THE POWER BEHIND POWER.

Operating instructions
MSENSE® BM. Monitoring system

8459847/05 EN

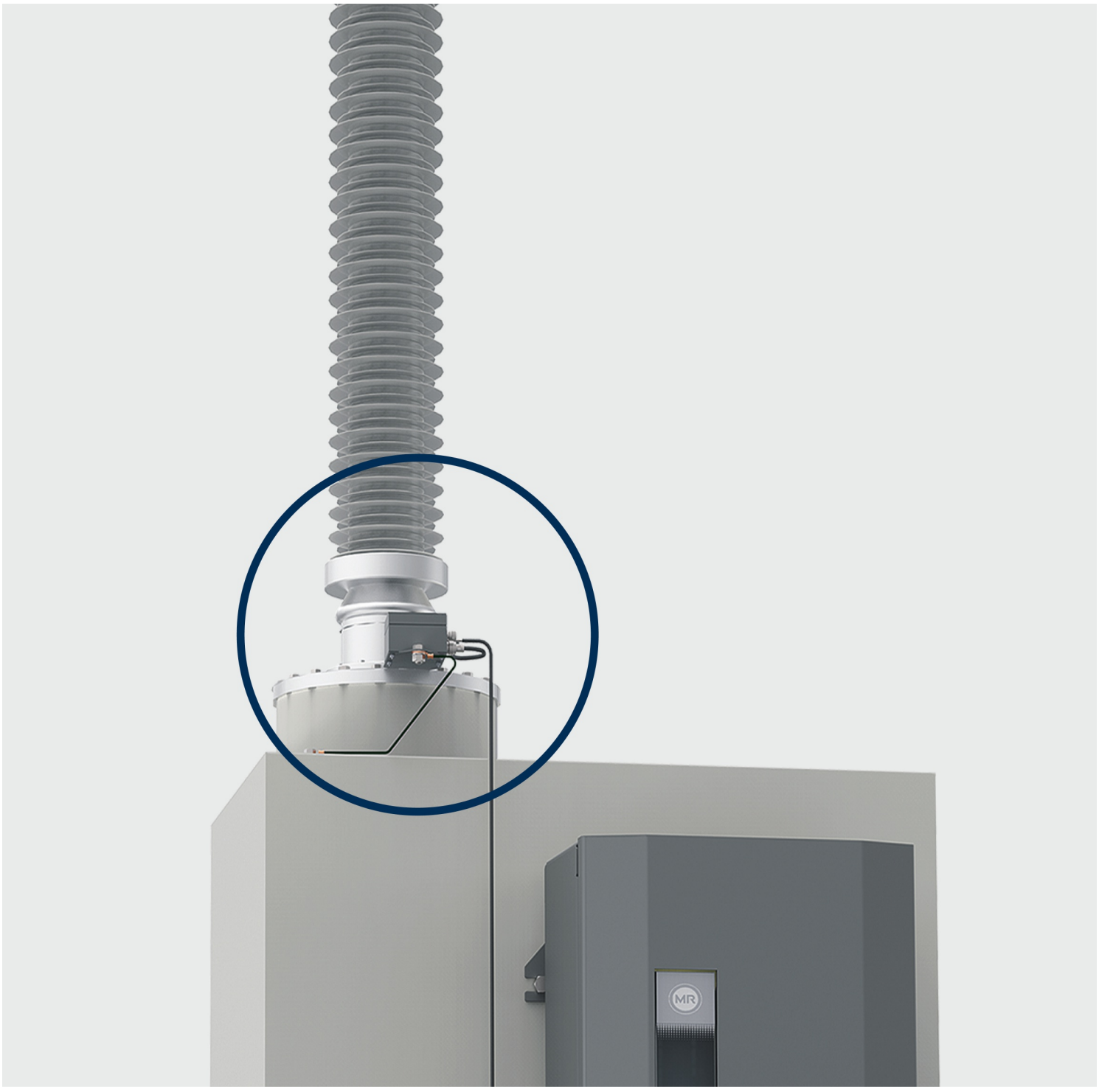


Table of contents

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

Maschinenfabrik Reinhausen GmbH
Falkensteinstraße 8
93059 Regensburg
Deutschland
+49 941 4090-0
sales@reinhausen.com
reinhausen.com

MR Reinhausen customer portal: https://portal.reinhausen.com.

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

1.2 Completeness

This technical file is incomplete without the supporting documents.

The following documents are considered supporting documents:
- Operating instructions
- Connection diagrams

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:

i 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

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 product is a monitoring system and is used to monitor capacitance graded bushings on power transformers of voltage levels U_m = 66...420 kV (other voltage ranges available upon request). You can use the product to detect sparkovers at partial capacitances in the bushing and to monitor aging in the bushings.

The product is designed solely for use in electrical energy systems and facilities. It may only be used in compliance with the requirements and conditions listed in this technical file as well as the warnings in this technical file and the warnings posted on the product. This applies throughout the service life of the product, from delivery, installation and operation to removal and disposal.

The following is considered intended use:

- This device is intended for indoor use in non-hazardous areas and should be operated only by qualified personnel who are familiar with its use. The switch-off device is part of the end application.
- The device is intended for installation. Protection against the spread of fire and protection against electric shock must be fulfilled in the end application. Resistance to mechanical stress must be fulfilled in the end application.
- Protect the connection to the line voltage with an overcurrent protective device. To do so, provide a type C, K, or Z miniature circuit breaker with a nominal current of 16 A or 20 A in the building installation.
- Use the product only with the bushings specified in the order.
- Use the product only for high-voltage bushings of a power transformer subject to similar installation conditions and thermal loads.
- Use the product only for bushings of the same type (manufacturer, series, technology, model year).
- Use the product only for bushings that were not previously damaged.
- Operate the product in accordance with this technical document, the agreed-upon delivery conditions and the technical data.
- Ensure that all necessary work is performed by qualified personnel only.
- Only use the equipment and special tools included in the scope of delivery for the intended purpose and in accordance with the specifications of this technical document.
- Only operate the product in industrial areas. Observe the notices in this technical 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 Appropriate use section. In addition, observe the following:

- The product is not suited for extending the permitted service life of the bushing specified by the bushing manufacturer.
- The product is not a protective device. Do not use it to handle safety-related functions.
- Risk of explosion and fire from highly flammable or explosive gases, vapors, or dusts. Do not operate the product in areas at risk of explosion.
- The product is not intended for use in environments subject to strong corrosion effects.
- Unauthorized or inappropriate changes to the product may lead to personal injury, material damage and operational faults. Only modify the product after consultation with Maschinenfabrik Reinhausen GmbH.
- Do not connect the product components to measurement systems from other manufacturers, because this can lead to bushing monitoring errors.

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:

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.

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.

Spare parts

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

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

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.

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.

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.

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.

Handling test taps on high voltage bushings

Test taps on high-voltage bushings must not be operated when open, as the voltages that occur can destroy the equipment.

- Close the test tap (= test connection of the bushing) with the original safety cap to ensure grounding, or:
- Ensure a complete installation and correct cabling for the monitoring function up to the measuring card in the control cabinet in accordance with the section Installation [▶Section 6, Page 45].

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.

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 170] 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.

Modifications and conversions

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

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

2.4 Personnel qualification

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

Electrically skilled person

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

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

Electrically trained persons

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

Operator

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

Technical Service

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

Authorized personnel

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

2.5 Personal protective equipment

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

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

Protective clothing	Close-fitting work clothing with a low tearing strength, with tight sleeves and with no protruding parts. It mainly serves to protect the wearer against being caught by moving machine parts.
Safety shoes	To protect against falling heavy objects and slipping on slippery surfaces.
Safety glasses	To protect the eyes from flying parts and splashing liquids.
Visor	To protect the face from flying parts and splashing liquids or other dangerous substances.
Hard hat	To protect against falling and flying parts and materials.
Hearing protection	To protect against hearing damage.
Protective gloves	To protect against mechanical, thermal, and electrical hazards.

Table 3: Personal protective equipment

3 IT security

Observe the following recommendations to operate the product safely.

3.1 General

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

3.2 Commissioning

Observe the following recommendations for device commissioning:

- User IDs must be unique and assignable. Do not use a "Group account" function or the "Auto login" function.
- Activate the "Auto logout [▶Section 8.1.1.2, Page 90]" function.
- Restrict the rights of the individual user groups as much as is feasible; this helps avoid errors during operations. A user with the "Operator" role, for example, should only perform operations and should not be able to change any device settings.
- Delete or disable the default "admin" user ID. This requires first creating a new user account with the "Administrator" role. You can then use it to delete or disable the default "admin" account.
- Deactivate service user access [▶Section 8.1.1.3, Page 90].
- Enable SSL/TLS encryption [▶Section 8.1.1, Page 89]; access to the device is then only possible using the SSL/TLS protocol. In addition to encrypting communication, this protocol also checks the authenticity of the server.
- Use TLS version 1.2 or higher wherever possible.
- Integrate the device into a public key infrastructure. Create your own SSL certificates for this if necessary and then import them.
- Connect the device to a central log server by using the syslog interface [▶Section 8.1.5, Page 97].
- Only use the [▶Section 8.1.1.4, Page 91]SNMP function if you can ensure that the communication is protected by external security equipment.
- Deactivate all unused interfaces.
- Media converter with managed switch (assembly SW 3-3) [▶Section 8.1.16, Page 133]:
  - Change user account and password.
  - Disable unnecessary services.

3.3 Operation

Observe the following recommendations during device operation:

- Change the password at regular intervals.

- Export the security log [▶Section 8.1.15.1, Page 129] at regular intervals.
- Check the log files regularly for unauthorized system access and other security-related events.
- Media converter with managed switch (assembly SW 3-3): Check at regular intervals whether the manufacturer Belden/Hirschmann has released an update for the product "EES 25" and, where necessary, perform a firmware update.

3.4 Interfaces

The device uses the following interfaces for communication:

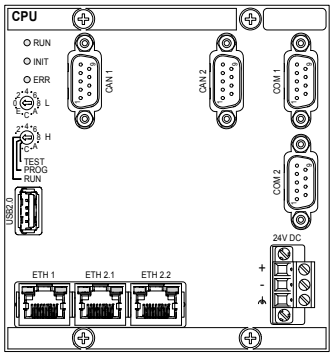


Figure 1: CPU assembly interfaces

Interface	Protocol	Port	Description
CAN 1	-	-	DIO assembly connection
CAN 2	-	-	Communication with other ISM® devices (e.g. parallel operation)
COM 1	-	-	Internal system interface
COM 2	-	-	Serial interface (SCADA)
USB	-	-	Import or export of data
ETH 1	TCP	80	HTTP for web-based visualization[1), 2)]
ETH 1	TCP	443	HTTPS for web-based visualization[2)]
ETH 1	TCP	102	IEC 61850
ETH 1	TCP	502	Modbus[3)]
ETH 1	TCP	20000	DNP3[3)]
ETH 1	UDP	161	SNMP[4)]
ETH 2.x	TCP	21	FTP[1)] (only for MR service)
ETH 2.x	TCP	80	HTTP for web-based visualization[1)]
ETH 2.x	TCP	443	HTTPS for web-based visualization
ETH 2.x	TCP	990	FTPS (only for MR service)
ETH 2.x	TCP	8080	HTTP for web-based visualization[1)]

Interface	Protocol	Port	Description
ETH 2.x	TCP	8081	HTTPS for web-based visualization
ETH 2.x	UDP	161	SNMP[4)]

Table 4: Interfaces and open ports of the CPU assembly

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

[2)] Depending on the setting of the parameter Visualization release [▶Page 93].

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

[4)] Depending on the setting of the SNMP agent [▶Page 92] parameter.

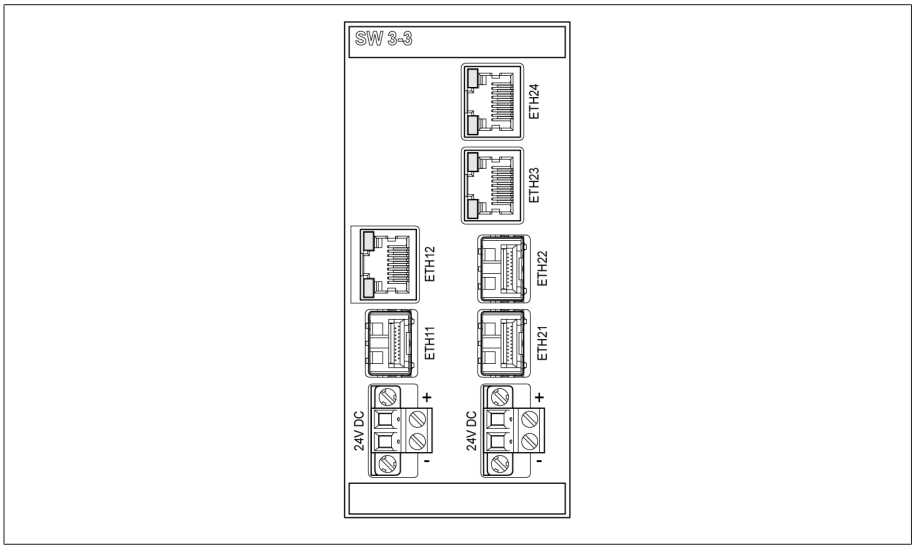


Figure 2: Assembly SW 3-3 interfaces

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

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

[1)] Port is closed if the corresponding service is disabled.

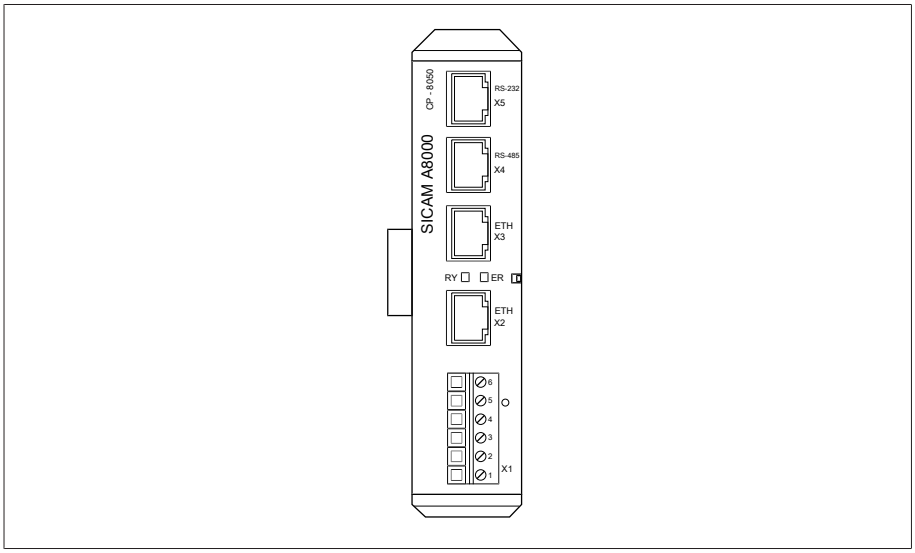


Figure 3: CPU assembly interfaces

Interface	Protocol	Port	Description
X2	TCP	102	IEC 61850
X2	TCP	502	Modbus[1)]
X2	TCP	20000	DNP3[1)]
X2	TCP	2404	IEC 60870-5-104[1)]
X2	UDP	123	SNTP
X2	-	-	Bus extension (optional)
X3	TCP	80	HTTP for web-based visualization[2)]
X3	TCP	443	HTTPS for web-based visualization
X3	TCP	22	SSH (only for MR Service)[3)]
X3	UDP/TCP	514	Syslog
X4	-	-	Serial interface (SCADA)
X5	-	-	Serial interface (SCADA)

Table 6: Interfaces and open ports of the CPU assembly

[1)] Default setting; if you have modified the port for the control system protocol, only the set port is open.

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

[3)] Port is closed if you deactivate the Service user access [▶Section 8.1.1.3, Page 90].

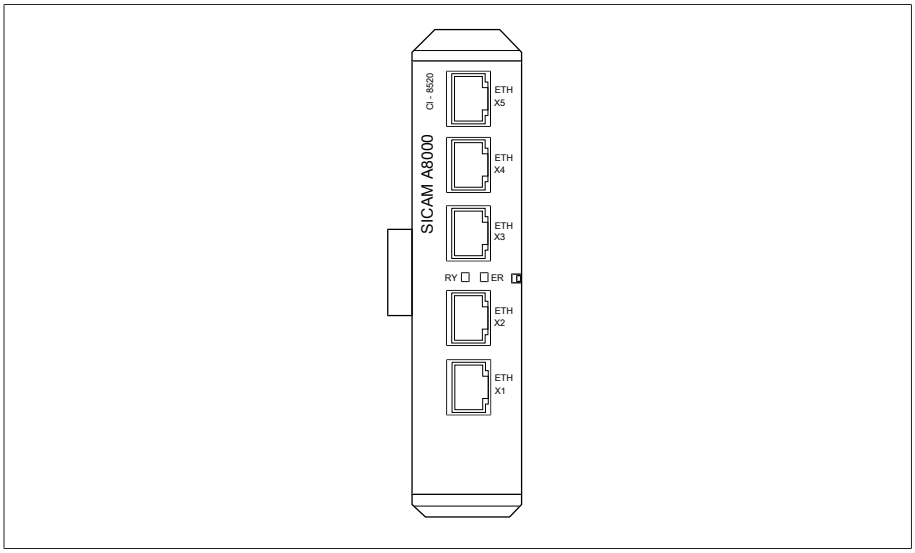


Figure 4: COM-ETH assembly interfaces

Interface	Protocol	Port	Description
X1			
X2			
X3			
X4			
X5			

Table 7: Interfaces and open ports of the COM-ETH assembly

3.5 Encryption standards

The device supports the following TLS versions:
- TLS 1.0
- TLS 1.1
- TLS 1.2
- TLS 1.3

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

Cipher suite	TLS version [▶ Page 93]			
	>=1.0	>=1.1	>=1.2	>=1.3
TLS_AKE_WITH_AES_128_GCM_SHA256	•	•	•	•
TLS_AKE_WITH_AES_256_GCM_SHA384	•	•	•	•
TLS_DHE_RSA_WITH_AES_128_CBC_SHA	•	•	-	-
TLS_DHE_RSA_WITH_AES_128_CBC_SHA256	•	•	•	-
TLS_DHE_RSA_WITH_AES_128_CCM	•	•	-	-
TLS_DHE_RSA_WITH_AES_128_CCM_8	•	•	-	-
TLS_DHE_RSA_WITH_AES_128_GCM_SHA256	•	•	•	-
TLS_DHE_RSA_WITH_AES_256_CBC_SHA	•	•	-	-

Cipher suite	TLS version [▶ Page 93]			
	>=1.0	>=1.1	>=1.2	>=1.3
TLS_DHE_RSA_WITH_AES_256_CBC_SHA256	•	•	•	-
TLS_DHE_RSA_WITH_AES_256_CCM	•	•	-	-
TLS_DHE_RSA_WITH_AES_256_CCM_8	•	•	-	-
TLS_DHE_RSA_WITH_AES_256_GCM_SHA384	•	•	•	-
TLS_DHE_RSA_WITH_ARIA_128_GCM_SHA256	•	•	-	-
TLS_DHE_RSA_WITH_ARIA_128_GCM_SHA256	•	•	-	-
TLS_DHE_RSA_WITH_CHACHA20_POLY1305_SHA256	•	•	-	-
TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA	•	•	-	-
TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA256	•	•	•	-
TLS_ECDHE_ECDSA_WITH_AES_128_CCM	•	•	-	-
TLS_ECDHE_ECDSA_WITH_AES_128_CCM_8	•	•	-	-
TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256	•	•	-	-
TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA	•	•	-	-
TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA384	•	•	•	-
TLS_ECDHE_ECDSA_WITH_AES_256_CCM	•	•	-	-
TLS_ECDHE_ECDSA_WITH_AES_256_CCM_8	•	•	-	-
TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384	•	•	•	-
TLS_ECDHE_ECDSA_WITH_ARIA_128_GCM_SHA256	•	•	-	-
TLS_ECDHE_ECDSA_WITH_ARIA_256_GCM_SHA384	•	•	-	-
TLS_ECDHE_ECDSA_WITH_CHACHA20_POLY1305_SHA256	•	•	-	-
TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA	•	•	-	-
TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA256	•	•	•	-
TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256	•	•	•	-
TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA	•	•	-	-
TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA384	•	-	-	-
TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384	•	•	•	-
TLS_ECDHE_RSA_WITH_ARIA_128_GCM_SHA256	•	-	-	-
TLS_ECDHE_RSA_WITH_ARIA_256_GCM_SHA384	•	-	-	-
TLS_RSA_WITH_AES_128_CBC_SHA	•	•	-	-
TLS_RSA_WITH_AES_128_CBC_SHA256	•	•	-	-
TLS_RSA_WITH_AES_128_CCM	•	•	-	-
TLS_RSA_WITH_AES_128_CCM_8	•	•	-	-
TLS_RSA_WITH_AES_128_GCM_SHA256	•	•	-	-
TLS_RSA_WITH_AES_256_CBC_SHA	•	•	-	-
TLS_RSA_WITH_AES_256_CBC_SHA256	•	•	-	-
TLS_RSA_WITH_AES_256_CCM	•	•	-	-
TLS_RSA_WITH_AES_256_CCM_8	•	•	-	-

Cipher suite	TLS version [▶ Page 93]			
	>=1.0	>=1.1	>=1.2	>=1.3
TLS_RSA_WITH_AES_256_GCM_SHA384	●	●	-	-
TLS_RSA_WITH_ARIA_128_GCM_SHA256	●	●	-	-
TLS_RSA_WITH_ARIA_256_GCM_SHA384	●	●	-	-
TLS_RSA_WITH_IDEA_CBC_SHA	●	-	-	-
TLS_RSA_WITH_IDEA_CBC_SHA	●	-	-	-

Table 8: Cipher suite (● = available, - = not available)

Cipher suite	TLS version [▶ Page 93]	
	>=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 9: Cipher suite (● = available, - = not available)

The device uses the SHA256 hash function to save passwords.
The SW 3-3 assembly supports the following TLS version:
– TLS 1.2
The assembly uses the following cipher suites for a TLS-secured connection:

	Key exchange	Authentication		Encryption	Key length	Operating mode	Hash function
TLS	ECDHE	RSA	WITH	AES	128	GCM	SHA265
	DHE					CBC	SHA

Table 10: Cipher suite

The device uses the following encryption standards in accordance with technical directive TR-02102-4 from Germany's Federal Office for Information Security:
– Key agreement:
  – diffie-hellman-group1-sha1
  – diffie-hellman-group14-sha1
  – diffie-hellman-group16-sha512
  – diffie-hellman-group18-sha512
  – diffie-hellman-group-exchange-sha256
  – ecdh-sha2-nistp256

- Server authentication:
  - ssh-rsa
  - rsa-sha2-512
  - rsa-sha2-256
- Encryption algorithms:
  - aes128-ctr
  - aes128-gcm@openssh.com
  - chacha20-poly1305@openssh.com
- MAC protection:
  - hmac-sha1
  - hmac-sha2-256
  - hmac-sha1-etm@openssh.com
  - hmac-sha2-256-etm@openssh.com
- Compression:
  - None
  - zlib@openssh.com
  - Zlib

4 Product description

4.1 MSENSE® BM monitoring system versions

The device is available in the following versions:
- MSENSE® BM:
  - Standalone version in the control cabinet
  - Integration solution in the customer control cabinet (pluggable modules)
- ETOS® with MSENSE® BM function:
  - Integration solution in the control cabinet
  - Integration solution in the customer control cabinet (pluggable modules)

4.2 Scope of delivery

The following components are included in the scope of delivery:
- Control cabinet with MSENSE® BM bushing monitoring
- For each bushing to be monitored (3 or 6):
  - Bushing adapter
  - Connection cable for the bushing adapter and bushing coupling unit
  - Bushing coupling unit
  - Set of fasteners for the bushing coupling unit
  - Connection cable for the bushing coupling unit and the control cabinet
- Technical documents

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.

4.3 Function description of MSENSE® BM-C

The product is a monitoring system and is used to monitor capacitance graded bushings on power transformers. You can use the product to detect sparkovers at partial capacitances in the bushings and to monitor aging in the bushings.

Change of capacitance Δ*C1*

To evaluate the condition of the bushing, the bushings are equipped with measurement equipment which constantly calculates the change of capacitance Δ*C1* during operation. ΔC1 is calculated by the change in voltage between two phases of the system and provides conclusions about sparkovers at partial capacitances in the bushings. The method is called a 2/3 reference algorithm below. For more information, see section Configuring capacitance monitoring [►Section 8.4.1.2, Page 154].

Using the 2/3 reference algorithm implemented, the monitoring system can largely compensate for voltage and temperature fluctuations in the 3-phase system and thus ensure reliable monitoring of the bushings.

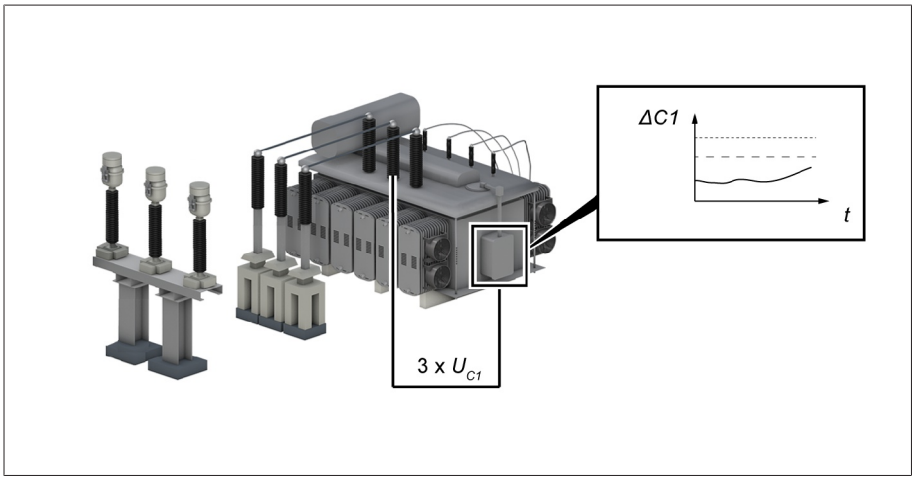


Figure 5: Operating principle

The bushing monitoring with 2/3 reference algorithm is also designed to monitor the bushings in systems in which a measurement of the reference grid voltage is not possible. To do so, the system uses a constant reference grid voltage. The angle between phases is a constant 120°.

Because the reference system voltage is not measured, strong asymmetries in the grid can lead to incorrect triggering of events.

4.4 Function description of MSENSE® BM-T

The product is a monitoring system and is used to monitor capacitance graded bushings on power transformers. You can use the product to detect sparkovers at partial capacitances in the bushings and to monitor aging in the bushings.

Change of capacitance Δ*C1*

To evaluate the condition of the bushing, the bushings are equipped with measurement equipment which constantly calculates the change of capacitance Δ*C1* during operation. ΔC1 is calculated by the change in voltage between two phases of the system and provides conclusions about sparkovers at partial capacitances in the bushings. The method is called a 2/3 reference algorithm below. For more information, see section Configuring capacitance monitoring [►Section 8.4.1.2, Page 154].

Constant comparison to a reference voltage increases the accuracy and eliminates the influence of asymmetries in the grid.

Change of dissipation factor Δtan*δ*

The system can determine the change of the dissipation factor Δtan*δ* of the bushings and thus monitor the aging of the bushing. For more information, see section Configuring dissipation factor monitoring [►Section 8.4.1.3, Page 157].

Using the reference measurement and the 2/3 reference algorithm implemented, the monitoring system can largely compensate for voltage and temperature fluctuations in the 3-phase system and thus ensure reliable monitoring of the bushings.

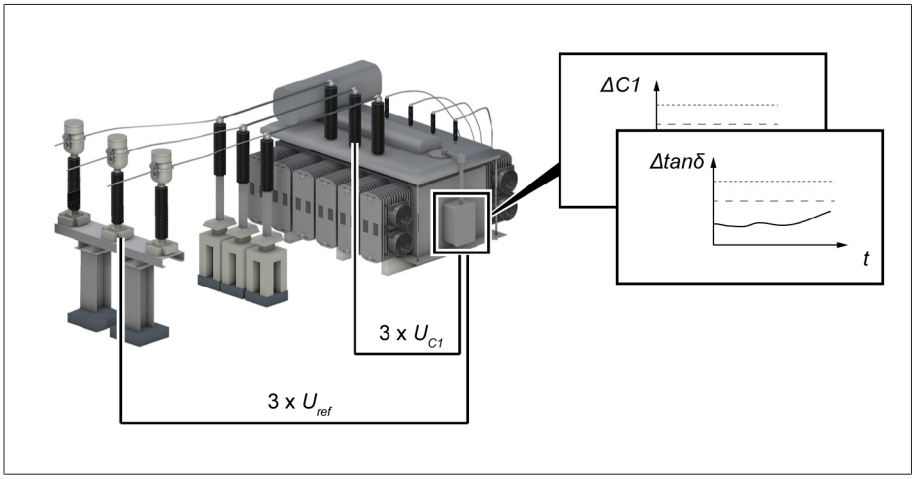


Figure 6: Operating principle (with the option "Reference measuring")

The bushing monitoring variant with 2/3 reference algorithm combined with the reference voltage measurement U_{ref} is used to monitor the bushings in systems in which strong asymmetries in the grid could lead to incorrect triggering of events. To compensate for this, the system carries out a reference voltage measurement U_{ref}.

4.5 Performance features bushing monitoring

The MSENSE® BM monitoring system monitors the bushings of a power transformer and has the following features:

- Monitoring oil-impregnated paper bushings (OIP) and resin-impregnated paper bushings (RIP) of voltage levels U_m = 66...420 kV (other voltage ranges available on request)
- Optional: Monitoring of 6 bushings, where 3 bushings each form one set (field 1 and field 2)
- Online monitoring of the bushing via capacitance measurement
  - Monitoring the change in capacitance *C1*
  - Compensation for temperature fluctuations
  - Compensation for the effects of weather
  - Compensation for voltage fluctuations

Only with option BM-T
- Compensation for grid asymmetry (only with active reference system measuring)

Only with option BM-T
- Online monitoring of the bushing using dissipation-factor measurement (reference voltage measurement)
  - 3-phase reference system (e.g. voltage transformer) with monitoring of the change in dissipation factor tanδ

- Display of the measured and calculated values
- Status messages via digital outputs
- Web-based visualization
- SCADA
  - IEC 60870-5-101
  - IEC 60870-5-103
  - IEC 60870-5-104
  - IEC 61850 (edition 1 and edition 2)
  - Modbus (RTU, TCP, ASCII)
  - DNP3

4.6 Operating modes

Local mode (LOCAL)

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

Remote mode (REMOTE)

In the Remote operating mode, you can make entries and carry out commands using digital inputs or the control system, depending on the setting of the Remote behavior [►Page 89] parameter.

4.7 Design

The complete system consists of the following subassemblies:

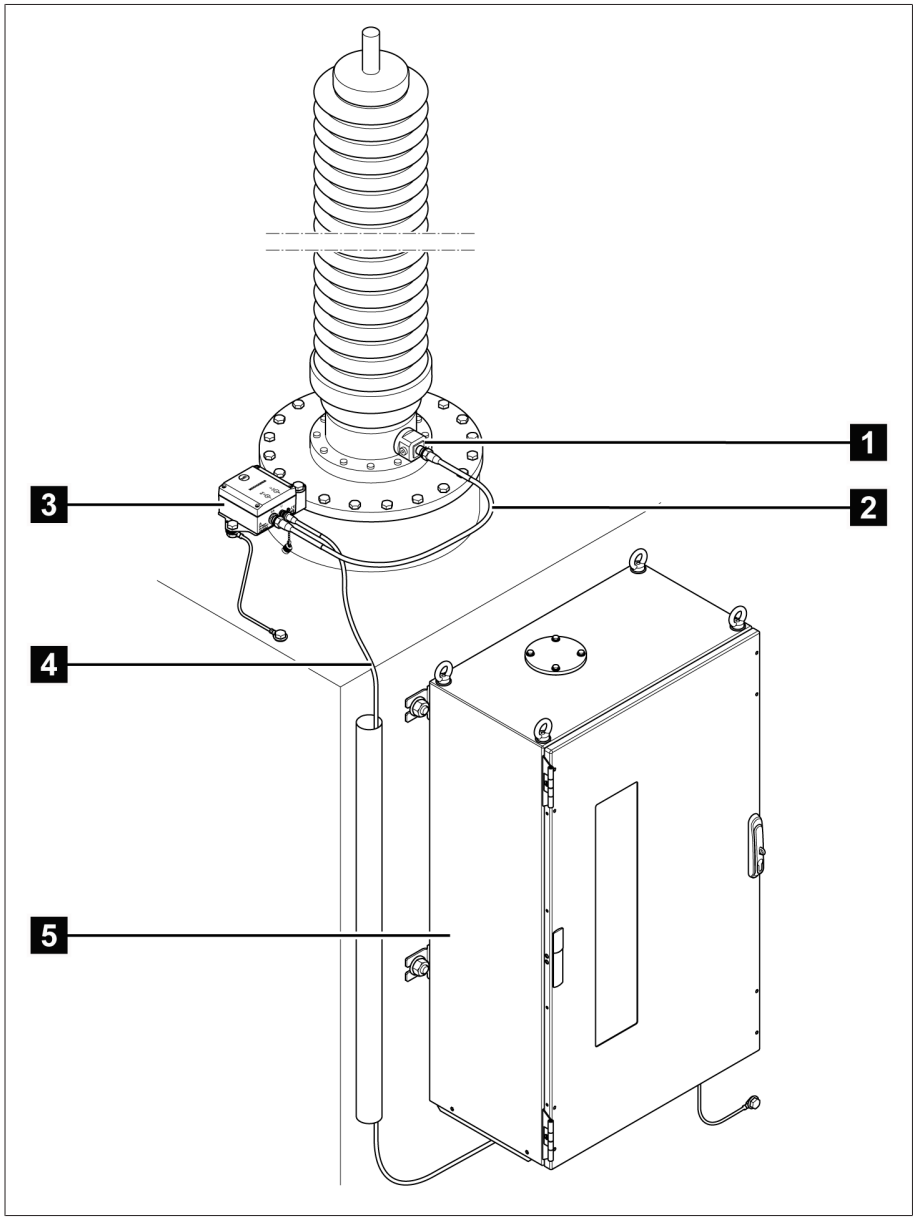


Figure 7: Design

1	Bushing adapter	2	Connection cable for the bushing adapter and bushing coupling unit
3	Bushing coupling unit	4	Connection cable for the bushing coupling unit and control cabinet
5	Control cabinet with monitoring system		

4.7.1 Bushing adapter and bushing coupling unit

The bushing adapter is used to pick up the measured voltage at the bushing test tap. The downstream bushing coupling unit is used to adjust the measured voltage. Both components are tuned to the bushings to be monitored in accordance with your order. They may be used only for those bushings.

The following components are used:
– Bushing adapter (A001...A010)

Type	Bushing types
A001	Micafil RTKF Micafil RTKG
A002	HSP SETFt 1550/420-1800 HSP SETFt 600/123-2000
A003	ABB GOB 1050-750-1100-0.6-B ABB GSA 123-OA/1600/0.5 ABB GSA 52-OA/2000/0.5
A004	Trench COT 750-800
A005	HSP SETFt 750-170-4000 HSP SETFt 1200/245-1250 HSP SETFt 1425-420-1600 HSP SESTFt 1050-245-B E6 B HSP SESTFt 1425-420-B E6 B-1600A HSP EKTG 72.5-800 kV
A006	PCORE CSA standard POC ser. 2 ABB GOE, GSB (245...550 kV)
A007	PCORE B-81515-57-70
A008	Passoni Villa PNO, POBO, PCTO, PAO < 110 kV
A010	ABB O Plus C (O Plus Dry)

Table 11: Bushing adapter

– C002: Bushing coupling unit

4.7.2 Control cabinet

The control cabinet contains the control system for monitoring the bushings as well as various display elements and operating controls. The MSENSE® BM product is a modular system. Depending on the order, the system has various components. The exact design can be found in the connection diagram provided.

4.7.3 ISM® assemblies

4.7.3.1 Power supply QS3.241

The PULS DIMENSION QS3.241 assembly supplies power to the ISM® assemblies.

Figure 8: PULS DIMENSION QS3.241 assembly

4.7.3.2 Power supply CP5.241

The PULS DIMENSION CP5.241 assembly supplies power to the ISM® assemblies.

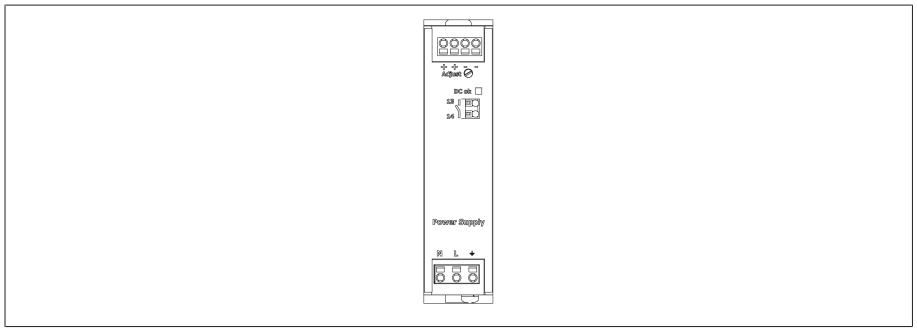


Figure 9: PULS DIMENSION CP5.241 assembly

4.7.3.3 Power supply PS

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

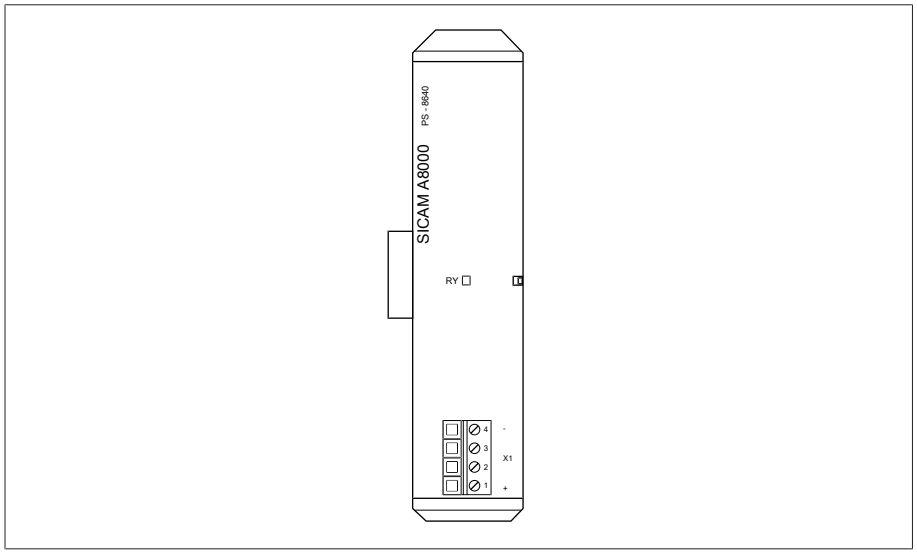


Figure 10: PS assembly

4.7.3.4 CPU (central processing unit) I

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

- Internal system interface RS232 (COM1)
- Serial interface RS232/485 (COM2)
- 3x Ethernet (ETH1, ETH 2.1, ETH 2.2)
- USB (USB 2.0)
- 2x CAN bus (CAN 1, CAN 2)

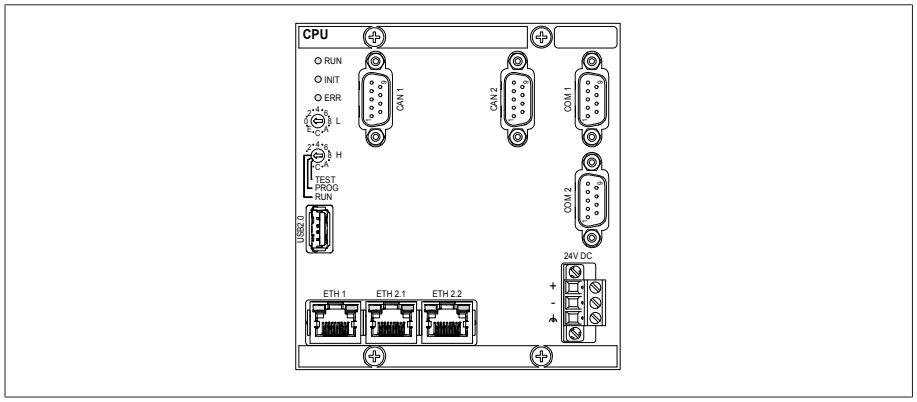


Figure 11: CPU I assembly

4.7.3.5 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)

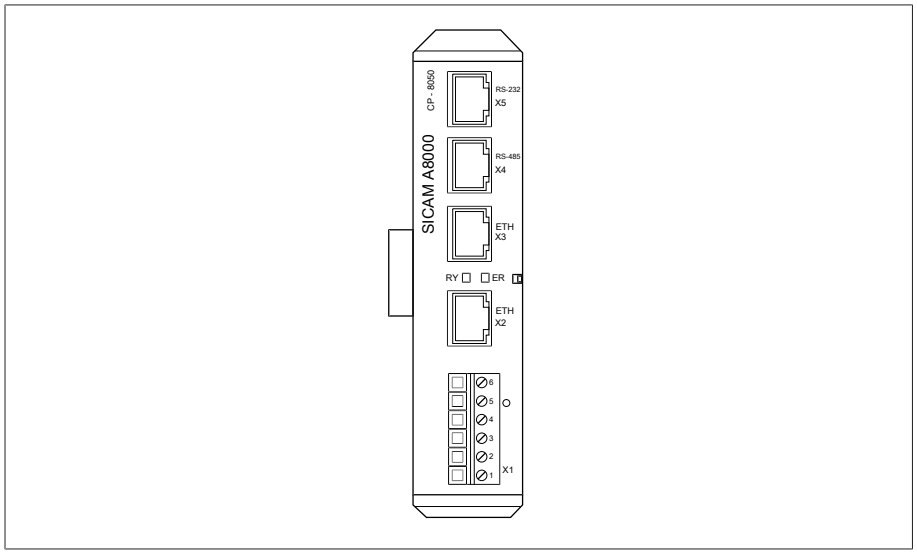


Figure 12: CPU assembly

4.7.3.6 Voltage measurement

The UI 5-3 assembly is used for measuring 3-phase voltage.

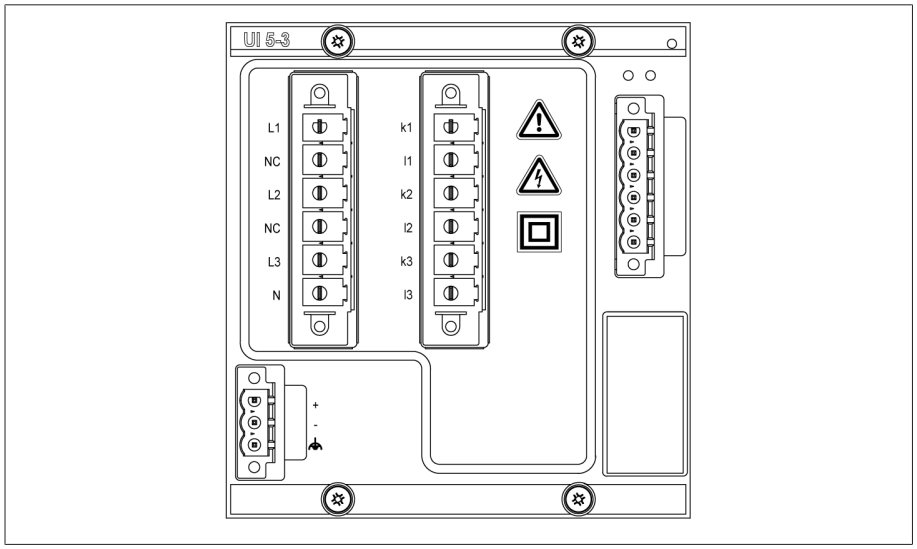


Figure 13: UI 5-3 assembly

4.7.3.7 Voltage measurement U 3

The U3 assembly is used for measuring 3-phase voltage. The *RY* LED signals that the assembly is ready for operation.

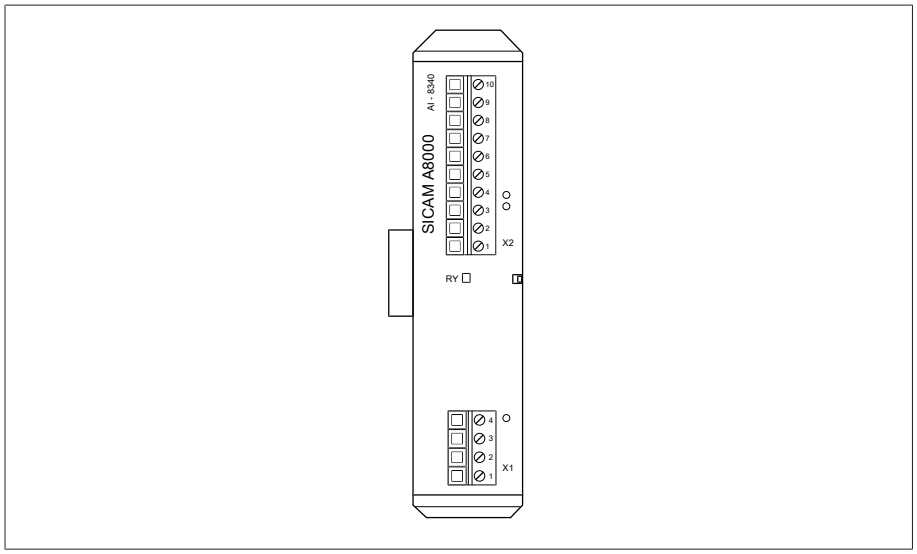


Figure 14: U 3 assembly

4.7.3.8 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.

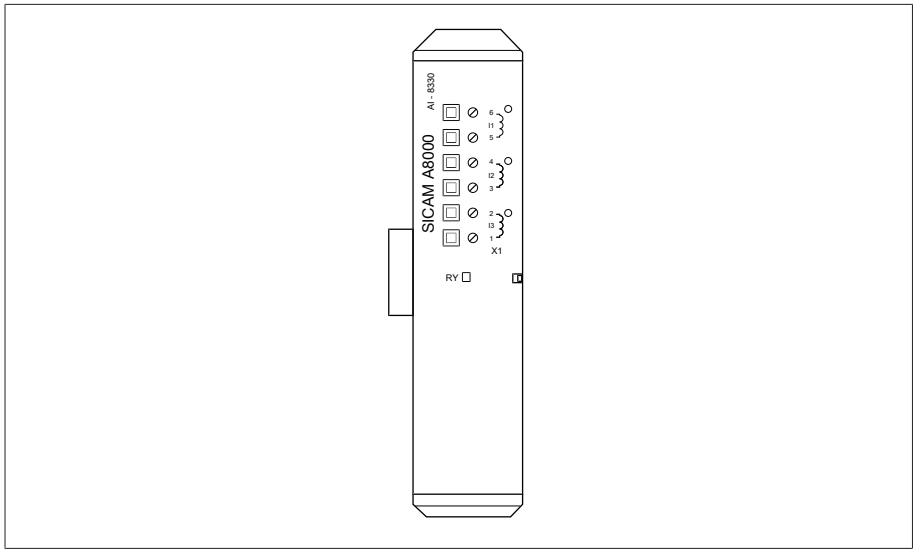


Figure 15: I 3 assembly

4.7.3.9 DIO 28-15 digital inputs and outputs

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

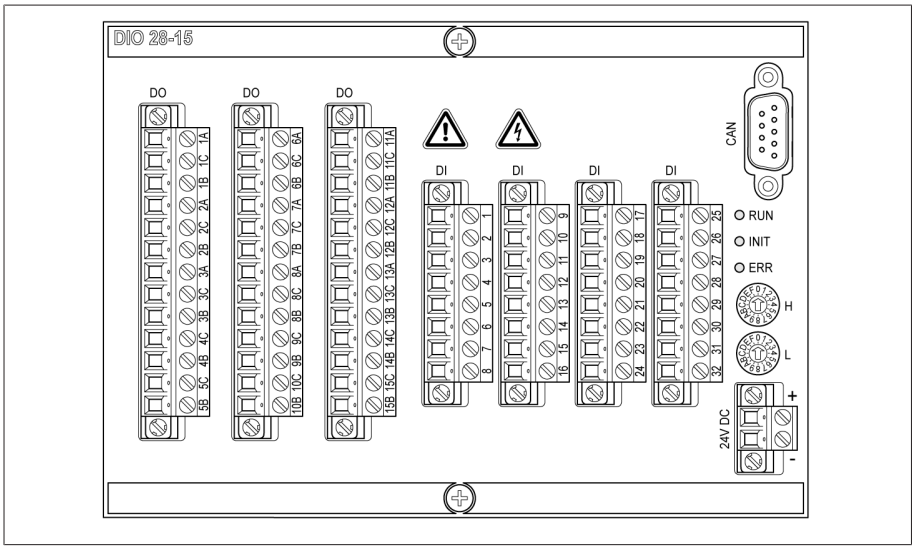


Figure 16: DIO 28-15 assembly

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

Table 12: Safety-relevant symbols on the assembly

4.7.3.10 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.

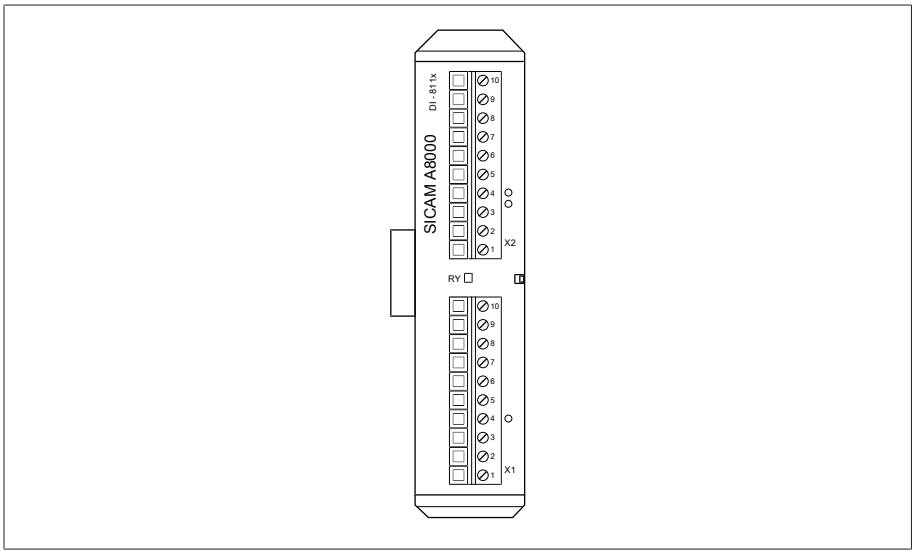


Figure 17: DI 16-24V assembly

4.7.3.11 Digital inputs DI 16-48 V

The DI 16-48V assembly has 16 digital inputs with a nominal voltage of 48 V DC. The *RY* LED signals that the assembly is ready for operation.

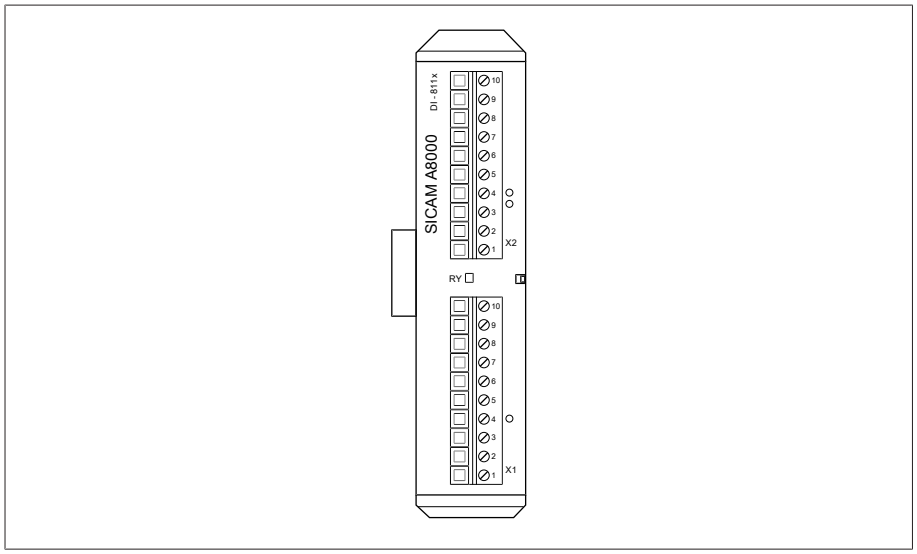


Figure 18: DI 16-48V assembly

4.7.3.12 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.

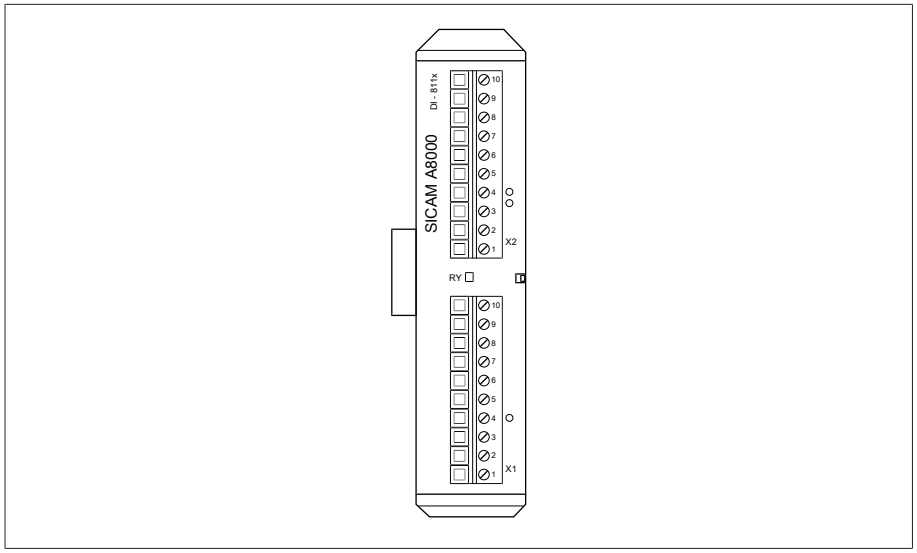


Figure 19: DI 16-110V assembly

4.7.3.13 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.

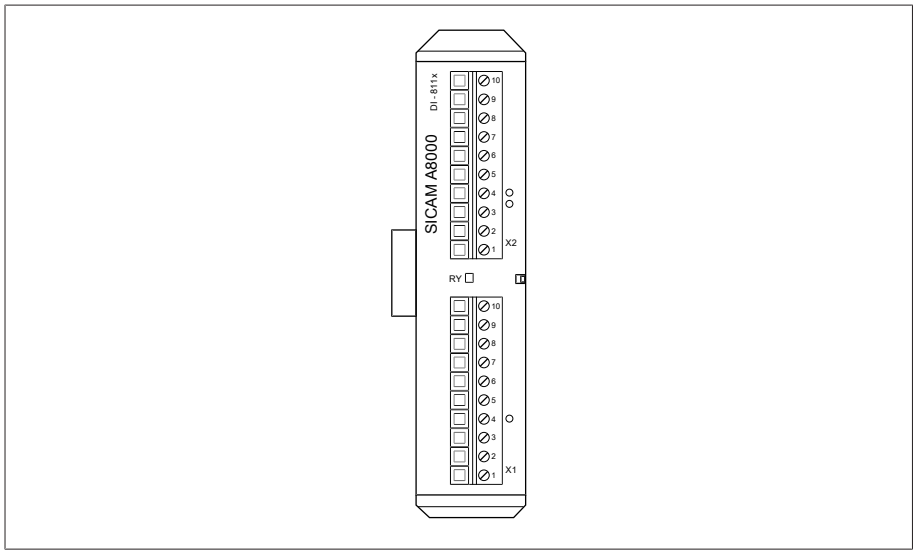


Figure 20: DI 16-220V assembly

4.7.3.14 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.

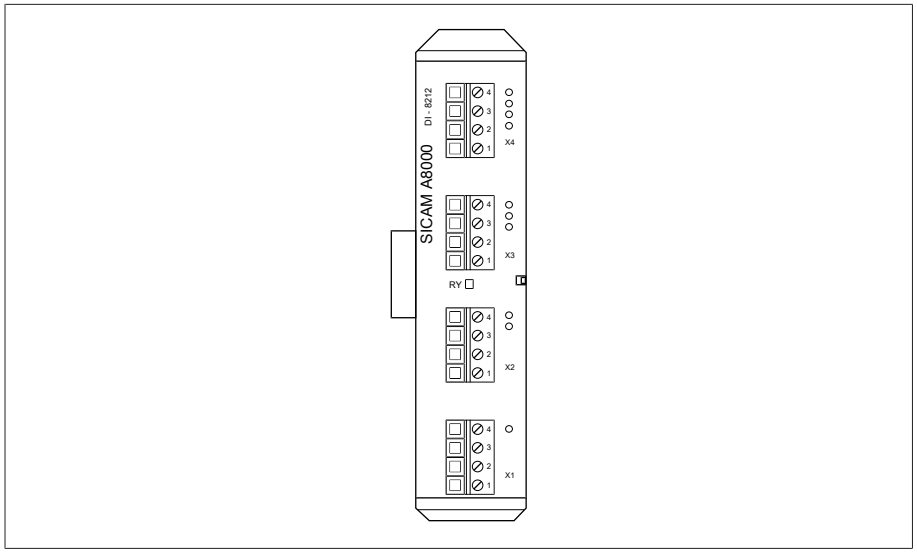


Figure 21: DO 8 assembly

4.7.3.15 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.

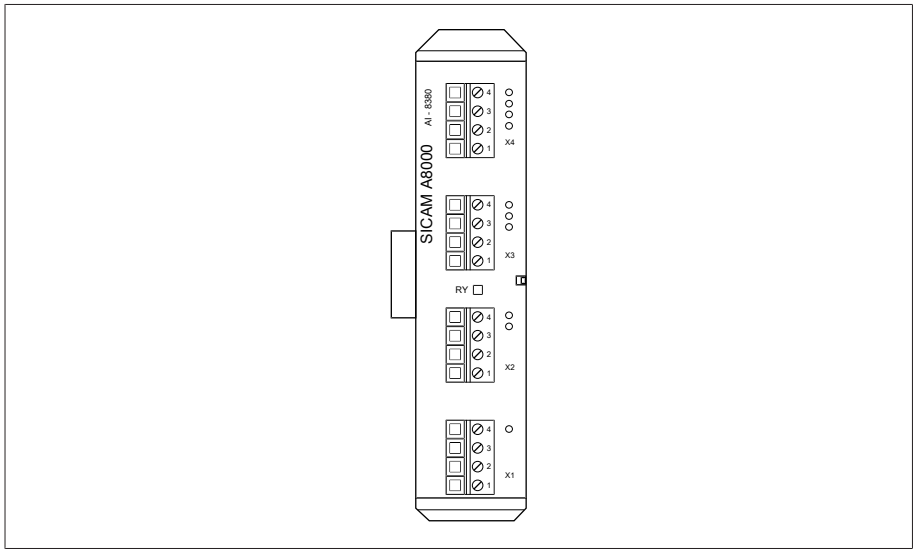


Figure 22: AO 4 assembly

4.7.3.16 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.

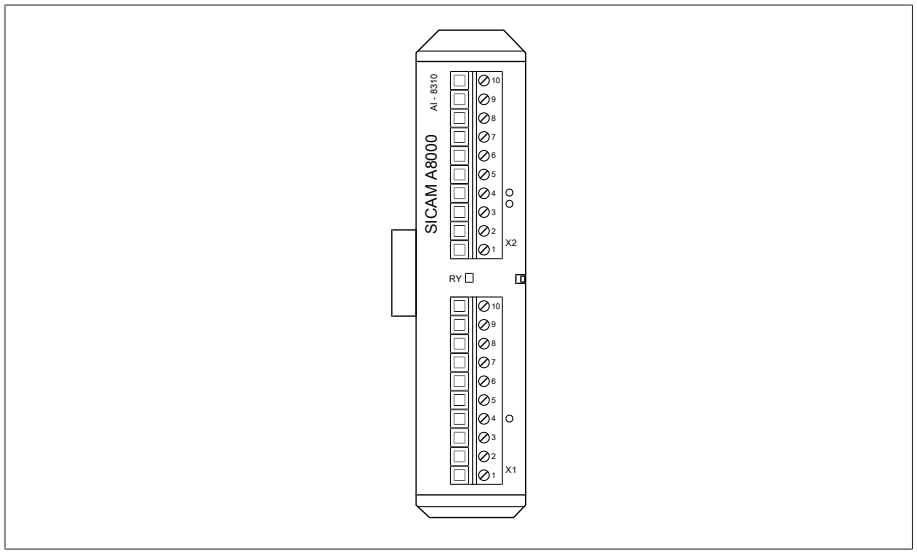


Figure 23: AI 4-T assembly

4.7.3.17 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.

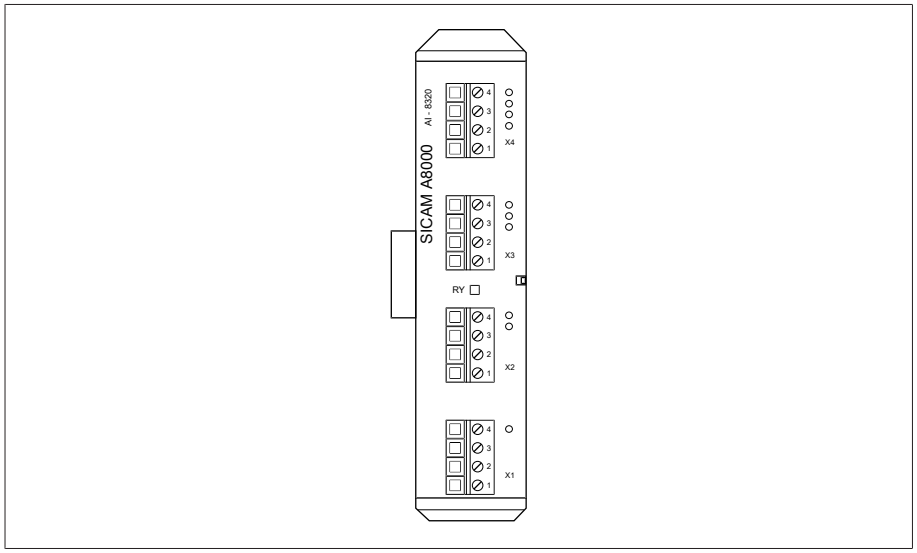


Figure 24: AI 4 assembly

4.7.3.18 System networking MC 2-2

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

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

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

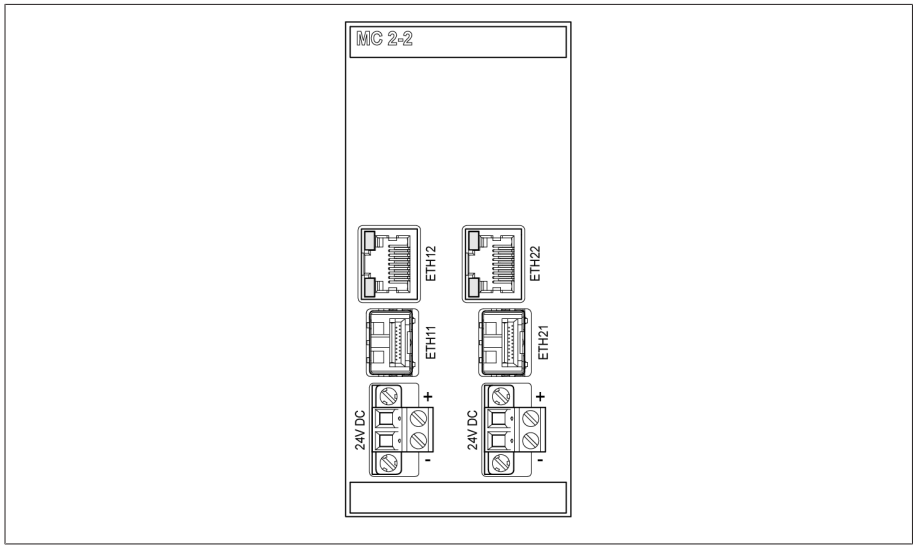


Figure 25: MC 2-2 assembly

4.7.3.19 System networking SW 3-3

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

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

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

- PRP (standard setting)
- RSTP

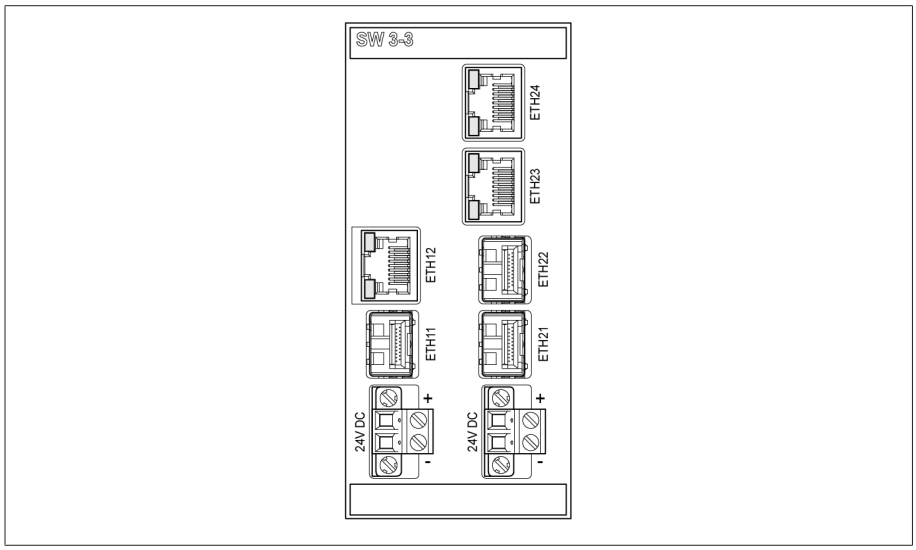


Figure 26: SW 3-3 assembly

4.7.3.20 System networking BEM1/BES1

The assemblies BEM 1 (master) and BES 1 (slave) are bus extension modules which are used to extend the system by one additional busbar with additional assemblies. Data is transmitted via fiber-optic cable. The assembly BES 1 has a connection for supplying voltage to the additional busbar.

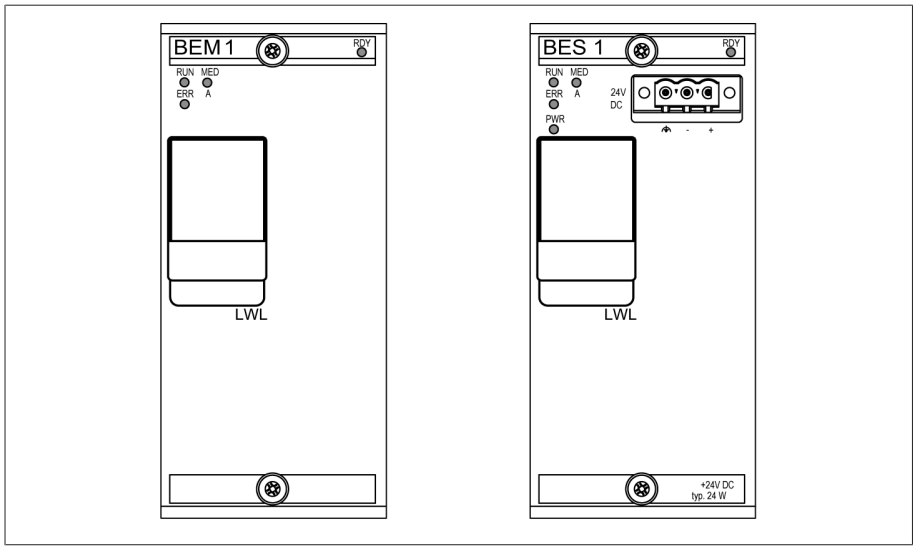


Figure 27: Assemblies BEM 1 and BES 1

4.7.3.21 System networking COM-ETH

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

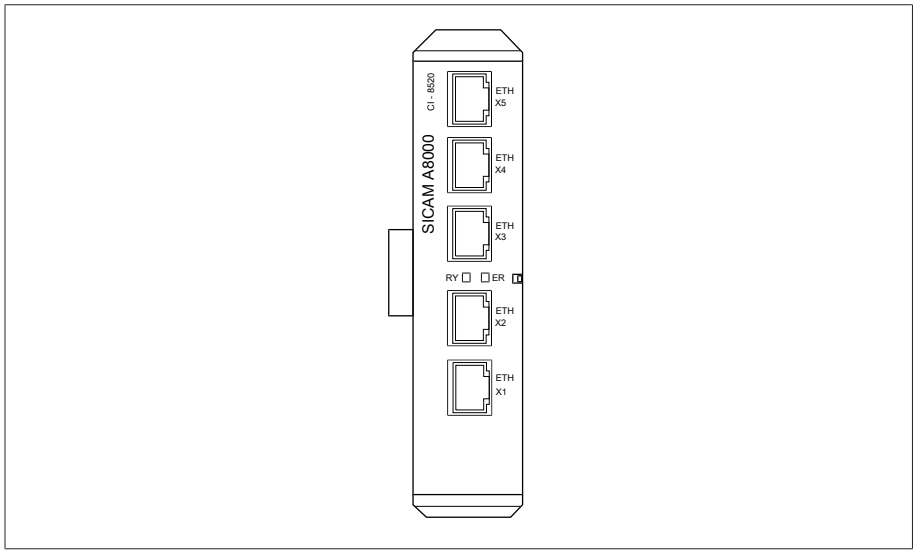


Figure 28: COM-ETH assembly

4.8 Operating concept

You can operate the device using the web-based ISM™ Intuitive Control Interface visualization via a PC.

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 8.1.12, Page 122] section.

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

Logging on, logging off and changing users

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

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 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.

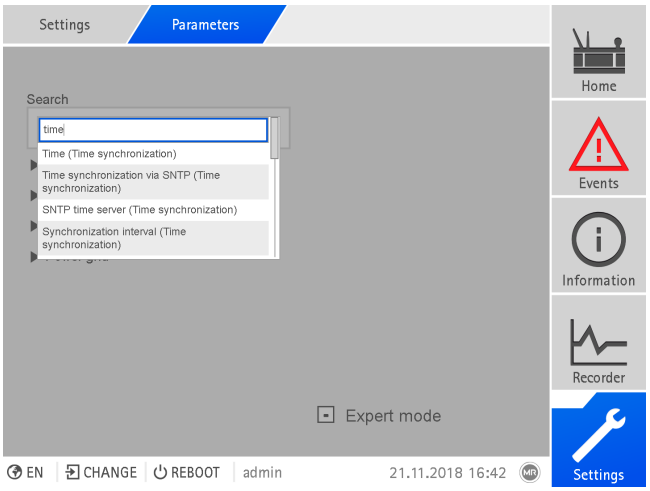


Figure 29: Quick search

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.

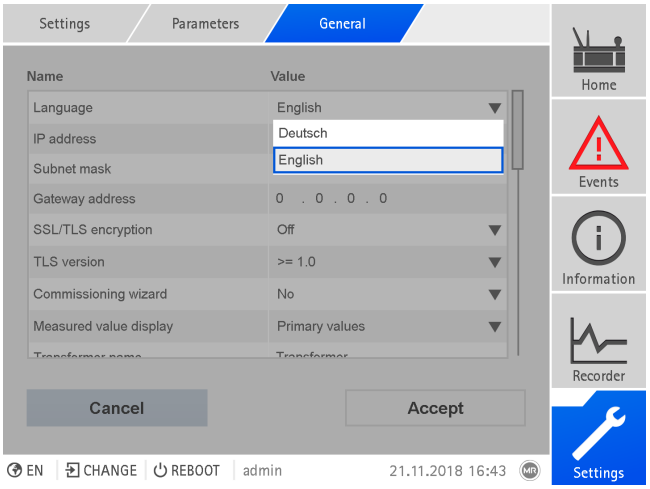


Figure 30: Expert mode

To activate the expert mode, proceed as follows:

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

» Expert mode is active.

Hiding/showing parameters

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

5 Packaging, transport and storage

5.1 Packaging

The products are sometimes supplied with sealed packaging and sometimes in a dry state, depending on requirements.

Sealed packaging surrounds the packaged goods with plastic foil on all sides.

Products that have also been dried are identified by a yellow label on the sealed packaging. In the dry state, delivery is also possible in a transport container.

The information in the following sections should be applied as appropriate.

5.1.1 Suitability

NOTICE

Property damage due to incorrectly stacked crates!

Stacking the crates incorrectly can lead to damage to the packaged goods.

- The outer marking on the packaging states if, for example, the on-load tap-changer or selector has been packed upright. Never stack these crates.
- General rule: Do not stack crates above a height of 1.5 m.
- For other crates: Only stack up to 2 equally sized crates on top of one another.

The packaging is suitable to ensure undamaged and fully functional means of transportation in compliance with local transportation laws and regulations.

The packaged goods are packed in a sturdy crate. This crate ensures that, when in the intended transportation position, the packaged goods are stabilized to prevent impermissible changes in position, and that none of the parts touch the loading surface of the means of transport or touch the ground after unloading.

Sealed packaging surrounds the packaged goods with plastic foil on all sides. The packaged goods are protected from humidity using a desiccant. The plastic foil was bonded after the desiccant is added.

5.1.2 Markings

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

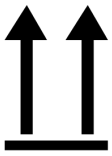
 Protect against moisture	 Top	 Fragile	 Attach lifting gear here	 Center of mass

Table 13: Shipping pictograms

5.2 Transportation, receipt and handling of shipments

⚠ WARNING

Danger of death or severe injury!

Danger of death or serious injuries due to tipping or falling load.

- Only transport the crate when closed.
- Do not remove the securing material used in the crate during transport.
- If the product is delivered on a pallet, secure it sufficiently.
- Only trained and authorized persons may select the sling gear and secure the load.
- Do not walk under the suspended load.
- Use means of transport and lifting gear with a sufficient carrying capacity in accordance with the weight stated on the delivery slip.

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

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

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

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

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

Visible damage

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

- Immediately record the identified transport damage 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 manufacturer 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.
- 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).
- *NOTICE!* Damage to packaged goods due to damaged sealed packaging. If the product is delivered in sealed packaging, check the sealed packaging immediately. If the sealed packaging is damaged, do not under any circumstances install or commission the packaged goods. Either re-dry the dried packaged goods as per the operating instructions, or contact the manufacturer to agree on how to proceed.
- Identify the damaged parts.

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.

5.3 Storage of shipments

Packaged goods dried by Maschinenfabrik Reinhausen

Upon receipt of the shipment, immediately remove the packaged goods dried by Maschinenfabrik Reinhausen from the sealed packaging and store air-tight in dry insulating fluid until used if the packaged goods were not supplied in insulating fluid.

Non-dried packaged goods

Non-dried packaged goods but with a functional sealed packaging can be stored outdoors when the following conditions are complied with.
When selecting and setting up the storage location, ensure the following:

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

Protect the packaging foil from direct sunlight so that it does not disintegrate under the influence of UV rays, which would cause the packaging to lose its sealing function.

If the product is installed more than 6 months after delivery, suitable measures must be taken without delay. The following measures can be used:

- Correctly regenerate the drying agent and restore the sealed packaging.
- Unpack the packed goods and store in a suitable storage space (well ventilated, as dust-free as possible, humidity < 50% where possible).

5.4 Unpacking shipments and checking for transportation damages

- *NOTICE!* Transport the packaged crate to the place where the packaged goods will be installed. Do not open the sealed packaging until just before installation. Otherwise, damage to the packaged goods may occur due to ineffectively sealed packaging.
- ⚠ WARNING! When unpacking, check the condition of the packaged goods. Place the packaged goods in an upright crate and protect them from tipping out. Otherwise, the packaged goods may become damaged and serious injuries may result.
- Check the completeness of the accessories kit based on the delivery slip.
- *NOTICE!* Do not set the device down on the pressure equalization element on the rear side. Otherwise the pressure equalization element may be damaged.

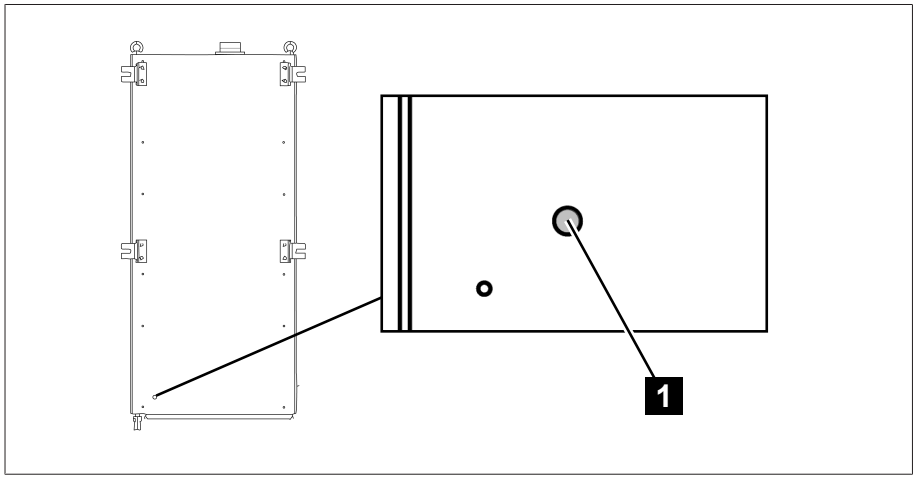


Figure 31: Pressure equalization element on the rear of the device

1	Pressure equalization element

Attachment points for lifting gear

⚠ WARNING

Danger of death and damage to property!

Danger of death and damage to property due to tipping or falling load!

- Only trained and authorized persons may select the sling gear and secure the load.
- Do not walk under the suspended load.
- Use means of transport and lifting gear with a sufficient carrying capacity in accordance with the weight stated in the Technical data [▶Section 13, Page 170] section.

– ⚠ WARNING! Serious injuries and damage to the control cabinet due to falling load. Use all 4 transport lugs or the 2 transport lugs on the side of the door. Turn the transport lugs to face the lifting gear. Attach the lifting gear so that the cable angle is always less than 45° in relation to the vertical.

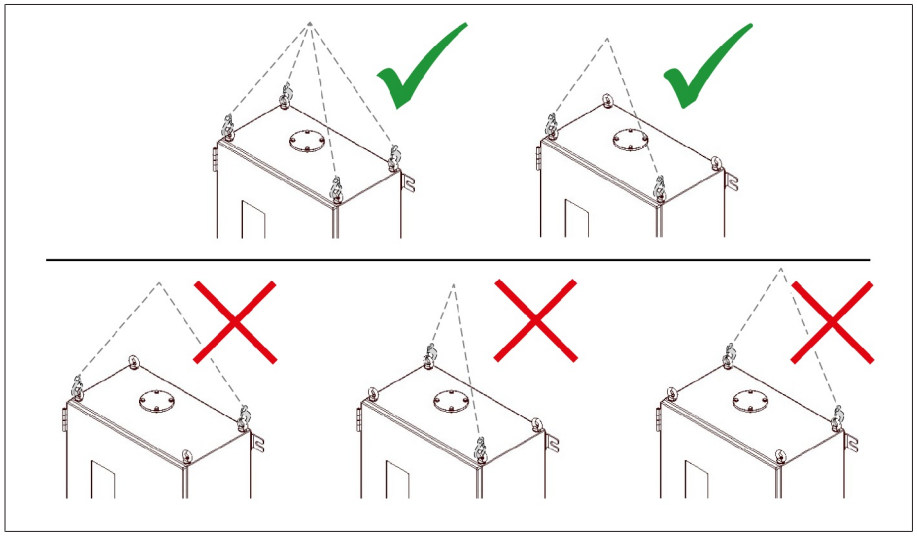


Figure 32: Transport lugs for lifting gear

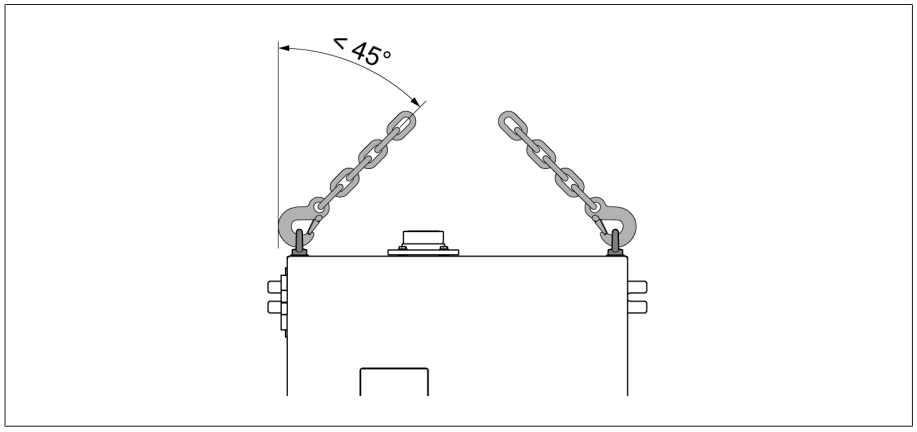


Figure 33: Maximum permissible cable angle for the lifting gear limit stop of the control cabinet

- ⚠ WARNING! Serious injuries due to the control cabinet tipping and damage to the cable gland if the control cabinet is set down, transported or stored upright. Only set down, transport and store the control cabinet on its back.
- Only remove the control cabinet from the crane once it has been fully connected to the transformer.

6 Mounting

This chapter describes how to correctly mount and connect the device. Note 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

Time delayed explosion hazard and fire hazard!

If the test tap is not grounded or not properly connected to the bushing adapter, the bushing may be destroyed and the transformer may catch fire. This can lead to death or severe injuries. Before commissioning the transformer, perform the following measures:

- Never operate the test tap when it is open. Observe the operating instructions for the bushing.
- Ensure the correct installation of the bushing adapter and the cable connection to the bushing coupling unit.
- Ensure a correct cable connection between the bushing coupling unit and the measuring card in the control cabinet.

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

Before installation, check that the serial numbers of the bushing adapter and bushing coupling unit match those on the delivery slip and are appropriate for the bushing you have specified.

Perform a plausibility check before starting the bushing coupling unit installation.

⚠ WARNING

Time delayed explosion hazard and fire hazard!

Installing a bushing coupling unit with an incorrect capacitance value can cause a malfunction and failure of the protective device. As a result, overheating occurs, posing a risk of explosion and serious injury.

- Perform a plausibility check in accordance with the following description.
- Proceed with installation and commissioning only if the target range of the measured voltage is maintained. Otherwise, contact the manufacturer and replace the bushing coupling unit.

Plausibility check

1. Check fields 1 and 2 separately to see if the respective capacitance value of the bushing coupling unit is correct.
2. Use the following formula to calculate the measured voltage at the output of the bushing coupling unit:

$$U_{out} = \frac{U_r}{\sqrt{3}} \times \frac{C_1}{C_{BCU}}$$

Figure 34: Plausibility check equation

U_{out}	Measured voltage (output of bushing coupling unit)	U_r	Nominal voltage of transformer
C1	Main capacitance of the bushing	C_{BCU}	Capacitance of bushing coupling unit

3. Compare the calculated value for U_{out} with the target range.

UI5-3 assembly: 55 V ≤ U_{out} ≤ 100 V

U 3 assembly: 25 V≤ U_{out} ≤ 125 V

1. If the calculated value is outside the target range, replace the bushing coupling unit.
2. Proceed with assembly only if the bushing coupling unit is designed correctly. If in doubt, contact MR.

6.2 Installing the bushing adapter

> Carry out the operating steps listed below on all bushings.

1. Remove the safety cap for the bushing test tap. Store the safety cap (and, where applicable, the built-in spring, see "Bushing adapter without pin connection") in a safe place for possible operation of the bushing later without the monitoring system.
2. Ensure that the test tap and the bushing adapter are dry and free of dirt. If this is not the case, clean and dry them with a cloth.

3. Ensure that the sealing ring of the bushing adapter is present and positioned correctly.

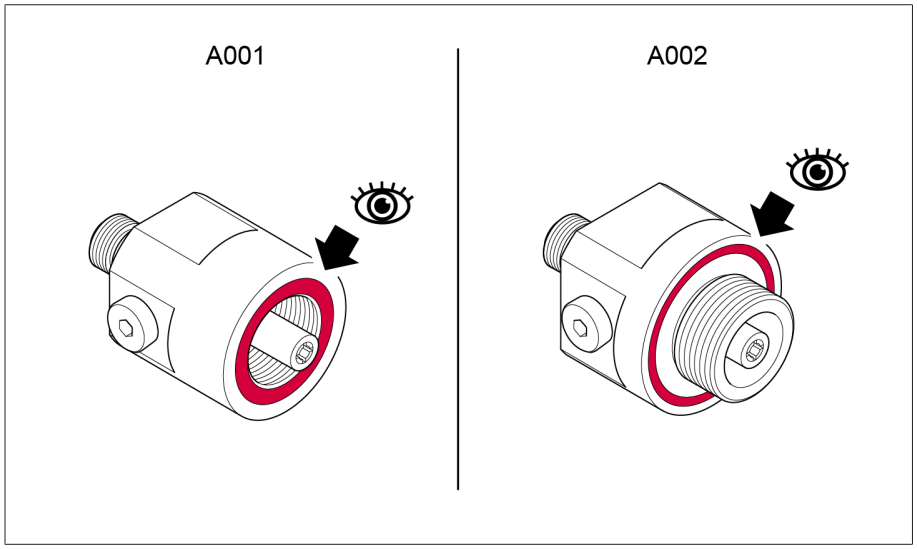


Figure 35: Checking the sealing ring (example illustration bushing adapter A001 and A002)

Bushing adapter with pin connection

– With bushing adapters with a pin port, visually check that the pin of the test tap fits mechanically into the port of the bushing adapter.

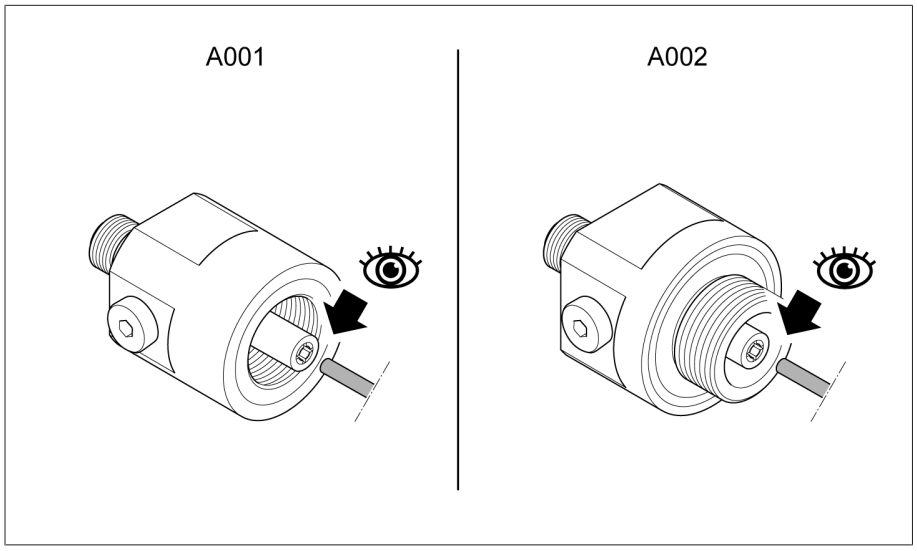


Figure 36: Checking the connection (example illustration bushing adapter A001 and A002)

Bushing adapter without pin connection

– If a spring is supplied with the bushing adapter, use the supplied spring and safely store the spring installed on the test tap.

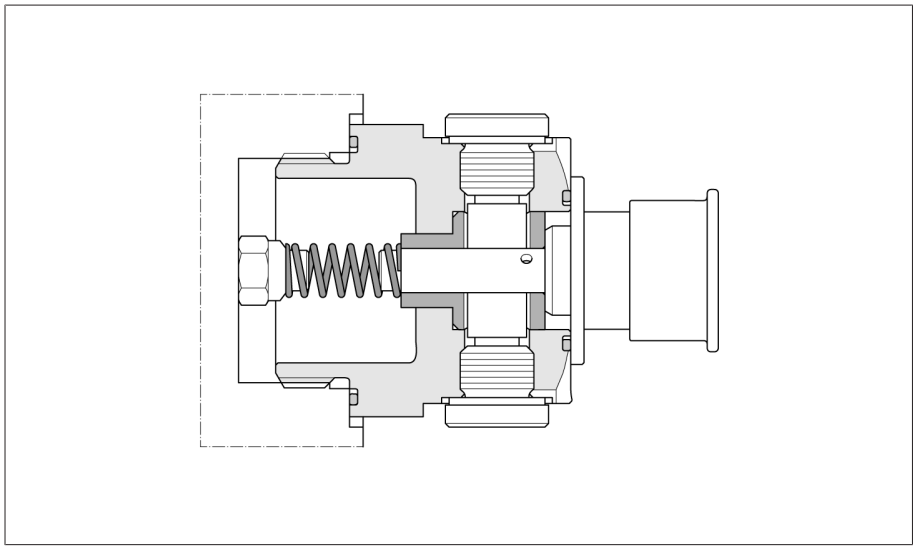


Figure 37: Test tap with spring

– If a spring is not supplied with the bushing adapter, use the spring installed on the test tap.
– With the bushing adapter A008, a flat connection is made and no spring is used. Safely store the spring installed on the test tap.

› *NOTICE!* Install the bushing adapter at the bushing test tap. Compare the following reference values for the tightening torque with the specifications of the bushing manufacturer and consult them if necessary. Otherwise, leakage or damage to the bushing may occur.

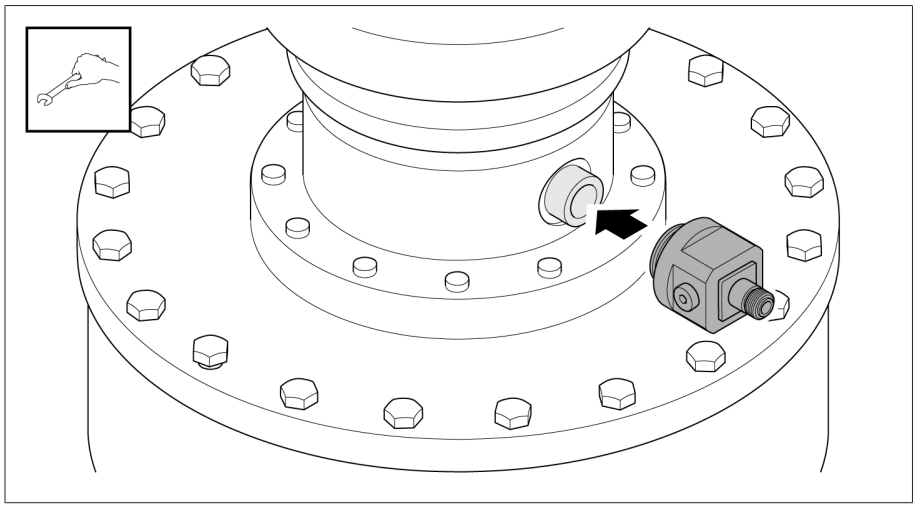


Figure 38: Installing the bushing adapter (example using bushing adapter A002)

Type	Tightening torque reference value
A001	6 ± 2 Nm
A002	30 Nm
A003	50 Nm
A004	10 Nm
A005	25 Nm
A006	160 Nm

Type	Tightening torque reference value
A007	35 Nm
A008	5 ± 1 Nm
A010	40 Nm

Table 14: Tightening torque reference values

6.3 Installing the bushing coupling unit

Observe the notes regarding the plausibility check [▶Section 6.1, Page 45].

> You can also use your own supporting plate instead of the provided supporting plate. In this case, you must ensure that the bushing coupling unit is continuously connected to the transformer tank by a low-resistance connection (e.g. via lock washers under the screw heads of the M4 fixing screws). The necessary dimensions for the holes can be found in the technical data for the bushing coupling unit [▶Section 13.2, Page 173].

> Carry out the operating steps listed below on all bushings.

Install the bushing coupling unit onto the bushing flange near the bushing adapter.

1. Unscrew the cover bolts for the bushing coupling unit and lift off the cover.

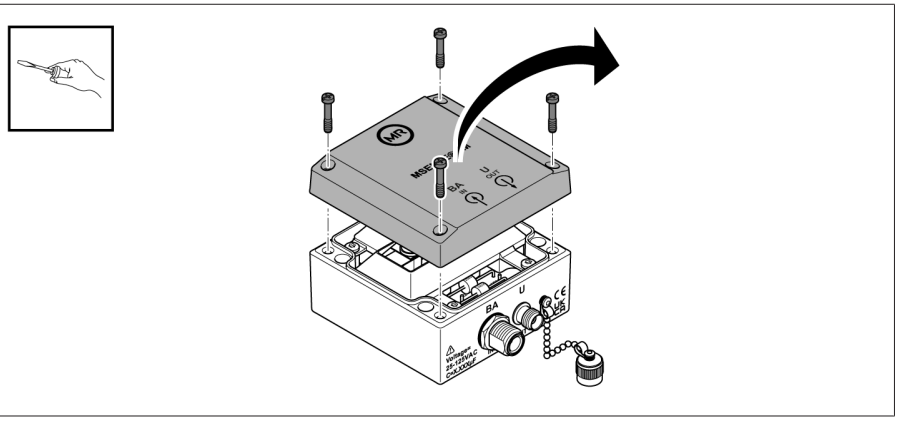


Figure 39: Loosening the screws and removing the cover

2. Align the supporting plate so that the grounding symbol is still clearly visible after installation. Insert Allen screws with lock washers into the intended holes and fasten the supporting plate on the other side with lock washers and nuts.

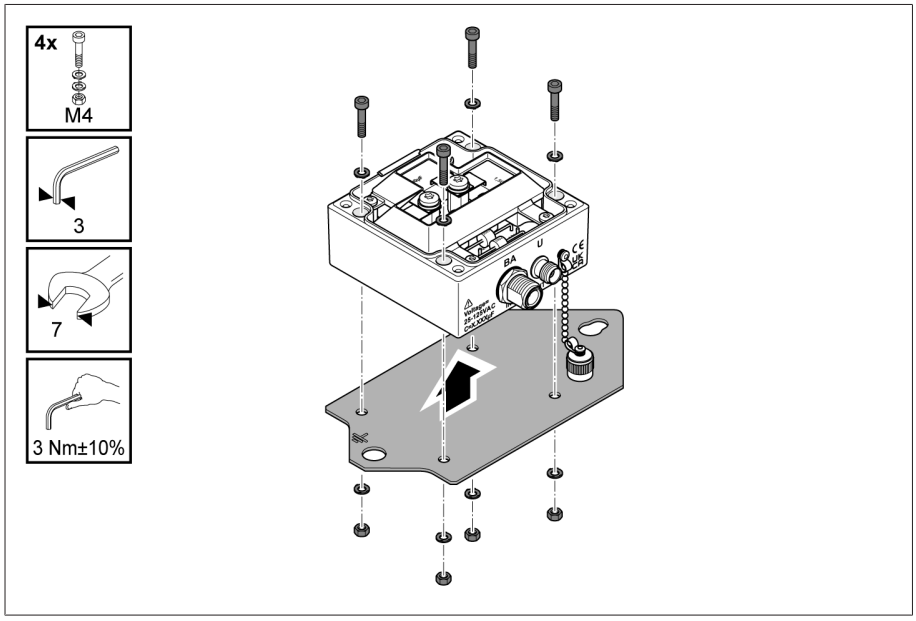


Figure 40: Fastening the bushing coupling unit to the supporting plate

3. Place the cover on the bushing coupling unit and screw it in place.

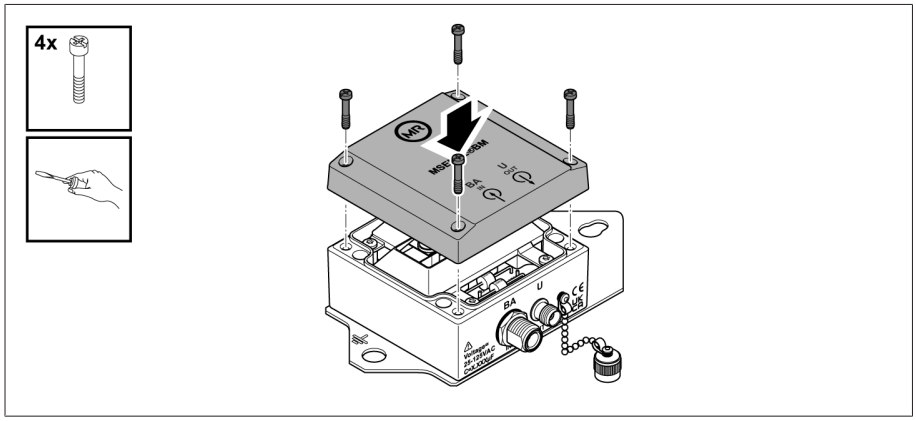


Figure 41: Fastening the cover

4. Unscrew the fixing screw for the bushing flange.
5. Install the supporting plate on the bushing flange.

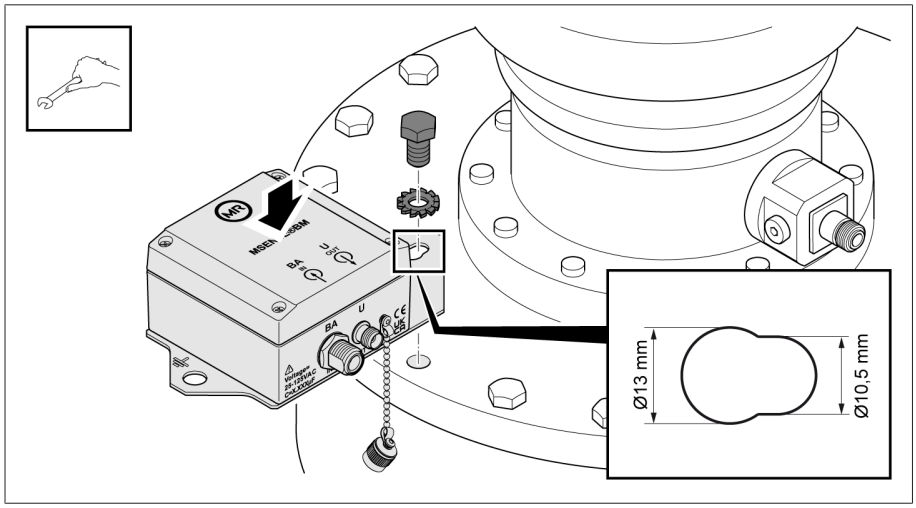


Figure 42: Installing the supporting plate on the bushing flange

6. Connect the earthing cable to the supporting plate and transformer.

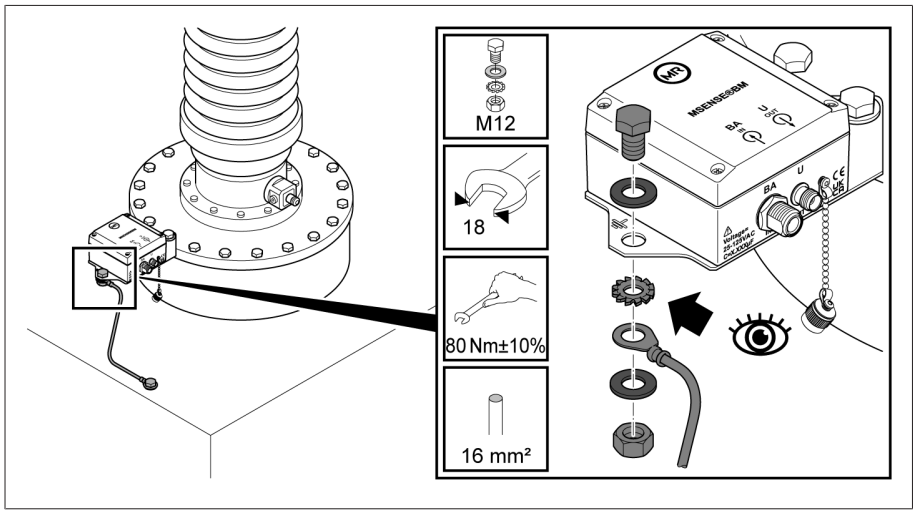


Figure 43: Connecting the earthing cable

6.4 Mounting the control cabinet

⚠ WARNING

Danger of death and damage to property!

Danger of death and damage to property due to tipping or falling load!

- Only trained and authorized persons may select the sling gear and secure the load.
- Do not walk under the suspended load.
- Use means of transport and lifting gear with a sufficient carrying capacity in accordance with the weight stated in the Technical data [▶Section 13, Page 170] section.

The control cabinet has four fixing lugs on the rear to secure it.

1. Attach four stud bolts (not supplied by MR) to the transformer tank. Recommended clearance between the control cabinet and floor is approx. 0.5...1 m.

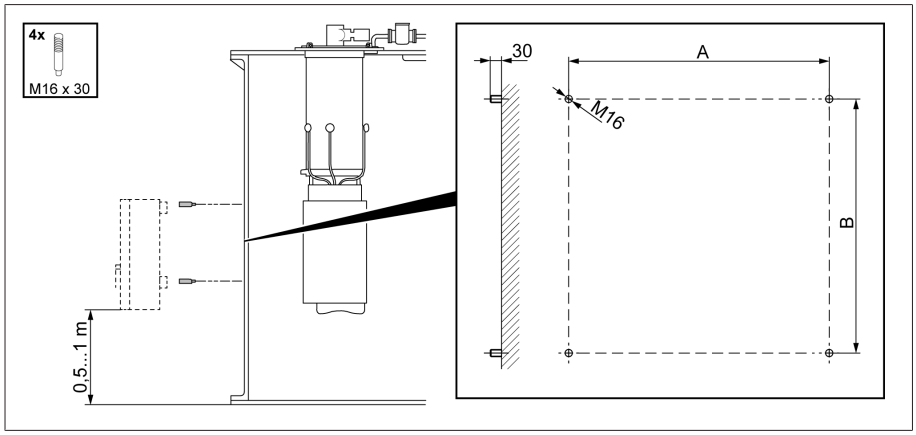


Figure 44: Fastening the stud bolts

A	Standard: 715 ± 2 mm (28.15 ± 0.08 in) Rail profile: 760 ± 2 mm (29.92 ± 0.08 in)	B	750 ± 2 mm (29.53 ± 0.08 in)

2. For control cabinets with vibration damper: Attach the inner brackets to the control cabinet. Attach the outer brackets to the transformer wall. The complete contact surfaces of the brackets must be in contact.

3. ⚠ WARNING! Serious injuries and damage to the control cabinet due to falling load. Use all 4 transport lugs or the 2 transport lugs on the side of the door. Attach the lifting gear so that the cable angle is always less than 45° in relation to the vertical.

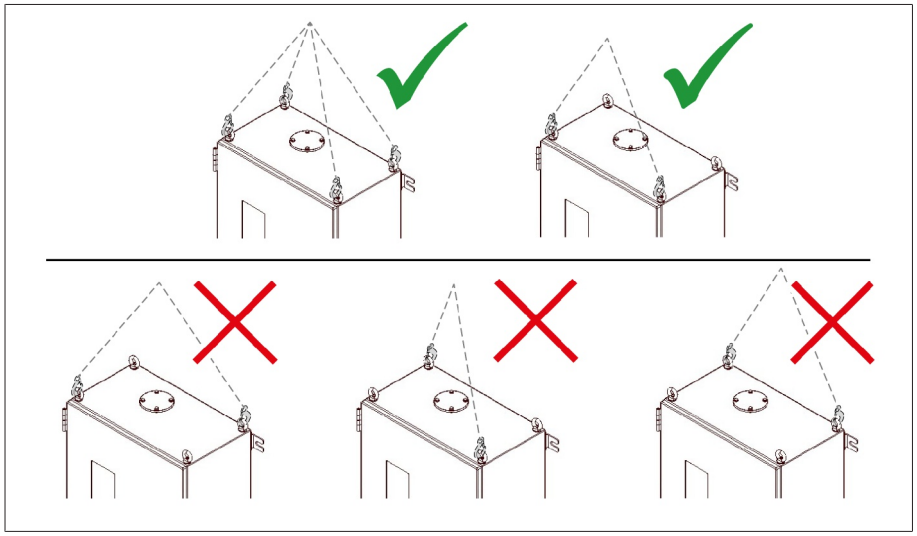


Figure 45: Transport lugs for lifting gear

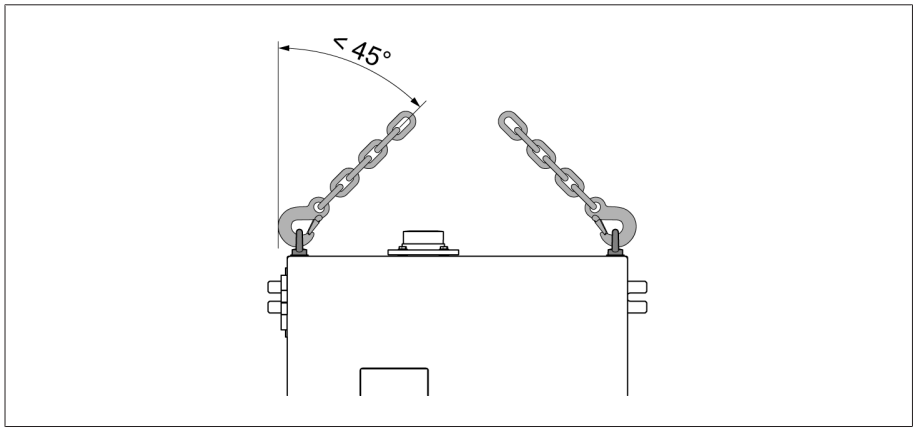


Figure 46: Maximum permissible cable angle for the lifting gear limit stop of the control cabinet

4. Use the fixing lugs to attach the control cabinet to the stud bolts and align it vertically on the transformer tank.

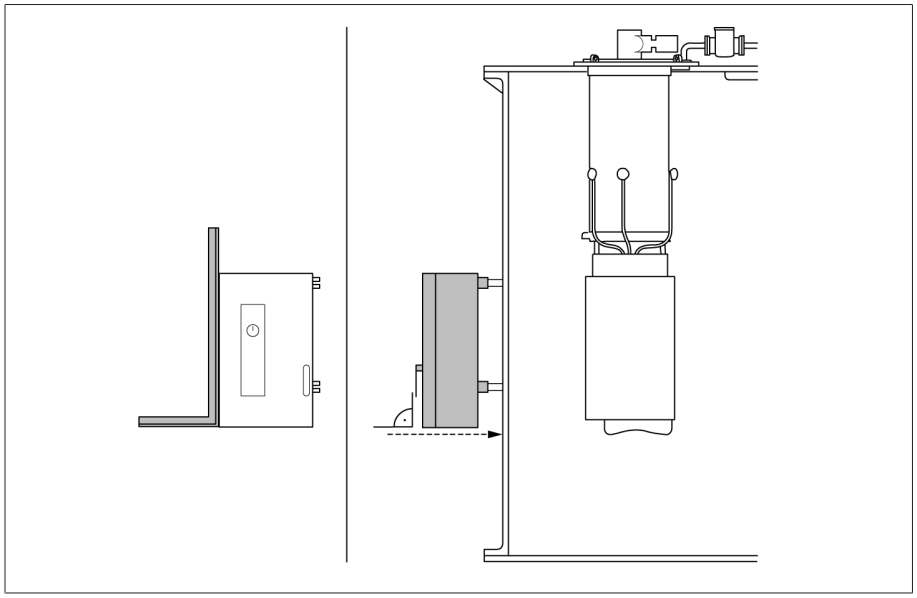


Figure 47: Attaching the control cabinet

5. *NOTICE!* Damage to the control cabinet due to mechanical tension if the offset to the plane is greater than 5 mm. The offset must be compensated using washers. Secure the control cabinet without subjecting it to mechanical tension.

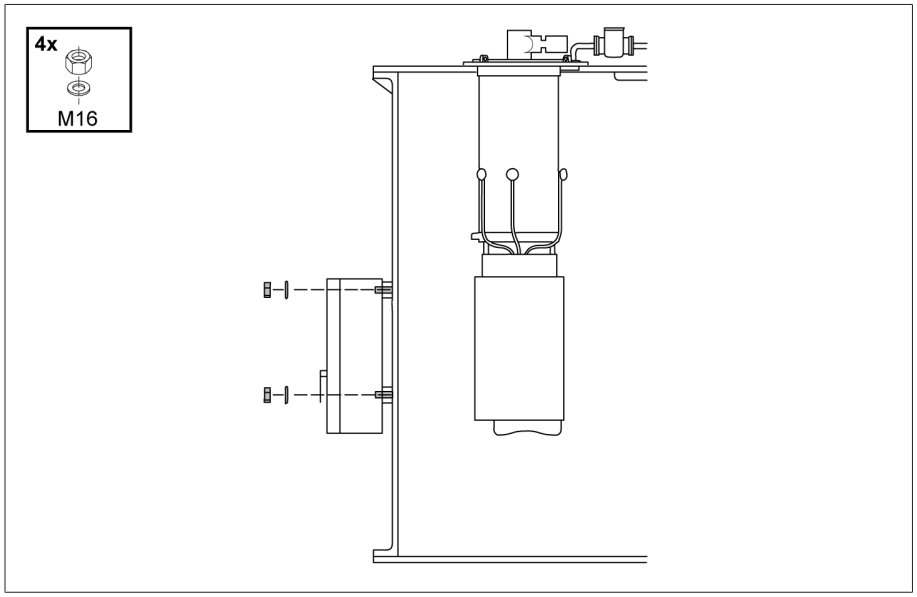


Figure 48: Securing the drive

6. Connect the grounding cable to the control cabinet and transformer tank.

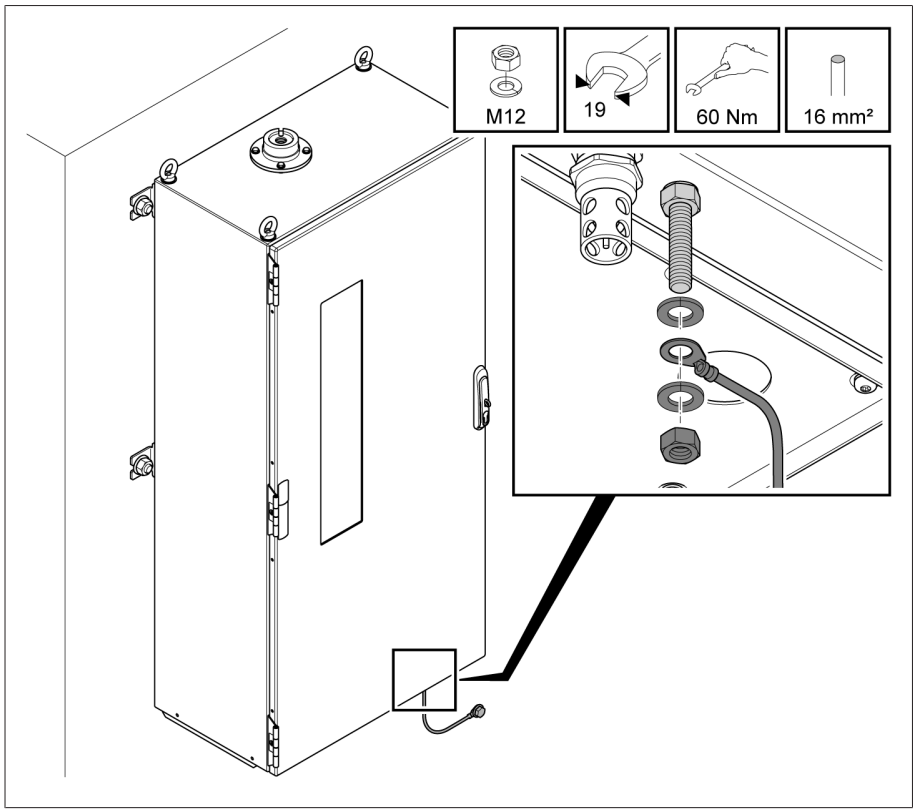


Figure 49: Connecting the grounding cable

6.5 Installing the cap rail modules

With the MSENSE® BM product version as an integration solution in the customer control cabinet, the cap rail modules must be installed in a suitable control cabinet, taking the EMC standards into consideration. This section does not apply for other product versions.

6.5.1 Minimum distances

NOTICE

Damage to the device!

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

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

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

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

Table 15: Minimum distances in the control cabinet

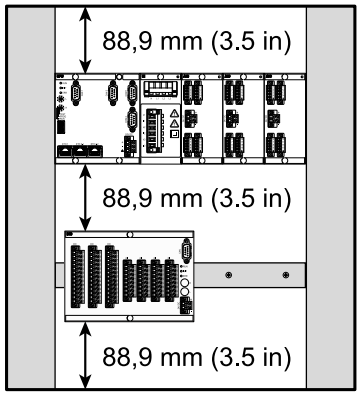


Figure 50: Example depiction of the minimum distances in a control cabinet

For other installation types, contact Maschinenfabrik Reinhausen GmbH.

6.5.2 Fastening the cap rail

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

- TH 35-7.5
- TH 35-15

The cap rail may not be painted or lacquered.

⚠ WARNING

Electric shock!

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

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

- Fasten the cap rail to the rear panel of the switch cabinet using screws and contact washers or lock washers. The distance between the screws may be no more than 10 cm (3.94 in).

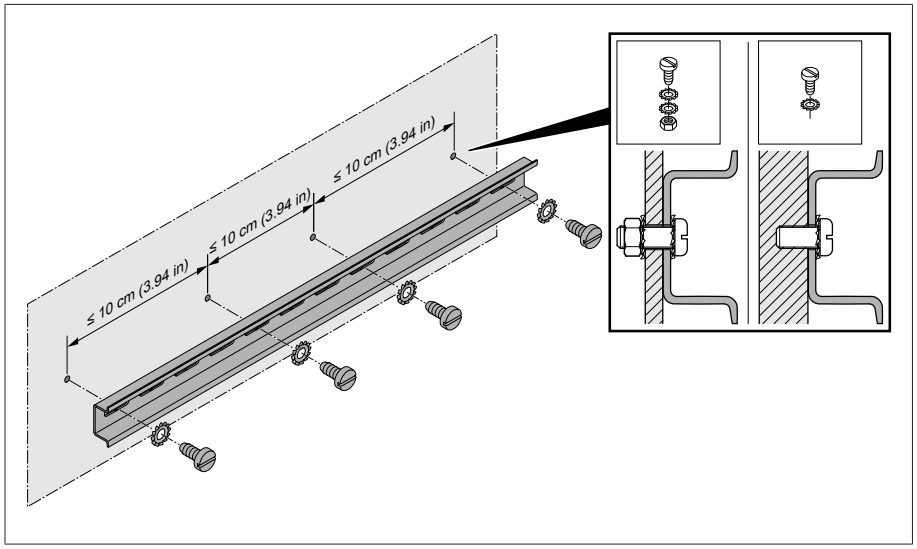


Figure 51: Fastening the cap rail

6.5.3 Installing the bus rail on the cap rail

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

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

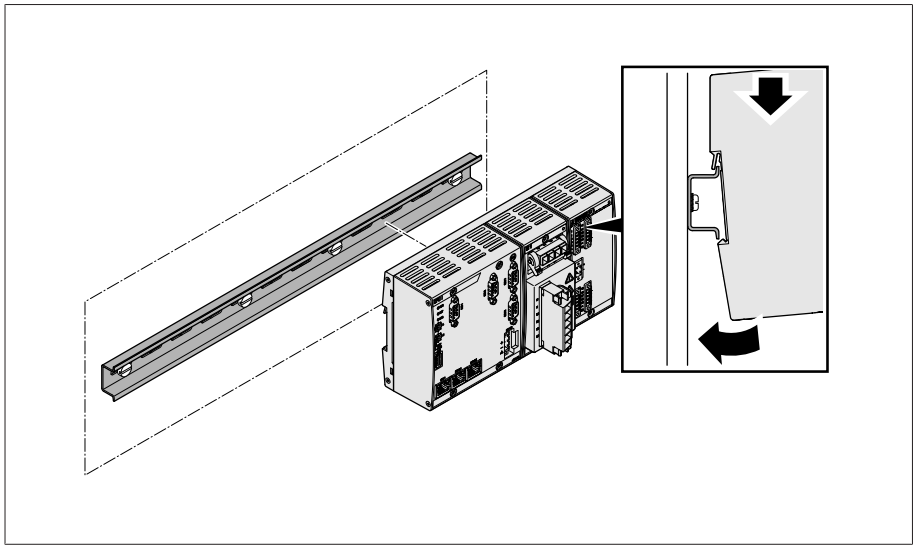


Figure 52: Hooking the bus rail into position

6.5.4 Installing the assembly at a distance on the cap rail

The assemblies VI 4, CPU II and AIO 2/AIO 4 are delivered pre-mounted on the bus rail. The following optional assemblies must be mounted with an offset on a cap rail:

- DIO 28-15 or DIO 42-20
- MC 2-2
- SW 3-3
- G1 (PULS)

✓ Cap rail fastened to the rear panel of the cabinet [▶Section 6.5.2, Page 54].

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

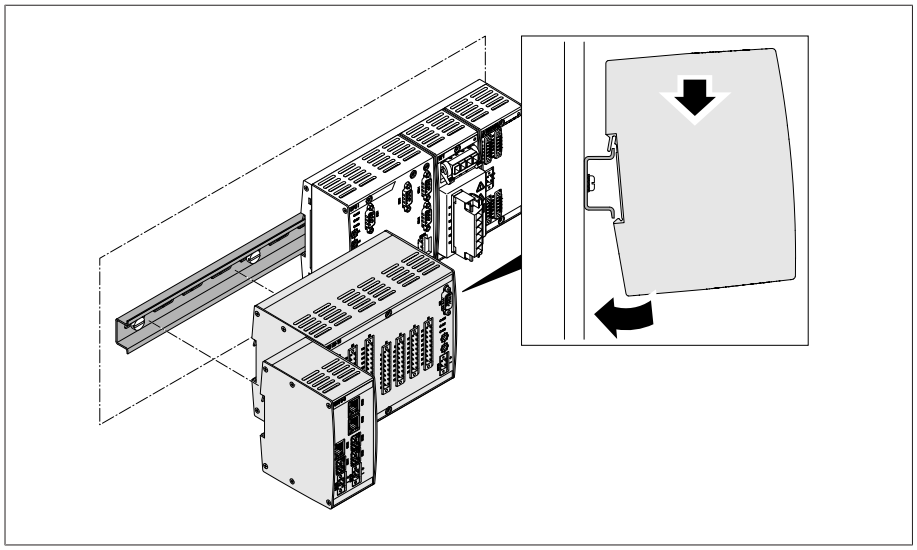


Figure 53: Example: Hooking on DIO and SW assemblies

6.5.5 Wiring the CPU I / CPU II assembly

1. Connect the ETH 2.1 or ETH 2.2 (optional) interface to a PC in accordance with the connection diagram to access the web-based visualization.

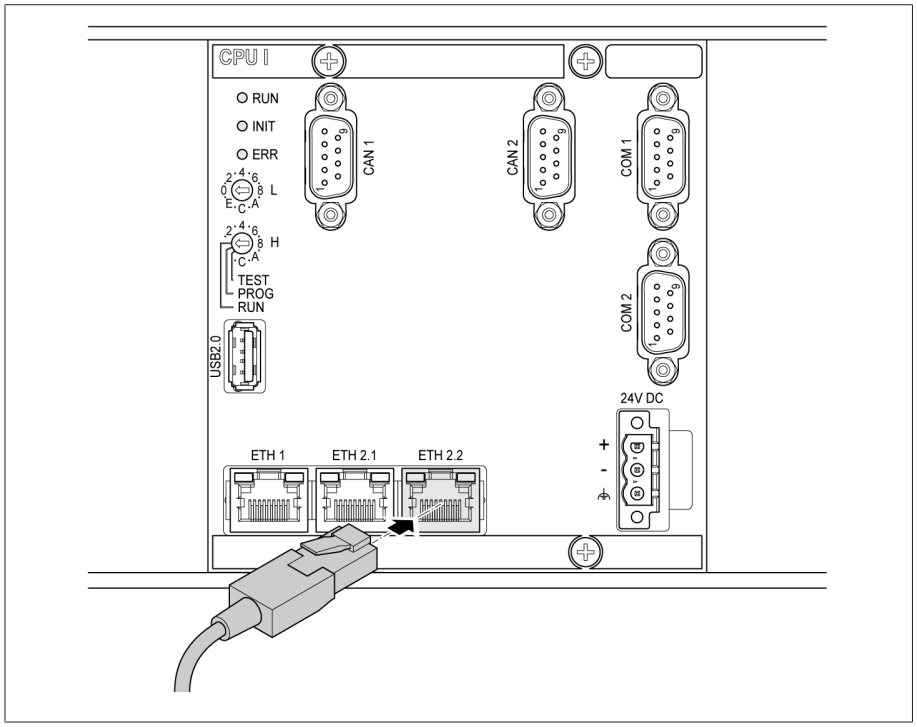


Figure 54: Connection to a PC via Ethernet interface

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

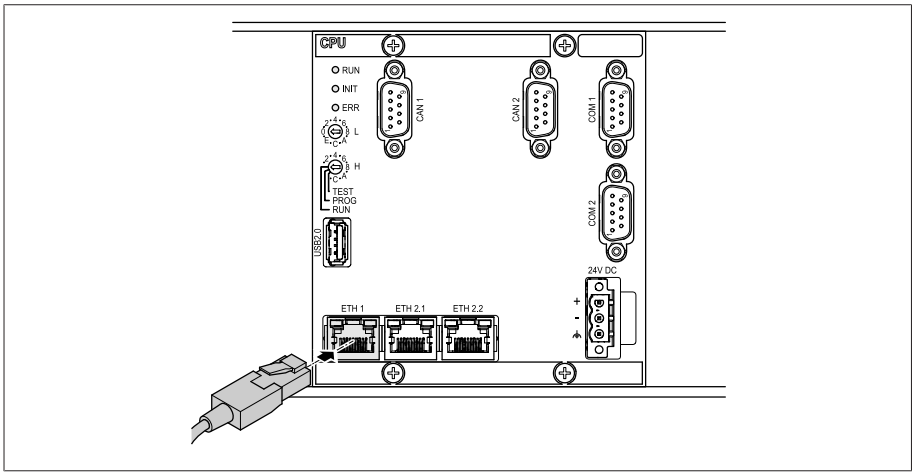


Figure 55: SCADA connection

Observe the information on connecting serial interfaces [▶ Section 6.6.3, Page 69].

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

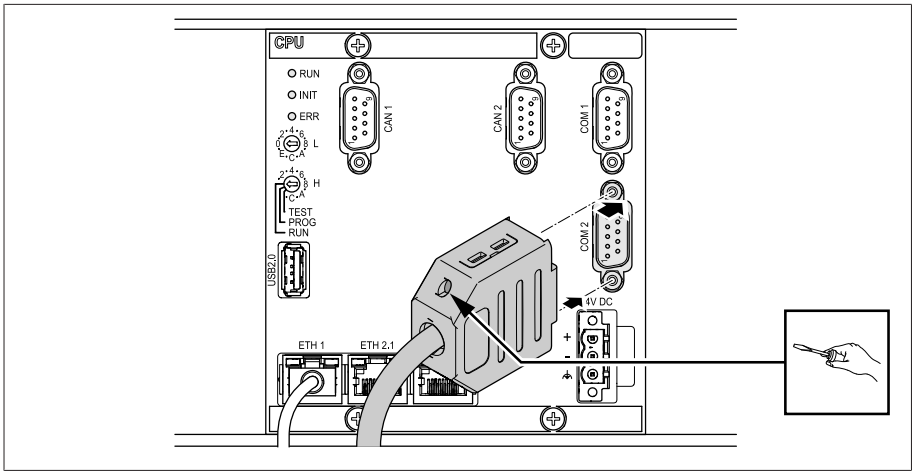


Figure 56: Serial SCADA connection via COM 2 interface

Power supply

The CPU I or CPU II assembly must be connected to the voltage supply of the voltage supply unit. Proceed as follows:

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

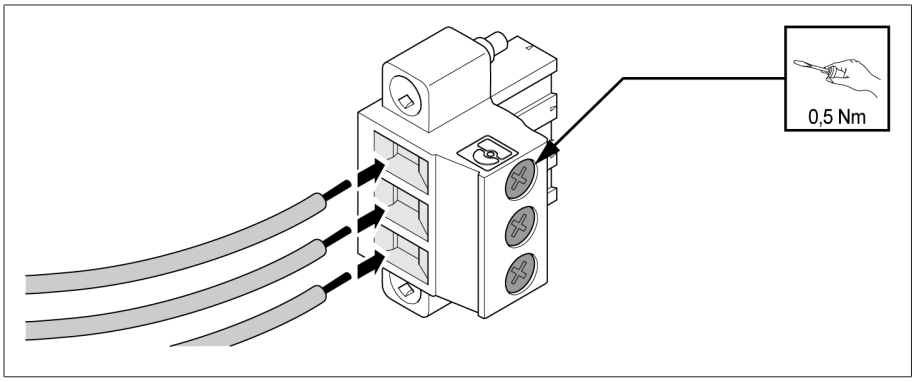


Figure 57: Inserting the leads

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

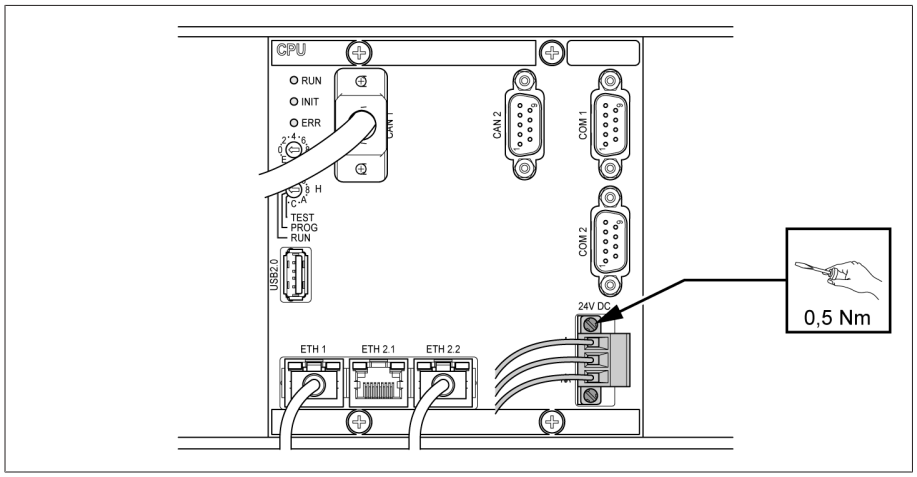


Figure 58: Fastening the 24 V DC plug

6.5.6 Wiring the UI assembly

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

	Miniature circuit breaker	Safety fuse
Standard	IEC 60947-2	IEC 60269
Rated voltage	400 V (L-L) or 230 V (L-N)	
Rated current	30 mA...16 A	
Characteristics	B, C, K or Z	Fast-acting, medium-acting or delayed-acting
Rated switching capacity	50 kA For installation in accordance with IEC 61010-2-30 CAT II: 10 kA	

Table 16: Permissible fuse types

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

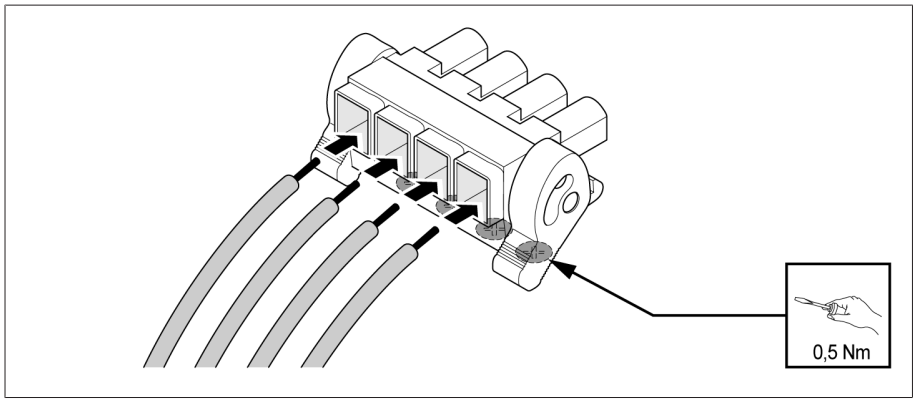


Figure 59: Example: Plug for voltage measurement

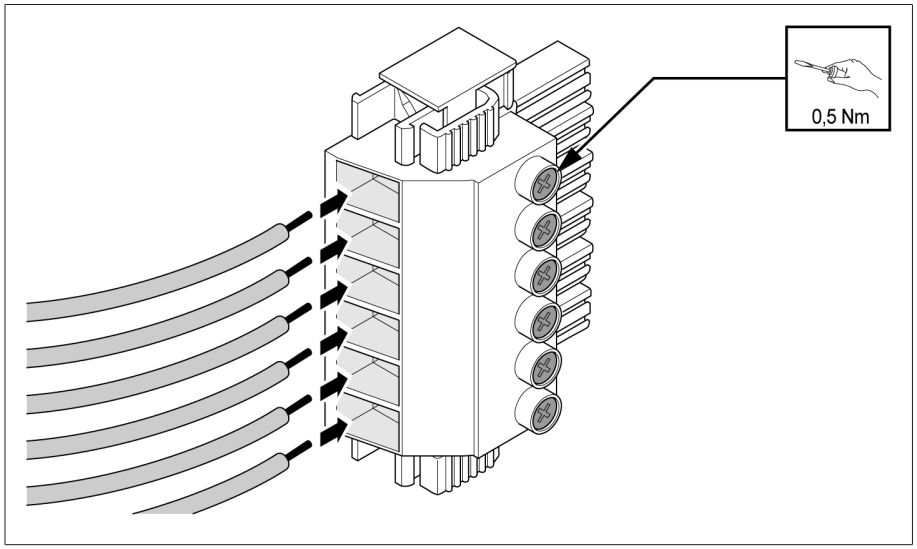


Figure 60: Example: Plug for current measurement

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

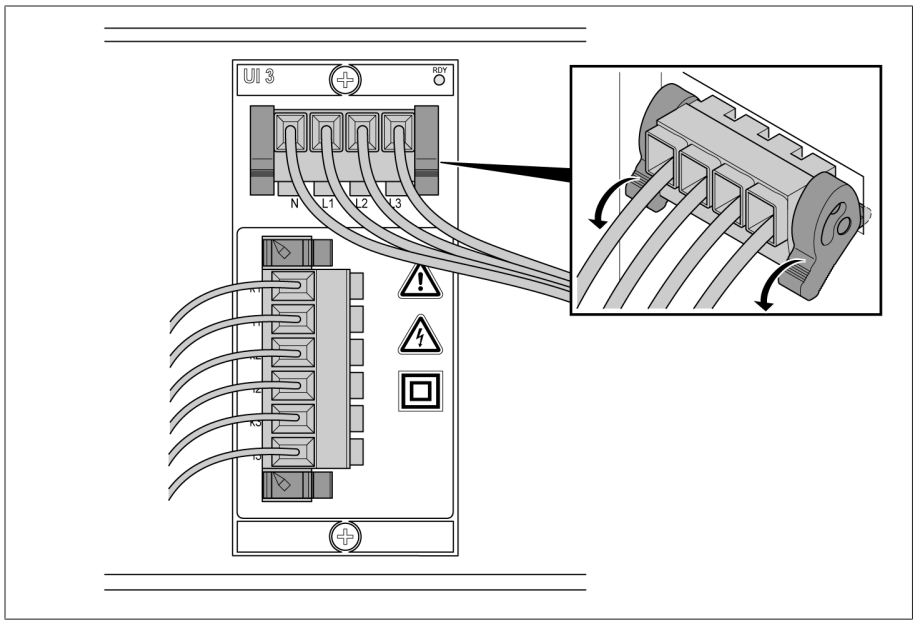


Figure 61: Engaging the plug

6.5.7 Wiring the DIO assembly

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

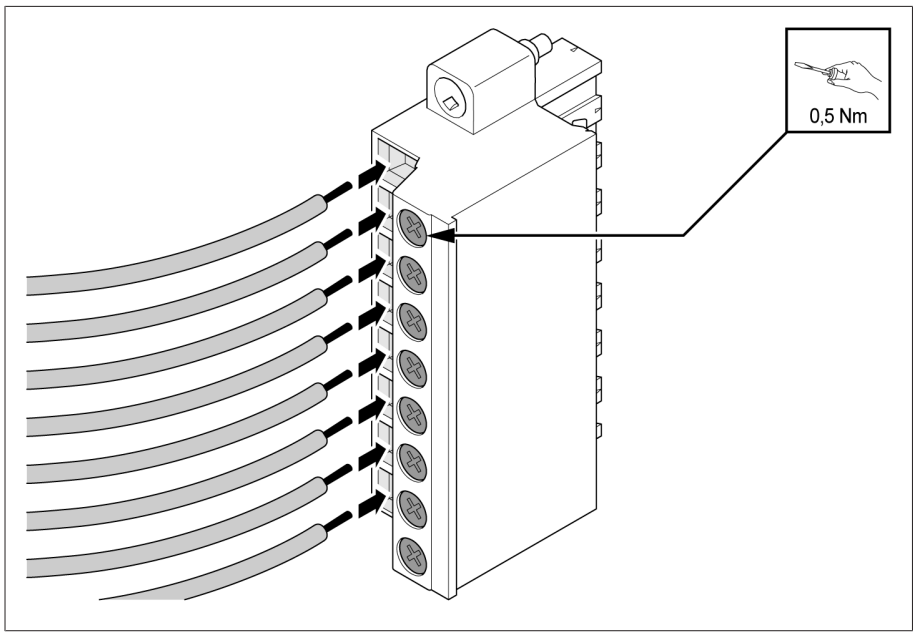


Figure 62: Inserting the leads

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

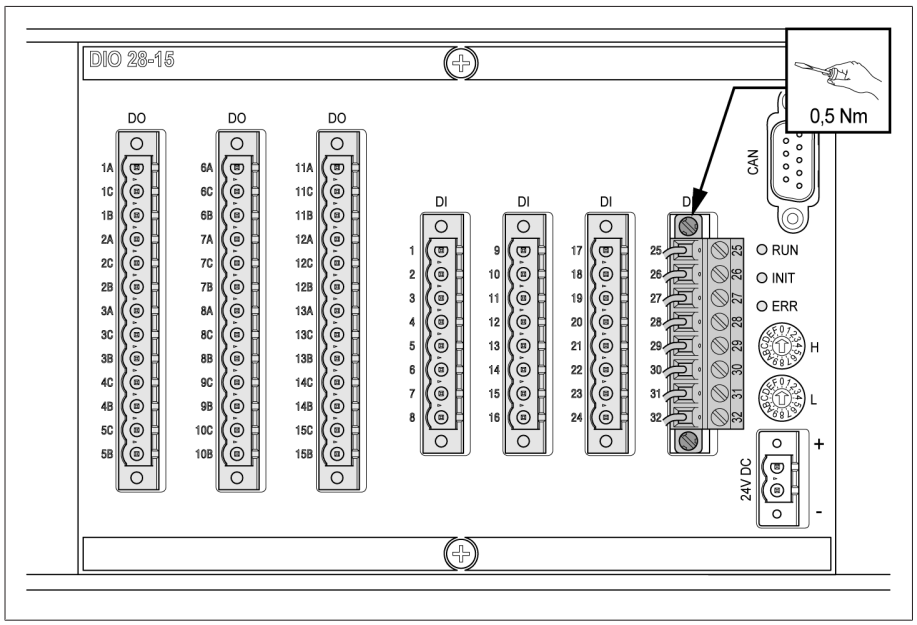


Figure 63: Fastening the plug

3. Connect the DIO 28-15/DIO 42-20 assemblies to CPU I using the CAN bus cable.

When connecting the DIO 28-15/DIO 42-20 assembly to the CPU assembly, it is imperative that you use only the supplied connection cable. If you use the 2.1 m or 3 m connection cable, you must insert the plug with the CPU label into the CPU assembly, because this plug contains a terminating resistor. If you are using shorter cables, you can swap the plugs.

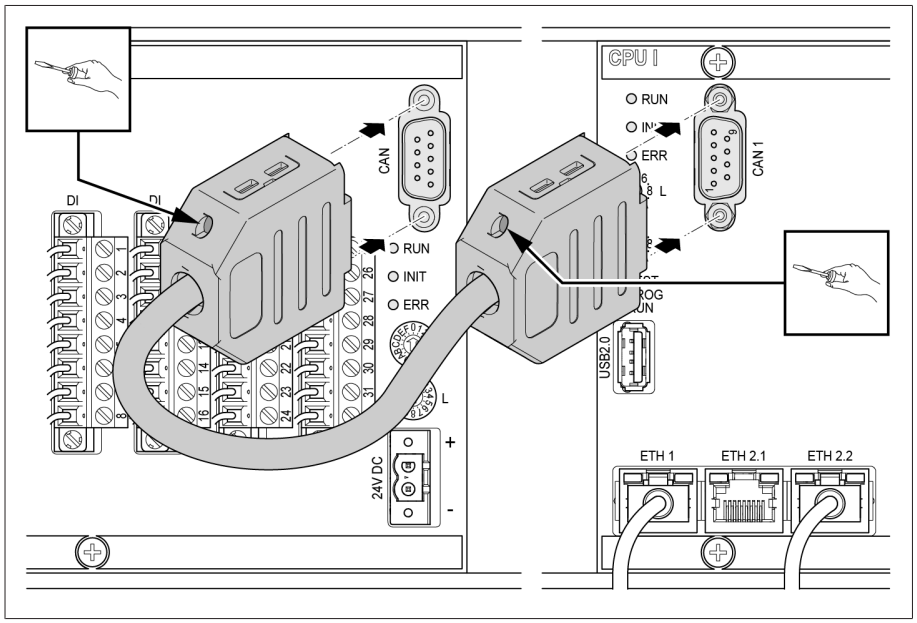


Figure 64: CAN bus connection

Voltage supply

Connect the DIO 28-15/DIO 42-20 assembly to the voltage supply of the voltage supply unit:

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

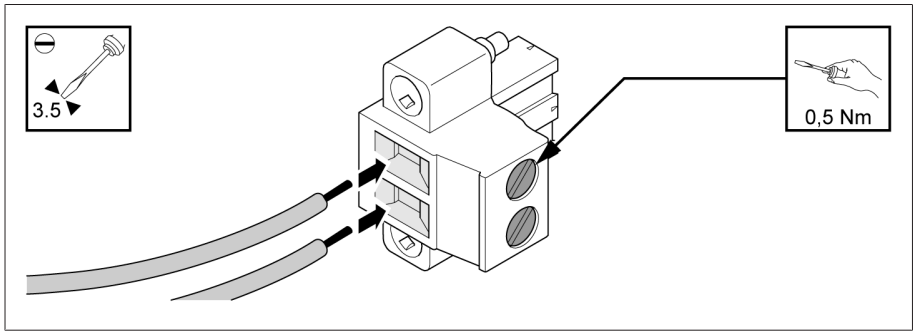


Figure 65: Inserting the leads

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

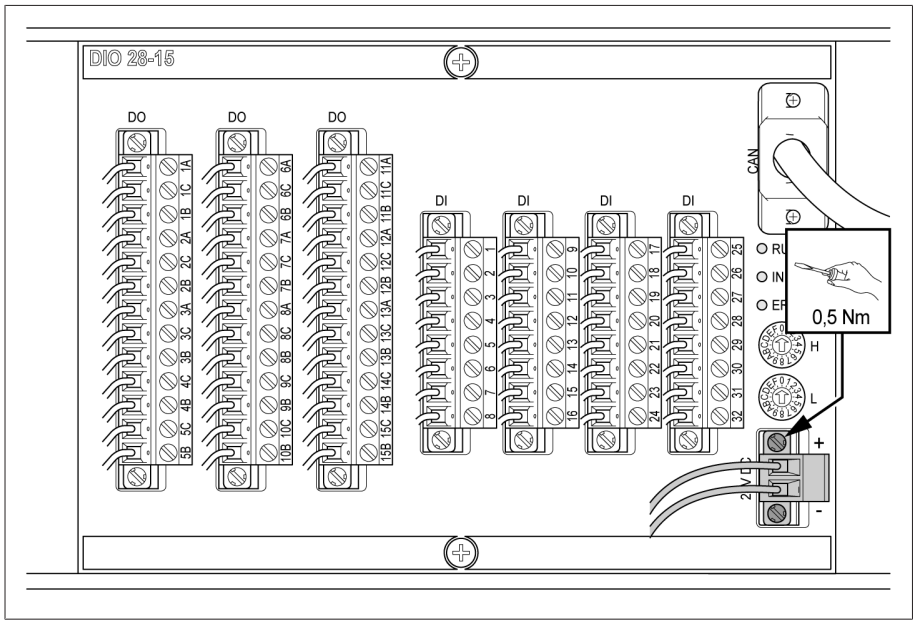


Figure 66: Fastening the 24 V DC plug

Setting rotary switches of DIO 28-15 and DIO 42-20

If the device has 2 DIO assemblies, you have to ensure that the L rotary switches have different settings on the respective assemblies. This is the only way of ensuring a perfect CAN bus connection.

DIO	H	L
First assembly – DIO 28-15 – DIO 42-20	0	1
Second assembly – DIO 28-15-1 – DIO 42-20-1	0	2

Table 17: Rotary switch configuration

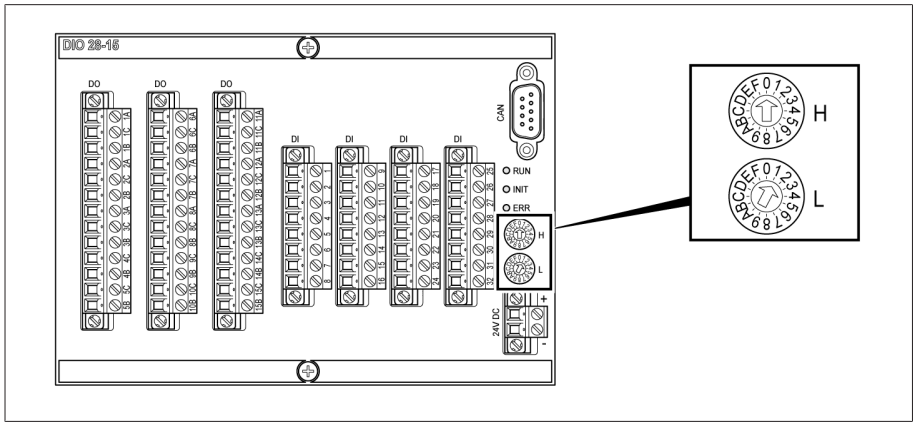


Figure 67: Rotary switch H and L of DIO assembly

6.5.8 Wiring the MC 2-2/SW3-3 assembly

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

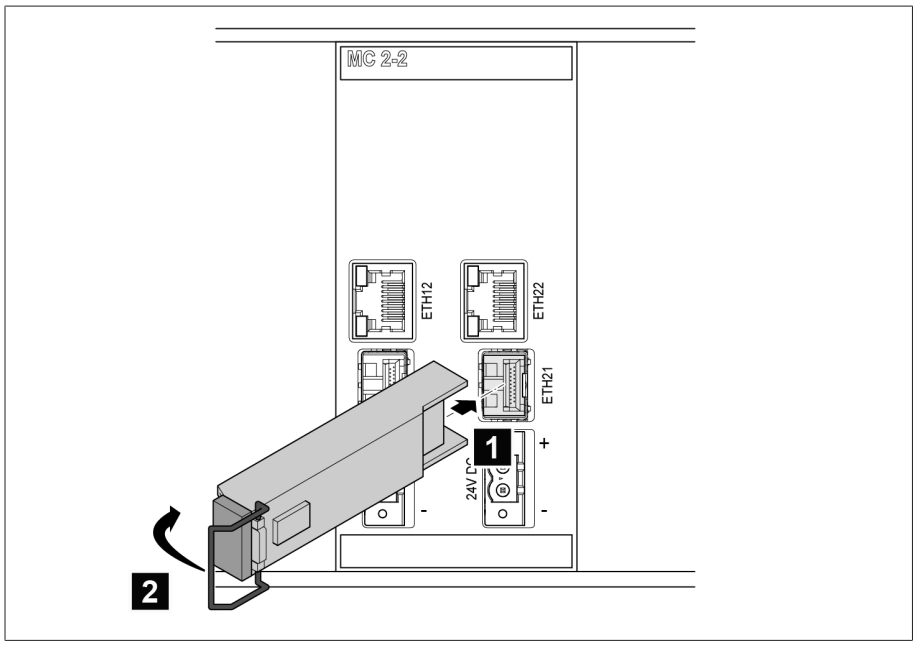


Figure 68: Engaging the SFP module

2. Remove the SFP module dust plug.

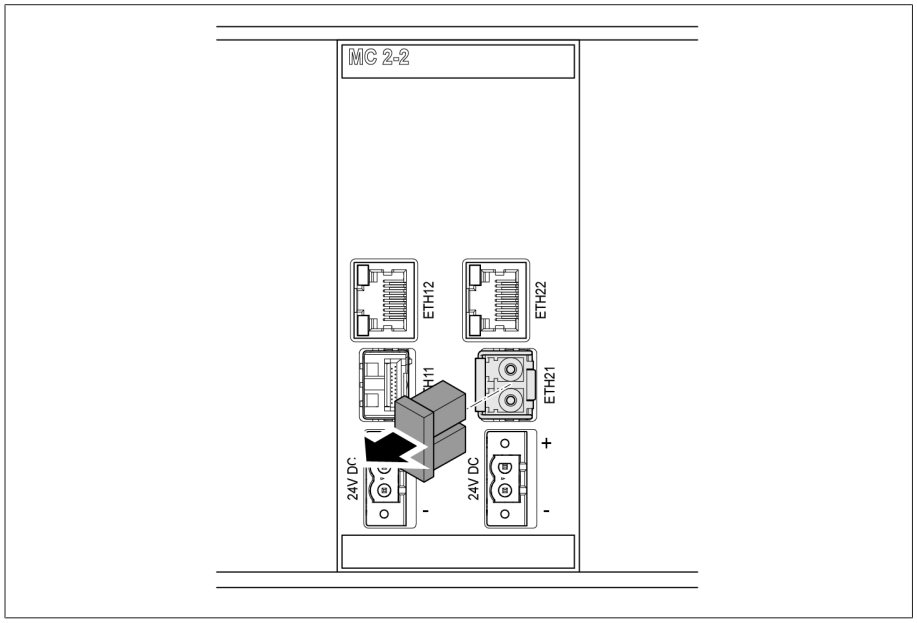


Figure 69: Removing the dust plug

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

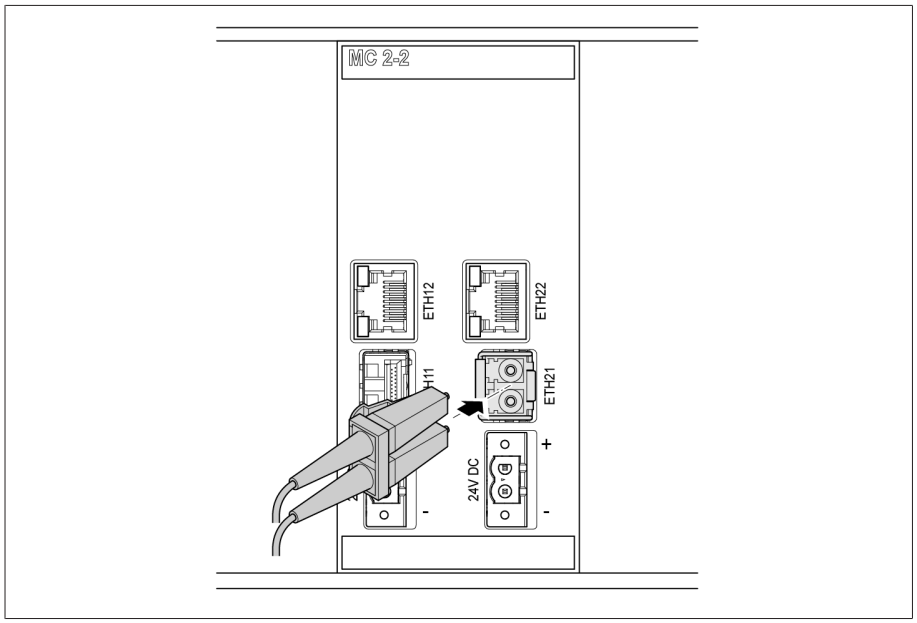


Figure 70: Inserting the fiber-optic cable

4. Insert the network cable.

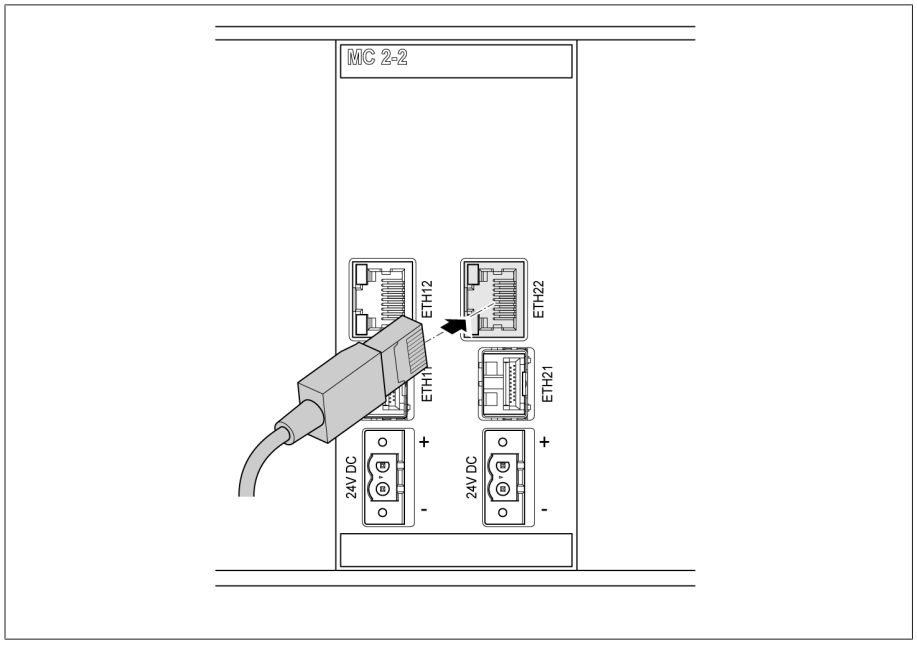


Figure 71: Inserting the network cable

Voltage supply

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

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

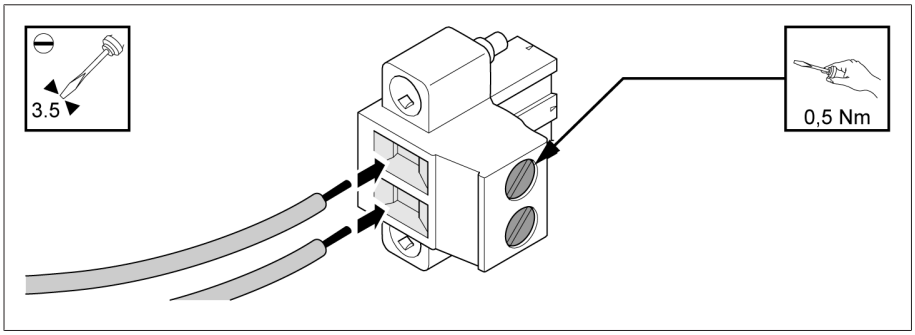


Figure 72: Inserting the leads

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

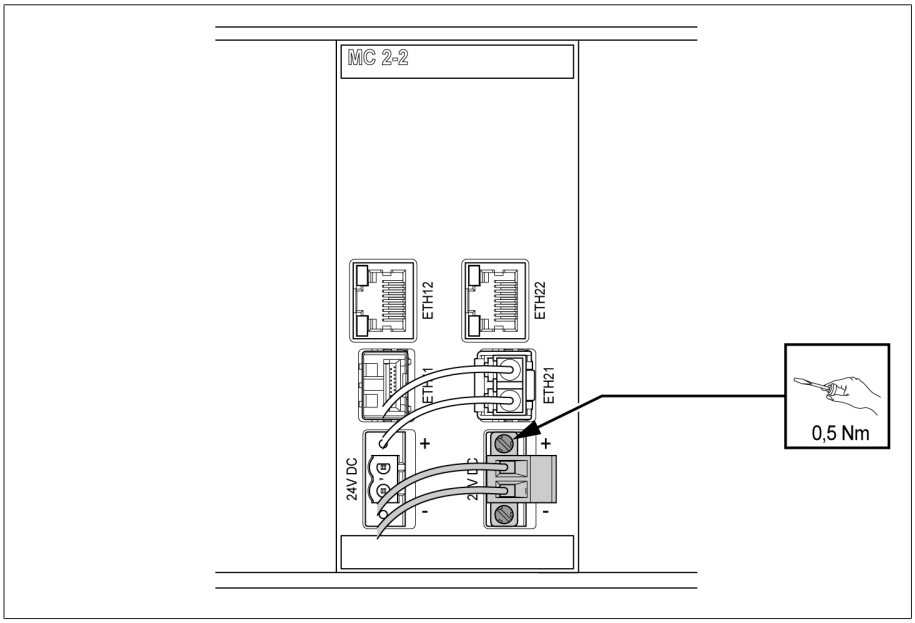


Figure 73: Fastening the 24 V DC plug

6.5.9 Wiring the QS3.241 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:

1. Insert the leads into the corresponding connections **1** and close the lever **2**.

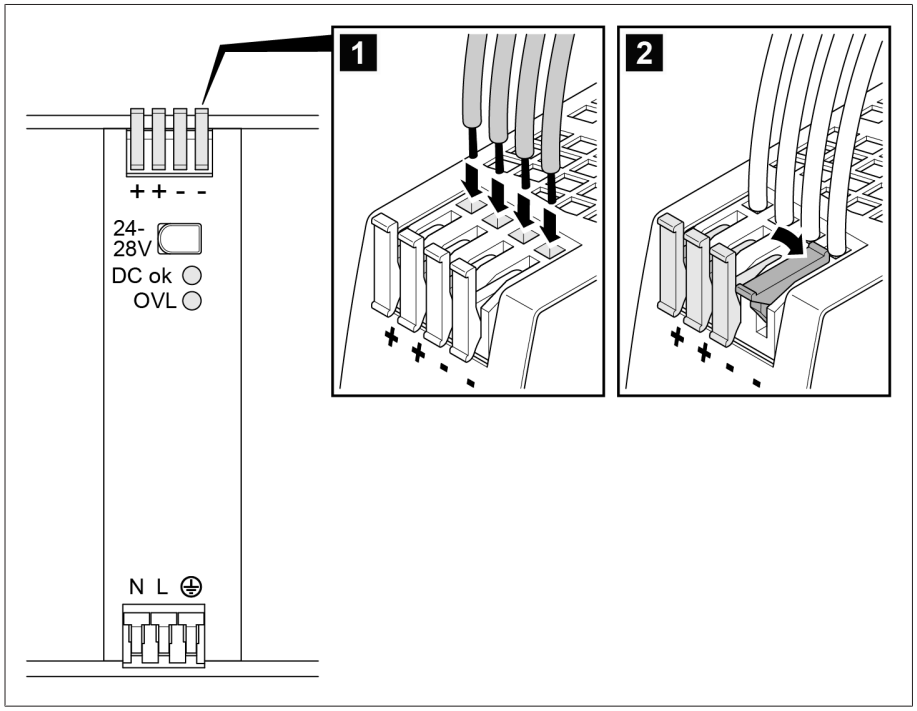


Figure 74: Inserting the leads

2. Insert the leads of the neutral conductor (N), phase conductor (L) and protective conductor into the corresponding connections **1** and close the lever **2**.

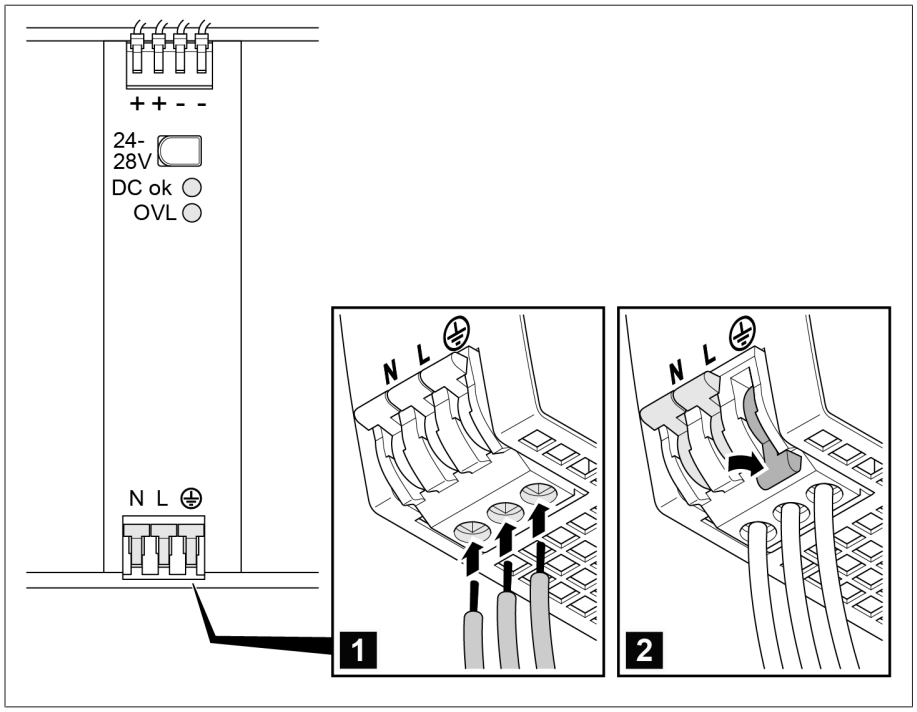


Figure 75: Inserting the neutral conductor, phase conductor and protective conductor

6.6 Connecting the device

6.6.1 Cable recommendation

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

> Excessive line capacitance can prevent the relay contacts from interrupting the contact current. In control circuits operated with alternating current, take into account the effect of the line capacitance of long control cables on the function of the relay contacts.
> If you want to route Ethernet connections from a control cabinet or building, we recommend using fiber-optic cables (in accordance with the IEC 61850-90-4 recommendation).

Cable	Assembly, terminal	Cable type	Conductor cross-section	Max. length
Power supply	PULS G1 and G2 N, L and PE	Unshielded	2.5 mm²	-
Voltage measurement	X2 (U3)	Shielded	2.5 mm²	-
Digital signal inputs	X1&X2 (DI 16-24 V)	Shielded	1.5 mm²	400 m (<25 Ω/km)
Digital signal outputs*	X1-X4 (DO 8)	Shielded	1.5 mm²	-
RS232, terminal	RJ45 on transducer terminal	Shielded	0.25 mm²	25 m
RS485, terminal	RJ45 on transducer terminal	Shielded	0.25 mm²	140 m
CAN bus	3onedata-CP-202-CI	Shielded	0.75 mm²	2,000 m (total CAN bus)
Ethernet RJ45	CP-8050	Min. CAT5, shielded S/FTP	-	100 m
Ethernet FO	MC 2-2, SW 3-3	Duplex LC, 1310 nm	-	2000 m
Grounding connection	Cap rail	Unshielded	16 mm²	-

Table 18: Recommendation for connection cables

*) Observe line capacitance, see note above.

6.6.2 Notes on the screw terminal tightening torque

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 0.5 Nm.

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

NOTICE

Damage to the device!

Using the wrong data cable may damage the device.

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

RS232 (D-SUB 9-pin)

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

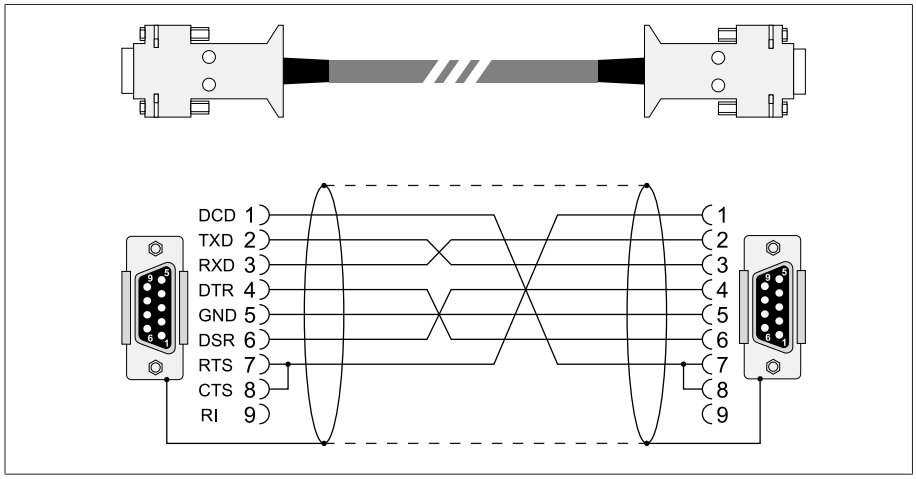


Figure 76: RS232 data cable (9-pin)

RS485 (D-SUB 9-pin)

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

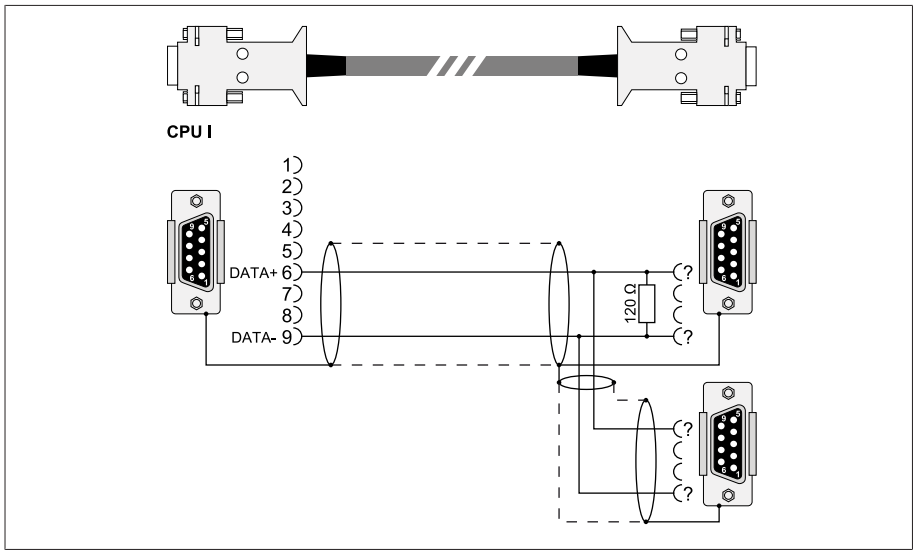


Figure 77: RS485 data cable

D-SUB 9-pin plug connection

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

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

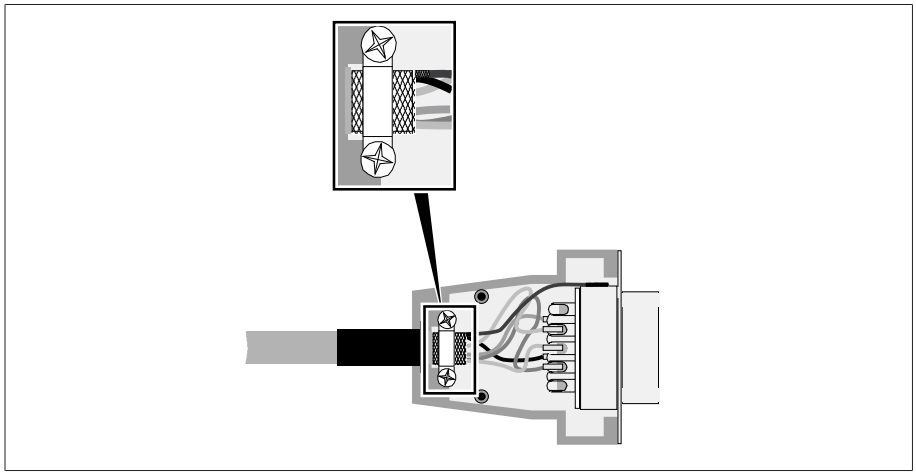


Figure 78: Example of a soldered shielding on a plug housing

6.6.4 Information about connecting serial interfaces RS232 and RS485 (with RJ45 data cable)

NOTICE

Damage to the device!

Using the wrong data cable may damage the device.

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

To connect the device via the RS485/RS232 interface, use a data cable with the following structure:

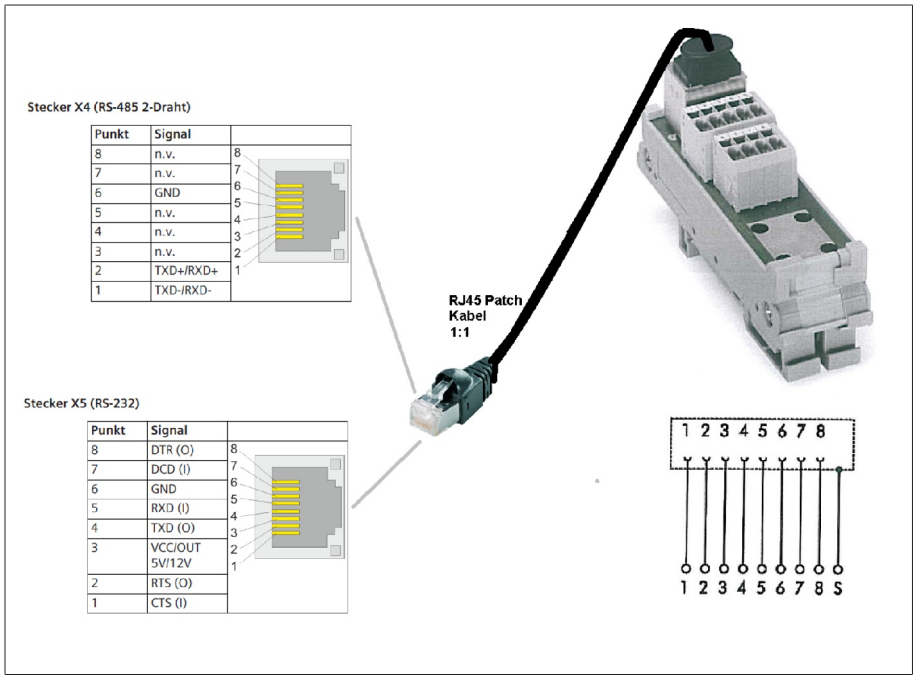


Figure 79: RJ45 data cable

6.6.5 Information about laying fiber-optic cable

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

- Radii must not fall below the minimum permissible bend radii (do not bend fiber-optic cable).
- The fiber-optic cables must not be over-stretched or crushed. Observe the permissible load values.
- The fiber-optic cables must not be twisted.
- Be aware of sharp edges because they can damage the fiber-optic cable's coating during laying or can place mechanical loads on the coating later on.
- Provide a sufficient cable reserve near distributor cabinets. Lay the reserve such that the fiber-optic cable is neither bent nor twisted when tightened.

6.6.6 Connecting the bushing adapter to the bushing coupling unit

The bushing adapter must be connected to the bushing coupling unit with the connection cable provided. To do so, proceed as follows:

1. Remove the N female connector safety cap from the bushing adapter.
2. Ensure that the plug of the connection cable and the connections of the bushing adapter and bushing coupling unit are dry and free of dirt. If this is not the case, clean and dry them with a cloth.
3. Attach the connection cable plug to the bushing adapter and screw it in place. Details on the thread can be found in the technical data.

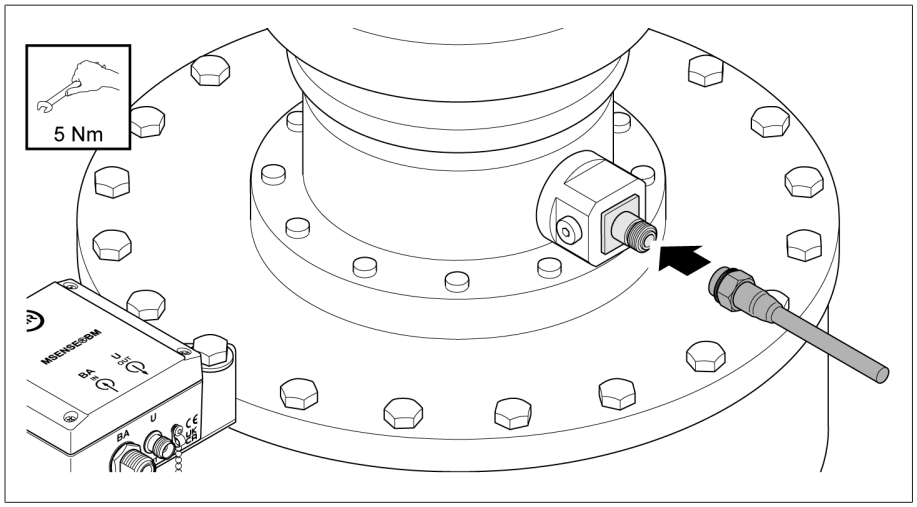


Figure 80: Connecting the connection cable to the bushing adapter

4. Attach the connection cable plug to the bushing coupling unit and screw it in place.

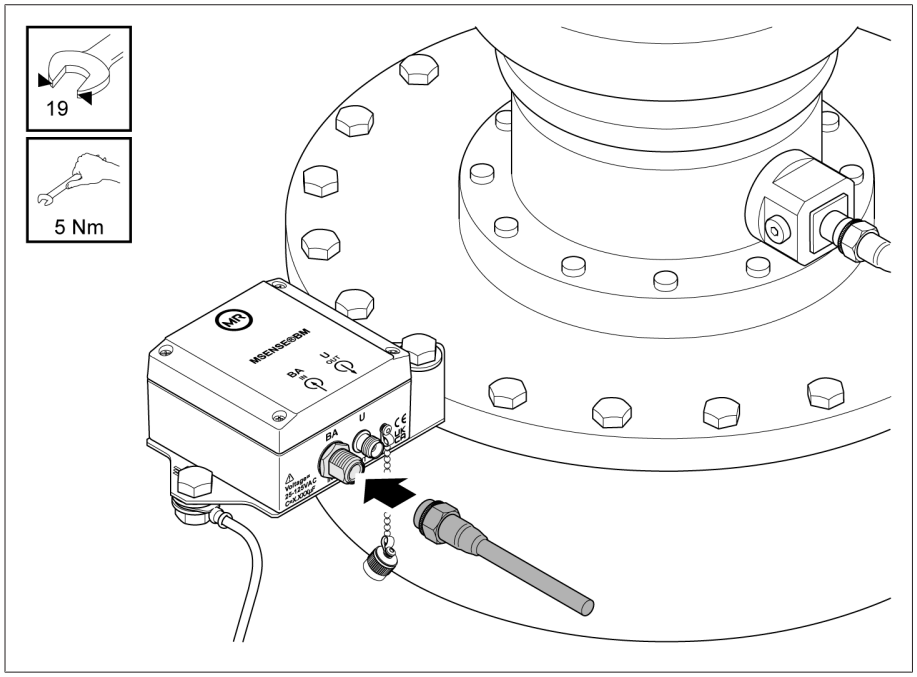


Figure 81: Connecting the connection cable to the bushing coupling unit

6.6.7 Connecting the bushing coupling unit to the control cabinet

The bushing coupling unit must be connected to the control cabinet with the connection cable provided. To do so, proceed as follows:

1. Remove the safety cap from the U connection of the bushing coupling unit.
2. Ensure that the plug of the connection cable and the U connection of the bushing coupling unit are dry and free of dirt. If this is not the case, clean and dry them with a cloth.
3. Attach the connection cable plug to the U connection of the bushing coupling unit and screw it in place.

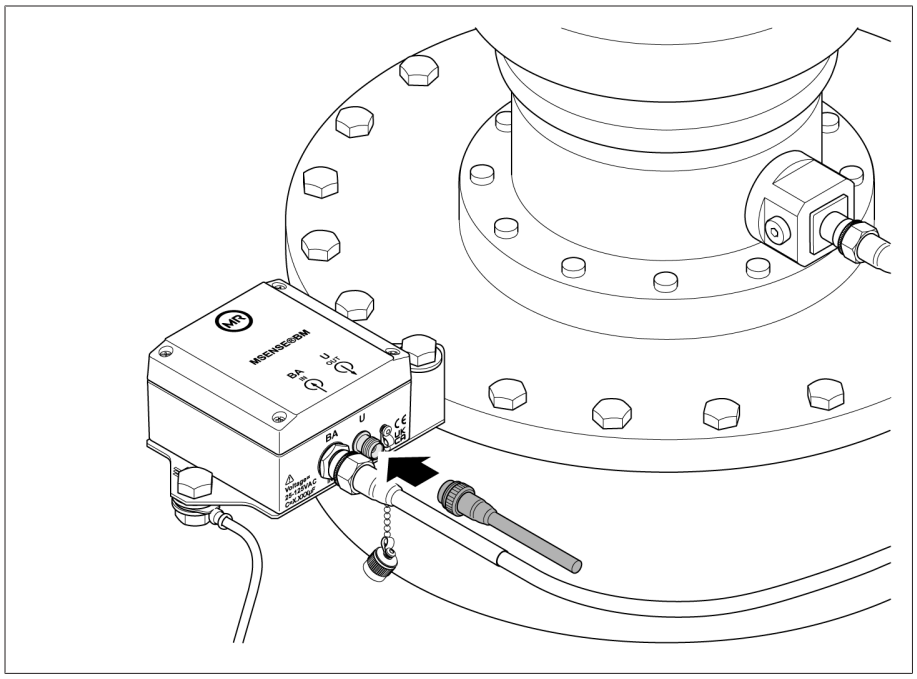


Figure 82: Connecting the connection cable to the bushing coupling unit

4. *NOTICE!* Laying the connection cable on the transformer to the control cabinet. While doing so, maintain the minimum permissible bending radius of 50 mm and take precautions to protect the cable from mechanical damage (e.g. protective tube). Otherwise, the connection cable may become damaged.

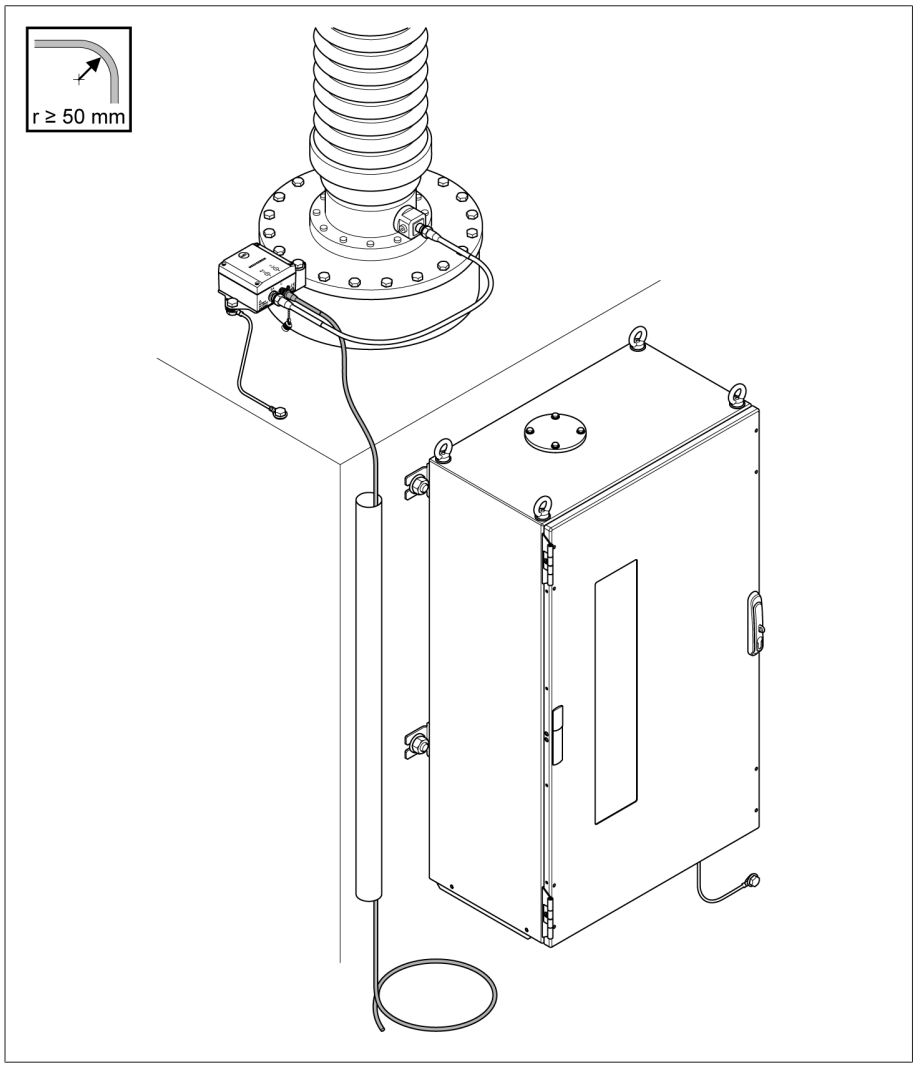


Figure 83: Laying the connection cable to the control cabinet

5. Shorten the connection cable to the desired length.

Connecting the connection cable in the control cabinet

The connection cable must be connected to the terminal in the control cabinet in accordance with the connection diagram. You must place the cable shield on the earthing bar using the clamping bracket.

1. Place the cable shield on the earthing bar of the control cabinet using the clamping bracket.

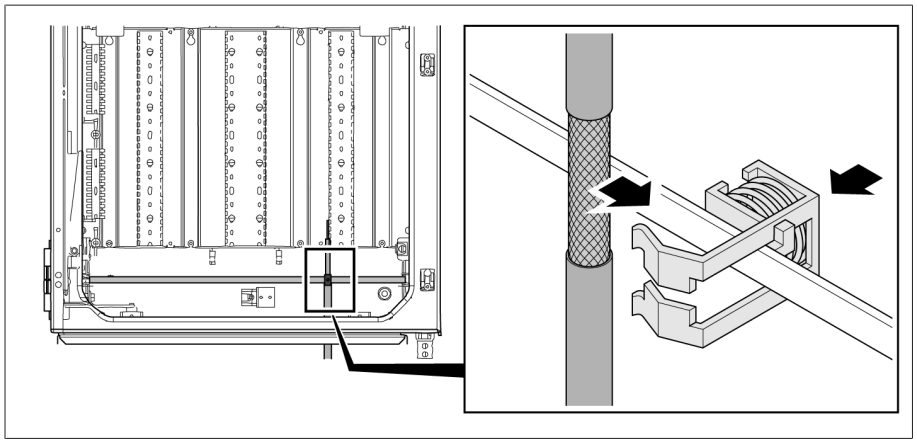


Figure 84: Placing the cable shield with clamping bracket on the earthing bar

2. Connect the connection cable to the measuring card as shown in the connection diagram.
3. *NOTICE!* Do not install this line together with the load line.

6.6.8 Connecting the voltage transformers for the reference system

NOTICE

Damage to the device!

If the voltage transformer and device have 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 cable's shielding to one device.

To connect the voltage transformers for the reference system, proceed as follows:

1. Remove the cable insulation.

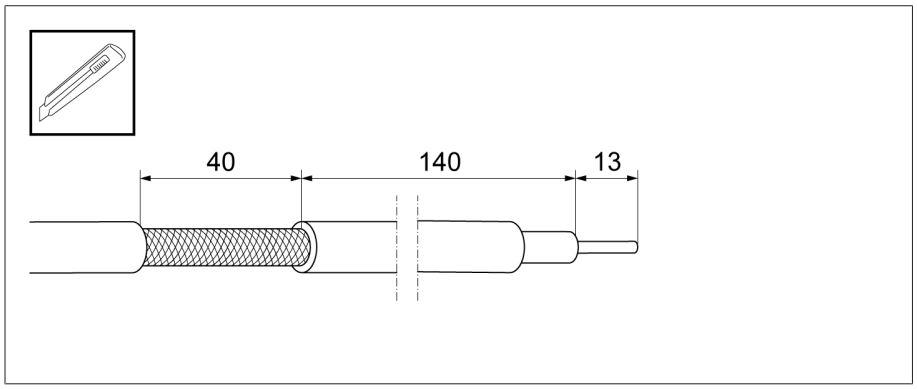


Figure 85: Removing the cable insulation

2. Connect the voltage transformers in accordance with the connection diagram.

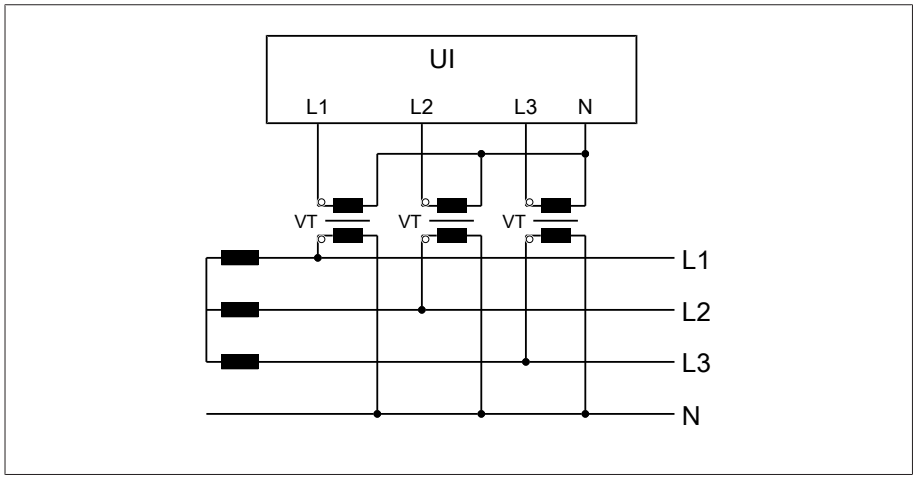


Figure 86: Connecting the voltage transformers for the reference system

3. Place the cable shield on the grounding bar of the control cabinet using the clamping bracket.

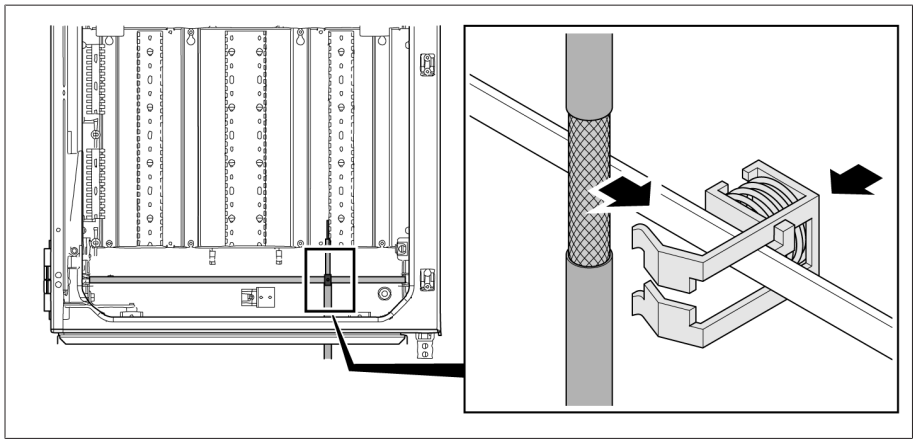


Figure 87: Placing the cable shield with clamping bracket on the grounding bar

6.6.9 Connecting additional leads (optional)

Connect additional leads as necessary in accordance with the connection diagram:

- Digital inputs and outputs
- Control system
- Visualization

Routing information for connecting the control system or visualization

When connecting the device to a control system or to your network for accessing the visualization, observe the following recommendation on the cable routing in the control cabinet:

› Route the cable along the outer edge of the control cabinet.

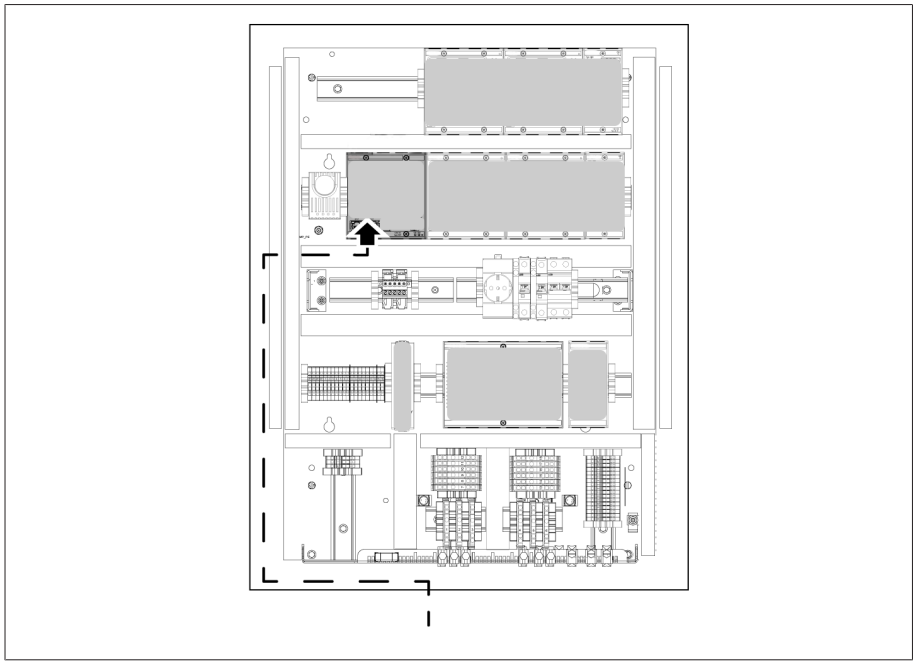


Figure 88: Example of the cable routing in the control cabinet for the connection of the control system or visualization

Connection to transfer module

If you connect the analog signals to the transfer module, you must place the cable shield on the transfer module using a shielding terminal.

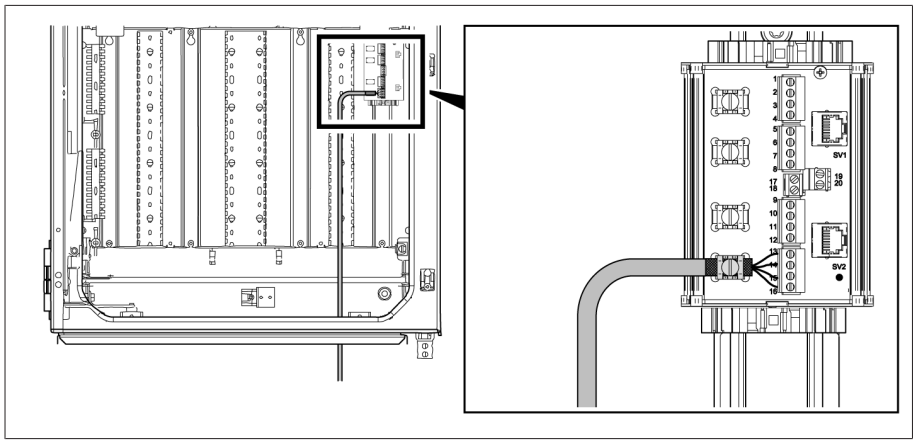


Figure 89: Placing cable shield on transfer module

6.6.10 Connecting the power supply

You may only connect the control cabinet to circuits with an external overcurrent protection device and an isolating device with all poles disconnected so the equipment can be fully de-energized if required (service, maintenance etc.).

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

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

You must connect the power supply circuit with a conductor cross-section of at least 2.5 mm^2 (AWG 13) and protect it with a C6A or B6A type miniature circuit breaker.

To connect the voltage supply, proceed as follows:

› Connect the power supply of the control cabinet to terminal X1 in accordance with the connection diagram provided.

6.7 Checking functional reliability

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

NOTICE

Damage to device and system periphery!

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

› Check the entire configuration before commissioning.

› Apply voltage to the control cabinet.

» The device's control system boots up. After a brief period, the relay switches the make contact *STATUS OK* (DIO 28-15:1B).

The device is fully mounted and can be configured. The actions required for this are described in the following chapter.

NOTICE

Damage to the device!

Damage to the device due to condensate in the control cabinet.

› Always keep the control cabinet tightly closed.

› In the event of downtimes of more than 8 weeks prior to initial commissioning or an operational interruption of more than 2 weeks, connect and operate the anti-condensation heater in the control cabinet. If this is not possible, place a sufficient amount of desiccant (silicon-free) in the control cabinet.

7 Commissioning

7.1 Determining the capacitance of the bushings with BM-C

To ensure that the bushings are in the correct condition, Maschinenfabrik Reinhausen GmbH recommends taking an initial measurement on new bushings when commissioning the bushing monitoring. If you are retrofitting the bushing monitoring on bushings already in operation, an initial measurement is absolutely essential.

To do so, measure the capacitance *C1* with a suitable measuring device. Follow the notes in the operating instructions from the bushing manufacturer.

Enter the measured values in the measured value log [▶Section 14.1, Page 201].

7.2 Determining the capacitance and dissipation factor of the bushings with BM-T

To ensure that the bushings are in the correct condition, Maschinenfabrik Reinhausen GmbH recommends taking an initial measurement on new bushings when commissioning the bushing monitoring. If you are retrofitting the bushing monitoring on bushings already in operation, an initial measurement is absolutely essential.

To do so, measure the capacitance *C1* and the dissipation factor tanδ with a suitable measuring device. Follow the notes in the operating instructions from the bushing manufacturer.

Enter the measured values in the measured value log [▶Section 14.1, Page 201].

7.3 Establishing a connection to the visualization (with CPU I / CPU II)

You can use the ETH 2.1 interface or the optional ETH 2.2 interface of the CPU I or CPU II assembly to establish a connection to the visualization. The interfaces do not use a DHCP server. Therefore, you must assign a static IP address to your PC. To do this, observe the following configuration example:

Interface		Configuration
Standard	ETH 2.1	IP address: 192.168.165.1 (not adjustable)
	PC	IP address: 192.168.165.100 Subnet mask: 255.255.255.0
Optional	ETH 2.2	IP address: 192.0.1.230 (factory setting) [▶ Section 8.1.2, Page 92] Subnet mask: 255.255.255.0
	PC	IP address: 192.0.1.100 Subnet mask: 255.255.255.0

Table 19: 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 the PC and device using an Ethernet cable (RJ45 plug) via the ETH 2.1 or ETH 2.2 interface.

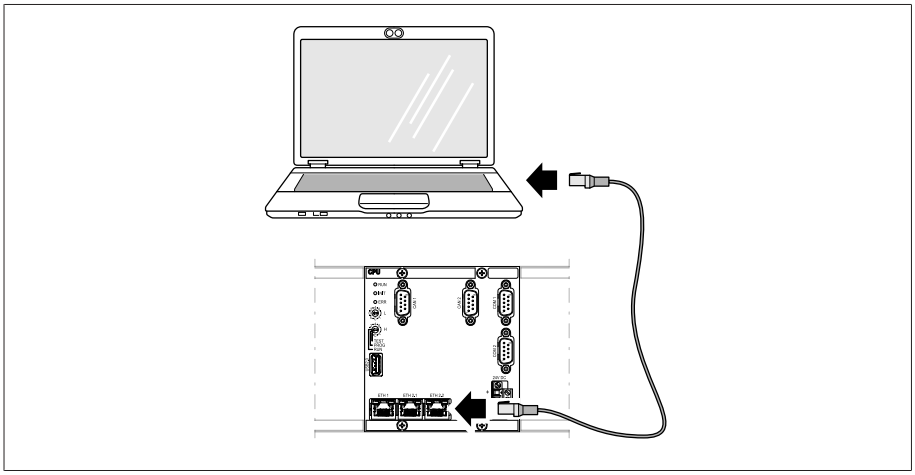


Figure 90: Establishing a connection via the ETH 2.1 or ETH 2.2 interface

2. Assign a unique IP address to the PC. This IP address must be in the same subnet as the device (e.g. ETH 2.1: `192.168.165.100`).
3. Enter the IP address of the visualization (e.g. ETH 2.1: `http://192.168.165.1`; if SSL encryption is active, enter `https://192.168.165.1`) in the browser on the PC.

» The visualization is accessed.

7.4 Establishing a connection to the visualization (with CPU / COM-ETH)

To establish a connection to the visualization, you must connect the CPU assembly to a PC via interface X2 or X3. 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) [▶Section 8.1.2, Page 92]
	PC	IP address: 192.0.1.100 Subnet mask: 255.255.255.0

Table 20: 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).

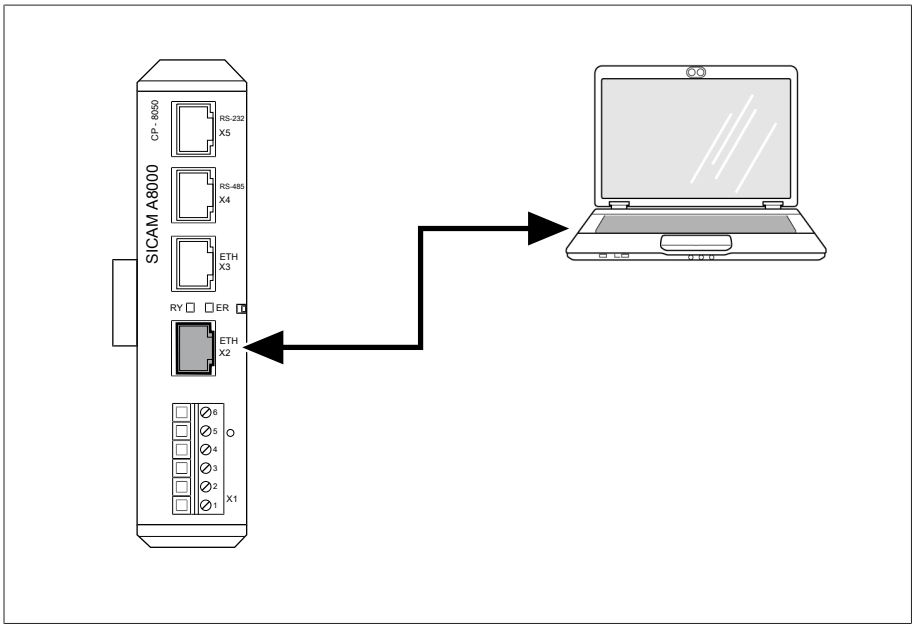


Figure 91: Establishing an example connection via the CPU-X2 interface

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.

Optional COM-ETH assembly

If your device is equipped with the optional COM-ETH assembly, you can establish a connection to the visualization via various interfaces. The interfaces do not use a DHCP server. Therefore, you must assign a static IP address to your PC. To do this, observe the following configuration example:

Interface		Configuration
Standard	CPU-X3 COM-ETH-X4	IP address: 192.0.1.230 (factory setting) [▶Section 8.1.2, Page 92]
	PC	IP address: 192.0.1.100 Subnet mask: 255.255.255.0
Optional	COM-ETH-X2 COM-ETH-X3	IP address: 192.168.165.1 (not adjustable)
	PC / MControl	IP address: 192.168.165.100 Subnet mask: 255.255.255.0

Table 21: Interface configuration example

7.5 Setting the language

You can use this parameter to set the display language for the device. The device comes with a maximum of four languages.

English	Italian*
German	Portuguese*
French*	Russian*
Spanish*	Chinese*
Korean*	Polish*

Table 22: Available display languages

*) Language is available as an option

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

Figure 92: 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.

7.6 Downloading the operating instructions

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

› Select in the status line.
» The operating instructions will be downloaded.

The document is also available for download in the MR Customer Portal and on our website www.reinhausen.com.

7.7 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 8.1.4, Page 95].

7.8 Setting the parameters

Commissioning the device requires setting some parameters. You can set the necessary parameters with the help of the commissioning assistant or set each parameter individually.

7.8.1 Commissioning wizard

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

A detailed description of each of the parameters can be found in the Operation [►Section 8, Page 89] chapter.

> To call up the commissioning wizard, you will need the necessary access rights [►Section 8.1.12, Page 122].

When in delivery status, you can log in as the administrator as follows:
- User name: `admin`
- Password: `admin`

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**.

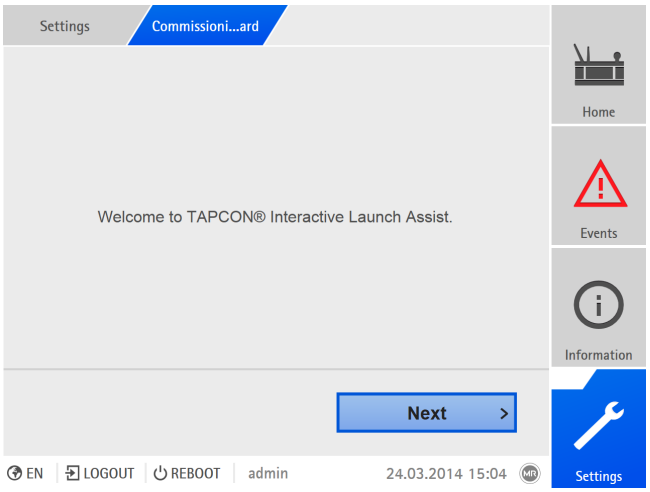


Figure 93: Calling up the commissioning wizard

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.

7.8.2 Setting the parameters manually

> If bushing monitoring with the option "Monitoring of 6 bushings" is used, the parameters for both field 1 (F1) and field 2 (F2) must be set. Field 1 and field 2 each describe a set consisting of 3 bushings respectively. If bushing monitoring with the option "Monitoring of 3 bushings" is used, only the parameters for field 1 are displayed.

To commission the bushing monitoring, you must set the following parameters:

Setting the transformer data for the reference system [▶Section 8.2.1, Page 152]

1. Set primary transformer voltage.
2. Set secondary transformer voltage.

Configuring capacitance monitoring [▶Section 8.4.1.2, Page 154]

1. C: Activate capacitance monitoring.
2. C: Set C1 phase L1.
3. C: Set C1 phase L2.
4. C: Set C1 phase L3.
5. C: Set ΔC1 >.
6. C: Set ΔC1 >>.

Only with option BM-T

Configuring dissipation factor monitoring [▶Section 8.4.1.3, Page 157]

1. tanδ: Activate dissipation factor monitoring.
2. tanδ: Set Δtanδ >.

Setting the control system protocol (optional)

If you need a control system protocol, you must set the parameters required for this. More information on this (e.g. data points) can be found in the supplement for the control system protocol provided.

7.9 Performing standardization

Once you have set all required parameters, you must perform a standardization for commissioning the device. The standardization is used to compensate for measurement tolerances along the measurement chain (bushing, bushing adapter and bushing coupling unit).

Follow the notes on this in the following sections:

- Configuring capacitance monitoring [▶Section 8.4.1.2, Page 154]

Only with option BM-T

- Configuring dissipation factor monitoring [▶Section 8.4.1.3, Page 157]

7.10 Performing tests

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

7.10.1 Ground test

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

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

To carry out the ground test, proceed as follows:

› Apply the test current at the grounding terminal of the assembly using a constant current source and measure the voltage between the measurement point and the protective conductor.

» The measured voltage must remain less than 10 V for a period of 1 minute.

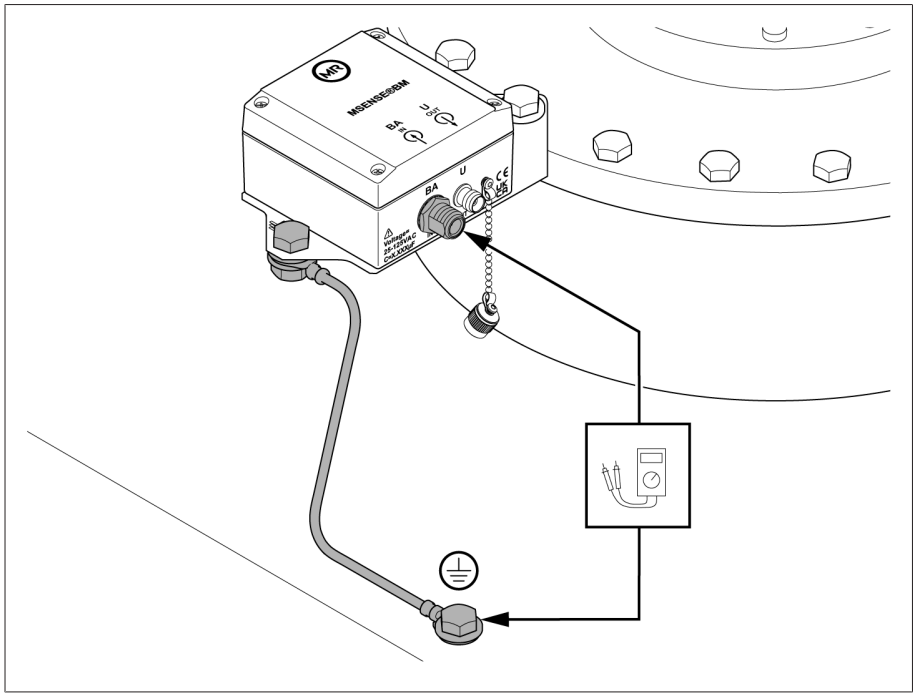


Figure 94: BCU ground test

7.10.2 Performing function tests

To check that the monitoring system is functioning correctly, proceed as follows:

1. Check the pending event messages [▶Section 8.1.11.1, Page 120]. If event messages are pending, resolve the cause of the event and acknowledge the event.
2. Optional: Check the control system.

» The monitoring system is ready to function.

7.10.3 High-voltage tests on the transformer

Note the following points before performing high-voltage tests on the transformer:

- Check that the ground connections on the control cabinet and the control cabinet fixings are free of paint.
- Only perform a high voltage test with the control cabinet door closed.
- Disconnect the sensor cable and other external connections to electronic components in the control cabinet to prevent damage through overvoltage.
- Remove the bushing adapter and fit the cap of the bushing test tap.
- When connecting the control cabinet supply voltage, only use the cable bushings provided for this in the control cabinet base.
- Guide all ground connecting leads to one central connection point (establishment of suitable reference earth).
- Disconnect all electronic components before the high voltage test. Before a dielectric test of the wiring, remove all devices with a withstand voltage of < 1,000 V.

- Remove leads used for testing before the high voltage test, because these function as antennas.
- Wherever possible, route the measurement leads and data leads separately to the energy cables.

Contact the manufacturer if you have any questions about possible sources of danger.

7.10.4 Dielectric tests on transformer wiring

Note the following points for dielectric testson the transformer wiring:

The monitoring system has been put through dielectric tests before delivery.

› Before the dielectric test for the transformer wiring, disconnect the monitoring system from the section to be tested to rule out increased component loading for those components fitted in the control cabinet.

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.

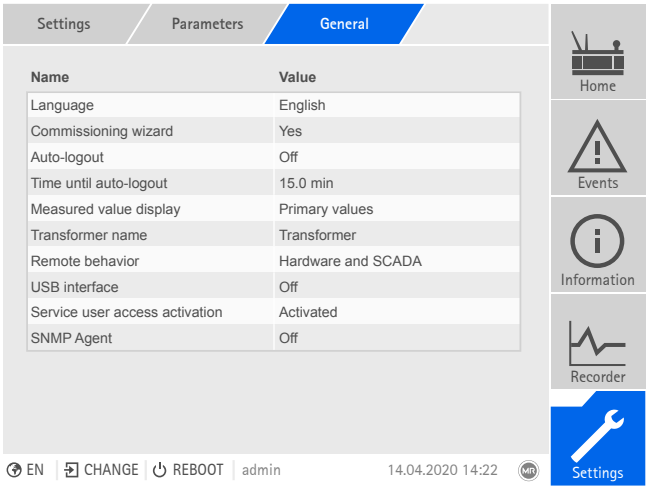


Figure 95: General

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

Commissioning wizard

You can use this parameter to set whether the commissioning wizard [▶Section 7.8.1, Page 83] 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 23: Selecting remote behavior

USB interface

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

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

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.

> These settings apply to all users. If you have activated the Auto login [▶Section 8.1.12.3, Page 125] function for a user, then this user will not be automatically logged out.

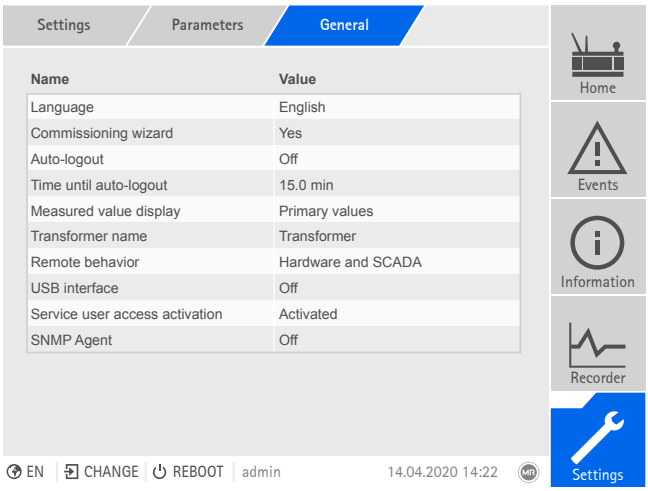


Figure 96: General

› 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 Maschinenfabrik Reinhausen GmbH Technical Service department. This access is for error diagnostics and troubleshooting in the event of device faults. To safeguard IT security, only activate service user access for a limited time period for remedying faults.

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

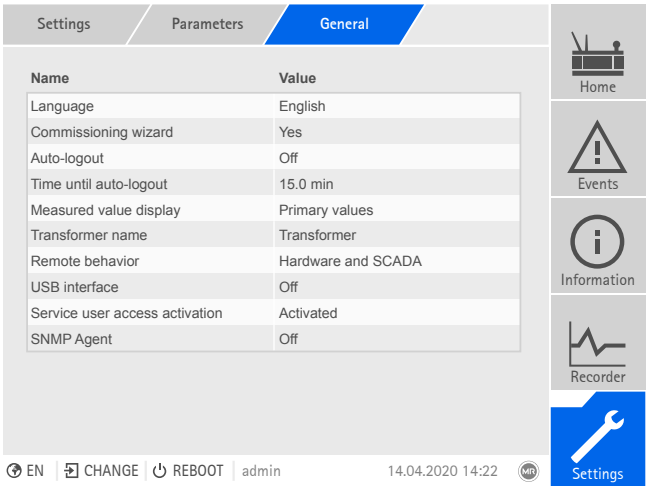


Figure 97: General

You must be assigned the administrator role to set parameters.
When in delivery status, you can log in as the administrator as follows:
- User name: `admin`
- Password: `admin`

1. Go to **Settings** > **Parameters** > **System** > **General**.
2. Set the parameter.
3. Restart the device to apply the change.

Service user access activation

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

8.1.1.4 Setting SNMP

The device supports the SNMP network management protocol (SNMPv1 and SNMPv2c). The protocol uses the port 161/UDP. To use SNMP, you must activate the SNMP agent.

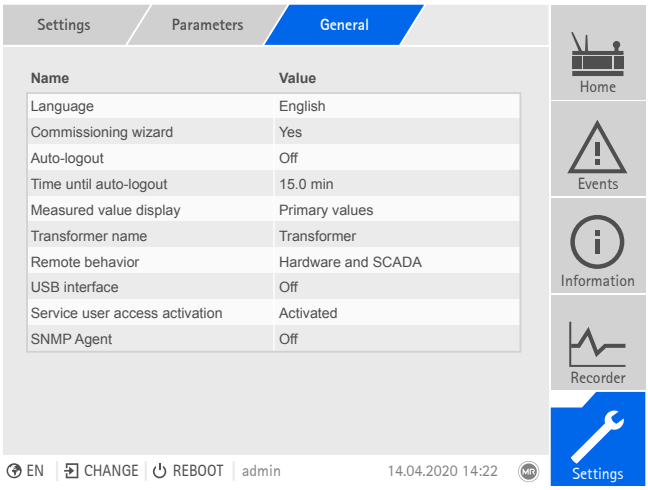


Figure 98: General

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

SNMP agent

You can use this parameter to activate or deactivate the SNMP agent. If you change the setting, you must then restart the device.

8.1.2 Configuring the network

You can use this menu item to configure the network interfaces of the CPU assembly.
You can only set the parameters for ETH 1 if the device is equipped with the optional control system connection via Ethernet (TCP/IP):

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

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

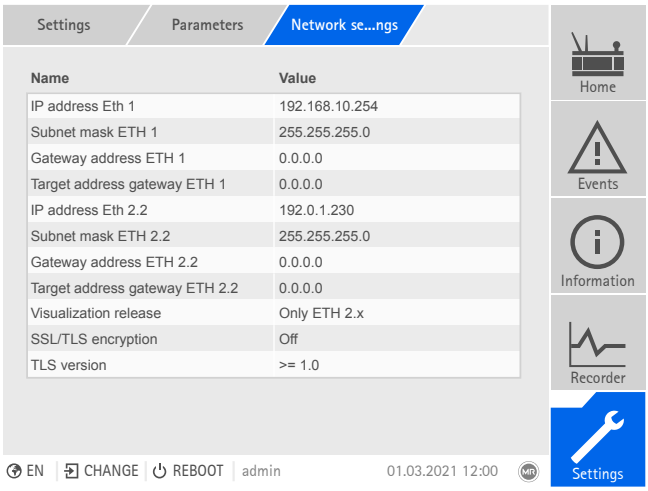


Figure 99: Network settings

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

IP address ETH 1/ETH 2.2

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

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

Subnet mask ETH 1/ETH 2.2

You can use this parameter to set the subnet mask.

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

Gateway address ETH 1/ETH 2.2

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

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

Visualization release

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

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

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

TLS version

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

Option	Accepted TLS versions
>= 1.0	– 1.0 – 1.1 – 1.2 – 1.3
>= 1.1	– 1.1 – 1.2 – 1.3
>= 1.2[1]	– 1.2 – 1.3
>= 1.3[1]	– 1.3

Table 24: TLS version

Activate DNS (optional)

You can use this parameter to activate DNS for name resolution. If you would like to use the MQTT protocol, you can establish the connection to the MQTT via a DNS server as an option. Also set the parameters necessary for the MQTT [▶Section 8.1.3, Page 93] protocol.

DNS server (optional)

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

8.1.3 MQTT

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

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

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

There are 2 options available for configuring the protocol:
- Via the IP address of the MQTT server:
  - Enter the IP address as the broker address.
  - It is not necessary to configure a DNS server.
- Via DNS server:
  - Configure the DNS server in "Network settings".
  - Enter the URL as the broker address.

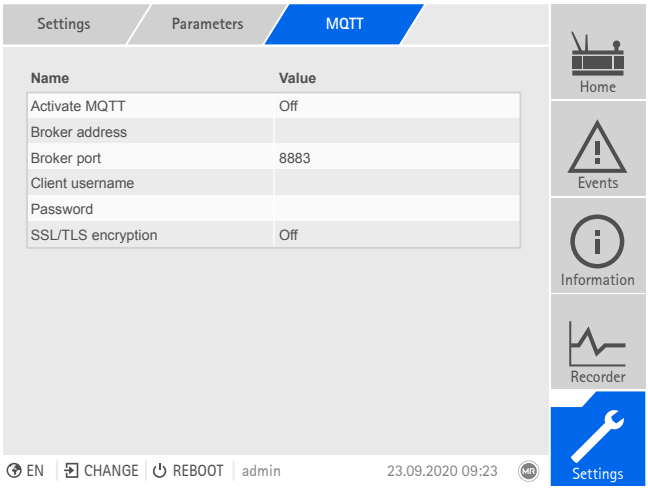


Figure 100: MQTT

✓ When using a URL on the broker, it may be necessary to enter and activate [▶Page 93] the IP address [▶Page 93] of the DNS server.
✓ If a DNS server is not available, enter the IP address [▶Page 92] 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.

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.

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

8.1.4 Setting the device time

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

You can operate SNTP and PTP at the same time. In this case, the PTP time is queried in slave operation.

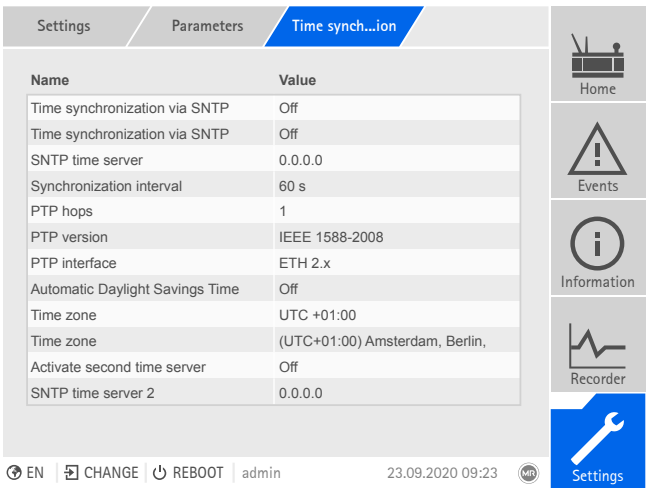


Figure 101: Time synchronization

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

Time

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

Time synchronization via SNTP

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

SNTP time server

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

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

Synchronization interval

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

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 25: Time shift to UTC (Coordinated Universal Time)

Activate second time server (optional)

As an option, you can use a second time server, e.g. as a backup should the first one fail. When you activate the second time server, the device synchronizes the time with the second time server if a connection cannot be established with the first time server. If the device is able to re-establish the connection to the first time server, it automatically synchronizes the time with the first time server again.

> You can only use the second time server if you have activated the **Time synchronization via SNTP** parameter and entered an **IP address** for the first time server.

SNTP time server 2 (optional)

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

Time synchronization via PTP

You can use this parameter to activate time synchronization via a PTP time server.

PTP hops

You can use this parameter to enter the number of network sections between master and slave. You can set up to 16 hops.

PTP version

You can use this parameter to select the PTP version.

- PTP version 1 (IEEE 1588-2002)
- PTP version 2 (IEEE 1588-2008)

PTP interface

You can use this parameter to select the interface that the device is to use for PTP.

8.1.5 Configuring syslog

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

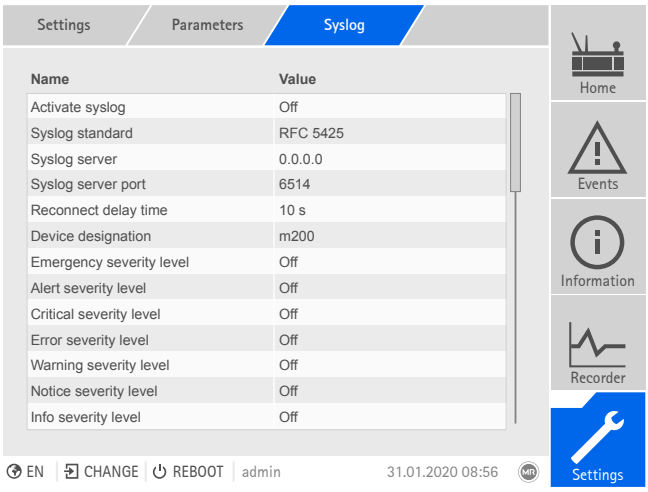


Figure 102: Syslog

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

Activate syslog

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

Syslog standard

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

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

Table 26: Syslog standard

> If you use the standard RFC 5245 (TLS), you have to import the root certificate and the client certificate with the corresponding key to the syslog server. For more information, refer to the section titled Importing data [▶Section 8.1.15.2, Page 131].

Syslog server

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

Syslog server port

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

Reconnect delay time

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

Device designation

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

Severity level

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

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

Table 27: Severity levels

8.1.6 SCADA

The following section describes how you can configure the device to connect to a control system (SCADA). You can download the data points with the help of the export manager [▶Section 8.1.15, Page 129].

8.1.6.1 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 92].

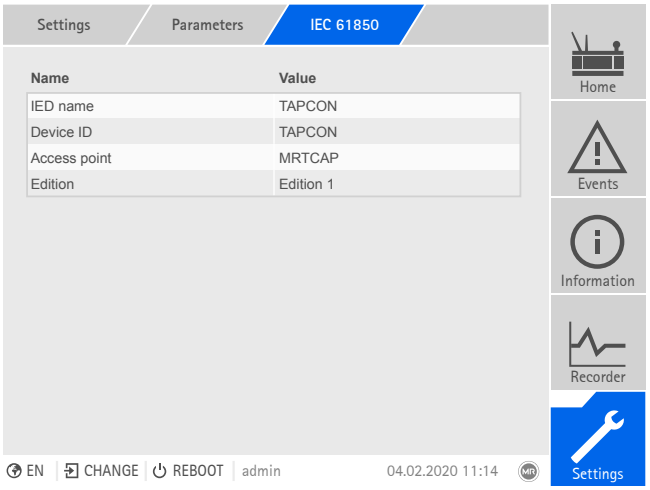


Figure 103: IEC 61850

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

IED name

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

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.

8.1.6.1.1 Downloading an ICD file

You can download the ICD file from the device via the Import/Export Manager [▶Section 8.1.15, Page 129]. To do this, you have to establish an Ethernet connection between the device and your PC.

8.1.6.1.2 Importing CID/SCD file (optional)

Note the following definitions for importing a CID file or SCD file.

Only the following elements may differ between the imported IED and the exported IED from the TEMPLATE.icd:

- DataSet elements can be created in each LN
- ReportControl elements can be created in the LN containing the associated DataSet
- IP address (if this is not present, the preset one is used)
- Subnet mask (if this is not present, the preset one is used)
- Gateway IP address (if this is not present, the preset one is used)
- Name of the IED (IED name)
- Name of the access point (AccessPoint attribute name)
- Name of the logical device (LDevice attribute inst)

OSI-PSEL, OSI-SSEL, and OSI-TSEL cannot be adjusted.

The SCD file may contain no more than 45 IEDs. It may take several minutes to import a complete SCD file. The SCD file should only contain the IEDs needed.

You can import the CID/SCD file via the Import/Export Manager. To do so, proceed as follows:

1. Go to **Settings** > **Import**.
2. Select the desired CID/SCD file and then press the **Start upload** button.
   » The file integrity is checked.
3. Select the desired IED and then press the **Accept** button.
   » The configuration integrity is checked.
4. Upon successful completion of the import, restart the device.

8.1.6.2 Configuring IEC 60870-5-101 (optional)

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

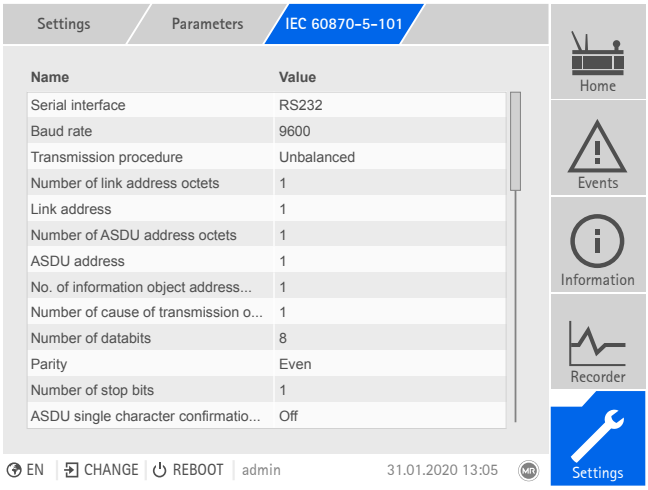


Figure 104: IEC 60870-5-101

1. Go to **Settings > Parameters > System > IEC 60870-5-101**.
2. Select the desired parameter.
3. Set the parameter.
4. Press the **Accept** button to save the modified parameter.

Serial interface

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

- RS232
- RS485

Baud rate

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

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

Transmission procedure

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

- Unbalanced transmission
- Balanced transmission

Number of link address octets

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

Link address

You can use this parameter to set the link address.

Number of ASDU address octets

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

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

No. of information object address octets
You can use this parameter to set how many octets are provided for the information object address.

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

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

Parity
You can use this parameter to set the parity. You can select the following options:
- None
- Even
- Odd

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

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

RES bit test
You can use this parameter to set whether the device is to check the RES bit (Reserved Bit) in the control field. You can select the following options:

Option	Description
On	Messages from the master with RES bit = 1 are declined by the device.
Off	Messages from the master with RES bit = 1 are accepted by the device.

Table 28: RES bit test

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 29: 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 8.1.4, Page 95]. 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 95]. 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 96].

Table 30: Reference time

8.1.6.3 Configuring IEC 60870-5-103 (optional)

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

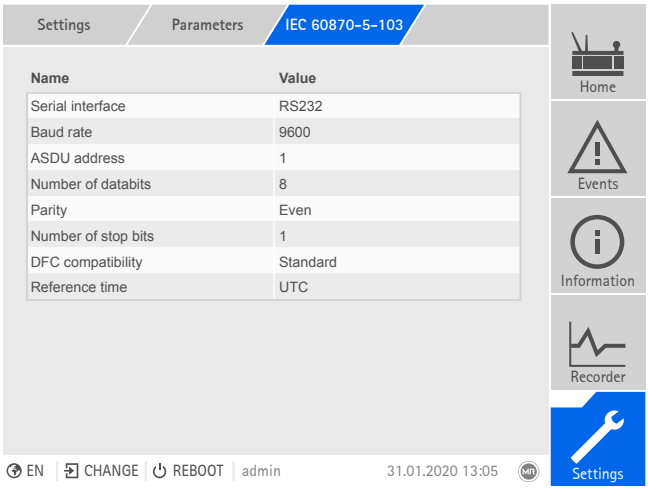


Figure 105: IEC 60870-5-103

1. Go to **Settings > Parameters > System > IEC 60870-5-103**.
2. Select the desired parameter.
3. Set the parameter.
4. Press the **Accept** button to save the modified parameter.

Serial interface
You can use this parameter to select the serial interface for data transmission. You can select the following options:
- RS232
- RS485

Baud rate
You can use this parameter to set the serial interface's baud rate. You can select the following options:
- 9600 baud
- 19200 baud
- 38400 baud
- 57600 baud
- 115200 baud

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

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

Parity
You can use this parameter to set the parity. You can select the following options:
- None
- Even
- Odd

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

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

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

Table 31: DFC compatibility

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 8.1.4, Page 95]. 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 95]. 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 96].

Table 32: Reference time

8.1.6.4 Configuring IEC 60870-5-104 (optional)

If you want to use the IEC 60870-5-104 control system protocol, you must set the following parameters. Also refer to the section Configuring the network [▶Section 8.1.2, Page 92].

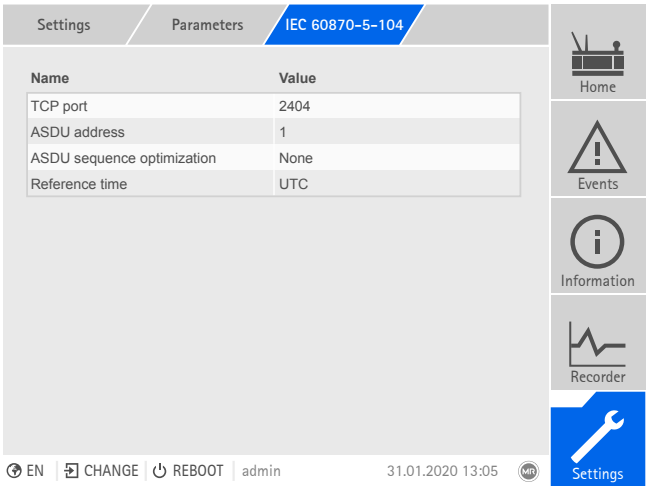


Figure 106: IEC 60870-5-104

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

TCP port

You can use this parameter to set the TCP port.

ASDU address

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

ASDU sequence optimization

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

You can select the following options:

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

Table 33: 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 8.1.4, Page 95]. 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 95]. 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 96].

Table 34: 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.

8.1.6.5 Configuring Modbus (optional)

If you want to use the Modbus control system protocol, you must set the corresponding parameters depending on the Modbus type selected. Also refer to the section Configuring the network [▶Section 8.1.2, Page 92] if you want to use Modbus TCP.

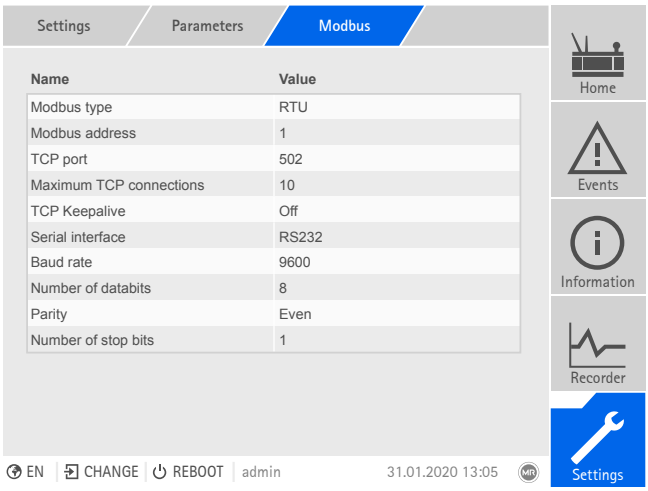


Figure 107: Modbus

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

Modbus type

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

- RTU
- TCP
- 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.

TCP Keepalive

You can use this parameter to activate/deactivate the "TCP Keepalive" function.

Serial interface

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

- RS232
- RS485

Baud rate

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

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

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

Parity
You can use this parameter to set the parity. You can select the following options:
- None
- Even
- Odd

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

8.1.6.6 Configuring DNP3 (optional)
If you would like to use the DNP3 control system protocol, you must set the parameters listed below. Also refer to the section Configuring the network [▶Section 8.1.2, Page 92] if you want to use the DNP3 via TCP.

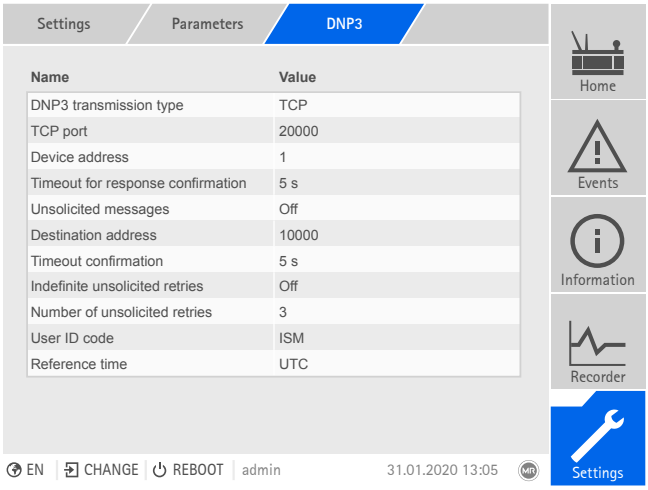


Figure 108: DNP3

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

8.1.6.6.1 DNP3 transmission type
You can use this parameter to set the transmission type. You can select the following options:
- TCP
- Serial

TCP port
You can use this parameter to set the TCP port.

Serial interface
You can use this parameter to select the serial interface for data transmission. You can select the following options:
- RS232
- RS485

Baud rate
You can use this parameter to set the serial interface's baud rate. You can select the following options:
- 9600 baud
- 19200 baud
- 38400 baud
- 57600 baud

– 115200 baud

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

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

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

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

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.

Timeout for response confirmation
You can use this parameter to set the timeout for response confirmation 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 8.1.4, Page 95]. 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 95]. 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 96].

Table 35: Reference time

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

8.1.6.7.1 Configuring IEC 60870-5-101 data points

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

Column	Description	Modifiable	Setting range
Active	You can use the checkbox to set whether the data point is to be transferred via the control system protocol or not.	Yes	Active/inactive
IOA	Data point address. The setting range is based on the setting for the "Octet number of information object address" parameter (octet 2 or 3).	Yes	Octet 2: 1...65535 Octet 3: 1...16777215
Name	Data point designation.	No	-
Type	Data point type.	No	-
Group	Data point group or groups. You must enter the group membership as a binary code (5 bits). A maximum of 5 groups is possible. Example: – 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
CT	Interval in ms for periodic transmission of the data point. If you set 0, the data point is not transmitted periodically. Notice: You can only enter an interval for data points of type 9, 11 or 13.	Yes	0...10000

Table 36: Configuring IEC 60870-5-101 data points

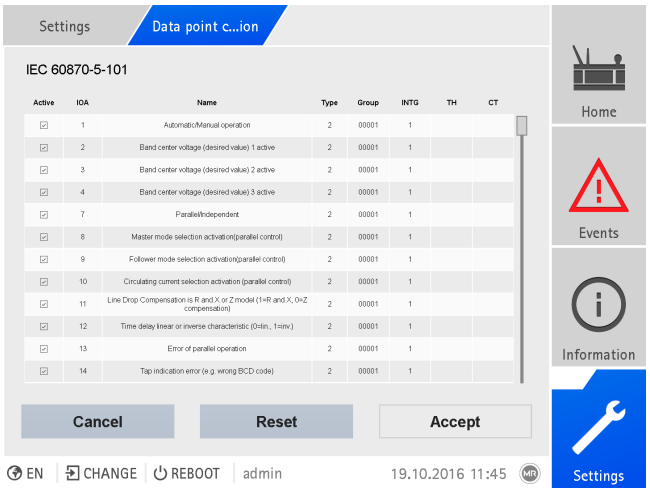


Figure 109: Configuring IEC 60870-5-101 data points

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.

8.1.6.7.2 Configuring IEC 60870-5-103 data points

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

Column	Description	Modifiable	Setting range
Active	You can use the checkbox to set whether the data point is to be transferred via the control system protocol or not.	Yes	Active/inactive
TYP	Data point type code.	No	-
FUN	Data point function type. Notice: You can only use function type 254 for data points with type code 10 or 11.	Yes	0...255
INF	Data point information number. Notice: You can only use information number 0 for data points with function type 254.	Yes	0...255
GIN	Data point generic identification number. Notice: You can only use generic identification number 0 for data points with a function type other than 254.	Yes	0...65535
Data Type	Data point data type.	No	-
Name	Data point designation.	No	-
Interrogation	The value indicates whether the data point is to be included in a general query (1) or not (0).	Yes	0, 1
Threshold	Threshold value for measured values. The data point is only transferred again if the change of value is greater than the threshold value. – 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 37: Configuring IEC 60870-5-103 data points

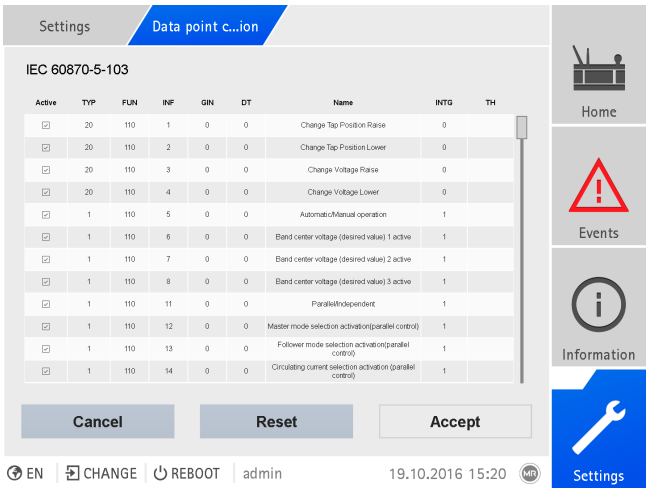


Figure 110: Configuring IEC 60870-5-103 data points

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.

8.1.6.7.3 Configuring IEC 60870-5-104 data points

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

Column	Description	Modifiable	Setting range
Active	You can use the checkbox to set whether the data point is to be transferred via the control system protocol or not.	Yes	Active/inactive
IOA	Data point address.	Yes	1...16777215
Name	Data point designation.	No	-
Type	Data point type.	No	-
Group	Data point group or groups. You must enter the group membership as a binary code (5 bits). A maximum of 5 groups is possible. Example: – 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
CT	Interval in ms for periodic transmission of the data point. If you set 0, the data point is not transmitted periodically. Notice: You can only enter an interval for data points of type 9, 11 or 13.	Yes	0...10000

Table 38: Configuring IEC 60870-5-104 data points

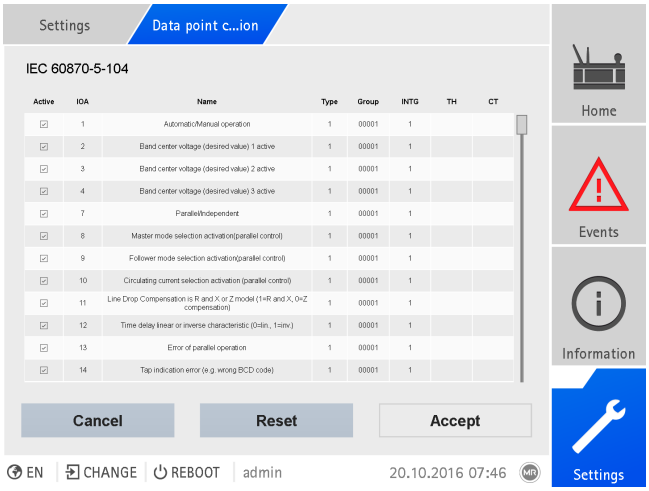


Figure 111: Configuring IEC 60870-5-104 data points

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.

8.1.6.7.4 Configuring Modbus data points

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

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

Table 39: Configuring Modbus data points

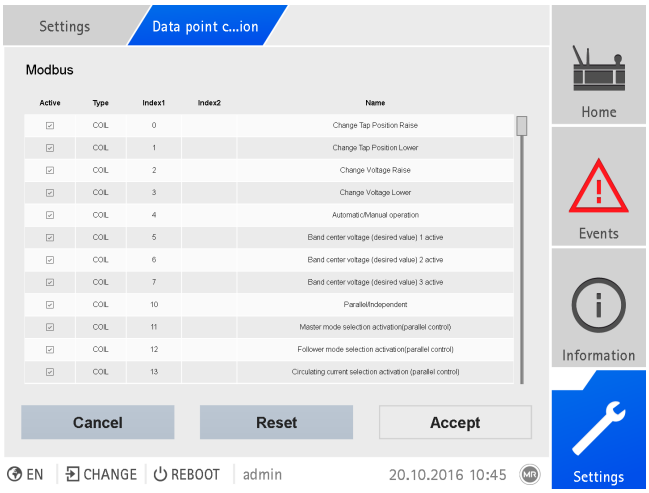


Figure 112: Configuring Modbus data points

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.

8.1.6.7.5 Configuring DNP3 data points

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

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

Table 40: Configuring DNP3 data points

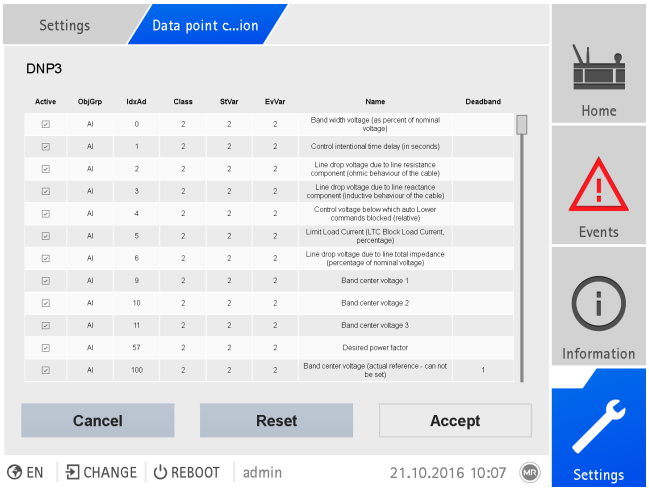


Figure 113: Configuring DNP3 data points

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.

8.1.6.7.6 Resetting the data point configuration to factory settings

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

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

8.1.6.7.7 Exporting and importing the data point configuration

You can export the data point configuration, e.g., to back it up or import it into another device. You will find more information in the Import/Export Manager [▶Section 8.1.15, Page 129] section.

8.1.7 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 access it via the web visualization, you can select a maximum of 10 measured values.

To display the measured value recorder, proceed as follows:

1. Go to **Recorder**.

Figure 114: 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).

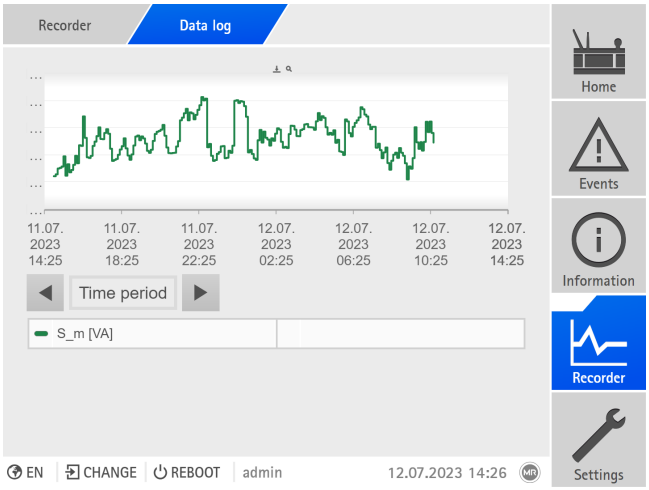


Figure 115: Data log

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.

8.1.8 Setting the measured value recorder

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

- Average value interval = 1 s: approx. 1 day and 4 hours
- Average value interval = 86,400 s (= 24 h): approx. 276 years

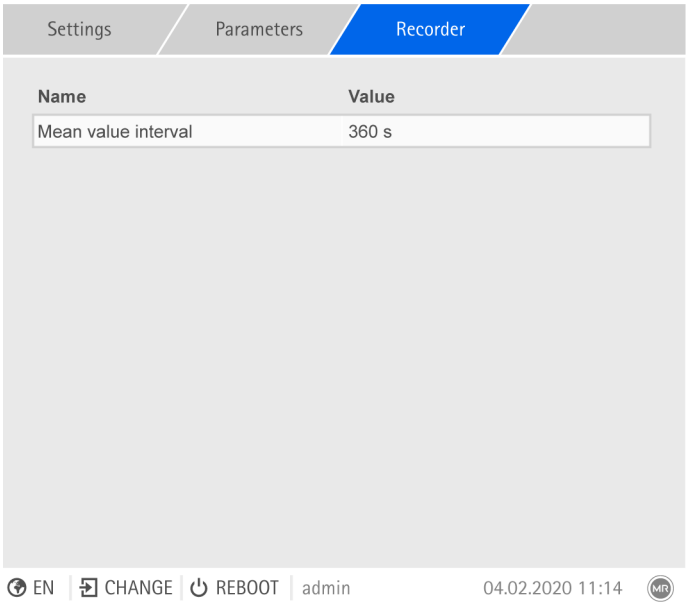


Figure 116: Recorder

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

Average value interval

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

8.1.9 Linking signals and events

The device enables 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 *Generic digital 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[1)]	Generic digital input 1
Digital input 2[1)]	Generic digital input 2
...	...
Digital input 42[1)]	Generic digital 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 41: Linking of digital inputs and control system commands with event messages

[1)] 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. *Undervoltage 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.

8.1.9.1 Linking digital outputs

You can link each event with a digital output. The device provides a maximum of 20 digital outputs for this purpose. When you link a digital output to an event, the device issues a signal to this output if the event occurs. The signal persists until the event stops. A parameter is available for each available digital output.

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

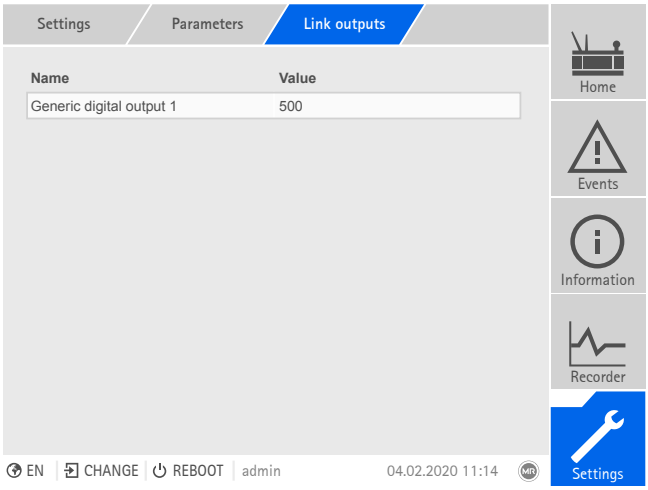


Figure 117: Linking digital outputs

✓ The desired event number is known [▶Section 8.1.11, Page 120].

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.

8.1.9.2 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.

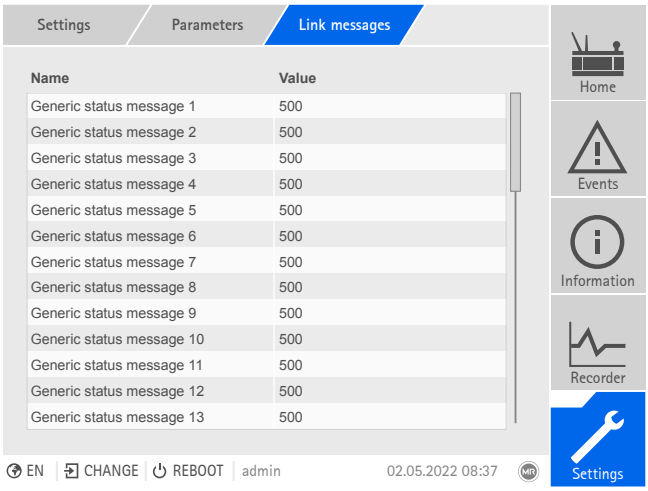


Figure 118: Linking SCADA messages

✓ The desired event number is known.

› Go to **Settings** > **Parameters** > **System** > **Link messages**.

Generic status message X

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

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

8.1.10 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.

8.1.10.1 Creating a backup

You need to create a backup to be able to reset the system in the event that any incorrect configuration settings are made. To do so, proceed as follows:

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

8.1.10.2 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.

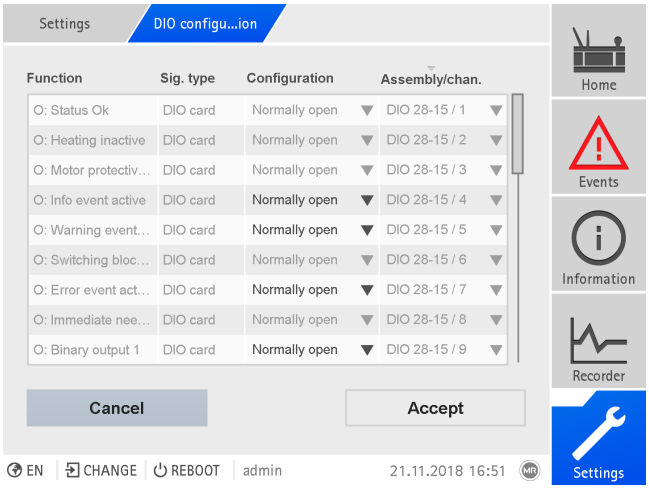


Figure 119: Configuring digital inputs and outputs

> 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.

When in delivery status, you can log in as the administrator as follows:
- User name: `admin`
- Password: `admin`

To configure the device's digital inputs and outputs, proceed as follows:
1. Go to **Settings** > **DIO configuration**.
2. Where necessary, select the buttons ▲ or ▼ to sort the properties in a column alphabetically.
3. Configure the properties as desired.
4. Press the **Accept** button.
5. Confirm the security prompt with **Yes** to save the changes.

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

Signal type
Select the signal type:
- Digital: Digital input

Configuration
Configure the device's digital inputs and outputs as follows:
- DI: High active or low active
- DO: N/O contact (NO), N/C contact (NC); Note: If the device is disconnected or in the event of an error, the digital outputs are always open (no bi-stable relay).

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

8.1.11 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.

8.1.11.1 Displaying and acknowledging events

To display the events currently active, proceed as follows:

› Go to **Events**.

» A list of currently pending events appears.

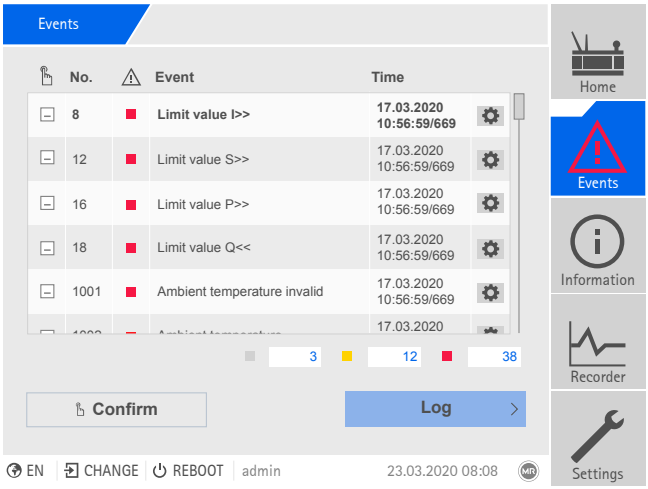


Figure 120: Overview of events currently active

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.

8.1.11.2 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 *Alarm* LED and the event symbol in the primary navigation.
Report	If you activate this option, the event is shown on the display and, if configured accordingly, issued via an output and the control system protocol.

Property	Description
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 42: Properties of events

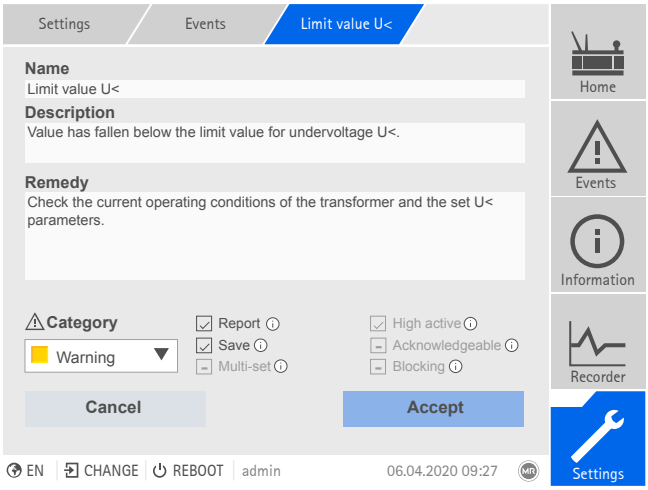


Figure 121: Configuring events

To configure an event, proceed as follows:

1. Go to **Settings** > **Events**.
2. Select the event to be changed in the list.
3. Select the desired options.
4. Press the **Accept** button to save the change.

8.1.11.3 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

Filter	Description
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**.

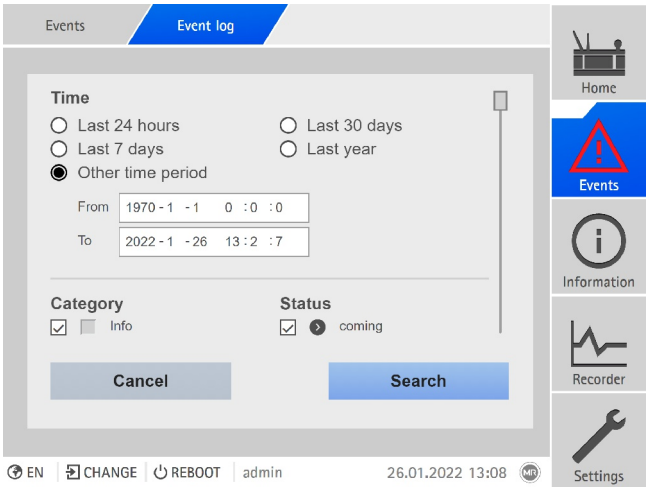


Figure 122: Event memory

2. Set the desired **Filter**.
3. Select the desired events in the **Events** list.
4. Press the **Search** button to display the desired events.

Exporting events

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

To export the events, proceed as follows:

✓ First, connect using Connect PC or connect a storage medium to the USB port on the CPU I/CPU II module.

1. Press the **Export** button.
2. Select the desired option for data transmission (PC or USB).

» The data is exported.

8.1.11.4 Exporting the event messages overview

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

✓ First, connect using Connect PC or connect a storage medium to the USB port on the CPU I [▶Section 4.7.3.4, Page 27] module.

1. Go to **Export** > **Event list**.
2. Select the location where you want to save it.
3. Press the **Start export** button.

» The overview of event messages is exported.

8.1.12 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.

8.1.12.1 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 8.1.12.4, Page 126] 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 43: 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 44: Access rights permanently linked to the roles

8.1.12.2 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.

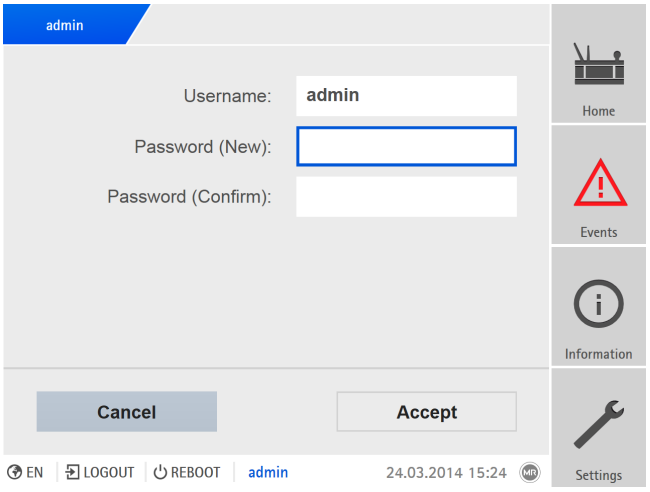


Figure 123: Changing the password

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

8.1.12.3 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.

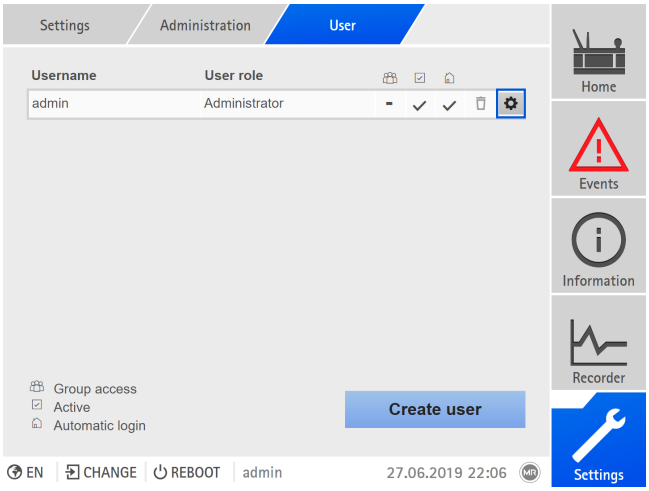


Figure 124: Overview of users created

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

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

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

Creating users

To create a new user, proceed as follows:

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

Editing users

To edit an existing user, proceed as follows:

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

Deleting a user

To delete an existing user, proceed as follows:

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

8.1.12.4 Setting access rights to parameters and events

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

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

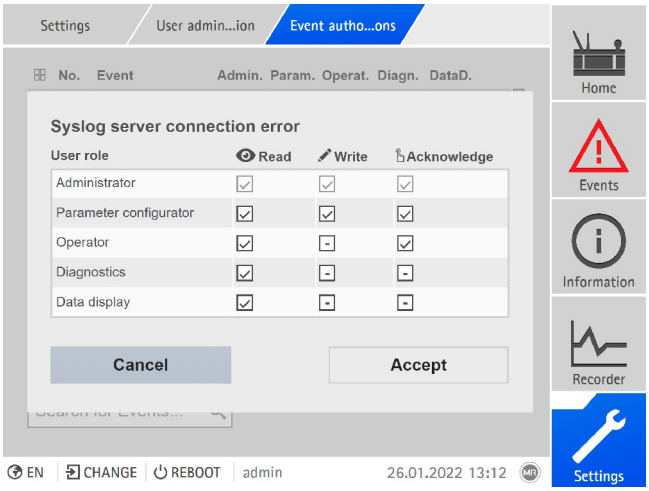


Figure 125: Setting access rights for an event

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

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

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

Setting access rights to parameters/events

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

8.1.12.5 User authentication via RADIUS (optional)

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

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

8.1.12.5.1 Creating a dictionary on the RADIUS server

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

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

If your RADIUS server supports the importing of a dictionary, you can export the dictionary for ISM® devices from the device and import it onto your RADIUS server. For more information, refer to the information in the section titled Exporting data [▶Section 8.1.15.1, Page 129].

The user groups of the dictionary correspond to the user roles [▶Section 8.1.12.1, Page 123] of the device and the corresponding authorizations.

8.1.12.5.2 Configuring RADIUS

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

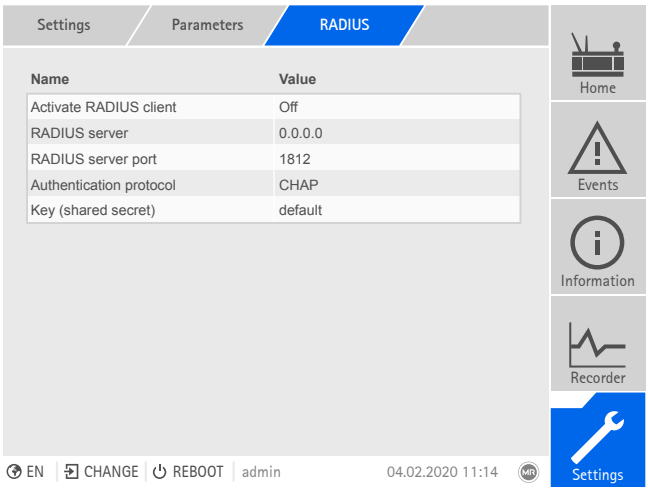


Figure 126: Configuring RADIUS

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

When in delivery status, you can log in as the administrator as follows:
- User name: `admin`
- Password: `admin`

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

Activate RADIUS client
You can use this parameter to activate the RADIUS client.

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

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

Authentication protocol
You can use this parameter to set the authentication protocol through which the server and client communicate. You can select the following options:
- PAP (password authentication protocol)
- CHAP (challenge handshake protocol)

Key (shared secret)
You can use this parameter to set the key (shared secret). You must set up the same key on the RADIUS client and the RADIUS server. The key may contain a maximum of 127 characters from the ASCII character set.

8.1.13 Hardware

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

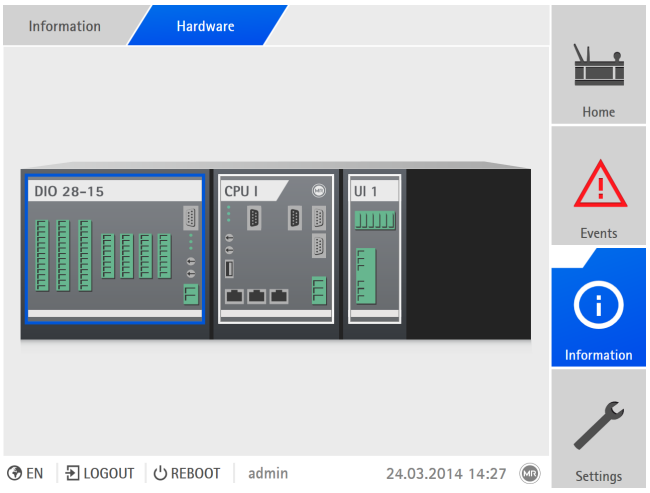


Figure 127: Displaying information for the device's hardware (example)

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

8.1.14 Software

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

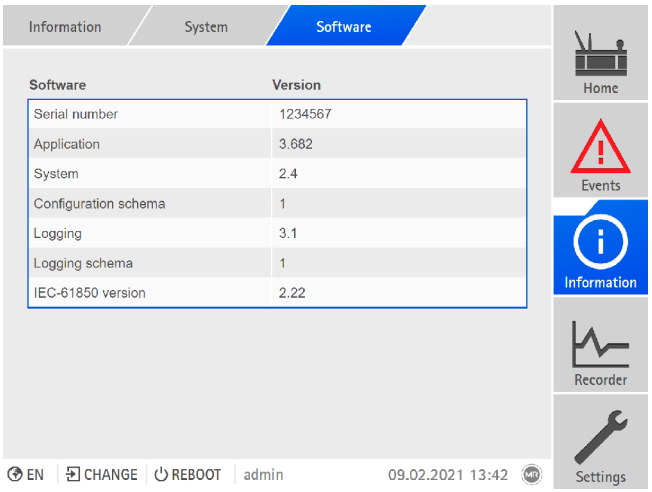


Figure 128: Information about the device's software

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

8.1.15 Import/export manager

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

To transfer the data, the following options are available:

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

Table 45: Data transfer options

8.1.15.1 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)	Complete image of the system (software and configuration). If you are using the option "with history", all of the event memory entries are also exported. If you select the "with TPLE" option, the customer program is exported. You can select whether you would like to export all records or only records from the last 10 days.
Settings (.rhi)	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 – Certificates
Customer program (TPLE) (.rhi)	Customer program export (TPLE).
Data point configuration (.rhi)	Data point configuration of the control system.
Sensor-bus device description (.rhi)	Sensor description of the sensors for MR sensor bus.
Custom sensor-bus dev. description (.rhi)	Sensor description of the sensors for MR sensor bus that have been created with the sensor editor.

Table 46: 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 47: Exporting data: Information group

System

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

Table 48: Exporting data: System group

Records

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

Table 49: Exporting data: Records group

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

To export data, proceed as follows:

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

8.1.15.2 Importing data (software version 3.800 and later)

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

Option	Description
System image	Complete image of the system (software and configuration), with or without history (recorded data). During import, you can select which of the following settings are to be imported: – 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).
Language	Import of additional languages. You can install a maximum of five different languages on the device. If five languages are already installed, you will be asked to delete one during the import process.

Option	Description
SSL certificate	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).
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
Data point configuration	Data point configuration import
SCADA configuration	Import of the control system configuration (e.g. SCD file for IEC 61850).
Sensor bus	Sensor description of the sensors for MR sensor bus.

Table 50: Importing data

If you import the settings of the AIO/DIO configuration of a system in which sensors are linked via sensor bus, you must also select the sensor bus option for the import. Otherwise you must re-link the sensor signals with the device functions (AIO configuration or DIO configuration [▶Section 8.1.10, Page 118]). The same applies if you want to import a sensor bus configuration. In this case, you must also import the AIO/DIO configuration or manually link the sensor signals with the device functions manually.

NOTICE

Damage to the file system!

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

- Do not disconnect the device from the power supply during the import.
- In addition, during the download, do not remove the USB flash drive or disconnect the network connection.

To import data, proceed as follows:

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

5. Press the **Start update** button.
   » *NOTICE!* The device function (monitoring/control) is stopped.
» The data is imported, then the device is restarted. During the restart, the relays are reset.

8.1.16 Configuring media converter with managed switch

Observe the following information on configuring the media converter with managed switch SW 3-3. Use the following browser to call up web-based visualization:
- Firmware version 02.0.01: Internet Explorer 11
- Firmware version 07.1.00 or higher: HTML5-compatible browser, e.g., Google Chrome

8.1.16.1 Commissioning

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

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

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

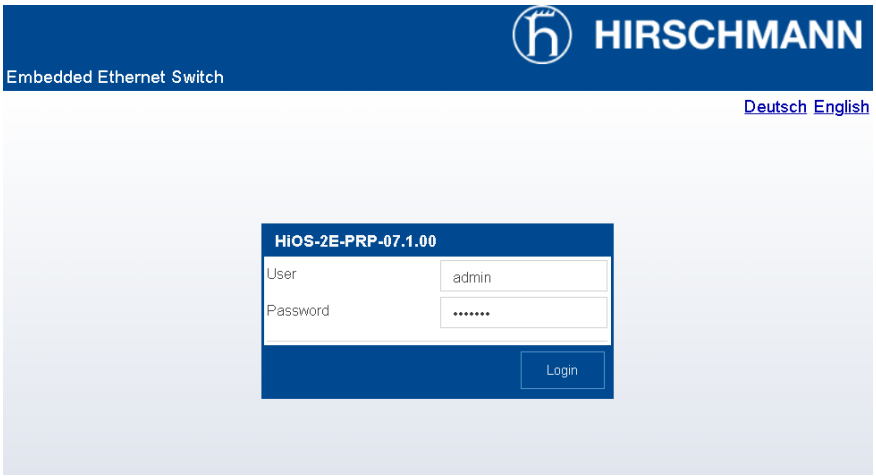


Figure 129: Login using a web interface

5. In the **Basic settings > Network > Global** menu, adjust the network settings and click on the **Write** button.

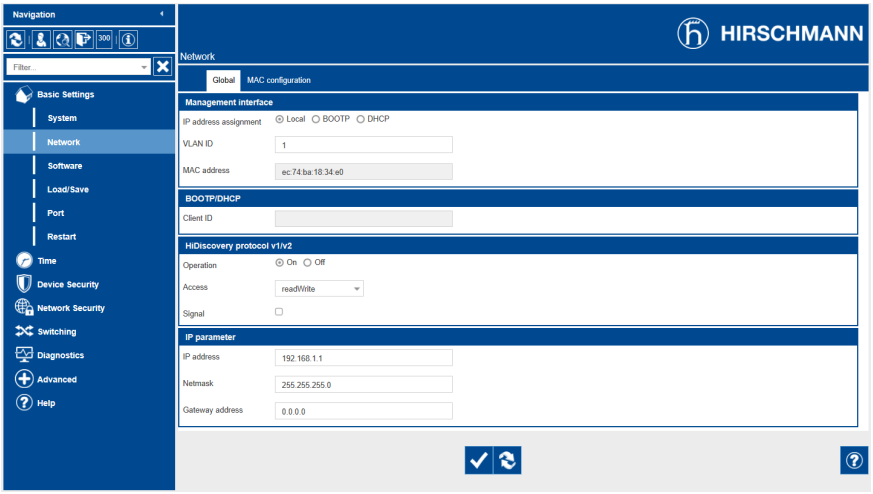


Figure 130: Network settings

6. In the **Basic settings > Load/Save** menu, click on the **Save** button to permanently store the settings.
7. If necessary, establish a connection to the new IP address to continue changing settings. Click on the **Help** button to find out more information.
8. Attach the cable for connecting to your network.

8.1.16.2 Configuration

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

Calling up the web interface

To access the web interface, follow the instructions outlined in the Commissioning [▶Section 8.1.16.1, Page 133] chapter.

Selecting the redundancy protocol

To select the redundancy protocol, proceed as follows:

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

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

Resetting to factory settings

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

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

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

Table 51: MR factory setting

8.1.17 Transformer Personal Logic Editor (TPLE)

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

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

8.1.17.1 Function

8.1.17.1.1 Function groups

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

8.1.17.1.2 Variables

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

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

8.1.17.1.3 Function modules

TPLE provides various function modules for processing the information.

8.1.17.1.3.1 AND

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

Table 52: AND function module

8.1.17.1.3.2 NAND

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

Table 53: NAND function module

8.1.17.1.3.3 OR

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

Table 54: OR function module

8.1.17.1.3.4 NOR

Description	NOR, logical NOT-OR link
Inputs	Input 1...4 (BOOL)
Outputs	Output (BOOL)
Parameter	None

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

Table 55: NOR function module

8.1.17.1.3.5 XOR

Description	XOR, logical EXCLUSIVE-OR link
Inputs	Input 1...2 (BOOL)
Outputs	Output (BOOL)
Parameter	None
Function	If an odd number of inputs is TRUE, the output is TRUE, otherwise it is FALSE.
Initial state	All inputs and outputs are FALSE. Non-configured inputs are assumed to be FALSE so that they have no impact on the output. If no input is configured, the output therefore remains in the initial state of FALSE.

Table 56: XOR function module

8.1.17.1.3.6 NOT

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

Table 57: NOT function module

8.1.17.1.3.7 Current impulse relay

Description	RS, current impulse relay
Inputs	Trigger (BOOL) Set (BOOL) Reset (BOOL)
Outputs	Output (BOOL)
Parameter	None

Function	If the Reset input is TRUE, Output forcibly becomes FALSE. If the Reset input is FALSE and the Set input is TRUE, Output forcibly becomes TRUE. If the Reset and Set inputs are FALSE, the status of Output changes when there is a rising edge at the Trigger input. If there is no edge at the Trigger input, Output remains unchanged.
Initial state	All inputs and outputs are FALSE. Non-configured inputs are assumed to be FALSE so that they have no impact on the output.

Table 58: Current impulse relay function module

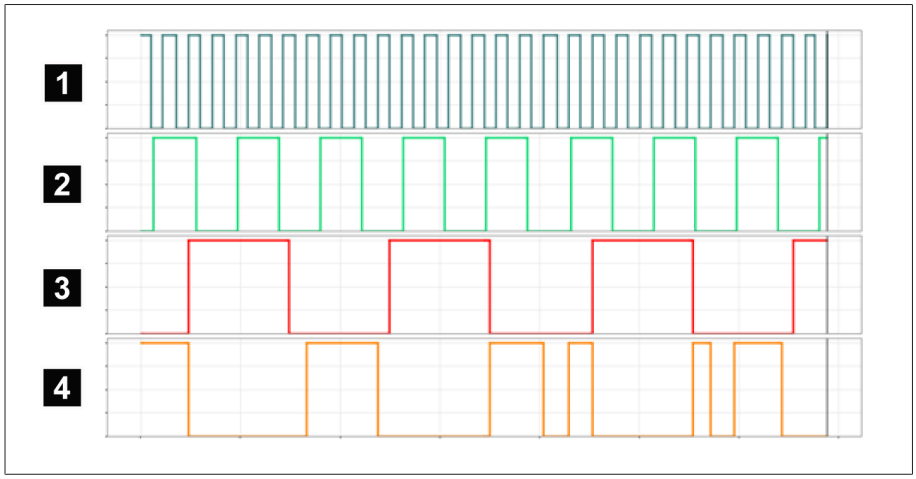


Figure 131: Example of RS

1	Trigger	2	Set
3	Reset	4	Output

8.1.17.1.3.8 Switch-on delay

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

Table 59: Switch-on delay function module

8.1.17.1.3.9 Switch-off delay

Description	TOFF, switch-off delay
Inputs	Trigger (BOOL) Reset (BOOL)
Outputs	Output (BOOL)
Parameter	Time ms (UINT32), 1...1,000,000, default = 1,000
Function	If Input becomes TRUE, Output also instantly becomes TRUE, this condition takes priority. If Input has a falling input, the internal timer is set to zero and starts to run. When the internal timer has reached or exceeded the parameter value, Output becomes FALSE and the counter stops running. If Input is FALSE and the Reset input becomes TRUE, Output instantly and forcibly becomes FALSE and the internal timer is set to the configured desired value. If the value of Time_ms is less than the cycle time, the cycle time applies instead.
Initial state	All inputs and outputs are FALSE.

Table 60: Switch-off delay function module

8.1.17.1.3.10 Pulse

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

Table 61: Pulse function module

8.1.17.1.3.11 Symmetrical pulse generator

Description	CLCK, symmetrical pulse generator
Inputs	Enable (BOOL)
Outputs	Output (BOOL)
Parameter	Time ms (UINT32), 1...1,000,000, default = 1,000

Function	The internal timer runs for a long as Enable is TRUE. When the internal timer has reached or exceeded the configured time value, the status of the output changes and the timer is restarted. The configured time therefore corresponds to half the period duration of the resulting signal. If the Enable input becomes FALSE, the output also instantly becomes FALSE and the internal timer is reset. If the value of Time_ms is less than the cycle time, the cycle time applies instead.
Initial state	All inputs and outputs are FALSE.

Table 62: Symmetrical pulse generator function module

8.1.17.1.3.12 Counter (forwards/backwards)

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

Table 63: Counter (forwards/backwards) function module

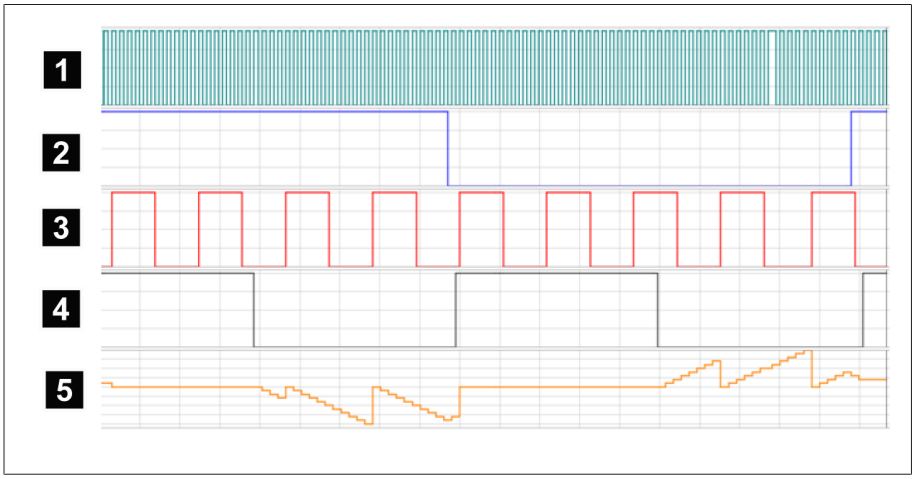


Figure 132: Example of COUNT

1	Trigger	2	Direction
3	Reset	4	Lock
5	Output		

8.1.17.1.3.13 Analog threshold value switch with hysteresis

Designation	THRES, threshold value switch with hysteresis
Inputs	Input (REAL32)
Outputs	Output (BOOL) Error (BOOL)
Parameter	On Limit (REAL32), -10,000,000... +10,000,000, default = 10,000,000 Off Limit (REAL32), -10,000,000 ... +10,000,000, default = -10,000,000
Function	On Limit ≥ Off Limit setting: – If the value of Input is greater than On Limit, Output becomes TRUE. – If the value of Input is less than or equal to Off Limit, Output becomes FALSE. On Limit < Off Limit setting: – If the value of Input is greater than On Limit and at the same time less than Off Limit, Output becomes TRUE. Otherwise, the Output is FALSE.
Initial state	All inputs and outputs are zero or FALSE.

Table 64: Analog threshold value switch with hysteresis function module

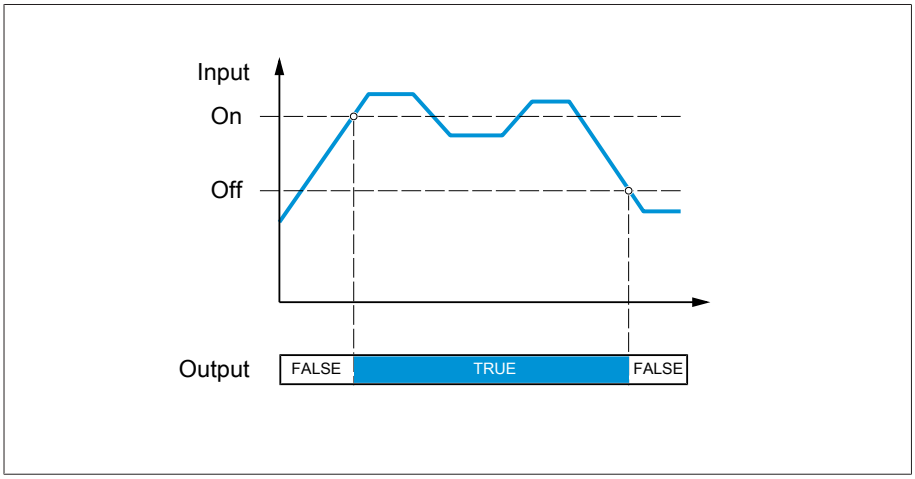


Figure 133: Analog threshold value switch with the On Limit > Off Limit setting

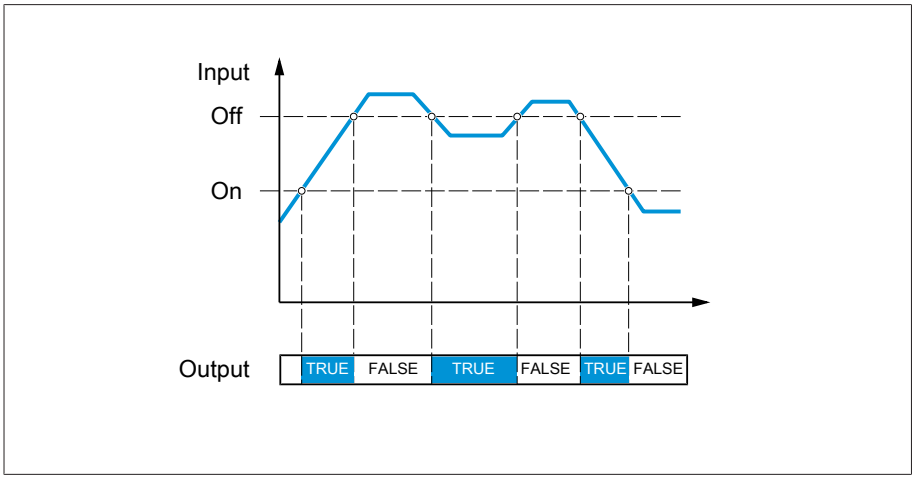


Figure 134: Analog threshold value switch with the On Limit < Off Limit setting

8.1.17.1.3.14 Analog multiplication

Description	MUL, analog multiplication
Inputs	Value (REAL32) Multiplier (REAL32)
Outputs	Result (REAL32) Overflow (BOOL)
Parameter	Constant multiplier (REAL32), -1,000,000...+1,000,000; default = 1
Function	Result = Value * Multiplier * Constant multiplier If the REAL32 range of numbers is exceeded, the Overflow output becomes TRUE.
Initial state	All inputs and outputs are zero or FALSE.

Table 65: Analog multiplication function module

8.1.17.1.3.15 Analog division

Description	DIV, analog division
Inputs	Divident (REAL32) Divisor (REAL32)
Outputs	Result (REAL32) DivByZero (BOOL) Overflow (BOOL)

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

Table 66: Analog division function module

8.1.17.1.3.16 Analog addition

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

Table 67: Analog addition function module

8.1.17.1.3.17 Analog subtraction

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

Table 68: Analog subtraction function module

8.1.17.1.3.18 Rising edge

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

Table 69: Rising edge function module

8.1.17.1.3.19 Falling edge

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

Table 70: Falling edge function module

8.1.17.1.3.20 Average value

Description	AVRG, average value
Inputs	Input (REAL32) Enable (BOOL) Reset (BOOL) Autorepeat (BOOL)
Outputs	Average (REAL32) Done (BOOL) Started (BOOL) SampleCount (UINT32)
Parameter	Time ms (UINT32): 1...2,000,000,000, default = 10,000 Sample time ms (UINT32): 1...10,000,000, default = 1,000
Function	Averaging starts with a rising edge of Enable. This does not affect averaging which is already underway. Any output value remaining from earlier is retained. The Done output becomes FALSE, the Started output becomes TRUE. Active averaging is interrupted with a rising edge of Reset. Average is set to zero, Done and Started become FALSE. If Enable is also TRUE during the rising Reset edge, a new averaging process is started. Done becomes TRUE and Started becomes FALSE once averaging is complete. Done remains TRUE until a Reset is detected or new averaging is triggered by a rising edge of Enable. If AutoRepeat and Enable are TRUE, a new averaging process is automatically started each time averaging is completed. Done is set for one cycle each time averaging is completed. The SampleCount output states how many samples have already been recorded. Sample time ms is the desired sample time in milliseconds. It is rounded up to the next whole multiple of the task cycle time and has a lower limit of at least one task cycle time. Time ms is the time period desired for averaging. It is internally rounded up to the next whole multiple of the sample time and has a lower limit of at least one sample time.
Initial state	All inputs and outputs are FALSE.

Table 71: Average value function module

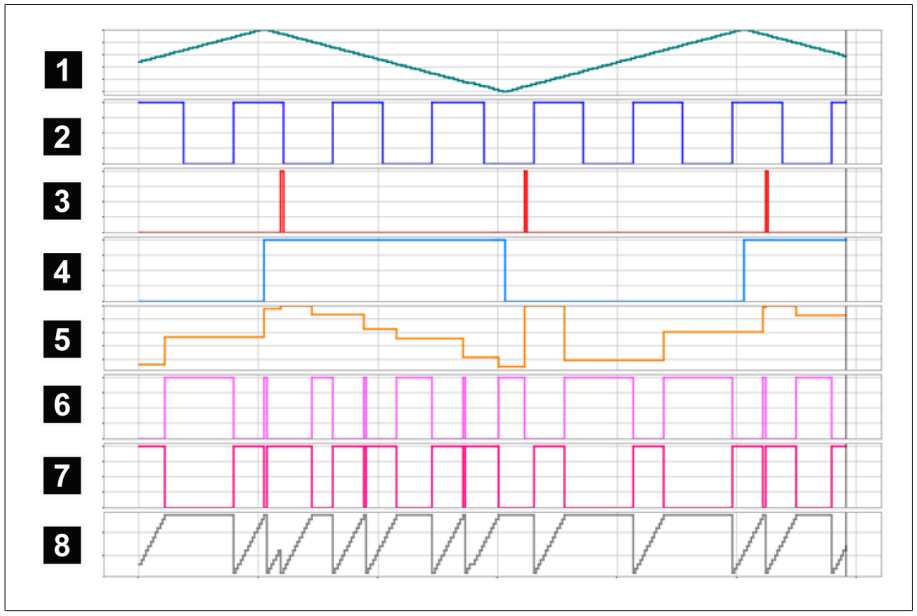


Figure 135: AVRG

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

8.1.17.1.3.21 Scaling

Description	SCAL, scaling
Inputs	Input (REAL32)
Outputs	Output (REAL32) Error (BOOL)
Parameter	Min In (REAL32): -10,000,000...+10,000,000, default = -10,000,000 Max In (REAL32): -10,000,000...+10,000,000, default = +10,000,000 Min Out (REAL32): -10,000,000...+10,000,000, default = -10,000,000 Max Out (REAL32): -10,000,000...+10,000,000, default = +10,000,000
Function	Output is calculated using the following formula: `Output = Min Out + (Max Out - Min Out) x (Input - Min In) / (Max In - Min In)` Output is set to 0 and Error = TRUE when: – Input is not within the parameters Min In and Max In – Min In is greater than Max In – Min Out is greater than Max Out – Max In is the same size as Min In (division by zero)
Initial state	All inputs and outputs are FALSE.

Table 72: Scaling function module

8.1.17.1.3.22 Bridge

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

Table 73: Bridge function module

8.1.17.1.3.23 RTOI

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

Table 74: RTOI function module

8.1.17.1.3.24 ITOR

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

Table 75: NAND function module

8.1.17.2 Configuring TPLE

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

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

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

8.1.17.2.1 Editing variables

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

- Binary inputs
- Binary outputs
- Analog inputs

- Binary flags
- Analog flags
- Discrete inputs

> The names and descriptions of the generic events can also be adapted like all other device events. Note the Event management [▶Section 8.1.11, Page 120] section.

The permissible number of characters is limited:
- Name: Maximum of 20 characters
- Description: Maximum of 80 characters

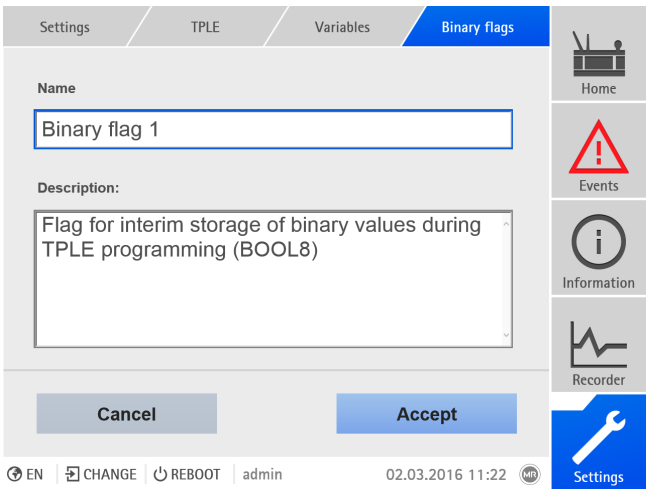


Figure 136: Editing variable

To edit the variable, proceed as follows:
1. Go to **Settings > TPLE > Variables**.
2. Select the **variable** you want.
3. Enter the **name** and **description**.
4. Press the **Accept** button to save the modified variable.

8.1.17.2.2 Creating functions

Within one function group, you can create up to 12 function modules to depict one function. To create, edit or delete a function, you have to call up the function group you want. To do so, proceed as follows:
1. Go to **Settings > TPLE > Function group**.
2. Select the **function group** you want.

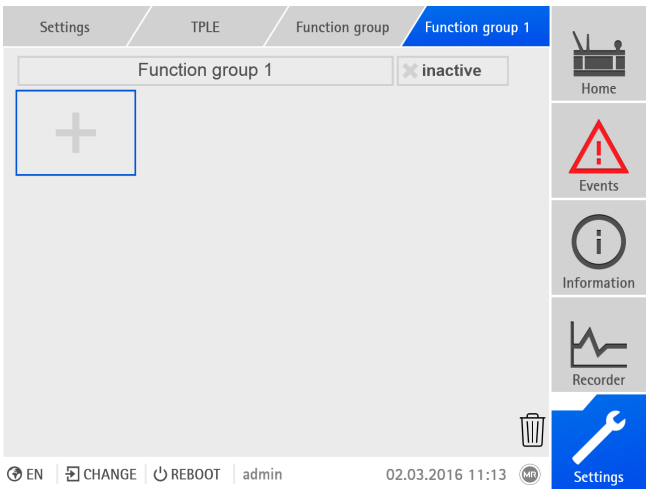


Figure 137: Function group

Creating function modules

To create a function module, proceed as follows:

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

Deleting function modules

To delete a function module, proceed as follows:

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

Sorting function modules

To sort a function module, proceed as follows:

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

Editing function module

To edit a function module, proceed as follows:

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

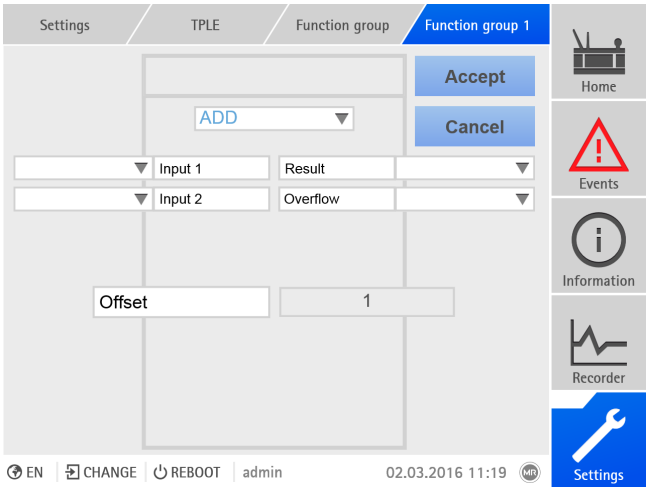


Figure 138: Editing function module

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

8.1.17.2.3 Renaming function group

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

To rename a function group, proceed as follows:

1. Go to **Settings > TPLE > Function group**.
2. Select the **function group** you want.

3. Select the text field with the **name of the function group** and enter the name you want.

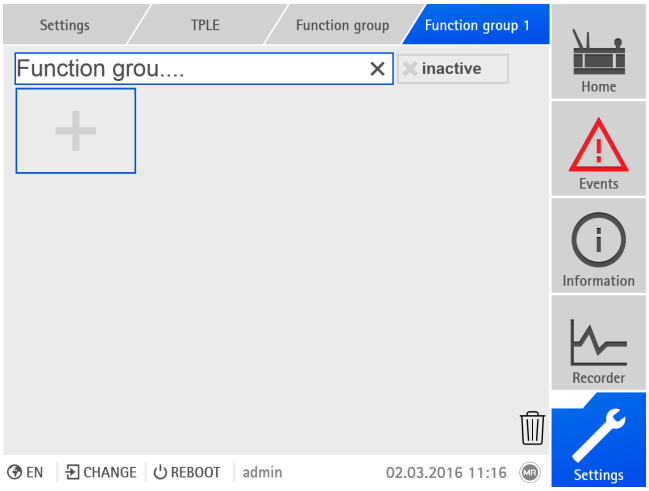


Figure 139: Renaming function group

4. Press [Enter] to accept the change.

8.1.17.2.4 Activating/deactivating function group

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

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

1. Go to **Settings > TPLE > Function group**.
2. Select the **function group** you want.
3. Press the **Inactive** button.

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

8.1.18 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.

8.1.18.1 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.

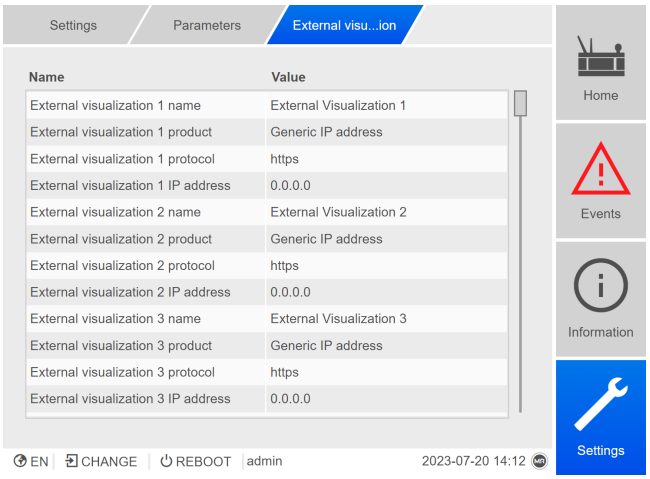


Figure 140: External visualization

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

External visualization name

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

External visualization product

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

External visualization protocol

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

- https
- http

External visualization IP address

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

8.1.18.2 Calling up an external visualization

To call up an external visualization, proceed as follows:

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

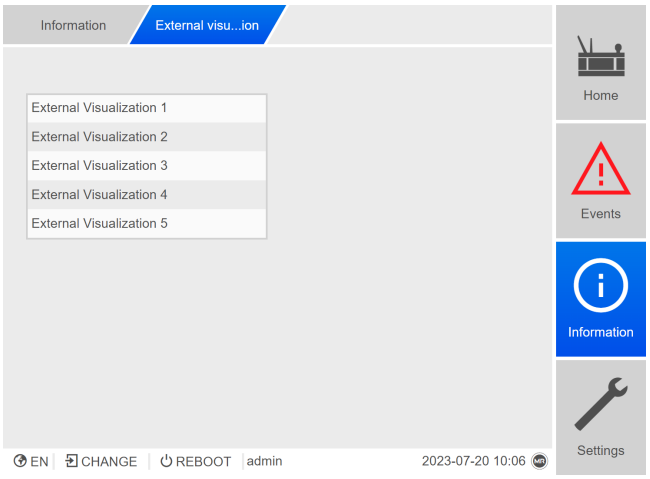


Figure 141: External visualization

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

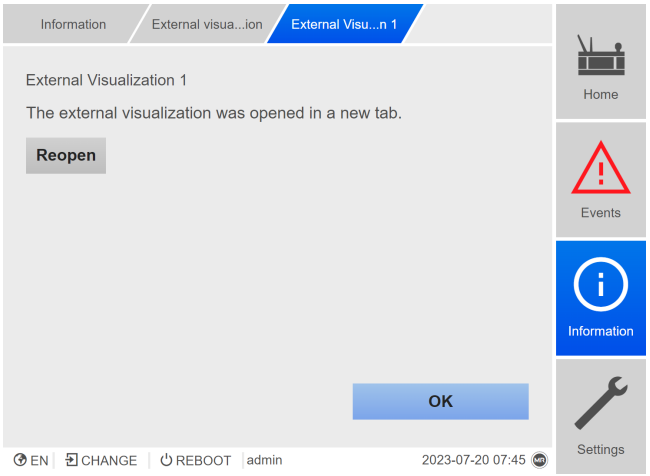


Figure 142: Visualization 1

8.2 Power grid

8.2.1 Setting the transformer data for the reference system (optional)

You can use the following parameters to set the transformer data. You can only access these parameters when the device allows for the measurement of the reference line voltage.

> If bushing monitoring with the option "Monitoring of 6 bushings" is used, the parameters for both field 1 (F1) and field 2 (F2) must be set. Field 1 and field 2 each describe a set consisting of 3 bushings respectively. If bushing monitoring with the option "Monitoring of 3 bushings" is used, only the parameters for field 1 are displayed.

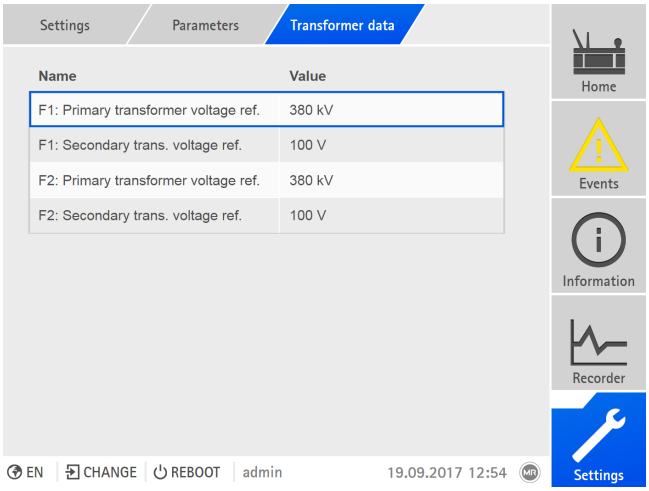


Figure 143: Transformer data for the reference system

› Go to **Settings** > **Parameter** > **Power grid**.

F1/F2: Reference system primary transformer voltage

You can use this parameter to set the primary voltage of the reference system voltage transformer for field 1 or field 2.

F1/F2: Reference system secondary transformer voltage

You can use this parameter to set the secondary voltage of the reference system voltage transformer for field 1 or field 2.

8.3 Circuit breaker monitoring

You can configure up to 4 digital inputs for monitoring the status messages of the circuit breakers in the reference system. This monitoring function is used for detecting whether the reference system is active (circuit breaker in ON position) or inactive (circuit breaker in OFF position).

If circuit breaker monitoring is configured and a circuit breaker is reported to be in the OFF position, the device reacts as follows:
- Bushing monitoring is deactivated.
- You cannot perform standardization.

When configuring this function, refer to the section Configuring digital inputs and outputs [▶Section 8.1.10, Page 118].

> If bushing monitoring with the option "Monitoring of 6 bushings" is used, you can configure up to 4 inputs for field 1 (F1) and for field 2 (F2) respectively. If bushing monitoring with the option "Monitoring of 3 bushings" is used, only the inputs for field 1 are displayed. Bushing monitoring is only deactivated for the respective field.

8.4 Bushings

8.4.1 Configuring bushing monitoring

Follow the notes in the following sections when configuring capacitance monitoring and dissipation factor monitoring.

8.4.1.1 Set the field designation

The field designation is displayed in the bushing monitoring overview screen [▶Section 8.4.2, Page 159]. You can set a unique field designation for each field.

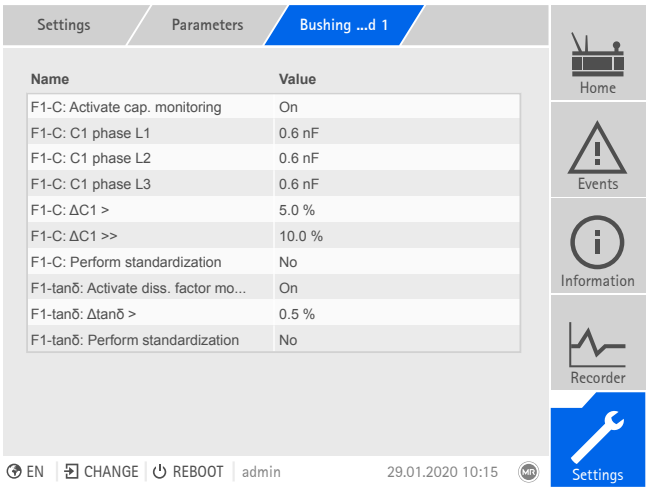


Figure 144: Bushing monitoring

1. Go to **Settings > Parameters > Bushing monitoring > Bushing monitoring field1/field2**.
2. Select the desired parameter.
3. Set the desired parameter.
4. Press the **Accept** button to save the modified parameter.

Field designation

You can use this parameter to set the field designation.

8.4.1.2 Configuring capacitance monitoring

The device monitors the amendment in the difference of capacitance C1 between the phases. If the capacitance C1 of all three bushings changes in the same way (e.g. due to a temperature change), the difference in capacitances ΔC1 remains constant. If the capacitance of one or two bushings changes, the difference in capacitance also changes.

You can set two limit values for monitoring the bushings in field 1 and field 2:

- F1/F2-C: ΔC1 >
- F1/F2-C: ΔC1 >>

If the limit values are exceeded, the monitoring system triggers an event message and issues a signal at the digital output.

> Maschinenfabrik Reinhausen recommends the following limit values: F1/F2-C: ΔC1 >: 5%, F1/F2-C: ΔC1 >>: 10%

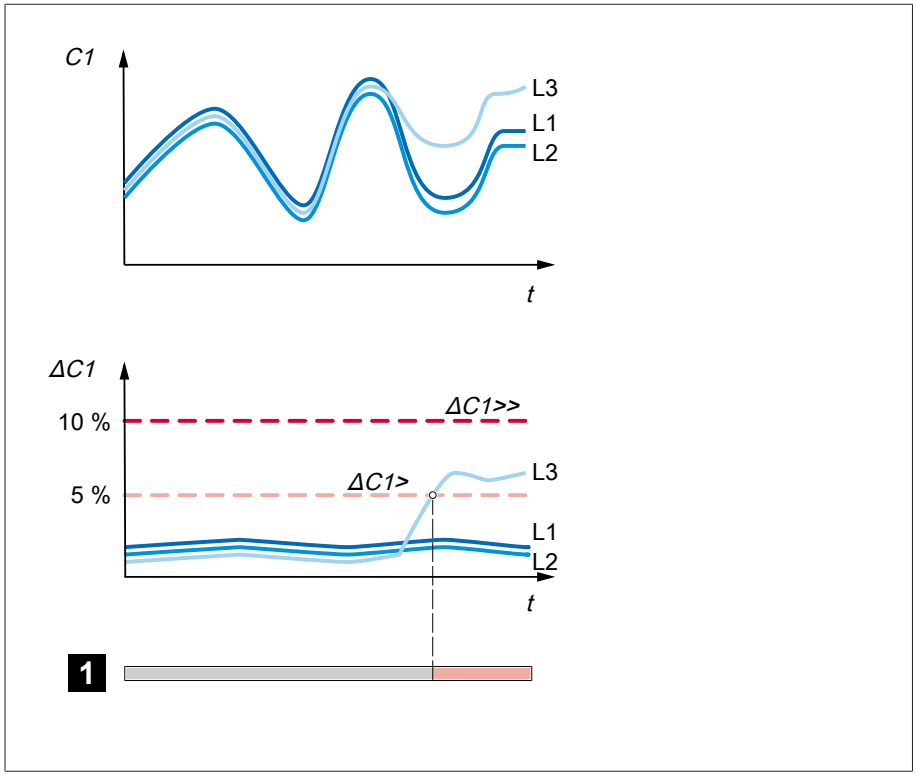


Figure 145: Capacitance monitoring

1	Status of the bushing (gray: ok, yellow/red: limit value exceeded)	C1	Capacitance C1
ΔC1	Capacitance difference ΔC1	ΔC1>	Limit value ΔC1>
ΔC1>>	Limit value ΔC1>>	L1, L2, L3	Phase L1, L2, L3

To monitor the capacitance of the bushings, the following parameters must be set for commissioning the transformer:

- F1/F2-C: Activate cap. monitoring
- F1/F2-C: C1 Phase L1/L2/L3
- F1/F2-C: ΔC1 >

- F1/F2-C: ΔC1 >>
- F1/F2-C: Perform standardization

If bushing monitoring with the option "Monitoring of 6 bushings" is used, the parameters for both field 1 (F1) and field 2 (F2) must be set. Field 1 and field 2 each describe a set consisting of 3 bushings respectively. If bushing monitoring with the option "Monitoring of 3 bushings" is used, only the parameters for field 1 are displayed.

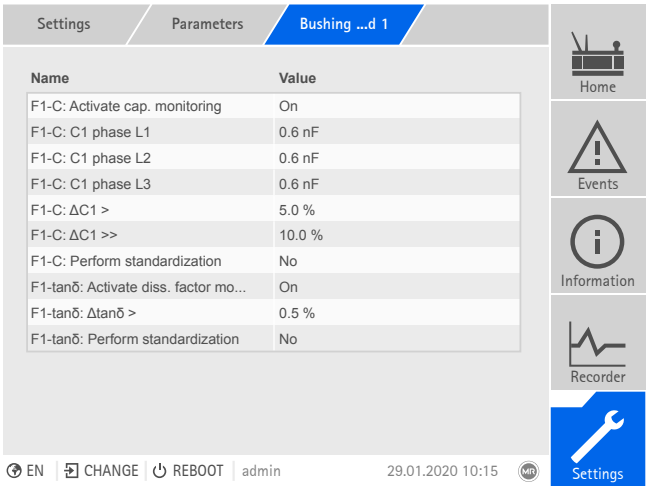


Figure 146: Bushing monitoring

1. Go to **Settings > Parameters > Bushing monitoring > Bushing monitoring field1/field2**.
2. Select the desired parameter.
3. Set the desired parameter.
4. Press the **Accept** button to save the modified parameter.

F1/F2-C: Activate capacitance monitoring

You can use this parameter to activate or deactivate capacitance monitoring for field 1 or field 2.

After being switched on, capacitance monitoring only becomes active once a delay time has elapsed (factory setting of 2 minutes) in order to avoid errors resulting from transients.

F1/F2-C: C1 phase L1

You can use this parameter to set the reference capacitance C1 for the bushings of the L1 phases in field 1 or field 2. The reference value is the value you have measured with an external measuring device for commissioning [▶ Section 7.2, Page 79].

F1/F2-C: C1 phase L2

You can use this parameter to set the reference capacitance C1 for the bushings of the L2 phases in field 1 or field 2. The reference value is the value you have measured with an external measuring device for commissioning [▶ Section 7.2, Page 79].

F1/F2-C: C1 phase L3

You can use this parameter to set the reference capacitance C1 for the bushings of the L3 phases in field 1 or field 2. The reference value is the value you have measured with an external measuring device for commissioning [▶ Section 7.2, Page 79].

F1/F2-C: ΔC1 >

You can use this parameter to set the limit value F1/F2-C: ΔC1 >.

F1/F2-C: ΔC1 >>

You can use this parameter to set the limit value F1/F2-C: ΔC1 >>.

F1/F2-C: Perform standardization

You must perform standardization for field 1 and field 2 to commission the monitoring system. The standardization is used to compensate for measurement tolerances along the measurement chain (bushing, bushing adapter and bushing coupling unit).

> Only perform the standardization while commissioning the monitoring system and with bushings in good condition. Otherwise correct bushing monitoring functionality cannot be guaranteed.

To perform the standardization, proceed as follows:

✓ The transformer is in a stable state (typical load, no on-load tap-change operation or significant change in the transformer load, thermally stabilized).

1. Go to **Settings > Parameters > Bushing monitoring > Bushing monitoring field1/field2 > F1/F2-C: Perform standardization**.
2. Select the **Yes** option.
3. Press the **Accept** button to perform the standardization.
   » The standardization is carried out and the parameter is reset to the **No** option.
4. Check the event messages [▶Section 8.1.11.1, Page 120] to see if the standardization was performed successfully. If this is not the case, resolve the cause of the error and repeat the standardization.

F1/F2-C: C BCU phase L1

Set the capacitance of the bushing coupling unit for every field for phase L1.

F1/F2-C: C BCU phase L2

Set the capacitance of the bushing coupling unit for every field for phase L2.

F1/F2-C: C BCU phase L3

Set the capacitance of the bushing coupling unit for every field for phase L3.

F1/F2-C: Min. measured voltage

Set the minimum permitted voltage on the bushing coupling units for bushing capacitance monitoring for every field.

F1/F2-C: Standardization min. ref. volt.

Set the minimum permitted voltage on the bushing coupling units for bushing capacitance monitoring for every field.

F1/F2-C: Standardization min.meas.volt.

Set the minimum permitted voltage on the bushing coupling unit for the standardization of capacitance monitoring for every field.

F1/F2-C: Standardization max.meas.volt.

Set the maximum permitted voltage on the bushing coupling unit for the standardization of capacitance monitoring for every field.

F1/F2-C: Min. reference voltage

Set the minimum permitted reference voltage for every field.

8.4.1.3 Configuring dissipation factor monitoring (MSENSE® BM-T)

The device monitors the change in the difference of the dissipation factor tanδ between the phases. If the tanδ of all 3 phases changes in the same way (e.g. due to a temperature change), the difference in the dissipation factor Δtanδ remains constant. If the dissipation factor of one or two bushings changes, the difference in the dissipation factor also changes.

You can set a limit value for monitoring the bushings in field 1 or field 2. If the limit value is exceeded, the monitoring system triggers an event message and issues a signal at the digital output.

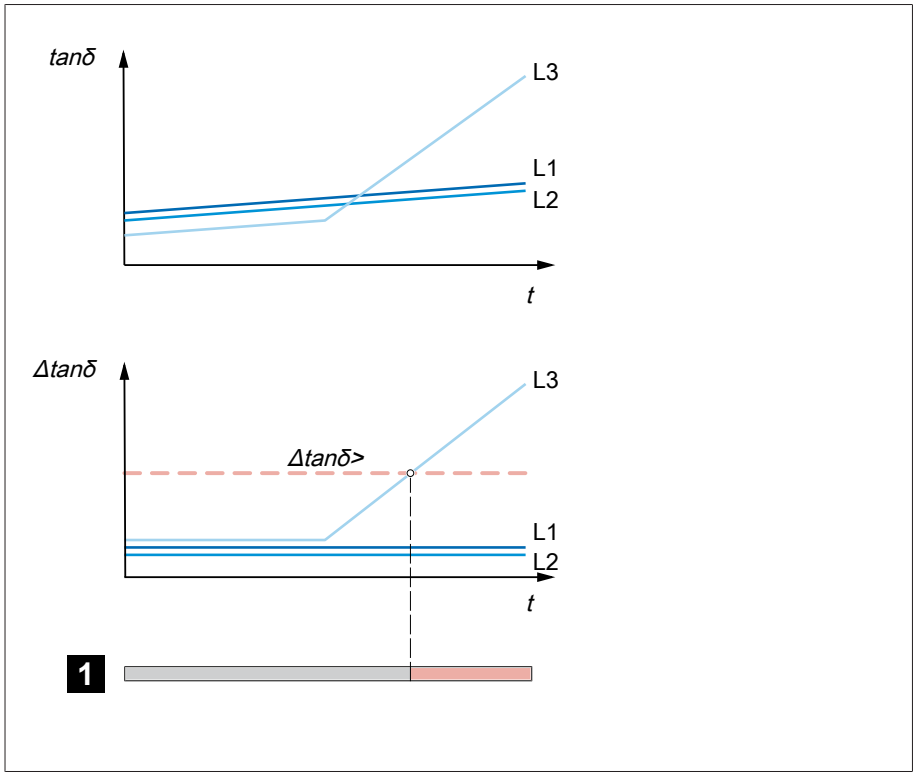


Figure 147: Dissipation factor monitoring

1	Status of the bushing (gray: ok, yellow/red: limit value exceeded)	tanδ	Dissipation factor tanδ
Δtanδ	Dissipation factor difference Δtanδ	Δtanδ>	Limit value Δtanδ>
L1, L2, L3	Phase L1, L2, L3		

To monitor the dissipation factor of the bushings, you must set the following parameters for commissioning the transformer:

- F1/F2-tanδ: Activate diss. factor monit.
- F1/F2-tanδ: tanδ phase L1/L2/L3
- F1/F2-tanδ: Δtanδ >
- F1/F2-tanδ: Perform standardization

If bushing monitoring with the option "Monitoring of 6 bushings" is used, the parameters for both field 1 (F1) and field 2 (F2) must be set. Field 1 and field 2 each describe a set consisting of 3 bushings respectively. If bushing monitoring with the option "Monitoring of 3 bushings" is used, only the parameters for field 1 are displayed.

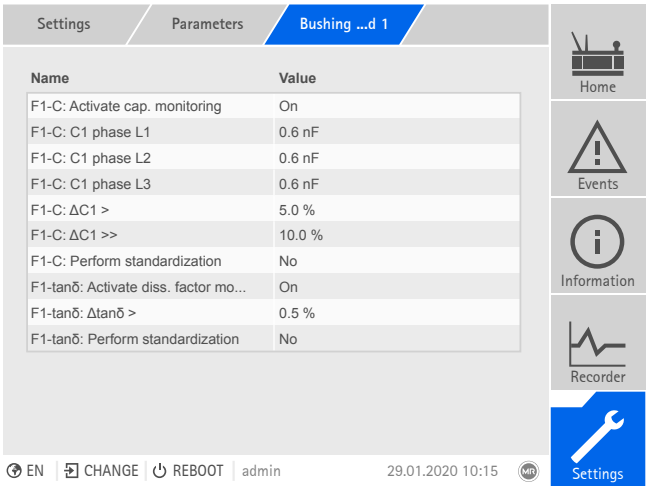


Figure 148: Bushing monitoring

1. Go to **Settings > Parameters > Bushing monitoring > Bushing monitoring field1/field2**.
2. Select the desired parameter.
3. Set the desired parameter.
4. Press the **Accept** button to save the modified parameter.

F1/F2-tanδ: Activate dissipation factor monitoring

You can use this parameter to activate or deactivate dissipation factor monitoring in field 1 or field 2.

> After being switched on, dissipation factor monitoring only becomes active once a delay time has elapsed (measured value display after approx. 7 minutes, monitoring after approx. 1 hour) in order to avoid errors resulting from transients.

8.4.1.3.1 F1/F2 tanδ: tanδ phase L1

You can use this parameter to set the reference dissipation factor tanδ for the bushing of phase L1 in field 1 or field 2. The reference value is the value you have measured with an external measuring device for commissioning [▶ Section 7.2, Page 79].

8.4.1.3.2 F1/F2 tanδ: tanδ phase L2

You can use this parameter to set the reference dissipation factor tanδ for the bushing of phase L2 in field 1 or field 2. The reference value is the value you have measured with an external measuring device for commissioning [▶ Section 7.2, Page 79].

8.4.1.3.3 F1/F2 tanδ: tanδ phase L3

You can use this parameter to set the reference dissipation factor tanδ for the bushing of phase L3 in field 1 or field 2. The reference value is the value you have measured with an external measuring device for commissioning [▶ Section 7.2, Page 79].

8.4.1.3.4 Limit value F1/F2-tanδ: Δtanδ >

You can use this parameter to set the limit value F1/F2-tanδ: Δtanδ >.

F1/F2-tanδ: Perform standardization

You can use this parameter to perform a standardization of the dissipation factor monitoring in field 1 and field 2. This clears all of the measured and calculated values for dissipation factor monitoring.

To perform the standardization, proceed as follows:

1. Go to **Settings > Parameters > Bushing monitoring > Bushing monitoring field1/field2 > F1/F2-tanδ: Perform standardization**.
2. Select the **Yes** option.
3. Press the **Accept** button to perform the standardization.
   » The standardization is carried out and the parameter is reset to the **No** option.
4. Check the event messages [▶Section 8.1.11.1, Page 120] to see if the standardization was performed successfully.

8.4.1.4 Sum current method

In this menu, you can set the parameters for the sum current method. This function allows the device to calculate the total current from the measured voltages and the phase shifts in the 3-phase network as well as the capacitances of the bushings.

> The device does not perform an analysis. This function supports you when making a diagnosis.

› Go to **Settings > Parameters > Bushings > Bushing monitoring field1/field2**.

I: F1-I/F2-I: Activate sum current method

You can use this parameter to activate or deactivate the sum current method for every field.

Alternatively, you can activate or deactivate the sum current method via digital inputs. While doing so, please note the following:

- You must select operating mode REMOTE.
- If a high signal is applied to both inputs simultaneously, only the first high signal is taken into account. You can set the parameter in the menu in the visualization if needed.
- You cannot adjust the parameter in the menu in the visualization if the high signal for activating or deactivating is applied.

I: F1-I/F2-I: Setting the interval for recording the sum current measurement

You can use this parameter to set the interval for recording the measurement and calculating the sum current for each field. Depending on the setting of this parameter, the median value, the maximum value and the minimum value are recorded and calculated.

8.4.2 Displaying the state of the bushings

The device displays the current state of the bushings and the following measured values:

- Status indicator for the bushing based on the set limit values
  - Gray: Everything OK
  - Yellow: The capacitance difference ΔC1 is greater than the limit value ΔC1 >

Only with option BM-T

- Yellow: The dissipation factor difference Δtanδ is greater than the limit value Δtanδ >
- Red: The capacitance difference ΔC1 is greater than the limit value ΔC1 >>

- C1: Calculated (compensated) bushing capacitance
- ΔC1: Percentage deviation of the capacitance difference ΔC1 from the reference capacitance C1

Only with option BM-T

- 3-phase reference system:
  - tanδ: Calculated (compensated) dissipation factor of the bushing
  - Δtanδ: Dissipation factor difference Δtanδ
  - U ref: Currently measured reference system voltage

> If bushing monitoring with the option "Monitoring of 6 bushings" is used, the following values will be displayed in two separate views for field 1 (F1) and field 2 (F2).

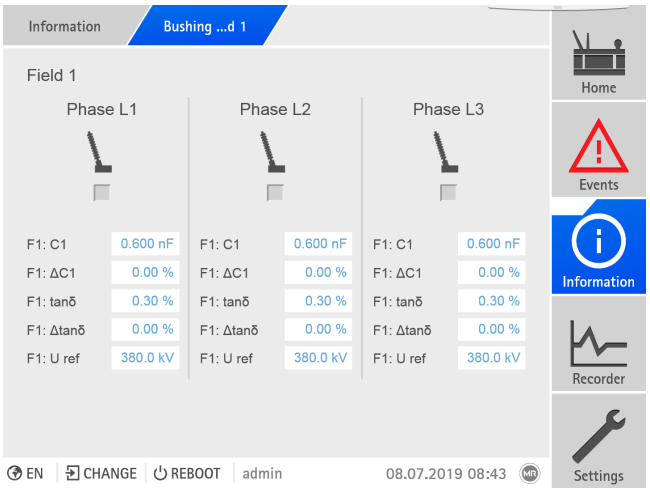


Figure 149: State of the bushings

› Go to **Information > Bushings > Bushing monitoring field1/field2**.

8.4.3 Displaying the capacitance progression

You can display the temporal progression of the capacitance C1 and the capacitance difference ΔC1 over the last 28 days.

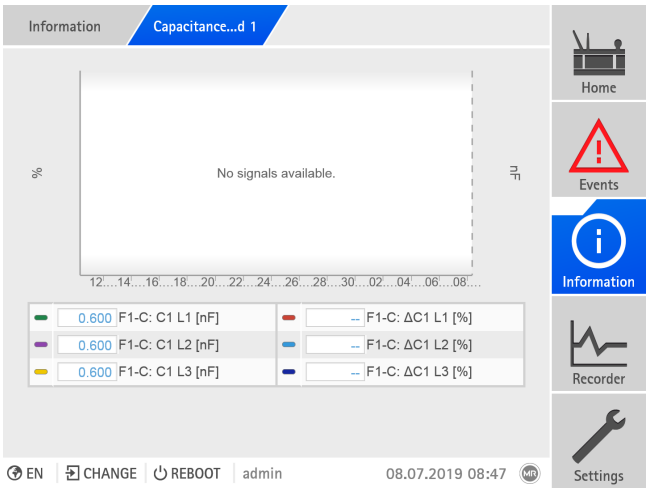


Figure 150: Capacitance progression

› Go to **Information > Bushings > Capacitance C1/ΔC1 field1/field2**.

8.4.4 Show dissipation factor curve (MSENSE® BM-T)

You can display the temporal progression of the dissipation factor tanδ and the dissipation factor difference Δtanδ over the last 28 days.

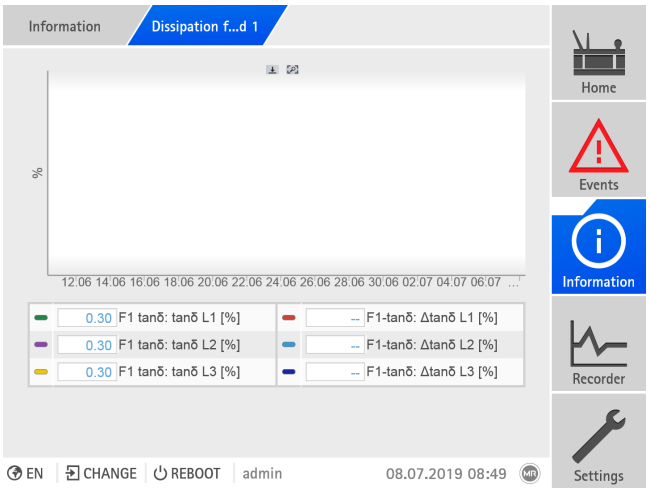


Figure 151: Dissipation factor progression

› Go to **Information > Bushings > Dissipation factor tanδ/Δtanδ field1/field2**.

8.4.5 Displaying sum current information

If you have activated the sum current method, you can display the recorded values as follows:

Field 1/Field 2 sum current

The tabular representation shows you the real-time values of the sum current method for the bushings.

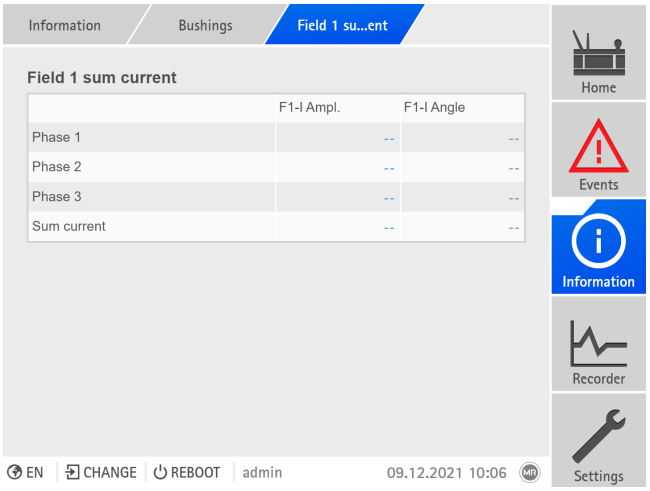


Figure 152: Tabular

› Go to **Information > Bushings > Field 1/Field 2 sum current**.

Field 1/Field 2 sum current diagram

You can display the values and the average value of a certain period for each field as a polar diagram.

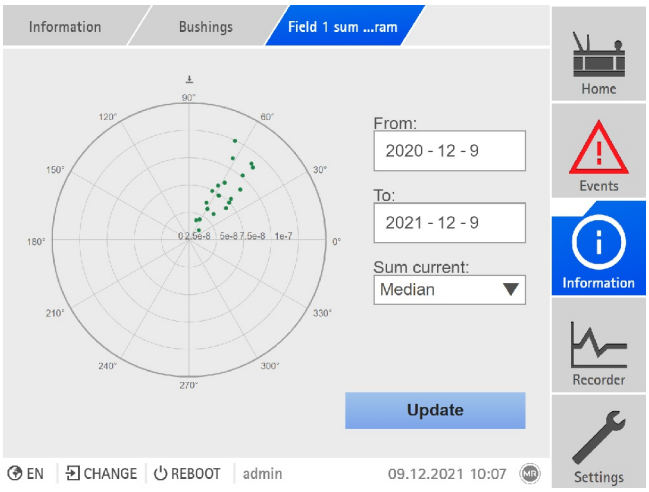


Figure 153: Diagram

› Go to **Information > Bushings > Field 1/Field 2 sum current diagram**.

9 Inspection and maintenance

This chapter contains information about inspecting and maintaining the product.

9.1 Care

You can clean the bushing adapter, the bushing coupling unit and the housing of the control cabinet with a moist cloth. You can clean the inside of the control cabinet with a dry cloth.

9.2 Inspection

Inspect the functionality of the signal lamp in the control cabinet once per year.

9.3 Maintenance

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

Technical Service

Maschinenfabrik Reinhausen GmbH
Technical Service
Postfach 12 03 60
93025 Regensburg
Germany
Phone: +49 94140 90-0
Fax: +49 9 41 40 90-7001
E-mail: service@reinhausen.com
Internet: www.reinhausen.com

10 Fault elimination

10.1 General faults

Characteristics/details	Cause	Corrective measure
No function – Indicator lamp does not light up – Lighting inside the control cabinet does not light up when the door is open	No voltage supply	Check the voltage supply.
	Fuse tripped	Switch on the breaker.
No function – Lighting inside the control cabinet lights up when the door is open – No signal at the *STATUS OK* output	Configuration error	Contact Maschinenfabrik Reinhausen GmbH.
	Assembly is defective	
Digital outputs and inputs switch accidentally	High EMC load	Use shielded cables or external filters.
	Poor grounding	Check the functional ground.

Table 76: General faults

10.2 Signal lights and digital outputs

Characteristics/details	Cause	Corrective measure
Signal light lights up yellow	Miscellaneous event message is pending.	Check the event message in the visualization.
Signal light lights up red	Miscellaneous event message is pending.	Check the event message in the visualization.
Signal at output *Limit value 1* – Event message *Limit value ΔC1 > exceeded* – Signal light lights up yellow (factory setting)	Measured capacitance difference is greater than the limit value ΔC1 >	Check the curve for the change in capacitance in the visualization. If ΔC1 is greater than 5% (factory setting of limit value ΔC1 >): 1. Disconnect transformer from grid 2. Use external measuring device to measure capacitance of bushing.
Signal at output *Limit value 1* – Event message *Limit value Δtanδ > exceeded* – Signal light lights up yellow (factory setting)	Measured dissipation factor difference is greater than the limit value Δtanδ >.	Check the curve for the change in dissipation factor in the visualization. Plan the measurement of the dissipation factor with an external measuring device.

Characteristics/details	Cause	Corrective measure
Signal at output *Limit value 2* – Event message *Limit value ΔC1 >> exceeded* – Signal light lights up red (factory setting)	Measured capacitance difference is greater than the limit value ΔC1 >>	Check the curve for the change in capacitance in the visualization. If ΔC1 is greater than 10% (factory setting of limit value ΔC1 >>): 1. ⚠ CAUTION! Danger of explosion. If damaged bushings are used, the bushing may explode. Disconnect transformer from grid immediately. 2. Use external measuring device to measure capacitance of bushing. 3. Replace bushings.
Signal at output *Monitoring inactive*	Bushing monitoring is deactivated	Check the "Activate capacitance method" parameter
	Bushing monitoring	Check the event message in the visualization.

Table 77: Signal lights and digital outputs

10.3 Human-machine interface

Characteristics/details	Cause	Corrective measure
Connection cannot be established with visualization	Connection cable defective	Check connection cable
	SSL encryption active	Accept SSL certificate in browser
		Call up IP address using `https://`
		Deactivate SSL encryption
	When establishing connection via CPU I interface: IP addresses of visualization and SCADA are in the same subnet	Check setting of device's IP addresses and correct if necessary.
	When establishing a connection via the CPU I interface: PC not in the same subnet as visualization	Check the setting of IP addresses of the device and PC and correct if necessary.
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 78: Human-machine interface

10.4 Other faults

If you cannot find a solution to a malfunction, please contact Technical Service and have the following information available:
- Serial number
  - Nameplate (can be found on CPU assembly)
- Software version

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

Technical Service

Maschinenfabrik Reinhausen GmbH
Technical Service
Postfach 12 03 60
93025 Regensburg
Germany
Phone: +49 94140 90-0
E-mail: service@reinhausen.com
Internet: www.reinhausen.com

You will find an overview of the services available for the product in the customer portal: https://portal.reinhausen.com

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.

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 control cabinet

⚠ WARNING

Danger of death and damage to property!

Danger of death and damage to property due to tipping or falling load!

- Only trained and authorized persons may select the sling gear and secure the load.
- Do not walk under the suspended load.
- Use means of transport and lifting gear with a sufficient carrying capacity in accordance with the weight stated in the Technical data [▶Section 13, Page 170] section.

✓ Disconnect all connection lines (sensor cable, control cable to the motor-drive unit, customer cables, grounds etc.) in the control cabinet.

1. ⚠ WARNING! Serious injuries and damage to the control cabinet due to falling load. Use all 4 transport lugs or the 2 transport lugs on the side of the door. Attach the lifting gear so that the cable angle is always less than 45° in relation to the vertical.

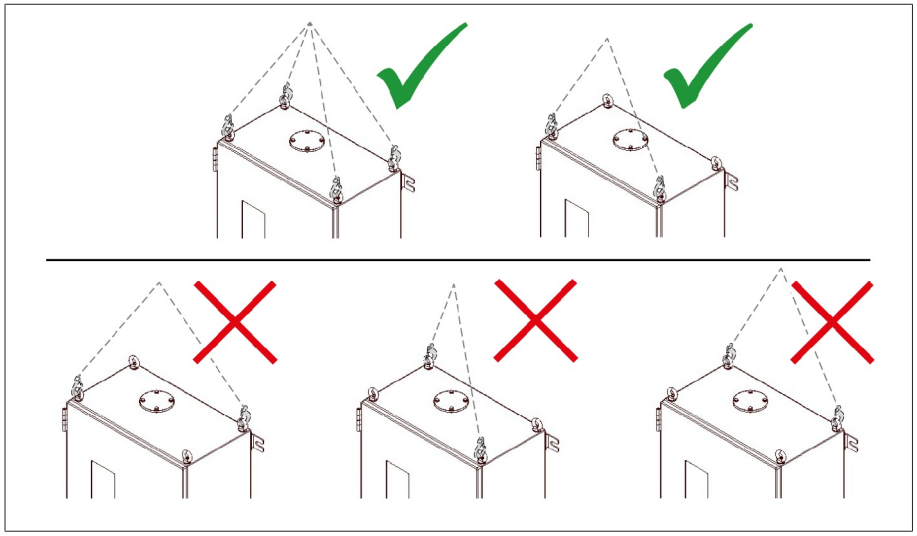


Figure 154: Transport lugs for lifting gear

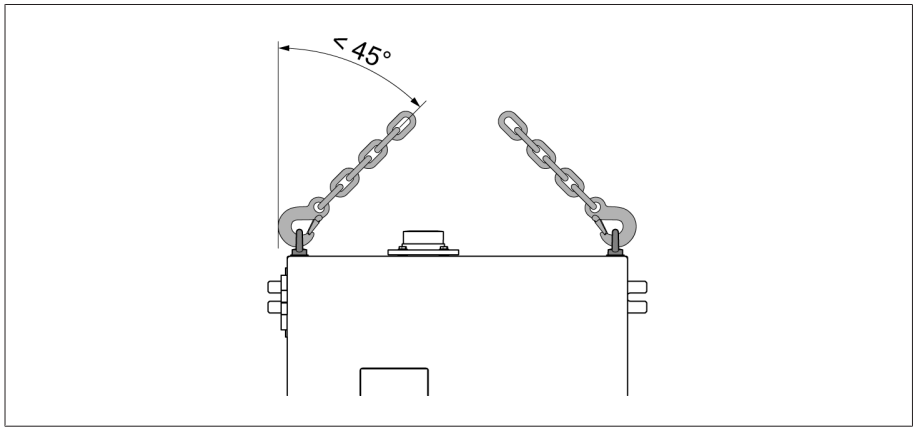


Figure 155: Maximum permissible cable angle for the lifting gear limit stop of the control cabinet

2. Remove the nuts for fastening the control cabinet.
3. Lift the control cabinet away from the transformer.
4. ⚠ WARNING! Serious injuries due to the control cabinet tipping and damage to the cable gland if the control cabinet is set down, transported or stored upright. Only set down, transport and store the control cabinet on its back.

11.2 Removing the bushing adapter and bushing coupling unit

⚠ WARNING

Time delayed explosion hazard and fire hazard!

If the test tap is not grounded or not properly connected to the bushing adapter, the bushing may be destroyed and the transformer may catch fire. This can lead to death or severe injuries.

› Never operate the test tap when it is open. Observe the operating instructions for the bushing.

› After removing the bushing adapter, close the test tap of the bushing with the original safety cap to ensure grounding.

Proceed as follows to remove the bushing coupling unit and the bushing adapter:

1. Remove the connection cable between the control cabinet and bushing coupling unit.
2. Install the safety cap for the U connection of the bushing coupling unit.
3. Remove the connection cable between the bushing coupling unit and the bushing adapter.
4. Remove the earthing cable between the transformer and the supporting plate of the bushing coupling unit.
5. Unscrew the fixing screw on the bushing flange and remove the bushing coupling unit together with the supporting plate.
6. Install the fixing screw on the bushing flange in accordance with the operating instructions from the bushing manufacturer.
7. Remove the bushing adapter.
8. ⚠ WARNING! Install the safety cap onto the bushing test tap. While doing so, follow the notes in the operating instructions from the bushing manufacturer. Otherwise, an explosion of the bushing can lead to death or serious injury.

» The bushing adapter and bushing coupling unit are removed.

12 Disposal

Observe the national requirements applicable in the country of use.

13 Technical data

13.1 Bushing adapter

The tightening torques for the bushing adapters are listed in the Installation section under Installing the bushing adapters [▶Section 6.2, Page 46].

Bushing adapter		A001
Bushing type		Micafil RTKF, RTKG
Dimensions		Ø 50 x 64 mm
Input	Test tap	Ø 4 mm (female)
	Thread	Inner, G¾"
	Gasket	O-ring, 40 x 2 NBR 70
Output		N female connector
Permitted ambient temperature during operation		-40°C...+90°C
Degree of protection (IEC 60529)		IP 66
Weight		approx. 170 g

Table 79: Technical data for the bushing adapter A001

Bushing adapter		A002
Bushing type		HSP SETFt 1550/420-1800, SETFt 600/123-2000
Dimensions		Ø 50 x 60 mm
Input	Test tap	Ø 4 mm (female)
	Thread	Outer, M30 x 1.5
	Gasket	Flat gasket, 26 x 35 x 2, 65 Shore
Output		N female connector
Permitted ambient temperature during operation		-40°C...+90°C
Degree of protection (IEC 60529)		IP 66
Weight		approx. 180 g

Table 80: Technical data for the bushing adapter A002

Bushing adapter		A003
Bushing type		ABB GOB 1050-750-1100-0.6-B GSA 123-OA/1600/0.5 GSA 52-OA/2000/0.5
Dimensions		Ø 40 x 82 mm
Input	Test tap	Ø 4 mm (female)
	Thread	Outer, M30 x 2
	Gasket	O-ring, 32 x 2 NBR 70

Bushing adapter	A003
Output	N female connector
Permitted ambient temperature during operation	-40°C...+90°C
Degree of protection (IEC 60529)	IP 66
Weight	approx. 190 g

Table 81: Technical data for the bushing adapter A003

Bushing adapter		A004
Bushing type		Trench COT 750-800
Dimensions		Ø 25 x 61 mm
Input	Test tap	Ø 4 mm (female)
	Thread	Outer, M16 x 1.5
	Gasket	O-ring, 14 x 2 NBR 70
Output		N female connector
Permitted ambient temperature during operation		-40°C...+90°C
Degree of protection (IEC 60529)		IP 66
Weight		approx. 60 g

Table 82: Technical data for the bushing adapter A004

Bushing adapter		A005
Bushing type		HSP SETFt 750-170-4000 SETFt 1200/245-1250 SETFt 1425-420-1600 SESTFt 1050-245-B E6 B SESTFt 1425-420-B E6 B-1600A EKTG 72.5-800 kV
Dimensions		Ø 45 x 71 mm
Input	Test tap	Ø 4 mm (female)
	Thread	Outer, M24 x 1.5
	Gasket	O-ring, 22 x 2.5 NBR 70
Output		N female connector
Permitted ambient temperature during operation		-40°C...+90°C
Degree of protection (IEC 60529)		IP 66
Weight		approx. 100 g

Table 83: Technical data for the bushing adapter A005

Bushing adapter		A006
Bushing type		PCORE CSA standard POC series II ABB GOE, GSB (245...550 kV)
Dimensions		Ø 80 x 104 mm
Input	Test tap	Ø 8 mm (female)
	Thread	Outer, 2¼" – 12 UNF
	Gasket	O-ring, 64 x 3 NBR 70
Output		N female connector
Permitted ambient temperature during operation		-40°C...+90°C
Degree of protection (IEC 60529)		IP 66
Weight		approx. 190 g

Table 84: Technical data for the bushing adapter A006

Bushing adapter		A007
Bushing type		PCORE B-81515-57-70
Dimensions		Ø 40 x 60 mm
Input	Test tap	Ø 5 mm (contact spring)
	Thread	Outer, 1¼" – 12 UNF
	Gasket	O-ring, 32 x 2 NBR 70
Output		N female connector
Permitted ambient temperature during operation		-40°C...+90°C
Degree of protection (IEC 60529)		IP 66
Weight		approx. 190 g

Table 85: Technical data for the bushing adapter A007

Bushing adapter		A008
Bushing type		Passoni Villa PNO, POBO, PCTO, PAO < 110 kV
Dimensions		Ø 45 x 70 mm
Input	Test tap	Ø 8 mm (female)
	Thread	Outer, 1⅛" – 12 UNF
	Gasket	O-ring, 25 x 2.5 NBR 70
Output		N female connector
Permitted ambient temperature during operation		-40°C...+90°C
Degree of protection (IEC 60529)		IP 66
Weight		approx. 150 g

Table 86: Technical data for the bushing adapter A008

Bushing adapter		A010
Bushing type		ABB O Plus C (O Plus Dry)
Exterior diameter x length		Ø 35 x 79 mm
Input	Test tap	Ø 9 mm (contact spring)
	Thread	Outer, $^{3}/_{4}$" – 14 NS PM
	Gasket	O-ring, 24 x 2 NVQ 70
Output		-40°C...+90°C
Permitted ambient temperature during operation		-40°C...+90°C
Degree of protection (IEC 60529)		IP 66
Weight		approx. 142 g

Table 87: Technical data for the bushing adapter A010

13.2 Bushing coupling unit

Bushing coupling unit		
Dimensions (width x height x depth)		117 x 100 x 60 mm
Input		N female connector
Output	Voltage measurement (U)	TNC female connector
	Partial discharge measurement (PD); optional	
Capacitance		In accordance with order: 0.033...4.7 µF (± 5%)
Output voltage		Type (RMS): 75 V AC Max. (RMS): 125 V AC
Permitted ambient temperature during operation		- 40...+ 80 °C
Degree of protection (IEC 60529)		IP 66
Weight		approx. 1.2 kg

Table 88: Technical data for the bushing coupling unit

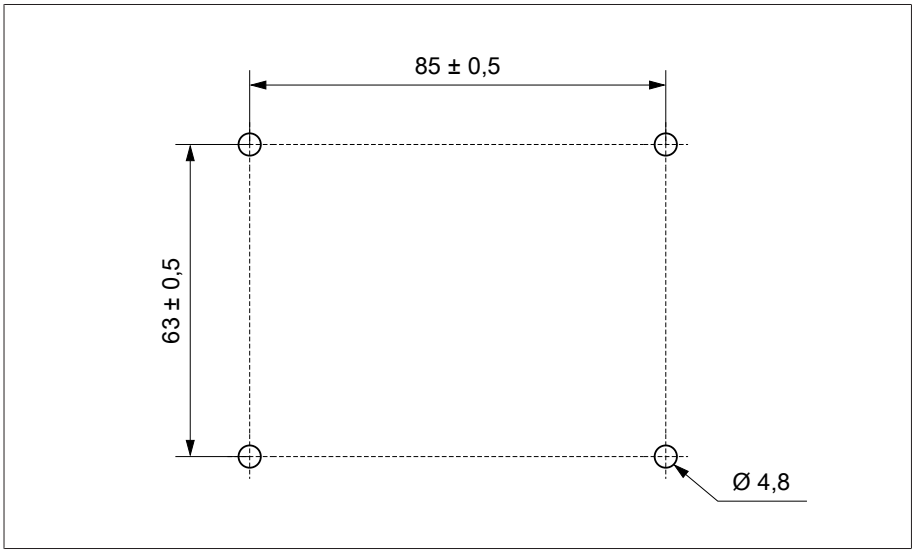


Figure 156: Dimensional drawing for holes in the bushing coupling unit's retaining plate (dimensions in mm)

13.3 Connection cable

Connection cable	Bushing adapter - bushing coupling unit	Bushing coupling unit - control cabinet
Cable type	RG142/U	
Length	0.8 m	10 m, 15 m or 25 m based on order
Connector	N connector (both sides)	TNC connector (one side)
Minimum permitted bending radius	50 mm	

Table 89: Technical data for the connection cable

13.4 Control cabinet

Design	900	1200	1500	1800
Dimensions (height x width x depth in mm)				
– Single-wall	924 x 700 x 446	1213 x 700 x 446	1524 x 700 x 446	1791 x 700 x 446
– Double-wall	961 x 766 x 478	1249 x 766 x 478	1560 x 766 x 478	1825 x 766 x 478
– Rail profile	-	1213 x 700 x 423	1524 x 700 x 423	-
Permissible total weight	120 kg	150 kg	200 kg	200 kg
Heating power	100 W	100 W	150 W	150 W
Power consumption I_{nA}	See nameplate			
Power supply U_n	See nameplate			
Frequency	See nameplate			

Design	900	1200	1500	1800
Control and heating circuit voltage supply U_e	See nameplate			
Plug socket	220...240 V AC, max. 10 A			
Degree of protection	IP66			
Potential corrosiveness category in accordance with ISO 12944-2:2018	C4 high, C4 very high C5 high, C5 very high			
Insulation strength (only with "insulated mounting" control cabinet design)	If the control cabinet is dry and clean: Control cabinet to transformer mount: 5 kV, 50 Hz, 1 min Grounding bar in the control cabinet to control cabinet: 5 kV, 50 Hz, 1 min			

Table 90: Technical data for the control cabinet

13.5 ISM® assemblies

13.5.1 Connection terminals

Terminal block	Maximum permitted operating voltage
X1	Max. 250 VAC
X10	Max. 150 VAC

Table 91: Maximum permitted operating voltage of the connection terminals for external circuits

13.5.2 Power supply QS3.241

	PULS QS3.241
Permissible voltage range	85...276 VAC 88...375 VDC U_N: 100...240 VAC U_N: 110...300 VDC
Permissible frequency range	50/60 Hz
Maximum power consumption (continuous)	66 W

Table 92: QS3.241 assembly technical data

13.5.3 Power supply CP5.241

	PULS CP5.241
Permissible voltage range	85...264 VAC 88...180 VDC U_N: 100...240 VAC U_N: 110...150 VDC
Permissible frequency range	50/60 Hz
Maximum power consumption (continuous)	97.5 W

Table 93: CP5.241 assembly technical data

13.5.4 Power supply PS

	8620	8640
Permissible voltage range	18...78 V DC U_N: 24...60 V DC	18...78 V DC U_N: 24...60 V DC
Permissible frequency range	-	-
Nominal power consumption	19.2 W	55 W
Power output	12 W	45 W

Table 94: PS assembly technical data

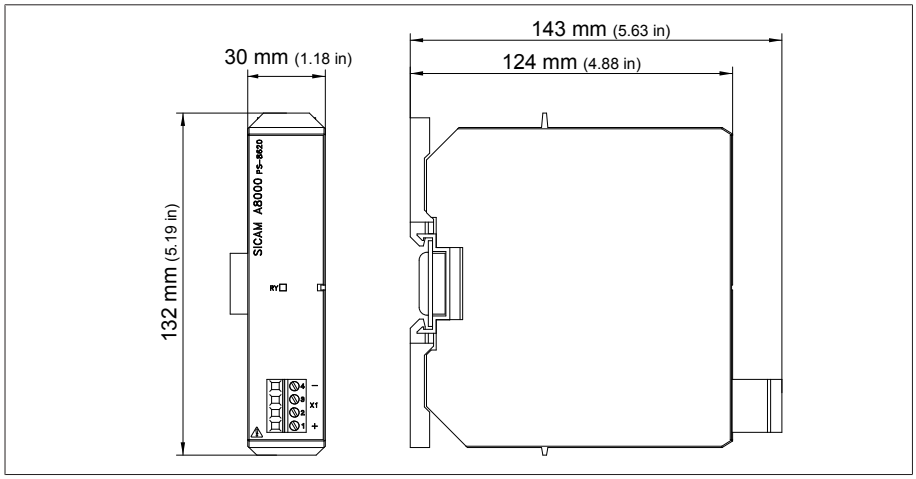


Figure 157: PS dimensions

13.5.5 CPU (central processing unit) I

	CPU I
Processor	266 MHz
RAM	256 MB
Interfaces	1x serial RS232/485 (electrically isolated) 3x Ethernet 10/100 Mbps 1x USB 2.0 1x CAN (electrically isolated) 1x CAN
NVRAM (SRAM with battery backup)	256 kB
Application memory	1 GB
Power supply	+24 V DC (18...36 V DC)

Table 95: Technical data for the CPU I assembly

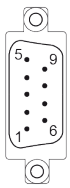
Interface	Pin	Description
	2	RXD (RS232)
	3	TXD (RS232)
	5	GND (RS232, RS485)
	6	RXD+/TXD+ (RS485)
	9	RXD-/TXD- (RS485)

Table 96: COM2 (RS232, RS485)

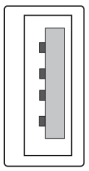
Interface	Pin	Description
	1	VCC
	2	D-
	3	D+
	4	GND

Table 97: USB 2.0

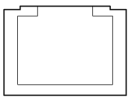
Interface	Pin	Description
	1	TxD+
	2	TxD-
	3	RxD+
	4	NC
	5	NC
	6	RxD-
	7	NC
	8	NC-

Table 98: ETH1, ETH 2.1, ETH 2.2 (RJ45)

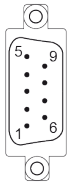
Interface	Pin	Description
	2	CAN-L
	3	CAN-GND
	7	CAN-H

Table 99: CAN1, CAN2

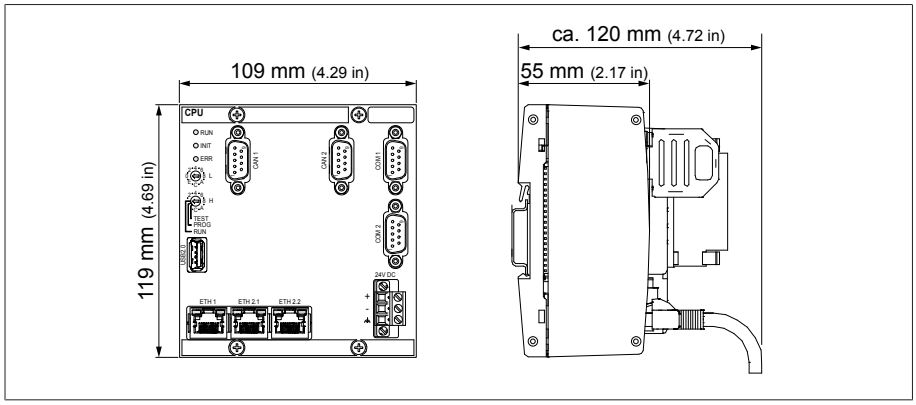


Figure 158: CPU dimensions

Optional accessories	
CAN bus	Terminating resistor – D-SUB plug connector (9-pole) – R = 120 Ω
	Connector with terminal strip for directly connecting CAN lines
Media converter for COM2 interface (only RS232)	Adapter from D-SUB (9-pole) to fiber-optic cable: – ACF660/ST: F-ST, 660 nm, range max. 60 m at 40 kBd – ACF660/SMA: F-SMA, 660 nm, range max. 60 m at 40 kBd – ACF850/ST: F-ST, 850 nm, range max. 1,000 m at 40 kBd – ACF850/SMA: F-SMA, 850 nm, range max. 1,000 m at 40 kBd

Table 100: Optional accessories

13.5.6 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	2 x 1 (electrically isolated) for watchdog/error messaging Nominal voltage 24/48/60 V DC Continuous current 1 A

Table 101: Technical data of CPU assembly

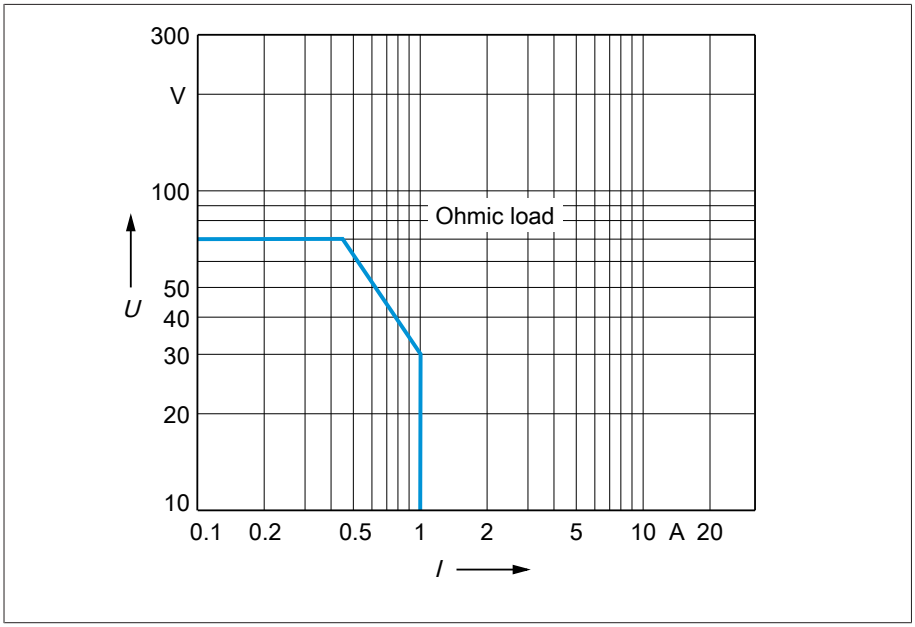


Figure 159: Contact load capacity of CPU-X1 digital outputs with resistive load

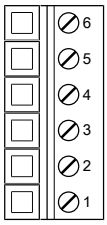
Interface	Pin	Description
	1	WD_COM
	2	WD_NC
	3	WD_NO
	4	ER_COM
	5	ER_NC
	6	ER_NO

Table 102: Connector X1 (watchdog, error)

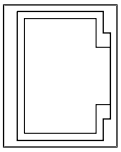
Interface	Pin	Description
	1	TxD+
	2	TxD-
	3	RxD+
	4	NC
	5	NC
	6	RxD-
	7	NC
	8	NC-

Table 103: Connectors X2, X3 (Ethernet)

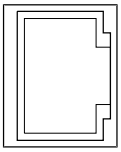
Interface	Pin	Description
	1	TXD-/RXD- (RS485/422)
	2	TXD+/RXD+ (RS485/422)
	3	NC
	4	NC
	5	NC
	6	GND
	7	RXD- (RS422)
	8	RXD+ (RS422)

Table 104: Connector X4 (RS485/422)

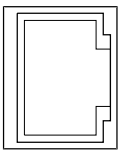
Interface	Pin	Description
	1	CTS (I)
	2	RTS (O)
	3	VCC/OUT 5 V/12 V
	4	TXD (O)
	5	RXD (I)
	6	GND
	7	DCD (I)
	8	DTR (O)

Table 105: Connector X5 (RS232)

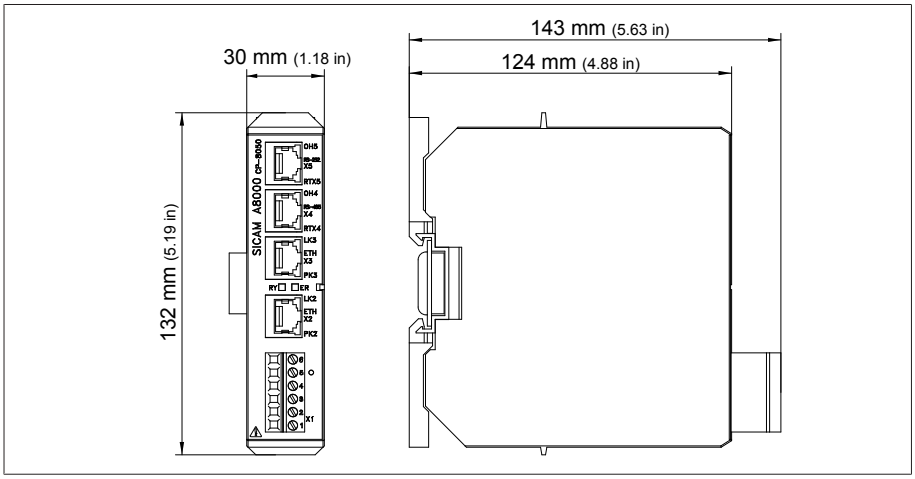


Figure 160: CPU dimensions

13.5.7 UI 5-3 voltage measurement and current measurement

	UI 5-3
Measurement	3-phase
Voltage measurement	U_N (RMS): 100 VAC Measuring range (RMS): 19.6...150 VAC Measuring accuracy (at U_N, -25...+70°C): <± 0.3% Intrinsic consumption: < 1 VA Measurement category III in accordance with IEC 61010-2-30
Current measurement	I_N: 5 A Measuring range: 10 mA...15 A Overload capacity: 15 A (continuous), 100 A (for 1 s) Measuring accuracy (at I_N, -25...+70°C): <± 0.4% Intrinsic consumption: < 1 VA
Phase angle	Measuring accuracy (-25...+70°C): U_x/I_x <± 0.6°; U_x/U_y < ± 0.15°
Frequency measurement	f_N: 50 / 60 Hz Measuring range: 35...75 Hz Measuring accuracy: (-25 to +70°C): <±0.002 Hz

Table 106: Technical data of the UI 5-3 assemblies

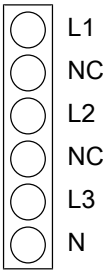
Interface	Pin	Description
	L1	Voltage input for phase L1
	NC	Not used
	L2	Voltage input for phase L2
	NC	Not used
	L3	Voltage input for phase L3
	N	Voltage input for neutral conductor

Table 107: Voltage measurement

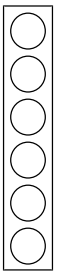
Interface	Pin	Description
	k1	Current input for phase L1
	I1	Current output for phase L1
	k2	Current input for phase L2
	I2	Current output for phase L2
	k3	Current input for phase L3
	I3	Current output for phase L3

Table 108: Current measurement

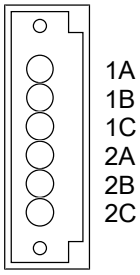
Interface	Pin	Description
	1A, 1B, 1C, 2A, 2B, 2C	No function

Table 109: Relay

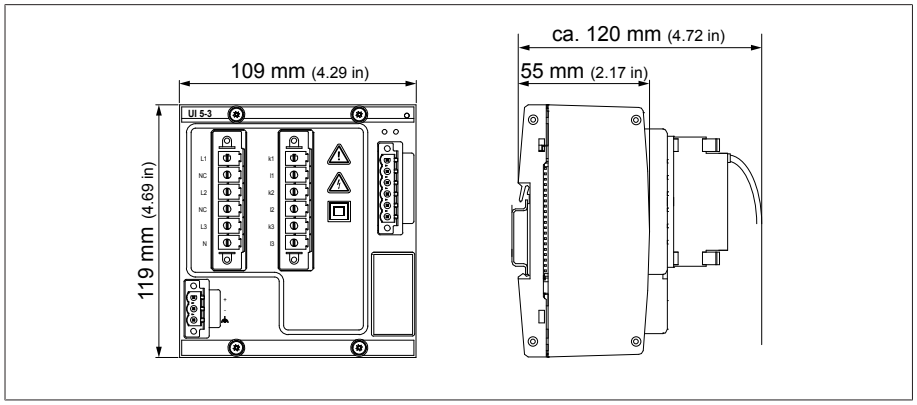


Figure 161: UI 5-3 dimensions

13.5.8 Voltage measurement U 3

	U 3
Measurement	3-phase
Voltage inputs	4 (electrically isolated)
Nominal voltage U_N (AC) U_N typical (AC)	10...250 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 [2]	Deviation < ±0.3% · U_N
Frequency measurement	f_N: 16.7, 50 or 60 Hz Measuring range: f_N ±15%

Table 110: U 3 assemblies technical data

2 At reference conditions

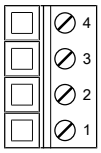
Interface	Pin	Description
	4	Common reference output 1
	3	Common reference output 0
	2	Digital output 1
	1	Digital output 0

Table 111: Connector X1

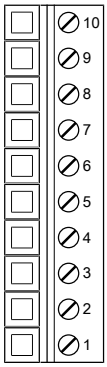
Interface	Pin	Description
	10	Not used
	9	Voltage input phase 1
	8	Voltage input neutral conductor 1
	7	Voltage input phase 2
	6	Voltage input neutral conductor 3
	5	Voltage input phase 3
	4	Voltage input neutral conductor 3
	3	Not used
	2	Voltage input phase 4
	1	Voltage input neutral conductor 4

Table 112: Connector X2

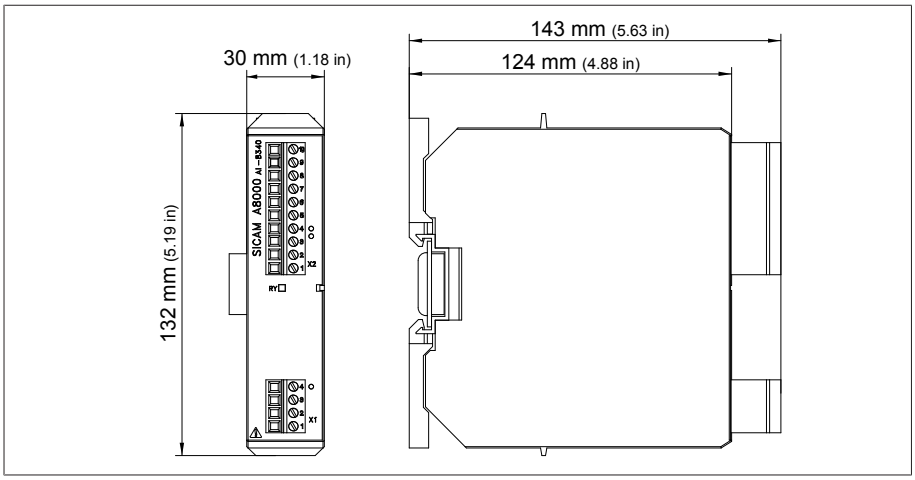


Figure 162: U 3 dimensions

13.5.9 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

	I 3
Measuring accuracy[3]	Deviation < ±0.5% · 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 113: I 3 assembly technical data

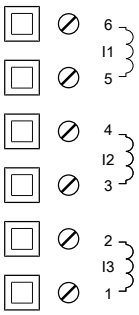
Interface	Pin	Description
	6	Current input phase 1
	5	Current input neutral conductor 1
	4	Current input phase 2
	3	Current input neutral conductor 2
	2	Current input phase 3
	1	Current input neutral conductor 3

Table 114: Connector X1

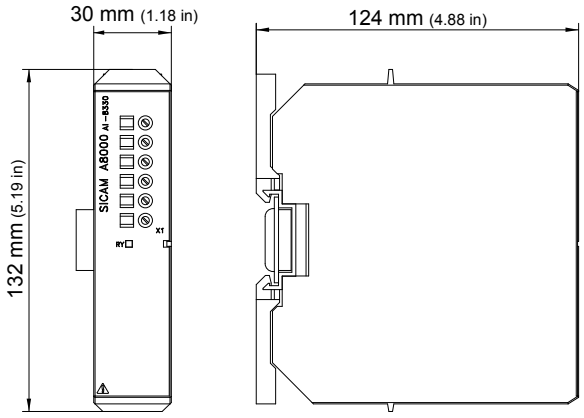


Figure 163: I 3 dimensions

3 At reference conditions

13.5.10 DIO 28-15 digital inputs and outputs

		DIO 28-15
Inputs (plug-based electrical isolation)	Quantity	28
	Logical 0	0...10 V AC (RMS) 0...10 V DC
	Logical 1	18...260 V AC (RMS) 18...260 V DC (RMS)
	Input current	min. 1.3 mA
	Simultaneity factor (at 70°C ambient temperature and input voltage ≥ 230 V)	max. 50%
Outputs (floating relay outputs)	Number (number of change-over contacts in parentheses)	15 (9)
	Contact load capacity	Alternating current mode: U_N: 230 V AC; I_N: 5 A Direct current mode: See diagram
	Simultaneity factor (if output is loaded with 5 A)	Up to 60°C: 100%, > 60°C: -5%/K

Table 115: Technical data for the DIO 28-15 assembly

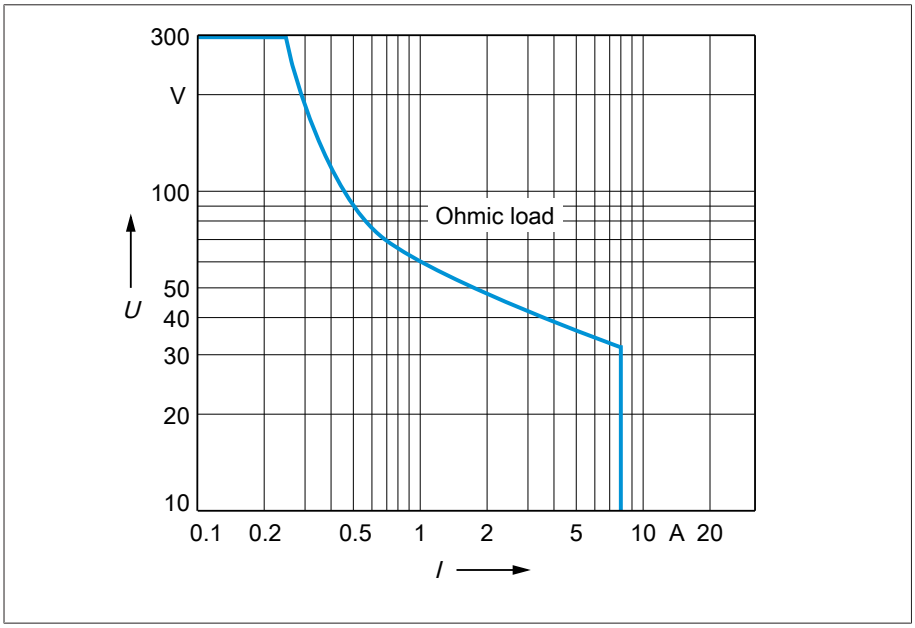


Figure 164: Contact load capacity of digital outputs with resistive load

⚠ CAUTION

Electric shock!

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

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

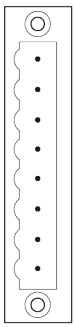
Interface	Pin				Description
	1	9	17	25	Input
	2	10	18	26	Input
	3	11	19	27	Input
	4	12	20	28	Input
	5	13	21	29	Input
	6	14	22	30	Input
	7	15	23	31	Input
	8	16	24	32	Common

Table 116: Digital inputs

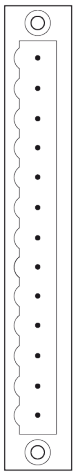
Interface	Pin			Description
	1A	6 A	11 A	Break contact
	1C	6C	11C	Source contact
	1B	6B	11B	Make contact
	2 A	7 A	12 A	Break contact
	2C	7C	12C	Source contact
	2B	7B	12B	Make contact
	3 A	8 A	13 A	Break contact
	3C	8C	13C	Source contact
	3B	8B	13B	Make contact
	4C	9C	14C	Source contact
	4B	9B	14B	Make contact
	5C	10C	15C	Source contact
	5B	10B	15B	Make contact

Table 117: Digital outputs

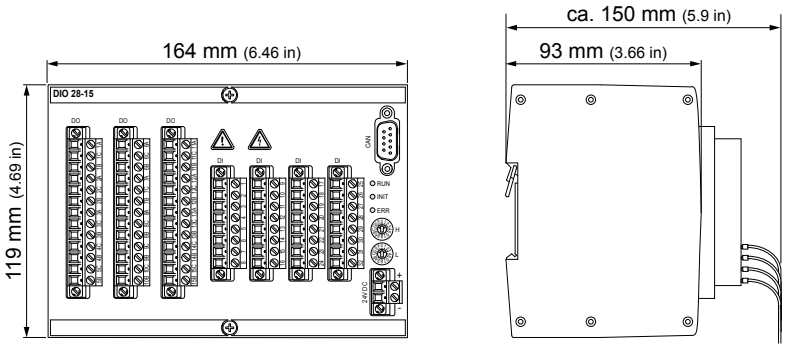


Figure 165: DIO 28-15 dimensions

13.5.11 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	2.4 mA
Simultaneity factor (at 65 °C ambient temperature)	-

Table 118: DI 16-24V assembly technical data

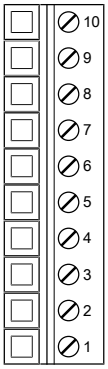
Interface	Pin	Description
	10	Common reference (common)
	9	Common reference (common)
	8	Input 7
	7	Input 6
	6	Input 5
	5	Input 4
	4	Input 3
	3	Input 2
	2	Input 1
	1	Input 0

Table 119: Connector X1 (group 0)

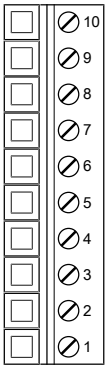
Interface	Pin	Description
	10	Common reference (common)
	9	Common reference (common)
	8	Input 17
	7	Input 16
	6	Input 15
	5	Input 14
	4	Input 13
	3	Input 12
	2	Input 11
	1	Input 10

Table 120: Connector X2 (group 1)

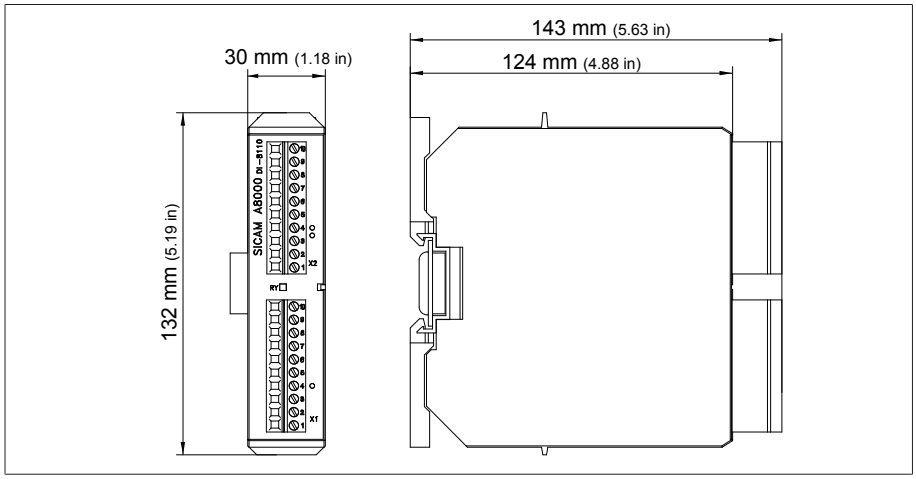


Figure 166: DI 16-24V dimensions

13.5.12 Digital inputs DI 16-48 V

	DI 16-48V
Inputs	2 x 8, plug-based electrical isolation
Nominal voltage	48 VDC / 60 VDC
Max. operating voltage	78 V DC
Logical 0	≤ 24 V
Logical 1	≥ 36 V
Input current	1.1 mA
Simultaneity factor (at 65 °C ambient temperature)	-

Table 121: DI 16-48V assembly technical data

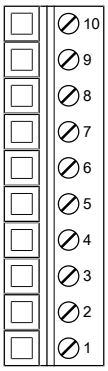
Interface	Pin	Description
	10	Common reference (common)
	9	Common reference (common)
	8	Input 7
	7	Input 6
	6	Input 5
	5	Input 4
	4	Input 3
	3	Input 2
	2	Input 1
	1	Input 0

Table 122: Connector X1 (group 0)

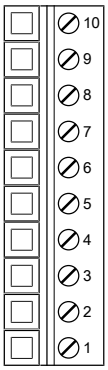
Interface	Pin	Description
	10	Common reference (common)
	9	Common reference (common)
	8	Input 17
	7	Input 16
	6	Input 15
	5	Input 14
	4	Input 13
	3	Input 12
	2	Input 11
	1	Input 10

Table 123: Connector X2 (group 1)

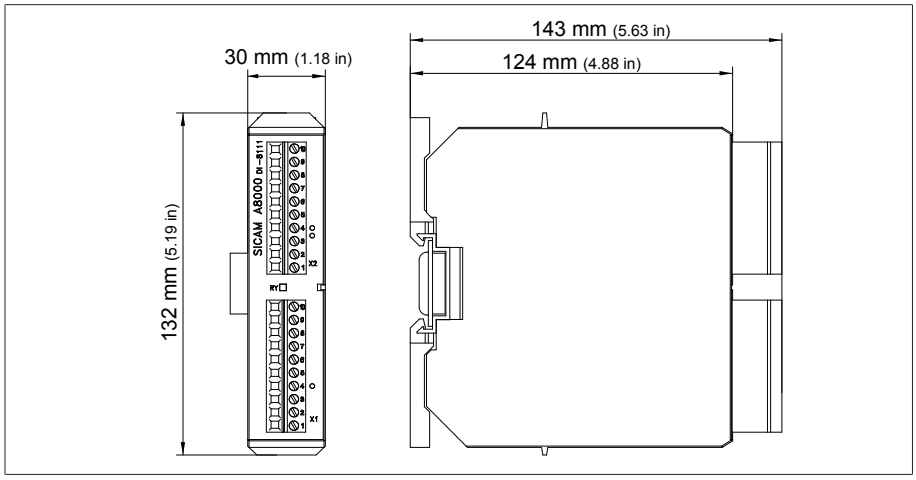


Figure 167: DI 16-48V dimensions

13.5.13 Digital inputs DI 16-110 V

	DI 16-110 V
Inputs	2 x 8, plug-based electrical isolation
Nominal voltage	110 VDC 110...127 VAC ± 10 % (50/60 Hz)
Max. operating voltage	143 V DC 144 VAC
Logical 0	≤ 55 V
Logical 1	≥ 82.5 V
Input current	0.9 mA
Simultaneity factor (at 65 °C ambient temperature)	Max. 13 inputs

Table 124: DI 16-110V assembly technical data

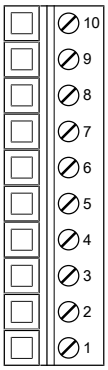
Interface	Pin	Description
	10	Common reference (common)
	9	Common reference (common)
	8	Input 7
	7	Input 6
	6	Input 5
	5	Input 4
	4	Input 3
	3	Input 2
	2	Input 1
	1	Input 0

Table 125: Connector X1 (group 0)

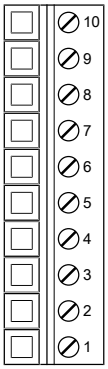
Interface	Pin	Description
	10	Common reference (common)
	9	Common reference (common)
	8	Input 17
	7	Input 16
	6	Input 15
	5	Input 14
	4	Input 13
	3	Input 12
	2	Input 11
	1	Input 10

Table 126: Connector X2 (group 1)

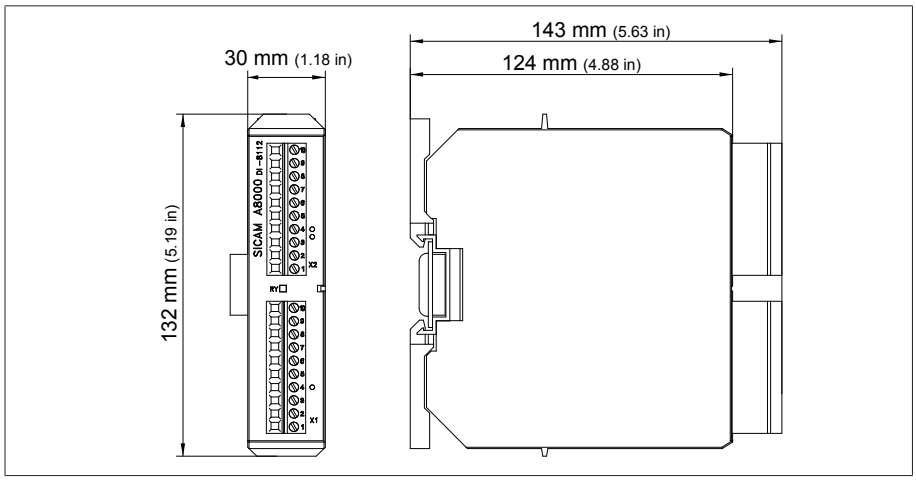


Figure 168: DI 16-110V dimensions

13.5.14 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	0.6 mA
Simultaneity factor (at 65 °C ambient temperature)	Max. 13 inputs

Table 127: DI 16-220V assembly technical data

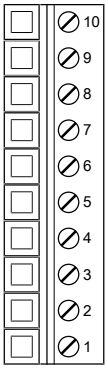
Interface	Pin	Description
	10	Common reference (common)
	9	Common reference (common)
	8	Input 7
	7	Input 6
	6	Input 5
	5	Input 4
	4	Input 3
	3	Input 2
	2	Input 1
	1	Input 0

Table 128: Connector X1 (group 0)

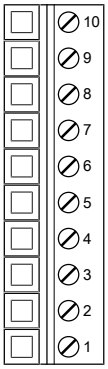
Interface	Pin	Description
	10	Common reference (common)
	9	Common reference (common)
	8	Input 17
	7	Input 16
	6	Input 15
	5	Input 14
	4	Input 13
	3	Input 12
	2	Input 11
	1	Input 10

Table 129: Connector X2 (group 1)

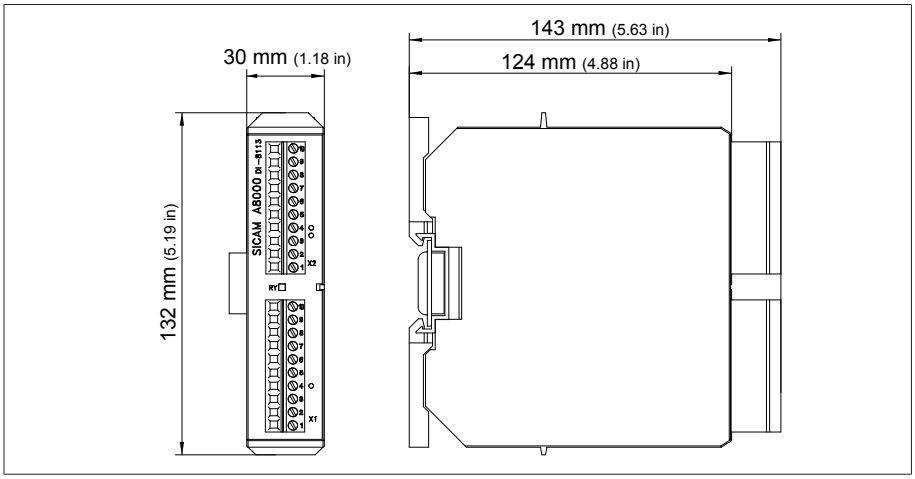


Figure 169: DI 16-220V dimensions

13.5.15 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 130: DO 8 assembly technical data

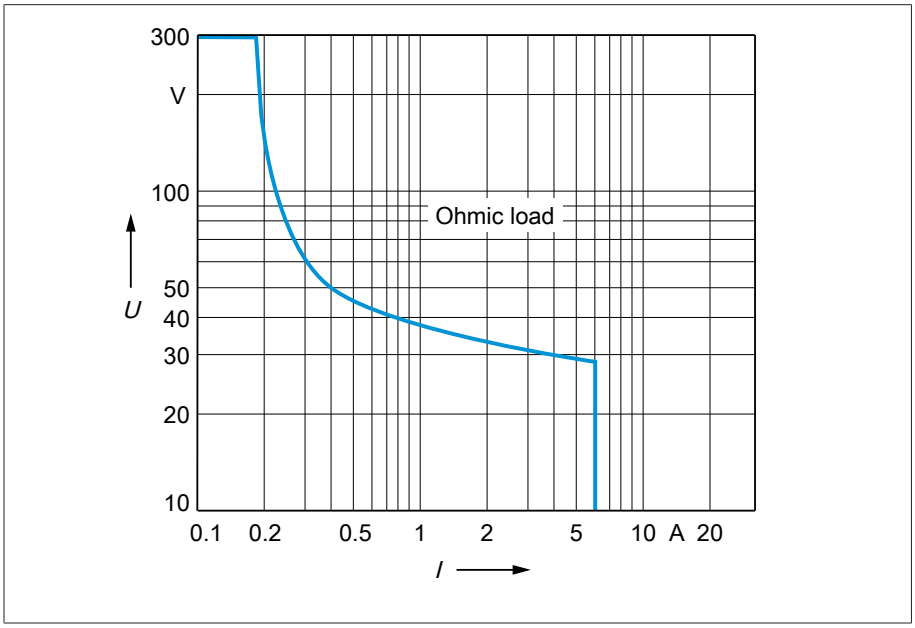


Figure 170: Contact load capacity of digital outputs with resistive load

⚠ 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.

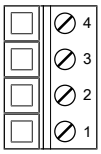
Interface	Pin	Description
	4	Common reference (common) output 1
	3	Common reference (common) output 0
	2	Output 1
	1	Output 0

Table 131: Connector X1 (group 0)

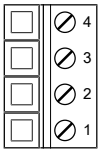
Interface	Pin	Description
	4	Common reference (common) output 3
	3	Common reference (common) output 2
	2	Output 3
	1	Output 2

Table 132: Connector X2 (group 1)

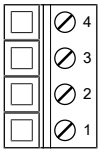
Interface	Pin	Description
	4	Common reference (common) output 5
	3	Common reference (common) output 4
	2	Output 5
	1	Output 4

Table 133: Connector X3 (group 2)

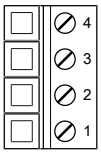
Interface	Pin	Description
	4	Common reference (common) output 7
	3	Common reference (common) output 6
	2	Output 7
	1	Output 6

Table 134: Connector X4 (group 3)

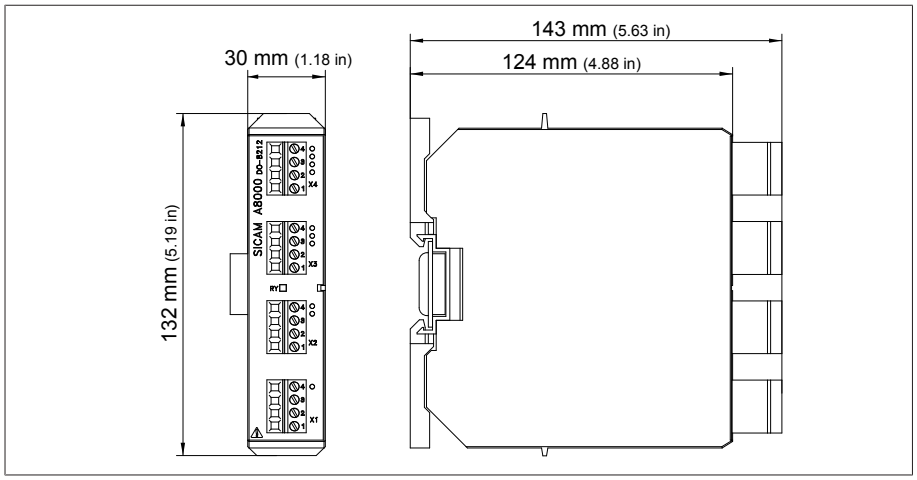


Figure 171: DO 8 dimensions

13.5.16 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

Table 135: AO 4 assembly technical data

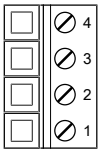
Interface	Pin	Description
	4	Not used
	3	V0- current input
	2	V0+ current output
	1	Not used

Table 136: Connector X1 (group 0)

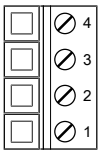
Interface	Pin	Description
	4	Not used
	3	V1- current input
	2	V1+ current output
	1	Not used

Table 137: Connector X2 (group 1)

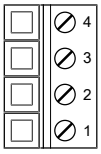
Interface	Pin	Description
	4	Not used
	3	V2- current input
	2	V2+ current output
	1	Not used

Table 138: Connector X3 (group 2)

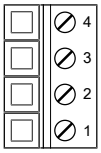
Interface	Pin	Description
	4	Not used
	3	V3- current input
	2	V3+ current output
	1	Not used

Table 139: Connector X4 (group 3)

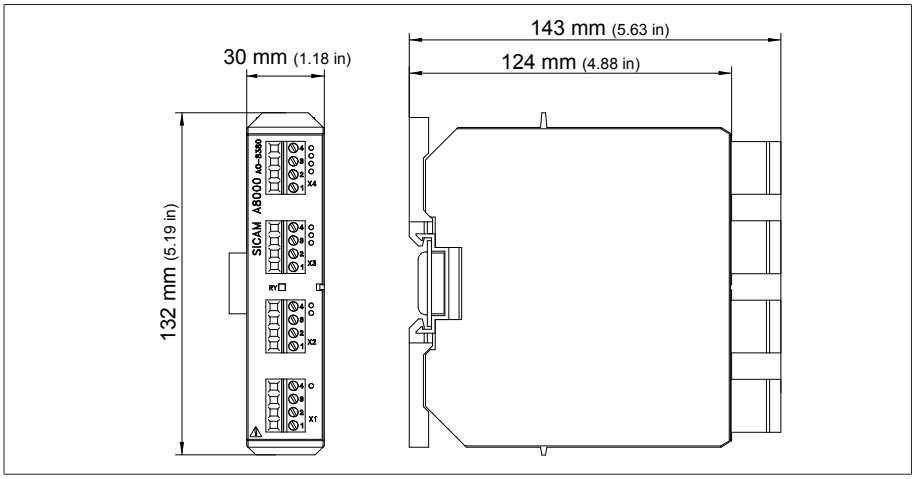


Figure 172: AO 4 dimensions

13.5.17 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 140: AI 4-T assembly technical data

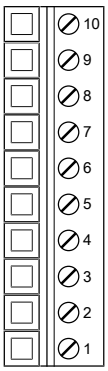
Interface	Pin	Description
	10	IREF1- current output 1
	9	IN V1- voltage input 1
	8	IN V1+ voltage input 1
	7	IREF1+ current output 1
	6	Not used
	5	Not used
	4	IREF0- current output 0
	3	IN V0- voltage input 0
	2	IN V0+ voltage input 0
	1	IREF0+ current output 0

Table 141: Connector X1 (group 0)

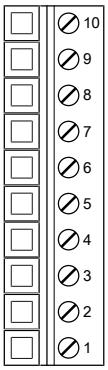
Interface	Pin	Description
	10	IREF3- current output 3
	9	IN V3- voltage input 3
	8	IN V3+ voltage input 3
	7	IREF3+ current output 3
	6	Not used
	5	Not used
	4	IREF2- current output 2
	3	IN V2- voltage input 2
	2	IN V2+ voltage input 2
	1	IREF2+ current output 2

Table 142: Connector X2 (group 1)

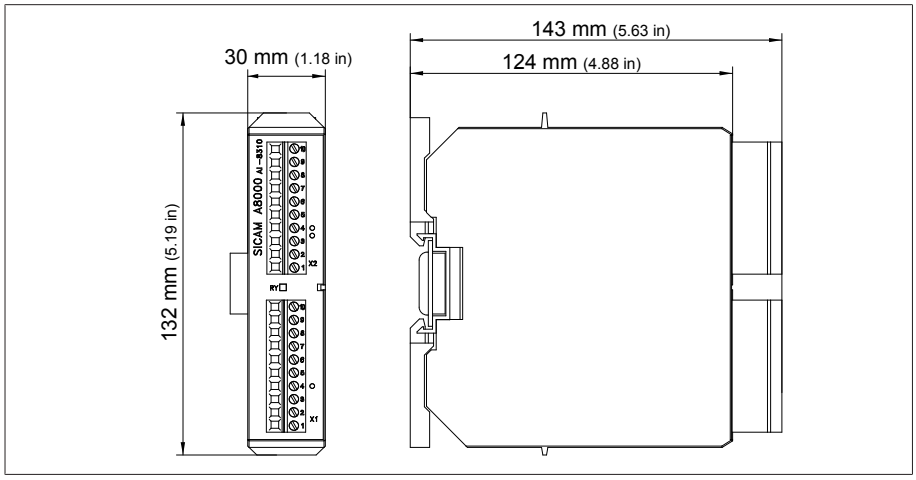


Figure 173: AI 4-T dimensions

13.5.18 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 143: AI 4 assembly technical data

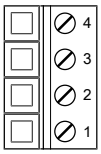
Interface	Pin	Description
	4	V0 U- voltage input
	3	V0 I- current input
	2	V0 I+ current output
	1	V0 U+ voltage output

Table 144: Connector X1 (group 0)

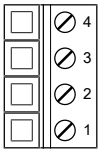
Interface	Pin	Description
	4	V1 U- voltage input
	3	V1 I- current input
	2	V1 I+ current output
	1	V1 U+ voltage output

Table 145: Connector X2 (group 1)

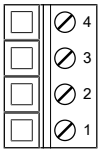
Interface	Pin	Description
	4	V2 U- voltage input
	3	V2 I- current input
	2	V2 I+ current output
	1	V2 U+ voltage output

Table 146: Connector X3 (group 2)

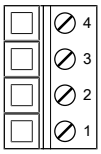
Interface	Pin	Description
	4	V3 U- voltage input
	3	V3 I- current input
	2	V3 I+ current output
	1	V3 U+ voltage output

Table 147: Connector X4 (group 3)

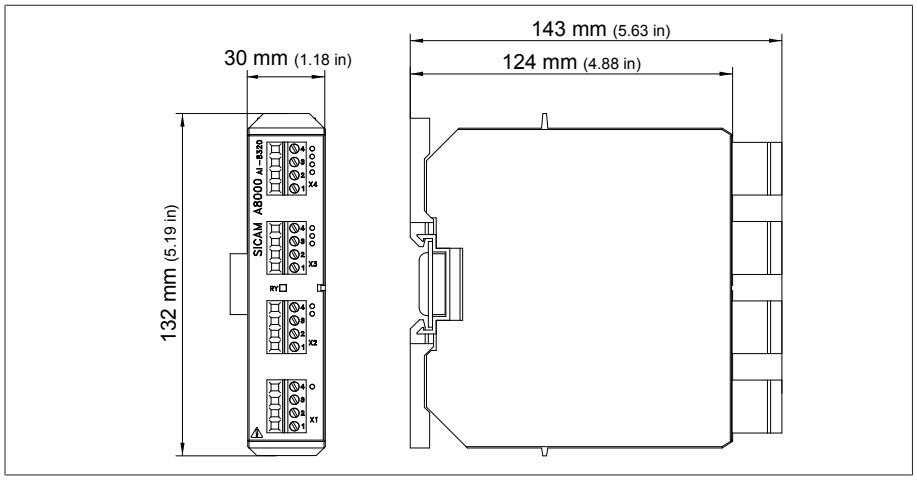


Figure 174: AI 4 dimensions

13.5.19 System networking MC 2-2

	MC 2-2
Description	Media converter
Interfaces	2x RJ45 2x duplex LC (SFP)
RJ45	Max. 100 m (per section) 10/100 Mbit/s Cable impedance 100 Ω
Fiber-optic cable	Max. 2,000 m 100 Mbit/s Light-emitting diode: class 1 Wave length: 1310 nm Max. optical output power: <1 mW (in accordance with IEC 60825-1:2014)

Table 148: Technical data for the MC 2-2 assembly

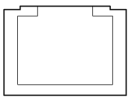
Interface	Pin	Description
	1	TxD+
	2	TxD-
	3	RxD+
	4	NC
	5	NC
	6	RxD-
	7	NC
	8	NC-

Table 149: ETHxx (RJ45)

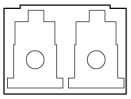
Interface	Description
	Fiber glass 50/125 and 62.5/125 multimode

Table 150: ETHxx (duplex LC SFP)

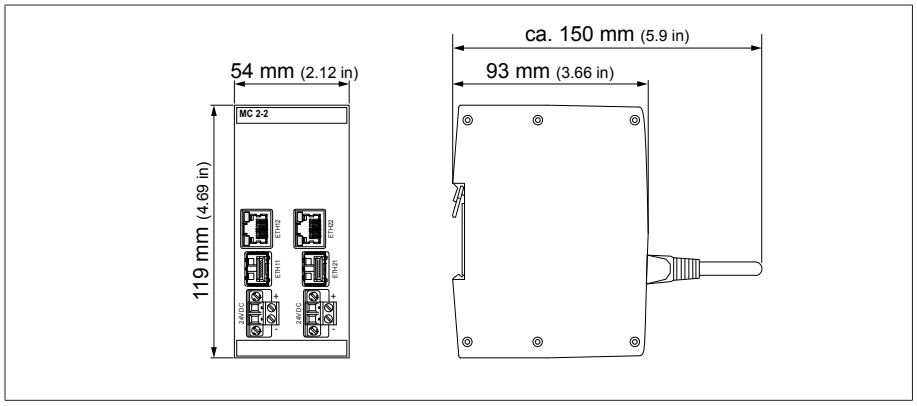


Figure 175: MC2-2 dimensions

13.5.20 System networking SW 3-3

	SW 3-3
Description	Managed fast Ethernet switch per IEEE 802.3, store-and-forward switching
Interfaces	Media converters: – 1x RJ45 – 1x duplex LC (SFP) Managed switch with redundancy function: – 2x RJ45 – 2x duplex LC (SFP)
Redundancy protocols	PRP[1], RSTP
Time synchronization	PTPv2 (IEEE 1588-2008)
RJ45	Max. 100 m (per section) 10/100 Mbps Cable impedance 100 Ω
Fiber-optic cable	Max. 2,000 m 100 Mbps Light-emitting diode: class 1 Wavelength: 1,310 nm Max. optical output power: <1 mW (in accordance with IEC 60825-1:2014)

Table 151: Technical data for the SW 3-3 assembly

[1] Factory setting

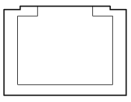
Interface	Pin	Description
	1	TxD+
	2	TxD-
	3	RxD+
	4	NC
	5	NC
	6	RxD-
	7	NC
	8	NC-

Table 152: ETHxx (RJ45)

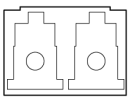
Interface	Description
	Fiber glass 50/125 and 62.5/125 multimode

Table 153: ETHxx (duplex LC SFP)

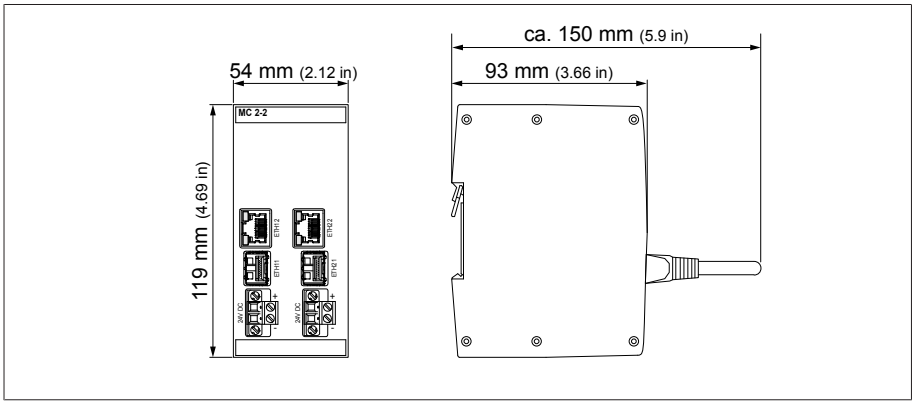


Figure 176: SW3-3 dimensions

13.5.21 System networking BEM1/BES1

	BEM 1	BES 1
Description	Master	Slave
Interfaces	1 fiber-optic cable	
Fiber-optic cable (Polymeric optical fiber)	Max. length: 40 m Min. bending radius: 30 mm	
Integrated power supply	No	Yes
Permissible voltage range	-	18...34 V DC U_N: 24 VDC
Power consumption	-	14 W

Table 154: Technical data for the BEM 1 and BES 1 assemblies

13.5.22 System networking COM-ETH

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

Table 155: COM-ETH assembly technical data

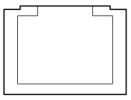
Interface	Pin	Description
	1	TxD+
	2	TxD-
	3	RxD+
	4	NC
	5	NC
	6	RxD-
	7	NC
	8	NC-

Table 156: Connectors X1...X5 (Ethernet)

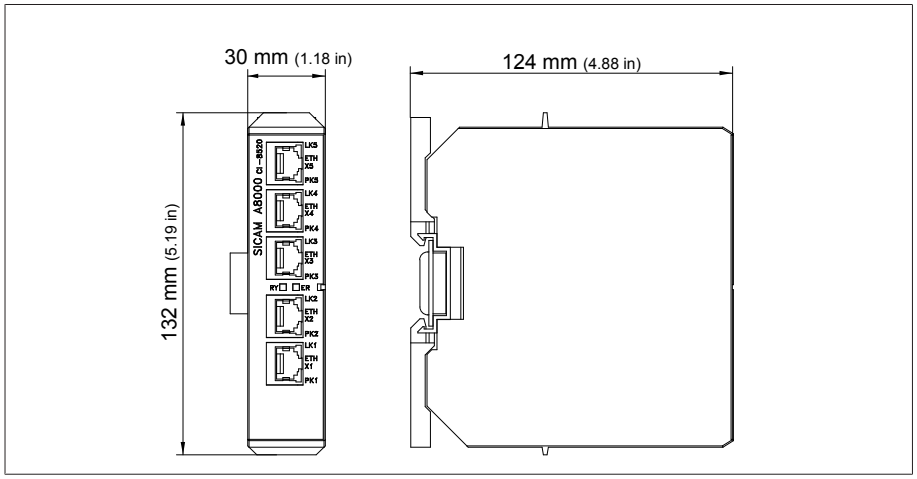


Figure 177: COM-ETH dimensions

14 Appendix

14.1 Measured log value of the bushings, field 1

Phase	Manufacturer	Type	Serial number	Year of manufacture	U_n
U1					
V1					
W1					

Table 157: Data for bushings, field 1

Date	Phase	Temperature		Capacitance	Dissipation factor*)
		Air t_a	Oil t_o	C1	tanδ*)
Commissioning	U1				
	V1				
	W1				
	U1				
	V1				
	W1				
	U1				
	V1				
	W1				
	U1				
	V1				
	W1				
	U1				
	V1				
	W1				

Table 158: Measured log value, field 1

*) Availability depending on device configuration. Only available with the "Reference system" function.

14.2 Measured log value of the bushings, field 2

Phase	Manufacturer	Type	Serial number	Year of manufacture	U_n
U2					
V2					
W2					

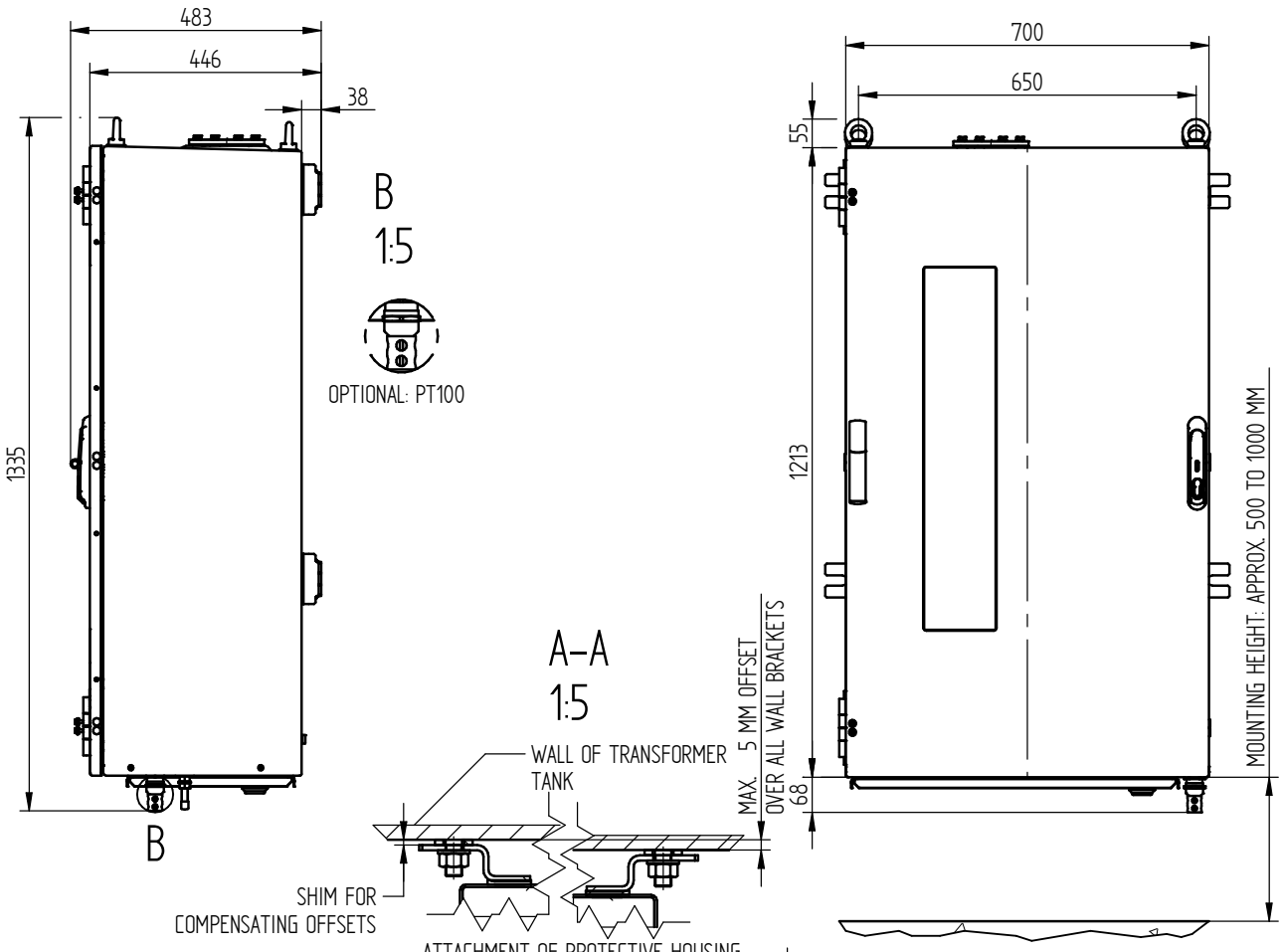
Table 159: Data for bushings, field 2

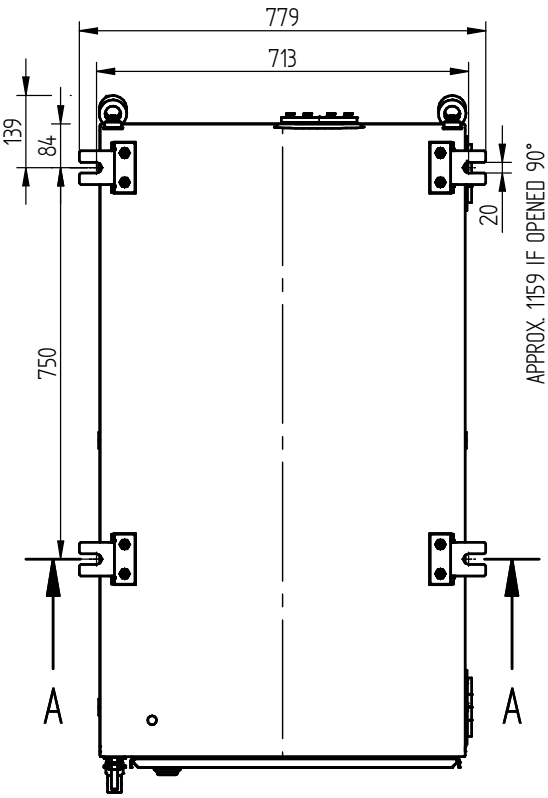
Date	Phase	Temperature		Capacitance	Dissipation factor*)
		Air t_a	Oil t_o	C1	tanδ*)
Commissioning	U2				
	V2				
	W2				
	U2				
	V2				
	W2				
	U2				
	V2				
	W2				
	U2				
	V2				
	W2				
	U2				
	V2				
	W2				

Table 160: Measured log value, field 2

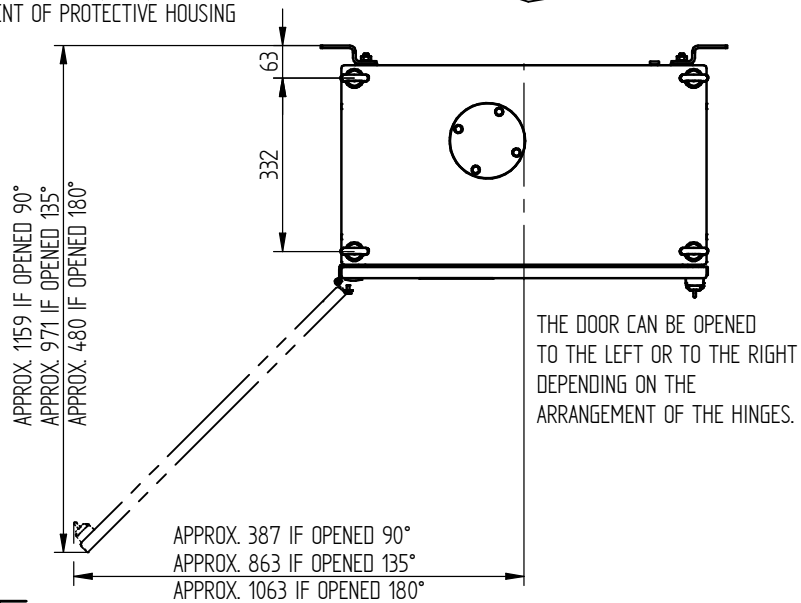
*) Availability depending on device configuration. Only available with the "Reference system" function.

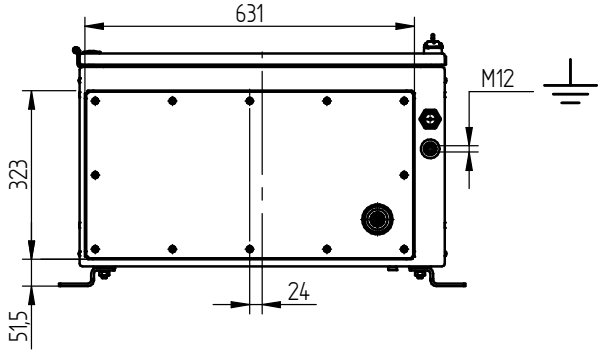
14.3 Dimensional drawings





ARRANGEMENT OF FIXING HOLES ON PROTECTIVE HOUSING
(VIEWED FROM BACK SIDE)





(VIEWED FROM BELOW)

	DATE	NAME	DOCUMENT NO.	
DFTR.	26.10.2022	NOVACKJ	SED 7754572 000 02	
CHKD.	19.04.2023	JOBST J	CHANGE NO.	SCALE
STAND.	20.04.2023	WANNINGER	1114388	1:10

DIMENSION IN mm EXCEPT AS NOTED

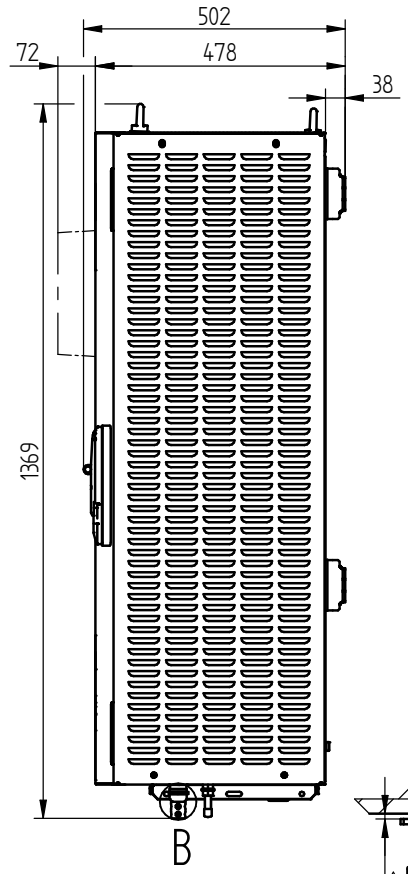
MOTOR-DRIVE UNIT ETOS®
ETOS CABINET 1200
DIMENSION DRAWING

SERIAL NUMBER
–

MATERIAL NUMBER 101335000E

SHEET 1 / 1

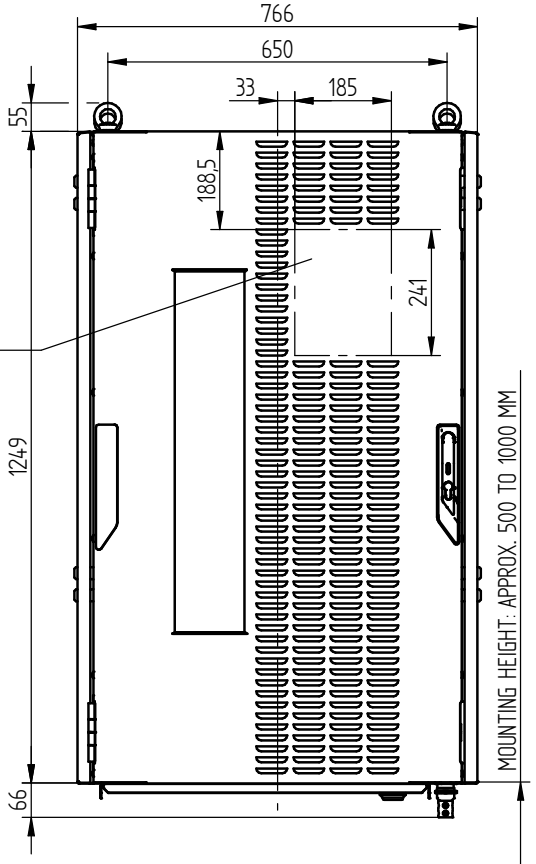
A3



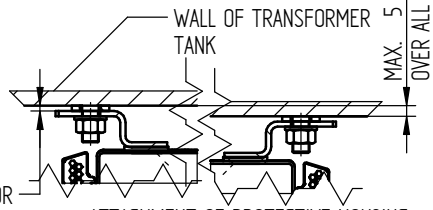
B
1:5

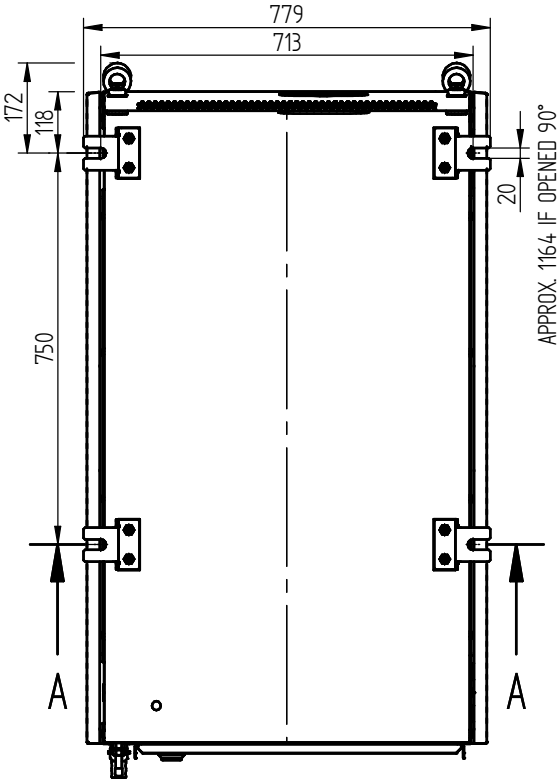
OPTIONAL: PT100

OPTIONAL: OPERATING ELEMENTS OUTSIDE

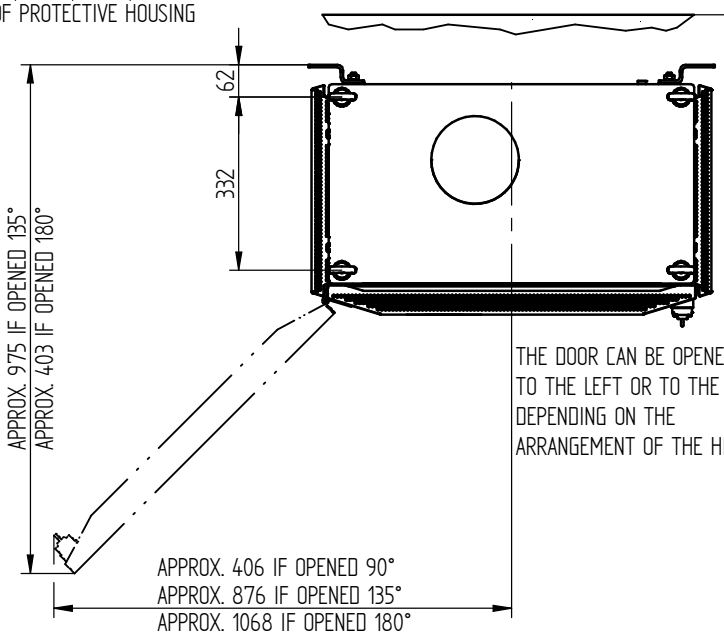


A–A
1:5

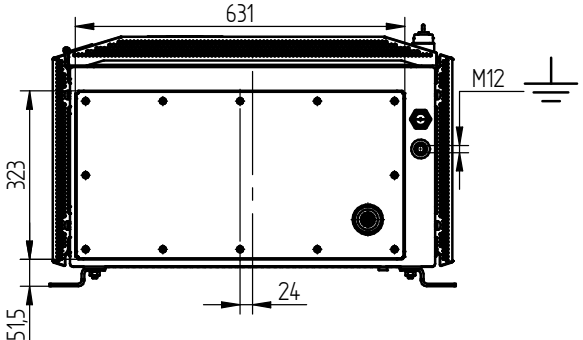




ARRANGEMENT OF FIXING HOLES ON PROTECTIVE HOUSING
(VIEWED FROM BACK SIDE)



THE DOOR CAN BE OPENED TO THE LEFT OR TO THE RIGHT DEPENDING ON THE ARRANGEMENT OF THE HINGES.



(VIEWED FROM BELOW)

	DATE	NAME	DOCUMENT NO.	
DFTR.	12.01.2023	NOVACKJ	SED 7940121 000 02	
CHKD.	19.04.2023	JOBST J	CHANGE NO.	SCALE
STAND.	20.04.2023	WANNINGER	1114388	1:10

DIMENSION IN mm EXCEPT AS NOTED

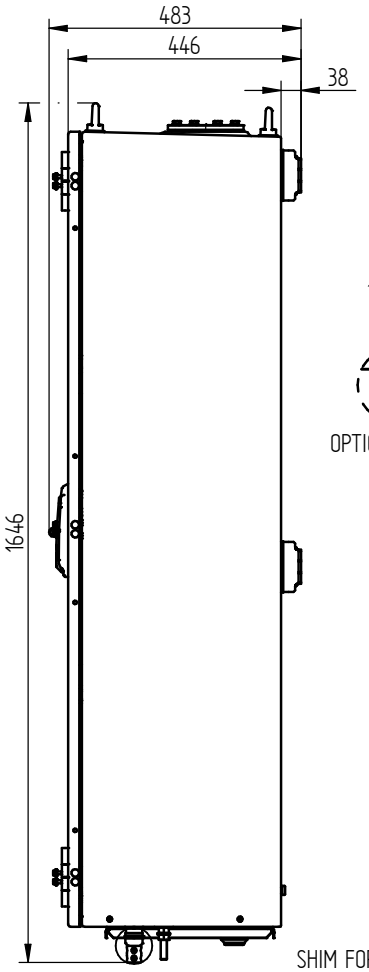
MOTOR-DRIVE UNIT ETOS®
ETOS CABINET 1200 DOUBLE WALL
DIMENSION DRAWING

SERIAL NUMBER
–

MATERIAL NUMBER 101358630E

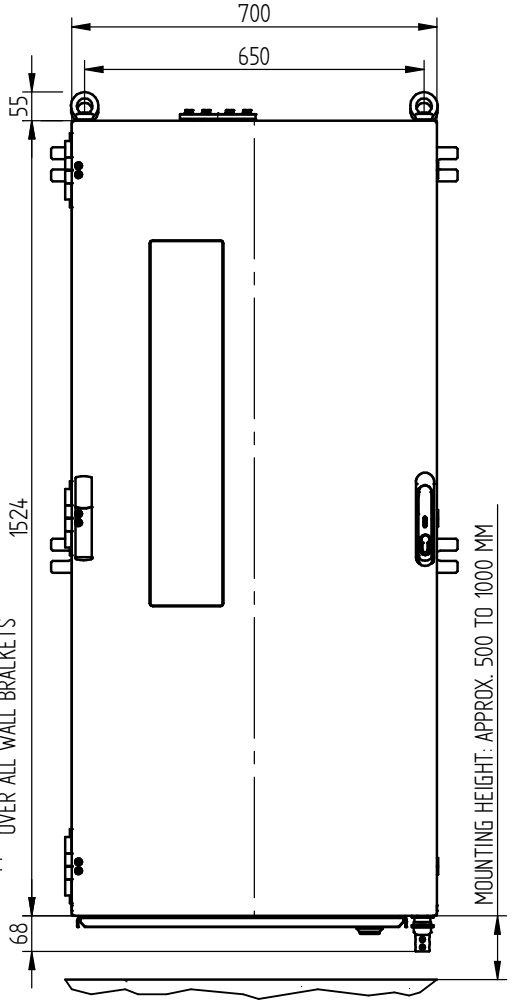
SHEET 1 / 1

A3

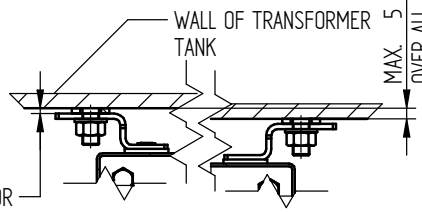


B
1:5

OPTIONAL: PT100

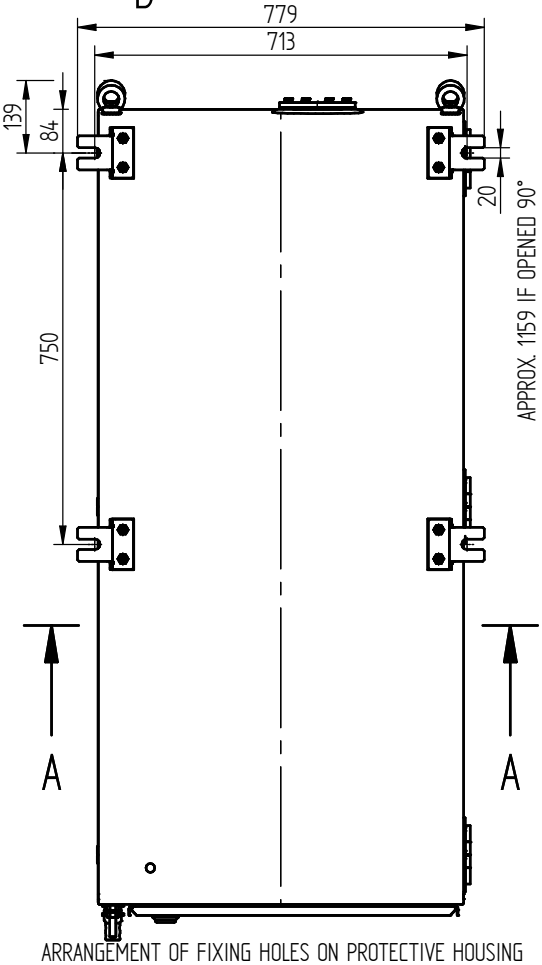


A–A
1:5

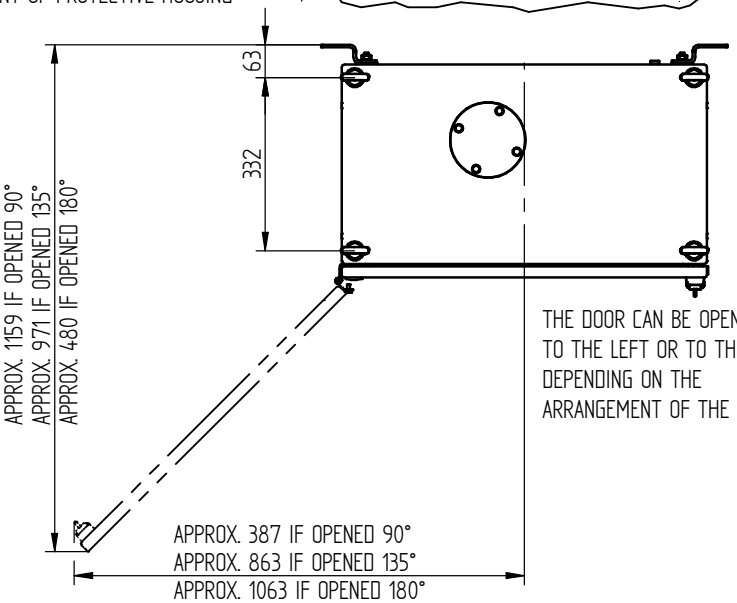


ATTACHMENT OF PROTECTIVE HOUSING

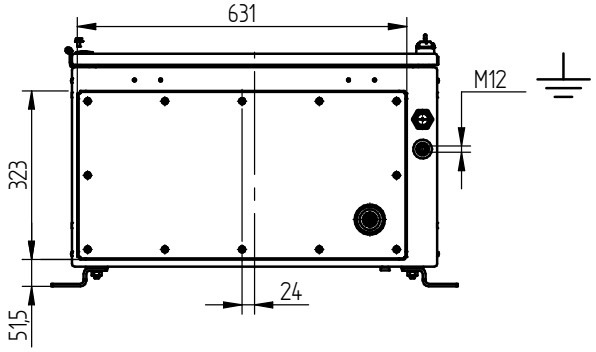
B



ARRANGEMENT OF FIXING HOLES ON PROTECTIVE HOUSING
(VIEWED FROM BACK SIDE)



THE DOOR CAN BE OPENED TO THE LEFT OR TO THE RIGHT DEPENDING ON THE ARRANGEMENT OF THE HINGES.



(VIEWED FROM BELOW)

	DATE	NAME	DOCUMENT NO.	
DFTR.	26.10.2022	NOVACKJ	SED 7751759 000 02	
CHKD.	19.04.2023	JOBST J	CHANGE NO.	SCALE
STAND	20.04.2023	WANNINGER	1114388	1:10

DIMENSION IN mm EXCEPT AS NOTED

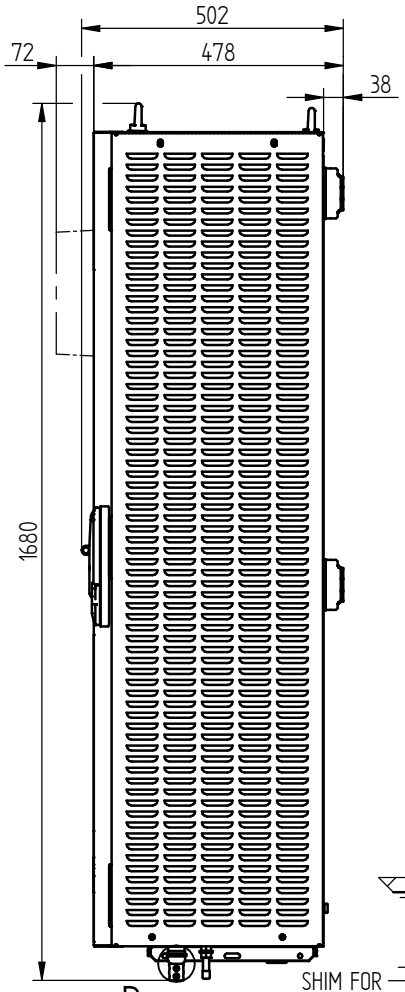
MOTOR-DRIVE UNIT ETOS®
ETOS CABINET 1500
DIMENSION DRAWING

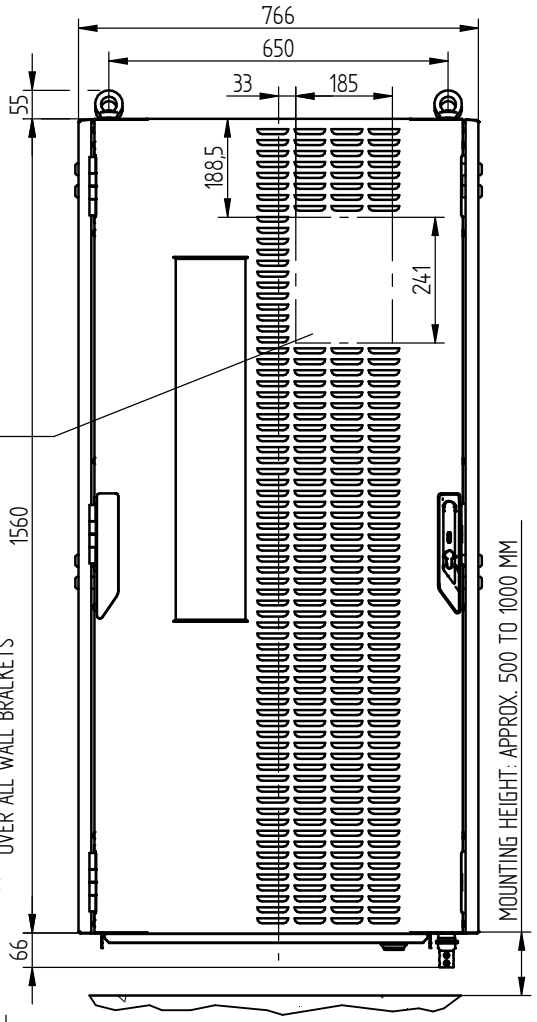
SERIAL NUMBER
–

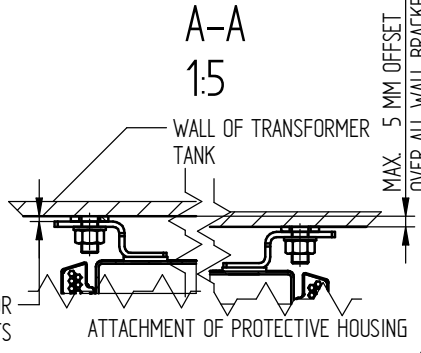
MATERIAL NUMBER
101334980E

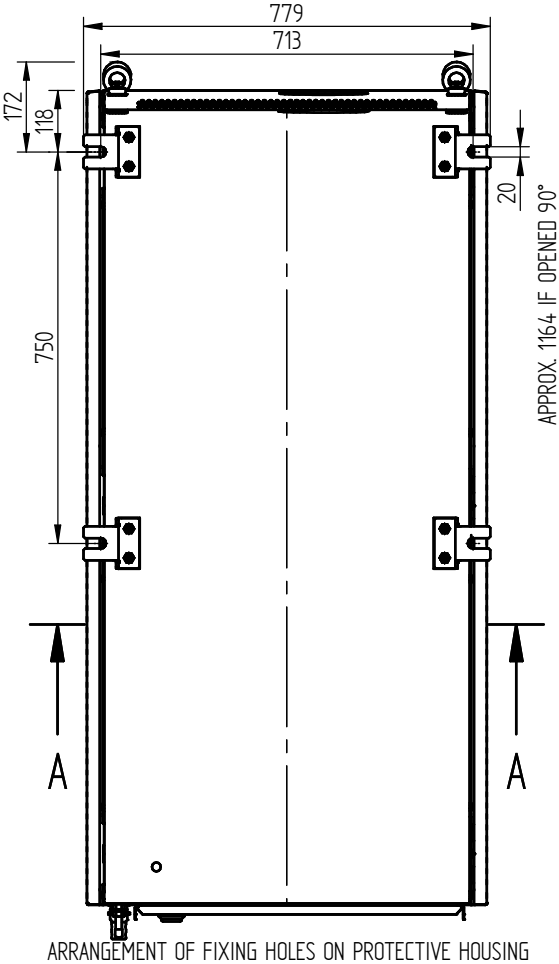
SHEET
1 / 1

A3

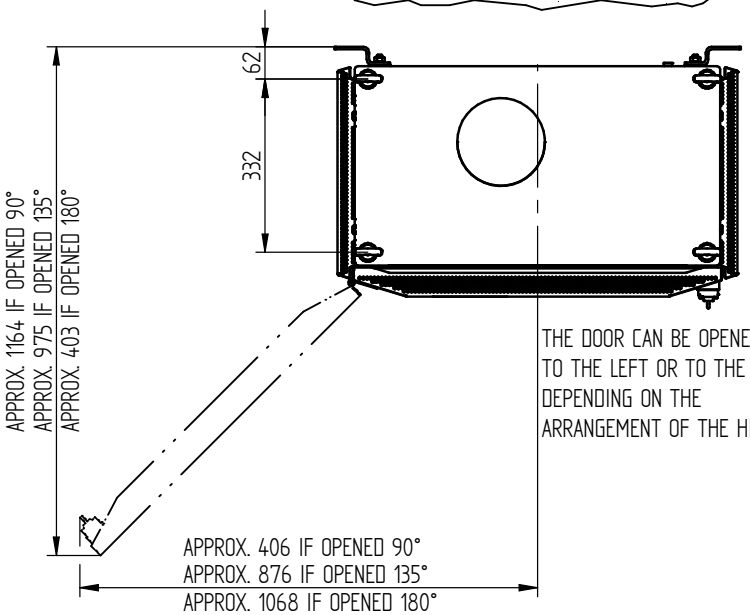




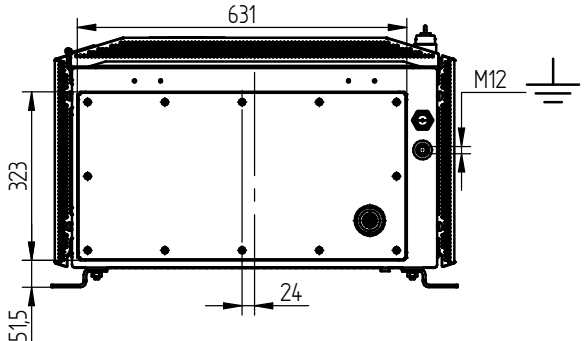




ARRANGEMENT OF FIXING HOLES ON PROTECTIVE HOUSING
(VIEWED FROM BACK SIDE)



THE DOOR CAN BE OPENED TO THE LEFT OR TO THE RIGHT DEPENDING ON THE ARRANGEMENT OF THE HINGES.



(VIEWED FROM BELOW)

	DATE	NAME	DOCUMENT NO.	
DFTR.	12.01.2023	NOVACKJ	SED 7939196 000 02	
CHKD.	19.04.2023	JOBST J	CHANGE NO.	SCALE
STAND	20.04.2023	WANNINGER	1114388	1:10

DIMENSION IN mm EXCEPT AS NOTED

MOTOR-DRIVE UNIT ETOS®
ETOS CABINET 1500 DOUBLE WALL
DIMENSION DRAWING

SERIAL NUMBER
–

MATERIAL NUMBER 101358640E

SHEET 1 / 1

A3

Glossary

GPI
General Purpose Input

GPO
General Purpose Output

ICD
IED Capability Description

IEEE
Worldwide association of engineers, mainly from the fields of electrical engineering and IT (Institute of Electrical and Electronics Engineers)

IP
Internet Protocol

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)

PTP
PTP (Precision Time Protocol) is a standard for synchronizing clocks in a computer network. This synchronization is high-precision.

RADIUS
Protocol for authentication of users in computer networks in accordance with RFC 2865 (Remote Authentication Dial-In User Service).

RSTP
Redundancy protocol in accordance with IEEE 802.1D-2004 (Rapid Spanning Tree Protocol)

SCADA
Technical processes are monitored and controlled using a computer system (Supervisory Control and Data Acquisition)

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.

TPLE
Transformer Personal Logic Editor

URL
Uniform Resource Locator

List of key words

V

Maschinenfabrik Reinhausen GmbH
Falkensteinstrasse 8
93059 Regensburg
Germany
+49 941 4090-0
info@reinhausen.com
reinhausen.com

8459847/05 EN - MSENSE® BM Operating instructions -
01/24

THE POWER BEHIND POWER.