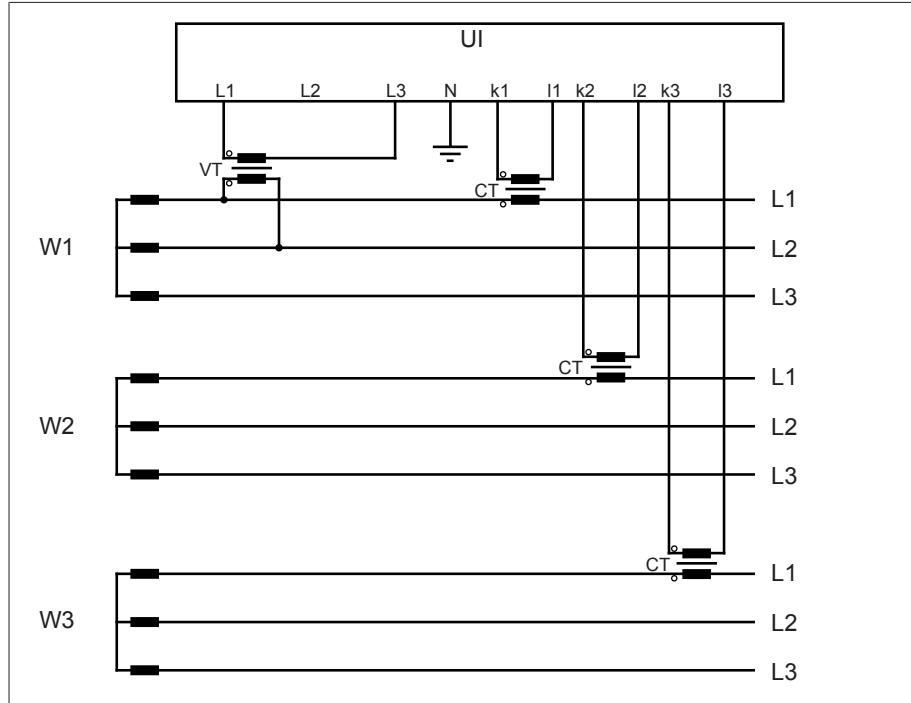


If you use this circuit, set the device as follows:

Parameters	Option
Voltage-transformer circuit	-
Current-transformer circuit	3 Ph phase current
Current-transformer circuit W2	Phase current
Current-transformer circuit W3	Phase current
Phase angle correction	0°
UI measuring channels	3-ph. voltage, 1-ph. current
Measurement mode	Phase-phase

Table 89: Circuit S-3

Circuit S-4



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

Parameters	Option
Voltage-transformer circuit	3 Ph differential voltage
Current-transformer circuit	3 Ph phase current
Current-transformer circuit W2	Phase current
Current-transformer circuit W3	Phase current
Phase angle correction	-30°
UI measuring channels	1-ph. measurement: Channel 1, 2, 3
Measurement mode	-

Table 90: Circuit S-4

9.3.2 Measurement

You can use the following parameters to configure the measurement of current and voltage.

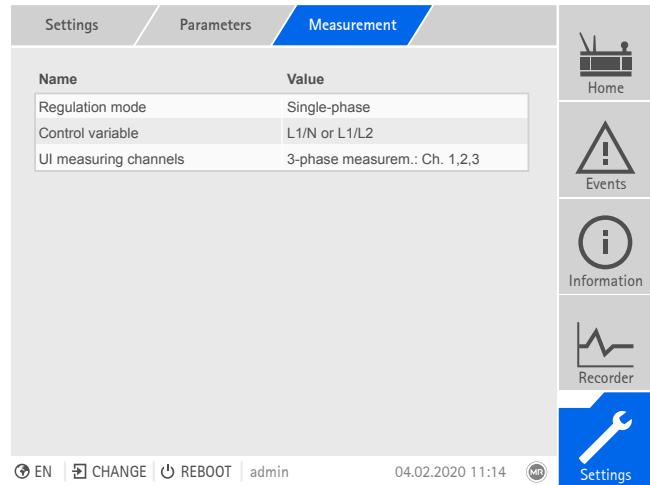


Figure 145: Measurement

› Go to **Settings > Parameters > Power grid > Measurement**.

UI measuring channels

If you are measuring the voltage and current with the 3-phase UI 3 measuring module, you can use this parameter to set the measurement channels in use:

Option	Description
1-ph. measurement: Channel 1	The device uses 1 channel each for measurement of voltage and current.
3-ph. measurement: Channel 1, 2, 3	The device uses 3 channels each for measurement of voltage and current.
3-ph. voltage, 1-ph. current	The device uses 3 channels for voltage measurement and 1 channel for current measurement.

Table 91: UI measuring channels

Control variable

If you are measuring the voltage and current with the 3-phase UI 3 measuring module and using the "single-phase" regulation mode, this parameter can be used to select the phase used for voltage regulation. You can select the following options:

- L1/N or L1/L2
- L2/N or L2/L3
- L3/N or L3/L1

Regulation mode

If you are measuring the voltage and current with the 3-phase UI 3 measuring module, you can use this parameter to set whether you want 1-phase voltage regulation or voltage regulation to the average value of the 3 phases. You can select the following options:

- Single-phase: Voltage is automatically regulated to one selected phase. Limit value monitoring, line drop compensation, and parallel operation also take place on the selected phase using the circulating reactive current minimization method.
- Average value regulation: Voltage is automatically regulated to the average of the 3 phases. Limit value monitoring, line drop compensation, and parallel operation also take place using the circulating reactive current minimization method to the average of the 3 phases.

i If you activate the average value regulation option, automatic voltage regulation is blocked should the voltage or current measurement of one of the 3 phases fail.

Display power factor negative

You can use this parameter to set whether the device is to display a negative power factor. You can select the following options:

Option	Description
Off	The power factor is always shown as positive.
$P > 0$	The power factor is shown as negative if the active power is positive.
$P < 0$	The power factor is shown as negative if the active power is negative.
$Q > 0$	The power factor is shown as negative if the reactive power is positive.
$Q < 0$	The power factor is shown as negative if the reactive power is negative.

Table 92: Setting the display for the power factor

9.3.3 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.

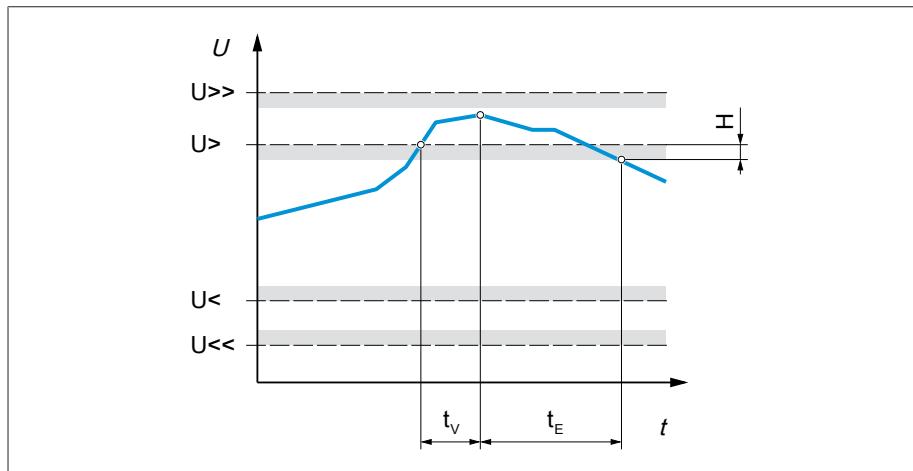


Figure 146: Example of voltage monitoring with the limit value Overvoltage $U>$ being exceeded

$U>>$	Overvoltage $U>>$	$U>$	Overvoltage $U>$
$U<$	Undervoltage $U<$	$U<<$	Undervoltage $U<<$
t_v	Delay time	t_E	Event duration
H	Hysteresis		

You can set the following parameters for each limit value:

- Relative/absolute limit value
- Limit value [V]: Absolute limit value
- Limit value [%]: Limit value relative to the desired voltage value (only for devices with voltage regulation)
- Hysteresis limit value
- Delay time limit value
- Behavior limit value (only for devices with voltage regulation)

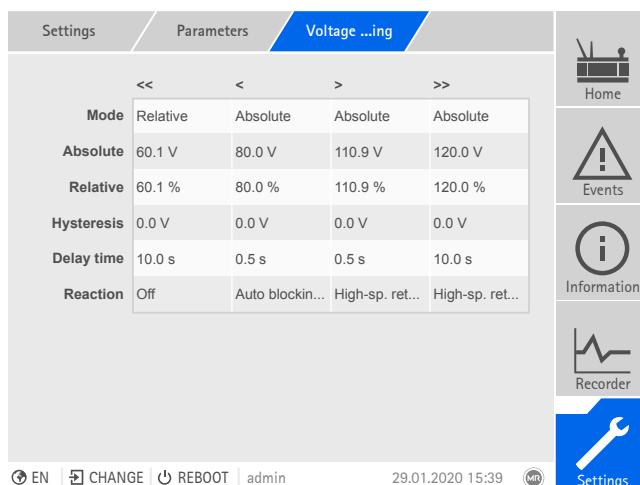


Figure 147: Voltage monitoring

> Go to **Settings > Parameters > Power grid > Voltage monitoring**.

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.

Absolute

You can use this parameter to specify an absolute limit value in V (relative to the secondary value of the voltage transformer) or in kV (relative to the primary value of the voltage transformer). Unlike the relative value, this limit is not dependent on a reference value.

Percentage

You can use this parameter to set the limit value 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	For U</U<<: The device performs tap-change operations in the raise voltage direction (U+) until the measured voltage is back above the limit value. For U>/U>>: The device performs tap-change operations in the lower voltage direction (U-) until the measured voltage is back below the limit value. With high-speed return, the device ignores the set delay time of automatic voltage regulation.
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 cannot 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 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.

Table 93: 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.

9.3.4 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.

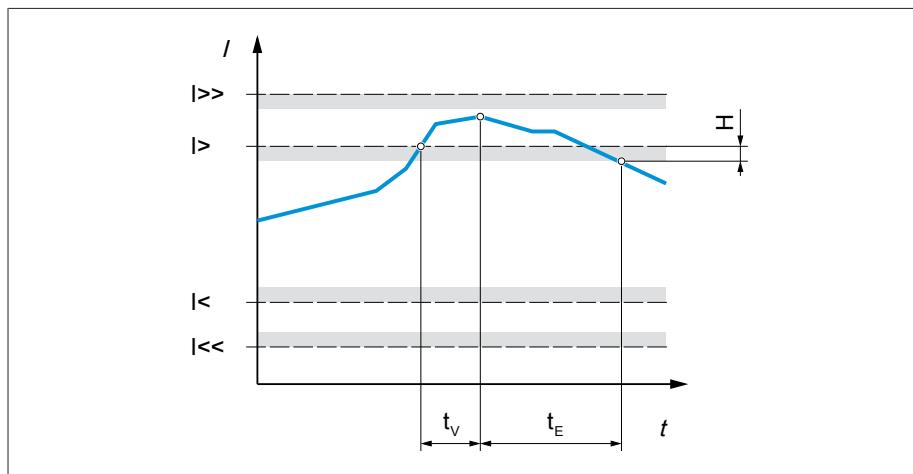


Figure 148: Example of current monitoring with the limit value $I_{>}$ being exceeded

$I_{>>}$	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		

You can set the following parameters for each limit value:

- Relative/absolute limit value
- Limit value [A] or [kA]: Absolute limit value
- Limit value [%]: Limit value relative to the rated current of current transformer. With current measurements via the analog input, the value is relative to the maximum value of the analog input (e.g. 100% = 20 mA).
- Hysteresis limit value
- Delay time limit value
- Behavior limit value (only for devices with voltage regulation)

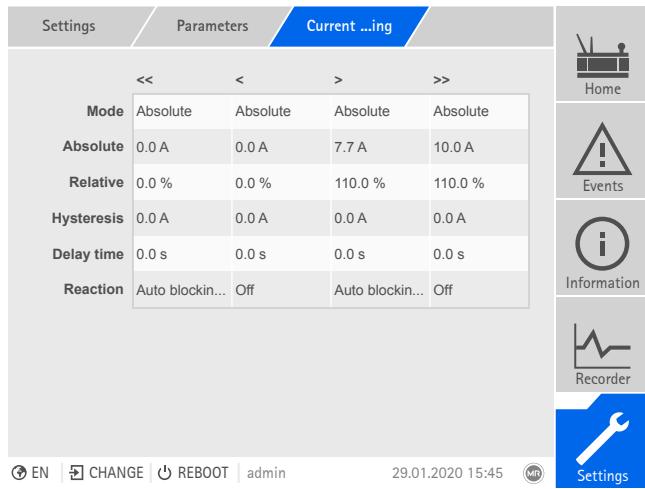


Figure 149: Current monitoring

> Go to **Settings > Parameters > Power grid > Current monitoring**.

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.

Absolute

You can use this parameter to specify an absolute limit value in A (in relation to the secondary value of the current transformer) or in kA (in relation to the primary value of the current transformer).

Percentage

You can use this parameter to set the limit value relative to the rated current of current transformer. With current measurements via the analog input, the value is relative to the maximum value of the analog input (e.g. 100% = 20 mA).

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 cannot perform tap-change operations in manual mode.

Table 94: Behavior when an event message is issued

9.3.5 Power monitoring

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

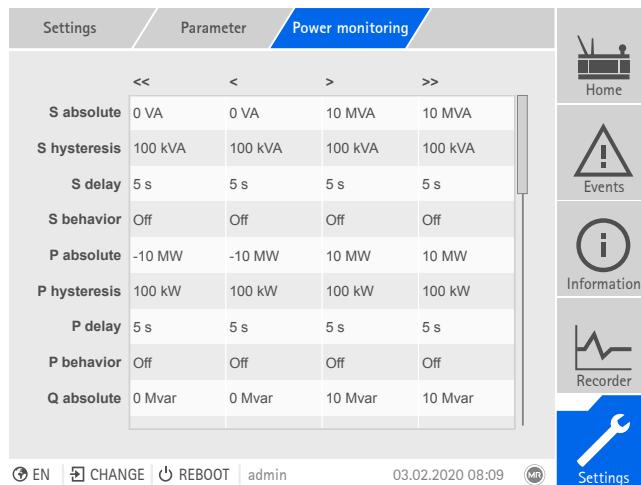
Measured value	Lower limit 2	Lower limit 1	Upper limit 1	Upper limit 2
Apparent power	S<<	S<	S>	S>>
Active power	P<<	P<	P>	P>>
Reactive power	Q<<	Q<	Q>	Q>>
Power factor (amount)	cos φ <<	cos φ <	-	-

Table 95: Limit values for power monitoring

You can set the following parameters for each limit value:

- Limit value: Absolute limit value
- Hysteresis limit value
- Delay time limit value
- Behavior limit value (only for devices with voltage regulation)

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



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Figure 150: Power monitoring

› Go to **Settings > Parameters > Power grid > Power monitoring**.

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 cannot 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 cannot 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.

Table 96: Behavior when an event message is issued

9.3.6 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

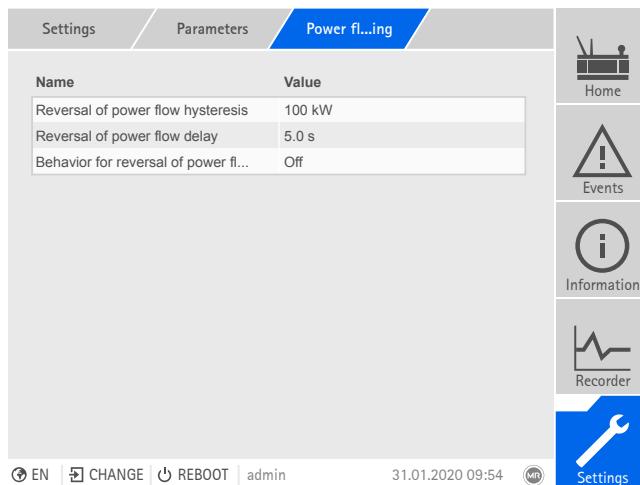


Figure 151: Power flow monitoring

> Go to **Settings > Parameters > Power grid > Power flow monitoring**.

Also refer to

Target-tap-position operation [► 210]

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">- The negative power flow is ignored.- Automatic regulation remains active.
Event only	<ul style="list-style-type: none">- The <i>Reversal of power flow</i> event is issued.- If Z compensation is activated, this function is deactivated.- Automatic regulation remains active.
Auto blocking	<ul style="list-style-type: none">- The <i>Reversal of power flow</i> event is issued.- If Z compensation is activated, this function is deactivated.- Automatic regulation is blocked.
Auto/manual blocking	<ul style="list-style-type: none">- The <i>Reversal of power flow</i> event is issued.- If Z compensation is activated, this function is deactivated.- Automatic regulation is blocked.- You cannot perform tap-change operations in manual mode.
Target tap position	<ul style="list-style-type: none">- The <i>Reversal of power flow</i> event is issued.- If Z compensation is activated, this function is deactivated.- The device triggers a tap-change operation to the tap position you defined in the "Target tap position" [► Section 9.4.6, Page 210] parameter.- The device blocks further tap-change operations.- The target-tap-position operation is ignored if there is no tap-position capture. Automatic regulation is blocked.

Table 97: Behavior in the event of a reversal of power flow

9.3.7 Phase symmetry monitoring

If you are measuring the voltage and current with the 3-phase UI 3 measuring module, you can set the maximum permitted differences for voltage and phase angle between the 3 phases. The difference is determined from the highest and lowest measured value of the 3 phases.

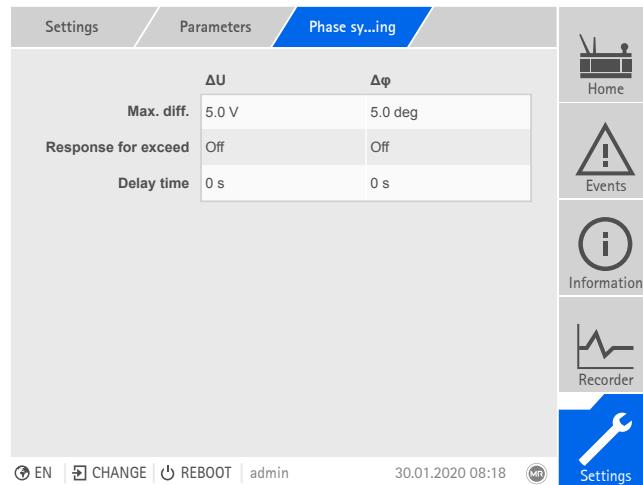


Figure 152: Phase symmetry monitoring

> Go to **Settings > Parameters > Power grid > Phase symmetry monitoring**.

Maximum difference

You can use this parameter to specify a limit value for the voltage difference in V (in relation to the secondary value of the voltage transformer) or in kV (in relation to the primary value of the voltage transformer) or the phase angle difference.

Behavior

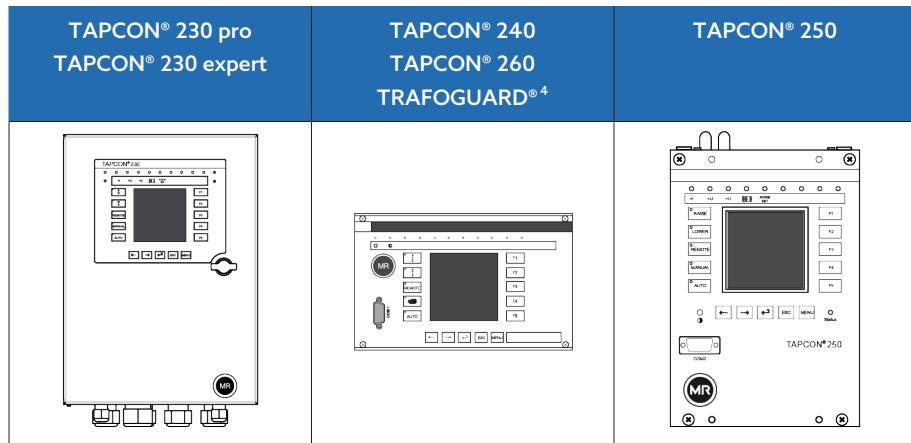
You can use this parameter to set the behavior of the device when the event message is issued. You can select the following options:

Setting	Behavior
Off	The limit value is not monitored.
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 cannot perform tap-change operations in manual mode.

Table 98: Behavior when an event message is issued

9.3.8 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:



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.

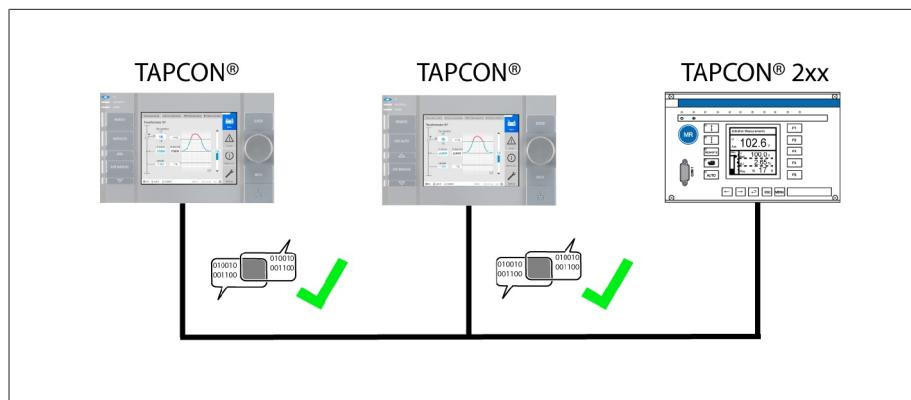


Figure 153: Parallel operation of 2 devices with one TAPCON® 2xx. The TAPCON® 2xx retrofit function must be active on both devices.

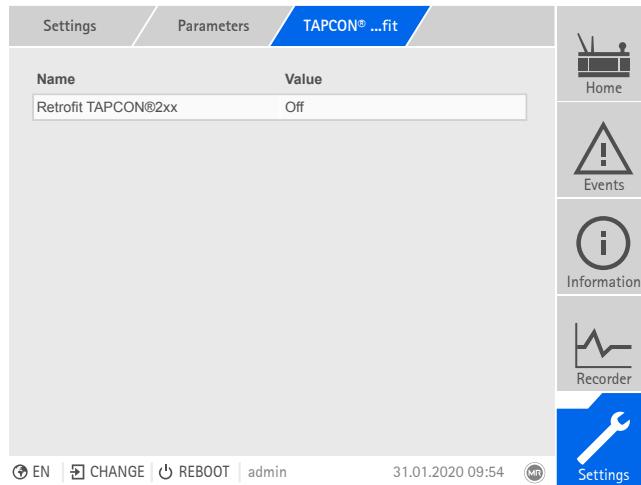


Figure 154: Retrofit TAPCON® 2xx

> Go to **Settings > Parameters > Power grid > TAPCON® 2xx retrofit**.

TAPCON® 2xx retrofit

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

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i 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 -).

9.3.9 Displaying current measured values

The current measured values can be displayed on the measured value screen. Note that the displayed measured values may differ from the raw values displayed in the information display of the UI assembly. The measured values are prepared for the measured value display by the device as follows:

- The tap-change operation set for the current transformer and voltage transformer is taken into account, as is a corresponding phase displacement.
- The UI assemblies use the generator sign convention. The device displays the measured values using the load sign convention.

i You can change the measured value display to the generator sign convention by activating the Retrofit TAPCON® 2xx [▶ Section 9.3.8, Page 169] parameter.

The following measured values are displayed:

- Voltage
- Current
- Power factor ($\cos \phi$)
- Frequency
- Reactive power
- Active power
- Apparent power

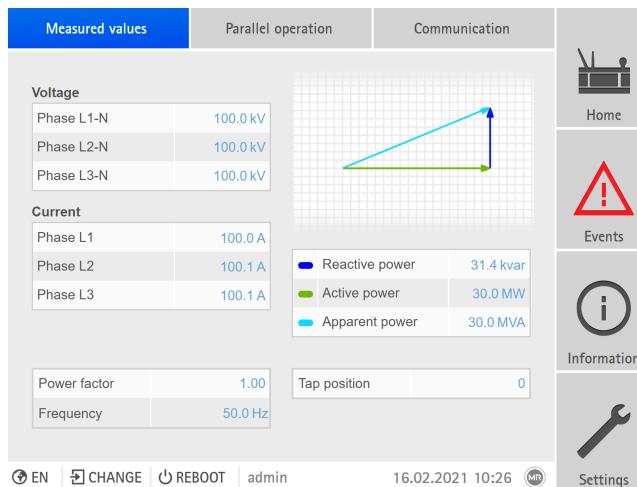


Figure 155: Measured values

› Go to **Information > Power grid > Measured values**.

Also refer to

▀ TAPCON® 2xx retrofit [▶ 169]

9.3.10 Displaying minimum and maximum measured values

You can display the minimum and maximum values reached and the corresponding time for the following measured values:

- Voltage
- Current
- Reactive power

- Active power
- Apparent power

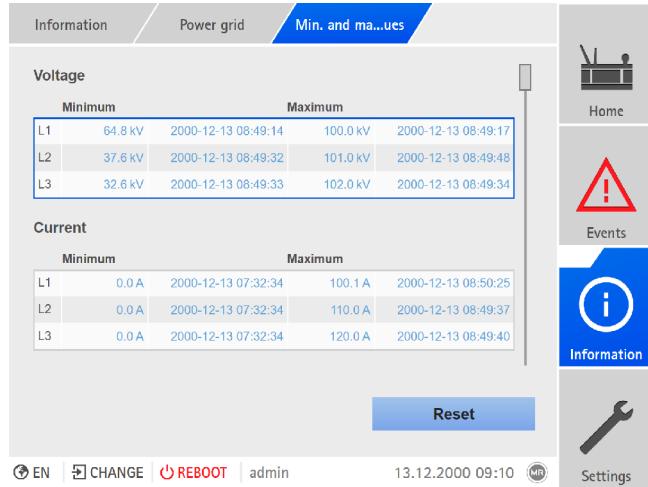


Figure 156: Min. and max. measured values

1. Go to **Information > Power grid > Min. and max. measured values**.
2. As needed, select the **Reset** button to reset the minimum and maximum values.

9.3.11 Setting bank parallel operation

You can set the following parameters for bank parallel operation.

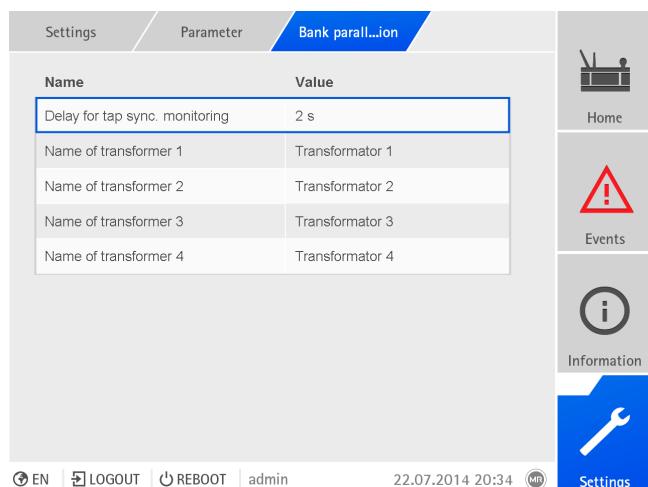


Figure 157: Bank parallel operation

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

Delay time for tap synchronization monitoring

You can use this parameter to set the delay time for the tap synchronization monitoring. If the individual transformers have a tap position difference in auto mode for longer than the set delay time, the device issues an event message. As long as the tap position difference exists, tap-change operations are blocked in auto mode and you can only switch the on-load tap-changers of the transformers individually in manual mode.

Name of transformer 1...4 (depending on device configuration)

You can use these parameters to set the transformer name. The transformer name appears in the display for manual tap-change operations.

9.4 On-load tap-changer regulator

9.4.1 Regulation

The general functions for regulating the on-load tap-changer are described in this section.

9.4.1.1 Response to control system disconnection (optional)

If your device is equipped with a connection to a control system (SCADA), you can use the following parameters to set how the device is to behave if the connection to the control system is interrupted.

i This function only works in the REMOTE operating mode.

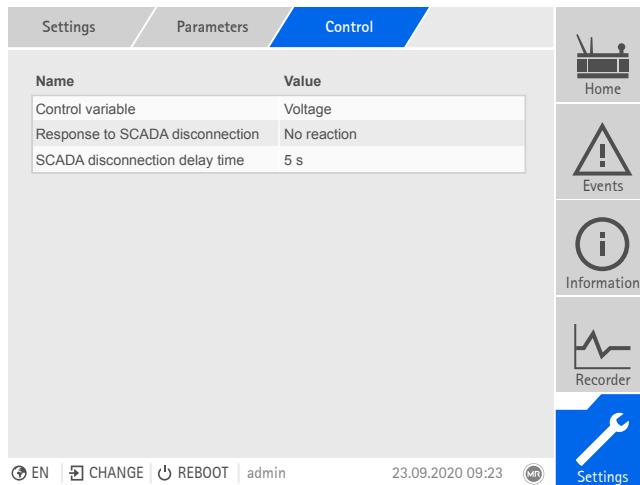


Figure 158: Regulation

› Go to **Settings > Parameters > Voltage regulator > Regulation**.

Response to SCADA disconnection

You can use this parameter to set the behavior of the device when the connection to the control system is interrupted. You can select the following options:

- No response: The device remains in the current operating mode.
- Switchover to auto mode: The device switches to auto mode.
- Desired value 1...5: The device uses the selected voltage desired value. This desired value will also continue to be used once the connection is reestablished. Depending on the device configuration, you can select up to 5 desired values.

SCADA disconnection delay time

You can use this parameter to set the delay time before the device responds to the SCADA interruption. If the connection to the control system is interrupted for longer than the delay time, the device triggers an event and responds with the set behavior.

9.4.2 Voltage regulation

All of the parameters required for voltage regulation are described in this section.

Settings	Parameters	Voltage regulation
Name	Value	
Desired value 1	100 V	
Desired value 2	100 V	
Desired value 3	100 V	
Selecting a desired value	Desired value 1	
Bandwidth setting	Percentage	
Bandwidth	1.0 %	
Delay time T1	40 s	
Time response T1	Linear	
Activate delay time T2	Off	
Delay time T2	10 s	

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Home Events Information Recorder Settings

Figure 159: Voltage regulation (example)

> Go to **Settings > Parameters > Voltage regulator > Voltage regulation**.

9.4.2.1 Setting the desired value

In accordance with the order, the device is equipped with one of the following variants for setting the desired value:

9.4.2.1.1 Desired value 1

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

9.4.2.1.2 Desired value 1...3

You can set 3 different desired values. The device always uses one of the set desired values for control. You can define the desired value used for control by means of the "Select desired value" parameter or with the digital inputs.

i The device only processes commands via digital inputs or the control system when it is in the Remote mode. You must also set the Remote behavior [► Page 81] parameter accordingly.

Setting the desired value

1. Go to **Settings > Parameters > Voltage regulator > Regulation > Desired value 1**.
2. Enter the desired value.
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.

1. Go to **Settings > Parameters > Voltage regulator > Regulation > Select desired value**.
2. Select the desired value from the list.
3. Press the **Accept** button to save the modified parameter.

9.4.2.1.3 Desired value 1...5

You can set 5 different desired values. The device always uses one of the set desired values for control. You can define the desired value used for control by means of the "Select desired value" parameter or with the digital inputs.



The device only processes commands via digital inputs or the control system when it is in the Remote mode. You must also set the Remote behavior [► Page 81] parameter accordingly.

Setting the desired value

1. Go to **Settings > Parameters > Voltage regulator > Regulation > Desired value 1**.
2. Enter the desired value.
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.

1. Go to **Settings > Parameters > Voltage regulator > Regulation > Select desired value**.
2. Select the desired value from the list.
3. Press the **Accept** button to save the modified parameter.

9.4.2.1.4 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).

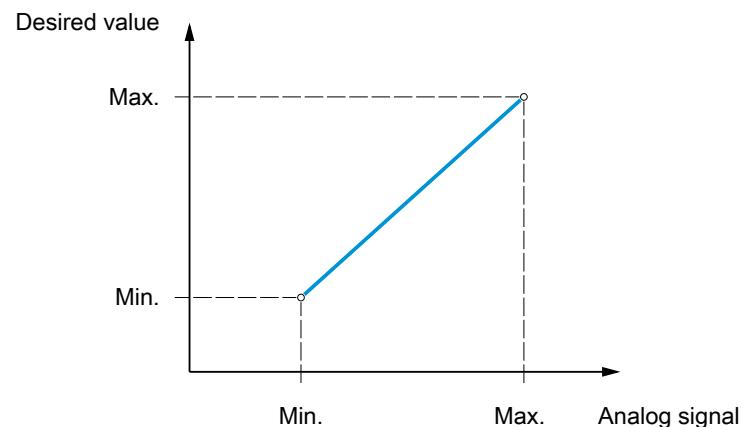


Figure 160: Analog setting of the desired value

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.

Setting desired value 1

1. Go to **Settings > Parameters > Voltage regulator > Regulation > Desired value 1**.
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.

9.4.2.1.5 Step-by-step setting of the desired value

For step-by-step setting of the desired value, you can increase or decrease the desired value 1 for the automatic voltage regulation by an adjustable step width using digital inputs or control system commands.

For each "Increase desired value" or "Decrease desired value" command, desired value 1 is increased or decreased by the set step width. It is not possible to set desired values outside of the permitted setting range (49...140 V).

Name	Description
I: Desired value step width +	A pulse signal at the input increases desired value 1 by the set step width.
I: Desired value step width -	A pulse signal at the input reduces desired value 1 by the set step width.

Table 99: Digital inputs (I)

i The device only processes commands via digital inputs or the control system when it is in the Remote mode. You must also set the Remote behavior [► Page 81] parameter accordingly.

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

Setting desired value 1

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

Setting desired value step width

1. Go to **Settings > Parameters > Voltage regulator > Regulation > Desired value step width**.
2. Enter the desired value step width.
3. Press the **Accept** button to save the modified parameter.

Also refer to

- Remote behavior [► 81]

9.4.2.1.6 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
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 100: Parameters to be set for active power-dependent adjustment of desired voltage value

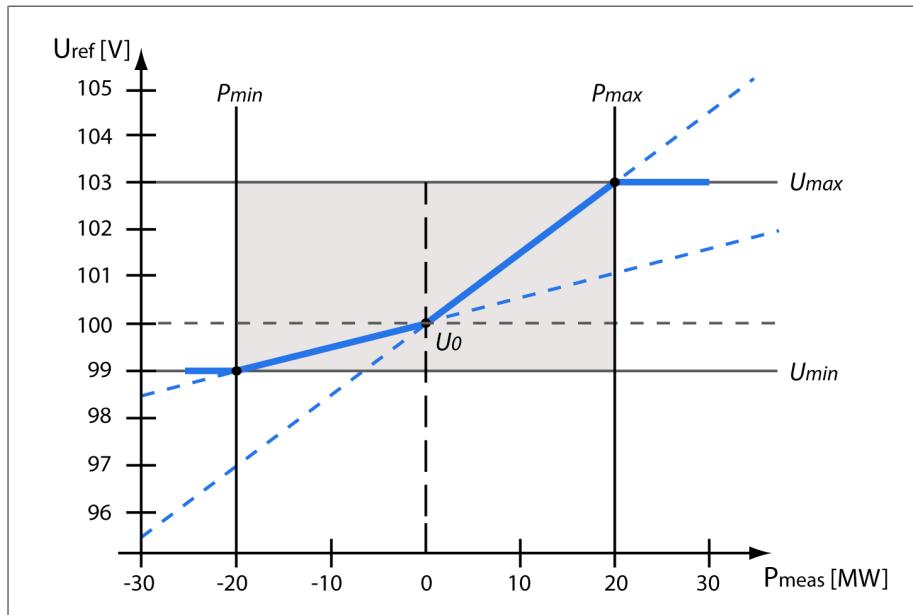


Figure 161: Active power-dependent adjustment of desired voltage value

U_{ref}	Desired value	U_{\min}	Minimum desired value
P_{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_{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.

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

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

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

$$U_{\text{ref}} = U_0$$

Linear dependency with negative active power:

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

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

Linear dependency with positive active power:

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

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

To set the TDSC parameters, proceed as follows:

- > Go to **Settings > Parameters > Voltage regulator > Voltage regulation**.

Also refer to

- ☰ Desired value 1 [▶ 175]

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, the voltage is regulated to the set desired value [▶ Section 9.4.2.1.1, Page 175]. You can activate or deactivate the power-dependent adjustment of the desired voltage value as follows:

- Parameter
- Digital inputs $I: \text{TDSC}^{\circledR} \text{ on}$ and $I: \text{TDSC}^{\circledR} \text{ off}$ (optional)
- Control system command (optional)



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

TDSC U_{\max}

You can use this parameter to set the maximum desired value. The maximum desired value is activated when the measured active power reaches the set maximum active power.

TDSC Umin

You can use this parameter to set the minimum desired value. The minimum desired value is activated when the measured active power reaches the set minimum active power.

TDSC U0

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

TDSC Pmax

You can use this parameter to set the maximum active power-dependent desired value that is to be used for regulation.

TDSC Pmin

You can use this parameter to set the minimum active power-dependent desired value that is to be used for regulation.

9.4.2.1.7 Active power-dependent adjustment of desired voltage value with 3 different desired values

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.

The device provides you with 3 different sets of parameters for this purpose. Depending on the selection of the desired value 1, 2 or 3, the device uses the parameter set 1, 2 or 3 for TDSC.

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

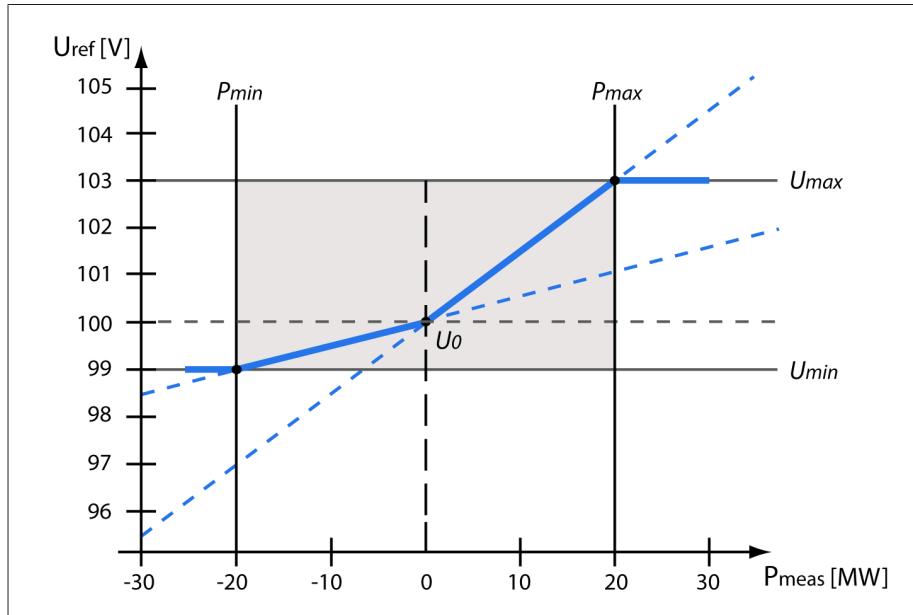


Figure 162: Active power-dependent adjustment of desired voltage value

U_{ref}	Desired value	U_{min}	Minimum desired value
P_{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_{meas} exceeds the set parameter P_{max} , the value U_{max} is adopted as the desired value.

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

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.

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

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

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

$$U_{\text{ref}} = U_0$$

Linear dependency with negative active power:

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

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

Linear dependency with positive active power:

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

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

To set the TDSC parameters, proceed as follows:

- › Go to **Settings > Parameters > Voltage regulator > Voltage regulation**.

Also refer to

-  Desired value 1...3 [▶ 175]

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, the voltage is regulated to the set desired value [▶ Section 9.4.2.1.1, Page 175]. You can activate or deactivate the power-dependent adjustment of the desired voltage value as follows:

- Parameter
- Digital inputs $I: TDSC^{\circ} on$ and $I: TDSC^{\circ} off$ (optional)
- Control system command (optional)

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

TDSC Umax

You can use this parameter to set the maximum desired value. The maximum desired value is activated when the measured active power reaches the set maximum active power.

TDSC Umin

You can use this parameter to set the minimum desired value. The minimum desired value is activated when the measured active power reaches the set minimum active power.

TDSC U0

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

TDSC Pmax

You can use this parameter to set the maximum active power-dependent desired value that is to be used for regulation.

TDSC Pmin

You can use this parameter to set the minimum active power-dependent desired value that is to be used for regulation.

9.4.2.1.8 Desired value setting via BCD

With the desired value setting via BCD, you can variably adjust the desired value for the automatic voltage regulation via digital inputs by means of BCD coding.

Depending on variant, desired value setting via BCD is always active or you can activate it by creating a signal at the *BCD desired value* input.

The following outputs are available to you as an option:

- *Desired value setting faulty*: The device issues a signal if the BCD code for the desired value setting is invalid.
- *Desired value active*: The device issues a signal if desired value setting via BCD is active.

The permissible setting range is 49...140 V. The specified value is written to the parameter desired value 1. If the BCD coding is invalid or desired value setting via BCD is deactivated, the device uses the value set in parameter desired value 1.

Desired value	BCD input									
	100	80	40	20	10	8	4	2	1	
49 V	0	0	1	0	0	1	0	0	1	
50 V	0	0	1	0	1	0	0	0	0	
51 V	0	0	1	0	1	0	0	0	1	
52 V	0	0	1	0	1	0	0	1	0	
53 V	0	0	1	0	1	0	0	1	1	
54 V	0	0	1	0	1	0	1	0	0	
55 V	0	0	1	0	1	0	1	0	1	
56 V	0	0	1	0	1	0	1	1	0	
57 V	0	0	1	0	1	0	1	1	1	
58 V	0	0	1	0	1	1	0	0	0	
59 V	0	0	1	0	1	1	0	0	1	
60 V	0	0	1	1	0	0	0	0	0	
61 V	0	0	1	1	0	0	0	0	1	
62 V	0	0	1	1	0	0	0	1	0	
63 V	0	0	1	1	0	0	0	1	1	
64 V	0	0	1	1	0	0	1	0	0	
65 V	0	0	1	1	0	0	1	0	1	
66 V	0	0	1	1	0	0	1	1	0	
67 V	0	0	1	1	0	0	1	1	1	
68 V	0	0	1	1	0	1	0	0	0	
69 V	0	0	1	1	0	1	0	0	1	
70 V	0	0	1	1	1	0	0	0	0	
71 V	0	0	1	1	1	0	0	0	1	
72 V	0	0	1	1	1	0	0	1	0	
73 V	0	0	1	1	1	0	0	1	1	
74 V	0	0	1	1	1	0	1	0	0	
75 V	0	0	1	1	1	0	1	0	1	
76 V	0	0	1	1	1	0	1	1	0	
77 V	0	0	1	1	1	0	1	1	1	
78 V	0	0	1	1	1	1	0	0	0	

Desired value	BCD input								
	100	80	40	20	10	8	4	2	1
79 V	0	0	1	1	1	1	0	0	1
80 V	0	1	0	0	0	0	0	0	0
81 V	0	1	0	0	0	0	0	0	1
82 V	0	1	0	0	0	0	0	1	0
83 V	0	1	0	0	0	0	0	1	1
84 V	0	1	0	0	0	0	1	0	0
85 V	0	1	0	0	0	0	1	0	1
86 V	0	1	0	0	0	0	1	1	0
87 V	0	1	0	0	0	0	1	1	1
88 V	0	1	0	0	0	1	0	0	0
89 V	0	1	0	0	0	1	0	0	1
90 V	0	1	0	0	1	0	0	0	0
91 V	0	1	0	0	1	0	0	0	1
92 V	0	1	0	0	1	0	0	1	0
93 V	0	1	0	0	1	0	0	1	1
94 V	0	1	0	0	1	0	1	0	0
95 V	0	1	0	0	1	0	1	0	1
96 V	0	1	0	0	1	0	1	1	0
97 V	0	1	0	0	1	0	1	1	1
98 V	0	1	0	0	1	1	0	0	0
99 V	0	1	0	0	1	1	0	0	1
100 V	1	0	0	0	0	0	0	0	0
101 V	1	0	0	0	0	0	0	0	1
102 V	1	0	0	0	0	0	0	1	0
103 V	1	0	0	0	0	0	0	1	1
104 V	1	0	0	0	0	0	1	0	0
105 V	1	0	0	0	0	0	1	0	1
106 V	1	0	0	0	0	0	1	1	0
107 V	1	0	0	0	0	0	1	1	1
108 V	1	0	0	0	0	1	0	0	0
109 V	1	0	0	0	0	1	0	0	1
110 V	1	0	0	0	1	0	0	0	0
111 V	1	0	0	0	1	0	0	0	1
112 V	1	0	0	0	1	0	0	1	0
113 V	1	0	0	0	1	0	0	1	1
114 V	1	0	0	0	1	0	1	0	0
115 V	1	0	0	0	1	0	1	0	1

Desired value	BCD input								
	100	80	40	20	10	8	4	2	1
116 V	1	0	0	0	1	0	1	1	0
117 V	1	0	0	0	1	0	1	1	1
118 V	1	0	0	0	1	1	0	0	0
119 V	1	0	0	0	1	1	0	0	1
120 V	1	0	0	1	0	0	0	0	0
121 V	1	0	0	1	0	0	0	0	1
122 V	1	0	0	1	0	0	0	1	0
123 V	1	0	0	1	0	0	0	1	1
124 V	1	0	0	1	0	0	1	0	0
125 V	1	0	0	1	0	0	1	0	1
126 V	1	0	0	1	0	0	1	1	0
127 V	1	0	0	1	0	0	1	1	1
128 V	1	0	0	1	0	1	0	0	0
129 V	1	0	0	1	0	1	0	0	1
130 V	1	0	0	1	1	0	0	0	0
131 V	1	0	0	1	1	0	0	0	1
132 V	1	0	0	1	1	0	0	1	0
133 V	1	0	0	1	1	0	0	1	1
134 V	1	0	0	1	1	0	1	0	0
135 V	1	0	0	1	1	0	1	0	1
136 V	1	0	0	1	1	0	1	1	0
137 V	1	0	0	1	1	0	1	1	1
138 V	1	0	0	1	1	1	0	0	0
139 V	1	0	0	1	1	1	0	0	1
140 V	1	0	1	0	0	0	0	0	0

Table 102: BCD-coded desired value

Setting desired value 1

1. Go to Settings > Parameters > Voltage regulator > Regulation > Desired value 1.
2. Enter the desired value.
3. Press the Accept button to save the modified parameter.

Bandwidth setting

You can use this parameter to set whether you want the bandwidth as an absolute variable (V or kV) or relative variable (%) in relation to the desired value.

Bandwidth

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

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

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.

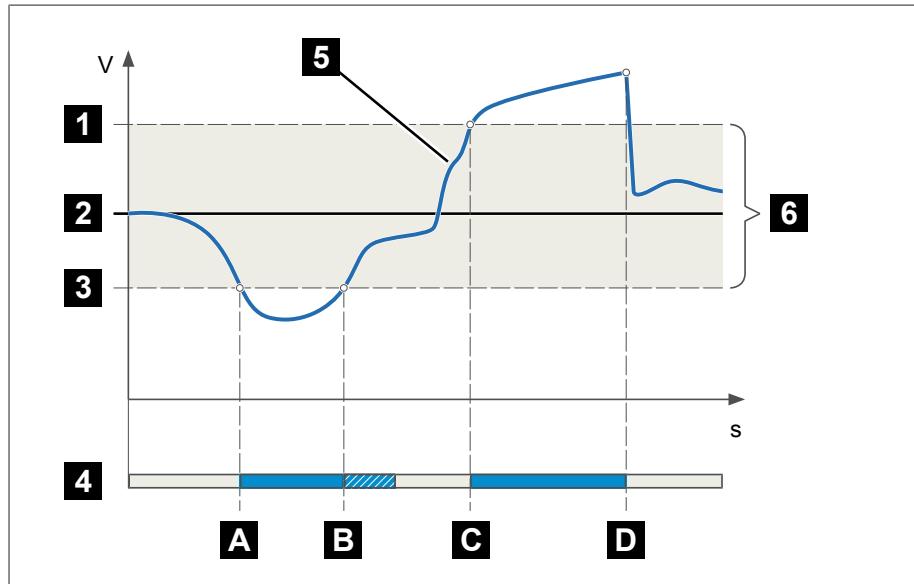


Figure 163: Behavior of the control function with delay time T1

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 when delay time T1 is complete. Tap-change operation is initiated.

Time response T1

You can use this parameter to set the time response for delay time T1. You can select the following options:

- Linear time response
- Integral time response

Linear time response With linear time response, the device responds with a constant delay time regardless of the control deviation.

Integral time response With integral time response, the device responds with a variable delay time depending on the control deviation. The greater the control deviation (ΔU) in relation to the set bandwidth (B), the shorter the delay time. This means that the device responds faster to large voltage changes in the grid. Regulation accuracy improves as a result but the frequency of tap-changes increases too.

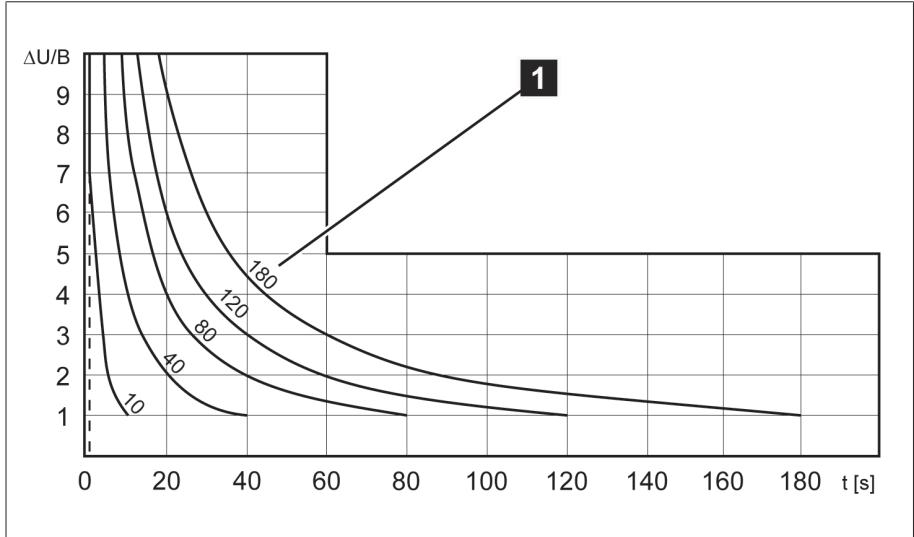


Figure 164: Diagram for integral time response

$\Delta U/B$	Control deviation " ΔU " as % of desired value in relation to the set bandwidth "B" as % of desired value
1	"Delay time T1" parameter

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.

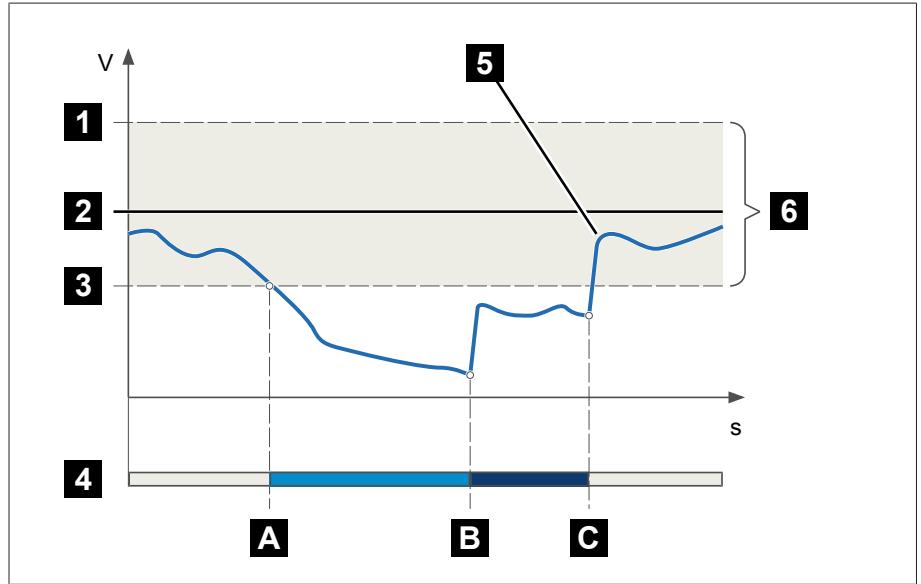


Figure 165: Behavior of the regulation function with delay times T1 and T2

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.		

Activate delay time T2

You can use this parameter to activate or deactivate the delay time T2.

9.4.3 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

9.4.3.1 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.

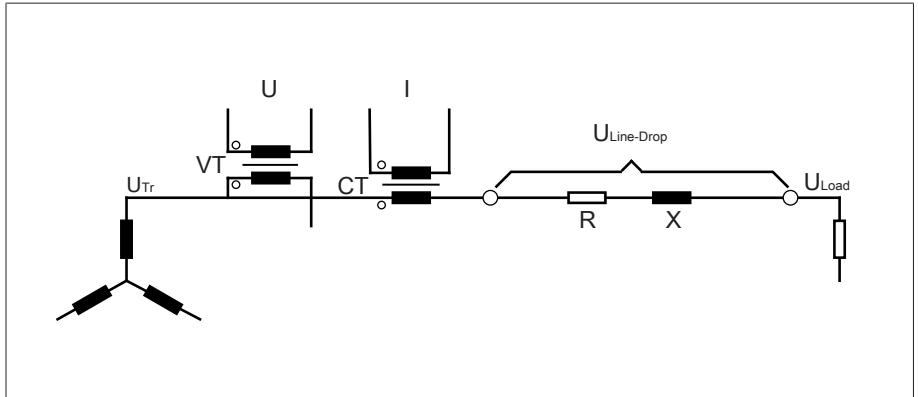


Figure 166: Equivalent circuit of R&X compensation

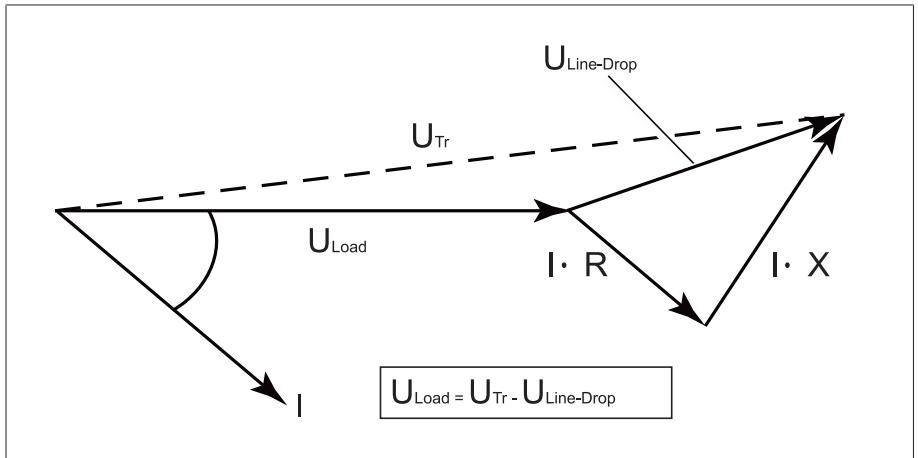


Figure 167: Phasor diagram of R&X compensation

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

- Ohmic resistance load in mΩ/m
- Inductive resistance load in mΩ/m
- Length of line in km

Settings	Parameters	Compensation
Name	Value	
Compensation method	R & X compensation	
Ohmic resistance load	0.0 Ohm/m	
Inductive resistance load	0.0 Ohm/m	
Length of line	0.00 m	
Voltage increase	0.0 %	
Voltage limit value	0.0 %	

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Settings

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Figure 168: Compensation

> Go to Settings > Parameters > Voltage regulator > Compensation.

9.4.3.2 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.

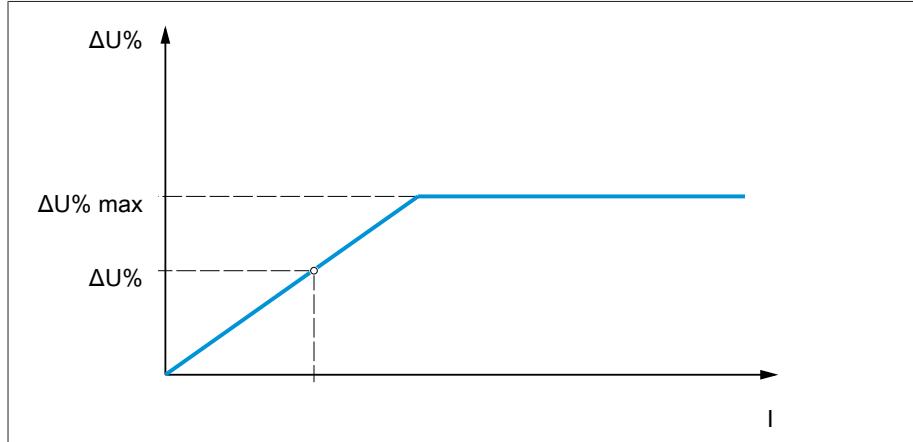


Figure 169: Z compensation

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

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

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

Produces a voltage increase ΔU of 0.2%

Settings	Parameters	Compensation														
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Name</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>Compensation method</td> <td>R & X compensation</td> </tr> <tr> <td>Ohmic resistance load</td> <td>0.0 Ohm/m</td> </tr> <tr> <td>Inductive resistance load</td> <td>0.0 Ohm/m</td> </tr> <tr> <td>Length of line</td> <td>0.00 m</td> </tr> <tr> <td>Voltage increase</td> <td>0.0 %</td> </tr> <tr> <td>Voltage limit value</td> <td>0.0 %</td> </tr> </tbody> </table>			Name	Value	Compensation method	R & X compensation	Ohmic resistance load	0.0 Ohm/m	Inductive resistance load	0.0 Ohm/m	Length of line	0.00 m	Voltage increase	0.0 %	Voltage limit value	0.0 %
Name	Value															
Compensation method	R & X compensation															
Ohmic resistance load	0.0 Ohm/m															
Inductive resistance load	0.0 Ohm/m															
Length of line	0.00 m															
Voltage increase	0.0 %															
Voltage limit value	0.0 %															

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Recorder

Settings

EN | CHANGE | REBOOT | admin
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MR

Figure 170: Compensation

› Go to **Settings > Parameters > Voltage regulator > Compensation**.

9.4.4 Parallel operation (optional)

Parallel transformer operation is used to increase the throughput capacity or short-circuit capacity at one location. The device provides you with specific functions for regulating transformers.

Conditions for parallel operation

Compliance with the following general conditions is required for operating transformers in parallel:

- Identical rated voltages
- Transformer power ratio ($< 3 : 1$)
- Maximum deviation of short-circuit voltages (U_k) for transformers connected in parallel $< 10\%$
- Same number of switching groups
- For parallel operation with CAN communication: Current transformers with the same rated values must be used for all devices operating in parallel

9.4.4.1 Parallel operation methods

You can undertake parallel operation with various parallel operation methods.

9.4.4.1.1 Tap synchronization

With the **tap synchronization** parallel operation method, one voltage regulator works as the master and all others as followers.

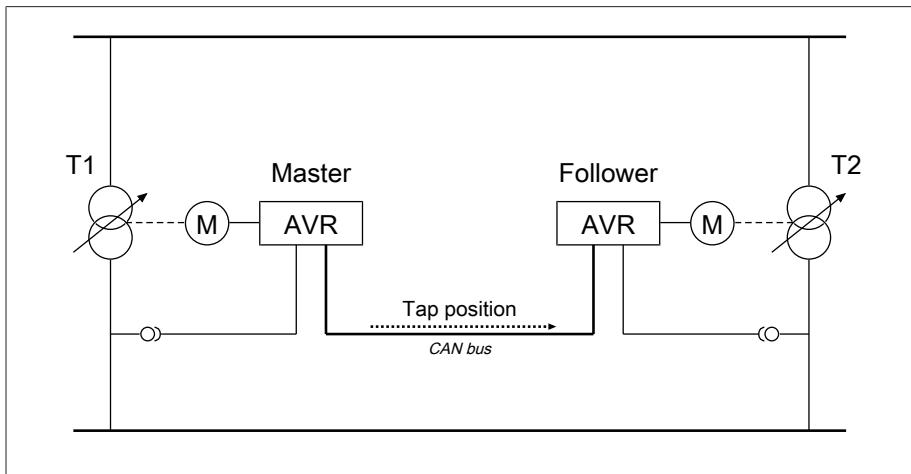


Figure 171: Tap synchronization

The master handles voltage regulation and transmits its current tap positions to all followers via the CAN bus. The followers compare the tap position received with their own tap position. If the tap position is not the same, the followers switch to the tap position received from the master. This ensures that the transformers operating in parallel are always in the same tap position.

You can set whether the master transfers the change in tap position to the followers before or after its own tap-change operation. The devices then either change position sequentially (first the master, then the followers) or in sync (master and followers at the same time).

If there is a tap difference between the master and followers, the master refrains from issuing any control commands to the motor-drive unit until all of the followers have reached the same tap position. If the tap difference persists for longer than the set delay time for parallel operation error messages, the master triggers the *Step difference to follower* event.

You can explicitly designate the voltage regulators as master and followers, or set automatic designation using the CAN bus address.

For the tap synchronization parallel operation method, you have to set the following parameters:

Parameter	Auto	Master	Follower
Activating parallel operation	Yes		
Parallel operation method	Auto. tap sync.	Master	Follower
CAN bus address	Yes		
Circulating reactive current blocking limit	Optional, if master/follower current blocking is active		
Master/follower current blocking	Yes		
Master/follower switching characteristics	Yes		
Maximum tap difference	Yes (if follower)	No	Yes
Error if no communication present	Yes		
Behavior if no communication present	Yes		
Parallel operation error delay time	Yes		

Table 103: Parameter

9.4.4.1.2 Circulating reactive current minimization with CAN bus communication

With the **circulating reactive current** parallel operation method, parallel operation is carried out using the circulating reactive current minimization method.

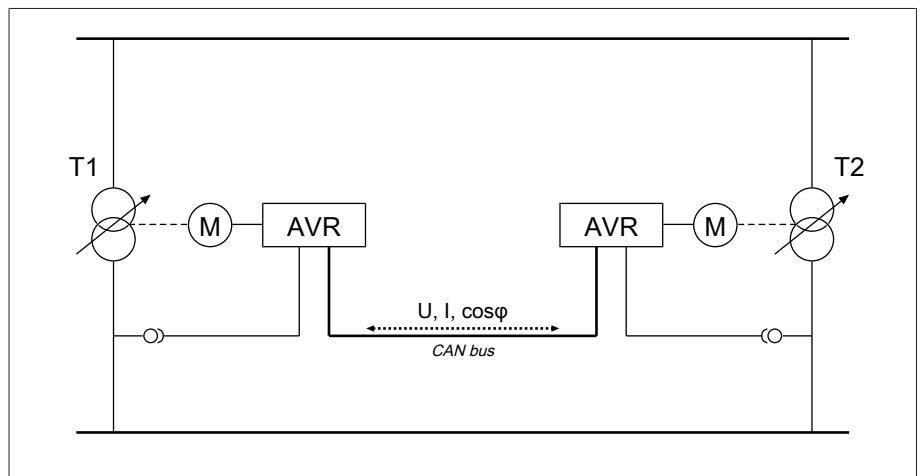


Figure 172: Circulating reactive current minimization with CAN bus communication

The circulating reactive current is calculated from the transformer currents and their phase angles. The voltage regulators in the parallel operation group share this information via CAN bus. An extra control deviation proportional to circulating reactive current is added to the independently regulating voltage regulators as a correction for the control deviation determined on the basis of the measurement voltage. You can use the circulating reactive current sensitivity parameter to decrease or increase this extra control deviation.

The circulating reactive current method is suited to transformers connected in parallel with a similar nominal output and short-circuit voltage U_k and to vector groups with the same and different step voltages. This does not require any information about the tap position.

Note that the following prerequisites must be met for the "circulating reactive current minimization" parallel operation method:

- You have to use current transformers with the same rated values for all transformers in parallel operation.
- If you wish to operate in parallel operation with existing devices, you have to activate the Retrofit TAPCON® 2xx [► Section 9.3.8, Page 169] parameter.

For the circulating reactive current minimization parallel operation method with CAN communication, you have to set the following parameters:

- Activate parallel operation
- Parallel operation method: Circulating reactive current
- CAN bus address
- Circulating reactive current sensitivity
- Circul. reactive current blocking limit
- Error if no communication present
- Behavior if no communication present
- Parallel operation error delay time

9.4.4.1.3 Circulating reactive current minimization without CAN bus communication

With this method, you can operate several voltage regulators without a communication connection (CAN bus) in parallel with circulating reactive current minimization.

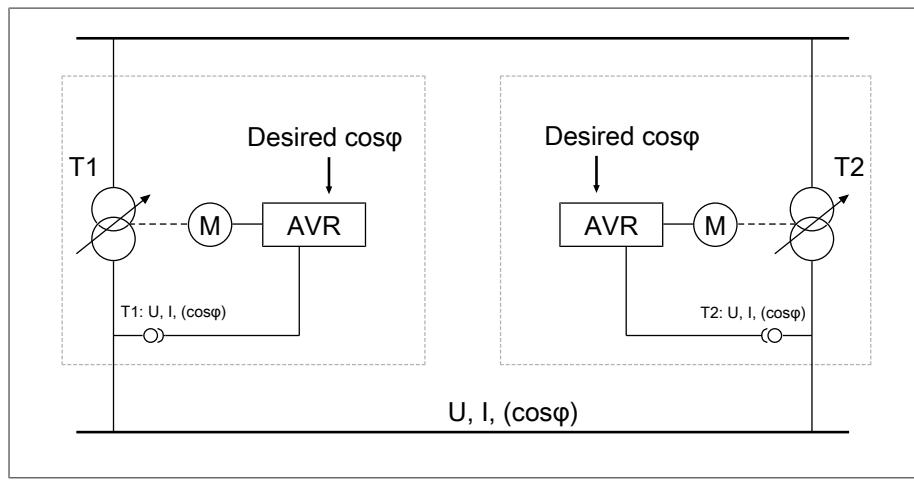


Figure 173: Circulating reactive current minimization without CAN bus communication

The circulating reactive current is calculated using the desired power factor parameter, the desired load stress type parameter, and the measured transformer current. An extra control deviation proportional to circulating reactive current is added to the independently regulating voltage regulators as a correction for the control deviation determined on the basis of the measurement voltage. This extra control deviation depends on how much the measured power factor deviates from the desired power factor.

To use the power factor method, you need to know the conditions of your network in order to correctly set the device parameters.

The power factor method is suited to transformers connected in parallel with a similar nominal output and short-circuit voltage U_k and to vector groups with the same and different step voltages. This does not require any information about the tap position.

For the circulating reactive current minimization parallel operation method without CAN communication, you have to set the following parameters:

- Activating parallel operation
- Parallel operation method: Power factor
- Circulating reactive current sensitivity
- Circulating reactive current blocking limit
- Desired power factor
- Desired load stress type
- Parallel operation error delay time

i Note that the parameters "Error if no communication" and "Behavior if no communication" have no function in the circulating reactive current minimization without CAN communication parallel operation method.

9.4.4.1.4 Tap stagger (optional)

The **tap stagger** parallel operation method is used to generate a defined circulating reactive current in two transformers running in parallel in order to compensate for the reactive power in the grid. In this case, one voltage regulator works as the master and one voltage regulator as the follower. The master handles voltage regulation and transmits the desired tap position to the follower over the CAN bus.

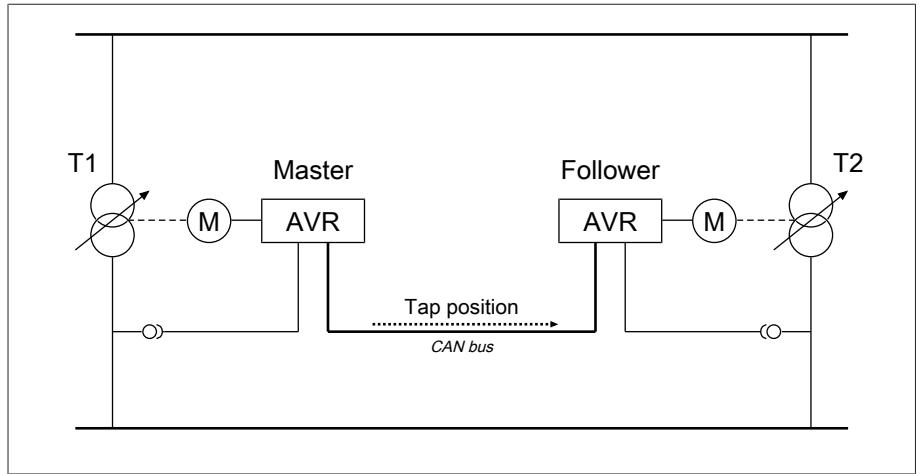


Figure 174: Tap stagger

NOTICE

Damage to the transformers

An inadmissibly high circulating reactive current can lead to the transformers being damaged.

- > Ensure that the circulating reactive current generated through the tap stagger parallel operation method does not exceed the performance limits of the transformers.

Function To generate a defined circulating reactive current, you must select the desired tap stagger level. Starting from the same tap position, the master and follower then switch in opposing directions (e.g. tap stagger level = 2: master +1, follower -1). The magnitude of the circulating reactive current depends on how large the tap position difference is between the master and follower. The on-load tap-changers switch in opposing directions based on the setting of the selected parameter until the desired tap stagger level is reached.

Limiting conditions If one of the tap changers reaches an end position ($\text{Pos} <$, $\text{Pos} >$, $\text{Pos} < \text{Follower}$ or $\text{Pos} > \text{Follower}$), before the desired tap stagger level is reached, both tap changers remain in a lower tap stagger level.

If the tap position of both on-load tap-changers is to be changed due to the voltage regulation (e.g. Master +1, Follower +1) and one tap changer has already reached an end position, the tap stagger level will be reduced.

Example

The following example demonstrates a possible switching sequence in the tap stagger parallel operation method. Here, it is assumed that the on-load tap-changers can be switched to the positions 1...12.

1. To start, the desired tap stagger level is 0; both on-load tap-changers are in tap position 8.
2. The desired tap stagger level 8 is selected. Both on-load tap-changers perform tap-change operations simultaneously until the desired tap stagger level is reached. The circulating reactive current increases with each tap-change operation. Because both on-load tap-changers switch simultaneously, the voltage of the transformers remains constant. Finally, the master is in tap position 12 and the follower in tap position 4.
3. Due to voltage fluctuations in the grid (the voltage U leaves the bandwidth), a "RAISE" tap-change operation is necessary. Because the master is already in the highest tap position, the system must reduce the tap stagger level in order to achieve the desired voltage change. To do so, the master switches one level lower and the follower one level higher. The master and follower then switch one level higher. The voltage returns to the bandwidth.

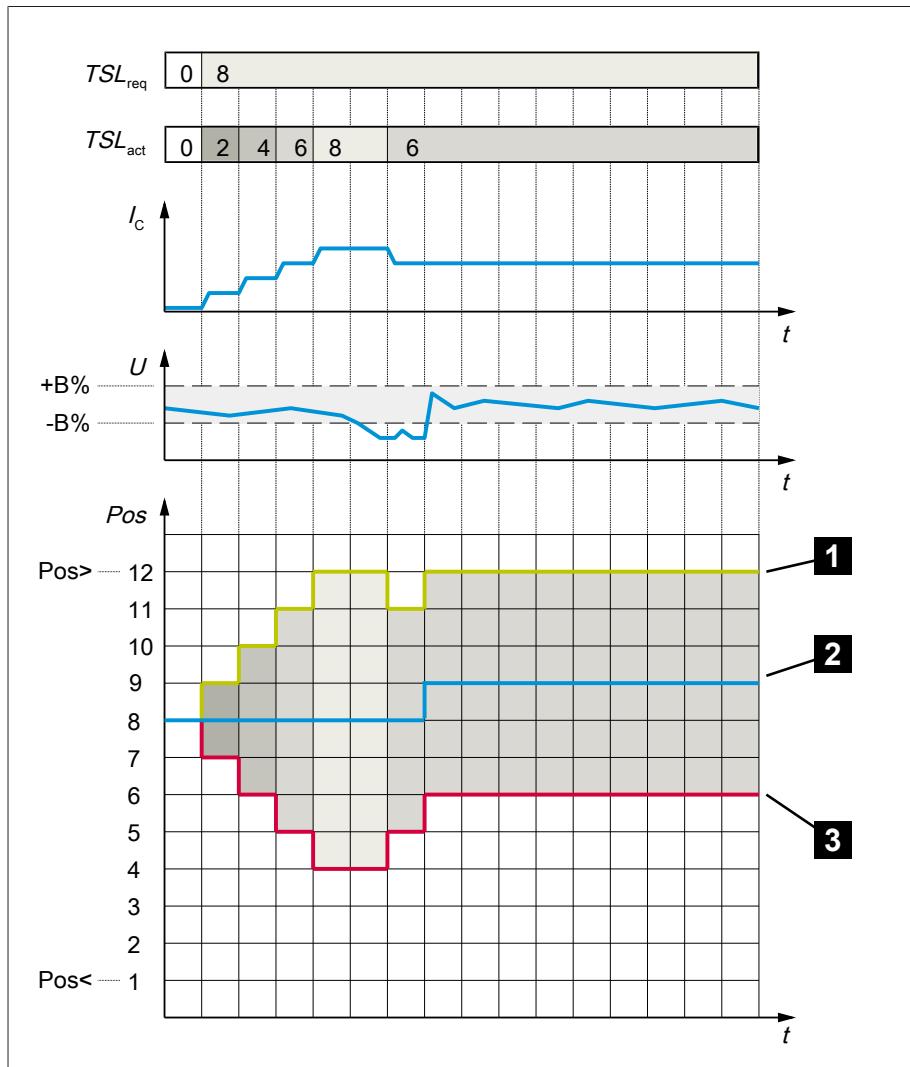


Figure 175: Example switching sequence of the tap stagger parallel operation method

1	Tap position of the master	2	Total tap position of the system
3	Tap position of the follower	B%	Bandwidth
I_c	Circulating reactive current	Pos	Tap position
TSL_{req}	Desired tap stagger level	Pos>/ Pos<	Maximum/minimum tap position
TSL_{act}	Current tap stagger level	U	Measured voltage

For the tap stagger parallel operation method, you have to set the following parameters:

Parameter	Master	Follower
Activate parallel operation [► Page 198]	Yes	
Parallel operation method [► Page 199]	Tap stagger	Follower
CAN bus address [► Page 199]	Yes	Yes ¹
Master/follower current blocking [► Page 200]	Off	Off
Tap stagger 1...8 [► Page 201]	Yes	No

Parameter	Master	Follower
Select tap stagger [► Page 202]	Yes	No
Pos< [► Section 9.5.1, Page 211]	Yes	No
Pos> [► Section 9.5.1, Page 211]	Yes	No
Pos< follower [► Page 202]	Yes	No
Pos> follower [► Page 202]	Yes	No
Error if no communication present [► Page 201]	Yes	
Behavior if no communication present [► Page 201]	Independent regulation, auto blocking or power factor	
Parallel operation error delay time [► Page 201]	Yes	

Table 104: Parameter

¹If there are several followers in your system, only the follower with the highest CAN bus address participates in the tap stagger function.

Special operating situations

- If you switch the master from auto mode to manual mode during the tap stagger parallel operation method, the follower immediately switches to the master's current tap position. To avoid this, you must activate manual mode on both the master and follower simultaneously.
- If you change the parallel operation method of the master from tap stagger to master, the tap stagger level is first reduced to 0 before parallel operation according to the tap synchronization method becomes active.

9.4.4.2 Configuring parallel operation

In the Parallel operation menu item, you can set the parameters needed for parallel transformer operation.

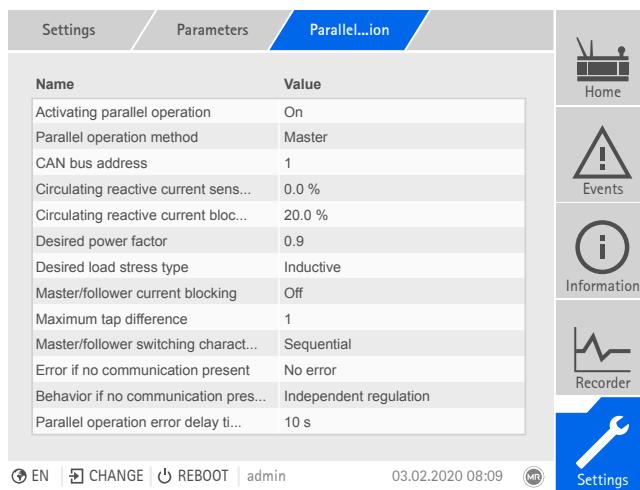


Figure 176: Parallel operation

› Go to Settings > Parameter > Voltage regulator > Parallel operation.

Activating parallel operation

You can use this parameter to activate parallel operation.

Parallel operation method

You can use this parameter to set the parallel operation method. You can select the following options:

Option	Description
Master	The device is designated as the master.
Follower	The device is designated as the follower.
Auto. tap synchronization	Automatic assignment of master or follower. If a master is not detected, the device with the lowest CAN bus address is automatically designated as the master. All other devices are designated as followers.
Circulating reactive current	Circulating reactive current minimization with CAN bus communication [▶ Section 9.4.4.1.2, Page 193] parallel operation method
Power factor	Circulating reactive current minimization without CAN bus communication [▶ Section 9.4.4.1.3, Page 194] parallel operation method
Tap stagger (optional)	The device is designated as the master for the tap stagger [▶ Section 9.4.4.1.4, Page 195] parallel operation method.

Table 105: Setting parallel operation method

i Only change the parallel operation method when the on-load tap-changers are not performing tap-change operations.

CAN bus address

You can use this parameter to assign a CAN bus address to the device. So that all devices can communicate using the CAN bus, each device requires a unique identifier. If the value is set to 0, then no communication takes place.

Circulating reactive current sensitivity

You can use this parameter to set the influence of circulating reactive current on how the control deviation is calculated. The higher the set value, the greater the calculated control deviation as a result of circulating reactive current.

To determine the ideal circulating reactive current sensitivity, note the relevant section in the Commissioning [▶ Section 8.3.3.1, Page 76] chapter.

Circulating reactive current blocking limit

You can use this parameter to set the limit value for the maximum permissible circulating reactive current. This value relates to the rated current of the current transformer. If, during parallel operation, the circulating reactive current exceeds the set limit value, the device triggers the *Circulating reactive current blocking limit exceeded* event. All devices operating in the parallel operation group are blocked.

Desired power factor

You can use this parameter to set the power factor, which the transformer has under normal operating conditions. If the measured power factor deviates from the desired one, the device calculates a correction which is added to the control deviation.

i Enter a desired power factor other than 0. If you enter a desired power factor of 0, the device is not able to calculate the voltage correction.

Desired load stress type

You can use this parameter to set the load stress type, which the transformer has under normal operating conditions.

You can determine the load stress type using the phase angle difference between voltage and current. You calculate the phase angle difference as follows:

$$\varphi_{UI} = \varphi_U - \varphi_I$$

φ_{UI}	Phase angle difference between voltage and current
φ_U	Phase angle of voltage
φ_I	Phase angle of current

Depending on the calculated phase angle difference, you have to select the following option:

- $\varphi_{UI} > 0$: Inductive
- $\varphi_{UI} < 0$: Capacitive

Master/follower current blocking

You can use this parameter to activate the circulating reactive current blocking limit for the tap synchronization parallel operation method. The device thereby calculates and monitors the circulating reactive current in the same manner as the parallel operation method for circulating reactive current minimization, and provides you with the safety function of circulating reactive current blocking. The Circulating reactive current blocking parameter is used to set the limit value.

Master/follower switching characteristics

You can use this parameter to set the switching characteristics for the tap synchronization parallel operation method.. You can select the following options:

- Sequentially: When a tap-change operation takes place, the master communicates its new tap position to the followers via the CAN bus as soon as the master has completed its tap-change operation. The tap-change operations of the master and followers thereby take place one after another (sequentially).
- In sync: When a tap-change operation takes place, the master communicates its new tap position to the followers via the CAN bus as the master starts its tap-change operation. The tap-change operations of the master and followers thereby take place at almost the same time (in sync).

Maximum tap difference

You can use this parameter to set the maximum permissible tap difference between followers and master on the follower.

If the tap difference is greater than the set maximum tap difference to the master, the follower blocks and no longer attempts to attain the master's tap position. After the set delay time for parallel operation error messages has elapsed, the follower issues the *Permitted tap difference to master exceeded* message.

Error if no communication present

You can use this parameter to set whether it is an error if the device does not receive any messages via the CAN bus or if there are no other CAN bus participants in the same parallel operation group.

Behavior if no communication present

You can use this parameter to set how the voltage regulator behaves if communication via the CAN bus is not possible.

i The setting for this parameter is only effective if you have selected the **Error** option for the **Error if no communication present** parameter.

You can select the following options:

Option	Description
Independent regulation	The device switches from parallel operation to normal automatic voltage regulation
Auto blocking	Automatic voltage regulation is blocked.
cosφ interpolation	Continuation of parallel operation with interpolated values (only possible with circulating reactive current parallel operation method)
Power factor	Circulating reactive current minimization without CAN bus communication [▶ Section 9.4.4.1.3, Page 194] parallel operation method

Table 106: Behavior if no communication present

Parallel operation error delay time

You can use this parameter to set the delay time for a parallel operation error message so that brief fault messages are not received if the motor-drive units involved in the parallel operation have different runtimes.

Tap stagger setting 1...8 (optional)

You can set up to eight different default settings for the desired tap stagger level (TSL).

The following tap stagger settings are possible:

TSL	Master ¹	Follower ¹
-1	-1	0
1	+1	0
-2	-1	+1
2	+1	-1
-3	-2	+1
3	+2	-1
-4	-2	+2
4	+2	-2

TSL	Master ¹	Follower ¹
...
-32	-16	+16
32	+16	-16

Table 107: Tap stagger setting

¹Tap position difference in relation to the tap position of the entire system

Selecting a tap stagger setting (optional)

This parameter allows you to select the tap stagger setting that the device is to use for control. The currently selected tap stagger setting is displayed in the voltage regulation overview screen.

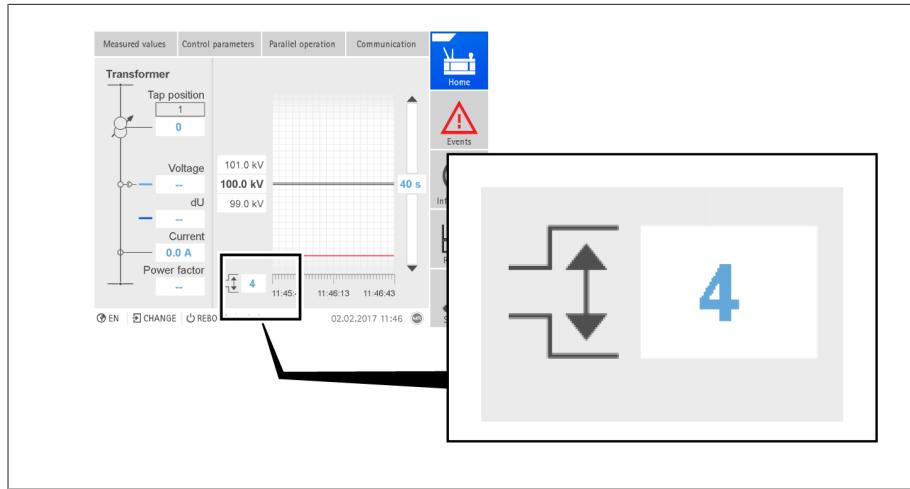


Figure 177: Current tap stagger setting

Pos</Pos> follower (optional)

You can use these parameters to set the highest and lowest permissible tap position of the follower. With the tap stagger parallel operation method, the device uses the following parameters for tap position monitoring [▶ Section 9.5.1, Page 211] of the master and follower:

Parameter	Pos< (follower)	Pos> (follower)
Behavior limit value	Auto blocking for lower tap	Auto blocking for raise tap
Delay time	0 s	

Table 108: Tap position monitoring

9.4.4.3 Detecting parallel operation via group inputs (optional)

You can control up to 16 transformers connected in parallel in one or 2 groups without detecting the system topology.

The devices in parallel operation only use the information communicated by devices in the same parallel operation group via CAN bus.

You can use the PARALLEL GROUP 1 and PARALLEL GROUP 2 inputs to assign the device to a parallel operation group. If you create a signal at both inputs, the device is assigned to both parallel operation groups.

i If no parallel operation group is assigned to a device, it doesn't take part in the parallel operation and undertakes its own voltage regulation.

9.4.4.4 Detecting parallel operation via topology (optional)

The topology function is used to detect which transformers are in parallel operation based on the position of the circuit breakers. Each circuit breaker is fitted with an auxiliary contact so that its status can be reported for this purpose.

9.4.4.4.1 Topology with fixed master/client

A device (topology master) records the status of the circuit breakers via digital inputs and reports which devices are taking part in parallel operation to the connected devices (topology clients) over the CAN bus.

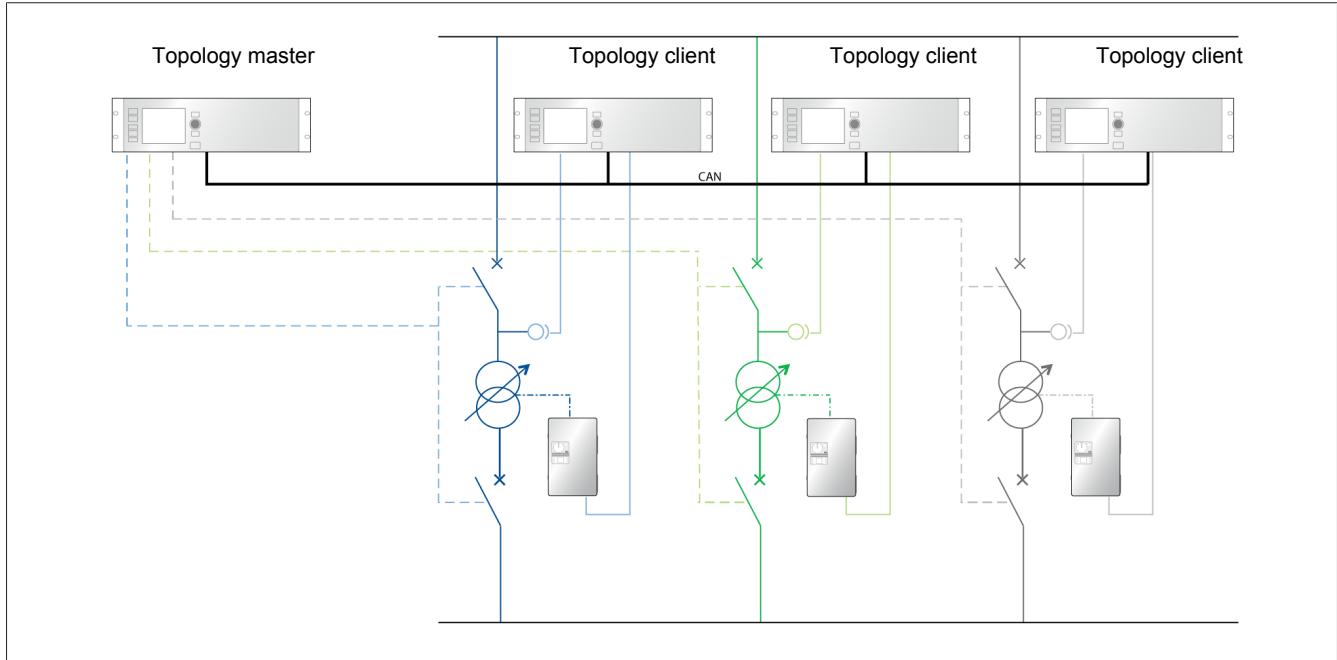


Figure 178: Operating principle for master without voltage regulation

- You can use the voltage regulator exclusively as a topology client with bank parallel operation.

You have to set the following parameters for the topology with fixed master/client function.

Parameters	Topology master	Topology client
Prim/sec. topology	Primary/Secondary	-
CAN address 1(2)...16 device name	User-defined	-
CAN bus address	1	2...16
Circuit breaker configuration	User-defined	-

Table 109: Configuring the topology

9.4.4.4.2 Topology with flexible master/client

Every device records the status of the circuit breakers via digital inputs. The device with the lowest CAN bus address operates as the topology master. The *Topology master* event message is active on the topology master. The topology master reports which devices take part in parallel operation to the connected devices. The devices compare self-determined topology information to the topology information received over CAN bus. If the topology information differs, the devices issue a *Internal topology deviation* event message.

If a topology master is switched off (e.g. if a transformer is disconnected from the grid for maintenance work), the topology client with the next highest CAN bus address takes over the function of the topology master.



Note that the *Topology master* and *Internal topology deviation* events are not output over the control system or digital output by default. If you would like to use this function, you have to link the event messages to a data point or digital output. Note the "Linking signals and events" [▶ Section 9.2.10, Page 106] section.

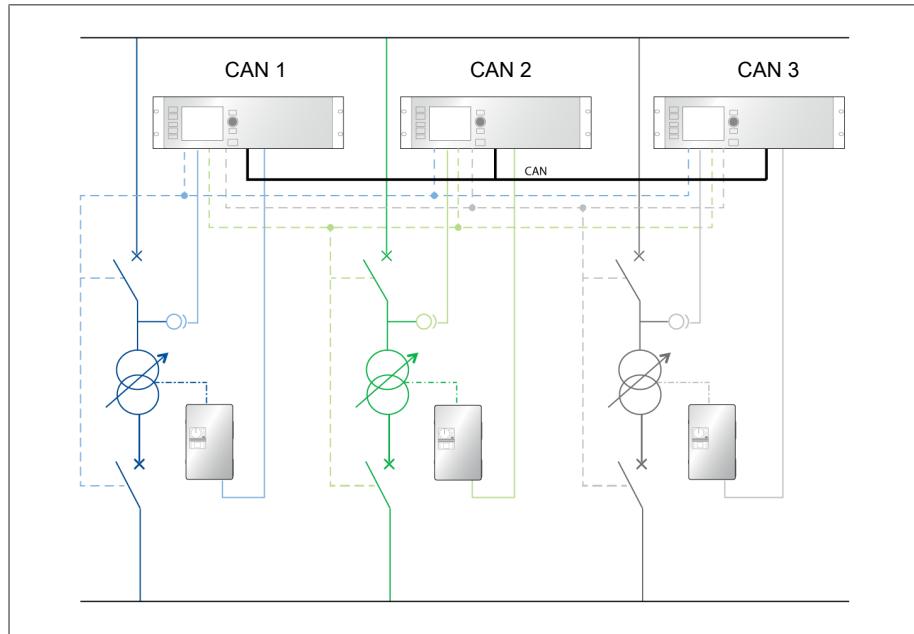


Figure 179: Operating principle

You have to set the following parameters for the topology with flexible master/client function.

Parameters	Master/Client
Prim/sec. topology	Primary/Secondary
CAN address 1...16 device name	User-defined
CAN bus address	1...16
Circuit breaker configuration	User-defined ¹⁾

Table 110: Configuring the topology

¹⁾ If you configure all switches with node 0 on a device, that device does not send any topology information over the CAN bus and operates solely as a topology client.

9.4.4.4.3 Configuring the topology

To configure the topology, you must adjust the following settings:

- Prim/sec. topology
- CAN address 1(2)...16 device name
- CAN bus address

Settings	Parameters	Parallel...ion
Name	Value	
Activating parallel operation	On	
Parallel operation method	Master	
CAN bus address	1	
Circulating reactive current sens...	0.0 %	
Circulating reactive current bloc...	20.0 %	
Desired power factor	0.9	
Desired load stress type	Inductive	
Master/follower current blocking	Off	
Maximum tap difference	1	
Master/follower switching charact...	Sequential	
Error if no communication present	No error	
Behavior if no communication pres...	Independent regulation	
Parallel operation error delay ti...	10 s	

EN | CHANGE | REBOOT | admin 03.02.2020 08:09 MR



Figure 180: Parallel operation

› Go to **Settings > Parameter > Voltage regulator > Parallel operation.**

Then configure the circuit breakers [▶ [Section 9.4.4.4.4, Page 205](#)].

Also refer to

CAN bus address [▶ [205](#)]

Prim/sec. topology

You can use this parameter to set the condition that defines when the transformers are connected in parallel. You can select the following options:

- Secondary side: Transformers are considered to be connected in parallel when the circuit breakers on the secondary side of the transformers are closed.
- Both sides: Transformers are considered to be connected in parallel when the circuit breakers on the primary and secondary sides of the transformers are closed.
- At least one side: Transformers are considered to be connected in parallel when the circuit breakers on the primary or secondary side of the transformers are closed.

CAN address 1(2)...16 device name

You can use these parameters to set the name of the transformers. The device uses the name in the information display for the topology.

CAN bus address

You can use this parameter to assign a CAN bus address to the device. So that all devices can communicate using the CAN bus, each device requires a unique identifier. If the value is set to 0, then no communication takes place.

9.4.4.4.4 Configuring the circuit breakers

You can set the assignment of circuit breakers to the individual node points. The device uses the assignment to detect which transformers are connected in parallel with one another.

i Upon delivery, the device is configured in accordance with your order. Note the connection diagram provided for the configuration.

Note the following conventions for the circuit breaker configuration:

- Nodes 1...16 correspond to the secondary side of the transformers according to the devices with CAN addresses 1...16 (node 1 = CAN address 1, node 2 = CAN address 2, etc.).
- You can use nodes 17...48 to configure the connection of the circuit breakers on the secondary side.
- Nodes 49...64 correspond to the primary side of the transformers according to the devices with CAN addresses 1...16 (node 49 = CAN address 1, node 50 = CAN address 2, etc.).
- You can use nodes 65...80 to configure the connection of the circuit breakers on the primary side.

If you assign the node A = 0 and node B = 0 node pair to a circuit breaker, the circuit breaker is deactivated for topology recording.

You have to assign a node pair to every circuit breaker.

1. Go to **Settings > Topology**.

The screenshot shows the 'Topology' settings page. On the left is a table with columns 'Circ. br.', 'Node A', and 'Node B'. The table lists 10 circuit breakers (Circ. br. 1 to 10) with their respective Node A and Node B values. To the right of the table is a detailed electrical diagram of a power distribution system. The diagram includes various components like switches (S1-S9), circuit breakers (K1-K22), and transformers (CAN1, CAN2, CAN3). Blue numbers (e.g., K49, S1, K50, K65) are placed near specific components in the diagram. On the far right, there is a vertical sidebar with icons for Home, Events, Information, Recorder, and Settings, each with a corresponding description text.

Circ. br.	Node A	Node B
Circ. br. 1	49	65
Circ. br. 2	50	65
Circ. br. 3	51	65
Circ. br. 4	52	66
Circ. br. 5	53	66
Circ. br. 6	0	0
Circ. br. 7	0	0
Circ. br. 8	0	0
Circ. br. 9	0	0
Circ. br. 10	0	0

Figure 181: Configuring the topology

2. Select the desired Circ. br..

The screenshot shows the configuration dialog for 'Circ. br. 1'. It has fields for 'Node A' (set to 49) and 'Node B' (set to 65). Below these fields is a note: 'Min: 0' and 'Max: 80'. To the right of the note is a detailed description of the node assignment rules. At the bottom are 'Cancel' and 'Accept' buttons. The right side of the screen features a vertical sidebar with icons for Home, Events, Information, Recorder, and Settings.

Figure 182: Configuring the topology for circuit breaker 1

3. Enter the desired node numbers in the fields **Node A** and **Node B**.
4. Press the **Accept** button to save the modified parameter.

9.4.4.4.5 Topology

In the Topology menu, you can display which transformers are in parallel operation and which parallel operation group the transformers belong to.

Column	Description
ldp. (Independent)	Blue: The transformer is in independent mode.
1...8	Blue: The transformer is part of parallel operation group (1...8) and is in parallel operation
	Red: The transformer is part of parallel operation group (1...8), but the CAN bus connection is disrupted

Table 111: Display options

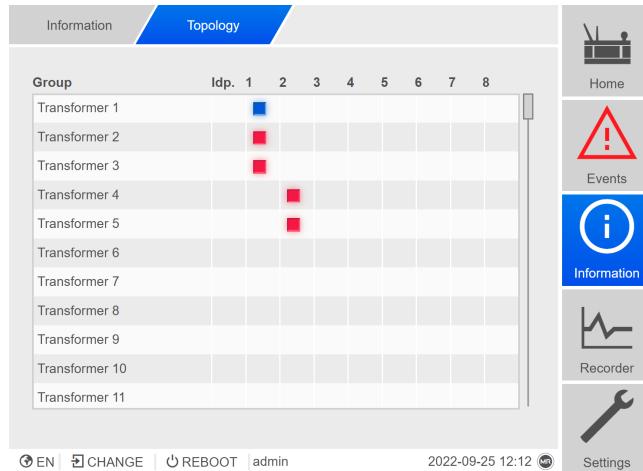


Figure 183: Topology

› Go to **Information > Voltage regulation > Topology**.

9.4.4.5 Parallel operation

In the parallel operation menu, you can display information about the devices that are connected by CAN bus.

	Description
	Parallel operation status: - - = Independent mode - ✓ = Parallel operation is active - △ = Parallel operation error
CAN	CAN bus address
Grp.	Parallel operation group
Method	Active parallel operation method
Position	Current tap position
U	Voltage
I_p	Active current
I_q	Reactive current
Block.	Blocking: - Gray: Parallel operation not blocked - Red: Parallel operation blocked

Table 112: Information about parallel operation

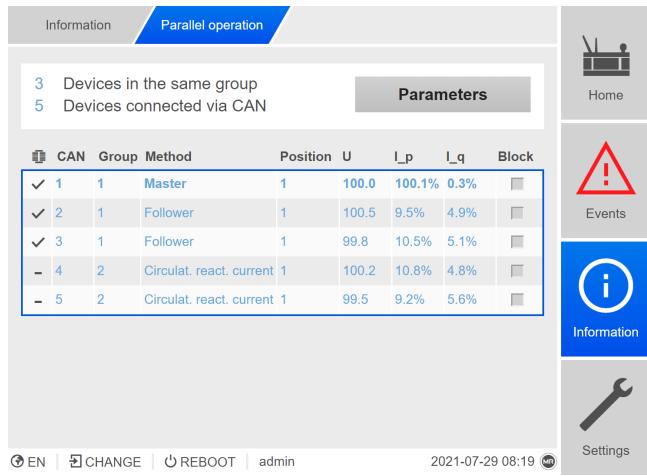


Figure 184: Parallel operation

1. Go to **Information > Voltage regulation > Parallel operation**.
2. If necessary, select the **Parameter** button to display the parallel operation settings for the device.
3. Select the desired parameter to change its setting.

9.4.5 U bandwidth monitoring

The following limit values are monitored via bandwidth monitoring. The set bandwidth [▶ Page 185] 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 [▶ Page 185], 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

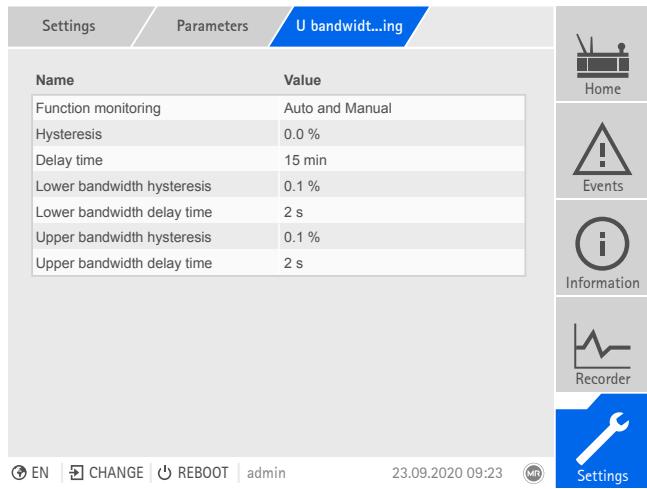


Figure 185: U bandwidth monitoring

› Go to **Settings > Parameter > Voltage regulator > U bandwidth monitoring.**

Also refer to

 Current monitoring [▶ 164]

Function monitoring

You can use this parameter to activate function monitoring. 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 113: 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 Target-tap-position operation

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



Figure 186: Move to the defined target tap position

- › Go to **Settings > Parameter > On-load tap-changer > Move to the defined target tap position.**

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

9.5 On-load tap-changer

9.5.1 Tap position monitoring (optional)

You can set 2 limit values for tap position monitoring:

- Pos<
- Pos>

You can set the following parameters for each limit value.

- Delay time limit value
- Behavior limit value

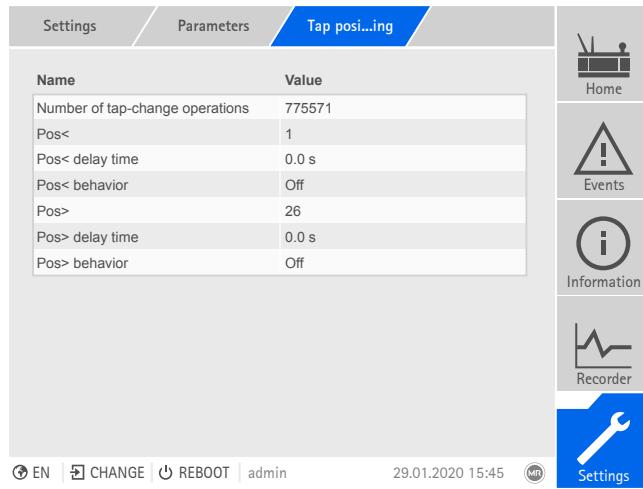


Figure 187: Tap position monitoring

› Go to **Settings > Parameter > On-load tap-changer > Tap position monitoring**.

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.

Setting	Behavior
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.

Also refer to

Target-tap-position operation [▶ 210]

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.

9.5.2 Switching interval monitoring

You can use this function to monitor the typical tap-change behavior of your transformer. To do so, 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

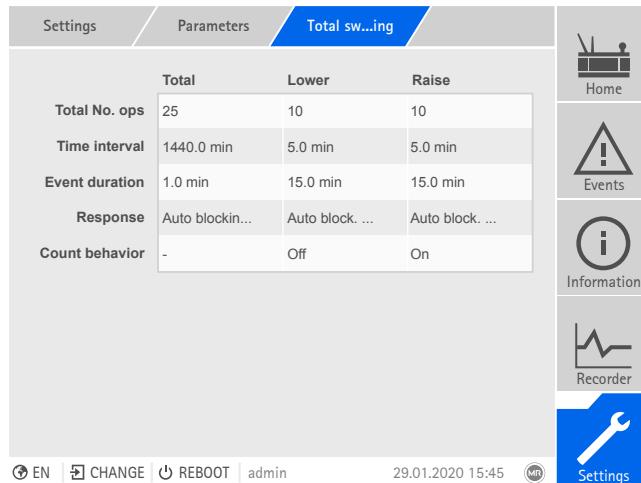


Figure 188: Switching interval monitoring

› Go to **Settings > Parameters > On-load tap-changer > Switching interval monitoring**.

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 115: 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.

9.5.3 Changing tap position designation (optional)

This function allows you edit the designation of the tap position. The designations are displayed on the main screen when each of the tap positions is active and are used for the control system.

Raw value	Tap position	Control system
1	1	1
2	2	2
3	3	3
4	4	1
5	5	2
6	6	1
7	7	3
8	8	4
9	9	5
10	10	6

Cancel **Accept**

EN | CHANGE | REBOOT | admin 23.03.2020 08:08 MFR Settings

Figure 189: Tap position table

1. Go to **Settings > Tap position table**.
2. Enter the designation for the tap position and for the control system.
3. Click on the **Accept** button.

9.5.4 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)

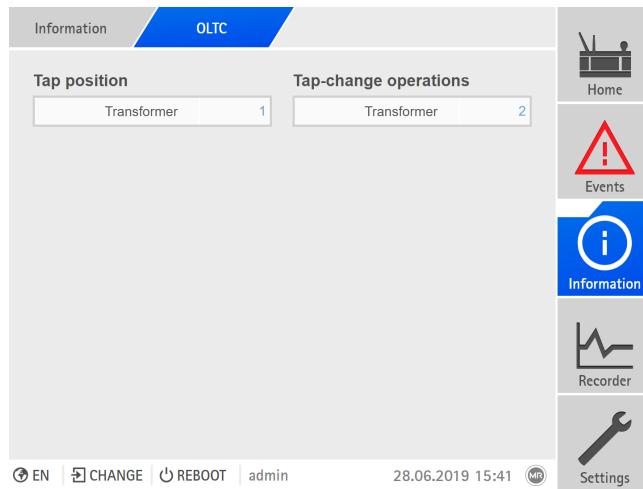


Figure 190: OLTC

› Go to **Information > On-load tap-changer > OLTC**.

9.5.5 Displaying tap-change operation statistics (optional)

In the switching statistics view, you can display how often the on-load tap-changer has been switched to a particular tap position and how long it has remained in a particular tap position.

The top diagram shows how often the on-load tap-changer was switched into a particular tap position and how long it spent there. The bottom diagram shows the time spent in the tap positions over the last 10 days.

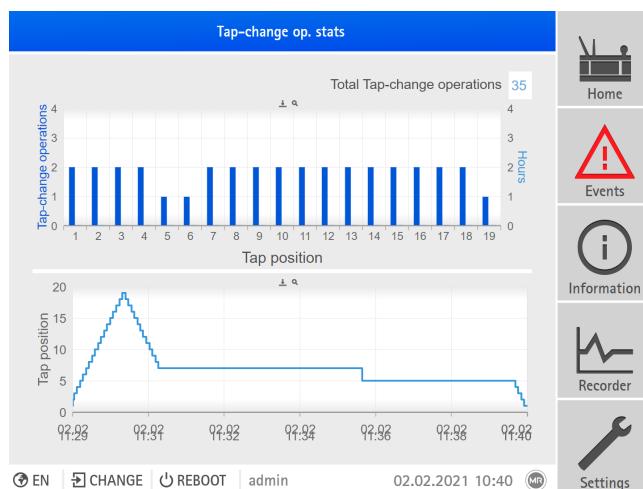


Figure 191: Tap-change operation statistics

› Go to **Information > On-load tap-changer > Tap-change operation statistics**.

9.5.6 Displaying information about contact wear (only OILTAP®)

If you are monitoring an on-load tap-changer of type OILTAP®, you can display the current wear values of the main switching contacts (MSCA, MSCB) and transition contacts (TC1A, TC1B, TC2A, TC2B).

The device also shows the differences in contact wear for different contacts.

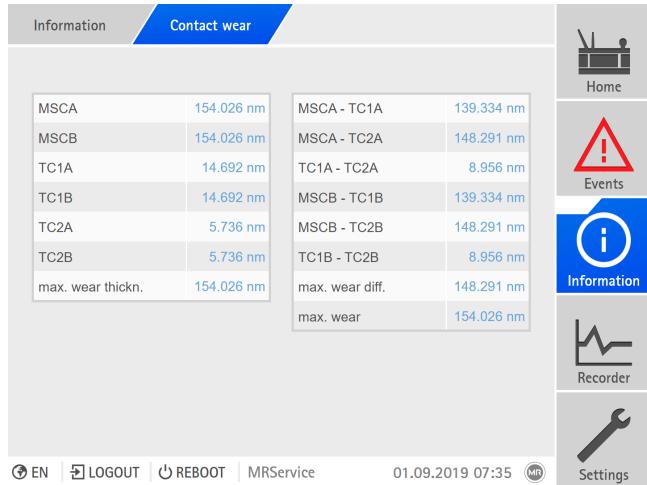


Figure 192: Contact wear

› Go to **Information > On-load tap-changer > Contact wear**.

9.5.7 Maintenance (optional)

The device monitors the following maintenance depending on the on-load tap-changer type:

Maintenance	Description
OLTC maintenance	The on-load tap-changer must be maintained in accordance with the MR standards.
OLTC replacement	The on-load tap-changer must be replaced with a new on-load tap-changer.
DSI replacement	The diverter switch insert must be replaced with a new diverter switch insert.
IEM replacement	The interrupter exchange module (IEM) of the on-load tap-changer must be replaced with a new IEM.
Contact wear	The main switching contacts or transition contacts of the on-load tap-changer must be exchanged or replaced.
Oil exchange and cleaning	The oil must be changed and the diverter switch insert, oil compartment, and oil conservator must be cleaned.
Selector maintenance	The on-load tap-changer selector must be maintained in accordance with the MR standards.
Cleaning/lubrication	The on-load tap-changer needs to be cleaned and lubricated.
Oil sample	An oil sample must be taken and analyzed; the limit values specified by MR for added insulating oil must be observed.
Oil filter unit	The oil filter of the oil filter unit must be replaced.

Maintenance	Description
OLTC operator interval	Maintenance interval for the on-load tap-changer; the interval depends on the number of tap-change operations or on time, and the operator can specify it.
Transformer operator interval	Time-dependent maintenance interval for the transformer, which the operator can specify.

Table 116: Maintenance (availability depends on the on-load tap-changer type)

9.5.7.1 Setting operator interval for OLTC maintenance

You can define the maintenance interval of your choice for the on-load tap-changer. You can define the maintenance interval as dependent on time and/or number of tap-change operations. If the limit is reached (100%), the device triggers an event message (red).

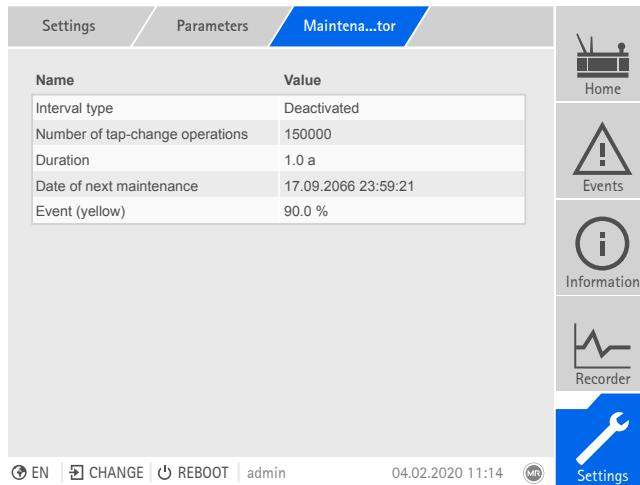


Figure 193: Maintenance: OLTC operator

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

9.5.7.2 Setting operator interval for transformer maintenance

You can define a maintenance interval of your choice for the transformer. The maintenance interval is dependent on time. If the limit is reached (100%), the device triggers an event message (red).

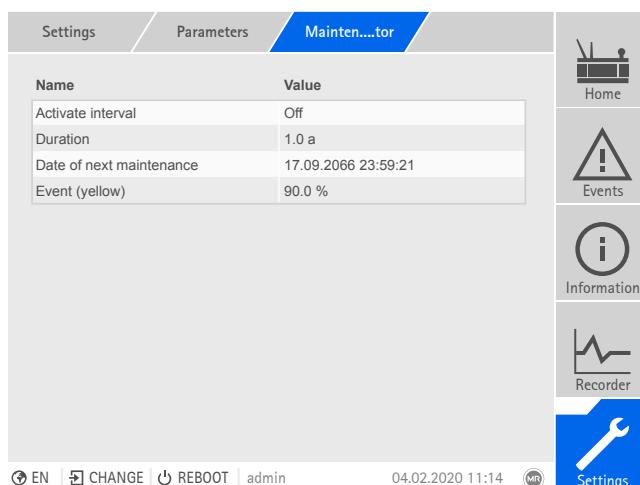


Figure 194: Maintenance: Transformer operator

1. Go to **Settings > Parameters > Active part > Maintenance: Transformer operator**.
2. Select the desired parameter.
3. Set the desired parameter.
4. Press the **Accept** button to save the modified parameter.

9.5.7.3 Undertaking and confirming maintenance

Once you have undertaken maintenance, you can confirm this on the device and thereby reset the maintenance interval. The following maintenance parameters can be entered based on the maintenance type:

Value	Description
Date	Date of maintenance.
Operation counter	Reading of the operations counter at the time of maintenance. You can enter the current counter reading or a smaller counter reading.
Contact wear (only OILTAP®)	<p>Overall contact wear on the stationary contact and moving contact.</p> <p>If you have measured the contact wear during maintenance and continue to use the contacts in their original positions, then enter the measured values and select "No" in the prompt that reads "Contacts exchanged/replaced" to confirm it. This causes the monitoring system to optimize its calculation model, and subsequent calculation of the contact wear is more precise.</p> <p>If you have exchanged (other position) or replaced contacts, then enter the contact wear found on the mounted contacts (for new contacts: 0.000 mm) and select "Yes" in the prompt that reads "Contacts exchanged/replaced" to confirm it.</p>

Table 117: Maintenance parameters

Determining the contact wear (only OILTAP®)

The thickness of the wear to be entered is the sum of the wear of the movable and the fixed contact part.

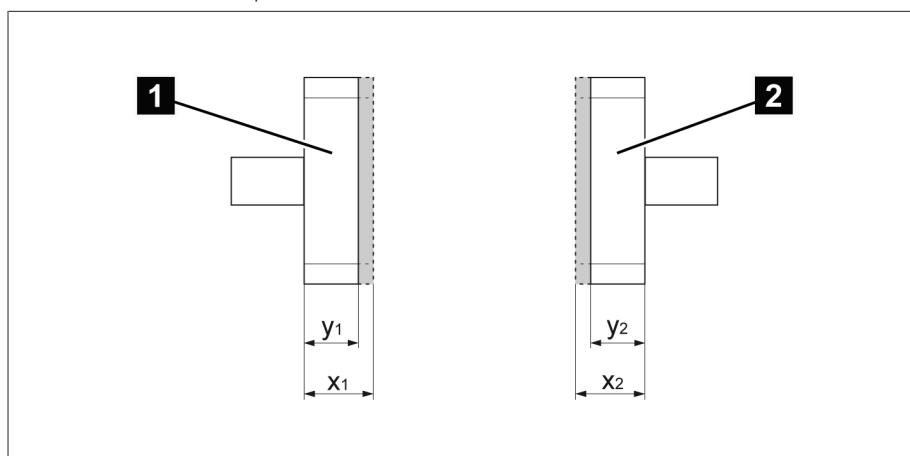


Figure 195: Determining contact wear

1	Fixed contact	y_1	Thickness of the worn contact coating (fixed contact)
2	Moving contact	x_2	Thickness of the contact coating when new (moving contact)
x_1	Thickness of the contact coating when new (fixed contact)	y_2	Thickness of the worn contact coating (moving contact)

The wear thickness z to be entered is determined as follows:

$$z = x_1 - y_1 + x_2 - y_2$$

Confirming maintenance

To confirm maintenance, proceed as follows:

1. Go to **Settings > Maintenance wizard**.

The screenshot shows a maintenance wizard interface. At the top, there are tabs for 'Settings' and 'Maintenance wizard'. The 'Maintenance wizard' tab is active. On the left, a list of maintenance tasks is shown with checkboxes. The first task, 'OLTC maintenance', has a checked checkbox. Other tasks listed include 'OLTC replacement', 'DSI replacement', 'Selector maintenance', 'Oil sample', 'OLTC operator interval', 'Transformer operator interval', 'Oil change and cleaning', and 'Oil filter change'. To the right of the list is a message: 'Please select the maintenance work you have undertaken.' Below the list is a 'Next' button. At the bottom of the screen, there are status indicators: EN, CHANGE, REBOOT, admin, the date 29.01.2021 07:35, and a battery icon.

Figure 196: Maintenance wizard

2. Select the maintenance to be confirmed.
3. Press the **Next** button.
4. Enter the maintenance parameters.

The screenshot shows the maintenance parameters screen. At the top, there are tabs for 'Settings', 'Maintenance wizard', and 'Reset maintenance'. The 'Maintenance wizard' tab is active. The screen is titled 'Maintenance undertaken' with the sub-instruction 'Please enter the values needed for the maintenance undertaken.' It contains four pairs of input fields for dates and measurements. The first pair is for Date (2021-1-29) and TC1A (0,000 mm). The second pair is for Operations counter (0) and TC1B (0,000 mm). The third pair is for MSCA (0,000 mm) and TC2A (0,000 mm). The fourth pair is for MSCB (0,000 mm) and TC2B (0,000 mm). Below these fields is a 'Description' section with a large text input field. At the bottom are 'Cancel' and 'Accept' buttons. At the very bottom, there are status indicators: EN, CHANGE, REBOOT, admin, the date 29.01.2021 07:36, and a battery icon.

Figure 197: Undertaking and confirming maintenance

5. Press the **Accept** button to save the modified parameters.
6. Optional: A prompt appears asking if the contacts were exchanged or replaced. Press **Yes** or **No** to confirm the prompt.

9.5.7.4 Displaying maintenance overview

The maintenance overview displays the progress of the individual maintenance intervals. You can also see the limit values for the "yellow" and "red" event messages. For the maintenance intervals of the on-load tap-changer, the device uses the recorded operating data to predict the date for the next maintenance appointment. The date is not displayed until enough operating data has been recorded.

i If you have deactivated the "OLTC operator maintenance" or "Transformer operator maintenance" interval, the interval is shown grayed out in the maintenance overview.

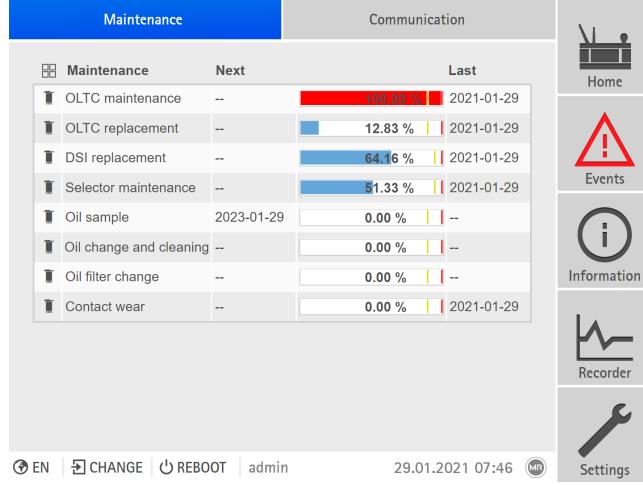


Figure 198: Maintenance overview

> Go to **Information > System > Maintenance**.

9.5.7.5 Displaying the maintenance logbook

All maintenance tasks that have been performed are displayed in the maintenance logbook. The entries are generated automatically if you perform maintenance using the maintenance wizard. You can also create separate entries.

The maintenance logbook displays the following information:

- Time of maintenance
- Mainten.type
- Description

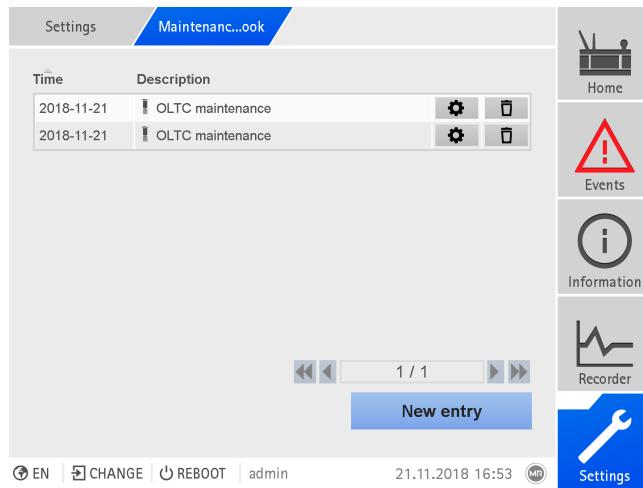


Figure 199: Maintenance logbook

To call up the maintenance logbook, proceed as follows:

> Go to **Settings > Maintenance logbook**.

Editing an entry in the maintenance logbook

You can edit the entries in the maintenance logbook as needed.

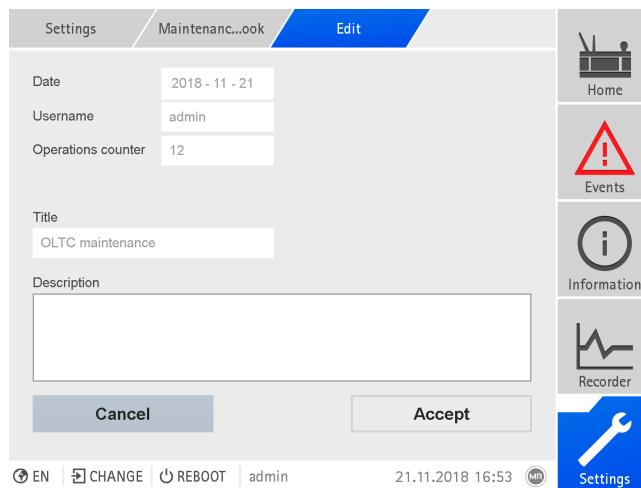


Figure 200: Editing an entry in the maintenance logbook

Proceed as follows to edit an entry in the maintenance logbook:

1. Go to **Settings > Maintenance logbook**.
2. Press the  button in order to edit an entry.

Creating an entry in the maintenance logbook

Proceed as follows to create an entry in the maintenance logbook without using the maintenance wizard:

1. Go to **Settings > Maintenance logbook**.
2. Press the **New entry** button.
3. Enter the maintenance data.
4. Press the **Accept** button to save the entry.

Deleting an entry in the maintenance logbook

You can delete the entries in the maintenance logbook as needed. To do so, proceed as follows:

1. Go to **Settings > Maintenance logbook**.
2. Press the  button in order to delete the entry.

9.5.7.6 Suppressing a maintenance event

You can use this function to suppress the event messages of maintenance tasks whose limit values have been reached for a specific number of on-load tap-change operations. If you acknowledge a maintenance event without performing maintenance, the device will report the event message after the set number of on-load tap-change operations.

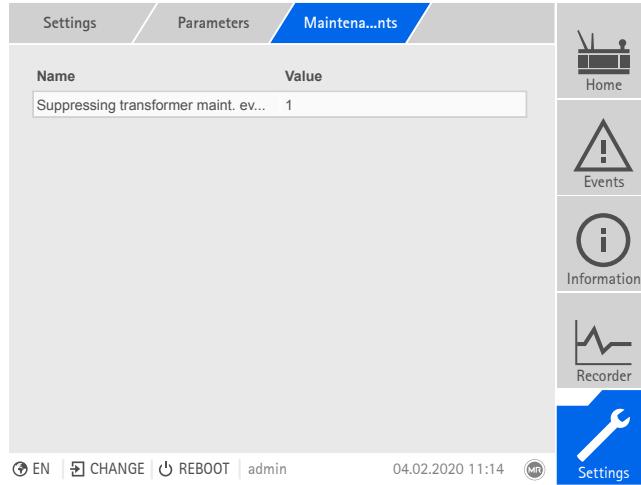


Figure 201: Suppressing a maintenance event

1. Go to **Settings > Parameters > Active part > Maintenance events or Settings > Parameters > On-load tap-changer > Maintenance events**.
2. Select the desired parameter.
3. Set the parameter.
4. Press the **Accept** button to save the modified parameter.

9.5.8 OLTC data

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

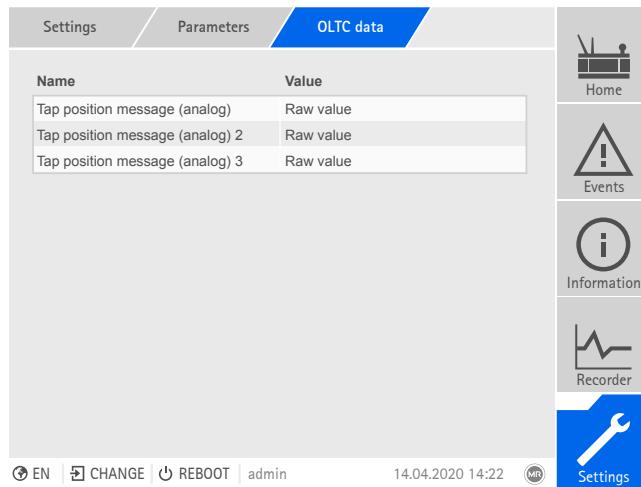


Figure 202: OLTC data

- › Go to **Settings > Parameters > On-load tap-changer > OLTC data**.

OLTC A/B/C serial number

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

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

9.5.8.1 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 [►Section 9.5.3, Page 213]. 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.

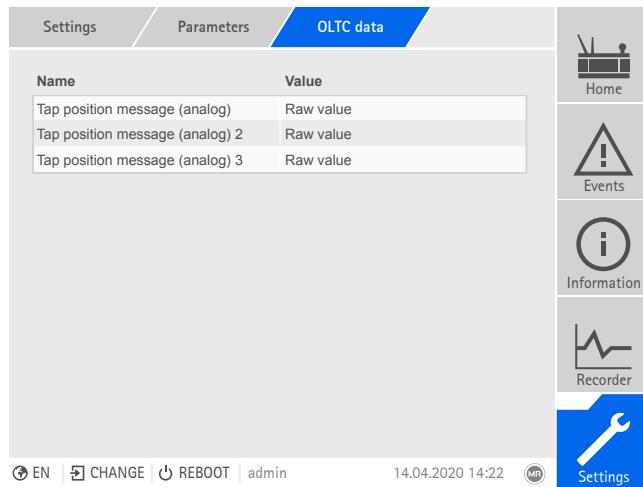


Figure 203: OLTC data (example with 3x tap position message via analog outputs)

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.

i If you change this parameter, you must then ensure that the configured analog output value range [►Section 9.2.11, Page 109] matches the value range in the tap position table [►Section 9.5.3, Page 213]. Otherwise, the tap position will not be reported correctly.

9.5.9 Displaying the minimum and maximum tap position

You can display the minimum and maximum tap position reached and the corresponding time. You can reset the display, which will cause the device to restart recording. The time of the reset will be logged as an event. If you reset the display, the drag hands will also be reset.

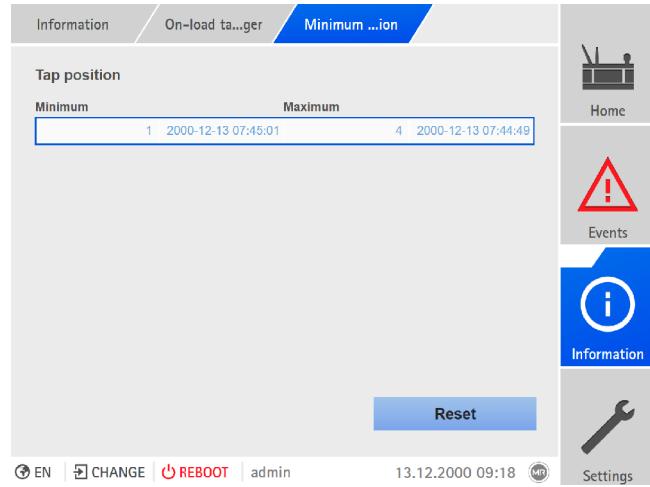


Figure 204: Minimum and maximum tap position

1. Go to **Information > On-load tap-changer > Min. and max. tap position (de-sig.)**.
2. As needed, select the **Reset** button to reset the minimum and maximum values.

9.6 Motor-drive unit and control cabinet

9.6.1 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

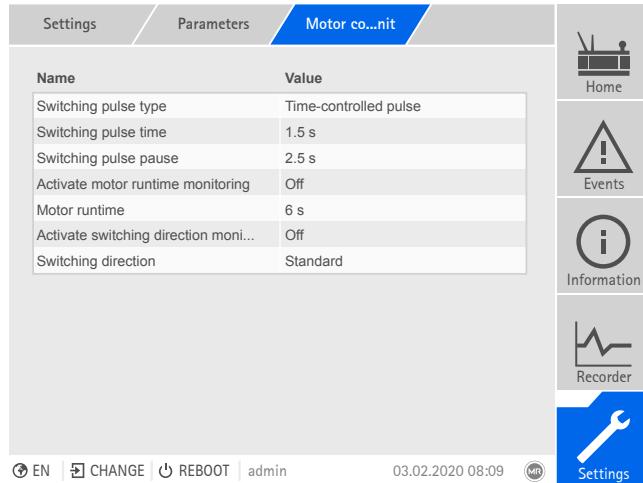


Figure 205: Motor control unit

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

9.6.1.1 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.

› Go to **Settings > Parameter > Motor and control cabinet > Motor control unit**.

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.

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

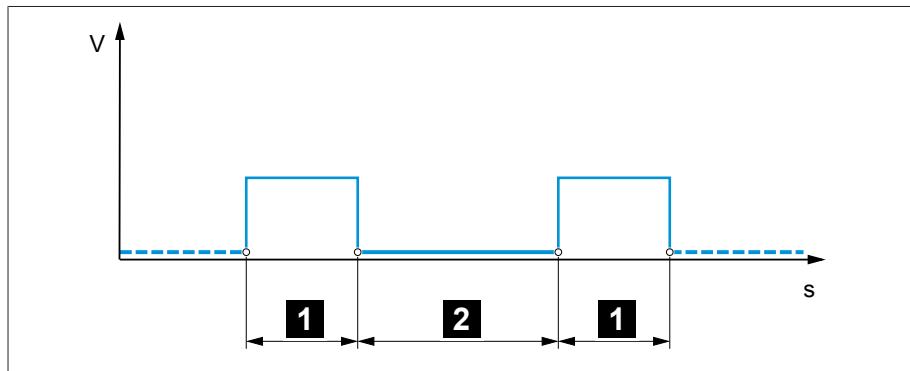


Figure 206: Switching pulse time and switching pulse pause

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.

9.6.1.2 Setting motor runtime monitoring

The runtime of the motor-drive unit 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*

i 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.

› Go to **Settings > Parameter > Motor and control cabinet > Motor control unit**.

Motor runtime monitoring limit

This parameter lets you set the motor runtime monitoring limit.

Motor runtime monitoring

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

9.6.1.3 Setting the switching direction

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

- Go to **Settings > Parameter > Motor and control cabinet > Motor control unit**.

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

Table 118: Behavior

Q switching direction (optional)

You can use this parameter to set the switching direction for reactive power 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	The device issues a signal via the <i>RAISE</i> output to increase the reactive power. The device issues a signal via the <i>LOWER</i> output to reduce the reactive power.
Swapped	The device issues a signal via the <i>LOWER</i> output to increase the reactive power. The device issues a signal via the <i>RAISE</i> output to reduce the reactive power.

Table 119: 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 [▶ Section 9.2.13.1, Page 113] the event.



Switching direction monitoring is not active if you control the motor-drive unit with a continuous pulse [▶ Section 9.6.1.1, Page 224].

Also refer to

- █ Setting the switching pulse for controlling the motor-drive unit [► 224]
- █ Displaying and acknowledging events [► 113]

9.6.2 Tap position capture

The current tap position of the on-load tap-changer is transmitted from the motor-drive unit to the device. You can define the type of tap position capture during the order. You cannot change this subsequently via a menu.

In accordance with your order, the tap position is transmitted in one of the following ways:

- Digital signal
 - BCD
- Analog signal
 - Injected current (0/4...20 mA)
 - Voltage (0...10 V)
 - Resistor contact series

9.6.2.1 Digital tap position capture

The tap position can optionally be transmitted from the motor-drive unit to the device as a digital signal. No further settings are needed.

9.6.2.2 Analog tap position capture

9.6.2.2.1 Injected current (0/4...20 mA) or voltage (0...10 V)

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

i The device is configured at the factory according to the order. However, should modifications be necessary, note the following sections.

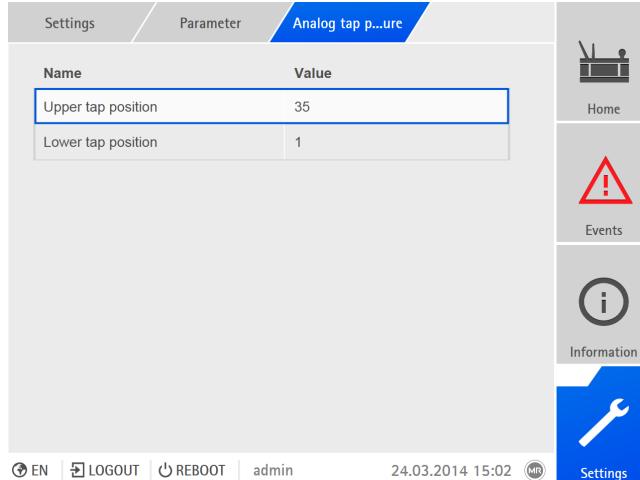


Figure 207: Setting analog tap position capture

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).

To set the tap position at the maximum analog signal, proceed as follows:

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).

To set the lower tap position, proceed as follows:

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

9.6.2.2.2 Resistor contact series

i 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.

To carry out the calibration, proceed as follows:

1. Go to **Settings > Calibrate hardware > Calibrate RCS**.

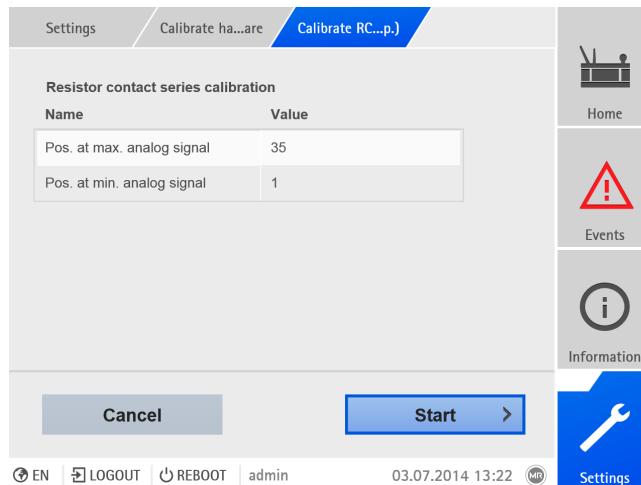


Figure 208: Calibrate resistor contact series (RCS)

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. Press 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.
 - ð Step 2: The device calibrates the current output and once complete moves onto step 3.

12. Step 3: Manually switch on-load tap-changer to the lowest tap position.
 - ð Step 4: The device determines the offset and once complete moves onto step 5.
13. Step 5: Press the **Next** button to complete calibration.
 - » Calibration of tap position capture using the resistor contact series has been undertaken successfully.

10 Maintenance and care

10.1 Cleaning the device

You can clean the device's housing with a dry cloth.

11 Fault elimination

11.1 General faults

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

Table 120: General faults

11.2 No regulation in AUTO mode

Characteristics/detail	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. – ALARM 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.
Bandwidth set too high	-	Determine the recommended bandwidth.

Characteristics/detail	Cause	Remedy
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 121: No regulation in AUTO mode

11.3 Bank parallel operation

Characteristics/details	Cause	Remedy
Automatic voltage regulation is blocked. Manual tap-change operations using digital inputs or a control system are blocked. – Event No. 159 <i>Tap positions of transformers not the same</i>	The transformers are in different tap positions.	Check whether the motor-drive unit or on-load tap-changer are ready to function. The motor-drive units must be in the REMOTE operating mode. If the motor-drive unit and on-load tap-changer are ready to function, switch transformers into the same tap position manually [▶ Section 9.1, Page 80].
Automatic voltage regulation is blocked. Manual tap-change operations using digital inputs or a control system are blocked. – Event No. 172, 172 or 174 <i>Motor-drive unit 1/2/3 LOCAL</i>	The motor-drive unit is in the LOCAL operating mode.	Switch the motor-drive unit to the REMOTE operating mode.

Table 122: Bank parallel operation

11.4 Unwanted on-load tap-change operation

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

Table 123: Unexplained tap change

11.5 Human-machine interface

OT1205

Characteristics/details	Cause	Remedy
Keys – MANUAL/AUTO operating mode cannot be changed	REMOTE operating mode active and LED in key REMOTE illuminated.	Press REMOTE to activate LOCAL mode.
Display – No display.	Power supply interrupted.	Check the voltage supply.
	Fuse faulty.	Contact Maschinenfabrik Reinhausen.
	Connection cable between front panel and CPU (ETH 2.1) defective.	Check connection cable
Display – No reaction to input	Display has crashed.	Press ENTER + BACK for longer than 2 s to reset the display.

Table 124: OT1205

Visualization

Characteristics/details	Cause	Remedy
Connection cannot be established with visualization	Connection cable defective	Check connection cable
	SSL encryption active	Accept SSL certificate in browser
		Call up IP address using https://
		Deactivate SSL encryption
	When establishing connection via front panel: Automatic sourcing of IP address of PC (DHCP) is not active	Activate automatic sourcing of IP address (DHCP) on the PC
	When establishing connection via the CPU I interface: IP addresses of visualization and SCADA are in the same subnet	Check setting of device's IP addresses and correct if necessary.
Incorrect display of visualization in the web browser.	When establishing a connection via the CPU I interface: PC not in the same subnet as visualization	Check the setting of IP addresses of the device and PC and correct if necessary.
	Access to the visualization using a web browser after a software update.	Delete the web browser's cache.

Table 125: Visualization

11.6 Incorrect measured values

Characteristics/details	Cause	Remedy
Measured voltage – No measured value available.	Connection has no contact in the plug terminal.	Check wiring and plug terminal.
	Insulation trapped	
	Wire not inserted far enough.	
	Miniature circuit breaker tripped.	Check fuse.
	Assembly UI 1 or UI 3 defective – RDY LED does not light up – RDY LED flashes	Contact Maschinenfabrik Reinhausen GmbH.
Measured voltage – Measured value too low.	Voltage drop on measuring line.	Check measured voltage.
Measured voltage – Measured value fluctuates.	Possible sources of interference: – Cables laid in parallel. – Tap-change operations.	Check measured voltage. Increase distance from source of interference. Install filter if necessary.
	Line to current transformer interrupted.	Check wiring.
	Short-circuiting jumper in current transformer not removed.	Remove short-circuiting jumper.
Measured current – No measured value.	Assembly UI 1 or UI 3 defective – RDY LED does not light up – RDY LED flashes	Contact Maschinenfabrik Reinhausen GmbH.
	Current transformer not correctly parameterized.	Correct parameterization.

Table 126: Incorrect measured values

11.7 Parallel operation faults

Characteristics/details	Cause	Remedy
Problem with CAN bus. – Device not listed.	Device incorrectly connected.	Check connections. Connect as shown in connection diagram.
	Devices have the same CAN bus addresses.	Set different CAN bus addresses.
	CAN bus address of device set to "0".	Set CAN bus address (anything but 0).
Problem with parallel operation.	Different parallel operation methods set for devices in the parallel operation group.	Check configuration.

Characteristics/details	Cause	Remedy
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 connection diagram.
Problem with master/follower parallel operation method: – Master/follower switching characteristics is "in sync".	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: – Manually correct the master's tap position. – Restart master. – Set master/follower switching characteristics to "sequential". – Change master device to follower and define a different device as the master.
Problem with circulating reactive current minimization parallel operation method.	Circulating reactive current cannot be calculated.	Check wiring. Connect as shown in connection diagram.
	Circulating reactive current blocking limit exceeded.	Check configuration.

Table 127: Parallel operation faults

11.8 Tap position capture incorrect

Characteristics/detail	Cause	Remedy
Position indicator incorrect. – Leading sign incorrect.	Incorrect wiring.	Check wiring. Connect as shown in connection diagram.
	Minimum value of the analog input signal not configured correctly.	Check parameters.
Position indicator incorrect. – Display fluctuates.	Interference.	Shield the line.
		Increase distance from source of interference. Lay interference lines separately.
		Route signal in separate lines (filter, shielded lines).
No position indicator. – "--" is displayed.	No measurement signal. No L- for digital input.	Connect signal as shown in connection diagram.
		Check wiring. Connect as shown in connection diagram.
No position indicator. – "?" is displayed.	Bit combination (code) impermissible.	Check wiring.
	"Motor running" signal present.	Check the signal sequence.

Characteristics/detail	Cause	Remedy
Tap position capture over resistor contact series faulty.	Faulty calibration.	Calibrate tap position capture over resistor contact series.
	Modified contact resistance values of the resistor contact series (e.g. due to weather or age).	Calibrate tap position capture over resistor contact series.

Table 128: Tap position capture

11.9 Assemblies

Consult the following table to check whether individual assemblies have a malfunction.

Assembly	Characteristics/details	Cause	Remedy
UI 1/UI 3	RDY LED (yellow) does not light up	No communication with assembly possible.	Contact Maschinenfabrik Reinhausen GmbH.
	RDY LED (yellow) flashes	An error was detected in the assembly.	Contact Maschinenfabrik Reinhausen GmbH.
CPU I	RUN LED (green) does not light up	No power supply.	Check power supply.
	ERR LED (red) lights up	An error was detected in the assembly.	Contact Maschinenfabrik Reinhausen GmbH.
DIO 28-15 DIO 42-20 DIO 42-20 HL	RUN LED (green) does not light up	No power supply	Check the power supply
	ERR LED (red) lights up	An error was detected in the assembly.	Contact Maschinenfabrik Reinhausen GmbH.
AIO 2 AIO 4	RDY LED (yellow) does not light up	No communication with assembly possible.	Contact Maschinenfabrik Reinhausen GmbH.
	RDY LED (yellow) flashes	Wiring faulty.	Check wiring.
		Interface configuration faulty.	Check configuration.

Table 129: Assembly faults

11.10 Other faults

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

- 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 Uninstallation

The following describes the safe removal of the device.

⚠ 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.

12.1 Uninstalling the CPU assembly

1. Remove the 24V DC plug.

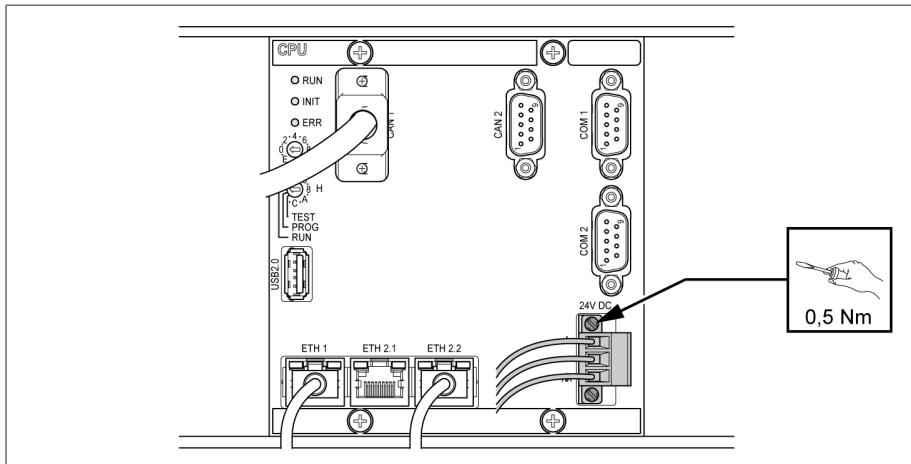


Figure 209: Removing the plug (voltage supply)

2. Remove the Ethernet cable.

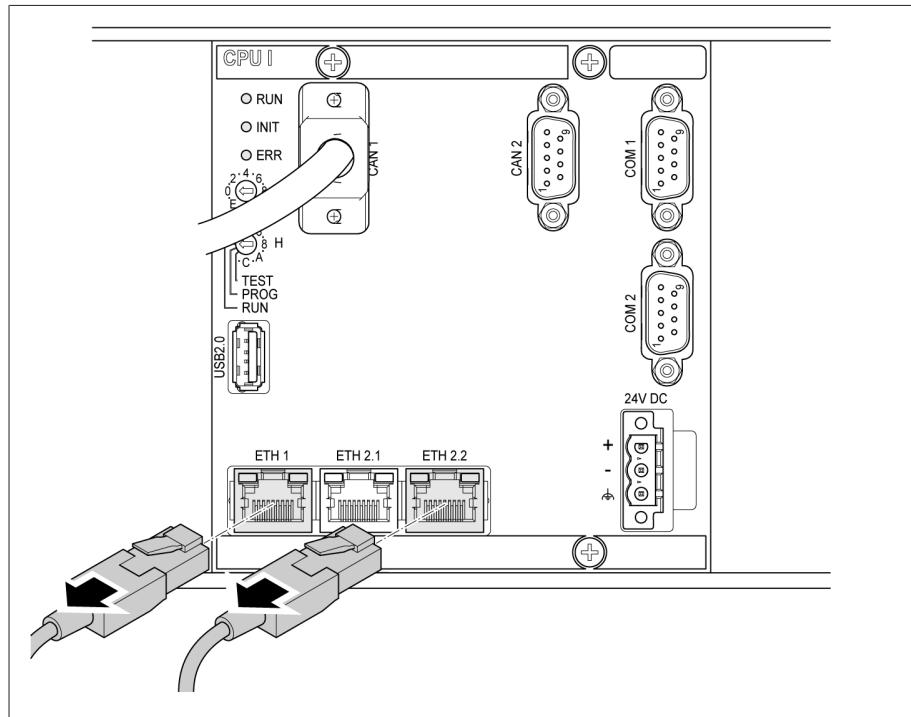


Figure 210: Removing the Ethernet cable

3. If necessary, remove the data cable (D-Sub 9-poles).

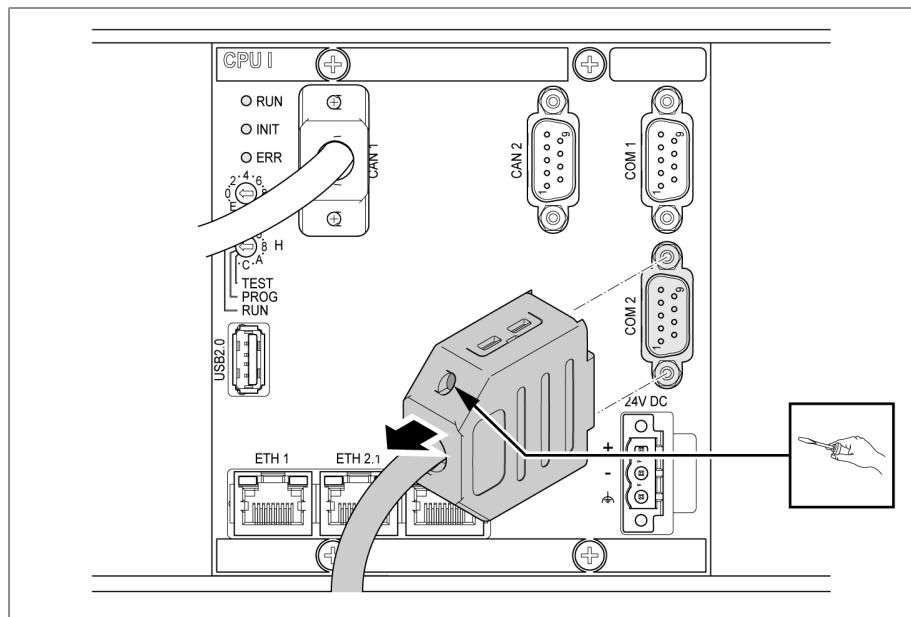


Figure 211: Removing the data cable

4. Remove the CAN bus cable.

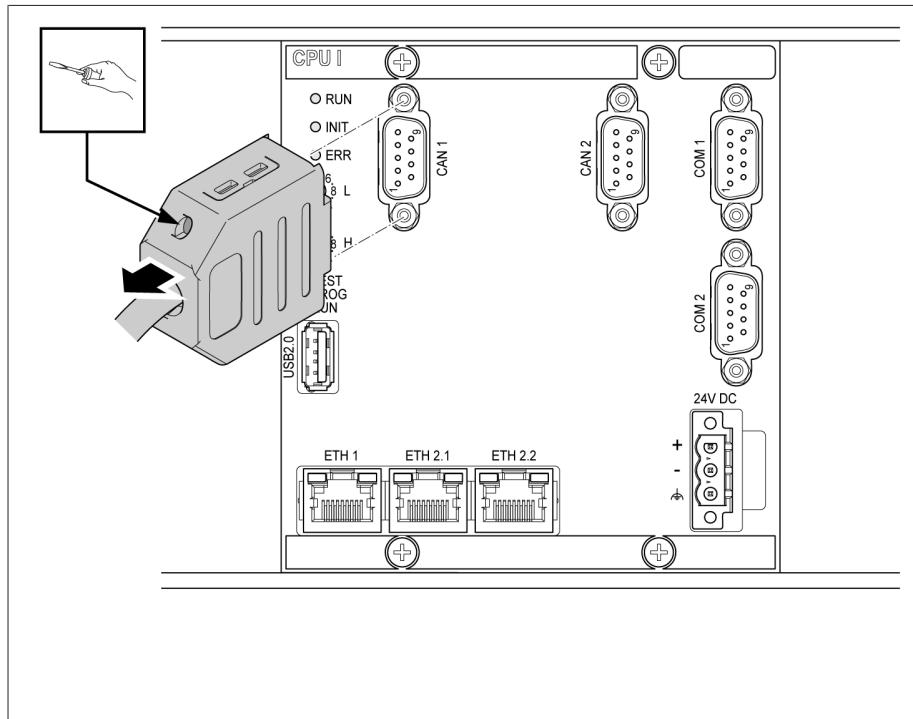


Figure 212: CAN bus cable

5. Unscrew the fixing screws.

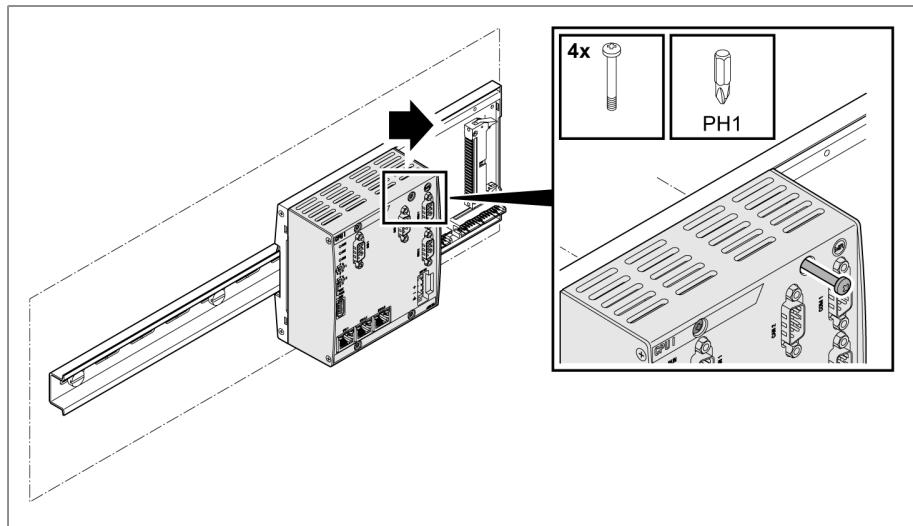


Figure 213: Unscrewing the fixing screws

6. Unplug the assembly.

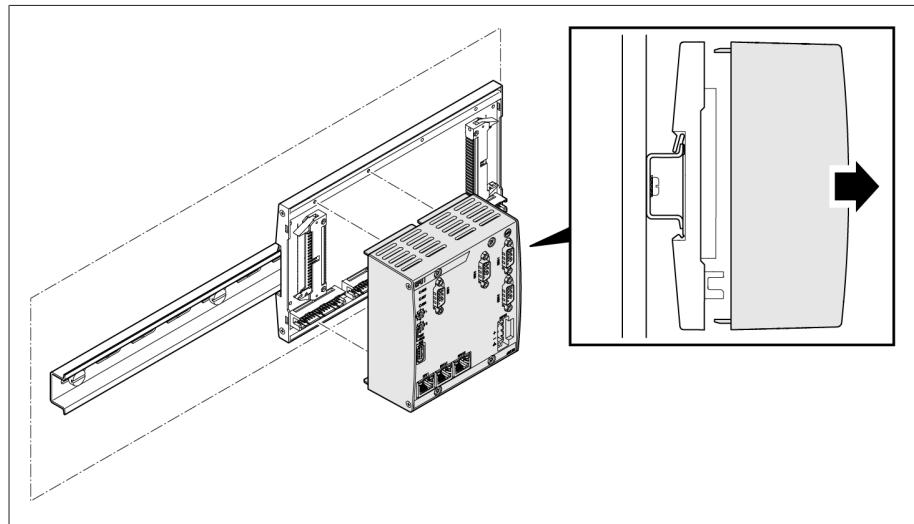


Figure 214: Unplugging the CPU assembly

12.2 Removing the UI 1 assembly

1. Remove the plug for the voltage measurement.

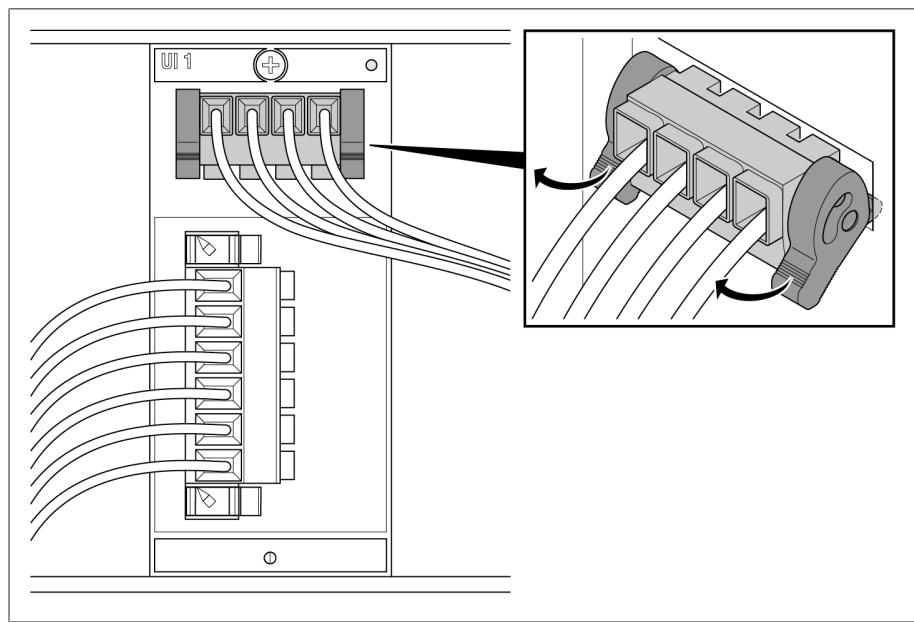


Figure 215: Voltage measurement

2. **⚠️ WARNING!** Make sure that the current transformer is shorted. Otherwise dangerously high voltages could occur. Remove the plug for the current measurement.

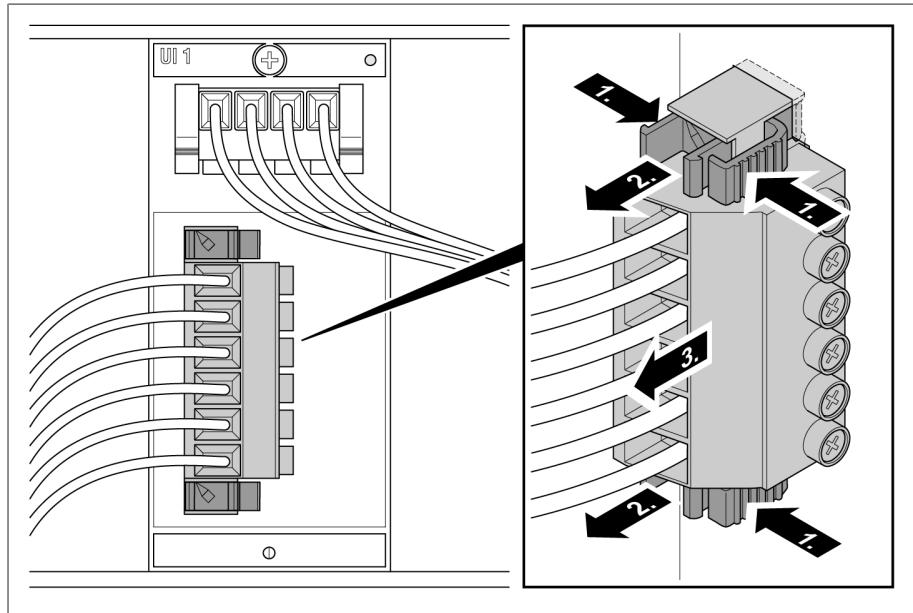


Figure 216: Current measurement

3. Loosen the fixing screws and unplug the assembly.

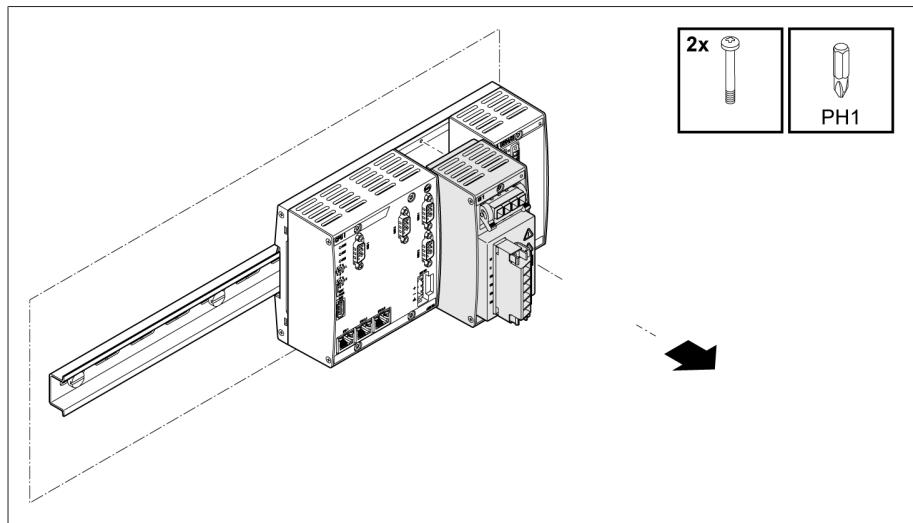
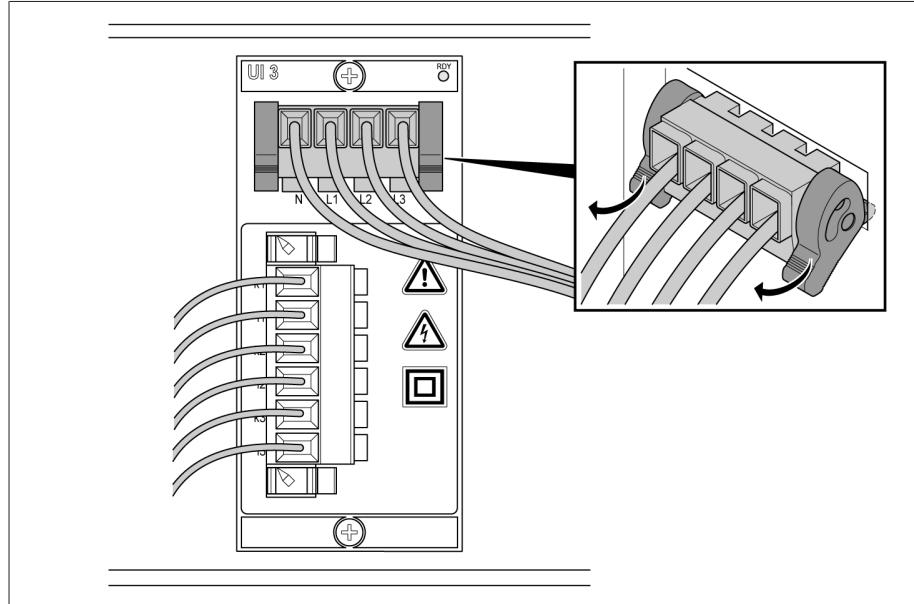


Figure 217: Unplugging the UI assembly

12.3 Removing the UI 3 assembly

1. Remove the plug for the voltage measurement.



2. **⚠ WARNING!** Make sure that the current transformer is shorted. Otherwise dangerously high voltages could occur. Remove the plug for the current measurement.

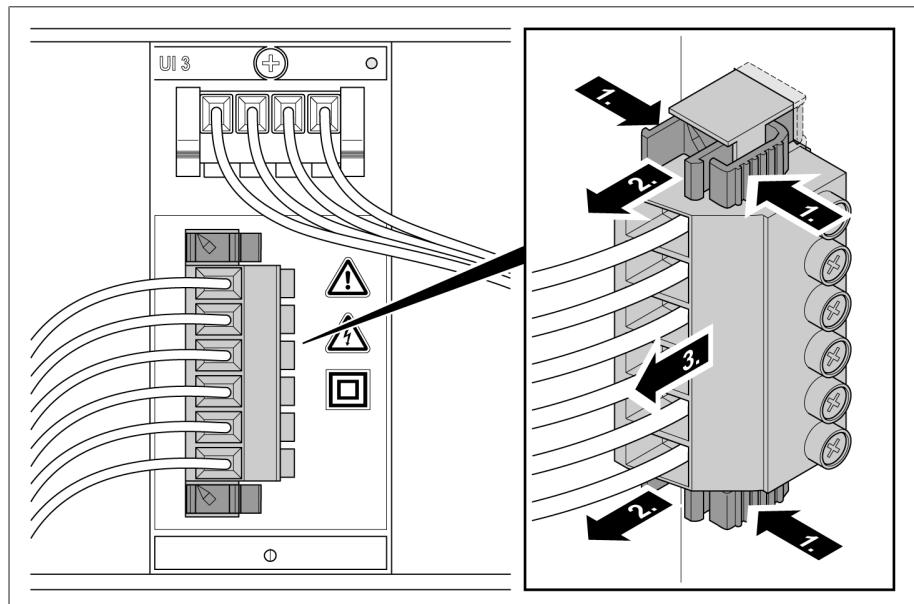


Figure 218: Current measurement

3. Loosen the fixing screws and unplug the assembly.

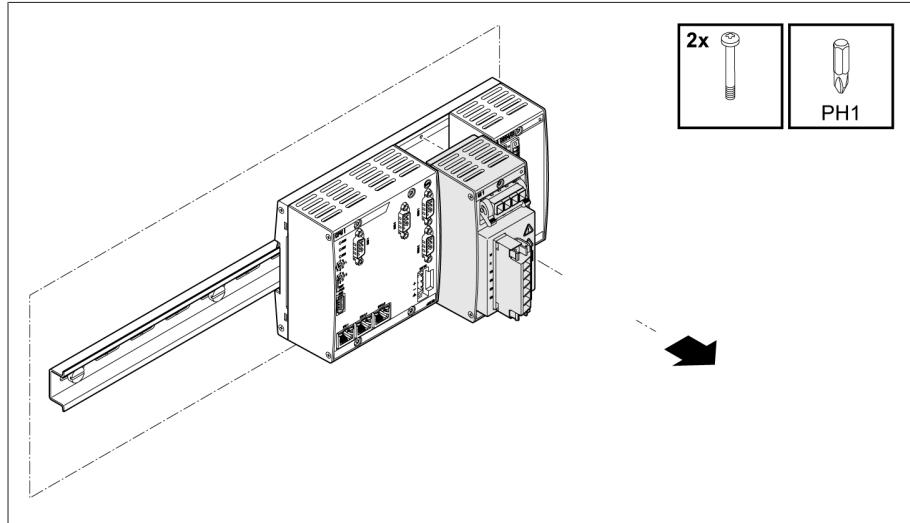


Figure 219: Unplugging the UI assembly

12.4 Removing the AIO 2 assembly

1. Remove the 24V DC plug.

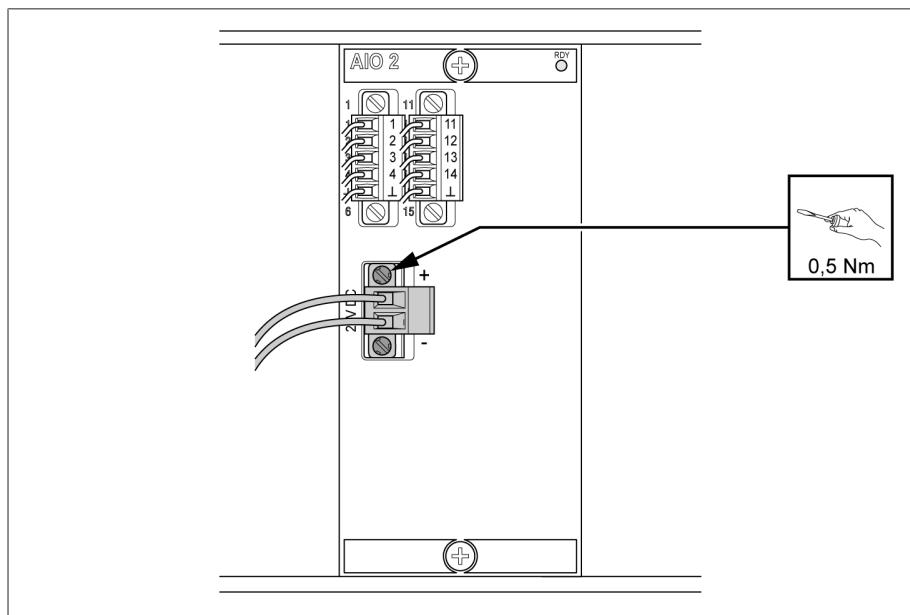


Figure 220: Removing the plug (voltage supply)

2. Remove the plug.

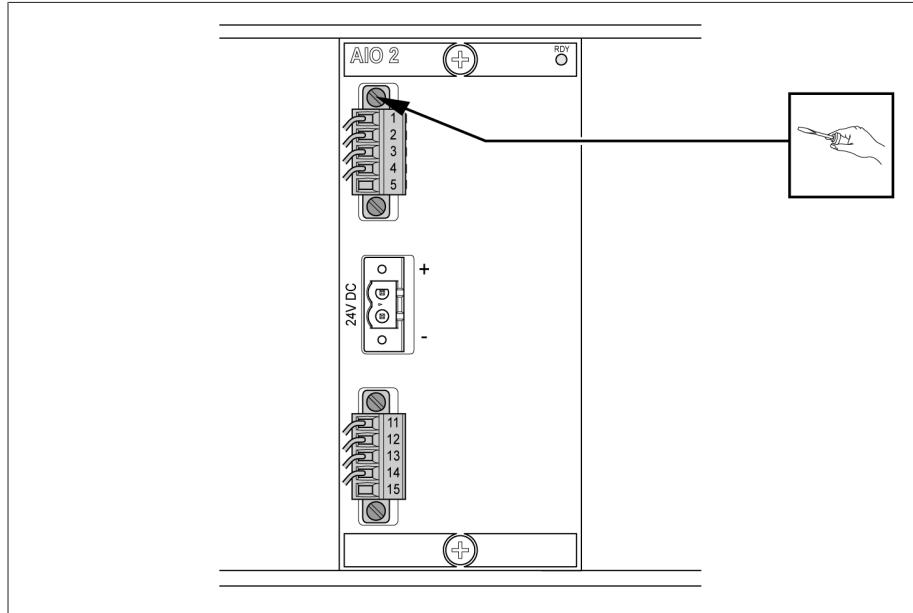


Figure 221: Removing the plug (analog inputs/outputs)

3. Unscrew the fixing screws and unplug the assembly.

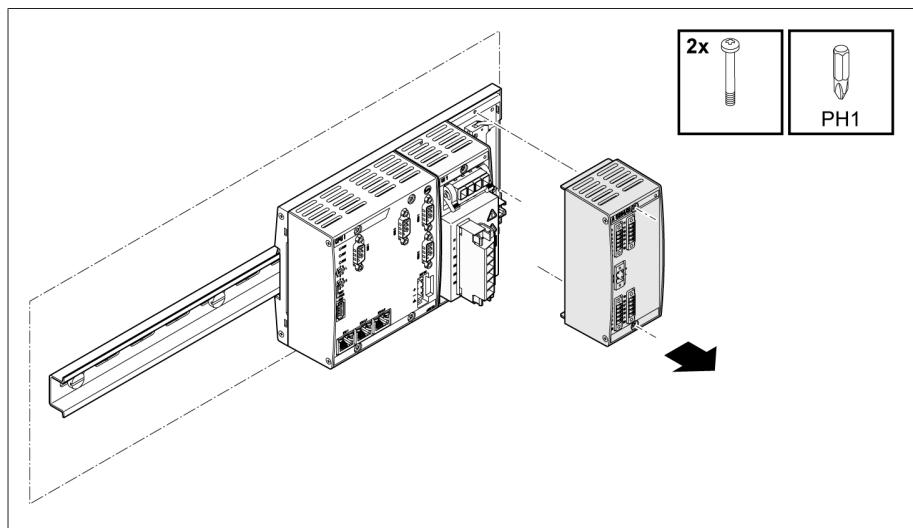


Figure 222: Unplugging the AIO assembly

12.5 Removing the AIO 4 assembly

1. Remove the "24V DC" plug.

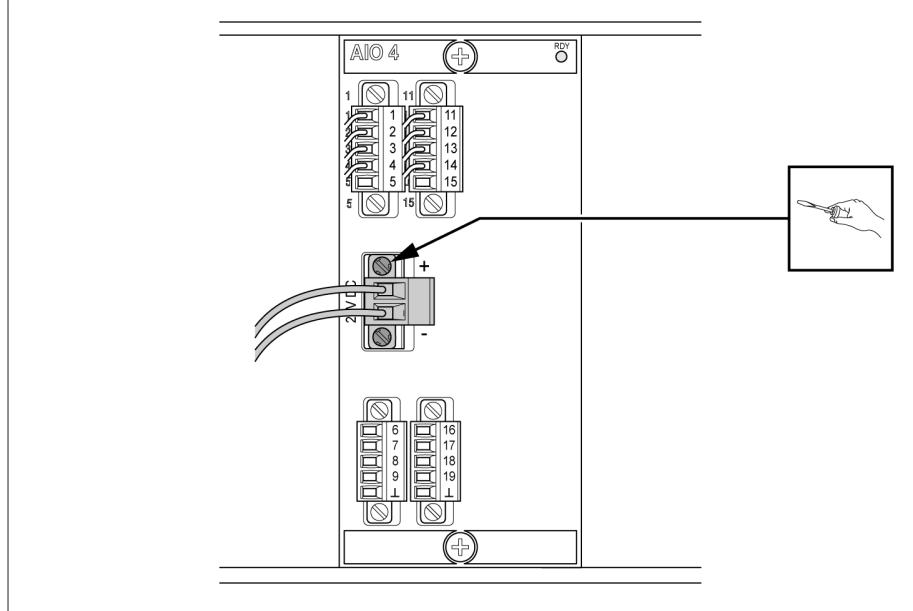


Figure 223: Removing the plug (voltage supply)

2. Remove the plug.

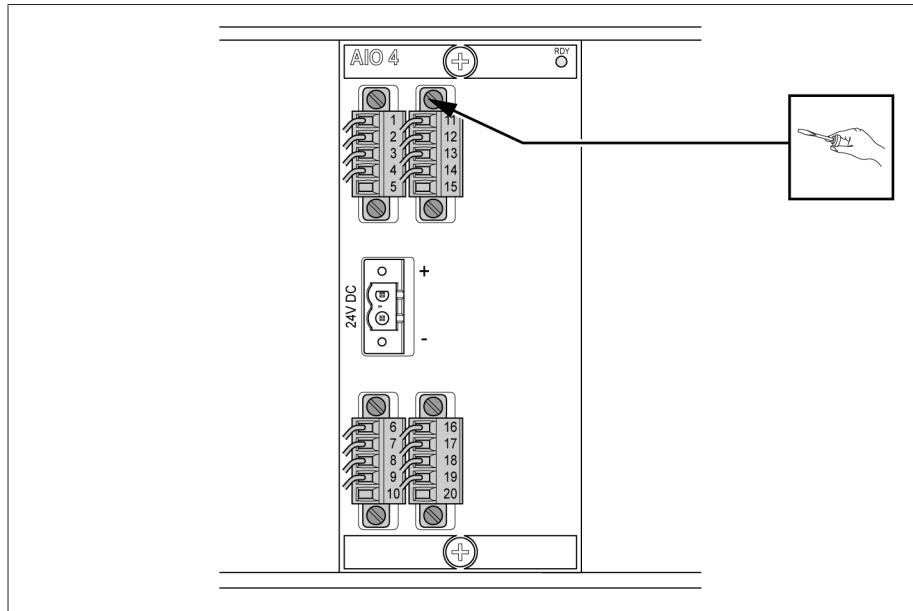


Figure 224: Removing the plug (analog inputs/outputs)

3. Unscrew the fixing screws and unplug the assembly.

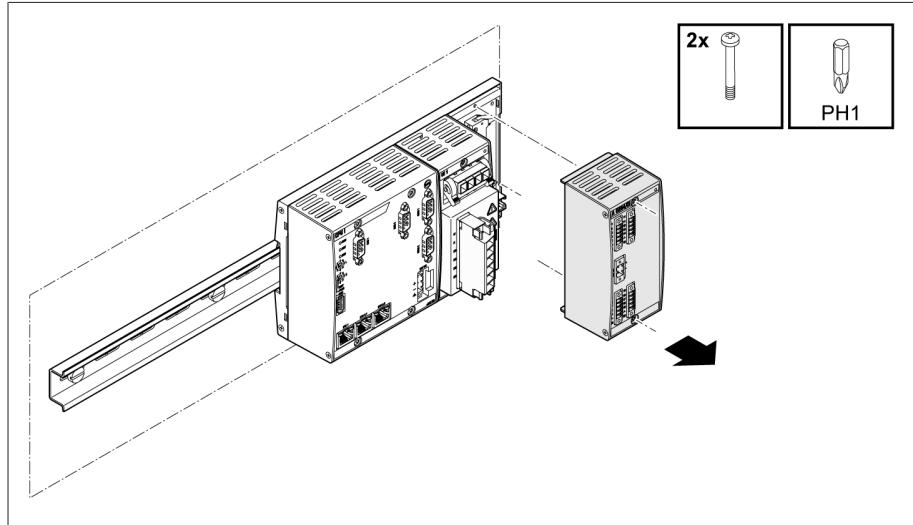


Figure 225: Unplugging the AIO assembly

12.6 Removing the DIO 28-15 assembly

1. Remove the 24V DC plug.

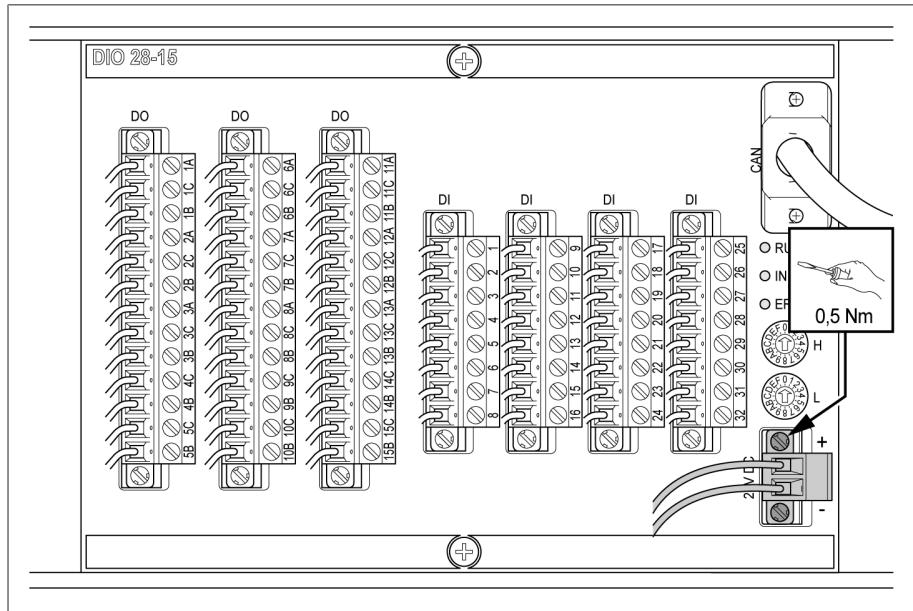


Figure 226: Removing the plug (voltage supply)

2. Remove the CAN bus cable.

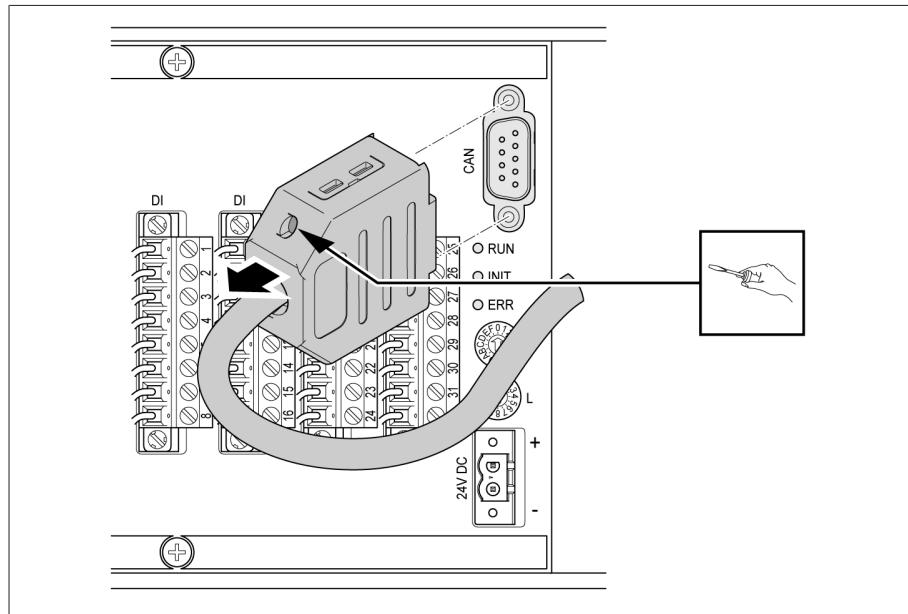


Figure 227: CAN bus cable

3. Remove all plugs in the "DI" and "DO" terminals.

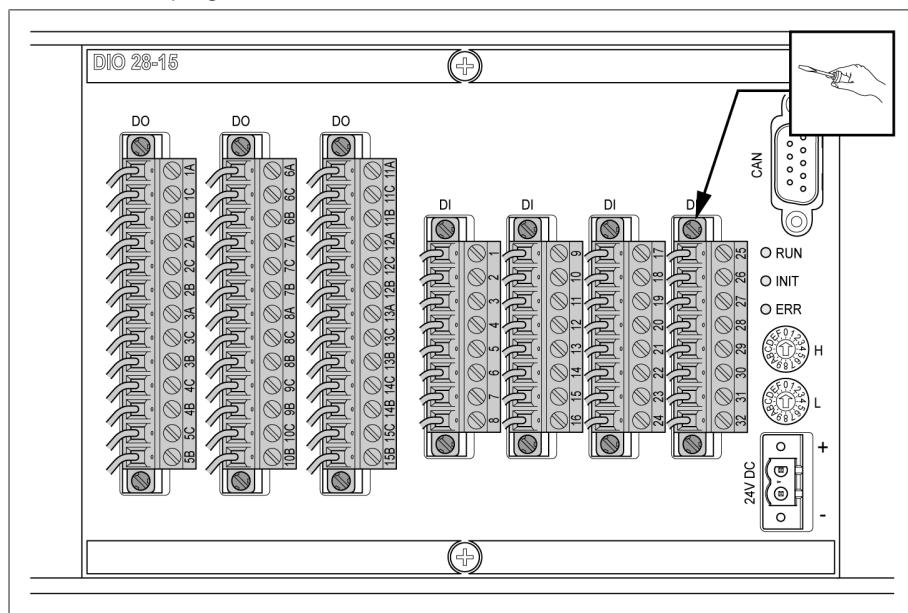


Figure 228: Removing the "DI" and "DO" plugs

4. Unplug the assembly.

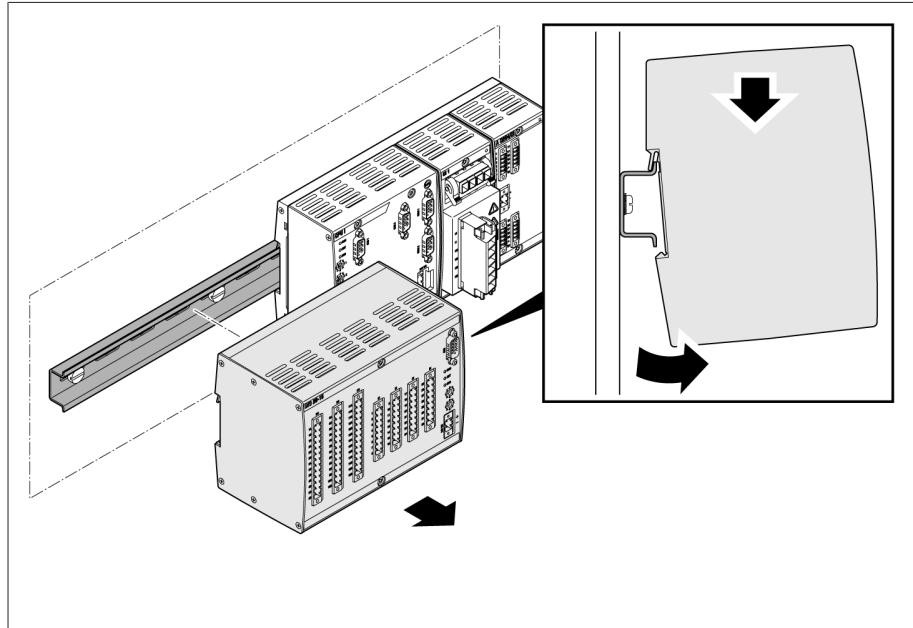


Figure 229: Unplugging the DIO assembly

12.7 Removing the DIO 42-20 assembly

1. Remove the "24V DC" plug.

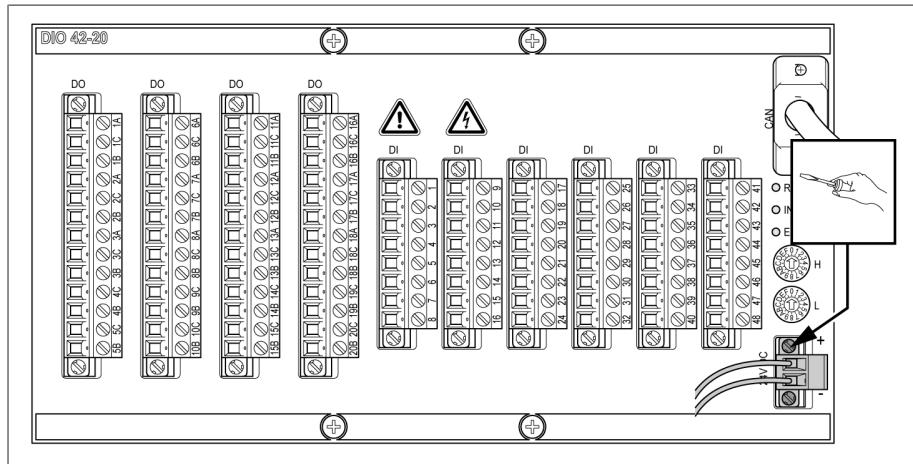


Figure 230: Removing the plug (voltage supply)

2. Remove the CAN bus cable.

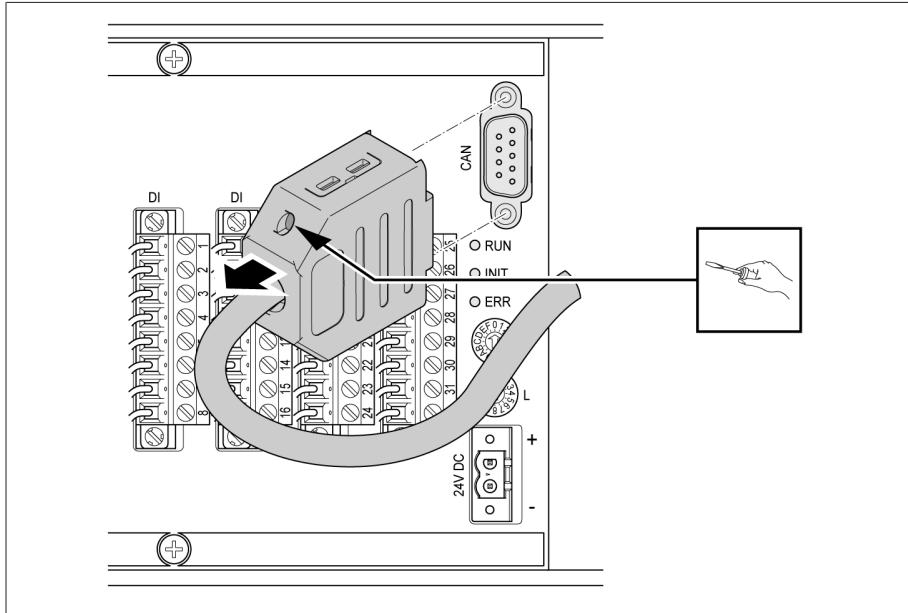


Figure 231: CAN bus cable

3. Remove all plugs in the "DI" and "DO" terminals.

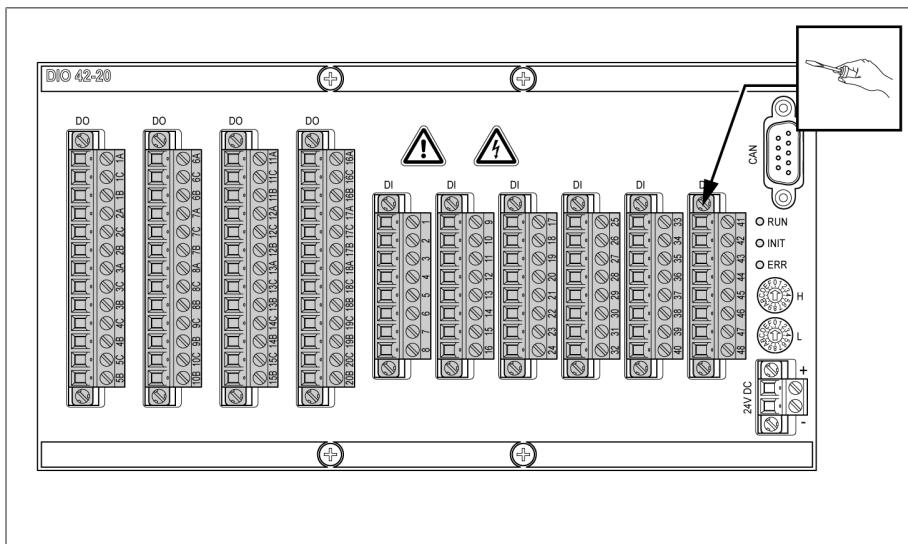


Figure 232: Removing the "DI" and "DO" plugs

4. Unplug the assembly.

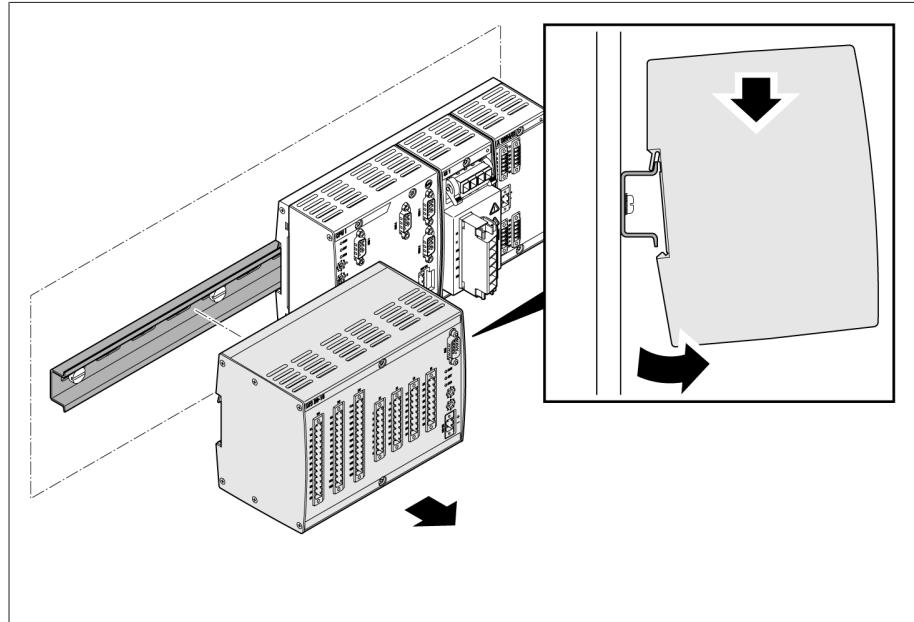


Figure 233: Unplugging the DIO assembly

12.8 Removing the MC 2-2 assembly

1. Remove the "24V DC" plug.

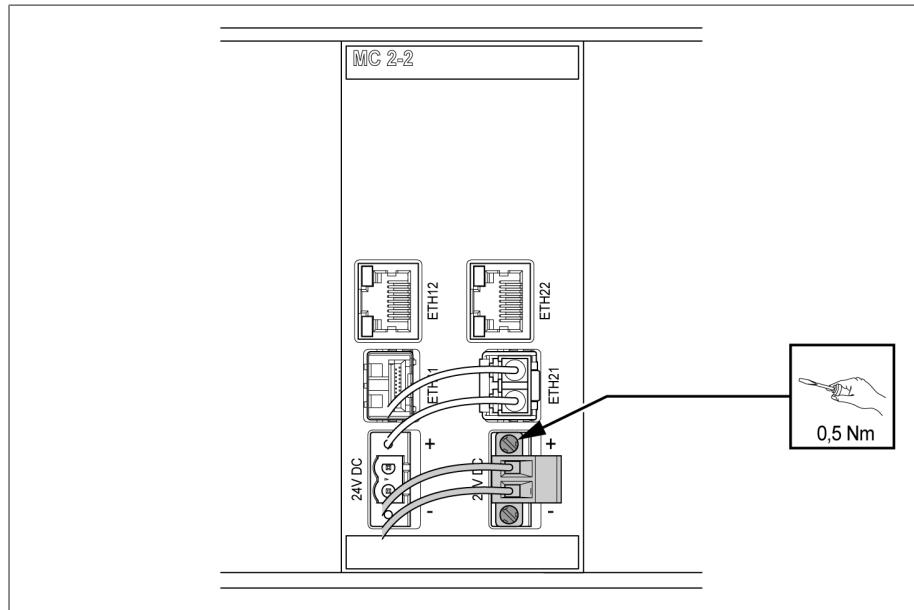


Figure 234: Removing the plug (voltage supply)

2. Remove the fiber-optic cable.

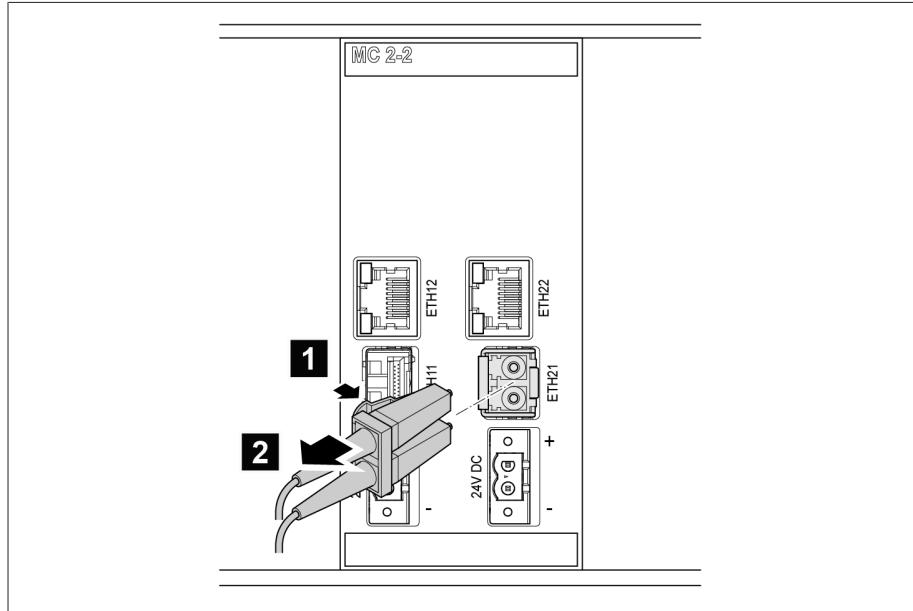


Figure 235: Fiber-optic cable

3. Remove the SFP module.

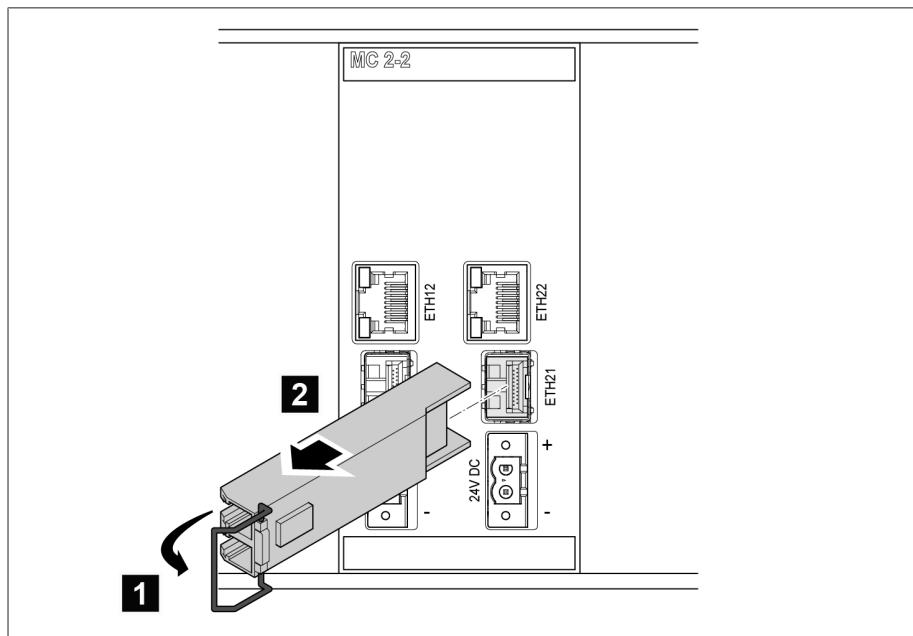


Figure 236: SFP module

4. Unplug the assembly.

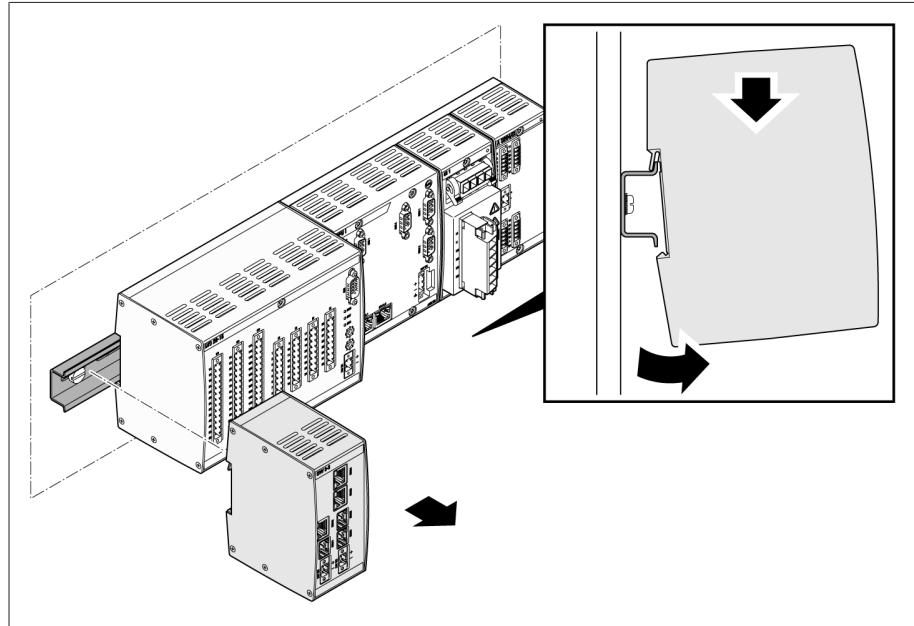


Figure 237: Unplugging the MC 2-2 assembly

12.9 Removing the SW 3-3 assembly

1. Remove the "24V DC" plug.

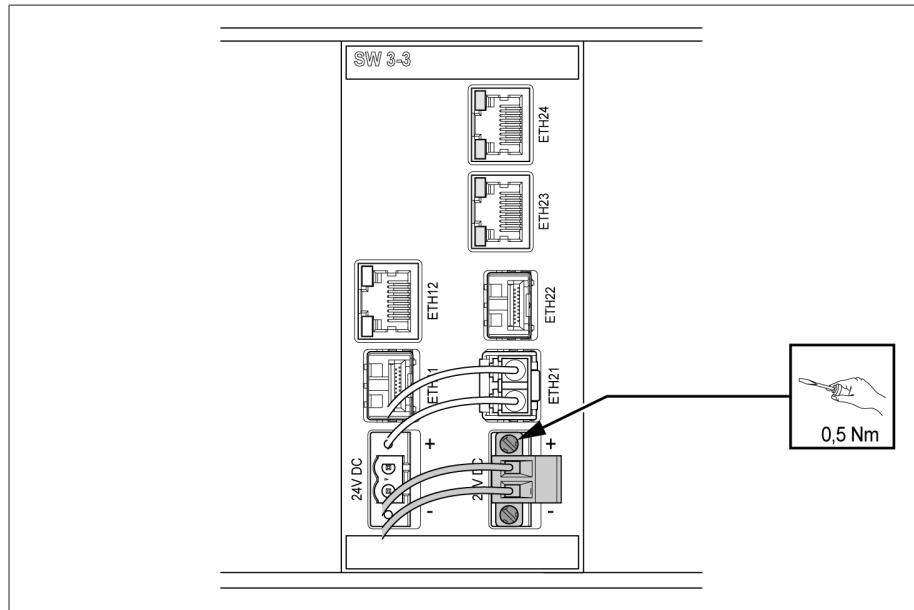


Figure 238: Removing the plug (voltage supply)

2. Remove the fiber-optic cable.

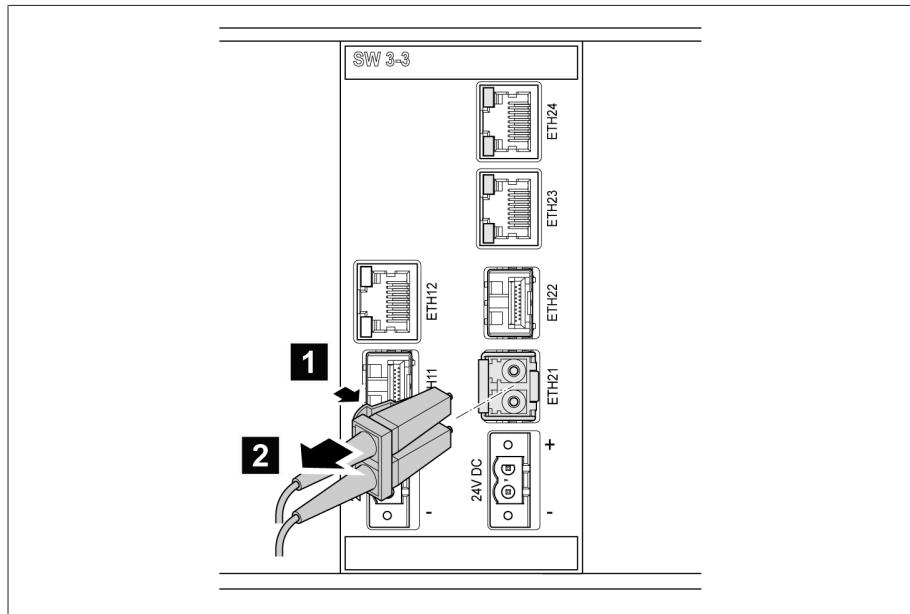


Figure 239: Fiber-optic cable

3. Remove the SFP module.

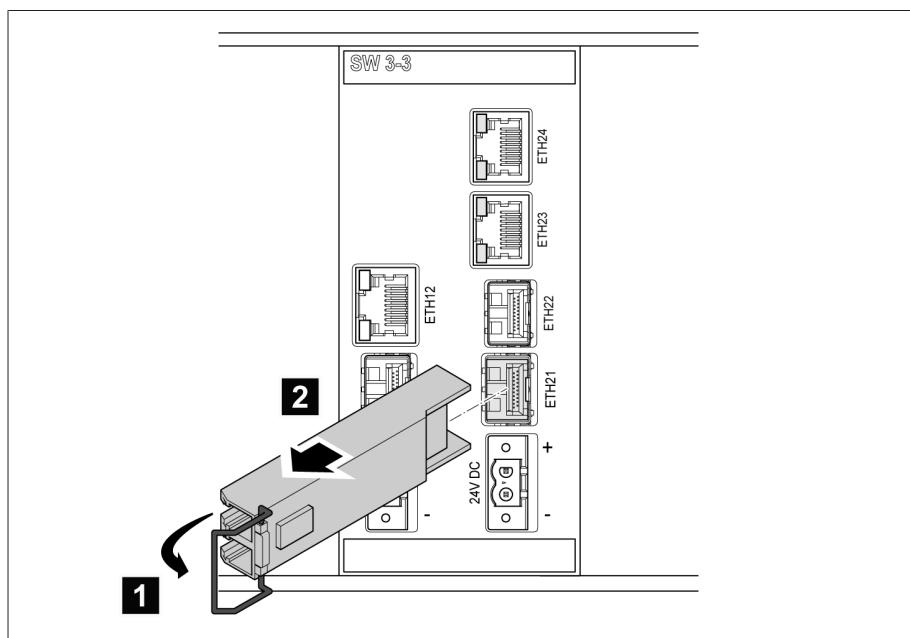


Figure 240: SFP module

4. Unplug the assembly.

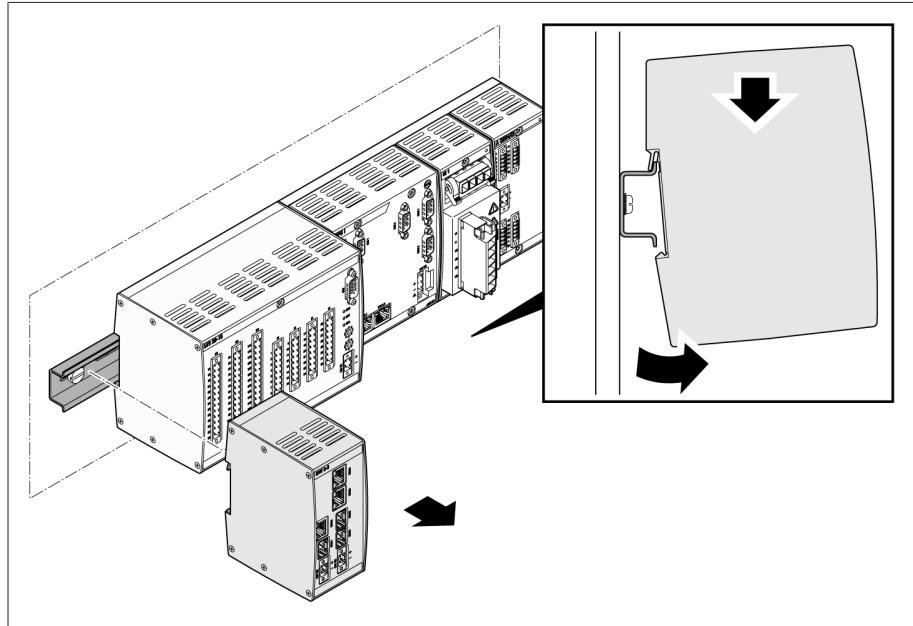


Figure 241: Unplugging the SW 3-3 assembly

12.10 Uninstalling the QS3.241 assembly

1. Open the lever **1** and remove the neutral conductor (N), phase conductor (L) and the protective conductor **2**.

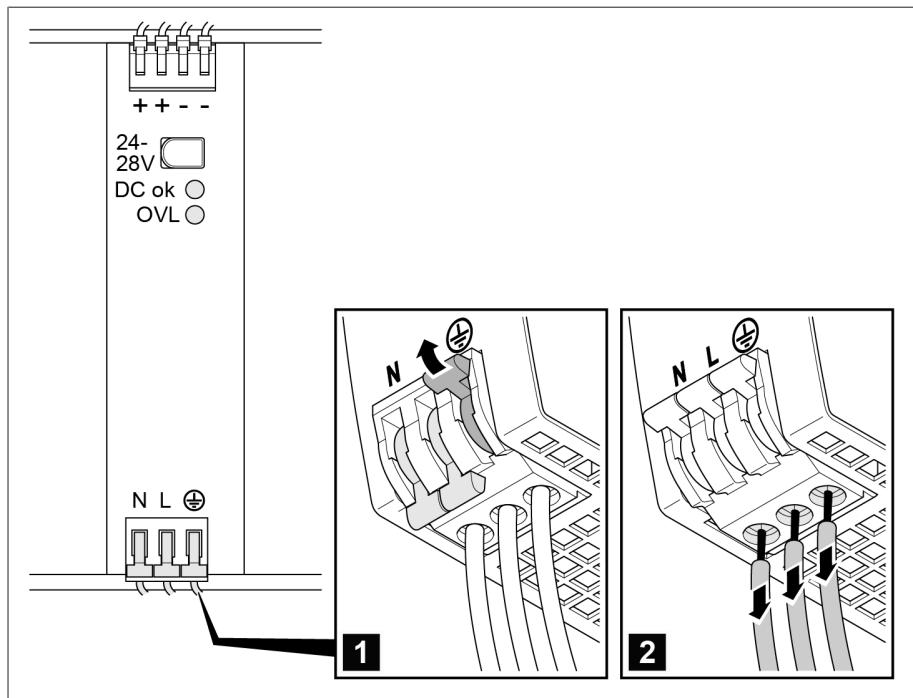


Figure 242: Removing the neutral conductor, phase conductor and protective conductor

2. Open the lever **1** and remove the wiring **2**.

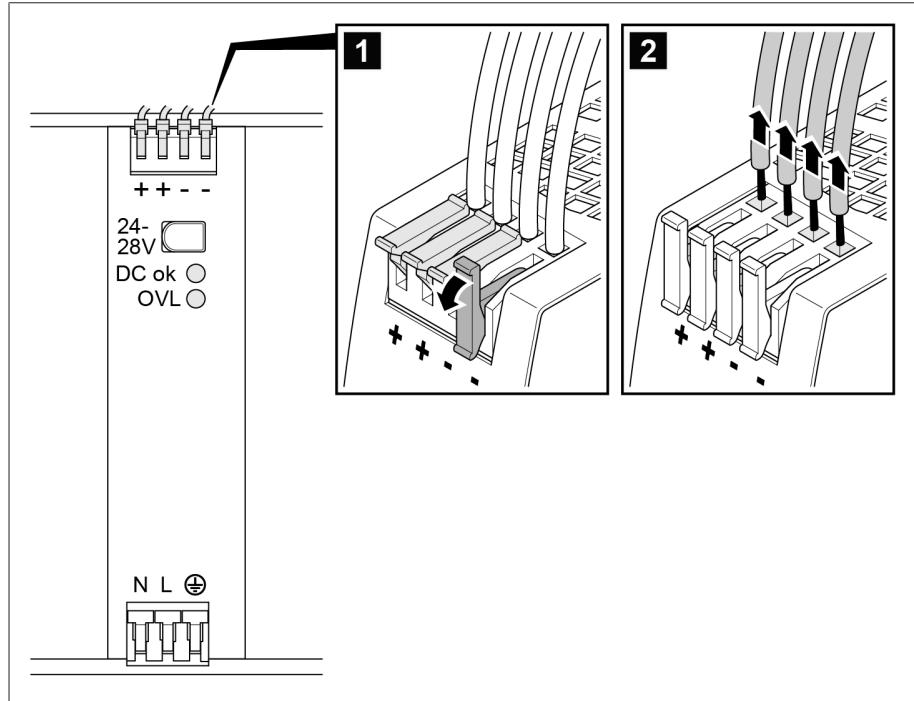


Figure 243: Removing the wiring

12.11 Uninstalling the bus rail

Once you have dismounted all assemblies, you can unhook the bus rails:

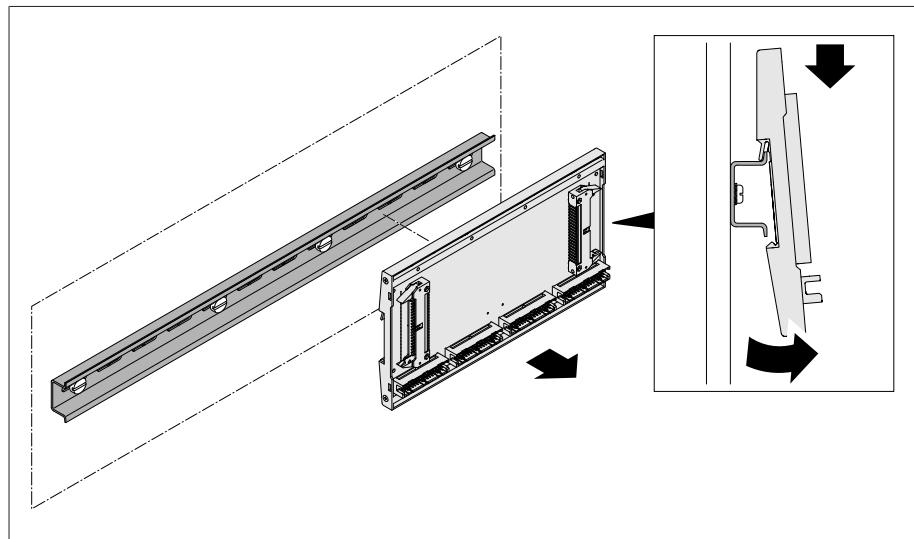


Figure 244: Unhooking the bus rails

13 Disposal

Observe the national requirements applicable in the country of use.

14 Technical data

14.1 Display elements

Display	5.7" LCD, Backlight LED VGA (640 x 480 pixels) 262,000 colors (18-bit)
LEDs	8 LEDs for operation display and messages

14.2 ISM® assemblies

14.2.1 Power supply OT1205

	OT1205 (MR/N)
Permissible voltage range	85 to 265 V AC / V DC U_N : 100...240 V AC U_N : 100 to 220 V DC
Permissible frequency range	50/60 Hz
Power consumption	55 W
Internal fuse (2x)	250 V; 2 A; 5 x 20 mm, T characteristic (delayed-action)

Table 130: Standard design with wide range power supply

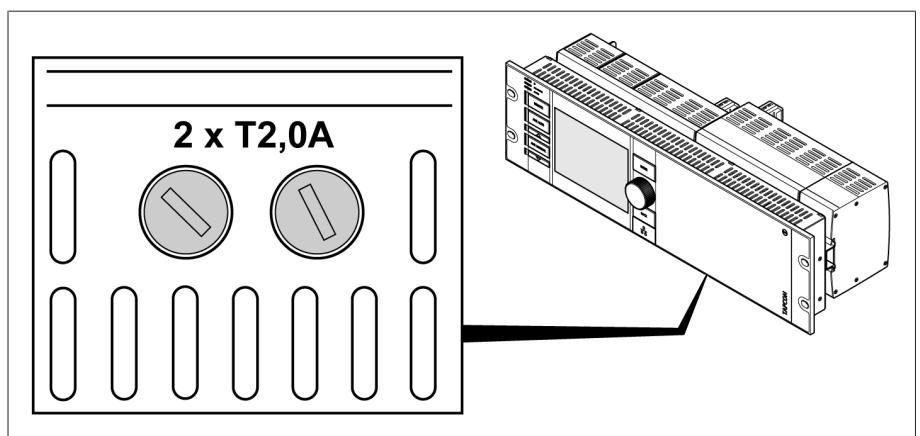


Figure 245: Internal fuse (2x) of wide range power supply in assembly OT1205

	OT1205 (MR/48)
Permissible voltage range	20...70 V DC U_N : 48 V DC
Power consumption	55 W
Internal fuse	250 V; 5 A; 5 x 20 mm, "fast-acting" characteristics

Table 131: Special version with DC voltage power supply

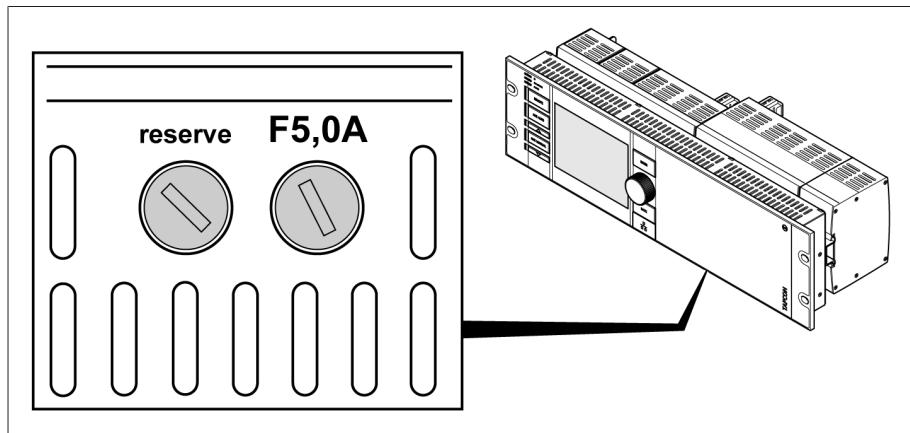


Figure 246: Internal fuse and spare fuse of DC voltage power supply in assembly OT1205

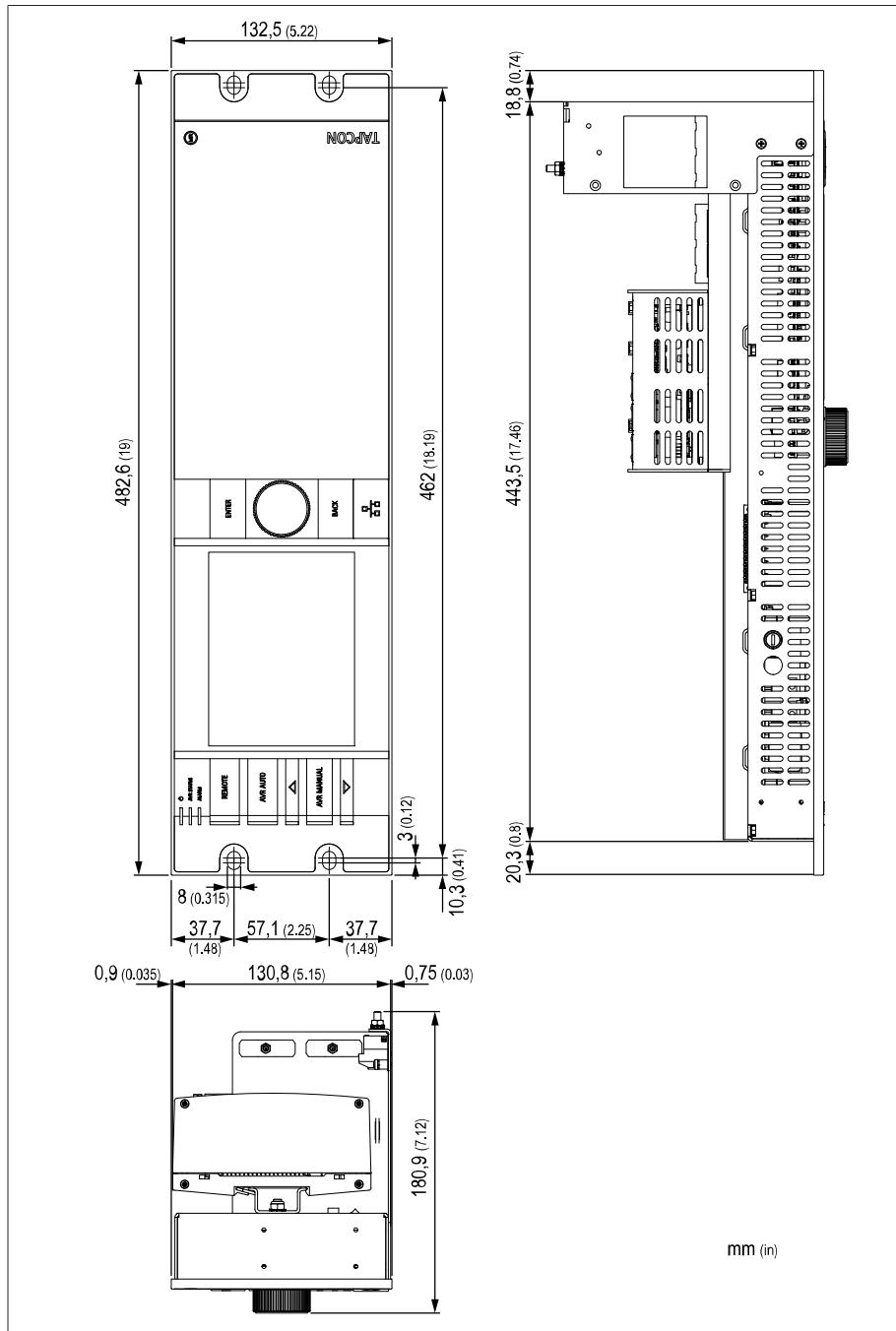


Figure 247: Dimensions

14.2.2 UI 1 voltage measurement and current measurement

	UI 1
Measurement	1-phase
Voltage measurement	U_N (RMS): 100 VAC Measuring range (RMS): 19.6...150 VAC Measuring accuracy (at U_N , -25...+70°C): $<\pm 0.3\%$ Intrinsic consumption: < 1 VA Measurement category III in accordance with IEC 61010-2-30
Current measurement	I_N : 0.2 / 1 / 5 A Measuring range: 0.01...2.1 · I_N Overload capacity: 12.5 A (continuous), 500 A (for 1 s) Measuring accuracy (at I_N , -25...+70°C): $<\pm 0.5\%$ Intrinsic consumption: < 1 VA
Phase angle	Measuring accuracy (-25...+70°C): $U_x/I_x <\pm 0.5^\circ$; $U_x/U_y <\pm 0.3^\circ$
Frequency measurement	f_N : 50 / 60 Hz Measuring range: 45...65 Hz Measuring accuracy (-25...+70°C): $<\pm 0.03\%$

Table 132: Technical data for the UI 1 assembly

Interface	Pin	Description
 N L NC NC	N	Voltage input for neutral conductor
	L	Voltage input for phase L
	NC	-
	NC	-

Table 133: Voltage measurement

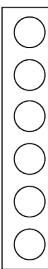
Interface	Pin	Description
 UI 1 k l NC NC NC NC	k	Current input for phase L
	l	Current output for phase L
	NC	-

Table 134: Current measurement

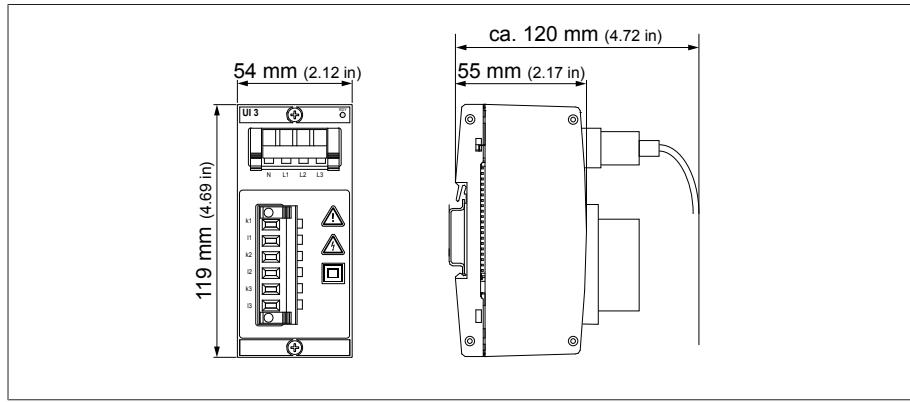


Figure 248: UI 1 dimensions

14.2.3 UI 3 voltage measurement and current measurement

	UI 3
Measurement	3-phase
Voltage measurement	U_N (RMS): 100 VAC Measuring range (RMS): 19.6...150 VAC Measuring accuracy (at U_N , -25...+70°C): $\pm 0.3\%$ Intrinsic consumption: < 1 VA Measurement category III in accordance with IEC 61010-2-30
Current measurement	I_N : 0.2 / 1 / 5 A Measuring range: 0.01...2.1 · I_N Overload capacity: 12.5 A (continuous), 500 A (for 1 s) Measuring accuracy (at I_N , -25...+70°C): $\pm 0.5\%$ Intrinsic consumption: < 1 VA
Phase angle	Measuring accuracy (-25...+70°C): $U_x/I_x \leq 0.5^\circ$; $U_x/U_y \leq 0.3^\circ$
Frequency measurement	f_N : 50 / 60 Hz Measuring range: 45...65 Hz Measuring accuracy (-25...+70°C): $\pm 0.03\%$

Table 135: Technical data for the UI 3 assembly

Interface	Pin	Description
 N L1 L2 L3	N	Voltage input for neutral conductor
	L1	Voltage input for phase L1 (UI 3)
	L2	Voltage input for phase L2
	L3	Voltage input for phase L3

Table 136: Voltage measurement

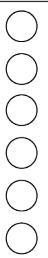
Interface	Pin	Description
UI 3 	k1	Current input for phase L1
	I1	Current output for phase L1
	k2	Current input for phase L2
	I2	Current output for phase L2
	k3	Current input for phase L3
	I3	Current output for phase L3

Table 137: Current measurement

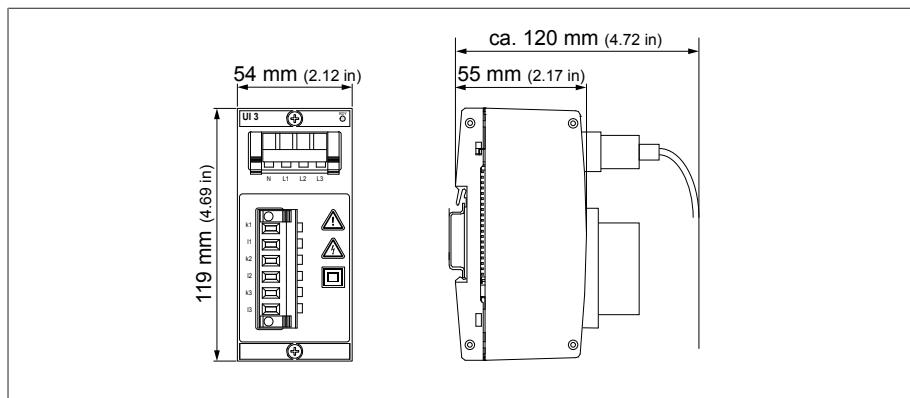


Figure 249: UI 3 dimensions

14.2.4 DIO 28-15 digital inputs and outputs

		DIO 28-15
Inputs (plug-based electrical isolation)	Quantity	28
	Logical 0	0...10 V AC (RMS) 0...10 V DC
	Logical 1	18...260 V AC (RMS) 18...260 V DC (RMS)
	Input current	min. 1.3 mA
	Simultaneity factor (at 70 °C ambient temperature and input voltage ≥ 230 V)	max. 50%
Outputs (floating relay outputs)	Number (number of change-over contacts in parentheses)	15 (9)
	Contact load capacity	Alternating current mode: U _N : 230 V AC; I _N : 5 A Direct current mode: See diagram
	Simultaneity factor (if output is loaded with 5 A)	Up to 60 °C: 100%, > 60 °C: -5%/K

Table 138: Technical data for the DIO 28-15 assembly

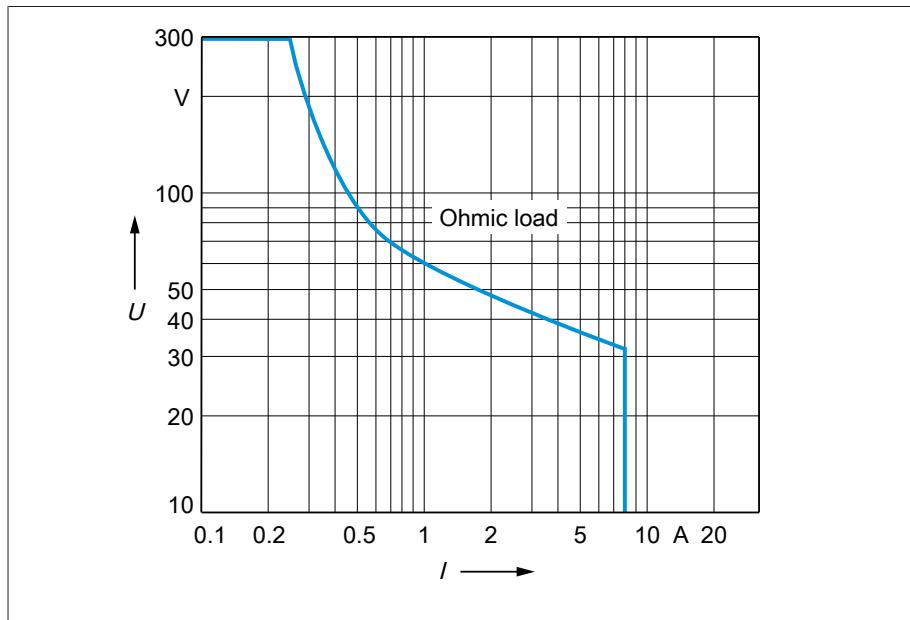


Figure 250: Contact load capacity of digital outputs with resistive load

⚠ CAUTION



Electric shock!

The inputs of the 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
	1	9	17	25	Input
	2	10	18	26	Input
	3	11	19	27	Input
	4	12	20	28	Input
	5	13	21	29	Input
	6	14	22	30	Input
	7	15	23	31	Input
	8	16	24	32	Common

Table 139: Digital inputs

Interface	Pin			Description
	1 A	6 A	11 A	Break contact
	1C	6C	11C	Source contact
	1B	6B	11B	Make contact
	2 A	7 A	12 A	Break contact
	2C	7C	12C	Source contact
	2B	7B	12B	Make contact
	3 A	8 A	13 A	Break contact
	3C	8C	13C	Source contact
	3B	8B	13B	Make contact
	4 C	9 C	14 C	Source contact
	4B	9B	14B	Make contact
	5C	10C	15C	Source contact
	5B	10B	15B	Make contact

Table 140: Digital outputs

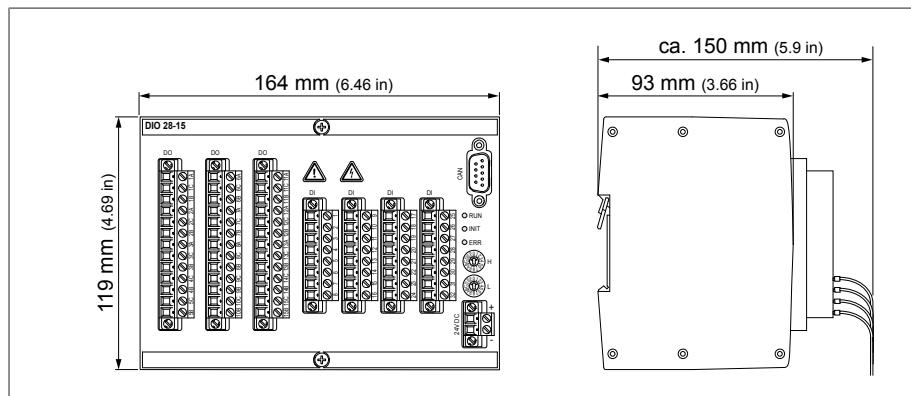


Figure 251: DIO 28-15 dimensions

14.2.5 Digital inputs and outputs DIO 42-20 (HL)

		DIO 42-20	DIO 42-20 HL
Inputs (plug-based electrical isolation)	Quantity	42	
	Logical 0	0...10 V AC (RMS) 0...10 V DC	
	Logical 1	18...260 V AC (RMS) 18...260 V DC	
	Input current	Typically 1.3 mA (regardless of U)	
	Simultaneity factor	At 70 °C and U ≥ 230 V: max. 50%	

	DIO 42-20	DIO 42-20 HL
Outputs (floating relay outputs)	Number (number of change-over contacts in parentheses)	20 (12)
Contact load capacity		Max. AC: 230 V AC; 5 A Max. DC: See diagram
Simultaneity factor		Up to 60 °C: 100%, > 60 °C: -5%/K

Table 141: Technical data for the DIO 42-20 (HL) assemblies

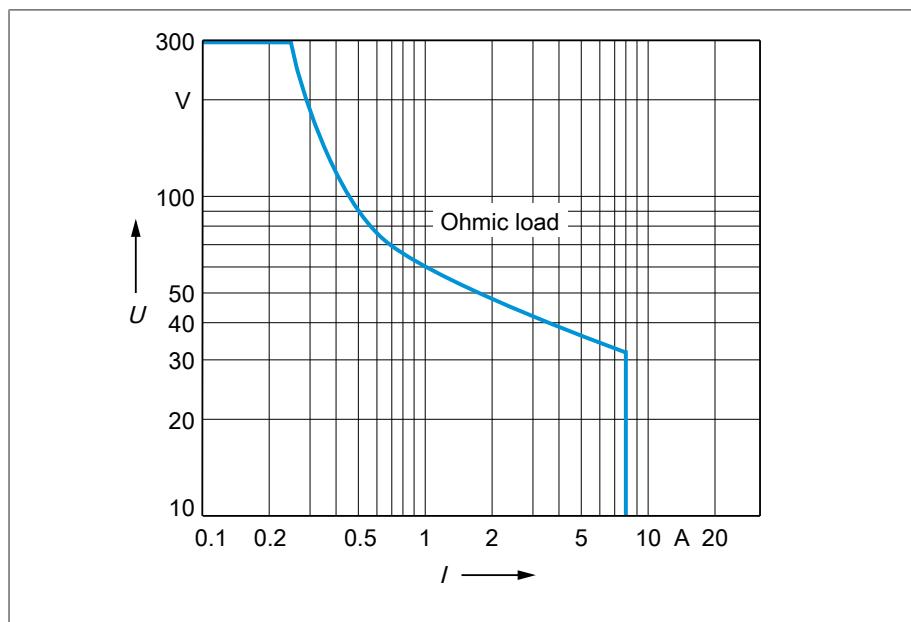


Figure 252: Contact load capacity of digital outputs with resistive load

⚠ CAUTION



Electric shock!

The inputs of the 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
	1	9	17	25	33	41	
	1	9	17	25	33	41	Input
	2	10	18	26	34	42	Input
	3	11	19	27	35	43	Input
	4	12	20	28	36	44	Input
	5	13	21	29	37	45	Input
	6	14	22	30	38	46	Input
	7	15	23	31	39	47	Input
	8	16	24	32	40	48	Common

Table 142: Digital inputs

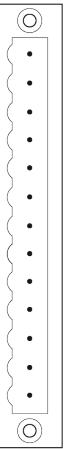
Interface	Pin				Description
	1 A	6 A	11 A	16A	Break contact
	1C	6C	11C	16C	Source contact
	1B	6B	11B	16B	Make contact
	2 A	7 A	12 A	17 A	Break contact
	2C	7C	12C	17C	Source contact
	2B	7B	12B	17B	Make contact
	3 A	8 A	13 A	18 A	Break contact
	3C	8C	13C	18C	Source contact
	3B	8B	13B	18B	Make contact
	4C	9C	14C	19C	Source contact
	4B	9B	14B	19B	Make contact
	5C	10C	15C	20C	Source contact
	5B	10B	15B	20B	Make contact

Table 143: Digital outputs

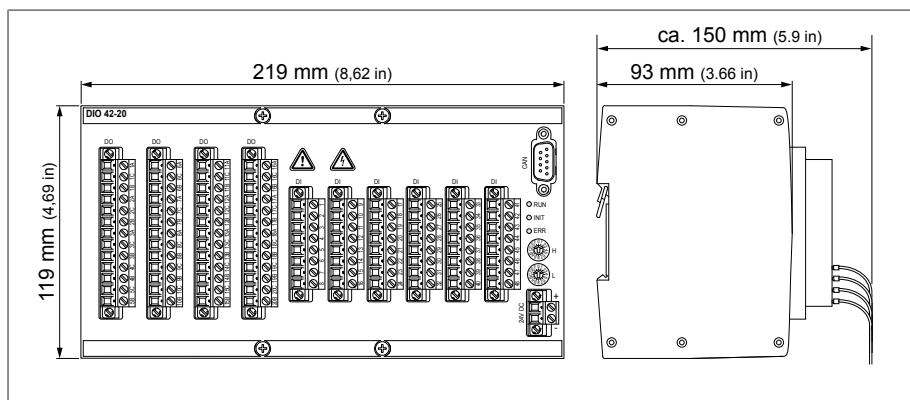


Figure 253: DIO 42-20 dimensions

14.2.6 AIO 2 analog inputs and outputs

Channels (input or output)		2
Inputs	Measuring range	0...10 V 0...20 mA 4...20 mA
	Load resistance (0/4...20 mA)	Max. 300 Ω
Outputs	Signal range	0...10 V 0...20 mA 4...20 mA
	Load resistance (0/4...20 mA)	Max. 500 Ω
Resistor contact series		Maximum resistance 100 Ω ...10 k Ω , max. 35 tap positions

Table 144: Technical data for the AIO 2 assembly

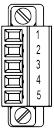
Interface	Pin		Description
	1	6	I OUT (+): Current output +
	2	7	I/U IN (+) U OUT (+): Voltage input +, current input +, voltage output +
	3	8	I/U IN (-): Voltage input -, current input -
	4	9	I/U OUT (-): Voltage output -, current output -
	5	10	Not used

Table 145: Analog inputs and outputs

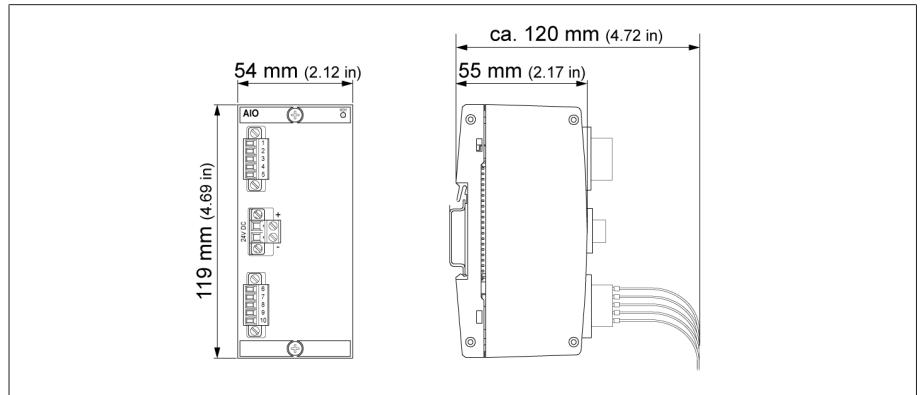


Figure 254: AIO 2 dimensions

14.2.7 AIO 4 analog inputs and outputs

		AIO 4
Channels (input or output)		4
Inputs	Measuring range	0...10 V 0...20 mA 4...20 mA
	Load resistance (0/4...20 mA)	Max. 300 Ω
Outputs	Signal range	0...10 V 0...20 mA 4...20 mA
	Load resistance (0/4...20 mA)	Max. 500 Ω
Resistor contact series		Maximum resistance 100 Ω...10 kΩ, max. 35 tap positions

Table 146: Technical data for the AIO 4 assembly

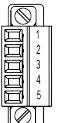
Interface	Pin				Description
	1	6	11	16	I OUT (+): Current output +
	2	7	12	17	I/U IN (+) U OUT (+): Voltage input +, current input +, voltage output +
	3	8	13	18	I/U IN (-): Voltage input -, current input -
	4	9	14	19	I/U OUT (-): Voltage output -, current output -
	5	10	15	20	Not used

Table 147: Analog inputs and outputs

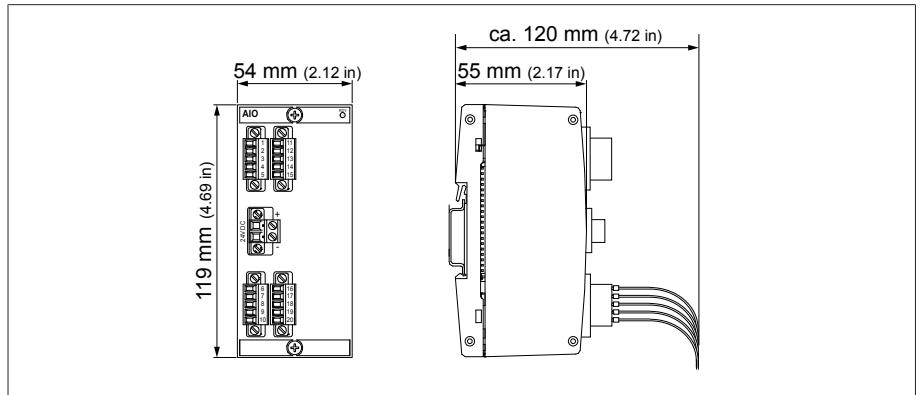


Figure 255: AIO 4 dimensions

14.2.8 CPU (central processing unit) I

	CPU I
Processor	266 MHz
RAM	256 MB
Interfaces	1x serial RS232/485 (electrically isolated) 3x Ethernet 10/100 Mbps 1x USB 2.0 1x CAN (electrically isolated) 1x CAN
NVRAM (SRAM with battery backup)	256 kB
Application memory	1 GB
Power supply	+24 V DC (18...36 V DC)

Table 148: Technical data for the CPU I assembly

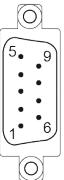
Interface	Pin	Description
	2	RXD (RS232)
	3	TXD (RS232)
	5	GND (RS232, RS485)
	6	RXD+/TXD+ (RS485)
	9	RXD-/TXD- (RS485)

Table 149: COM2 (RS232, RS485)

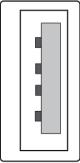
Interface	Pin	Description
	1	VCC
	2	D-
	3	D+
	4	GND

Table 150: USB 2.0

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

Table 151: ETH1, ETH 2.1, ETH 2.2 (RJ45)

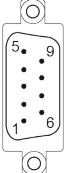
Interface	Pin	Description
	2	CAN-L
	3	CAN-GND
	7	CAN-H

Table 152: CAN1, CAN2

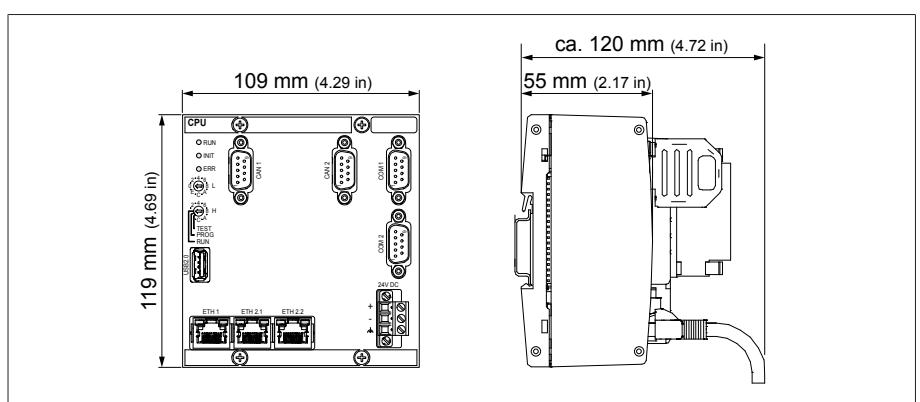


Figure 256: CPU dimensions

Optional accessories	
CAN bus	Terminating resistor – D-SUB plug connector (9-pole) – $R = 120 \Omega$
	Connector with terminal strip for directly connecting CAN lines
Media converter for COM2 interface (only RS232)	Adapter from D-SUB (9-pole) to fiber-optic cable: – ACF660/ST: F-ST, 660 nm, range max. 60 m at 40 kBd – ACF660/SMA: F-SMA, 660 nm, range max. 60 m at 40 kBd – ACF850/ST: F-ST, 850 nm, range max. 1,000 m at 40 kBd – ACF850/SMA: F-SMA, 850 nm, range max. 1,000 m at 40 kBd

Table 153: Optional accessories

14.2.9 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 Ω
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 154: Technical data for the MC 2-2 assembly

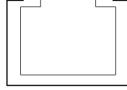
Interface	Pin	Description
	1	TxD+
	2	TxD-
	3	RxD+
	4	NC
	5	NC
	6	RxD-
	7	NC
	8	NC-

Table 155: ETHxx (RJ45)

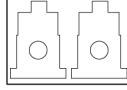
Interface	Description
	Fiber glass 50/125 and 62.5/125 multimode

Table 156: ETHxx (duplex LC SFP)

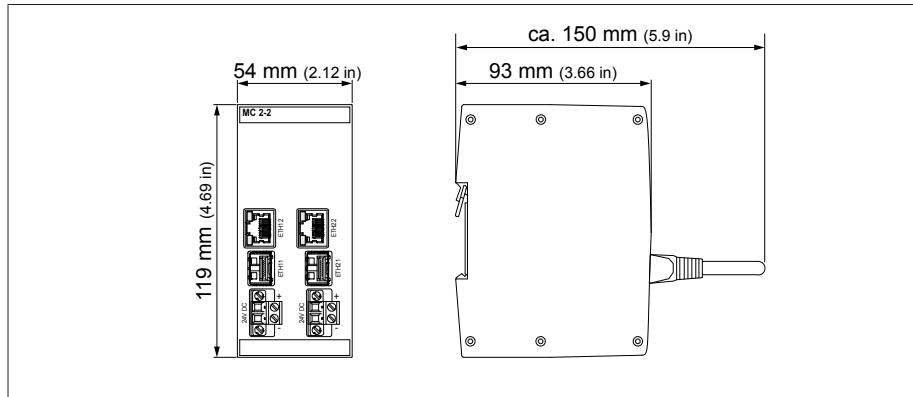


Figure 257: MC2-2 dimensions

14.2.10 System networking SW 3-3

	SW 3-3
Description	Managed fast Ethernet switch per IEEE 802.3, store-and-forward switching
Interfaces	<p>Media converters:</p> <ul style="list-style-type: none"> - 1x RJ45 - 1x duplex LC (SFP) <p>Managed switch with redundancy function:</p> <ul style="list-style-type: none"> - 2x RJ45 - 2x duplex LC (SFP)
Redundancy protocols	PRP ⁵ , RSTP.....
Time synchronization	PTPv2 (IEEE 1588-2008)
RJ45	<p>Max. 100 m (per section) 10/100 Mbps Cable impedance 100 Ω</p>
Fiber-optic cable	<p>Max. 2,000 m 100 Mbps Light-emitting diode: class 1 Wavelength: 1,310 nm Max. optical output power: <1 mW (in accordance with IEC 60825-1:2014)</p>

Table 157: Technical data for the SW 3-3 assembly

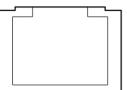
Interface	Pin	Description
	1	TxD+
	2	TxD-
	3	RxD+
	4	NC
	5	NC
	6	RxD-
	7	NC
	8	NC-

Table 158: ETHxx (RJ45)

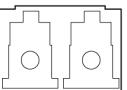
Interface	Description
	Fiber glass 50/125 and 62.5/125 multimode

Table 159: ETHxx (duplex LC SFP)

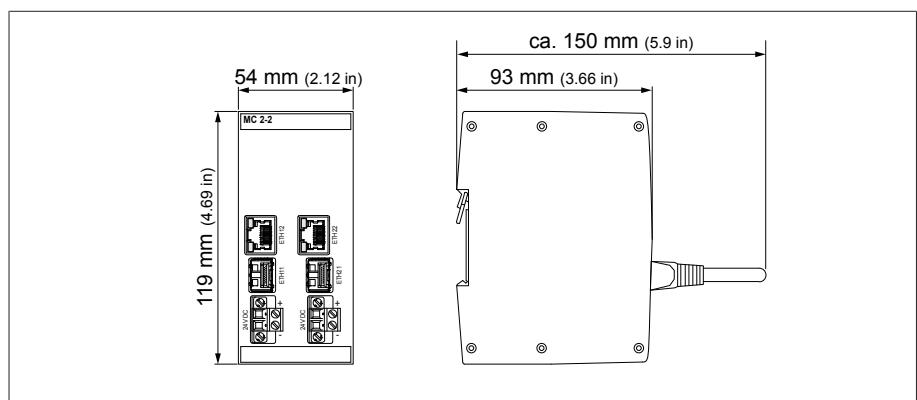


Figure 258: SW3-3 dimensions

14.3 Dimensions and weight

Housing W x H x D	19-inch plug-in housing in accordance with DIN 41494 Part 5 483 mm x 133 mm x 178 mm (19 in x 5.2 in x 7 in)
Weight	Max. 7.9 kg

14.4 Ambient conditions

Operating temperature	-25...+70 °C
Storage temperature	-40...+85 °C
Relative humidity	10...95% non-condensing
Air pressure	Corresponds to 2000 m above sea levelCorresponds to 2000 m above sea level
Minimum spacing to other devices/control cabinet	Top/Bottom: 88.9 mm (3.5 in; corresponds to 2 RU), back 30 mm (1.2 in)

Table 160: Permissible ambient conditions

14.5 Standards and directives

Electrical safety

IEC 61010-1 IEC 61010-2-030	Safety requirements for electrical measurement and control and regulation equipment and laboratory instruments <ul style="list-style-type: none"> - Protection class 1 - Overvoltage category III - Contamination level 2
IEC 60950-1	Information technology equipment – Safety

Table 161: Electrical safety

Electromagnetic compatibility

IEC 61000-4-2	Immunity to electrostatic discharge (ESD) <ul style="list-style-type: none"> - Front panel and operating elements - Contact: ±8 kV - Air: ±15 kV - Terminals, plug connectors, and interfaces: - Contact: ±6 kV - Air: ±8 kV
IEC 61000-4-3	Immunity to high-frequency electromagnetic fields <ul style="list-style-type: none"> - 20 V/m; 80...4000 MHz; 80% AM - 20 V/m; 900 MHz ±5 MHz; PM
IEC 61000-4-4	Immunity to quick, transient electrical disturbances (burst) <ul style="list-style-type: none"> - Power supply: 4 kV - Measurement (UI1/3): 4 kV - Digital I/O: 4 kV - Analog I/O, shielding on both sides: 4 kV - Communication interfaces, shielding on both sides: 4 kV

IEC 61000-4-5	Immunity to impulse voltages (surge) <ul style="list-style-type: none"> - AC power supply: 4 kV CM, 2 kV DM - DC power supply: 2 kV CM, 1 kV DM - Measurement (UI1/3): 4 kV CM, 2 kV DM - Digital I/O: 2 kV CM, 1 kV DM - Analog I/O, shielding on both sides: 2 kV CM - Communication interfaces, shielding on both sides: 2 kV CM
IEC 61000-4-6	Immunity to conducted disturbances, induced by high-frequency fields <ul style="list-style-type: none"> - 10 V, 150 kHz...80 MHz, 80% AM
IEC 61000-4-8	Immunity to power frequency magnetic fields <ul style="list-style-type: none"> - 100 A/m, 50/60 Hz, continuously - 1000 A/m, 50/60 Hz, for 1 s
IEC 61000-4-11 IEC 61000-4-29	Immunity to drops in voltage, short interruptions, and voltage fluctuations <ul style="list-style-type: none"> - 40% U_N for 300 ms - 0% U_N for 100 ms

Table 162: Immunity in accordance with IEC 61000-6-2

CISPR 11 (EN 55011)	Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement: Class A
CISPR 16-2-1	Procedure for measuring high-frequency emitted interference (radio interference) and immunity - measurement of conducted emitted interference: Class A
CISPR 16-2-3	Procedure for measuring high-frequency emitted interference (radio interference) and immunity - measurement of radiated emitted interference: Class A
CISPR 22 (EN 55022)	Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement: Class A

Table 163: Emitted interference in accordance with IEC 61000-6-4

Environmental durability tests

IEC 60529	With OT1205: Degree of protection IP52 for the front, IP20 for the rear Without OT1205: IP20
IEC 60068-2-1	Dry cold - 25 °C / 96 hours
IEC 60068-2-2	Dry heat 70 °C / 96 hours
IEC 60068-2-78	Constant moist heat + 40 °C / 93% / 4 days, no dew
ASTM D 4169-09	Standard Practice for Performance Testing of Shipping Containers and Systems DC 3, safety level II
IEC 60255-21-1 Class 1	Oscillations (3 cycles, 0.5 g 1 octave/min; 60 cycles, 1.0 g, 1 octave/min)
IEC 60255-21-2 Class 1	Shocks (11 ms, 5 g, 15 g, 3 axes)
IEC 60255-21-3 Class 1	Earthquakes (1...35 Hz; 3.5 mm/1 g horizontal; 1.5 mm/0.5 g vertical; 1 octave/min, 10 min/axis)

Table 164: Environmental durability tests

Glossary

ASTM

American Society for Testing and Materials

EMC

Electromagnetic compatibility

EN

European standard

Generator sign convention

Definition for describing electrical circuits. The arrows for current rating and voltage on a "consumer" absorbing electrical power (e.g. a resistor) face opposite directions. $U*I$ is the power generated in the component and $-U*I$ is the power absorbed by the component.

GPI

General Purpose Input

GPO

General Purpose Output

ICD

IED Capability Description

IEC

The International Electrotechnical Commission (IEC for short) is involved in the preparation and publication of international standards for electrical, electronic and related technologies.

IEEE

Worldwide association of engineers, mainly from the fields of electrical engineering and IT (Institute of Electrical and Electronics Engineers)

IP

Internet Protocol

Load sign convention

Definition for describing electrical circuits. The arrows for current rating and voltage on a "consumer" absorbing electrical power (e.g. a resistor) face the same direction. $U*I$ is the power absorbed by the component.

MQTT

Message Queuing Telemetry Transport. A network protocol for machine-to-machine communication which enables the transmission of ISM® data in the form of messages between two devices.

PRP

Redundancy protocol in accordance with IEC 62439-3 (Parallel Redundancy Protocol)

RADIUS

Protocol for authentication of users in computer networks in accordance with RFC 2865 (Remote Authentication Dial-In User Service).

RSTP

Redundancy protocol in accordance with IEEE 802.1D-2004 (Rapid Spanning Tree Protocol)

SCADA

Technical processes are monitored and controlled using a computer system (Supervisory Control and Data Acquisition)

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

TAPCON® Dynamic Set Point Control

TPLE

Transformer Personal Logic Editor

URL

Uniform Resource Locator

List of key words

A	C	Dimming	90		
Absolute	163, 165, 166	Cable recommendation	45	Dimming brightness	90
Access rights	119	CAN address 1...16 device name	205	Dimming waiting time	90
Activate delay time T2	189	CAN bus	199, 205	DIO 28-15	26
Activate desired value 1	107	Changing users	29	DIO 42-20	26
Activate desired value 2	108	Channel (AIO)	53, 56	Display elements	
Activate desired value 3	108	Circulating reactive current	193	LED	21
Activate desired value 4	108	Circulating reactive current blocking		DNP3	96
Activate desired value 5	108	limit	199	DNP3 transmission type	97
Activate parallel operation	198	Circulating reactive current sensitivity		DNS	
Activate remote mode	107	Commissioning wizard	73, 80	activate	84
Activate syslog	88	Compensation	189	DNS server	
Activate tap synchronization mon.	172	Z compensation	191	IP address	84
AIO 2	26	Configure data points	97	E	
Analog input	227	Connection	45	Electromagnetic compatibility	35
Analog inputs and outputs	109	contact wear		Error if no communication present	
ASDU address	91, 93, 94	Determining	217	201	
ASDU sequence optimization	92, 94	Display	215	Event duration	213
ASDU single character confirmation		Control system	90	Event memory	115
92		Control variable	160	Events	113
assembly		Counting behavior	213	Acknowledge	113
AIO	26	CPU I	24	Configure	114
CPU I	24	Current monitoring	164	Display	113
DIO	26	Current transformer		Exporting	115
MC 2-2	27	Secondary current	147	Expert mode	32
OT1205	24	Current-transformer circuit	148	Export	122
SW	28	D		External visualization IP address	145
UI	25	Data		External visualization name	145
Auto logout	82	Import/export	122	External visualization product	145
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Bandwidth	185	Date	73, 87	F	
Bandwidth monitoring	208	Date format	86	Fiber-optic cable	
Bandwidth setting	185	Deactivate parallel operation	107	Information about laying	47
Bank parallel operation	172	Decrease desired value	108	Follower parallel operation method	
Baud rate	91, 93, 96, 97	Delay time T1	186	107	
Behavior	163, 169, 213	Delay time T2	188	Function monitoring	208, 209
Behavior for reversal of power flow	168	Desired load stress type	200	Function test	
Behavior if no communication present	201	Desired power factor	200	Circulating reactive current blocking	77
Blocking	107	Desired value	175, 176, 177, 185	Circulating reactive current sensitivity	
Broker	84	Desired value adjustment		76	
Client user name	85	Active power-dependent	178, 180	Control functions	75
Port	85	desired value setting		Parallel operation	76
Broker address	85	BCD	182	Tap synchronization	77
Broker port	85	Max.	177	Function tests	74
		Min.	177		
		Desired value step width	177	G	
		Destination address	97	Gateway address	83
		Device address	97	Gateway target address	84
		Device designation	89	General	80
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4016640/19 EN - TAPCON® Operating instructions -

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