



Voltage monitoring TAPCON[®] LV

Operating Instructions

7370895/00 EN . Limit Volt



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

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

The original operating instructions were written in German.



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1 Introduction

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

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

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

1.1 Manufacturer

The product is manufactured by:

Maschinenfabrik Reinhausen GmbH

Falkensteinstraße 8
93059 Regensburg
Tel.: (+49) 9 41/40 90-0
E-mail: sales@reinhausen.com

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

1.2 Completeness

This technical file is incomplete without the supporting documents.

The following documents are considered supporting documents:

- Connection diagrams
- Quick reference guide
- Supplement (optional)
- Connection diagrams
- Supplement (optional)

1.3 Safekeeping

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

1.4 Notation conventions

1.4.1 Hazard communication system

Warnings in this technical file are displayed as follows.

1.4.1.1 Warning relating to section

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

▲ WARNING



Type of danger!

Source of the danger and outcome.

- ▶ Action
- ▶ Action

1.4.1.2 Embedded warning information

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

▲ DANGER! Instruction for avoiding a dangerous situation.

1.4.1.3 Signal words and pictograms

The following signal words are used:

Signal word	Definition
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

Pictograms warn of dangers:

Pictogram	Definition
	Warning of a danger point
	Warning of dangerous electrical voltage

Pictogram	Definition
	Warning of combustible substances
	Warning of danger of tipping
	Warning of danger of crushing

Table 2: Pictograms used in warning notices

1.4.2 Information system

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



Important information.

1.4.3 Instruction system

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

Single-step instructions

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

Aim of action

✓ Requirements (optional).

► Step 1 of 1.

⇒ Result of step (optional).

⇒ Result of action (optional).

Multi-step instructions

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



- Aim of action
- ✓ Requirements (optional).
- 1. Step 1.
 - ⇒ Result of step (optional).
- 2. Step 2.
 - ⇒ Result of step (optional).
 - ⇒ Result of action (optional).

1.4.4 Typographic conventions

The following typographic conventions are used in this technical file:

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

Table 3: Typographic conventions



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 device and is used to monitor a voltage regulator for power transformers with an on-load tap-changer. The product monitors the entire control path of the voltage regulator (voltage transformer, voltage regulator and motor-drive unit).

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

The following is considered appropriate use:

- You will find the standard valid for the product and the year of issue on the nameplate.
- Operate the product in accordance with this technical file, the agreed-upon delivery conditions and the technical data.
- Ensure that all necessary work is performed by qualified personnel only.
- Only use the equipment and special tools included in the scope of delivery for the intended purpose and in accordance with the specifications of this technical file.
- Only operate the product in industrial areas.
- Observe the notices in this technical file regarding electromagnetic compatibility and the technical data.

2.2 Fundamental safety instructions

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



Personal protective equipment

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

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

Work area

Untidy and poorly lit work areas can lead to accidents.

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

Working during operation

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

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

Invisible laser radiation

Looking directly into the beam or the reflected beam can cause eye damage. The beam is emitted at the optical connections or at the end of the fiber-optic cables connected to them on the assemblies. Read the chapter "Technical Data" [► Section 15, Page 106] for further information.

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

Working with current transformers

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

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



Handling electrical components

Electrical components can be damaged by electrostatic discharges.

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

Explosion protection

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

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

Safety markings

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

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

Ambient conditions

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

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

Modifications and conversions

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

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

Spare parts

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

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



2.3 Personnel qualification

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

Electrically skilled person

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

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

Electrically trained persons

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

Operator

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

Technical Service

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

Authorized personnel

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



2.4 Personal protective equipment

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

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

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

Table 4: Personal protective equipment



3 IT security

Observe the following recommendations to operate the product safely.

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 segmenting and security gateways (firewalls) at the transition points.
- Ensure that the device is only operated by trained personnel who are familiar with IT security.

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 8.2.2, Page 61]" 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 8.2.3, Page 62].
- Enable SSL/TLS encryption [► Section 8.2, Page 60]; 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.
- Only use the SNMP function if you can ensure that the communication is protected by external security equipment.

Operation

Observe the following recommendations during device operation:

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



Interfaces

The device uses the following interfaces for communication:

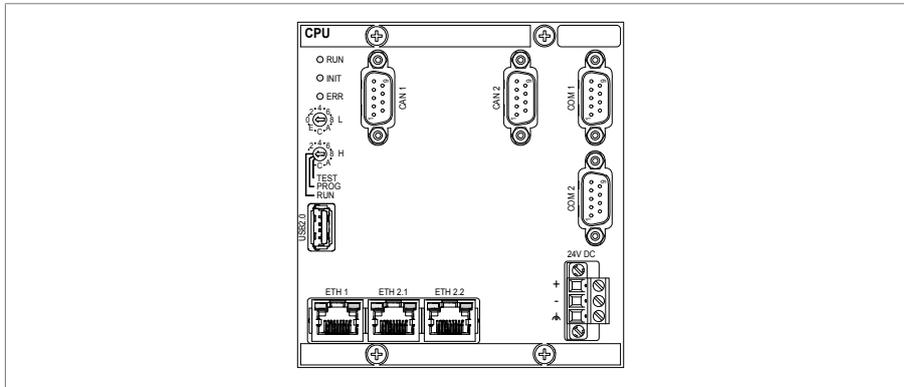


Figure 1: CPU assembly interfaces

Interface	Protocol	Port	Description
CAN 1	-	-	DIO assembly connection
CAN 2	-	-	No function
COM 1	-	-	Internal system interface
COM 2	-	-	No function
USB	-	-	Import or export of data
ETH 1	-	-	No function
ETH 2.1	TCP	21	FTP ¹⁾ (only for MR service)
ETH 2.1	TCP	80	HTTP for web-based visualization ¹⁾
ETH 2.1	TCP	443	HTTPS for web-based visualization ¹⁾
ETH 2.1	TCP	990	FTPS (only for MR service)
ETH 2.1	TCP	8080	HTTP for web-based visualization ¹⁾
ETH 2.1	TCP	8081	HTTPS for web-based visualization ¹⁾
ETH 2.2	-	-	No function

Table 5: Interfaces and open ports of the CPU assembly

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

Encryption standards

The device supports the following TLS versions:

- TLS 1.0
- TLS 1.1
- TLS 1.2



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

	Key exchange	Authentication		Encryption	Key length	Operating mode	Hash function
TLS	ECDHE	RSA	WITH	AES	128	CBC	SHA ¹⁾
	DHE						SHA265
	ECDHE	ECDSA				GCM	SHA256
	ECDH					256	CBC
		RSA ¹⁾			GCM		SHA256
					GCM	SHA384	

Table 6: Cipher suite

¹⁾ Not available with TLS version >= 1.2

The device uses the SHA256 hash function to save passwords.

Also refer to

 General [▶ 60]

4 Product description

4.1 Scope of delivery

The following items are included in the scope of delivery:

- TAPCON® LV
- Technical files
- Additional nameplate

Please note the following:

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

4.2 Function description

The product is a monitoring device and is used to monitor a voltage regulator for power transformers with an on-load tap-changer. It measures voltage independently of the voltage regulator and blocks the voltage regulator's switching commands if the voltage is outside of the permitted range. The device uses digital inputs to detect when the voltage regulator outputs a switching command to the motor-drive unit.

You can adapt the behavior of the device to your needs using adjustable parameters.

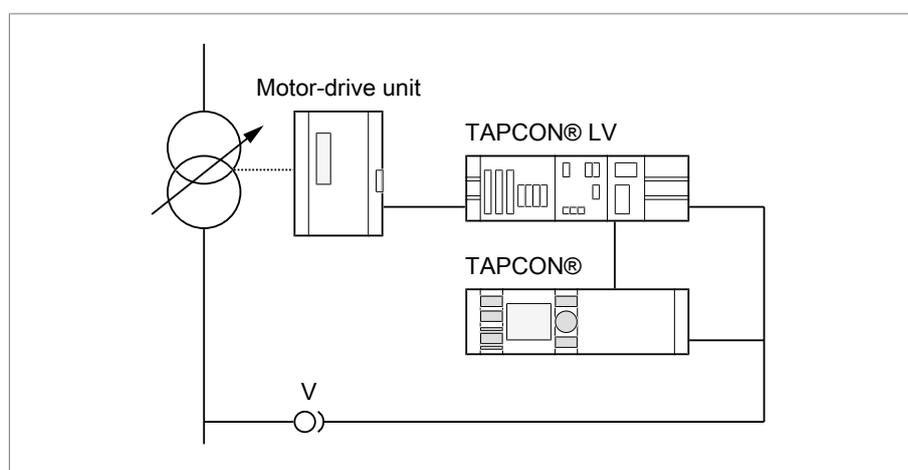


Figure 2: Function overview

Switching blocking

If the measured voltage is greater than the limit $U>$ or less than the limit $U<$, the device blocks the switching commands of the voltage regulator which would lead to an even greater control deviation:

- Voltage less than limit $U<$: Operations are only possible in the direction of higher voltage.
- Voltage greater than limit $U>$: Operations are only possible in the direction of lower voltage.

High-speed return

If the measured voltage is greater than the limit $U>$ or less than the limit $U<$, the device generates a signal at the $U<>$ output. You can combine this signal with the optional *High-speed return* input of the voltage regulator. With high-speed return, the voltage regulator ignores the set delay time of automatic voltage regulation.

Return

The return function is used to switch the on-load tap-changer to a certain tap position if the measured voltage is less than the limit $U<<$ (e.g. loss of transformer voltage). To do so, the device outputs switching commands to the motor-drive unit until the motor-drive unit is in the desired tap position.



To use this function, the motor-drive unit must output a signal to communicate to the device that the desired tap position or tap position range has been reached.

4.3 Performance features

The device features the following functions:

- Voltage monitoring
 - Voltage measurement monitoring
 - Blocking of switching commands from the voltage regulator
 - Return to desired tap position
 - Activation of the voltage regulator high-speed return
- Display of all measured values

4.4 Design

The device is supplied in the form of individual components for assembly on a cap rail. The individual device assemblies are described in the following section.

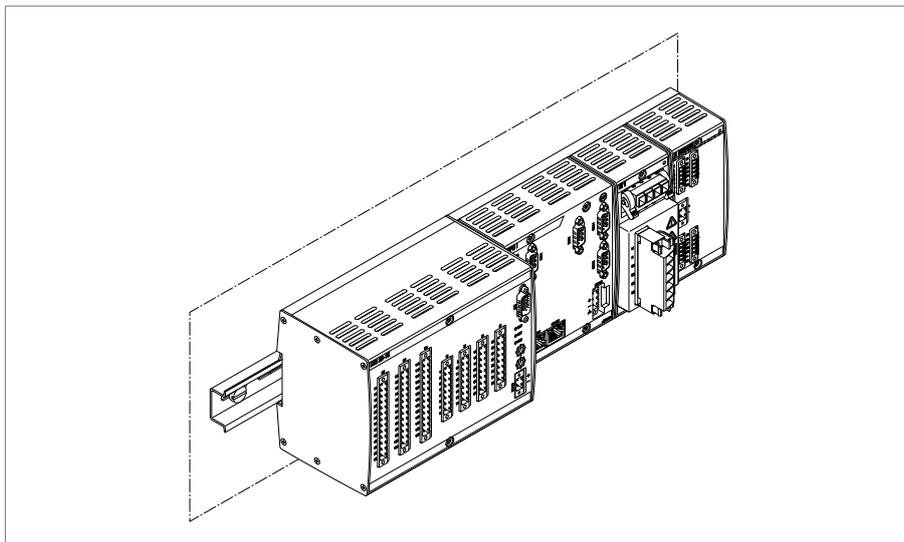


Figure 3: Example: Individual components for assembly on a cap rail

4.4.1 Power supply

The G1 PULS DIMENSION QS3.241 assembly supplies power to the device.

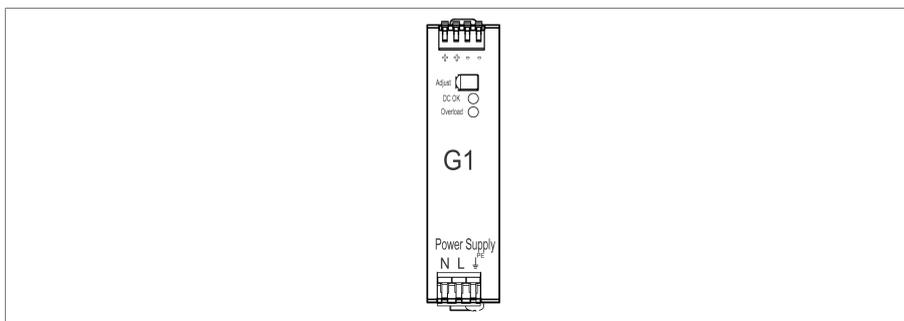


Figure 4: G1 PULS DIMENSION QS3.241 assembly

4.4.2 CPU (central processing unit) I

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

- Internal system interface RS232 (COM1)
- Serial interface RS232/485 (COM2)
- 3x Ethernet (ETH1, ETH 2.1, ETH 2.2)

- USB (USB 2.0)
- 2x CAN bus (CAN 1, CAN 2)

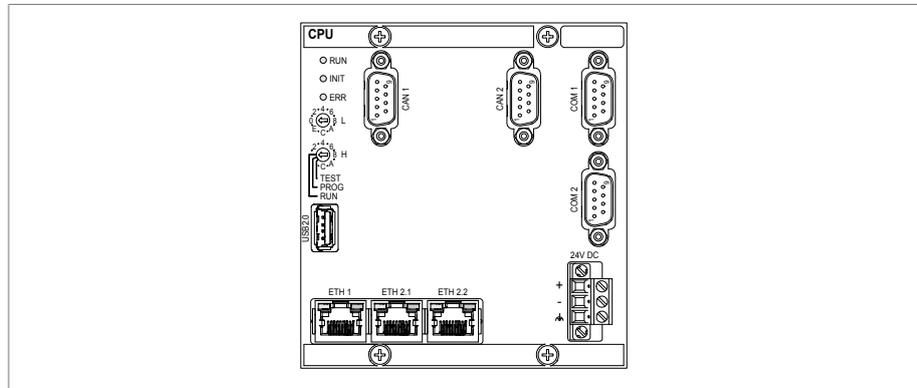


Figure 5: CPU I assembly

4.4.3 UI 1 voltage measurement and current measurement

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

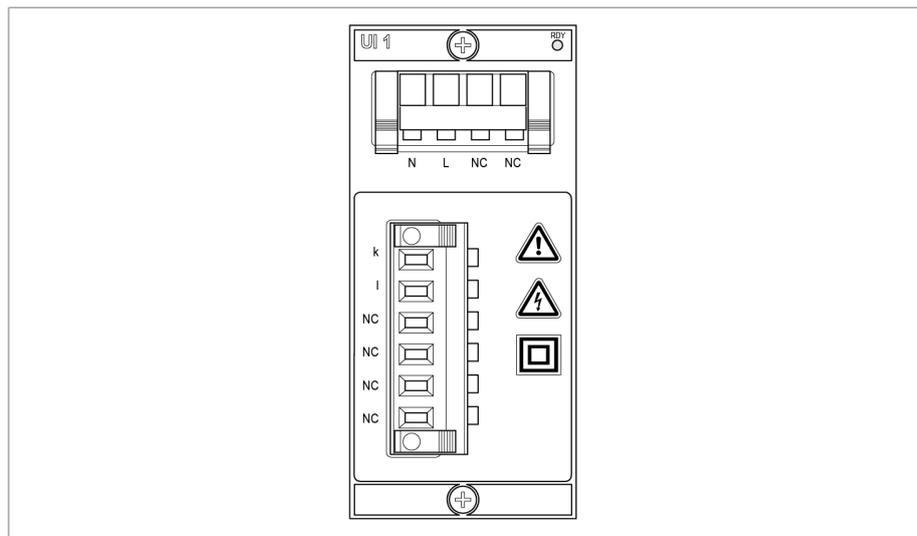


Figure 6: UI 1 assembly

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

Table 7: Safety-relevant symbols on the assembly

4.4.4 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.

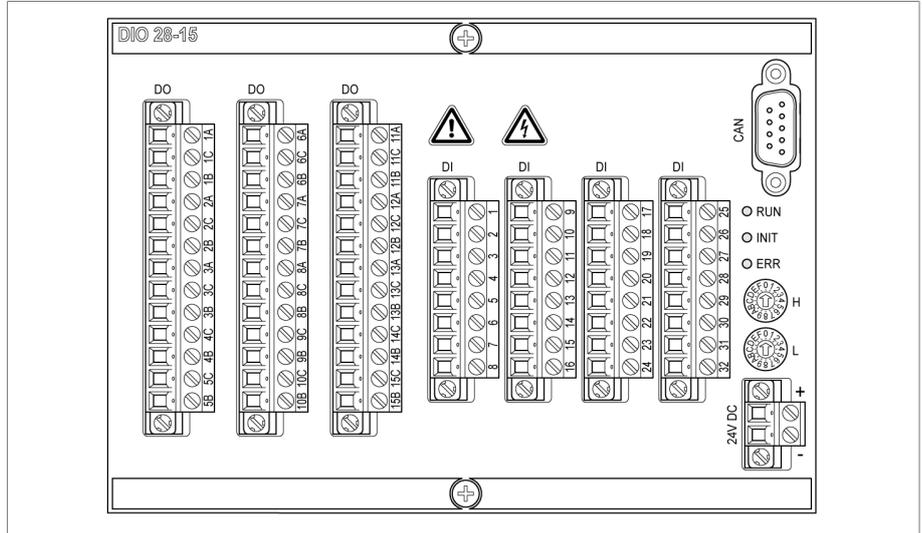


Figure 7: DIO 28-15 assembly

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

Table 8: Safety-relevant symbols on the assembly

4.5 Visualization

4.5.1 Main screen

The main screen of the visualization is divided into the following areas:

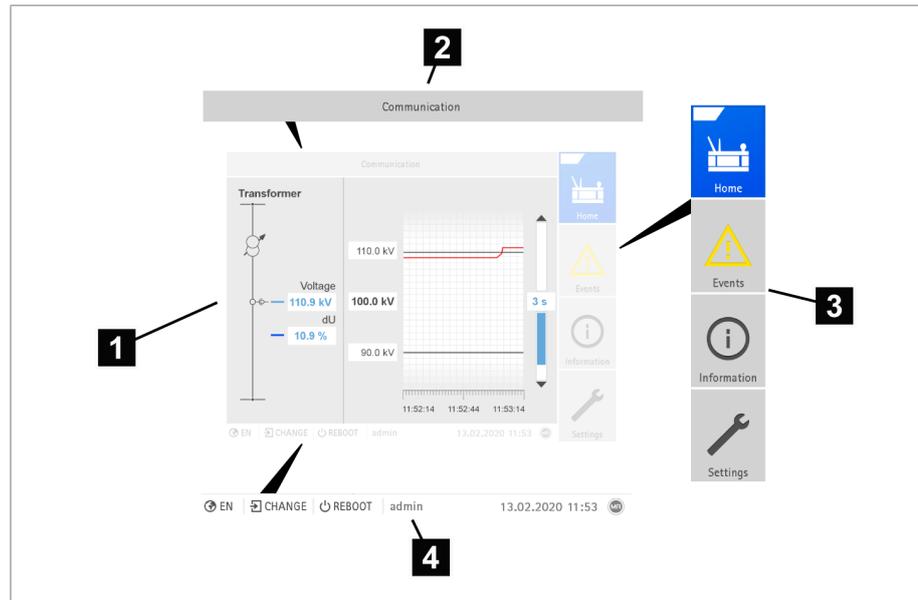


Figure 8: Main screen

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

The display area of the main screen shows the currently measured voltage and the control deviation on the left side. On the right side, the measured value trend is displayed as a diagram.

4.5.2 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 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 8.11, Page 78] section.



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

Logging on, logging off and changing users

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

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 **OK** button.
- ⇒ The name of the logged-in user appears in the status line.

To log out as a user, proceed as follows:

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

Navigation

If you are operating the device using the 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 **Time synchronization**.
4. Select **Time**.

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

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.

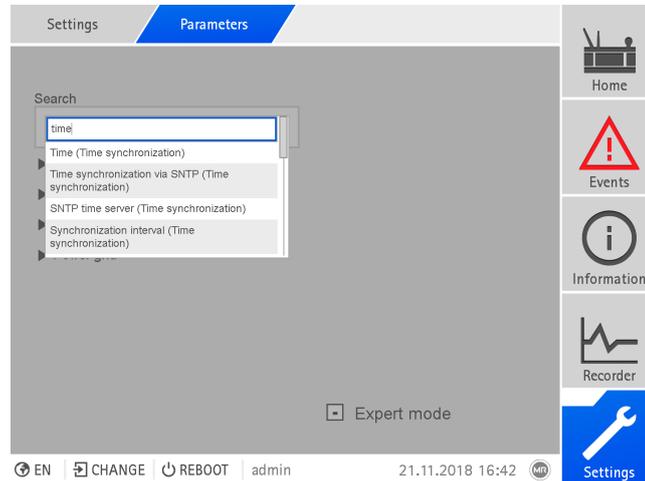


Figure 9: Quick search

Expert mode

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

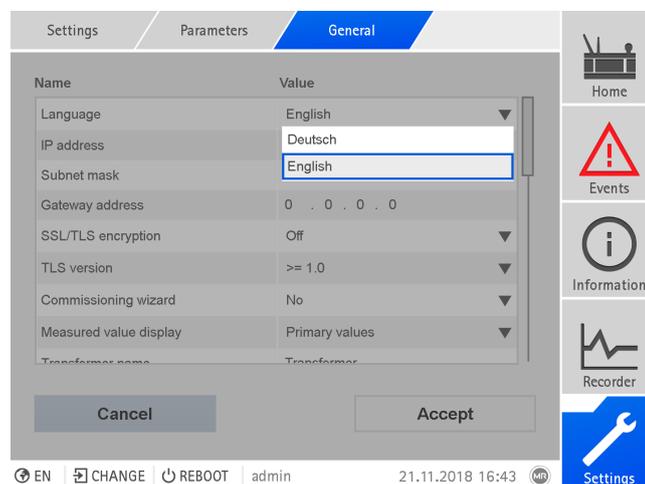


Figure 10: Expert mode

To activate the expert mode, proceed as follows:

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



Hiding/showing parameters

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

5 Packaging, transport and storage

5.1 Suitability, structure and production

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

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

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

5.2 Markings

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

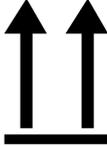
				
Protect against moisture	Top	Fragile	Attach lifting gear here	Center of mass

Table 9: Shipping pictograms

5.3 Transportation, receipt and handling of shipments

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

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

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

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

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



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

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

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

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

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

5.4 Storage of shipments

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

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

6 Mounting

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

▲ DANGER



Electric shock!

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

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

▲ WARNING



Electric shock!

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

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

NOTICE

Damage to the device!

Electrostatic discharge may cause damage to the device.

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

6.1 Preparation

The following tools are needed for installation:

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



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

6.2 Electromagnetic compatibility

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

6.2.1 Wiring requirement of installation site

Note the following when selecting the installation site:

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

6.2.2 Wiring requirement of operating site

Note the following when wiring the operating site:

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

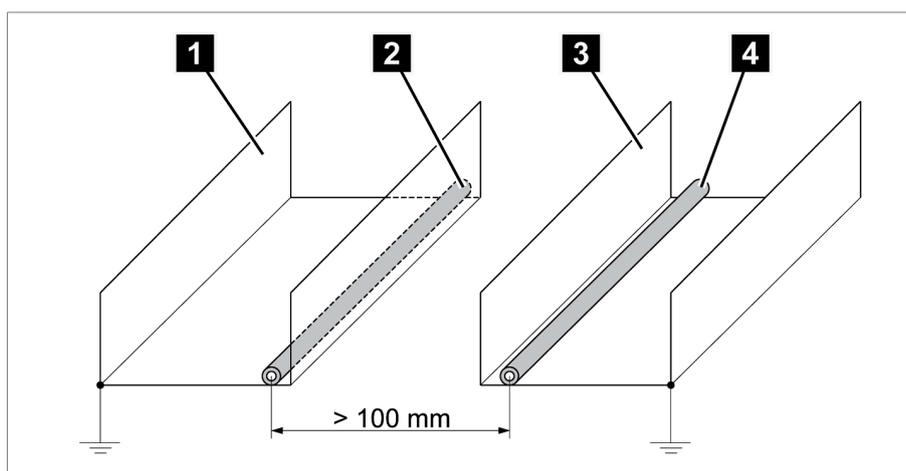


Figure 11: Recommended wiring

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

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



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

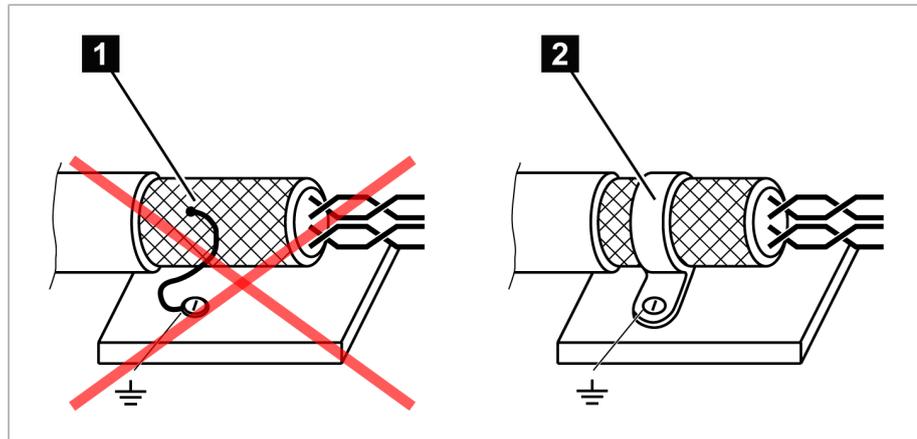


Figure 12: Recommended connection of the shielding

1 Connection of the shielding via a single conductor

2 Full-surface connection of the shielding

6.2.3 Wiring requirement in control cabinet

Note the following when wiring the control cabinet:

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

6.3 Minimum distances

NOTICE

Damage to the device!

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

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

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

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

Table 10: Minimum distances in the control cabinet

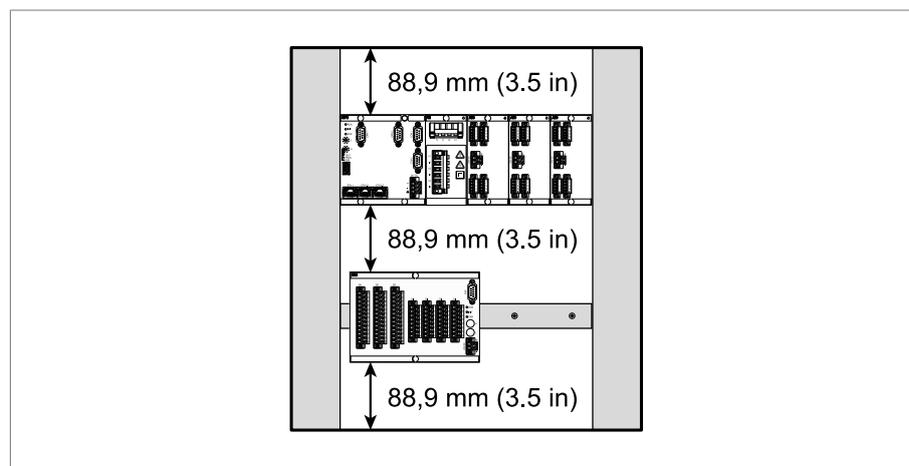


Figure 13: Example depiction of the minimum distances in a control cabinet

For other installation types, contact Maschinenfabrik Reinhausen GmbH.

6.4 Installing the individual components on a cap rail

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



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

6.4.1 Fastening the cap rail

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

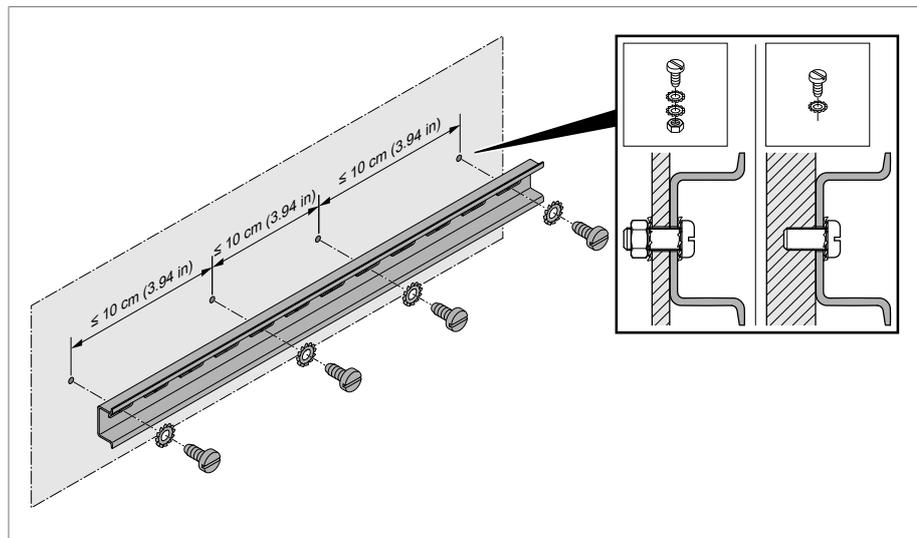


Figure 14: Fastening the cap rail

6.4.2 Installing the bus rail on the cap rail

The bus rail connects assemblies, such as the CPU, DIO 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.

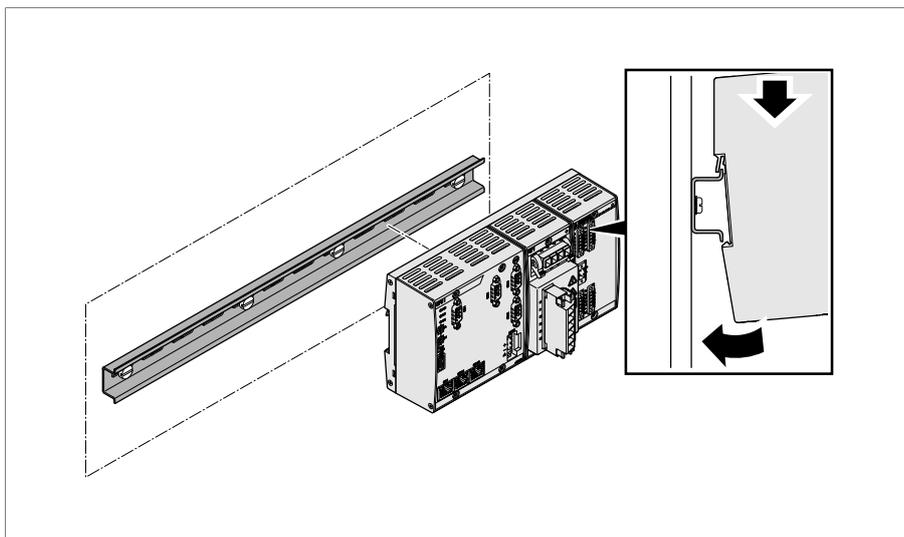


Figure 15: Hooking the bus rail into position

6.4.3 Installing the assembly at a distance on the cap rail

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

- DIO 28-15
 - DIO 42-20
 - MC 2-2
 - SW 3-3
 - G1 (PULS)
- ✓ Cap rail fastened to the rear panel of the cabinet [► Section 6.4.1, Page 34].
- **⚠ 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.

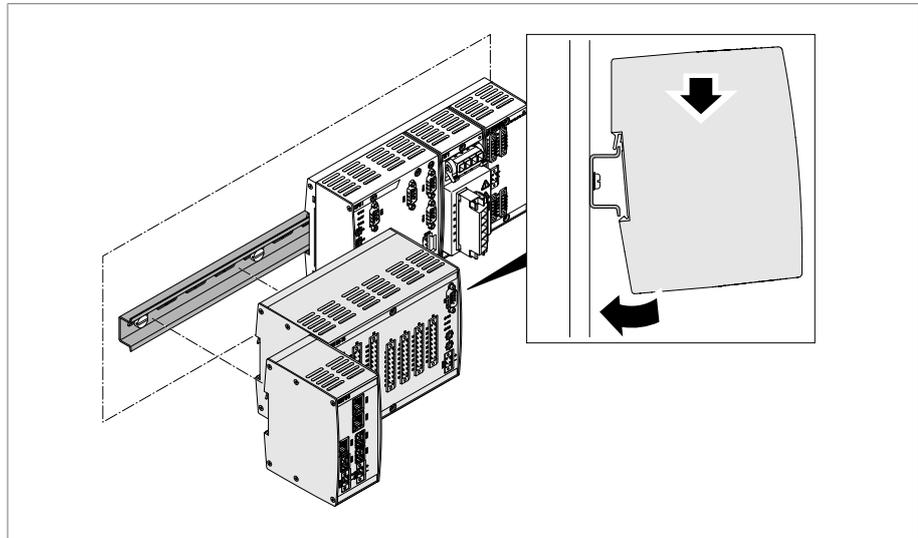


Figure 16: Example: Hooking on DIO and SW assemblies

6.5 Connecting the device

The following section describes how to establish the electrical connection to the device.

▲ WARNING



Electric shock!

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

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



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

Wiring information

Note this procedure for the wiring:

- To obtain a better overview when connecting cables, only use as many cables as necessary.
- Note the connection diagram.
- Only use the specified cables for wiring. Note the cable recommendation.

6.5.1 Cable recommendation

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

- Excessive line capacitance can prevent the relay contacts from interrupting the contact current. In control circuits operated with alternating current, take into account the effect of the line capacitance of long control cables on the function of the relay contacts.
- If you want to route Ethernet connections from a control cabinet or building, we recommend using fiber-optic cables (in accordance with the IEC 61850-90-4 recommendation).
- Ensure that the copper cables used have a temperature resistance of 70 °C.
- Keep the connection lines between the motor-drive unit and TAPCON® LV as short as possible to prevent interference (cross talk) between the lines.

Cable	Assembly	Type	Cross section	Material	Max. length
Power supply (external)	G1 PULS QS3.241	Unshielded	1.5 mm ²	Copper	-
Power supply (internal, 24 V DC)	CPU, DIO	Unshielded	1.5 mm ²	Copper	-
Voltage measurement	UI	Shielded	2.5 mm ²	Copper	-
Current measurement	UI	Unshielded	4 mm ²	Copper	-
Digital signal inputs	DIO	Shielded	1.5 mm ²	Copper	400 m (<25 Ω/km)
Digital signal outputs*	DIO	Shielded	1.5 mm ²	Copper	-
Ethernet RJ45	CPU	Min. CAT5, shielded S/FTP	-	-	100 m

Table 11: Recommendation for connection cables

*) Observe line capacitance, see note above.

6.5.2 Connecting cables to the system periphery



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

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

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

6.5.3 Wiring the CPU assembly

- ▶ 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.

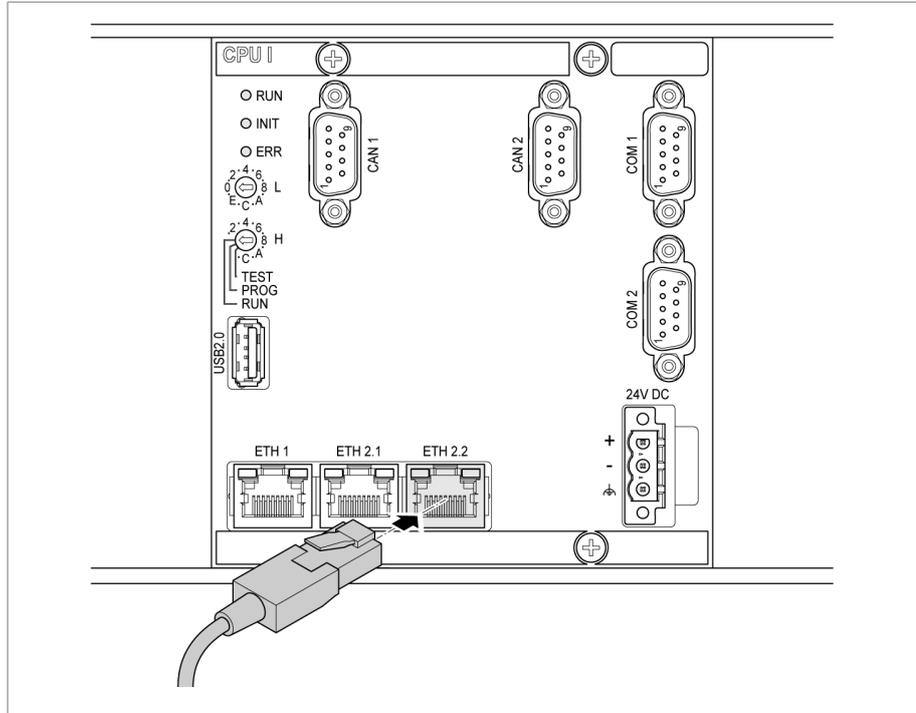


Figure 17: Connection to a PC via Ethernet interface

Voltage supply

You have to connect the CPU assembly to the voltage supply of the voltage supply unit. Proceed as follows:

1. Guide the leads into the plug terminal and fasten them using a screwdriver.

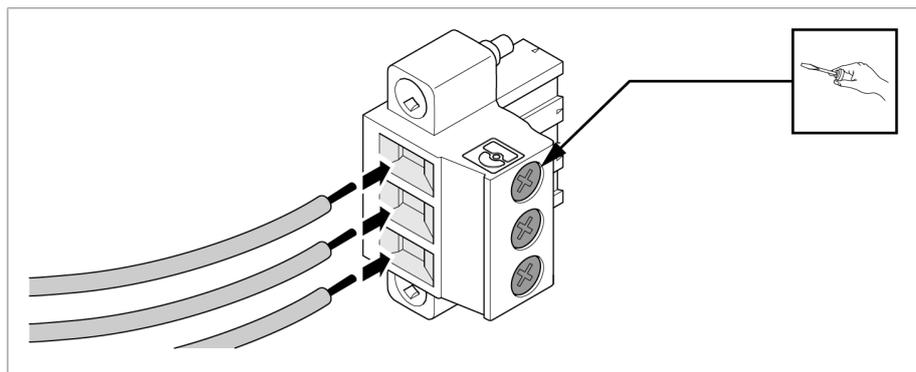


Figure 18: Inserting the leads



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

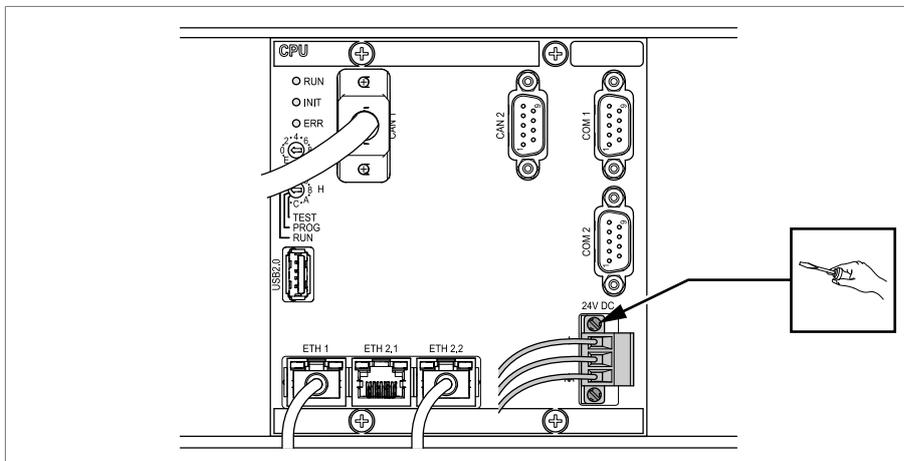


Figure 19: Fastening the 24 V DC plug

6.5.4 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 12: Permissible fuse types

To wire the UI assembly, proceed as follows:

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

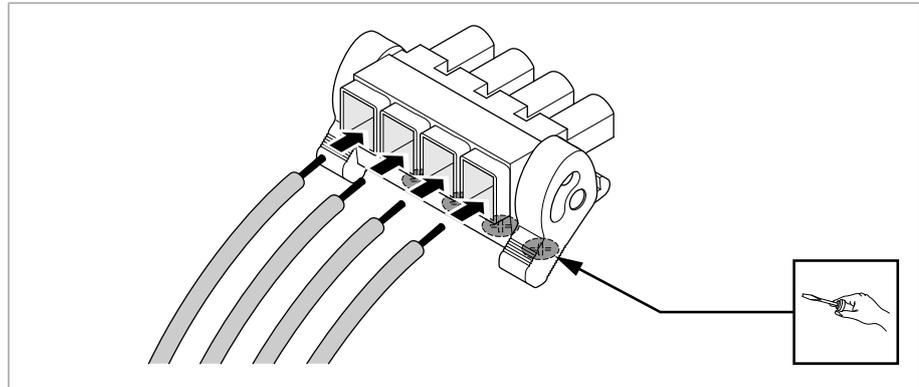


Figure 20: Example: Plug for voltage measurement

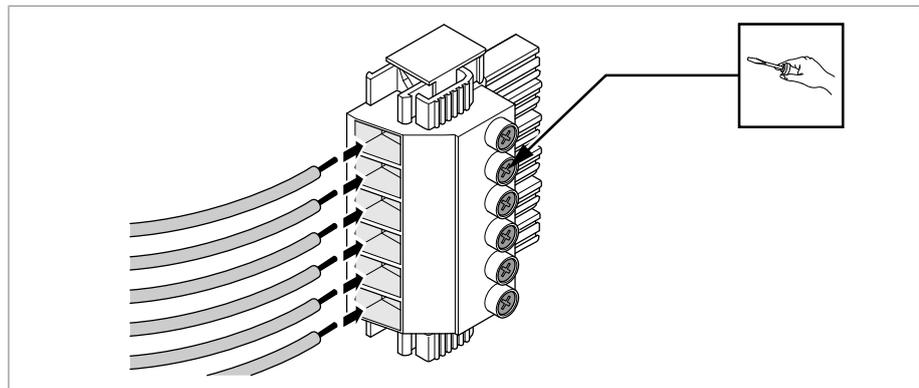


Figure 21: Example: Plug for current measurement

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

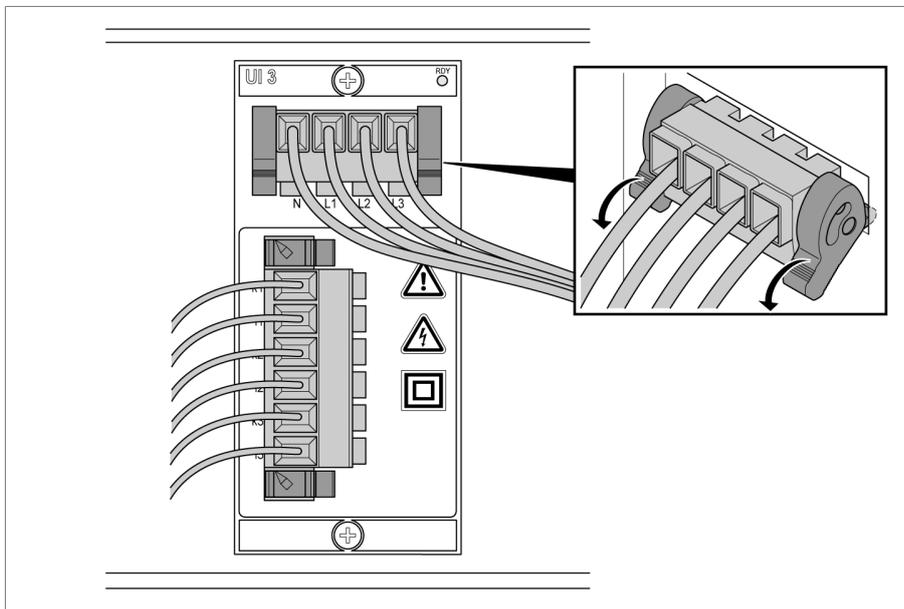


Figure 22: Engaging the plug

6.5.5 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.

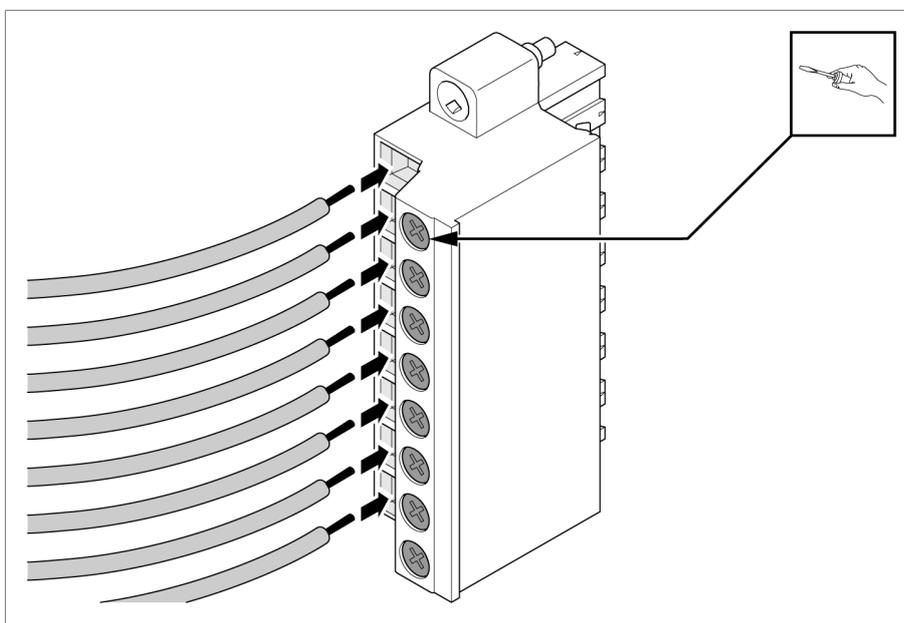


Figure 23: Inserting the leads

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

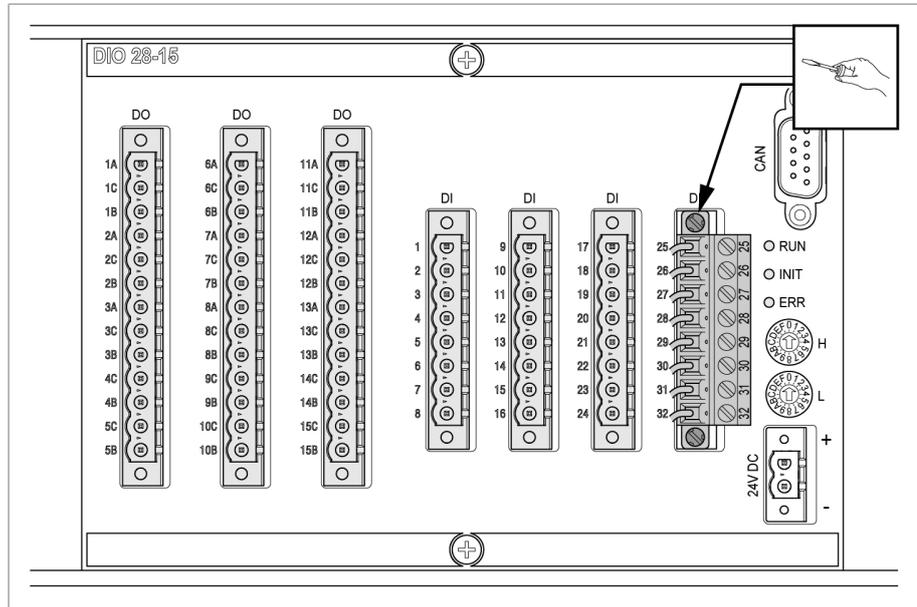


Figure 24: Fastening the plug

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.

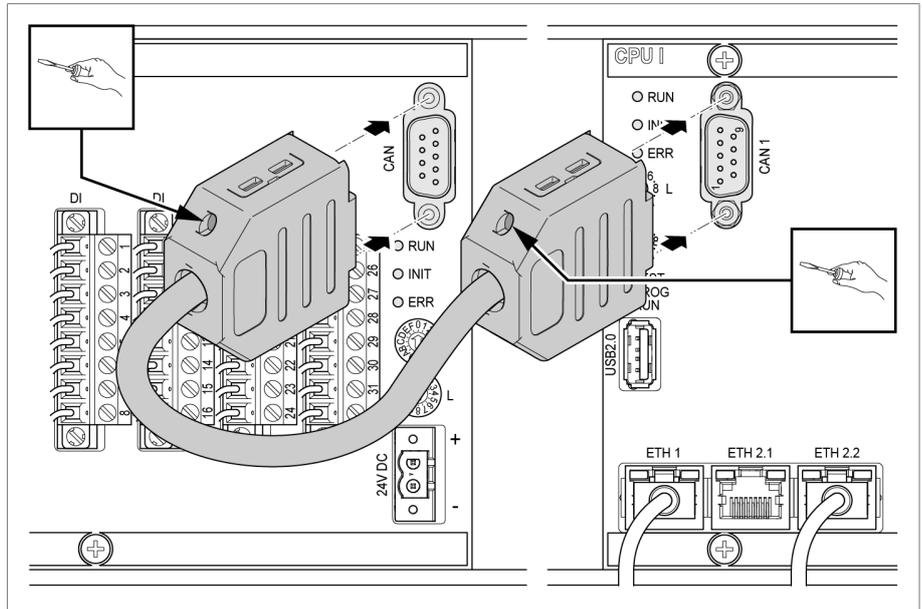


Figure 25: CAN bus connection

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.

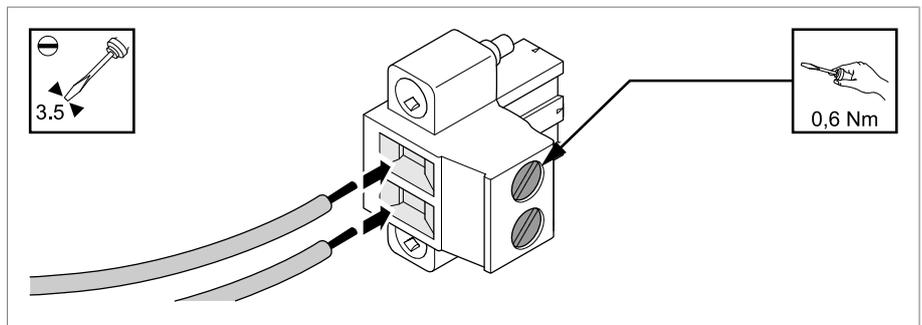


Figure 26: Inserting the leads

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

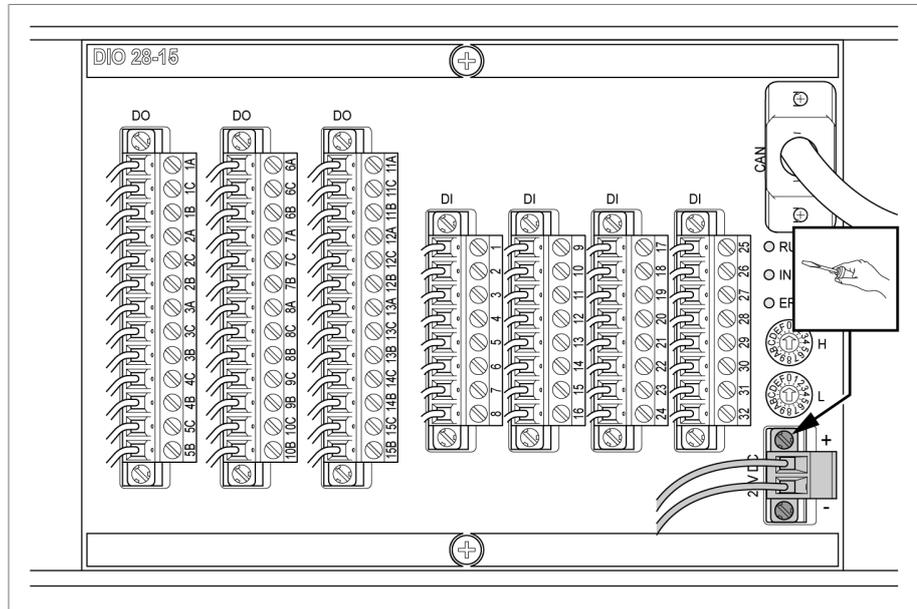


Figure 27: Fastening the 24 V DC plug

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	0	1
<ul style="list-style-type: none"> ▪ DIO 28-15 ▪ DIO 42-20 		
Second assembly	0	2
<ul style="list-style-type: none"> ▪ DIO 28-15-1 ▪ DIO 42-20-1 		

Table 13: Rotary switch configuration

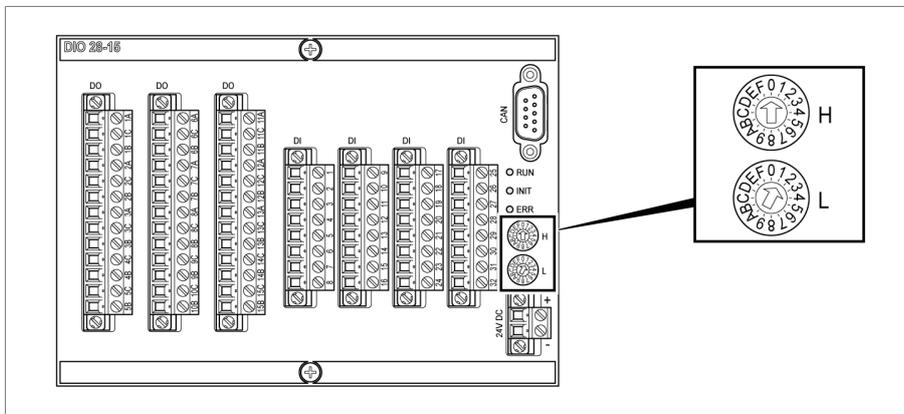


Figure 28: Rotary switch H and L of DIO assembly

6.5.6 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**.

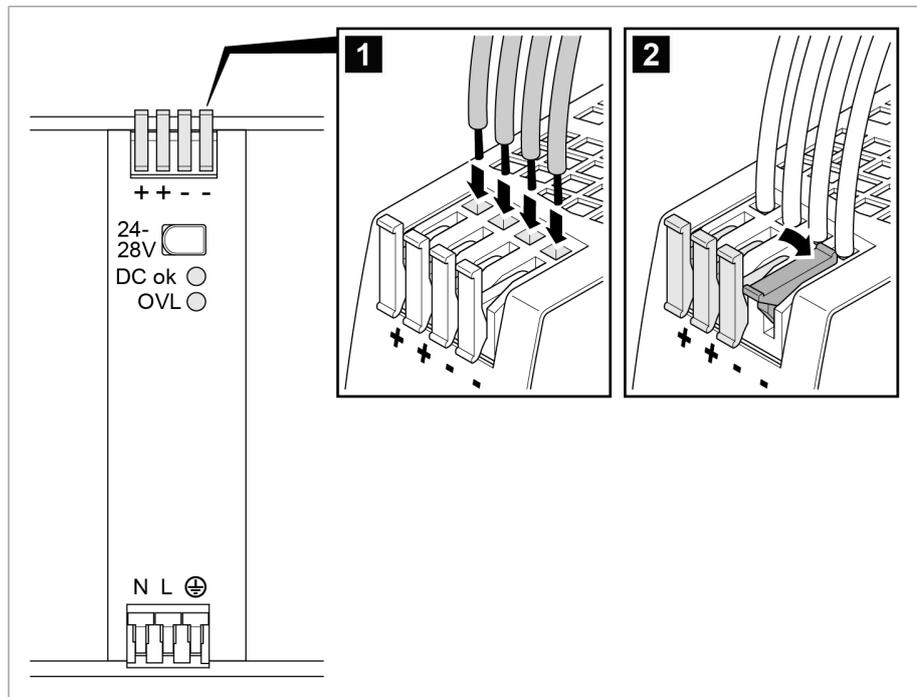


Figure 29: Inserting the leads

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**.

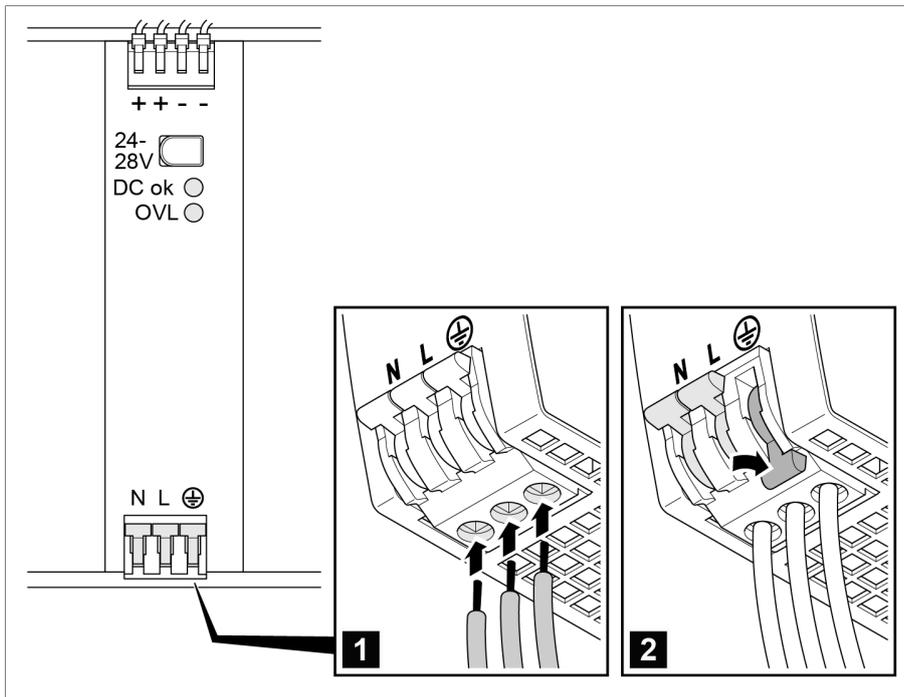


Figure 30: Inserting the neutral conductor, phase conductor and protective conductor

6.5.7 Connecting the power supply

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

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

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

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

- Rated current: 6 to 20 A
- Triggering characteristic: B or C

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



Connecting the voltage supply

To connect the voltage supply, proceed as follows:

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

6.6 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 lead to damage to the device and system periphery.

- ▶ Check the entire configuration before commissioning.
- ▶ Prior to commissioning, check the supply voltage and the measured voltage.

Check the following:

- Once you have connected the device to the grid, the display shows the MR logo and then the operating screen.
- The *voltage display* LED on the top left of the device's front panel lights up.

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



7 Commissioning

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

NOTICE

Damage to device and system periphery

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

- ▶ Check the entire configuration before commissioning.

7.1 Performing tests



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

7.1.1 Ground test

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

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

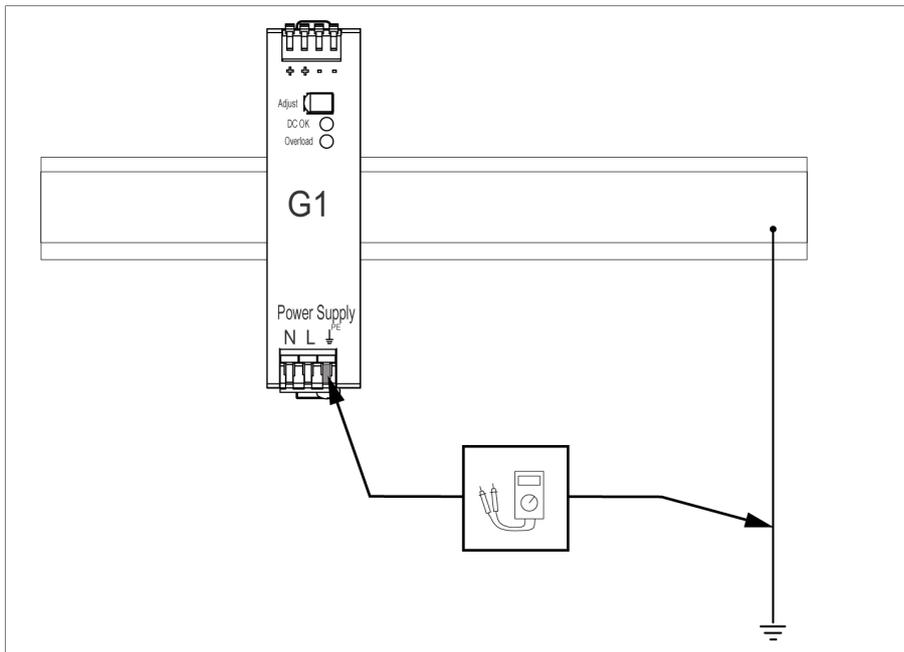


Figure 32: Perform a ground test on the G1 PULS DIMENSION QS3.241 assembly

7.1.2 Performing a dielectric test

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

NOTICE

Damage to the device!

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

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

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

Assembly	Interfaces	Test parameters			
		Max. test voltage	Max. test duration	Ramp	Breaking current threshold
OT1205 (MR/N) ¹	N, L	2.2 kV AC	2 s	5 s	> 10 mA
UI 1	N, L k, l	2.2 kV AC	2 s	5 s	> 4 mA
UI 3	N, L1, L2, L3 k1, l1, k2, l2, k3, l3	2.2 kV AC	2 s	5 s	> 4 mA
UI 5-3, UI 5-4	N, L1, L2, L3 k1, l1, k2, l2, k3, l3	2.2 kV AC	2 s	5 s	> 4 mA

Assembly	Interfaces	Test parameters			
		Max. test voltage	Max. test duration	Ramp	Breaking current threshold
DIO 28-15 DIO 42-20 DIO 42-20 HL	any DI, DO	2.2 kV AC	2 s	5 s	> 1 mA
G1 (PULS)	N, L	2.2 kV AC	2 s	5 s	> 4 mA

Table 14: Permitted interfaces and test parameters for the dielectric test

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

Sample dielectric test set-up

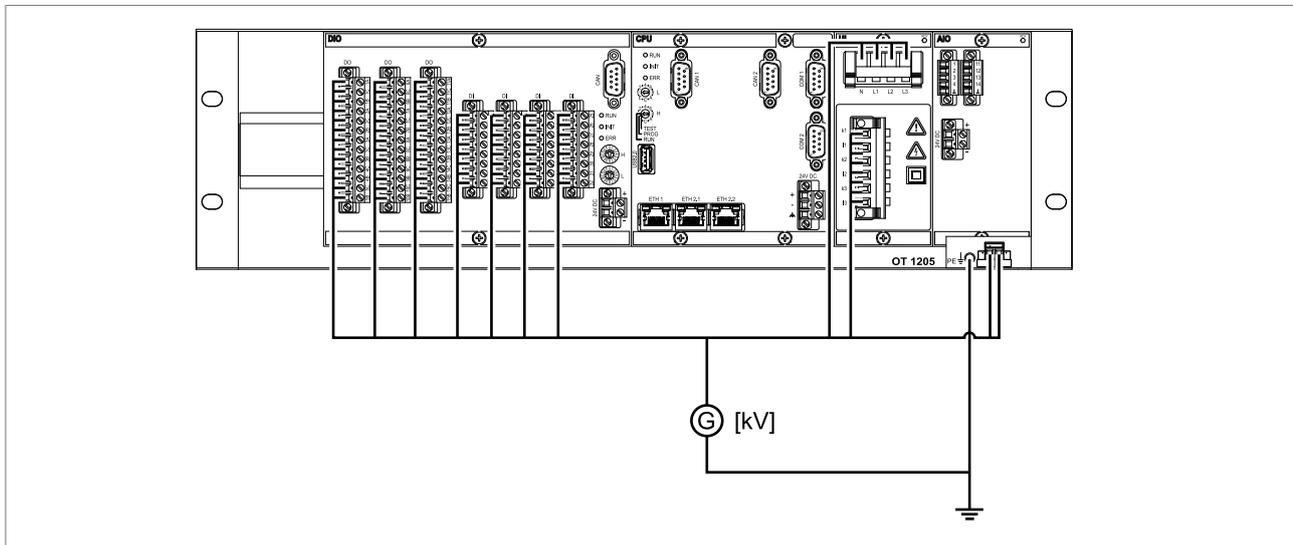


Figure 33: Sample set-up of the dielectric test for a device designed with the OT 1205 wide-range power supply

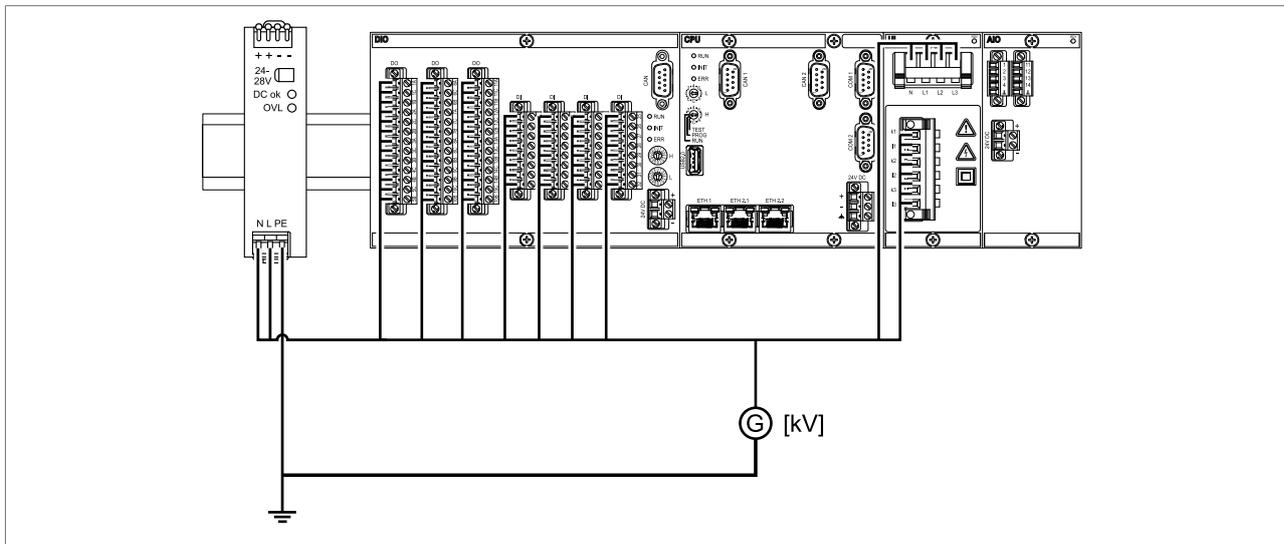


Figure 34: Sample dielectric test set-up for a device designed with the G1 (PULS) power supply

7.2 Establishing connection to visualization

You can use the ETH 2.1 interface of the CPU assembly to establish the 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
ETH2.1	IP address: 192.168.165.1 (not adjustable)
PC	IP address: 192.168.165.100 Subnet mask: 255.255.255.0

Table 15: 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® Internet Explorer 11
- Google Chrome™

To establish a connection, proceed as follows:

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

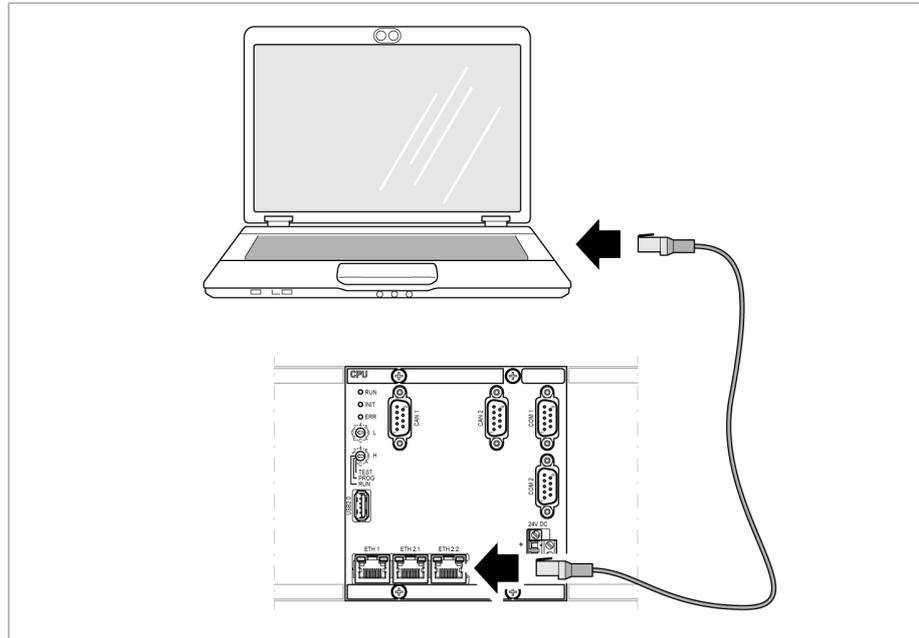


Figure 35: Establishing a connection via the ETH2.1 or ETH2.2 interface

2. Assign a unique IP address to the PC. This IP address must be in the same subnet as the device (e.g. ETH2.1: 192.168.165.100).
 3. Enter the IP address of the visualization (e.g. ETH2.1: `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.

7.3 Setting the language

You can use this parameter to set the display language for the device. The device comes with two languages. The following languages are available:

English	German
---------	--------

To set the language, proceed as follows:

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

EN | LOGIN | REBOOT | User | 28.11.2013 14:34:44

Figure 36: Setting the language

2. Select the desired language from the list box.
 3. Press the **Accept** button to save the modified parameter.
- ⇒ The "Restart device" dialog appears.

- Restart the device to apply the changed language setting.

7.4 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 59] chapter.



To call up the commissioning wizard, you will need the necessary access rights [► Section 8.11, Page 78].

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:

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

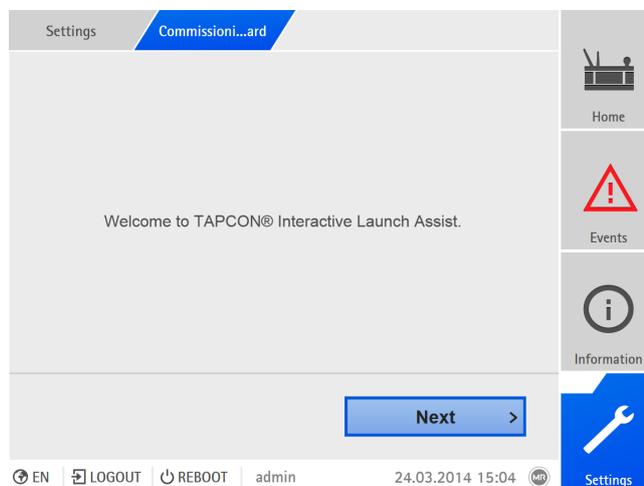


Figure 37: Calling up the commissioning wizard

- Press the **Next** button to launch the commissioning wizard.
- Follow the on-screen instructions.

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



7.5 Function tests

For commissioning, perform the function checks described below. You will need a controllable voltage source to simulate the measured voltage for the function test.

The function test requires that you register on the device as a user in the parameter configurator or administrator user role.

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

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

During the function test, you must set the most important parameters. Details on the parameters listed can be found in the Operation [► Section 8, Page 59] chapter.

7.5.1 Checking measured values and status of digital inputs and outputs

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

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

1. Establish a connection to the visualization [► Section 7.2, Page 53].
2. Call up the **main screen** and check the measured voltage values.
3. Go to **Information > Hardware**.
4. Select the **DIO assembly** and check the status of the digital inputs and outputs.
5. If errors arise, check the measurement path and the wiring [► Section 6.5, Page 36].

7.5.2 Testing voltage monitoring

To test the voltage monitoring, proceed as follows:

- ✓ The controllable voltage source is connected to the voltage transformer.
 - ✓ The voltage supply of the device is switched on.
1. Adjust the transmission ratio of the voltage transformer.
 2. Compare the supplied voltage from the voltage source with the measured value displayed on the device's main screen.
 3. Set the desired value to the value you want.
 4. Set the limit $U>$ to the value you want.
 5. Increase the supplied voltage until it is greater than the limit $U>$.
 6. Check whether the *Limit $U>$* event is reported and if the associated signaling relay $U>$ switches.



7. Set the limit $U<$ to the value you want.
 8. Reduce the supplied voltage until it is less than the limit $U<$.
 9. Check whether the *Limit $U<$* event is reported and if the associated signaling relay $U<$ switches.
- ⇒ The function test is complete.

7.5.3 Testing blocking of switching commands from the voltage regulator

To test the blocking of switching commands from the voltage regulator, proceed as follows:

- ✓ The normally closed contacts of the DIO28-15/3 and DIO28-15/2 relays are looped in to the connections of the RAISE/LOWER switching commands between the voltage regulator and motor-drive unit in accordance with the connection diagram.
 - ✓ The controllable voltage source is connected to the voltage transformer.
 - ✓ The voltage supply of the device is switched on.
 - ✓ Voltage regulation is in manual mode (AVR MANUAL).
1. Adjust the transmission ratio of the voltage transformer.
 2. Compare the supplied voltage from the voltage source with the measured value displayed on the device's main screen.
 3. Set the desired value to the value you want.
 4. Set the limit $U>$ to the value you want.
 5. Increase the supplied voltage until it is greater than the limit $U>$.
 6. Press the  key on the voltage regulator.
 - ⇒ The motor-drive unit must not switch position.
 7. Reduce the supplied voltage until it is less than the limit $U<$.
 8. Press the  key on the voltage regulator.
 - ⇒ The motor-drive unit must not switch position.
- ⇒ The function test is complete.

7.5.4 Testing voltage regulator monitoring

- ✓ The DIO28-15/1 and DIO28-15/2 inputs are looped in to the connections of the RAISE/LOWER switching commands between the voltage regulator and the motor-drive unit in accordance with the connection diagram and the DIO28-15/8 input is connected with the neutral conductor of the motor-drive unit.
 - ✓ The controllable voltage source is connected to the voltage transformer.
 - ✓ The voltage supply of the device is switched on.
 - ✓ Voltage regulation is in manual mode (AVR MANUAL).
1. Adjust the transmission ratio of the voltage transformer.



2. Compare the supplied voltage from the voltage source with the measured value displayed on the device's main screen.
3. Set the desired value to the value you want.
4. Set the limit $U>$ to the value you want.
5. Increase the supplied voltage until it is greater than the limit $U>$.
6. After the time T_2 has expired, press the  key on the voltage regulator.
⇒ The *Voltage regulator fault* event must appear.
7. Reduce the supplied voltage until it is less than the limit $U<$.
8. After the time T_2 has expired, press the  key on the voltage regulator.
⇒ The *Voltage regulator fault* event must appear.
9. Increase the supplied voltage until it is greater than the limit $U>$.
10. After the time T_2 has expired, press the  key on the voltage regulator.
⇒ The *Voltage regulator fault* event must not appear.

8 Operation

This chapter describes all the functions and setting options for the device.

8.1 Establishing connection to visualization

You can use the ETH 2.1 interface of the CPU assembly to establish the 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
ETH2.1	IP address: 192.168.165.1 (not adjustable)
PC	IP address: 192.168.165.100 Subnet mask: 255.255.255.0

Table 16: 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® Internet Explorer 11
- Google Chrome™

To establish a connection, proceed as follows:

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

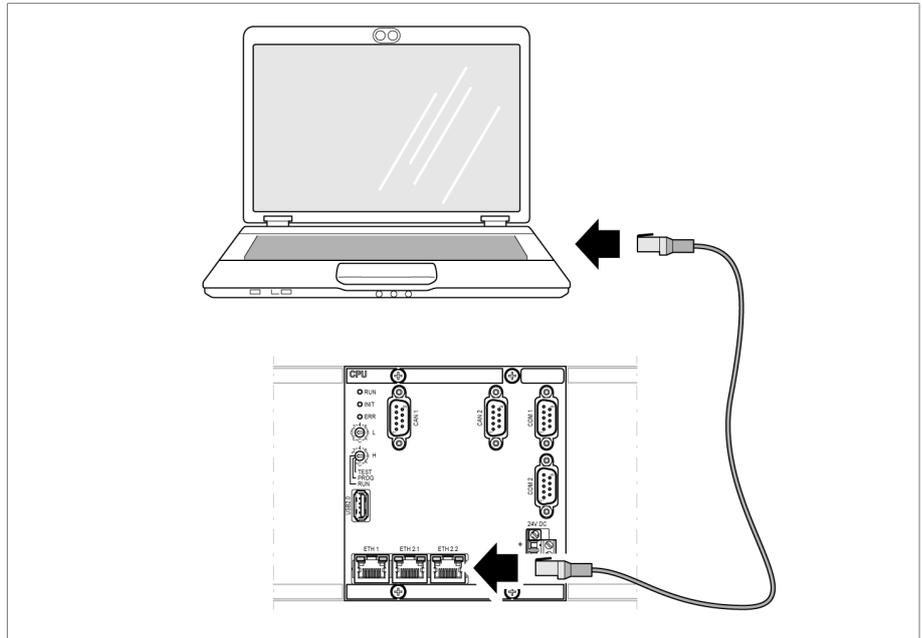


Figure 38: Establishing a connection via the ETH2.1 or ETH2.2 interface

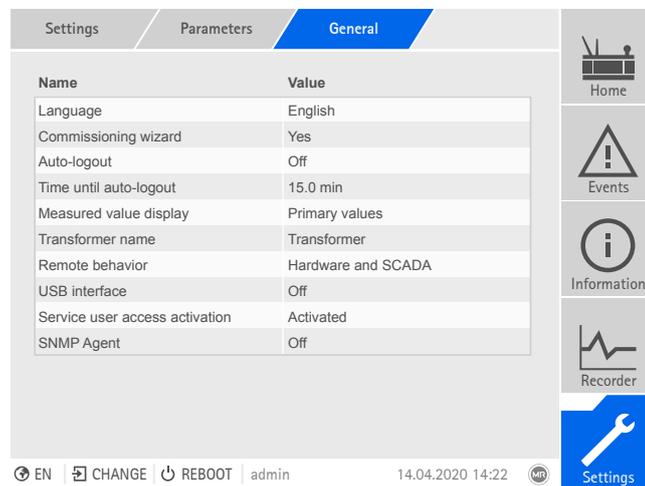
2. Assign a unique IP address to the PC. This IP address must be in the same subnet as the device (e.g. ETH2.1: 192.168.165.100).
 3. Enter the IP address of the visualization (e.g. ETH2.1: `http://192.168.165.1`; if SSL encryption is active, enter `https://192.168.165.1`) in the browser on the PC.
- ⇒ The visualization is accessed.

8.2 General

You can set general parameters in this menu item.

8.2.1 Setting general device functions

You can set general device functions with the following parameters.



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

EN CHANGE REBOOT admin 14.04.2020 14:22 Settings

Figure 39: 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.

Commissioning wizard

You can use this parameter to set whether the commissioning wizard [► Section 7.4, Page 55] 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.

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

8.2.2 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 8.11.3, Page 80] function for a user, then this user will not be automatically logged out.

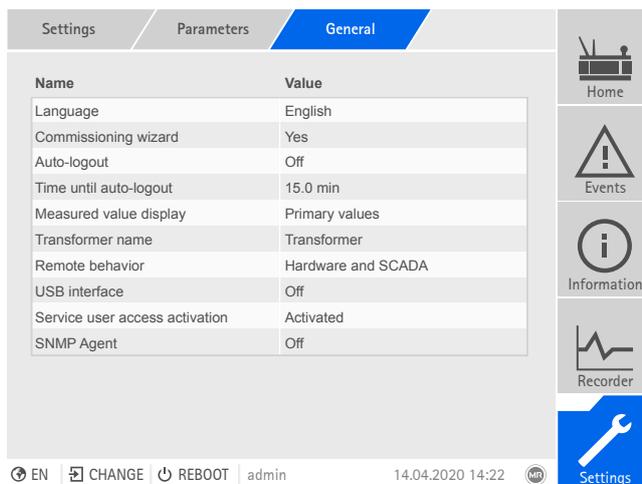


Figure 40: General

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.

Auto logout

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

Time until auto logout

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

8.2.3 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. Only activate service user access for a limited time period for remedying faults in order to safeguard IT security.



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.

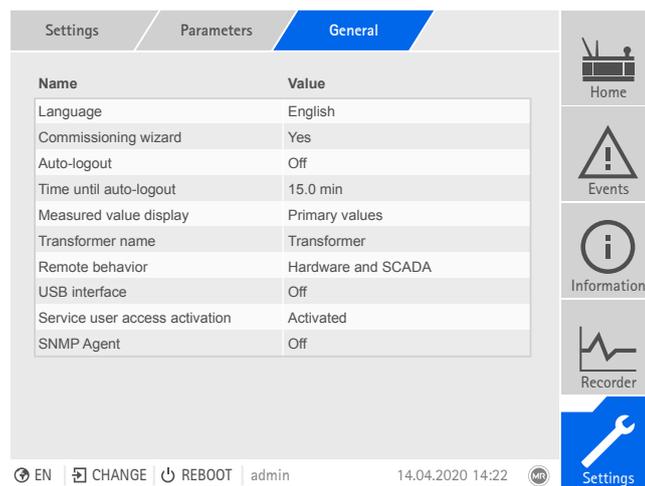


Figure 41: General

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. Select the desired parameter.
 3. Set the parameter.
 4. Press the **Accept** button to save the modified parameter.
 5. Restart the device to apply the change.



Service user access activation

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

8.3 Configuring the network

In this menu item, you can configure the network interface.

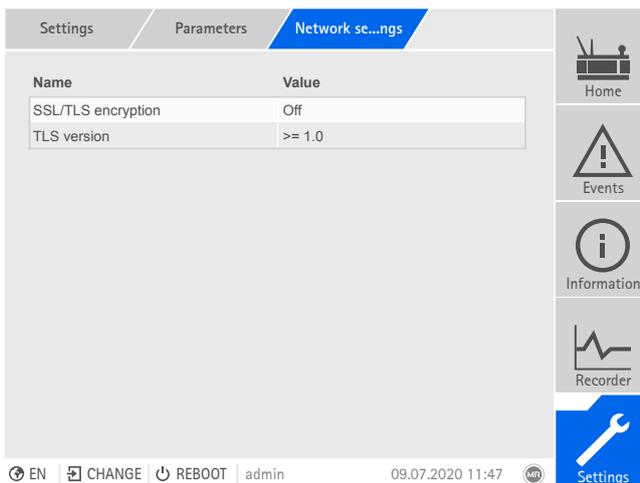


Figure 42: Network settings

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

SSL/TLS encryption

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

TLS version

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

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

Table 17: TLS version

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

8.4 Setting the device time

You can adjust the device time manually.

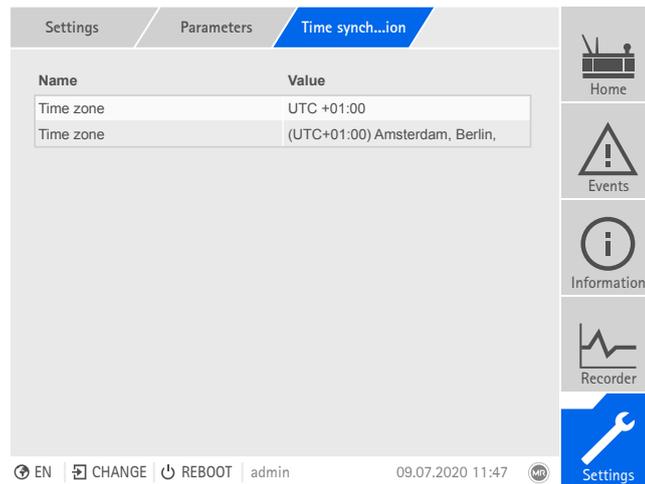


Figure 43: Time synchronization

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

Time zone

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

Example:

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

Table 18: Time shift to UTC (Coordinated Universal Time)

Time

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



8.5 Control of the motor-drive unit

The following parameters let you configure control of the motor-drive unit during an active return.

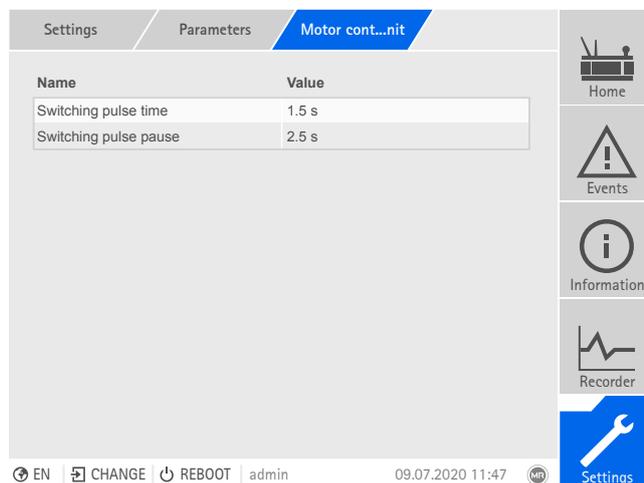


Figure 44: Motor control unit

Switching pulse time

You can use this parameter to set the maximum duration of the switching pulse. The switching pulse is reset after the switching pulse time has expired.

Switching pulse pause

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

8.6 Regulation

In this menu, you can configure the functions for monitoring voltage regulation.

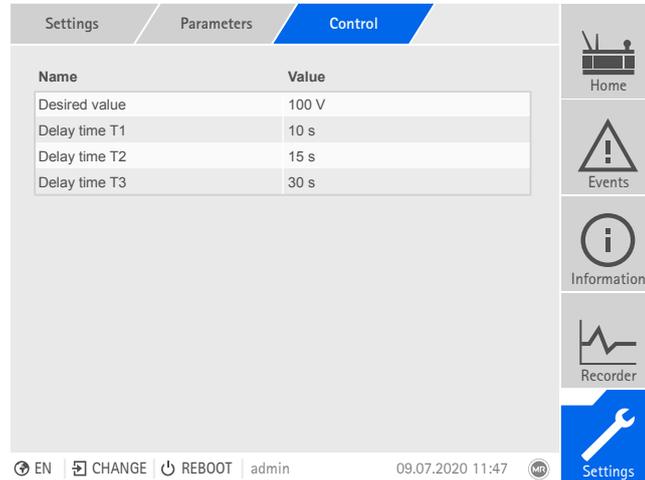


Figure 45: Control

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

Desired value

With this parameter, you can set the desired value for voltage monitoring. The desired value is the reference variable for the voltage limits ($U_{<<}$, $U_{<}$, $U_{>}$, $U_{>>}$).



Delay time T1

If the measured voltage is beyond the limit $U_{>>}$, the delay time $T1$ starts. Once the delay time $T1$ has expired, the device outputs a signal (pulse with a duration of 3 s) at output $U_{>> +T1 3s}$.

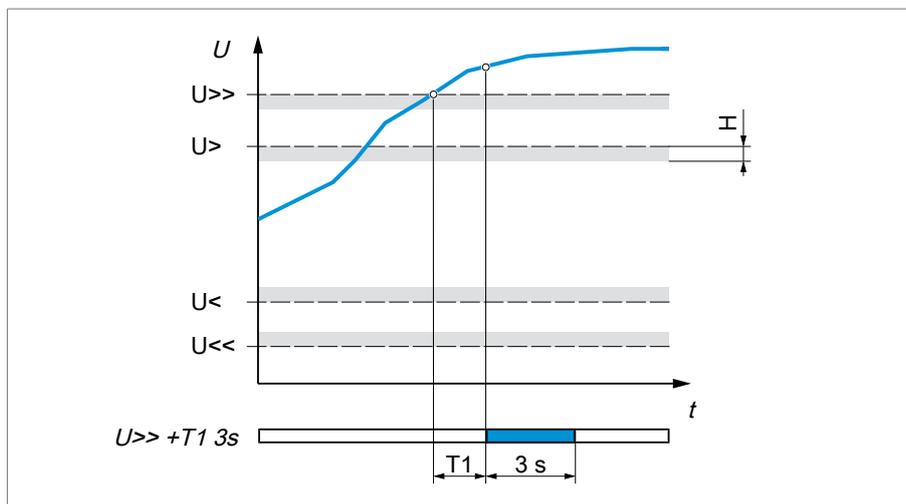


Figure 46: Response to delay time T1

$U_{>>}$	Overvoltage $U_{>>}$	$U_{>}$	Overvoltage $U_{>}$
$U_{<<}$	Undervoltage $U_{<<}$	$U_{<}$	Undervoltage $U_{<}$
$T1$	Delay time	H	Hysteresis

Delay time T2

The delay time $T2$ is used to detect a malfunction of the voltage regulator or on-load tap-changer. If the measured voltage is greater than the limit $U_{>}$ or less than the limit $U_{<}$, the delay time $T2$ starts.



Set the delay time $T2$ to the same value as the motor runtime parameter of the voltage regulator.

Voltage regulator fault If the voltage regulator outputs a switching command in the wrong direction after the expiration of delay time T2 (LOWER for U< or RAISE for U>), then the device outputs a signal at output *Voltage regulator fault*.

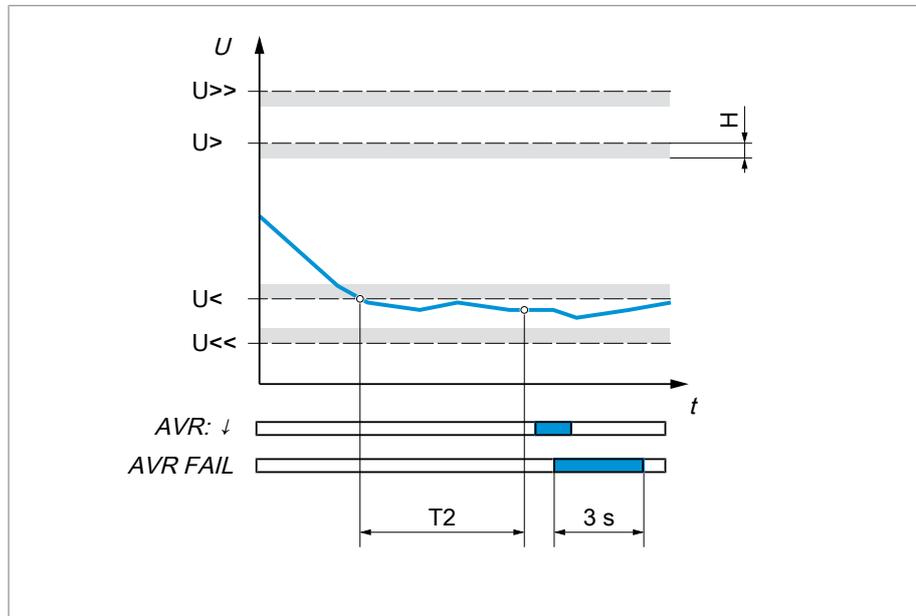


Figure 47: Delay time T2 AVR

U>> Overvoltage U>>	U> Overvoltage U>
U< Undervoltage U<	U<< Undervoltage U<<
H Hysteresis	AVR: ↓ Switching command from the voltage regulator in the lower-voltage direction
AVR Voltage regulator fault output	
FAIL	

On-load tap-changer fault If the measured voltage is not back within the limits after the delay time T2 has expired (e.g. because the motor-drive unit is interrupted due to a contactor getting stuck), the device outputs a signal (pulse with a duration of 3 s) at output *U<> +t2 3s*. Depending on the type of limit violation, the device simultaneously outputs a signal (pulse with a duration of 3 s) at output *U< +t2 3s* or *U> +t2 3s*. You can use these signals to trigger the motor protective switch of the motor-drive unit.



To use this function, the motor protective switch must be equipped with a trip coil.

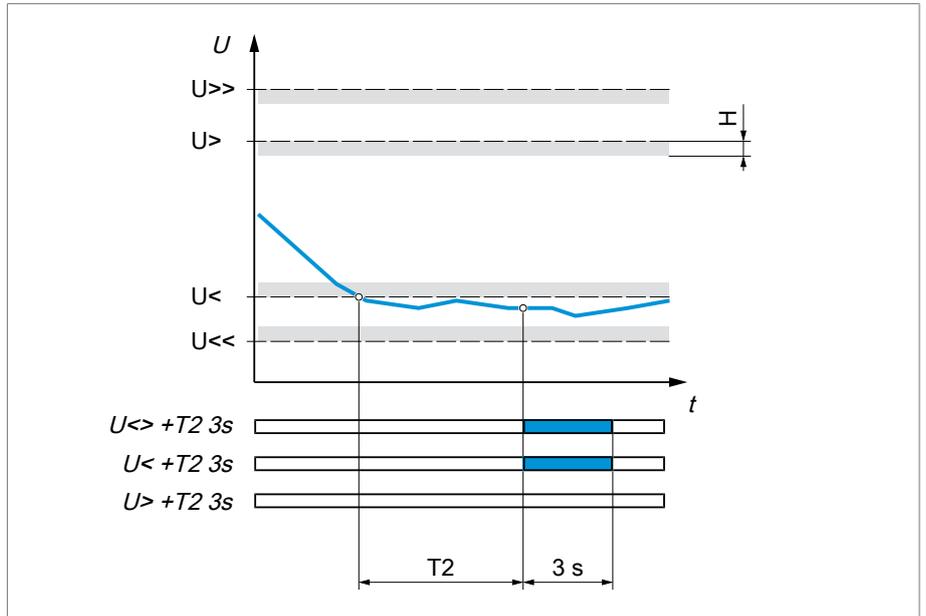


Figure 48: Delay time T2 of OLTC

U>> Overvoltage U>>	U> Overvoltage U>
U< Undervoltage U<	U<< Undervoltage U<<
H Hysteresis	U<> Output U<> +T2 3s +T2 3s
U< +T2 Output U< +T2 3s 3s	U> +T2 Output U> +T2 3s 3s

Delay time T3

If the measured voltage is less than the limit U<<, the delay time T3 starts. After the delay time T3 has expired, the device starts the Return [► Section 4.2, Page 19] function.

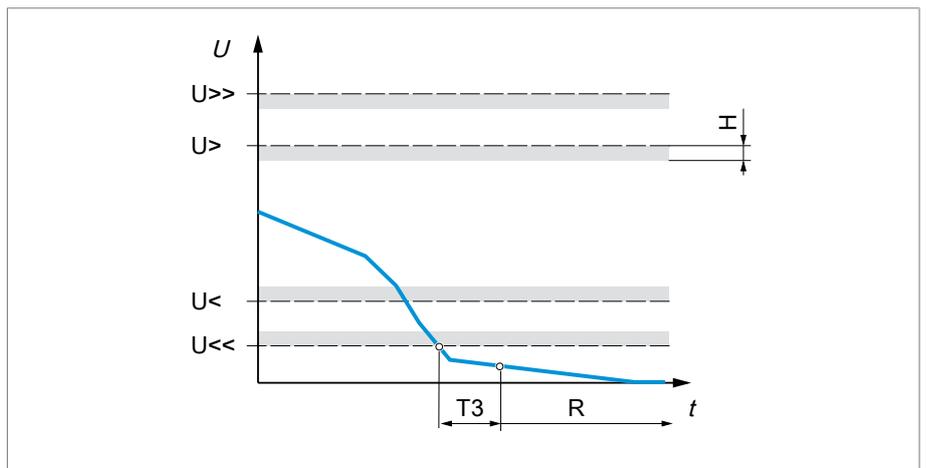


Figure 49: Response to delay time T3

U>>	Overvoltage U>>	U>	Overvoltage U>
U<<	Undervoltage U<<	U<	Undervoltage U<
T3	Delay time	H	Hysteresis
R	Return		

8.7 Voltage monitoring

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

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

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

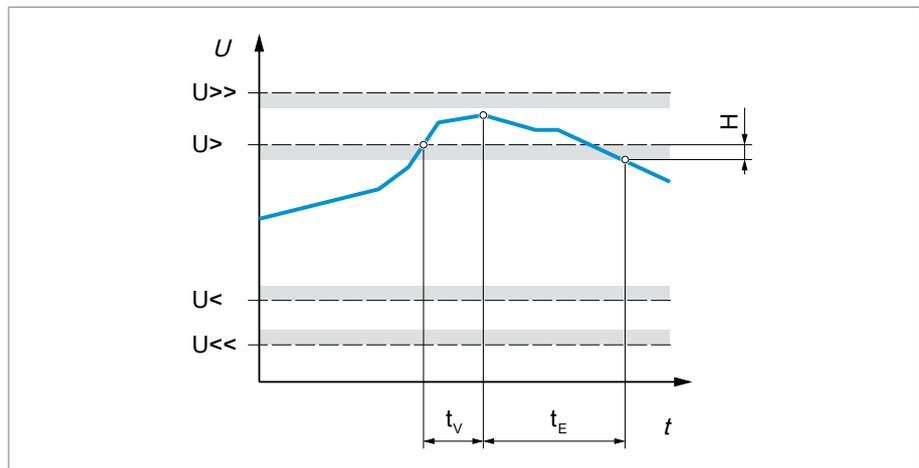


Figure 50: Example of voltage monitoring with the limit value Overvoltage U> being exceeded

U>>	Overvoltage U>>	U>	Overvoltage U>
U<	Undervoltage U<	U<<	Undervoltage U<<
t _V	Delay time	t _E	Event duration
H	Hysteresis		

You can set the following parameters for each limit value:

- Limit value [%]: Limit value relative to desired voltage value
- Hysteresis limit value
- Delay time limit value
- Behavior limit value

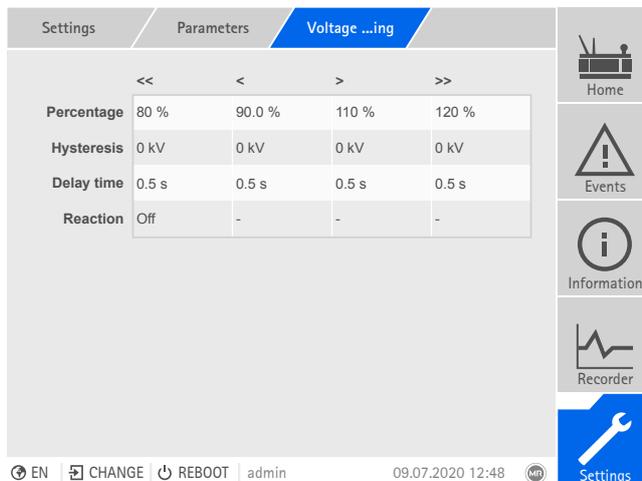


Figure 51: Voltage monitoring

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

Percentage

You can use this parameter to set the limit value relative to the desired voltage value.

Hysteresis

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

Delay time

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

Reaction

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

Setting	Behavior
Off	The limit value is not monitored.
Return	<ul style="list-style-type: none"> ▪ An event message is issued. ▪ The device starts the Return [▶ Section 4.2, Page 19] function.

Table 19: Behavior when an event message is issued

8.8 Setting transformer data

You can use the following parameters to set the transformer data for displaying the measured voltage.

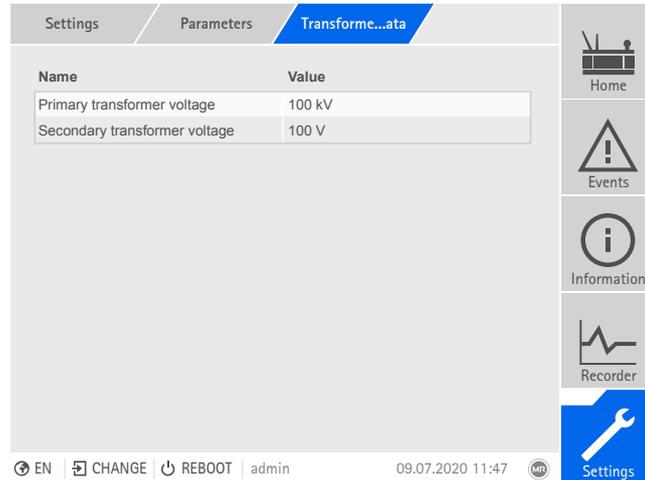


Figure 52: Transformer data

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

Primary transformer voltage

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

Secondary transformer voltage

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

8.9 Configuring digital inputs and outputs

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

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

You can change this configuration if necessary.

If you have connected sensors over the MR sensor bus, you must select the "Modbus" signal type for the desired functions. Observe the additional information provided in the MR sensor bus section.



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

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

Property	Options
Function	Function of the digital input (I: ...) or the digital output (O: ...). You can adjust the designation.
Signal type	Select signal type: <ul style="list-style-type: none"> ▪ Digital: Digital input ▪ Modbus (MR sensor bus)
Configuration ¹⁾	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 ¹⁾	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.

Table 20: Configuration of the digital inputs and outputs

¹⁾ Not available with sensors connected over the MR sensor bus (Modbus).

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

Table 21: Configuration of the digital inputs and outputs

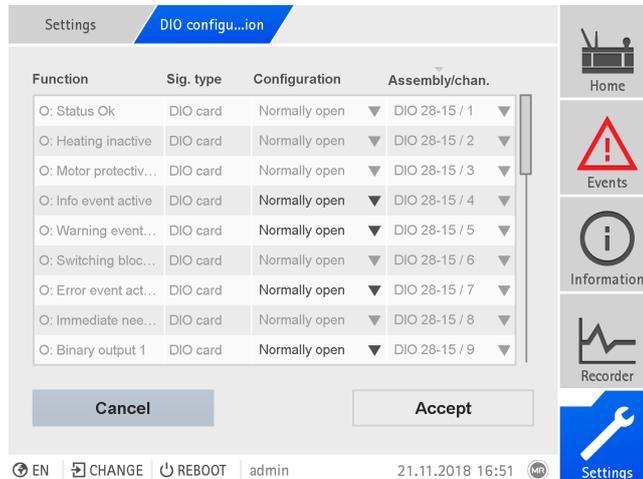


Figure 53: Configuring digital inputs and outputs



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`

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. Go to 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.

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

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

8.10 Event management

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

8.10.1 Displaying and acknowledging events

To display the events currently active, proceed as follows:

► Go to **Events**.

⇒ A list of currently pending events appears.

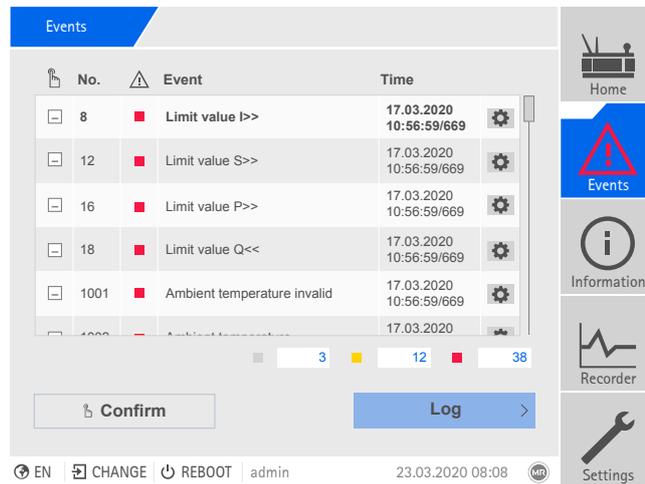


Figure 54: Overview of events currently active

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 is remedied (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.

8.10.2 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.

Property	Description
Category	<ul style="list-style-type: none"> Error (red) Warning (yellow) Info (gray) <p>This setting affects the color of the <i>Alarm</i> LED and the event symbol in the primary navigation.</p>
Report	If you activate this option, the event is shown on the display and, if configured accordingly, issued via an output and the control system protocol.
Save	If you activate this option, the event is stored in the event memory.
Multi-set (not configurable)	The event can be triggered several times without having been deactivated in the meantime.
High active (not configurable)	<p>High active: The device generates a signal if the event is pending.</p> <p>Low active: The device generates a signal so long as the event is not pending. If the event is pending, the signal is reset.</p>
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 is remedied (e.g. limit value is no longer exceeded).
Blocking (not configurable)	If the event is active, it blocks automatic voltage regulation.

Table 22: Properties of events

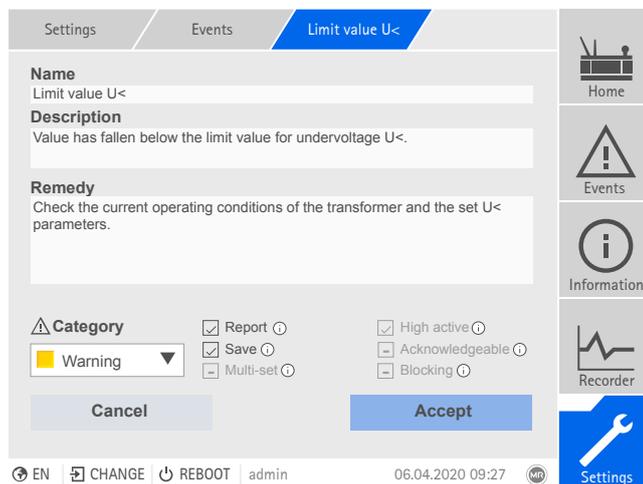


Figure 55: Configuring events

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.

8.10.3 Displaying event memory

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

Column	Description
#	Consecutive number of events
No.	Event number for clear identification
	Event category: <ul style="list-style-type: none"> ▪ Error (red) ▪ Warning (yellow) ▪ Info (gray)
Event	Event text
Time	Date and time of event (DD-MM-YYYY, HH:MM:SS/ms)
 / 	Event coming/going: <ul style="list-style-type: none"> ➤ Event coming ➤ Event going

Table 23: Event memory

To call up the event memory, proceed as follows:

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

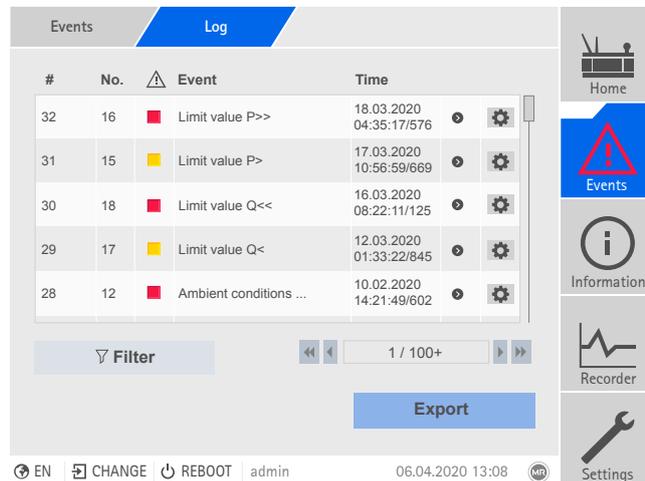


Figure 56: Event memory

Filtering events

To adjust the display, you can define a filter. To do so, proceed as follows:

1. Press the **Filter** button.
2. Enter the desired time period.

3. Select the desired event categories and the desired event status.
4. Select the desired events in the **Events** list.
5. Press the **Search** button to display the desired events.

Exporting events

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

To export the events, proceed as follows:

- ✓ First connect using Connect PC or connect a storage medium to the USB port on the CPU I [► Section 4.4.2, Page 21] module.
1. Press the **Export** button.
 2. Select the desired option for data transmission (PC or USB).
- ⇒ The data is exported.

8.11 User administration

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

8.11.1 User roles

The access rights to the 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 8.11.4, Page 82] 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. <ul style="list-style-type: none"> ▪ Display all parameters ▪ Display all events
Diagnostics	User who can view data and log data of relevance to operation. <ul style="list-style-type: none"> ▪ Display all parameters ▪ Display all events ▪ Export log data



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

Table 24: Roles in delivery status

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

Function	Data display	Diagnostics	Operator	Parameter configurator	Administrator
Administration	-	-	-	-	+
Restart device	-	-	+	+	+
Import	-	-	-	+	+
Export	-	+	-	+	+
Set date and time	-	-	+	+	+
Calling up the commissioning wizard	-	-	-	+	+
Configuring digital inputs and outputs	-	-	-	+	+

Table 25: Access rights permanently linked to the roles

8.11.2 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 the **user name** in the status line.

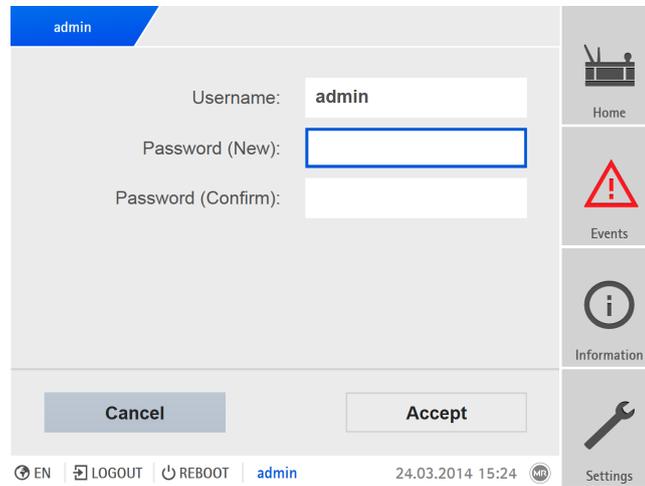


Figure 57: Changing the password

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

8.11.3 Creating, editing and deleting users

You can set the following options for all users:

- Username and password
- Role: You can assign a role to every user. The access rights to parameters and events are linked to the roles.
- Group account: With this option, you can declare a user account to be a group account (e.g. for access by different people). Users with a group account 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.

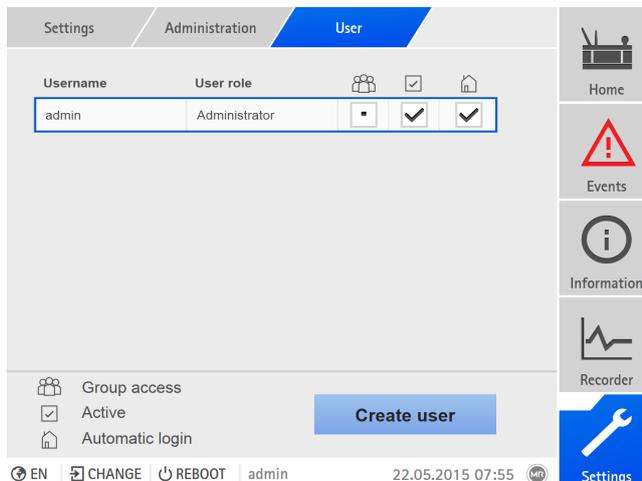


Figure 58: Overview of users created



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 > Administration > User**.
2. Press the **Create user** button.
3. Enter the **user name** once and the **password** twice.
4. Select the **role** you want.
5. If necessary activate the **Group account**, **Active** or **Auto 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 > Administration > User**.
2. Select the desired user in the list.
3. Make the amendments desired.
4. Press the **Accept** button to save the user.

Deleting user

To delete an existing user, proceed as follows:

1. Go to **Settings > Administration > User**.
2. Select the desired user in the list.
3. Press the **Delete user** button.
4. Press the **Accept** button to delete the user.

8.11.4 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.

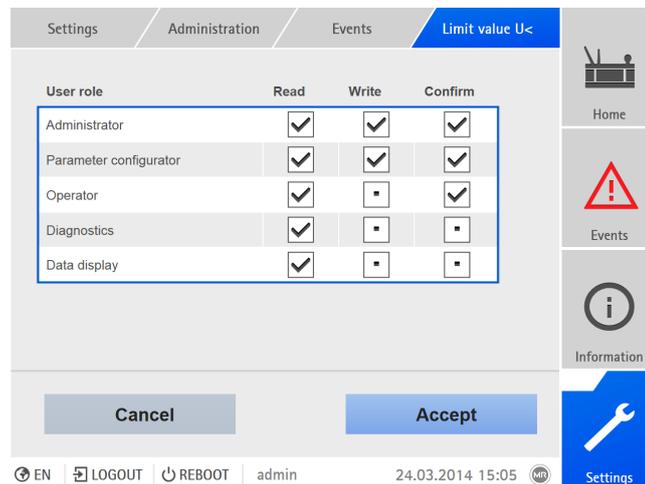


Figure 59: Setting access rights for an event



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`

To set the access rights to parameters and events, proceed as follows:

1. Go to **Settings > Administration > Parameters/events**.
⇒ A list of all parameters or events appears.
2. Select the desired entry in the list.
3. Select the options you want.

4. Press the **Accept** button to save the change.

8.12 Information about device

In this menu, you can view information about the device.

8.12.1 Hardware

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

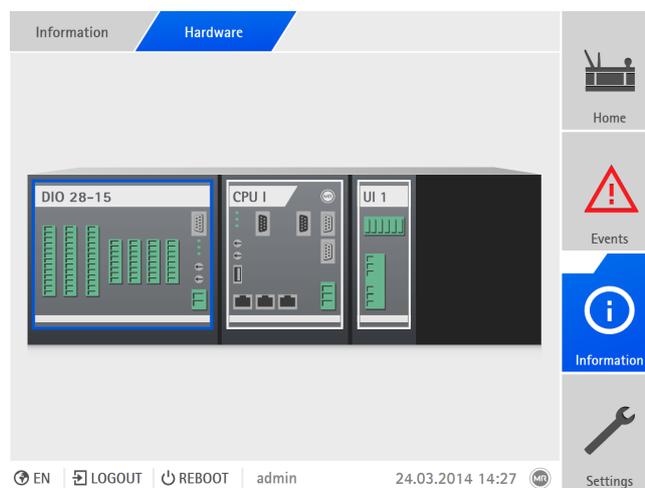


Figure 60: Displaying information about the device's hardware

To retrieve information on the hardware, proceed as follows:

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

8.12.2 Software

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

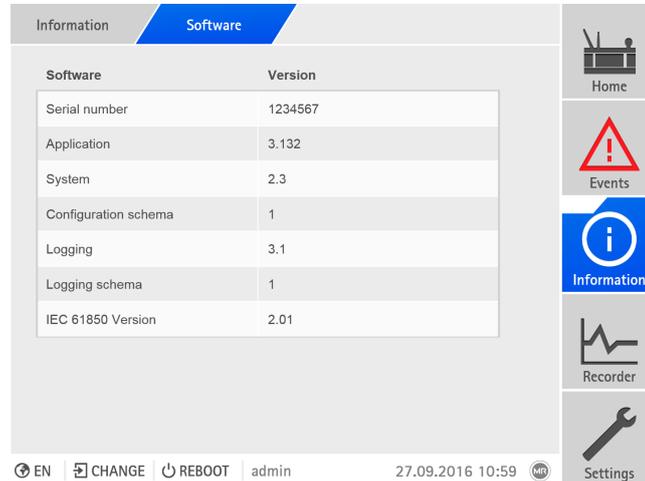


Figure 61: Information on the device's software

To retrieve information on the device's software, proceed as follows:

- Go to **Information > Software**.

8.13 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 assembly.
PC	Data transfer via PC using web-based visualization.

Table 26: Data transfer options

8.13.1 Exporting data



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



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

Option	Description
System image	Complete image of the system (software and configuration). If you are using the option "with history", all of the event memory entries are also exported.
System configuration	System configuration
Event memory	All event memory entries.
Parameter list	Parameter list with descriptive text and values (min, max, current).
Event list	Complete list of all possible events.
Operating Instructions	Operating instructions, protocol specifications.
Settings	Configuration of parameters and events.
Service data	Device data for support from the Maschinenfabrik Reinhausen GmbH Technical Service department
Security log	Logbook of all instances of access and changes relating to security.

Table 27: Exporting data



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.



8.13.2 Importing data

You can import the following data:

Option	Description
System image	Complete image of the system (software and configuration), with or without history.
Settings	All device settings: <ul style="list-style-type: none">▪ Parameter settings▪ Event settings▪ Administrative settings (users, access rights) The settings can also be imported from another device.
SSL certificate	Import of an SSL certificate with associated key: <ul style="list-style-type: none">▪ 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: <ul style="list-style-type: none">▪ RSA with 1024 bits▪ ECDSA with 256 bits ("secp256r1" or "prime256v1" curve).

Table 28: Importing data

NOTICE

Damage to the file system!

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

- ▶ Do not disconnect the device from the power supply during the import.
- ▶ During the import, do not remove the USB stick 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 the file to be imported.
 - ⇒ The file is checked.
4. Press the **Import** button.
 - ⇒ The data is imported, then the device is restarted.



9 Maintenance and care

The device is maintenance-free. You can clean the device's housing with a dry cloth.



10 Fault elimination

This chapter describes how to rectify simple operating faults.

10.1 General faults

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

Table 29: General faults

10.2 Regulation and monitoring

Characteristics/details	Cause	Remedy
Voltage regulator is faulty	Wiring error	Check wiring as per connection diagram.
▪ Event <i>Voltage regulator fault</i> is active.	Unintentional interference (cross talk) of the lines to the motor-drive unit	Keep lines as short as possible.

Table 30: No regulation in AUTO mode

10.3 Unwanted on-load tap-change operation

Characteristics/details	Cause	Remedy
Return activated	Setting of parameter U<<	Check parameters.
	Missing return at input <i>Low position</i>	Check wiring.

Table 31: Unexplained tap change



10.4 Human-machine interface

Characteristics/details	Cause	Remedy
Connection cannot be established with visualization	Connection cable defective	Check connection cable
	SSL encryption active	Accept SSL certificate in browser
		Call up IP address using <code>https://</code>
		Deactivate SSL encryption
	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 web browser.	Access to the visualization using a web browser after a software update.	Delete the web browser's cache.

Table 32: Human-machine interface

10.5 Incorrect measured values

Characteristics/details	Cause	Remedy
Measured voltage <ul style="list-style-type: none"> No measured value available. 	Connection has no contact in the plug terminal.	Check wiring and plug terminal.
	Insulation trapped	
	Wire is not inserted far enough.	
	Miniature circuit breaker has tripped.	Check fuse.
	Assembly UI 1 or UI 3 defective <ul style="list-style-type: none"> RDY LED does not light up RDY LED flashes 	Contact Maschinenfabrik Reinhausen GmbH.
Measured voltage <ul style="list-style-type: none"> Measured value too low. 	Voltage drop on the measuring line.	Check the measured voltage.
Measured voltage <ul style="list-style-type: none"> Measured value fluctuates. 	Possible sources of interference: <ul style="list-style-type: none"> Cables laid in parallel. Tap-change operations. 	Check the measured voltage.
		Increase the distance from the source of interference.
		Install a filter if necessary.

Table 33: Incorrect measured values



10.6 Assemblies

Consult the following table to check whether individual assemblies have a malfunction.

Assembly	Characteristics/details	Cause	Remedy
UI 1	<i>RDY</i> LED (yellow) does not light up	Communication with the assembly not possible.	Contact Maschinenfabrik Reinhausen GmbH.
	<i>RDY</i> LED (yellow) flashes	An error was detected in the assembly.	Contact Maschinenfabrik Reinhausen GmbH.
CPU I	<i>RUN</i> LED (green) does not light up	No voltage supply.	Check the voltage supply.
	<i>ERR</i> LED (red) lights up	An error was detected in the assembly.	Contact Maschinenfabrik Reinhausen GmbH.
DIO 28-15	<i>RUN</i> LED (green) does not light up	No voltage supply	Check the voltage supply
	<i>ERR</i> LED (red) lights up	An error was detected in the assembly.	Contact Maschinenfabrik Reinhausen GmbH.

Table 34: Assembly faults

10.7 Other faults

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

- Serial number
 - Nameplate
 - Info screen
- Software version [► Section 8.12, Page 83]

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?



11 Messages

11.1 Event messages

No.	Category	Name	Description	Remedy
3	Warning	Limit value U>	The limit value for overvoltage U> has been exceeded.	Check the current operating conditions of the transformer and the set U> parameters.
4	Warning	Limit value U>>	The limit value for overvoltage U>> has been exceeded.	Check the current operating conditions of the transformer and the set U>> parameters.
2177	Info	Return off	A signal is present at the Return OFF input.	-
2178	Info	LOW position reached	A signal is present at the LOW position reached input.	-
2179	Info	Raise voltage from regulator	A signal is present at the Raise voltage from regulator input.	-
2180	Info	Lower voltage from regulator	A signal is present at the Lower voltage from regulator input.	-
2181	Warning	U<<	The voltage is below the limit U<<.	-
2182	Warning	U<	The voltage is below the U< limit but above the U<< limit.	-
2183	Warning	U<>	One or both of the voltage limits U< or U> has been violated.	-
2184	Warning	U<> +T2 3s	The U<> +T2 3s relay is switched on.	-
2185	Warning	U>> +T1 3s	The U>> +T1 3s relay is switched on.	-
2186	Warning	U> +T2 3s	The U> +T2 3s relay is switched on.	-
2187	Warning	U< +T2 3s	The U< +T2 3s relay is switched on.	-
2188	Warning	Voltage regulator fault	The voltage regulator fault relay is switched on.	-
2189	Info	Return ON	The Return ON function is switched on.	-
2190	Warning	Return running	The return is active. The voltage is below the limit U<<. Switching pulses will be issued until a signal is present at the LOW position input.	-

Table 35: Event messages



11.2 Digital inputs and outputs

Designation	Input*	Function
Return OFF	DIO 28-15:9	Deactivate the temporary return function.
LOW position	DIO 28-15:10	Message from the motor-drive unit that the return target range has been reached.
RAISE signal (AVR)	DIO 28-15:1	RAISE voltage switching command from voltage regulator
LOWER signal (AVR)	DIO 28-15:2	LOWER voltage switching command from voltage regulator

Table 36: Digital inputs

*) Factory setting; for commissioning the device, you can configure the digital inputs and outputs [► Section 8.9, Page 72].

Designation	Output*	Function
U>	DIO 28-15:3A/C	N/C contact for interrupting the switching command of the voltage regulator in the RAISE direction.
U<	DIO 28-15:2A/C	N/C contact for interrupting the switching command of the voltage regulator in the LOWER direction.
Return pulse	DIO 28-15:13B/C	N/O contact for switching command to the motor-drive unit for the return function.
U<	DIO 28-15:4B/C	N/O contact for U< message
U>	DIO 28-15:5B/C	N/O contact for U> message
AVR FAIL	DIO 28-15:9B/C	N/O contact for the Voltage regulator fault message
U<<	DIO 28-15:12B/C	N/O contact for U<< message
U<>	DIO 28-15:6B/C	N/O contact for the message that measured voltage is greater than limit U> or less than limit U<
U<> +t2 3s	DIO 28-15:7B/C	Pulse (duration = 3 s) after T2 expires in case of U> or U<.
U>> +t1 3s	DIO 28-15:8B/C	Pulse (duration = 3 s) after T1 expires in case of U>>.
U> +t2 3s	DIO 28-15:10B/C	Pulse (duration = 3 s) after T2 expires in case of U>.
U< +t2 3s	DIO 28-15:11B/C	Pulse (duration = 3 s) after T2 expires in case of U<.
Status OK	DIO 28-15:1A/B/C	N/O contact: Device ready to operate message N/C contact: Device faulty message



Designation	Output*	Function
Return ON	DIO 28-15:14B/C	N/O contact for Return switched on message.
Return running	DIO 28-15:15B/C	N/O contact for Return running message.
U>>	Inactive	N/O contact for U>> message
U>> + t1 3s	Inactive	Pulse (duration = 3 s) after T1 expires in case of U>>.

Table 37: Digital outputs

*) Factory setting; for commissioning the device, you can configure the digital inputs and outputs [► Section 8.9, Page 72].

12 Uninstallation

The following describes the safe removal of the device.

⚠ DANGER



Electric shock!

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

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

⚠ WARNING



Electric shock!

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

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

NOTICE

Damage to the device!

Electrostatic discharge may cause damage to the device.

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

12.1 Uninstalling the CPU assembly

1. Remove the 24V DC plug.

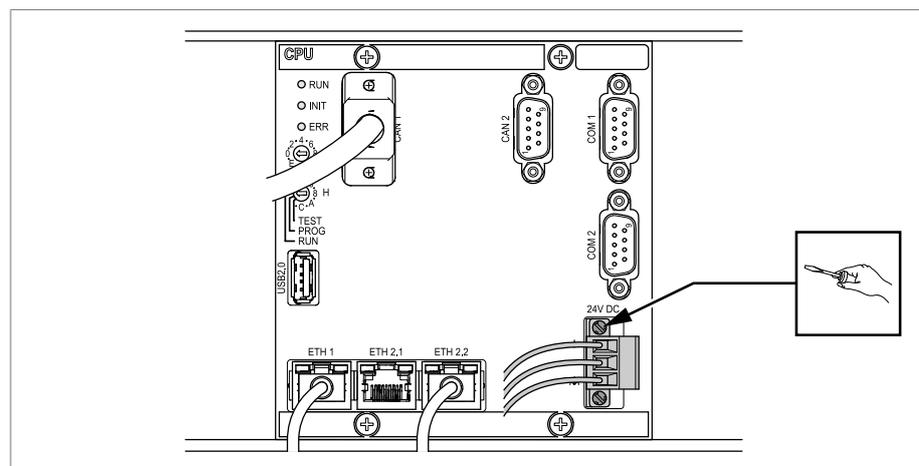


Figure 62: Removing the plug (voltage supply)

2. Remove the Ethernet cable.

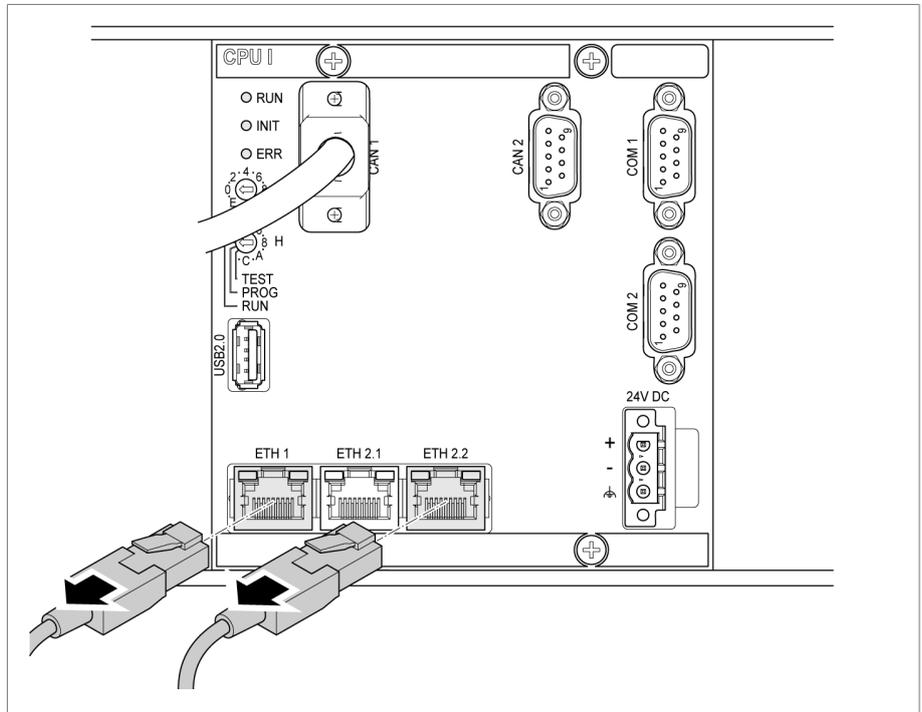


Figure 63: Removing the Ethernet cable

3. If necessary, remove the data cable (D-Sub 9-poles).

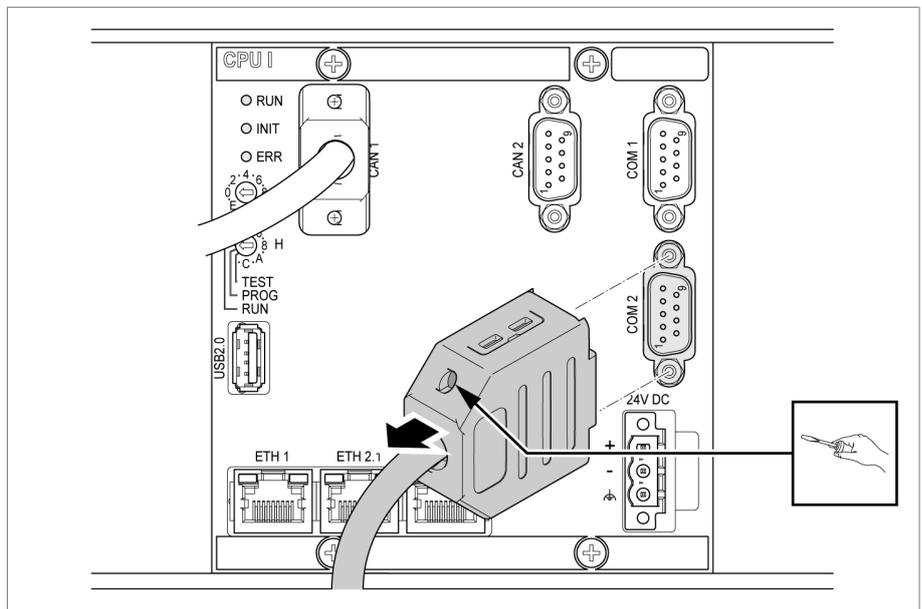


Figure 64: Removing the data cable

4. Remove the CAN bus cable.

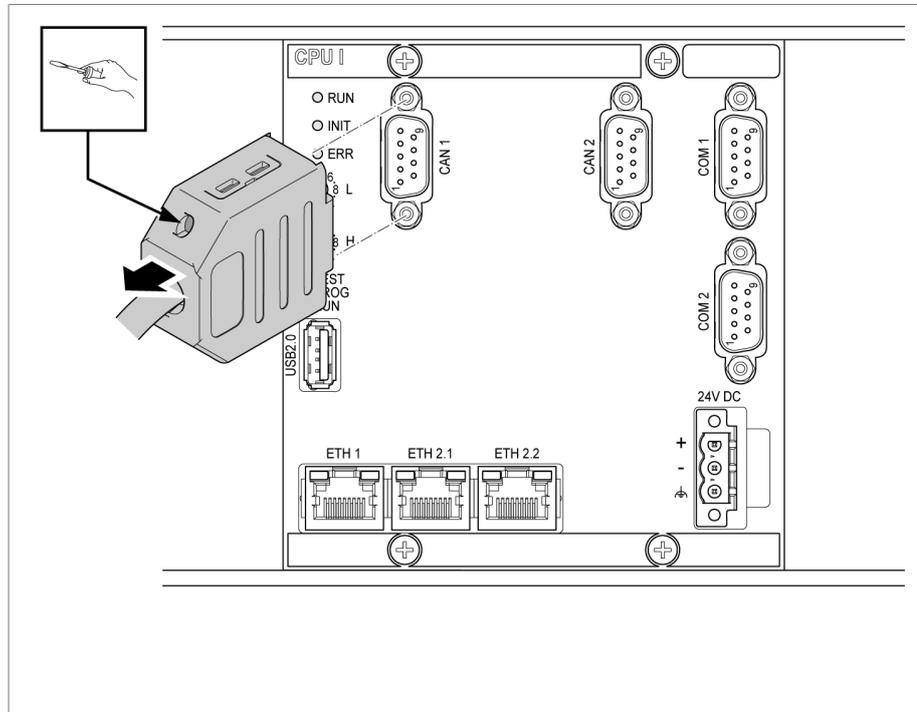


Figure 65: CAN bus cable

5. Unscrew the fixing screws.

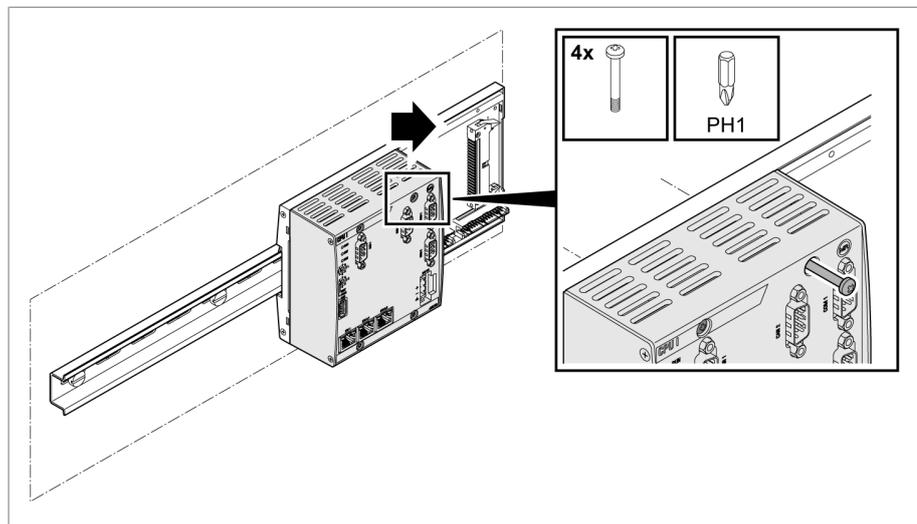


Figure 66: Unscrewing the fixing screws



6. Unplug the assembly.

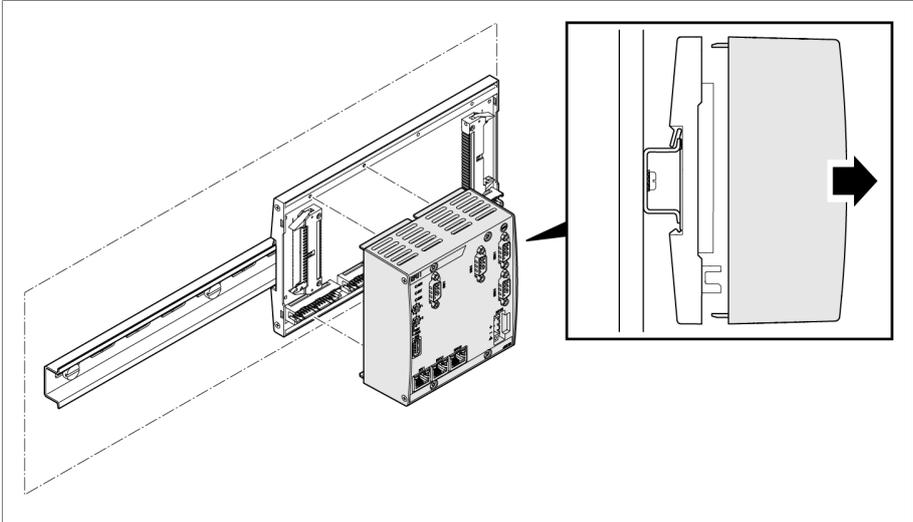


Figure 67: Unplugging the CPU assembly

12.2 Uninstalling the UI 1/UI 3 assembly

1. Remove the plug for the voltage measurement.

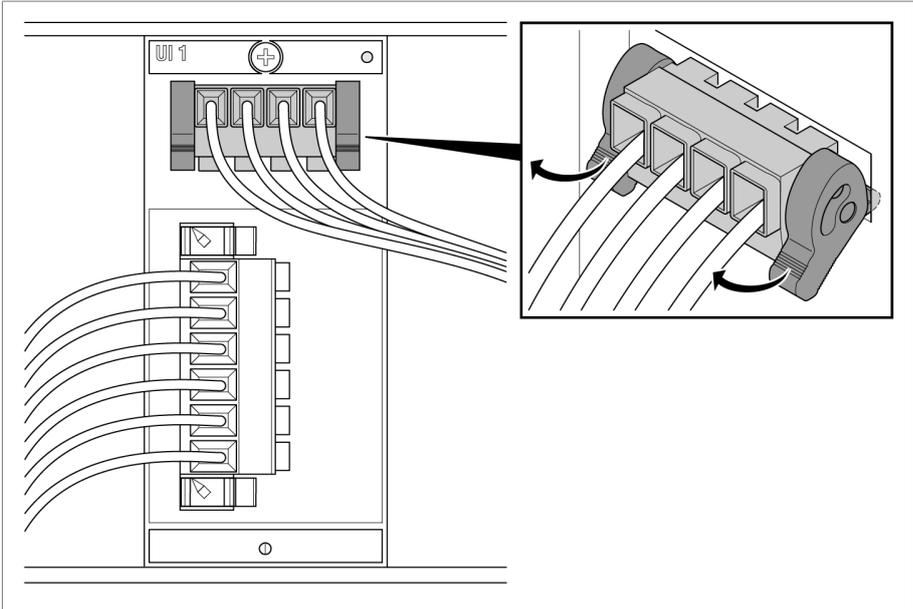


Figure 68: Voltage measurement

2. **⚠ WARNING!** Make sure that the current transformer is shorted. Otherwise dangerously high voltages could occur. Remove the plug for the current measurement.

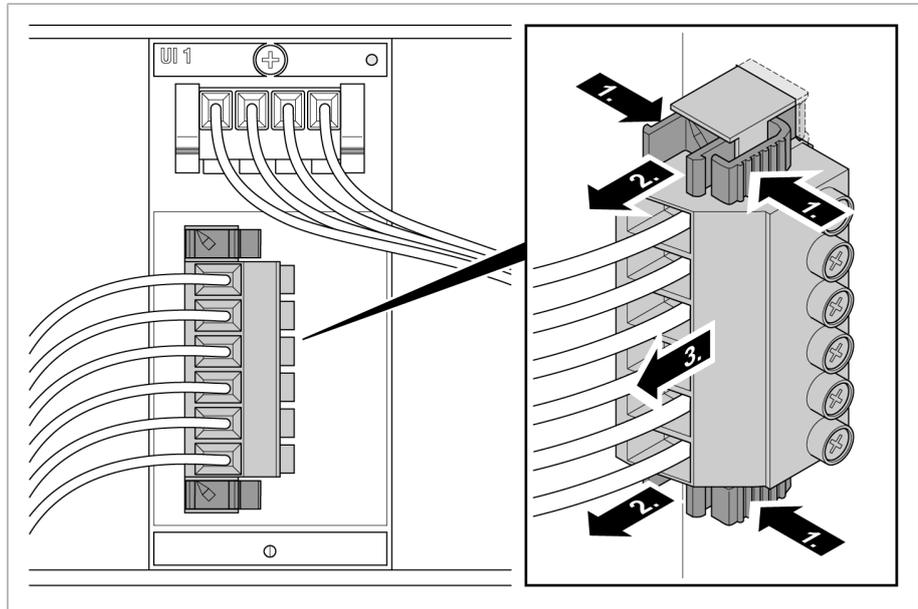


Figure 69: Current measurement

3. Loosen the fixing screws and unplug the assembly.

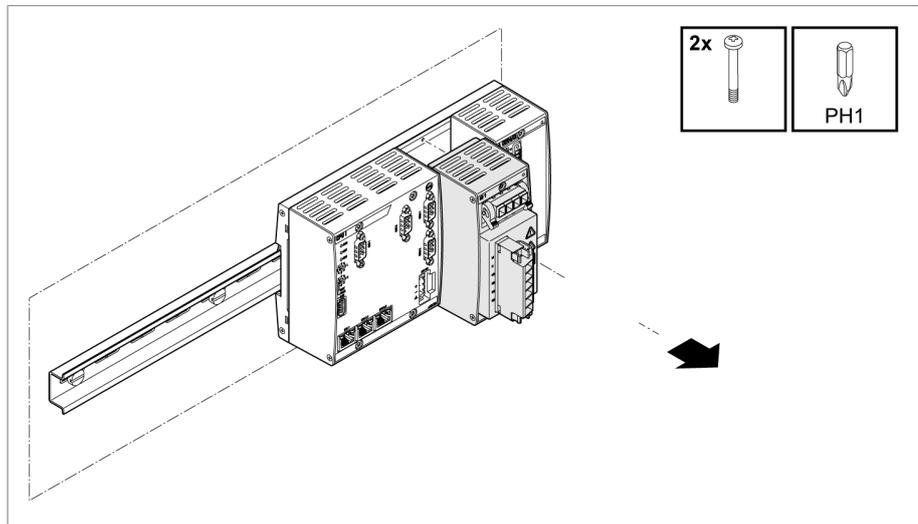


Figure 70: Unplugging the UI assembly

12.3 Uninstalling the DIO 28-15/DIO 42-20 assembly

1. Remove the 24V DC plug.

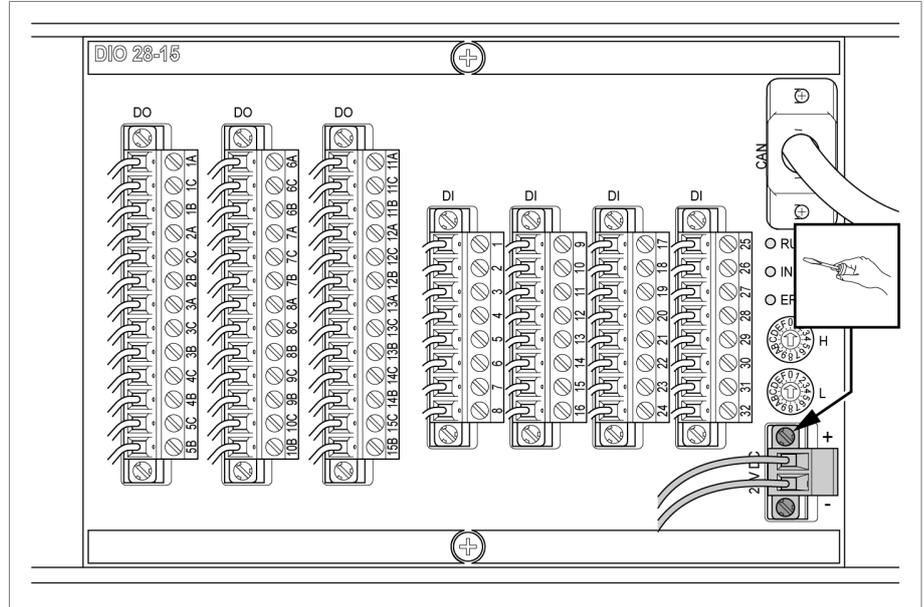


Figure 71: Removing the plug (voltage supply)

2. Remove the CAN bus cable.

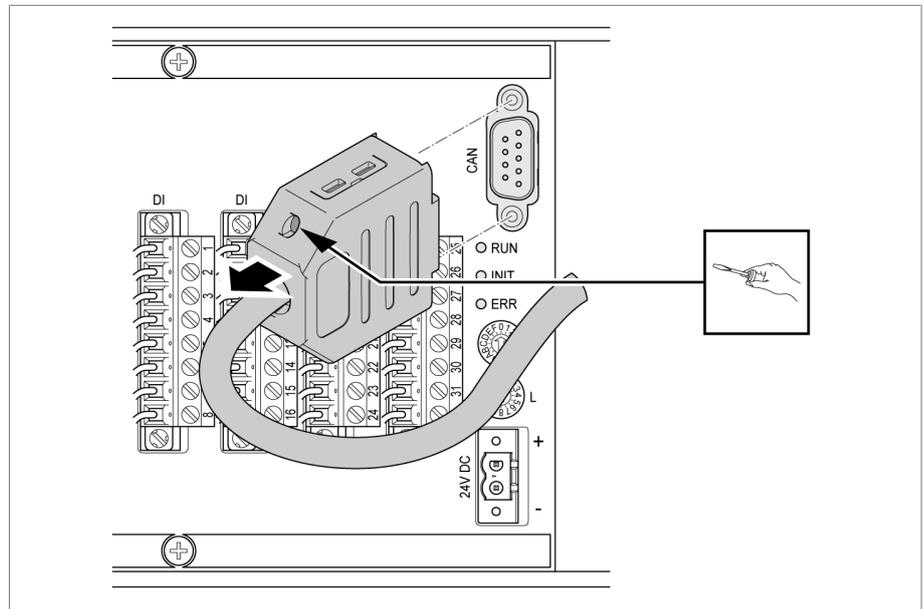


Figure 72: CAN bus cable

3. Remove all plugs in the "DI" and "DO" terminals.

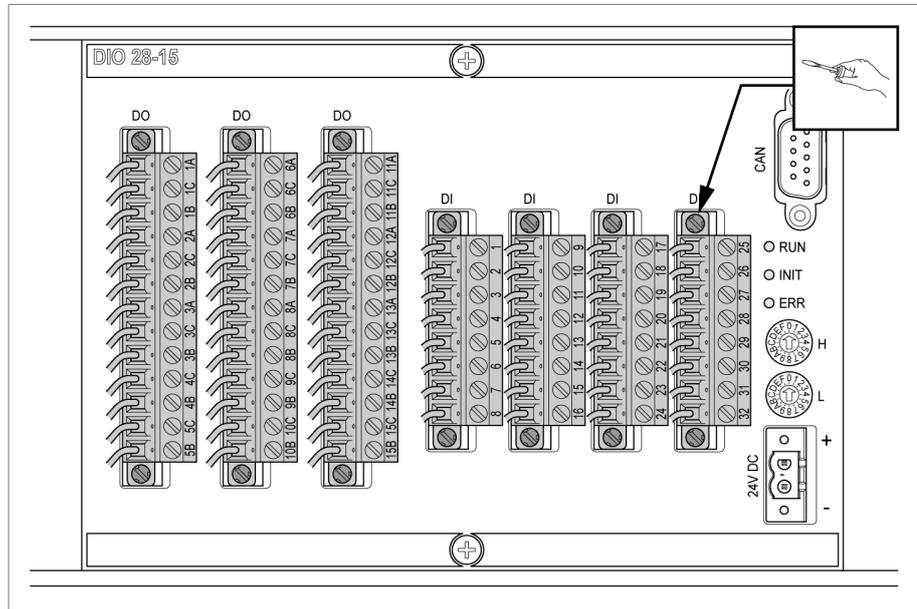


Figure 73: Removing the "DI" and "DO" plugs

4. Unplug the assembly.

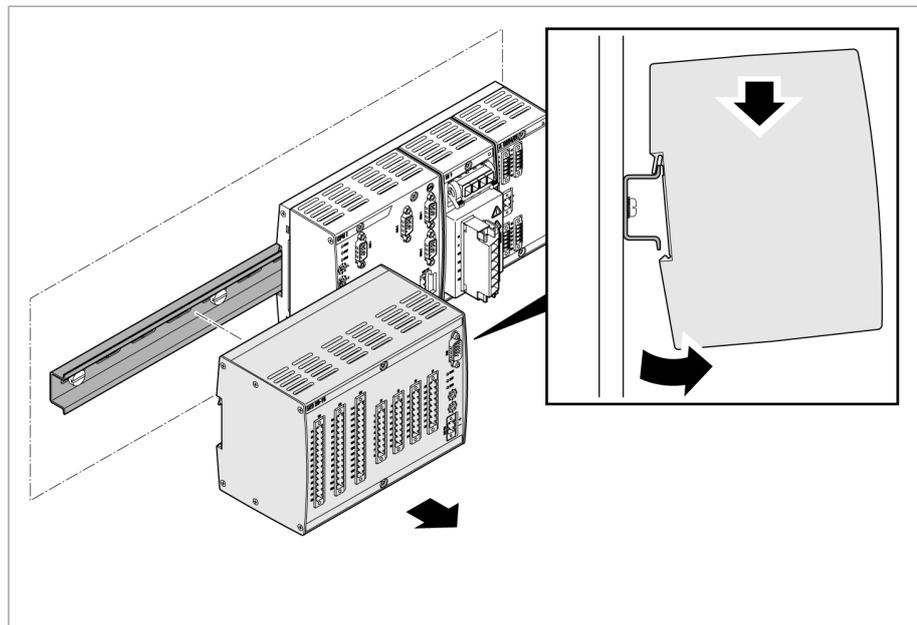


Figure 74: Unplugging the DIO assembly

12.4 Uninstalling the QS3.241 assembly

1. Open the lever **1** and remove the neutral conductor (N), phase conductor (L) and the protective conductor **2**.

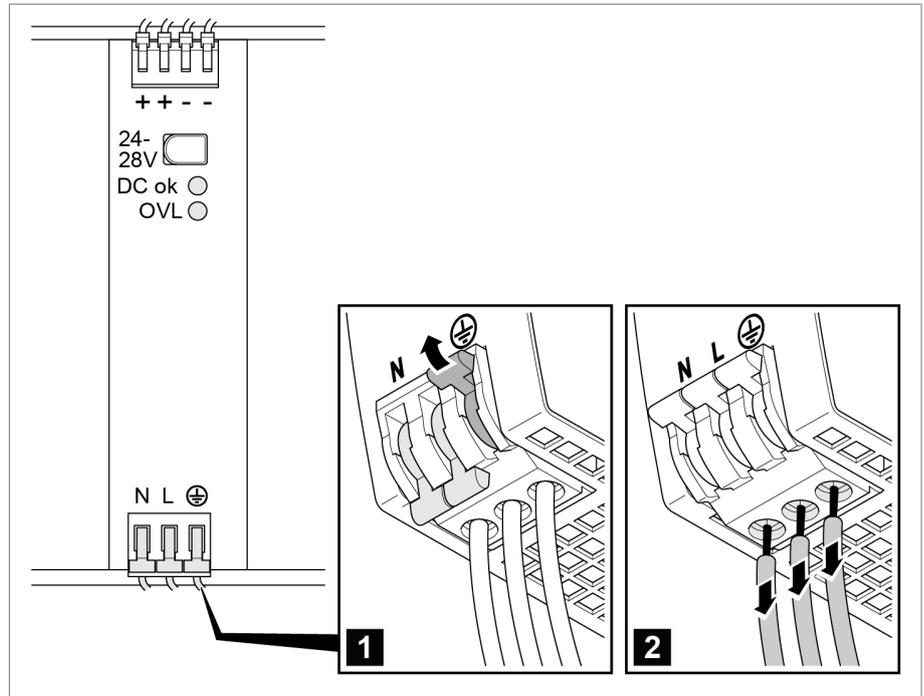


Figure 75: Removing the neutral conductor, phase conductor and protective conductor

2. Open the lever **1** and remove the wiring **2**.

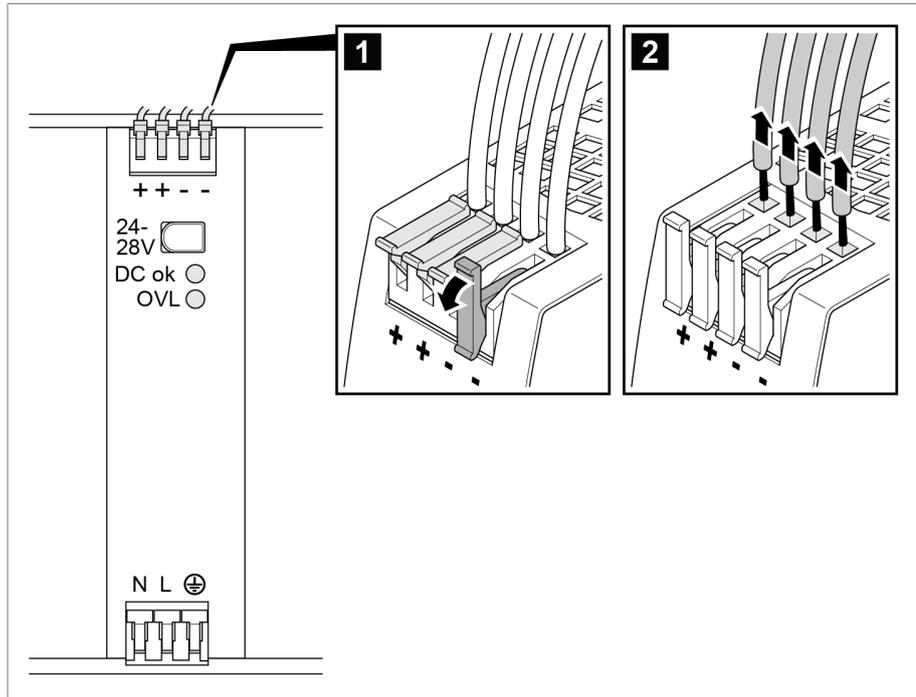


Figure 76: Removing the wiring

12.5 Uninstalling the bus rail

Once you have dismantled all assemblies, you can unhook the bus rails:

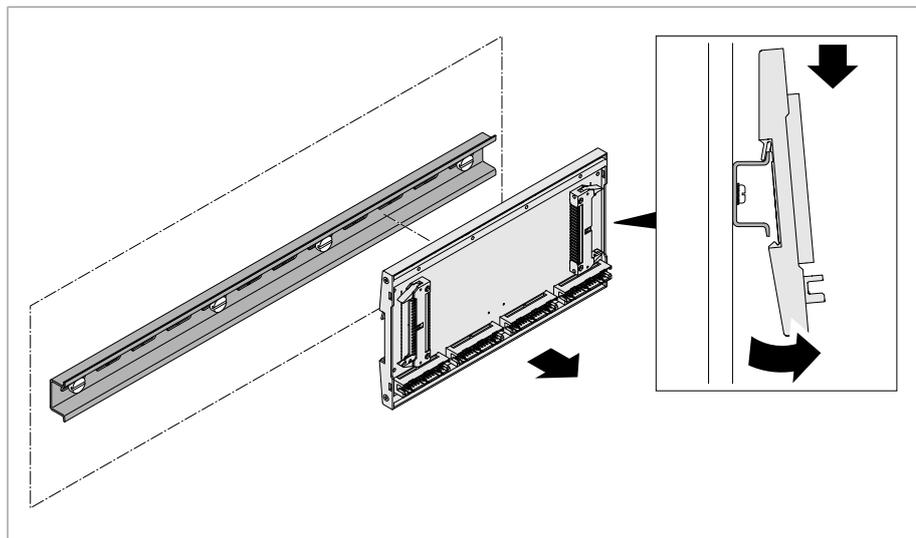


Figure 77: Unhooking the bus rails



13 Disposal

Observe the national requirements applicable in the country of use.



14 Overview of parameters

Parameter	Setting range	Factory settings	Current settings
Settings > Parameters > System > General			
Language	German English	English	
Commissioning wizard	Yes No	Yes	
Auto-logout	Off On	Off	
Time until auto-logout	5.0 min...120.0 min	15.0 min	
Measured value display	Primary values Secondary values	Primary values	
Transformer name	-	Transformer	
USB interface	Off On	Off	
Service user access activation	Deactivated Activated	Activated	
Settings > Parameters > System > Network settings			
SSL/TLS encryption	Off On	Off	
TLS version	>= 1.0 >= 1.1 >= 1.2	>= 1.0	
Settings > Parameters > System > Time synchronization			
Time zone	UTC -12:00...UTC +12:00	UTC +01:00	
Time zone	(UTC-11:00) Coordinated Universal Time -11...(UTC +14:00) Kiritimati (Christmas Island)	(UTC+01:00) Amsterdam, Berlin, Bern, Rome, Stockholm, Vienna	
Settings > Parameters > Motor-drive unit > Motor control			
Switching pulse time	0.5 s...10.0 s	1.5 s	
Switching pulse pause	0.5 s...10.0 s	2.5 s	
Settings > Parameters > Grid > Control			
Desired value	49.0 V...140.0 V	100.0 V	
Delay time T1	1.0 s...10.0 s	10.0 s	
Delay time T2	5.0 s...15.0 s	15.0 s	
Delay time T3	2.0 s...30.0 s	30.0 s	
Settings > Parameters > Grid > Transformer data			
Primary transformer voltage	57 V...1,000,000 V	100,000 V	



Parameter	Setting range	Factory settings	Current settings
Secondary transformer voltage	57 V...135 V	100 V	
Settings > Parameters > Grid > Voltage monitoring			
U< [%]	60.0 %...100.0 %	90.0 %	
U< hysteresis	0.0 V...10.0 V	0.0 V	
U< delay time	0.5 s...60.0 s	0.5 s	
U<< [%]	60.0%...100.0%	80.0%	
U<< hysteresis	0.0 V...10.0 V	0.0 V	
U<< delay time	0.5 s...60.0 s	0.5 s	
U<< behavior	Off Return	Off	
U> [%]	100.0%...140.0%	110.0%	
U> hysteresis	0.0 V...10.0 V	0.0 V	
U> delay time	0.5 s...60.0 s	0.5 s	
U>> [%]	100.0%...140.0%	120.0%	
U>> hysteresis	0.0 V...10.0 V	0.0 V	
U>> delay time	0.5 s...60.0 s	0.5 s	

Table 38: Overview of parameters



15 Technical data

15.1 Voltage supply

G1 PULS QS3.241	
Permissible voltage range	85 to 276 V AC
	88 to 375 V DC
	V_N : 100 to 240 V AC
	U_N : 110 to 300 V DC
Permissible frequency range	50/60 Hz
Nominal power consumption	55 W
Maximum power consumption (continuous)	70 W

Table 39: Voltage supply

15.2 UI 1 voltage measurement and current measurement

UI 1	
Measurement	1-phase
Voltage measurement	U_N (RMS): 100 VAC
	Measuring range (RMS): 19.6...150 VAC
	Measuring accuracy (at U_N , -25...+70°C): $<\pm 0.3\%$
	Intrinsic consumption: < 1 VA
	Measurement category III in accordance with IEC 61010-2-30
Current measurement	I_N : 0.2 / 1 / 5 A
	Measuring range: $0.01...2.1 \cdot I_N$
	Overload capacity: 12.5 A (continuous), 500 A (for 1 s)
	Measuring accuracy (at I_N , -25...+70°C): $<\pm 0.5\%$
	Intrinsic consumption: < 1 VA
Phase angle	Measuring accuracy (-25...+70°C): $U_x/I_x <\pm 0.5^\circ$; $U_x/U_y <\pm 0.3^\circ$
Frequency measurement	f_N : 50 / 60 Hz
	Measuring range: 45...65 Hz
	Measuring accuracy (-25...+70°C): $<\pm 0.03\%$

Table 40: Technical data for the UI 1 assembly

Interface	Pin	Description
	N	Voltage input for neutral conductor
	L	Voltage input for phase L
	NC	-
	NC	-

Table 41: Voltage measurement

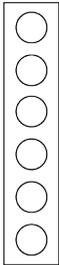
Interface	Pin	Description	
	UI 1	k	Current input for phase L
	k	I	Current output for phase L
	I	NC	-
	NC	NC	-

Table 42: Current measurement

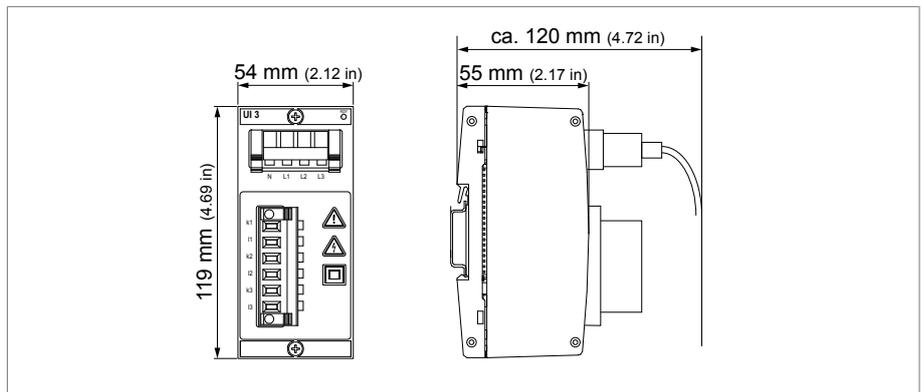


Figure 78: UI 1 dimensions

15.3 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 to 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 43: Technical data for the DIO 28-15 assembly

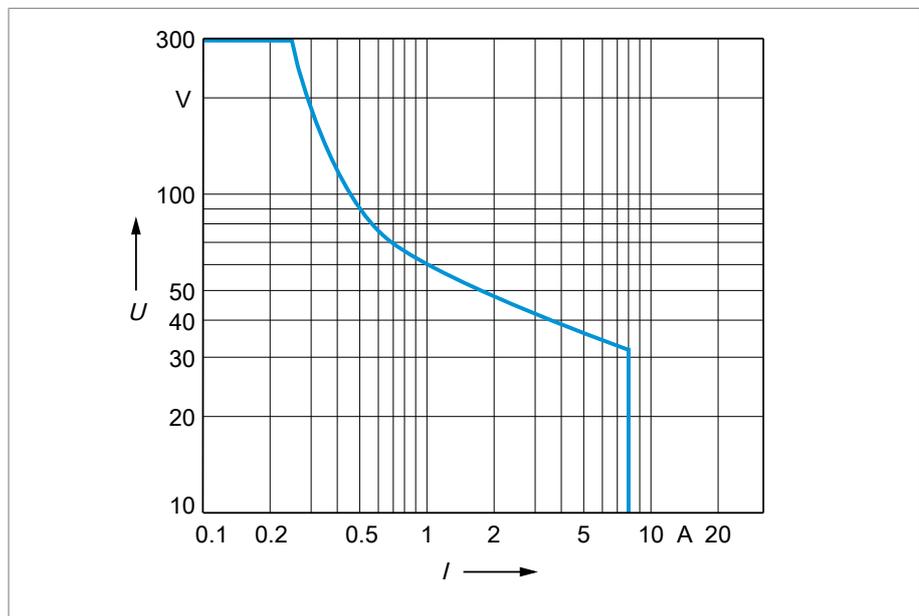


Figure 79: Contact load capacity DIO

▲ 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.

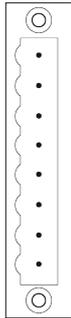
Interface	Pin				Description
	1	9	17	25	Input
	2	10	18	26	Input
	3	11	19	27	Input
	4	12	20	28	Input
	5	13	21	29	Input
	6	14	22	30	Input
	7	15	23	31	Input
	8	16	24	32	Common

Table 44: Digital inputs

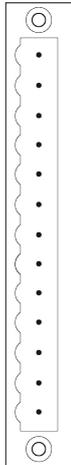
Interface	Pin			Description
	1A	6A	11A	Break contact
	1C	6C	11C	Source contact
	1B	6B	11B	Make contact
	2A	7A	12A	Break contact
	2C	7C	12C	Source contact
	2B	7B	12B	Make contact
	3A	8A	13A	Break contact
	3C	8C	13C	Source contact
	3B	8B	13B	Make contact
	4C	9C	14C	Source contact
	4B	9B	14B	Make contact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

Table 45: Digital outputs

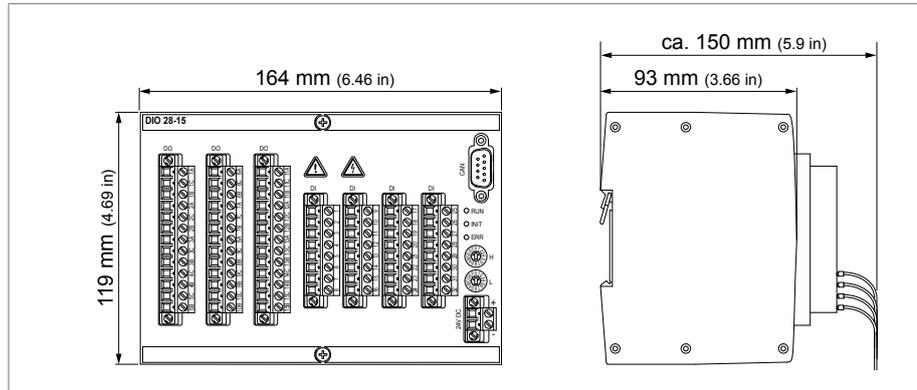


Figure 80: DIO 28-15 dimensions

15.4 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 46: Technical data for the CPU I assembly

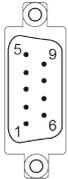
Interface	Pin	Description
	2	RXD (RS232)
	3	TXD (RS232)
	5	GND (RS232, RS485)
	6	RXD+/TXD+ (RS485)
	9	RXD-/TXD- (RS485)

Table 47: COM2 (RS232, RS485)



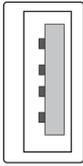
Interface	Pin	Description
	1	VCC
	2	D-
	3	D+
	4	GND

Table 48: USB 2.0

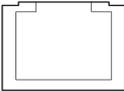
Interface	Pin	Description
	1	TxD+
	2	TxD-
	3	RxD+
	4	NC
	5	NC
	6	RxD-
	7	NC
	8	NC-

Table 49: ETH1, ETH 2.1, ETH 2.2 (RJ45)

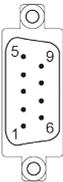
Interface	Pin	Description
	2	CAN-L
	3	CAN-GND
	7	CAN-H

Table 50: CAN1, CAN2

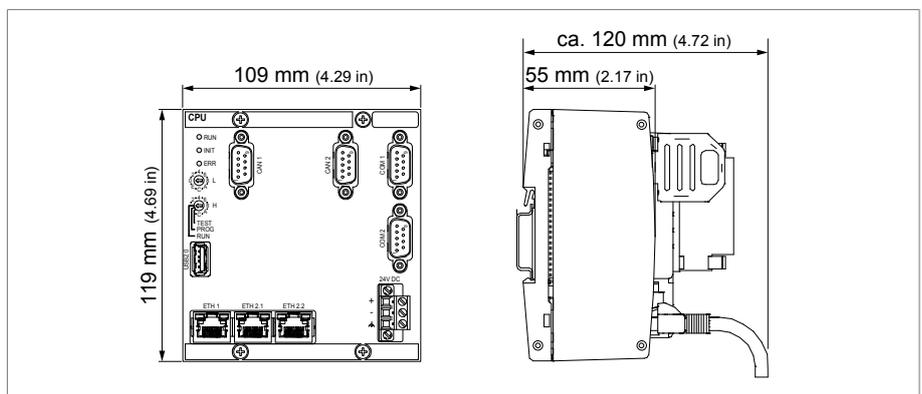


Figure 81: CPU dimensions



Optional accessories	
CAN bus	Terminating resistor <ul style="list-style-type: none"> ▪ 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: <ul style="list-style-type: none"> ▪ 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 51: Optional accessories

15.5 Ambient conditions

Operating temperature	-25...+70 °C
Storage temperature	-40...+85 °C
Relative humidity	10...95% non-condensing
Air pressure	Corresponds to 2000 m above sea level Corresponds to 2000 m above sea level
Minimum spacing to other devices/control cabinet	Top/Bottom: 88.9 mm (3.5 in; corresponds to 2 RU), back 30 mm (1.2 in)

Table 52: Permissible ambient conditions

15.6 Standards and directives

Electrical safety

IEC 61010-1 IEC 61010-2-030	Safety requirements for electrical measurement and control and regulation equipment and laboratory instruments <ul style="list-style-type: none"> ▪ Protection class 1 ▪ Overvoltage category III ▪ Contamination level 2
IEC 60950-1	Information technology equipment – Safety

Table 53: Electrical safety



Electromagnetic compatibility

IEC 61000-4-2	Immunity to electrostatic discharge (ESD) <ul style="list-style-type: none"> ▪ Front panel and operating elements ▪ Contact: ±8 kV ▪ Air: ±15 kV ▪ Terminals, plug connectors, and interfaces: ▪ Contact: ±6 kV ▪ Air: ±8 kV
IEC 61000-4-3	Immunity to high-frequency electromagnetic fields <ul style="list-style-type: none"> ▪ 20 V/m; 80...4000 MHz; 80% AM ▪ 20 V/m; 900 MHz ±5 MHz; PM
IEC 61000-4-4	Immunity to quick, transient electrical disturbances (burst) <ul style="list-style-type: none"> ▪ Power supply: 4 kV ▪ Measurement (UI1/3): 4 kV ▪ Digital I/O: 4 kV ▪ Analog I/O, shielding on both sides: 4 kV ▪ Communication interfaces, shielding on both sides: 4 kV
IEC 61000-4-5	Immunity to impulse voltages (surge) <ul style="list-style-type: none"> ▪ AC power supply: 4 kV CM, 2 kV DM ▪ DC power supply: 2 kV CM, 1 kV DM ▪ Measurement (UI1/3): 4 kV CM, 2 kV DM ▪ Digital I/O: 2 kV CM, 1 kV DM ▪ Analog I/O, shielding on both sides: 2 kV CM ▪ Communication interfaces, shielding on both sides: 2 kV CM
IEC 61000-4-6	Immunity to conducted disturbances, induced by high-frequency fields <ul style="list-style-type: none"> ▪ 10 V, 150 kHz...80 MHz, 80% AM
IEC 61000-4-8	Immunity to power frequency magnetic fields <ul style="list-style-type: none"> ▪ 100 A/m, 50/60 Hz, continuously ▪ 1000 A/m, 50/60 Hz, for 1 s
IEC 61000-4-11 IEC 61000-4-29	Immunity to drops in voltage, short interruptions, and voltage fluctuations <ul style="list-style-type: none"> ▪ 40% U_N for 300 ms ▪ 0% U_N for 100 ms

Table 54: Immunity in accordance with IEC 61000-6-2



CISPR 11 (EN 55011)	Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement: Class A
CISPR 16-2-1	Procedure for measuring high-frequency emitted interference (radio interference) and immunity - measurement of conducted emitted interference: Class A
CISPR 16-2-3	Procedure for measuring high-frequency emitted interference (radio interference) and immunity - measurement of radiated emitted interference: Class A
CISPR 22 (EN 55022)	Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement: Class A

Table 55: Emitted interference in accordance with IEC 61000-6-4

Environmental durability tests

IEC 60529	With OT1205: Degree of protection IP52 for the front, IP20 for the rear Without OT1205: IP20
IEC 60068-2-1	Dry cold - 25 °C / 96 hours
IEC 60068-2-2	Dry heat 70 °C / 96 hours
IEC 60068-2-78	Constant moist heat + 40 °C / 93% / 4 days, no dew
ASTM D 4169-09	Standard Practice for Performance Testing of Shipping Containers and Systems DC 3, safety level II
IEC 60255-21-1 Class 1	Oscillations (3 cycles, 0.5 g 1 octave/min; 60 cycles, 1.0 g, 1 octave/min)
IEC 60255-21-2 Class 1	Shocks (11 ms, 5 g, 15 g, 3 axes)
IEC 60255-21-3 Class 1	Earthquakes (1...35 Hz; 3.5 mm/1 g horizontal; 1.5 mm/0.5 g vertical; 1 octave/min, 10 min/axis)

Table 56: Environmental durability tests



Glossary

ASTM

American Society for Testing and Materials

EMC

Electromagnetic compatibility

EN

European standard

IEC

The International Electrotechnical Commission (IEC for short) is involved in the preparation and publication of international standards for electrical, electronic and related technologies.



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