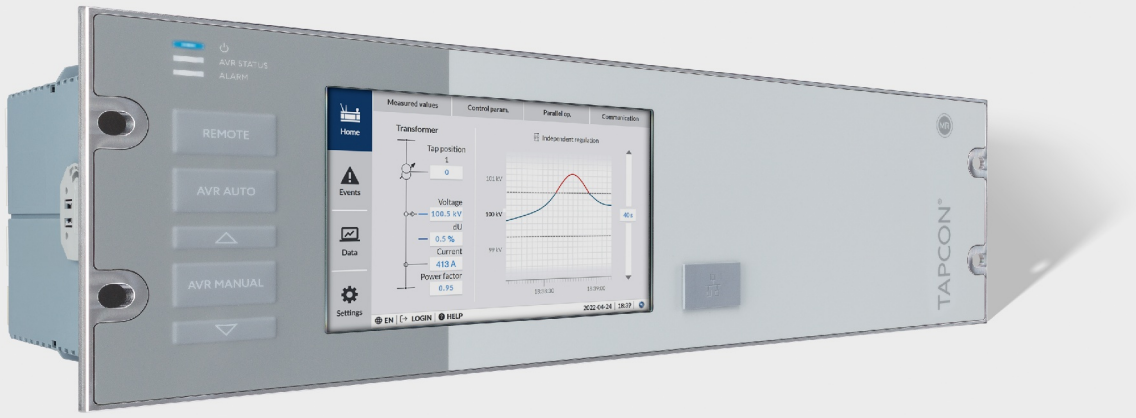
THE POWER BEHIND POWER.

Operating instructions TAPCON®. Voltage regulator

Three-winding transformer | HV/LV regulation
12882293/01 EN



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The product may have been altered since this document was published.
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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reinhausen.com

Customer portal

You can find additional information on this product in our customer portal at portal.reinhausen.com.

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
Italics	System messages, error messages, signals	*Function monitoring* alarm triggered
[► Number of pages]	Cross reference	[► Page 41].
Dotted underscore	Glossary entry, abbreviations, definitions, etc.	Glossary entry

Table 2: Typographic conventions used in this technical file

1.5 Open source software

This product contains open source software, which has been developed by third parties. The open source software and the corresponding license conditions can be called up in the menu via **Settings** > **Export** > **Licenses**.

The open source software is protected by copyright. You are free to use the open source software provided that you comply with the respective license conditions. In the event of a conflict, these license conditions will take precedence over other license conditions.

The open source software is provided free of charge. Insofar as this is provided for by the license conditions of the open source software, you can obtain the source text of the open source software at least for three years from receipt of the product against payment of the corresponding costs from your respective contact person at Reinhausen GmbH.

2 Safety

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

2.1 Appropriate use

The device serves to keep the output voltage of a three-winding transformer constant or to regulate the high-voltage side or low-voltage side of a transformer depending on the active power flow. 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 Inappropriate use

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

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

2.3 Fundamental safety instructions

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

Personal protective equipment

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

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

Work area

Untidy and poorly lit work areas can lead to accidents.

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

Working during operation

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

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

Invisible laser radiation

Looking directly into the beam or the reflected beam can cause eye damage. The beam is emitted at the optical connections or at the end of the fiber-optic cables connected to them on the assemblies. Read the chapter "Technical Data" [▶Section 13, Page 196] 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/or operational faults.

- Only modify the product after consultation with Reinhausen GmbH.

Spare parts

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

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

2.4 Personnel qualification

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

Electrically skilled person

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

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

Electrically trained persons

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

Operator

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

Technical Service

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

Authorized personnel

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

2.5 Personal protective equipment

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

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

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

Read and follow the instructions in this chapter on how 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

You must configure the device as follows during commissioning to ensure its safe operation:

- User IDs must be unique and assignable. Do not use a "Group account" function or the "Auto login" function.
- Activate the "Auto logout [▶Section 8.1.1.2, Page 71]" 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 the service user access [▶Section 8.1.1.3, Page 71].
- Activate brute-force protection.
- Enable SSL/TLS encryption [▶Section 8.1.1, Page 70]; 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 8.1.8, Page 80].
- Deactivate all unused interfaces [▶Section 8.1.2, Page 72].
- Extension module for the CPU (COM-ETH-FO assembly):
  - Change the user account and password.
  - Disable unnecessary services.

3.3 Operation

To ensure safe operation of the device, observe the following information:
- Change the password at regular intervals.
- Export the security log [▶Section 8.1.20.1, Page 99] at regular intervals.
- Check the log files regularly for unauthorized system access and other security-related events.

> The MCONTROL® 7 R-A has the fixed IP address 192.168.165.242. Interactions via the HMI are logged in the log data with this IP address.

3.4 Interfaces

The device uses the following interfaces for communication:

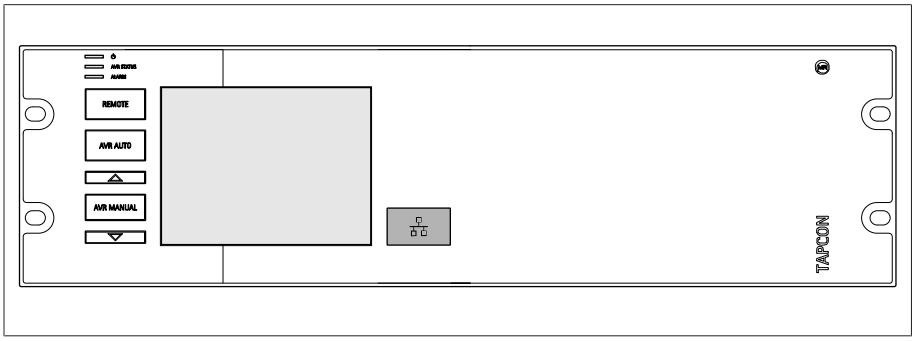


Figure 1: Front interface on the MCONTROL® 7 R-A assembly

Interface	Protocol	Port	Description
Front interface	TCP	67	DHCP server
Front interface	TCP	22	SSH service access[1]
Front interface	TCP	80	Web visualization[2]
Front interface	TCP	443	SSL-protected web visualization[2]

Table 4: Interfaces and open ports of the MCONTROL® 7 R-A assembly

1 Port is closed if you deactivate the Service user access [▶Section 8.1.1.3, Page 71].

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

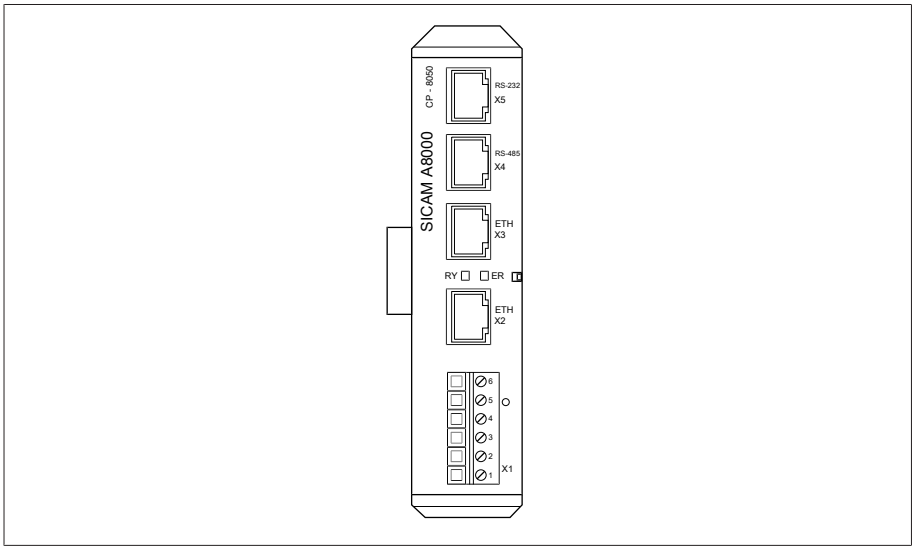


Figure 2: CPU assembly interfaces

Interface	Protocol	Port	Description
X2	TCP	102	IEC 61850
X2	TCP	502	Modbus[3]
X2	TCP	20000	DNP3[3]
X2	TCP	2404	IEC 60870-5-104[3]
X2	-	-	Bus extension (optional)
X3	TCP	80	HTTP for web-based visualization[4]
X3	TCP	443	HTTPS for web-based visualization
X3	TCP	22	SSH (only for MR Service)[5]
X4	-	-	Serial interface (SCADA)
X5	-	-	Serial interface (SCADA)

Table 5: Interfaces and open ports of the CPU 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:

3 Default setting; if you have modified the port for the control system protocol, only the set port is open.

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

5 Port is closed if you deactivate the Service user access [▶Section 8.1.1.3, Page 71].

Cipher suite	TLS version [▶ Page 75]	
	>=1.2	>=1.3
TLS_AES_128_GCM_SHA256	●	●
TLS_AES_256_GCM_SHA384	●	●
TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA256	●	-
TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256	●	-
TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA384	●	-
TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384	●	-
TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA256	●	-
TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256	●	-
TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA384	●	-
TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384	●	-

Table 6: Cipher suite (● = available, - = not available)

The device uses the SHA256 hash function to save passwords.

4 Product description

4.1 Scope of delivery

The following components are included in the scope of delivery:
- TAPCON®
- Installation set
- Shield connection set
- 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 the output voltage of a three-winding transformer constant or to regulate the high-voltage side or low-voltage side of a transformer depending on the active power flow.

To regulate the voltage, the device compares the measured voltage of the active winding U_{actual} with the defined desired voltage $U_{desired}$ of the active winding. The difference between U_{actual} and $U_{desired}$ is the control deviation dU. If the control deviation is greater than the set bandwidth, the device triggers a tap-change operation. 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.

Three-winding transformer

The three-winding transformer consists of one high-voltage winding and two low-voltage windings. The high voltage winding is equipped with an on-load tap-changer.

The device measures the voltage of the two low-voltage windings. The voltage is regulated via one of the two windings (winding 1 or winding 2). How your device is configured determines which winding is regulated. The set limit values on the winding not being regulated are still monitored.

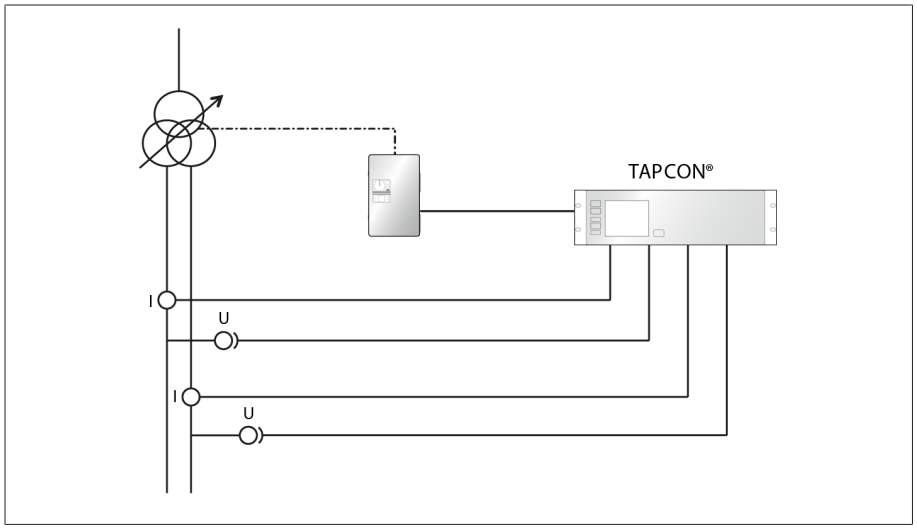


Figure 3: Overview of three-winding transformer voltage regulation

HV/LV regulation

The device measures the voltage on the high-voltage side and on the low-voltage side of the transformer. With automatic winding selection, the voltage on one of the two windings (winding 1 or winding 2) is regulated based on the active power flow. You can select when and which winding is to be regulated via the device configuration. The set limit values on the winding not being regulated are still monitored.

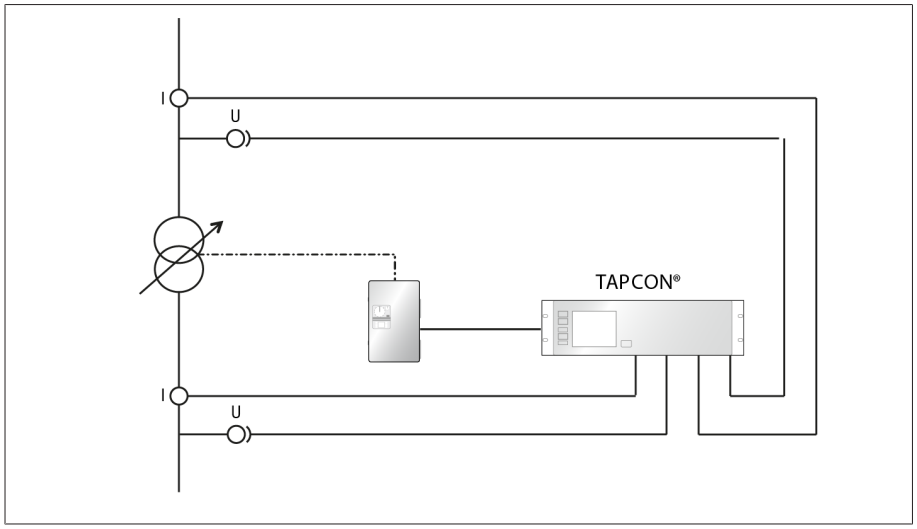


Figure 4: Overview of voltage regulation on the high-voltage side or low-voltage side of the transformer

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 decadal 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
  - Motor-drive unit status (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 70] 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 70] parameter to set the behavior

4.5 Design

The device is designed as a 19-inch plug-in housing.

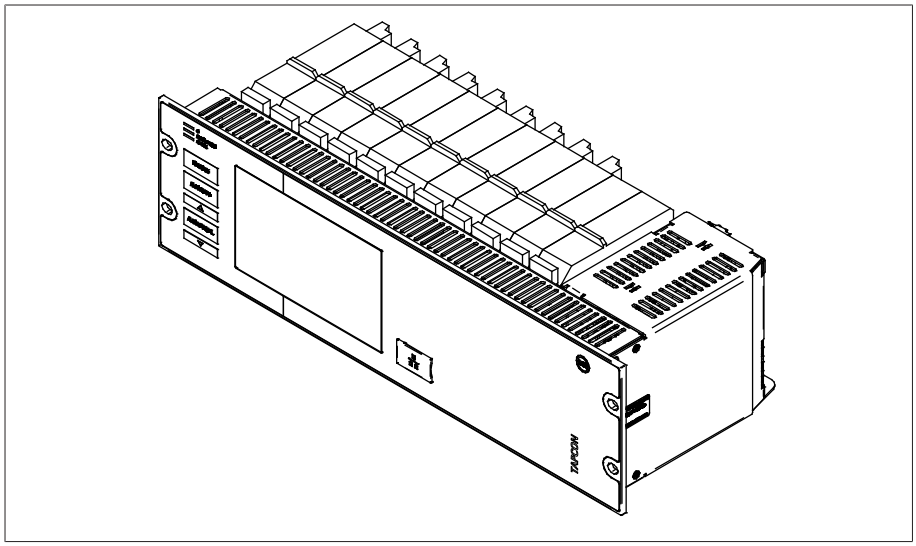


Figure 5: 19-inch plug-in housing

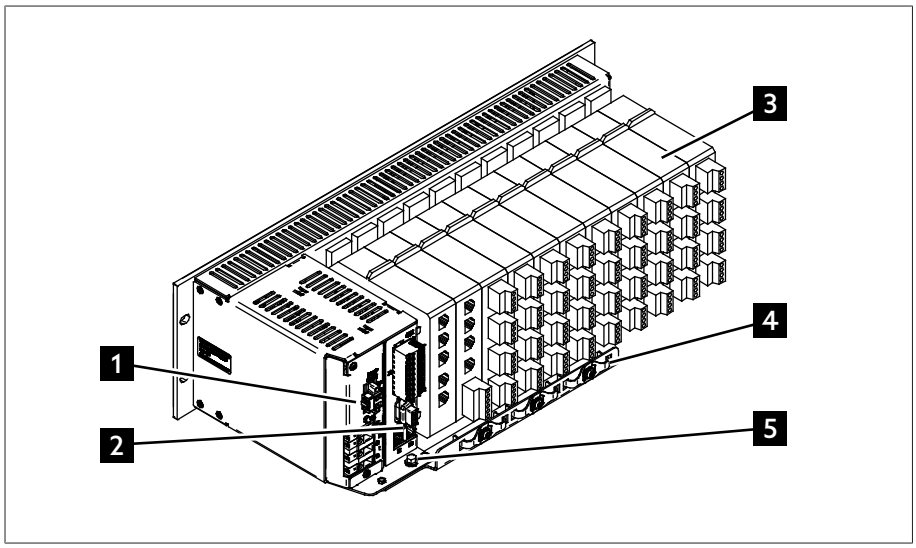


Figure 6: Rear

1	MCONTROL® 7 R-A power supply	2	MCONTROL® 7 R-A communication module
3	ISM® assemblies	4	Shield connection set
5	Grounding screw		

4.5.1 Operating elements

The device has 5 pushbuttons and one touchscreen. You can operate the device with your bare fingers but not when wearing gloves. The illustration below is an overview of the device's operating elements.

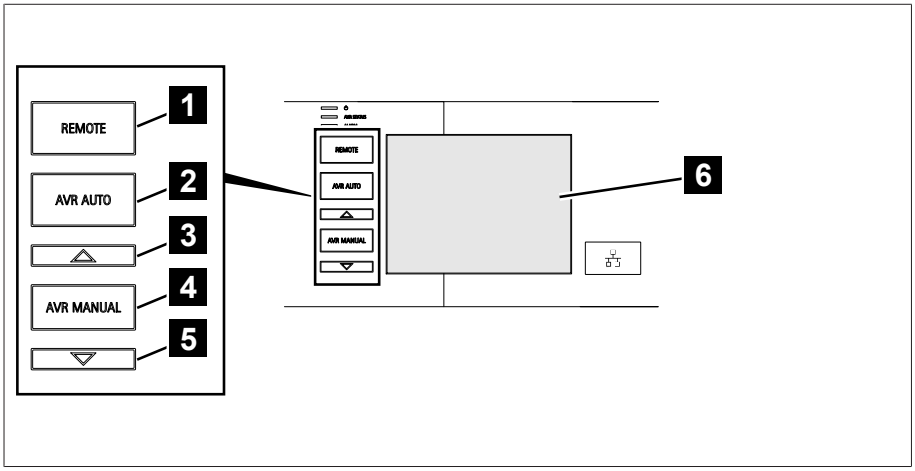


Figure 7: Operating elements

1	REMOTE key[6]	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	Touchscreen	Navigation through individual menu items and parameters.

6 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.

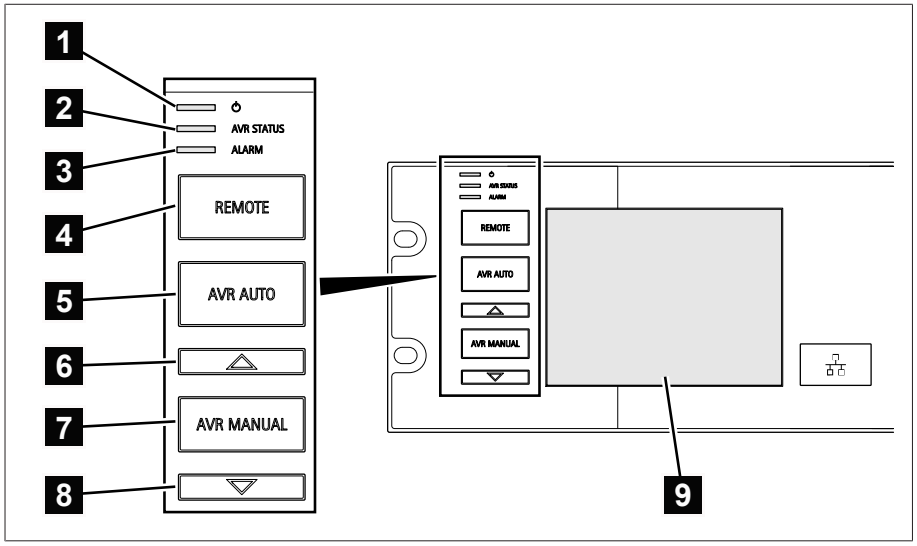


Figure 8: Display elements

1	⏻ LED	Blue	Illuminates when the device is supplied with power.
2	*AVR STATUS* LED	Red	Illuminates when the device is in the error state.
		Yellow	Illuminates when the device starts or has been paused; e.g. during a software update.
		Blue	Illuminates when the device is in the operating state.
3	*ALARM* LED	Red	Illuminates as soon as a red event is present.
		Yellow	Illuminates as soon as a yellow event is present.
		Blue	Illuminates if there are no events or a gray event is present.
4	*REMOTE* LED	Blue	Lights up when the REMOTE operating mode is on.
5	*AVR AUTO* LED	Blue	Lights up when auto mode is active.
6	*RAISE VOLTAGE* LED	Blue	Lights up while a control command is being sent to the motor-drive unit.
7	*AVR MANUAL* LED	Blue	Lights up when manual mode is active.
8	*LOWER VOLTAGE* LED	Blue	Lights up while a control command is being sent to the motor-drive unit.
9	Display	-	-

4.5.2.1 Display

The TAPCON® display is divided into the following areas:

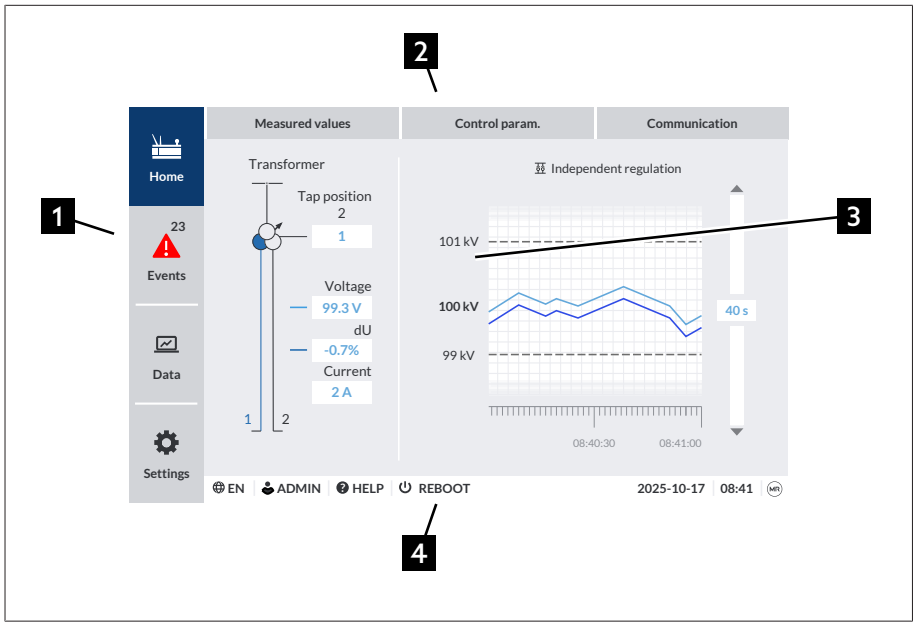


Figure 9: Display

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

4.5.2.2 Measured value trend and operating mode

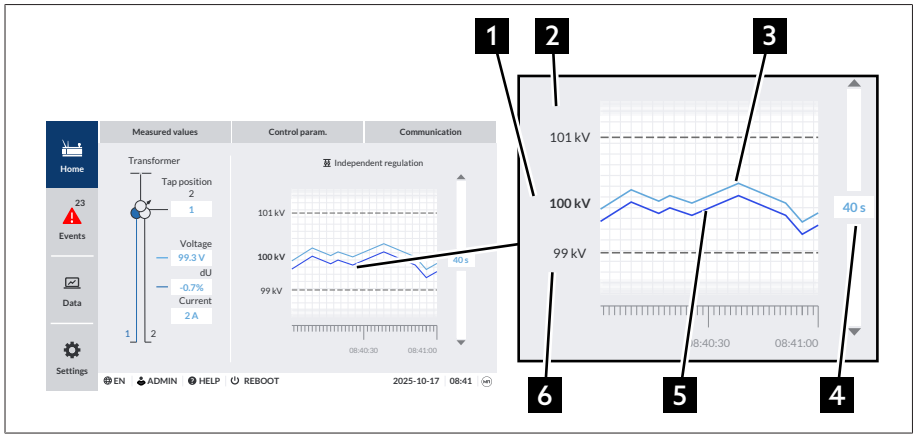


Figure 10: Measured value trend/operating mode

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

4.5.2.3 Transformer overview with current measured values

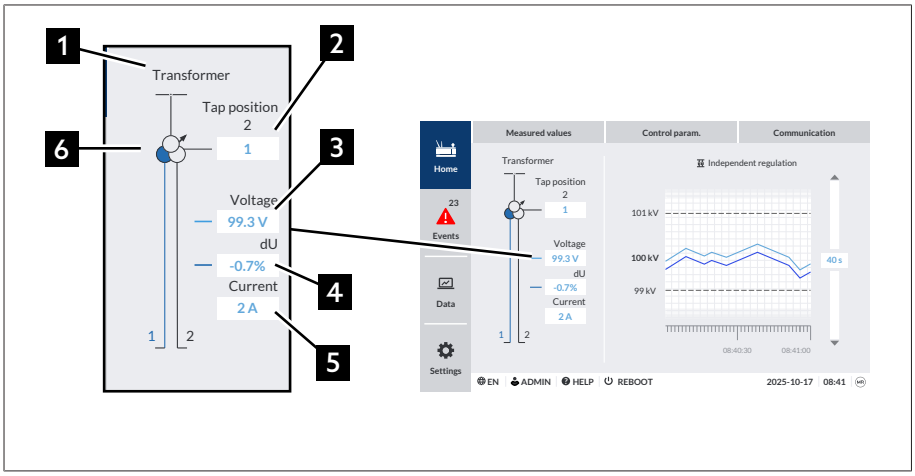


Figure 11: Transformer overview with display showing the current measured values

1	Transformer designation	2	On-load tap-changer tap position
3	Voltage	4	Control deviation in % (with correction)
5	Current	6	Winding currently being regulated (HV/LV)

4.5.3 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 7.1, Page 61] section.

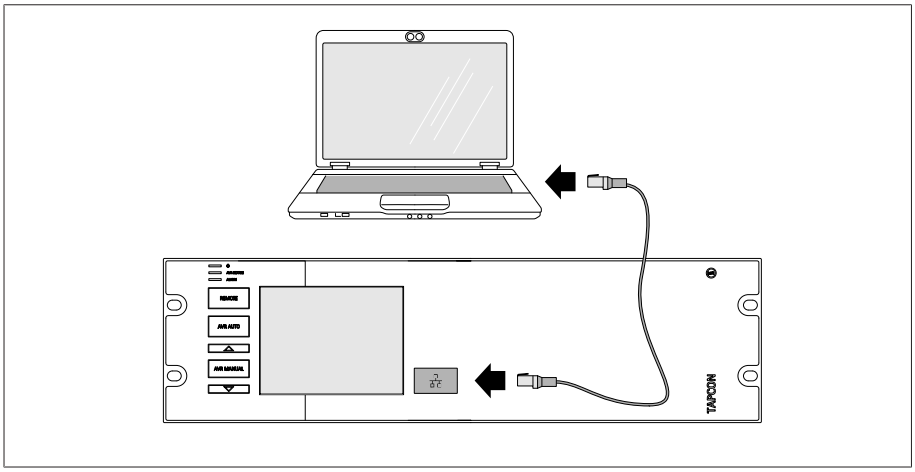


Figure 12: Device connection to a PC

4.5.4 MCONTROL® 7 R-A assemblies

The power supply and the communication module are on the rear side of the MCONTROL® 7 R-A. You will find more information on the connections in the Technical data section.

4.5.4.1 MCONTROL® 7 R-A power supply

The MCONTROL® 7 R-A 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:

- 85...265 V AC/V DC multi-voltage mains unit
- 38.4...70 V DC power supply unit

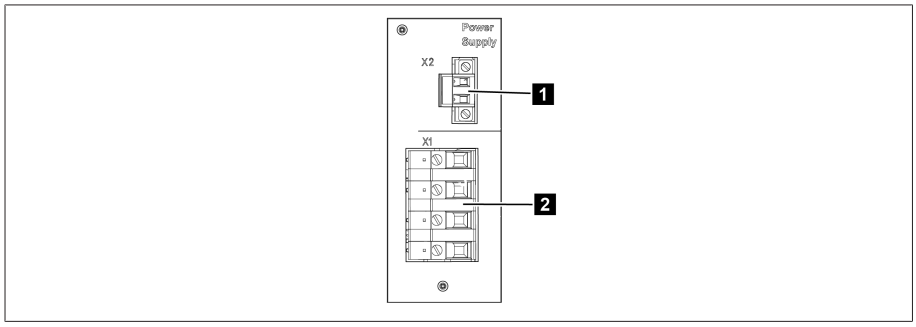


Figure 13: MCONTROL® 7 R-A power supply

1	X2	Power supply	2	X1	Voltage measurement/current measurement

4.5.4.2 MCONTROL® 7 R-A communication interfaces

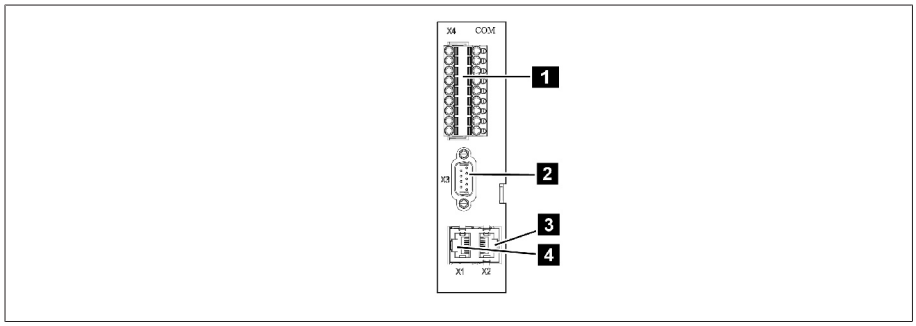


Figure 14: MCONTROL® 7 R-A communication module

1	COM X4	CAN bus/SCADA interface RS485/resistor contact series	2	COM X3	SCADA interface RS232
3	COM X2	Interface for visualization via the front interface	4	COM X1	Interface for patch cable for RS232 or RS485

4.5.5 ISM® assemblies

The assembly is mounted on a cap rail with a bus connector. The bus connectors are plugged into each other and connect the individual assemblies.

4.5.5.1 Power supply CP5.242

The PULS DIMENSION CP5.242 assembly supplies power to the ISM® assemblies.

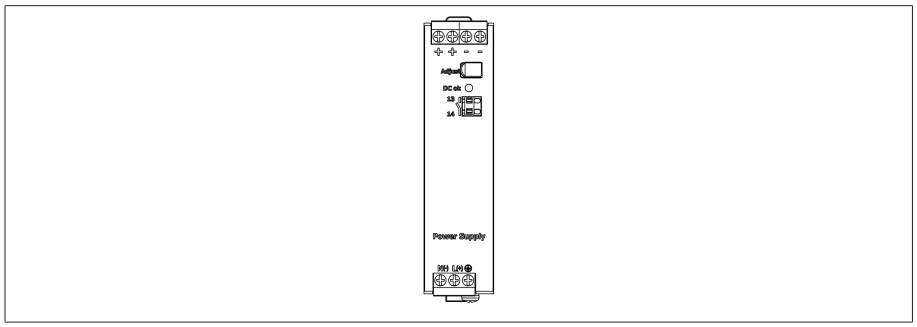


Figure 15: PULS DIMENSION CP5.242 assembly

4.5.5.2 CPU (central processing unit)

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

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

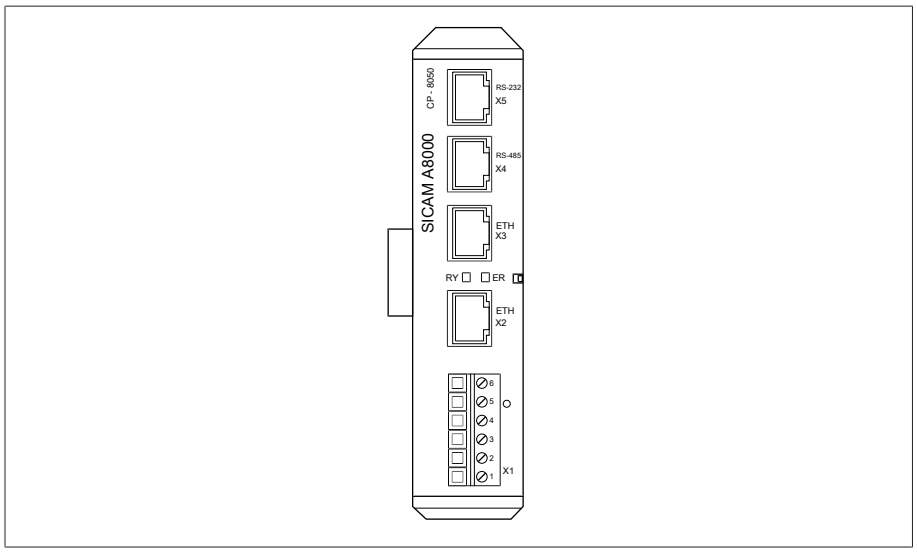


Figure 16: CPU assembly

4.5.5.3 Voltage measurement U 3

The U 3 assembly is used for measuring 3-phase voltage. The *RY* LED signals that the assembly is ready for operation.

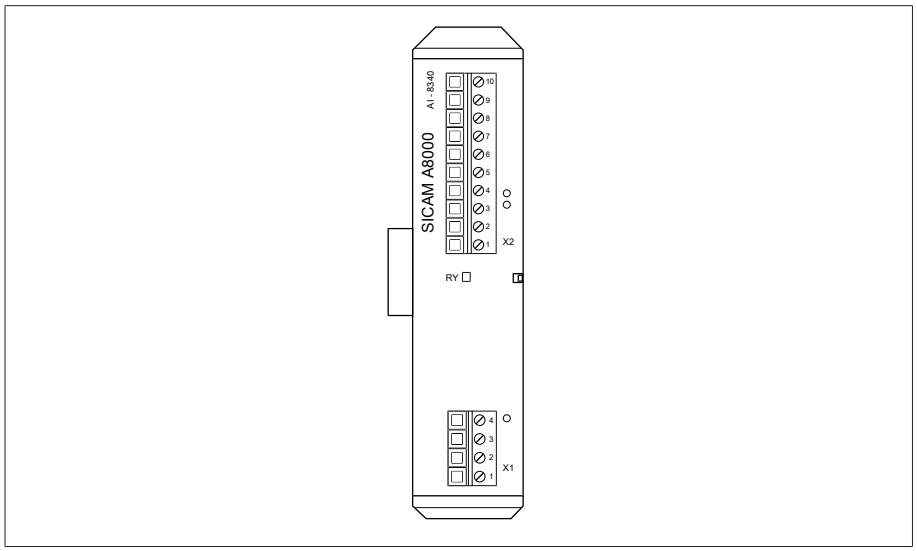


Figure 17: U 3 assembly

4.5.5.4 Current measurement I 3

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

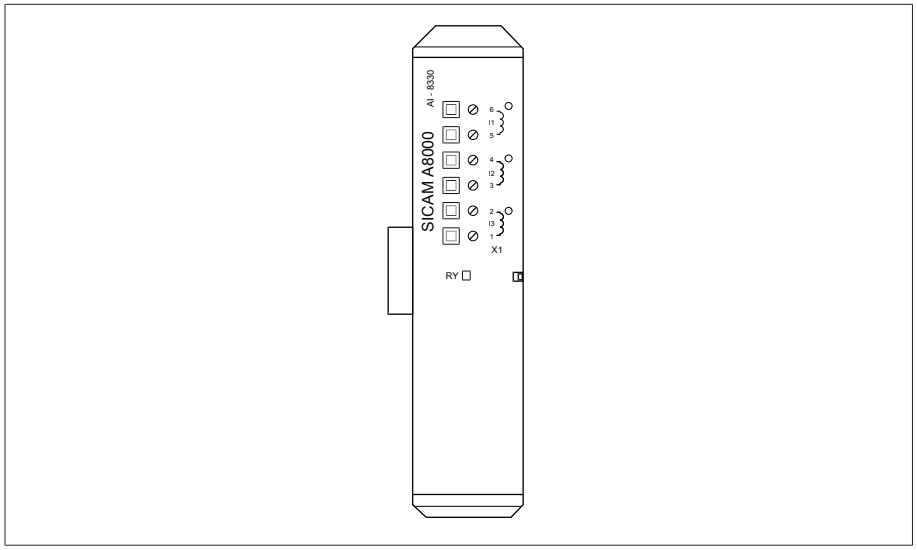


Figure 18: I 3 assembly

4.5.5.5 Digital inputs DI 16-24 V

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

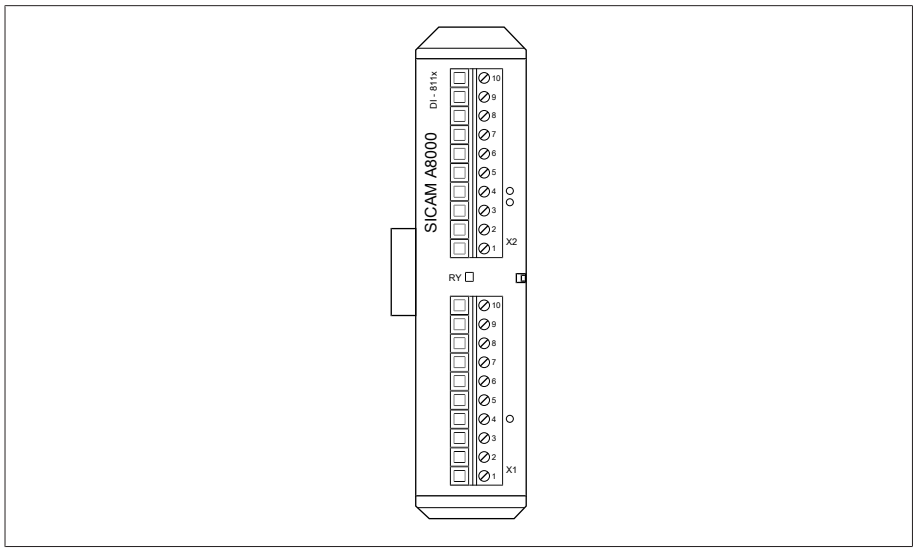


Figure 19: DI 16-24V assembly

4.5.5.6 Digital inputs DI 16-110 V

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

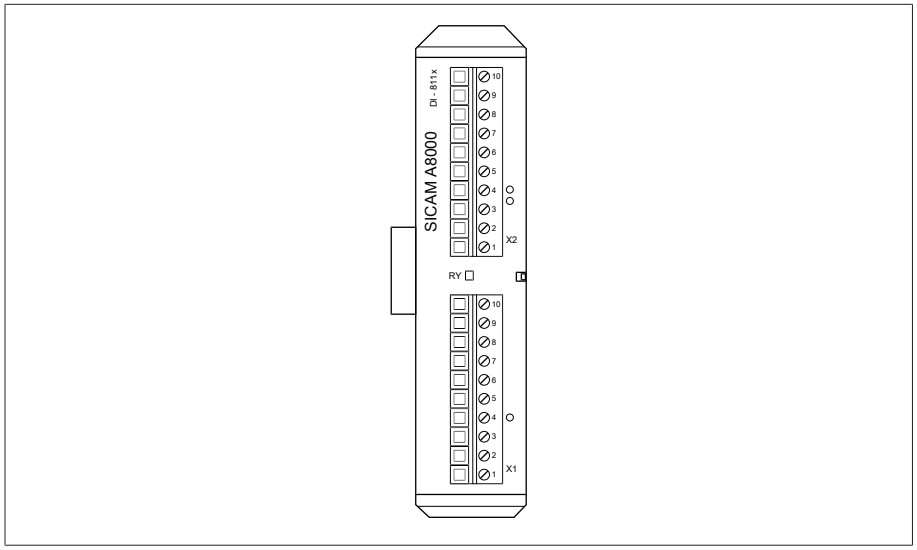


Figure 20: DI 16-110V assembly

4.5.5.7 Digital inputs DI 16-220 V

The DI 16-220V assembly has 16 digital inputs with a nominal voltage of 220 V DC. The *RY* LED signals that the assembly is ready for operation.

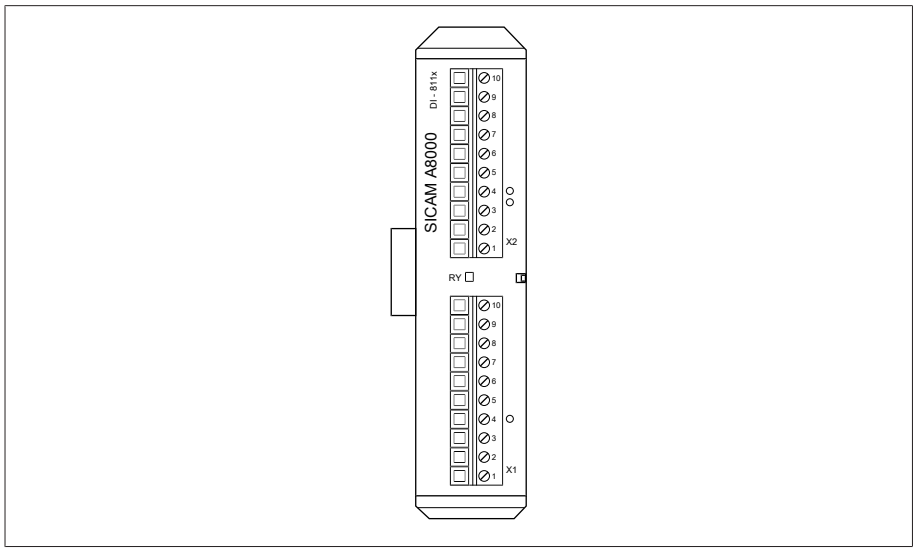


Figure 21: DI 16-220V assembly

4.5.5.8 Digital outputs DO 8

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

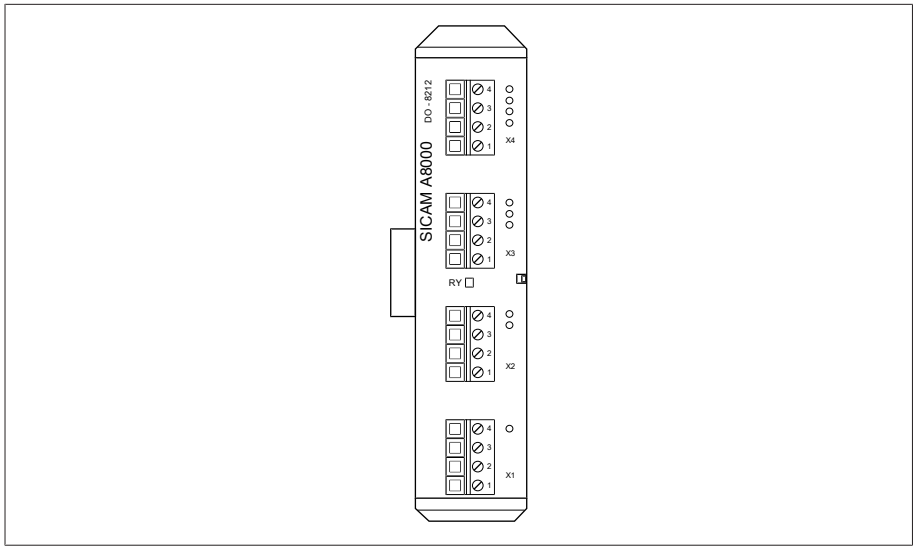


Figure 22: DO 8 assembly

4.5.5.9 Analog inputs AI 4-T

The AI 4-T assembly provides you with 4 analog inputs for temperature measuring (PT100, PT1000). The *RY* LED signals that the assembly is ready for operation.

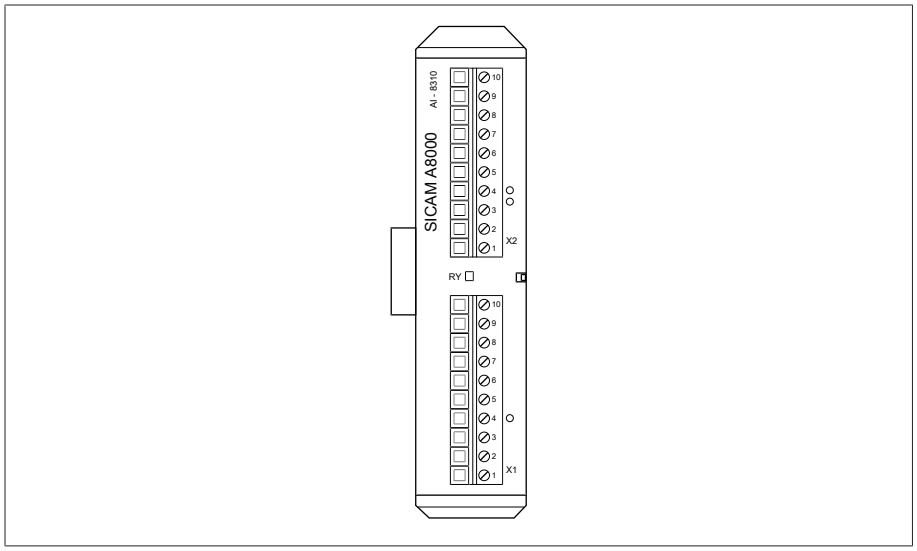


Figure 23: AI 4-T assembly

4.5.5.10 Analog inputs AI 4

The AI 4 assembly provides you with 4 analog inputs for current measurement (0/4...20 mA) or voltage measurement (0...10 V) via analog sensors. The *RY* LED signals that the assembly is ready for operation.

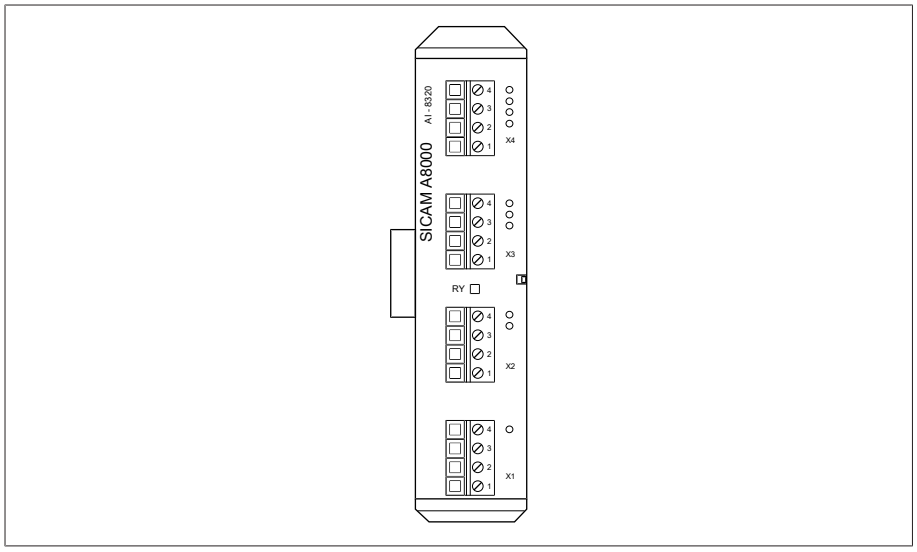


Figure 24: AI 4 assembly

4.5.5.11 Analog outputs AO 4

The AO 4 assembly provides you with 4 analog outputs for outputting measured values (0/4...20 mA, 0...10 V). The *RY* LED signals that the assembly is ready for operation.

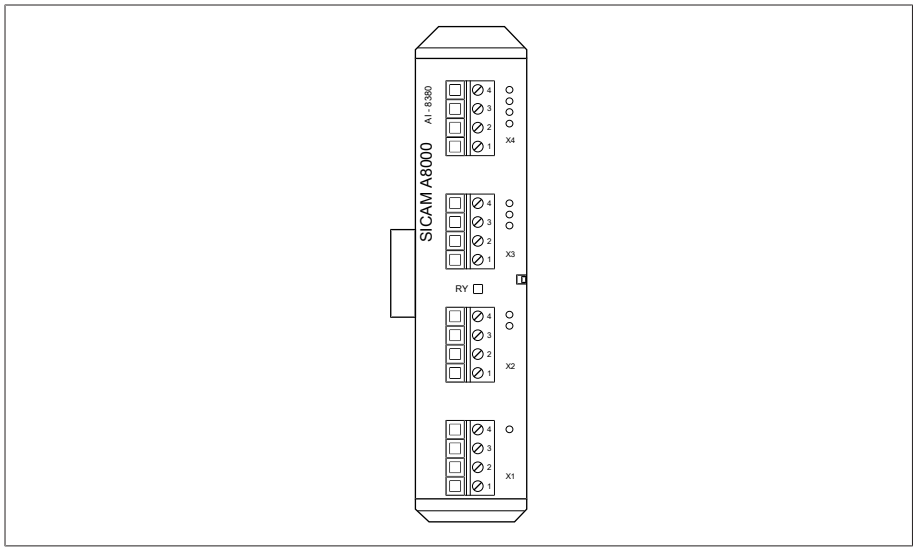


Figure 25: AO 4 assembly

4.5.5.12 System networking COM-ETH

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

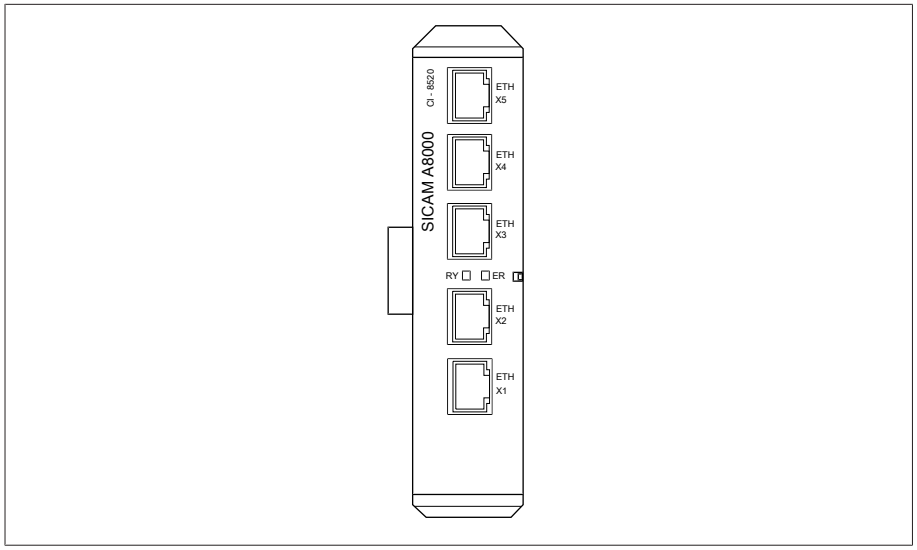


Figure 26: COM-ETH assembly

4.5.5.13 System networking COM-ETH-FO

The COM-ETH-FO assembly provides you with 3 Ethernet interfaces and 2 Duplex-LC (SFP) interfaces.

Depending on the order, the following redundancy protocols will be available via the X4 and X5 interfaces:

- HSR
- PRP
- RSTP

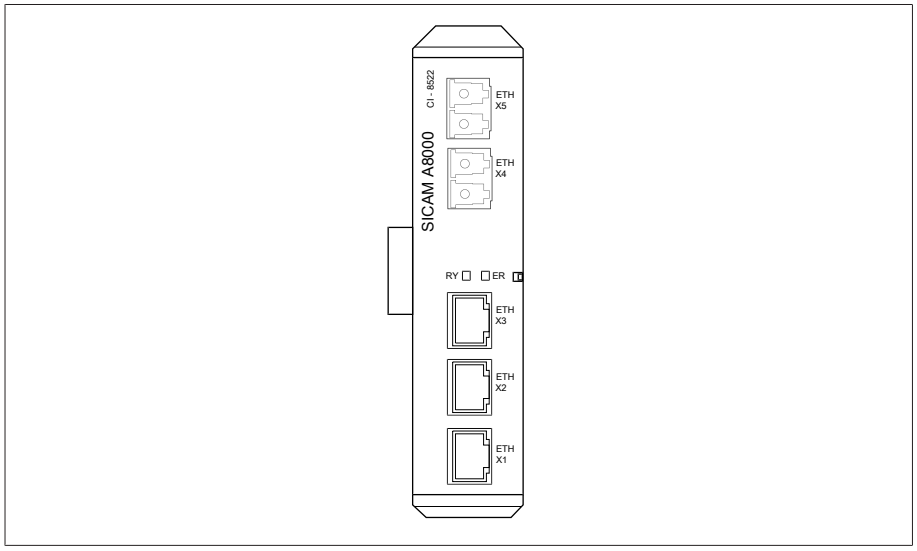


Figure 27: COM-ETH assembly

4.5.5.14 System networking BES

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

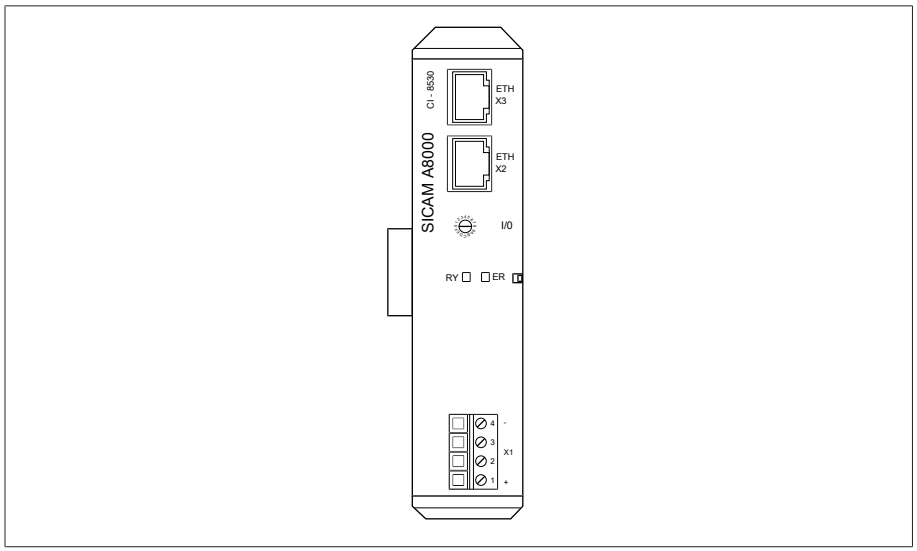


Figure 28: BES assembly

4.5.5.15 Control status message

The device reports the status of the control via digital outputs:

- OFF: Control is switched off.
- RDY: Control is ready.
- ERR: There is an error.

Output	Configuration	OFF	RDY	ERR
DO 8: Status OK	NO, High active[7]	0	1	0
DO 8: Status OK	NO, Low active[7]	0	0	1
CPU: Status OK	NO, High active	0	1	0
CPU: Status OK	NC, High active	1	0	1

Table 8: Status message (DO 8 and CPU)

4.5.6 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 elements are displayed in the overview screen on the right-hand edge of the screen. Depending on the device configuration, a variety of keys are available.

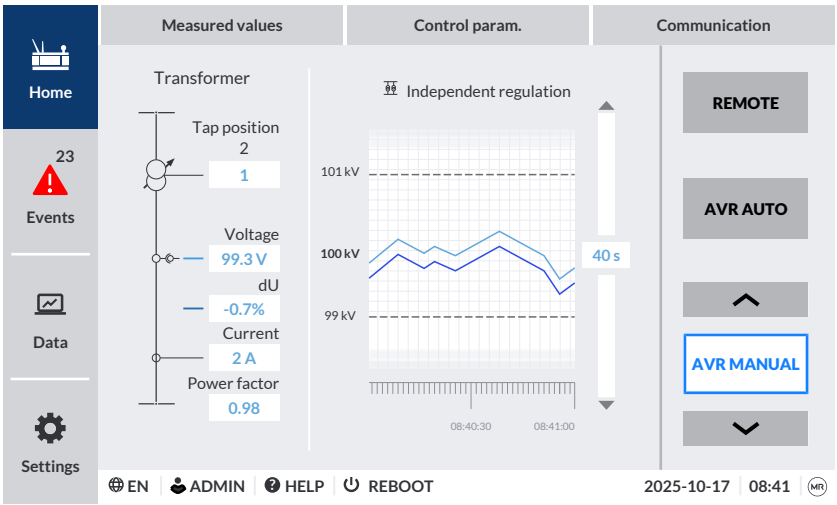


Figure 29: Additional operating elements

REMOTE [8]	REMOTE key	Select the operating mode: – On: REMOTE – Off: LOCAL
AVR AUTO	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	AVR Manual key	Activate manual mode.
v	LOWER key	Send a control command to the motor-drive unit to reduce the voltage. Only possible in manual mode.

7 In this case, note that in the DIO configuration "NO, High-active" is shown as NO and that "NO, Low-active" is shown as NC.

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

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 and user roles in the User administration [▶Section 8.1.17, Page 94] section.

> 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.

> 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.

To log in as a user, proceed as follows:

1. Select the **LOGIN** or **CHANGE** button in the status line.
2. Enter your user name and password and select the **Accept** 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 touchscreen to navigate through the entire menu. You can operate the touchscreen with your fingers, but not when wearing gloves.

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

Example To navigate to the "Date" parameter, proceed as follows:

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** > **Time**.

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.

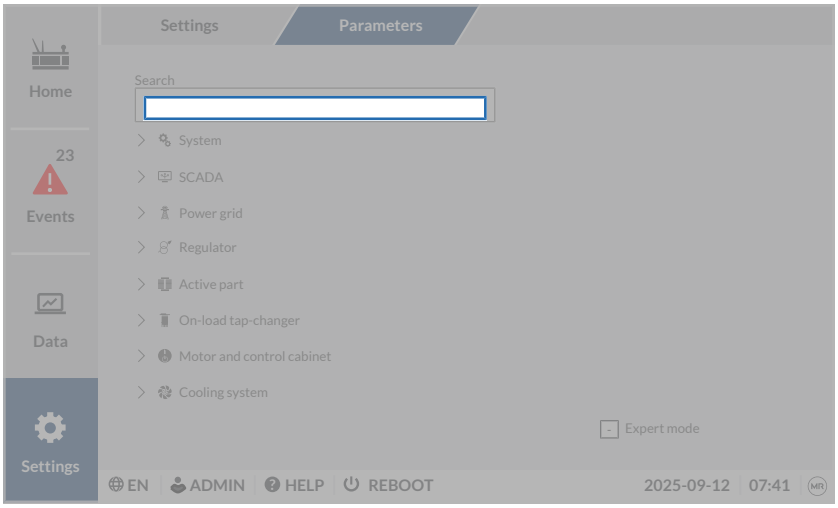


Figure 30: Quick search

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.

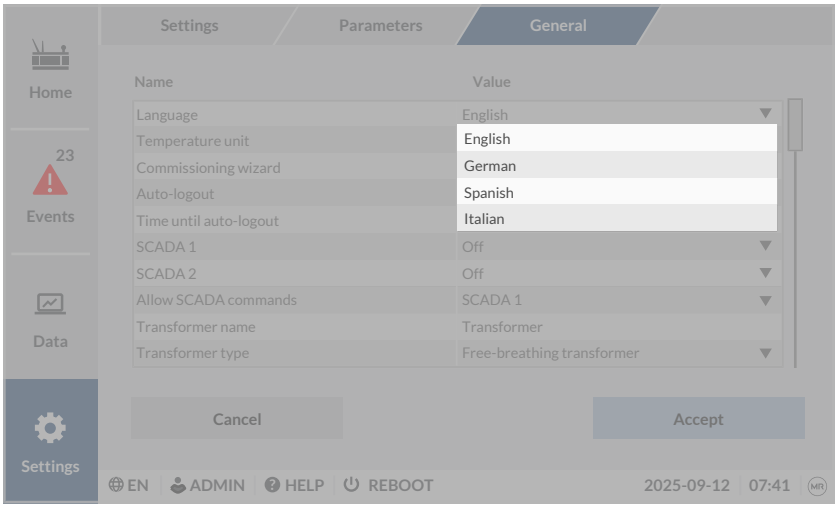


Figure 31: Expert mode

To activate the expert mode, proceed as follows:

1. Go to **Settings** > **Parameters**.
2. Select the **Expert mode** checkbox.

» Expert mode is active.

Hiding/showing parameters

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

4.7 Administrator password

In the delivery state, you can log in as the administrator as follows:

- User name: admin
- Password: see label

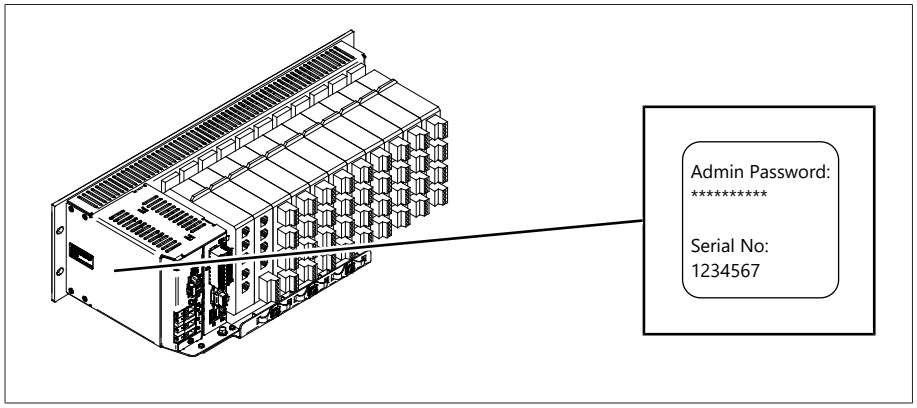


Figure 32: Label with the administrator password

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.

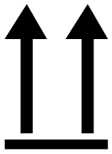
Protect against moisture	 Top	Fragile	Attach lifting gear here	Center of mass

Table 9: 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 the packaging 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 packaging or transport container can be accessed from all sides.

Visible damage

If external transport damage is found upon receipt of the shipment, proceed as follows:

- Immediately record the transport damage found in the shipping documents and have this countersigned by the carrier.
- In the event of severe damage, total loss or high damage costs, immediately notify the sales department at Reinhausen GmbH 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 on site together with the carrier involved. This is essential for any claim for damages!
- If possible, photograph damage to packaging and packaged goods. This also applies to signs of corrosion on the packaged goods due to moisture inside the packaging (rain, snow, condensation).
- Be absolutely sure to also check the sealed packaging.

Hidden damage

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

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

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

5.4 Storage of shipments

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

- Protect stored goods against moisture (flooding, water from melting snow and ice), dirt, pests such as rats, mice, termites and so on, and against unauthorized access.
- Store the packaging on timber beams and planks as 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

> **i** 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 have a minimum clearance of 10 mto 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 causing interference (e.g. supply lines) and lines susceptible to interference (e.g. signal lines) in the same cable duct.
- A clearance of greater than 100 mmbetween lines which cause interference and those susceptible to interference.

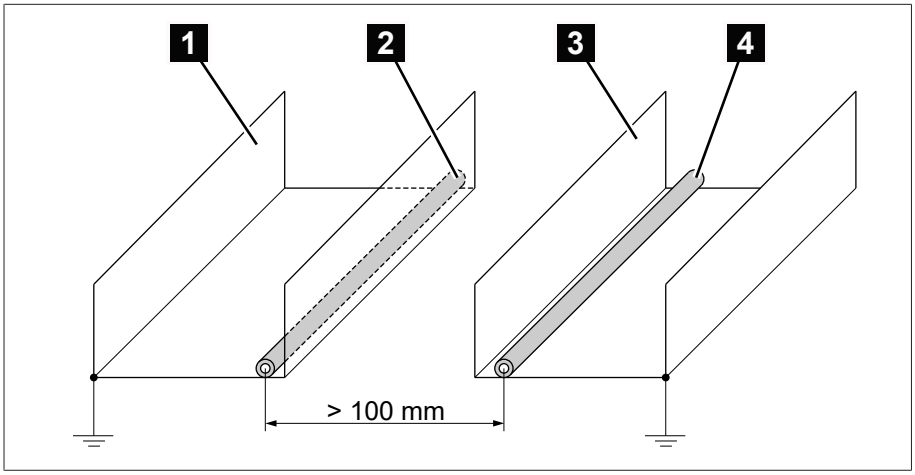


Figure 33: Recommended wiring

1	Cable duct for lines causing interference	3	Cable duct for lines susceptible to interference
2	Line causing interference (e.g. supply 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 (360º) to device or to a nearby grounding bar.

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

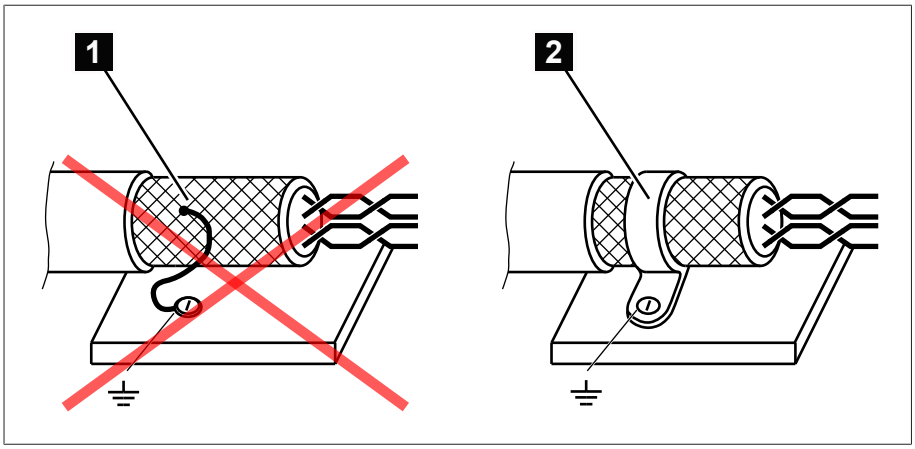


Figure 34: Recommended connection of the shielding

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:

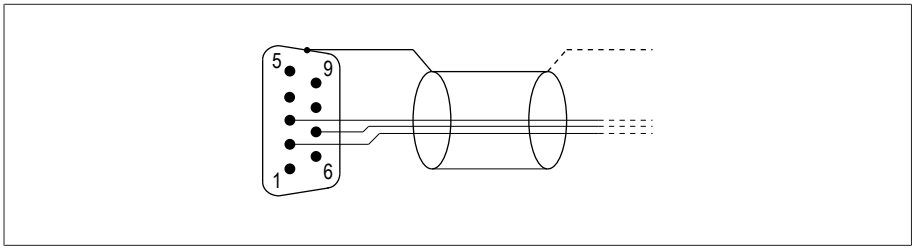


Figure 35: Connection of CAN bus cable shielding to the 9-pin D-sub connector

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	Above/below: 88.9 mm (3.5 in; equivalent to 2 RU) Left/right 30 mm (1.18 in) Depth 30 mm (1.18 in)
To the roof of the control cabinet	
Between assemblies on the bus bar and assemblies on the remote cap rail	

Table 10: Minimum distances in the control cabinet

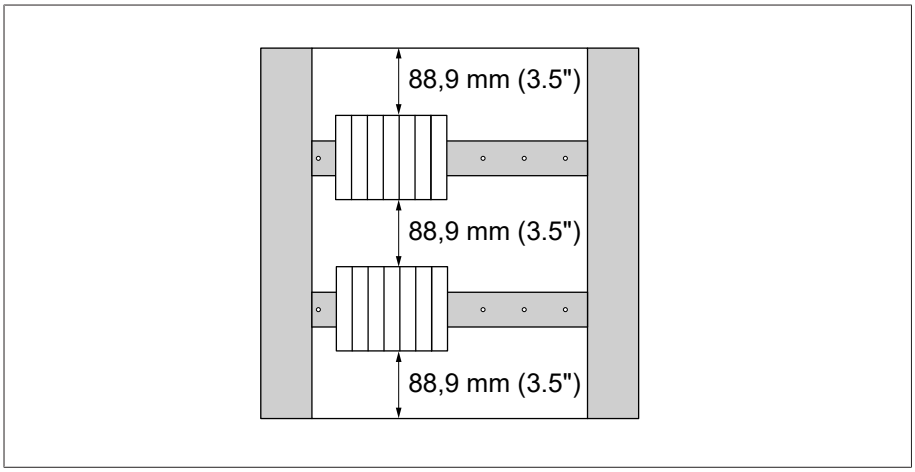


Figure 36: Depiction of the minimum distances in a control cabinet

For other installation types, contact Reinhausen.

6.4 Installing the 19-inch plug-in housing

Mounting in a 19″ frame (in accordance with IEC 60297-3-100)

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 the 19″ frame and screw down.

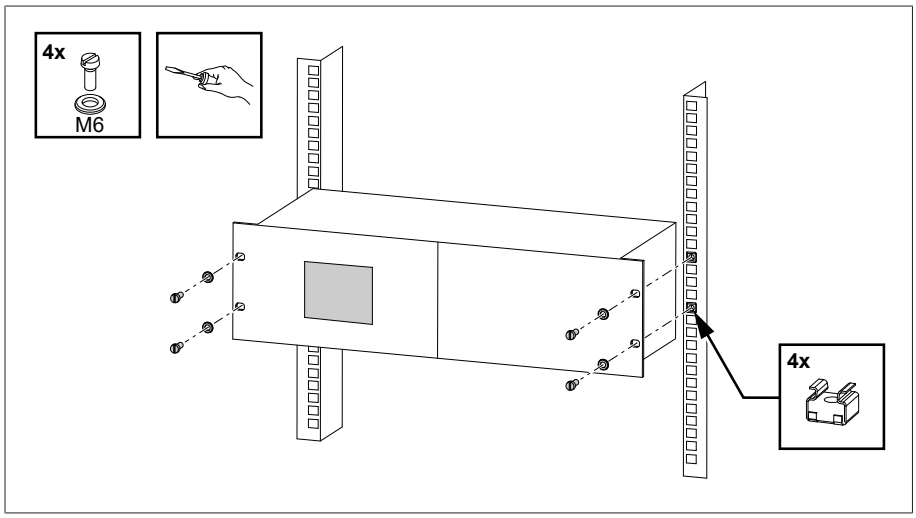


Figure 37: Example of device mounting in a 19″ frame

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.

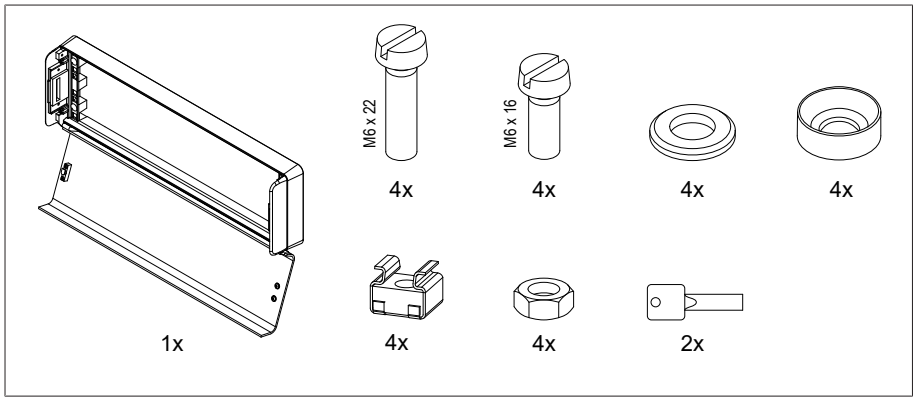


Figure 38: Scope of delivery

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

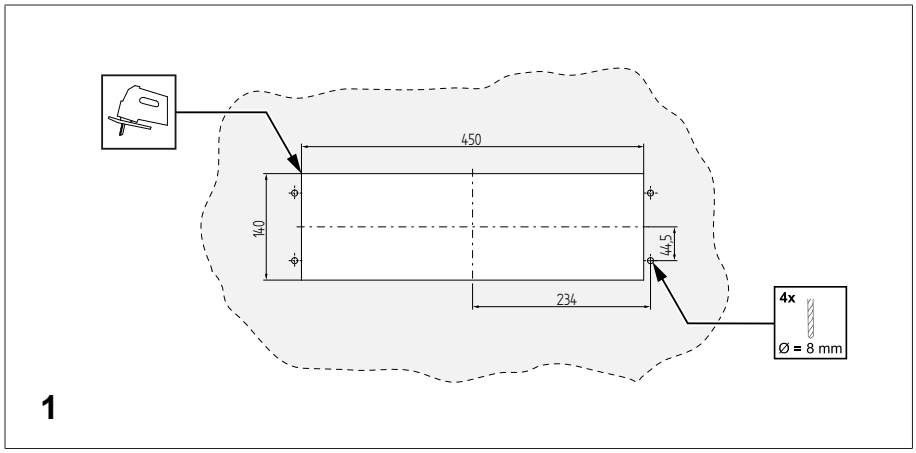


Figure 39: Producing the cut-out in the control panel

2. Mounting cage nuts

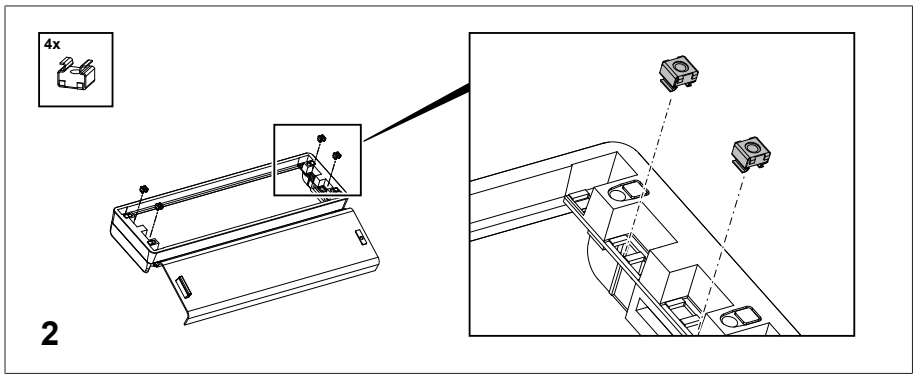


Figure 40: Mounting cage nuts

3. Secure frame to control panel.

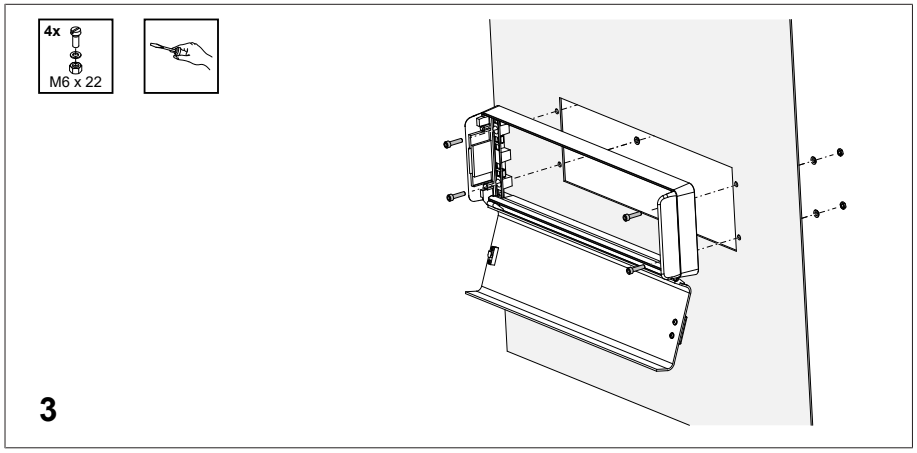


Figure 41: Securing frame to control panel

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

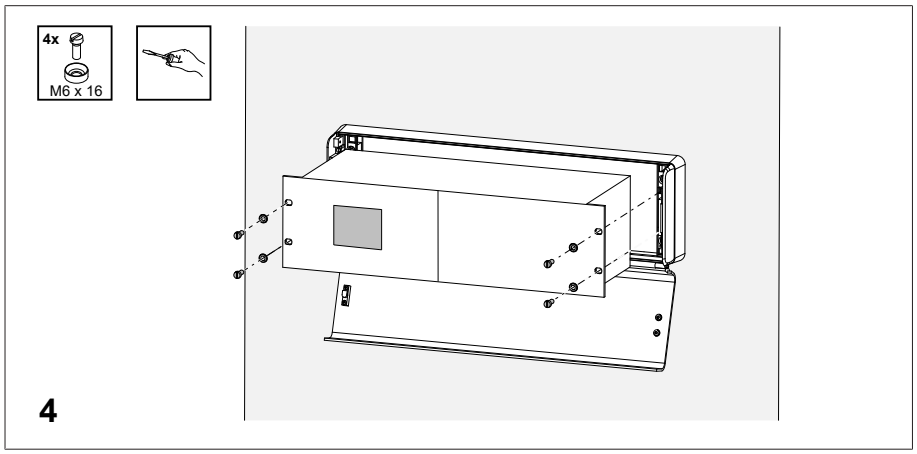


Figure 42: Securing device

5. Close cover of flush control panel frame.

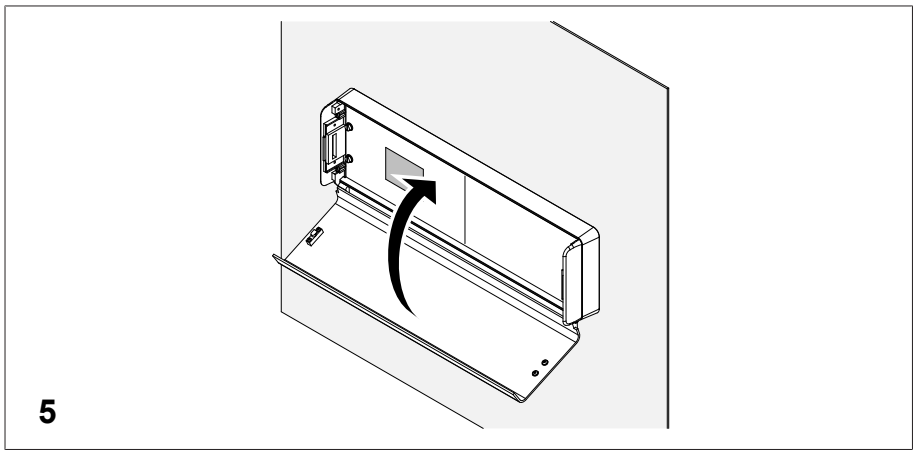


Figure 43: Closing cover

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).

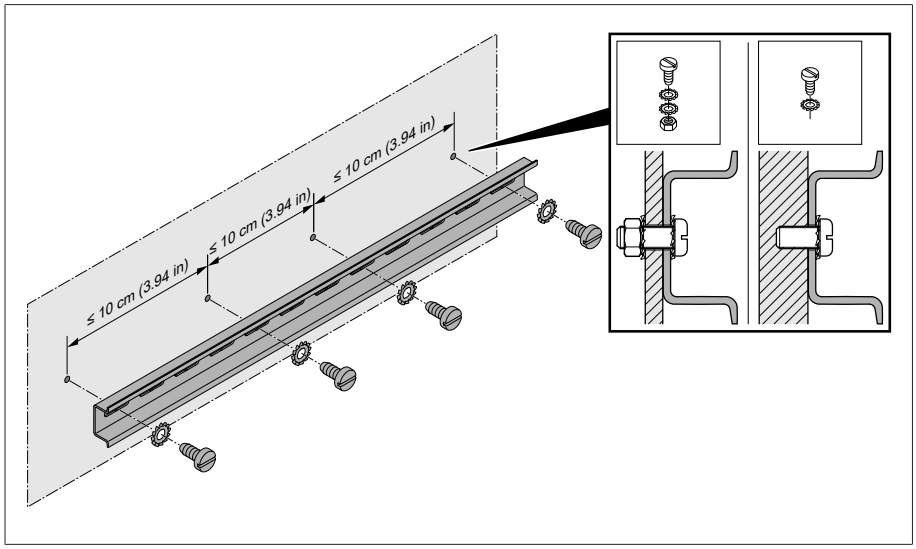


Figure 44: Fastening the cap rail

6.5.2 Installing the assembly at a distance on the cap rail

As an option, the device can include the following assemblies that must be mounted with an offset on the cap rail:

- G1 (PULS)
- U module
- I module
- DI module
- DO module
- AI module
- AO module

✓ Cap rail fastened to the rear panel of the cabinet [▶Section 6.5.1, Page 48].

1. ⚠ 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.
2. Wire the assemblies [▶Section 6.6, Page 52]. Note the connection diagram.

6.5.3 Installing modules in the control cabinet

The modules are delivered ex-works mounted on a cap rail. Remove the individual modules and mount them on your own cap rail.

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

Mounting modules on your own cap rail

⚠ WARNING

Electric shock!

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

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

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.

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

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

If you use a cap rail with a depth of 7.5 mm (TH 35-7.5), you must ensure that the screw head does not touch the bus connector. In this case, use fixing screws with a flat head.

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

- TH 35-7.5
- TH 35-15

1. If the bus connector was previously removed: Plug the bus connector onto the cap rail and then plug it into an existing bus connector if necessary. Note that you can only mount the U 3 and I 3 assemblies with the common combination bus connector.

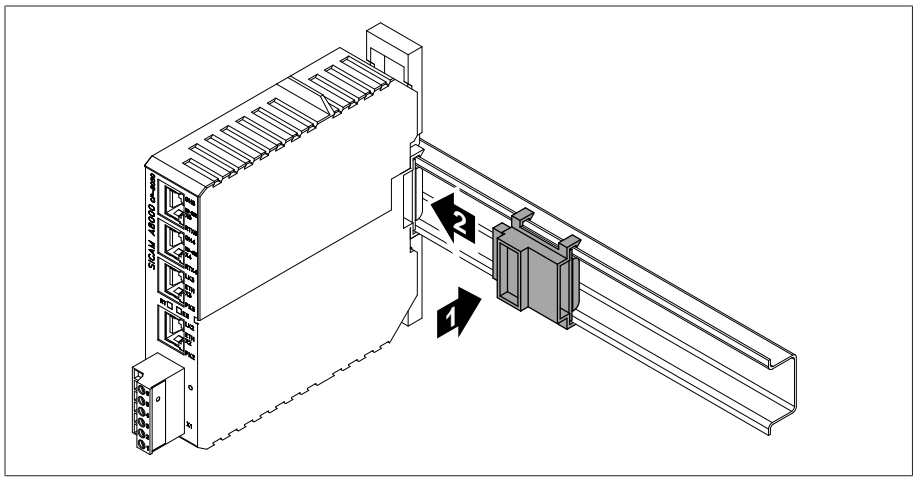


Figure 45: Attaching the bus connector

2. Unlock the assembly.

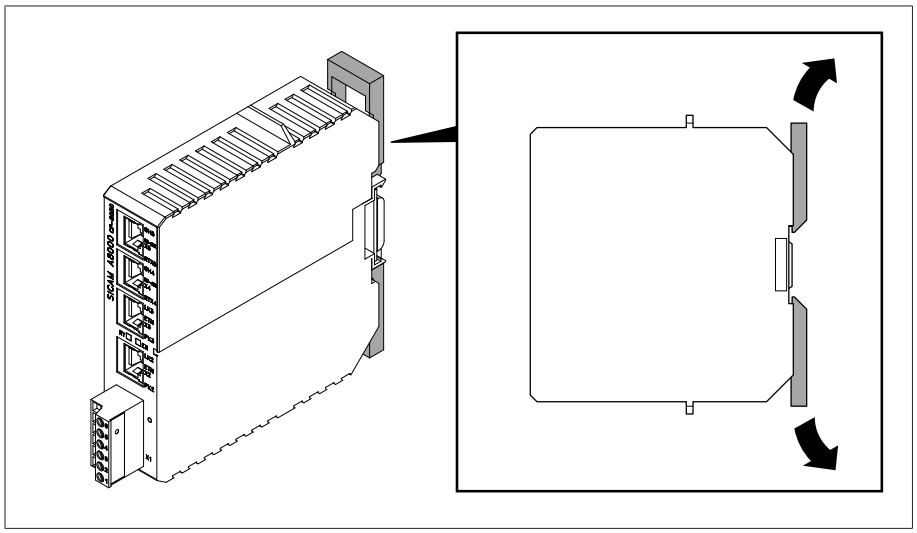


Figure 46: Unlocking the assembly

3. Attach the assembly to the bus connector.

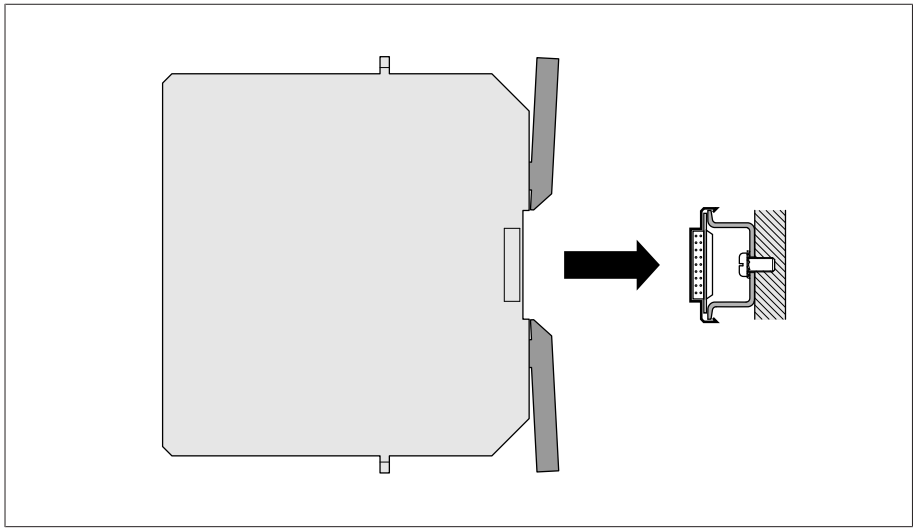


Figure 47: Attaching the assembly

4. Lock the locking latches.

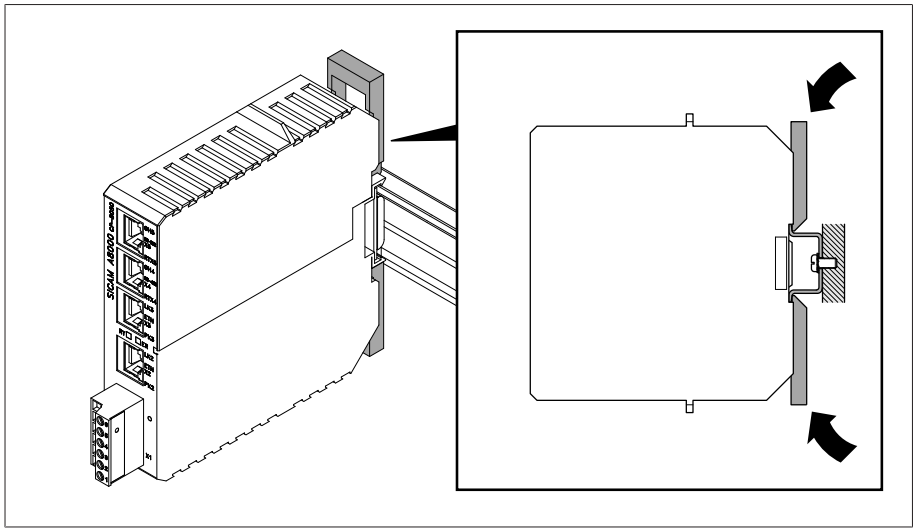


Figure 48: Locking the locking latches

5. Plug the connectors to the assembly. Note the connection diagram.
6. Ensure strain relief, for example, through the use of a cable duct.

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 and freely accessible, close to the device's power supply. This ensures that the device can be replaced with ease in the event of a defect.

Wiring information

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 recommendation when wiring the device:

- Where possible, route signal lines with shielding.
- Excessive line capacitances 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 a building, we recommend using fiber-optic cables (in accordance with the IEC 61850-90-4 recommendation). If use of fiber-optic cables is not possible, you must ensure that the cable shield is placed in the control cabinet (e.g. on the grounding bar or using a network socket for cap rail installation).
- Ensure that the copper cables used have a temperature resistance of 70 °C.
- Strip the wires to a sufficient length for connection to a terminal block (>10 mm) or use a sufficiently long wire ferrule (>10 mm).

Cable	Assembly	Cable type	Conductor cross-section	Conductor material	Max. length
Voltage measurement	U 3	Shielded	2.5 mm^2	Copper	-
Current measurement	I 3	Unshielded	2.5 mm^2	Copper	-
Signal inputs	DI 16	Shielded	1.5 mm^2	Copper	400 m (<25 Ω/km)
Signal outputs	DO 8	Shielded	1.5 mm^2	Copper	-
Signal inputs	AI 4, AI 4-T	Shielded	1 mm^2	Copper	400 m (<25 Ω/km)

Cable	Assembly	Cable type	Conductor cross-section	Conductor material	Max. length
Signal outputs	AO 4	Shielded	1 mm^2	Copper	-
RS232, RJ45	CPU	Shielded	0.25 mm^2	-	2.5 m (internal)
RS485; RJ45	CPU	Shielded	0.25 mm^2	-	140 m
Ethernet RJ45	CPU	Min. CAT5, shielded S/FTP	-	-	100 m
Ethernet RJ45	COM-ETH	Min. CAT5, shielded S/FTP	-	-	100 m
Ethernet RJ45	COM-ETH-FO	Min. CAT5, shielded S/FTP	-	-	100 m
Ethernet FO	COM-ETH-FO	Duplex LC multi-mode, OM3, 1,310 nm	-	-	2,000 m
Power supply (external)	X2	Unshielded	1.5 mm^2	Copper	-

Table 11: Recommendation for connection cables to ISM® assemblies

Voltage measurement	X1	Shielded	2.5 mm^2	Copper	-
Current measurement	X1	Unshielded	2.5 mm^2	Copper	-
CAN bus	COM X4	Shielded	0.75 mm^2	Copper	2,000 m (entire CAN bus)
RS485	COM X4	Shielded	0.25 mm^2	Copper	140 m
RS232, D-SUB 9-pin	COM X3	Shielded	0.25 mm^2	Copper	25 m
Ethernet RJ45	COM X2	Min. CAT5, shielded S/FTP	-	-	100 m
Patch cable	COM X1	Min. CAT5, shielded S/FTP	-	-	Approx. 30 m

6.6.2 Wiring the MCONTROL® 7 R-A and CPU

› The COM-X2 interface and the CPU-X3 interface are already connected together via the supplied patch cable.

6.6.3 Connecting the CAN bus

6.6.3.1 Shielding the CAN bus

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

NOTICE

Damage to the device!

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

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

Variant 1: The connected devices share the same potential

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

Variant 2: The connected devices have different potential levels

Note that the shielding is less effective with this variant.

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

6.6.3.2 Mounting terminating resistor of CAN bus

If you want to operate the device in parallel operating state, you need to mount a 120 Ω terminating resistor at both ends of the CAN bus between CAN_L and CAN_H (see supplied connection diagram).

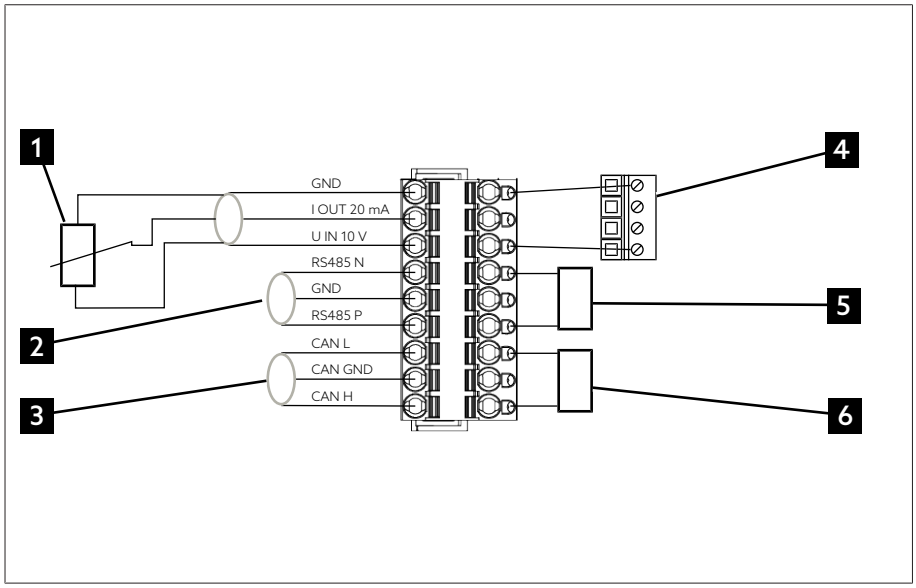


Figure 49: Mounting terminating resistor/RS485 and CAN

1	Resistor contact series	2	RS485
3	CAN	4	AI: X4 resistor contact series
5	RS485 120 Ω terminating resistor	6	CAN 120 Ω terminating resistor

6.6.4 Connecting SCADA

NOTICE

Damage to the device!

Using the wrong data cable may damage the device.

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

Depending on the control system used, you have to connect the device with one of the following versions.

6.6.4.1 Serial interface RS485 (COM-X4)

If you want to use the RS485 serial interface, you need to mount a 120 Ω terminating resistor at both ends of the RS485 bus.

1. Connect the wires of the shielded cable to pins 6 (RS485 N), 5 (RS485 GND), and 4 (RS485 P) of the COM-X4 connector.
2. Position the cable shielding and screw it into the shield set provided.
3. Connect the COM-X1 RJ45 interface and the CPU-X4 interface together using the supplied patch cable.

6.6.4.2 Serial RS232 (D-SUB 9-pole) interface

Data cable

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

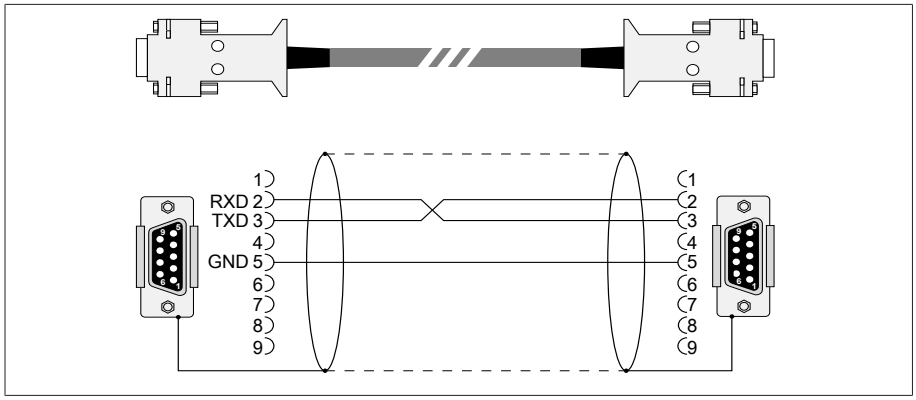


Figure 50: RS232 data cable (9-pole)

D-SUB 9-pole plug connection

Only use 9-pole 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.

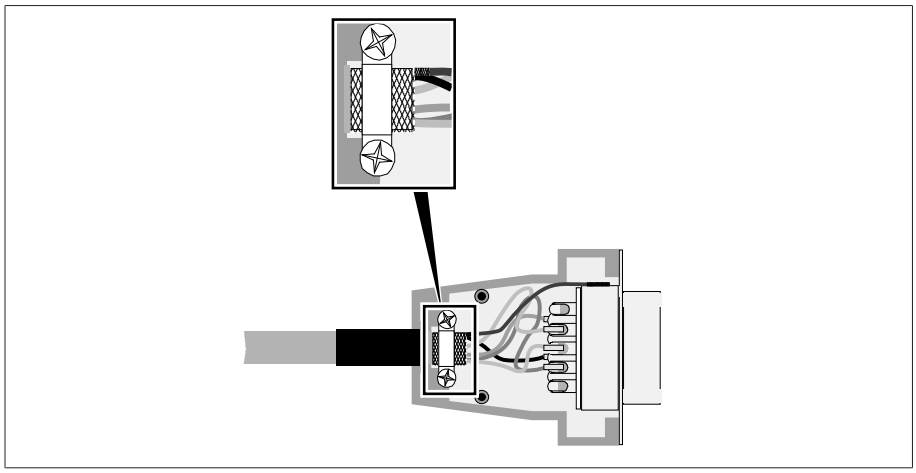


Figure 51: Example of a soldered shielding on a plug housing

Connection

1. Connect the D-SUB 9-pole connector to the COM-X3 interface.
2. Connect the COM-X1 RJ45 interface to the CPU-X5 interface using the supplied patch cable.

6.6.5 Connecting cables to the system periphery

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

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

✓ Only use the specified cables for wiring. Note the cable recommendation [▶Section 6.6.1, Page 52].

› Connect the lines to be wired to the device to the system periphery as shown in the connection diagrams supplied.

6.6.6 Wiring voltage measurement/current measurement UI

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

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

1-phase voltage measurement and current measurement

1. Voltage measurement: Feed the wires into the terminals UI:X1-4 (N conductor) and UI:X1-3 (L conductor) and fasten them using a screwdriver.
2. Current measurement: Feed the wires into the terminals UI:X1-2 (I) and UI:X1-1 (k) and fasten them using a screwdriver.

3-phase voltage measurement and current measurement

If you wish to perform a 3-phase voltage and current measurement, please refer to the wiring instructions in the corresponding description.

6.6.7 Wiring analog inputs AI

You can connect the following types of analog sensors:

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

In order to correctly record the analog signals, you must place the cable shielding on the supplied shield connection 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.

Block diagram and wiring versions

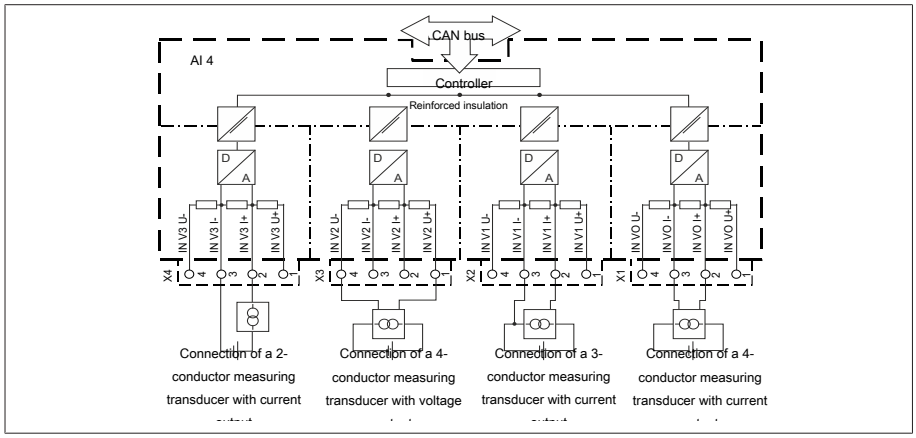


Figure 52: Block diagram for analog inputs

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

6.6.8 Wiring digital inputs DI

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

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

6.6.9 Wiring digital outputs DO

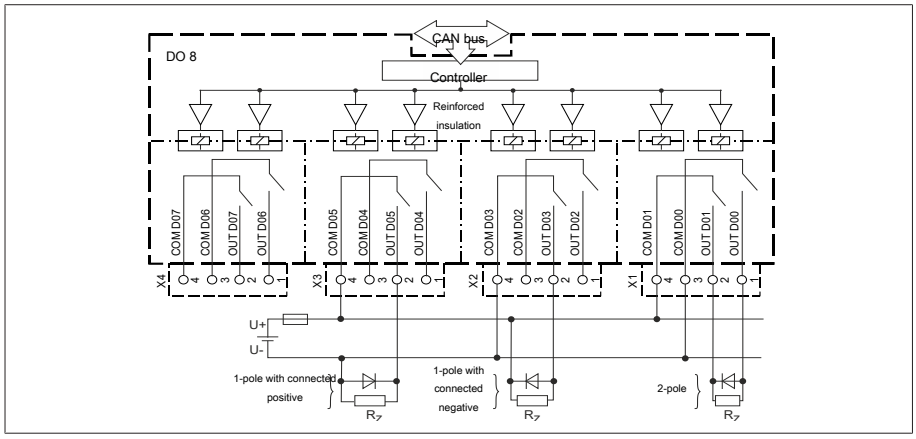


Figure 53: Block diagram for digital outputs

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

6.6.10 Wiring resistor contact series

Connect the resistor contact series to the COM X4 and AI 4 interfaces in accordance with the connection diagram.

6.6.11 Wiring the CP5.241-S2 assembly

⚠ WARNING

Risk of burns and damage to the device!
There is a fire hazard if the cables for the 24 V supply to the assemblies are insufficiently dimensioned. This can lead to severe burns and property damage.
› Only use cables with a cross-section of 1.5 mm².

> The G1 (PULS) assembly is to be used exclusively for supplying the assemblies of this product and the cable routing is to be as short as possible (cable length: max. 2.5 m). Otherwise malfunctions may occur.

Connect the G1 (PULS) assembly in accordance with the connection diagram.

6.6.12 Wiring the COM-ETH, COM-ETH-FO and BES assembly

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

6.6.13 Connecting the power supply

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

Suitable equipment includes isolating devices in accordance with IEC 60947-1 and IEC 60947-3 (e.g. circuit breakers). Observe the properties of the relevant circuits (voltage, maximum currents) when selecting the circuit breaker type. In addition, observe the following:
– It must be easy for the operator to access the isolating device
– The isolating device must be labeled for the device and the circuits to be isolated
– The isolating device may not be a part of the power line
– The isolating device may not interrupt the main protective conductor

Miniature circuit breaker

You must fuse the power supply circuit with a miniature circuit breaker. The miniature circuit breaker must have the following properties:
– Rated current: 6...20 A
– Triggering characteristic: B, C, K or Z

Conductor cross-section

For the power supply circuit, use a conductor cross-section suitable for the miniature circuit breaker that you have selected, but at least 1.5 mm² (AWG 15).

Connecting the power supply

To connect the power supply, proceed as follows:
› Connect the power supply in accordance with the supplied connection diagram.

6.7 Performing tests

Please contact Reinhausen GmbH if any aspect of the tests is not clear.

6.7.1 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.

6.7.2 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
MCONTROL® 7 R-A ACDC	L1 (L+), N (L-)	2.0 kV AC	2 s	5 s	> 10 mA
MCONTROL® 7 R-A DC	L+, L-	2.0 kV AC	2 s	5 s	> 10 mA
AI-8340	X2-9 to 8 X2-7 to 6 X2-5 to 4	2.0 kV AC	2 s	5 s	> 4 mA

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

Table 13: Permitted interfaces and test parameters for the dielectric test

7 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.

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).

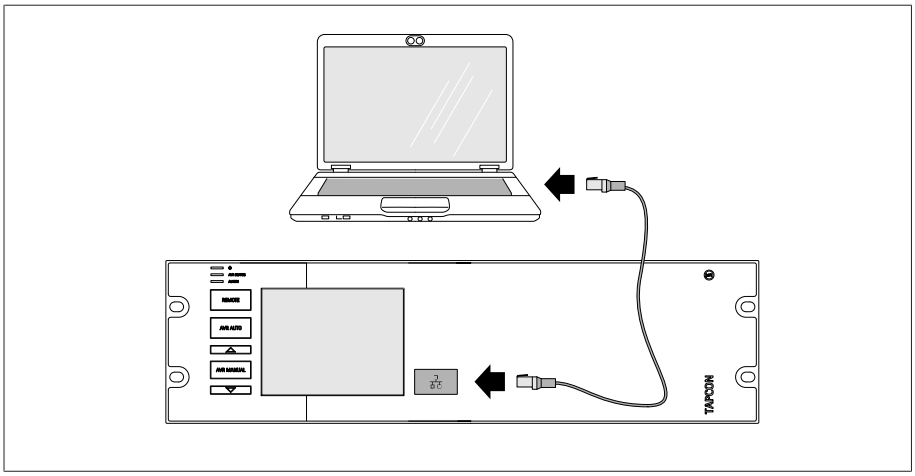


Figure 54: Establishing a connection via the front interface

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 a connection via the rear interface on the CPU assembly

To establish a connection to the visualization via the rear interface, you must connect a PC to interface X2 or X3 of the CPU assembly. The interface does not use a DHCP server, so you must assign a fixed IP address to your PC. To do this, observe the following configuration example:

Interface		Configuration
Standard	CPU-X2	IP address: 192.168.165.1 (not adjustable)
	PC	IP address: 192.168.165.100 Subnet mask: 255.255.255.0
Optional	CPU-X3	IP address: 192.0.1.230 (factory setting)
	PC	IP address: 192.0.1.100 Subnet mask: 255.255.255.0

Table 14: Interface configuration example

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™

To establish a connection, proceed as follows:

1. Connect PC and device via the CPU-X2 or CPU-X3 interface using an Ethernet cable (RJ45 plug).

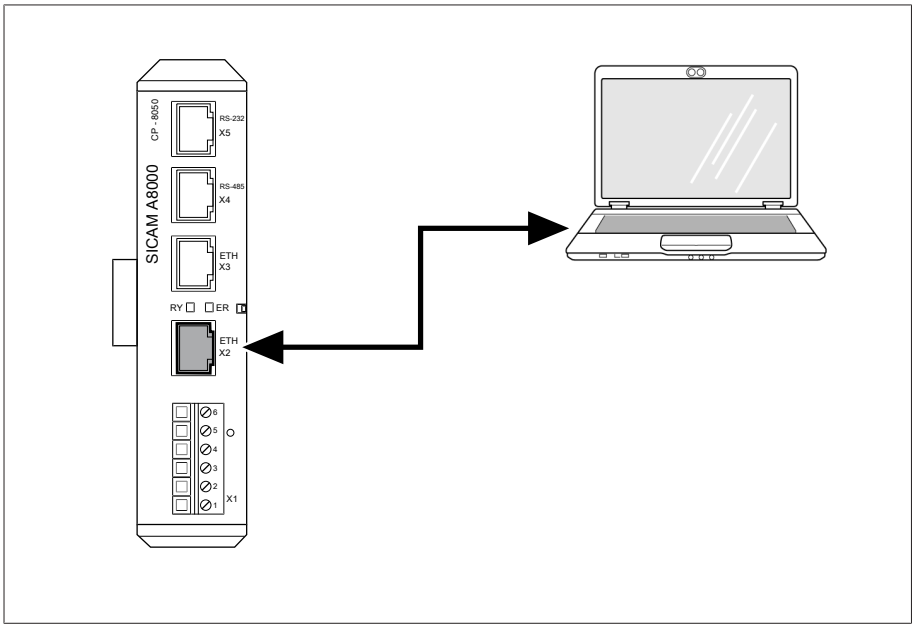


Figure 55: Establishing an example connection via the CPU-X2 interface

2. Assign a unique IP address to the PC in the same subnet as the device (e.g. `192.168.165.100`).
3. Enter the IP address of the visualization (`192.168.165.1`) in the PC's browser.

» 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
Japanese	Slovenian

Table 15: Available display languages

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

Figure 56: 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 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 8.1.5, Page 76].

7.4 Downloading the operating instructions

Download the operating instructions from the device to start device commissioning and parameterization.
› Import/export manager

The document is also available for download in the myReinhausen customer portal, https://portal.reinhausen.com, and on our website, www.reinhausen.com.

7.5 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 8, Page 70] chapter.

> To call up the commissioning wizard, you will need the necessary access rights [▶Section 8.1.17, Page 94].

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**.

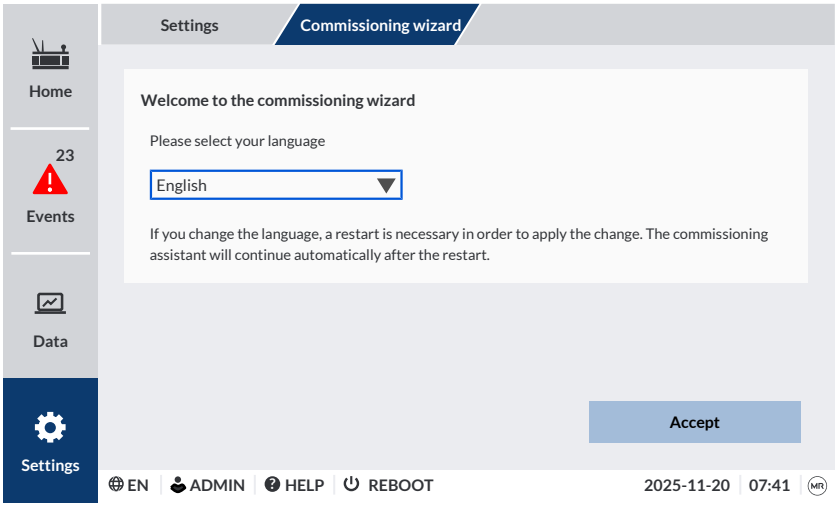


Figure 57: Commissioning wizard

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 7.6, Page 64].

7.6 Function tests

Before switching from manual mode to auto mode, Reinhausen GmbH 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 8, Page 70] section.

7.6.1 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 **Data** > **System** > **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 52].

7.6.2 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 8.4.2.1, Page 137].
7. Set bandwidth depending on step voltage [▶Page 149].
8. Set delay time T1 to 20 seconds [▶Page 150].
9. Set time response T1 to linear [▶Page 150].
10. Press △ to raise the on-load tap-changer 1 step.
11. Press AVR AUTO to select auto mode.
    » If the actual voltage is outside the bandwidth, the device returns the on-load tap-changer to the original operating position after 20 seconds.
12. Press 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.
    » 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 152].
17. Press △ twice to raise the on-load tap-changer 2 steps.
18. Press AVR AUTO to select auto mode.
    » If the actual voltage is outside the bandwidth, after 20 seconds the device lowers the on-load tap-changer one step and after another 10 seconds another step.

19. Press AVR MANUAL to select manual mode.
20. Set delay time T1 [▶Page 150] and delay time T2 [▶Page 152] 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.

7.6.3 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 150].
- The "Activate parallel operation" [▶Page 159] parameter is set to **ON**
- The desired Parallel operation method is selected.
- A different CAN bus address [▶Page 159] (≠ 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.

7.6.3.1 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 8.3.9, Page 133] parameter.

Consult the section Circulating reactive current minimization for more information.

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

1. Select the "Circulating reactive current" parallel operation method.
2. Set circulating reactive current sensitivity to a value of 0%.
3. If necessary, activate the Retrofit TAPCON® 2xx function [▶Section 8.3.9, Page 133].
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 8.4.2.1, Page 137].

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.

> 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.

7.6.3.2 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%.

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.

> 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.

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 10, Page 187].

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

7.6.3.3 Checking tap synchronization method

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

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 a 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 the 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®.
2. Assign the follower function to the other TAPCON® units.
3. Compare the tap position indicators of the master and follower. 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.

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 expiration of the set delay time for parallel operation errors [▶Page 160], 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 expiration of the set delay time for parallel operation errors, there is a tap difference to follower on the master.
   » After expiration of the set delay time for parallel operation errors, there is a tap difference to master on the follower.
10. Press AVR AUTO on the follower to select auto mode.
    » There is no response. All devices remain blocked.

11. Press AVR MANUAL 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.

8 Operation

8.1 System

8.1.1 General

You can set general parameters in this menu item.

8.1.1.1 Setting general device functions

You can set general device functions with the following parameters.

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

Commissioning wizard

You can use this parameter to set whether the commissioning wizard [▶Section 7.5, Page 64] 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 16: Selecting remote behavior

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).

Device designation

You can use this parameter to set the device designation by which the device is identified. Depending on the device configuration, the device designation is used for the following services:

- Syslog
- SNMP

Login text

You can use this parameter to enter a user-defined text that will be displayed in the device's registration mask. If you enter the value "-", the device will display the standard text (**Please note that every interaction will be logged!**). If you enter a space, the device will not display any text.

8.1.1.2 Set up automatic logout

You can change the settings so that the device of a logged-in user automatically logs the user out after a certain period of inactivity. Note the following information for this:

- Depending on the browser's set energy saving options, the user can also be automatically logged out if the function is deactivated.
- These settings apply to all users. If you have activated the Auto login function for a user, then this user will not be automatically logged out.

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

Auto logout

You can use this parameter to activate th 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.

8.1.1.3 Activating/deactivating service user access

The device is equipped with user access for the 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.

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

You must be assigned the administrator role to set parameters.

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.

8.1.2 Configuring the network (ISM® Gen.2)

The device network configuration is split into 3 areas:
- Network setting: IP address setting, subnet mask setting, etc.
- Network assignment: Assignment of one or more Ethernet interfaces to a network
- Network release: Release of network services such as web visualization and SCADA

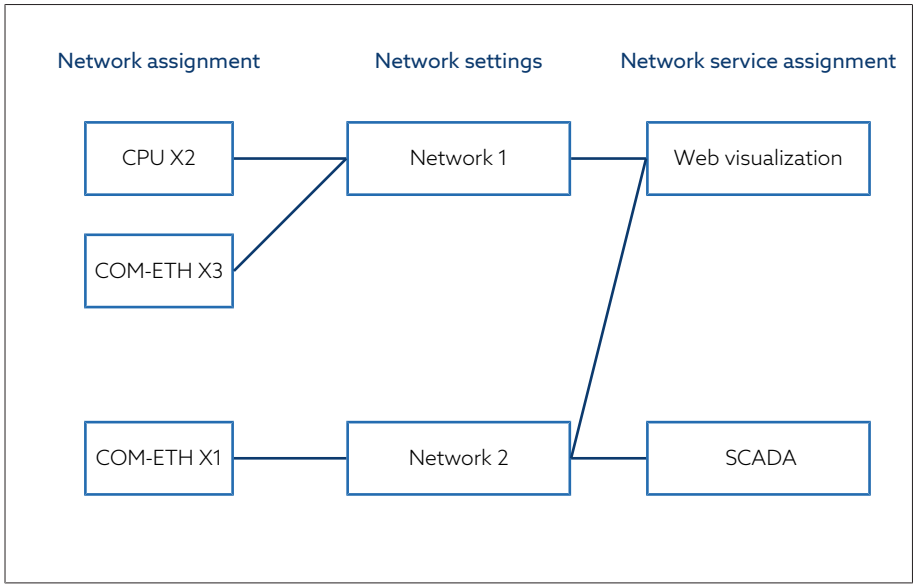


Figure 58: Configuration example: The CPU X2 and COM-ETH X3 interfaces are assigned to network 1. The web visualization service is available in network 1. The COM-ETH X1 interface is linked to network 2. The web visualization service and a SCADA service are available in network 2 (e.g., IEC 61850).

Ensure that you **do not** bundle the network interfaces (so-called bonding or NIC teaming). NIC teaming may disrupt the network connection.

8.1.2.1 Configure network

You can configure the network settings in this menu. Depending on the device configuration, there are a different number of networks available.

Network 1 is a service interface. A connection to the web-based visualization is also possible in network 1.

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

Network X IP address

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

Assign the IP addresses for each of the individual networks in different subnets. Otherwise you will not be able to establish a connection.

Network X subnet mask

You can use this parameter to set the subnet mask of the network.

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.

Network X gateway address

You can use this parameter to set the IP address of the gateway of the network.

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

8.1.2.2 Assign network interfaces

This menu is used to assign the Ethernet interfaces of the device to a network.
Note the following information:

- If you change the assignment of the network interfaces, the MAC address of the network may change.
- Deactivate all network interfaces that you do not need. This may relieve the strain on the network bandwidth.
- If you are using GOOSE: Configure the network via which you want to send GOOSE messages to use just a single network interface. This may relieve the strain on the network bandwidth.

› Go to **Settings** > **Parameters** > **System** > **Network interface assignment**.

CPU X2 network assignment

You can use this parameter to set which network is to be available via the CPU X2 interface.

CPU X3 network assignment

You can use this parameter to set which network is to be available via the CPU X3 interface.

COM-ETH X1 network assignment

You can use this parameter to set which network is to be available via the COM-ETH X1 interface.

COM-ETH X2 network assignment

You can use this parameter to set which network is to be available via the COM-ETH X2 interface.

COM-ETH X3 network assignment

You can use this parameter to set which network is to be available via the COM-ETH X3 interface.

COM-ETH X4 network assignment

You can use this parameter to set which network is to be available via the COM-ETH X4 interface.

COM-ETH X5 network assignment

You can use this parameter to set which network is to be available via the COM-ETH X5 interface.

8.1.2.3 Assign network services

This menu is used to assign the available network services of the device to the various networks.

› Go to **Settings** > **Parameters** > **System** > **Network service assignment**.

Web visualization network release

You can use this parameter to set via which network the device's web visualization is to be available.

> Regardless of your configuration, the web visualization service is always available in network 1 as well.

SCADA 1 network release

You can use this parameter to set via which network the connection to the control system (SCADA 1) should be made available to.

SCADA 2 network release (optional)

You can use this parameter to set via which network the connection to the control system (SCADA 2) should be made available to.

GOOSE 1 network release (optional)

You can use this parameter to set via which network the connection to the GOOSE 1 network is to be available.

> If your device is equipped with IEC 61850 and GOOSE, both functions are always released on the same network. A change to the parameters **SCADA 1 network release** and **GOOSE 1 network release** always affects both functions in the same way.

GOOSE 2 network release (optional)

You can use this parameter to set via which network the connection to the GOOSE 2 network is to be available.

SNMP network release

You can use this parameter to set via which network the SNMP [▶Section 8.1.7, Page 78] service is to be available.

PTP network release

You can use this parameter to set via which network the PTP service is to be available.

8.1.3 Web visualization

In this menu you can make settings for the web visualization.

› Go to **Settings** > **Parameters** > **System** > **Web 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
>= 1.2[9]	– 1.2 – 1.3
>= 1.3[9]	– 1.3

Table 17: TLS version

8.1.4 MQTT

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

> The device is prepared for communication with the TESSA® APM by default.

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.

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

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.

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

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. Import a certificate for the SSL/TLS encryption.

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

8.1.5 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.

ISM® Gen.2: You cannot operate NTP, SNTP and PTP at the same time. Select NTP, SNTP or PTP.

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 18: Date and time format

› 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.

The maximum waiting time for a response from time server 1 is 1 second. If no response is received from time server 1 within the waiting period, time server 2 is used automatically. The maximum waiting time for a response from time server 2 is 1 second.

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.

Automatic daylight saving / standard time

You can use this parameter to activate the automatic switchover between daylight saving time and standard time. Depending on the time zone (region) set, the device switches automatically between daylight saving time and standard time on the specified days.

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 19: 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).

8.1.6 Screensaver

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

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

The screensaver waiting time cannot be shorter than the waiting time for dimming.

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

Screensaver waiting time

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

Reinhausen GmbH recommends that you set a waiting time of 15 minutes.

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.

8.1.7 Device management via the network (SNMP ISM® Gen. 2)

The device supports central device management via a network via SNMP. You can use parameters to configure the agent (SNMP server).

The device supports the following SNMP versions:
- SNMPv3
- SNMPv2c

You can only call up the device data as read-only via SNMP. Certain changes on the device will be transmitted as traps:
- System restart
- Performing an update
- Changes to the network settings
- Incorrect SNMP authentication data (standard AuthTrap)

The following data is available as OID:

OID		Name	Description
1		sysInfo	Nodes for system information
	1	sysName	<Host name>
	2	firmwareVersion	Firmware version
	3	serialNumber	Serial number of the device
	4	sysDesc	Device description
	5	sysLocation	Device location
	6	sysStatus	Device status (red, yellow, green)
400		notifications	Nodes for traps
	1	nsNotifyUpdate	An update has been performed
	2	nsNotifyNetworkChange	The network settings have been changed

The device makes a configuration file (MIB file) available. The SNMP agent supports MIB-II objects in accordance with RFC 1213. For more information, refer to the section Exporting data [▶Section 8.1.20.1, Page 99].

8.1.7.1 Configuring SNMP
You can configure the device SNMP function with the following parameters.

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

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

Activate SNMP
You can use this parameter to activate or deactivate the device SNMP function.

SNMP version
You can use this parameter to select the SNMP version. You can select the following options:
- SNMPV2c
- SNMPV3

Community string
You can use this parameter to set the community string that is to be used for access to the device data via SNMPV2c. The community string will also be used for traps.

User name
You can use this parameter to set the user name that is to be used for access to the device data via SNMPV3. The user name will also be used for traps.

Auth. algorithm
You can use this parameter to select the authentication algorithm that is to be used for access to the device data via SNMPV3. The authentication algorithm will also be used for traps. You can select the following options:
- Inactive
- SHA
- SHA-256

Authpass
You can use this parameter to set the password that is to be used for authenticating access to the device data via SNMPV3. The password will also be used for traps.

Priv. algorithm
You can use this parameter to select the encryption algorithm that is to be used for access to the device data via SNMPV3. The encryption algorithm will also be used for traps. You can select the following options:
- Inactive
- DES
- AES-128

Privpass
You can use this parameter to set the password that is to be used for encrypting access to the device data via SNMPV3. The password will also be used for traps.

Activate SNMP traps
You can use this parameter to activate the device SNMP traps function.

Trap server
You can use this parameter to set the IP address of the server for receipt of the SNMP traps.

Device location

You can use this parameter to specify the device location. You can query this information via SNMP.

Device designation

You can use this parameter to set the device designation by which the device is identified. Depending on the device configuration, the device designation is used for the following services:

- Syslog
- SNMP

8.1.8 Configuring syslog

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

› 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 20: Syslog standard

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.

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).

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 21: Severity levels

8.1.9 Name plate

You can enter the data of the nameplates from the transformer, on-load tap-changer and motor-drive unit and display it later.

> When operating devices with the MSENSE® VAM option, you must enter the correct serial number for every on-load tap-changer. This entry is necessary to ensure the correct assignment of the vibro-acoustic records in the external database.

8.1.9.1 Enter the name plate data

You can enter the name plate data for the transformer, the on-load tap-changer and the motor-drive unit.

› Go to **Settings** > **Parameter** > **System** > **Name plate**.

8.1.9.2 Displaying the name plate

You can display the nameplate data for the transformer, on-load tap-changer, and motor-drive unit.

› Go to **Data** > **System** > **Name plate** > **Transformer/On-load tap-changer/ Control cabinet/drive**.

8.1.10 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.

> 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 **Data** > **Recorder** > **Signals**.

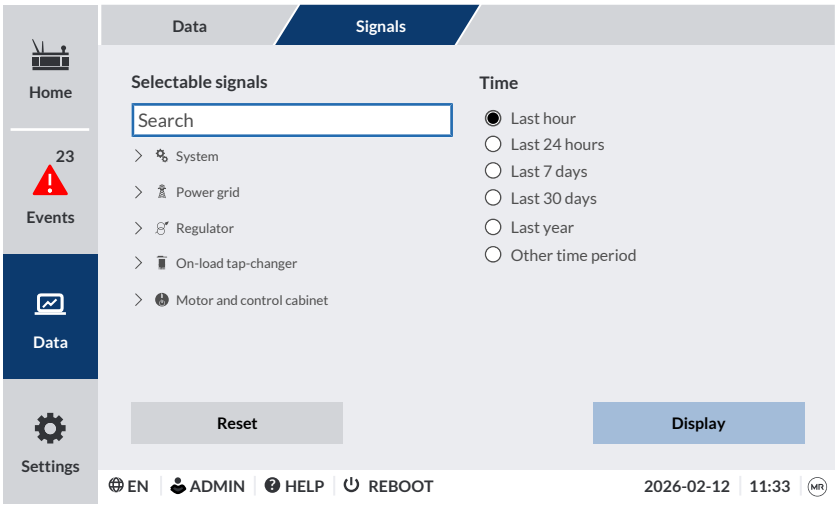


Figure 59: Recorder

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).

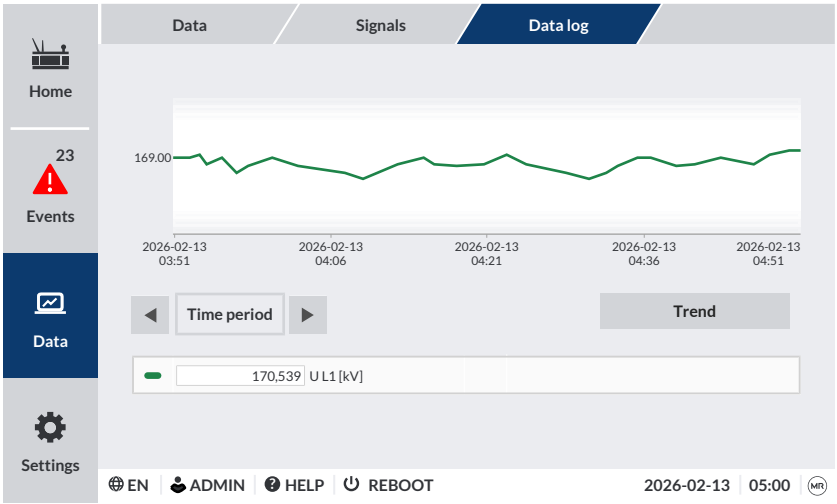


Figure 60: Data log

> 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.

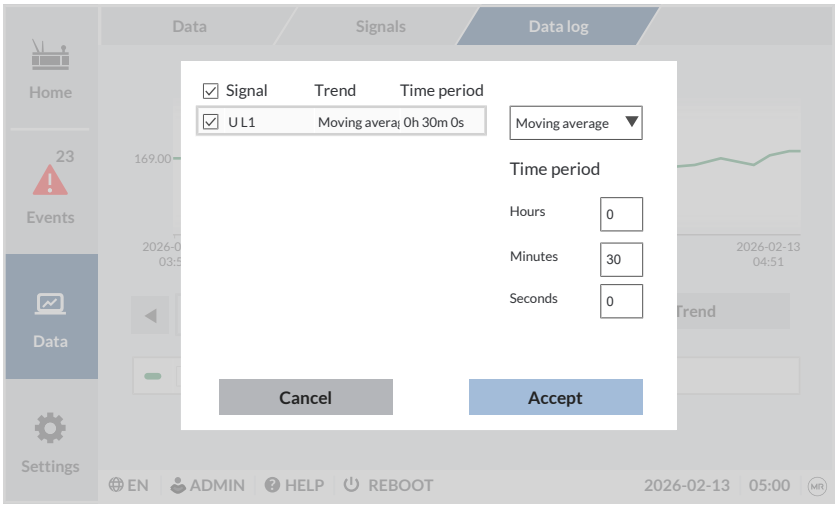


Figure 61: Creating trend curves

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.

8.1.11 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[10]	General purpose input 1
Digital input 2[10]	General purpose input 2
...	...
Digital input 42[10]	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 22: Linking of digital inputs and control system commands with event messages

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

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.

8.1.11.1 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.

> 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.

✓ The desired event number is known [▶Section 8.1.13, Page 87].
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.

Event counter 1...10
If the assigned event is active, the device increases the event counter [▶Section 8.1.13.4, Page 90] by 1.

8.1.11.2 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.

✓ The desired event number is known [▶Section 8.1.13, Page 87].
1. Go to **Settings** > **Parameter** > **System** > **Link outputs**.
2. Select the desired parameter.
3. Enter the desired event number.
4. Press the **Accept** button to save the modified parameter.

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

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

8.1.11.3 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.

✓ 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.

8.1.12 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.

> 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.

8.1.12.1 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.
› 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.

8.1.12.1.1 Port external visualization

You can use this parameter to select the port that you would like to connect to external visualization 1...5. If the setting is **0**, the browser standard for the selected protocol will be used.

8.1.12.2 Calling up an external visualization

To call up an external visualization, proceed as follows:

1. Go to **Data** > **System** > **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.

8.1.13 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.

8.1.13.1 Displaying and acknowledging events

To display the events currently active, proceed as follows:

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

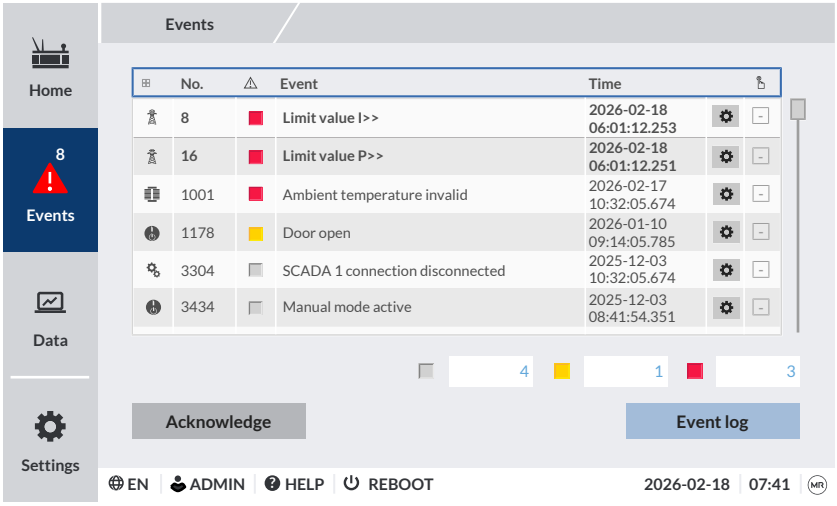


Figure 62: Overview of events currently active

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.

8.1.13.2 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	– Error (red) – Warning (yellow) – Info (gray) This setting affects the color of the event symbol in the primary navigation.
Report	If you activate this option, the event is shown on the display. With the appropriate configuration, the event can be issued via an output (*O: LED yellow* or *O: LED red*) 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 23: Properties of events

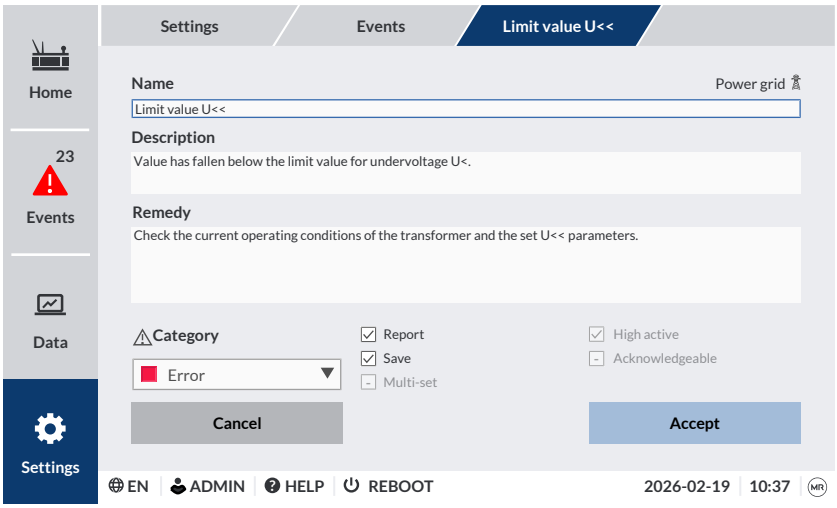


Figure 63: Configuring events

To configure an event, proceed as follows:

1. Go to **Settings** > **Events**.
2. Search for the desired event in the list and select the ⚙ button.
3. Select the desired options.
4. Press the **Accept** button to save the change.

8.1.13.3 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**.

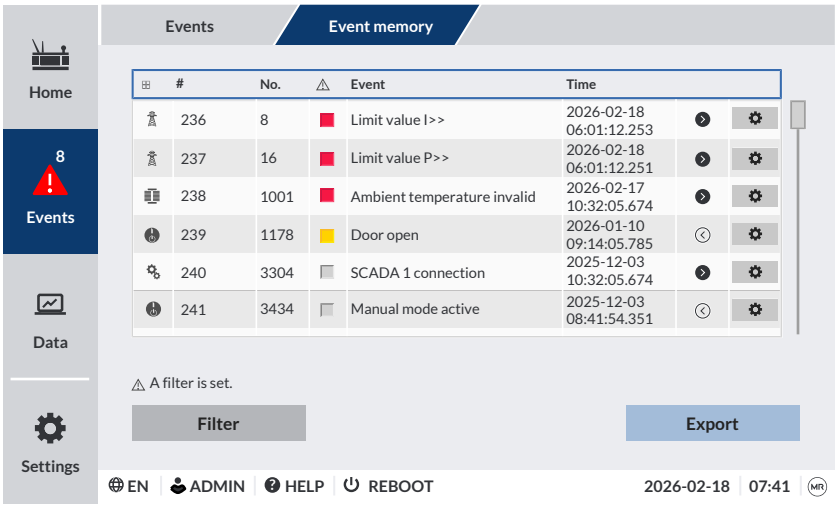


Figure 64: Event log

2. Set the desired **Filter** and then select the **Search** button to display the desired events.

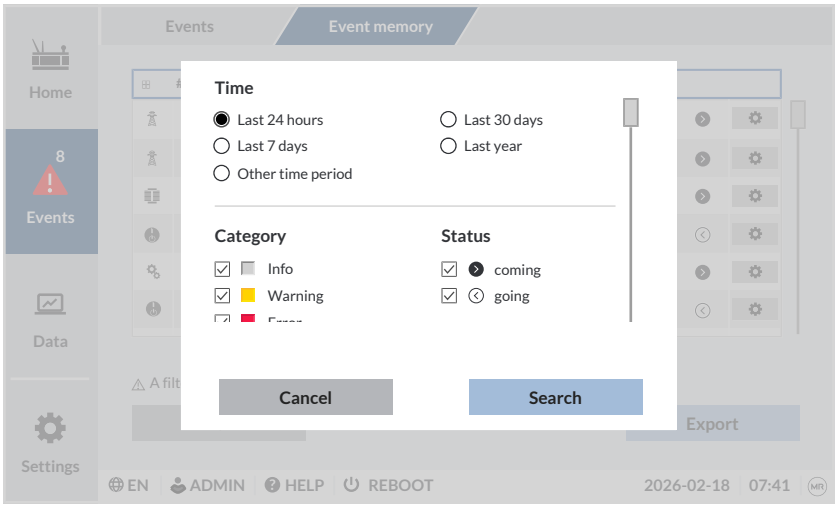


Figure 65: Setting the filter

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.

› Press the **Export** button.

» The data is exported.

8.1.13.4 Event counter

The device is equipped with 10 event counters. You can assign the event counters to an event [▶Section 8.1.11.1, Page 84]. If the assigned event is active, the device increases the event counter by 1. The device transmits the value of the event counter via the control system.

You can set the value of the event counter using the following parameters.

› Go to **Settings** > **Parameters** > **System** > **Event counter**.

8.1.13.4.1 Event counter 1...10

You can use these parameters to set the value of the event counter.

8.1.14 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.

8.1.14.1 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. Press the **Export** button to start the export.

8.1.14.2 DIO configuration

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.

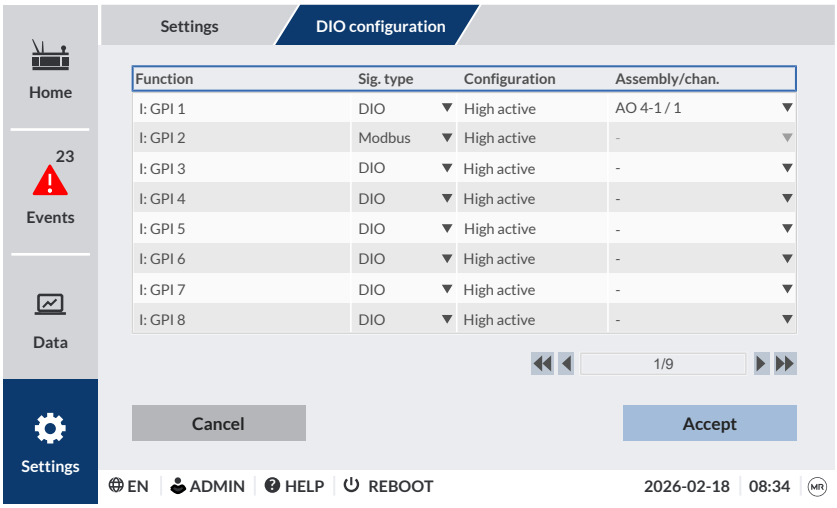


Figure 66: Configuring digital inputs and outputs

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

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 of the generic inputs and outputs (GPI, GPO).

Signal type

Select the signal type:

- Digital: Digital input
- GOOSE (available as an option with ISM® Gen. 2)

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.

8.1.15 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.

8.1.15.1 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. Press the **Export** button to start the export.

8.1.15.2 AIO configuration

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

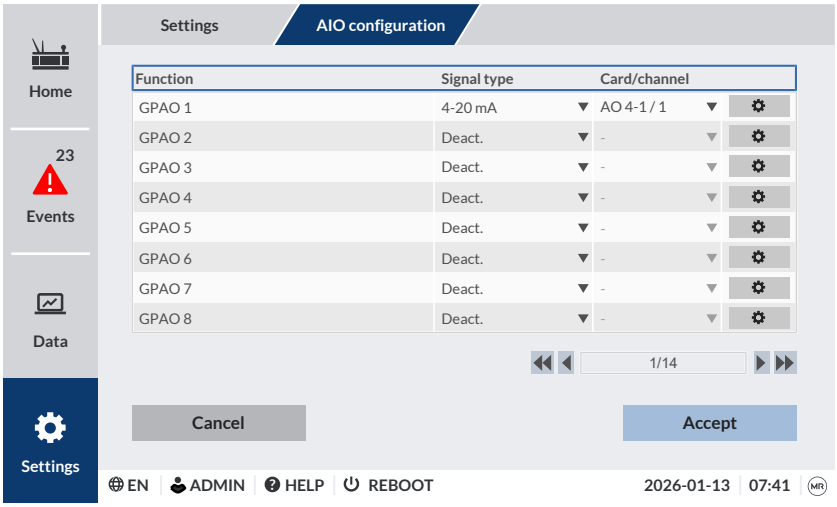


Figure 67: Configuring analog inputs/outputs

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

1. Go to **Settings** > **AIO configuration**.
2. Configure the properties such as **Function**, **Sign. type** and **Card/channel**.
3. Select the ⚙ button to configure the values as desired.

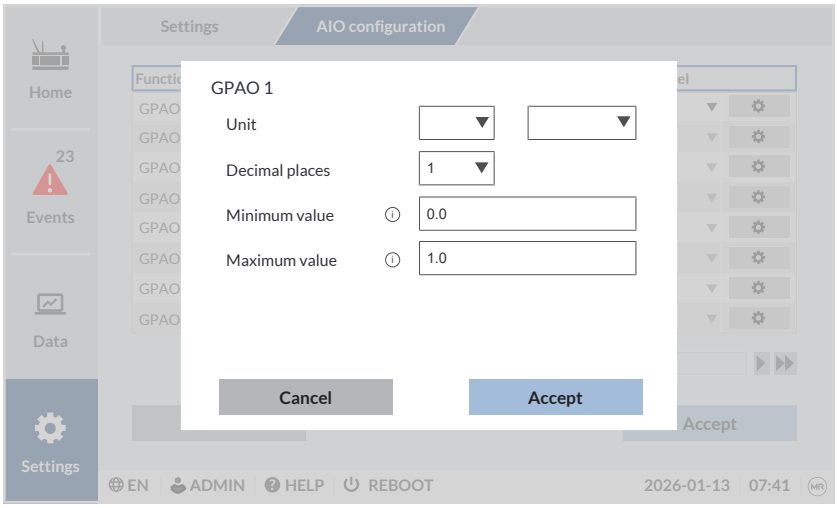


Figure 68: Entering values

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

Function

Function of the analog input (I: ...) or the analog output (O: ...). You can adjust the designation of the generic inputs and outputs (GPAI, GPAO).

Signal type

Select the signal type of the analog sensor or deactivate the analog input.

- 0...20 mA
- 4...20 mA
- 0...10 V
- PT100-2/3/4, PT1000-2/3/4
- GOOSE (available as an option with ISM® Gen. 2)

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. You can select a prefix and the SI unit. 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.

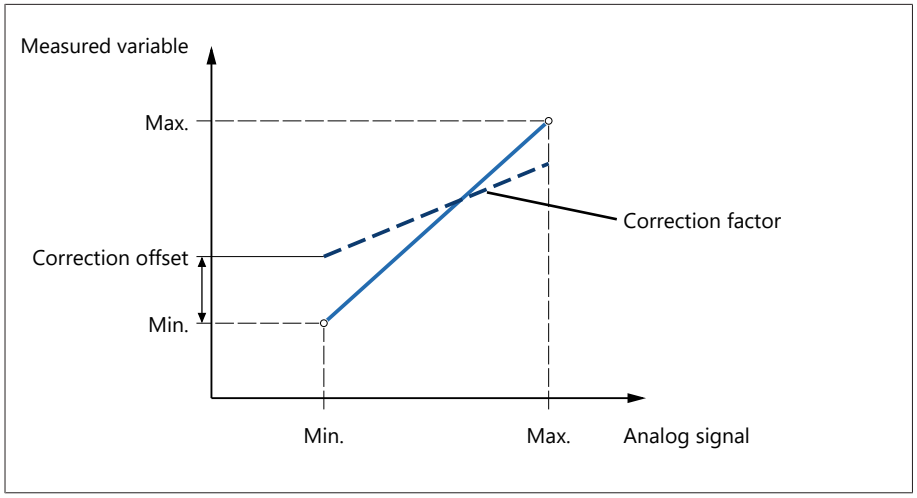


Figure 69: Analog signal with linear characteristic curve, correction factor <1 and correction offset

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.

8.1.16 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.

- Operating position: Numerical value (cannot be set)
- Tap position: Tap position designation
- SCADA: Numerical designation for messaging to the control system

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.

8.1.17 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.

8.1.17.1 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.

> 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. – Display all parameters – Display all events
Diagnostics	User who can view data and log data of relevance to operation. – 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. – Display all parameters – Display and acknowledge all events
Parameter configurator	User who can view and modify data of relevance to operation. – Display and modify all parameters – Import and export parameters – Display, modify, and acknowledge all events
Administrator	User who can view and modify all data. – Read all parameters – Display, modify, and acknowledge all events

Table 24: 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	-	-	-	+	+
Actuation of the RAISE, LOWER, REMOTE, AVR AUTO, and AVR MANUAL keys	-	-	+	+	+
Setting topology	-	-	-	+	+

Function	Data display	Diagnostics	Operator	Parameter configurator	Administrator
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 25: Access rights permanently linked to the roles

8.1.17.2 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.

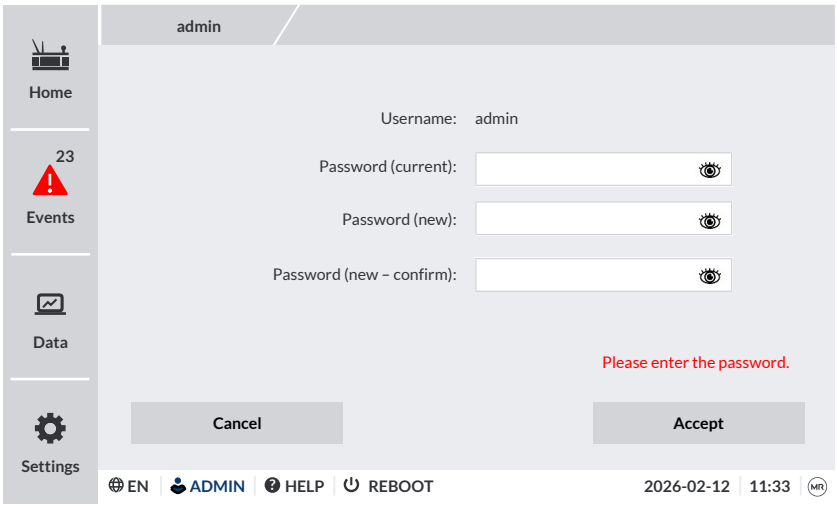


Figure 70: Changing the password

2. Enter the old password.
3. Enter the new **Password** twice.
4. Press the **Accept** button to save the changed password.

8.1.17.3 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.

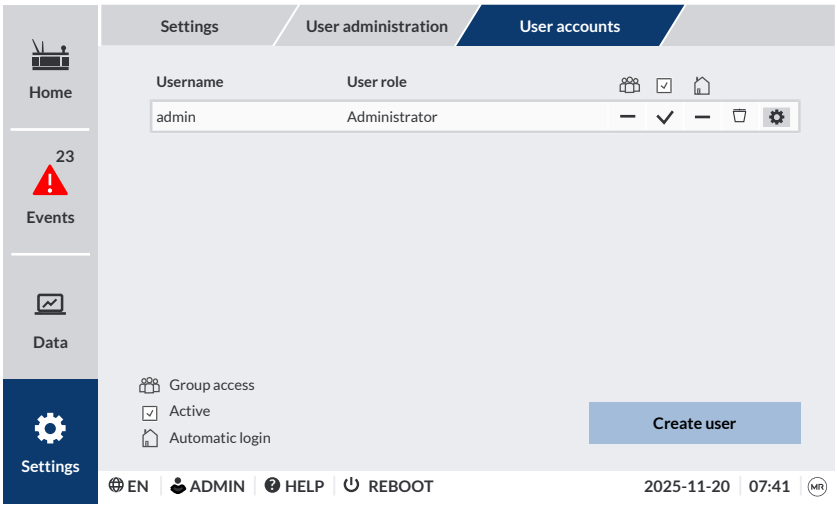


Figure 71: Overview of users created

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

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.

8.1.17.4 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:

System components	Options
Events	: The event can be shown.
	: The event can be changed.
	: The event can be acknowledged.
Parameter	: The parameter value can be changed.

Table 26: Possible access rights

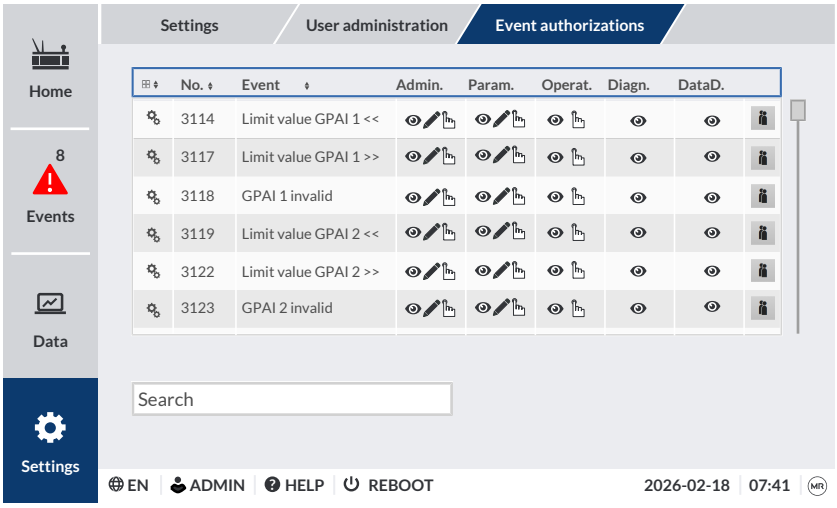


Figure 72: Setting access rights for an event

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

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.

8.1.18 Hardware

You can display information about the device hardware under Hardware. You will find information about the signal level of the individual channels for the assemblies.

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

8.1.18.1 Status of the DI and DO assemblies

You can display the status of the digital inputs and digital outputs of the DI and DO assemblies.

– 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

8.1.18.2 Status of the AI and AO assemblies

You can display the status of the analog inputs and analog outputs of the AI and AO assemblies.

- Raw value: Sensor measured value. If the value is invalid, the display turns red, and the displayed value might not match the raw value that was recorded.
- Function value: Calculated function value in accordance with the configuration; an invalid value will be displayed as "—". If the value is invalid, check the pending events.

8.1.18.3 Status of the U 3 and I 3 assemblies

You can display the status of the U 3 and I 3 modules for voltage and current measurement respectively.

8.1.18.4 Status of the MCONTROL® 7 R-A grid measurement

You can display the status of the grid measurement when measuring the voltage and current via the MCONTROL® 7 R-A.

8.1.19 About the device

You can display the version status of the hardware and software components of the device under About the device.

- **Serial number**
- **Application** (ISM®)
- **Hardware** (ISM® Gen.1 or ISM® Gen.2)
- **Software version display** (MCONTROL® 7 R-A)

› Go to **Data** > **System** > **About the device**.

8.1.20 Import/export manager

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

8.1.20.1 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 and the measured value log records will also be exported. If you select the "with TPLE" option, the customer program is exported.
Settings (.rhi / .rhp)	Device settings: – Parameters (settings, access rights) – Events (category, behavior, text, access rights) – User configuration If available, the settings of the following functions are also exported: – Topology – AIO configuration – DIO configuration – Tap position table – Sensor bus
MODBUS (.rhp) DNP3 (.rhp) IEC 60870-5-101 (.rhp) IEC 60870-5-103 (.rhp) IEC 60870-5-104 (.rhp)	Data point configuration of the respective control system.

Table 27: 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 28: 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.
SNMP MIBs (.zip)	Management Information Base for managing the device via SNMP

Table 29: Exporting data: System group

Records

Option	Description
Event memory (.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.

Option	Description
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 30: Exporting data: Records group

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.

8.1.20.2 Importing data

When importing the system image to update the system software on ISM® Gen.2 devices, please note the following:

- The device reports on the update progress via the syslog.
- If a part of the update process fails, try to reimport the system image. If the update process fails again, contact Reinhausen GmbH.

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: – Parameters (settings, access rights) – Events (category, behavior, text, access rights) – User configuration If available, you can also import the settings of the following functions: – Topology – AIO configuration – DIO configuration – Tap position table – Sensor bus – Certificates
Customer program	Customer program import (TPLE).
SSL certificate	Import of an SSL certificate with associated key: – Server certificate (.crt + .pem) – Client certificate (.crt + .pem) – Client CA (.crt) For the import, you will have to compress the certificate (*.crt) and key (*.pem) in a zip file. You can import certificates with the following key authentication: – RSA with 1,024 bits – ECDSA with 256 bits ("secp256r1" or "prime256v1" curve).

Option	Description
Settings	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: – Parameters (settings, access rights) – Events (category, behavior, text, access rights) – User configuration If available, you can also import the settings of the following functions: – 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 31: 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.

To import data, proceed as follows:

1. Go to **Settings** > **Import**.
2. Select **Browse**, select the file to be imported, and select **Start upload**.
   » The file is checked.
3. Optional: Select the desired options for the import.
4. 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.

8.1.21 Simulation mode

8.1.21.1 Activating simulation mode

NOTICE

Damage to the transformer

Depending on the device configuration, simulating signals or measured values may lead to unintended on-load tap-change operations or to the tripping of circuit breakers.

› Only use the simulation mode when the transformer is switched off.

Note the following information:

- To protect the product against damage, not all signals are available in simulation mode.
- You can only activate simulation mode if you have the administrator user role and the device is in the LOCAL operating mode.
- You can only activate simulation mode from one client instance at a time. The button will be blocked for all other client instances.
- In the event of inactivity, simulation mode will be ended automatically after a configurable time [▶Page 104].

To start the simulation mode, proceed as follows:

1. Go to **Settings** > **Simulation mode**.
2. Press the **Start simulations** button and confirm the subsequent statements.

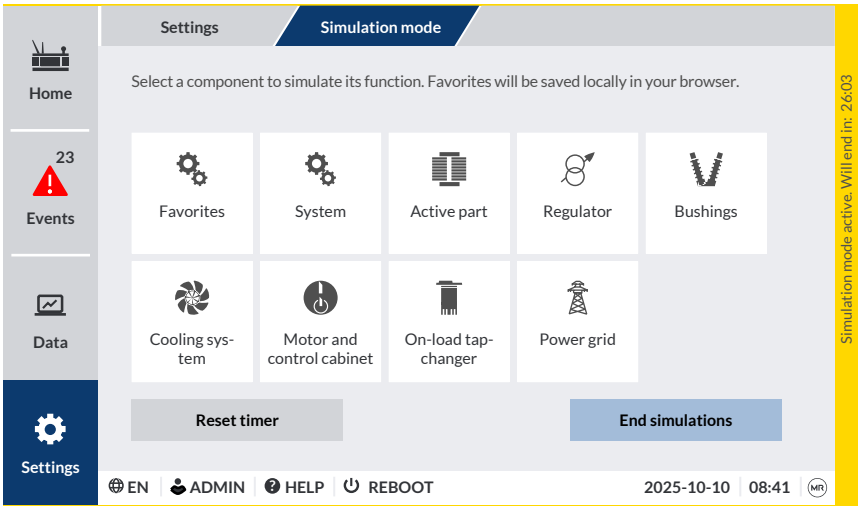


Figure 73: Simulation mode

When the simulation mode is active, you can simulate the signals and measured values for the various sub-functions[11] of the device. To do so, select the desired tile for the device's sub-function. The available signals and measured values will be shown in a table. The following operating controls are available:

- Signal filter for filtering the display
  - Inputs
  - Outputs
  - Digital
  - Analog
- Sorting: you can sort the rows of the table.
- Search by signal name: You can search for the name of the signal/measured value.
- On/off switch: You can use this switch to activate the simulation for the signal/measured value. The device only uses the simulated value when the switch is activated.

11 The number of available sub-functions depends on the order-specific device configuration.

- Simulation value or status: Display of the set value or status for the simulation.
- Add to favorites: You can add the measured value to the Favorites tile.

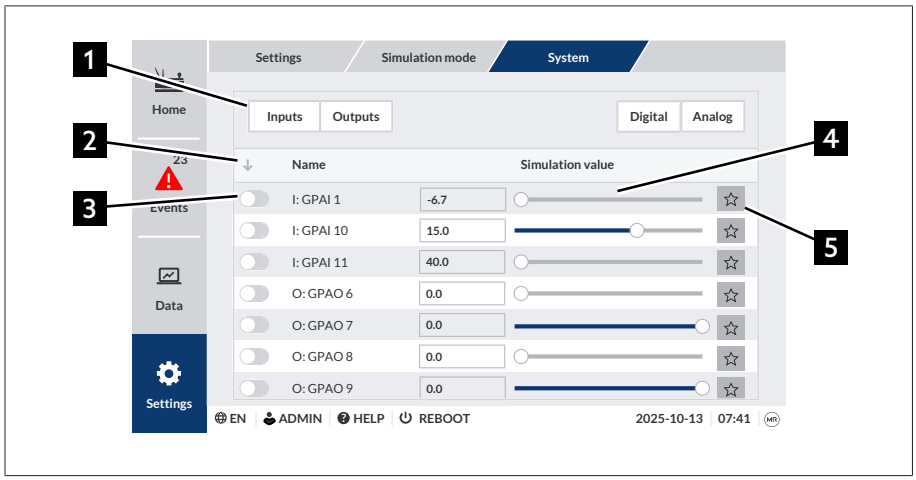


Figure 74: Simulation mode

1	Filter options	2	Sorting
3	On/off switch	4	Simulation value
5	Favorites		

8.1.21.2 Configuring simulation mode

You can use the following parameters to configure simulation mode.

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

Timer simulation mode end

You can use this parameter to set the time after which simulation mode is to end automatically after a period of inactivity.

Simulation mode end warning

You can use this parameter to set the time after which the device is to display a message stating that simulation mode will end automatically soon.

8.2 SCADA

The following section describes how you can configure the device for connection to a control system (SCADA). You can download the data points with the help of the export manager.

> If your device has the optional function "2nd control system", you must then set the parameters for configuring the control system separately for both control systems (SCADA 1 and SCADA 2).

> If you want to block the command direction from both SCADA systems, you must set the parameter **Remote behavior**. You can only set this parameter if you are using a second control system.

8.2.1 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 8.1.2, Page 72].

› Go to **Settings** > **Parameters** > **SCADA** > **IEC 61850 (SCADA 1)**.

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.

Device ID

You can use this parameter to assign a device ID to the device so that it can be identified in the IEC 61850 network.

Access point

You can use this parameter to assign a name to the access point in the IEC 61850 network.

Edition

You can use this parameter to switch between the editions of the IEC 61850 control system protocol.

8.2.1.1 Downloading an ICD file

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

8.2.2 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.

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

Transmission procedure

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

- Unbalanced transmission
- Balanced transmission

Octet number of link address
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.

Octet number of ASDU address
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.

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

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

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 32: ASDU sequence optimization

Reference time

You can use this parameter to set which time is to be transmitted by the control system. The device uses this information for time synchronization [▶Section 8.1.5, Page 76]. You can select the following options:

Option	Description
Local	The control system transmits the local time. Note: If you use this option, you must deactivate the automatic changeover between daylight saving time and standard time [▶Page 77]. Otherwise the device will use an incorrect time.
UTC	The control system transmits the time as UTC. The device calculates the local time from UTC and the set time zone [▶Page 77].

Table 33: Reference time

8.2.3 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.

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

ASDU address

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

Reference time

You can use this parameter to set which time is to be transmitted by the control system. The device uses this information for time synchronization [▶Section 8.1.5, Page 76]. You can select the following options:

Option	Description
Local	The control system transmits the local time. Note: If you use this option, you must deactivate the automatic changeover between daylight saving time and standard time [▶Page 77]. Otherwise the device will use an incorrect time.
UTC	The control system transmits the time as UTC. The device calculates the local time from UTC and the set time zone [▶Page 77].

Table 34: Reference time

8.2.4 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.

› Go to **Settings** > **Parameters** > **SCADA** > **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 35: ASDU sequence optimization

Reference time

You can use this parameter to set which time is to be transmitted by the control system. The device uses this information for time synchronization [▶Section 8.1.5, Page 76]. You can select the following options:

Option	Description
Local	The control system transmits the local time. Note: If you use this option, you must deactivate the automatic changeover between daylight saving time and standard time [▶Page 77]. Otherwise the device will use an incorrect time.
UTC	The control system transmits the time as UTC. The device calculates the local time from UTC and the set time zone [▶Page 77].

Table 36: Reference time

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.

> 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.

8.2.5 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 if you want to use Modbus TCP.

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

Modbus type

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

- RTU
- TCP
- ASCII

Modbus address

You can use this parameter to set the Modbus address.

TCP port

You can use this parameter to set the TCP port.

Maximum TCP connections

You can use this parameter to set the maximum number of TCP connections.

8.2.6 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 if you want to use the DNP3 via TCP.

› Go to **Settings** > **Parameters** > **SCADA** > **DNP3**.

8.2.6.1 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.

Device address

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

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.

Repeat unsolicited messages indefinitely

You can use this parameter to set the device to send an indefinite number of unsolicited messages until it receives a response from the DNP3 master.

Timeout

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

User ID code

You can use this parameter to set the user ID code.

Reference time

You can use this parameter to set which time is to be transmitted by the control system. The device uses this information for time synchronization [▶Section 8.1.5, Page 76]. You can select the following options:

Option	Description
Local	The control system transmits the local time. Note: If you use this option, you must deactivate the automatic changeover between daylight saving time and standard time [▶Page 77]. Otherwise the device will use an incorrect time.
UTC	The control system transmits the time as UTC. The device calculates the local time from UTC and the set time zone [▶Page 77].

Table 37: Reference time

8.2.7 Configuring GOOSE (optional)

You can use the optional GOOSE function to send GOOSE messages (GOOSE publisher) or receive GOOSE messages (GOOSE subscriber) via the IEC 61850 control system protocol with the device.

The configuration of GOOSE is described in the following chapters.

8.2.7.1 Configuring GOOSE publisher

If you configure the device as a GOOSE publisher, you can send all data points which the device provides via MMS as GOOSE messages. To do this, you have to configure the data points using DataSets in an SCD/CID file.

SCD/CID file requirements

- The GOOSE control block (GSEControl) and the associated DataSet can only be created in LLN0.
- GSE elements for the configuration of the GOOSE message can be created under ConnectedAP.
- The maximum number of data points per GOOSE message is defined in Private Element type="MR-MAX-GOOSE-PUBLISH-FCDA". You cannot adjust this value.
- The maximum number of usable GSEControl elements is defined in TEMPLATE.icd under Services GOOSE. You cannot adjust this value. For 2 GOOSE instances, the maximum number applies to both instances together.
- The shortest repeat time is defined in Private Element type="MR-MINTIME-GOOSE". You cannot adjust this value.

Example:

```
<DataSet name="DataSet_CbStates">
    <FCDA ldInst="ISM" lnClass="GGIO" lnInst="1" doName="Ind1" fc="ST"/>
    <FCDA ldInst="ISM" lnClass="GGIO" lnInst="1" doName="Ind2" fc="ST"/>
    <FCDA ldInst="ISM" lnClass="GGIO" lnInst="1" doName="Ind3" fc="ST"/>
    <FCDA ldInst="ISM" lnClass="GGIO" lnInst="1" doName="Ind4" fc="ST"/>
</DataSet>
```

```
<GSE ldInst="ISM" cbName="CbStates">
    <Address>
        <P type="MAC-Address">01-0C-CD-01-00-01</P>
        <P type="APPID" xsi:type="tP_APPID">0021</P>
        <P type="VLAN-PRIORITY">7</P>
        <P type="VLAN-ID">FAB</P>
    </Address>
    <MinTime unit="s" multiplier="m">100</MinTime>
    <MaxTime unit="s" multiplier="m">1000</MaxTime>
</GSE>

<GSEControl name="CbStates" datSet="DataSet_CbStates"
appID="Goo1" desc="ISM states" confRev="1"/>
```

Configuration

> To configure the device as a GOOSE publisher, you have to call up the visualization via a PC. You must have a parameter configurator or administrator user role.

To configure the device as a GOOSE publisher, proceed as follows:

1. Go to **Settings** > **Export**.
2. In the **System** area, select the option **SCADA configuration (.zip)**.
   » The SCADA configuration is exported as a zip archive.
3. Unzip the zip archive and adapt the TEMPLATE.icd file to the requirements.
4. Go to **Settings** > **Import**.
5. Select the SCD/CID file and select **Transfer**.
6. Select the desired **IED name** with the configuration that is to be imported and select **Accept** to start the import.
7. Upon successful completion of the import, restart the device.

» The system restarts and checks the configuration. If the configuration failed, an error message appears and the device resets the configuration to the one with which it was delivered.

8.2.8 Configuring data points

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.

8.2.8.1 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	-

Column	Description	Modifiable	Setting range
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: – 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. – 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
CY	Interval in ms for the cyclic transmission of the data point. Notice: You can only enter an interval for data points of type 9, 11 or 13.	Yes	0, 1

Table 38: Configuring IEC 60870-5-101 data points

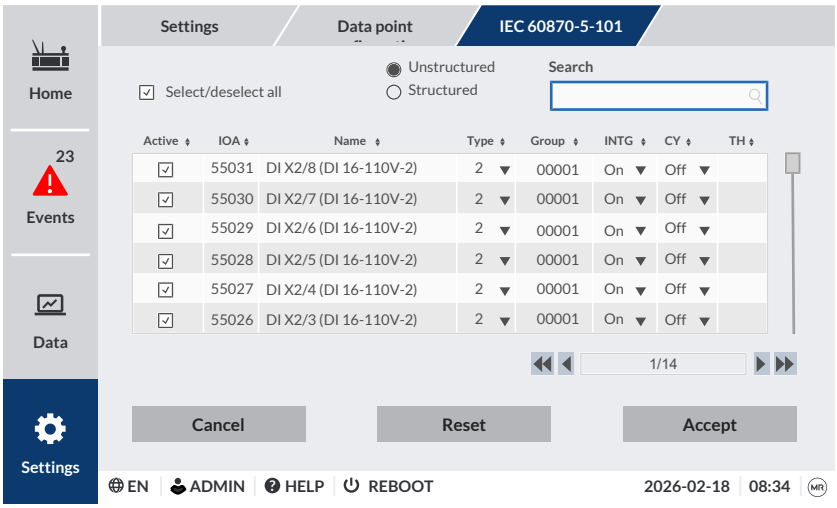


Figure 75: Configuring IEC 60870-5-101 data points

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.

8.2.8.2 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. – 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 39: Configuring IEC 60870-5-103 data points

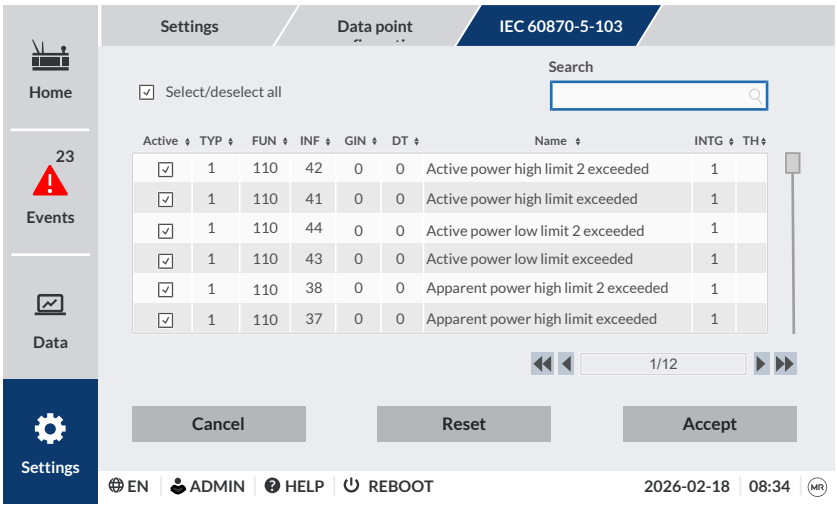


Figure 76: Configuring IEC 60870-5-103 data points

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.

8.2.8.3 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: – 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. – 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
CY	Interval in ms for the cyclic transmission of the data point. Notice: You can only enter an interval for data points of type 9, 11 or 13.	Yes	0, 1

Table 40: Configuring IEC 60870-5-104 data points

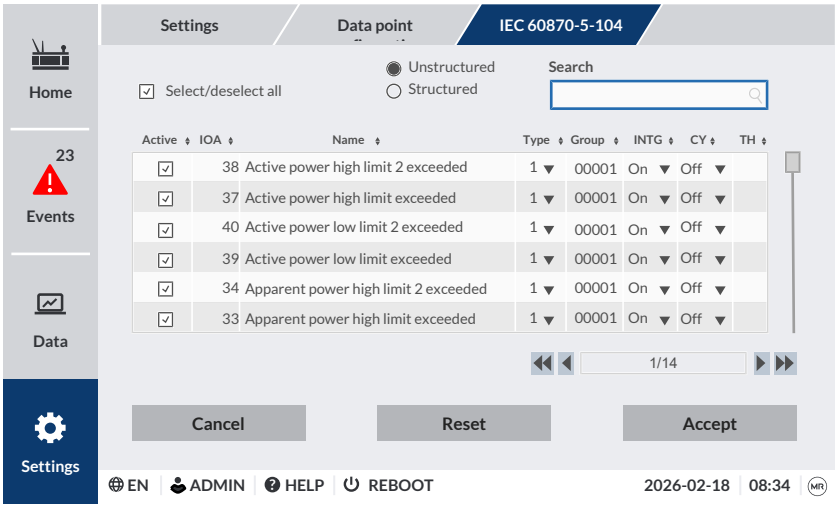


Figure 77: Configuring IEC 60870-5-104 data points

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.

8.2.8.4 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 41: Configuring Modbus data points

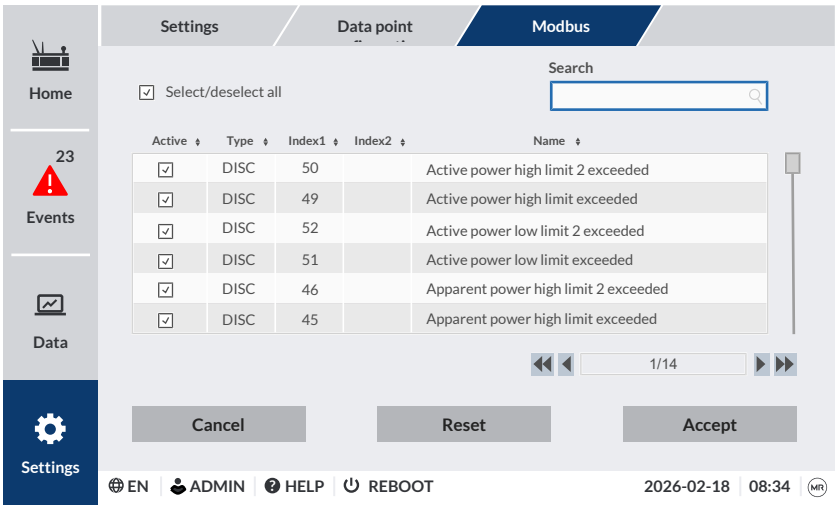


Figure 78: Configuring Modbus data points

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.

8.2.8.5 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
ObjGrp	The ObjGrp column indicates the data point object group: – AI = Analog Input – AO = Analog Output – BI = Binary Input – BO = Binary Output – CT = Counter	No	-
IdxAdr	Data point address.	Yes	0...4294967296

Column	Description	Modifiable	Setting range
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
StVar	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, 5 – AO: 2 – CT: 1, 2, 5, 6	Yes	1, 2, 4, 5, 6
EvVar	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, 5, 7 – AO: no value – CT: 1, 2, 5, 6	Yes	1, 2, 4, 5, 6, 7
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
Decimal places	Scaling factor (multiplier) to calculate the integer values. The multiplier is only used with integer variations (EvVar 2 or 4). The multiplier is not used with float variations (EvVar 5 or 7). If you use EvVar 2 or 4, then the set threshold value is divided by the multiplier: Deadband_input / Multiplier = Deadband_real	Yes	1E-12...1E+12

Table 42: Configuring DNP3 data points

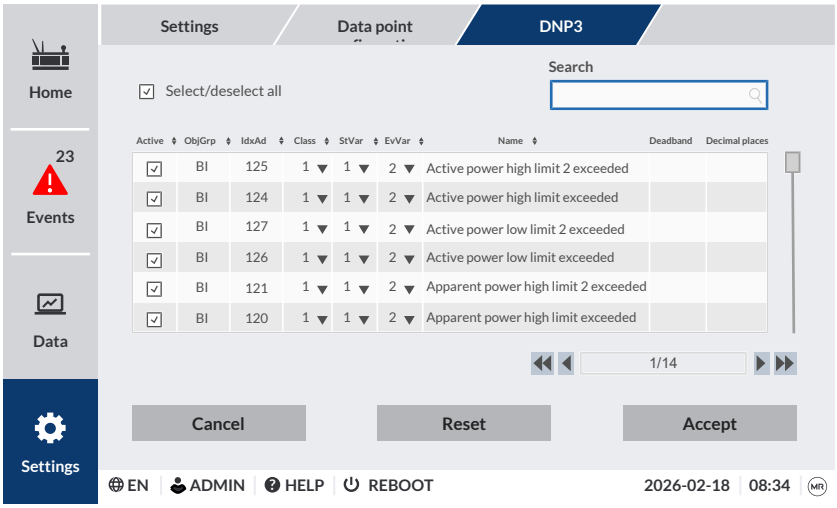


Figure 79: Configuring DNP3 data points

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.

8.2.8.6 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.

8.2.8.7 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.

8.3 Power grid

8.3.1 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.

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

8.3.1.1 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 8.3.1.2, Page 119].

› 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 43: 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 44: 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 devices adds the correction value to the measured voltage (secondary side).

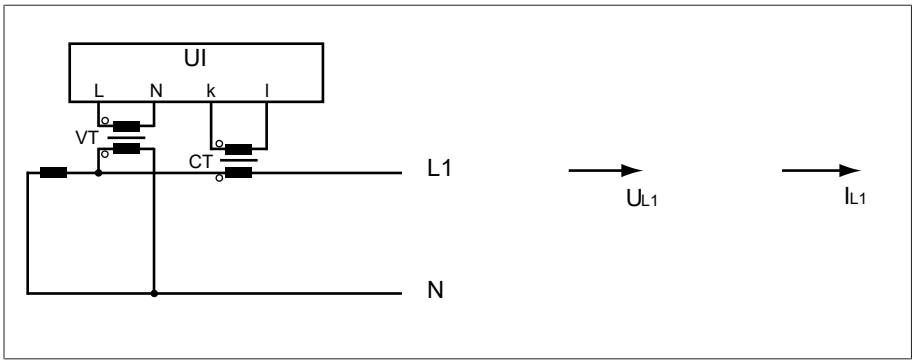
If the voltage is measured with a 3-phase measurement module, you can only set the voltage balance if you select the "1-ph. measurement" option for the parameter UI measuring channels [▶Page 127].

8.3.1.2 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.

8.3.1.2.1 1-phase measurement

Circuit 1-A



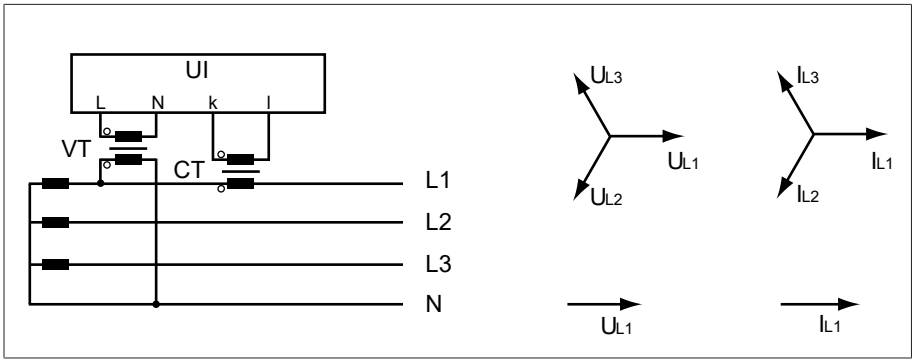
- The voltage transformer VT is connected to the phase conductor and neutral conductor.
- The current transformer CT is looped into the phase conductor.
- The voltage U_{L1} and current I_{L1} are in phase.
- The voltage drop on a phase conductor is determined by the current I_{L1}.

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 45: Circuit 1-A

Circuit 1-B



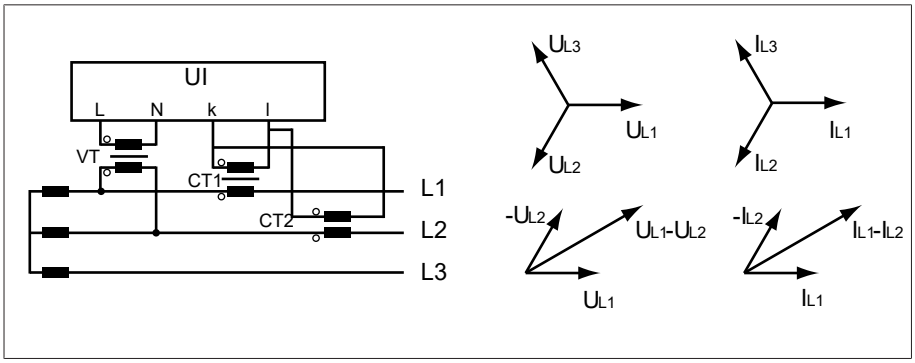
- The voltage transformer VT is connected to the phase conductor L1 and the neutral conductor.
- The current transformer CT is looped into the phase conductor L1.
- The voltage U and current I are in phase.
- The voltage drop on a phase conductor is determined by the current I_{L1}.

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 46: 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.

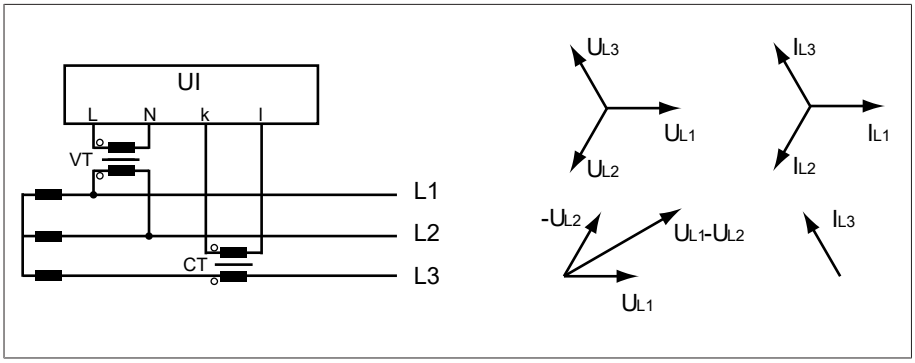
- The current transformers CT1 and CT2 are connected crosswise in parallel (total current = $I_{L1} + I_{L2}$).
- The total current $I_{L1} + I_{L2}$ and voltage U_{L1}-U_{L2} are in phase.
- The voltage drop on a phase conductor is determined by the current: $(I_{L1} + I_{L2}) / \sqrt{3}$.

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 47: Circuit 1-C

Circuit 1-D



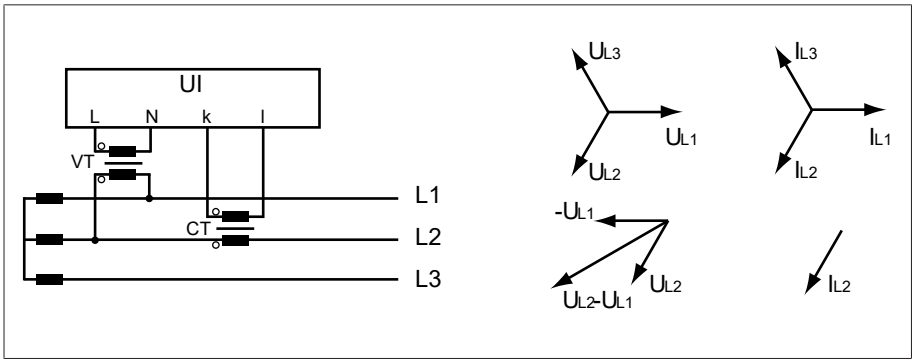
- The voltage transformer VT is connected to the phase conductors L1 and L2.
- The current transformer CT is looped into the phase conductor L3.
- The current I_{L3} is ahead of voltage U_{L1}-V_{L2} by 90°. This corresponds to a phase shift of -90°.
- The voltage drop on a phase conductor is determined 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 48: 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.

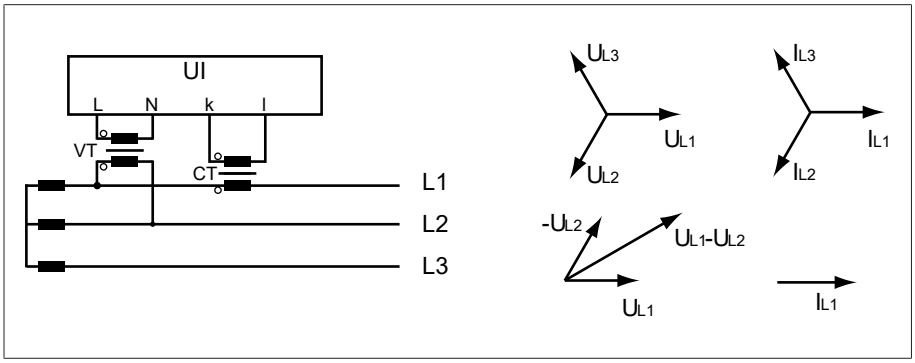
- The current I_{L2} is ahead of voltage U_{L2}-U_{L1} by 30°. This corresponds to a phase shift of -30°.
- The voltage drop on a phase conductor is determined by the current I_{L2}.

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 49: 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° and a correction value of -30°.
- The voltage drop on a phase conductor is determined by the current I_{L1}.

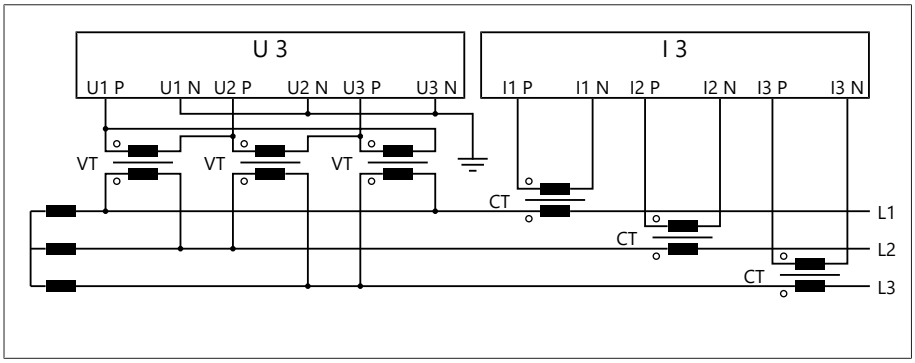
If you use this circuit, set the device as follows:

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

Table 50: Circuit 1-F

8.3.1.2.2 3-phase measurement

Circuit 3-A



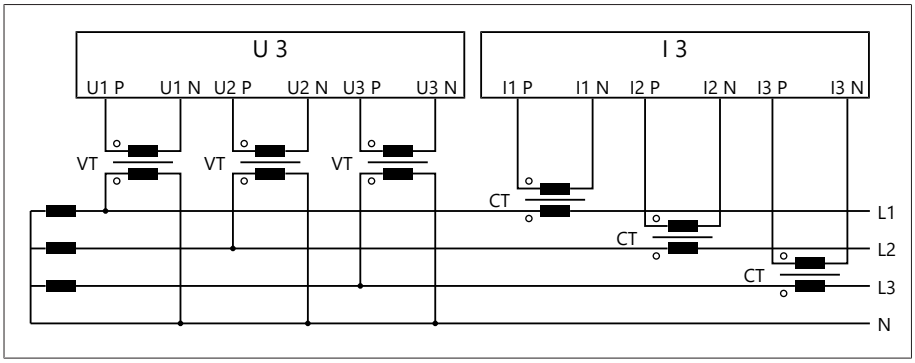
- Three-phase measurement.
- The voltage transformers are connected between the phases.
- The current lags behind the voltage by 30°.

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 51: Circuit 3-A

Circuit 3-B



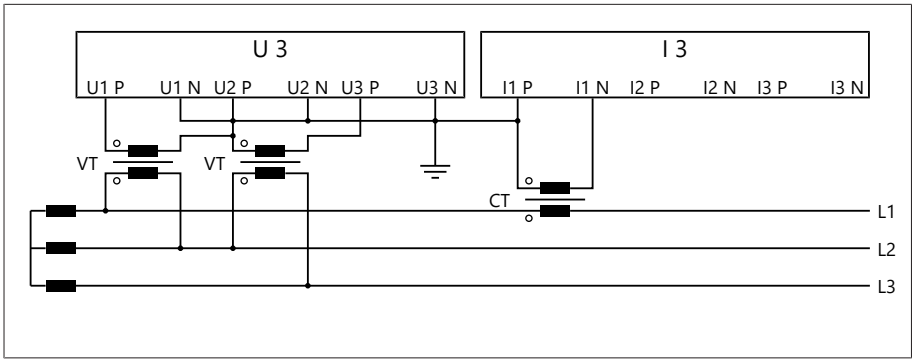
- Three-phase measurement.
- The voltage transformers are connected between the phase and neutral conductor.

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 52: Circuit 3-B

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



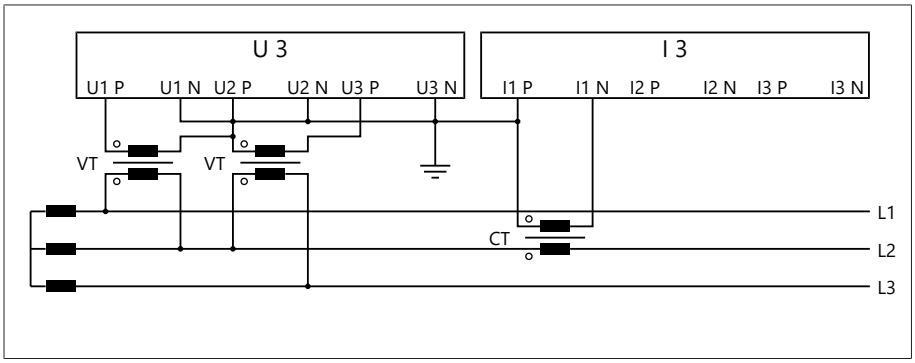
- Three-phase voltage measurement, single-phase current measurement.
- The voltage transformers are connected between the phases.
- The current transformer is connected to phase L1.

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 53: Circuit 3-C

Circuit 3-D

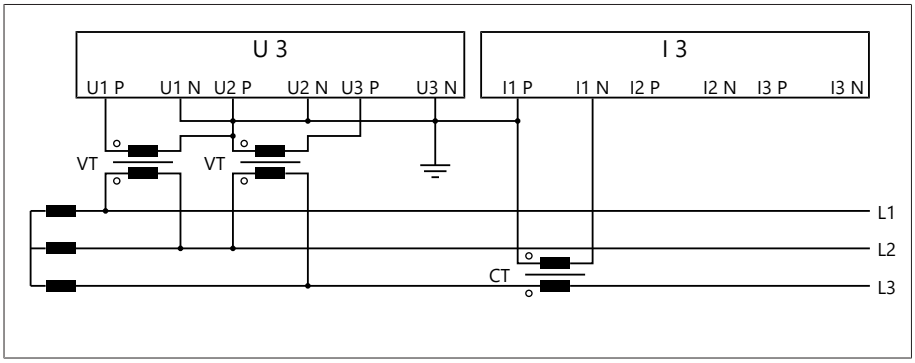


- Three-phase voltage measurement, single-phase current measurement.
- The voltage transformers are connected between the phases.
- The current transformer is connected to phase L2.

Parameters	Option
Voltage-transformer circuit	-
Current-transformer circuit	-
Phase angle correction	-150°
UI measuring channels	3-ph. voltage, 1-ph. current
Measurement mode	Phase-phase

Table 54: Circuit 3-D

Circuit 3-E

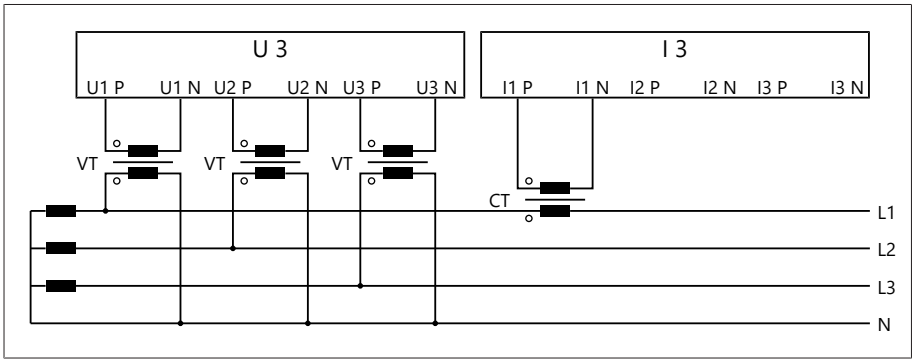


- Three-phase voltage measurement, single-phase current measurement.
- The voltage transformers are connected between the phases.
- The current transformer is connected to phase L3.

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 55: Circuit 3-E

Circuit 3-F

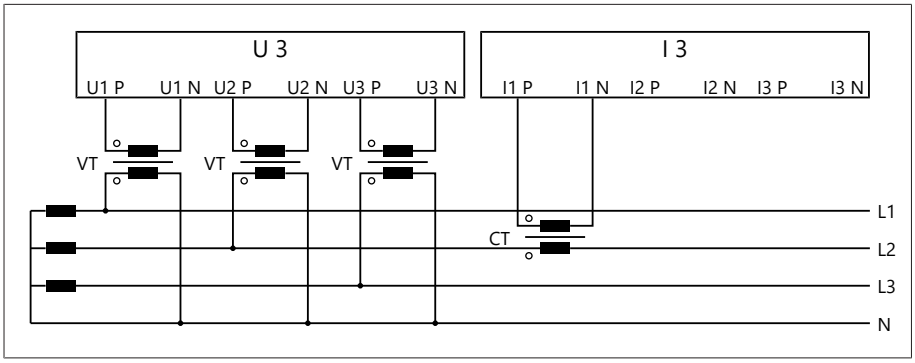


- Three-phase voltage measurement, single-phase current measurement.
- The voltage transformers are connected between the phase and neutral conductor.
- The current transformer is connected to phase L1.

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

Table 56: Circuit 3-F

Circuit 3-G

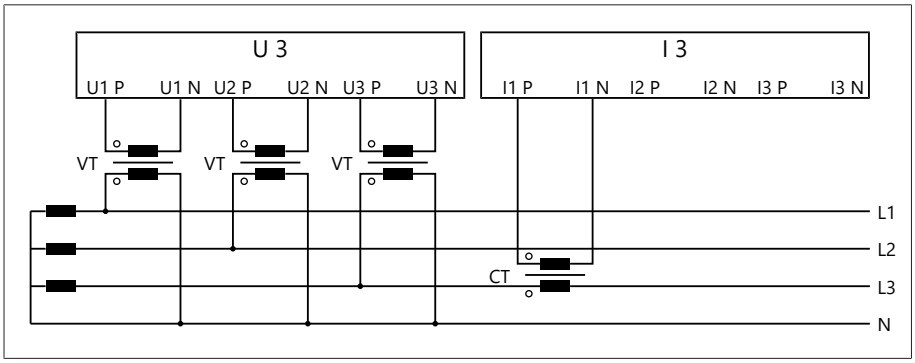


- Three-phase voltage measurement, single-phase current measurement.
- The voltage transformers are connected between the phase and neutral conductor.
- The current transformer is connected to phase L2.

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 57: 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 58: Circuit 3-H

8.3.2 Measurement

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

› 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 59: 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.

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 60: Setting the display for the power factor

8.3.3 Monitoring functions

For various measured values, you can define limit values that are monitored by the device.

> You have to set this parameter for both winding 1 (W1) and winding 2 (W2). Limit value monitoring of the regulated winding takes priority over limit value monitoring of the non-regulated winding.

8.3.4 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.

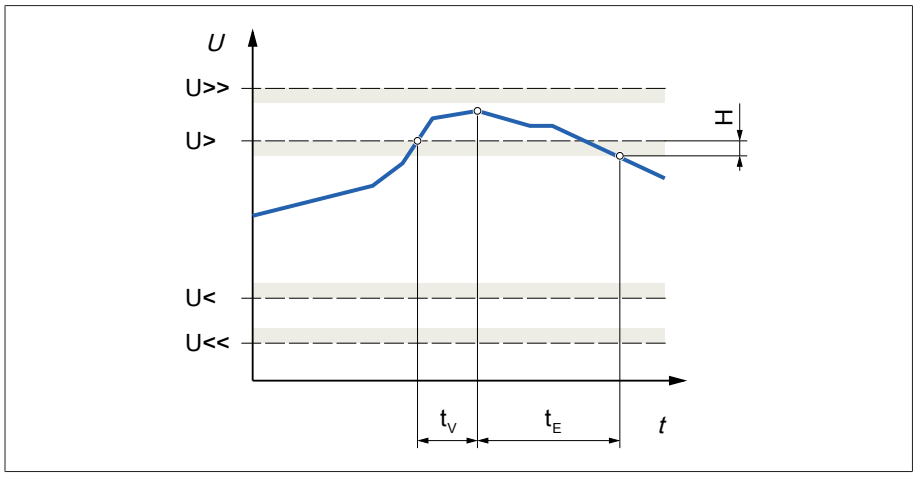


Figure 80: Example of voltage monitoring with the limit value Overvoltage U> being exceeded

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)

› 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 61: 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.

8.3.5 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.

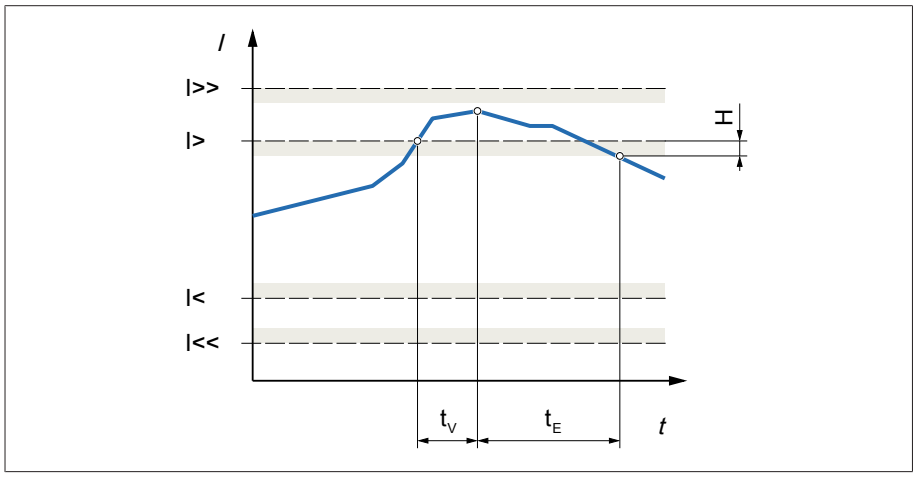


Figure 81: Example of current monitoring with the limit value I> being exceeded

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 (AIO), 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)

› 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 62: Behavior when an event message is issued

8.3.6 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 63: 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

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

› 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.

8.3.7 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

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

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	– The negative power flow is ignored. – Automatic regulation remains active.
Event only	– The *Reversal of power flow* event is issued. – If Z compensation is activated, this function is deactivated. – Automatic regulation remains active.
Auto blocking	– The *Reversal of power flow* event is issued. – If Z compensation is activated, this function is deactivated. – Automatic regulation is blocked.

Setting	Behavior
Auto/manual blocking	– The *Reversal of power flow* 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	– The *Reversal of power flow* 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 8.4.7, Page 163] 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 64: Behavior in the event of a reversal of power flow

8.3.8 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.

› 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

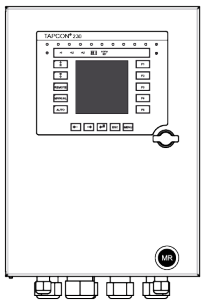
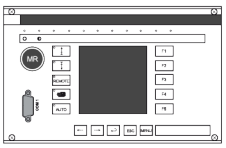
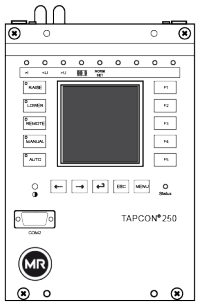
You can use this parameter to set the behavior of the device when the event message is issued. You can select the following options:

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 65: Behavior when an event message is issued

8.3.9 TAPCON® 2xx retrofit

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

TAPCON® 230 pro TAPCON® 230 expert	TAPCON® 240 TAPCON® 260 TRAFOGUARD®[12]	TAPCON® 250
		

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.

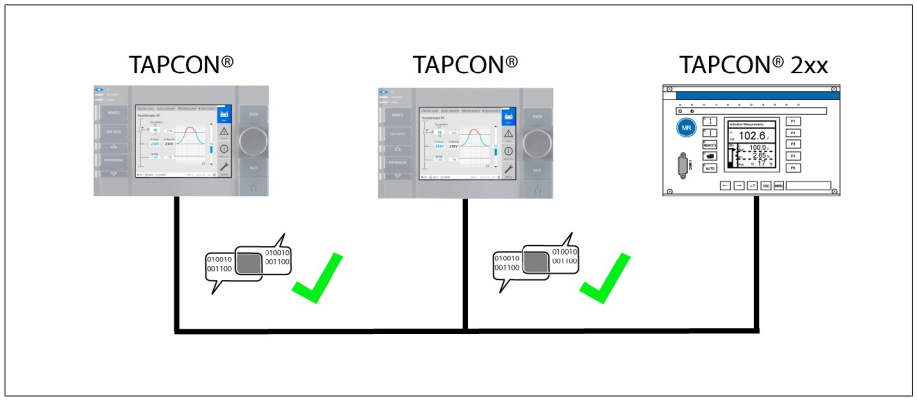


Figure 82: Parallel operation of 2 devices with one TAPCON® 2xx. The TAPCON® 2xx retrofit function must be active on both devices.

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

TAPCON® 2xx retrofit

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

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

8.3.10 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.

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You can change the measured value display to the generator sign convention by activating the Retrofit TAPCON® 2xx [▶Section 8.3.9, Page 133] parameter.

The following measured values are displayed:
- Voltage
- Current
- Power factor (cos ϕ)
- Frequency
- Reactive power
- Active power
- Apparent power

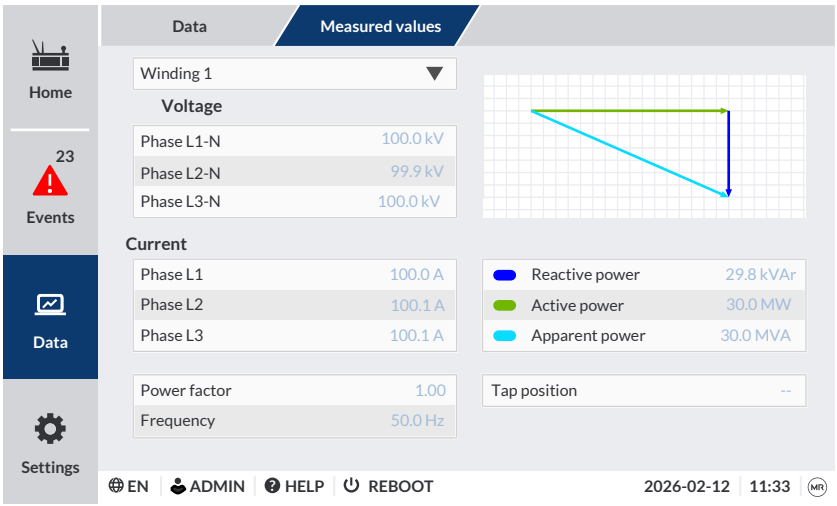


Figure 83: Measured values

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

8.3.11 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

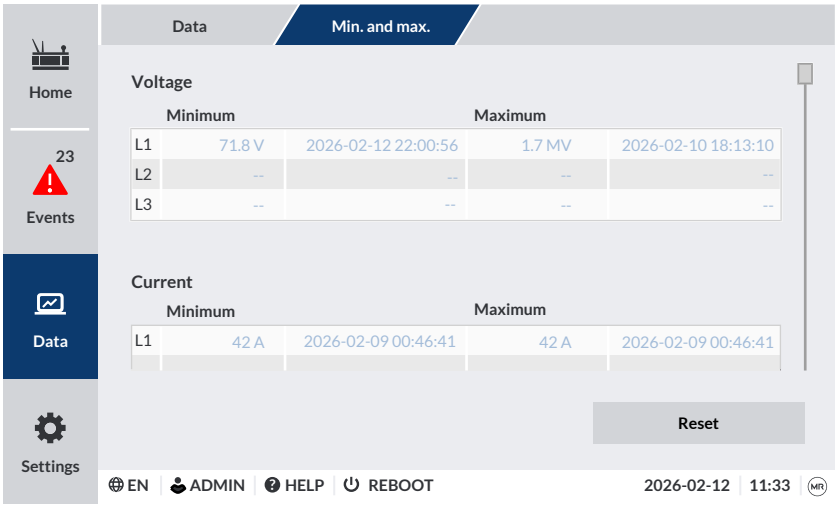


Figure 84: Min. and max. measured values

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

8.4 On-load tap-changer regulator

8.4.1 Regulation

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

8.4.1.1 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.

> This function only works in the REMOTE operating mode.

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

8.4.2 Voltage regulation

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

› Go to **Settings** > **Parameters** > **Regulator** > **Voltage regulation**.

8.4.2.1 Setting the desired value

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

8.4.2.1.1 Desired value 1

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

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

8.4.2.1.2 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.

> 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 70] parameter accordingly.

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

Setting the desired value

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

8.4.2.1.3 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 70] parameter accordingly.

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

Setting the desired value

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

8.4.2.1.4 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).

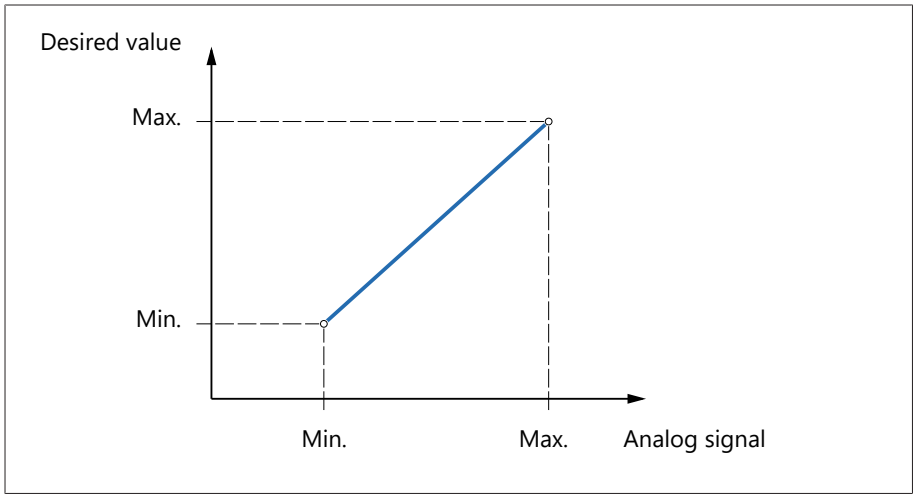


Figure 85: Analog setting of the desired value

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

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

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

Setting desired value 1

1. Go to **Settings** > **Parameters** > **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.

8.4.2.1.5 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 66: 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 70] 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** > **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** > **Regulator** > **Regulation** > **Desired value step width**.
2. Enter the desired value step width.
3. Press the **Accept** button to save the modified parameter.

8.4.2.1.6 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 the example in the diagram below).

Parameters	Function	Settings (see the 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 67: Parameters to be set for active power-dependent adjustment of desired voltage value

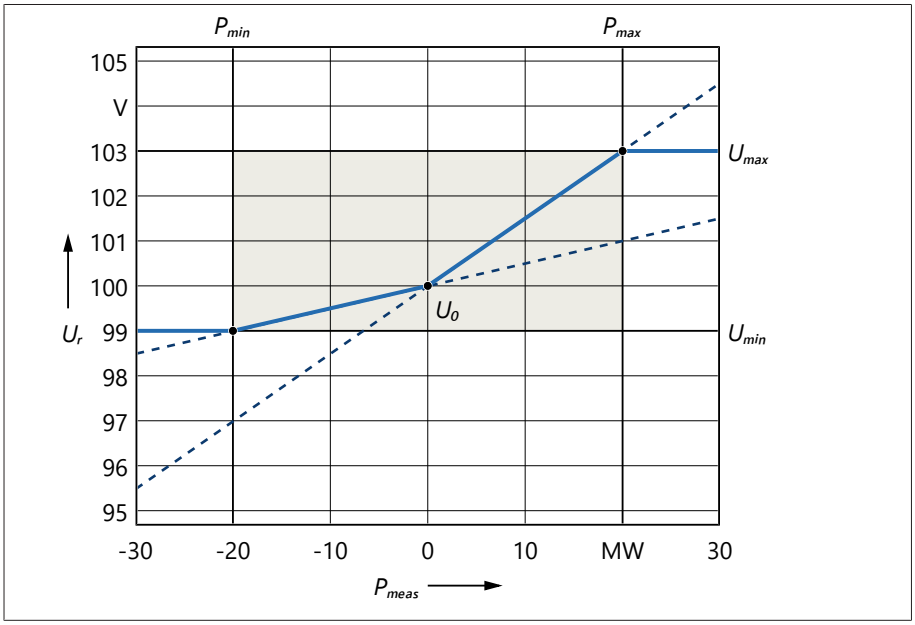


Figure 86: Active power-dependent adjustment of desired voltage value

U_r	Desired value	U_0	Set desired value when measured active power = 0
U_{min}	Minimum desired value	U_{max}	Maximum desired value
P_{meas}	Measured active power	P_{min}	Active power at minimum desired value
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.

$$U_{ref} = U_{max}$$

Response to value falling below active power P_{min}

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

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

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

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

$$U_{ref} = U_0$$

Linear dependency with negative active power:

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

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

Linear dependency with positive active power:

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

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

To set the TDSC parameters, proceed as follows:

› Go to **Settings** > **Parameters** > **Regulator** > **Voltage regulation**.

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

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 8.4.2.1.1, Page 137]. You can activate or deactivate the power-dependent adjustment of the desired voltage value as follows:

- Parameter
- Digital inputs *I: TDSC® on* and *I: TDSC® off* (optional)
- Control system command (optional)

> 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.

8.4.2.1.7 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 the example in the diagram below).

Parameters	Function	Settings (see the 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 68: Parameters to be set for active power-dependent adjustment of desired voltage value

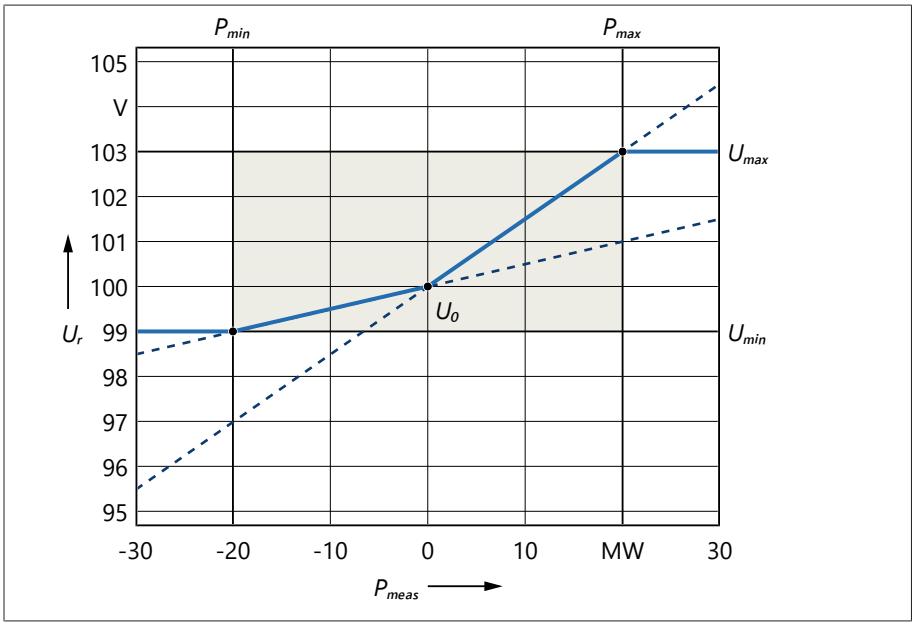


Figure 87: Active power-dependent adjustment of desired voltage value

U_r	Desired value	U_0	Set desired value when measured active power = 0
U_{min}	Minimum desired value	U_{max}	Maximum desired value
P_{meas}	Measured active power	P_{min}	Active power at minimum desired value
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.

$U_{ref} = U_{max}$

Response to value falling below active power P_{min}

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

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

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

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

$$U_{ref} = U_0$$

Linear dependency with negative active power:

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

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

Linear dependency with positive active power:

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

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

To set the TDSC parameters, proceed as follows:

› Go to **Settings** > **Parameters** > **Regulator** > **Voltage regulation**.

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

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 8.4.2.1.1, Page 137]. You can activate or deactivate the power-dependent adjustment of the desired voltage value as follows:

- Parameter
- Digital inputs *I: TDSC® on* and *I: TDSC® off* (optional)
- Control system command (optional)

> 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.

8.4.2.1.8 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

Desired value	BCD input								
	100	80	40	20	10	8	4	2	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
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

Desired value	BCD input								
	100	80	40	20	10	8	4	2	1
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
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

Desired value	BCD input								
	100	80	40	20	10	8	4	2	1
139 V	1	0	0	1	1	1	0	0	1
140 V	1	0	1	0	0	0	0	0	0

Table 69: BCD-coded desired value

Setting desired value 1

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

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

8.4.2.1.9 Desired value setting according to the day profile

You can use the function "Desired value setting according to the day profile" to set 24 desired values respectively for 2 profiles (Working day or Non-working day). You can set a start time for each of these desired values. As soon as the current device time reaches the start time, the device will activate the assigned desired value.

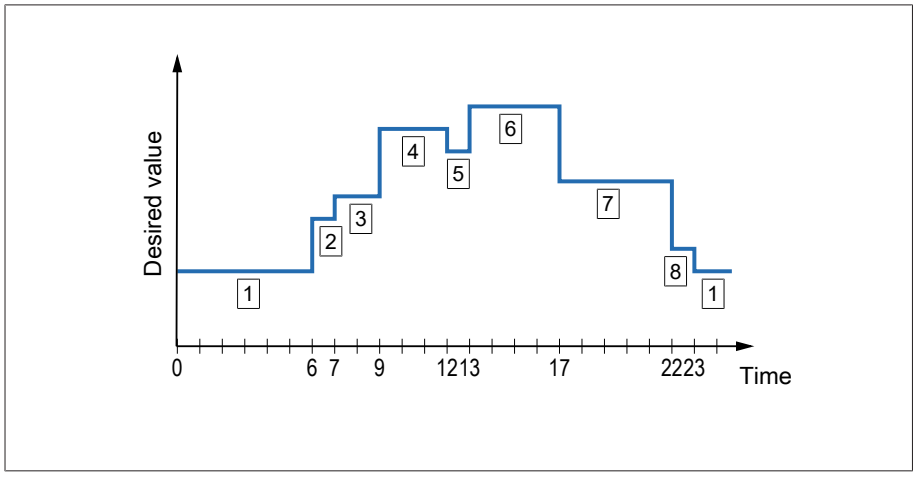


Figure 88: Desired value setting according to the day profile

1	Desired value 1 active	2	Desired value 2 active
3	Desired value 3 active	4	Desired value 4 active
5	Desired value 5 active	6	Desired value 6 active
7	Desired value 7 active	8	Desired value 8 active

If you use the automatic daylight saving/standard time [▶Page 77] function and the device sets the time 1 hour forward or back, the current desired value remains active until the "new" device time reaches the next start time. This applies in particular if a start time is skipped due to the automatic changeover between daylight saving/standard time.

8.4.2.1.9.1 Selecting a day profile

You can select the active day using a digital input. The device will report the active day profile using a digital output and as an event message.

8.4.2.1.9.2 Activating the next desired value

You can use the digital input *next desired value* to activate the next desired value based on the start time of the day profile.

Example: It is 11:30; currently, the desired value with the start time 11:00 is active. The start time of the next desired value is 13:00 and the start time of the desired value after that is 18:00. Using a command via the *next desired value* input, you can activate the next desired value (13:00), and with another command the desired value after that (18:00).

8.4.2.1.9.3 Setting the desired values for the "Working day" profile

You can input 24 desired values and 24 start times each for the "Working day" profile.

› Go to **Settings** > **Parameters** > **Regulator** > **Working day voltage regulation**.

Desired value 1...24

You can use these parameters to set up to 24 different desired values. The desired values are coupled to the respective start times. If you would like to use less than 24 different desired values, you must enter the same desired value multiple times (e.g. desired value 21, 22, 23, 24 = 100 V).

Start time 1...24

You can use the parameters to set the start time for each desired value. As soon as the current device time reaches the start time, the device will activate the associated desired value. Note that you must input different times for each parameter.

8.4.2.1.9.4 Setting the desired values for the "Non-working day" profile

You can input 24 desired values and 24 start times each for the "Non-working day" profile.

› Go to **Settings** > **Parameters** > **Regulator** > **Non-working-day voltage regulation**.

Desired value 1...24

You can use these parameters to set up to 24 different desired values. The desired values are coupled to the respective start times. If you would like to use less than 24 different desired values, you must enter the same desired value multiple times (e.g. desired value 21, 22, 23, 24 = 100 V).

Start time 1...24

You can use the parameters to set the start time for each desired value. As soon as the current device time reaches the start time, the device will activate the associated desired value. Note that you must input different times for each 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 $U_N = 11000\ V$
Step voltage in tap position 4 $U_{Step4} = 11275\ V$
Step voltage in tap position 5 $U_{Step5} = 11000\ V$

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

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

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

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.

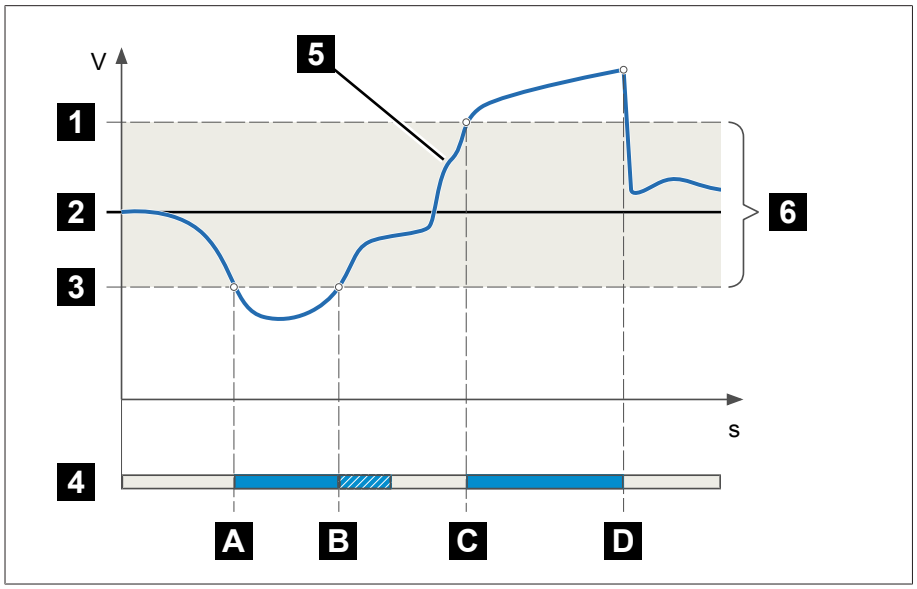


Figure 89: Behavior of the control function with delay time T1

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.

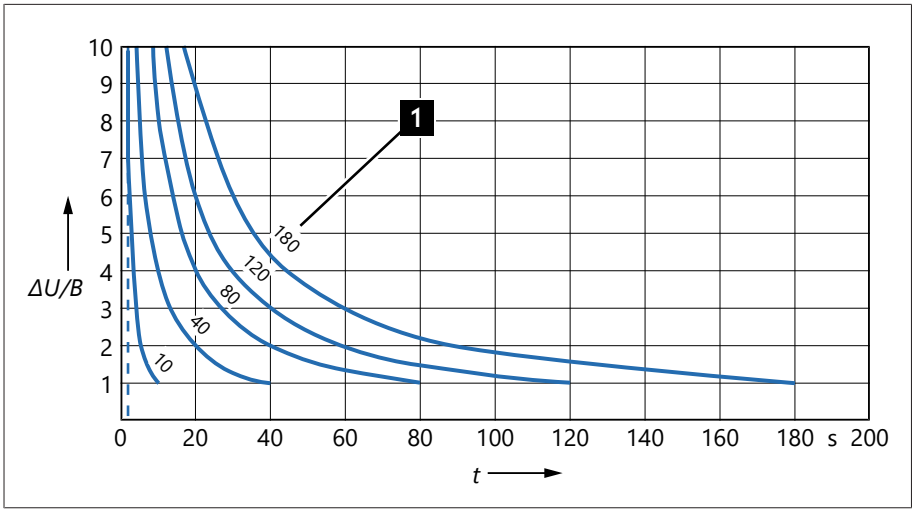


Figure 90: Diagram for integral time response

t	Delay time in seconds	ΔU/B	Control deviation "ΔU" as % of desired value in relation to the set bandwidth
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.

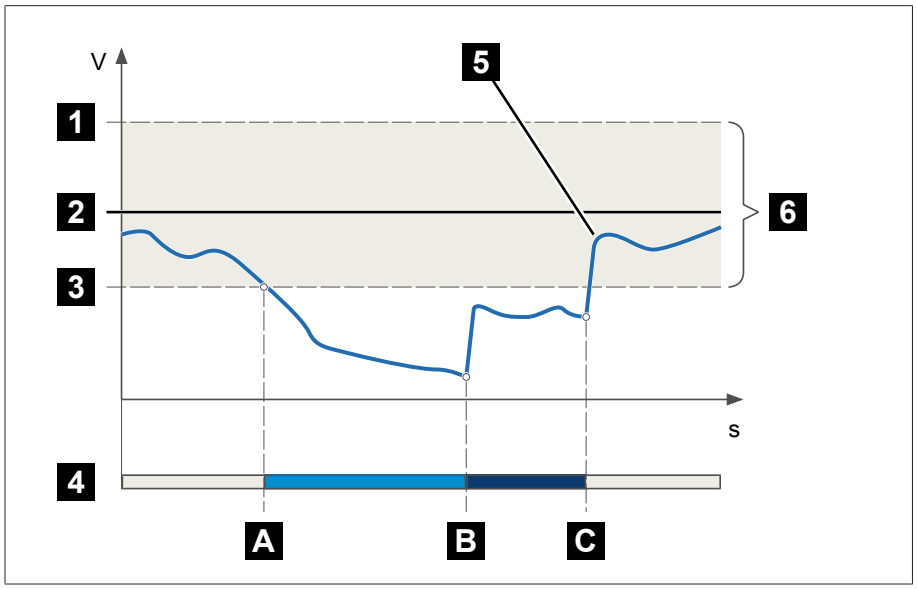


Figure 91: Behavior of the regulation function with delay times T1 and T2

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.

8.4.2.2 Several parameter sets (optional)

If your device is equipped with the optional "Several parameter sets" function, you can set the associated control parameters (bandwidth, delay times, etc.) for each desired value individually.

8.4.3 Three-winding transformer and HV/LV regulation

The voltage is regulated via one of the two windings (winding 1 or winding 2). Depending on the device configuration, there are various ways of selecting the active winding:

- Automatic winding selection
  - Selection based on apparent current (only with three-winding transformer)
  - Selection based on voltage (only with three-winding transformer)
  - Selection based on active power flow (only with HV/LV regulation)
- Manual winding selection (optional)
  - Selection using parameters
  - Selection using inputs
  - Selection using control system commands

8.4.3.1 Configuring automatic winding selection

If you want to regulate a three-winding transformer, the winding can be selected automatically via the calculated apparent current or measured voltage. If you want to regulate the high-voltage side or low-voltage side of a transformer, the winding can be selected automatically via the calculated active power flow.

› Go to **Settings** > **Parameters** > **Regulator** > **Three-winding transformer**.

Regulation type

You can use this parameter to set which type of voltage regulation the device is to use. You can select the following options:

- Three-winding transformer: Regulation of a three-winding transformer
- HV/LV regulation: Regulation of the high-voltage side or low-voltage side of a transformer

Winding selection

You can use this parameter to set which winding the device is to regulate. You can select the following options:

- Winding 1
- Winding 2
- Automatic: The device decides which winding to regulate based on the set parameters.

Automatic winding selection mode

You can use this parameter to set the control variable the device is to use to select which winding is to be regulated. Depending on the regulation type [▶Page 154], you can select the following options:

- Apparent current (only with three-winding transformers): The device regulates the winding across which the higher apparent current flows. The changeover between the windings takes place once the set delay time has elapsed.
- Voltage (only with three-winding transformer): The device regulates the winding on which the measured voltage violates one of the two switching limits (U<, U>). The changeover between the windings takes place once the set delay time has elapsed. Observe the following information when testing:
  - If no switching limits are violated, the device regulates the winding last active. The initial status after switching on the device is winding 1.
  - If the switching limits for both windings are exceeded at the same time in the same direction (e.g. winding 1 U> and winding 2 U>), the device regulates the winding last active.
  - If the switching limits for both windings are violated at the same time in opposite directions (e.g. winding 1 U> and winding 2 U<), the device blocks automatic voltage regulation.
- Pos. active power: Winding 1 (only with HV/LV regulation): With positive active power (active power flow from winding 2 to winding 1), the device regulates winding 1. With negative active power, the device regulates winding 2.
- Pos. active power: Winding 2 (only with HV/LV regulation): With positive active power (active power flow from winding 2 to winding 1), the device regulates winding 2. With negative active power, the device regulates winding 1.

Apparent current change delay

You can use this parameter to set the change delay for the automatic winding selection using the calculated apparent current. Once the delay time has elapsed, the device regulates the winding with the greater apparent current.

Change delay voltage

You can use this parameter to set the change delay for the automatic winding selection using the measured voltage. If a switching limit is exceeded, the device regulates the corresponding winding once the delay time has elapsed.

W1/W2: U>/U< Switching limit

You can use these parameters to set the switching limits for automatic winding selection using the measured voltage. You can set a lower limit (U<) and upper limit (U>) for each winding.

Monitoring of the unregulated winding

You can use this parameter to deactivate the monitoring function for the unregulated winding if the measured voltage of the unregulated winding is less than 30 V (e.g. with open circuit breaker). You can select the following options:

Option	Description
On	If the measured voltage of the unregulated winding is less than 30 V, the voltage regulation is blocked. Furthermore, the following monitoring functions of the unregulated winding will continue to be performed: – Voltage monitoring – Current monitoring – Power monitoring – Power flow monitoring
Off	If the measured voltage of the unregulated winding is less than 30 V, the voltage regulation is not blocked. Furthermore, the following monitoring functions of the unregulated winding will not be performed: – Voltage monitoring – Current monitoring – Power monitoring – Power flow monitoring

Table 70: Monitoring of the unregulated winding

8.4.3.2 Manually selecting winding (optional)

You have the option of manually selecting the winding to be regulated. If your device is equipped with this function, you can use a parameter on the device, digital inputs or control system commands to select the winding to be regulated. The following options are available:

- Automatic winding selection
- Winding 1
- Winding 2

Selecting winding using parameters

To select the winding to be regulated using parameters, proceed as follows:

1. Go to **Settings** > **Parameters** > **Regulator** > **Three-winding transformer** > **Winding selection**.
2. Select the desired option from the list box.
3. Press the **Accept** button to save the modified parameter.

Selecting winding using digital input or control system

To select the winding to be regulated using digital input or control system, proceed as follows:

› Create pulse at the desired input or send desired control system command to the device.

8.4.4 Line drop compensation

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

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

8.4.4.1 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.

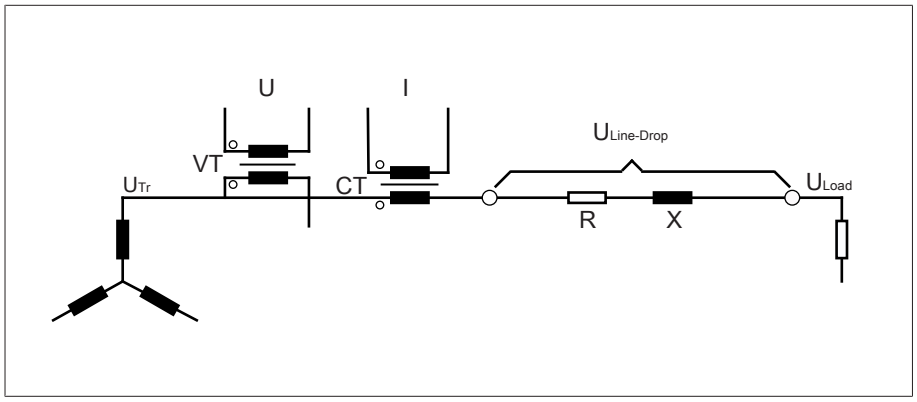


Figure 92: Equivalent circuit of R&X compensation

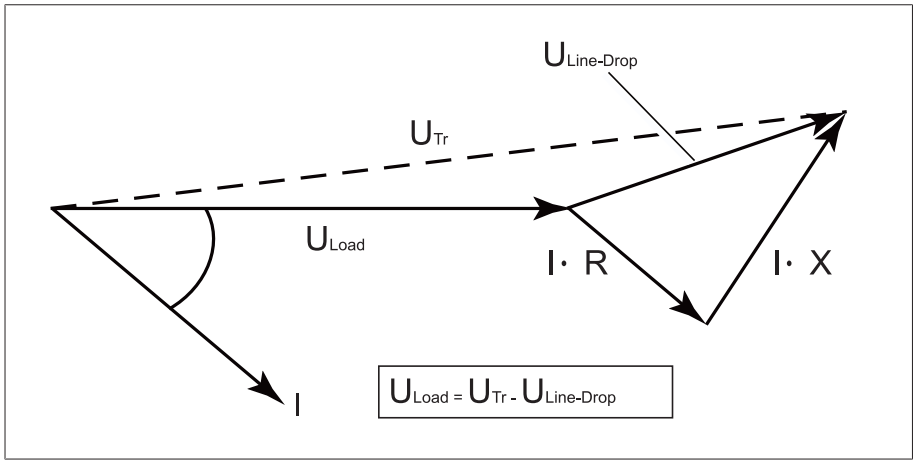


Figure 93: Phasor diagram of R&X compensation

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

› Go to **Settings** > **Parameters** > **Regulator** > **Compensation**.

Compensation method

You can use this parameter to set the compensation method.

Ohmic resistance load

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

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

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

8.4.4.2 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.

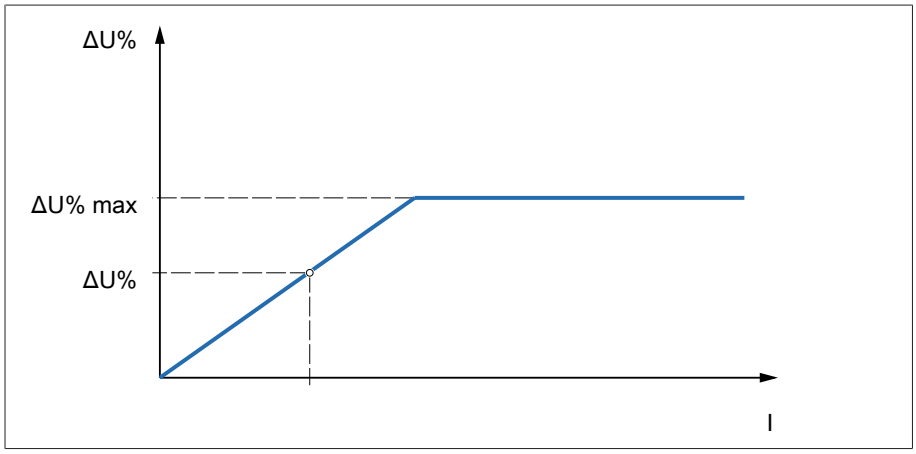


Figure 94: Z compensation

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 V, U_{Load} = 100.0 V, I_N = 5 A k_{CT} = 200 A/5 A, I = 100 A
Produces a voltage increase ΔU of 0.2%

› Go to **Settings** > **Parameters** > **Regulator** > **Compensation**.

Compensation method
You can use this parameter to set the compensation method.

Voltage increase
You can use this parameter to set the current-dependent voltage increase ΔU.

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

8.4.5 Parallel operation (optional)

Parallel transformer operating state 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 operating state

Compliance with the following general conditions is required for operating transformers in parallel operating state:

- Identical rated voltages
- Transformer power ratio (< 3 : 1)
- Maximum deviation of short-circuit voltages (U_K) for transformers connected in parallel < 10%
- The same number of switching groups
- For parallel operation with communication link: Current transformers with the same connection values must be used for all devices operating in parallel

8.4.5.1 Parallel operation methods

You can undertake parallel operation with various parallel operation methods.

8.4.5.1.1 Tap synchronization

With the **tap synchronization** parallel operation method, one voltage regulator works as the master and all others as followers.

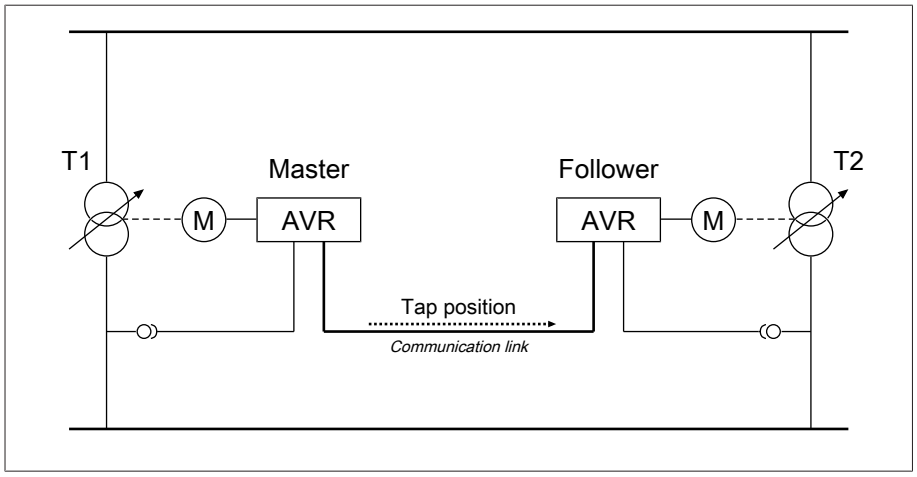


Figure 95: Tap synchronization

The master handles voltage regulation and transmits its current tap positions to all followers via the communication link. The followers compare the tap position received to 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 transmits 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 synch (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 *Tap difference to follower* event.

You can explicitly designate the voltage regulators as master and followers, or set automatic designation using the parallel operation ID (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
Parallel operation ID (CAN bus address)	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 71: Parameter

8.4.5.2 Configuring parallel operation

In the Parallel operation menu item, you can set the parameters needed for parallel transformer operation.

› Go to **Settings** > **Parameter** > **Regulator** > **Parallel operation**.

Activating parallel operation

You can use this parameter to activate parallel operation.

8.4.5.2.1 Setting parallel operation method (tap synchronization)

You can use this parameter to set the tap synchronization [▶Section 8.4.5.1.1, Page 158]. You can select the following options:

Option	Description
Master	The TAPCON® is designated as the master.
Follower	The TAPCON® is designated as the follower.
Auto. tap synchronization	Automatic assignment of master or follower. If no master is detected, the TAPCON® with the lowest CAN bus address is automatically designated as the master. All other TAPCON® are designated as followers.

Table 72: Setting tap synchronization

To set the tap synchronization, proceed as follows:

1. Go to **Settings > Parameter > Parallel operation > Parallel operation method > Tap synchronization**.
2. Select the option you want.
3. Press the **Accept** button to save the modified parameter.

Parallel operation ID (CAN bus address)

You can use this parameter to assign a parallel operation ID (CAN bus address) to the device. Each device requires a unique identifier so that all devices can communicate via the communication link. If the value is set to 0, then no communication takes place.

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 communication link 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 communication link when 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 synch).

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, the follower triggers the *Permitted tap difference* 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 communication link or if there are no other parallel operation participants in the same parallel operation group.

Behavior if no communication present

You can use this parameter to set how the device behaves if communication via the communication link is not possible.

> 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 communication link parallel operation method

Table 73: 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.

8.4.5.3 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 the communication link.

You can use the *I: Parallel group 1* and *I: 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.

> 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.

8.4.5.4 Parallel operation

In the parallel operation menu, you can display information about the devices that are connected via the communication link.

	Description
	Parallel operation status: – - = Independent mode – ✓ = Parallel operation is active – ⚠ = Parallel operation error
Par.Id	Parallel operation ID (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 74: Information about parallel operation

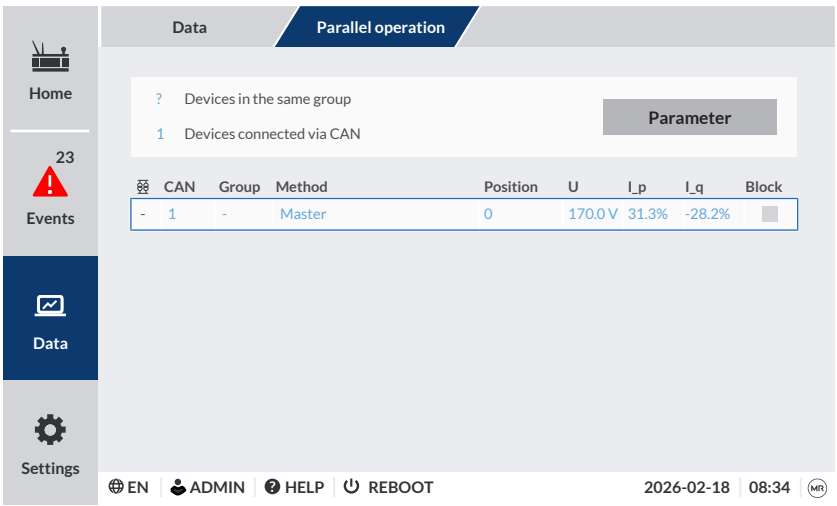


Figure 96: Parallel operation

1. Go to **Data** > **Regulator** > **Parallel operation**.
2. If necessary, select the **Parameters** button to display the parallel operation settings for the device.
3. Select the desired parameter to change its setting.

8.4.6 U bandwidth monitoring

The following limit values are monitored via bandwidth monitoring. The set bandwidth [▶ Page 149] 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 149], 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

› Go to **Settings** > **Parameter** > **Regulator** > **U bandwidth monitoring**.

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 75: 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.

8.4.7 Target-tap-position operation

When target-tap-position operation is activated, the device automatically switches to this 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 76: Behavior of the Target-tap-position operation function depending on the selected option and the operating mode of the device

8.5 On-load tap-changer

8.5.1 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

› 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.
Auto/manual blocking position+	The automatic control does not perform a tap-change operation in the direction of a higher tap position (position+). You cannot perform a tap-change operation in the direction of a higher tap position (position+) in manual mode.
Auto/manual blocking position-	The automatic control does not perform a tap-change operation in the direction of a lower tap position (position-). You cannot perform a tap-change operation in the direction of a lower tap position (position-) in manual mode.

Operations counter

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

8.5.2 Tap position capture method (optional)

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

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

› Go to **Settings** > **Parameter** > **On-load tap-changer** > **Tap position monitoring**.

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

8.5.2.1 Digital tap position capture

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

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

8.5.2.2 Analog tap position capture

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

8.5.2.2.1 Injected current (0/4...20 mA)

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

Pos. at max. analog signal

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

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

Pos. at min. analog signal

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

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

8.5.2.2.2 Resistor contact series

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

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

1. Go to **Settings > Calibrate hardware > Calibrate RCS** .

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

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

8.5.3 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

› 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 77: 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.

8.5.4 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.

- Operating position: Numerical value (cannot be set)
- Tap position: Tap position designation
- SCADA: Numerical designation for messaging to the control system

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.

8.5.5 Information about the on-load tap-changer

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

- Current tap position
  - Optional with multi-column use: Actual tap position A/B/C
- Total tap-change operations (operations counter)
  - Optional with multi-column use: A/B/C
- DSI switching operations (optional)
- Change-over selector operations (only with the options torque monitoring or vibro-acoustic monitoring of the on-load tap-changer)

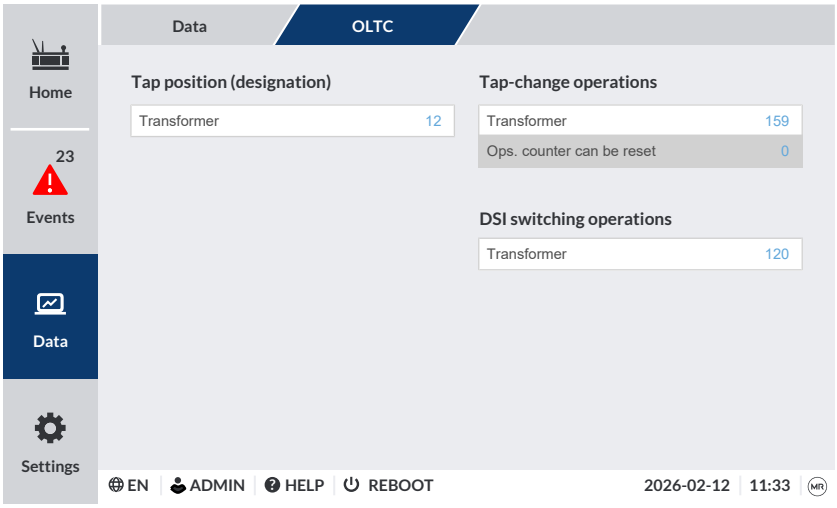


Figure 97: OLTC

› Go to **Data** > **On-load tap-changer** > **OLTC**.

8.5.6 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.

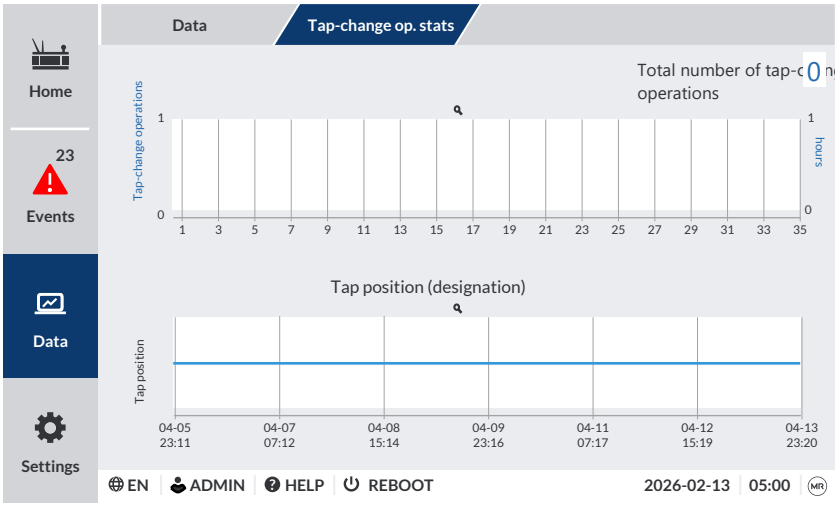


Figure 98: Tap-change operation statistics

› Go to **Data** > **On-load tap-changer** > **Tap-change op. stats** .

8.5.7 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 (TCA, TCB).

The device also shows the differences in contact wear for different contacts.

Figure 99: Contact wear

› Go to **Data** > **On-load tap-changer** > **Contact wear**.

8.5.8 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.
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 78: Maintenance (availability depends on the on-load tap-changer type)

8.5.8.1 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).

› Go to **Settings** > **Parameters** > **On-load tap-changer** > **Maintenance (operator): OLTC**.

Interval type

You can use this parameter to define the interval type for OLTC maintenance or to deactivate maintenance. You can select the following options:

- Deactivated: The maintenance interval is deactivated.
- Time: The maintenance interval is dependent on time.
- Counter: The maintenance interval is dependent on number of tap-change operations.
- Time and counter: The maintenance interval is dependent on time and number of tap-change operations. The limit reached first triggers the event.

Number of tap-change operations

You can use this parameter to define the reading of the tap-change operation counter at which the device should issue an event message.

Duration

You can use this parameter to set how long this interval should be. The device uses this to calculate the current maintenance progress.

Date of next maintenance

You can use this parameter to set the target date for the next maintenance. The device uses this to calculate the current maintenance progress.

Event (yellow)

You can use this parameter to set the maintenance progress (as a percentage) after which the device should issue an event message (yellow).

8.5.8.2 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).

› Go to **Settings** > **Parameters** > **On-load tap-changer** > **Maintenance (operator): Transf.**.

Activate interval

You can use this parameter to activate or deactivate the maintenance interval.

Duration

You can use this parameter to set how long this interval should be. The device uses this to calculate the current maintenance progress.

Date of next maintenance

You can use this parameter to set the target date for the next maintenance. The device uses this to calculate the current maintenance progress.

Event (yellow)

You can use this parameter to set the maintenance progress (as a percentage) after which the device should issue an event message (yellow).

8.5.8.3 Undertaking and confirming maintenance

Once you have performed 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®) – MSCA – MSCB – TC1A – TC1B – TC2A – TC2B	Overall contact wear on the stationary contact and moving contact. 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. 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.

Table 79: 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.

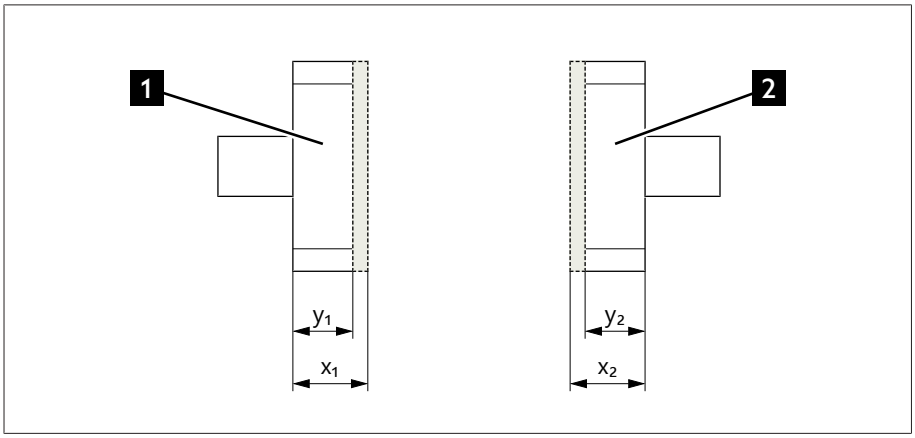


Figure 100: Determining contact wear

1	Feststehender Kontakt	2	Beweglicher Kontakt
x_1	Dicke des Kontaktbelags im Neuzustand	y_1	Dicke des abgenutzten Kontaktbelags
y_2	Dicke des abgenutzten Kontaktbelags	x_2	Dicke des Kontaktbelags im Neuzustand

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**.

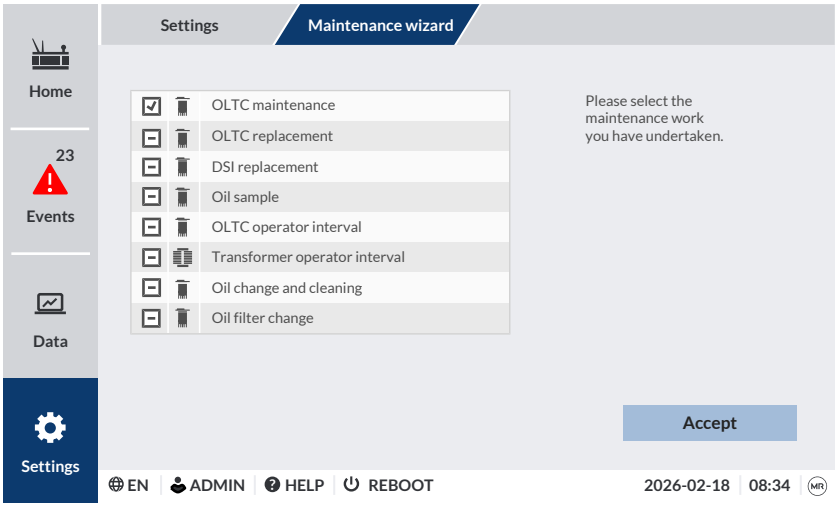


Figure 101: Maintenance wizard

2. Select the maintenance to be confirmed.
3. Press the **Next** button.
4. Enter the maintenance parameters.

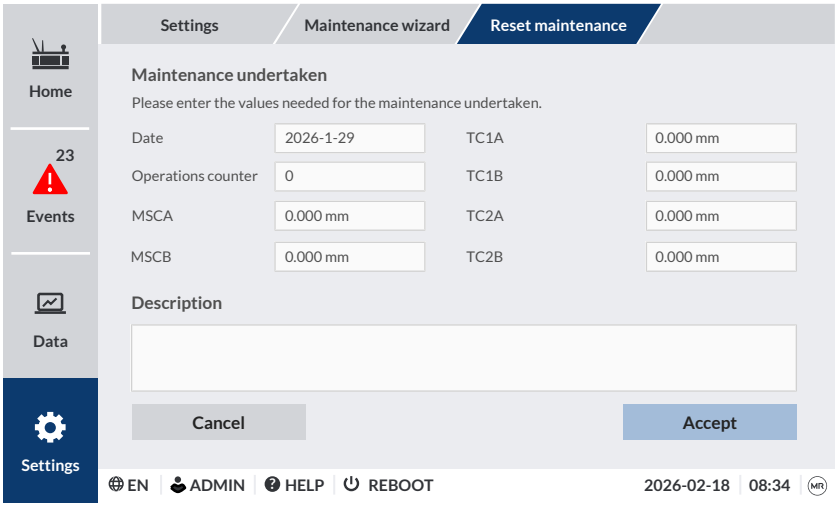


Figure 102: Performing and confirming maintenance

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.

8.5.8.4 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.

> If you have deactivated the "OLTC operator maintenance" or "Transformer operator maintenance" interval, the interval is shown grayed out in the maintenance overview.

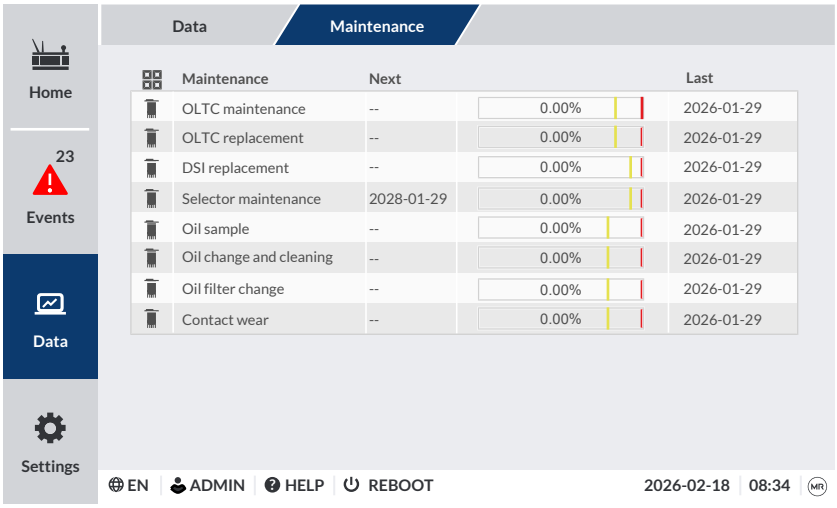


Figure 103: Maintenance overview

› Go to **Data** > **System** > **Maintenance**.

8.5.8.5 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
- Maintenance type
- Description

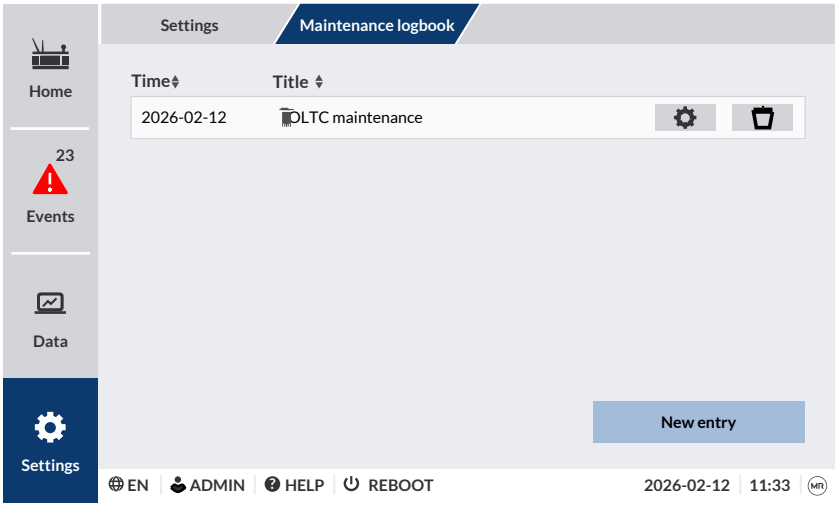


Figure 104: Maintenance logbook

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.

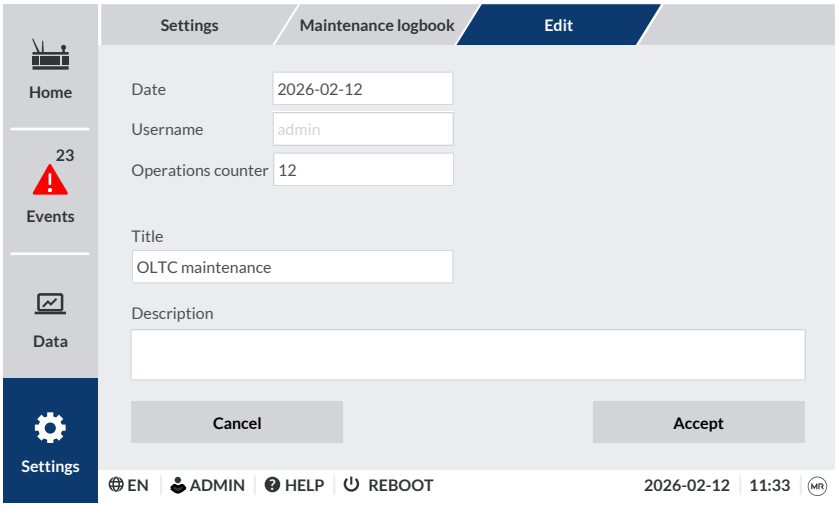


Figure 105: Editing an entry in the maintenance logbook

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.

8.5.8.6 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.

› Go to **Settings** > **Parameters** > **Active part** > **Maintenance events** or **Settings** > **Parameters** > **On-load tap-changer** > **Maintenance events**.

Suppressing a transformer maintenance event

You can use this parameter to set the number of on-load tap-change operations for which the event message for maintaining the transformer should be suppressed.

Suppressing an OLTC maintenance event

You can use this parameter to set the number of on-load tap-change operations for which the event message for maintaining the on-load tap-changer should be suppressed.

8.5.9 OLTC data

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

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

8.5.9.1 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 operating position or the tap position for the control system in accordance with the tap position table [▶Section 8.5.4, Page 167]. 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.
› Go to **Settings** > **Parameters** > **On-load tap-changer** > **OLTC data**.

Tap position message (analog)

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

> If you change this parameter, you must then ensure that the configured analog output value range [▶Section 8.1.15, Page 92] matches the value range in the tap position table [▶Section 8.5.4, Page 167]. Otherwise, the tap position will not be reported correctly.

BCD tap position message

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

8.5.9.2 Tap-change operations waiting time

> This parameter can only be set by the Reinhausen GmbH Technical Service department.

You can set the waiting time between 2 consecutive tap-change operations with this parameter. This function is used to prevent the on-load tap-changer from overheating due to frequent tap-change operations.

8.5.10 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.

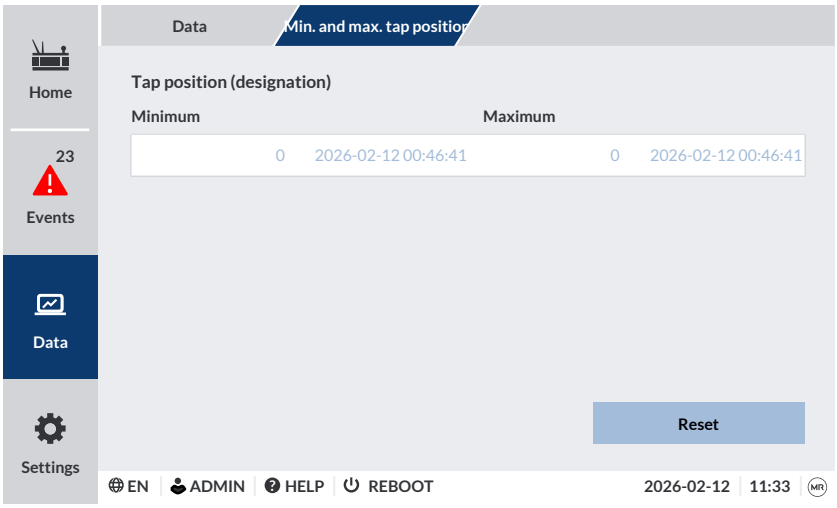


Figure 106: Minimum and maximum tap position

1. Go to **Data** > **On-load tap-changer** > **Min. and max. tap position (desig.)**.
2. As needed, select the **Reset** button to reset the minimum and maximum values.

8.6 Motor-drive unit and control cabinet

8.6.1 Control of the motor-drive unit

The following parameters let you configure control of the motor-drive unit.

8.6.1.1 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 device will issue the switching pulse until one of the following requirements has been met:

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

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

Time-controlled switching pulse

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

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

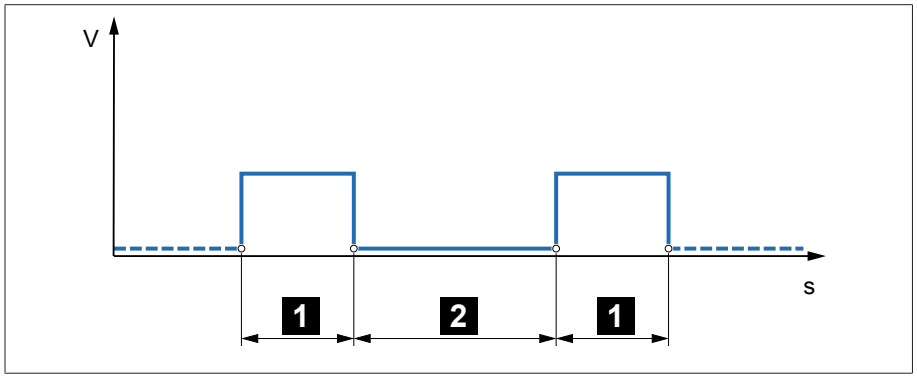


Figure 107: Switching pulse time and switching pulse pause

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.

8.6.1.2 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

> 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.

8.6.1.3 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 *Raise* output to increase the voltage. The device issues a signal via the *Lower* output to reduce the voltage.
Swapped	The device issues a signal via the *Lower* output to increase the voltage. The device issues a signal via the *Raise* output to reduce the voltage.

Table 80: 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 *RAISE* output to increase the reactive power. The device issues a signal via the *LOWER* output to reduce the reactive power.
Swapped	The device issues a signal via the *LOWER* output to increase the reactive power. The device issues a signal via the *RAISE* output to reduce the reactive power.

Table 81: Behavior

Switching direction monitoring

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

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

> Switching direction monitoring is not active if you control the motor-drive unit with a continuous pulse [▶Section 8.6.1.1, Page 177].

8.6.2 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
  - Dual code
  - Gray code
  - N/O contact series
  - Decadal contact series
- Analog signal
  - Injected current (0/4...20 mA)
  - Voltage (0...10 V)
  - Resistor contact series

8.6.2.1 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.

8.6.2.2 Analog tap position capture

8.6.2.2.1 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.

> The device is configured at the factory according to the order. However, should modifications be necessary, note the following sections.

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

8.6.2.2.2 Resistor contact series

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

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

To carry out the calibration, proceed as follows:

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

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

9 Maintenance and care

9.1 Cleaning the device

You can clean the device's housing with a dry cloth.

9.2 Updating application software

NOTICE

Damage to the device due to incompatible wiring and configuration.

If the configuration of the device inputs and outputs is changed as a result of updating the application software, the device can become damaged due to incompatible wiring.

› Before updating the device application software, wire it according to the connection diagram provided with the device.

Note that you can only transmit the application software to the device with the same serial number. The serial number belonging to the software can be found in the enclosed `config.txt` file.

Update the ISM® and MCONTROL®7R-A application software separately. The system automatically performs a version check before the update. If the versions differ, the display will show a corresponding message.

You can use one of the following methods to update the ISM® and MCONTROL® 7 R-A application software:

– Web-based visualization: The application software is on a PC and can be imported via the web-based visualization.

To do so, proceed as follows:

1. Copy the application software to the PC.
2. Establish a connection to the visualization. [▶Section 9.2.2, Page 183]
3. Update the ISM® application software [▶Section 9.2.3, Page 185] or MCONTROL® 7 R-A application software [▶Section 9.2.4, Page 186].

9.2.1 Copy the application software to the PC

Prior to downloading, check which software version is currently installed on your device (go to **Data** > **System** > **About the device**). Then download the update package for your software version as described in the following.

You can download the latest version of the application software from the Reinhausen GmbH customer portal. To do so, proceed as follows:

1. Call up the website www.reinhausen.com.
2. Select the **myReinhausen** button.
3. Log in with your login data or register.
4. In the **myEquipment** area, press the **Open** button.

5. If the desired device does not appear in the list, press the **Add device** button and enter the device data (serial number, name, location, etc.).
6. Select the desired device from the list.
7. Select the device in the **Firmware** tab and select the **Create firmware** button in the **MR Versions** entry for the desired version. If the firmware cannot be generated automatically, you will see the **Request** button, which you can use to send a request to Reinhausen GmbH.
   » The firmware is generated. You will receive an email when the firmware is available for download.
8. Press the **Download** button to save the firmware to the PC.
9. Press the **...** button to display the hash value for verifying the download.
10. Calculate the hash value of the downloaded zip file on your PC and compare it with the hash value displayed in the customer portal. If both values are identical, the file was downloaded correctly.

> Depending on your operating system, you can calculate the hash value of the file in different ways. If you run your PC with Windows 10, you can calculate the hash value in the command line with the following command:
> `certutil –hashfile <filename>.zip sha256`

11. Unzip the zip file on your PC.

» The application software has been downloaded correctly.

9.2.2 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).

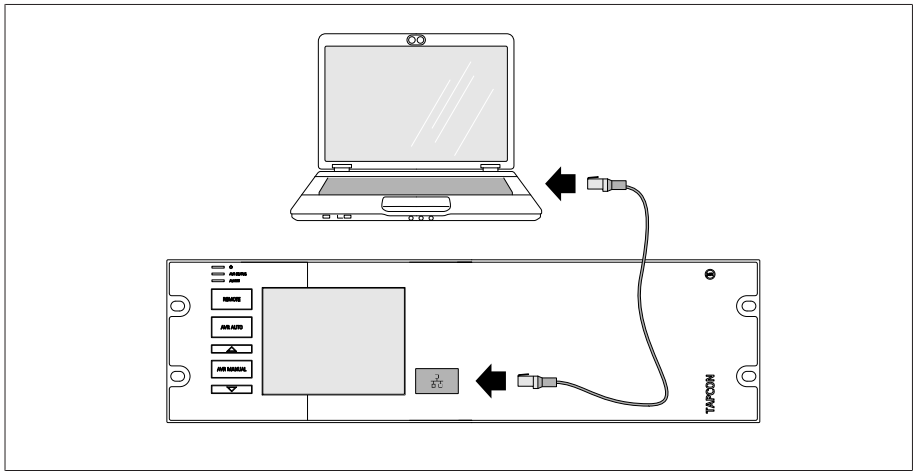


Figure 108: Establishing a connection via the front interface

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 a connection via the rear interface on the CPU assembly

To establish a connection to the visualization via the rear interface, you must connect a PC to interface X2 or X3 of the CPU assembly. The interface does not use a DHCP server, so you must assign a fixed IP address to your PC. To do this, observe the following configuration example:

Interface		Configuration
Standard	CPU-X2	IP address: 192.168.165.1 (not adjustable)
	PC	IP address: 192.168.165.100 Subnet mask: 255.255.255.0
Optional	CPU-X3	IP address: 192.0.1.230 (factory setting)
	PC	IP address: 192.0.1.100 Subnet mask: 255.255.255.0

Table 82: Interface configuration example

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™

To establish a connection, proceed as follows:

1. Connect PC and device via the CPU-X2 or CPU-X3 interface using an Ethernet cable (RJ45 plug).

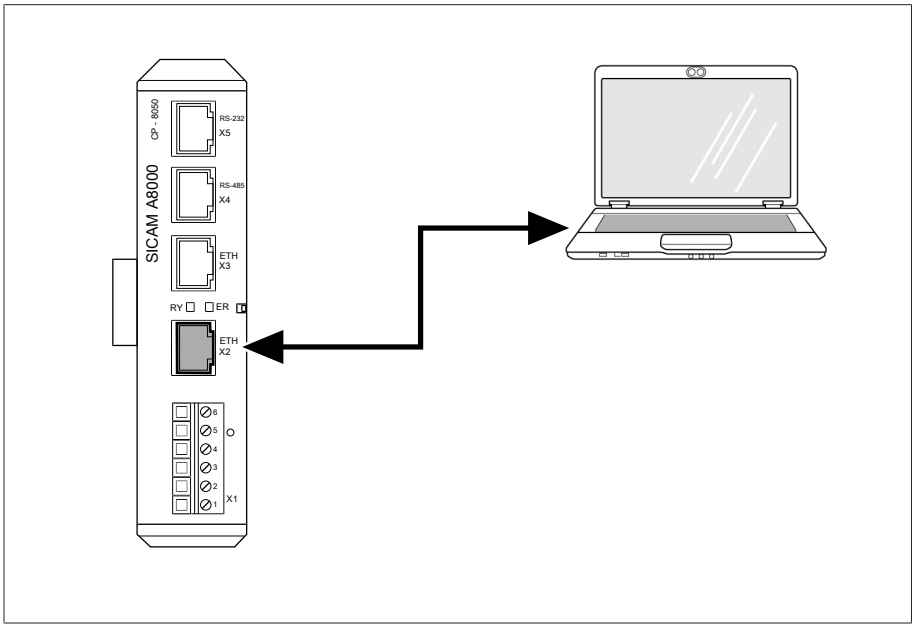


Figure 109: Establishing an example connection via the CPU-X2 interface

2. Assign a unique IP address to the PC in the same subnet as the device (e.g. `192.168.165.100`).
3. Enter the IP address of the visualization (`192.168.165.1`) in the PC's browser.

» The visualization is accessed.

9.2.3 Updating the ISM® application software

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.

When importing the system image for updating the system software from version 3.xx to 4.xx on ISM® Gen.2 devices, observe the following information:

- If you import a system image of the version 4.xx, it is no longer possible to import a system image of the version 3.xx (no downgrade).
- The system software update from version 3.xx to 4.xx is a two-stage update. Therefore, the device will be restarted several times during the update. Do not disconnect the device from the power supply during this process.
- The device reports on the update progress via the syslog [▶Section 8.1.8, Page 80].
- If a part of the update process fails, try to reimport the system image. If the update process fails again, contact Reinhausen GmbH.

Preparation

✓ The web-based visualization is accessed. [▶Section 9.2.2, Page 183]

1. Press the **LOGIN** button and log in as a user with the user role **Parameter configurator** or **Administrator**.
2. Go to **Data** > **System** > **About the device** and make a note of the ISM® application software version.

Creating a backup copy of the ISM® application software and event memory

1. Go to **Settings** > **Export** > **System image**.
2. Select the option **with history** and, optionally, **with TPLE**, and then press the button **Next** to export a backup copy of the current system.
3. If the software version is earlier than v3.430, save the settings manually (**Settings** > **Export** > **Settings**).
4. Press the **Start export** button to start the export.
5. Go to **Settings** > **Export** > **Event memory** to export a backup copy of the event memory (.csv file).
6. Press the **Start export** button to start the export.

Updating the ISM® application software

i When the ISM® application software is updated, the event memory on the device is deleted.

1. Go to **Settings** > **Import**.
2. Select **Browse**, select the file to be imported, and select **Start upload**.
   » The file is checked.
3. Optional: Select the desired options for the import.
4. 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.

Examination of success

1. Go to **Data** > **System** > **About the device** and compare the application software version with the version noted down. The version number must be higher.
2. If the software version was below v3.430 before the update, import the settings manually.

9.2.4 Updating the MCONTROL® 7 R-A application software

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.

Preparation

✓ The web-based visualization is accessed [▶ Section 9.2.2, Page 183].

1. Press the **LOGIN** button and log in as a user with the user role **Parameter configurator** or **Administrator**.
2. Go to **Data** > **System** > **About the device** and make a note of the MCONTROL® 7 R-A application software version.

Updating the MCONTROL® 7 R-A application software

1. Go to **Settings** > **Import** > **Backup and updates**.
2. Select **Browse**, select the file to be imported, and select **Start upload**.
   » The file is checked.
3. Optional: Select the desired options for the import.
4. Press the **Start update** button.
   » *NOTICE!* The device function is stopped.

» The data is imported, then the device is restarted.

Examination of success

› Go to **Data** > **System** > **About the device** and compare the MCONTROL® 7 R-A application software version with the version noted down previously. The version number must be higher.

10 Fault elimination

10.1 General faults

Characteristic/detail	Cause	Remedy
No function – ⏻ LED not lit up	No power supply	Check the power supply.
	Fuse tripped	Contact Reinhausen GmbH.
No function – *AVR STATUS* LED lights up red – No *O: Status Ok* message – The visualization displays the Device error display.	Device error	1. Check the syslog messages in the visualization and correct the cause of error where necessary. 2. Restart the device. 3. If the error persists, export the settings [▶ Section 8.1.20.1, Page 99] and then reset the device to factory settings. 4. If the error cannot be corrected, contact Reinhausen GmbH.
Relay chatter	High EMC load	Use shielded cables or external filters.
	Poor grounding	Check the functional ground.

Table 83: General faults

10.2 CPU

Characteristic/detail	Cause	Remedy
No function – LED *RY* is not lit – LED *ER* is not lit	No power supply	Check the power supply.
No function – LED *RY* is flashing – LED *ER* is lit	System start	Wait until the system has fully started.
No function – LED *RY* is lit – LED *ER* is lit	The assembly has detected an error	Contact Reinhausen GmbH.

Table 84: Faults of the CPU assembly

10.3 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.
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 85: No regulation in AUTO mode

10.4 Unwanted on-load tap-change operation

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

Table 86: Unexplained tap change

10.5 Human-machine interface

MCONTROL® 7 R-A

Characteristic/detail	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 Reinhausen GmbH.
	Connection cable between COM-X2 and CPU-X3 defective.	Check connection cable
Display – No reaction to input	Display has crashed.	Restart
Syslog message – Grid measurement unit on MCONTROL® 7 R-A failed – Analog output unit on MCONTROL® 7 R-A failed	-	Contact Reinhausen GmbH.

Table 87: MCONTROL® 7 R-A

Visualization

Characteristic/detail	Cause	Remedy
Connection cannot be established with visualization	Connection cable defective	Check the connection cable.
	SSL encryption active	Accept the SSL certificate in the browser.
		Call up the IP address using `https://`.
		Deactivate the SSL encryption.
	When establishing a connection via the 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 interface: IP addresses of visualization and SCADA are in the same subnet	Check setting of device's IP addresses and correct if necessary.
	When establishing a connection via the CPU interface: PC not in the same subnet as visualization	Check the settings of the IP addresses of the device and the PC and correct them if necessary.
Incorrect display of visualization in the web browser	Access to the visualization using a web browser after a software update	Delete the web browser's cache.

Table 88: Visualization

10.6 Incorrect measured values

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

Table 89: Incorrect measured values

10.7 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 synch".	Master and followers have different tap positions.	Check tap position capture or check why the tap-change operation has not been undertaken (e.g. mechanical defect), then perform one of the following steps: – 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.

Table 90: Parallel operation faults

10.8 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.
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 91: Tap position capture

10.9 Other faults

If you cannot find a solution to a malfunction, please contact Reinhausen GmbH. Have the following information available:

- Serial number
  - Name plate
  - 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 Reinhausen GmbH about this issue? If yes, then who was the contact?

11 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.

11.1 Removing the ISM Gen.2 assembly

The assembly is mounted on a cap rail with a bus connector. The bus connectors are plugged into each other and connect the individual assemblies. If you want to remove the bus connector in addition to the assembly, you must first remove all the assemblies that are located directly to the right of the desired assembly.

Proceed as follows to remove the assembly:

1. Remove all plugs from the assembly.

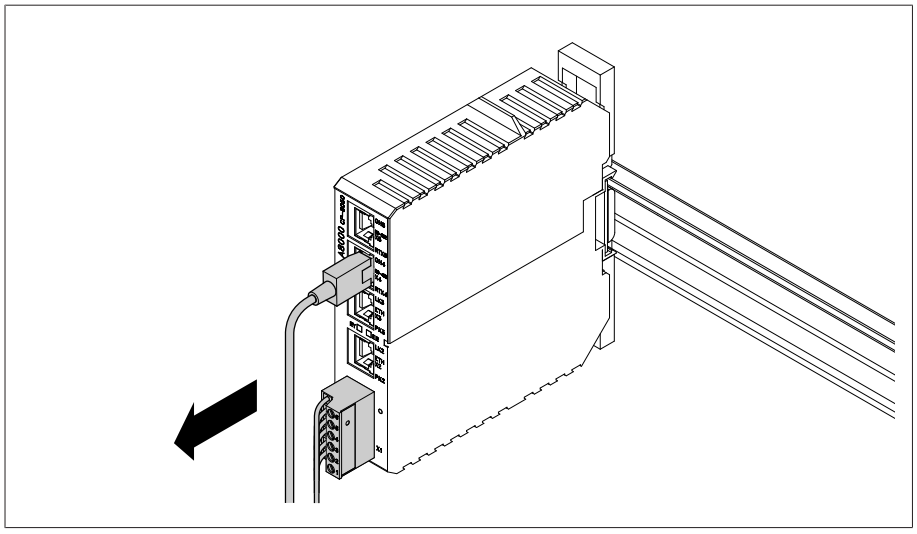


Figure 110: Remove all plugs from the assembly (example CPU assembly)

2. Release the locking latches. Make sure that the latches are completely released.

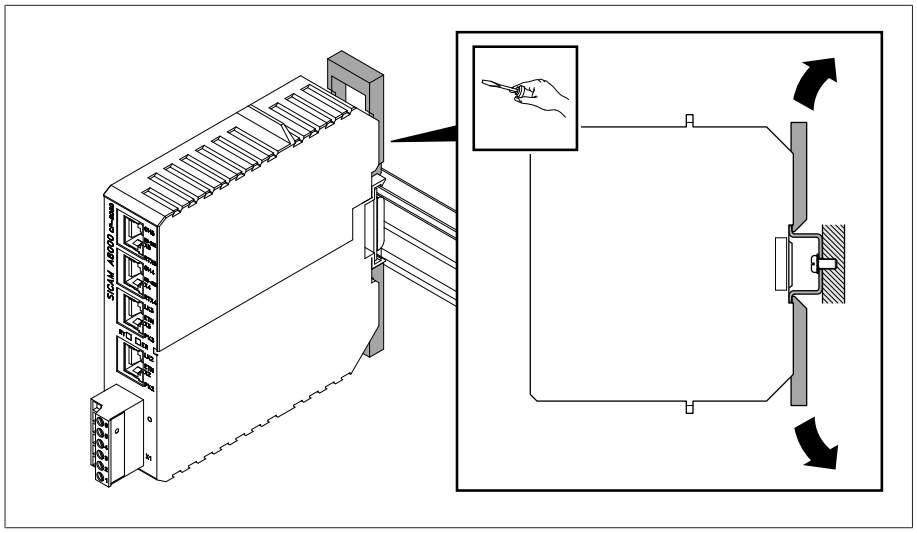


Figure 111: Releasing the locking latches

3. Pull out the assembly to the front.

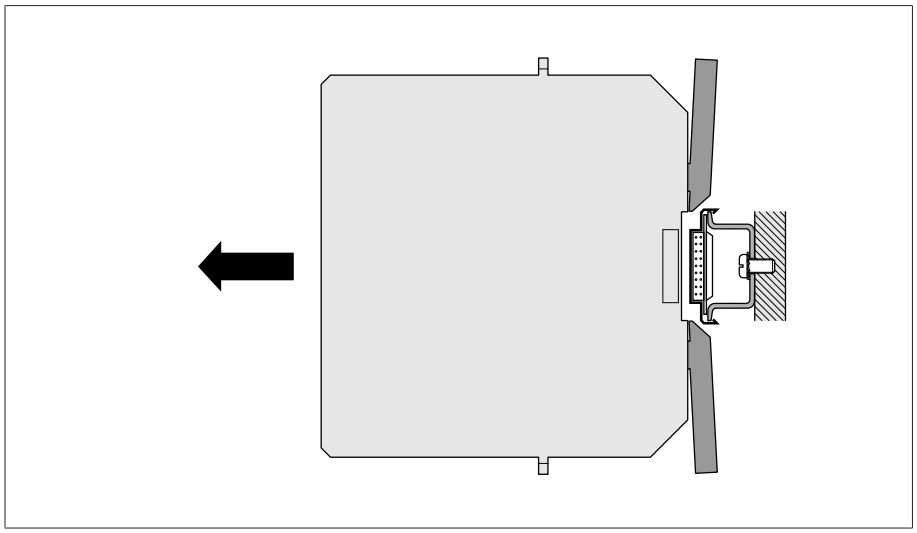


Figure 112: Pulling the assembly out

4. Optional: Push the bus connector to the right to disconnect it from the adjacent bus connector on the left. Then pull the bus connector off the cap rail.

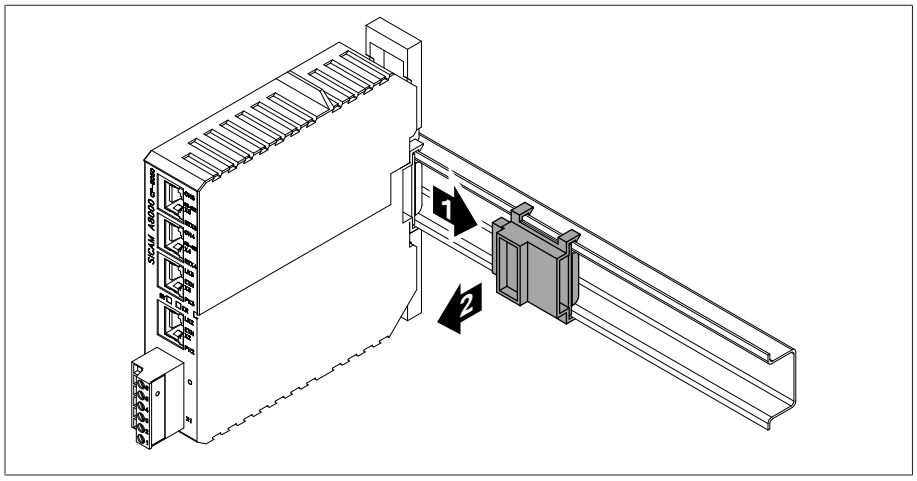


Figure 113: Removing the bus connector

12 Disposal

For disposal, observe the national requirements applicable in the country of use.

If you have any questions about removal and disposal, please contact the Reinhausen GmbH Technical Service department.

13 Technical data

13.1 Display elements

Display	7.0″ LCD, Backlight LED WVGA (800 x 480 pixels) 262,000 colors (16.7 million)
LEDs	8 LEDs for operation display and messages

13.2 MCONTROL® 7 R-A assemblies

13.2.1 MCONTROL® 7 R-A power supply

	MCONTROL® 7 R-A ACDC	MCONTROL® 7 R-A DC
Permissible voltage range	85 to 265 V AC / V DC U_N: 100...240 V AC U_N: 110...240 V DC	U_N: 48...60 V DC -20%, +15%
Permissible frequency range	50/60 Hz	-
Power consumption	50 W	50 W
Internal fuse	5 x 20 mm; slow-blow fuse; rated voltage: 250 VAC; rated current: 1.25 A; manufacturer LITTELFUSE INC; type 02151.25MXP	5 x 20 mm; slow-blow fuse; rated voltage: 500 VAC/ 400 VAC; rated current: 2.0 A; manufacturer LITTELFUSE INC; type 0477002.MXP

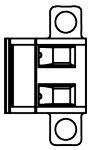
Interface	Pin	Description MCONTROL® 7 R-A ACDC	Description MCONTROL® 7 R-A DC
	2	L1 (L+)	L+
	1	N (L-)	L-

Table 92: Connection X2

	U1 / I1
Measurement	1-phase
Voltage measurement	U_N: 100 VAC / 110 VAC / 120 VAC / 100 VAC√3 / 110 VAC√3 / 120 VAC√3 Overload capability: 250 VAC Measuring range: 20...200 VAC Measuring accuracy (at U_N, -25...+70 °C): <±0.3% Rated frequency: f_n: 50 or 60 Hz; measuring range: f_n: ±10% Measurement category: CAT III <2,000 m; CAT II <3,000 m in accordance with IEC 61010-2-30 Surge test voltage: 5 kV in accordance with IEC 60255-27
Current measurement	I_N: 0.2 / 1 / 5 A Measuring range: 5...210% I_n Overload capacity: 12.5 A (continuous), 500 A (for 1 s) Measuring accuracy (at I_N, -25...+70 °C): <±0.5% (at 1 A; 5 A); <±1% (at 0.2 A) Rated frequency: f_n: 50 or 60 Hz; measuring range: f_n: ±10% Intrinsic consumption: <0.1 W to I=1 A; <0.3 W to I=5 A Measurement category: CAT III <2,000 m; CAT II <3,000 m in accordance with IEC 61010-2-30
Phase angle	Measuring accuracy (-25...+70°C): U_x/I_x <±0.5°; U_x/U_y <±0.3°
Frequency measurement	f_N: 50 / 60 Hz Measuring range: 45...65 Hz Measuring accuracy (-25...+70°C): <± 0.03%

Table 93: Technical data voltage measurement/current measurement

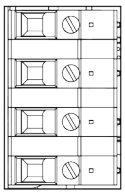
Interface	Pin	Description	
	4	N	VT
	3	L	VT
	2	I	CT
	1	k	CT

Table 94: Connection X1

13.2.2 MCONTROL® 7 R-A communication interfaces

Description	Assembly for converting interfaces and media
Interfaces	1x RS232/RS485 (RJ45): COM X1 1x Ethernet (RJ45): COM-X2 1x RS232 (D-SUB): COM X3 1x plug terminal 9-pin: COM X4
COM X1	Internal system interface for connecting the COM X4 interface to the central processing unit (CPU)
COM X2	Internal system interface for connecting the MCONTROL® 7 R-A to the central processing unit (CPU)

COM X3	Serial SCADA interface RS232 – 9-pin D-SUB connector
COM X4	9-pin plug terminal – Tap position capture via resistor contact series – CAN bus – Serial SCADA interface RS485 – Electrically isolated

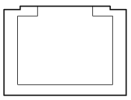
Interface	Pin	Description
	1	CTS (I) (RS232); TXD-/RXD- (RS485)
	2	RTS (O) (RS232); TXD+/RXD+ (RS485)
	3	VCC/OUT 5 V/12 V (RS232)
	4	TXD (O) (RS232)
	5	RXD (I) (RS232)
	6	GND
	7	DCD (I) (RS232)
	8	DTR (O) (RS232)

Table 95: COM X1 (RS232/RS485)

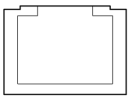
Interface	Pin	Description
	1	TxD+
	2	TxD-
	3	RxD+
	4	NC
	5	NC
	6	RxD-
	7	NC
	8	NC

Table 96: COM-X2 (RJ45)

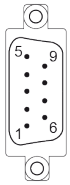
Interface	Pin	Description
	2	RxD
	3	TxD
	5	GND

Table 97: COM X3 (RS232)

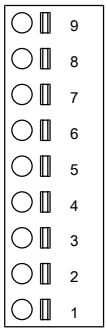
Interface	Pin	Description
	1	CAN H (CAN bus)
	2	CAN GND (CAN bus)
	3	CAN L (CAN bus)
	4	RS485 P
	5	RS485 GND
	6	RS485 N
	7	U IN 10 V (resistor contact series)
	8	I OUT 20 mA (resistor contact series)
	9	GND (resistor contact series)

Table 98: COM X4

13.3 ISM® assemblies

13.3.1 Power supply CP5.242

	PULS CP5.242
Permissible voltage range	85...264 V AC 88...360 V DC U_N: 100...240 V AC U_N: 110 to 300 V DC
Permissible frequency range	50/60 Hz
Maximum power consumption (continuous)	70 W

Table 99: CP5.242 assembly technical data

13.3.2 CPU (central processing unit)

	CPU
Processor	800 MHz
RAM	512 MB
NVRAM (SRAM with battery backup)	256 kB
Application memory	4 GB
Interfaces	1x serial RS232 1x serial RS485/422 (electrically isolated) 2x Ethernet 10/100 Mbps (electrically isolated)
Outputs	2x 1 (electrically isolated) for "Status OK" message Nominal voltage 24/48/60 V DC Continuous current 1 A

Table 100: Technical data of CPU assembly

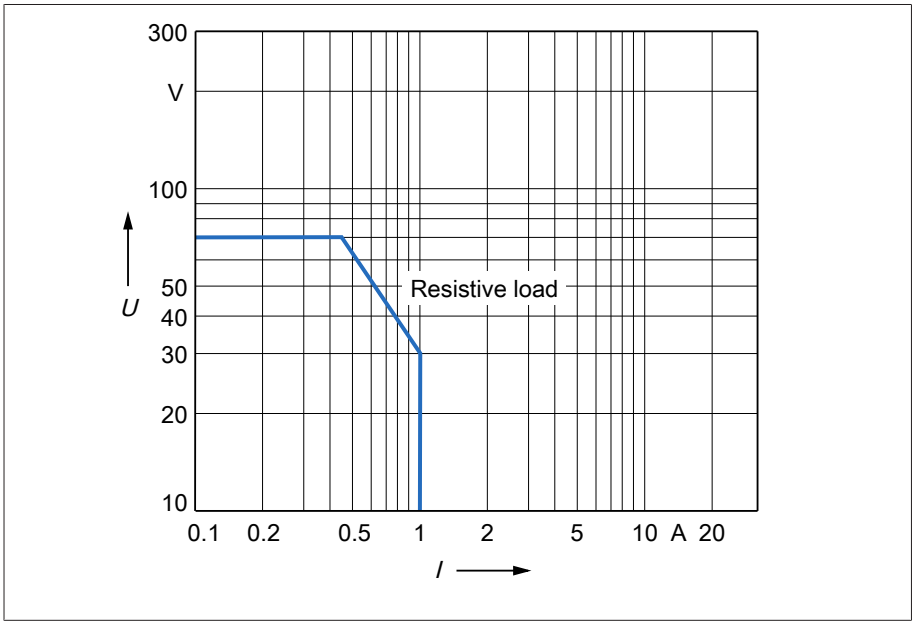


Figure 114: Contact load capacity of CPU-X1 digital outputs with resistive load

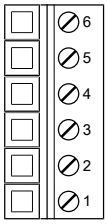
Interface	Pin	Description
	1	STATUS-OK_COM
	2	STATUS-OK_NC
	3	STATUS-OK_NO
	4	Not used
	5	Not used
	6	Not used

Table 101: Connector X1 (Status OK)

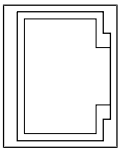
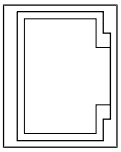
Interface	Pin	Description
	1	TxD+
	2	TxD-
	3	RxD+
	4	NC
	5	NC
	6	RxD-
	7	NC
	8	NC-

Table 102: Connectors X2, X3 (Ethernet)

Interface	Pin	Description
	1	TXD-/RXD- (RS485/422)
	2	TXD+/RXD+ (RS485/422)
	3	NC
	4	NC
	5	NC
	6	GND

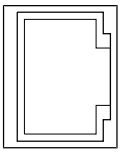
Interface	Pin	Description
	7	RXD- (RS422)
	8	RXD+ (RS422)

Table 103: Connector X4 (RS485/422)

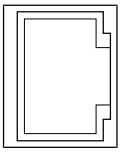
Interface	Pin	Description
	1	CTS (I)
	2	RTS (O)
	3	VCC/OUT 5 V/12 V
	4	TXD (O)
	5	RXD (I)
	6	GND
	7	DCD (I)
	8	DTR (O)

Table 104: Connector X5 (RS232)

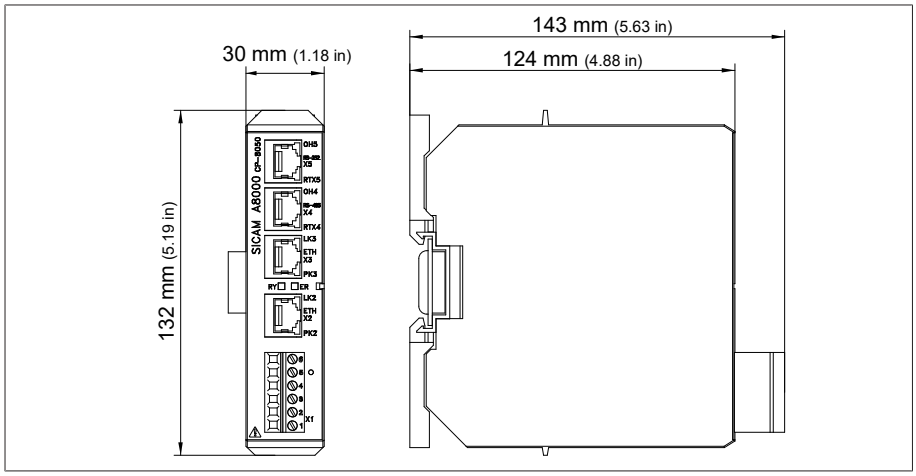


Figure 115: CPU dimensions

Optional accessories	
Media converter for serial interface (RS232)	Adapter CM-0847 from RJ45 to fiber-optic cable: – F-ST, 850 nm – Range max. 1,500 m – Rest position can be set via a slide switch. The rest position must be the same on both ends of the fiber-optic cable.

Table 105: Optional accessories

13.3.3 Voltage measurement U 3

	U 3
Measurement	3-phase
Voltage inputs	4 (electrically isolated)
Nominal voltage U_N (AC) U_N typical (AC)	20...200 V 110 V, 110 V/√3, 230 V
Max. measured voltage	150% U_N when $U_N \leq 110$ V 110% U_N when $U_N \leq 250$ V
Measuring accuracy[13]	Deviation < ±0.2% · U_N
Frequency measurement	f_N: 16.7, 50 or 60 Hz Measuring range: f_N ±15%

Table 106: U 3 assemblies technical data

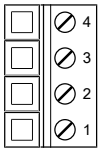
Interface	Pin	Description
	4	Common reference output 1
	3	Common reference output 0
	2	Digital output 1
	1	Digital output 0

Table 107: Connector X1

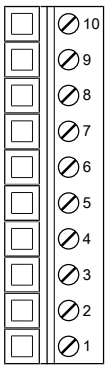
Interface	Pin	Description
	10	Not used
	9	Voltage input phase 1
	8	Voltage input neutral conductor 1
	7	Voltage input phase 2
	6	Voltage input neutral conductor 2
	5	Voltage input phase 3
	4	Voltage input neutral conductor 3
	3	Not used
	2	Voltage input phase 4
	1	Voltage input neutral conductor 4

Table 108: Connector X2

13 At reference conditions 23 °C; deviation 100 ppm/K

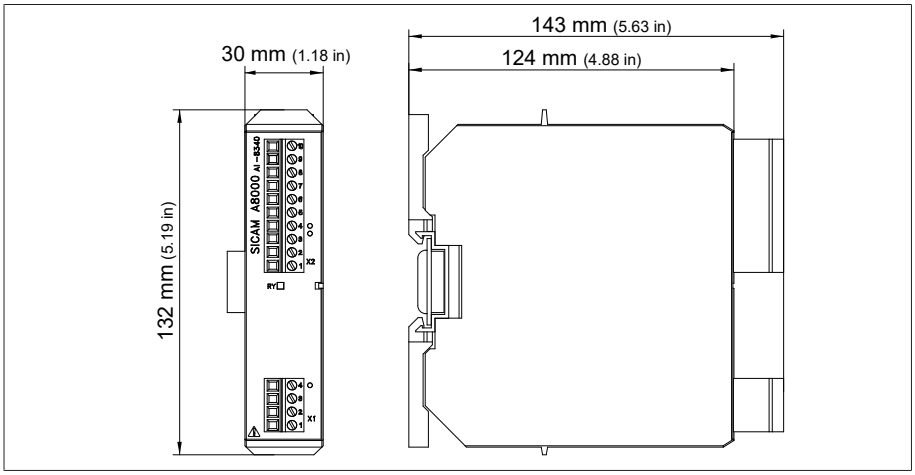


Figure 116: U 3 dimensions

13.3.4 Current measurement I 3

	I 3
Measurement	3-phase
Nominal current I_N	0.2...6 A 1 A / 2 A / 5 A / 6 A
Overload capability	2 x I_N
Measuring accuracy[14]	Deviation < ±0.2% · I_N (1 A, 5 A) Deviation < ±1% · I_N (0.2 A)
Rated frequency	50 / 60 / 16.7 Hz
Intrinsic consumption	< 0.1 W up to I = 1 A < 0.3 W up to I = 5 A

Table 109: I 3 assembly technical data

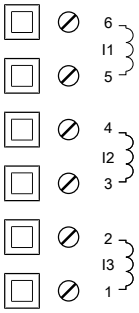
Interface	Pin	Description
	6	Current input phase 1
	5	Current input neutral conductor 1
	4	Current input phase 2
	3	Current input neutral conductor 2
	2	Current input phase 3
	1	Current input neutral conductor 3

Table 110: Connector X1

14 At reference conditions 23 °C; deviation 100 ppm/K

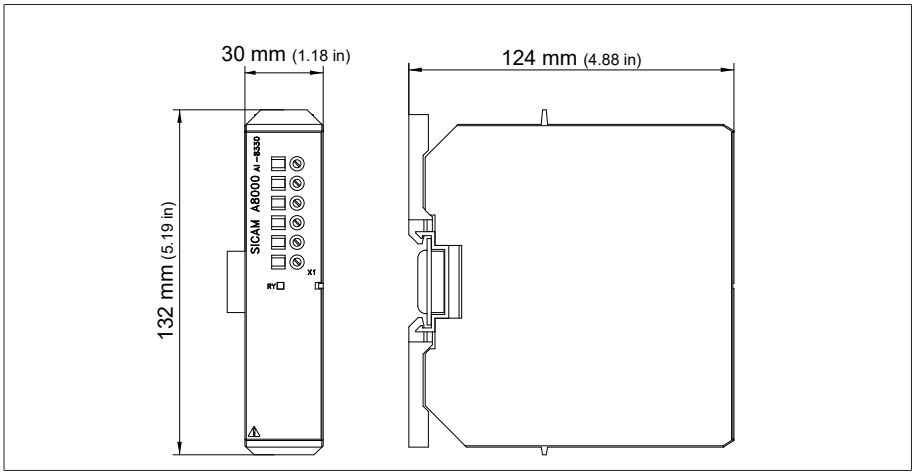


Figure 117: I 3 dimensions

13.3.5 Digital inputs DI 16-24 V

	DI 16-24V
Inputs	2 x 8, plug-based electrical isolation
Nominal voltage	24 V DC
Max. operating voltage	31.2 V DC
Logical 0	≤ 12 V
Logical 1	≥ 18 V
Input current	0.9...4.8 mA at 18...31.2 V

Table 111: DI 16-24V assembly technical data

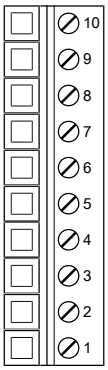
Interface	Pin	Description
	10	Common reference (common)
	9	Common reference (common)
	8	Input 7
	7	Input 6
	6	Input 5
	5	Input 4
	4	Input 3
	3	Input 2
	2	Input 1
	1	Input 0

Table 112: Connector X1 (group 0)

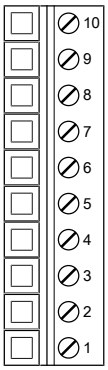
Interface	Pin	Description
	10	Common reference (common)
	9	Common reference (common)
	8	Input 17
	7	Input 16
	6	Input 15
	5	Input 14
	4	Input 13
	3	Input 12
	2	Input 11
	1	Input 10

Table 113: Connector X2 (group 1)

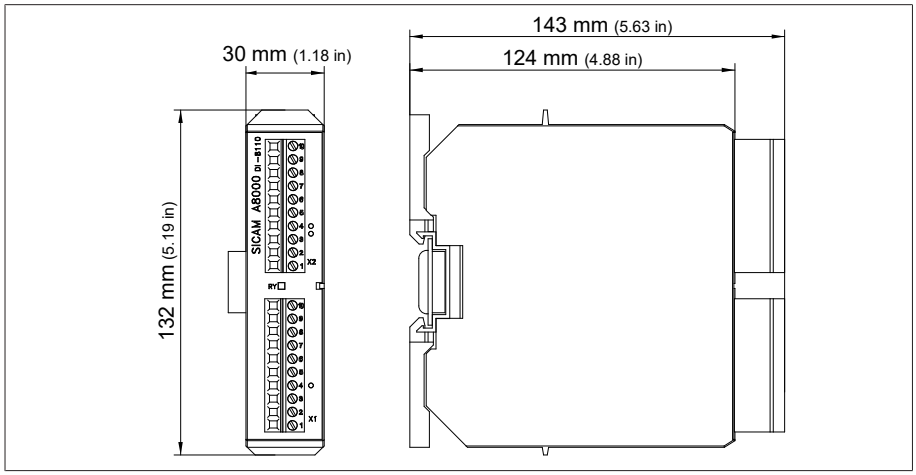


Figure 118: DI 16-24V dimensions

13.3.6 Digital inputs DI 16-110 V

	DI 16-110 V
Inputs	2 x 8, plug-based electrical isolation
Nominal voltage	110 V DC 110...127 V AC ± 10% (50/60 Hz)
Max. operating voltage	143 V DC 144 V AC
Logical 0	≤ 55 V DC, ≤ 44 V AC
Logical 1	≥ 82.5 V DC, ≥ 96 V AC
Input current	0.4...1.4 mA at 82.5...143 V

Table 114: DI 16-110V assembly technical data

Derating begins at an ambient temperature of 65 °C. In this case, only operate a maximum of 13 inputs at the same time.

⚠ 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.

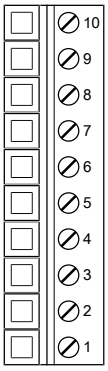
Interface	Pin	Description
	10	Common reference (common)
	9	Common reference (common)
	8	Input 7
	7	Input 6
	6	Input 5
	5	Input 4
	4	Input 3
	3	Input 2
	2	Input 1
	1	Input 0

Table 115: Connector X1 (group 0)

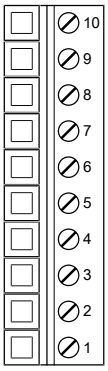
Interface	Pin	Description
	10	Common reference (common)
	9	Common reference (common)
	8	Input 17
	7	Input 16
	6	Input 15
	5	Input 14
	4	Input 13
	3	Input 12
	2	Input 11
	1	Input 10

Table 116: Connector X2 (group 1)

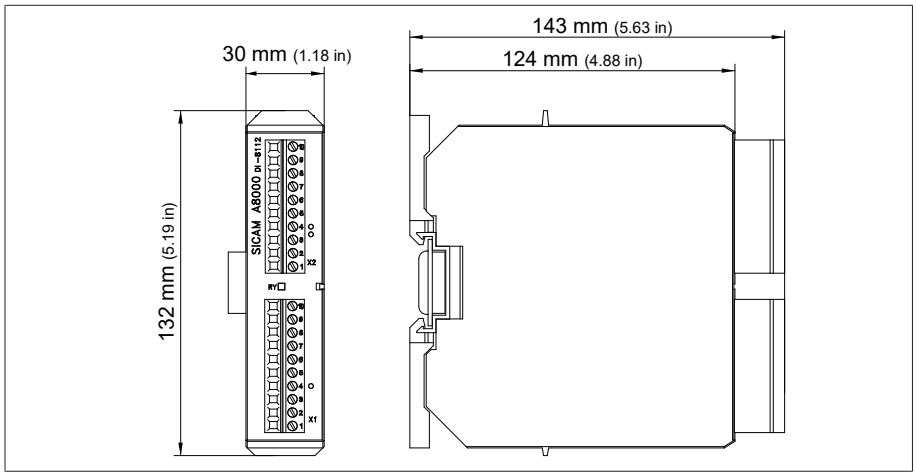


Figure 119: DI 16-110V dimensions

13.3.7 Digital inputs DI 16-220 V

	DI 16-220 V
Inputs	2 x 8, plug-based electrical isolation
Nominal voltage	220 V DC
Max. operating voltage	253 V DC
Logical 0	≤ 110 V
Logical 1	≥ 165 V
Input current	0.3...0.7 mA at 165...253 V

Table 117: DI 16-220V assembly technical data

Derating begins at an ambient temperature of 65 °C. In this case, only operate a maximum of 13 inputs at the same time.

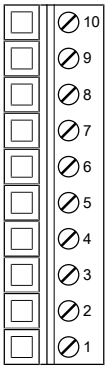
Interface	Pin	Description
	10	Common reference (common)
	9	Common reference (common)
	8	Input 7
	7	Input 6
	6	Input 5
	5	Input 4
	4	Input 3
	3	Input 2
	2	Input 1
	1	Input 0

Table 118: Connector X1 (group 0)

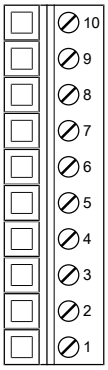
Interface	Pin	Description
	10	Common reference (common)
	9	Common reference (common)
	8	Input 17
	7	Input 16
	6	Input 15
	5	Input 14
	4	Input 13
	3	Input 12
	2	Input 11
	1	Input 10

Table 119: Connector X2 (group 1)

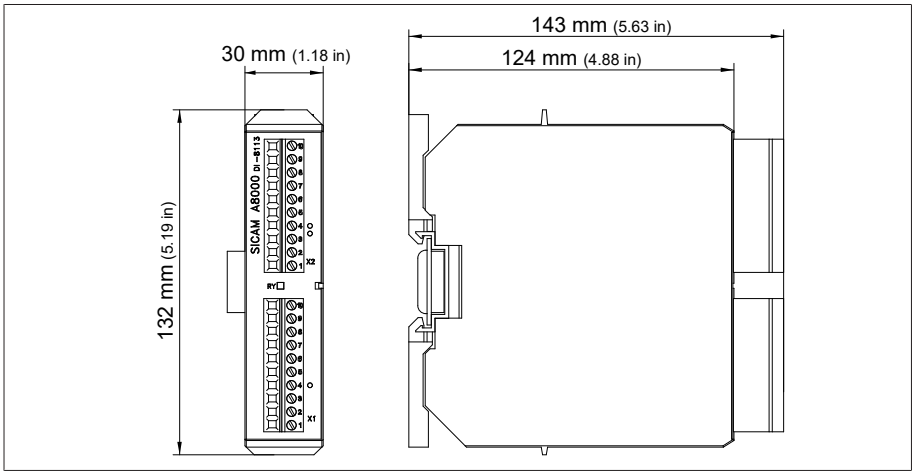


Figure 120: DI 16-220V dimensions

13.3.8 Digital outputs DO 8

	DO 8
Outputs (plug-based electrical isolation)	8 relays 4 groups per module
Switching voltage	DC: 24 V, 48 V, 60 V, 110 V, 220 V AC: 110 V, 230 V
Contact load capacity	Min.: 5 V DC, 10 mA Max. DC: See diagram Max. AC: 250 V; 3 A (8 active outputs) or 5 A (4 active outputs)

Table 120: DO 8 assembly technical data

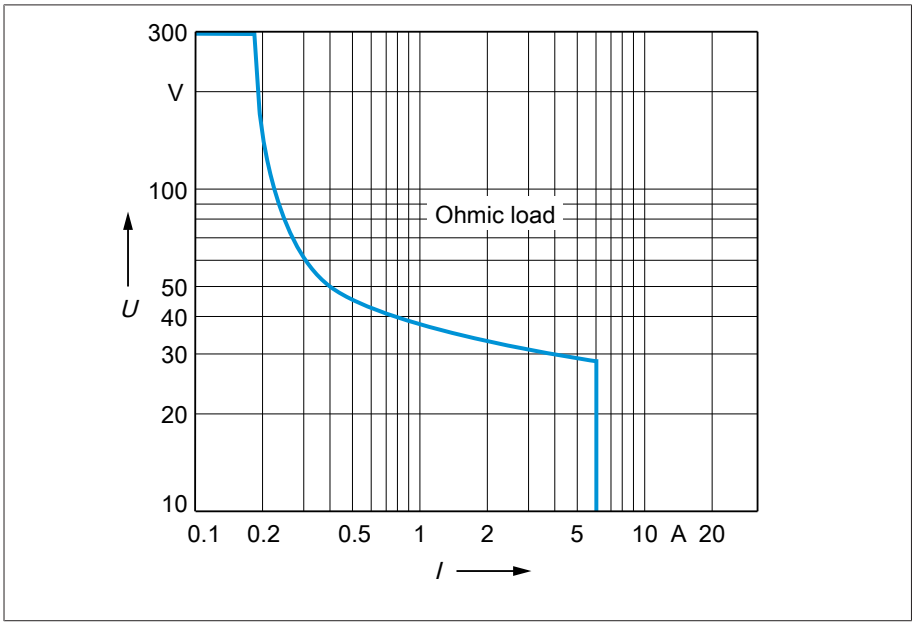


Figure 121: Contact load capacity of digital outputs with resistive load

⚠ CAUTION

Electric shock!

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

- Use the same voltage ranges within a plug.
- Use the same phase within a plug.

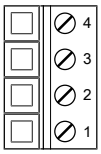
Interface	Pin	Description
	4	Common reference (common) output 1
	3	Common reference (common) output 0
	2	Output 1
	1	Output 0

Table 121: Connector X1 (group 0)

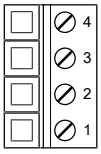
Interface	Pin	Description
	4	Common reference (common) output 3
	3	Common reference (common) output 2
	2	Output 3
	1	Output 2

Table 122: Connector X2 (group 1)

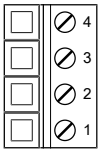
Interface	Pin	Description
	4	Common reference (common) output 5
	3	Common reference (common) output 4
	2	Output 5
	1	Output 4

Table 123: Connector X3 (group 2)

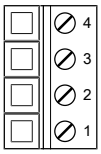
Interface	Pin	Description
	4	Common reference (common) output 7
	3	Common reference (common) output 6
	2	Output 7
	1	Output 6

Table 124: Connector X4 (group 3)

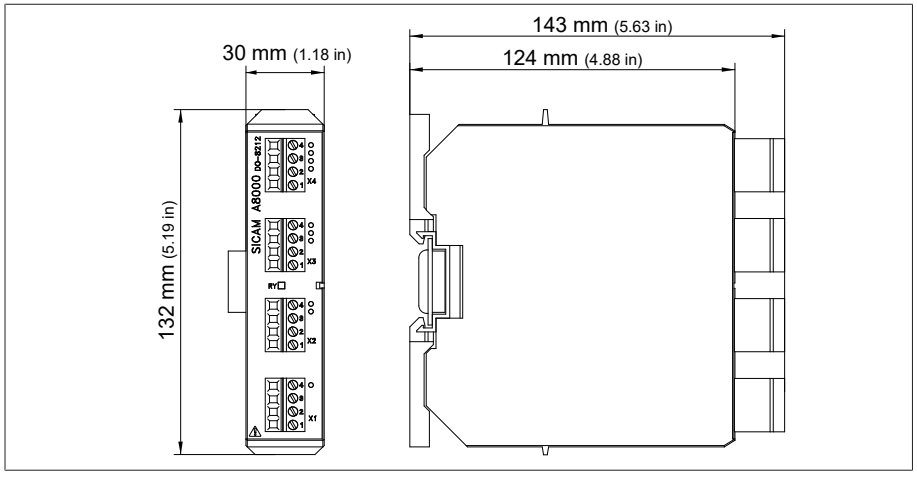


Figure 122: DO 8 dimensions

13.3.9 Analog inputs AI 4-T

	AI 4-T
Inputs (electrically isolated)	2 x 2
Measuring range	40...400 Ω (Pt100) 400...4,000 Ω (Pt1000)
Accuracy	0.19% at 0...+50 °C 0.4% at -40...+70 °C
Reference current	0.25 mA
Max. conductor resistance outgoing and return conductor	300 Ω

Table 125: AI 4-T assembly technical data

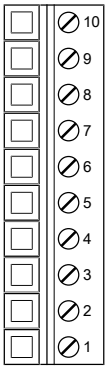
Interface	Pin	Description
	10	IREF1- current output 1
	9	IN V1- voltage input 1
	8	IN V1+ voltage input 1
	7	IREF1+ current output 1
	6	Not used
	5	Not used
	4	IREF0- current output 0
	3	IN V0- voltage input 0
	2	IN V0+ voltage input 0
	1	IREF0+ current output 0

Table 126: Connector X1 (group 0)

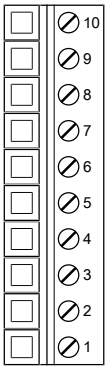
Interface	Pin	Description
	10	IREF3- current output 3
	9	IN V3- voltage input 3
	8	IN V3+ voltage input 3
	7	IREF3+ current output 3
	6	Not used
	5	Not used
	4	IREF2- current output 2
	3	IN V2- voltage input 2
	2	IN V2+ voltage input 2
	1	IREF2+ current output 2

Table 127: Connector X2 (group 1)

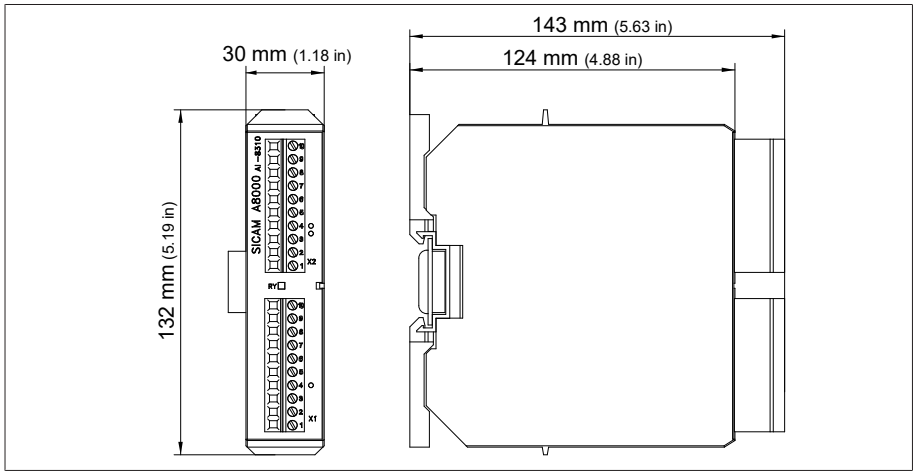


Figure 123: AI 4-T dimensions

13.3.10 Analog inputs AI 4

	AI 4
Inputs (electrically isolated)	4 x 1
Measuring range	0...20 mA, overcurrent approx. 20% 0...10 V, overvoltage approx. 30%
Accuracy	0.15% at 25°C Current 0.2% at 0...50 °C 0.3% at -20...70°C 0.4% at -40...70°C Voltage 0.4% at 0...50°C 0.5% at -20...70°C 0.6% at -40...70°C
Input impedance	52 Ω at 0...20 mA 20.5 kΩ at 0...10 V

Table 128: AI 4 assembly technical data

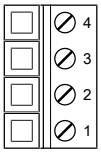
Interface	Pin	Description
	4	V0 U- voltage input
	3	V0 I- current input
	2	V0 I+ current input
	1	V0 U+ voltage input

Table 129: Connector X1 (group 0)

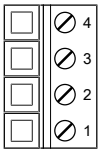
Interface	Pin	Description
	4	V1 U- voltage input
	3	V1 I- current input
	2	V1 I+ current input
	1	V1 U+ voltage input

Table 130: Connector X2 (group 1)

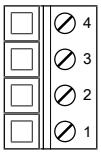
Interface	Pin	Description
	4	V2 U- voltage input
	3	V2 I- current input
	2	V2 I+ current input
	1	V2 U+ voltage input

Table 131: Connector X3 (group 2)

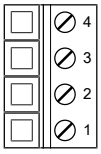
Interface	Pin	Description
	4	V3 U- voltage input
	3	V3 I- current input
	2	V3 I+ current input
	1	V3 U+ voltage input

Table 132: Connector X4 (group 3)

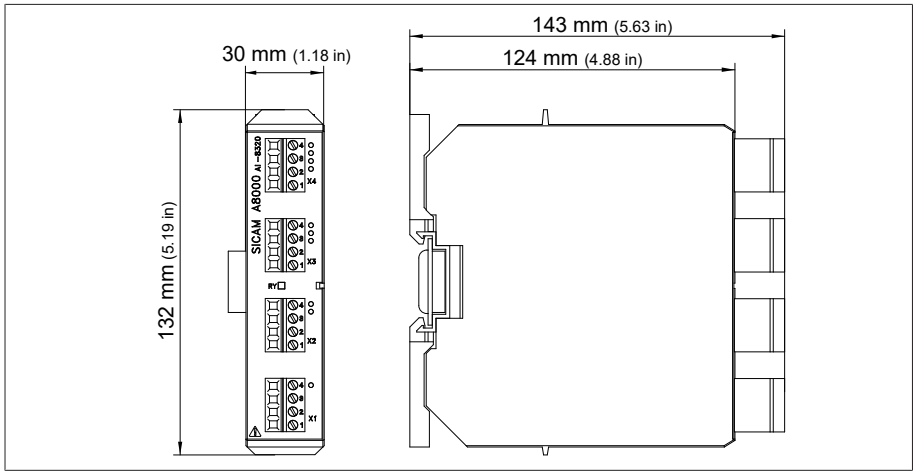


Figure 124: AI 4 dimensions

13.3.11 Analog outputs AO 4

	AO 4
Outputs (electrically isolated)	4 x 1
Signal range	Max. 0...10 V on min. 1 kΩ load Max. 0/4...20 mA on max. 1 kΩ load
Accuracy	0.3% at 25 °C 0.4% at 0 °C to 50 °C 0.7% at -20 °C to 70 °C 0.8% at -40 °C to 70 °C
Resistor contact series	Maximum resistance 100 ... 600 Ω, max. 35 tap positions

Table 133: AO 4 assembly technical data

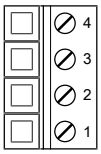
Interface	Pin	Description
	4	Not used
	3	V0- current/voltage output
	2	V0+ current/voltage output
	1	Not used

Table 134: Connector X1 (group 0)

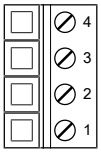
Interface	Pin	Description
	4	Not used
	3	V1- current/voltage output
	2	V1+ current/voltage output
	1	Not used

Table 135: Connector X2 (group 1)

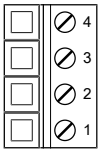
Interface	Pin	Description
	4	Not used
	3	V2- current/voltage output
	2	V2+ current/voltage output
	1	Not used

Table 136: Connector X3 (group 2)

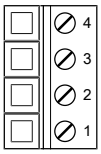
Interface	Pin	Description
	4	Not used
	3	V3- current/voltage output
	2	V3+ current/voltage output
	1	Not used

Table 137: Connector X4 (group 3)

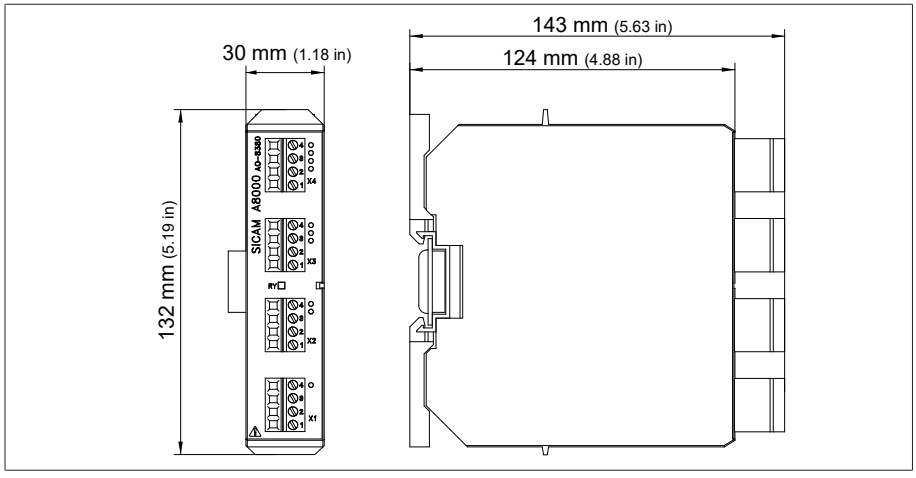


Figure 125: AO 4 dimensions

13.3.12 System networking COM-ETH

	COM-ETH
Interfaces	5x Ethernet via RJ45
RJ45	Max. 100 m (per section) 10/100 Mbps 100 Mbps total bandwidth for all interfaces

Table 138: COM-ETH assembly technical data

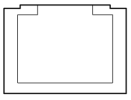
Interface	Pin	Description
	1	TxD+
	2	TxD-
	3	RxD+
	4	NC
	5	NC
	6	RxD-
	7	NC
	8	NC-

Table 139: Connectors X1...X5 (Ethernet)

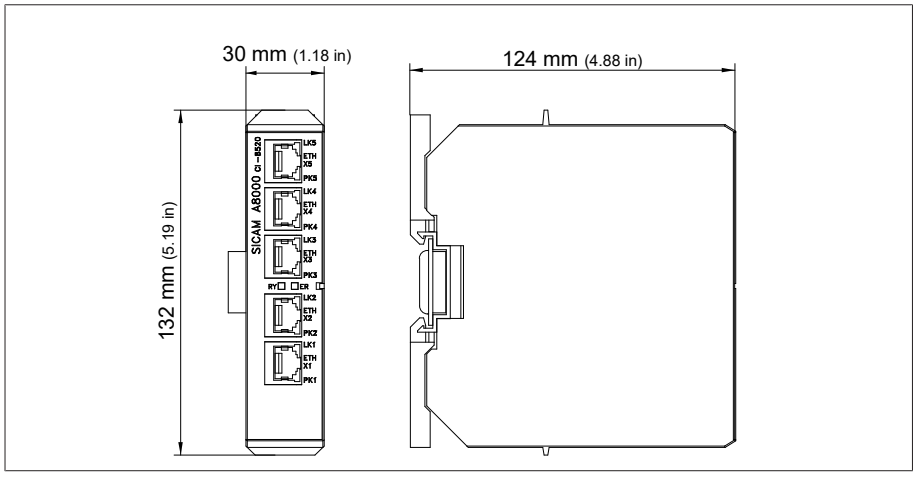


Figure 126: COM-ETH dimensions

13.3.13 System networking COM-ETH-FO

	COM-ETH-FO
Interfaces	3x Ethernet via RJ45 2x duplex LC (SFP)
RJ45	Max. 100 m (per section) 10/100 Mbps 100 Mbps total bandwidth for all interfaces
Fiber-optic cable	Max. 2000 m 100 Mbps 100 Mbps total bandwidth for all interfaces Light-emitting diode: class 1 Wave length: 1310 nm Max. optical output power: <1 mW (in accordance with IEC 60825-1:2014)
Redundancy protocols (optional)	HSR, PRP, RSTP

Table 140: COM-ETH-FO assembly technical data

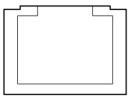
Interface	Pin	Description
	1	TxD+
	2	TxD-
	3	RxD+
	4	NC
	5	NC
	6	RxD-
	7	NC
	8	NC-

Table 141: Connectors X1...X3 (Ethernet)

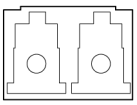
Interface	Description
	Fiber glass 50/125 and 62.5/125 multimode SFP optical transceiver, 60 km single-mode fiber-optic cable (optional for long distances)

Table 142: Connector X4...X5 (Duplex-LC)

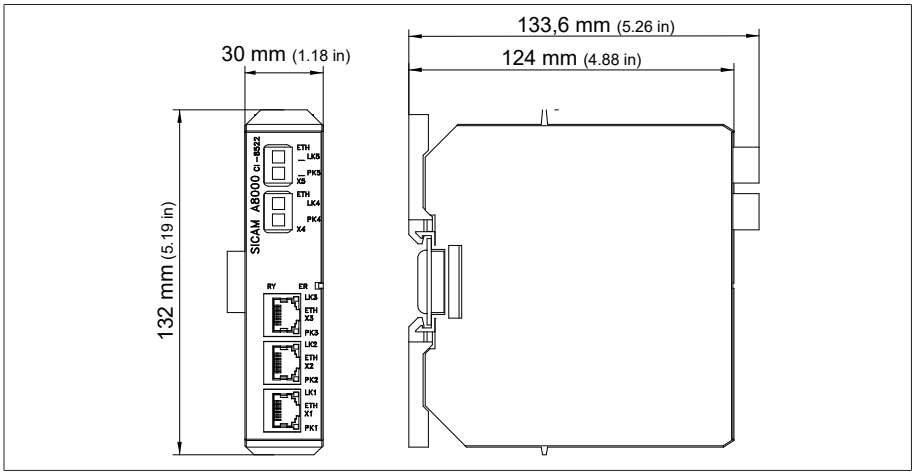


Figure 127: COM-ETH-FO dimensions

13.3.14 System networking BES

	BES
Interfaces	2x Ethernet via RJ45
RJ45	Max. 100 m (per section) 10/100 Mbps
Input voltage	18...78 V DC U_N 24...60 V DC
Input current	0.6/0.3/0.25 A (24/48/60 VDC)

Table 143: BES assembly technical data

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

Table 144: Terminal X1

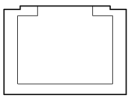
Interface	Pin	Description
	1	TxD+
	2	TxD-
	3	RxD+
	4	NC
	5	NC
	6	RxD-
	7	NC
	8	NC-

Table 145: Jacks X2, X3 (Ethernet)

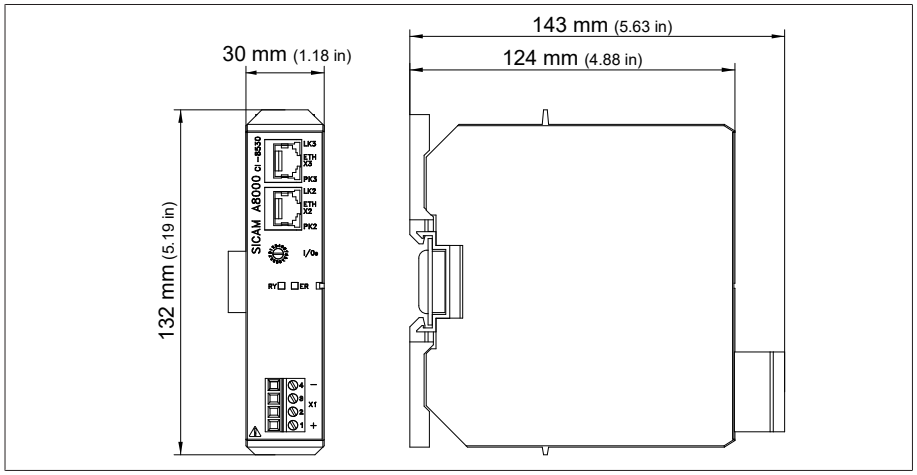


Figure 128: BES dimensions

13.3.15 Tap position capture / resistor contact series

Electrical isolation	Test voltage power-frequency withstand voltage: 500 V_{eff}; 50 Hz; 1 min
Tap position capture	35 tap positions, 2,000 ohms

13.4 Dimensions and weight

Housing W x H x D	19-inch plug-in housing in accordance with DIN 41494 Part 5 482.6 mm x 132.5 mm x 197.25 mm (19 in x 5.22 in x 7.77 in)
Weight	Max. 10 kg

13.5 Ambient conditions

Operating temperature	-25...+70 °C
Storage temperature	-40...+85 °C
Relative humidity	10...95%, non-condensing
Air pressure	Corresponds to 3,000 m above sea level
Minimum clearance to other devices / control cabinet	Above/below: 88.9 mm (3.5 in; equivalent to 2 RU), behind 30 mm (1.2 in)

Table 146: Permissible ambient conditions

13.6 Standards and directives

Electromagnetic compatibility	IEC 61000-6-2, IEC 61000-6-4, IEC 61000-6-5 EN 60255-26 KS C 9610-6-2 or KN 61000-6-2, KN 61000-6-4 KS C 9610-6-4 FCC 47 CFR Part 15 B ICES-003
Electrical safety	IEC 61010-1 IEC 61010-2-201 IEC 61010-2-030 EN 61010-1 UL 61010-1 CAN/CSA-C22.2 No. 61010-1 Measurement category CAT III
Measurement relays and protective devices	IEC 60255-11 – Supply fluctuations +/-20% – Frequency fluctuations IEC 60255-1 max. 12% IEC 60255-27:2013 sections 10.6.4.2, 10.6.4.3, 10.6.4.4, 10.6.5.3, 10.6.4.5, 10.6.5.2, 10.6.5.5, 10.6.5.1 and 10.6.6

Climatic ambient conditions	IEC 60068-2-1 (-25°C; 96 h) cold IEC 60068-2-2 (+70°C; 96 h) dry heat IEC 60068-2-78 (+40°C / 93% rH, 96 h) moist heat, constant IEC 60068-2-30 (+55°C, 6 cycles 12 + 12 hours) moist heat, cyclical IEC 60068-2-14 temperature change: test sequence Nb, upper temperature +55°C, lower temperature -10°C (temperature change +1K/min, over 3 h)
Degree of protection test	IEC 60529
Environmental durability tests	Device rear IP20 Device front IP54
	IEC 60255-21-1 vibration class 1 (3 cycles, 0.5g acceleration, 1 octave/min or 60 cycles, 1.0g acceleration, 1 octave/min)
	IEC 60255-21-2 shock class 1 (duration 11 ms, 5g or 15g acceleration, number of axes 3)
	IEC 60255-21-3 seismic class 1 (frequency 1–35 Hz, 3.5 mm/1g acceleration horizontal, 1.5 mm/0.5g acceleration vertical, 1 octave/min, duration 10 min/axis)
	IEC 60255-21-2 continuous shock class 1 (duration 16 ms, 10g, 1,000 pulses per direction, test object passive)

Table 147: Standards and directives

14 Drawings

	DATE	NAME	DOCUMENT NO.	
DFTR.	24.02.2026	STEMPFHUBERJ	SED 13008899 000 00	
CHKD.	24.02.2026	GOSSMIC	CHANGE NO.	SCALE
STAND.	24.02.2026	KLEYN	1143040	1:2

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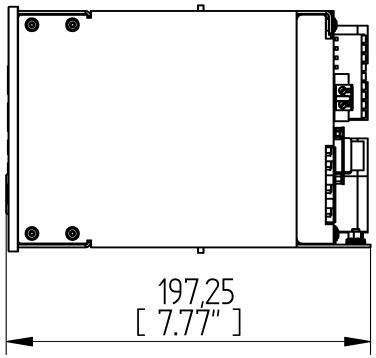
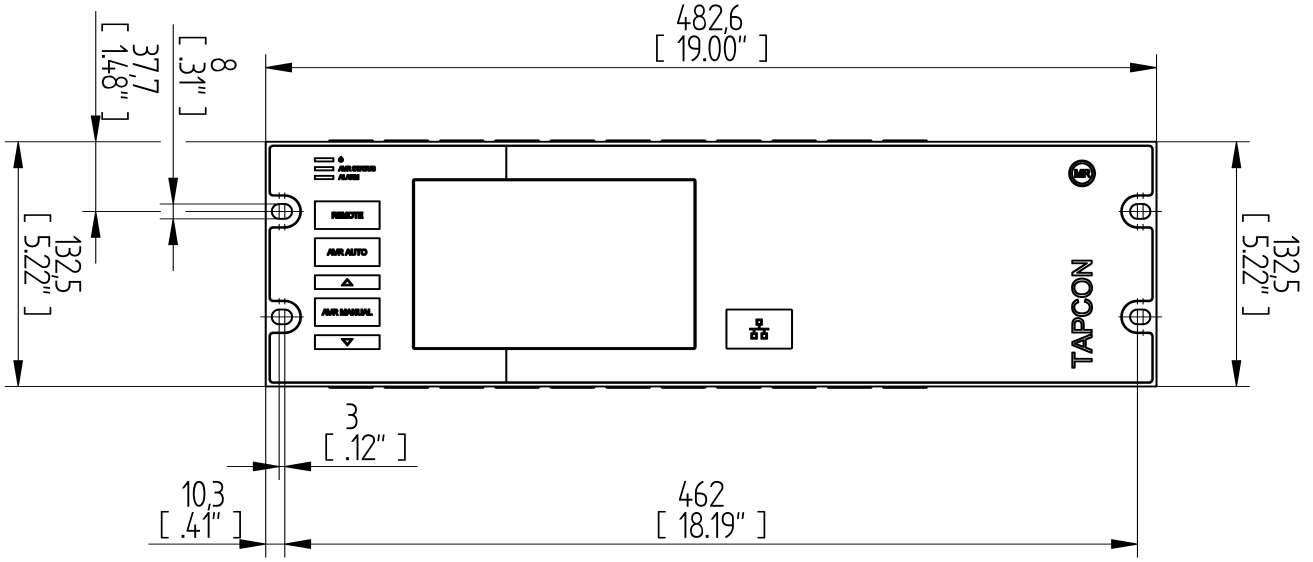
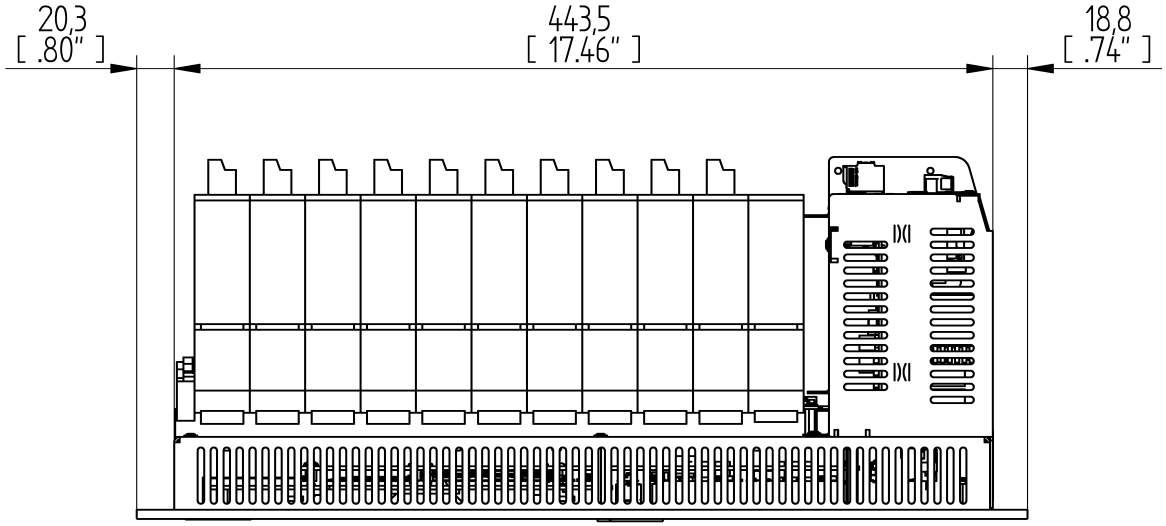
DIMENSION IN mm EXCEPT AS NOTED

VOLTAGE CONTROLLER TAPCON® ISM
–
DIMENSION DRAWING







SERIAL NUMBER
–

MATERIAL NUMBER
10194681OE

SHEET
1/1

Glossary

EMC
Electromagnetic compatibility

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

HSR
Redundancy protocol in accordance with IEC 62439-3 (High-availability Seamless Redundancy)

ICD
IED Capability Description

IP
Internet Protocol

Load sign convention
Definition for describing electrical circuits. If the current and voltage arrows point in the same direction on a “load”, i.e. a two-pole (resistor, coil, etc.) that draws electrical power, this is a load sign convention. The quantity u * i is the power consumed 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)

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)

SNMP
SNMP (Simple Network Management Protocol) is a protocol for managing network devices.

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

URL
Uniform Resource Locator

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